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SERVICE MANUAL

RAM TRUCK 1500 - 3500



***2 WHEEL DRIVE
4 WHEEL DRIVE***

VOL.1 00-08

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SERVICE MANUAL

RAM TRUCK 1500 - 3500



***2 WHEEL DRIVE
4 WHEEL DRIVE***

VOL.2 09-25

CHRYSLER CORPORATION

SERVICE MANUAL

1996
RAM TRUCK
1500 - 3500

To order the special service tools used and illustrated, please refer to the instructions on inside back cover.



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FOREWORD

The information contained in this service manual has been prepared for the professional automotive technician involved in daily repair operations. This manual does not cover theory of operation, which is addressed in service training material. Information describing the operation and use of standard and optional equipment is included in the Owner's Manual provided with the vehicle.

Information in this manual is divided into groups. These groups contain general information, diagnosis, testing, adjustments, removal, installation, disassembly, and assembly procedures for the systems and components. To assist in locating a group title page, use the Group Tab Locator on the following page. The solid bar after the group title is aligned to a solid tab on the first page of each group. The first page of the group has a contents section that lists major topics within the group. If you are not sure which Group contains the information you need, look up the Component/System in the alphabetical index located in the rear of this manual.

A Service Manual Comment form is included at the rear of this manual. Use the form to provide Chrysler Corporation with your comments and suggestions.

Tightening torques are provided as a specific value throughout this manual. This value represents the midpoint of the acceptable engineering torque range for a given fastener application. These torque values are intended for use in service assembly and installation procedures using the correct OEM fasteners. When replacing fasteners, always use the same type (part number) fastener as removed.

Chrysler Corporation reserves the right to change testing procedures, specifications, diagnosis, repair methods, or vehicle wiring at any time without prior notice or incurring obligation.

Navigation Tools: Click on the "Table of Contents" below, or use the Bookmarks to the left.

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Service Manual Comment Forms

(Rear of Manual)

INTRODUCTION

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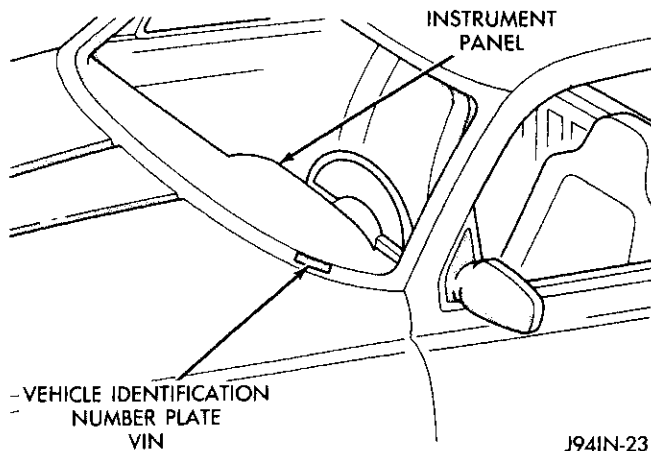
GENERAL INFORMATION

VEHICLE IDENTIFICATION NUMBER

The Vehicle Identification Number (VIN) plate is located on the lower windshield fence near the left A-pillar (Fig. 1). The VIN contains 17 characters that provide data concerning the vehicle. Refer to the VIN decoding chart to determine the identification of a vehicle.

The Vehicle Identification Number is also imprinted on the:

- Body Code Plate.
- Equipment Identification Plate.
- Vehicle Safety Certification Label.
- Frame rail.



J94IN-23

Fig. 1 Vehicle Identification Number (VIN) Location

GENERAL INFORMATION (Continued)

POSITION	INTERPRETATION	CODE = DESCRIPTION
1	Country of Origin	1 = United States 3 = Mexico
2	Make	B = Dodge
3	Vehicle Type	4 = Multipurpose Passenger 5 = Bus 6 = Incomplete 7 = Truck
4	Gross Vehicle Weight Rating	H = 6001-7000 J = 7001-8000 K = 8001-9000 L = 9001-10,000 M = 10,001-14,000 W = Hydraulic Brakes
5	Vehicle Line	C = Ram Cab Chassis/Ram Pick Up (4x2) F = Ram Cab Chassis/Ram Pick Up (4x4)
6	Series	1 = 1500 2 = 2500 3 = 3500
7	Body Style	3 = Club Cab 6 = Conventional Cab Cab Chassis
8	Engine	C = 5.9L 6cyl. Diesel W = 8.0L 10 cyl. MPI X = 3.9L 6 cyl. MPI Y = 5.2L 8 cyl. MPI Z = 5.9L 8 cyl. MPI-LDC 5 = 5.9L 8cyl. MPI-HDC
9	Check Digit	
10	Model Year	T = 1996
11	Plant Location	J = St. Louis North S = Dodge City G = Saltillo M = Lago Alberto Assembly
12 thru 17	Vehicle Build Sequence	

VEHICLE SAFETY CERTIFICATION LABEL

A certification label is attached to the left side B-pillar (Fig. 2). The label certifies that the vehicle conforms to Federal Motor Vehicle Safety Standards (FMVSS). The label also lists the:

- Month and year of vehicle manufacture.
- Gross Vehicle Weight Rating (GVWR). The gross front and rear axle weight ratings (GAWR's) are based on a minimum rim size and maximum cold tire inflation pressure.
- Vehicle Identification Number (VIN).
- Type of vehicle.
- Type of rear wheels.
- Bar code.
- Paint Code.
- Month, Day and Hour (MDH) of final assembly.

BODY CODE PLATE

The Body Code Plate is located on the floor pan under the passenger seat (Fig. 3). There can be a maximum of seven rows of vehicle information imprinted on the plate. The information should be read from left to right, starting with line 1 at the bottom of the plate up through line 7 (as applicable) at the top of the code plate.

Refer to the decoding chart to decode lines 1 up through 3.

Lines 4 through 7 (if used) on the vehicle code plate are imprinted on the plate (in sequence) according to the following:

- 3-character sales code.

GENERAL INFORMATION (Continued)


MFD BY CHRYSLER CORPORATION DATE OF MFR XX-XX GVWR 06400 LB 2903 KG

GAHR FRONT 3300 LB 1497 KG WITH TIRES P235/75R15XL RIMS AT 15 X 6.5HD PSI COLD 35

GAHR REAR 3850 LB 1747 KG WITH TIRES P235/75R15XL RIMS AT 15 X 6.5HD PSI COLD 41

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN: XXXXXXXXXXXXXXXX TYPE: TRUCK SINGLE X DUAL



HDH: XXXXXX XXX PAINT:PWG VEHICLE MADE IN TRIM:M6DS 464R5H5 8020cd69

Fig. 2 Vehicle Safety Certification Label—Typical

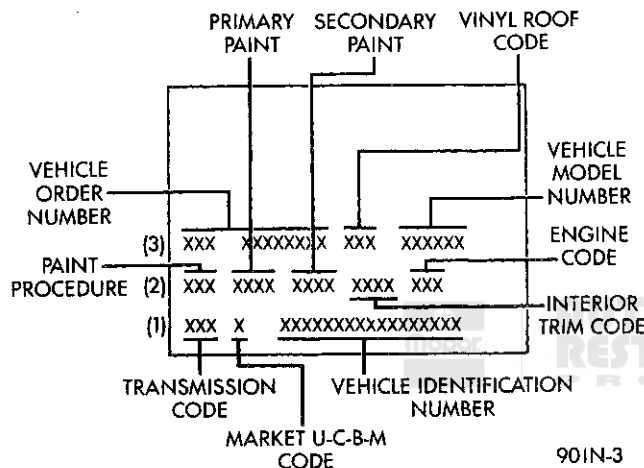


Fig. 3 Body Code Plate

BODY CODE DECODING

Line #1	Digit 1-3	Transmission Sales Code
	Digit 4	Open Space
	Digit 5	Market Code - U-C-B-M
	Digit 6	Open Space
	Digit 7-23	Vehicle Identification No.
Line #2	Digit 1-3	Paint Procedure
	Digit 4	Open Space
	Digit 5-8	Primary Paint
	Digit 9	Open Space
	Digit 10-13	Secondary Paint
	Digit 14	Open Space
	Digit 15-18	Trim Code
	Digit 19	Open Space
	Digit 20-22	Engine Sales Code
	Digit 23	Open Space
Line #3	Digit 1-12	Vehicle Order Number
	Digit 13	Open Space
	Digit 14-16	Vinyl Roof Code (Door Combo Code - Pillette)
	Digit 17	Open Space
	Digit 18-23	Model

J901N-20

- 3-digit numerical code.
- 6-digit SEC code.

If there is not enough space left in the row for all of the 6-digit SEC code (if used):

- The unused space will remain blank.
- The code will be listed in the next row.

The last nine positions of row 7 will contain a 2-digit code, when applicable, and a 6-digit gateline serial number (same as the last 6 numbers of the VIN).

The last code imprinted on a vehicle code plate will be followed by the imprinted word END. When two vehicle code plates are required, the last available spaces on the first plate will be imprinted with the letters CTD (for continued).

When a second vehicle code plate is necessary, the first four spaces on each row will not be used because of the plate overlap.

EQUIPMENT IDENTIFICATION PLATE

The Equipment Identification Plate (Fig. 4) is located at the left, front of the inner hood panel. The plate lists information concerning the vehicle as follows:

- The model.
- The wheelbase.
- The VIN (Vehicle Identification Number).
- The T.O.N. (order number).
- The optional and special equipment installed on the vehicle.

Refer to the information listed on the plate when ordering replacement parts.

EQUIPMENT IDENTIFICATION		4215000
MODELS	V.I.N.	T.O.N.
CODE NO.	DESCRIPTION	CODE NO. DESCRIPTION

J901N-37

Fig. 4 Equipment Identification Plate

VEHICLE DIMENSIONS

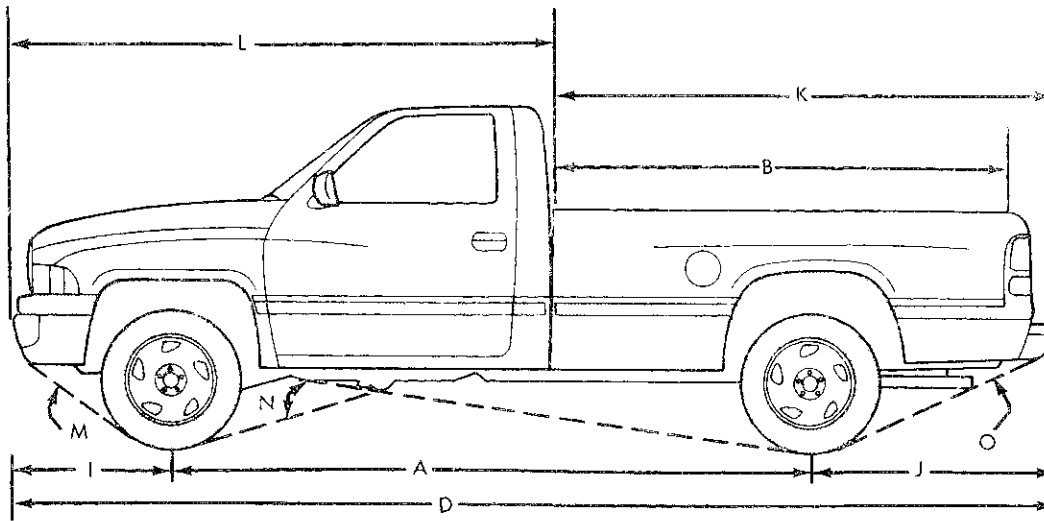
The Vehicle Dimension charts provides the dimensions for each type of Ram truck.

INTERNATIONAL VEHICLE CONTROL AND DISPLAY SYMBOLS

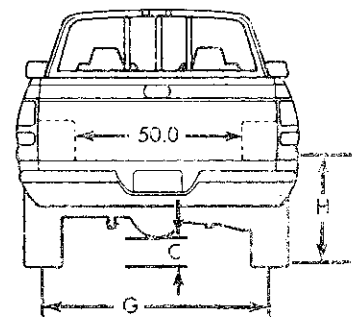
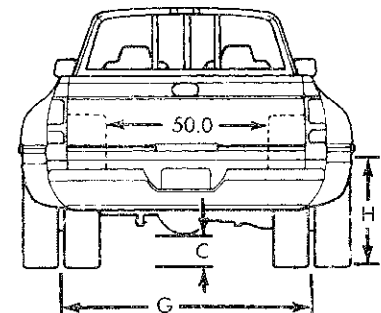
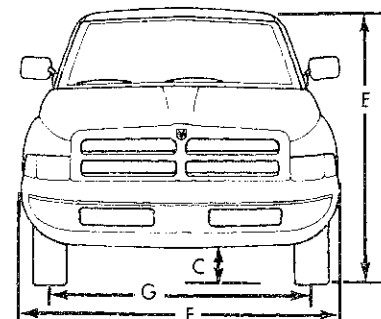
The graphic symbols illustrated in the following chart are used to identify various instrument controls. The symbols correspond to the controls and displays that are located on the instrument panel.

GENERAL INFORMATION (Continued)

VEHICLE EXTERIOR DIMENSIONS—STD CAB



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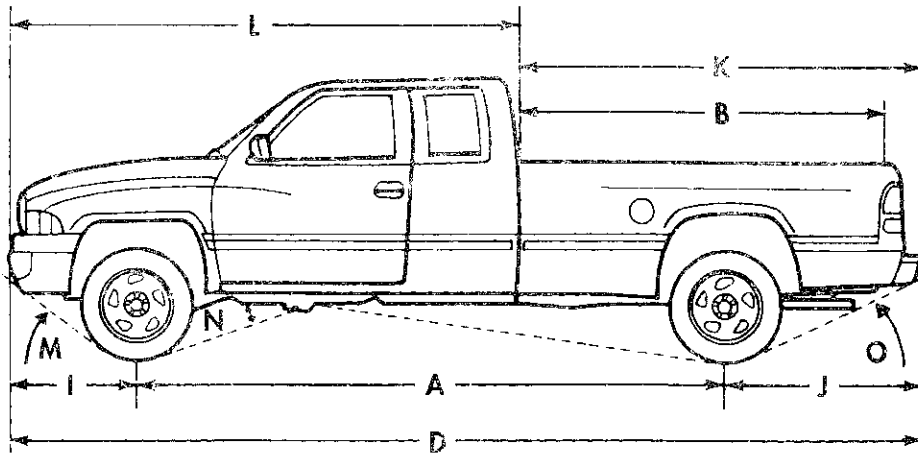


		1500/ 1500 4×4		2500/ 2500 4×4	3500/ 3500 4×4
A	Wheelbase	119"	135"	135"	135"
B	Box Length (feet)	6.5	8.0	8.0	8.0
C	Ground Clearance (Empty)				
	—Front	9.7/8.1	10.0/8.1	10.1/8.1	13.1/10.2
	—Rear	10.1/9.8	10.1/9.8	10.1/9.8	10.1/9.8
D	Overall Length				
	—Without rear bumper	199.9	220.1	220.1	220.1
	—With rear bumper	204.1	224.3	224.3	224.3
E	Overall Height (Empty)	72.1/75.9	72.1/75.9	73.7/78.0	73.6/75.9
F	Overall Width				
	—At Front Wheel Lip	79.4	79.4	79.4	79.5¹
G	Track				
	—Front	68.5	68.5	68.6	68.6
	—Rear	68.0	68.0	68.0	73.0
H	Tailgate Load Height	31.2/35.6	31.5/35.6	31.5/35.6	31.4/35.6
I	Overhang—Front	37.9	37.9	37.9	37.9
J	Overhang—Rear				
	—Without Rear Bumper	47.6	47.6	47.6	47.6
	—With Rear Bumper	51.7	51.7	51.7	51.7
K	Back Of Cab To Rear Bumper	87.2	107.4	107.4	107.4
L	Front Bumper To Back Of Cab	116.9	116.9	116.9	116.9
M	Approach Angle (Degrees)	25.3/29.7	25.3/29.7	25.3/29.7	25.3/29.7
N	Breakover Angle (Degrees)	17.8/21.0	17.8/21.0	17.8/21.0	17.8/21.0
O	Departure Angle (Degrees)	30.6/36.2	30.6/36.2	30.6/36.2	30.6/36.2

¹93.5 at cargo box.

GENERAL INFORMATION (Continued)

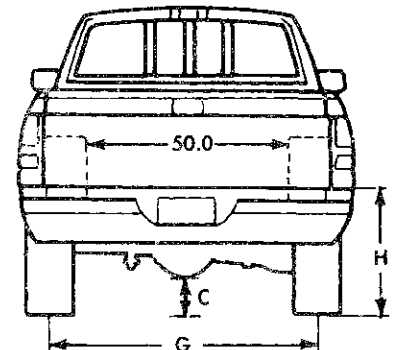
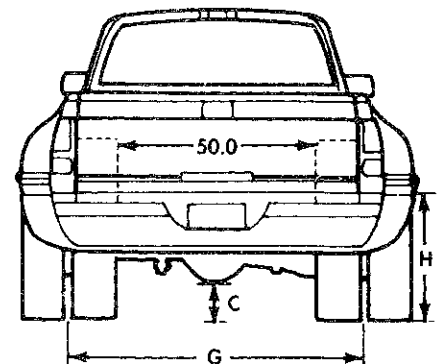
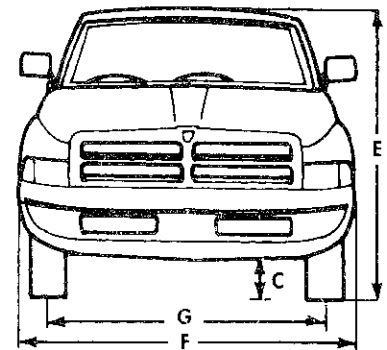
VEHICLE EXTERIOR DIMENSIONS—CLUB CAB



		1500/ 1500 4x4		2500/ 2500 4x4		3500/ 3500 4x4
A	Wheelbase	139"	155"	139"	155"	155"
B	Box Length (Feet)	6.5	8.0	8.0	6.5	8.0
C	Ground Clearance—(Empty)					
	—Front	8.7/8.5	8.6/8.5	9.9/9.0	9.8/9.1	9.8/8.1
	—Rear	7.5/7.7	7.5/7.7	8.6	8.6	8.6
D	Overall Length					
	—Without rear bumper	220.1	240.1	220.1	240.1	240.1
	—With rear bumper	224.0	244.0	224.0	244.0	244.0
E	Overall Height (Empty)	71.6/74.6	71.5/74.5	72.9/77.2	72.8/77.1	72.8/77.2
F	Overall Width Of Cab	79.4	79.4	79.4	79.4	79.4
G	Track					
	—Front	66.9/68.5	66.9/68.5	68.6/68.9	68.6/68.9	69.8
	—Rear	66.9	66.9	68.0	68.0	73.0
H	Tailgate Load Height	31.3/33.9	31.3/34.4	34.4/37.3	33.3/37.2	33.8/37.8
I	Overhang—Front	37.9	37.9	37.9	37.9	37.9
J	Overhang—Rear					
	—Without rear bumper	43.5	47.5	47.5	43.5	47.5
	—With rear bumper	47.5	51.5	51.5	47.5	51.5
K	Back of Cab To Rear Bumper	87.1	107.1	107.1	87.1	107.1
L	Front Bumper To Back Of Cab	136.9	136.9	136.9	136.9	136.9
M	Approach Angle (Degrees)	25.1/30.6	25.2/30.6	26.7/33.7	26.8/33.8	26.3/33.4
N	Breakover Angle (Degrees)	16.7/18.4	15.8/17.1	19.2/23.0	18.1/21.3	18.0/21.4
O	Departure Angle (Degrees)	23.8/26.9	21.8/24.7	26.0/31.0	24.1/28.4	24.6/28.9

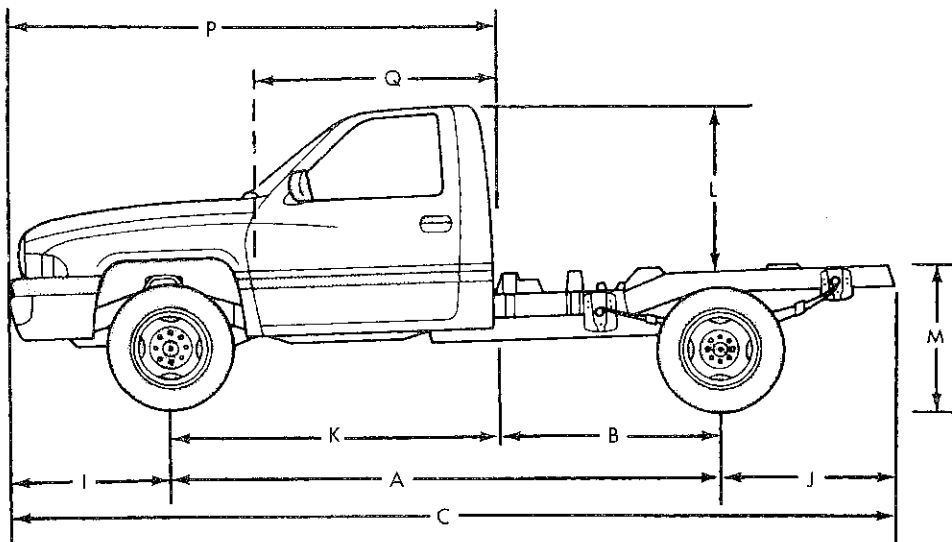
(1) 93.8 at cargo box with dual-rear wheels.

Note: All dimensions in inches unless otherwise noted.



GENERAL INFORMATION (Continued)

VEHICLE EXTERIOR DIMENSIONS—CHASSIS CAB



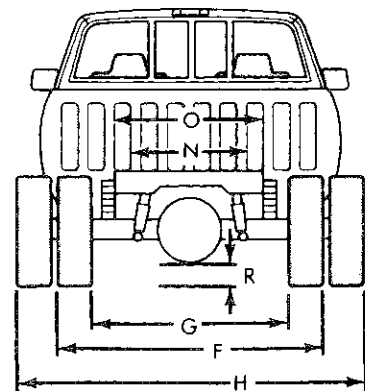
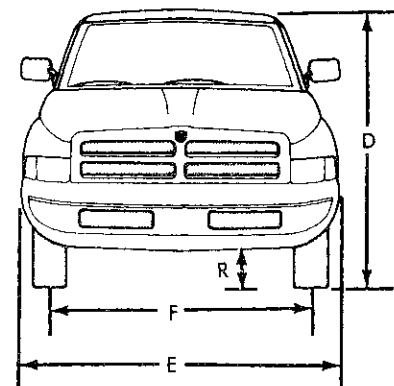
EXTERIOR

Model	4 × 2 Models			4 × 4 Models		
	2500 HD	3500 DRW	3500 DRW	2500 HD	3500 DRW	3500 DRW
A Wheelbase	135	139	163	135	139	163
B Cab To Axle	55.7	59.7	83.7	55.7	59.7	83.7
C Overall Length	216.7	220.7	244.7	216.7	220.7	244.7
D Overall Height (Empty)	72.4	77.3	77.1	75.9	77.2	77.1
E Overall Width	79.4	94.6	94.6	79.4	94.6	94.6
F Track						
—Front	68.6	69.8	69.8	68.9	69.8	69.8
—Rear	68.0	73.0	73.0	68.0	73.0	73.0
G Rear Track, Inside	58.0	51.4	51.4	58.0	51.4	51.4
H Rear Track, Outside	78.0	94.6	94.6	78.0	94.6	94.6
I Overhang—Front	37.9	37.9	37.9	37.9	37.9	37.9
J Axle To End Of Frame	44.1	44.1	44.1	44.1	44.1	44.1
K Center Of Front Wheel To Back Of Cab	79.0	79.0	79.0	79.0	79.0	79.0
L Frame To Top Of Cab	52.9	52.9	52.9	52.9	52.9	52.9
M Top Of Frame To Ground	29.6	34.3	34.1	34.0	34.3	34.2
N Inside Width Between Frame Rails	31.7	31.7	31.7	31.7	31.7	31.7
O Outside Width Between Frame Rails	37.6	37.6	37.6	37.6	37.6	37.6
P Front Bumper To Back Of Cab	116.9	116.9	116.9	116.9	116.9	116.9
Q Front Of Dash To Back Of Cab	NA	NA	NA	NA	NA	NA
R Ground Clearance						
—Front	10.1	15.2	15.2	8.1	8.6	8.6
—Rear	8.5	9.0	9.0	8.4	9.0	9.0

























NOTE: All dimensions are in inches unless noted.

DRW = Dual-rear wheel.

NA = Not available at time of printing.



GENERAL INFORMATION (Continued)**INTERNATIONAL CONTROL AND DISPLAY SYMBOLS**

					
HIGH BEAM	FOG LIGHTS	HEADLIGHTS, PARKING LIGHTS, PANEL LIGHTS	TURN SIGNAL	HAZARD WARNING	WINDSHIELD WASHER
					
WINDSHIELD WIPER	WINDSHIELD WIPER AND WASHER	WINDSCREEN DEMISTING AND DEFROSTING	VENTILATING FAN	REAR WINDOW DEFOGGER	REAR WINDOW WIPER
					
REAR WINDOW WASHER	FUEL	ENGINE COOLANT TEMPERATURE	BATTERY CHARGING CONDITION	ENGINE OIL	SEAT BELT
					
BRAKE FAILURE	PARKING BRAKE	FRONT HOOD	REAR HOOD (TRUNK)	HORN	LIGHTER

J95IN-23

FASTENER IDENTIFICATION**THREAD IDENTIFICATION**

SAE and metric bolt/nut threads are not the same. The difference is described in the Thread Notation chart (Fig. 5).

GRADE/CLASS IDENTIFICATION

The SAE bolt strength grades range from grade 2 to grade 8. The higher the grade number, the greater the bolt strength. Identification is determined by the line marks on the top of each bolt head. The actual bolt strength grade corresponds to the number of line marks plus 2. The most commonly used metric bolt strength classes are 9.8 and 12.9. The metric strength class identification number is imprinted on the head of the bolt. The higher the class number,

INCH		METRIC	
5/16-18		M8 X 1.25	
THREAD MAJOR DIAMETER IN INCHES	NUMBER OF THREADS PER INCH	THREAD MAJOR DIAMETER IN MILLIMETERS	DISTANCE BETWEEN THREADS IN MILLIMETERS

PR606B

Fig. 5 Thread Notation—SAE and Metric

the greater the bolt strength. Some metric nuts are imprinted with a single-digit strength class on the nut face. Refer to the Fastener Identification and Fastener Strength Charts.

GENERAL INFORMATION (Continued)

FASTENER IDENTIFICATION

Bolt Markings and Torque - Metric

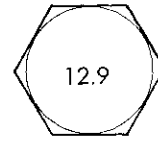
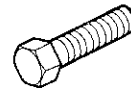
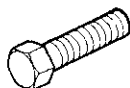
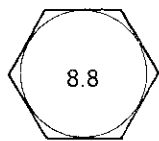
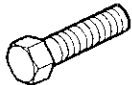
Commercial Steel Class

8.8

10.9

12.9

Bolt Head Markings



Body Size

Torque

Torque

Torque

Diam.	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	14	9	11	7	14	9	11	7
7	14	9	11	7	18	14	14	11	23	18	18	14
8	25	18	18	14	32	23	25	18	36	27	28	21
10	40	30	30	25	60	45	45	35	70	50	55	40
12	70	55	55	40	105	75	80	60	125	95	100	75
14	115	85	90	65	160	120	125	95	195	145	150	110
16	180	130	140	100	240	175	190	135	290	210	220	165
18	230	170	180	135	320	240	250	185	400	290	310	230

Bolt Markings and Torque Values - U.S. Customary

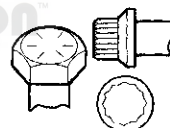
SAE Grade Number

5

8

Bolt Head Markings

These are all SAE Grade 5 (3) line



Bolt Torque - Grade 5 Bolt







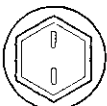

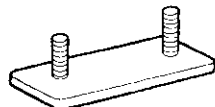

Bolt Torque - Grade 8 Bolt

Body Size	Cast Iron		Aluminum		Cast Iron		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	12	9
- 28	12	9	9	7	18	13	14	10
5/16 - 18	20	15	16	12	30	22	24	18
- 24	23	17	19	14	33	24	25	19
3/8 - 16	40	30	25	20	55	40	40	30
- 24	40	30	35	25	60	45	45	35
7/16 - 14	60	45	45	35	90	65	65	50
- 20	65	50	55	40	95	70	75	55
1/2 - 13	95	70	75	55	130	95	100	75
- 20	100	75	80	60	150	110	120	90
9/16 - 12	135	100	110	80	190	140	150	110
- 18	150	110	115	85	210	155	170	125
5/8 - 11	180	135	150	110	255	190	205	150
- 18	210	155	160	120	290	215	230	170
3/4 - 10	325	240	255	190	460	340	365	270
- 16	365	270	285	210	515	380	410	300
7/8 - 9	490	360	380	280	745	550	600	440
- 14	530	390	420	310	825	610	660	490
1 - 8	720	530	570	420	1100	820	890	660
- 14	800	590	650	480	1200	890	960	710

GENERAL INFORMATION (Continued)

FASTENER STRENGTH

HOW TO DETERMINE BOLT STRENGTH

	Mark	Class		Mark	Class
Hexagon head bolt	 Bolt head No. 4 — 4T 5 — 5T 6 — 6T 7 — 7T 8 — 8T 9 — 9T 10 — 10T 11 — 11T		Stud bolt	 No mark 4T	
	 No mark 4T				
Hexagon flange bolt w/washer hexagon bolt	 No mark 4T		Welded bolt	 Grooved 6T	
Hexagon head bolt	 Two protruding lines 5T				
Hexagon flange bolt w/washer hexagon bolt	 Two protruding lines 6T		Welded bolt		
Hexagon head bolt	 Three protruding lines 7T			 4T	
Hexagon head bolt	 Four protruding lines 8T				

GENERAL INFORMATION (Continued)**METRIC SYSTEM**

WARNING: USE OF AN INCORRECT FASTENER MAY RESULT IN COMPONENT DAMAGE OR PERSONAL INJURY.

Figure art, specifications and torque references in this Service Manual are identified in metric and SAE format.

During any maintenance or repair procedures, it is important to salvage metric fasteners (nuts, bolts, etc.) for reassembly. If the fastener is not salvageable, a fastener of equivalent specification should be used.

The metric system is based on quantities of one, ten, one hundred, one thousand and one million (Fig. 6).

The following chart will assist in converting metric units to equivalent English and SAE units, or vice versa.

Mega	-	(M) Million	Deci	-	(D) Tenth
Kilo	-	(K) Thousand	Centi	-	(C) Hundreth
Milli	-	(m) Thousandth			

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Fig. 6 Metric Prefixes

Refer to the Conversion Chart to convert torque values listed in metric Newton- meters (N·m). Also, use the chart to convert between millimeters (mm) and inches (in.)

CONVERSION FORMULAS AND EQUIVALENT VALUES

Multiply	By	To Get	Multiply	By	To Get
in-lbs	x 0.11298	= Newton-Meters (N·m)	N·m	x 8.851	= in-lbs
ft-lbs	x 1.3558	= Newton-Meters (N·m)	N·m	x 0.7376	= ft-lbs
Inches Hg (60°F)	x 3.377	= Kilopascals (kPa)	kPa	x 0.2961	= Inches Hg
psi	x 6.895	= Kilopascals (kPa)	kPa	x 0.145	= psi
Inches	x 25.4	= Millimeters (mm)	mm	x 0.03937	= Inches
Feet	x 0.3048	= Meters (M)	M	x 3.281	= Feet
Yards	x 0.9144	= Meters (M)	M	x 1.0936	= Yards
Miles	x 1.6093	= Kilometers (Km)	Km	x 0.6214	= Miles
mph	x 1.6093	= Kilometers/Hr. (Km/h)	Km/h	x 0.6214	= mph
Feet/Sec.	x 0.3048	= Meters/Sec. (M/S)	M/S	x 3.281	= Feet/Sec.
Kilometers/Hr.	x 0.27778	= Meters/Sec. (M/S)	M/S	x 3.600	= Kilometers/Hr.
mph	x 0.4470	= Meters/Sec. (M/S)	M/S	x 2.237	= mph

COMMON METRIC EQUIVALENTS			
1 Inch	=	25 Millimeters	
1 Foot	=	0.3 Meter	
1 Yard	=	0.9 Meter	
1 Mile	=	1.6 Kilometers	
1 Cubic Inch	=	16 Cubic Centimeters	
1 Cubic Foot	=	0.03 Cubic Meter	
1 Cubic Yard	=	0.8 Cubic Meter	

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GENERAL INFORMATION (Continued)

METRIC CONVERSION

in-lbs to N•m

N•m to in-lbs

in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m	in-lb	N•m
2	.2260	42	4.7453	82	9.2646	122	13.7839	162	18.3032	.2	1.7702	4.2	37.1747	8.2	72.5792	12.2	107.9837	16.2	143.3882	
4	.4519	44	4.9713	84	9.4906	124	14.0099	164	18.5292	.4	3.5404	4.4	38.9449	8.4	74.3494	12.4	109.7539	16.4	145.1584	
6	.6779	46	5.1972	86	9.7165	126	14.2359	166	18.7552	.6	5.3107	4.6	40.7152	8.6	76.1197	12.6	111.5242	16.6	146.9287	
8	.9039	48	5.4232	88	9.9425	128	14.4618	168	18.9811	.8	7.0809	4.8	42.4854	8.8	77.8899	12.8	113.2944	16.8	148.6989	
10	1.1298	50	5.6492	90	10.1685	130	14.6878	170	19.2071	1	8.8511	5	44.2556	9	79.6601	13	115.0646	17	150.4691	
12	1.3558	52	5.8751	92	10.3944	132	14.9138	172	19.4331	1.2	10.6213	5.2	46.0258	9.2	81.4303	13.2	116.8348	17.2	152.2393	
14	1.5818	54	6.1011	94	10.6204	134	15.1397	174	19.6590	1.4	12.3916	5.4	47.7961	9.4	83.2006	13.4	118.6051	17.4	154.0096	
16	1.8077	56	6.3270	96	10.8464	136	15.3657	176	19.8850	1.6	14.1618	5.6	49.5663	9.6	84.9708	13.6	120.3753	17.6	155.7798	
18	2.0337	58	6.5530	98	11.0723	138	15.5917	178	20.1110	1.8	15.9320	5.8	51.3365	9.8	86.7410	13.8	122.1455	17.8	157.5500	
20	2.2597	60	6.7790	100	11.2983	140	15.8176	180	20.3369	2	17.7022	6	53.1067	10	88.5112	14	123.9157	18	159.3202	
22	2.4856	62	7.0049	102	11.5243	142	16.0436	182	20.5629	2.2	19.4725	6.2	54.8770	10.2	90.2815	14.2	125.6860	18.2	161.0907	
24	2.7116	64	7.2309	104	11.7502	144	16.2696	184	20.7889	2.4	21.2427	6.4	56.6472	10.4	92.0517	14.4	127.4562	19	168.1714	
26	2.9376	66	7.4569	106	11.9762	146	16.4955	186	21.0148	2.6	23.0129	6.6	58.4174	10.6	93.8219	14.6	129.2264	19.5	172.5970	
28	3.1635	68	7.6828	108	12.2022	148	16.7215	188	21.2408	2.8	24.7831	6.8	60.1876	10.8	95.5921	14.8	130.9966	20	177.0225	
30	3.3895	70	7.9088	110	12.4281	150	16.9475	190	21.4668	3	26.5534	7	61.9579	11	97.3624	15	132.7669	20.5	181.4480	
32	3.6155	72	8.1348	112	12.6541	152	17.1734	192	21.6927	3.2	28.3236	7.2	63.7281	11.2	99.1326	15.2	134.5371	21	185.8736	
34	3.8414	74	8.3607	114	12.8801	154	17.3994	194	21.9187	3.4	30.0938	7.4	65.4983	11.4	100.9028	15.4	136.3073	22	194.7247	
36	4.0674	76	8.5867	116	13.1060	156	17.6253	196	22.1447	3.6	31.8640	7.6	67.2685	11.6	102.6730	15.6	138.0775	23	203.5759	
38	4.2934	78	8.8127	118	13.3320	158	17.8513	198	22.3706	3.8	33.6342	7.8	69.0388	11.8	104.4433	15.8	139.8478	24	212.4270	
40	4.5193	80	9.0386	120	13.5580	160	18.0773	200	22.5966	4	35.4045	8	70.8090	12	106.2135	16	141.6180	25	221.2781	

ft-lbs to N•m

N•m to ft-lbs

ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m
1	1.3558	21	28.4722	41	55.5885	61	82.7049	81	109.8212	1	.7376	21	15.9888	41	30.2400	61	44.9913	81	59.7425	
2	2.7116	22	29.8280	42	56.9444	62	84.0607	82	111.1770	2	1.4751	22	16.2264	42	30.9776	62	45.7289	82	60.4801	
3	4.0675	23	31.1838	43	58.3002	63	85.4165	83	112.5328	3	2.2127	23	16.9639	43	31.7152	63	46.4664	83	61.2177	
4	5.4233	24	32.5396	44	59.6560	64	86.7723	84	113.8888	4	2.9502	24	17.7015	44	32.4527	64	47.2040	84	61.9552	
5	6.7791	25	33.8954	45	61.0118	65	88.1281	85	115.2446	5	3.6878	25	18.4391	45	33.1903	65	47.9415	85	62.6928	
6	8.1349	26	35.2513	46	62.3676	66	89.4840	86	116.6004	6	4.4254	26	19.1766	46	33.9279	66	48.6791	86	63.4303	
7	9.4907	27	36.6071	47	63.7234	67	90.8398	87	117.9562	7	5.1629	27	19.9142	47	34.6654	67	49.4167	87	64.1679	
8	10.8465	28	37.9629	48	65.0793	68	92.1956	88	119.3120	8	5.9005	28	20.6517	48	35.4030	68	50.1542	88	64.9545	
9	12.2024	29	39.3187	49	66.4351	69	93.5514	89	120.6678	9	6.6381	29	21.3893	49	36.1405	69	50.8918	89	65.6430	
10	13.5582	30	40.6745	50	67.7909	70	94.9073	90	122.0236	10	7.3756	30	22.1269	50	36.8781	70	51.6293	90	66.3806	
11	14.9140	31	42.0304	51	69.1467	71	96.2631	91	123.3794	11	8.1132	31	22.8644	51	37.6157	71	52.3669	91	67.1181	
12	16.2698	32	43.3862	52	70.5025	72	97.6189	92	124.7352	12	8.8507	32	23.6020	52	38.3532	72	53.1045	92	67.8557	
13	17.6256	33	44.7420	53	71.8583	73	98.9747	93	126.0910	13	9.5883	33	24.3395	53	39.0908	73	53.8420	93	68.5933	
14	18.9815	34	46.0978	54	73.2142	74	100.3316	94	127.4468	14	10.3259	34	25.0771	54	39.8284	74	54.5720	94	69.3308	
15	20.3373	35	47.4536	55	74.5700	75	101.6862	95	128.8026	15	11.0634	35	25.8147	55	40.5659	75	55.3172	95	70.0684	
16	21.6931	36	48.8094	56	75.9258	76	103.0422	96	130.1586	16	11.8010	36	26.5522	56	41.3035	76	56.0547	96	70.8060	
17	23.0489	37	50.1653	57	77.2816	77	104.3980	97	131.5144	17	12.5386	37	27.2898	57	42.0410	77	56.7923	97	71.5435	
18	24.4047	38	51.5211	58	78.6374	78	105.7538	98	132.8702	18	13.2761	38	28.0274	58	42.7786	78	57.5298	98	72.2811	
19	25.7605	39	52.8769	59	79.9933	79	107.1196	99	134.2260	19	14.0137	39	28.7649	59	43.5162	79	58.2674	99	73.0187	
20	27.1164	40	54.2327	60	81.3491	80	108.4654	100	135.5820	20	14.7512	40	29.5025	60	44.2537	80	59.0050	100	73.7562	

in. to mm

mm to in.

in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
.01	.254	.21	5.334	.41	10.414	.61	15.494	.81	20.574	.01	.00039	.21	.00827	.41	.01614	.61	.02402	.81	.03189
.02	.508	.22	5.588	.42	10.668	.62	15.748	.82	20.828	.02	.00079	.22	.00866	.42	.01654	.62	.02441	.82	.03228
.03	.762	.23	5.842	.43	10.922	.63	16.002	.83	21.082	.03	.00118	.23	.00906	.43	.01693	.63	.02480	.83	.03268
.04	1.016	.24	6.096	.44	11.176	.64	16.256	.84	21.336	.04	.00157	.24	.00945	.44	.01732	.64	.02520	.84	.03307
.05	1.270	.25	6.350	.45	11.430	.65	16.510	.85	21.590	.05	.00197	.25	.00984	.45	.01772	.65	.02559	.85	.03346
.06	1.524	.26	6.604	.46	11.684	.66	16.764	.86	21.844	.06	.00236	.26	.01024	.46	.01811	.66	.02598	.86	.03386
.07	1.778	.27	6.858	.47	11.938	.67	17.018	.87	22.098	.07	.00276	.27	.01063	.47	.01850	.67	.02638	.87	.03425
.08	2.032	.28	7.112	.48	12.192	.68	17.272	.88	22.352	.08	.00315	.28	.01102	.48	.01890	.68	.02677	.88	.03465
.09	2.286	.29	7.366	.49	12.446	.69	17.526	.89	22.606	.09	.00354	.29	.01142	.49	.01929	.69	.02717	.89	.03504
.10	2.540	.30	7.620	.50	12.700	.70	17.780	.90	22.860	.10	.00394	.30	.01181	.50	.01969	.70	.02756	.90	.03543
.11	2.794	.31	7.874	.51	12.954	.71	18.034	.91	23.114	.11	.00433	.31	.01220	.51	.02008	.71	.02795	.91	.03583
.12	3.048	.32	8.128	.52	13.208	.72	18.288	.92	23.368	.12	.00472	.32	.01260	.52	.02047	.72	.02835	.92	.03622
.13	3.302	.33	8.382	.53	13.462	.73	18.542	.93	23.622	.13	.00512	.33	.01299	.53	.02087	.73	.02874	.93	.03661
.14	3.556	.34	8.636	.54	13.716	.74	18.796	.94	23.876	.14	.00551	.34	.01339	.54	.02126	.74	.02913	.94	.03701
.15	3.810	.35	8.890	.55	13.970	.75	19.050	.95	24.130	.15	.00591	.35	.01378	.55	.02165	.75	.02953	.95	.03740
.16	4.064	.36	9.144	.56	14.224	.76	19.304	.96	24.384	.16	.00630	.36	.01417	.56	.02205	.76	.02992	.96	.03780
.17	4.318	.37	9.398	.57	14.478	.77	19.558	.97	24.638	.17	.00669	.37	.01457	.57	.02244	.77	.03032	.97	.03819
.18	4.572	.38	9.652	.58	14.732	.78	19.812	.98	24.892	.18	.00709	.38	.01496	.58	.02283	.78	.03071	.98	.03858
.19	4.826	.39	9.906	.59	14.986	.79	20.066	.99	25.146	.19	.00748	.39	.01535	.59	.02323	.79	.03110	.99	.03898
.20	5.080	.40	10.160	.60	15.240	.80	20.320	1.00	25.400	.20	.00787	.40	.01575	.60	.02362	.80	.03150	1.00	.03937

LUBRICATION AND MAINTENANCE

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GENERAL INFORMATION

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GENERAL INFORMATION

INTRODUCTION

Service and maintenance procedures for components and systems listed in Schedule—A or B can be found by using the Group Tab Locator index at the front of this manual. If it is not clear which group contains the information needed, refer to the index at the back of this manual.

There are two maintenance schedules that show proper service based on the conditions that the vehicle is subjected to.

Schedule—A, lists scheduled maintenance to be performed when the vehicle is used for general transportation.

Schedule—B, lists maintenance intervals for vehicles that are operated under the conditions listed at the beginning of the Maintenance Schedule section.

Use the schedule that best describes your driving conditions.

Where time and mileage are listed, follow the interval that occurs first.








PARTS AND LUBRICANT RECOMMENDATIONS

When service is required, Chrysler Corporation recommends that only Mopar® brand parts, lubricants and chemicals be used. Mopar provides the

best engineered products for servicing Chrysler Corporation vehicles.

INTERNATIONAL SYMBOLS

Chrysler Corporation uses international symbols to identify engine compartment lubricant and fluid inspection and fill locations (Fig. 1).

 CHRYSLER CORPORATION			
	ENGINE OIL		BRAKE FLUID
	AUTOMATIC TRANSMISSION FLUID		POWER STEERING FLUID
	ENGINE COOLANT		WINDSHIELD WASHER FLUID

9500-1

Fig. 1 International Symbols

GENERAL INFORMATION (Continued)**CLASSIFICATION OF LUBRICANTS**

Only lubricants that are endorsed by the following organization should be used to service a Chrysler Corporation vehicle.

- Society of Automotive Engineers (SAE)
- American Petroleum Institute (API) (Fig. 2)
- National Lubricating Grease Institute (NLGI) (Fig. 3)



9400-9

*Fig. 2 API Symbol***GASOLINE ENGINE OIL****SAE GRADE RATING INDICATES ENGINE OIL VISCOSITY**

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 30 specifies a single viscosity engine oil. Engine oils also have multiple viscosities. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range.

- SAE 30 = single grade engine oil.
- SAE 10W-30 = multiple grade engine oil.

API QUALITY CLASSIFICATION

The API Service Grade specifies the type of performance the engine oil is intended to provide. The API Service Grade specifications also apply to energy conserving engine oils.

Use engine oil that is API Service Grade Certified or an oil that conforms to the API Service Grade SH or SH/CD. MOPAR engine oils conform to all of these service grades.

Refer to Group 9, Engine for gasoline engine oil specification.

DIESEL ENGINE OIL**ENGINE OIL QUALITY**

Use only oils conforming to API Quality CE, or CE/SG. A sulfated ash limit is specified for lubrication oil used in Cummins engines. Oils with a high ash content may produce deposits on valves that can

progress to guttering and valve burning. A maximum sulfated ash content of 1.85 mass % is recommended for all oil used in the engine.

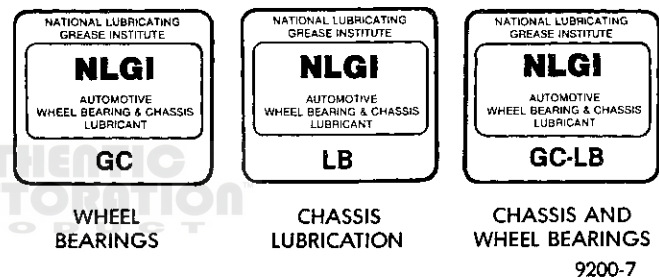
Refer to Group 9, Engine for diesel engine oil specification.

GEAR LUBRICANTS

SAE ratings also apply to multiple grade gear lubricants. In addition, API classification defines the lubricants usage.

LUBRICANTS AND GREASES

Lubricating grease is rated for quality and usage by the NLGI. All approved products have the NLGI symbol (Fig. 3) on the label. At the bottom NLGI symbol is the usage and quality identification letters. Wheel bearing lubricant is identified by the letter "G". Chassis lubricant is identified by the letter "L". The letter following the usage letter indicates the quality of the lubricant. The following symbols indicate the highest quality.

*Fig. 3 NLGI Symbol***FLUID CAPACITIES****FUEL TANK**

119 inch wheel base. . . . .	.98 L (26 gal.)
135 inch wheel base . . . . .	.98 L (26 gal.)
All others. . . . .	.132 L (35 gal.)

ENGINE OIL W/FILTER CHANGE

3.9L	3.8 L (4.0 qts.)
5.2L & 5.9L Gasoline.	4.7 L (5.0 qts.)
5.9L Diesel.	9.5 L (10.0 qts.)
8.0 L	6.6 L (7.0 qts.)

ENGINE OIL W/O FILTER CHANGE

3.9L	3.3 L (3.5 qts.)
5.2L & 5.9L Gasoline.	4.3 L (4.5 qts.)
5.9L Diesel*	
8.0L*	

*Oil filter must be changed with every oil change.

GENERAL INFORMATION (Continued)**COOLING SYSTEM**

3.9L.....	.19 L (20 qts.)
5.2L.....	.19 L (20 qts.)
5.9L Gas.....	.19 L (20 qts.)
5.9L Diesel.....	.24.5 L (26.0 qts.)
8.0L.....	.22.7 L (24.0 qts.)

AUTOMATIC TRANSMISSION

Dry fill capacity*

42RE.....	.8.0-10.4 L (17-22 pts.)
46RE.....	.8.2-12.3L (17.5-26 pts.)
47RE.....	.8.2-15.6 L (17.5-33 pts.)

*Depending on type and size of internal cooler, length and inside diameter of cooler lines, or use of an auxiliary cooler, these figures may vary. Refer to Group 21, Transmission for proper fluid fill procedure.

MANUAL TRANSMISSION

NV3500.....	.2.0 L (4.2 pts.)
NV4500.....	.3.8 L (8.0 pts.)

TRANSFER CASE

NV231 HD.....	.1.2 L (2.5 pts.)
NV241.....	.2.7 L (5.0 pts.)
NV241 HD.....	.3.5 L (6.5 pts.)
NV241 HD W/PTO.....	.4.9 L (9.0 pts.)

POWER TAKE OFF ADAPTER

NV021.....	.2.1 L (4.6 pts.)
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FRONT AXLE

Dana 44.....	.3.2 L (6.8 pts.)
Dana 60.....	.3.6 L (7.6 pts.)

REAR AXLE

9-1/4 inch.....	.2.3 L (4.8 pts.)
Dana 60 (2WD).....	.3.0 L (6.3 pts.)
Dana 60 (4WD).....	.3.4 L (7.3 pts.)
Dana 70 (2WD).....	.3.3 L (7.0 pts.)
Dana 70 (4WD).....	.3.6 L (7.8 pts.)
Dana 80 (2WD).....	.3.2 L (6.8 pts.)
Dana 80 (4WD).....	.4.8 L (10.1 pts.)

REAR AXLE—LIMITED SLIP DIFFERENTIAL

Dana 60 (2WD).....	.3.0 L (6.3 pts.)*
Dana 60 (4WD).....	.3.4 L (7.3 pts.)*
Dana 70 (2WD).....	.3.3 L (7.0 pts.)*
Dana 70 (4WD).....	.3.6 L (7.8 pts.)*
Dana 80 (2WD).....	.3.2 L (6.8 pts.)*
Dana 80 (4WD).....	.4.8 L (10.1 pts.**)

* Include 0.2 L (0.4 pts.) friction modifier.

** Include 0.3 L (0.6 pts.) friction modifier.

POWER STEERING

All.....	.1.3 L (2.7 pts.)
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MAINTENANCE SCHEDULES—LIGHT DUTY VEHICLES

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GENERAL INFORMATION

INTRODUCTION

The following is a list of Maintenance Schedules for Light Duty Cycle vehicles (1500 and 2500 Models Except 8.0L).

There are two maintenance schedules that show proper service based on the conditions that the vehicle is subjected to. Use the schedule that best describes these conditions.

Schedule—**A**, lists all the scheduled maintenance to be performed under “normal” operating conditions for Light Duty vehicles.

Schedule—**B**, lists maintenance recommended for Light Duty vehicles operated under the following conditions:

- Frequent short trip driving less than 5 miles (8 km)
- Frequent driving in dusty conditions
- Frequent trailer towing
- Extensive idling
- More than 50% of your driving is at sustained high speeds during hot weather, above 90°F (32°C)

Where time and mileage are listed, follow the interval that occurs first.

EMISSION CONTROL SYSTEM MAINTENANCE

The scheduled emission maintenance listed in **bold type** on the Maintenance Schedules, must be done at the mileage specified to assure the continued proper functioning of the emission control system. These, and all other maintenance services included in this manual, should be done to provide the best vehicle performance and reliability. More frequent maintenance may be needed for vehicles in severe operating conditions such as dusty areas and very short trip driving.

UNSCHEDULED INSPECTION

At Each Stop For Fuel

- Check engine oil level and add as required.
- Check windshield washer solvent and add as required.

Once A Month

- Check tire pressure and look for unusual wear or damage.
- Inspect battery and clean and tighten terminals as required.
- Check fluid levels of coolant reservoir, brake master cylinder, power steering, and transmission and add as needed.
- Check all lights and all other electrical items for correct operation.

At Each Oil Change

- Inspect exhaust system.
- Inspect brake hoses.
- Rotate the tires at each oil change interval shown on Schedule—A (7,500 Miles) or every other interval shown on Schedule—B (6,000 Miles).
- Check engine coolant level, hoses, and clamps.
- If your mileage is less than 7,500 miles (12 000 km) yearly, replace the engine oil filter at each oil change.
- Lubricate steering linkage.

LIGHT DUTY SCHEDULE—A

7,500 Miles (12 000 km) or at 6 months

- Change engine oil.

15,000 Miles (24 000 km) or at 12 months

- Change engine oil.
- Replace engine oil filter.

22,500 Miles (36 000 km) or at 18 months

- Change engine oil.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

30,000 Miles (48 000 km) or at 24 months

- Change engine oil.
- Change engine oil filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**

37,500 Miles (60 000 km) or at 30 months

- Change engine oil.

GENERAL INFORMATION (Continued)

- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.

45,000 Miles (72 000 km) or at 36 months

- Change engine oil.
- Replace engine oil filter.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.
- Flush and replace engine coolant at 36 months regardless of mileage.

52,500 Miles (84 000 km) or at 42 months

- Change engine oil.
- Flush and replace engine coolant, if not done at 36 months.

60,000 Miles (96 000 km) or at 48 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Check PCV valve and replace as necessary.***
- **Replace spark plugs.**

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain the warranty on the PCV valve.

67,500 Miles (108 000 km) or at 54 months

- Change engine oil.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

75,000 Miles (120 000 km) or at 60 months

- Change engine oil.
- Replace engine oil filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

82,500 Miles (132 000 km) or at 66 months

- Change engine oil.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

90,000 Miles (144 000 km) or at 72 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

97,500 Miles (156 000 km) or at 78 months

- Change engine oil.

105,000 Miles (168 000 km) or at 84 months

- Change engine oil.
- Replace engine oil filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

112,500 Miles (180 000 km) or at 90 months

- Change engine oil.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.
- Inspect brake linings.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

120,000 Miles (192 000 km) or at 96 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Check PCV valve and replace as necessary.***
- **Replace spark plugs.**

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain warranty on the PCV valve.

LIGHT DUTY SCHEDULE—B**3,000 Miles (5 000 km)**

- Change engine oil.

6,000 Miles (10 000 km)

- Change engine oil.
- Replace engine oil filter.

9,000 Miles (14 000 km)

- Change engine oil.

12,000 Miles (19 000 km)

- Change engine oil.
- Replace engine oil filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.**
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

15,000 Miles (24 000 km)

- Change engine oil.
- **Inspect engine air cleaner element, replace as necessary.**

GENERAL INFORMATION (Continued)**18,000 Miles (29 000 km)**

- Change engine oil.
- Replace engine oil filter.

21,000 Miles (34 000 km)

- Change engine oil.
- Inspect front wheel bearings. Clean and repack, if required (4x2)

24,000 Miles (38 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

27,000 Miles (43 000 km)

- Change engine oil.

30,000 Miles (48 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Inspect PCV valve, replace as necessary.***
- **Replace spark plugs.**

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain warranty on the PCV.

33,000 Miles (53 000 km)

- Change engine oil.

36,000 Miles (58 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.**
- Drain and refill transfer case fluid.
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

39,000 Miles (62 000 km)

- Change engine oil.

42,000 Miles (67 000 km)

- Change engine oil.
- Replace engine oil filter.
- Inspect front wheel bearing. Clean and repack, if required (4x2).

45,000 Miles (72 000 km)

- Change engine oil.
- **Inspect engine air cleaner element, replace as necessary.**

48,000 Miles (77 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

51,000 Miles (82 000 km)

- Change engine oil.
- Flush and replace engine coolant.

54,000 Miles (86 000 km)

- Change engine oil.
- Replace engine oil filter.

57,000 Miles (91 000 km)

- Change engine oil.

60,000 Miles (96 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Inspect PCV valve and replace as necessary.***
- **Replace spark plugs.**
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.**

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain warranty on the PCV valve.

63,000 Miles (101 000 km)

- Change engine oil.
- Inspect front wheel bearings. Clean and repack, if required (4x2)

66,000 Miles (106 000 km)

- Change engine oil.
- Replace engine oil filter.

69,000 Miles (110 000 km)

- Change engine oil.

72,000 Miles (115 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Drain and refill transfer case fluid.
 - Change rear axle fluid.
 - Change front axle fluid (4x4).

GENERAL INFORMATION (Continued)

- Inspect brake linings.

75,000 Miles (120 000 km)

- Change engine oil.
- **Inspect engine air cleaner element, replace as necessary.**

78,000 Miles (125 000 km)

- Change engine oil.
- Replace engine oil filter.

81,000 Miles (130 000 km)

- Change engine oil.
- Flush and replace engine coolant.

84,000 Miles (134 000 km)

- Change engine oil.
- Replace engine oil filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.**
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack if required (4x2).
- Inspect brake linings.

87,000 Miles (139 000 km)

- Change engine oil.

90,000 Miles (144 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Inspect PCV valve, replace as necessary.***
- **Replace spark plugs.**

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain warranty on the PCV valve.

93,000 Miles (149 000 km)

- Change engine oil.

96,000 Miles (154 000 km)

- Change engine oil.
- Replace engine oil filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

99,000 Miles (158 000 km)

- Change engine oil.

102,000 Miles (163 000 km)

- Change engine oil.
- Replace engine oil filter.

105,000 Miles (168 000 km)

- Change engine oil.
- **Inspect engine air cleaner element, replace as necessary.**
- Inspect front wheel bearings. Clean and repack if required (4x2).

108,000 Miles (173 000 km)

- Change engine oil.
- Replace engine oil filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.**
- Drain and refill transfer case fluid.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

111,000 Miles (178 000 km)

- Change engine oil.
- Flush and replace engine coolant.

114,000 Miles (182 000 km)

- Change engine oil.
- Replace engine oil filter.

117,000 Miles (187 000 km)

- Change engine oil.

120,000 Miles (192 000 km)

- Check engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element.**
- **Replace ignitions cables.**
- **Check PCV valve and replace as necessary.***
- **Replace spark plugs.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

*This maintenance is recommended by Chrysler to the customer but it is not required to maintain warranty on the PCV valve.

**Off-the-highway operation, trailer towing, snow plowing, or prolonged operation with heavy loading, especially in hot weather require the more frequent transmission service indicated with a ** in Schedule—B. Perform these services if the vehicle is operated under these conditions.

Inspection and service should also be performed anytime a malfunction is observed or suspected.



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MAINTENANCE SCHEDULES—MEDIUM DUTY VEHICLES

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GENERAL INFORMATION

INTRODUCTION

The following is a list of Maintenance Schedules for Medium Duty Cycle vehicles (8.0L 2500 and 3500 Models — California Only).

There are two maintenance schedules that show proper service based on the conditions that the vehicle is subjected to. Use the schedule that best describes these conditions.

Schedule—A, lists all the scheduled maintenance to be performed under normal operating conditions for Medium Duty vehicles.

Schedule—B, lists maintenance recommended for Medium Duty vehicles operated under the following conditions:

- Frequent short trip driving less than 5 miles (8 km)
- Frequent driving in dusty conditions
- Frequent trailer towing
- Extensive idling
- More than 50% of your driving is at sustained high speeds during hot weather, above 90°F (32°C)

Where time and mileage are listed, follow the interval that occurs first.

EMISSION CONTROL SYSTEM MAINTENANCE

The scheduled emission maintenance listed in **bold type** on the Maintenance Schedules, must be done at the mileage specified to assure the continued proper functioning of the emission control system. These, and all other maintenance services included in this manual, should be done to provide the best vehicle performance and reliability. More frequent maintenance may be needed for vehicles in severe operating conditions such as dusty areas and very short trip driving.

UNSCHEDULED INSPECTION

At Each Stop For Fuel

- Check engine oil level and add as required.
- Check windshield washer solvent and add as required.

Once A Month

- Check tire pressure and look for unusual wear or damage.
- Inspect battery and clean and tighten terminals as required.
- Check fluid levels of coolant reservoir, brake master cylinder, power steering, and transmission and add as needed.
- Check all lights and all other electrical items for correct operation.

At Each Oil Change

- Inspect exhaust system.
- Inspect brake hoses.
- Rotate the tires at each oil change interval shown on Schedule—A (7,500 Miles) or every other interval shown on Schedule—B (6,000 Miles).
- Check engine coolant level, hoses, and clamps.
- Lubricate steering linkage.

MEDIUM DUTY SCHEDULE—A

6,000 miles (10 000 km) or at 6 months

- Replace engine oil and filter.

12,000 Miles (19 000 km) or at 12 months

- Replace engine oil and filter.

18,000 Miles (29 000 km) or at 18 months

- Replace engine oil and filter.
- Inspect brake linings.

24,000 Miles (38 000 km) or at 24 months

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).

30,000 Miles (48 000 km) or at 30 months

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**

GENERAL INFORMATION (Continued)**36,000 Miles (58 000 km) or at 36 months**

- Replace engine oil and filter.
- Drain and refill transfer case fluid.
- Inspect brake linings
- Flush and replace engine coolant at 36 months, regardless of mileage.

42,000 Miles (67 000 km) or at 42 months

- Replace engine oil and filter.

48,000 Miles (77 000 km) or at 48 months

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Flush and replace engine coolant if not done at 36 months.

54,000 Miles (86 000 km) or at 54 months

- Replace engine oil and filter.
- Inspect brake linings.

60,000 Miles (96 000 km) or at 60 months

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Replace spark plugs.**
- Replace battery.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

66,000 Miles (106 000 km) or at 66 months

- Replace engine oil and filter.

72,000 Miles (115 000 km) or at 72 months

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

78,000 Miles (125 000 km) or at 78 months

- Replace engine oil and filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

84,000 Miles (134 000 km) or at 84 months

- Replace engine oil and filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

90,000 Miles (144 000 km) or at 90 months

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**
- Inspect brake linings.

96,000 Miles (154 000 km) or at 96 months

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).

102,000 Miles (163 000 km) or at 102 months

- Replace engine oil and filter.

108,000 Miles (173 000 km) or at 108 months

- Replace engine oil and filter.
- Drain and refill transfer case fluid.
- Inspect brake linings.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

114,000 Miles (183 000 km) or at 114 months

- Replace engine oil and filter.

120,000 Miles (192 000 km) or at 120 months

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Replace spark plugs.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.

MEDIUM DUTY SCHEDULE—B**3,000 Miles (5 000 km)**

- Replace engine oil and filter.

6,000 Miles (10 000 km)

- Replace engine oil and filter.

9,000 Miles (14 000 km)

- Replace engine oil and filter.

12,000 Miles (19 000 km)

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.*
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

15,000 Miles (24 000 km)

- Replace engine oil and filter.

GENERAL INFORMATION (Continued)**18,000 Miles (29 000 km)**

- Replace engine oil and filter.

21,000 Miles (29 000 km)

- Replace engine oil and filter.

24,000 Miles (38 000 km)

- Replace engine oil and filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

27,000 Miles (43 000 km)

- Replace engine oil and filter.

30,000 Miles (48 000 km)

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**

33,000 Miles (53 000 km)

- Replace engine oil and filter.

36,000 Miles (58 000 km)

- Replace engine oil and filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.*
- Drain and refill transfer case fluid.
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

39,000 Miles (62 000 km)

- Replace engine oil and filter.

42,000 Miles (67 000 km)

- Replace engine oil and filter.

45,000 Miles (72 000 km)

- Replace engine oil and filter.

48,000 Miles (77 000 km)

- Replace engine oil and filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.
 - Flush and replace engine coolant.

51,000 Miles (82 000 km)

- Replace engine oil and filter.

54,000 Miles (86 000 km)

- Replace engine oil and filter.

57,000 Miles (91 000 km)

- Replace engine oil and filter.

60,000 Miles (96 000 km)

- Replace engine oil and filter.
 - **Replace engine air cleaner element.**
 - **Replace ignition cables.**
 - **Replace spark plugs.**
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.*
- Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.
 - Replace battery.

63,000 Miles (101 000 km)

- Replace engine oil and filter.

66,000 Miles (106 000 km)

- Replace engine oil and filter.

69,000 Miles (110 000 km)

- Replace engine oil and filter.

72,000 Miles (115 000 km)

- Replace engine oil and filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Drain and refill transfer case fluid.
 - Inspect front wheel bearings. Clean and repack, if required (4x2).
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

75,000 Miles (120 000 km)

- Replace engine oil and filter.

78,000 Miles (125 000 km)

- Replace engine oil and filter.
- Flush and replace engine coolant.

81,000 Miles (130 000 km)

- Replace engine oil and filter.

84,000 Miles (134 000 km)

- Replace engine oil and filter.
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.*
- Change rear axle fluid.
 - Change front axle fluid (4x4).

GENERAL INFORMATION (Continued)

- Inspect brake linings.

87,000 Miles (139 000 km)

- Replace engine oil and filter.

90,000 Miles (144 000 km)

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace spark plugs.**

93,000 Miles (149 000 km)

- Replace engine oil and filter.

96,000 Miles (154 000 km)

- Replace engine oil and filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

99,000 Miles (156 000 km)

- Replace engine oil and filter.

102,000 Miles (163 000 km)

- Replace engine oil and filter.

105,000 Miles (168 000 km)

- Replace engine oil and filter.

108,000 Miles (173 000 km)

- Replace engine oil and filter.

- Drain and refill automatic transmission fluid. Replace filter and adjust bands.*

- Drain and refill transfer case fluid.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.
- Flush and replace engine coolant.

111,000 Miles (178 000 km)

- Replace engine oil and filter.

114,000 Miles (183 000 km)

- Replace engine oil and filter.

117,000 Miles (187 000 km)

- Replace engine oil and filter.

120,000 Miles (192 000 km)

- Replace engine oil and filter.
- **Replace engine air cleaner element.**
- **Replace ignition cables.**
- **Replace spark plugs.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

*Off-the-highway operation, trailer towing snow plowing, prolonged operation with heavy loading, especially in hot weather require the more frequent transmission service indicated with a * in Schedule—B. Perform these services if the vehicle is operated under these conditions.



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MAINTENANCE SCHEDULES—HEAVY DUTY VEHICLES

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GENERAL INFORMATION

INTRODUCTION

The following is a list of Maintenance Schedules for Heavy Duty Cycle vehicles (Federal Only – 2500 8.0L HD and 3500 5.9L & 8.0L Models).

There are two maintenance schedules that show proper service based on the conditions that the vehicle is subjected to. Use the schedule that best describes these conditions.

Schedule—**A**, lists all the scheduled maintenance to be performed under normal operating conditions for Heavy Duty vehicles.

Schedule—**B**, lists maintenance recommended for Heavy Duty vehicles operated under the following conditions:

- Frequent short trip driving less than 5 miles (8 km)
- Frequent driving in dusty conditions
- Frequent trailer towing
- Extensive idling
- More than 50% of your driving is at sustained high speeds during hot weather, above 90°F (32°C)

Where time and mileage are listed, follow the interval that occurs first.

EMISSION CONTROL SYSTEM MAINTENANCE

The schedule emission maintenance listed in **bold type** on the following schedules, must be done at the mileage specified to assure the continued proper functioning of the emission control system. These, and all other maintenance services included in this manual, should be done to provide the best vehicle performance and reliability. More frequent maintenance may be needed for vehicles in severe operating conditions such as dusty areas and very short trip driving.

UNSCHEDULED INSPECTION

At Each Stop For Fuel

- Check engine oil level and add as required.
- Check windshield washer solvent and add as required.

Once A Month

- Check tire pressure and look for unusual wear or damage.
- Inspect battery and clean and tighten terminals as required.
- Check fluid levels of coolant reservoir, brake master cylinder, power steering, and transmission and add as needed.
- Check all lights and all other electrical items for correct operation.

At Each Oil Change

- Inspect exhaust system.
- Inspect brake hoses.
- Rotate the tires at each oil change interval shown on Schedule—A (7,500 Miles) or every other interval shown on Schedule—B (6,000 Miles).
- Check engine coolant level, hoses, and clamps.
- If your mileage is less than 7,500 miles (12 000 km) yearly, replace the engine oil filter at each oil change.
- Lubricate steering linkage.
- Replace engine oil filter at every oil change (8.0L only).

HEAVY DUTY SCHEDULE—A

6,000 miles (10 000 km) or at 6 months

- Change engine oil.
- Replace engine oil filter (8.0L only).

12,000 Miles (19 000 km) or at 12 months

- Change engine oil.
- Replace engine oil filter.

18,000 Miles (29 000 km) or at 18 months

- Change engine oil.
- Replace engine oil filter (8.0L only).
- Inspect brake linings

24,000 Miles (38 000 km) or at 24 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**

GENERAL INFORMATION (Continued)

- Clean and relubricate crankcase inlet air filter (5.9L).
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).

30,000 Miles (48 000 km) or at 30 months

- Change engine oil.
- Replace engine oil filter (8.0L only).
- **Replace spark plugs.**

36,000 Miles (58 000 km) or at 36 months

- Change engine oil.
- Replace engine oil filter.
- Drain and refill transfer case fluid.
- Inspect brake linings.
- Flush and replace engine coolant at 36 months, regardless of mileage.

42,000 Miles (67 000 km) or at 42 months

- Change engine oil.
- Replace engine oil filter (8.0L only).

48,000 Miles (77 000 km) or at 48 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Flush and replace engine coolant if not done at 36 months.

54,000 Miles (86 000 km) or at 54 months

- Change engine oil.
- Replace engine oil filter (8.0L only).
- Inspect brake linings.

60,000 Miles (96 000 km) or at 60 months

- Change engine oil.
- Replace engine oil filter.
- **Replace ignition cables.**
- **Replace PCV valve (5.9L).***
- **Replace distributor cap and rotor (5.9L only).**
- **Replace spark plugs.**
- Clean EGR air passages (5.9L if equipped).*
- Replace EGR valve (5.9L if equipped).*
- Replace battery.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

66,000 Miles (106 000 km) or at 66 months

- Change engine oil.
- Replace engine oil filter (8.0L only).

72,000 Miles (115 000 km) or at 72 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

78,000 Miles (125 000 km) or at 78 months

- Change engine oil.
- Replace engine oil filter (8.0L only).
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

82,500 Miles (132 000 km) or at 82 months

- Replace oxygen sensor (5.9L only).*

84,000 Miles (134 000 km) or at 84 months

- Change engine oil.
- Replace engine oil filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

90,000 Miles (144 000 km) or at 90 months

- Change engine oil.
- Replace engine oil filter (8.0L only).
- Replace spark plugs.
- Inspect brake linings.

96,000 Miles (154 000 km) or at 96 months

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).

102,000 Miles (163 000 km) or at 102 months

- Change engine oil.
- Replace engine oil filter (8.0L only).

108,000 Miles (173 000 km) or at 108 months

- Change engine oil.
- Replace engine oil filter.
- Drain and refill transfer case fluid.

GENERAL INFORMATION (Continued)

- Inspect brake linings.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

*Requires Service Reminder Indicator Light. If so equipped, these parts are to be replaced at the indicated mileage or when the service reminder indicator light remains on continuously with the key in the "ON" position, whichever occurs first.

HEAVY DUTY SCHEDULE—B**3,000 Miles (5 000 km)**

- Change engine oil.
- Replace engine oil filter (8.0L only).

6,000 Miles (10 000 km)

- Change engine oil.
- Replace engine oil filter.

9,000 Miles (14 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

12,000 Miles (19 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Inspect engine air cleaner element and air pump filter, replace as necessary.**
- Clean and relubricate crankcase inlet air filter (5.9L).

• Drain and refill automatic transmission fluid. Replace filter and adjust bands.**

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

15,000 Miles (24 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

18,000 Miles (29 000 km)

- Change engine oil.
- Replace engine oil filter.

21,000 Miles (34 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

24,000 Miles (38 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.

- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

27,000 Miles (43 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

30,000 Miles (48 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Inspect PCV valve, replace as necessary (5.9L).**
- **Replace spark plugs.**

33,000 Miles (53 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

36,000 Miles (58 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Inspect engine air cleaner element and air pump filter, replace as necessary.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.**
- Drain and refill transfer case.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

39,000 Miles (62 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

42,000 Miles (67 000 km)

- Change engine oil.
- Replace engine oil filter.

45,000 Miles (72 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

48,000 Miles (77 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Replace engine air cleaner element and air pump filter.**
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.
- Flush and replace engine coolant.

GENERAL INFORMATION (Continued)**51,000 Miles (82 000 km)**

- Change engine oil.
- Replace engine oil filter (8.0L only).

54,000 Miles (86 000 km)

- Change engine oil.
- Replace engine oil filter.

57,000 Miles (91 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

60,000 Miles (96 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Inspect engine air cleaner element and air pump filter, replace as necessary.**
- **Replace PCV valve (5.9L).***
- **Replace distributor cap and rotor (5.9L).**
- **Replace ignition cables.**
- **Replace spark plugs.**
- Clean EGR passages (5.9L if equipped).*
- Replace EGR valve (5.9L if equipped).*
- Replace battery.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.**

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

63,000 Miles (101 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

66,000 Miles (106 000 km)

- Change engine oil.
- Replace engine oil filter.

69,000 Miles (110 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

72, 000 Miles (115 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - **Replace engine air cleaner element and air pump filter.**
 - Clean and relubricate crankcase inlet air filter (5.9L).
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Drain and refill transfer case fluid.
 - Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect front wheel bearings. Clean and repack, if required (4x2).
 - Inspect brake linings.

75,000 Miles (120 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

78,000 Miles (125 000 km)

- Change engine oil.
- Replace engine oil filter.
- Flush and replace engine coolant.

81,000 Miles (130 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

82,500 Miles (132 000 km)

- Replace oxygen sensor (5.9L only).*

84,000 Miles (134 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - **Inspect engine air cleaner element and air pump filter, replace as necessary.**
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.**
- Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect brake linings.

87,000 Miles (139 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

90,000 Miles (144 000 km)

- Change engine oil.
- Replace engine oil filter.
- **Inspect PCV valve, replace as necessary (5.9L).**
- **Replace spark plugs.**

93,000 Miles (149 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

96,000 Miles (154 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - **Replace engine air cleaner element and air pump filter.**
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.
- Change rear axle fluid.
 - Change front axle fluid (4x4).
 - Inspect front wheel bearings. Clean and repack, if required (4x2).
 - Inspect brake linings.

GENERAL INFORMATION (Continued)**99,000 Miles (156 000 km)**

- Change engine oil.
- Replace engine oil filter (8.0L only).

102,000 Miles (163 000 km)

- Change engine oil.
- Replace engine oil filter.

105,000 Miles (168 000 km)

- Change engine oil.
- Replace engine oil filter (8.0L only).

108,000 Miles (173 000 km)

- Change engine oil.
 - Replace engine oil filter.
 - **Inspect engine air cleaner element and air pump filter, replace as necessary.**
 - Drain and refill automatic transmission fluid.
- Replace filter and adjust bands.**

- Drain and refill transfer case fluid.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.
- Flush and replace engine coolant.

*Requires Service Reminder Indicator Light. If so equipped, these parts are to be replaced at the indicated mileage or when the service reminder indicator light remains on continuously with the key in the ON position, whichever occurs first.

**Off-the-highway operation, trailer towing, snow plowing, prolonged operation with heavy loading, especially in hot weather require the more frequent transmission service indicated with a ** in Schedule—B. Perform these services if the vehicle is operated under these conditions.

Inspection and service should also be performed anytime a malfunction is observed or suspected.



**AUTHENTIC
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MAINTENANCE SCHEDULES—DIESEL ENGINE VEHICLES

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GENERAL INFORMATION

INTRODUCTION

The following is a list of Maintenance Schedules for Diesel Engine equipped vehicles.

There are two maintenance schedules that show proper service based on the conditions that the vehicle is subjected to. Use the schedule that best describes these conditions.

Schedule—A, lists all the scheduled maintenance to be performed under normal operating conditions for Diesel Engine equipped vehicles.

Schedule—B, lists maintenance recommended for Diesel Engine equipped vehicles operated under the following conditions:

- Frequent short trip driving less than 5 miles (8 km)
- Frequent driving in dusty conditions
- Frequent trailer towing
- Extensive idling
- More than 50% of your driving is at sustained high speeds during hot weather, above 90°F (32°C)

Where time and mileage are listed, follow the interval that occurs first.

UNSCHEDULED INSPECTION

At Each Stop For Fuel

- Check engine oil level, add as required.
- Check windshield washer solvent and add if required.

Once A Month

- Check tire pressure and look for unusual wear or damage.
- Inspect battery and clean and tighten terminals as required.
- Check fluid levels of coolant reservoir, brake master cylinder, power steering, and transmission. Add fluid as required.
- Check all lights and all other electrical items for correct operation.
- Drain water from fuel filter.
- **Check Filter Minder®. Replace filter if necessary.**

At Each Oil Change

- Inspect exhaust system.
- Inspect brake hoses.
- Rotate the tires at each oil change interval shown, 6,000 miles (9 600 km) on Schedule —A or every other interval shown on Schedule—B.
- Check engine coolant level, hoses, and clamps.
- Lubricate steering linkage.

SCHEDULE—A

6,000 Miles (10 000 km) or at 6 months

- Change engine oil and filter.

12,000 Miles (19 000 km) or at 12 months

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.

18,000 Miles (29 000 km) or at 18 months

- Change engine oil and filter.
- inspect drive belts, replace as necessary.
- Inspect brake linings.

24,000 Miles (38 000 km) or at 24 months

- Change engine oil and filter.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Inspect front wheel bearings. Clean and repack, if required (4x2).

30,000 Miles (48 000 km) or at 30 months

- Change engine oil and filter.

36,000 Miles (58 000 km) or at 36 months

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill transfer case fluid.

GENERAL INFORMATION (Continued)

- Inspect brake linings.
- Flush and replace engine coolant at 36 months, regardless of mileage.

42,000 Miles (67 000 km) or at 42 months

- Change engine oil and filter.

48,000 Miles (77 000 km) or at 48 months

- Change engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Flush and replace engine coolant if not done at 36 months.

54,000 Miles (86 000 km) or at 54 months

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.
- Inspect brake linings.

60,000 Miles (96 000 km) or at 60 months

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

66,000 Miles (106 000 km) or at 66 months

- Change engine oil and filter.

72,000 Miles (115 000 km) or at 72 months

- Change engine oil and filter.
- Inspect drive belts, replace as required.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Drain and refill transfer case fluid.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

78,000 Miles (125 000 km) or at 78 months

- Change engine oil and filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

84,000 Miles (134 000 km) or at 84 months

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

90,000 Miles (144 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace if necessary.
- Inspect brake linings.

96,000 Miles (154 000 km) or at 96 months

- Change engine oil and filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect water pump weep hole for blockage.
- Replace fuel filter.

102,000 Miles (163 000 km) or at 102 months

- Change engine oil and filter.

108,000 Miles (173 000 km) or at 108 months

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill transfer case fluid.
- Inspect brake linings.
- Flush and replace engine coolant if it has been 30,000 miles (48 000 km) or 24 months since last change.

SCHEDULE—B**3,000 Miles (5 000 km)**

- Change engine oil and filter.

6,000 Miles (10 000 km)

- Change engine oil and filter.

9,000 Miles (14 000 km)

- Change engine oil and filter.

12,000 Miles (19 000 km)

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid. Replace filter and adjust bands.
- Change rear axle fluid.

GENERAL INFORMATION (Continued)

- Change front axle fluid (4x4).
- Inspect brake linings.

15,000 Miles (24 000 km)

- Change engine oil and filter.

18,000 Miles (29 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.

21,000 Miles (34 000 km)

- Change engine oil and filter.

24,000 Miles (38 000 km)

- Change engine oil and filter.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack, if required (4x2).
- Inspect brake linings.

27,000 Miles (43 000 km)

- Change engine oil and filter.

30,000 Miles (48 000 km)

- Change engine oil and filter.

33,000 Miles (53 000 km)

- Change engine oil and filter.

36,000 Miles (58 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Drain and refill transfer case fluid.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

39,000 Miles (62,000 km)

- Change engine oil and filter.

42,000 Miles (67 000 km)

- Change engine oil and filter.

45,000 Miles (72 000 km)

- Change engine oil and filter.

48,000 Miles (77 000 km)

- Change engine oil and filter.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack if required (4x2).
- Inspect brake linings.
- Flush and replace engine coolant.

51,000 Miles (82 000 km)

- Change engine oil and filter.

54,000 Miles (86 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.

57,000 Miles (91 000 km)

- Change engine oil and filter.

60,000 Miles (96 000 km)

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

63,000 Miles (101 000 km)

- Change engine oil and filter.

66,000 Miles (106 000 km)

- Change engine oil and filter.

69,000 Miles (110 000 km)

- Change engine oil and filter.

72,000 Miles (115 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.
- Adjust valve lash clearance.
- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Drain and refill transfer case fluid.
- Change rear axle fluid.

GENERAL INFORMATION (Continued)

- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack if required (4x2).
- Inspect brake linings.

75,000 Miles (120 000 km)

- Change engine oil and filter.

78,000 Miles (125 000 km)

- Change engine oil and filter.
- Flush and replace engine coolant.

81,000 Miles (130 000 km)

- Change engine oil and filter.

84,000 Miles (134 000 km)

- Change engine oil and filter.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.

87,000 Miles (139 000 km)

- Change engine oil and filter.

90,000 Miles (144 000 km)

- Change engine oil and filter.
- Inspect drive belts, replace as necessary.

93,000 Miles (149 000 km)

- Change engine oil and filter.

96,000 Miles (154 000 km)

- Change engine oil and filter.
- Adjust valve lash clearance.

- Inspect fan hub.
- Inspect damper.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect front wheel bearings. Clean and repack if required (4x2).
- Inspect brake linings.

99,000 Miles (158 000 km)

- Change engine oil and filter.

102,000 Miles (163 000 km)

- Change engine oil and filter.

105,000 Miles (168 000 km)

- Change engine oil and filter.

108,000 Miles (173 000 km)

- Change engine oil and filter.
- Clean engine air filter canister.
- Inspect drive belts, replace as necessary.
- Inspect water pump weep hole for blockage.
- Replace fuel filter.
- Drain and refill automatic transmission fluid.

Replace filter and adjust bands.

- Drain and refill transfer case fluid.
- Change rear axle fluid.
- Change front axle fluid (4x4).
- Inspect brake linings.
- Flush and replace engine coolant.



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JUMP STARTING, TOWING AND HOISTING

INDEX

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SERVICE PROCEDURES

JUMP STARTING PROCEDURE

WARNING: REVIEW ALL SAFETY PRECAUTIONS AND WARNINGS IN GROUP 8A, BATTERY/STARTING/CHARGING SYSTEMS DIAGNOSTICS. DO NOT JUMP START A FROZEN BATTERY, PERSONAL INJURY CAN RESULT. DO NOT JUMP START WHEN MAINTENANCE FREE BATTERY INDICATOR DOT IS YELLOW OR BRIGHT COLOR. DO NOT JUMP START A VEHICLE WHEN THE BATTERY FLUID IS BELOW THE TOP OF LEAD PLATES. DO NOT ALLOW JUMPER CABLE CLAMPS TO TOUCH EACH OTHER WHEN CONNECTED TO A BOOSTER SOURCE. DO NOT USE OPEN FLAME NEAR BATTERY. REMOVE METALLIC JEWELRY WORN ON HANDS OR WRISTS TO AVOID INJURY BY ACCIDENTAL ARCING OF BATTERY CURRENT. WHEN USING A HIGH OUTPUT BOOSTING DEVICE, DO NOT ALLOW BATTERY VOLTAGE TO EXCEED 16 VOLTS. REFER TO INSTRUCTIONS PROVIDED WITH DEVICE BEING USED.

CAUTION: When using another vehicle as a booster, do not allow vehicles to touch. Electrical systems can be damaged on either vehicle.

TO JUMP START A DISABLED VEHICLE:

(1) Raise hood on disabled vehicle and visually inspect engine compartment for:

- Battery cable clamp condition, clean if necessary.
- Frozen battery.
- Yellow or bright color test indicator, if equipped.
- Low battery fluid level.
- Generator drive belt condition and tension.
- Fuel fumes or leakage, correct if necessary.

CAUTION: If the cause of starting problem on disabled vehicle is severe, damage to booster vehicle charging system can result.

(2) When using another vehicle as a booster source, turn off all accessories, place gear selector in

park or neutral, set park brake and operate engine at 1200 rpm.

(3) On disabled vehicle, place gear selector in park or neutral and set park brake. Turn off all accessories.

(4) Connect jumper cables to booster battery. RED clamp to positive terminal (+). BLACK clamp to negative terminal (-). DO NOT allow clamps at opposite end of cables to touch, electrical arc will result. Review all warnings in this procedure.

(5) On disabled vehicle, connect RED jumper cable clamp to positive (+) terminal. Connect BLACK jumper cable clamp to engine ground as close to the ground cable attaching point as possible (Fig. 1) and (Fig. 2).

CAUTION: Do not crank starter motor on disabled vehicle for more than 15 seconds, starter will overheat and could fail.

(6) Allow battery in disabled vehicle to charge to at least 12.4 volts (75% charge) before attempting to start engine. If engine does not start within 15 seconds, stop cranking engine and allow starter to cool (15 min.), before cranking again.

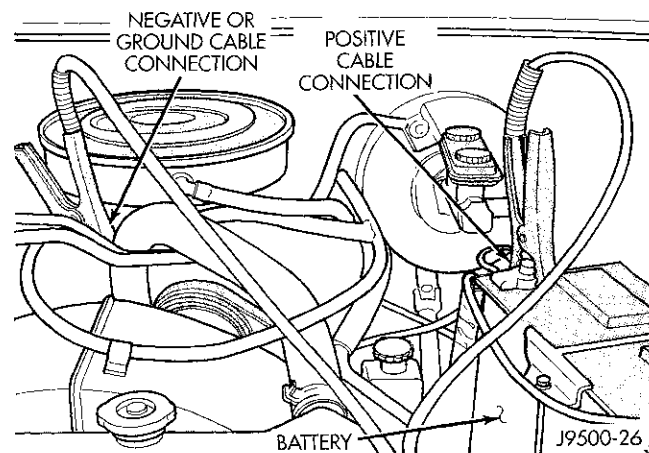


Fig. 1 Jumper Cable Clamp Connections—Gas Engine

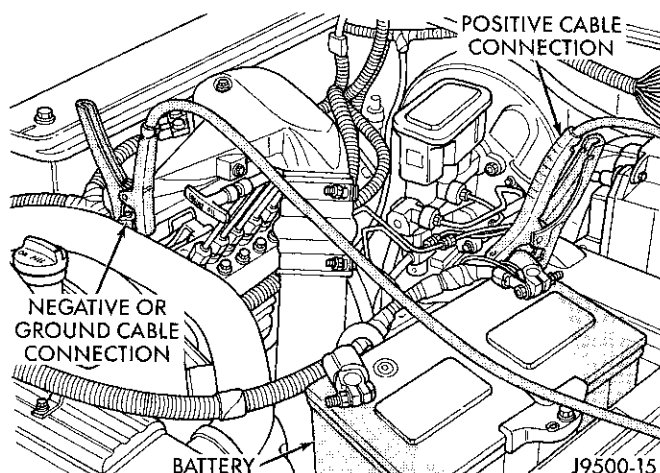
SERVICE PROCEDURES (Continued)

Fig. 2 Jumper Cable Clamp Connections—Diesel Engine

DISCONNECT CABLE CLAMPS AS FOLLOWS:

- Disconnect BLACK cable clamp from engine ground on disabled vehicle.
- When using a Booster vehicle, disconnect BLACK cable clamp from battery negative terminal. Disconnect RED cable clamp from battery positive terminal.
- Disconnect RED cable clamp from battery positive terminal on disabled vehicle.

TOWING RECOMMENDATIONS

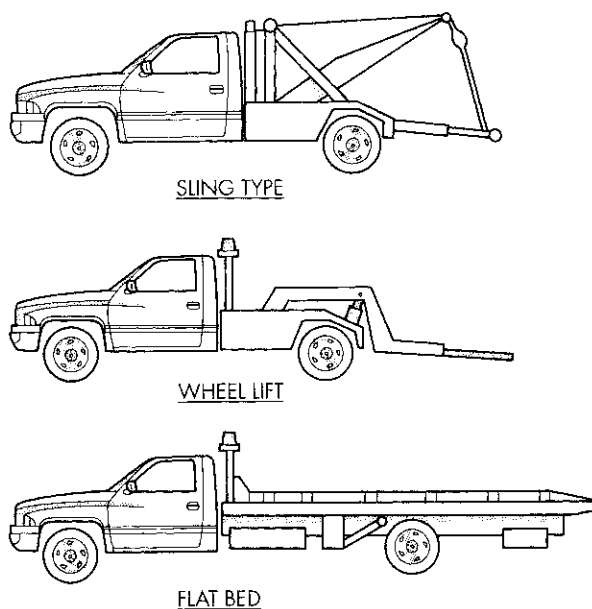
A vehicle equipped with SAE approved sling-type towing equipment can be used to tow all vehicles. When towing a 4WD vehicle using a wheel-lift towing device, use a tow dolly under the opposite end of the vehicle. A vehicle with flat-bed device can also be used to transport a disabled vehicle (Fig. 3).

A wooden crossbeam may be required for proper connection when using the sling-type, front-end towing method.

SAFETY PRECAUTIONS

CAUTION: The following safety precautions must be observed when towing a vehicle:

- Secure loose and protruding parts.
- Always use a safety chain system that is independent of the lifting and towing equipment.
- Do not allow towing equipment to contact the disabled vehicle's fuel tank.
- Do not allow anyone under the disabled vehicle while it is lifted by the towing device.
- Do not allow passengers to ride in a vehicle being towed.
- Always observe state and local laws regarding towing regulations.



J9500-6

Fig. 3 Tow Vehicles With Approved Equipment

- Do not tow a vehicle in a manner that could jeopardize the safety of the operator, pedestrians or other motorists.
- Do not attach tow chains, T-hooks, J-hooks, or a tow sling to a bumper, steering linkage, drive shafts or a non-reinforced frame hole.
- Do not tow a heavily loaded vehicle. Damage to the cab, cargo box or frame may result. Use a flatbed device to transport a loaded vehicle.

GROUND CLEARANCE

CAUTION: If vehicle is towed with wheels removed, install lug nuts to retain brake drums or rotors.

A towed vehicle should be raised until lifted wheels are a minimum 100 mm (4 in) from the ground. Be sure there is adequate ground clearance at the opposite end of the vehicle, especially when towing over rough terrain or steep rises in the road. If necessary, remove the wheels from the lifted end of the vehicle and lower the vehicle closer to the ground, to increase the ground clearance at the opposite end of the vehicle. Install lug nuts on wheel attaching studs to retain brake drums or rotors.

RAMP ANGLE

If a vehicle with flat-bed towing equipment is used, the approach ramp angle should not exceed 15 degrees.

SERVICE PROCEDURES (Continued)

TOWING WHEN KEYS ARE NOT AVAILABLE

When the vehicle is locked and keys are not available, use a flat bed hauler. A Wheel-lift or Sling-type device can be used on 4WD vehicles provided **all the wheels are lifted off the ground using tow dollies.**

TWO-WHEEL-DRIVE VEHICLE TOWING

Chrysler Corporation recommends that a vehicle be towed with the rear end lifted, whenever possible.

TOWING-REAR END LIFTED

CAUTION: Do not use steering column lock to secure steering wheel during towing operation.

- Unlock steering column and secure steering wheel in straight ahead position with a clamp device designed for towing.
- Verify that steering components are in good condition.

TOWING-FRONT END LIFTED

If a two-wheel-drive vehicle cannot be towed with the rear wheels lifted, it can be towed with the front wheels lifted with the transmission in the neutral position.

FOUR-WHEEL-DRIVE VEHICLE TOWING

Chrysler Corporation recommends that a vehicle be transported on a flat-bed device. A Wheel-lift or Sling-type device can be used provided all the wheels are lifted off the ground using tow dollies.

HOISTING RECOMMENDATIONS

Refer to the Owner's Manual for emergency vehicle lifting procedures.

WARNING: THE HOISTING AND JACK LIFTING POINTS PROVIDED ARE FOR A COMPLETE VEHICLE. WHEN A CHASSIS OR DRIVETRAIN COMPONENT IS REMOVED FROM A VEHICLE, THE CENTER OF GRAVITY IS ALTERED MAKING SOME HOISTING CONDITIONS UNSTABLE. PROPERLY SUPPORT OR SECURE VEHICLE TO HOISTING DEVICE WHEN THESE CONDITIONS EXIST.

FLOOR JACK

When properly positioned, a floor jack can be used to lift a vehicle (Fig. 4). Support the vehicle in the raised position with jack stands at the front and rear ends of the frame rails.

CAUTION: Do not lift vehicle with a floor jack positioned under:

- An axle tube.
- A body side sill.
- A steering linkage component.
- A drive shaft.
- The engine or transmission oil pan.
- The fuel tank.
- A front suspension arm.

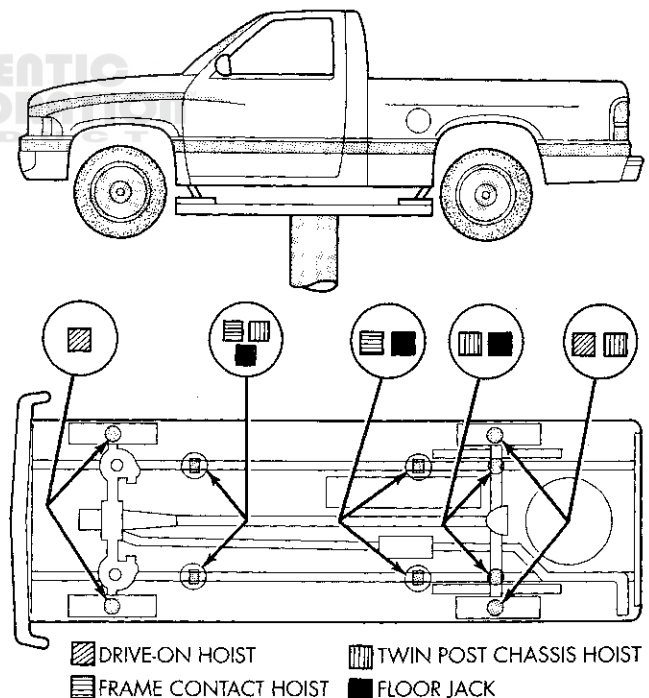
NOTE: Use the correct frame rail lifting locations only (Fig. 4).

HOIST

A vehicle can be lifted with:

- A single-post, frame-contact hoist.
- A twin-post, chassis hoist.
- A ramp-type, drive-on hoist.

NOTE: When a frame-contact type hoist is used, verify that the lifting pads are positioned properly (Fig. 4).



J9500-5

Fig. 4 Vehicle Lifting Locations

SUSPENSION

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WHEEL ALIGNMENT

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GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

DESCRIPTION AND OPERATION

WHEEL ALIGNMENT

Front wheel alignment involves the correct positioning of the wheels in relation to the vehicle. The

positioning is accomplished through suspension and steering linkage adjustments. An alignment is considered essential for efficient steering, good directional stability and to maximize tire wear. The most important measurements of front end alignment are caster, camber and toe position (Fig. 1) and (Fig. 2).

NOTE: Routine inspection of the front suspension and steering components is a good preventative maintenance practice. Inspection also helps to ensure safe operation of the vehicle.

- **CASTER** is the forward or rearward tilt of the steering knuckle from vertical. Tilting the top of the knuckle rearward provides positive caster. Tilting the top of the knuckle forward provides negative caster. Caster is a directional stability angle which enables the front wheels to return to a straight ahead position after turns.

- **CAMBER** is the inward or outward tilt of the wheel relative to the center of the vehicle. Tilting the top of the wheel inward provides negative camber. Tilting the top of the wheel outward provides positive camber. Incorrect camber will cause wear on the inside or outside edge of the tire.

- **WHEEL TOE POSITION** is the difference between the leading inside edges and trailing inside edges of the front tires. Incorrect wheel toe position is the most common cause of unstable steering and uneven tire wear. The wheel toe position is the **final** front wheel alignment adjustment.

DESCRIPTION AND OPERATION (Continued)

• **STEERING AXIS INCLINATION ANGLE** is measured in degrees. It is the angle that the steering knuckles are tilted (Fig. 1). The inclination angle has a fixed relationship with the camber angle. It will not change except when a spindle or ball stud is damaged or bent. The angle is not adjustable and the damaged component(s) must be replaced to correct mis-alignment.

CAUTION: Do not attempt to modify any suspension or steering components by heating and bending.

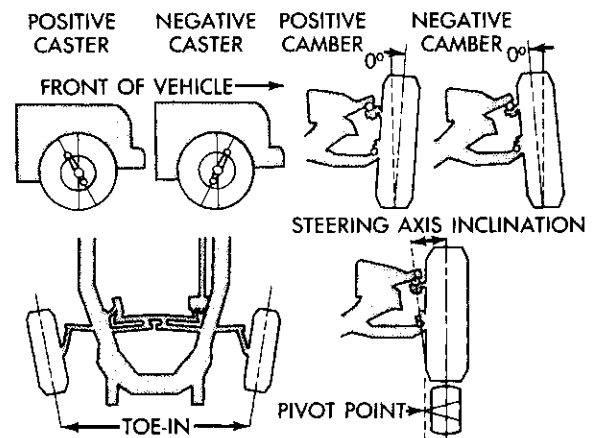
SERVICE PROCEDURES**PRE-ALIGNMENT INSPECTION**

Before starting wheel alignment, the following inspection and necessary corrections must be completed. Refer to Suspension and Steering System Diagnosis Chart for additional information.

(1) Tires with the same recommended air pressure, size, and tread wear. Refer to Group 22, Wheels and Tires for diagnosis information.

(2) Inspect front wheel bearings for wear or adjustment.

(3) Inspect front wheels for excessive radial, lateral runout and unbalance. Refer to Group 22, Wheels and Tires for diagnosis information.

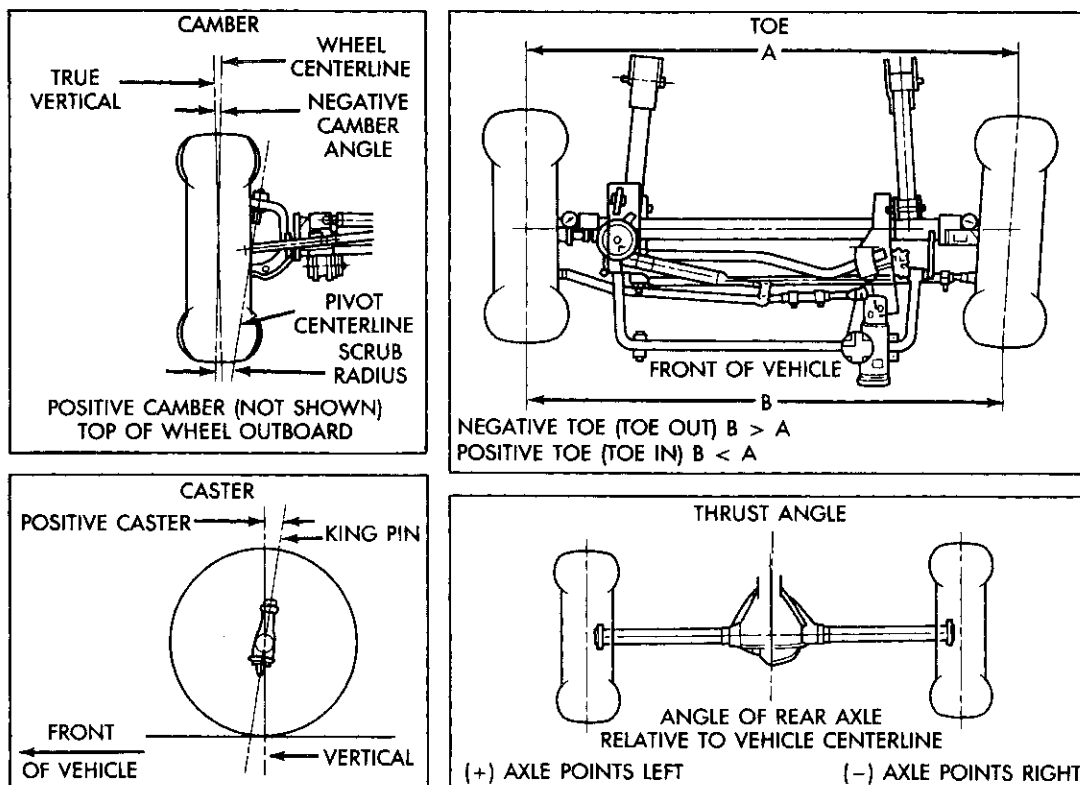


J9402-56

Fig. 1 Alignment Angles IFS

(4) Inspect ball studs, linkage pivot points and steering gear for looseness, roughness, binding or a sticking condition. Refer to Group 19, Steering for additional information.

(5) Inspect suspension components for wear and noise. Check components for correct torque.



J9402-57

Fig. 2 Alignment Angles Link/Coil

SERVICE PROCEDURES (Continued)**SUSPENSION AND STEERING SYSTEM DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
FRONT END NOISE	<ol style="list-style-type: none"> 1. Loose or worn front wheel bearings. 2. Loose or worn suspension bushings or components. 	<ol style="list-style-type: none"> 1. Adjust or replace wheel bearings. 2. Replace worn bushings or suspension components.
EXCESSIVE PLAY IN STEERING	<ol style="list-style-type: none"> 1. Loose or worn front wheel bearings. 2. Loose or worn steering components. 3. Loose or worn steering gear. 	<ol style="list-style-type: none"> 1. Adjust or replace wheel bearings. 2. Replace loose or worn steering components. 3. Adjust or replace steering gear.
FRONT WHEELS SHIMMY	<ol style="list-style-type: none"> 1. Loose or worn front wheel bearings. 2. Loose or worn suspension bushings or components. 3. Tires worn or out of balance. 4. Alignment. 	<ol style="list-style-type: none"> 1. Adjust or replace wheel bearings. 2. Replace worn bushings or suspension components. 3. Replace or balance tires as needed. 4. Align front end.
VEHICLE INSTABILITY	<ol style="list-style-type: none"> 1. Loose or worn front wheel bearings. 2. Alignment. 3. Loose or worn suspension bushings or components. 4. Weak or broken spring. 5. Tire pressure. 	<ol style="list-style-type: none"> 1. Adjust or replace wheel bearings. 2. Align front end. 3. Replace worn bushings or suspension components. 4. Replace weak or broken spring. 5. Correct tire pressure.
DIFFICULT STEERING	<ol style="list-style-type: none"> 1. Tire pressure. 2. Alignment. 3. Steering gear or pump. 	<ol style="list-style-type: none"> 1. Correct tire pressure. 2. Align front end. 3. Adjust or replace steering gear. Test and repair pump as needed.
VEHICLE PULLS TO ONE SIDE	<ol style="list-style-type: none"> 1. Tire pressure. 2. Alignment. 3. Loose or worn suspension bushings or components. 4. Weak or broken spring. 5. Brake pull. 	<ol style="list-style-type: none"> 1. Correct tire pressure. 2. Align front end. 3. Replace worn bushings or suspension components. 4. Replace weak or broken spring. 5. Repair brakes.

SERVICE PROCEDURES (Continued)**ALIGNMENT IFS SUSPENSION**

Before each alignment reading the vehicle should be jounced (rear first, then front). Grasp each bumper at the center and jounce the vehicle up and down several times. Always release the bumper in the down position. **Set the front end alignment to specifications while the vehicle is in its NORMALLY LOADED CONDITION.**

Camber and caster angle adjustments involve changing the position of the upper suspension arm pivot bar (Fig. 3). Refer to the Alignment Specification Chart for the correct setting.

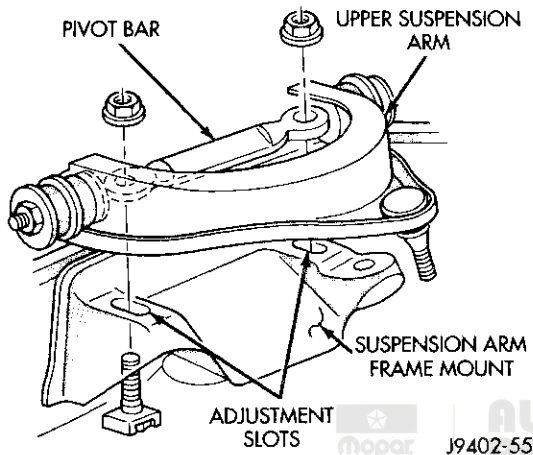


Fig. 3 Caster Camber Adjustment Location

CASTER: Move only the rear position of the pivot bar in or out. This will change the caster angle significantly and camber angle only slightly. To retain the camber while adjusting caster, move the rear pivot bar in or out. Move the forward pivot very slightly in the opposite direction.

NOTE: For example, to increase a positive caster angle, move the rear position of the pivot bar inward (toward the engine). Move the front of pivot bar outward (away from the engine) slightly until the original camber angle is obtained.

CAMBER: Move only the forward position of the pivot bar in or out. This will change the camber angle significantly and caster angle only slightly. The camber angle should be adjusted as close as possible to the **preferred service specification**. After adjustment is made tighten pivot bar nuts to specifications.

TOE POSITION: The wheel toe position adjustment should be the final adjustment.

(1) Start the engine and turn wheels both ways before straightening the wheels. Center and secure the steering wheel and turn off engine.

(2) Loosen the tie rod adjustment sleeve clamp bolts/nuts.

NOTE: Each front wheel should be adjusted for one-half of the total toe position specification. This will ensure the steering wheel will be centered when the wheels are positioned straight-ahead.

(3) Adjust the wheel toe position by turning the tie rod adjustment sleeves as necessary.

ALIGNMENT LINK/COIL SUSPENSION

Before each alignment reading the vehicle should be jounced (rear first, then front). Grasp each bumper at the center and jounce the vehicle up and down several times. Always release the bumper in the down position. **Set the front end alignment to specifications while the vehicle is in its NORMALLY LOADED CONDITION.**

CAMBER: The wheel camber angle is preset and is not adjustable.

CASTER: Check the caster of the front axle for correct angle. Be sure the axle is not bent or twisted. Road test the vehicle and make left and right turn. Observe the steering wheel return-to-center position. Low caster will cause poor steering wheel returnability.

Caster can be adjusted by rotating the cams on the lower suspension arm (Fig. 4). Refer to the Alignment Specification for the correct setting.

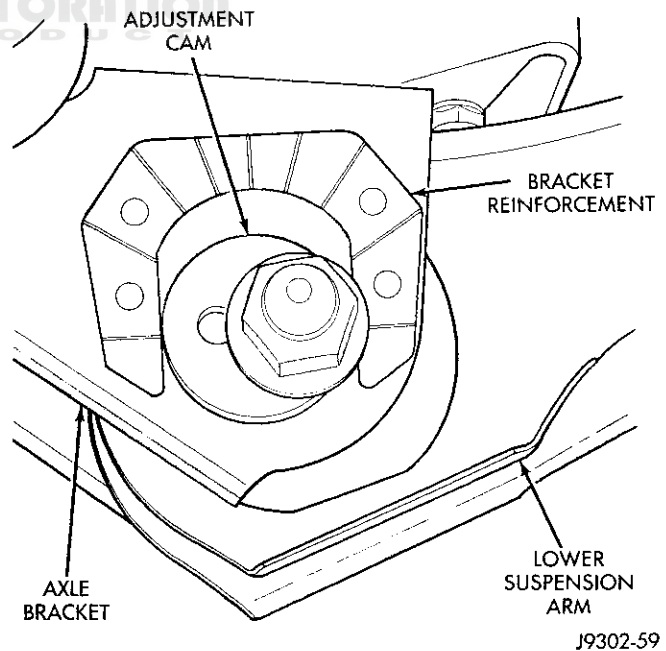


Fig. 4 Cam Adjuster

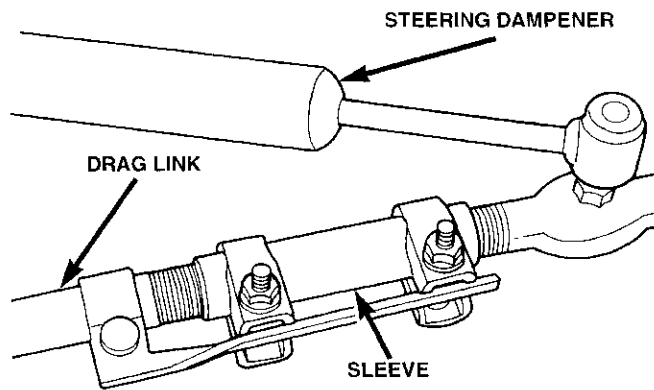
TOE POSITION: The wheel toe position adjustment should be the final adjustment.

(1) Start the engine and turn wheels both ways before straightening the wheels. Center and Secure the steering wheel and turn off engine.

(2) Loosen the adjustment sleeve clamp bolts.

SERVICE PROCEDURES (Continued)

(3) Adjust the right wheel toe position with the drag link (Fig. 5). Turn the sleeve until the right wheel is at the correct TOE-IN position. Position clamp bolts to their original position and tighten to specifications. **Make sure the toe setting does not change during clamp tightening.**



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Fig. 5 Drag Link Adjustment

(4) Adjust left wheel toe position with tie rod at left knuckle. Turn the sleeve until the left wheel is at the correct TOE-IN position. Position clamp bolts to

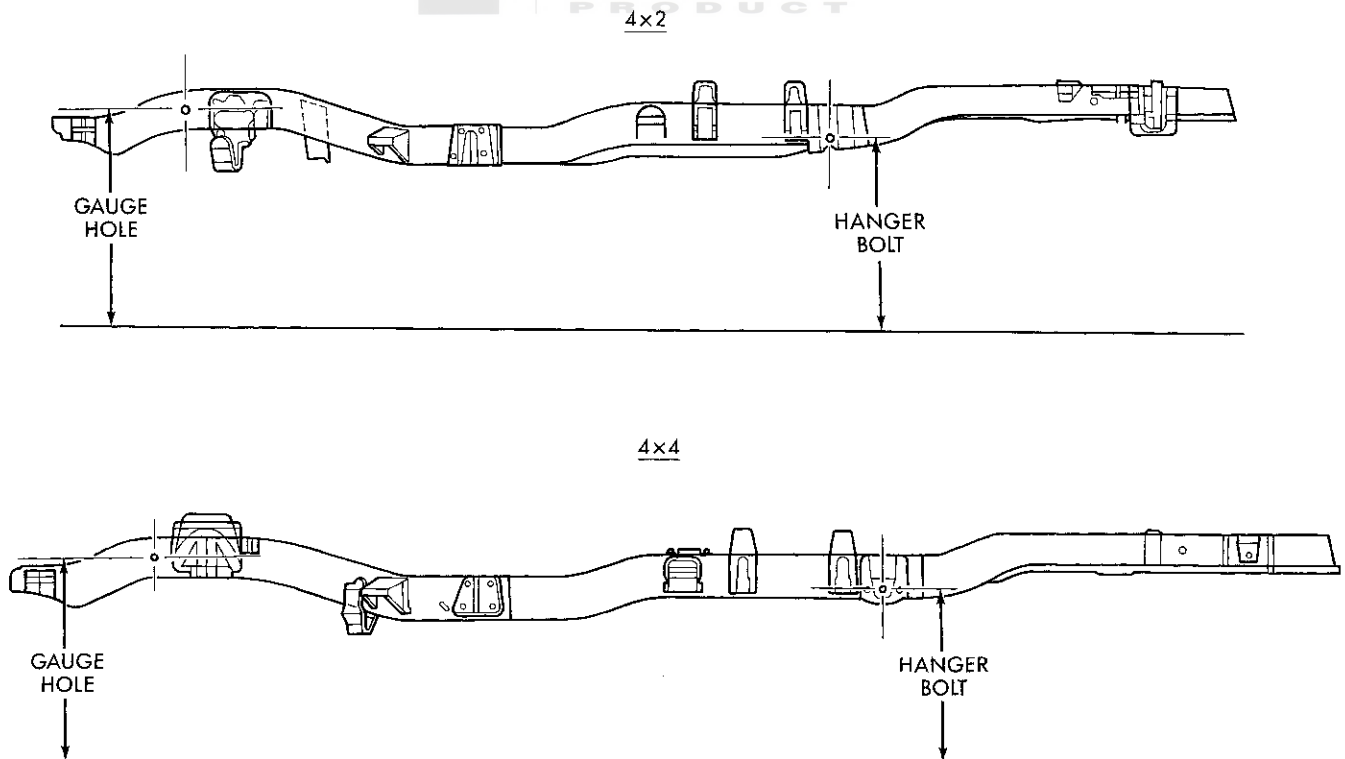
their original position and tighten to specifications. **Make sure the toe setting does not change during clamp tightening.**

(5) Verify the right toe setting.

CAB-CHASSIS CASTER CORRECTION MEASUREMENT

To determine the correct caster alignment angle for Cab- Chassis vehicles the following procedure must be performed.

(1) Take a height measurement to the center of the front gauge hole in the frame. Take another measurement to the center of the rear spring hanger bolt (Fig. 6). Take these measurements on both sides of the vehicle.



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Fig. 6 Cab-Chassis Measurement

SERVICE PROCEDURES (Continued)

(2) Subtract the front measurement from the rear measurement and use the average between the right and left side. Use this number with the Caster Correction Chart to obtain the correct caster angle (Fig. 7).

134.7" or 138.7" WHEELBASE		162.7" WHEELBASE	
Hanger Bolt- Gauge Hole (inches)	Caster Correction (degrees)	Hanger Bolt- Gauge Hole (inches)	Caster Correction (degrees)
-5.00	-0.23	-5.00	-0.19
-4.75	-0.11	-4.75	-0.09
-4.50	0.01	-4.50	0.01
-4.25	0.14	-4.25	0.11
-4.00	0.26	-4.00	0.21
-3.75	0.38	-3.75	0.31
-3.50	0.50	-3.50	0.41
-3.25	0.62	-3.25	0.51
-3.00	0.75	-3.00	0.61
-2.75	0.87	-2.75	0.71
-2.50	0.99	-2.50	0.81
-2.25	1.11	-2.25	0.91
-2.00	1.24	-2.00	1.01
-1.75	1.36	-1.75	1.11
-1.50	1.48	-1.50	1.21
-1.25	1.60	-1.25	1.31
-1.00	1.73	-1.00	1.41
-0.75	1.85	-0.75	1.51
-0.50	1.97	-0.50	1.61
-0.25	2.09	-0.25	1.71
0.00	2.21	0.00	1.81

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Fig. 7 Caster Correction Chart

SPECIFICATIONS**ALIGNMENT SPECIFICATION**

4×2/4×4	GVW (lbs)	WHEEL BASE (inches)	PREFERRED CASTER (degrees) (+/- 1.00)	PREFERRED CAMBER (degrees) (+/- 0.50)
4×2	6010	118.7	3.65	0.50
4×2	6400	118.7	3.65	0.50
4×2	6010	134.7	3.80	0.50
4×2	6400	134.7	3.80	0.50
4×2	6400	138.7	3.70	0.50
4×2	6400	154.7	3.85	0.50
4×2	7500	134.7	3.55	0.50
4×2	8800	134.7	3.45	0.50
4×2	8800	154.7	3.65	0.50
4×2	10500	134.7	3.25	0.50
4×2	10500	154.7	3.45	0.50
4×4	6400	118.7	3.35	not set
4×4	6400	134.7	3.45	not set
4×4	6400	138.7	3.40	not set
4×4	6400	154.7	3.55	not set
4×4	7500	134.7	3.00	not set
4×4	8800	134.7	3.10	not set
4×4	8800	154.7	3.25	not set
4×4	10500	134.7	2.90	not set
4×4	10500	154.7	3.00	not set
4×2/4×4	8800	134.7	USE CAB-CHASSIS PROCEDURE	not set
*4×2/4×4	11000	138.7		not set
*4×2/4×4	11000	162.7		not set
Preferred Total Toe-in 0.25° (+/- 0.25)				

* 4x2 11000# GVW has a solid front axle link coil suspension system.

FRONT SUSPENSION (IFS)

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GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BFi frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

DESCRIPTION AND OPERATION

INDEPENDENT FRONT SUSPENSION (IFS)

The IFS suspension is comprised of (Fig. 1) and (Fig. 2);

- Shock absorbers
- Coil springs
- Upper and lower suspension arms

- Stabilizer bar

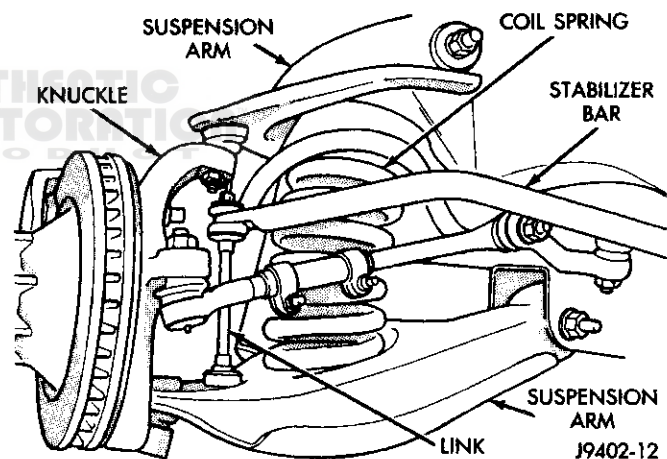


Fig. 1 Independent Front Suspension

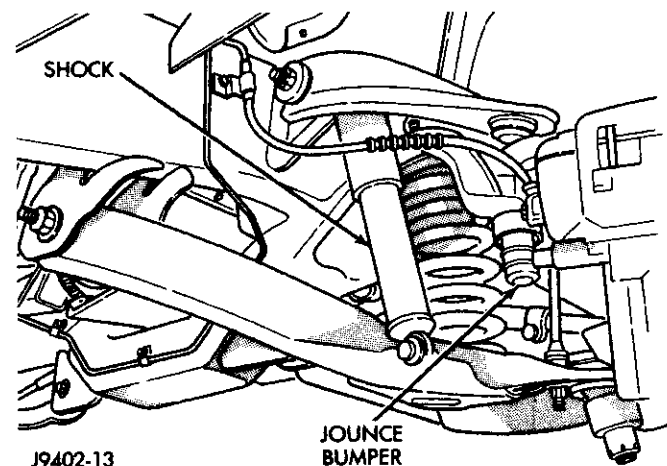


Fig. 2 Independent Front Suspension

DESCRIPTION AND OPERATION (Continued)

Shock Absorbers: The shock absorbers dampen jounce and rebound of the vehicle over various road conditions. Shocks are mounted on the bottom to the lower suspension arms. The top of the shock mounts on frame brackets using grommets.

Coil Springs: The coil springs control ride quality and maintain proper ride height. The springs mount between the lower suspension arm and the front cross member spring seat. A rubber isolator seats on top off the spring to help prevent noise.

Suspension Arms: The suspension arms have replaceable ball studs which are pressed into the arms. Bushings located inboard are not replaceable. The upper arm has a pivot bar which mounts on a frame bracket. The bracket has slotted holes this allows the arm to be adjusted for caster and camber. The suspension arm travel (jounce or rebound) is limited through the use of urethane bumpers.

Stabilizer Bar: The stabilizer bar is used to minimize vehicle front sway during turns. The spring steel bar helps to control the vehicle body in relationship to the suspension. The bar extends across the front underside of the chassis and mounts on the frame rails. Links connected the bar to the lower suspension arms. Stabilizer bar mounts are isolated by rubber bushings. Links are isolated with rubber grommet.

DIAGNOSIS AND TESTING**LOWER BALL STUD**

(1) Raise the front of the vehicle. Install safety floor stands under both lower suspension arms as far outboard as possible. The upper suspension arms must not contact the rebound bumpers.

(2) Install a dial indicator and clamp assembly to the lower suspension arm.

(3) Position indicator plunger against knuckle arm and zero indicator.

(4) Raise and lower the wheel with a pry bar under the center of the tire. Measure the axial movement of the knuckle with respect to the suspension arm.

(5) If the travel of the suspension arm is 0.030 inch (0.8 mm) or more, replace the ball joint.

UPPER BALL STUD

(1) Position a floor jack under the lower suspension arm. Raise the wheel and allow the tire to lightly contact the floor (vehicle weight relieved from the tire).

(2) Mount a dial indicator on the upper suspension arm. Position the indicator plunger against the upper ball stud boss of the steering knuckle.

(3) Grasp the top of the tire and apply force in and out. Look for movement at the ball joint between the upper suspension arm and steering knuckle.

(4) If lateral movement is greater than 0.8 mm (0.030 in.), replace the ball joint.

SHOCK DIAGNOSIS

A noise from a shock absorber may be caused by movement between mounting bushings and metal brackets or attaching components. This noise can usually be stopped by tightening the attaching nuts. If the noise persists, inspect for damaged and worn bushings, and attaching components. Repair as necessary if any of these conditions exist.

The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber, hold it in an upright position and force the piston in and out of the cylinder four or five times. The action throughout each stroke should be smooth and even.

The shock absorber bushings do not require any type of lubrication. Do not attempt to stop bushing noise by lubricating them. Grease and mineral oil-base lubricants will deteriorate the bushing rubber.

REMOVAL AND INSTALLATION**SHOCK ABSORBER**

WARNING: DO NOT REMOVE SHOCK UNTIL LOWER SUSPENSION ARM IS SUPPORTED. THE SHOCK HOLDS THE LOWER SUSPENSION ARM AND SPRING IN POSITION.

REMOVAL

- (1) Raise and support vehicle.
- (2) Remove shock upper nut and remove retainer and grommet.
- (3) Remove lower mounting bolt from suspension arm and remove shock (Fig. 3).

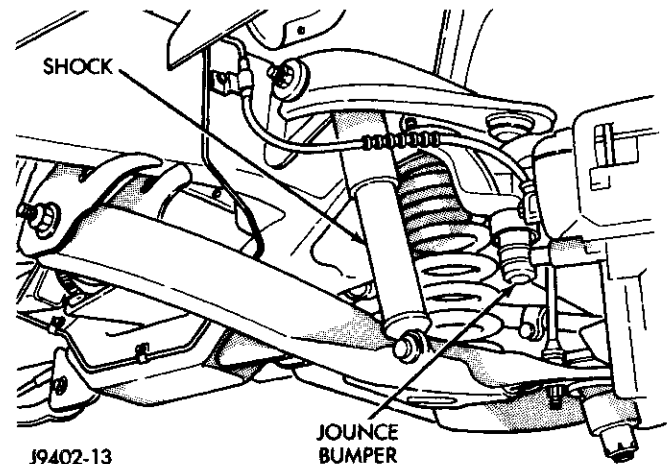


Fig. 3 Shock Absorber

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

(1) Extend shock fully, install retainer and grommet on top of shock absorber. Check grommets and retainer for wear.

(2) Guide shock up through upper suspension arm bracket. Install top grommet, retainer and nut. Tighten nut to specifications.

(3) Align bottom end of shock into lower suspension arm and install mounting bolt. Tighten bolt to specifications.

(4) Remove support and lower vehicle.

COIL SPRINGS

WARNING: DO NOT REMOVE SHOCK UNTIL LOWER SUSPENSION ARM IS SUPPORTED. THE SHOCK HOLDS THE LOWER SUSPENSION ARM AND SPRING IN POSITION.

REMOVAL

- (1) Raise and support vehicle.
- (2) Remove tire and wheel assembly.
- (3) Remove brake caliper assembly and rotor refer to Group 5 Brakes.
- (4) Disconnect tie rod from steering knuckle.
- (5) Disconnect stabilizer bar link from lower suspension arm.
- (6) Support lower suspension arm outboard end with jack. Place jack under arm in front of shock mount.
- (7) Remove cotter pin and nut from lower ball stud. Separate ball stud with remover C-4150A.
- (8) Remove lower shock bolt from suspension arm.
- (9) Lower jack and suspension arm until spring tension is relieved. Remove spring and rubber isolator (Fig. 4).

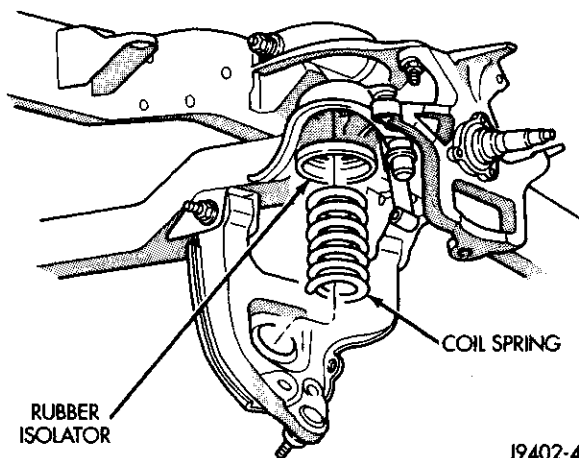


Fig. 4 Coil Spring

INSTALLATION

(1) Install rubber isolator on top of spring. Position spring into upper spring seat and lower suspension arm.

(2) Raise suspension arm with jack and position shock into suspension arm mount. Install shock bolt and tighten to specifications.

(3) Install steering knuckle on lower ball stud. Install lower ball stud nut and tighten to specifications. Replace cotter pin and remove jack.

(4) Install stabilizer bar link on lower suspension arm. Install grommet, retainer and nut and tighten to specifications.

(5) Install tie rod on steering knuckle and tighten nut to specifications.

(6) Install brake caliper assembly and rotor, refer to Group 5 Brakes.

(7) Install tire and wheel assembly.

(8) Remove support and lower vehicle.

STEERING KNUCKLE**REMOVAL**

- (1) Raise and support vehicle.
- (2) Remove wheel and tire assembly. Remove the brake caliper, refer to Group 5 Brakes.
- (3) Remove the wheel hub and bearing assembly from the spindle. Refer to Wheel Hub and Bearings service removal.
- (4) Remove the cotter pin and nut from the tie-rod end and disconnect tie rod.
- (5) Remove the cotter pins and nuts from the upper and lower ball studs. Separate upper ball stud from knuckle with remover MD-990635. Separate lower ball stud with remover C-4150A and remove knuckle.

INSTALLATION

(1) Position knuckle on ball stud and install ball stud nuts. Tighten nuts to specifications and install cotter pins.

(2) Install the brake rotor hub and bearing assembly on spindle. Refer to Wheel Hub and Bearings service installation.

(3) Install the brake caliper, refer to Group 5 Brakes.

(4) Install wheel and tire assembly.

(5) Remove support and lower vehicle.

LOWER SUSPENSION ARM

WARNING: DO NOT REMOVE SHOCK UNTIL LOWER SUSPENSION ARM IS SUPPORTED. THE SHOCK HOLDS THE LOWER SUSPENSION ARM AND SPRING IN POSITION.

REMOVAL AND INSTALLATION (Continued)

REMOVAL

- (1) Raise and support vehicle.
- (2) Follow procedure under Coil Spring Removal.
- (3) Remove bolts mounting suspension arm to crossmember and remove arm.

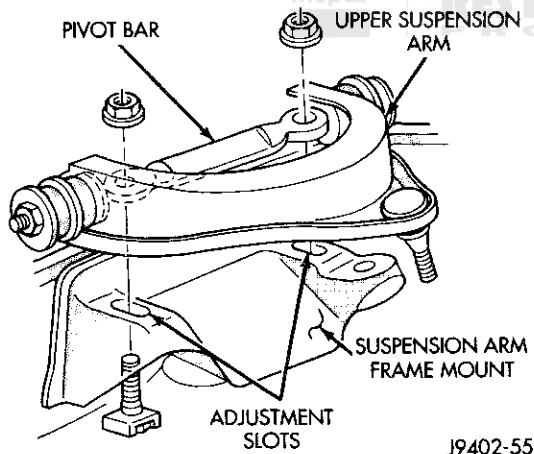
INSTALLATION

- (1) Position suspension arm on crossmember and install bolts snug.
- (2) Follow procedure under Coil Spring Installation.
- (3) Remove support and lower vehicle.
- (4) Tighten suspension arm crossmember bolts to specifications.

UPPER SUSPENSION ARM

REMOVAL

- (1) Raise and support vehicle.
- (2) Remove tire and wheel assembly.
- (3) Support lower suspension arm at outboard end with jack stand.
- (4) Remove upper ball stud cotter pin and nut.
- (5) Separate ball stud from knuckle with remover MB-990635.
- (6) Remove pivot bar bolts from upper suspension arm bracket and remove arm from vehicle (Fig. 5).



J9402-55

Fig. 5 Upper Suspension Arm

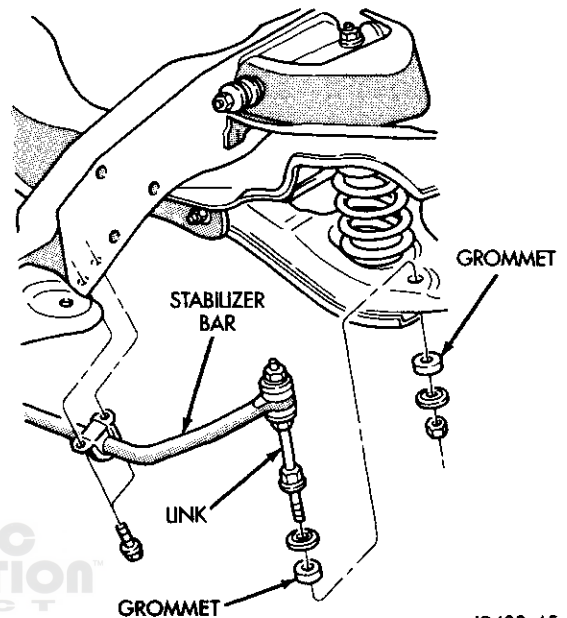
INSTALLATION

- (1) Position upper suspension arm on bracket and install pivot bar bolts. Tighten to specifications.
- (2) Install ball stud in knuckle. Install nut and tighten to specifications. Install replacement cotter pin.
- (3) Remove jack from lower suspension arm.
- (4) Install tire and wheel assembly.
- (5) Remove support and lower vehicle.
- (6) Align front suspension.

STABILIZER BAR

REMOVAL

- (1) Raise and support the vehicle.
- (2) Disconnect the link from lower suspension arm and stabilizer bar (Fig. 6).
- (3) Disconnect the stabilizer bar clamps from the frame rails. Remove the stabilizer bar.



J9402-45

Fig. 6 STABILIZER BAR

INSTALLATION

- (1) Position the stabilizer bar on the frame rail and install the clamps and bolts. Ensure the bar is centered with equal spacing on both sides. Tighten the bolts to specifications.
- (2) Install links on stabilizer bar and lower suspension arm. Install grommets, retainers and nuts. Tighten nuts to specifications.
- (3) Remove the supports and lower the vehicle.

WHEEL BEARINGS

REMOVAL

- (1) Raise and support the vehicle.
- (2) Remove the wheel and tire assembly.
- (3) Remove disc brake caliper from steering knuckle. Refer to Group 5 Brakes.
- (4) Remove the dust cap, cotter pin, and hub nut from spindle.

CAUTION: Use care to prevent inner wheel bearing and seal from contacting spindle threads during removal.

- (5) Carefully slide the hub/rotor from spindle.
- (6) Remove the seal and inner wheel bearing from the hub/rotor.

REMOVAL AND INSTALLATION (Continued)

(7) Remove inner bearing races from hub/rotor with a pin punch if bearings are going to be replaced.

INSTALLATION

(1) Install the new bearing cup(s) with an appropriate installation tool.

(2) Apply a coating of MOPAR Wheel Bearing Grease or equivalent lubricant to inner surface area of hub/rotor. Install inner wheel bearing and seal in the hub/rotor.

(3) Inspect bearing and seal contact surfaces on spindle for burrs and/or roughness.

(4) Remove all rough contact surfaces from spindle. Apply a coating of lubricant.

CAUTION: Use care to prevent inner wheel bearing and seal from contacting spindle threads during installation.

(5) Carefully slide the hub/rotor onto spindle. Install outer wheel bearing, washer and retaining nut.

(6) Tighten the nut to 41-54 N·m (30-40 ft. lbs.) torque to preload bearing while rotating the hub/rotor. Stop hub/rotor and loosen nut to completely release bearing preload torque. Tighten the nut finger-tight and install the nut lock. Install a new cotter pin.

(7) The adjustment (above) should have 0.001 to 0.003 inch (0.254 to 0.0762 mm) end play.

(8) Clean the dust cap and apply a coating lubricant to the internal surface. **Do not fill the dust cap with lubricant.** Install the cap.

(9) Install disc brake caliper, refer to Group 5 Brakes.

(10) Install the wheel and tire assembly.

WHEEL STUDS**REMOVAL**

- (1) Remove wheel and tire assembly.
- (2) Remove disc brake rotor, refer Group 5 Brakes.
- (3) Place rotor on flat surface and drive studs out of the with a hammer and punch.

INSTALLATION

- (1) Turn the rotor over and place in a vise.
- (2) Drive new studs into the rotor with hammer and punch.
- (3) Install rotor, refer to Group 5 Brakes.
- (4) Install wheel and tire assembly.

DISASSEMBLY AND ASSEMBLY**LOWER BALL STUD****DISASSEMBLY**

- (1) Remove lower suspension arm.

- (2) Position special tool on lower suspension arm and press out ball stud (Fig. 7).

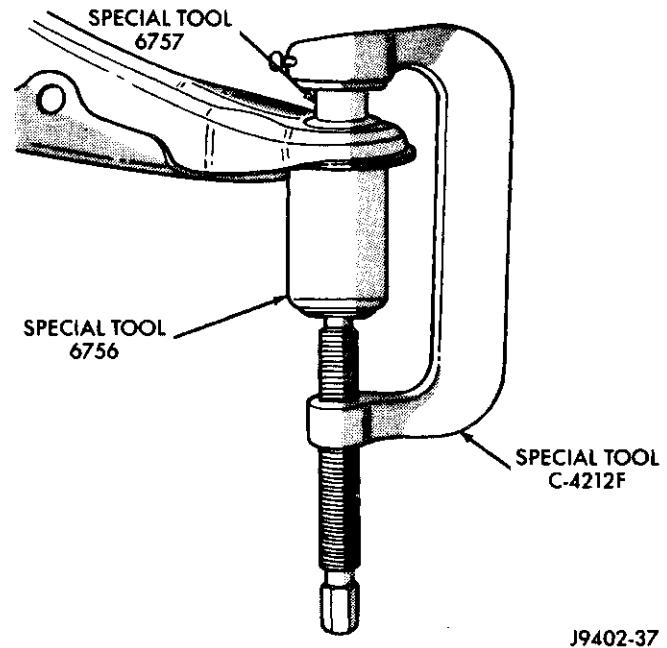


Fig. 7 Lower Ball Stud Removal

ASSEMBLY

- (1) Press replacement ball stud into the lower suspension arm bore with special tools (Fig. 8).
- (2) Install lower suspension arm.

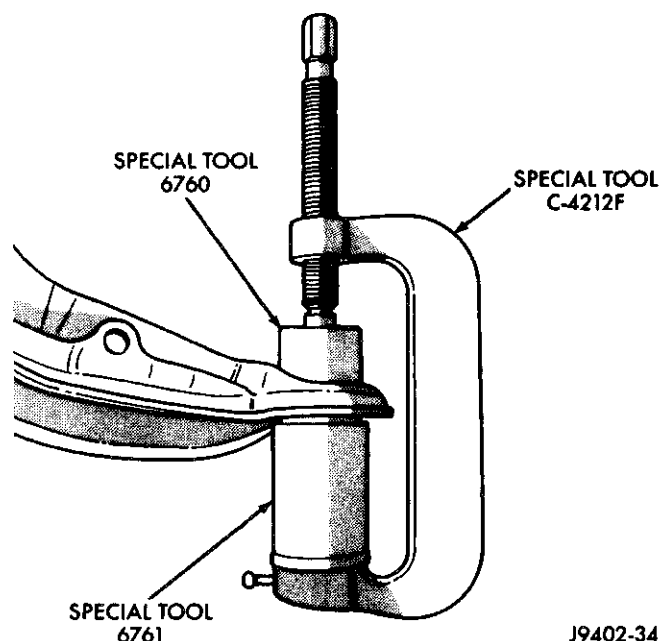
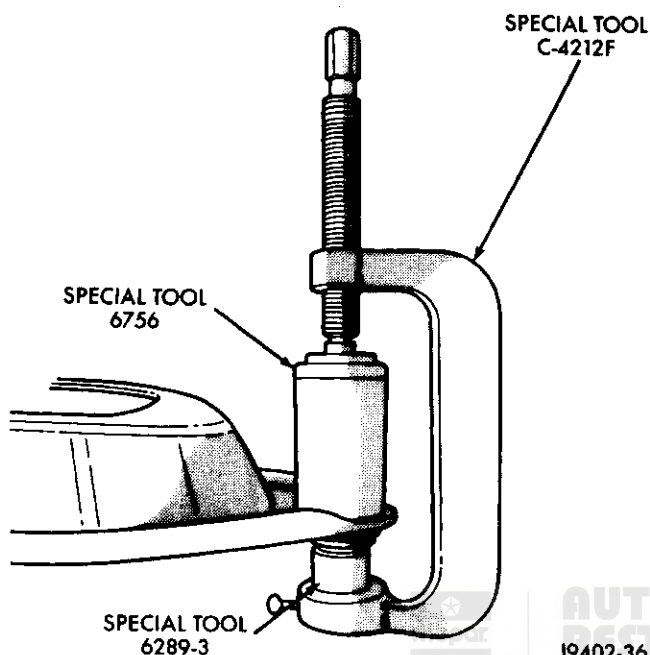


Fig. 8 Lower Ball Stud Installation

DISASSEMBLY AND ASSEMBLY (Continued)**UPPER BALL STUD****DISASSEMBLY**

- (1) Remove the upper suspension arm.
- (2) Position special tools on upper suspension arm and press ball stud out of arm (Fig. 9).

*Fig. 9 Upper Ball Stud Removal***ASSEMBLY**

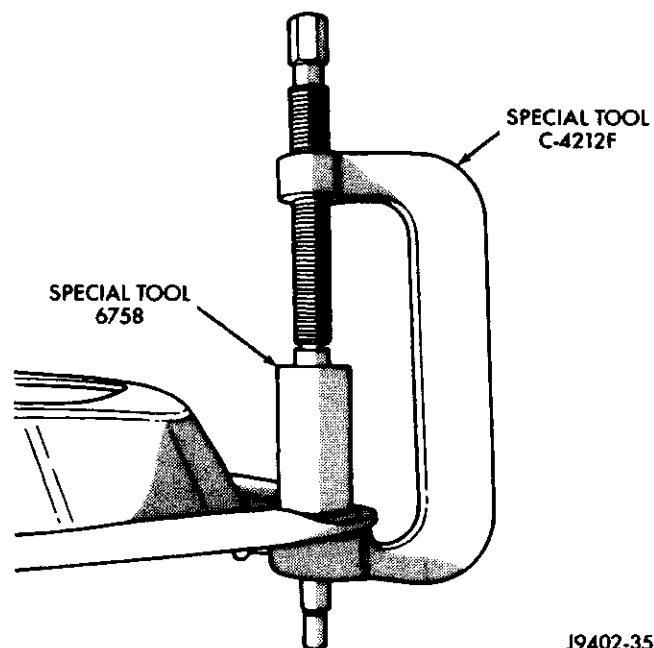
- (1) Press ball stud into upper suspension arm with special tools (Fig. 10).
- (2) Install the upper suspension arm.

CLEANING AND INSPECTION**WHEEL BEARINGS**

NOTE: Bearing and races must be replaced as a set if worn or damaged.

- (1) Thoroughly clean the interior of hub/rotor.
- (2) Clean the bearings with solvent and towel dry.
- (3) After cleaning, apply engine oil to each bearing.
- (4) Rotate each bearing slowly while applying downward force. Examine the rollers for pitting and roughness, replace bearing if worn or defective.
- (5) Remove the engine oil from each bearing. Pack each bearing with multi-purpose NLGI, grade 2, EP-type lubricant (or an equivalent lubricant).

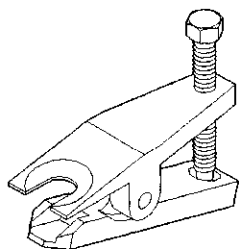
NOTE: Ensure that lubricant is forced into all the cavities between the bearing cage and rollers.

*Fig. 10 Upper Ball Stud Installation***SPECIFICATIONS****IFS SUSPENSION (WAX COAT FRAME)**

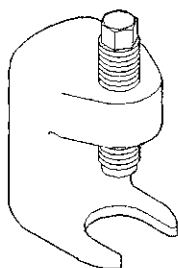
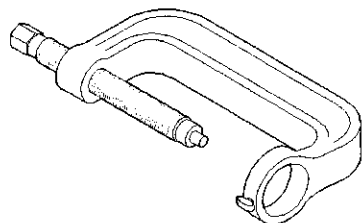
DESCRIPTION	TORQUE
Shock Absorber	
Upper Nut . . . . .	.41 N·m (30 ft. lbs.)
Lower Bolt . . . . .	.135 N·m (100 ft. lbs.)
Lower Suspension Arm	
Frame Nuts . . . . .	.149 N·m (110 ft. lbs.)
Ball Stud Nut . . . . .	.75 N·m (55 ft. lbs.)
Upper Suspension Arm	
Pivot Bar Nuts . . . . .	.203 N·m (150 ft. lbs.)
Ball Stud Nut . . . . .	.75 N·m (55 ft. lbs.)
Stabilizer Bar	
Clamp Bolt . . . . .	.47 N·m (35 ft. lbs.)
Link Nuts . . . . .	.34 N·m (25 ft. lbs.)

IFS SUSPENSION (E-COAT FRAME)

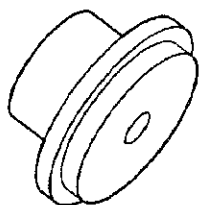
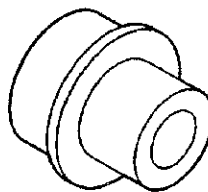
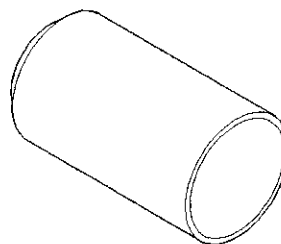
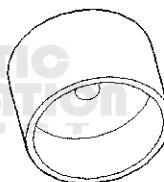
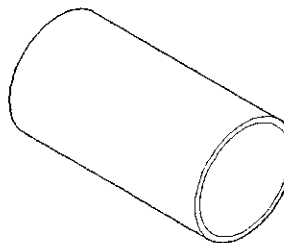
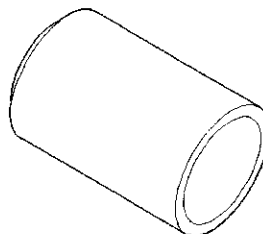
DESCRIPTION	TORQUE
Shock Absorber	
Upper Nut . . . . .	.41 N·m (30 ft. lbs.)
Lower Bolt . . . . .	.135 N·m (100 ft. lbs.)
Lower Suspension Arm	
Frame Nuts . . . . .	.271 N·m (200 ft. lbs.)
Ball Stud Nut . . . . .	.75 N·m (55 ft. lbs.)
Upper Suspension Arm	
Pivot Bar Nuts . . . . .	.271 N·m (200 ft. lbs.)
Ball Stud Nut . . . . .	.75 N·m (55 ft. lbs.)
Stabilizer Bar	
Clamp Bolt . . . . .	.61 N·m (45 ft. lbs.)
Link Nuts . . . . .	.34 N·m (25 ft. lbs.)

SPECIAL TOOLS**IFS FRONT SUSPENSION**

20143-11

Remover, Tie Rod End MB-990635**Remover, Lower Ball Stud C-4150A**

421212F

Press Ball Stud Remover/Installer C-4212F**Remover, Ball Stud 6757****Remover, Ball Stud 6289-3****Reciever, Ball Stud 6756****Reciever, Ball Stud 6760****Installer, Ball Stud 6758****Installer, Ball Stud 6761**

FRONT SUSPENSION LINK/COIL

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GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

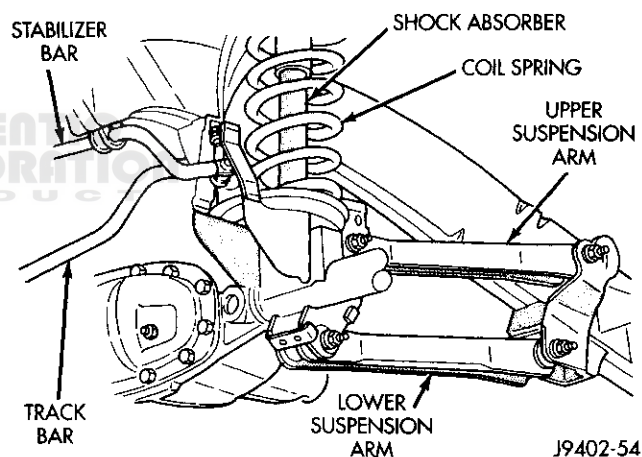
DESCRIPTION AND OPERATION

FRONT SUSPENSION LINK/COIL

The Ram Truck Link/coil suspension allows each wheel to adapt to different road surfaces. The suspension is comprised of (Fig. 1);

- Shock absorbers
- Coil springs
- Upper and lower suspension arms

- Stabilizer bar
- Track bar



J9402-54

Fig. 1 Link/Coil Suspension

Shock Absorbers: The shock absorbers dampen the jounce and rebound of the vehicle over various road conditions. Shocks are mounted inside the springs and attached at the top to brackets with grommets. These brackets are bolted on the frame with three studs on a ring. The shock is mounted at the bottom of the axle below the spring seat.

Coil Springs: The coil springs control ride quality and maintain proper ride height. The springs use a rubber isolators between the frame bracket and spring. The isolators help prevent road noise. The bottom of the spring sits on a seat mounted to the axle.

Suspension Arms: The upper and lower suspension arms use bushings to isolate road noise. The suspension arms are bolted to the frame and axle through the rubber bushings. The lower suspension arm uses cam bolts at the axle to allow for caster

DESCRIPTION AND OPERATION (Continued)

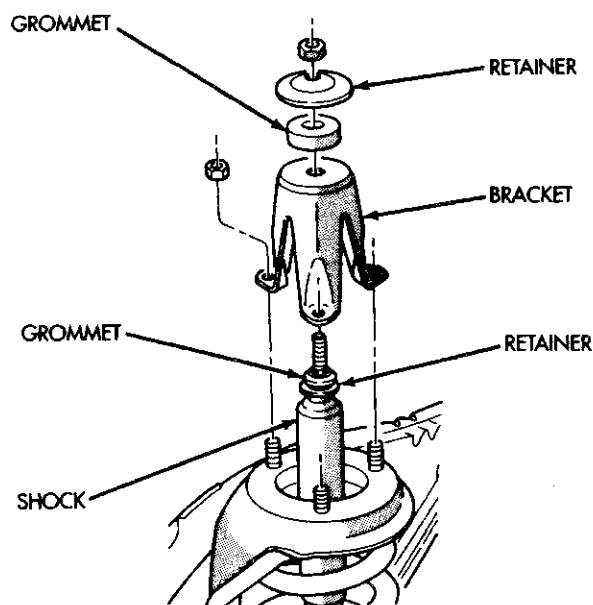
and pinion angle adjustment. The suspension arm travel (jounce or rebound) is limited through the use of urethane bumpers.

Stabilizer Bar: The stabilizer bar is used to minimize vehicle front sway during turns. The spring steel bar helps to control the vehicle body in relationship to the suspension. The bar extends across the front underside of the chassis and connects to the frame rails. Links are connected from the bar to the axle brackets. Stabilizer bar mounts are isolated by teflon lined rubber bushings.

Track Bar: The track bar is used to minimize front axle side-to-side movement. The bar is attached to a frame rail bracket with a ball stud and is isolated with a bushing at the axle bracket.

Steering Knuckles: The steering knuckles pivot on replaceable ball studs attached to the axle tube yokes.

NOTE: Suspension components which use rubber bushings should be tightened at vehicle ride height. This will prevent premature failure of the bushing and maintain ride comfort. Bushings must never be lubricated.



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Fig. 2 Shock Absorber and Bracket

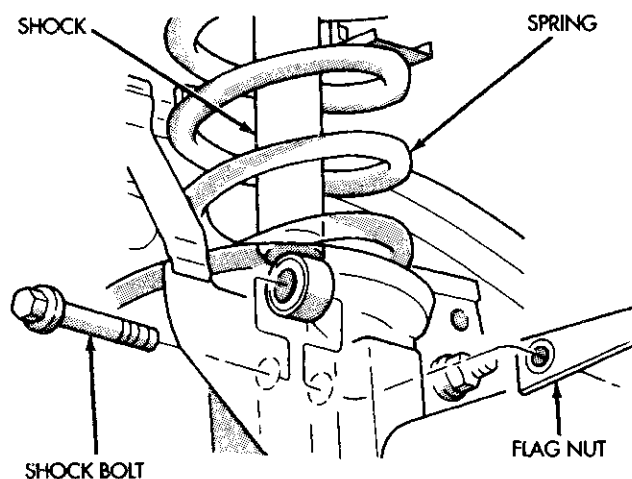
(3) Remove the lower bolt from the axle bracket (Fig. 3). Remove the shock absorber from engine compartment.

DIAGNOSIS AND TESTING**SHOCK DIAGNOSIS**

A noise from a shock absorber may be caused by movement between mounting bushings and metal brackets or attaching components. This noise can usually be stopped by tightening the attaching nuts. If the noise persists, inspect for damaged and worn bushings, and attaching components. Repair as necessary if any of these conditions exist.

The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber, hold it in an upright position and force the piston in and out of the cylinder four or five times. The action throughout each stroke should be smooth and even.

The shock absorber bushings do not require any type of lubrication. Do not attempt to stop bushing noise by lubricating them. Grease and mineral oil-base lubricants will deteriorate the bushing rubber.



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Fig. 3 Shock Absorber Axle Mount**REMOVAL AND INSTALLATION****SHOCK ABSORBER****REMOVAL**

(1) Remove the nut, retainer and grommet from the upper stud in the engine compartment.

(2) Remove three nuts from the upper shock bracket (Fig. 2).

INSTALLATION

(1) Position the lower retainer and grommet on the upper stud. Insert the shock absorber through the spring from engine compartment.

(2) Install the lower bolt and tighten bolt to specifications.

REMOVAL AND INSTALLATION (Continued)

(3) Install the upper shock bracket and three nuts. Tighten nuts to specifications.

(4) Install upper grommet and retainer. Install upper shock nut and tighten to specifications.

COIL SPRING

REMOVAL

(1) Raise and support the vehicle. Position a hydraulic jack under the axle to support it.

(2) Paint or scribe alignment marks on lower suspension arm cam adjusters and axle bracket for installation reference.

(3) Remove the upper suspension arm and loosen lower suspension arm bolts.

(4) Mark and disconnect the front propeller shaft from the axle 4x4 models.

(5) Disconnect the track bar from the frame rail bracket.

(6) Disconnect the drag link from pitman arm.

(7) Disconnect the stabilizer bar link and shock absorber from the axle.

(8) Lower the axle until the spring is free from the upper mount. Remove the coil spring.

INSTALLATION

(1) Position the coil spring on the axle pad.

(2) Raise the axle into position until the spring seats in the upper mount.

(3) Connect the stabilizer bar links and shock absorbers to the axle bracket. Connect the track bar to the frame rail bracket.

(4) Install the upper suspension arm.

(5) Install the front propeller shaft to the axle 4x4 model.

(6) Install drag link to pitman arm and tighten nut to specifications. Install new cotter pin.

(7) Remove the supports and lower the vehicle.

(8) Tighten the following suspension components to specifications:

- Link to stabilizer bar nut.
- Lower shock bolt.
- Track bar bolt at axle shaft tube bracket.
- Upper suspension arm nut at axle bracket.
- Upper suspension nut at frame bracket.
- Align lower suspension arm reference marks and tighten cam nut.
- Lower suspension nut at frame bracket.

STEERING KNUCKLE

For service procedures on the steering knuckle and ball studs refer to Group 3 Differentials And Driveline.

LOWER SUSPENSION ARM

REMOVAL

(1) Raise and support the vehicle.

(2) Paint or scribe alignment marks on the cam adjusters and suspension arm for installation reference (Fig. 4).

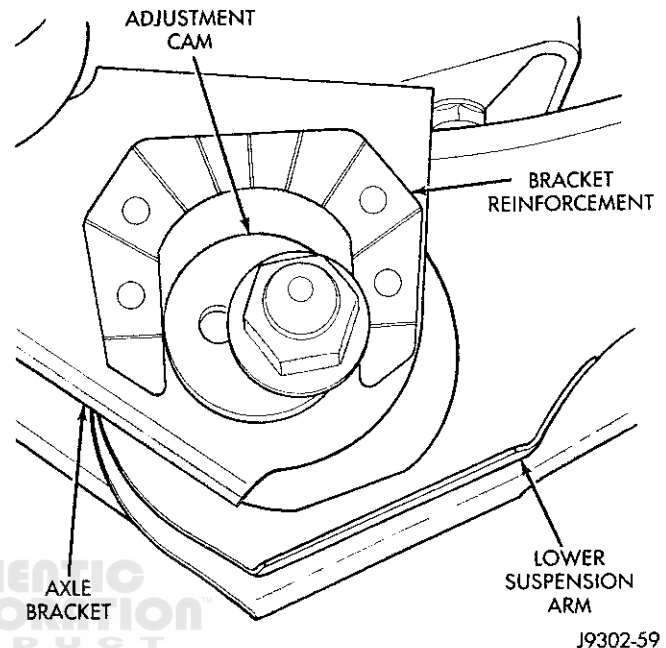


Fig. 4 Cam Adjuster

(3) Remove the lower suspension arm nut, cam and cam bolt from the axle.

(4) Remove the nut and bolt from the frame rail bracket and remove the lower suspension arm (Fig. 5).

INSTALLATION

(1) Position the lower suspension arm at the axle bracket and frame rail bracket.

(2) Install the rear bolt and finger tighten the nut.

(3) Install the cam bolt, cam and nut in the axle. Re-align the reference marks.

(4) Remove support and lower the vehicle.

(5) Tighten cam nut to specifications. Tighten rear nut to specifications.

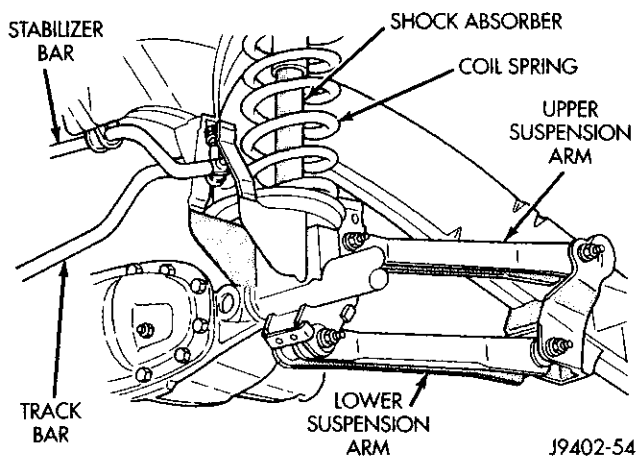
UPPER SUSPENSION ARM

REMOVAL

(1) Raise and support the vehicle.

(2) Remove the upper suspension arm nut and bolt at the axle bracket (Fig. 5).

(3) Remove the nut and bolt at the frame rail and remove the upper suspension arm.

REMOVAL AND INSTALLATION (Continued)

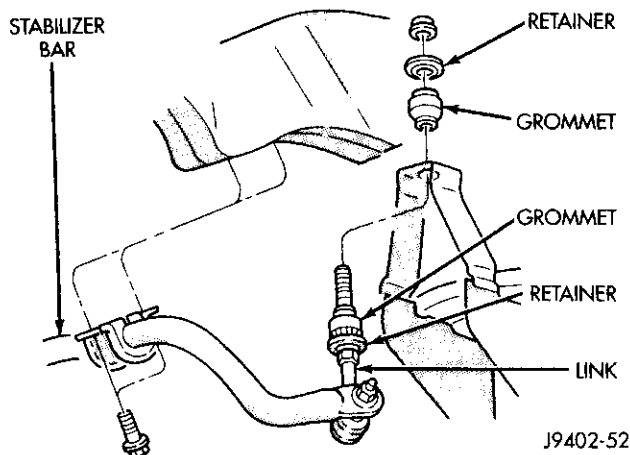
J9402-54

Fig. 5 Upper and Lower Suspension Arm**INSTALLATION**

- (1) Position the upper suspension arm at the axle and frame rail.
- (2) Install the bolts and finger tighten the nuts.
- (3) Remove the supports and lower the vehicle.
- (4) Tighten nut at the axle bracket to specifications. Tighten nut at frame bracket to specifications.

STABILIZER BAR**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Disconnect the stabilizer bar links from the axle brackets.
- (3) Disconnect the stabilizer bar from the links.
- (4) Disconnect the stabilizer bar clamps from the frame rails and remove the stabilizer bar (Fig. 6).



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Fig. 6 Stabilizer Bar**INSTALLATION**

- (1) Position the stabilizer bar on the frame rail and install the clamps and bolts. Ensure the bar is

centered with equal spacing on both sides. Tighten the bolts to specifications.

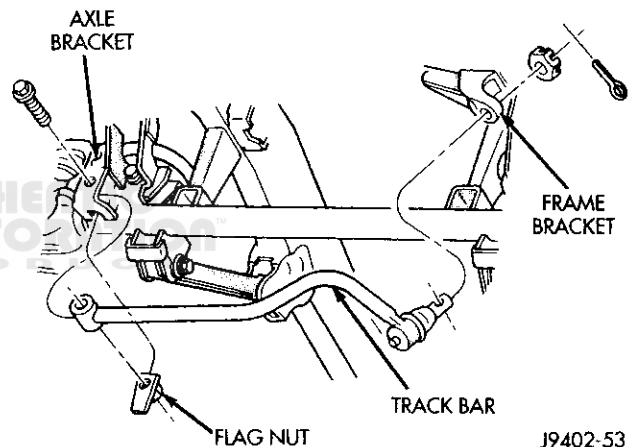
- (2) Install the links, grommets retainers and nuts onto the axle brackets. Tighten the nuts to specifications.

- (3) Install link on stabilizer bar and tighten nut to specifications.

- (4) Remove the supports and lower the vehicle.

TRACK BAR**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove the cotter pin and nut from the ball stud end at the frame rail bracket (Fig. 7).
- (3) Remove ball stud from bracket with Puller C-3894-A
- (4) Remove the bolt and flag nut from the axle bracket and remove the track bar (Fig. 7).



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Fig. 7 Track Bar**INSTALLATION**

- (1) Install the track bar at axle tube bracket. Loosely install the retaining bolt and flag nut.
- (2) Pry the axle assembly over to install the track bar at the frame rail bracket.
- (3) Install the retaining nut on the stud. Tighten the ball stud nut to specifications. Install a new cotter pin.
- (4) Remove the supports and lower the vehicle.
- (5) Tighten the bolt at the axle shaft tube bracket to specifications.

WHEEL HUB/BEARING**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove wheel and tire assembly.
- (3) Remove brake caliper and rotor, refer to Group 5 Brakes.
- (4) Remove cotter pin and axle hub nut.

REMOVAL AND INSTALLATION (Continued)

(5) Remove hub/bearing mounting bolts (Fig. 8) and remove hub/bearing from knuckle.

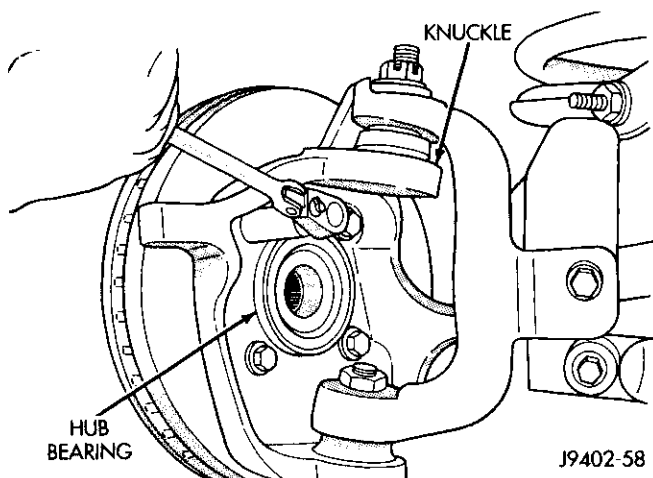


Fig. 8 Hub/Bearing & Knuckle

INSTALLATION

- (1) Install hub/bearing and tighten mounting bolts to specifications.
- (2) Install axle hub nut and tighten to specifications. Install cotter pin.
- (3) Install brake rotor and caliper, refer to Group 5 Brakes.
- (4) Install wheel and tire assembly.
- (5) Remove support and lower vehicle.

WHEEL MOUNTING STUDS

REMOVAL

- (1) Raise and support vehicle.
- (2) Remove wheel and tire assembly.
- (3) Remove brake caliper and rotor, refer to Group 5 Brakes for procedure.
- (4) Remove stud from hub with Remover C-4150A (Fig. 9).

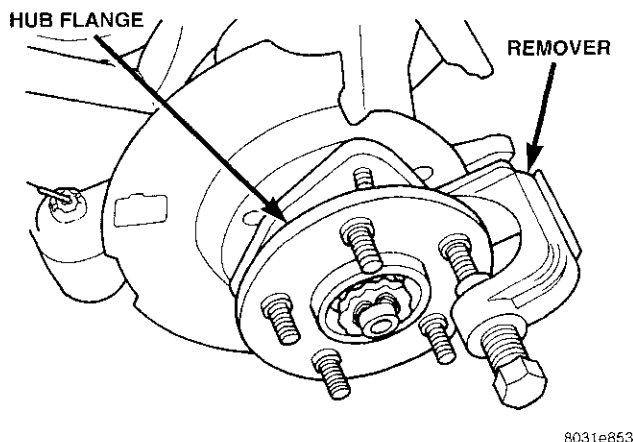


Fig. 9 Wheel Stud Removal

INSTALLATION

- (1) Install new stud into hub flange.
- (2) Install three washer onto stud, then install lug nut with the flat side of the nut against the washers.
- (3) Tighten lug nut until the stud is pulled into the hub flange. Verify that the stud is properly seated into the flange.
- (4) Remove lug nut and washers.
- (5) Install the brake rotor and caliper, refer to Group 5 Brakes for procedure.
- (6) Install wheel and tire assembly, use new lug nut on stud or studs that were replaced.
- (7) Remove support and lower vehicle.

SPECIFICATIONS

LINK/COIL SUSPENSION (WAX COAT FRAME)

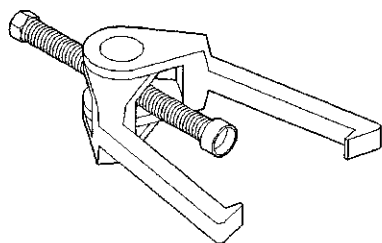
DESCRIPTION	TORQUE
Shock Absorber	
Upper Nut.....	.41 N·m (30 ft. lbs.)
Lower Bolt.....	.135 N·m (100 ft. lbs.)
Bracket.....	.75 N·m (55 ft. lbs.)
Suspension Arm Upper	
Axle Nut.....	.121 N·m (89 ft. lbs.)
Frame Nut.....	.84 N·m (62 ft. lbs.)
Suspension Arm Lower	
Axle Nut.....	.149 N·m (110 ft. lbs.)
Frame Nut.....	.122 N·m (90 ft. lbs.)
Stabilizer Bar	
Clamp Bolt.....	.47 N·m (35 ft. lbs.)
Link Upper Nut.....	.37 N·m (27 ft. lbs.)
Link Lower Nut.....	.118 N·m (87 ft. lbs.)
Track Bar	
Ball Stud Nut.....	.84 N·m (62 ft. lbs.)
Axle Bracket Bolt.....	.176 N·m (130 ft. lbs.)

LINK/COIL SUSPENSION (E-COAT FRAME)

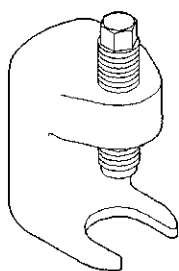
DESCRIPTION	TORQUE
Shock Absorber	
Upper Nut.....	.41 N·m (30 ft. lbs.)
Lower Bolt.....	.135 N·m (100 ft. lbs.)
Bracket.....	.75 N·m (55 ft. lbs.)
Suspension Arm Upper	
Axle Nut.....	.121 N·m (89 ft. lbs.)
Frame Nut.....	.149 N·m (110 ft. lbs.)
Suspension Arm Lower	
Axle Nut.....	.149 N·m (110 ft. lbs.)
Frame Nut.....	.217 N·m (150 ft. lbs.)
Stabilizer Bar	
Clamp Bolt.....	.61 N·m (45 ft. lbs.)
Link Upper Nut.....	.37 N·m (27 ft. lbs.)
Link Lower Nut.....	.118 N·m (87 ft. lbs.)
Track Bar	
Ball Stud Nut.....	.84 N·m (62 ft. lbs.)
Axle Bracket Bolt.....	.176 N·m (130 ft. lbs.)

SPECIAL TOOLS

LINK/COIL SUSPENSION



Puller C-3894-A



Remover C-4150A



**AUTHENTIC
RESTORATION™**
PRODUCT

REAR SUSPENSION

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GENERAL INFORMATION

WEIGHT DISTRIBUTION

A vehicle should always be loaded so the vehicle weight center-line is located immediately forward of the rear axle. Correct vehicle loading provides proper front tire-to-road contact. This results in maximum vehicle handling stability and safety. Incorrect vehicle weight distribution can cause excessive tire tread wear, spring fatigue or failure, and erratic steering.

DESCRIPTION AND OPERATION

SUSPENSION COMPONENT

The rear suspension is comprised of:

- Drive Axle
- Leaf Springs
- Dual-Action Shock Absorbers
- Stabilizer Bar
- Jounce Bumpers

Leaf Springs: The rear suspension system uses a multi-leaf springs and a solid drive axle. The forward end of the springs are mounted to the body rail hangers through rubber bushings. The rearward end of the springs are attached to the body by the use of shackles. The spring and shackles use rubber bushings. The bushing help to isolate road noise. The shackles allow the springs to change their length as the vehicle moves over various road conditions.

Shock Absorbers: Ride control is accomplished through the use of dual-action shock absorbers. The shocks dampen the jounce and rebound as the vehicle travels over various road conditions. The top of the shock absorbers are bolted to the body crossmember. The bottom of the shocks are bolted to the axle bracket.

Stabilizer Bar: The stabilizer bar is used to minimize vehicle body roll. The spring steel bar helps to control the vehicle body in relationship to the suspension. The bar extends across the underside of the

body and is attached to the body rails with grommets. Links at the end of the bar are attached to the leaf spring brackets.

Jounce Bumpers: The jounce bumpers are used to limit the spring and axle travel. They are bolted to the body rail above the axle.

NOTE: Suspension components that use rubber bushings should be tightened with the vehicle at the normal height. Rubber bushings must never be lubricated.

DIAGNOSIS AND TESTING

SPRING AND SHOCK DIAGNOSIS

A noise from a shock absorber may be caused by movement between mounting bushings and metal bracket or attaching components. This noise can usually be stopped by tightening the attaching nuts. If the noise persists, inspect for damaged and worn bushings, and attaching components. Repair as necessary if any of these conditions exist.

The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber, hold it in an upright position and force the piston in and out of the cylinder four or five times. The action throughout each stroke should be smooth and even.

The spring eye and shock absorber bushings do not require any type of lubrication. Do not attempt to stop spring bushing noise by lubricating them. Grease and mineral oil-base lubricants will deteriorate the bushing rubber.

If the vehicle is used for severe, off-road operation, the springs should be examined periodically. Check for broken and shifted leaves, loose and missing clips, and broken center bolts. Refer to Spring and Shock Absorber Diagnosis chart for additional information.

SPRING AND SHOCK ABSORBER DIAGNOSIS

CONDITION	POSSIBLE CAUSES	CORRECTION
SPRING SAGS	1. Broken leaves 2. Spring fatigue	1. Replace broken leaves 2. Replace spring
SPRING NOISE	1. Loose U-bolts 2. Worn bushings 3. Worn or missing leaf liners	1. Tighten U-bolts to specified torque 2. Replace bushings 3. Replace leaf liners
SHOCK ABSORBERS NOISY	1. Loose mounting bolt or nut 2. Worn bushings 3. Leaking shock	1. Tighten bolt or nut to specified torque 2. Replace shock absorber 3. Replace shock



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J9503-2

REMOVAL AND INSTALLATION**SHOCK ABSORBER****REMOVAL**

- (1) Raise vehicle and support axle.
- (2) Remove the bolt and flag nut from the frame crossmember bracket.
- (3) Remove the bolt and nut from the axle bracket.
- (4) Remove the rear shock absorber from the vehicle.

INSTALLATION

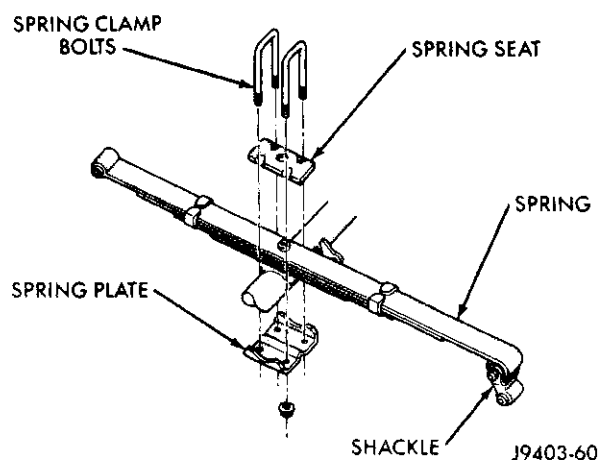
- (1) Position shock absorber in brackets.
- (2) Install bolts through the brackets and shock. Install flag nut on top bolt and nut on lower bolt.
- (3) Tighten upper and lower bolts to specifications
- (4) Remove the support and lower vehicle.

LEAF SPRING**REMOVAL**

- (1) Raise vehicle and support axle to remove all weight from springs.
- (2) Remove the nuts and spring clamp bolts that attach the spring to the axle (Fig. 1) and (Fig. 2) and (Fig. 3).

(3) Remove the nuts and bolts from the spring front and rear shackle eyes. **Note: To remove front eye bolt on left side spring fuel tank must be removed, refer to Group 14 for fuel tank procedure.**

- (4) Remove spring from vehicle.
- (5) Remove shackle from spring.

**Fig. 1 Rear Spring—4X2**

REMOVAL AND INSTALLATION (Continued)

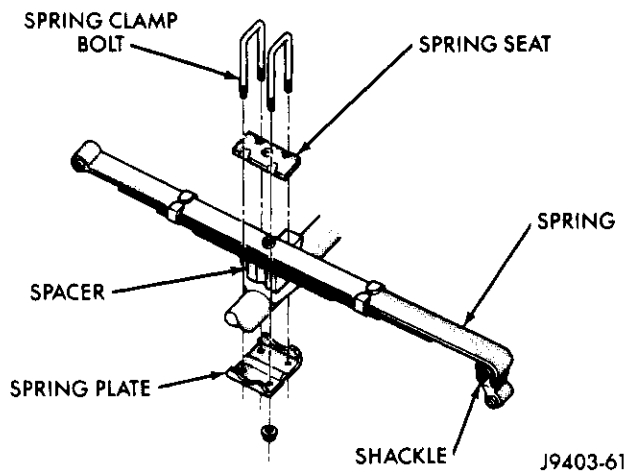


Fig. 2 Rear Spring—4X4

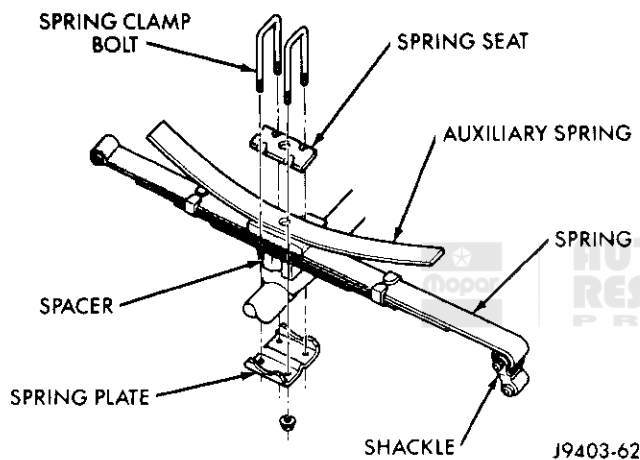


Fig. 3 Rear Spring—Cab-Chassis 11000 GVW

INSTALLATION

- (1) Install shackle on rear spring eye and install bolt and nut.
- (2) Position spring on axle shaft tube so spring center bolt is inserted into the locating hole in the axle tube spring pad or spacer.
- (3) Align spring front eye with bolt hole in the front bracket. Install the eye pivot bolt and nut.
- (4) Align shackle eye with bolt hole in rear bracket. Install bolt and nut.
- (5) Tighten the spring front and rear eye pivot bolt snug do not torque.

(6) Install spring clamp bolts and the retaining nuts.

(7) Align the auxiliary spring with the primary spring if equipped. Tighten the nuts until they force the plate flush against the axle tube.

(8) Remove the supports and lower the vehicle so that the weight is being supported by the tires.

(9) Tighten the spring clamp retaining nuts to specifications

(10) Tighten spring front and rear eye pivot bolt nuts and shackle eye to specifications.

SPECIFICATIONS

REAR SUSPENSION (WAX COAT FRAME)

DESCRIPTION	TORQUE
Shock Absorber	
Lower Nut	136 N·m (100 ft. lbs.)
Upper Nut	95 N·m (70 ft. lbs.)
Spring Clamp Nuts	
6,010-10,500 GVW	149 N·m (110 ft. lbs.)
11,000 GVW Cab-Chassis	163 N·m (120 ft. lbs.)
Spring Front and Rear Eye	
Bolt/Nut 6,010-7,500 GVW.	203 N·m (150 ft. lbs.)
Bolt/Nut 8,800-1,100 GVW.	285 N·m (210 ft. lbs.)
Jounce Bumper	
Bolts	45 N·m (33 ft. lbs.)

REAR SUSPENSION (E-COAT FRAME)

DESCRIPTION	TORQUE
Shock Absorber	
Lower Nut	136 N·m (100 ft. lbs.)
Upper Nut	149 N·m (110 ft. lbs.)
Spring Clamp Nuts	
6,010-10,500 GVW	149 N·m (110 ft. lbs.)
11,000 GVW Cab-Chassis	163 N·m (120 ft. lbs.)
Spring Front and Rear Eye	
Bolt/Nut 6,010-7,500 GVW.	203 N·m (150 ft. lbs.)
Bolt/Nut 8,800-1,100 GVW.	2271 N·m (200 ft. lbs.)
Jounce Bumper	
Bolts	61 N·m (45 ft. lbs.)

DIFFERENTIAL AND DRIVELINE

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PROPELLER SHAFTS

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GENERAL INFORMATION

PROPELLER SHAFTS

The function of a propeller shaft is to transmit power from one point to another in a smooth action. The shaft is designed to send torque through an angle from the transmission (transfer case on 4WD vehicles) to the axle.

The propeller shaft must operate through constantly changing relative angles between the transmission and axle. It must also be capable of changing length while transmitting torque. The axle rides suspended by springs in a floating motion. This means the propeller shaft must be able to change angles when going over various roads. This is accomplished through universal joints, which permit the propeller shaft to operate at different angles. The slip joints (or yokes) permit contraction or expansion.

Tubular propeller shafts are balanced by the manufacturer with weights spot welded to the tube.

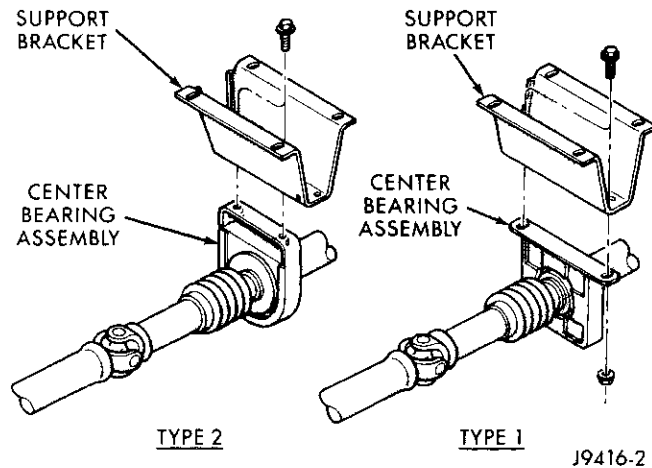
The propeller shaft is designed and built with the yoke lugs in line with each other which is called phasing. This design produces the smoothest running condition. An out of phase shaft can cause a vibration.

Before undercoating a vehicle, the propeller shaft and the U-joints should be covered. This will prevent the undercoating from causing an out of balance condition and vibration.

CAUTION: Use exact replacement parts for attaching the propeller shafts. This will ensure safe operation. The specified torque must always be applied when tightening the fasteners.

GENERAL INFORMATION (Continued)**CENTER BEARING**

The two-piece propeller shaft uses a center bearing to support the shafts. Two types of center bearings are used. Type 1 is used with the 9 1/4 axle. Type 2 is used with the Dana axles (Fig. 1). Both types are mounted in the same location.

**Fig. 1 Center Bearing****UNIVERSAL JOINTS**

The front prop shaft uses a 7290 series universal joints. The rear prop shaft uses a 7290 series universal joint with a 9 1/4 axle. A 1410 series universal joint is used with the Dana 60, 70 and 80 rear axles.

Shaft with 7290 series universal joints use external snap rings. Shafts with 1410 series universal joints use internal snap rings.

Two different types of universal joints systems are used:

- Single cardan universal joint (Fig. 2)
- Double cardan universal joint (Fig. 3)

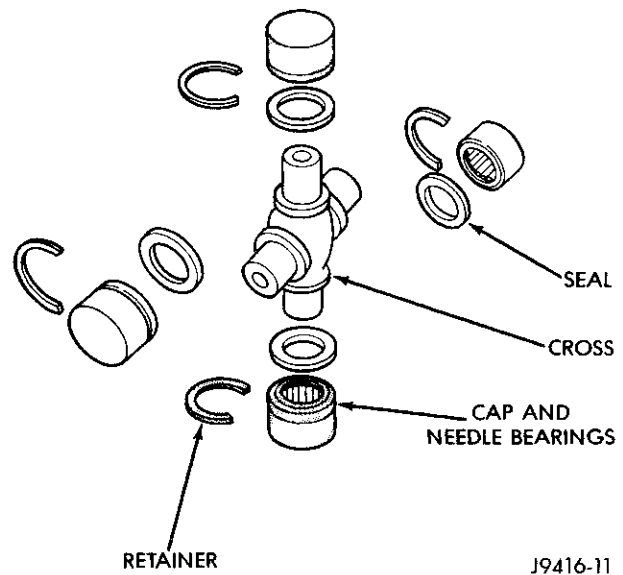
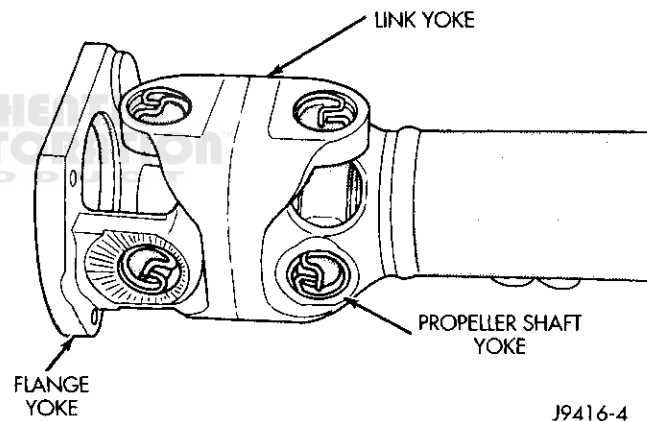
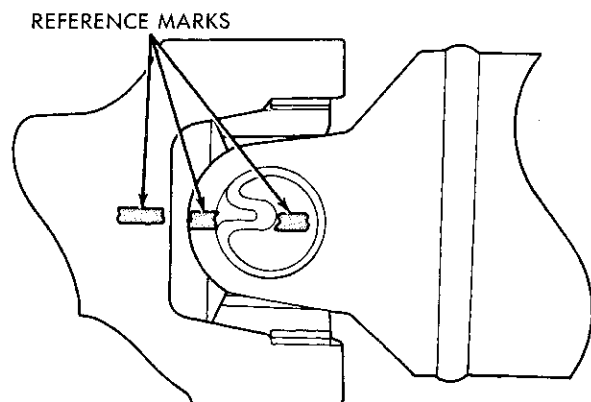
LUBRICATION

The slip yoke on the Type 1 front shaft is equipped with a lubrication fitting. Use a multi-purpose NLGI Grade 2 EP lubricant. The factory installed U-joints are lubricated for the life of the vehicle and do not need lubrication. All U-joints should be inspected for leakage and damage each time the vehicle is serviced. If seal leakage or damage exists, the U-joint should be replaced.

PRECAUTIONS

Use exact replacement hardware for attaching the propeller shafts. Exact replacement will ensure safe operation. The specified torque must always be applied when tightening the fasteners.

Put reference marks on the propshaft yoke and axle or transmission yoke before service (Fig. 4). This will assure correct phasing and eliminate possible vibration.

**Fig. 2 Single Cardan Universal Joint—Typical****Fig. 3 Double Cardan Universal Joint—Typical****Fig. 4 Reference Marks on Yokes**

GENERAL INFORMATION (Continued)

CAUTION: Do not allow the propeller shaft to drop or hang from either universal joint during removal. Attach it to the vehicle underside with wire to prevent damage to the universal joints.

CAUTION: It is very important to protect the machined, external surface of the slip yoke from damage after propeller shaft removal. If damaged, the transmission extension seal could be damaged and cause a leak.

DIAGNOSIS AND TESTING

VIBRATION

Tires that are out-of-round or wheels that are unbalanced will cause a low frequency vibration. Refer to Group 22, Wheels and Tires for additional information.

Brake drums that are unbalanced will cause a harsh, low frequency vibration. Refer to Group 5, Brakes for additional information.

Driveline vibration can also result from loose or damaged engine mounts. Refer to Group 21, Transmissions for additional information.

Propeller shaft vibration will increase as the vehicle speed is increased. A vibration that occurs within a specific speed range is not caused by propeller shaft unbalance. Defective universal joints or an incorrect propeller shaft angle are usually the cause.

UNBALANCE

If propeller shaft unbalance is suspected, it can be verified with the following procedure:

Removing and re-indexing the propeller shaft 180° may eliminate some vibrations.

- Clean all the foreign material from the propeller shaft and the universal joints.

- Inspect the propeller shaft for missing balance weights, broken welds, and bent areas. **If the propeller shaft is bent, it must be replaced.**

- Ensure the universal joints are not worn, are properly installed, and are correctly aligned with the shaft.

- Check the universal joint clamp screws torque

- (1) Raise the vehicle.

- (2) Remove the wheel and tires assembly. Install the wheel lug nuts to retain the brake drums.

- (3) Mark and number the shaft six inches from the yoke end at four positions 90° apart.

- (4) Run and accelerate the vehicle until vibration occurs. Note the intensity and speed the vibration occurred. Stop the engine.

- (5) Install a screw clamp at position 1 (Fig. 5).

- (6) Start the engine and re-check for vibration. If there is little or no change in vibration, move the clamp to one of the other three positions. Repeat the vibration test.

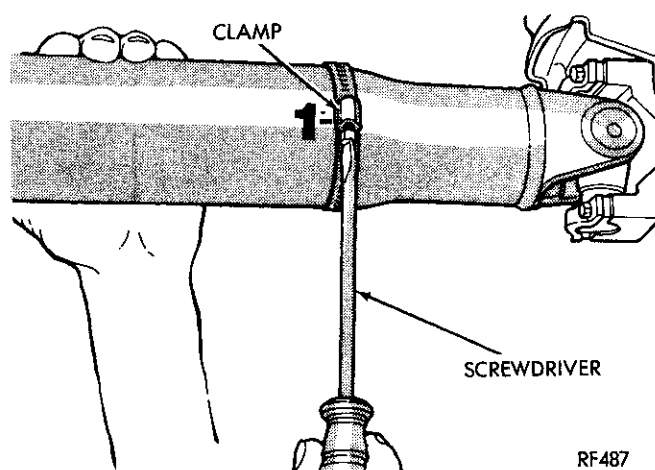
- (7) If there is no difference in vibration at the other positions, the vibration may not be propeller shaft unbalance.

- (8) If the vibration decreased, install a second clamp (Fig. 6) and repeat the test.

DRIVELINE VIBRATION

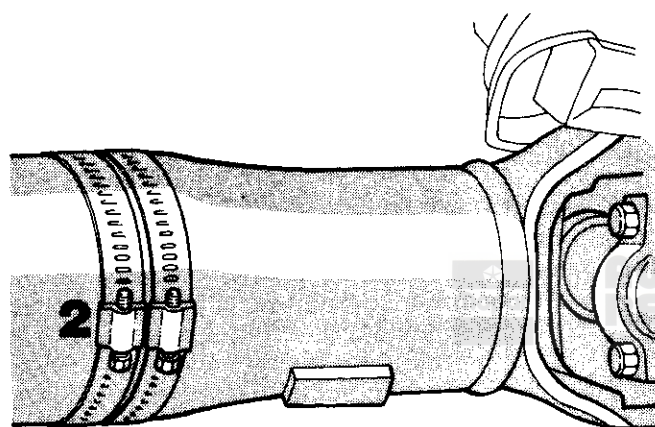
Drive Condition	Possible Cause	Correction
PROPELLER SHAFT	a. Undercoating or other foreign material on shaft. b. Loose U-joint clamp screws. c. Loose or bent U-joint yoke or excessive runout. d. Incorrect drive line angularity. e. Rear spring center bolt not in seat. f. Worn U-joint bearings. g. Propeller shaft damaged (bent tube) or out of balance. h. Broken rear spring. i. Excessive runout or unbalanced condition. j. Excessive drive pinion gear shaft yoke runout.	a. Clean exterior of shaft and wash with solvent. b. Tighten screws properly. c. Install replacement yoke. d. Correct angularity e. Loosen spring U-bolts and seat center bolts. f. Replace U-joint. g. Install replacement propeller shaft. h. Replace rear spring. i. Reindex propeller shaft 180°, test and correct as necessary. j. Reindex propeller shaft 180° and evaluate.
UNIVERSAL JOINT NOISE	a. U-joint clamp screws loose. b. Lack of lubrication.	a. Tighten screws with specified torque. b. Replace U-joint.

DIAGNOSIS AND TESTING (Continued)



RF487

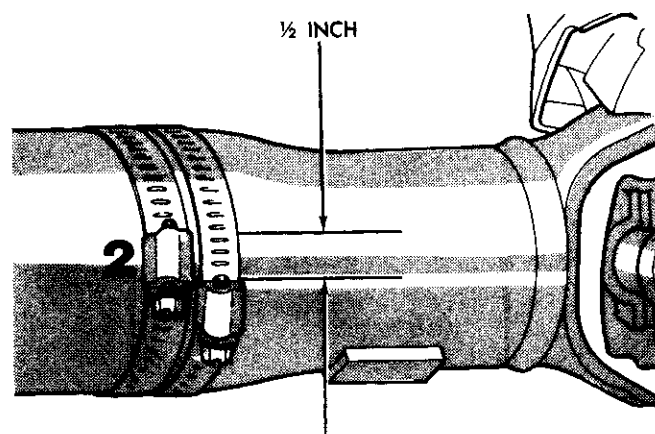
Fig. 5 Clamp Screw At Position 1



RF488

Fig. 6 Two Clamp Screws At The Same Position

(9) If the clamps cause an additional unbalance, separate the clamps (1/4 inch above and below the mark). Repeat the vibration test (Fig. 7).



RF489

Fig. 7 Clamp Screws Separated

(10) Increase distance between the clamp screws and repeat the test until the amount of vibration is at the lowest level. Bend the slack end of the clamps so the screws will not loosen.

(11) Install the wheel and tires. Lower the vehicle.

(12) If the amount of vibration remains unacceptable, apply procedures at the front end of the propeller shaft.

RUNOUT

(1) Remove dirt, rust, paint, and undercoating from the propeller shaft surface. Areas where the dial indicator will contact the shaft must be clean.

(2) The dial indicator must be installed perpendicular to the shaft surface.

(3) Measure runout at the center and ends away from welds.

(4) Refer to Runout Specifications chart.

(5) Replace the propeller shaft if the runout exceeds the limit.

RUNOUT SPECIFICATIONS

Front of shaft	0.010 in. (0.25 mm)
Center of shaft	0.015 in. (0.38 mm)
Rear of shaft	0.010 in. (0.25 mm)

NOTE: Measure front/rear runout approximately 3 inches (76 mm) from the weld seam at each end of the shaft tube for tube lengths over 30 inches. Under 30 inches the max. runout is 0.20 inch for full length of the tube.

J9116-15

SERVICE PROCEDURES

UNIVERSAL JOINT ANGLE

INFORMATION

When two shafts come together at any common joint, the bend that is formed is called the operating angle. The larger the angle, the larger the amount of acceleration and deceleration of the joint. This speeding up and slowing down of the joint must be cancelled to produce a smooth power flow. This is done through phasing and proper universal joint working angles.

A propeller shaft is properly phased when the yoke ends are on the same plane or in line. A twisted shaft will throw the yokes out of phase and cause a noticeable vibration.

When taking universal joint angle measurements or checking phasing with two piece shafts, consider each shaft separately. On 4WD vehicles, the front shaft input (pinion shaft) angle has priority over the caster angle.

Ideally the driveline system should have;

SERVICE PROCEDURES (Continued)

- Angles that are in equal or opposite within 1 degree of each other
- Have a 3 degree maximum operating angle
- Have at least a 1/2 degree continuous operating (propeller shaft) angle

Engine speed (rpm) is the main factor though in determining maximum allowable operating angles. As a guide to maximum normal operating angles refer to the chart listed (Fig. 8).

PROPELLER SHAFT R.P.M.	MAX. NORMAL OPERATING ANGLES
5000	3°
4500	3°
4000	4°
3500	5°
3000	5°
2500	7°
2000	8°
1500	11°

J9316-4

Fig. 8 Maximum Angles And Engine Speed

INSPECTION

Before measuring universal joint angles, the following must be done.

- Inflate all tires to correct pressure
- Check angles in the same loaded or unloaded condition as when the vibration occurred. Propeller shaft angles will change according to the amount of load in the vehicle. Always check angles in loaded and unloaded conditions.
- Check the condition of all suspension components and verify all fasteners are torqued to specifications.
- Check the condition of the engine and transmission mounts and verify all fasteners are torqued to specifications.

PROPELLER SHAFT ANGLE MEASUREMENT

To accurately check driveline alignment, raise and support the vehicle at the axles as level as possible. Allow the wheels and propeller shaft to turn. Remove any external bearing snap rings (if equipped) from universal joint so protractor base sits flat.

(1) Rotate the shaft until transmission/transfer case output yoke bearing is facing downward.

Always make measurements from front to rear.

(2) Place Inclinator on yoke bearing (A) parallel to the shaft (Fig. 9). Center bubble in sight glass and record measurement.

This measurement will give you the transmission or Output Yoke Angle (A).

(3) Rotate propeller shaft 90 degrees and place Inclinator on yoke bearing parallel to the shaft (Fig. 10). Center bubble in sight glass and record

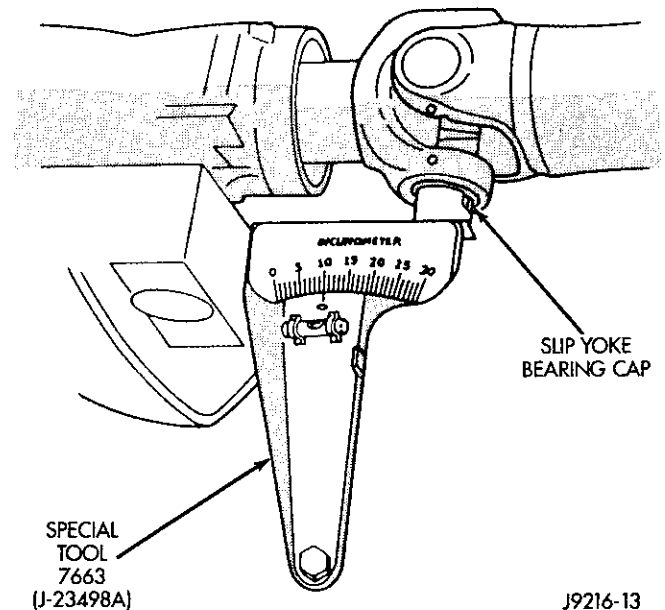


Fig. 9 Front (Output) Angle Measurement (A)

measurement. This measurement can also be taken at the rear end of the shaft.

This measurement will give you the Propeller Shaft Angle (C).

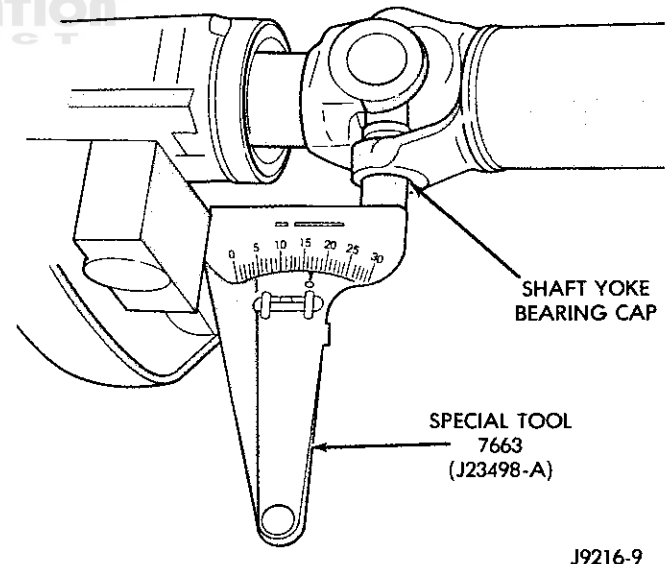


Fig. 10 Propeller Shaft Angle Measurement (C)

(4) Subtract smaller figure from larger (C minus A) to obtain Transmission Output Operating Angle.

(5) Rotate propeller shaft 90 degrees and place Inclinator on pinion yoke bearing parallel to the shaft (Fig. 11). Center bubble in sight glass and record measurement.

This measurement will give you the pinion shaft or Input Yoke Angle (B).

SERVICE PROCEDURES (Continued)

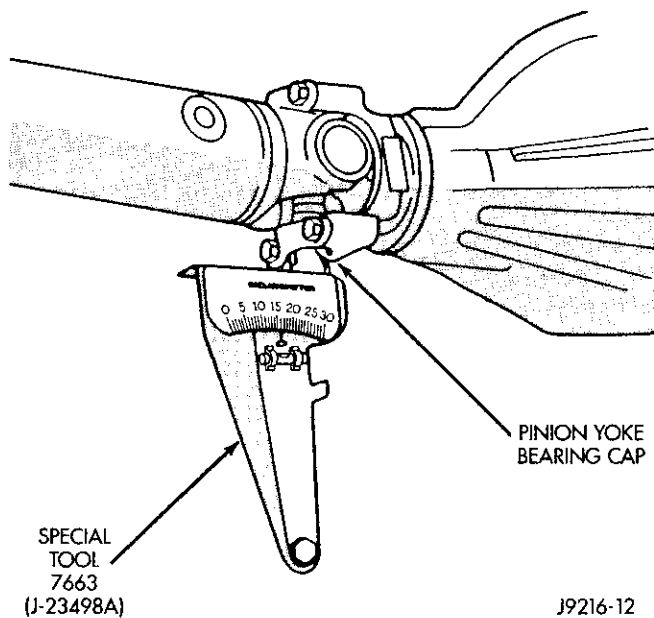


Fig. 11 Rear (Input) Angle Measurement (B)

(6) Subtract smaller figure from larger (C minus B) to obtain axle Input Operating Angle.

Refer to rules given below and the example in (Fig. 12) for additional information.

- Good cancellation of U-joint operating angles (within 1°)

- Operating angles less than 3°
- At least 1/2 of one degree continuous operating (propeller shaft) angle

MEASUREMENT—TWO-PIECE SHAFT

A rear propeller shaft U-joint angle can be easily measured with Special Tool 7663.

The front half-shaft must be parallel to the rear axle pinion gear shaft. The front and rear half-shafts must be offset by a minimum of 1/2 of a degree. From the transmission/transfer case output shaft and from each other.

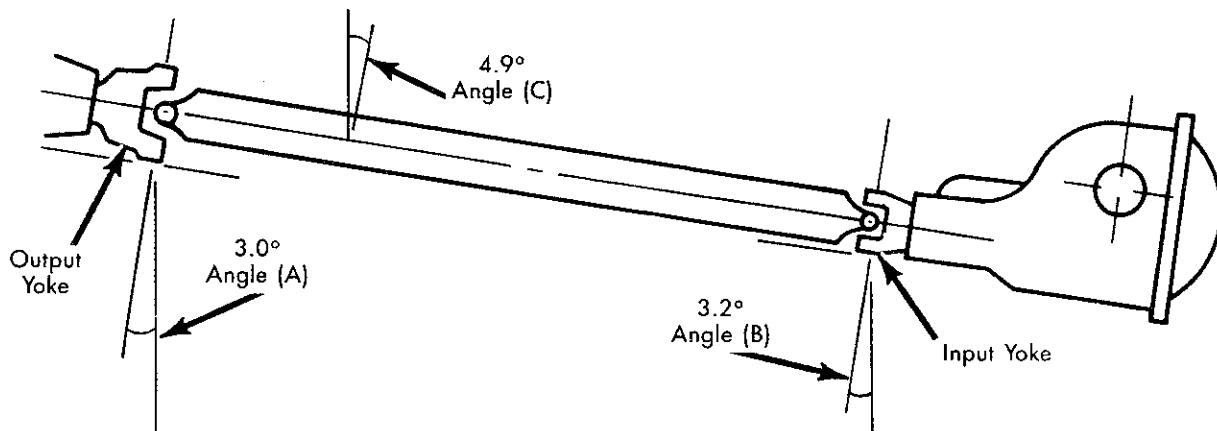
To accurately check driveline alignment, raise and support the vehicle at the axles as level as possible. Allow the wheels and propeller shaft to turn. Remove any external bearing snap rings (if equipped) from universal joint so protractor base sits flat.

(1) Rotate the shaft until transmission/transfer case output yoke bearing is facing downward.

(2) Place Inclinator on yoke bearing (A) parallel to the shaft (Fig. 13). Center bubble in sight glass and record measurement.

(3) Repeat measurement procedure on bearing cap B and C. Record these measurements.

(4) Excessive variation in measurement angles of A, B or C indicate propeller mis-alignment. **Vertical alignment of a two-piece shaft at the yokes should be greater than one-half degree and as close to one degree as possible.**



Horizontal Level

(A) Output Yoke = 3.0° 4.9°
 (C) Prop. Shaft = 4.9° or -3.0°

Transmission Output 1.9°
 Operating Angle

(B) Axle Input Yoke = 3.2° 4.9°
 (C) Prop. Shaft = 4.9° or -3.2°

Axle Input 1.7°
 Operating Angle

Trans. Output Operating Angle 1.9°
 Axle Input Operating Angle -1.7°

Amount of U-Joint Cancellation 0.2°

J9316-3

Fig. 12 Universal Joint Angle Example

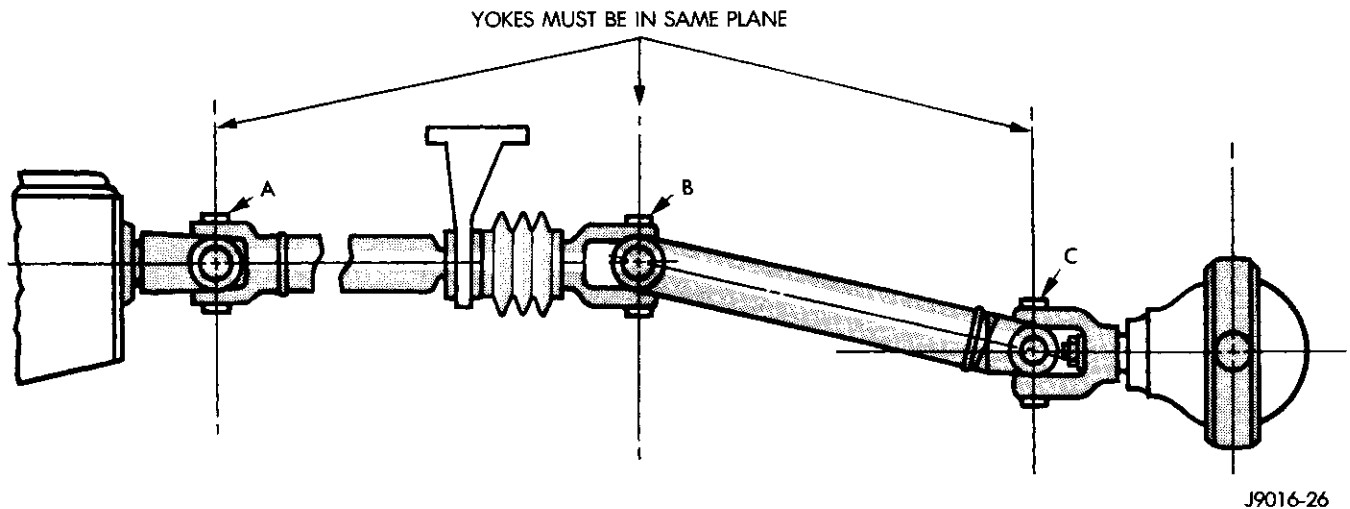


Fig. 13 Universal Joint Angle—Two-Piece Shaft

REMOVAL AND INSTALLATION

FRONT PROPELLER SHAFT

REMOVAL

(1) Shift the transmission and transfer case to their neutral positions. Raise and support vehicle. Remove skid plates (if equipped), refer to Group 13 Frames.

(2) Scribe alignment mark on transfer case and propeller shaft flanges. Scribe mark on pinion shaft yoke and propeller shaft. These marks will be used for installation reference (Fig. 14).

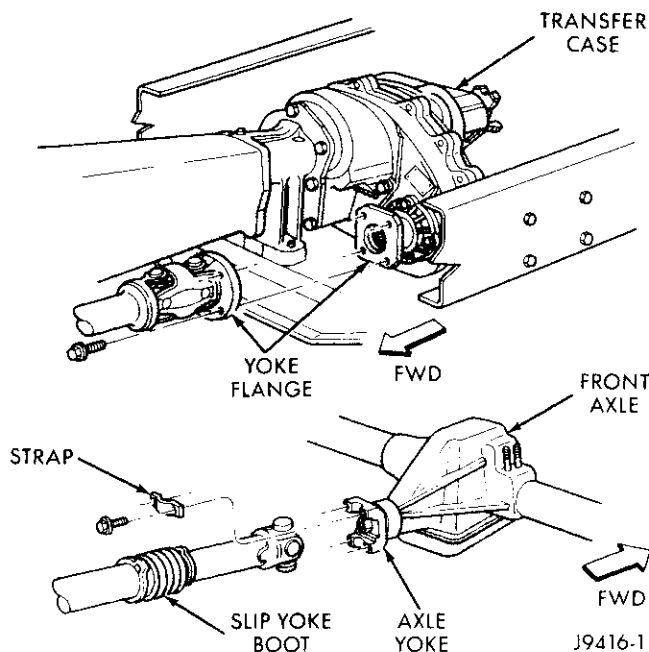


Fig. 14 Front Propeller Shaft

(3) Remove the U-joint strap bolts at the pinion shaft yoke.

(4) Remove bolts from transfer case yoke flange and remove the propeller shaft.

INSTALLATION

(1) Position the propeller shaft with the yoke reference marks aligned. Install the propeller shaft (Fig. 14).

Replacement U-joint straps and bolts must be installed.

(2) Tighten the U-joint strap bolts at the pinion shaft to 19 N·m (14 ft. lbs.) torque.

Tighten the transfer case bolts to 88 N·m (65 ft. lbs.) torque.

(3) Install skid plates (if equipped), refer to Group 13, Frames. Remove support and lower the vehicle.

REAR PROPELLER SHAFT

REMOVAL

(1) Shift the transmission and transfer case (if applicable) to their Neutral positions. Raise and support vehicle.

(2) Scribe alignment marks on the pinion yoke.

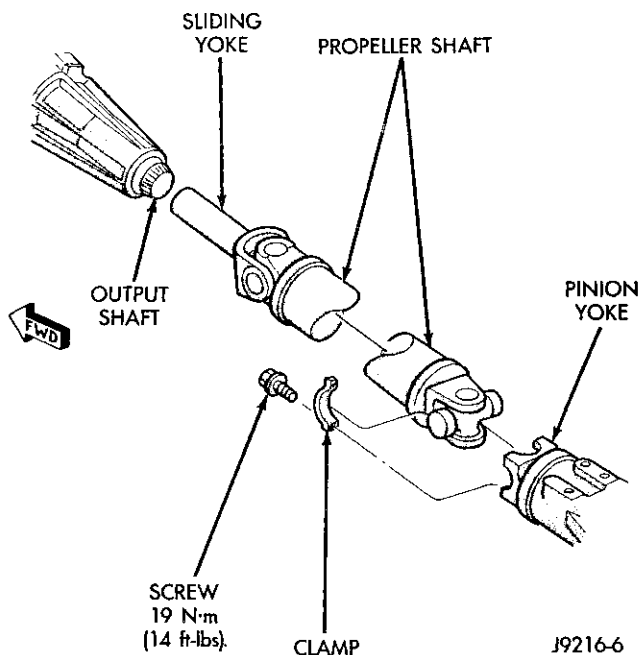
(3) Remove the U-joint strap bolts at pinion shaft yoke.

(4) Slide the slip yoke off of the transmission/transfer case output shaft and remove the propeller shaft (Fig. 15).

INSTALLATION

(1) Slide the slip yoke on the transmission/transfer case output shaft. Align the installation reference marks at the axle yoke and install the propeller shaft (Fig. 15).

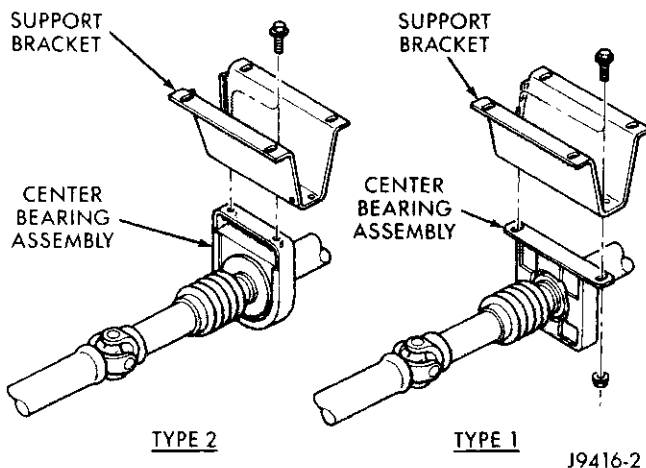
Replacement U-joint straps and bolts must be installed.

REMOVAL AND INSTALLATION (Continued)**Fig. 15 Rear Propeller Shaft**

- (2) Tighten the U-joint strap bolts to;
 - Dana Axle: 29 N·m (22 ft. lbs.) torque.
 - 9 1/4 Axle: 19 N·m (14 ft. lbs.) torque.
- (3) Remove support and lower the vehicle.

TWO PIECE PROPELLER SHAFT—REAR

The two piece shaft has a center bearing which supports the shafts where they are joined together (Fig. 16).

**Fig. 16 Center Bearing****REMOVAL**

- (1) Shift the transmission/transfer case to their Neutral positions. Raise and support vehicle.
- (2) Scribe alignment marks on the pinion yoke.
- (3) Remove the universal joint strap bolts at the pinion shaft yoke.

(4) Scribe alignment marks on the frame cross-member for center bearing reference. Remove bolts that attach the center bearing to the support bracket (Fig. 16).

(5) Slide the slip yoke off transmission output shaft and remove the propeller shaft.

INSTALLATION

(1) Slide the slip yoke on transmission output shaft. Align the installation reference marks at the axle yoke.

(2) Align and install the center bearing to the support bracket. Install the bolts and tighten to 68 N·m (50 ft. lbs.) torque.

Replacement U-joint straps and bolts must be installed.

- (3) Tighten the U-joint strap bolts to;
 - Dana Axle: 29 N·m (22 ft. lbs.) torque.
 - 9 1/4 Axle: 19 N·m (14 ft. lbs.) torque.
- (4) Lower the vehicle.

DISASSEMBLY AND ASSEMBLY**CENTER BEARING**

Vehicles equipped with a two-piece rear propeller shaft have a rubber insulated center bearing. The bearing supports the shafts where they join together. The two-piece propeller shaft uses two types of center bearings. Type 1 is used with the 9 1/4 axle. Type 2 is used with the Dana axles. Both types are mounted in the same location and service the same.

REMOVAL

- (1) Remove rear two-piece shaft. Refer to two-piece removal.
- (2) Remove slip joint boot clamp and separate the two shafts. The slip joints are master splined.
- (3) Use hammer and punch to tap slinger away from shaft to provide room for bearing splitter.
- (4) Position Bearing Splitter Tool 1130 between slinger and shaft.

CAUTION: Do not damage shaft spline during removal of center bearing.

(5) Set shaft in press and press bearing off the shaft.

INSTALLATION

(1) Install new slinger on shaft and drive into position with 2 1/2 in. ID pipe for type 1 center bearing. For type 2 center bearing use 2 1/4 in. ID pipe to install slinger.

(2) Install new center bearing on shaft with Bearing Installer Tool 6052. Drive on shaft with hammer until bearing is seated.

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Clean shaft splines and apply a coat of multi-purpose grease.

(4) Align master splines and slide front and rear shafts together. Reposition slip yoke boot and install new clamp.

(5) Install two-piece shaft in vehicle. Refer to installation two-piece shaft.

SINGLE CARDAN

REMOVAL

Single cardan universal joints are not serviceable. If worn or leaking, they must be replaced as a unit.

(1) Remove the propeller shaft. Refer to Propeller Shaft Replacement in this Group.

(2) **Paint or score alignment marks on the yokes and propeller shaft for installation reference.**

(3) Using a soft drift, tap the outside of the bearing assembly to loosen snap ring.

(4) Remove snap rings from both sides of yoke (Fig. 17).

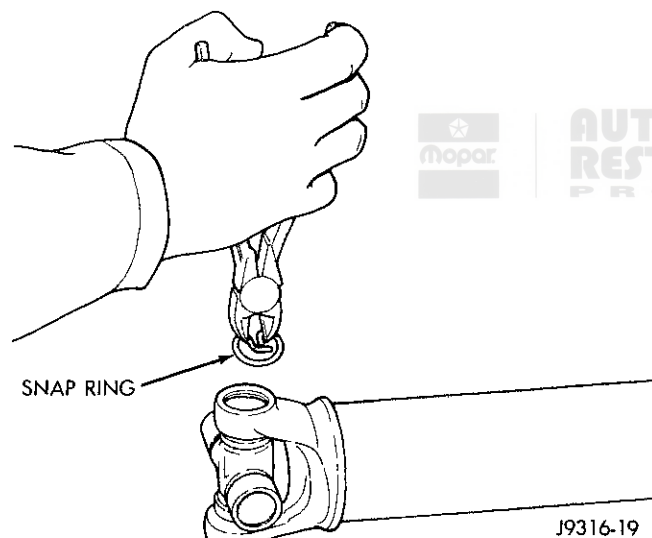


Fig. 17 Remove Snap Ring

(5) Set the yoke in an arbor press or vise with a large socket beneath it. Position the yoke with the grease fitting pointing up (if equipped). Place a smaller socket on the upper bearing assembly and press it through to release the lower bearing assembly (Fig. 18).

(6) If the bearing assembly will not pull out by hand after pressing, tap the base of the lug near it to dislodge.

(7) To remove the opposite bearing, turn the yoke over and straighten the cross in the open hole. Then carefully press the end of the cross until the remaining bearing can be removed (Fig. 19).

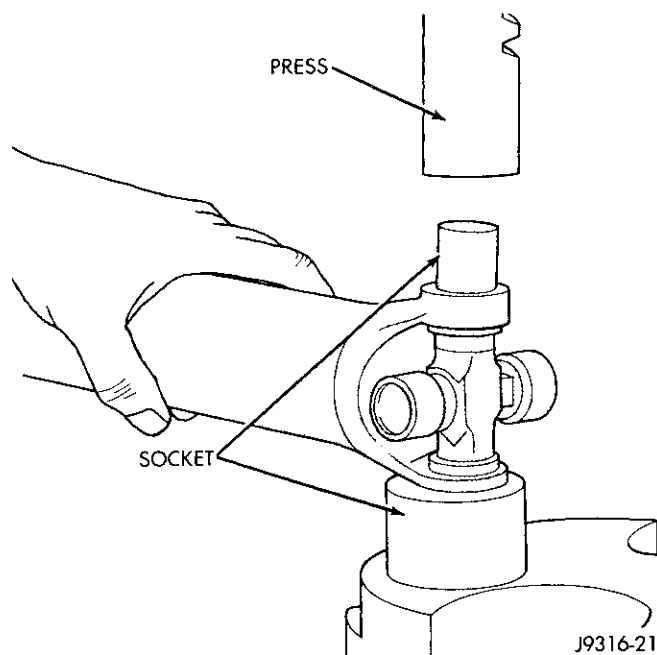


Fig. 18 Press Out Bearing

CAUTION: If the cross or bearing assembly are cocked when being pressed, the bearing assembly will score the walls of the yoke bore and ruin the yoke.

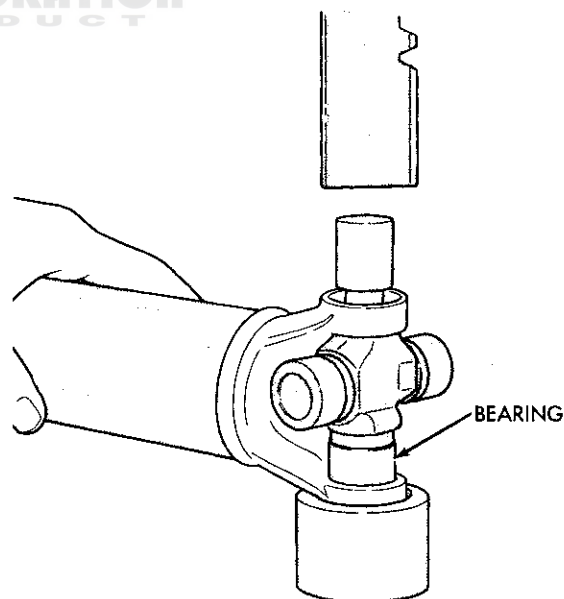


Fig. 19 Press Out Remaining Bearing

DISASSEMBLY AND ASSEMBLY (Continued)**ASSEMBLY**

(1) Apply extreme pressure (EP) N.L.G.I. Grade 1 or 2 grease to aid in installation.

(2) Position the cross in the yoke with its lube fitting (if equipped) pointing up (Fig. 20).

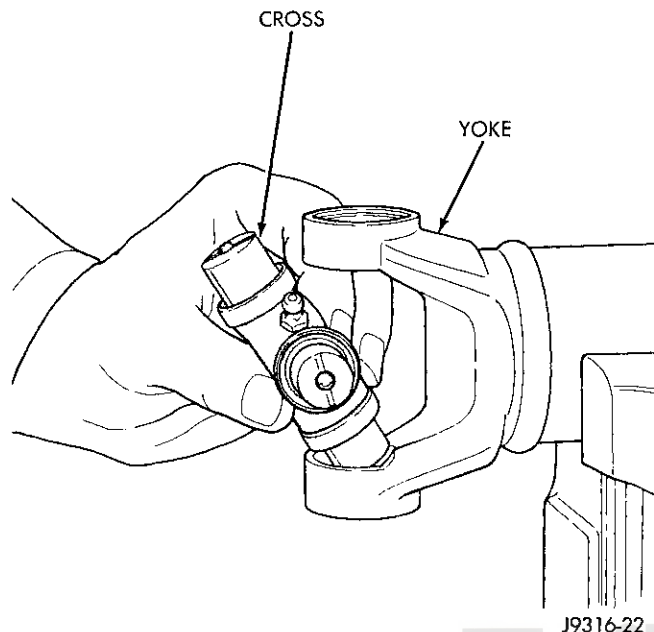


Fig. 20 Install Cross In Yoke

(3) Place a bearing assembly over the trunnion and align it with the cross hole (Fig. 21). Keep the needle bearings upright in the bearing assembly. A needle roller lying at the bottom will prevent proper assembly.

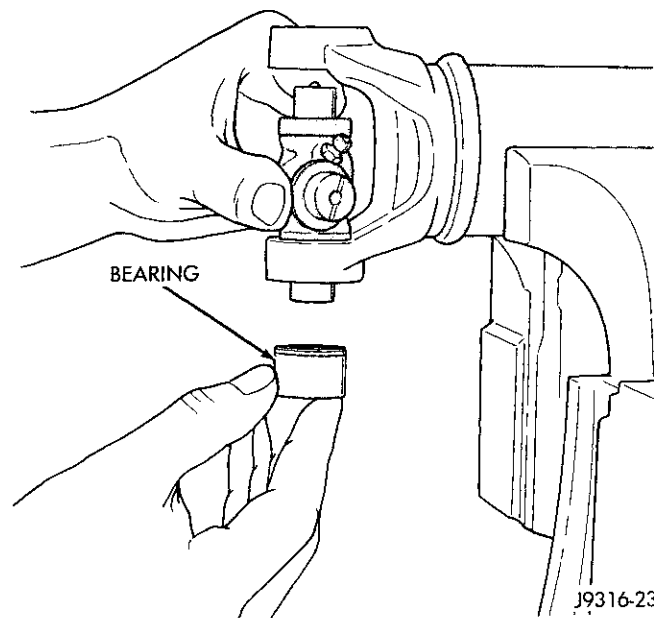


Fig. 21 Install Bearing On Trunnion

(4) Press the bearing assembly into the cross hole enough to install a snap ring. Install a snap ring.

(5) Repeat steps 3 and 4 to install the opposite bearing assembly. If the joint is stiff, strike the yoke with a soft hammer to seat the needle bearings. Install a snap ring.

(6) Add grease to lube fitting (if equipped).

(7) Install the propeller shaft.

DOUBLE CARDAN (CV)**REMOVAL**

Cardan universal joints are not serviceable. If worn or leaking, they must be replaced as a unit.

(1) Remove the propeller shaft. Refer to Propeller Shaft Replacement in this Group.

(2) **Paint or score alignment marks on the yokes and propeller shaft for installation reference.**

(3) Remove all the bearing assembly snap rings (Fig. 22).

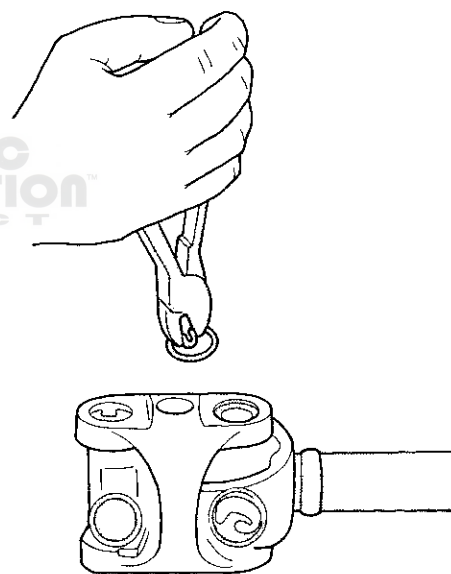
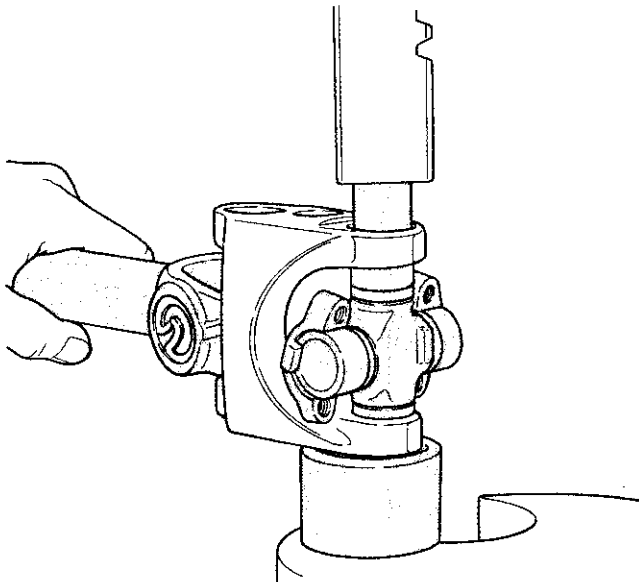


Fig. 22 Remove Snap Rings

DISASSEMBLY AND ASSEMBLY (Continued)

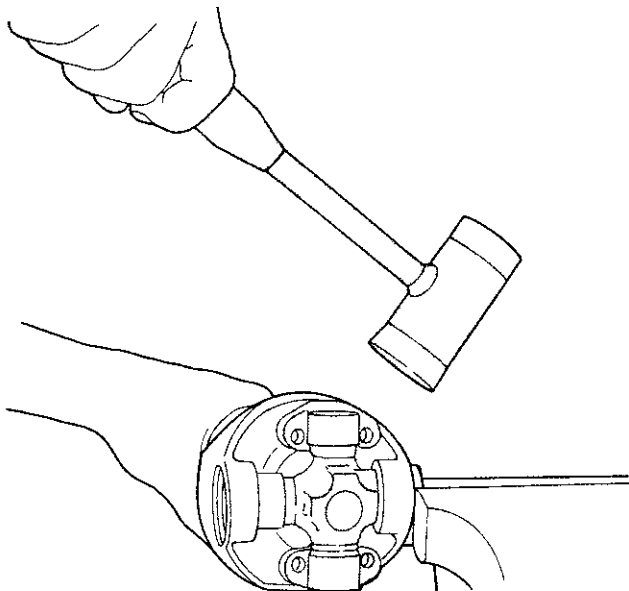
(4) Press the bearing assembly partially from the outboard side of the center yoke, enough to grasp by vise jaws (Fig. 23). Be sure to remove grease fittings that interfere with removal.



J9316-6

Fig. 23 Press Out Bearing

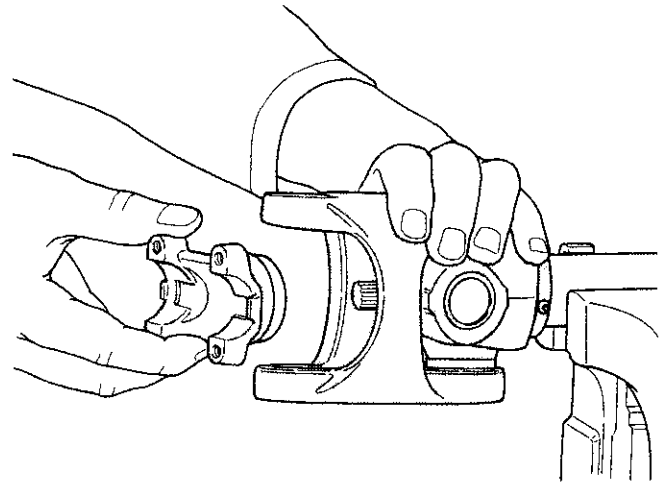
(5) Grasp the protruding bearing by vise jaws. Tap the tube yoke with a mallet and drift to dislodge from the yoke (Fig. 24).



J9316-7

Fig. 24 Remove Bearing From Yoke

(6) Flip assembly and repeat steps 4 and 5 for removing the opposite side bearing. This will then allow removal of the cross centering kit assembly and spring (Fig. 25).



J9316-8

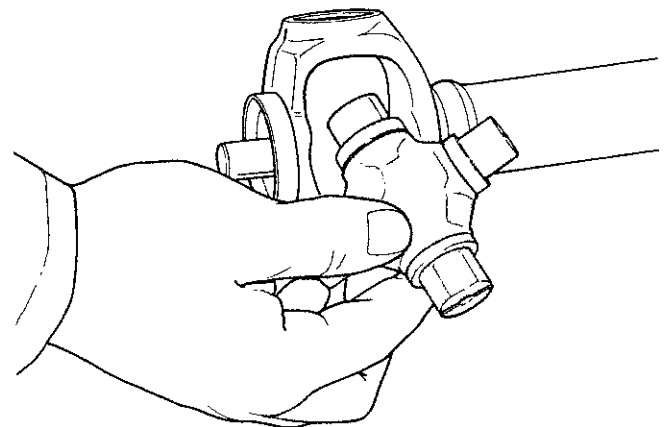
Fig. 25 Remove Centering Kit

(7) Press the remaining bearing assemblies out the other cross as described above to complete the disassembly.

INSTALLATION

During installation, ensure that the spiders and yokes are aligned to the reference marks.

(1) Fit a cross into the tube yoke (Fig. 26).

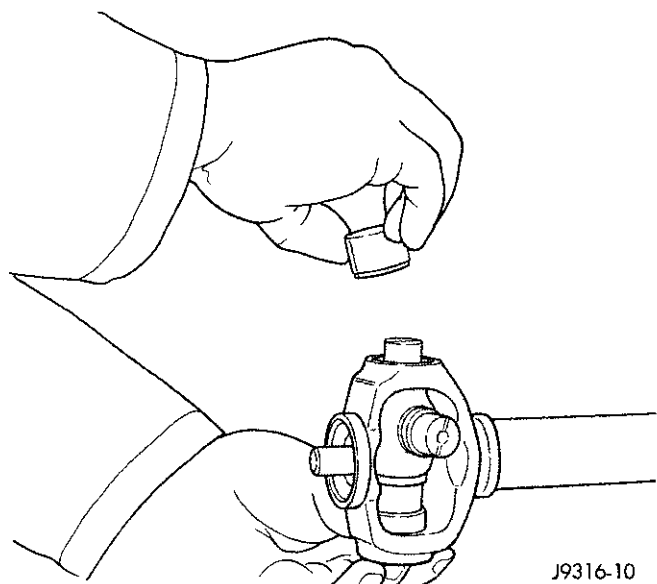


J9316-9

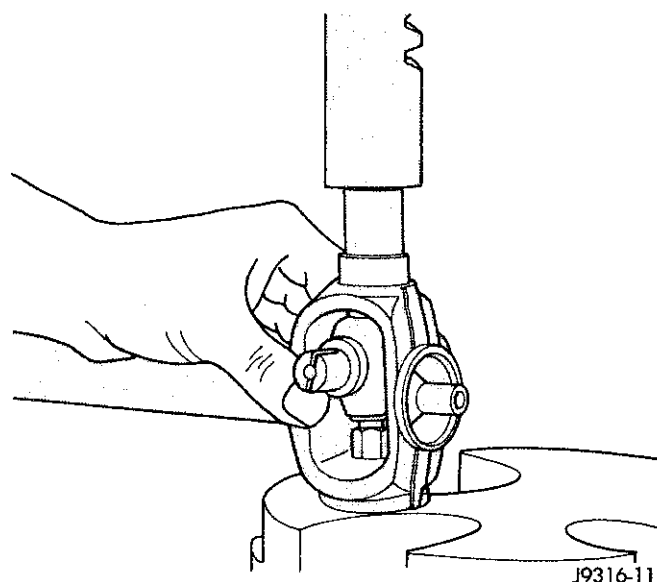
Fig. 26 Install Cross In Yoke

DISASSEMBLY AND ASSEMBLY (Continued)

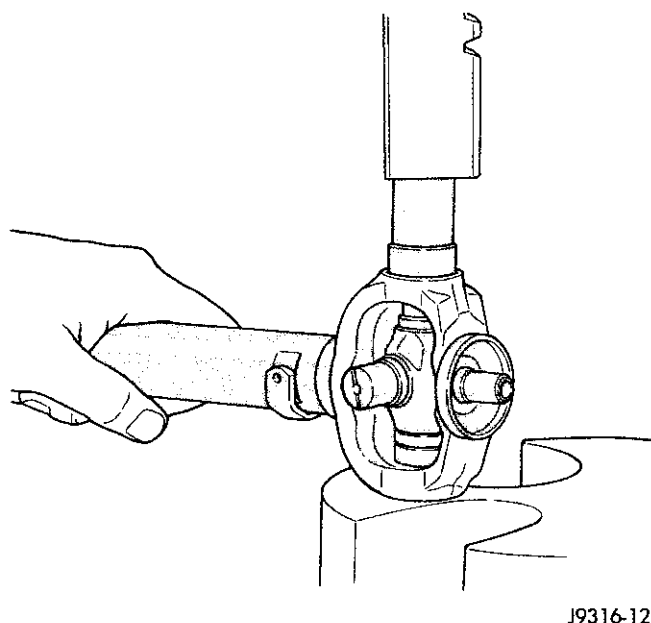
(2) Place a bearing assembly in a tube yoke hole and over a trunnion. Keep the needle bearings upright in the bearing assembly (Fig. 27). A needle roller lying at the bottom will prevent proper assembly. Be sure to remove any lube fittings that may interfere with removal.

**Fig. 27 Install Bearing Assembly**

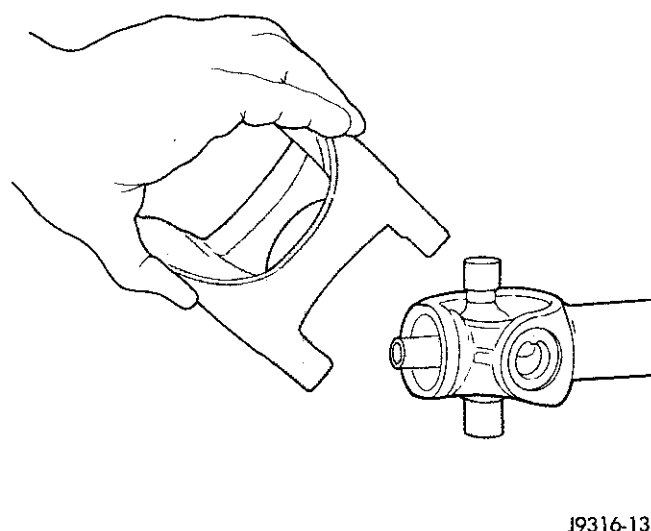
(3) Press the bearing assembly in place and install a snap ring (Fig. 28).

**Fig. 28 Press In Bearing Assembly**

(4) Flip the tube yoke and bearing assembly installation on the opposite trunnion. Install a snap ring (Fig. 29).

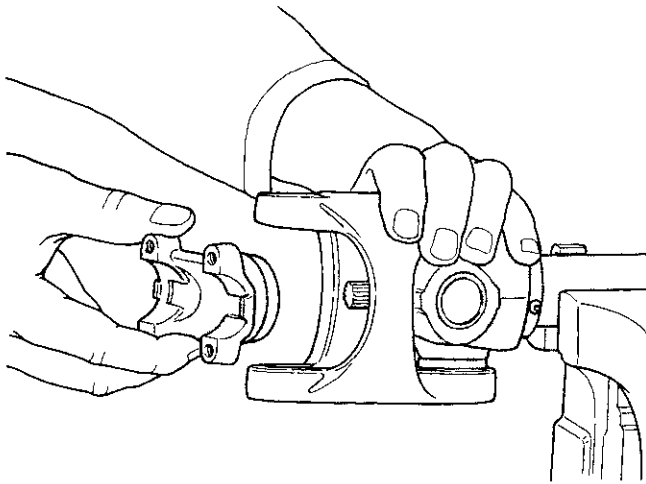
**Fig. 29 Press In Bearing Assembly**

(5) Fit the center yoke on the remaining two trunnions and press bearing assemblies in place, both sides (Fig. 30). Install a snap ring.

**Fig. 30 Install Center Yoke**

DISASSEMBLY AND ASSEMBLY (Continued)

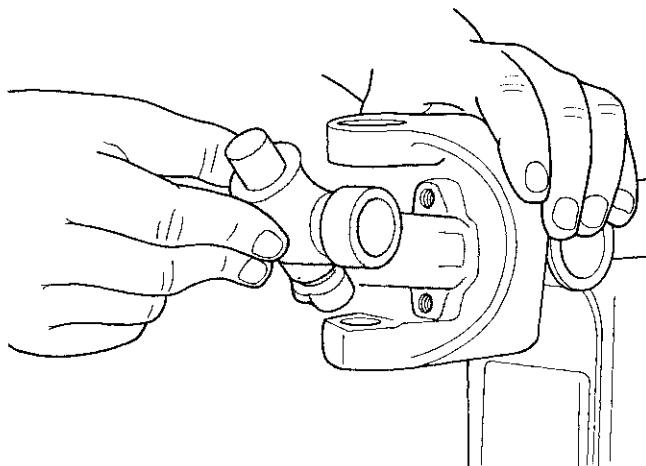
(6) Install the centering kit assembly inside the center yoke making sure the spring is in place (Fig. 31).



J9316-14

Fig. 31 Install Centering Kit

(7) Place two bearing assemblies on the remaining cross (opposite sides). Fit the open trunnions into the center yoke holes and the bearing assemblies into the centering kit (Fig. 32).



J9316-15

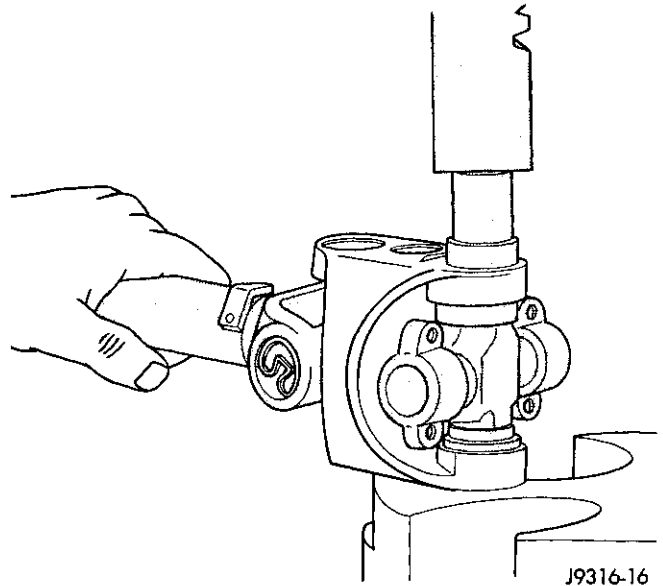
Fig. 32 Install Remaining Cross

(8) Press the remaining two bearing assemblies into place and install snap rings (Fig. 33).

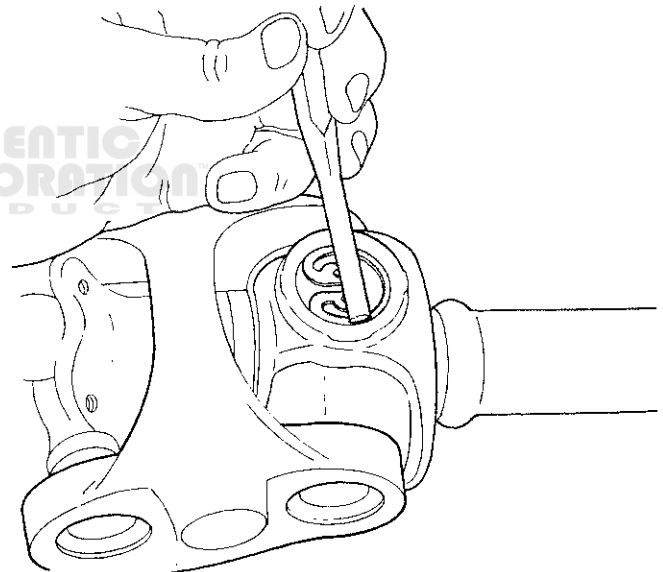
(9) Tap the snap rings to allow them to seat into the grooves (Fig. 34).

(10) Check for proper assembly. Flex the CV joint beyond center, it should snap over-center in both directions when correctly assembled (Fig. 35).

(11) Install the propeller shaft.



J9316-16

Fig. 33 Press In Bearing Assembly

J9316-17

Fig. 34 Seat Snap Rings In Groove**CLEANING AND INSPECTION****SINGLE AND DOUBLE CARDAN JOINT**

(1) Clean all the universal joint yoke bores with cleaning solvent and a wire brush.

(2) Inspect the yokes for distortion, cracks and worn bearing assembly bores.

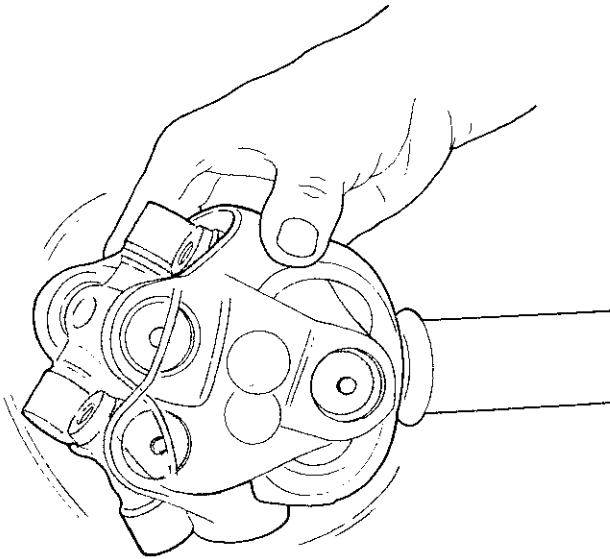


Fig. 35 Check Assembly

J9316-18

ADJUSTMENTS

ADJUSTMENT AT AXLE WITH LEAF SPRINGS

Adjust the pinion shaft angle at the springs with tapered shims (Fig. 36). Install tapered shims between the springs and axle pad to correct the angle. Refer to Rear Suspension for additional information.

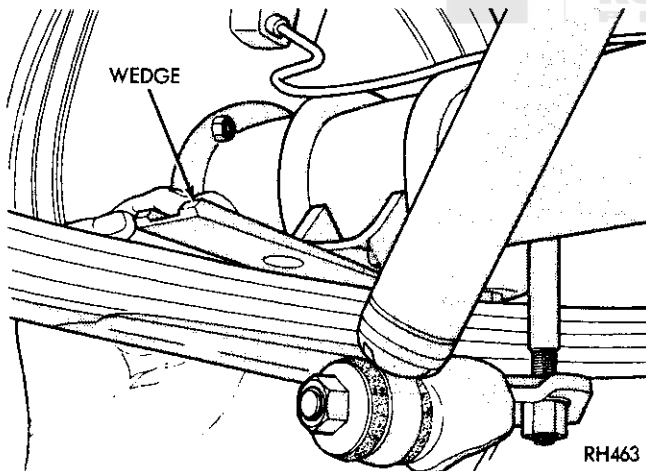


Fig. 36 Adjustment at Leaf Springs—Typical

CENTER BEARING ADJUSTMENT—TWO PIECE SHAFT

Drive away shudder is the vibration that occurs at first acceleration from a stop. Shudder vibration usually peaks at the engines highest torque output. Shudder is a symptom associated on vehicles using a two-piece prop shaft. To decreased shudder lowering the center bearing in 1/8 inch increments. Use shim stock or fabricated plates (Fig. 37). Plate stock must be used to maintain compression of the rubber insulator around the bearing. Do not use

washers. Replace the original bolts with the appropriate increased length bolts.

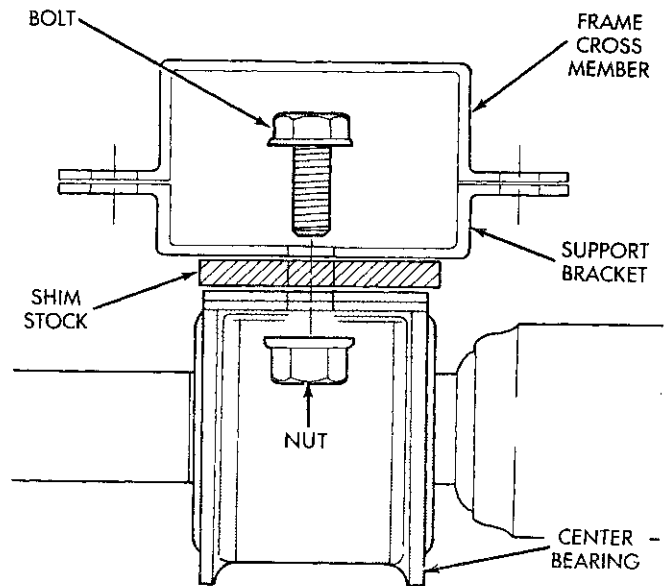


Fig. 37 Angle Adjustment at Center Bearing

J9316-25

SPECIFICATIONS

TORQUE

DESCRIPTION

TORQUE

FRONT SHAFT

Bolts, flange yoke88 N·m (65 ft. lbs.)
Bolts, axle yoke.....19 N·m (14 ft. lbs.)

REAR SHAFT AXLE YOKE BOLTS

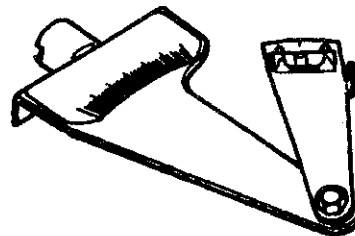
9 1/4 Axle19 N·m (14 ft. lbs.)
Dana Axle.....30 N·m (22 ft. lbs.)

CENTER BEARING BRACKET

Frame Bolts68 N·m (50 ft. lbs.)
Bearing Bolts68 N·m (50 ft. lbs.)

SPECIAL TOOLS

PROPELLER SHAFT



Inclinometer—7663

FRONT AXLE—MODEL 44/60

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GENERAL INFORMATION

GENERAL INFORMATION

The housing for Model 44/60 front axles consists of an iron center casting with tubes on each side. The tubes are pressed into and welded to the differential housing.

The integral type housing, hypoid gear design has the centerline of the pinion set below the centerline of the ring gear.

The axle has a vent used to relieve internal pressure caused by lubricant vaporization and internal expansion.

The axles are equipped with semi-floating axle shafts, meaning that loads are supported by the hub bearings. The axle shafts are retained by nuts at the hub bearings. The hub bearings are bolted to the steering knuckle at the outboard end of the axle tube yoke. The hub bearings are serviced as an assembly.

The axles are equipped with ABS brake sensors. The sensors are attached to the knuckle assemblies and tone rings are pressed on the axle shaft. **Use care when removing axle shafts as NOT to damage the tone wheel or the sensor.**

The stamped steel cover provides a means for inspection and servicing the differential.

The Model 44/60 axle has the assembly part number and gear ratio listed on a tag. The tag is attached to the housing cover. Build date identification codes are stamped on the axle shaft tube cover side.

The differential case is a one-piece design. The differential pinion mate shaft is retained with a roll pin. Differential bearing preload and ring gear backlash is adjusted by the use of shims. The shims are located between the differential bearing cones and case. Pinion bearing preload is set and maintained by the use of a collapsible spacer.

FRONT DRIVE AXLE

The integral type housing, has the centerline of the pinion set below the centerline of the ring gear.

The axles are equipped with optional A.B.S. brake system. The A.B.S. tone rings are pressed onto the axle shaft near the hub and knuckle. For additional information on the A.B.S. system refer to Group 5, Brakes.

The Dana 44 and 60 axle has the assembly part number and gear ratio listed on a tag. The tag is

GENERAL INFORMATION (Continued)

attached to the housing cover (Fig. 1) or (Fig. 2). Build date identification codes are stamped on the axle shaft tube cover side.

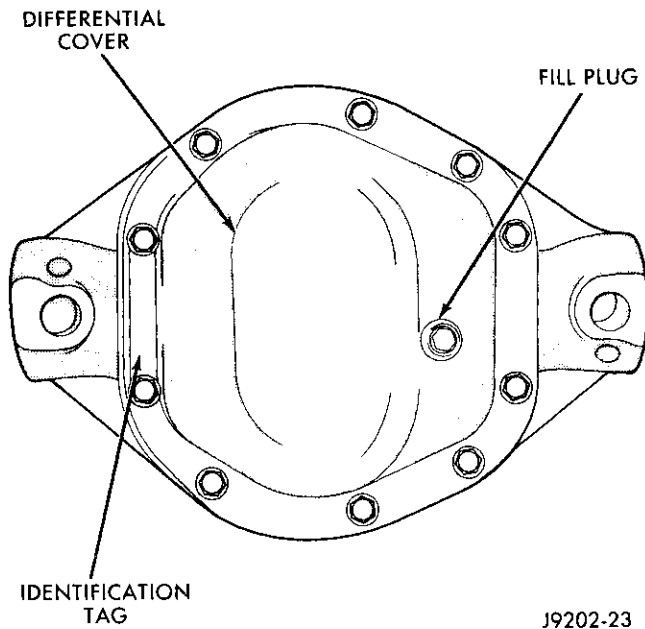


Fig. 1 Model 44 Differential Cover

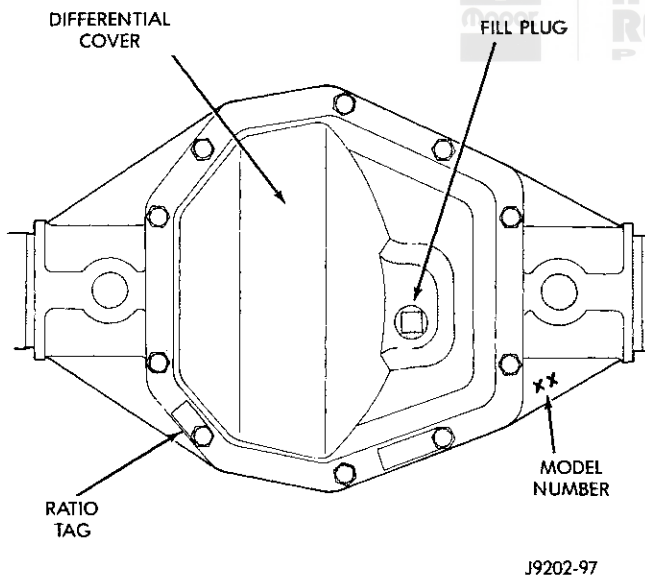


Fig. 2 Model 60 Differential Cover

LUBRICANT SPECIFICATIONS

Thermal Stable Multi-Purpose Gear Lubricant is used for Model 44/60 axles. The lubricant should have API GL 5 quality specifications. Mopar, Thermal Stable Multi-Purpose Gear Lubricant conforms to these specifications.

- The factory fill for the Model 44/60 axle is SAE 80W-90 gear lubricant

Refer to Group 0, Lubrication and Maintenance for additional information.

CAUTION: If axle is submerged in water, the lubricant must be replaced immediately to avoid contamination.

STANDARD DIFFERENTIAL OPERATION

The differential gear system divides the torque between the axle shafts. It allows the axle shafts to rotate at different speeds when turning corners.

Each differential side gear is splined to an axle shaft. The pinion gears are mounted on a pinion mate shaft and are free to rotate on the shaft. The pinion gear is fitted in a bore in the differential case and is positioned at a right angle to the axle shafts.

In operation, power flow occurs as follows:

- Pinion gear rotates the ring gear
- Ring gear (bolted to the differential case) rotates the case
- Differential pinion gears (mounted on the pinion mate shaft in the case) rotate the side gears
- Side gears (splined to the axle shafts) rotate the shafts

During straight-ahead driving, the differential pinion gears do not rotate on the pinion mate shaft. This occurs because input torque applied to the gears is divided and distributed equally between the two side gears. As a result, the pinion gears revolve with the pinion mate shaft but do not rotate around it (Fig. 3).

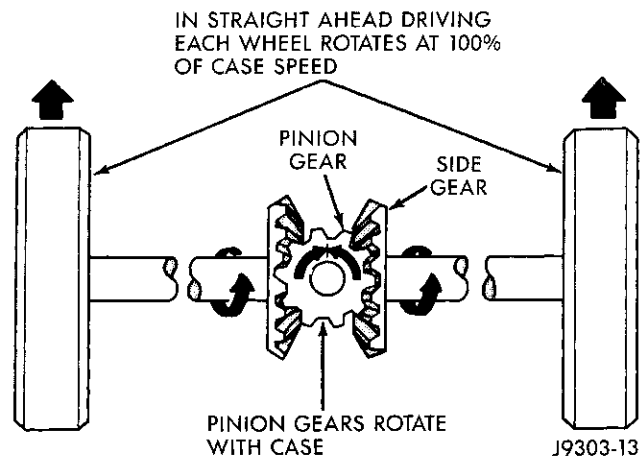


Fig. 3 Differential Operation—Straight Ahead Driving

When turning corners, the outside wheel must travel a greater distance than the inside wheel in order to complete a turn. This difference must be compensated for in order to prevent the wheels from scuffing and skidding through the turn. To accomplish this the differential allows the axle shafts to turn at unequal speeds (Fig. 4). In this instance, the

GENERAL INFORMATION (Continued)

input torque applied to the pinion gears is not divided equally. The pinion gears now rotate around the pinion mate shaft in opposite directions. This allows the side gear and axle shaft attached to the outside wheel to rotate at a faster speed.

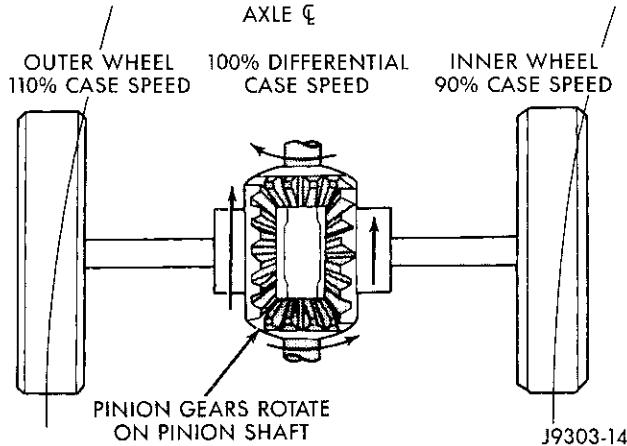


Fig. 4 Differential Operation—On Turns

VACUUM DISCONNECT

VACUUM CONTROL SYSTEM

The disconnect axle control system consists of;

- Shift motor
- Indicator switch
- Vacuum switch
- Vacuum harness (Fig. 5)

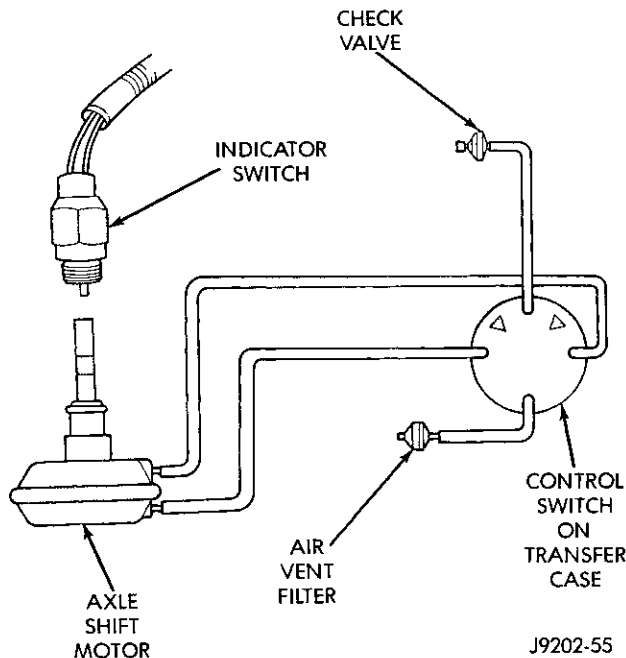


Fig. 5 Vacuum Control System

Refer to Group 21 Transmissions for additional information.

DIAGNOSIS AND TESTING

DIAGNOSIS INFORMATION

Axle bearing problem conditions are usually caused by:

- Insufficient or incorrect lubricant
- Foreign matter/water contamination
- Incorrect bearing preload torque adjustment
- Incorrect backlash (to tight)

When serviced, the bearings must be cleaned thoroughly. They should be dried with lint-free shop towels. **Never dry bearings with compressed air. This will overheat them and brinell the bearing surfaces. This will result in noisy operation after repair.**

Axle gear problem conditions are usually the result of:

- Insufficient lubrication
- Incorrect or contaminated lubricant
- Overloading (excessive engine torque)
- Exceeding vehicle weight capacity
- Incorrect clearance or backlash adjustment

Insufficient lubrication is usually the result of a housing cover leak. It can also be from worn axle shaft or pinion gear seals. Check for cracks or porous areas in the housing or tubes.

Using the wrong lubricant will cause overheating and gear failure. Gear tooth cracking and bearing spalling are indicators of this.

Axle component breakage is most often the result of:

- Severe overloading
- Insufficient lubricant
- Incorrect lubricant
- Improperly tightened components

Common causes of overloading is from full throttle acceleration. Overloading happens when towing heavier than recommended loads. Component breakage can occur when the wheels are spun excessively. Insufficient or incorrect lubricants contribute to breakage through overheating. Loose differential components can also cause breakage.

Incorrect bearing preload or gear backlash will not result in component breakage. This will cause accelerated wear and contribute to early failure. Mis-adjustment will produce noise. If a mis-adjustment condition is not corrected, component failure can result.

Excessive bearing preload may not be noisy. This condition will cause high temperature which can result in bearing failure.

DIAGNOSIS AND TESTING (Continued)**GEAR AND BEARING NOISE****GEAR NOISE**

Axle gear noise can be caused by insufficient lubricant. Incorrect backlash, tooth contact, or worn/damaged gears can cause noise.

Gear noise usually happens at a specific speed range. The range is 30 to 40 mph, or above 50 mph. The noise can also occur during a specific type of driving condition. These conditions are acceleration, deceleration, coast, or constant load.

When road testing, accelerate the vehicle to the speed range where the noise is the greatest. Shift out-of-gear and coast through the peak-noise range. If the noise stops or changes greatly, check for insufficient lubricant. Incorrect ring gear backlash, or gear damage can cause noise changes.

Differential side and pinion gears can be checked by turning the vehicle. They usually do not cause noise in straight-ahead driving. The side gears are loaded during vehicle turns. If noise does occur during vehicle turns, the side or pinion gears could be worn or damaged. A worn pinion gear mate shaft can also cause a snapping or a knocking noise.

BEARING NOISE

The axle shaft, differential and pinion gear bearings can all produce noise when worn or damaged. Bearing noise can be either a whining, or a growling sound.

Pinion gear bearings have a constant-pitch noise. This noise changes only with vehicle speed. Pinion bearing noise will be higher because it rotates at a faster rate. Drive the vehicle and load the differential. If bearing noise occurs the pinion rear bearing is the source of the noise. If the bearing noise is heard during a coast, front bearing is the source.

Worn, damaged differential bearings usually produce a low pitch noise. Differential bearing noise is similar to pinion bearing. The pitch of differential bearing noise is also constant and varies only with vehicle speed.

Axle shaft bearings produce noise and vibration when worn or damaged. The noise generally changes when the bearings are loaded. Road test the vehicle. Turn the vehicle sharply to the left and to the right. This will load the bearings and change the noise level. Where axle bearing damage is slight, the noise is usually not noticeable at speeds above 30 mph.

LOW SPEED KNOCK

Low speed knock is generally caused by a worn U-joint or by worn side-gear thrust washers. A worn pinion gear shaft bore will also cause low speed knock.

VIBRATION

Vibration at the rear of the vehicle is usually caused by:

- Damaged drive shaft
- Missing drive shaft balance weight
- Worn, out-of-balance wheels
- Loose wheel lug nuts
- Worn U-joint
- Loose spring U-bolts
- Loose/broken springs
- Damaged axle shaft bearings
- Loose pinion gear nut
- Excessive pinion yoke run out
- Bent axle shaft

Check for loose or damaged front-end components or engine/transmission mounts. These components can contribute to what appears to be a rear-end vibration. Do not overlook engine accessories, brackets and drive belts.

All driveline components should be examined before starting any repair.

Refer to Group 22, Tires And Wheels for additional information involving vibration diagnosis.

DRIVELINE SNAP

A snap or clunk noise when the vehicle is shifted into gear (or the clutch engaged), can be caused by:

- High engine idle speed
- Loose engine/transmission/transfer case mounts
- Worn U-joints
- Loose spring mounts
- Loose pinion gear nut and yoke
- Excessive ring gear backlash
- Excessive side gear/case clearance

The source of a snap or a clunk noise can be determined with the assistance of a helper. Raise the vehicle on a hoist with the wheels free to rotate. Instruct the helper to shift the transmission into gear. Listen for the noise, a mechanics stethoscope is helpful in isolating the source of a noise.

DIAGNOSIS AND TESTING (Continued)**FRONT DRIVE AXLE****DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
WHEEL NOISE	<ol style="list-style-type: none"> 1. Wheel loose. 2. Faulty, brinelled wheel bearing. 	<ol style="list-style-type: none"> 1. Tighten loose nuts. 2. Faulty or brinelled bearings must be replaced.
AXLE SHAFT NOISE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Bent or sprung axle shaft. 3. End play in drive pinion bearings. 4. Excessive gear backlash between ring gear and pinion gear. 5. Improper adjustment of drive pinion gear shaft bearings. 6. Loose drive pinion gearshaft yoke nut. 7. Improper wheel bearing adjustment. 8. Scuffed gear tooth contact surfaces. 	<ol style="list-style-type: none"> 1. Inspect axle shaft tube alignment. Correct as necessary. 2. Replace bent or sprung axle shaft. 3. Refer to Drive Pinion Bearing Pre-Load Adjustment. 4. Check adjustment of ring gear backlash and pinion gear. Correct as necessary. 5. Adjust drive pinion shaft bearings. 6. Tighten drive pinion gearshaft yoke nut with specified torque. 7. Readjust as necessary. 8. If necessary, replace scuffed gears.
AXLE SHAFT BROKE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Vehicle overloaded. 3. Erratic clutch operation. 4. Grabbing clutch. 	<ol style="list-style-type: none"> 1. Replace broken axle shaft after correcting axle shaft tube alignment. 2. Replace broken axle shaft. Avoid excessive weight on vehicle. 3. Replace broken axle shaft after inspecting for other possible causes. Avoid erratic use of clutch. 4. Replace broken axle shaft. Inspect clutch and make necessary repairs or adjustments.
DIFFERENTIAL CASE CRACKED	<ol style="list-style-type: none"> 1. Improper adjustment of differential bearings. 2. Excessive ring gear backlash. 3. Vehicle overloaded. 4. Erratic clutch operation. 	<ol style="list-style-type: none"> 1. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust differential bearings properly. 2. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust ring gear backlash properly. 3. Replace cracked case; examine gears and bearings for possible damage. Avoid excessive weight on vehicle. 4. Replace cracked case. After inspecting for other possible causes, examine gears and bearings for possible damage. Avoid erratic use of clutch.
DIFFERENTIAL GEARS SCORED	<ol style="list-style-type: none"> 1. Insufficient lubrication. 2. Improper grade of lubricant. 3. Excessive spinning of one wheel/tire. 	<ol style="list-style-type: none"> 1. Replace scored gears. Scoring marks on the drive face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear differential housing to required capacity with proper lubricant. Refer to Specifications. 2. Replace scored gears. Inspect all gears and bearings for possible damage. Clean and refill differential housing to required capacity with proper lubricant. 3. Replace scored gears. Inspect all gears, pinion bores and shaft for damage. Service as necessary.
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 1. Lubricant level too high. 	<ol style="list-style-type: none"> 1. Drain excess lubricant by removing fill plug and allow lubricant to level at lower edge of fill plug hole.

DIAGNOSIS AND TESTING (Continued)**CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 2. Worn axle shaft seals. 3. Cracked differential housing. 4. Worn drive pinion gear shaft seal. 5. Scored and worn yoke. 6. Axle cover not properly sealed. 	<ol style="list-style-type: none"> 2. Replace worn seals. 3. Repair or replace housing as necessary. 4. Replace worn drive pinion gear shaft seal. 5. Replace worn or scored yoke and seal. 6. Remove cover and clean flange and reseal.
AXLE OVERHEATING	<ol style="list-style-type: none"> 1. Lubricant level too low. 2. Incorrect grade of lubricant. 3. Bearings adjusted too tight. 4. Excessive gear wear. 5. Insufficient ring gear backlash. 	<ol style="list-style-type: none"> 1. Refill differential housing. 2. Drain, flush and refill with correct amount of the correct lubricant. 3. Readjust bearings. 4. Inspect gears for excessive wear or scoring. Replace as necessary. 5. Readjust ring gear backlash and inspect gears for possible scoring.
GEAR TEETH BROKE (RING GEAR AND PINION)	<ol style="list-style-type: none"> 1. Overloading. 2. Erratic clutch operation. 3. Ice-spotted pavements. 4. Improper adjustments. 	<ol style="list-style-type: none"> 1. Replace gears. Examine other gears and bearings for possible damage. 2. Replace gears and examine the remaining parts for possible damage. Avoid erratic clutch operation. 3. Replace gears. Examine the remaining parts for possible damage. Replace parts as required. 4. Replace gears. Examine other parts for possible damage. Ensure ring gear backlash is correct.
AXLE NOISE	<ol style="list-style-type: none"> 1. Insufficient lubricant. 2. Improper ring gear and drive pinion gear adjustment. 3. Unmatched ring gear and drive pinion gear. 4. Worn teeth on ring gear or drive pinion gear. 5. Loose drive pinion gear shaft bearings. 6. Loose differential bearings. 7. Misaligned or sprung ring gear. 8. Loose differential bearing cap bolts 	<ol style="list-style-type: none"> 1. Refill axle with correct amount of the proper lubricant. Also inspect for leaks and correct as necessary. 2. Check ring gear and pinion gear teeth contact pattern. 3. Remove unmatched ring gear and drive pinion gear. Replace with matched gear and drive pinion gear set. 4. Check teeth on ring gear and drive pinion gear for correct contact. If necessary, replace with new matched set. 5. Adjust drive pinion gearshaft bearing preload torque. 6. Adjust differential bearing preload torque. 7. Measure ring gear runout. 8. Tighten with specified torque

DIAGNOSIS AND TESTING (Continued)**VACUUM DISCONNECT AXLE/SHIFT MOTOR
DIAGNOSIS****VACUUM CONTROL SYSTEM**

The disconnect axle control system consists of;

- Shift motor
- Indicator switch
- Vacuum switch
- Vacuum harness (Fig. 6)

Refer to Group 21 Transmissions for additional information.

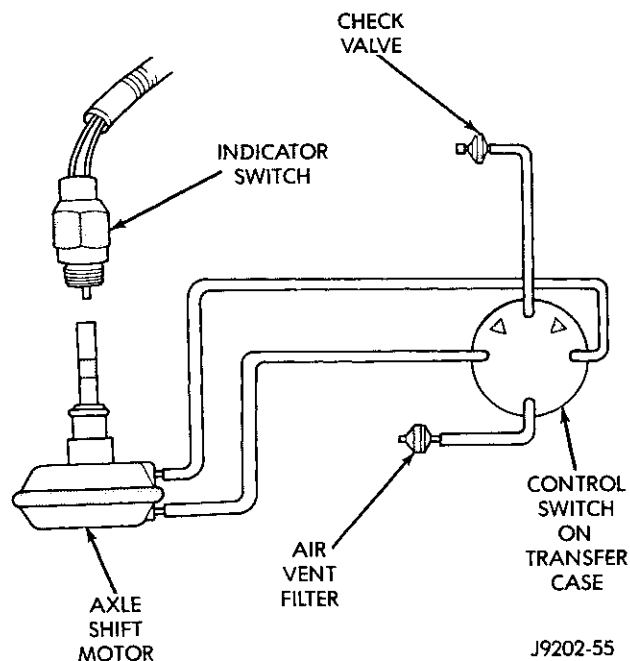


Fig. 6 Vacuum Control System

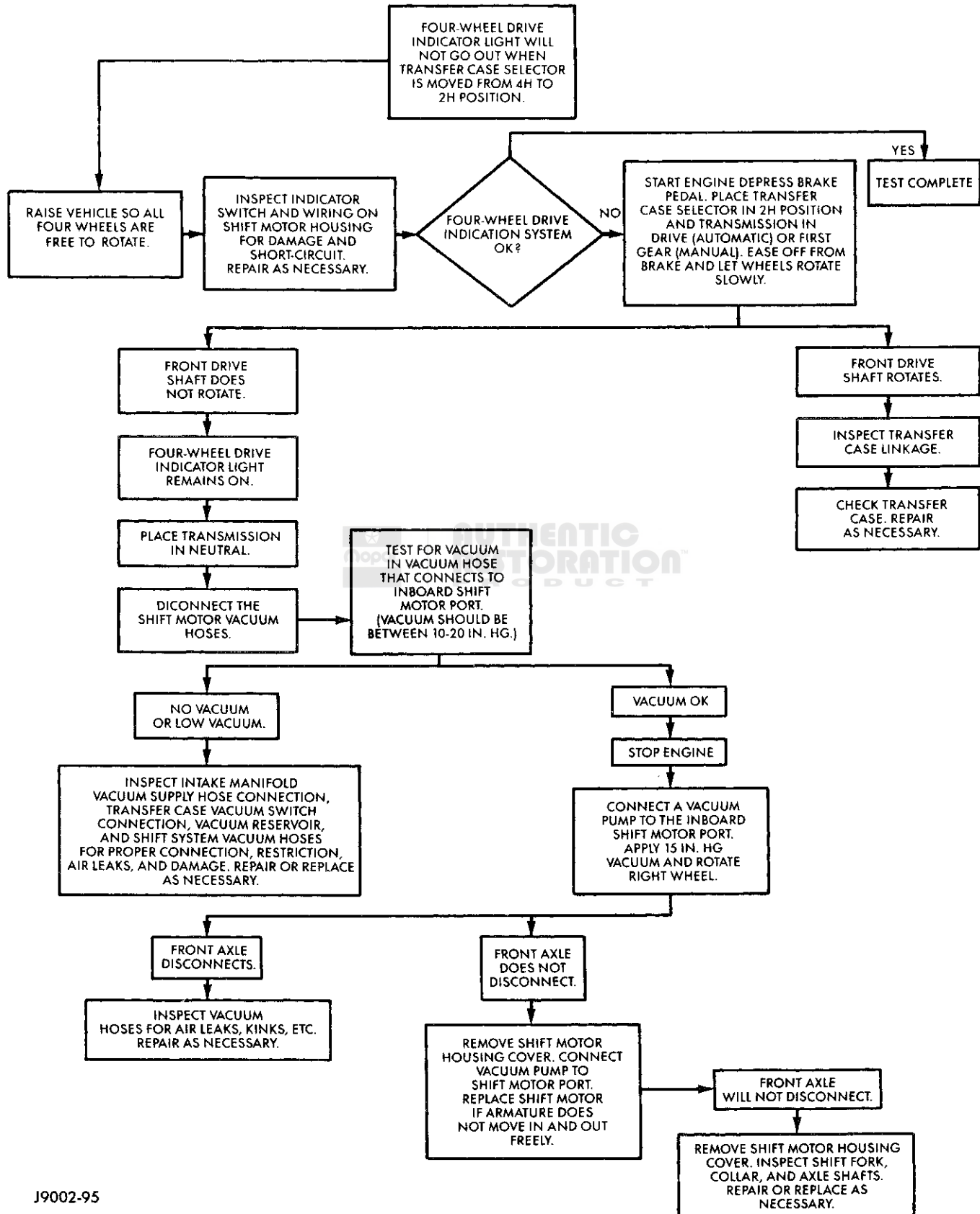


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DIAGNOSIS AND TESTING (Continued)

DISCONNECT AXLE/SHIFT MOTOR DIAGNOSIS

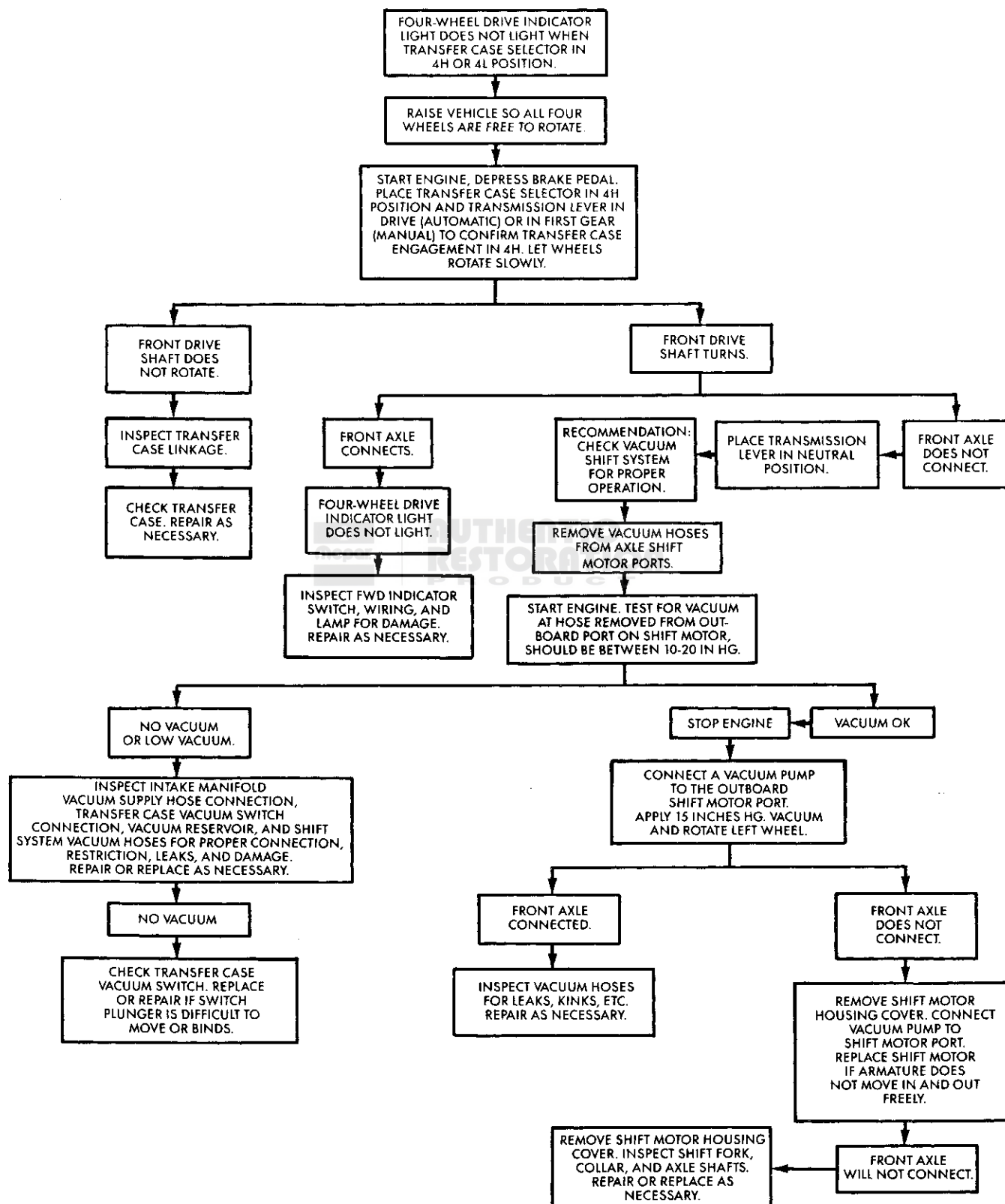
TWO-WHEEL DRIVE OPERATION DIAGNOSIS



DIAGNOSIS AND TESTING (Continued)

DISCONNECT AXLE/SHIFT MOTOR DIAGNOSIS (CONT'D)

FOUR-WHEEL DRIVE OPERATION DIAGNOSIS



SERVICE PROCEDURES

LUBRICANT CHANGE

The gear lubricant will drain quicker if the vehicle has been recently driven.

- (1) Raise and support the vehicle.
- (2) Remove the lubricant fill hole plug from the differential housing cover.
- (3) Remove the differential housing cover and drain the lubricant from the housing.
- (4) Clean the housing cavity with a flushing oil, light engine oil or lint free cloth. **Do not use water, steam, kerosene or gasoline for cleaning.**
- (5) Remove the sealant from the housing and cover surfaces. Use solvent to clean the mating surfaces.
- (6) Apply a bead of Mopar, Silicone Rubber Sealant to the housing cover (Fig. 7). **Allow the sealant to cure for a few minutes.**

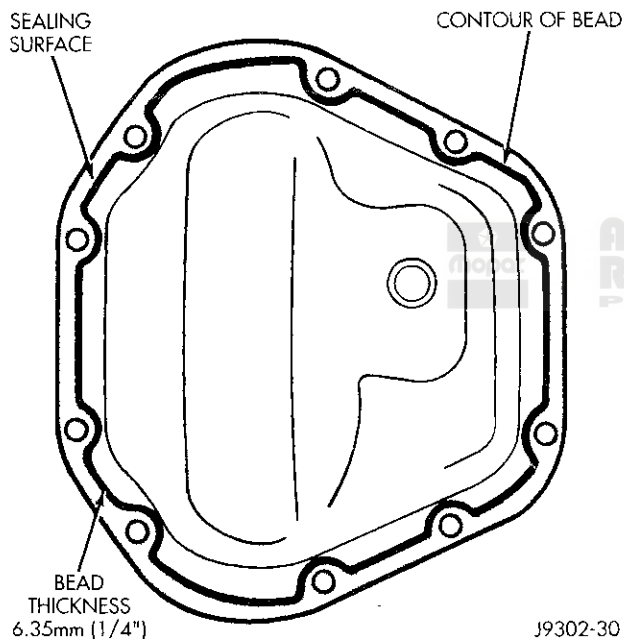


Fig. 7 Typical Housing Cover With Sealant

Install the housing cover within 5 minutes after applying the sealant. If not installed the sealant must be removed and another bead applied.

- (7) Install the cover and any identification tag. Tighten the cover bolts in a criss-cross pattern to;
 - Model 44: 41 N-m (30 ft. lbs.) torque.
 - Model 60: 47 N-m (35 ft. lbs.) torque.
- (8) Refill differential with the specified quantity of Mopar, Hypoid Gear Lubricant.

CAUTION: Overfilling the differential can result in lubricant foaming and overheating.

- (9) Install the fill hole plug and lower the vehicle.

REMOVAL AND INSTALLATION

VACUUM SHIFT MOTOR

REMOVE AND DISASSEMBLE

- (1) Disconnect the vacuum and wiring connector from the shift housing.
- (2) Remove indicator switch.
- (3) Remove the shift motor housing cover, gasket and shield from the housing (Fig. 8).

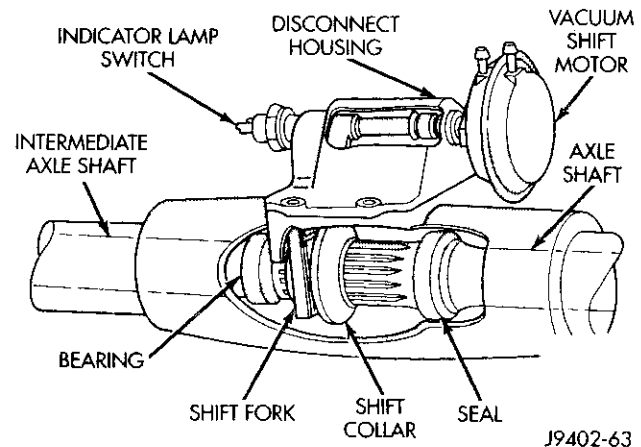


Fig. 8 Shift Motor Housing

- (4) Remove the E-clips from the shift motor housing and shaft. Remove shift motor and shift fork from the housing (Fig. 9).

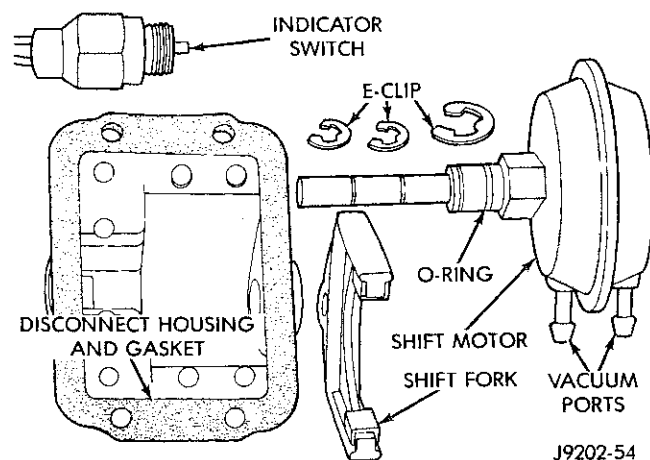


Fig. 9 Shift Motor Components

- (5) Remove the O-ring seal from the shift motor shaft.
- (6) Clean and inspect all components. If any component is excessively worn or damaged, it should be replaced.

REMOVAL AND INSTALLATION (Continued)

ASSEMBLY AND INSTALL

(1) Install a new O-ring seal on the shift motor shaft.

(2) Insert the shift motor shaft through the hole in the housing and shift fork. The shift fork offset should be toward the differential.

(3) Install the E-clips on the shift motor shaft and housing.

(4) Install the shift motor housing gasket and cover. **Ensure the shift fork is correctly guided into the shift collar groove.**

(5) Install the shift motor housing shield and attaching bolts. Tighten the bolts to 11 N·m (96 in. lbs.) torque.

(6) Add 148 ml (5 ounces) of API grade GL 5 hypoid gear lubricant to the shift motor housing. Add lubricant through indicator switch mounting hole.

(7) Install indicator switch, electrical connector and vacuum harness.

DRIVE AXLE ASSEMBLY REPLACEMENT

REMOVAL

(1) Raise vehicle and position support stands under the frame rails behind the lower suspension arm brackets.

(2) Remove the front wheels assemblies.

(3) Remove the brake components and ABS brake sensor (if equipped). Refer to Group 5, Brakes.

(4) On 4WD vehicles, disconnect the axle vent hose. Disconnect vacuum hose and electrical connector at disconnect housing.

(5) On 4WD vehicles, mark the drive shaft yoke, axle pinion yoke and transfer case flange for alignment reference. Disconnect the drive shaft from the axle and transfer case.

(6) Disconnect the stabilizer bar link at the axle bracket.

(7) Disconnect the shock absorbers from axle bracket.

(8) Disconnect the track bar from the axle bracket.

(9) Disconnect the tie rod and drag link from the steering knuckle.

(10) Support the axle with a hydraulic jack under the differential.

(11) Disconnect the upper and lower suspension arms from the axle bracket. **Mark cams for installation reference.**

(12) Lower the jack enough to remove the axle. The coil springs will drop with the axle.

(13) Remove the coil springs from the axle bracket.

INSTALLATION

CAUTION: Suspension components with rubber bushings should be tightened with the weight of the vehicle on the suspension, at normal height. It is

important to have the springs supporting the weight of the vehicle when the fasteners are tightened. If springs are not at their normal ride position, vehicle ride comfort could be affected and premature bushing wear may occur. Rubber bushings must never be lubricated.

(1) Install the springs, retainer clip and bolts.

(2) Support the axle on a hydraulic jack under the differential. Position the axle under the vehicle.

(3) Raise the axle with a floor jack and align it with the spring pads.

(4) Position the upper and lower suspension arm at the axle bracket. Install bolts, nuts and align cams to reference marks. **Do not tighten at this time.**

(5) Connect the track bar to the axle bracket and install the bolt. **Do not tighten at this time.**

It is important that the springs support the weight of the vehicle when the track bar is connected. If the springs are not at normal ride height, the vehicle ride comfort could be affected.

(6) Install the shock absorber and tighten bolts to 121 N·m (89 ft. lbs.) torque.

(7) Install the stabilizer bar link to the axle bracket. Tighten the nut to 37 N·m (27 ft. lbs.) torque.

(8) Install the drag link and tie rod to the steering knuckles and tighten the nuts to 88 N·m (65 ft. lbs.) torque.

(9) Install the brake components and ABS brake sensor (if equipped). Refer to Group 5, Brakes.

(10) On 4WD vehicles, connect the vent hose to the tube fitting. Connect vacuum hose and electrical connector to disconnect housing.

(11) On 4WD vehicles, align the reference marks and connect the drive shaft to the axle yoke and transfer case flange. Tighten the U-joint clamp bolts to 19 N·m (14 ft. lbs.) torque. Tighten flange bolts to 88 N·m (65 ft. lbs.) torque.

(12) Check differential lubricant and add if necessary.

(13) Install the wheel and tire assemblies.

(14) Remove the supports and lower the vehicle.

(15) Tighten the upper suspension arm nuts at axle to 121 N·m (89 ft. lbs.) torque. Tighten the upper suspension arm nuts at frame to 84 N·m (62 ft. lbs.) torque.

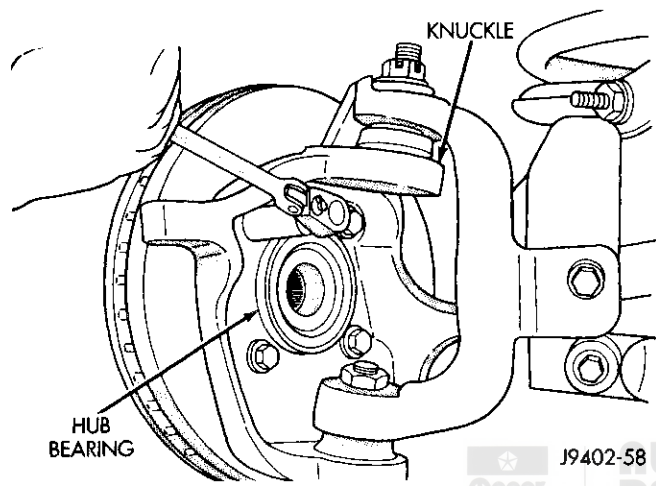
(16) Tighten the lower suspension arm nuts at axle to 84 N·m (62 ft. lbs.) torque. Tighten the lower suspension arm nuts at frame to 119 N·m (88 ft. lbs.) torque.

(17) Tighten the track bar bolt at the axle bracket to 176 N·m (130 ft. lbs.) torque.

(18) Check the front wheel alignment.

REMOVAL AND INSTALLATION (Continued)**HUB BEARING AND AXLE SHAFT****REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove the wheel and tire assembly.
- (3) Remove the brake components from the axle, refer to Group 5, Brakes.
- (4) Remove the cotter pin and axle hub nut.
- (5) Remove the hub to knuckle bolts (Fig. 10). Remove the hub bearing from the steering knuckle and axle shaft.

**Fig. 10 Hub and Knuckle**

- (6) Remove the brake dust shield.
- (7) **Remove the axle shaft from the housing. Avoid damaging the axle shaft oil seal.**

INSTALLATION

- (1) Clean the axle shaft and apply a thin film of Mopar Wheel Bearing Grease to the shaft splines, seal contact surface, hub bore. Install the axle shaft into the housing and differential side gears. Avoid damaging the axle shaft oil seals in the differential.
- (2) Install dust shield and hub bearing on knuckle.
- (3) Install the hub bearing to knuckle bolts and tighten to 170 N·m (125 ft. lbs.) torque.
- (4) Install the axle washer and nut, tighten nut to 237 N·m (175 ft. lbs.) torque. Align nut to next cotter pin hole and install new cotter pin.
- (5) Install the brake components, refer to Group 5, Brakes.
- (6) Install the wheel and tire assembly.
- (7) Remove support and lower the vehicle.

STEERING KNUCKLE 44 AXLE**KNUCKLE REMOVAL**

- (1) Remove hub bearing and axle shaft. Refer to the Removal procedures in this Group.

(2) Remove tie-rod or drag link end from the steering knuckle arm. Remove the ABS sensor wire and bracket from knuckle.

(3) Remove the cotter pin from the upper ball stud nut. Remove the upper and lower ball stud nuts.

(4) Strike the steering knuckle with a brass hammer to loosen. Remove knuckle from axle tube yokes.

KNUCKLE INSTALLATION

(1) Position the steering knuckle on the ball studs.

(2) Install and tighten lower ball stud nut to 108 N·m (80 ft. lbs.) torque. Advance nut to next slot to line up hole and install new cotter pin.

(3) Install and tighten upper ball stud nut to 101 N·m (75 ft. lbs.) torque. Advance nut to next slot to line up hole and install new cotter pin.

(4) Install the Hub Bearing and Axle Shaft. Refer to the installation procedure.

(5) Install tie-rod or drag link end onto the steering knuckle arm. Install the ABS sensor wire and bracket to the knuckle, refer to Group 5, Brakes for proper set-up.

STEERING KNUCKLE 60 AXLE**KNUCKLE REMOVAL**

(1) Remove hub bearing and axle shaft. Refer to the Removal procedures in this Group.

(2) Remove tie-rod or drag link end from the steering knuckle arm. Remove the ABS sensor wire and bracket from knuckle.

(3) Remove the cotter pin from the upper ball stud nut. Remove the upper and lower ball stud nuts.

(4) Strike the steering knuckle with a brass hammer to loosen. Remove knuckle from axle tube yokes.

KNUCKLE INSTALLATION

(1) Position the steering knuckle on the ball studs.

(2) Install and tighten lower ball stud nut to 47 N·m (35 ft. lbs.) torque. **Do not install cotter pin at this time.**

(3) Install and tighten upper ball stud nut to 94 N·m (70 ft. lbs.) torque. Advance nut to next slot to line up hole and install new cotter pin.

(4) Retorque lower ball stud nut to 190 – 217 N·m (140 – 160 ft. lbs.) torque. Advance nut to next slot to line up hole and install new cotter pin.

(5) Install the Hub Bearing and Axle Shaft. Refer to the installation procedure.

(6) Install tie-rod or drag link end onto the steering knuckle arm. Install the ABS sensor wire and bracket to the knuckle, refer to Group 5, Brakes for proper set-up.

REMOVAL AND INSTALLATION (Continued)**BALL STUDS 44 AXLE****UPPER BALL STUD REPLACEMENT**

(1) Position tools as shown to remove ball stud (Fig. 11).

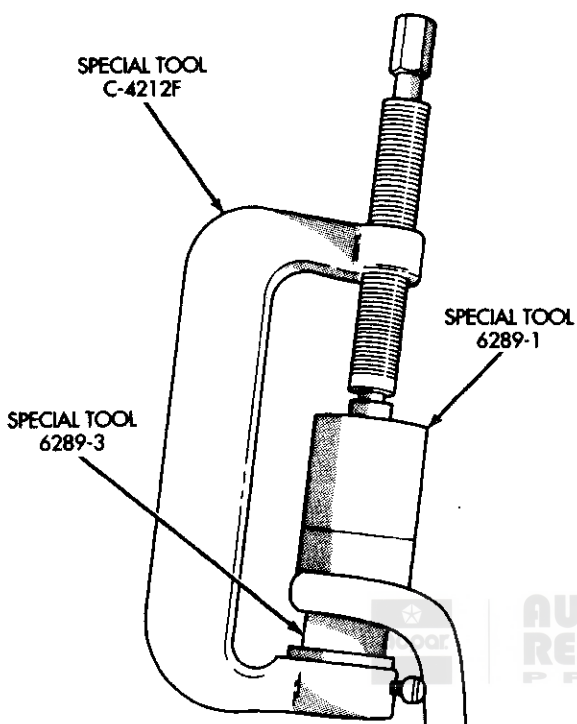


Fig. 11 Upper Ball Stud Remove

(2) Position tools as shown to install ball stud (Fig. 12).

LOWER BALL STUD REPLACEMENT

(1) Position tools as shown to remove ball stud (Fig. 13).

(2) Position tools as shown to install ball stud (Fig. 14).

BALL STUDS 60 AXLE**UPPER BALL STUD REPLACEMENT**

(1) Position tools as shown to remove ball stud (Fig. 15).

(2) Position tools as shown to install ball stud (Fig. 16).

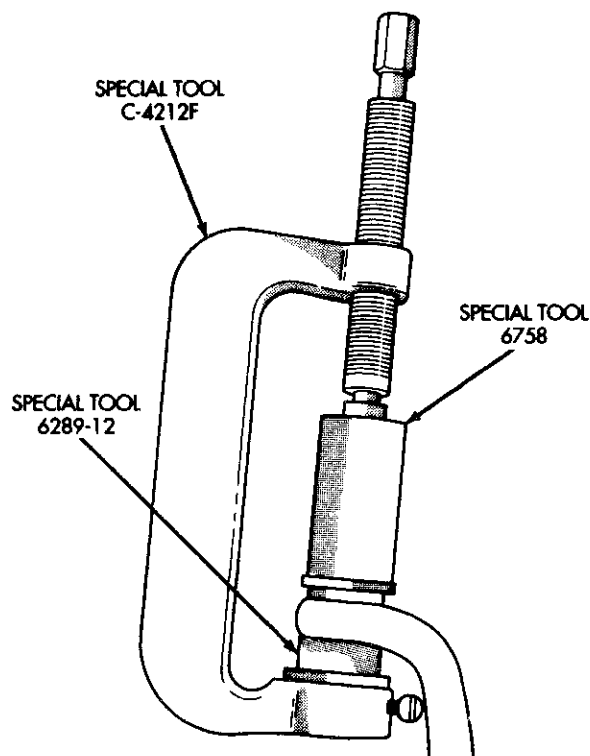


Fig. 12 Upper Ball Stud Install

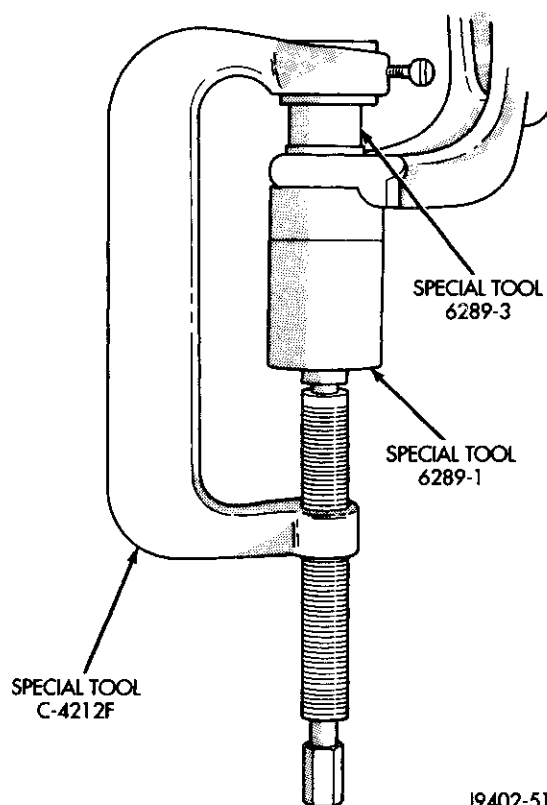
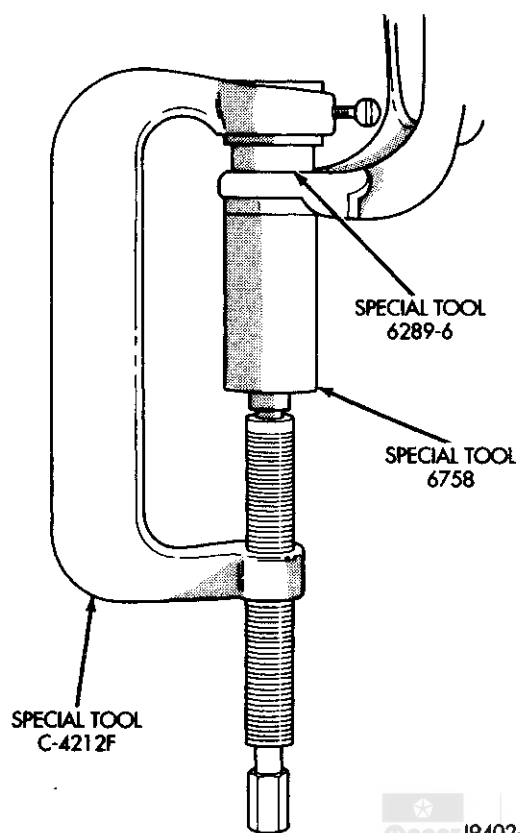
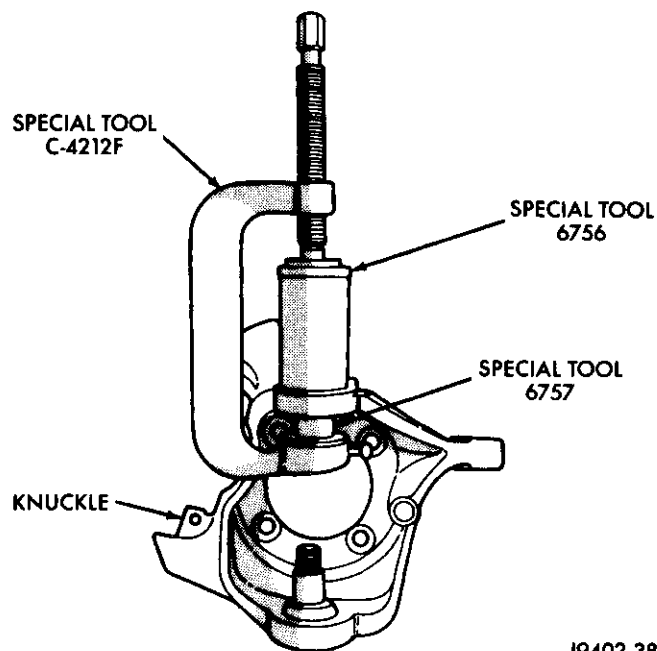
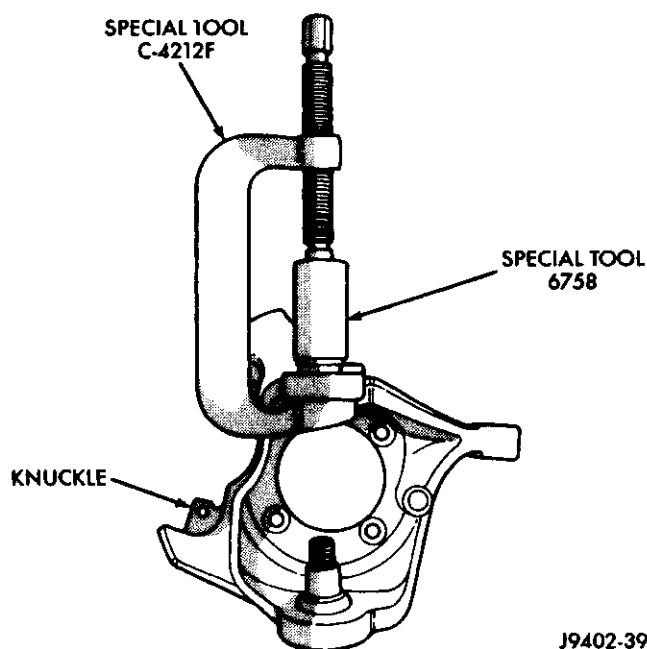
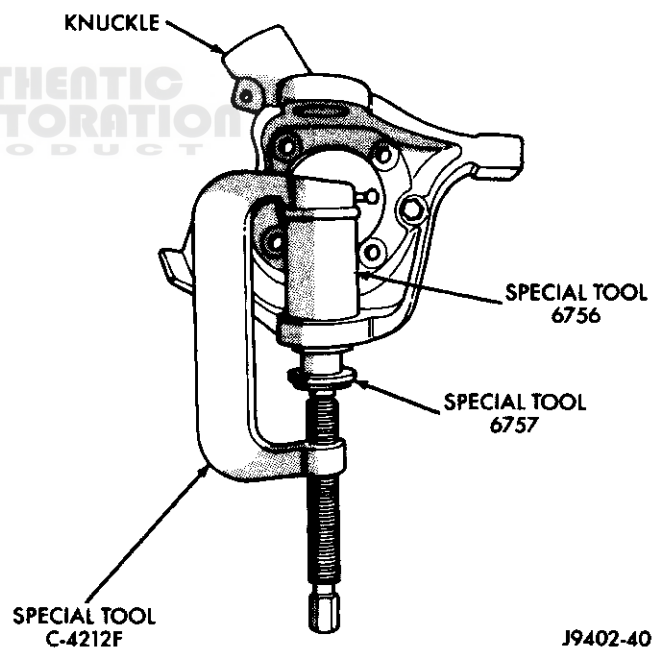


Fig. 13 Lower Ball Stud Remove

REMOVAL AND INSTALLATION (Continued)**Fig. 14 Lower Ball Stud Install****Fig. 15 Upper Ball Stud Remove****LOWER BALL STUD REPLACEMENT**

(1) Position tools as shown to remove ball stud (Fig. 17).

**Fig. 16 Upper Ball Stud Install****Fig. 17 Lower Ball Stud Remove**

(2) Position tools as shown to install ball stud (Fig. 18).

PINION SHAFT SEAL REPLACEMENT**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove wheel and tire assemblies.
- (3) Mark the drive shaft yoke and pinion yoke for installation alignment reference.

REMOVAL AND INSTALLATION (Continued)

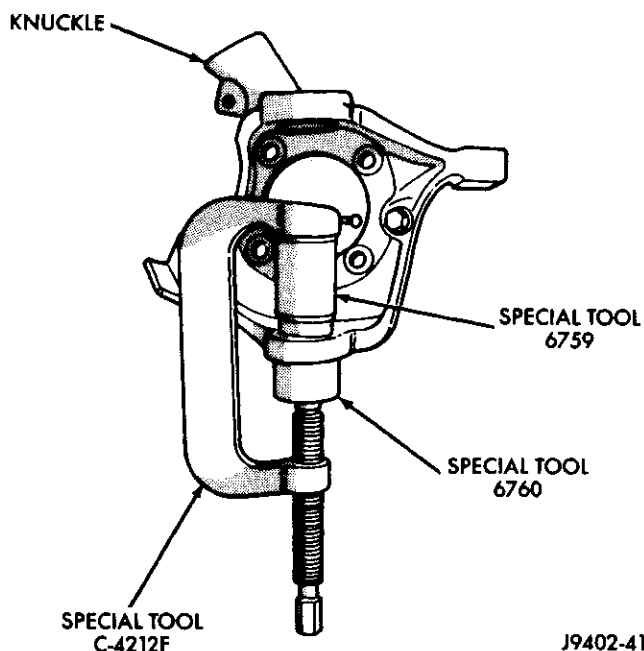


Fig. 18 Lower Ball Stud Install

(4) Remove the drive shaft from the yoke.

(5) Rotate the pinion gear three or four times. **Make sure brakes are not dragging during this procedure.**

(6) Measure the amount of torque (in Newton-meters or inch-pounds) necessary to rotate the pinion gear with a torque wrench. Note the torque for installation reference. **It must be known to properly adjust the pinion gear bearing preload torque after seal installation.**

(7) Remove the pinion yoke nut and washer. Use Remover C-452 and Wrench C-3281 to remove the pinion yoke (Fig. 19).

(8) Mark the positions of the yoke and pinion gear for installation alignment reference.

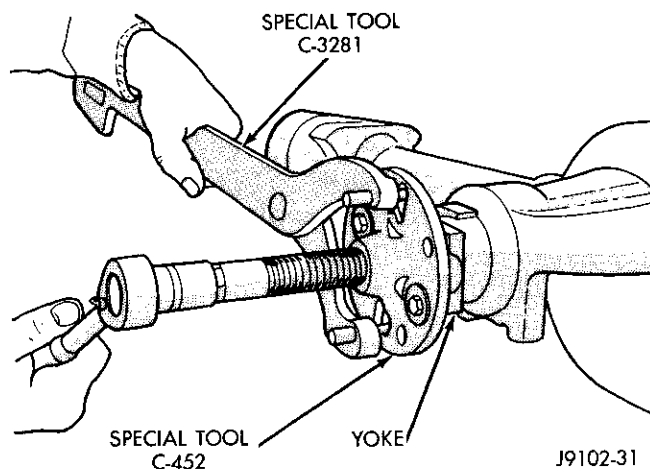
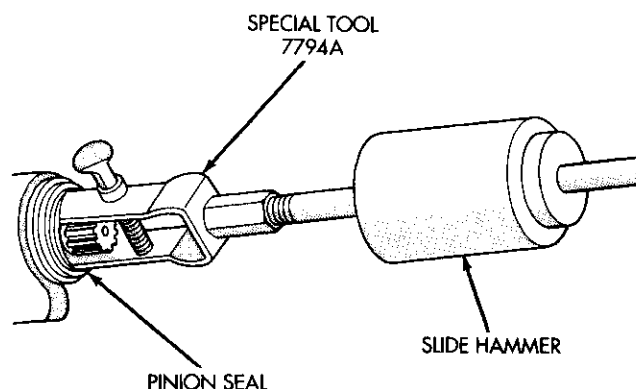


Fig. 19 Pinion Yoke Removal

(9) Use Remover 7794A and slide hammer to remove the pinion gear seal (Fig. 20).

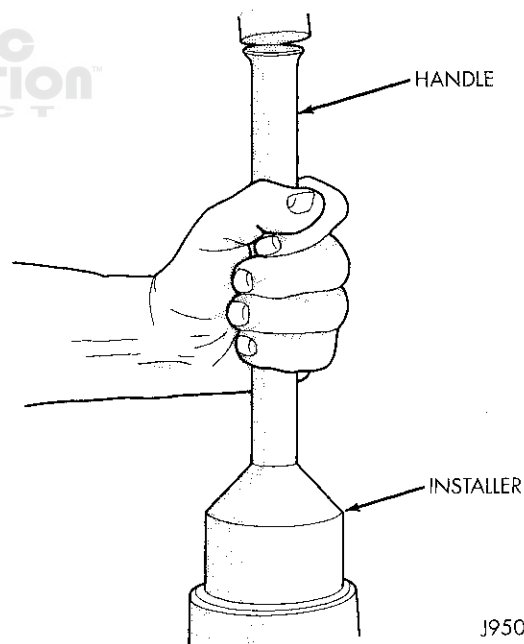


J9402-59X

Fig. 20 Seal Removal

INSTALLATION

(1) Apply a light coating of gear lubricant on the lip of pinion seal. Install seal with Installer D-163 and Handle C-4171 (Fig. 21).



J9502-1

Fig. 21 Pinion Seal Installation

(2) Align the installation reference marks and install yoke on the pinion gear with Installer W-162D.

(3) Install a new nut on the pinion gear. **Tighten the nut only enough to remove the shaft end play.**

REMOVAL AND INSTALLATION (Continued)

CAUTION: Exercise care during the bearing preload torque adjustment. Do not over-tighten, or loosen and then re-tighten the nut. Do not exceed the bearing preload torque. The collapsible preload spacer on the shaft will have to be replaced. The bearing preload torque will be re-adjusted afterward.

(4) Install a socket and inch-pound torque wrench on the pinion nut.

(5) Rotate the shaft with the torque wrench and note the torque (Fig. 22).

The required preload torque is equal to the amount recorded during removal plus an additional 0.56 N·m (5 in. lbs.).

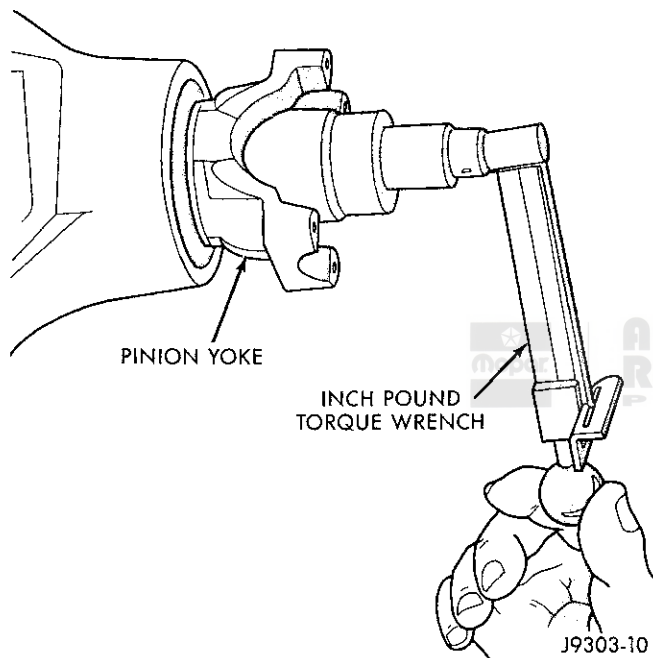


Fig. 22 Check Pinion Rotation Torque

(6) Use Flange Wrench 6719 to retain the yoke and shaft (Fig. 23). Tighten the shaft nut in very small increments.

(7) Continue tightening the shaft nut in small increments until the correct bearing rotation preload torque is attained.

(8) Align the installation reference marks and attach the drive shaft to the yoke.

(9) Add API grade GL 5 hypoid gear lubricant to the differential housing, if necessary.

(10) Install wheel and tire assemblies.

(11) Lower the vehicle.

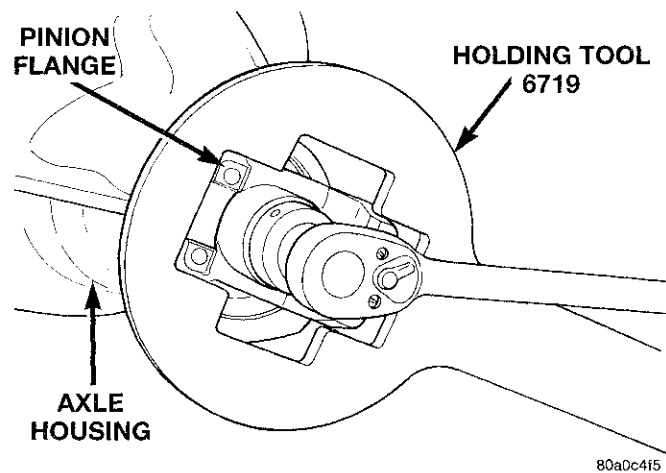


Fig. 23 Tightening Pinion Shaft Nut

DIFFERENTIAL**REMOVAL**

To service the differential the axle shafts must be removed. Refer to the removal procedures in this Group.

(1) Note the installation reference letters stamped on the bearing caps and housing machined sealing surface (Fig. 24).

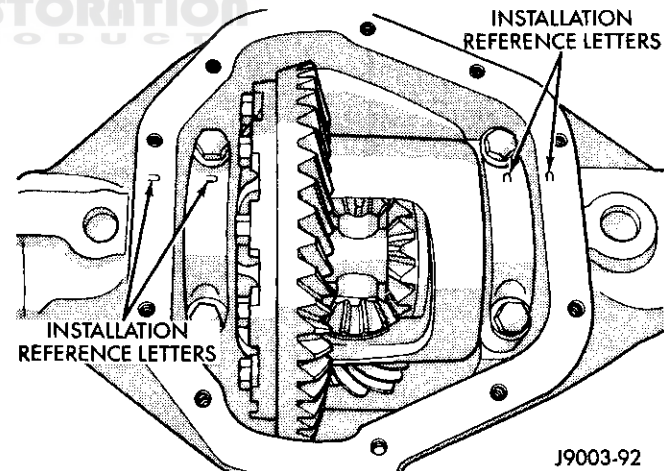


Fig. 24 Bearing Cap Identification

(2) Remove the differential bearing caps.

(3) Position Spreader W-129-B with the tool dowel pins seated in the locating holes (Fig. 25). Install the hold down clamps and tighten the tool turnbuckle finger-tight.

(4) Install a pilot stud at the left side of the differential housing. Attach Dial Indicator to housing pilot stud. Load the indicator plunger against the opposite side of the housing (Fig. 25) and zero the indicator.

REMOVAL AND INSTALLATION (Continued)

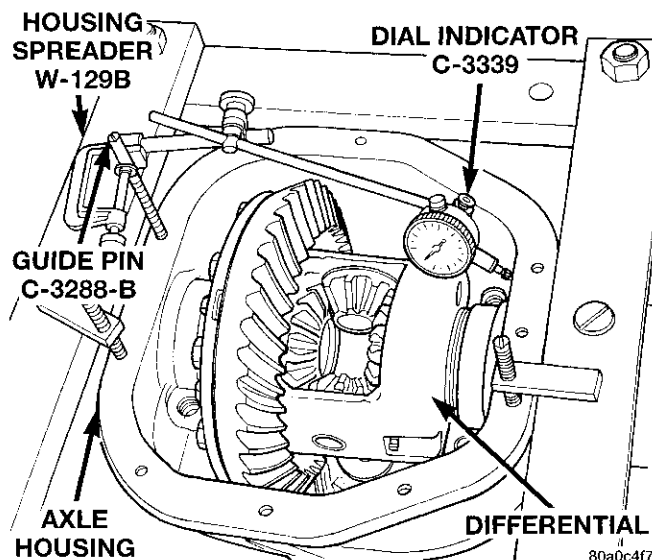


Fig. 25 Spread Differential Housing

CAUTION: Do not spread over 0.38 mm (0.015 in). If the housing is over-separated, it could be distorted or damaged.

(5) Separate the housing enough to remove the case from the housing. Measure the distance with the dial indicator (Fig. 25).

(6) Remove the dial indicator.

(7) Pry the differential case loose from the housing. To prevent damage, pivot on housing with the end of the pry bar against spreader (Fig. 26).

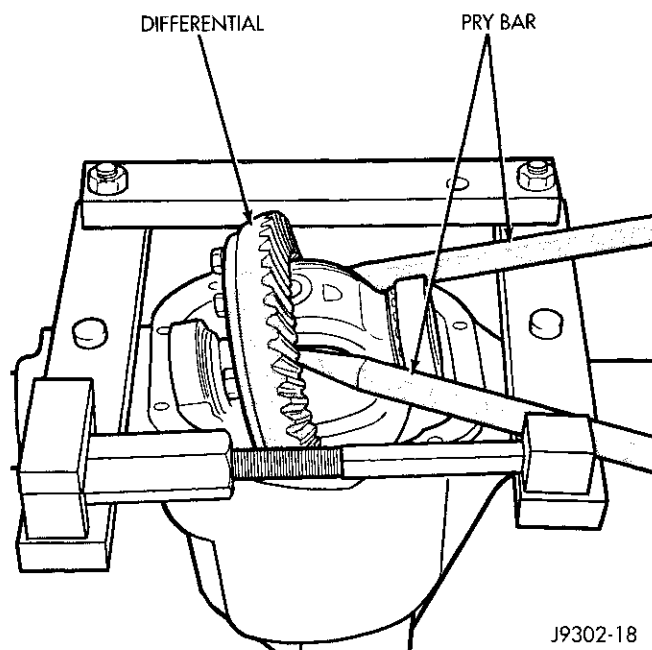


Fig. 26 Differential Removal

(8) Remove the case from housing. Mark or tag bearing cups and outboard shim/spacer (selected thickness) indicating which side they were removed.

DIFFERENTIAL INSTALLATION

(1) Position Spreader W-129-B with the tool dowel pins seated in the locating holes (Fig. 25). Install the hold down clamps and tighten the tool turnbuckle finger-tight.

(2) Install a pilot stud at the left side of the differential housing. Attach Dial Indicator to housing pilot stud. Load the indicator plunger against the opposite side of the housing (Fig. 25) and zero the indicator.

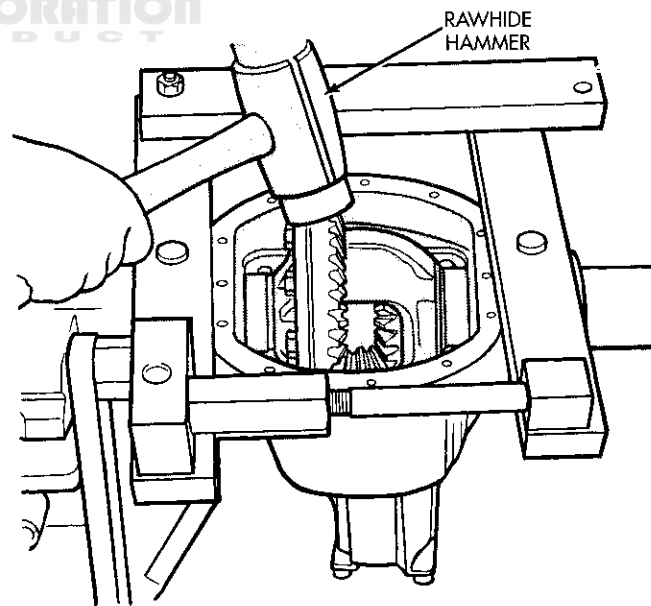
CAUTION: Do not spread over 0.38 mm (0.015 in). If the housing is over-separated, it could be distorted or damaged.

(3) Separate the housing enough to install the case in the housing. Measure the distance with the dial indicator (Fig. 25).

(4) Remove the dial indicator.

(5) Install differential and outboard shim/spacer (selected thickness) in housing.

(6) Install case in the housing. Tap the differential case to ensure the bearings are fully seated (Fig. 27). Remove the spreader.



J9302-19

Fig. 27 Differential Installation

(7) Install the bearing caps at their original locations (Fig. 28). Tighten the bearing cap bolts to 77 N·m (57 ft. lbs.) torque.

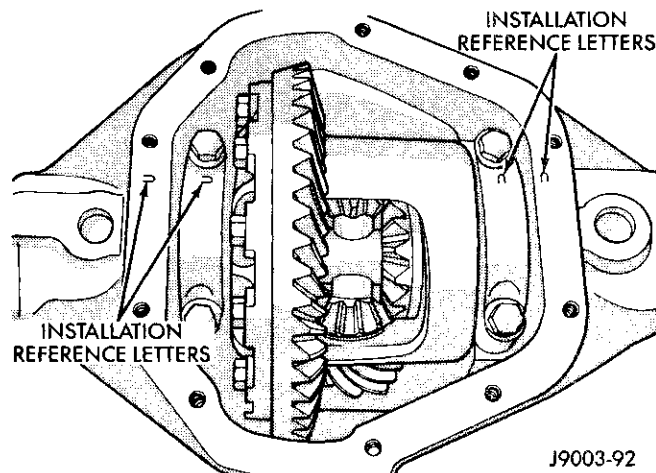
REMOVAL AND INSTALLATION (Continued)

Fig. 28 Differential Bearing Cap Reference Letters
DIFFERENTIAL SIDE BEARINGS

REMOVAL

- (1) Remove Differential case from axle housing.
- (2) Remove the bearings from the differential case with Press 938, and Adapter 1130 (Fig. 29).

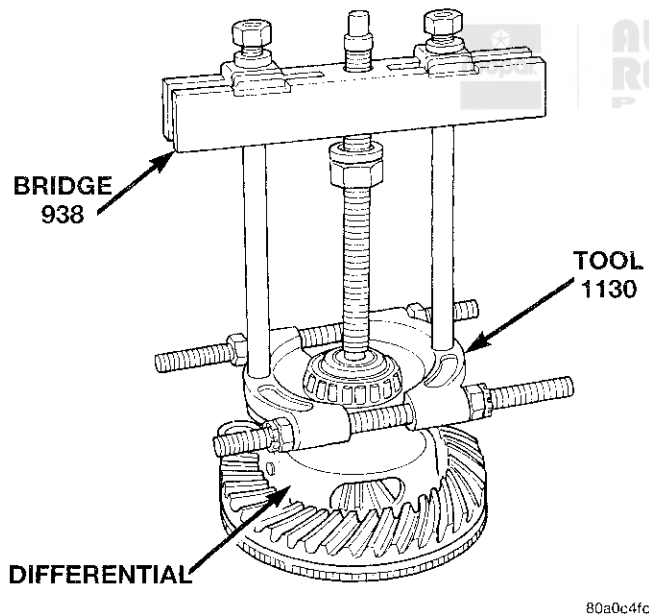


Fig. 29 Differential Bearing Removal

DIFFERENTIAL SIDE BEARING INSTALLATION

If ring and pinion gears have been replaced, verify differential side bearing preload and gear mesh backlash.

- (1) Using tool C-4340 with handle C-4171, install differential side bearings (Fig. 30).
- (2) Install differential in axle housing.

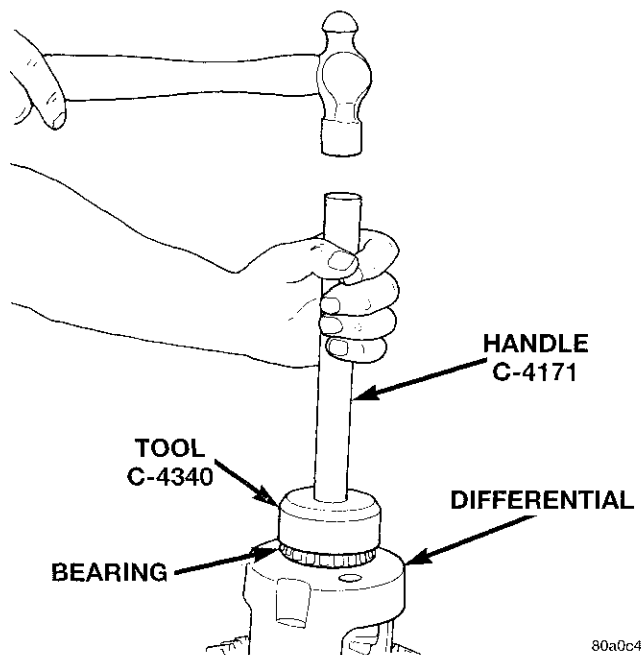


Fig. 30 Install Differential Side Bearings

AXLE SHAFT OIL SEAL

- (1) Remove the axle shaft seal from the differential housing with a long drift or punch. **Be careful not to damage housing.**
- (2) Clean the inside perimeter of the differential housing with fine crocus cloth.
- (3) Apply a light film of oil to the inside lip of the new axle shaft seal.
- (4) Install the inner axle seal (Fig. 31) or (Fig. 32).

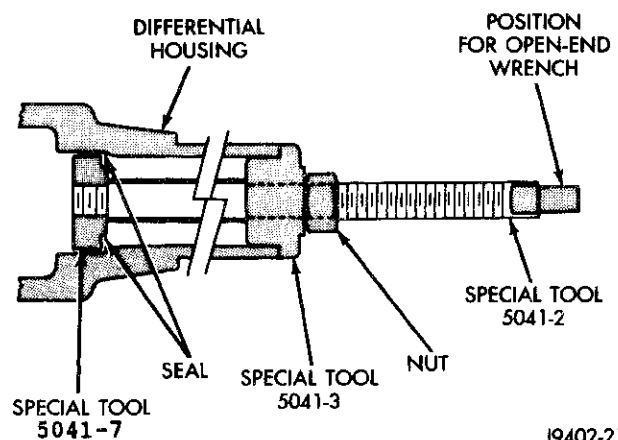


Fig. 31 Axle Seal Installation—44 Axle

INTERMEDIATE AXLE SHAFT**REMOVAL/DISASSEMBLY**

Service to the Disconnect axle seals and bearing require the use of Tool Set 5041 (J34659) and Seal Installer D-354.

REMOVAL AND INSTALLATION (Continued)

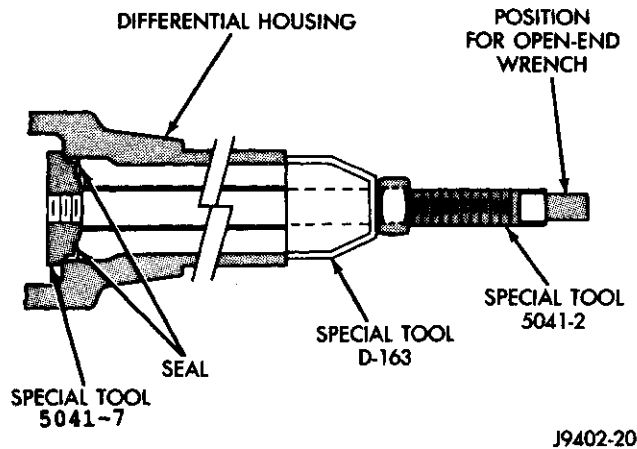


Fig. 32 Axle Seal Installation—60 Axle

- (1) Remove the vacuum motor housing. Refer to Shift Motor Removal in this section.
- (2) Remove the outer axle shaft. Refer to Hub Bearing and Axle Shaft in this section.
- (3) Remove shift collar and intermediate axle shaft.
- (4) Remove the inner axle shaft seal from the shift motor housing with a long drift or punch. **Be careful not to damage housing.**
- (5) Remove the intermediate axle shaft bearing (Fig. 33).

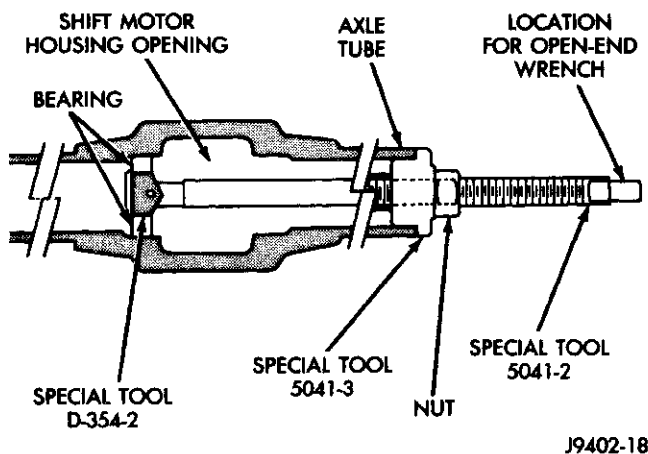


Fig. 33 Bearing Removal Tool Installed

ASSEMBLY/INSTALLATION

- (1) Position the bearing on installation tool. Seat the bearing in the housing bore (Fig. 34).
 - (2) Clean the inside perimeter of the axle shaft tube with fine crocus cloth.
 - (3) Apply a light film of oil to the inside lip of the new axle shaft seal.
 - (4) Install the inner axle seal (Fig. 35) or (Fig. 36).
- The inner axle seal position is different on a 44 then a 60 axle. Be sure to use the correct

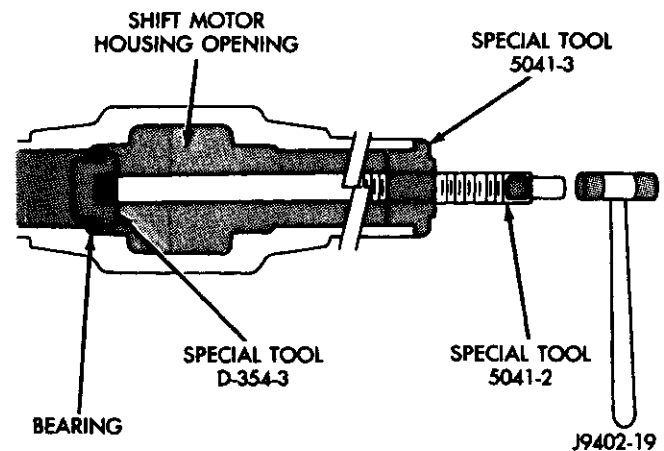


Fig. 34 Intermediate Shaft Bearing Installation

installer, if wrong installer is use axle will not seal.

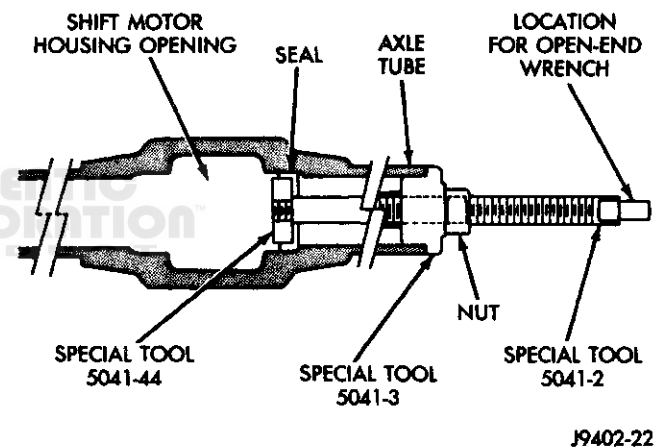


Fig. 35 Inner Axle Seal Installation—44 Axle

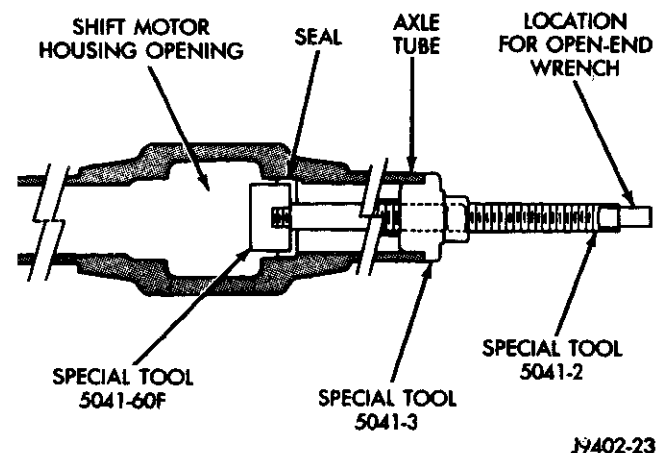


Fig. 36 Inner Axle Seal Installation—60 Axle

- (5) Insert the intermediate axle shaft into the differential side gear.

REMOVAL AND INSTALLATION (Continued)

(6) Install the shift collar on the splined end of the intermediate axle shaft.

(7) Lubricate the splined end of the intermediate axle shaft with multi-purpose lubricant.

CAUTION: Apply all-purpose lubricant to the axle shaft splines to prevent damage to the seal during axle shaft installation.

(8) Insert the axle shaft into the tube. Engage the splined end of the shaft with the shift collar. Refer to Hub Bearing and Axle Shaft in this section.

(9) Install the vacuum motor housing. Refer to Shift Motor Installation in this section.

RING GEAR

The ring and pinion gears are service in a matched set. Do not replace the ring gear without replacing the pinion gear. Refer to Pinion Gear removal and installation paragraph in this section for proper procedure.

REMOVAL

- (1) Remove differential from axle housing.
- (2) Place differential case in a suitable vise with soft metal jaw protectors. (Fig. 37)
- (3) Remove bolts holding ring gear to differential case.
- (4) Using a soft hammer, drive ring gear from differential case (Fig. 37).

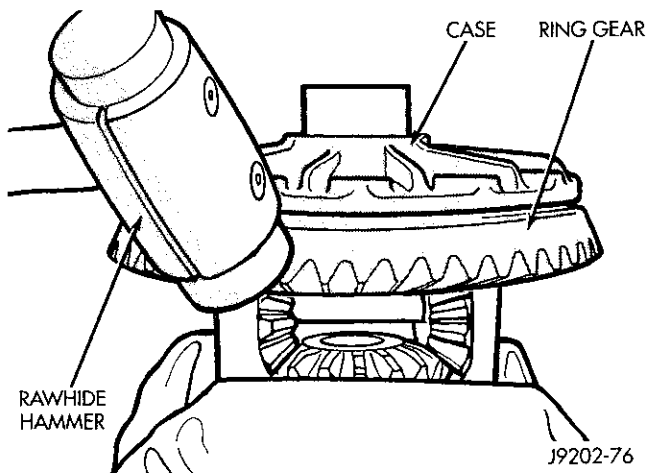


Fig. 37 Ring Gear Removal

RING GEAR INSTALLATION

CAUTION: Do not reuse the bolts that held the ring gear to the differential case. The bolts can fracture causing extensive damage.

- (1) Invert the differential case and start two ring gear bolts. This will provide case-to-ring gear bolt hole alignment.

- (2) Install new ring gear bolts and alternately tighten to 95–122 N·m (70–90 ft. lbs.) torque (Fig. 38).

- (3) Install differential in axle housing and verify gear mesh and contact pattern.

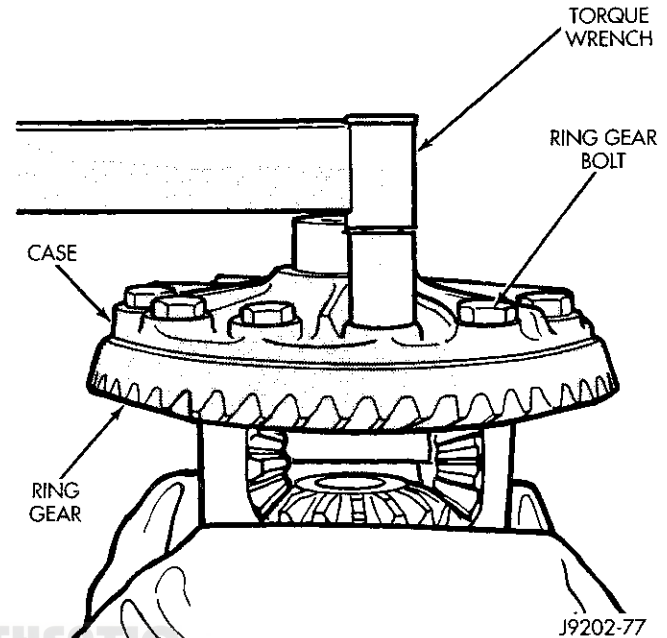


Fig. 38 Ring Gear Bolt Installation

PINION GEAR**REMOVAL**

- (1) Remove differential assembly from axle housing.
- (2) Remove the pinion yoke nut and washer. Use Remover C-452 and Wrench C-3281 to remove the pinion yoke (Fig. 39).

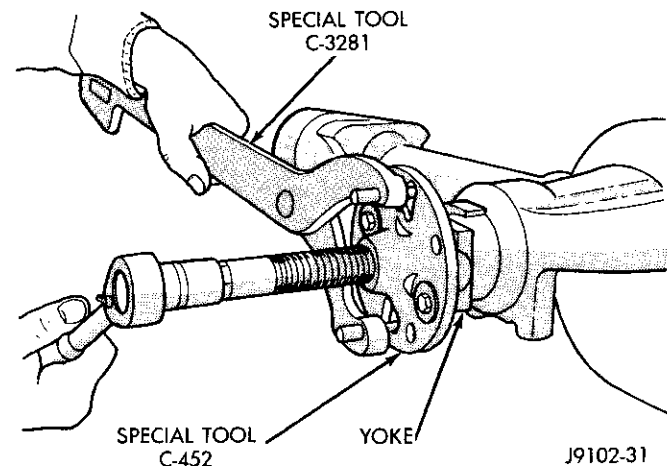


Fig. 39 Pinion Yoke Removal

REMOVAL AND INSTALLATION (Continued)

(3) Remove the pinion gear from housing (Fig. 40). Catch the pinion with your hand to prevent it from falling and being damaged.

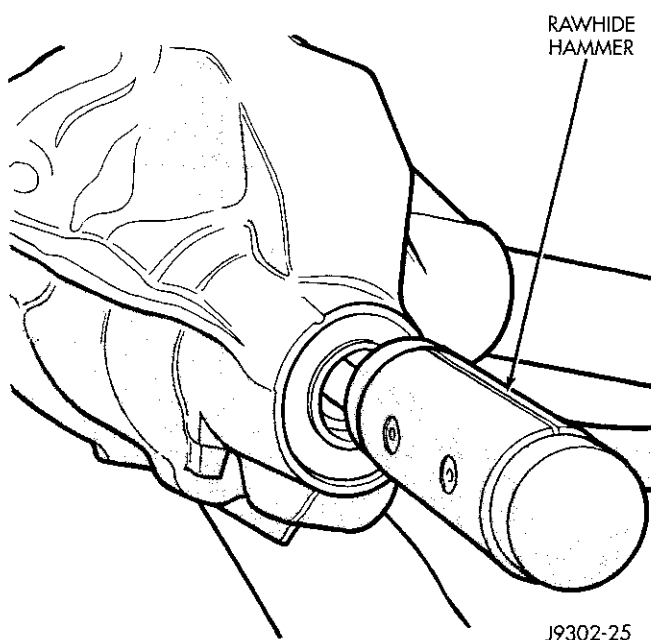


Fig. 40 Remove Pinion Gear

(4) Remove the pinion gear seal with a slide hammer or pry out with bar.

(5) Remove oil slinger, front bearing.

(6) Remove the front pinion bearing cup and seal with Remover D-147 for model 44 or D-158 for model 60 and Handle C-4171 (Fig. 41).

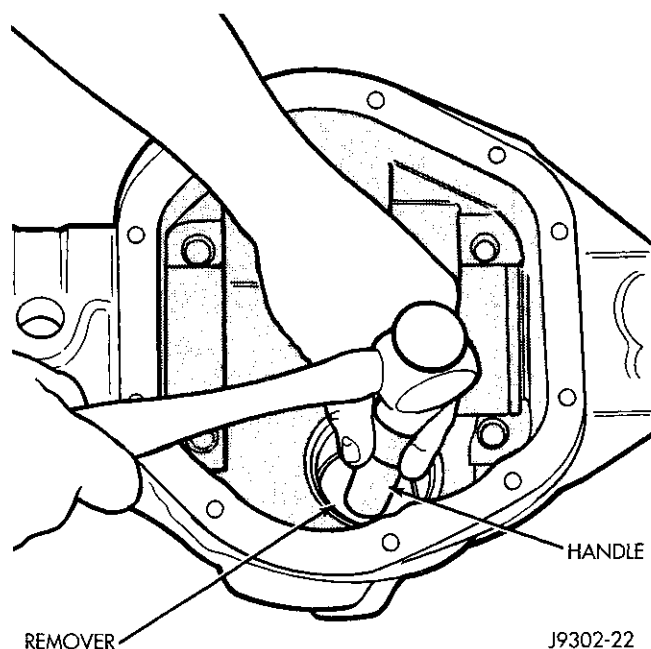


Fig. 41 Front Bearing Cup Removal

(7) Remove the rear bearing cup from housing (Fig. 42). Use Remover D-148 for model 44 or D-162 for model 60 and Handle C-4171.

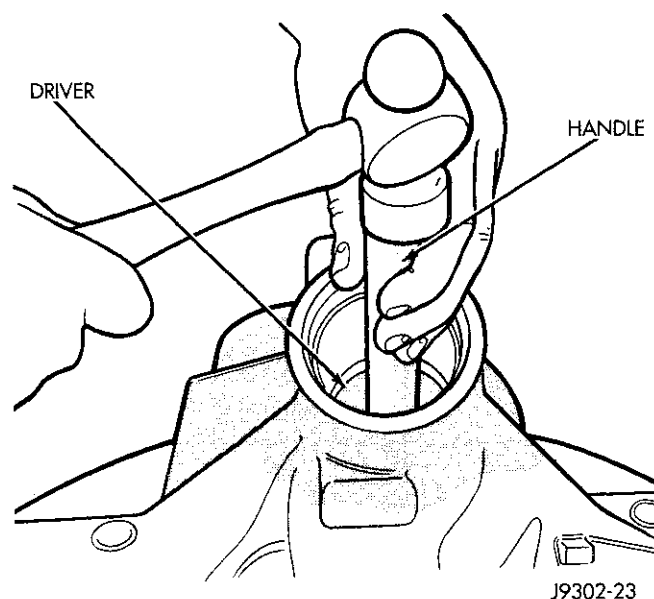


Fig. 42 Rear Bearing Cup Removal

(8) Remove the collapsible preload spacer (Fig. 43).

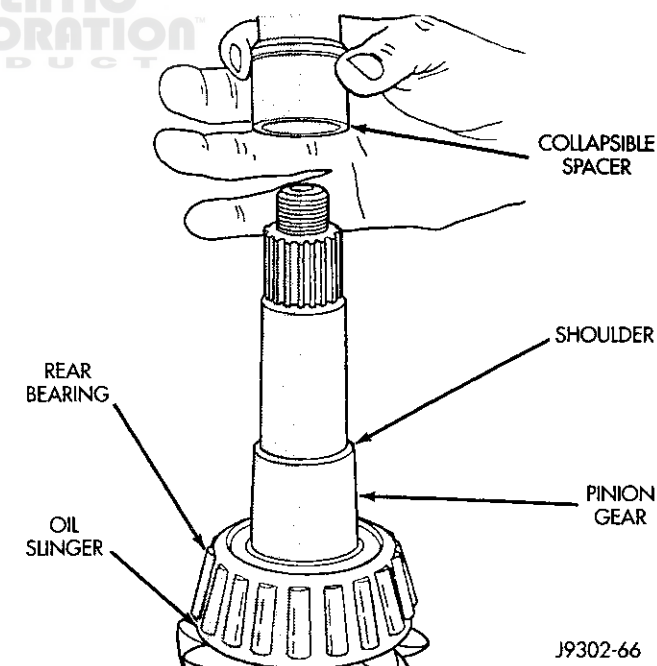
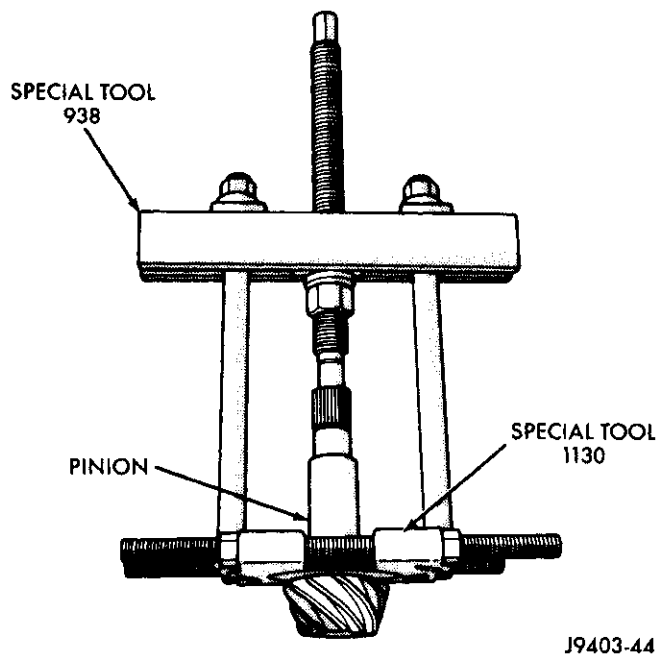


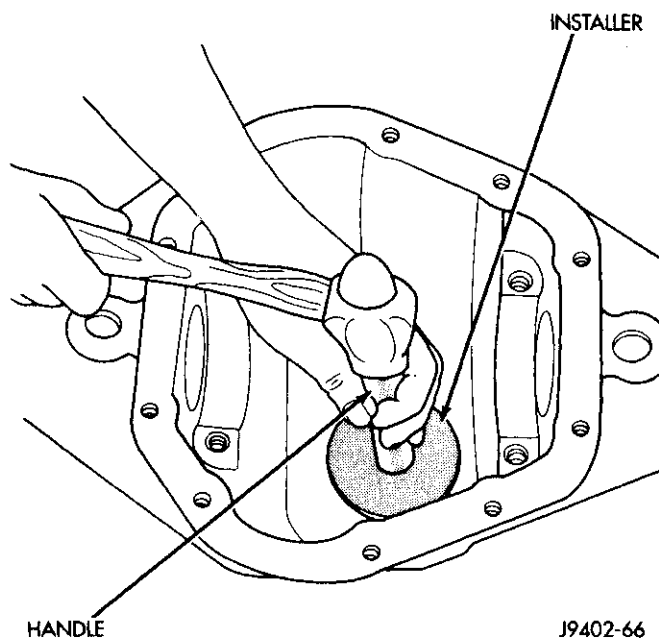
Fig. 43 Collapsible Spacer

(9) Remove the inner bearing from the pinion with Splitter 1130 and Bridge 938 (Fig. 44).

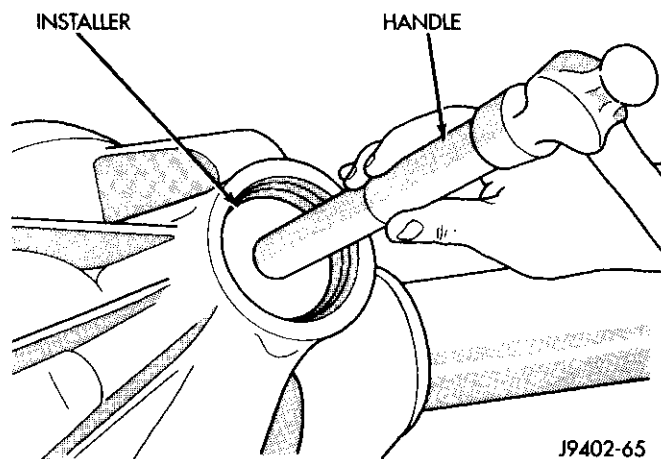
(10) Remove the depth shims from the pinion gear shaft. Record the thickness of the depth shims.

REMOVAL AND INSTALLATION (Continued)**Fig. 44 Inner Bearing Removal****PINION GEAR INSTALLATION**

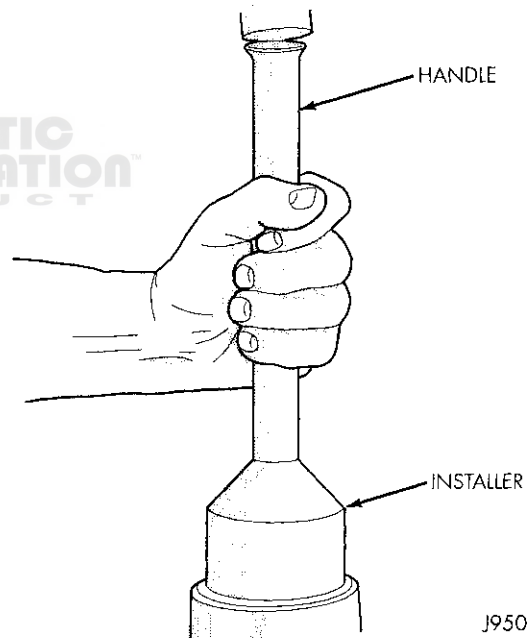
(1) Install the pinion rear bearing cup with Installer D-145 for model 44 or D-111 for model 60 and Driver Handle C-4171 (Fig. 45). Ensure cup is correctly seated.

**Fig. 45 Pinion Rear Bearing Cup Installation**

(2) Install the pinion front bearing cup with Installer D-144 for model 44 or C-4203 for model 60 and Handle C-4171 (Fig. 46).

**Fig. 46 Pinion Front Bearing Cup Installation**

(3) Install pinion front bearing, oil slinger. Apply a light coating of gear lubricant on the lip of pinion seal. Install seal with Installer D-163 and Handle C-4171 (Fig. 47).

**Fig. 47 Pinion Seal Installation**

NOTE: Pinion depth shims are placed between the rear pinion bearing cone and pinion gear to achieve proper ring and pinion gear mesh. If the factory installed ring and pinion gears are reused, the pinion depth shim should not require replacement. Refer to Pinion Gear Depth paragraph in this section to select the proper thickness shim before installing rear pinion bearing cone.

(4) Place the proper thickness depth shim on the pinion gear and install the rear bearing. Refer to

REMOVAL AND INSTALLATION (Continued)

Pinion Gear Depth paragraph in Adjustments section of this group.

(5) Install the rear bearing (and slinger if used) on the pinion gear with Installer W-262 for model 44 or C-3095A for model 60 and an arbor press (Fig. 48).

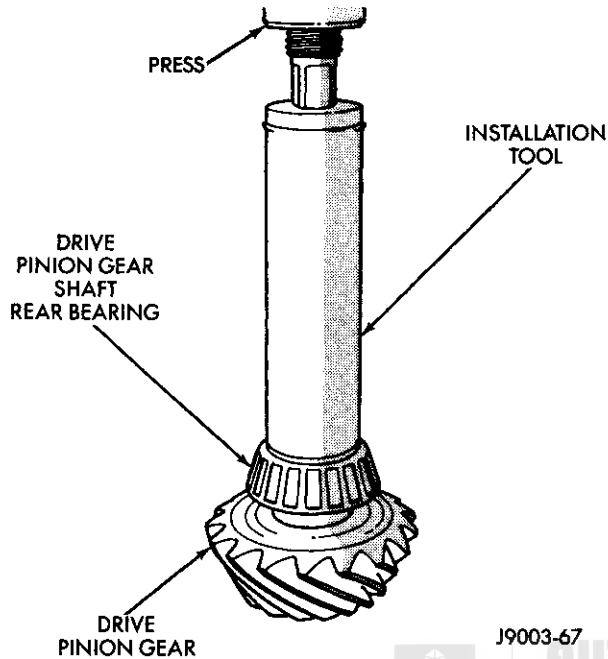


Fig. 48 Shaft Rear Bearing Installation

(6) Install a new collapsible preload spacer on pinion shaft and install pinion gear in housing (Fig. 49).

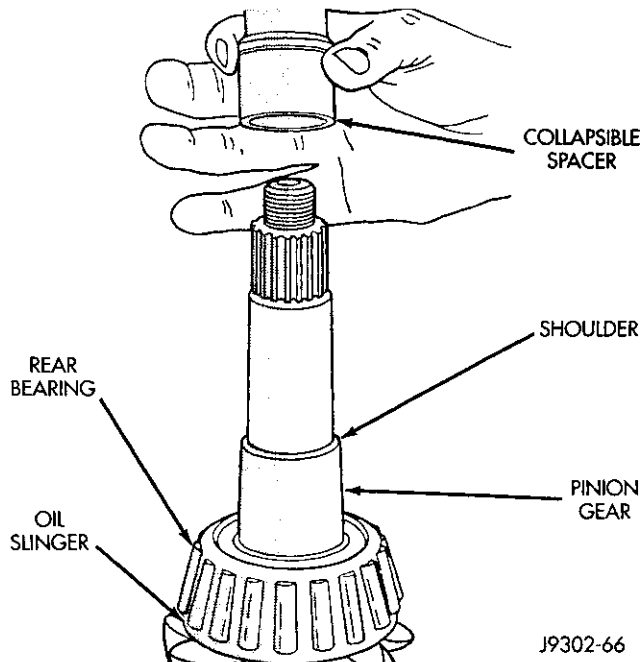


Fig. 49 Collapsible Preload Spacer

(7) Install yoke with Installer W-162D for model 44 or C-3716A for model 60 and Wrench 6719 (Fig. 50).

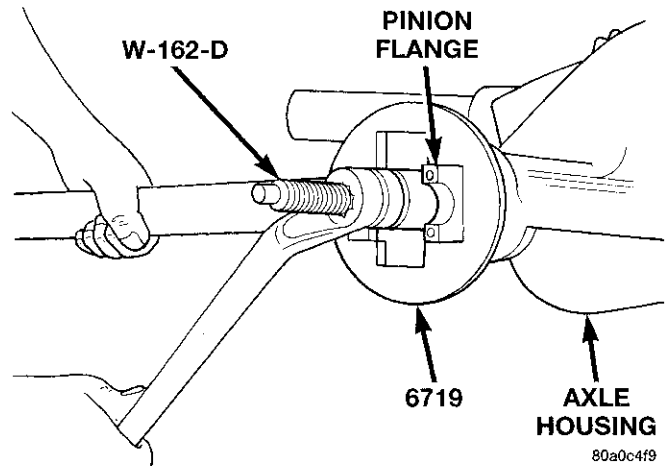


Fig. 50 Pinion Yoke Installation—Typical

(8) Install the yoke washer and a new nut on the pinion gear. Tighten the nut to 258 N·m (190 ft. lbs.) for model 44 or 291 N·m (215 ft. lbs.) for model 60 minimum. **Do not over-tighten.** Maximum torque is 380 N·m (280 ft. lbs.).

CAUTION: Never loosen pinion gear nut to decrease pinion gear bearing preload torque and never exceed specified preload torque. If preload torque is exceeded a new collapsible spacer must be installed. The torque sequence will have to be repeated.

(9) Use Flange Wrench 6719 to retain the yoke (Fig. 51). Slowly tighten the nut in small increments until the rotating torque is achieved. Measure the preload torque frequently to avoid over-tightening the nut.

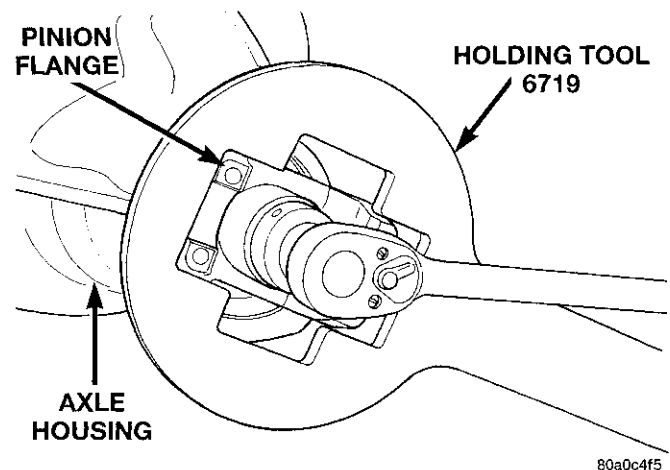
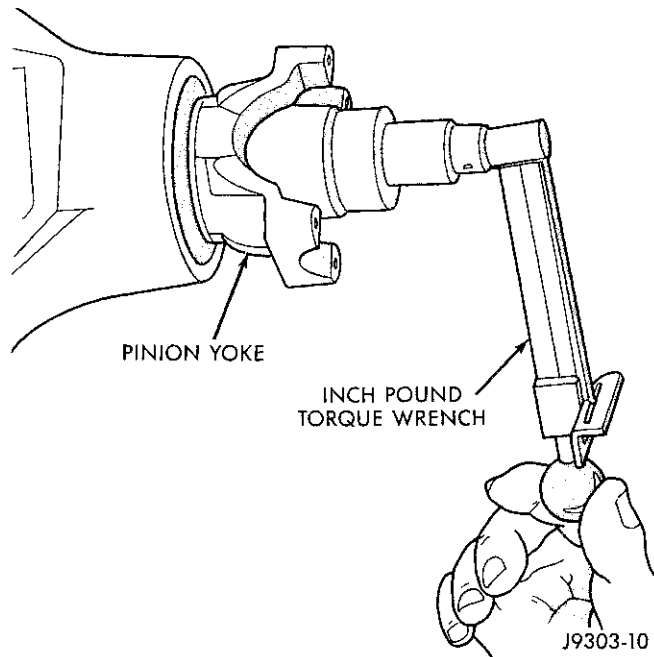


Fig. 51 Tightening Pinion Nut

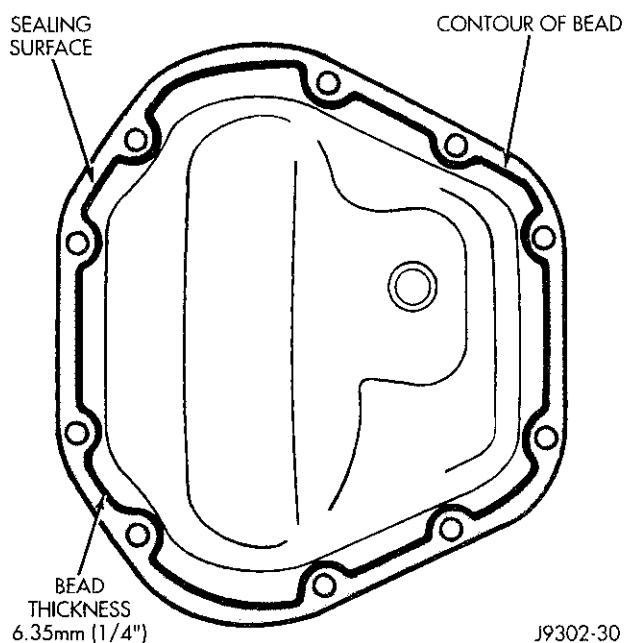
(10) Check bearing preload torque with an inch pound torque wrench (Fig. 52). The torque necessary to rotate the pinion gear should be:

- Original Bearings — 1 to 3 N·m (10 to 20 in. lbs.).
- New Bearings — 2 to 5 N·m (15 to 35 in. lbs.).

REMOVAL AND INSTALLATION (Continued)**Fig. 52 Check Pinion Gear Rotation Torque****FINAL ASSEMBLY**

(1) Install the axle shafts. Refer to Axle Shaft Installation within this group.

(2) Scrape the residual sealant from the housing and cover mating surfaces. Clean the mating surfaces with mineral spirits. Apply a bead of Mopar Silicone Rubber Sealant on the housing cover (Fig. 53). Allow the sealant to cure for a few minutes.

**Fig. 53 Typical Housing Cover With Sealant**

Install the housing cover within 5 minutes after applying the sealant.

(3) Install the cover on the differential with the attaching bolts. Install the identification tag. Tighten the cover bolts to 41 N·m (30 ft. lbs.) torque.

CAUTION: Overfilling the differential can result in lubricant foaming and overheating.

(4) Refill the differential housing with the specified quantity of Mopar Hypoid Gear Lubricant.

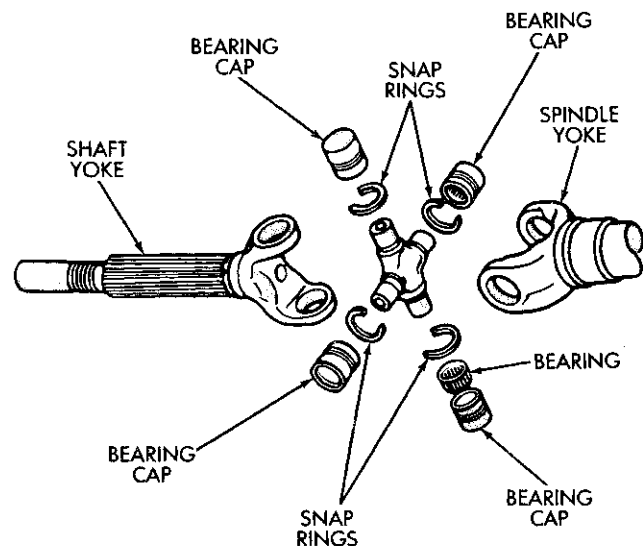
(5) Install the fill hole plug and tighten to 34 N·m (25 ft. lbs.) torque.

DISASSEMBLY AND ASSEMBLY**AXLE SHAFT—CARDAN U-JOINT****DISASSEMBLY**

Single cardan U-joints are not serviceable. If defective, they must be replaced as a unit. If the bearings, seals, spider or bearing caps are damaged or worn, replace the complete U-joint.

CAUTION: Clamp only the forged portion of the yoke in the vise. Also, to avoid distorting the yoke, do not over tighten the vise jaws.

(1) Remove the bearing cap retaining snap rings (Fig. 54).

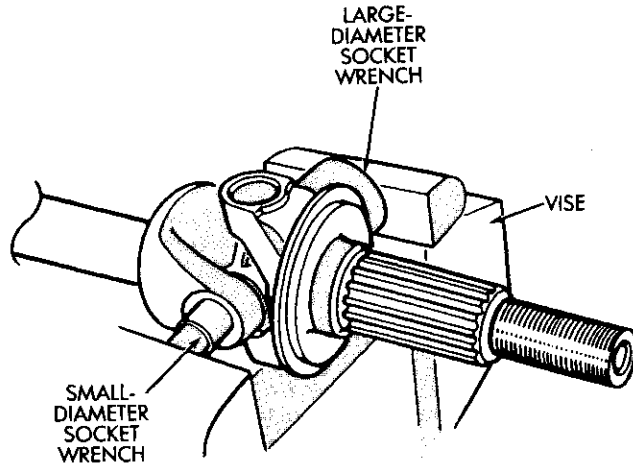
**Fig. 54 Axle Shaft Outer U-Joint**

It can be helpful to saturate the bearing caps with penetrating oil prior to removal.

(2) Locate a socket that is larger in diameter than the bearing cap. Place the socket (receiver) against the yoke and around the perimeter of the bearing cap

DISASSEMBLY AND ASSEMBLY (Continued)

to be removed. Locate a socket that is smaller in diameter than the bearing cap. Place the socket (driver) against the opposite bearing cap. Position the yoke with the sockets in a vise (Fig. 55).



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Fig. 55 Yoke Bearing Cap Removal

(3) Compress the vise jaws to force the bearing cap into the larger socket (receiver).

(4) Release the vise jaws. Remove the sockets and bearing cap that was partially forced out of the yoke.

(5) Repeat the above procedure for the remaining bearing cap.

(6) Remove the remaining bearing cap, bearings, seals and spider from the propeller shaft yoke.

ASSEMBLY

(1) Pack the bearing caps 1/3 full of wheel bearing lubricant. Apply extreme pressure (EP), lithium-base lubricant to aid in installation.

(2) Position the spider in the yoke. Insert the seals and bearings. Tap the bearing caps into the yoke bores far enough to hold the spider in position.

(3) Place the socket (driver) against one bearing cap. Position the yoke with the socket wrench in a vise.

(4) Compress the vise to force the bearing caps into the yoke. Force the caps enough to install the retaining clips.

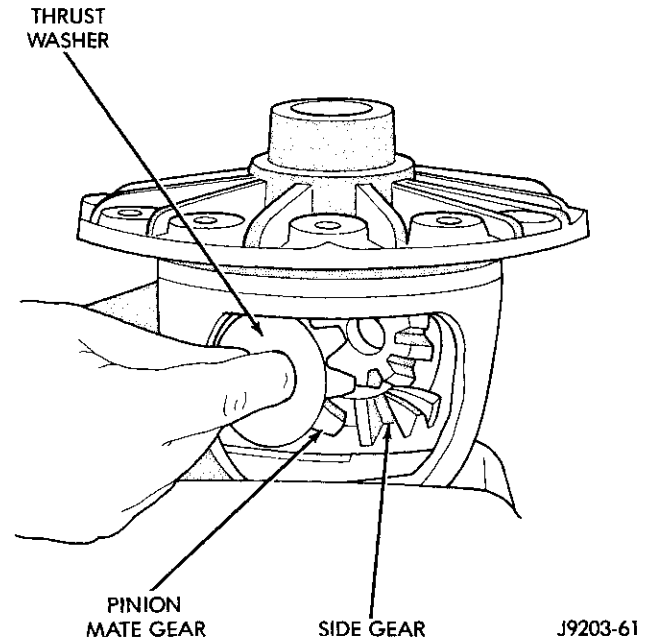
(5) Install the bearing cap retaining clips.

(6) Install the axle shaft, refer to Hub Bearing and Axle Shaft installation.

STANDARD DIFFERENTIAL**DISASSEMBLE**

(1) Remove pinion gear mate shaft.

(2) Rotate the differential side gears and remove the pinion mate gears and thrust washers (Fig. 56).



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Fig. 56 Pinion Mate Gear Removal

(3) Remove the differential side gears and thrust washers.

DIFFERENTIAL ASSEMBLE

(1) Differential side gears and thrust washers

(2) Pinion gears and thrust washers

(3) Pinion gear mate shaft (align holes in shaft and case)

(4) Lubricate all differential components with hypoid gear lubricant.

(5) Install differential case in axle housing. Refer to Differential removal and installation procedure.

CLEANING AND INSPECTION**AXLE COMPONENTS**

Wash differential components with cleaning solvent and dry with compressed air. **Do not steam clean the differential components.**

Wash bearings with solvent and towel dry, or dry with compressed air. **DO NOT** spin bearings with compressed air. **Cup and bearing must be replaced as matched sets only.**

Clean axle shaft tubes and oil channels in housing. Inspect for;

- Smooth appearance with no broken/dented surfaces on the bearing rollers or the roller contact surfaces

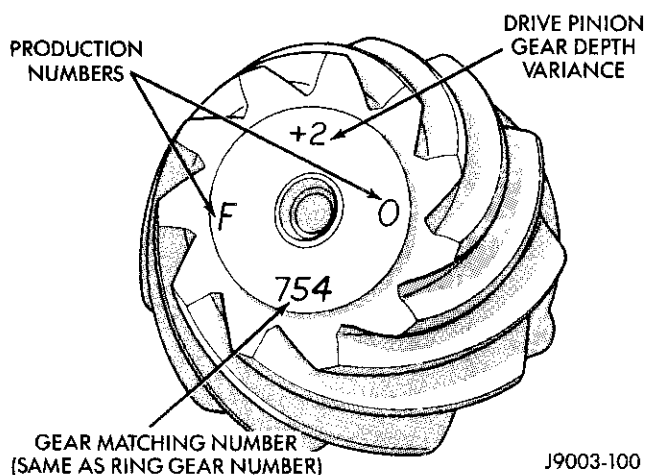
- Bearing cups must not be distorted or cracked

CLEANING AND INSPECTION (Continued)

- Machined surfaces should be smooth and without any raised edges
- Raised metal on shoulders of cup bores should be removed with a hand stone
- Wear and damage to pinion gear mate shaft, pinion gears, side gears and thrust washers. Replace as a matched set only.
- Ring and pinion gear for worn and chipped teeth
- Ring gear for damaged bolt threads. Replaced as a matched set only.
- Pinion yoke for cracks, worn splines, pitted areas, and a rough/corroded seal contact surface. Repair or replace as necessary.
- Preload shims for damage and distortion. Install new shims if necessary.

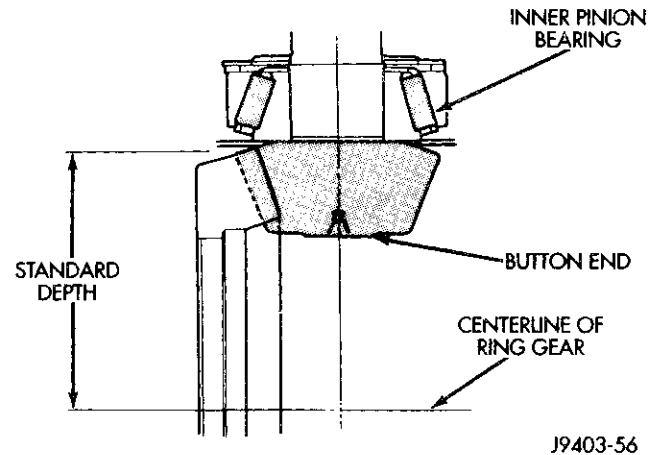
ADJUSTMENTS**PINION GEAR DEPTH****GENERAL INFORMATION**

Ring and pinion gears are supplied as matched sets only. The identifying numbers for the ring and pinion gear are etched into the face of each gear (Fig. 57). A plus (+) number, minus (-) number or zero (0) is etched into the face of the pinion gear. This number is the amount (in thousandths of an inch) the depth varies from the standard depth setting of a pinion etched with a (0). The standard setting from the center line of the ring gear to the back face of the pinion is 109.5 mm (4.312 inches) for Model 44 axles and 127 mm (5 in.) for Model 60 axles. The standard depth provides the best teeth contact pattern. Refer to Backlash and Contact Pattern Analysis Paragraph in this section for additional information.

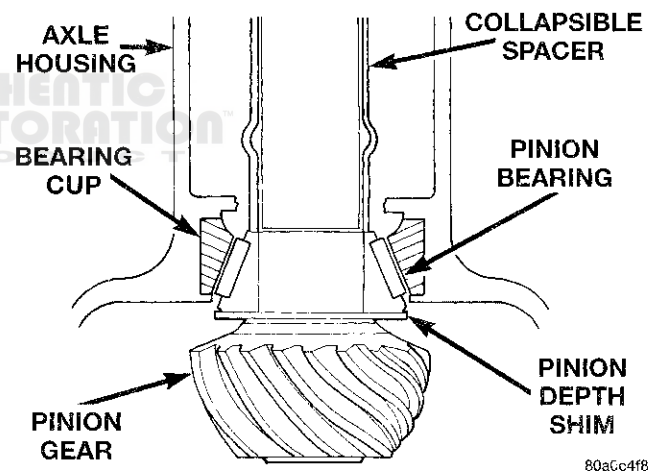
**Fig. 57 Pinion Gear ID Numbers**

NOTE: The button end on the pinion gear head is no longer a machined-to-specifications surface. Do

not use this surface for pinion depth setup or checking (Fig. 58).

**Fig. 58 Pinion Gear Head**

Compensation for pinion depth variance is achieved with select shims. The shims are placed under the inner pinion bearing cone (Fig. 59).

**Fig. 59 Shim Locations**

If a new gear set is being installed, note the depth variance etched into both the original and replacement pinion gear. Add or subtract the thickness of the original depth shims to compensate for the difference in the depth variances. Refer to the Depth Variance charts.

Note where Old and New Pinion Marking columns intersect. Intersecting figure represents plus or minus amount needed.

For example, if old pinion is plus (+) 1 and the new pinion is minus (-) 3, intersecting figure is (+) 0.004 in. (0.10 mm). Add this amount to the original shim. Or if the old pinion is (-) 3 and the new pinion is (-) 2, intersecting figure is (-) 0.001 in. (0.025 mm). Subtract this amount from original shim. Refer to the Pinion Gear Depth Variance Chart.

ADJUSTMENTS (Continued)**PINION GEAR DEPTH VARIANCE**

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

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PINION DEPTH MEASUREMENT AND ADJUSTMENT

Pinion gear depth measurement is necessary when;

- Axle housing or differential case is replaced
- Pinion select shim pack is unknown
- Ring and pinion gears are replaced

Measurements are taken with pinion cups and pinion bearings installed in housing. Take measurements with Pinion Gauge Set 6730. Use Pinion Block 6734 for Model 44 and 6736 for model 60 axle. Use Dial Indicator C-3339 dial indicator to measure difference in height of the arbor and the pinion block. (Fig. 60).

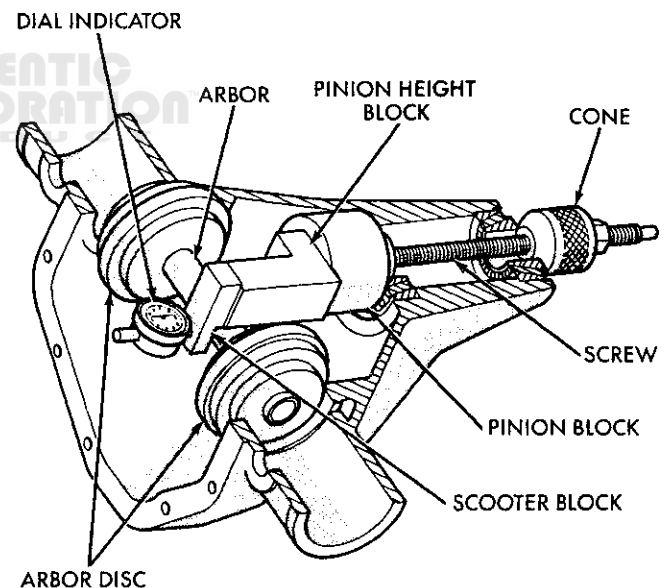
(1) Assemble Pinion Gauge Set, Pinion Block and pinion bearings. Install assembly into differential pinion gear bore and hand tighten cone (Fig. 61).

(2) Place Arbor Disc 6732 on Arbor D-115-3 and position in the bearing cradles (Fig. 62). Install differential bearing caps on Arbor Discs and tighten caps snug only.

Arbor Discs have different steps to fit other axle sizes. Pick correct size step for axle being serviced.

(3) Firmly place Scooter Block D-115-2 and Dial Indicator on pinion height block tool and zero the dial indicator pointer.

(4) Slide the Scooter Block across the arbor while observing indicator (Fig. 63). Record the longest travel distance, whether inward (-) or outward (+), indicated by the pointer.

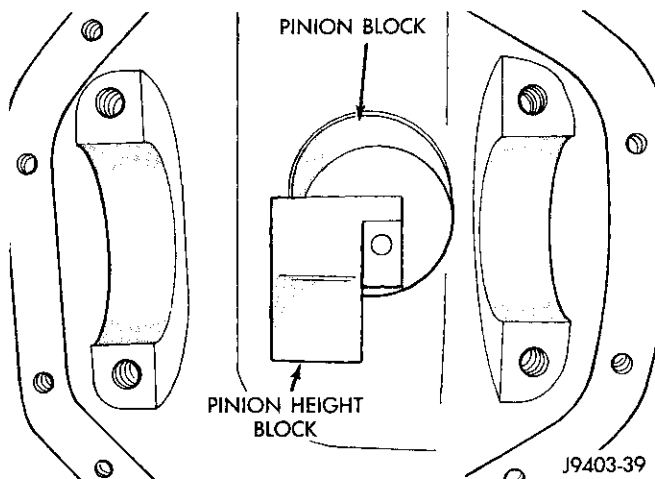
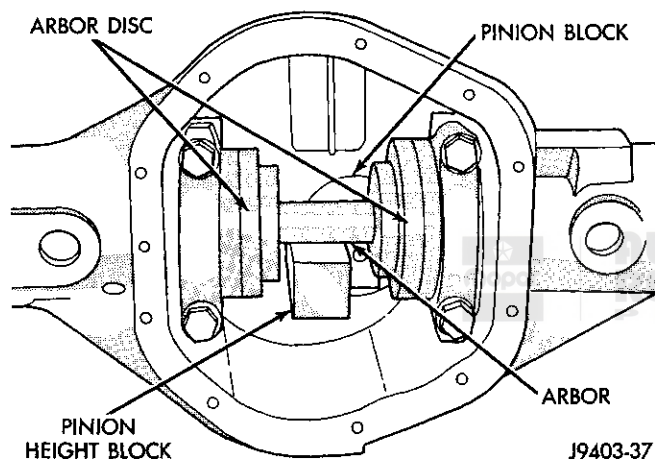
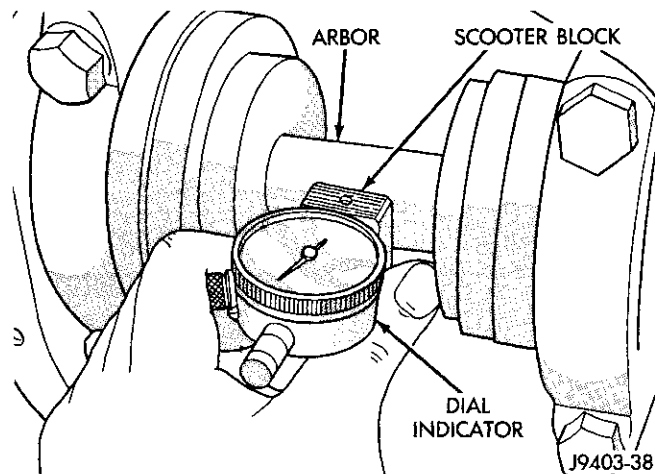


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Fig. 60 Pinion Gear Depth Gauge Tools—Typical

The plunger travel distance indicated, plus or minus the variance etched in the gear is the required thickness for the depth shims.

(5) Measure the thickness of each depth shim with a micrometer and combine the shims necessary for total required shim pack thickness. **Include oil slinger or baffle thickness with the total shim pack thickness.**

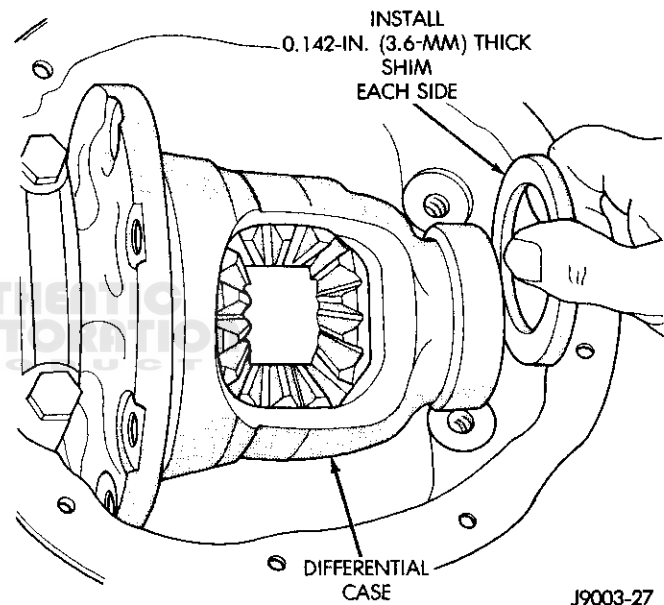
ADJUSTMENTS (Continued)**Fig. 61 Pinion Height Block—Typical****Fig. 62 Gauge Tools In Housing—Typical****Fig. 63 Pinion Gear Depth Measurement—Typical**

(6) Remove the measurement tools from the differential housing.

DIFFERENTIAL BEARING PRELOAD AND GEAR LASH**DIFFERENTIAL SHIM PACK MEASUREMENT**

NOTE: It is recommended whenever bearings are removed that they be replaced.

- (1) Install dummy side bearings D-345 for model 44 or D-343 for model 60 axles on differential.
- (2) Install the differential case in the axle housing.
- (3) Install the outboard shim/spacer (selected thickness) on each side between bearing cup and housing (Fig. 64). Use 0.142 in. (3.6 mm) as a starting point, shim/spacers are available in various thicknesses.

**Fig. 64 Differential Bearing Shim Installation**

- (4) Install the marked bearing caps in their correct positions. Install and snug the bolts.
- (5) Attach a dial indicator to the housing. Position the indicator plunger so that it contacts the ring gear mating surface (Fig. 65).
- (6) Pry the differential case to one side and zero the dial indicator pointer.
- (7) Pry the differential case to the opposite side and record indicator reading. Reading is additional shim thickness needed for zero end play. For example, if reading was 0.008 in. (0.20 mm), an additional 0.004-in. (0.10 mm) thick shim will be needed at each side zero end play.
- (8) Install zero end-play shims on each side of case.

The differential bearings must be preloaded to compensate for heat and load during operation.

ADJUSTMENTS (Continued)

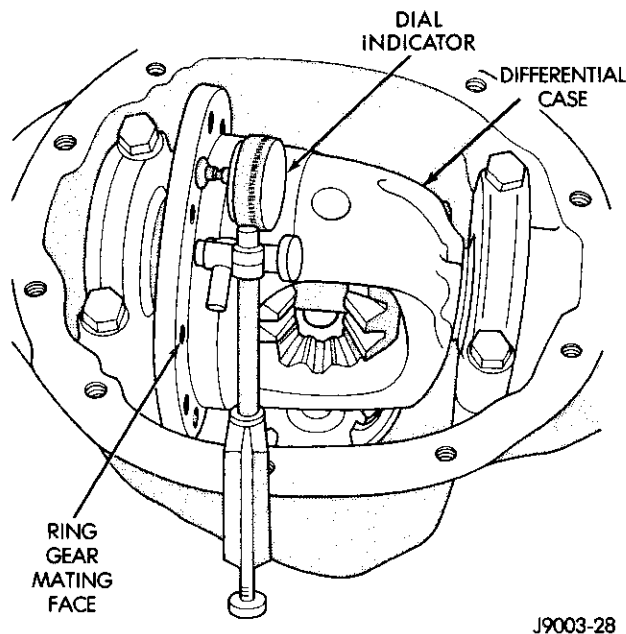


Fig. 65 Shim Measurement

- (9) Add an additional 0.004-in. (0.1 mm) to each outboard shim/spacer for bearing preload.
- (10) Remove differential from axle housing.
- (11) Remove dummy bearings.
- (12) Install new side bearing cones and cups.
- (13) Install ring gear.
- (14) Install differential and verify gear lash and contact pattern.
- (15) Proceed to Final Assembly paragraph in this section.

GEAR BACKLASH AND CONTACT PATTERN ANALYSIS

After installing new side bearings or ring and pinion set adjusting the bearing perload and gear mash backlash will be necessary.

- (1) Rotate assembly several revolutions to seat bearings. Measure backlash at three equally spaced locations around the perimeter of the ring gear with a dial indicator (Fig. 66).

The ring gear backlash must be within 0.12 - 0.20 mm (0.005 - 0.008 in.). It cannot vary more than 0.05 mm (0.002 in.) between the points checked.

If backlash must be adjusted, spacers are available in various thicknesses. Adjust the backlash accordingly (Fig. 67). **Do not increase the total shim pack thickness, excessive bearing preload and damage will occur.**

The ring gear teeth contact patterns will show if the pinion gear depth shim(s) have the correct thickness. It will also show if the ring gear backlash has been adjusted correctly. The backlash must be main-

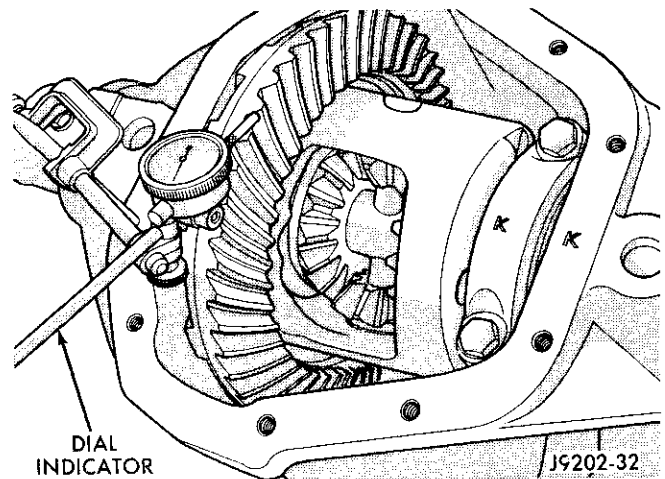


Fig. 66 Ring Gear Backlash Measurement

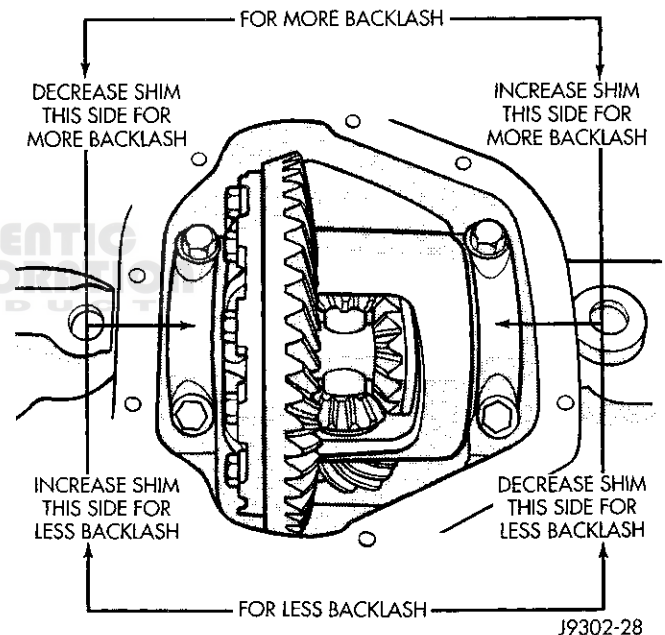


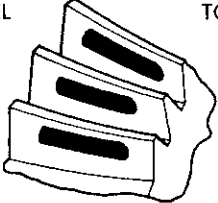
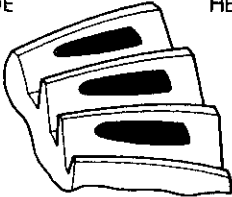
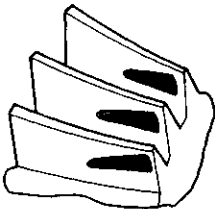
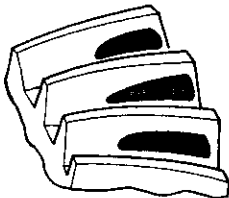
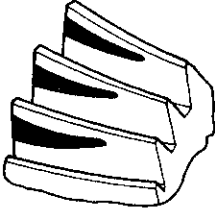
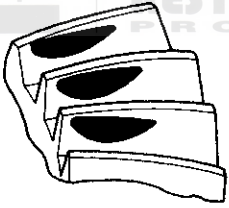
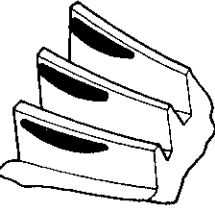
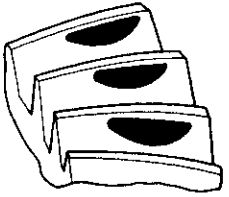
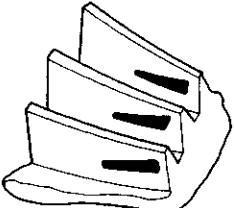
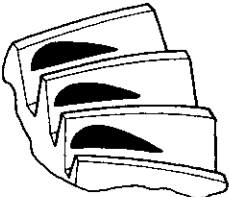
Fig. 67 Backlash Shim Adjustment

tained within the specified limits until the correct tooth contact patterns are obtained.

- (2) Apply a thin coat of hydrated ferric oxide, or equivalent, to the drive and coast side of the ring gear teeth.

- (3) Rotate the ring gear one complete revolution in both directions while a load is being applied. Insert a pry bar between the differential housing and the case flange. This will produce distinct contact patterns on both the drive side and coast side of the ring gear teeth.

- (4) Note patterns in compound. Refer to (Fig. 68) for interpretation of contact patterns and adjust accordingly.

<p>DRIVE SIDE OF RING GEAR TEETH</p> <p>HEEL TOE</p> 	<p>COAST SIDE OF RING GEAR TEETH</p> <p>TOE HEEL</p> 	<p>DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.</p>
		<p>RING GEAR BACKLASH CORRECT. THINNER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>RING GEAR BACKLASH CORRECT. THICKER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. DECREASE RING GEAR BACKLASH.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. INCREASE RING GEAR BACKLASH.</p>

J9003-24

Fig. 68 Gear Tooth Contact Patterns

SPECIFICATIONS**FRONT AXLE****MODEL 44**

DESCRIPTION	SPEC.
Axle Type	Hypoid
Lubricant	Thermal Stable SAE 80W-90
Lube Capacity	2.28 L (4.8 pts.)
Axle Ratio	3.54, 3.55, 3.92, 4.09
Ring Gear Diameter	215.9 mm (8.50 in.)
Pinion Standard Setting	109.5 mm (4.312 in.)
Pinion Bearing Preload	
Original Bearing	1-2 N·m (10-20 in. lbs.)
New Bearing	2.3-4.5 N·m (20-40 in. lbs.)

MODEL 60 FRONT AXLE

DESCRIPTION	SPEC.
Axle Type	Hypoid
Lubricant	Thermal Stable SAE 80W-90
Lube Capacity	3.61 L (122 oz.)
Axle Ratio	3.54 4.10
Ring Gear Diameter	247.6 mm (9.75 in.)
Pinion Standard Setting	127 mm (5.000 in.)
Pinion Bearing Preload	
Original Bearing	1-2 N·m (10-20 in. lbs.)
New Bearing	2.3-4.5 N·m (20-40 in. lbs.)

TORQUE**MODEL 44 AXLE**

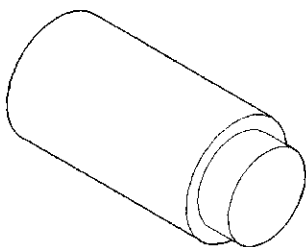
DESCRIPTION	TORQUE
Plug, Fill Hole	34 N·m (25 ft. lbs.)
Bolt, Diff. Cover	42 N·m (31 ft. lbs.)
Bolt, Bearing Cap	108 N·m (80 ft. lbs.)
Nut, Pinion	258-393 N·m (190-290 ft. lbs.)
Bolt, Ring Gear	95-122 N·m (70-90 ft. lbs.)
Bolt, Shift Motor	11 N·m (8 ft. lbs.)
Nut, Axle	237 N·m (175 ft. lbs.)
Bolt, Wheel Brg.	170 N·m (125 ft. lbs.)
Nut, Lower Ball Stud	108 N·m (80 ft. lbs.)
Nut, Upper Ball Stud	101 N·m (75 ft. lbs.)
Bolt, RWAL/ABS Sensor	11 N·m (96 in. lbs.)

MODEL 60 AXLE

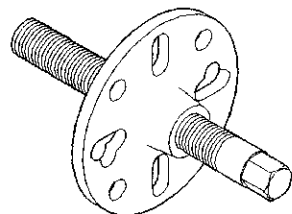
DESCRIPTION	TORQUE
Plug, Fill Hole	34 N·m (25 ft. lbs.)
Bolt, Diff. Cover	47 N·m (35 ft. lbs.)
Bolt, Bearing Cap	108 N·m (80 ft. lbs.)
Nut, Pinion	292-427 N·m (215-315 ft. lbs.)
Bolt, Ring Gear	95-122 N·m (70-90 ft. lbs.)
Bolt, Shift Motor	11 N·m (8 ft. lbs.)
Nut, Axle	237 N·m (175 ft. lbs.)
Bolt, Wheel Brg.	170 N·m (125 ft. lbs.)
Nut, Lower Ball Stud	108 N·m (80 ft. lbs.)
Nut, Upper Ball Stud	101 N·m (75 ft. lbs.)
Bolt, RWAL/ABS Sensor	11 N·m (96 in. lbs.)

SPECIAL TOOLS

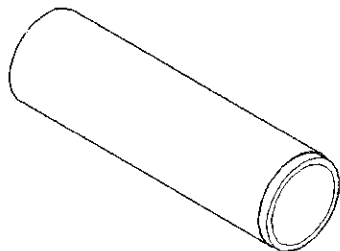
FRONT AXLE



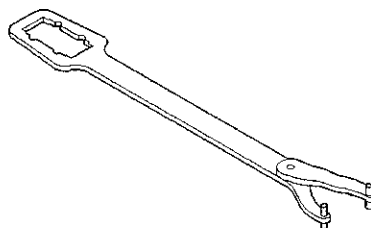
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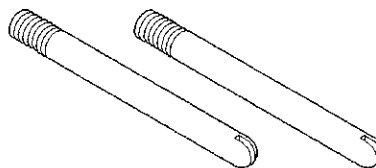
Remover—C-452



Installer—C-3095-A



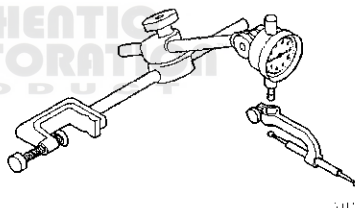
Holder—C-3281



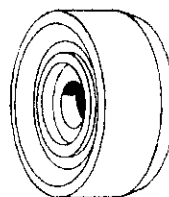
Pilots—C-3288-B



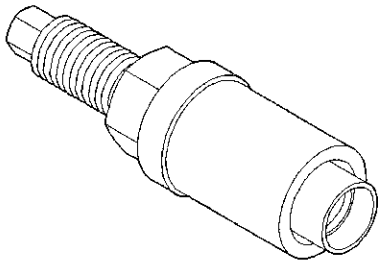
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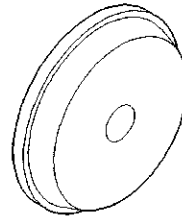
Dial Indicator Set—C-3339



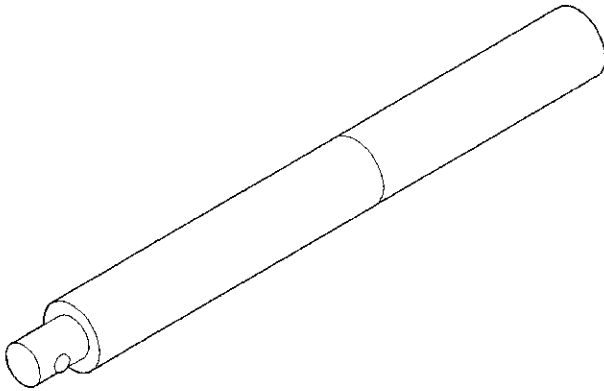
Driver—C-3716-A



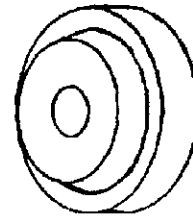
Installer—C-3718



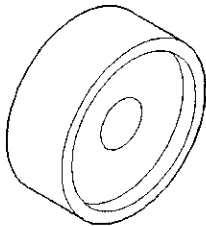
Installer, Pinion Bearing Cup—D-111



Handle—C-4171



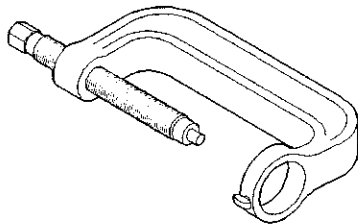
Installer, Pinion Bearing Cup—D-144



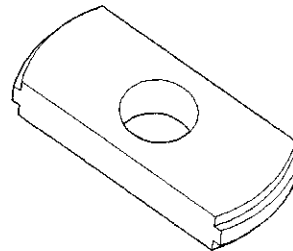
Installer, Differential Bearing—C-4190



Installer—D-145

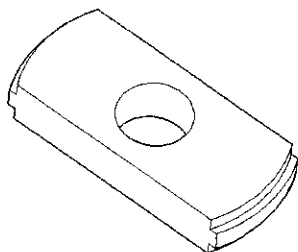


Press, Ball Joint Remover/Installer—C-4212-F

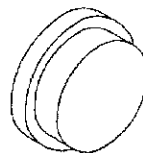


Remover, Pinion Bearing Cup—D-147

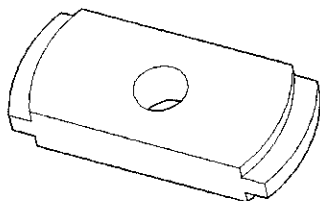
SPECIAL TOOLS (Continued)



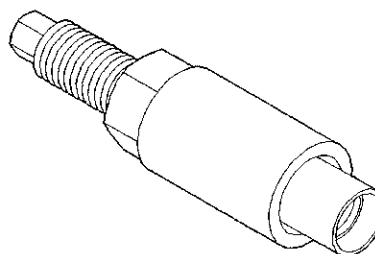
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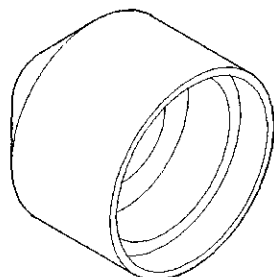
Button, Bearing Puller —DD-914-42



Remover, Pinion Bearing Cup—D-162



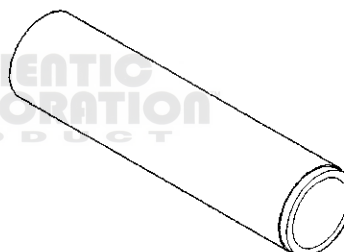
Installer—W-162-D



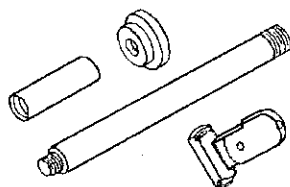
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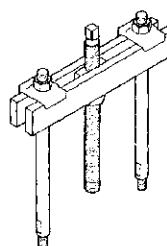
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Installer, Pinion Bearing—W-262

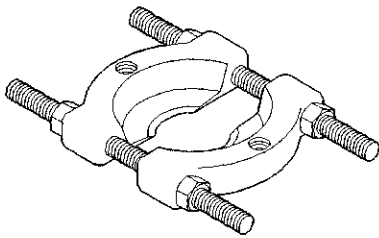


Remover/Installer Set—D-354

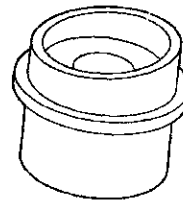


Puller Head—938

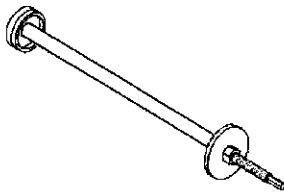
SPECIAL TOOLS (Continued)



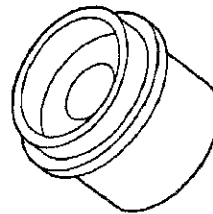
Splitter, Bearing—1130



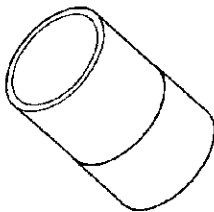
Receiver, Ball Joint—6289-6



Installer Set—5041



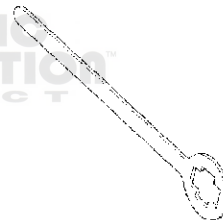
Adapter, Ball Stud Installer—6289-12



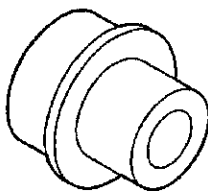
Receiver, Ball Stud—6289-1



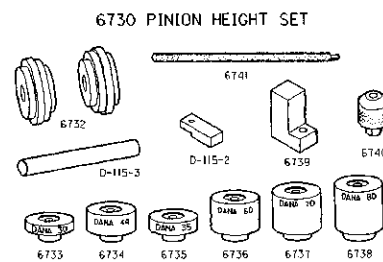
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Holder—6719

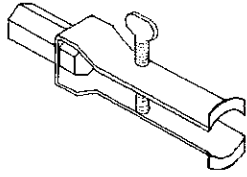


Remover, Ball Stud—6289-3

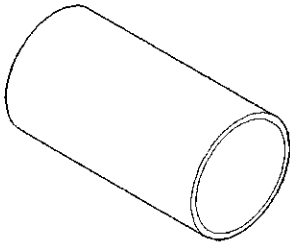


Set, Pinion Depth Setting—6730

SPECIAL TOOLS (Continued)



Remover—7794-A



Installer, Ball Joint—6758



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REAR AXLE—MODEL 9 1/4

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GENERAL INFORMATION

AXLES

The 9 1/4-Inch axle housings consist of a cast iron center section. They also have two steel axle shaft tubes that are pressed into and welded to the differential housing (Fig. 1).

The removable, stamped steel cover provides a means for inspection and service without removing the complete axle from the vehicle.

Both axle types are equipped with a remote vent fitting.

A small, stamped metal axle gear ratio identification tag is attached to the housing cover.

The Rear Wheel Anti-lock (RWAL) brake speed sensor is attached to the top, forward exterior of the differential housing. A seal is located between the sensor and the wire harness connector. **The seal must be in place when the wire connector is connected to the sensor.** The RWAL brake exciter ring is press-fitted onto the differential case against the flange.

Axles equipped with a Trac-Lok[®] differential are optional. A Trac-Lok differential has a one-piece differential case, and the same internal components as a standard differential, plus two clutch disc packs.

DIAGNOSIS AND TESTING

GENERAL INFORMATION

Axle bearing problem conditions are usually caused by:

- Insufficient or incorrect lubricant
- Foreign matter/water contamination
- Incorrect bearing preload torque adjustment
- Incorrect backlash (to tight)

When serviced, the bearings must be cleaned thoroughly. They should be dried with lint-free shop towels. **Never spin dry bearings with compressed air. This will overheat them and brinell the bearing surfaces. This will result in noisy operation after repair.**

Axle gear problem conditions are usually the result of:

- Insufficient lubrication
- Incorrect or contaminated lubricant
- Overloading (excessive engine torque) or exceeding vehicle weight capacity
- Incorrect clearance or backlash adjustment

Insufficient lubrication is usually the result of a housing cover leak. It can also be from worn axle shaft or pinion gear seals. Check for cracks or porous areas in the housing or tubes.

DIAGNOSIS AND TESTING (Continued)

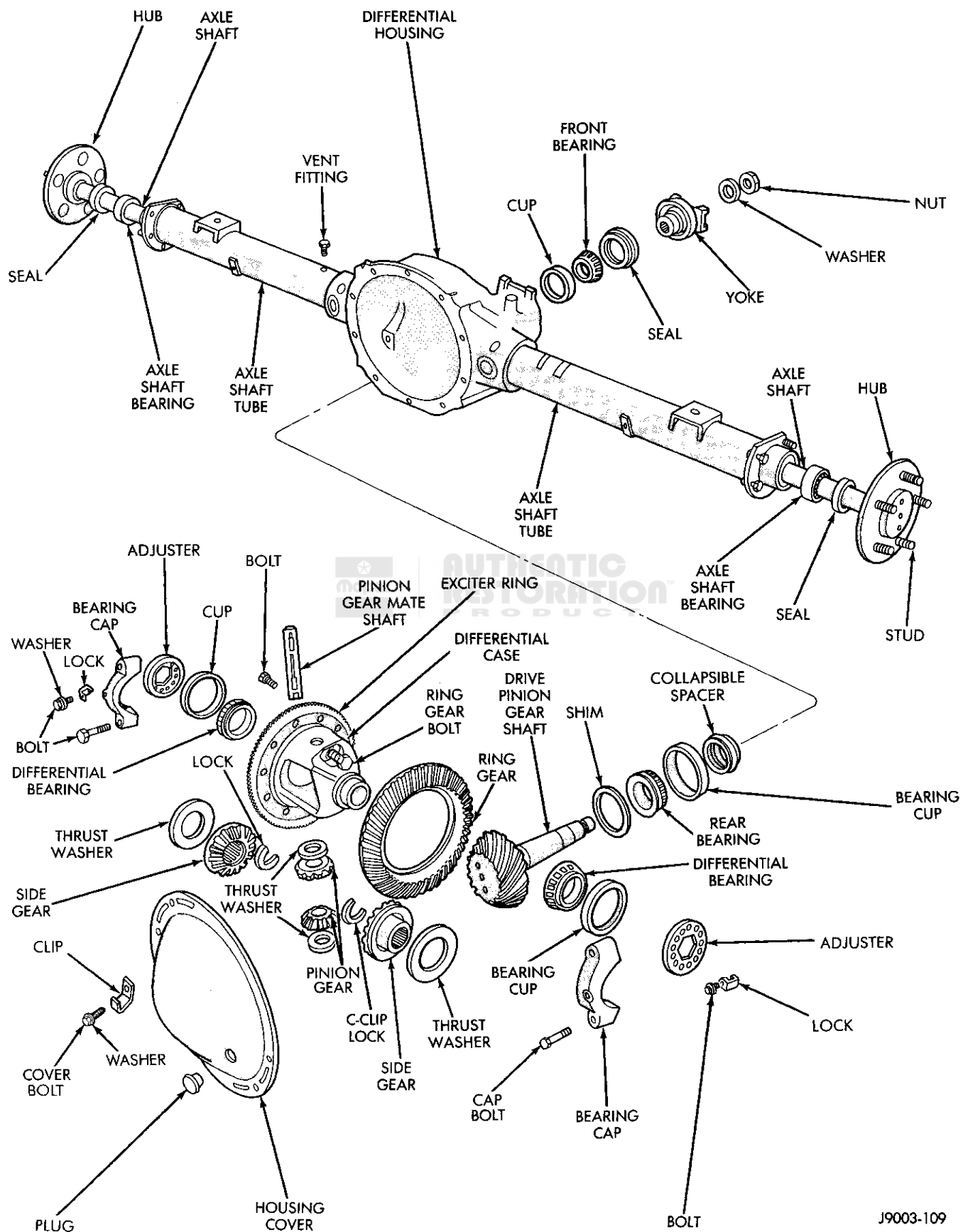


Fig. 1 9 1/4 Axle

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DIAGNOSIS AND TESTING (Continued)

Using the wrong lubricant will cause overheating and gear failure. Gear tooth cracking and bearing spalling are indicators of this.

Axle component breakage is most often the result of:

- Severe overloading
- Insufficient lubricant
- Incorrect lubricant
- Improperly tightened components

Overloading occurs when towing heavier than recommended loads. Component breakage can occur when the wheels are spun excessively. Incorrect lubricant quantity contributes to breakage. Loose differential components can also cause breakage.

Incorrect bearing preload or gear backlash will not result in component breakage. Mis-adjustment will produce enough noise to cause service repair before a failure occurs. If a mis-adjustment condition is not corrected, component failure can result.

Excessive bearing preload may not be noisy. This condition will cause high temperature which can result in bearing failure.

GEAR AND BEARING NOISE

GEAR NOISE

Axle gear noise can be caused by insufficient lubricant. Incorrect backlash, tooth contact, or worn/damaged gears can cause noise.

Gear noise usually happens at a specific speed range. The range is 30 to 40 mph, or above 50 mph. The noise can also occur during a specific type of driving condition. These conditions are acceleration, deceleration, coast, or constant load.

When road testing, accelerate the vehicle to the speed range where the noise is the greatest. Shift out-of-gear and coast through the peak-noise range. If the noise stops or changes greatly, check for insufficient lubricant. Incorrect ring gear backlash, or gear damage can cause noise changes.

Differential side and pinion gears can be checked by turning the vehicle. They usually do not cause noise in straight-ahead driving. These gears are loaded during vehicle turns. If noise does occur during vehicle turns, the side or pinion gears could be worn or damaged. A worn pinion gear mate shaft can also cause a snapping or a knocking noise.

BEARING NOISE

The axle shaft, differential and pinion gear bearings can all produce noise when worn or damaged. Bearing noise can be either a whining, or a growling sound.

Pinion gear bearings have a constant-pitch noise. This noise changes only with vehicle speed. Pinion bearing noise will be higher because it rotates at a faster rate. Drive the vehicle and load the differen-

tial. If bearing noise occurs the pinion rear bearing is the source of the noise. If the bearing noise is heard during a coast, front bearing is the source.

Worn, damaged differential bearings usually produce a low pitch noise. Differential bearing noise is similar to pinion bearing. The pitch of differential bearing noise is also constant and varies only with vehicle speed.

Axle shaft bearings produce noise and vibration when worn or damaged. The noise generally changes when the bearings are loaded. Road test the vehicle. Turn the vehicle sharply to the left and to the right. This will load the bearings and change the noise level. Where axle bearing damage is slight, the noise is usually not noticeable at speeds above 30 mph.

LOW SPEED KNOCK

Low speed knock is generally caused by a worn U-joint or by worn side-gear thrust washers. A worn pinion gear shaft bore will also cause low speed knock.

VIBRATION

Vibration at the rear of the vehicle is usually caused by a:

- Damaged drive shaft
- Missing drive shaft balance weight
- Worn, out-of-balance wheels
- Loose wheel lug nuts
- Worn U-joint
- Loose spring U-bolts
- Loose/broken springs
- Damaged axle shaft bearings
- Loose pinion gear nut
- Excessive pinion yoke run out
- Bent axle shaft

Check for loose or damaged front-end components or engine/transmission mounts. These components can contribute to what appears to be a rear-end vibration. Do not overlook engine accessories, brackets and drive belts.

All driveline components should be examined before starting any repair.

Refer to Group 22, Wheels and Tires for additional information.

DRIVELINE SNAP

A snap or clunk noise when the vehicle is shifted into gear (or the clutch engaged), can be caused by:

- High engine idle speed
- Loose engine/transmission/transfer case mounts
- Worn U-joints
- Loose spring mounts
- Loose pinion gear nut and yoke
- Excessive ring gear backlash
- Excessive side gear/case clearance

DIAGNOSIS AND TESTING (Continued)

The source of a snap or a clunk noise can be determined with the assistance of a helper. Raise the vehicle on a hoist with the wheels free to rotate. Instruct the helper to shift the transmission into gear. Listen for the noise, a mechanics stethoscope is helpful in isolating the source of a noise.

REAR AXLE ALIGNMENT**MEASUREMENT**

The following procedure can be used to determine if abnormal rear tire tread wear is the result of a bent or deformed rear axle shaft.

(1) Raise both rear wheels off the surface with a frame contact hoist.

(2) Attach a one-inch long piece of masking tape at the center of each tire tread for use as reference marks.

(3) Rotate the rear wheels until both reference marks face the front of the vehicle. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Front Of Tire (FTR) measurement.

(4) Rotate the rear wheels until both reference marks face the rear of the vehicle. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Rear Of Tire (RTR) measurement.

(5) Subtract the RTR measurement from the FTR measurement to obtain the amount of wheel toe. The acceptable rear wheel toe-in position is 1/16 in. (1.6 mm) to 3/16 in. (4.8 mm) toe-out.

(6) Rotate the rear wheels until the reference marks are facing downward. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Bottom Of Tire (BTR) measurement.

(7) Average the FTR and the RTR distance measurements. Subtract the BTR measurement from this average distance to obtain the camber. The acceptable amount of camber is 1/16 inch to 3/32 inch (1.6 to 2.4 mm).

NOTE: FTR + RTR Divided By two Minus BTR Equals Camber

If the BTR distance measurement is less than the average FTR and RTR distance measurement, the camber will be positive (+). If the BTR distance measurement is greater than the average FTR and RTR distance, the camber will be negative (-).

If the toe position or camber is not acceptable, a bent or deformed rear axle shaft is most likely the cause.

LIMITED SLIP DIFFERENTIAL

Under normal traction conditions, engine torque is divided evenly. With low-traction surfaces, engine torque is transferred to the wheel with the most tire traction. When diagnosing a limited-slip differential the wheel with the least traction can continue spinning.

The most common problem is a chatter noise when turning corners. Check for incorrect or contaminated lubricant. Replace the gear lubricant if necessary.

- With Trac-Lok[®] differentials add a container of Mopar Trac-Lok Lubricant.

This will correct the condition in most instances. If the chatter persists, clutch damage could have occurred.

After changing the lubricant, drive the vehicle and make 10 to 12 slow, figure-eight turns. This maneuver will pump lubricant through the clutches.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS****SERVICE DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
WHEEL NOISE	<ol style="list-style-type: none"> 1. Wheel loose. 2. Faulty, brinelled wheel bearing. 	<ol style="list-style-type: none"> 1. Tighten loose nuts. 2. Faulty or brinelled bearings must be replaced.
AXLE SHAFT NOISE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Bent or sprung axle shaft. 3. End play in drive pinion bearings. 4. Excessive gear backlash between ring gear and pinion gear. 5. Improper adjustment of drive pinion gear shaft bearings. 6. Loose drive pinion gearshaft yoke nut. 7. Improper wheel bearing adjustment. 8. Scuffed gear tooth contact surfaces. 	<ol style="list-style-type: none"> 1. Inspect axle shaft tube alignment. Correct as necessary. 2. Replace bent or sprung axle shaft. 3. Refer to Drive Pinion Bearing Pre-Load Adjustment. 4. Check adjustment of ring gear backlash and pinion gear. Correct as necessary. 5. Adjust drive pinion shaft bearings. 6. Tighten drive pinion gearshaft yoke nut with specified torque. 7. Readjust as necessary. 8. If necessary, replace scuffed gears.
AXLE SHAFT BROKE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Vehicle overloaded. 3. Erratic clutch operation. 4. Grabbing clutch. 	<ol style="list-style-type: none"> 1. Replace broken axle shaft after correcting axle shaft tube alignment. 2. Replace broken axle shaft. Avoid excessive weight on vehicle. 3. Replace broken axle shaft after inspecting for other possible causes. Avoid erratic use of clutch. 4. Replace broken axle shaft. Inspect clutch and make necessary repairs or adjustments.
DIFFERENTIAL CASE CRACKED	<ol style="list-style-type: none"> 1. Improper adjustment of differential bearings. 2. Excessive ring gear backlash. 3. Vehicle overloaded. 4. Erratic clutch operation. 	<ol style="list-style-type: none"> 1. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust differential bearings properly. 2. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust ring gear backlash properly. 3. Replace cracked case; examine gears and bearings for possible damage. Avoid excessive weight on vehicle. 4. Replace cracked case. After inspecting for other possible causes, examine gears and bearings for possible damage. Avoid erratic use of clutch.
DIFFERENTIAL GEARS SCORED	<ol style="list-style-type: none"> 1. Insufficient lubrication. 2. Improper grade of lubricant. 3. Excessive spinning of one wheel/tire. 	<ol style="list-style-type: none"> 1. Replace scored gears. Scoring marks on the drive face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear differential housing to required capacity with proper lubricant. Refer to Specifications. 2. Replace scored gears. Inspect all gears and bearings for possible damage. Clean and refill differential housing to required capacity with proper lubricant. 3. Replace scored gears. Inspect all gears, pinion bores and shaft for damage. Service as necessary.
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 1. Lubricant level too high. 	<ol style="list-style-type: none"> 1. Drain excess lubricant by removing fill plug and allow lubricant to level at lower edge of fill plug hole.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS (CONT'D)**

CONDITION	POSSIBLE CAUSES	CORRECTION
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 2. Worn axle shaft seals. 3. Cracked differential housing. 4. Worn drive pinion gear shaft seal. 5. Scored and worn yoke. 6. Axle cover not properly sealed. 	<ol style="list-style-type: none"> 2. Replace worn seals. 3. Repair or replace housing as necessary. 4. Replace worn drive pinion gear shaft seal. 5. Replace worn or scored yoke and seal. 6. Remove cover and clean flange and reseal.
AXLE OVERHEATING	<ol style="list-style-type: none"> 1. Lubricant level too low. 2. Incorrect grade of lubricant. 3. Bearings adjusted too tight. 4. Excessive gear wear. 5. Insufficient ring gear backlash. 	<ol style="list-style-type: none"> 1. Refill differential housing. 2. Drain, flush and refill with correct amount of the correct lubricant. 3. Readjust bearings. 4. Inspect gears for excessive wear or scoring. Replace as necessary. 5. Readjust ring gear backlash and inspect gears for possible scoring.
GEAR TEETH BROKE (RING GEAR AND PINION)	<ol style="list-style-type: none"> 1. Overloading. 2. Erratic clutch operation. 3. Ice-spotted pavements. 4. Improper adjustments. 	<ol style="list-style-type: none"> 1. Replace gears. Examine other gears and bearings for possible damage. 2. Replace gears and examine the remaining parts for possible damage. Avoid erratic clutch operation. 3. Replace gears. Examine the remaining parts for possible damage. Replace parts as required. 4. Replace gears. Examine other parts for possible damage. Ensure ring gear backlash is correct.
AXLE NOISE	<ol style="list-style-type: none"> 1. Insufficient lubricant. 2. Improper ring gear and drive pinion gear adjustment. 3. Unmatched ring gear and drive pinion gear. 4. Worn teeth on ring gear or drive pinion gear. 5. Loose drive pinion gear shaft bearings. 6. Loose differential bearings. 7. Misaligned or sprung ring gear. 8. Loose differential bearing cap bolts. 	<ol style="list-style-type: none"> 1. Refill axle with correct amount of the proper lubricant. Also inspect for leaks and correct as necessary. 2. Check ring gear and pinion gear teeth contact pattern. 3. Remove unmatched ring gear and drive pinion gear. Replace with matched gear and drive pinion gear set. 4. Check teeth on ring gear and drive pinion gear for correct contact. If necessary, replace with new matched set. 5. Adjust drive pinion gearshaft bearing preload torque. 6. Adjust differential bearing preload torque. 7. Measure ring gear runout. 8. Tighten with specified torque.

DIAGNOSIS AND TESTING (Continued)

TRAC-LOK NOISE DIAGNOSIS

If a noise occurs when turning corners, the most probable cause is incorrect or contaminated lubricant. Before removing the Trac-lok unit for repair, drain, flush and refill the axle with the specified lubricant. Refer to Lubricant change in this Group.

A container of Trac-lok Lubricant (friction modifier) should be added after repair service or a lubricant change.

Vehicles with a limited slip differential should be road tested by making 10 to 12 slow figure eight turns. This maneuver will pump the lubricant through the clutch discs to eliminate a possible **chatter or pop** noise complaint.

Refer to Group 0, Lubrication and Maintenance for additional information.

DIFFERENTIAL TEST

WARNING: WHEN SERVICING VEHICLES WITH A LIMITED SLIP DIFFERENTIAL DO NOT USE THE ENGINE TO TURN THE AXLE AND WHEELS. BOTH REAR WHEELS MUST BE RAISED AND THE VEHICLE SUPPORTED. A LIMITED SLIP AXLE CAN EXERT ENOUGH FORCE (IF ONE WHEEL IS IN CONTACT WITH THE SURFACE) TO CAUSE THE VEHICLE TO MOVE.

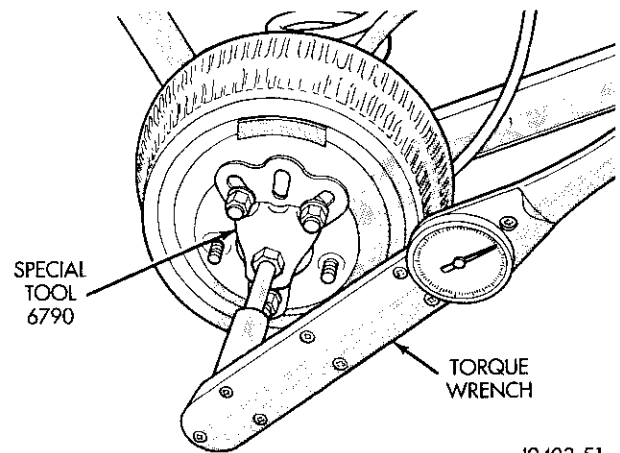
The differential can be tested without removing the differential case by measuring rotating torque. Make sure brakes are not dragging during this measurement.

- (1) Engine off, transmission in neutral, and parking brake off.
- (2) Place blocks in front and rear of both front wheels.
- (3) Raise one rear wheel until it is completely off the ground.
- (4) Remove wheel and bolt Special Tool 6790 to studs.
- (5) Use torque wrench on special tool to rotate wheel and read rotating torque (Fig. 2).
- (6) If rotating torque is less than 22 N·m (30 ft. lbs.) or more than 271 N·m (200 ft. lbs.) on either wheel the unit should be service.

SERVICE PROCEDURES

DRAIN AND REFILL

- (1) Drive the vehicle until the gear lubricant reaches normal operating temperature.
- (2) Raise and support the vehicle.
- (3) Remove the lubricant fill hole plug from the differential housing cover.
- (4) Remove the differential housing cover and drain lubricant from the housing and axle shaft tubes.

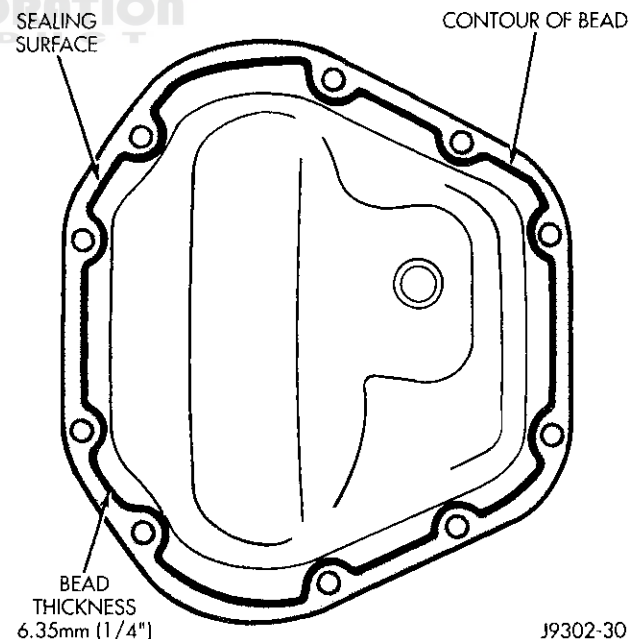


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Fig. 2 Trac-loc Test

(5) With standard differential, clean the differential and the housing cavity with a flushing oil (or light engine oil). This will remove the residual lubricant and foreign matter. **Do not use water, steam, kerosene or gasoline for flushing.**

(6) Scrape the residual sealant from the housing and cover mating surfaces. Clean the mating surfaces with mineral spirits. Apply a bead of MOPAR Silicone Rubber Sealant on the housing cover (Fig. 3). **Allow the sealant to cure for a few minutes.**



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Fig. 3 Typical Housing Cover

NOTE: Install the housing cover within 5 minutes after applying the sealant. If not installed, the sealant must be removed and another bead applied.

(7) Install the cover on the differential. Install the identification tag. Tighten the cover bolts to 47 N·m (35 ft. lbs.).

SERVICE PROCEDURES (Continued)

CAUTION: Overfilling the differential can result in lubricant foaming and overheating.

(8) Refill the differential with the specified quantity of Mopar Hypoid gear Lubricant. With Trac-Lok differentials, add a container of friction modifier.

(9) Install the fill hole plug.

(10) Road test the vehicle.

REMOVAL AND INSTALLATION**AXLE ASSEMBLY**

It is not necessary to remove the complete axle from the vehicle for routine differential inspection and service. If the differential housing, case or axle shaft tubes are damaged the complete axle can be removed and replaced.

REMOVAL

- (1) Raise and support vehicle.
- (2) Block the brake pedal in the up (non-depressed) position with a wooden block.
- (3) Remove the rear wheels and brake drums.
- (4) Disconnect the brake fluid tube fittings from the wheel cylinders. Cap the fittings to prevent loss of brake fluid.
- (5) Remove the vent hose from the brake tee nipple.
- (6) Remove the brake tee bolt. Carefully detach the brake fluid tubes from the clips.
- (7) Disconnect the parking brake cables and unbolt backing plates.

Mark the U-joint, pinion yoke, and pinion shaft for reference.

(8) Disconnect the drive shaft from the pinion yoke. Secure the drive shaft in an upright position to prevent damage to the rear U-joint.

(9) Remove the shock absorber lower attaching nuts and bolts.

(10) Support axle and remove rear spring U-bolts and the spring brackets.

WARNING: AXLE MAY ROTATE ON SUPPORT WHEN SPRING CLAMP BOLTS ARE REMOVED ENSURE AXLE IS SECURED ON SUPPORT.

(11) Remove the axle assembly from the vehicle.

(12) Wash and clean the outer surface of the housing and tubes. Use an appropriate cleaning solution and dry the surface with compressed air.

INSTALLATION

(1) Position the rear axle spring pads over the spring center bolts.

(2) Install the spring clamp bolts and nuts, and shock absorber lower bolts. Tighten the nuts to the specified torque.

(3) Connect the parking brake cables.

(4) Connect the brake fluid tube fittings to the wheel cylinders. Bleed and adjust brakes refer to Group 5 Brakes for procedure.

(5) Align the installation reference marks and connect the drive shaft yoke to the pinion yoke. Tighten the U-joint clamp bolts to 19-23 N·m (170-200 in. lbs.) torque.

(6) Install wheel and tire assemblies.

(7) Remove support and lower vehicle.

AXLE SHAFT, SEAL AND BEARING

CAUTION: When rear axle service is necessary, both rear wheels must be raised off the surface so that they are free to rotate. Be cautious when the tires are being rotated by the engine or by other means.

AXLE SHAFT REMOVAL

- (1) Raise and support the vehicle.
- (2) Remove wheel and tire assembly.
- (3) Remove the brake drum.
- (4) Clean all the foreign material from housing cover area.
- (5) Loosen the housing cover bolts. Drain the lubricant from the housing. Remove the housing cover.
- (6) Rotate the differential case so the pinion mate gear shaft lock screw is accessible. Remove the lock screw and the pinion mate gear shaft from the case (Fig. 4).

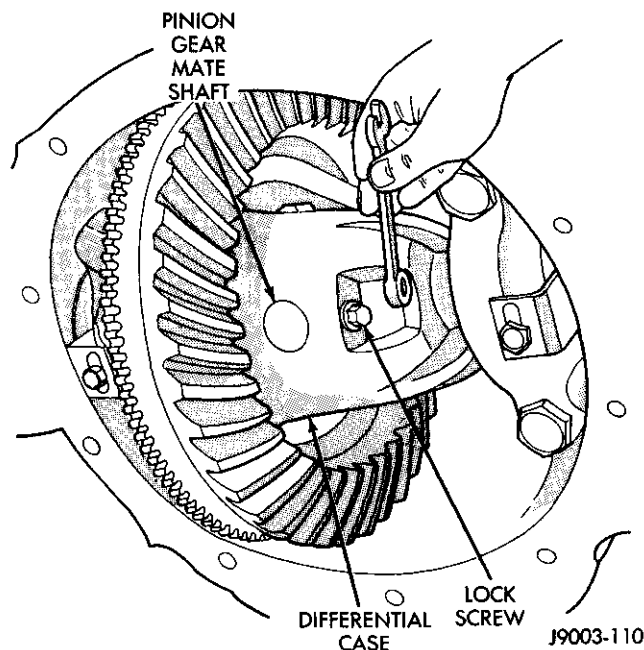


Fig. 4 Pinion Mate Shaft Lock Screw

REMOVAL AND INSTALLATION (Continued)

(7) Push the axle shaft in toward the center of the vehicle. Remove the axle shaft C-clip lock from the axle shaft (Fig. 5).

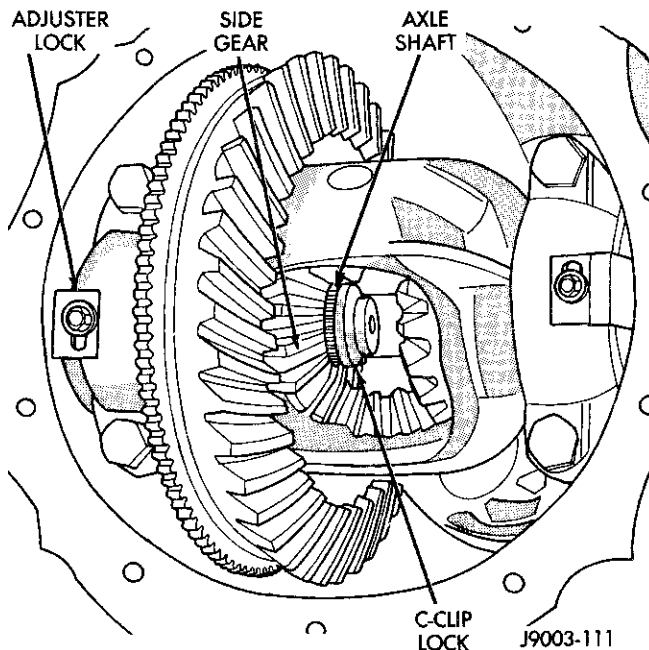


Fig. 5 Axle Shaft C-Clip Lock

(8) Remove the axle shaft. Use care to prevent damage to the axle shaft bearing.

(9) Inspect the axle shaft bearing contact surface area for indications of wear (Fig. 6).

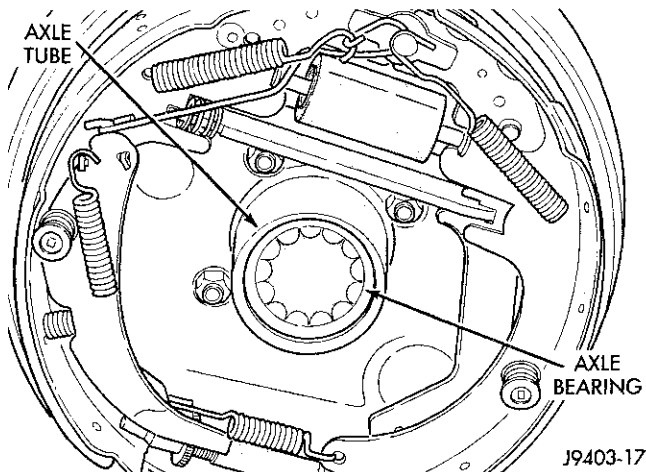


Fig. 6 Axle Shaft Bearing

NOTE: If wear exists, the axle shaft and bearing should be replaced. Normal bearing contact on the shaft will be a dull gray and it could appear to be lightly dented.

(10) If any of these conditions exist, the axle shaft and bearing must be replaced.

SEAL AND BEARING REMOVAL

(1) Remove the axle shaft seal with a small pry bar (Fig. 7).

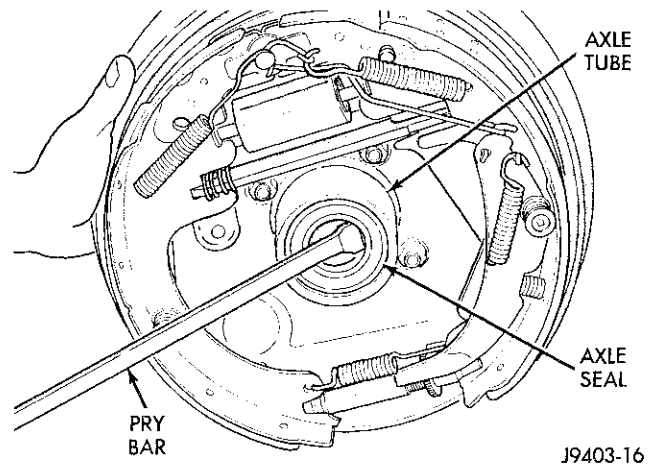


Fig. 7 Axle Seal Removal

(2) Remove the axle bearing with Remover C-4828 (Fig. 8)

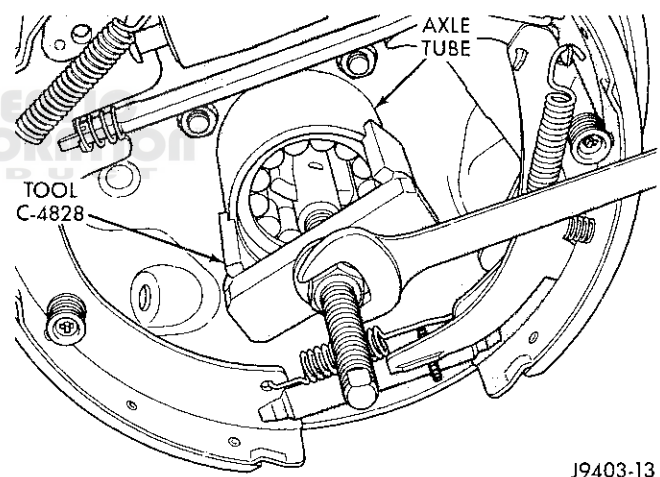


Fig. 8 Bearing Removal

(3) Inspect the axle shaft seal surface and tube bore for roughness and burrs. **Polish each axle shaft with No. 600 crocus cloth. This will remove slight surface damage. Do not reduce the diameter of the axle shaft seal contact surface. When polishing, the crocus cloth should be moved around the circumference of the shaft (not in-line with the shaft).**

REMOVAL AND INSTALLATION (Continued)**BEARING AND SEAL INSTALLATION**

NOTE: Always install a new seal.

- (1) Wipe the axle shaft tube bore clean.
- (2) Install a new bearing with Installer C-4826 with Handle C-4171
- (3) Ensure that the bearing is not cocked and is seated firmly against the tube shoulder.

CAUTION: DO NOT use the new axle shaft seal to position or seat the bearing in the axle shaft bore.

- (4) Install the new axle shaft seal (Fig. 9) with Installer C-4826 and Handle C-4171.

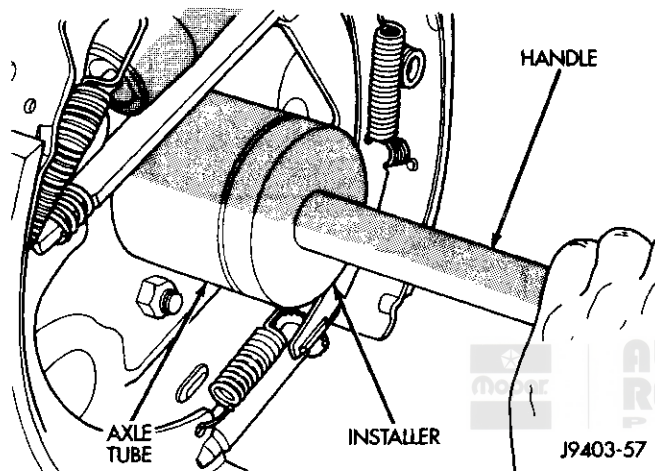


Fig. 9 Axle Shaft Seal Installation

- (5) When the tool contacts the tube end (face), the seal is position to the correct depth.

AXLE SHAFT INSTALLATION

- (1) Lubricate the bearing bore and seal lip. Insert the axle shaft and engage the splines with the side gear. **Use care to prevent the shaft splines from damaging the axle shaft seal lip.**
- (2) Insert C-clip lock in the recessed groove of the axle shaft. Push the axle shaft outward to seat the C-clip lock.
- (3) Insert pinion gear mate shaft in the case through the thrust washers and pinion gears. Align the hole in the shaft with the lock screw hole. Install the lock screw with Loctite® on the threads. Tighten the screw to 11 N·m (8 ft. lbs.) torque.
- (4) Clean the cover and apply a bead of sealant and install cover.
- (5) Install the brake drum.
- (6) Install wheel and tire assembly and lower the vehicle.
- (7) Raise or lower the hoist until the vehicle is level.

- (8) Remove the fill hole plug and fill the differential housing with lubricant. Refer to the Specifications chart for the type and the quantity. Install the fill hole plug.

PINION SEAL

CAUTION: The following procedures must be used so the correct pinion bearing preload torque is retained. If not followed completely, failure of the rear axle can result.

REMOVAL

- (1) Raise and support the vehicle.
- (2) Scribe a mark on the U-joint, pinion yoke, and pinion shaft for reference.
- (3) Disconnect the drive shaft from the pinion yoke. Secure the drive shaft in an upright position to prevent damage to the rear U-joint.
- (4) Remove the wheel and tire assemblies and remove the brake drums to prevent any drag. The drag may cause a false bearing preload torque measurement.
- (5) Use a Newton-meter or an inch-pound torque wrench to measure the pinion bearing preload. Rotate the pinion shaft several times with the torque wrench. Note the indicated torque as the wrench is moved through several revolutions.

NOTE: This measurement is critical for bearing preload torque which must be re-adjusted after the new seal is installed.

- (6) Hold the yoke with Wrench 6719. Remove the pinion shaft nut and Belleville washer.
- (7) Remove the yoke with Remover C-452 (Fig. 10).

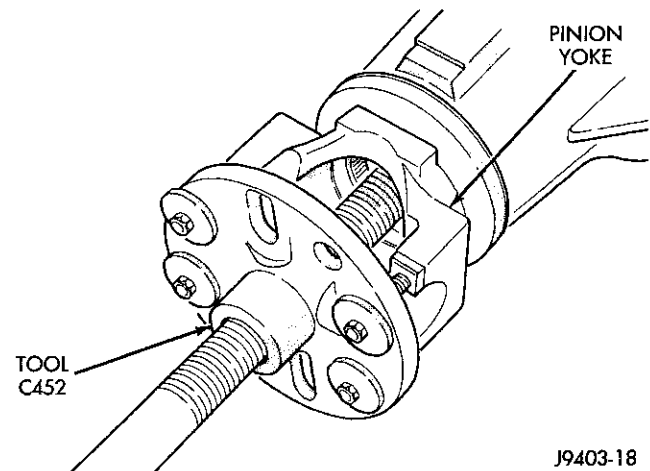
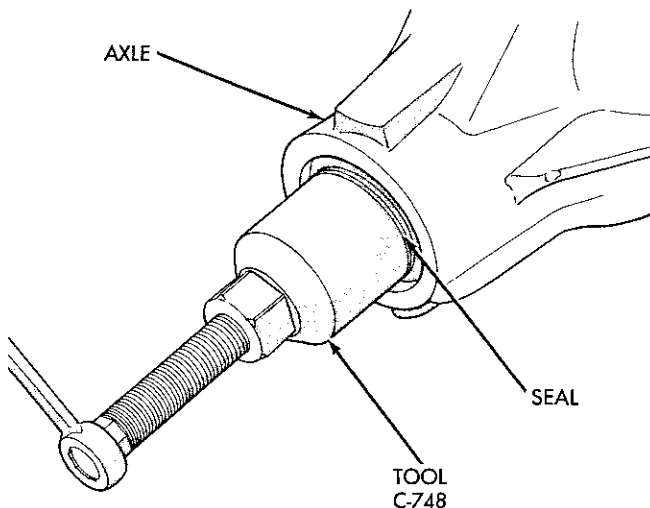


Fig. 10 Yoke Removal

REMOVAL AND INSTALLATION (Continued)

(8) Remove the pinion shaft seal with Puller C-748 (Fig. 11).



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Fig. 11 Pinion Seal Removal**INSTALLATION**

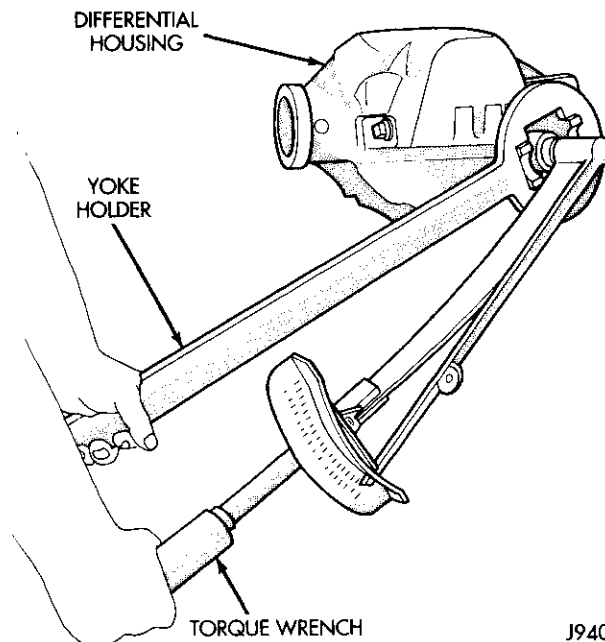
- (1) Clean the seal contact surface in the housing bore.
- (2) Examine the splines on the pinion shaft for burrs or wear. Remove any burrs and clean the shaft.
- (3) Inspect pinion yoke for cracks, worn splines and worn seal contact surface, replace yoke if necessary.

NOTE: The outer perimeter of the seal is pre-coated with a special sealant. An additional application of sealant is not required.

- (4) Install the new pinion shaft seal with Installer C-3980A or C-4109A and Handle C-4735

NOTE: The seal is correctly installed when the seal flange contacts the face of the differential housing flange.

- (5) Position the pinion yoke on the end of the shaft with the reference marks aligned.
- (6) Seat yoke on pinion shaft with Installer W-162D and Wrench 6719
- (7) Remove the tools and install the Belleville washer. The convex side of the washer must face outward.
- (8) Hold pinion yoke with Yoke Holder 6719 and tighten shaft nut to 285 N·m (210 ft. lbs.) (Fig. 12). Rotate pinion shaft several revolutions to ensure the bearing rollers are seated.
- (9) Use a Newton-meter or an inch-pound torque wrench to measure the pinion bearing preload torque.



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Fig. 12 Tightening Pinion Shaft Nut

CAUTION: Never loosen pinion gear nut to decrease pinion gear bearing preload torque and never exceed specified preload torque. If preload torque is exceeded a new collapsible spacer must be installed. The torque sequence will have to be repeated.

- (10) Continue tightening and measuring the bearing preload torque until the torque is the same as the original. The bearing preload torque should never be greater than 1 N·m (10 in. lbs.) more than the recorded value.

NOTE: The bearing preload torque should be constant during a complete revolution of the pinion. If the preload torque varies, this indicates a binding condition. This condition must be corrected before installation of the drive shaft.

- (11) If the specified torque is not obtained, tighten the nut in small increments until the preload torque is obtained.
- (12) The seal replacement is unacceptable if the final nut torque is less than 285 N·m (210 ft. lbs.).
- (13) Install the drive shaft with the installation reference marks aligned. Tighten the U-joint yoke clamp screws to 19 N·m (14 ft. lbs.).
- (14) Install the brake drums.
- (15) Install wheel and tire assemblies and lower the vehicle.
- (16) Check the differential housing lubricant level.

REMOVAL AND INSTALLATION (Continued)**DIFFERENTIAL**

It is not necessary to remove the complete axle to service the differential.

REMOVAL

(1) Remove the axle shafts, refer to Axle Shaft Removal.

Side play resulting from bearing races being loose on case hubs requires replacement of the differential case. Otherwise, use threaded adjuster to remove the side play before measuring the ring gear runout.

(2) Attach Dial Indicator to Pilot stud C-3288B. Place the indicator plunger at a right angle (90°) to the ring gear (Fig. 13).

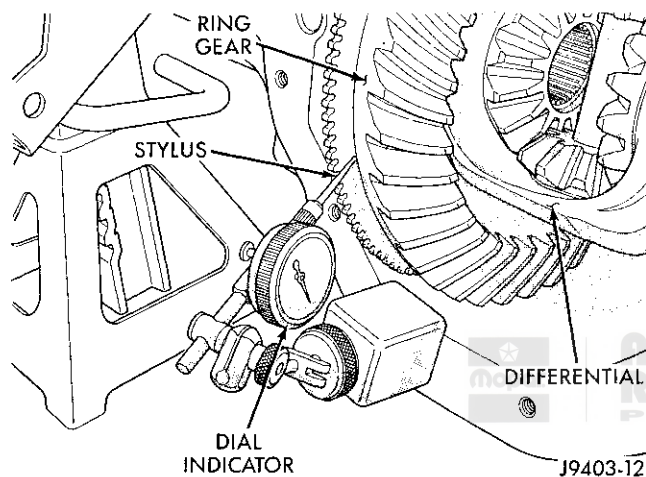


Fig. 13 Ring Gear Runout Measurement

(3) Measure runout by turning the ring gear several complete revolutions. Observe dial indicator and mark the ring gear and differential case at maximum runout areas. The ring gear runout should not exceed 0.005 inch (0.13 mm). If runout exceeds 0.005 inch (0.13 mm), a damaged differential case could be the cause.

The marking on the differential case will be very useful later during the differential case runout.

(4) Remove RWAL/ABS sensor from housing.

(5) Mark the differential housing and the differential bearing caps for installation reference (Fig. 14).

(6) Remove bearing threaded adjuster lock from each bearing cap. Loosen the bolts, but do not remove the bearing caps.

(7) Loosen the threaded adjusters with Wrench C-4164 (Fig. 15).

(8) Hold the differential case while removing bearing caps and adjusters.

(9) Remove the differential case.

Each differential bearing cup and threaded adjuster must be kept with their original bearing cone.

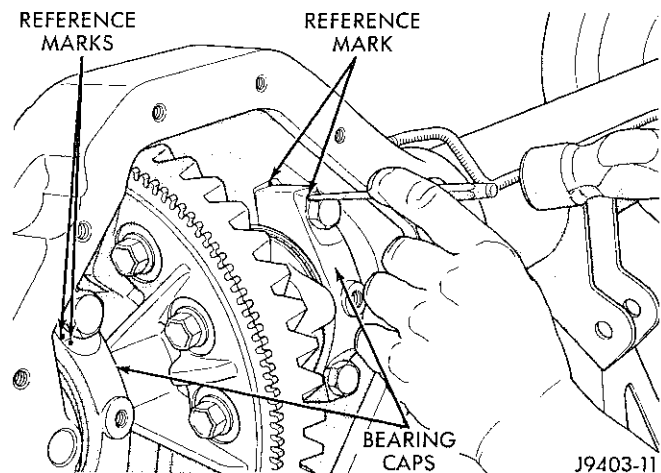


Fig. 14 Mark For Installation Reference

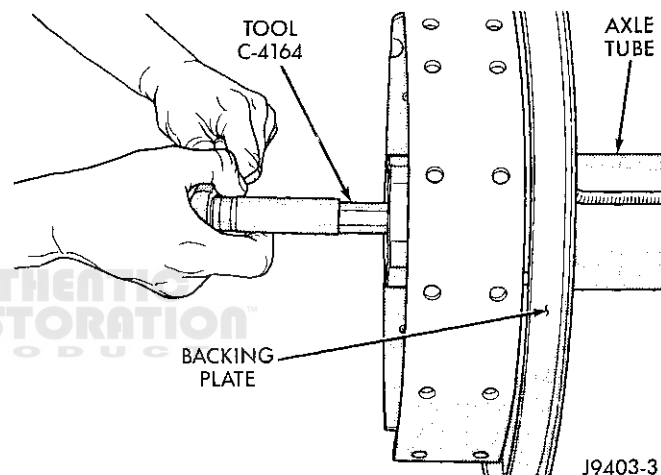


Fig. 15 Threaded Adjuster Tool

DIFFERENTIAL INSTALLATION

(1) Apply a coating of hypoid gear lubricant to the differential bearings, bearing cups and threaded adjusters. A dab of grease can be used to keep the adjusters in position. Carefully position the assembled differential case in the housing.

(2) Observe the reference marks and install the differential bearing caps at their original locations (Fig. 16).

(3) Install the bearing cap bolts (Fig. 16). Tighten the upper bolts to 14 N·m (10 ft. lbs.) torque. Tighten the lower bolts finger-tight until the bolt head is lightly seated.

RING GEAR

The ring and pinion gears are service in a matched set. Do not replace the ring gear without replacing the pinion gear. Refer to Pinion Gear removal and installation paragraph in this section for proper procedure.

REMOVAL AND INSTALLATION (Continued)

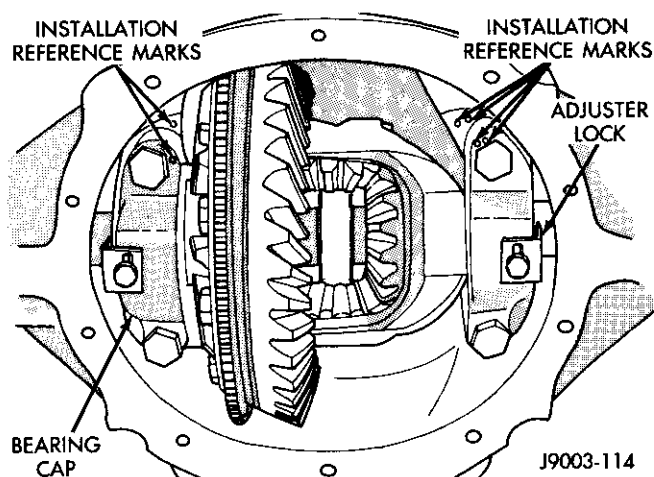


Fig. 16 Bearing Caps & Bolts

REMOVAL

- (1) Remove differential from axle housing.
- (2) Place differential case in a suitable vise with soft metal jaw protectors.
- (3) Remove bolts holding ring gear to differential case.
- (4) Using a soft hammer, drive ring gear from differential case.

RING GEAR INSTALLATION

CAUTION: Do not reuse the bolts that held the ring gear to the differential case. The bolts can fracture causing extensive damage.

- (1) Using a suitable solvent, wash oil residue from differential case and ring gear.
- (2) Using a suitable file, remove burrs or sharp edges that may cause ring gear to not mate flush with differential and exciter ring.
- (3) Thread two pilot studs C-3288-B in ring gear 180° across from each other to aid alignment.

CAUTION: Do not use open flame to heat ring gear, damage to ring gear can result.

- (4) Using a heat lamp or paint stripping heat gun, warm ring gear to **no greater** than 150° C (300° F).
- (5) Invert the differential case and start two ring gear bolts. This will provide case-to-ring gear bolt hole alignment.
- (6) Install new ring gear bolts and draw ring gear to exciter ring.
- (7) Place differential case in a suitable vise with soft metal jaw protectors.
- (8) Alternately tighten bolt holding ring gear to differential to 102 N·m (75 ft. lbs.) torque.

When installing differential in axle housing after ring and pinion gear replacement, pinion depth, side

bearing preload, and gear lash will require adjustment.

EXCITER RING

REMOVAL

The ring gear must be removed before the RWAL/ABS brake exciter ring can be replaced.

- (1) Remove exciter ring with a hammer and drift.

INSTALLATION

(1) Heat the replacement exciter ring with a heat lamp or by immersing in a hot fluid. The temperature should not exceed 149°C (300°F). **Do not use a torch to heat the ring.**

(2) After heating, quickly position the exciter ring on the differential case adjacent to the flange.

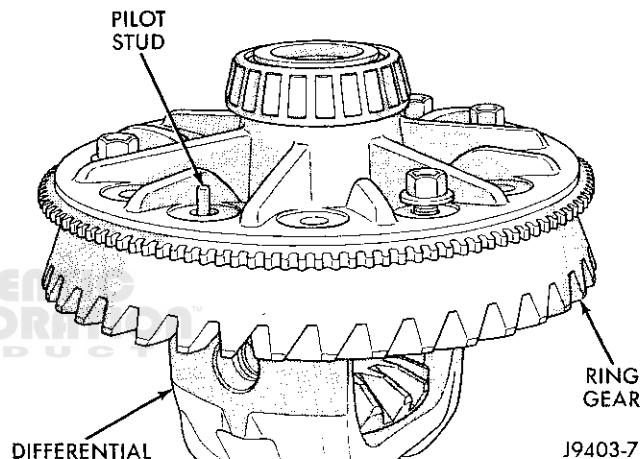


Fig. 17 EXCITER RING

PINION GEAR AND BEARINGS

Before removing the pinion flange, measure and record the rotation resistance of the pinion gear using a torque wrench. Use this measurement when installing the pinion gear using the original bearings.

REMOVAL

- (1) Remove pinion gear nut and washer. Use Puller C-452 and Wrench C-3281 to remove the pinion yoke.
- (2) Drive pinion gear out of housing with plastic or rawhide hammer. **This will damage the front bearing rollers and bearing cup. The front bearing and cup must be replaced.**
- (3) Remove the collapsible preload spacer
- (4) Remove the pinion seal with Puller C-748.
- (5) Remove the front and rear bearing cups with Remover Set C-4306 and Handle C-4171.
- (6) Remove rear bearing from pinion shaft (Fig. 18). Remove and record the pinion gear depth shims.
- (7) Using remover C-4306 and handle C-4171, remove rear pinion bearing cups from axle housing.

REMOVAL AND INSTALLATION (Continued)

(8) Using remover D-103, remove front pinion bearing cups from axle housing.

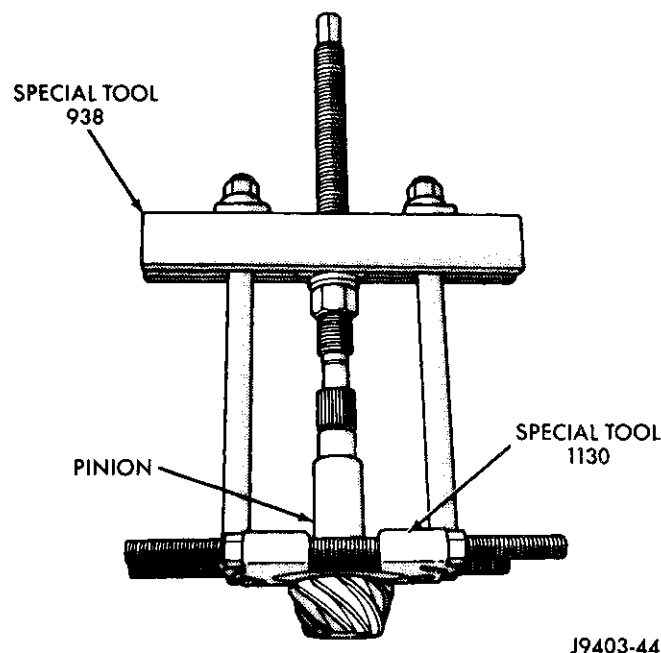


Fig. 18 Inner Bearing Removal

PINION GEAR INSTALLATION

Determine the proper pinion depth shim thickness using Pinion Depth Measurement paragraph in the Adjustment section of this group.

(1) Using installer D-129 and handle C-4171, install front pinion bearing cup in axle housing.

(2) Using installer tool C-4306 and handle C-4171, install rear pinion bearing cup in axle housing.

(3) Position depth shim(s) on pinion gear shaft and install rear bearing with Installer C-3095A (Fig. 19).

(4) Install front pinion bearing and install pinion shaft seal with Installer C-4109A and Handle C-4735.

NOTE: The outer perimeter of the seal is pre-coated with a special sealant. An additional application of sealant is not required.

(5) Lubricate the pinion gear front and rear bearings with gear lubricant.

(6) Install new collapsible spacer on pinion gear shaft. Install pinion gear in housing.

CAUTION: Use care to prevent over collapsing preload spacer during installation of the yoke and seating the front bearing.

(7) Install the pinion yoke with Installer W-162D and Holder 6719 (Fig. 20).

(8) Remove tools from the pinion gear.

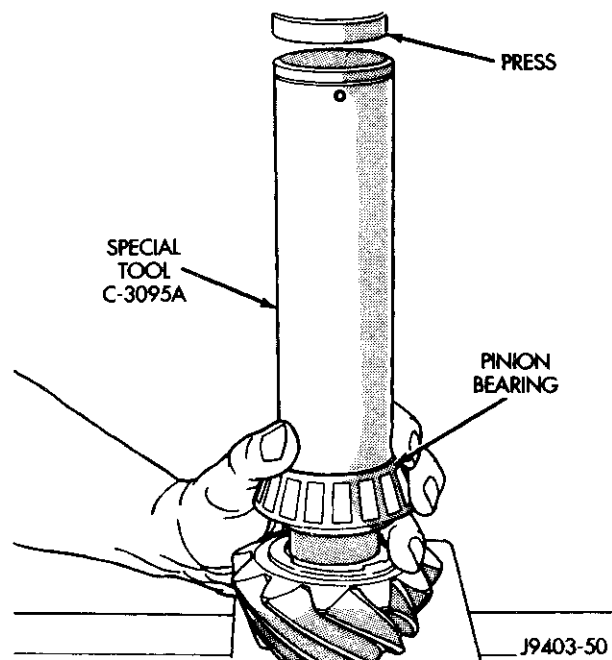


Fig. 19 Shaft Rear Bearing Installation

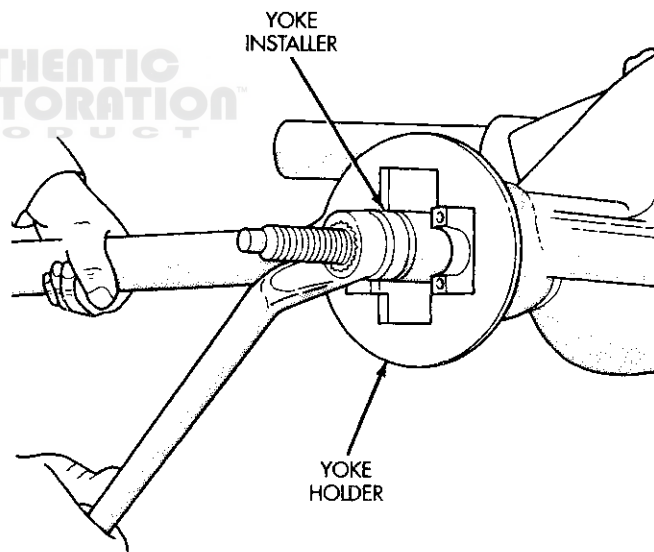


Fig. 20 Pinion Yoke Installation

(9) Install the Belleville washer. The convex side of the washer must face outward. Install the pinion nut.

(10) Retain pinion yoke with Holder 6719. Initially tighten the drive pinion gear shaft nut enough to remove the bearing end play. While tightening, rotate the pinion shaft to ensure the bearing rollers are correctly seated.

(11) Tighten the pinion nut to (Fig. 21) 285 N·m (210 ft. lbs.) torque (minimum).

REMOVAL AND INSTALLATION (Continued)

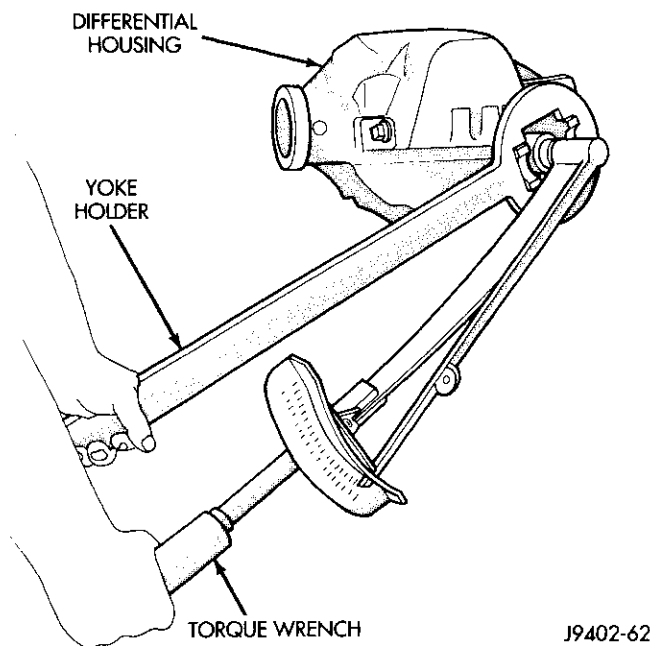


Fig. 21 Tightening Pinion Gear Nut

(12) Remove the tools from the shaft. Rotate the pinion several complete revolutions (both directions) to additionally seat the bearing rollers.

CAUTION: Do not loosen pinion gear nut to decrease pinion gear bearing preload or exceed specified preload torque. If preload torque is exceeded a new collapsible spacer must be installed. The tightening sequence must be repeated.

(13) Measure the pinion bearing preload torque by rotating pinion shaft with a torque wrench. The correct bearing preload torque is 2-4 N·m (20-30 in. lbs.). This torque value is with replacement bearings and pinion nut tightened to a minimum of 285 N·m (210 ft. lbs.) torque (Fig. 22)

When using original pinion rear bearing and a replacement front bearing. The correct preload torque is 1 N·m (10 in. lbs.) torque plus the torque measured and recorded during disassembly.

The bearing preload torque should be constant during a complete revolution of the drive pinion gear shaft. If preload torque varies while rotating the shaft, there is an internal binding that must be corrected before assembly.

(14) If specified torque is not obtained, tighten the nut in small increments until preload torque is obtained.

The differential will be unacceptable for use if the final nut torque is less than 285 N·m (210

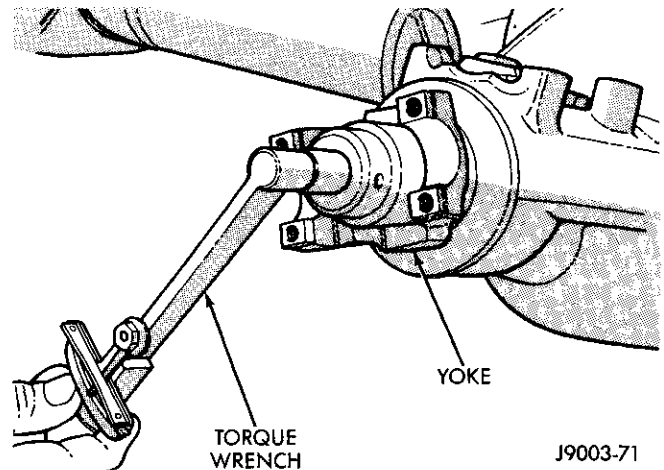


Fig. 22 Bearing Preload Torque Measurement

ft. lbs.) torque. If preload torque is not within the specified range this is also unacceptable.

DISASSEMBLY AND ASSEMBLY

STANDARD DIFFERENTIAL

DISASSEMBLE

- (1) Remove pinion gear mate shaft.
- (2) Rotate the differential side gears and remove the pinion mate gears and thrust washers (Fig. 23).

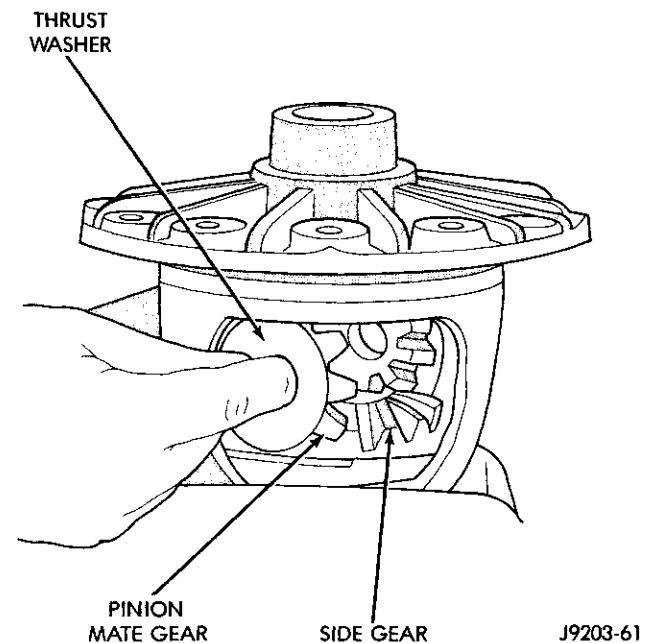
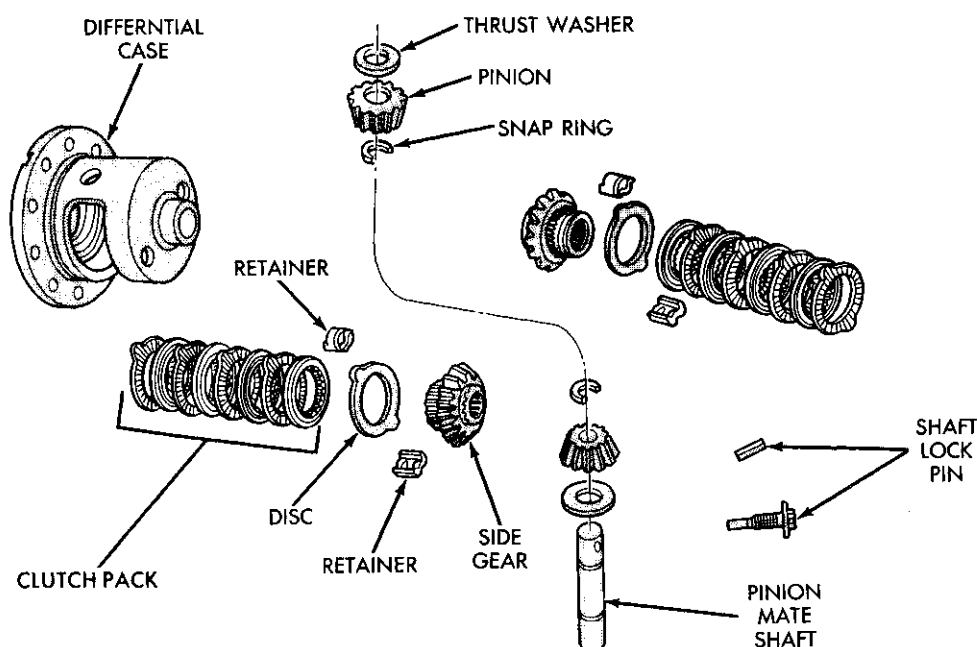


Fig. 23 Pinion Mate Gear Removal

- (3) Remove the differential side gears and thrust washers.

DISASSEMBLY AND ASSEMBLY (Continued)

J9203-13

Fig. 24 Trac-Lok Differential Components**DIFFERENTIAL ASSEMBLE**

- (1) Differential side gears and thrust washers
- (2) Pinion gears and thrust washers
- (3) Pinion gear mate shaft (align holes in shaft and case)
- (4) Lubricate all differential components with hypoid gear lubricant.
- (5) Install differential case in axle housing. Refer to Differential removal and installation procedure.

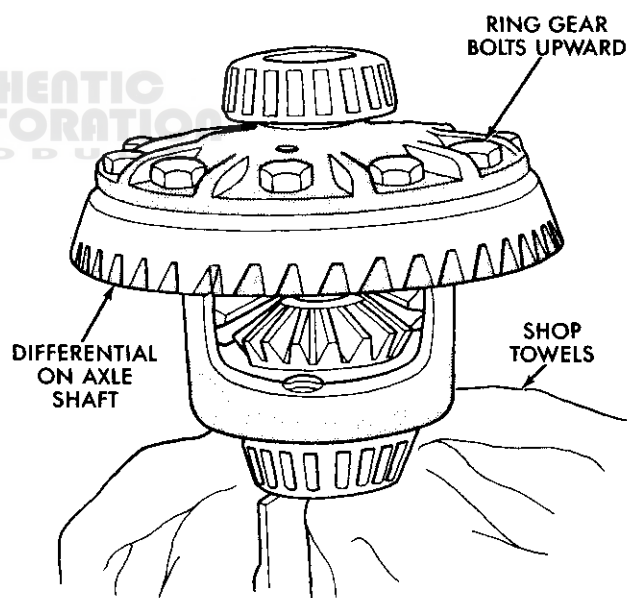
TRAC-LOK DIFFERENTIAL

The **Trac-Lok** (limited-slip) differential components are illustrated in (Fig. 24). Refer to this illustration during repair service.

DISASSEMBLY

Service to the Trac-Lok differential requires the use of Tool Set 6960. Refer to Model 35 Axle section in this Group for Differential Removal and Installation.

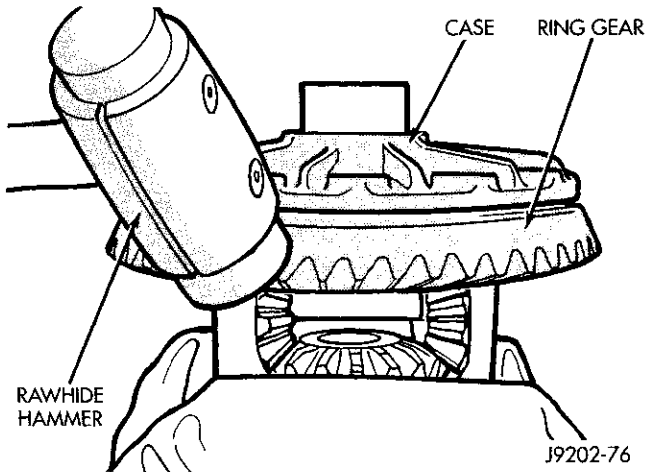
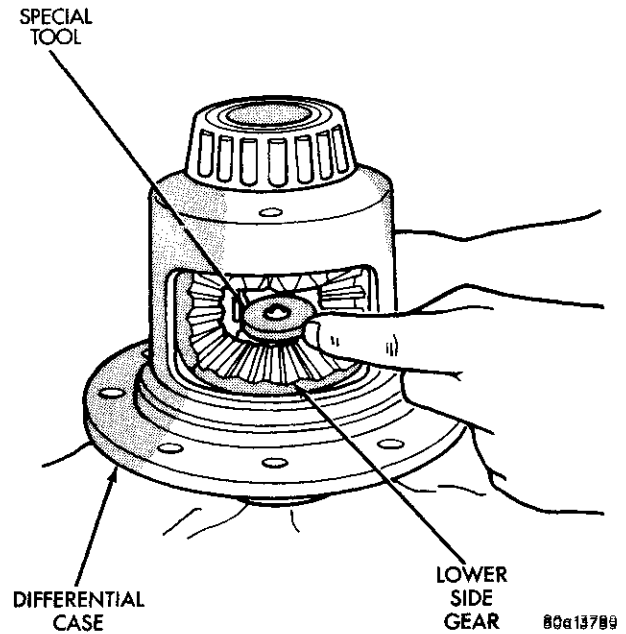
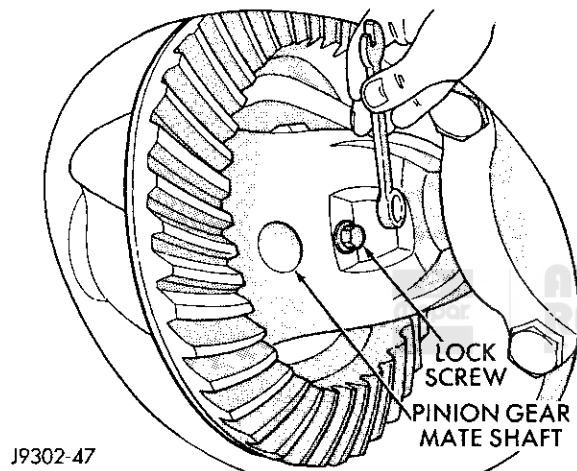
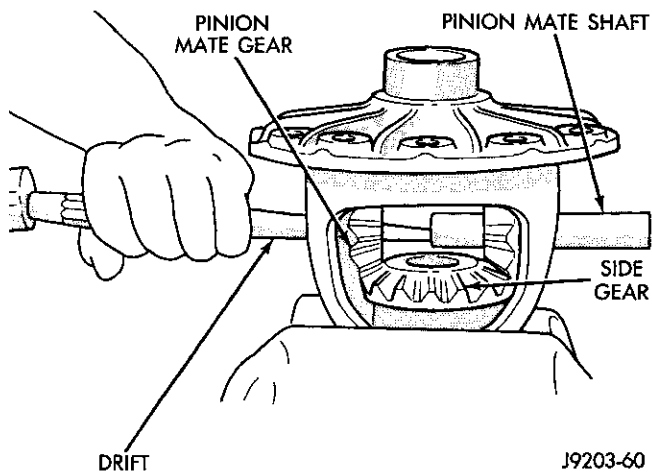
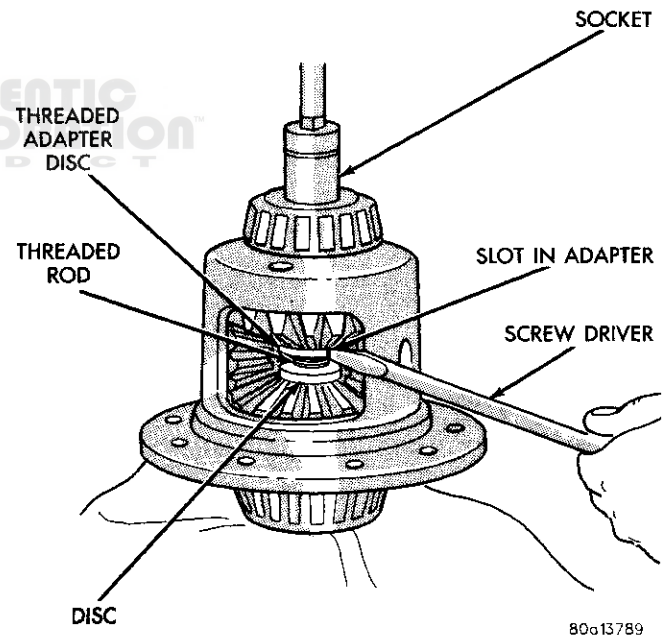
- (1) Clamp Side Gear Holding Tool 6965 in a vise.
- (2) Position the differential case on the holding tool (Fig. 25). Place shop towels under the differential to avoid damage if removal of the ring gear is required (Fig. 25).
- (3) If ring gear replacement is required, remove **and discard** the bolts holding the ring gear to the case. Tap the ring gear with a rawhide or plastic mallet and separate ring gear from case (Fig. 26).
- (4) Remove the pinion gear mate shaft lock screw (Fig. 27).
- (5) Remove the pinion gear mate shaft. If necessary, use a drift and hammer (Fig. 28).



J8903-43

Fig. 25 Differential Case Holding Tool

- (6) Install and lubricate Step Plate 6960-3 (Fig. 29).
- (7) Assemble Threaded Adapter 6960-1 into top side gear. Thread forcing Screw 6960-4 into adapter until it becomes centered in adapter plate.
- (8) Position a small screw driver in slot of Threaded Adapter 6960-1 (Fig. 30) to prevent adapter from turning.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 26 Ring Gear Removal****Fig. 29 Step Plate Tool Installation****Fig. 27 Mate Shaft Lock Screw****Fig. 28 Mate Shaft Removal****Fig. 30 Threaded Adapter Installation**

DISASSEMBLY AND ASSEMBLY (Continued)

(9) Tighten forcing screw tool 122 N·m (90 ft. lbs.) (maximum) to compress Belleville springs in clutch packs (Fig. 31).

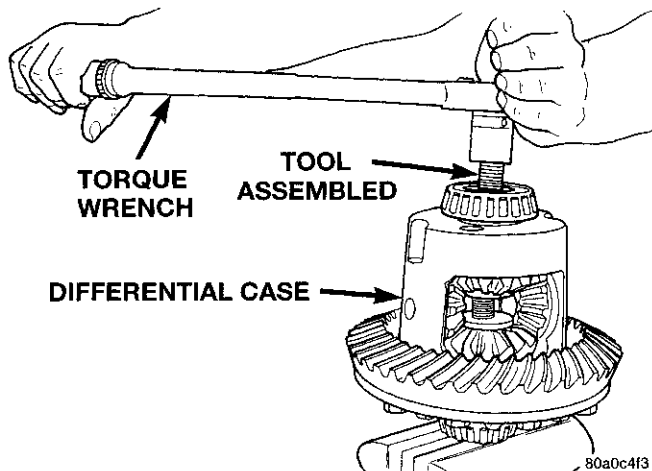


Fig. 31 Tighten Belleville Spring Compressor Tool

(10) Using a 0.020 in. feeler gauge and mallet, remove thrust washers from behind the pinion gears (Fig. 32).

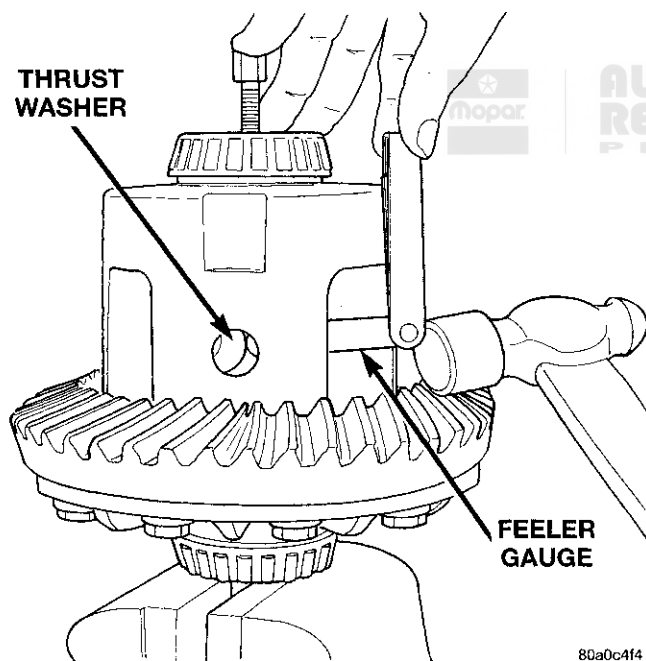


Fig. 32 Remove Pinion Thrust Washer

(11) Loosen the forcing screw tool until the clutch pack tension is relieved and the pinion gears can be slightly rattled between the case and side gears.

(12) Insert Turning Bar 6960-2 in case. Rotate case with tool until pinion gears can be removed (Fig. 33).

(13) Remove top side gear and clutch pack. Keep plates in correct order during removal (Fig. 34).

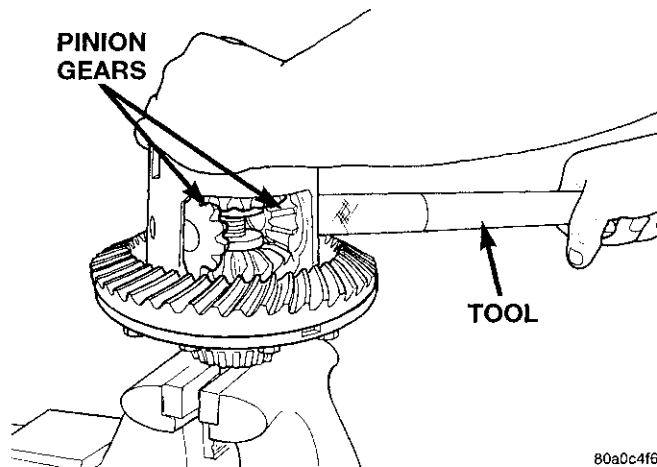


Fig. 33 Pinion Gear Removal

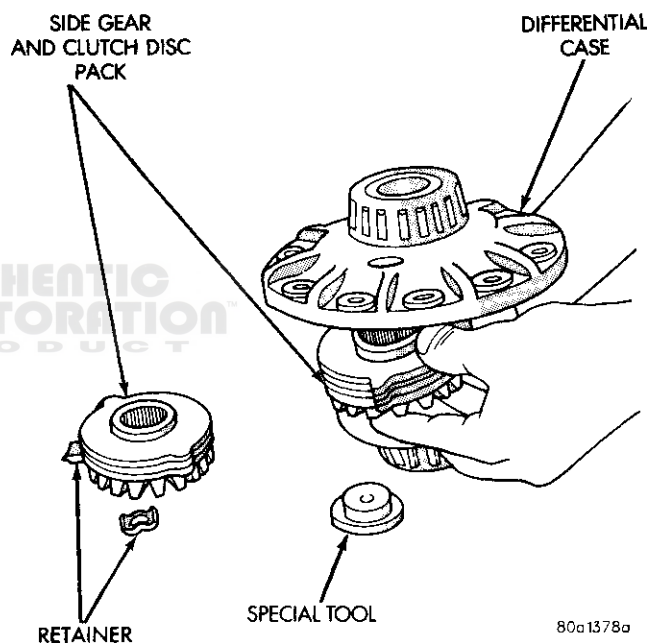


Fig. 34 Side Gear & Clutch Disc Removal

(14) Remove case from fixture. Remove remaining clutch pack.

(15) Remove clutch pack retaining clips. Mark each clutch pack for installation reference.

ASSEMBLY

The clutch discs are replaceable as complete sets only. **If one clutch disc pack is damaged, both packs must be replaced.**

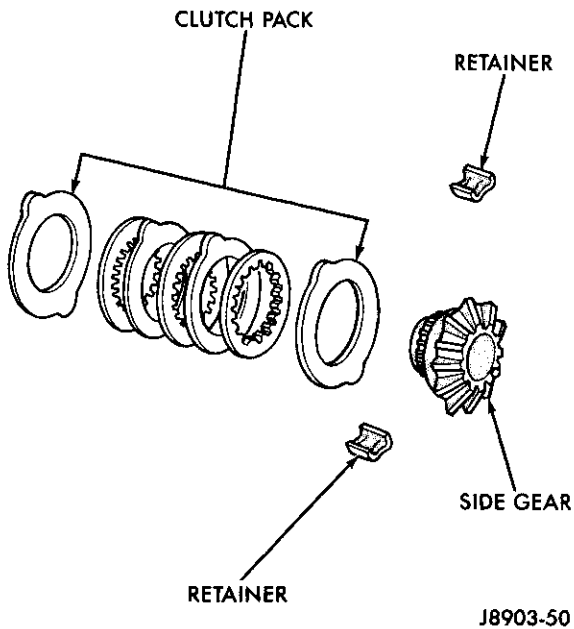
Lubricate each component with gear lubricant before assembly.

(1) Assemble the clutch discs into packs secure disc packs with retaining clips (Fig. 35).

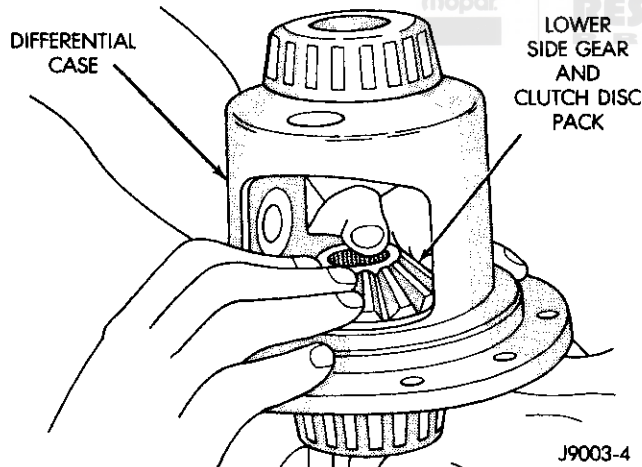
(2) Position assembled clutch disc packs on the side gear hubs.

(3) Position case on axle fixture.

DISASSEMBLY AND ASSEMBLY (Continued)

**Fig. 35 Clutch Disc Pack**

(4) Install clutch pack and side gear in lower bore (Fig. 36). **Be sure clutch pack retaining clips remain in position and are seated in the case pockets.**

**Fig. 36 Clutch Discs & Lower Side Gear Installation**

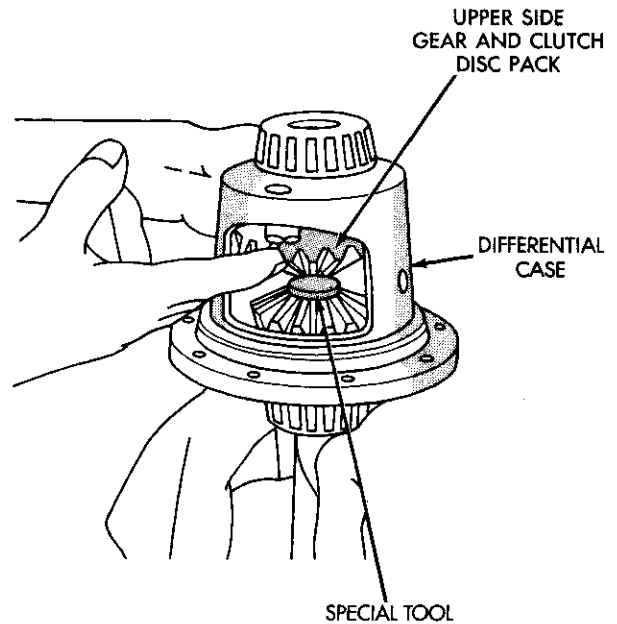
(5) Install lubricated Step Plate 6960-3 on first clutch pack (Fig. 37).

(6) Install the upper side gear and clutch disc pack (Fig. 37).

(7) Hold assembly in position. Insert Threaded Adapter 6960-1 into top side gear, insert forcing Screw 6960-4.

(8) Tighten forcing screw tool to slightly compress clutch discs.

(9) Place pinion gears in position in side gears and verify that mate shaft hole line up.

**Fig. 37 Upper Side Gear & Clutch Disc Pack Installation**

(10) Rotate case with Turning Bar 6960-2 until mate shaft holes in pinion gears align with holes in case.

(11) Tighten forcing screw to 122 N·m (90 ft. lbs.) to compress the Belleville springs. Lubricate and install thrust washers behind pinion gears and align washers with a small screw driver. Insert mate shaft into each pinion gear to verify alignment.

(12) Remove forcing screw, threaded adapter and step plate. Install pinion gear mate shaft, align holes in shaft and case.

(13) Install the pinion mate shaft lock screw finger tight to hold shaft during installation.

If replacement gears and thrust washers were installed, it is not necessary to measure the gear backlash. Correct fit is due to close machining tolerances during manufacture.

(14) Lubricate all differential components with hypoid gear lubricant.

CLEANING AND INSPECTION**AXLE COMPONENTS**

Wash differential components with cleaning solvent and dry with compressed air. **Do not steam clean the differential components.**

Wash bearings with solvent and towel dry, or dry with compressed air. **DO NOT** spin bearings with compressed air. **Cup and bearing must be replaced as matched sets only.**

Clean axle shaft tubes and oil channels in housing.

CLEANING AND INSPECTION (Continued)

Inspect for;

- Smooth appearance with no broken/dented surfaces on the bearing rollers or the roller contact surfaces
- Bearing cups must not be distorted or cracked
- Machined surfaces should be smooth and without any raised edges
- Raised metal on shoulders of cup bores should be removed with a hand stone
- Wear and damage to pinion gear mate shaft, pinion gears, side gears and thrust washers. Replace as a matched set only.
- Ring and pinion gear for worn and chipped teeth
- Ring gear for damaged bolt threads. Replaced as a matched set only.
- Pinion yoke for cracks, worn splines, pitted areas, and a rough/corroded seal contact surface. Repair or replace as necessary.
- Preload shims for damage and distortion. Install new shims if necessary.

DIFFERENTIAL CASE RUNOUT

(1) If the ring gear runout exceeded 0.005 inch (0.13 mm), case flange runout should be measured. Install the case with the bearing cups and the threaded adjusters close to their original position.

(2) Install the bearing caps and bolts. Tighten the bolts lightly. Use Wrench C-4164 to thread both adjusters inward. Remove all side play.

(3) Attach Dial Indicator to measure the flange runout. The plunger should contact the ring squarely between the outer edge and the gear attaching bolt holes (Fig. 38).

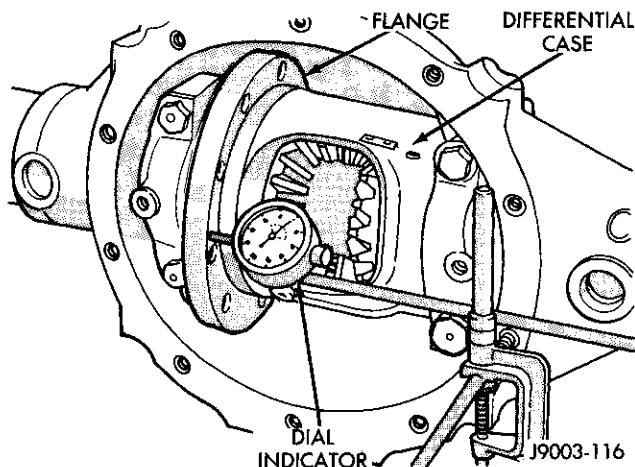


Fig. 38 Case Flange Runout Measurement

(4) Rotate the differential case several times and observe the dial indicator. Mark the area of maximum flange runout. The differential case flange runout must not exceed 0.003 inch (0.08 mm). If the

runout exceeds this amount replace the differential case.

To reduce ring gear runout positioning the ring gear runout mark 180 degrees opposite the flange runout mark.

(5) Remove the differential bearing cap bolts. Remove the differential case from the differential housing.

TRAC-LOK

(1) Clean all components in cleaning solvent. Dry components with compressed air.

(2) Inspect clutch pack plates for wear, scoring or damage. Replace both clutch packs if any one component in either pack is damaged.

(3) Inspect side and pinion gears. Replace any gear that is worn, cracked, chipped or damaged.

(4) Inspect differential case and pinion shaft. Replace if worn or damaged.

PRESOAK PLATES AND DISC

Plates and discs with fiber coating (no grooves or lines) must be presoaked in Friction Modifier before assembly. Soak plates and discs for a minimum of 20 minutes. Add remaining Friction Modifier to differential after assembly.

ADJUSTMENTS**PINION DEPTH MEASUREMENT AND ADJUSTMENT**

Pinion depth measurement is taken with Tool Set C-758-D6 with new pinion bearing cups installed.

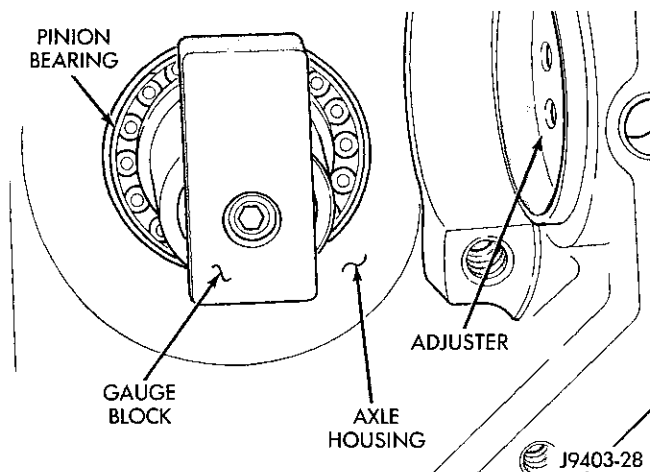
- Position Spacer (SP-6017) over Shaft (SP-526)
- Position pinion rear bearing on shaft
- Position tools (with bearing) in the housing
- Install Sleeve (SP-1730)
- Install pinion front bearing
- Install Spacer (SP-6022)
- Install Sleeve (SP-535-A), Washer (SP-534) and Nut (SP-533)

(1) Tighten the nut to seat the pinion bearings in the housing. Allow the sleeve to turn several times during the tightening to prevent brinelling the bearing cups or the bearings.

Depth shim(s) are positioned between the pinion gear rear bearing and pinion gear to provide the separation distance. The required thickness of the depth shim(s) is determined according to the following information.

(2) Loosen the compression nut tool. Lubricate the pinion gear front and rear bearings with gear lubricant. Re-tighten the compression nut tool to 1-3 N·m (15-25 in. lbs.) torque. Rotate the pinion gear several complete revolutions to align the bearing rollers.

- Install Gauge Block SP-6020 at the end of SP-526

ADJUSTMENTS (Continued)**Fig. 39 Gauge Block**

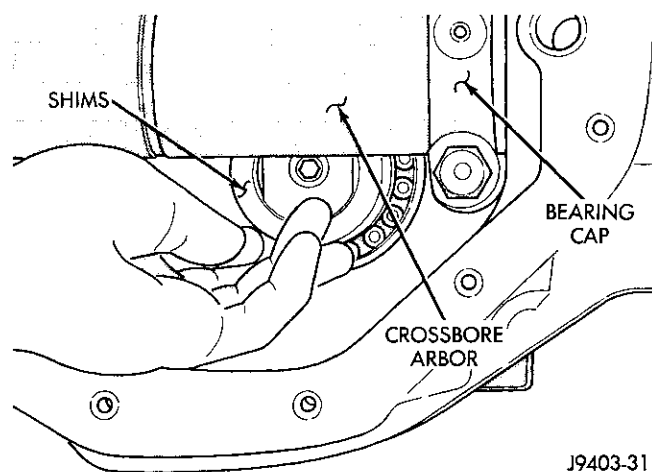
• Install Cap Screw (SP-536) and tighten with Wrench SP-531 (Fig. 39).

(3) Position Crossbore Arbor SP-6018 in the differential housing.

(4) Center the tool and place a piece of 0.002 inch shim stock at each end of the arbor. Position the bearing caps on the arbor tool. Install the attaching bolts. Tighten the cap bolts to 14 N·m (10 ft. lbs.) torque.

(5) Trial fit depth shim(s) between the crossbore arbor and gauge block (Fig. 40). **The depth shim(s) fit must be snug but not tight (drag friction of a feeler gauge blade).**

Depth shims are available in 0.001-inch increments from 0.020 inch to 0.038 inch.

**Fig. 40 Depth Shim(s) Selection**

(6) Note the etched number on the face of the drive pinion gear (-1, -2, 0, +1, +2, etc.). The numbers represent thousands of an inch deviation from the standard. If the number is negative, add that value to the required thickness of the depth shim(s). If the number is positive, subtract that value from the thickness of the depth shim(s). If the number is 0 no change is necessary.

After selecting the proper pinion depth shim (s), remove the measurement tools from the axle housing.

PINION GEAR DEPTH VARIANCE

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

ADJUSTMENTS (Continued)**DIFFERENTIAL BEARING PRELOAD AND GEAR LASH****BEARING PRELOAD AND GEAR LASH ADJUSTMENT**

The following must be considered when adjusting bearing preload and gear backlash:

- The maximum ring gear backlash variation is 0.003 inch (0.076 mm)
- Mark the gears so the same teeth are meshed during all backlash measurements
- Maintain the torque while adjusting the bearing preload and ring gear backlash
- Excessive adjuster torque will introduce a high bearing load and cause premature bearing failure. Insufficient torque can cause excessive differential case free-play and ring gear noise
- Insufficient adjuster torque will not support the ring gear correctly. This can cause excessive differential case free-play and ring gear noise.

The differential bearing cups will not always immediately follow the threaded adjusters as they are moved during adjustment. Ensure accurate bearing cup responses to the adjustments. Maintain the gear teeth engaged (meshed) as marked. The bearings must be seated by rapidly rotating the pinion gear a half turn back and forth. Do this five to ten times each time the threaded adjusters are adjusted.

(1) Use Wrench C-4164 to adjust each threaded adjuster inward (Fig. 41). Adjust until the differential bearing free-play is eliminated. Allow some ring gear backlash (approximately 0.01 inch/0.25 mm) between the ring and pinion gear. Seat the bearing cups with the procedure described above.

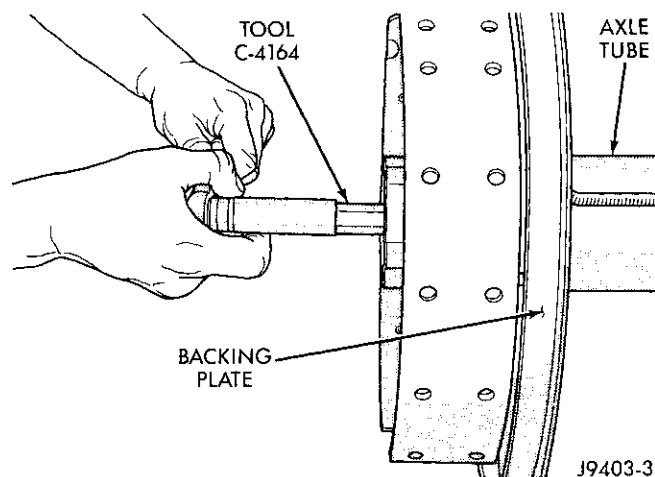


Fig. 41 Threaded Adjuster Tool

(2) Install Dial Indicator (Fig. 42). Position the plunger against the drive side of a ring gear tooth.

Measure the backlash at 4 positions (90 degrees apart) around the ring gear. Locate and mark the area of minimum backlash.

(3) Rotate the ring gear to the position of the least backlash. Mark the gear so that all future backlash measurements will be taken with the same gear teeth meshed.

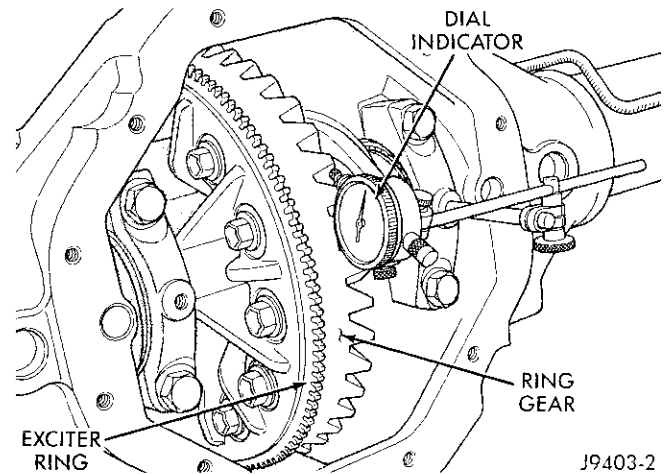


Fig. 42 Ring Gear Backlash Measurement

(4) Loosen the right-side, tighten the left-side threaded adjuster. Obtain backlash of 0.003 to 0.004 inch (0.076 to 0.102 mm) with each adjuster tightened to 14 N·m (10 ft. lbs.) torque. Seat the bearing cups with the procedure described above.

(5) Tighten the differential bearing cap bolts to 136 N·m (100 ft. lbs.) torque.

(6) Use Wrench C-4164 to tighten the right-side threaded adjuster to 102 N·m (75 ft. lbs.) torque. Seat the bearing cups with the procedure described above. Continue to tighten the right-side adjuster and seat bearing cups until the torque remains constant at 102 N·m (75 ft. lbs.)

(7) Measure the ring gear backlash. The range of backlash is 0.006 to 0.008 inch (0.15 to 0.203 mm).

Continue increasing the torque at the right-side threaded adjuster until the specified backlash is obtained.

The left-side threaded adjuster torque should have approximately 102 N·m (75 ft. lbs.) torque. If the torque is considerably less, the complete adjustment procedure must be repeated.

(8) Tighten the left-side threaded adjuster until 102 N·m (75 ft. lbs.) torque is indicated. Seat the bearing rollers with the procedure described above. Do this until the torque remains constant.

(9) Install the threaded adjuster locks. Ensure the lock finger is engaged with the adjuster hole. Tighten the lock screws to 10 N·m (90 in. lbs.) torque.

ADJUSTMENTS (Continued)**GEAR CONTACT PATTERN**

The ring gear teeth contact patterns will show if the pinion gear depth shim(s) have the correct thickness. It will also show if the ring gear backlash has been adjusted correctly. The backlash must be maintained within the specified limits until the correct teeth contact patterns are obtained.

- Excessive backlash is corrected by moving the ring gear teeth closer to the pinion gear teeth

- Insufficient backlash is corrected by moving the ring gear away from the pinion gear

(1) Apply yellow ferrous (iron) oxide compound to both drive and coast sides of ring gear teeth.

(2) Rotate the ring gear one complete revolution in both directions.

(3) Note patterns in compound. Refer to chart for interpretation of contact patterns and adjust accordingly.

(4) Install the axle shafts. Refer to Axle Shaft Installation within this group.

(5) Install the housing cover. Refill the differential with lubricant.

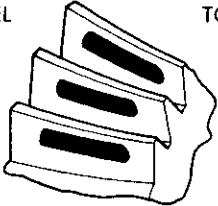
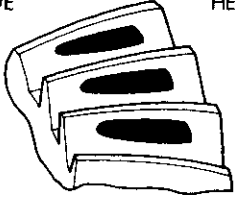
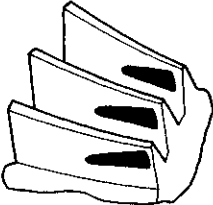
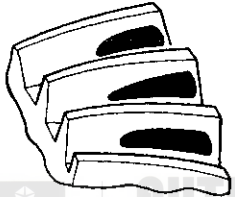
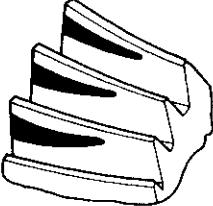
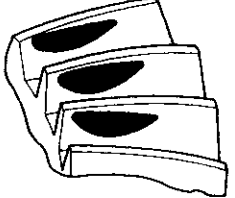
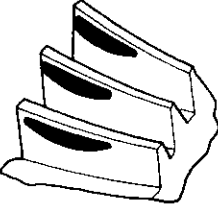
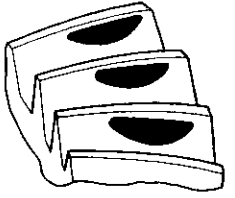
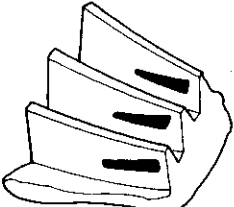
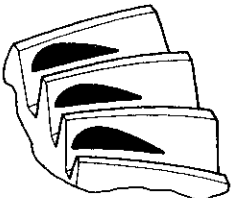
(6) Install the RWAL/ABS brake speed sensor and cover onto the axle housing. Tighten the sensor to 13 N·m (10 ft. lbs.) torque.



**AUTHENTIC
RESTORATION™
PRODUCT**

ADJUSTMENTS (Continued)

GEAR TEETH CONTACT PATTERNS

<p>DRIVE SIDE OF RING GEAR TEETH</p> <p>HEEL TOE</p> 	<p>COAST SIDE OF RING GEAR TEETH</p> <p>TOE HEEL</p> 	<p>DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.</p>
		<p>RING GEAR BACKLASH CORRECT. THINNER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>RING GEAR BACKLASH CORRECT. THICKER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. DECREASE RING GEAR BACKLASH.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. INCREASE RING GEAR BACKLASH.</p>

ADJUSTMENTS (Continued)

SIDE GEAR CLEARANCE MEASUREMENT AND ADJUSTMENT

When measuring side gear clearance, check each gear independently. If it necessary to replace a side gear, replace both gears as a matched set.

(1) Install the axle shafts and C-clip locks and pinion mate shaft. If necessary, refer to the installation located within this group.

(2) Measure each side gear clearance. Insert a matched pair of feeler gauge blades between the gear and differential housing on opposite sides of the hub (Fig. 43).

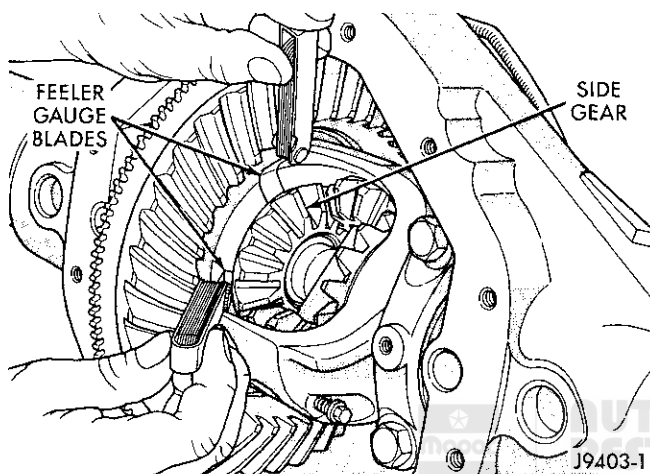


Fig. 43 Side Gear Clearance Measurement

(3) If side gear clearances is no more than 0.005 inch. Determine if the shaft is contacting the pinion gear mate shaft. **Do not remove the feeler gauges, inspect the axle shaft with the feeler gauge inserted behind the side gear.** If the end of the axle shaft is not contacting the pinion gear mate shaft, the side gear clearance is acceptable.

(4) If clearance is more than 0.005 inch (axle shaft not contacting mate shaft), record the side gear clearance. Remove the thrust washer and measure its thickness with a micrometer. Add the washer thickness to the recorded side gear clearance. The sum of gear clearance and washer thickness will determine required thickness of replacement thrust washer (Fig. 44).

In some cases, the end of the axle shaft will move and contact the mate shaft when the feeler gauge is inserted. The C-clip lock is preventing the side gear from sliding on the axle shaft.

(5) If there is no side gear clearance, remove the C-clip lock from the axle shaft. Use a micrometer to measure the thrust washer thickness. Record the

SIDE GEAR CLEARANCE	0.007
THRUST WASHER THICKNESS	+ 0.033
TOTAL	0.040
REPLACEMENT WASHER THICKNESS	- 0.037
NEW SIDE GEAR CLEARANCE	0.003
	J9203-31

Fig. 44 Side Gear Calculations

thickness and install the thrust washer. Assemble the differential case without the C-clip lock installed and measure the side gear clearance.

(6) Compare both clearance measurements. If the difference is less than 0.012 inch (0.305 mm), add clearance recorded when the C-clip lock was installed to thrust washer thickness measured. The sum will determine the required thickness of the replacement thrust washer.

(7) If clearance is 0.012 inch (0.305 mm) or greater, both side gears must be replaced (matched set) and the clearance measurements repeated.

(8) If clearance (above) continues to be 0.012 inch (0.305 mm) or greater, the case must be replaced.

SPECIFICATIONS

9 1/4 INCH AXLE

Axle Type	Semi-floating, hypoid
Lubricant	SAE 80W-90
Lube Capacity	2.3 L (4.8 pts.)
Axle Ratio	3.21, 3.55, 3.92

Differential

Case Clearance	.012 mm (0.005 in.)
Case Flange Runout	.076 mm (0.003 in.)

Ring gear

Diameter	23.50 cm (9.25 in.)
Backlash	.012-0.20 mm (0.005-0.008 in.)
Runout	.0127 mm (0.005 in.)

Pinion Bearing

Preload	1-2 N·m (10-20 in.lbs.)
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TORQUE

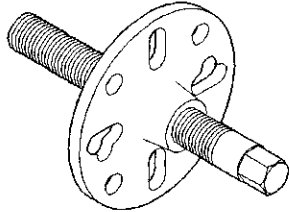
DESCRIPTION

TORQUE

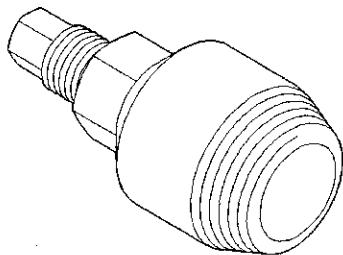
Bolt, Diff. cover	.47 N·m (35 ft. lbs.)
Bolt, Bearing cap	.136 N·m (100 ft. lbs.)
Nut, Pinion	.285 N·m (210 ft. lbs.)
Bolt, Ring gear	.95 N·m (70 ft. lbs.)
Bolt, Backing plate	.64 N·m (48 ft. lbs.)
Bolt, RWAL/ABS sensor	.24 N·m (18 ft. lbs.)

SPECIAL TOOLS

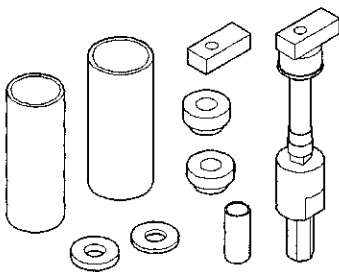
9 1/4 AXLE



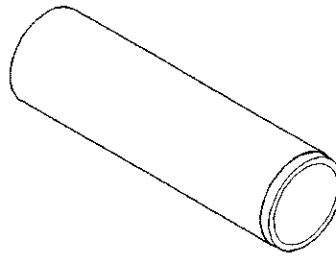
Remover—C-452



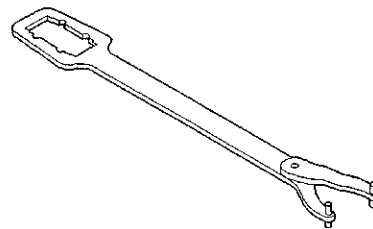
Puller—C-748



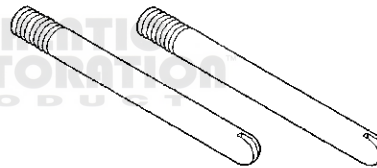
Gauge Set, Pinion & Ring Gear Adjustment—C-758D6



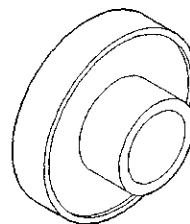
Installer—C-3095A



Wrench—C-3281



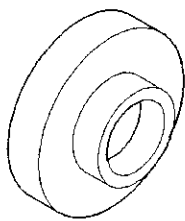
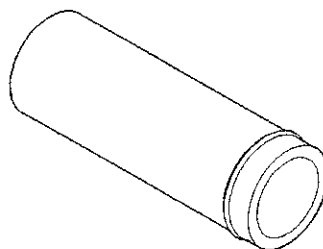
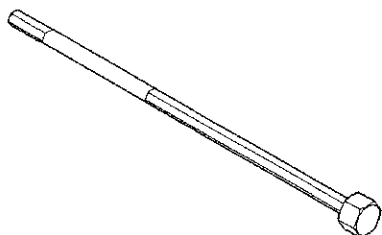
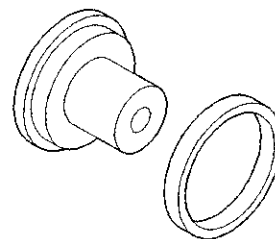
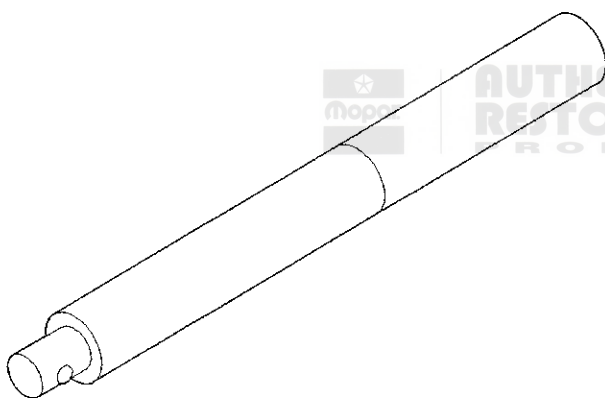
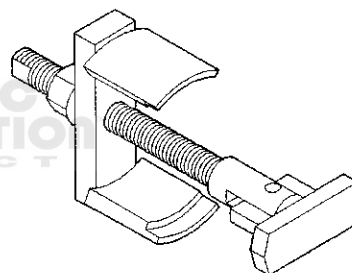
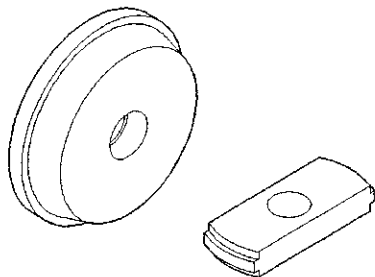
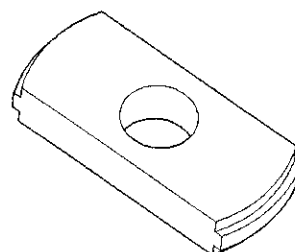
Pilot—C-3288B



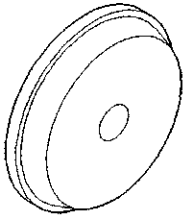
Installer—C-3980A



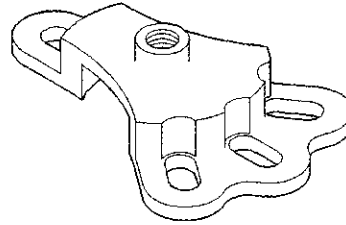
AUTOMATIC
RESTORATION
PRODUCTS

SPECIAL TOOLS (Continued)**Installer—C-4109A****Handle—C-4735****Rod, Adjustment—C-4164****Installer—C-4826****Handle—C-4171****Remover—C-4828****Remover/Installer, Bearing Set—C-4306****Remover, Pinion Bearing Cup—D-103**

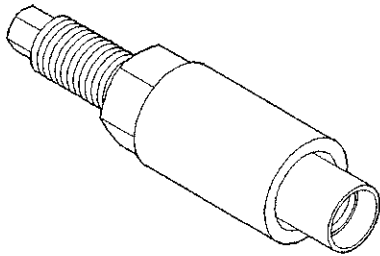
SPECIAL TOOLS (Continued)



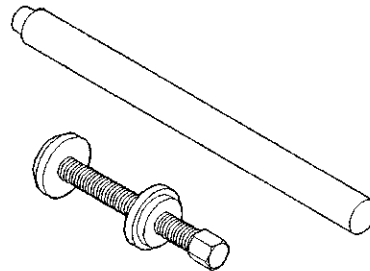
Installer, Pinion Bearing Cup—D-129



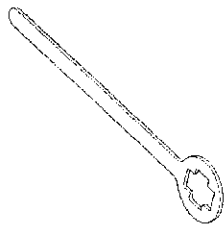
Puller, Hub—6790



Installer—W-162D



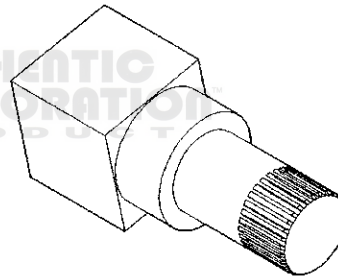
Trac-Lok Tools—6960



Wrench—6719



**AUTHENTIC
RESTORATION
PRODUCT**



Fixture Tool—6965

MODEL 60/70/80 AXLES

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GENERAL INFORMATION

GENERAL INFORMATION

The axle housing (Fig. 1) consists of an iron center casting with axle shaft tubes extending from either

side. The tubes are pressed in to form a one-piece axle housing.

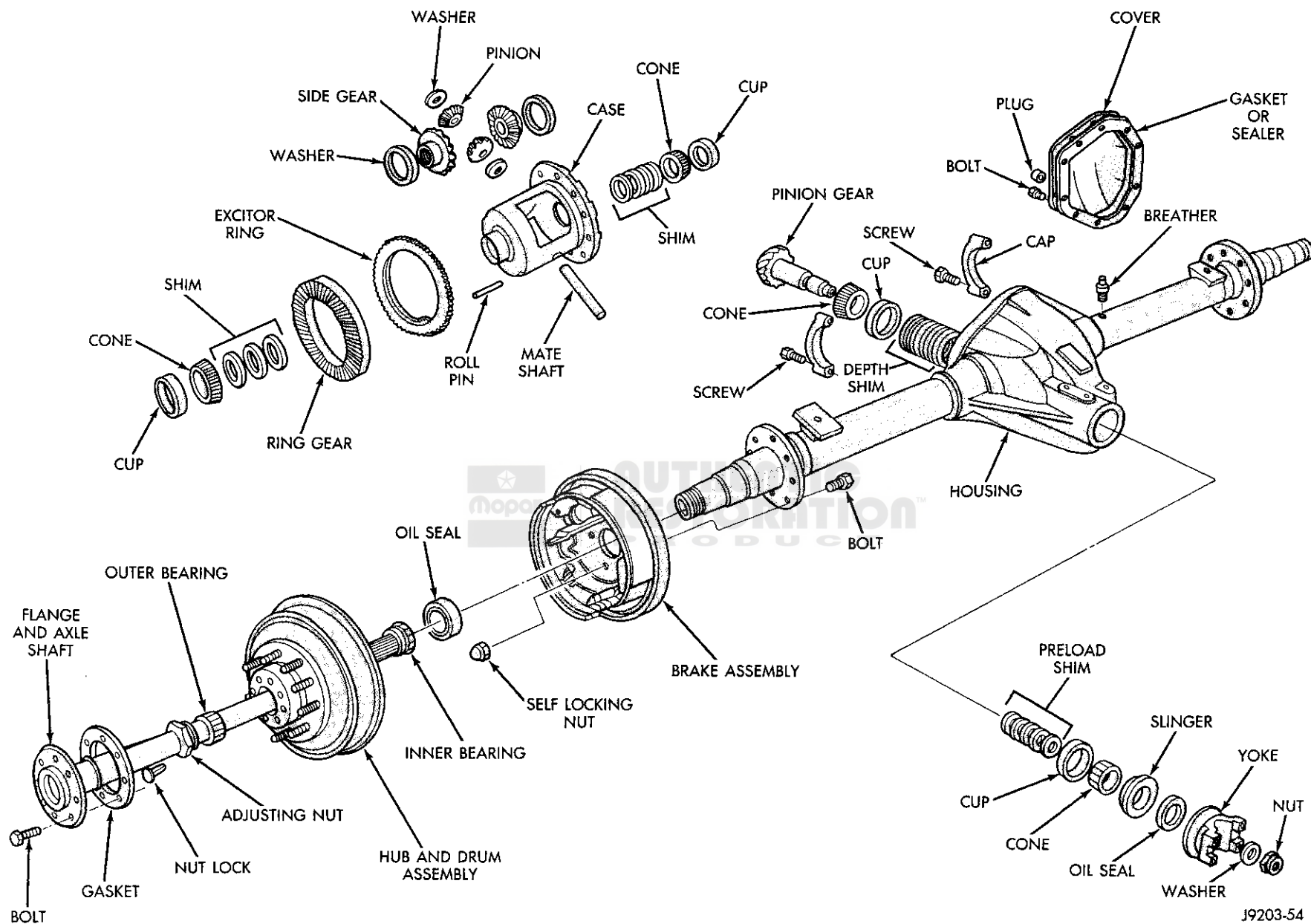


Fig. 1 Model 60, 70 and 80 Rear Axle

GENERAL INFORMATION (Continued)

The integral type housing, hypoid gear design has the centerline of the pinion set below the centerline of the ring gear.

The axles are equipped with full floating axle shafts. Vehicle load is supported by the axle housing tubes. The full-float axle shafts are retained by bolts attached to the hub. The hub rides on two taper bearings at the outboard end of the axle tube. The axle shafts can be removed without disassembling the wheel bearings. The wheel bearings are opposed tapered roller bearings that contained in the wheel hub.

The removable steel cover provides a means for inspection and service without removing the axle from the vehicle.

A stamped metal axle gear ratio identification tag is attached to the housing cover with one cover bolts. This tag also identifies the number of ring and pinion teeth. An addition tag will be attached if equipped with a limited-slip differential.

The differential case is a one-piece design. The differential pinion mate shaft is retained with a roll pin. Model 60 axles with the optional Trac-lok use a one piece case. Model 70 axles with the optional Power-Lok use a two piece differential case. Model 80 axles with the optional Trac-lok also uses a two piece case. Differential bearing preload and ring gear backlash are adjusted with shims located between the differential bearing cones and case.

For complete drive axle assembly removal and installation refer to Drive Axle Assembly Replacement in this Group.

LUBRICANT

Dana® axles use a thermally stable Lubricant, 80W-90 or equivalent GL-5 grade lubricant. Vehicles with Trac-Lok/Power-Lok also use 6 oz. of friction modifier added to the lubricant. Dana 80 4x4 vehicles use 10 oz. of friction modifier added to the lubricant.

CAUTION: If axle is submerged in water, lubricant must be replaced immediately to avoid possible premature axle failure.

DESCRIPTION AND OPERATION

STANDARD DIFFERENTIAL OPERATION

The differential gear system divides the torque between the axle shafts. It allows the axle shafts to rotate at different speeds when turning corners.

Each differential side gear is splined to an axle shaft. The pinion gears are mounted on a pinion mate shaft and are free to rotate on the shaft. The pinion gear is fitted in a bore in the differential case and is positioned at a right angle to the axle shafts.

In operation, power flow occurs as follows:

- The pinion gear rotates the ring gear
- The ring gear (bolted to the differential case) rotates the case
- The differential pinion gears (mounted on the pinion mate shaft in the case) rotate the side gears
- The side gears (splined to the axle shafts) rotate the shafts

During straight-ahead driving, the differential pinion gears do not rotate on the pinion mate shaft. This occurs because input torque applied to the gears is divided and distributed equally between the two side gears. As a result, the pinion gears revolve with the pinion mate shaft but do not rotate around it (Fig. 2).

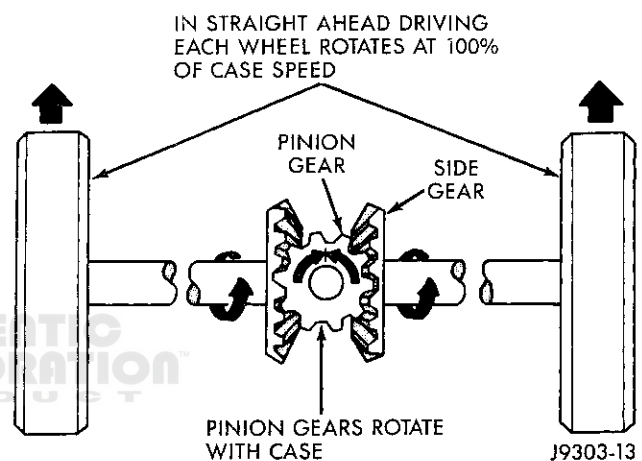


Fig. 2 Differential Operation—Straight Ahead Driving

When turning corners, the outside wheel must travel a greater distance than the inside wheel in order to complete a turn. The difference must be compensated for, to prevent the tires from scuffing and skidding through turns. To accomplish this, the differential allows the axle shafts to turn at unequal speeds (Fig. 3). In this instance, the input torque applied to the pinion gears is not divided equally. The pinion gears now rotate around the pinion mate shaft in opposite directions. This allows the side gear and axle shaft attached to the outside wheel to rotate at a faster speed.

TRAC-LOK/POWER-LOK OPERATION

Trac-Lok differential is available on Model 60 and 80 axles. Power-Lok differential is available on Model 70 axles.

In a conventional differential, torque applied to the ring gear is transmitted to the axle shafts through differential gears. During normal operation, the torque transmitted to each wheel is equal at all times. However, if one wheel spins, the opposite wheel will generate only as much torque as the spinning wheel.

DESCRIPTION AND OPERATION (Continued)

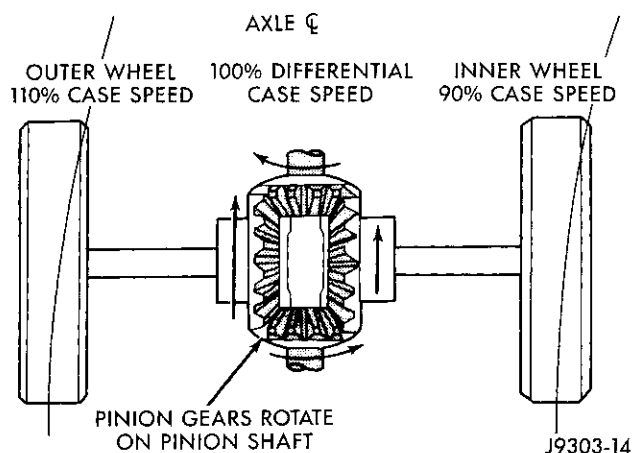


Fig. 3 Differential Operation—On Turns

In the Trac-Lok/Power-Lok differential, part of the ring gear torque is transmitted through clutch packs. The clutch packs contain multiple disc clutches, that have radial grooves on the plates and concentric grooves on the discs.

Trac-Lok differentials can also use plates and discs with bonded fiber material that is smooth in appearance.

In operation, the Trac-Lok/Power-Lok clutches are engaged by two concurrent forces. The first being preload force exerted through dished spring washers contained in the clutch packs. The second from separating forces generated by the side gears as torque is applied through the ring gear (Fig. 4).

The Trac-Lok design provides differential action needed for turning corners and for driving straight ahead. However, when one wheel loses traction, the clutch packs transfer additional torque to the wheel having the most traction. Trac-Lok differentials resist wheel spin on bumpy roads and provide more pulling power when one wheel loses traction. Pulling power is provided continuously until both wheels lose traction. If both wheels slip due to unequal traction, Trac-Lok operation is normal. In extreme cases of differences of traction, the wheel with the least traction may spin.

DIAGNOSIS AND TESTING

GENERAL INFORMATION

Axle bearing problem conditions are usually caused by:

- Insufficient or incorrect lubricant
- Foreign matter/water contamination
- Incorrect bearing preload torque adjustment
- Incorrect backlash (to tight)

When serviced, the bearings must be cleaned thoroughly. They should be dried with lint-free shop towels. **Never spin dry bearings with compressed**

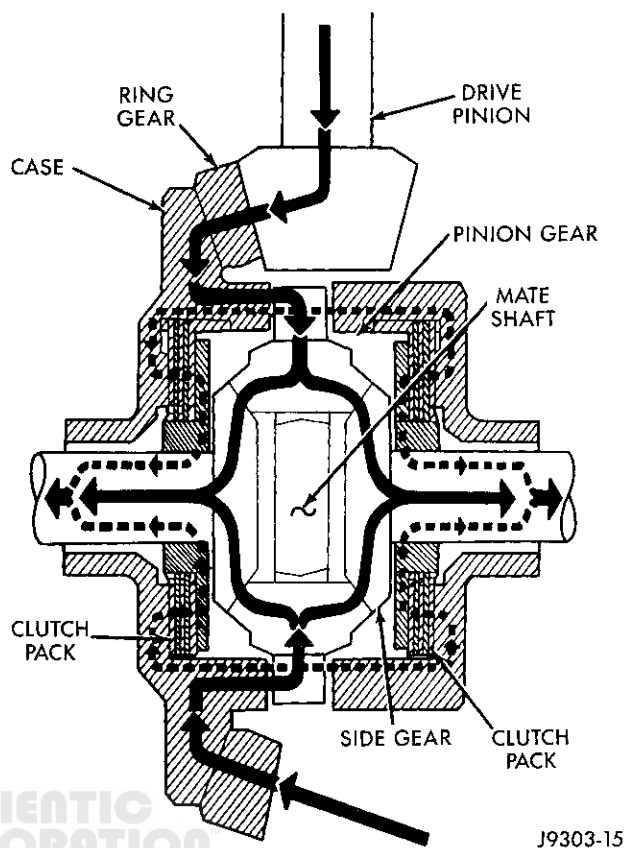


Fig. 4 Limited Slip Differential Operation—Both Wheels Driving

air. This will overheat them and brinell the bearing surfaces. This will result in noisy operation after repair.

Axle gear problem conditions are usually the result of:

- Insufficient lubrication
- Incorrect or contaminated lubricant
- Overloading (excessive engine torque) or exceeding vehicle weight capacity
- Incorrect clearance or backlash adjustment

Insufficient lubrication is usually the result of a housing cover leak. It can also be from worn axle shaft or pinion gear seals. Check for cracks or porous areas in the housing or tubes.

Using the wrong lubricant will cause overheating and gear failure. Gear tooth cracking and bearing spalling are indicators of this.

Axle component breakage is most often the result of:

- Severe overloading
- Insufficient lubricant
- Incorrect lubricant
- Improperly tightened components

Overloading occurs when towing heavier than recommended loads. Component breakage can occur when the wheels are spun excessively. Incorrect

DIAGNOSIS AND TESTING (Continued)

lubricant quantity contributes to breakage. Loose differential components can also cause breakage.

Incorrect bearing preload or gear backlash will not result in component breakage. Mis-adjustment will produce enough noise to cause service repair before a failure occurs. If a mis-adjustment condition is not corrected, component failure can result.

Excessive bearing preload may not be noisy. This condition will cause high temperature which can result in bearing failure.

GEAR AND BEARING NOISE

GEAR NOISE

Axle gear noise can be caused by insufficient lubricant. Incorrect backlash, tooth contact, or worn/damaged gears can cause noise.

Gear noise usually happens at a specific speed range. The range is 30 to 40 mph, or above 50 mph. The noise can also occur during a specific type of driving condition. These conditions are acceleration, deceleration, coast, or constant load.

When road testing, accelerate the vehicle to the speed range where the noise is the greatest. Shift out-of-gear and coast through the peak-noise range. If the noise stops or changes greatly, check for insufficient lubricant. Incorrect ring gear backlash, or gear damage can cause noise changes.

Differential side and pinion gears can be checked by turning the vehicle. They usually do not cause noise in straight-ahead driving. These gears are loaded during vehicle turns. If noise does occur during vehicle turns, the side or pinion gears could be worn or damaged. A worn pinion gear mate shaft can also cause a snapping or a knocking noise.

BEARING NOISE

The axle shaft, differential and pinion gear bearings can all produce noise when worn or damaged. Bearing noise can be either a whining, or a growling sound.

Pinion gear bearings have a constant-pitch noise. This noise changes only with vehicle speed. Pinion bearing noise will be higher because it rotates at a faster rate. Drive the vehicle and load the differential. If bearing noise occurs the pinion rear bearing is the source of the noise. If the bearing noise is heard during a coast, front bearing is the source.

Worn, damaged differential bearings usually produce a low pitch noise. Differential bearing noise is similar to pinion bearing. The pitch of differential bearing noise is also constant and varies only with vehicle speed.

Axle shaft bearings produce noise and vibration when worn or damaged. The noise generally changes when the bearings are loaded. Road test the vehicle. Turn the vehicle sharply to the left and to the right.

This will load the bearings and change the noise level. Where axle bearing damage is slight, the noise is usually not noticeable at speeds above 30 mph.

LOW SPEED KNOCK

Low speed knock is generally caused by a worn U-joint or by worn side-gear thrust washers. A worn pinion gear shaft bore will also cause low speed knock.

VIBRATION

Vibration at the rear of the vehicle is usually caused by a:

- Damaged drive shaft
- Missing drive shaft balance weight
- Worn, out-of-balance wheels
- Loose wheel lug nuts
- Worn U-joint
- Loose spring U-bolts
- Loose/broken springs
- Damaged axle shaft bearings
- Loose pinion gear nut
- Excessive pinion yoke run out
- Bent axle shaft

Check for loose or damaged front-end components or engine/transmission mounts. These components can contribute to what appears to be a rear-end vibration. Do not overlook engine accessories, brackets and drive belts.

All driveline components should be examined before starting any repair.

Refer to Group 22, Wheels and Tires for additional information.

DRIVELINE SNAP

A snap or clunk noise when the vehicle is shifted into gear (or the clutch engaged), can be caused by:

- High engine idle speed
- Loose engine/transmission/transfer case mounts
- Worn U-joints
- Loose spring mounts
- Loose pinion gear nut and yoke
- Excessive ring gear backlash
- Excessive side gear/case clearance

The source of a snap or a clunk noise can be determined with the assistance of a helper. Raise the vehicle on a hoist with the wheels free to rotate. Instruct the helper to shift the transmission into gear. Listen for the noise, a mechanics stethoscope is helpful in isolating the source of a noise.

REAR AXLE ALIGNMENT

MEASUREMENT

The following procedure can be used to determine if abnormal rear tire tread wear is the result of a bent or deformed rear axle shaft.

DIAGNOSIS AND TESTING (Continued)

(1) Raise both rear wheels off the surface with a frame contact hoist.

(2) Attach a one-inch long piece of masking tape at the center of each tire tread for use as reference marks.

(3) Rotate the rear wheels until both reference marks face the front of the vehicle. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Front Of Tire (FTR) measurement.

(4) Rotate the rear wheels until both reference marks face the rear of the vehicle. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Rear Of Tire (RTR) measurement.

(5) Subtract the RTR measurement from the FTR measurement to obtain the amount of wheel toe. The acceptable rear wheel toe-in position is 1/16 in. (1.6 mm) to 3/16 in. (4.8 mm) toe-out.

(6) Rotate the rear wheels until the reference marks are facing downward. Measure the distance between the outside edges of the two pieces of tape. Record this measurement as the Bottom Of Tire (BTR) measurement.

(7) Average the FTR and the RTR distance measurements. Subtract the BTR measurement from this average distance to obtain the camber. The acceptable amount of camber is 1/16 inch to 3/32 inch (1.6 to 2.4 mm).

NOTE: FTR + RTR Divided By two Minus BTR Equals Camber

If the BTR distance measurement is less than the average FTR and RTR distance measurement, the camber will be positive (+). If the BTR distance measurement is greater than the average FTR and RTR distance, the camber will be negative (-).

If the toe position or camber is not acceptable, a bent or deformed rear axle shaft is most likely the cause.

LIMITED SLIP DIFFERENTIAL

Under normal traction conditions, engine torque is divided evenly. With low-traction surfaces, engine torque is transferred to the wheel with the most tire traction. When diagnosing a limited-slip differential the wheel with the least traction can continue spinning.

The most common problem is a chatter noise when turning corners. Check for incorrect or contaminated lubricant. Replace the gear lubricant if necessary.

- With Trac-Lok[®] differentials add a container of Mopar Trac-Lok Lubricant.

This will correct the condition in most instances. If the chatter persists, clutch damage could have occurred.

After changing the lubricant, drive the vehicle and make 10 to 12 slow, figure-eight turns. This maneuver will pump lubricant through the clutches.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS****SERVICE DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
WHEEL NOISE	<ol style="list-style-type: none"> 1. Wheel loose. 2. Faulty, brinelled wheel bearing. 	<ol style="list-style-type: none"> 1. Tighten loose nuts. 2. Faulty or brinelled bearings must be replaced.
AXLE SHAFT NOISE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Bent or sprung axle shaft. 3. End play in drive pinion bearings. 4. Excessive gear backlash between ring gear and pinion gear. 5. Improper adjustment of drive pinion gear shaft bearings. 6. Loose drive pinion gearshaft yoke nut. 7. Improper wheel bearing adjustment. 8. Scuffed gear tooth contact surfaces. 	<ol style="list-style-type: none"> 1. Inspect axle shaft tube alignment. Correct as necessary. 2. Replace bent or sprung axle shaft. 3. Refer to Drive Pinion Bearing Pre-Load Adjustment. 4. Check adjustment of ring gear backlash and pinion gear. Correct as necessary. 5. Adjust drive pinion shaft bearings. 6. Tighten drive pinion gearshaft yoke nut with specified torque. 7. Readjust as necessary. 8. If necessary, replace scuffed gears.
AXLE SHAFT BROKE	<ol style="list-style-type: none"> 1. Misaligned axle shaft tube. 2. Vehicle overloaded. 3. Erratic clutch operation. 4. Grabbing clutch. 	<ol style="list-style-type: none"> 1. Replace broken axle shaft after correcting axle shaft tube alignment. 2. Replace broken axle shaft. Avoid excessive weight on vehicle. 3. Replace broken axle shaft after inspecting for other possible causes. Avoid erratic use of clutch. 4. Replace broken axle shaft. Inspect clutch and make necessary repairs or adjustments.
DIFFERENTIAL CASE CRACKED	<ol style="list-style-type: none"> 1. Improper adjustment of differential bearings. 2. Excessive ring gear backlash. 3. Vehicle overloaded. 4. Erratic clutch operation. 	<ol style="list-style-type: none"> 1. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust differential bearings properly. 2. Replace cracked case; examine gears and bearings for possible damage. At reassembly, adjust ring gear backlash properly. 3. Replace cracked case; examine gears and bearings for possible damage. Avoid excessive weight on vehicle. 4. Replace cracked case. After inspecting for other possible causes, examine gears and bearings for possible damage. Avoid erratic use of clutch.
DIFFERENTIAL GEARS SCORED	<ol style="list-style-type: none"> 1. Insufficient lubrication. 2. Improper grade of lubricant. 3. Excessive spinning of one wheel/tire. 	<ol style="list-style-type: none"> 1. Replace scored gears. Scoring marks on the drive face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear differential housing to required capacity with proper lubricant. Refer to Specifications. 2. Replace scored gears. Inspect all gears and bearings for possible damage. Clean and refill differential housing to required capacity with proper lubricant. 3. Replace scored gears. Inspect all gears, pinion bores and shaft for damage. Service as necessary.
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 1. Lubricant level too high. 	<ol style="list-style-type: none"> 1. Drain excess lubricant by removing fill plug and allow lubricant to level at lower edge of fill plug hole.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS (CONT'D)**

CONDITION	POSSIBLE CAUSES	CORRECTION
LOSS OF LUBRICANT	<ol style="list-style-type: none"> 2. Worn axle shaft seals. 3. Cracked differential housing. 4. Worn drive pinion gear shaft seal. 5. Scored and worn yoke. 6. Axle cover not properly sealed. 	<ol style="list-style-type: none"> 2. Replace worn seals. 3. Repair or replace housing as necessary. 4. Replace worn drive pinion gear shaft seal. 5. Replace worn or scored yoke and seal. 6. Remove cover and clean flange and reseal.
AXLE OVERHEATING	<ol style="list-style-type: none"> 1. Lubricant level too low. 2. Incorrect grade of lubricant. 3. Bearings adjusted too tight. 4. Excessive gear wear. 5. Insufficient ring gear backlash. 	<ol style="list-style-type: none"> 1. Refill differential housing. 2. Drain, flush and refill with correct amount of the correct lubricant. 3. Readjust bearings. 4. Inspect gears for excessive wear or scoring. Replace as necessary. 5. Readjust ring gear backlash and inspect gears for possible scoring.
GEAR TEETH BROKE (RING GEAR AND PINION)	<ol style="list-style-type: none"> 1. Overloading. 2. Erratic clutch operation. 3. Ice-spotted pavements. 4. Improper adjustments. 	<ol style="list-style-type: none"> 1. Replace gears. Examine other gears and bearings for possible damage. 2. Replace gears and examine the remaining parts for possible damage. Avoid erratic clutch operation. 3. Replace gears. Examine the remaining parts for possible damage. Replace parts as required. 4. Replace gears. Examine other parts for possible damage. Ensure ring gear backlash is correct.
AXLE NOISE	<ol style="list-style-type: none"> 1. Insufficient lubricant. 2. Improper ring gear and drive pinion gear adjustment. 3. Unmatched ring gear and drive pinion gear. 4. Worn teeth on ring gear or drive pinion gear. 5. Loose drive pinion gear shaft bearings. 6. Loose differential bearings. 7. Misaligned or sprung ring gear. 8. Loose differential bearing cap bolts 	<ol style="list-style-type: none"> 1. Refill axle with correct amount of the proper lubricant. Also inspect for leaks and correct as necessary. 2. Check ring gear and pinion gear teeth contact pattern. 3. Remove unmatched ring gear and drive pinion gear. Replace with matched gear and drive pinion gear set. 4. Check teeth on ring gear and drive pinion gear for correct contact. If necessary, replace with new matched set. 5. Adjust drive pinion gearshaft bearing preload torque. 6. Adjust differential bearing preload torque. 7. Measure ring gear runout. 8. Tighten with specified torque

DIAGNOSIS AND TESTING (Continued)

TRAC-LOK NOISE DIAGNOSIS

If a noise occurs when turning corners, the most probable cause is incorrect or contaminated lubricant. Before removing the Trac-lok unit for repair, drain, flush and refill the axle with the specified lubricant. Refer to Lubricant change in this Group.

A container of Trac-lok Lubricant (friction modifier) should be added after repair service or a lubricant change.

Vehicles with a limited slip differential should be road tested by making 10 to 12 slow figure eight turns. This maneuver will pump the lubricant through the clutch discs to eliminate a possible **chatter or pop** noise complaint.

Refer to Group 0, Lubrication and Maintenance for additional information.

DIFFERENTIAL TEST

WARNING: WHEN SERVICING VEHICLES WITH A LIMITED SLIP DIFFERENTIAL DO NOT USE THE ENGINE TO TURN THE AXLE AND WHEELS. BOTH REAR WHEELS MUST BE RAISED AND THE VEHICLE SUPPORTED. A LIMITED SLIP AXLE CAN EXERT ENOUGH FORCE (IF ONE WHEEL IS IN CONTACT WITH THE SURFACE) TO CAUSE THE VEHICLE TO MOVE.

The differential can be tested without removing the differential case by measuring rotating torque. Make sure brakes are not dragging during this measurement.

(1) Engine off, transmission in neutral, and parking brake off.

(2) Place blocks in front and rear of both front wheels.

(3) Raise one rear wheel until it is completely off the ground.

(4) Remove wheel and bolt Special Tool 6790 to studs.

(5) Use torque wrench on special tool to rotate wheel and read rotating torque (Fig. 5).

(6) If rotating torque is less than 22 N·m (30 ft. lbs.) or more than 271 N·m (200 ft. lbs.) on either wheel the unit should be service.

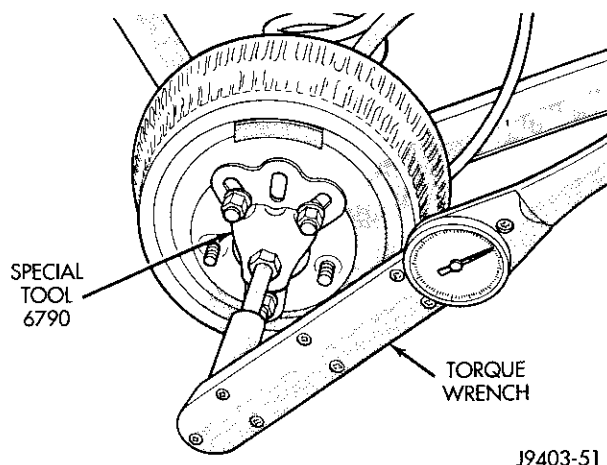
SERVICE PROCEDURES

DRAIN AND REFILL

(1) Drive the vehicle until the gear lubricant reaches normal operating temperature.

(2) Raise and support the vehicle.

(3) Remove the lubricant fill hole plug from the differential housing cover.



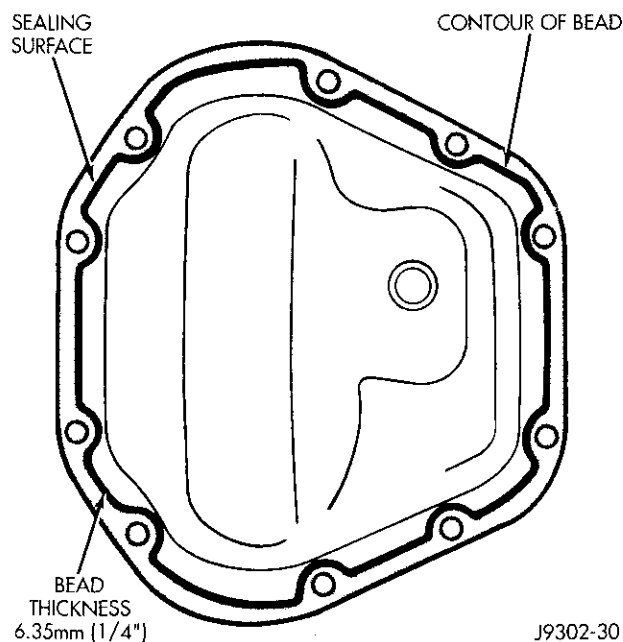
J9403-51

Fig. 5 Trac-loc Test

(4) Remove the differential housing cover and drain lubricant from the housing and axle shaft tubes.

(5) With standard differential, clean the differential and the housing cavity with a flushing oil (or light engine oil). This will remove the residual lubricant and foreign matter. **Do not use water, steam, kerosene or gasoline for flushing.**

(6) Scrape the residual sealant from the housing and cover mating surfaces. Clean the mating surfaces with mineral spirits. Apply a bead of MOPAR Silicone Rubber Sealant on the housing cover (Fig. 6). **Allow the sealant to cure for a few minutes.**



J9302-30

Fig. 6 Typical Housing Cover

NOTE: Install the housing cover within 5 minutes after applying the sealant. If not installed, the sealant must be removed and another bead applied.

SERVICE PROCEDURES (Continued)

(7) Install the cover on the differential. Install the identification tag. Tighten the cover bolts to 47 N·m (35 ft. lbs.).

CAUTION: Overfilling the differential can result in lubricant foaming and overheating.

(8) Refill the differential with the specified quantity of Mopar Hypoid gear Lubricant. With Trac-Lok differentials, add a container of friction modifier.

(9) Install the fill hole plug.

(10) Road test the vehicle.

WHEEL BEARINGS**REMOVAL**

(1) Remove the axle shaft.

(2) Remove the lock wedge and adjustment nut.

(3) Remove the hub and drum assembly. The outer wheel bearing will slide out as the hub is being removed.

(4) Remove inner grease seal and discard.

(5) Remove inner wheel bearing and inspect wheel bearings for wear. Replace as necessary.

INSTALLATION

(1) Thoroughly clean both wheel bearings and interior of the hub with an appropriate cleaning solvent.

(2) If a bearing and cup must be replaced, remove the cup from the hub bore. Use a brass drift or an appropriate removal tool to tap out the cup.

(3) Install the replacement bearing cup(s) with an appropriate installation tool.

(4) Apply lubricant to surface area of the hub bore. Install the inner wheel bearing in the hub. Install a replacement bearing seal with an appropriate seal installation tool.

(5) Inspect the bearing and seal contact surfaces on the axle tube spindle for burrs and/or roughness.

(6) Remove all the rough contact surfaces from the axle. Apply a coating of multi-purpose NLGI, grade 2, EP-type lubricant to the axle.

CAUTION: Use care to prevent the inner wheel bearing and bearing seal from contacting the axle tube spindle threads during installation. Otherwise, the threads, bearing, and seal could be damaged.

(7) Carefully slide the hub onto the axle. Install the outer wheel bearing, the locktab and outer wheel bearing locknut.

(8) Tighten the adjustment nut to 163-190 N·m (120-140 ft. lbs.) while rotating the wheel.

(9) Loosen the adjustment nut 1/8 of-a-turn (120 degrees) to provide 0.001-inch to 0.010-inch wheel bearing end play.

(10) Tap the locking wedge into the spindle keyway and adjustment nut.

(11) Install the axle shaft.

REMOVAL AND INSTALLATION**AXLE ASSEMBLY****REMOVAL**

It is not necessary to remove the complete axle from the vehicle for routine differential service. If the differential housing or axle shaft tubes are damaged, the complete axle assembly can be removed.

(1) Raise vehicle and place support stands axle.

(2) Use a wooden block to retain the brake pedal in the up position.

(3) Remove axle shafts, wheels, hubs and brake drums.

(4) Disconnect brake lines and cap the fittings to prevent loss of brake fluid.

(5) Disconnect parking brake cables and cable brackets.

(6) Remove RWAL sensor from axle housing.

(7) **Scribe alignment reference marks on drive shaft U-joint and pinion yoke.** Disconnect the drive shaft U-joint from the pinion yoke. Secure it in an upright position to prevent damage to the U-joint.

(8) Remove the rear shock absorbers and the rear spring U-bolts from the axle.

(9) Remove the rear axle from the vehicle.

INSTALLATION

(1) If the differential housing cover was removed, ensure differential housing and cover mating surfaces are clean.

(2) If cover was removed, apply a bead of MOPAR Silicone Rubber Sealant around the cover bolt circle. Install the differential housing cover. Tighten the cover bolts to 47 N·m (35 ft. lbs.). Install the axle gear ratio identification tag under one of the cover bolts.

(3) Position axle under the rear springs.

(4) Install the spring U-bolts and tighten the nuts to the specified torque.

(5) Install shock absorbers.

(6) Connect parking brake cables and cable brackets.

(7) Install RWAL sensor.

(8) Connect the brake lines. Install the hubs and brake drums. Adjust the wheel bearings (refer to Wheel Bearing Adjustment).

(9) Remove the block from the brake pedal. Bleed and adjust the brakes.

REMOVAL AND INSTALLATION (Continued)

(10) Connect the drive shaft to the pinion yoke with the reference marks aligned. Tighten the U-joint clamp bolts to 21 N·m (16 ft. lbs.).

(11) Install wheel and tire assemblies.

(12) Remove the fill hole plug from housing cover. Fill the housing to the correct level with MOPAR Hypoid gear Lubricant. If equipped with Trac-Lok add correct amount of friction modifier.

(13) Install the fill hole plug. Remove the supports and lower the vehicle.

PINION SHAFT SEAL

REMOVAL

(1) Raise and support the vehicle.

(2) Mark the U-joint, pinion yoke, and pinion shaft for reference.

(3) Disconnect the drive shaft from the pinion yoke. Secure the drive shaft in an upright position to prevent damage to the rear U-joint.

(4) Remove the pinion yoke nut and washer. Use Remover C-452 and Wrench C-3281 to remove the pinion yoke (Fig. 7).

(5) Using an inch pound torque wrench, check rotation resistance of the pinion and record the results to aid installation.

(6) Mark the positions of the yoke and pinion gear for installation alignment reference.

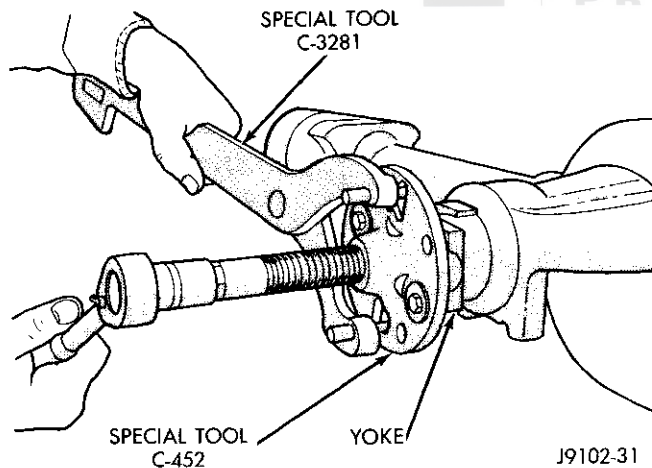


Fig. 7 Pinion Yoke Removal

(7) Use Remover C-748 to remove the pinion gear seal (Fig. 8).

INSTALLATION

(1) Apply a light coating of gear lubricant on the lip of pinion seal. Install the new seal with Installer C-3719-A and Handle C-4735.

(2) Align the installation reference marks and position the yoke on the pinion gear.

(3) Install the pinion yoke, washer, and nut on shaft. Tighten the nut to 292 N·m (215 ft. lbs.) (Fig. 9).

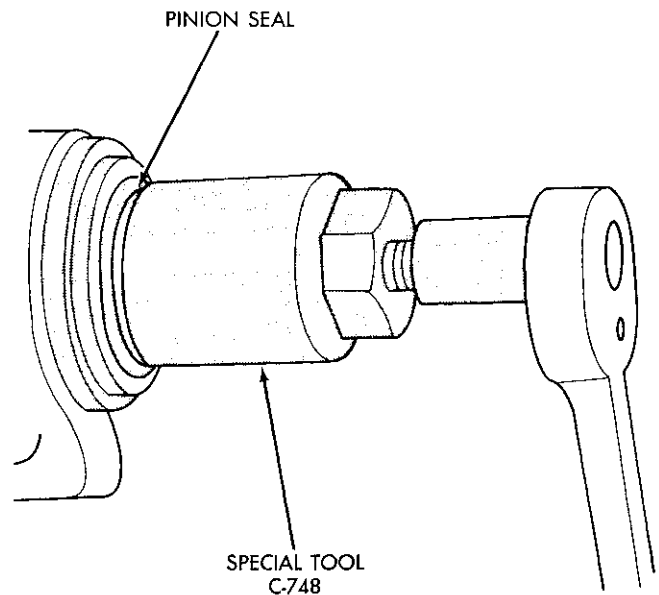


Fig. 8 Pinion Seal Removal

(4) Verify that the pinion rotation resistance value is equal to that recorded during removal procedure. If not, adjust flange nut until pinion resistance is correct.

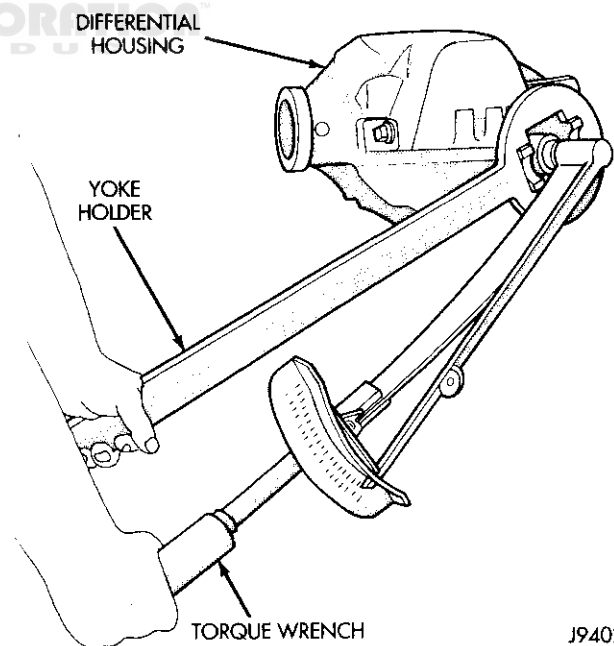


Fig. 9 Tightening Pinion Shaft Nut

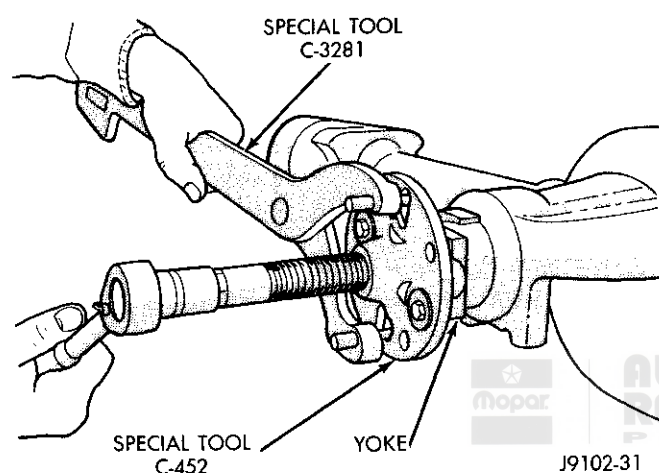
(5) Align the installation reference marks and attach the drive shaft to the yoke.

(6) Add hypoid gear lubricant to the differential housing, if necessary.

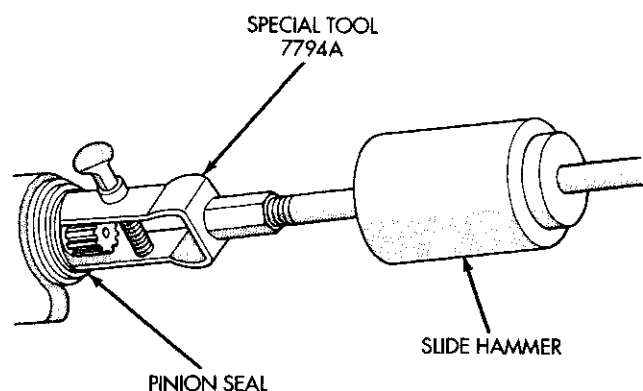
(7) Lower the vehicle.

REMOVAL AND INSTALLATION (Continued)**PINION SEAL—MODEL 70/80****REMOVAL**

- (1) Raise and support the vehicle.
- (2) Mark the U-joint, pinion yoke, and pinion shaft for reference.
- (3) Disconnect the drive shaft from the pinion yoke. Secure the drive shaft in an upright position to prevent damage to the rear U-joint.
- (4) Mark the positions of the yoke and pinion gear for installation alignment reference.
- (5) Remove the pinion yoke nut and washer. Use Remover C-452 and Wrench C-3281 to remove the pinion yoke (Fig. 10).

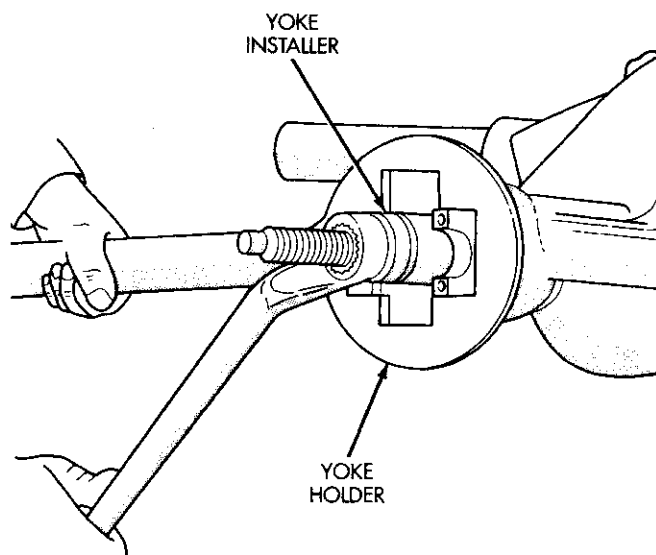
**Fig. 10 Pinion Yoke Removal**

- (6) Use Remover 7794A and slide hammer to remove pinion seal (Fig. 11).

**Fig. 11 Pinion Seal Removal****INSTALLATION**

- (1) Apply a light coating of gear lubricant on the lip of pinion seal. Install the new seal with Installer D-187B.

- (2) Align the installation reference marks and position the yoke on the pinion gear.
- (3) Install yoke with Installer D-191 (Fig. 12).

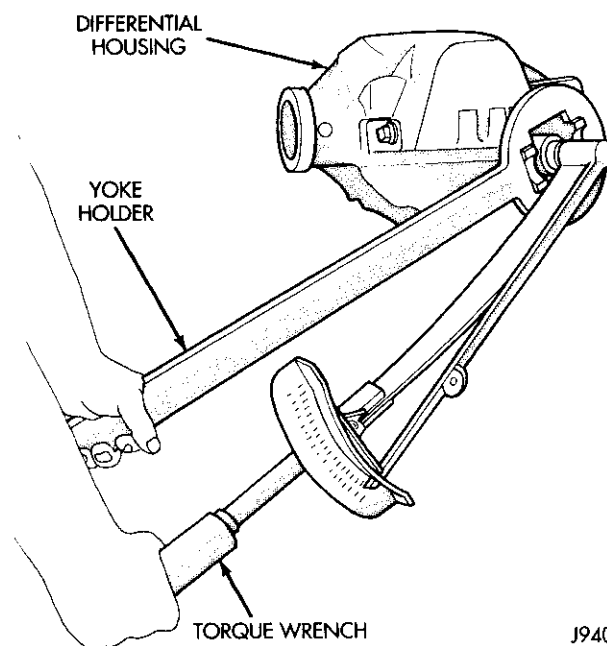


J9402-61

Fig. 12 Yoke Installation

- (4) Install washer with concave surface against yoke on Model 70 axle. Install nut on shaft and tighten nut to (Fig. 13);

- Model 70: 298-379 N·m (220-280 ft. lbs.) torque
- Model 80: 597-678 N·m (440-500 ft. lbs.) torque



J9402-62

Fig. 13 Tightening Pinion Shaft Nut

REMOVAL AND INSTALLATION (Continued)

Optional Torque Method, Model 80: Torque pinion nut to 339 N·m (250 ft. lbs.). Then scribe a line on the yoke 3/8 of an inch from one point of the pinion nut (Fig. 14). Tighten the nut until the point of the nut lines up with the scribe mark. This will tighten the nut to the correct torque.

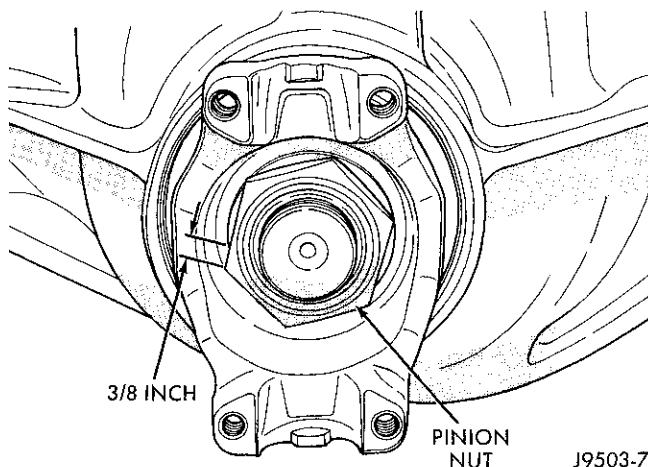


Fig. 14 Pinion Nut

(5) Align the installation reference marks and attach the drive shaft to the yoke.

(6) Add gear lubricant to the differential housing if necessary.

(7) Remove support and lower the vehicle.

AXLE ASSEMBLY

It is not necessary to remove the complete axle from the vehicle for routine differential inspection and service. If the differential housing, case or axle shaft tubes are damaged the complete axle can be removed and replaced.

REMOVAL

(1) Raise and support vehicle.

(2) Block the brake pedal in the up (non-depressed) position with a wooden block.

(3) Remove the rear wheels and brake drums.

(4) Disconnect the brake fluid tube fittings from the wheel cylinders. Cap the fittings to prevent loss of brake fluid.

(5) Remove the vent hose from the brake tee nipple.

(6) Remove the brake tee bolt. Carefully detach the brake fluid tubes from the clips.

(7) Disconnect the parking brake cables and unbolt backing plates.

Mark the U-joint, pinion yoke, and pinion shaft for reference.

(8) Disconnect the drive shaft from the pinion yoke. Secure the drive shaft in an upright position to prevent damage to the rear U-joint.

(9) Remove the shock absorber lower attaching nuts and bolts.

(10) Support axle and remove rear spring U-bolts and the spring brackets.

WARNING: AXLE MAY ROTATE ON SUPPORT WHEN SPRING CLAMP BOLTS ARE REMOVED ENSURE AXLE IS SECURED ON SUPPORT.

(11) Remove the axle assembly from the vehicle.

(12) Wash and clean the outer surface of the housing and tubes. Use an appropriate cleaning solution and dry the surface with compressed air.

INSTALLATION

(1) Position the rear axle spring pads over the spring center bolts.

(2) Install the spring clamp bolts and nuts, and shock absorber lower bolts. Tighten the nuts to the specified torque.

(3) Connect the parking brake cables.

(4) Connect the brake fluid tube fittings to the wheel cylinders. Bleed and adjust brakes refer to Group 5 Brakes for procedure.

(5) Align the installation reference marks and connect the drive shaft yoke to the pinion yoke. Tighten the U-joint clamp bolts to 19-23 N·m (170-200 in. lbs.) torque.

(6) Install wheel and tire assemblies.

(7) Remove support and lower vehicle.

DIFFERENTIAL

REMOVAL

To service the differential the axle shafts must be removed. Refer to the removal procedures in this Group.

(1) Note the installation reference letters stamped on the bearing caps and housing machined sealing surface (Fig. 15).

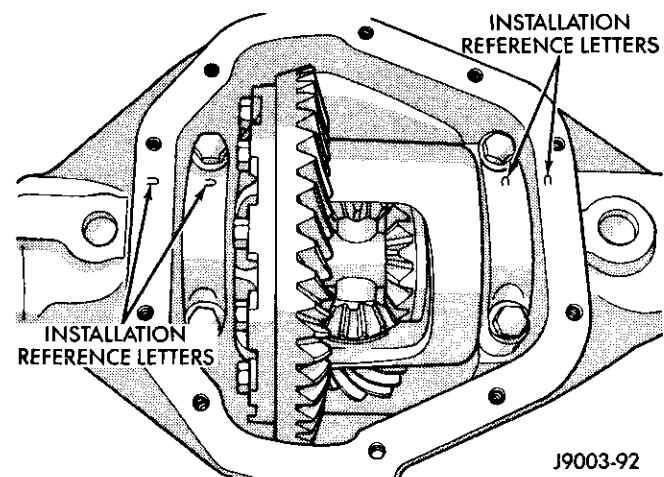
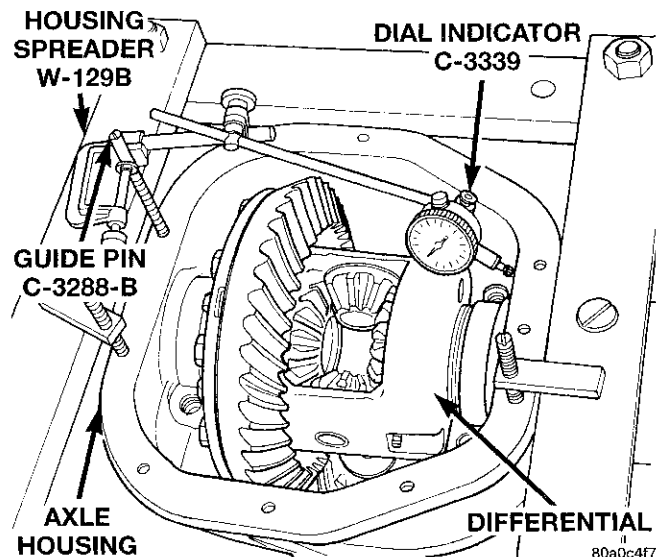


Fig. 15 Bearing Cap Identification

REMOVAL AND INSTALLATION (Continued)

- (2) Remove the differential bearing caps.
- (3) Position Spreader W-129-B with the tool dowel pins seated in the locating holes (Fig. 16). Install the hold down clamps and tighten the tool turnbuckle finger-tight.

**Fig. 16 Spread Differential Housing**

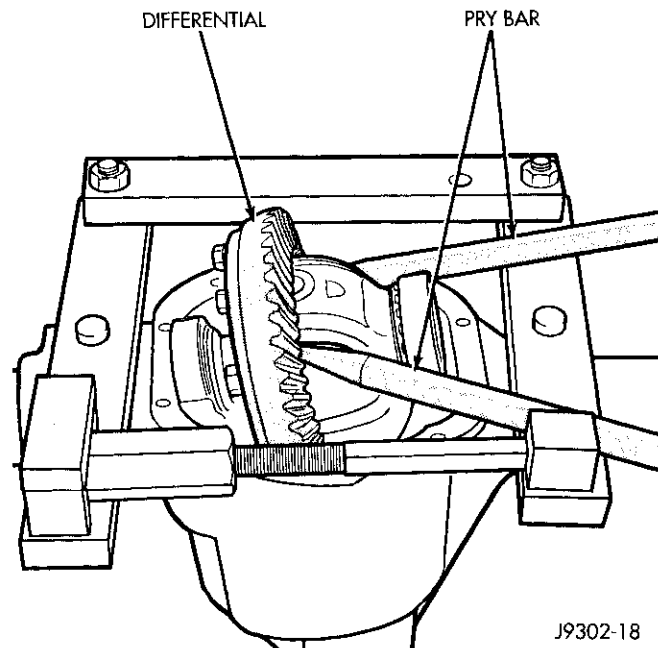
- (4) Install a pilot stud at the left side of the differential housing. Attach Dial Indicator to housing pilot stud. Load the indicator plunger against the opposite side of the housing (Fig. 16) and zero the indicator.

CAUTION: Do not spread over 0.38 mm (0.015 in). If the housing is over-separated, it could be distorted or damaged.

- (5) Separate the housing enough to remove the case from the housing. Measure the distance with the dial indicator (Fig. 16).
- (6) Remove the dial indicator.
- (7) Pry the differential case loose from the housing. To prevent damage, pivot on housing with the end of the pry bar against spreader (Fig. 17).
- (8) Remove the case from housing. Mark or tag bearing cups and outboard shim/spacer (selected thickness) indicating which side they were removed.

DIFFERENTIAL INSTALLATION

- (1) Position Spreader W-129-B with the tool dowel pins seated in the locating holes (Fig. 16). Install the hold down clamps and tighten the tool turnbuckle finger-tight.
- (2) Install a pilot stud at the left side of the differential housing. Attach Dial Indicator to housing pilot stud. Load the indicator plunger against the opposite side of the housing (Fig. 16) and zero the indicator.

**Fig. 17 Differential Removal**

CAUTION: Do not spread over 0.38 mm (0.015 in). If the housing is over-separated, it could be distorted or damaged.

- (3) Separate the housing enough to install the case in the housing. Measure the distance with the dial indicator (Fig. 16).
- (4) Remove the dial indicator.
- (5) Install differential and outboard shim/spacer (selected thickness) in housing.
- (6) Install case in the housing. Tap the differential case to ensure the bearings are fully seated (Fig. 18). Remove the spreader.
- (7) Install the bearing caps at their original locations (Fig. 19). Tighten the bearing cap bolts to 77 N·m (57 ft. lbs.) torque.

DIFFERENTIAL SIDE BEARINGS**REMOVAL**

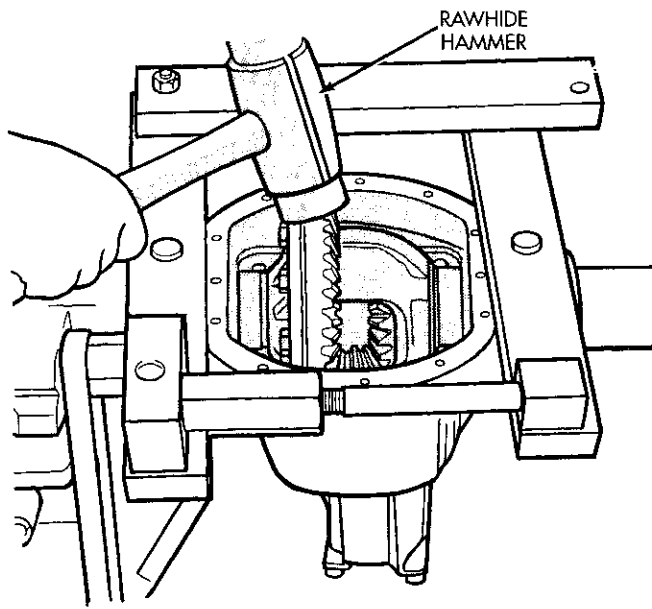
- (1) Remove Differential case from axle housing.
- (2) Remove the bearings from the differential case with Press 938, and Adapter 1130 (Fig. 20).

DIFFERENTIAL SIDE BEARING INSTALLATION

If ring and pinion gears have been replaced, verify differential side bearing preload and gear mesh backlash.

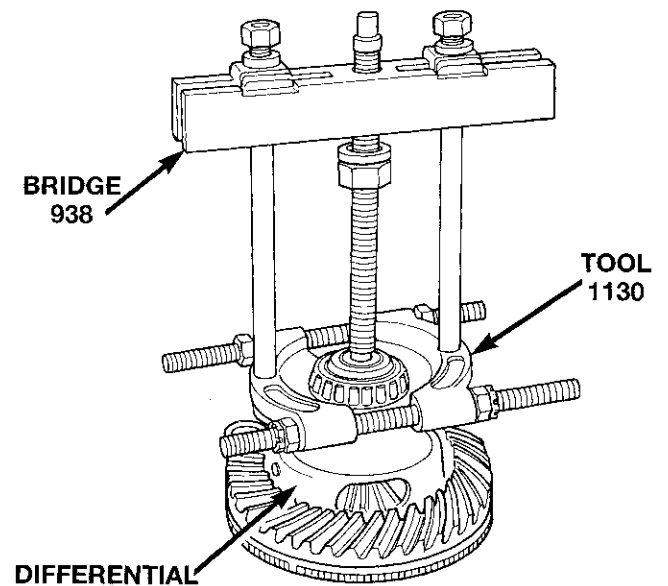
- (1) Using tool C-4340 with handle C-4171, install differential side bearings (Fig. 21).
- (2) Install differential in axle housing.

REMOVAL AND INSTALLATION (Continued)



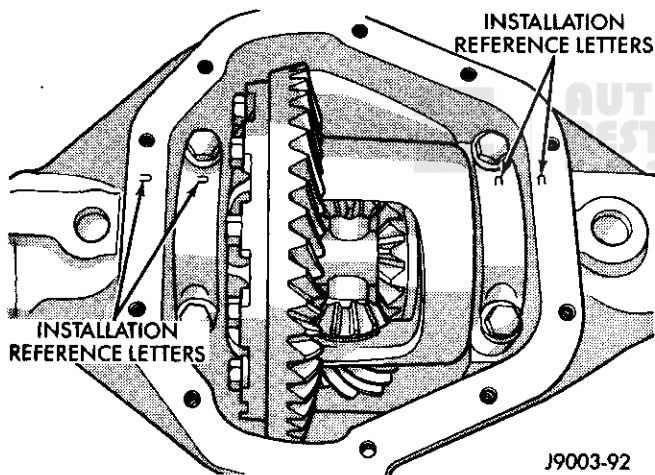
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Fig. 18 Differential Installation



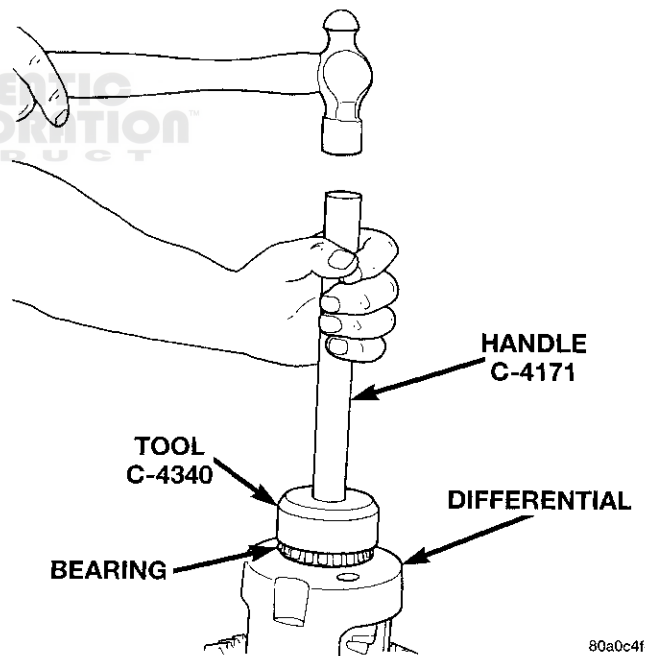
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Fig. 20 Differential Bearing Removal



J9003-92

Fig. 19 Differential Bearing Cap Reference Letters

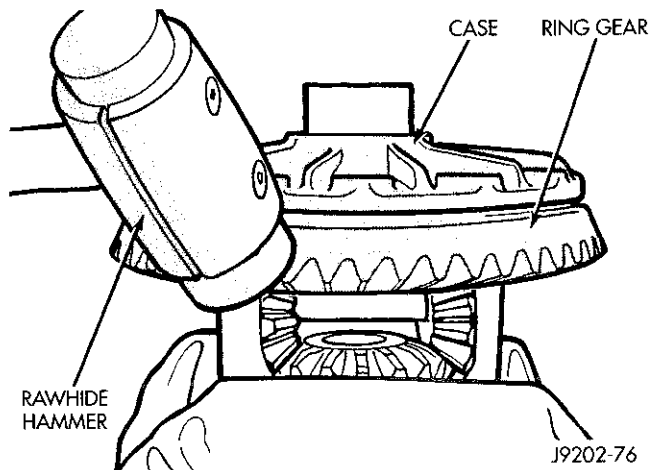


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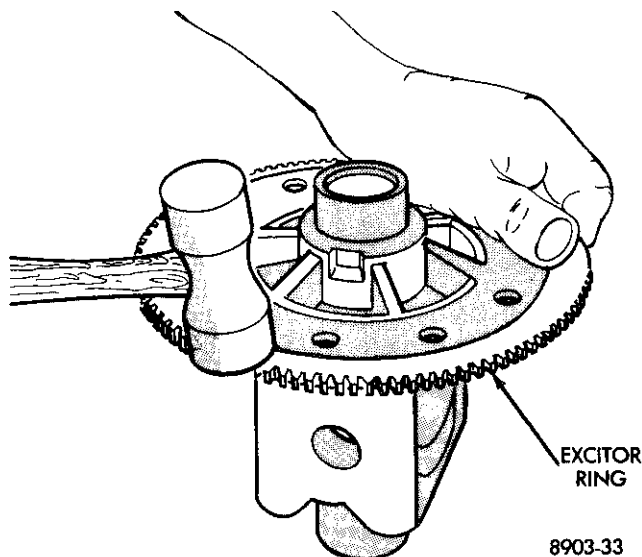
Fig. 21 Install Differential Side Bearings

REMOVAL AND INSTALLATION (Continued)**EXCITER AND RING GEAR****REMOVAL**

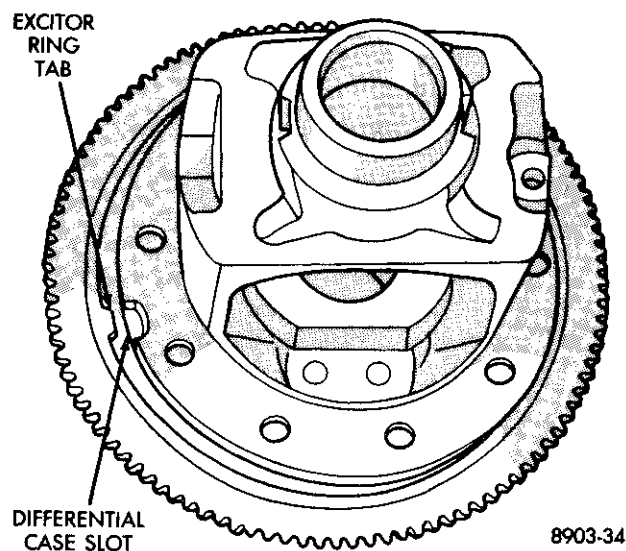
- (1) Remove the differential case from axle housing.
- (2) Clamp the differential case in a vise equipped with soft jaws.
- (3) Remove and discard the ring gear bolts.
- (4) Tap the ring gear off with a rawhide or plastic mallet (Fig. 22).

**Fig. 22 Ring Gear Removal**

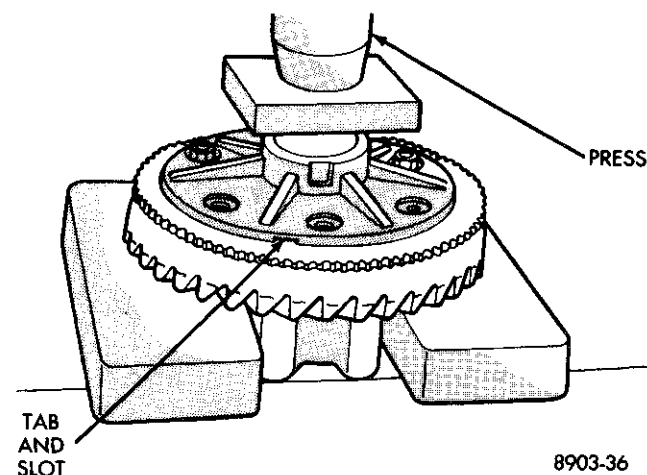
- (5) The can be removed with a soft-faced hammer (Fig. 23). Discard exciter ring after removal.

**Fig. 23 Exciter Ring Removal****EXCITER AND RING GEAR INSTALLATION**

- (1) If exciter ring was removed, align exciter ring tab with slot in differential case (Fig. 24).

**Fig. 24 Exciter Ring Alignment**

- (2) Invert the differential case and start two ring gear bolts. This will provide case to ring gear bolt hole alignment.
- (3) Press the exciter ring onto the differential case using the ring gear as a pilot (Fig. 25).

**Fig. 25 Ring Gear Bolt Hole Alignment**

- (4) Install new ring gear bolts and alternately tighten to;

- Model 60 and 70: 163-190 N·m (120-140 ft. lbs.) torque
- Model 80: 272-325 N·m (200-240 ft. lbs.) torque

REMOVAL AND INSTALLATION (Continued)**PINION GEAR****REMOVAL**

(1) Remove differential assembly from axle housing.

(2) Remove the pinion yoke nut and washer. Use Remover C-452 and Wrench C-3281 to remove the pinion yoke (Fig. 26).

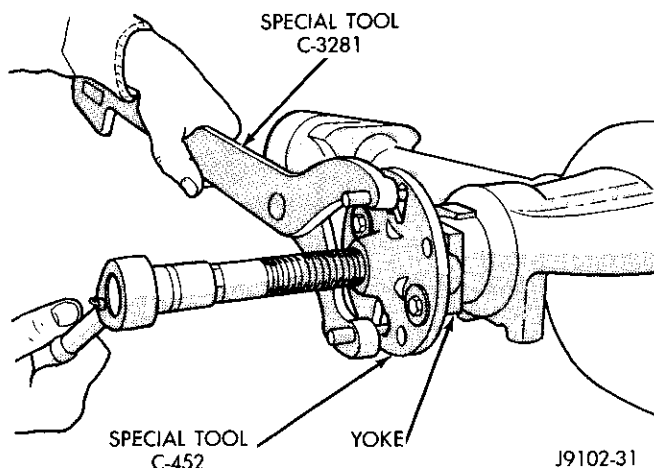


Fig. 26 Pinion Yoke Removal

(3) Remove the pinion gear from housing (Fig. 27). Catch the pinion with your hand to prevent it from falling and being damaged.

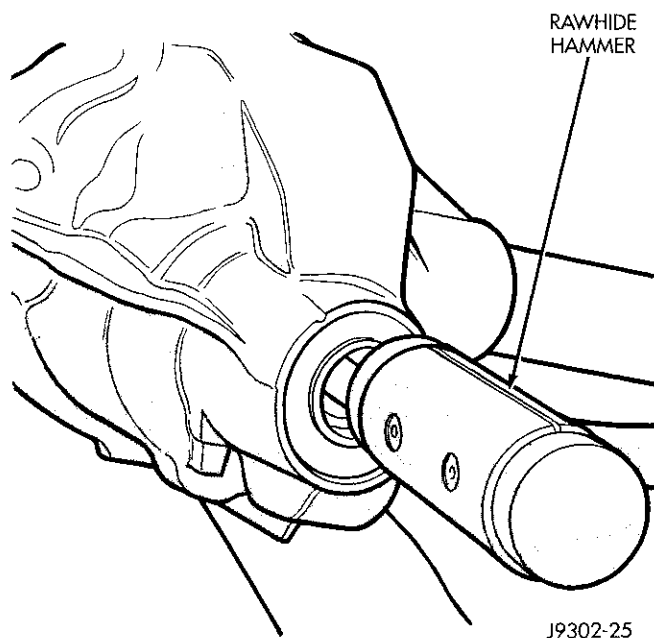


Fig. 27 Remove Pinion Gear

(4) Remove the pinion gear seal with a slide hammer or pry out with bar.

(5) Remove oil slinger, front bearing.

(6) Remove the front pinion bearing cup and seal with Remover C-4307 for model 80 or D-158 for model 60/70 and Handle C-4171 (Fig. 28).

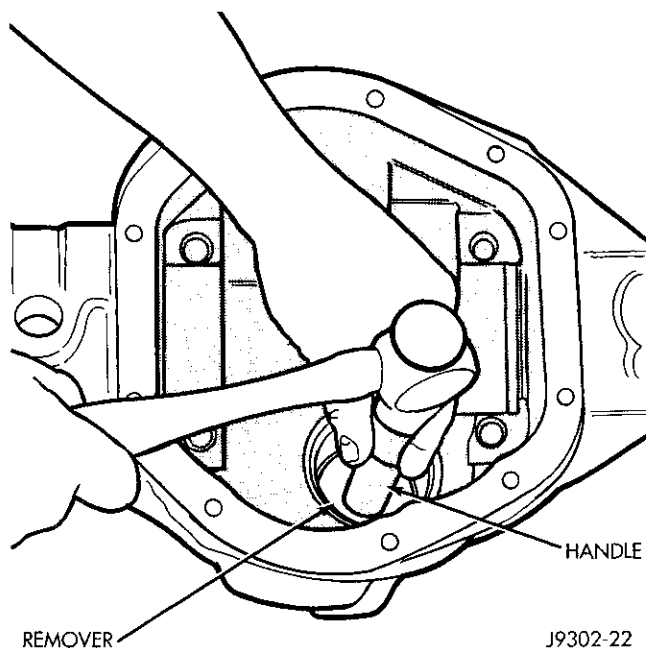


Fig. 28 Front Bearing Cup Removal

(7) Remove the rear bearing cup from housing (Fig. 29). Use Remover D-159 for model 80 or D-162 for model 60/70 and Handle C-4171.

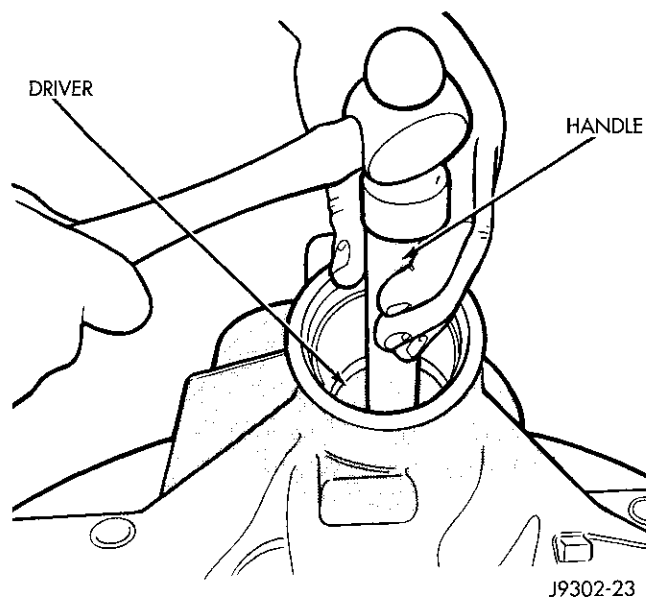
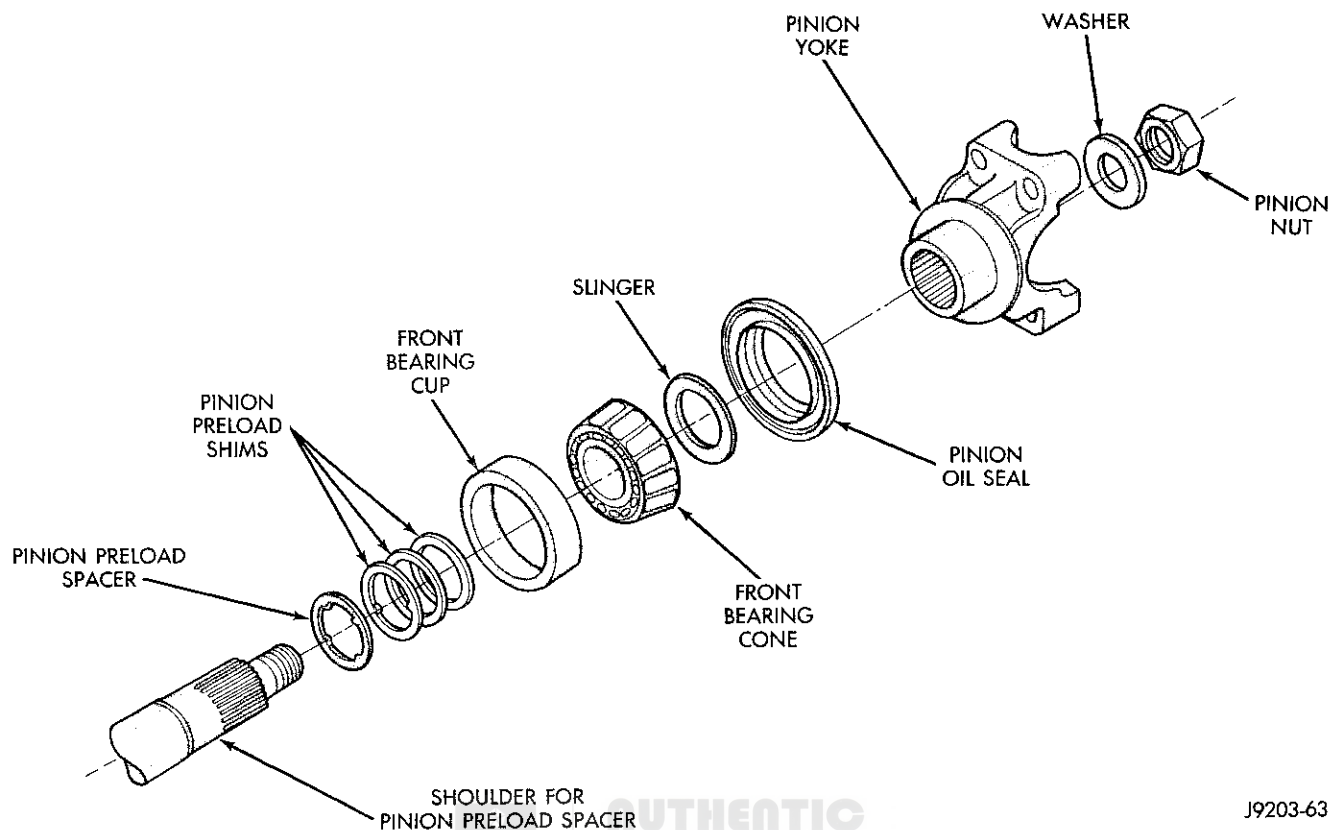


Fig. 29 Rear Bearing Cup Removal

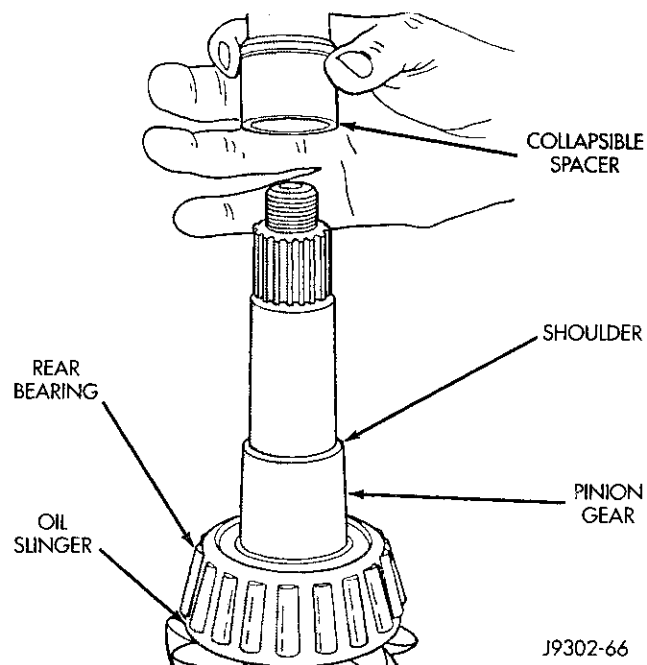
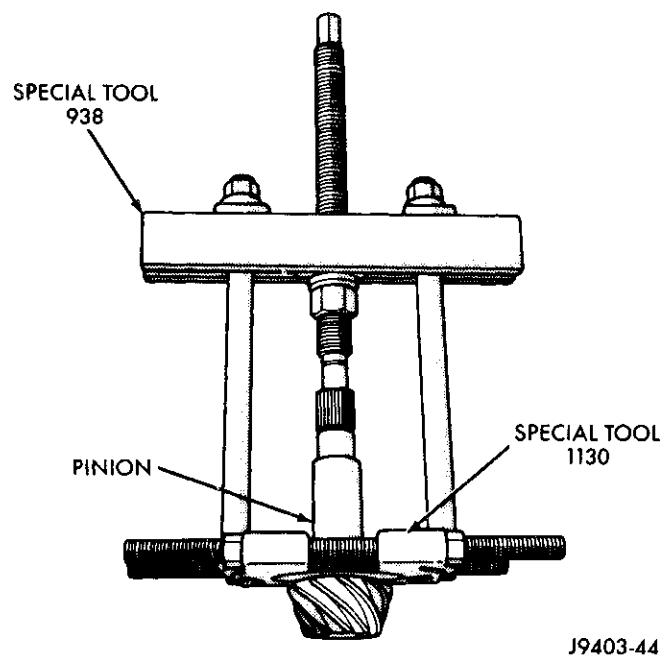
REMOVAL AND INSTALLATION (Continued)

**Fig. 30 Pinion Preload Shims—Model 70/80**

(8) Remove the preload shims on model 70/80 (Fig. 30) or collapsible spacer on model 60 axles (Fig. 31).

(9) Remove the inner bearing from the pinion with Splitter 1130 and Bridge 938 (Fig. 32).

(10) Remove the depth shims from the pinion gear shaft. Record the thickness of the depth shims.

**Fig. 31 Collapsible Preload Spacer—Model 60****Fig. 32 Inner Bearing Removal**

REMOVAL AND INSTALLATION (Continued)**PINION GEAR INSTALLATION**

After selecting the proper pinion depth shim using the Pinion Depth Measurement paragraph in the Adjustment section of this Group, proceed with installation procedure. Model 60 axle uses a collapsible spacer to preload the pinion bearings. Model 70/80 uses shims to set pinion bearing preload.

(1) On model 70/80 axles, place pinion depth shims in axle housing rear bearing bore.

(2) Install the pinion rear bearing cup with Installer C-4204 for model 80 or D-111 for model 60/70 and Driver Handle C-4171 (Fig. 33). Ensure cup is correctly seated.

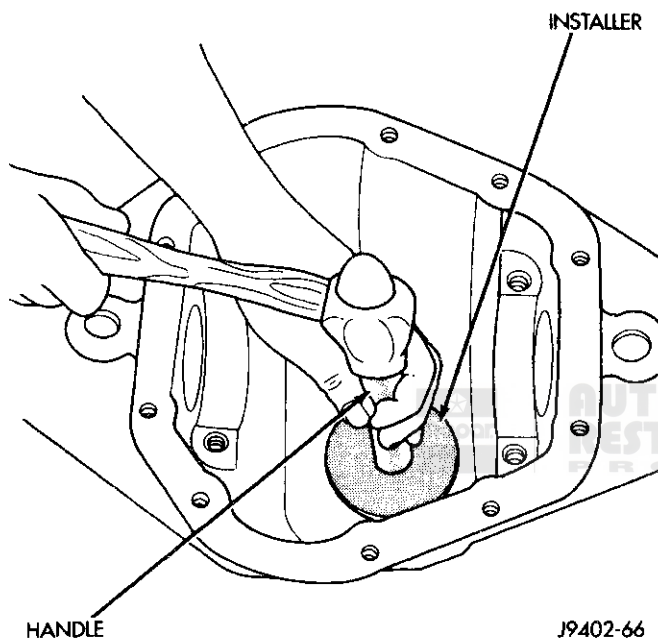


Fig. 33 Pinion Rear Bearing Cup Installation

(3) Install the pinion front bearing cup with Installer C-4308 for model 80 or C-4203 for model 60/70 and Handle C-4171 (Fig. 34).

(4) If equipped, install pinion front bearing, oil slinger.

(5) Apply a light coating of gear lubricant on the lip of pinion seal. Install seal with Installer D-163 and Handle C-4171 (Fig. 35).

NOTE: Pinion depth shims are used to achieve proper ring and pinion gear mesh. If the factory installed ring and pinion gears are reused, the pinion depth shim should not require replacement. Refer to Pinion Gear Depth paragraph in this section to select the proper thickness shim before installing rear pinion bearing cone. The shims are between the rear pinion bearing cone and pinion gear on model 60 axle and in the axle housing behind the rear bearing cup on model 70/80 axles

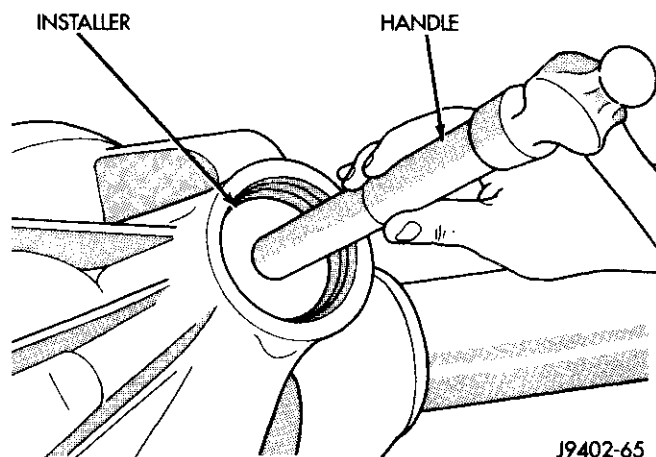


Fig. 34 Pinion Front Bearing Cup Installation

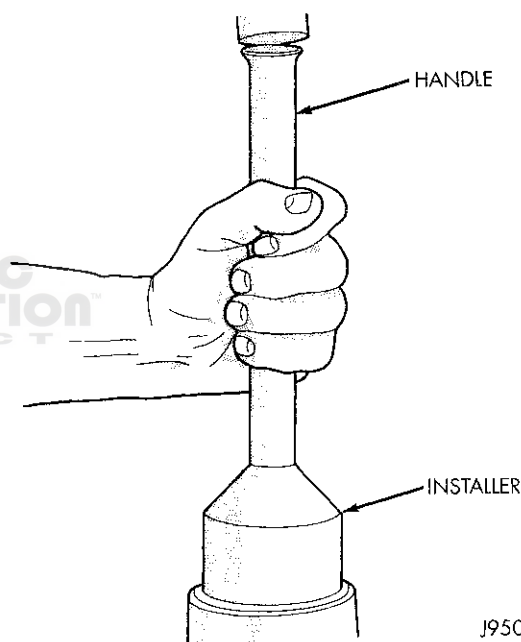


Fig. 35 Pinion Seal Installation

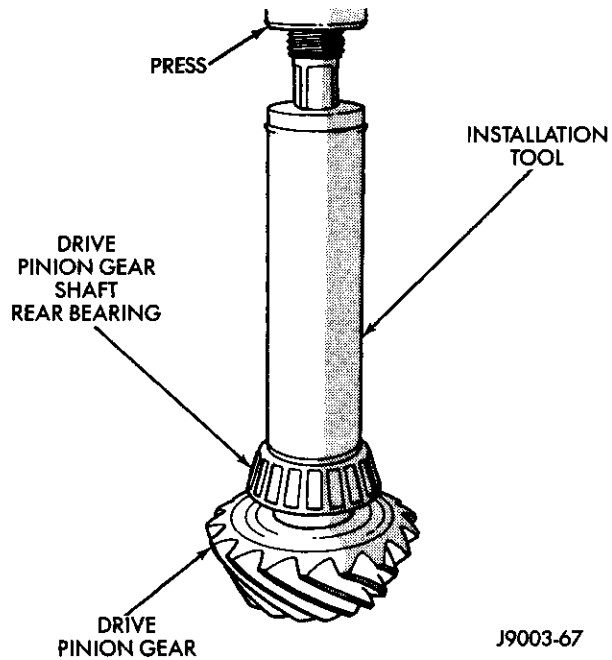
(6) On model 60 axle, place the proper thickness depth shim on the pinion gear and install the rear bearing. Refer to Pinion Gear Depth paragraph in Adjustments section of this group.

(7) Install the rear bearing (and slinger if used) on the pinion gear with Installer D-389 for model 70/80 or C-3095A for model 60 and an arbor press (Fig. 36).

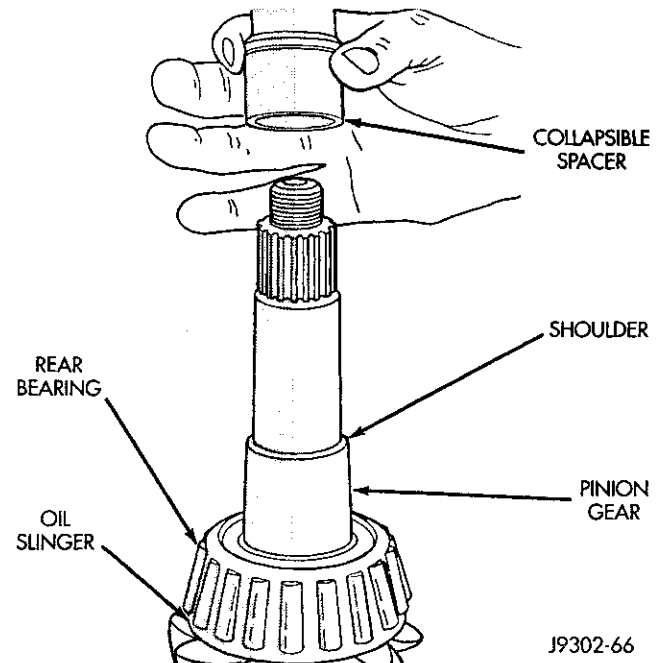
(8) On model 60 axle, install a new collapsible preload spacer on pinion shaft and install pinion gear in housing (Fig. 37). On model 70/80 axles, install pinion bearing preload shims (Fig. 38).

(9) Install yoke with Installer D-191 for model 80 or C-3716A for model 60/70 and Wrench 6719 (Fig. 39).

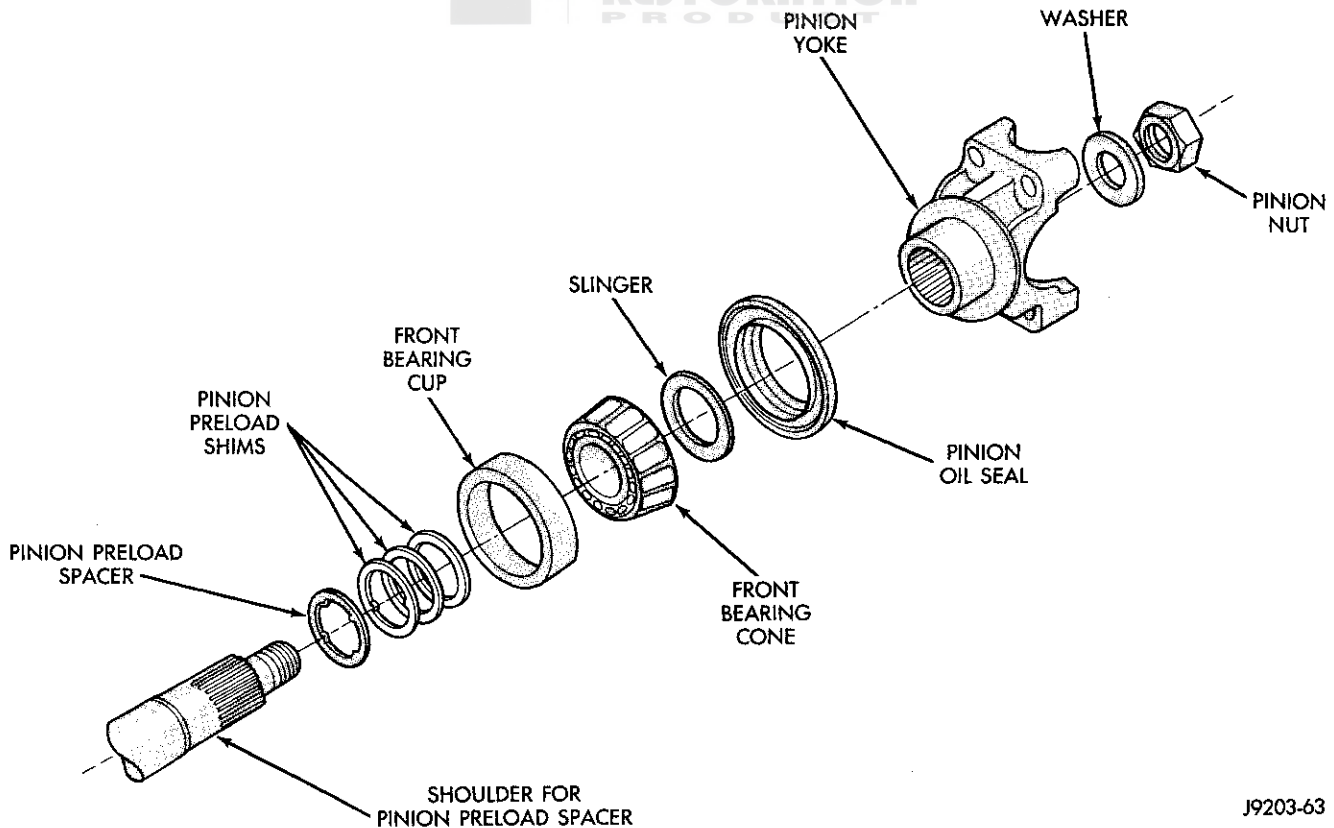
(10) Install the yoke washer and a new nut on the pinion gear. Tighten the nut to 258 N·m (190 ft. lbs.)

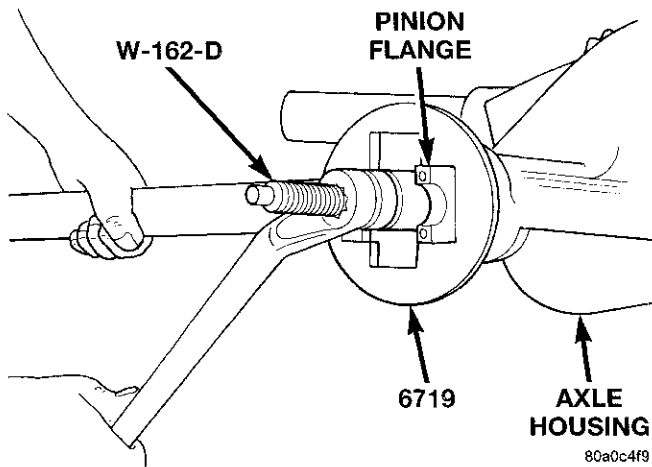
REMOVAL AND INSTALLATION (Continued)**Fig. 36 Shaft Rear Bearing Installation**

for model 44 or 291 N·m (215 ft. lbs.) for model 60 minimum. **Do not over tighten.** Maximum torque is 380 N·m (280 ft. lbs.).

**Fig. 37 Collapsible Preload Spacer—Model 60**

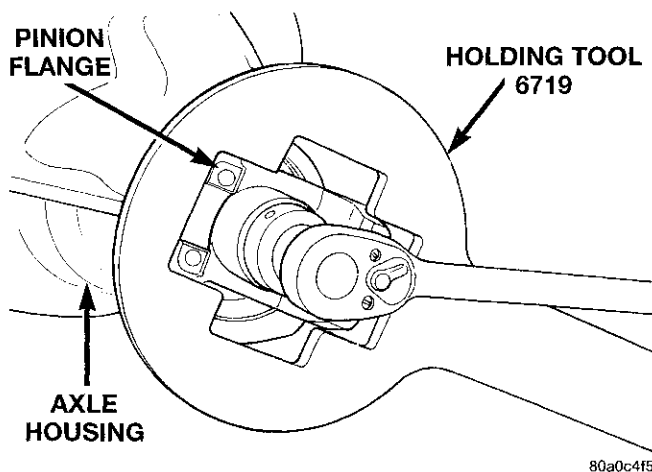
NOTE: On model 60 and 70 axles, install yoke washer with concave surface against the yoke.

**Fig. 38 Pinion Preload Shims—Model 70/80**

REMOVAL AND INSTALLATION (Continued)**Fig. 39 Pinion Yoke Installation—Typical**

CAUTION: On model 60 axle, never loosen pinion gear nut to decrease pinion gear bearing preload torque and never exceed specified preload torque. If preload torque is exceeded a new collapsible spacer must be installed. The torque sequence will have to be repeated.

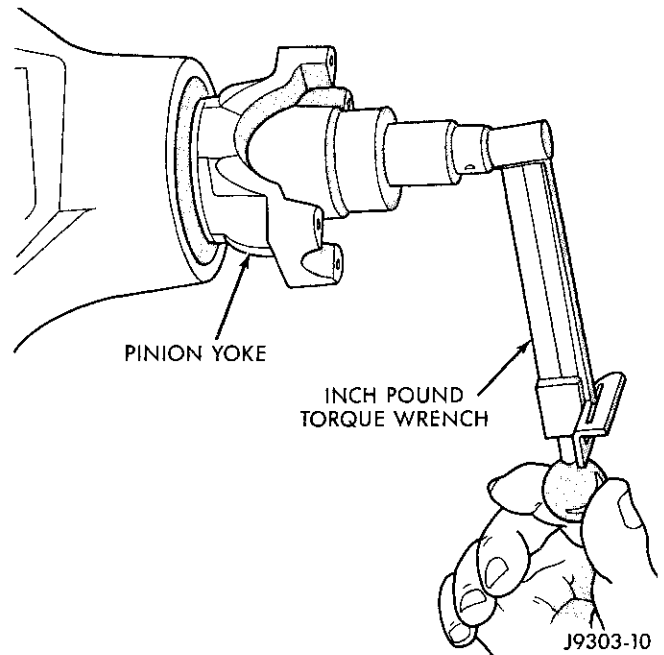
(11) On model 60 axle, use Flange Wrench 6719 to retain the yoke (Fig. 40). Slowly tighten the nut in small increments until the rotating torque is achieved. Measure the preload torque frequently to avoid over tightening the nut. On model 70/80 axles

**Fig. 40 Tightening Pinion Nut**

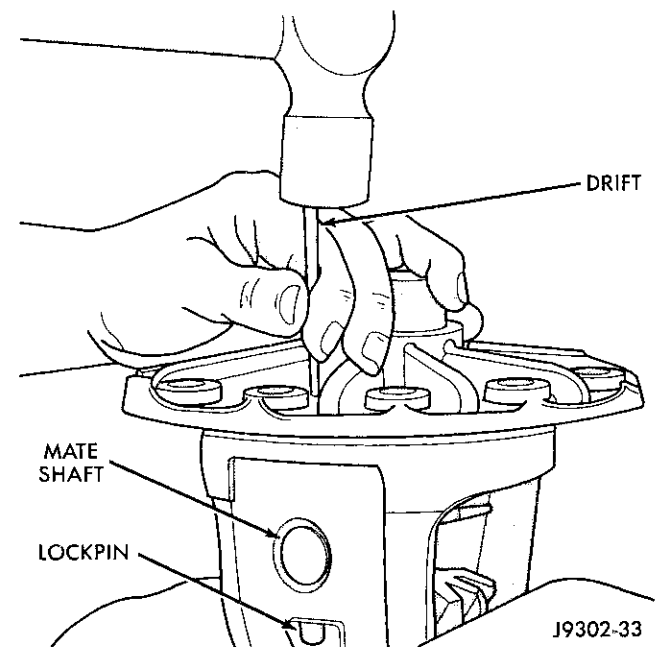
(12) Check bearing preload torque with an inch pound torque wrench (Fig. 41). The torque necessary to rotate the pinion gear should be:

- Original Bearings—1 to 3 N·m (10 to 20 in. lbs.).
- New Bearings—2 to 5 N·m (15 to 35 in. lbs.).

To achieve proper pinion bearing preload on model 70/80 axles, remove pinion gear from axle housing. Increase shim thickness if rotation torque is too high. Decrease thickness if rotation torque is too low.

**Fig. 41 Check Pinion Gear Rotation Torque****DISASSEMBLY AND ASSEMBLY****STANDARD DIFFERENTIAL****DISASSEMBLE**

(1) Clamp the differential case in a vise equipped with soft jaws. Use a pin punch to remove the pinion gear mate shaft lock pin (Fig. 42).

**Fig. 42 Mate Shaft Lock Pin Removal**

DISASSEMBLY AND ASSEMBLY (Continued)

(2) Remove the mate shaft with a drift and hammer (Fig. 43).

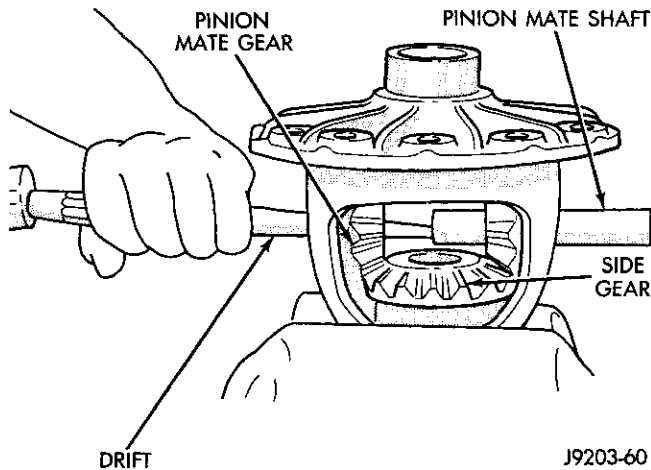


Fig. 43 Mate Shaft Removal

(3) Rotate the differential side gears and remove the pinion mate gears and thrust washers (Fig. 44).

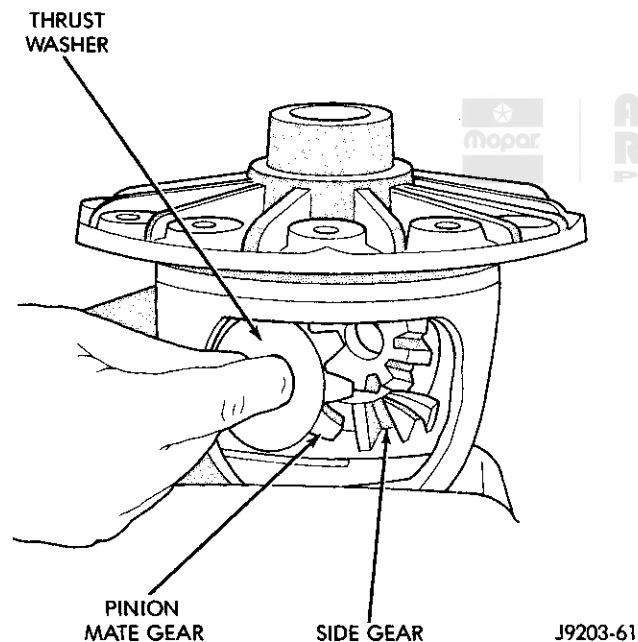


Fig. 44 Pinion Mate Gear Removal

(4) Remove the differential side gears and thrust washers.

ASSEMBLE

(1) Lubricate all differential components with hypoid gear lubricant.

(2) Install the following components in the differential case.

- Differential side gears and thrust washers
- Pinion gears and thrust washers

• Pinion gear mate shaft (align holes in shaft and case)

(3) Install and seat the lock pin in differential case and mate shaft with a punch and hammer (Fig. 45). Peen metal part of case over pin in two places 180 degrees apart.

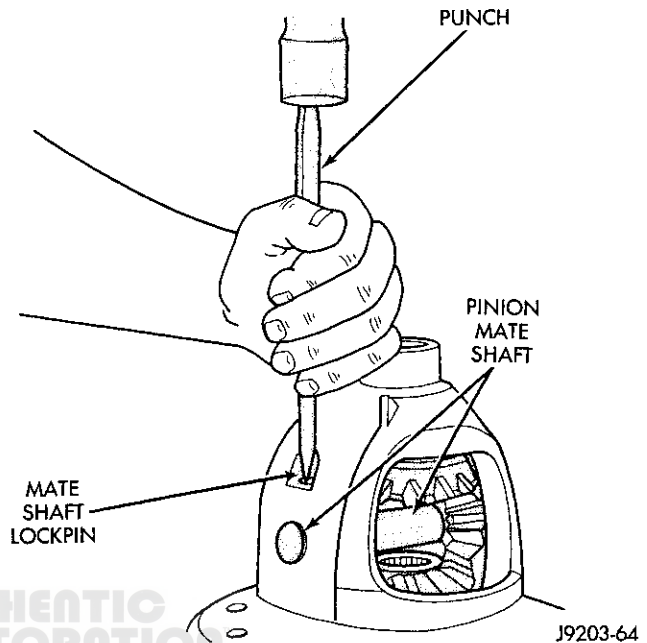


Fig. 45 Mate Shaft Pin Installation

If replacement gears and thrust washers were installed, it is not necessary to measure the gear backlash. Correct fit is due to close machining tolerances during manufacture.

TRAC-LOK DIFFERENTIAL

The **Trac-Lok** (limited-slip) differential components are illustrated in (Fig. 46). Refer to this illustration during repair service.

DISASSEMBLY

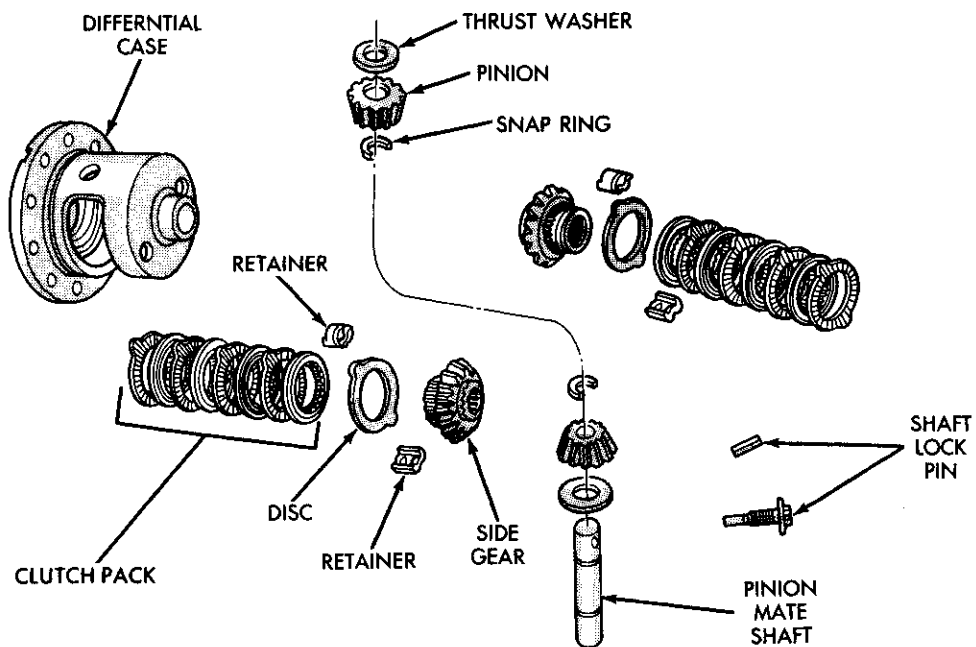
Service to the Trac-Lok differential requires the use of Tool Set C-4487 (J-23781). Refer to Model 44 Axle section in this Group for Differential Removal and Installation.

(1) Clamp Side Gear Holding Tool 6963 in a vise.

(2) Position the differential case on the holding tool (Fig. 47). Place shop towels under the differential to avoid damage if removal of the ring gear is required (Fig. 47).

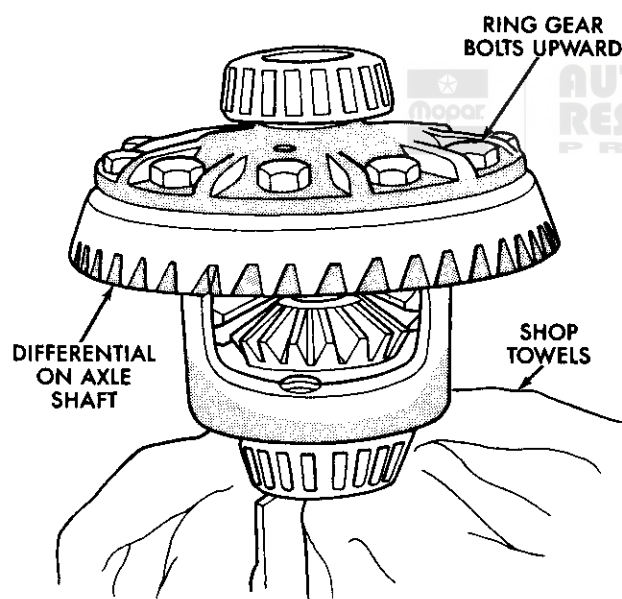
(3) If ring gear replacement is required, remove **and discard** the bolts holding the ring gear to the case. Tap the ring gear with a rawhide or plastic mallet and separate ring gear from case (Fig. 48).

DISASSEMBLY AND ASSEMBLY (Continued)



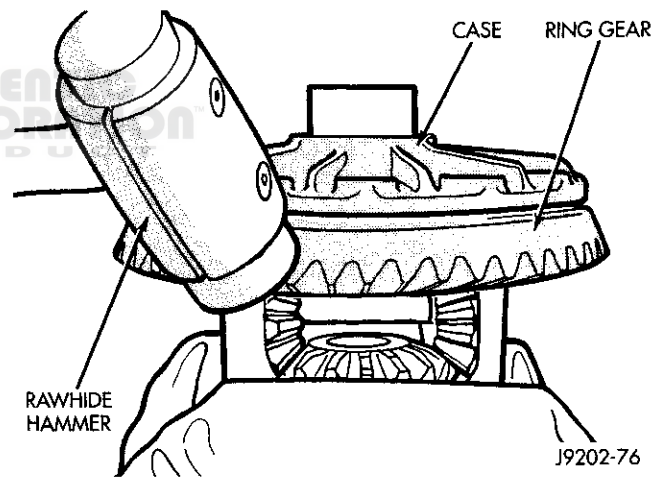
J9203-13

Fig. 46 Trac-Lok Differential Components



J8903-43

Fig. 47 Differential Case Holding Tool



J9202-76

Fig. 48 Ring Gear Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(4) Remove the pinion gear mate shaft lock screw (Fig. 49).

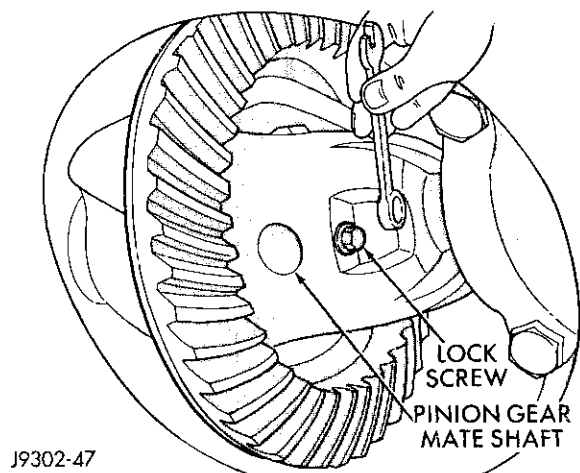


Fig. 49 Mate Shaft Lock Screw

(5) Remove the pinion gear mate shaft. If necessary, use a drift and hammer (Fig. 50).

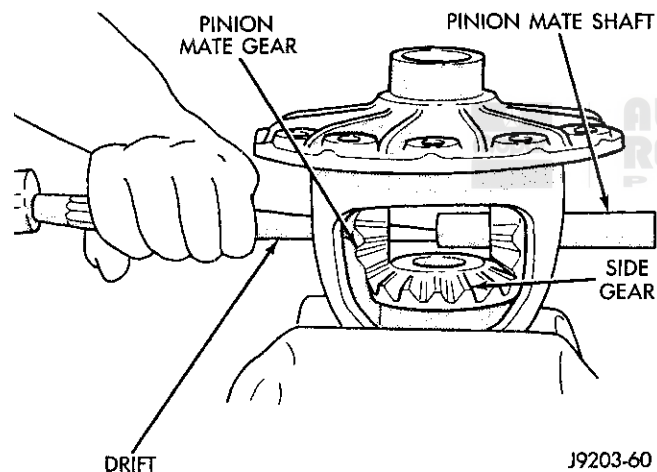


Fig. 50 Mate Shaft Removal

(6) Install and lubricate Step Plate C-4487-1 (Fig. 51).

(7) Assemble Threaded Adapter C-4487-3 into top side gear. Thread forcing Screw C-4487-2 into adapter until it becomes centered in adapter plate.

(8) Position a small screw driver in slot of Threaded Adapter C-4487-3 (Fig. 52) to prevent adapter from turning.

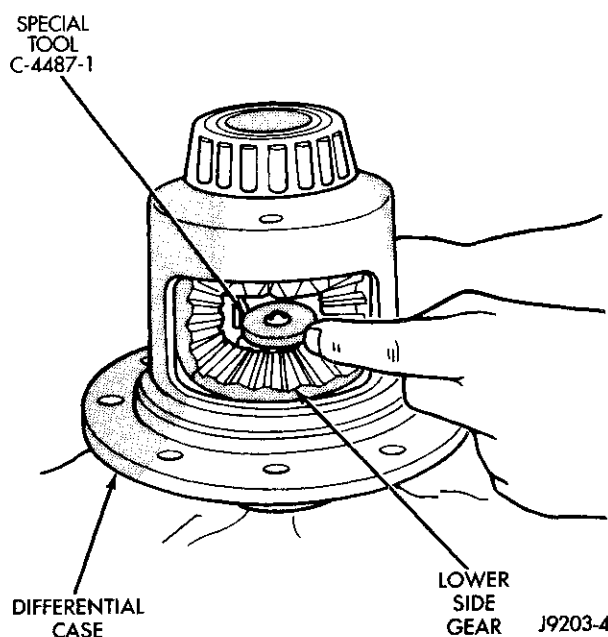


Fig. 51 Step Plate Tool Installation

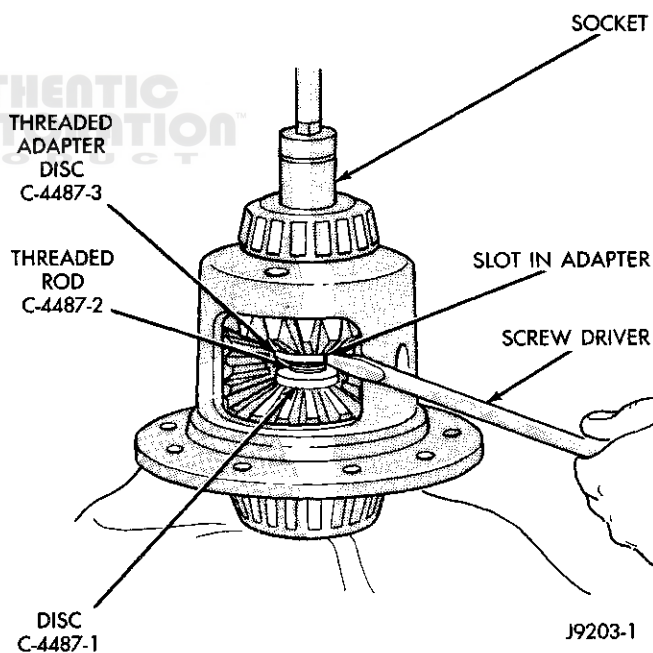


Fig. 52 Threaded Adapter Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(9) Tighten forcing screw tool 122 N·m (90 ft. lbs.) (maximum) to compress Belleville springs in clutch packs (Fig. 53).

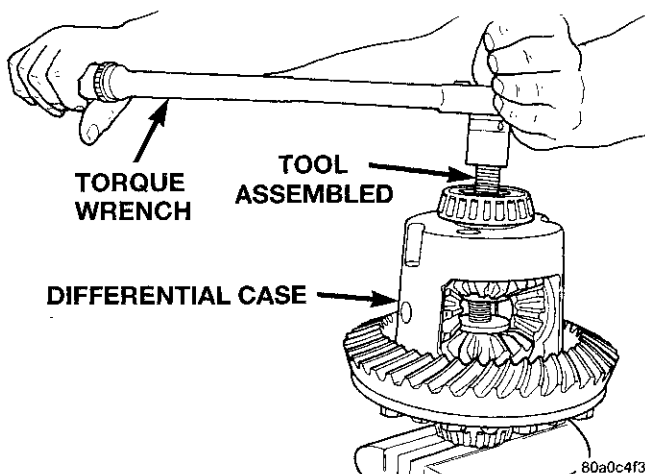


Fig. 53 Tighten Belleville Spring Compressor Tool

(10) Using a 0.020 in. feeler gauge and mallet, remove thrust washers from behind the pinion gears (Fig. 54).

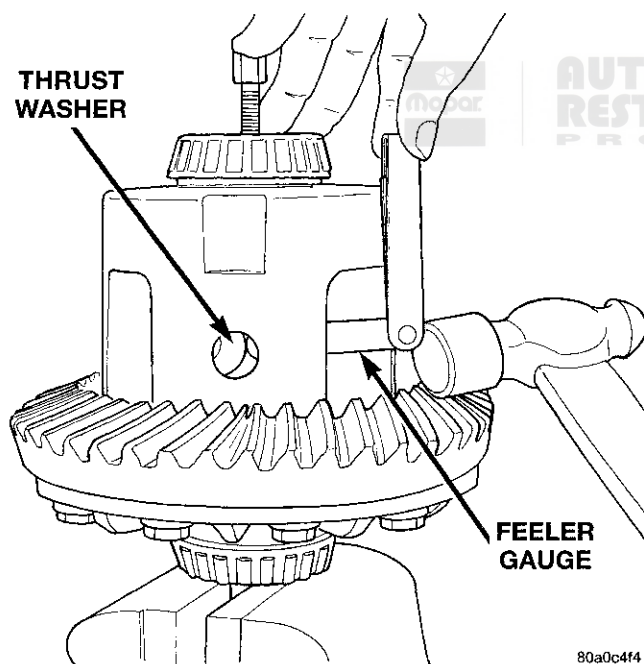


Fig. 54 Remove Pinion Thrust Washer

(11) Loosen the forcing screw tool until the clutch pack tension is relieved and the pinion gears can be slightly rattled between the case and side gears.

(12) Insert Turning Bar C-4487-4 in case. Rotate case with tool until pinion gears can be removed (Fig. 55).

(13) Remove top side gear and clutch pack. Keep plates in correct order during removal (Fig. 56).

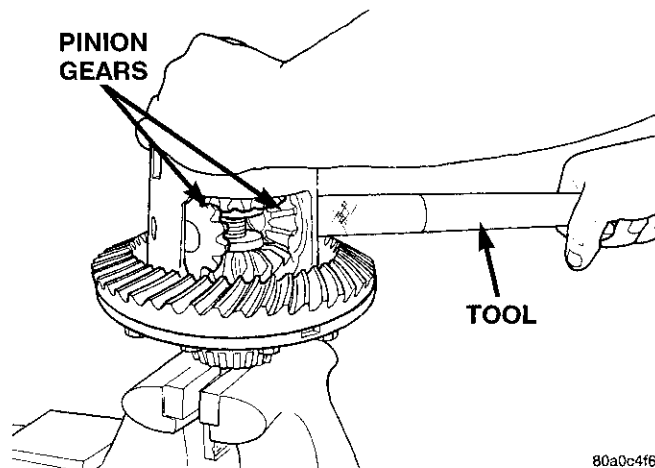


Fig. 55 Pinion Gear Removal

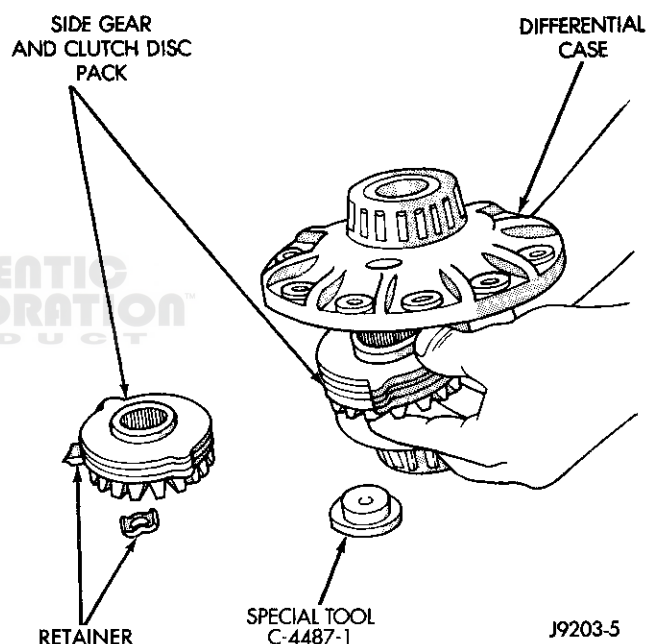


Fig. 56 Side Gear & Clutch Disc Removal

(14) Remove case from fixture. Remove remaining clutch pack.

(15) Remove clutch pack retaining clips. Mark each clutch pack for installation reference.

ASSEMBLY

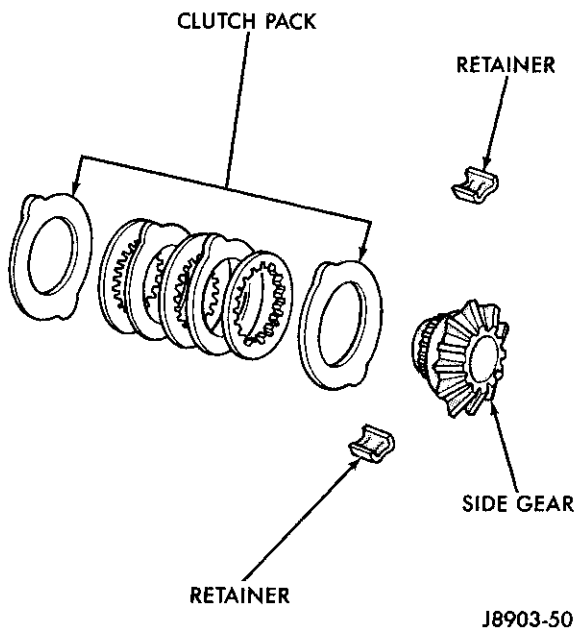
The clutch discs are replaceable as complete sets only. **If one clutch disc pack is damaged, both packs must be replaced.**

Lubricate each component with gear lubricant before assembly.

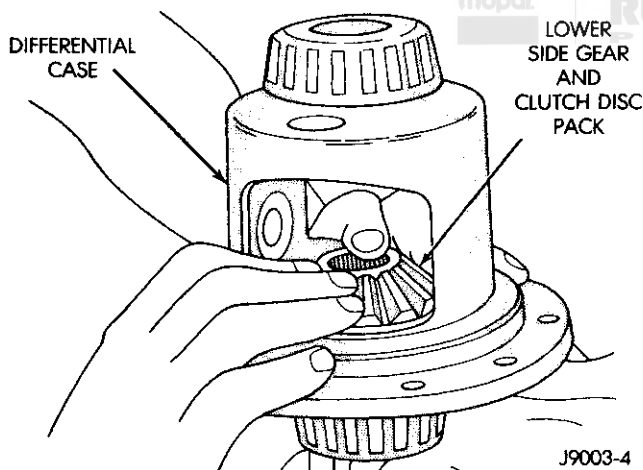
(1) Assemble the clutch discs into packs secure disc packs with retaining clips (Fig. 57).

(2) Position assembled clutch disc packs on the side gear hubs.

(3) Position case on axle fixture.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 57 Clutch Disc Pack**

(4) Install clutch pack and side gear in lower bore (Fig. 58). **Be sure clutch pack retaining clips remain in position and are seated in the case pockets.**

**Fig. 58 Clutch Discs & Lower Side Gear Installation**

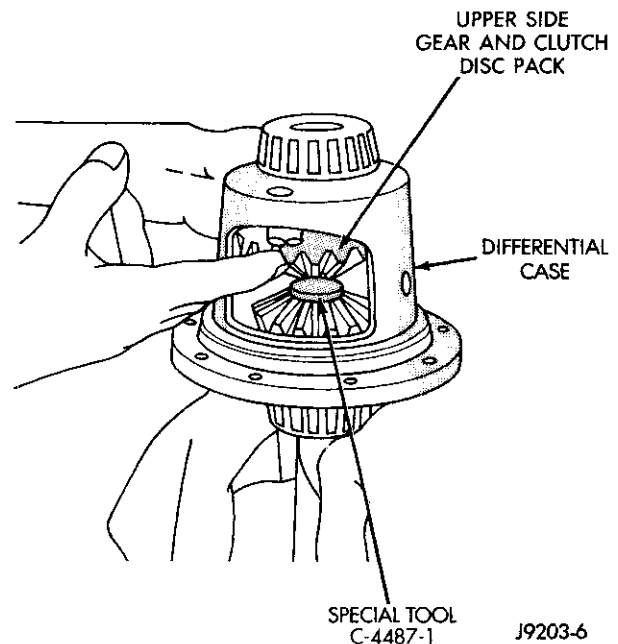
(5) Install lubricated Step Plate C-4487-1 on first clutch pack (Fig. 59).

(6) Install the upper side gear and clutch disc pack (Fig. 59).

(7) Hold assembly in position. Insert Threaded Adapter C-4487-3 into top side gear, insert forcing Screw C-4487-2.

(8) Tighten forcing screw tool to slightly compress clutch discs.

(9) Place pinion gears in position in side gears and verify that mate shaft hole line up.

**Fig. 59 Upper Side Gear & Clutch Disc Pack Installation**

(10) Rotate case with Turning Bar C-4487-4 until mate shaft holes in pinion gears align with holes in case.

(11) Tighten forcing screw to 122 N·m (90 ft. lbs.) to compress the Belleville springs. Lubricate and install thrust washers behind pinion gears and align washers with a small screw driver. Insert mate shaft into each pinion gear to verify alignment.

(12) Remove forcing screw, threaded adapter and step plate. Install pinion gear mate shaft, align holes in shaft and case.

(13) Install the pinion mate shaft lock screw finger tight to hold shaft during installation.

If replacement gears and thrust washers were installed, it is not necessary to measure the gear backlash. Correct fit is due to close machining tolerances during manufacture.

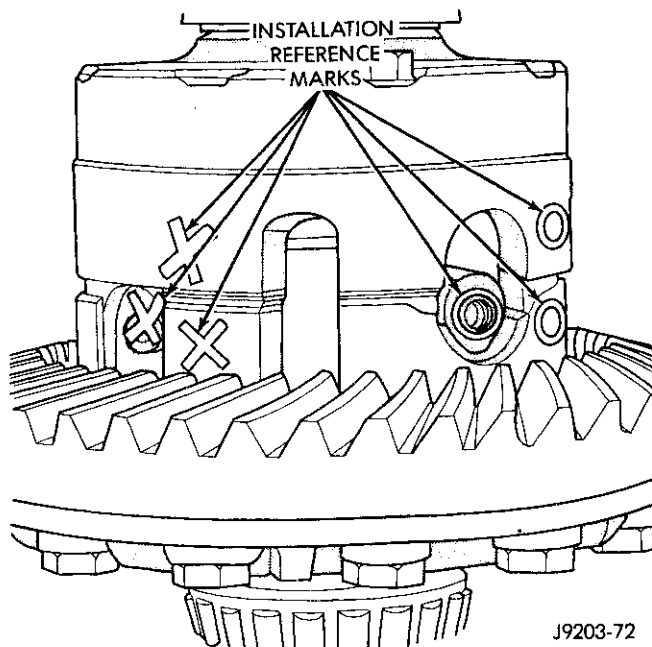
(14) Lubricate all differential components with hypoid gear lubricant.

POWER-LOK—MODEL 70/TRAC-LOK—MODEL 80

The Trac-Lok differential for the Model 80 axle looks like the Power-Lok differential for the Model 70 axle but there are differences.

The Model 80 Trac-Lok differential has a one-piece cross shaft and uses 6 disc and 5 plates for each clutch pack. Only one disc in each clutch pack is dished.

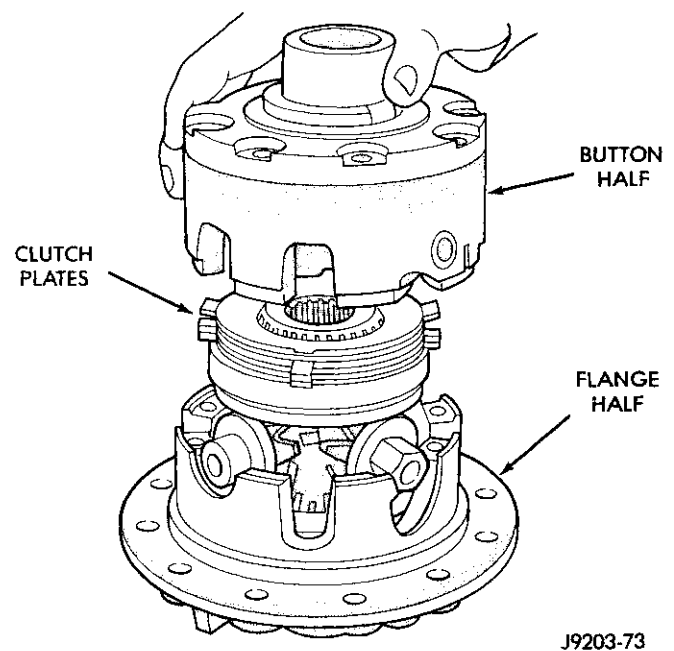
The Model 70 Power-Lok differential has a two-piece cross shaft and uses 2 disc and 3 plates for each clutch pack. All disc are dished in this unit.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 60 Case Marked****DISASSEMBLE**

Pay close attention to the clutch pack arrangement during this procedure. Note the direction of the concave and convex side of the plates and discs.

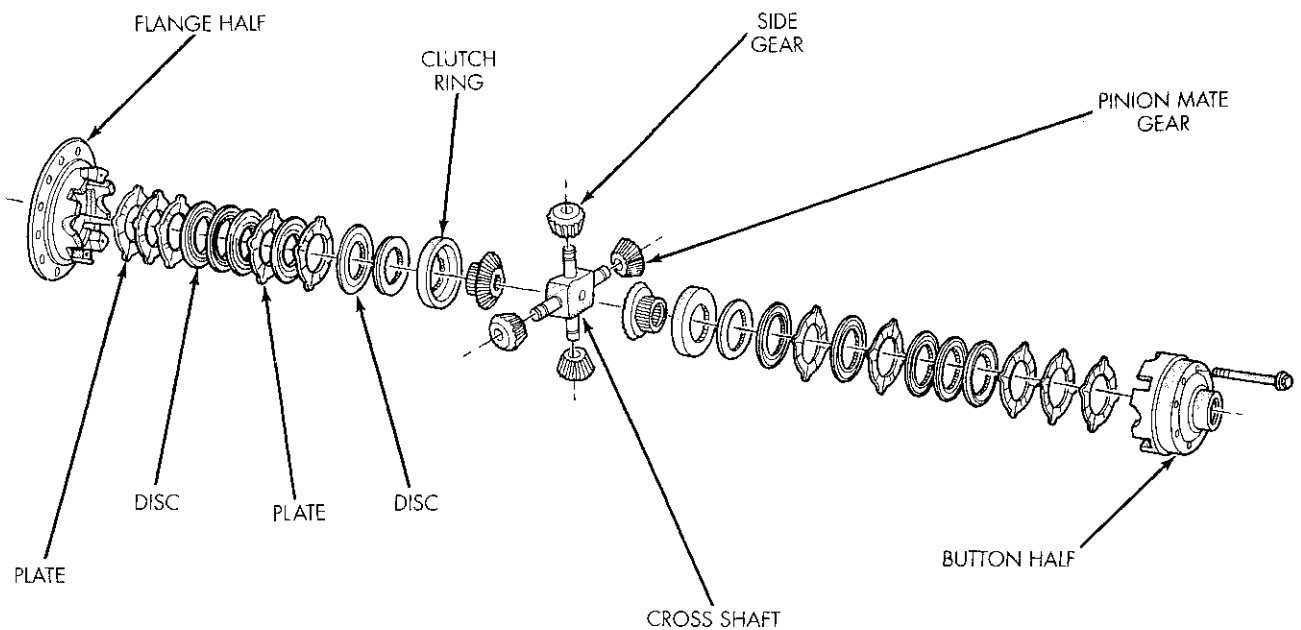
(1) Mark the ring gear half and cover half for installation reference (Fig. 60).

(2) Remove the case attaching bolts and remove the button cover half (Fig. 61).

**Fig. 61 Cover Half Removal**

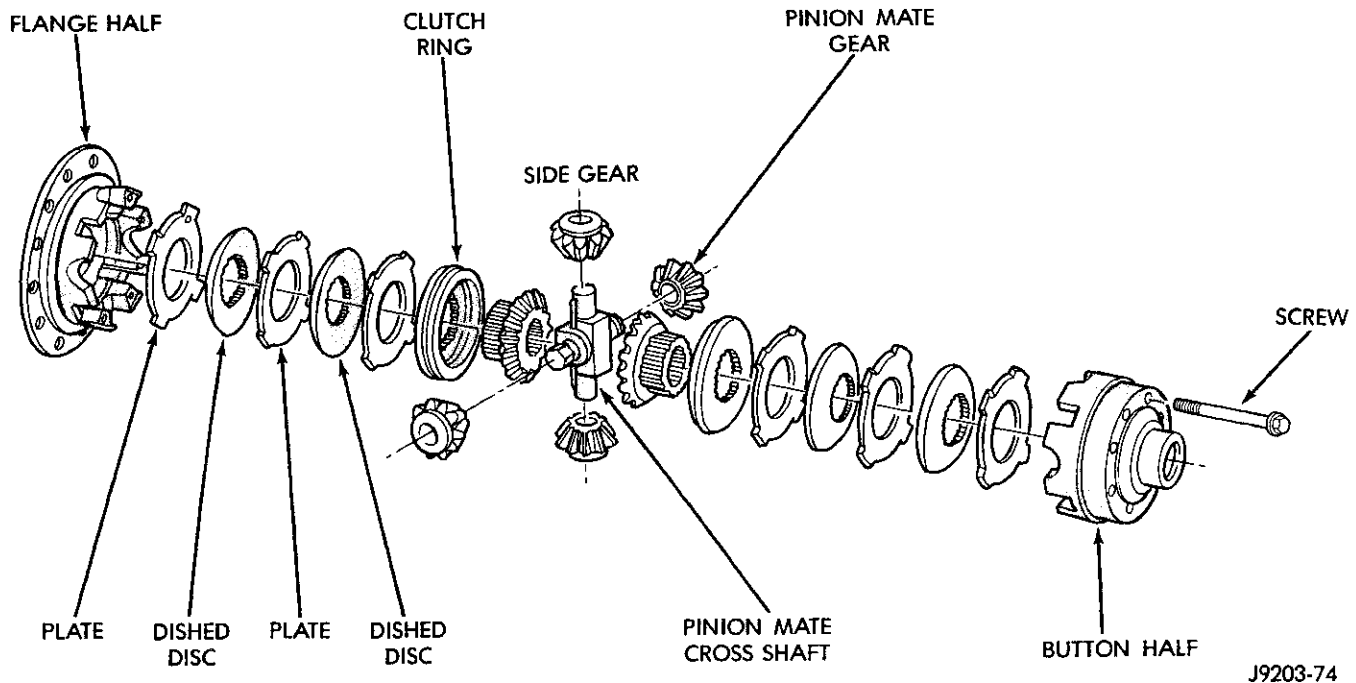
(3) Remove the pinion mate gear, side gear (clutch) ring and clutch pack cross shaft (Fig. 62), (Fig. 63). Keep these parts with the button cover half for correct installation in their original positions.

(4) Remove the same parts listed above from the ring gear flange half of the case. Keep these parts with the flange cover half for correct installation in their original positions.



J9503-8

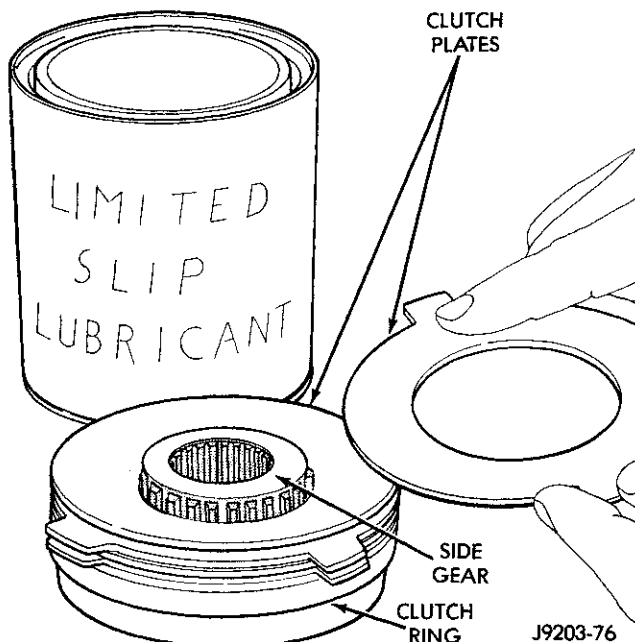
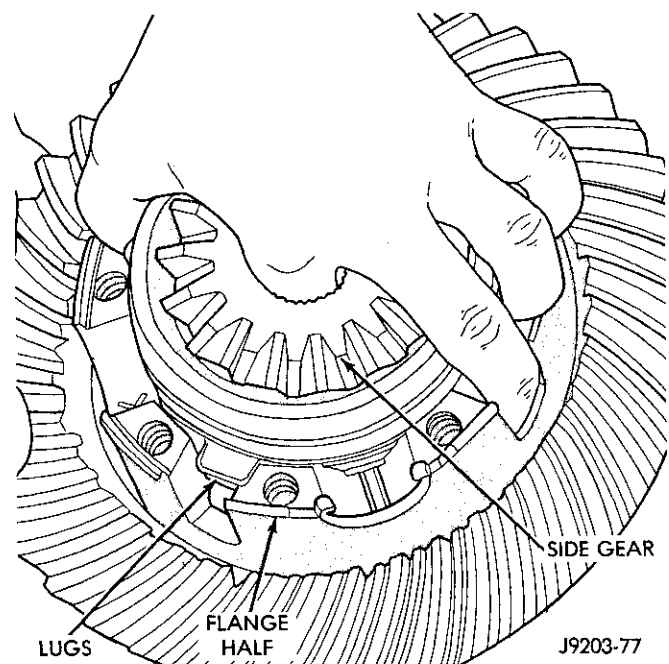
Fig. 62 Trac-Lok Dana 80 Components

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 63 Power-Lok Components****ASSEMBLE**

The clutch discs are replaceable as complete sets only. **If one clutch disc pack is damaged, both packs must be replaced.** Lubricate each component with gear lube before assembly and installation.

(1) Saturate the clutch plates with Hypoid Gear Lubricant or Additive. Assemble clutch packs into the side gear plate in exactly the same position as removed (Fig. 62), (Fig. 63), or (Fig. 64).

(2) Line up the plate ears and install the assembled pack into the flange half (Fig. 65). **Make sure the clutch plate lugs enter the slots in the case.** Also make sure the clutch pack bottoms out on the case.

**Fig. 64 Clutch Pack Power-Lok****Fig. 65 Clutch Pack Installation**

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Install pinion mate shafts and pinion mate gears (Fig. 66). **Make sure shafts are correctly installed according to the alignment marks.**

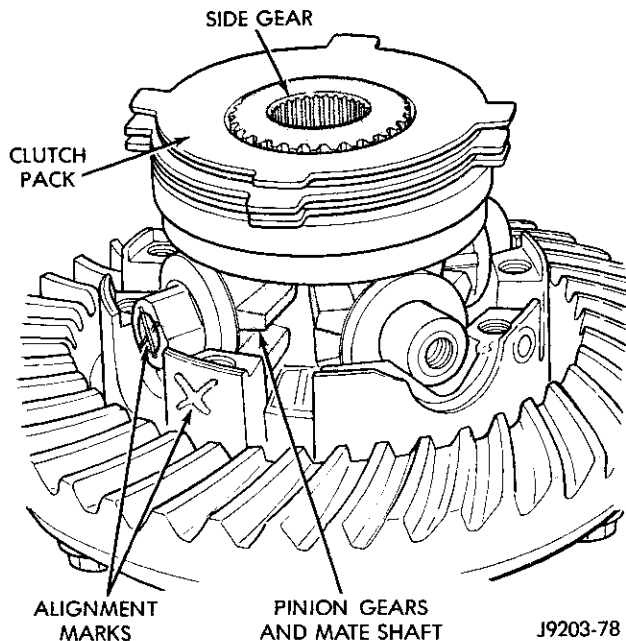


Fig. 66 Clutch Pack Installation

(4) Lubricate and install the other side gear and clutch pack (Fig. 65).

(5) Correctly align and assemble button half to flange half. Install case body screws finger tight.

(6) Tighten body screws alternately and evenly. Tighten screws to 89-94 N·m (65-70 ft. lbs.) torque (Fig. 67).

If bolt heads have 7 radial lines or the number 180 stamped on the head, tighten these bolts to 122-136 N·m (90-100 ft. lbs.) torque.

CLEANING AND INSPECTION

AXLE COMPONENTS

Wash differential components with cleaning solvent and dry with compressed air. **Do not steam clean the differential components.**

Wash bearings with solvent and towel dry, or dry with compressed air. **DO NOT spin bearings with compressed air. Cup and bearing must be replaced as matched sets only.**

Clean axle shaft tubes and oil channels in housing. Inspect for;

- Smooth appearance with no broken/dented surfaces on the bearing rollers or the roller contact surfaces
- Bearing cups must not be distorted or cracked
- Machined surfaces should be smooth and without any raised edges

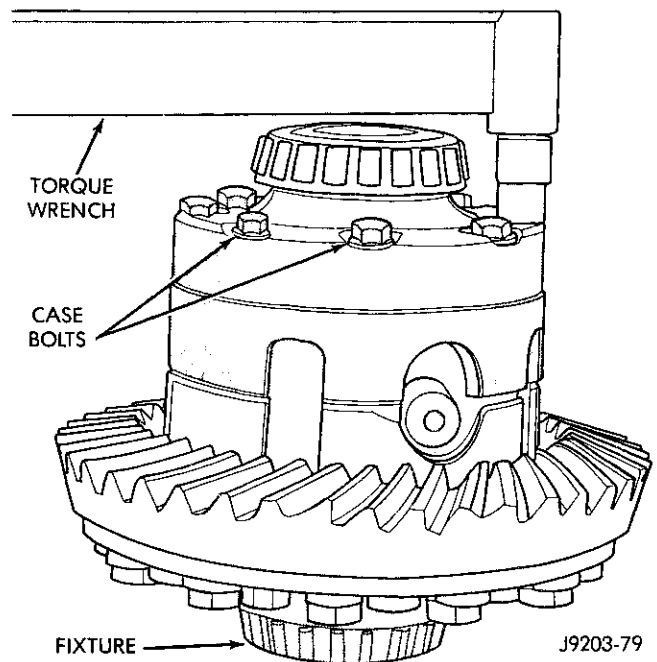


Fig. 67 Case Half Installation

- Raised metal on shoulders of cup bores should be removed with a hand stone
- Wear and damage to pinion gear mate shaft, pinion gears, side gears and thrust washers. Replace as a matched set only.
- Ring and pinion gear for worn and chipped teeth
- Ring gear for damaged bolt threads. Replaced as a matched set only.
- Pinion yoke for cracks, worn splines, pitted areas, and a rough/corroded seal contact surface. Repair or replace as necessary.
- Preload shims for damage and distortion. Install new shims if necessary.

TRAC-LOK AND POWER-LOK

- (1) Clean all components in cleaning solvent. Dry components with compressed air.
- (2) Inspect clutch pack plates for wear, scoring or damage. Replace both clutch packs if any one component in either pack is damaged.
- (3) Inspect side and pinion gears. Replace any gear that is worn, cracked, chipped or damaged.
- (4) Inspect differential case and pinion shaft. Replace if worn or damaged.

PRESOAK PLATES AND DISC

Plates and discs with fiber coating (no grooves or lines) must be presoaked in Friction Modifier before assembly. Soak plates and discs for a minimum of 20 minutes. Add remaining Friction Modifier to differential after assembly.

ADJUSTMENTS

PINION GEAR DEPTH

GENERAL INFORMATION

Gears are supplied as matched sets only. The identifying numbers for the ring and pinion gear are etched into the face of each gear (Fig. 68). A plus (+) number, minus (-) number or zero (0) is etched into the face of the pinion gear. This number is the amount (in thousandths of an inch) the depth varies from the standard depth setting. The standard depth provides the best teeth contact pattern.

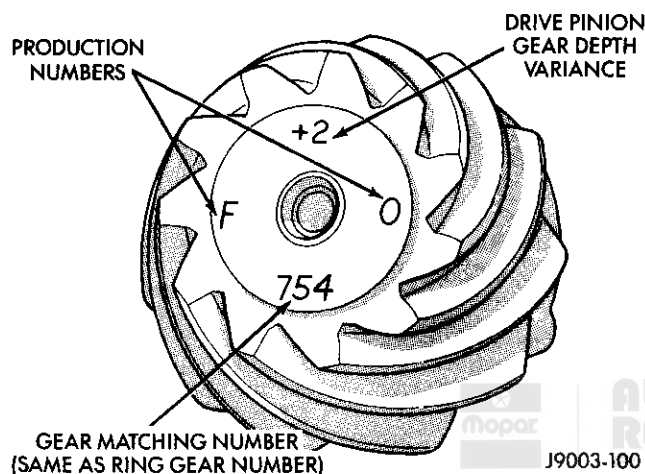


Fig. 68 Pinion Gear ID Numbers

The standard depth is the distance (Fig. 69) from the centerline of the axle shaft/ring gear to the shoulder of the rear pinion bearing.

- Model 60 axle, the standard depth/distance is 127.00 mm (5.000 inches)
- Model 70 axle, the standard depth/distance is 136.525 mm (5.375 inches).
- Model 80 axle, the standard depth/distance is 147.625 mm (5.812 inches).

Compensation for depth variance is achieved by two methods. One method is shims placed between the pinion gear rear bearing cup and housing (Fig. 70). The second method is selective shim between the pinion gear head and bearing cone.

If new gear set is being installed, note the depth variance etched into original and new pinion gear. Add or subtract the thickness of the original depth shims to compensate for the difference in the depth variances. Refer to the Depth Variance charts.

For example, if old pinion is plus (+) 1 and the new pinion is minus (-) 3, intersecting figure is (+) 0.004 inch (0.10mm). Add this amount to the original shim. Or if the old pinion is (-) 3 and the new pinion is (-) 2, intersecting figure is (-) 0.001 inch (0.025mm).

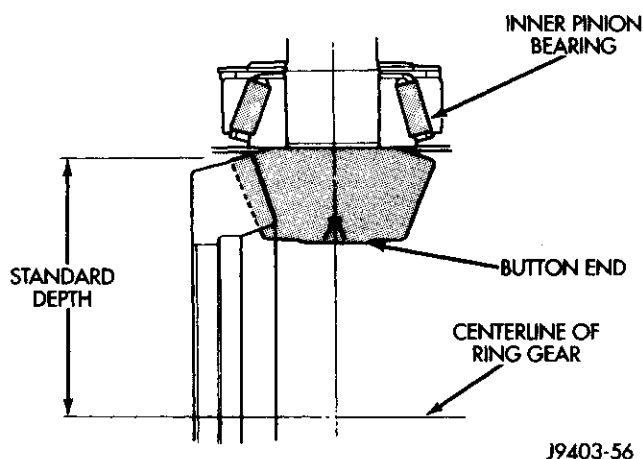


Fig. 69 Pinion Gear Standard Depth/Distance

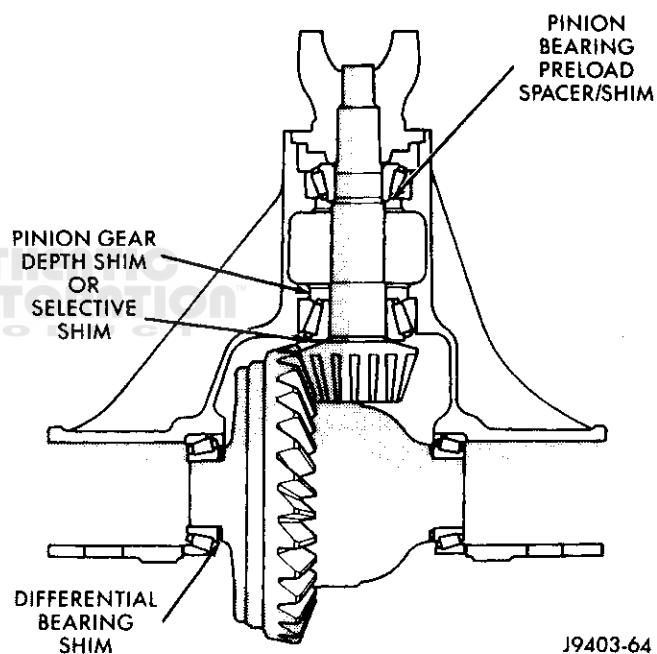


Fig. 70 Shim Locations

Subtract this amount from original shim. Refer to the Pinion Gear Depth Variance Chart.

If equipped, the oil slinger must be measured and the thickness included with the total shim pack thickness.

Depth shim thickness for the new pinion gear must be determined before installing differential case in housing.

PINION DEPTH MEASUREMENT AND ADJUSTMENT

Pinion gear depth measurement is necessary when;

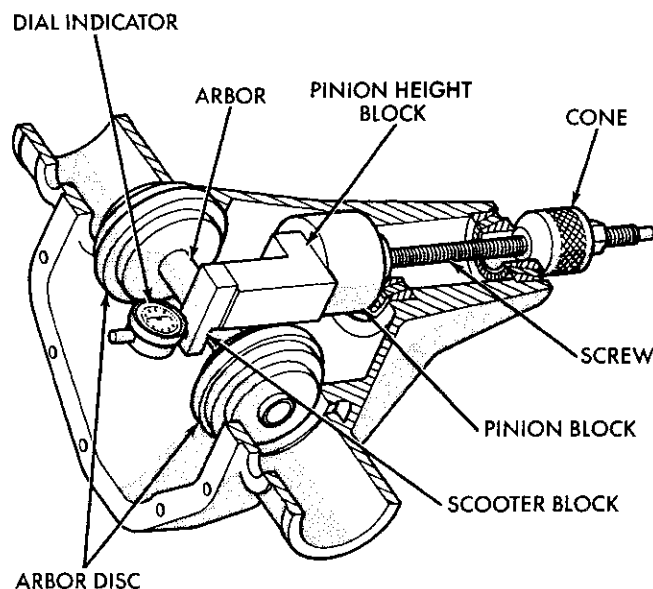
- Axle housing or differential case is replaced
- Pinion select shim pack is unknown
- Ring and pinion gears are replaced

ADJUSTMENTS (Continued)**PINION GEAR DEPTH VARIANCE**

Original Pinion Gear Depth Variance	Replacement Pinion Gear Depth Variance								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

J8902-46

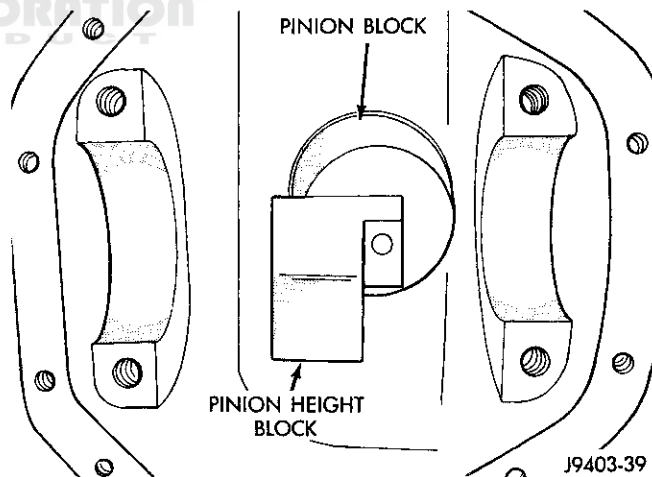
Measurements are taken with pinion cups and pinion bearings installed in housing. Take measurements with Pinion Gauge Set 6730. Use Pinion Block 6734 for Model 44 and 6736 for model 60 axle. Use Dial Indicator C-3339 dial indicator to measure difference in height of the arbor and the pinion block. (Fig. 71).



J9403-45

Fig. 71 Pinion Gear Depth Gauge Tools—Typical

(1) Assemble Pinion Gauge Set, Pinion Block and pinion bearings. Install assembly into differential pinion gear bore and hand tighten cone (Fig. 72).



J9403-39

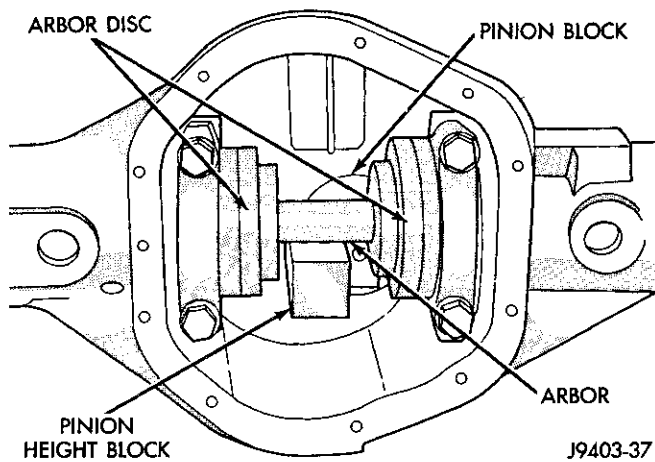
Fig. 72 Pinion Height Block—Typical

(2) Place Arbor Disc 6732 on Arbor D-115-3 and position in the bearing cradles (Fig. 73). Install differential bearing caps on Arbor Discs and tighten caps snug only.

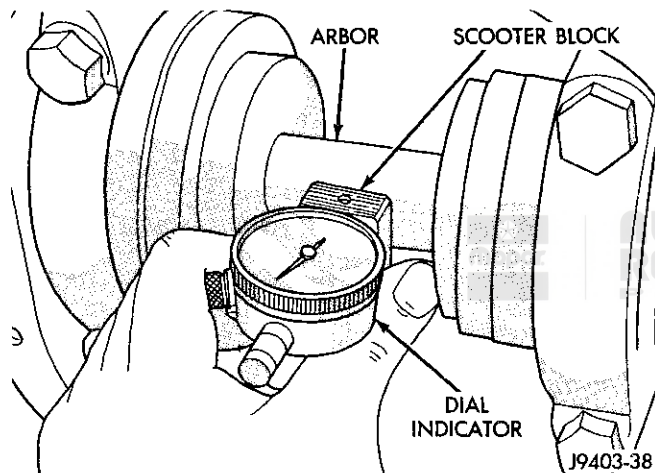
Arbor Discs have different steps to fit other axle sizes. Pick correct size step for axle being serviced.

(3) Firmly place Scooter Block D-115-2 and Dial Indicator on pinion height block tool and zero the dial indicator pointer.

(4) Slide the Scooter Block across the arbor while observing indicator (Fig. 74). Record the longest

ADJUSTMENTS (Continued)**Fig. 73 Gauge Tools In Housing—Typical**

travel distance, whether inward (−) or outward (+), indicated by the pointer.

**Fig. 74 Pinion Gear Depth Measurement—Typical**

The plunger travel distance indicated, plus or minus the variance etched in the gear is the required thickness for the depth shims.

(5) Measure the thickness of each depth shim with a micrometer and combine the shims necessary for total required shim pack thickness. **Include oil slinger or baffle thickness with the total shim pack thickness.**

(6) Remove the measurement tools from the differential housing.

DIFFERENTIAL BEARING PRELOAD AND GEAR LASH

This procedure requires tool kit 6770 to determine the proper differential side gear preload.

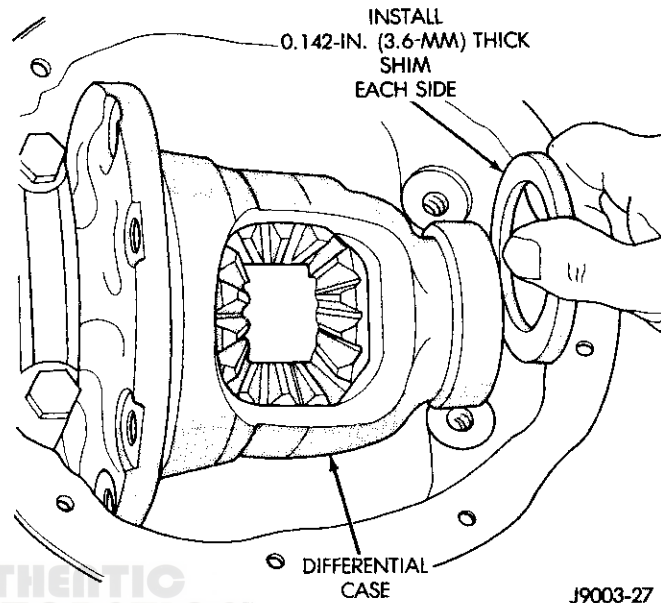
DIFFERENTIAL SHIM PACK MEASUREMENT

NOTE: It is recommended whenever bearings are removed that they be replaced.

(1) Install dummy side bearings D-343 on differential.

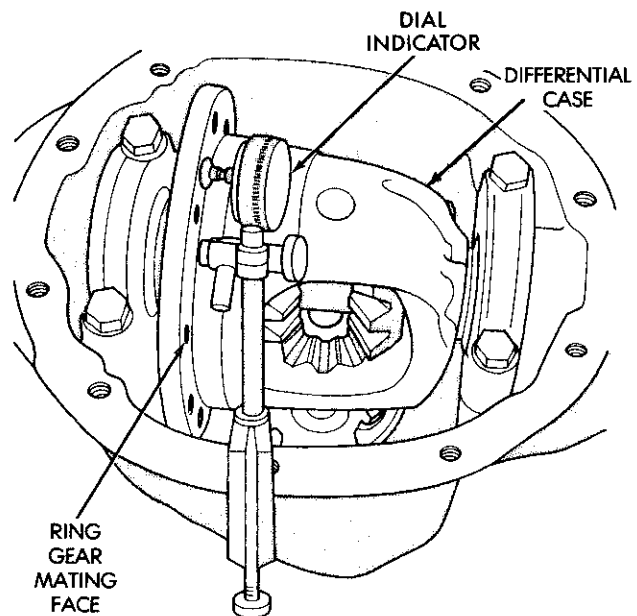
(2) Install the differential case in the axle housing.

(3) Install the outboard shim/spacer (selected thickness) on each side between bearing cup and housing (Fig. 75). Use 0.142 in. (3.6 mm) as a starting point, shim/spacers are available in various thicknesses.

**Fig. 75 Differential Bearing Shim Installation**

(4) Install the marked bearing caps in their correct positions. Install and snug the bolts.

(5) Attach a dial indicator to the housing. Position the indicator plunger so that it contacts the ring gear mating surface (Fig. 76).

**Fig. 76 Shim Measurement**

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ADJUSTMENTS (Continued)

(6) Pry the differential case to one side and zero the dial indicator pointer.

(7) Pry the differential case to the opposite side and record indicator reading. Reading is additional shim thickness needed for zero end play. For example, if reading was 0.008 in. (0.20 mm), an additional 0.004-in. (0.10 mm) thick shim will be needed at each side zero end play.

(8) Install zero end-play shims on each side of case.

The differential bearings must be preloaded to compensate for heat and load during operation.

(9) Add an additional 0.004-in. (0.1 mm) to each outboard shim/spacer for bearing preload.

(10) Remove differential from axle housing.

(11) Remove dummy bearings.

(12) Install new side bearing cones and cups.

(13) Install ring gear.

(14) Install differential and verify gear lash and contact pattern.

(15) Proceed to Final Assembly paragraph in this section.

GEAR BACKLASH AND CONTACT PATTERN ANALYSIS

After installing new side bearings or ring and pinion set adjusting the bearing preload and gear mesh backlash will be necessary.

(1) Rotate assembly several revolutions to seat bearings. Measure backlash at three equally spaced locations around the perimeter of the ring gear with a dial indicator (Fig. 77).

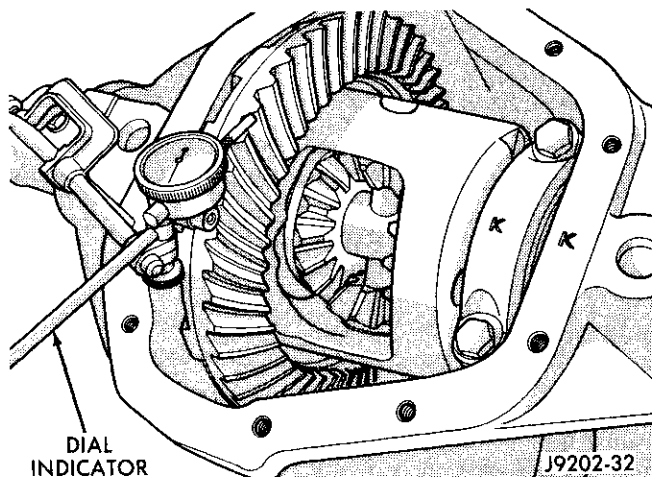


Fig. 77 Ring Gear Backlash Measurement

The ring gear backlash must be within 0.12 – 0.20 mm (0.005 – 0.008 in.). It cannot vary more than 0.05 mm (0.002 in.) between the points checked.

If backlash must be adjusted, spacers are available in various thicknesses. Adjust the backlash accordingly (Fig. 78). **Do not increase the total shim pack thickness, excessive bearing preload and damage will occur.**

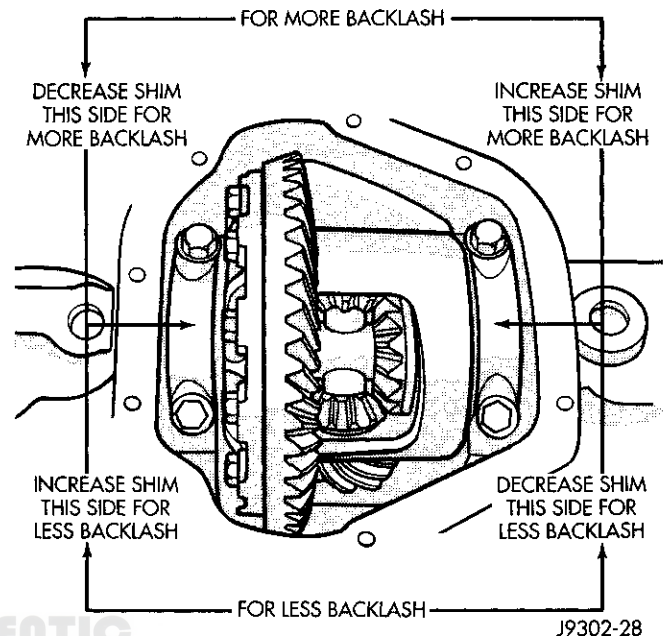


Fig. 78 Backlash Shim Adjustment

The ring gear teeth contact patterns will show if the pinion gear depth shim(s) have the correct thickness. It will also show if the ring gear backlash has been adjusted correctly. The backlash must be maintained within the specified limits until the correct tooth contact patterns are obtained.

(2) Apply a thin coat of hydrated ferric oxide, or equivalent, to the drive and coast side of the ring gear teeth.

(3) Rotate the ring gear one complete revolution in both directions while a load is being applied. Insert a pry bar between the differential housing and the case flange. This will produce distinct contact patterns on both the drive side and coast side of the ring gear teeth.

(4) Note patterns in compound. Refer to (Fig. 79) for interpretation of contact patterns and adjust accordingly.

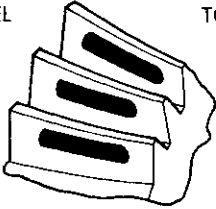
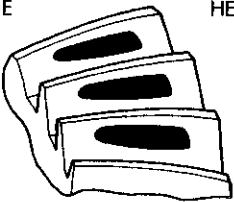
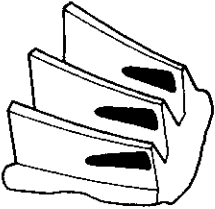
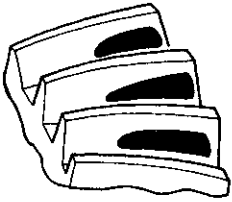
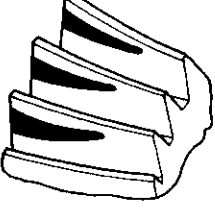

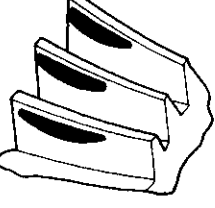
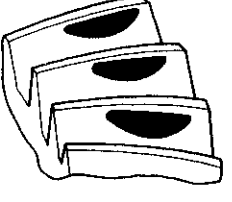
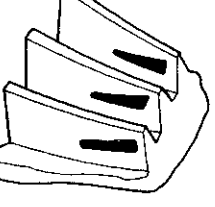
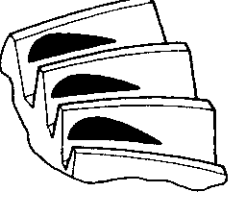
<p>DRIVE SIDE OF RING GEAR TEETH</p> <p>HEEL TOE</p> 	<p>COAST SIDE OF RING GEAR TEETH</p> <p>TOE HEEL</p> 	<p>DESIRABLE CONTACT PATTERN. PATTERN SHOULD BE CENTERED ON THE DRIVE SIDE OF TOOTH. PATTERN SHOULD BE CENTERED ON THE COAST SIDE OF TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD ALWAYS BE SOME CLEARANCE BETWEEN CONTACT PATTERN AND TOP OF THE TOOTH.</p>
		<p>RING GEAR BACKLASH CORRECT. THINNER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>RING GEAR BACKLASH CORRECT. THICKER PINION GEAR DEPTH SHIM REQUIRED.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. DECREASE RING GEAR BACKLASH.</p>
		<p>PINION GEAR DEPTH SHIM CORRECT. INCREASE RING GEAR BACKLASH.</p>

Fig. 79 Gear Tooth Contact Patterns

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SPECIFICATIONS**MODEL 60/70/80 REAR AXLES****MODEL 60 AXLE**

DESCRIPTION	SPEC.
Axle Type	Hypoid
Lubricant.	Thermally Stable SAE 80W-90
Lube Capacity	
4x2.	2.95 L (6.26 pts.)
4x4.	3.43 L (7.25 pts.)
Axle Ratio	3.54 4.09
Ring Gear	
Diameter	247.7 mm (9.75 in.)
Backlash	0.10-0.23 mm (0.004-0.009 in.)
Pinion Std. Depth	127.0 mm (5.000 in.)
Pinion Bearing Preload	
Original Bearing.	1-3 N·m (10-20 in. lbs.)
New Bearing.	2-5 N·m (20-40 in. lbs.)

MODEL 70 AXLE

DESCRIPTION	SPEC.
Axle Type	Hypoid
Lubricant.	Thermally Stable SAE 80W-90
Lube Capacity	
4x2.	3.311 L (7.0 pts.)
4x4.	3.666 L (7.75 pts.)
Axle Ratio	3.54 4.10
Ring Gear	
Diameter	266.7 mm (10.50 in.)
Backlash	0.10-0.23 mm (0.004-0.009 in.)
Pinion Std. Depth	136.525 mm (5.375 in.)
Pinion Bearing Preload	
Original Bearing.	1-3 N·m (10-20 in. lbs.)
New Bearing.	2-5 N·m (20-40 in. lbs.)

MODEL 80 AXLE

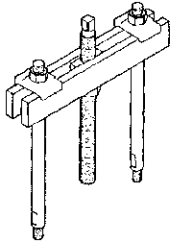
DESCRIPTION	SPEC.
Axle Type	Hypoid
Lubricant.	Thermally Stable SAE 80W-90
Lube Capacity	
4x2.	3.22 L (6.8 pts.)
4x4.	4.79 L (10.1 pts.)
Axle Ratio	3.54 4.10
Ring Gear	
Diameter	279.4 mm (11.00 in.)
Backlash	0.13-0.23 mm (0.005-0.009 in.)
Pinion Std. Depth.	124.625 mm (5.812 in.)
Pinion Bearing Preload	
Original Bearing.	1-3 N·m (10-20 in. lbs.)
New Bearing.	2-5 N·m (20-40 in. lbs.)

TORQUE

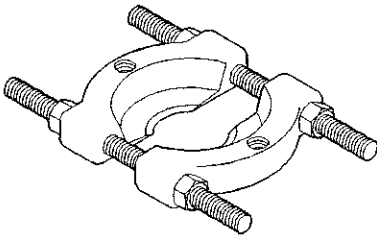
DESCRIPTION	TORQUE
DIFFERENTIAL	
Fill Hole Plug	34 N·m (25 ft. lbs.)
Cover Bolts	47 N·m (35 ft. lbs.)
Bearing Cap Bolts.	108 N·m (80 ft. lbs.)
PINION NUT	
Model 60	292-427 N·m (215-315 ft. lbs.)
Model 70	298-379 N·m (220-280 ft. lbs.)
Model 80	597-678 N·m (440-500 ft. lbs.)
RING GEAR BOLT	
Model 60 & 70	163-190 N·m (120-140 ft. lbs.)
Model 80	272-325 N·m (200-240 ft. lbs.)
Axle to Hub Bolt.	123 N·m (90 ft. lbs.)
POWER-LOK CASE BOLT	
Standard	89-94 N·m (65-70 ft. lbs.)
Heavy Duty	122-136 N·m (90-100 ft. lbs.)
RWAL/ABS Sensor Bolt	24 N·m (18 ft. lbs.)

SPECIAL TOOLS

MODEL 60/70/80 AXLES



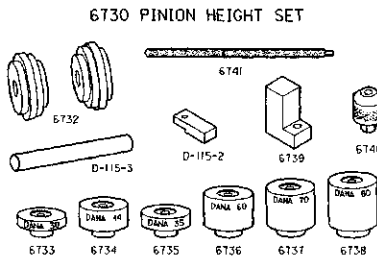
Puller—938



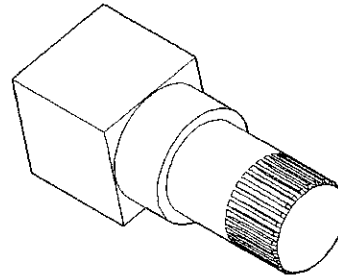
Splitter, Bearing—1130



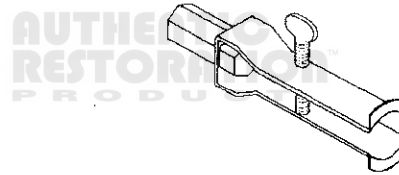
Holder, Yoke—6719



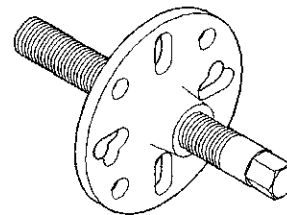
Gauge, Pinion Depth Setting—6730



Fixture Tool—6963

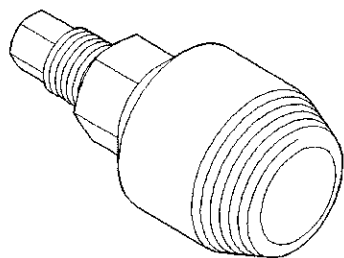


Puller, Bearing & Seal—7794A

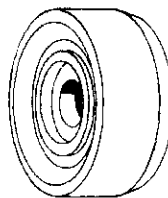


Puller—C-452

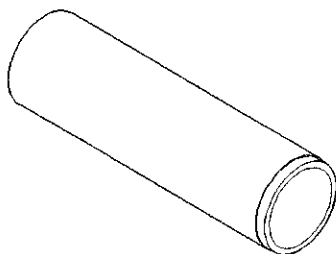
SPECIAL TOOLS (Continued)



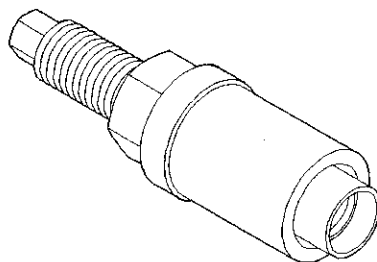
Remover, Pinion Seal—C-748



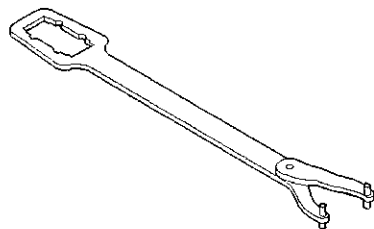
Driver—C-3716A



Installer—C-3095A



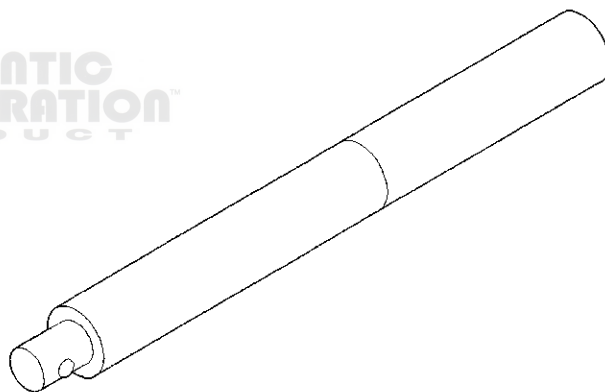
Installer—C-3718



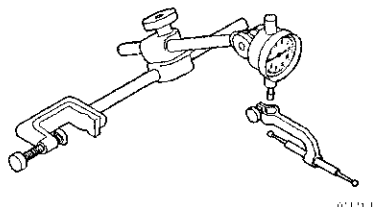
Wrench—C-3281



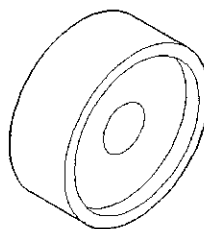
**AUTHENTIC
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Handle—C-4171

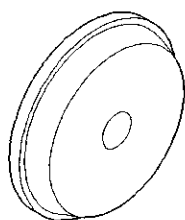


Dial Indicator Set—C-3339

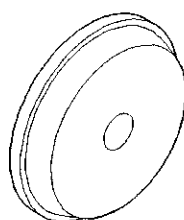


Installer, Differential Bearing—C-4190

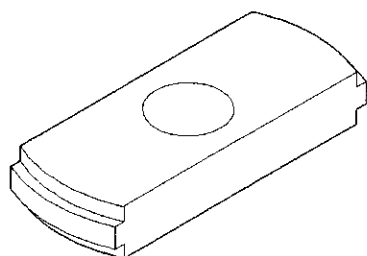
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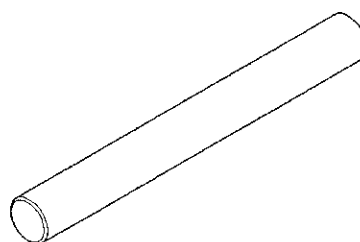
Installer, Rear Bearing Cup—C-4204



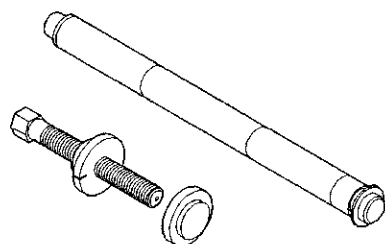
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Remover, Bearing Cup—C-4307



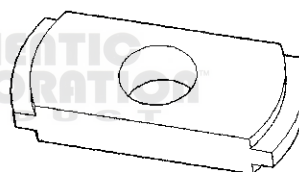
Arbor, Pinion Position—D-115-3



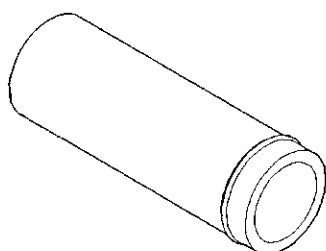
Remover/Installer—C-4487



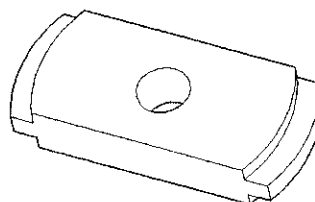
AUTHENTIC
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PRODUCTS



Remover, Pinion Bearing Cup—D-158

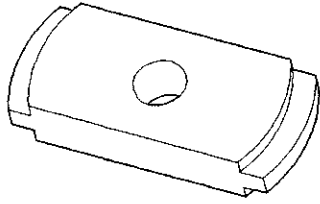


Handle, Drive—C-4735

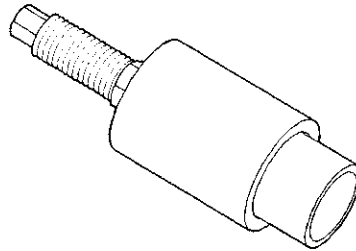


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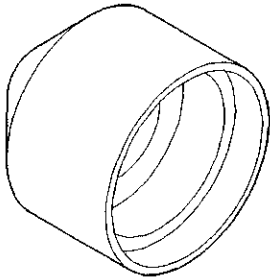
SPECIAL TOOLS (Continued)



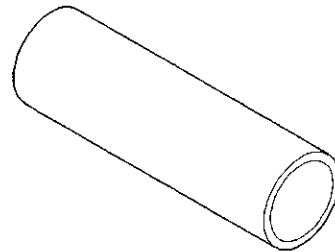
Remover, Pinion Bearing Cup—D-162



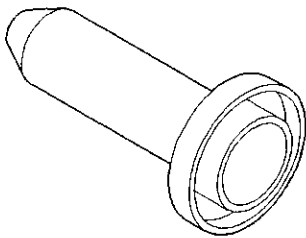
Installer, U-Joint Companion Flange—D-191



Installer, Pinion Oil Seal—D-163



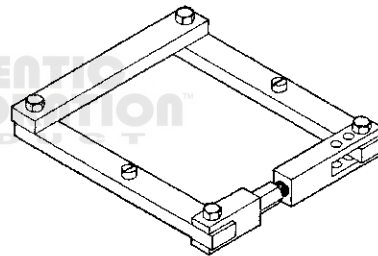
Installer, Inner Pinion bearing cone—D-389



Installer, Pinion Seal—D-187B



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PROJECT



Spreader, Differential—W-129B

BRAKES

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BASE BRAKE SYSTEM

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GENERAL INFORMATION

BRAKE SYSTEM

This vehicle is equipped with front disc brakes and rear drum brakes. The front disc brakes consist of single piston calipers and ventilated rotors. The rear brakes are dual brakeshoe, internal expanding units with cast brake drums. The parking brake mechanism is cable operated and connected to the rear brake trailing shoes. Power brake assist is standard equipment. A vacuum operated power brake booster is used for all applications.

Two antilock brake systems are used on this vehicle. A rear wheel antilock (RWAL) brake system is standard. An all-wheel antilock brake system (ABS) is available as an option. The RWAL and ABS systems are designed to retard wheel lockup while braking. Retarding wheel lockup is accomplished by modulating fluid pressure to the wheel brake units. Both systems are monitored by a microprocessor which controls the operation of the systems.

SERVICE WARNINGS & CAUTIONS

WARNING: DUST AND DIRT ACCUMULATING ON BRAKE PARTS DURING NORMAL USE MAY CONTAIN ASBESTOS FIBERS. BREATHING EXCESSIVE CONCENTRATIONS OF ASBESTOS FIBERS CAN CAUSE SERIOUS BODILY HARM. EXERCISE CARE WHEN SERVICING BRAKE PARTS. DO NOT CLEAN BRAKE PARTS WITH COMPRESSED AIR OR BY DRY BRUSHING. USE A VACUUM CLEANER SPECIFICALLY DESIGNED FOR THE REMOVAL OF ASBESTOS FIBERS FROM BRAKE COMPONENTS. IF A SUITABLE VACUUM CLEANER IS NOT AVAILABLE, CLEANING SHOULD BE DONE WITH A WATER DAMPENED CLOTH. DO NOT SAND, OR GRIND BRAKE LINING UNLESS EQUIPMENT USED IS DESIGNED TO CONTAIN THE DUST RESIDUE. DISPOSE OF ALL RESIDUE CONTAINING ASBESTOS FIBERS IN SEALED BAGS OR CONTAINERS TO MINIMIZE EXPOSURE TO YOURSELF AND OTHERS. FOLLOW PRACTICES PRESCRIBED BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION AND THE ENVIRONMENTAL PROTECTION AGENCY FOR THE HANDLING, PROCESSING, AND DISPOSITION OF DUST OR DEBRIS THAT MAY CONTAIN ASBESTOS FIBERS.

CAUTION: Never use gasoline, kerosene, alcohol, motor oil, transmission fluid, or any fluid containing mineral oil to clean the system components. These fluids damage rubber cups and seals. Use only fresh brake fluid or Mopar brake cleaner to clean or flush brake system components. These are the only cleaning materials recommended. If system contam-

ination is suspected, check the fluid for dirt, discoloration, or separation into distinct layers. Drain and flush the system with new brake fluid if contamination is suspected.

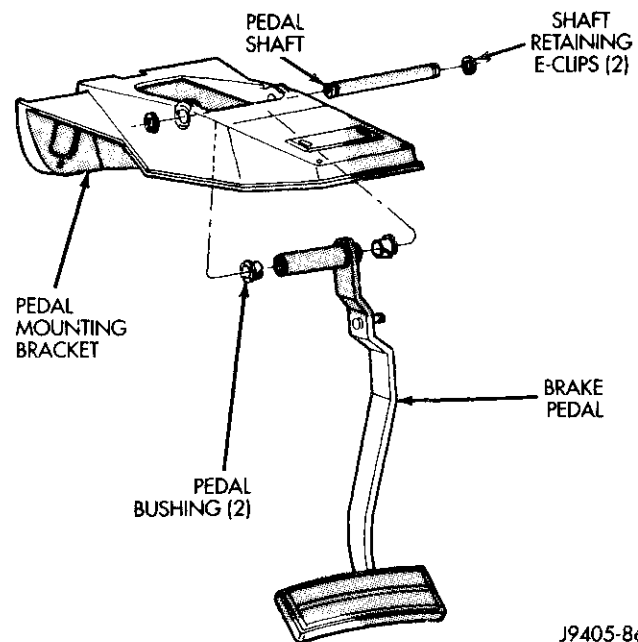
CAUTION: Use Mopar brake fluid, or an equivalent quality fluid meeting SAE/DOT standards J1703 and DOT 3. Brake fluid must be clean and free of contaminants. Use fresh fluid from sealed containers only to ensure proper antilock component operation.

Use Mopar multi-mileage or high temperature grease to lubricate caliper slide surfaces, drum brake pivot pins, and shoe contact points on the backing plates. Use multi-mileage grease or GE 661 or Dow 111 silicone grease on caliper bushings and slide pins to ensure proper operation.

DESCRIPTION AND OPERATION

Brake Pedal

The brake booster is operated by a suspended type brake pedal (Fig. 1). The pedal pivots on a shaft located in a mounting bracket attached to the dash panel. The pedal shaft is supported by bushings in the pedal and mounting bracket.



J9405-86

Fig. 1 Brake Pedal

STOP LAMP SWITCH

The plunger type stop lamp switch is mounted on a bracket attached to the brake pedal support. The switch can be adjusted when necessary.

DESCRIPTION AND OPERATION (Continued)

RED BRAKE WARNING LAMP

A red warning lamp is used for the service brake portion of the hydraulic system. The lamp is located in the instrument panel.

The red warning light alerts the driver if a pressure differential exists between the front and rear hydraulic systems. The light also alerts the driver when the parking brakes are applied.

Power Brake Booster

All BR models are equipped with a tandem (dual) diaphragm power brake booster (Fig. 2). Two versions are used. A standard duty is used in all 1/2 ton models and a higher output version is used in 3/4 and 1 ton models. The standard and high output boosters are identified by code letters on the forward face of the booster (Fig. 2).

Booster I.D. code letters are as follows:

- 1/2 ton booster code: ZK
- 3/4 and 1 ton booster code: ZL

The only serviceable power brake booster components are the vacuum hose and check valve. The booster itself is not a repairable component. The booster must be replaced as an assembly whenever diagnosis indicates a fault has occurred.

POWER BRAKE BOOSTER OPERATION

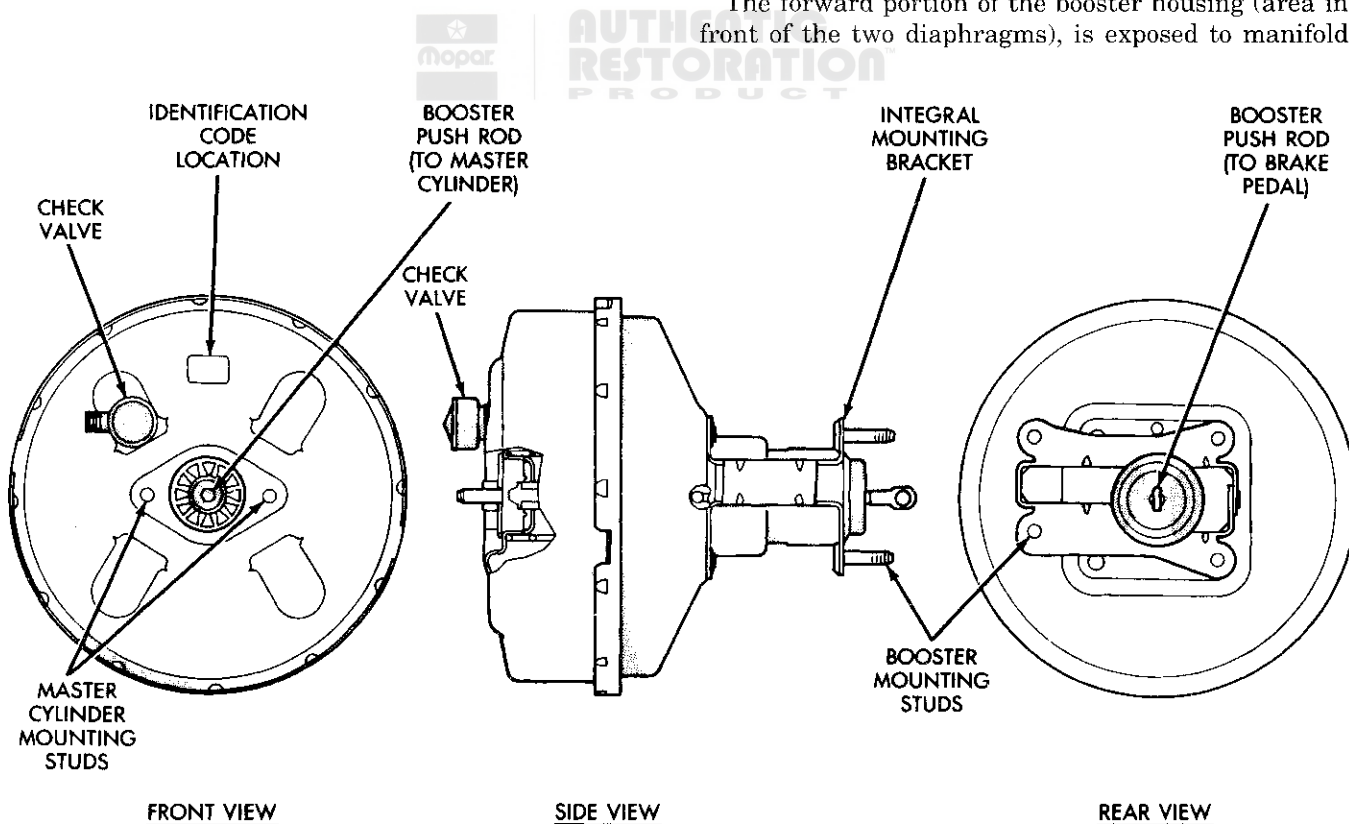
The booster assembly consists of a housing divided into separate chambers by two internal diaphragms. The outer edge of each diaphragm is attached to the booster housing. The diaphragms are in turn, connected to the booster push rod.

Two push rods are used to operate the booster. One push rod connects the booster to the brake pedal. The second push rod (at the forward end of the housing), strokes the master cylinder pistons. The rear push rod is connected to the two diaphragms in the booster housing.

The atmospheric inlet valve is opened and closed by the push rod connected to the brake pedal. The booster vacuum supply is through a hose attached to a fitting on the intake manifold. The hose is connected to a vacuum check valve in the booster housing. The check valve is a one-way device that prevents vacuum leak back.

Power assist is generated by utilizing the pressure differential between normal atmospheric pressure and a vacuum. The vacuum needed for booster operation is taken directly from the engine intake manifold. The entry point for atmospheric pressure is through an inlet valve at the rear of the housing.

The forward portion of the booster housing (area in front of the two diaphragms), is exposed to manifold



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Fig. 2 Power Brake Booster

DESCRIPTION AND OPERATION (Continued)

vacuum. The rear portion (area behind the diaphragms), is exposed to normal atmospheric pressure of 101.3 kilopascals (14.7 psi).

Pressing the brake pedal causes the rear push rod to open the inlet valve. This exposes the area behind the diaphragms to atmospheric pressure. The resulting force applied to the diaphragms is what provides the extra boost in apply pressure for power assist.

POWER BRAKE VACUUM PUMP (DIESEL MODELS)

The power brake vacuum pump and the power steering pump are combined into a single assembly on diesel engine models (Fig. 3). Both pumps are operated by a drive gear attached to the vacuum pump shaft. The shaft gear is driven by the camshaft gear.

The vacuum pump is a constant displacement, vane-type pump. Vacuum is generated by four vanes mounted in the pump rotor. The rotor is located in the pump housing and is pressed onto the pump shaft.

The vacuum and steering pumps are operated by a single drive gear pressed onto the vacuum pump shaft. The drive gear is operated by the engine camshaft gear.

The vacuum and power steering pump shafts are connected by a coupling. Each pump shaft has an adapter with drive lugs that engage in the coupling.

The vacuum pump rotating components are lubricated by engine oil. Lubricating oil is supplied to the pump through an oil line at the underside of the pump housing.

The complete assembly must be removed in order to service either pump. However, the power steering pump can be removed and serviced separately when necessary.

The vacuum pump is not a serviceable component. If diagnosis indicates a pump malfunction, the pump must be replaced as an assembly. Do not disassemble or attempt to repair the pump.

The combined vacuum and steering pump assembly must be removed for access to either pump. However, the vacuum pump can be removed without having to disassemble the power steering pump.

If the power steering pump requires service, simply remove the assembly and separate the two pumps. Refer to the pump removal and installation procedures in this section.

LOW VACUUM WARNING SWITCH

A vacuum switch is used to monitor output of the vacuum pump. The switch is in circuit with the red brake warning light.

A vacuum hose connects the switch to the power brake booster. A wire harness connects the switch to the brake warning light.

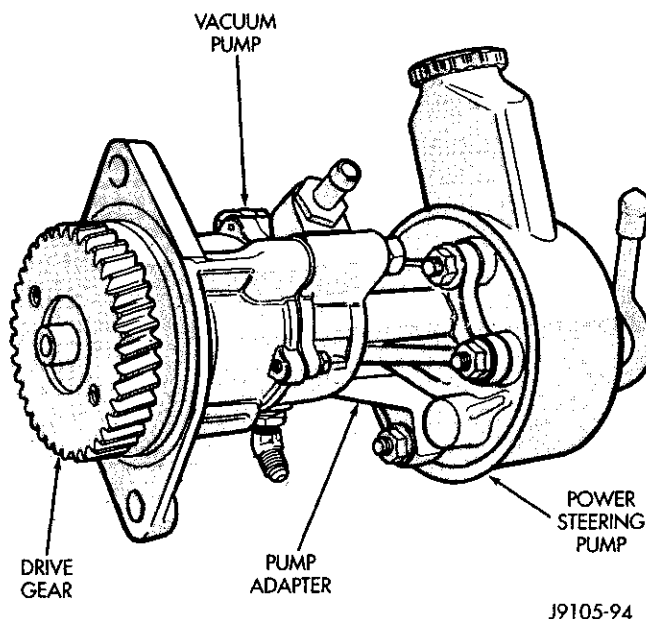


Fig. 3 Diesel Vacuum & Power Steering Pump Assembly

The switch is mounted on the driver side inner fender panel just below the hood hinge (Fig. 4). The switch is located just under the front antilock valve on ABS models.

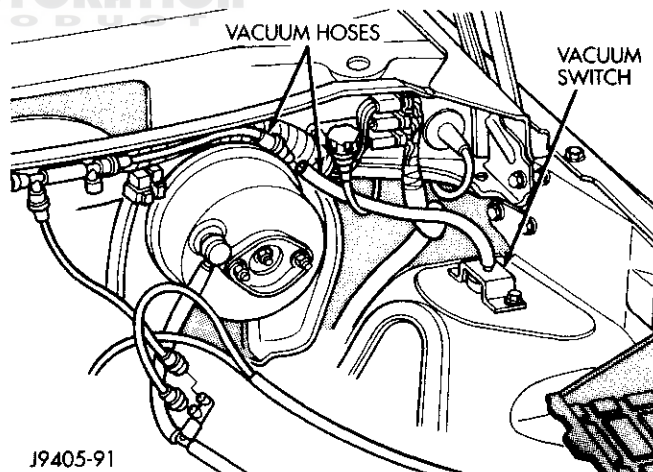


Fig. 4 Diesel Vacuum Switch Location (Without ABS)

VACUUM PUMP OPERATION

Vacuum pump output is transmitted to the power brake booster through a supply hose. The hose is connected to an outlet port on the pump housing and to the check valve in the power brake booster.

Pump output ranges from a minimum of 8.5 to 25 inches vacuum.

The pump rotor and vanes are rotated by the pump drive gear. The drive gear is operated by the camshaft gear.

DESCRIPTION AND OPERATION (Continued)

Booster vacuum level is monitored by a warning switch. The switch consists of a vacuum chamber that measures vacuum level and a sensor in circuit with the red brake warning light.

The vacuum chamber is connected to the booster check valve by a vacuum supply hose. A wire harness connects the switch sensor to the brake warning light. If booster vacuum falls below 8.5 inches for 8-10 seconds or more, the switch sensor completes the circuit to the warning light causing it to illuminate.

MASTER CYLINDER

BR models are equipped with a two-section master cylinder assembly. Major components are the aluminum cylinder body and a removable plastic reservoir (Fig. 5).

The primary and secondary pistons are located in the cylinder body. Grommets are used to secure and seal the reservoir in the cylinder body. The reservoir cover is equipped with diaphragm seal and is a snap fit on the reservoir.

The cylinder body is equipped with a quick take-up valve located in the primary piston inlet port (Fig. 5). The valve provides an extra volume of low pressure fluid during initial brake apply. Extra fluid volume provides faster take-up of normal clearances in the calipers and wheel cylinders.

The cylinder body, piston assemblies, reservoir, grommets, seal and cover are all serviceable parts. The take-up valve is the only non-serviceable component. The valve is available only as part of a complete cylinder body assembly.

APPLICATION

Three master cylinders are used in BR models. The differences between them concern cylinder bore size and fluid reservoir capacity.

- The master cylinder in 1500 models has a 28.6 mm (1.125 in.) bore.
- The master cylinder in 2500 and 3500 models has a 31.8 mm (1.252 in.) bore.

Although the master cylinders used in 2500 and 3500 models have the same bore size, they have different piston stroke lengths and fluid reservoir capacities.

NOTE: Master cylinders and reservoirs must not be interchanged. This will cause unsatisfactory operation and improper brake balance.

IDENTIFICATION CODES

The master cylinder and reservoir are coded for identification. Code letters are provided on the cylinder body and reservoir for proper component matching.

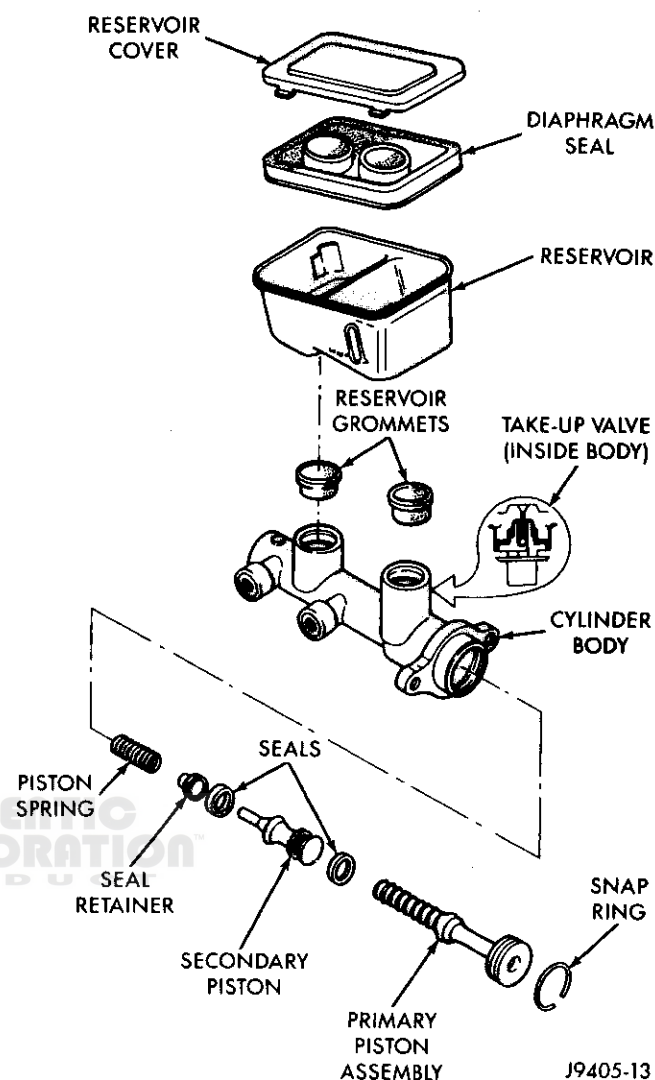


Fig. 5 Master Cylinder

The cylinder body code letters are etched into the front end of the cylinder. The reservoir code letters are on an adhesive backed tag attached to the front face of the reservoir (Fig. 6).

Code letters are as follows:

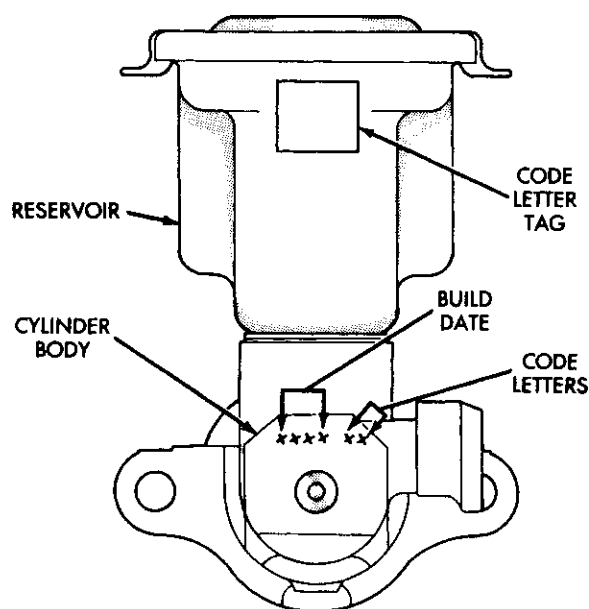
- 1/2 ton (Model 1500) code: NK
- 3/4 ton (Model 2500) code: NL
- 1 ton (Model 3500) code: NP

COMBINATION VALVE

Pressure Differential Switch

The pressure differential switch is connected to the brake warning lamp. The switch is triggered by movement of the switch valve. The purpose of the switch is to monitor fluid pressure in the separate front/rear brake hydraulic circuits.

A decrease or loss of fluid pressure in either hydraulic circuit will cause the switch valve to shut-

DESCRIPTION AND OPERATION (Continued)

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Fig. 6 Identification Code Locations

tle forward or rearward in response to the pressure differential. Movement of the switch valve will push the switch plunger upward. This closes the switch internal contacts completing the electrical circuit to the warning lamp. The switch valve may remain in an actuated position until repair restores system pressures to normal levels.

Metering Valve

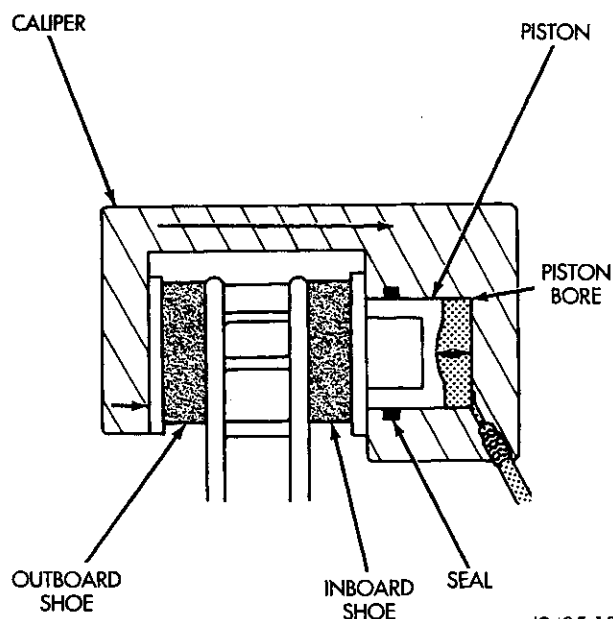
The metering valve is used to balance brake action between the front disc and rear drum brakes. The valve meters (holds-off) full apply pressure to the front disc brakes until the rear brakeshoes are in full contact with the drums. The valve is designed to maintain front brake fluid pressure at 21-207 kPa (3-30 psi) until the hold-off limit of 807 kPa (117 psi) is reached. At this point, the metering valve opens completely permitting full fluid apply pressure to the front disc brakes.

FRONT DISC BRAKES

The calipers are a single piston type. The calipers are free to slide laterally, this allows continuous compensation for lining wear.

When the brake are applied fluid pressure is exerted against the caliper piston. The fluid pressure is exerted equally and in all directions. This means pressure exerted against the caliper piston and within the caliper bore will be equal (Fig. 7).

Fluid pressure applied to the piston is transmitted directly to the inboard brakeshoe. This forces the shoe lining against the inner surface of the disc brake rotor. At the same time, fluid pressure within



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Fig. 7 Brake Caliper Operation

the piston bore forces the caliper to slide inward on the mounting bolts. This action brings the outboard brakeshoe lining into contact with the outer surface of the disc brake rotor.

In summary, fluid pressure acting simultaneously on both piston and caliper, produces a strong clamping action. When sufficient force is applied, friction will stop the rotors from turning and bring the vehicle to a stop.

Application and release of the brake pedal generates only a very slight movement of the caliper and piston. Upon release of the pedal, the caliper and piston return to a rest position. The brakeshoes do not retract an appreciable distance from the rotor. In fact, clearance is usually at, or close to zero. The reasons for this are to keep road debris from getting between the rotor and lining and in wiping the rotor surface clear each revolution.

The caliper piston seal controls the amount of piston extension needed to compensate for normal lining wear.

During brake application, the seal is deflected outward by fluid pressure and piston movement (Fig. 8). When the brakes (and fluid pressure) are released, the seal relaxes and retracts the piston.

The amount of piston retraction is determined by brakelining wear. Generally the amount is just enough to maintain contact between the piston and inboard brakeshoe.

DESCRIPTION AND OPERATION (Continued)

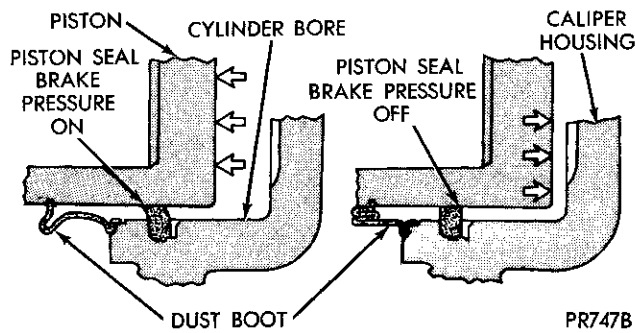


Fig. 8 Lining Wear Compensation By Piston Seal

DRUM BRAKES

All BR models are equipped with rear drum brake assemblies. They are two-shoe, duo-servo units with an automatic adjuster mechanism.

Three different size drum brake assemblies are used:

- 1/2 ton (1500) models: 11 x 2 in.
- 3/4 ton (2500) models: 13 x 2.5 in.
- 1 ton (3500) models: 13 x 3.5 in.

Two different wheel cylinders are used. The difference being cylinder bore size. The cylinders used on 1/2 and 3/4 ton models have a bore diameter of 23.8 mm (0.937 or 15/16 in.). The cylinders used on 1 ton models have a bore diameter of 27 mm (1.06 or 1-1/16 in.).

The drum brakes are a semi-floating, self-energizing, servo action design. The brakeshoes are not fixed on the support plate. This type of brake allows the shoes to pivot and move vertically to a certain extent.

In operation, fluid apply pressure causes the wheel cylinder pistons to move outward. This movement is transferred directly to the brakeshoes by the cylinder connecting links. The resulting brakeshoe expansion brings the lining material into contact with the rotating brake drum.

Two forces affect the brakeshoes once they contact the drum. The first force being hydraulic pressure exerted through the wheel cylinder pistons. And the second force is the friction generated turning torque of the rotating drum.

The drum forces both brakeshoes to move in the same direction of rotation. Servo action begins with the primary brakeshoe which begins to wedge (or wrap) itself against the rotating drum surface. This force is transmitted equally to the secondary brakeshoe through the adjuster screw and anchor pin. The net result is that each shoe helps the other exert extra force against the drum. It is servo action that creates the wedging (or wrap) effect which produces increased force on the drum braking surface.

All drum brake assemblies are equipped with a self adjusting mechanism. The components forming the mechanism consist of the: adjuster screw, adjuster

lever, actuating lever (11 inch brake), lever return spring and the adjuster lever spring. The adjuster lever on the 13 inch brake, is also equipped with a lever and tension spring.

The adjuster mechanism performs two important functions. First, is in maintaining proper brakeshoe operating clearance. And second, is to maintain brake pedal height. The mechanism does so, by adjusting the shoes in small increments to compensate for lining wear. The adjustment process is continuous throughout the useful life of the brakelining.

The adjuster components are all connected to the secondary brakeshoes. Actual adjustment only occurs during reverse brake stops. Secondary brakeshoe movement (during reverse stops), is what activates the adjuster components.

In operation, secondary shoe movement causes the adjuster lever spring to exert pull on the lever. This pivots the lever away from the adjuster screw teeth. When the stop is completed and the brakes released, the adjuster lever pivots back to a normal position. It is during this return movement of the lever when adjustment occurs. At this point, the lever comes back into contact with the adjuster screw teeth as it moves upward. The lever will then rotate the adjuster screw one or two teeth as needed for adjustment.

NOTE: The adjustment process requires a complete stop to actually occur. Rolling stops will NOT activate the adjuster components. In addition, the adjuster screws are left and right hand parts and must NOT be interchanged.

PARKING BRAKES

The parking brakes are operated by a system of cables and levers attached to the rear brake secondary shoes.

The rear drum brakeshoes serve as the parking brakes. The shoes make contact with the brake drum surface by a cable and lever mechanism attached to the secondary brakeshoe. A strut installed between the primary and secondary shoes maintains shoe position when the parking brakes are applied.

The front parking brake cable is connected to the parking brake pedal and to an intermediate cable. The intermediate cable connects the front cable to the rear cables.

The parking brake pedal assembly is mounted on the driver side cowl panel. The front cable is directly attached to the assembly. The pedal assembly contains a spring loaded, ratchet-type mechanism to hold the pedal in the applied position. A cable and spring are used to release the ratchet mechanism and return the pedal to normal position.

DESCRIPTION AND OPERATION (Continued)**BRAKE HOSES AND LINES**

Flexible rubber hose is used at both front brakes and at the rear axle junction block. Double walled steel tubing is used to connect the master cylinder to the major hydraulic braking components and then to the flexible rubber hoses.

DIAGNOSIS AND TESTING**BASE BRAKE SYSTEM**

Base brake components consist of the brakeshoes, calipers, wheel cylinders, brake drums, rotors, brakelines, master cylinder, booster, and parking brake components.

Brake diagnosis involves determining if the problem is related to a mechanical, hydraulic, or vacuum operated component.

The first diagnosis step is the preliminary check.

PRELIMINARY BRAKE CHECK

(1) Check condition of tires and wheels. Damaged wheels and worn, damaged, or underinflated tires can cause pull, shudder, vibration, and a condition similar to grab.

(2) If complaint was based on noise when braking, check suspension components. Jounce front and rear of vehicle and listen for noise that might be caused by loose, worn or damaged suspension or steering components.

(3) Inspect brake fluid level and condition. Note that the front disc brake reservoir fluid level will decrease in proportion to normal lining wear. **Also note that brake fluid tends to darken over time. This is normal and should not be mistaken for contamination.**

(a) If fluid level is abnormally low, look for evidence of leaks at calipers, wheel cylinders, brakelines, and master cylinder.

(b) If fluid appears contaminated, drain out a sample. System will have to be flushed if fluid is separated into layers, or contains a substance other than brake fluid. The system seals and cups will also have to be replaced after flushing. Use clean brake fluid to flush the system.

(4) Check parking brake operation. Verify free movement and full release of cables and pedal. Also note if vehicle was being operated with parking brake partially applied.

(5) Check brake pedal operation. Verify that pedal does not bind and has adequate free play. If pedal lacks free play, check pedal and power booster for being loose or for bind condition. Do not road test until condition is corrected.

(6) If components checked appear OK, road test the vehicle.

ROAD TESTING

(1) If complaint involved low brake pedal, pump pedal and note if it comes back up to normal height.

(2) Check brake pedal response with transmission in Neutral and engine running. Pedal should remain firm under constant foot pressure.

(3) During road test, make normal and firm brake stops in 25-40 mph range. Note faulty brake operation such as low pedal, hard pedal, fade, pedal pulsation, pull, grab, drag, noise, etc.

PEDAL FALLS AWAY

A brake pedal that falls away under steady foot pressure is generally the result of a system leak. The leak point could be at a brakeline, fitting, hose, or caliper/wheel cylinder. Internal leakage in the master cylinder caused by worn or damaged piston cups, may also be the problem cause.

If leakage is severe, fluid will be evident at or around the leaking component. However, internal leakage in the master cylinder may not be physically evident.

LOW PEDAL

If a low pedal is experienced, pump the pedal several times. If the pedal comes back up, worn lining, rotors, or drums are the most likely causes.

SPONGY PEDAL

A spongy pedal is most often caused by air in the system. However, thin brake drums or substandard brake lines and hoses can also cause a spongy pedal. The proper course of action is to bleed the system, or replace thin drums and suspect quality brake lines and hoses.

HARD PEDAL OR HIGH PEDAL EFFORT

A hard pedal or high pedal effort may be due to lining that is water soaked, contaminated, glazed, or badly worn. The power booster or check valve could also be faulty.

PEDAL PULSATION

Pedal pulsation is caused by components that are loose, or beyond tolerance limits.

The primary cause of pulsation are disc brake rotors with excessive lateral runout or thickness variation, or out of round brake drums. Other causes are loose wheel bearings or calipers and worn, damaged tires.

NOTE: Some pedal pulsation may be felt during RWAL/ABS activation.

DIAGNOSIS AND TESTING (Continued)

BRAKE DRAG

Brake drag occurs when the lining is in constant contact with the rotor or drum. Drag can occur at one wheel, all wheels, fronts only, or rears only.

Drag is a product of incomplete brakeshoe release. Drag can be minor or severe enough to overheat the linings, rotors and drums.

Minor drag will usually cause slight surface charring of the lining. It can also generate hard spots in rotors and drums from the overheat-cool down process. In most cases, the rotors, drums, wheels and tires are quite warm to the touch after the vehicle is stopped.

Severe drag can char the brake lining all the way through. It can also distort and score rotors and drums to the point of replacement. The wheels, tires and brake components will be extremely hot. In severe cases, the lining may generate smoke as it chars from overheating.

Common causes of brake drag are:

- Seized or improperly adjusted parking brake cables.
- Loose/worn wheel bearing.
- Seized caliper or wheel cylinder piston.
- Caliper binding on corroded bushings or rusted slide surfaces.
- Loose caliper mounting bracket.
- Drum brakeshoes binding on worn/damaged support plates.
- Misassembled components.

If brake drag occurs at all wheels, the problem may be related to a blocked master cylinder return port, or faulty power booster (binds-does not release).

BRAKE FADE

Brake fade is usually a product of overheating caused by brake drag. However, brake overheating and resulting fade can also be caused by riding the brake pedal, making repeated high deceleration stops in a short time span, or constant braking on steep mountain roads. Refer to the Brake Drag information in this section for causes.

BRAKE PULL

Front brake pull condition could result from:

- Contaminated lining in one caliper
- Seized caliper piston
- Binding caliper
- Loose caliper
- Rusty adapter/caliper slide surfaces
- Improper brakeshoes
- Damaged rotor

A worn, damaged wheel bearing or suspension component are further causes of pull. A damaged front tire (bruised, ply separation) can also cause pull.

A common and frequently misdiagnosed pull condition is where direction of pull changes after a few stops. The cause is a combination of brake drag followed by fade at one of the brake units.

As the dragging brake overheats, efficiency is so reduced that fade occurs. Since the opposite brake unit is still functioning normally, its braking effect is magnified. This causes pull to switch direction in favor of the normally functioning brake unit.

An additional point when diagnosing a change in pull condition concerns brake cool down. Remember that pull will return to the original direction, if the dragging brake unit is allowed to cool down (and is not seriously damaged).

REAR BRAKE GRAB OR PULL

Rear grab or pull is usually caused by improperly adjusted or seized parking brake cables, contaminated lining, bent or binding shoes and support plates, or improperly assembled components. This is particularly true when only one rear wheel is involved. However, when both rear wheels are affected, the master cylinder, proportioning valve, or RWAL valve could be at fault.

BRAKES DO NOT HOLD AFTER DRIVING THROUGH DEEP WATER PUDDLES

This condition is generally caused by water soaked lining. If the lining is only wet, it can be dried by driving with the brakes very lightly applied for a mile or two. However, if the lining is both soaked and dirt contaminated, cleaning and/or replacement will be necessary.

BRAKE SQUEAK/SQUEAL

Brake squeak or squeal may be due to linings that are wet or contaminated with brake fluid, grease, or oil. Glazed linings and rotors with hard spots can also contribute to squeak. Dirt and foreign material embedded in the brake lining will also cause squeak/squeal.

A very loud squeak or squeal is frequently a sign of severely worn brake lining. If the lining has worn through to the brakeshoes in spots, metal-to-metal contact occurs. If the condition is allowed to continue, rotors and drums can become so scored that replacement is necessary.

BRAKE CHATTER

Brake chatter is usually caused by loose or worn components, or glazed/burnt lining. Rotors with hard spots can also contribute to chatter. Additional causes of chatter are out-of-tolerance rotors, brake lining not securely attached to the shoes, loose wheel bearings and contaminated brake lining.

DIAGNOSIS AND TESTING (Continued)

THUMP/CLUNK NOISE

Thumping or clunk noises during braking are frequently **not** caused by brake components. In many cases, such noises are caused by loose or damaged steering, suspension, or engine components. However, calipers that bind on the slide surfaces can generate a thump or clunk noise. In addition, worn out, improperly adjusted, or improperly assembled rear brakeshoes can also produce a thump noise.

BRAKELINING CONTAMINATION

Brakelining contamination is mostly a product of leaking calipers or wheel cylinders, worn seals, driving through deep water puddles, or lining that has become covered with grease and grit during repair. Contaminated lining should be replaced to avoid further brake problems.

WHEEL AND TIRE PROBLEMS

Some conditions attributed to brake components may actually be caused by a wheel or tire problem.

A damaged wheel can cause shudder, vibration and pull. A worn or damaged tire can also cause pull.

Severely worn tires with very little tread left can produce a grab-like condition as the tire loses and recovers traction. Flat-spotted tires can cause vibration and generate shudder during brake operation. A tire with internal damage such as a severe bruise, cut, or ply separation can cause pull and vibration.

STOP LAMP SWITCH

Stoplamp switch operation can be tested with an ohmmeter. The ohmmeter is used to check continuity between the pin terminals at different plunger positions (Fig. 9).

NOTE: The switch wire harness must be disconnected before testing switch continuity.

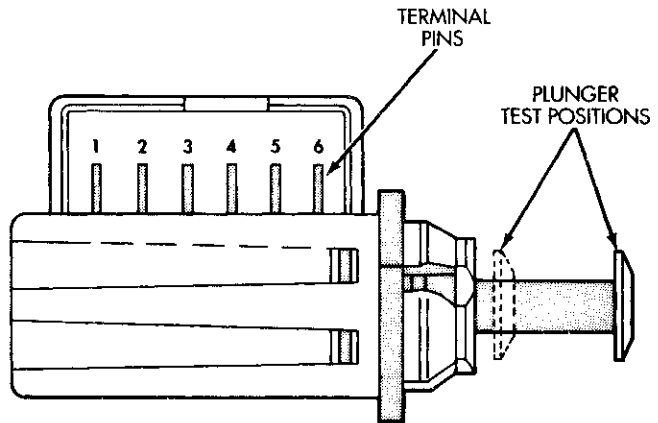
SWITCH CIRCUIT IDENTIFICATION

- terminals 1 and 2 are for the RWAL/ABS module and Powertrain Control Module (PCM) circuit
- terminals 5 and 6 are for the stoplamp circuit
- terminals 3 and 4 are for the speed control circuit

SWITCH CONTINUITY TEST

(1) Check continuity between terminal pins 5 and 6 as follows:

- Pull plunger all the way out to fully extended position.
- Attach test leads to pins 5 and 6 and note ohmmeter reading.
- If continuity exists, proceed to next test. Replace switch if meter indicates lack of continuity (shorted or open).



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Fig. 9 Stoplamp Switch Terminal Identification

(2) Check continuity between terminal pins 1 and 2 and pins 3 and 4 as follows:

(a) Push switch plunger inward to fully retracted position.

(b) Attach test leads to pins 1 and 2 and note ohmmeter reading.

(c) If continuity exists, switch is OK. Replace switch if meter indicates lack of continuity (switch is open).

RED BRAKE WARNING LAMP

The red warning lamp is in circuit with the parking brake switch and pressure differential switch in the combination valve. On diesel models, the lamp is also in circuit with the low vacuum switch.

The red lamp illuminates when the parking brakes are applied, or when a pressure drop occurs in the front or rear brake hydraulic circuit.

The lamp illuminates for approximately 2-4 seconds at every engine start up. This is a self test feature designed to check bulb and circuit operation.

A pressure drop in the front or rear brake hydraulic circuit activates the pressure differential valve inside the combination valve. A pressure decrease moves the valve toward the low pressure side. As the valve moves, it pushes the pressure differential switch contact plunger upward. This closes the switch internal contacts and completes the circuit to the red warning lamp. The lamp will remain on until repairs are made and normal fluid pressure restored.

LOW VACUUM SWITCH—DIESEL MODELS

On diesel models, the red brake warning lamp is also used to alert the driver of a low brake booster vacuum condition. The warning lamp is in circuit with a vacuum warning switch mounted on the driver side fender panel. The vacuum side of the switch is connected to the power brake booster. The

DIAGNOSIS AND TESTING (Continued)

electrical side of the switch is connected to the red brake warning lamp.

The low vacuum switch monitors booster vacuum level whenever the engine is running. If booster vacuum falls below 8.5 inches for a minimum of 10 seconds, the switch completes the circuit to the warning lamp. The warning lamp is designed to differentiate between a low vacuum condition and a hydraulic circuit fault.

MASTER CYLINDER/POWER BOOSTER

(1) Start engine and check booster vacuum hose connections. A hissing noise indicates vacuum leak. Correct any vacuum leak before proceeding.

(2) Stop engine and shift transmission into Neutral.

(3) Pump brake pedal until all vacuum reserve in booster is depleted.

(4) Press and hold brake pedal under light foot pressure. The pedal should hold firm, if the pedal falls away master cylinder is faulty (internal leakage).

(5) Start engine and note pedal action it should fall away slightly under light foot pressure then holds firm. If no pedal action is discernible, power booster, vacuum supply, or vacuum check valve is faulty. Proceed to the POWER BOOSTER VACUUM TEST.

(6) If the POWER BOOSTER VACUUM TEST passes, rebuild booster vacuum reserve as follows: Release brake pedal. Increase engine speed to 1500 rpm, close the throttle and immediately stop turn off ignition to stop engine.

(7) Wait a minimum of 90 seconds and try brake action again. Booster should provide two or more vacuum assisted pedal applications. If vacuum assist is not provided, booster is faulty.

POWER BOOSTER VACUUM TEST

(1) Connect vacuum gauge to booster check valve with short length of hose and T-fitting (Fig. 10).

(2) Start and run engine at curb idle speed for one minute.

(3) Observe the vacuum supply. If vacuum supply is not adequate, repair vacuum supply.

(4) Clamp hose shut between vacuum source and check valve.

(5) Stop engine and observe vacuum gauge.

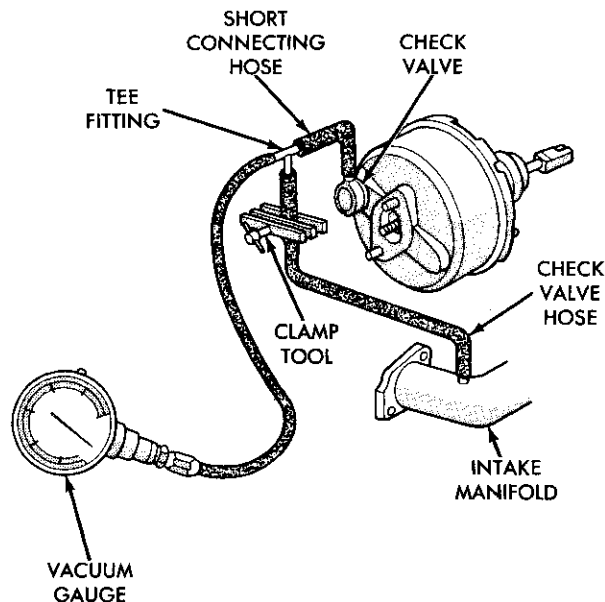
(6) If vacuum drops more than one inch HG (33 millibars) within 15 seconds, booster diaphragm or check valve is faulty.

POWER BOOSTER CHECK VALVE TEST

(1) Disconnect vacuum hose from check valve.

(2) Remove check valve and valve seal from booster.

(3) Use a hand operated vacuum pump for test.

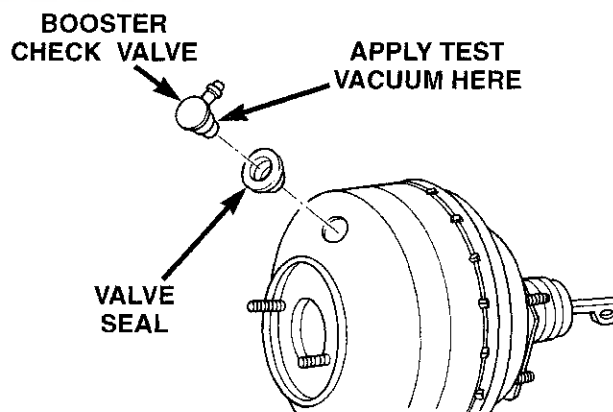


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Fig. 10 Typical Booster Vacuum Test Connections

(4) Apply 15-20 inches vacuum at large end of check valve (Fig. 11).

(5) Vacuum should hold steady. If gauge on pump indicates vacuum loss, check valve is faulty and should be replaced.



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Fig. 11 Vacuum Check Valve And Seal

DIESEL ENGINE VACUUM PUMP OUTPUT

Vacuum pump diagnosis involves checking pump output with a vacuum gauge. The low vacuum warning switch can also be checked with a vacuum gauge.

A standard vacuum gauge can be used to check pump output when necessary. Simply disconnect the pump supply hose and connect a vacuum gauge to the outlet port for testing purposes. Vacuum should hold steady in a range of approximately 8.5 to 25 inches at various engine speeds.

DIAGNOSIS AND TESTING (Continued)**DIAGNOSING LOW VACUUM OUTPUT CONDITION**

A low booster vacuum condition or a faulty low vacuum warning switch will cause the brake warning lamp to illuminate. If the lamp does go on and indicates the existence of a low vacuum condition, check the vacuum pump, booster and warning switch as follows:

(1) Check vacuum pump oil feed line. Verify that line connections are secure and not leaking. If leakage is noted and pump is noisy, replace pump.

(2) Disconnect supply hose to booster. Connect vacuum gauge to this hose and run engine at various throttle openings. Output should range from 8.5 to 25 inches vacuum. If vacuum is consistently below 8.5 inches, problem is with vacuum hoses or pump component. If output is within specified limits, continue testing.

(3) Check booster operation as described in diagnosis section. Replace check valve, vacuum hoses, or booster if necessary. However, if booster operation is correct but warning lamp is still on, continue testing.

(4) Disconnect vacuum hose at warning switch. Plug hose and connect hand vacuum pump to switch.

(5) Start and run engine.

(6) Apply 8.5 to 9 inches of vacuum to warning switch and observe warning lamp. If lamp goes out, switch vacuum hose is either loose or leaking. If lamp remains on, leave engine running and continue testing.

(7) Apply 20-25 inches vacuum to switch and observe warning lamp operation. If lamp now goes out, switch is at fault and should be replaced. If lamp remains on, continue testing.

(8) Connect vacuum hoses and replace original warning switch with known good switch. Run engine and observe warning lamp operation. If lamp is now off, old switch is faulty. If lamp remains on, problem is in wiring between switch and warning lamp.

COMBINATION VALVE**Metering Valve**

Metering valve operation can be checked visually and with the aid of a helper. Observe the metering valve stem while a helper applies and releases the brakes. If the valve is operating correctly, the stem will extend slightly when the brakes are applied and retract when the brakes are released. If the valve is faulty, replace the entire combination valve as an assembly.

Pressure Differential Switch

(1) Have helper sit in drivers seat to apply brake pedal and observe red brake warning light.

(2) Raise vehicle on hoist.

(3) Connect bleed hose to a rear wheel cylinder and immerse hose end in container partially filled with brake fluid.

(4) Have helper press and hold brake pedal to floor and observe warning light.

(a) If warning light illuminates, switch is operating correctly.

(b) If light fails to illuminate, check circuit fuse, bulb, and wiring. The parking brake switch can be used to aid in identifying whether or not the brake light bulb and fuse is functional. Repair or replace parts as necessary and test differential pressure switch operation again.

(5) If warning light still does not illuminate, switch is faulty. Replace combination valve assembly, bleed brake system and verify proper switch and valve operation.

DISC BRAKE ROTOR

The rotor braking surfaces should not be refinished unless necessary.

Light surface rust and scale can be removed with a lathe equipped with dual sanding discs. The rotor surfaces can be restored by machining in a disc brake lathe if surface scoring and wear are light.

Replace the rotor under the following conditions:

- severely scored
- tapered
- hard spots
- cracked
- below minimum thickness

ROTOR MINIMUM THICKNESS

Measure rotor thickness at the center of the brake-shoe contact surface. Replace the rotor if worn below minimum thickness, or if machining would reduce thickness below the allowable minimum.

Rotor minimum thickness is usually specified on the rotor hub. The specification is either stamped or cast into the hub surface.

ROTOR RUNOUT

Check rotor lateral runout with dial indicator C-3339 (Fig. 12). Excessive lateral runout will cause brake pedal pulsation and rapid, uneven wear of the brakeshoes. Position the dial indicator plunger approximately 25.4 mm (1 in.) inward from the rotor edge.

NOTE: Be sure wheel bearing has zero end play before checking rotor runout.

DIAGNOSIS AND TESTING (Continued)

Maximum allowable rotor runout is 0.127 mm (0.005 in.).

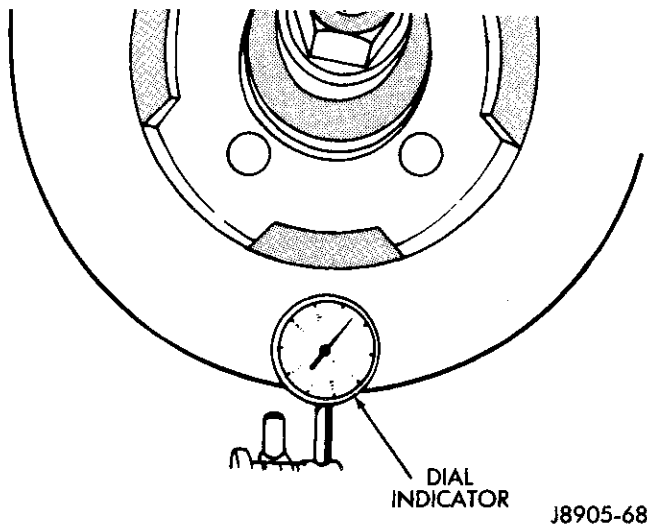


Fig. 12 Checking Rotor Runout And Thickness Variation

ROTOR THICKNESS VARIATION

Variations in rotor thickness will cause pedal pulsation, noise and shudder.

Measure rotor thickness at 6-to-12 points around the rotor face (Fig. 13).

Position the micrometer approximately 25.4 mm (1 in.) from the rotor outer circumference for each measurement.

Thickness should not vary by more than 0.025 mm (0.001 in.) from point-to-point on the rotor. Machine or replace the rotor if necessary.

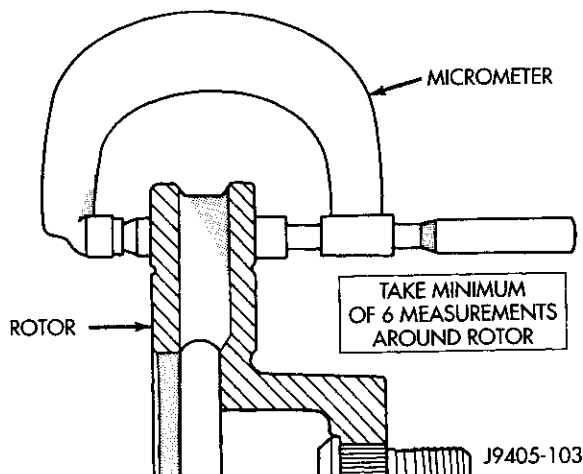


Fig. 13 Measuring Rotor Thickness

BRAKE DRUM

The maximum allowable diameter of the drum braking surface is stamped or cast into the drum

outer edge. Generally, a drum can be machined to a maximum of 1.52 mm (0.060 in.) oversize. Always replace the drum if machining would cause drum diameter to exceed the size limit indicated on the drum.

BRAKE DRUM RUNOUT

Measure drum diameter and runout with an accurate gauge. The most accurate method of measurement involves mounting the drum in a brake lathe and checking variation and runout with a dial indicator.

Variations in drum diameter should not exceed 0.076 mm (0.003 in.). Drum runout should not exceed 0.20 mm (0.008 in.) out of round. Machine the drum if runout or variation exceed these values. Replace the drum if machining causes the drum to exceed the maximum allowable diameter.

BRAKE LINE AND HOSES

Flexible rubber hose is used at both front brakes and at the rear axle junction block. Inspect the hoses whenever the brake system is serviced, at every engine oil change, or whenever the vehicle is in for service.

Inspect the hoses for surface cracking, scuffing, or worn spots. Replace any brake hose immediately if the fabric casing of the hose is exposed due to cracks or abrasions.

Also check brake hose installation. Faulty installation can result in kinked, twisted hoses, or contact with the wheels and tires or other chassis components. All of these condition can lead to scuffing, cracking and eventual failure.

The steel brake lines should be inspected periodically for evidence of corrosion, twists, kinks, leaks, or other damage. Heavily corroded lines will eventually rust through causing leaks. In any case, corroded or damaged brake lines should be replaced.

Factory replacement brake lines and hoses are recommended to ensure quality, correct length and superior fatigue life. Care should be taken to make sure that brake line and hose mating surfaces are clean and free from nicks and burrs. Also remember that right and left brake hoses are not interchangeable.

Use new copper seal washers at all caliper connections. Be sure brake line connections are properly made (not cross threaded) and tightened to recommended torque.

BRAKE FLUID CONTAMINATION

Indications of fluid contamination are swollen or deteriorated rubber parts.

Swollen rubber parts indicate the presence of petroleum in the brake fluid.

To test for contamination, put a small amount of drained brake fluid in clear glass jar. If fluid sepa-

DIAGNOSIS AND TESTING (Continued)

rates into layers, there is mineral oil or other fluid contamination of the brake fluid.

If brake fluid is contaminated, drain and thoroughly flush system. Replace master cylinder, proportioning valve, caliper seals, wheel cylinder seals, Antilock Brakes hydraulic unit and all hydraulic fluid hoses.

SERVICE PROCEDURES

BRAKE FLUID LEVEL

Correct fluid level is to the top of the oval indicator window on the side of the reservoir (Fig. 14) and (Fig. 15). An acceptable level is between the top of the indicator window and the MIN mark. **The hydraulic system should be checked for leaks, or the brakeshoes for excessive wear, if fluid level is very near the MIN level.**

Always clean the master cylinder reservoir and cover before removing the cover to add fluid. If this is not done, dirt from the cover or reservoir could enter the fluid.

Add fluid to the correct level if necessary. Note that fluid level in the reservoirs will decrease slightly in proportion to lining wear. This is a normal condition. If fluid is needed, use Mopar brake fluid or an equivalent meeting SAE standard J1703 and Federal standard DOT 3.

Check the cover diaphragm seal and replace it if torn or distorted. Snap the seal into place before installing the cover.

CAUTION: Verify that the diaphragm seal is firmly seated in the reservoir cover. If the seal is improperly seated, it will shift out of position when the cover is installed resulting in fluid leakage and eventual contamination.

MASTER CYLINDER BLEEDING

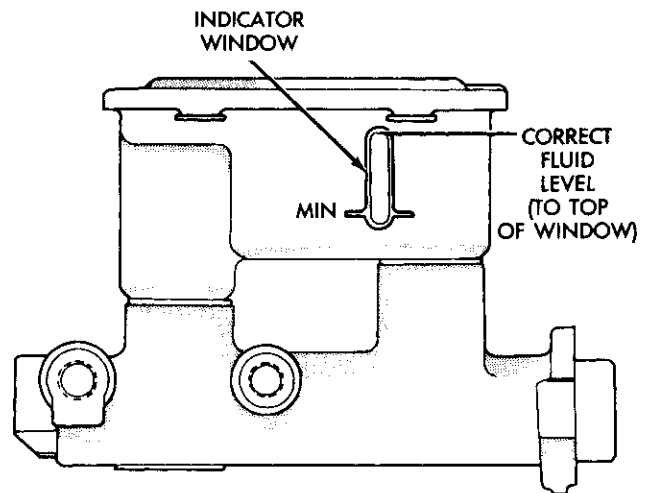
An overhauled, or new master cylinder should always be bled before installation in the vehicle. This practice saves time during brake bleeding because air in the cylinder will not be pumped into the lines.

The only tools needed for bench bleeding are a vise, a pair of bleed tubes, and a length of wood dowel. Bleed tubes can either be purchased or fabricated from spare brake lines and fittings.

(1) Mount master cylinder in vise. Clamp vise jaws on one of the cylinder mounting ears.

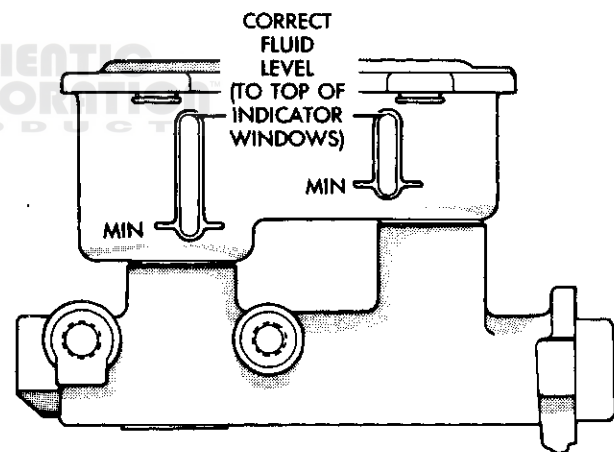
(2) Install bleed tubes in cylinder outlet ports and direct tube ends into appropriate reservoir chambers (Fig. 16).

(3) Fill reservoir chambers about 3/4 full with fresh, clean brake fluid.



J9405-23

Fig. 14 Fluid Level Indicator (Model 1500 & 2500)



J9405-24

Fig. 15 Fluid Level Indicators (Model 3500)

(4) Bleed cylinder by stroking cylinder pistons inward then allowing them to return under spring pressure. Use a wood dowel, or similar tool to stroke pistons (Fig. 16).

(5) Continue stroking pistons until bubbles no longer appear in fluid entering reservoir.

(6) Remove bleed tubes and install plastic plugs in cylinder outlet ports. Plugs will prevent fluid loss and keep dirt out until cylinder assembly is ready for installation.

SERVICE PROCEDURES (Continued)

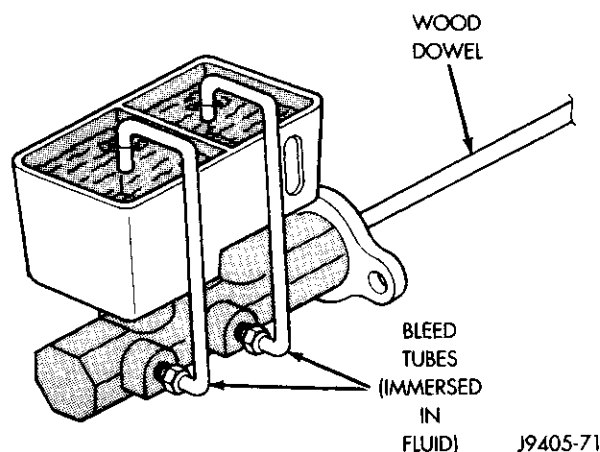


Fig. 16 Master Cylinder Bleeding

(7) Top off reservoir fluid level and install cover and seal.

CAUTION: Be sure the seal is properly positioned on the reservoir cover. The seal can shift out of position during installation if care is not exercised. This will result in leakage and possible fluid contamination.

BRAKE BLEEDING

Use Mopar brake fluid, or an equivalent quality fluid meeting SAE J1703-F and DOT 3 standards only. Use fresh, clean fluid from a sealed container at all times.

Do not pump the brake pedal at any time while bleeding. Air in the system will be compressed into small bubbles that are distributed throughout the hydraulic system. This will make additional bleeding operations necessary.

Do not allow the master cylinder to run out of fluid during bleed operations. An empty cylinder will allow additional air to be drawn into the system. Check the cylinder fluid level frequently and add fluid as needed.

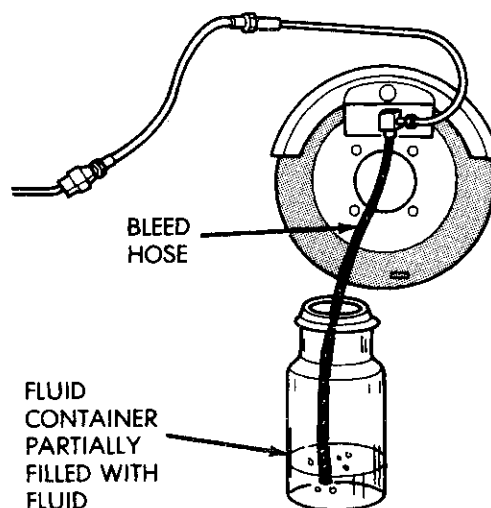
The Brakes should be bled in sequence. First the right rear wheel then the left rear wheel. Then move to the front brakes and bleed the right front wheel then the left front wheel.

MANUAL BLEEDING

(1) Remove reservoir filler caps and fill reservoir with Mopar, or equivalent quality DOT 3 brake fluid.

(2) If calipers, or wheel cylinders were overhauled, open all caliper and wheel cylinder bleed screws. Then close each bleed screw as fluid starts to drip from it. Top off master cylinder reservoir once more before proceeding.

(3) Attach one end of bleed hose to bleed screw and insert opposite end in glass container partially filled with brake fluid (Fig. 17). Be sure end of bleed hose is immersed in fluid.



J8905-18

Fig. 17 Typical Fluid Container And Bleed Hose Setup

(4) Open up bleeder, then have a helper press down the brake pedal. Once the pedal is down close the bleeder. Repeat bleeding until fluid stream is clear and free of bubbles. Then move to the next wheel.

DISC ROTOR MACHINING

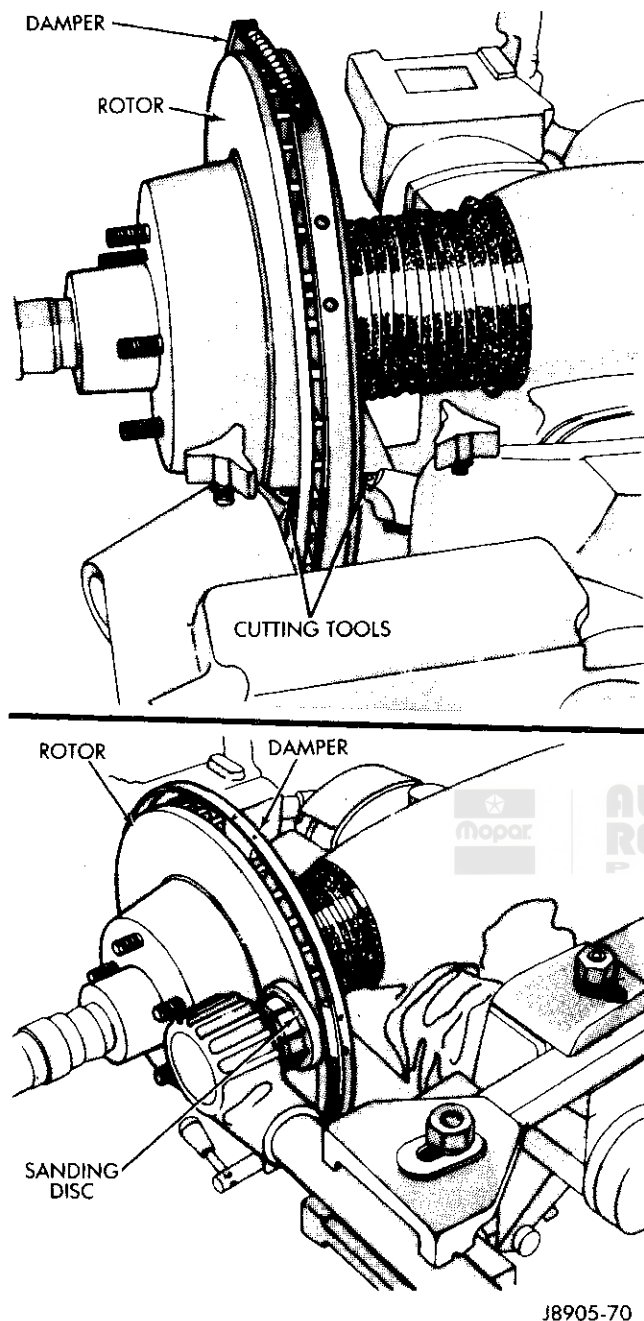
Rotor braking surfaces can be sanded or machining in a disc brake lathe.

The lathe must machine both sides of the rotor simultaneously with dual (two) cutter heads (Fig. 18). Equipment capable of machining only one side at a time will produce a tapered rotor.

The lathe should also be equipped with a grinder attachment or dual sanding discs for final cleanup or light refinishing (Fig. 18).

If the rotor surfaces only need minor cleanup of rust, scale, or minor scoring, use abrasive discs to clean up the rotor surfaces. However, when a rotor is scored or worn, machining with cutting tools will be required.

CAUTION: Do not machine the rotor if it will cause the rotor to fall below minimum allowable thickness.

SERVICE PROCEDURES (Continued)**Fig. 18 Rotor Refinishing****BRAKE DRUM MACHINING**

The brake drums can be machined on a drum lathe when necessary. Initial machining cuts should be limited to 0.12 - 0.20 mm (0.005 - 0.008 in.) at a time as heavier feed rates can produce taper and surface variation. Final finish cuts of 0.025 to 0.038 mm (0.001 to 0.0015 in.) are recommended and will generally provide the best surface finish.

Be sure the drum is securely mounted in the lathe before machining operations. A damper strap should

always be used around the drum to reduce vibration and avoid chatter marks.

The maximum allowable diameter of the drum braking surface is stamped or cast into the drum outer edge. Always replace the drum if machining would cause drum diameter to exceed the size limit indicated on the drum.

BRAKE LINE

Mopar preformed metal brake line is recommended and preferred for all repairs. However, double-wall steel line can be used for emergency repair when factory replacement parts are not readily available.

Special, heavy duty tube bending and flaring equipment is required to prepare double wall brake line. Special bending tools are needed to avoid kinking or twisting metal brake line. In addition, special flaring tools are needed to provide the inverted-type, double flare required on metal brake lines.

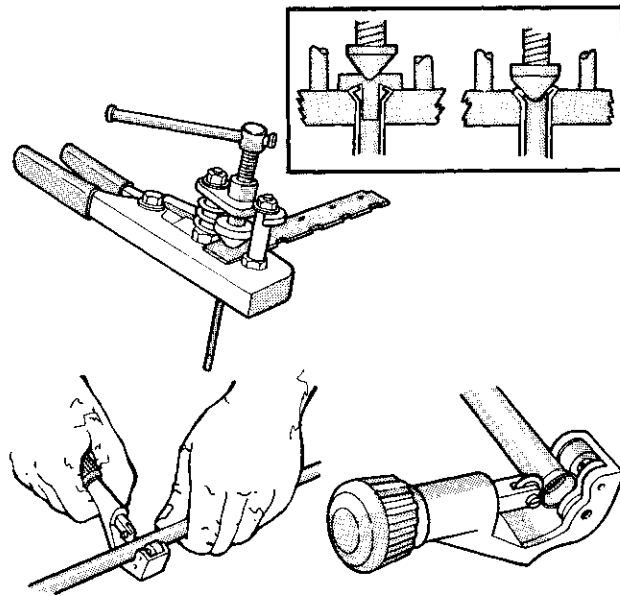
FLARING PROCEDURE

- (1) Cut off damaged tube with Tubing Cutter.
- (2) Ream cut edges of tubing to ensure proper flare.
- (3) Install replacement tube nut on section of tube to be repaired.
- (4) Insert tube in flaring tool. Center tube in area between vertical posts.
- (5) Place gauge form over the end of the tube.
- (6) Push tubing through flaring tool jaws until tube contacts recessed notch in gauge that matches tube diameter.
- (7) Squeeze flaring tool jaws to lock tubing in place.
- (8) Insert plug on gauge in the tube. Then swing compression disc over gauge and center tapered flaring screw in recess of compression disc (Fig. 19).
- (9) Tighten tool handle until plug gauge is seated on jaws of flaring tool. This will start the inverted flare.
- (10) Remove the plug gauge and complete the inverted flare.
- (11) Remove the flaring tools and verify that the inverted flare is correct.

REMOVAL AND INSTALLATION**STOP LAMP SWITCH****REMOVAL**

- (1) Remove knee bolster for access to stop lamp switch and pedal.
- (2) Disconnect switch harness (Fig. 20).
- (3) Press and hold brake pedal in applied position.
- (4) Rotate switch counterclockwise about 30° to align switch lock tab with notch in bracket.

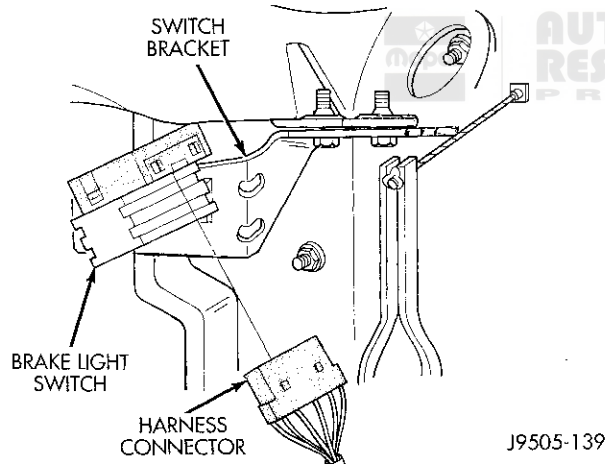
REMOVAL AND INSTALLATION (Continued)



RH222

Fig. 19 Inverted Flare Tools

(5) Pull switch rearward out of mounting bracket and release brake pedal.



J9505-139

**Fig. 20 Stop Lamp Switch & Harness Connector
INSTALLATION**

- (1) Pull switch plunger all the way out to fully extended position.
- (2) Push switch plunger inward 4 detent positions (or clicks). This is required preset position for switch installation. Plunger will extend approximately 14 mm (0.55 in.) out of housing at this setting.
- (3) Connect harness wires to switch.
- (4) Press and hold brake pedal down.
- (5) Install switch. Align tab on switch with notch in switch bracket (Fig. 21). Then insert switch in bracket and turn it clockwise about 30° to lock it in place.

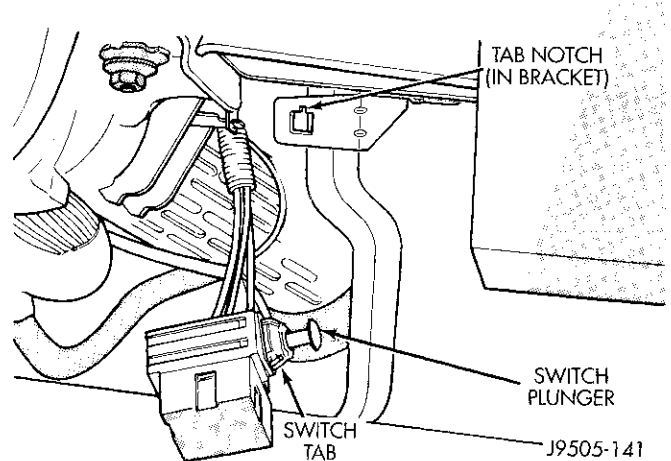


Fig. 21 Stop Lamp Switch

(6) Release brake pedal. Then lightly pull pedal fully rearward. Pedal will adjust switch plunger to correct position as pedal is moved to rear.

CAUTION: Do not use excessive force to move the pedal rearward for switch adjustment. Excessive force will damage the switch.

BRAKE PEDAL

REMOVAL

- (1) Remove knee bolster.
- (2) Remove stop lamp switch.
- (3) Remove switches from tabs on stop lamp switch bracket.
- (4) Remove stop lamp switch bracket bolts and remove bracket (Fig. 22).

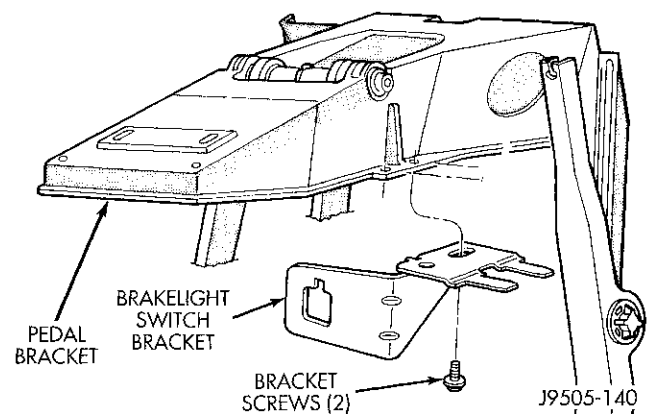


Fig. 22 Brake Lamp Switch Bracket

- (5) Remove clip and washer attaching booster push rod and slide push rod off pedal.

REMOVAL AND INSTALLATION (Continued)

(6) Remove E-clip from passenger side of pedal shaft (Fig. 23). Use flat blade screwdriver to pry clip out of shaft groove.

(7) Push shaft toward driver side of bracket just enough to expose opposite E-clip. Then remove E-clip with flat blade screwdriver.

(8) Push pedal shaft back and out of passenger side of bracket (Fig. 23).

(9) Remove brake pedal and pedal shaft from vehicle.

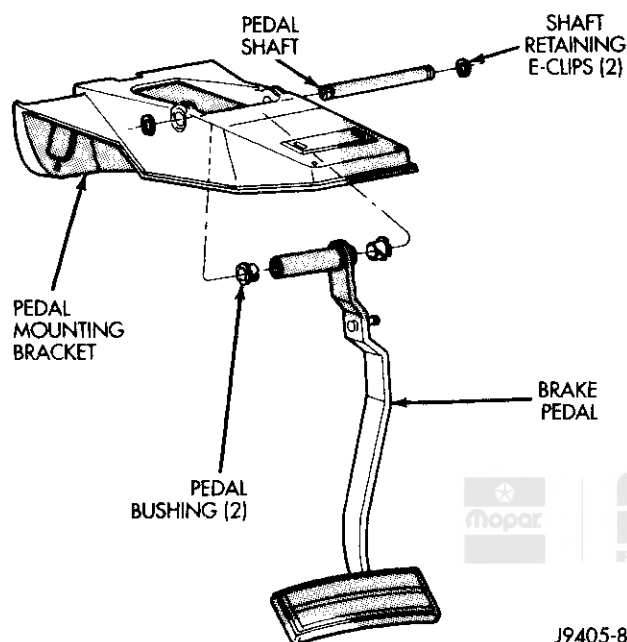


Fig. 23 Brake Pedal Mounting (With Automatic Transmission)

INSTALLATION

(1) Replace bracket and pedal bushings if necessary. Lubricate shaft bores in bracket and pedal before installing bushings with Mopar Multi-mileage silicone grease.

(2) Apply liberal quantity of Mopar multi-mileage grease to pedal shaft and to pedal and bracket bushings.

(3) Position brake pedal in mounting bracket.

(4) Slide pedal shaft into bracket and through pedal from passenger side.

(5) Push pedal shaft out driver side of mounting bracket just enough to allow installation of retaining E-clip.

(6) Push pedal shaft back toward passenger side of bracket and install remaining E-clip on pedal shaft.

(7) Install booster push rod on brake pedal. Secure push rod to pedal with washer and retaining clip.

(8) Install stop lamp switch bracket and switch.

(9) Install knee bolster.

RWAL VALVE/COMBINATION VALVE**REMOVAL**

(1) Disconnect ground wire and harness wires from combination valve switch and RWAL valve (Fig. 24).

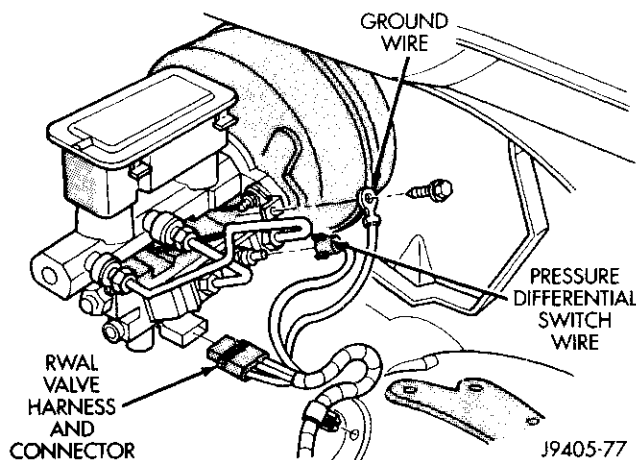


Fig. 24 Valve Harness

(2) Disconnect lines to front and rear brakes from RWAL and combination valves (Fig. 25).

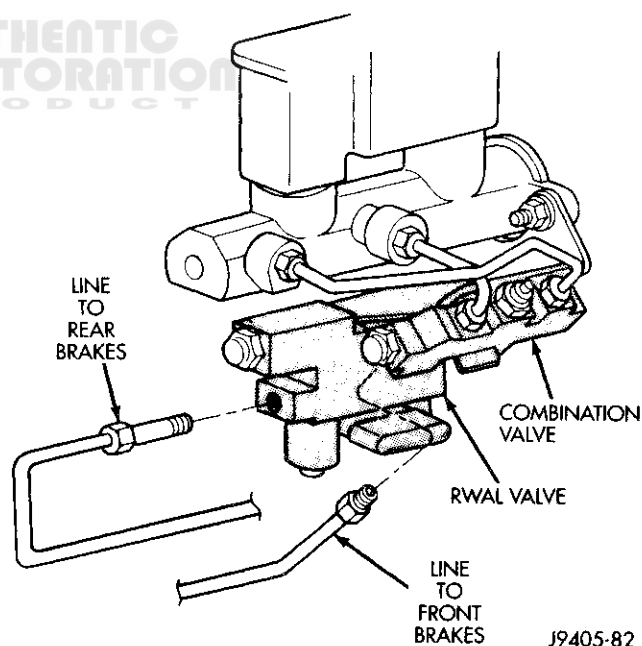


Fig. 25 Master Cylinder brake lines

(3) Remove brake lines connecting master cylinder to combination valve.

(4) Remove nuts attaching master cylinder and combination valve bracket to booster studs.

(5) Remove master cylinder.

(6) Remove combination valve, valve bracket and RWAL valve as assembly.

REMOVAL AND INSTALLATION (Continued)

(7) Remove brake line connecting combination valve to RWAL valve.

(8) Remove bolt attaching RWAL valve to combination valve bracket (Fig. 26). Then separate RWAL valve from bracket.

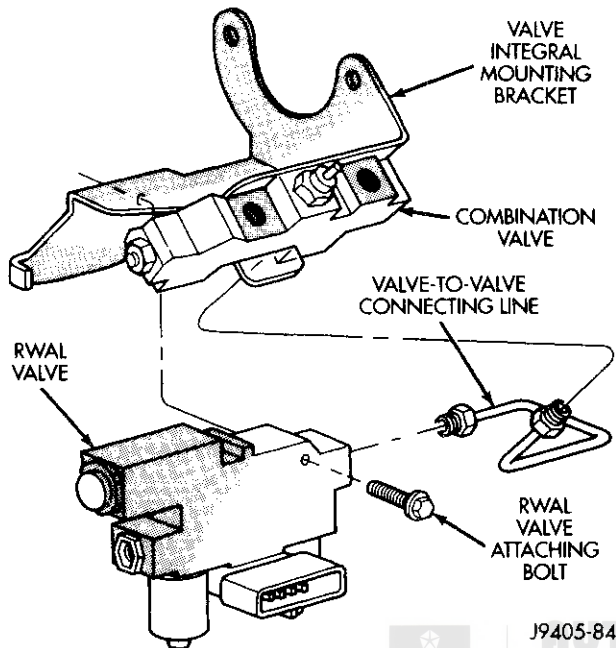


Fig. 26 RWAL Valve/Combination Valve

INSTALLATION

(1) Install RWAL valve on combination valve bracket. Do not tighten RWAL valve bolt completely at this time.

(2) Install short brake line that connects RWAL valve to combination valve. Tighten line fittings to 16-23 N·m (140-200 in. lbs.).

(3) Tighten RWAL valve attaching bolt to 23-34 N·m (200-300 in. lbs.).

(4) Install master cylinder on booster mounting studs.

(5) Attach antilock harness ground wire to combination valve bracket.

(6) Install combination valve bracket on booster mounting studs and against master cylinder.

(7) Loosely install nuts that retain master cylinder and combination valve on booster studs.

(8) Install and connect all remaining brake lines. Tighten line fittings to 16-23 N·m (140-200 in. lbs.).

(9) Connect harness wires to RWAL valve and to combination valve switch.

(10) Fill and bleed brake system.

MASTER CYLINDER

Exercise care when removing/installing the master cylinder, combination valve and antilock valve connecting lines. The threads in the cylinder and valve fluid ports can be dam-

aged if care is not exercised. Use a flare nut wrench to loosen or tighten the fittings and start all brake line fittings by hand to avoid cross threading.

REMOVAL

(1) Remove brake lines connecting master cylinder to combination valve (Fig. 27).

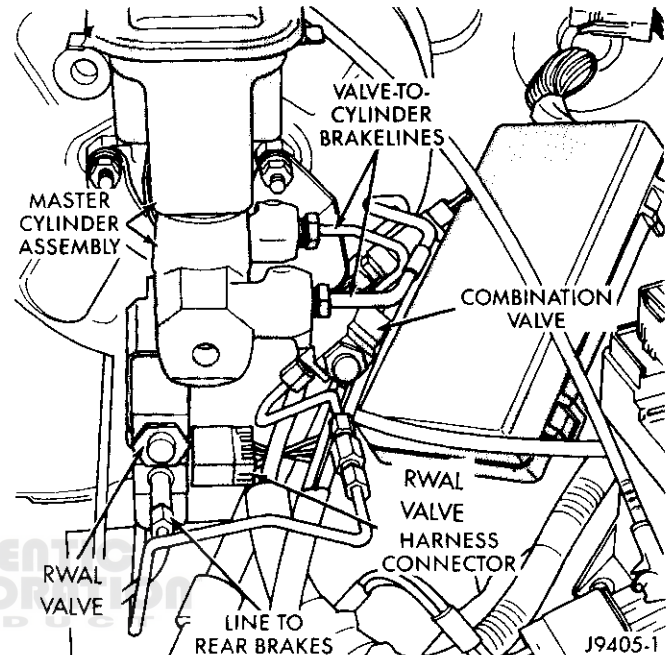


Fig. 27 Combination Valve-To-Master Cylinder brake lines

(2) Remove nuts attaching combination valve bracket and master cylinder to brake booster mounting studs.

(3) Slide combination valve bracket off booster mounting studs.

(4) Remove master cylinder.

INSTALLATION

(1) Position master cylinder on booster mounting studs. Be sure booster push rod is aligned and seated in primary piston.

(2) Install combination valve bracket on mounting studs. Bracket goes on top of cylinder mounting (Fig. 28).

(3) Start all brake line fittings in cylinder and valves by hand.

(4) Install master cylinder attaching nuts on booster studs. Tighten nuts to 23-34 N·m (200-300 in. lbs.).

(5) Have an assistant depress the brake pedal slowly and hold it down.

(6) Tighten brake line fittings to 16-23 N·m (140-200 in. lbs.).

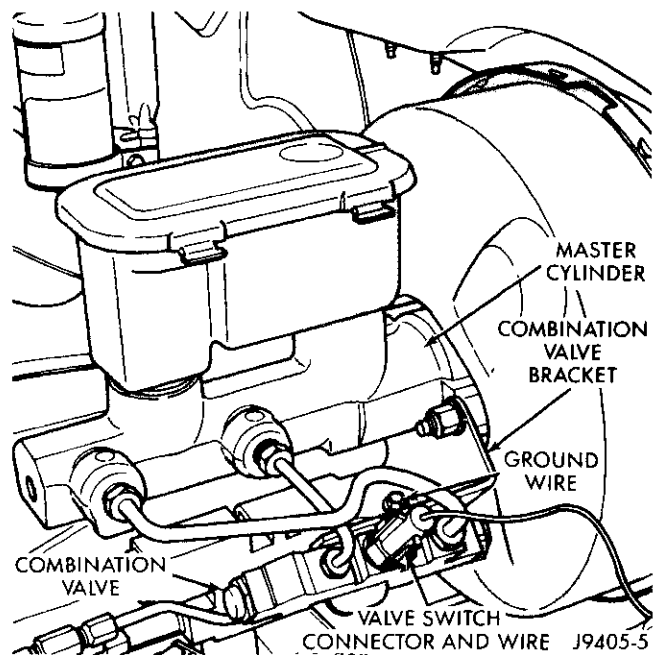
REMOVAL AND INSTALLATION (Continued)

Fig. 28 Master Cylinder/Combination Valve Bracket Mounting

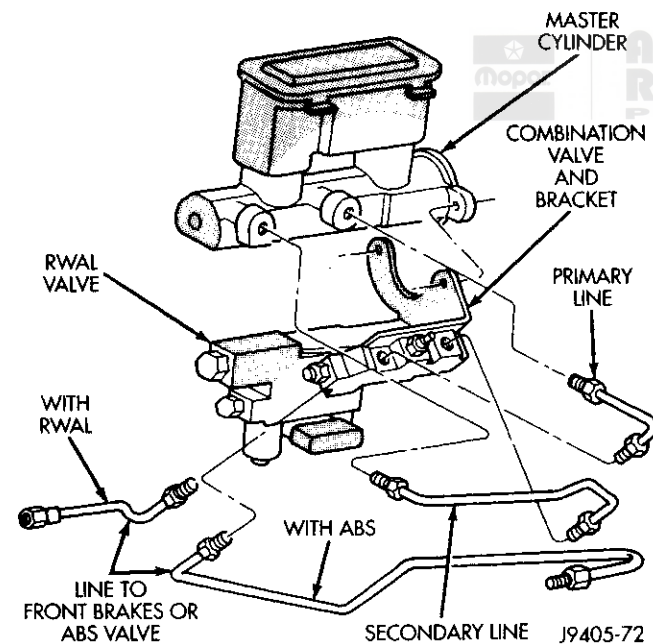


Fig. 29 Master Cylinder & Valve brake line Connections

POWER BRAKE BOOSTER

The standard and high output boosters are identified by code letters on the forward face of the booster.

Booster I.D. code letters are:

- 1/2 ton booster code is ZK
- 3/4 and 1 ton booster code is ZL

REMOVAL

(1) Disconnect harness wires from differential switch on combination valve and from RWAL valve.

(2) Disconnect brake line from combination valve to front brakes, or ABS valve. Then disconnect brake line from RWAL valve to rear brakes.

(3) Remove nuts attaching master cylinder and valves to power brake booster studs. Then remove master cylinder and valves as assembly (Fig. 30).

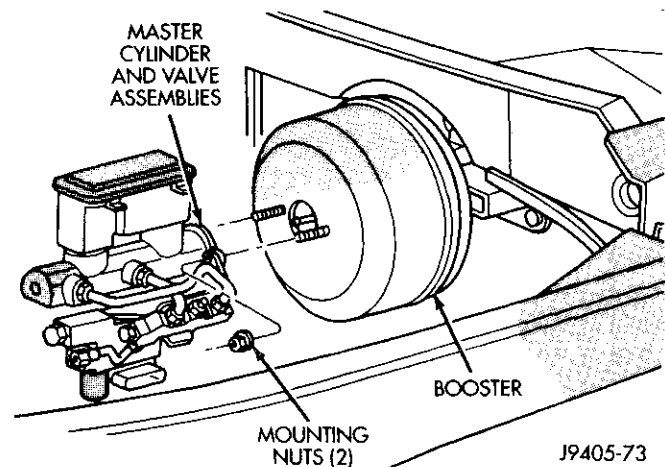


Fig. 30 Master Cylinder & Valve Assembly

(4) Disconnect vacuum hose at booster check valve.

(5) Remove knee bolster for access to brake pedal.

(6) Remove clip and washer securing booster push rod to brake pedal and slid rod off pedal (Fig. 31).

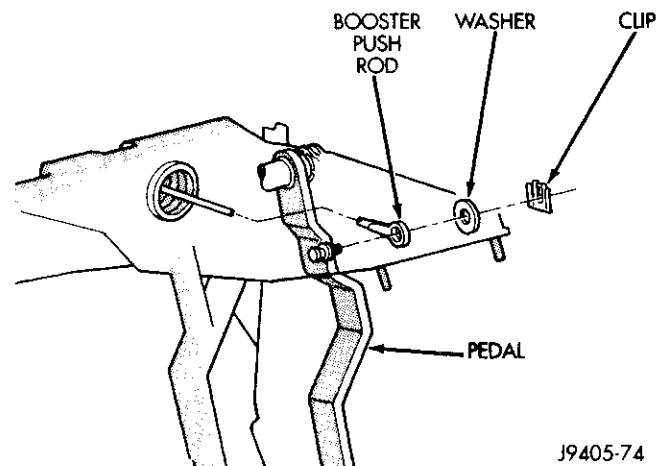


Fig. 31 Booster Push Rod

(7) Remove nuts attaching booster mounting studs to dash panel and pedal mounting bracket and remove booster (Fig. 32).

REMOVAL AND INSTALLATION (Continued)

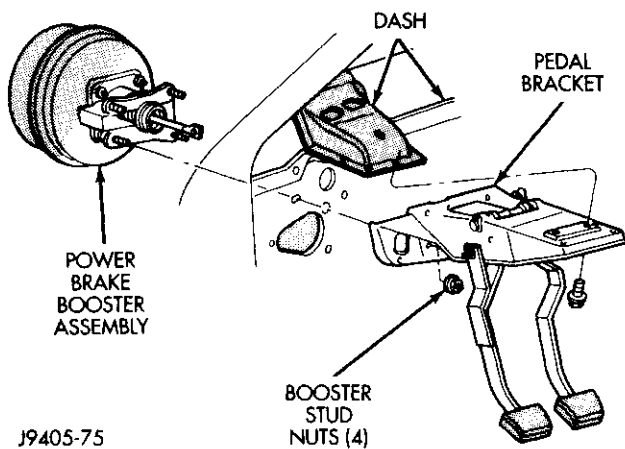


Fig. 32 Booster Mounting

INSTALLATION

NOTE: If new booster is being installed, check code letters to verify that correct booster is being installed.

- (1) Position booster on engine compartment dash panel.
- (2) Install and tighten booster mounting stud nuts to 23-34 N·m (200-300 in. lbs.).
- (3) Connect booster push rod to brake pedal.
- (4) Install knee bolster.
- (5) Connect vacuum hose to booster check valve.
- (6) Install master cylinder and valves on booster as assembly and tighten mounting nuts to 23-34 N·m (200-300 in. lbs.).
- (7) Connect front/rear brake lines to combination valve and RWAL valve. Tighten brake line fittings to 16-23 N·m (140-200 in. lbs.).
- (8) Connect harness wires to RWAL valve and pressure differential switch on combination valve.
- (9) Fill and bleed brake system. Refer to procedures in appropriate antilock brake section.

POWER BRAKE VACUUM PUMP (DIESEL ENGINE)

REMOVAL

- (1) Disconnect battery negative cable.
- (2) Position drain pan under power steering pump.
- (3) Disconnect vacuum and steering pump hoses (Fig. 33).
- (4) Disconnect oil pressure sender wires and remove sending unit (Fig. 34).

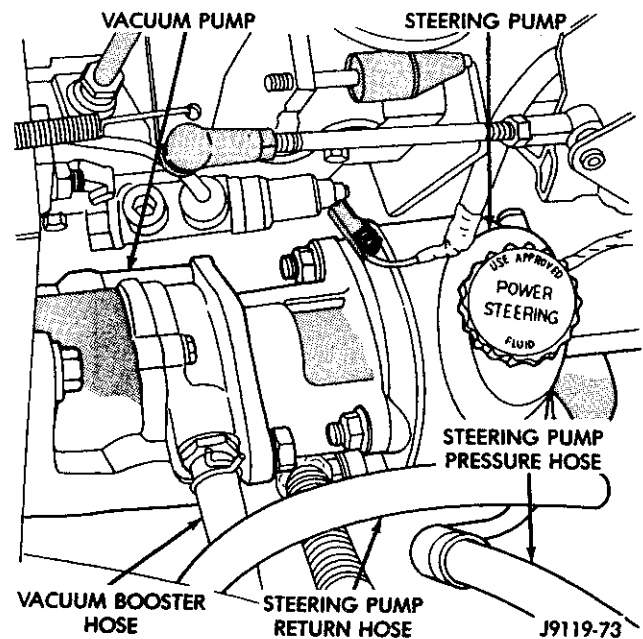


Fig. 33 Vacuum And Steering Pump Hose Connections

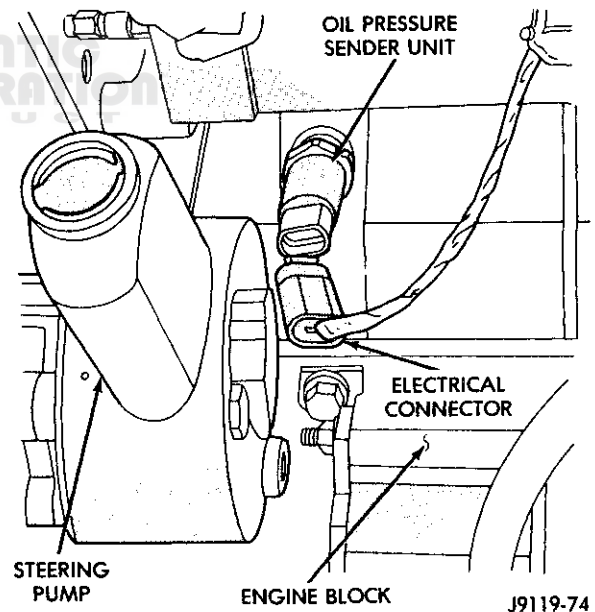


Fig. 34 Oil Pressure Sender Location

REMOVAL AND INSTALLATION (Continued)

(5) Disconnect lubricating oil feed line from fitting at underside of vacuum pump (Fig. 35).

(6) Remove lower bolt that attaches pump assembly to engine block (Fig. 36).

(7) Remove bottom, inboard nut that attaches adapter to steering pump. This nut secures a small bracket to engine block. Nut and bracket must be removed before pump assembly can be removed from block.

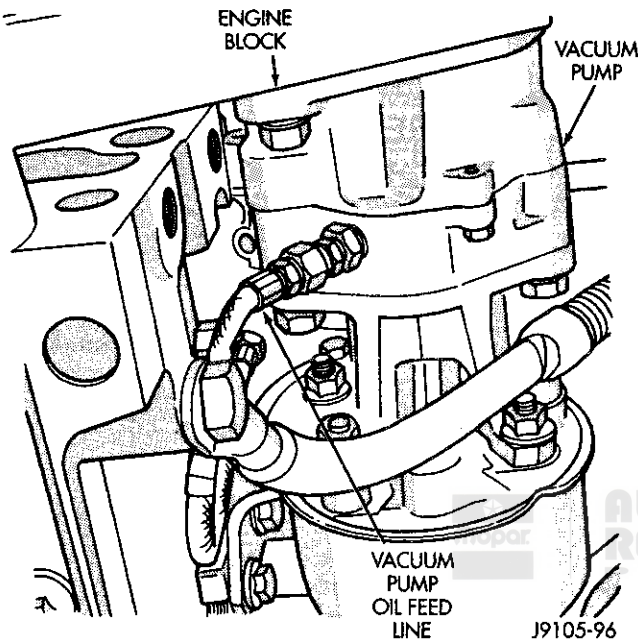


Fig. 35 Oil Feed Line Connection At Pump

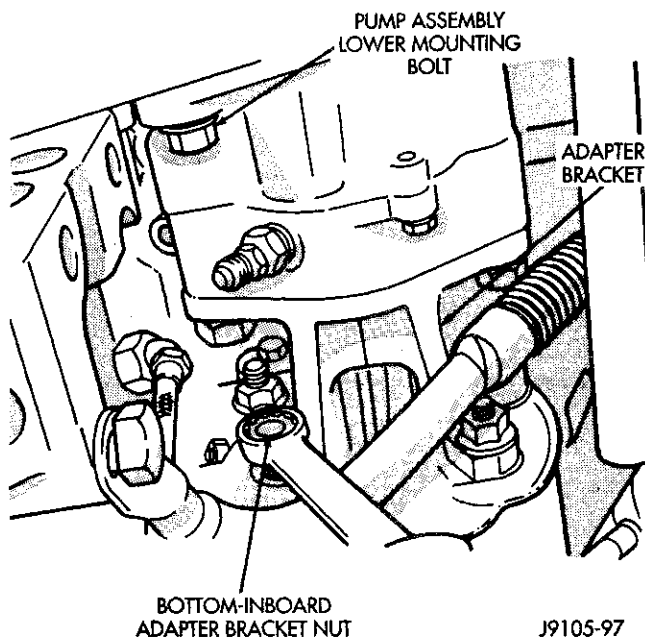


Fig. 36 Adapter And Pump Mounting Fastener Location

(8) Remove upper bolt that attaches pump assembly to engine block (Fig. 37).

(9) Remove pump assembly from vehicle.

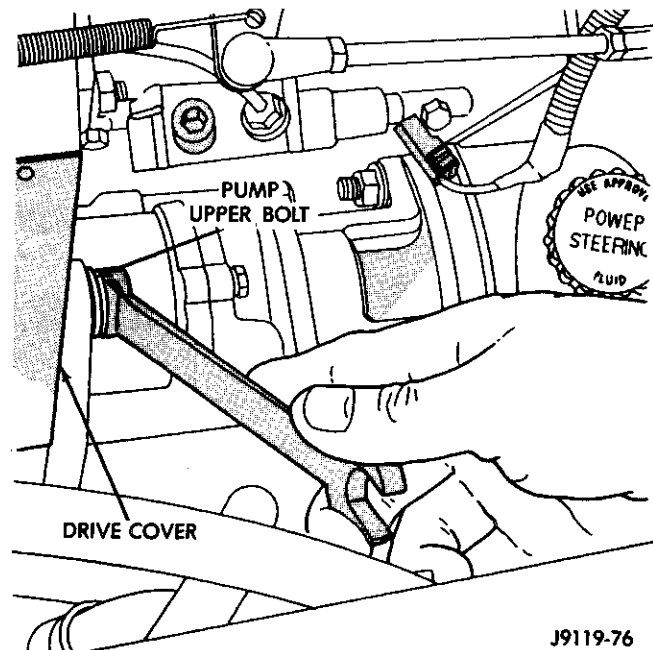


Fig. 37 Pump Assembly Upper Mounting Bolt

(10) Remove nuts attaching vacuum pump to adapter (Fig. 38).

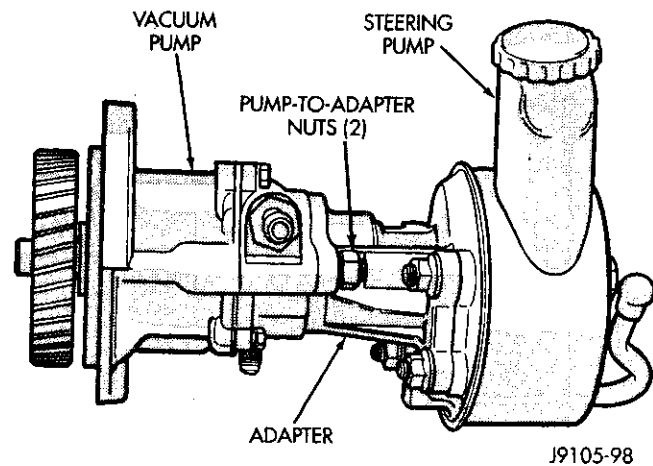


Fig. 38 Pump Assembly Removal

(11) Remove vacuum pump from adapter (Fig. 39). Turn pump gear back and forth to disengage pump shaft from coupling.

(12) Remove coupling from adapter (Fig. 40).

(13) Remove remaining adapter attaching nuts and remove adapter from steering pump (Fig. 41). If steering pump will be serviced, remove spacer from each inboard mounting stud on pump.

REMOVAL AND INSTALLATION (Continued)

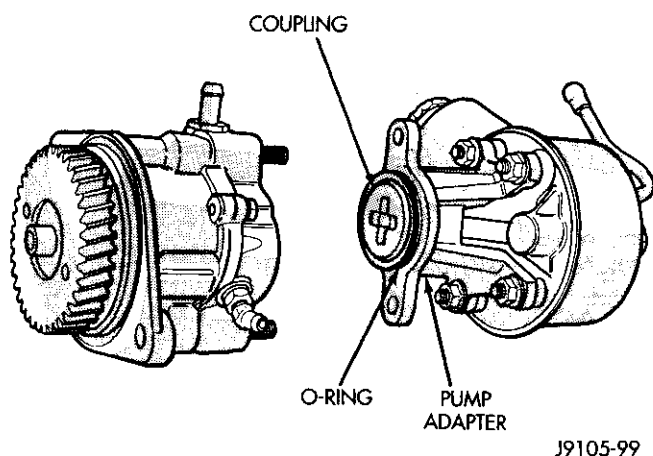


Fig. 39 Vacuum Pump Removed From Adapter

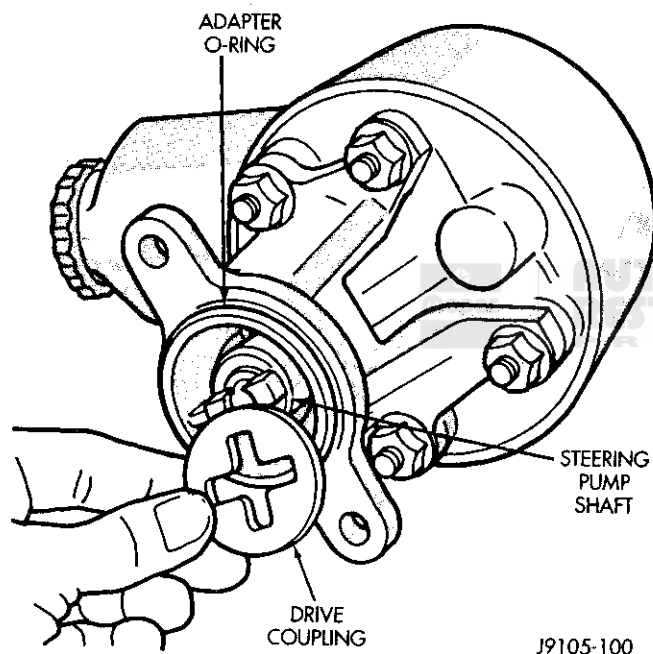


Fig. 40 Pump Drive Coupling

INSTALLATION

- (1) Clean and lubricate pump shaft with engine oil.
- (2) Install spacers on steering pump studs.
- (3) Install O-ring on adapter.
- (4) Position adapter on pump studs.
- (5) Install attaching nuts on outboard stud and on the two upper pump studs. Do **not** install nut on lower, inboard stud at this time. Tighten nuts to 24 N·m (18 ft. lbs.).
- (6) Install coupling on pump shaft. Be sure coupling is securely engaged in shaft drive tangs.
- (7) Install vacuum pump on adapter. Rotate drive gear until tangs on pump shaft engage in coupling. Verify that pump is seated before installing attaching nuts.

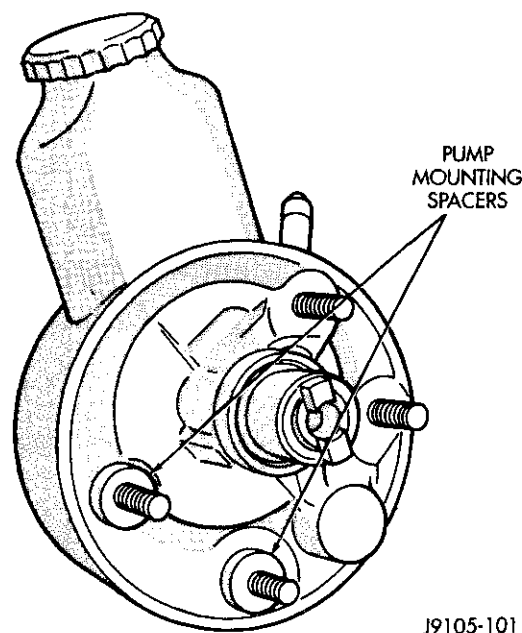


Fig. 41 Steering Pump Mounting Stud Spacer Locations

- (8) Install and tighten vacuum pump attaching nuts.
- (9) Inspect adapter O-ring and replace O-ring if cut or torn.
- (10) Lubricate adapter O-ring with engine oil.
- (11) Note position of drive slots in coupling (Fig. 42). Then rotate drive gear to align tangs on vacuum pump shaft with coupling.

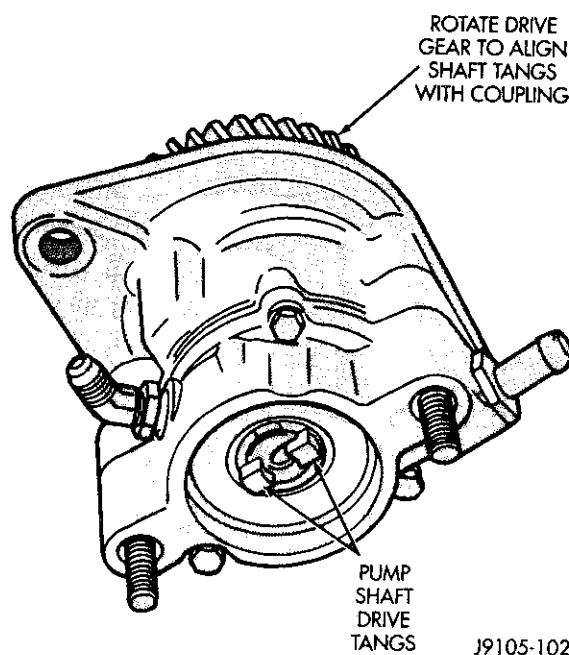


Fig. 42 Pump Shaft Drive Tangs

REMOVAL AND INSTALLATION (Continued)

(12) Verify that pump is seated in adapter and coupling.

(13) Install and tighten pump attaching nuts and washers.

(14) Position new gasket on vacuum pump mounting flange (Fig. 43). Use Mopar Perfect Seal, or silicone adhesive/sealer to hold gasket in place.

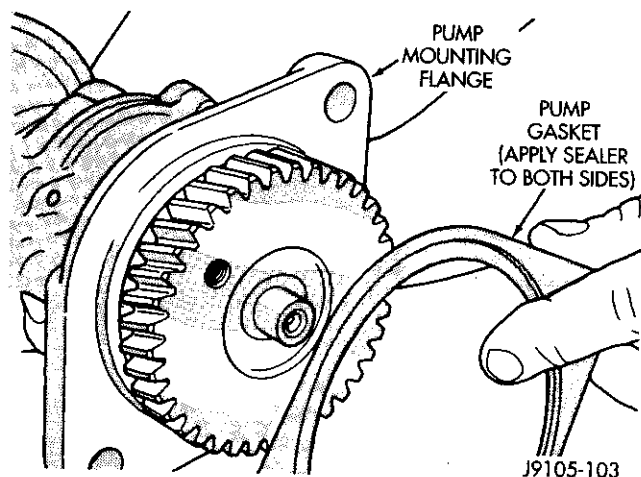


Fig. 43 Pump Mounting Flange Gasket

(15) Insert pump assembly upper attaching bolt in mounting flange and gasket. Use sealer or grease to hold bolt in place if necessary.

(16) Position pump assembly on engine and install upper bolt (Fig. 44). Tighten upper bolt only enough to hold assembly in place at this time.

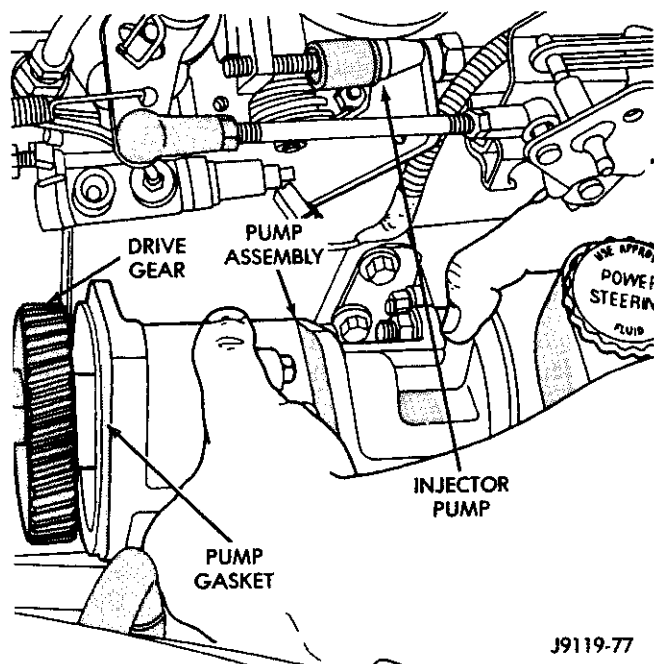


Fig. 44 Installing Pump Assembly On Engine

(17) Working from under vehicle, install pump assembly lower attaching bolt. Then tighten upper and lower bolt to 77 N·m (57 ft. lbs.).

(18) Position bracket on steering pump inboard stud. Then install remaining adapter attaching nut on stud. Tighten nut to 24 N·m (18 ft. lbs.).

(19) Connect oil feed line to vacuum pump connector and tighten line fitting.

(20) Install oil pressure sender and connect sender wires.

(21) Connect steering pump pressure and return lines to pump. Tighten pressure line fitting to 30 N·m (22 ft. lbs.).

(22) Connect vacuum hose to vacuum pump.

(23) Connect battery cables, if removed.

(24) Fill power steering pump reservoir.

(25) Purge air from steering pump lines. Start engine and slowly turn steering wheel left and right to circulate fluid and purge air from system.

(26) Stop engine and top off power steering reservoir fluid level.

(27) Start engine and check brake and steering operation. Verify that power brake booster is providing vacuum assist and firm brake pedal is obtained. Then verify that steering action is correct. Do this before moving vehicle.

DISC BRAKE CALIPER**REMOVAL**

(1) Raise vehicle.

(2) Remove wheel and tire assemblies.

(3) Press caliper piston back into bore with large flat blade screwdriver (Fig. 45). Use large C-clamp to bottom piston in bore if additional force is required.

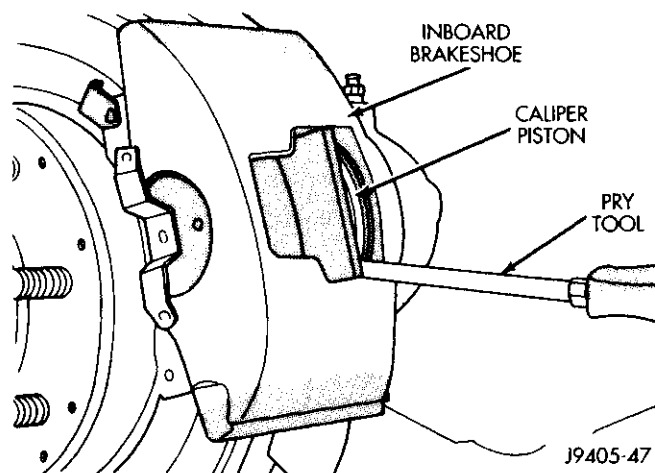


Fig. 45 Pressing Caliper Piston Into Bore

REMOVAL AND INSTALLATION (Continued)

(4) Remove caliper mounting bolts with 3/8 hex wrench or socket (Fig. 46) and (Fig. 47).

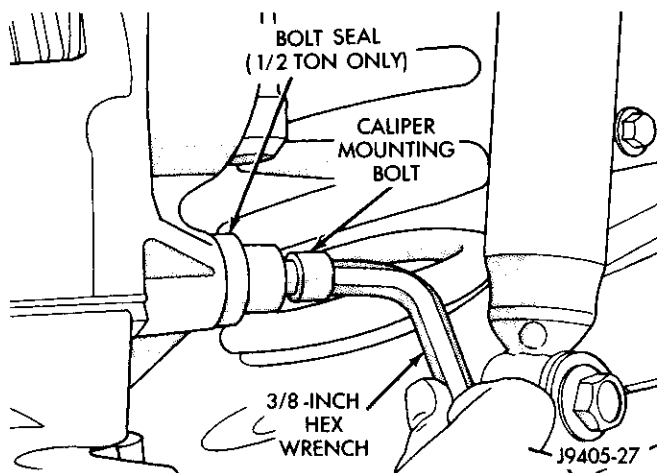


Fig. 46 Caliper Mounting Bolt (1/2 Ton)

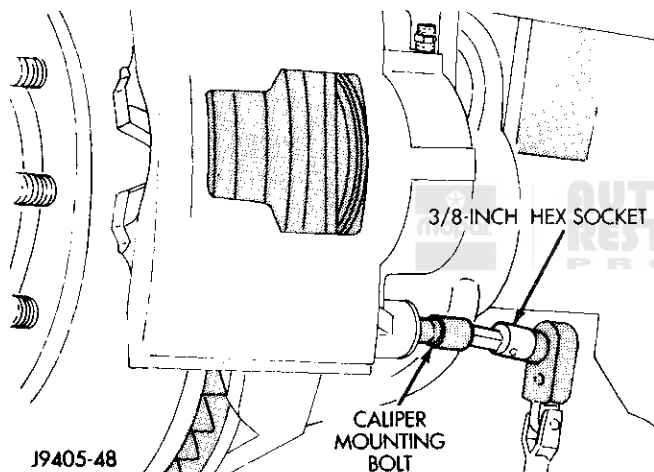


Fig. 47 Caliper Mounting Bolt (3/4 and 1 Ton)

(5) Rotate caliper rearward off rotor and out of steering knuckle support ledges (Fig. 48).

(6) Remove front brake hose fitting bolt completely and remove caliper and brakeshoes as assembly.

(7) Cover open end of front brake hose fitting to prevent dirt entry.

INSTALLATION

(1) Clean caliper and steering knuckle slide surfaces with wire brush. Then apply coat of Mopar multi-mileage grease, or Dow/GE silicone grease to slide surfaces.

(2) Install caliper over rotor and seat it on steering knuckle mounting arms.

(3) Start caliper mounting bolts by hand to avoid cross threading. Then tighten mounting bolts to 51 N·m (38 ft.lbs.).

(4) Connect brake hose to caliper (Fig. 49) and (Fig. 50). **Inure brake hose fitting is correctly**

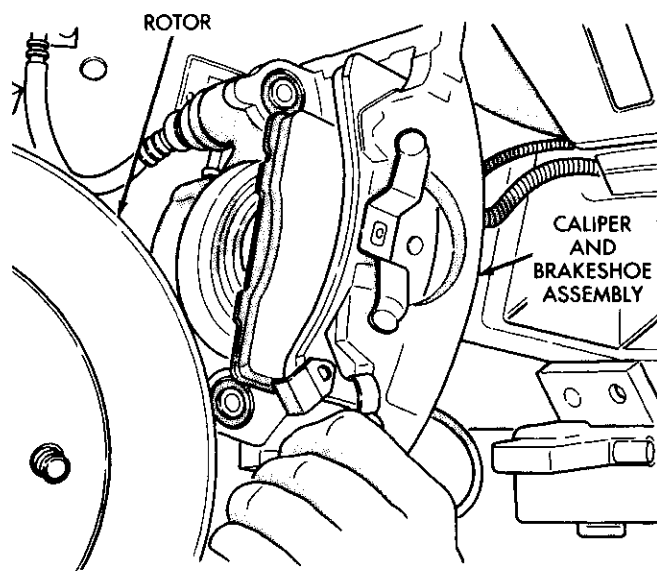


Fig. 48 Caliper Removal/Installation

seated against locating shoulder on caliper and hose is not twisted, or kinked before tightening fitting bolt.

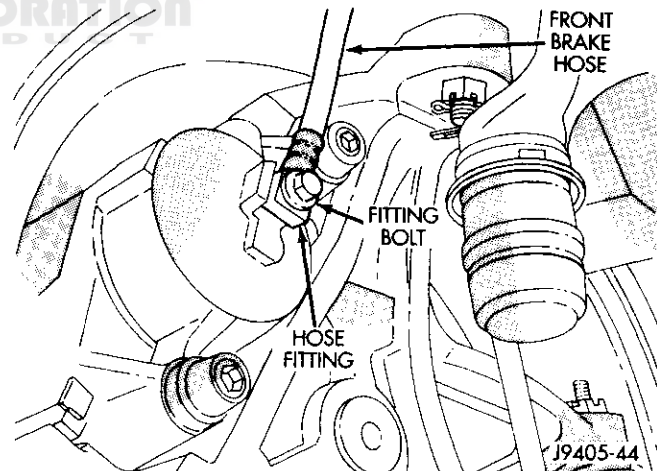


Fig. 49 Front Brake Hose Attachment

(5) Fill and bleed brake system. Refer to procedure in appropriate antilock brake section.

(6) Install wheel and tire assemblies and lower vehicle.

DISC BRAKESHOE

REMOVAL

- (1) Raise and support vehicle.
- (2) Remove wheel and tire assemblies.

REMOVAL AND INSTALLATION (Continued)

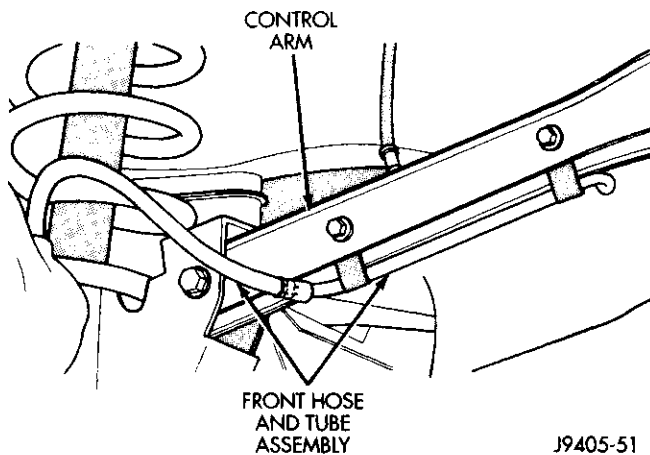


Fig. 50 Front Brake Hose Routing (4WD)

(3) Press caliper piston back into bore with large flat blade screwdriver. Use large C-clamp if more force is required to bottom piston in bore.

(4) Loosen bolt that secures front brake hose fitting bolt in caliper.

(5) Remove caliper mounting bolts with 3/8 hex wrench or socket.

(6) Rotate caliper rearward off rotor and out of steering knuckle support ledges.

(7) Remove inboard and outboard brakeshoes (Fig. 51) and (Fig. 52). Inboard shoe has spring clip that holds it in caliper piston. Tilt this shoe out at top to unseat clip. Outboard shoe has retaining spring that secures it in caliper. Unseat one spring end and rotate shoe out of caliper.

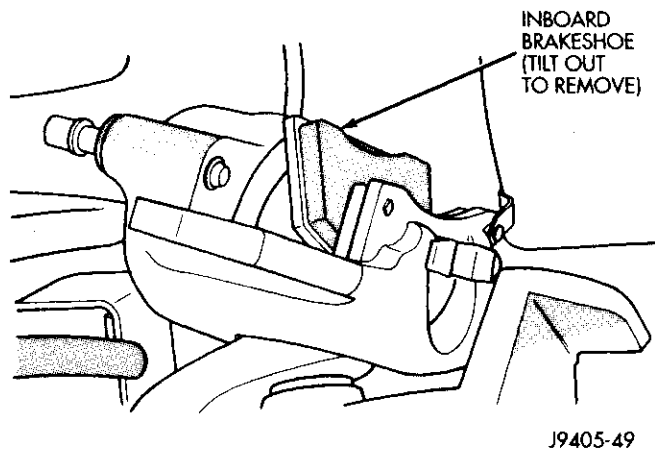


Fig. 51 Inboard Brakeshoe Removal

(8) Secure caliper to convenient chassis or suspension component with wire.

CAUTION: Do not allow the brake hose to support the caliper. Suspending the caliper by the brake hose can damage the hose and fitting joints. Use

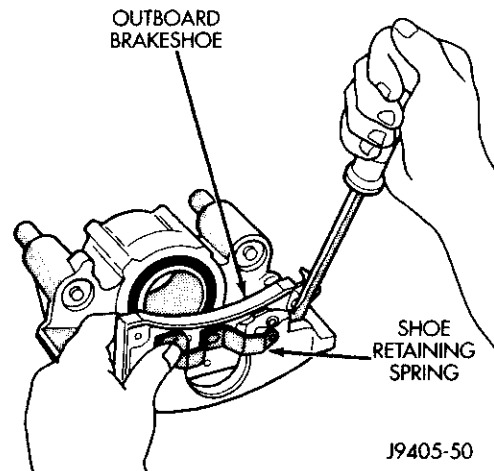


Fig. 52 Outboard Brakeshoe Removal

wire to support and secure the caliper to a chassis or suspension component.

If the brakeshoes will be reused, do not intermix them. Keep the brakeshoes with the caliper they were removed from.

INSTALLATION

NOTE: Replace riveted lining if worn to within 1.5 mm (1/16 in.) of rivet heads. Replace bonded lining if thickness is 3 mm (3/16 in.) or less.

(1) Clean caliper and steering knuckle slide surfaces with wire brush (Fig. 53). Then apply coat of Mopar multi-mileage grease to slide surfaces.

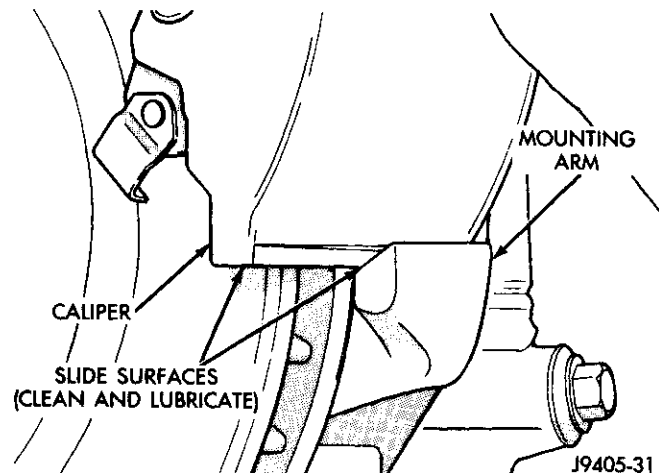


Fig. 53 Caliper And Steering Knuckle Slide Surfaces

(2) Lubricate caliper mounting bolts, collars, bushings and bores with Dow 111, or GE 661 silicone grease as follows:

REMOVAL AND INSTALLATION (Continued)

- 1/2 ton models with 75 mm caliper, apply silicone grease to mounting pins and collars. Then fill space between bushings in caliper (Fig. 54).
- 3/4 and 1 ton models with 80 or 86 mm calipers, coat mounting pin and interior of bushing with silicone grease (Fig. 55).

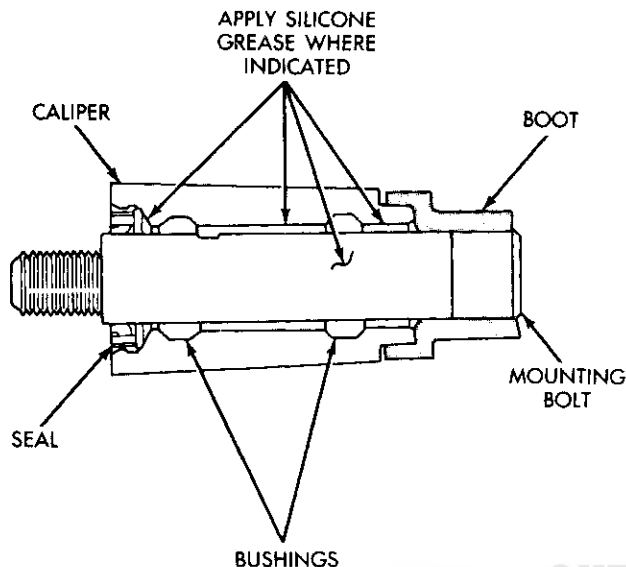


Fig. 54 Mounting Bolt Lubrication (75mm Caliper)

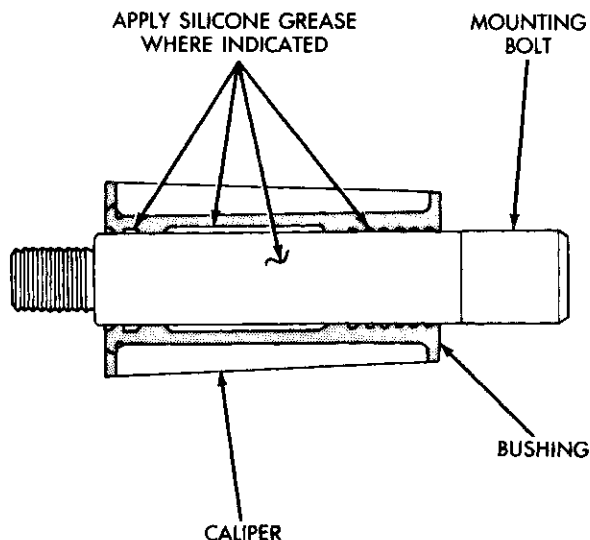


Fig. 55 Mounting Bolt Lubrication (80 or 86mm Caliper)

- (3) Install inboard brakeshoe in caliper. Be sure spring clip on shoe is properly aligned and seated in caliper piston (Fig. 56).

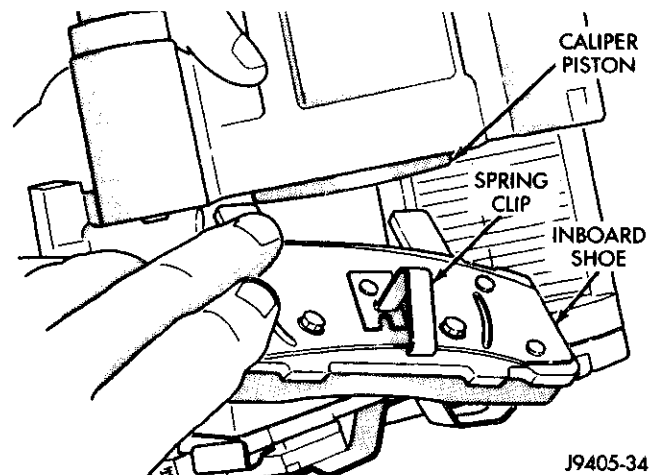


Fig. 56 Inboard Brakeshoe Installation

- (4) Install outboard brakeshoe in caliper. Be sure spring ends are seated in dimples in caliper (Fig. 57).

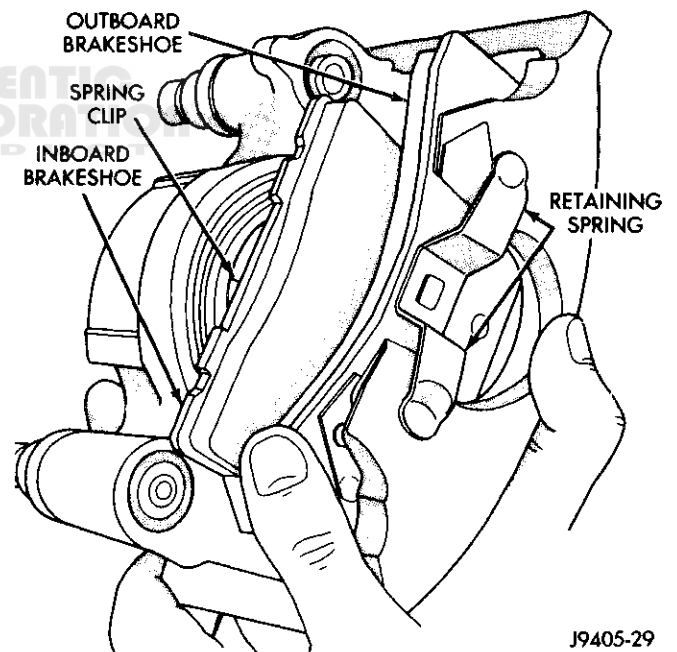


Fig. 57 Brakeshoe Position In Caliper

- (5) Install caliper over rotor and into steering knuckle mounting arms (Fig. 58). **Be sure caliper is seated flush on mounting arm surfaces as shown.**

- (6) Start caliper mounting bolts by hand to avoid cross threading. Then tighten mounting bolts to 51 N·m (38 ft. lbs.) torque.

- (7) Install wheel and tire assemblies.

- (8) Lower vehicle and tighten wheel lug nuts to following torque:

REMOVAL AND INSTALLATION (Continued)

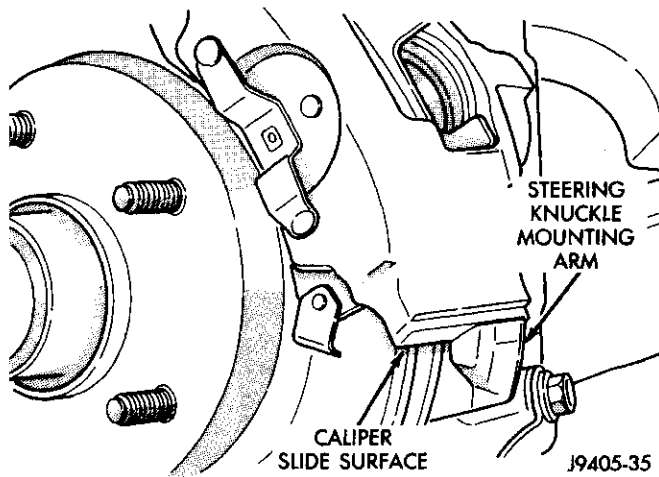


Fig. 58 Caliper Installation

- 108-150 N·m (80-110 ft. lbs.) on 5 stud wheel
- 163-203 N·m (120-150 ft. lbs.) on 8 stud single wheel

(9) Pump brake pedal to reseal caliper pistons and brakeshoes. **Do not move vehicle until shoes have been properly seated.**

(10) Check brake fluid level and add fluid if necessary.

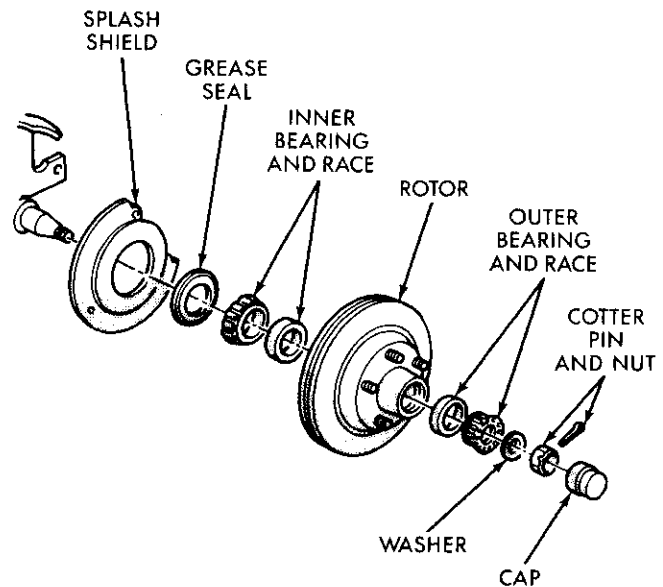
DISC BRAKE ROTOR (WITH TAPERED BEARINGS)

REMOVAL

- (1) Raise vehicle.
- (2) Remove wheel and tire assembly.
- (3) Remove caliper from rotor.
- (4) On models with removable adapter hub, remove hub from rotor.
- (5) On models with one-piece rotor and hub assembly, remove grease cap that covers cotter pin and hub nut.
- (6) Remove grease cap from hub. On models with long adapter, use long pry tool with angled end to remove grease cap. Pry against flats at each side of cap to loosen and remove it.
- (7) Remove cotter pin from spindle and wheel bearing adjusting nut (Fig. 59).
- (8) Remove locknut from wheel bearing adjusting nut. Then remove thrust washer and outer wheel bearing.
- (9) Remove rotor and hub assembly from spindle.
- (10) Inspect wheel bearings and interior of hub. If bearings need repacking, remove grease seal and inner wheel bearing from rotor hub.

INSTALLATION

- (1) Repack wheel bearings with Mopar high temperature bearing grease. Apply grease to bearing races as well. Then install inner bearing in hub and install new grease seal.



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Fig. 59 Rotor And Hub Assembly (With Tapered Bearings)

(2) Apply liberal coat of bearing grease to spindle, interior of rotor hub, grease seal lip and seal surface of spindle.

(3) Install rotor and hub assembly on spindle.

(4) Install outer wheel bearing thrust washer and bearing adjusting nut. Tighten nut only enough to remove end play at this time.

(5) Install disc brake caliper. **Do not seat caliper pistons at this time. Pistons must not be seated until after wheel bearing adjustment has been completed.**

(6) On models with removable hub adapter install adapter on rotor.

(7) Install wheel and tire assembly. Tighten wheel nuts snug but not to final torque at this time.

(8) Adjust wheel bearings by rotate wheel and fully tighten bearing adjusting nut to seat bearings. Loosen and tighten bearing adjusting nut once again while rotating wheel.

(9) Continue rotating wheel and back off adjusting nut until wheel end play is no more than 0.025 to 0.051 mm (0.001 to 0.002 in.).

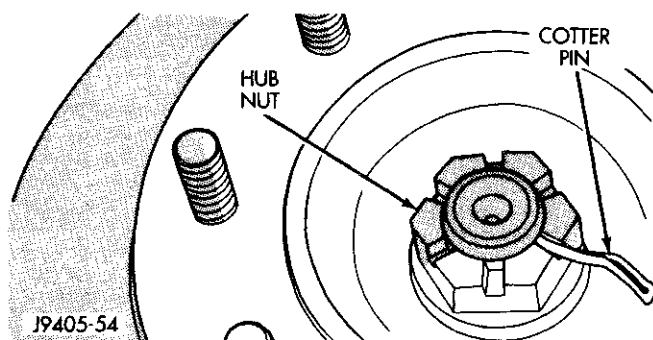
(10) Install nut lock on adjusting nut and install new cotter pin. Adjusting nut can be tightened slightly to align cotter pin holes if necessary. Verify that wheel bearing adjustment is still OK.

(11) Install grease cap and wheel cover/hub cap.

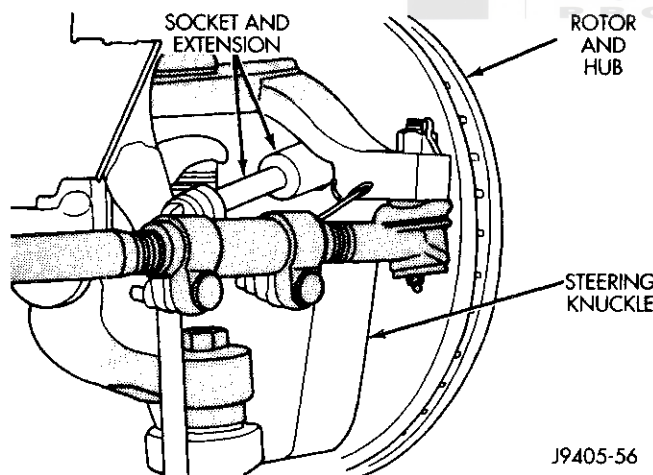
(12) Tighten lug nuts to proper torque.

REMOVAL AND INSTALLATION (Continued)**DISC BRAKE ROTOR (WITH UNIT BEARINGS)****REMOVAL**

- (1) Raise vehicle.
- (2) Remove wheel and tire assembly.
- (3) Remove caliper from rotor.
- (4) On 1500 model vehicles remove rotor.
- (5) On models with removable adapter hub, remove hub from rotor.
- (6) Remove cotter pin from rotor hub nut and remove nut (Fig. 60).

**Fig. 60 Hub Nut Cotter Pin**

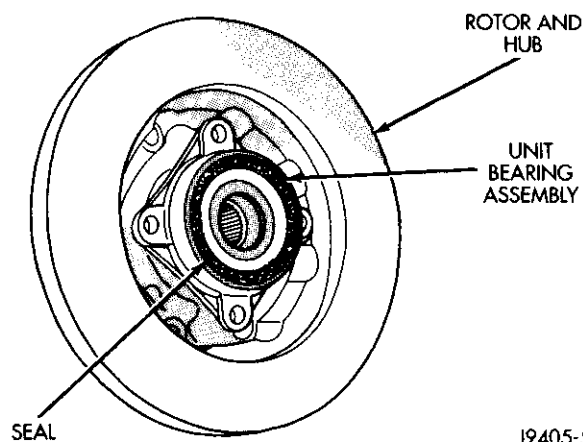
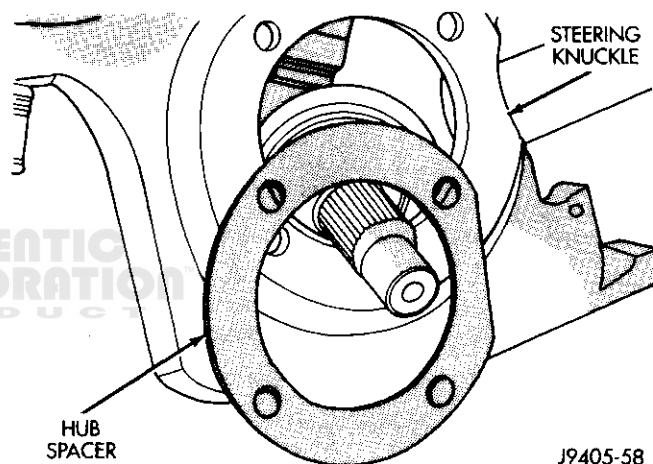
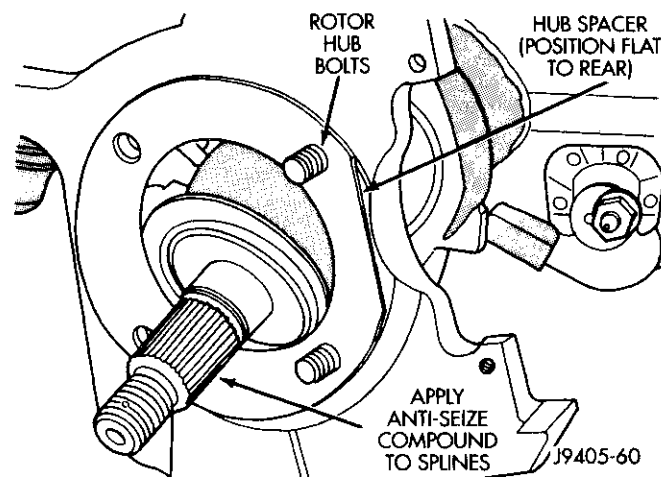
- (7) Remove bolts that secure rotor and hub to steering knuckle from inboard (back) side of steering knuckle (Fig. 61).

**Fig. 61 Rotor And Hub Attaching Bolts**

- (8) Remove rotor and hub assembly (Fig. 62). Replace bearing assembly if damaged.
- (9) Remove hub spacer from steering knuckle (Fig. 63). Note spacer position for installation reference.

INSTALLATION

- (1) Apply liberal quantity of Mopar, or Permatex anti-seize compound to splines of front drive shaft (Fig. 64).
- (2) Replace grease seal in steering knuckle if damaged.

**Fig. 62 Rotor Hub And Unit Wheel Bearing Assembly****Fig. 63 Hub Spacer****Fig. 64 Hub Spacer Positioning**

- (3) Insert two rearmost, top and bottom rotor hub bolts in steering knuckle. Insert bolts through back

REMOVAL AND INSTALLATION (Continued)

side of knuckle so they extend out front face as shown.

(4) Position hub spacer on bolts just installed in knuckle. Be sure flat on spacer is positioned toward rear. Use chassis grease to hold spacer in place on knuckle.

(5) Apply 1-2 drops of Mopar Lock N' Seal, or Loctite 242 to threads of rotor and hub retaining bolts.

(6) Align rotor hub with drive shaft. Then start shaft into rotor hub splines.

(7) Align bolt holes in unit bearing flange with bolts previously installed in knuckle. Then thread bolts into bearing flange far enough to hold assembly in place.

(8) Install remaining rotor retaining bolts. Tighten all bolts securely.

(9) Install washer and hub nut. Tighten nut securely.

(10) Install new cotter pin in hub nut. Tighten nut as needed to align cotter pin hole in shaft with opening in nut.

(11) Install disc brake caliper.

(12) Install wheel and tire assemblies and lower vehicle.

(13) Apply brakes several times to reseal brake-shoes and caliper piston. Do not move vehicle until firm brake pedal is obtained.

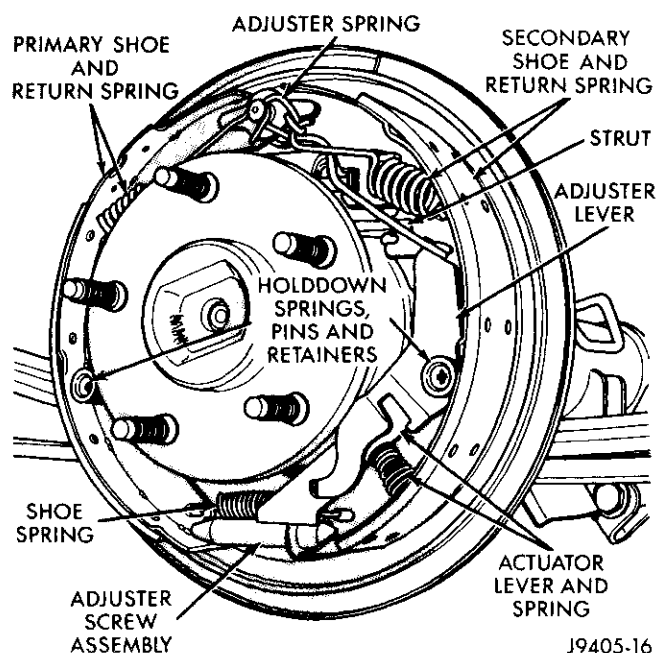
FRONT WHEEL BEARING

On models with tapered roller front wheel bearings, the bearings and races can be serviced when necessary. The bearing races do not require special tools for removal. The race can be removed with a long tapered brass drift. Race installation is performed with a bearing race driver set.

On vehicles with unit style hub bearings the unit is a bolted to the knuckle. 2500 and 3500 model vehicles with unit style hub bearing have the disc brake rotor pressed onto the unit with the wheel studs. The wheel studs must be pressed or driven out in order to separate the rotor from the hub bearing for replacement.

BRAKESHOE (11 INCH BRAKE)**REMOVAL**

- (1) Raise vehicle.
- (2) Remove rear wheels.
- (3) Remove brake drums.
- (4) Remove primary (front) brakeshoe return spring (Fig. 65) and (Fig. 66). Use brake spring pliers to unseat and remove spring from anchor pin.
- (5) Remove primary shoe holddown spring, pin and retainers. Use brake spring tool to rotate retainers and disengage pins.
- (6) Tilt primary brakeshoe outward. Then disengage shoe spring and remove primary brakeshoe.

**Fig. 65 Brakeshoe Mounting**

(7) Remove adjuster screw, shoe spring and park brake strut and spring.

CAUTION: The adjuster screw assemblies have different threads and must be kept separate. The driver side adjuster screw has a right hand thread. And the passenger side adjuster screw has a left hand thread. Do not interchange them as the brake shoes will not adjust properly.

(8) Remove secondary brakeshoe holddown spring, pin and retainers.

(9) Pull adjuster lever and retainer out of secondary brakeshoe. Then rotate brakeshoe out and up and remove adjuster spring and secondary shoe return spring.

(10) Disconnect park brake cable from lever on secondary brakeshoe. Then remove brakeshoe.

(11) If brakeshoes are to be replaced, remove E-clip (or U-clip) that attaches park brake lever to secondary brakeshoe and remove lever.

INSTALLATION

(1) Clean support plate with Mopar brake cleaner. Then smooth shoe contact pads with wire brush or emery cloth.

(2) Apply coat of Mopar multi-mileage, or high temp bearing grease to each shoe contact pad on support plate (Fig. 67).

(3) Lubricate adjuster levers and anchor pin and shoe contact surfaces on support plate with Mopar multi-mileage grease, or high temp bearing grease.

(4) Clean and check operation of adjuster screw assemblies. Make sure each screw assembly rotates

REMOVAL AND INSTALLATION (Continued)

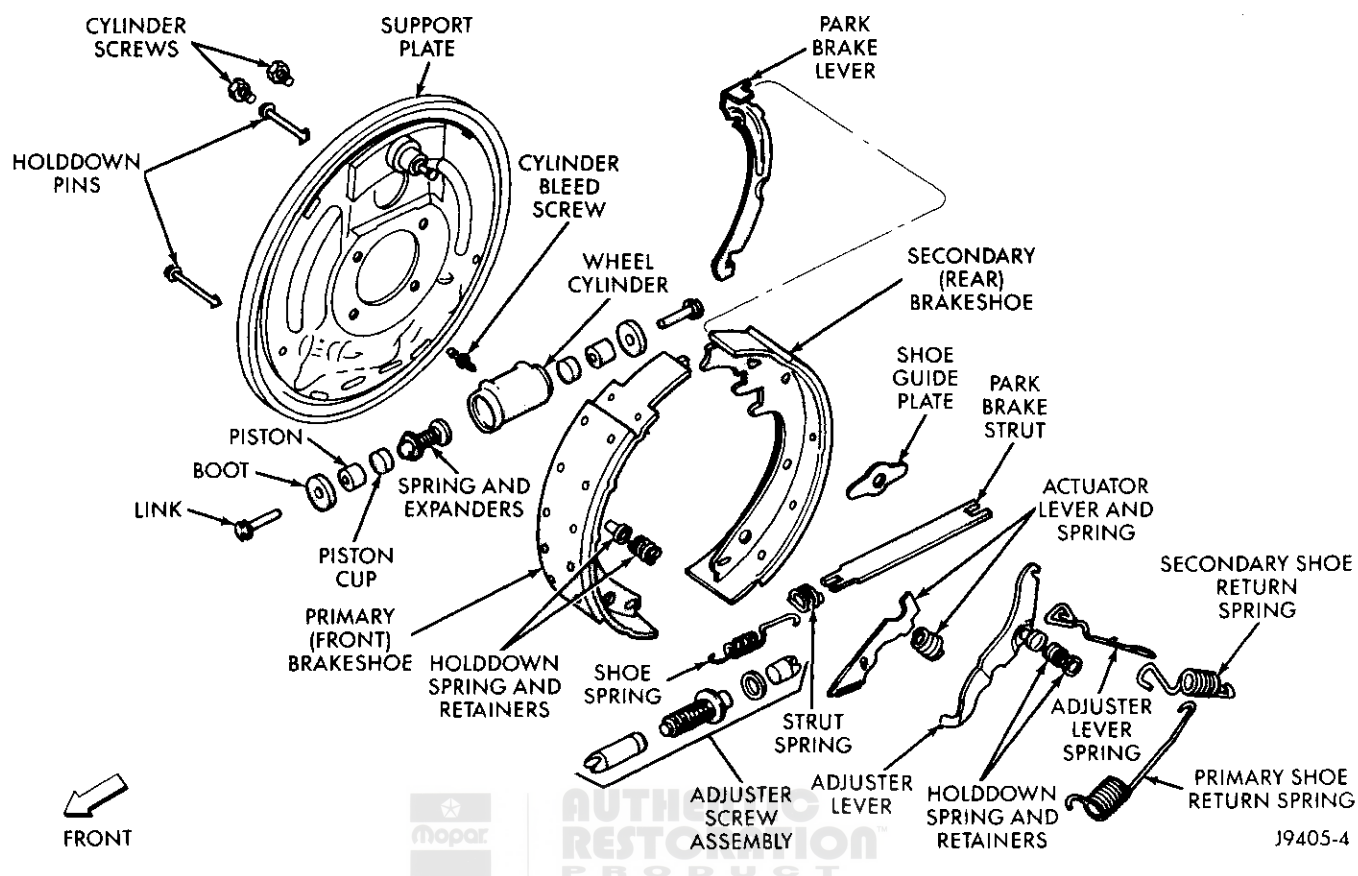


Fig. 66 Brakeshoes and Hardware

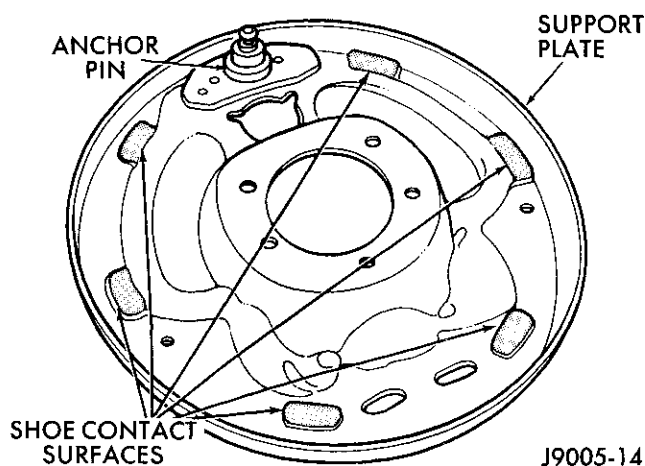


Fig. 67 Typical Brakeshoe Contact Pad Locations

freely. Lubricate screw threads with Mopar spray lube. Replace either assembly if threads are heavily rusted, corroded, or damaged.

(5) Attach park brake lever to secondary brake shoe. Use new U-clip to secure lever to shoe. If U-clip is used to secure shoe, pinch clip together with channel lock pliers to secure it. If E-clip is used, be sure clip is fully seated in notch.

(6) Attach park brake cable to lever.

(7) Position adjuster lever on secondary brake shoe. Then install spring retainer with shoulder on in lever and into shoe.

(8) Position secondary brake shoe on support plate. Use new holddown spring, pin and retainer to secure shoe and adjuster lever.

(9) Attach shoe spring to secondary brake shoe. Connect long end of spring in secondary shoe.

(10) Engage parking brake strut in secondary brake shoe and install oval shaped spring on opposite end of strut (spring end of strut goes in primary shoe).

(11) Install primary brake shoe on support plate. Use new holddown spring, pin and retainers to secure shoe. Be sure parking brake strut is seated in both brakeshoes.

(12) Install actuator lever and spring. Hook actuator lever under adjuster lever as shown. Large diameter end of spring goes on shoe and small end on lever.

(13) Install adjuster screw assembly. Be sure star wheel is positioned adjacent to adjuster lever and that notches in buttons are properly seated on brake shoes.

REMOVAL AND INSTALLATION (Continued)

CAUTION: Be sure the adjuster screws are installed on the correct side. The driver side adjuster screw has right hand threads and the passenger side has left hand threads. Also be sure the short end of the screw is toward the secondary brakeshoe.

- (14) Attach shoe spring to primary brakeshoe.
- (15) Install guide plate on anchor pin.
- (16) Attach adjuster spring to adjuster lever.
- (17) Install secondary brakeshoe return spring in shoe.
- (18) Attach secondary shoe return spring to adjuster spring. Then install adjuster spring on anchor pin.
- (19) Install primary brakeshoe return spring.
- (20) Verify that adjuster and return springs are properly installed.
- (21) Adjust brakeshoes to drum with brake gauge.
- (22) Install brake drum and wheel and tire assemblies.
- (23) Lower vehicle.

BRAKESHOE (13-INCH BRAKE)**REMOVAL**

- (1) Raise vehicle.
- (2) Remove rear wheel and tire assemblies.
- (3) Remove brake drums.

(4) Remove primary (front) brakeshoe return spring from anchor pin with brake spring pliers (Fig. 68).

(5) Remove primary brakeshoe holddown spring, pin and retainers with holddown spring tool.

(6) Disconnect shoe spring and remove primary brakeshoe and parking brake lever strut.

(7) Remove adjuster screw assembly.

(8) Remove secondary brakeshoe holddown spring, pin and retainers. Then remove adjuster lever, spring and spring retainer assembly. It is not necessary to disassemble adjuster lever components unless they are worn, or damaged.

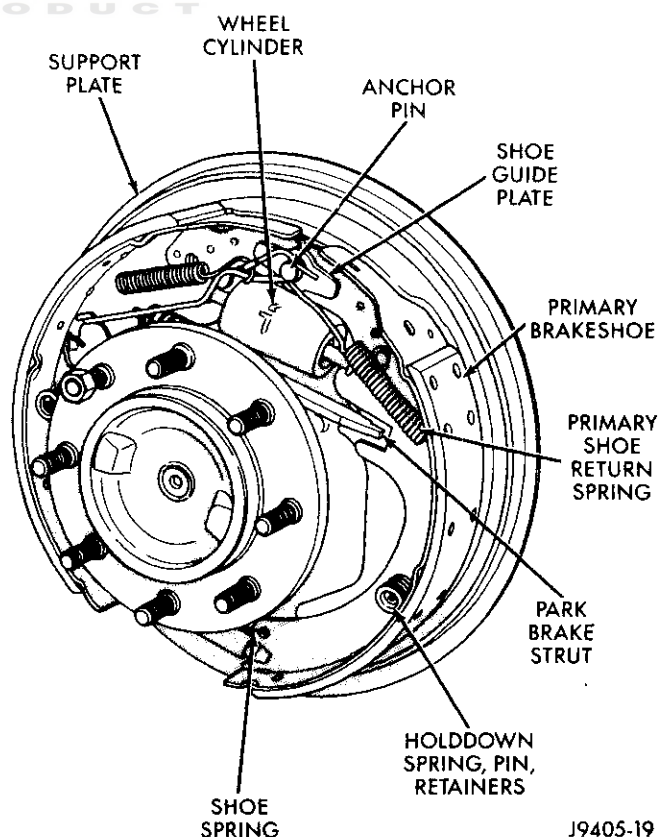
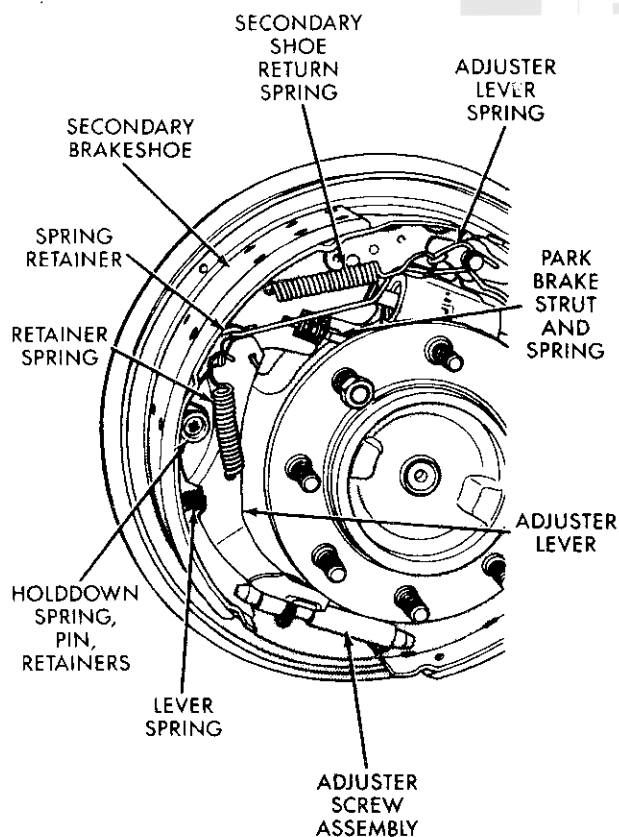
(9) Disconnect parking brake cable from lever attached to secondary brakeshoe. Then remove brakeshoe.

(10) If brakeshoes are to be replaced, remove E-clip attaching parking brake lever to secondary brakeshoe and remove lever.

(11) Inspect wheel cylinder. If leakage is evident, remove and overhaul cylinder. Refer to overhaul procedure in this section.

INSTALLATION

(1) Clean support plate with Mopar brake cleaner. Then smooth shoe contact pads with wire brush or emery cloth.



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Fig. 68 Brakeshoes and Hardware (13 Inch Brake)

REMOVAL AND INSTALLATION (Continued)

(2) Lubricate adjuster levers and anchor pin and shoe contact surfaces on support plate with Mopar multi-mileage grease, or high temp bearing grease.

(3) Clean and check operation of both adjuster screw assemblies. Replace either assembly if threads are heavily rusted, corroded, or damaged. Make sure each screw assembly rotates freely. Then lubricate adjuster screw threads with Mopar spray lube.

(4) Attach parking brake lever to secondary brake-shoe. Use new E-clip to secure lever to shoe. If lever is secured with U-clip, pinch new clip together with channel lock pliers to secure it.

(5) Attach parking brake cable to parking brake lever.

(6) If adjuster lever was disassembled, reassemble it as follows:

(a) Clamp adjuster lever in vise (Fig. 69). **Clamp center portion of lever in vise only. Do not clamp bottom end of lever in vise. Lever flange that rotates adjuster screw star wheel teeth is at bottom of lever and will be damaged.**

(b) Position small, hooked spring retainer in upper end of lever (Fig. 69). Be sure tang on retainer is securely engaged in hole in lever. Locking pliers can be used to hold retainer in place after positioning.

(c) Secure retainer in lever with retainer spring. Hook spring over end of retainer as shown (Fig. 70). Needle-nose pliers and number 2 Phillips screwdriver can be used to attach spring to lever and retainer.

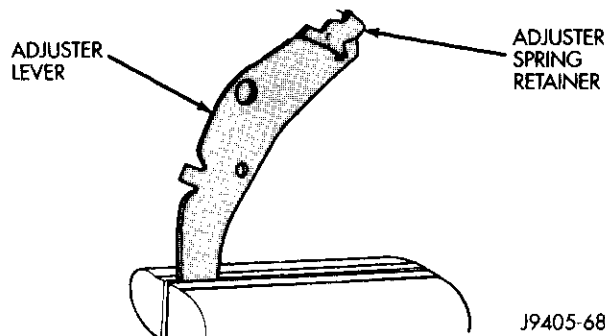


Fig. 69 Positioning Retainer On Adjuster Lever

(7) Install secondary brakeshoe and adjuster lever as follows:

(a) Insert secondary shoe holddown pin through support plate.

(b) Position secondary brakeshoe on support plate and insert pin through shoe.

(c) Position adjuster lever on brakeshoe and insert holddown spring inner retainer into lever and shoe. Inner retainer has shoulder on it which seats in lever and shoe.

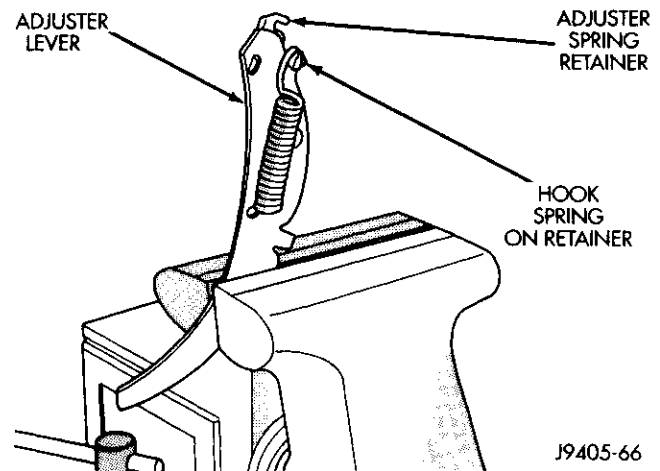


Fig. 70 Assembling Adjuster Lever, Spring And Retainer

(d) Install holddown spring over pin and seat it in inner retainer. Then install and seat holddown spring outer retainer on pin with holddown spring tool.

(8) Install adjuster lever spring between brakeshoe and lever. Be sure spring is seated on lever tang.

(9) Attach shoe spring to secondary brakeshoe. Long end of spring goes in secondary shoe.

(10) Install oval shaped spring on park brake strut and engage spring end of strut in secondary brake-shoe.

(11) Install primary brakeshoe on support plate. Use new holddown spring, pin and retainers to secure shoe. Be sure parking brake strut is seated in both brakeshoes.

(12) Install adjuster screw assembly. Be sure star wheel is positioned adjacent to adjuster lever and that notches in adjuster screw are properly seated on brakeshoes.

CAUTION: Be sure the adjuster screws were not intermixed and are installed on the correct side. The driver side adjuster screw has right hand threads and the passenger side has left hand threads. Also be sure the short end of the screw is toward the secondary brakeshoe.

(13) Attach shoe spring to primary brakeshoe. Use brake spring pliers and long screwdriver to seat spring in shoe.

(14) Install shoe guide plate on anchor pin.

(15) Attach adjuster spring to spring retainer at top of adjuster lever. Then seat spring on anchor pin with brake spring pliers.

(16) Install secondary brakeshoe return spring. Attach short end of spring to brakeshoe. Then hook opposite end on adjuster spring. Use brake spring

REMOVAL AND INSTALLATION (Continued)

pliers, or a long shank screwdriver to engage return spring in adjuster spring.

(17) Install primary brakeshoe return spring.

(18) Check component installation. Be sure adjuster screw, wheel cylinder links and park brake strut are all seated in brakeshoes.

(19) Adjust brakeshoes to drum with brake gauge.

(20) Install brake drums.

(21) Install wheel and tire assemblies and lower vehicle.

(22) Install wheel cover or hub cap.

WHEEL CYLINDER**REMOVAL**

(1) Raise vehicle and remove tire and wheel assembly.

(2) Remove brake drum.

(3) Lift adjuster lever away from adjuster screw. Then turn screw star wheel until screw is fully retracted.

(4) Remove brakeshoe return springs, adjuster spring and adjuster screw. Move upper ends of brakeshoes apart to provide removal clearance for wheel cylinder links.

(5) Disconnect brake line from wheel cylinder.

(6) Remove wheel cylinder attaching screws and remove cylinder from support plate

INSTALLATION

(1) Apply thin coat of Mopar silicone sealer to wheel cylinder mounting surface of support plate (Fig. 71). Sealer prevents road splash from entering brake drum past cylinder.

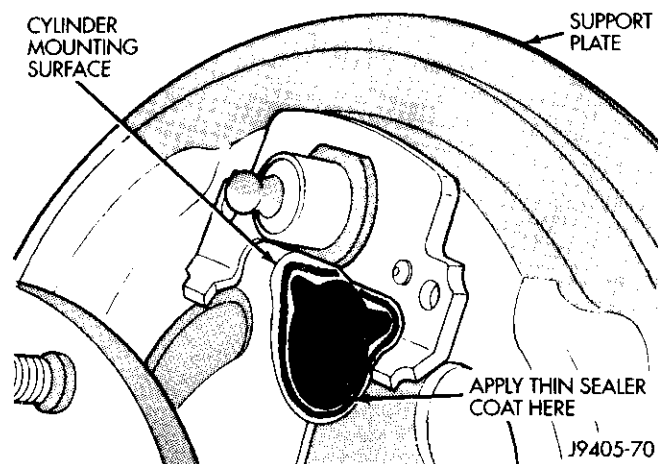


Fig. 71 Wheel Cylinder Mounting Surface

(2) Start brake line in cylinder inlet by hand. Do not tighten fitting at this time.

(3) Mount wheel cylinder on support plate and install cylinder attaching screws. Tighten screws to 20 N·m (15 ft. lbs.).

(4) Tighten brake line fitting to 13 N·m (115 in. lbs.).

(5) Install brakeshoe components.

(6) Adjust brakeshoes to drum using brake gauge.

(7) Install brake drum.

(8) Fill and bleed brake system.

(9) Install wheel and tire assemblies and lower vehicle.

BRAKE SUPPORT PLATE**REMOVAL**

(1) Remove wheel and tire assemblies.

(2) Remove brake drums

(3) Remove axle shaft, refer to Group 3 for procedures.

(4) Remove brakeshoes and hardware for access to parking brake cable.

(5) Remove parking brake cable from support plate.

(6) Disconnect brake line at wheel cylinder and remove cylinder.

(7) Remove bolts attaching support plate to axle and remove support plate.

INSTALLATION

(1) Apply thin bead of Mopar silicone sealer around axle mounting surface of support plate.

(2) Install support plate on axle flange. Tighten attaching bolts to 47-68 N·m (35-50 ft. lbs.).

(3) Apply thin bead of Mopar silicone sealer around wheel cylinder mounting surface. Install wheel cylinder on new support plate.

(4) Install parking brake cable in support plate.

(5) Install brakeshoes and hardware.

(6) Install axle shaft, refer to Group 3 for procedure.

(7) Adjust brakeshoes to drum with brake gauge.

(8) Install brake drums.

(9) Fill and bleed brake system.

(10) Install wheel and tire assemblies and lower vehicle.

FRONT PARKING BRAKE CABLE**REMOVAL**

(1) Remove knee bolster.

(2) Release parking brake pedal completely.

(3) Raise vehicle.

(4) Loosen tensioner nut to create slack in front cable and extension cable (Fig. 72).

(5) Disengage front cable from extension cable connector. Extension cable also be removed at this time if necessary.

(6) Lower vehicle.

REMOVAL AND INSTALLATION (Continued)

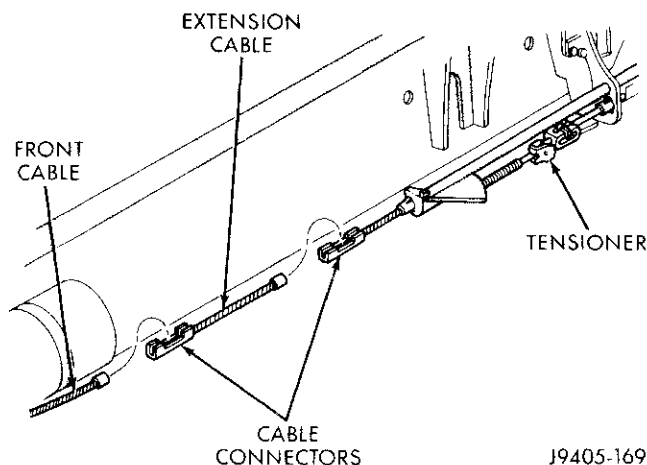


Fig. 72 Extension-To-Front Cable Attachment

(7) Roll back carpet and loosen cable grommet (Fig. 73). Then pull cable through floorpan grommet and remove cable.

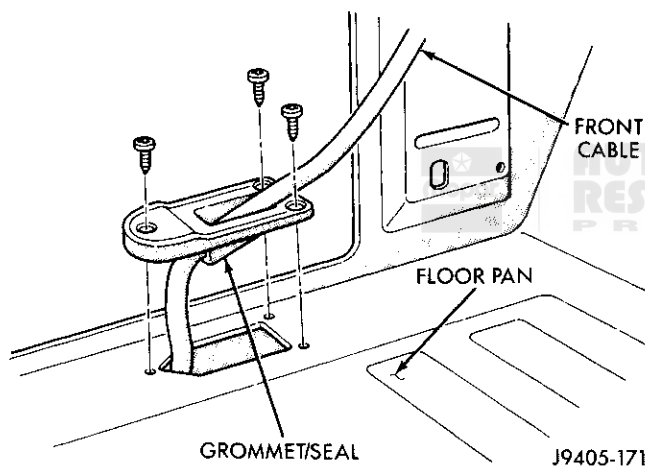


Fig. 73 Cable Grommet In Floorpan

(8) Disengage front cable from arm on foot pedal assembly (Fig. 74).

INSTALLATION

- (1) Insert new cable through floorpan grommet and up to arm on pedal assembly.
- (2) Hook cable T-connector in arm on pedal assembly.
- (3) Secure floorpan grommet/seal.
- (4) Realign floor carpet.
- (5) Install knee bolster.
- (6) Engage front cable and extension cable in cable connectors. Make sure right rear cable is secured in tensioner connector.
- (7) Adjust cable tensioner. Refer to procedure in this section.

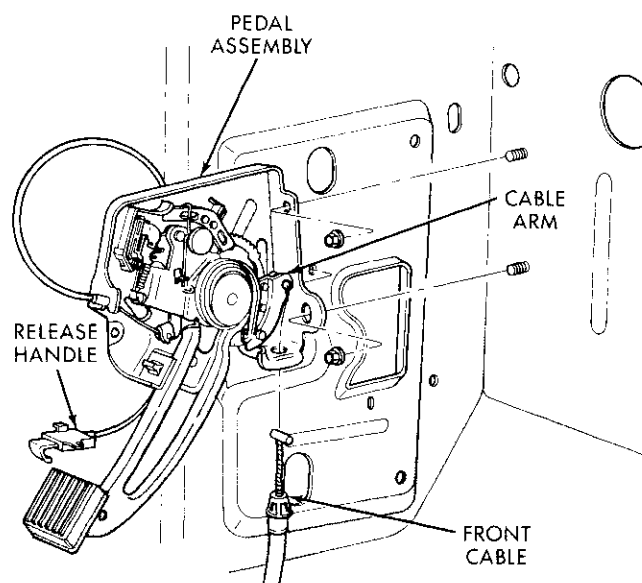


Fig. 74 Cable Attachment At Foot Pedal

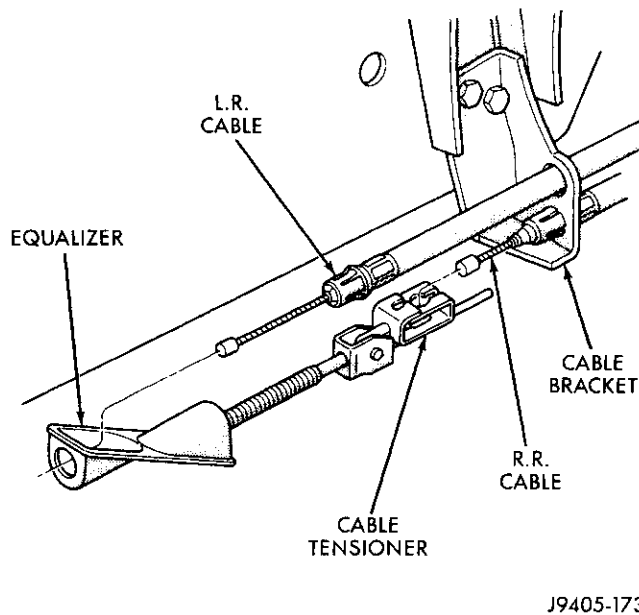
REAR PARK BRAKE CABLE

REMOVAL

- (1) Raise vehicle and remove necessary wheel and brake drum.
- (2) Remove secondary brakeshoe and disconnect cable from parking lever attached to secondary shoe.
- (3) Compress rear cable retainer with hose clamp or pliers and pull cable out of support plate.
- (4) Remove one (or both) cables reaction bracket on left rear frame rail.
- (5) Disengage rear cable from tensioner (Fig. 75).
- (6) Compress cable retainer with hose clamp or pliers and slide cable out of bracket.

INSTALLATION

- (1) Route new cable to rear brake support plate.
- (2) Insert cable through support plate, seat cable retainers and attach cable to parking brake lever on secondary brakeshoe.
- (3) Install brakeshoes.
- (4) Seat cable in body clips, reaction bracket, and frame bracket.
- (5) Connect cable to tensioner.
- (6) Adjust cable tensioner. Refer to procedure in this section.
- (7) Install wheel and tire assemblies.
- (8) Lower vehicle.
- (9) Verify parking brake operation.

REMOVAL AND INSTALLATION (Continued)

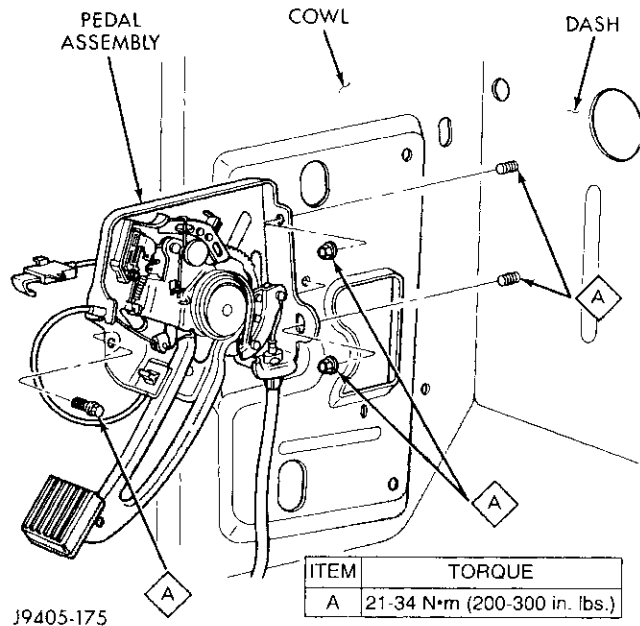
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Fig. 75 Cable And Tensioner Attachment**PARKING BRAKE PEDAL****REMOVAL**

- (1) Release parking brakes.
- (2) Raise vehicle.
- (3) Loosen cable tensioner nut at equalizer to create slack in front cable.
- (4) Lower vehicle.
- (5) Remove knee bolster.
- (6) Disconnect brakelamp wire from switch on pedal assembly.
- (7) Roll carpet back and loosen front cable grommet from floorpan.
- (8) Disengage cable end connector from arm on pedal assembly.
- (9) Remove bolts/nuts from pedal assembly and remove assembly (Fig. 76).

INSTALLATION

- (1) Position replacement pedal assembly on dash and cowl.
- (2) Install bolts/nuts and tighten to 21-34 N·m (200-300 in. lbs.).
- (3) Connect front cable to arm on pedal assembly.
- (4) Connect wires to brakelamp switch.
- (5) Install knee bolster.
- (6) Raise vehicle.
- (7) Adjust parking brake cable tensioner. Refer to procedure in this section.

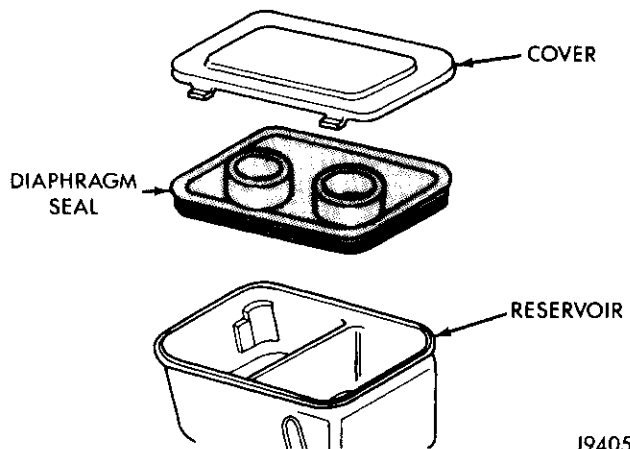


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Fig. 76 Parking Brake Pedal Mounting**DISASSEMBLY AND ASSEMBLY****MASTER CYLINDER****DISASSEMBLY**

The master cylinder primary piston is serviced as an assembly. Only the secondary piston can be disassembled for service.

- (1) Remove reservoir cover and seal (Fig. 77).



J9405-7

Fig. 77 Reservoir Seal And Cover

- (2) Drain reservoir fluid into drain container.
- (3) Clamp cylinder body in vise. Clamp vise jaws on one of the cylinder mounting ears as shown.
- (4) Remove reservoir with a rocking motion. Use a pry tool to help ease reservoir out of cylinder body and grommets (Fig. 78). **If reservoir is to be**

DISASSEMBLY AND ASSEMBLY (Continued)

replaced, note and record reservoir code letters.

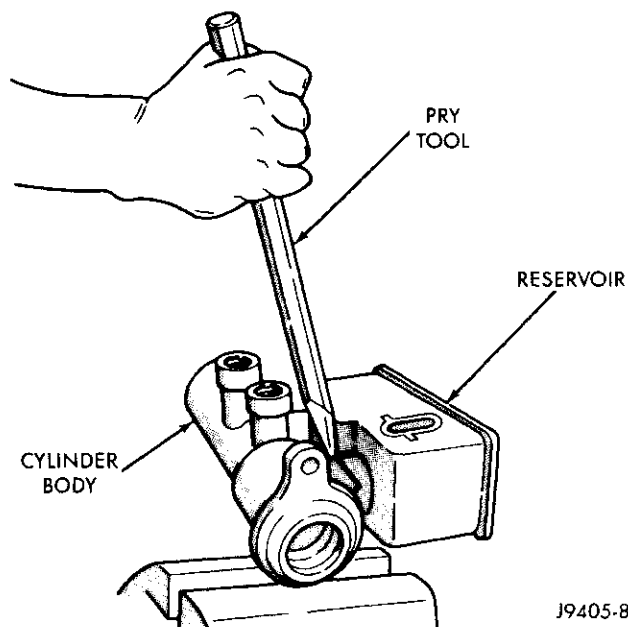


Fig. 78 Reservoir Removal

(5) Remove grommets from cylinder body (Fig. 79). Discard grommets as they are not reusable.

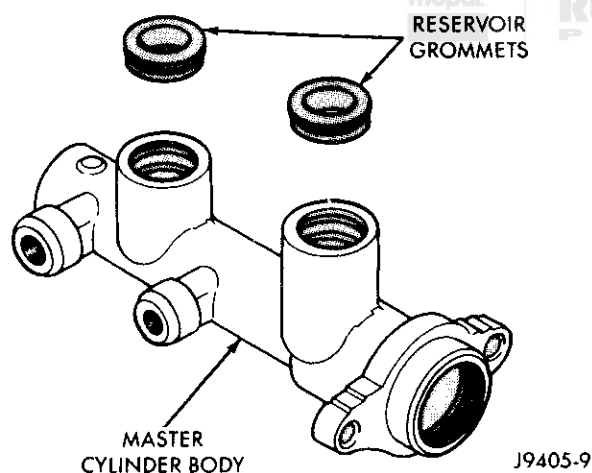


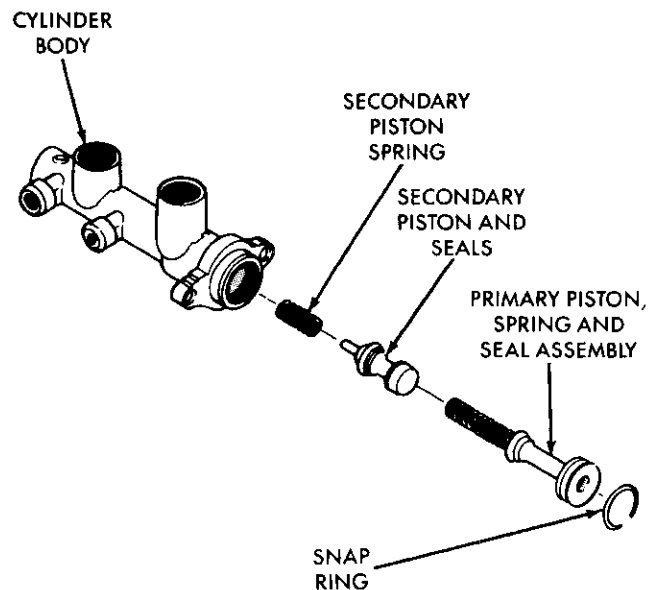
Fig. 79 Reservoir Grommet

(6) Remove master cylinder piston retaining snap ring with small pointed tool and flat blade screwdriver.

(7) Remove primary piston and spring assembly (Fig. 80). **Discard assembly, primary piston is only serviced as complete assembly.**

(8) Remove secondary piston by apply air pressure through rear outlet port to ease piston out of bore.

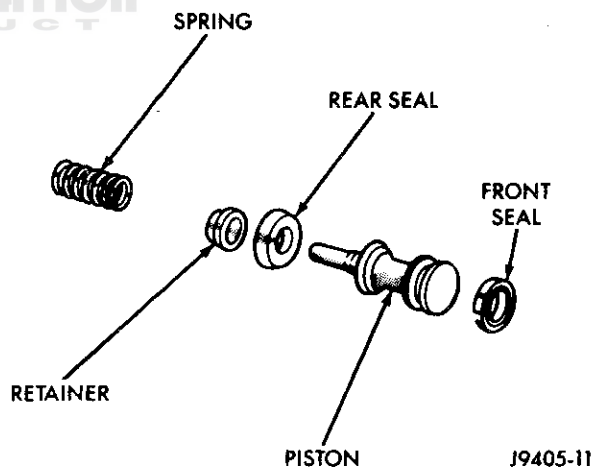
(9) Remove secondary piston spring by tilting the cylinder body downward so the spring slides out of bore.



J9405-10

Fig. 80 Master Cylinder

(10) Remove seal retainer from secondary piston. Then remove front and rear seals from piston (Fig. 81). Discard seals, spring, and retainer after these parts are not reusable.



J9405-11

Fig. 81 Secondary Piston Components

CLEANING AND INSPECTION

Clean the cylinder body and reservoir with Mopar brake cleaner only. Do not use any other type of cleaning solvent. Dry the cylinder parts with compressed air. The reservoir can be air dried or wiped dry with lint-free shop towels.

Inspect the cylinder bore. A light discoloration of the bore surface is normal and acceptable. However, replace the cylinder body if the bore is scored, pitted, or corroded.

DISASSEMBLY AND ASSEMBLY (Continued)

Inspect the cylinder cover and diaphragm seal. Replace the seal if torn, or distorted. Replace the cover if warped, cracked, or the snap fasteners are damaged.

Inspect the reservoir. A slight discoloration of the reservoir surface is normal. Replace the reservoir if distorted, cracked, or otherwise damaged.

Inspect the take up valve in the cylinder body. The valve should move freely and not be stuck or seized. The valve is not serviceable. It will be necessary to replace the cylinder body if the valve is faulty.

Inspect condition of the secondary piston. Replace the piston if it is scored, corroded, or doubt exists about its condition.

ASSEMBLY

(1) Coat cylinder body bore, piston components and reservoir grommets with fresh, clean brake fluid.

(2) Mount cylinder body in vise. Clamp one cylinder mounting ear in vise jaws.

(3) Assemble secondary piston components. Be careful when installing seals. Avoid distorting them during installation.

CAUTION: Do not use any kind of metal tool to ease piston seal installation in the cylinder bore. Metal tools will cut the seals and scratch the bore. If a tool is needed, use a small flexible item made from nylon, rubber or plastic only.

(4) Install secondary piston assembly (spring end first), in cylinder bore. **Do not force piston into bore. Work it into place with a twisting/turning motion.**

(5) Install primary piston in cylinder bore (spring end first). **Do not force piston into bore. Work it into place with a twisting/turning motion.**

(6) Insert piston retaining snap ring in cylinder body. Then push pistons inward with wood dowel and seat snap ring.

CAUTION: Be very sure the piston retaining snap ring is fully seated. Recheck snap ring installation before proceeding.

(7) Install new grommets on cylinder body.

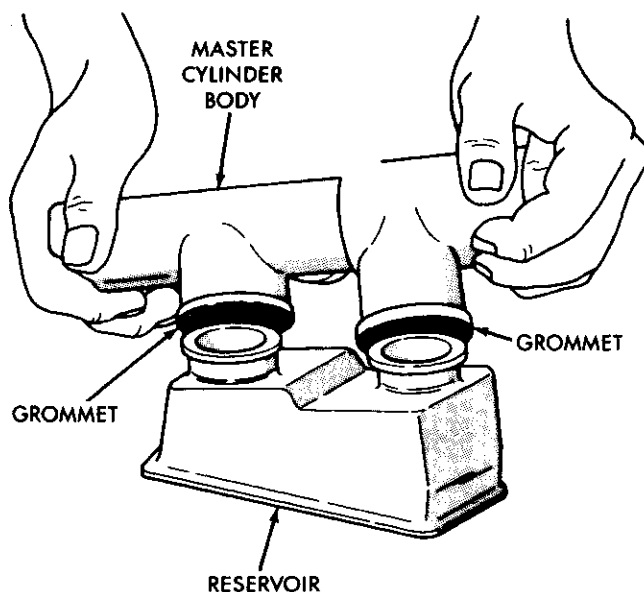
(8) Remove cylinder body from vise.

(9) Position reservoir on clean work surface with fluid inlet necks facing upward. Padding work surface with clean shop towels will keep reservoir in place during installation. It will also keep dirt out as well.

(10) Install cylinder body on reservoir by rocking the cylinder onto the reservoir necks (Fig. 82).

(11) Verify that reservoir is properly seated and that grommets have not slipped out of place.

(12) Bleed master cylinder on bench before installing it in vehicle.



J9405-12

Fig. 82 Assembling Reservoir**DISC BRAKE CALIPER****DISASSEMBLY**

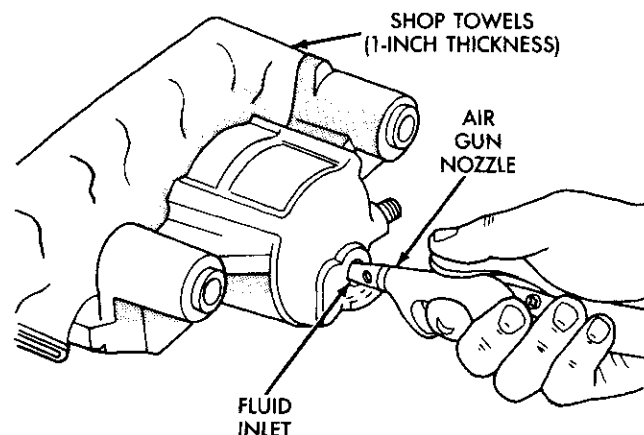
(1) Drain brake fluid from caliper.

(2) Remove brakeshoes from caliper.

(3) Pad interior of caliper with one-inch thickness of shop towels to cushion and protect caliper piston during removal (Fig. 83).

(4) Remove caliper piston with several **short bursts** of low pressure compressed air. Direct air through fluid inlet port to ease piston out of bore (Fig. 83).

CAUTION: Do not blow the piston out of the bore with sustained high pressure. This practice will result in a chipped, or cracked piston. In addition, **NEVER** attempt to catch the piston as it exits the bore. This will result in personal injury.

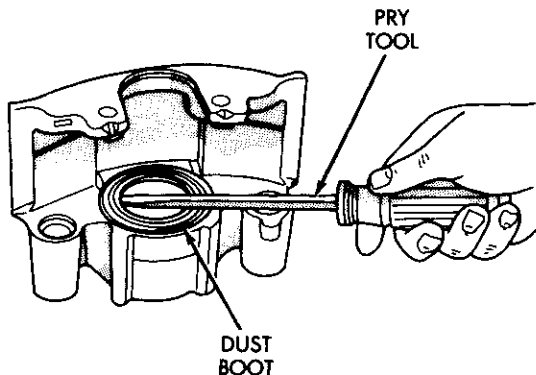


J9405-38

Fig. 83 Caliper Piston Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Remove piston dust boot with a suitable pry tool (Fig. 84). **Do not scratch piston bore while removing boot.** Discard dust boot as it is not reusable.



J9405-39

Fig. 84 Dust Boot Removal

(6) Remove piston seal from caliper and discard seal it is not reusable (Fig. 85) and (Fig. 86).

(7) Remove mounting bolts from calipers and inspect seals, boots, and bushings (Fig. 85) and (Fig.

86). Remove these components only if cut, worn, or damaged.

(8) Remove caliper bleed screw.

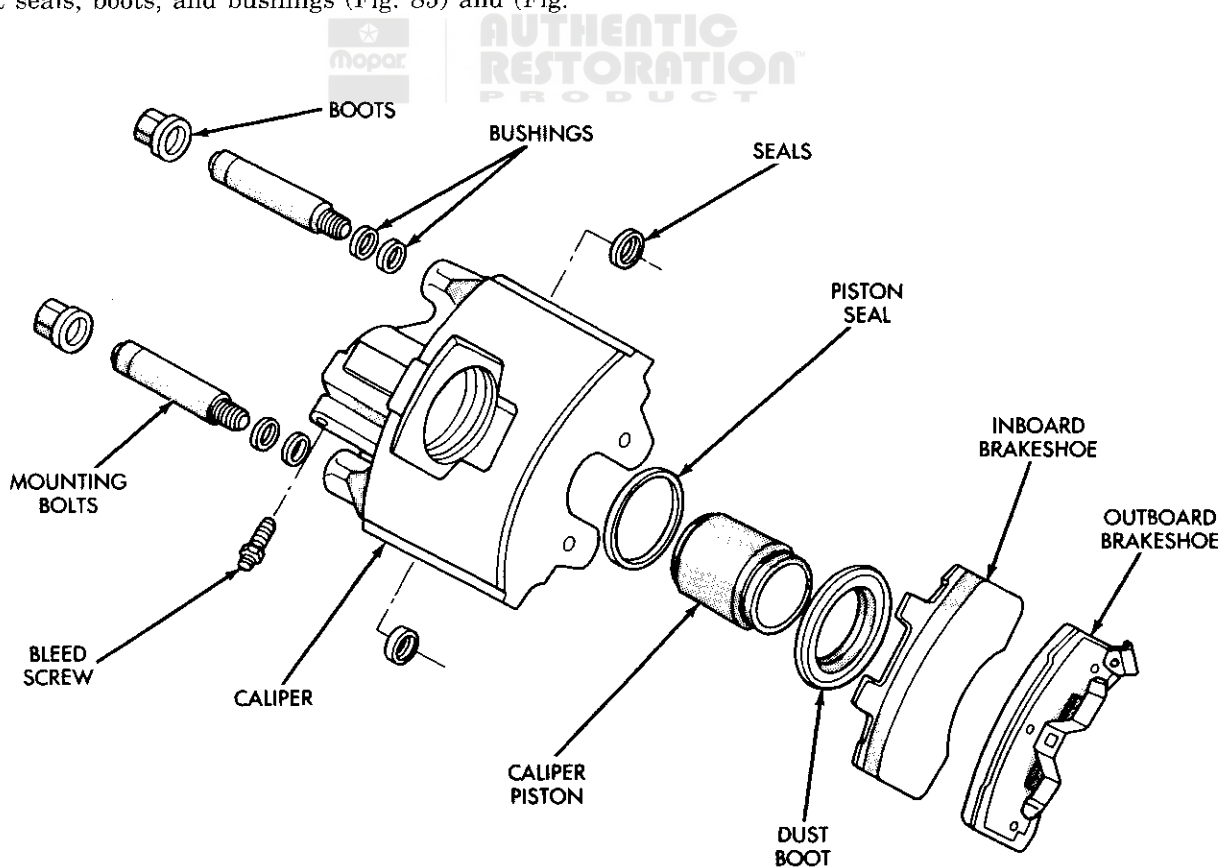
ASSEMBLY

NOTE: Be sure caliper assembly area of workbench is clean and dry. This is important as dust, dirt, foreign material, oil, or solvents can damage seals, harm piston surfaces and contaminate fluid.

(1) Clean the caliper and piston with Mopar brake cleaner, clean brake fluid, or denatured alcohol. Do not use any other cleaning agents.

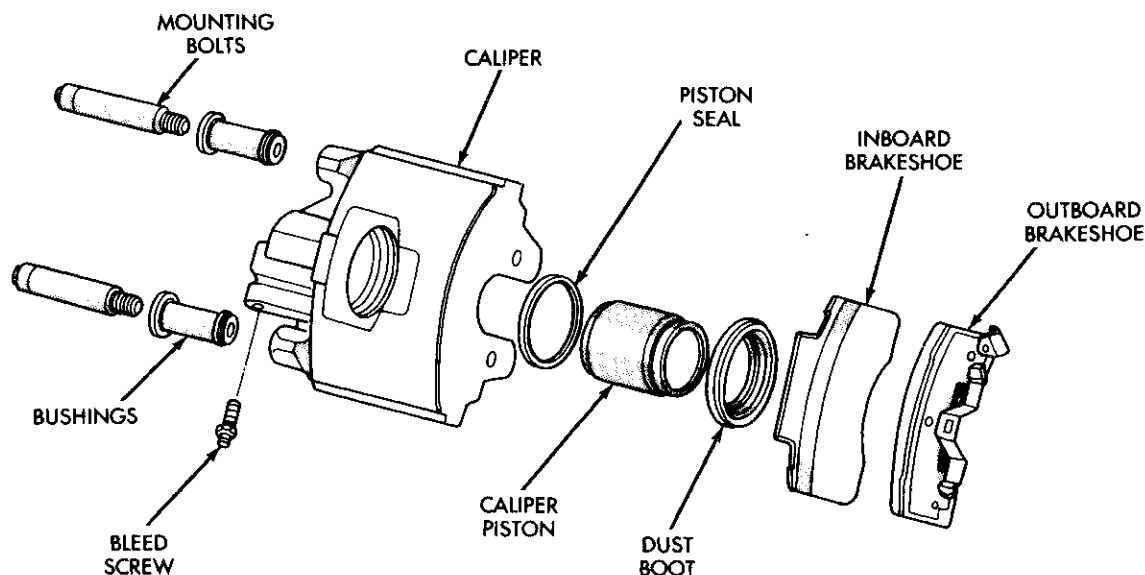
(2) Inspect condition of the caliper piston bore. The piston must be free of corrosion, rust, pitting, or scoring. replace the piston if it exhibits any of these conditions.

(3) A fiber brush can be used to clean the bore if necessary. The bore should be free of corrosion, pitting, or scoring. Discoloration of the bore is a normal condition and not cause for replacement. The bore can be lightly polished by hand but only with crocus cloth.



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Fig. 85 Caliper Components (75mm Caliper)

DISASSEMBLY AND ASSEMBLY (Continued)

J9405-37

Fig. 86 Caliper Components (80/86mm Caliper)

CAUTION: Never hone the caliper piston bore, or use any kind of abrasive material on the piston surface. Honing will result in an oversize bore and abrasives will damage the piston coating. Either of these practices will result in piston bind and eventual seizure.

(4) Inspect condition of the threads in the inlet and bleed screw ports. Replace the caliper if thread damage is evident. Do not attempt to salvage the threads.

(5) Check the bushings in the caliper mounting bolt bores. Replace the bushings if worn, cut, or torn.

(6) Lubricate caliper piston, piston seal and piston bore with liberal quantity of clean, fresh brake fluid.

(7) Lightly lubricate lip of new boot with Dow or GE silicone grease. Install boot on piston and work boot lip into the groove at the top of piston (Fig. 87).

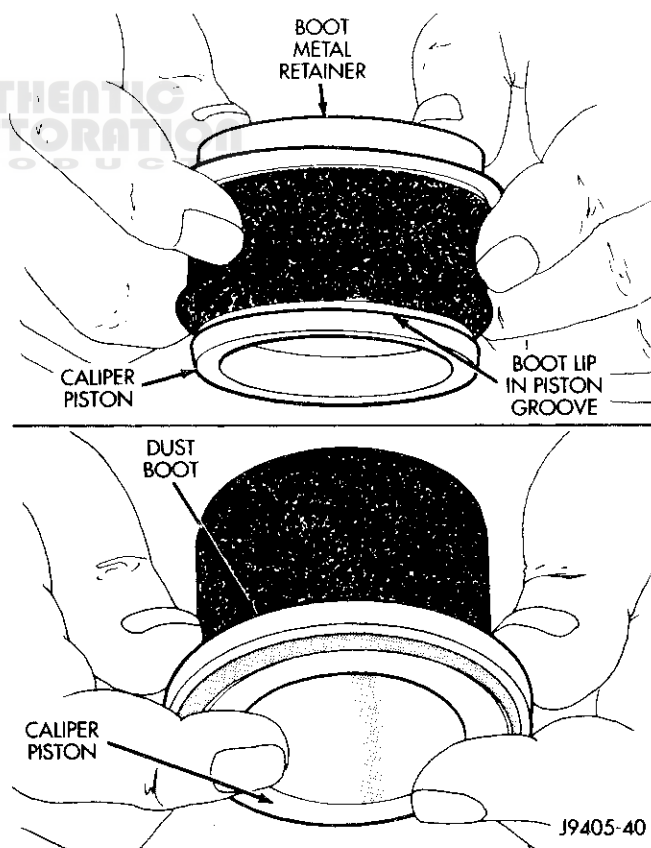
(8) Stretch boot rearward to straighten boot folds, then move boot forward until folds snap into place (Fig. 87).

(9) Install new piston seal into caliper bore. **Be sure square cut seal is fully seated and is not twisted.**

(10) Install piston into caliper bore. Once piston is started into the piston seal, press piston 3/4 of way down into the caliper bore by hand or with hammer handle.

(11) Seat dust boot in caliper with installer (Fig. 88):

- 1/2 ton 75mm caliper: Installer 6753
- 3/4 ton 80 mm caliper: Installer 6754
- 1 ton 86mm caliper: Installer 6755



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Fig. 87 Installing Dust Boot

(12) Press piston to the bottom of the caliper bore.

DISASSEMBLY AND ASSEMBLY (Continued)

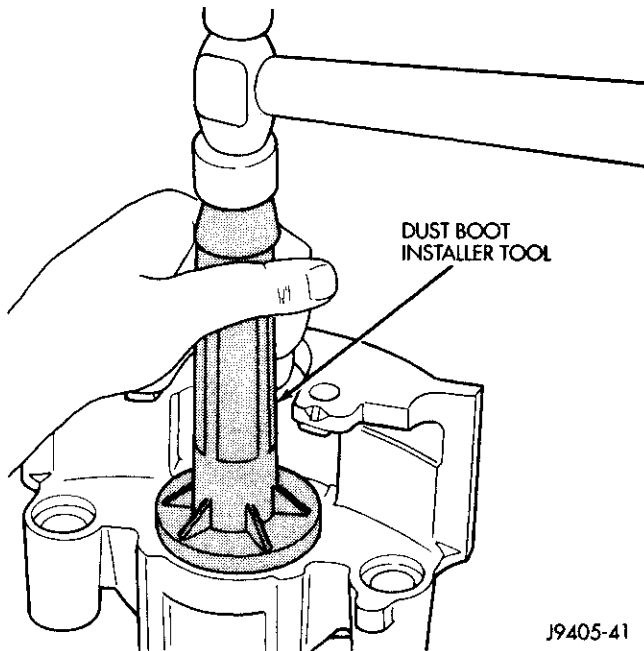


Fig. 88 Seating Dust Boot

(13) Lubricate caliper mounting bolts, collars, bushings and bores with Dow 111, or GE 661 silicone grease.

(14) Install bushings, seals, boots and mounting bolts in caliper (Figs. 23 and 24).

(15) Install caliper bleed screw.

WHEEL CYLINDER

DISASSEMBLY

- (1) Remove push rods and boots (Fig. 89).
- (2) Press pistons, cups and spring and expander out of cylinder bore.
- (3) Remove bleed screw.

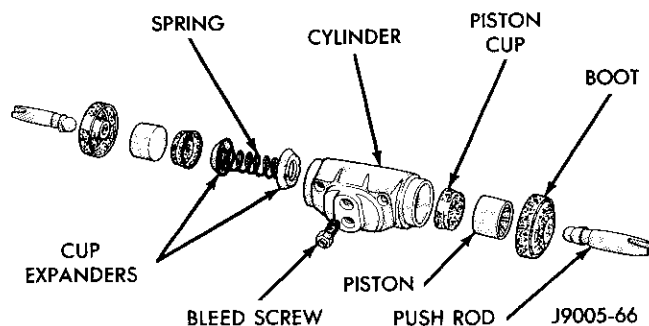


Fig. 89 Wheel Cylinder Components

ASSEMBLY

- (1) Lubricate wheel cylinder bore, pistons, piston cups and spring and expander with clean brake fluid.
- (2) Install first piston in cylinder bore. Then install first cup in bore and against piston. **Be sure lip of piston cup is facing inward (toward**

spring and expander) and flat side is against piston.

(3) Install spring and expander followed by remaining piston cup and piston.

(4) Install boots on each end of cylinder and insert push rods in boots.

(5) Install cylinder bleed screw.

CLEANING AND INSPECTION

REAR DRUM BRAKE

CLEANING

Clean the individual brake components, including the support plate and wheel cylinder exterior, with a water dampened cloth or with Mopar brake cleaner. Do not use any other cleaning agents. Remove light rust and scale from the brakeshoe contact pads on the support plate with fine sandpaper.

INSPECTION

As a general rule, riveted brakeshoes should be replaced when worn to within 0.78 mm (1/32 in.) of the rivet heads. Bonded lining should be replaced when worn to a thickness of 1.6 mm (1/16 in.).

Examine the lining contact pattern to determine if the shoes are bent or the drum is tapered. The lining should exhibit contact across its entire width. Shoes exhibiting contact only on one side should be replaced and the drum checked for runout or taper.

Inspect the adjuster screw assembly. Replace the assembly if the star wheel threads are damaged, or the components are severely rusted or corroded.

Discard the brake springs and retainer components if worn distorted, or collapsed. Also replace the springs if a brake drag condition had occurred. Overheating will distort and weaken the springs.

Inspect the brakeshoe contact pads on the support plate, replace the support plate if any of the pads are worn or rusted through. Also replace the plate if it is bent or distorted (Fig. 90).

CALIPER

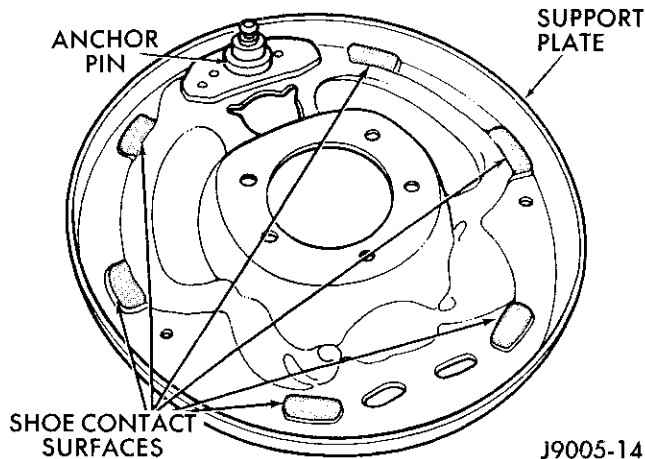
CLEANING

Clean the caliper components with clean brake fluid or Mopar brake cleaning solvent only. Do not use gasoline, kerosene, thinner, or similar solvents. These products may leave a residue that could damage the piston and seal.

Wipe the caliper and piston dry with lint free towels or use low pressure compressed air.

INSPECTION

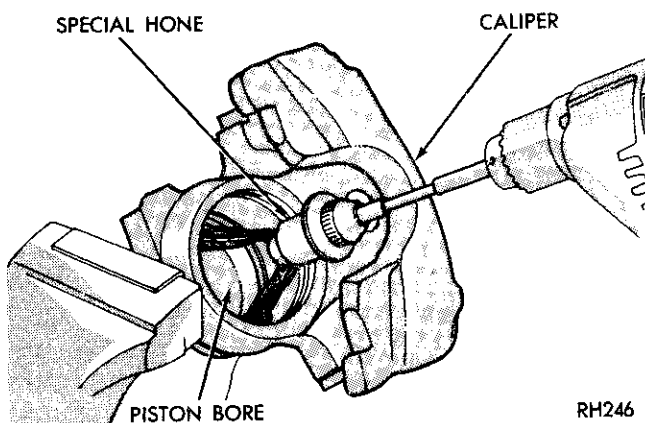
The piston is made from a phenolic resin (plastic material) and should be smooth and clean.

CLEANING AND INSPECTION (Continued)**Fig. 90 Shoe Contact Surfaces**

Replace the piston if cracked or scored. Do not attempt to restore a scored piston surface by sanding or polishing. The piston must be replaced if damaged.

NOTE: If the caliper piston must be replaced, install the same type of piston in the caliper. Never interchange phenolic resin and steel caliper pistons. The pistons, seals, seal grooves, caliper bore and piston tolerances are different for resin and steel pistons. Do not intermix these components at any time.

The bore can be lightly polished with a brake hone to remove very minor surface imperfections (Fig. 91). The caliper should be replaced if the bore is severely corroded, rusted, scored, or if polishing would increase bore diameter more than 0.025 mm (0.001 inch).

**Fig. 91 Lightly Polishing Piston Bore With Tool****WHEEL CYLINDER****CLEANING**

Clean the cylinder and pistons with clean brake fluid or brake cleaner only. Do not use any other cleaning agents.

Dry the cylinder and pistons with compressed air. Do not use rags or shop towels to dry the cylinder components. Lint from cloth material will adhere to the cylinder bores and pistons.

INSPECTION

Inspect the cylinder bore. Light discoloration and dark stains in the bore are normal and will not impair cylinder operation.

The cylinder bore can be lightly polished but only with crocus cloth. Replace the cylinder if the bore is scored, pitted or heavily corroded. Honing the bore to restore the surface is not recommended.

Inspect the cylinder pistons. The piston surfaces should be smooth and free of scratches, scoring and corrosion. Replace the pistons if worn, scored, or corroded. Do attempt to restore the surface by sanding or polishing.

Discard the old piston cups and the spring and expander. These parts are not reusable. The original dust boots may be reused but only if they are in good condition.

ADJUSTMENTS**STOP LAMP SWITCH**

- (1) Push and hold brake pedal down
- (2) Pull switch plunger all the way out to fully extended position.
- (3) Push switch plunger inward 4 detent positions (or clicks). This is required preset position. Plunger will extend approximately 14 mm (0.55 in.) out of housing at this setting.
- (4) Release brake pedal. Then lightly pull pedal fully rearward. Pedal will adjust switch plunger to correct position as pedal is moved to rear.

CAUTION: Do not use excessive force to move the pedal rearward for switch adjustment. Excessive force will damage the switch.

REAR DRUM BRAKE

The rear drum brakes are equipped with a self-adjusting mechanism. Under normal circumstances, the only time adjustment is required is when the shoes are replaced, removed for access to other parts, or when one or both drums are replaced.

Adjustment can be made with a standard brake gauge or with adjusting tool. Adjustment is per-

ADJUSTMENTS (Continued)

formed with the complete brake assembly installed on the backing plate.

ADJUSTMENT WITH BRAKE GAUGE

- (1) Be sure parking brakes are fully released.
- (2) Raise rear of vehicle and remove wheels and brake drums.
- (3) Verify that left and right automatic adjuster levers and cables are properly connected.
- (4) Insert brake gauge in drum. Expand gauge until gauge inner legs contact drum braking surface. Then lock gauge in position (Fig. 92).

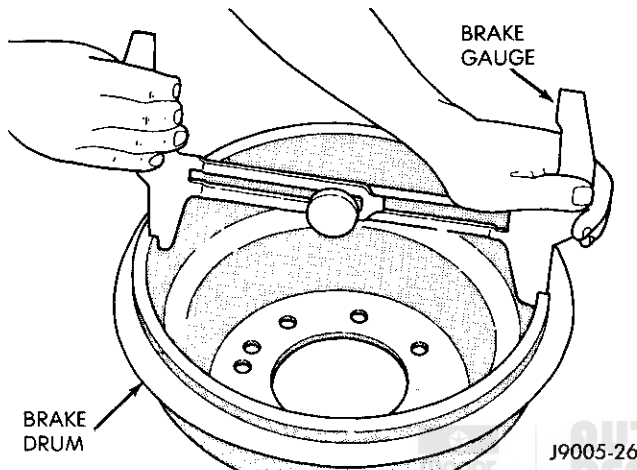


Fig. 92 Adjusting Gauge On Drum

- (5) Reverse gauge and install it on brakeshoes. Position gauge legs at shoe centers as shown (Fig. 93). If gauge does not fit (too loose/too tight), adjust shoes.

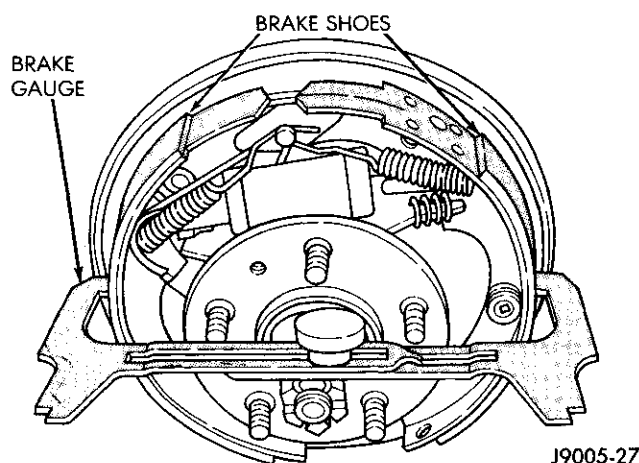


Fig. 93 Adjusting Gauge On Brakeshoes

- (6) Pull shoe adjuster screw star wheel away from adjuster lever.
- (7) Turn adjuster screw star wheel (by hand) to expand or retract brakeshoes. Continue adjustment until gauge outside legs are light drag-fit on shoes.

- (8) Install brake drums and wheels and lower vehicle.

- (9) Drive vehicle and make one forward stop followed by one reverse stop. Repeat procedure 8-10 times to operate automatic adjusters and equalize adjustment.

NOTE: Bring vehicle to complete standstill at each stop. Incomplete, rolling stops will not activate automatic adjusters.

ADJUSTMENT WITH ADJUSTING TOOL

- (1) Be sure parking brake lever is fully released.
- (2) Raise vehicle so rear wheels can be rotated freely.
- (3) Remove plug from each access hole in brake support plates.
- (4) Loosen parking brake cable adjustment nut until there is slack in front cable.
- (5) Insert adjusting tool through support plate access hole and engage tool in teeth of adjusting screw star wheel (Fig. 94).

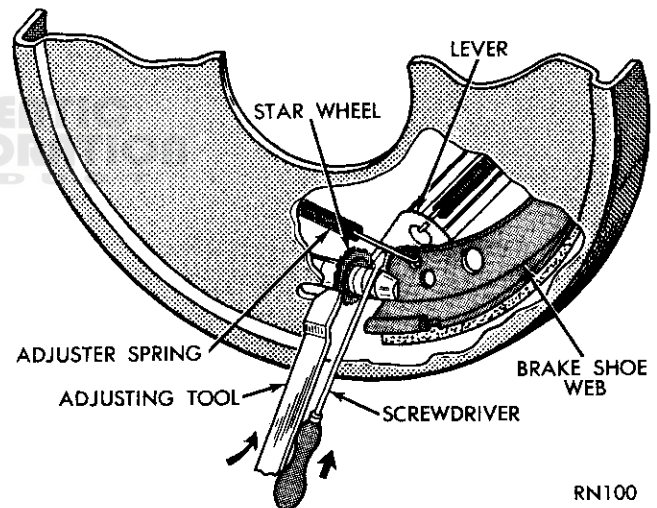


Fig. 94 Brake Adjustment

- (6) Rotate adjuster screw star wheel (move tool handle upward) until slight drag can be felt when wheel is rotated.
- (7) Push and hold adjuster lever away from star wheel with thin screwdriver.
- (8) Back off adjuster screw star wheel until brake drag is eliminated.
- (9) Repeat adjustment at opposite wheel. Be sure adjustment is equal at both wheels.
- (10) Install support plate access hole plugs.
- (11) Adjust parking brake cable and lower vehicle.
- (12) Install brake drums and wheels and lower vehicle.
- (13) Drive vehicle and make one forward stop followed by one reverse stop. Repeat procedure 8-10

ADJUSTMENTS (Continued)

times to operate automatic adjusters and equalize adjustment.

NOTE: Bring vehicle to complete standstill at each stop. Incomplete, rolling stops will not activate automatic adjusters.

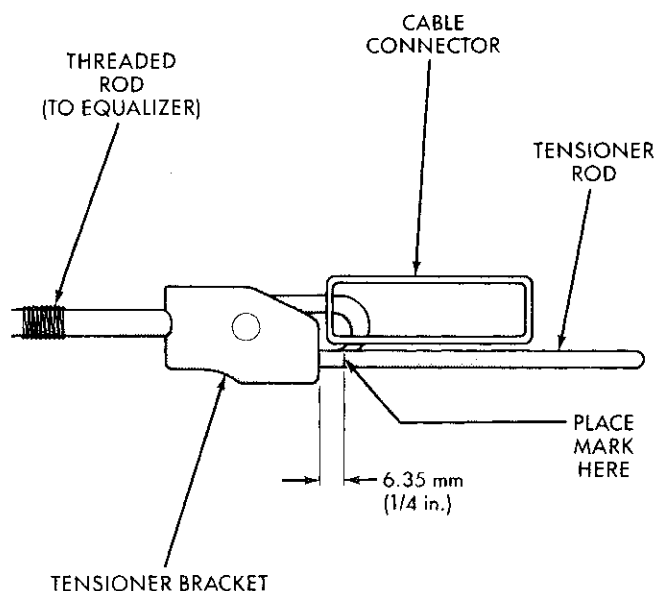
PARKING BRAKE CABLE TENSIONER ADJUSTMENT

NOTE: Tensioner adjustment is only necessary when the tensioner, or a cable has been replaced or disconnected for service. When adjustment is necessary, perform adjustment only as described in the following procedure. This is necessary to avoid faulty parking brake operation.

- (1) Raise vehicle.
- (2) Back off cable tensioner adjusting nut to create slack in cables.
- (3) Remove rear wheel and tire assemblies. Then remove brake drums.
- (4) Check rear brakeshoe adjustment with standard brake gauge.
- (5) Replace worn brakeshoes if necessary.
- (6) Verify parking brake cables operate freely. Replace faulty cables if necessary.
- (7) Install drums and verify that drums rotate freely without drag.
- (8) Install wheel/tire assemblies.
- (9) Lower vehicle enough for access to parking brake foot pedal.
- (10) Fully apply parking brakes and leave brakes applied until adjustment is complete.
- (11) Raise vehicle again.
- (12) Mark tensioner rod 6.5 mm (1/4 in.) from edge of tensioner bracket (Fig. 95).
- (13) Tighten adjusting nut at equalizer until mark on tensioner rod moves into alignment with tensioner bracket (Fig. 95).

CAUTION: Do not loosen, or tighten the tensioner adjusting nut for any reason after completing adjustment.

- (14) Release parking brake and verify rear wheels rotate freely without drag. Then lower vehicle.



J9405-176

Fig. 95 Adjustment Mark On Cable Tensioner Rod
SPECIFICATIONS

BRAKE FLUID

The brake fluid used in this vehicle must conform to DOT 3 specifications and SAE J1703 standards. No other type of brake fluid is recommended or approved for usage in the vehicle brake system. Use only Mopar brake fluid or an equivalent from a tightly sealed container.

CAUTION: Never use reclaimed brake fluid or fluid from an container which has been left open. An open container will absorb moisture from the air and contaminate the fluid.

CAUTION: Never use any type of a petroleum-based fluid in the brake hydraulic system. Use of such type fluids will result in seal damage of the vehicle brake hydraulic system causing a failure of the vehicle brake system.

SPECIFICATIONS (Continued)**BASE BRAKE**

Disc Brake Caliper

Type Sliding

Caliper Piston Diameter

1/2 Ton Model 75 mm (2.95 in.)

3/4 Ton Model 80 mm (3.14 in.)

1 Ton Model 86 mm (3.38 in.)

Disc Brake Rotor

1/2 Ton Model Size . . . 2.94x32 mm (11.57x1.26 in.)

3/4 Ton Model Size . . . 317.5x38 mm (12.5x1.5 in.)

1 Ton Model Size 317.5x 8 mm (12.5x1.5 in.)

Max. Runout 0.127 mm (0.005 in.)

Max. Thickness Variation . . . 0.025 mm (0.001 in.)

Drum Brake

1/2 Ton Model Size 279x51 mm (11x2 in.)

3/4 Ton Model Size 330x63.5 mm (13x2.5 in.)

1 Ton Model Size 330x89 mm (13x3.5 in.)

Max. Runout 0.20 mm (0.008 in.)

Max. Thickness Variation . . . 0.076 mm (0.003 in.)

Wheel Cylinder Bore Size

1/2 Ton Model 23.8 mm (0.937 in.)

3/4 Ton Model 23.8 mm (0.937 in.)

1 Ton Model 27 mm (1.06 in.)

Master Cylinder Bore Size

1/2 Ton Model 28.6 mm (1.125 in.)

3/4 Ton Model 31.8 mm (1.25 in.)

1 Ton Model 31.8 mm (1.25 in.)

Brake Booster

1/2 Ton Model Dual Diaphragm

3/4 Ton Model Dual Diaphragm High Output

1 Ton Model Dual Diaphragm High Output

TORQUE CHART**DESCRIPTION****TORQUE**

Booster

Mounting Nuts 23-34 N·m (200-300 in. lbs.)

Diesel Vacuum Pump

Mounting Bolts 77 N·m (57 ft. lbs.)

Master Cylinder

Mounting Nuts 23-34 N·m (200-300 in. lbs.)

Brake Lines 16-23 N·m (140-200 in. lbs.)

Combination Valve

Mounting Nuts 23-34 N·m (200-300 in. lbs.)

Brake Lines 16-23 N·m (140-200 in. lbs.)

Caliper

Mounting Bolts 51 N·m (38 ft. lbs.)

Wheel Cylinder

Mounting Bolts 20 N·m (15 ft. lbs.)

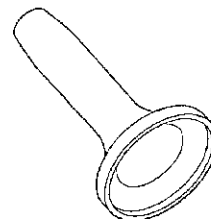
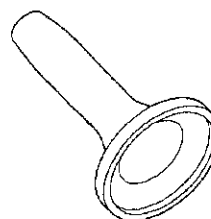
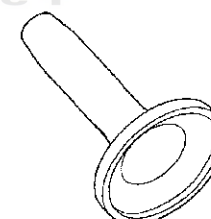
Brake Line 13 N·m (115 in. lbs.)

Support Plate

Mounting Bolts 47-68 N·m (35-50 ft. lbs.)

Park Brake Pedal Assembly

Mounting Bolts/Nuts . 21-34 N·m (200-300 in. lbs.)

SPECIAL TOOLS**BASE BRAKES***Installer, Brake Caliper Dust Boot 6753**Installer, Brake Caliper Dust Boot 6754**Installer, Brake Caliper Dust Boot 6755*

REAR WHEEL ANTILOCK (RWAL) BRAKES

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DESCRIPTION AND OPERATION

REAR WHEEL ANTILOCK

A Rear Wheel Antilock (RWAL) brake system is standard equipment on all Dodge trucks and full size vans (Fig. 1). This system utilizes a standard vacuum operated power brake booster and a standard master cylinder. When the brakes are applied, hydraulic fluid is routed from the master cylinder's secondary circuit to the RWAL valve (Hydraulic Control Unit - HCU). From there hydraulic fluid is routed to the rear brake wheel cylinders. During a normal stop hydraulic brake fluid flows to the rear wheel cylinders unrestricted to allow the vehicle to stop. During an ABS stop, the HCU modulates the hydraulic brake pressure to the rear wheels.

The RWAL brake system is designed to prevent rear wheel lock-up under heavy braking conditions on virtually all types of road surfaces. Antilock braking is desirable because a vehicle which is stopped without locking the wheels will retain directional stability and some steering capability. This allows the driver to retain greater control of the vehicle during braking.

The RWAL brake system operates by using a Controller Antilock Brake (CAB) to constantly monitor rear wheel speed through the rear wheel speed sensor. If a wheel is about to lock-up, the CAB signals the rear hydraulic control unit to rapidly turn on and off. This valve action will hold, release, and reapply hydraulic brake fluid pressure to the rear brakes.

This section of the Service Manual covers the description, operation, diagnosis, and on car service

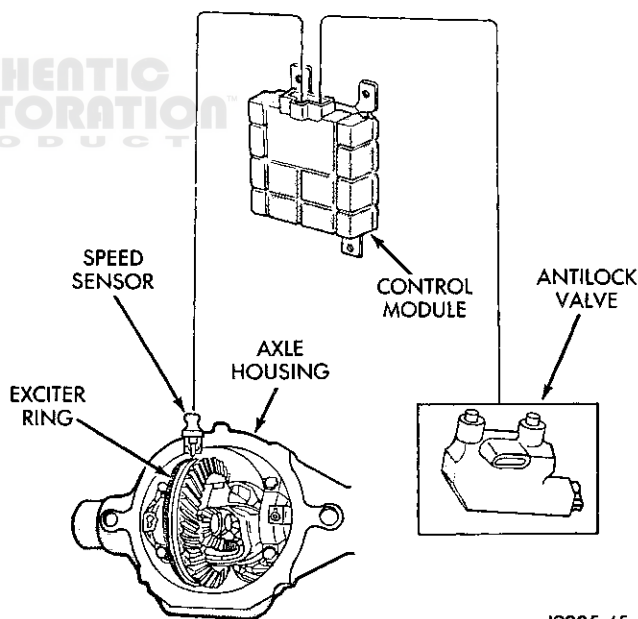


Fig. 1 Rear Wheel Antilock (RWAL)

of the RWAL brake system, refer to the appropriate section in this group of the Service Manual for the specific details.

RWAL COMPONENT ABBREVIATION LIST

In this section of the service manual, the following abbreviations are used for the components of the Kelsey Hayes RWAL brake system.

- CAB - Controller Antilock Brake
- DLC - Data Link Connector

DESCRIPTION AND OPERATION (Continued)

- DTC - Diagnostic Trouble Code
- HCU - Hydraulic Control Unit
- ABS - Antilock Brake System
- WSS - Wheel Speed Sensor

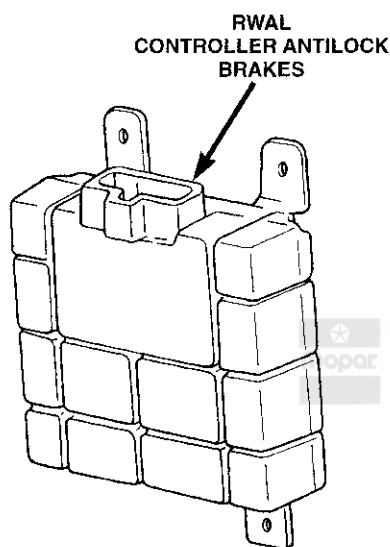
RWAL COMPONENT LOCATION

COMPONENT	LOCATION	FUNCTION
CONTROLLER ANTILOCK BRAKE	Center of instrument panel.	Gathers information from various inputs to control the rear brake system during an ABS stop. Also, it monitors the ABS system for proper operation
DATA LINK CONNECTOR	Located to the right of the steering column, below the knee blocker.	Provides a means to activate the CAB's diagnostic trouble code read out.
HYDRAULIC CONTROL UNIT	Located under the master cylinder and is mounted on a bracket with the combination valve.	Provides modulation of the hydraulic portion of the rear brakes during an ABS stop.
REAR WHEEL SPEED SENSOR	Mounted at the top of the rear axle housing.	Sends an AC voltage sinewave to the CAB whose frequency is proportional to vehicle speed.
EXCITER RING	Attached to the ring gear inside the differential housing.	Provides a means to pull the magnetic field across the wheel speed sensor's windings.
RED BRAKE WARNING LAMP	Located in the instrument cluster.	Provides the driver with a indicator of park brake engagement, hydraulic brake malfunction, or ABS malfunction. Also, is used to identify any diagnostic trouble codes.
AMBER ABS WARNING LAMP	Located next to the red brake warning lamp in the instrument cluster.	Provides the driver with an indicator of an ABS malfunction and is used to identify any diagnostic trouble codes.
BRAKE WARNING LAMP DIODE	Located in the instrument panel harness near the parking brake switch.	Provides a means to isolate the park brake switch circuit from the CAB for proper red brake warning lamp operation.
ISOLATION AND DUMP VALVE FUSE	Located internally to the CAB.	Provides a fail-safe device for unwanted control of the isolation and dump solenoid/valves
ISOLATION AND DUMP SOLENOID/VALVES	Located internally to the HCU.	Provides modulation of the hydraulic portion of the rear brakes during an ABS stop.

DESCRIPTION AND OPERATION (Continued)**RWAL SYSTEM COMPONENTS****CONTROLLER ANTILOCK BRAKES**

The Controller Antilock Brakes (CAB) is a micro-processor which monitors and controls the ABS brake system operation (Fig. 2). It has a 14 terminal connector to deliver power and ground to the CAB and connect all inputs and outputs associated with the ABS system. The CAB primary functions are:

- Detect wheel locking tendencies.
- Control the application of brake fluid pressure to the rear brakes during antilock braking.
- Monitor the RWAL brake system for proper operation.
- Perform self-check diagnostics.



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Fig. 2 RWAL CAB

The CAB continuously monitors the speed of the differential ring gear by monitoring signals generated by the rear wheel speed sensor. The CAB determines a wheel locking tendency when it recognizes the ring gear decelerating too rapidly.

When a wheel-locking tendency is detected, the CAB energizes the isolation solenoid in the RWAL valve. When the isolation solenoid is energized, hydraulic pressure cannot be increased to the rear wheel cylinders. If the rear wheel speed sensor still indicate that the ring gear is decelerating too rapidly, the CAB then energizes the dump solenoid to reduce pressure at the rear wheel cylinders. The CAB continues this action until the wheel-locking tendency no longer exists.

When a fault is detected, the CAB will generate and store diagnostic trouble codes. Only one code can be stored at any one time. If the CAB senses a fault

in any one of its monitored circuits, it will illuminate the red brake warning and ABS warning lamps. It will then generate a Diagnostic Trouble Code (DTC) and store it in memory. In general, the diagnostic trouble code will remain in memory when the ignition key has been turned OFF. The exception to this is codes 9 and 11 which are erased any time the key has been turned OFF. Also, code 11 will be removed from memory when the ignition is in the RUN or ACC. positions if the malfunction that caused the code has been eliminated. For both codes 9 and 11, if the malfunction remains, the DTC will be reset on the next ignition key cycle to ON.

Cab Inputs

The CAB monitors the following inputs to determine when a wheel locking tendency may exist:

- Rear Wheel Speed Sensor
- Brake Lamp Switch
- Brake Warning Lamp Switch
- Reset Switch
- 4WD Switch (If equipped)

Cab Outputs

The CAB controls the following outputs for antilock braking and brake warning information:

- RWAL Valve
- ABS Warning Lamp
- Brake Warning Lamp

Power Supply And Ground

Ignition voltage is provided to the CAB through pin 3 and is protected by a 20 amp fuse. Ignition voltage is supplied when the ignition switch is in the RUN or ACC. positions. The CAB requires ignition voltage to be able to operate the function of antilock brakes. Battery voltage is provided to the CAB through pin 9 and is protected by a 20 amp fuse. This circuit supplies power to the memory cells so that the CAB can retain diagnostic information. Except for trouble codes 9 and 11, the CAB stores DTCs in the battery fed volatile memory. Volatile memories only retain information as long as power is supplied to the memory. If a DTC is stored in the battery fed volatile memory, the DTC can be cleared from the memory by disconnecting the battery supply to the CAB. Trouble codes 9 and 11 are also in a volatile memory but their memories are fed with ignition voltage. A ground is provided to the CAB through pin 12 of the 14-way connector. It is required by the CAB to be able to operate any of its circuits.

REAR WHEEL SPEED SENSOR AND EXCITER RING

The rear Wheel Speed Sensor (WSS) is mounted in the rear differential housing (Fig. 3). The WSS consists of a magnet surrounded by windings from a sin-

DESCRIPTION AND OPERATION (Continued)

gle strand of wire. The sensor sends a small AC signal to the CAB. This signal is generated by magnetic induction. The magnetic induction is created when a toothed sensor ring (exciter ring or tone wheel) passes the stationary magnetic WSS.

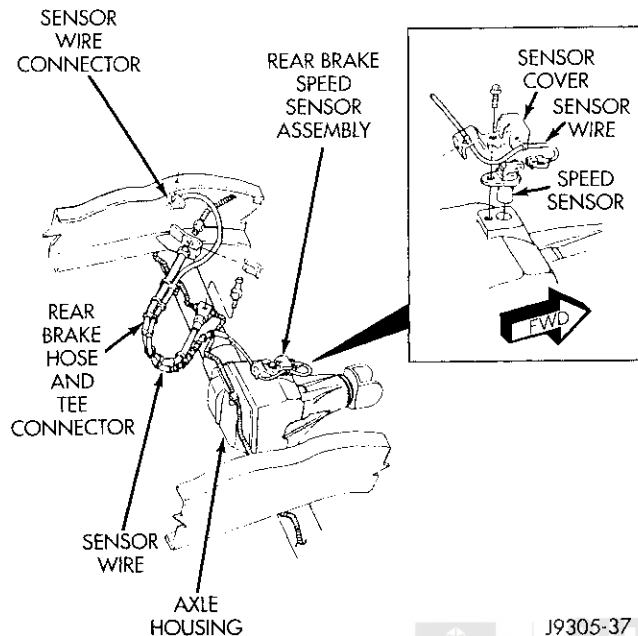


Fig. 3 Rear Wheel Speed Sensor Location

The exciter ring is press fitted onto the differential carrier next to the final drive ring gear (Fig. 4). For service replacement of the exciter ring, refer to section 3 of this Service Manual.

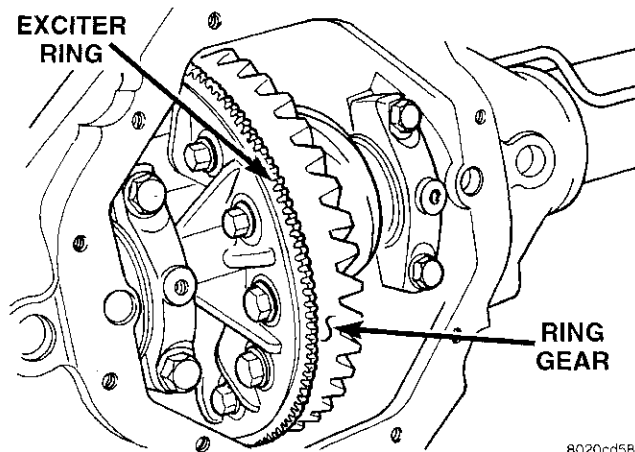


Fig. 4 Exciter Ring Location

When the ring gear is rotated, the exciter ring passes the tip of the WSS. As the exciter ring passes the tip of the WSS, the magnetic lines of force of the sensor are cut, causing the magnetic field to be moved across the sensor's windings. This, in turn causes current to flow through the WSS circuit (Fig.

5). Every time a tooth of the exciter ring passes the tip of the WSS, an AC signal is generated. Each AC signal (positive to negative signal or sinewave) is interpreted by the CAB. It then compares the frequency of the sinewave to a time value to calculate vehicle speed. The CAB continues to monitor the frequency to determine a deceleration rate that would indicate a possible wheel-locking tendency.

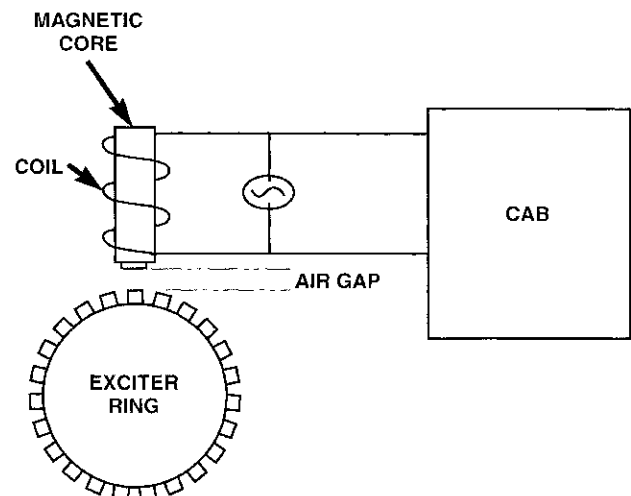


Fig. 5 Operation of the Wheel Speed Sensor

The signal strength of any magnetic induction sensor is directly affected by:

- Magnetic field strength; the stronger the magnetic field, the stronger the signal
- Number of windings in the sensor; more windings provide a stronger signal
- Exciter ring speed; the faster the exciter ring rotates, the stronger the signal will be
- Distance between the exciter ring teeth and WSS; the closer the WSS is to the exciter ring, the stronger the signal will be

The rear WSS is not adjustable. A clearance specification has been established for manufacturing tolerances. If the clearance is not within these specifications, then either the WSS or other components may be damaged. The clearance between the WSS and the exciter ring is 0.005 – 0.050 in.

The assembly plant performs a "Rolls Test" on every vehicle that leaves the assembly plant. One of the test performed is a test of the WSS. To properly test the sensor, the assembly plant connects test equipment to the Data Link Connector (DLC). This connector is located to the left of the steering column and attached to the lower portion of the instrument panel (Fig. 6). The rolls test terminal is spliced to the

DESCRIPTION AND OPERATION (Continued)

WSS circuit. The vehicle is then driven on a set of rollers and the WSS output is monitored for proper operation.

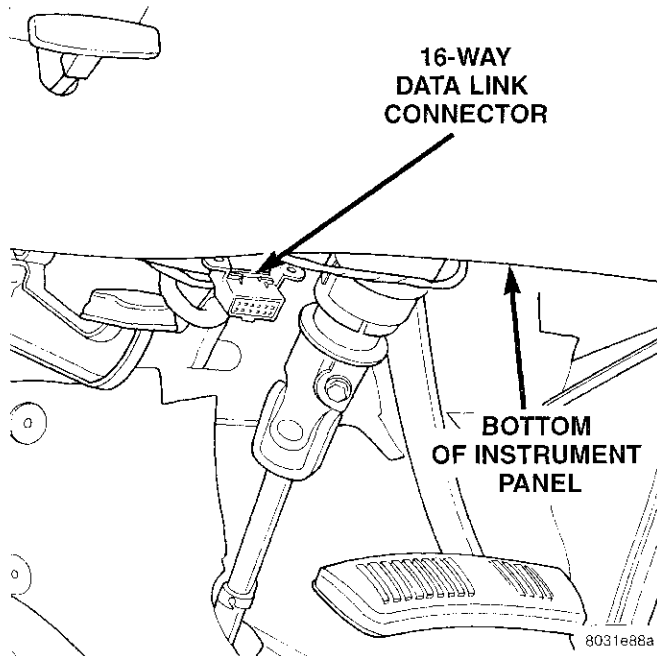


Fig. 6 Data Link Connector

STOP LAMP SWITCH

The primary function of the switch is to turn on the stop lamps during braking. The switch is also used to send signals to components that must know when the brakes are applied, such as the Powertrain Control Module (PCM), which uses the signal to cancel speed control. The CAB uses the brake switch signal to monitor brake pedal application. When the switch contacts open (brakes applied), the CAB receives the brake applied signal. The CAB then monitors the ABS system to anticipate the need for an ABS stop.

RWAL VALVE

If the CAB senses that rear wheel speed deceleration is excessive, it will energize a isolation solenoid by providing battery voltage to the solenoid. This prevents a further increase of driver induced brake pressure to the rear wheels. If this initial action is not enough to prevent rear wheel lock-up, the CAB will momentarily energize a dump solenoid (the CAB energizes the dump solenoid by providing battery voltage to the solenoid). This opens the dump valve to vent a small amount of isolated rear brake pressure to an accumulator. The action of fluid moving to the accumulator reduces the isolated brake pressure at the wheel cylinders. The dump (pressure venting) cycle is limited to very short time periods (milliseconds). The CAB will pulse the dump valve until rear wheel deceleration matches the vehicle deceleration

rate or the desired slip rate programmed into the CAB. The system will switch to normal braking once wheel locking tendencies are no longer present.

A predetermined maximum number of consecutive dump cycles can be performed during any one antilock stop. If excessive dump cycles occur, a DTC will be set and stored in the CAB memory. If during an antilock stop, the driver releases the brake pedal, the reset switch contacts will open. This signal to the CAB is an indication that pressure has equalized across the RWAL valve. The CAB will then reset the dump cycle counter in anticipation of the next antilock stop. Additionally, any fluid stored in the accumulator will force its way past the dump valve, back into the hydraulic circuit and return to the master cylinder.

A fuse internal to the CAB, provides a fail-safe device which prevents unwanted control over the isolation and dump solenoids. The fuse is in series with the isolation and dump solenoids output circuits. If the internal fuse is open, the CAB cannot provide voltage to energize either solenoid and antilock stops are prevented. If the fuse is open, the braking system will operate normally but without antilock control over rear brake pressure.

WARNING LAMPS

In the RWAL brake system, as in other brake systems, the brake warning lamp (red) is used to alert the driver of a hydraulic fault or that the parking brake is applied. However, in the RWAL system, the brake warning lamp is also used to alert the driver that there is a problem with the RWAL system. There is also an ABS warning lamp (amber). The ABS warning lamp is only used to alert the driver of RWAL malfunctions and to identify DTCs stored in the CABs memory.

Brake Warning Lamp

The brake warning lamp illuminates when ignition voltage is supplied to the bulb and a ground is provided for the bulb. The bulb has ignition voltage supplied to it any time the ignition switch is in the RUN or START positions. A ground for the bulb is provided by the:

- Ignition switch during the START mode
- Parking brake switch when the park brake is applied
- Brake warning lamp switch when a hydraulic fault has occurred
- CAB during diagnostics and when a RWAL fault has occurred

ABS Warning Lamp

The ABS warning lamp illuminates when ignition voltage is supplied to the bulb and a ground is provided for the bulb. The bulb has ignition voltage sup-

DESCRIPTION AND OPERATION (Continued)

plied to it anytime the ignition switch is in the RUN or START positions. A ground for the bulb is provided by the CAB only. A circuit in the CAB monitors the brake warning lamp switch and the ignition switch bulb check circuit (grounds the brake warning lamp bulb during the START position). When the CAB identifies a ground on this circuit, the CAB illuminates the ABS warning lamp.

COMBINATION VALVE

Pressure Differential Switch

The pressure differential switch is connected to the brake warning light. The switch is triggered by movement of the switch valve. The purpose of the switch is to monitor fluid pressure in the separate front/rear brake hydraulic circuits.

A decrease or loss of fluid pressure in either hydraulic circuit will cause the switch valve to shuttle forward or rearward in response to the pressure differential. Movement of the switch valve will push the switch plunger upward. This closes the switch internal contacts completing the electrical circuit to the warning light. The switch valve may remain in an actuated position until repair restores system pressures to normal levels.

Metering Valve

The metering valve is used to balance brake action between the front disc and rear drum brakes. The valve meters (holds-off) full apply pressure to the front disc brakes until the rear brake shoes are in full contact with the drums. The valve is designed to maintain front brake fluid pressure at 21-207 kPa (3-30 psi) until the hold-off limit of 807 kPa (117 psi) is reached. At this point, the metering valve opens completely permitting full fluid apply pressure to the front disc brakes.

RWAL SYSTEM OPERATION

During light brake application, rear wheel deceleration is not sufficient to activate the antilock system components. Brake fluid applies pressure to the rear wheels remains normal and is not modulated. However, when braking effort, and rate of deceleration approach programmed limits, sensor inputs will cause the CAB module to activate the system.

Normal Braking Mode

In normal braking mode, the antilock solenoid valves are inactive. The valve is open and the dump valve is closed allowing normal fluid flow to the rear wheel cylinders.

Antilock Braking Mode

If the CAB senses that rear wheel speed deceleration is excessive, it will energize the isolation solenoid.

This prevents a further increase of driver induced brake pressure to the rear wheels. If this initial action is not enough to prevent rear wheel lock-up, the CAB will momentarily energize a dump solenoid. This opens the dump valve to vent a small amount of isolated rear brake pressure to an accumulator. The action of fluid moving to the accumulator reduces the isolated brake pressure at the wheel cylinders. The dump (pressure venting) cycle is limited to very short time periods (milliseconds). The CAB will pulse the dump valve until rear wheel deceleration matches the vehicle's deceleration rate or the desired slip rate programmed into the CAB. The system will switch to normal braking once wheel locking tendencies are no longer present.

DIAGNOSIS AND TESTING

RWAL GENERAL DIAGNOSTIC INFORMATION

This section contains information necessary to diagnose the Rear Wheel Antilock (RWAL) brake system. This section should be used to help diagnose the following conditions:

- Brake warning lamp (red) illuminated
- ABS warning lamp (amber) illuminated
- Rear brakes lock-up on hard application

Diagnosis of base brake conditions which are obviously mechanical in nature should be directed to Group 5 Base Brake System in this Service Manual. This includes brake noise, lack of power assist, parking brake, or vehicle vibration during normal braking.

Many conditions that generate customer complaints may be normal operating conditions, but are judged to be a problem due to not being familiar with the RWAL system. These conditions can be recognized without performing extensive diagnostic work, given adequate understanding of the operating principles and performance characteristics of the RWAL system. See the RWAL Description and Operation section in this group of the Service Manual to familiarize yourself with the operating principles of the RWAL system.

RWAL PERFORMANCE CHARACTERISTICS

Wheel/Tire Size And Input Signals

Antilock system operation depends on accurate signals from the rear wheel speed sensor. Ideally, the vehicle's wheels and tires should all be the same size and type to ensure accurate signals and satisfactory operation.

RWAL And Low Vehicle Speed

The RWAL braking system will revert to normal braking and automatically turn off if the vehicle is

DIAGNOSIS AND TESTING (Continued)

moving less than a few mph. The lower limit at which RWAL is cancelled may be different depending on tire and wheel diameters. Wheel lock-up may be noticed at the very end of an antilock stop and is considered normal.

Distribution Of Braking Effects

The RWAL system controls hydraulic pressure to both rear wheels simultaneously, not each one independently. If one rear wheel starts to decelerate too rapidly, the RWAL system affects the hydraulic pressure to both rear brakes (Fig. 7).

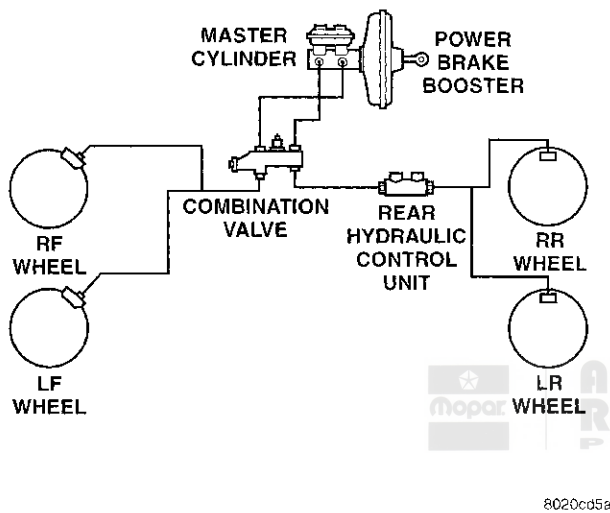


Fig. 7 RWAL Hydraulic Circuit

Directional Stability

Since the RWAL system operates on the rear wheels only, it is possible to lock the front wheels of the vehicle during a high deceleration stop. In this event, the vehicle will be stable, but the driver will be unable to alter the direction of the vehicle with the steering wheel (Fig. 8).

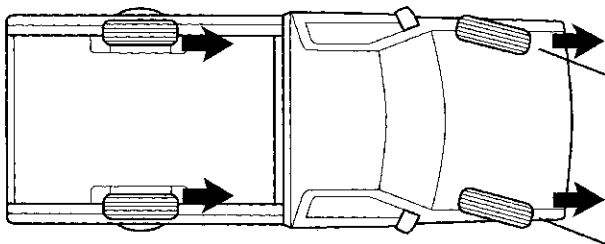


Fig. 8 Directional Stability

Stopping Distance

The RWAL brake system limits wheel slip to approximately 20%. This provides for maximum brake effectiveness. Wheel slip means how well the tires grip the road surface. With light or no braking there is no wheel slip. With the wheels locked (not rotating) during a panic stop, there is 100% wheel slip. To obtain the shortest stopping distance and the greatest control over the vehicle during heavy braking, approximately 20% wheel slip is most efficient, under most conditions.

Pedal Feel

In general, pedal feel will be similar to that of a conventional vacuum boosted brake system. Under certain conditions the pedal may drop slightly when there is a need for pressure increase during a long antilock stop. Remember, the sequence of antilock events is to isolate, decrease, and then increase pressure to maintain brake effectiveness. At the point when the system is in the increase mode is when the pedal will drop slightly.

Tire Noise And Marks

Although the RWAL system prevents complete rear wheel lock-up, some wheel slip is desired to obtain optimum braking performance. During brake pressure modulation brake pressure is increased and wheel slip controlled by the CAB is allowed to reach up to approximately 20%. This means that the wheel rolling speed is approximately 20% less than that of a free rolling wheel at any given vehicle speed. The wheel slip may result in some tire "chirping", depending upon the road surface. This sound should not be interpreted as a total wheel lock-up and can be considered normal under most conditions.

Complete wheel lock-up normally leaves a continuous black tire mark on dry pavement. Antilock braking will not leave a continuous black mark since the wheel never reaches a totally locked condition. Tire marks may be noticeable as light, patched marks on the pavement.

Sound Level

The noise level of antilock braking is different from normal braking. The noise level of a vehicle equipped with ABS actually may be less during antilock braking. Because the rear wheels never fully lock-up, which would cause tire noise. Also, since the RWAL brake system has no pump to produce noise that might be associated with other antilock brake systems, RWAL's ABS mode will be noticeably different.

Vehicle Response In Antilock Mode

During antilock braking, the RWAL valve cycles rapidly in response to CAB inputs. The driver may experience a pulsing sensation in the brake pedal

DIAGNOSIS AND TESTING (Continued)

and vehicle as the valves modulate brake fluid pressure as needed. Brake pedal and vehicle pulsations during an antilock stop should be considered as normal.

RWAL SYSTEM SELF DIAGNOSTICS

The microprocessor in the CAB has both a self test feature and a memory. The self test feature occurs every time the ignition key is turned to the START or RUN positions and continues as long as the ignition is in the RUN position. During the self test, the microprocessor monitors and processes signals generated by the systems inputs and outputs. It also performs a bulb check when the ignition key is first turned to START or RUN which turns on the brake warning lamp (red) and the ABS warning lamp (amber). If the self test does not identify any malfunctions, both lamps will illuminate for a few seconds and then go out.

If a system fault is detected, the ABS warning lamp and the brake warning lamp are illuminated. A Diagnostic Trouble Code (DTC) is also stored in the microprocessor's memory. The DTC remains in memory even after the ignition key is turned to OFF with the exception of codes 9 and 11 which are erased anytime the ignition key is turned to OFF. The memory has the capability to store only one DTC at any given time. The problem that caused the DTC must be repaired and the DTC erased before another code will appear (if any).

If a system malfunction should occur, **DO NOT** immediately replace the CAB. A blown system fuse, poor ground, or loss of feed voltage will cause system faults similar to a CAB failure. **Never replace the CAB unless the diagnostic procedure identifies a CAB replacement is necessary.**

RWAL DIAGNOSTIC TROUBLE CODES

When a DTC is generated, the brake warning lamp and ABS warning lamp are illuminated. To retrieve a DTC place the ignition key in the RUN position. Then momentarily ground pin 13 of the Data Link Connector. When the ground is removed the ABS and Brake Warning Lamp will begin to flash.

The initial flash will be a long flash followed by one or more short flashes. The long flash indicates the beginning of the DTC number. The short flashes are a continuation of the DTC number. **You must count the long flash and short flashes for an accurate trouble code number.** When the DTC has been retrieved compare it to the Diagnostic Trouble Code Chart (Fig. 9).

There may be a problem if the brake warning lamp and/or ABS lamp:

- Does not come on
- Is on all of the time
- Flashes incorrectly

FAULT CODE NUMBER	TYPICAL FAILURE DETECTED
1	Not used.
2	Open isolation valve wiring or bad control module.
3	Open dump valve wiring or bad control module.
4	Closed RWAL valve switch.
5	Over 16 dump pulses generated in 2WD vehicles (disabled for 4WD).
6	Erratic speed sensor reading while rolling.
7	Electronic control module fuse pellet open, isolation output missing, or valve wiring shorted to ground.
8	Dump output missing or valve wiring shorted to ground.
9	Speed sensor wiring/resistance (usually high reading).
10	Sensor wiring/resistance (usually low reading).
11	Brake switch always on. RWAL light comes on when speed exceeds 40 mph.
12	Not used.
13	Electronic control module phase lock loop failure.
14	Electronic control module program check failure.
15	Electronic control module RAM failure.

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Fig. 9 RWAL Diagnostic Trouble Codes

Refer to the diagnostic test procedures in this section of the Service Manual for proper testing procedures.

Erasing Diagnostic Trouble Code From Memory

To erase a DTC from the CAB's memory, battery voltage must be removed from the CAB. To remove battery voltage from the CAB, first turn the ignition key to the OFF position. Then one of the following

DIAGNOSIS AND TESTING (Continued)

methods can be used to remove the battery supply voltage from the CAB.

- Disconnect CAB 14-way connector
- Disconnect battery ground connector
- Remove CAB fuse from fuse box

ABS SERVICE PRECAUTIONS

The ABS uses an electronic control module, the CAB. This module is designed to withstand normal current draws associated with vehicle operation. Care must be taken to avoid overloading the CAB circuits. **In testing for open or short circuits, do not ground or apply voltage to any of the circuits unless instructed to do so for a diagnostic procedure.** These circuits should only be tested using a high impedance multi-meter or the DRB tester as described in this section. Power should never be removed or applied to any control module with the ignition in the ON position. Before removing or connecting battery cables, fuses, or connectors, always turn the ignition to the OFF position.

CAUTION: Use only factory wiring harnesses. Do not cut or splice wiring to the brake circuits. The addition of after-market electrical equipment (car phone, radar detector, citizen band radio, trailer lighting, trailer brakes, ect.) on a vehicle equipped with antilock brakes may affect the function of the antilock brake system.

RWAL DIAGNOSIS

An RWAL system malfunction will be indicated by illumination of the ABS warning lamp. In most cases, the brake warning lamp will also be illuminated at the same time. If either or both warning lamps illuminate, the following six step troubleshooting procedure should be implemented.

- Verify the customer's concern
- Determine any related symptoms
- Diagnose the concern
- Isolate the concern
- Repair the concern
- Verify the repair

The RWAL diagnosis begins by verifying the customer's concern. This test starts by verifying the ABS warning lamp and brake warning lamp operation. When this test is complete, you will be instructed to perform either RWAL DIAGNOSTIC PROCEDURES TEST 1 or RWAL DIAGNOSTIC PROCEDURES TEST 2. The test usually will begin with a brief explanation of the procedure or provide guidelines for the test. Then, you will begin with step 1. Each test has four columns; STEP, ACTION, YES, and NO. You will be guided through each test by the ACTION. The ACTION questions will all have bullets (•) in front of them. Answer all questions either with a YES or NO

statement. The YES or NO columns will guide you to the next appropriate test.

Start - RWAL Diagnosis - Verifying the Customer's Concern

Start the engine and monitor the brake warning lamp and ABS warning lamp. Both lamps will illuminate for a few seconds when the ignition is turned on. If the brake warning lamp and or ABS warning lamp remain illuminated or do not come on, continue on to the RWAL DIAGNOSTIC TEST PROCEDURES TEST 1 section of this group. If the warning lamps illuminate for a few seconds and then go out, proceed with this test.

With the engine running and the vehicle in PARK or NEUTRAL, check the service brake. The brake pedal should remain firm under steady foot pressure and not travel too far towards the floor.

The vehicle can be test driven if it is determined that the base brake system is functioning normally. Refer to the Base Brake Diagnose and Testing section in this group of the Service Manual if the previous checks determine a malfunction with the base brakes.

Test Driving RWAL Complaint Vehicle

Most RWAL complaints will require a test drive as part of the diagnostic procedure. The purpose of the test drive is to duplicate and verify the customer's concern.

WARNING: Reduced braking may be encountered if the vehicle is test driven with either the brake warning lamp or the ABS warning lamp illuminated. Extreme caution should be used.

Perform both normal and firm braking stops in the 25-40 mph range. At least one complete ABS stop should be performed. Determine if there are any unusual brake operating conditions such as vehicle lead during braking, brakes grabbing, brakes dragging, noise, low brake pedal, etc. If the brake warning lamp and or ABS warning lamps illuminate during the test drive, proceed to the RWAL DIAGNOSTICS PROCEDURES TEST 1 section in this group. If the vehicle leads during braking, the brakes grab, the brakes are dragging, there is brake related noise, a low brake pedal, etc., refer to the base brake diagnosis section in this section of the Service Manual. If the warning lamps remain extinguished and the brakes respond normally, then proceed to the RWAL DIAGNOSTIC PROCEDURES TEST 2 section in this group.

DIAGNOSIS AND TESTING (Continued)

NOTE: If either warning lamp is illuminated, a DTC should have been generated. Certain DTCs are erased when the ignition key is turned to OFF. Do not turn the ignition key OFF until you have recorded the DTC. Refer to RWAL SYSTEM SELF DIAGNOSIS for instructions on retrieving any DTC.

This procedure starts with the brake warning lamp and/or ABS warning lamp illuminated, flashing, or not coming on at all. Do not attempt to perform this test without first performing RWAL DIAGNOSIS. If you have arrived at this procedure from RWAL DIAGNOSIS, make sure you do not turn the ignition key OFF prior to recording the DTC.

RWAL DIAGNOSTIC PROCEDURES—TEST 1

RWAL DIAGNOSIS must be performed before beginning this diagnostic test procedure.

Step	Action	Yes	No
1	RWAL DIAGNOSIS must be performed before beginning this diagnostic test procedure. <ul style="list-style-type: none"> Has RWAL DIAGNOSIS test been performed? 	Perform step 2.	Perform RWAL DIAGNOSIS.
2	The ignition switch should be in the run position prior to starting. <ul style="list-style-type: none"> Are both brake warning and ABS warning lamps illuminated? 	Perform step 6.	Perform step 3.
3	<ul style="list-style-type: none"> Is the ABS warning lamp illuminated only? 	Perform RWAL DIAGNOSTIC PROCEDURES TEST 3.	Perform step 4.
4	<ul style="list-style-type: none"> Is the brake warning lamp illuminated only? 	Perform RWAL DIAGNOSTIC PROCEDURE TEST 4.	Perform step 5.
5	<ul style="list-style-type: none"> Are either the brake warning lamp or ABS warning lamp flashing? 	Perform step 11.	Perform RWAL DIAGNOSTIC PROCEDURES TEST 5.
6	Check the RWAL system for a DTC. Refer to the RWAL DIAGNOSTIC CONNECTOR LOCATION section and the RWAL DIAGNOSTIC TROUBLE CODES section in this group. Record the DTC before proceeding. <ul style="list-style-type: none"> Were you able to retrieve a DTC from the CAB's memory? 	Perform step 7.	Perform RWAL DIAGNOSTIC PROCEDURES TEST 6.
7	<ul style="list-style-type: none"> Was DTC 9 or 11 recorded? 	Perform RWAL DIAGNOSTIC PROCEDURES TEST 7.	Perform step 8.
8	<ul style="list-style-type: none"> Were you required to perform the Test Driving RWAL Complaint Vehicle procedure prior to beginning RWAL DIAGNOSTIC PROCEDURES TEST 1? 	Perform RWAL DIAGNOSTIC PROCEDURES TEST 7.	Perform step 9.

DIAGNOSIS AND TESTING (Continued)

Step	Action	Yes	No
9	To verify if the DTC is related to an intermittent fault, the fault code should be erased from the CAB's memory. Refer to the RWAL DIAGNOSTIC TROUBLE CODE section of this group and erase the DTC. Turn the ignition key to the run position. <ul style="list-style-type: none"> Did both the brake warning lamp and ABS warning lamp illuminate for a few seconds and then go out? 	Perform RWAL DIAGNOSTIC PROCEDURES TEST 2.	Perform step 10.
10	Recheck the RWAL system for DTCs. Refer to the RWAL DIAGNOSTIC CONNECTOR LOCATION section and the RWAL DIAGNOSTIC TROUBLE CODE section in this group. Record the DTC before proceeding. <ul style="list-style-type: none"> Did the same DTC that was recorded in step 6 reappear? 	Perform RWAL DIAGNOSTIC PROCEDURES TEST 7.	The code that was generated in step 6 does not have diagnostic priority over the DTC recorded in this test. Perform RWAL DIAGNOSTIC PROCEDURES TEST 7 for the code identified in this test first, and then verify the repair.
11	<ul style="list-style-type: none"> Have you initiated the self diagnostic program? 	Record the DTC and perform step 7.	Perform step 12.
12	Turn the ignition key to the OFF position. Disconnect the CAB 14-way connector and leave disconnected for 5 seconds. Reconnect the CAB 14-way connector. Turn the ignition switch to the RUN position. <ul style="list-style-type: none"> Is/are the warning lamp(s) still flashing? 	Perform step 13.	Perform step 2.
13	Turn the ignition key to the OFF position. Disconnect and inspect the CAB 14-way connector for indications of poor connections. <ul style="list-style-type: none"> Are there any connections that appear inadequate? 	Repair as necessary and perform the Verification Test.	Perform step 14.
14	Connect a voltmeter between terminal 3 and ground. Turn the ignition key to the RUN position. Perform a wiggle test on the RWAL wiring harness while observing the voltmeter. <ul style="list-style-type: none"> Did the voltage remain steady at 9 volts or greater? 	Perform step 15.	Repair the ignition feed circuit for an intermittent connection and perform the Verification Test.
15	Turn the ignition key to the OFF position. Connect an ohmmeter between terminal 10 and ground. Perform a wiggle test on the RWAL wiring harness while observing the ohmmeter. <ul style="list-style-type: none"> Is the resistance steady at less than 1 ohm? 	Perform step 16.	Repair the ground circuit for an intermittent connection and perform the Verification Test.
16	Connect an ohmmeter between terminal 12 and ground. Perform a wiggle test on the RWAL wiring harness while observing the ohmmeter. <ul style="list-style-type: none"> Is the resistance greater than 100K and steady? 	Replace the RWAL module and perform the Verification Test.	Repair the diagnostic terminal circuit for an intermittent short to ground and perform the Verification Test.

DIAGNOSIS AND TESTING (Continued)**RWAL DIAGNOSTIC PROCEDURE—TEST 2**

RWAL DIAGNOSIS must be performed before beginning this diagnostic test procedure.

This procedure is performed only when there is a customer's concern related to the RWAL system and no DTC is recorded.

Your diagnostic test procedure must begin with a visual inspection of the following items.

- **Brake fluid** - verify proper level, condition, and visually inspect for leaks around the master cylinder, hoses, lines, RWAL valve, calipers, and wheel cylinders.

- **Wheels and tires** - inflate the tires to the recommended tire pressures and verify that all tires are of the same size

- **Parking brake** - verify proper operation of the parking brake

- **Service brakes** - apply the service brakes and verify whether or not the pedal returns to its normal height

- **Suspension components** - verify all suspension components for proper installation

- **Brake lines and hoses** - inspect all lines and hose for leaks and proper routing.

- **RWAL related components, wiring, and connectors** - Electrical connectors should be inspected for bent or expanded pins and terminals, broken or distorted locking tabs, damaged or missing weather seals, or pushed out wires (refer to section 8W in this Service Manual for proper location).

Once the visual inspection is completed, your next step in the diagnostic sequence is to proceed to step 1 in the following table.

Step	Action	Yes	No
1	Apply the brakes and observe the stop lamps. • Did the stop lamps illuminate while depressing the brake pedal?	Perform step 2.	Perform step 15.
2	Release the brake pedal. • Are the stop lamps on all of the time?	Perform step 3.	Perform step 6.
3	Adjust the stop lamp switch. Apply and release the brakes. • Did the brake pedal return to its proper position when you released the brakes?	Perform step 4.	Inspect the master cylinder push rod and brake pedal arm pivot for any binding. Repair as necessary and perform Verification Test.
4	• Are the stop lamps still on all of the time?	Perform step 5.	Perform Verification Test.
5	Inspect the wiring, connectors, and brake switch for a short to battery voltage. • Was there a short to battery voltage at the wiring, connectors, or brake switch?	Repair the short as necessary and perform the Verification Test.	Replace the brake switch and perform the Verification Test.
6	Remove RWAL speed sensor from differential housing. Inspect the exciter ring. • Is the exciter ring present?	Perform step 7.	Install a exciter ring and perform Verification Test.
7	• Does the exciter ring have any missing teeth or is cracked?	Replace the exciter ring and perform the Verification Test.	Perform step 8.
8	Install speed sensor. Position vehicle on a hoist. Raise rear wheels to safely clear the floor. Connect a voltmeter to the RWAL rolls test connector. Set scale to an AC voltage scale of approximately 2 volts. Start the engine and rotate the wheels at approximately 5 mph. WARNING: WARNING: STAY CLEAR OF ROTATING WHEELS • Is the voltage 650mv (rms) or greater?	Perform step 14.	Perform step 9.

DIAGNOSIS AND TESTING (Continued)

Step	Action	Yes	No
9	Turn ignition key to the OFF position. Disconnect the 14-way connector from the CAB. Connect a ohmmeter across terminals 13 and 14 and measure the resistance of the RWAL speed sensor circuit. • Is the resistance 1750 ohms + or - 750 ohms?	Perform step 10.	Perform Test 20.
10	Measure resistance from terminal 13 to a good chassis ground. • Is the resistance less than 1000 ohms?	Repair the RWAL speed sensor circuit for a short to ground and perform the Verification Test.	Perform step 11.
11	Measure resistance from terminal 14 to a good chassis ground. • Is the resistance less than 1000 ohms?	Repair the RWAL speed sensor circuit for a short to ground and perform the Verification Test.	Perform step 12.
12	Use the procedure "CHECKING RWAL SPEED SENSOR AIR GAP" and verify the clearance between the sensor and exciter ring. • Is the clearance less than 0.050 in. and greater than 0.005 in.?	Perform step 14.	Perform step 13.
13	• Was the dimension recorded from the RWAL speed sensor underside flange to sensor pole piece between 1.07 - 1.08 in. (27.18 - 27.43 mm)?	Replace the exciter ring or repair differential as required and perform the Verification Test.	Replace the RWAL speed sensor and perform the Verification Test.
14	Inspect the rear brakes for mechanical problems such as brakes grabbing, locking, or vehicle lead during braking. • Do the rear brakes have any mechanical problems?	Repair the rear brakes as necessary and perform the Verification Test.	The RWAL brake system is operational at this time.
15	Inspect the fuse that feeds the stop lamp switch. • Is the fuse for the stop lamp switch functional?	Perform step 16.	Perform step 19.
16	Use a voltmeter and verify battery voltage supplied to the fuse. • Is battery voltage supplied to the fuse?	Perform step 17.	Repair the open circuit to the fuse and perform the Verification Test.
17	Use a voltmeter and verify that battery voltage is supplied to the stop lamp switch for the stop lamp circuit. • Is battery voltage supplied to the stop lamp switch for the stop lamps?	Adjust the stop lamp switch and perform step 18.	Repair the open circuit from the fuse to the stop lamp switch.
18	Verify if battery voltage is applied to the stop lamp circuit at the stop lamp bulb when the brakes are applied. • Is battery voltage supplied to the stop lamp circuit at the stop lamp bulb when the brakes are applied?	Replace the stop lamp bulb(s) and perform the Verification Test.	Repair the open circuit as necessary and perform the Verification Test.

DIAGNOSIS AND TESTING (Continued)

Step	Action	Yes	No
19	Inspect for the presence of any add-on (trailer) wiring that may cause a short to ground. • Is any additional wiring added to the vehicle that may cause a short to ground?	Repair, remove, or replace the wiring. Replace the fuse. Perform the Verification Test and inform the customer of any alterations to their add-on wiring.	Inspect the stop lamp switch wiring for any causes that may allow the fuse to blow. Repair the short to ground. Replace the fuse. Perform the Verification Test.
20	Disconnect the 2-way rear WSS connector. Connect an ohmmeter across the terminals of the RWAL speed sensor. • Is the resistance 1750 ohms + or - 750 ohms?	Perform step 21	Replace the RWAL speed sensor and perform the Verification Test.
21	Connect an ohmmeter between terminal 13 of the 14-way CAB connector and terminal 1 of the RWAL speed sensor's connector. • Is the resistance less than 1 ohm?	Repair the RWAL speed sensor circuit for an open or high resistance between terminal 14 of the CAB and terminal 2 of the RWAL speed sensor's connector. Then, perform the Verification Test.	Repair the RWAL speed sensor circuit for an open or high resistance between terminal 13 of the CAB and terminal 1 of the RWAL speed sensor's connector. Then, perform the Verification Test.

CHECKING RWAL SPEED SENSOR AIR GAP

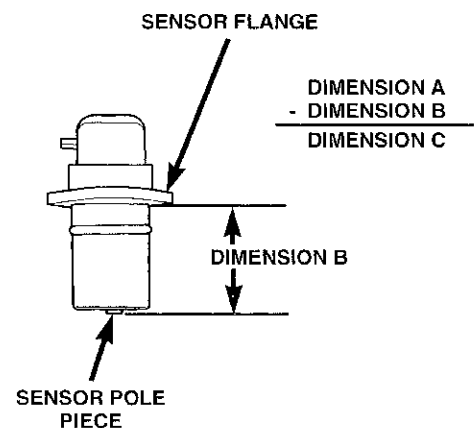
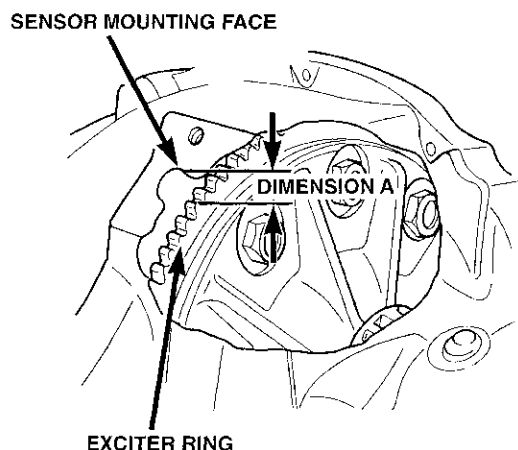
- (1) Remove sensor from differential.
- (2) Measure and record the distance from the underside of the sensor flange to the end of the sensor pole piece (Fig. 10). This distance represents dimension B.
- (3) Measure and record the distance between the sensor mounting surface of differential case and teeth at top of the exciter ring (Fig. 10). This distance represents dimension A.
- (4) Subtract dimension B from dimension A to determine the RWAL speed sensor air gap. The gap

should be a minimum of 0.127 mm (0.005 in.) and a maximum of 1.27 mm (0.050 in.).

- (5) If air gap is **not** within stated limits, proceed as follows:

- (a) Dimension B distance should be between 27.18 - 27.43 mm (1.07 -1.08 in.). If the RWAL speed sensor is not within these limits, replace the RWAL speed sensor.

- (b) Dimension A distance should be between 27.56 - 28.45 mm (1.085 - 1.120 in.). If dimension A is not within the specification, replace the exciter ring or repair the differential.



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Fig. 10 Checking RWAL Speed Sensor Air Gap

DIAGNOSIS AND TESTING (Continued)

(c) If dimension A and dimension B exceeds their specifications, replace both the RWAL speed sensor and exciter ring. Also, repair the differential if necessary.

RWAL DIAGNOSIS PROCEDURES—TEST 3

The CAB illuminates the brake warning lamp any-time it illuminates the ABS warning lamp. This test is performed only to identify the reason why the CAB

did not illuminate the brake warning lamp when the ABS lamp was illuminated. During the test, the RWAL 14-way CAB connector will be disconnected. When the connector is disconnected, all DTCs stored in memory will be erased. Prior to this test, retrieve and record all DTCs for future reference. Refer to the RWAL DIAGNOSTIC CONNECTOR LOCATION and the RWAL DIAGNOSTIC TROUBLE CODE section in this group

Step	Action	Yes	No
1	With the ignition key in the RUN position, apply the parking brake. • Did the brake warning lamp illuminate?	Perform step 4.	Perform step 2.
2	Turn the ignition switch to the START position. • Did the brake warning lamp illuminate while the ignition switch was placed in the START position?	Perform step 4.	Perform step 3.
3	Remove the brake warning lamp bulb. Verify the bulb is not burned out or damaged. • Is the bulb functional?	Perform step 6.	Replace the bulb and restart the test at the RWAL DIAGNOSIS section.
4	Disconnect the RWAL 14-way connector and the connector to the brake warning lamp bulb. Refer to section 8W for proper brake warning lamp wiring. Connect an ohmmeter between terminal 5 of the RWAL 14-way connector and the brake warning lamp bulb's ground circuit. Refer to section 8W for proper brake warning lamp wiring. • Is there continuity between the brake warning lamp bulb's ground circuit and terminal 5 of the RWAL 14-way connector?	Perform step 5.	Repair the open circuit between the RWAL 14-way connector and the brake warning lamp. Once the repair is complete, restart the test at the RWAL DIAGNOSIS section.
5	Inspect the RWAL 14-way CAB connector. • Are there any terminals that are bent, expanded, broken? Are the locking tabs functional? Are any wires pushed out from the connector?	Repair as necessary and restart the test at the RWAL DIAGNOSIS section.	Replace the CAB and perform the Verification Test.
6	Inspect the connector to the brake warning lamp circuit. Refer to section 8W for proper brake warning lamp wiring. • Are there any terminals that are bent, expanded, broken? Are the locking tabs functional? Are any wires pushed out from the connector?	Repair as necessary and restart the test at the RWAL DIAGNOSIS section.	Replace the message center or instrument cluster as required and restart the test at the RWAL DIAGNOSIS section.

DIAGNOSIS AND TESTING (Continued)**RWAL DIAGNOSTIC PROCEDURES—TEST 4**

This test has only the brake warning lamp illuminated. Except for the parking brake switch, all other brake warning lamp switched ground circuits will cause the ABS warning lamp to illuminate also. This

test verifies whether the parking brake switch is the only cause for brake warning lamp illumination or there is a malfunction with the ABS warning lamp circuit.

Step	Action	Yes	No
1	Turn the ignition key OFF. Turn the ignition key to the RUN position. • Did the ABS warning lamp illuminate for a few seconds and then extinguish?	Perform step 2	Perform step 6.
2	Release the parking brake. • Did the brake warning lamp extinguish?	System is operating normally	Perform step 3.
3	Pull the parking brake release handle and pull the parking brake pedal upward. Verify the operation of the parking brake mechanism. • Were you able to pull the pedal up any higher?	Perform step 4.	Perform step 5.
4	• Did the brake warning lamp extinguish when the parking brake was released fully?	Repair the parking brake system as necessary.	Repair the parking brake system as necessary then, perform step 5.
5	Turn the ignition key to the OFF position. Disconnect the CAB 14-way connector. WARNING: NOTE: Vehicles with diesel engines must also have the vacuum sensor disconnected. Turn the ignition key to the RUN position. • Is the brake warning lamp illuminated?	Repair the brake warning lamp ground control circuit for a short to ground and perform the Verification Test.	Replace the CAB and perform the Verification Test.
6	• Is the ABS warning lamp illuminated continuously?	Perform RWAL DIAGNOSTIC PROCEDURES TEST 1.	Perform step 7.
7	Inspect the CAB 14-way connector. • Is the connector properly connected to the CAB?	Perform step 8	Reconnect and perform the Verification Test.
8	Inspect the wiring and terminals at the connector. • Are the terminals or wiring pushed out or damaged?	Repair as necessary and perform the Verification Test.	Perform step 9.
9	Connect an ohmmeter to terminal 10 and a good chassis ground. • Is the resistance to ground less than 1 ohm?	Perform step 10	Repair the ground circuit and perform the Verification Test.
10	Connect a voltmeter to terminal 2 and a good chassis ground. Turn the ignition key to the RUN position. • Is the voltage less than 9 volts?	Perform step 11.	Replace the CAB and perform the Verification Test.
11	Inspect the ABS warning lamp bulb. • Is bulb functional?	Repair the open circuit from terminal 2 to the ABS warning lamp and perform the Verification Test.	Replace the bulb and perform the Verification Test.

DIAGNOSIS AND TESTING (Continued)**RWAL DIAGNOSTIC PROCEDURES—TEST 5**

This procedure starts with neither the brake warning lamp illuminated nor the ABS warning lamp illu-

minated during the CRANKING bulb check. If either lamp illuminated during the bulb check, then perform RWAL DIAGNOSTIC PROCEDURES TEST 1

Step	Action	Yes	No
1	In most cases, the fuse that feeds the brake warning lamp also feeds the ABS warning lamp. Inspect the fuse that feeds the warning lamp circuit. • Is the fuse functional?	Perform step 2	Inspect and repair the warning lamp circuit for a short to ground and replace the fuse, then perform the Verification Test.
2	Turn the ignition key to the RUN position. Use a voltmeter and verify battery voltage supplied to the fuse. • Is battery voltage supplied to the fuse?	Perform step 3.	Repair the open circuit to the fuse and perform the Verification Test.
3	Apply the parking brake. • Did the brake warning lamp illuminate?	Repair the open circuit from the ignition switch START circuit (ground side during cranking) to the brake warning lamp, then perform RWAL DIAGNOSIS.	Repair the open circuit from the fuse to the warning lamp circuit and perform the Verification Test.

RWAL DIAGNOSTIC PROCEDURES—TEST 6

This procedure starts with both the brake warning lamp illuminated and ABS warning lamp illuminated and RWAL diagnostics cannot be performed. If you

are able to retrieve a DTC from the CAB's memory, then perform RWAL DIAGNOSTIC PROCEDURES TEST 1.

Step	Action	Yes	No
1	Turn the ignition key to the OFF position. Disconnect the 14-way RWAL CAB connector. Turn the ignition key to the RUN position. • Is the brake warning lamp illuminated?	Perform step 2	Perform step 8.
2	Inspect the level of brake fluid in the master cylinder reservoir. • Is the fluid level correct?	Perform step 3.	Find and repair cause of leakage then perform the Verification Test.
3	• Is the vehicle equipped with a diesel engine?	Perform step 5.	Perform step 4.
4	Disconnect the harness connector from the differential pressure switch • Is the brake warning lamp still illuminated?	Repair the short to ground for the brake warning lamp circuit and perform the Verification Test.	The pressure differential switch has shuttled. Check the brake system for air in the hydraulic circuit or possible mechanical damage. Repair as necessary and then perform the Verification Test.
5	Start the engine. • Is the brake warning lamp still illuminated?	Perform step 6.	Perform step 8.

DIAGNOSIS AND TESTING (Continued)

Step	Action	Yes	No
6	Turn the engine OFF. Turn the ignition key to the RUN position. Disconnect the harness connector from the diesel vacuum warning switch. • Is the warning lamp still illuminated?	Perform step 4.	Perform step 7.
7	Disconnect the vacuum hose from the diesel vacuum warning switch and connect a vacuum gauge to the hose. Start the engine. • Is there an adequate supply of vacuum to the warning switch?	Replace the diesel vacuum warning switch and perform the Verification Test.	Repair the vacuum supply as required and perform the Verification Test.
8	Turn the ignition key to the OFF position. Connect a ohmmeter across terminal 12 to the terminal in the diagnostic test connector. • Is the resistance less than 1 ohm?	Perform step 9.	Repair the open circuit between the CAB's 14-way connector and the diagnostic terminal then perform RWAL DIAGNOSIS.
9	With the ohmmeter still installed in terminal 12 of the CAB's 14-way connector, install the other end of the ohmmeter to ground. • Is the resistance less than 1 ohm?	Repair the short to ground of the diagnostic terminal circuit and perform the verification test.	Perform step 10.
10	Install a voltmeter between terminal 3 of the CAB's 14-way connector and ground. Turn the ignition key to the RUN position. • Is the voltage greater than 9 volts?	Perform step 11.	Perform step 13.
11	Install a voltmeter between terminal 9 of the CAB's 14-way connector and ground. • Is the voltage greater than 9 volts?	Perform step 12.	Perform step 14.
12	Inspect the CAB's 14-way connector. • Are there any bent terminals, terminals that are pushed out, terminals that are corroded, a locking tab that is damaged or pins that are bent on the CAB?	Repair as necessary and perform the Verification Test.	Replace the CAB and perform the Verification Test.
13	Inspect the fuse that feeds the ignition circuit of the CAB. • Is the fuse functional	Repair the open circuit to terminal 3 of the CAB's 14-way connector and perform the Verification Test.	Repair the short to ground, replace the fuse, and then perform the Verification Test.
14	Inspect the fuse that feeds the battery feed circuit of the CAB. • Is the fuse functional	Repair the open circuit to terminal 9 of the CAB's 14-way connector. and perform the Verification Test.	Repair the short to ground, replace the fuse, and then perform the Verification Test.

DIAGNOSIS AND TESTING (Continued)**RWAL DIAGNOSTIC PROCEDURES—TEST 7**

This test begins with a DTC that can be regenerated anytime the CAB memory is cleared. You can begin your diagnosis by locating the recorded DTC in the chart below. A brief description follows the code. The final column provides a list of circuits and components to test along with specifications and values.

Once your diagnosis is complete, perform the VERIFICATION TEST.

An intermittent DTC can be tested in the same manner as DTCs that are reoccurring. The only difference is usually an intermittent DTC will have a malfunction with either a poor electrical connection or have a problem with the wiring. Never replace the CAB for an intermittent DTC unless otherwise told to do so.

DTC	DTC DESCRIPTION	DIAGNOSIS
1	DTC 1 is not a fault code and should not occur.	Attempt to retrieve the DTCs again. If DTC 1 appears again, perform step 12 of the RWAL DIAGNOSTIC PROCEDURES TEST 1. If not, record the DTC and start at the appropriate test.
2	This code identifies a open in the isolation valve circuit.	Components and circuits involved include: <ul style="list-style-type: none"> • Open circuit from terminal 1 of the 14-way connector to the RWAL valve. • Ground connection for the RWAL valve. • Open circuit in the RWAL valve's isolation solenoid. • Poor connections in the 14-way CAB connector. • Poor connections in the RWAL valve's 4-way connector. • CAB. Check resistance of the isolation solenoid and circuit. Resistance of the solenoid should be approximately 3-6 ohms.
3	This code identifies an open in the dump valve circuit.	Components and circuits involved include: <ul style="list-style-type: none"> • Open circuit from terminal 8 of the 14-way connector to the RWAL valve. • Ground connection for the RWAL valve. • Open circuit in the RWAL valve's dump solenoid. • Poor connections in the 14-way CAB connector. • Poor connections in the RWAL valve's 4-way connector. • CAB. Check resistance of the dump solenoid and circuit. Resistance of the solenoid should be approximately 2-3 ohms.
4	This code identifies a short in the reset switch circuit.	Components and circuits involved include: <ul style="list-style-type: none"> • Short circuit from terminal 11 of the 14-way connector to the RWAL valve. • Short circuit in the RWAL valve's reset switch. • CAB. Check resistance of the reset switch circuit and ground. Resistance of the circuit to ground should be over 10,000 ohms.
5	This code identifies that over 16 dump pulses occurred during an antilock stop. This code only affects 2WD vehicles and 4WD vehicles while in 2WD mode. 4WD vehicles use the 4WD switch to disable the diagnostics. During an antilock stop, a vehicle in 4WD mode may normally have 16 dump pulses.	Components and circuits involved include: <ul style="list-style-type: none"> • Open circuit from terminal 4 of the 14-way connector to the 4X4 switch (fault may have occurred in 4WD mode) • Mechanical malfunction in the rear brakes (brakes may be locking-up). • RWAL valve.

DIAGNOSIS AND TESTING (Continued)

DTC	DTC DESCRIPTION	DIAGNOSIS
6	This code identifies an erratic rear wheel speed sensor reading. This code can only be recorded by the CAB while the CAB is monitoring a speed sensor that identifies the vehicle is moving.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Intermittent poor connection between terminals 13 and 14 of the 14-way connector and the RWAL WSS. • Build-up of foreign material on the tip of the RWAL WSS. • Exciter ring - broken, chipped teeth, teeth that are missing, exciter ring that is bent. • RWAL WSS. • CAB. <p>The RWAL WSS can be tested by connecting a voltmeter into the RWAL WSS circuit. Set the voltmeter to the AC scale. Then, rotating the rear wheels (both wheels must be rotated at same speed and in same direction) at 5 mph. The RWAL WSS should produce a voltage of at least 650 mv (rms) and should be steady.</p>
7	This code identifies a short in the isolation valves circuit.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Short to ground from terminal 1 in the 14-way connector to the RWAL valve. • Short in the RWAL valve's isolation solenoid. • CAB. <p>Check resistance of the isolation solenoid and circuit. Resistance of the solenoid should be approximately 3-6 ohms.</p> <p>WARNING: CAUTION: It is important to remember that the short to ground must be repaired prior to installing a CAB for this DTC.</p>
8	This code identifies a short in the dump valve circuit.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Short to ground from terminal 8 in the 14-way connector to the RWAL valve. • Short in the RWAL valve's dump solenoid. • CAB. <p>Check resistance of the dump solenoid and circuit. Resistance of the solenoid should be approximately 2-3 ohms.</p> <p>WARNING: CAUTION: It is important to remember that the short to ground must be repaired prior to installing a CAB for this DTC.</p>
9	This code usually identifies an open in the RWAL WSS circuit.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Open circuit between terminals 13 and 14 and the RWAL WSS. • Poor connection in the 14-way connector. • Poor connection at the RWAL WSS. • RWAL WSS. • CAB. <p>The RWAL WSS should have a resistance between 1000 and 2500 ohms.</p>
10	This code usually identifies a short in the RWAL WSS circuit.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Short circuit between terminals 13 and 14 and the RWAL WSS. • Short circuit between terminals 13 and 14, the RWAL WSS and a ground. • RWAL WSS. • CAB. <p>The RWAL WSS should have a resistance between 1000 and 2500 ohms.</p>

DIAGNOSIS AND TESTING (Continued)

DTC	DTC DESCRIPTION	DIAGNOSIS
11	This code indicates the CAB sensed the brakes being on for an extended length of time with the vehicle exceeding 40 mph.	<p>Components and circuits involved include:</p> <ul style="list-style-type: none"> • Open circuit from terminal 7 to the stop lamp switch • Poor connection in the 14-way connector. • Poor connection in the stop lamp switch connector. • Open circuit from stop lamp switch to ground. • Mis-adjusted stop lamp switch. • Stop lamp switch. • CAB. <p>The stop lamp switch provides a path to ground when the brakes are released. When the brakes are applied, the path to ground is interrupted.</p>
12	This code is not used	Attempt to retrieve the DTCs again.
13	This code identifies that the CAB had a phase lock loop failure.	The CAB is the only component that will affect this DTC.
14	This code identifies that the CAB had a program check failure.	The CAB is the only component that will affect this DTC.
15	This code identifies that the CAB had a RAM failure.	The CAB is the only component that will affect this DTC.
>16	There are no DTC greater than 15.	Attempt to retrieve the DTCs again.

RWAL VERIFICATION TEST

The verification test will require a test drive as part of the diagnostic procedure. The purpose of the test drive is to duplicate and verify the previous condition.

WARNING: Reduced braking may be encountered if the vehicle is test driven with either the brake warning lamp or the ABS warning lamp illuminated. Extreme caution should be used.

Perform both normal and firm braking stops in the 25-40 mph range. At least one complete ABS stop should be performed. Determine if there are any unusual brake operating conditions such as vehicle lead during braking, brakes grabbing, brakes dragging, noise, low brake pedal, etc. If the brake warning lamp and/or the ABS warning lamps illuminate or flash during the test drive, proceed to the RWAL DIAGNOSTICS PROCEDURES TEST 1 section in this group. If the warning lamps remain extinguished and the brakes respond normally, then the previous malfunction has successfully been repaired and the vehicle can be returned to the customer.

NOTE: If either warning lamp is illuminated, a DTC may have been generated. Restart your diagnosis at the RWAL DIAGNOSTIC PROCEDURES TEST 1. Certain DTCs are erased when the ignition key is turned to OFF. Do not turn the ignition key OFF until you have recorded the DTC.

SERVICE PROCEDURES**RWAL BRAKE BLEEDING**

RWAL brake bleeding can be performed manually, or with vacuum/pressure equipment. Refer to the vacuum and pressure bleeding information in this section.

Bleed only one brake component at a time. Recommended bleed sequence is:

- master cylinder
- combination valve
- rear antilock valve
- left rear wheel
- right rear wheel
- right front wheel
- left front wheel

Use Mopar DOT 3 brake fluid, or an equivalent meeting SAE J1703-F and DOT 3 standards, to fill and bleed the system.

Use a bleed hose at each caliper/cylinder bleed screw. Attach one end of the hose to the bleed screw and insert the opposite end in glass container partially filled with brake fluid. A glass container makes it easier to see air bubbles as they exit the bleed hose. Be sure the end of the bleed hose remains immersed in fluid. This prevents air from being drawn back into the system.

Do not allow the master cylinder to run out of fluid when bleeding the brakes. An empty cylinder will allow air to be drawn back into the system. Check fluid level frequently during bleeding operations.

SERVICE PROCEDURES (Continued)

Be sure to tighten each brake line fitting, or bleed screw once bleeding is completed. Loose fittings and bleed screws allows air to enter the system.

Vacuum Bleeding

If vacuum bleeding equipment is being used, it is not necessary to hold the front brake metering valve open. Simply bleed the brakes following the bleed equipment manufacturers instructions.

Pressure Bleeding

If pressure bleeding equipment will be used, the front brake metering valve will have to be held open to bleed the front brakes. The valve stem is located in the forward end of the combination valve. The stem must either be pressed inward, or held outward slightly. a spring clip tool or helper is needed to hold the valve stem in position.

Follow the manufacturers instructions carefully when using pressure equipment. Do not exceed the tank manufacturers pressure recommendations. Generally, a tank pressure of 15-20 psi is more than sufficient for bleeding purposes.

Fill the bleeder tank with recommended fluid and purge air from the tank lines before bleeding.

Do not pressure bleed without a proper master cylinder adapter. The wrong adapter can lead to leakage, or drawing air back into the system.

Make sure the front brake metering valve in the combination valve is held open. A spring clip tool is best for securing the valve stem in an open position.

REMOVAL AND INSTALLATION

RWAL VALVE/COMBINATION VALVE

REMOVAL

(1) Disconnect ground wire and harness wires from combination valve switch and RWAL valve (Fig. 11).

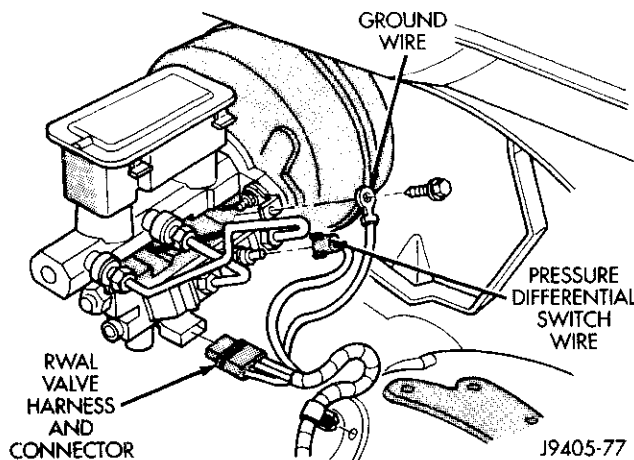


Fig. 11 Valve Harness

(2) Disconnect lines to front and rear brakes from RWAL and combination valves (Fig. 12).

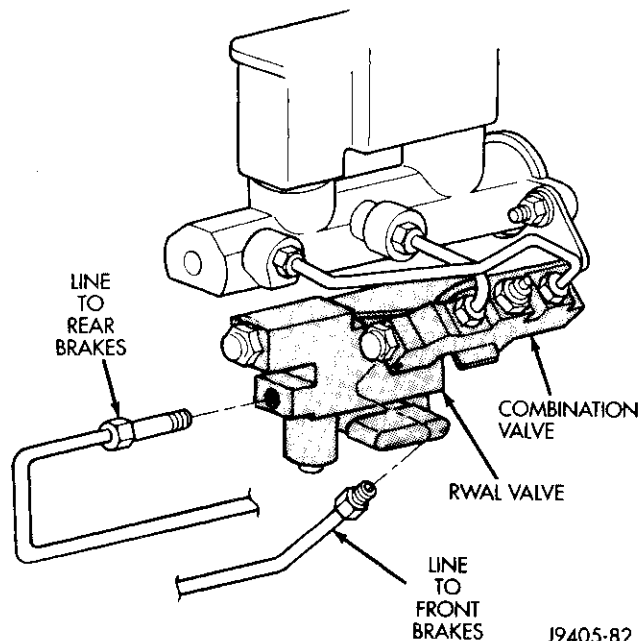


Fig. 12 Master Cylinder brake lines

(3) Remove brake lines connecting master cylinder to combination valve.

(4) Remove nuts attaching master cylinder and combination valve bracket to booster studs.

(5) Remove master cylinder.

(6) Remove combination valve, valve bracket and RWAL valve as assembly.

(7) Remove brake line connecting combination valve to RWAL valve.

(8) Remove bolt attaching RWAL valve to combination valve bracket (Fig. 13). Then separate RWAL valve from bracket.

INSTALLATION

(1) Install RWAL valve on combination valve bracket. Do not tighten RWAL valve bolt completely at this time.

(2) Install short brake line that connects RWAL valve to combination valve. Tighten line fittings to 16-23 N-m (140-200 in. lbs.).

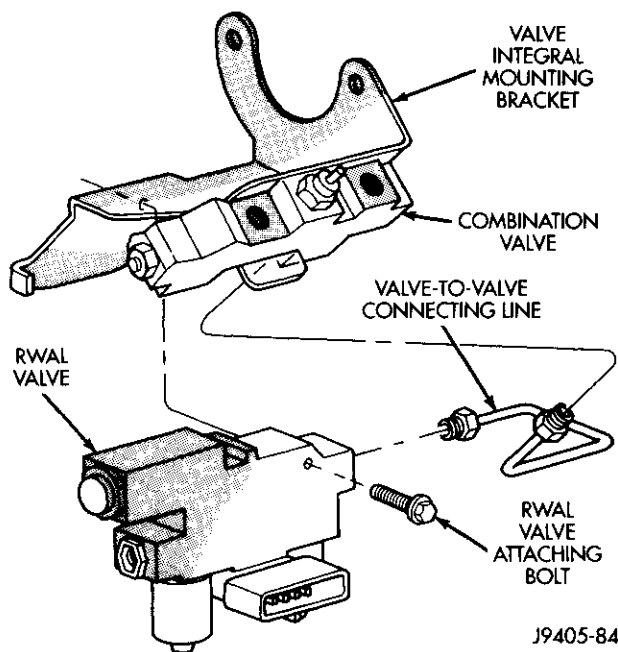
(3) Tighten RWAL valve attaching bolt to 23-34 N-m (200-300 in. lbs.).

(4) Install master cylinder on booster mounting studs.

(5) Attach antilock harness ground wire to combination valve bracket.

(6) Install combination valve bracket on booster mounting studs and against master cylinder.

(7) Loosely install nuts that retain master cylinder and combination valve on booster studs.

REMOVAL AND INSTALLATION (Continued)

J9405-84

Fig. 13 RWAL Valve/Combination Valve

(8) Install and connect all remaining brake lines. Tighten line fittings to 16-23 N·m (140-200 in. lbs.).

(9) Connect harness wires to RWAL valve and to combination valve switch.

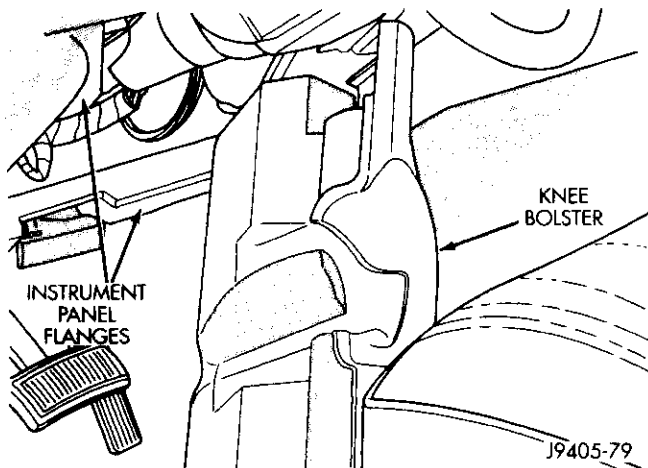
(10) Fill and bleed brake system.

RWAL CONTROLLER

The RWAL electronic control module is located under the central portion of the instrument panel. It is mounted on a bracket attached to the back side of the panel. The module is accessible through an opening created by removal of the knee bolster.

REMOVAL

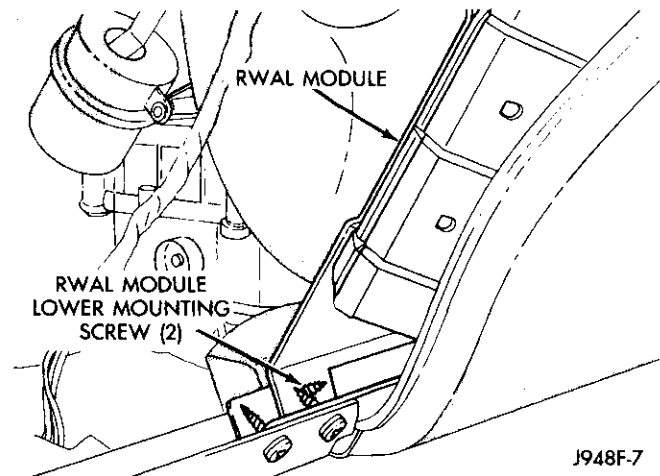
(1) Remove screws from knee bolster attached to panel flange (Fig. 14).



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Fig. 14 Knee Bolster

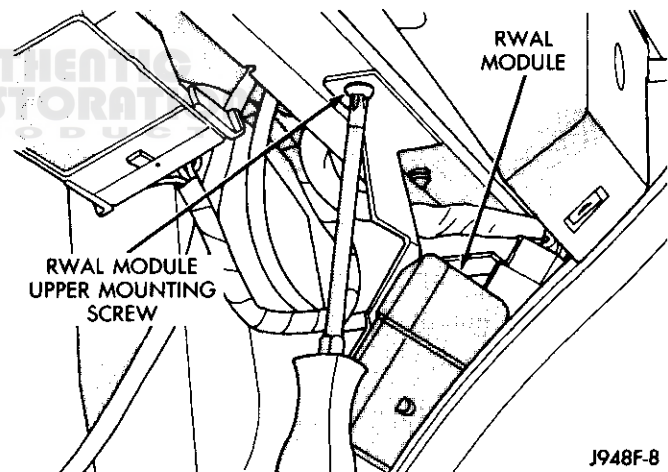
(2) Remove module lower attaching screws (Fig. 15). Screws are partially hidden by air duct but can be removed with long shank, number 2 Phillips screwdriver as shown.



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Fig. 15 RWAL Module Lower Attaching Screws

(3) Remove module upper attaching screw (Fig. 16).



J948F-8

Fig. 16 RWAL Module Upper Attaching Screw

(4) Remove module and bracket from underside of instrument panel.

(5) Disconnect harness wires from module.

(6) If module is to be replaced, remove module from bracket. However, if module is only being removed for access to another component, leave module in place on bracket.

INSTALLATION

(1) Install module on mounting bracket, if removed.

(2) Connect harness wires to module.

(3) Position module and bracket on instrument panel and install attaching screws.

(4) Install knee bolster.

REMOVAL AND INSTALLATION (Continued)**REAR WHEEL SPEED SENSOR****REMOVAL**

- (1) Raise vehicle on hoist.
- (2) Clean sensor, cover and sensor mounting area of axle housing (Fig. 17).
- (3) Disconnect harness wires from sensor (Fig. 17).
- (4) Remove screw that secures brake cable, brake line, sensor cover and sensor in axle housing.
- (5) Remove sensor and cover.
- (6) Cover sensor opening in axle housing to prevent dirt entry.

INSTALLATION

- (1) Insert sensor in axle housing opening.
- (2) Position cover over sensor and install cover and sensor attaching screw and tighten to 24 N·m (18 ft. lbs.).
- (3) Connect harness wires to sensor and lower vehicle.
- (4) Lower vehicle.

EXCITER RING

The exciter ring is mounted on the differential case. If the ring is damaged refer to Group 3 Differential and Driveline for service procedures.

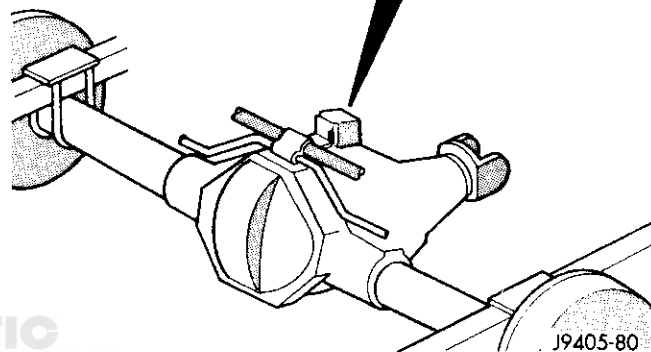
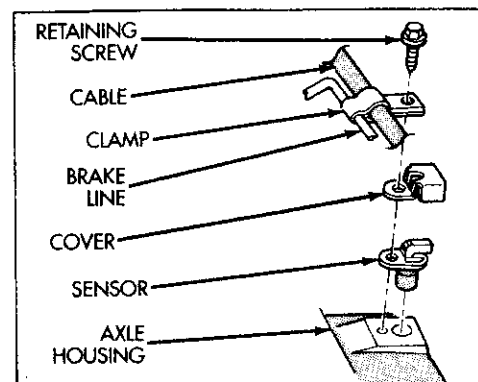


Fig. 17 Rear Wheel Speed Sensor Mounting

SPECIFICATIONS**TORQUE CHART**

DESCRIPTION	TORQUE
RWAL Valve	
Mounting Bolt	23-34 N·m (200-300 in. lbs.)
Brake Lines	16-23 N·m (140-200 in. lbs.)
Wheel Speed Sensor	
Rear Mounting Bolt	24 N·m (212 in. lbs.)

FOUR WHEEL ANTILOCK BRAKE SYSTEM

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GENERAL INFORMATION

ABS BRAKES COMPONENTS

The following is a list of components used in the All Wheel Antilock Brakes System (ABS). It consists of the standard Rear Wheel Antilock brake components, plus the parts needed for ABS.

- Controller Antilock Brake (CAB)
- Hydraulic Control Unit (HCU)
- Wheel Speed Sensor (WSS)
- Rear Antilock Valve
- Combination Valve
- Front Tone Rings
- Rear Exciter Ring

DESCRIPTION AND OPERATION

ALL WHEEL ANTILOCK BRAKE SYSTEM (ABS)

The ABS system is designed to prevent wheel lock-up during braking under virtually any road surface conditions. This allows the driver to retain greater control of the vehicle during braking.

The ABS system is a three channel design (Fig. 1). The front brake antilock valve provides two channel pressure control of the front brakes. Each front wheel brake unit is controlled separately. Two solenoid valves are used in each control channel.

The rear brake antilock valve controls the rear wheel brakes in tandem. The rear brake valve contains two solenoid valves.

The front and rear antilock valves contain electrically operated solenoid valves. The solenoid valves modulate brake fluid apply pressure during antilock

braking. The valves are operated by the antilock electronic module.

The antilock electrical system is separate from other electrical circuits in the vehicle. A specially programmed electronic control module is used to operate the system components.

The pump/motor assembly on the front antilock valve provides the fluid volume needed during antilock braking. The pump is operated by an integral electric motor. The DC type motor is controlled by the Controller Antilock Brake (CAB).

NOTE: For additional information refer to the Antilock Brake Section in Group 8W. For test procedures refer to the Chassis Diagnostic Manual.

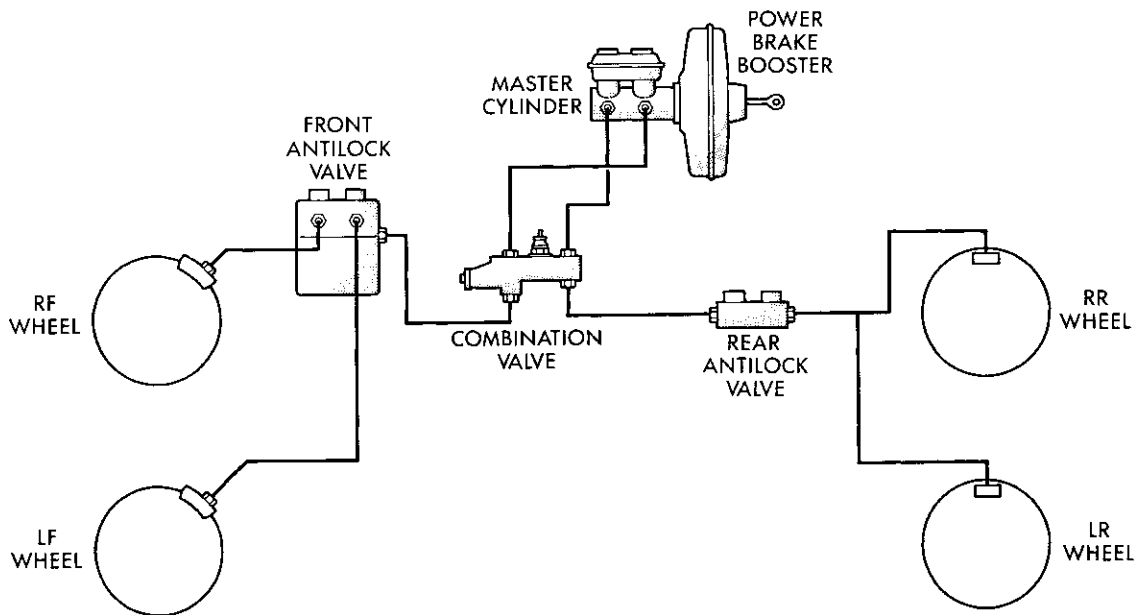
Normal Braking Mode

The ABS electronic control module monitors wheel speed sensor inputs continuously while the vehicle is in motion. The module will not activate the ABS system as long as sensor inputs indicate normal braking.

During normal braking, the master cylinder, power booster and wheel brakes units all function as they would in a vehicle without ABS. The solenoid valves are not activated.

Antilock Braking Mode

The wheel speed sensors converts wheel speed into electrical signals. These signals are transmitted to the module for processing and determine wheel lock-up and deceleration rate. When a wheel speed

DESCRIPTION AND OPERATION (Continued)

J9305-113

Fig. 1 ABS Hydraulic System

sensor signal indicate the onset of wheel lock-up the ABS braking is activated.

The antilock system retards the lockup conditions by modulating fluid apply pressure to the wheel brake units. The pressure is modulated according to wheel speed, degree of lock-up and rate of deceleration.

The solenoid valves are cycled continuously to modulate pressure. Solenoid cycle time in antilock mode can be measured in milliseconds.

CONTROLLER ANTILOCK BRAKES (CAB)

The CAB is located at the drivers inner fender panel. The CAB is attached to the forward side of the Hydraulic Control Unit mounting bracket (Fig. 2).

The CAB is used to monitor and operate the ABS system. It monitors the brake switch and wheel speed sensors inputs to prepare for possible antilock braking. The CAB controls the antilock valve solenoid operation during all phases of antilock braking.

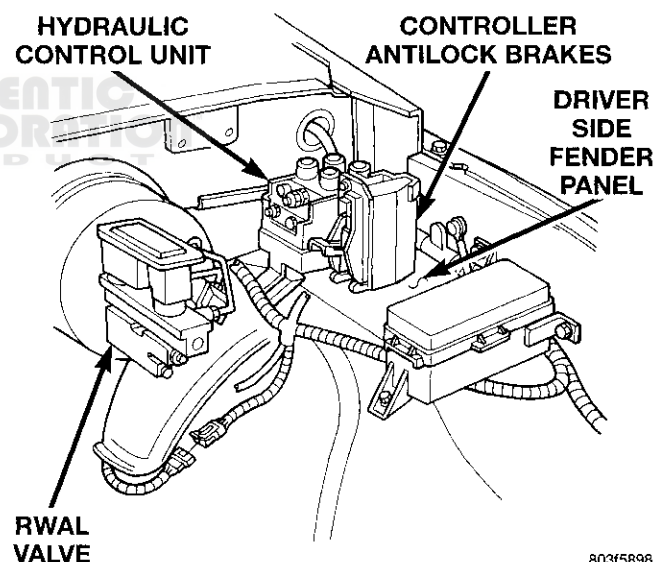
HYDRAULIC CONTROL UNIT (HCU)

The HCU mounted on the driver side inner fender panel (Fig. 2).

The HCU consist of the front antilock valve assembly and pump/motor unit.

FRONT ANITLOCK VALVE

The front brake antilock valve consists of a solenoid valve body. The antilock valve provides two channel pressure control of the front brakes. One channel controls the left front brake unit. The second



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Fig. 2 Controller Antilock Brakes and Hydraulic Control Unit

channel controls the right front brake unit. Each front brake unit is controlled independently.

The solenoid valves are cycled open and closed as needed during antilock braking. They are cycled rapidly and continuously to modulate brake fluid pressure and control wheel lock-up and deceleration.

PUMP/MOTOR

The pump is run by a DC type motor controlled by the Controller Antilock Brake (CAB). The pump supplies the additional fluid volume needed during antilock braking.

DESCRIPTION AND OPERATION (Continued)**WHEEL SPEED SENSOR (WSS)**

The ABS brake system uses 3 wheel speed sensors. A sensor is mounted to each front steering knuckles. The third sensor is mounted on top of the rear axle differential housing. The sensor is a magnet coil that is mounted over a tone wheel front/exciter ring rear with an air gap between them.

The sensors measure the wheel speed by monitoring the rotation of the tone wheels front/exciter ring rear. As the teeth of the tone wheels front/exciter ring rear move through the magnetic field of the sensor an AC voltage is generated. This signal frequency increases or decreases proportionally to the speed of the wheel. The CAB monitors these signals for changes in wheel deceleration. If the CAB detects a sudden wheel or wheels deceleration within a predetermined amount the CAB will activate the ABS system.

COMBINATION VALVE**Pressure Differential Switch**

The pressure differential switch is connected to the brake warning lamp. The switch is triggered by movement of the switch valve. The purpose of the switch is to monitor fluid pressure in the separate front/rear brake hydraulic circuits.

A decrease or loss of fluid pressure in either hydraulic circuit will cause the switch valve to shuttle forward or rearward in response to the pressure differential. Movement of the switch valve will push the switch plunger upward. This closes the switch internal contacts completing the electrical circuit to the warning lamp. The switch valve may remain in an actuated position until repair restores system pressures to normal levels.

Metering Valve

The metering valve is used to balance brake action between the front disc and rear drum brakes. The valve meters (holds-off) full apply pressure to the front disc brakes until the rear brakeshoes are in full contact with the drums. The valve is designed to maintain front brake fluid pressure at 21-207 kPa (3-30 psi) until the hold-off limit of 807 kPa (117 psi) is reached. At this point, the metering valve opens completely permitting full fluid apply pressure to the front disc brakes.

ABS RELAYS

Two relays are use on the ASB system. An ABS warning lamp relay is used to activate the amber ABS warning lamp. When the lamp is, lit the voltage at the CAB monitoring point will be 0 volts. The voltage at the monitoring point will be 12 volts when the CAB energizes the relay turning the ABS lamp off.

The second relay is the ASB main (pump) relay. This relay is used to supply voltage to the ABS pump motor, Front Antilock Valve and Rear Wheel Antilock Valve.

Both relays are located in the engine compartment in the Power Distribution Center.

ABS WARNING LAMP

The amber ABS warning lamp in located in the vehicle instrument cluster. The ABS warning lamp relay completes the circuit for the lamp by providing a ground. The CAB checks the warning lamp at the beginning of each ignition cycle by turning on the lamp for 3.4 seconds. The lamp is used to alert the driver if a malfunction in the ABS system has occurred by turning the lamp on steady.

DIAGNOSIS AND TESTING**ANTILOCK BRAKES**

The ABS brake system performs several self-tests every time the ignition switch is turned on and the vehicle is driven. The CAB monitors the systems input and output circuits to verify the system is operating correctly. If the on board diagnostic system senses that a circuit is malfunctioning the system will set a trouble code in its memory.

NOTE: The MDS or DRB III scan tool is used to diagnose the ABS system. For additional information refer to the Antilock Brake section in Group 8W. For test procedures refer to the Chassis Diagnostic Manual.

SERVICE PROCEDURES**ABS BRAKE BLEEDING**

ABS brake bleeding can be performed manually, or with vacuum/pressure equipment. Refer to the vacuum and pressure bleeding information in this section.

Bleed only one brake component at a time. Recommended bleed sequence is:

- master cylinder
- combination valve
- rear antilock valve
- front antilock valve
- left rear wheel
- right rear wheel
- right front wheel
- left front wheel

Use Mopar DOT 3 brake fluid, or an equivalent meeting SAE J1703-F and DOT 3 standards, to fill and bleed the system.

SERVICE PROCEDURES (Continued)

Use a bleed hose at each caliper/cylinder bleed screw. Attach one end of the hose to the bleed screw and insert the opposite end in glass container partially filled with brake fluid. A glass container makes it easier to see air bubbles as they exit the bleed hose. Be sure the end of the bleed hose remains immersed in fluid. This prevents air from being drawn back into the system.

Do not allow the master cylinder to run out of fluid when bleeding the brakes. An empty cylinder will allow air to be drawn back into the system. Check fluid level frequently during bleeding operations.

Be sure to tighten each brakeline fitting, or bleed screw once bleeding is completed. Loose fittings and bleed screws allow air to enter the system.

ABS MANUAL BRAKE BLEEDING

Bleed new or overhauled master cylinder **on bench** before installation. This shortens overall bleed time and ensures proper cylinder operation. Refer to procedure in Master Cylinder Service section.

Bleed master cylinder first, combination valve second, rear antilock valve third and front antilock valve fourth. Bleed cylinder and valves at brakeline fittings one at a time. Procedure is as follows:

- (1) Remove cap or caps and fill reservoir with fresh Mopar, or equivalent quality brake fluid.
- (2) Loosen brakeline fitting about 1-1/2 turns.
- (3) Have helper press **and hold** brake pedal to floor. Observe condition of fluid coming out of brake-line fitting.
- (4) Tighten brakeline fitting and have helper release brake pedal. **Be sure to tighten fitting before helper releases brake pedal.**
- (5) Continue bleeding until fluid coming out of fitting, is clear and free of bubbles.

NEW FRONT ANTILOCK VALVE

If a **new** front antilock valve assembly was installed, bleed new valve as follows:

- (1) Loosen bleed plug on new front valve about 1/4 to one full turn (Fig. 3). Plug must be open to fully bleed upper and lower sections of front antilock valve.
- (2) Remove cap from bleed valve stem (Fig. 3).
- (3) Install Valve Depressor Tool 6670 on bleed valve stem by sliding notched side of tool onto boss that surrounds bleed valve stem (Fig. 4).
- (4) Tighten thumbscrew on bleed Tool 6670 just enough to push valve stem inward about 0.51 - 0.76 mm (0.020 - 0.030 in.). Stem must be held inward (in open position) to fully bleed upper section of new valve assembly.
- (5) Apply brake pedal. Pedal will fall off significantly when bleed plug is properly open and bleed

valve stem is correctly unseated (pressed inward) by tool.

(6) Stroke brake pedal rapidly 5-10 times. This action will fill upper and lower sections of valve rapidly.

(7) Bleed new valve assembly at each brakeline fitting one at a time. Remember to close valve bleed plug before each brake pedal stroke. Continue bleeding until fluid flowing from fittings is clear and free of bubbles.

(8) Remove depressor tool from valve stem and install cap on stem. Then tighten bleed plug to 7-9 N·m (60-84 in. lbs.).

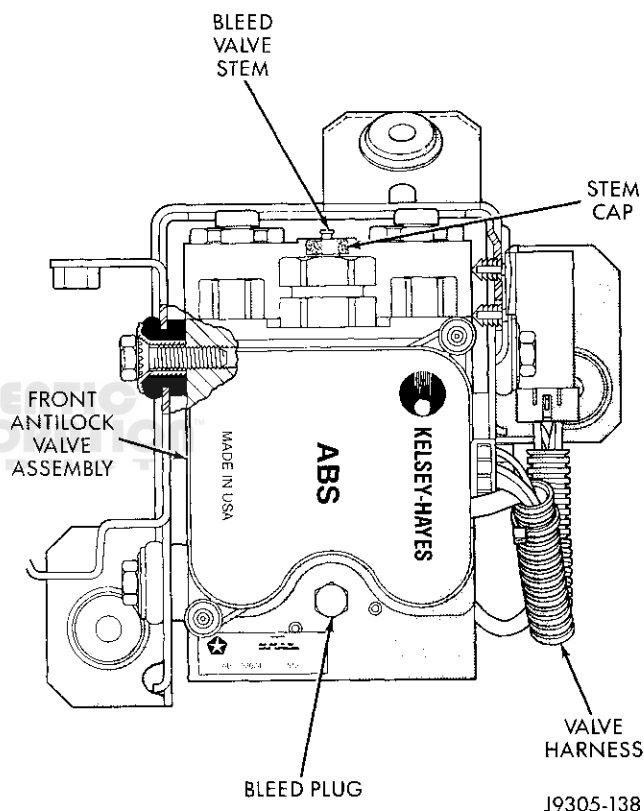
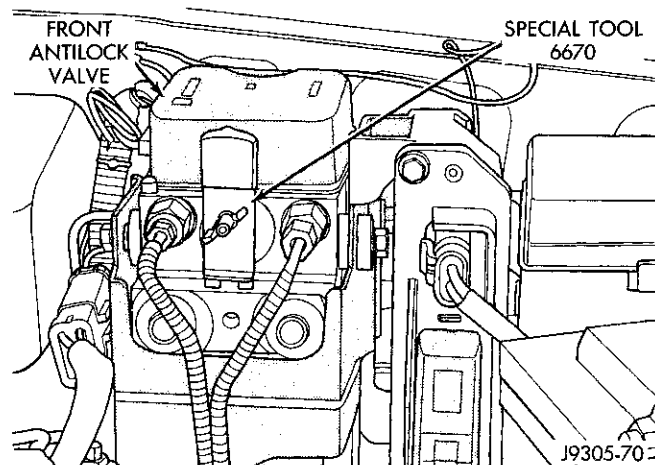


Fig. 3 Front Antilock Valve Bleed Valve Stem & Plug
ORIGINAL FRONT ANTILOCK VALVE

If **original** assembly is being used, bleed plug and bleed valve do not have to be open during bleeding operations. Just bleed the valve assembly at each brakeline fitting one at a time.

Bleed first wheel brake unit. Start at left rear wheel and follow sequence recommended. Repeat bleeding operation at each wheel until fluid coming out of bleed screw is clear and free of bubbles.

Top off master cylinder reservoir fluid level. Then verify proper brake operation before moving vehicle.

SERVICE PROCEDURES (Continued)**Fig. 4 Front Antilock Valve Bleed Tool****Vacuum Bleeding**

If vacuum bleeding equipment is being used, it is not necessary to hold the front brake metering valve open. Simply bleed the brakes following the bleed equipment manufacturers instructions.

Pressure Bleeding

If pressure bleeding equipment will be used, the front brake metering valve will have to be held open to bleed the front brakes. The valve stem is located in the forward end of the combination valve. The stem must either be pressed inward, or held outward slightly. a spring clip tool or helper is needed to hold the valve stem in position.

Follow the manufacturers instructions carefully when using pressure equipment. Do not exceed the tank manufacturers pressure recommendations. Generally, a tank pressure of 15-20 psi is more than sufficient for bleeding purposes.

Fill the bleeder tank with recommended fluid and purge air from the tank lines before bleeding.

Do pressure bleed without a proper master cylinder adapter. The wrong adapter can lead to leakage, or drawing air back into the system.

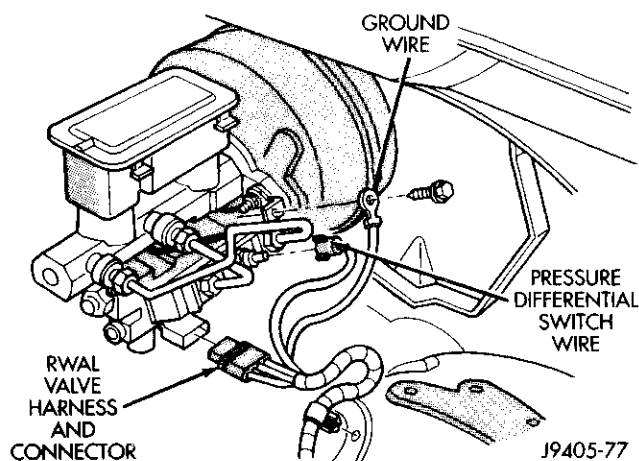
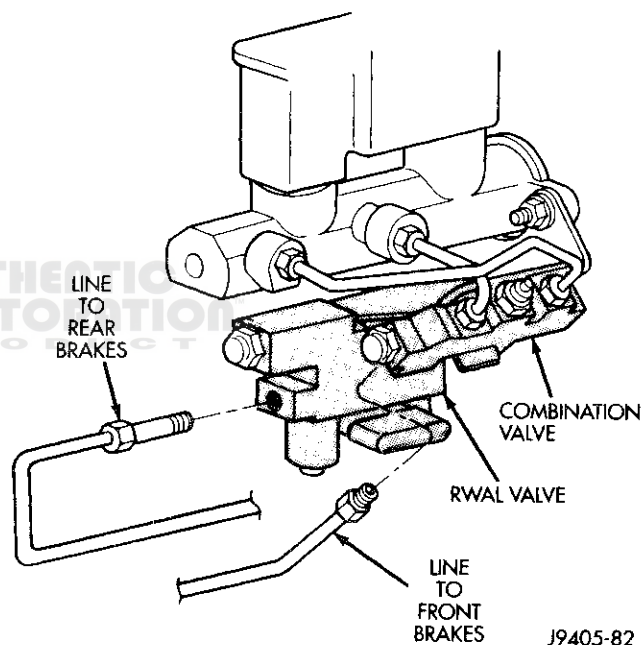
Make sure the front brake metering valve in the combination valve is held open. A spring clip tool is best for securing the valve stem in an open position.

REMOVAL AND INSTALLATION**RWAL VALVE/COMBINATION VALVE****REMOVAL**

(1) Disconnect ground wire and harness wires from combination valve switch and RWAL valve (Fig. 5).

(2) Disconnect lines to front and rear brakes from RWAL and combination valves (Fig. 6).

(3) Remove brake lines connecting master cylinder to combination valve.

**Fig. 5 Valve Harness****Fig. 6 Master Cylinder brake lines**

(4) Remove nuts attaching master cylinder and combination valve bracket to booster studs.

(5) Remove master cylinder.

(6) Remove combination valve, valve bracket and RWAL valve as assembly.

(7) Remove brake line connecting combination valve to RWAL valve.

(8) Remove bolt attaching RWAL valve to combination valve bracket (Fig. 7). Then separate RWAL valve from bracket.

INSTALLATION

(1) Install RWAL valve on combination valve bracket. Do not tighten RWAL valve bolt completely at this time.

REMOVAL AND INSTALLATION (Continued)

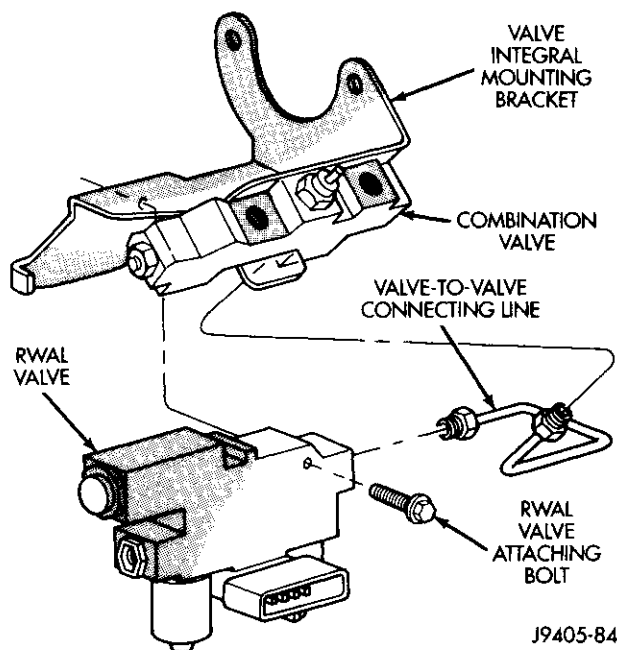


Fig. 7 RWAL Valve/Combination Valve

- (2) Install short brake line that connects RWAL valve to combination valve. Tighten line fittings to 16-23 N·m (140-200 in. lbs.).
- (3) Tighten RWAL valve attaching bolt to 23-34 N·m (200-300 in. lbs.).
- (4) Install master cylinder on booster mounting studs.
- (5) Attach antilock harness ground wire to combination valve bracket.
- (6) Install combination valve bracket on booster mounting studs and against master cylinder.
- (7) Loosely install nuts that retain master cylinder and combination valve on booster studs.
- (8) Install and connect all remaining brake lines. Tighten line fittings to 16-23 N·m (140-200 in. lbs.).
- (9) Connect harness wires to RWAL valve and to combination valve switch.
- (10) Fill and bleed brake system.

CONTROLLER ANTILOCK BRAKE (CAB)

REMOVAL

- (1) Remove and isolate negative battery cable.
- (2) Release CAB connector locking handle and remove connector (Fig. 8).
- (3) Remove the 2 CAB mounting bolts and remove CAB from bracket.

INSTALLATION

- (1) Install CAB in mounting bracket.
- (2) Install mounting bolts.
- (3) Connect harness and lock into place with locking handle.

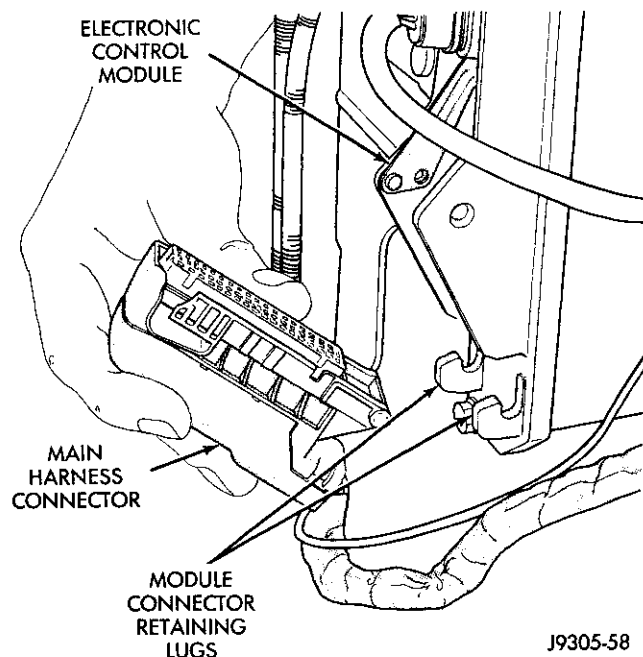


Fig. 8 CAB Harness Connector

- (4) Install negative battery cable.

HYDRAULIC CONTROL UNIT/CONTROLLER ANTILOCK BRAKE

REMOVAL

- (1) Disconnect ABS harness at HCU (Fig. 9).
- (2) Unlatch and disconnect harness at controller.

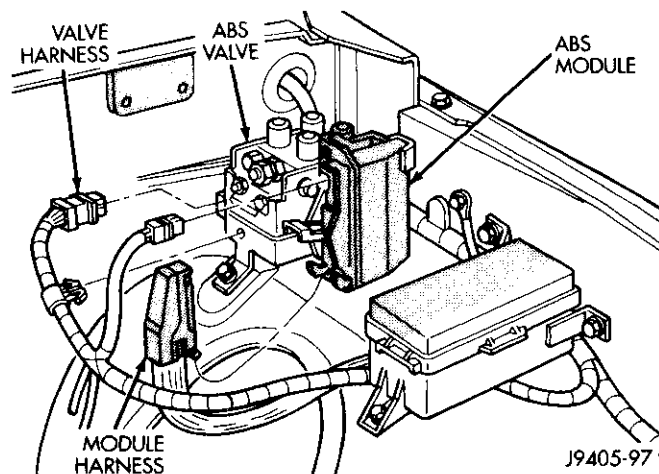
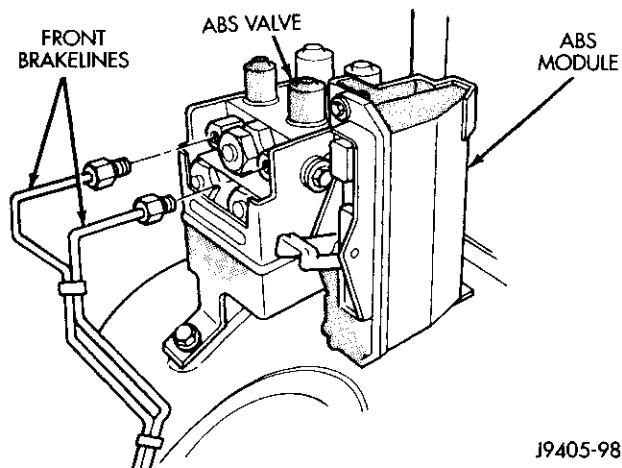
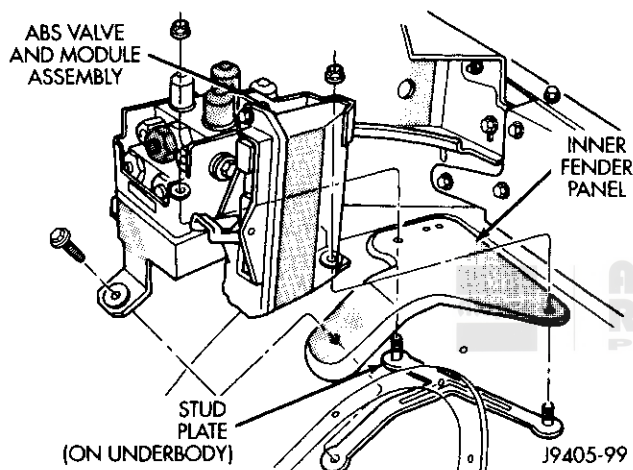


Fig. 9 ABS Harness

- (3) Disconnect lines to front brakes at HCU (Fig. 10).
- (4) Remove stud nuts and bolt that attach HCU to inner fender panel (Fig. 11). Then remove valve from engine compartment.

REMOVAL AND INSTALLATION (Continued)**Fig. 10 HCU Brakelines****Fig. 11 HCU Mounting**

(5) If valve is only being removed for access to another component, cover brake line fluid ports with tape or plugs to prevent dirt entry.

(6) Remove bolts attaching CAB to HCU and remove controller.

INSTALLATION

(1) Install module on HCU.
 (2) Position HCU on mounting studs.
 (3) Install and tighten mounting bolt and stud nuts. Tighten bolts and nuts to 10-13 N·m (92-112 in. lbs.).

(4) Connect ABS harnesses to HCU and CAB. Be sure CAB harness is securely latched in place.

(5) Connect brake lines to HCU and tighten line fittings to 19-23 N·m (170-200 in. lbs.).

(6) Fill and bleed brake system.

FRONT SPEED SENSOR**REMOVAL**

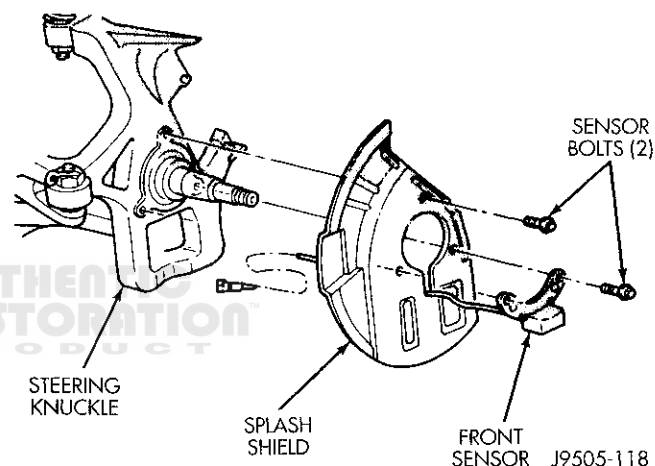
(1) Raise vehicle and support vehicle front end.
 (2) Remove wheel and tire assembly.
 (3) Press caliper piston back into bore with pry tool.

(4) Remove brake caliper bolts and lift caliper from knuckle and rotor. Secure caliper to frame or chassis component with wire. Do not allow brake hose to support caliper weight.

(5) Remove rotor, refer to Group 5 Brakes.

(6) Remove bolts attaching sensor to steering knuckle (Fig. 12). Retain bolts. They are special and must be reused if in good condition.

(7) Disconnect sensor wire and remove sensor from vehicle.

**Fig. 12 Front Speed Sensor Mounting (2-Wheel Drive Shown)****INSTALLATION**

(1) Position sensor in knuckle.
 (2) Install and tighten sensor bolts to 21-25 N·m (190-250 in. lbs.). **Use original or replacement sensor bolts only. The bolts are special and must not be substituted.**

(3) Connect sensor wire to harness wire from CAB.

(4) Install rotor and brake caliper.

(5) Install wheel and tire assembly.

(6) Lower vehicle.

(7) Verify sensor operation with scan tool.

FRONT WHEEL SPEED SENSOR (4WD)**REMOVAL**

(1) Remove bolt attaching sensor to the inside of the steering knuckle.

(2) In engine compartment, disconnect sensor wire connector at harness plug.

(3) Remove sensor and wire assembly.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) Position sensor on steering knuckle. Seat sensor locating tab in hole in knuckle and install sensor attaching bolt and tighten to 14 N·m (11 ft. lbs.).
- (2) Route sensor wire from steering knuckle to harness connector.
- (3) Check sensor wire routing. Be sure wire is clear of all chassis components and is not twisted or kinked at any spot.
- (4) Connect sensor wire to harness in engine compartment.

FRONT TONE WHEEL

The tone wheel for the front speed sensor is located in the rotor hub on 2-wheel drive models (Fig. 13). On 4-wheel drive models, the tone wheel is located on the axle outer stub shaft.

The tone wheel is not a serviceable component. On 2-wheel drive models, the complete rotor and hub assembly will have to be replaced if the tone wheel is damaged. On 4-wheel drive models, the driveshaft will have to be removed and the axle outer stub shaft replaced, if the tone wheel is damaged.

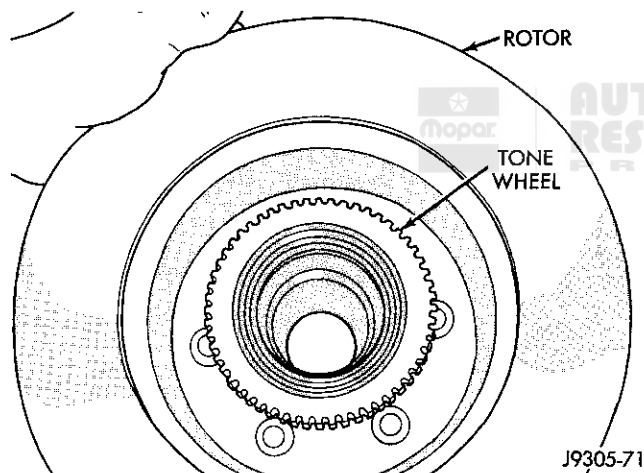


Fig. 13 Front Tone Wheel 2WD

REAR WHEEL SPEED SENSOR

REMOVAL

- (1) Raise vehicle on hoist.
- (2) Clean sensor, cover and sensor mounting area of axle housing (Fig. 14).
- (3) Disconnect harness wires from sensor (Fig. 14).
- (4) Remove screw that secures brake cable, brake line, sensor cover and sensor in axle housing.
- (5) Remove sensor and cover.
- (6) Cover sensor opening in axle housing to prevent dirt entry.

INSTALLATION

- (1) Insert sensor in axle housing opening.

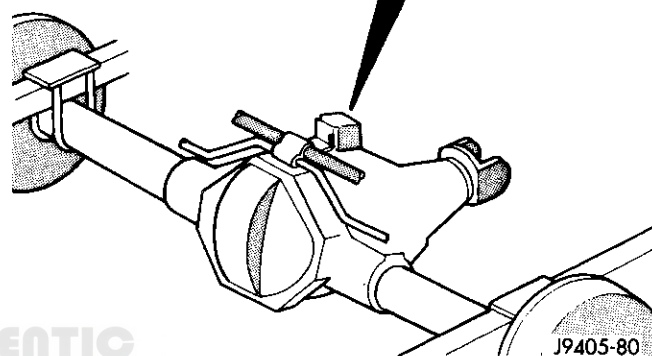
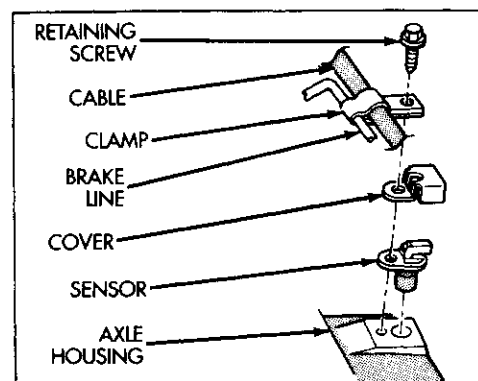


Fig. 14 Rear Wheel Speed Sensor Mounting

- (2) Position cover over sensor and install cover and sensor attaching screw and tighten to 24 N·m (18 ft. lbs.).
- (3) Connect harness wires to sensor and lower vehicle.
- (4) Lower vehicle.

EXCITER RING

The exciter ring is mounted on the differential case. If the ring is damaged refer to Group 3 Differential and Driveline for service procedures.

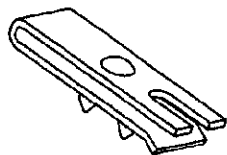
SPECIFICATIONS

TORQUE CHART

DESCRIPTION	TORQUE
Hydraulic Control Unit	
Mounting Bolts/Nuts	10-13 N·m (92-112 in. lbs.)
Brake Lines	19-23 N·m (170-200 in. lbs.)
RWAL Valve	
Mounting Bolt	23-34 N·m (200-300 in. lbs.)
Brake Lines	16-23 N·m (140-200 in. lbs.)
Wheel Speed Sensor	
Front Mounting Bolts	21-25 N·m (190-250 in. lbs.)
Rear Mounting Bolt	24 N·m (212 in. lbs.)

SPECIAL TOOLS

ABS BRAKES



Depressor Brake Valve 6670



**AUTHENTIC
RESTORATION™**
PRODUCT

CLUTCH

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GENERAL INFORMATION

CLUTCH COMPONENTS

The clutch mechanism in BR models with a gas or diesel engine consists of a single, dry-type clutch disc and a diaphragm style clutch cover. A hydraulic linkage is used to engage/disengage the clutch disc and cover.

The transmission input shaft is supported in the crankshaft by a bearing. A sleeve type release bearing is used to engage and disengage the clutch cover pressure plate.

The release bearing is operated by a release fork in the clutch housing. The fork pivots on a ball stud mounted inside the housing. The release fork is actuated by a hydraulic slave cylinder mounted in the housing. The slave cylinder is operated by a clutch master cylinder mounted on the dash panel. The cylinder push rod is connected to the clutch pedal.

The clutch disc has damper springs in the disc hub. The clutch disc facing is riveted to the hub. The facing is made from a non-asbestos material. The clutch cover pressure plate is a diaphragm type with a one-piece spring and multiple release fingers. The pressure plate release fingers are preset during manufacture and are not adjustable.

CLUTCH DISC APPLICATION

Two clutch disc diameters and four different thicknesses are used.

A 281 mm (11 in.) diameter clutch disc is used with a 3.9L, 5.2L, or 5.9L gas engines (Fig. 1) and (Fig. 2).

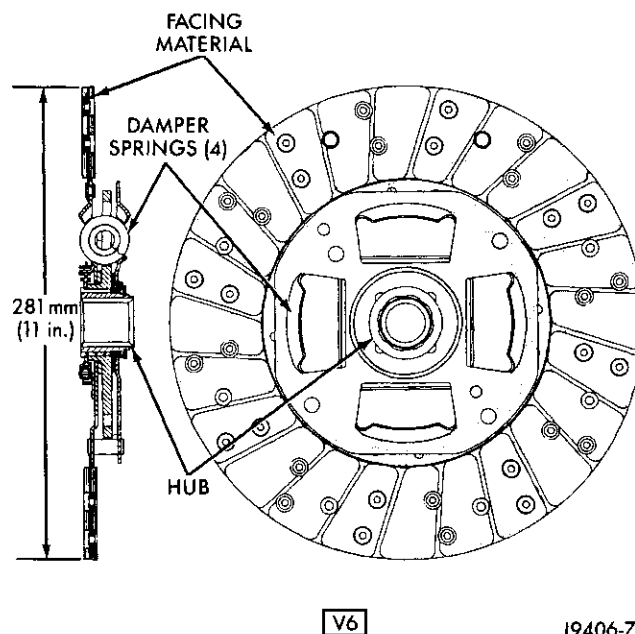
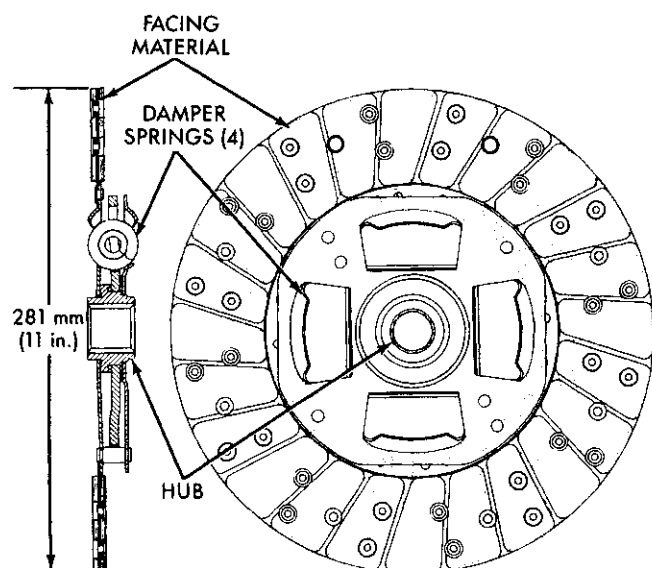


Fig. 1 Clutch Disc—V6 Engine

GENERAL INFORMATION (Continued)

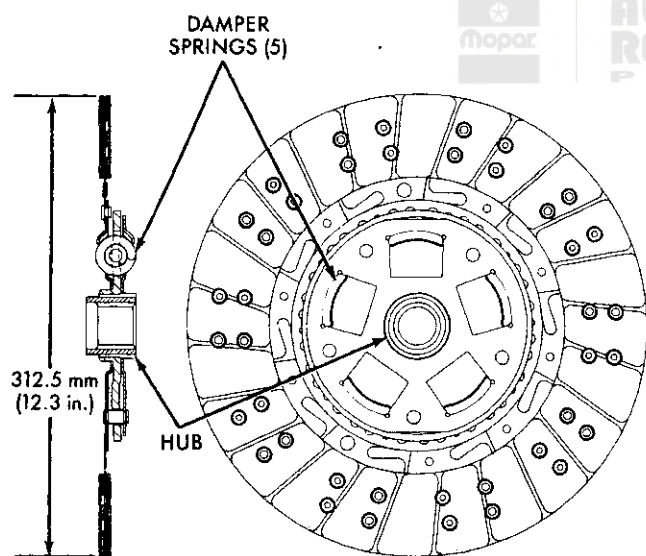


V8

J9406-8

Fig. 2 Clutch Disc—V8 Engine

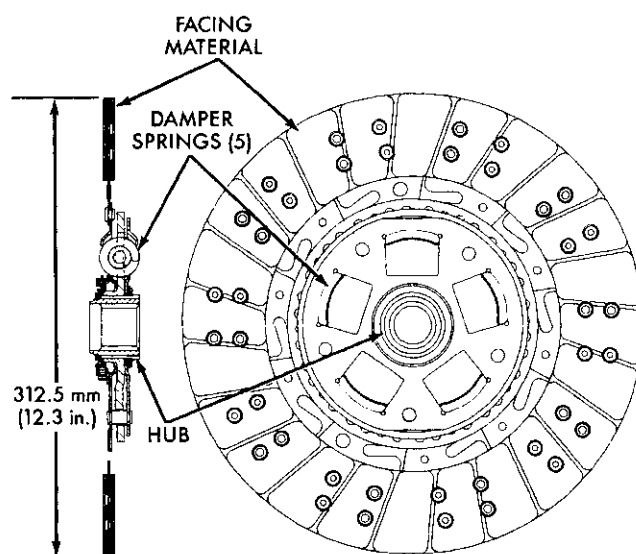
A 312.5 mm (12.3 in.) diameter clutch disc is used with diesel and V10 engines (Fig. 3) and (Fig. 4).



V10

J9406-9

Fig. 3 Clutch Disc—V10 Engine



DIESEL

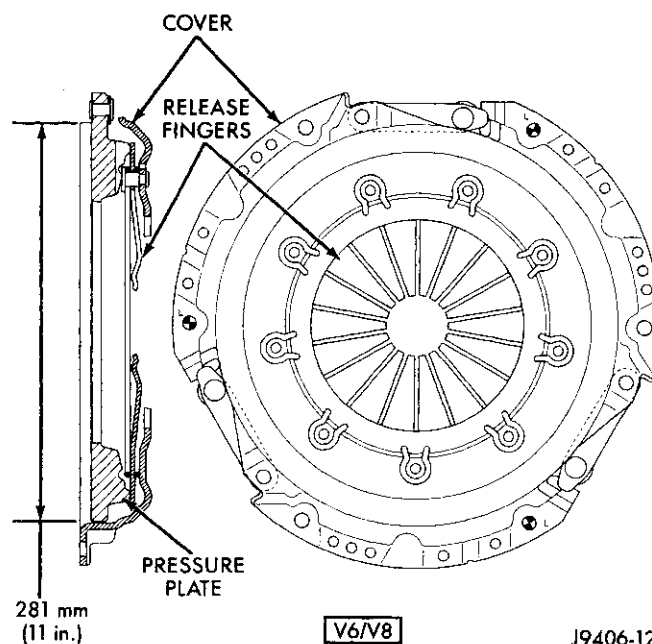
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Fig. 4 Clutch Disc—Diesel Engine

All the discs have damper springs in the hub. The 281 mm discs have four springs while the 312.5 mm disc has five springs. The damper springs provide smoother torque transfer and disc engagement.

CLUTCH COVER APPLICATION

Two clutch covers are used for all applications. The 281 mm cover (Fig. 5), is used for 3.9L, 5.2L and 5.9L gas engine applications.



V6/V8

J9406-12

Fig. 5 Clutch Cover—V6/V8 Gas Engine

GENERAL INFORMATION (Continued)

The 312.5 mm cover (Fig. 6), is used for 5.9L diesel and V10 gas engine applications.

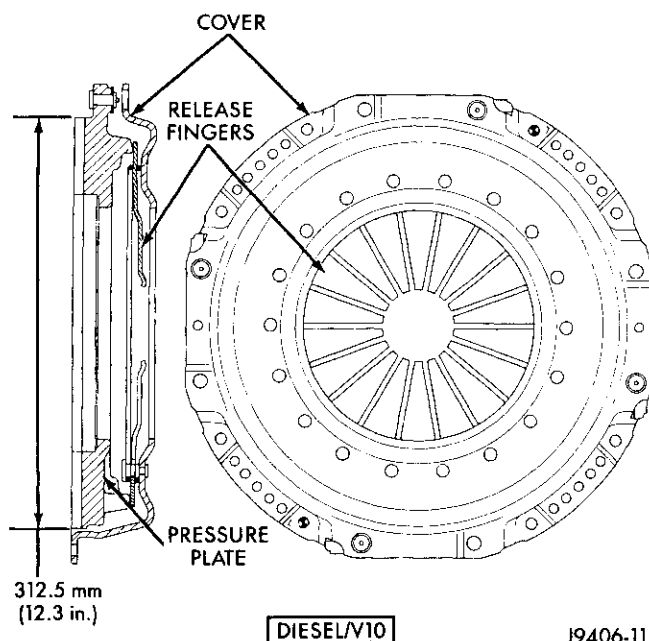
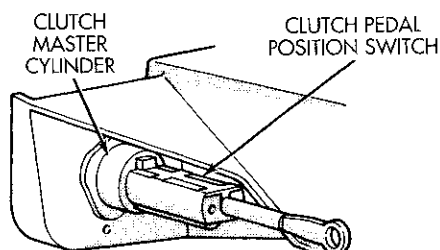


Fig. 6 Clutch Cover—V10 and Diesel Engine

CLUTCH PEDAL POSITION SWITCH

All BR models are equipped with a clutch pedal position switch (Fig. 7). The switch is in circuit with the starter relay and is mounted on the clutch master cylinder push rod. The switch is actuated by clutch pedal movement. The clutch pedal must be fully depressed in order to start the engine.



J9506-26

Fig. 7 Clutch Pedal Position (Interlock) Switch

The position switch is an integral part of the clutch master cylinder push rod and is not serviced separately.

Refer to Group 8W, Wiring Diagrams for component locations and circuit information.

CLUTCH HYDRAULIC LINKAGE

The hydraulic linkage consists of a remote reservoir, clutch master cylinder, clutch slave cylinder and interconnecting fluid lines (Fig. 8).

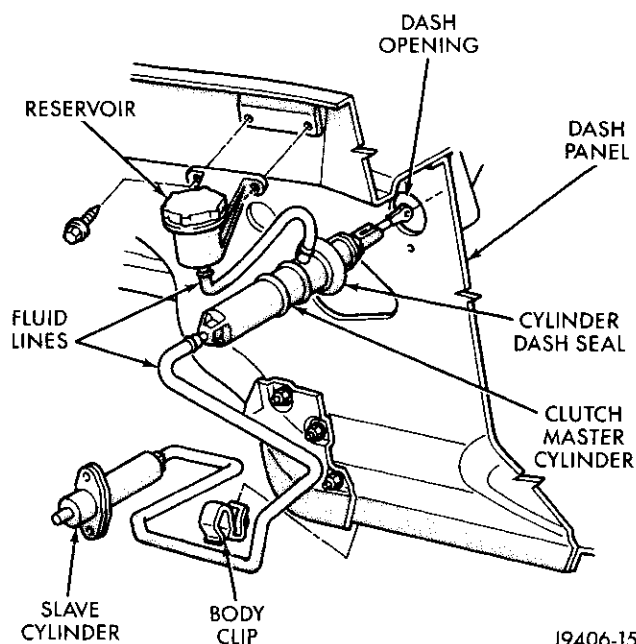


Fig. 8 Clutch Hydraulic Linkage

The clutch master cylinder is connected to the clutch pedal and the slave cylinder is connected to the clutch release fork. The master cylinder is mounted on the drivers' side of the dash panel adjacent to the brake master cylinder.

CLUTCH LINKAGE FLUID

The clutch fluid reservoir, master cylinder, slave cylinder and fluid lines are prefilled with fluid at the factory during assembly operations.

The hydraulic system should not require additional fluid under normal circumstances. In fact, the reservoir fluid level will actually **increase** as normal clutch wear occurs. For this reason, it is important to avoid overfilling, or removing fluid from the reservoir.

If inspection or diagnosis indicates additional fluid may be needed, use Mopar brake fluid, or an equivalent meeting SAE and DOT standards J1703 and DOT 3. Do not use any other type of fluid.

CLUTCH COMPONENT LUBRICATION

Proper clutch component lubrication is important to satisfactory operation. The correct lubricant and not over lubricating are equally important. Apply recommended lubricant sparingly to avoid disc and pressure plate contamination.

Clutch and transmission components requiring lubrication are:

- pilot bearing
- release lever pivot ball stud
- release lever contact surfaces
- clutch disc hub splines

GENERAL INFORMATION (Continued)

- clutch pedal pivot shaft bore
- clutch pedal bushings
- input shaft splines
- input shaft pilot hub
- transmission front bearing retainer slide surface

Do not apply grease to any part of the clutch cover, disc, or release bearing.

RECOMMENDED LUBRICANTS

Use Mopar multi-purpose grease for the clutch pedal bushings and pivot shaft. Use Mopar high temperature grease (or equivalent) for all other lubrication requirements. Apply recommended amounts and do not over lubricate.

INSTALLATION METHODS AND PARTS USAGE

Distortion of clutch components during installation and the use of non-standard components are additional causes of clutch malfunction.

Improper clutch cover bolt tightening can distort the cover. The usual result is clutch grab, chatter and rapid wear. Tighten the cover bolts as described in the Clutch Service section.

Improperly seated flywheels and clutch housings are other causes of clutch failure. Improper seating will produce misalignment and subsequent clutch problems.

Tighten the clutch housing bolts to proper torque before installing any struts. Also be sure the alignment dowels are in place and seated in the block and housing beforehand.

The use of non-standard or low quality parts can also lead to problems and wear. Use the recommended factory quality parts to avoid comebacks.

DIAGNOSIS AND TESTING**GENERAL DIAGNOSIS INFORMATION**

Unless the cause of a clutch problem is obvious, a road test and component inspection will be required for accurate diagnosis.

A road test will help determine the type of fault while component inspection will identify the problem component.

During a road test, drive the vehicle at normal speeds. Shift the transmission through all gear ranges and observe clutch action.

If chatter, grab, slip, or improper release is experienced, remove and inspect the clutch components. However, if the problem is noise or hard shifting, further diagnosis is needed. The transmission or another driveline component may actually be at fault.

Careful observation during a road test will help narrow the problem area.

CLUTCH PROBLEM CAUSES**CONTAMINATION**

Fluid contamination is one of the more common causes of clutch malfunctions. Oil, water, or clutch fluid on the clutch contact surfaces will result in faulty operation. The usual result is chatter, slip, or grab.

During inspection, note if any components are contaminated with oil, hydraulic fluid, or water/road splash.

Oil contamination indicates a leak at either the rear main seal or transmission input shaft.

Oil leakage produces a residue of oil on the housing interior and on the clutch cover and flywheel.

Heat buildup caused by slippage between the cover, disc and flywheel, can sometimes bake the oil residue onto the components. The glaze-like residue ranges in color from amber to black.

Road splash contamination means dirt and water are entering the clutch housing due to loose bolts, housing cracks, vent openings, or through the slave cylinder opening. Driving through deep water puddles can force water/road splash into the housing through such openings.

An additional problem caused by water contamination and especially by steam cleaning, involves clutch disc sticking and poor release.

Water and steam vapors can be absorbed by the clutch facing material. If the vehicle sits idle for long periods after water contamination, the force exerted by the pressure plate may cause the disc to bond itself to the flywheel or pressure plate.

Frequently, the only remedy for the above condition is component replacement. To avoid this problem, a vehicle should be driven as soon as possible to heat and dry the clutch components.

Clutch fluid leaks are from a loose or damaged slave cylinder line or connection. However, clutch fluid leaks will usually be noted and corrected before severe contamination occurs.

CLUTCH MISALIGNMENT

Clutch components must be in proper alignment with the crankshaft and transmission input shaft. Misalignment caused by excessive runout or warpage of any clutch component will cause grab, chatter and improper clutch release.

FLYWHEEL RUNOUT

Common causes of runout are heat warping, improper machining, mounting the flywheel on a dirty crankshaft flange, incorrect bolt tightening, or improper seating on the crankshaft flange shoulder.

Very light scratches or surface roughness on the flywheel face can be cleaned up by scuff sanding with

DIAGNOSIS AND TESTING (Continued)

180 grit emery cloth. However, if the surface is warped or severely scored, replace the flywheel.

Do not machine the flywheel. The flywheel face is manufactured with a unique surface contour. Machining would negate this feature and could result in unsatisfactory operation.

Clean the crankshaft flange before mounting the flywheel. Dirt and grease on the flange surface may cock the flywheel causing runout.

Use new bolts when remounting a flywheel and secure the bolts with Mopar Lock And Seal, or Loctite 242. Tighten flywheel bolts to specified torque only. Overtightening could distort the flywheel hub causing runout.

CLUTCH COVER AND DISC RUNOUT

Check the clutch disc before installation. Axial (face) runout of a **new** disc should not exceed 0.5 mm (0.020 in.). Measure runout about 6 mm (1/4 in.) from the outer edge of the disc facing. Obtain another disc if runout is excessive.

Check condition of the clutch before installation. A warped cover or diaphragm spring will cause grab and incomplete release or engagement.

Be careful when handling the cover and disc. Impact can distort the cover, diaphragm spring, release fingers and the hub of the clutch disc.

Use an alignment tool when positioning the disc on the flywheel. The tool prevents accidental misalignment which could result in cover distortion and disc damage.

A frequent cause of clutch cover distortion (and consequent misalignment) is improper bolt tightening. To avoid warping the cover, tighten the bolts alternately (in a diagonal pattern) and evenly (2-3 threads at a time) to specified torque.

CLUTCH HOUSING MISALIGNMENT AND RUNOUT

Clutch housing alignment is important to proper operation. The housing bore maintains alignment

between the crankshaft and transmission input shaft.

Misalignment can cause noise, incomplete clutch release and chatter. It can also result in premature wear of the pilot bearing, cover release fingers and clutch disc. In severe cases, misalignment can also cause premature wear of the transmission input shaft and bearing.

Housing face misalignment is generally caused by incorrect seating on the engine or transmission, loose housing bolts, missing alignment dowels or housing damage. Infrequently, misalignment may also be caused by housing mounting surfaces that are not parallel.

If housing misalignment is suspected, the housing is probably not fully seated on either the engine, alignment dowels, or transmission front face. Since the NV3500 clutch housing is an integral part of the transmission front case, it will be necessary to remove the transmission and housing as an assembly to check seating. Housing bore and face runout can only be checked in the vehicle on models with a NV4500 transmission. The runout check procedure is described in detail in the Clutch Service section.

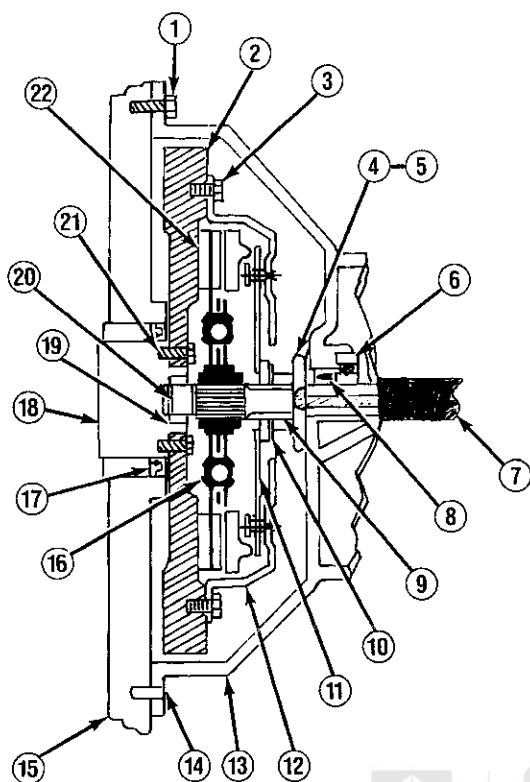
INSPECTION AND DIAGNOSIS CHARTS

The clutch inspection chart (Fig. 9) outlines items to be checked before and during clutch installation. Use the chart as a check list to help avoid overlooking potential problem sources during service operations.

The diagnosis charts describe common clutch problems, causes and correction. Fault conditions are listed at the top of each chart. Conditions, causes and corrective action are outlined in the indicated columns.

The charts are provided as a convenient reference when diagnosing faulty clutch operation.

DIAGNOSIS AND TESTING (Continued)



- 1 Check clutch housing bolts. Tighten if loose. Be sure housing is fully seated on engine block.
- 2 Check flywheel. Scuff sand face to remove glaze. Clean surface with wax and grease remover. Replace flywheel if severely scored, worn or cracked. Secure flywheel with new bolts (if removed). Do not reuse old bolts. Use Mopar Lock N'Seal on bolts.
- 3 Tighten clutch cover bolts 2-3 threads at a time, alternately and evenly (in a star pattern) to specified torque. Failure to do so could warp the cover.
- 4 Check release fork. Replace fork if bent or worn. Make sure pivot and bearing contact surfaces are lubricated.
- 5 Check release fork pivot (in housing). Be sure pivot is secure and ball end is lubricated.
- 6 Transmission input shaft bearing will cause noise, chatter, or improper release if damaged. Check condition before installing transmission.
- 7 Check slave cylinder. Replace it if leaking. Be sure cylinder is properly secured in housing and cylinder piston is seated in release fork.
- 8 Check input shaft seal if clutch cover and disc were oil covered. Replace seal if worn, or cut.
- 9 Inspect release bearing slide surface of trans. front bearing retainer. Surface should be smooth, free of nicks, scores. Replace retainer if necessary. Lubricate slide surface before installing release bearing.
- 10 Do not replace release bearing unless actually faulty. Replace bearing only if seized, noisy, or damaged.
- 11 Check clutch cover diaphragm spring and release fingers. Replace cover if spring or fingers are bent, warped, broken, cracked. Do not tamper with factory spring setting as clutch problems will result.
- 12 Check condition of clutch cover. Replace clutch cover if plate surface is deeply scored, warped, worn, or cracked. Be sure cover is correct size and properly aligned on disc and flywheel.
- 13 Inspect clutch housing. Be sure bolts are tight. Replace housing if damaged.
- 14 Verify that housing alignment dowels are in position before installing housing.
- 15 Clean engine block surface before installing clutch housing. Dirt, grime can produce misalignment.
- 16 Make sure side of clutch disc marked "flywheel side" is toward flywheel.
- 17 Check rear main seal if clutch disc and cover were oil covered. Replace seal if necessary.
- 18 Check crankshaft flange (if flywheel is removed). Be sure flange is clean and flywheel bolt threads are in good condition.
- 19 Check pilot bearing. Replace bearing if damaged. Lube with Mopar high temp. bearing grease before installation.
- 20 Check transmission input shaft. Disc must slide freely on shaft splines. Lightly grease splines before installation. Replace shaft if splines or pilot bearing hub are damaged.
- 21 Check flywheel bolt torque. If bolts are loose, replace them. Use Mopar Lock N'Seal to secure new bolts.
- 22 Check clutch disc facing. Replace disc if facing is charred, scored, flaking off, or worn. Also check runout of new disc. Runout should not exceed 0.5 mm (0.02 in.).

J9506-2

Fig. 9 Clutch Inspection Points

DIAGNOSIS AND TESTING (Continued)**CLUTCH DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
DISC FACING WORN OUT	1. Normal wear. Driver frequently rides (slips) clutch. Results in rapid wear overheating. Insufficient clutch cover diaphragm spring tension.	1. Replace clutch disc. Also replace cover if spring is weak or pressure plate surface is damaged.
CLUTCH DISC FACING CONTAMINATED WITH OIL, GREASE, OR CLUTCH FLUID	1. Leak at rear main seal or at transmission input shaft seal. Excessive amount of grease applied to input shaft splines. Road splash, water entering housing. Slave cylinder leaking.	1. Replace leaking seals. Apply less grease to input shaft splines. Replace clutch disc (do not clean and reuse). Clean clutch cover and reuse only if cover is in good condition. Replace slave cylinder if leaking.
CLUTCH IS RUNNING PARTIALLY DISENGAGED	1. Release bearing sticking-binding. Does not return to normal running position.	1. Verify that bearing is actually binding, then replace bearing and transmission front bearing retainer if sleeve surface is damaged.
FLYWHEEL HEIGHT INCORRECT	1. Flywheel surface improperly machined. Too much stock removed or surface is tapered.	1. Replace flywheel.
WRONG DISC OR PRESSURE PLATE INSTALLED	1. Incorrect parts order or model number.	1. Replace with correct parts. Compare old and new parts before installation.
CLUTCH DISC, COVER AND/OR DIAPHRAGM SPRING, WARPED, DISTORTED	1. Rough handling (impact) bent cover, spring, or disc. Incorrect bolt tightening sequence and method caused warped cover.	1. Install new disc or cover as needed. Follow installation/tightening instructions.
FACING ON FLYWHEEL SIDE OF DISC TORN, GOUGED, WORN	1. Flywheel surface scored and nicked.	1. Reduce scores and nicks by sanding or surface grinding. Replace flywheel if scores-nicks are deeper than .002-.004 inch.
CLUTCH DISC FACING BURNT (CHARRED). FLYWHEEL AND COVER PRESSURE PLATE SURFACES HEAVILY GLAZED	1. Frequent operation under high loads or hard acceleration conditions. Driver frequently rides (slips) clutch. Results in rapid wear and overheating of disc and cover.	1. Scuff sand flywheel. Replace clutch cover and disc. Alert driver to problem cause.

DIAGNOSIS AND TESTING (Continued)**CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
CLUTCH DISC WARPED	1. New disc not checked for axial runout before installation.	1. Replace disc. Be sure runout of new disc is less than .5 mm (.020 in.).
CLUTCH DISC BINDS ON INPUT SHAFT SPLINES	1. Clutch disc hub splines damaged during installation. Input shaft splines rough, damaged. Corrosion, rust formations on splines of disc and input shaft.	1. Clean, smooth and lubricate disc and shaft splines. Replace disc and/or input shaft if splines are severely damaged.
CLUTCH DISC RUSTED TO FLYWHEEL AND/OR PRESSURE PLATE	1. Occurs in vehicles stored, or not driven for extended periods of time. Also occurs after steam cleaning if vehicle is not used for extended period.	1. Remove clutch cover and disc. Sand rusted surfaces clean with 180 grit paper. Replace disc cover, and flywheel if corrosion is severe.
CLUTCH DISC FACING STICKS TO FLYWHEEL	1. Vacuum may form in pockets over rivet heads in clutch disc. Occurs as clutch cools down after use.	1. Drill 1/16 inch diameter hole through rivets and scuff sand disc facing with 180 grit paper.
CLUTCH DISC TOO THICK	1. Wrong disc installed.	1. Replace disc.
PILOT BEARING SEIZED, LOOSE, OR ROLLERS ARE WORN	1. Bearing cocked during installation. Bearing defective. Bearing not lubricated. Clutch misalignment.	1. Lubricate and install new bearing. Check and correct any misalignment.
CLUTCH WILL NOT DISENGAGE PROPERLY	1. Low clutch fluid level. 2. Clutch cover loose. 3. Wrong clutch disc. 4. Disc bent, distorted during installation. 5. Clutch cover diaphragm spring bent or warped during transmission installation. 6. Clutch disc installed backwards. 7. Release fork bent or fork pivot is loose or damaged. 8. Clutch master or slave cylinder fault.	1. Top off reservoir and check for leaks. 2. Tighten bolts. 3. Install correct disc. 4. Replace disc. 5. Replace cover. 6. Remove and reinstall disc correctly. Be sure disc side marked "to flywheel" is actually toward flywheel. 7. Replace fork and pivot if worn or damaged. 8. Replace master and slave cylinder as assembly.

DIAGNOSIS AND TESTING (Continued)**CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
CLUTCH DISC FACING COVERED WITH OIL, GREASE, OR CLUTCH FLUID	<ol style="list-style-type: none"> 1. Oil leak at rear main or input shaft seal. 2. Too much grease applied to splines or disc and input shaft. 	<ol style="list-style-type: none"> 1. Correct leak and replace disc (do not clean and reuse the disc). 2. Apply lighter grease coating to splines and replace disc (do not clean and reuse the disc).
CLUTCH DISC AND/OR COVER WARPED, OR DISC FACINGS EXHIBIT UNUSUAL WRONG TYPE	<ol style="list-style-type: none"> 1. Incorrect or substandard parts. 	<ol style="list-style-type: none"> 1. Replace disc and/or cover with correct parts.
CLUTCH MASTER OR SLAVE CYLINDER PLUNGER DRAGGING-BINDING	<ol style="list-style-type: none"> 1. Master or slave cylinder components worn or corroded. 	<ol style="list-style-type: none"> 1. Replace both cylinders as assembly (and reservoir).
NO FAULT FOUND WITH CLUTCH COMPONENTS	<ol style="list-style-type: none"> 1. Problem actually related to suspension or driveline component. 2. Engine related problem. 	<ol style="list-style-type: none"> 1. Further diagnosis required. Check engine/transmission mounts, propeller shafts and U-joints, tires, suspension attaching parts and other driveline components as needed. 2. Check EFI and ignition systems.
PARTIAL ENGAGEMENT OF CLUTCH DISC (ONE SIDE WORN-OPPOSITE SIDE GLAZED AND LIGHTLY WORN)	<ol style="list-style-type: none"> 1. Clutch pressure plate position setting incorrect or modified. 2. Clutch cover, spring, or release fingers bent, distorted (rough handling, improper assembly). 3. Clutch disc damaged or distorted. 4. Clutch misalignment. 	<ol style="list-style-type: none"> 1. Replace clutch cover and disc. 2. Replace clutch cover and disc. 3. Replace disc. 4. Check alignment and runout of flywheel, disc, or cover and/or clutch housing. Correct as necessary.

DIAGNOSIS AND TESTING (Continued)**CONTINUED**

CONDITION	POSSIBLE CAUSE	CORRECTION
Clutch components damaged or worn out prematurely.	1. Incorrect or sub-standard clutch parts.	1. Replace with parts of correct type and quality.
Pilot bearing damaged.	1. Bearing cocked during installation. Bearing not lubricated prior to installation. Bearing defect. 2. Clutch misalignment.	1. Replace bearing. Be sure it is properly seated and lubricated before installing clutch. 2. Check and correct misalignment caused by excessive runout of flywheel, disc, cover or clutch housing. Replace input shaft if bearing hub is damaged.
Loose components.	1. Attaching bolts loose at flywheel, cover, or clutch housing.	1. Tighten bolts to specified torque. Replace any clutch bolts that are damaged.
Components appear overheated. Hub of disc cracked or torsion damper springs are distorted or broken.	1. Frequent high load, full throttle operation.	1. Replace parts as needed. Alert driver to condition causes.
Contact surface of release bearing damaged.	1. Clutch cover incorrect, or release fingers are bent or distorted causing damage. 2. Release bearing defect. 3. Release bearing misaligned.	1. Replace clutch cover and bearing. 2. Replace bearing. 3. Check and correct runout of clutch components. Check front bearing retainer sleeve surface. Replace if damaged.
Release bearing is noisy.	1. Release bearing defect.	1. Replace bearing.
Clutch pedal squeak.	1. Pivot pin loose. Pedal bushings worn out or cracked.	1. Tighten pivot pin. Replace bushings if worn or damaged. Lubricate pin and bushings with silicone base lubricator chassis grease.

DIAGNOSIS AND TESTING (Continued)

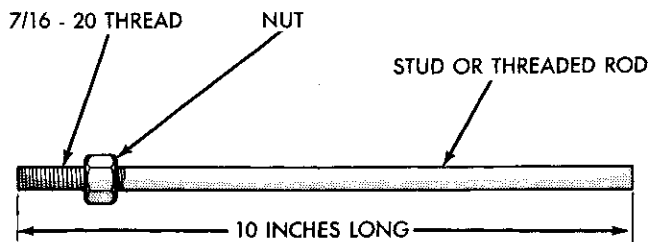
NV4500 CLUTCH HOUSING

CHECKING RUNOUT

Only the NV4500 clutch housing can be checked using the following bore and face runout procedures. The NV3500 clutch housing is an integral part of the transmission front case and can only be checked off the vehicle.

MEASURING CLUTCH HOUSING BORE RUNOUT—NV4500 ONLY

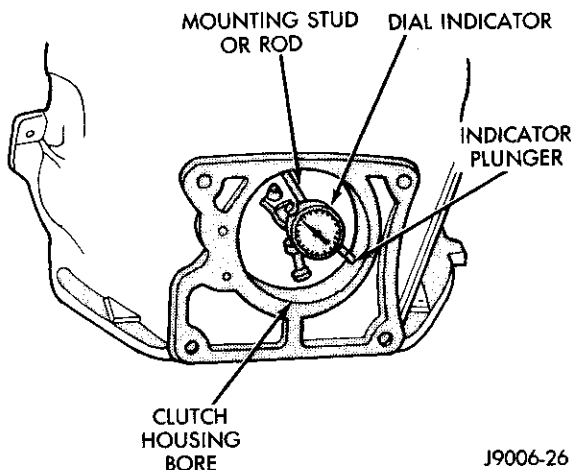
- (1) Remove the clutch housing and strut.
- (2) Remove the clutch cover and disc.
- (3) Replace one of the flywheel bolts with an appropriate size threaded rod that is 10 in. (25.4 cm) long (Fig. 10). The rod will be used to mount the dial indicator.



J9006-25

Fig. 10 Dial Indicator Mounting Stud Or Rod

- (4) Remove the release fork from the clutch housing.
- (5) Reinstall the clutch housing. Tighten the housing bolts nearest the alignment dowels first.
- (6) Mount the dial indicator on the threaded rod and position the indicator plunger on the surface of the clutch housing bore (Fig. 11).



J9006-26

Fig. 11 Checking Clutch Housing Bore Runout

(7) Rotate the crankshaft until the indicator plunger is at the top center of the housing bore. Zero the indicator at this point.

(8) Rotate the crankshaft and record the indicator readings at eight points (45° apart) around the bore (Fig. 10) and (Fig. 11). Repeat the measurement at least twice for accuracy.

(9) Subtract each reading from the one 180° opposite to determine magnitude and direction of runout. Refer to (Fig. 12) and following example.

Bore runout example:

$$0.000 - (-0.007) = 0.007 \text{ in.}$$

$$+0.002 - (-0.010) = 0.012 \text{ in.}$$

$$+0.004 - (-0.005) = 0.009 \text{ in.}$$

$$-0.001 - (+0.001) = -0.002 \text{ in. (= 0.002 inch)}$$

In the above example, the largest difference is 0.012 in. and is called the total indicator reading (TIR). This means that the housing bore is offset from the crankshaft centerline by 0.006 in. (which is 1/2 of 0.012 in.).

On gas engines, the acceptable maximum TIR for housing bore runout is 0.010 inch. If measured TIR is more than 0.010 in. (as in the example), bore runout will have to be corrected with offset dowels. Offset dowels are available in 0.007, 0.014 and 0.021 in. sizes for this purpose (Fig. 12). Refer to Correcting Housing Bore Runout for dowel installation.

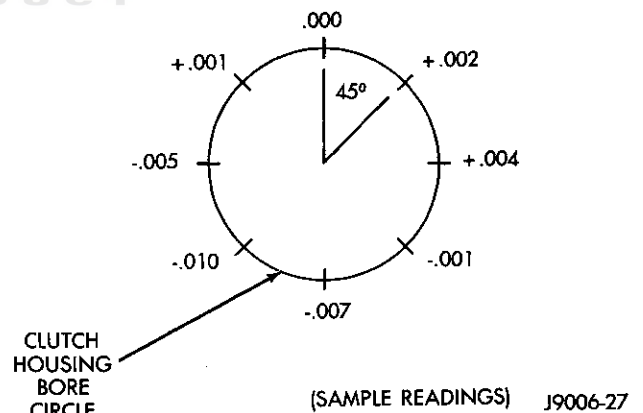


Fig. 12 Housing Bore Measurement Points And Sample Readings

On diesel engines, the acceptable maximum TIR for housing bore runout is 0.015 inch. However, unlike gas engines, offset dowels are not available to correct runout on diesel engines. If bore runout exceeds the stated maximum on a diesel engine, it may be necessary to replace either the clutch housing, or transmission adapter plate.

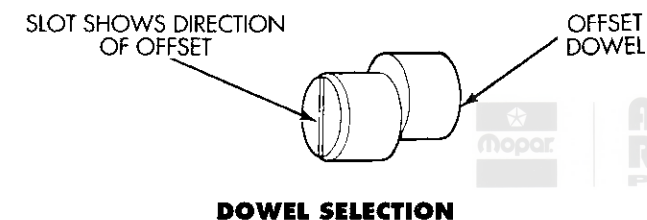
DIAGNOSIS AND TESTING (Continued)**Correcting Clutch Housing Bore Runout—NV4500 Gas Engine Only**

On gas engine vehicles, clutch housing bore runout is corrected with offset dowels. However, if bore runout exceeds 0.015 in. TIR on a diesel equipped model, the clutch housing, or transmission adapter plate may have to be replaced. Offset dowels are not available for diesel models.

The dial indicator reads positive when the plunger moves inward (toward indicator) and negative when it moves outward (away from indicator). As a result, the lowest or most negative reading determines the direction of housing bore offset (runout).

In the sample readings shown (Fig. 13) and in Step 7 above, the bore is offset toward the 0.010 inch reading. To correct this, remove the housing and original dowels. Then install the new offset dowels in the direction needed to center the bore with the crankshaft centerline.

In the example, TIR was 0.012 inch. The dowels needed for correction would have an offset of 0.007 in. (Fig. 13).

**DOWEL SELECTION**

TIR VALUE	OFFSET DOWEL REQUIRED
0.011 - 0.021 inch	0.007 inch
0.022 - 0.035 inch	0.014 inch
0.036 - 0.052 inch	0.021 inch

J9206-7

Fig. 13 Housing Bore Alignment Dowel Selection

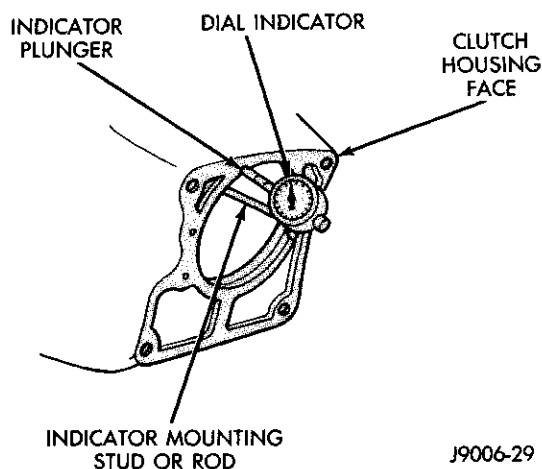
Install the dowels with the slotted side facing out so they can be turned with a screwdriver. Then install the housing, remount the dial indicator and check bore runout again. Rotate the dowels until the TIR is less than 0.010 in. if necessary.

If a TIR of 0.053 in. or greater is encountered, it may be necessary to replace the clutch housing.

Measuring Clutch Housing Face Runout—NV4500

(1) Reposition the dial indicator plunger on the housing face (Fig. 14). Place the indicator plunger at the rim of the housing bore as shown.

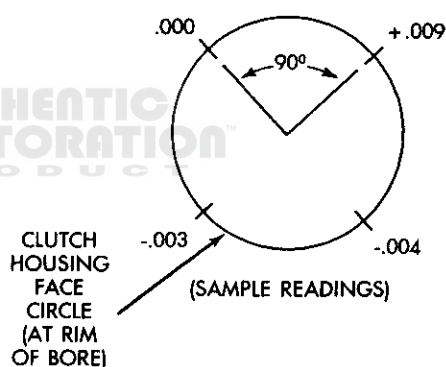
(2) Rotate the crankshaft until the indicator plunger is at the 10 O'clock position on the bore. Then zero the dial indicator.



J9006-29

Fig. 14 Measuring Clutch Housing Face Runout

(3) Measure and record face runout at four points 90° apart around the housing face (Fig. 15). Perform the measurement at least twice for accuracy.



J9006-30

Fig. 15 Housing Face Measurement Points And Sample Readings

(4) Subtract the lowest reading from the highest to determine total runout. As an example, refer to the sample readings shown (Fig. 17). If the low reading was **minus** 0.004 in. and the highest reading was **plus** 0.009 in., total runout is actually 0.013 inch.

(5) Total allowable face runout is 0.010 inch. If runout exceeds this figure, runout will have to be corrected. Refer to Correcting Clutch Housing Face Runout.

CORRECTING CLUTCH HOUSING FACE RUNOUT—NV4500

Housing face runout, on gas or diesel engines, can be corrected by installing shims between the clutch housing and transmission (Fig. 16). The shims can be made from shim stock or similar materials of the required thickness.

As an example, assume that face runout is the same as shown in (Fig. 17) and in Step 4. In this

DIAGNOSIS AND TESTING (Continued)

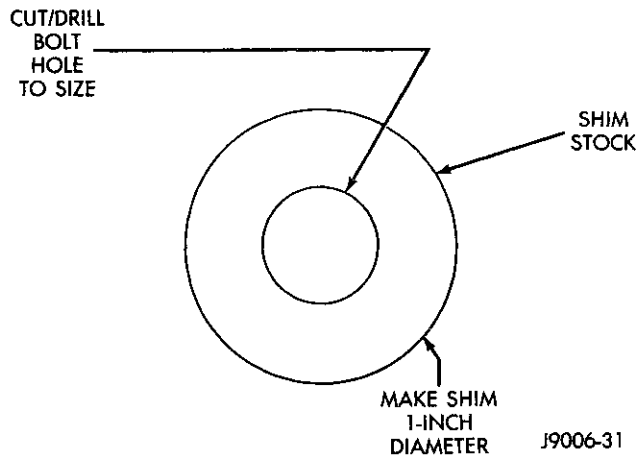


Fig. 16 Housing Face Alignment Shims

case, three shims will be needed. Shim thicknesses should be 0.009 in. (at the 0.000 corner), 0.012 in. (at the -0.003 corner) and 0.013 in. (at the -0.004 corner).

After installing the clutch assembly and housing, tighten the housing bolts nearest the alignment dowels first.

Clutch housing preferred bolt torques are:

- 41 N·m (30 ft. lbs.) for 3/8 in. diameter bolts
- 68 N·m (50 ft. lbs.) for 7/16 in. diameter bolts
- 47 N·m (35 ft. lbs.) for V10 and diesel clutch housing bolts

During final transmission installation, install the shims between the clutch housing and transmission at the appropriate bolt locations.

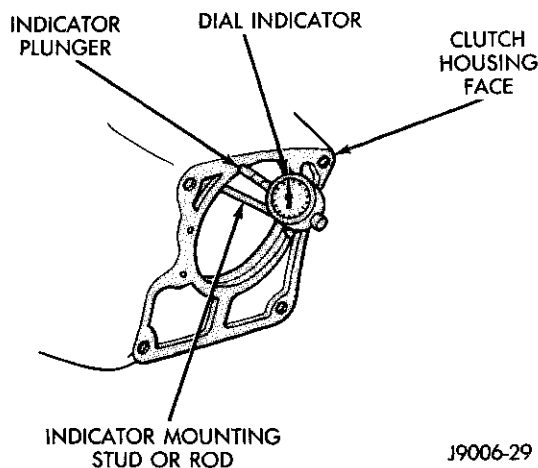


Fig. 17 Measuring Clutch Housing Face Runout

SERVICE PROCEDURES

CLUTCH LINKAGE

The clutch master cylinder, remote reservoir, slave cylinder and connecting lines are all serviced as an assembly. These components cannot

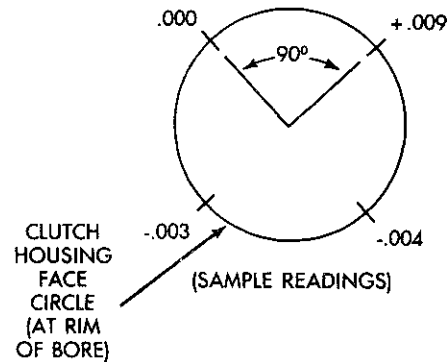
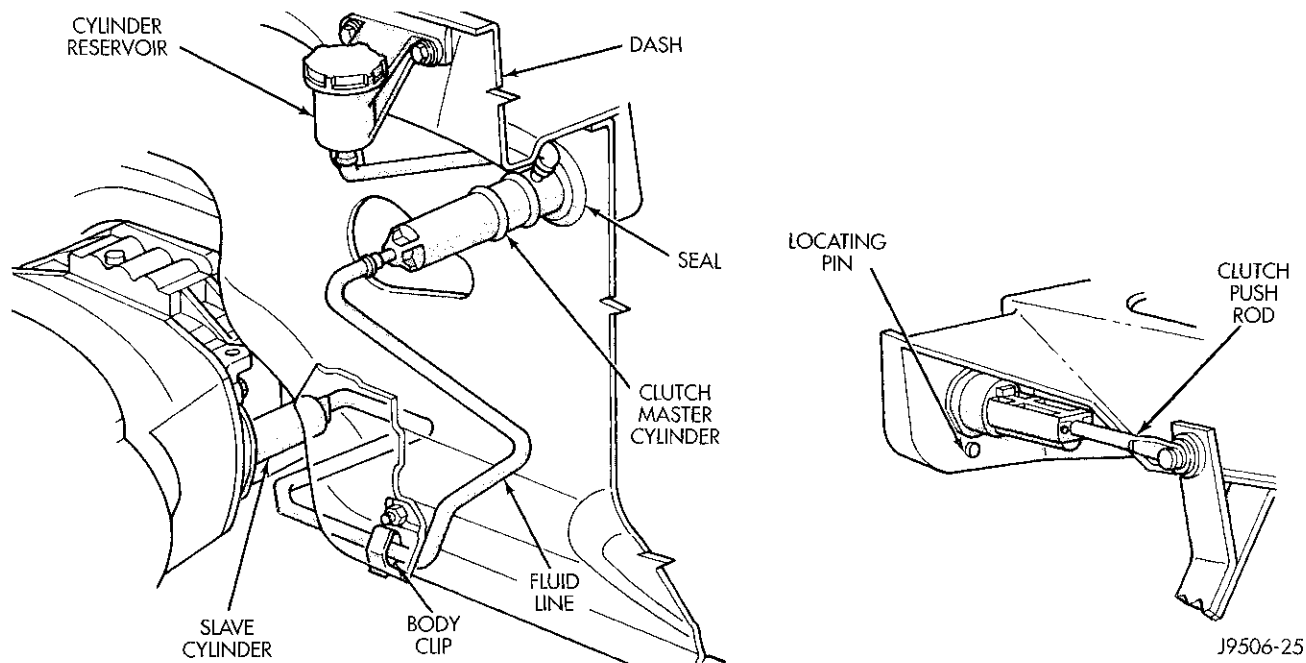
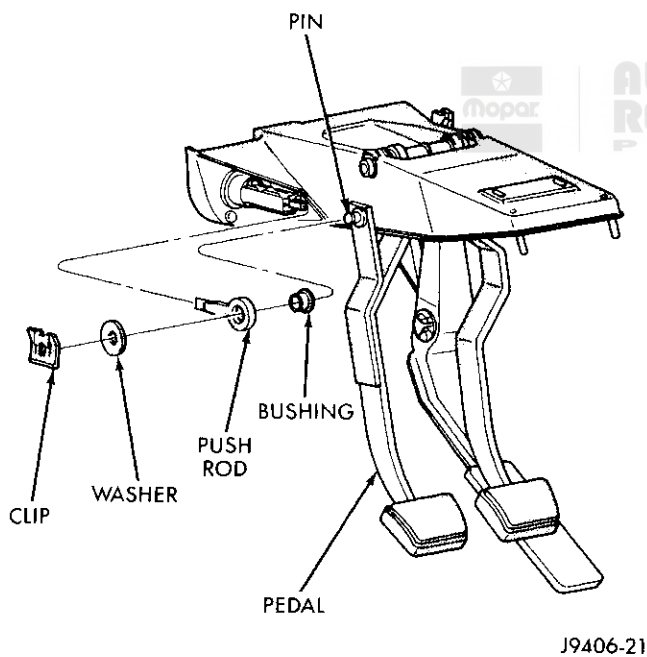


Fig. 18 Housing Face Measurement Points And Sample Readings

be serviced separately. The linkage cylinders and connecting lines are sealed units. They are pre-filled with fluid during manufacture and must not be disassembled nor disconnected.

Linkage Removal

- (1) Raise vehicle.
- (2) On diesel models, remove slave cylinder shield from clutch housing if equipped.
- (3) Remove nuts attaching slave cylinder to studs on clutch housing.
- (4) Remove slave cylinder from clutch housing.
- (5) Disengage slave cylinder fluid line from body retainer clips.
- (6) Lower vehicle.
- (7) Disconnect clutch pedal interlock switch wires.
- (8) Remove locating clip from clutch master cylinder mounting bracket (Fig. 19).
- (9) Remove retaining clip, flat washer and wave washer that attach clutch master cylinder push rod to clutch pedal (Fig. 20).
- (10) Slide clutch master cylinder push rod off pedal pin.
- (11) Inspect condition of bushing on clutch pedal pin (Fig. 20). Remove and replace bushing if worn or damaged.
- (12) Verify that cap on clutch master cylinder reservoir is tight. This will avoid spillage during removal.
- (13) Remove screws that attach clutch fluid reservoir to dash panel.
- (14) Remove reservoir mounting bracket screws and remove reservoir from dash panel.
- (15) Rotate clutch master cylinder 45° counter-clockwise to unlock it. Then remove cylinder from dash panel.
- (16) Remove clutch master cylinder rubber seal from dash panel (Fig. 19).

SERVICE PROCEDURES (Continued)**Fig. 19 Clutch Hydraulic Linkage****Fig. 20 Clutch Cylinder Push Rod Attachment**

(17) Remove clutch cylinders, reservoir and connecting lines from vehicle.

LINKAGE INSTALLATION

(1) Tighten cap on clutch fluid reservoir to avoid spillage during installation.

(2) Position cylinders, connecting lines and reservoir in vehicle engine compartment.

(3) Lubricate cylinder seal with liquid dish soap to ease installation. Then seat seal in dash and around cylinder.

(4) Insert clutch master cylinder in dash panel. Rotate cylinder 45° clockwise to lock it in place.

(5) If cylinder seal is hard to seat, unlock cylinder and reseal if necessary. Then lock cylinder afterward.

(6) Position clutch fluid reservoir on dash panel and install reservoir screws. Tighten screws to 5 N·m (40 in. lbs.) torque.

(7) Install reservoir mounting bracket on dash panel, if removed.

(8) Install replacement bushing on clutch pedal pin if necessary.

(9) Install clutch master cylinder push rod on clutch pedal pin. Secure rod with wave washer, flat washer and retainer ring.

(10) Connect clutch pedal position (interlock) switch wires.

(11) Install locating clip in clutch master cylinder mounting bracket.

(12) Raise vehicle.

(13) Install slave cylinder. Be sure cap at end of cylinder rod is seated in release lever. Check this before installing cylinder attaching nuts.

(14) Install and tighten slave cylinder attaching nuts to 23 N·m (200 in. lbs.) torque.

(15) Lower vehicle.

(16) If new linkage has been installed, remove plastic shipping stop from master cylinder push rod. Do this after installing slave cylinder and before operating linkage.

SERVICE PROCEDURES (Continued)

(17) Operate linkage several times to verify proper operation.

FLYWHEEL SERVICE

Inspect the flywheel whenever the clutch disc, cover and housing are removed for service. Check condition of the flywheel face, hub, ring gear teeth, and flywheel bolts.

Minor scratches, burrs, or glazing on the flywheel face can be scuff sanded with 180 grit emery cloth. However, the flywheel should be replaced if the disc contact surface is severely scored, heat checked, cracked, or obviously worn.

Cleanup of minor flywheel scoring should be performed with surface grinding equipment. Remove only enough material to reduce scoring (approximately 0.001 – 0.003 in.). Heavy stock removal is **not recommended**. Replace the flywheel if scoring is severe and deeper than 0.076 mm (0.003 in.). Excessive stock removal can result in flywheel cracking or warping after installation; it can also weaken the flywheel and interfere with proper clutch release.

Check flywheel runout if misalignment is suspected. Runout should not exceed 0.08 mm (0.003 in.). Measure runout at the outer edge of the flywheel face with a dial indicator. Mount the dial indicator on a stud installed in place of one of the flywheel attaching bolts.

Clean the crankshaft flange before mounting the flywheel. Dirt and grease on the flange surface may cock the flywheel causing excessive runout.

Check condition of the flywheel hub and attaching bolts. Replace the flywheel if the hub exhibits cracks in the area of the attaching bolt holes.

Install new attaching bolts whenever the flywheel is replaced and use Mopar Lock N' Seal, or Loctite 242 on replacement bolt threads.

Recommended flywheel bolt torques are:

- 75 N·m (55 ft. lbs.) for gas engine flywheels
- 137 N·m (101 ft. lbs.) for diesel flywheels

Inspect the teeth on the starter ring gear. **If the teeth are worn or damaged, the flywheel should be replaced as an assembly. This is the recommended and preferred method of repair.**

In cases where a new flywheel is not readily available, a replacement ring gear can be installed. However, the following precautions must be observed to avoid damaging the flywheel and replacement gear.

(1) Mark position of the old gear for alignment reference on the flywheel. Use a scribe for this purpose.

(2) Wear protective goggles or approved safety glasses. Also wear heat resistant gloves when handling a heated ring gear.

(3) Remove the old gear by cutting most of the way through it (at one point) with an abrasive cut-off

wheel. Then complete removal with a cold chisel or punch.

(4) The ring gear is a shrink fit on the flywheel. This means the gear must be expanded by heating in order to install it. **The method of heating and expanding the gear is extremely important.** Every surface of the gear must be heated at the same time to produce uniform expansion. An oven or similar enclosed heating device must be used. Temperature required for uniform expansion is 325–350° F.

CAUTION: Never use an oxy/acetylene torch to remove the old gear, or to heat and expand a new gear. The high temperature of the torch flame will cause localized heating and damage the flywheel. In addition, using the torch to heat a replacement gear will cause uneven heating and expansion. The torch flame will also anneal the gear teeth resulting in rapid wear and damage after installation.

(5) The heated gear must be installed evenly to avoid misalignment or distortion. A shop press and suitable press plates should be used to install the gear if at all possible.

(6) Be sure to wear eye and hand protection. Heat resistant gloves and safety goggles are needed for personal safety. Also use metal tongs, vise grips, or similar tools to position the gear as necessary for installation.

(7) Allow the flywheel and ring gear to cool down before installation. Set the assembly on a workbench and let it cool in normal shop air.

CAUTION: Never use water, or compressed air to cool the flywheel. The rapid cooling produced by water or compressed air can distort, or crack the gear and flywheel.

REMOVAL AND INSTALLATION

CLUTCH COVER AND DISC

REMOVAL

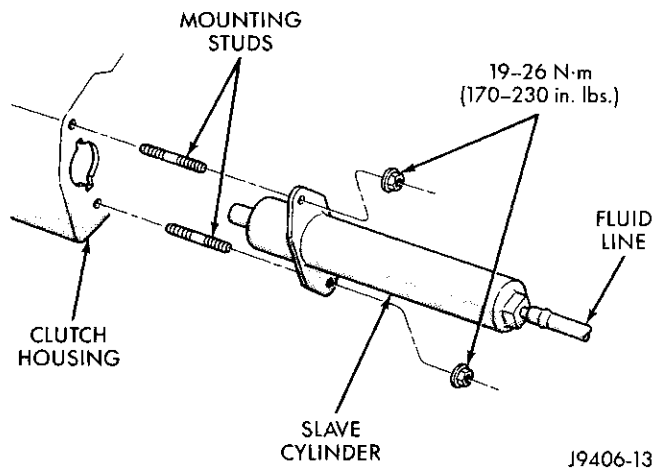
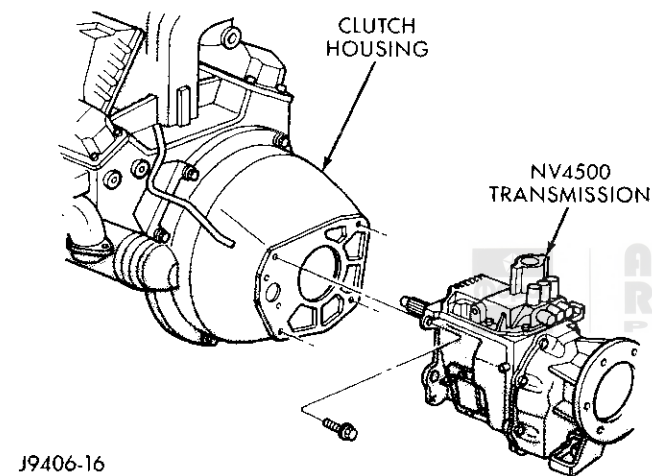
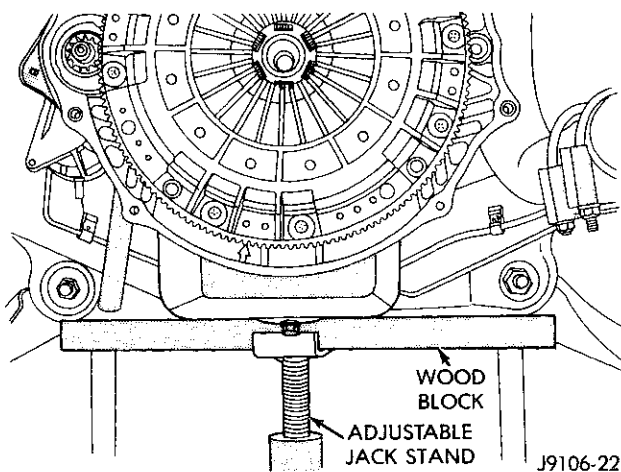
(1) Raise vehicle.

(2) Remove transmission and transfer case if equipped. Refer to Group 21 for procedures.

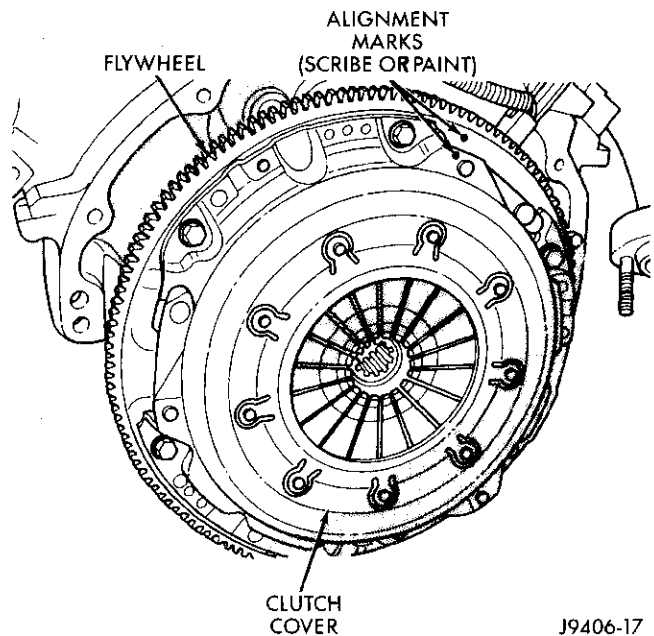
(3) On models with NV4500 transmission, remove clutch slave cylinder from clutch housing (Fig. 21). Then remove transmission and clutch housing from engine (Fig. 22).

(4) Support engine with wood block and adjustable jack stand (Fig. 23). Supporting engine is necessary to avoid undue strain on engine mounts.

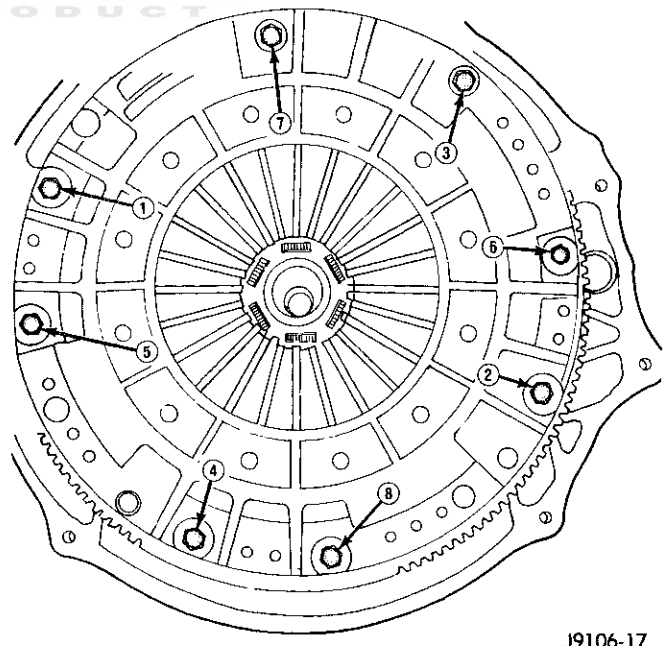
(5) If clutch cover will be reused, mark position of cover on flywheel with paint or scribe (Fig. 24).

REMOVAL AND INSTALLATION (Continued)**Fig. 21 Slave Cylinder Mounting****Fig. 22 Transmission/Clutch Housing—NV4500****Fig. 23 Supporting Engine With Jack Stand And Wood Block—Diesel Model Shown**

(6) Insert clutch alignment tool in clutch disc and into pilot bushing. Tool will hold disc in place when cover bolts are removed.

**Fig. 24 Marking Clutch Cover Position**

(7) If clutch cover will be reused, loosen cover bolts evenly, only few threads at a time, and in a diagonal pattern (Fig. 25). This relieves cover spring tension evenly to avoid warping.

**Fig. 25 Clutch Cover Bolt Loosening/Tightening Pattern**

(8) Remove cover bolts completely and remove cover, disc and alignment tool.

REMOVAL AND INSTALLATION (Continued)

CLUTCH COVER AND DISC INSTALLATION

(1) Check runout and free operation of new clutch disc:

(a) Install disc on transmission input shaft splines and check fit. Disc should slide freely on splines.

(b) Leave disc on shaft and check disc runout with dial indicator.

(c) Position indicator plunger about 1/4 inch from outer edge of disc facing.

(d) Runout should not exceed 0.5 mm (0.020 in.). Obtain another clutch disc if runout exceeds this limit.

(2) Lubricate crankshaft pilot bearing with Mopar high temperature bearing grease.

(3) Insert clutch alignment tool in clutch disc hub.

(4) Verify that disc hub is positioned correctly. Side of hub marked Flywheel Side should face flywheel (Fig. 26).

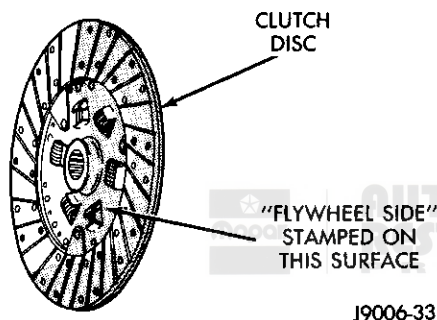


Fig. 26 Clutch Disc Position (Typical)

(5) Insert alignment tool in pilot bearing and position disc on flywheel surface (Fig. 27).

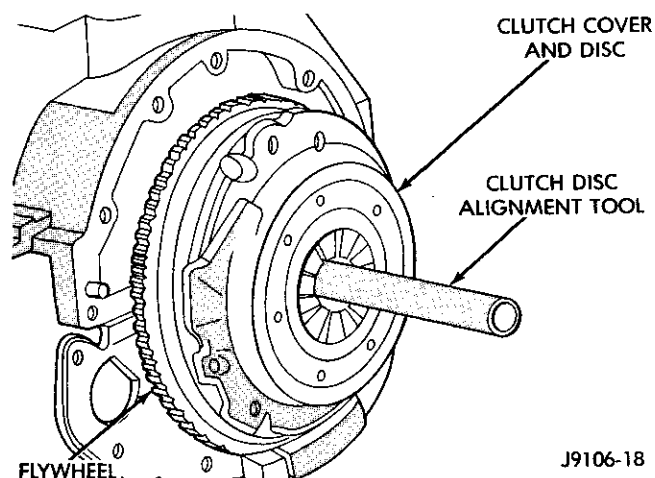


Fig. 27 Clutch Disc And Cover Alignment/Installation

(6) Position clutch cover over disc and onto flywheel (Fig. 27).

(7) Align and hold clutch cover in position and install cover bolts finger tight.

(8) Tighten cover bolts evenly and a few threads at a time. **Cover bolts must be tightened evenly and to specified torque to avoid distorting cover.**

- Tighten 5/16 in. diameter bolts to 23 N·m (17 ft. lbs.)

- Tighten 3/8 in. diameter bolts to 41 N·m (30 ft. lbs.)

(9) Remove release lever and release bearing from clutch housing. Apply Mopar high temperature bearing grease to bore of release bearing, release lever contact surfaces and release lever pivot stud (Fig. 28).

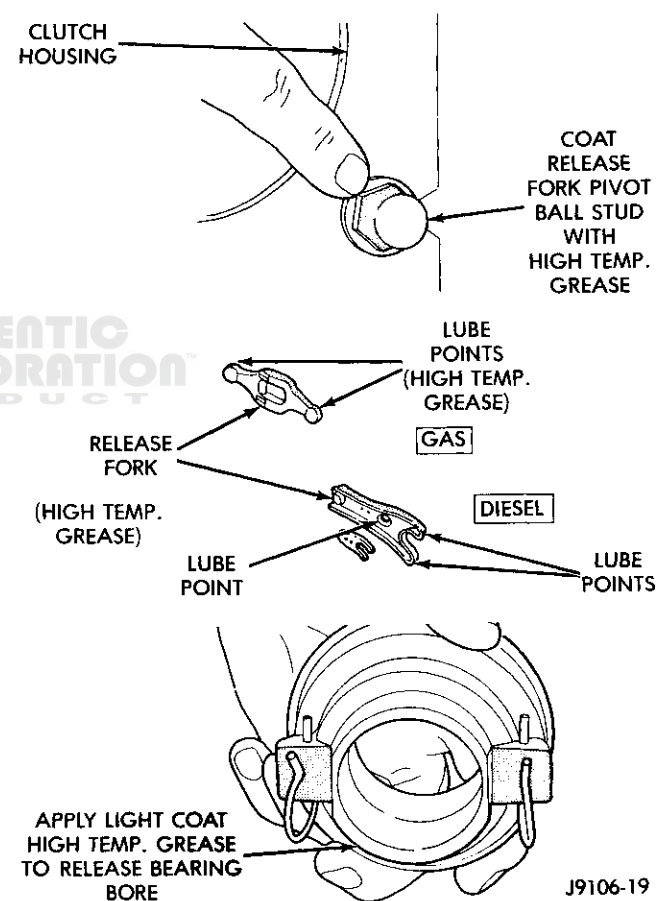


Fig. 28 Clutch Release Component Lubrication Points

(10) Apply light coat of Mopar high temperature bearing grease to splines of transmission input shaft (or drive gear) and to release bearing slide surface of the transmission front bearing retainer (Fig. 29). **Do not over lubricate shaft splines. This can result in grease contamination of disc.**

(11) Install release lever and bearing in clutch housing. Be sure spring clips that retain fork on

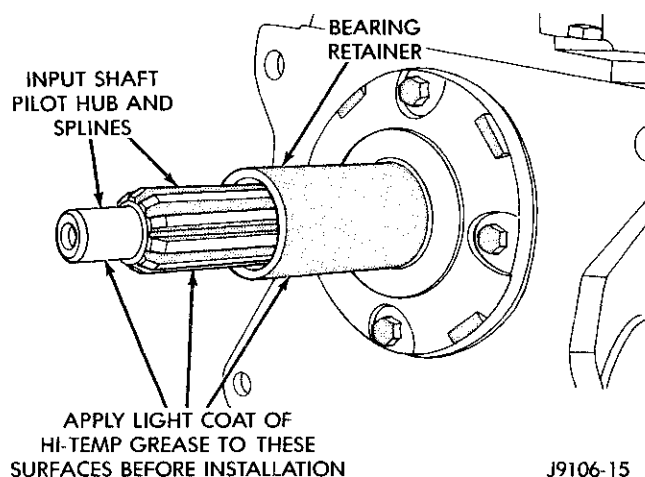
REMOVAL AND INSTALLATION (Continued)

Fig. 29 Input Shaft Lubrication Points—Typical
pivot ball and release bearing on fork are properly installed and (Fig. 30).

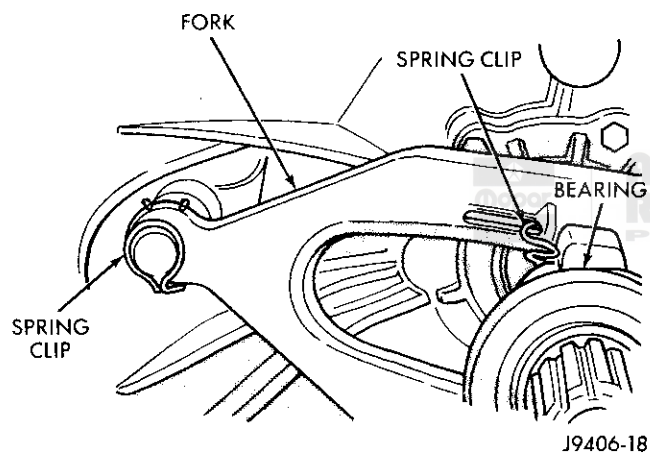


Fig. 30 Release Fork And Bearing Spring Clip Position

(12) Install clutch housing (Fig. 31) and (Fig. 32). Be sure housing is properly seated on alignment dowels before tightening housing bolts.

(13) Install transmission.

(14) Check fluid level in clutch master cylinder.

CLUTCH HOUSING REPLACEMENT—NV4500

Only the NV4500 clutch housing is serviced separately. The NV3500 clutch housing is part of the transmission front case and is therefore serviced only as part of the case assembly.

(1) Raise vehicle and remove transmission and transfer case if equipped.

(2) Remove clutch housing bolts and remove housing from engine (Fig. 33) and (Fig. 34).

(3) Clean housing mounting surface of engine block with wax and grease remover.

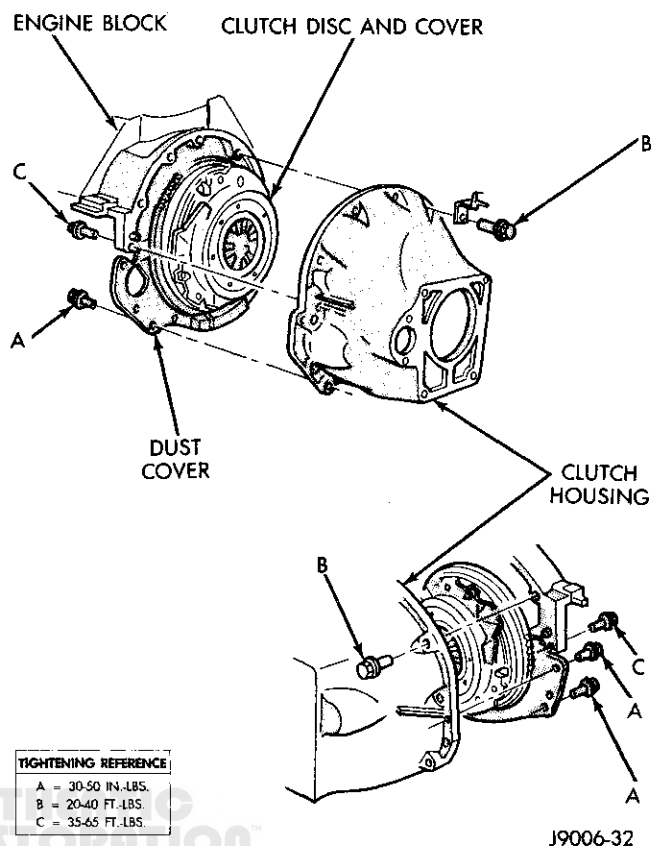


Fig. 31 Clutch Housing Installation—NV4500

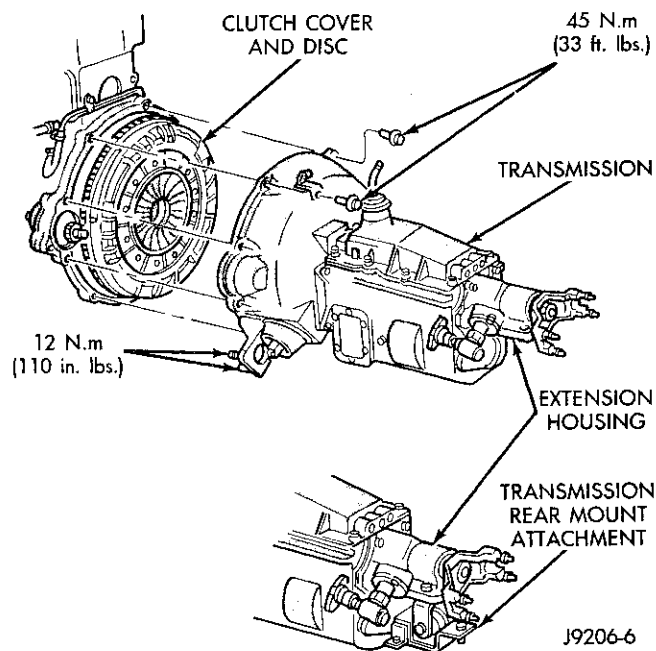
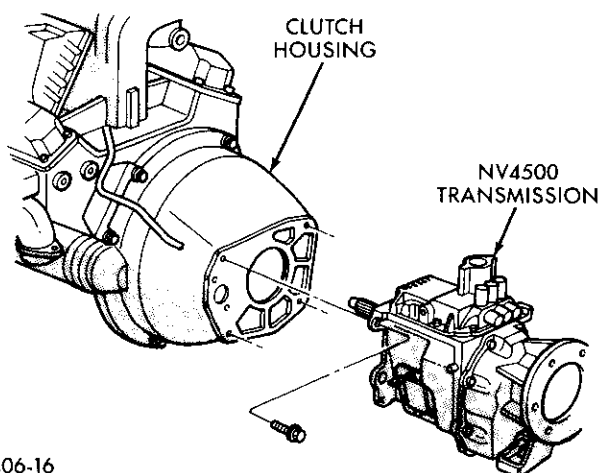


Fig. 32 Clutch Housing/Transmission Installation—Diesel Engine

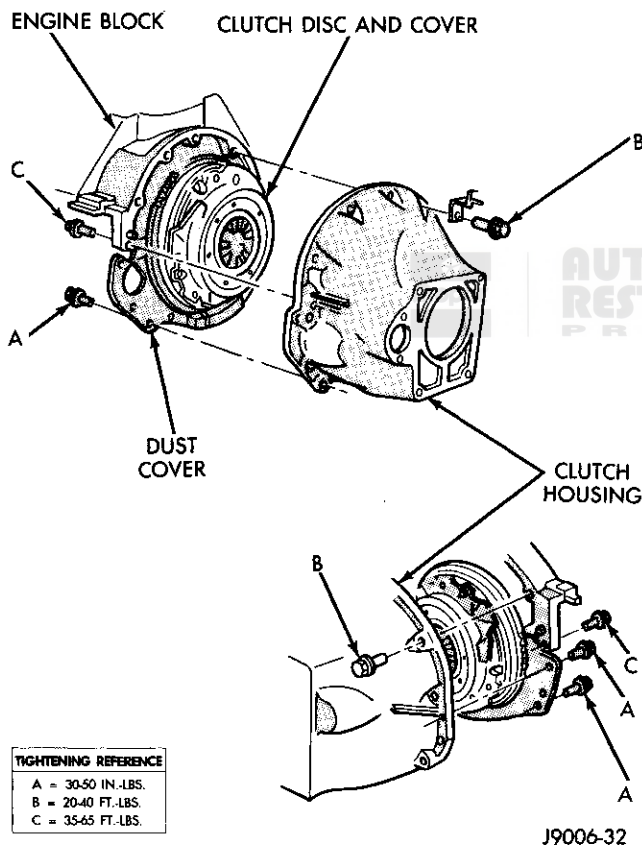
(4) Verify that clutch housing alignment dowels are in good condition and properly seated.

REMOVAL AND INSTALLATION (Continued)



J9406-16

Fig. 33 Transmission/Clutch Housing—NV4500



J9006-32

Fig. 34 Clutch Housing Installation—NV4500

(5) Transfer slave cylinder, release fork and boot, fork pivot stud and wire/hose brackets to new housing.

(6) Lubricate release fork and pivot contact surfaces with Mopar High Temperature wheel bearing grease before installation.

(7) Align and install clutch housing on transmission. Tighten housing bolts closest to alignment dow-

els first and to torque values indicated (Fig. 33) and (Fig. 34).

(8) Install transmission-to-engine strut after installing clutch housing. Tighten bolt attaching strut to clutch housing first and engine bolt last.

(9) Install transmission and transfer case if equipped. Refer to procedure in Group 21.

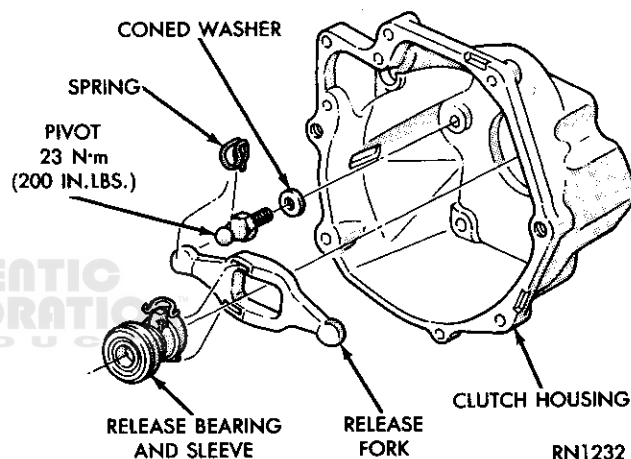
RELEASE BEARING

REMOVAL

(1) Remove transmission.

(2) On models with gas engine and new style release fork, remove clutch housing for access to release fork and release bearing retainer springs.

(3) Disconnect release bearing from release fork and remove bearing (Fig. 35).



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Fig. 35 Clutch Release Components

RELEASE BEARING INSTALLATION

(1) Inspect bearing slide surface on transmission front bearing retainer. Replace retainer if slide surface is scored, worn or cracked.

(2) Inspect release lever and pivot stud. Be sure stud is secure and in good condition. Be sure fork is not distorted or worn. Replace fork spring clips if bent or damaged.

(3) Lubricate crankshaft pilot bearing, input shaft splines, bearing retainer slide surface, lever pivot ball stud and release lever pivot surface with Mopar high temperature bearing grease.

(4) Install release fork and release bearing (Fig. 36). Be sure fork and bearing are properly secured by spring clips.

(5) Install clutch housing, if removed.

(6) Install transmission. Also install transfer case on 4-wheel drive models.

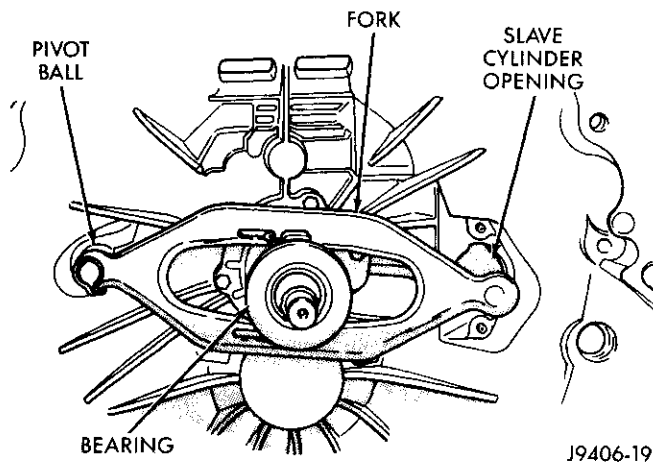
REMOVAL AND INSTALLATION (Continued)

Fig. 36 Clutch Release Fork And Bearing Installation

PILOT BEARING**REMOVAL**

- (1) Remove transmission and clutch housing.
- (2) Remove clutch cover and disc.
- (3) Remove pilot bearing. Use blind hole puller tools such as those included in Snap-On set CG40CB to remove bearing.

INSTALLATION

- (1) Clean bearing bore with solvent and wipe dry with shop towel.
- (2) Install new bearing with clutch alignment tool (Fig. 37). Keep bearing straight during installation. Do not allow bearing to become cocked. Tap bearing into place until flush with edge of bearing bore. Do not recess bearing.
- (3) Lubricate bearing with Mopar high temperature grease, or an equivalent quality grease.
- (4) Install clutch cover and disc.
- (5) Install clutch housing, transmission and transfer case on 4-wheel drive models.

CLUTCH PEDAL**REMOVAL**

- (1) Remove retaining ring, flat washer and wave washer that secure brake and clutch pedals to push rods (Fig. 38).
- (2) Remove knee bolster (Fig. 39) for access to pedal pivot shaft.
- (3) Remove brake light switch. Turn switch clockwise about 30° to release it then remove switch from bracket.
- (4) Remove retainer from passenger side of pedal pivot shaft (Fig. 40).
- (5) Push pedal pivot shaft toward driver side of support only enough to remove clutch pedal. It is not

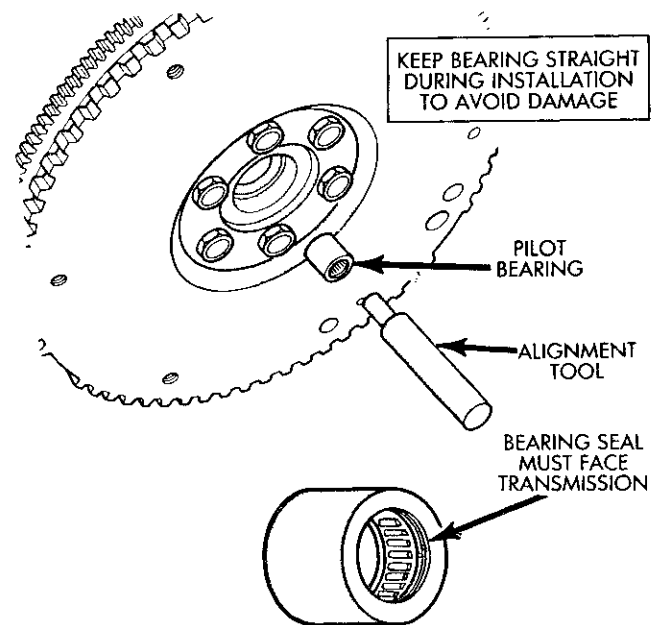


Fig. 37 Typical Method Of Installing Pilot Bearing

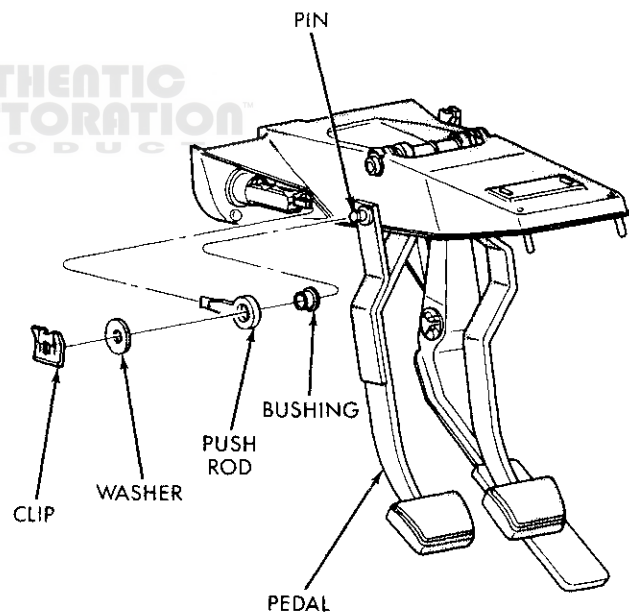


Fig. 38 Clutch Cylinder Push Rod Attachment

necessary to remove shaft from pedal support entirely.

- (6) Remove clutch pedal.

CLUTCH PEDAL INSTALLATION

- (1) Inspect bushings in clutch and brake pedals (Fig. 41). Replace bushings if worn, cracked, or distorted.

REMOVAL AND INSTALLATION (Continued)

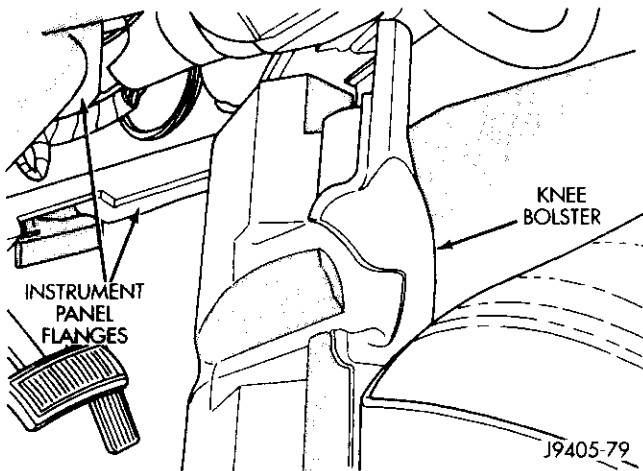


Fig. 39 Knee Bolster Removal

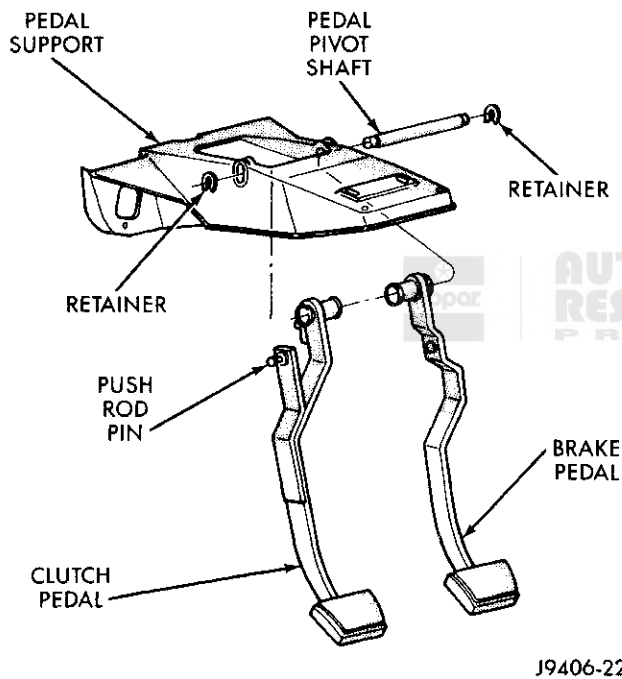


Fig. 40 Clutch/Brake Pedal Mounting

(2) Lubricate pedal shaft, pedal shaft bore (Fig. 40) and (Fig. 41) and all bushings with Mopar Multi Mileage, or high temperature bearing grease.

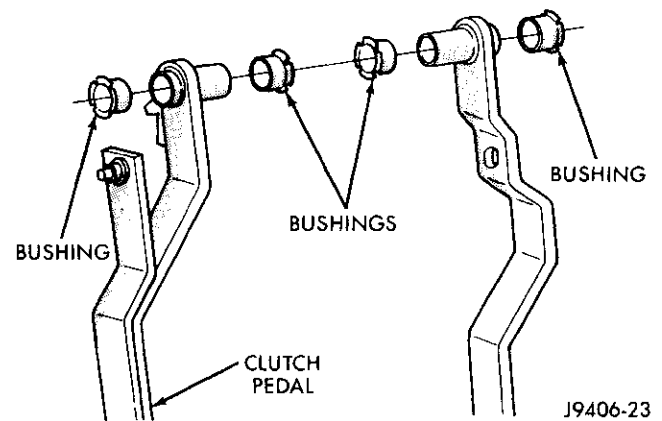


Fig. 41 Clutch/Brake Pedal Bushings

(3) Position clutch pedal in support. Align pedal with pivot shaft and slide shaft through pedal bushings. Then repeat process for brake pedal.

(4) Slide pedal shaft through support and install shaft retainer.

(5) Secure push rods to clutch and brake pedals.

(6) Install brake light switch in bracket. Rotate switch into place to lock it in bracket.

(7) Install knee bolster.

SPECIFICATIONS

TORQUE

DESCRIPTION	TORQUE
Nut, slave cylinder	19-26 N·m (170-230 in. lbs.)
Bolt, clutch cover—5/16 in.	23 N·m (17 ft. lbs.)
Bolt, clutch cover—3/8 in.	41 N·m (30 ft. lbs.)
Pivot, release bearing	23 N·m (17 ft. lbs.)
Bolt, housing to engine—	
3/8 in.	45 N·m (33 ft. lbs.)
Bolt, housing to engine—	
7/16 in.	68 N·m (50 ft. lbs.)
Bolt, housing to engine—V-10	47 N·m (35 ft. lbs.)
Screw, fluid reservoir5 N·m (40 in. lbs.)

COOLING SYSTEM

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GENERAL INFORMATION**COOLING SYSTEM**

The cooling system regulates engine operating temperature. It allows the engine to reach normal operating temperature as quickly as possible. It also maintains normal operating temperature and prevents overheating.

The cooling system also provides a means of heating the passenger compartment and cooling the automatic transmission fluid (if equipped). The cooling system is pressurized and uses a centrifugal water pump on all engines to circulate coolant throughout the system.

An optional factory installed maximum duty cooling package is available for some engines on most models. This package will provide additional cooling capacity for vehicles used under extreme conditions such as trailer towing in high ambient temperatures.

COOLING SYSTEM COMPONENTS AND FLOW—GAS ENGINES

The cooling system consists of:

- A cross-flow radiator
- Thermal viscous fan drive
- Fan shroud
- Radiator pressure cap
- Thermostat
- Coolant reserve/overflow system
- Transmission oil cooler (automatic transmission)
- Coolant
- Water pump (to circulate coolant)
- Hoses and hose clamps

Typical coolant flow circuits for gas powered engines are shown in (Fig. 1).

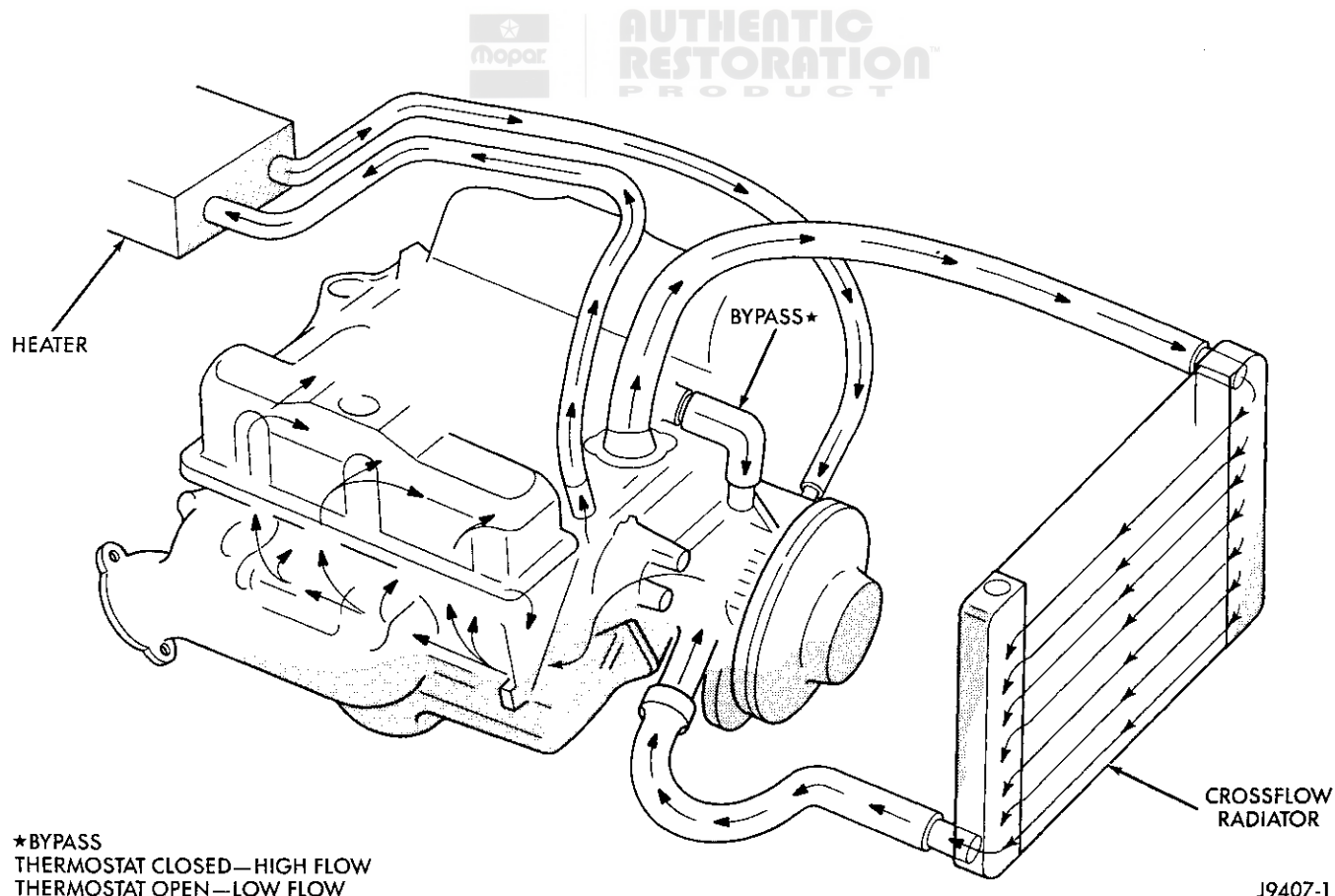


Fig. 1 Typical Cooling System Flow—Gas Powered Engines

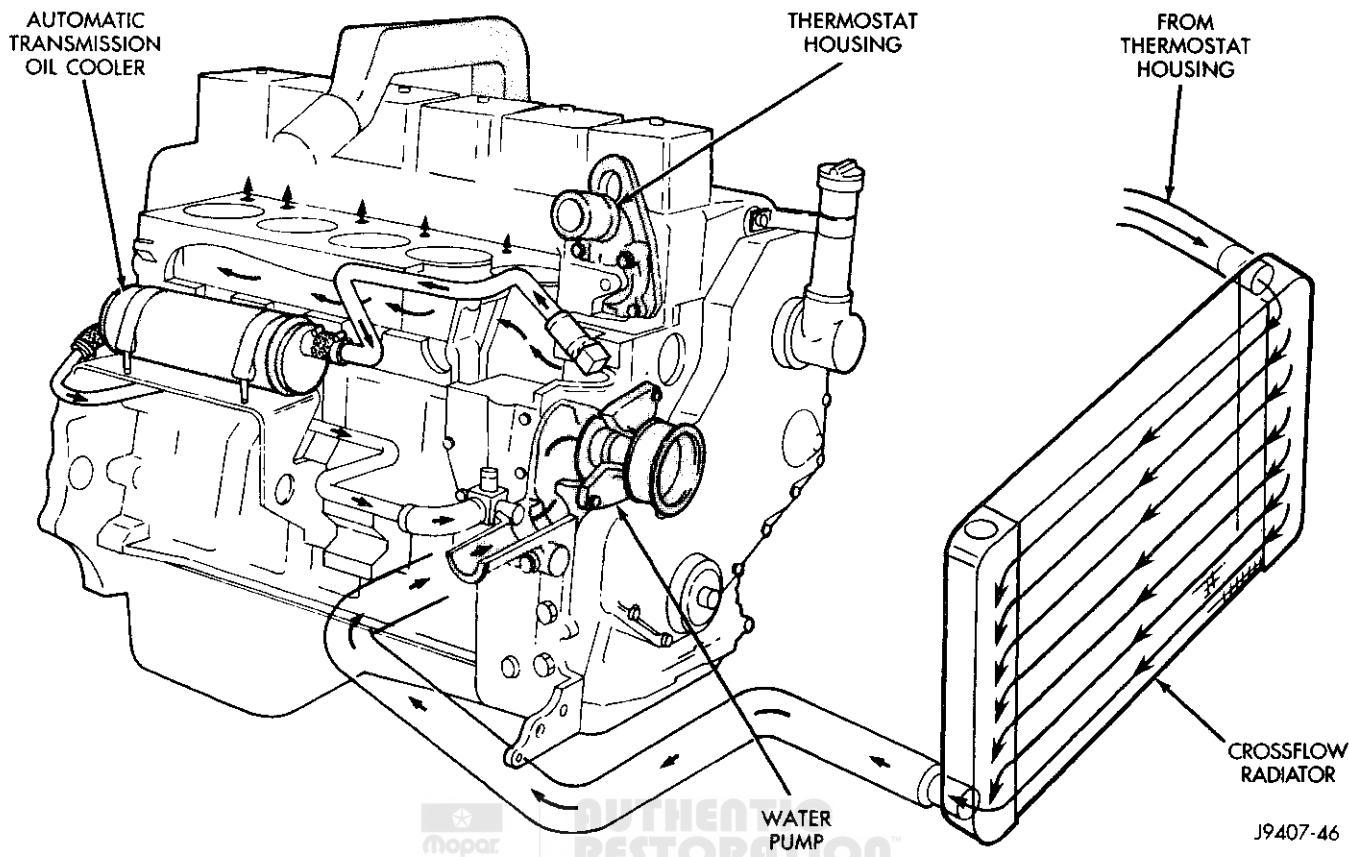
GENERAL INFORMATION (Continued)

Fig. 2 Typical Cooling System Flow—Diesel Powered Engine

COOLING SYSTEM COMPONENTS AND FLOW—DIESEL

Coolant flow circuits for the 5.9L diesel engine are shown in (Fig. 2).

The diesel cooling system consists of: a cross-flow radiator, engine driven cooling fan, thermal viscous fan drive, fan shroud, radiator pressure cap, thermostat, a vertically mounted one-way check valve (jiggle pin) at cylinder head, a bypass hose at thermostat, coolant reserve/overflow system, transmission oil cooler (if equipped with an automatic transmission), coolant, water pump, hoses and hose clamps.

Coolant is drawn from radiator into the water pump. Water pump output is directed to the engine oil cooler cavity of the cylinder block (Fig. 3).

From the oil cooler cavity, the coolant circulates around each cylinder. It then crosses to the transfer (lift) pump side of the engine where it flows up into the cylinder head through openings in top of the cylinder block (Fig. 3). Coolant flows past the valve bridges (Fig. 4), to exhaust manifold side of engine and to thermostat. As coolant flows toward the thermostat, it provides cooling for the injector nozzle.

Also refer to Thermostat Operation—5.9L Diesel Engine. This can be found in the Thermostat section of this group.

COOLANT RESERVE/OVERFLOW SYSTEM

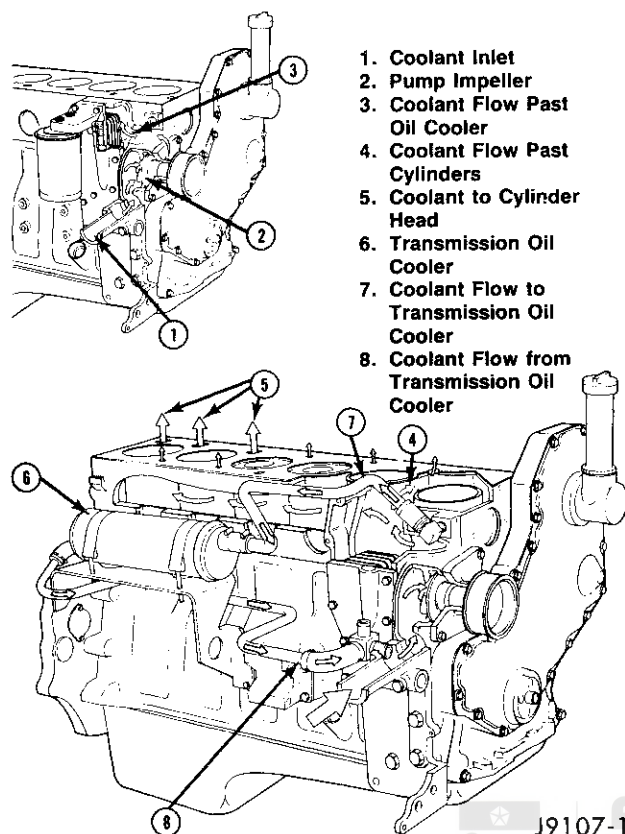
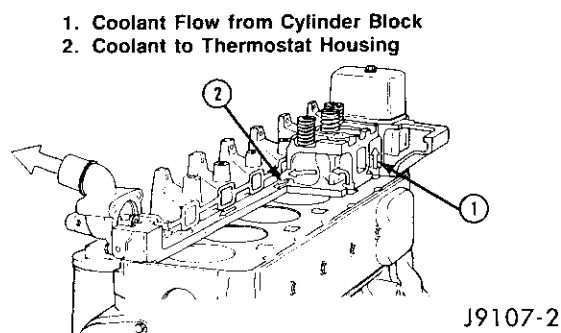
The coolant reserve/overflow system works in conjunction with the radiator pressure cap. It utilizes thermal expansion and contraction of coolant to keep coolant free of trapped air. It provides a volume for expansion and contraction of coolant. Refer to Description and Operation in this group for more information.

COOLANT

The cooling system is designed around the coolant. Coolant flows through the engine water jacket absorbing heat produced during engine operation. The coolant carries the heat to radiator and heater core. Here it is transferred to the ambient air passing through the radiator and heater core fins. The coolant also removes heat from the automatic transmission fluid in vehicles equipped with an automatic transmission.

RADIATOR PRESSURE CAP

Radiators are equipped with a pressure cap, which releases pressure at some point within a range of 97-124 kPa (14-18 psi). The pressure relief point (in pounds) is engraved on top of cap. See Description and Operation in this group for more information.

GENERAL INFORMATION (Continued)**Fig. 3 Cylinder Block Coolant Routing—Diesel Engine****Fig. 4 Cylinder Head Coolant Routing—Diesel Engine****RADIATORS**

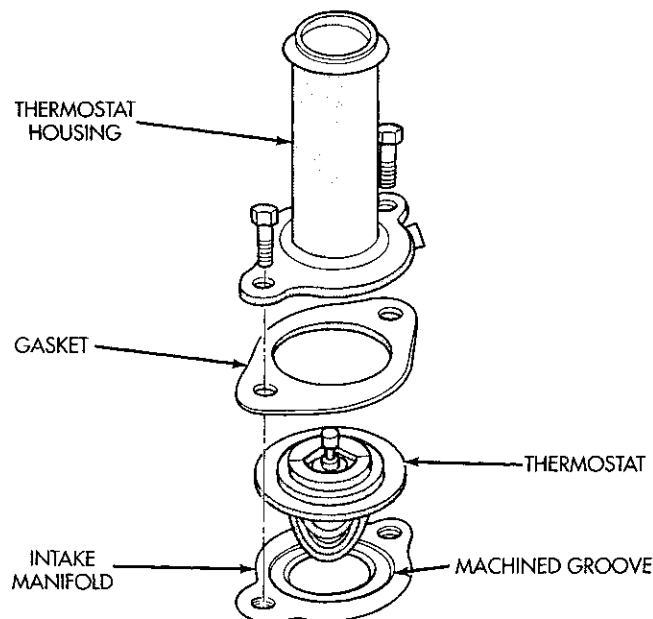
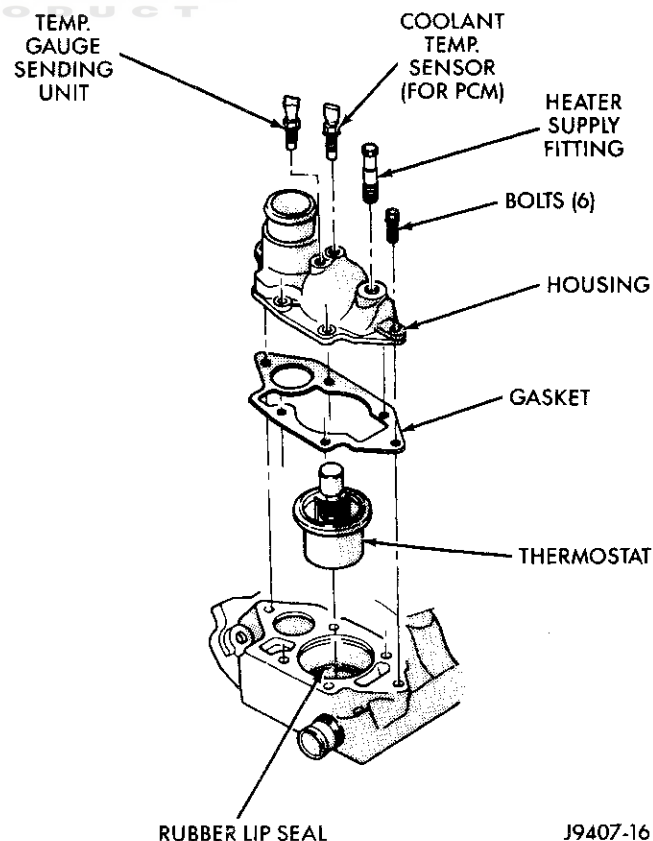
The radiator used on all engines (both gas powered and diesel) are of a cross-flow design with horizontal tubes through the radiator core and vertical side tanks.

Aluminum cores with plastic side tanks are used on all 3.9L V-6 and 5.2/5.9L V-8 engines. Copper-brass cores are used with the 8.0L V-10 and diesel engines.

The radiator supplies sufficient heat transfer to cool the engine and automatic transmission (if equipped).

THERMOSTAT

The thermostat on all gas powered engines is located beneath the thermostat housing at the front of the intake manifold (Fig. 5) (Fig. 6).

**Fig. 5 Thermostat—3.9L V-6 or 5.2/5.9L V-8 Gas Powered Engines****Fig. 6 Thermostat—8.0L V-10 Engine**

GENERAL INFORMATION (Continued)

The thermostat of the 5.9L diesel engine is located in the thermostat housing (Fig. 7). The housing is located behind the generator mounting bracket, at front of cylinder head.

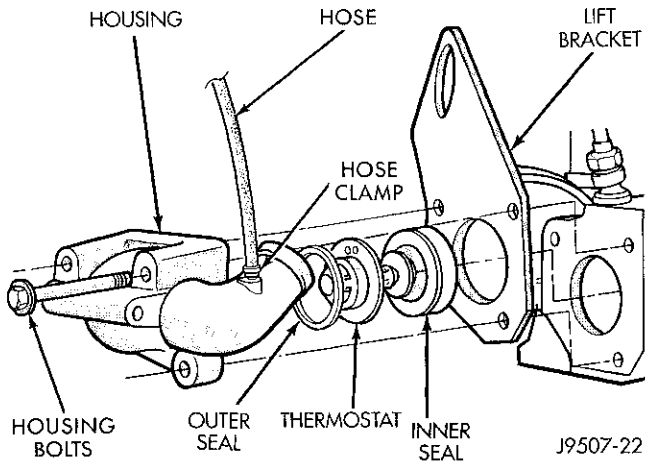


Fig. 7 Thermostat—5.9L Diesel—Typical

Gas powered engines: The thermostat is a wax pellet driven, reverse poppet choke type (3.9L/5.2L/5.9L), or moveable sleeve type (8.0L V-10). The wax pellet is located in a sealed container at the spring end of the thermostat. When heated, the pellet expands, overcoming closing spring tension and water pump pressure to force the valve to open. Coolant leakage into the pellet container will cause the thermostat to fail in the open position. Thermostats very rarely stick. Do not attempt to free a thermostat with a prying device.

The same thermostat is used for winter and summer seasons. An engine should not be operated without a thermostat, except for servicing or testing. Operating without a thermostat causes longer engine warmup time, unreliable warmup performance, increased exhaust emissions and crankcase condensation that can result in sludge formation.

CAUTION: Do not operate an engine without a thermostat, except for servicing or testing.

ENGINE ACCESSORY DRIVE BELTS

All vehicles are available with either a 3.9L V-6, a 5.2L V-8, two different 5.9L V-8 engines, an 8.0L V-10 or a 5.9L in-line 6 cylinder diesel engine.

The accessory drive components are operated by a single, crankshaft driven, serpentine drive belt on all engines. An automatic belt tensioner is also used to maintain correct belt tension at all times. This is used on all engines. Refer to Automatic Belt Tensioner proceeding in this group.

BELT TENSION—ALL ENGINES

Correct accessory drive belt tension is required to be sure of optimum performance of belt driven engine accessories. If specific tension is not maintained, belt slippage may cause; engine overheating, lack of power steering assist, loss of air conditioning capacity, reduced generator output rate and greatly reduced belt life.

It is not necessary to adjust belt tension on any engine. All engines are equipped with an automatic belt tensioner. The tensioner maintains correct belt tension at all times. For other tensioner information and removal/installation procedures, refer to Automatic Belt Tensioner proceeding in this group. Due to use of this belt tensioner, do not attempt to use a belt tension gauge on any engine.

DESCRIPTION AND OPERATION

THERMOSTAT—V-6, V-8, AND V-10

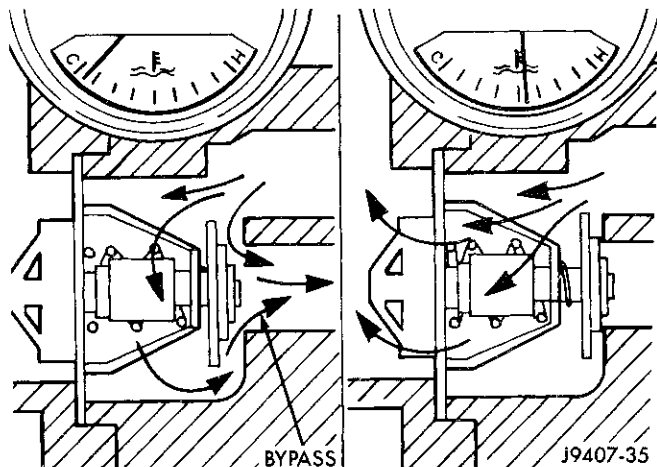
The thermostat controls the operating temperature of the engine by controlling the amount of coolant flow to the radiator. The thermostat is closed below 88°C (192°F). When the coolant reaches this temperature, the thermostat begins to open, allowing coolant flow to the radiator. This provides quick engine warmup and overall temperature control. The thermostat is designed to provide a minimum engine operating temperature of 88 to 93°C (192 to 199°F). It should be fully open for maximum coolant flow during operation in hot ambient temperatures of approximately 104°C (220°F). Above 104°C (220°F), coolant temperature is controlled by the radiator, fan and ambient temperature.

THERMOSTAT—DIESEL

The thermostat controls the operating temperature of the engine by controlling the amount of coolant flow to the radiator. When coolant temperature is below 83°C (181°F), the thermostat is closed (Fig. 8).

When coolant temperature reaches 83°C (181°F), the thermostat begins to open allowing coolant flow to the radiator. This provides quick engine warm-up and overall temperature control. The thermostat is designed to provide a minimum engine operating temperature of 83°C (181°F) and to be fully open for maximum coolant flow at approximately 95°C (203°F). Above 95°C (203°F), coolant temperature is controlled by the radiator, fan and ambient temperature.

The air bleeds (jiggle pins) that were used on the thermostats of diesel engines in previous years are no longer used. They have been replaced by a vertically mounted one-way check valve (jiggle pin) and a rubber bypass hose. The check valve is used as a servicing feature and will vent air when the system is

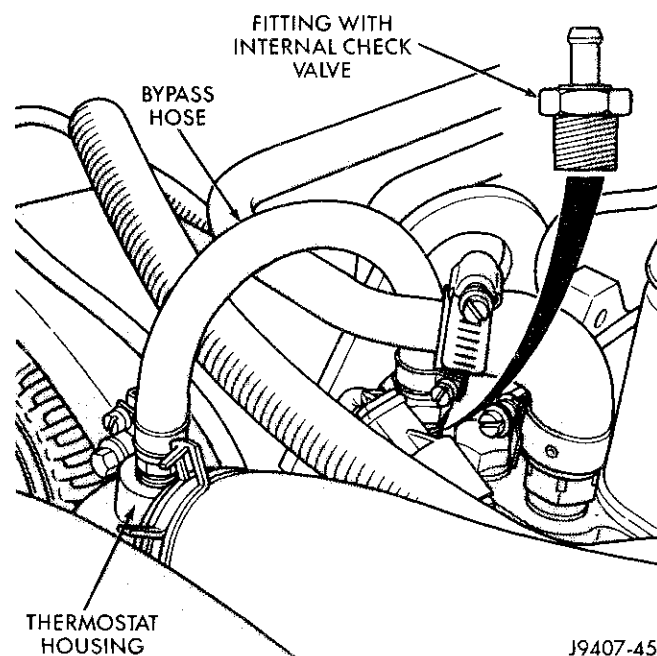
DESCRIPTION AND OPERATION (Continued)**Fig. 8 Thermostat Operation—5.9L Diesel—Typical**

being filled. It is also used to block the flow of coolant during engine operation (all coolant will pass through the thermostat).

Water pressure (or flow) will hold the pin closed.

When the engine is off, the check valve will be in the open position. When the engine is operating, the check valve will be in the closed position.

The check valve is located inside of a brass fitting. This fitting is threaded into the front of the cylinder head (Fig. 9). It is connected to the thermostat housing with a rubber hose and screw-type clamps (Fig. 9).

**Fig. 9 One-Way Check Valve (Jiggle Pin) Location****AUTOMATIC TRANSMISSION OIL COOLERS—GAS ENGINES****WATER-TO-OIL COOLER**

All gas powered models equipped with an automatic transmission are equipped with a transmission oil cooler mounted internally within the radiator side tank. This internal cooler is supplied as standard equipment on all gas powered models equipped with an automatic transmission.

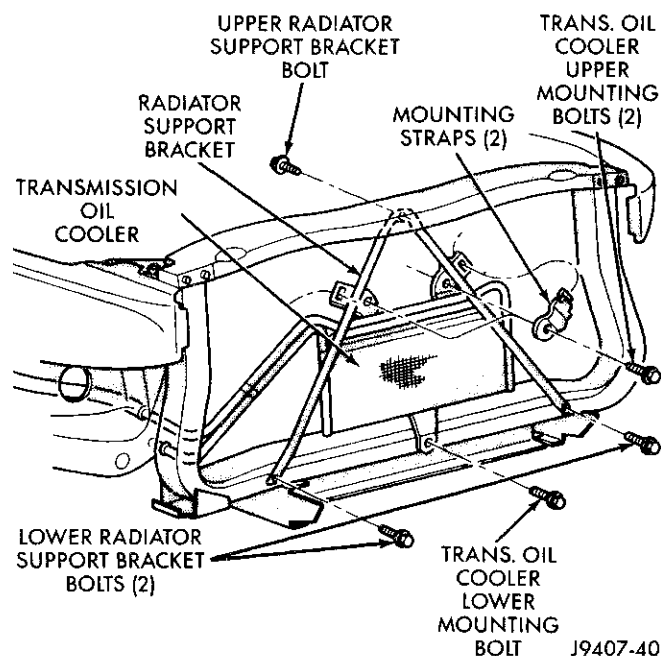
The internal radiator oil cooler **is not used** with the diesel engine.

Transmission oil is cooled when it passes through this separate cooler. In case of a leak in the internal radiator mounted transmission oil cooler, engine coolant may become mixed with transmission fluid or transmission fluid may enter engine cooling system. Both cooling system and transmission should be drained and inspected if the internal radiator mounted transmission cooler is leaking.

Also refer to the section on Transmission Air-to-Oil Coolers. This heavy duty air-to-oil cooler is an option on most engine packages. It is supplied as standard equipment on both the 8.0L V-10 and 5.9L diesel engines.

AIR-TO-OIL COOLER

5.2/5.9L V-8 Gas Powered Engines: An optional air-to-oil transmission oil cooler is available with most engine packages. On the 5.2/5.9L V-8 engines, this optional cooler is located between the radiator and air conditioning condenser (Fig. 10).

**Fig. 10 Air-To-Oil Cooler—3.9L V-6 or 5.2/5.9L V-8 Engines**

DESCRIPTION AND OPERATION (Continued)

8.0L V-10 Engine: The air-to-oil cooler is located in front of and to the left side of the radiator (Fig. 11). This secondary cooler is supplied as standard equipment on models equipped with the 8.0L V-10 engine and an automatic transmission.

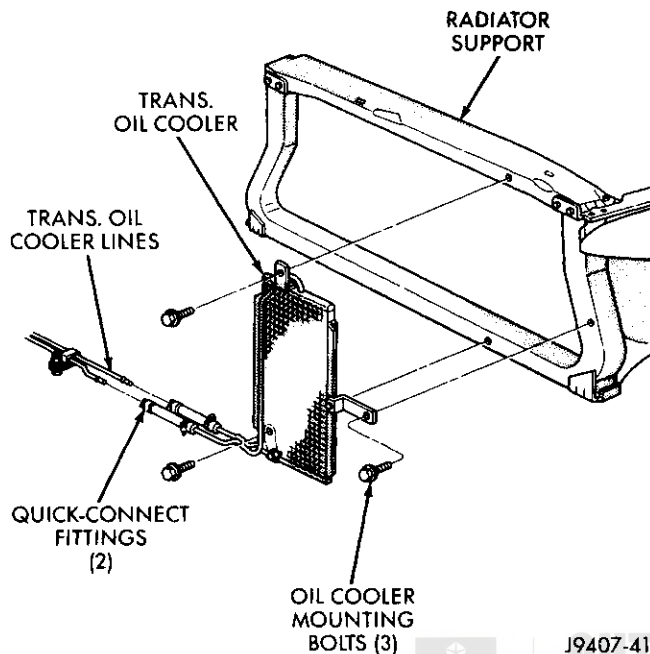


Fig. 11 Air-To-Oil Cooler—8.0L V-10 Engine

The oil coolers on all gas powered engines operate in conjunction with the internal radiator mounted main oil cooler. The transmission oil is routed through the main cooler first, then the optional cooler, before returning to the transmission.

AUTOMATIC TRANSMISSION OIL COOLERS—DIESEL ENGINE

All diesel models equipped with an automatic transmission are equipped with both a main water-to-oil cooler and a separate air-to-oil cooler. Both coolers are supplied as standard equipment on diesel engine powered models when equipped with an automatic transmission.

Transmission oil is cooled when it passes through these coolers.

The main water-to-oil transmission oil cooler is mounted to a bracket on the turbocharger side of the engine (Fig. 12).

The air-to-oil cooler is located in front of and to the left side of the radiator (Fig. 13).

The diesel engine is not equipped with an internal radiator mounted oil cooler.

AUTOMATIC BELT TENSIONER

Drive belts on all engines are equipped with a spring loaded automatic belt tensioner (Fig. 14) (Fig.

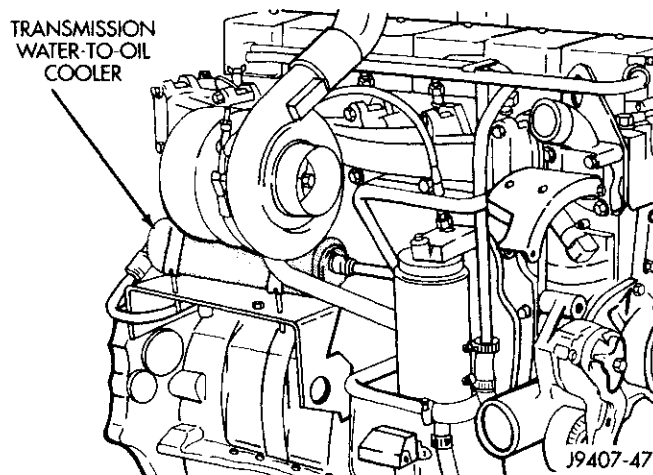


Fig. 12 Transmission Water-To-Oil Cooler—Diesel Engine—Typical

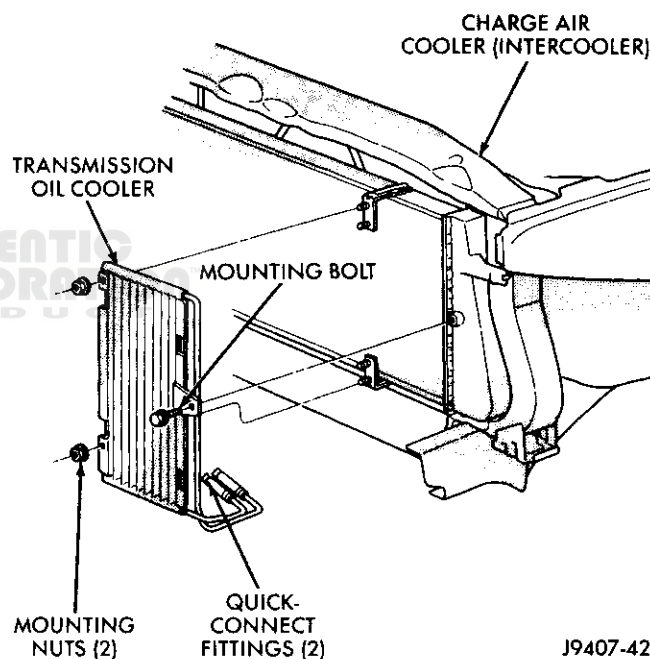


Fig. 13 Air-To-Oil Cooler—Diesel Engine

15) (Fig. 16). This belt tensioner will be used with all belt configurations, such as with or without power steering or air conditioning.

CAUTION: Do not attempt to check belt tension with a belt tension gauge on vehicles equipped with an automatic belt tensioner.

On 3.9L V-6 or 5.2/5.9L V-8 LDC-gas engines, the tensioner is equipped with an indexing arrow (Fig. 17) on back of tensioner and an indexing mark on tensioner housing. If a new belt is being installed, arrow must be within approximately 3 mm (1/8 in.) of indexing mark (point B-) (Fig. 17). Belt is consid-

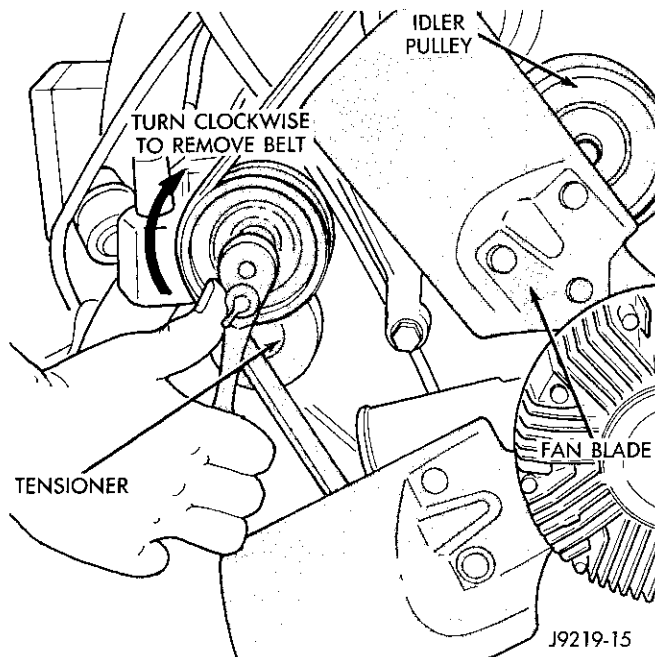
DESCRIPTION AND OPERATION (Continued)

Fig. 14 Belt Tensioner—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

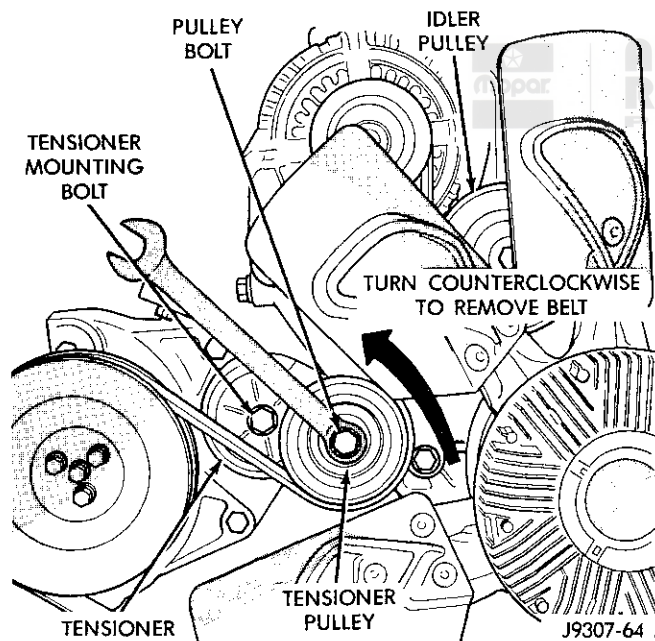


Fig. 15 Belt Tensioner—5.9L HDC-Gas and 8.0L V-10 Engines

ered new if it has been used 15 minutes or less. If this specification cannot be met, check for:

- The wrong belt being installed (incorrect length/width)
- Worn bearings on an engine accessory (A/C compressor, power steering pump, water pump, idler pulley or generator)
- A pulley on an engine accessory being loose

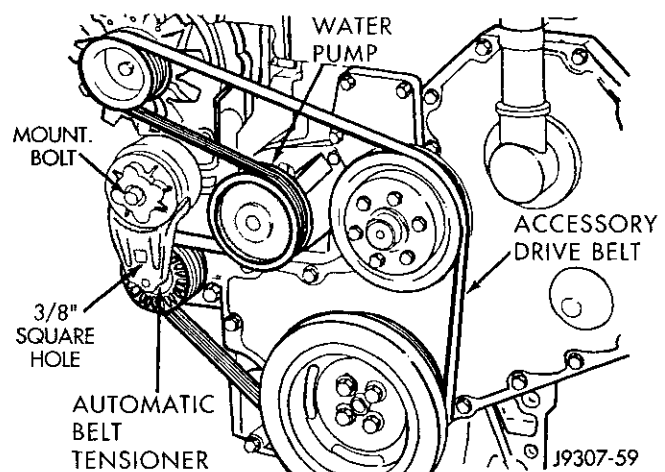


Fig. 16 Belt Tensioner—5.9L Diesel—Typical (non-A/C shown)

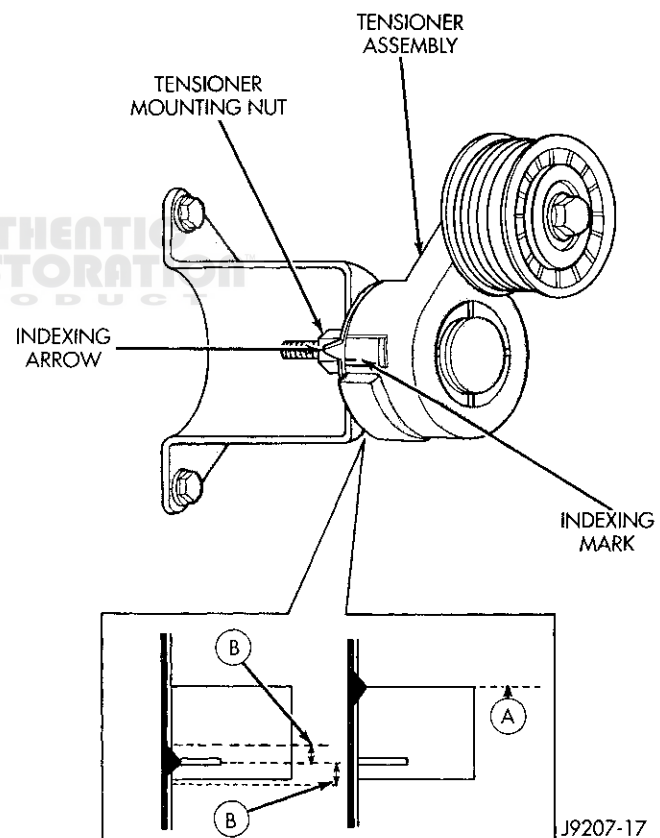


Fig. 17 Indexing Marks—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

- Misalignment of an engine accessory
- Belt incorrectly routed.

On 3.9L V-6 or 5.2/5.9L V-8 LDC-gas engines, a used belt should be replaced if tensioner indexing arrow has moved to point-A (Fig. 17). Tensioner travel stops at point-A.

DESCRIPTION AND OPERATION (Continued)

ENGINE BLOCK HEATERS

An optional engine block heater is available on all models. The heater is equipped with a power cord. The cord is attached to an engine compartment component with tie-straps. The heater warms the engine providing easier engine starting and faster warm-up in low temperatures. The heater is mounted in a core hole of the engine cylinder block (in place of a freeze plug) with the heating element immersed in engine coolant. Connect the power cord to a grounded 110-120 volt AC electrical outlet with a grounded three wire extension cord.

WARNING: DO NOT OPERATE ENGINE UNLESS BLOCK HEATER CORD HAS BEEN DISCONNECTED FROM POWER SOURCE AND SECURED IN PLACE. THE POWER CORD MUST BE SECURED IN ITS RETAINING CLIPS AND ROUTED AWAY FROM EXHAUST MANIFOLDS AND MOVING PARTS.

The 3.9L/5.2L/5.9L gas powered engine has the block heater located on the right side of engine next to the oil filter (Fig. 18).

The 8.0L V-10 engine has the block heater located on the right side of engine next to the engine oil dipstick tube (Fig. 19).

The 5.9L diesel engine has the block heater located on the right side of the engine below the exhaust manifold (Fig. 20).

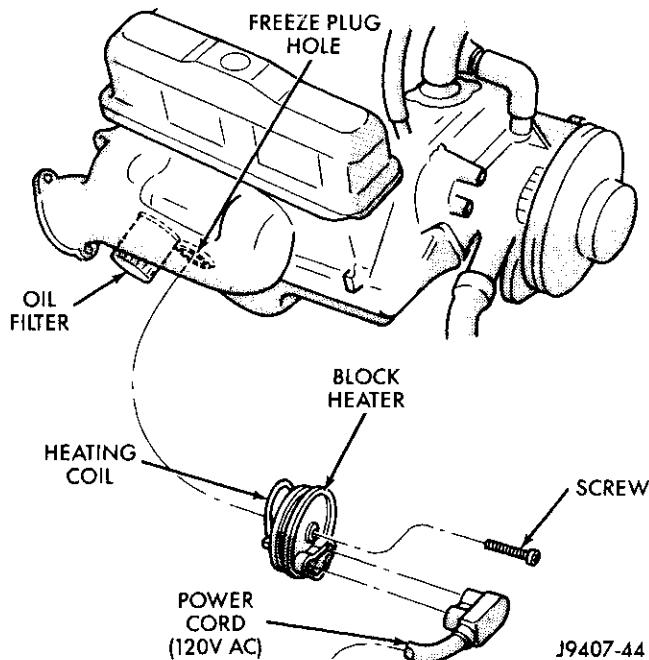


Fig. 18 Engine Block Heater—3.9L/5.2L/5.9L Gas Powered Engine

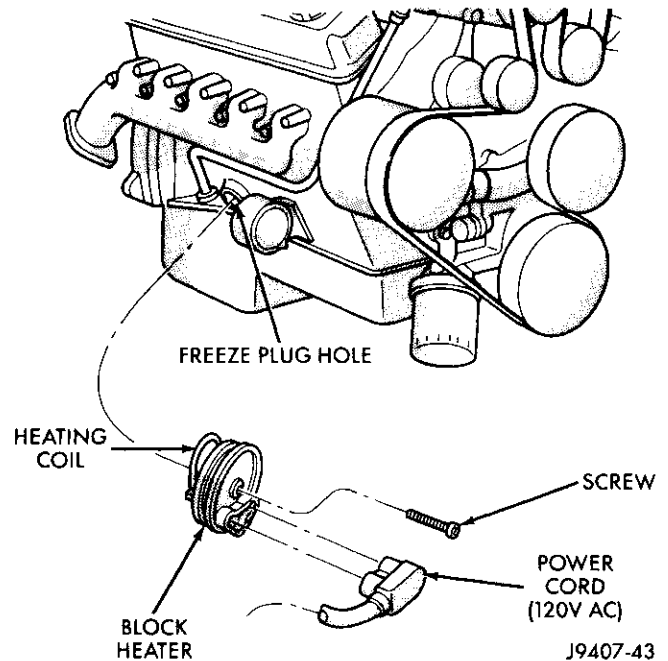


Fig. 19 Engine Block Heater—8.0L V-10 Engine

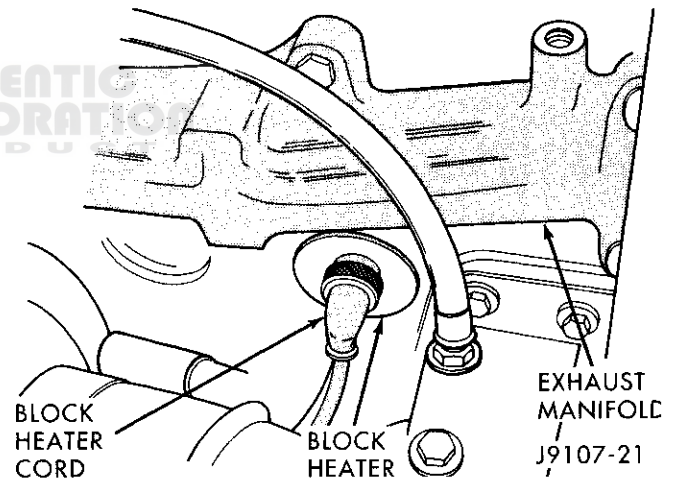


Fig. 20 Engine Block Heater—5.9L Diesel Engine

COOLANT PERFORMANCE

ETHYLENE-GLYCOL MIXTURES

The required ethylene-glycol (antifreeze) and water mixture depends upon the climate and vehicle operating conditions. The recommended mixture of 50/50 ethylene-glycol and water will provide protection against freezing to -37 deg. C (-35 deg. F). The anti-freeze concentration **must always** be a minimum of 44 percent, year-round in all climates. **If percentage is lower than 44 percent, engine parts may be eroded by cavitation, and cooling system components may be severely damaged by corrosion.** Maximum protection against freezing is provided with a 68 percent antifreeze concentration, which

DESCRIPTION AND OPERATION (Continued)

prevents freezing down to -67.7 deg. C (-90 deg. F). A higher percentage will freeze at a warmer temperature. Also, a higher percentage of antifreeze can cause the engine to overheat because the specific heat of antifreeze is lower than that of water.

100 Percent Ethylene-Glycol—Should Not Be Used in Chrysler Vehicles

Use of 100 percent ethylene-glycol will cause formation of additive deposits in the system, as the corrosion inhibitive additives in ethylene-glycol require the presence of water to dissolve. The deposits act as insulation, causing temperatures to rise to as high as 149 deg. C (300 deg. F). This temperature is hot enough to melt plastic and soften solder. The increased temperature can result in engine detonation. In addition, 100 percent ethylene-glycol freezes at 22 deg. C (-8 deg. F).

Propylene-glycol Formulations—Should Not Be Used in Chrysler Vehicles

Propylene-glycol formulations do not meet Chrysler coolant specifications. Its overall effective temperature range is smaller than that of ethylene-glycol. The freeze point of 50/50 propylene-glycol and water is -32 deg. C (-26 deg. F). 5 deg. C higher than ethylene-glycol's freeze point. The boiling point (protection against summer boil-over) of propylene-glycol is 125 deg. C (257 deg. F) at 96.5 kPa (14 psi), compared to 128 deg. C (263 deg. F) for ethylene-glycol. Use of propylene-glycol can result in boil-over or freeze-up in Chrysler vehicles, which are designed for ethylene-glycol. Propylene glycol also has poorer heat transfer characteristics than ethylene glycol. This can increase cylinder head temperatures under certain conditions.

Propylene-glycol/Ethylene-glycol Mixtures—Should Not Be Used in Chrysler Vehicles

Propylene-glycol/ethylene-glycol Mixtures can cause the destabilization of various corrosion inhibitors, causing damage to the various cooling system components. Also, once ethylene-glycol and propylene-glycol based coolants are mixed in the vehicle, conventional methods of determining freeze point will not be accurate. Both the refractive index and specific gravity differ between ethylene glycol and propylene glycol.

CAUTION: Richer antifreeze mixtures cannot be measured with normal field equipment and can cause problems associated with 100 percent ethylene-glycol.

COOLANT SELECTION-ADDITIVES

The presence of aluminum components in the cooling system requires strict corrosion protection. Maintain coolant at specified level with a mixture of ethylene glycol based antifreeze and water. Only use an antifreeze containing ALUGARD 340-2 [®] such as Mopar Antifreeze. If coolant becomes contaminated or loses color, drain and flush cooling system and fill with correctly mixed solution.

CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

RADIATOR PRESSURE CAP

Radiators are equipped with a pressure cap, which releases pressure at some point within a range of 97-124 kPa (14-18 psi). The pressure relief point (in pounds) is engraved on top of cap.

The cooling system will operate at pressures slightly above atmospheric pressure. This results in a higher coolant boiling point allowing increased radiator cooling capacity. The cap (Fig. 21) contains a spring-loaded pressure relief valve that opens when system pressure reaches release range of 97-124 kPa (14-18 psi).

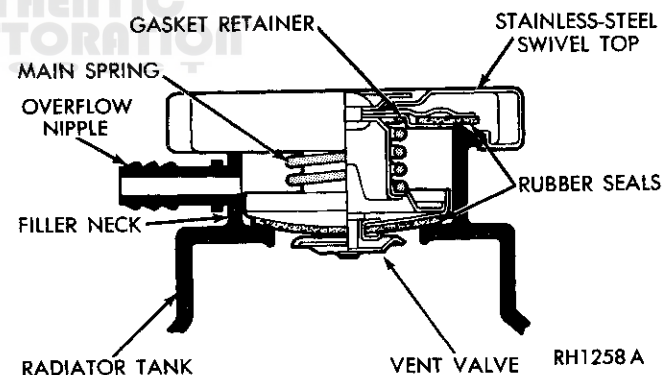


Fig. 21 Radiator Pressure Cap and Filler Neck—Typical

A vent valve in the center of cap allows a small coolant flow through cap when coolant is below boiling temperature. The valve is completely closed when boiling point is reached. As the coolant cools, it contracts and creates a vacuum in the cooling system. This causes the vacuum valve to open and coolant in the reserve/overflow tank to be drawn through its connecting hose into radiator. If the vacuum valve is stuck shut, the radiator hoses will collapse on cool-down. Clean the vent valve (Fig. 21).

A rubber gasket seals radiator filler neck to prevent leakage. This is done to keep system under pressure. It also maintains vacuum during coolant cool-down allowing coolant to return from reserve/overflow tank.

DESCRIPTION AND OPERATION (Continued)

WATER PUMPS—V-6, V-8, AND V-10 ENGINES

A centrifugal water pump circulates coolant through the water jackets, passages, intake manifold, radiator core, cooling system hoses and heater core. The pump is driven from the engine crankshaft by a drive belt.

The water pump impeller is pressed onto the rear of a shaft that rotates in a bearing pressed into the water pump body. The body has a small hole for ventilation. The water pump seals are lubricated by antifreeze in the coolant mixture. Additional lubrication is not necessary.

WATER PUMP—5.9L DIESEL

The diesel engine water pump draws coolant from radiator outlet and circulates it through engine, heater core and back to radiator inlet. The crankshaft pulley drives the water pump with a serpentine drive belt (Fig. 22). An automatic belt tensioner (Fig. 22) is used to prevent the belt from slipping.

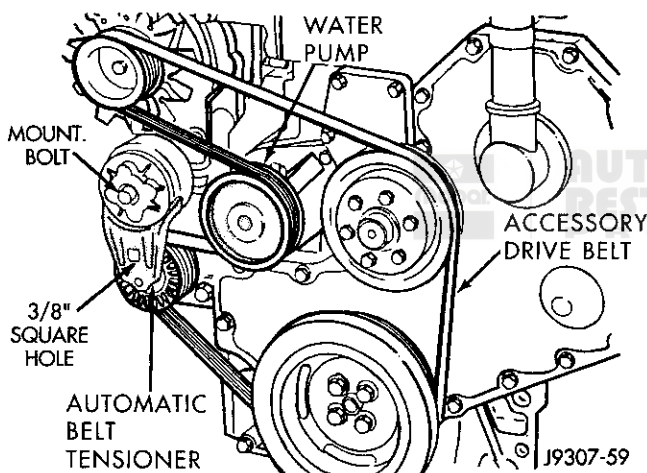


Fig. 22 Water Pump—5.9L Diesel—Typical (non-A/C shown)

COOLING SYSTEM HOSES AND CLAMPS

Rubber hoses route coolant to and from the radiator, intake manifold and heater core. Radiator lower hoses are spring-reinforced to prevent collapse from water pump suction at moderate and high engine speeds.

Inspect the hoses at regular intervals. Replace hoses that are cracked, feel brittle when squeezed or swell excessively when system is pressurized. The use of molded replacement hoses is recommended. When performing a hose inspection, inspect radiator lower hose for proper position and condition of spring.

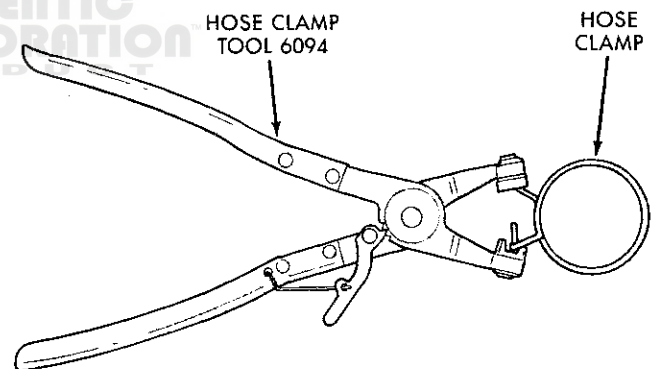
WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY

TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

Ordinary worm gear type hose clamps (when equipped) can be removed with a straight screwdriver or a hex socket. **To prevent damage to hoses or clamps, the hose clamps should be tightened to 4 N-m (34 in. lbs.) torque. Do not over tighten hose clamps.**

For all vehicles: In areas where specific routing clamps are not provided, be sure that hoses are positioned with sufficient clearance. Check clearance from exhaust manifolds and pipe, fan blades, drive belts and sway bars. Improperly positioned hoses can be damaged, resulting in coolant loss and engine overheating.

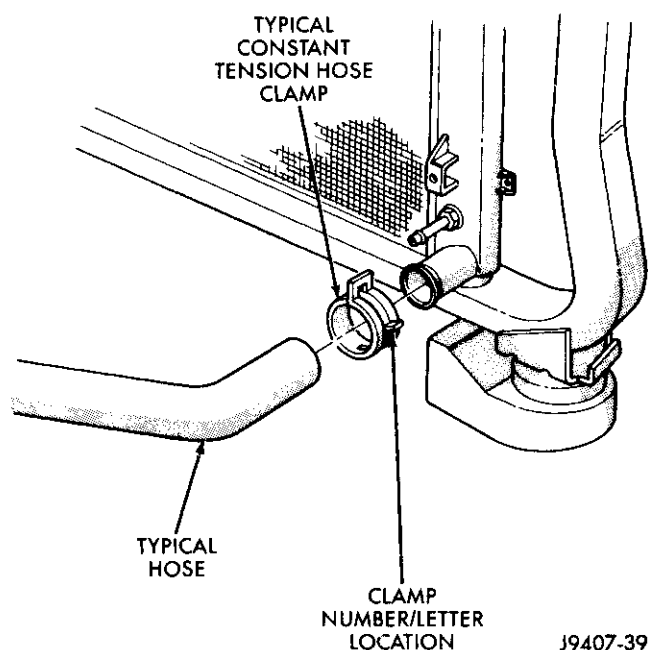


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Fig. 23 Hose Clamp Tool—Typical

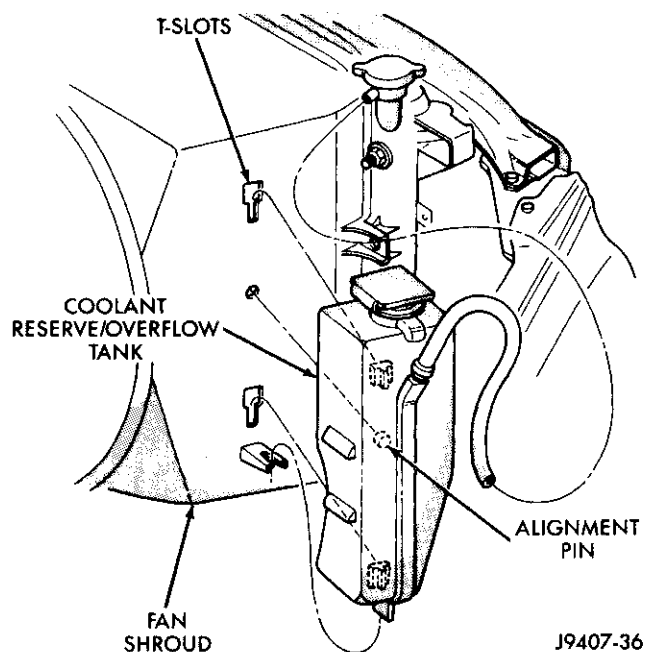
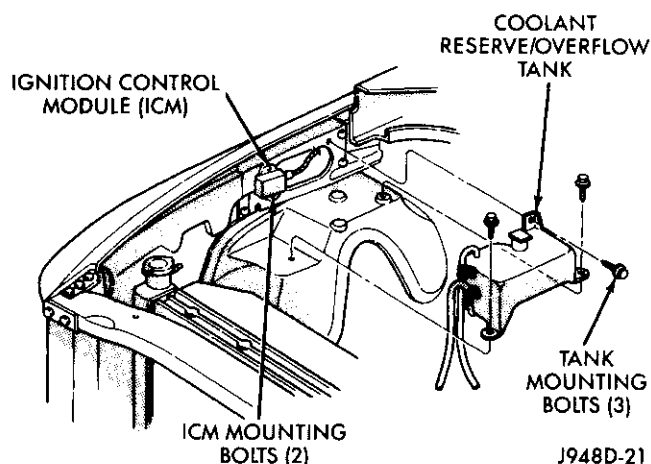
COOLANT RESERVE/OVERFLOW SYSTEM

The coolant reserve/overflow system works in conjunction with the radiator pressure cap. It utilizes thermal expansion and contraction of coolant to keep coolant free of trapped air. It provides a volume for expansion and contraction of coolant. It also provides a convenient and safe method for checking coolant level and adjusting level at atmospheric pressure. This is done without removing the radiator pressure cap. The system also provides some reserve coolant to the radiator to cover minor leaks and evaporation or boiling losses.

DESCRIPTION AND OPERATION (Continued)**Fig. 24 Clamp Number/Letter Location**

As the engine cools, a vacuum is formed in the cooling system of both the radiator and engine. Coolant will then be drawn from the coolant tank and returned to a proper level in the radiator.

On 3.9L/5.2L/5.9L gas engines and the 5.9L diesel engine, the coolant reserve/overflow tank is mounted to the side of the fan shroud (Fig. 25). On the 8.0L V-10 engine the tank is mounted to right inner fender (Fig. 26).

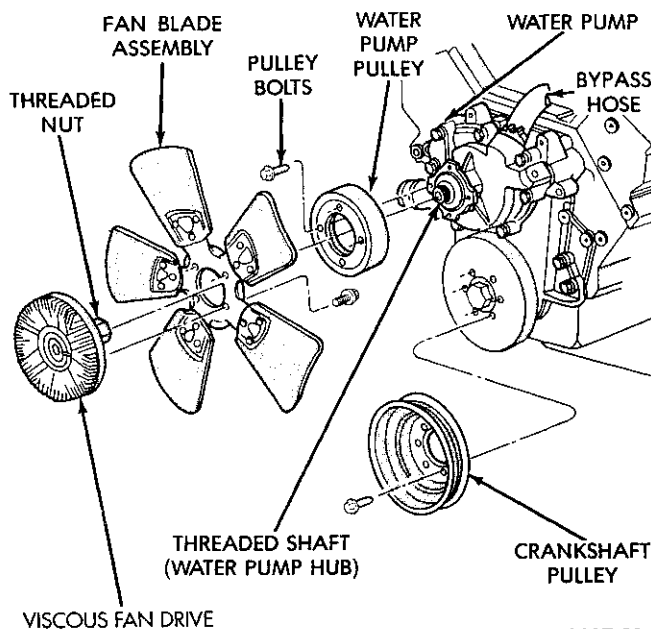
**Fig. 25 Coolant Reserve/Overflow Tank—All Except 8.0L V-10 Engine****Fig. 26 Coolant Reserve/Overflow Tank—8.0L V-10 Engine**

Refer to Coolant Level Check—Service, Deaeration and Radiator Pressure Cap sections in this group for coolant reserve/overflow system operation and service.

Should the reserve/overflow tank become coated with corrosion, it can be cleaned with detergent and water. Rinse tank thoroughly before refilling cooling system as described in the Coolant section of this group.

VISCOUS FAN DRIVE

The thermal viscous fan drive (Fig. 27) (Fig. 28) is a silicone-fluid-filled coupling used to connect the fan blades to the water pump shaft. The coupling allows the fan to be driven in a normal manner. This is done at low engine speeds while limiting the top speed of the fan to a predetermined maximum level at higher engine speeds.

**Fig. 27 Viscous Fan Drive—Gas Engines**

DESCRIPTION AND OPERATION (Continued)

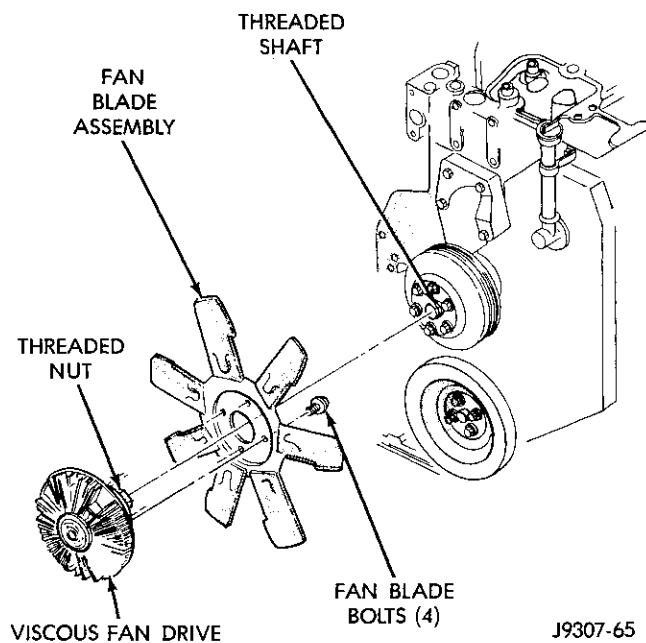


Fig. 28 Viscous Fan Drive—Diesel Engine

A thermostatic bimetallic spring coil is located on the front face of the viscous fan drive unit (a typical viscous unit is shown in (Fig. 29). This spring coil reacts to the temperature of the radiator discharge air. It engages the viscous fan drive for higher fan speed if the air temperature from the radiator rises above a certain point. Until additional engine cooling is necessary, the fan will remain at a reduced rpm regardless of engine speed.

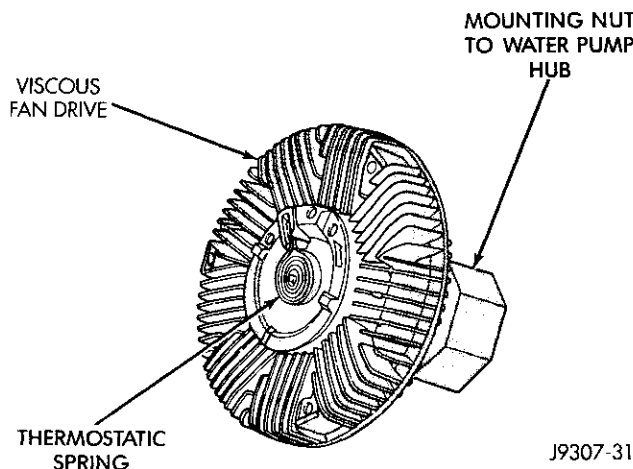


Fig. 29 Viscous Fan Drive—Typical

Only when sufficient heat is present, will the viscous fan drive engage. This is when the air flowing through the radiator core causes a reaction to the bimetallic coil. It then increases fan speed to provide the necessary additional engine cooling.

Once the engine has cooled, the radiator discharge temperature will drop. The bimetallic coil again reacts and the fan speed is reduced to the previous disengaged speed.

CAUTION: Some engines equipped with serpentine drive belts have reverse rotating fans and viscous fan drives. They are marked with the word **REVERSE** to designate their usage. Installation of the wrong fan or viscous fan drive can result in engine overheating.

CAUTION: If the viscous fan drive is replaced because of mechanical damage, the cooling fan blades should also be inspected. Inspect for fatigue cracks, loose blades, or loose rivets that could have resulted from excessive vibration. Replace fan blade assembly if any of these conditions are found. Also inspect water pump bearing and shaft assembly for any related damage due to a viscous fan drive malfunction.

DIAGNOSIS AND TESTING

ON-BOARD DIAGNOSTICS (OBD)

FOR CERTAIN COOLING SYSTEM COMPONENTS

The powertrain control module (PCM) has been programmed to monitor certain cooling system components **on gasoline powered engines only:**

- If the engine has remained cool for too long a period, such as with a stuck open thermostat, a Diagnostic Trouble Code (DTC) number 17 can be observed at the malfunction indicator lamp. This lamp is displayed on the instrument panel as the **CHECK ENGINE** lamp (Fig. 30). **DTC number 17 is not used with diesel powered engines.**

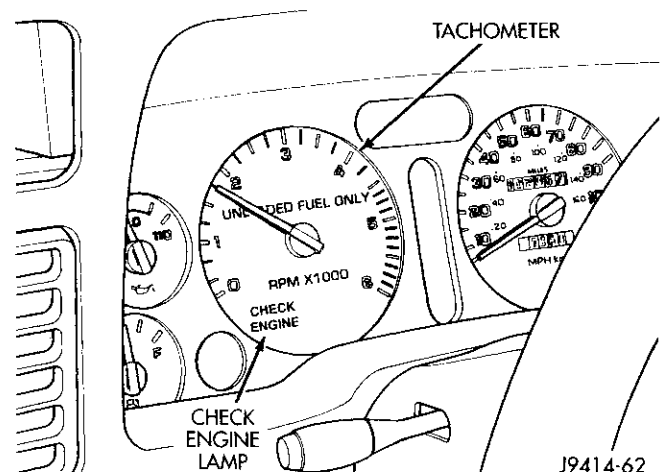


Fig. 30 Check Engine Lamp Location

DIAGNOSIS AND TESTING (Continued)

If the problem is sensed in a monitored circuit often enough to indicate an actual problem, a DTC is stored. The DTC will be stored in the PCM memory for eventual display to the service technician. If the problem is repaired or ceases to exist, the PCM cancels the DTC after 51 engine starts.

Certain criteria must be met for a DTC to be entered into PCM memory. The criteria may be a specific range of engine rpm, engine temperature and/or input voltage to the PCM.

A DTC indicates that the PCM has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

It is possible that a DTC for a monitored circuit may not be entered into memory even though a malfunction has occurred. Refer to On-Board Diagnostics (OBD) in Group 14, Fuel Systems for additional information.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored Diagnostic Trouble Code (DTC) can be displayed by cycling the ignition key On-Off-On-Off-On within three seconds and observing the malfunction indicator lamp. This lamp is displayed on the instrument panel as the CHECK ENGINE lamp (Fig. 30).

They can also be displayed through the use of the Diagnostic Readout Box (DRB) scan tool. The DRB connects to the data link connector (Fig. 31) located at the lower edge of instrument panel near the steering column. For operation of the DRB, refer to the appropriate Powertrain Diagnostic Procedures service manual.

**16-WAY DATA
LINK CONNECTOR**

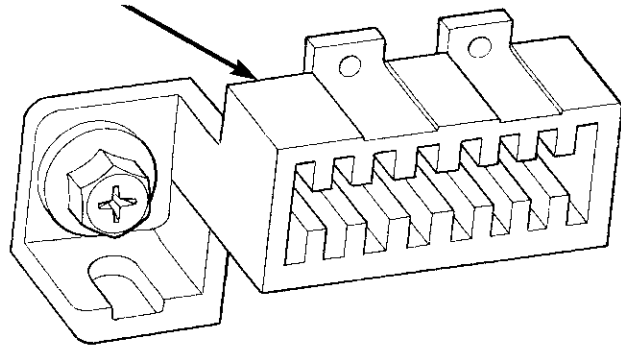


Fig. 31 Data Link Connector

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EXAMPLES:

- If the lamp (Fig. 30) flashes 1 time, pauses and flashes 2 more times, a flashing Diagnostic Trouble Code (DTC) number 12 is indicated. If this code is observed, it is indicating that the battery has been disconnected within the last 50 key-on cycles. It could also indicate that battery voltage has been disconnected to the PCM. In either case, other DTC's may have been erased.

- If the lamp flashes 1 time, pauses and flashes 7 more times, a flashing Diagnostic Trouble Code (DTC) number 17 is indicated.

After any stored DTC information has been observed, the display will end with a flashing DTC number 55. This will indicate the end of all stored information.

ERASING TROUBLE CODES

After the problem has been repaired, use the DRB scan tool to erase a DTC. Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.

DRB SCAN TOOL

For operation of the DRB scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

PRELIMINARY CHECKS**ENGINE COOLING SYSTEM OVERHEATING**

Establish what driving conditions caused the complaint. Abnormal loads on the cooling system such as the following may be the cause:

(1) PROLONGED IDLE, VERY HIGH AMBIENT TEMPERATURE, SLIGHT TAIL WIND AT IDLE, SLOW TRAFFIC, TRAFFIC JAMS, HIGH SPEED OR STEEP GRADES.

Driving techniques that avoid overheating are:

- Idle with A/C off when temperature gauge is at end of normal range.

- Increasing engine speed for more air flow is recommended.

(2) TRAILER TOWING:

Consult Trailer Towing section of owners manual. Do not exceed limits.

(3) AIR CONDITIONING; ADD-ON OR AFTER MARKET:

A maximum cooling package should have been ordered with vehicle if add-on or after market A/C is installed. If not, maximum cooling system components should be installed for model involved per manufacturer's specifications.

(4) RECENT SERVICE OR ACCIDENT REPAIR:

Determine if any recent service has been performed on vehicle that may effect cooling system. This may be:

- Engine adjustments (incorrect timing)
- Slipping engine accessory drive belt(s)
- Brakes (possibly dragging)
- Changed parts. Incorrect water pump or pump rotating in wrong direction due to belt not correctly routed
- Reconditioned radiator or cooling system refilling (possibly under filled or air trapped in system).

NOTE: If investigation reveals none of the previous items as a cause for an engine overheating complaint, refer to following Cooling System Diagnosis charts.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS LOW	<ol style="list-style-type: none"> 1. Has a Diagnostic Trouble Code (DTC) number 17 been set indicating a stuck open engine thermostat? 2. Is the temperature gauge (if equipped) connected to the temperature gauge coolant sensor on the engine? 3. Is the temperature gauge (if equipped) operating OK? 4. Coolant level low in cold ambient temperatures accompanied with poor heater performance. 5. Improper operation of internal heater doors or heater controls. 	<ol style="list-style-type: none"> 1. Refer to On-Board Diagnostics in the service manual text. Replace thermostat if necessary. If a Diagnostic Trouble Code (DTC) number 17 has not been set, the problem may be with the temperature gauge. 2. Check the engine temperature sensor connector in the engine compartment. Refer to Group 8E. Repair as necessary. 3. Check gauge operation. Refer to Group 8E. Repair as necessary. 4. Check coolant level in the coolant reserve/overflow tank and the radiator. Inspect system for leaks. Repair leaks as necessary. Refer to the Coolant section of the manual text for WARNINGS and precautions before removing the radiator cap. 5. Inspect heater and repair as necessary. Refer to Group 24, Heating and Air Conditioning for procedures.
TEMPERATURE GAUGE READS HIGH OR ENGINE COOLANT WARNING LAMP ILLUMINATES. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM COOLING SYSTEM	<ol style="list-style-type: none"> 1. Trailer is being towed, a steep hill is being climbed, vehicle is operated in slow moving traffic, or engine is being idled with very high ambient (outside) temperatures and the air conditioning is on. Higher altitudes could aggravate these conditions. 2. Is temperature gauge (if equipped) reading correctly? 3. Is temperature warning lamp (if equipped) illuminating unnecessarily? 4. Coolant low in coolant reserve/overflow tank and radiator? 5. Pressure cap not installed tightly. If cap is loose, boiling point of coolant will be lowered. Also refer to the following step 6. 6. Poor seals at radiator cap. 	<ol style="list-style-type: none"> 1. This may be a temporary condition and repair is not necessary. Turn off the air conditioning and attempt to drive the vehicle without any of the previous conditions. Observe the temperature gauge. The gauge should return to the normal range. If the gauge does not return to normal range, determine the cause for overheating and repair. Refer to POSSIBLE CAUSES (numbers 2 through 20). 2. Check gauge. Refer to Group 8E. Repair as necessary. 3. Check warning lamp operation. Refer to Group 8E. Repair as necessary. 4. Check for coolant leaks and repair as necessary. Refer to Testing Cooling System For Leaks in this group. 5. Tighten cap. 6. (a) Check condition of cap and cap seals. Refer to Radiator Cap. Replace cap if necessary. (b) Check condition of radiator filler neck. If neck is bent or damaged, replace radiator.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—ALL EXCEPT DIESEL**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS HIGH OR ENGINE COOLANT WARNING LAMP ILLUMINATES. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM COOLING SYSTEM - CONT.	7. Coolant level low in radiator but not in coolant reserve/overflow tank. This means the radiator is not drawing coolant from the coolant reserve/overflow tank as the engine cools. As the engine cools, a vacuum is formed in the cooling system of the engine and radiator. If radiator cap seals are defective, or cooling system has leaks, a vacuum can not be formed.	7. (a) Check condition of radiator cap and cap seals. Refer to Radiator Cap in this group. Replace cap if necessary. (b) Check condition of radiator filler neck. If neck is bent or damaged, replace radiator. (c) Check the condition of the hose from the radiator to the coolant tank. It should fit tight at both ends without any kinks or tears. Replace hose if necessary. (d) Check coolant reserve/overflow tank and tank hoses for blockage. Repair as necessary.
	8. Freeze point of antifreeze not correct. Mixture may be too rich.	8. Check antifreeze. Refer to Coolant section of this group. Adjust antifreeze-to-water ratio as required.
	9. Coolant not flowing through system.	9. Check for coolant flow at radiator filler neck with some coolant removed, engine warm and thermostat open. Coolant should be observed flowing through radiator. If flow is not observed, determine reason for lack of flow and repair as necessary.
	10. Radiator or A/C condenser fins are dirty or clogged.	10. Clean insects or debris. Refer to Radiator Cleaning in this group.
	11. Radiator core is corroded or plugged.	11. Have radiator re-cored or replaced.
	12. Aftermarket A/C installed without proper radiator.	12. Install proper radiator.
	13. Fuel or ignition system problems.	13. Refer to Fuel and Ignition System groups for diagnosis. Also refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.
	14. Dragging brakes.	14. Check and correct as necessary. Refer to Group 5, Brakes in the manual text.
	15. Bug screen is being used reducing airflow.	15. Remove bug screen.
	16. Thermostat partially or completely shut. This is more prevalent on high mileage vehicles.	16. Check thermostat operation and replace as necessary. Refer to Thermostats in this group.
	17. Thermal viscous fan drive not operating properly.	17. Check fan drive operation and replace if necessary. Refer to Viscous Fan Drive in this group.
	18. Cylinder head gasket leaking.	18. Check for cylinder head gasket leaks. Refer to Testing Cooling System For Leaks in this group. For repair, refer to Group 9, Engines.
	19. Heater core leaking.	19. Check heater core for leaks. Refer to Group 24, Heating and Air Conditioning. Repair as necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—ALL EXCEPT DIESEL—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READING IS INCONSISTENT (FLUCTUATES, CYCLES OR IS ERRATIC)	<ol style="list-style-type: none"> 1. During cold weather operation, with the heater blower in the high position, the gauge reading may drop slightly. 2. Temperature gauge or engine mounted gauge sensor defective or shorted. Also, corroded or loose wiring in this circuit. 3. Gauge reading rises when vehicle is brought to a stop after heavy use (engine still running). 4. Gauge reading high after re-starting a warmed-up (hot) engine. 5. Coolant level low in radiator (air will build up in the cooling system causing the thermostat to open late). 6. Cylinder head gasket leaking allowing exhaust gas to enter cooling system causing thermostat to open late. 7. Water pump impeller loose on shaft. 8. Loose accessory drive belt (water pump slipping). 9. Air leak on the suction side of water pump allows air to build up in cooling system causing thermostat to open late. 	<ol style="list-style-type: none"> 1. A normal condition. No correction is necessary. 2. Check operation of gauge and repair if necessary. Refer to Group 8E, Instrument Panel And Gauges. 3. A normal condition. No correction is necessary. Gauge reading should return to normal range after vehicle is driven. 4. A normal condition. No correction is necessary. The gauge should return to normal range after a few minutes of engine operation. 5. Check and correct coolant leaks. Refer to Testing Cooling System For Leaks in this group. 6. (a) Check for cylinder head gasket leaks with a commercially available Block Leak Tester. Repair as necessary. (b) Check for coolant in the engine oil. Inspect for white steam emitting from exhaust system. Repair as necessary. 7. Check water pump and replace as necessary. Refer to Water Pumps in this group. 8. Refer to Engine Accessory Drive Belts in this group. Check and correct as necessary. 9. Locate leak and repair as necessary.
PRESSURE CAP IS BLOWING OFF STEAM AND/OR COOLANT TO COOLANT TANK. TEMPERATURE GAUGE READING MAY BE ABOVE NORMAL BUT NOT HIGH. COOLANT LEVEL MAY BE HIGH IN COOLANT RESERVE/OVERFLOW TANK	<ol style="list-style-type: none"> 1. Pressure relief valve in radiator cap is defective. 	<ol style="list-style-type: none"> 1. Check condition of radiator cap and cap seals. Refer to Radiator Caps in this group. Replace cap as necessary.
COOLANT LOSS TO THE GROUND WITHOUT PRESSURE CAP BLOWOFF. GAUGE IS READING HIGH OR HOT	<ol style="list-style-type: none"> 1. Coolant leaks in radiator, cooling system hoses, water pump or engine. 	<ol style="list-style-type: none"> 1. Pressure test and repair as necessary. Refer to Testing Cooling System For Leaks in this group.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—ALL EXCEPT DIESEL—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
DETONATION OR PRE-IGNITION (NOT CAUSED BY IGNITION SYSTEM). GAUGE MAY OR MAY NOT BE READING HIGH	<ol style="list-style-type: none"> 1. Engine overheating. 2. Freeze point of antifreeze not correct. Mixture is too rich or too lean. 	<ol style="list-style-type: none"> 1. Check reason for overheating and repair as necessary. 2. Check antifreeze. Refer to the Coolant section of this group. Adjust antifreeze-to-water ratio as required.
HOSE OR HOSES COLLAPSE WHEN ENGINE IS COOLING	<ol style="list-style-type: none"> 1. Vacuum created in cooling system on engine cool-down is not being relieved through coolant reserve/overflow system. 	<ol style="list-style-type: none"> 1. (a) Radiator cap relief valve stuck. Refer to Radiator Cap in this group. Replace if necessary. (b) Hose between coolant reserve/overflow tank and radiator is kinked. Repair as necessary. (c) Vent at coolant reserve/overflow tank is plugged. Clean vent and repair as necessary. (d) Reserve/overflow tank is internally blocked or plugged. Check for blockage and repair as necessary.
NOISY FAN	<ol style="list-style-type: none"> 1. Fan blades loose. 2. Fan blades striking a surrounding object. 3. Air obstructions at radiator or air conditioning condenser. 4. Thermal viscous fan drive has defective bearing. 5. A certain amount of fan noise (roaring) may be evident on models equipped with a thermal viscous fan drive. Some of this noise is normal. 	<ol style="list-style-type: none"> 1. Replace fan blade assembly. Refer to Cooling System Fans in this group. 2. Locate point of fan blade contact and repair as necessary. 3. Remove obstructions and/or clean debris or insects from radiator or A/C condenser. 4. Replace fan drive. Bearing is not serviceable. Refer to Viscous Fan Drive in this group. 5. Refer to Viscous Fan Drive in this group for an explanation of normal fan noise.
INADEQUATE AIR CONDITIONER PERFORMANCE (COOLING SYSTEM SUSPECTED)	<ol style="list-style-type: none"> 1. Radiator and/or A/C condenser is restricted, obstructed or dirty (insects, leaves etc.). 2. Thermal viscous fan drive is free-wheeling. 3. Engine is overheating (heat may be transferred from radiator to A/C condenser. High underhood temperatures due to engine overheating may also transfer heat to A/C components). 4. Some models with certain engines are equipped with air seals at the radiator and/or A/C condenser. If these seals are missing or damaged, not enough air flow will be pulled through the radiator and A/C condenser. 	<ol style="list-style-type: none"> 1. Remove restriction and/or clean as necessary. Refer to Radiator Cleaning in this group. 2. Refer to Viscous Fan Drive for diagnosis. Repair as necessary. 3. Correct overheating condition. Refer to text in Group 7, Cooling. 4. Check for missing or damaged air seals and repair as necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—ALL EXCEPT DIESEL—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
INADEQUATE HEATER PERFORMANCE. THERMOSTAT FAILED IN OPEN POSITION	<ol style="list-style-type: none"> 1. Has a diagnostic trouble code (DTC) number 17 been set? 2. Coolant level low. 3. Obstructions in heater hose fittings at engine. 4. Heater hose kinked. 5. Some models with certain engines are equipped with a water control valve located on one of the heater hoses. This valve may be defective. 6. Water pump is not pumping water to heater core. When the engine is fully warmed up, both heater hoses should be hot to the touch. If only one of the hoses is hot, the water pump may not be operating correctly. The accessory drive belt may also be slipping causing poor water pump operation. 	<ol style="list-style-type: none"> 1. Refer to On-Board Diagnostics in the manual text and replace thermostat if necessary. 2. Refer to Testing Cooling System For Leaks in the manual text. Repair as necessary. 3. Remove heater hoses at both ends and check for obstructions. Repair as necessary. 4. Locate kinked area and repair as necessary. 5. Refer to Group 24, Heating and Air Conditioning for diagnosis. Repair as necessary. 6. Refer to Water Pumps in this group. Repair as necessary. If a slipping belt is detected, refer to Engine Accessory Drive Belts in this group. Repair as necessary.
HEAT ODOR	<ol style="list-style-type: none"> 1. Various heat shields are used at certain drive line components. One or more of these shields may be missing. 2. Is temperature gauge reading above the normal range? 3. Is cooling fan operating correctly? 4. Has undercoating been applied to any unnecessary component? 5. Engine may be running rich causing the catalytic converter to overheat. 	<ol style="list-style-type: none"> 1. Locate missing shields and replace or repair as necessary. 2. Refer to the previous Temperature Gauge Reads High in these Diagnosis Charts. Repair as necessary. 3. Refer to Cooling System Fan in this group for diagnosis. Repair as necessary. 4. Clean undercoating as necessary. 5. Refer to the DRB scan tool and the appropriate Powertrain Diagnostic Procedures service manual. Repair as necessary.
POOR DRIVEABILITY (THERMOSTAT POSSIBLY STUCK OPEN). GAUGE MAY BE READING LOW	<ol style="list-style-type: none"> 1. For proper driveability, good vehicle emissions and for preventing build-up of engine oil sludge, the thermostat must be operating properly. Has a diagnostic trouble code (DTC) number 17 been set? 	<ol style="list-style-type: none"> 1. Refer to On-Board Diagnostics in this group. DTC's may also be checked using the DRB scan tool. Refer to the proper Powertrain Diagnostics Procedures service manual for checking the thermostat using the DRB scan tool. Replace thermostat if necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—ALL EXCEPT DIESEL—CONTINUED**

Condition	Possible Causes	Correction
STEAM IS COMING FROM FRONT OF VEHICLE NEAR GRILL AREA WHEN WEATHER IS WET, ENGINE IS WARMED UP AND RUNNING, AND VEHICLE IS STATIONARY. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. During wet weather, moisture (snow, ice or rain condensation) on the radiator will evaporate when the thermostat opens. This opening allows heated water into the radiator. When the moisture contacts the hot radiator, steam may be emitted. This usually occurs in cold weather with no fan or airflow to blow it away.	1. Occasional steam emitting from this area is normal. No repair is necessary.
COOLANT COLOR	1. Coolant color is not necessarily an indication of adequate corrosion or temperature protection. Do not rely on coolant color for determining condition of coolant.	1. Refer to Coolant in this group for antifreeze tests. Adjust antifreeze-to-water ratio as necessary.
COOLANT LEVEL CHANGES IN COOLANT RESERVE/OVERFLOW TANK. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. Level changes are to be expected as coolant volume fluctuates with engine temperature. If the level in the tank was between the FULL and ADD marks at normal engine operating temperature, the level should return to within that range after operation at elevated temperatures.	1. A normal condition. No repair is necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS LOW	<ol style="list-style-type: none"> 1. Diesel engines, due to their inherent efficiency are slower to warm up than gasoline powered engines, and will operate at lower temperatures when the vehicle is unloaded. 2. Is the temperature gauge connected to the temperature gauge coolant sensor on the engine? 3. Is the temperature gauge operating OK? 4. Coolant level low in cold ambient temperatures accompanied with poor heater performance. 5. Improper operation of internal heater doors or heater controls. 	<ol style="list-style-type: none"> 1. The low gauge reading may be normal. Refer to thermostats in the manual text for information. See Thermostat Diagnosis - Diesel Engine. 2. Check the engine temperature sensor connector in the engine compartment. Refer to Group 8E. Repair as necessary. 3. Check gauge operation. Refer to Group 8E. Repair as necessary. 4. Check coolant level in the coolant reserve/overflow tank and the radiator. Inspect system for leaks. Repair leaks as necessary. Refer to the Coolant section of the manual text for WARNINGS and precautions before removing the radiator cap. 5. Inspect heater and repair as necessary. Refer to Group 24, Heating and Air Conditioning for procedures.
TEMPERATURE GAUGE READS HIGH. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM COOLING SYSTEM	<ol style="list-style-type: none"> 1. Trailer is being towed, a steep hill is being climbed, vehicle is operated in slow moving traffic, or engine is being idled with very high ambient (outside) temperatures and the air conditioning is on. Higher altitudes could aggravate these conditions. 2. Is temperature gauge reading correctly? 3. Coolant low in coolant reserve/overflow tank and radiator? 4. Pressure cap not installed tightly. If cap is loose, boiling point of coolant will be lowered. Also refer to the following step 5. 5. Poor seals at radiator cap. 	<ol style="list-style-type: none"> 1. This may be a temporary condition and repair is not necessary. Turn off the air conditioning and attempt to drive the vehicle without any of the previous conditions. Observe the temperature gauge. The gauge should return to the normal range. If the gauge does not return to normal range, determine the cause for overheating and repair. Refer to POSSIBLE CAUSES (numbers 2 through 17). 2. Check gauge. Refer to Group 8E. Repair as necessary. 3. Check for coolant leaks and repair as necessary. Refer to Testing Cooling System For Leaks in this group. 4. Tighten cap. 5. (a) Check condition of cap and cap seals. Refer to Radiator Cap. Replace cap if necessary. (b) Check condition of radiator filler neck. If neck is bent or damaged, replace radiator.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS HIGH. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM COOLING SYSTEM - CONT.	6. Coolant level low in radiator but not in coolant reserve/overflow tank. This means the radiator is not drawing coolant from the coolant reserve/overflow tank as the engine cools. As the engine cools, a vacuum is formed in the cooling system of the engine and radiator. If radiator cap seals are defective, or cooling system has leaks, a vacuum can not be formed.	6. (a) Check condition of radiator cap and cap seals. Refer to Radiator Cap in this group. Replace cap if necessary. (b) Check condition of radiator filler neck. If neck is bent or damaged, replace radiator. (c) Check the condition of the hose from the radiator to the coolant tank. It should fit tight at both ends without any kinks or tears. Replace hose if necessary. (d) Check coolant reserve/overflow tank and tank hoses for blockage. Repair as necessary.
	7. Freeze point of antifreeze not correct. Mixture may be too rich.	7. Check antifreeze. Refer to Coolant section of this group. Adjust antifreeze-to-water ratio as required.
	8. Coolant not flowing through system.	8. Check for coolant flow at radiator filler neck with some coolant removed, engine warm and thermostat open. Coolant should be observed flowing through radiator. If flow is not observed, determine reason for lack of flow and repair as necessary.
	9. Radiator or A/C condenser fins are dirty or clogged.	9. Clean insects or debris. Refer to Radiator Cleaning in this group.
	10. Radiator core is corroded or plugged.	10. Have radiator re-cored or replaced.
	11. Aftermarket A/C installed without proper radiator.	11. Install proper radiator.
	12. Dragging brakes.	12. Check and correct as necessary. Refer to Group 5, Brakes in the manual text.
	13. Bug screen is being used reducing airflow.	13. Remove bug screen.
	14. Thermostat partially or completely shut. This is more prevalent on high mileage vehicles.	14. Check thermostat operation and replace as necessary. Refer to Thermostats in this group.
	15. Thermal viscous fan drive not operating properly.	15. Check fan drive operation and replace if necessary. Refer to Viscous Fan Drive in this group.
	16. Cylinder head gasket leaking.	16. Check for cylinder head gasket leaks. Refer to Testing Cooling System For Leaks in this group. For repair, refer to Group 9, Engines.
	17. Heater core leaking.	17. Check heater core for leaks. Refer to Group 24, Heating and Air Conditioning. Repair as necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READING IS INCONSISTENT (FLUCTUATES, CYCLES OR IS ERRATIC)	<ol style="list-style-type: none"> 1. During cold weather operation, with the heater blower in the high position, the gauge reading may drop slightly. Fluctuation is also influenced by loads, outside temperature and extended idle time with diesel engines. 2. Temperature gauge or engine mounted gauge sensor defective or shorted. Also, corroded or loose wiring in this circuit. 3. Gauge reading rises when vehicle is brought to a stop after heavy use (engine still running). 4. Gauge reading high after re-starting a warmed-up (hot) engine. 5. Coolant level low in radiator (air will build up in the cooling system causing the thermostat to open late). 6. Cylinder head gasket leaking allowing exhaust gas to enter cooling system causing thermostat to open late. 7. Water pump impeller loose on shaft. 8. Loose accessory drive belt (water pump slipping). 9. Air leak on the suction side of water pump allows air to build up in cooling system causing thermostat to open late. 	<ol style="list-style-type: none"> 1. A normal condition. No correction is necessary. 2. Check operation of gauge and repair if necessary. Refer to Group 8E, Instrument Panel And Gauges. 3. A normal condition. No correction is necessary. Gauge reading should return to normal range after vehicle is driven. 4. A normal condition. No correction is necessary. The gauge should return to normal range after a few minutes of engine operation. 5. Check and correct coolant leaks. Refer to Testing Cooling System For Leaks in this group. 6. (a) Check for cylinder head gasket leaks with a commercially available Block Leak Tester. Repair as necessary. (b) Check for coolant in the engine oil. Inspect for white steam emitting from exhaust system. Repair as necessary. 7. Check water pump and replace as necessary. Refer to Water Pumps in this group. 8. Refer to Engine Accessory Drive Belts in this group. Check and correct as necessary. 9. Locate leak and repair as necessary.
PRESSURE CAP IS BLOWING OFF STEAM AND/OR COOLANT TO COOLANT TANK. TEMPERATURE GAUGE READING MAY BE ABOVE NORMAL BUT NOT HIGH. COOLANT LEVEL MAY BE HIGH IN COOLANT RESERVE/OVERFLOW TANK	<ol style="list-style-type: none"> 1. Pressure relief valve in radiator cap is defective. 	<ol style="list-style-type: none"> 1. Check condition of radiator cap and cap seals. Refer to Radiator Caps in this group. Replace cap as necessary.
COOLANT LOSS TO THE GROUND WITHOUT PRES-SURE CAP BLOWOFF. GAUGE IS READING HIGH OR HOT	<ol style="list-style-type: none"> 1. Coolant leaks in radiator, cooling system hoses, water pump or engine. 	<ol style="list-style-type: none"> 1. Pressure test and repair as necessary. Refer to Testing Cooling System For Leaks in this group.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
HOSE OR HOSES COLLAPSE WHEN ENGINE IS COOLING	1. Vacuum created in cooling system on engine cool-down is not being relieved through coolant reserve/overflow system.	1. (a) Radiator cap relief valve stuck. Refer to Radiator Cap in this group. Replace if necessary. (b) Hose between coolant reserve/overflow tank and radiator is kinked. Repair as necessary. (c) Vent at coolant reserve/overflow tank is plugged. Clean vent and repair as necessary. (d) Reserve/overflow tank is internally blocked or plugged. Check for blockage and repair as necessary.
NOISY FAN	1. Fan blades loose. 2. Fan blades striking a surrounding object. 3. Air obstructions at radiator or air conditioning condenser. 4. Thermal viscous fan drive has defective bearing. 5. A certain amount of fan noise (roaring) may be evident on models equipped with a thermal viscous fan drive. Some of this noise is normal.	1. Replace fan blade assembly. Refer to Cooling System Fans in this group. 2. Locate point of fan blade contact and repair as necessary. 3. Remove obstructions and/or clean debris or insects from radiator or A/C condenser. 4. Replace fan drive. Bearing is not serviceable. Refer to Viscous Fan Drive in this group. 5. Refer to Viscous Fan Drive in this group for an explanation of normal fan noise.
INADEQUATE AIR CONDITIONER PERFORMANCE (COOLING SYSTEM SUSPECTED)	1. Radiator and/or A/C condenser is restricted, obstructed or dirty (insects, leaves etc.). 2. Thermal viscous fan drive is free-wheeling. 3. Engine is overheating (heat may be transferred from radiator to A/C condenser. High underhood temperatures due to engine overheating may also transfer heat to A/C components). 4. Some models with certain engines are equipped with air seals at the radiator and/or A/C condenser. If these seals are missing or damaged, not enough air flow will be pulled through the radiator and A/C condenser.	1. Remove restriction and/or clean as necessary. Refer to Radiator Cleaning in this group. 2. Refer to Viscous Fan Drive for diagnosis. Repair as necessary. 3. Correct overheating condition. Refer to text in Group 7, Cooling. 4. Check for missing or damaged air seals and repair as necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE—CONTINUED**

CONDITION	POSSIBLE CAUSES	CORRECTION
INADEQUATE HEATER PERFORMANCE. MAY BE ACCOMPANIED BY LOW GAUGE READING	<ol style="list-style-type: none"> 1. Diesel engines, due to their inherent efficiency are slower to warm up than gasoline powered engines, and will operate at lower temperatures when the vehicle is unloaded. 2. Coolant level low. 3. Obstructions in heater hose fittings at engine. 4. Heater hose kinked. 5. Water pump is not pumping water to heater core. When the engine is fully warmed up, both heater hoses should be hot to the touch. If only one of the hoses is hot, the water pump may not be operating correctly. The accessory drive belt may also be slipping causing poor water pump operation. 	<ol style="list-style-type: none"> 1. The low gauge reading may be normal. Refer to Thermostats in the manual text for information. See Thermostat Diagnosis - Diesel Engine. 2. Refer to Testing Cooling System For Leaks in the manual text. Repair as necessary. 3. Remove heater hoses at both ends and check for obstructions. Repair as necessary. 4. Locate kinked area and repair as necessary. 5. Refer to Water Pumps in this group. Repair as necessary. If a slipping belt is detected, refer to Engine Accessory Drive Belts in this group. Repair as necessary.
HEAT ODOR	<ol style="list-style-type: none"> 1. Various heat shields are used at certain drive line components. One or more of these shields may be missing. 2. Is temperature gauge reading above the normal range? 3. Is cooling fan operating correctly? 4. Has undercoating been applied to any unnecessary component? 	<ol style="list-style-type: none"> 1. Locate missing shields and replace or repair as necessary. 2. Refer to the previous Temperature Gauge Reads High in these Diagnosis Charts. Repair as necessary. 3. Refer to Cooling System Fan in this group for diagnosis. Repair as necessary. 4. Clean undercoating as necessary.

DIAGNOSIS AND TESTING (Continued)**COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE—CONTINUED**

Condition	Possible Causes	Correction
STEAM IS COMING FROM FRONT OF VEHICLE NEAR GRILL AREA WHEN WEATHER IS WET, ENGINE IS WARMED UP AND RUNNING, AND VEHICLE IS STATIONARY. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. During wet weather, moisture (snow, ice or rain condensation) on the radiator will evaporate when the thermostat opens. This opening allows heated water into the radiator. When the moisture contacts the hot radiator, steam may be emitted. This usually occurs in cold weather with no fan or airflow to blow it away.	1. Occasional steam emitting from this area is normal. No repair is necessary.
COOLANT COLOR	1. Coolant color is not necessarily an indication of adequate corrosion or temperature protection. Do not rely on coolant color for determining condition of coolant.	1. Refer to Coolant in this group for antifreeze tests. Adjust antifreeze-to-water ratio as necessary.
COOLANT LEVEL CHANGES IN COOLANT RESERVE/ OVERFLOW TANK. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. Level changes are to be expected as coolant volume fluctuates with engine temperature. If the level in the tank was between the FULL and ADD marks at normal engine operating temperature, the level should return to within that range after operation at elevated temperatures.	1. A normal condition. No repair is necessary.

DIAGNOSIS AND TESTING (Continued)

RADIATOR COOLANT FLOW TEST

Use the following procedure to determine if coolant is flowing through the cooling system.

(1) Idle engine until operating temperature is reached. If the upper radiator hose is warm to the touch, the thermostat is opening and coolant is flowing to the radiator.

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. USING A RAG TO COVER THE RADIATOR PRESSURE CAP, OPEN RADIATOR CAP SLOWLY TO THE FIRST STOP. THIS WILL ALLOW ANY BUILT-UP PRESSURE TO VENT TO THE RESERVE/OVERFLOW TANK. AFTER PRESSURE BUILD-UP HAS BEEN RELEASED, REMOVE CAP FROM FILLER NECK.

(2) Drain a small amount of coolant from the radiator until the ends of the radiator tubes are visible through the filler neck. Idle the engine at normal operating temperature. If coolant is flowing past the exposed tubes, the coolant is circulating.

TESTING COOLING SYSTEM FOR LEAKS

PRESSURE TESTER METHOD

The engine should be at normal operating temperature. Recheck the system cold if cause of coolant loss is not located during the warm engine examination.

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING.

Carefully remove radiator pressure cap from filler neck and check coolant level. Push down on cap to disengage it from stop tabs. Wipe inside of filler neck and examine lower inside sealing seat for nicks, cracks, paint, dirt and solder residue. Inspect radiator-to-reserve/overflow tank hose for internal obstructions. Insert a wire through the hose to be sure it is not obstructed.

Inspect cams on outside of filler neck. If cams are bent, seating of pressure cap valve and tester seal will be affected. Replace cap if cams are bent.

Attach pressure tester (7700 or an equivalent) to radiator filler neck (Fig. 32).

Operate tester pump to apply 103.4 kPa (15 psi) pressure to system. If hoses enlarge excessively or bulges while testing, replace as necessary. Observe gauge pointer and determine condition of cooling system according to following criteria:

Holds Steady: If pointer remains steady for two minutes, serious coolant leaks are not present in system. However, there could be an internal leak that does not appear with normal system test pressure. If it is certain that coolant is being lost and leaks can-

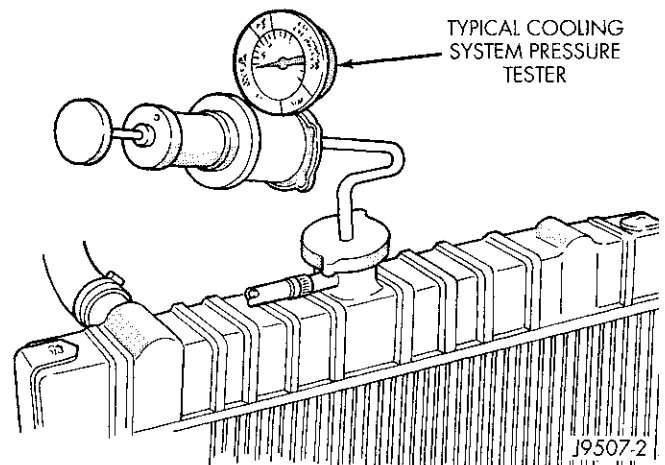


Fig. 32 Pressure Testing Cooling System—Typical

not be detected, inspect for interior leakage or perform Internal Leakage Test.

Drops Slowly: Indicates a small leak or seepage is occurring. Examine all connections for seepage or slight leakage with a flashlight. Inspect radiator, hoses, gasket edges and heater. Seal small leak holes with a sealer lubricant (or equivalent). Repair leak holes and inspect system again with pressure applied.

Drops Quickly: Indicates that serious leakage is occurring. Examine system for external leakage. If leaks are not visible, inspect for internal leakage. Large radiator leak holes should be repaired by a reputable radiator repair shop.

ULTRAVIOLET LIGHT METHOD

A leak detection additive is available through the parts department that can be added to cooling system. The additive is highly visible under ultraviolet light (black light). Pour one ounce of additive into cooling system. Place heater control unit in HEAT position. Start and operate engine until radiator upper hose is warm to touch. Aim the commercially available black light tool at components to be checked. If leaks are present, black light will cause additive to glow a bright green color.

The black light can be used in conjunction with a pressure tester to determine if any external leaks exist (Fig. 33).

INTERNAL LEAKAGE TEST

Remove engine oil pan drain plug and drain a small amount of engine oil. If coolant is present in the pan, it will drain first because it is heavier than oil. An alternative method is to operate engine for a short period to churn the oil. After this is done, remove engine dipstick and inspect for water globules. Also inspect transmission dipstick for water globules and transmission fluid cooler for leakage.

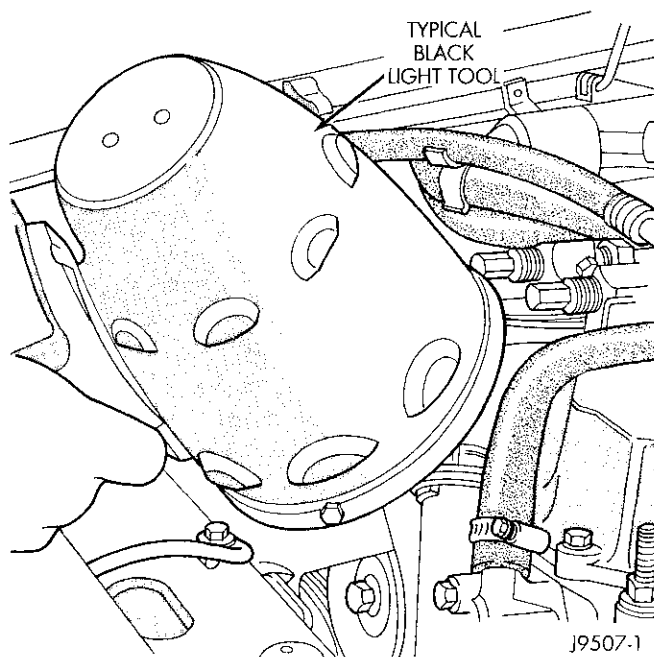
DIAGNOSIS AND TESTING (Continued)

Fig. 33 Leak Detection Using Black Light—Typical

WARNING: WITH COOLING SYSTEM PRESSURE TESTER TOOL INSTALLED ON RADIATOR, DO NOT ALLOW PRESSURE TO EXCEED 110 KPA (20 PSI). PRESSURE WILL BUILD UP QUICKLY IF A COMBUSTION LEAK IS PRESENT. TO RELEASE PRESSURE, ROCK TESTER FROM SIDE TO SIDE. WHEN REMOVING TESTER, DO NOT TURN TESTER MORE THAN 1/2 TURN IF SYSTEM IS UNDER PRESSURE.

Operate engine without pressure cap on radiator until thermostat opens. Attach a pressure tester to filler neck. If pressure builds up quickly it indicates a combustion leak exists. This is usually the result of a cylinder head gasket leak or crack in engine. Repair as necessary.

If there is not an immediate pressure increase, pump the pressure tester. Do this until indicated pressure is within system range of 110 kPa (16 psi). Fluctuation of gauge pointer indicates compression or combustion leakage into cooling system.

Because the vehicle is equipped with a catalytic converter, **do not** remove spark plug cables or short out cylinders (non-diesel engines) to isolate compression leak.

If the needle on dial of pressure tester does not fluctuate, race engine a few times to check for an abnormal amount of coolant or steam. This would be emitting from exhaust pipe. Coolant or steam from exhaust pipe may indicate a faulty cylinder head gasket, cracked engine cylinder block or cylinder head.

A convenient check for exhaust gas leakage into cooling system is provided by a commercially avail-

able Block Leak Check tool. Follow manufacturers instructions when using this product.

COMBUSTION LEAKAGE TEST—WITHOUT PRESSURE TESTER

DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

WARNING: DO NOT REMOVE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN RADIATOR DRAIN-CK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

Drain sufficient coolant to allow thermostat removal. Refer to Thermostat Replacement. Disconnect water pump drive belt.

Add coolant to radiator to bring level to within 6.3 mm (1/4 in) of top of thermostat housing.

CAUTION: Avoid overheating. Do not operate engine for an excessive period of time. Open drain-cock immediately after test to eliminate boil over.

Start engine and accelerate rapidly three times, to approximately 3000 rpm (2000 rpm for diesel) while observing coolant. If internal engine combustion gases are leaking into cooling system, bubbles will appear in coolant. If bubbles do not appear, internal combustion gas leakage is not present.

VISCOUS FAN DRIVE

NOISE

NOTE: It is normal for fan noise to be louder (roaring) when:

- The underhood temperature is above the engagement point for the viscous drive coupling. This may occur when ambient (outside air temperature) is very high.
- Engine loads and temperatures are high such as when towing a trailer.
- Cool silicone fluid within the fan drive unit is being redistributed back to its normal disengaged (warm) position. This can occur during the first 15 seconds to one minute after engine start-up on a cold engine.

LEAKS

Viscous fan drive operation is not affected by small oil stains near the drive bearing. If leakage appears excessive, replace the fan drive unit.

TESTING

If the fan assembly free-wheels without drag (the fan blades will revolve more than five turns when

DIAGNOSIS AND TESTING (Continued)

spun by hand), replace the fan drive. This spin test must be performed when the engine is cool.

For the following test, the cooling system must be in good condition. It also will ensure against excessively high coolant temperature.

WARNING: BE SURE THAT THERE IS ADEQUATE FAN BLADE CLEARANCE BEFORE DRILLING.

(1) Drill a 3.18-mm (1/8-in) diameter hole in the top center of the fan shroud.

(2) Obtain a dial thermometer with an 8 inch stem (or equivalent). It should have a range of -18°-to-105°C (0°-to-220° F). Insert thermometer through the hole in the shroud. Be sure that there is adequate clearance from the fan blades.

(3) Connect a tachometer and an engine ignition timing light. The timing light is to be used as a strobe light. This step cannot be used on the diesel engine.

(4) Block the air flow through the radiator. Secure a sheet of plastic in front of the radiator (or air conditioner condenser). Use tape at the top to secure the plastic and be sure that the air flow is blocked.

(5) Be sure that the air conditioner (if equipped) is turned off.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(6) Start the engine and operate at 2400 rpm. Within ten minutes the air temperature (indicated on the dial thermometer) should be up to 88° C (190° F). Fan drive **engagement** should have started to occur at between 74° to 82° C (165° to 180° F). Engagement is distinguishable by a definite **increase** in fan flow noise (roaring). The timing light also will indicate an increase in the speed of the fan (non-diesel only).

(7) When the air temperature reaches 88° C (190° F), remove the plastic sheet. Fan drive **disengagement** should have started to occur at between 57° to 79° C (135° to 175° F). A definite **decrease** of fan flow noise (roaring) should be noticed. If not, replace the defective viscous fan drive unit.

CAUTION: Some engines equipped with serpentine drive belts have reverse rotating fans and viscous fan drives. They are marked with the word **REVERSE** to designate their usage. Installation of the wrong fan or viscous fan drive can result in engine overheating.

CAUTION: If the viscous fan drive is replaced because of mechanical damage, the cooling fan blades should also be inspected. Inspect for fatigue cracks, loose blades, or loose rivets that could have resulted from excessive vibration. Replace fan blade assembly if any of these conditions are found. Also inspect water pump bearing and shaft assembly for any related damage due to a viscous fan drive malfunction.

SERPENTINE DRIVE BELT DIAGNOSIS—ALL ENGINES

When diagnosing serpentine drive belts, small cracks that run across ribbed surface of belt from rib to rib (Fig. 34), are considered normal. These are not a reason to replace belt. However, cracks running along a rib (not across) are **not** normal. Any belt with cracks running along a rib must be replaced (Fig. 34). Also replace belt if it has excessive wear, frayed cords or severe glazing.

Refer to the Serpentine Drive Belt Diagnosis chart for further belt diagnosis. Also refer to Automatic Belt Tensioner proceeding in this group.

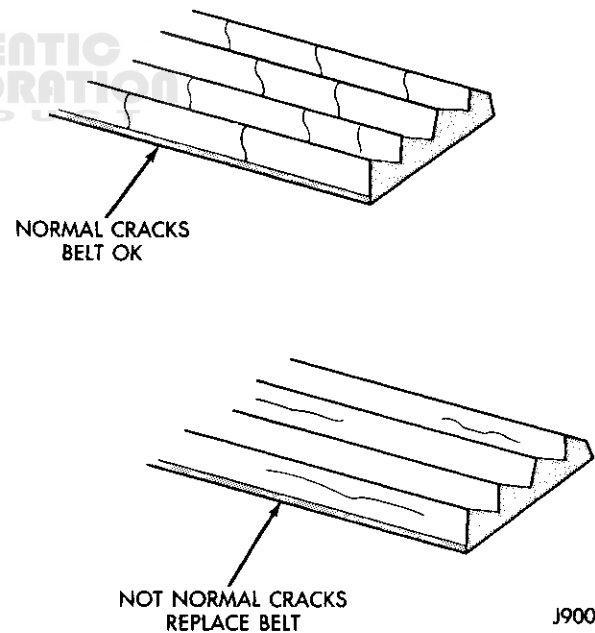


Fig. 34 Serpentine Accessory Drive Belt Wear Patterns

DIAGNOSIS AND TESTING (Continued)**SERPENTINE DRIVE BELT DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
RIB CHUNKING (ONE OR MORE RIBS HAS SEPARATED FROM BELT BODY)	<ol style="list-style-type: none"> 1. Foreign objects imbedded in pulley grooves. 2. Installation damage. 	<ol style="list-style-type: none"> 1. Remove foreign objects from pulley grooves. Replace belt. 2. Replace belt.
RIB OR BELT WEAR	<ol style="list-style-type: none"> 1. Pulley(s) misaligned. 2. Abrasive environment. 3. Rusted pulley(s). 4. Sharp or jagged pulley groove tips. 5. Rubber deteriorated. 	<ol style="list-style-type: none"> 1. Align pulley(s). 2. Clean pulley(s). Replace belt if necessary. 3. Clean rust from pulley(s). 4. Replace pulley. 5. Replace belt.
LONGITUDINAL BELT CRACKING (CRACKS BETWEEN TWO RIBS)	<ol style="list-style-type: none"> 1. Belt has mistracked from pulley groove. 2. Pulley groove tip has worn away rubber to tensile member. 	<ol style="list-style-type: none"> 1. Replace belt. 2. Replace belt.
BELT SLIPS	<ol style="list-style-type: none"> 1. Belt slipping because of insufficient tension. 2. Incorrect belt. 3. Belt or pulley subjected to substance (belt dressing, oil, ethylene glycol) that has reduced friction. 4. Driven component bearing failure. 5. Belt glazed and hardened from heat and excessive slippage. 	<ol style="list-style-type: none"> 1. Replace automatic belt tensioner. 2. Replace belt. 3. Replace belt and clean pulleys. 4. Replace faulty component bearing. 5. Replace belt.
"GROOVE JUMPING" (BELT DOES NOT MAINTAIN CORRECT POSITION ON PULLEY)	<ol style="list-style-type: none"> 1. Belt tension either too high or too low. 2. Incorrect belt. 3. Pulley(s) not within design tolerance. 4. Foreign object(s) in grooves. 4. Pulley misalignment. 5. Belt cordline is broken. 	<ol style="list-style-type: none"> 1. Replace automatic belt tensioner. 2. Replace belt. 3. Replace pulley(s). 4. Remove foreign objects from grooves. 4. Check and replace. 5. Replace belt.
BELT BROKEN (NOTE: IDENTIFY AND CORRECT PROBLEM BEFORE NEW BELT IS INSTALLED)	<ol style="list-style-type: none"> 1. Excessive tension. 2. Incorrect belt. 3. Tensile member damaged during belt installation. 4. Severe misalignment. 5. Bracket, pulley, or bearing failure. 	<ol style="list-style-type: none"> 1. Replace belt and automatic belt tensioner. 2. Replace belt. 3. Replace belt. 4. Check and replace. 5. Replace defective component and belt.
NOISE (OBJECTIONAL SQUEAL, SQUEAK, OR RUMBLE IS HEARD OR FELT WHILE DRIVE BELT IS IN OPERATION)	<ol style="list-style-type: none"> 1. Belt slippage. 2. Bearing noise. 3. Belt misalignment. 4. Belt-to-pulley mismatch. 	<ol style="list-style-type: none"> 1. Replace belt or automatic belt tensioner. 2. Locate and repair. 3. Replace belt. 4. Install correct belt.

DIAGNOSIS AND TESTING (Continued)

THERMOSTAT—DIESEL

The cooling system used with the diesel engine provides the extra coolant capacity and extra cooling protection needed for higher GVWR (Gross Vehicle Weight Rating) and GCWR (Gross Combined Weight Rating) vehicles.

This system capacity will not effect warm up or cold weather operating characteristics if the thermostat is operating properly. This is because coolant will be held in the engine until it reaches the thermostat "set" temperature.

Diesel engines, due to their inherent efficiency are slower to warm up than gasoline powered engines, and will operate at lower temperatures when the vehicle is unloaded. Because of this, lower temperature gauge readings for diesel versus gasoline engines may, at times be normal.

Typically, complaints of low engine coolant temperature are observed as low heater output when combined with cool or cold outside temperatures.

To help promote faster engine warm-up, the electric engine block heater must be used with cool or cold outside temperatures. This will help keep the engine coolant warm when the vehicle is parked. Use the block heater if the outside temperature is below 4°C (40°F). **Do not use the block heater if the outside temperature is above 4°C (40°F).**

A "Cold Weather Cover" is available from the parts department through the Mopar Accessories product line. This accessory cover is designed to block airflow entering the radiator and engine compartment to promote faster engine warm-up. It attaches to the front of the vehicle at the grill opening. **The cover is to be used with cool or cold temperatures only. If used with high outside temperatures, serious engine damage could result.** Refer to the literature supplied with the cover for additional information.

TESTING

The following test procedure is to be used for the diesel engine only.

NOTE: The DRB scan tool cannot be used to monitor engine coolant temperature on the diesel engine.

(1) To determine if the thermostat is defective, it must be removed from the vehicle. Refer to Thermostats for removal and installation procedures.

(2) After the thermostat has been removed, examine the thermostat and inside of thermostat housing for contaminants. If contaminants are found, the thermostat may already be in a "stuck open" position. Flush the cooling system before replacing thermostat. Refer to Cooling System Cleaning/Reverse Flushing in this group for additional information.

(3) Place the thermostat into a container filled with water.

(4) Place the container on a hot plate or other suitable heating device.

(5) Place a commercially available radiator thermometer into the water.

(6) Apply heat to the water while observing the thermostat and thermometer.

(7) When the water temperature reaches 83°C (181°F) the thermostat should start to open (valve will start to move). If the valve starts to move before this temperature is reached, it is opening too early. Replace thermostat. The thermostat should be fully open (valve will stop moving) at 95°C (203°F).

(8) If the valve is still moving when the water temperature reaches 203°, it is opening too late. Replace thermostat.

(9) If the valve refuses to move at any time, replace thermostat.

THERMOSTAT—GAS ENGINES

ON-BOARD DIAGNOSTICS

All gasoline powered models are equipped with On-Board Diagnostics for certain cooling system components. Refer to On-Board Diagnostics (OBD) in the Diagnosis section of this group for additional information. If the powertrain control module (PCM) detects low engine coolant temperature, it will record a Diagnostic Trouble Code (DTC) in the PCM memory. The DTC number for low coolant temperature is 17. Do not change a thermostat for lack of heat as indicated by the instrument panel gauge or by poor heater performance unless a DTC number 17 is present. Refer to the Diagnosis section of this group for other probable causes. For other DTC numbers, refer to On-Board Diagnostics in the General Diagnosis section of Group 14, Fuel Systems.

NOTE: Vehicles equipped with a 5.9L diesel engine do not have the DTC number 17 check engine lamp feature.

The DTC can also be accessed through the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures manual for diagnostic information and operation of the DRB scan tool.

WATER PUMP

A quick test to determine if pump is working is to check if heater warms properly. A defective water pump will not be able to circulate heated coolant through the long heater hose to the heater core.

DIAGNOSIS AND TESTING (Continued)**RADIATOR CAP-TO-FILLER NECK SEAL—
PRESSURE RELIEF CHECK**

The pressure cap upper gasket (seal) pressure relief can be tested by removing overflow hose from radiator filler neck nipple. Attach hose of pressure tester tool 7700 (or equivalent) to nipple. It will be necessary to disconnect hose from its adapter for filler neck. Pump air into radiator. The pressure cap upper gasket should relieve at 69-124 kPa (10-18 psi) and hold pressure at a minimum of 55 kPa (8 psi).

WARNING: THE WARNING WORDS —DO NOT OPEN HOT— ON RADIATOR PRESSURE CAP, ARE A SAFETY PRECAUTION. WHEN HOT, PRESSURE BUILDS UP IN COOLING SYSTEM. TO PREVENT SCALDING OR INJURY, RADIATOR CAP SHOULD NOT BE REMOVED WHILE SYSTEM IS HOT AND/OR UNDER PRESSURE.

Do not remove radiator cap at any time **except** for the following purposes:

- Check and adjust antifreeze freeze point
- Refill system with new antifreeze
- Conducting service procedures
- Checking for vacuum leaks

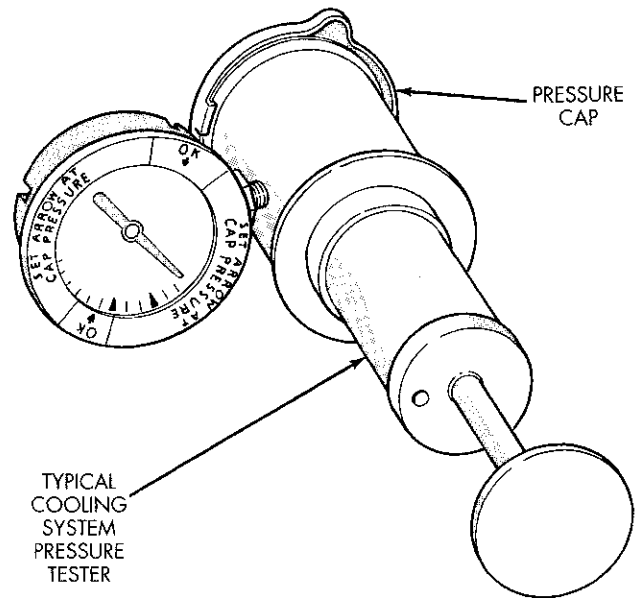
WARNING: IF VEHICLE HAS BEEN RUN RECENTLY, WAIT AT LEAST 15 MINUTES BEFORE REMOVING RADIATOR CAP. WITH A RAG, SQUEEZE RADIATOR UPPER HOSE TO CHECK IF SYSTEM IS UNDER PRESSURE. PLACE A RAG OVER CAP AND WITHOUT PUSHING CAP DOWN, ROTATE IT COUNTER-CLOCKWISE TO FIRST STOP. ALLOW FLUID TO ESCAPE THROUGH THE COOLANT RESERVE/OVERFLOW HOSE INTO RESERVE/OVERFLOW TANK. SQUEEZE RADIATOR UPPER HOSE TO DETERMINE WHEN PRESSURE HAS BEEN RELEASED. WHEN COOLANT AND STEAM STOP BEING PUSHED INTO TANK AND SYSTEM PRESSURE DROPS, REMOVE RADIATOR CAP COMPLETELY.

PRESSURE TESTING RADIATOR CAPS

Remove cap from radiator. Be sure that sealing surfaces are clean. Moisten rubber gasket with water and install cap on pressure tester 7700 or an equivalent (Fig. 35).

Operate tester pump to bring pressure to 104 kPa (15 psi) on gauge. If pressure cap fails to hold pressure of at least 97 kPa (14 psi) replace cap. Refer to **CAUTION** below.

The pressure cap may test properly while positioned on tool 7700 (or equivalent). It may not hold pressure or vacuum when installed on radiator. If so, inspect radiator filler neck and cap's top gasket for



J9507-3

Fig. 35 Pressure Testing Radiator Cap—Typical Tester

damage. Also inspect for dirt or distortion that may prevent cap from sealing properly.

CAUTION: Radiator pressure testing tools are very sensitive to small air leaks, which will not cause cooling system problems. A pressure cap that does not have a history of coolant loss should not be replaced just because it leaks slowly when tested with this tool. Add water to tool. Turn tool upside down and recheck pressure cap to confirm that cap needs replacement.

LOW COOLANT LEVEL—AERATION

If the coolant level in the radiator drops below the top of the radiator core tubes, air will enter the system.

Low coolant level can cause the thermostat pellet to be suspended in air instead of coolant. This will cause the thermostat to open later, which in turn causes higher coolant temperature. Air trapped in cooling system also reduces the amount of coolant circulating in the heater core. This may result in low heat output.

DEAERATION

As the engine operates, air trapped in the cooling system gathers under the radiator cap. The next time engine is operated, thermal expansion of coolant will push trapped air past radiator cap into coolant reserve/overflow tank. Here it escapes to atmosphere in the tank. When engine cools down the coolant, it

DIAGNOSIS AND TESTING (Continued)

will be drawn from reserve/overflow tank into radiator to replace removed air.

SERVICE PROCEDURES

COOLANT LEVEL CHECK—ROUTINE

NOTE: Do not remove radiator cap for routine coolant level inspections. The coolant level can be checked at the coolant reserve/overflow tank.

The coolant reserve/overflow system provides a quick visual method for determining the coolant level without removing the radiator pressure cap. With engine idling and at normal operating temperature, observe coolant level in coolant reserve/overflow tank. The coolant level should be between the ADD and FULL marks.

COOLANT SERVICE—V-6, V-8, AND V-10 ENGINES

It is recommended that the cooling system be drained and flushed at 84,000 kilometers (52,500 miles) or 3 years, whichever occurs first. Then every two years or 48,000 kilometers (30,000 miles), whichever occurs first.

COOLANT SERVICE—DIESEL ENGINE

It is recommended that the cooling system be drained and flushed every 24 months or 38,600 kilometers (24,000 miles), whichever occurs first.

ADDING ADDITIONAL COOLANT—ROUTINE

Do not remove the radiator cap to add coolant to the system. When adding coolant to maintain the correct level, do so at the coolant reserve/overflow tank with a 50/50 mixture of ethylene glycol antifreeze (containing Alugard 340-2 TM) and water. Remove the radiator cap only for testing or when refilling the system after service. Removing cap unnecessarily can cause loss of coolant and allow air to enter system. This produces corrosion.

COOLANT LEVEL CHECK—SERVICE

The cooling system is closed and designed to maintain coolant level to the top of the radiator.

WARNING: DO NOT OPEN RADIATOR DRAINCOCK WITH ENGINE RUNNING OR WHILE ENGINE IS HOT AND COOLING SYSTEM IS UNDER PRESSURE.

When vehicle servicing requires a coolant level check in the radiator, drain several ounces of coolant from the radiator drain cock. Do this while observing the coolant reserve/overflow system tank. The coolant level in the reserve/overflow tank should drop slightly. If not, inspect for a leak between radiator

and coolant reserve/overflow system connection. Remove radiator cap. The coolant level should be to the top of the radiator. If not and if coolant level in reserve/overflow tank is at the ADD mark, check for:

- An air leak in the coolant reserve/overflow tank
- An air leak in the radiator filler neck
- Leak in the pressure cap seal to the radiator filler neck

DRAINING COOLING SYSTEM

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAIN PLUG WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(1) Start the engine and place the heater control temperature selector in the Full-On position. Engine vacuum is needed to actuate the heater controls.

(2) Turn the ignition off.

(3) Do not remove radiator cap when draining coolant from reserve/overflow tank. Open radiator drain plug and when tank is empty, remove radiator cap. If the coolant reserve/overflow tank does not drain, refer to the Testing Cooling System for Leaks section in this group. The coolant need not be removed from tank unless the system is being refilled with fresh mixture.

(4) On vehicles equipped with gas powered engines, remove the cylinder block drain plugs. These are located on the sides of the block just above the oil pan (Fig. 36).

(5) Remove radiator pressure cap.

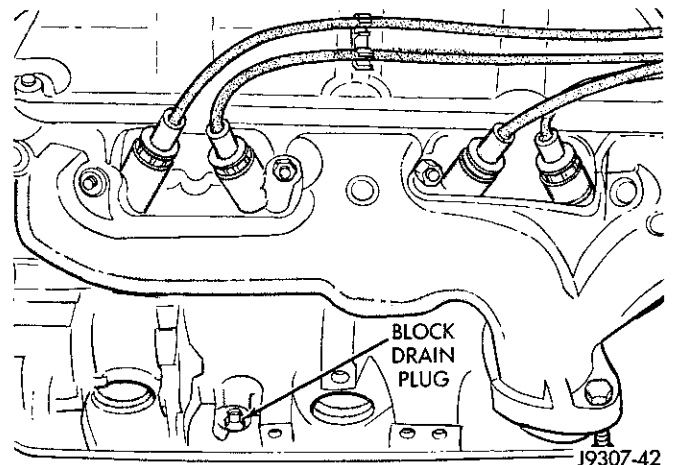


Fig. 36 Drain Plugs—Gas Powered Engines—Typical

SERVICE PROCEDURES (Continued)**REFILLING COOLING SYSTEM**

Clean cooling system prior to refilling. Refer to Cooling System Cleaning section of this group.

- (1) Install the cylinder block drain plugs (Fig. 36).
- (2) Close radiator drain plug.
- (3) Fill the cooling system with a 50/50 mixture of water and antifreeze. **5.9L Diesel Engine Only:** The diesel engine is equipped with a one-way check valve (jiggle pin). The check valve is used as a servicing feature and will vent air when the system is being filled. Water pressure (or flow) will hold the valve closed. **Due to the use of this valve, the engine must not be operating when refilling the cooling system.** Refer to Thermostat Operation—5.9L Diesel Engine in the Thermostat section of this group for more information.

- (4) Fill coolant reserve/overflow tank to the FULL mark.

- (5) Start and operate engine until thermostat opens. Upper radiator hose should be warm to touch.

- (6) If necessary, add 50/50 water and antifreeze mixture to the coolant reserve/overflow tank to maintain coolant level. This level should be between the ADD and FULL marks. The level in the reserve/overflow tank may drop below the ADD mark after three or four warm-up and cool-down cycles.

COOLING SYSTEM CLEANING/REVERSE FLUSHING**CLEANING**

Drain cooling system and refill with water. Run engine with radiator cap installed until upper radiator hose is hot. Stop engine and drain water from system. If water is dirty, fill system with water, run engine and drain system. Repeat until water drains clean.

REVERSE FLUSHING

Reverse flushing of cooling system is the forcing of water through the cooling system. This is done using air pressure in the opposite direction of normal coolant flow. It is usually only necessary with very dirty systems with evidence of partial plugging.

REVERSE FLUSHING RADIATOR

Disconnect radiator hoses from radiator inlet and outlet. Attach a section of radiator hose to radiator bottom outlet fitting and insert flushing gun. Connect a water supply hose and air supply hose to flushing gun.

CAUTION: Internal radiator pressure must not exceed 138 kPa (20 psi) as damage to radiator may result.

Allow radiator to fill with water. When radiator is filled, apply air in short blasts. Allow radiator to

refill between blasts. Continue this reverse flushing until clean water flows out through rear of radiator cooling tube passages. Have radiator cleaned more extensively by a radiator repair shop.

REVERSE FLUSHING ENGINE—V-6, V-8, AND V-10

Drain cooling system. Remove thermostat housing and thermostat. Install thermostat housing. Disconnect radiator upper hose from radiator and attach flushing gun to hose. Disconnect radiator lower hose from water pump and attach a lead-away hose to water pump inlet fitting.

Connect water supply hose and air supply hose to flushing gun. Allow engine to fill with water. When engine is filled, apply air in short blasts, allowing system to fill between air blasts. Continue until clean water flows through the lead away hose.

Remove lead away hose, flushing gun, water supply hose and air supply hose. Remove thermostat housing and install thermostat. Install thermostat housing with a replacement gasket. Refer to Thermostat Replacement. Connect radiator hoses. Refill cooling system with correct antifreeze/water mixture. Refer to Refilling the Cooling System.

REVERSE FLUSHING ENGINE—DIESEL

- (1) Drain the cooling system.
- (2) Disconnect the upper hose from the radiator.
- (3) Disconnect the radiator lower hose from the water pump.
- (4) Remove the heater core inlet hose from tube (Fig. 37).

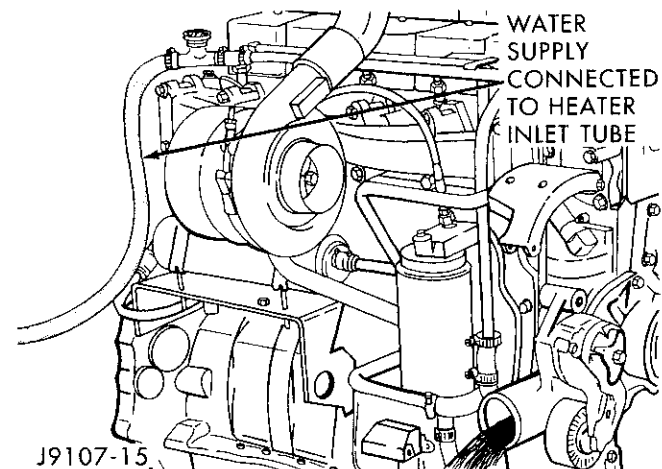


Fig. 37 Typical Reverse-flushing—5.9L Diesel

- (5) Attach water supply hose to heater tube.
- (6) Back-flush the engine until clean water exits the water pump inlet.

SERVICE PROCEDURES (Continued)

CHEMICAL CLEANING

In some instances, use a radiator cleaner (Mopar Radiator Klean or equivalent) before flushing. This will soften scale and other deposits and aid flushing operation.

CAUTION: Follow manufacturers instructions when using these products.

REMOVAL AND INSTALLATION

COOLANT RESERVE/OVERFLOW TANK

TANK REMOVAL—ALL EXCEPT 8.0L V-10 ENGINE

- (1) Remove overflow hose from radiator.
- (2) Unsnap the coolant reserve/overflow tank from fan shroud. Lift straight up. The fan shroud is equipped with T-shaped slots (Fig. 38) to attach the tank. An alignment pin is located on the side of tank.

INSTALLATION

- (1) Snap the tank into the two T-slots and the alignment pin on fan shroud.
- (2) Connect overflow hose to radiator.

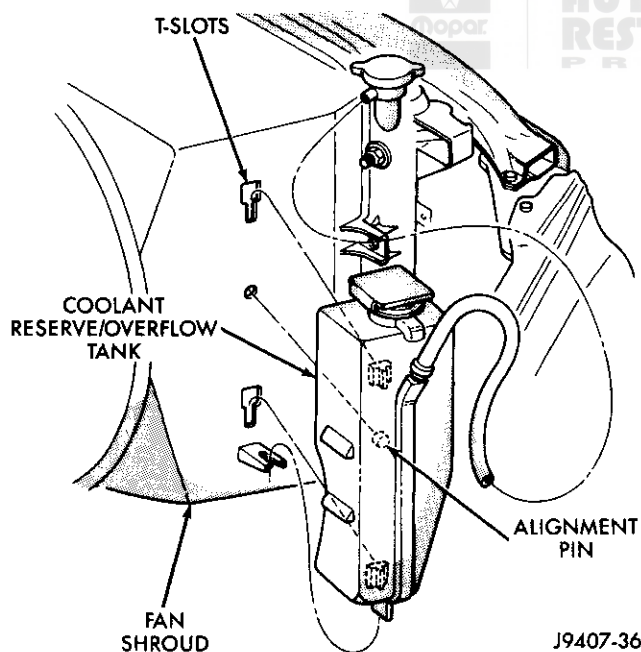


Fig. 38 COOLANT RESERVE/OVERFLOW TANK—ALL EXCEPT 8.0L V-10 ENGINE

TANK REMOVAL—8.0L V-10 ENGINE

- (1) Remove overflow hose from radiator.
- (2) Remove three tank mounting bolts (Fig. 39) and remove tank.

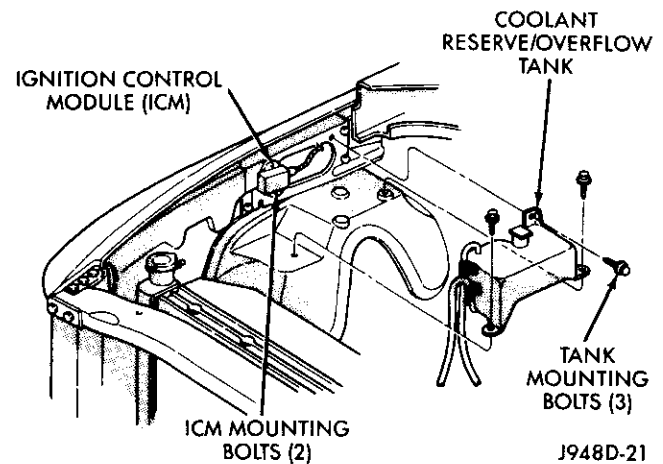


Fig. 39 COOLANT RESERVE/OVERFLOW TANK—V-10 ENGINE

INSTALLATION

- (1) Position tank to inner fender.
- (2) Install bolts and tighten to 6 N·m (50 in. lbs.) torque.
- (3) Connect overflow hose to radiator.

WATER PUMP—V-6 AND V-8 ENGINES

REMOVAL

The water pump on all models can be removed without discharging the air conditioning system (if equipped).

The water pump on all gas powered engines is bolted directly to the engine timing chain case/cover.

On all 3.9L/5.2L/5.9L gas powered engines, a gasket is used as a seal between the water pump and timing chain case/cover.

If water pump is replaced because of bearing/shaft damage or leaking shaft seal, the mechanical cooling fan assembly should also be inspected. Inspect for fatigue cracks, loose blades or loose rivets that could have resulted from excessive vibration. Replace fan if any of these conditions are found. Also check condition of the thermal viscous fan drive. Refer to Viscous Fan Drive in this group.

- (1) Disconnect negative battery cable from battery.
- (2) Drain cooling system. Refer to Draining Cooling System in this group.

Do not waste reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

- (3) Remove windshield washer reservoir tank from radiator fan shroud. Refer to Group 8K, Windshield Wiper and Washer Systems.

- (4) Disconnect the coolant reserve/overflow tank-to-radiator hose at the tank.

- (5) Remove the four fan shroud mounting bolts at the radiator (Fig. 40). Do not attempt to remove shroud from vehicle at this time.

REMOVAL AND INSTALLATION (Continued)

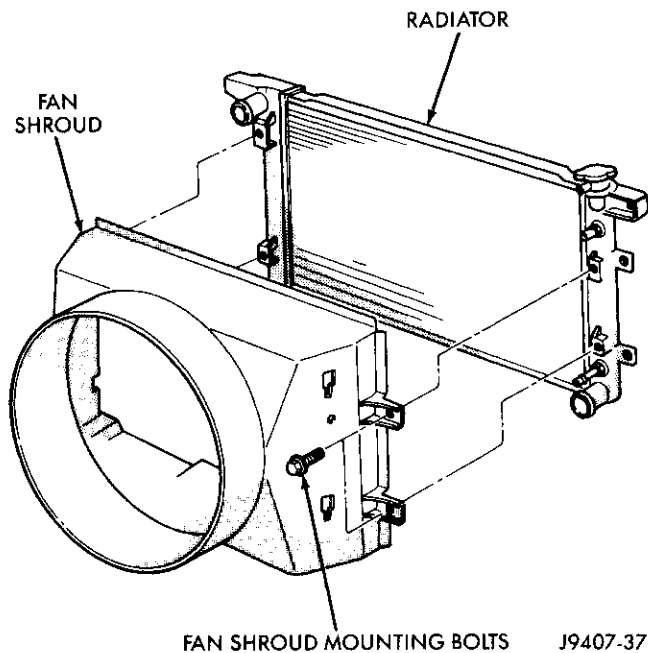


Fig. 40 Typical Fan Shroud Mounting

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(6) Remove upper radiator hose at radiator.

(7) The thermal viscous fan drive is attached (threaded) to the water pump hub shaft (Fig. 41). Remove the fan/fan drive assembly from water pump by turning the mounting nut counterclockwise (as viewed from front). Threads on the fan drive are **RIGHT-HAND**. A Snap-On 36 MM Fan Wrench (number SP346 from Snap-On Cummins Diesel Tool Set number 2017DSP) can be used. Place a bar or screwdriver between the water pump pulley bolts (Fig. 41) to prevent the pulley from rotating.

(8) If water pump is being replaced, do not unbolt fan blade assembly (Fig. 41) from the thermal control fan drive.

(9) Remove fan blade/fan drive and fan shroud as an assembly from vehicle.

(10) After removing fan blade/fan drive assembly, **do not** place the thermal viscous fan drive in the horizontal position. If stored horizontally, the silicone

fluid in the viscous drive could drain into its bearing assembly and contaminate the bearing lubricant.

(11) **Do not** remove the water pump pulley bolts at this time.

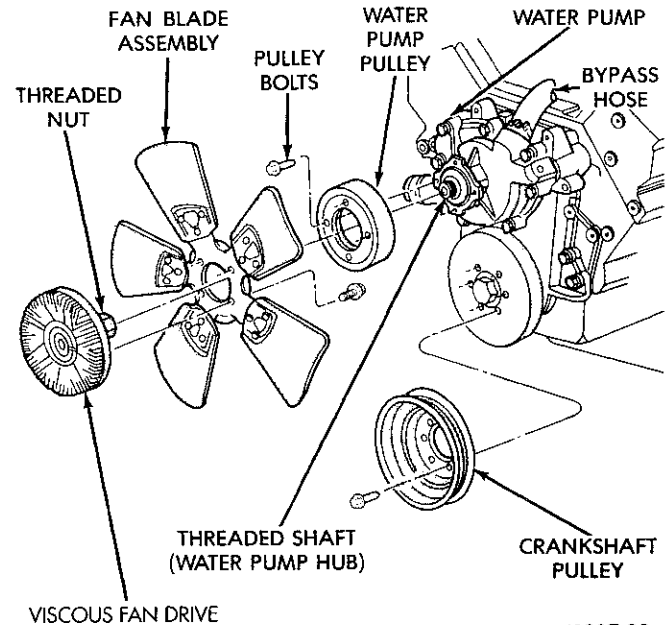


Fig. 41 Fan Blade and Viscous Fan Drive—Typical

(12) Remove accessory drive belt as follows: The drive belt is equipped with a spring loaded automatic tensioner (Fig. 42) (Fig. 43).

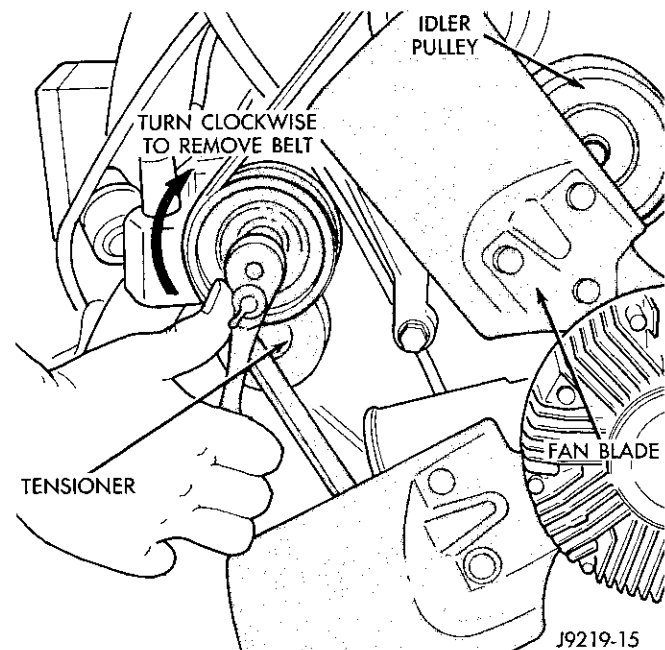


Fig. 42 Belt Tensioner—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

(13) 3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines: Relax the tension from the belt by rotating the ten-

REMOVAL AND INSTALLATION (Continued)

sioner clockwise (as viewed from front) (Fig. 42). When all belt tension has been relaxed, remove accessory drive belt.

(14) 5.9L HDC-Gas Engine: Relax the tension from the belt by rotating the tensioner counterclockwise (as viewed from front) (Fig. 43). When all belt tension has been relaxed, remove accessory drive belt.

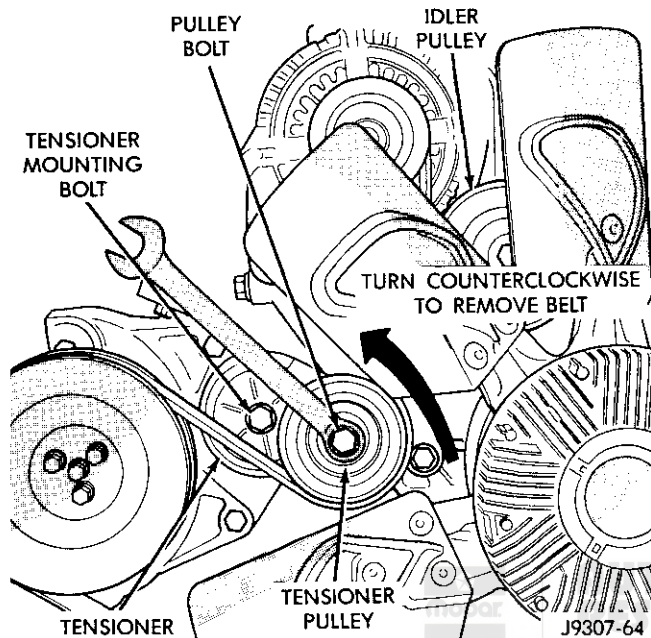


Fig. 43 Belt Tensioner—5.9L HDC-Gas Engine

(15) Remove the four water pump pulley-to-water pump hub bolts (Fig. 41) and remove pulley from vehicle.

(16) Remove the lower radiator hose and heater hose from water pump.

(17) Loosen heater hose coolant return tube mounting bolt (Fig. 44) (Fig. 45) and remove tube from water pump. Discard the old tube O-ring.

(18) Remove the seven water pump mounting bolts (Fig. 46).

(19) Loosen the clamp at the water pump end of bypass hose (Fig. 41). Slip the bypass hose from the water pump while removing pump from vehicle. Do not remove the clamp from the bypass hose.

(20) Discard old gasket.

CAUTION: Do not pry the water pump at timing chain case/cover. The machined surfaces may be damaged resulting in leaks.

INSTALLATION

(1) Clean gasket mating surfaces.

(2) Using a new gasket, install water pump to engine as follows: Guide water pump nipple into bypass hose as pump is being installed. Install water

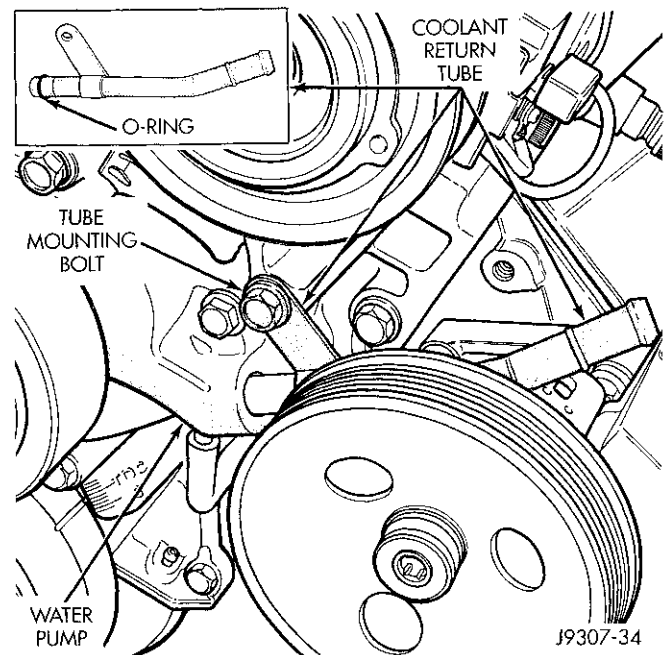


Fig. 44 Coolant Return Tube—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

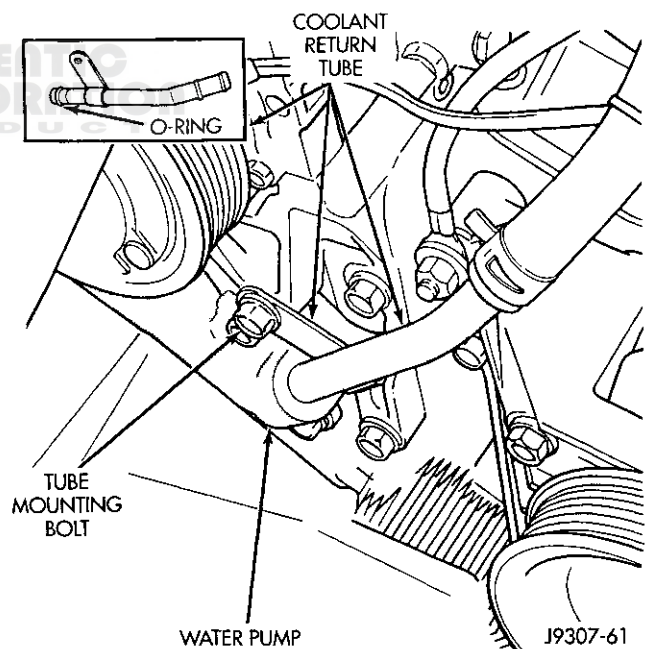


Fig. 45 Coolant Return Tube—5.9L HDC-Gas Engine

pump bolts (Fig. 46). Tighten water pump mounting bolts to 40 N·m (30 ft. lbs.) torque.

(3) Position bypass hose clamp to bypass hose.

(4) Spin water pump to be sure that pump impeller does not rub against timing chain case/cover.

(5) Install a new o-ring to the heater hose coolant return tube (Fig. 44) (Fig. 45). Coat the new o-ring with antifreeze before installation.

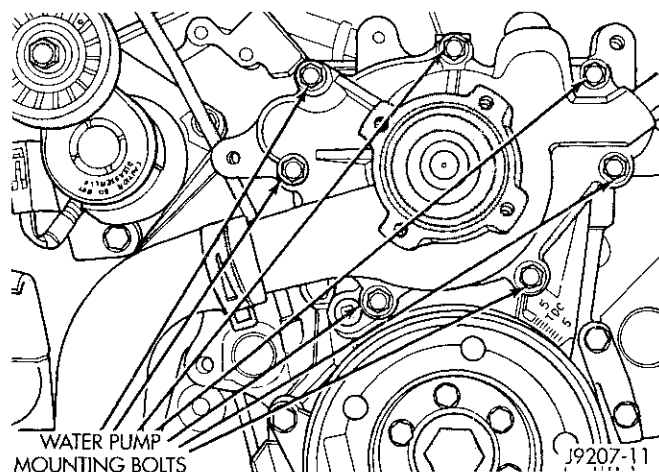
REMOVAL AND INSTALLATION (Continued)

Fig. 46 Water Pump Bolts—3.9L V-6 or 5.2/5.9L V-8 Gas Engines—Typical

(6) Install coolant return tube and its mounting bolt to engine (Fig. 44) (Fig. 45). Be sure the slot in tube bracket is bottomed to mounting bolt. This will properly position return tube.

(7) Connect radiator lower hose to water pump.

(8) Connect heater hose and hose clamp to coolant return tube.

(9) Install water pump pulley. Tighten bolts to 27 N·m (20 ft. lbs.) torque. Place a bar or screwdriver between water pump pulley bolts (Fig. 41) to prevent pulley from rotating.

(10) Relax tension from automatic belt tensioner (Fig. 42) (Fig. 43). Install drive belt.

CAUTION: When installing the serpentine accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in wrong direction. Refer to (Fig. 47) (Fig. 48) (Fig. 49) for correct belt routing. The correct belt with correct length must be used.

(11) Position fan shroud and fan blade/viscous fan drive assembly to vehicle as a complete unit.

(12) Install fan shroud.

(13) Install fan blade/viscous fan drive assembly to water pump shaft.

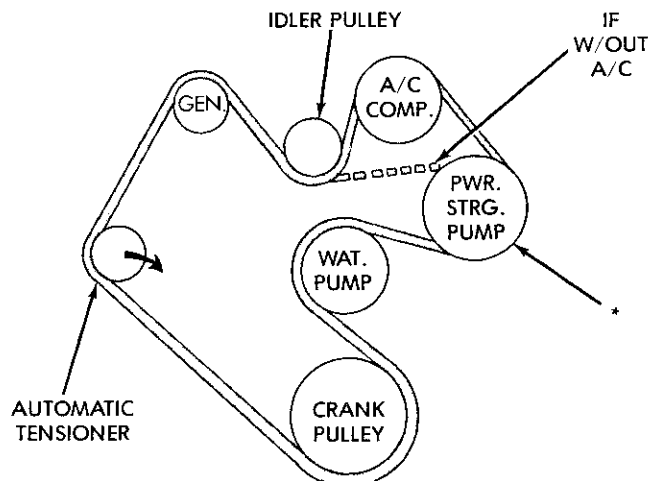
(14) Fill cooling system. Refer to Refilling Cooling System in this group.

(15) Connect negative battery cable.

(16) Start and warm the engine. Check for leaks.

WATER PUMP—8.0L V-10 ENGINE**REMOVAL**

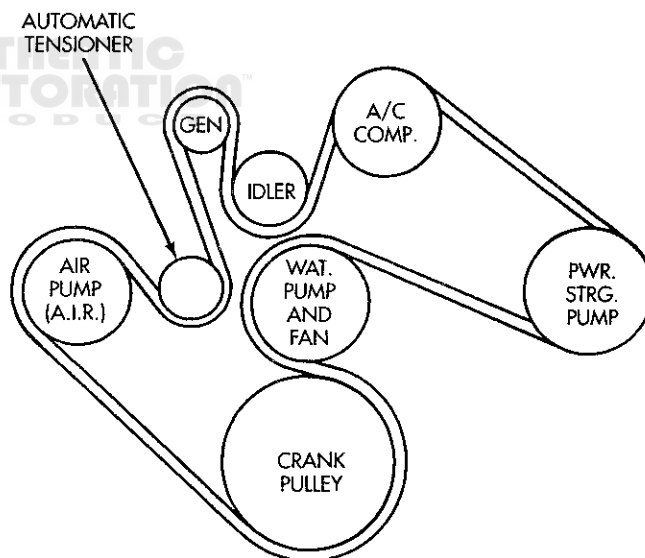
The water pump on all models can be removed without discharging the air conditioning system (if equipped).



*IF VEHICLE IS NOT EQUIPPED WITH POWER STEERING, THIS WILL BE AN IDLER PULLEY.

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Fig. 47 Belt Routing—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines



J9307-55

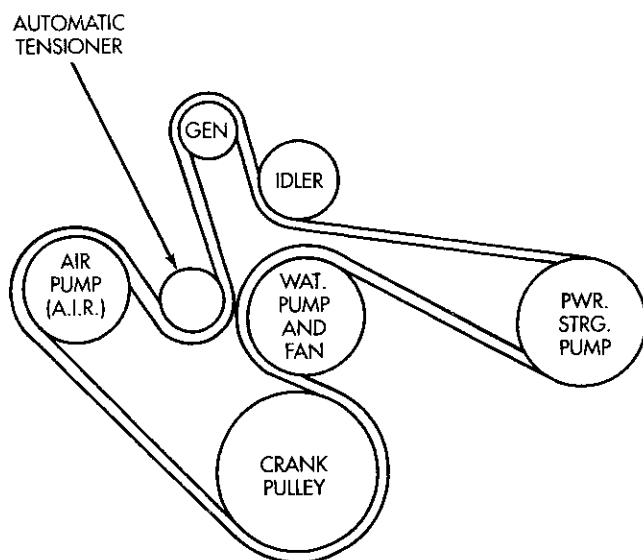
Fig. 48 Belt Routing—5.9L HDC-Gas Engine—With A/C

The water pump on all gas powered engines is bolted directly to the engine timing chain case/cover.

On the 8.0L V-10 engine, a rubber o-ring (instead of a gasket) is used as a seal between the water pump and timing chain case/cover.

If water pump is replaced because of bearing/shaft damage or leaking shaft seal, the mechanical cooling fan assembly should also be inspected. Inspect for

REMOVAL AND INSTALLATION (Continued)



J9307-56

**Fig. 49 Belt Routing—5.9L HDC-Gas Engine—
Without A/C**

fatigue cracks, loose blades or loose rivets that could have resulted from excessive vibration. Replace fan if any of these conditions are found. Also check condition of the thermal viscous fan drive. Refer to Viscous Fan Drive in this group.

- (1) Disconnect negative battery cable from battery.
- (2) Drain cooling system. Refer to Draining Cooling System in this group.

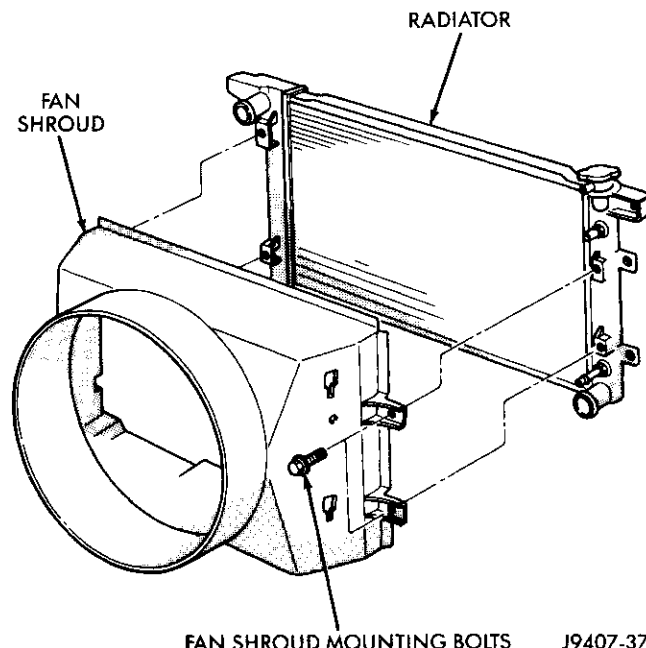
Do not waste reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

- (3) Remove windshield washer reservoir tank from radiator fan shroud. Refer to Group 8K, Windshield Wiper and Washer Systems.

- (4) Remove the four fan shroud mounting bolts at the radiator (Fig. 50). Do not attempt to remove shroud from vehicle at this time.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.



J9407-37

Fig. 50 Typical Fan Shroud Mounting

- (5) Remove upper radiator hose at radiator.

- (6) The thermal viscous fan drive is attached (threaded) to the water pump hub shaft (Fig. 51). Remove the fan/fan drive assembly from water pump by turning the mounting nut counterclockwise (as viewed from front). Threads on the fan drive are **RIGHT-HAND**. A Snap-On 36 MM Fan Wrench (number SP346 from Snap-On Cummins Diesel Tool Set number 2017DSP) can be used. Place a bar or screwdriver between the water pump pulley bolts (Fig. 51) to prevent the pulley from rotating.

- (7) If water pump is being replaced, do not unbolt fan blade assembly (Fig. 51) from the thermal control fan drive.

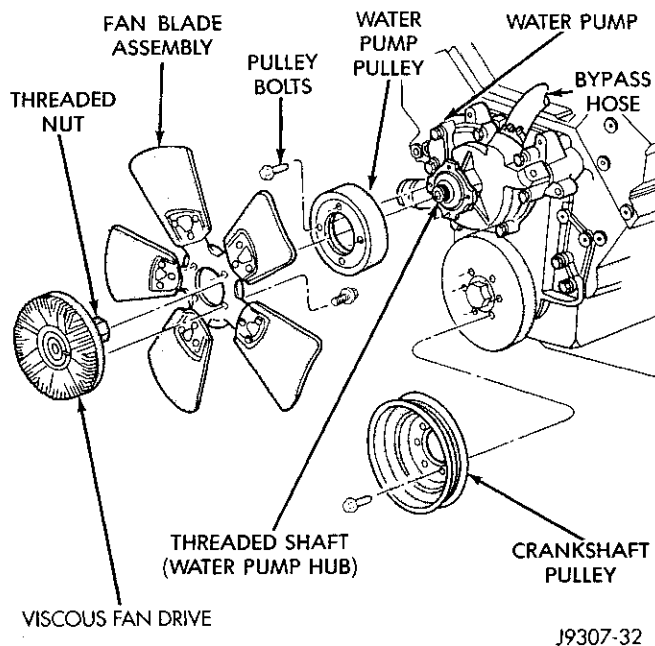
- (8) Remove fan blade/fan drive and fan shroud as an assembly from vehicle.

After removing fan blade/fan drive assembly, **do not** place the thermal viscous fan drive in the horizontal position. If stored horizontally, the silicone fluid in the viscous drive could drain into its bearing assembly and contaminate the bearing lubricant.

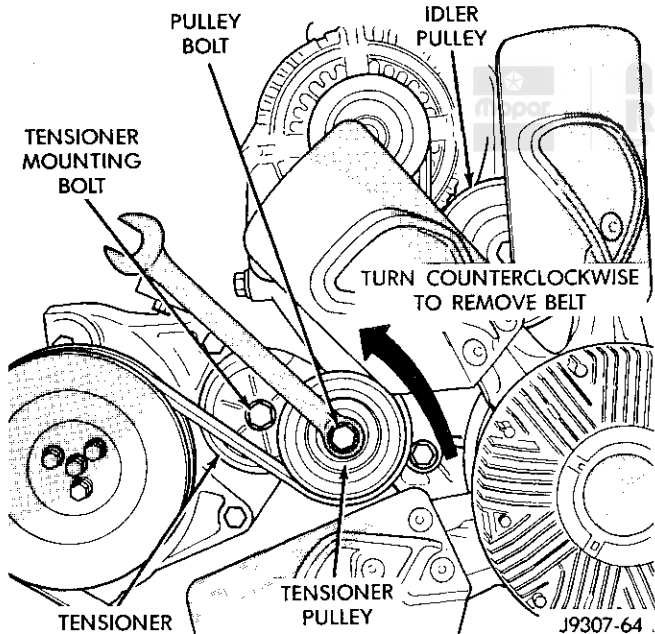
Do not remove the water pump pulley bolts at this time.

- (9) Remove accessory drive belt as follows: The drive belt is equipped with a spring loaded automatic tensioner (Fig. 52).

Relax the tension from the belt by rotating the tensioner counterclockwise (as viewed from front) (Fig. 17). The threads on the pulley bolt are left-hand. When all belt tension has been relaxed, remove accessory drive belt.

REMOVAL AND INSTALLATION (Continued)

J9307-32

Fig. 51 Fan Blade and Viscous Fan Drive—Typical

J9307-64

Fig. 52 Belt Tensioner—8.0L V-10 Engine

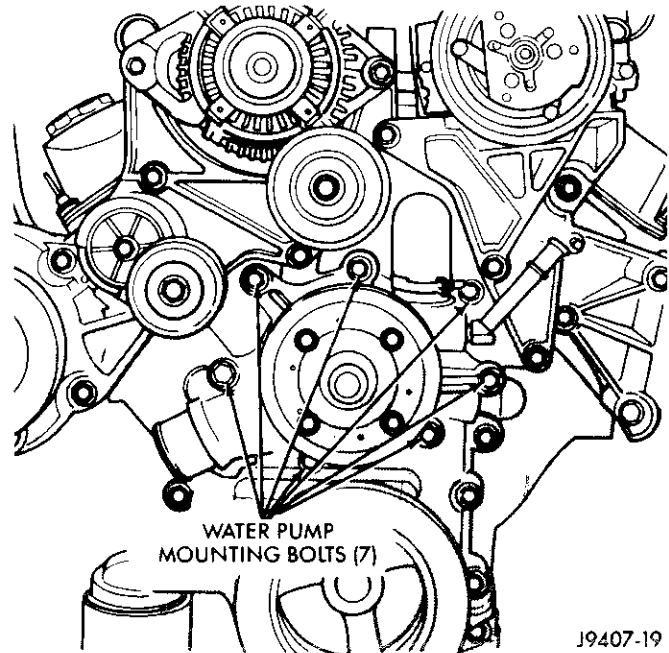
(10) Remove the four water pump pulley-to-water pump hub bolts (Fig. 51) and remove pulley from vehicle.

(11) Remove the lower radiator hose at water pump.

(12) Remove heater hose at water pump fitting.

(13) Remove the seven water pump mounting bolts (Fig. 53).

(14) Loosen the clamp at the water pump end of bypass hose. Slip the bypass hose from the water

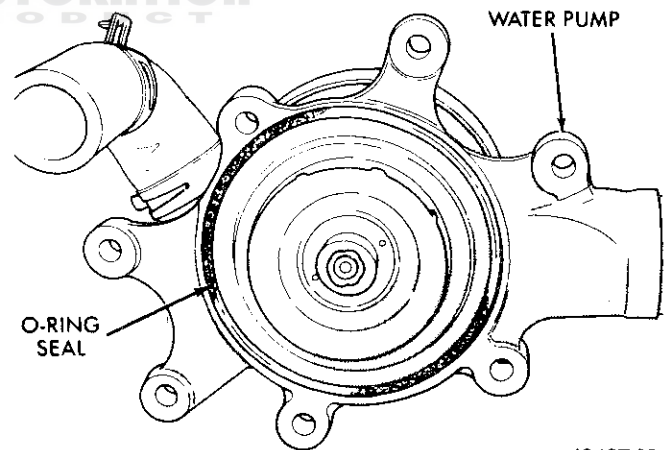


J9407-19

Fig. 53 Water Pump Bolts—8.0L V-10—Typical

pump while removing pump from vehicle. Do not remove the clamp from the bypass hose.

(15) Discard the water pump-to-timing chain/case cover o-ring seal (Fig. 54).



J9407-18

Fig. 54 Water Pump O-Ring Seal—8.0L V-10

(16) Remove the heater hose fitting from water pump if pump replacement is necessary. Note position (direction) of fitting before removal. Fitting must be re-installed to same position.

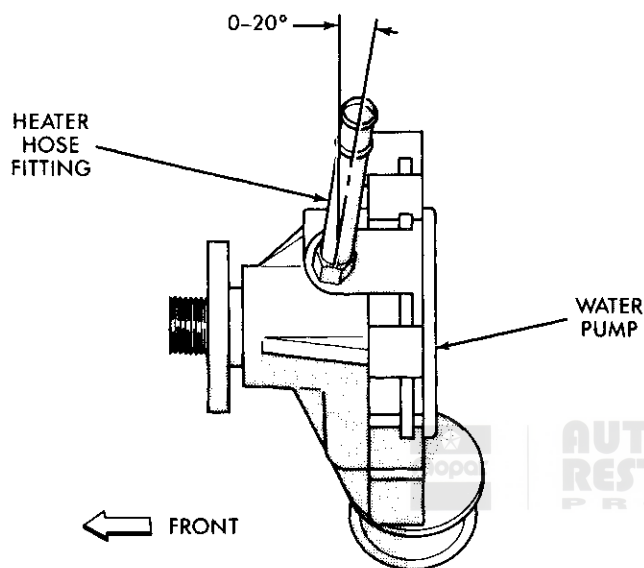
CAUTION: Do not pry the water pump at timing chain case/cover. The machined surfaces may be damaged resulting in leaks.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) If water pump is being replaced, install the heater hose fitting to the pump. Tighten fitting to 16 N·m (144 in. lbs.) torque. After fitting has been torqued, position fitting as shown in (Fig. 55). When positioning fitting, do not back off (rotate counter-clockwise). Use a sealant on the fitting such as Mopar® Thread Sealant With Teflon. Refer to the directions on the package.

CAUTION: This heater hose fitting must be installed to pump before pump is installed to engine.



J9407-17

Fig. 55 Heater Hose Fitting Position—8.0L V-10

(2) Clean the o-ring mating surfaces at rear of water pump and front of timing chain/case cover.

(3) Apply a small amount of petroleum jelly to o-ring (Fig. 54). This will help retain o-ring to water pump.

(4) Install water pump to engine as follows: Guide water pump fitting into bypass hose as pump is being installed. Install water pump bolts (Fig. 53). Tighten water pump mounting bolts to 40 N·m (30 ft. lbs.) torque.

(5) Position bypass hose clamp to bypass hose.

(6) Spin water pump to be sure that pump impeller does not rub against timing chain case/cover.

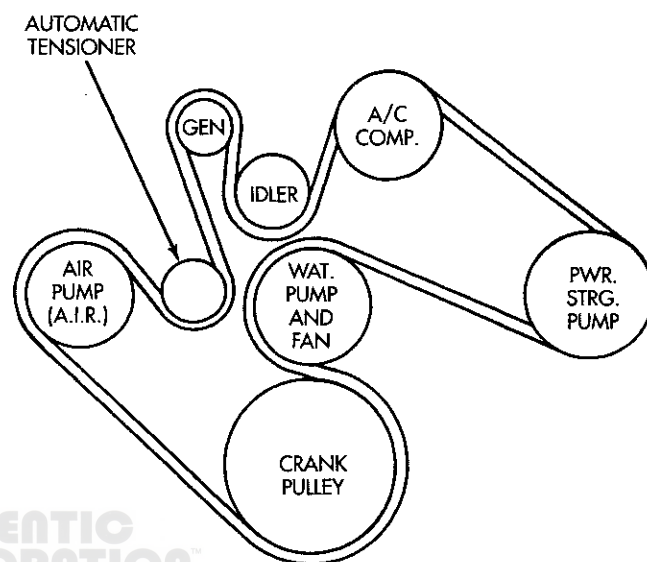
(7) Connect radiator lower hose to water pump.

(8) Connect heater hose and hose clamp to heater hose fitting.

(9) Install water pump pulley. Tighten bolts to 22 N·m (16 ft. lbs.) torque. Place a bar or screwdriver between water pump pulley bolts (Fig. 51) to prevent pulley from rotating.

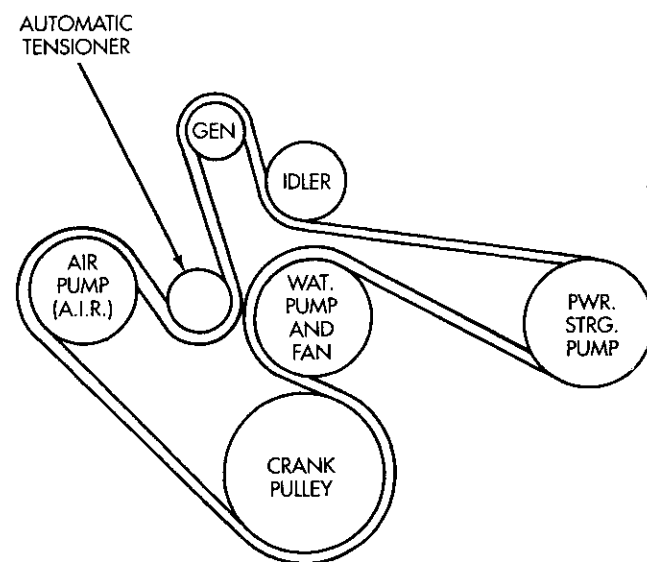
(10) Relax tension from automatic belt tensioner (Fig. 52). Install drive belt.

CAUTION: When installing the serpentine accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in wrong direction. Refer to (Fig. 56) (Fig. 57) for correct belt routing. The correct belt with correct length must be used.



J9307-55

Fig. 56 Belt Routing—8.0L V-10 Engine—With A/C



J9307-56

Fig. 57 Belt Routing—8.0L V-10 Engine—Without A/C

REMOVAL AND INSTALLATION (Continued)

- (11) Position fan shroud and fan blade/viscous fan drive assembly to vehicle as a complete unit.
- (12) Install fan shroud to radiator. Tighten bolts to 6 N·m (50 in. lbs.) torque.
- (13) Install fan blade/viscous fan drive assembly to water pump shaft.
- (14) Fill cooling system. Refer to Refilling Cooling System in this group.
- (15) Connect negative battery cable.
- (16) Start and warm the engine. Check for leaks.

WATER PUMP—5.9L DIESEL

REMOVAL

- (1) Disconnect the negative battery cables from both batteries.
- (2) Drain cooling system. Refer to Draining Cooling System in this section.
- (3) Remove the bolt retaining the wiring harness near the top of water pump. Position wire harness to the side.
- (4) Remove the accessory drive belt. Refer to the Engine Accessory Drive Belt section of this group.
- (5) Remove water pump mounting bolts (Fig. 58).

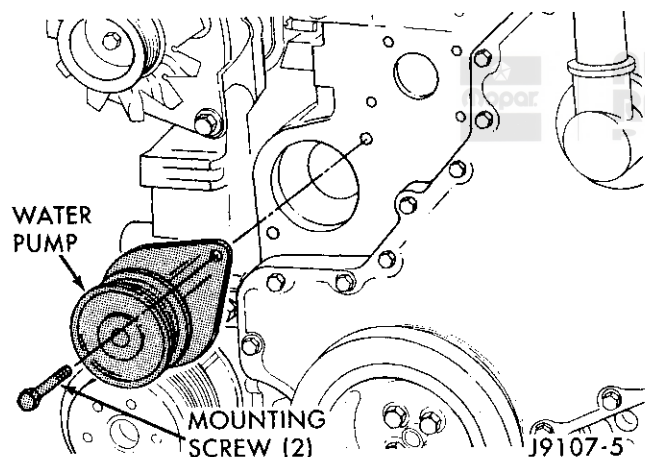


Fig. 58 Pump Removal/Installation—5.9L Diesel

- (6) Clean water pump sealing surface on cylinder block.

INSTALLATION

- (1) Install new O-ring seal in groove on water pump (Fig. 59).
- (2) Install water pump. Tighten mounting bolts to 24 N·m (18 ft. lbs.) torque.
- (3) Install accessory drive belt. Refer to the Engine Accessory Drive Belt section of this group.
- (4) Install the bolt retaining the wiring harness near top of water pump.
- (5) Fill cooling system. Refer to Refilling Cooling System in this section.
- (6) Connect both battery cables.

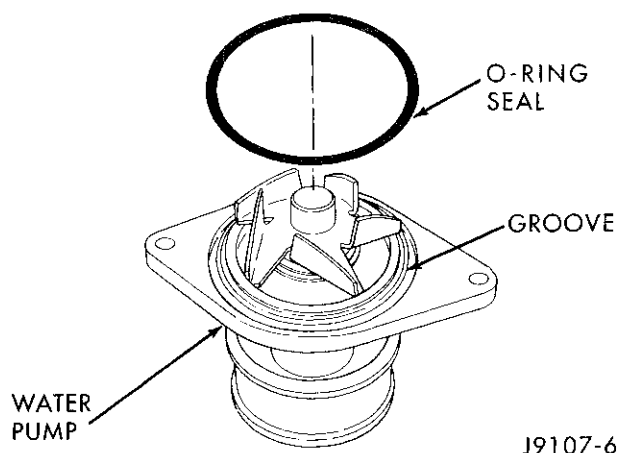


Fig. 59 Pump O-ring Seal—5.9L Diesel

- (7) Start and warm the engine. Check for leaks.

WATER PUMP BYPASS HOSE

REMOVAL—3.9L V-6 OR 5.2/5.9L V-8 ENGINES WITHOUT AIR CONDITIONING

A water pump bypass hose (Fig. 60) is used between the intake manifold and water pump on all gas powered engines. To test for leaks, refer to Testing Cooling System for Leaks in this group.

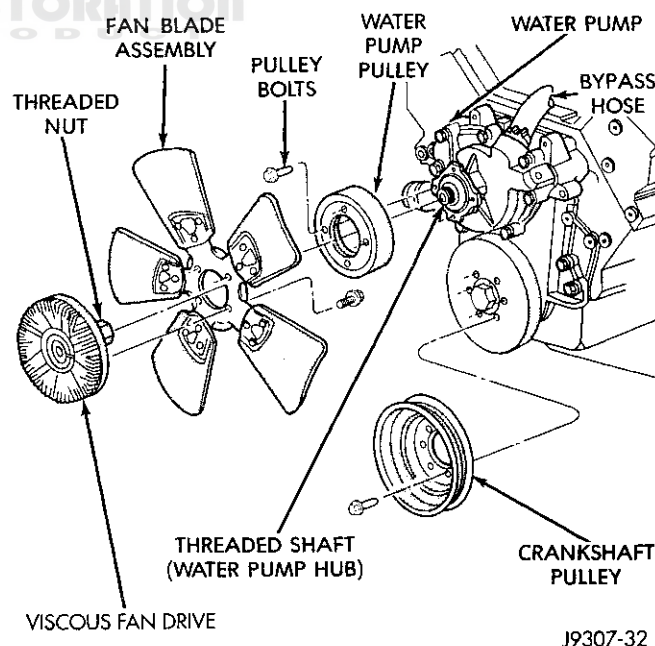


Fig. 60 Water Pump Bypass Hose—Typical

- (1) Partially drain cooling system. Refer to Draining Cooling System in this group.
- (2) Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

REMOVAL AND INSTALLATION (Continued)

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(3) Loosen both bypass hose clamps and position to the center of hose.

(4) Remove hose from vehicle.

INSTALLATION

(1) Position bypass hose clamps to the center of hose.

(2) Install bypass hose to engine.

(3) Secure both hose clamps.

(4) Fill cooling system. Refer to Refilling Cooling System in this group.

(5) Start and warm the engine. Check for leaks.

REMOVAL—3.9L V-6 OR 5.2/5.9L V-8 ENGINE—WITH AIR CONDITIONING

If equipped with A/C, the generator and A/C compressor along with their common mounting bracket (Fig. 61) must be partially removed. Removing the generator or A/C compressor from their mounting bracket is not necessary. Also, discharging the A/C system is not necessary. **Do not** remove any refrigerant lines from A/C compressor.

WARNING: THE A/C SYSTEM IS UNDER PRESSURE EVEN WITH THE ENGINE OFF. REFER TO REFRIGERANT WARNINGS IN GROUP 24, HEATING AND AIR CONDITIONING.

(1) Disconnect negative battery cable from battery.

(2) Partially drain cooling system. Refer to Draining Cooling System in this group.

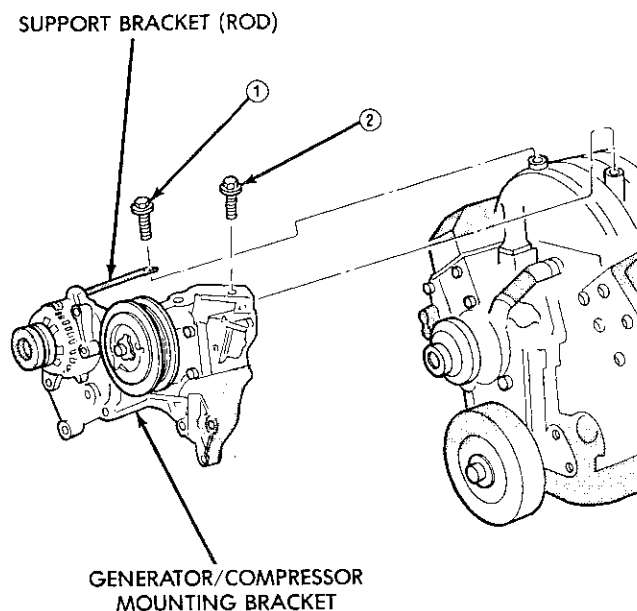
(3) Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(4) Remove upper radiator hose clamp at radiator. A special clamp tool (Fig. 23) must be used to remove the constant tension clamps. Remove hose at radiator.

(5) Disconnect throttle cable from clip at radiator fan shroud.

(6) Unplug wiring harness from A/C compressor.

(7) Remove the air cleaner assembly.

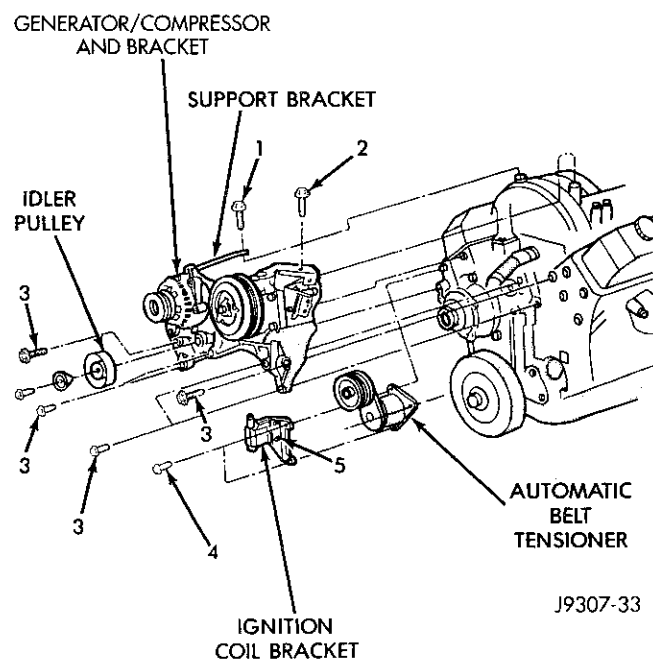


J9307-66

Fig. 61 Generator—A/C Compressor Mounting Bracket—Typical

(8) Remove accessory drive belt. Refer to Belt Removal/Installation in the Engine Accessory Drive Belt section of this group.

(9) (8) **3.9L V-6 or 5.2/5.9L V-8 LDC-Gas:** The drive belt idler pulley must be removed to gain access to one of the A/C compressor/generator bracket mounting bolts. Remove the idler pulley bolt and remove idler pulley (Fig. 62).



J9307-33

Fig. 62 Idler Pulley—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

REMOVAL AND INSTALLATION (Continued)

(10) **5.9L HDC-Gas:** The automatic belt tensioner/pulley assembly must be removed to gain access to one of the A/C compressor/generator bracket mounting bolts. Remove the tensioner mounting bolt (Fig. 63) and remove tensioner.

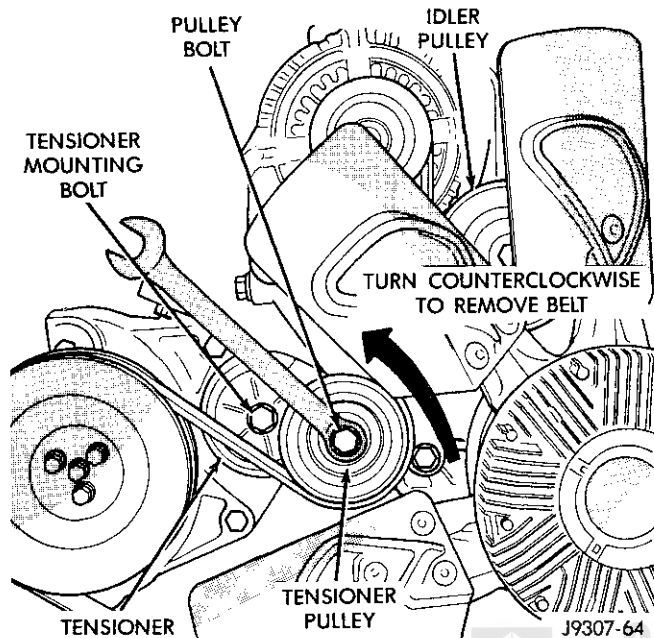


Fig. 63 Belt Tensioner—5.9L HDC-Gas Engine

(11) Remove the engine oil dipstick tube mounting bolt at the side of the A/C-generator mounting bracket.

(12) Disconnect throttle body control cables. Refer to Accelerator Pedal and Throttle Cable in Group 14, Fuel System.

(13) Remove heater hose coolant return tube mounting bolt (Fig. 64) (Fig. 65) and remove tube from engine. Discard the old tube O-ring.

(14) Remove bracket-to-intake manifold bolts (number 1 and 2 (Fig. 61).

(15) Remove remaining bracket-to-engine bolts (Fig. 66) (Fig. 67).

(16) Lift and position generator and A/C compressor (along with their common mounting bracket) to gain access to bypass hose. A block of wood may be used to hold assembly in position.

(17) Loosen and position both hose clamps to the center of bypass hose. A special clamp tool (Fig. 23) must be used to remove the constant tension clamps. Remove hose from vehicle.

INSTALLATION

(1) Position bypass hose clamps to the center of hose.

(2) Install bypass hose to engine.

(3) Secure both hose clamps.

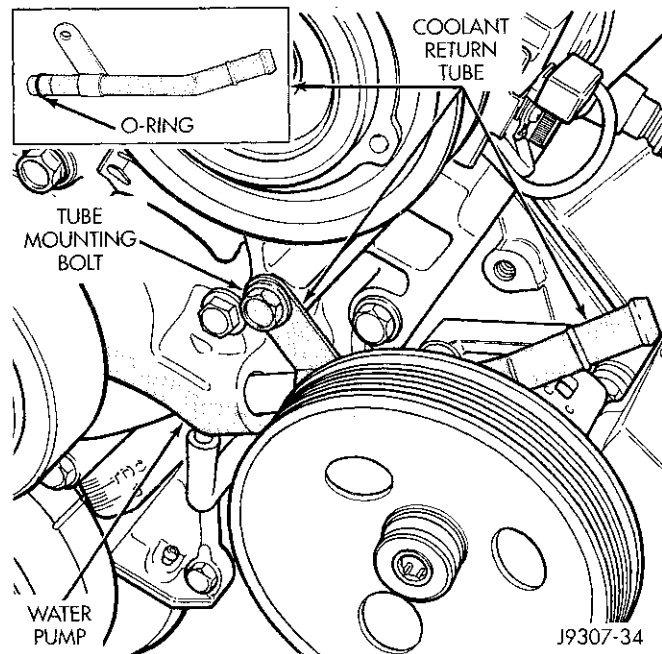


Fig. 64 Coolant Return Tube—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

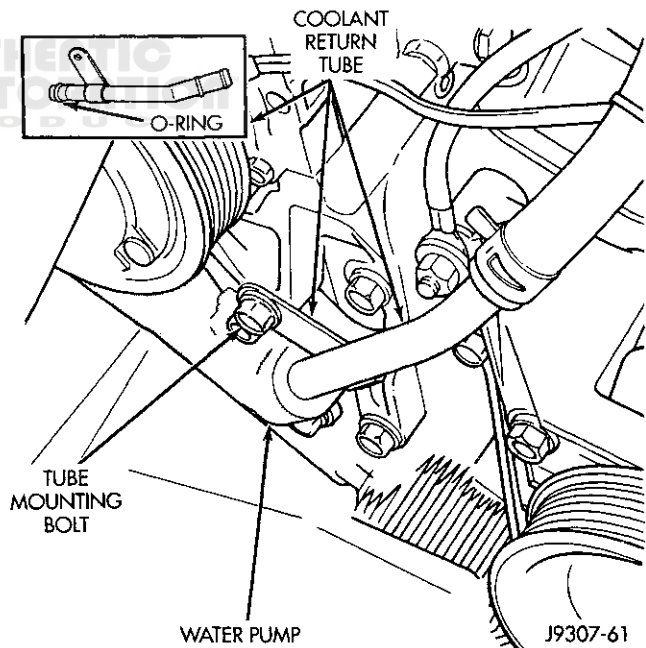


Fig. 65 Coolant Return Tube—5.9L HDC-Gas Engine

(4) Install generator-A/C mounting bracket assembly to engine. Tighten bolt number 1 (Fig. 61) to 41 N·m (30 ft. lbs.) torque. Tighten bolt number 2 (Fig. 61) to 28 N·m (20 ft. lbs.) torque. Tighten bracket mounting bolts (Fig. 66) (Fig. 67) to 40 N·m (30 ft. lbs.) torque.

(5) Install a new O-ring to the heater hose coolant return tube (Fig. 64) (Fig. 65). Coat the new O-ring with antifreeze before installation.

REMOVAL AND INSTALLATION (Continued)

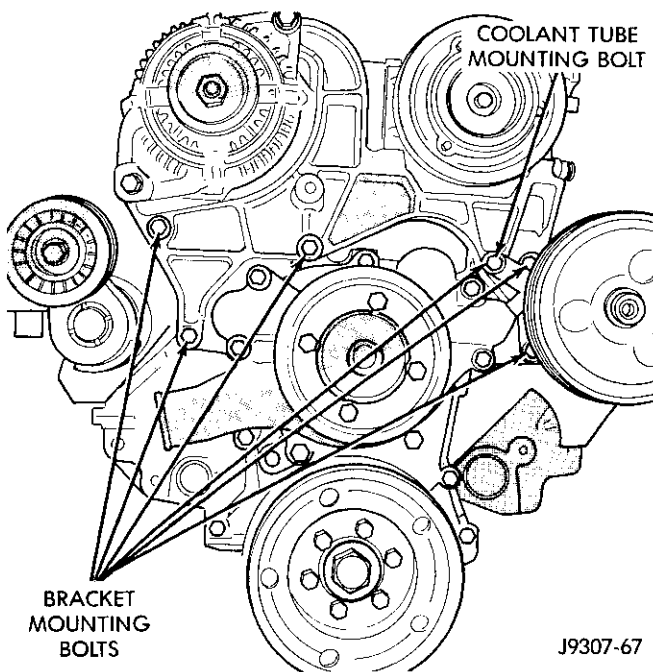


Fig. 66 Bracket Bolts—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

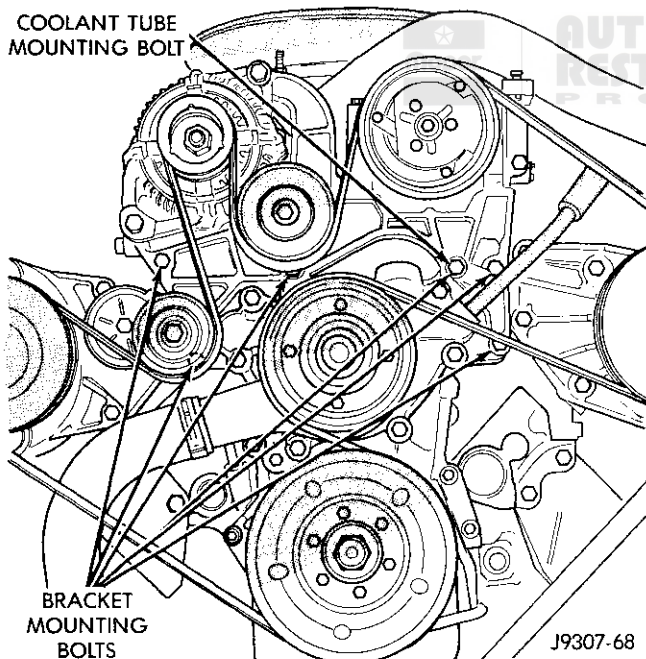


Fig. 67 Bracket Bolts—5.9L HDC-Gas Engine

(6) Install coolant return tube and its mounting bolt to engine (Fig. 64) (Fig. 65).

(7) Connect throttle body control cables.

(8) Install oil dipstick mounting bolt.

(9) **3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines:** Install idler pulley. Tighten bolt to 41 N·m (30 ft. lbs.) torque.

(10) **5.9L HDC-Gas:** Install automatic belt tensioner assembly to mounting bracket. A dowel pin is located on back of tensioner (Fig. 68). Align this to dowel hole (Fig. 69) in tensioner mounting bracket. Tighten bolt to 41 N·m (30 ft. lbs.) torque.

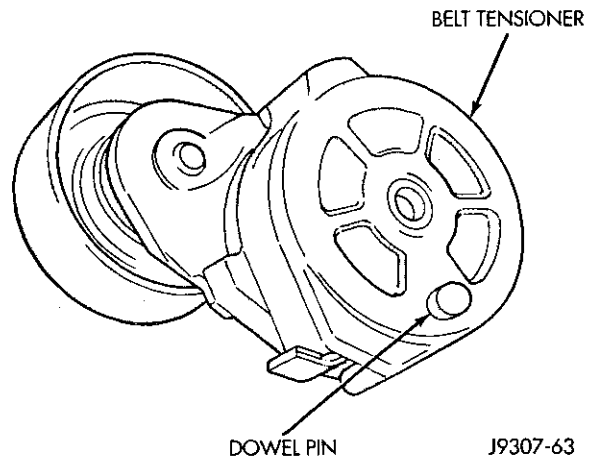


Fig. 68 Tensioner Dowel Pin—5.9L HDC-Gas Engine

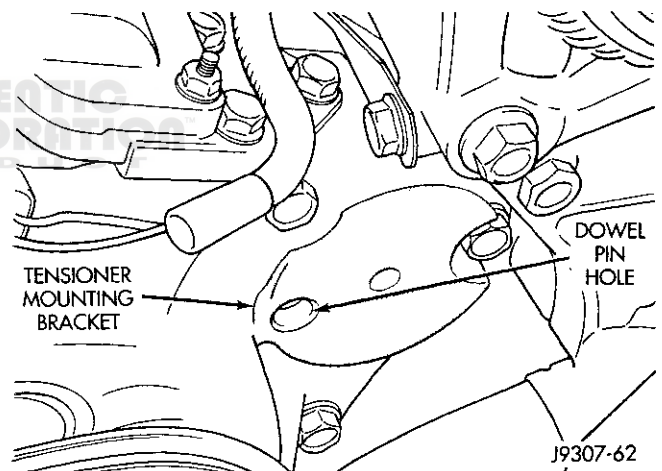


Fig. 69 Tensioner Mounting Bracket Dowel Hole—5.9L HDC-Gas Engine

(11) Install drive belt. Refer to Belt Removal/Installation in the Engine Accessory Drive Belt section of this group.

CAUTION: When installing the serpentine accessory drive belt, the belt must be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction. Refer to Belt Schematics in the Engine Accessory Drive Belt section of this group for correct belt routing. The correct belt with the correct length must be used.

(12) Install air cleaner assembly.

(13) Install upper radiator hose to radiator.

REMOVAL AND INSTALLATION (Continued)

(14) Connect throttle cable to clip at radiator fan shroud.

(15) Connect wiring harness to A/C compressor.

(16) Fill cooling system. Refer to Refilling Cooling System in this group.

(17) Start and warm the engine. Check for leaks.

THERMOSTAT—3.9L V-6 OR 5.2/5.9L V-8**REMOVAL**

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED. SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

If the thermostat is being replaced, be sure that the replacement is the specified thermostat for the vehicle model and engine type.

Factory installed thermostat housings on 3.9L V-6 or 5.2/5.9L V-8 engines are installed on a gasket with an anti-stick coating. This will aid in gasket removal and cleanup.

(1) Disconnect negative battery cable at battery.

(2) Drain cooling system until coolant level is below thermostat. Refer to Draining Cooling System in this group. If not equipped with air conditioning, proceed to step number 4.

(3) If equipped with air conditioning:

(a) Remove the support bracket (rod) located near the rear of generator (Fig. 70).

(b) The drive belt must be removed. Refer to Belt Removal/Installation in the Engine Accessory Drive Belt section of this group.

(c) The generator must be partially removed. Remove the two generator mounting bolts. Do not remove any wiring at generator. If equipped with 4WD, unplug the 4WD indicator lamp wiring harness (located near rear of generator).

(d) Remove generator. Position generator to gain access for thermostat gasket removal.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

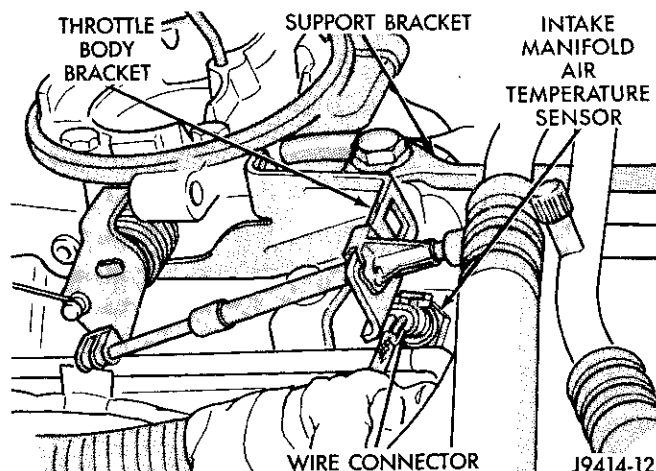


Fig. 70 Support Bracket—Generator Mounting Bracket-to-Intake Manifold—Typical

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(4) Remove upper radiator hose clamp. Remove upper radiator hose at thermostat housing.

(5) Position the wiring harness (behind the thermostat housing) to gain access to thermostat housing.

(6) Remove thermostat housing mounting bolts, thermostat housing, gasket and thermostat (Fig. 71). Discard old gasket.

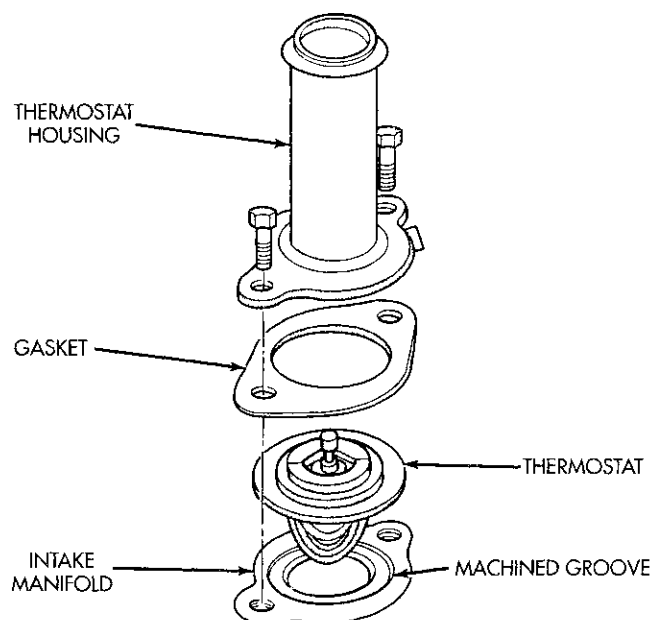


Fig. 71 Thermostat—3.9L V-6 or 5.2/5.9L V-8 Gas Engines

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Clean mating areas of intake manifold and thermostat housing.

(2) Install thermostat (spring side down) into recessed machined groove on intake manifold (Fig. 71).

(3) Install gasket on intake manifold and over thermostat (Fig. 71).

(4) Position the thermostat housing to the intake manifold. Note the word **FRONT** stamped on the housing (Fig. 72). For adequate clearance, this **must** be placed towards the front of vehicle. The housing should be slightly angled forward after installation to intake manifold.

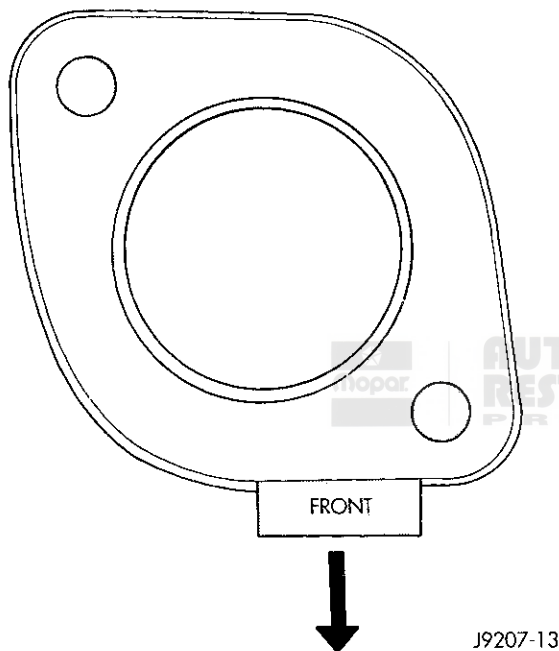


Fig. 72 Thermostat Position—3.9L V-6 or 5.2/5.9L V-8 Gas Engines

(5) Install two housing-to-intake manifold bolts. Tighten bolts to 23 N·m (200 in. lbs.) torque.

CAUTION: Housing must be tightened evenly and thermostat must be centered into recessed groove in intake manifold. If not, it may result in a cracked housing, damaged intake manifold threads or coolant leak.

(6) Install upper radiator hose to thermostat housing.

(7) Air conditioned vehicles:

(a) Install generator. Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(b) Install support bracket (generator mounting bracket-to-intake manifold) (Fig. 70). Tighten bolts to 54 N·m (40 ft. lbs.) torque.

CAUTION: When installing the serpentine accessory drive belt, the belt must be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction. Refer to **Belt Schematics in the Engine Accessory Drive Belt** section of this group for correct engine belt routing. The correct belt with the correct length must be used.

(8) Fill cooling system. Refer to Refilling Cooling System in this group.

(9) Connect negative battery cable to battery.

(10) Start and warm engine. Check for leaks.

THERMOSTAT—8.0L V-10

REMOVAL

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED. SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

If the thermostat is being replaced, be sure that the replacement is the specified thermostat for the vehicle model and engine type.

A rubber lip-type seal with a metal shoulder is pressed into the intake manifold beneath the thermostat (Fig. 73).

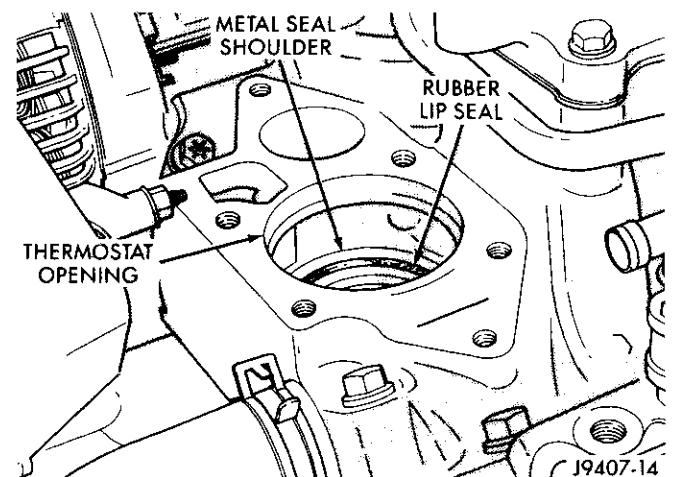
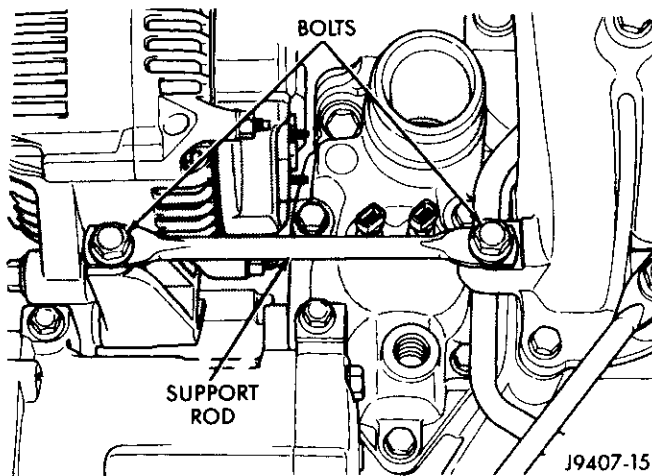


Fig. 73 Thermostat Seal—8.0L V-10 Engine

(1) Disconnect negative battery cable at battery.

(2) Drain cooling system until coolant level is below thermostat. Refer to Draining Cooling System in this group.

(3) Remove the two support rod mounting bolts and remove support rod (intake manifold-to-generator mount) (Fig. 74).

REMOVAL AND INSTALLATION (Continued)**Fig. 74 Support Rod—8.0L V-10 Engine**

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps. If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(4) Remove upper radiator hose clamp. Remove upper radiator hose at thermostat housing.

(5) Disconnect the wiring connectors at both of the sensors located on thermostat housing.

(6) Remove six thermostat housing mounting bolts, thermostat housing, gasket and thermostat. Discard old gasket.

INSTALLATION

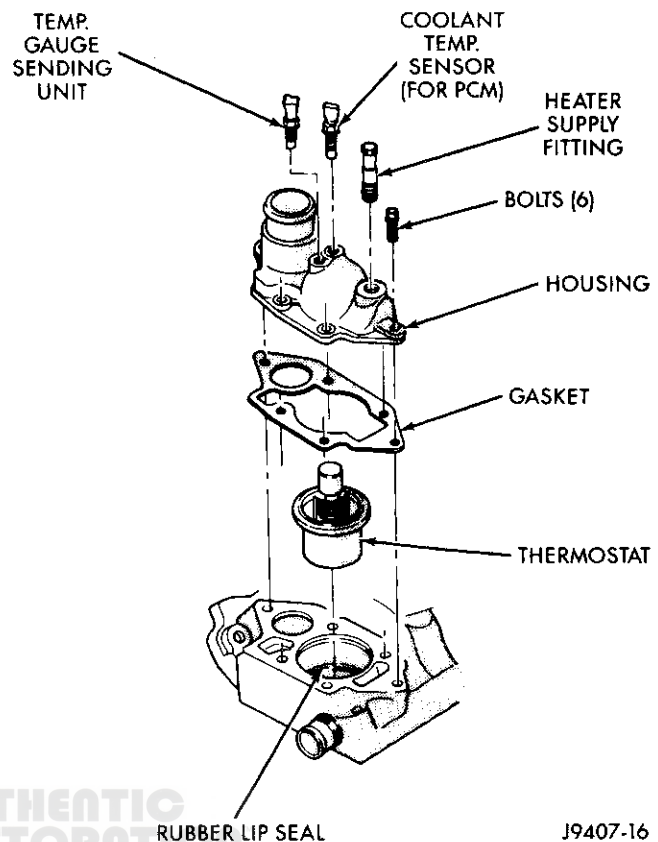
(1) Clean mating areas of intake manifold and thermostat housing.

(2) Check the condition (for tears or cracks) of the rubber thermostat seal located in the intake manifold (Fig. 73) (Fig. 75). The thermostat should fit snugly into the rubber seal.

(3) If seal replacement is necessary, coat the outer (metal) portion of the seal with Mopar® Gasket Maker. Install the seal into the manifold using Special Seal Tool number C-3995-A with handle tool number C-4171.

(4) Install thermostat into recessed machined groove on intake manifold (Fig. 75).

(5) Install gasket on intake manifold and over thermostat (Fig. 75).

**Fig. 75 Thermostat—8.0L V-10 Engine**

(6) Install housing-to-intake manifold bolts. Tighten bolts to 25 N·m (220 in. lbs.) torque.

CAUTION: Housing bolts should be tightened evenly to prevent damage to housing and to prevent leaks.

(7) Connect the wiring to both sensors.

(8) Install the upper radiator hose and hose clamp to thermostat housing.

(9) Install support rod.

(10) Fill cooling system. Refer to Refilling Cooling System in this group.

(11) Connect negative battery cable to battery.

(12) Start and warm engine. Check for leaks.

THERMOSTAT—DIESEL ENGINE**REMOVAL**

WARNING: DO NOT LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND PRESSURIZED. SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

Do not waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

REMOVAL AND INSTALLATION (Continued)

(1) Disconnect both negative battery cables from both batteries.

(2) Remove accessory drive belt. Refer to Belt Removal/Installation in the Engine Accessory Drive Belt section in this group.

(3) Drain cooling system until coolant level is below thermostat. Refer to Draining Cooling System in this section.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(4) Remove radiator hose clamp and hose from thermostat housing. A special clamp tool (Fig. 23) must be used to remove the constant tension clamps.

(5) Remove the hose clamp and check valve hose at thermostat housing (Fig. 76).

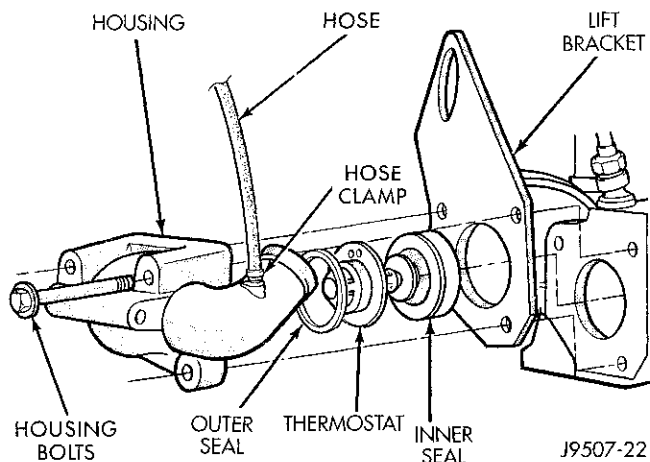


Fig. 76 Thermostat Removal—5.9L Diesel

(6) Remove the two upper generator bracket mounting bolts (Fig. 77).

(7) Remove the upper generator mounting bracket (Fig. 77).

(8) Loosen but do not remove the generator lower pivot bolt.

(9) Position the generator to gain access to thermostat housing and housing bolts.

(10) Remove thermostat housing mounting bolts.

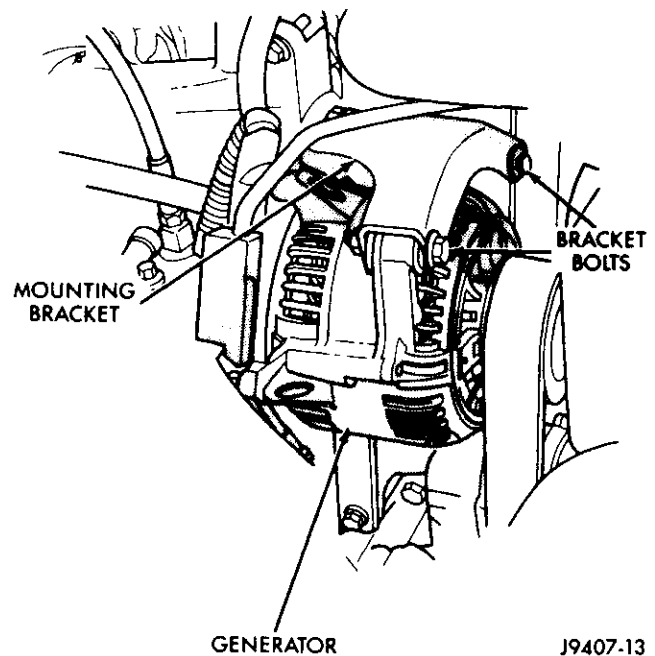


Fig. 77 Generator Mounting Bracket Bolts—Diesel

(11) Remove the thermostat housing, thermostat, inner and outer seals and lift bracket (Fig. 76).

(12) Clean the mating surfaces of the thermostat housing and the cylinder head.

INSTALLATION

(1) Install the outer seal (Fig. 76) (Fig. 78) into the machined shoulder on the thermostat housing.

(2) Install the thermostat into the machined shoulder next to the outer seal. Note direction of thermostat in (Fig. 76) (Fig. 78).

(3) Position the inner thermostat seal with the shoulder towards the thermostat housing (Fig. 78).

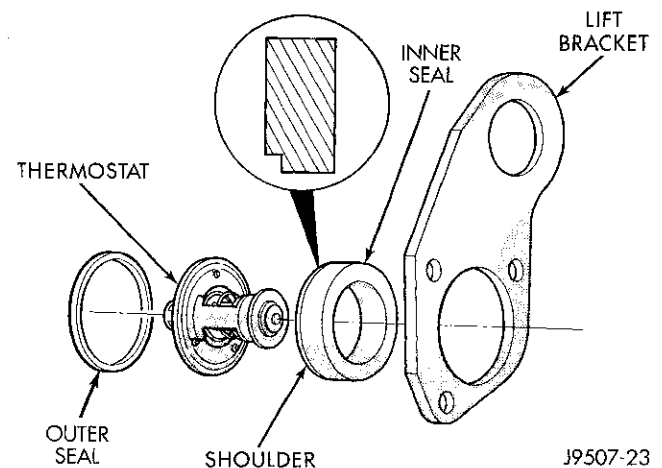


Fig. 78 Thermostat Seals—5.9L Diesel—Typical

REMOVAL AND INSTALLATION (Continued)

(4) Install thermostat, lift bracket, seals and housing to the engine as an assembly. Install and tighten mounting bolts to 24 N·m (18 ft. lbs.) torque.

(5) Position generator to thermostat housing. Install and tighten mounting bolt to 24 N·m torque. Tighten pivot bolt to 43 N·m (32 ft. lbs.) torque.

(6) Install the check valve hose and hose clamp at thermostat housing (Fig. 76).

(7) Install accessory drive belt. Refer to Belt Removal/Installation in the Engine Accessory Drive Belt section of this group.

(8) Connect negative battery cables to both batteries.

(9) Fill cooling system and check for leaks. Refer to Refilling Cooling System in this group.

REPLACING WATER-TO-OIL COOLER IN RADIATOR SIDE TANK

The internal transmission oil cooler located within the radiator is not serviceable. If it requires service, the radiator must be replaced.

Once the repaired or replacement radiator has been installed, fill the cooling system and inspect for leaks. Refer to the Refilling Cooling System and Testing Cooling System For Leaks sections in this group. If the transmission operates properly after repairing the leak, drain the transmission and remove the transmission oil pan. Inspect for sludge and/or rust. Inspect for a dirty or plugged inlet filter. If none of these conditions are found, the transmission and torque converter may not require reconditioning. Refer to Group 21 for automatic transmission servicing.

AIR-TO-OIL COOLER—3.9L/5.2L/5.9L ENGINES**REMOVAL**

CAUTION: If a leak should occur in the internal radiator mounted transmission air-to-oil cooler (gas engines only), engine coolant may become mixed with transmission fluid. Transmission fluid may also enter engine cooling system. Both cooling system and transmission should be drained and inspected in case of oil cooler leakage.

(1) Disconnect negative battery cable at battery.
(2) Drain cooling system. Refer to Draining Cooling System.

(3) Place a drain pan under the oil cooler lines.

(4) Disconnect the two transmission oil cooler line quick-connect fittings at the radiator. Refer to Group 21, Transmissions for procedures. Plug cooler lines to prevent oil leakage.

(5) Disconnect the oil cooler quick-connect fitting at the transmission oil cooler line. Refer to Group 21, Transmissions for procedures.

(6) Disconnect the windshield washer reservoir tank at the fan shroud. Refer to Group 8K, Windshield Wiper and Washer Systems for procedures.

(7) Remove the rubber shield at right side of radiator. The shield is held to vehicle body with plastic clips.

(8) Remove the two radiator upper mounting bolts (Fig. 79).

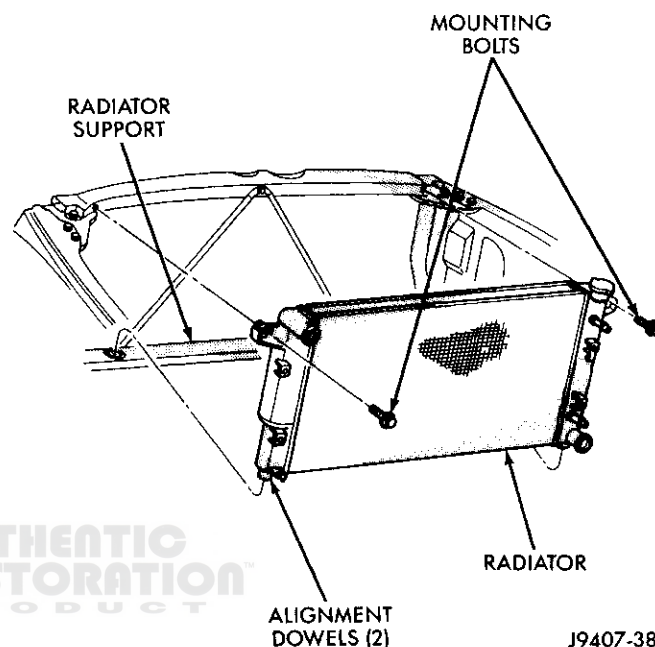


Fig. 79 Radiator Mounting Bolts—Typical

(9) Position the upper part of radiator towards engine.

(10) Remove the oil cooler lower mounting bolt (oil cooler-to- vehicle body) (Fig. 80).

(11) Remove three bolts (radiator support bracket-to-body). Remove this A-shaped support bracket and the transmission oil cooler as an assembly from the vehicle. Take care not to damage the radiator core or A/C condenser fins with the cooling lines when removing.

(12) Remove oil cooler from A-shaped support bracket by removing two upper mounting strap bolts and mounting straps at support bracket (Fig. 80).

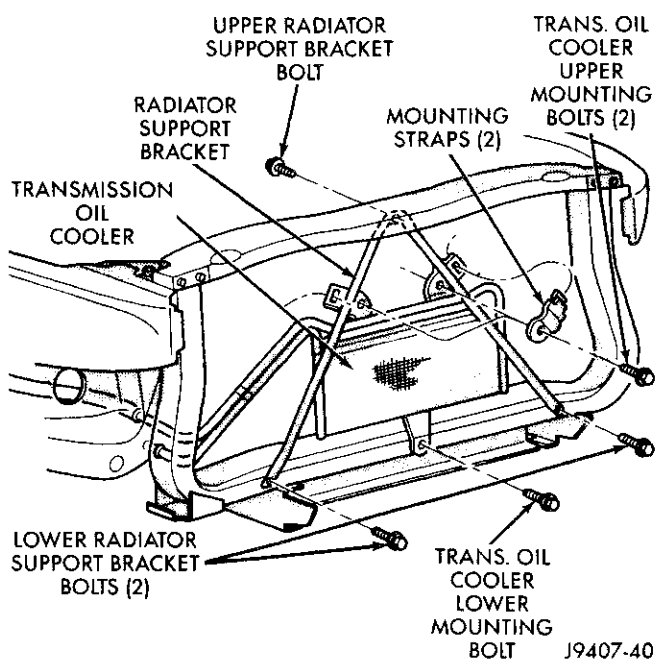
(13) Remove oil cooler from the A-shaped radiator support bracket.

INSTALLATION

(1) Install the oil cooler assembly to the A-shaped radiator support bracket using the two upper mounting bolts and mounting straps. Install the bolts but do not tighten at this time.

(2) Install the radiator support bracket and oil cooler (as an assembly) to the vehicle.

(3) Install the two lower radiator A-shaped support bracket bolts. Do not tighten bolts at this time.

REMOVAL AND INSTALLATION (Continued)**Fig. 80 Air-to-oil Cooler 3.9L or 5.2/5.9L Engines**

(4) Slide and position the oil cooler on the A-shaped bracket until its lower mounting hole lines up with the bolt hole on the vehicle body. Tighten the oil cooler mounting strap bolts to 6 N·m (50 in. lbs.) torque.

(5) Install the upper radiator A-shaped support bracket bolt. Tighten all three radiator support bracket mounting bolts to 11 N·m (95 in. lbs.) torque.

(6) Install the two radiator upper mounting bolts (Fig. 79). Tighten bolts to 11 N·m (95 in. lbs.) torque.

(7) Install windshield washer reservoir tank.

(8) Install rubber shield to radiator.

(9) Install the quick-connect fittings on the two oil cooler lines to the radiator. Refer to Group 21, Transmissions for procedures.

(10) Fill cooling system. Refer to Refilling the Cooling System in this group.

(11) Connect negative battery cable to battery.

(12) Start the engine and check all fittings for leaks.

(13) Check the fluid level in the automatic transmission. Refer to Group 21, Transmissions for procedures.

AIR-TO-OIL COOLER—8.0L V-10 ENGINE**REMOVAL**

CAUTION: If a leak should occur in the internal radiator mounted transmission oil cooler (gas engines only), engine coolant may become mixed with transmission fluid. Transmission fluid may also enter engine cooling system. Both cooling system

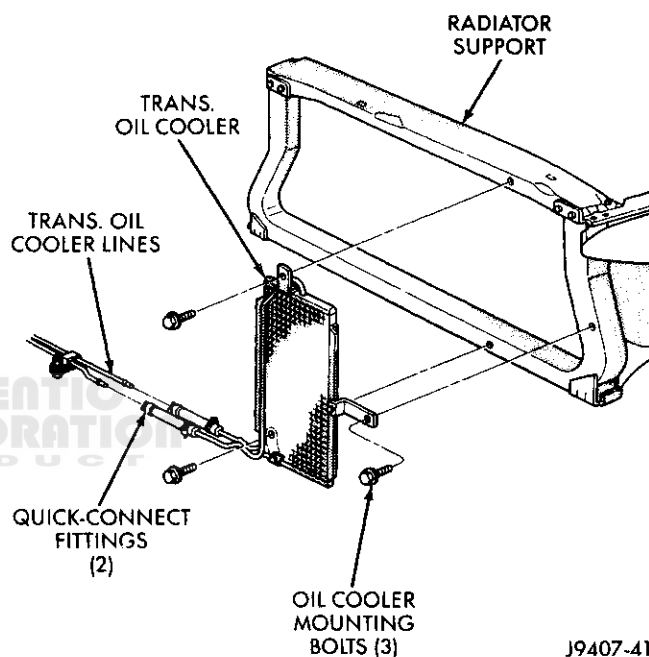
and transmission should be drained and inspected in case of oil cooler leakage.

(1) Place a drain pan under the oil cooler lines.

(2) Disconnect the two transmission oil cooler line quick-connect fittings from the transmission oil cooler lines (Fig. 81). Refer to Group 21, Transmissions for procedures. Plug cooler lines to prevent oil leakage.

(3) Remove three oil cooler-to-radiator support mounting bolts (Fig. 81).

(4) Remove the oil cooler and line assembly from the vehicle.

**Fig. 81 Air To Oil Cooler—V-10 Engine****INSTALLATION**

(1) Install the oil cooler and cooler line assembly to the vehicle.

(2) Install three mounting bolts and tighten to 6 N·m (50 in. lbs.) torque.

(3) Connect the quick-connect fittings. Refer to Group 21, Transmissions for procedures.

(4) Start the engine and check all fittings for leaks.

(5) Check the fluid level in the automatic transmission. Refer to Group 21, Transmissions for procedures.

REMOVAL AND INSTALLATION (Continued)**WATER-TO-OIL COOLER—5.9L DIESEL ENGINE****REMOVAL**

CAUTION: If a leak should occur in the water-to-oil cooler mounted to the side of the engine block, engine coolant may become mixed with transmission fluid. Transmission fluid may also enter engine cooling system. Both cooling system and transmission should be drained and inspected in case of oil cooler leakage.

- (1) Disconnect both negative battery cables at batteries.
- (2) Remove air cleaner assembly and air cleaner intake hoses. Refer to Group 14, Fuel System for procedures.
- (3) Drain cooling system. Refer to Draining Cooling System.
- (4) Disconnect coolant lines from cooler.
- (5) Disconnect transmission oil lines from cooler. Plug cooler lines to prevent oil leakage.
- (6) Remove oil cooler mounting straps (Fig. 82).

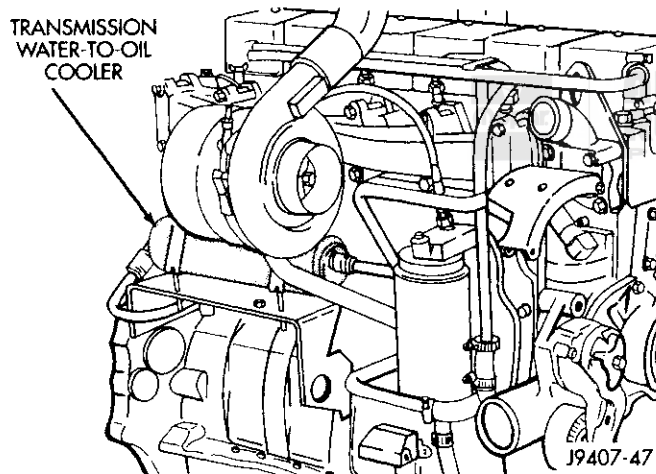


Fig. 82 Transmission Water-To- Oil Cooler—Diesel

- (7) Lift oil cooler off of mounting bracket.

INSTALLATION

- (1) Position oil cooler on bracket.
- (2) Install mounting straps.
- (3) Connect transmission oil lines to cooler.
- (4) Connect coolant hoses to cooler.
- (5) Connect negative battery cables to both batteries.
- (6) Fill cooling system. Refer to Refilling Cooling System in this section.
- (7) Check transmission oil level and fill as necessary.
- (8) Install air cleaner assembly and air cleaner intake hoses. Refer to Group 14, Fuel System for procedures.

AIR-TO-OIL COOLER—5.9L DIESEL ENGINE**REMOVAL**

- (1) Remove front bumper. Refer to Group 23, Body.
- (2) Place a drain pan under the oil cooler.
- (3) Raise the vehicle.
- (4) Disconnect the oil cooler quick-connect fittings from the transmission lines. These are located near the power steering gearbox. Refer to Group 21, Transmissions for procedures.
- (5) Remove the charge air cooler-to-oil cooler bolt (Fig. 83).

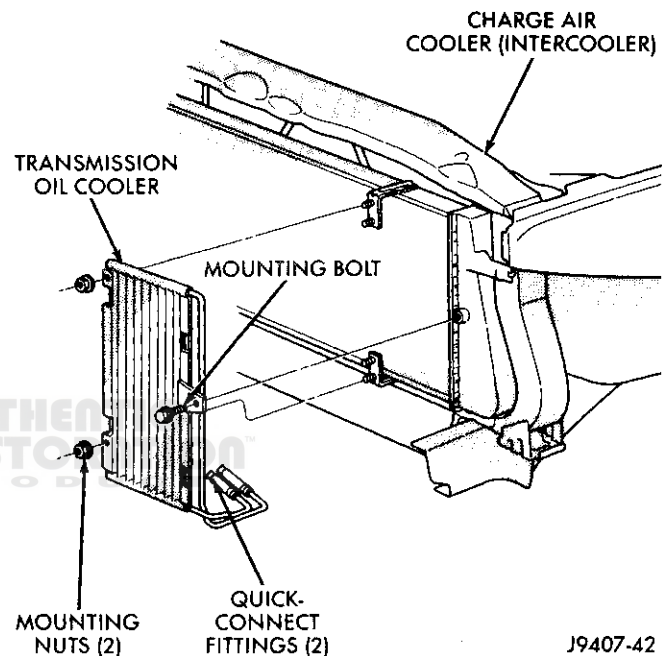


Fig. 83 Air-to-Oil Cooler—Diesel Engine

- (6) Remove two mounting nuts.
- (7) Remove the oil cooler and line assembly towards the front of vehicle. Cooler must be rotated and tilted into position while removing.

INSTALLATION

- (1) Carefully position the oil cooler assembly to the vehicle.
- (2) Install two nuts and one bolt. Tighten to 11 N-m (95 in. lbs.) torque.
- (3) Connect the quick-connect fittings to the transmission cooler lines. Refer to Group 21, Transmissions for procedures.
- (4) Install front bumper. Refer to Group 23, Body.
- (5) Start the engine and check all fittings for leaks.
- (6) Check the fluid level in the automatic transmission. Refer to Group 21, Transmissions for procedures.

REMOVAL AND INSTALLATION (Continued)

RADIATOR

REMOVAL—ALL ENGINES

(1) **All Engines Except Diesel:** Disconnect negative battery cable from battery.

(2) **Diesel engine:** Disconnect both negative battery cables at both batteries. Remove the nuts retaining the positive cable to the top of radiator. Position positive battery cable to rear of vehicle.

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH THE SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

(3) Drain the cooling system. Refer to Draining Cooling System in this group.

(4) Disconnect throttle cable from clip at top of radiator fan shroud.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 23). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps (Fig. 24). If replacement is necessary, use only an original equipment clamp with a matching number or letter.

(5) Remove hose clamps and hoses from radiator.

(6) All engines: Remove coolant reserve/overflow tank hose from radiator filler neck nipple.

(7) All engines **except 8.0L V-10:** Remove the coolant reserve/overflow tank from the fan shroud (pull straight up). The tank slips into T-slots on the fan shroud.

(8) Disconnect electrical connectors at windshield washer reservoir tank and remove tank. Refer to Group 8K, Windshield Wiper and Washer Systems for procedures.

(9) If equipped with an automatic transmission (all engines except diesel), disconnect oil cooler lines (hoses) at radiator tank. Refer to Group 21, Transmissions for procedures.

(10) **Diesel Engine Only:** Remove the two metal clips retaining the upper part of fan shroud to the top of radiator.

(11) Remove the four fan shroud mounting bolts (Fig. 84). Position shroud rearward over the fan blades towards engine.

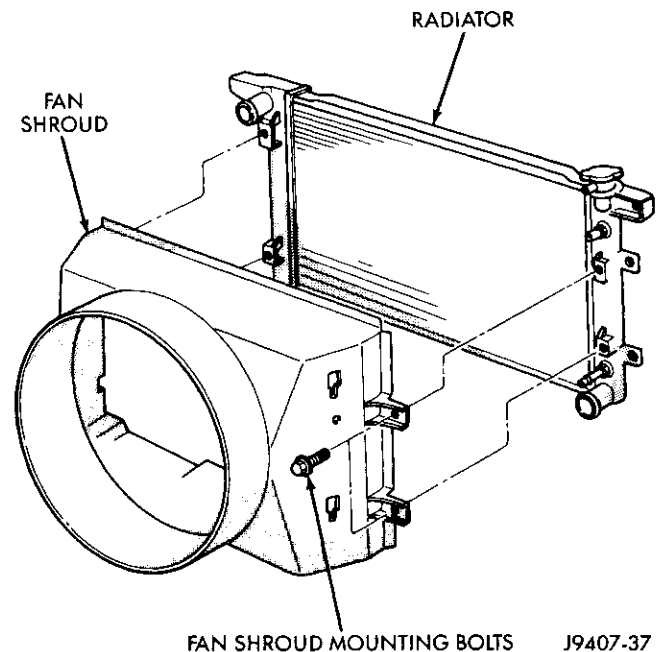


Fig. 84 Typical Fan Shroud Mounting

(12) All Engines **Except 8.0L V-10 and Diesel:** Remove the plastic clips retaining the rubber shields to the sides of radiator. Position rubber shields to the side.

(13) Remove the two radiator upper mounting bolts (Fig. 85).

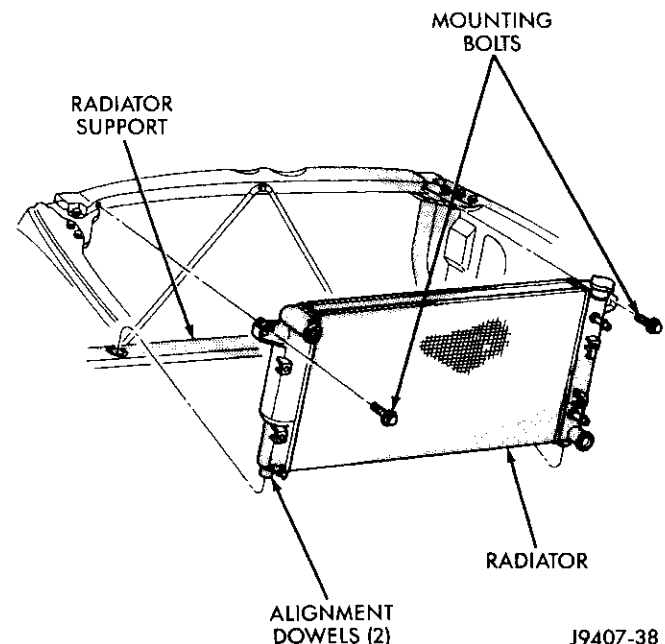


Fig. 85 Typical Radiator Mounting

REMOVAL AND INSTALLATION (Continued)

(14) Lift radiator straight up and out of engine compartment. The bottom of the radiator is equipped with two alignment dowels that fit into holes in the lower radiator support panel (Fig. 85). Rubber biscuits (insulators) are installed to these dowels. Take care not to damage cooling fins or tubes on the radiator and air conditioning condenser when removing.

INSTALLATION

(1) Position fan shroud over the fan blades rearward towards engine.

(2) Install rubber insulators to alignment dowels at lower part of radiator.

(3) Lower the radiator into position while guiding the two alignment dowels into lower radiator support. Different alignment holes are provided in the lower radiator support for each engine application.

(4) Install two upper radiator mounting bolts. Tighten bolts to 11 N·m (95 in. lbs.) torque.

(5) 3.9L V-6 or 5.2L/5.9L V-8 Engines: Position the rubber shields to the sides of radiator. Install the plastic clips retaining the rubber shields to the sides of radiator.

(6) Connect both radiator hoses. Refer to previous **CAUTION** and install hose clamps.

(7) If equipped, connect transmission oil cooler lines to radiator tank. Refer to Group 21, Transmissions for procedures.

(8) Install windshield washer reservoir tank. Refer to Group 8K.

(9) Position fan shroud to flanges on sides of radiator. Install fan shroud mounting bolts (Fig. 84). Tighten bolts to 6 N·m (50 in. lbs.) torque.

(10) **Diesel Engines:** Install metal clips to top of fan shroud.

(11) All engines: Install coolant reserve/overflow tank hose to radiator filler neck nipple.

(12) All Engines **Except 8.0L V-10:** Install coolant reserve/overflow tank to fan shroud (fits into T-slots on shroud).

(13) Connect throttle cable to fan shroud.

(14) Install negative battery cable to battery.

(15) **Diesel Engine:** Install positive battery cable to top of radiator. Tighten radiator-to-battery cable mounting nuts.

(16) Position heater controls to **full heat** position.

(17) Fill cooling system with coolant. Refer to Refilling Cooling System in this group.

(18) Operate engine until it reaches normal temperature. Check cooling system and automatic transmission (if equipped) fluid levels.

ENGINE BLOCK HEATER**REMOVAL**

(1) Disconnect negative battery cable(s) from battery(s).

(2) Drain coolant from radiator and cylinder block.

(3) Remove power cord from heater by unplugging (Fig. 86) (Fig. 87). On the diesel engine, the cord is connected to the heater with a knurled cap. Unscrew this cap for cord removal.

(4) Loosen (but do not completely remove) the screw at center of block heater (Fig. 86) (Fig. 87). On the diesel engine, an allen headed screw is used.

(5) Remove block heater from engine by carefully prying from side- to-side. When removing block heater, note direction of heating element coil (up or down). Element coil must be installed correctly to prevent damage.

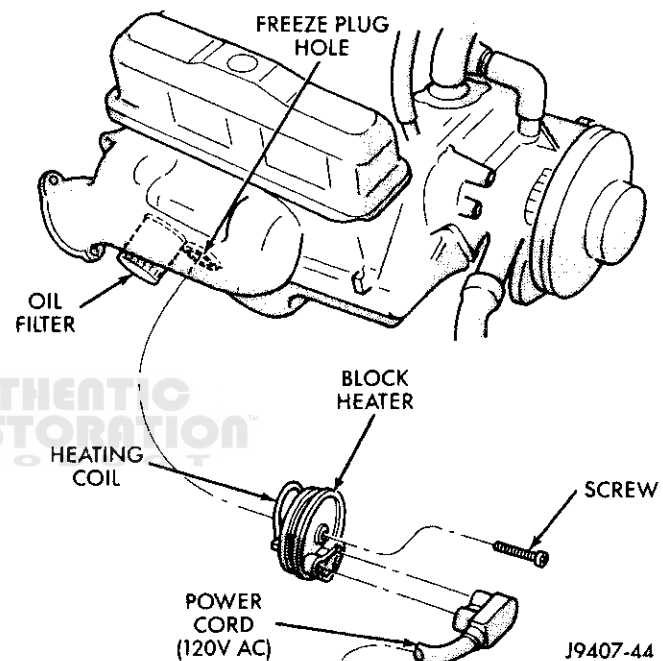


Fig. 86 Engine Block Heater—3.9L/5.2L/5.9L Gas Powered Engine

INSTALLATION

(1) Thoroughly clean the cylinder block freeze plug hole and block heater seat.

(2) Install new O-ring seal(s) to heater.

(3) Insert block heater into cylinder block.

(4) With heater fully seated, tighten center screw.

(5) Fill cooling system with recommended coolant. Refer to Refilling Cooling System section in this group.

(6) Start and warm the engine.

(7) Check block heater for leaks.

REMOVAL AND INSTALLATION (Continued)

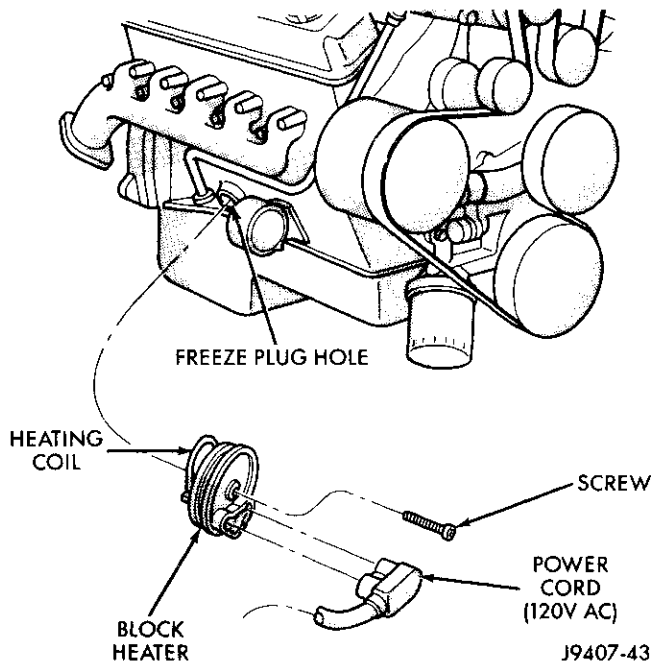


Fig. 87 Engine Block Heater—8.0L V-10 Engine
SERPENTINE DRIVE BELTS

NOTE: The belt routing schematics are published from the latest information available at the time of publication. If anything differs between these schematics and the Belt Routing Label, use the schematics on Belt Routing Label. This label is located in the engine compartment.

CAUTION: Do not attempt to check belt tension with a belt tension gauge on vehicles equipped with an automatic belt tensioner. Refer to Automatic Belt Tensioner in this group.

3.9L V-6 OR 5.2/5.9L V-8 LDC-GAS ENGINES

REMOVAL

Drive belts on these engines are equipped with a spring loaded automatic belt tensioner (Fig. 88). This belt tensioner will be used on all belt configurations, such as with or without power steering or air conditioning. For more information, refer to Automatic Belt Tensioner, proceeding in this group.

- (1) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 88).
- (2) Rotate tensioner assembly clockwise (as viewed from front) until tension has been relieved from belt.
- (3) Remove belt from idler pulley first.
- (4) Remove belt from vehicle.

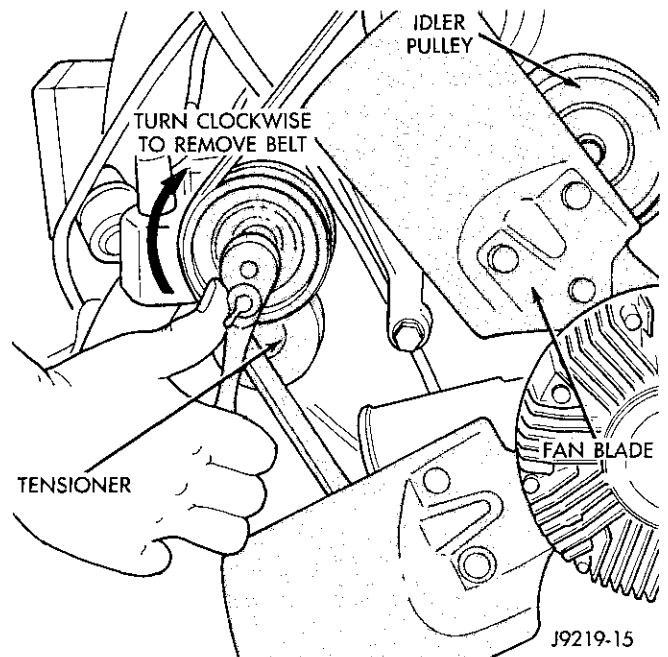


Fig. 88 Belt Tensioner—3.9L V-6 or 5.2/5.9L V-8
LDC-Gas Engines

INSTALLATION

CAUTION: When installing serpentine accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in wrong direction. Refer to (Fig. 89) for correct engine belt routing. The correct belt with correct length must be used.

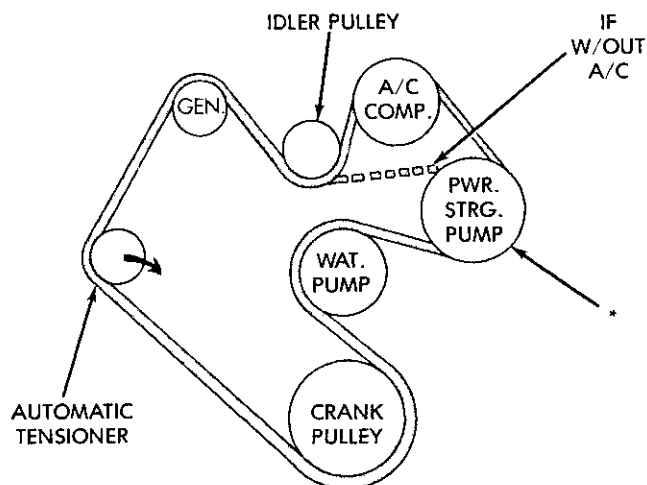
- (1) Position drive belt over all pulleys **except** idler pulley. This pulley is located between generator and A/C compressor.
- (2) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 88).
- (3) Rotate socket/wrench clockwise. Place belt over idler pulley. Let tensioner rotate back into place. Remove wrench. Be sure belt is properly seated on all pulleys.
- (4) Check belt indexing marks. Refer to the proceeding Automatic Belt Tensioner for more belt information.

5.9L HDC-GAS AND 8.0L V-10 ENGINES

REMOVAL

Drive belts are equipped with a spring loaded automatic belt tensioner (Fig. 90). This belt tensioner will be used on all belt configurations, such as with or without power steering or air conditioning. For more information, refer to Automatic Belt Tensioner, proceeding in this group.

REMOVAL AND INSTALLATION (Continued)



*IF VEHICLE IS NOT EQUIPPED WITH POWER STEERING, THIS WILL BE AN IDLER PULLEY.

J9307-26

Fig. 89 Belt Routing—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

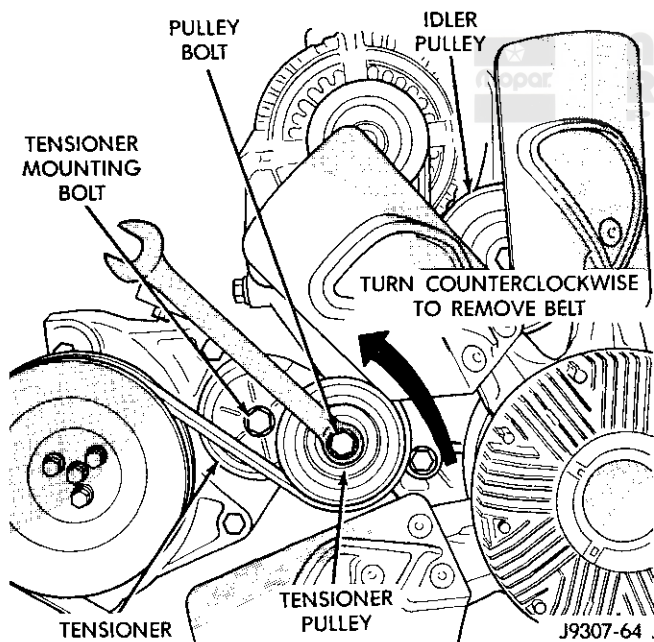


Fig. 90 Belt Tensioner—5.9L HDC-Gas and 8.0L V-10 Engines—Typical

(1) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 90). The threads on the pulley mounting bolt are left-hand.

(2) Relax the tension from the belt by rotating the tensioner counterclockwise (as viewed from front) (Fig. 90). When all belt tension has been relaxed, remove belt from tensioner pulley first and other pulleys last.

INSTALLATION

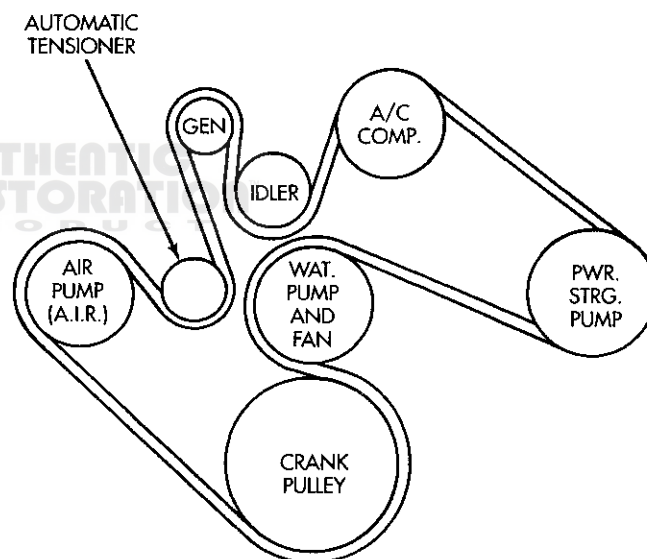
CAUTION: When installing serpentine accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in wrong direction. Refer to (Fig. 91) (Fig. 92) for correct engine belt routing. The correct belt with correct length must be used.

CAUTION: If the pulley is to be removed from the tensioner, its mounting bolt has left-hand threads.

(1) Position drive belt over all pulleys **except** tensioner pulley.

(2) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 90).

(3) Rotate socket/wrench counterclockwise. Install belt over tensioner pulley. Let tensioner rotate back into place. Remove wrench. Be sure belt is properly seated on all pulleys.



J9307-55

Fig. 91 Belt Routing—5.9L HDC-Gas Engine and 8.0L V-10—With A/C

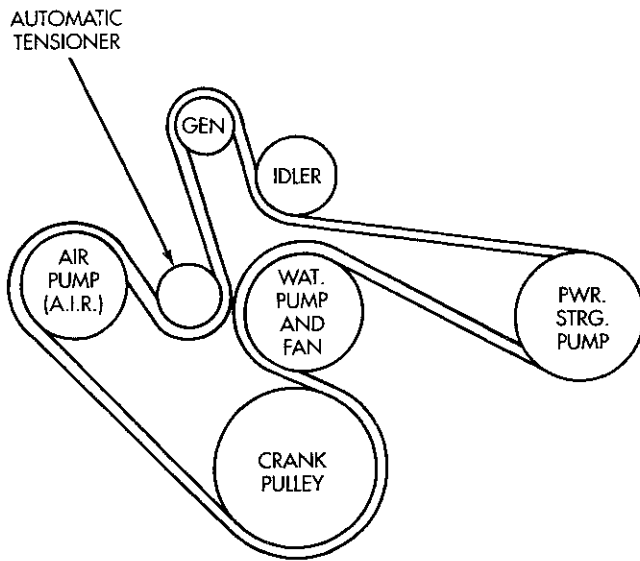
5.9L DIESEL ENGINE

REMOVAL

Drive belts on diesel engines are equipped with a spring loaded automatic belt tensioner (Fig. 93). (Fig. 93) displays the tensioner for vehicles without air conditioning.

This belt tensioner will be used on all belt configurations, such as with or without air conditioning. For more information, refer to Automatic Belt Tensioner, proceeding in this group.

REMOVAL AND INSTALLATION (Continued)



J9307-56

Fig. 92 Belt Routing—5.9L HDC-Gas Engine and 8.0 L V-10—Without A/C

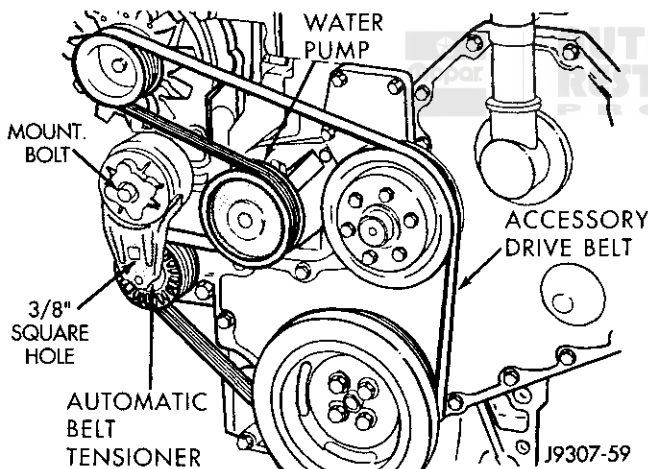


Fig. 93 Belt Tensioner—5.9L Diesel—Typical (non-A/C shown)

(1) A 3/8 inch square hole is provided in the automatic belt tensioner (Fig. 93). Attach a 3/8 inch drive-long handle ratchet to this hole.

(2) Rotate ratchet and tensioner assembly counterclockwise (as viewed from front) until tension has been relieved from belt.

(3) Remove belt from water pump pulley first.

(4) Remove belt from vehicle.

INSTALLATION

CAUTION: When installing serpentine accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in

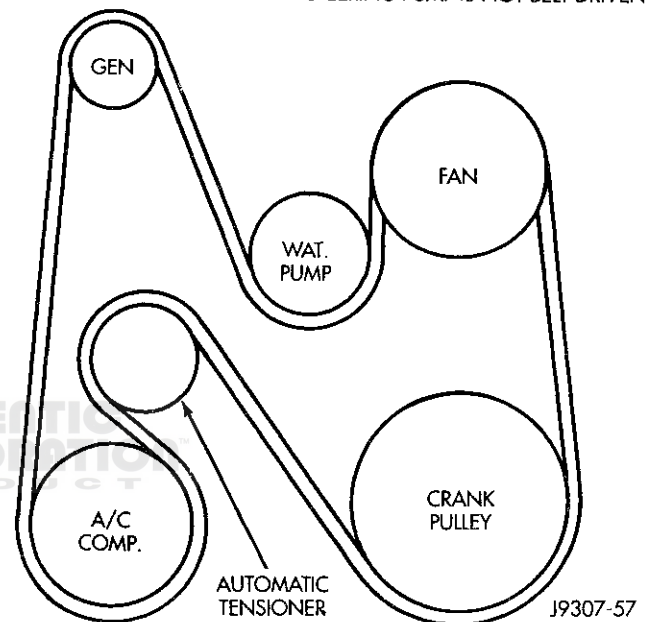
wrong direction. Refer to (Fig. 94) (Fig. 95) for correct engine belt routing. The correct belt with correct length must be used.

(1) Position drive belt over all pulleys **except** water pump pulley.

(2) Attach a 3/8 inch ratchet to tensioner.

(3) Rotate ratchet and belt tensioner counterclockwise. Place belt over water pump pulley. Let tensioner rotate back into place. Remove ratchet. Be sure belt is properly seated on all pulleys.

*POWER STEERING PUMP IS NOT BELT DRIVEN



J9307-57

**Fig. 94 Belt Routing—5.9L Diesel Engine—With A/C
AUTOMATIC BELT TENSIONER**

NOTE: On 3.9L V-6 or 5.2/5.9L V-8 LDC-gas engines, the tensioner is equipped with an indexing arrow (Fig. 96) on back of tensioner and an indexing mark on tensioner housing. If a new belt is being installed, arrow must be within approximately 3 mm (1/8 in.) of indexing mark (point B-) (Fig. 96). Belt is considered new if it has been used 15 minutes or less. If this specification cannot be met, check for:

- The wrong belt being installed (incorrect length/width)

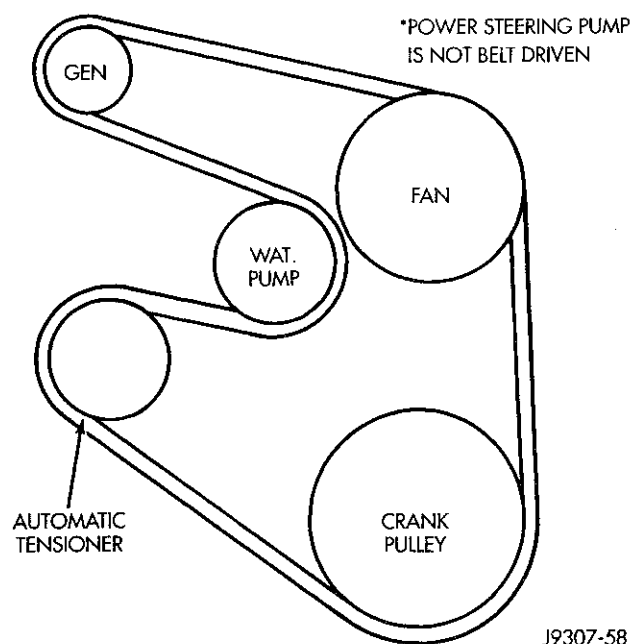
- Worn bearings on an engine accessory (A/C compressor, power steering pump, water pump, idler pulley or generator)

- A pulley on an engine accessory being loose

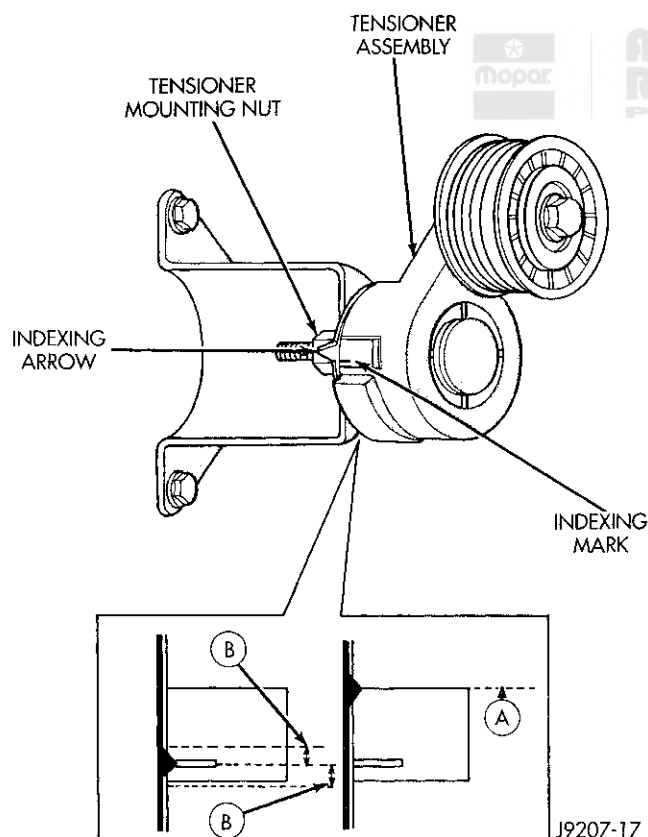
- Misalignment of an engine accessory

- Belt incorrectly routed.

On 3.9L V-6 or 5.2/5.9L V-8 LDC-gas engines, a used belt should be replaced if tensioner indexing arrow has moved to point-A (Fig. 96). Tensioner travel stops at point-A.

REMOVAL AND INSTALLATION (Continued)

J9307-58

Fig. 95 Belt Routing—5.9L Diesel Engine—Without A/C**Fig. 96 Indexing Marks—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines****3.9L V-6 OR 5.2/5.9L V-8 LDC-GAS ENGINES****REMOVAL**

- (1) Remove accessory drive belt. Refer to Belt Removal/Installation in this group.
- (2) Disconnect wiring and secondary cable from ignition coil.
- (3) Remove ignition coil from coil mounting bracket (two bolts). Do not remove coil mounting bracket from cylinder head.
- (4) Remove tensioner assembly from mounting bracket (one nut) (Fig. 96).

WARNING: BECAUSE OF HIGH SPRING PRESSURE, DO NOT ATTEMPT TO DISASSEMBLE AUTOMATIC TENSIONER. UNIT IS SERVICED AS AN ASSEMBLY (EXCEPT FOR PULLEY).

- (5) Remove pulley bolt. Remove pulley from tensioner.

INSTALLATION

- (1) Install pulley and pulley bolt to tensioner. Tighten bolt to 61 N·m (45 ft. lbs.) torque.
- (2) Install tensioner assembly to mounting bracket. An indexing tab is located on back of tensioner. Align this tab to slot in mounting bracket. Tighten nut to 67 N·m (50 ft. lbs.) torque.
- (3) Connect all wiring to ignition coil.
- (4) Install coil to coil bracket. If nuts and bolts are used to secure coil to coil bracket, tighten to 11 N·m (100 in. lbs.) torque. If coil mounting bracket has been tapped for coil mounting bolts, tighten bolts to 5 N·m (50 in. lbs.) torque.

CAUTION: To prevent damage to coil case, coil mounting bolts must be torqued.

- (5) Install drive belt. Refer to Belt Removal/Installation in this group.
- (6) Check belt indexing marks (Fig. 96).

5.9L HDC-GAS AND 8.0L V-10 ENGINES**REMOVAL**

- (1) Remove accessory drive belt. Refer to Belt Removal/Installation in this group.
- (2) Remove tensioner mounting bolt (Fig. 97) and remove tensioner.

CAUTION: If the pulley is to be removed from the tensioner, its mounting bolt has left-hand threads.

WARNING: BECAUSE OF HIGH SPRING PRESSURE, DO NOT ATTEMPT TO DISASSEMBLE AUTOMATIC TENSIONER. UNIT IS SERVICED AS AN ASSEMBLY (EXCEPT FOR PULLEY).

REMOVAL AND INSTALLATION (Continued)

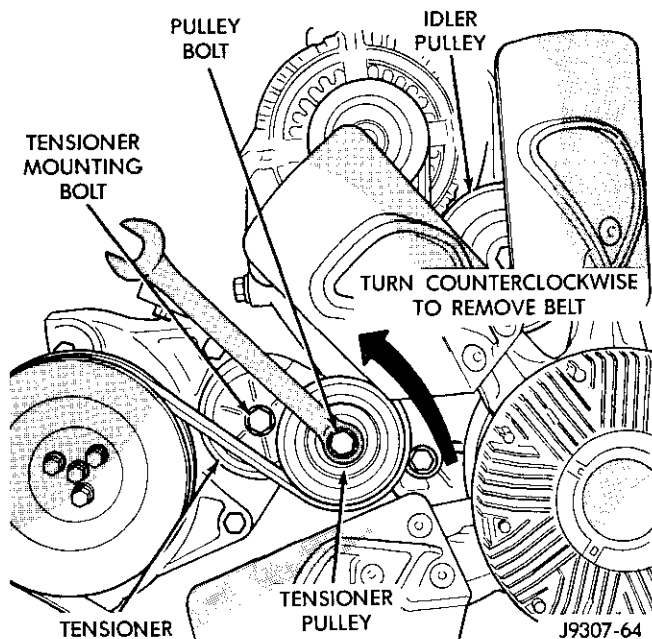


Fig. 97 Belt Tensioner—5.9L HDC-Gas and 8.0L v-10 INSTALLATION

(1) Install pulley and pulley bolt to tensioner (observe the previous CAUTION). Tighten bolt to 88 N·m (65 ft. lbs.) torque.

(2) Install tensioner assembly to mounting bracket. A dowel pin is located on back of tensioner (Fig. 98). Align this to dowel hole (Fig. 99) in tensioner mounting bracket. Tighten bolt to 41 N·m (30 ft. lbs.) torque.

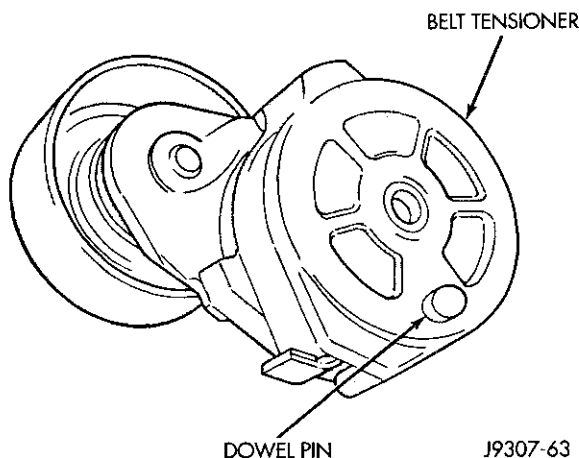


Fig. 98 Tensioner Dowel Pin—5.9L HDC-Gas and 8.0L V-10 Engines

(3) Install drive belt. Refer to Belt Removal/Installation in this group.

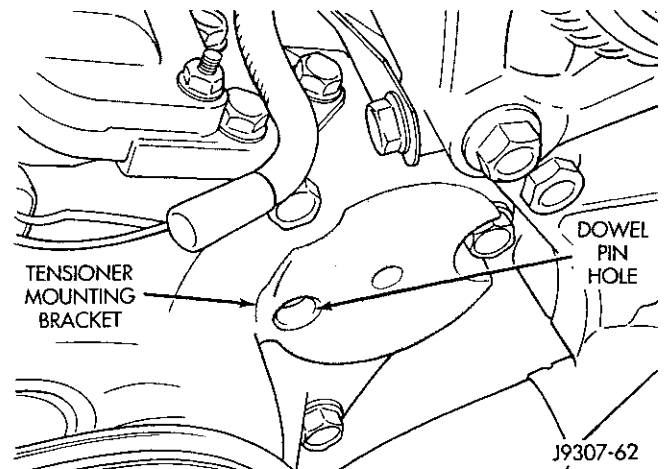


Fig. 99 Tensioner Dowel Hole—5.9L HDC-Gas and 8.0L V-10 Engines

5.9L DIESEL ENGINE

REMOVAL

(1) Remove accessory drive belt. Refer to Belt Removal/Installation in this group.

(2) Remove tensioner mounting bolt (Fig. 97) and remove tensioner.

WARNING: BECAUSE OF HIGH SPRING PRESSURE, DO NOT ATTEMPT TO DISASSEMBLE AUTOMATIC TENSIONER. UNIT IS SERVICED AS AN ASSEMBLY (EXCEPT FOR PULLEY).

INSTALLATION

(1) Install pulley to tensioner.

(2) Install tensioner assembly to mounting bracket. A dowel is located on back of tensioner. Align this dowel to hole in tensioner mounting bracket. Tighten bolt to 41 N·m (30 ft. lbs.) torque.

(3) Install drive belt. Refer to Belt Removal/Installation in this group.

COOLING SYSTEM FAN—GAS ENGINES

REMOVAL

CAUTION: If the viscous fan drive is replaced because of mechanical damage, the cooling fan blades should also be inspected. Inspect for fatigue cracks, loose blades, or loose rivets that could have resulted from excessive vibration. Replace fan blade assembly if any of these conditions are found. Also inspect water pump bearing and shaft assembly for any related damage due to a viscous fan drive malfunction.

- (1) Disconnect negative battery cable from battery.
- (2) Remove throttle cable at top of fan shroud.

REMOVAL AND INSTALLATION (Continued)

(3) All Except 8.0L V-10 Engine: Unsnap coolant reserve/overflow tank from fan shroud and lay aside. The tank is held to shroud with T-shaped slots. Do not disconnect hose or drain coolant from tank.

(4) The thermal viscous fan drive/fan blade assembly is attached (threaded) to water pump hub shaft (Fig. 100). Remove fan blade/viscous fan drive assembly from water pump by turning mounting nut counterclockwise as viewed from front. Threads on viscous fan drive are **RIGHT-HAND**. A Snap-On 36 MM Fan Wrench (number SP346 from Snap-On Cummins Diesel Tool Set number 2017DSP) can be used. Place a bar or screwdriver between water pump pulley bolts (Fig. 100) to prevent pulley from rotating.

(5) Do not attempt to remove fan/viscous fan drive assembly from vehicle at this time.

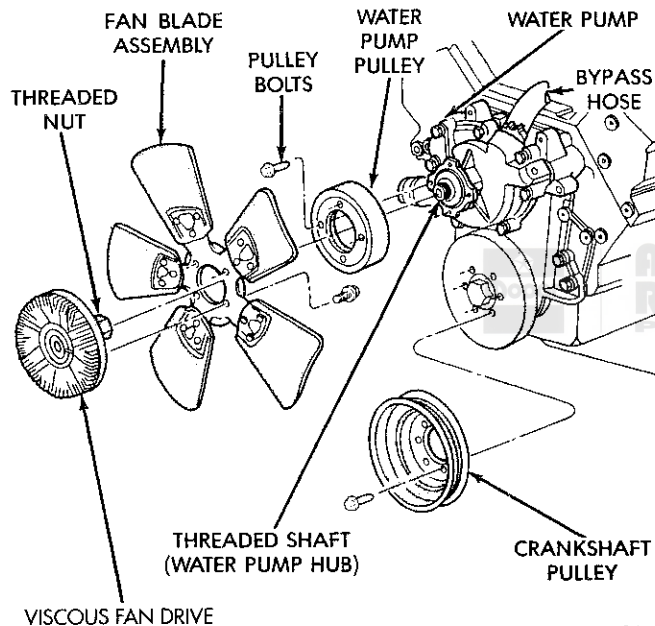


Fig. 100 Fan Blade/Viscous Fan Drive—Gas Engines—Typical

(6) Do not unbolt fan blade assembly (Fig. 100) from viscous fan drive at this time.

(7) Remove four fan shroud-to-radiator mounting bolts.

(8) Remove fan shroud and fan blade/viscous fan drive assembly as a complete unit from vehicle.

(9) After removing fan blade/viscous fan drive assembly, **do not** place viscous fan drive in horizontal position. If stored horizontally, silicone fluid in the viscous fan drive could drain into its bearing assembly and contaminate lubricant.

CAUTION: Do not remove water pump pulley-to-water pump bolts (Fig. 68). This pulley is under spring tension.

(10) Remove four bolts securing fan blade assembly to viscous fan drive (Fig. 100).

CAUTION: Some engines equipped with serpentine drive belts have reverse rotating fans and viscous fan drives. They are marked with the word **REVERSE** to designate their usage. Installation of the wrong fan or viscous fan drive can result in engine overheating.

INSTALLATION

(1) Install fan blade assembly to viscous fan drive. Tighten bolts (Fig. 100) to 23 N·m (17 ft. lbs.) torque.

(2) Position fan shroud and fan blade/viscous fan drive assembly to vehicle as a complete unit.

(3) Install fan shroud.

(4) Install fan blade/viscous fan drive assembly to water pump shaft (Fig. 100).

(5) Except 8.0L V-10 Engine: Install coolant reserve/overflow tank to fan shroud. Snaps into position.

(6) Install throttle cable to fan shroud.

(7) Connect negative battery cable.

NOTE: Viscous Fan Drive Fluid Pump Out Requirement: After installing a new viscous fan drive, bring the engine speed up to approximately 2000 rpm and hold for approximately two minutes. This will ensure proper fluid distribution within the drive.

COOLING SYSTEM FAN DRIVE—DIESEL ENGINE**REMOVAL**

CAUTION: If the viscous fan drive is replaced because of mechanical damage, the cooling fan blades should also be inspected. Inspect for fatigue cracks, loose blades, or loose rivets that could have resulted from excessive vibration. Replace fan blade assembly if any of these conditions are found. Also inspect water pump bearing and shaft assembly for any related damage due to a viscous fan drive malfunction.

(1) Disconnect both negative battery cables at both batteries.

(2) Remove the fan shroud mounting bolts. Position fan shroud towards engine.

CAUTION: Do not remove the fan pulley bolts. This pulley is under spring tension.

(3) The thermal viscous fan drive/fan blade assembly is attached (threaded) to the fan hub shaft (Fig. 101). Remove the fan blade/fan drive assembly from fan pulley by turning the mounting nut clockwise (as

REMOVAL AND INSTALLATION (Continued)

viewed from front). Threads on the viscous fan drive are **LEFT-HAND**. A Snap-On 36 MM Fan Wrench (number SP346 from Snap-On Cummins Diesel Tool Set number 2017DSP) can be used. Place a bar or screwdriver between the fan pulley bolts to prevent pulley from rotating.

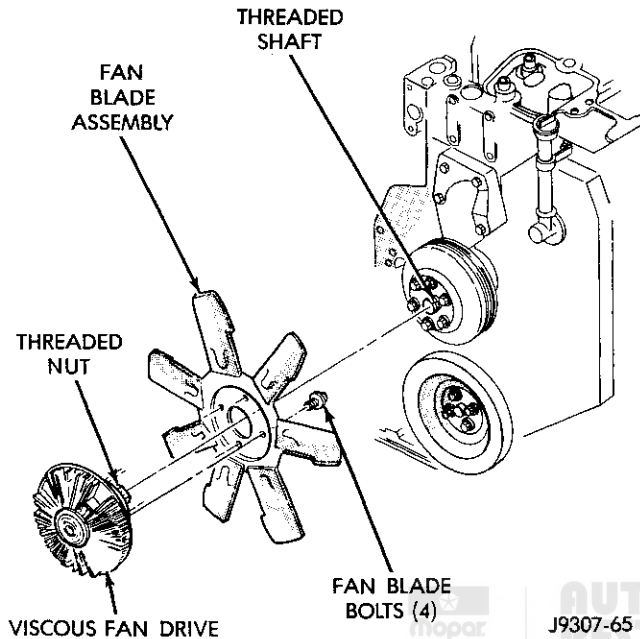


Fig. 101 Fan Blades/Viscous Fan Drive—5.9L Diesel

(4) Remove the fan shroud and the fan blade/viscous drive as an assembly from vehicle.

(5) Remove fan blade-to-viscous fan drive mounting bolts.

(6) Inspect the fan for cracks, loose rivets, loose or bent fan blades.

CAUTION: Some engines equipped with serpentine drive belts have reverse rotating fans and viscous fan drives. They are marked with the word **REVERSE** to designate their usage. Installation of the wrong fan or viscous fan drive can result in engine overheating.

INSTALLATION

(1) Install fan blade assembly to viscous fan drive. Tighten mounting bolts to 23 N·m (17 ft. lbs.) torque.

(2) Position the fan shroud and fan blade/viscous fan drive to the vehicle as an assembly.

(3) Install viscous fan drive assembly on fan hub shaft. Tighten mounting nut to 57 N·m (42 ft. lbs.) torque.

(4) Install fan shroud bolts.

(5) Install battery cables to batteries.

NOTE: Viscous Fan Drive Fluid Pump Out Requirement: After installing a new viscous fan drive, bring the engine speed up to approximately 2000 rpm and hold for approximately two minutes. This will ensure proper fluid distribution within the drive.

CLEANING AND INSPECTION

RADIATOR CAP

INSPECTION

Hold cap at eye level, right side up. The vent valve (Fig. 102) at bottom of cap should open. If rubber gasket has swollen and prevents vent valve from opening, replace cap.

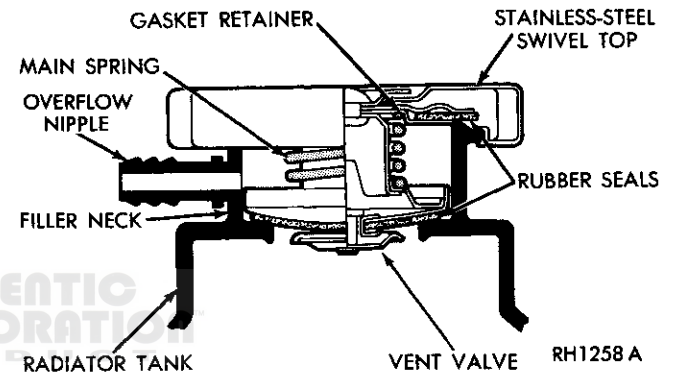


Fig. 102 Radiator Pressure Cap

Hold cap at eye level, upside down. If any light can be seen between vent valve and rubber gasket, replace cap. **Do not use a replacement cap that has a spring to hold vent shut.** A replacement cap must be the type designed for a coolant reserve/overflow system with a completely sealed diaphragm spring and a rubber gasket. This gasket is used to seal to radiator filler neck top surface. Use of proper cap will allow coolant return to radiator.

RADIATOR

CLEANING

The radiator and air conditioning fins should be cleaned when an accumulation of bugs, leaves etc. has occurred. Clean radiator fins are necessary for good heat transfer. With the engine cold, apply cold water and compressed air to the back (engine side) of the radiator to flush the radiator and/or A/C condenser of debris.

WATER PUMP INSPECTION

Replace water pump assembly if it has any of the following conditions:

- The body is cracked or damaged

CLEANING AND INSPECTION (Continued)

- Water leaks from the shaft seal. This is evident by traces of coolant below the vent hole
- Loose or rough turning bearing. Also inspect thermal fan drive
- Impeller rubs either the pump body or timing chain case/cover

FAN**INSPECTION**

The fan cannot be repaired. If fan is damaged, it must be replaced. Inspect fan as follows:

- (1) Remove fan blade and viscous fan drive as an assembly from the engine. Refer to preceding Removal procedure.
- (2) Remove fan blade assembly from viscous fan drive unit (four bolts).
- (3) Lay fan on a flat surface with leading edge facing down. With tip of blade touching flat surface, replace fan if clearance between opposite blade and surface is greater than 2.0 mm (.090 inch). Rocking motion of opposite blades should not exceed 2.0 mm (.090 inch). Test all blades in this manner.

WARNING: DO NOT ATTEMPT TO BEND OR STRAIGHTEN FAN BLADES IF NOT WITHIN SPECIFICATIONS.

- (4) Inspect fan assembly for cracks, bends, loose rivets or broken welds. Replace fan if any damage is found.

CAUTION: If fan blade assembly is replaced because of mechanical damage, water pump and viscous fan drive should also be inspected. These components could have been damaged due to excessive vibration.

Also refer to the preceding Viscous Fan Drive section for additional information.

SPECIFICATIONS**COOLANT CAPACITIES**

3.9L/5.2L/5.9L Gas Engines	19 Liters (20 Qts. or 5.0 Gals.)
8.0L Engine	25 Liters (26 Qts. or 6.5 Gals.)
5.9L Diesel Engine	23 Liters (24 Qts. or 6.0 Gals.)

* Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerances and refill procedures.

* Capacities shown include vehicles with air conditioning and or heavy-duty cooling systems.

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SPECIFICATIONS (Continued)

TORQUE

Description	Torque
Automatic Belt Tensioner Pulley Bolt — 3.9L/5.2L/5.9L LDC Gas Engine . . .	61 N•m (45 ft. lbs.)
Automatic Belt Tensioner Pulley Bolt — 5.9L HDC Gas and 8.0L V-10 Engine	88 N•m (65 ft. lbs.)
Automatic Belt Tensioner-to-Mounting Bracket—3.9L/5.2L/5.9L LDC Gas Engine	67 N•m (50 ft. lbs.)
Automatic Belt Tensioner-to-Mounting Bracket—5.9L HDC Gas and 8.0L V-10 Engines	41 N•m (30 ft. lbs.)
Fan Shroud-to-Radiator Mounting Bolts	6 N•m (50 in. lbs.)
Heater Hose Fitting at Water Pump — 8.0L V-10 Engine	16 N•m (14 ft. in. lbs.)
Hose Clamps	4 N•m (34 in. lbs.)
Idle Pulley Mounting Bolt — All Gas Engines	61 N•m (45 ft. lbs.)

Description	Torque
Radiator Mounting Bolts	11 N•m (95 in. lbs.)
Thermal Viscous Fan-to-Hub-Diesel Engine	57 N•m (42 ft. lbs.)
Thermostat Housing Bolts — All Gas Engines Except 8.0L V-10 . .	23 N•m (200 in. lbs.)
Thermostat Housing Bolts — 8.0L V-10	25 N•m (220 in. lbs.)
Thermostat Housing Bolts — Diesel Engine	24 N•m (18 ft. lbs.)
Water Pump Mounting Bolts — All Gas Engines	40 N•m (30 ft. lbs.)
Water Pump Pulley Bolts — All Gas Engines	22 N•m (16 ft. lbs.)
Water Pump Mounting Bolts — Diesel Engine	24 N•m (18 ft. lbs.)

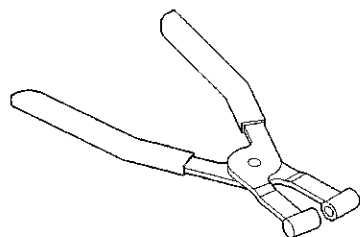
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SPECIAL TOOLS

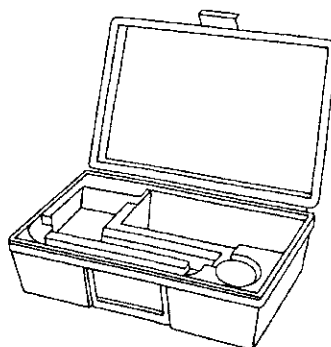
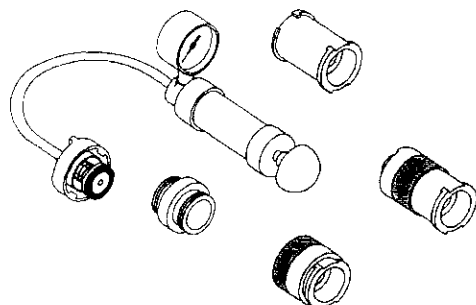
COOLING



**AUTHENTIC
RESTORATION[™]
PRODUCT**



Pliers 6094



Pressure Tester 7700-A

BATTERY

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GENERAL INFORMATION

OVERVIEW

The battery, starting, and charging systems operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components involved in these systems must perform within specifications.

Group 8A covers the battery, Group 8B covers the starting system, and Group 8C covers the charging system. Refer to Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in these groups include the most basic conventional diagnostic methods to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of a induction milliamperage ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See the On-Board Diagnostics Test in Group 8C - Charging System for more information.

INTRODUCTION

This section covers battery diagnostic and service procedures only. For battery maintenance procedures, refer to Group 0 - Lubrication and Maintenance. While battery charging can be considered a maintenance procedure, battery charging information is located in this

group. This was done because the battery must be fully-charged before any diagnosis can be performed.

The factory-installed maintenance-free battery has non-removable battery vent caps (Fig. 1). Water cannot be added to this battery. The chemical composition within the maintenance-free battery reduces battery gassing and water loss at normal charge and discharge rates. Therefore, the battery should not require additional water in normal service.

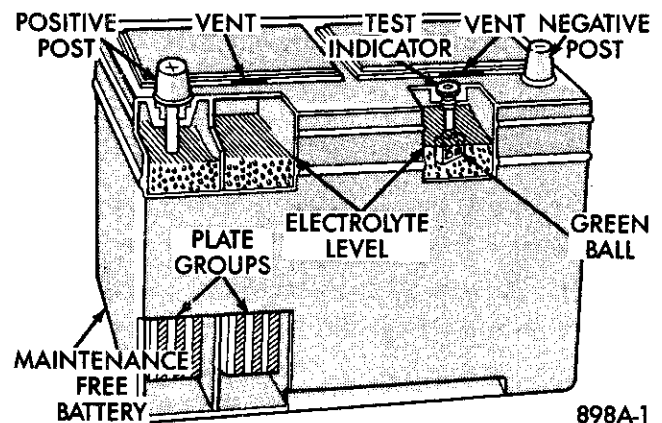


Fig. 1 Maintenance-Free Battery

If the battery electrolyte level becomes low, the battery must be replaced. However, rapid loss of electrolyte can be caused by an over-charging condition. Be certain to diagnose the charging system before returning the vehicle to service. Refer to Group 8C - Charging System for more information.

The factory-installed battery also has a built-in test indicator (hydrometer). The color visible in the sight glass of the indicator will reveal the battery condition. See Built-In Test Indicator in this group for more information.

GENERAL INFORMATION (Continued)

It is important that the battery, starting, and charging systems be thoroughly tested and inspected any time a battery needs to be charged or replaced. The cause of abnormal discharge, over-charging, or early battery failure must be diagnosed and corrected before a battery is replaced or returned to service.

DESCRIPTION AND OPERATION

BATTERY

The storage battery is a device used to store electrical energy potential in a chemical form. When an electrical load is applied to the battery terminals, an electrochemical reaction occurs within the battery. This reaction causes the battery to discharge electrical current.

The battery is made up of six individual cells that are connected in series. Each cell contains positively charged plate groups made of lead oxide, and negatively charged plate groups made of sponge lead. These dissimilar metal plates are submerged in a sulfuric acid and water solution called an electrolyte.

As the battery discharges, a gradual chemical change takes place within each cell. The sulfuric acid in the electrolyte combines with the plate materials, causing both plates to slowly change to lead sulfate. At the same time, oxygen from the positive plate material combines with hydrogen from the sulfuric acid, causing the electrolyte to become mainly water.

The chemical changes within the battery are caused by the movement of excess, or free, electrons between the positive and negative plate groups. This movement of electrons produces a flow of electrical current through the load device attached to the battery terminals.

As the plate materials become more similar chemically, and the electrolyte becomes less acid, the voltage potential of each cell is reduced. However, by charging the battery with a voltage higher than that of the battery, the battery discharging process is reversed.

Charging the battery gradually changes the sulfated lead plates back into sponge lead and lead oxide, and the water back into sulfuric acid. This action restores the difference in the electron charges deposited on the plates, and the voltage potential of the battery cells.

For a battery to remain useful, it must be able to produce high-amperage current over an extended period. A battery must also be able to accept a charge, so that its voltage potential may be restored.

In addition to producing and storing electrical energy, the battery serves as a capacitor, or voltage stabilizer, for a vehicle's electrical system. It absorbs most abnormal or transient voltages caused by the switching of any of the vehicle's electrical components.

The battery is vented to release excess hydrogen gas that is created when the battery is being charged or discharged. However, even with these vents, the hydrogen

gas can collect in or around the battery. If hydrogen gas is exposed to flame or sparks, it may ignite.

If the electrolyte level is low, the battery may arc internally and explode. If the battery is equipped with removable cell caps, add distilled water whenever the electrolyte level is below the top of the plates. If the battery cell caps cannot be removed, the battery must be replaced if the electrolyte level becomes low.

BATTERY SIZE AND RATINGS

The outside dimensions and terminal placement of the battery conform to standards established by the Battery Council International (BCI). Each battery is assigned a BCI Group Size number to help identify a correctly-sized replacement.

In addition, there are two commonly accepted methods for rating and comparing battery performance. These ratings are called Cold Cranking Amperage (CCA) and Reserve Capacity (RC). Both ratings are described in more detail below.

The Group Size number, CCA rating, and RC rating can be found on the original equipment battery label. Be certain that a replacement battery has the correct Group Size number, as well as CCA and RC ratings that equal or exceed the original equipment specification for the vehicle being serviced. See the Battery Classifications and Ratings chart in Specifications at the back of this group for more information.

COLD CRANKING AMPERAGE

The Cold Cranking Amperage (CCA) rating specifies how much current (in amperes) the battery can deliver for 30 seconds at -17.7°C (0°F). Terminal voltage must not fall below 7.2 volts during or after the 30 second discharge. The CCA required is generally higher as engine displacement increases, depending also upon the starter current draw requirements.

RESERVE CAPACITY

The Reserve Capacity (RC) rating specifies the time (in minutes) it takes for battery terminal voltage to fall below 10.2 volts, at a discharge rate of 25 amperes. RC is determined with the battery fully-charged at 26.7°C (80°F). This rating estimates how long the battery might last after a charging system failure, under minimum electrical load.

BATTERY MOUNTING

The battery is mounted to a molded plastic tray located in the left front corner of the engine compartment. A U-nut is held in a formation on each side of the battery tray. A holddown strap fits across the top of the battery case. A bolt passes through the holddown strap on each side of the battery, and is threaded into the U-nut on each side of the battery tray.

The battery tray is fastened to the inner fender shield with two bolts. The tray is also fastened to the

DESCRIPTION AND OPERATION (Continued)

inner wheelhouse panel. A plate with two studs passes through the front of the tray and wheelhouse panel from the top. A second plate with two studs passes through the rear of the tray and wheelhouse panel from underneath. Nuts are used to secure each of the four exposed studs.

Models with the diesel engine option have a second battery tray located in the right front corner of the engine compartment. This tray, and its mounting method and hardware, is a mirror image of the left battery tray.

A hole in the bottom of the left battery tray is fitted with a battery temperature sensor on some models. Models without the battery temperature sensor have a plug fitted to this hole. Refer to Group 8C - Charging System for more information on the battery temperature sensor.

Models with an optional vehicle speed control system have the speed control servo mounting bracket attached to the bottom of the left battery tray. Refer to Group 8H - Vehicle Speed Control System for more information.

DIAGNOSIS AND TESTING

BATTERY

The battery must be completely charged and the top, posts, and terminal clamps should be properly cleaned before diagnostic procedures are performed. See Battery Charging in this group for more information.

NOTE: Models equipped with the diesel engine option are equipped with two 12-volt batteries, connected in parallel (positive-to-positive/negative-to-negative). The secondary battery, on the passenger's side, is dedicated to providing current for the operation of the intake manifold air heater. The primary battery, on the driver's side, is dedicated to all other vehicle electrical requirements. In order to ensure accurate diagnostic results, these batteries **MUST** be disconnected from each other, as well as from the vehicle electrical system, when being tested.

WARNING:

- IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.
- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.
- THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CON-

TACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.

- IF THE BATTERY IS EQUIPPED WITH REMOVABLE CELL CAPS, BE CERTAIN THAT EACH OF THE CELL CAPS IS IN PLACE AND TIGHT BEFORE THE BATTERY IS RETURNED TO SERVICE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT FROM LOOSE OR MISSING CELL CAPS.

The condition of a battery is determined by two criteria:

1. **State-Of-Charge** - This can be determined by viewing the built-in test indicator, by checking the specific gravity of the electrolyte (hydrometer test), or by checking the battery voltage (open circuit voltage test).

2. **Cranking Capacity** - This can be determined by performing a battery load test, which measures the ability of the battery to supply high-amperage current.

First, determine the battery state-of-charge. This can be done in one of three ways. If the battery has a built-in test indicator, use this test to determine the state-of-charge. If the battery has no test indicator, but has removable cell caps, perform the hydrometer test to determine the state-of-charge. If the cell caps are not removable, or a hydrometer is not available, perform the open circuit voltage test to determine the state-of-charge.

The battery must be charged before proceeding with a load test if:

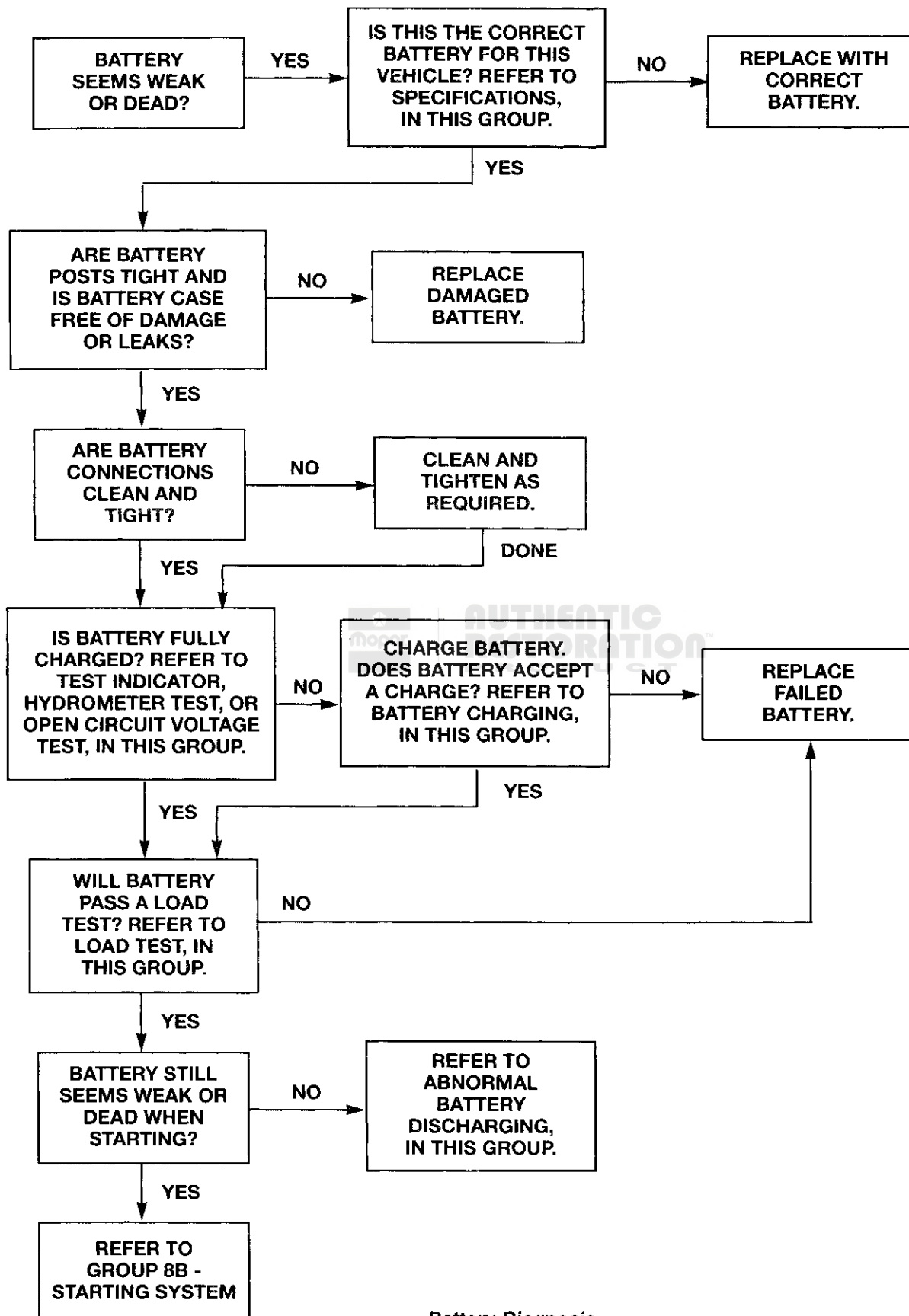
- The built-in test indicator has a black or dark color visible.
- The temperature corrected specific gravity is less than 1.235.
- The open circuit voltage is less than 12.4 volts.

A battery that will not accept a charge is faulty, and must be replaced. Further testing is not required. A fully-charged battery must be load tested to determine its cranking capacity. A battery that is fully-charged, but does not pass the load test, is faulty and must be replaced.

NOTE: Completely discharged batteries may take several hours to accept a charge. See Charging A Completely Discharged Battery in this group for more information.

A battery is fully-charged when:

- All cells are gassing freely during charging.
- A green color is visible in the sight glass of the built-in test indicator.
- Three corrected specific gravity tests, taken at 1-hour intervals, indicate no increase in the specific gravity.
- Open circuit voltage is 12.4 volts or greater.

DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS AND TESTING (Continued)

ABNORMAL BATTERY DISCHARGING

Any of the following conditions can result in abnormal battery discharging:

1. Corroded or loose battery posts and terminal clamps.
2. A loose or worn generator drive belt.
3. Electrical loads that exceed the output of the charging system. This can be due to equipment installed after manufacture, or repeated short trip use.
4. Slow driving speeds (heavy traffic conditions) or prolonged idling, with high-amperage draw systems in use.
5. A faulty circuit or component causing excessive ignition-off draw. See Ignition-Off Draw Test in this group for more information.
6. A faulty or incorrect charging system component.
7. A faulty or incorrect battery.

BUILT-IN TEST INDICATOR

A test indicator (hydrometer) built into the top of the battery case provides visual information for battery testing (Fig. 2). Like a hydrometer, the built-in test indicator measures the specific gravity of the electrolyte. The test indicator reveals the battery state-of-charge; however, it will not reveal the cranking capacity of the battery. A load test must be performed to determine the battery cranking capacity. See Load Test in this group for more information.

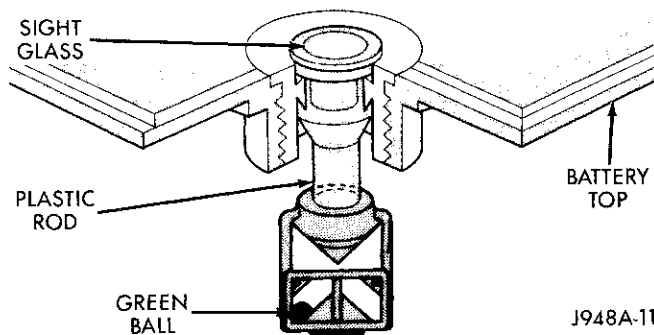


Fig. 2 Built-In Test Indicator

WARNING:

• IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST-BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

• EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

• THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.

• IF THE BATTERY IS EQUIPPED WITH REMOVABLE CELL CAPS, BE CERTAIN THAT EACH OF THE CELL CAPS IS IN PLACE AND TIGHT BEFORE THE BATTERY IS RETURNED TO SERVICE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT FROM LOOSE OR MISSING CELL CAPS.

Before testing, visually inspect the battery for any damage (a cracked case or cover, loose posts, etc.) that would cause the battery to be faulty. In order to obtain correct indications from the built-in test indicator, it is important that the battery be level and have a clean sight glass. Additional light may be required to view the indicator. **Do not use open flame as a source of additional light.**

To read the built-in test indicator, look into the sight glass and note the color of the indicator (Fig. 3). Refer to the following description, as the color indicates:

• **Green** - indicates 75% to 100% state-of-charge. The battery is adequately charged for further testing or return to use. If the vehicle will not crank for a minimum of 15 seconds with a fully-charged battery, perform the Load Test.

• **Black or Dark** - indicates 0% to 75% state-of-charge. The battery is inadequately charged and must be charged until a green indication is visible in the sight glass (12.4 volts or more), before the battery is tested further or returned to service. See Battery Charging in this group for more information. Also see Abnormal Battery Discharging in this group for possible causes of the discharged condition.

• **Yellow or Bright** - indicates a low electrolyte level. The electrolyte level in the battery is below the test indicator. A maintenance-free battery with non-removable cell caps must be replaced if the electrolyte level is low. Water must be added to a low-maintenance battery with removable cell caps before it is charged. See Battery Charging in this group for more information. A low electrolyte level may be caused by an over-charging condition. Refer to Group 8C - Charging System to diagnose an over-charging condition.

HYDROMETER TEST

The hydrometer test reveals the battery state-of-charge by measuring the specific gravity of the electrolyte. This test cannot be performed on maintenance-free batteries with non-removable cell caps. If the battery has non-removable cell caps, see

DIAGNOSIS AND TESTING (Continued)

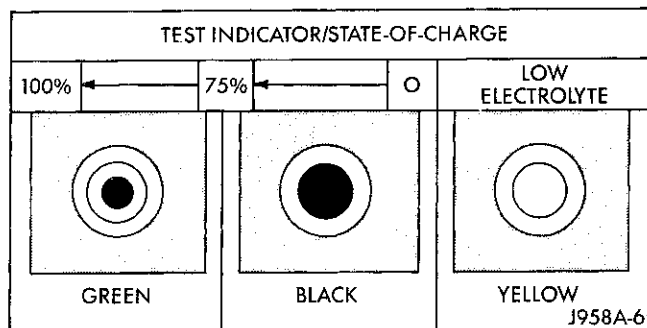


Fig. 3 Built-In Test Indicator Sight Glass

Built-In Test Indicator or Open Circuit Voltage Test in this group.

Specific gravity is a comparison of the density of the electrolyte to the density of pure water. Pure water has a specific gravity of 1.000, and sulfuric acid has a specific gravity of 1.835. Sulfuric acid makes up approximately 35% of the electrolyte by weight, or 24% by volume.

In a fully-charged battery the electrolyte will have a temperature-corrected specific gravity of 1.260 to 1.290. However, a specific gravity of 1.235 or above is satisfactory for battery load testing and/or return to service.

WARNING:

- IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST-BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.

- IF THE BATTERY IS EQUIPPED WITH REMOVABLE CELL CAPS, BE CERTAIN THAT EACH OF THE CELL CAPS IS IN PLACE AND TIGHT BEFORE THE BATTERY IS RETURNED TO SERVICE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT FROM LOOSE OR MISSING CELL CAPS.

Before testing, visually inspect the battery for any damage (a cracked case or cover, loose posts, etc.) that would cause the battery to be faulty. Then remove the cell caps and check the electrolyte level.

Add distilled water if the electrolyte level is below the top of the battery plates.

Refer to the hydrometer manufacturer's instructions for correct use of the hydrometer. Remove only enough electrolyte from the battery so that the float is off the bottom of the hydrometer barrel with pressure on the bulb released.

CAUTION: Exercise care when inserting the tip of the hydrometer into a cell to avoid damaging the plate separators. Damaged plate separators can cause early battery failure.

To read the hydrometer correctly, hold it with the top surface of the electrolyte at eye level. Hydrometer floats are generally calibrated to indicate the specific gravity correctly only at 26.7°C (80°F). When testing the specific gravity at any other temperature, a correction factor is required.

The correction factor is approximately a specific gravity value of 0.004, referred to as 4 points of specific gravity. For each 5.5°C above 26.7°C (10°F above 80°F), add 4 points. For each 5.5°C below 26.7°C (10°F below 80°F), subtract 4 points. Always correct the specific gravity for temperature variation. Test the specific gravity of the electrolyte in each battery cell.

EXAMPLE: A battery is tested at -12.2°C (10°F) and has a specific gravity of 1.240. Determine the actual specific gravity as follows:

(1) Determine the number of degrees above or below 26.7°C (80°F):

$$26.6^{\circ}\text{C} - -12.2^{\circ}\text{C} = 38.8^{\circ}\text{C} \quad (80^{\circ}\text{F} - 10^{\circ}\text{F} = 70^{\circ}\text{F})$$

(2) Divide the result from Step 1 by 5.5 (10):

$$38.8^{\circ}\text{C}/5.5 = 7 \quad (70^{\circ}\text{F}/10 = 7)$$

(3) Multiply the result from Step 2 by the temperature correction factor (0.004):

$$7 \times 0.004 = 0.028$$

(4) The temperature at testing was below 26.7°C (80°F); therefore, the temperature correction factor is subtracted:

$$1.240 - 0.028 = 1.212$$

The corrected specific gravity of the battery in this example is 1.212.

If the specific gravity of all cells is above 1.235, but the variation between cells is more than 50 points (0.050), the battery should be replaced. If the specific gravity of one or more cells is less than 1.235, charge the battery at a rate of approximately 5 amperes.

Continue charging until three consecutive specific gravity tests, taken at 1-hour intervals, are constant. If the cell specific gravity variation is more than 50 points (0.050) at the end of the charge period, replace the battery.

When the specific gravity of all cells is above 1.235, and the cell variation is less than 50 points (0.050),

DIAGNOSIS AND TESTING (Continued)

the battery may be load tested to determine its cranking capacity. See Load Test in this group for more information.

OPEN-CIRCUIT VOLTAGE TEST

A battery open-circuit voltage (no load) test will show the state-of-charge of a battery. This test can be used in place of the hydrometer test, if a hydrometer is not available; or, for maintenance-free batteries with non-removable cell caps.

WARNING:

- IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

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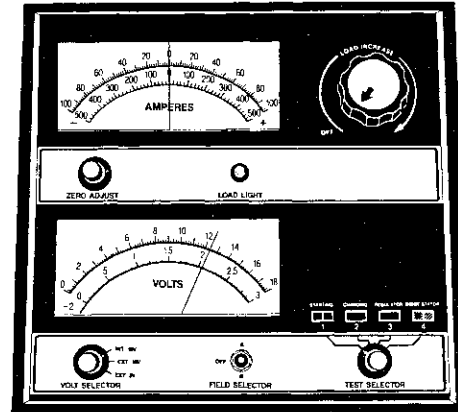
Before proceeding with this test, completely charge the battery as described in Battery Charging in this group.

(1) Before measuring the open-circuit voltage, the surface charge must be removed from the battery. Turn the headlamps on for 15 seconds, then allow up to five minutes for the battery voltage to stabilize.

NOTE: Models equipped with the diesel engine option are equipped with two 12-volt batteries, connected in parallel (positive-to-positive/negative-to-negative). The secondary battery, on the passenger's side, is dedicated to providing current for the operation of the intake manifold air heater. The primary battery, on the driver's side, is dedicated to all other vehicle electrical requirements. In order to ensure accurate diagnostic results, these batteries **MUST** be disconnected from each other, as well as from the vehicle electrical system, when being tested.

(2) Disconnect and isolate both battery cables, negative cable first.

(3) Using a voltmeter connected to the battery posts (refer to the instructions provided with the voltmeter), measure the open-circuit voltage (Fig. 4).



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Fig. 4 Testing Open-Circuit Voltage

See the Open-Circuit Voltage chart. This voltage reading will indicate the battery state-of-charge, but will not reveal its cranking capacity. If a battery has an open-circuit voltage reading of 12.4 volts or greater, it may be load tested to reveal its cranking capacity. See Load Test in this group for more information.

Open Circuit Voltage	
Open Circuit Volts	Charge Percentage
11.7 volts or less	0%
12.0 volts	25%
12.2 volts	50%
12.4 volts	75%
12.6 volts or more	100%

LOAD TEST

A battery load test will verify the battery cranking capacity. The test is based on the Cold Cranking Amperage (CCA) rating of the battery. See the Battery Classifications and Ratings chart in Specifications at the back of this group.

DIAGNOSIS AND TESTING (Continued)**WARNING:**

- IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

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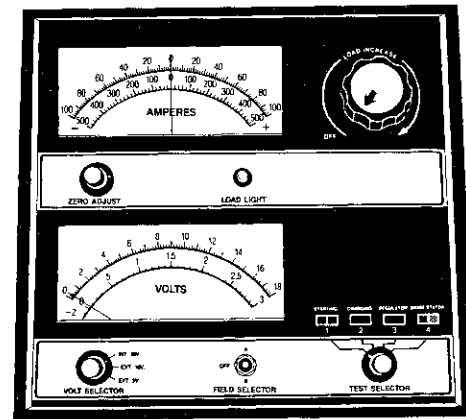
Before proceeding with this test, completely charge the battery as described in Battery Charging in this group.

NOTE: Models equipped with the diesel engine option are equipped with two 12-volt batteries, connected in parallel (positive-to-positive/negative-to-negative). The secondary battery, on the passenger's side, is dedicated to providing current for the operation of the intake manifold air heater. The primary battery, on the driver's side, is dedicated to all other vehicle electrical requirements. In order to ensure accurate diagnostic results, these batteries **MUST** be disconnected from each other, as well as from the vehicle electrical system, when being tested.

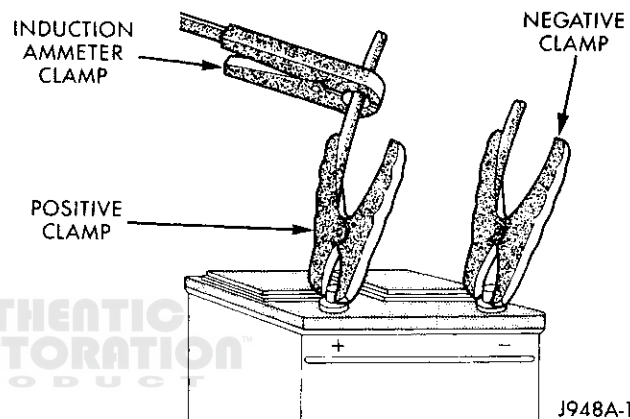
(1) Disconnect and isolate both battery cables, negative cable first. The battery top and posts should be clean.

(2) Connect a suitable volt-ammeter-load tester (Fig. 5) to the battery posts (Fig. 6). Refer to the operating instructions provided with the tester being used. Check the open-circuit voltage (no load) of the battery. Open-circuit voltage must be 12.4 volts or greater.

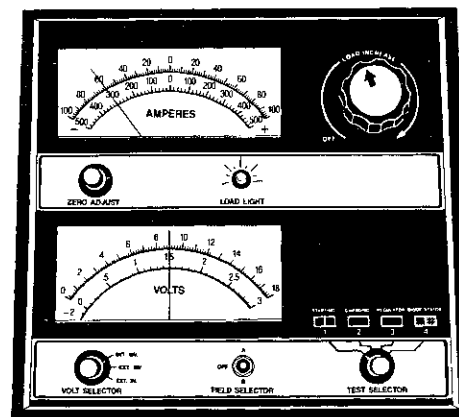
(3) Rotate the load control knob (carbon pile rheostat) to apply a 300 amp load to the battery for 15 seconds, then return the control knob to the Off position (Fig. 7). This will remove the surface charge from the battery.



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Fig. 5 Volt-Ammeter-Load Tester - Typical

J948A-13

Fig. 6 Volt-Ammeter-Load Tester Connections

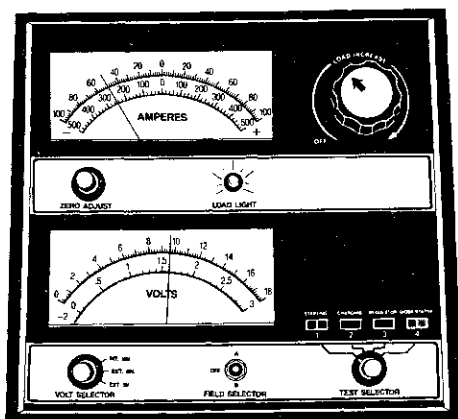
898A-10

Fig. 7 Remove Surface Charge from Battery

(4) Allow the battery to stabilize to open-circuit voltage. It may take up to five minutes for the battery voltage to stabilize.

(5) Rotate the load control knob to maintain a load equal to 50% of the battery's CCA rating (Fig. 8). After 15 seconds, record the loaded voltage reading, then return the load control knob to the Off position.

DIAGNOSIS AND TESTING (Continued)



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Fig. 8 Load 50% CCA Rating - Note Voltage

(6) The voltage drop will vary with the battery temperature at the time of the load test. The battery temperature can be estimated by the ambient temperature during the past several hours. If the battery has been charged, boosted, or loaded a few minutes prior to test, the battery will be somewhat warmer. See the Load Test Temperature chart for the proper loaded voltage reading.

Load Test Temperature		
Minimum Voltage	Temperature	
	°F	°C
9.6 volts	70° and above	21° and above
9.5 volts	60°	16°
9.4 volts	50°	10°
9.3 volts	40°	4°
9.1 volts	30°	-1°
8.9 volts	20°	-7°
8.7 volts	10°	-12°
8.5 volts	0°	-18°

(7) If the voltmeter reading falls below 9.6 volts, at a minimum battery temperature of 21°C (70°F), the battery is faulty and must be replaced.

IGNITION-OFF DRAW TEST

Ignition-Off Draw (IOD) refers to power being drained from the battery with the ignition switch in the Off position. A normal vehicle electrical system will draw from 5 to 20 milliamperes (0.005 - 0.020 ampere) with the ignition switch in the Off position, and all non-ignition controlled circuits in proper working order. The 20 milliamperes are needed to supply Powertrain Control Module (PCM) memory, digital clock memory, and electronically tuned radio memory.

A vehicle that has not been operated for approximately 20 days, may discharge the battery to an inadequate level. When a vehicle will not be used for 20 days or more (stored), remove the IOD fuse from the fuseblock module. This will reduce battery discharging.

Excessive IOD can be caused by:

- Electrical items left on
- Faulty or improperly adjusted switches
- An internally shorted generator
- Intermittent shorts in the wiring.

If the IOD is over 20 milliamperes, the problem must be found and corrected before replacing a battery. In most cases, the battery can be charged and returned to service.

DIAGNOSIS

CAUTION: Testing for high-amperage IOD must be performed first to prevent damage to most milliamperere meters.

NOTE: When testing a diesel engine-equipped vehicle (dual batteries), do not check the IOD between batteries. One battery may be at a higher state-of-charge than the other, which will cause a high IOD between the batteries. Remove the negative cable from the passenger's side battery negative terminal post prior to performing the IOD diagnosis outlined below.

(1) Verify that all electrical accessories are off. Turn off all lamps, remove the ignition key, and close all doors. If the vehicle is equipped with a illuminated entry system or electronically tuned radio, allow the electronic timer function of these systems to automatically shut off (time out). This may take up to three minutes.

(2) Determine that the underhood lamp is operating properly, then disconnect the lamp or remove the bulb.

(3) Disconnect the battery negative cable.

(4) Connect a typical 12-volt test lamp (low-wattage bulb) between the disconnected battery negative cable clamp and the battery negative terminal post. Make sure that the doors remain closed so that the illuminated entry system is not activated. The test lamp may light brightly for up to three minutes, or may not light at all, depending upon the vehicle's electrical equipment. The term "brightly," as used throughout the following tests, implies the brightness of the test lamp will be the same as if it were connected across the battery. The test lamp must be securely clamped to the battery negative cable clamp and the battery negative terminal post. If the continuity between the battery negative terminal post and

DIAGNOSIS AND TESTING (Continued)

cable clamp is lost during any part of the IOD test, the electronic timer function will be activated and all tests must be repeated.

(5) After three minutes, the test lamp should turn off or be dimly lit, depending upon the vehicle's electrical equipment. If the test lamp remains brightly lit, do not disconnect it. Remove each fuse or circuit breaker (refer to Group 8W - Wiring Diagrams for more information) until the test lamp is either off, or dimly lit. This will isolate each circuit and identify the source of the high-amperage IOD. If the test lamp is still brightly lit after disconnecting each fuse and circuit breaker, disconnect the wiring harness from the generator. If the test lamp now turns off or is dimly lit, refer to Group 8C - Charging System to diagnose the faulty charging system. Do not disconnect the test lamp. After the high-amperage IOD has been corrected, the low-amperage IOD may be checked. It is now safe to install a milliamperage meter to check the low-amperage IOD.

(6) With the test lamp still connected securely, clamp a milliamperage meter between the battery negative terminal post and the negative cable clamp.

CAUTION: Do not open any doors, or turn on any electrical accessories, with the test lamp disconnected or the milliamperage meter may be damaged.

(7) Disconnect the test lamp. Observe the milliamperage meter. The current draw should not exceed 20 milliamperes (0.020 ampere). If draw exceeds 20 milliamperes, isolate each circuit by removing the circuit breakers and fuses. The milliamperage meter reading will drop when the source of the draw is disconnected. Repair this circuit as required, whether it is a wiring short, incorrect switch adjustment, or a component failure.

SERVICE PROCEDURES**BATTERY CHARGING**

A battery is fully-charged when:

- All cells are gassing freely during battery charging.
- A green color is visible in the sight glass of the built-in test indicator.
- Three corrected specific gravity tests, taken at 1-hour intervals, indicate no increase in the specific gravity.
- Open-circuit voltage is 12.4 volts or above.

WARNING:

• IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY

AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

- THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.

- IF THE BATTERY IS EQUIPPED WITH REMOVABLE CELL CAPS, BE CERTAIN THAT EACH OF THE CELL CAPS IS IN PLACE AND TIGHT BEFORE THE BATTERY IS RETURNED TO SERVICE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT FROM LOOSE OR MISSING CELL CAPS.

CAUTION:

- Always disconnect and isolate the battery negative cable before charging a battery. Do not exceed 16.0 volts while charging a battery. Damage to the vehicle electrical system components may result.

- Battery electrolyte will bubble inside the battery case during normal battery charging. Electrolyte boiling or being discharged from the battery vents indicates a battery over-charging condition. Immediately reduce the charging rate or turn off the charger to evaluate the battery condition. Damage to the battery may result from over-charging.

- The battery should not be hot to the touch. If the battery feels hot to the touch, turn off the charger and let the battery cool before continuing the charging operation. Damage to the battery may result.

NOTE: Models equipped with the diesel engine option are equipped with two 12-volt batteries, connected in parallel (positive-to-positive/negative-to-negative). The secondary battery, on the passenger's side, is dedicated to providing current for the operation of the intake manifold air heater. The primary battery, on the driver's side, is dedicated to all other vehicle electrical requirements. In order to ensure proper charging of each battery, these batteries **MUST** be disconnected from each other, as well as from the vehicle electrical system, while being charged.

Some battery chargers are equipped with polarity-sensing circuitry. This circuitry protects the charger and/or battery from being damaged if they are improperly connected. If the battery state-of-charge

SERVICE PROCEDURES (Continued)

is too low for the polarity-sensing circuitry to detect, the charger will not operate. This makes it appear that the battery will not accept charging current. Refer to the instructions provided with the battery charger to bypass the polarity-sensing circuitry.

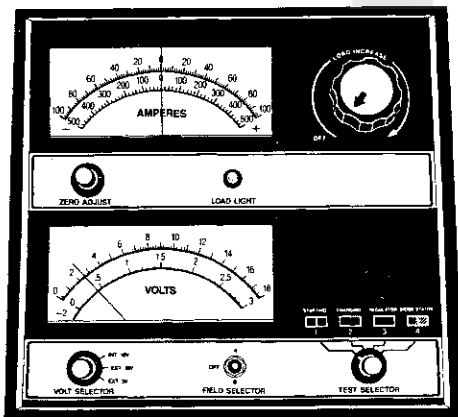
After the battery has been charged to 12.4 volts or greater, perform a load test to determine the battery cranking capacity. If the battery will endure a load test, return the battery to use. If the battery will not endure a load test, it is faulty and must be replaced.

Clean and inspect the battery holdowns, tray, terminals, posts, and top before completing service. See the Battery Removal and Installation procedures in this group for more information.

CHARGING A COMPLETELY DISCHARGED BATTERY

The following procedure should be used to recharge a completely discharged battery. Unless this procedure is properly followed, a good battery may be needlessly replaced.

(1) Measure the voltage at the battery posts with a voltmeter, accurate to 1/10 (0.10) volt (Fig. 9). If the reading is below 10 volts, the charge current will be low. It could take some time before the battery accepts a current greater than a few milliamperes. Such low current may not be detectable on the ammeters built into many chargers.



898A-12

Fig. 9 Voltmeter Accurate to 1/10 Volt Connected

(2) Disconnect and isolate the battery negative cable. Connect the battery charger leads. Some battery chargers are equipped with polarity-sensing circuitry. This circuitry protects the charger and/or battery from being damaged if they are improperly connected. If the battery state-of-charge is too low for the polarity-sensing circuitry to detect, the charger will not operate. This makes it appear that the battery will not accept charging current. Refer to the instructions provided with the battery charger to bypass the polarity-sensing circuitry.

(3) Battery chargers vary in the amount of voltage and current they provide. The amount of time required for a battery to accept measurable charger current at various voltages is shown in the Charge Rate chart. If the charge current is still not measurable at end of the charging time, the battery is faulty and must be replaced. If the charge current is measurable during the charging time, the battery may be good and the charging should be completed in the normal manner.

Charge Rate	
Voltage	Hours
16.0 volts maximum	up to 4 hours
14.0 to 15.9 volts	up to 8 hours
13.9 volts or less	up to 16 hours

CHARGING TIME REQUIRED

The time required to charge a battery will vary, depending upon the following factors:

- **Battery Capacity** - A completely discharged heavy-duty battery requires twice the charging time of a small capacity battery.

- **Temperature** - A longer time will be needed to charge a battery at -18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. As the battery warms, it will accept a higher charging current rate (amperage).

- **Charger Capacity** - A charger that supplies only 5 amperes will require a longer charging time. A charger that supplies 20 amperes or more will require a shorter charging time.

- **State-Of-Charge** - A completely discharged battery requires more charging time than a partially discharged battery. Electrolyte is nearly pure water in a completely discharged battery. At first, the charging current (amperage) will be low. As the battery charges, the specific gravity of the electrolyte will gradually rise..

Battery Charging Timetable			
Charging Amperage	5 Amperes	10 Amperes	20 Amperes
Open Circuit Voltage	Hours Charging at 21°C (70°F)		
12.25 to 12.39	6 hours	3 hours	1.5 hours
12.00 to 12.24	8 hours	4 hours	2 hours
11.95 to 11.99	12 hours	6 hours	3 hours
10.00 to 11.94	14 hours	7 hours	3.5 hours
less than 10.00	See Charging Completely Discharged Battery		

SERVICE PROCEDURES (Continued)

WARNING: NEVER EXCEED 20 AMPS WHEN CHARGING A COLD (-1°C/30°F) BATTERY. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

REMOVAL AND INSTALLATION**BATTERY**

(1) Turn the ignition switch to the Off position. Make sure all electrical accessories are off.

(2) Loosen the cable terminal clamps and disconnect both battery cables, negative cable first. If necessary, use a puller to remove the terminal clamps from the battery posts (Fig. 10).

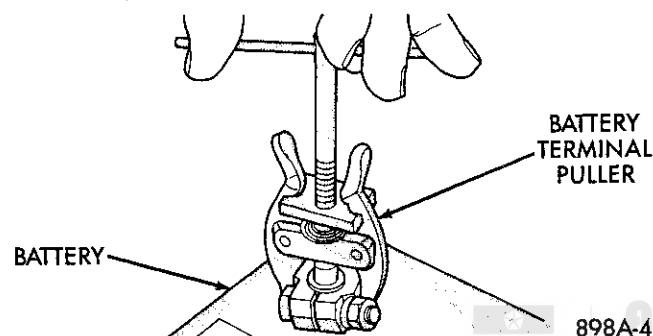


Fig. 10 Remove Battery Terminal Clamp

(3) Inspect the cable terminal clamps for corrosion and damage. Remove any corrosion using a wire brush or a post and terminal cleaning tool, and a sodium bicarbonate (baking soda) and warm water cleaning solution (Fig. 11). Replace any cable that has damaged or deformed terminal clamps.

WARNING: WEAR A SUITABLE PAIR OF RUBBER GLOVES (NOT THE HOUSEHOLD TYPE) WHEN REMOVING A BATTERY BY HAND. SAFETY GLASSES SHOULD ALSO BE WORN. IF THE BATTERY IS CRACKED OR LEAKING, THE ELECTROLYTE CAN BURN THE SKIN AND EYES.

(4) Remove the battery holddowns and remove the battery from the vehicle (Fig. 12) or (Fig. 13).

(5) Inspect the battery tray and the holddowns for corrosion or damage (Fig. 14), (Fig. 15) or (Fig. 16). Remove any corrosion using a wire brush and a sodium bicarbonate (baking soda) and warm water cleaning solution. Paint any exposed bare metal and replace any damaged parts.

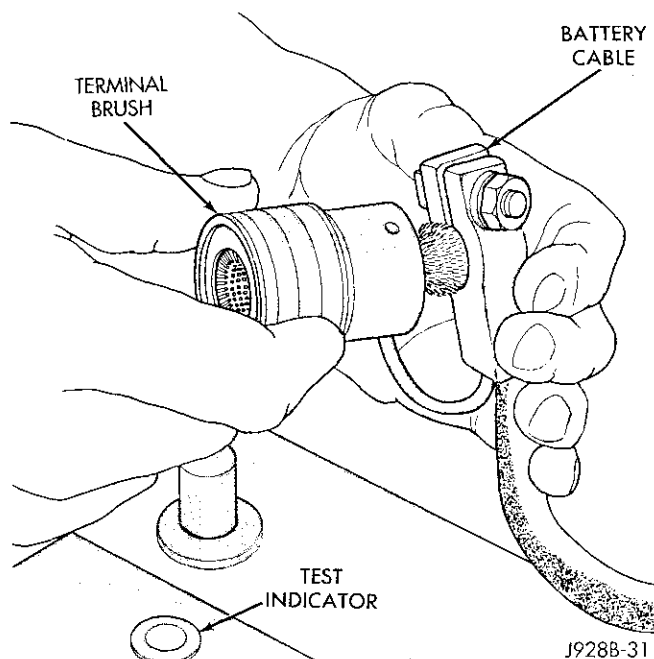


Fig. 11 Clean Battery Cable Terminal Clamp

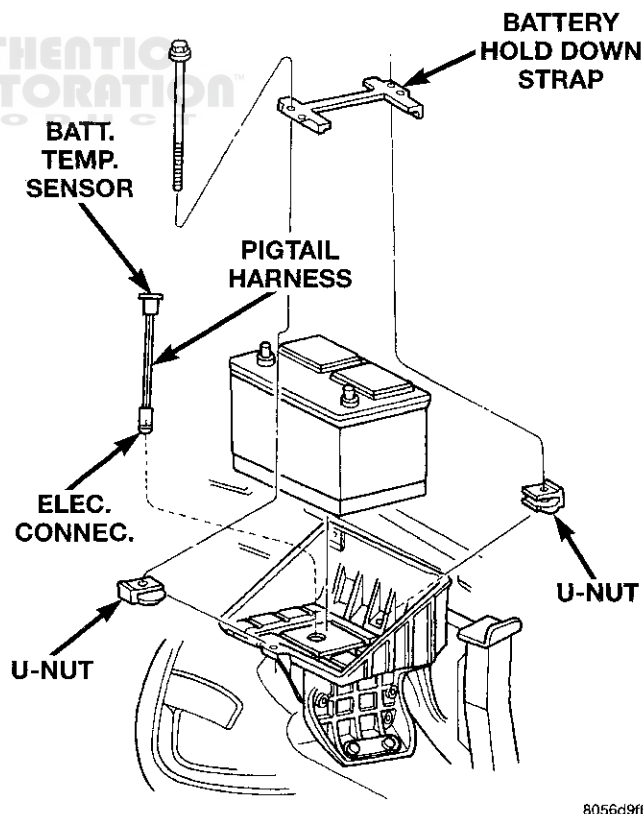


Fig. 12 Left Battery Holddown

REMOVAL AND INSTALLATION (Continued)

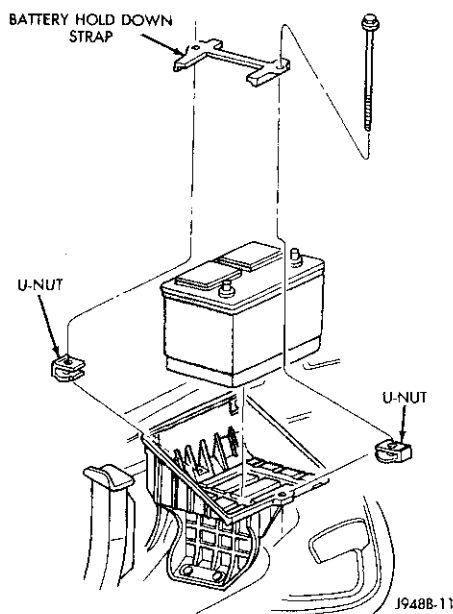


Fig. 13 Right Battery Holddown - Diesel Engine

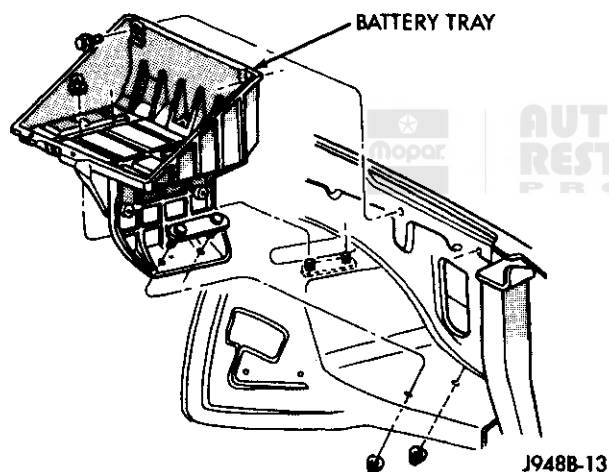


Fig. 14 Left Battery Tray - w/o Speed Control

(6) Inspect the battery case for cracks or other damage that could result in electrolyte leaks. Also, check the battery terminal posts for looseness. Batteries with damaged cases or loose posts must be replaced.

(7) Inspect the battery built-in test indicator sight glass for an indication of the battery condition. If the electrolyte level is low, the battery must be replaced. If the battery is discharged, charge as required. See Built-In Test Indicator and Battery Charging in this group for more information.

(8) If the battery is to be reinstalled, clean the outside of the battery case and the top cover with a sodium bicarbonate (baking soda) and warm water cleaning solution to remove any acid film (Fig. 17). Rinse the battery with clean water. Ensure that the

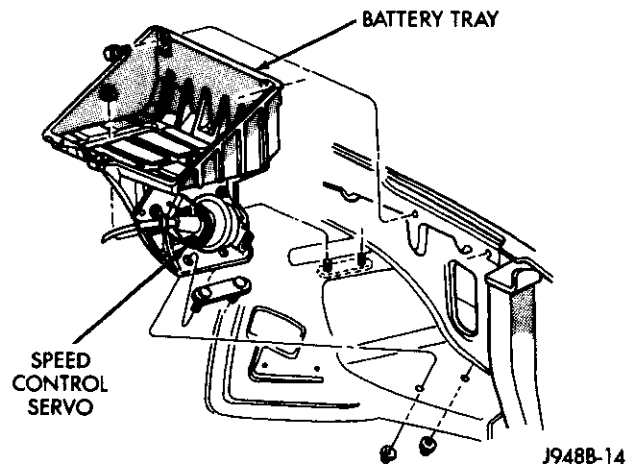


Fig. 15 Left Battery Tray - w/Speed Control

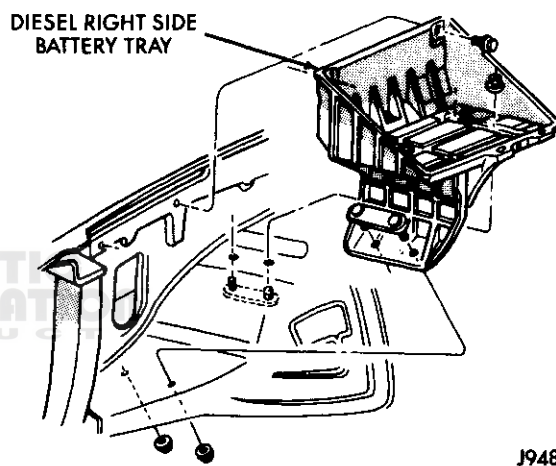


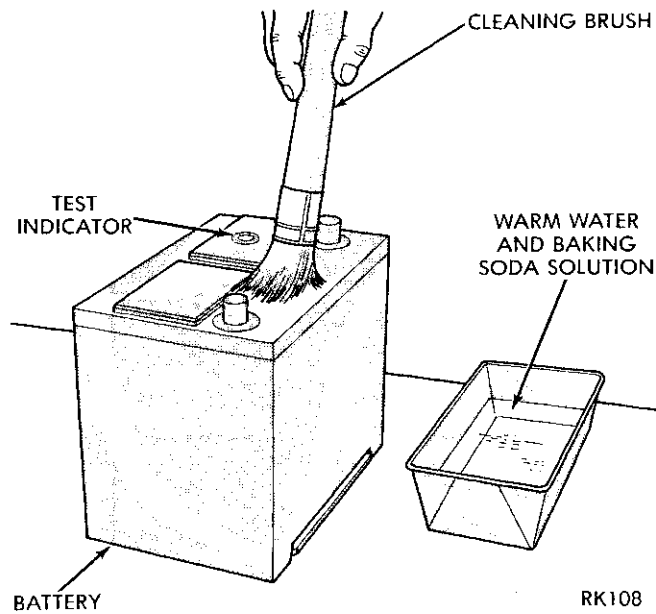
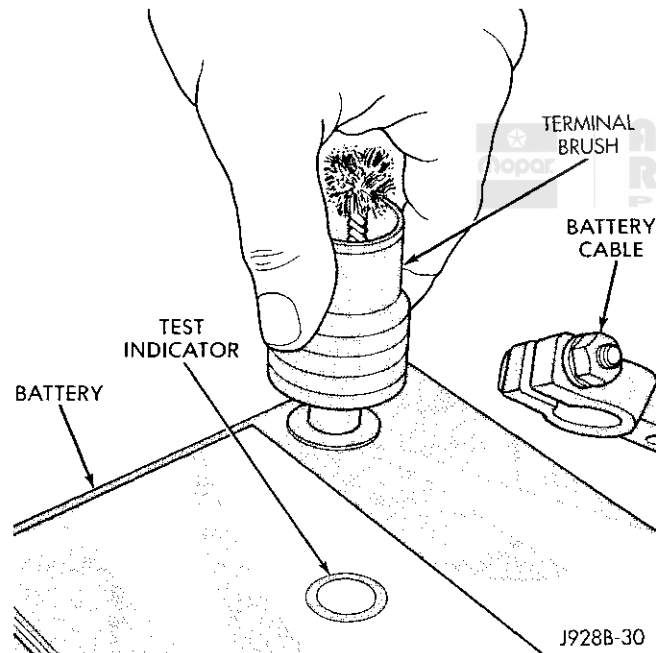
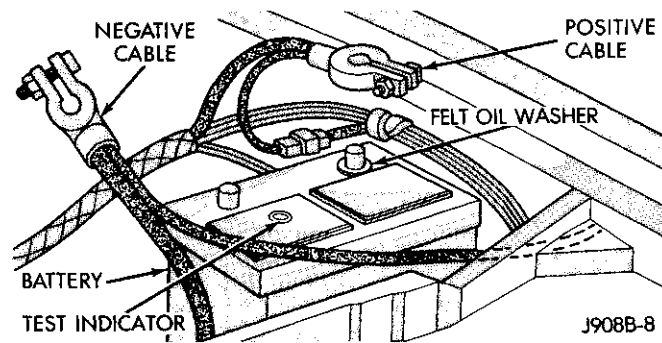
Fig. 16 Right Battery Tray - Diesel Engine

cleaning solution does not enter the battery cells through the vent holes. If the battery is being replaced, see the Battery Ratings and Classifications chart in Specifications at the back of this group. Confirm that the replacement battery is the correct size and has the correct ratings for the vehicle.

(9) Clean any corrosion from the battery terminal posts with a wire brush or a post and terminal cleaner, and a sodium bicarbonate (baking soda) and warm water cleaning solution (Fig. 18).

(10) Position the battery in the tray. Ensure that the positive and negative terminal posts are correctly positioned. The cable terminal clamps must reach the correct battery post without stretching the cables (Fig. 19).

(11) Loosely install the battery holddown hardware. Ensure that the battery base is correctly positioned in the tray, then tighten the holddowns to 12 N·m (100 in. lbs.).

REMOVAL AND INSTALLATION (Continued)**Fig. 17 Clean Battery****Fig. 18 Clean Battery Terminal Post****Fig. 19 Battery Cables - Typical**

CAUTION: Be certain that the battery cables are connected to the correct battery terminals. Reverse polarity may damage electrical components.

(12) Place an oiled felt washer on the battery positive terminal post.

(13) Install and tighten the battery positive cable terminal clamp. Then install and tighten the negative cable terminal clamp. Tighten both cable terminal clamp bolts to 8.5 N·m (75 in. lbs.).

(14) Apply a thin coating of petroleum jelly or chassis grease to the exposed surfaces of the cable terminal clamps and battery terminal posts.

SPECIFICATIONS**BATTERY**

Battery Classifications and Ratings			
BCI Group Size Classification	Cold Cranking Amperage	Reserve Capacity	Load Test Amperage
27	600	120 Minutes	300
27	750	150 Minutes	375

STARTING SYSTEMS

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STARTER RELAY	2	STARTER RELAY	10
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DIAGNOSIS AND TESTING		STARTING SYSTEM	10
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GENERAL INFORMATION

OVERVIEW

The battery, starting, and charging systems operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components involved in these systems must perform within specifications.

Group 8A covers the battery, Group 8B covers the starting system, and Group 8C covers the charging system. Refer to Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in these groups include the most basic conventional diagnostic methods to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of a induction milliamperage ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See the On-Board Diagnostics Test in Group 8C - Charging System for more information.

INTRODUCTION

The starting system consists of:

- Battery
- Starter relay
- Starter with an integral solenoid
- Ignition switch

- Clutch pedal position switch (manual transmission)
- Park/neutral position switch (automatic transmission)

- Wiring harness and connections.

This group covers diagnosis of the complete starting system, except the battery. However, this group only covers service procedures for the starter and starter relay. Service procedures for other starting system components can be located as follows:

- Battery - refer to Group 8A - Battery for the diagnostic and service procedures
- Ignition switch - refer to Group 8D - Ignition Systems for the service procedures
- Clutch pedal position switch - refer to Group 6 - Clutch for the service procedures
- Park/neutral position switch - refer to Group 21 - Transmission for the service procedures
- Wiring harness and connections - refer to Group 8W - Wiring Diagrams for the service procedures.

DESCRIPTION AND OPERATION

STARTING SYSTEM

The starting system components form two separate circuits. A high-amperage feed circuit that feeds the starter between 150 and 350 amperes (700 amperes - diesel engine), and a low-amperage control circuit that operates on less than 20 amperes.

If the vehicle is equipped with an automatic transmission, battery voltage is supplied through the low-amperage control circuit to the coil battery terminal of the starter relay when the ignition switch is turned to the Start position. If the vehicle is equipped with a manual transmission, it has a clutch pedal position switch. The clutch pedal position switch is connected in series between the ignition switch and the coil battery terminal of the starter relay. This normally open switch

DESCRIPTION AND OPERATION (Continued)

closes only when the clutch pedal is depressed, preventing starter operation while the clutch disc and the flywheel are engaged.

If the vehicle is equipped with an automatic transmission, the park/neutral position switch is installed in series between the starter relay coil ground terminal and ground. This normally open switch closes only with the automatic transmission gear selector in the Neutral or Park positions. In vehicles with a manual transmission, the starter relay coil ground terminal is always grounded.

With the starter relay coil now energized, the normally open relay contacts close. The relay contacts connect the relay common feed terminal to the relay normally open terminal. The closed relay contacts energize the starter solenoid coil windings.

The energized solenoid pull-in coil pulls in the solenoid plunger. The solenoid plunger pulls the shift lever in the starter. This engages the starter overrunning clutch and pinion gear with the starter ring gear on the flywheel (manual transmission) or torque converter (automatic transmission).

As the solenoid plunger reaches the end of its travel, the solenoid contact disc completes the high-amperage starter feed circuit and energizes the solenoid plunger hold-in coil. Current now flows between the solenoid battery terminal and the starter motor, energizing the starter.

Once the engine starts, the overrunning clutch protects the starter from damage by allowing the starter pinion gear to spin faster than the pinion shaft. When the driver releases the ignition switch to the On position, the starter relay coil is de-energized. This causes the relay contacts to open. When the relay contacts open, the starter solenoid plunger hold-in coil is de-energized.

When the solenoid plunger hold-in coil is de-energized, the solenoid plunger return spring returns the plunger to its relaxed position. This causes the contact disc to open the starter feed circuit, and the shift lever to disengage the overrunning clutch and pinion gear from the starter ring gear.

STARTER

The starter motor incorporates several features to create a reliable, efficient, compact, and lightweight unit. A planetary gear system (intermediate transmission) is used between the electric motor and the pinion gear. This feature makes it possible to reduce the dimensions of the starter. At the same time, it allows higher armature rotational speed and delivers increased torque through the pinion gear to the starter ring gear on the flywheel (manual transmission), or torque converter (automatic transmission).

The starter motors for all engines are activated by a solenoid mounted to the overrunning clutch housing.

However, the starter motor and solenoid are serviced only as a complete assembly. If either component fails, the entire assembly must be replaced.

STARTER RELAY

The starter relay is a International Standards Organization (ISO)-type relay. The starter relay is an electro-mechanical device that switches current to the pull-in coil of the starter solenoid, when the ignition switch is turned to the Start position. See the Diagnosis and Testing section of this group for more information on the starter relay's operation.

The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location.

DIAGNOSIS AND TESTING**STARTING SYSTEM**

For circuit descriptions and diagrams, refer to 8W-21 - Starting System in Group 8W - Wiring Diagrams.

INSPECTION

Before removing any unit from the starting system for repair or diagnosis, perform the following inspections:

- **Battery** - Visually inspect the battery for indications of physical damage and loose or corroded cable connections. Determine the state-of-charge and cranking capacity of the battery. Charge or replace the battery, if required. Refer to Group 8A - Battery for more information.
- **Ignition Switch** - Visually inspect the ignition switch for indications of physical damage and loose or corroded wiring connections.
- **Clutch Pedal Position Switch** - Visually inspect the clutch pedal position switch for indications of physical damage and loose or corroded wiring connections.
- **Park/Neutral Position Switch** - Visually inspect the park/neutral position switch for indications of physical damage and loose or corroded wiring connections.
- **Starter Relay** - Visually inspect the starter relay for indications of physical damage and loose or corroded wiring connections.
- **Starter** - Visually inspect the starter for indications of physical damage and loose or corroded wiring connections.
- **Starter Solenoid** - Visually inspect the starter solenoid for indications of physical damage and loose or corroded wiring connections.
- **Wiring** - Visually inspect the wiring for damage. Repair or replace the faulty wiring, as required.

DIAGNOSIS AND TESTING (Continued)**Starting System Diagnosis**

Starting System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
STARTER FAILS TO ENGAGE.	<ol style="list-style-type: none"> 1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter relay faulty. 4. Ignition switch faulty. 5. Park/Neutral position switch (auto trans) faulty or misadjusted. 6. Clutch pedal position switch (man trans) faulty. 7. Starter solenoid faulty. 8. Starter assembly faulty. 	<ol style="list-style-type: none"> 1. Refer to Group 8A - Battery. Charge or replace battery, if required. 2. See Cold Cranking Test, in this group. Test and repair feed and/or control circuits, if required. 3. See Relay Test, in this group. Replace relay, if required. 4. See Ignition Switch Test, in this group. Replace switch, if required. 5. See Park/Neutral Position Switch Test, in this group. Replace switch, if required. 6. See Clutch Pedal Position Switch Test, in this group. Replace switch, if required. 7. See Solenoid Test, in this Group. Replace starter assembly, if required. 8. If all other starting system components and circuits check OK, replace starter assembly.
STARTER ENGAGES, FAILS TO TURN ENGINE.	<ol style="list-style-type: none"> 1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter assembly faulty. 4. Engine seized. 	<ol style="list-style-type: none"> 1. Refer to Group 8A - Battery. Charge or replace battery, if required. 2. See Cold Cranking Test, in this group. Test and repair feed and/or control circuits, if required. 3. If all other starting system components and circuits check OK, replace starter assembly. 4. Refer to Group 9 - Engine, for diagnostic and service procedures.
STARTER ENGAGES, SPINS OUT BEFORE ENGINE STARTS.	<ol style="list-style-type: none"> 1. Broken teeth on starter ring gear. 2. Starter assembly faulty. 	<ol style="list-style-type: none"> 1. Remove starter as described in this group. Inspect ring gear and replace, if required. 2. If all other starting system components and circuits check OK, replace starter assembly.
STARTER DOES NOT DISENGAGE.	<ol style="list-style-type: none"> 1. Starter improperly installed. 2. Starter relay faulty. 3. Ignition switch faulty. 4. Starter assembly faulty. 	<ol style="list-style-type: none"> 1. Install starter as described in this group. Tighten starter mounting hardware to correct torque specifications. 2. See Relay Test, in this group. Replace relay, if required. 3. See Ignition Switch Test, in this group. Replace switch, if required. 4. If all other starting system components and circuits check OK, replace starter assembly.

DIAGNOSIS AND TESTING (Continued)**COLD CRANKING TEST**

For circuit descriptions and diagrams, refer to 8W-21 - Starting System in Group 8W - Wiring Diagrams. The battery must be fully-charged and load-tested before proceeding. Refer to Group 8A - Battery for more information.

(1) Connect a suitable volt-ampere tester to the battery terminals (Fig. 1). Refer to the operating instructions provided with the tester being used.

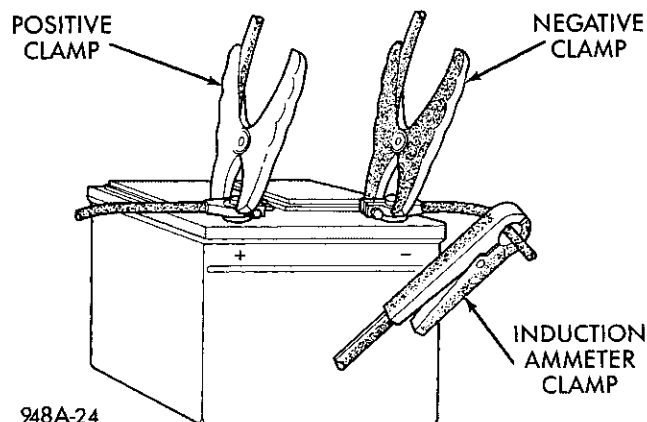


Fig. 1 Volts-Amps Tester Connections - Typical

(2) Fully engage the parking brake.

(3) Place the manual transmission gearshift selector lever in the Neutral position and fully depress the clutch pedal. Place the automatic transmission gear selector lever in the Park position.

(4) Verify that all lamps and accessories are turned off.

WARNING: MODELS EQUIPPED WITH THE DIESEL ENGINE OPTION ALSO HAVE AN AUTOMATIC SHUT-DOWN (ASD) RELAY LOCATED IN THE POWER DISTRIBUTION CENTER (PDC). HOWEVER, REMOVAL OF THE ASD RELAY MAY NOT PREVENT THE DIESEL ENGINE FROM STARTING. BE CERTAIN TO DISCONNECT THE FUEL SHUTDOWN SOLENOID CONNECTOR. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY.

(5) To prevent a gasoline engine from starting, unplug the Automatic Shut-Down (ASD) relay. To prevent a diesel engine from starting, disconnect the fuel shutdown solenoid connector (Fig. 2). The ASD relay is located in the Power Distribution Center (PDC). Refer to the PDC label for relay identification and location.

(6) Rotate and hold the ignition switch in the Start position. Note the cranking voltage and current (amperage) draw.

(a) If the voltage reads above 9.6 volts and the current (amperage) draw reads above specifications, see the Feed Circuit Tests in this group.

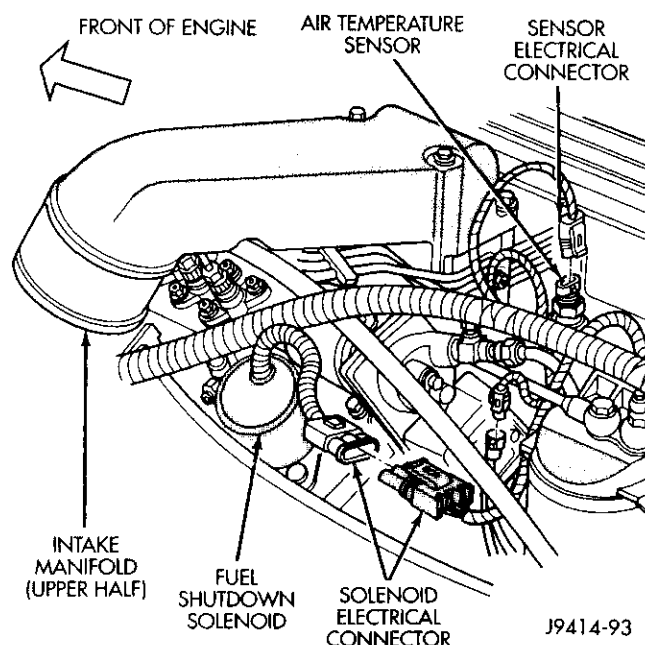


Fig. 2 Fuel Shutdown Solenoid Connector - Diesel Engine

(b) If the voltage reads 12.5 volts or greater and the current (amperage) draw reads below specifications, see the Control Circuit Tests in this group.

NOTE: A cold engine will increase the starter current (amperage) draw reading, and reduce the battery voltage reading.

FEED CIRCUIT TESTS

The starter feed circuit tests (voltage drop method) will determine if there is excessive resistance in the high-amperage circuit. For circuit descriptions and diagrams, refer to 8W-21 - Starting System in Group 8W - Wiring Diagrams.

When performing these tests, it is important to remember that the voltage drop is giving an indication of the resistance between the two points at which the voltmeter probes are attached.

Example: When testing the resistance of the battery positive cable, touch the voltmeter leads to the battery positive cable clamp and the cable connector at the starter solenoid. If you probe the battery positive terminal post and the cable connector at the starter solenoid, you are reading the combined voltage drop in the battery positive cable clamp-to-terminal post connection and the battery positive cable.

The following operation will require a voltmeter accurate to 1/10 (0.10) volt. Before performing the tests, be certain the following procedures are accomplished:

DIAGNOSIS AND TESTING (Continued)

WARNING: MODELS EQUIPPED WITH THE DIESEL ENGINE OPTION ALSO HAVE AN AUTOMATIC SHUT-DOWN (ASD) RELAY LOCATED IN THE POWER DISTRIBUTION CENTER (PDC). HOWEVER, REMOVAL OF THE ASD RELAY MAY NOT PREVENT THE DIESEL ENGINE FROM STARTING. BE CERTAIN TO DISCONNECT THE FUEL SHUTDOWN SOLENOID CONNECTOR. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY.

- Battery is fully-charged. Refer to Group 8A - Battery for more information.
- Fully engage the parking brake.
- Place the manual transmission gearshift selector lever in the Neutral position and fully depress the clutch pedal. Place the automatic transmission gear selector lever in the Park position.
- Unplug the Automatic Shut-Down (ASD) relay to prevent a gasoline engine from starting. The relay is located in the Power Distribution Center (PDC). Refer to the PDC label for relay identification and location. To prevent a diesel engine from starting, disconnect the fuel shutdown solenoid connector (Fig. 2).

(1) Connect the positive lead of the voltmeter to the battery negative terminal post. Connect the negative lead of the voltmeter to the battery negative cable clamp (Fig. 3). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.

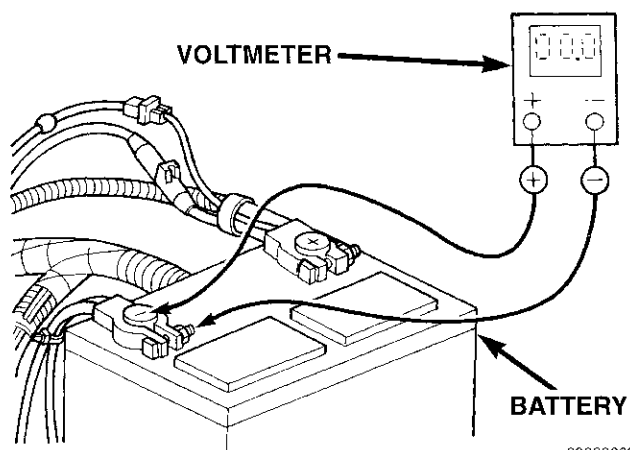


Fig. 3 Test Battery Negative Connection Resistance - Typical

(2) Connect the positive lead of the voltmeter to the battery positive terminal post. Connect the negative lead of the voltmeter to the battery positive cable clamp (Fig. 4). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor contact between the cable clamp and the terminal post.

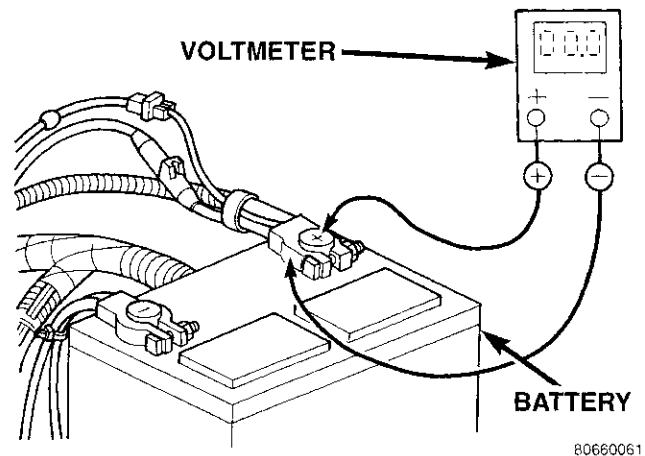


Fig. 4 Test Battery Positive Connection Resistance - Typical

(3) Connect the voltmeter to measure between the battery positive terminal post and the starter solenoid battery terminal stud (Fig. 5). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery cable connection at the solenoid. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery positive cable.

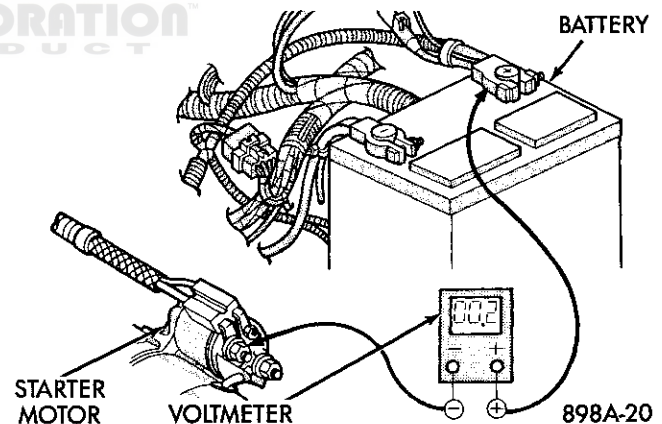
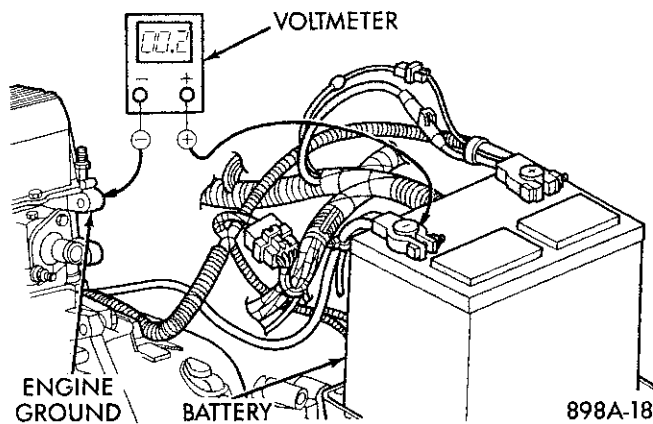


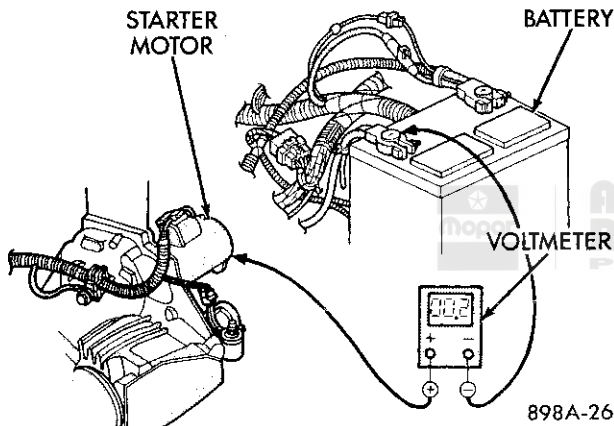
Fig. 5 Test Battery Positive Cable Resistance - Typical

(4) Connect the voltmeter to measure between the battery negative terminal post and a good clean ground on the engine block (Fig. 6). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery negative cable attachment on the engine block. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery negative cable.

(5) Connect the positive lead of the voltmeter to the starter housing. Connect the negative lead of the voltmeter to the battery negative terminal post (Fig. 7). Rotate and hold the ignition switch in the Start

DIAGNOSIS AND TESTING (Continued)**Fig. 6 Test Ground Circuit Resistance - Typical**

position. Observe the voltmeter. If the reading is above 0.2 volt, correct the poor starter to engine block ground contact.

**Fig. 7 Test Starter Ground - Typical**

If the resistance tests detect no feed circuit problems, remove the starter and see the Solenoid Test in this group.

CONTROL CIRCUIT TESTS

For circuit descriptions and diagrams, refer to 8W-21 - Starting System in Group 8W - Wiring Diagrams. The starter control circuit consists of:

- Battery
- Starter relay
- Starter solenoid
- Ignition switch
- Park/neutral position switch (automatic transmission)
- Clutch pedal position switch (manual transmission)
- Wiring harness and connections.

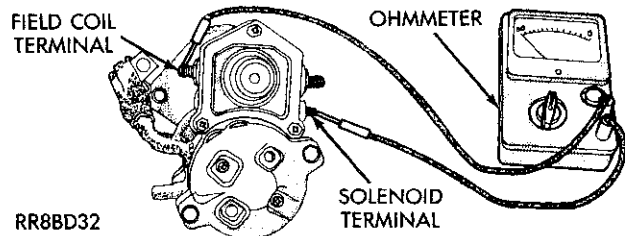
Test procedures for these components should be performed in the order in which they are listed, as follows:

SOLENOID TEST

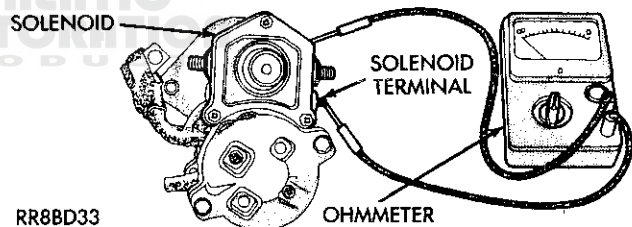
Remove the starter as described in this group. Then proceed as follows:

(1) Disconnect the wire from the solenoid field coil terminal.

(2) Check for continuity between the solenoid terminal and the field coil terminal with a continuity tester (Fig. 8). There should be continuity. If OK, go to Step 3. If not OK, replace the faulty starter assembly.

**Fig. 8 Continuity Test Between Solenoid Terminal and Field Coil Terminal**

(3) Check for continuity between the solenoid terminal and the solenoid case (Fig. 9). There should be continuity. If OK, go to Step 4. If not OK, replace the faulty starter assembly.

**Fig. 9 Continuity Test Between Solenoid Terminal and Solenoid Case**

(4) Connect the solenoid field coil wire to the field coil terminal.

(5) Install the starter as described in this group.

RELAY TEST

The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location.

Remove the starter relay from the PDC as described in this group to perform the following tests:

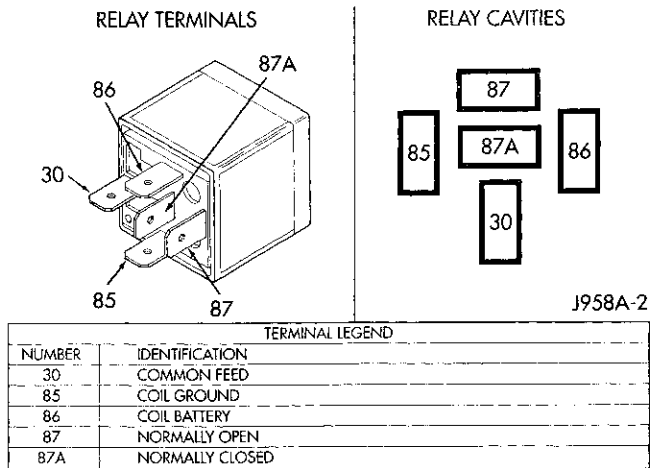
(1) A relay in the de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 2. If not OK, replace the faulty relay.

(2) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 3. If not OK, replace the faulty relay.

(3) Connect a battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A

DIAGNOSIS AND TESTING (Continued)

and 30. If OK, see the Relay Circuit Test in this group. If not OK, replace the faulty relay.



Starter Relay

RELAY CIRCUIT TEST

(1) The relay common feed terminal cavity (30) is connected to battery voltage and should be hot at all times. If OK, go to Step 2. If not OK, repair the open circuit to the PDC fuse as required.

(2) The relay normally closed terminal (87A) is connected to terminal 30 in the de-energized position, but is not used for this application. Go to Step 3.

(3) The relay normally open terminal (87) is connected to the common feed terminal (30) in the energized position. This terminal supplies battery voltage to the starter solenoid field coils. There should be continuity between the cavity for relay terminal 87 and the starter solenoid terminal at all times. If OK, go to Step 4. If not OK, repair the open circuit to the starter solenoid as required.

(4) The coil battery terminal (86) is connected to the electromagnet in the relay. It is energized when the ignition switch is held in the Start position. On vehicles with a manual transmission, the clutch pedal must be fully depressed for this test. Check for battery voltage at the cavity for relay terminal 86 with the ignition switch in the Start position, and no voltage when the ignition switch is released to the On position. If OK, go to Step 5. If not OK with an automatic transmission, check for an open or short circuit to the ignition switch and repair, if required. If the circuit to the ignition switch is OK, see the Ignition Switch Test in this group. If not OK with a manual transmission, check the circuit between the relay and the clutch pedal position switch for an open or a short. If the circuit is OK, see the Clutch Pedal Position Switch Test in this group.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. On vehicles with an automatic transmission, it is grounded through the park/neutral position switch only when the gearshift selector

lever is in the Park or Neutral positions. On vehicles with a manual transmission, it is grounded at all times. Check for continuity to ground at the cavity for relay terminal 85. If not OK with an automatic transmission, check for an open or short circuit to the park/neutral position switch and repair, if required. If the circuit is OK, see the Park/Neutral Position Switch Test in this group. If not OK with a manual transmission, repair the circuit to ground as required.

PARK/NEUTRAL POSITION SWITCH TEST

(1) Place the transmission gear selector lever in the Park position.

(2) Disconnect and isolate the battery negative cable.

(3) Raise and support the vehicle.

(4) Disconnect the park/neutral position switch harness connector.

(5) Check for continuity between the center switch terminal and a good chassis ground. There should be continuity. If OK, go to Step 6. If not OK, replace the faulty switch.

(6) Move the transmission gear selector lever to the Reverse position and check for continuity between the center switch terminal and a good chassis ground. There should be no continuity. If not OK, replace the faulty switch.

CLUTCH PEDAL POSITION SWITCH TEST

The clutch pedal position switch is integral to the clutch pedal pushrod. It is located near the dash panel under the instrument panel. The harness connector for the switch is wrapped with foam tape.

(1) Disconnect and isolate the battery negative cable.

(2) Disconnect the switch harness connector.

(3) Check for continuity between the two cavities in the switch-half of the harness connector with the clutch pedal released. There should be no continuity. If OK, go to Step 4. If not OK, replace the faulty switch.

(4) Check for continuity between the two cavities in the switch-half of the harness connector again with the clutch pedal depressed. There should now be continuity. If OK, see the Ignition Switch Test in this group. If not OK, replace the faulty switch.

IGNITION SWITCH TEST

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

DIAGNOSIS AND TESTING (Continued)

(1) Disconnect and isolate the battery negative cable.

(2) Remove the steering column shrouds and disconnect the ignition switch harness connector. Refer to Group 8D - Ignition Systems for the procedures.

(3) With the ignition switch in the On position, check for continuity between the ignition switch terminals 1 and 7. These are the terminals at each end of the switch connector. There should be no continuity. If OK, go to Step 4. If not OK, replace the faulty switch.

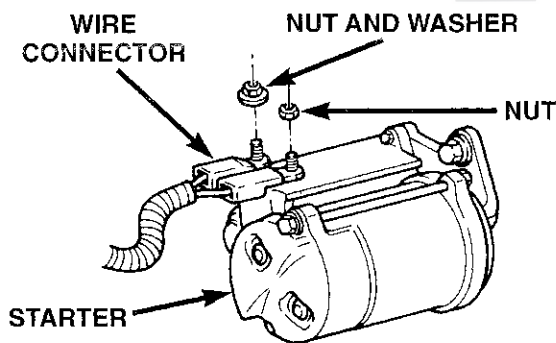
(4) With the ignition switch held in the Start position, check for continuity between the ignition switch terminals 1 and 7 again. There should now be continuity. If not OK, replace the faulty switch.

REMOVAL AND INSTALLATION**STARTER****GASOLINE ENGINE**

(1) Disconnect and isolate the battery negative cable.

(2) Raise and support the vehicle.

(3) Remove the nuts from the terminal studs for the starter battery lead and solenoid lead (Fig. 10) or (Fig. 11).



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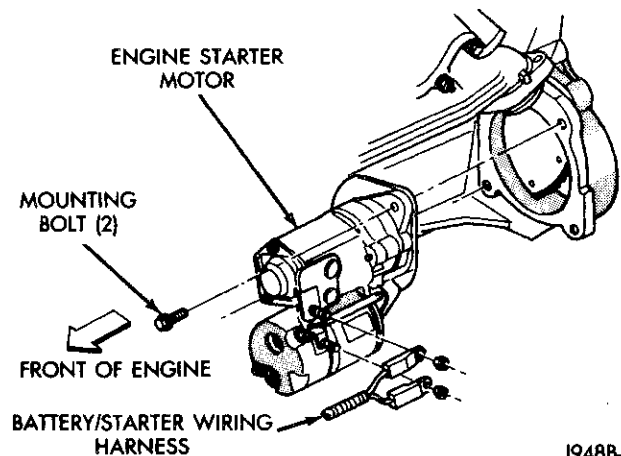
Fig. 10 Starter Connector Remove/Install - V-6/V-8 Engine

(4) Remove the hardware securing the starter to the bellhousing (Fig. 11) or (Fig. 12).

(5) Move the starter forward to clear the lower mounting stud (V-6/V-8 engine) and for the starter gear housing nose to clear the bellhousing. This allows the starter to come down past the exhaust pipe (Fig. 11) or (Fig. 13).

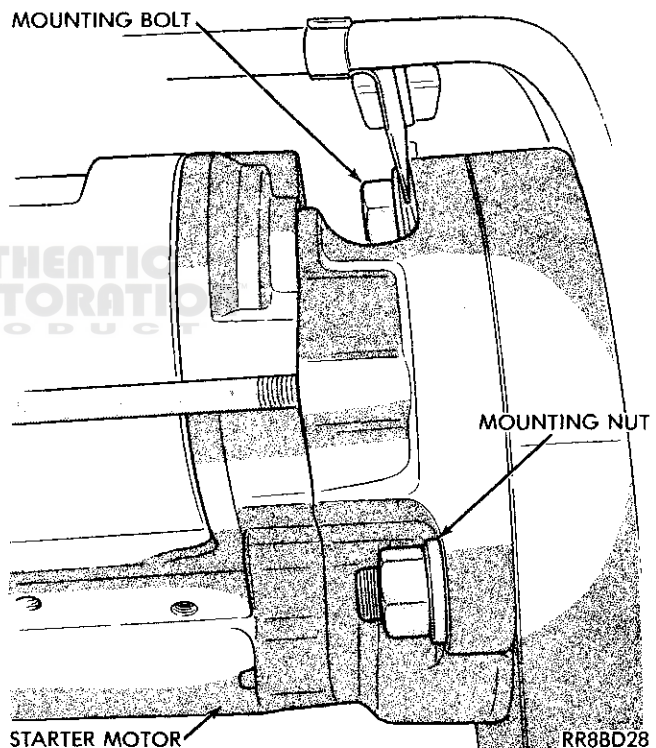
(6) Reverse the removal procedures to install. Tighten the starter hardware as follows:

- Starter mounting bolts to 68 N·m (50 ft. lbs.)
- Starter mounting nut - 27 N·m (20 ft. lbs.)
- Battery lead terminal nut - 14 N·m (120 in. lbs.)



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Fig. 11 Starter Remove/Install - V-10 Engine



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Fig. 12 Starter Mounting Hardware Remove/Install - V-6/V-8 Engine

- Solenoid lead terminal nut - 2.5 N·m (22 in. lbs.).

DIESEL ENGINE

(1) Disconnect and isolate both of the battery negative cables.

(2) Raise and support the vehicle.

(3) Remove the battery lead from the solenoid terminal by pulling the rubber boot up and removing the nut (Fig. 14).

(4) Remove the nut from the solenoid lead terminal at the solenoid.

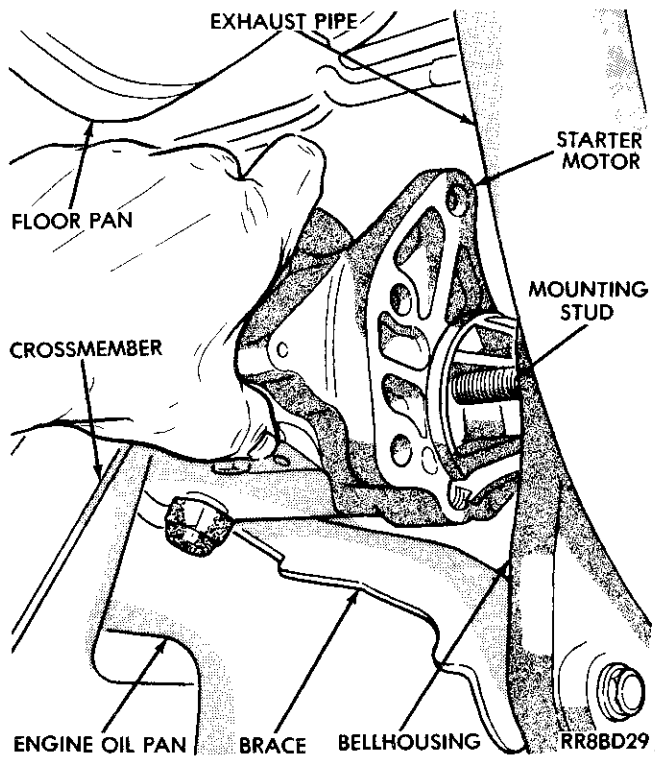
REMOVAL AND INSTALLATION (Continued)

Fig. 13 Starter Remove/Install - V-6/V-8 Engine

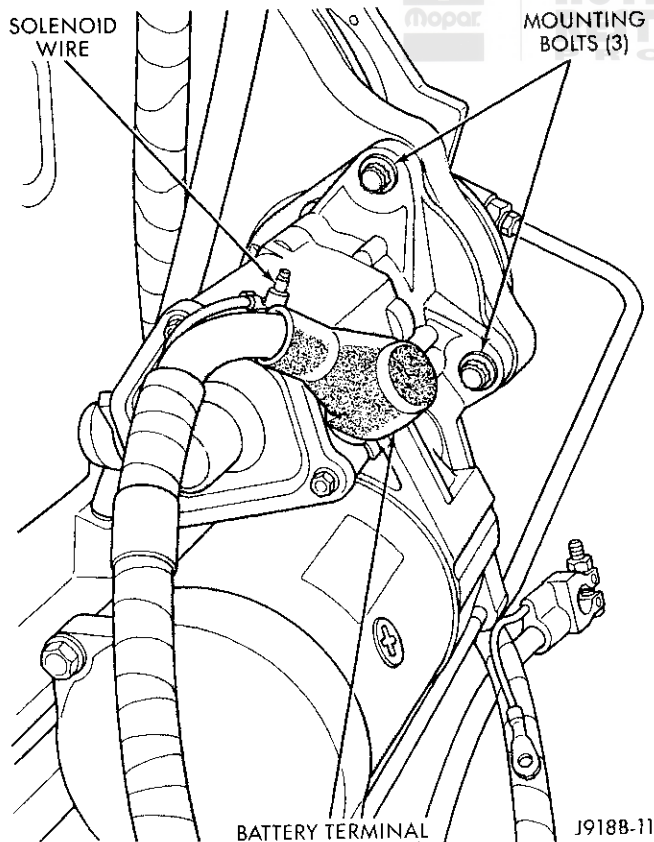


Fig. 14 Starter Connectors Remove/Install - Diesel Engine

(5) Remove the starter mounting bolts (Fig. 14) and (Fig. 15).

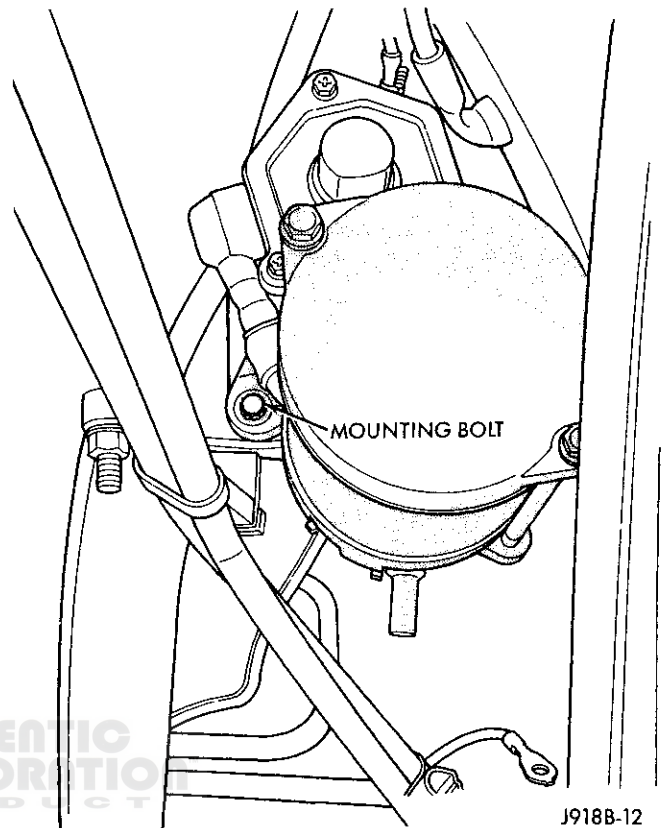


Fig. 15 Starter Mounting Bolt - Diesel Engine

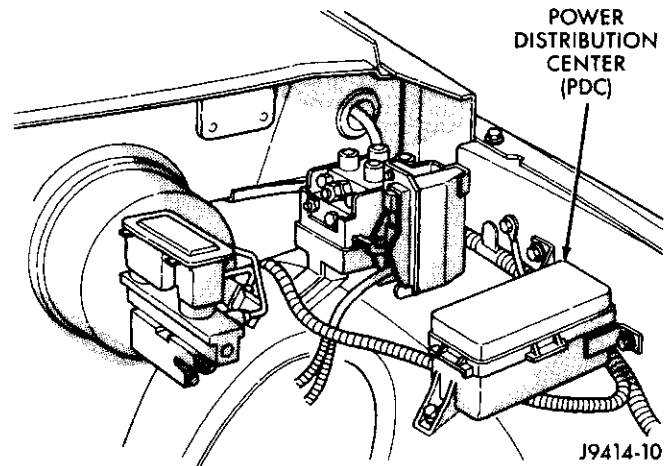
(6) Remove the starter motor.

(7) Reverse the removal procedures to install. Tighten the starter hardware as follows:

- Starter mounting bolts - 43 N·m (32 ft. lbs.)
- Solenoid lead nut - 6 N·m (55 in. lbs.)
- Battery lead nut - 10 N·m (90 in. lbs.).

REMOVAL AND INSTALLATION (Continued)**STARTER RELAY**

- (1) Disconnect and isolate the battery negative cable(s).
- (2) Remove the cover from the Power Distribution Center (PDC) (Fig. 16).
- (3) Refer to the label on the PDC for starter relay identification and location.
- (4) Remove the starter relay by unplugging it from the PDC.
- (5) Install the starter relay by aligning the relay terminals with the cavities in the PDC and pushing the relay firmly into place.
- (6) Install the PDC cover.
- (7) Connect the battery negative cable(s).
- (8) Test the relay operation.

**Fig. 16 Power Distribution Center****SPECIFICATIONS****STARTING SYSTEM**

Starter and Solenoid			
Engine Application	3.9L, 5.2L, 5.9L (Gas)	8.0L	5.9L (Diesel)
Manufacturer	Nippon Denso	Nippon Denso	Nippon Denso
Part Number	56027702	56004757	4741012
Power Rating	1.4 Kilowatt	1.4 Kilowatt	2.7 Kilowatt
Voltage	12 Volts	12 Volts	12 Volts
Number of Fields	4	4	4
Number of Poles	4	4	4
Number of Brushes	4	4	4
Drive Type	Reduction Gear Train	Reduction Gear Train	Conventional Gear Train
Free Running Test Voltage	11 Volts	11 Volts	11 Volts
Free Running Test Amperage Draw	73 Amperes	73 Amperes	200 Amperes
Free Running Test Minimum Speed	3601 rpm	3601 rpm	3000 rpm
Solenoid Closing Voltage	7.5 Volts	7.5 Volts	8.0 Volts
Cranking Amperage Draw Test*	125 - 250 Amperes	125 - 250 Amperes	450 - 700 Amperes
*Test at operating temperature. Cold engine, tight (new) engine, or heavy oil will increase starter amperage draw.			

CHARGING SYSTEM

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GENERAL INFORMATION

OVERVIEW

The battery, starting, and charging systems operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components involved in these systems must perform within specifications.

Group 8A covers the battery, Group 8B covers the starting system, and Group 8C covers the charging system. Refer to Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in these groups include the most basic conventional diagnostic methods to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of a induction milliampere ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See the On-Board Diagnostics Test in Group 8C - Charging System for more information.

DESCRIPTION AND OPERATION

CHARGING SYSTEM OPERATION

The charging system consists of:

- Generator
- Electronic Voltage Regulator (EVR) circuitry within the Powertrain Control Module (PCM)
- Ignition switch (refer to Group 8D, Ignition System for information)
- Battery (refer to Group 8A, Battery for information)
- Battery temperature sensor
- Voltmeter (refer to Group 8E, Instrument Panel and Gauges for information)
- Wiring harness and connections (refer to Group 8W, Wiring for information)

The charging system is turned on and off with the ignition switch. When the ignition switch is turned to the ON position, battery voltage is applied to the generator rotor through one of the two field terminals to produce a magnetic field. The generator is driven by the engine through a serpentine belt and pulley arrangement.

The amount of DC current produced by the generator is controlled by the EVR (field control) circuitry, contained within the PCM. This circuitry is connected in series with the second rotor field terminal and ground.

A battery temperature sensor located in the battery tray housing, is used to sense battery temperature. This temperature data, along with data from monitored line voltage, is used by the PCM to vary the battery charging rate. This is done by cycling the ground path to control the strength of the rotor magnetic field. The PCM then compensates and regulates generator current output accordingly.

DESCRIPTION AND OPERATION (Continued)

All vehicles are equipped with On-Board Diagnostics (OBD). All OBD-sensed systems, including the EVR (field control) circuitry, are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See On-Board Diagnostic System Test in this group for more information.

GENERATOR

The generator is belt-driven by the engine using a serpentine type drive belt. It is serviced only as a complete assembly. If the generator fails for any reason, the entire assembly must be replaced.

As the energized rotor begins to rotate within the generator, the spinning magnetic field induces a current into the windings of the stator coil. Once the generator begins producing sufficient current, it also provides the current needed to energize the rotor.

The Y type stator winding connections deliver the induced AC current to 3 positive and 3 negative diodes for rectification. From the diodes, rectified DC current is delivered to the vehicle electrical system through the generator battery and ground terminals.

Although the generators appear the same externally, different generators with different output ratings are used on this vehicle. This will depend upon engine size and optional equipment. Be certain that the replacement generator has the same output rating as the original unit. See Generator Ratings in the Specifications section at the back of this group for amperage ratings.

Noise emitting from the generator may be caused by: worn, loose or defective bearings; a loose or defective drive pulley; incorrect, worn, damaged or misadjusted fan drive belt; loose mounting bolts; a misaligned drive pulley or a defective stator or diode.

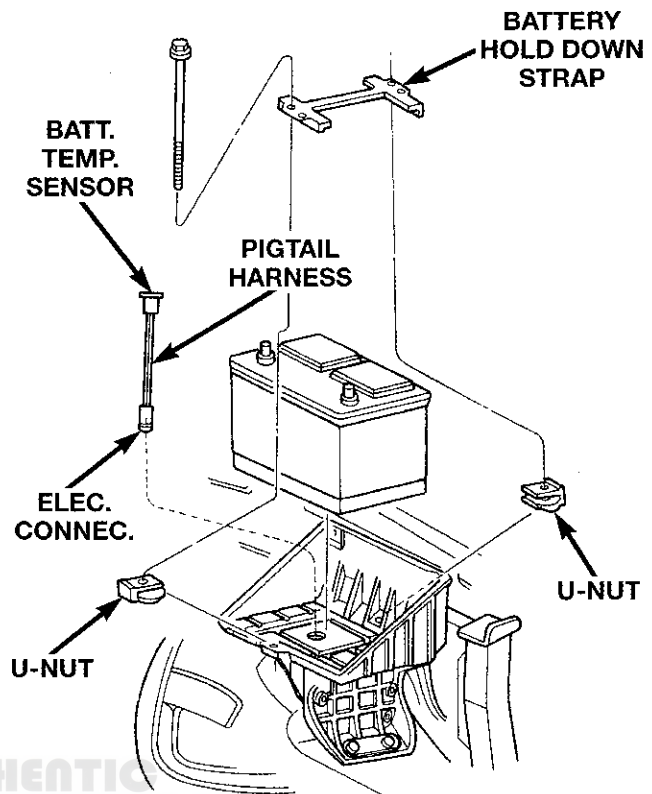
BATTERY TEMPERATURE SENSOR

The battery temperature sensor is used to determine the battery temperature and control battery charging rate. This temperature data, along with data from monitored line voltage, is used by the PCM to vary the battery charging rate. System voltage will be higher at colder temperatures and is gradually reduced at warmer temperatures.

The sensor is located under the vehicle battery and is attached (snapped into) the battery tray (Fig. 1). On models equipped with a diesel engine (dual batteries), only one sensor is used. Location is under battery on drivers side of vehicle.

VOLTAGE REGULATOR

The voltage regulator is not a separate component. It is actually a voltage regulating circuit located within the PCM. This EVR is not serviced separately.



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Fig. 1 Battery Temperature Sensor Location

If replacement is necessary, the PCM must be replaced.

Operation: The amount of DC current produced by the generator is controlled by EVR circuitry contained within the PCM. This circuitry is connected in series with the generator's second rotor field terminal and its ground.

Voltage is regulated by cycling the ground path to control the strength of the rotor magnetic field. The EVR circuitry monitors system line voltage and battery temperature (refer to Battery Temperature Sensor for more information). It then compensates and regulates generator current output accordingly. Also see Charging System Operation for additional information.

DIAGNOSIS AND TESTING**CHARGING SYSTEM**

When the ignition switch is turned to the ON position, battery potential will register on the voltmeter. During engine cranking a lower voltage will appear on the meter. With the engine running, a voltage reading higher than the first reading (ignition in ON) should register.

DIAGNOSIS AND TESTING (Continued)

The following procedures may be used to diagnose the charging system if:

- the voltmeter does not operate properly
- an undercharged or overcharged battery condition occurs.

Remember that an undercharged battery is often caused by:

- accessories being left on with the engine not running
- a faulty or improperly adjusted switch that allows a lamp to stay on. See Ignition-Off Draw Test in Group 8A, Battery for more information.

INSPECTION

(1) Inspect condition of battery cable terminals, battery posts, connections at engine block, starter solenoid and relay. They should be clean and tight. Repair as required.

(2) Inspect all fuses in the fuseblock module and Power Distribution Center (PDC) for tightness in receptacles. They should be properly installed and tight. Repair or replace as required.

(3) Inspect the electrolyte level in the battery. Replace battery if electrolyte level is low.

(4) Inspect generator mounting bolts for tightness. Replace or tighten bolts if required. Refer to the Generator Removal/Installation section of this group for torque specifications.

(5) Inspect generator drive belt condition and tension. Tighten or replace belt as required. Refer to Belt Tension Specifications in Group 7, Cooling System.

(6) Inspect automatic belt tensioner (if equipped). Refer to Group 7, Cooling System for information.

(7) Inspect connections at generator field, battery output, and ground terminals. Also check ground connection at engine. They should all be clean and tight. Repair as required.

CHARGING SYSTEM RESISTANCE TESTS

These tests will show the amount of voltage drop across the generator output wire, from the generator output (B+) terminal (Fig. 2) to the battery positive post. They will also show the amount of voltage drop from the ground (-) terminal on the generator (Fig. 2) to the battery negative post.

A voltmeter with a 0-18 volt DC scale should be used for these tests. By repositioning the voltmeter test leads, the point of high resistance (voltage drop) can easily be found.

PREPARATION

(1) Before starting test, make sure battery is in good condition and is fully-charged. See Group 8A, Battery for more information.

(2) Check condition of battery cables at battery. Clean if necessary.

(3) Start the engine and allow it to reach normal operating temperature.

(4) Shut engine off.

(5) Connect an engine tachometer.

(6) Fully engage the parking brake.

TEST

(1) Start engine.

(2) Place heater blower in high position.

(3) Turn on headlamps and place in high-beam position.

(4) Turn vehicle interior lamps on.

(5) Start engine. Bring engine speed up to 2400 rpm and hold.

(6) Testing (+) circuitry:

(a) Touch the negative lead of voltmeter directly to battery positive post.

(b) Touch the positive lead of voltmeter to the B+ output terminal stud on the generator (not the terminal mounting nut). Voltage should be no higher than 0.6 volts. If voltage is higher than 0.6 volts, touch test lead to terminal mounting stud nut and then to the wiring connector. If voltage is now below 0.6 volts, look for dirty, loose or poor connection at this point. Also check condition of the generator output wire-to-battery bullet connector. Refer to Group 8, Wiring for connector location. A voltage drop test may be performed at each (+) connection in this circuit to locate the excessive resistance.

(7) Testing (-) circuitry:

(a) Touch the negative lead of voltmeter directly to battery negative post.

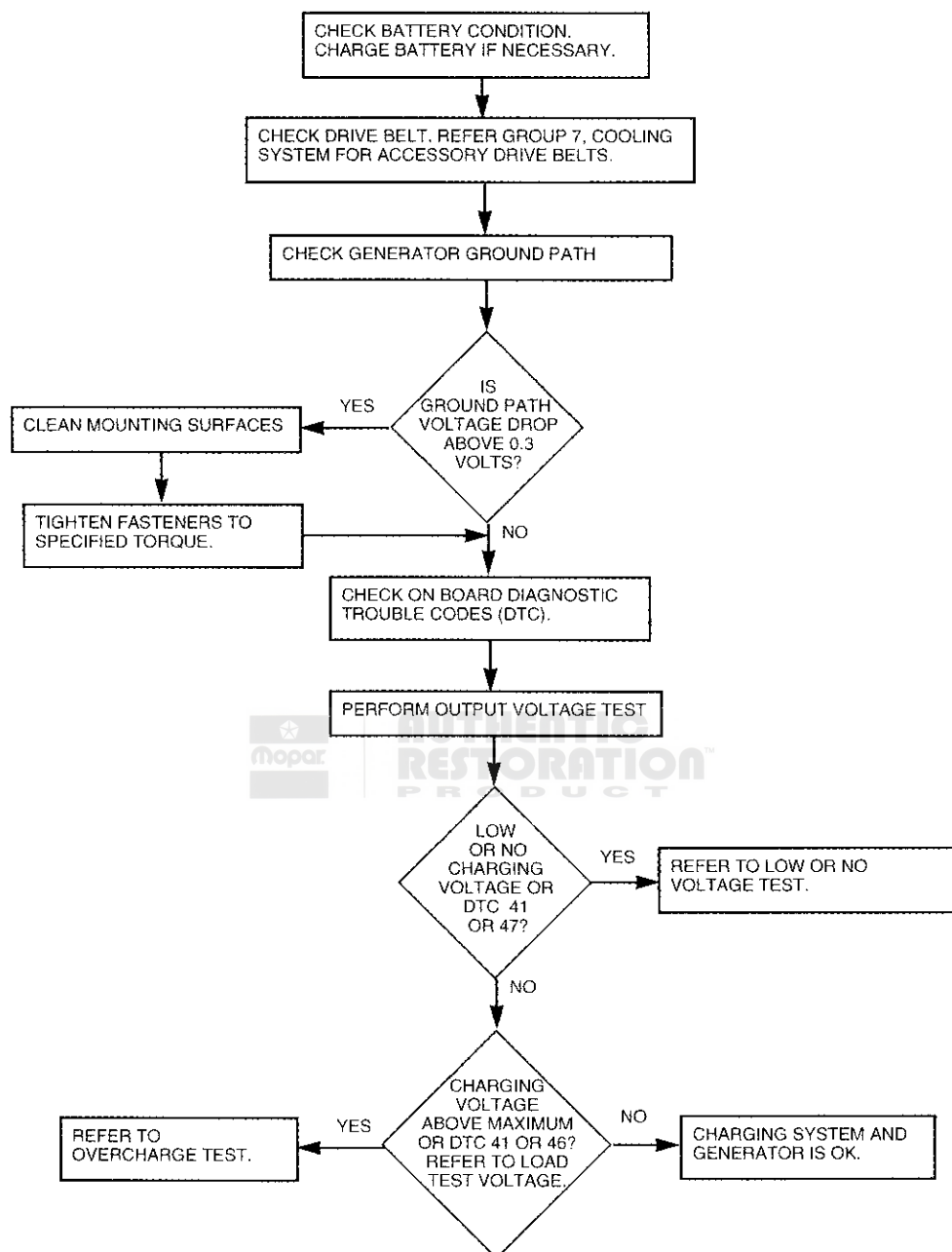
(b) Touch the positive lead of voltmeter to the ground terminal stud on the generator case (not the terminal mounting nut). Voltage should be no higher than 0.3 volts. If voltage is higher than 0.3 volts, touch test lead to terminal mounting stud nut and then to the wiring connector. If voltage is now below 0.3 volts, look for dirty, loose or poor connection at this point. A voltage drop test may be performed at each (-) connection in this circuit to locate the excessive resistance. This test can also be performed between the generator case and the engine. If test voltage is higher than 0.3 volts, check for corrosion at generator mounting points or loose generator mounting.

CURRENT OUTPUT TEST

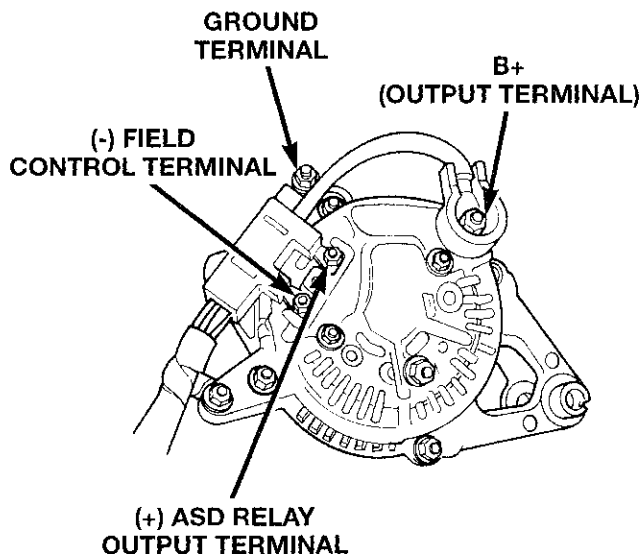
The current output test will determine if the charging system can deliver its minimum test current (amperage) output. Refer to the Specifications section at the end of this group for minimum test current (amperage) requirements.

The first part of this test (Test 1) will determine the combined amperage output of both the generator and the Electronic Voltage Regulator (EVR) circuitry.

DIAGNOSIS AND TESTING (Continued)



DIAGNOSIS AND TESTING (Continued)



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Fig. 2 Generator Terminals

The second part of this test (Test 2) will determine only generator amperage and **will not** include analysis of EVR circuitry. EVR circuitry is located within the Powertrain Control Module (PCM). To test voltage regulator circuitry, refer to the appropriate Powertrain Diagnostic Procedures service manual.

PREPARATION

(1) Determine if any Diagnostic Trouble Codes (DTC's) exist. To determine a DTC, refer to On-Board Diagnostics in this group. For repair, refer to the appropriate Powertrain Diagnostic Procedures manual.

(2) Before starting test, make sure battery is in good condition and is fully-charged. See Group 8A, Battery for more information.

(3) Check condition of battery cables at battery. Clean if necessary.

(4) Perform the previous Output Wire Resistance Test (voltage drop test). This will ensure clean and tight generator/battery electrical connections.

(5) Be sure the generator drive belt is properly tensioned. Refer to Group 7, Cooling System for information.

(6) A volt/amp tester equipped with both a battery load control (carbon pile rheostat) and an inductive-type pickup clamp (ammeter probe) will be used for this test. Refer to operating instructions supplied with tester. When using a tester equipped with an inductive-type clamp, removal of wiring at the generator will not be necessary.

(7) Start the engine and allow it to reach operating temperature.

(8) Shut engine off.

(9) Turn off all electrical accessories and all vehicle lighting.

(10) Connect the volt/amp tester leads to the battery. Be sure the carbon pile rheostat control is in the OPEN or OFF position before connecting leads. See Load Test in Group 8A, Battery for more information. Also refer to the operating instructions supplied with test equipment.

(11) Connect the inductive clamp (ammeter probe). Refer to the operating instructions supplied with test equipment.

(12) If volt/amp tester is not equipped with an engine tachometer, connect a separate tachometer to the engine.

TEST 1

(1) Perform the previous test Preparation.

(2) Fully engage the parking brake.

(3) Start engine.

(4) Bring engine speed to 2500 rpm.

(5) With engine speed held at 2500 rpm, slowly adjust the rheostat control (load) on the tester to obtain the highest amperage reading. Do not allow voltage to drop below 12 volts. Record the reading. **This load test must be performed within 15 seconds to prevent damage to test equipment.** On certain brands of test equipment, this load will be applied automatically. Refer to the operating manual supplied with test equipment.

(6) The ammeter reading must meet the Minimum Test Amps specifications as displayed in the Generator Ratings chart. This can be found in the Specifications section at the end of this group. A label stating a part reference number is attached to the generator case. On some engines this label may be located on the bottom of the case. Compare this reference number to the Generator Ratings chart.

(7) Rotate the load control to the OFF position.

(8) Continue holding engine speed at 2500. If EVR circuitry is OK, amperage should drop below 15–20 amps. With all electrical accessories and vehicle lighting off, this could take several minutes of engine operation. If amperage did not drop, refer to the appropriate Powertrain Diagnostic Procedures manual for testing.

(9) Remove volt/amp tester.

If minimum amperage could not be met, proceed to Test 2. This test will determine if the generator is faulty, or if EVR circuitry is defective.

TEST 2

(1) Perform the previous test preparation.

(2) Fully engage the parking brake.

(3) Connect one end of a jumper wire to a good ground. Connect the other end of jumper wire to the (-) field control circuit terminal. This terminal is

DIAGNOSIS AND TESTING (Continued)

located on the back of the generator (Fig. 2). Connecting the jumper wire will remove the voltage regulator circuitry from the test. It will also generate a Diagnostic Trouble Code (DTC).

CAUTION: Do not connect the jumper wire to the (+) ASD Relay output terminal (Fig. 2). Damage to electrical system components may result. The (-) field control circuit terminal is located farther away from the B+ output terminal than the (+) ASD Relay terminal (Fig. 2).

(4) Start engine. **Immediately** after starting, reduce engine speed to idle. This will prevent any electrical accessory damage from high voltage.

(5) Adjust carbon pile rheostat (load) and engine speed in slow increments until a speed of 1250 rpm, and a voltmeter reading of 15 volts is obtained. Immediately record ammeter reading. Do not apply load to system longer than 15 seconds as damage to test equipment may result.

CAUTION: When adjusting rheostat load, do not allow voltage to rise above 16 volts. Damage to the battery and electrical system components may result.

(6) The ammeter reading must meet the Minimum Test Amps specifications as displayed in the Generator Ratings chart. This can be found in the Specifications section at the end of this group. A label stating a part reference number is attached to the generator case. On some engines this label may be located on the bottom of the case. Compare this reference number to the Generator Rating chart.

(7) Remove volt/amp tester.

(8) Remove jumper wire.

(9) Use the DRB scan tool to erase the DTC. Refer to the DRB screen for procedures.

RESULTS

- If amp reading meets specifications in Test 2, generator is OK.

- If amp reading is less than specified in Test 2, and wire resistance (voltage drop) tests were OK, the generator should be replaced. Refer to Removal and Installation in this group for procedures.

- If Test 2 results were OK, but Test 1 results were not, the problem is in EVR circuitry. Refer to appropriate Powertrain Diagnostic Procedures manual for diagnosis.

BATTERY TEMPERATURE SENSOR

To perform a complete test of this sensor and its circuitry, refer to the appropriate Powertrain Diagnostic Procedures manual. To test the sensor only, refer to the following:

(1) The sensor is located under the battery and is attached (snapped into) the battery tray (Fig. 1). A two-wire pigtail harness is attached directly to the sensor. The opposite end of this harness connects the sensor to the engine wiring harness.

(2) Disconnect the two-wire pigtail harness from the engine harness.

(3) Attach ohmmeter leads to the wire terminals of the pigtail harness.

(4) At room temperature of 25° C (75–80° F), an ohmmeter reading of 9 to 11K ohms should be observed.

(5) If reading is above or below the specification, replace the sensor.

(6) Refer to the Removal and Installation section for procedures.

ON-BOARD DIAGNOSTIC SYSTEM TEST

GENERAL INFORMATION

The Powertrain Control Module (PCM) monitors critical input and output circuits of the charging system, making sure they are operational. A Diagnostic Trouble Code (DTC) is assigned to each input and output circuit monitored by the OBD system. Some circuits are checked continuously and some are checked only under certain conditions.

If the OBD system senses that a monitored circuit is bad, it will put a DTC into electronic memory. The DTC will stay in electronic memory as long as the circuit continues to be bad. The PCM is programmed to clear the memory after 50 engine starts if the problem does not occur again.

DIAGNOSTIC TROUBLE CODES

Diagnostic Trouble Codes (DTC) are two-digit numbers flashed on the malfunction indicator (Check Engine) lamp that identify which circuit is bad. Refer to Group 14, Fuel Systems for more information. A DTC description can also be read using the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures manual for information.

A DTC does not identify which component in a circuit is bad. Thus, a DTC should be treated as a symptom, not as the cause for the problem. In some cases, because of the design of the diagnostic test procedure, a DTC can be the reason for another DTC to be set. Therefore, it is important that the test procedures be followed in sequence, to understand what caused a DTC to be set.

See the Generator Diagnostic Trouble Code chart (Fig. 3) for DTC's which apply to the charging system. Refer to the Powertrain Diagnostic Procedures manual to diagnose an on-board diagnostic system trouble code.

DIAGNOSIS AND TESTING (Continued)

Diagnostic Trouble Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
12*	Battery Disconnect	Direct battery input to PCM was disconnected within the last 50 key-on cycles.
41**	Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
46**	Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.
47**	Charging System Voltage Too Low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of generator output.
55*	N/A	Completion of fault code display on Check Engine lamp.

* Check Engine lamp will not illuminate at all times if this Diagnostic Trouble Code was recorded. Cycle ignition key as described in manual and observe code flashed by Check Engine lamp.

** Check Engine lamp will illuminate during engine operation if this Diagnostic Trouble Code was recorded.

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Fig. 3 Generator Diagnostic Trouble Code**RETRIEVING DIAGNOSTIC TROUBLE CODES**

To start this function, cycle the ignition switch ON-OFF-ON-OFF-ON within 5 seconds. This will cause any DTC stored in the PCM memory to be displayed. The malfunction indicator (Check Engine) lamp will display a DTC by flashing on and off. There is a short pause between flashes and a longer pause between digits. All DTC's displayed are two-digit numbers, with a four-second pause between codes.

An example of a DTC is as follows:

- (1) Lamp on for 2 seconds, then turns off.
- (2) Lamp flashes 4 times pauses and then flashes 1 time.
- (3) Lamp pauses for 4 seconds, flashes 4 times, pauses, then flashes 7 times.

(4) The two DTC's are 41 and 47. Any number of DTC's can be displayed, as long as they are in memory. The lamp will flash until all stored DTC's are displayed, then it will flash a DTC 55 to indicate the test is complete.

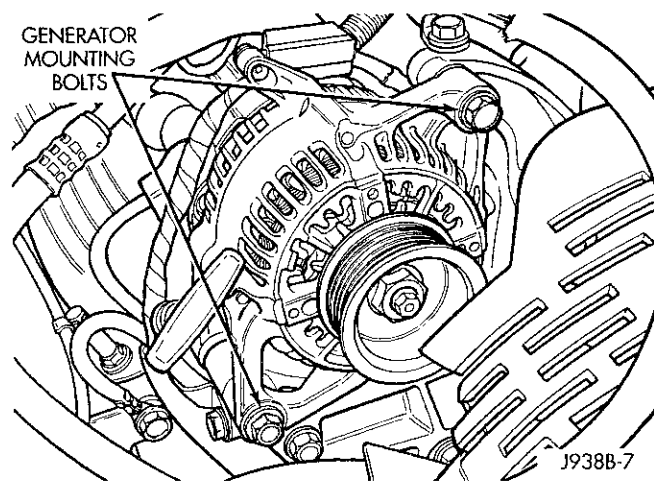
ERASING DIAGNOSTIC TROUBLE CODES

The DRB Scan Tool must be used to erase a DTC.

REMOVAL AND INSTALLATION**GENERATOR**

WARNING: DISCONNECT NEGATIVE CABLE FROM BATTERY BEFORE REMOVING BATTERY OUTPUT WIRE FROM GENERATOR. FAILURE TO DO SO CAN RESULT IN INJURY.

- (1) Disconnect negative battery cable.
- (2) Remove generator drive belt. Refer to Group 7, Cooling System for procedure.
- (3) Remove the generator pivot and mounting bolts (Fig. 4). Position generator for access to wire connectors.

**Fig. 4 Remove/Install Generator—Typical**

- (4) Remove nuts from harness holddown, battery terminal, ground terminal and 2 field terminals (Fig. 5). Remove wire connectors.
- (5) Remove the generator.
- (6) Reverse removal procedures to install. Tighten generator hardware as follows:
 - Generator mounting bolt - 41 N·m (30 ft. lbs.)
 - Generator pivot bolt - 41 N·m (30 ft. lbs.)
 - Battery terminal nut - 8.5 N·m (75 in. lbs.)

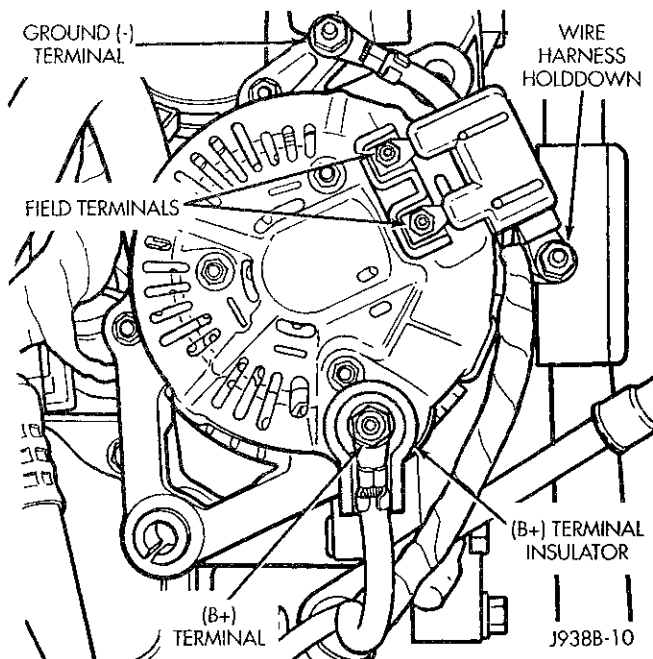
REMOVAL AND INSTALLATION (Continued)

Fig. 5 Remove/Install Generator Connectors—Typical

- Ground terminal nut - 8.5 N·m (75 in. lbs.)
- Harness holddown nut - 8.5 N·m (75 in. lbs.)
- Field terminal nuts - 2.8 N·m (25 in. lbs.)

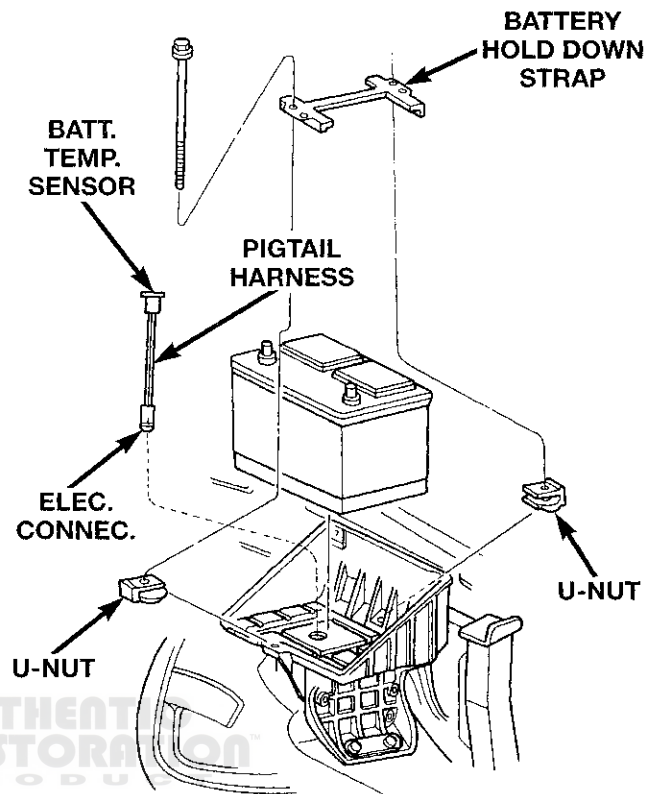
CAUTION: Never force a belt over a pulley rim using a screwdriver. The synthetic fiber of the belt can be damaged.

CAUTION: When installing a serpentine accessory drive belt, the belt **MUST** be routed correctly. The water pump will be rotating in the wrong direction if the belt is installed incorrectly, causing the engine to overheat. Refer to belt routing label in engine compartment, or refer to Belt Schematics in Group 7, Cooling System.

BATTERY TEMPERATURE SENSOR

The battery temperature sensor is located under the vehicle battery (Fig. 6) and is attached (snapped into) a mounting hole on battery tray. On models equipped with a diesel engine (dual batteries), only

one sensor is used. The sensor is located under the battery on drivers side of vehicle.



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Fig. 6 Battery Temperature Sensor Location

REMOVAL

- (1) Remove the battery. Refer to Group 8A, Battery for procedures.
- (2) Disconnect the sensor pigtail harness from the engine wire harness.
- (3) Pry the sensor straight up from the battery tray mounting hole.

INSTALLATION

- (1) Feed the pigtail harness through the mounting hole in top of battery tray and press sensor into top of tray (snaps in).
- (2) Connect the pigtail harness.
- (3) Install the battery. Refer to Group 8A, Battery for procedures.

SPECIFICATIONS**GENERATOR RATINGS**

TYPE	PART NUMBER	RATED SAE AMPS	ENGINES	MINIMUM TEST AMPS
DENSO	53008646	81	3.9L/5.2L/5.9L	75
DENSO	53008647	117	3.9L/5.2L/5.9L	90
DENSO	53008651	136	3.9L/5.2L/5.9L	120
DENSO	56027221	136	DIESEL	120

TORQUE SPECIFICATIONS**DESCRIPTION****TORQUE**

Generator Mounting Bolt—

All Engines41 N·m (30 ft. lbs.)

Generator Pivot Bolt—

All Engines41 N·m (30 ft. lbs.)

Battery Terminal Nut8.5 N·m (75 in. lbs.)

Ground Terminal Nut8.5 N·m (75 in. lbs.)

Harness Hold-down Nut8.5 N·m (75 in. lbs.)

Field Terminal Nuts2.8 N·m (25 in. lbs.)

**AUTHENTIC
RESTORATION™
PRODUCT**

IGNITION SYSTEM

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GENERAL INFORMATION

INTRODUCTION

This group describes the ignition systems for 3.9L V-6, 5.2L/5.9L V-8, and 8.0L V-10 engines.

The 3.9L V-6 and 5.2L V-8 engines will be referred to in this Ignition Group as: Light Duty Cycle (LDC) engines. The 5.9L V-8 gas powered engine will be referred to as either: Light Duty Cycle (LDC) or Heavy Duty Cycle (HDC) engines. The 8.0L V-10 engine will be referred to as either: Light Duty Cycle (LDC) or Heavy Duty Cycle (HDC) engines.

Either of the HDC gas powered engines can be easily identified by the use of an engine mounted air injection pump. The 3.9L V-6 engine, the 5.2/5.9L V-8 LDC or the 8.0L V-10 LDC gas engines will not use an air injection pump.

On Board Diagnostics is described in Group 25, Emission Control Systems.

Group 0, Lubrication and Maintenance, contains general maintenance information (in time or mileage intervals) for ignition related items. The Owner's Manual also contains maintenance information.

DESCRIPTION AND OPERATION

IGNITION SYSTEM—V-6/V-8 ENGINES

The ignition systems used on the 3.9L V-6, the 5.2L V-8 and the 5.9L V-8 are basically identical. Similarities and differences between the systems will be discussed.

The ignition system is controlled by the powertrain control module (PCM) on all engines.

The ignition system consists of:

- Spark Plugs
- Ignition Coil
- Secondary Ignition Cables
- Distributor (contains rotor and camshaft position sensor)
- Powertrain Control Module (PCM)
- Also to be considered part of the ignition system are certain inputs from the Crankshaft Position,

Camshaft Position, Throttle Position and MAP Sensors

IGNITION SYSTEM—8.0L V-10 ENGINE

The ignition system used on the 8.0L V-10 engine will not use a conventional mechanical distributor. It will be referred to as a distributor-less ignition system. The ignition coils are individually fired, but each coil is a dual output. Refer to Ignition Coil Pack for additional information.

The ignition system is controlled by the powertrain control module (PCM) on all engines.

The ignition system consists of:

- Spark Plugs
- Ignition Coil Packs containing individual coils
- Secondary Ignition Cables
- Powertrain Control Module (PCM)
- Also to be considered part of the ignition system are certain inputs from the Crankshaft Position, Camshaft Position, Throttle Position and MAP Sensors

POWERTRAIN CONTROL MODULE

The Powertrain Control Module (PCM) is located in the engine compartment (Fig. 1).

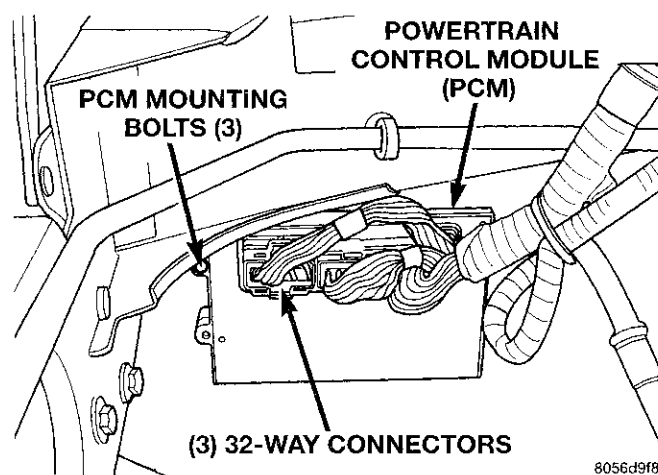


Fig. 1 Powertrain Control Module (PCM)

The ignition system is controlled by the PCM.

DESCRIPTION AND OPERATION (Continued)

NOTE: On 3.9L/5.2L/5.9L engines, base ignition timing by rotation of distributor is not adjustable.

The PCM opens and closes the ignition coil ground circuit (or circuits) to operate the ignition coil (or coil packs). This is done to adjust ignition timing, both initial (base) and advance, and for changing engine operating conditions.

The amount of electronic spark advance provided by the PCM is determined by five input factors: engine coolant temperature, engine rpm, intake manifold temperature, manifold absolute pressure and throttle position.

DISTRIBUTOR

All 3.9L V-6 and 5.2L/5.9L V-8 engines are equipped with a conventional camshaft driven mechanical distributor containing a shaft driven distributor rotor. The distributor is equipped with the camshaft position (fuel sync) sensor (Fig. 2). This sensor provides fuel injection synchronization and cylinder identification.

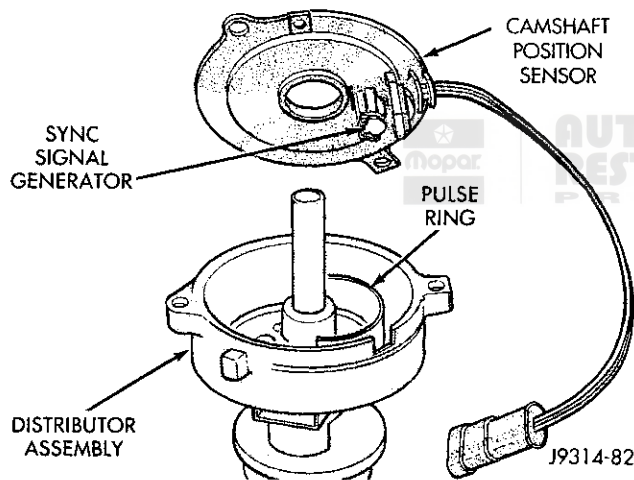


Fig. 2 Distributor and Camshaft Position Sensor—Typical

The distributor does not have built in centrifugal or vacuum assisted advance. Base ignition timing and all timing advance is controlled by the Powertrain Control Module (PCM). Because ignition timing is controlled by the PCM, **base ignition timing is not adjustable.**

The distributor is held to the engine in the conventional method using a holddown clamp and bolt.

Although the distributor can be rotated, it will have no effect on ignition timing.

All distributors contain an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

SPARK PLUGS

All engines use resistor type spark plugs. Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. A single plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O, Lubrication and Maintenance.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective, carbon or oil fouled. Refer to the Spark Plug Condition section of this group.

SPARK PLUG CABLES

Spark plug cables are sometimes referred to as secondary ignition wires. These cables transfer electrical current from the ignition coil(s) and/or distributor, to individual spark plugs at each cylinder. The resistive spark plug cables are of nonmetallic construction. The cables provide suppression of radio frequency emissions from the ignition system.

IGNITION COIL—3.9L/5.2L/5.9L ENGINES

Battery voltage is supplied to the ignition coil positive terminal from the ASD relay.

The Powertrain Control Module (PCM) opens and closes the ignition coil ground circuit for ignition coil operation.

Base ignition timing is not adjustable on any engine. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

The ignition coil is not oil filled. The windings are embedded in an epoxy compound. This provides heat and vibration resistance that allows the ignition coil to be mounted on the engine.

IGNITION COIL PACKS—8.0L ENGINE

The ignition system used on the 8.0L V-10 engine does not use a conventional mechanical distributor. It will be referred to as a distributor-less ignition system. **Ignition timing is not adjustable on any 8.0L V-10 engine.**

DESCRIPTION AND OPERATION (Continued)

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 3). The coil packs are not oil filled. The front coil pack contains three independent epoxy filled coils. The rear coil pack contains two independent epoxy filled coils.

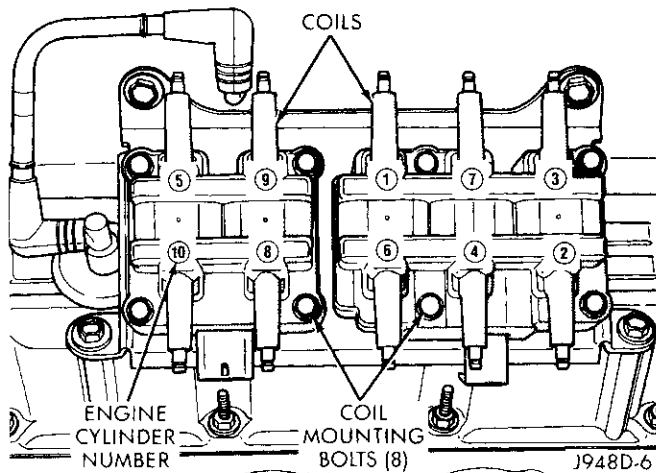


Fig. 3 Ignition Coil Packs—8.0L V-10 Engine

When one of the 5 independent coils discharges, it fires two paired cylinders at the same time (one cylinder on compression stroke and the other cylinder on exhaust stroke).

Coil firing is paired together on cylinders:

- Number 5 and 10
- Number 9 and 8
- Number 1 and 6
- Number 7 and 4
- Number 3 and 2

The ignition system is controlled by the powertrain control module (PCM) on all engines. The PCM was formerly referred to as the SBEC or engine controller.

The automatic shutdown (ASD) relay, after receiving signals from the crankshaft and camshaft position sensors, will supply battery voltage to all of the ignition coil positive terminals. If these signals are not received by the PCM after approximately one second of engine cranking (start-up), the ASD relay will shut off positive voltage to all of the coils. Coil operation (firing) is then controlled by switching ground circuits (off-and-on) through the PCM. The PCM will determine cylinder identification after receiving signals from the crankshaft and camshaft position sensors.

The PCM adjusts ignition timing based on inputs it receives from:

- The engine coolant temperature sensor
- The crankshaft position sensor (engine speed)
- The manifold absolute pressure (MAP) sensor

- The throttle position sensor
- Transmission gear selection

AUTOMATIC SHUTDOWN (ASD) RELAY—3.9L/5.2L/5.9L ENGINES

As one of its functions, the ASD relay will supply battery voltage to the ignition coil. The ground circuit for the ASD relay is controlled by the Powertrain Control Module (PCM). The PCM regulates ASD relay operation by switching the ground circuit on-and-off.

AUTOMATIC SHUTDOWN (ASD) RELAY—8.0L V-10 ENGINE

As one of its functions, the ASD relay will supply battery voltage to each of the 5 independent ignition coils. The ground circuit for the ASD relay is controlled by the Powertrain Control Module (PCM). The PCM regulates ASD relay operation by switching the ground circuit on-and-off.

CRANKSHAFT POSITION SENSOR—3.9L V-6 ENGINE

Engine speed and crankshaft position are provided through the crankshaft position sensor. The sensor generates pulses that are the input sent to the Powertrain Control Module (PCM). The PCM interprets the sensor input to determine the crankshaft position. The PCM then uses this position, along with other inputs, to determine injector sequence and ignition timing.

The sensor is a hall effect device combined with an internal magnet. It is also sensitive to steel within a certain distance from it.

The flywheel/drive plate has groups of notches at its outer edge. On 3.9L V-6 engines, there are three sets of double notches and three sets of single notches (Fig. 4).

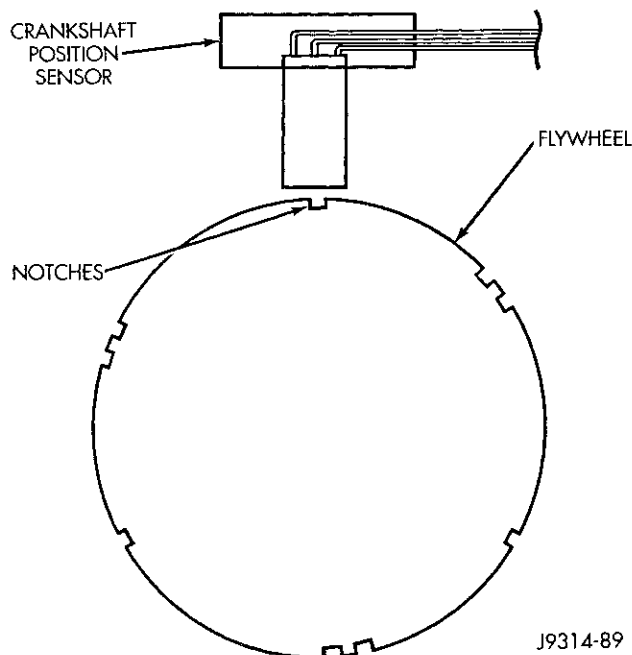
The notches cause a pulse to be generated when they pass under the sensor. The pulses are the input to the PCM.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

CRANKSHAFT POSITION SENSOR—5.2L/5.9L V-8 ENGINES

Engine speed and crankshaft position are provided through the crankshaft position sensor. The sensor generates pulses that are the input sent to the Powertrain Control Module (PCM). The PCM interprets the sensor input to determine the crankshaft position. The PCM then uses this position, along with other inputs, to determine injector sequence and ignition timing.

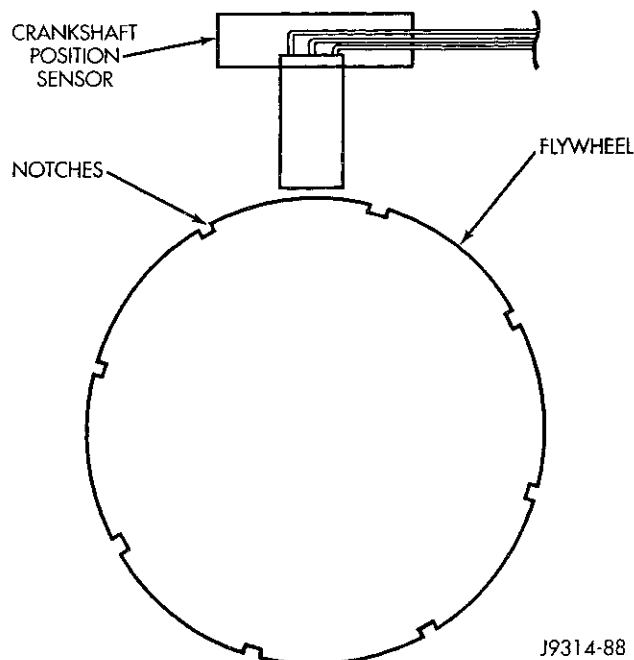
The sensor is a hall effect device combined with an internal magnet. It is also sensitive to steel within a certain distance from it.

DESCRIPTION AND OPERATION (Continued)**Fig. 4 Sensor Operation—3.9L Engine**

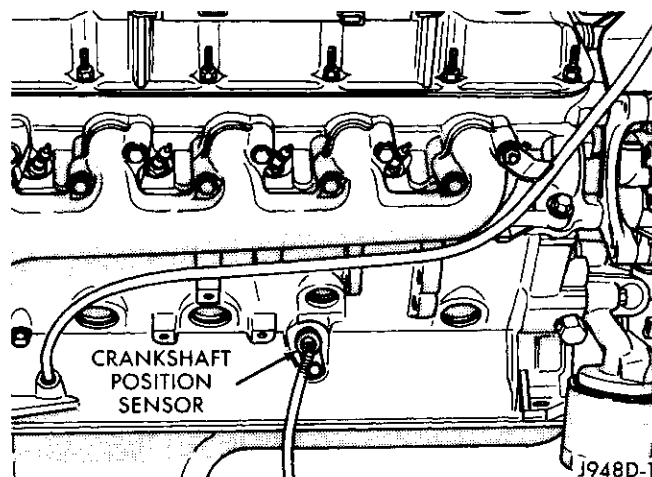
On 5.2L and 5.9L V-8 engines, the flywheel/drive plate has 8 single notches, spaced every 45 degrees, at its outer edge (Fig. 5).

The notches cause a pulse to be generated when they pass under the sensor. The pulses are the input to the PCM. For each engine revolution, there are 8 pulses generated on V-8 engines.

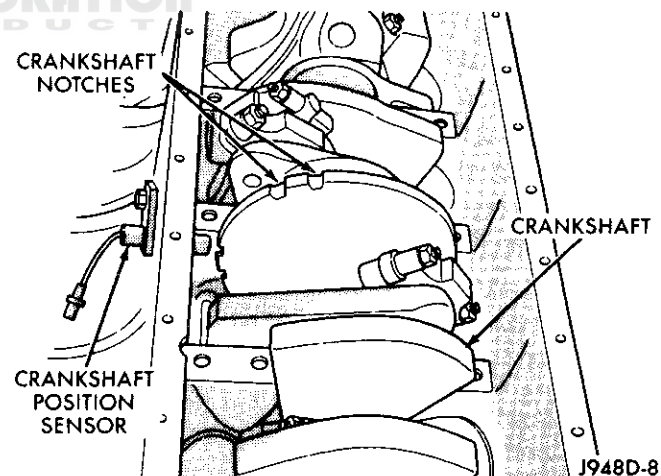
The engine will not operate if the PCM does not receive a crankshaft position sensor input.

**Fig. 5 Sensor Operation—5.2L/5.9L Engine****CRANKSHAFT POSITION SENSOR—8.0L V-10 ENGINE**

The crankshaft position sensor is located on the right-lower side of the cylinder block, forward of the right engine mount, just above the oil pan rail (Fig. 6).

**Fig. 6 Crankshaft Position Sensor—8.0L V-10 Engine**

The crankshaft position sensor detects notches machined into the middle of the crankshaft (Fig. 7).

**Fig. 7 Sensor Operation—8.0L V-10 Engine**

There are five sets of notches. Each set contains two notches. Basic ignition timing is determined by the position of the last notch in each set of notches. Once the powertrain control module (PCM) senses the last notch, it will determine crankshaft position (which piston will next be at Top Dead Center). An input from the camshaft position sensor is also needed. It may take the module up to one complete engine revolution to determine crankshaft position during engine cranking.

DESCRIPTION AND OPERATION (Continued)

The PCM uses the signal from the camshaft position sensor to determine fuel injector sequence. Once crankshaft position has been determined, the PCM begins energizing a ground circuit to each fuel injector to provide injector operation.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

The camshaft position sensor is located in the distributor on all engines.

The sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects a rotating pulse ring (shutter) on the distributor shaft. The pulse ring rotates 180 degrees through the sync signal generator. Its signal is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

When the leading edge of the pulse ring (shutter) enters the sync signal generator, the following occurs: The interruption of magnetic field causes the voltage to switch high resulting in a sync signal of approximately 5 volts.

When the trailing edge of the pulse ring (shutter) leaves the sync signal generator, the following occurs: The change of the magnetic field causes the sync signal voltage to switch low to 0 volts.

CAMSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 8).

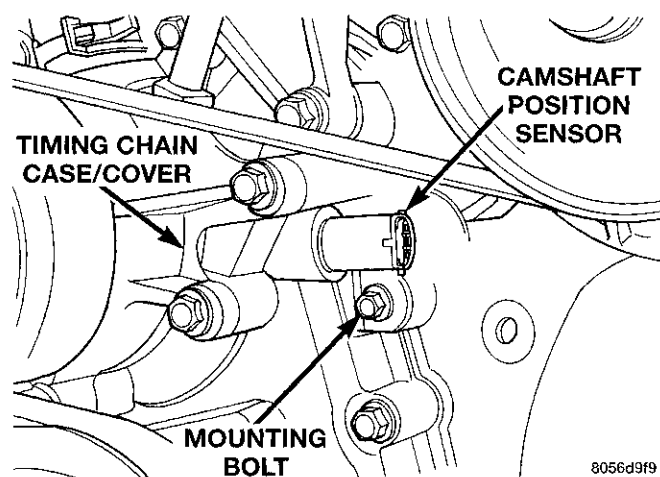


Fig. 8 Camshaft Position Sensor Location—8.0L V-10 Engine

The camshaft position sensor is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also

used to synchronize the fuel injectors with their respective cylinders. The sensor generates electrical pulses. These pulses (signals) are sent to the powertrain control module (PCM). The PCM will then determine crankshaft position from both the camshaft position sensor and crankshaft position sensor.

A low and high area are machined into the camshaft drive gear (Fig. 9). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 9) exists between the face of sensor and the high machined area of cam gear.

When the cam gear is rotating, the sensor will detect the machined low area. Input voltage from the sensor to the PCM will then switch from a low (approximately 0.3 volts) to a high (approximately 5 volts). When the sensor detects the high machined area, the input voltage switches back low to approximately 0.3 volts.

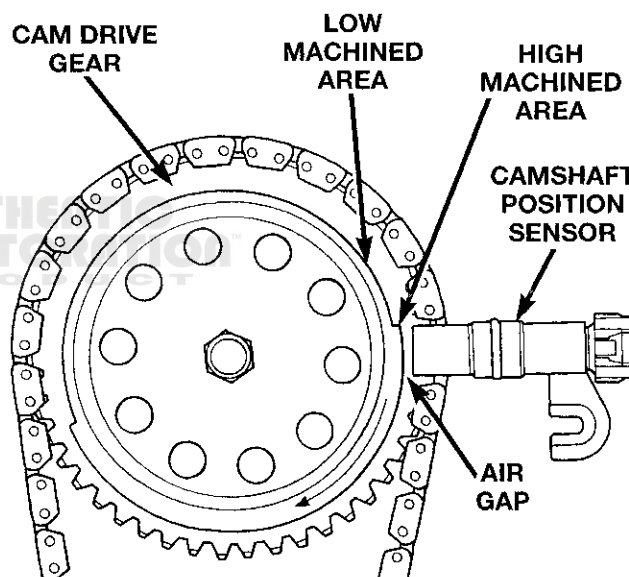


Fig. 9 Sensor Operation—8.0L V-10 Engine

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

ENGINE COOLANT TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

THROTTLE POSITION SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

DESCRIPTION AND OPERATION (Continued)

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

IGNITION SWITCH AND KEY LOCK CYLINDER

The ignition switch is located on the steering column. The Key-In-Switch is located in the ignition switch module. For diagnosis of the Key-In-Switch, refer to Group, 8U.

A column shift interlock device is used to lock the transmission shifter in the Park position when the key is in the Off position. The interlock device is located within the steering column assembly and is not servicable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures.

DIAGNOSIS AND TESTING

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown (ASD) relay is located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 10). Refer to label on PDC cover for relay location.

To perform a complete test of the ASD relay and its related circuitry, refer to the appropriate Powertrain Diagnostic Procedures service manual. To test the relay only, refer to ASD and Fuel Pump Relays in Group 14, Fuel System.

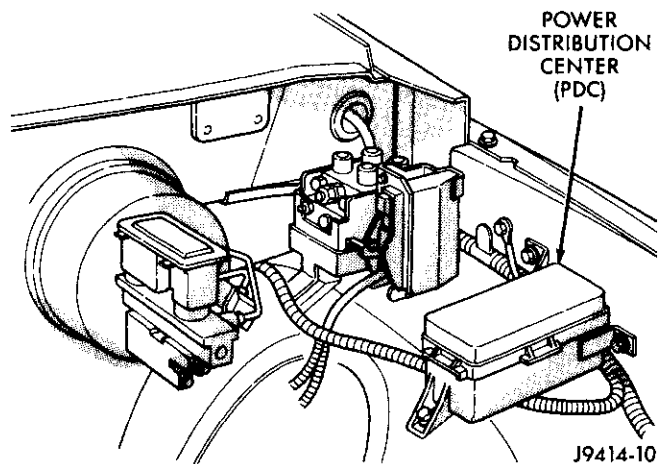


Fig. 10 Power Distribution Center

TESTING FOR SPARK AT COIL—3.9L/5.2L/5.9L ENGINES

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it

loose (Fig. 11). Grasp the boot (not the cable) and pull it off with a steady, even force.

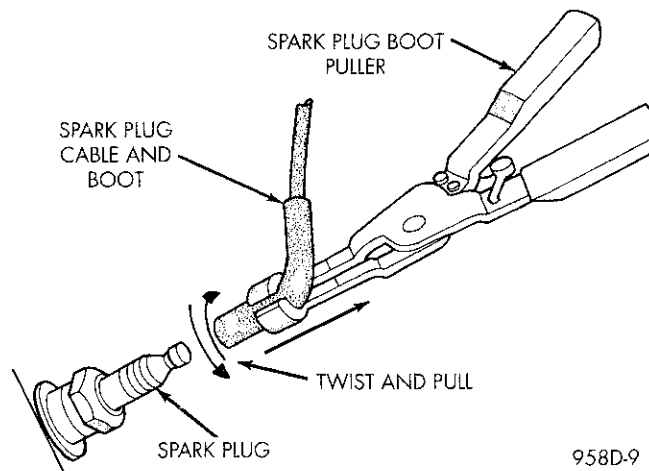


Fig. 11 Cable Removal

(1) Disconnect the ignition coil secondary cable from center tower of the distributor cap. Hold the cable terminal approximately 12 mm (1/2 in.) from a good engine ground (Fig. 12).

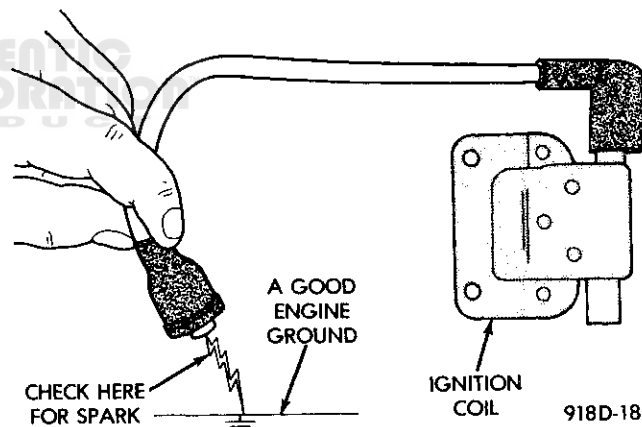


Fig. 12 Checking for Spark—Typical

WARNING: BE VERY CAREFUL WHEN THE ENGINE IS CRANKING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE FITTING CLOTHING.

(2) Rotate (crank) the engine with the starter motor and observe the cable terminal for a steady arc. If steady arcing does not occur, inspect the secondary coil cable. Refer to Spark Plug Cables in this group. Also inspect the distributor cap and rotor for cracks or burn marks. Repair as necessary. If steady arcing occurs, connect ignition coil cable to the distributor cap.

(3) Remove a cable from one spark plug.

(4) Using insulated pliers, hold the cable terminal approximately 12 mm (1/2 in.) from the engine cylinder.

DIAGNOSIS AND TESTING (Continued)

der head or block while rotating the engine with the starter motor. Observe the spark plug cable terminal for an arc. If steady arcing occurs, it can be expected that the ignition secondary system is operating correctly. **(If the ignition coil cable is removed for this test, instead of a spark plug cable, the spark intensity will be much higher).** If steady arcing occurs at the spark plug cables, but the engine will not start, connect the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual.

IGNITION COIL TEST—3.9L/5.2L/5.9L ENGINES

To perform a complete test of the ignition coil and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the coil only, refer to the following:

The ignition coil (Fig. 13) is designed to operate without an external ballast resistor.

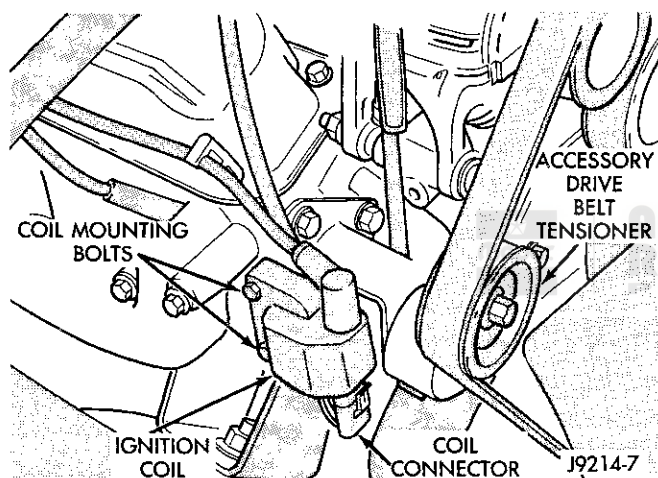


Fig. 13 Ignition Coil (5.2L Shown)

Inspect the ignition coil for arcing. Test the coil according to coil tester manufacturer's instructions. Test the coil primary and secondary resistance. Replace any coil that does not meet specifications. Refer to the Ignition Coil Resistance chart.

If the ignition coil is being replaced, the secondary spark plug cable must also be checked. Replace cable if it has been burned or damaged.

Arcing at the tower will carbonize the cable boot, which if it is connected to a new ignition coil, will cause the coil to fail.

If the secondary coil cable shows any signs of damage, it should be replaced with a new cable and new terminal. Carbon tracking on the old cable can cause arcing and the failure of a new ignition coil.

IGNITION COIL PACK TESTS—8.0L V-10 ENGINE

To perform a complete test of the ignition coil packs and their circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the coil packs only, refer to the following procedure:

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 14). The coil packs are not oil filled. The front coil pack contains three independent epoxy filled coils that will fire six cylinders. The rear coil pack contains two independent epoxy filled coils that will fire four cylinders.

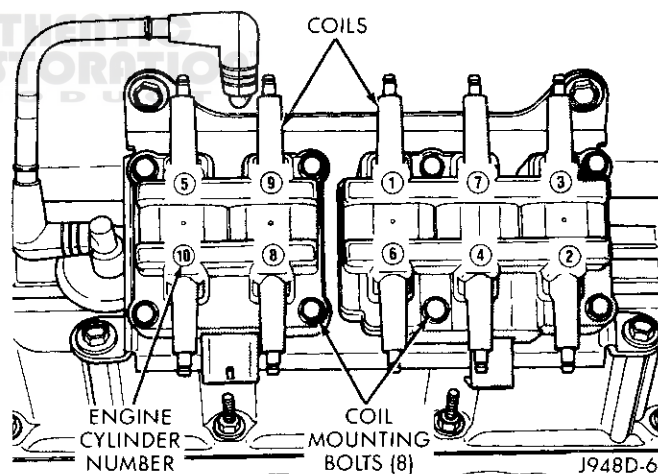


Fig. 14 Ignition Coil Packs—8.0L V-10 Engine

COIL (MANUFACTURER)	PRIMARY RESISTANCE 21–27°C (70–80°F)	SECONDARY RESISTANCE 21–27°C (70–80°F)
Diamond	0.97 - 1.18 Ohms	11,300 - 15,300 Ohms
Toyodenso	0.95 - 1.20 Ohms	11,300 - 13,300 Ohms

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IGNITION COIL RESISTANCE

DIAGNOSIS AND TESTING (Continued)

To test the secondary resistance of each individual paired coil, attach an ohmmeter across the coil towers (Fig. 15) or (Fig. 16). This must be done between corresponding cylinders number 3/2, 7/4, 1/6, 9/8 or 5/10 (Fig. 14). Refer to (Fig. 19) for resistance specifications.

To test the primary resistance of the front coil pack, attach an ohmmeter between the B+ coil terminal and either the right (cylinders 3/2), center (cylinders 7/4) or left coil (cylinders 1/6) terminals (Fig. 17). Refer to (Fig. 19) for resistance specifications.

To test the primary resistance of the rear coil pack, attach an ohmmeter between the B+ coil terminal and either the right (cylinders 9/8) or left (cylinders 5/10) coil terminals (Fig. 18). Refer to (Fig. 19) for resistance specifications.

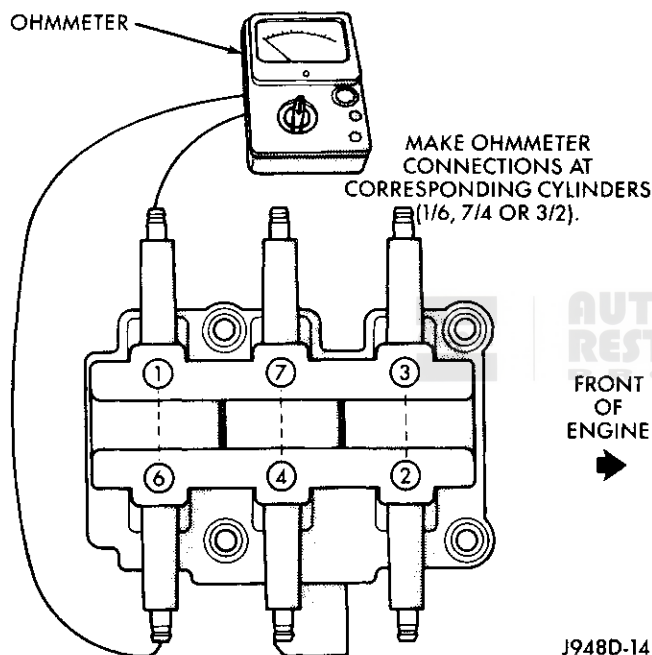


Fig. 15 Checking Coil Secondary Resistance—Front Coils—8.0L V-10 Engine

FAILURE TO START TEST—3.9L/5.2L/5.9L ENGINES

To prevent unnecessary diagnostic time and wrong test results, the Testing For Spark At Coil test should be performed prior to this test.

WARNING: SET PARKING BRAKE OR BLOCK THE DRIVE WHEELS BEFORE PROCEEDING WITH THIS TEST.

(1) Unplug the ignition coil harness connector at the coil (Fig. 13).

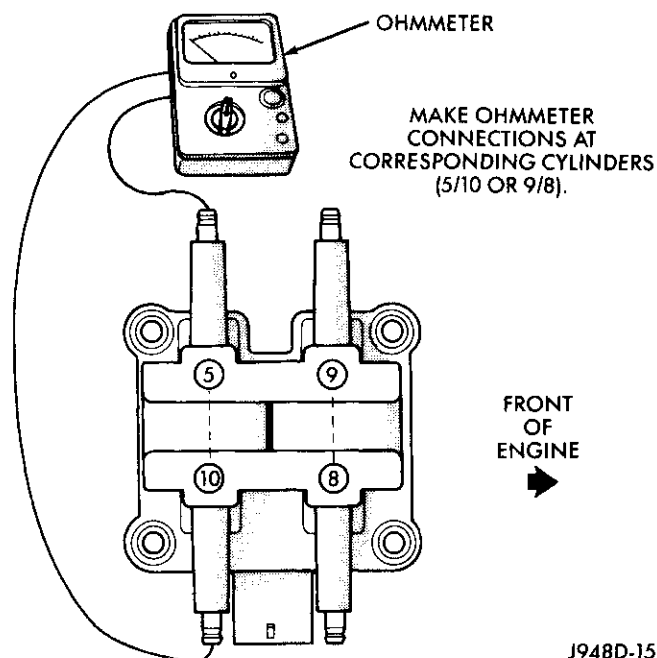


Fig. 16 Checking Coil Secondary Resistance—Rear Coils—8.0L V-10 Engine

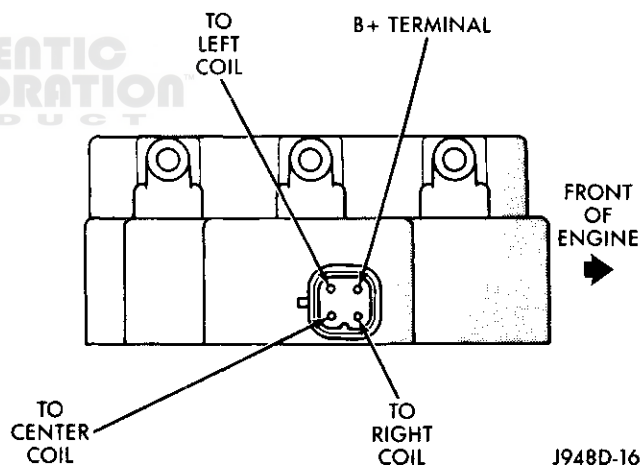


Fig. 17 Checking Coil Primary Resistance—Front Coils—8.0L V-10 Engine

(2) Connect a set of small jumper wires (18 gauge or smaller) between the disconnected harness terminals and the ignition coil terminals. To determine polarity at connector and coil, refer to the Wiring Diagrams section.

(3) Attach one lead of a voltmeter to the positive (12 volt) jumper wire. Attach the negative side of voltmeter to a good ground. Determine that sufficient battery voltage (12.4 volts) is present for the starting and ignition systems.

DIAGNOSIS AND TESTING (Continued)

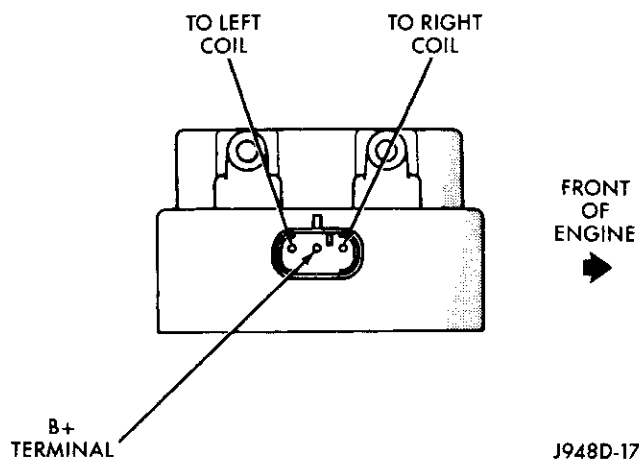


Fig. 18 Checking Coil Primary Resistance—Rear Coils—8.0L V-10 Engine

* Primary Resistance: 0.53 to 0.65 ohms
** Secondary Resistance: 10.9 to 14.7 K ohms
* Test across the primary connector. Refer to text for test procedures.
** Test across the individual coil towers. Refer to text for test procedures.

Fig. 19 Ignition Coil Resistance Specifications—8.0L V-10 Engine

(4) Determine that sufficient battery voltage (12.4 volts) is present for the starting and ignition systems.

(5) Crank the engine for 5 seconds while monitoring the voltage at the coil positive terminal:

- If the voltage remains near zero during the entire period of cranking, refer to On-Board Diagnostics in Group 14, Fuel Systems. Check the Powertrain Control Module (PCM) and auto shutdown relay.

- If voltage is at or near battery voltage and drops to zero after 1-2 seconds of cranking, check the powertrain control module circuit. Refer to On-Board Diagnostics in Group 14, Fuel Systems.

- If voltage remains at or near battery voltage during the entire 5 seconds, turn the key off. Remove the three 32-way connectors (Fig. 20) from the PCM.

Check 32-way connectors for any spread terminals or corrosion.

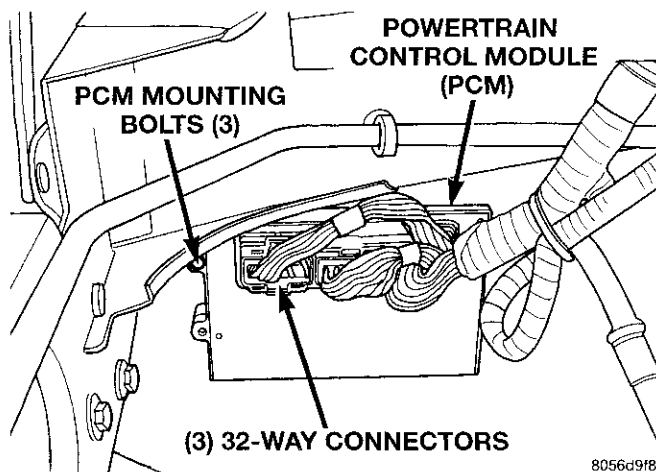


Fig. 20 PCM and Three 32-Way Connectors

(6) Remove test lead from the coil positive terminal. Connect an 18 gauge jumper wire between the battery positive terminal and the coil positive terminal.

(7) Make the special jumper shown in (Fig. 21). Using the jumper, **momentarily** ground the ignition coil driver circuit at the PCM connector (cavity A-7). For cavity/terminal location of this circuit, refer to Group 8W, Wiring. A spark should be generated at the coil cable when the ground is removed.

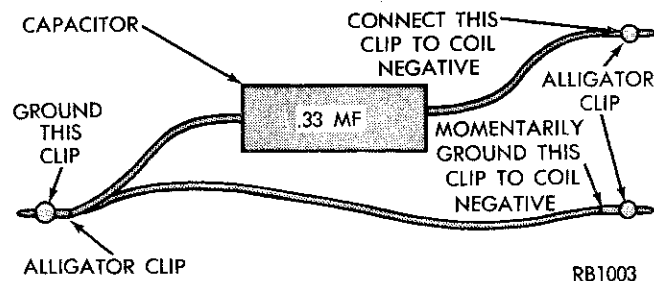


Fig. 21 Special Jumper Ground-to-Coil Negative Terminal

(8) If spark is generated, replace the PCM.

(9) If spark is not seen, use the special jumper to ground the coil negative terminal directly.

(10) If spark is produced, repair wiring harness for an open condition.

(11) If spark is not produced, replace the ignition coil.

DIAGNOSIS AND TESTING (Continued)

DISTRIBUTOR CAP—3.9L/5.2L/5.9L ENGINES

Remove the distributor cap and wipe it clean with a dry lint free cloth. Visually inspect the cap for cracks, carbon paths, broken towers or damaged rotor button (Fig. 22) or (Fig. 23). Also check for white deposits on the inside (caused by condensation entering the cap through cracks). Replace any cap that displays charred or eroded terminals. The machined surface of a terminal end (faces toward rotor) will indicate some evidence of erosion from normal operation. Examine the terminal ends for evidence of mechanical interference with the rotor tip.

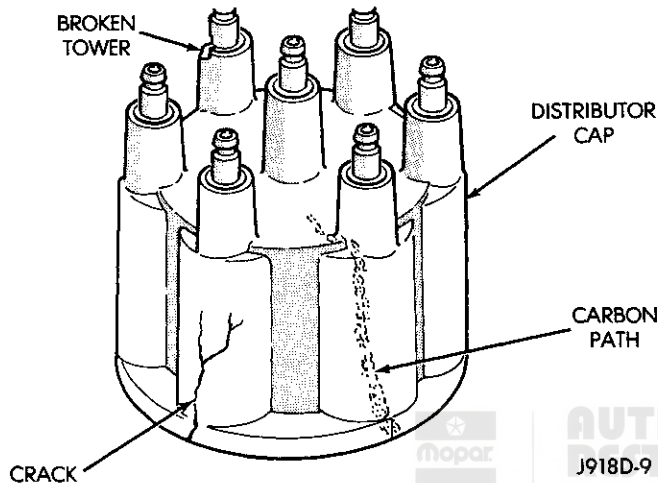


Fig. 22 Cap Inspection—External—Typical

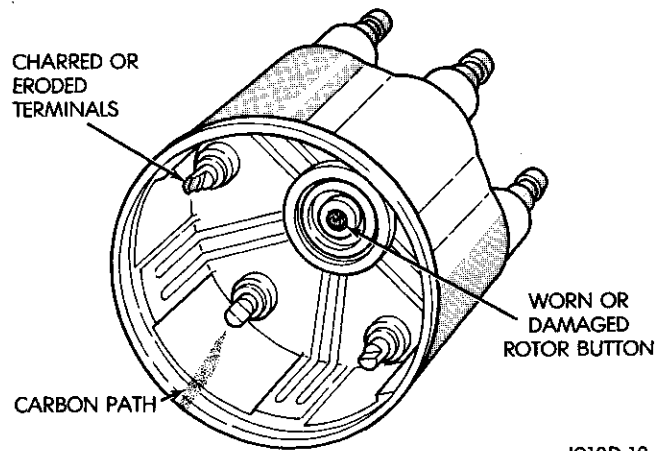
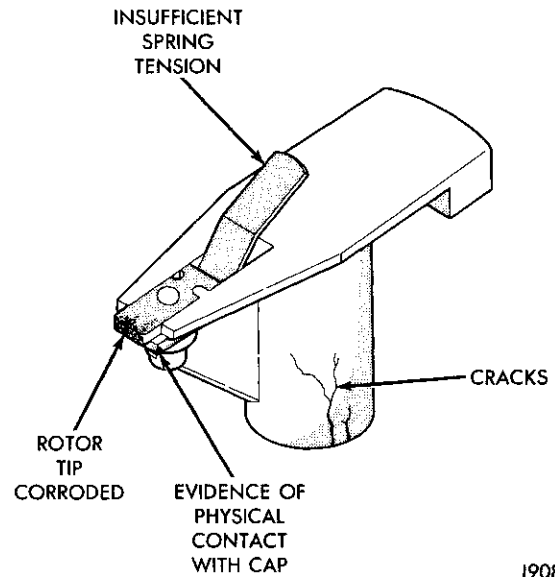


Fig. 23 Cap Inspection—Internal—Typical

DISTRIBUTOR ROTOR—3.9L/5.2L/5.9L ENGINES

Visually inspect the rotor (Fig. 24) for cracks, evidence of corrosion or the effects of arcing on the metal tip. Also check for evidence of mechanical interference with the cap. Some charring is normal on the end of the metal tip. The silicone-dielectric-varnish-compound applied to the rotor tip for radio interference noise suppression, will appear charred.

This is normal. **Do not remove the charred compound.** Test the spring for insufficient tension. Replace a rotor that displays any of these adverse conditions.



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Fig. 24 Rotor Inspection—Typical

IGNITION TIMING

NOTE: Base (initial) ignition timing is **NOT** adjustable on any engine. On 3.9L/5.2L/5.9L engines, do not attempt to adjust ignition timing by rotating the distributor.

All ignition timing functions are controlled by the Powertrain Control Module (PCM). The DRB scan tool may be used to verify base timing and electronic timing advance. Refer to the appropriate Powertrain Diagnostics Procedures service manual for operation of the DRB Scan Tool.

Fuel synchronization can be verified and set by rotating the distributor. Refer to the Distributor Removal/Installation section of this group. See Checking Distributor Position. This operation can be performed on 3.9L/5.2L/5.9L engines only.

MAP SENSOR

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

CRANKSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINE

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

DIAGNOSIS AND TESTING (Continued)

The sensor is located on the top of cylinder block near the rear of right cylinder head (Fig. 25).

(1) Near the rear of the intake manifold, disconnect sensor pigtail harness connector from main wiring harness.

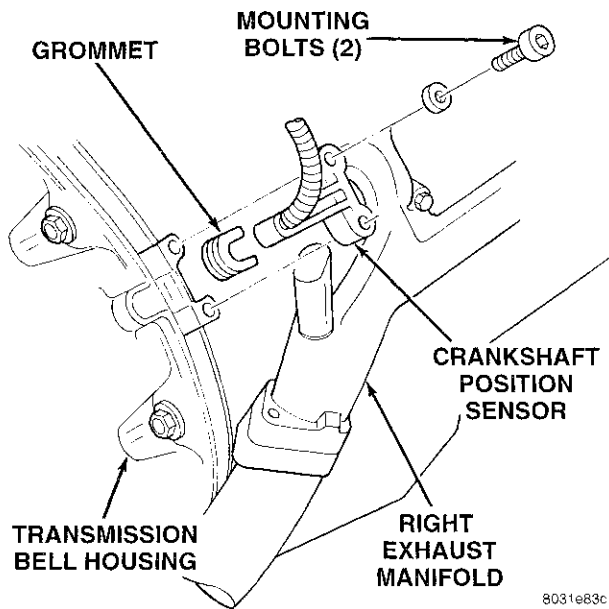
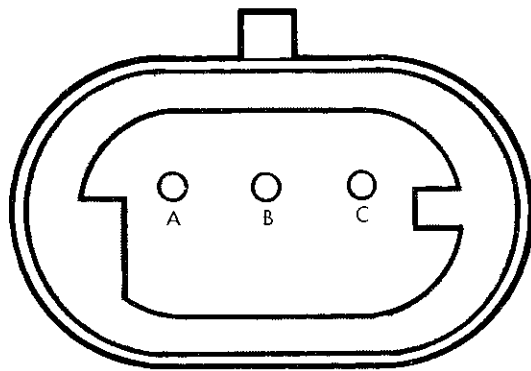


Fig. 25 Crankshaft Position Sensor—Typical

(2) Place an ohmmeter across terminals B and C (Fig. 26). Ohmmeter should be set to 1K-to-10K scale for this test. The meter reading should be open (no resistance). Replace sensor if a low resistance is indicated.



VIEW LOOKING INTO
CPS CONNECTOR

J938D-7

Fig. 26 Sensor Connector

CRANKSHAFT POSITION SENSOR TEST—8.0L V-10 ENGINE

The crankshaft position sensor is located on the right-lower side of the cylinder block, forward of the right engine mount, just above the oil pan rail (Fig. 27).

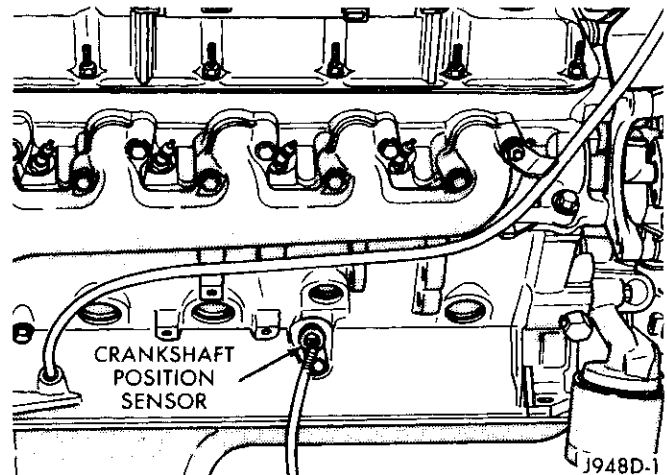


Fig. 27 Crankshaft Position Sensor—8.0L V-10 Engine—Typical

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

- (1) Raise and support the vehicle.
- (2) Disconnect the sensor pigtail harness from the main engine wiring harness connector.
- (3) Place an ohmmeter across terminals B and C (Fig. 26). **Ohmmeter should be set to 1K-to-10K scale for this test.** The meter reading should be open (no resistance). Replace sensor if a low resistance is indicated.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

The camshaft position sensor is located in the distributor (Fig. 28) on all engines.

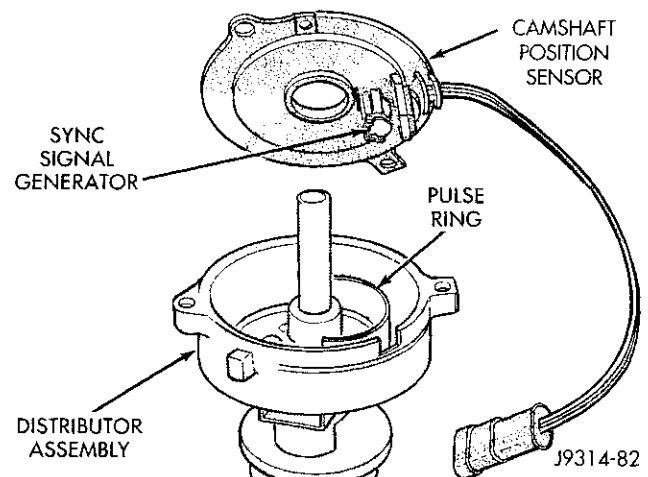


Fig. 28 Camshaft Position Sensor—Typical

To perform a complete test of this sensor and its circuitry, refer to the appropriate Powertrain Diag-

DIAGNOSIS AND TESTING (Continued)

nostics Procedures service manual. To test the sensor only, refer to the following:

For this test, an analog (non-digital) voltmeter is needed. Do not remove the distributor connector from the distributor. Using small paper clips, insert them into the backside of the distributor wire harness connector to make contact with the terminals. Be sure that the connector is not damaged when inserting the paper clips. Attach voltmeter leads to these paper clips.

(1) Connect the positive (+) voltmeter lead into the sensor output wire. This is at the distributor wire harness connector. For wire identification, refer to Group 8W, Wiring Diagrams.

(2) Connect the negative (-) voltmeter lead into the ground wire. For wire identification, refer to Group 8W, Wiring Diagrams.

(3) Set the voltmeter to the 15 Volt DC scale.

(4) Remove distributor cap from distributor (two screws). Rotate (crank) the engine until the distributor rotor is pointed towards the rear of vehicle. The movable pulse ring should now be within the sensor pickup.

(5) Turn ignition key to ON position. Voltmeter should read approximately 5.0 volts.

(6) If voltage is not present, check the voltmeter leads for a good connection.

(7) If voltage is still not present, check for voltage at the supply wire. For wire identification, refer to Group 8W, Wiring Diagrams.

(8) If 5 volts is not present at supply wire, check for voltage at PCM 32-way connector (cavity A-17). Refer to Group 8W, Wiring for location of connector/terminal. Leave the PCM connector connected for this test.

(9) If voltage is still not present, perform vehicle test using the DRB scan tool.

(10) If voltage is present at cavity A-17, but not at the supply wire:

(a) Check continuity between the supply wire. This is checked between the distributor connector and cavity A-17 at the PCM. If continuity is not present, repair the harness as necessary.

(b) Check for continuity between the camshaft position sensor output wire and cavity A-18 at the PCM. If continuity is not present, repair the harness as necessary.

(c) Check for continuity between the ground circuit wire at the distributor connector and ground. If continuity is not present, repair the harness as necessary.

(11) While observing the voltmeter, crank the engine with ignition switch. The voltmeter needle should fluctuate between 0 and 5 volts while the engine is cranking. This verifies that the camshaft

position sensor in the distributor is operating properly and a sync pulse signal is being generated.

If sync pulse signal is not present, replacement of the camshaft position sensor is necessary.

CAMSHAFT POSITION SENSOR TEST—8.0L V-10 ENGINE

The camshaft position sensor is located in the timing chain case/cover on the left-front side of the engine (Fig. 29).

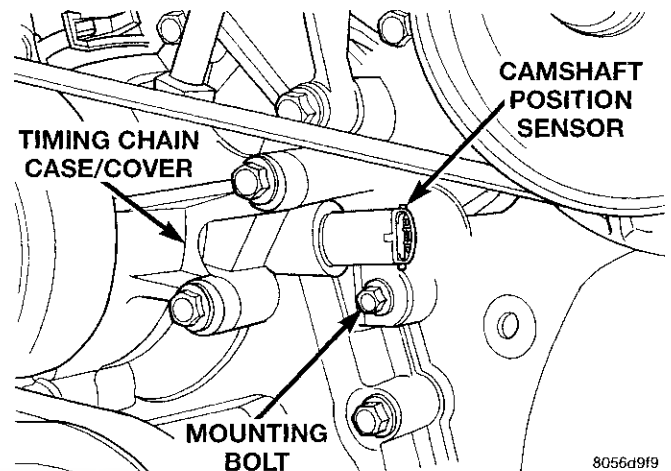


Fig. 29 Camshaft Position Sensor—8.0L V-10 Engine

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the sensor connector at sensor.

(2) Place an ohmmeter across terminals B and C (Fig. 30). **Ohmmeter should be set to 1K-to-10K scale for this test.** The meter reading should be open (no resistance). Replace sensor if a low resistance is indicated.

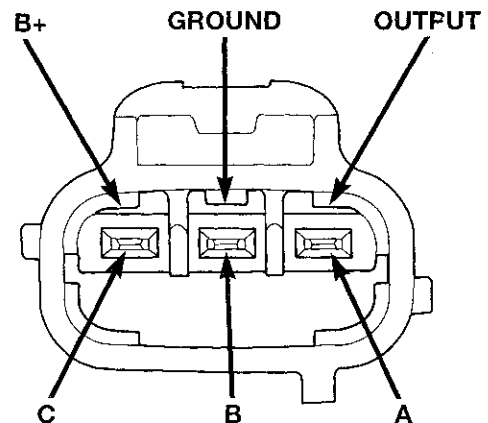


Fig. 30 Sensor Connector—8.0L Engine

DIAGNOSIS AND TESTING (Continued)**ENGINE COOLANT TEMPERATURE SENSOR**

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

SPARK PLUG CABLES

Check the spark plug cable connections for good contact at the coil(s), distributor cap towers, and spark plugs. Terminals should be fully seated. The insulators should be in good condition and should fit tightly on the coil, distributor and spark plugs. Spark plug cables with insulators that are cracked or torn must be replaced.

Clean high voltage ignition cables with a cloth moistened with a non-flammable solvent. Wipe the cables dry. Check for brittle or cracked insulation.

On 3.9L/5.2L/5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each spark plug cable boot and spark plug (Fig. 31). These shields protect the spark plug boots from damage (due to intense engine heat generated by the exhaust manifolds) and should not be removed. After the spark plug cable has been installed, the lip of the cable boot should have a small air gap to the top of the heat shield (Fig. 31).

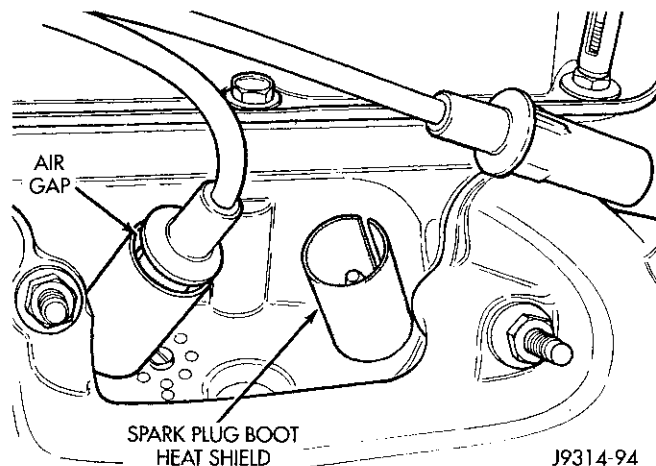


Fig. 31 Heat Shields—3.9L/5.2L/5.9L Engines

TESTING

When testing secondary cables for damage with an oscilloscope, follow the instructions of the equipment manufacturer.

If an oscilloscope is not available, spark plug cables may be tested as follows:

CAUTION: Do not leave any one spark plug cable disconnected for longer than necessary during test-

ing. This may cause possible heat damage to the catalytic converter. Total test time must not exceed ten minutes.

With the engine running, remove spark plug cable from spark plug (one at a time) and hold next to a good engine ground. If the cable and spark plug are in good condition, the engine rpm should drop and the engine will run poorly. If engine rpm does not drop, the cable and/or spark plug may not be operating properly and should be replaced. Also check engine cylinder compression.

With the engine not running, connect one end of a test probe to a good ground. Start the engine and run the other end of the test probe along the entire length of all spark plug cables. If cables are cracked or punctured, there will be a noticeable spark jump from the damaged area to the test probe. The cable running from the ignition coil to the distributor cap can be checked in the same manner. Cracked, damaged or faulty cables should be replaced with resistance type cable. This can be identified by the words **ELECTRONIC SUPPRESSION** printed on the cable jacket.

Use an ohmmeter to test for open circuits, excessive resistance or loose terminals. If equipped, remove the distributor cap from the distributor. **Do not remove cables from cap.** Remove cable from spark plug. Connect ohmmeter to spark plug terminal end of cable and to corresponding electrode in distributor cap. Resistance should be 250 to 1000 Ohms per inch of cable. If not, remove cable from distributor cap tower and connect ohmmeter to the terminal ends of cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, replace the cable. Test all spark plug cables in this manner.

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

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SPARK PLUG CABLE RESISTANCE

To test ignition coil-to-distributor cap cable, do not remove the cable from the cap. Connect ohmmeter to rotor button (center contact) of distributor cap and terminal at ignition coil end of cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, remove the cable from the distributor cap. Connect the ohmmeter to the terminal ends of the cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, replace the cable. Inspect the ignition coil tower for cracks, burns or corrosion.

DIAGNOSIS AND TESTING (Continued)**SPARK PLUG CONDITIONS****NORMAL OPERATING**

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 32). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 1600 km (1000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed, have the gap set and then be installed.

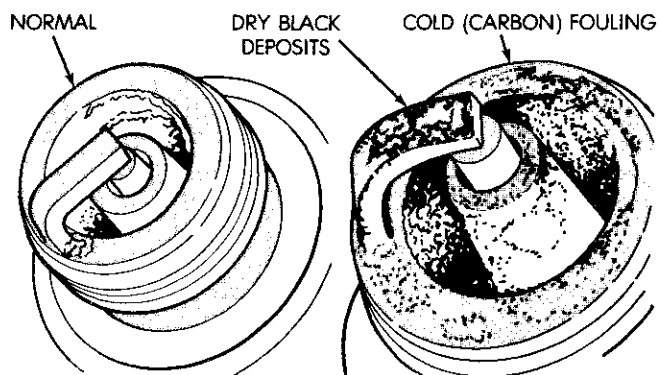


Fig. 32 Normal Operation and Cold (Carbon) Fouling

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT causes the entire tip of the spark plug to be coated with a rust colored deposit. This rust color can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance is not affected by MMT deposits.

COLD FOULING/CARBON FOULING

Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 32). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

WET FOULING OR GAS FOULING

A spark plug coated with excessive wet fuel or oil is wet fouled. In older engines, worn piston rings, leaking valve guide seals or excessive cylinder wear can cause wet fouling. In new or recently overhauled engines, wet fouling may occur before break-in (normal oil control) is achieved. This condition can usually be resolved by cleaning and reinstalling the fouled plugs.

OIL OR ASH ENCRUSTED

If one or more spark plugs are oil or oil ash encrusted (Fig. 33), evaluate engine condition for the cause of oil entry into that particular combustion chamber.

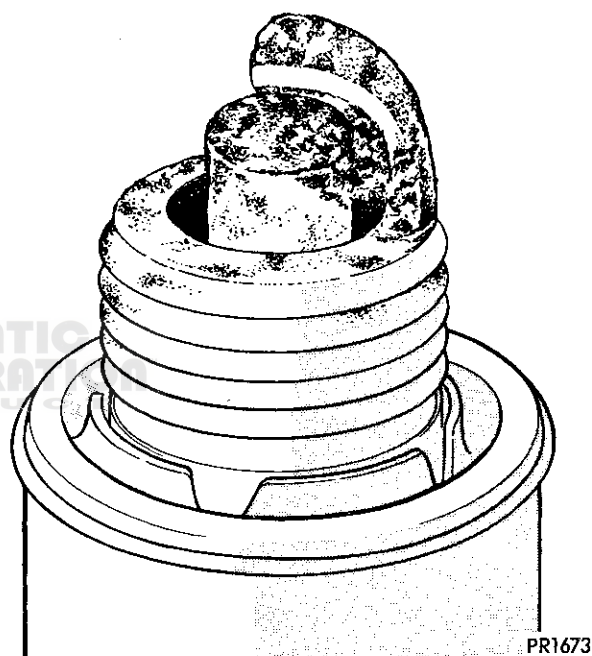
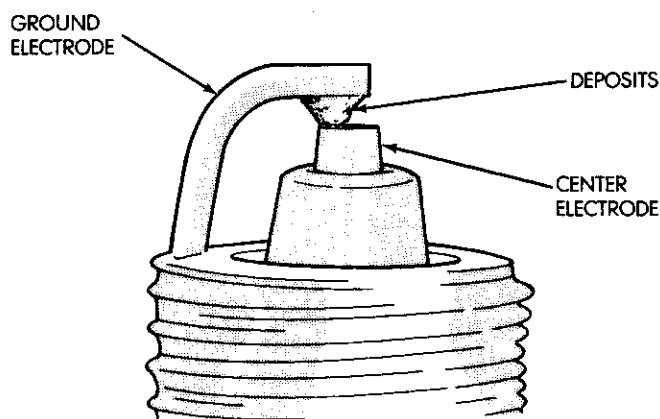


Fig. 33 Oil or Ash Encrusted

ELECTRODE GAP BRIDGING

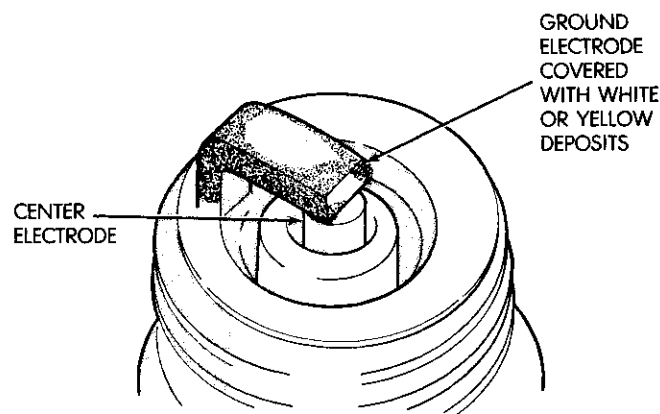
Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 34). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

DIAGNOSIS AND TESTING (Continued)

J908D-11

Fig. 34 Electrode Gap Bridging**SCAVENGER DEPOSITS**

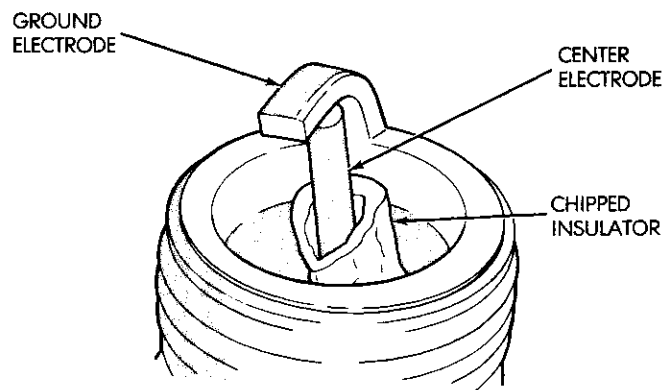
Fuel scavenger deposits may be either white or yellow (Fig. 35). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy, but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.



J908D-12

Fig. 35 Scavenger Deposits**CHIPPED ELECTRODE INSULATOR**

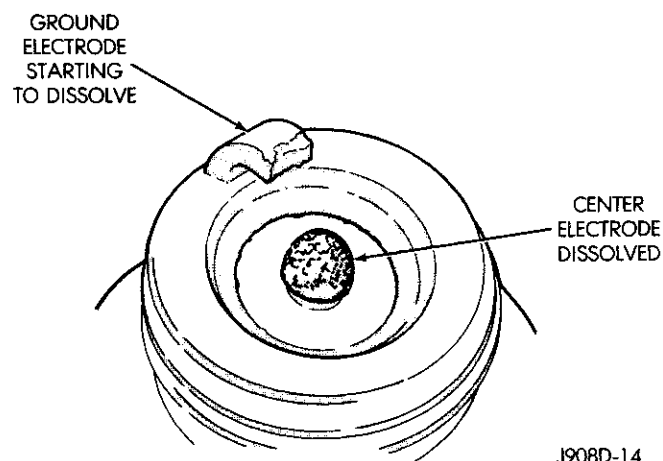
A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode (Fig. 36). Spark plugs with this condition must be replaced.



J908D-13

Fig. 36 Chipped Electrode Insulator**PREIGNITION DAMAGE**

Preignition damage is usually caused by excessive combustion chamber temperature. The center electrode dissolves first and the ground electrode dissolves somewhat latter (Fig. 37). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine. Determine if ignition timing is over advanced or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug. Spark plugs are designed to operate within specific temperature ranges. This depends upon the thickness and length of the center electrodes porcelain insulator.)



J908D-14

Fig. 37 Preignition Damage

DIAGNOSIS AND TESTING (Continued)

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 38). The increase in electrode gap will be considerably in excess of 0.001 inch per 1000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions can also cause spark plug overheating.

BLISTERED
WHITE OR
GRAY
COLORED
INSULATOR



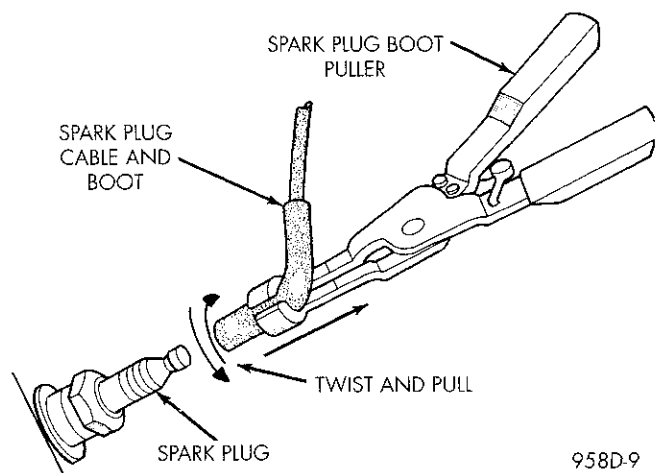
J908D-16

Fig. 38 Spark Plug Overheating

REMOVAL AND INSTALLATION

SPARK PLUG CABLES

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 39). Grasp the boot (not the cable) and pull it off with a steady, even force.



958D-9

Fig. 39 Cable Removal

Install cables into the proper engine cylinder firing order (Fig. 40), (Fig. 41) or (Fig. 42).

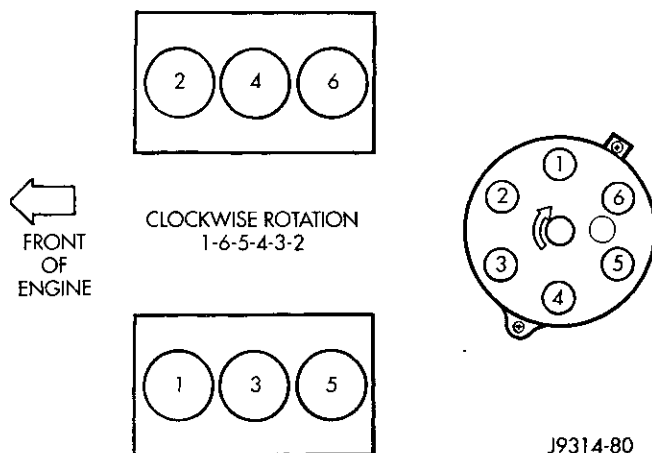


Fig. 40 Engine Firing Order—3.9L V-6 Engine

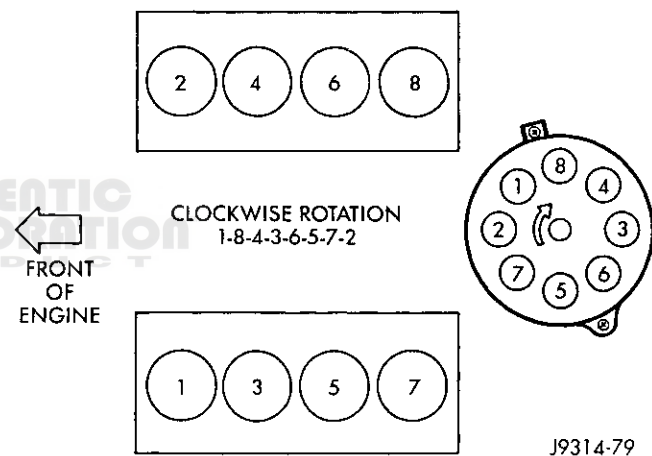
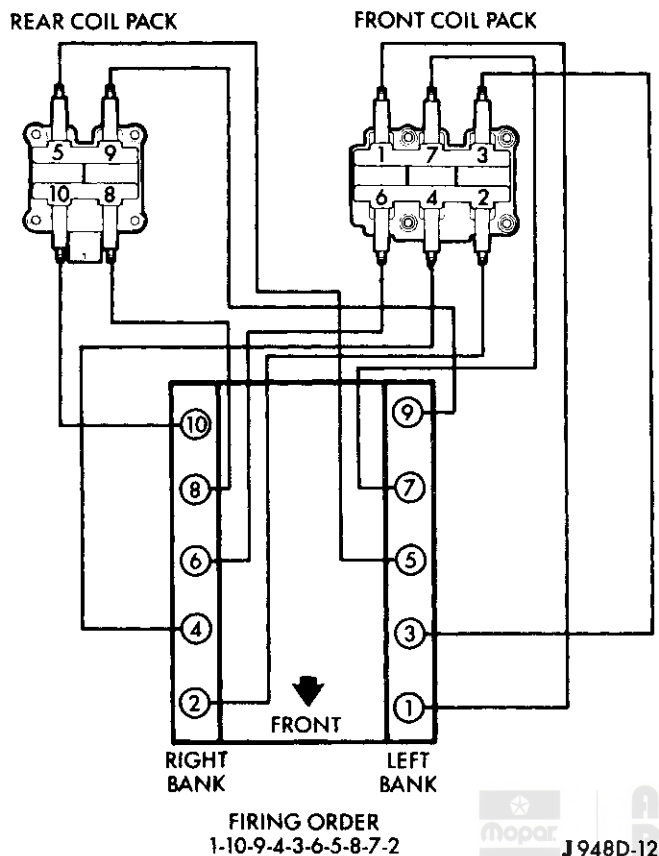


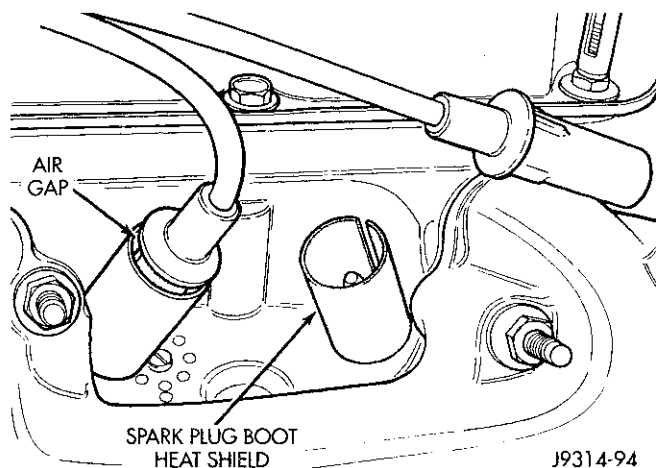
Fig. 41 Engine Firing Order—5.2L/5.9L V-8 Engines

When replacing the spark plug and coil cables, route the cables correctly and secure in the proper retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise. It could also cause cross ignition of the plugs or short circuit the cables to ground.

When installing new cables, make sure a positive connection is made. A snap should be felt when a good connection is made between the plug cable and the distributor cap tower.

REMOVAL AND INSTALLATION (Continued)**Fig. 42 Spark Plug Cable Order—8.0L V-10 Engine****SPARK PLUGS**

On 3.9L/5.2L/5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each cable boot and spark plug (Fig. 43).

**Fig. 43 Heat Shields—3.9L/5.2L/5.9L Engines**

If removal of the heat shield(s) is necessary, remove the spark plug cable and compress the sides of shield for removal. Each shield is slotted to allow for compression and removal. To install the shields, align shield to machined opening in cylinder head and tap into place with a block of wood.

PLUG REMOVAL

(1) Always remove spark plug or ignition coil cables by grasping at the cable boot (Fig. 39). Turn the cable boot 1/2 turn and pull straight back in a steady motion. Never pull directly on the cable. Internal damage to cable will result.

(2) Prior to removing the spark plug, spray compressed air around the spark plug hole and the area around the spark plug. This will help prevent foreign material from entering the combustion chamber.

(3) Remove the spark plug using a quality socket with a rubber or foam insert.

(4) Inspect the spark plug condition. Refer to Spark Plug Condition in the Diagnostics and Testing section of this group.

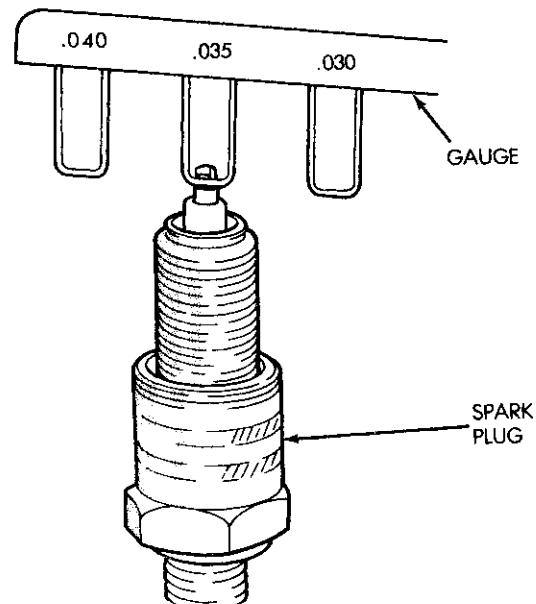
PLUG CLEANING

The plugs may be cleaned using commercially available spark plug cleaning equipment. After cleaning, file the center electrode flat with a small point file or jewelers file before adjusting gap.

CAUTION: Never use a motorized wire wheel brush to clean the spark plugs. Metallic deposits will remain on the spark plug insulator and will cause plug misfire.

PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge tool. If the gap is not correct, adjust it by bending the ground electrode (Fig. 44). **Never attempt to adjust the gap by bending the center electrode.**

**Fig. 44 Setting Spark Plug Gap—Typical**

REMOVAL AND INSTALLATION (Continued)**SPARK PLUG GAP**

3.9L/5.2L/5.9L Engines: .89 mm (.035 in).

8.0L Engine: 1.14 mm (.045 in).

PLUG INSTALLATION

Special care should be taken when installing spark plugs into the cylinder head spark plug wells. Be sure the plugs do not drop into the plug wells as electrodes can be damaged.

Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap or a cracked porcelain insulator.

When replacing the spark plug and ignition coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise. It could cause cross ignition of the spark plugs or short circuit the cables to ground.

- (1) Start the spark plug into the cylinder head by hand to avoid cross threading.
- (2) Tighten spark plugs to 35-41 N·m (26-30 ft. lbs.) torque.
- (3) Install spark plug cables over spark plugs.

IGNITION COIL—3.9L/5.2L/5.9L ENGINES

The ignition coil is an epoxy filled type. If the coil is replaced, it must be replaced with the same type.

REMOVAL

3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines: The coil is mounted to a bracket that is bolted to the front of the right engine cylinder head (Fig. 45). This bracket is mounted on top of the automatic belt tensioner bracket using common bolts.

5.9L V-8 HDC-Gas Engine: The coil is mounted to a bracket that is bolted to the air injection pump (AIR pump) mounting bracket (Fig. 46).

- (1) Disconnect the primary wiring from the ignition coil.
- (2) Disconnect the secondary spark plug cable from the ignition coil.

WARNING: 3.9L V-6 OR 5.2/5.9L V-8 LDC-GAS ENGINES: DO NOT REMOVE THE COIL MOUNTING BRACKET-TO-CYLINDER HEAD MOUNTING BOLTS. THE COIL MOUNTING BRACKET IS UNDER ACCESSORY DRIVE BELT TENSION. IF THIS BRACKET IS TO BE REMOVED FOR ANY REASON, ALL BELT TENSION MUST FIRST BE RELIEVED. REFER TO

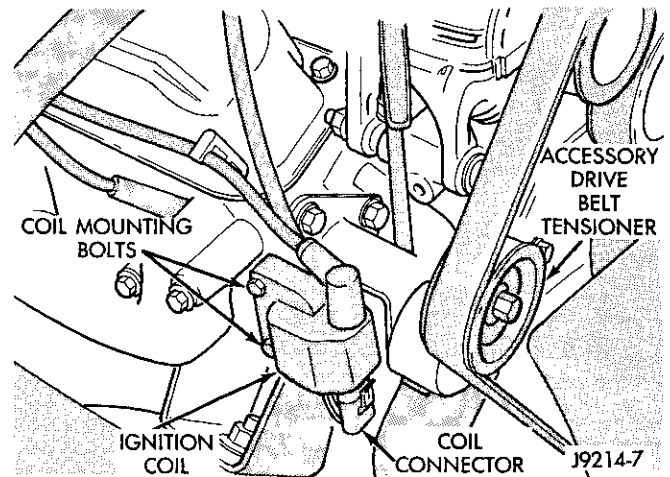


Fig. 45 Ignition Coil—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

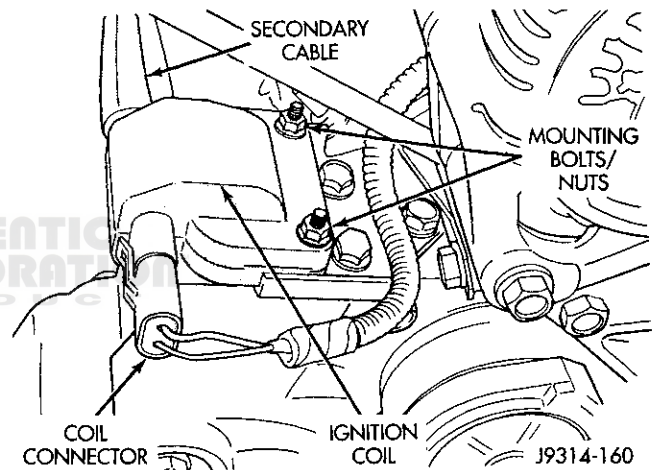


Fig. 46 Ignition Coil—5.9L V-8 HDC-Gas Engine
THE BELT SECTION OF GROUP 7, COOLING SYSTEM.

- (3) Remove ignition coil from coil mounting bracket (two bolts).

INSTALLATION

- (1) Install the ignition coil to coil bracket. If nuts and bolts are used to secure coil to coil bracket, tighten to 11 N·m (100 in. lbs.) torque. If the coil mounting bracket has been tapped for coil mounting bolts, tighten bolts to 5 N·m (50 in. lbs.) torque.
- (2) Connect all wiring to ignition coil.

REMOVAL AND INSTALLATION (Continued)**IGNITION COIL PACKS—8.0L V-10 ENGINE****REMOVAL**

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 47). The front and rear coil packs can be serviced separately.

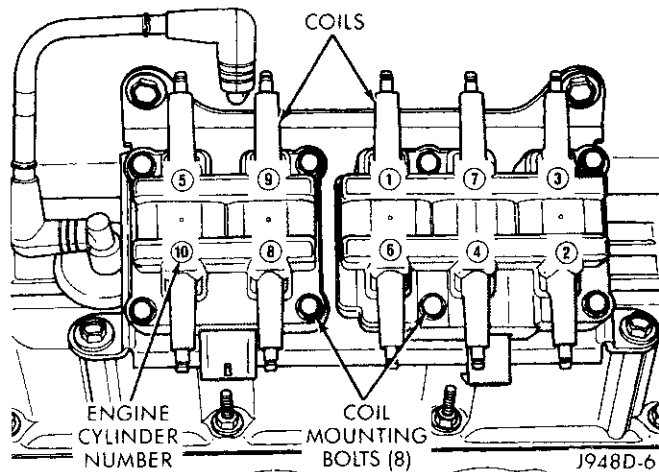


Fig. 47 Ignition Coil Packs—8.0L V-10 Engine

- (1) Remove the secondary spark plug cables from the coil packs. Note position of cables before removal.
- (2) Disconnect the primary wiring harness connectors at coil packs.
- (3) Remove the four (4) coil pack-to-coil mounting bracket bolts for the coil pack being serviced (Fig. 47).
- (4) Remove coil(s) from mounting bracket.

INSTALLATION

- (1) Position coil packs to mounting bracket (primary wiring connectors face downward).
- (2) Install coil pack mounting bolts. Tighten bolts to 10 N·m (90 in. lbs.) torque.
- (3) Install coil pack-to-engine mounting bracket (if necessary).
- (4) Connect primary wiring connectors to coil packs (four wire connector to front coil pack and three wire connector to rear coil pack).
- (5) Connect secondary spark plug cables to coil packs. Refer to (Fig. 48) for correct cable order.

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown (ASD) relay is located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 49). Refer to label on PDC cover for relay location. Check the terminals in the PDC relay connector for corrosion or damage before installation.

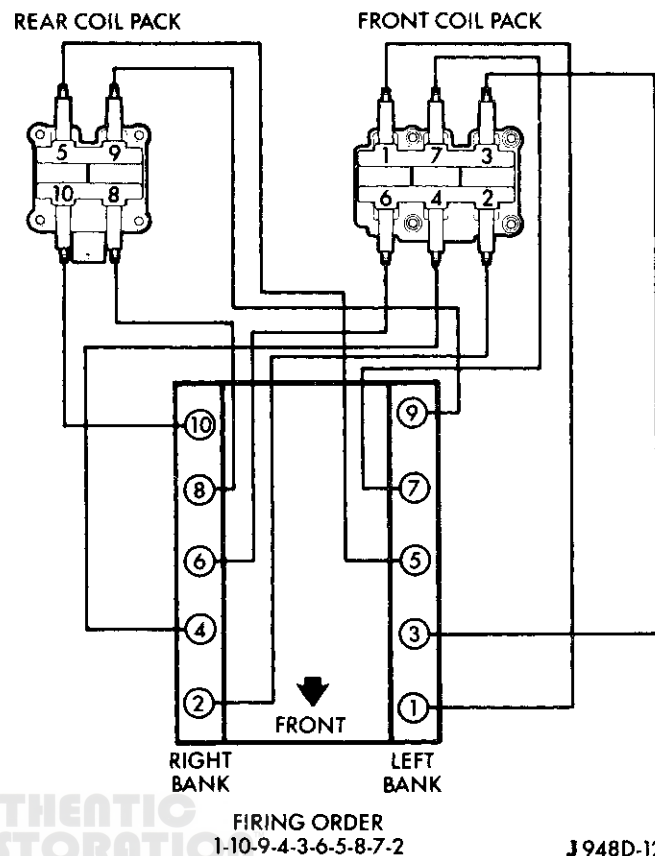


Fig. 48 Spark Plug Cable Order—8.0L V-10 Engine

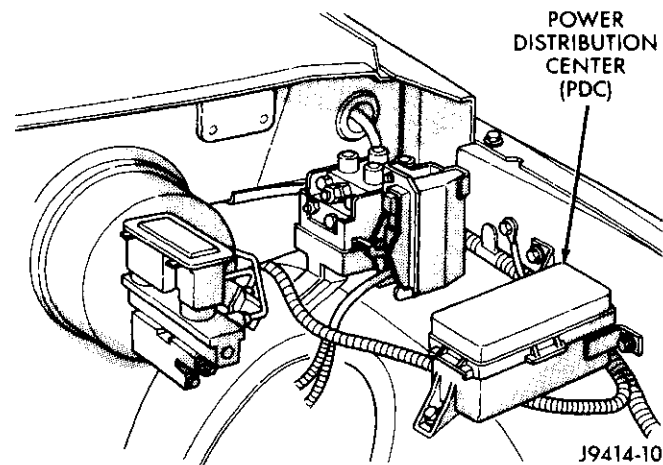


Fig. 49 Power Distribution Center

CRANKSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES**REMOVAL—EXCEPT 5.9L HDC ENGINE**

Use the following procedure if engine is not equipped with an EGR system.

REMOVAL AND INSTALLATION (Continued)

The sensor is bolted to the top of the cylinder block near the rear of right cylinder head (Fig. 50).

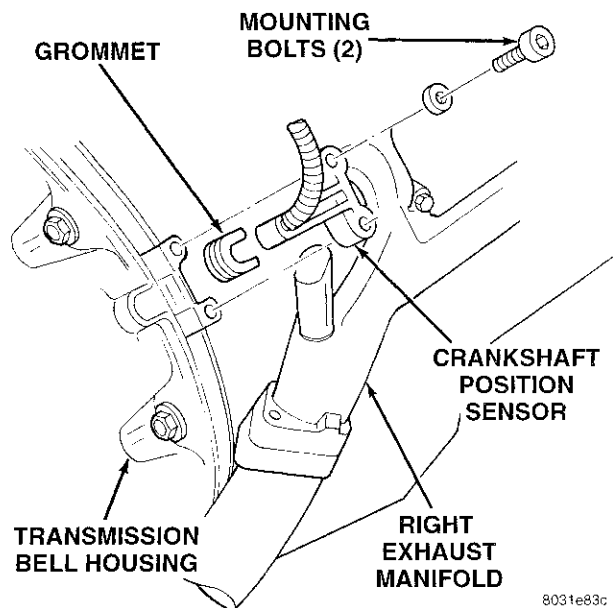


Fig. 50 Crankshaft Position Sensor—Except 5.9L HDC Engine

- (1) Remove the air cleaner intake tube.
- (2) Disconnect crankshaft position sensor pigtail harness from main wiring harness.
- (3) Remove two sensor (recessed hex head) mounting bolts (Fig. 50).
- (4) Remove sensor from engine.

INSTALLATION—EXCEPT 5.9L HDC ENGINE

- (1) Position crankshaft position sensor to engine.
- (2) Install mounting bolts and tighten to 8 N·m (70 in. lbs.) torque.
- (3) Connect main harness electrical connector to sensor.
- (4) Install air cleaner tube.

REMOVAL—5.9L HDC ENGINE

Use the following procedure if the 5.9L HDC engine is equipped with an EGR system.

The sensor is bolted to the top of the cylinder block near the rear of right cylinder head (Fig. 51).

- (1) Remove the air cleaner assembly and its plastic air intake tube.
- (2) Remove the spark plug cable loom and spark plug cables from valve cover mounting stud at rear of right valve cover (Fig. 51). Position spark plug cables to top of valve cover.
- (3) Disconnect 2 hoses at Exhaust Gas Recirculation (EGR) valve. Note position of hoses at EGR valve before removal.
- (4) Disconnect electrical connector and hoses at electric EGR valve control. Note position of hoses before removal.

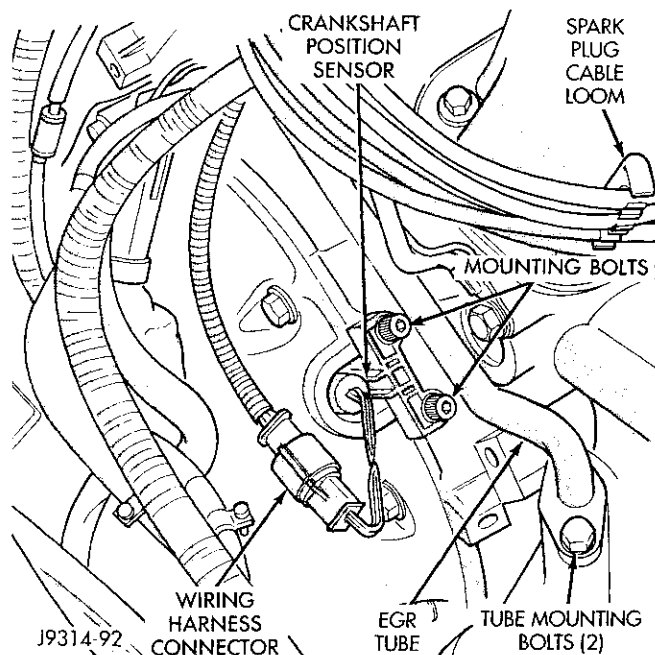


Fig. 51 Crankshaft Position Sensor—5.9L HDC V-8 Engine

- (5) Remove 2 EGR valve mounting bolts and remove EGR valve. Discard old EGR gasket.
- (6) Disconnect electrical connector at engine oil pressure sending unit.
- (7) To prevent damage to oil pressure sending unit, a special tool, such as number C-4597 must be used (Fig. 52). Remove sending unit from engine.

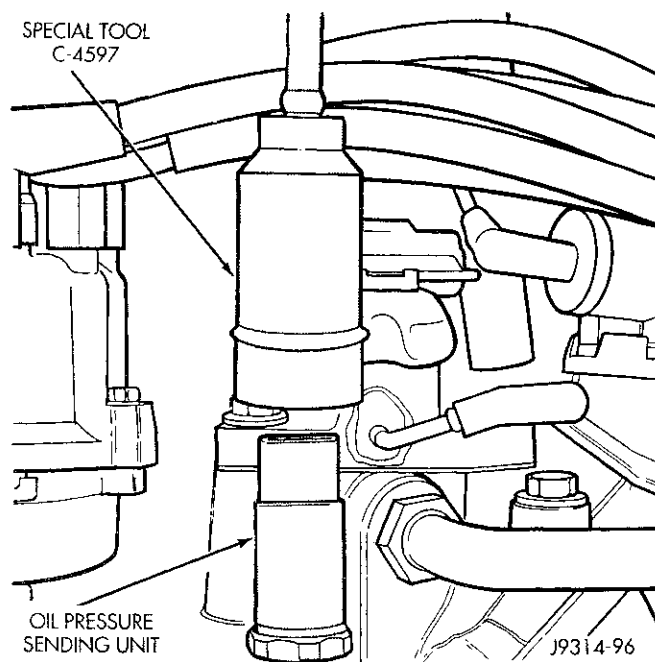


Fig. 52 Oil Pressure Sending Unit—Removal/Installation

REMOVAL AND INSTALLATION (Continued)

(8) Loosen EGR tube mounting nut at intake manifold.

(9) Remove 2 EGR tube mounting bolts at exhaust manifold and remove EGR tube. Discard old gasket at exhaust manifold.

(10) Disconnect crankshaft position sensor pigtail harness from main wiring harness.

(11) Remove 2 sensor (recessed hex head) mounting bolts and remove sensor.

INSTALLATION—5.9L HDC ENGINE

(1) Position crankshaft position sensor to engine and install mounting bolts. Tighten bolts to 8 N·m (70 in. lbs.) torque.

(2) Connect main harness electrical connector to sensor.

(3) Clean the EGR tube and exhaust manifold (at EGR tube mounting point) of any old gasket material.

(4) Install a new gasket to exhaust manifold end of EGR tube and install EGR tube to both manifolds. Tighten mounting nut at intake manifold. Tighten 2 mounting bolts at exhaust manifold to 23 N·m (204 in. lbs.) torque.

(5) Coat the threads of the oil pressure sending unit with thread sealant. Do not allow any of the thread sealant to get into the sending unit opening, or the opening at the engine. Install sending unit to engine and tighten to 14 N·m (130 in. lbs.) torque. Install electrical connector to sending unit.

(6) Clean the intake manifold and EGR valve of any old gasket material.

(7) Install a new EGR valve gasket at intake manifold.

(8) Install EGR valve to intake manifold. Tighten 2 bolts to 23 N·m (200 in. lbs.) torque.

(9) Position EGR valve control and install its electrical connector. Connect hoses between EGR valve and EGR valve control. Connect hose between main vacuum harness and control valve.

(10) Install spark plug cable loom and spark plug cables to valve cover mounting stud.

(11) Install the air cleaner housing and plastic air intake tube.

CRANKSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The crankshaft position sensor is located on the right-lower side of the cylinder block, forward of the right engine mount, just above the oil pan rail (Fig. 53).

REMOVAL

- (1) Raise and support the vehicle.
- (2) Disconnect the sensor harness connectors.
- (3) Remove the sensor mounting bolt (Fig. 54).
- (4) Carefully pry the sensor from the cylinder block in a rocking action with two small screwdrivers.

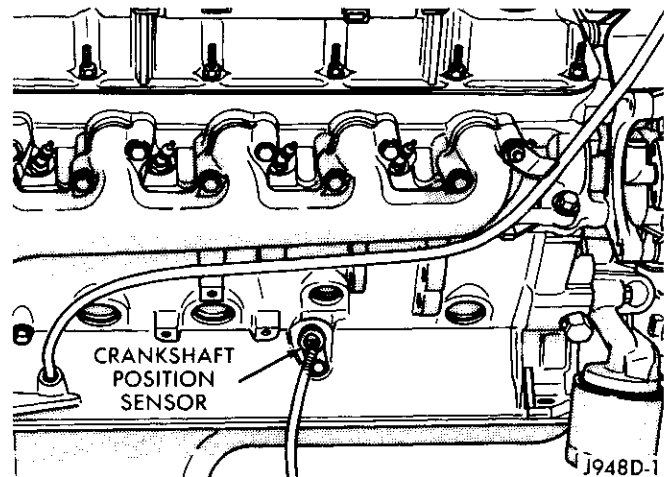


Fig. 53 Crankshaft Position Sensor—8.0L V-10 Engine

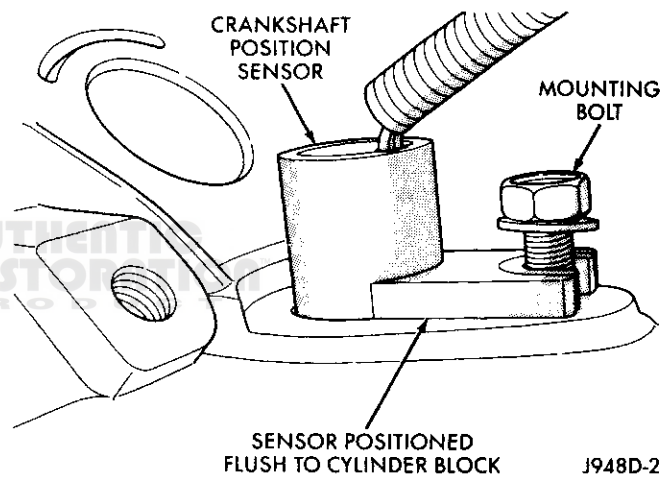


Fig. 54 Sensor Removal/Installation—8.0L V-10 Engine

- (5) Remove the sensor from vehicle.
- (6) Check condition of sensor o-ring (Fig. 55).

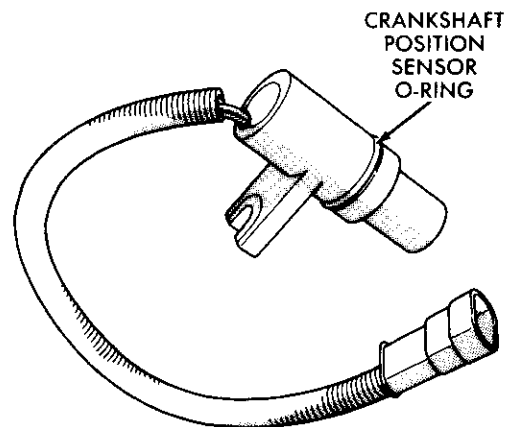


Fig. 55 Sensor O-Ring—8.0L V-10 Engine

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Apply a small amount of engine oil to the sensor o-ring (Fig. 55).

(2) Install the sensor into the cylinder block with a slight rocking action. Do not twist the sensor into position as damage to the o-ring may result.

CAUTION: Before tightening the sensor mounting bolt, be sure the sensor is completely flush to the cylinder block (Fig. 54). If sensor is not flush, damage to the sensor mounting tang may result.

(3) Install the mounting bolt and tighten to 8 N·m (70 in. lbs.) torque.

(4) Connect sensor wiring harness and lower the vehicle.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

The camshaft position sensor is located in the distributor (Fig. 56).

REMOVAL

Distributor removal is not necessary to remove camshaft position sensor.

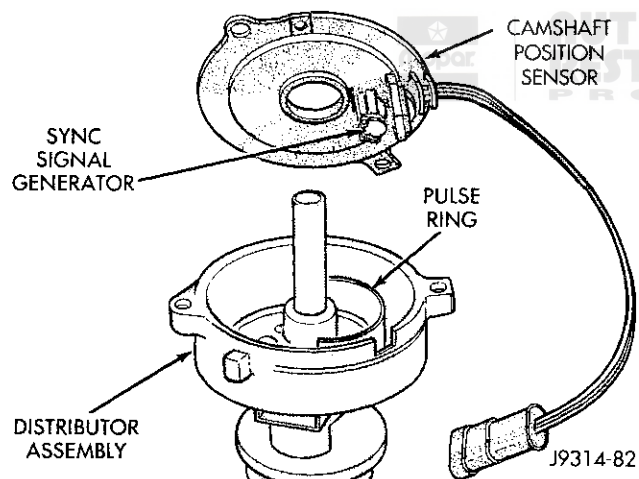


Fig. 56 Camshaft Position Sensor—Typical

- (1) Remove air cleaner assembly.
- (2) Disconnect negative cable from battery.
- (3) Remove distributor cap from distributor (two screws).
- (4) Disconnect camshaft position sensor wiring harness from main engine wiring harness.
- (5) Remove distributor rotor from distributor shaft.
- (6) Lift the camshaft position sensor assembly from the distributor housing (Fig. 56).

INSTALLATION

(1) Install camshaft position sensor to distributor. Align sensor into notch on distributor housing.

(2) Connect wiring harness.

(3) Install rotor.

(4) Install distributor cap. Tighten mounting screws.

(5) Install air cleaner assembly.

CAMSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 57).

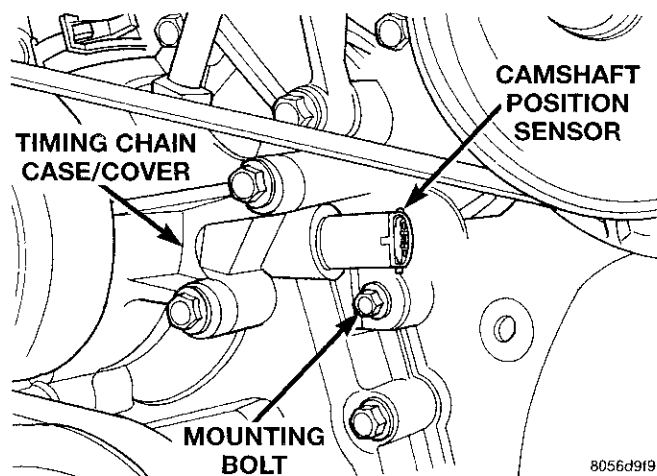


Fig. 57 Camshaft Position Sensor Location—8.0L V-10 Engine

A thin plastic rib is molded into the face of the sensor (Fig. 58) to position the depth of sensor to the upper cam gear (sprocket). This rib can be found on both the new replacement sensors and sensors that were originally installed to the engine. The first time the engine has been operated, part of this rib may be sheared (ground) off. Depending on parts tolerances, some of the rib material may still be observed after removal.

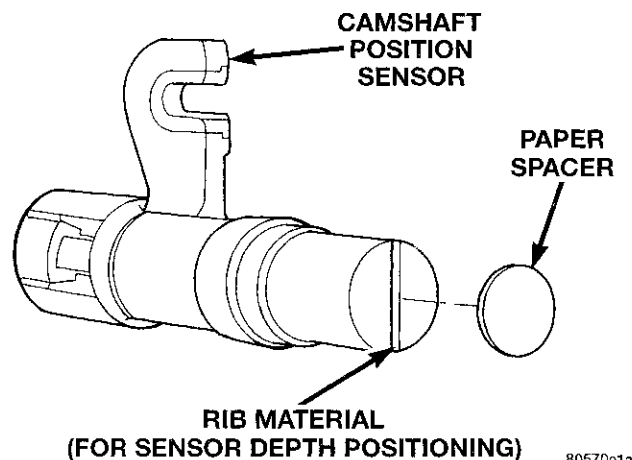


Fig. 58 Sensor Depth Positioning Rib—8.0L V-10 Engine

REMOVAL AND INSTALLATION (Continued)

Refer to either of the following procedures, Sensor Removal—Replacing Old Sensor With Original, or Sensor Removal—Replacing With New Sensor:

SENSOR REMOVAL—REPLACING OLD SENSOR WITH ORIGINAL

If the original camshaft position sensor is to be removed and installed, such as when servicing the timing chain, timing gears or timing chain cover, use this procedure.

- (1) Disconnect the sensor harness connector from the sensor.
- (2) Remove the sensor mounting bolt (Fig. 57).
- (3) Carefully pry the sensor from the timing chain case/cover in a rocking action with two small screwdrivers.
- (4) Remove the sensor from vehicle.
- (5) Check condition of sensor o-ring (Fig. 59).

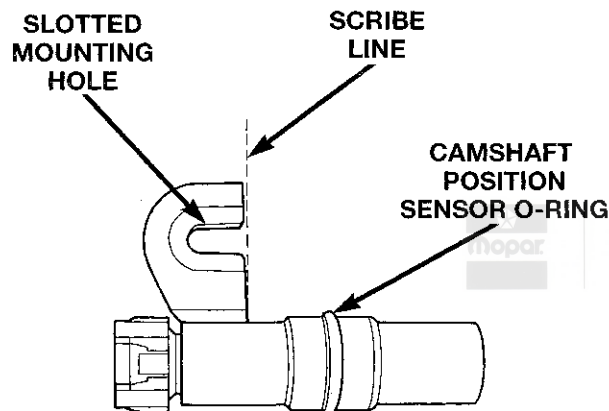


Fig. 59 Camshaft Sensor O-Ring—8.0L V-10 Engine INSTALLATION

When installing a used camshaft position sensor, the sensor depth must be adjusted to prevent contact with the camshaft gear (sprocket).

(1) Observe the face of the sensor. If any of the original rib material remains (Fig. 58), it must be cut down flush to the face of the sensor with a razor knife. Remove only enough of the rib material until the face of the sensor is flat. Do not remove more material than necessary as damage to sensor may result. Due to a high magnetic field and possible electrical damage to the sensor, never use an electric grinder to remove material from sensor.

(2) From the parts department, obtain a peel-and-stick paper spacer (Fig. 58). These special paper spacers are of a certain thickness and are to be used as a tool to set sensor depth.

(3) Clean the face of sensor and apply paper spacer (Fig. 58).

(4) Apply a small amount of engine oil to the sensor o-ring (Fig. 59).

A low and high area are machined into the camshaft drive gear (Fig. 60). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 60) exists between the face of sensor and the high machined area of cam gear.

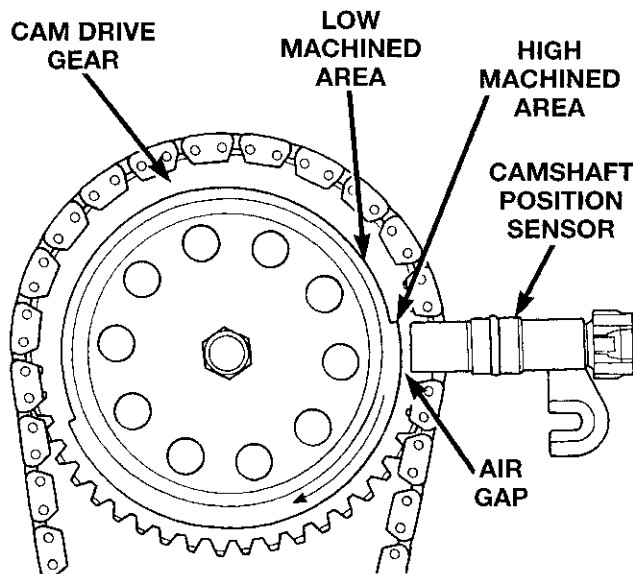


Fig. 60 Sensor Operation—8.0L V-10 Engine

Before the sensor is installed, the cam gear may have to be rotated. This is to allow the high machined area on the gear to be directly in front of the sensor mounting hole opening on the timing gear cover.

Do not install sensor with gear positioned at low area (Fig. 61) or (Fig. 60). When the engine is started, the sensor will be broken.

(5) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 61).

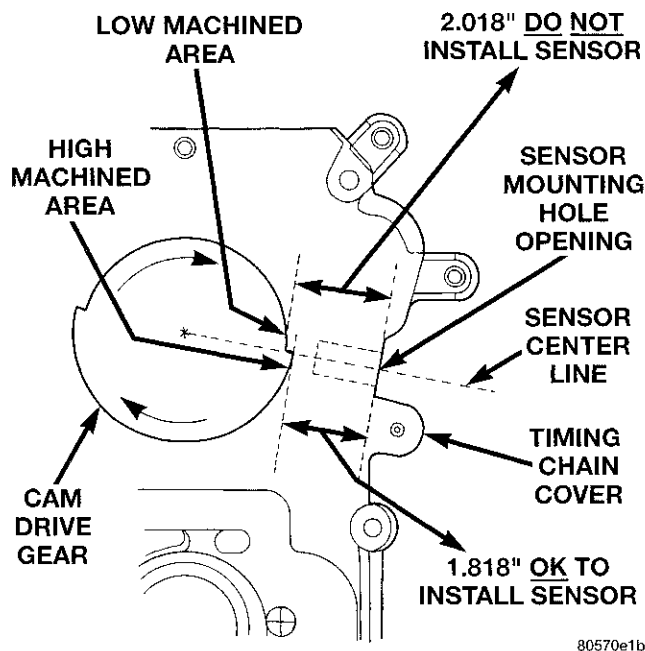
(6) If the dimension is approximately 1.818 inches, it is OK to install sensor. Proceed to step Step 9.

(7) If the dimension is approximately 2.018 inches, the cam gear will have to be rotated.

(8) Attach a socket to the vibration damper mounting bolt and rotate engine until the 1.818 inch dimension is attained.

(9) Install the sensor into the timing case/cover with a slight rocking action until the paper spacer contacts the camshaft gear. Do not install the sensor mounting bolt. Do not twist the sensor into position as damage to the o-ring or tearing of the paper spacer may result.

(10) Scratch a scribe line into the timing chain case/cover to indicate depth of sensor (Fig. 59).

REMOVAL AND INSTALLATION (Continued)**Fig. 61 Sensor Depth Dimensions**

(11) Remove the sensor from timing chain case/cover.

(12) Remove the paper spacer from the sensor. This step must be followed to prevent the paper spacer from getting into the engine lubrication system.

(13) Again, apply a small amount of engine oil to sensor o-ring.

(14) Again, install the sensor into the timing case/cover with a slight rocking action until the sensor is aligned to scribe line.

(15) Install sensor mounting bolt and tighten to 6 N·m (50 in. lbs.) torque.

(16) Connect engine wiring harness to sensor.

SENSOR REMOVAL—REPLACING WITH NEW SENSOR

If a new replacement camshaft position sensor is to be installed, use this procedure.

(1) Disconnect the sensor wiring harness connector from sensor.

(2) Remove the sensor mounting bolt (Fig. 57).

(3) Carefully pry the sensor from the timing chain case/cover in a rocking action with two small screwdrivers.

(4) Remove the sensor from vehicle.

INSTALLATION

(1) Apply a small amount of engine oil to the sensor o-ring (Fig. 59).

A low and high area are machined into the camshaft drive gear (Fig. 60). The sensor is positioned in the timing gear cover so that a small air gap (Fig.

60) exists between the face of sensor and the high machined area of cam gear.

Before the sensor is installed, the cam gear may have to be rotated. This is to allow the high machined area on the gear to be directly in front of the sensor mounting hole opening on the timing gear cover.

Do not install sensor with gear positioned at low area (Fig. 61) or (Fig. 60). When the engine is started, the sensor will be broken.

(2) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 61).

(3) If the dimension is approximately 1.818 inches, it is OK to install sensor. Proceed to step Step 9.

(4) If the dimension is approximately 2.018 inches, the cam gear will have to be rotated.

(5) Attach a socket to the vibration damper mounting bolt and rotate engine until the 1.818 inch dimension is attained.

(6) Install the sensor into the timing case/cover with a slight rocking action. Do not twist the sensor into position as damage to the o-ring may result. Push the sensor all the way into the cover until the rib material on the sensor (Fig. 58) contacts the camshaft gear.

(7) Install the mounting bolt and tighten to 6 N·m (50 in. lbs.) torque.

(8) Connect sensor wiring harness to engine harness.

When the engine is started, the rib material will be sheared off the face of sensor. This will automatically set sensor air gap.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

For removal and installation, refer to Manifold Absolute Pressure Sensor in group 14, Fuel Systems.

ENGINE COOLANT TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

THROTTLE POSITION SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

REMOVAL AND INSTALLATION (Continued)**DISTRIBUTORS****REMOVAL**

CAUTION: Base ignition timing is not adjustable on any engine. Distributors do not have built in centrifugal or vacuum assisted advance. Base ignition timing and timing advance are controlled by the Powertrain Control Module (PCM). Because a conventional timing light can not be used to adjust distributor position after installation, note position of distributor before removal.

- (1) Remove air cleaner assembly.
- (2) Disconnect negative cable from battery.
- (3) Remove distributor cap from distributor (two screws).
- (4) Mark the position of distributor housing in relationship to engine or dash panel. This is done to aid in installation.
- (5) Before distributor is removed, the number one cylinder must be brought to the Top Dead Center (TDC) firing position.
- (6) Attach a socket to the Crankshaft Vibration Damper mounting bolt.
- (7) Slowly rotate engine clockwise, as viewed from front, until indicating mark on crankshaft vibration damper is aligned to 0 degree (TDC) mark on timing chain cover (Fig. 62).

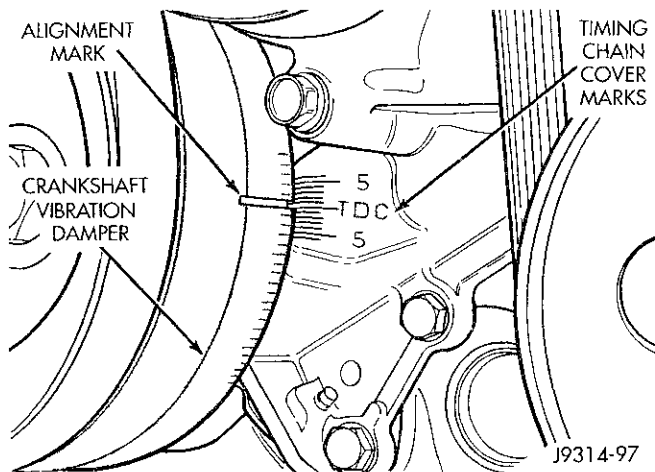


Fig. 62 Damper-To-Cover Alignment Marks—Typical

(8) The distributor rotor should now be aligned to the CYL. NO. 1 alignment mark (stamped) into the camshaft position sensor (Fig. 63). If not, rotate the crankshaft through another complete 360 degree turn. Note the position of the number one cylinder spark plug cable (on the cap) in relation to rotor. Rotor should now be aligned to this position.

(9) Disconnect camshaft position sensor wiring harness from main engine wiring harness.

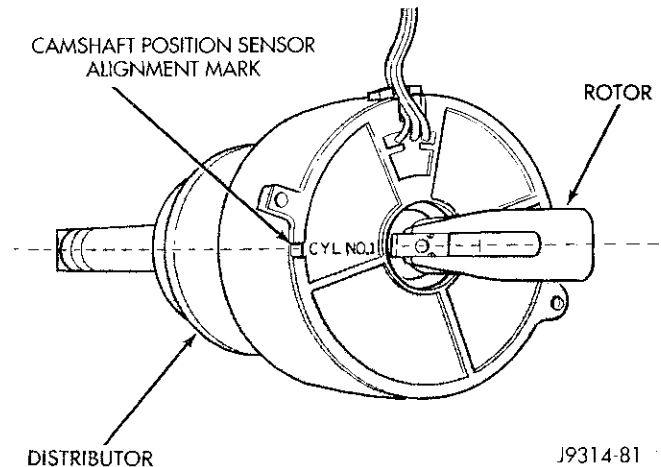


Fig. 63 Rotor Alignment Mark

- (10) Remove distributor rotor from distributor shaft.
- (11) Remove distributor holddown clamp bolt and clamp (Fig. 64). Remove distributor from vehicle.

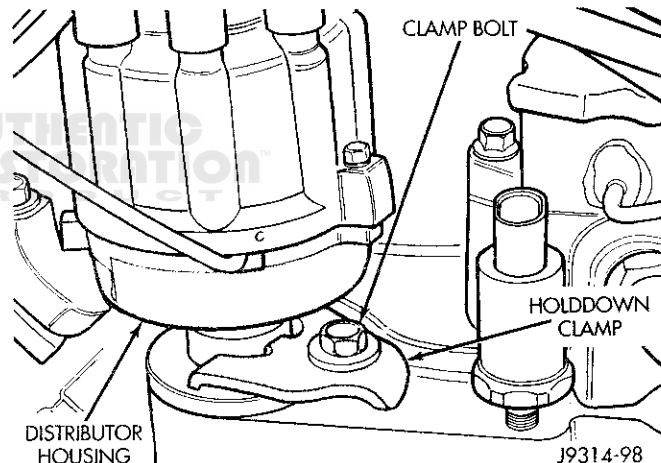


Fig. 64 Distributor Holddown Clamp

CAUTION: Do not crank engine with distributor removed. Distributor/crankshaft relationship will be lost.

INSTALLATION

If engine has been cranked while distributor is removed, establish the relationship between distributor shaft and number one piston position as follows:

Rotate crankshaft in a clockwise direction, as viewed from front, until number one cylinder piston is at top of compression stroke (compression should be felt on finger with number one spark plug removed). Then continue to slowly rotate engine clockwise until indicating mark (Fig. 62) is aligned to 0 degree (TDC) mark on timing chain cover.

REMOVAL AND INSTALLATION (Continued)

- (1) Clean top of cylinder block for a good seal between distributor base and block.
- (2) Lightly oil the rubber o-ring seal on the distributor housing.
- (3) Install rotor to distributor shaft.
- (4) Position distributor into engine to its original position. Engage tongue of distributor shaft with slot in distributor oil pump drive gear. Position rotor to the number one spark plug cable position.
- (5) Install distributor holddown clamp and clamp bolt. Do not tighten bolt at this time.
- (6) Rotate the distributor housing until rotor is aligned to CYL. NO. 1 alignment mark on the camshaft position sensor (Fig. 63).
- (7) Tighten clamp holddown bolt (Fig. 64) to 22.5 N·m (200 in. lbs.) torque.
- (8) Connect camshaft position sensor wiring harness to main engine harness.
- (9) Install distributor cap. Tighten mounting screws.
- (10) Refer to the following, Checking Distributor Position.

CHECKING DISTRIBUTOR POSITION

To verify correct distributor rotational position, connect the DRB scan tool to the data link connector. The data link connector is located in the engine compartment. Gain access to the SET SYNC screen on the DRB.

WARNING: WHEN PERFORMING THE FOLLOWING TEST, THE ENGINE WILL BE RUNNING. BE CAREFUL NOT TO STAND IN LINE WITH THE FAN BLADES OR FAN BELT. DO NOT WEAR LOOSE CLOTHING.

Follow the directions on the DRB screen and start the engine. With the engine running, the words IN RANGE should appear on the screen along with 0°. This indicates correct distributor position.

If a plus (+) or a minus (-) is displayed next to the degree number, and/or the degree displayed is not zero, loosen but do not remove the distributor hold-down clamp bolt. Rotate the distributor until IN RANGE appears on the screen. Continue to rotate the distributor until achieving as close to 0° as possible. After adjustment, tighten clamp bolt to 22.5 N·m (200 in. lbs.) torque.

The degree scale on the SET SYNC screen of the DRB is referring to fuel synchronization only. **It is not referring to ignition timing.** Because of this, do not attempt to adjust ignition timing using this method. Rotating the distributor will have no effect on ignition timing. All ignition timing values are controlled by the powertrain control module (PCM).

After testing, install air cleaner assembly.

POWERTRAIN CONTROL MODULE (PCM)

Refer to Group 14, Fuel System for procedures.

IGNITION SWITCH AND KEY CYLINDER

The ignition switch is located on the steering column. The Key-In-Switch is located in the ignition switch module. For diagnosis of the Key-In-Switch, refer to Section 8U.

REMOVAL

- (1) Disconnect negative cable from battery.
- (2) If vehicle has a tilt column, remove tilt lever by turning it counterclockwise.
- (3) Remove upper and lower covers from steering column (Fig. 65).

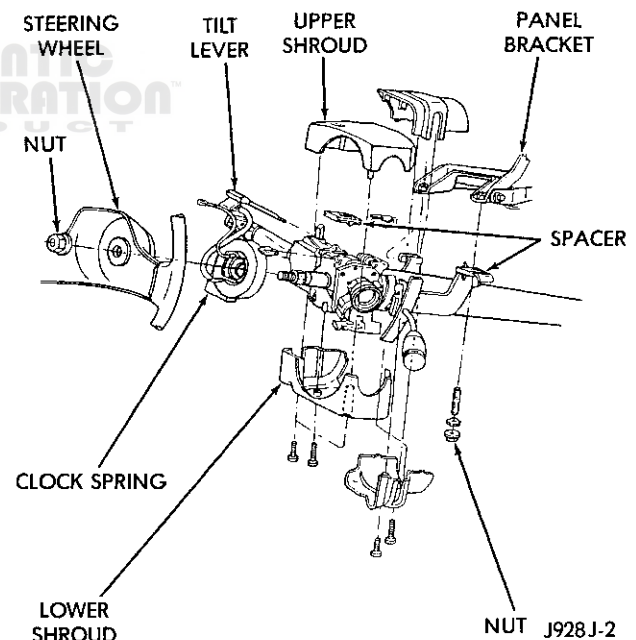


Fig. 65 Shroud Removal/Installation—Typical

REMOVAL AND INSTALLATION (Continued)

(4) Remove ignition switch mounting screws. Use tamper proof torx bit Snap-on TTXR20A2 or equivalent to remove the screws (Fig. 66) or (Fig. 67).

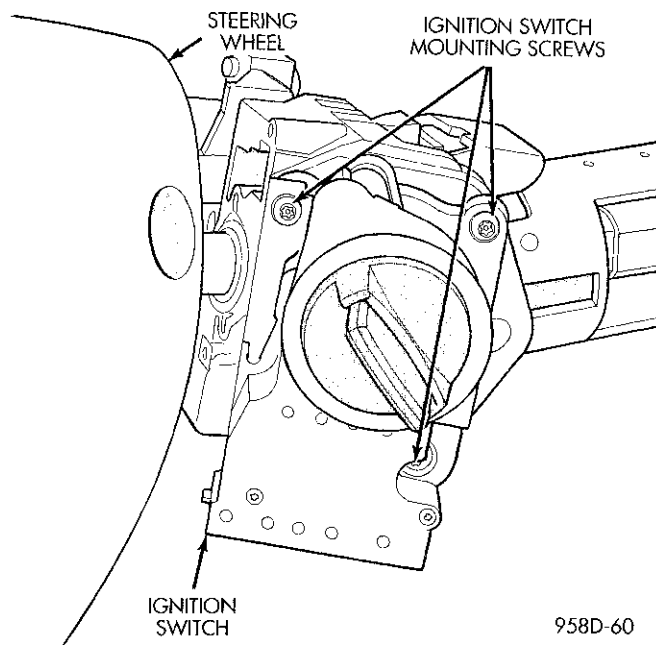


Fig. 66 Ignition Switch Screw Removal

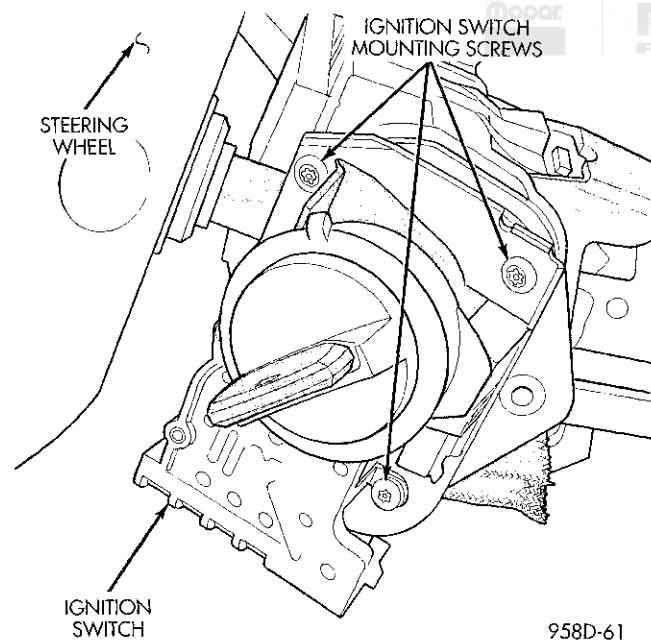


Fig. 67 Ignition Switch Screw Removal

(5) Gently pull switch away from column. Release connector locks on 7-terminal wiring connector, then remove connector from ignition switch.

(6) Release connector lock on 4-terminal connector, then remove connector from ignition switch (Fig. 68).

(7) To remove key cylinder from ignition switch:

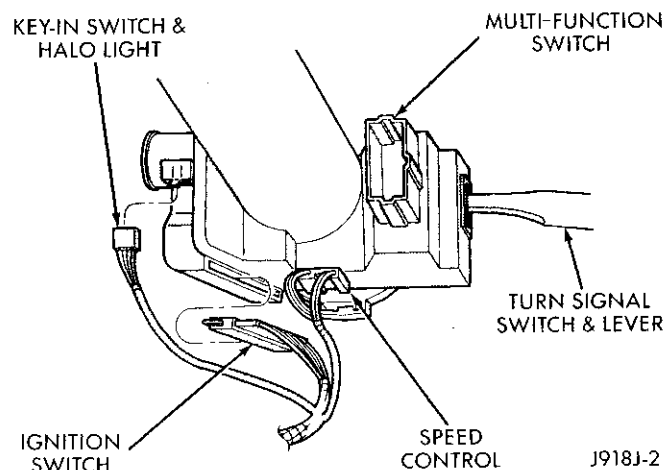


Fig. 68 Key-In-Switch and Halo Lamp Connector

(a) Insert key in ignition switch. Turn key to LOCK position. Using a TTXR20A2 or equivalent torx bit, remove key cylinder retaining screw and bracket (Fig. 69) or (Fig. 70).

(b) Rotate key clockwise to the OFF position. Key cylinder will unseat from ignition switch (Fig. 71). When key cylinder is unseated, it will be approximately 1/8 inch away from ignition switch halo light ring. **Do not attempt to remove key cylinder at this time.**

(c) With key cylinder in unseated position, rotate key counterclockwise to the lock position and remove key.

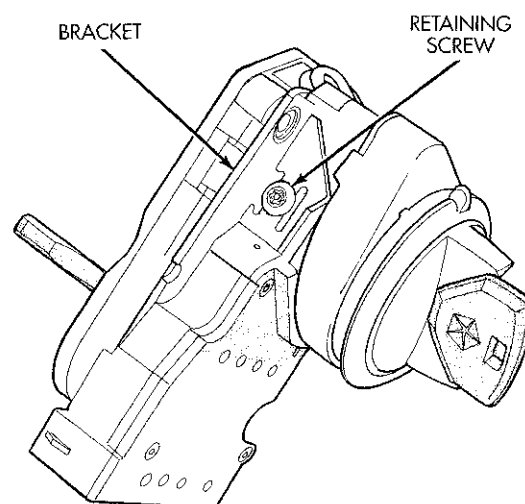
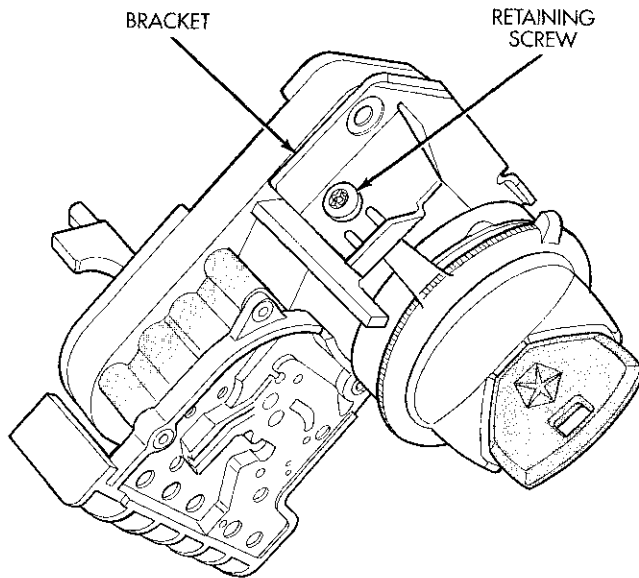


Fig. 69 Key Cylinder Retaining Screw

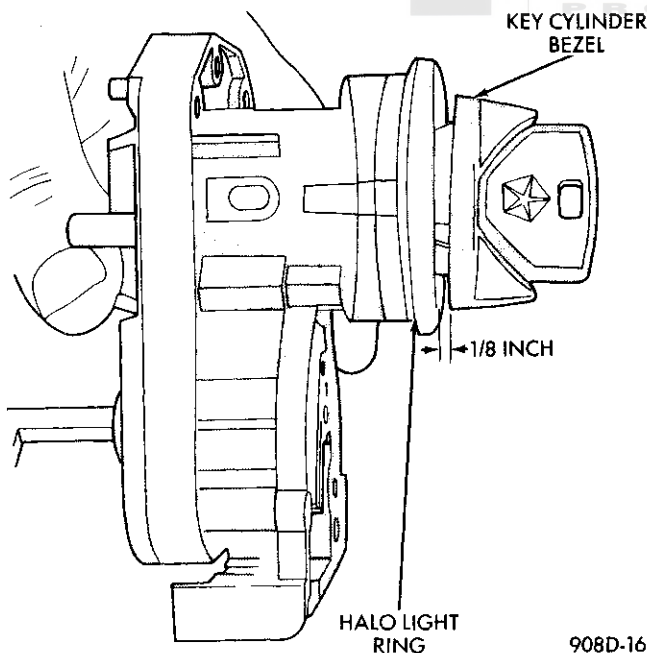
REMOVAL AND INSTALLATION (Continued)

(d) With key cylinder in unseated position, rotate key counterclockwise to the lock position and remove key.

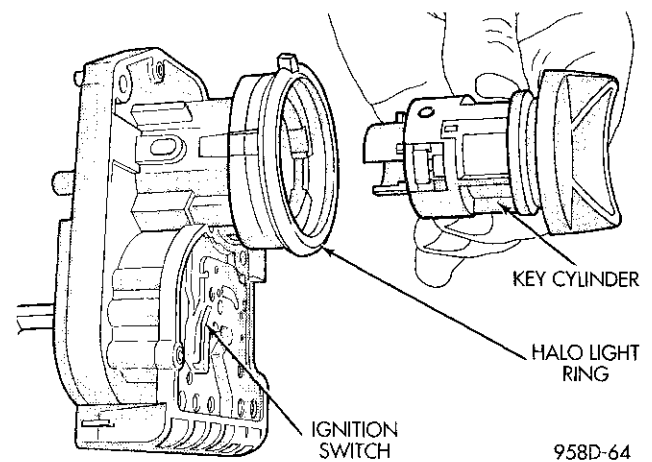
(e) Remove key cylinder from ignition switch (Fig. 72).



958D-63

Fig. 70 Key Cylinder Retaining Screw

908D-16

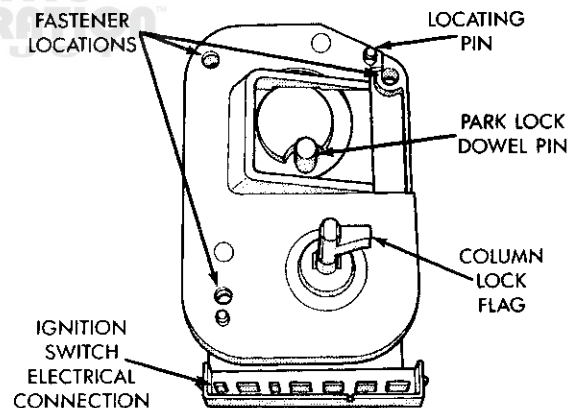
Fig. 71 Unseated Key Cylinder

958D-64

Fig. 72 Key Cylinder Removal**INSTALLATION**

(1) Connect electrical connectors to ignition switch. Make sure that switch locking tabs are fully seated in wiring connectors.

(2) Before attaching ignition switch to a tilt steering column, the transmission shifter must be in Park position. The park lock dowel pin and column lock flag must also be properly indexed before installing switch (Fig. 73).



908D-18

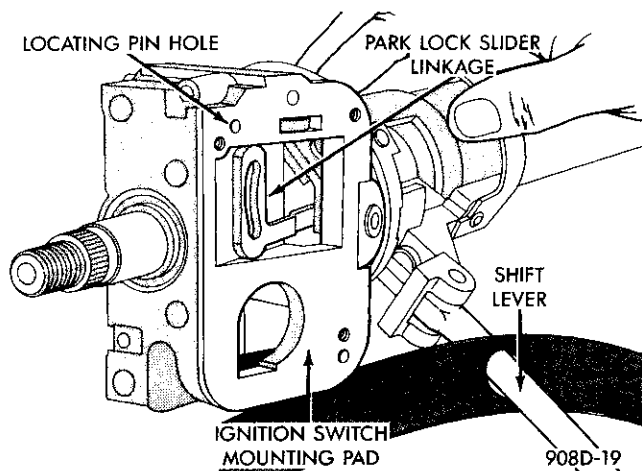
Fig. 73 Ignition Switch View From Column

(a) Place transmission shifter in PARK position.

(b) Place ignition switch in lock position. The switch is in the lock position when column lock flag is parallel to ignition switch terminals (Fig. 73).

(c) Position ignition switch park lock dowel pin so it will engage steering column park lock slider linkage (Fig. 74).

(d) Apply a light coating of grease to column lock flag and park lock dowel pin.

REMOVAL AND INSTALLATION (Continued)**Fig. 74 Ignition Switch Mounting Pad**

(3) Place ignition switch against lock housing opening on steering column. Ensure that ignition switch park lock dowel pin enters slot in park lock slider linkage in steering column.

(4) Install retaining bracket and ignition switch mounting screws. Tighten screws to 3 ± 5 N·m (26 ± 4 in. lbs.) torque.

(5) Install ignition lock cylinder:

(6) With lock cylinder and ignition switch in Lock position, insert lock cylinder into ignition switch until it bottoms.

(7) Insert ignition key into lock cylinder. While gently pushing lock cylinder in toward ignition switch, rotate ignition key to end of travel.

(8) Install retaining screw into bracket and lock cylinder. Tighten screw to 3 ± 5 N·m (26 ± 4 in. lbs.) torque.

(9) Install steering column covers. Tighten screws to 2 N·m (17 in. lbs.) torque.

(10) If vehicle is equipped with a tilt steering column, install tilt lever.

(11) Connect negative cable to battery.

(12) Check for proper operation of halo light, shift lock (if applicable), and column lock. Also check for proper operation of ignition switch accessory, lock, off, run, and start positions.

COLUMN SHIFT INTERLOCK

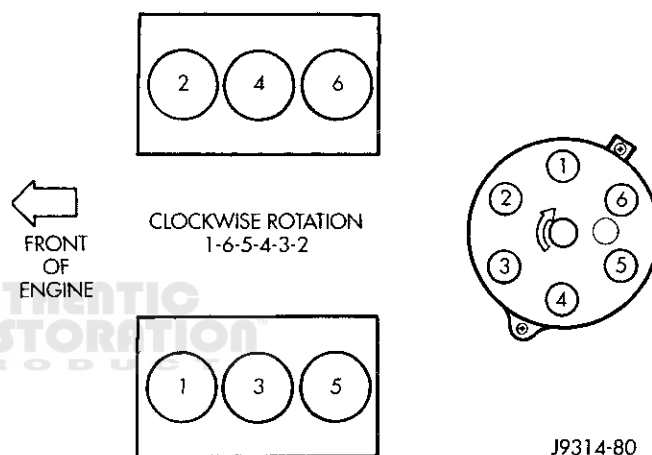
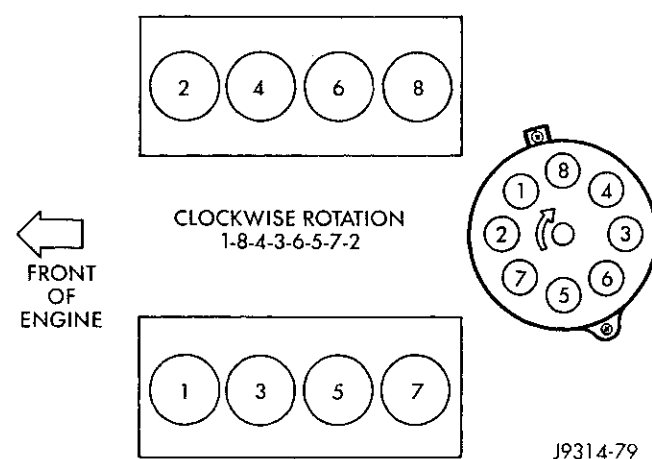
The column shift interlock is used to lock the transmission shifter in the Park position when the key is in the Off position. The interlock device is located within the steering column assembly and is not servicable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures.

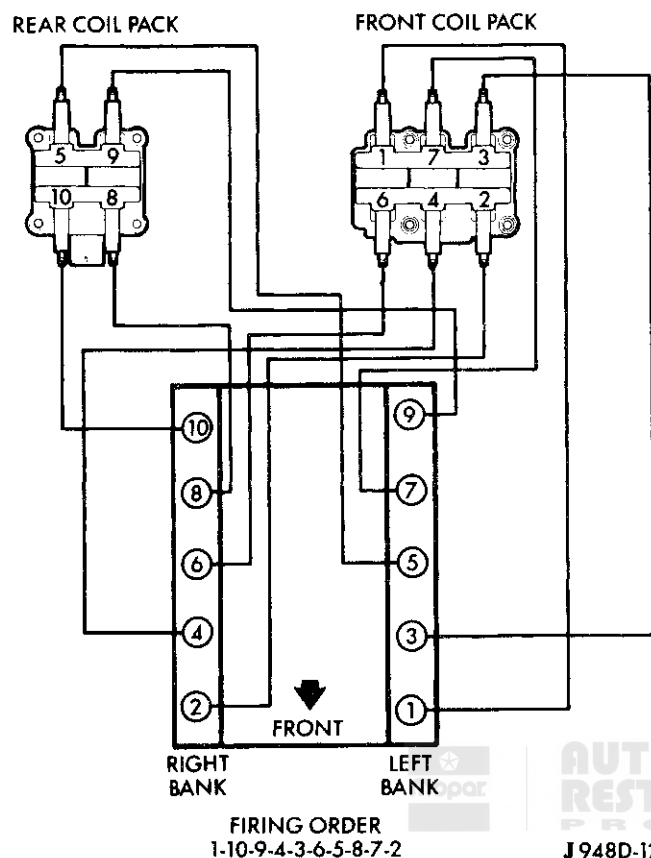
SPECIFICATIONS**VECI LABEL SPECIFICATIONS**

If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label. The VECI label is located in the engine compartment.

IGNITION TIMING

Ignition timing is not adjustable on any engine. Refer to Ignition Timing in the Diagnostics/Service Procedures section of this group for more information.

ENGINE FIRING ORDER—3.9L V-6 ENGINE**ENGINE FIRING ORDER—5.2L/5.9L V-8 ENGINES**

SPECIFICATIONS (Continued)**SPARK PLUG CABLE ORDER—8.0L V-10 ENGINE****TORQUE SPECIFICATIONS****DESCRIPTION****TORQUE**

Camshaft Position

Sensor—8.0L Engine6 N·m (50 in. lbs.)

Crankshaft Position

Sensor—All Engines8 N·m (70 in. lbs.)

Distributor Hold Down Bolt23 N·m (17 ft. lbs.)

Ignition Coil Mounting—

3.9L/5.2L/5.9L Engines—

if tapped bolts are used5 N·m (50 in. lbs.)

Ignition Coil Mounting—

3.9L/5.2L/5.9L Engines—

if nuts/bolts are used11 N·m (100 in. lbs.)

Ignition Coil Mounting—

8.0L Engine10 N·m (90 in. lbs.)

Powertrain Control Module

(PCM) Mounting Screws1 N·m (9 in. lbs.)

Spark Plugs (all engines)41 N·m (30 ft. lbs.)

SPARK PLUGS

Engine	Spark Plug		Application	Gap	Tightening Torque	Size
	Original Equipment	Replacement				
3.9L V-6	RC12YC	RC12YC	ALL	.035" (0.9MM)	41 N.m (30 ft. lbs.)	14 mm Thread 3/4" Reach
5.2/5.9L V-8	RC12YC	RC12YC	ALL	.035" (0.9MM)	41 N.m (30 ft. lbs.)	14 mm Thread 3/4" Reach
8.0L V-10	QC9MC4	QC9MC4	ALL	.045" (1.14MM)	41 N.m (30 ft. lbs.)	14 mm Thread 3/4" Reach

SPECIFICATIONS (Continued)**SPARK PLUG CABLE RESISTANCE**

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

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IGNITION COIL RESISTANCE—3.9L/5.2L/5.9L ENGINES

COIL (MANUFACTURER)	PRIMARY RESISTANCE 21–27°C (70–80°F)	SECONDARY RESISTANCE 21–27°C (70–80°F)
Diamond	0.97 - 1.18 Ohms	11,300 - 15,300 Ohms
Toyodenso	0.95 - 1.20 Ohms	11,300 - 13,300 Ohms

J918D-2

IGNITION COIL RESISTANCE—8.0L V-10 ENGINE

* Primary Resistance: 0.53 to 0.65 ohms
** Secondary Resistance: 10.9 to 14.7 K ohms
* Test across the primary connector. Refer to text for test procedures.
** Test across the individual coil towers. Refer to text for test procedures.

J948D-13

AUTHENTIC
RESTORATION
PRODUCT

INSTRUMENT PANEL SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

This group is responsible for covering the vehicle instrument panel. However, because the instrument panel serves as the vehicle's command center, it is a very complex unit. The instrument panel is designed to house the controls and monitors for standard and optional powertrains, climate control systems, audio systems, lighting systems, safety systems and many other comfort or convenience items. It is also designed so that all of the controls and monitors can be safely reached and/or viewed by the vehicle operator, while still allowing relative ease of access to these items for service.

Complete service information coverage for all of the systems and components housed in the instrument panel in this section of the service manual would not be practical. It would result in a great deal of duplication and make this group too large for the information to be easily accessed and used. Therefore, the information found in this group has been limited as follows:

- General Information - Covers non-electrical components and features of the instrument panel that are not related to other systems.
- Description and Operation - Covers gauges and their sending units, warning lamps and their switches, and instrument panel illumination lamps.
- Diagnosis and Testing - Covers gauges and their sending units, warning lamps and their switches, and instrument panel illumination lamps.
- Removal and Installation - Covers components installed on or in the instrument panel that require removal for diagnosis or service of instrument panel components covered in this group.

For more information on components or systems not covered above, refer to the appropriate group in this manual. If you are uncertain as to the appropriate group, refer to the Component and System Index at the back of this manual. Refer to Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

INSTRUMENT PANEL

Modular instrument panel construction allows all of the gauges and controls to be serviced from the front of the panel. In addition, most of the instrument panel wiring or heating and air conditioning

components can be accessed without complete instrument panel removal. If necessary, the instrument panel can be rolled-down and removed from the vehicle as an assembly.

Removal of the instrument cluster bezel allows access to the cluster assembly, most switches, the climate controls, and the radio. Removal of the cluster assembly allows access to the individual gauges, illumination and indicator lamp bulbs, printed circuits, and most of the instrument panel wiring.

Removal of the steering column cover/knee blocker provides access to the steering column mounts, the intermittent wipe module, the fuseblock module (removal of a snap-fit cover on the left end of the instrument panel allows access to the fuses and circuit breakers) and the gear selector indicator cable (automatic transmission).

INSTRUMENT CLUSTERS

Two basic instrument cluster options are offered on Ram truck models. One is referred to as a low-line cluster, and the other is referred to as a high-line cluster. Each cluster is served by a printed circuit and two wiring connectors. Some variations of each cluster exist due to optional equipment and regulatory requirements.

The low-line cluster includes the following gauges:

- Coolant temperature gauge
- Fuel gauge
- Gear selector indicator (automatic transmission)
- Oil pressure gauge
- Speedometer/odometer.
- Trip odometer
- Voltmeter.

The low-line cluster includes provisions for the following indicator lamps:

- Airbag indicator lamp
- Anti-lock brake system lamp
- Brake warning lamp
- Four-wheel drive indicator lamps
- Generator warning lamp
- Headlamp high beam indicator lamp
- Low oil pressure warning lamp
- Malfunction indicator (Check Engine) lamp
- Seat belt reminder lamp
- Turn signal indicator lamps
- Upshift indicator lamp.

The high-line cluster includes all of the gauges and indicator lamps found in the low line cluster, but

GENERAL INFORMATION (Continued)

adds a analog tachometer, low fuel warning lamp and low washer fluid warning lamp. Some of the low line cluster gauges and indicator lamps have different positions or sizes in the high line cluster to accommodate the tachometer.

MESSAGE CENTER

In addition to the warning lamps found in the instrument cluster, a message center located directly below the climate controls has provisions for up to five warning lamps. These lamps may or may not be functional, depending upon the optional equipment and regulatory requirements affecting the vehicle being serviced. The available lamps in the message center include:

- Hazard warning indicator (export vehicles)
- Maintenance required indicator (heavy-duty emissions cycle engines)
- Master lighting indicator (export vehicles)
- Transmission oil temperature warning (V-10 and diesel engines with an automatic transmission)
- Wait-to-start (diesel engines)
- Water-in-fuel (diesel engines).

GAUGES

With the ignition switch in the On or Start positions, voltage is supplied to all gauges through the instrument cluster printed circuits. With the ignition switch in the Off position, voltage is not supplied to the gauges. A gauge pointer may remain within the gauge scale with the ignition switch in the Off position. However, the gauges do not accurately indicate any vehicle condition unless the ignition switch is in the On or Start positions.

All gauges, except the odometer, are air core magnetic units. Two fixed electromagnetic coils are located within the gauge. These coils are wrapped at right angles to each other around a movable permanent magnet. The movable magnet is suspended within the coils on one end of a shaft. The gauge needle is attached to the other end of the shaft.

One of the coils has a fixed current flowing through it to maintain a constant magnetic field strength. Current flow through the second coil changes, which causes changes in its magnetic field strength. The current flowing through the second coil can be changed by:

- A variable resistor-type sending unit (fuel level, coolant temperature, or oil pressure gauges)
- Changes in electrical system voltage (voltmeter)
- Electronic control circuitry (speedometer/odometer, tachometer).

The gauge needle moves as the movable permanent magnet aligns itself to the changing magnetic fields created around it by the electromagnets.

INDICATOR LAMPS

Indicator lamps are located in several areas of the instrument cluster and the instrument panel. Those lamps within the gauge area of the cluster are served by the cluster printed circuit(s) and cluster connector(s). Those lamps located in the message center area of the cluster are served by the message center printed circuit and connector.

FUSEBLOCK MODULE

The fuseblock module is mounted to the left end of the instrument panel. It has cavities for 24 blade-type fuses and circuit breakers, the turn signal and hazard warning flashers, a buzzer module, and the ignition switch lamp time delay relay.

The fuses, circuit breakers, flashers, and relay can be accessed by removing a snap-in cover located on the left outboard end of the instrument panel. The fuseblock module can be accessed for removal from under the instrument panel by removing the lower steering column cover/knee blocker.

DESCRIPTION AND OPERATION

COOLANT TEMPERATURE GAUGE

The coolant temperature gauge gives an indication of the engine coolant temperature. The coolant temperature sending unit is a thermistor that changes electrical resistance with changes in the engine coolant temperature. Some gauge needle cycling, depending upon the vehicle load, is normal on models equipped with the diesel engine option. High sending unit resistance causes low coolant temperature readings. Low resistance causes high coolant temperature readings. The sending unit resistance values are shown in a chart in Specifications at the back of this group.

FUEL GAUGE

The fuel gauge gives an indication of the level of fuel in the fuel tank. The fuel gauge sending unit is mounted to the electric fuel pump module located inside the fuel tank. Refer to Group 14 - Fuel System for sending unit service procedures.

The sending unit has a float attached to the end of a swing-arm. The float moves up or down within the fuel tank as the fuel level changes. As the float moves, an electrical contact on the pivot end of the swing-arm wipes across a resistor coil, which changes the resistance of the sending unit. High sending unit resistance causes low fuel level readings. Low resistance causes high fuel level readings. The sending unit resistance values are shown in a chart in Specifications at the back of this group.

DESCRIPTION AND OPERATION (Continued)**GEAR SELECTOR INDICATOR**

The gear selector indicator gives an indication of the position of the automatic transmission gear selector lever. The indicator is mounted to the instrument cluster housing.

The indicator is mechanically actuated by a cable connected to the PRNDL driver of the gear selector lever mechanism on the steering column. This group covers only the removal and installation of the gear selector indicator. Refer to Group 21 - Transmission for the diagnosis and adjustment of this component.

OIL PRESSURE GAUGE

The oil pressure gauge gives an indication of the engine oil pressure. The combination oil pressure switch/sending unit contains a flexible diaphragm and a variable resistor coil. The diaphragm moves in response to changes in the engine oil pressure. The sending unit is installed in a threaded hole that penetrates a oil passage of the engine. As the diaphragm moves, resistance in the coil increases or decreases. High resistance on the gauge side of the sending unit causes low oil pressure readings. Low resistance causes high oil pressure readings. Sending unit resistance values are shown in a chart in Specifications at the back of this group.

SPEEDOMETER/ODOMETER

The speedometer/odometer gives an indication of the current vehicle speed, and displays a cumulative total of the distance the vehicle has traveled. The speedometer/odometer unit receives a vehicle speed pulse signal from the Vehicle Speed Sensor (VSS). An electronic integrated circuit contained within the speedometer/odometer unit reads and analyzes the pulse signal. It then adjusts the ground path resistance of one electromagnet in the gauge to control speedometer needle movement. It also sends signals to an electric stepper motor to control movement of the odometer number rolls. The frequency values for the pulse signal are shown in a chart in Specifications at the back of this group.

The VSS is mounted to an adapter near the transmission (two-wheel drive) or transfer case (four-wheel drive) output shaft. The sensor is driven through the adapter by a speedometer pinion gear. The adapter and pinion used may vary with transmission and transfer case models, axle ratio and tire size. Refer to Group 21 - Transmission for more information.

TACHOMETER

The tachometer gives an indication of the engine speed in revolutions-per-minute (rpm). With the engine running, the tachometer receives an engine speed pulse signal from the powertrain control module. An electronic integrated circuit contained within

the tachometer unit reads and analyzes this pulse signal. It then adjusts the ground path resistance for one of the electromagnets in the gauge to control gauge needle movement. The frequency values for the pulse signal are shown in a chart in Specifications at the back of this group.

TRIP ODOMETER

Like the odometer, the trip odometer gives an indication of the distance the vehicle has travelled. However, by depressing the trip odometer reset knob on the face of the speedometer/odometer unit, the trip odometer number rolls can be reset to zero. The trip odometer is driven by the same signal and circuits as the speedometer and odometer. The trip odometer is serviced only as a part of the speedometer/odometer gauge unit.

VOLTMETER

The voltmeter gives an indication of the vehicle's electrical system voltage. The voltmeter is connected in parallel with the battery. With the ignition switch in the On position, the voltmeter indicates the battery voltage or the generator output voltage, whichever is greater.

AIRBAG INDICATOR LAMP

The airbag indicator lamp lights for 6 to 8 seconds each time the ignition switch is turned to the On position as a bulb test, and to indicate that a system self-test is in progress. The lamp is switched to ground by the Airbag Control Module (ACM). If the lamp remains on after the self-test, or comes on while driving, it may indicate that the ACM has detected a system malfunction and/or that the airbag system has become inoperative. Refer to Group 8M - Passive Restraint Systems for more information.

ANTI-LOCK BRAKE SYSTEM LAMP**REAR WHEEL ANTI-LOCK**

On vehicles equipped with the standard Rear Wheel Anti-Lock (RWAL) brake system, the Anti-Lock Brake System (ABS) lamp is switched to ground by the RWAL control module. The RWAL control module lights the lamp when the ignition switch is turned to the Start position as a bulb test. The lamp will stay on for 3 to 5 seconds after vehicle start-up to indicate that a system self-test is in progress. If the lamp remains on after start-up, or comes on and stays on while driving, it may indicate that the RWAL control module has detected a system malfunction and/or that the RWAL system has become inoperative. Refer to Group 5 - Brakes for more information.

DESCRIPTION AND OPERATION (Continued)**ANTI-LOCK BRAKE SYSTEM**

The optional all-wheel Anti-Lock Brake System (ABS) lamp is grounded through the normally closed contacts of the de-energized ABS lamp relay. When the ignition switch is turned to the Start position, the lamp is lighted as a bulb test. The lamp will stay on for 3 to 5 seconds after vehicle start-up to indicate a system self-test is in progress. If the self-test is successfully completed, the Controller Anti-lock Brake (CAB) module energizes the ABS lamp relay, which turns the lamp off. If the lamp remains on after start-up, or comes on and stays on while driving, it may indicate that the CAB module has detected a system malfunction and/or that the ABS system has become inoperative. Refer to Group 5 - Brakes for more information.

BRAKE WARNING LAMP

The brake warning lamp gives the driver an indication that the parking brake is applied, or that the pressures in the two halves of the split brake hydraulic system are unequal. With the ignition switch turned to the On or Start positions, battery voltage is supplied to one side of the indicator bulb. A ground path for the bulb is provided by up to five switches. The bulb will light when:

- The ignition switch is in the Start position (bulb test).
- The brake warning switch is closed (indicating unequal split brake hydraulic system pressures, due to low brake fluid or brake fluid leakage).
- The parking brake switch is closed (indicating the parking brake is applied).
- The vacuum sensor (models with the diesel engine option) senses low system vacuum.
- If certain ABS or RWAL system faults are detected.

Refer to Group 5 - Brakes for more information.

CLUSTER ILLUMINATION LAMPS

Each of the instrument cluster illumination lamps receives battery feed through the panel dimmer rheostat of the headlamp switch from the instrument lamps fuse in the fuseblock module. When the park or head lamps are on, the cluster illumination lamps light. Illumination brightness can be adjusted by rotating the headlamp switch knob (clockwise to dim, counterclockwise to brighten).

FOUR-WHEEL DRIVE INDICATOR LAMP

On models equipped with the four-wheel drive option, a four-wheel drive indicator lamp in the instrument cluster lights any time the front axle is in the four-wheel drive operating mode. Ignition-switched battery voltage is supplied to one side of the indicator lamp bulb. A normally open, plunger-type,

four-wheel drive switch is threaded into the front axle disconnect housing. The switch is connected in series between the other side of the indicator lamp bulb and ground. When the vacuum-actuated front axle disconnect is engaged, providing four-wheel drive, the plunger of the four-wheel drive switch is moved by the internal axle disconnect mechanism, closing the switch and providing a path to ground. This causes the four-wheel drive indicator lamp bulb to light.

GENERATOR WARNING LAMP

The generator warning lamp gives the driver an indication of a charging system problem. One side of the bulb is connected to an ignition-switched battery feed. The other side of the bulb is switched to ground by the Powertrain Control Module (PCM).

The lamp should light when the ignition switch is turned to the On position, but should go out whenever the engine is running. If the lamp comes on and stays on while the engine is running, it indicates that the PCM has detected a charging system malfunction and/or that the charging system has become inoperative.

Refer to Group 8C - Charging System for diagnosis of a charging system problem. Refer to Group 14 - Fuel System for more information on the PCM generator warning lamp control output.

HAZARD WARNING INDICATOR LAMP

The hazard warning indicator lamp is only used on certain export models, where required. The lamp in the message center is turned on by a signal from the hazard warning (multi-function) switch to indicate that the hazard warning lamp system is activated.

HEADLAMP HIGH BEAM INDICATOR LAMP

The headlamp high beam indicator lamp lights when the high beam circuit is activated. The circuit is controlled by the headlamp dimmer (multi-function) switch. One side of the indicator bulb is grounded at all times. The other side of the bulb receives a battery feed through the contacts of the dimmer switch when the multi-function switch stalk is actuated to turn on the headlamp high beams. Refer to Group 8L - Lamps for more information.

LOW FUEL WARNING LAMP

The low fuel warning lamp will light when the fuel level falls below approximately four gallons. One side of the low fuel warning bulb is grounded at all times. A low fuel warning circuit attached to the rear of the gauge cluster provides ignition-switched battery voltage to the lamp when the fuel level is low. The low fuel warning circuit monitors the signal from the fuel level sending unit. When the circuit senses approxi-

DESCRIPTION AND OPERATION (Continued)

mately 65 ohms or more from the fuel level sending unit for 8 to 30 continuous seconds, the indicator lamp will light. The indicator lamp will remain on until the circuit senses approximately 65 ohms or less from the fuel sender for 8 to 30 continuous seconds. See the chart in Specifications at the back of this group for more information.

LOW OIL PRESSURE WARNING LAMP

The low oil pressure warning lamp lights with the ignition switch in the On position and the engine not running. The lamp should be off when the engine is running.

Battery voltage is supplied to one side of the indicator bulb when the ignition switch is turned to the On position. The warning lamp side of the combination oil pressure switch/sending unit resistor coil is connected to the other side of the bulb.

When normal engine oil pressure is applied to the sending unit, resistance on the warning lamp side of the resistor coil is high and the lamp goes off. When the engine oil pressure is too low, resistance on the warning lamp side of the resistor coil is low, which causes the bulb to light.

LOW WASHER FLUID WARNING LAMP

The low washer fluid warning lamp indicates when the fluid level in the washer fluid reservoir is too low. The washer fluid level sensor uses a float in the reservoir to monitor the fluid level. The up and/or down action of the float opens or closes the switch within the sensor that provides a ground path to the warning lamp bulb. Refer to Group 8K - Wiper and Washer Systems for more information.

MAINTENANCE REQUIRED INDICATOR LAMP

The maintenance required indicator lamp is used on vehicles equipped with a heavy-duty emissions cycle package, and a 5.9L V-8, or 8.0L V-10 engine. This lamp is intended to act as a reminder that scheduled vehicle emissions services and maintenance must be performed, as required by federal emissions laws. It is not intended to indicate a warning, or that a state of emergency exists. However, when the lamp has been activated, the required services and maintenance must be performed, before the lamp can be legally reset. For a list of the required services and maintenance, stated in time or mileage, refer to Group 0 - Lubrication and Maintenance. Also refer to Group 25 - Emission Control System for more information.

MALFUNCTION INDICATOR LAMP

The Check Engine or Malfunction Indicator Lamp (MIL) lights each time the ignition switch is turned to the On position, and stays on for three seconds as

a bulb test. If the Powertrain Control Module (PCM) receives an incorrect signal or no signal from certain fuel or emission system related circuits or components, the lamp is turned on. This indicates that the PCM has recorded a Diagnostic Trouble Code (DTC) in electronic memory for a circuit or component malfunction. Refer to Group 14 - Fuel System for more information.

MASTER LIGHTING INDICATOR LAMP

The master lighting indicator lamp is only used on certain export models, where required. The lamp in the message center is turned on by a signal from the headlamp switch to indicate that the exterior lamps are lighted.

SEAT BELT REMINDER LAMP

The seat belt reminder lamp lights for four to eight seconds after the ignition switch is turned to the On position. A timer circuit within the chime/buzzer module controls ignition-switched battery feed to the lamp. Refer to Group 8U - Chime/Buzzer Warning Systems for more information.

TRANSMISSION OIL TEMPERATURE WARNING LAMP

The transmission oil temperature warning lamp lights to indicate that the transmission oil is overheated. One side of the lamp bulb receives battery voltage when the ignition switch is turned to the On position. The other side of the bulb is grounded by the Powertrain Control Module (PCM), when it senses transmission oil temperature is too high. A sensor located within the transmission sends a signal to the PCM, indicating the transmission fluid temperature. Refer to Group 21 - Transmission for more information on the sensor and its circuit. This lamp is only used on vehicles equipped with a diesel or V-10 engine option, and an automatic transmission.

TURN SIGNAL INDICATOR LAMPS

The left and right turn signal indicator lamps are controlled by the turn signal and hazard warning (multi-function) switches. One side of the bulb for each lamp is grounded at all times. The other side of the bulb receives a battery feed through the contacts of the multi-function switch when the turn signal lever (multi-function switch stalk) or hazard warning button is actuated. Refer to Group 8J - Turn Signal and Hazard Warning Systems for more information.

UPSHIFT INDICATOR LAMP

Vehicles equipped with a manual transmission may have an optional upshift indicator lamp. One side of the indicator lamp bulb receives ignition-switched battery feed. The ground feed for the other side of

DESCRIPTION AND OPERATION (Continued)

the lamp bulb is switched by the Powertrain Control Module (PCM). The lamp lights to indicate when the driver should shift to the next highest gear for best fuel economy. The PCM will turn the lamp off after 3 to 5 seconds if the upshift is not performed. The lamp will remain off until the vehicle stops accelerating and is brought back to the range of lamp operation, or until the transmission is shifted into another gear.

The indicator lamp is normally on when the ignition switch is in the On position, and is turned off when the engine is started. The lamp will be turned on and off during vehicle operation, according to the engine speed and load conditions that are being monitored by the PCM. Refer to Group 14 - Fuel System for more information on the PCM upshift indicator lamp control output.

WAIT-TO-START LAMP

The wait-to-start lamp is only used on diesel engine models. The wait-to-start lamp bulb in the message center is lighted by a ground signal from the Powertrain Control Module (PCM), after the ignition switch is turned to the On position. It gives the driver an indication to wait until the intake manifold air heater grid has had sufficient time to warm the intake air for a good quality start. The intake manifold air preheat cycle is controlled by an electronic air heater control module. The lamp will be turned off by the PCM when the heater control module cycle is completed, or if the driver turns the ignition switch to the Start position prior to the end of the heater control module cycle. Refer to Group 14 - Fuel Systems for more information.

WATER-IN-FUEL LAMP

The water-in-fuel lamp is only used on models with the diesel engine option. The water-in-fuel lamp in the message center is turned on by the Powertrain Control Module (PCM) for two seconds, when the ignition switch is first turned to the On position, as a bulb check. The PCM will also turn on the lamp any time there is excess water accumulated in the fuel filter/water separator and the ignition switch is in the On position. A water-in-fuel sensor in the fuel filter/water separator signals the PCM that excess water has accumulated. The PCM will turn the lamp off when the excess water has been drained. Refer to Group 14 - Fuel Systems for more information.

DIAGNOSIS AND TESTING**PRINTED CIRCUITS****GAUGE CLUSTER**

If an individual gauge or lamp is inoperative, see the diagnostic procedure under the heading for that

gauge or lamp. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams. If more than one gauge or lamp is inoperative, perform the following:

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Check for battery voltage at the fuse with the ignition switch in the On position. If OK, go to Step 3. If not OK, repair the open circuit from the ignition switch and/or refer to Group 8D - Ignition Systems for testing of the ignition switch, as required.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Disconnect the gauge cluster connectors.

(4) Connect the battery negative cable. Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the right cluster connector. If OK, go to Step 5. If not OK, repair the open circuit from the fuse as required.

(5) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Probe the ground circuit cavities of both the left and right cluster connectors. Check for continuity to a good ground. There should be continuity. If OK, replace the faulty gauge cluster printed circuit. If not OK, repair the open circuit(s) to ground as required.

MESSAGE CENTER

If an individual lamp is inoperative, see the diagnostic procedure under the heading for that lamp. The message center printed circuit is only serviced as a part of the heater-A/C control unit. If the printed circuit is faulty, the entire control unit must be replaced. For circuit descriptions and diagrams, refer to 8W-46 - Message Center in Group 8W - Wiring Diagrams. If more than one lamp is inoperative, perform the following:

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Check for battery voltage at the fuse with the ignition switch in the On position. If OK, go to Step 3. If not OK, repair the open circuit from the ignition switch and/or refer to Group 8D - Ignition Systems for testing of the ignition switch, as required.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the message center assembly. Disconnect the message center connector.

(4) Connect the battery negative cable. Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the message center connector. If OK, replace the faulty heater-A/C control unit. If not OK, repair the open circuit from the fuse as required.

DIAGNOSIS AND TESTING (Continued)**COOLANT TEMPERATURE GAUGE**

The diagnosis found here addresses an inoperative gauge condition. If the problem being diagnosed is related to gauge accuracy, be certain to confirm that the problem is with the gauge and not with cooling system performance. The actual engine coolant temperature should be checked with a test gauge or thermometer and compared to the gauge readings before you proceed with gauge diagnosis. Refer to Group 7 - Cooling System for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

NOTE: Models equipped with the 8.0L V-10 engine have the coolant temperature sending unit threaded into the plastic water outlet. Therefore, an extra spade terminal and connector near the side of the coolant temperature sending unit is wired to provide a ground path for the sending unit case. Be certain that there is continuity between the sending unit case and ground on these models. If not OK, repair this circuit to ground as required.

(1) Turn the ignition switch to the On position. Disconnect the coolant temperature sending unit connector (Fig. 1), (Fig. 2) or (Fig. 3). The gauge needle should move to the low end of the gauge scale. If OK, go to Step 2. If not OK, go to Step 3.

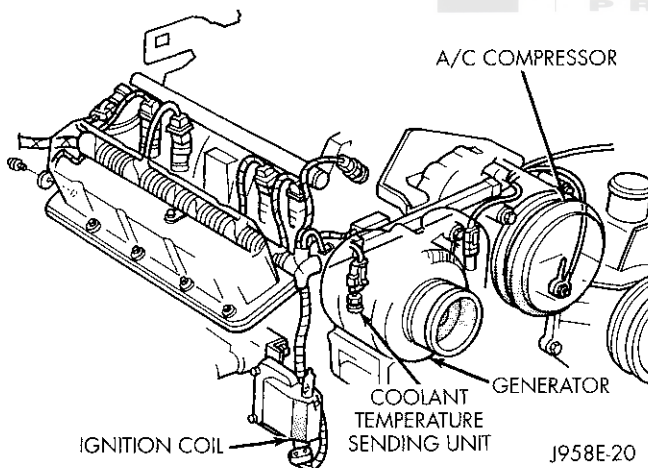


Fig. 1 Coolant Temperature Sending Unit - V-6/V-8 Engine

(2) Install a jumper wire from the sending unit connector to a good ground. The gauge needle should move to the high end of the gauge scale. If OK, replace the faulty sending unit. If not OK, remove the jumper wire and go to Step 3.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Disconnect the left cluster connector.

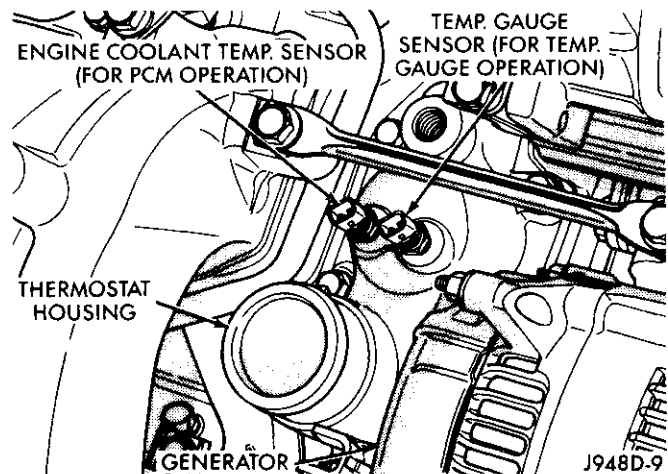


Fig. 2 Coolant Temperature Sending Unit - V-10 Engine

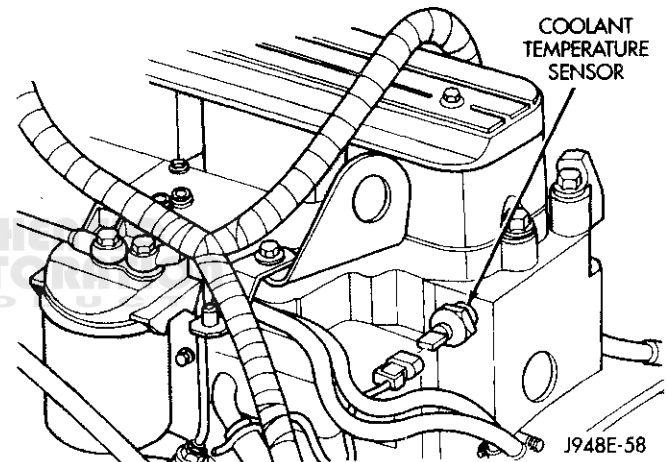


Fig. 3 Coolant Temperature Sending Unit - Diesel Engine

(4) Probe the engine coolant temperature sending unit circuit cavity of the left cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Still probing the engine coolant temperature sending unit circuit cavity of the left cluster connector, check for continuity to the sending unit connector. There should be continuity. If OK, replace the faulty gauge. If not OK, repair the open circuit as required.

FUEL GAUGE

The diagnosis found here addresses an inoperative gauge condition. If the problem being diagnosed is related to gauge accuracy, be certain to confirm that the problem is with the gauge or sending unit and not with the fuel tank. Inspect the fuel tank for signs of damage or distortion that could affect the sending unit performance before you proceed with gauge

DIAGNOSIS AND TESTING (Continued)

diagnosis. Refer to Group 14 - Fuel System for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the On position. Disconnect the fuel pump module connector. The connector is located on top of the fuel tank. The gauge needle should move to the low end of the gauge scale. If OK, go to Step 2. If not OK, go to Step 4.

(2) Connect a jumper wire between the sending unit ground circuit cavity and the fuel level sensor signal circuit cavity of the fuel pump module wiring connector. The gauge needle should move to the high end of the gauge scale. If OK, refer to Group 14 - Fuel System for the procedures to replace the faulty sending unit. If not OK, remove the jumper wire and go to Step 3.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Check for continuity between the sending unit ground circuit cavity of the fuel pump module wiring connector and a good ground. There should be continuity. If OK, go to Step 4. If not OK, repair the open circuit to ground as required.

(4) Remove the instrument cluster bezel and the cluster assembly. Disconnect the right cluster connector.

(5) Probe the fuel level sensor signal circuit cavity of the right cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 6. If not OK, repair the short circuit as required.

(6) Check for continuity between the fuel level sensor signal circuit cavities of the right cluster connector and the fuel pump module connector. There should be continuity. If OK, replace the faulty gauge. If not OK, repair the open circuit as required.

OIL PRESSURE GAUGE

The diagnosis found here addresses an inoperative gauge condition. If the problem being diagnosed is related to gauge accuracy, be certain to confirm that the problem is with the gauge and not with the engine oiling system performance. The actual engine oil pressure should be checked with a test gauge and compared to the instrument cluster gauge readings before you proceed with gauge diagnosis. Refer to Group 9 - Engines for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the On position. Disconnect the oil pressure sending unit connector (Fig. 4), (Fig. 5) or (Fig. 6). The gauge needle should move to the low end of the gauge scale. If OK, go to Step 2. If not OK, go to Step 3.

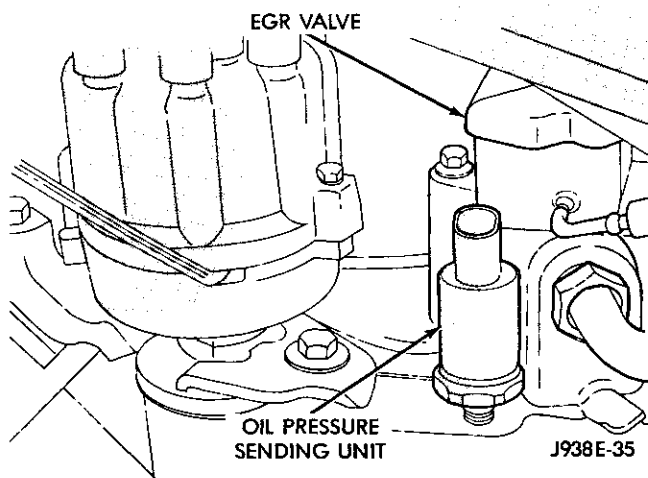


Fig. 4 Oil Pressure Switch/Sending Unit - V-6/V-8 Engine

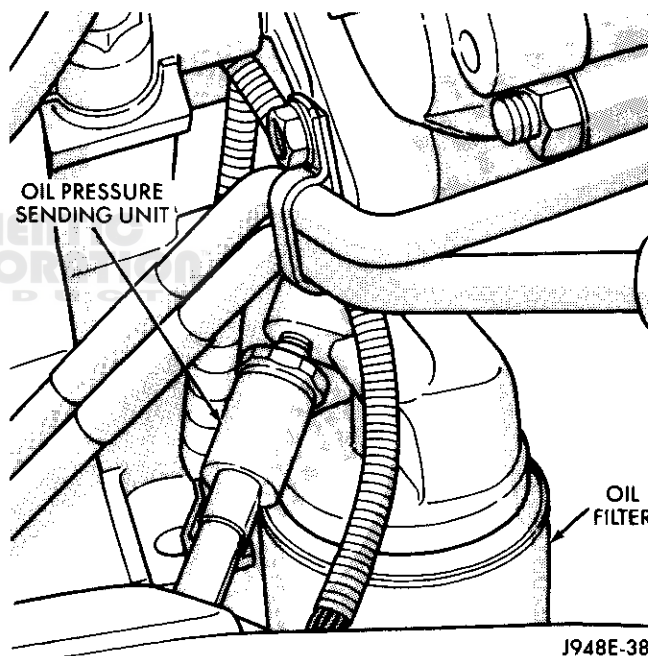


Fig. 5 Oil Pressure Switch/Sending Unit - V-10 Engine

(2) Install a jumper wire from the oil pressure sensor signal circuit cavity of the sending unit connector to a good ground. The gauge needle should move to the high end of the gauge scale. If OK, replace the faulty sending unit. If not OK, remove the jumper wire and go to Step 3.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Disconnect the right instrument cluster connector.

(4) Probe the oil pressure sensor signal circuit cavity of the right cluster connector and check for conti-

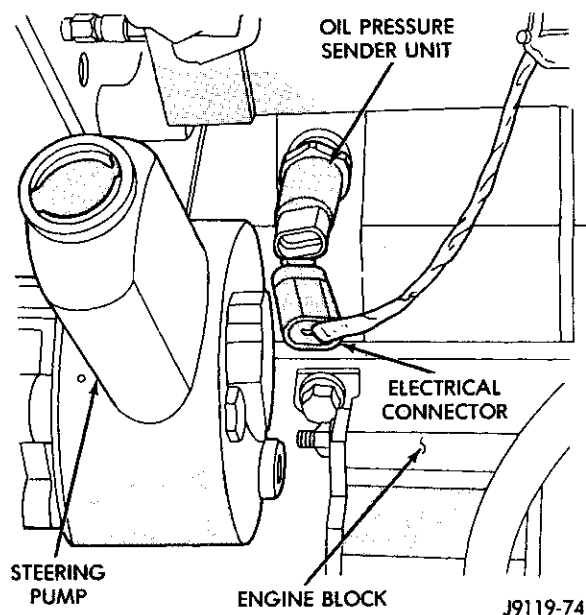
DIAGNOSIS AND TESTING (Continued)

Fig. 6 Oil Pressure Switch/Sending Unit - Diesel Engine

nuity to a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Check for continuity between the oil pressure sensor signal circuit cavities of the right cluster connector and the sending unit connector. There should be continuity. If OK, replace the faulty gauge. If not OK, repair the open circuit as required.

SPEEDOMETER/ODOMETER

The diagnosis found here addresses an inoperative gauge condition. If the problem being diagnosed is related to gauge accuracy, be certain to confirm that the problem is with the gauge and not with an incorrect speedometer pinion, axle ratio, or tire size. Refer to Group 21 - Transmission for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Perform the vehicle speed sensor test as described in the appropriate Powertrain Diagnostic Procedures manual. If OK, go to Step 2. If not OK, replace the faulty vehicle speed sensor.

(2) Disconnect and isolate the battery negative cable. Unplug the vehicle speed sensor connector, the buzzer module connector (export only), and the PCM connector B (white). Remove the instrument cluster bezel and the cluster assembly. Disconnect the left instrument cluster connector.

(3) Probe the vehicle speed sensor signal circuit cavity of the left cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the vehicle speed sensor signal circuit cavities of the left cluster connector and the vehicle speed sensor connector. There should be continuity. If OK, replace the faulty speedometer/odometer unit. If not OK, repair the open circuit as required.

TACHOMETER

For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) With the engine running, check for a tachometer signal at the tachometer signal circuit cavity of the PCM connector C (gray). See the Tachometer Calibration chart in Specifications at the back of this group for the frequency ranges. If OK, go to Step 2. If not OK, refer to the appropriate Powertrain Diagnostic Procedures manual to test the PCM.

(2) Disconnect and isolate the battery negative cable. Unplug the PCM connector C. Remove the instrument cluster bezel and the cluster assembly. Disconnect the right instrument cluster connector.

(3) Probe the tachometer signal circuit cavity of the right cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the tachometer signal circuit cavities of the right cluster connector and the PCM connector C. There should be continuity. If OK, replace the faulty tachometer. If not OK, repair the open circuit as required.

TRIP ODOMETER

If the trip odometer is inoperative, but the speedometer/odometer functions are unaffected, replace the faulty speedometer/odometer unit. If the speedometer/odometer functions are affected, see the diagnosis for Speedometer/Odometer in this group.

VOLTMETER

The diagnosis found here addresses an inoperative gauge condition. If the gauge accuracy is suspect, be certain to confirm proper charging system operation before considering gauge replacement. Refer to Group 8C - Charging System for more information. If no charging system problem is found, the following procedure will help diagnose an inaccurate gauge. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the On position. The voltmeter should read battery voltage. If all gauges except the voltmeter are OK, go to Step 2. If the other gauges are inoperative, see the diagnosis for Printed Circuits in this group.

DIAGNOSIS AND TESTING (Continued)

(2) Using an accurate test voltmeter, measure the battery voltage at the battery. Compare this reading to the instrument cluster voltmeter reading. Now, see the Voltmeter Calibration chart in Specifications at the back of this group. If the voltmeter does not perform within the specifications, replace the faulty voltmeter.

AIRBAG INDICATOR LAMP

The diagnosis found here addresses an inoperative lamp condition. If the airbag indicator lamp stays on with the ignition switch in the On position, or comes on while driving, refer to Group 8M - Passive Restraint Systems for diagnosis. If no airbag system problem is found, the following procedure will help locate a short or open in the airbag warning lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster, and 8W-43 - Airbag System in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Unplug the left instrument cluster connector.

(2) Connect the battery negative cable. Check for battery voltage at the airbag system warning lamp driver circuit cavity of the left cluster connector within 6 seconds after turning the ignition switch to the On position. If OK, replace the faulty bulb. If not OK, go to Step 3.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Disconnect the 13-way Airbag Control Module (ACM) connector. Check for continuity between the airbag system warning lamp driver circuit cavities of the left cluster connector and the ACM connector. There should be continuity. If OK, refer to Group 8M - Restraint Systems for diagnosis of the ACM. If not OK, repair the open circuit as required.

ANTI-LOCK BRAKE SYSTEM LAMP

The diagnosis found here addresses an inoperative Anti-lock Brake System (ABS) lamp condition. If the ABS lamp stays on with the ignition switch in the On position, or comes on and stays on while driving, refer to Group 5 - Brakes for diagnosis. If no RWAL or ABS problem is found, the following procedure will help locate a short or open in the ABS lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster, and 8W-34 - Rear Wheel Anti-Lock Brakes or 8W-35 - All-Wheel Anti-Lock Brakes in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly.

(2) Connect the battery negative cable. Check for battery voltage between the fused ignition switch

output circuit and the ABS warning lamp driver circuit cavities of the right cluster connector within five seconds of turning the ignition switch to the On position. If OK, replace the faulty bulb. If not OK, go to Step 3.

(3) Disconnect and isolate the battery negative cable. Disconnect the RWAL/ABS control module connector. If the vehicle has ABS, remove the ABS lamp relay from the Power Distribution Center (PDC). See the PDC label for relay identification and location. Check for continuity between the ABS warning lamp driver circuit cavity of the right cluster connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the ABS warning lamp driver circuit cavities of the right cluster connector and the RWAL/ABS control module connector. There should be continuity. If OK, refer to Group 5 - Brakes for diagnosis of RWAL/ABS control module. If not OK, repair the open circuit as required.

BRAKE WARNING LAMP

The diagnosis found here addresses an inoperative brake warning lamp condition. If the brake warning lamp stays on with the ignition switch in the On position and the parking brake released, refer to Group 5 - Brakes for diagnosis. If no service brake or parking brake problem is found, the following procedure will help locate a short circuit or a faulty switch. For circuit descriptions or diagrams, refer to 8W-40 - Instrument Cluster, and 8W-34 - Rear Wheel Anti-Lock Brakes, or 8W-35 - All-Wheel Anti-Lock Brakes in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the Start position. The lamp should light. Release the ignition switch to the On position. The lamp should go off. If not OK, go to Step 2.

(2) Turn the ignition switch to the Off position. Unplug the brake warning switch connector. Check for continuity between the switch terminal and a good ground. There should be no continuity. If OK, go to Step 3. If not OK, replace the faulty brake warning switch.

(3) Unplug the parking brake switch connector. With the parking brake released, check for continuity between the switch terminal and a good ground. There should be no continuity. Apply the parking brake and check for continuity between the switch terminal and a good ground. There should be continuity. If OK, go to. If not OK, adjust or replace the parking brake switch as required.

(4) Check for continuity between the metal steering column jacket and a good ground. There should be continuity. If OK, go to Step 5. If not OK, refer to

DIAGNOSIS AND TESTING (Continued)

Group 19 - Steering to check the steering column ground clip installation.

(5) Disconnect and isolate the battery negative cable. Unplug the ignition switch connector. While holding the ignition switch in the Start position, check for continuity between the red brake warning lamp driver circuit terminal of the ignition switch and a good ground. There should be continuity. Release the ignition switch to the On position and check for continuity again. There should be no continuity. If OK, go to Step 6. If not OK, repair the ignition switch case ground or replace the faulty ignition switch as required.

(6) Remove the instrument cluster bezel and the cluster assembly. Connect the battery negative cable and the ignition switch connector. Do not unplug the cluster connectors. Install a jumper wire between the red brake warning lamp driver circuit cavity of the left cluster connector and a good ground. Turn the ignition switch to the On position. The lamp should light. If OK, go to Step 7. If not OK, replace the faulty bulb.

(7) Turn the ignition switch to the Off position and remove the jumper wire. Disconnect and isolate the battery negative cable. Unplug the ignition switch, parking brake switch, vacuum sensor (diesel engine only) and brake warning switch connectors. Unplug the connector at the RWAL or ABS control module, as equipped. Unplug the left cluster connector. Check for continuity between the red brake warning lamp driver circuit cavity of the left cluster connector and a good ground. There should be no continuity. If OK, go to Step 8. If not OK, repair the short circuit as required.

(8) Check for continuity between the red brake warning lamp driver circuit cavities of the left cluster connector and the following connectors:

- Parking brake switch
- Brake warning switch
- Vacuum sensor (diesel engine only)
- Ignition switch
- RWAL control module
- ABS control module.

(9) In each case there should be continuity. If not OK, repair the open circuit as required.

CLUSTER ILLUMINATION LAMPS

For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Turn the park lamps on with the headlamp switch. Rotate the headlamp switch knob counterclockwise to just before the interior lamps detent. Check for battery voltage at the fuse in the fuseblock

module. Rotate the headlamp switch knob clockwise while observing the test voltmeter. The reading should go from battery voltage to zero volts. If OK, go to Step 3. If not OK, repair the open circuit to the headlamp switch or refer to Group 8L - Lamps to diagnose the headlamp switch.

(3) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Unplug the right cluster connector. Connect the battery negative cable. Turn the park lamps on with the headlamp switch. Rotate the headlamp switch knob counterclockwise to just before the interior lamps detent. Check for battery voltage at the fused panel lamps dimmer switch signal circuit cavity of the right cluster connector. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) Turn the park lamps off. Disconnect and isolate the battery negative cable. Remove the fuse from the fuseblock module. Probe the fused panel lamps dimmer switch signal circuit cavity of the right cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Check for continuity between the fused panel lamps dimmer switch signal circuit cavity of the right cluster connector and the output side of the fuse cavity. There should be continuity. If OK, replace the faulty bulb(s). If not OK, repair the open circuit as required.

FOUR-WHEEL DRIVE INDICATOR LAMP

The diagnosis found here addresses an inoperative four-wheel drive indicator lamp condition. If the problem being diagnosed is related to lamp accuracy, be certain to confirm that the problem is with the lamp or switch and not with a damaged or inoperative front axle disconnect. Refer to Group 2 - Front Suspension and Axle for more information. If no front axle disconnect problem is found, the following procedure will help locate a short or open in the indicator lamp circuit. For circuit diagrams and descriptions, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the On position. Unplug the four-wheel drive switch connector at the front axle disconnect housing. Install a jumper wire between the two cavities in the switch connector. The lamp should light. Remove the jumper and the lamp should go off. If OK, replace the faulty four-wheel drive switch. If not OK, go to Step 2.

(2) Turn the ignition switch to the Off position. Check for continuity between the ground circuit cavity of the four-wheel drive switch connector and a good ground. There should be continuity. If OK, go to Step 3. If not OK, repair the ground circuit as required.

DIAGNOSIS AND TESTING (Continued)

(3) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Do not unplug the cluster connectors. Connect the battery negative cable. Install a jumper wire between the 4WD lamp circuit cavity of the right cluster connector and a good ground. Turn the ignition switch to the On position. The lamp should light. If OK, go to Step 4. If not OK, replace the faulty bulb.

(4) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Unplug the right cluster connector, and the RWAL or ABS control module connector. Probe the 4WD lamp circuit cavity of the right cluster connector. Check for continuity to a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Check for continuity between the 4WD lamp circuit cavity of the right cluster connector and the 4WD sense circuit cavity of the four-wheel drive switch connector. There should be continuity. If not OK, repair the open circuit as required.

GENERATOR WARNING LAMP

The diagnosis found here addresses an inoperative generator warning lamp condition. If the generator warning lamp comes on or stays on with the engine running, refer to Group 8C - Charging System for diagnosis. If no charging system problem is found, the following procedure will help locate a short or open in the generator warning lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Unplug the PCM connector C (gray). Install a jumper wire between the generator lamp driver circuit cavity of the PCM connector and a good ground. Connect the battery negative cable and turn the ignition switch to the On position. The lamp should light. Unplug the jumper wire and the lamp should go off. If OK, refer to the Powertrain Diagnostic Procedures to check the PCM. If not OK, go to Step 2.

(2) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. The PCM connector C is still unplugged. Remove the instrument cluster bezel and the instrument cluster. Do not unplug the cluster connectors. Install a jumper wire between the generator lamp driver circuit cavity of the right cluster connector and a good ground. Connect the battery negative cable and turn the ignition switch to the On position. The lamp should light. If OK, go to Step 3. If not OK, replace the faulty bulb.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. The PCM connector C is still unplugged. Unplug the

right cluster connector. Probe the generator lamp driver circuit cavity of the right cluster connector and check for continuity to a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the generator lamp driver circuit cavities of the right cluster connector and the PCM connector C. There should be continuity. If not OK, repair the open circuit as required.

HEADLAMP HIGH BEAM INDICATOR LAMP

The diagnosis found here addresses an inoperative headlamp high beam indicator lamp condition. If the problem being diagnosed is related to inoperative headlamp high beams, refer to Group 8L - Lamps for diagnosis of the headlamp system. If no headlamp system problems are found, the following procedure will help locate an open in the high beam indicator lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Check that the headlamp high beams are functional. If OK, go to Step 2. If not OK, refer to Group 8L - Lamps for diagnosis of the headlamp system.

(2) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Unplug the left cluster connector. Connect the battery negative cable. Turn the headlamps on and select high beam. Check for battery voltage at the high beam indicator lamp driver circuit cavity of the left cluster connector. If OK, replace the faulty bulb. If not OK, repair the open circuit to the headlamp dimmer (multi-function) switch as required.

LOW FUEL WARNING LAMP

The diagnosis found here addresses an inoperative low fuel warning lamp condition. If the problem being diagnosed is related to lamp accuracy, be certain to confirm the problem is the with the low fuel warning lamp and not with the fuel gauge circuit. See the diagnosis for the Fuel Gauge in this group. If no fuel gauge problem is found, the following procedure will help to identify a faulty low fuel warning lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Check that the fuel gauge is operating as designed. See the Fuel Gauge Calibration chart in Specifications. If OK, go to Step 2. If not OK, see Fuel Gauge in this section for diagnosis.

(2) Disconnect and isolate the battery negative cable. Unplug the fuel pump module connector. Remove the instrument cluster bezel and the instrument cluster. Replace the low fuel warning bulb with

DIAGNOSIS AND TESTING (Continued)

a known good unit. Connect the battery negative cable and test the lamp operation. If OK, discard the faulty bulb. If not OK, replace the faulty low fuel warning printed circuit.

LOW OIL PRESSURE WARNING LAMP

The diagnosis found here addresses an inoperative low oil pressure warning lamp condition. If the problem being diagnosed is related to lamp accuracy, be certain to confirm that the problem is with the lamp and not with the engine oiling system. The actual engine oil pressure should be checked with a test gauge before you proceed with lamp diagnosis. Refer to Group 9 - Engines for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Turn ignition the switch to the On position. Disconnect the oil pressure sending unit connector (Fig. 7), (Fig. 8) or (Fig. 9). Install a jumper wire between the oil pressure switch sense circuit cavity of the sending unit connector and a good ground. The lamp should light. Remove the jumper wire and the lamp should go off. If OK, replace the faulty sending unit. If not OK, go to Step 2.

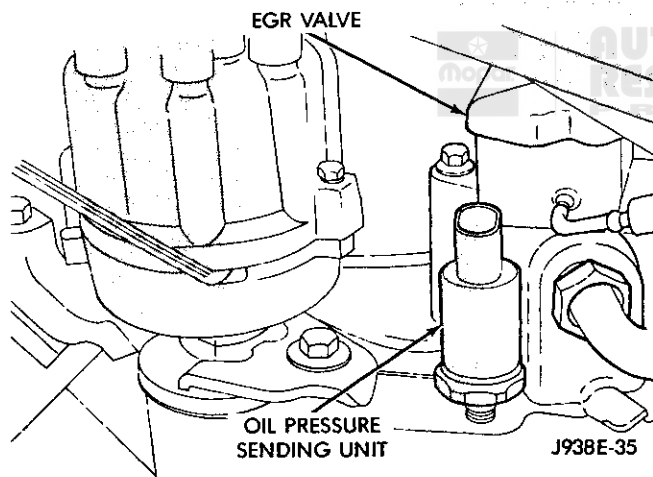


Fig. 7 Oil Pressure Switch/Sending Unit - V-6/V-8 Engine

(2) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Disconnect the right cluster connector.

(3) Probe the oil pressure switch sense circuit cavity of the right cluster connector and check for continuity to a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the oil pressure switch sense circuit cavities of the right cluster connector and the sending unit wire connector. There

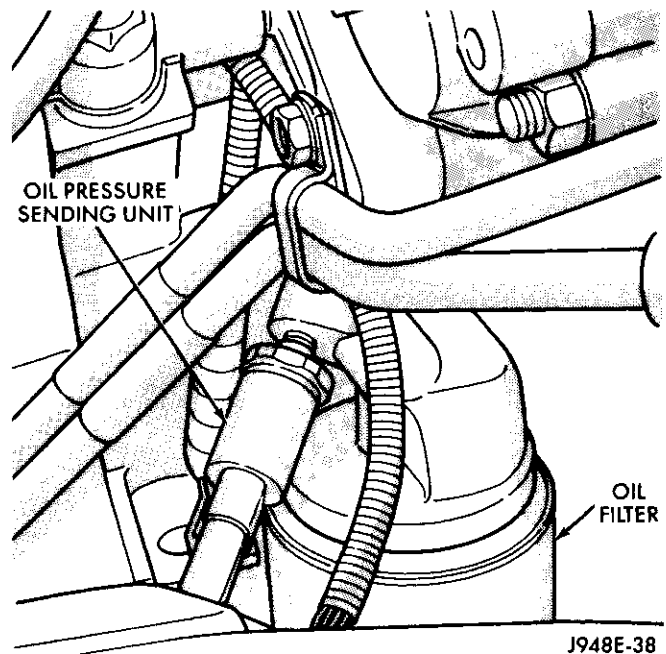


Fig. 8 Oil Pressure Switch/Sending Unit - V-10 Engine

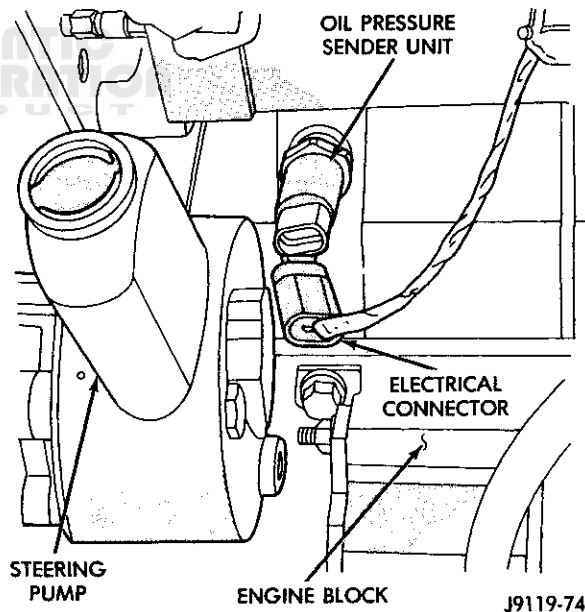


Fig. 9 Oil Pressure Switch/Sending Unit - Diesel Engine

should be continuity. If OK, replace the faulty bulb. If not OK, repair the open circuit as required.

LOW WASHER FLUID WARNING LAMP

The diagnosis found here addresses an inoperative low washer fluid warning lamp condition. If the problem being diagnosed is related to lamp accuracy, be certain to confirm that the problem is with the lamp or switch and not with a damaged or empty washer

DIAGNOSIS AND TESTING (Continued)

fluid reservoir. Inspect the reservoir for proper fluid level and signs of damage or distortion that could affect switch performance before you proceed with lamp diagnosis. Refer to Group 8K - Wiper and Washer Systems for more information. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Unplug the washer fluid level switch connector. Install a jumper wire between the two cavities of the connector. Turn the ignition switch to the On position. The lamp should light. Remove the jumper wire and the lamp should go off. If OK, replace the faulty washer fluid level switch. If not OK, go to Step 2.

(2) Turn the ignition switch to the Off position. Check for continuity between the washer fluid level switch connector ground circuit cavity and a good ground. There should be continuity. If OK, go to Step 3. If not OK, repair the open circuit as required.

(3) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Unplug the right instrument cluster connector. Check for continuity between the washer fluid switch sense circuit cavity of the right cluster connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the washer fluid switch sense circuit cavities of the right cluster connector and the washer fluid level switch connector. There should be continuity. If OK, replace the faulty bulb. If not OK, repair the open circuit as required.

MAINTENANCE REQUIRED INDICATOR LAMP

The diagnosis found here addresses an inoperative maintenance required indicator lamp condition. If the lamp comes on and stays on while driving, refer to Group 25 - Emission Control Systems for diagnosis. If no emission control system problem is found, the following procedure will help locate a short or open in the indicator lamp circuit. For circuit descriptions and diagrams, refer to 8W-46 - Message Center in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Unplug the Powertrain Control Module (PCM) connector C (gray). Remove the instrument cluster bezel and the message center assembly. Do not unplug the message center connector.

(2) Install a jumper wire between the service reminder indicator lamp driver circuit cavity of the message center connector and a good ground. Connect the battery negative cable. Turn the ignition switch to the On position. The lamp should light. If OK, remove the jumper wire and go to Step 3. If not OK, replace the faulty bulb.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable.

Unplug the message center connector. Check for continuity between the service reminder indicator lamp driver circuit cavity of the message center connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the service reminder indicator lamp driver circuit cavities of the message center connector and the PCM connector C. There should be continuity. If OK, refer to Group 14 - Fuel Systems for diagnosis of the PCM. If not OK, repair the open circuit as required.

MALFUNCTION INDICATOR LAMP

The diagnosis found here addresses an inoperative malfunction indicator lamp condition. If the lamp comes on and stays on with the engine running, refer to Group 14 - Fuel System for diagnosis. If no fuel or emission system problem is found, the following procedure will help locate a short or open in the lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Unplug the Powertrain Control Module (PCM) connector C (gray). Install a jumper wire between the malfunction indicator lamp driver circuit cavity of the PCM connector C and a good ground. Connect the battery negative cable. Turn the ignition switch to the On position. The lamp should light. Remove the jumper wire and the lamp should go off. If OK, refer to the Powertrain Diagnostic Procedures to diagnose the PCM. If not OK, go to Step 2.

(2) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Do not unplug the cluster connectors. Install a jumper wire between the malfunction indicator lamp driver circuit cavity of the right cluster connector and a good ground. Connect the battery negative cable. Turn the ignition switch to the On position. The lamp should light. If OK, go to Step 3. If not OK, replace the faulty bulb.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Unplug the right cluster connector. Check for continuity between the malfunction indicator lamp driver circuit cavity of the right cluster connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the malfunction indicator lamp driver circuit cavities of the right cluster connector and the PCM connector C. There should be continuity. If not OK, repair the open circuit as required.

DIAGNOSIS AND TESTING (Continued)**SEAT BELT REMINDER LAMP**

The diagnosis found here addresses an inoperative seat belt reminder lamp condition. If the lamp comes on and stays on, refer to Group 8U - Chime/Buzzer Warning Systems for diagnosis. If no warning system problem is found, the following procedure will help locate a short or open in the lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Unplug the left cluster connector. Check for continuity between the ground circuit cavity of the left cluster connector and a good ground. There should be continuity. If OK, plug the left cluster connector back into the cluster and go to Step 2. If not OK, repair the open circuit as required.

(2) Connect the battery negative cable. Install a jumper wire between a 12-volt battery feed source and the seat belt lamp driver circuit cavity of the left cluster connector. The lamp should light. If OK, go to Step 3. If not OK, replace the faulty bulb.

(3) Disconnect and isolate the battery negative cable. Unplug the chime/buzzer module from the buzzer module connector. Unplug the left cluster connector. Check for continuity between the seat belt lamp driver circuit cavity of the left cluster connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the seat belt lamp driver circuit cavities of the left cluster connector and the buzzer module connector. There should be continuity. If not OK, repair the open circuit as required.

TRANSMISSION OIL TEMPERATURE WARNING LAMP

The diagnosis found here addresses an inoperative transmission oil temperature warning lamp condition. If the problem being diagnosed is related to lamp accuracy, be certain to confirm that the problem is with the lamp and not with the transmission oil cooling system. Proper transmission oil flow and cooler operation should be checked before you proceed with lamp diagnosis. For diagnosis and service of the sensor and transmission oil cooling system, refer to Group 21 - Transmission. For circuit descriptions and diagrams, refer to 8W-46 - Message Center in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the message center. Do not unplug the message center connector. Connect the battery negative cable. Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output cir-

cuit cavity of the message center connector. If OK, go to Step 2. If not OK, repair the open circuit as required.

(2) Turn the ignition switch to the Off position. Install a jumper wire between the transmission temperature lamp driver circuit cavity of the message center connector and a good ground. Turn the ignition switch to the On position. The lamp should light. If OK, go to Step 2. If not OK, replace the faulty bulb.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Unplug the message center connector, and the Powertrain Control Module (PCM) connector C (gray). Check for continuity between the transmission temperature lamp driver circuit cavity of the message center connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the transmission temperature lamp driver circuit cavities of the message center connector and the PCM connector C. There should be continuity. If OK, refer to Group 21 - Transmission to diagnose the temperature sensor and circuit. If not OK, repair the open circuit as required.

TURN SIGNAL INDICATOR LAMPS

The diagnosis found here addresses an inoperative turn signal indicator lamp condition. For any other turn signal problem, refer to Group 8J - Turn Signal and Hazard Warning Systems for diagnosis. If no turn signal or hazard warning system problem is found, the following procedure will help locate a short or open in the indicator lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster and 8W-50 - Front Lighting in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Do not unplug the cluster connectors. Probe the ground circuit cavities of the left cluster connector. Check for continuity to a good ground. There should be continuity. If OK, go to Step 2. If not OK, repair the open circuit(s) as required.

(2) Connect the battery negative cable. Install a jumper wire from the inoperative (right or left) turn signal circuit cavity of the left cluster connector to a 12-volt battery feed source. The lamp should light. If OK, go to Step 3. If not OK, replace the faulty bulb.

(3) Disconnect and isolate the battery negative cable. Unplug the left cluster connector. Disconnect the turn signal (multi-function) switch connector. Check for continuity between the inoperative (right or left) turn signal circuit cavities of the left cluster connector and the multi-function switch connector. There should be continuity. If OK, refer to Group 8J -

DIAGNOSIS AND TESTING (Continued)

Turn Signal and Hazard Warning Systems for further diagnosis. If not OK, repair the open circuit as required.

UPSHIFT INDICATOR LAMP

The diagnosis found here addresses an inoperative upshift indicator lamp condition. If the lamp comes on and stays on with the engine running, refer to Group 14 - Fuel System for diagnosis of the Powertrain Control Module (PCM). If no fuel or emission control systems problem is found, the following procedure will help locate a short or open in the lamp circuit. For circuit descriptions and diagrams, refer to 8W-40 - Instrument Cluster in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Unplug the PCM connector B (white). Connect the battery negative cable. Turn the ignition switch to the On position. Install a jumper wire between the upshift lamp driver circuit cavity of the PCM connector B and a good ground. The lamp should light. Remove the jumper wire and the lamp should go off. If OK, refer to the Powertrain Diagnostic Procedures manual to diagnose the PCM. If not OK, turn the ignition switch to the Off position and go to Step 2.

(2) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the cluster assembly. Install a jumper wire between the upshift lamp driver circuit cavity of the left cluster connector and a good ground. Connect the battery negative cable. Turn the ignition switch to the On position. The lamp should light. If OK, go to Step 3. If not OK, replace the faulty bulb.

(3) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Unplug the left cluster connector. Check for continuity between the upshift lamp driver circuit cavity of the left cluster connector and a good ground. There should be no continuity. If OK, go to Step 4. If not OK, repair the short circuit as required.

(4) Check for continuity between the upshift lamp driver circuit cavities of the left cluster connector and the PCM connector B. There should be continuity. If not OK, repair the open circuit as required.

WAIT-TO-START LAMP

The diagnosis found here addresses an inoperative wait-to-start lamp condition. If the lamp comes on and stays on while driving or flashes, refer to Group 14 - Fuel System for diagnosis. If no problem is found with the intake manifold air temperature sensor circuit or the Powertrain Control Module (PCM), the following procedure will help locate a short or open in the lamp circuit. For circuit descriptions and diagrams, refer to 8W-46 - Message Center in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the message center. Unplug the message center connector.

(2) Connect the battery negative cable. Turn the ignition switch to the ON position. Check for battery voltage at the fused ignition switch output circuit cavity of the message center connector. If OK, turn the ignition switch to the Off position and go to Step 3. If not OK, repair the open circuit as required.

(3) Plug in the message center connector. Install a jumper wire between the wait-to-start warning lamp driver circuit cavity of the message center connector and a good ground. Turn the ignition switch to the On position. The lamp should light. If OK, turn the ignition switch to the Off position, remove the jumper wire, and go to Step 4. If not OK, replace the faulty bulb.

(4) Disconnect and isolate the battery negative cable. Unplug the message center connector and the PCM connector B (white). Check for continuity between the wait-to-start warning lamp driver circuit cavity of the message center connector and a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Check for continuity between the wait-to-start warning lamp driver circuit cavities of the message center connector and the PCM connector B. There should be continuity. If OK, refer to Group 14 - Fuel System to diagnose the PCM and its inputs. If not OK, repair the open circuit as required.

WATER-IN-FUEL LAMP

The diagnosis found here addresses an inoperative water-in-fuel lamp condition. If the lamp comes on and stays on while driving, refer to Group 14 - Fuel System for diagnosis. If no problem is found with the water-in-fuel sensor circuit or the Powertrain Control Module (PCM), the following procedure will help locate a short or open in the lamp circuit. For circuit descriptions and diagrams, refer to 8W-46 - Message Center in Group 8W - Wiring Diagrams.

(1) Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and the message center. Unplug the message center connector.

(2) Connect the battery negative cable. Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the message center connector. If OK, turn the ignition switch to the Off position and go to Step 3. If not OK, repair the open circuit as required.

(3) Plug in the message center connector. Install a jumper wire between the water-in-fuel warning lamp driver circuit cavity of the message center connector

DIAGNOSIS AND TESTING (Continued)

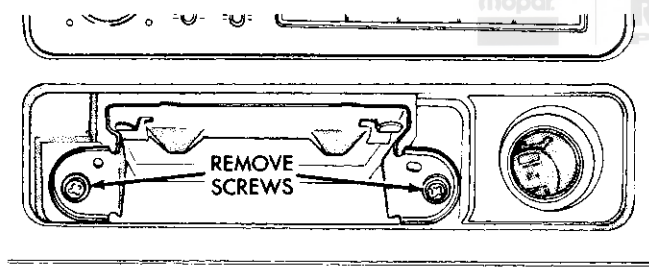
and a good ground. Turn the ignition switch to the On position. The lamp should light. If OK, turn the ignition switch to the Off position, remove the jumper wire, and go to Step 4. If not OK, replace the faulty bulb.

(4) Disconnect and isolate the battery negative cable. Unplug the message center connector and the PCM connector C (gray). Check for continuity between the water-in-fuel warning lamp driver circuit cavity of the message center connector and a good ground. There should be no continuity. If OK, go to Step 5. If not OK, repair the short circuit as required.

(5) Check for continuity between the water-in-fuel warning lamp driver circuit cavities of the message center connector and the PCM connector C. There should be continuity. If OK, refer to Group 14 - Fuel Systems to diagnose the PCM and its inputs. If not OK, repair the open circuit as required.

REMOVAL AND INSTALLATION**ASH RECEIVER**

- (1) Remove the ash receiver.
- (2) Remove the two screws securing the ash receiver bracket to the instrument panel (Fig. 10).



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Fig. 10 Ash Receiver Remove/Install

- (3) Remove the ash receiver bracket assembly from the instrument panel.

- (4) Reverse the removal procedures to install.

CUP HOLDER

- (1) Open the cup holder and remove the two screws securing the assembly to the instrument panel (Fig. 11).

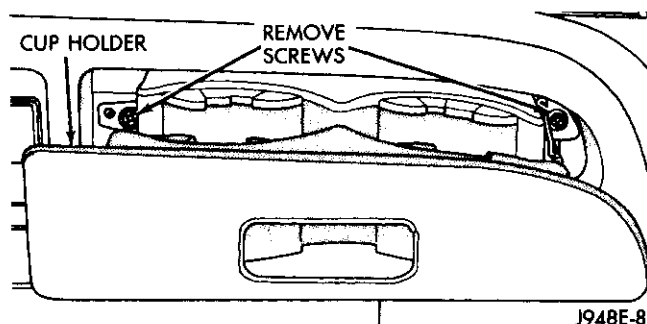
- (2) Remove the cup holder assembly from the instrument panel.

- (3) Reverse the removal procedures to install.

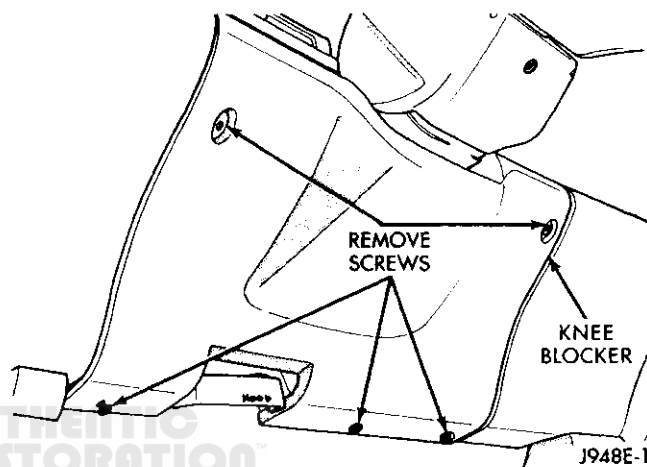
KNEE BLOCKER

- (1) Remove the five screws securing the knee blocker to the lower instrument panel (Fig. 12).

- (2) Remove the knee blocker from the lower instrument panel.



J948E-8

Fig. 11 Cup Holder Remove/Install

J948E-1

Fig. 12 Knee Blocker Remove/Install

- (3) Reverse the removal procedures to install.

FUSEBLOCK MODULE

- (1) Disconnect and isolate the battery negative cable.

- (2) Remove the knee blocker as described in this group.

- (3) Remove the two screws holding the fuseblock module to the instrument panel (Fig. 13).

- (4) Remove the fuseblock module from the instrument panel.

- (5) Reverse the removal procedures to install.

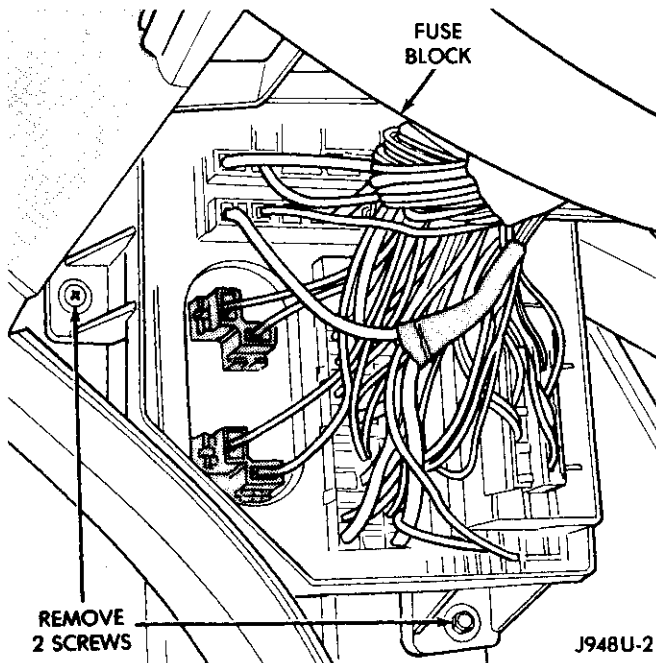
INSIDE HOOD RELEASE

- (1) Disengage the inside hood release cable from the hood latch in the engine compartment.

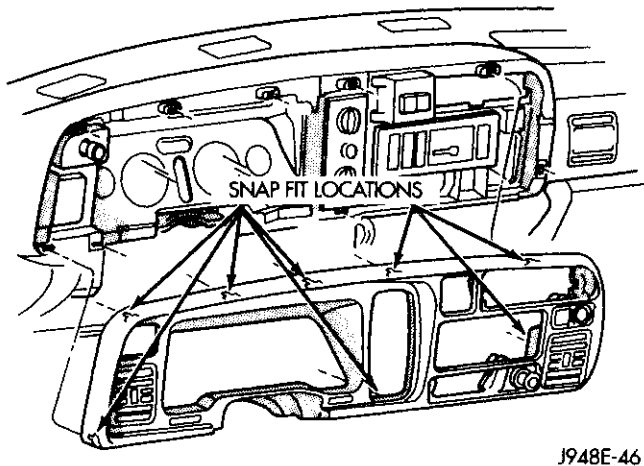
- (2) Remove the two screws holding the hood release handle assembly to the lower instrument panel support.

- (3) Remove the assembly by pulling the cable and grommet through the dash panel from the passenger compartment.

- (4) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**Fig. 13 Fuseblock Module Remove/Install****CLUSTER BEZEL**

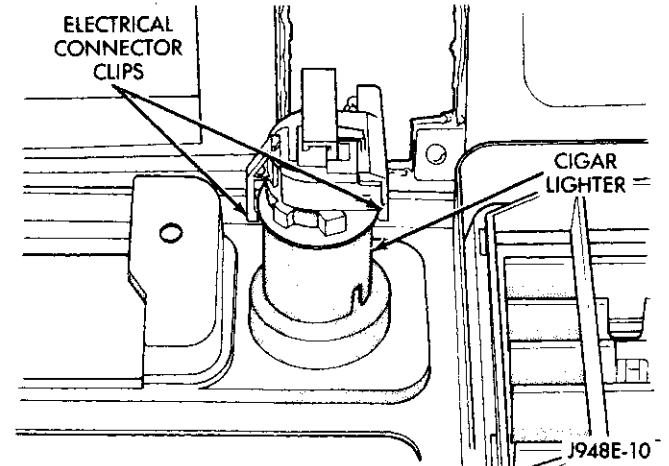
- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the cup holder as described in this group.
- (3) Remove the ash receiver as described in this group.
- (4) Carefully pry the bezel away from the instrument panel to disengage the retaining clips (Fig. 14).

**Fig. 14 Cluster Bezel Remove/Install**

- (5) Unplug the connector from the cigar lighter.
- (6) Unplug the connector from the auxiliary power outlet.
- (7) Reverse the removal procedures to install.

CIGAR LIGHTER/POWER OUTLET

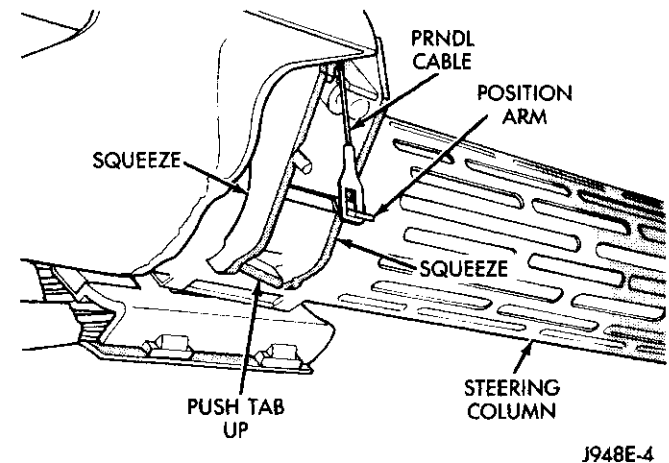
- (1) Remove the cluster bezel as described in this group.
- (2) Unscrew the cigar lighter and/or power outlet housing from the rear of the cluster bezel (Fig. 15).

**Fig. 15 Cigar Lighter Remove/Install**

- (3) Remove the cigar lighter and/or power outlet from the front of the cluster bezel.
- (4) Reverse the removal procedures to install.

INSTRUMENT CLUSTER

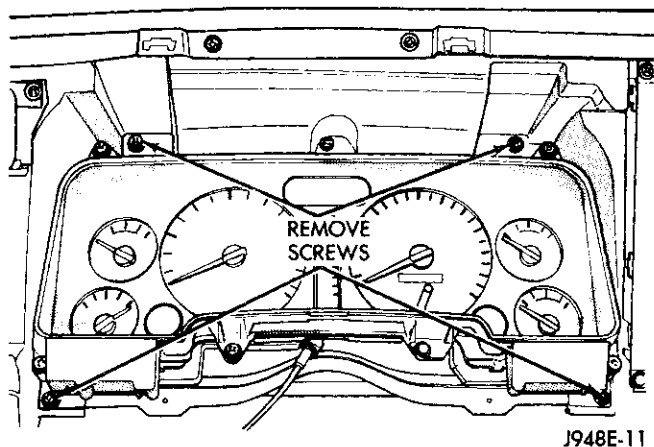
- (1) Remove the cluster bezel as described in this group.
- (2) Remove the knee blocker as described in this group.
- (3) Pull the gear selector indicator (PRND21) cable and twist to remove from the position arm on the steering column, if equipped (Fig. 16).

**Fig. 16 PRND21 Cable Remove**

- (4) Push the tab on the bottom of the cable retainer up, then squeeze the sides to remove the retainer from the steering column.

REMOVAL AND INSTALLATION (Continued)

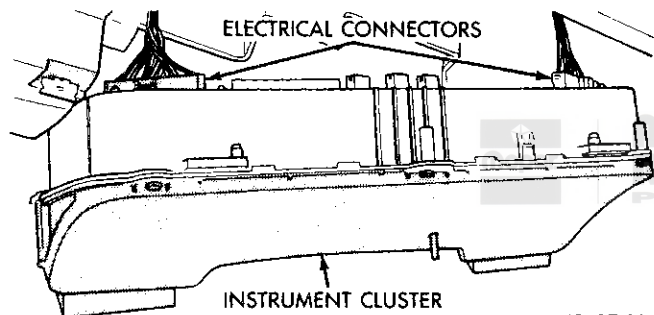
(5) Remove the four screws that hold the cluster to the instrument panel (Fig. 17).



J948E-11

Fig. 17 Instrument Cluster Remove/Install

(6) Pull the cluster rearward and unplug the two cluster electrical connectors (Fig. 18).



J948E-12

Fig. 18 Cluster Connectors

(7) Remove the cluster from the instrument panel.

(8) Reverse the removal procedures to install. Refer to Group 21 - Transmission for the gear selector indicator (PRND21) cable adjustment procedure.

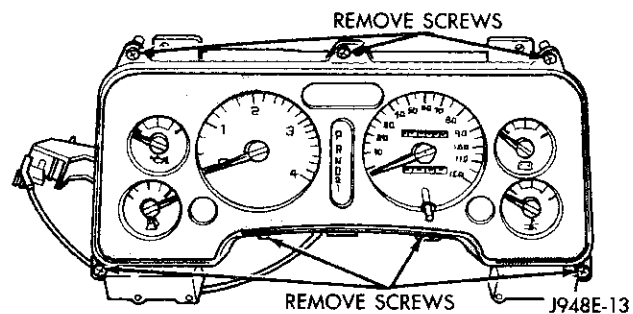
CLUSTER LENS AND MASK

(1) Remove the instrument cluster as described in this group.

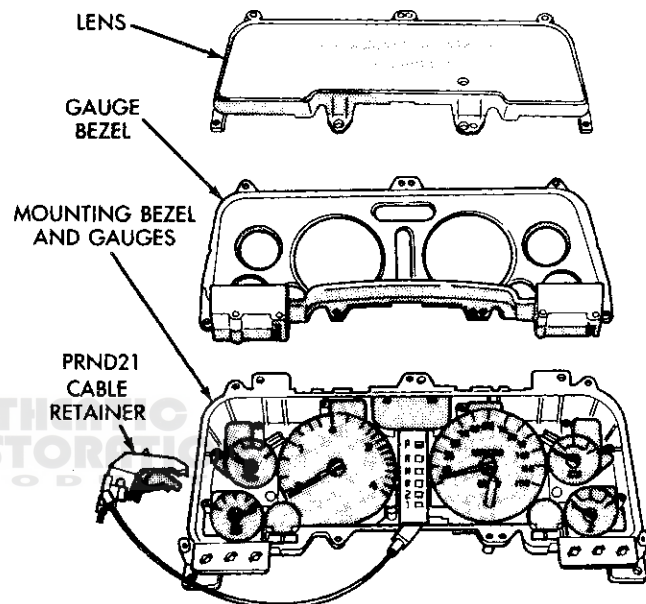
(2) Remove the seven screws securing the lens and mask to the cluster housing (Fig. 19).

(3) Remove the cluster lens and the gauge mask (Fig. 20).

NOTE: Do not touch the face of a gauge or the back of the lens with your finger. It will leave a permanent finger print.



J948E-13

Fig. 19 Cluster Lens Remove/Install

J948E-14

Fig. 20 Instrument Cluster Assembly

(4) Reverse the removal procedures to install.

GAUGES

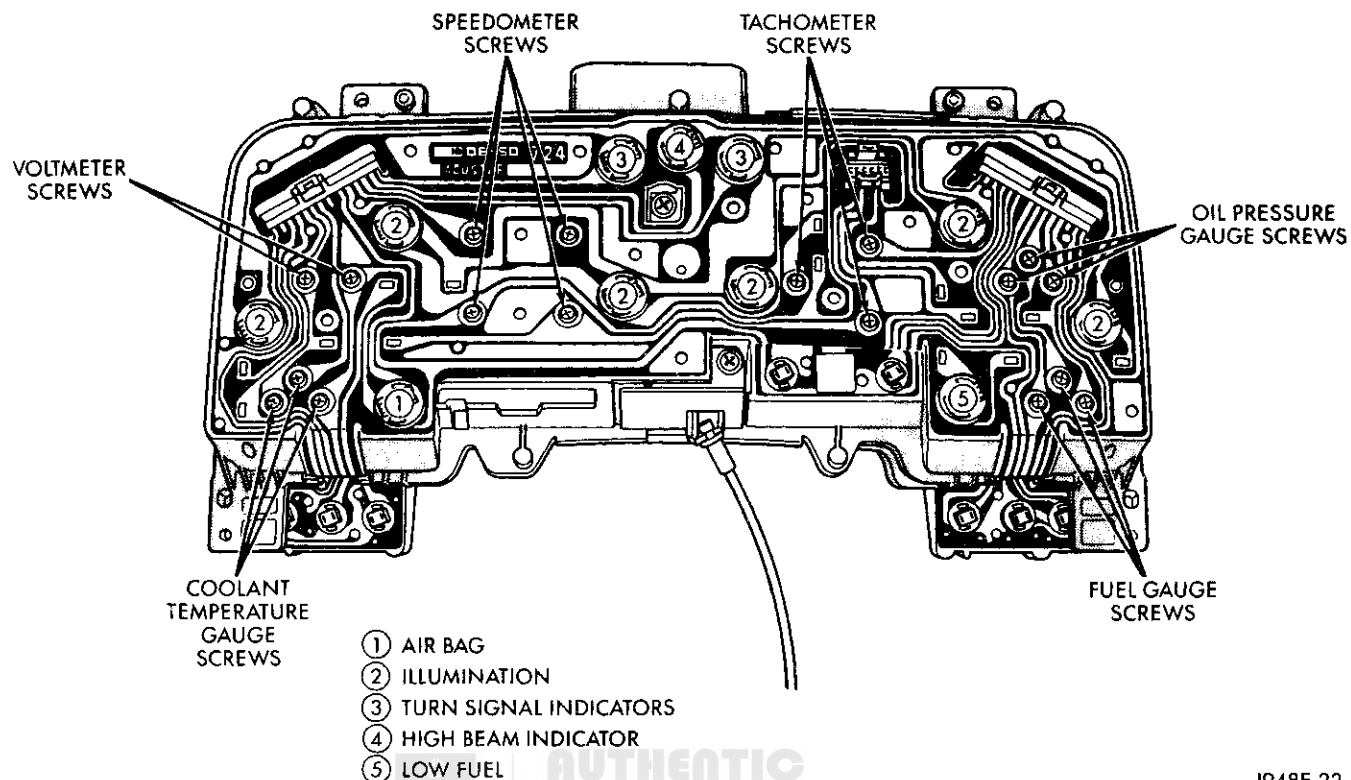
(1) Remove the cluster lens and mask as described in this group.

(2) Remove the screws securing the gauge unit(s) from the rear of the cluster housing (Fig. 21) or (Fig. 22). Remove the gauge unit from the front of the cluster housing.

CAUTION: Do not overtighten the gauge mounting screws or damage to the printed circuit and/or the cluster housing will occur.

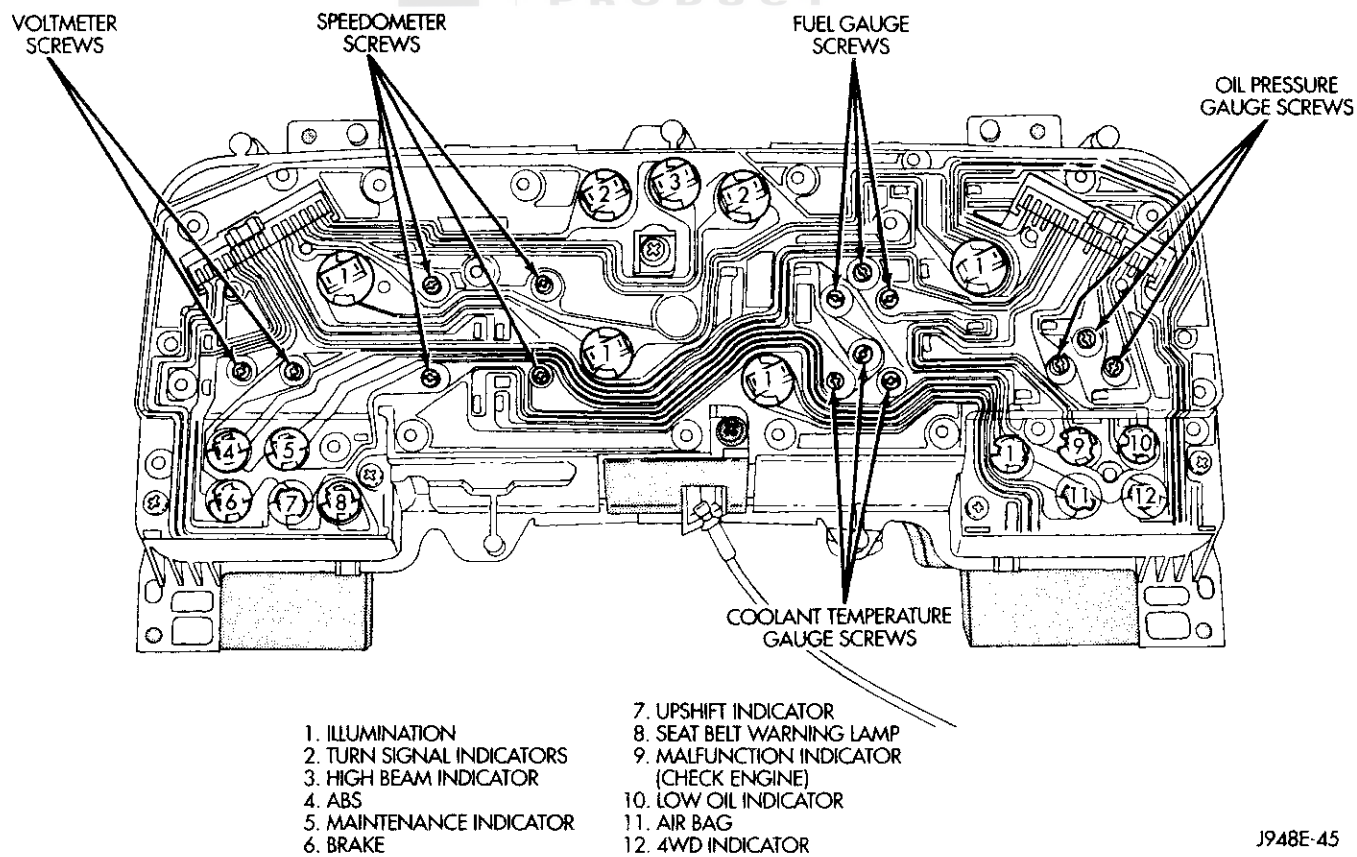
(3) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)



J948E-22

Fig. 21 Gauge Mounting - High-Line Cluster



J948E-45

Fig. 22 Gauge Mounting - Low-Line Cluster

REMOVAL AND INSTALLATION (Continued)**GEAR SELECTOR INDICATOR**

- (1) Remove the instrument cluster as described in this group.
- (2) Remove the screws attaching the gearshift selector (PRND21) indicator mechanism to the rear of the cluster housing (Fig. 23).

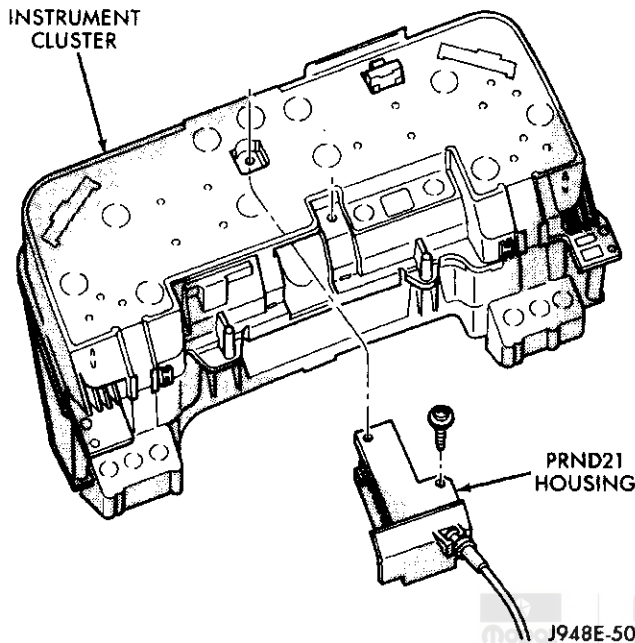


Fig. 23 Gearshift Selector (PRND21) Indicator Housing Remove/Install

- (3) Remove the gearshift selector indicator mechanism from the cluster housing.
- (4) Reverse the removal procedures to install. Refer to Group 21 - Transmission for the gearshift selector indicator cable adjustment procedure.

CLUSTER BULBS

- (1) Remove the instrument cluster as described in this group.
- (2) Twist the lamp socket assembly to remove it from the printed circuit board on the rear of the cluster housing.
- (3) Remove the bulb from the lamp socket.
- (4) Install the correct replacement bulb into the lamp socket.
- (5) Reverse the removal procedures to install.

LOW FUEL WARNING CIRCUIT

- (1) Remove the instrument cluster as described in this group.
- (2) Remove the low fuel warning circuit from the printed circuit connector on the rear of the cluster housing (Fig. 24).
- (3) Remove the left turn signal bulb and cluster illumination bulb.

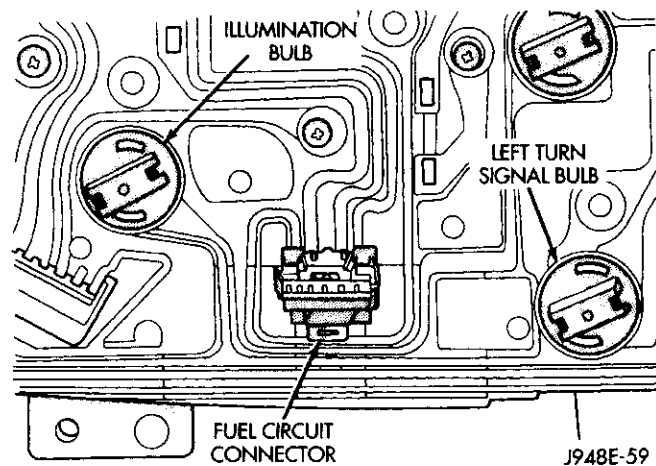


Fig. 24 Low Fuel Warning Circuit Connector

- (4) Pull the flexible printed circuit back away from the rear of the cluster housing.
- (5) Remove the low fuel warning circuit.
- (6) Reverse the removal procedures to install.

PRINTED CIRCUIT

- (1) Remove the instrument cluster as described in this group.
- (2) Remove all of the cluster bulb lamp socket assemblies as described in this group.
- (3) If equipped, remove the low fuel warning circuit as described in this group.
- (4) Remove all of the gauge units as described in this group.
- (5) Remove the printed circuit from the rear of the cluster housing.

CAUTION: Do not overtighten the gauge mounting screws or damage to the printed circuit and/or the cluster housing will occur.

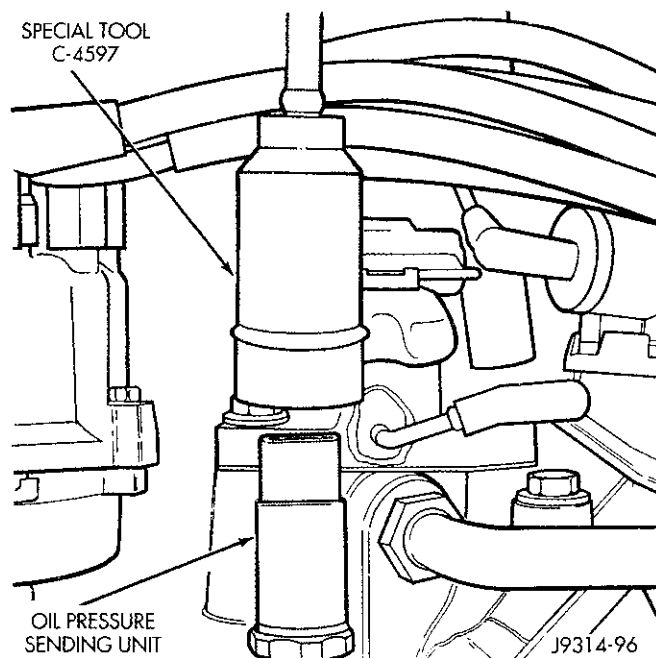
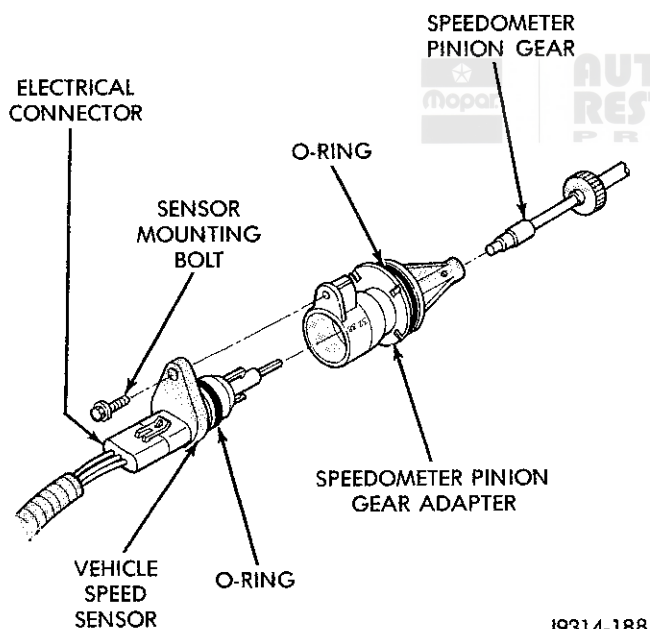
- (6) Reverse the removal procedures to install.

OIL PRESSURE SENDING UNIT

- (1) Unplug the connector from the sending unit.
- (2) Using the oil pressure sending unit socket (Special Tool C-4597), remove the sending unit (Fig. 25).
- (3) Reverse the removal procedures to install. Tighten the sending unit to 23 N·m (200 in. lbs.).

VEHICLE SPEED SENSOR

- (1) Remove the harness connector from the sensor. Be sure the weather seal stays on the harness connector.
- (2) Remove the sensor by loosening the sensor coupling nut from the pinion gear adapter until the sensor is free (Fig. 26).

REMOVAL AND INSTALLATION (Continued)**Fig. 25 Oil Pressure Sending Unit Remove/Install****Fig. 26 Vehicle Speed Sensor Remove/Install**

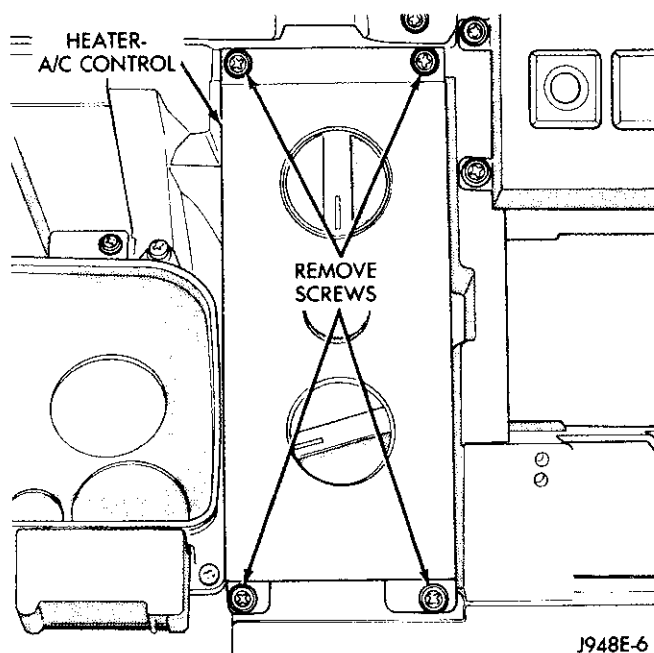
(3) Reverse the removal procedures to install. Tighten coupling nut to 17 N·m (150 in. lbs.).

MESSAGE CENTER

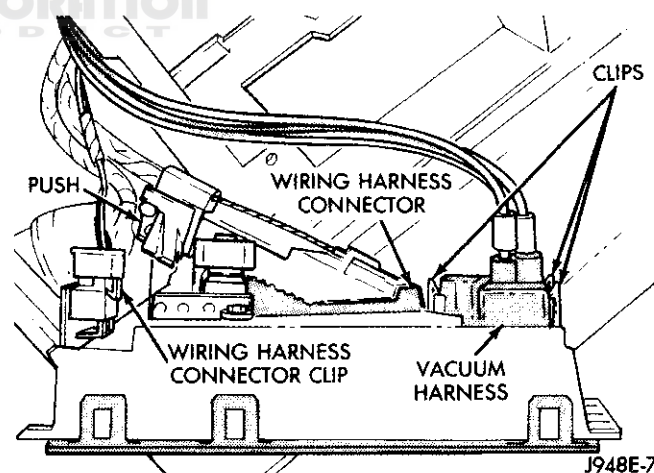
(1) Remove the cluster bezel as described in this group.

(2) Remove the four message center/heater-A/C control attaching screws (Fig. 27).

(3) Pull the message center and heater-A/C control assembly rearward.

**Fig. 27 Message Center and Heater-A/C Control Remove/Install**

(4) Unplug the two wiring harness connectors from the rear of the message center and heater-A/C control assembly (Fig. 28).

**Fig. 28 Message Center and Heater-A/C Control Connectors**

(5) Push in on the red temperature control cable connector to release it from the heater-A/C control housing. Remove the cable end from the control unit.

(6) Remove the message center and heater A/C control assembly from the instrument panel.

(7) Reverse the removal procedures to install.

MESSAGE CENTER BULBS

(1) Remove the message center as described in this group.

REMOVAL AND INSTALLATION (Continued)

(2) Twist the lamp socket assembly to remove it from the printed circuit board on the rear of the message center housing.

(3) Remove the bulb from the lamp socket.

(4) Install the correct replacement bulb into the lamp socket.

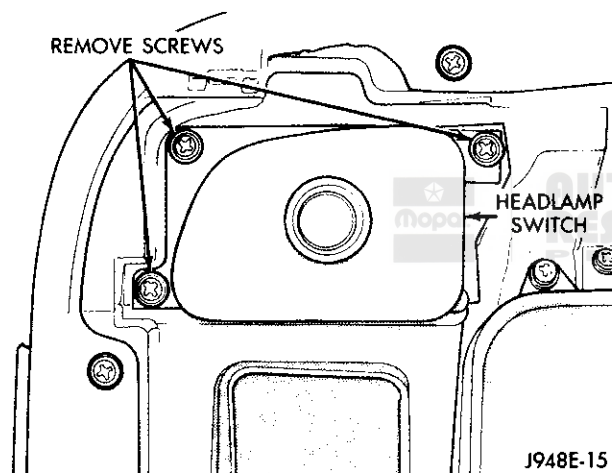
(5) Reverse the removal procedures to install.

HEADLAMP SWITCH

WARNING: IF THE HEADLAMP SWITCH WAS TURNED ON, WAIT FIVE MINUTES TO ALLOW THE CERAMIC PANEL LAMPS DIMMER RESISTOR TO COOL. IF THE RESISTOR IS NOT ALLOWED TO COOL, IT CAN BURN YOUR FINGERS.

(1) Remove the cluster bezel as described in this group.

(2) Remove the three screws securing the headlamp switch bezel to the instrument panel (Fig. 29).



J948E-15

Fig. 29 Headlamp Switch and Bezel Remove/Install

(3) Remove the headlamp switch and bezel from the instrument panel.

(4) Unplug the two harness connectors from the headlamp switch (Fig. 30).

(5) Pull the headlamp switch knob and stem assembly out to its stop. Depress the release button on the bottom of the switch housing and remove the knob and stem from the switch.

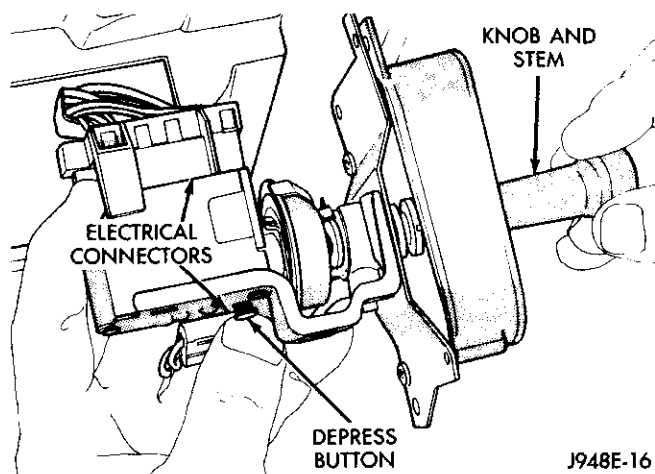
(6) Remove the two screws and the switch bezel from the housing.

(7) Reverse the removal procedures to install.

OVERDRIVE LOCKOUT/FOG LAMP SWITCH

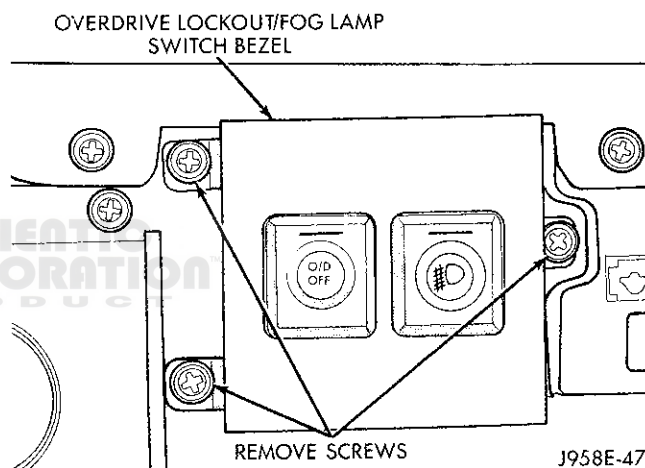
(1) Remove the cluster bezel as described in this group.

(2) Remove the three screws from the switch bezel and remove the switch and bezel unit from the instrument panel (Fig. 31).



J948E-16

Fig. 30 Headlamp Switch Knob and Stem Remove/Install



J958E-47

Fig. 31 Overdrive Lockout/Fog Lamp Switch Remove/Install

(3) From the rear of the switch and bezel unit, pull up on the retaining tab(s) and unplug the electrical connector(s).

(4) Release the retaining tabs and remove the switch(es) from the rear of the bezel.

(5) Reverse the removal procedures to install.

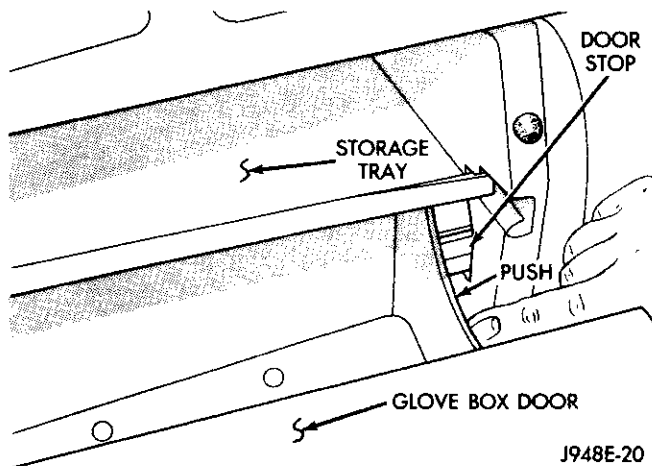
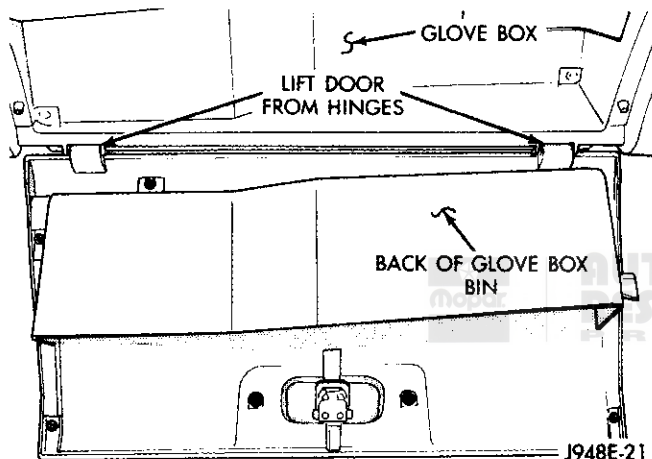
GLOVE BOX

(1) Open the glove box door. Depress the right side of the glove box bin far enough to allow the door stop to clear the glove box opening (Fig. 32).

(2) From inside of the glove box, push on the stem of the button holding the retaining strap at the left end of the door. The button will push out allowing the strap to be removed.

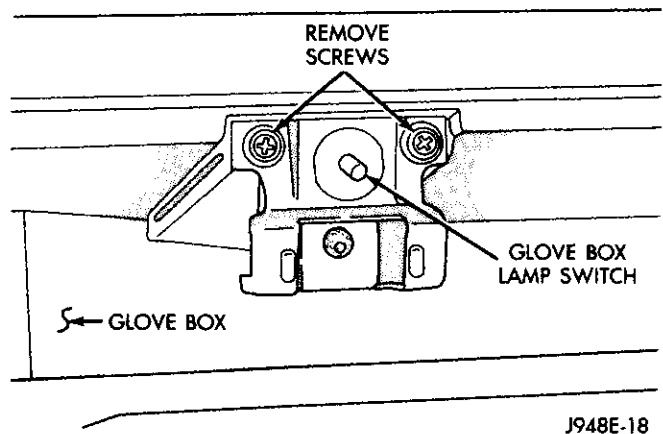
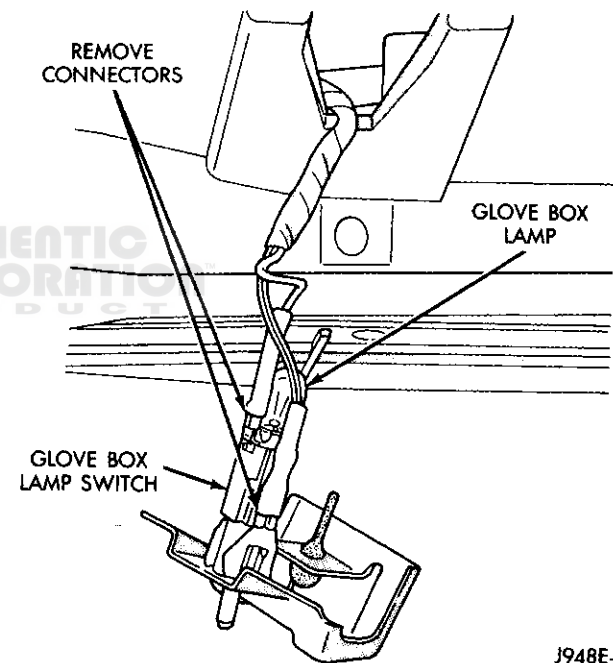
(3) The glove box door and bin are removed by lifting the door off of the hinges (Fig. 33).

(4) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**Fig. 32 Glove Box Door Release****Fig. 33 Glove Box and Bin Remove/Install****GLOVE BOX LAMP/SWITCH/LATCH STRIKER**

- (1) Disconnect and isolate the battery negative cable.
- (2) Open the glove box door until the door stops in the bin rest against the instrument panel glove box opening.
- (3) To remove the lamp and switch, grasp the switch by the plunger and pull firmly outward. The switch and lamp assembly are retained in the mounting hole by a light snap fit.
- (4) To remove the latch striker, remove the two mounting screws (Fig. 34).
- (5) Disconnect the wires to the switch and lamp (Fig. 35).
- (6) Remove the bulb from the lamp socket.
- (7) Reverse the removal procedures to install.

NOTE: Tuck any wiring that was exposed by the lamp removal procedure back into the recess behind the lamp. Do not leave wires exposed in the glove box latch area.

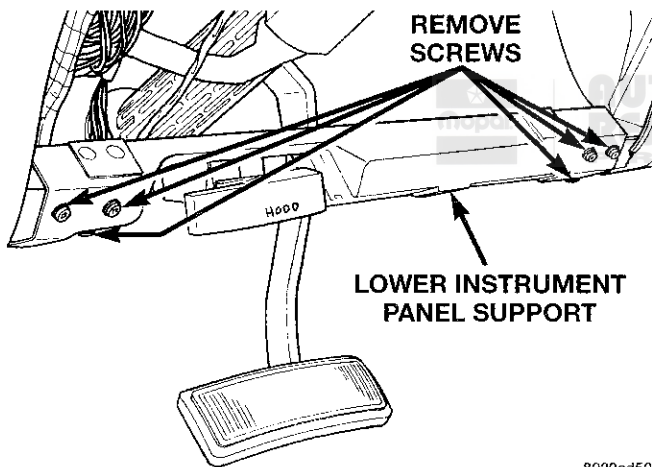
**Fig. 34 Glove Box Lamp/Switch/Latch Striker - Typical****Fig. 35 Glove Box Lamp/Switch Connections - Typical****GLOVE BOX LATCH**

- (1) Open the glove box door.
- (2) Remove the glove box latch retaining clip.
- (3) Remove the glove box latch from the glove box door.
- (4) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**INSTRUMENT PANEL ASSEMBLY**

WARNING: ON VEHICLES EQUIPPED WITH AN AIRBAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING AIRBAG SYSTEM OR STEERING WHEEL COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

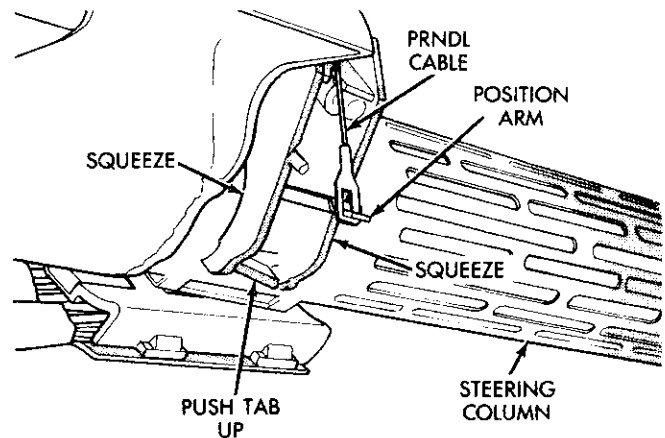
- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the left and right cowl side panel trim.
- (3) Remove the knee blocker as described in this group.
- (4) Remove the two screws securing the inside hood release handle to the lower instrument panel support.
- (5) Remove the screw securing the parking brake release handle to the lower instrument panel support.
- (6) Remove the six retaining screws and the lower instrument panel support (Fig. 36).



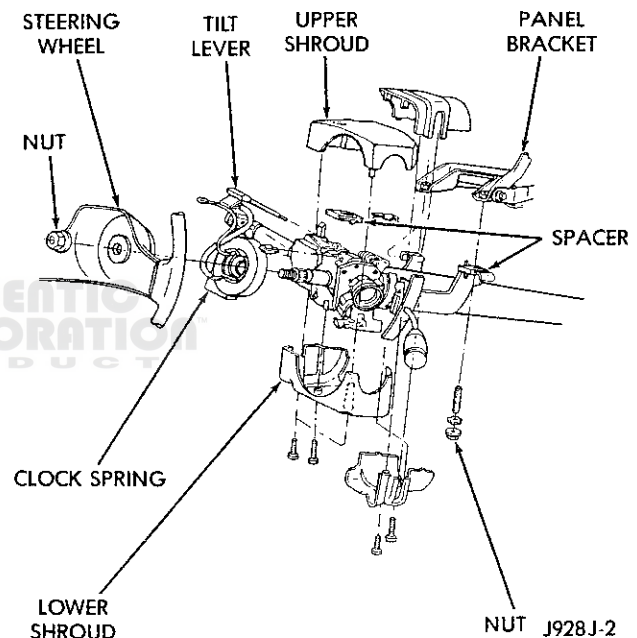
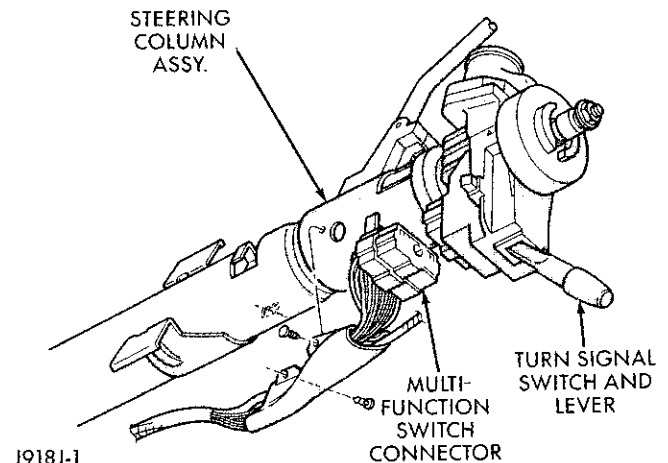
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Fig. 36 Lower Instrument Panel Support Remove/Install

- (7) Unplug the airbag wiring connector at the lower left corner of the instrument panel.
- (8) Pull the gearshift selector (PRND21) indicator cable and twist to remove it from the position arm on the steering column (Fig. 37).
- (9) Push tab on bottom of cable retainer up then squeeze sides to remove retainer from column.
- (10) Remove the tilt steering column lever, if equipped.
- (11) Remove the upper and lower shrouds from the steering column (Fig. 38).
- (12) Remove the lower fixed steering column shroud.
- (13) Loosen the multi-function switch connector screw. The screw will remain in the connector. Remove the multi-function switch connector (Fig. 39).



J948E-4

Fig. 37 Gearshift Indicator (PRND21) Cable Remove**Fig. 38 Steering Column Shrouds**

J918J-1

Fig. 39 Multi-Function Switch Connector -Typical

REMOVAL AND INSTALLATION (Continued)

(14) Remove the other steering column connectors (Fig. 40).

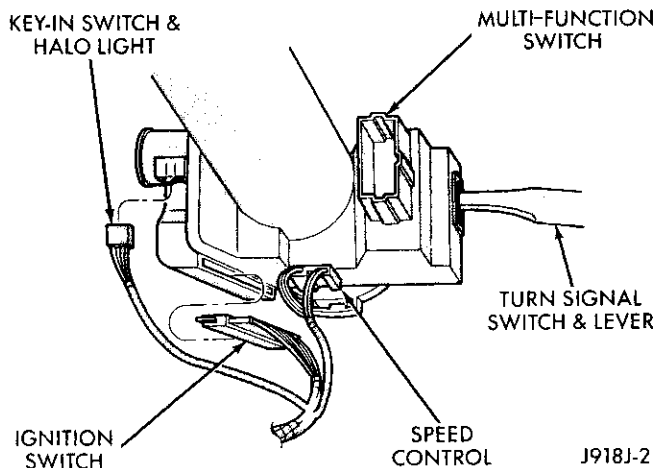


Fig. 40 Steering Column Connectors

(15) Remove airbag wiring harness from the steering column wiring trough.

(16) Remove the wiring trough from the steering column.

(17) Remove the three steering column toe plate nuts and washers (Fig. 41).

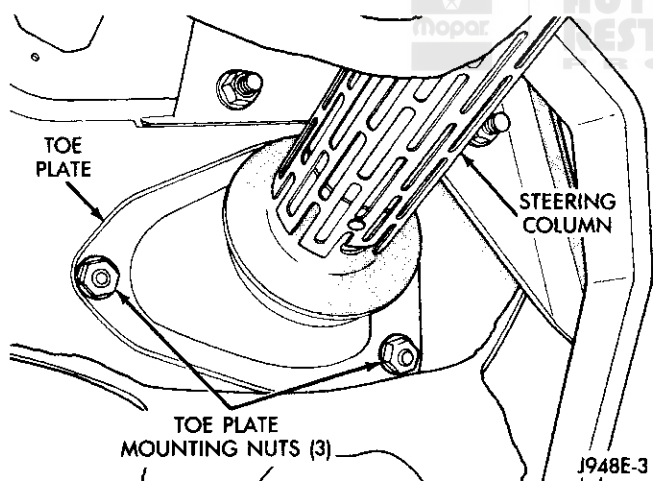


Fig. 41 Steering Column Toe Plate

(18) Remove the two nuts and washers attaching the steering column bracket to the instrument panel steering column support bracket (Fig. 42).

(19) Lower the steering column and allow it to rest on the seat.

(20) Remove the two screws from the bottom of the Airbag Control Module (ACM) cover (Fig. 43).

(21) Remove the four screws holding the ACM to the transmission tunnel on the floor (Fig. 44).

(22) Disconnect the wiring at the ACM.

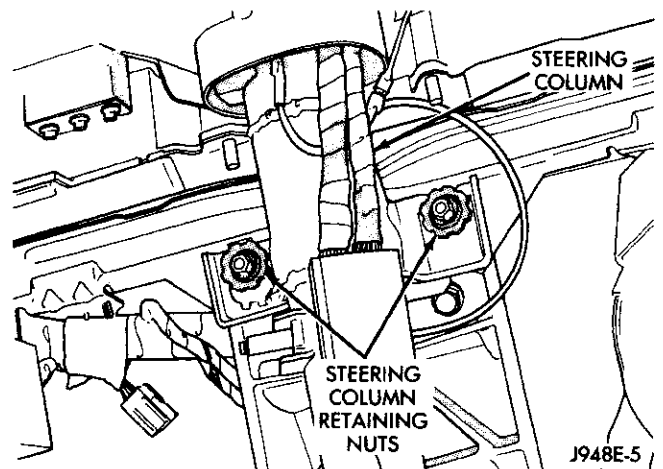


Fig. 42 Steering Column Mounting

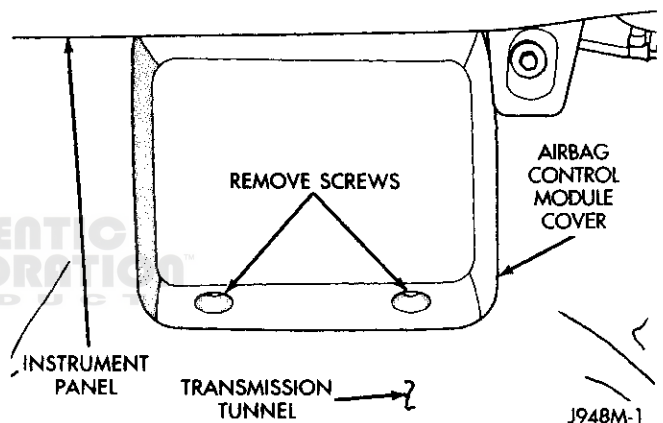


Fig. 43 Airbag Control Module Cover Screws

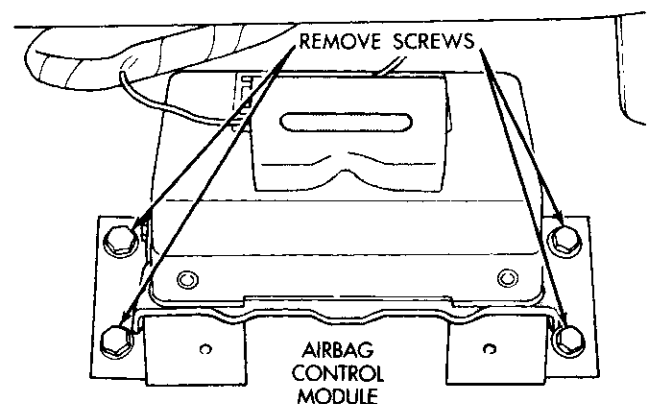


Fig. 44 Airbag Control Module Remove/Install

REMOVAL AND INSTALLATION (Continued)

(23) Disconnect the wiring connectors at the left end of the instrument panel.

(24) Remove the screw holding the parking brake release to the bottom of the instrument panel.

(25) Disconnect the wiring connectors at the right end of the instrument panel. There are:

- Two connectors attached to the heater-A/C housing
- Courtesy lamp connector
- Antenna cable connector
- Two body harness connectors
- Vacuum harness for heater-A/C system.

(26) Remove the five screws holding the instrument panel to the dash panel.

(27) Remove the lower center instrument panel mounting screw.

(28) Loosen the lower instrument panel pivot bolts.

(29) Roll the instrument panel down.

(30) Using a screwdriver or pointed tool, push through the plastic flashing to release the locking tab on heater-A/C temperature control cable (Fig. 45).

(33) Reverse the removal procedures to install. Be certain that all wiring and hoses are not pinched. Refer to Group 8M - Restraint Systems before connecting the battery negative cable. Tighten the hardware as follows:

- Instrument panel upper mounting screws - 3 N·m (28 in. lbs.)
- Instrument panel pivot bolts - 12 N·m (110 in. lbs.)
- Steering column shroud screws - 2 N·m (17 in. lbs.)
- Steering column bracket nuts - 12 N·m (110 in. lbs.)
- Toe plate nuts - 23 N·m (200 in. lbs.)
- Multi-function switch connector screw - 2 N·m (17 in. lbs.)
- ACM mounting bolts - 11 N·m (105 in. lbs.)

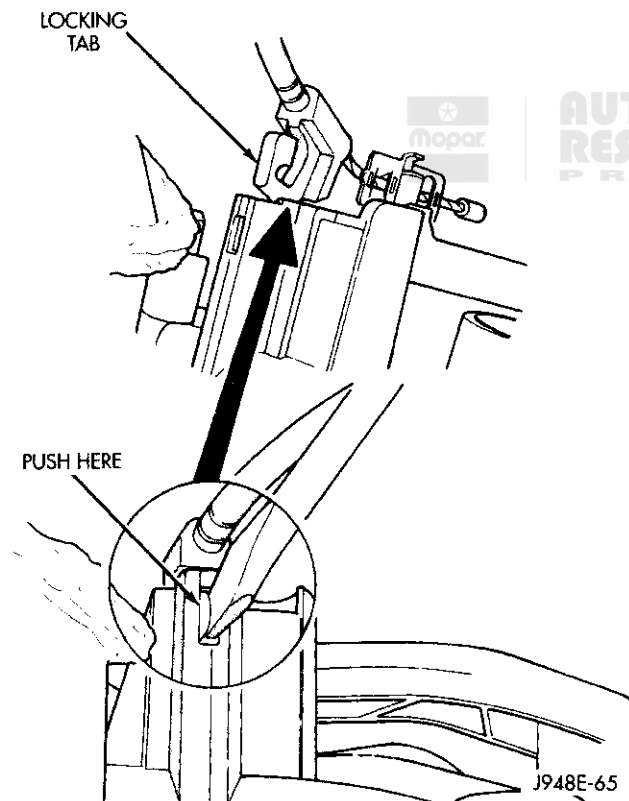


Fig. 45 Heat-A/C Temperature Control Cable Remove

(31) Pull the temperature control cable from the top of the heater-A/C housing.

(32) Remove the instrument panel from the vehicle.

SPECIFICATIONS**GAUGE CALIBRATION**

Fuel Gauge Calibration	
Pointer Position	Resistance
Empty Graduation ($\pm 2.5^\circ$)	97 ohms
Full Graduation ($\pm 2.5^\circ$)	9 ohms
1/2 Graduation ($\pm 5^\circ$)	32.5 ohms

Low Fuel Warning Indicator		
Sending Unit Resistance	Lamp	Delay Time
65.4 ohms (+5.3 / -5.0)	On or Off	8 to 30 seconds

Oil Pressure Gauge Calibration	
Pointer Position	Resistance
Low Normal ($\pm 3^\circ$)	65 ohms
High Normal ($\pm 4^\circ$)	24.5 ohms

Speedometer Calibration	
Pointer Position	Frequency
20 mph (± 3.0)	41.1 Hz
55 mph (± 2.5)	118.8 Hz
75 mph (± 2.5)	163.2 Hz

Tachometer Calibration		
Engines	Pointer Position	Frequency
I-6, V-6, V-8	3000 rpm (± 200)	100 Hz
V-10	3000 rpm (± 200)	125 Hz

Temperature Gauge Calibration		
Engine	Pointer Position	Resistance
Gas	Low Normal ($\pm 3^\circ$)	361.7 ohms
Gas	High Normal ($\pm 3^\circ$)	77 ohms
Diesel	Low Normal ($\pm 3^\circ$)	155 ohms
Diesel	High Normal ($\pm 4^\circ$)	80.9 ohms

Voltmeter Calibration	
Pointer Position	Input Voltage
11.75 Graduation ($\pm 3^\circ$)	12 volts
15.80 Graduation ($\pm 4^\circ$)	16 volts

AUDIO SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Following are general descriptions of the major components used in both the standard and optional equipment audio systems. Refer to 8W-47 Audio System in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

RADIOS

Radio options include an AM/FM, an AM/FM/cassette, an AM/FM/CD, or an AM/FM/cassette with graphic equalizer. All receivers are stereo Electronically Tuned Radios (ETR) and include a clock function. For more information on radio features, setting procedures, and control functions refer to the Sound System manual. The Sound System manual is included with the owner's manual in the vehicle glove box.

IGNITION-OFF DRAW FUSE

All vehicles are equipped with an Ignition-Off Draw (IOD) fuse that is removed when the vehicle is shipped from the factory. This fuse feeds various accessories that require current when the ignition switch is in the Off position, including the clock and radio station preset memory functions. The fuse is removed to prevent battery discharge during vehicle storage.

When removing or installing the IOD fuse, it is important that the ignition switch be in the Off position. Failure to place the ignition switch in the Off

position can cause the radio display to become scrambled when the IOD fuse is removed and replaced. Removing and replacing the IOD fuse again, with the ignition switch in the Off position, will correct the scrambled display condition.

The IOD fuse should be checked if the radio station preset memory or clock functions are erratic or inoperative. The IOD fuse is located in the fuseblock module. Refer to the fuseblock module label for IOD fuse identification and location.

SPEAKERS

Speaker system options include two or four speaker locations. On two-speaker systems, one full-range speaker is located in each front door. Four-speaker systems add one full-range speaker in each rear cab side panel.

The premium speaker option upgrades all the speakers in the above locations to Infinity bi-amplified models. Infinity coaxial speakers are mounted in the rear cab side panels. Each front door has two separate Infinity speakers, a woofer and a tweeter. Each Infinity woofer features an integral amplifier and frequency filter unit. The amplifier of the radio is used to drive the tweeters at each speaker location. The speaker-mounted amplifiers drive the woofers at each speaker location.

FILTER CHOKE/SPEAKER RELAY

Models equipped with the Infinity premium speaker package use this choke/relay to control battery feed to the speaker-mounted amplifiers. The choke/relay is mounted to the center lower instrument panel brace to the right of the knee blocker opening. The choke/relay can be accessed by remov-

DESCRIPTION AND OPERATION (Continued)

ing the knee blocker. The choke/relay should be checked if there is a lack of bass and low frequency response noted at the rear cab side speakers, and no sound output at the front door woofers.

ANTENNA

All models use a fixed-length stainless steel rod-type antenna mast, installed at the right front fender of the vehicle. The antenna mast is connected to the center wire of the coaxial antenna cable and is not grounded to any part of the vehicle.

To eliminate static, the antenna base must have a good ground. The coaxial antenna cable shield (the outer wire mesh of the cable) is grounded to the antenna base and the radio chassis. The antenna cable has an additional disconnect, located near the right end of the instrument panel and the right cowl side panel, to allow instrument panel installation and removal without removing the radio.

The factory-installed ETRs automatically compensate for radio antenna trim. Therefore, no antenna trimmer adjustment is required or possible when replacing the receiver or the antenna.

RADIO NOISE SUPPRESSION

Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) noise suppression is accomplished primarily through circuitry internal to the radio receivers. These internal suppression devices are only serviced as part of the radio receiver.

External suppression devices that are serviced, and should be checked in the case of RFI or EMI noise complaints, include the following:

- Radio antenna base ground
- Radio chassis ground wire, strap, or bracket
- Engine-to-body ground strap (if equipped)
- Cab-to-bed ground strap (if equipped)

- Heater core ground strap (if equipped)
- Resistor-type spark plugs
- Radio suppression-type secondary ignition wiring.

In addition, if the source of RFI or EMI noise is identified as a component on the vehicle (i.e., generator, blower motor, etc.), the ground path for that component should be checked. If excessive resistance is found in that circuit, repair that circuit as required before considering any component replacement.

If the source of the noise is identified as two-way mobile radio or telephone equipment, check the following:

- Power connections should be made directly to the battery, and fused as closely to the battery as possible.
- The antenna should be mounted on the roof or toward the rear of the vehicle. Remember that magnetic antenna mounts on the roof panel can adversely affect the operation of an overhead console compass (if equipped).
- Antenna cable should be fully shielded coaxial cable, should be as short as is practical, and should be routed away from the vehicle wiring whenever possible.
- The antenna and cable must be carefully matched to ensure a low Standing Wave Ratio (SWR).

Fleet vehicles are available with an extra-cost RFI-suppressed Powertrain Control Module (PCM). This unit reduces interference generated by the PCM on some radio frequencies used in two-way radio communications. However, this unit will not resolve complaints of RFI in the commercial AM or FM radio frequency ranges.

DIAGNOSIS AND TESTING**AUDIO SYSTEM**

Audio System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
NO AUDIO.	<ol style="list-style-type: none"> 1. Fuse faulty. 2. Radio connector faulty. 3. Wiring faulty. 4. Ground faulty. 5. Radio faulty. 6. Speakers faulty. 	<ol style="list-style-type: none"> 1. Check radio fuses in fuseblock module. Replace fuses, if required. 2. Check for loose or corroded radio connector. Repair, if required. 3. Check for battery voltage at radio connector. Repair wiring, if required. 4. Check for continuity between radio chassis and a known good ground. There should be continuity. Repair ground, if required. 5. Exchange or replace radio, if required. 6. See speaker diagnosis, in this group.
NO DISPLAY.	<ol style="list-style-type: none"> 1. Fuse faulty. 2. Radio connector faulty. 3. Wiring faulty. 4. Ground faulty. 5. Radio faulty. 	<ol style="list-style-type: none"> 1. Check radio fuses in fuseblock module. Replace fuses, if required. 2. Check for loose or corroded radio connector. Repair, if required. 3. Check for battery voltage at radio connector. Repair wiring, if required. 4. Check for continuity between radio chassis and a known good ground. There should be continuity. Repair ground, if required. 5. Exchange or replace radio, if required.
NO MEMORY.	<ol style="list-style-type: none"> 1. Fuse faulty. 2. Radio connector faulty. 3. Wiring faulty. 4. Ground faulty. 5. Radio faulty. 	<ol style="list-style-type: none"> 1. Check ignition-off draw fuse. Replace fuse, if required. 2. Check for loose or corroded radio connector. Repair, if required. 3. Check for battery voltage at radio connector. Repair wiring, if required. 4. Check for continuity between radio chassis and a known good ground. There should be continuity. Repair ground, if required. 5. Exchange or replace radio, if required.
POOR RADIO RECEPTION.	<ol style="list-style-type: none"> 1. Antenna faulty. 2. Ground faulty. 3. Radio faulty. 	<ol style="list-style-type: none"> 1. See antenna diagnosis, in this group. Repair or replace antenna, if required. 2. Check for continuity between radio chassis and a known good ground. There should be continuity. Repair ground, if required.. 3. Exchange or replace radio, if required.

DIAGNOSIS AND TESTING (Continued)

Audio System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
NO/POOR TAPE OPERATION.	1. Faulty tape. 2. Foreign objects behind tape door. 3. Faulty tape deck.	1. Insert known good tape and test operation. 2. Remove foreign objects and test operation. 3. Exchange or replace radio, if required.
NO COMPACT DISC OPERATION	1. Faulty CD. 2. Foreign material on CD. 3. Condensation on CD or optics. 4. Faulty CD player.	1. Insert known good CD and test operation. 2. Clean CD and test operation. 3. Allow temperature of vehicle interior to stabilize and test operation. 4. Exchange or replace radio, if required.

RADIO

For circuit descriptions and diagrams, refer to 8W-47 - Audio System in Group 8W - Wiring Diagrams.

CAUTION: The speaker output of the radio is a "floating ground" system. Do not allow any speaker lead to short to ground, as damage to the radio may result.

(1) Check the fuse(s) in the fuseblock module and the Power Distribution Center (PDC). If OK, go to Step 2. If not OK, replace the faulty fuse(s).

(2) Check for battery voltage at the fuse in the PDC. If OK, go to Step 3. If not OK, repair the open circuit as required.

(3) Turn the ignition switch to the On position. Check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) Turn the ignition switch to the Off position. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel. Remove the radio, but do not unplug any connections. Check for continuity between the radio chassis and a good ground. There should be continuity. If OK, go to Step 5. If not OK, repair the open circuit as required.

(5) Connect the battery negative cable. Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the left (gray) radio connector. If OK, go to Step 6. If not OK, repair the open circuit as required.

(6) Turn the ignition switch to the Off position. Check for battery voltage at the fused B(+) circuit cavity of the left (gray) radio connector. If OK, replace the faulty radio. If not OK, repair the open circuit as required.

SPEAKERS

For circuit descriptions and diagrams, refer to 8W-47 - Audio System in Group 8W - Wiring Diagrams.

CAUTION: The speaker output of the radio is a "floating ground" system. Do not allow any speaker lead to short to ground, as damage to the radio may result.

(1) Turn the radio on. Adjust the balance and fader controls to check the performance of each individual speaker. Note the speaker locations that are not performing correctly. Go to Step 2.

NOTE: If the vehicle has the Infinity premium speaker package and the coaxial speakers lack bass or low frequency, while no response is noted at the woofers, see the diagnosis for the Filter Choke/Speaker Relay.

(2) Turn the radio off. Disconnect and isolate the battery negative cable. Remove the instrument cluster bezel and remove the radio. Check both the speaker feed (+) circuit and return (-) circuit cavities at the radio connectors for continuity to ground. In each case, there should be no continuity. If OK, go to Step 3. If not OK, repair the shorted speaker circuit(s) as required.

(3) If equipped with the Infinity speaker system, go to Step 5. If equipped with the non-Infinity speaker system, check the resistance between the speaker feed (+) circuit and return (-) circuit cavities, for each speaker location. The meter should read between 3 and 8 ohms (speaker resistance). If OK, go to Step 4. If not OK, go to Step 5.

(4) Install a known good radio. Connect the battery negative cable. Turn on the radio and test the

DIAGNOSIS AND TESTING (Continued)

speaker operation. If OK, replace the faulty radio. If not OK, disconnect and isolate the battery negative cable, remove the test radio, and go to Step 5.

(5) Unplug the speaker wiring connector at the speaker. Check for continuity between the speaker feed (+) circuit cavities of the radio connector and the speaker connector. Repeat the check between the speaker return (-) circuit cavities of the radio connector and the speaker connector. In each case, there should be continuity. If OK with the Infinity speakers, go to Step 6. If OK with the non-Infinity speakers, replace the faulty speaker. If not OK, repair the open circuit(s) as required.

(6) Check for continuity between the amplified speaker (-) circuit cavity of the body half of the speaker connector and a good ground. There should be continuity. If OK, go to Step 7. If not OK, repair the open circuit as required.

(7) Install the radio. Connect the battery negative cable. Turn the radio on. Check for battery voltage at the amplified speaker (+) circuit cavity of the speaker connector. If OK, replace the faulty speaker. If not OK, repair the open circuit to the filter choke/speaker relay as required.

FILTER CHOKE/SPEAKER RELAY

The filter choke/speaker relay is used to switch power to the individual speaker amplifiers used with the Infinity premium speaker package. The choke and relay are serviced only as a unit. If the coaxial speakers lack bass or low frequency response, while no sound is noted at the woofers, the choke/relay is suspect. However, before replacement make the following checks of the choke/relay circuits. For circuit descriptions and diagrams, refer to 8W-47 - Audio System in Group 8W - Wiring Diagrams.

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 3. If not OK, repair the open circuit as required.

(3) Unplug the choke/relay harness connector. Check for battery voltage at the fused B(+) circuit cavity of the choke/relay connector. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) Probe the ground circuit cavity of the choke/relay connector. Check for continuity to a good ground. There should be continuity. If OK, go to Step 5. If not OK, repair the open circuit to ground as required.

(5) Turn the ignition switch to the On position and turn the radio on. Check for battery voltage at the radio 12-volt output circuit cavity of the choke/relay connector. If OK, go to Step 6. If not OK, repair the open circuit as required.

(6) Turn the radio and ignition switches to the Off position. Connect the choke/relay connector. Check

for battery voltage at the amplified speaker (+) circuit cavity of the choke/relay connector. There should be zero volts. Turn the ignition and radio switches to the On position. There should now be battery voltage. If OK, repair the circuits from the choke/relay connector to the speaker amplifiers as required. If not OK, replace the faulty choke/relay.

ANTENNA

The following four tests are used to diagnose the antenna with an ohmmeter:

- **Test 1** - Mast to ground test
- **Test 2** - Tip-of-mast to tip-of-conductor test
- **Test 3** - Body ground to battery ground test
- **Test 4** - Body ground to coaxial shield test.

The ohmmeter test lead connections for each test are shown in Antenna Tests (Fig. 1).

NOTE: This model has a two-piece antenna cable. Tests 2 and 4 must be conducted in two steps to isolate a coaxial cable problem; from the coaxial cable connection under the right end of the instrument panel near the right cowl side panel to the antenna base, and then from the coaxial cable connection to the radio chassis connection.

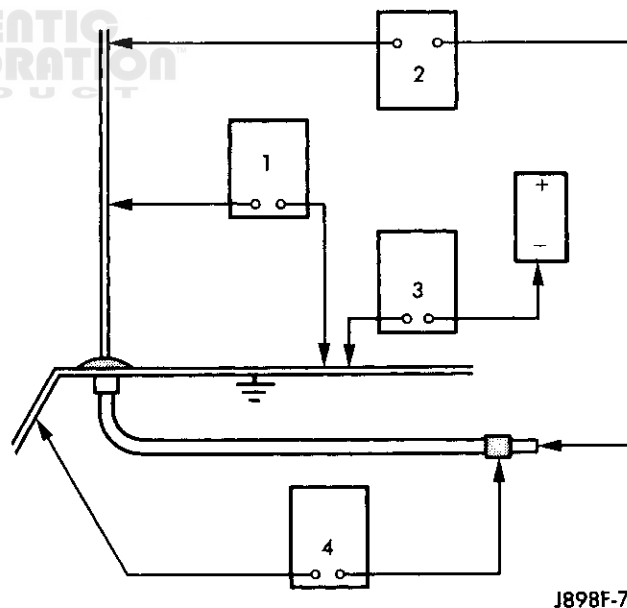


Fig. 1 Antenna Tests

TEST 1

Test 1 determines if the antenna mast is insulated from the base. Proceed as follows:

(1) Disconnect the antenna cable lead from the radio chassis and isolate.

(2) Connect one ohmmeter lead to the tip of the antenna mast and the other lead to the antenna base. Check for continuity.

DIAGNOSIS AND TESTING (Continued)

(3) There should be no continuity. If continuity is found, replace the faulty or damaged antenna base and cable assembly.

TEST 2

Test 2 checks the antenna for an open circuit as follows:

(1) Disconnect the antenna cable lead from the radio chassis.

(2) Connect one ohmmeter test lead to the tip of the antenna mast. Connect the remaining lead to the tip of the antenna cable lead (the part inserted into the radio).

(3) Continuity should exist (the ohmmeter should only register a fraction of an ohm). High or infinite resistance indicates damage to the base and cable assembly. Replace the faulty base and cable, if required.

TEST 3

Test 3 checks the condition of the vehicle body ground connection. This test should be performed with the battery positive cable removed from the battery. Disconnect both battery cables, the negative cable first. Reconnect the negative cable and perform the test as follows:

(1) Connect one ohmmeter test lead to the vehicle fender and the other lead to the battery negative post.

(2) The resistance should be less than one ohm.

(3) If the resistance is more than one ohm, check the braided ground strap connected to the engine and the vehicle body for being loose, corroded, or damaged. Repair the ground strap connection, if required.

TEST 4

Test 4 checks the condition of the ground between the antenna base and the vehicle body as follows:

(1) Connect one ohmmeter test lead to the fender and the other lead to the crimp on the coaxial antenna cable shield.

(2) The resistance should be less than one ohm.

(3) If the resistance is more than one ohm, clean and/or tighten antenna base to fender mounting hardware.

RADIO FREQUENCY INTERFERENCE

Inspect the ground connections at the following:

- Blower motor
- Electric fuel pump
- Generator
- Ignition module
- Wiper motor
- Antenna coaxial ground
- Radio ground
- Body-to-engine braided ground strap (if equipped).

Clean, tighten or repair the connections as required.

Also inspect the following secondary ignition system components:

- Spark plug wire routing and condition
- Distributor cap and rotor
- Ignition coil
- Spark plugs.

Reroute the spark plug wires or replace the faulty components as required.

REMOVAL AND INSTALLATION**RADIO**

(1) Disconnect and isolate the battery negative cable.

(2) Open the cup holder and remove the two screws securing the assembly to the instrument panel (Fig. 2). Remove the cup holder assembly from the instrument panel.

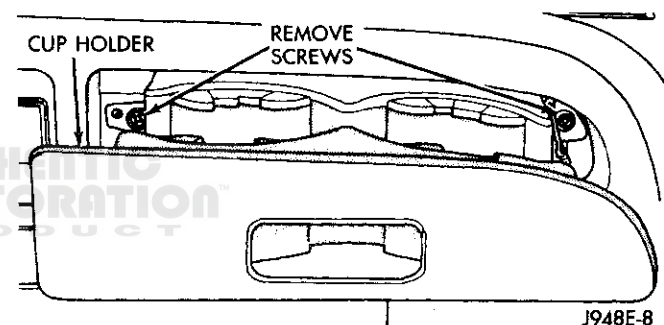


Fig. 2 Cup Holder Remove/Install

(3) Remove the ash receiver. Remove the two screws securing the ash receiver bracket to the instrument panel (Fig. 3). Remove the ash receiver bracket assembly from the instrument panel.

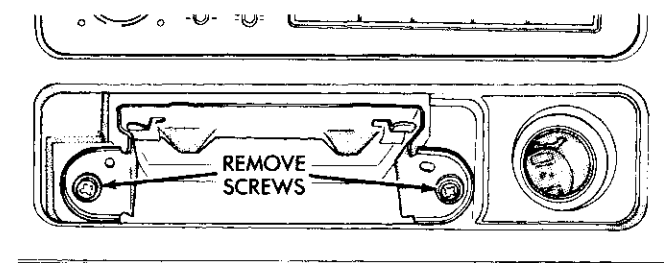


Fig. 3 Ash Receiver Remove/Install

REMOVAL AND INSTALLATION (Continued)

(4) Carefully pry the bezel away from the instrument panel to disengage the retaining clips (Fig. 4).

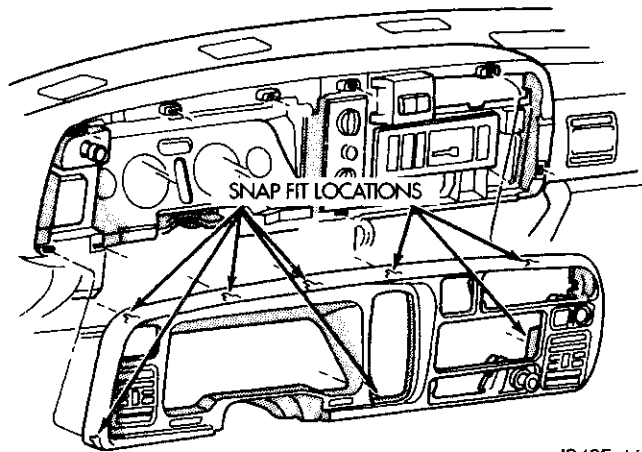


Fig. 4 Cluster Bezel Remove/Install

(5) Unplug the connector from cigar lighter (Fig. 5).

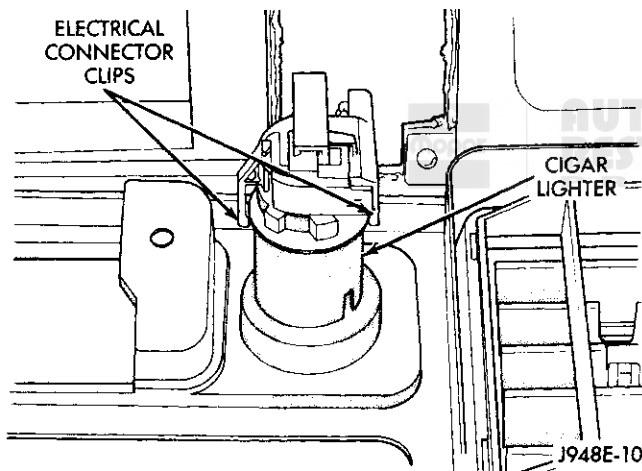


Fig. 5 Cigar Lighter Remove/Install

(6) Unplug the connector from the auxiliary power outlet.

(7) Remove the two radio mounting screws from the front of the radio (Fig. 6).

(8) Pull the radio out from the instrument panel far enough to disconnect the wiring and the antenna coaxial cable (Fig. 7).

(9) Remove the screw from the radio ground strap and remove the radio.

(10) Reverse the removal procedures to install.

SPEAKERS**FRONT DOOR**

(1) Disconnect and isolate the battery negative cable.

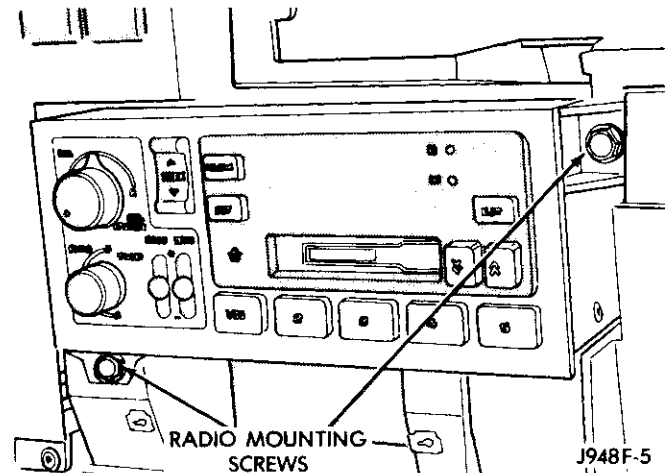


Fig. 6 Radio Mounting

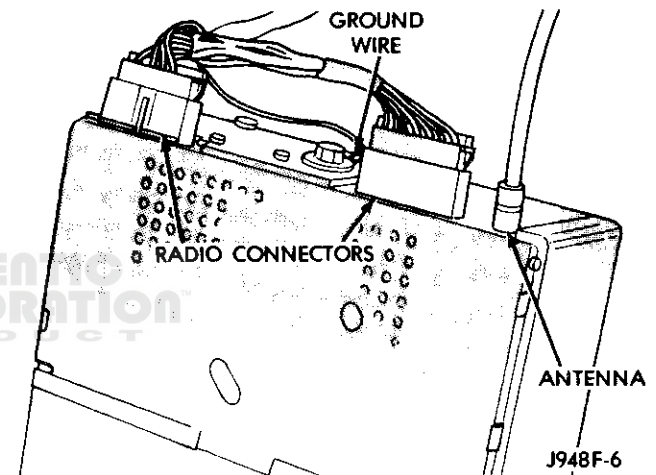


Fig. 7 Radio Connectors

(2) Remove the two screws in the door pull cup and remove the cup (Fig. 8).

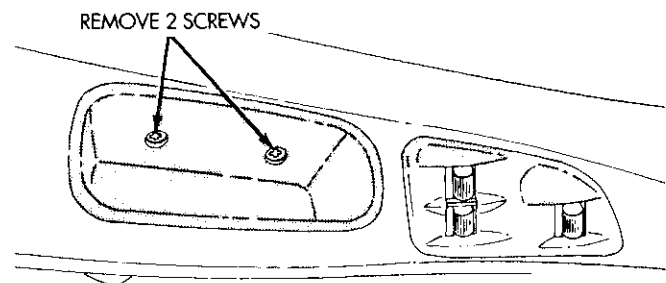


Fig. 8 Door Pull Cup Remove/Install

(3) If equipped, remove the manual window regulator crank handle with a removal tool (Fig. 9).

(4) If equipped, remove the power window and lock switches by reaching through the door pull cup opening and depressing the switch bezel rear retaining tab (Fig. 10).

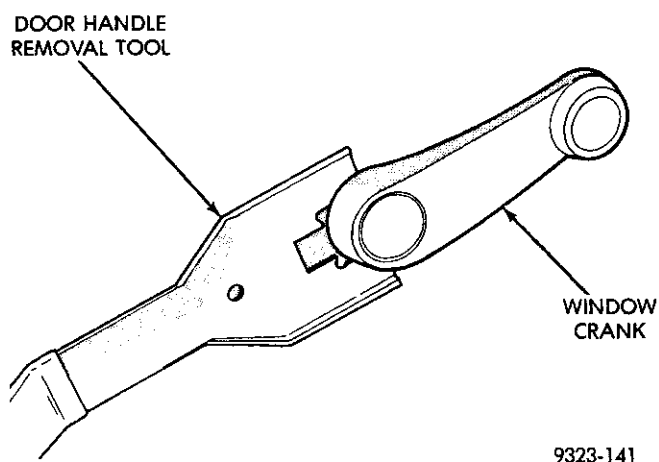
REMOVAL AND INSTALLATION (Continued)

Fig. 9 Window Regulator Crank Handle Remove - Typical

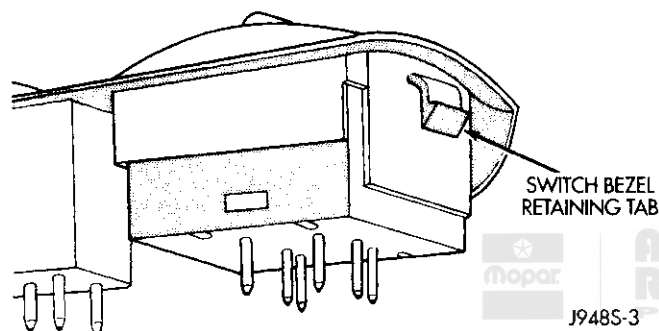


Fig. 10 Switch Bezel Rear Retaining Tab

(5) Pull the rear of the switch bezel up and away from the door trim panel.

(6) Unplug the wiring connectors from the switches (Fig. 11).

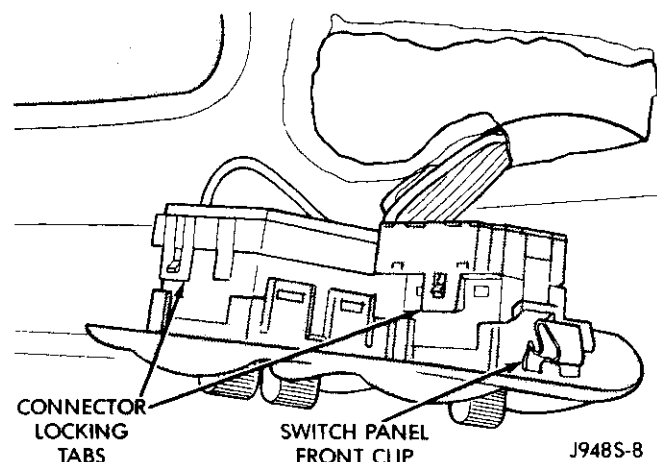


Fig. 11 Door Switch Connectors

(7) On the driver's side only, if equipped with power mirrors, pull the power mirror switch control

knob rearward to remove it from the switch stem (Fig. 12).

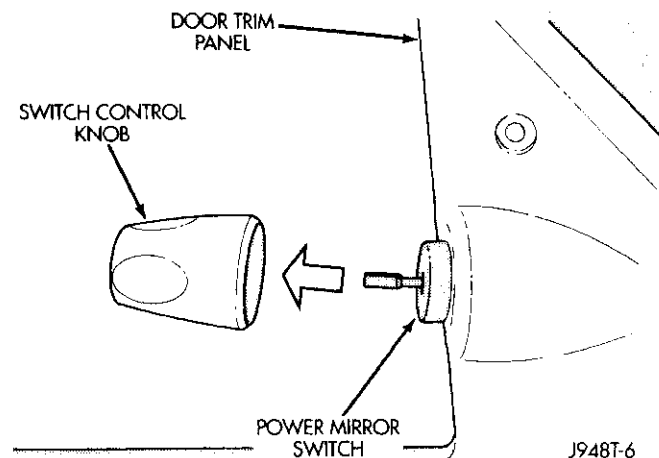


Fig. 12 Power Mirror Switch Knob Remove/Install

(8) Remove the mirror switch retaining nut from the switch (Fig. 13).

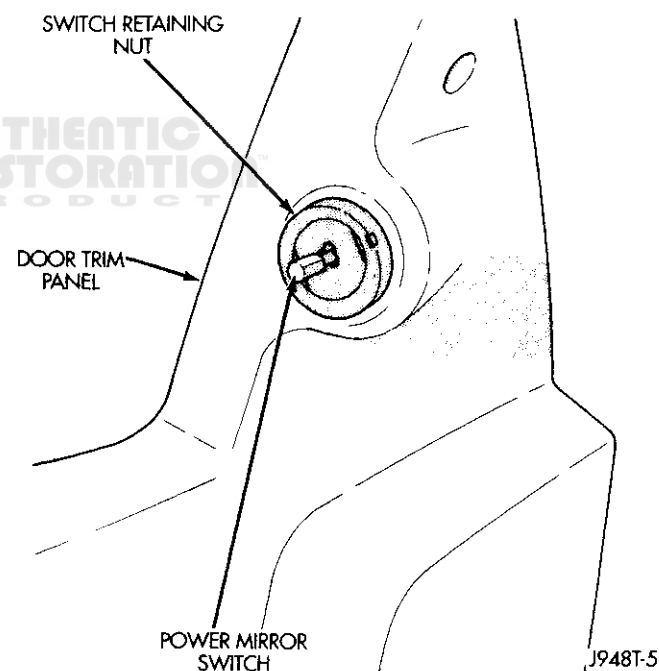


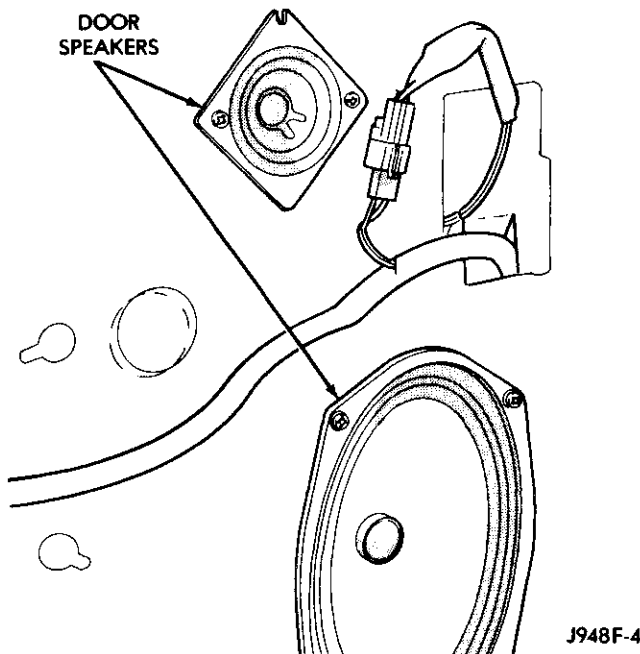
Fig. 13 Power Mirror Switch Nut

(9) Using a wide flat-bladed tool such as a trim stick, pry the trim panel away from the door around the perimeter and remove the trim panel.

NOTE: To aid in the removal of the trim panel, start at the bottom of the panel.

(10) Remove the screws holding the speaker(s) to the inner door panel (Fig. 14).

(11) Disconnect the speaker wiring connector and remove the speaker.

REMOVAL AND INSTALLATION (Continued)**Fig. 14 Door Mounted Speaker Remove/Install**

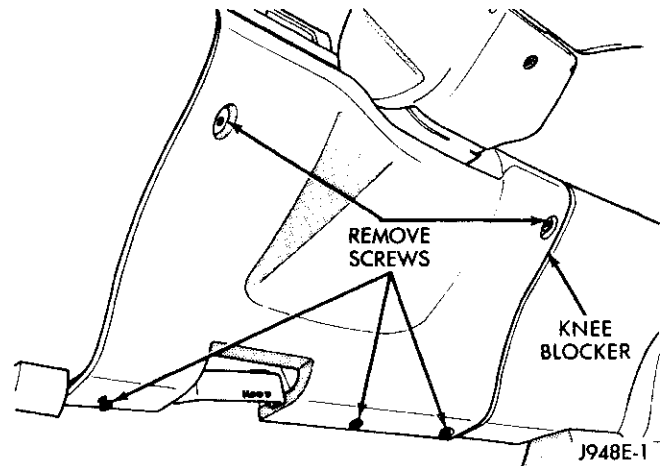
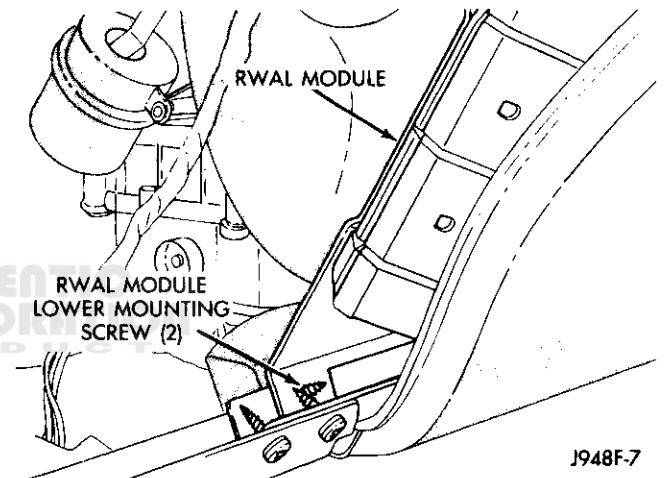
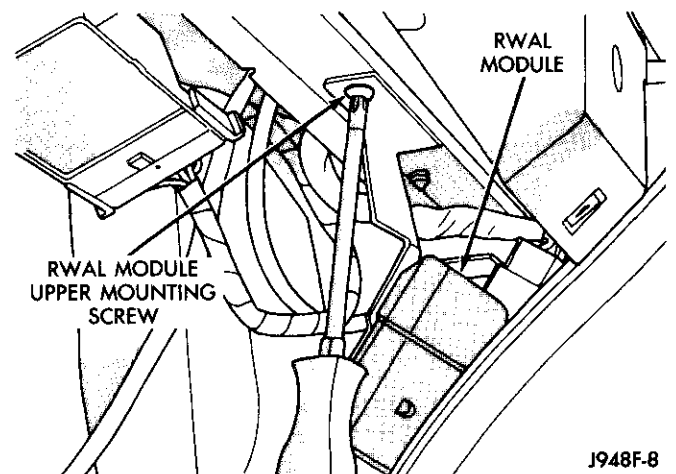
(12) Reverse the removal procedures to install.

REAR CAB SIDE PANEL

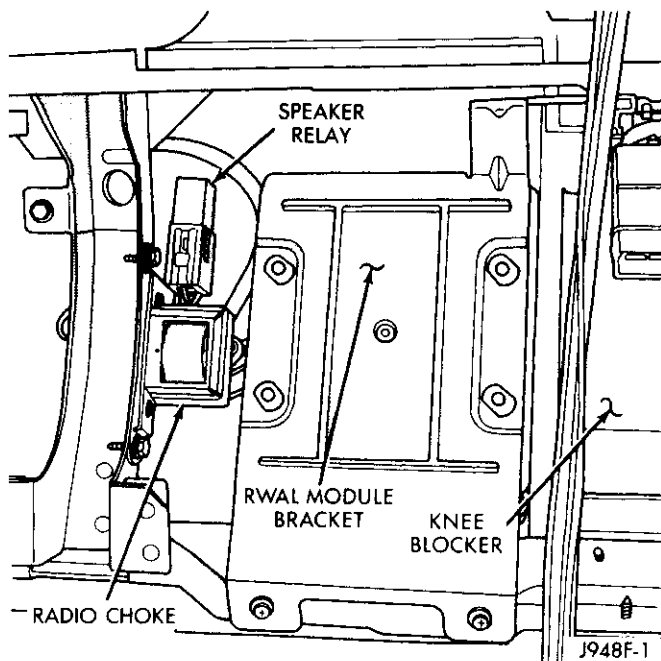
- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the rear cab side panel trim as described in Group 23 - Body Components.
- (3) Move the side panel trim far enough to access the speaker mounting screws.
- (4) Remove the speaker mounting screws.
- (5) Pull the speaker out and unplug the wiring connector.
- (6) Reverse the removal procedures to install.

FILTER CHOKE/SPEAKER RELAY

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the five screws securing the knee blocker to the lower instrument panel and remove the knee blocker (Fig. 15).
- (3) If equipped, remove the two screws holding the bottom of the RWAL module bracket to the instrument panel brace (Fig. 16).
- (4) If equipped, remove the screw holding the top of the RWAL module bracket to the instrument panel and remove the module (Fig. 17).
- (5) Remove the two screws securing the relay/choke mounting bracket to the instrument panel center support and remove the relay/choke assembly (Fig. 18).
- (6) Reverse the removal procedures to install.

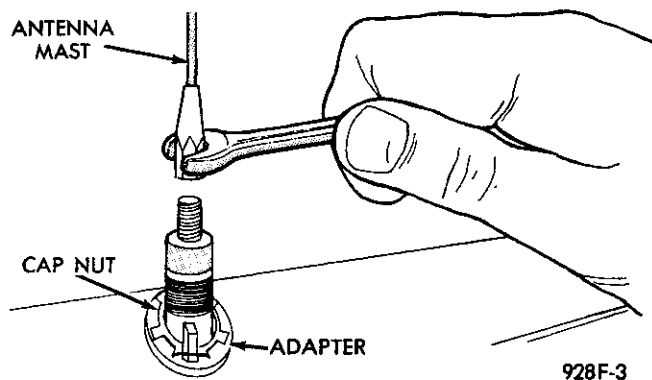
**Fig. 15 Knee Blocker Remove/Install****Fig. 16 RWAL Module Lower Mounting****Fig. 17 RWAL Module Upper Mounting****ANTENNA**

- (1) Disconnect and isolate the battery negative cable.

REMOVAL AND INSTALLATION (Continued)**Fig. 18 Relay/Choke Assembly**

(2) Remove the five screws holding the right cowl side kick panel/sill trim. Remove the kick panel/sill trim.

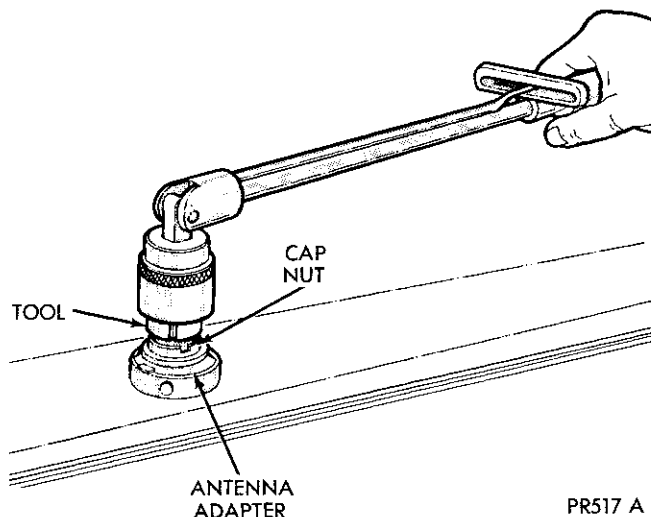
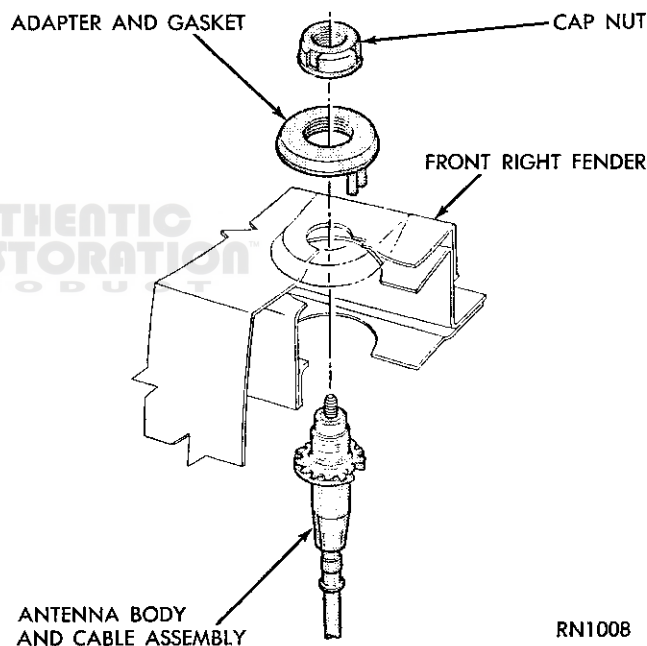
(3) Remove the antenna mast from the antenna body (Fig. 19).

**Fig. 19 Antenna Mast Remove/Install**

(4) Remove the antenna cap nut using antenna nut wrench (Special Tool C-4816) (Fig. 20).

(5) Lower the antenna assembly through the fender far enough to gain access to the antenna body (Fig. 21).

(6) Remove the antenna body and cable by pulling the coaxial cable and grommet out through the

**Fig. 20 Cap Nut and Adapter - Typical****Fig. 21 Antenna Mounting - Typical**

engine compartment side of the dash panel outboard of the powertrain control module, then through the opening in the cowl side reinforcement.

(7) To install the antenna body and cable, route the coaxial cable between the fender and the cowl side reinforcement to the engine compartment.

(8) Reverse the remaining removal procedures to complete the installation. Tighten the antenna cap nut to 7.9 N·m (70 in. lbs.).

HORN SYSTEMS

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HORN RELAY	1		

GENERAL INFORMATION

INTRODUCTION

Following are general descriptions of the major components in the factory-installed horn systems. Refer to 8W-41 - Horns/Cigar Lighter in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

HORN RELAY

The horn relay is a International Standards Organization (ISO) micro-relay. The terminal designations and functions are the same as a conventional ISO relay. However, the micro-relay terminal orientation (or footprint) is different, current capacity is lower, and the relay case dimensions are smaller than on the conventional ISO relay.

The horn relay is a electro-mechanical device that switches current to the horn when the horn switch on the steering wheel is depressed. See the Diagnosis and Testing section of this group for more information on the horn relay's operation.

The horn relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for horn relay identification and location.

If a problem is encountered with a continuously sounding horn, it can usually be quickly resolved by removing the horn relay from the PDC until further diagnosis is completed.

HORN SWITCH

Two horn switches are installed in the steering wheel, one on each side of the center-mounted driver's airbag module. When either switch is depressed it completes a circuit to ground for the coil side of the

horn relay. The steering wheel and steering column must be properly grounded for the horn switches to function. The horn switches are serviced only as a set with their wiring. If either switch should fail, both switches must be replaced.

HORN

The standard single, low-note, diaphragm-type horn is located on a bracket behind the left end of the front bumper. It is grounded through its wiring connector and circuit to an eyelet near the power distribution center, and receives battery feed through the closed contacts of the horn relay. If the vehicle is equipped with a dual horn option, a high-note, diaphragm-type horn is connected in parallel with, and mounted next to, the standard low-note horn behind the front bumper.

DIAGNOSIS AND TESTING

HORN RELAY

For circuit descriptions and diagrams, refer to 8W-41 - Horns/Cigar Lighter in Group 8W - Wiring Diagrams.

RELAY TESTS

The horn relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for horn relay identification and location.

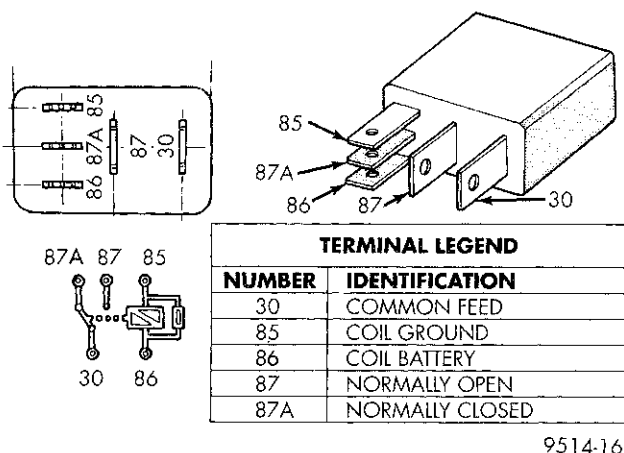
Remove the horn relay from the PDC as described in this group to perform the following tests:

(1) A relay in the de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 2. If not OK, replace the faulty relay.

DIAGNOSIS AND TESTING (Continued)

(2) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 3. If not OK, replace the faulty relay.

(3) Connect a battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, see the Relay Circuit Test in this group. If not OK, replace the faulty relay.

**Horn Relay****RELAY CIRCUIT TESTS**

(1) The relay common feed terminal cavity (30) is connected to battery voltage and should be hot at all times. If OK, go to Step 2. If not OK, repair the open circuit to the PDC fuse as required.

(2) The relay normally closed terminal (87A) is connected to terminal 30 in the de-energized position, but is not used for this application. Go to Step 3.

(3) The relay normally open terminal (87) is connected to the common feed terminal (30) in the energized position. This terminal supplies battery voltage to the horn(s). There should be continuity between the cavity for relay terminal 87 and the horn(s) feed terminal(s) at all times. If OK, go to Step 4. If not OK, repair the open circuit to the horn(s) as required.

(4) The coil battery terminal (86) is connected to the electromagnet in the relay. It is connected to battery voltage and should be hot at all times. Check for battery voltage at the cavity for relay terminal 86. If OK, go to Step 5. If not OK, repair the open circuit to the PDC fuse as required.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. It is grounded through the horn switch when the horn switch is depressed. Check for continuity to ground at the cavity for relay terminal 85. There should be continuity with the horn switch depressed, and no continuity with the horn switch released. If not OK, see the diagnosis for the Horn Switch in this group.

HORN SWITCH

For circuit descriptions and diagrams, refer to 8W-41 - Horns/Cigar Lighter in Group 8W - Wiring Diagrams.

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

(1) Disconnect and isolate the battery negative cable. Remove the knee blocker. Check for continuity between the metal steering column jacket and a good ground. There should be continuity. If OK, go to Step 2. If not OK, refer to Group 19 - Steering and check for proper installation of the steering column ground clip.

(2) Remove the horn relay from the PDC. Unplug the horn switch wire connector. Check for continuity between the steering column half of the horn switch wire connector and a good ground. There should be no continuity. If OK, go to Step 3. If not OK, repair the short circuit as required.

(3) Check for continuity between the steering column half of the horn switch wire connector and the horn relay control circuit cavity in the PDC. There should be continuity. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) Check for continuity between the horn switch half of the horn switch wire connector and a good ground. There should be no continuity. If OK, go to Step 5. If not OK, replace the faulty horn switches.

(5) Depress one horn switch and check for continuity between the horn switch half of the horn switch wire connector and a good ground. There should be continuity. Repeat this test for the other horn switch. If either switch is not OK, replace the faulty horn switches.

HORN

For circuit descriptions and diagrams, refer to 8W-41 - Horns/Cigar Lighter in Group 8W - Wiring Diagrams.

(1) Disconnect the horn wiring connector. Measure the resistance between the ground circuit cavity of the horn connector and a good ground. There should be zero ohms resistance. If OK, go to Step 2. If not OK, repair the faulty horn ground circuit as required.

(2) Depress the horn switch. There should be battery voltage at the horn relay output circuit cavity of the horn connector. If OK, replace the faulty horn. If not OK, repair the open circuit to the horn relay as required.

REMOVAL AND INSTALLATION

HORN RELAY

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the cover from the Power Distribution Center (PDC) (Fig. 1).

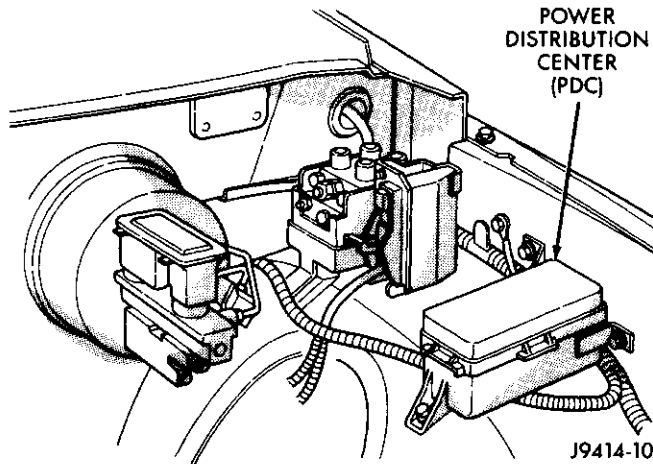


Fig. 1 Power Distribution Center

- (3) Refer to the label on the PDC for horn relay identification and location.
- (4) Remove the horn relay by unplugging it from the PDC.
- (5) Install the horn relay by aligning the relay terminals with the cavities in the PDC and pushing the relay firmly into place.
- (6) Install the PDC cover.
- (7) Connect battery negative cable.
- (8) Test the relay operation.

HORN SWITCH

WARNING: ON VEHICLES EQUIPPED WITH AN AIRBAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

- (1) Disconnect and isolate the battery negative cable. Wait two minutes for the airbag system capacitor to discharge before further service.
- (2) From the underside of the steering wheel, remove the speed control switch or trim bar mounting screws (Fig. 2).
- (3) Pull the switch/trim bar from the steering wheel and unplug the wiring connector (Fig. 3).
- (4) Remove the four nuts attaching the airbag module to the steering wheel (Fig. 4).

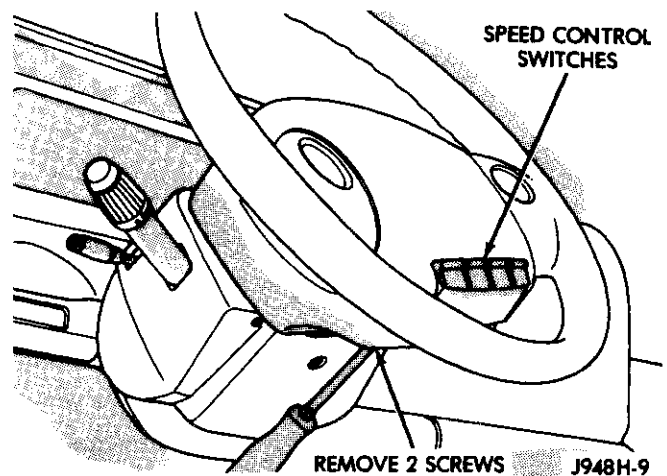


Fig. 2 Speed Control Switch/Trim Bar Remove/Install

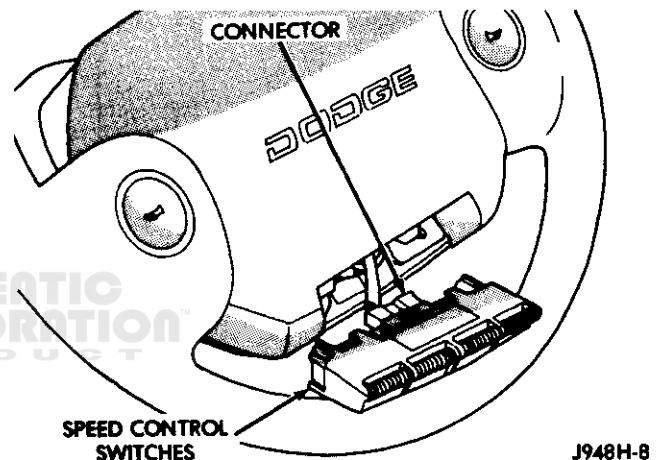


Fig. 3 Speed Control Switch Connector Remove/Install

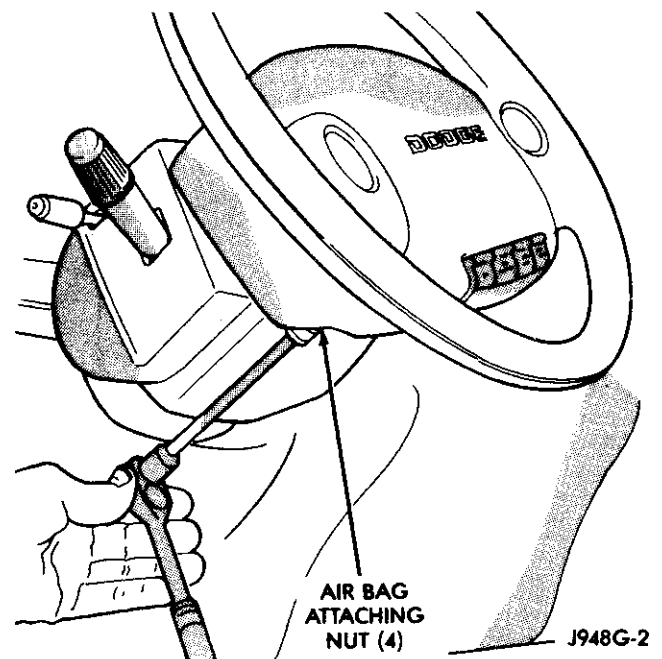


Fig. 4 Airbag Module Remove/Install

REMOVAL AND INSTALLATION (Continued)

(5) Remove the airbag module from the steering wheel.

(6) Using a small screwdriver pry the horn button from the steering wheel spoke (Fig. 5). There are two locking tabs holding each horn button to the steering wheel spoke cavities (Fig. 6).

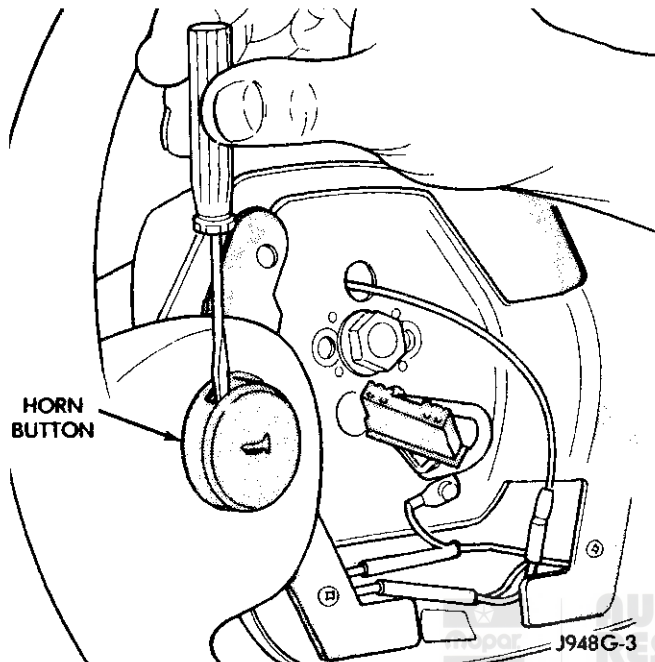


Fig. 5 Horn Button Remove

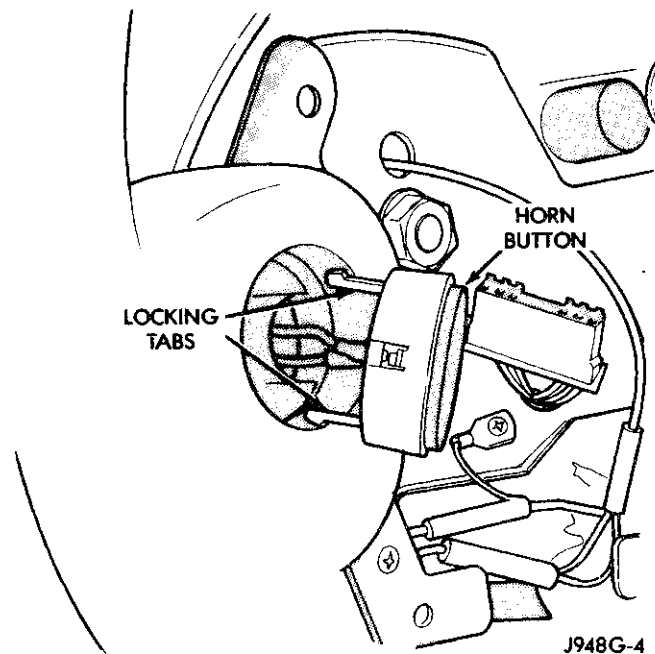


Fig. 6 Horn Button Locking Tabs

(7) Disconnect the horn switch wire connectors and remove the horn switch assembly (Fig. 7).

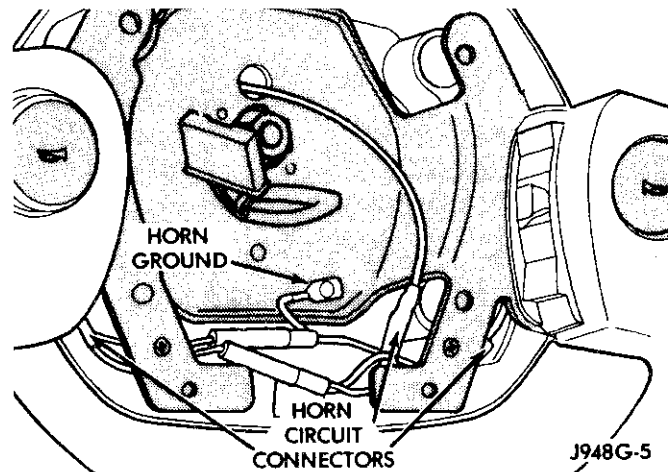


Fig. 7 Horn Switch Connectors

(8) Reverse the removal procedures to install. Tighten the airbag module mounting nuts to 1.5 N·m (15 in. lbs.).

HORN

- (1) Disconnect and isolate the battery negative cable.
- (2) Raise and support the vehicle.
- (3) Disconnect the horn(s) wiring connector(s) (Fig. 8).

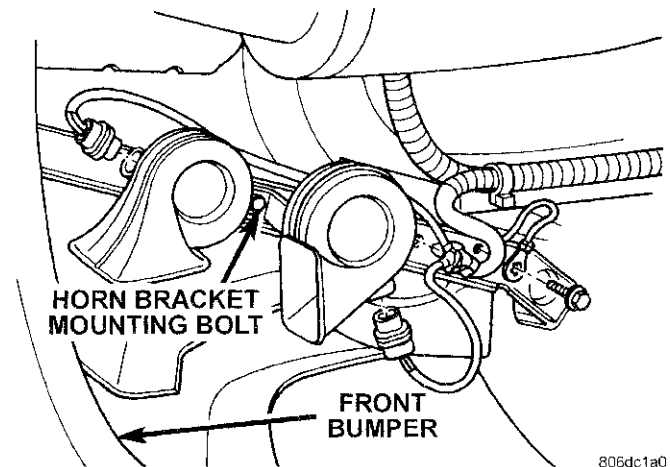


Fig. 8 Horn Remove/Install

(4) Remove the bolt holding the horn bracket to the bumper support and remove the horn(s).

(5) Reverse the removal procedures to install. Tighten the horn bracket mounting bolt to 28 N·m (20 ft. lbs.).

VEHICLE SPEED CONTROL SYSTEM

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GENERAL INFORMATION

INTRODUCTION

The vehicle speed control system is electronically controlled and vacuum operated. The system is designed to operate between approximately 35 and 85 mph (56 and 137 km/h). Following are general descriptions of the major components in the speed control system. Refer to Group 8W, Wiring Diagrams for complete circuit descriptions and wiring diagrams.

DESCRIPTION AND OPERATION

SPEED CONTROL SERVO

The speed control servo is mounted to a bracket under the battery tray on the left side of engine compartment. The servo unit consists of a solenoid valve body, a vacuum servo and the mounting bracket. The PCM controls the solenoid valve body. The solenoid valve body controls the application and release of vacuum to the diaphragm of the vacuum servo. The servo unit cannot be repaired and is serviced only as a complete assembly.

SPEED CONTROL SWITCH

The speed control switch module is mounted to the center of the steering wheel below the driver's airbag module. Three **momentary** contact switches, sup-

porting six different speed control functions are used. The outputs from these switches are filtered into one input. The Powertrain Control Module (PCM) determines which output has been applied through **resistive multiplexing**. The input circuit voltage is measured by the PCM to determine which switch function has been selected.

An indicator lamp (LED) located on the switch module is energized by the PCM. This occurs when the speed control system has been engaged.

The three switches are labeled: OFF/ON, RESUME/ACCEL, SET/DECEL. Refer to the owner's manual for more information on speed control switch functions and setting procedures. The individual switches cannot be repaired. If one individual switch fails, or the indicator lamp fails, the entire switch module must be replaced.

STOP LAMP SWITCH

Vehicles equipped with the speed control option use a dual function stop lamp switch. The switch is mounted in the same location as the conventional stop lamp switch, on the brake pedal mounting bracket under the instrument panel. The PCM monitors the state of the dual function stop lamp switch. Refer to Group 5, Brakes for more information on stop lamp switch service and adjustment procedures.

DESCRIPTION AND OPERATION (Continued)**SERVO CABLE**

The speed control servo cable is connected between the speed control vacuum servo diaphragm and the throttle body control linkage. This cable causes the throttle control linkage to open or close the throttle valve in response to movement of the vacuum servo diaphragm.

POWERTRAIN CONTROL MODULE

The speed control electronic control circuitry is integrated into the Powertrain Control Module (PCM). The PCM is located in the right-rear area of the engine compartment. The PCM speed control functions are monitored by the On-Board Diagnostics (OBD). All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for certain failures it detects. See On-Board Diagnostic Tests in this group for more information. The PCM cannot be repaired and must be replaced if faulty.

VACUUM RESERVOIR

The vacuum reservoir is mounted under the cowl intake air screen in the cowl plenum. The reservoir contains a one-way check valve to trap engine vacuum in the reservoir. When engine vacuum drops, as in climbing a grade while driving, the reservoir supplies the vacuum needed to maintain proper speed control operation. The vacuum reservoir cannot be repaired and must be replaced if faulty.

VEHICLE SPEED SENSOR

The Vehicle Speed Sensor (VSS) is a pulse generator mounted to an adapter near the transmission output shaft. The sensor is driven through the adapter by a speedometer pinion gear. The VSS pulse signal to the speedometer/odometer is monitored by the PCM speed control circuitry to determine vehicle speed and to maintain speed control set speed. Refer to the appropriate Powertrain Diagnostic Procedures manual for diagnosis and testing of this component. Refer to Group 14, Fuel System for removal/installation procedures.

DIAGNOSIS AND TESTING**ROAD TEST**

Perform a vehicle road test to verify reports of speed control system malfunction. The road test should include attention to the speedometer. Speedometer operation should be smooth and without flutter at all speeds.

Flutter in the speedometer indicates a problem which might cause surging in the speed control system. The cause of any speedometer problems should

be corrected before proceeding. Refer to Group 8E, Instrument Panel and Gauges for speedometer diagnosis.

If a road test verifies a system problem and the speedometer operates properly, check for:

- A misadjusted brake (stop) lamp switch. This could also cause an intermittent problem.
- Loose or corroded electrical connections at the servo. Corrosion should be removed from electrical terminals and a light coating of Mopar MultiPurpose Grease, or equivalent, applied.
- Loose or leaking vacuum hoses or connections.
- Secure attachment of both ends of the speed control servo cable.
- Smooth operation of throttle linkage and throttle body air valve.

CAUTION: When test probing for voltage or continuity at electrical connectors, care must be taken not to damage connector, terminals or seals. If these components are damaged, intermittent or complete system failure may occur.

ON-BOARD DIAGNOSTICS TEST

The Powertrain Control Module (PCM) monitors critical input and output circuits of the speed control system making sure they are operational. A Diagnostic Trouble Code (DTC) is assigned to each input and output circuit monitored by the On-Board Diagnostic (OBD) system. Some circuits are checked continuously and some are checked only under certain conditions.

If the OBD system senses that a monitored circuit is bad, it will put a DTC into electronic memory. The DTC will stay in electronic memory as long as the circuit continues to be bad. The PCM is programmed to clear the memory after 50 engine starts if the problem does not occur again.

DIAGNOSTIC TROUBLE CODES

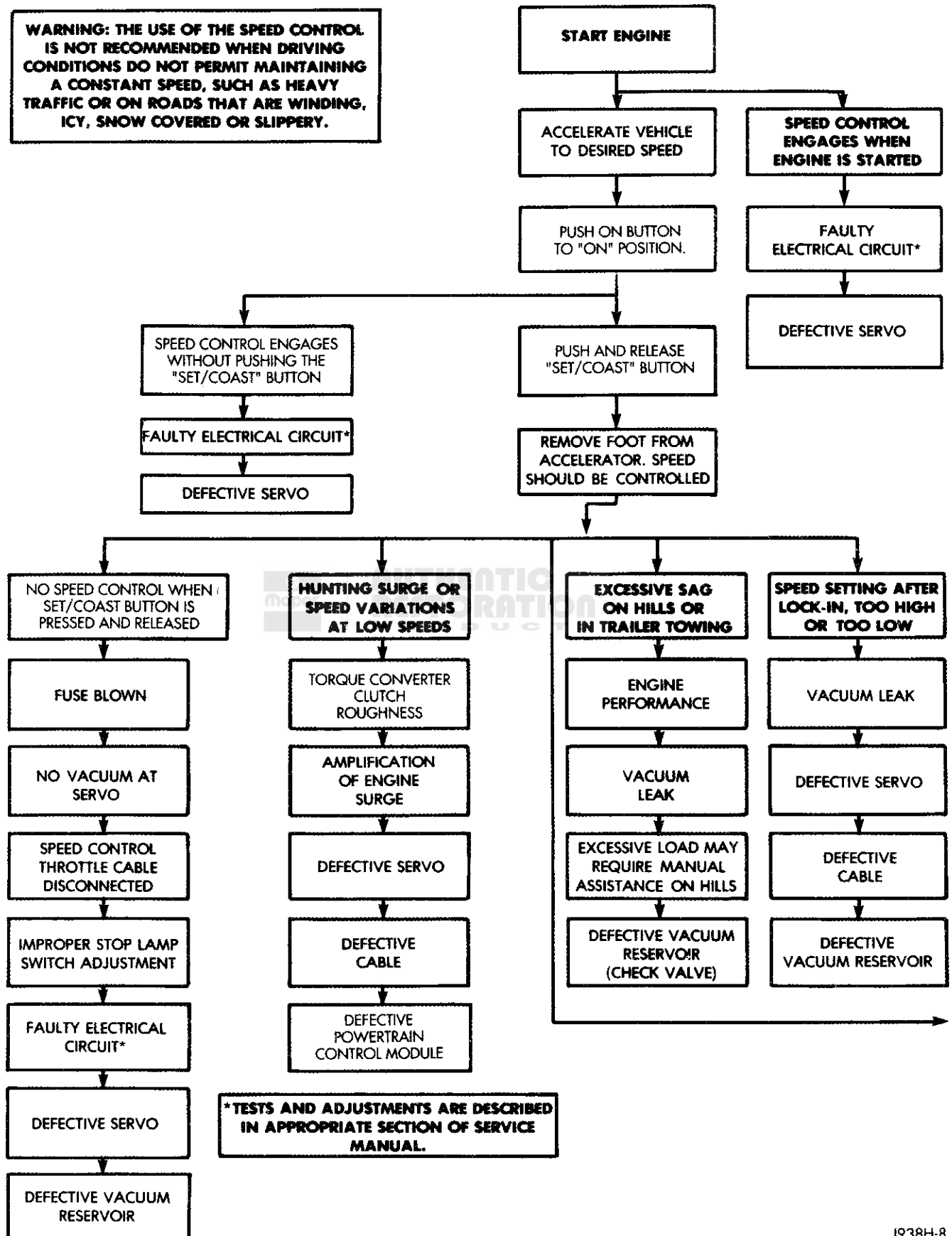
Diagnostic Trouble Codes (DTC's) are two-digit numbers flashed on the Malfunction Indicator (Check Engine) Lamp that identify which circuit is bad. A DTC description can also be read using the DRB scan tool. Refer to Group 25, Emission Control System for more DTC information.

A DTC does not identify which component in a circuit is bad. Thus, a DTC should be treated as a symptom, not as the cause for the problem. In some cases, because of the design of the diagnostic test procedure, a DTC can be the reason for another DTC to be set. Therefore, it is important that the test procedures be followed in sequence, to understand what caused a DTC to be set.

Refer to the following Speed Control Diagnostic Trouble Code chart for DTC's which apply to the

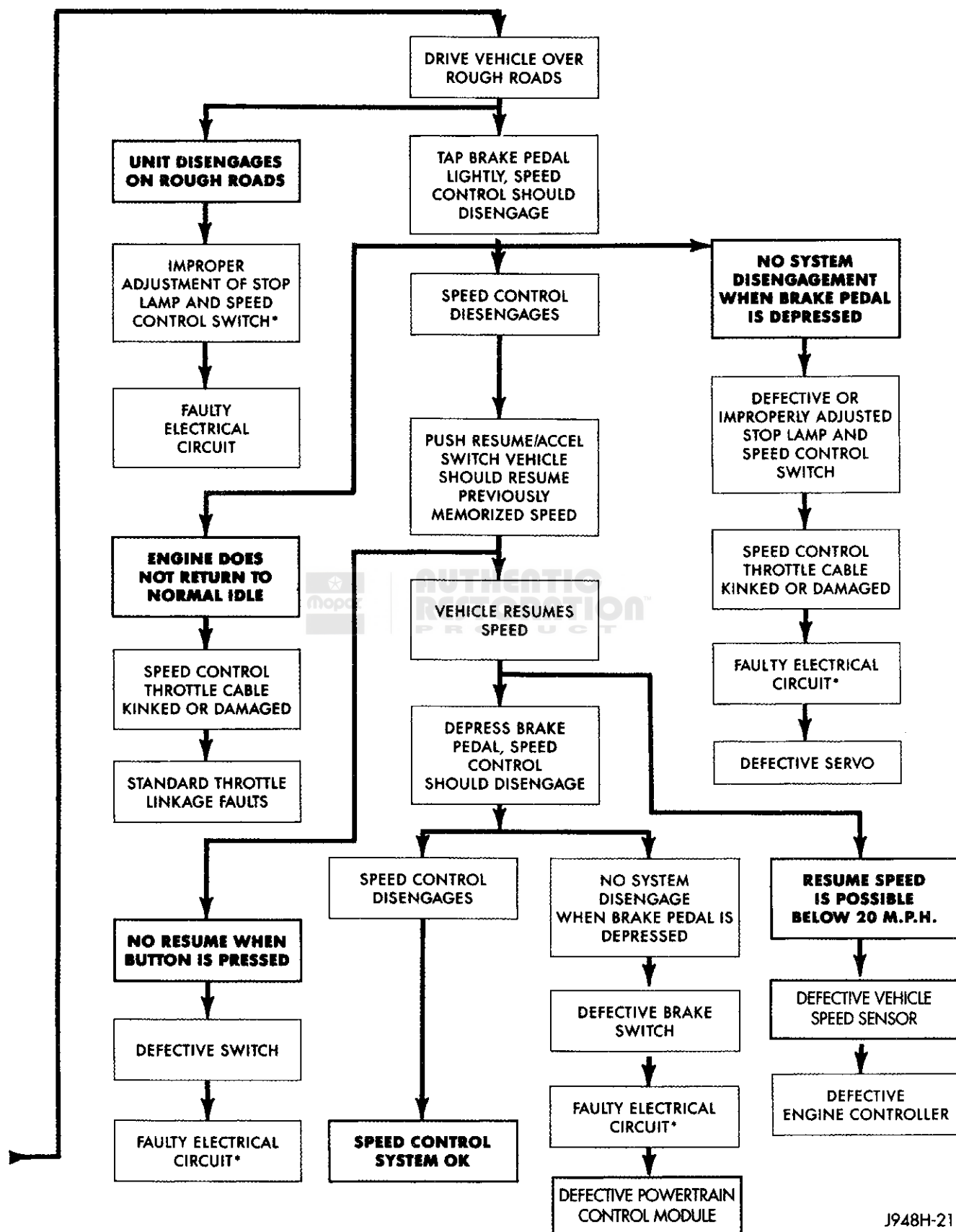
DIAGNOSIS AND TESTING (Continued)

WARNING: THE USE OF THE SPEED CONTROL IS NOT RECOMMENDED WHEN DRIVING CONDITIONS DO NOT PERMIT MAINTAINING A CONSTANT SPEED, SUCH AS HEAVY TRAFFIC OR ON ROADS THAT ARE WINDING, ICY, SNOW COVERED OR SLIPPERY.



DIAGNOSIS CHART 1—GAS ENGINE

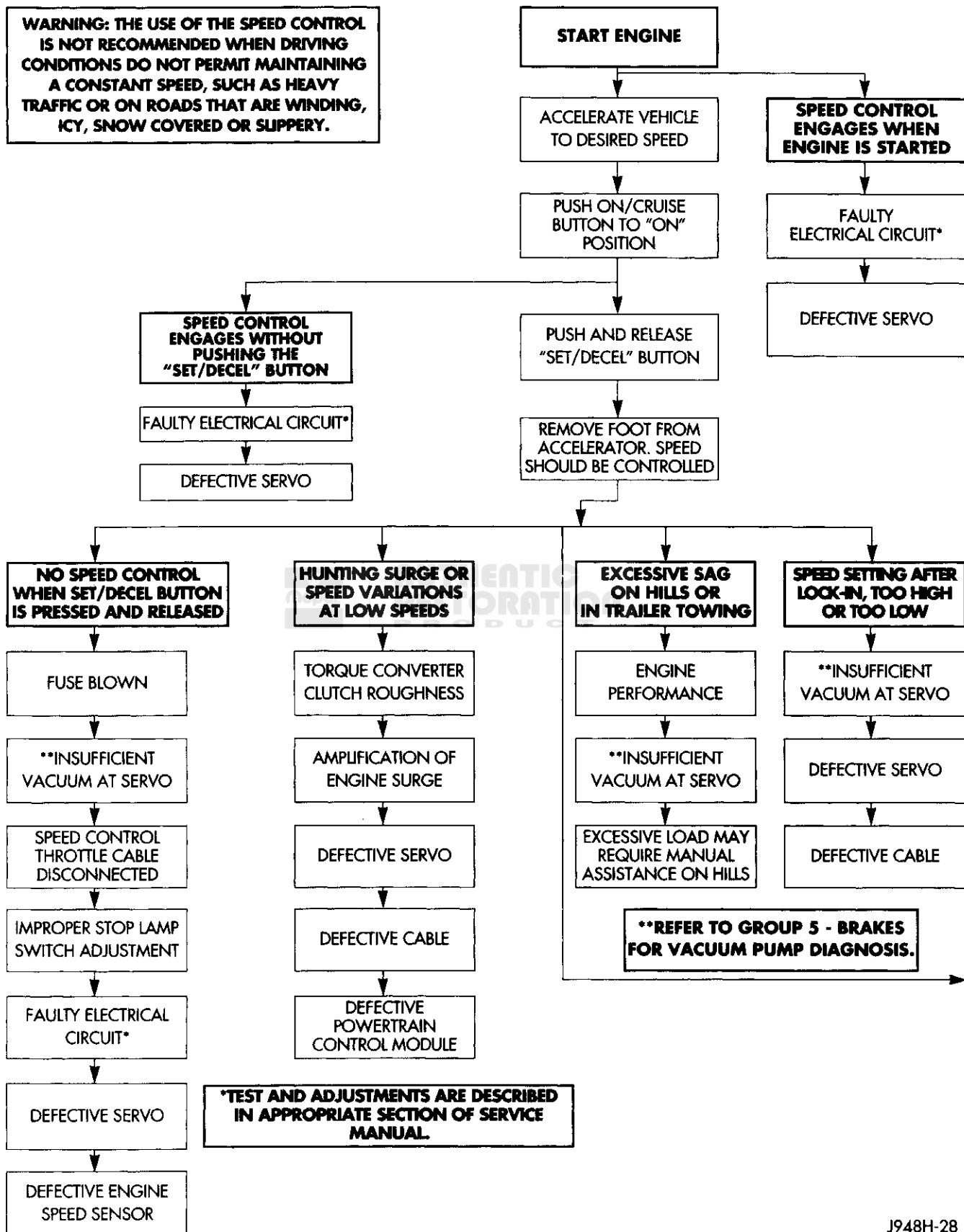
DIAGNOSIS AND TESTING (Continued)



DIAGNOSIS CHART 2—GAS ENGINE

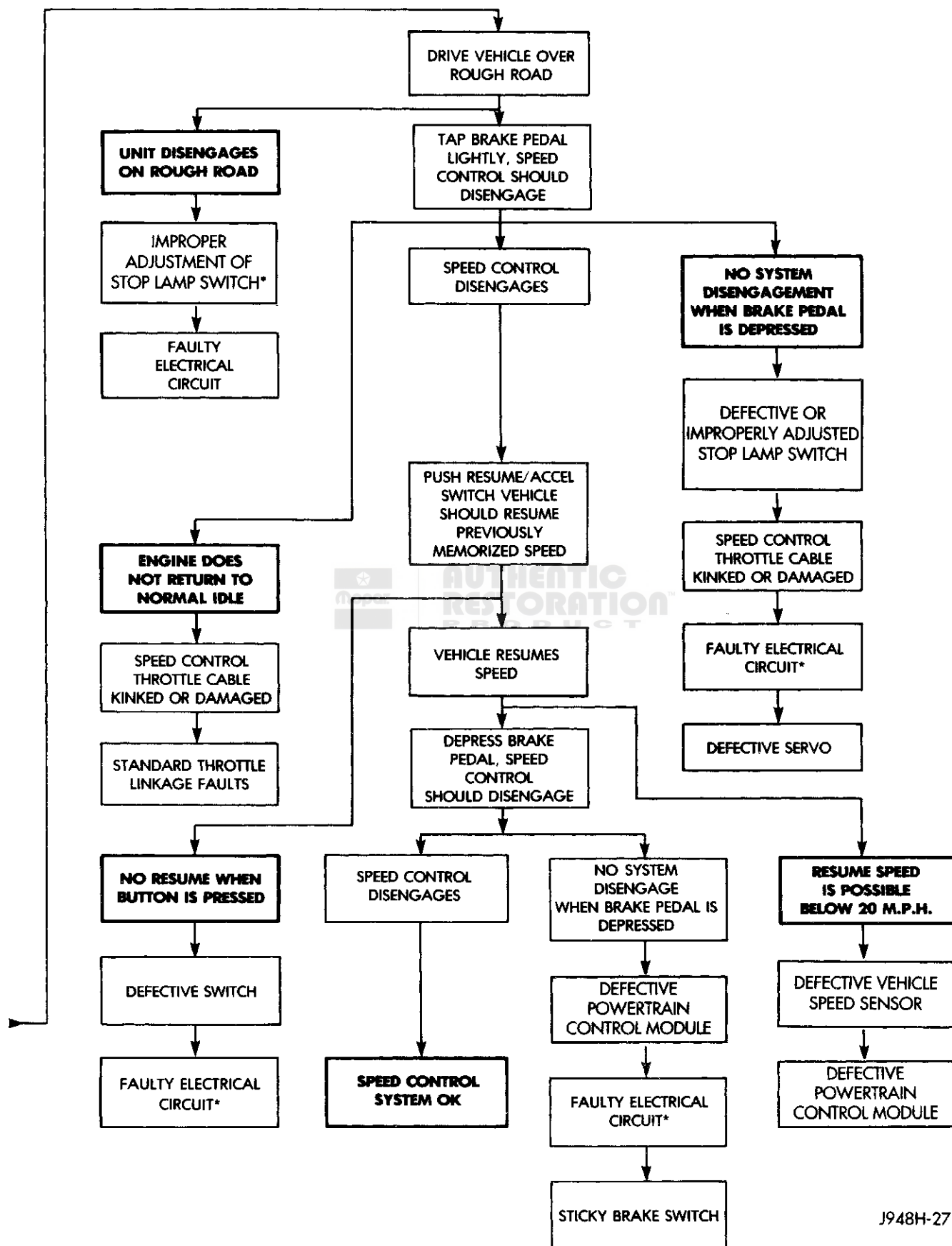
J948H-21

DIAGNOSIS AND TESTING (Continued)



DIAGNOSIS CHART 1—DIESEL ENGINE

DIAGNOSIS AND TESTING (Continued)



J948H-27

DIAGNOSIS CHART 2—DIESEL ENGINE

DIAGNOSIS AND TESTING (Continued)

speed control system. Refer to the appropriate Powertrain Diagnostic Procedures manual to diagnose an on-board diagnostic system trouble code.

RETRIEVING DIAGNOSTIC TROUBLE CODES

To start this function, cycle the ignition switch ON-OFF-ON-OFF-ON within 5 seconds. This will cause any DTC stored in the PCM memory to be displayed. The instrument panel mounted malfunction indicator (Check Engine) lamp will display a DTC by flashing on and off. There is a short pause between flashes and a longer pause between digits. All DTC's displayed are two-digit numbers, with an approximate four-second pause between codes.

An example of a DTC is as follows:

- (1) Lamp on for 2 seconds, then turns off.
- (2) Lamp flashes 1 time pauses and then flashes 5 times.
- (3) Lamp pauses for 4 seconds, flashes 3 times, pauses, then flashes 4 times.

The two DTC's are 15 and 34. Any number of DTC's can be displayed, as long as they are in memory. The lamp will flash until all stored DTC's are displayed. A DTC code number 55 signifies the end of tests.

If a DTC number 15 or 34 is observed, refer to the appropriate Powertrain Diagnostic Procedures manual. Correct any problems found in your diagnosis, then recheck for a DTC after corrections are completed. Use the DRB scan tool to erase a DTC after repair.

SPEED CONTROL ELECTRICAL TEST

Two different test methods may be used to check the electronic speed control system. One involves using the DRB scan tool. If this test method is desired, refer to the appropriate Powertrain Diagnostic Procedures service manual.

The other test method will involve the use of a volt/ohm meter. The volt/ohm meter method is

described within the tests on the following pages. Refer to Group 8W, Wiring Diagrams for speed control electrical schematics and connector location.

CAUTION: When test probing for voltage or continuity at electrical connectors, care must be taken not to damage connector, terminals or seals. If these components are damaged, intermittent or complete system failure may occur.

When electrical connections are removed, corrosion should be removed from electrical terminals and a light coating of Mopar Multi-Purpose Grease, or equivalent, should be applied.

Inspect connectors for damaged terminals. A poor electrical connection can cause a complete or intermittent malfunction. For this reason, a poor connection may be misdiagnosed as a component malfunction.

VEHICLE SPEED SENSOR

For diagnosis and testing of the speed sensor, refer to the appropriate Powertrain Diagnostic Procedures service manual.

SPEED CONTROL SWITCH

For complete speed control system diagnosis, refer to the appropriate Powertrain Diagnostic Procedures manual. To test the speed control switch only, refer to the following:

WARNING: BEFORE ATTEMPTING TO DIAGNOSE, REMOVE OR INSTALL ANY AIRBAG SYSTEM OR RELATED STEERING WHEEL AND STEERING COLUMN COMPONENTS, YOU MUST FIRST DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE. WAIT 2 MINUTES FOR SYSTEM CAPACITOR TO DISCHARGE BEFORE FURTHER SYSTEM SERVICE. FAILURE TO DO SO COULD RESULT IN ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

SPEED CONTROL DIAGNOSTIC TROUBLE CODES

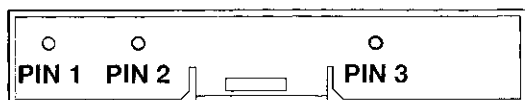
Diagnostic Trouble Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
15**	No Vehicle Speed Sensor Signal	No vehicle distance (speed) sensor signal detected during road load conditions.
34*	Speed Control Solenoid Circuits	An open or shorted condition detected in the Speed Control vacuum or vent solenoid circuits.
55*	N/A	Completion of fault code display on Check Engine Lamp.
* Check Engine Lamp will not illuminate at all times if this Diagnostic Trouble Code was recorded. Cycle ignition key as described in manual and observe code flashed by Check Engine Lamp.		
** Check Engine Lamp will illuminate during engine operation if this Diagnostic Trouble Code was recorded.		

DIAGNOSIS AND TESTING (Continued)

(1) Disconnect negative battery cable. Wait 2 minutes for airbag system capacitor to discharge.

(2) Remove speed control switch module from steering wheel. Refer to the removal/installation section for procedures.

(3) Check speed control switch module continuity as shown in chart (Fig. 1). If OK, reinstall switch. If not OK, replace switch module assembly. The individual switches and the indicator lamp can not be serviced separately.

REAR VIEW OF SWITCH

SWITCH POSITION	RESISTANCE BETWEEN PINS 2 AND 3	RESISTANCE BETWEEN PINS 1 AND 2
NO SWITCHES DEPRESSED	OPEN CIRCUIT	806 ohms +/- 8 ohms
ON	909 ohms +/- 9 ohms	
RESUME/ACCEL	15,400 ohms +/- 154 ohms	
SET/COAST	6650 ohms +/- 66 ohms	

80468d39

Fig. 1 Speed Control Switch Continuity**STOP LAMP SWITCH**

For continuity checks and switch adjustment, refer to Group 5, Brakes.

VACUUM SUPPLY TEST

(1) Gain access to vacuum reservoir. Refer to Removal/Installation section for procedures.

(2) Disconnect vacuum hose at the servo and install a vacuum gauge into the disconnected hose.

(3) Start engine and observe gauge at idle. Vacuum gauge should read at least ten inches of mercury.

(4) If vacuum does not meet this requirement, check for vacuum leaks or poor engine performance. On diesel powered engines, refer to Group 5, Brakes for vacuum pump diagnosis.

SPEED CONTROL SERVO

For complete speed control system diagnosis, refer to the appropriate Powertrain Diagnostic Procedures manual. To test the speed control servo only, refer to the following:

The engine must be started and running for the following voltage tests.

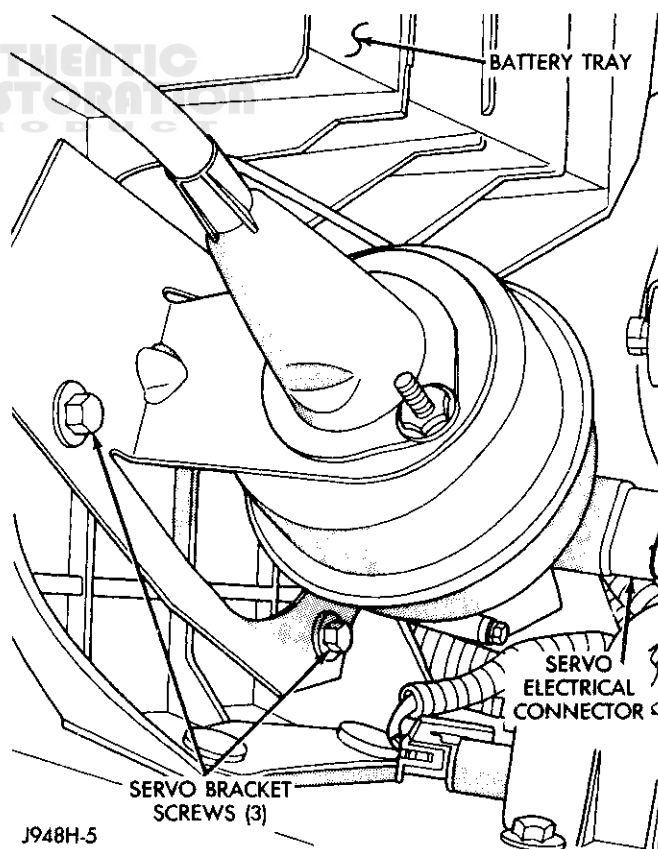
(1) Start engine.

(2) Disconnect 4-way electrical connector at servo (Fig. 2).

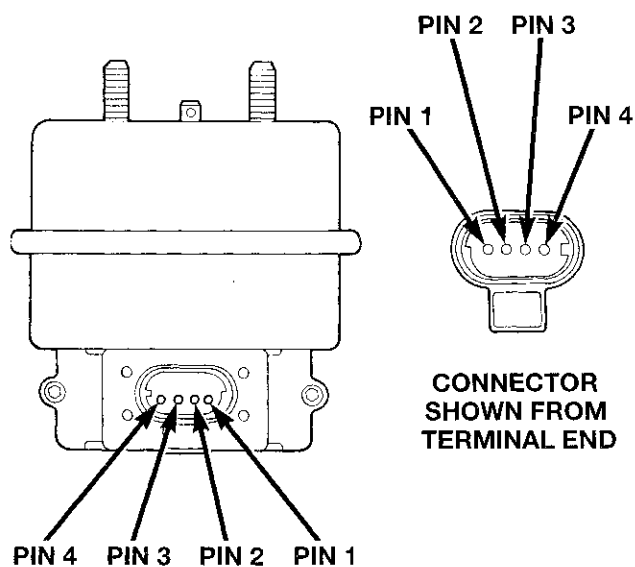
(3) Turn speed control switch to ON position.

(4) Check for battery voltage at pin-3 of wiring harness 4-way connector (Fig. 3). This is the 12 volt feed from the stoplamp switch. When the brake pedal is depressed, voltage should not be present at pin-3. If voltage is not present with brake pedal **not** depressed, check for continuity between servo and stop lamp switch. Also check stop lamp switch adjustment. Refer to Group 5, Brakes for procedures.

(5) Connect a small gauge jumper wire between the disconnected servo harness 4-way connector pin-3, and pin-3 on the servo. Check for battery voltage at pins-1, 2 and 4 of the servo. If battery voltage is not at these pins, replace the servo.

**Fig. 2 Speed Control Servo Location**

(6) Turn ignition switch to OFF position. Check for continuity between disconnected servo harness

DIAGNOSIS AND TESTING (Continued)

80468d3a

Fig. 3 Servo 4-Way Harness Connector

4-way connector pin-4 and a good ground. There should be continuity. If not OK, repair open circuit to ground as required.

POWERTRAIN CONTROL MODULE (PCM)

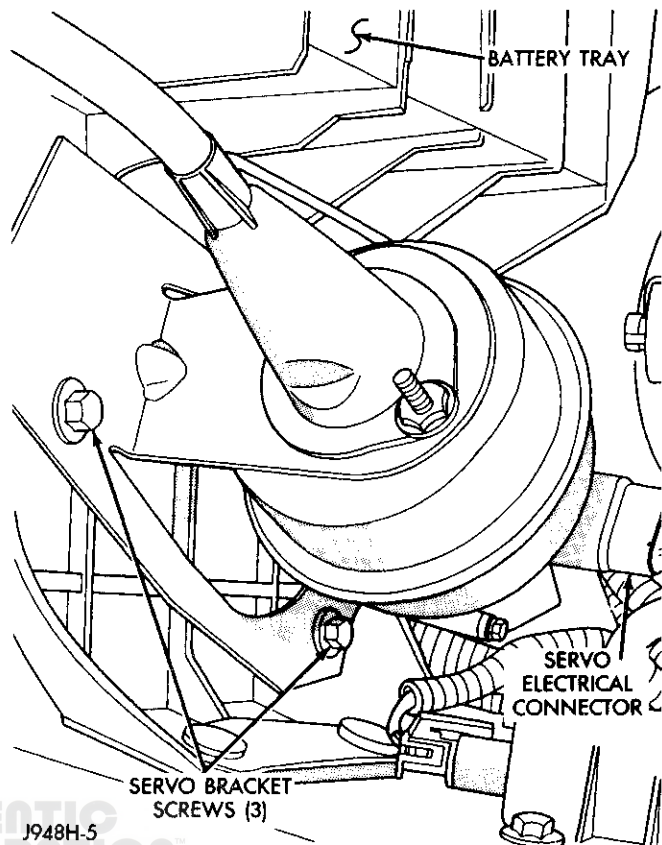
For complete PCM diagnosis on the speed control system, refer to the DRB scan tool and the appropriate Powertrain Diagnostic Procedures manual.

REMOVAL AND INSTALLATION**SPEED CONTROL SERVO****V-6/V-8 GAS ENGINES—REMOVAL**

- (1) Disconnect vacuum hose at servo (Fig. 4).
- (2) Disconnect electrical connector at servo.
- (3) Remove 2 nuts from cable sleeve.
- (4) Pull speed control cable away from servo to expose cable hairpin clip.
- (5) Remove hairpin clip attaching cable to servo.
- (6) Pull servo away from mounting bracket.

INSTALLATION

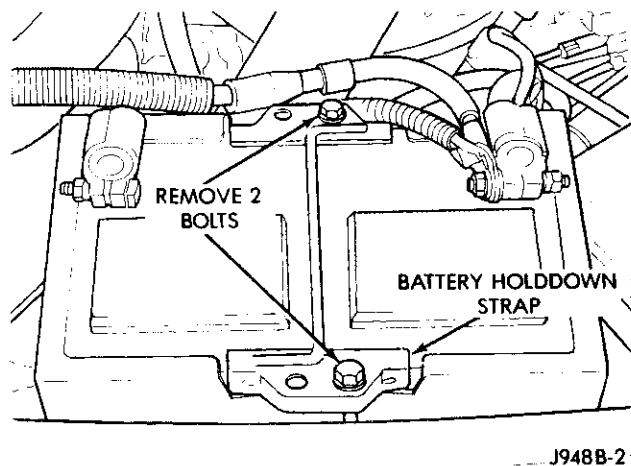
- (1) Insert servo studs through holes in servo mounting bracket.
- (2) With throttle blocked to full open position, align hole in cable sleeve with hole in servo pin and install hairpin clip.
- (3) Insert servo studs through holes in cable sleeve.
- (4) Install 2 attaching nuts and tighten to 6 N·m (50 in. lbs.) torque.
- (5) Connect vacuum hose to servo.

**Fig. 4 Servo Removal/Installation**

- (6) Connect electrical connector to servo terminals.

8.0L V-10 AND 5.9L DIESEL ENGINE—REMOVAL

- (1) Disconnect both battery cables, negative cables first.
- (2) Remove 2 bolts and battery holddown (Fig. 5).

**Fig. 5 Battery Holddown**

- (3) If equipped, pull up on battery heat shield to remove it (Fig. 6).

REMOVAL AND INSTALLATION (Continued)

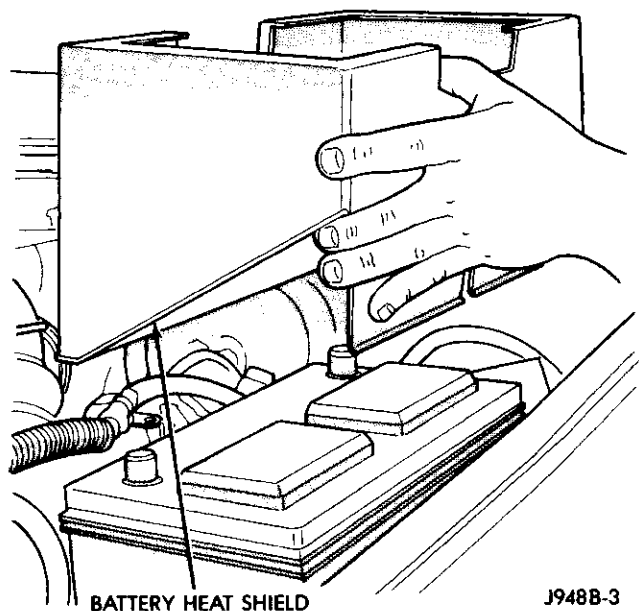


Fig. 6 Battery Heat Shield

- (4) Remove battery from vehicle.
- (5) From under left front wheel opening, remove 2 forward battery tray nuts (Fig. 7).

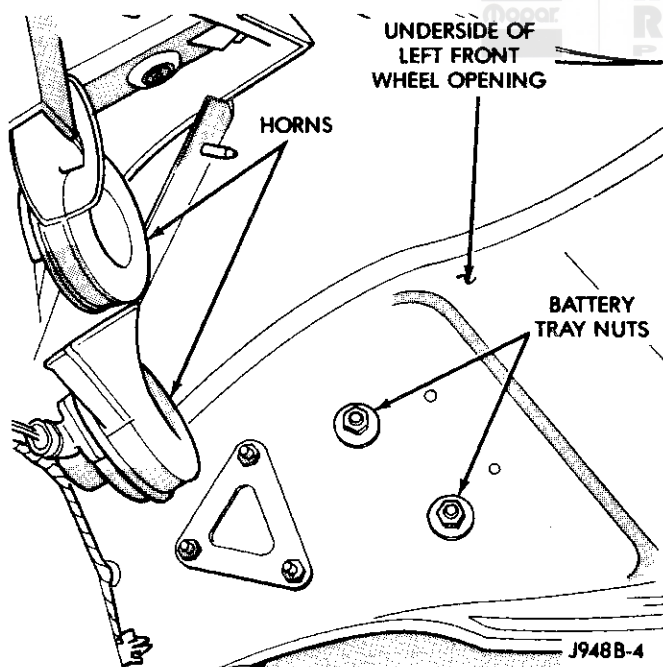


Fig. 7 Forward Battery Tray Nuts

- (6) Remove 2 nuts and 2 bolts holding battery tray to vehicle (Fig. 8).
- (7) Lift battery tray up far enough for access to speed control servo electrical connector (Fig. 9).
- (8) Unplug electrical connector.
- (9) Remove 2 nuts from cable sleeve.

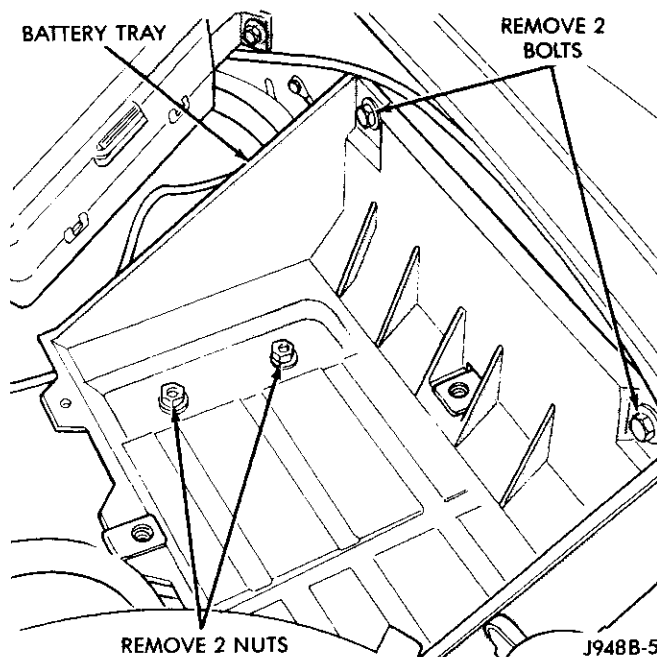


Fig. 8 Battery Tray Mounting

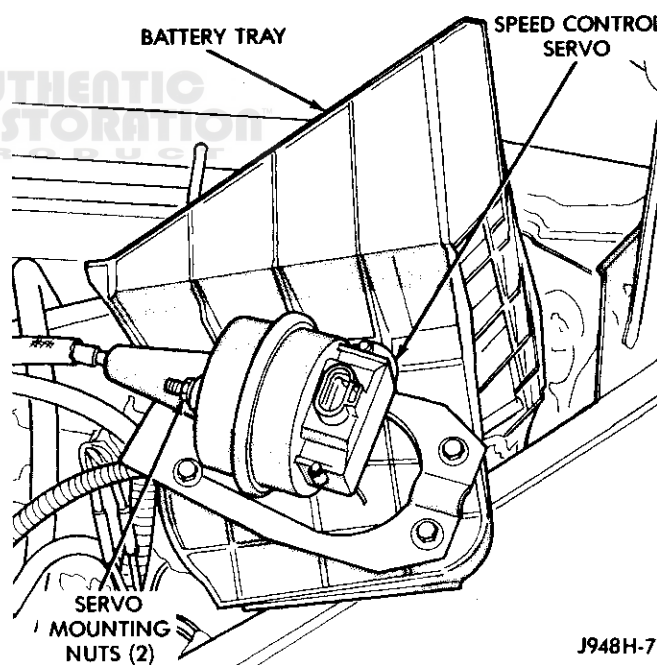
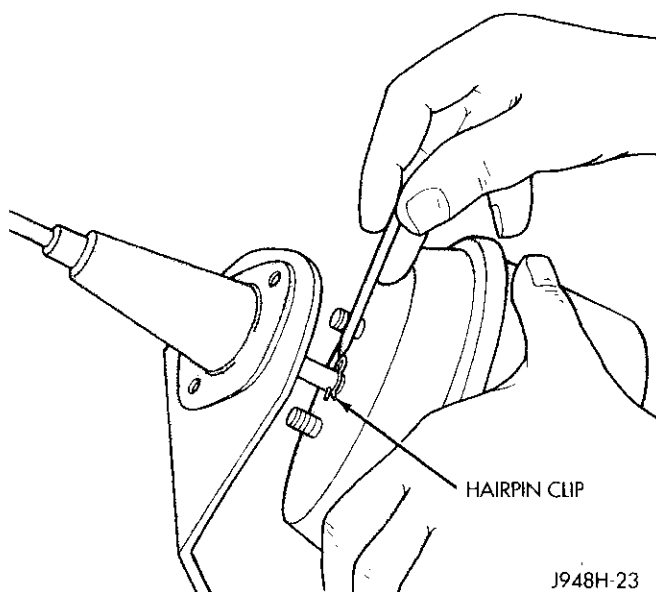


Fig. 9 Servo Mounting

- (10) Pull speed control cable away from servo to expose cable hairpin clip (Fig. 10).
- (11) Remove hairpin clip attaching cable to servo.
- (12) Pull servo away from mounting bracket.

INSTALLATION

- (1) Insert servo studs through holes in servo mounting bracket.

REMOVAL AND INSTALLATION (Continued)**Fig. 10 Servo Cable Hairpin Clip**

(2) With throttle blocked to full open position, align hole in cable sleeve with hole in servo pin and install hairpin clip.

(3) Insert servo studs through holes in cable sleeve.

(4) Install 2 attaching nuts and tighten to 6 N·m (50 in. lbs.) torque.

(5) Connect vacuum hose to servo.

(6) Connect electrical connector to servo terminals.

(7) Install battery tray. Tighten all battery tray mounting hardware to 16 N·m (140 in. lbs.) torque.

(8) Install battery in vehicle making sure battery is properly positioned on battery tray.

(9) If equipped, install battery heat shield.

(10) Install battery holddown clamp, making sure it is properly positioned on battery. Tighten bolt to 4 N·m (35 in. lbs.) torque.

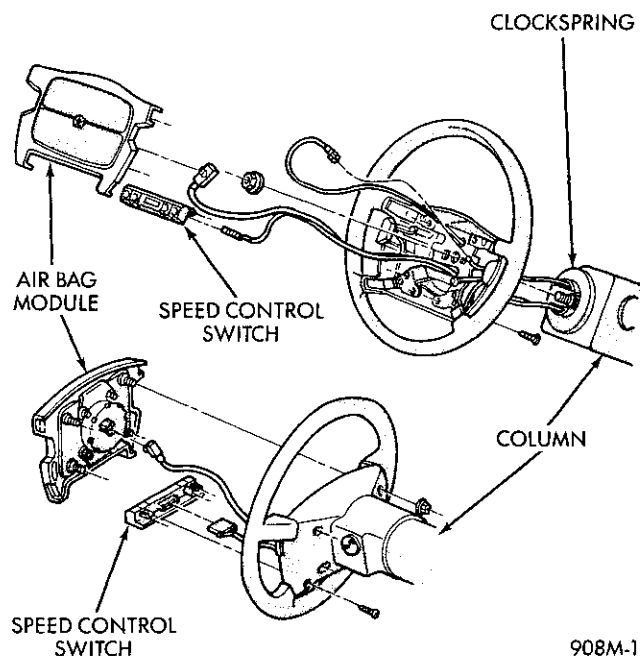
SPEED CONTROL SWITCH

WARNING: BEFORE ATTEMPTING TO DIAGNOSE, REMOVE OR INSTALL ANY AIRBAG SYSTEM OR RELATED STEERING WHEEL AND STEERING COLUMN COMPONENTS YOU MUST FIRST DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE. WAIT 2 MINUTES FOR SYSTEM CAPACITOR TO DISCHARGE BEFORE FURTHER SYSTEM SERVICE. FAILURE TO DO SO COULD RESULT IN ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

REMOVAL

(1) Disconnect and isolate negative battery cable from battery.

(2) From underside of steering wheel, remove 2 speed control switch mounting screws (Fig. 11).

**Fig. 11 Speed Control Switch Remove/Install**

(3) Pull switch module assembly from wheel and unplug electrical connector.

INSTALLATION

(1) Plug electrical connector into switch module.

(2) Install switch with 2 screws.

(3) Tighten screws to 1.5 N·m (15 in. lbs.) torque

STOP LAMP SWITCH

Refer to Group 5, Brakes for removal/installation and adjustment procedures.

SERVO CABLE**REMOVAL/INSTALLATION**

(1) Remove air cleaner (all except V-10 and diesel engine).

(2) Using finger pressure only, remove speed control cable connector at bellcrank by pushing connector off the bellcrank (Fig. 12), (Fig. 13) or (Fig. 14). DO NOT try to pull connector off perpendicular to the bellcrank.

(3) Squeeze tabs on speed control cable and push out of locking plate.

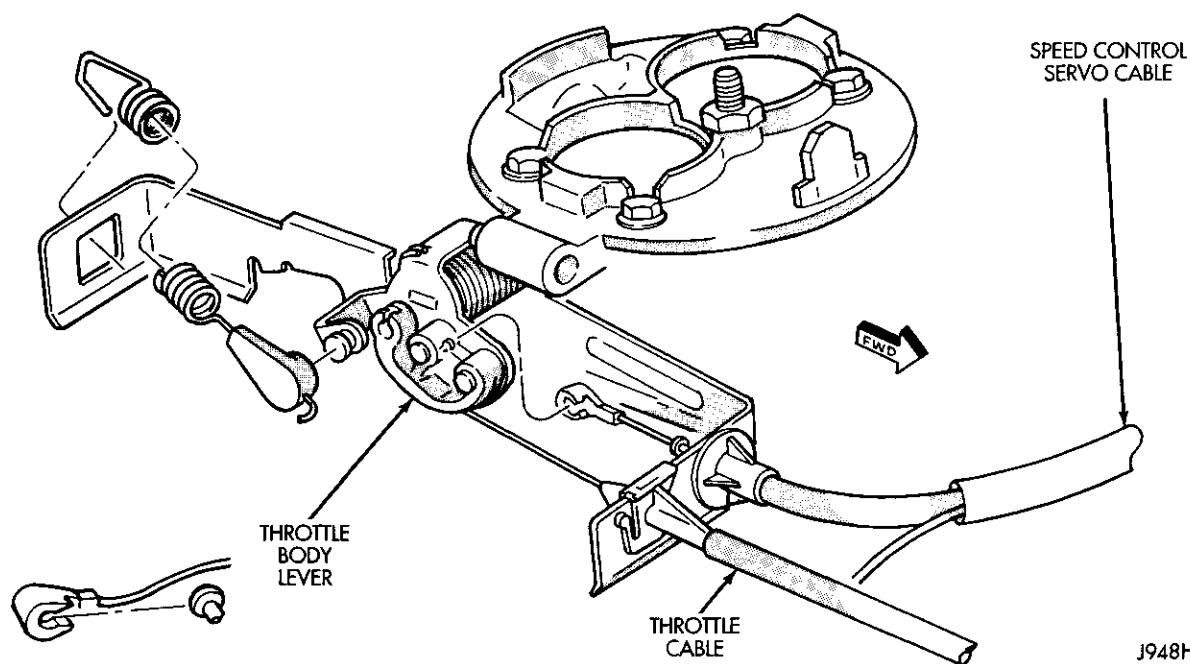
(4) Remove servo cable from servo as described in Speed Control Servo Remove/Install.

(5) Reverse removal procedures to install.

POWERTRAIN CONTROL MODULE

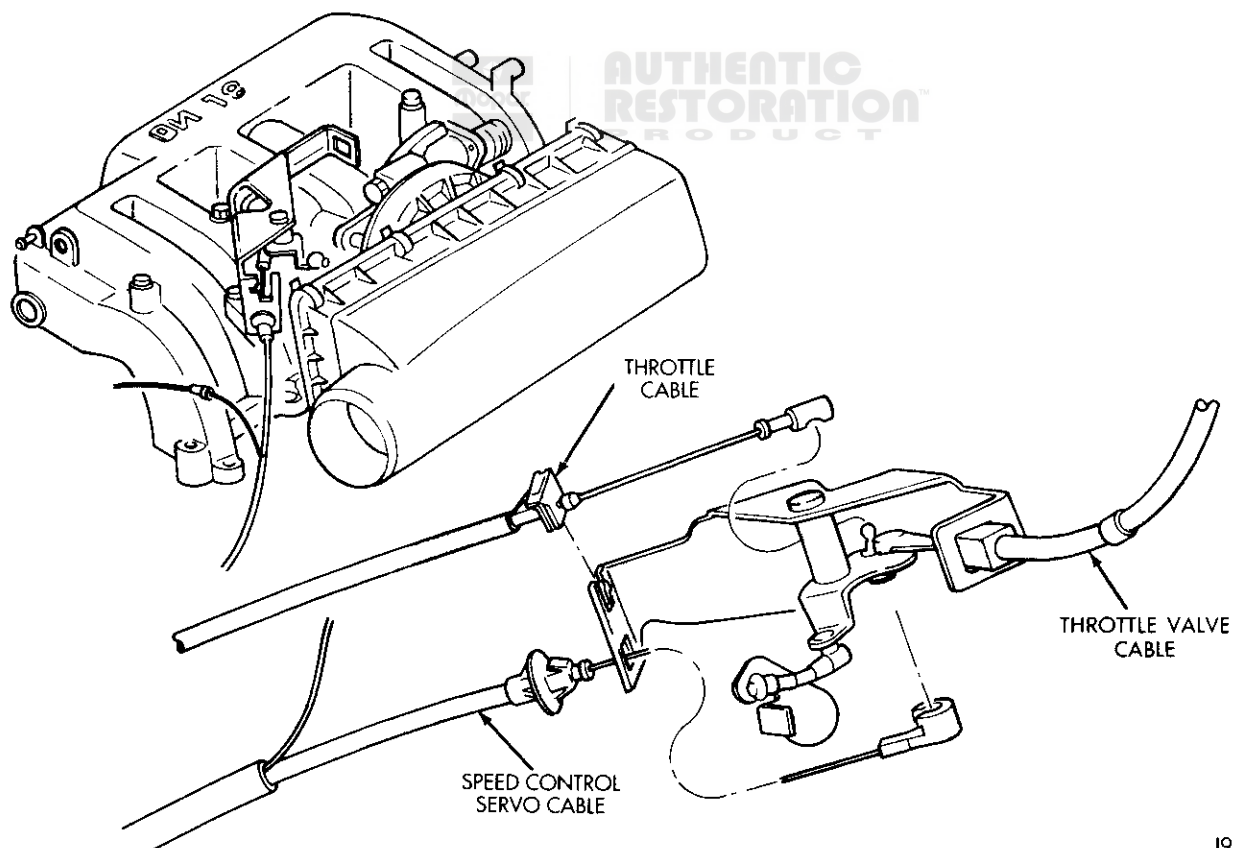
For Removal/Installation refer to Group 14, Fuel Injection System.

REMOVAL AND INSTALLATION (Continued)



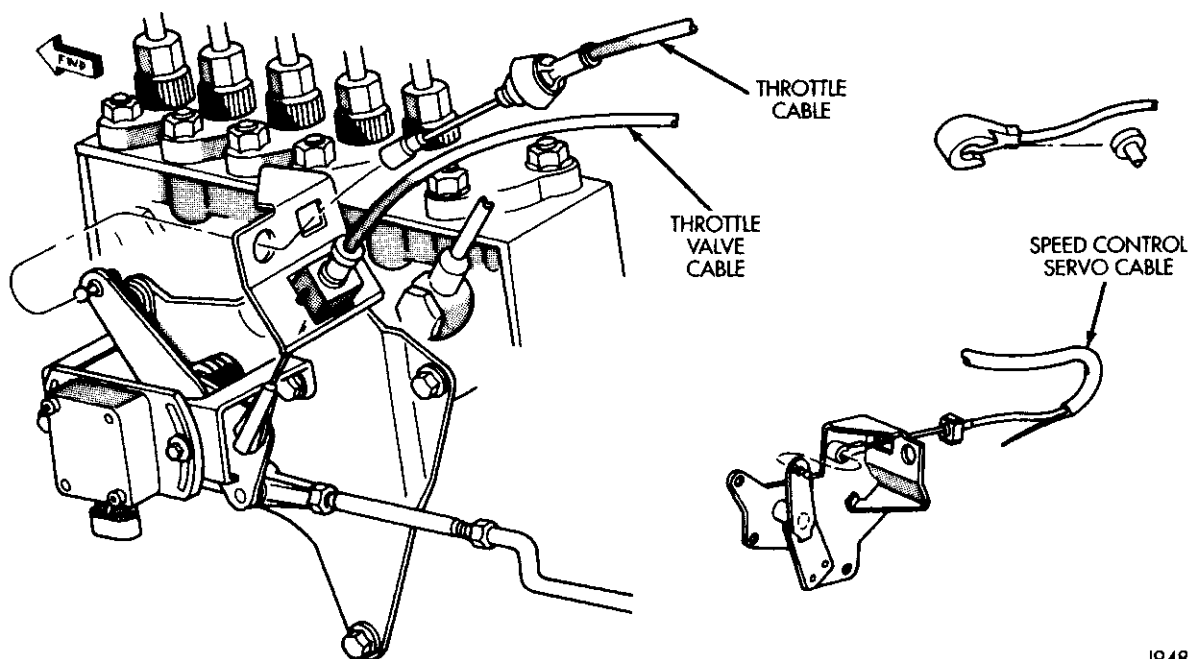
J948H-11

Fig. 12 Servo Cable—V-6/V-8 Engine



J948H-10

Fig. 13 Servo Cable—V-10 Engine

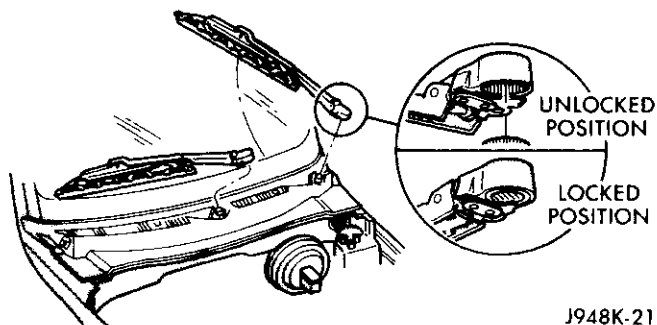
REMOVAL AND INSTALLATION (Continued)

J948H-12

Fig. 14 Servo Cable—Diesel Engine**VACUUM RESERVOIR****REMOVAL/INSTALLATION**

(1) Lift wiper arm to permit the latch (Fig. 15) to be pulled out to the holding position. Remove arms from pivots using a rocking motion.

CAUTION: The use of a screwdriver or other prying tool to remove a wiper arm may distort it. This distortion could allow the arm to come off the pivot shaft, regardless of how carefully it is installed.



J948K-21

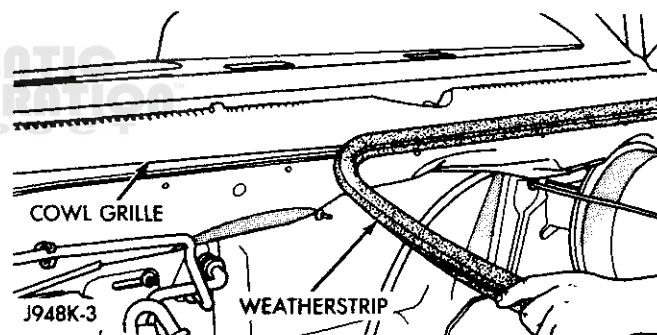
Fig. 15 Removing Wiper Arms

(2) Remove weather-strip along front edge of cowl screen (Fig. 16).

(3) Release plastic anchor screws (Fig. 17).

(4) Move cowl screen aside far enough to access reservoir in right cowl plenum area.

(5) Remove 2 push nuts and slide vacuum reservoir off studs (Fig. 18).

**Fig. 16 Cowl Screen Weather-strip**

(6) Disconnect all hoses.

(7) Reverse removal procedures to install. Refer to Group 8K, Wiper and Washer Systems for correct indexing of wiper arms.

VEHICLE SPEED SENSOR

For Removal/Installation of the Vehicle Speed Sensor refer to Group 14, Fuel System.

SPECIFICATIONS**TORQUE SPECIFICATIONS****Description****Torque**

Servo Mounting Bracket Nuts.8.5 N·m (75 in. lbs.)

Switch Module Mounting

Screws1.5 N·m (15 in. lbs.)

8H - 14 VEHICLE SPEED CONTROL SYSTEM
SPECIFICATIONS (Continued)

BR

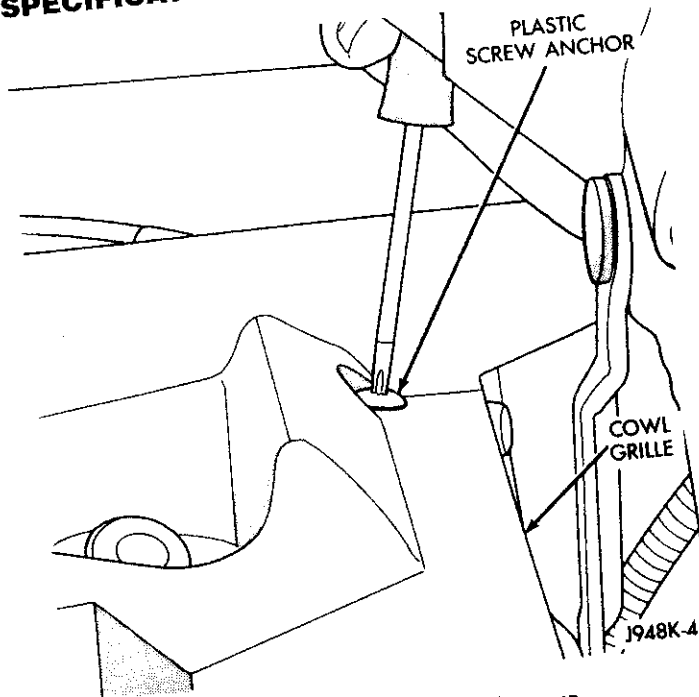


Fig. 17 Plastic Anchor Screws

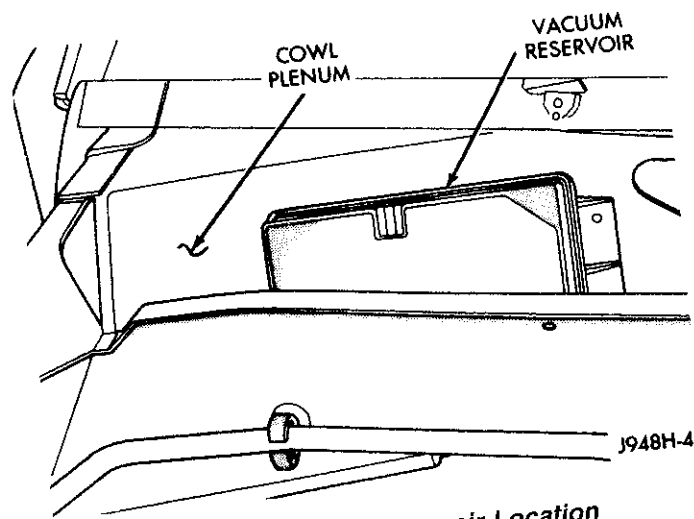


Fig. 18 Vacuum Reservoir Location



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PRODUCT

TURN SIGNAL AND HAZARD WARNING SYSTEMS

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TURN SIGNAL FLASHER	1	REMOVAL AND INSTALLATION	
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GENERAL INFORMATION

INTRODUCTION

Following are general descriptions of the major components in the turn signal and hazard warning systems. Refer to 8W-52 - Turn Signals in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

TURN SIGNAL SYSTEM

With the ignition switch in the On or Accessory position, and the multi-function switch control lever moved up (right turn) or down (left turn), the turn signal system is activated.

When the turn signal system is activated, the selected (right or left) turn signal indicator lamp, front park/turn signal lamp and rear tail/stop/turn signal lamp bulbs will flash.

HAZARD WARNING SYSTEM

The hazard warning system is activated by a switch button in the multi-function switch. The button is located on the top of the steering column between the steering wheel and the instrument panel. The hazard warning switch button is identified with a double triangle.

The hazard warning system is connected to an unswitched battery feed so that the system remains functional, regardless of the ignition switch position. Push the switch button in to activate the hazard warning system, and push in on the button again to turn the system off. When the hazard warning system is activated, the right and left turn signal indi-

cators, front park/turn signal lamps and rear tail/stop/turn signal lamps will flash.

TURN SIGNAL FLASHER

The turn signal flasher contains one fixed contact point, and one contact point attached to a flexible bimetal arm. The contact points are normally closed. When a turn signal is activated, current flows through the flasher. As the current flows through the bimetal arm, it heats and flexes to pull the contact points open, stopping current flow. As the bimetal arm cools, it straightens until the contact points close, then the cycle repeats.

The standard turn signal flasher is designed to handle the current flow requirements of the factory-installed lighting. If supplemental lighting is added to the turn signal circuits, such as when towing a trailer with lights, the current flow through the flasher increases. This causes the flash rate to increase. It is recommended that the standard flasher be replaced with a heavy-duty (hazard warning) flasher when supplemental lighting is added.

However, when a turn signal bulb fails with a standard flasher, the remaining bulbs in that circuit will light, but not flash. This will give the driver an indication to check the turn signal bulbs. Because a heavy-duty flasher has different internal circuitry, a failed bulb will not prevent the remaining bulbs in the circuit from flashing. Therefore, it is recommended that an occasional visual inspection of exterior turn signal lamp operation be performed, when a heavy-duty flasher has been installed in the place of the standard flasher.

HAZARD WARNING FLASHER

The hazard warning flasher contains two normally open contact points mounted to two movable arms. A

DESCRIPTION AND OPERATION (Continued)

bimetal strip is attached between the two arms. When the hazard warning switch is activated, current flows through the flasher. As the current flows through the bimetal strip it heats and pulls the movable arms together until the contact points close, allowing current flow to the lamps. As the bimetal strip cools, the contact points are pushed open and the cycle repeats.

MULTI-FUNCTION SWITCH

The multi-function switch assembly is mounted to the left side of the steering column (Fig. 1). This switch contains circuitry for the following functions:

- Turn signals
- Hazard warning
- Headlamp beam selection
- Headlamp optical horn
- Windshield wipers
- Windshield washers.

The information contained in this group addresses only the switch functions for the turn signal and hazard warning circuits. For information relative to the other switch functions, refer to the appropriate group. However, the multi-function switch cannot be repaired. If any function of the switch is faulty, the entire switch assembly must be replaced.

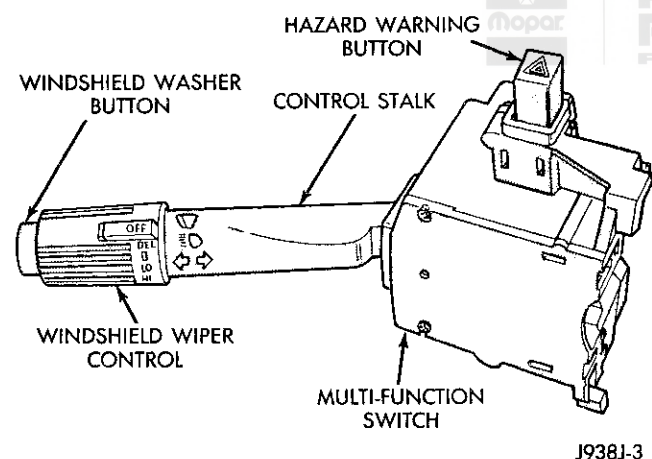


Fig. 1 Multi-Function Switch

TURN SIGNAL INDICATOR LAMPS

The turn signal indicator lamps are located in the instrument cluster. They flash with the exterior turn signal lamps to give the driver a visual indication that a turn signal or the hazard warning system is operating. For diagnosis and service of this component, refer to Group 8E - Instrument Panel Systems.

TURN SIGNAL LAMPS

The exterior lamps in the turn signal and hazard warning circuits include the front park/turn signal,

and the rear tail/stop/turn signal. For diagnosis and service of these lamps, refer to Group 8L - Lamps.

DIAGNOSIS AND TESTING**INTRODUCTION**

When diagnosing the turn signal or hazard warning circuits, remember that high generator output can burn out bulbs rapidly and repeatedly. If this is a problem on the vehicle being diagnosed, refer to Group 8C - Charging System for further diagnosis.

WARNING: ON VEHICLES EQUIPPED WITH AN AIRBAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

TURN SIGNAL SYSTEM

For circuit descriptions and diagrams, refer to 8W-52 - Turn Signals in Group 8W - Wiring Diagrams.

(1) Turn the ignition switch to the On position. Move the turn signal lever down for a left turn signal problem, or up for a right turn signal problem. Observe the turn signal indicator lamp in the instrument cluster. If the lamp lights but does not flash, check for an exterior turn signal lamp that is not lit. Replace the faulty bulb or repair the circuits to that lamp, as required. Test the turn signal operation again. If the turn signal indicator lamp does not light or still doesn't flash, go to Step 2.

(2) Check the fuse in the fuseblock module. If OK, go to Step 3. If not OK, replace the faulty fuse.

(3) With the ignition switch in the On position, check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) With the ignition switch in the On position, place the turn signal lever in the neutral position. There should be battery voltage at the fused ignition switch output circuit cavity for the turn signal flasher. If OK, go to Step 5. If not OK, repair the open circuit as required.

(5) Replace the turn signal flasher with a known good unit of the same rating. The lamps should flash. If OK, discard the faulty flasher. If not OK, re-install the original flasher and go to Step 6.

DIAGNOSIS AND TESTING (Continued)

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

(6) Check for continuity between the turn signal flasher signal circuit cavities for the turn signal flasher and in the multi-function switch connector. There should be continuity. If OK, see the diagnosis for the multi-function switch in this group. If not OK, repair the open circuit as required.

HAZARD WARNING SYSTEM

For circuit descriptions and diagrams, refer to 8W-52 - Turn Signals in Group 8W - Wiring Diagrams.

(1) Check the fuse in the Power Distribution Center (PDC). If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Check for battery voltage at the fused B(+) circuit cavity for the hazard warning flasher. If OK, go to Step 3. If not OK, repair the open circuit as required.

(3) Replace the hazard flasher with a known good unit of the same rating. With the hazard warning switch in the On position, the lamps should flash. If OK, discard the faulty flasher. If not OK, re-install the original flasher and go to Step 4.

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

(4) Check for continuity between the hazard flasher signal circuit cavities for the hazard flasher and in the multi-function switch connector. There should be continuity. If OK, see the diagnosis for the multi-function switch in this group. If not OK, repair the open circuit as required.

MULTI-FUNCTION SWITCH

Perform the diagnosis of the hazard warning and/or turn signal systems as described in this group before testing the multi-function switch. For circuit descriptions and diagrams, see 8W-52 - Turn Signals in Group 8W - Wiring Diagrams.

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

DIAGNOSIS AND TESTING (Continued)

- (1) Disconnect the multi-function switch connector as described in this group.
- (2) Using an ohmmeter, perform the switch continuity checks at the switch terminals as shown in the chart (Fig. 2).
- (3) If the switch fails any of the continuity checks, replace the faulty switch. If the switch is OK, repair the lighting circuits as required.

REMOVAL AND INSTALLATION

HAZARD WARNING/TURN SIGNAL FLASHER

- (1) Disconnect and isolate the battery negative cable.
- (2) Open the driver's door and remove the snap-in fuseblock module cover on the left end of the instrument panel (Fig. 3).
- (3) Unplug the flasher from the fuseblock module.
- (4) To install the flasher, align the terminals with the cavities in the fuseblock module and push the flasher firmly into place.
- (5) Reverse the remaining removal procedures to complete the installation.

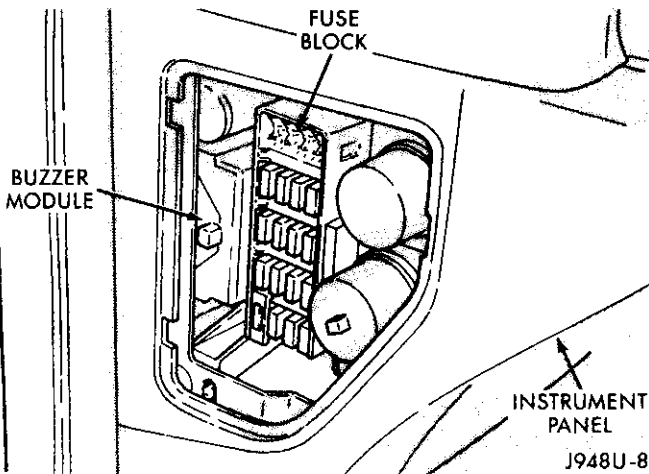
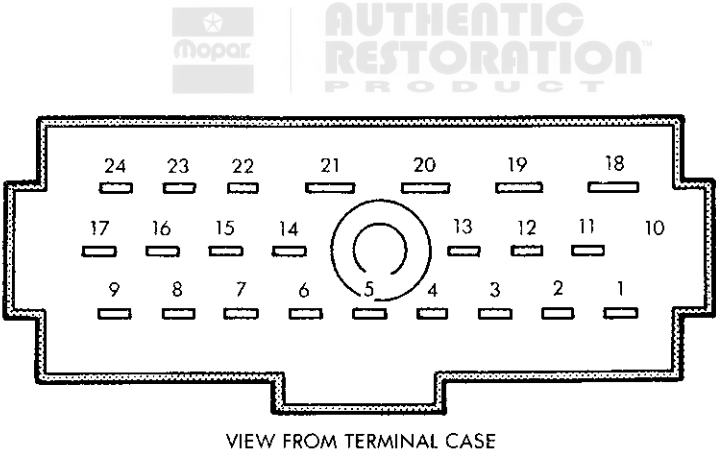


Fig. 3 Fuseblock Module



VIEW FROM TERMINAL CASE

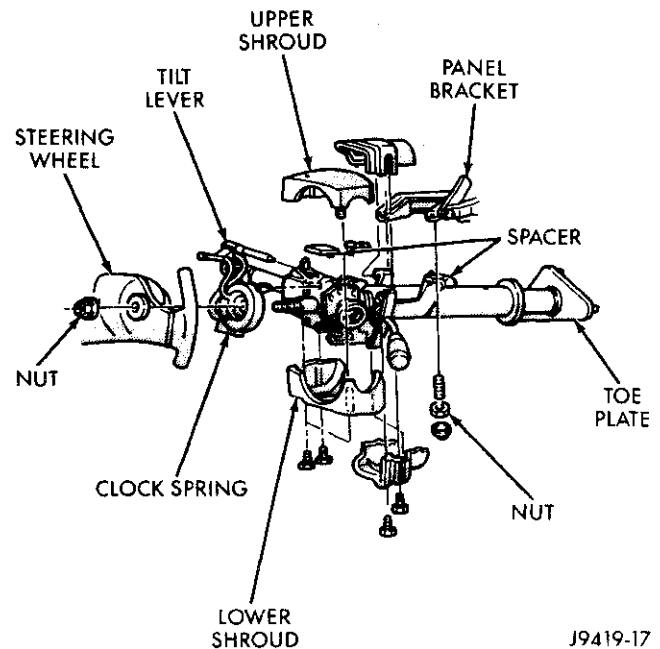
SWITCH POSITIONS		CONTINUITY BETWEEN
TURN SIGNAL	HAZARD WARNING	
NEUTRAL	OFF	12 AND 14 AND 15
LEFT LEFT LEFT	OFF	15 AND 16 AND 17
	OFF	12 AND 14
	OFF	22 AND 23 WITH OPTIONAL CORNER LAMPS
RIGHT RIGHT RIGHT	OFF	11 AND 12 AND 17
	OFF	14 AND 15
	OFF	23 AND 24 WITH OPTIONAL CORNER LAMPS
NEUTRAL	ON	11 AND 12 AND 13 AND 15 AND 16

Fig. 2 Multi-Function Switch Continuity

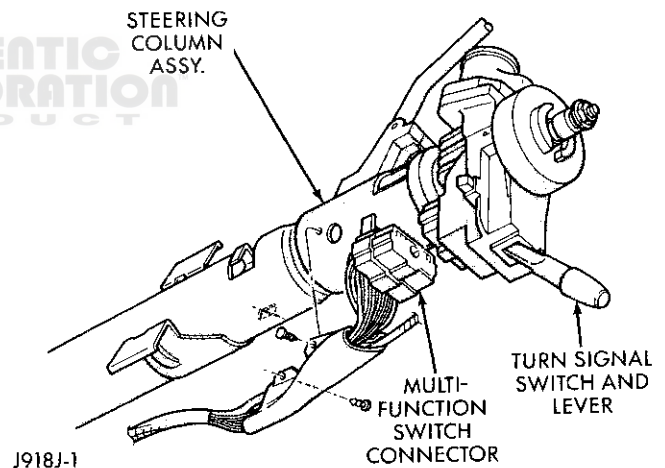
REMOVAL AND INSTALLATION (Continued)**MULTI-FUNCTION SWITCH**

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the tilt steering column lever, if equipped.
- (3) Remove both the upper and lower shrouds from the steering column (Fig. 4).
- (4) Remove the lower fixed column shroud.
- (5) Move the upper fixed column shroud to gain access to the rear of the multi-function switch (Fig. 5).
- (6) Remove the multi-function switch tamper proof mounting screws (a Snap On tamper proof torx bit TTXR20B2 or equivalent is required).
- (7) Gently pull the switch away from the column. Loosen the connector screw. The screw will remain in the connector.
- (8) Remove the wiring connector from the multi-function switch.
- (9) Reverse the removal procedures to install. Tighten the fasteners as follows:
 - Multi-function switch connector screw - 1.9 N·m (17 in. lbs.)
 - Multi-function switch retaining screws - 1.9 N·m (17 in. lbs.)



J9419-17

Fig. 4 Steering Column Shrouds Remove/Install

J918J-1

Fig. 5 Multi-Function Switch Connector

WIPER AND WASHER SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Following are general descriptions of the major components in the wiper and washer systems. Refer to 8W-53 - Wipers in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

WINDSHIELD WIPER SYSTEM

An intermittent wiper system is standard equipment. This system lets the driver select from two wiper speeds, or an intermittent wipe feature that allows a delay between wipes of 2 to 15 seconds.

The wipers will operate only when the ignition switch is in the Accessory or On positions. A fuse in the fuseblock module protects the circuitry of the wiper system. Refer to the owner's manual for more information on wiper system controls and operation.

WINDSHIELD WASHER SYSTEM

A electrically operated windshield washer system is standard equipment. A reservoir in the engine compartment holds the washer fluid, which is pressurized by a pump when the washer (multi-function) switch is actuated. The washer pump feeds the pressurized washer fluid through the washer system plumbing to the washer nozzles.

An optional low washer fluid warning lamp on the instrument panel will warn the driver when the washer fluid level needs to be checked. Refer to Group 8E - Instrument Panel Systems for more information on this feature.

The washers will operate only when the ignition switch is in the Accessory or On positions. A fuse in the fuseblock module protects the circuitry of the washer system. Refer to the owner's manual for more information on washer system controls and operation.

WIPER ARMS AND BLADES

All Ram truck models have two 20-inch wiper blades with replaceable rubber elements (squeegees). These wiper blades include an anti-lift feature. These blades and squeegees must be oriented correctly when installed on the wiper arms for the anti-lift feature to be effective. See Removal and Installation in this group for more information.

Caution should be exercised to protect the rubber squeegees from any petroleum-based cleaners or contaminants, which will rapidly deteriorate the rubber. If the squeegees are damaged, worn, or contaminated they must be replaced.

Wiper squeegees exposed to the elements for a long time tend to lose their wiping effectiveness. Periodic cleaning of the squeegees is suggested to remove deposits of salt and road film. The wiper blades, arms, and windshield should be cleaned with a sponge or cloth and a mild detergent or non-abrasive

DESCRIPTION AND OPERATION (Continued)

cleaner. If the squeegees continue to streak or smear, they should be replaced.

The blades are mounted to two spring-loaded wiper arms. Spring tension of the wiper arms controls the pressure applied to the blades on the windshield. The wiper arms are attached by an integral latch to the two wiper pivots on the cowl plenum cover/grille panel at the base of the windshield. The wiper arms and blades cannot be adjusted or repaired. If faulty, they must be replaced.

WIPER LINKAGE AND PIVOTS

The wiper linkage and pivot module is fastened with screws to the cowl plenum panel beneath the cowl plenum cover/grille panel. The wiper motor is fastened with screws to the center of the linkage and pivot module bracket. The wiper pivots are fastened to the ends of the module bracket.

The two wiper pivot crank arms and the wiper motor crank arm each have ball studs on their ends. The motor crank arm ball stud is the longer of the three. Two drive links connect the motor crank arm to the pivot crank arms. The right drive link has a plastic socket-type bushing on each end. The left drive link has a plastic socket-type bushing on one end, and a plastic sleeve-type bushing on the other end. The socket-type bushing on one end of each drive link is fit over the ball stud on the crank arm of its respective pivot. The left drive link sleeve-type bushing end is then fit over the motor crank arm ball stud, and the other socket-type bushing of the right drive link is snap-fit over the exposed end of the motor crank arm ball stud.

The wiper linkage, pivots, bushings, and mounting bracket are only serviced as a complete unit. If any part of this assembly is faulty, the entire unit must be replaced. The wiper motor and motor crank arm are serviced separately.

WIPER MOTOR

The two-speed permanent magnet wiper motor has an integral transmission and park switch. The motor is mounted to the wiper linkage and pivot module bracket with three screws. The motor output shaft passes through a hole in the module bracket, where a nut secures the wiper motor crank arm to the motor output shaft.

Wiper speed is controlled by current flow to the appropriate set of brushes. The wiper motor completes its wipe cycle when the wiper/washer (multi-function) switch is turned to the Off position, and parks the blades in the lowest portion of the wipe pattern. The wiper motor cannot be repaired. If faulty, the entire wiper motor assembly must be replaced. The motor crank arm and the linkage and pivot module are available for service.

WIPER AND WASHER SWITCHES

The wiper and washer switches are contained in the multi-function switch assembly. The multi-function switch assembly is mounted to the left side of the steering column (Fig. 1). This switch contains circuitry for the following functions:

- Turn signals
- Hazard warning
- Headlamp beam selection
- Headlamp optical horn
- Windshield wipers
- Windshield washers.

The information contained in this group addresses only the switch functions for the wiper and washer systems. For information relative to the other switch functions, refer to the appropriate group. However, the multi-function switch cannot be repaired. If any function of the switch is faulty, the entire switch assembly must be replaced.

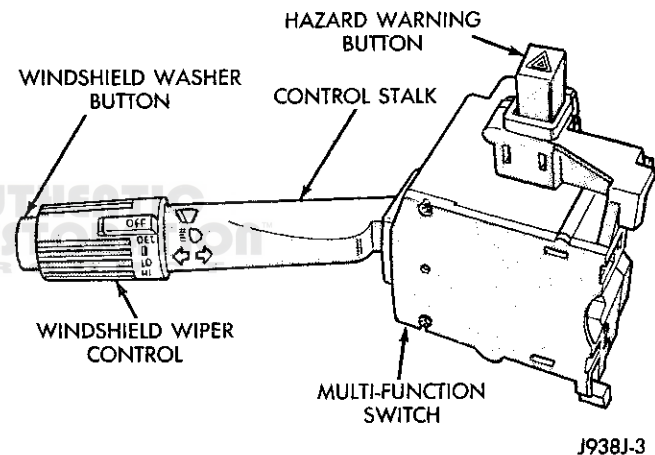


Fig. 1 Multi-Function Switch

INTERMITTENT WIPE MODULE

In addition to low and high speed, the intermittent wipe system has a delay mode. The delay mode has a range of two to fifteen seconds.

The length of the delay is selected with a variable resistor in the wiper (multi-function) switch, and is accomplished by electronic circuitry within the intermittent wipe module. If the washer knob is depressed while the wiper switch is in the Off position, the intermittent wipe module will operate the wiper motor for approximately two wipes and automatically turn off the motor.

The intermittent wipe module is snap-fit onto a single blade-type mounting bracket located under the instrument panel. The module cannot be repaired and, if faulty, must be replaced.

DESCRIPTION AND OPERATION (Continued)**WASHER RESERVOIR**

The washer fluid reservoir is mounted to the left side of the radiator fan shroud in the engine compartment. The washer pump and motor unit has a threaded nipple, which is press-fit into a grommet seal inserted in a hole in the bottom of the reservoir.

The reservoir also has a provision for a low washer fluid level sensor. Refer to Group 8E - Instrument Panel Systems for diagnosis and service of the sensor. The reservoir and filler cap are each available for service.

WASHER PUMP

The washer pump and motor are mounted near the bottom of the washer reservoir. A threaded nipple on the pump housing is press-fit into a rubber grommet seal installed in the bottom of the reservoir.

A permanently lubricated and sealed motor is coupled to a rotor-type pump. Washer fluid is gravity-fed from the reservoir to the pump. The pump then pressurizes the fluid and forces it through the plumbing to the nozzles, when the motor is energized. The pump and motor cannot be repaired. If faulty, the entire washer pump and motor unit must be replaced.

WASHER NOZZLES AND PLUMBING

Pressurized washer fluid is fed through a single hose, attached to a nipple on the washer pump, to a

tee fitting located in the cowl plenum area beneath the cowl plenum cover/grille panel. Hoses from the tee fitting are routed to the two nozzles, which are snap-fit into openings in the cowl plenum cover/grille panel. The hoses are clipped to the underside of the cowl plenum cover/grille panel.

The two fluidic washer nozzles are not adjustable. The nozzles cannot be repaired and, if faulty, must be replaced.

DIAGNOSIS AND TESTING**WIPER AND WASHER SYSTEMS**

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

Wiper and Washer Systems Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
WIPER MOTOR WILL NOT RUN.	<ol style="list-style-type: none"> 1. Fuse faulty. 2. Switch faulty. 3. Wiring faulty. 4. Ground faulty. 5. Motor faulty. 	<ol style="list-style-type: none"> 1. Check fuse in fuseblock module. Replace fuse, if required. 2. See Multi-Function Switch tests, in this group. Replace switch, if required. 3. Refer to Group 8W - Wiring Diagrams. Check continuity between switch and motor. Repair wiring, if required. 4. Check for continuity between motor ground strap and a known good ground. Repair ground circuit, if required. 5. See Wiper Motor tests, in this group. Replace wiper motor, if required.
WIPER MOTOR RUNS, BLADES DO NOT MOVE.	<ol style="list-style-type: none"> 1. Loose motor crank arm. 2. Linkage disconnected. 3. Faulty pivots. 4. Faulty motor. 	<ol style="list-style-type: none"> 1. Tighten motor crank arm nut, if required. 2. Re-install linkage or replace linkage assembly, if required. 3. Replace linkage assembly, if required. 4. See Wiper Motor tests, in this group. Replace wiper motor, if required.

DIAGNOSIS AND TESTING (Continued)

Wiper and Washer Systems Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
BLADES DO NOT PARK PROPERLY.	<ol style="list-style-type: none"> 1. Wiper arms improperly installed. 2. Faulty linkage. 3. Wiring faulty. 4. Switch faulty. 5. Motor faulty. 	<ol style="list-style-type: none"> 1. See Wiper Arm installation procedure, in this group. Re-install wiper arms, if required. 2. Replace linkage assembly, if required. 3. Refer to Group 8W - Wiring Diagrams. Check continuity between switch and motor. Repair wiring, if required. 4. See Multi-Function Switch tests, in this group. Replace switch, if required. 5. See Wiper Motor tests, in this group. Replace wiper motor, if required.
WIPER KNOCK NOISE.	<ol style="list-style-type: none"> 1. Wiper arms improperly installed. 2. Faulty linkage. 3. Motor faulty. 	<ol style="list-style-type: none"> 1. See Wiper Arm installation procedure, in this group. Re-install wiper arms, if required. 2. Replace linkage assembly, if required. 3. Replace worn motor, if required.
BLADES CHATTER.	<ol style="list-style-type: none"> 1. Contaminated glass or blade elements. 2. Wiper arm faulty. 3. Wiper blade faulty. 	<ol style="list-style-type: none"> 1. Clean glass thoroughly and replace blade elements, if required. 2. Twisted arm holds blade at wrong angle. Replace arm, if required. 3. Replace damaged or worn blade, if required.
WASHERS DO NOT OPERATE.	<ol style="list-style-type: none"> 1. No fluid in reservoir. 2. Contaminated fluid. 3. Mis-routed or leaking plumbing. 4. Wiring faulty. 5. Switch faulty. 6. Pump faulty. 	<ol style="list-style-type: none"> 1. Fill reservoir, if required. 2. Drain and flush system, if required. 3. Re-route pinched or kinked hoses. Replace leaking hoses or fittings. 4. Refer to Group 8W - Wiring Diagrams. Check continuity between switch and pump. Repair wiring, if required. 5. See Multi-Function Switch tests, in this group. Replace switch, if required. 6. See Washer Pump tests, in this group. Replace pump, if required.

WIPER MOTOR

The following are wiper motor problems, tests to be performed to locate the faulty component, and the proper action to be taken. If the problem involves only the delay mode, the wiper/washer switch, or the wiring, see the diagnosis for Intermittent Wipe Module and Multi-Function Switch in this group. For circuit descriptions and diagrams, refer to 8W-53 - Wipers in Group 8W - Wiring Diagrams.

CONDITION

The wiper motor will not run in any wiper/washer switch position.

PROCEDURE

(1) Check the fuse in the fuseblock module. If OK, go to Step 3. If not OK, replace the faulty fuse and go to Step 2.

(2) Check the wiper motor operation in all wiper/washer switch positions. If not OK and the fuse blows, go to Step 5. If not OK and the fuse is OK, go to Step 3.

(3) Place the wiper/washer switch in the Low position and listen to the motor. If you cannot hear it running, go to Step 4. If the motor is running, check the motor output shaft. If the output shaft is not turning, replace the faulty wiper motor assembly. If

DIAGNOSIS AND TESTING (Continued)

it is turning, the crank arm is not connected to the output shaft or the linkage is not properly connected. Replace the faulty linkage assembly and/or properly connect the crank arm to the motor output shaft.

(4) Connect a voltmeter between the motor terminal L and the ground strap (Fig. 2). If there is little or no voltage (less than 1 volt), move the negative test lead from the ground strap to the battery negative terminal. If an increase in voltage is noticed, the problem is a bad ground circuit. Make sure the motor mounting is free of paint and that the mounting fasteners are tight. If there is still no indication of voltage, the problem is an open in the wiring or a faulty multi-function switch. If a small increase (greater than 3 volts) in voltage is observed, the problem is a faulty wiper motor assembly.

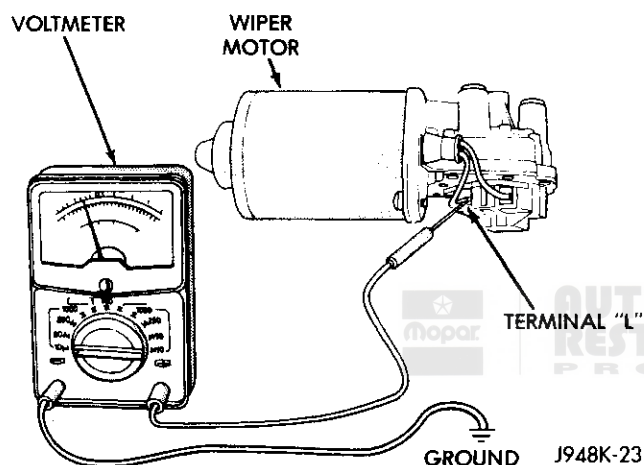


Fig. 2 Voltmeter Between Terminal L and Ground

(5) Disconnect the motor wiring connector and replace the fuse. If the fuse does not blow, the wiper motor is faulty. If the fuse blows, the multi-function switch or the wiring is at fault.

CONDITION

The wiper motor runs slowly at all speeds.

PROCEDURE

(1) Disconnect the wiring harness connector at the wiper motor. Remove the wiper arms and blades. Connect an ammeter between the battery and terminal L on the motor (Fig. 3). If the motor runs and the average ammeter reading is more than 6 amps, go to Step 2. If the motor runs and the average ammeter reading is less than 6 amps, go to Step 3.

(2) Check the wiper linkage or pivots for binding or obstruction. Disconnect the drive links from the motor. If the motor now runs and draws less than 3 amps, repair the linkage system. If the motor continues to draw more than 3 amps, replace the faulty motor assembly.

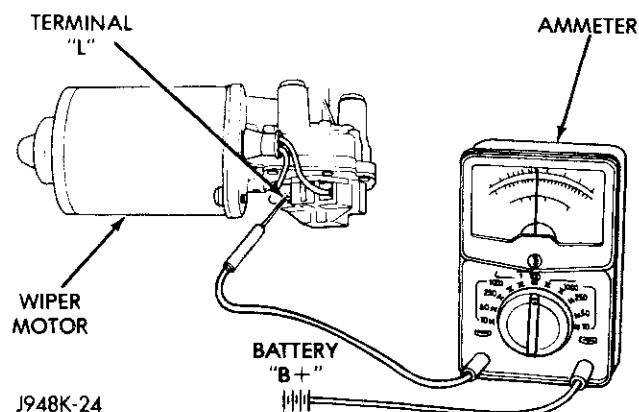


Fig. 3 Ammeter Between Terminal L and Battery

(3) Check the motor wiring harness for a short between the high and low speed circuits. Connect a voltmeter or test lamp to the motor ground strap. Set the wiper/washer switch in the Low position. Connect the other lead of the voltmeter or test lamp to terminal H of the wiring harness. If voltage is present, there is a short in the wiring or multi-function switch. If no voltage is present, go to Step 4.

(4) Set the wiper/washer switch in the High position. Move the voltmeter or test lamp lead from terminal H to terminal L of the wiring harness. If voltage is present, there is a short in the wiring or the multi-function switch.

CONDITION

The wiper motor will run at high speed, but not at low speed.

The wiper motor will run at low speed, but not at high speed.

PROCEDURE

(1) If the motor will not run on high speed, set the wiper/washer switch in the High position. Connect a test lamp between the motor terminal H and a good ground (Fig. 4). If the motor will not run on low speed, set the wiper/washer switch in the Low position. Connect a test lamp between the motor terminal L and a good ground.

(2) If the test lamp does not light at the motor terminal, there is an open in the wiring or the multi-function switch. If the test lamp lights at the motor terminal, replace the faulty motor assembly.

CONDITION

The wiper motor will keep running with the wiper/washer switch in the Off position.

PROCEDURE

(1) Disconnect the wiring harness connector at the motor. Connect a jumper wire from terminal P2 to terminal L of the wiper motor (Fig. 5).

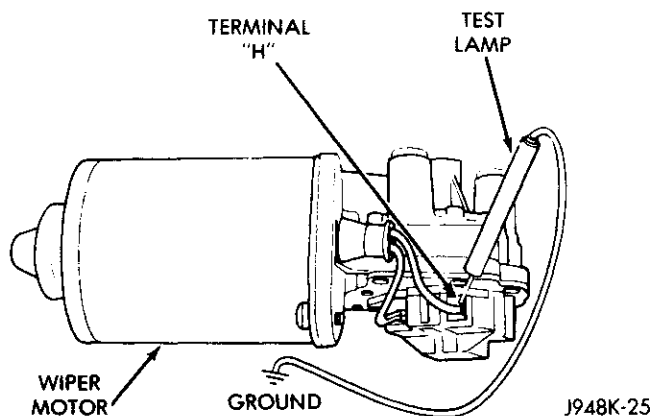
DIAGNOSIS AND TESTING (Continued)

Fig. 4 Test Lamp Between Terminal H and Ground

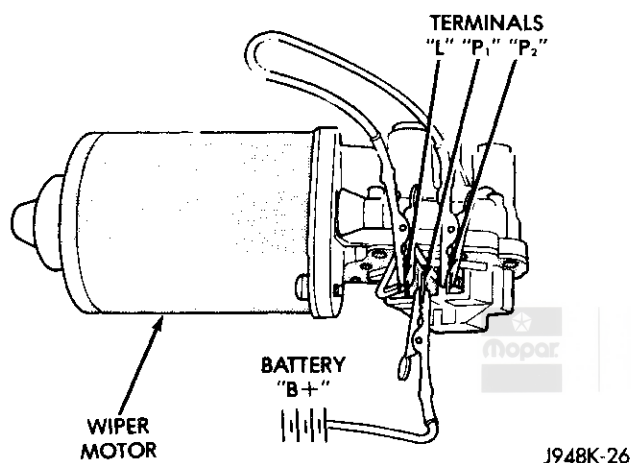


Fig. 5 One Jumper Wire Between Terminal P2 and L - One Jumper Wire Between Terminal P1 and B+

(2) Connect a second jumper from terminal P1 to the battery. If motor runs to the park position and stops, the multi-function switch is faulty. If the motor keeps running and does not park, replace the faulty motor assembly.

CONDITION

The wiper motor will stop when wiper/washer switch is set in the Off position, but the wipers do not continue running to the park position.

PROCEDURE

(1) Remove the motor wiring connector and clean the terminals. Reconnect the wiring and test the motor. If not OK, go to Step 2.

(2) Set the wiper/washer switch in the Off position. Disconnect the motor wiring connector. Connect a voltmeter or test lamp to the motor ground strap. Connect the other lead to terminal P1 of the wiring connector. If voltage is not present, check for an open circuit in the wiring harness or multi-function switch. If voltage is present, go to Step 3.

(3) Connect an ohmmeter or continuity tester between terminals L and P2 (Fig. 6). If there is continuity between these terminals, the problem is a faulty motor. If there is no continuity, the problem is an open in the wiring or a faulty multi-function switch.

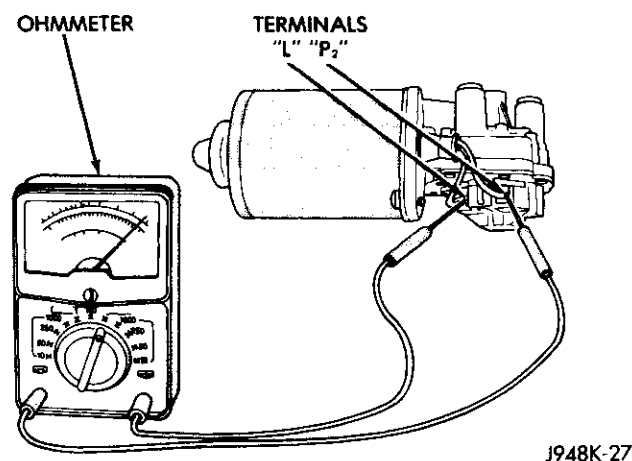


Fig. 6 Ohmmeter Between Terminal L and P2

MULTI-FUNCTION SWITCH

Perform the diagnosis for the wiper and/or washer systems as described in this group before testing the multi-function switch. For circuit descriptions and diagrams, see 8W-53 - Wipers in Group 8W - Wiring Diagrams.

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(1) Disconnect the multi-function switch connector as described in this group.

(2) Using an ohmmeter, perform the switch continuity checks at the switch terminals as shown in the chart (Fig. 7).

(3) If the switch fails any of the continuity checks, replace the faulty switch.

INTERMITTENT WIPE MODULE

See the diagnosis for the Wiper Motor or Multi-Function Switch if the problems do not involve the Delay function. If the problem occurs only in the Delay mode, the following tests are to be performed. For circuit descriptions and diagrams, refer to 8W-53 - Wipers in Group 8W - Wiring Diagrams.

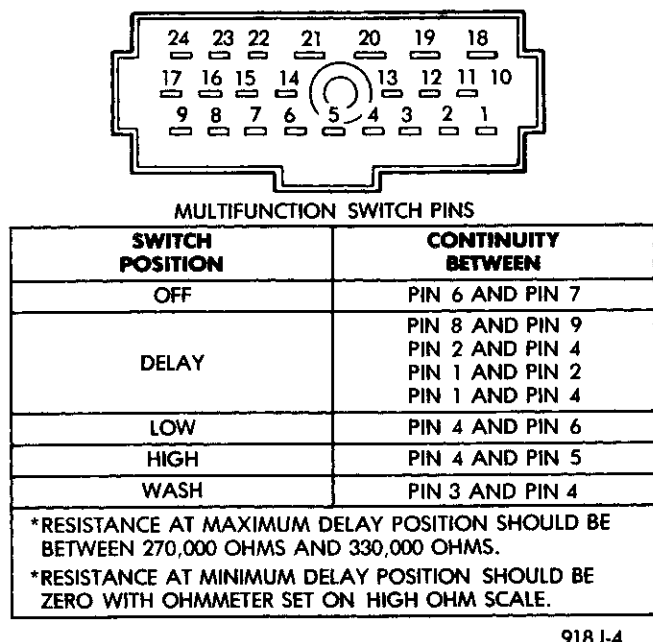
DIAGNOSIS AND TESTING (Continued)

Fig. 7 Multi-Function Switch Continuity

CONDITION

Excessive delay (more than 30 seconds) or inadequate variation in the delay.

PROCEDURE

Variations in the delay should be as follows:

(1) Minimum delay (wiper/washer switch to extreme counterclockwise position before Low detent) - 1/2 to 2 seconds.

(2) Maximum delay (wiper/washer switch to extreme clockwise position before Off detent) - 10 to 30 seconds.

If there is excessive delay or no variation in the delay, see the Multi-Function Switch tests.

CONDITION

In the Delay mode the wipers run continually when the washers are operated, but do not provide an extra wipe when the washer switch is released.

PROCEDURE

Replace the faulty intermittent wipe module.

CONDITION

The wipers start erratically during the Delay mode.

PROCEDURE

Perform the following checks:

(1) Verify that the ground connection at the instrument panel is clean and tight.

(2) Verify that the wiper motor ground strap connections are clean and tight, and that the wiper motor mounting bolts are tight.

(3) Verify that the ground circuit connections for the intermittent wipe module and the wiper/washer (multi-function) switch are clean and tight.

If all of the above grounds are confirmed OK and the condition is not corrected, replace the faulty intermittent wipe module.

WASHER PUMP

For circuit descriptions and diagrams, refer to 8W-53 - Wipers in Group 8W - Wiring Diagrams.

(1) Check for continuity between the ground circuit cavity of the pump connector and a good ground. There should be continuity. If OK, go to Step 2. If not OK, repair the open circuit as required.

(2) Turn the ignition switch to the On position. Check for battery voltage at the washer pump control circuit output cavity of the pump connector with the washer switch depressed. If OK, replace the faulty washer pump. If not OK, see the diagnosis for the Multi-Function Switch in this group. If the switch tests OK, repair the circuits between the switch and the washer pump as required.

REMOVAL AND INSTALLATION**WIPER BLADES AND ELEMENTS**

The wiper blade and element are an anti-lift design, so as to resist the effects of air lifting the blade and element off the windshield glass in high winds or at highway speeds. However, in order for this feature to be effective, the wiper blades and elements must be properly oriented on the windshield.

Note that the center bridge of the wiper arm has a long leading edge, and a short trailing edge. When the wipers are in the Park position, the leading edge of the wiper blade must always be oriented towards the base of the windshield. Also note that the pinch-release for the wiper element should always be oriented towards the end of the wiper blade that is nearest to the wiper pivot.

To remove the wiper blade and/or element, proceed as follows:

(1) Turn the wiper/washer switch to the On position. By turning the ignition switch to the On and Off positions, cycle the wiper blades to a convenient working location on the windshield.

(2) Lift the wiper arm to raise the wiper blade and element off of the windshield glass.

(3) Remove the wiper blade from the wiper arm, or the wiper element from the wiper blade as follows:

(a) To remove the wiper blade from the wiper arm, push the release tab under the arm tip and

REMOVAL AND INSTALLATION (Continued)

slide the blade away from the tip towards the pivot end of the arm (Fig. 8).

(b) To remove the wiper element from the wiper blade, pinch the notched (pivot) end of the wiper element tightly between the thumb and forefinger (Fig. 9). Then, pull the element firmly towards the wiper pivot to release the wiper blade claw from the wiper element retaining pocket. Once the claw is released from the pocket, the element will slide easily out of the remaining claws.

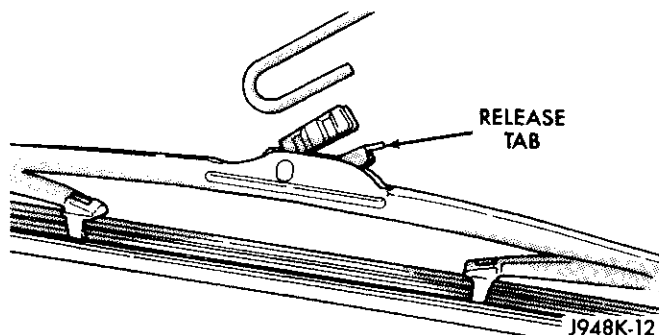


Fig. 8 Wiper Blade Remove/Install

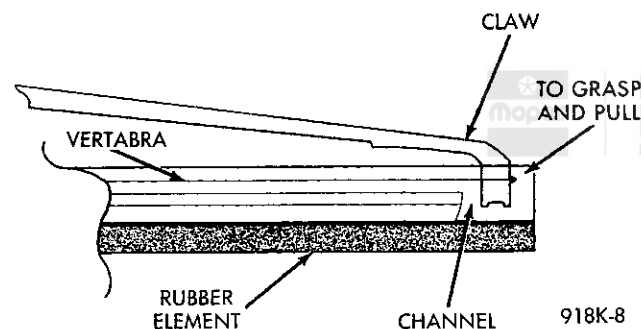


Fig. 9 Wiper Element Remove

(4) Install the wiper blade on the wiper arm, or the wiper element in the wiper blade as follows:

(a) To install the wiper blade on the wiper arm, slide the blade retainer into the U-shaped formation on the tip of the wiper arm until the release tab snaps into its locked position. Be certain that the leading edge of the blade center bridge is oriented towards the base of the windshield.

(b) To install the wiper element in the wiper blade, be certain that the metal element rails (vertebra) are properly seated in the slots on either side of the rubber element. Starting at the wiper pivot end of the blade, slide the element through each pair of wiper blade claws. The element is fully installed when the claws on the wiper pivot end of the blade are engaged in the wiper element retaining pockets.

WIPER ARM

CAUTION: The use of a screwdriver or other prying tool to remove a wiper arm may distort it. This distortion could allow the arm to come off of the pivot shaft, regardless of how carefully it is installed.

(1) Lift the wiper arm to permit the latch to be pulled out to the holding position, then release the arm (Fig. 10). The arm will remain off the windshield with the latch in this position.

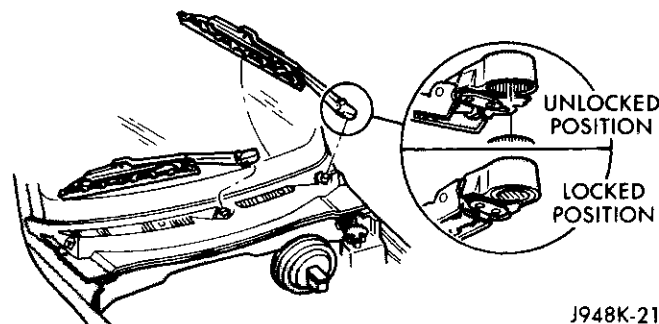


Fig. 10 Wiper Arm Remove/Install

(2) Remove the arm from the pivot using a rocking motion.

(3) Install the arm and blade with the wiper motor in the Park position. See the Wiper Arm Installation illustration (Fig. 11). Mount the arms on the pivot shafts so that the distance of the wiper blade tip from the upper edge of the lower windshield blackout area is ± 22 mm (0.86 in.).

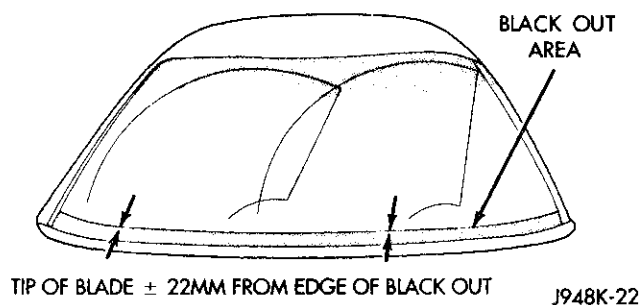


Fig. 11 Wiper Arm Installation

(4) Lift the wiper arm away from the windshield slightly to relieve the spring tension on the locking latch. Push the latch into the locked position and slowly release the arm until the wiper blade rests on the windshield.

(5) Operate the wipers with the windshield glass wet, then turn the wiper switch to the Off position. Check for the correct wiper arm positioning and re-adjust if required.

REMOVAL AND INSTALLATION (Continued)**WIPER MOTOR**

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the wiper arms as described in this group.
- (3) Remove the weatherstrip along the front edge of cowl plenum cover/grille panel (Fig. 12).

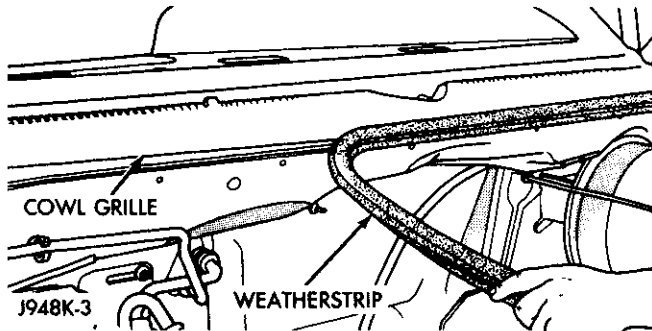


Fig. 12 Cowl Plenum Cover/Grille Panel Weatherstrip

- (4) Release the plastic anchor screws (Fig. 13).

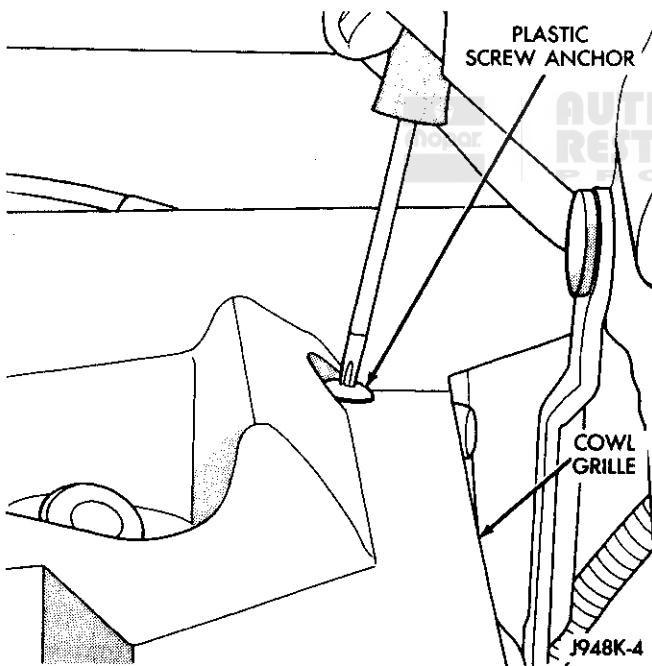


Fig. 13 Plastic Anchor Screws Remove/Install

- (5) Lift the cowl plenum cover/grille panel from the vehicle.
- (6) Remove the washer nozzle hoses from the supply hose at the tee fitting (Fig. 14). Set the cowl plenum cover/grille panel aside.
- (7) Remove the wiper linkage and pivots module mounting bolts (Fig. 15).
- (8) Turn the wiper linkage module over and unplug the wiring harness and ground tab connectors from the wiper motor (Fig. 16).

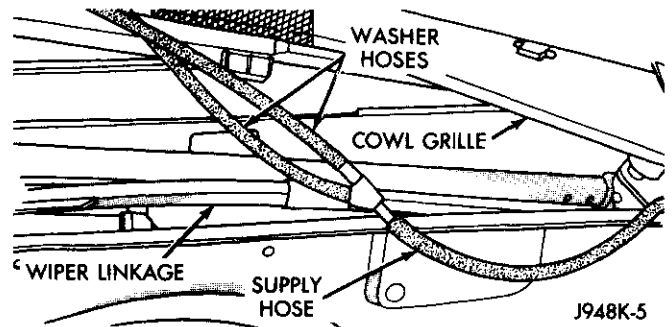


Fig. 14 Washer Hoses Remove/Install

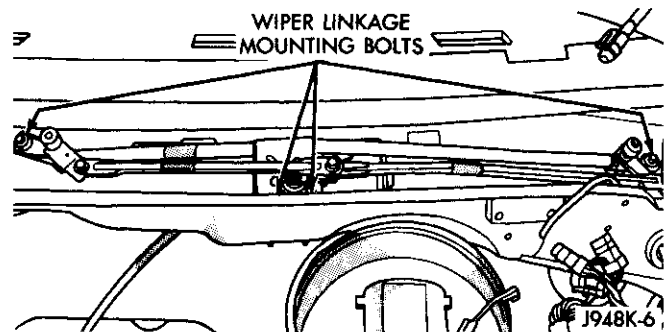


Fig. 15 Linkage and Pivots Module Mounting Bolts

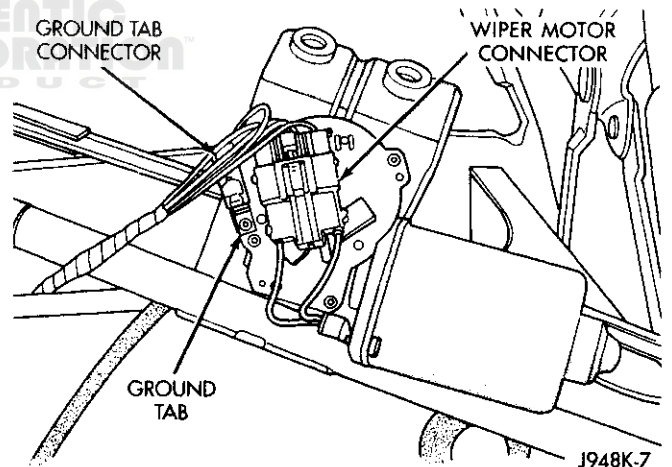


Fig. 16 Wiper Motor Connectors

- (9) Remove the drive links from the wiper motor crank arm by prying the retainer bushing from the crank arm ball stud with a suitably sized screwdriver (Fig. 17).
- (10) Remove the three screws securing the wiper motor to the linkage module bracket and remove the motor.
- (11) Remove the nut attaching the motor crank arm to the motor output shaft.
- (12) Remove the crank arm from the motor.
- (13) To install, position the crank arm on the motor output shaft being certain that the crank arm slot is indexed properly to the output shaft. Install

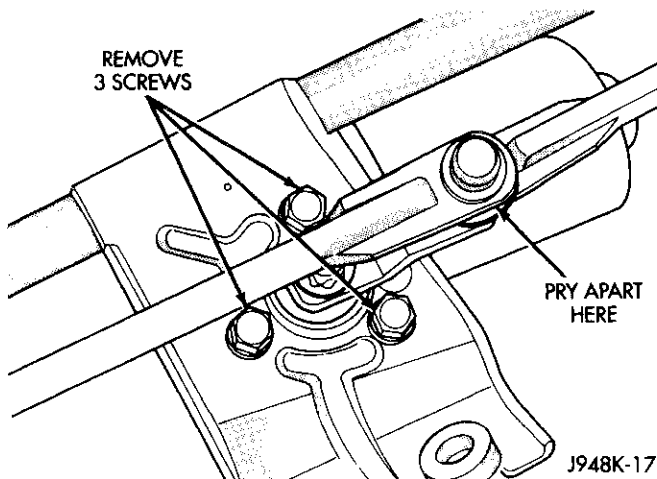
REMOVAL AND INSTALLATION (Continued)

Fig. 17 Wiper Motor/Linkage and Pivots Remove/Install

the crank arm nut to the output shaft and tighten to 14 N·m (11 ft. lbs.).

(14) Install the drive links to the crank arm ball stud and snap together using channel-lock pliers.

(15) Position the motor on the linkage module bracket. Install the motor mounting screws and tighten to 6 N·m (55 in. lbs.).

(16) Reverse the remaining removal procedures to complete the installation.

WIPER LINKAGE AND PIVOTS

The wiper linkage and pivots can only be removed or installed as a unit with the wiper motor. See Wiper Motor in this group for the procedures.

INTERMITTENT WIPE MODULE

(1) Disconnect and isolate the battery negative cable.

(2) Remove the knee blocker as described in Group 8E - Instrument Panel Systems.

(3) Unplug the harness connector from the intermittent wipe module (Fig. 18).

(4) Disengage the intermittent wipe module snap-fit mounting slot from the blade of the mounting bracket.

(5) Reverse the removal procedures to install.

MULTI-FUNCTION SWITCH

WARNING: ON VEHICLES EQUIPPED WITH AN AIR-BAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

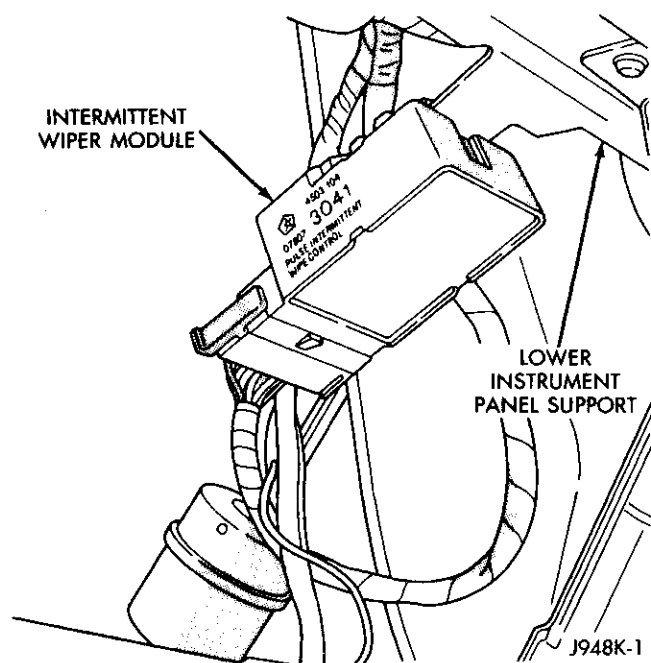


Fig. 18 Intermittent Wipe Module Remove/Install

(1) Disconnect and isolate the battery negative cable.

(2) Remove the tilt steering column lever, if equipped.

(3) Remove both the upper and lower shrouds from the steering column (Fig. 19).

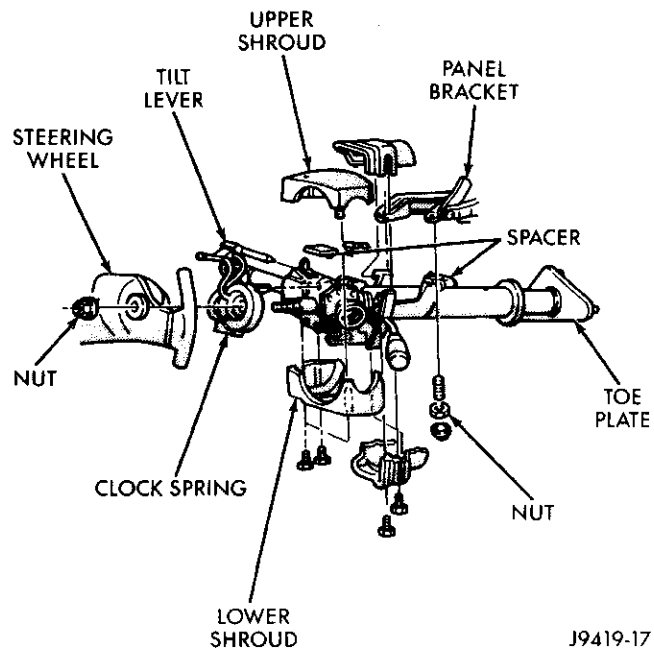


Fig. 19 Steering Column Shrouds Remove/Install

(4) Remove the lower fixed column shroud.

REMOVAL AND INSTALLATION (Continued)

(5) Move the upper fixed column shroud to gain access to the rear of the multi-function switch (Fig. 20).

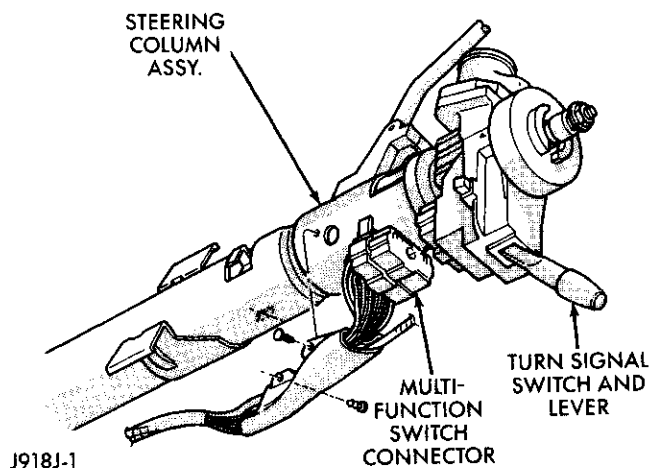


Fig. 20 Multi-Function Switch Connector

(6) Remove the multi-function switch tamper proof mounting screws (a Snap On tamper proof torx bit TTXR20B2 or equivalent is required).

(7) Gently pull the switch away from the column. Loosen the connector screw. The screw will remain in the connector.

(8) Remove the wiring connector from the multi-function switch.

(9) Reverse the removal procedures to install. Tighten the fasteners as follows:

- Multi-function switch connector screw - 1.9 N·m (17 in. lbs.)
- Multi-function switch retaining screws - 1.9 N·m (17 in. lbs.).

WASHER PUMP AND RESERVOIR

(1) Disconnect and isolate the battery negative cable.

(2) Drain the engine coolant and remove the upper radiator hose from the radiator. Refer to Group 7 - Cooling System for the procedures.

(3) Remove the hose from the washer pump and drain the washer fluid from the reservoir into a clean container for reuse.

(4) Unplug the connectors from the washer pump and the washer fluid level sensor, if equipped (Fig. 21).

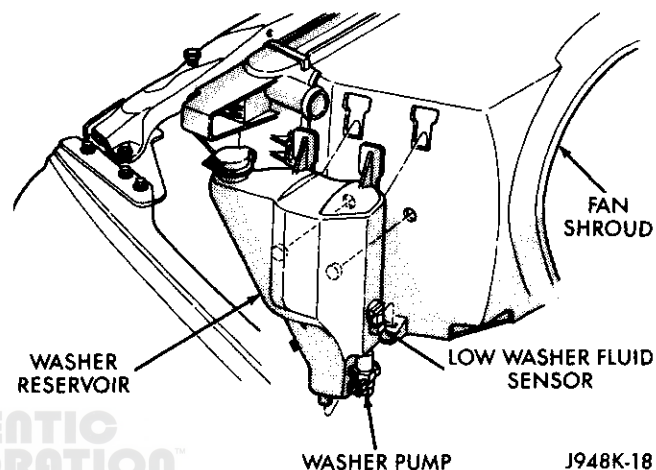


Fig. 21 Washer Fluid Reservoir Remove/Install

(5) Pull the reservoir up and out of the radiator shroud.

(6) Gently pry the pump out of the grommet seal and/or the fluid level sensor away from the reservoir. Care must be taken not to puncture the reservoir.

(7) Remove the rubber grommet seal from the reservoir and discard.

(8) Reverse the removal procedures to install. Always use a new rubber grommet on the reservoir.

LAMPS

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LAMP DIAGNOSIS

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GENERAL INFORMATION	1	FOG LAMP DIAGNOSIS	4
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GENERAL INFORMATION

GENERAL INFORMATION

Each vehicle is equipped with various lamp assemblies. A good ground is necessary for proper lighting operation. Grounding is provided by the lamp socket when it comes in contact with the metal body, or through a separate ground wire.

When changing lamp bulbs check the socket for corrosion. If corrosion is present, clean it with a wire brush and coat the inside of the socket lightly with Mopar Multi-Purpose Grease or equivalent.

SAFETY PRECAUTIONS

WARNING: EYE PROTECTION SHOULD BE USED WHEN SERVICING GLASS COMPONENTS. PERSONAL INJURY CAN RESULT.

CAUTION: Do not touch the glass of halogen bulbs with fingers or other possibly oily surface, reduced bulb life will result.

Do not use bulbs with higher candle power than indicated in the Bulb Application table at the end of this group. Damage to lamp can result.

Do not use fuses, circuit breakers or relays having greater amperage value than indicated on the fuse panel or in the Owners Manual.

When it is necessary to remove components to service another, it should not be necessary to apply excessive force or bend a component to remove it. Before damaging a trim component, verify hidden fasteners or captured edges are not holding the component in place.

DAYTIME RUNNING LAMPS

The daytime running lamps are controlled by the Daytime Running Lamp Relay (DRLR). The DRLR is located in the engine compartment on the left fender wheelhouse. The DRLR allows the high beam headlamps to illuminate at 50% of the switched ON brightness when the engine is running with the headlamp switch OFF. The Daytime running lamps will go out when the headlamp switch is pulled out. The passing light feature will flash bright high beams while the daytime running lamps are activated.

DIAGNOSIS AND TESTING

DIAGNOSTIC PROCEDURES

When a vehicle experiences problems with the headlamp system, verify the condition of the battery connections, charging system, headlamp bulbs, wire connectors, relay, high beam dimmer switch and headlamp switch. Refer to Group 8W, Wiring Dia-

DIAGNOSIS AND TESTING (Continued)

grams for component locations and circuit information.

HEADLAMP DIAGNOSIS

Always begin any diagnosis by testing all of the fuses and circuit breakers in the system. Refer to Group 8W, Wiring Diagrams.

Conventional and halogen headlamps are interchangeable. It is recommended that they not be intermixed on a given vehicle.



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DIAGNOSIS AND TESTING (Continued)**HEADLAMP DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
HEADLAMPS ARE DIM WITH ENGINE IDLING OR IGNITION TURNED OFF.	<ol style="list-style-type: none"> 1. Loose or corroded battery cables. 2. Loose or worn generator drive belt. 3. Charging system output too low. 4. Battery has insufficient charge. 5. Battery is sulfated or shorted. 6. Poor lighting circuit Z1-ground. 7. Both headlamp bulbs defective. 	<ol style="list-style-type: none"> 1. Clean and secure battery cable clamps and posts. 2. Adjust or replace generator drive belt. 3. Test and repair charging system, refer to Group 8A. 4. Test battery state-of-charge, refer to Group 8A. 5. Load test battery, refer to Group 8A. 6. Test for voltage drop across Z1-ground locations, refer to Group 8W. 7. Replace both headlamp bulbs.
HEADLAMP BULBS BURN OUT FREQUENTLY.	<ol style="list-style-type: none"> 1. Charging system output too high. 2. Loose or corroded terminals or splices in circuit. 	<ol style="list-style-type: none"> 1. Test and repair charging system, refer to Group 8A. 2. Inspect and repair all connectors and splices, refer to Group 8W.
HEADLAMPS ARE DIM WITH ENGINE RUNNING ABOVE IDLE.*	<ol style="list-style-type: none"> 1. Charging system output too low. 2. Poor headlamp circuit ground. 3. High resistance in headlamp circuit. 4. Both headlamp bulbs defective. 	<ol style="list-style-type: none"> 1. Test and repair charging system, refer to Group 8A. 2. Test voltage drop across Z1-ground, refer to Group 8W. 3. Test amperage draw of headlamp circuit. 4. Replace both headlamp bulbs.
HEADLAMPS FLASH RANDOMLY.	<ol style="list-style-type: none"> 1. Poor headlamp circuit ground. 2. High resistance in headlamp circuit. 3. Faulty headlamp switch circuit breaker. 4. Loose or corroded terminals or splices in circuit. 	<ol style="list-style-type: none"> 1. Repair circuit ground, refer to Group 8W. 2. Test amperage draw of headlamp circuit. 3. Replace headlamp switch. 4. Repair connector terminals or splices, refer to Group 8W.
HEADLAMPS DO NOT ILLUMINATE.	<ol style="list-style-type: none"> 1. No voltage to headlamps. 2. No ground at headlamps. 3. Faulty headlamp switch. 4. Faulty headlamp dimmer switch. 5. Broken connector terminal or wire splice in headlamp circuit. 	<ol style="list-style-type: none"> 1. Replace fuse, refer to group 8W. 2. Repair circuit ground, refer to Group 8W. 3. Replace headlamp switch. 4. Replace headlamp dimmer switch. 5. Repair connector terminal or wire splices.
* Canada vehicles must have lamps ON.		

DIAGNOSIS AND TESTING (Continued)**FOG LAMP DIAGNOSIS**

CONDITION	POSSIBLE CAUSES	CORRECTION
FOG LAMPS ARE DIM WITH ENGINE IDLING OR IGNITION TURNED OFF.	<ol style="list-style-type: none"> 1. Loose or corroded battery cables. 2. Loose or worn generator drive belt. 3. Charging system output too low. 4. Battery has insufficient charge. 5. Battery is sulfated or shorted. 6. Poor lighting circuit Z1-ground. 7. Both fog lamp bulbs defective. 	<ol style="list-style-type: none"> 1. Clean and secure battery cable clamps and posts. 2. Adjust or replace generator drive belt. 3. Test and repair charging system, refer to Group 8A. 4. Test battery state-of-charge, refer to Group 8A. 5. Load test battery, refer to Group 8A. 6. Test for voltage drop across Z1-ground locations, refer to Group 8W. 7. Replace both lamp bulbs.
FOG LAMP BULBS BURN OUT FREQUENTLY.	<ol style="list-style-type: none"> 1. Charging system output too high. 2. Loose or corroded terminals or splices in circuit. 	<ol style="list-style-type: none"> 1. Test and repair charging system, refer to Group 8A. 2. Inspect and repair all connectors and splices, refer to Group 8W.
FOG LAMPS ARE DIM WITH ENGINE RUNNING ABOVE IDLE.	<ol style="list-style-type: none"> 1. Charging system output too low. 2. Poor fog lamp circuit ground. 3. High resistance in fog lamp circuit. 4. Both fog lamp bulbs defective. 	<ol style="list-style-type: none"> 1. Test and repair charging system, refer to Group 8A. 2. Test voltage drop across Z1-ground, refer to Group 8W. 3. Test amperage draw of fog lamp circuit. 4. Replace both fog lamp bulbs.
FOG LAMPS FLASH RANDOMLY.	<ol style="list-style-type: none"> 1. Poor fog lamp circuit ground. 2. High resistance in fog lamp circuit. 3. Faulty fog lamp switch circuit breaker. 4. Loose or corroded terminals or splices in circuit. 	<ol style="list-style-type: none"> 1. Repair circuit ground, refer to Group 8W. 2. Test amperage draw of fog lamp circuit. 3. Replace fog lamp switch. 4. Repair connector terminals or splices, refer to Group 8W.
FOG LAMPS DO NOT ILLUMINATE.	<ol style="list-style-type: none"> 1. Blown fuse for fog lamps. 2. No ground at fog lamps. 3. Faulty fog lamp switch. 4. Broken connector terminal or wire splice in fog lamp circuit. 	<ol style="list-style-type: none"> 1. Replace fuse, refer to group 8W. 2. Repair circuit ground, refer to Group 8W. 3. Replace fog lamp switch. 4. Repair connector terminal or wire splices.

HEADLAMP ALIGNMENT

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GENERAL INFORMATION

HEADLAMP ALIGNMENT

Headlamps can be aligned using the screen method provided in this section. Alignment Tool C-4466-A or equivalent can also be used. Refer to instructions provided with the tool for proper procedures. **The preferred headlamp alignment setting is 0 for the left/right adjustment and 1" down for the up/down adjustment.**

SERVICE PROCEDURES

HEADLAMP ALIGNMENT PREPARATION

(1) Verify headlamp dimmer switch and high beam indicator operation.

(2) Correct defective components that could hinder proper headlamp alignment.

(3) Verify proper tire inflation.

(4) Clean headlamp lenses.

(5) Verify that luggage area is not heavily loaded.

(6) Fuel tank should be FULL. Add 2.94 kg (6.5 lbs.) of weight over the fuel tank for each estimated gallon of missing fuel.

ALIGNMENT SCREEN PREPARATION

(1) Position vehicle on a level surface perpendicular to a flat wall 7.62 meters (25 ft) away from front of headlamp lens (Fig. 1).

(2) If necessary, tape a line on the floor 7.62 meters (25 ft) away from and parallel to the wall.

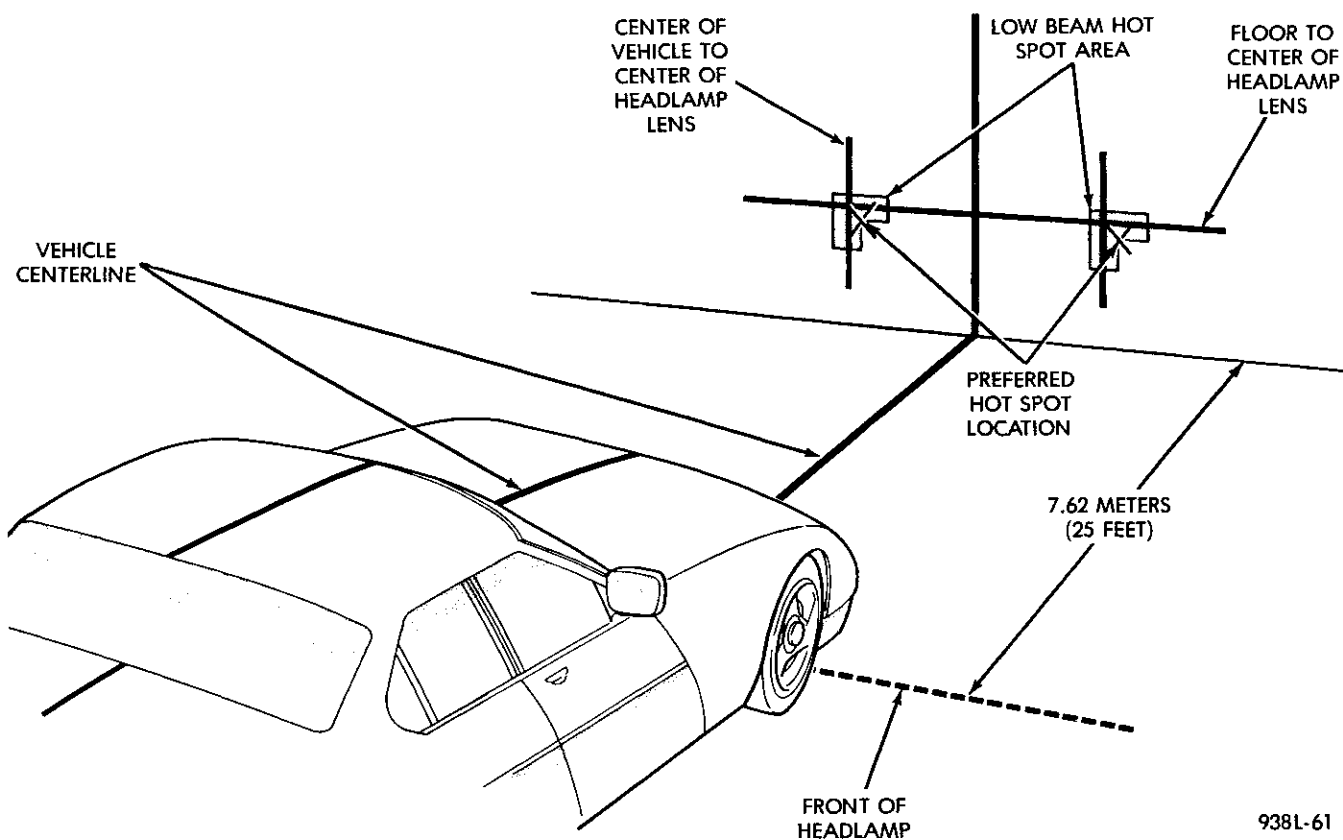


Fig. 1 Headlamp Alignment Screen—Typical

SERVICE PROCEDURES (Continued)

(3) Up 1.27 meters (5 feet) from the floor, tape a line on the wall at the centerline of the vehicle. Sight along the centerline of the vehicle (from rear of vehicle forward) to verify accuracy of the line placement.

(4) Rock vehicle side-to-side three times to allow suspension to stabilize.

(5) Jounce front suspension three times by pushing downward on front bumper and releasing.

(6) Measure the distance from the center of headlamp lens to the floor. Transfer measurement to the alignment screen (with tape). Use this line for up/down adjustment reference.

(7) Measure distance from the centerline of the vehicle to the center of each headlamp being aligned. Transfer measurements to screen (with tape) to each side of vehicle centerline. Use these lines for left/right adjustment reference.

HEADLAMP ADJUSTMENT

A properly aimed low beam headlamp will project top edge of high intensity pattern on screen from 50 mm (2 in.) above to 50 mm (2 in.) below headlamp centerline. The side-to-side outboard edge of high intensity pattern should be from 50 mm (2 in.) left to 50 mm (2 in.) right of headlamp centerline (Fig. 1). **The preferred headlamp alignment is 1" down for the up/down adjustment and 0**

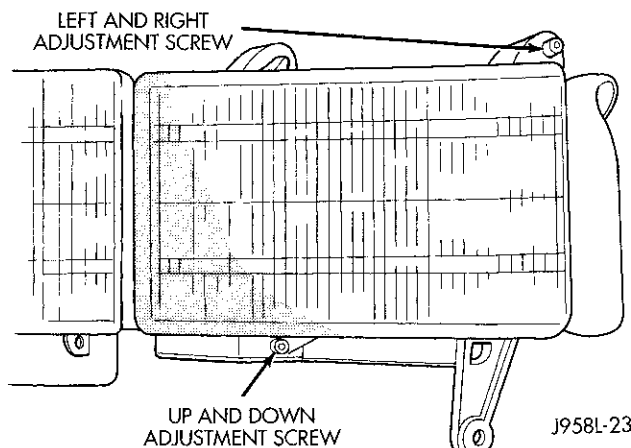


Fig. 2 Aero Headlamp Alignment

for the left/right adjustment. The high beam pattern should be correct when the low beams are aligned properly.

To adjust headlamp aim, rotate alignment screws (Fig. 2) to achieve the specified high intensity pattern.

FOG LAMP ALIGNMENT

Prepare an alignment screen. Refer to Alignment Screen Preparation paragraph in this section. A properly aligned fog lamp will project a pattern on the alignment screen 100 mm (4 in.) below the fog lamp centerline and straight ahead (Fig. 3).

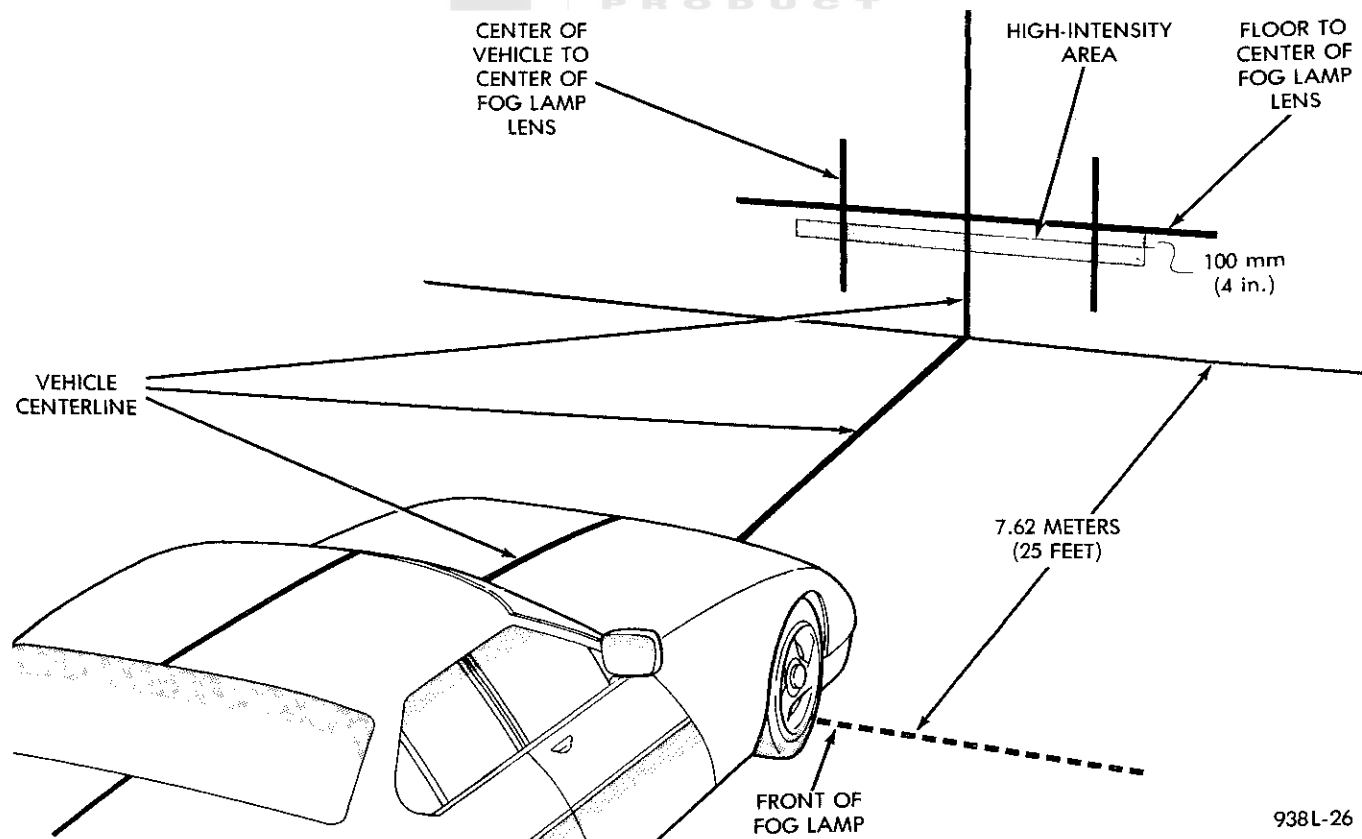
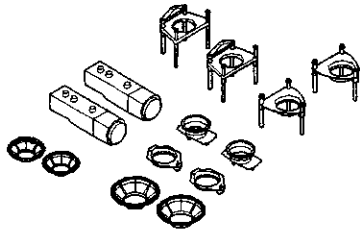


Fig. 3 Fog Lamp Alignment — Typical

SPECIAL TOOLS**HEADLAMP ALIGNMENT**

Headlamp Aiming Kit C-4466-A



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LAMP BULB SERVICE

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REMOVAL AND INSTALLATION

HEADLAMP

On driver side and on vehicles with dual batteries, the headlamp assembly must be removed to service the headlamp bulb.

REMOVAL

- (1) Release hood latch and open hood.
- (2) To remove headlamp assembly on drivers side or passenger side when equipped with dual batteries, refer to Headlamp Removal paragraph of Exterior Lamps section.
- (3) Disengage wire connector from headlamp bulb.
- (4) Remove retaining ring holding bulb to headlamp (Fig. 1).
- (5) Pull bulb from headlamp.

INSTALLATION

CAUTION: Do not touch the bulb glass with fingers or other oily surfaces. Reduced bulb life will result.

- (1) Position bulb in headlamp.
- (2) Install retaining ring holding bulb to headlamp (Fig. 1).
- (3) Connect wire connector to headlamp bulb.

FOG LAMP

REMOVAL

- (1) Disengage fog lamp harness connector.
- (2) Rotate bulb assembly counterclockwise and pull from lamp to separate (Fig. 2).

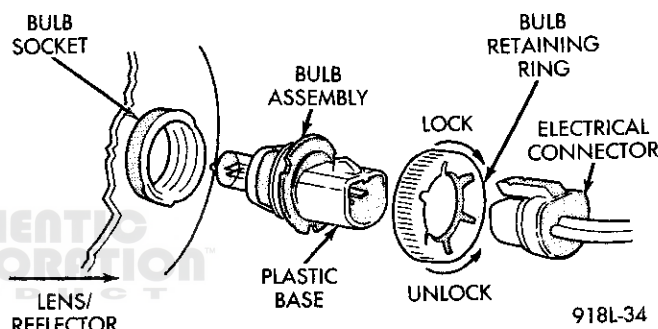


Fig. 1 Headlamp Bulb Removal

INSTALLATION

CAUTION: Do not touch the bulb glass with fingers or other oily surfaces. Reduced bulb life will result.

- (1) Position bulb assembly in lamp and rotate clockwise.
- (2) Connect fog lamp harness connector.

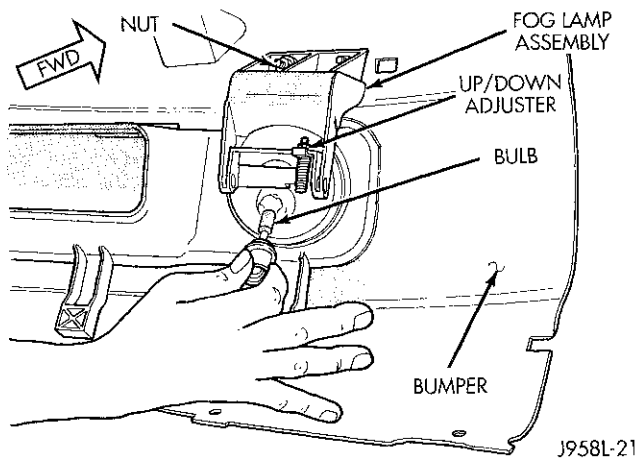
PARK AND TURN SIGNAL LAMP

REMOVAL

- (1) Remove park and turn signal lamp.
- (2) Rotate bulb socket 1/4 turn counterclockwise and pull turn signal lamp socket from back of lamp.
- (3) Pull park and turn signal lamp bulb from socket.

INSTALLATION

- (1) Install park and turn signal lamp bulb in socket.
- (2) Install park and turn signal lamp socket into back of lamp.
- (3) Install park/turn signal lamp.

REMOVAL AND INSTALLATION (Continued)**Fig. 2 Fog Lamp****FRONT SIDE MARKER LAMP BULB****REMOVAL**

- (1) Remove park and turn signal lamp.
- (2) Remove side marker lamp socket from back of lamp.
- (3) Pull side marker lamp bulb from socket.

INSTALLATION

- (1) Install side marker lamp bulb in socket.
- (2) Install side marker lamp socket into back of lamp.
- (3) Install park/turn signal lamp.

ROOF CLEARANCE LAMP BULB

For bulb replacement refer roof clearance lamp removal/installation procedure.

CENTER HIGH MOUNTED STOP LAMP (CHMSL) BULB**REMOVAL**

- (1) Remove the CHMSL from the roof panel.
- (2) Rotate sockets 1/4 turn clockwise and remove from lamp. (The center bulbs light the stoplamp and the outside bulbs light the cargo lamp.)
- (3) Pull bulb from socket.

INSTALLATION

- (1) Push bulb into socket.
- (2) Position socket in lamp and rotate socket 1/4 turn counterclockwise.
- (3) Install the CHMSL.

CARGO LAMP BULB

The cargo lamp bulb is incorporated in the CHMSL assembly, refer to the CHMSL bulb removal and installation procedure for bulb replacement.

SIDE IDENTIFICATION (ID) LAMP BULBS

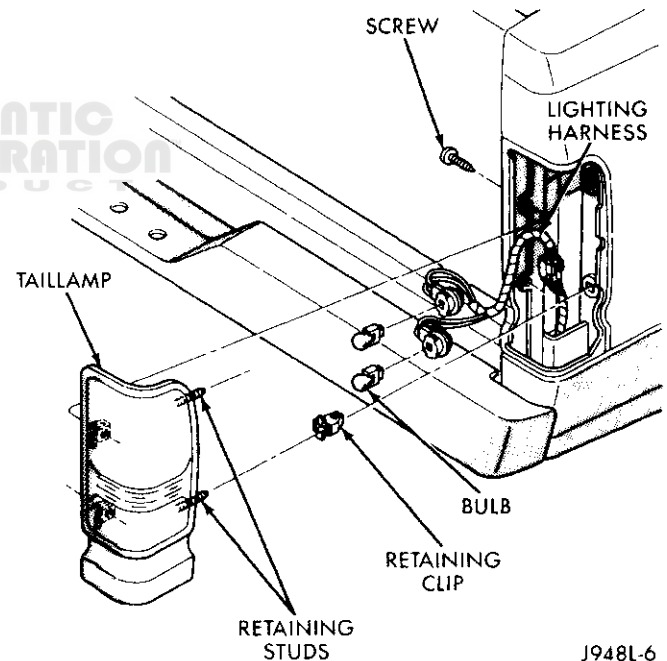
The bulbs in the side ID lamps can not be replaced. If a bulb should fail, the entire lamp would require replacement. Refer to the Side Identification Lamp Removal/Installation procedure in this group.

TAIL, STOP, TURN SIGNAL AND BACK-UP LAMP BULB—PICKUP**REMOVAL**

- (1) Remove screws from tail lamp (Fig. 3).
- (2) Grasp lamp, firmly pull lamp rearward to disengage retaining studs.
- (3) Remove socket from tail lamp.
- (4) Separate tail lamp from cargo box.
- (5) Pull bulb from socket.

INSTALLATION

- (1) Install bulb in socket.
- (2) Install socket in tail lamp.
- (3) Position tail lamp in cargo box, engage retaining studs and install screws (Fig. 3).

**Fig. 3 Tail, Stop, Turn Signal and Back-up Lamp Bulb****TAIL, STOP, TURN SIGNAL AND BACK-UP LAMP BULB—CAB CHASSIS****REMOVAL**

- (1) Remove screws holding tail lamp lens to lamp body.
- (2) Separate lens from lamp.
- (3) Remove bulb from socket.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

- (1) Install bulb in socket.
- (2) Install lamp lens.

REAR IDENTIFICATION (ID) LAMP BULBS

The bulbs in the rear ID lamps can not be replaced. If a bulb should fail, the entire lamp would require replacement.

LICENSE PLATE LAMP BULB**REMOVAL**

- (1) Remove license plate lamp lens.
- (2) Pull bulb from license plate lamp.

INSTALLATION

- (1) Install bulb in license plate lamp.
- (2) Install license plate lamp lens.

UNDERHOOD LAMP BULB**REMOVAL**

- (1) Disconnect the wire harness connector from the underhood lamp.
- (2) Rotate the bulb counterclock-wise. Remove it from the lamp socket.

INSTALLATION

- (1) Insert the replacement bulb in the lamp base socket. Rotate it clockwise.
- (2) Connect the wire harness connector to the lamp.

DOME LAMP BULB**REMOVAL**

- (1) Remove dome lamp lens.
- (2) Pull bulb from lamp.

INSTALLATION

- (1) Install bulb in lamp.
- (2) Position lens on lamp and snap into place.

OVERHEAD CONSOLE READING LAMP BULB**REMOVAL**

- (1) Insert a flat blade screwdriver in slot at front of lens (Fig. 4).
- (2) Rotate the screwdriver until lens snaps out of the housing.
- (3) Remove lens from housing.
- (4) Remove bulb from terminals.

INSTALLATION

- (1) Insert bulb into reading lamp terminals.
- (2) Replace lens by holding lens level and pushing rearward into housing.
- (3) Push lens up to snap into housing.

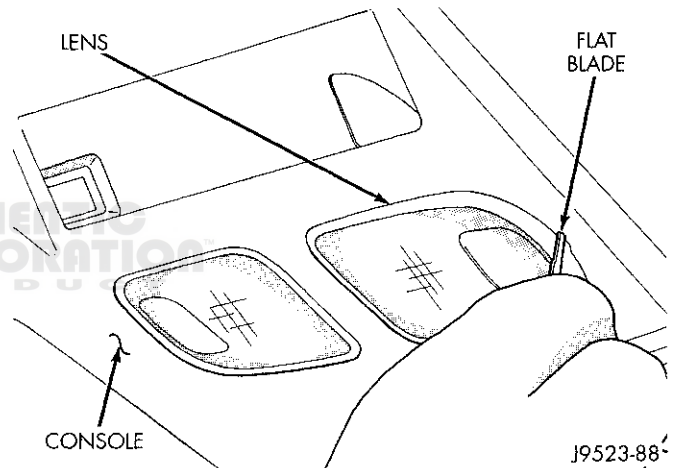


Fig. 4 Overhead Console Reading Lamp Bulb Removal

LAMP SERVICE

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REMOVAL AND INSTALLATION

HEADLAMP

REMOVAL

- (1) Release hood latch and open hood.
- (2) Remove park and turn signal lamp.
- (3) Remove screws holding top of headlamp module to radiator closure panel (Fig. 1).
- (4) From behind front bumper, remove screws holding bottom of headlamp module to radiator closure panel.
- (5) Separate headlamp module from radiator closure panel.
- (6) Disengage wire connector from headlamp bulb.
- (7) Separate headlamp module from vehicle.

INSTALLATION

- (1) If removed, install headlamp bulb.
- (2) Connect headlamp bulb wire connector.
- (3) Position headlamp in radiator closure panel.
- (4) From behind front bumper, install the screws holding bottom of headlamp module to radiator closure panel.
- (5) Install the screws holding top of headlamp module to radiator closure panel (Fig. 1).
- (6) Install park and turn signal lamp.
- (7) Close hood.

FOG LAMP

The fog lamps are serviced from the rearward side of the front bumper.

REMOVAL

- (1) Disengage fog lamp harness connector.
- (2) Remove fog lamp to bumper attaching nuts (Fig. 2).
- (3) Separate fog lamp from bumper.

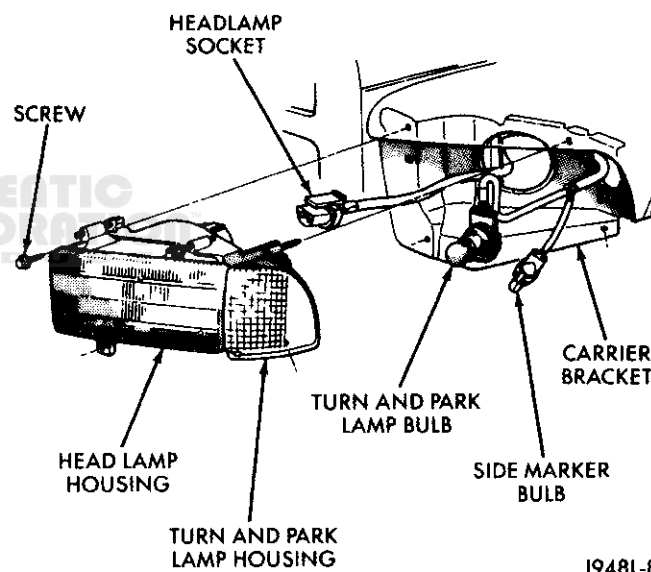


Fig. 1 Headlamp Removal/Installation

INSTALLATION

- (1) Position fog lamp in bumper.
- (2) Install fog lamp to bumper attaching nuts.
- (3) Connect fog lamp harness connector.
- (4) Check for proper operation and beam alignment.

PARK, TURN SIGNAL AND SIDE MARKER LAMP

REMOVAL

- (1) Remove screw holding park lamp to headlamp module.
- (2) Disengage clip holding park lamp to headlamp module.
- (3) Separate park lamp headlamp module.

REMOVAL AND INSTALLATION (Continued)

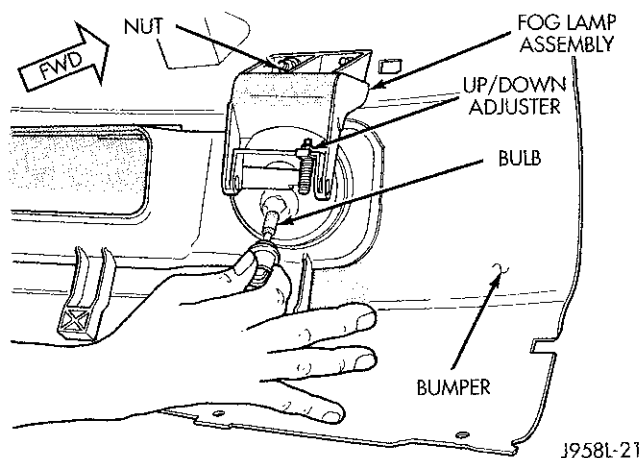


Fig. 2 Fog Lamp

- (4) Remove park and turn signal socket from back of lamp.
- (5) Remove side marker socket from back of lamp.
- (6) Separate park and turn signal lamp from vehicle.

INSTALLATION

Reverse the removal procedure.

ROOF CLEARANCE LAMP

REMOVAL

- (1) Remove screws holding clearance lamp lens to roof panel (Fig. 3).
- (2) Rotate socket 1/4 turn counterclockwise and separate socket from lamp.

INSTALLATION

- (1) Install socket in lamp and rotate socket 1/4 turn clockwise.
- (2) Position clearance lamp on roof.
- (3) Install screws holding clearance lamp lens to roof panel. Tighten to 1 N·m (13 in. lbs.).

CENTER HIGH MOUNTED STOP LAMP (CHMSL)

REMOVAL

- (1) Remove screws holding CHMSL to roof panel (Fig. 4).
- (2) Separate CHMSL from roof.
- (3) Disengage wire connector from body wire harness.
- (4) Separate CHMSL from vehicle.

INSTALLATION

- (1) Position lamp at cab roof and connect wire connector.
- (2) Install screws holding CHMSL to roof panel. Tighten securely.

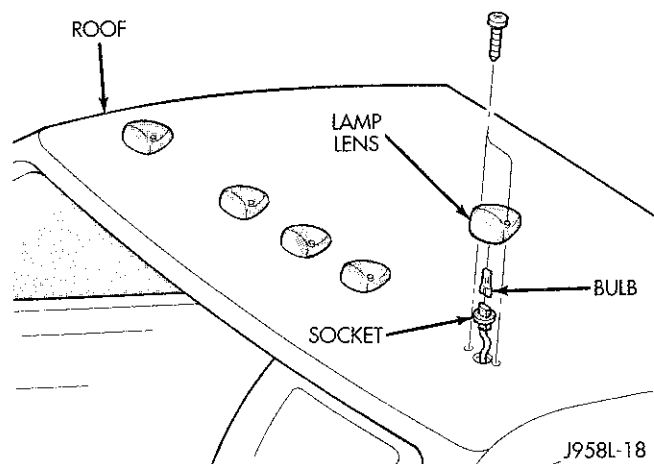


Fig. 3 Roof Clearance Lamps

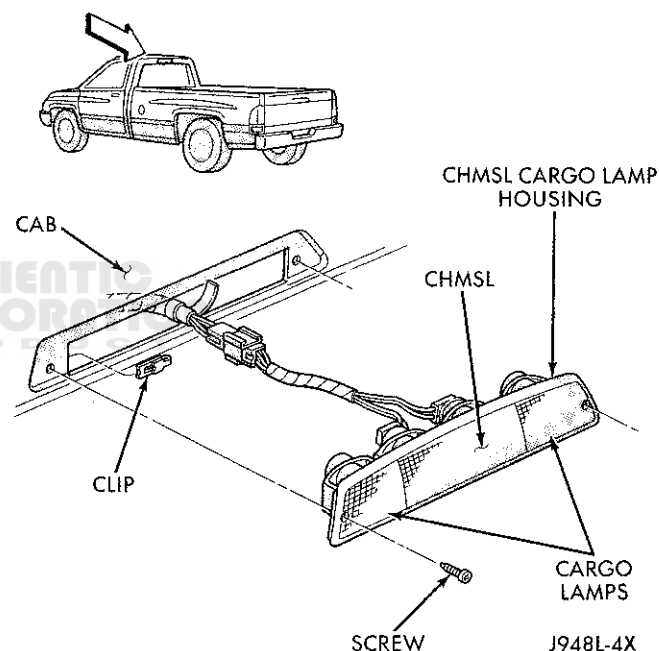


Fig. 4 Center High Mounted Stop Lamp

CARGO LAMP

The cargo lamp is incorporated into the CHMSL, if equipped. Refer to Center High Mounted Stop Lamp paragraph for service procedures.

SIDE IDENTIFICATION (ID) LAMPS

REMOVAL

- (1) Using a flat blade screw driver, disengage clips holding ID lamp to retainer (Fig. 5).
- (2) Separate ID lamp from retainer.
- (3) Disengage lamp bulb socket from lamp.
- (4) Remove screws holding lamp retainer to rear fender.
- (5) Separate retainer from rear fender.

REMOVAL AND INSTALLATION (Continued)

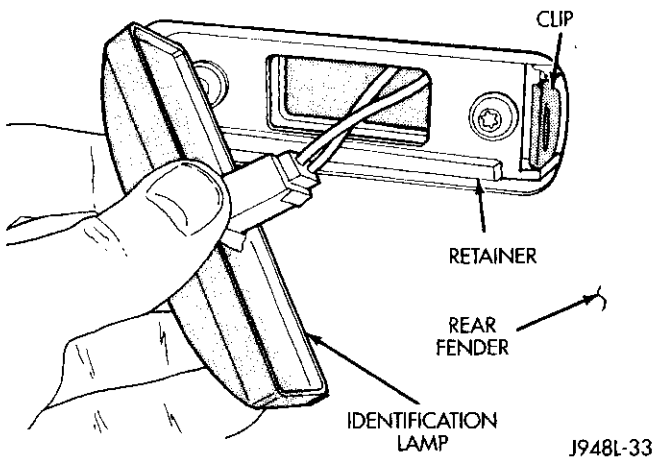


Fig. 5 Side Identification Lamps

INSTALLATION

Reverse the removal procedure.

TAIL, STOP, TURN SIGNAL AND BACK-UP LAMPS—PICKUP

REMOVAL

- (1) Release tailgate latch and open tailgate.
- (2) Remove screws holding tail lamp to cargo box (Fig. 6).
- (3) Grasp lamp, firmly pull lamp rearward to disengage retaining studs.
- (4) Remove socket from tail lamp.
- (5) Separate tail lamp from cargo box.
- (6) Separate tail lamp from vehicle.

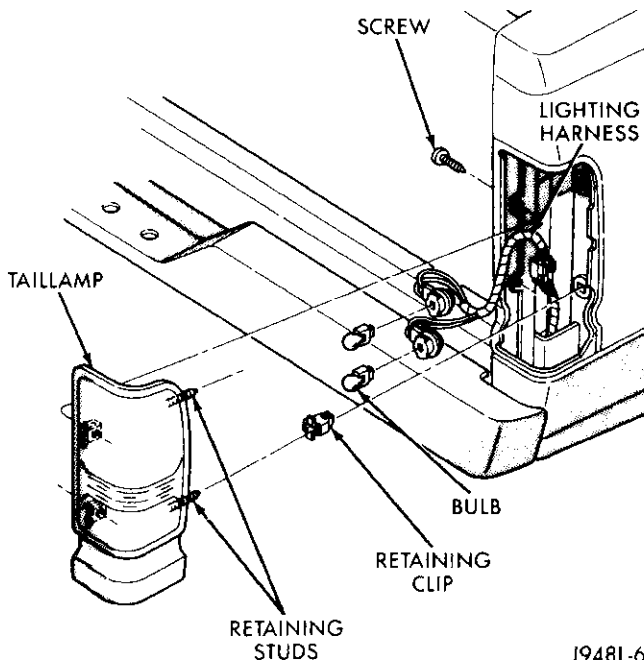


Fig. 6 Tail Lamp Assembly

INSTALLATION

- (1) Install socket in tail lamp.
- (2) Position tail lamp in cargo box, engage retaining studs and install screws.
- (3) Close tailgate.

TAIL, STOP, TURN SIGNAL AND BACK-UP LAMPS—CHASSIS CAB

REMOVAL

- (1) Remove nuts holding tail lamp to mounting bracket (Fig. 7).
- (2) Disengage tail lamp wire connector from body wire harness.
- (3) Separate tail lamp from vehicle.

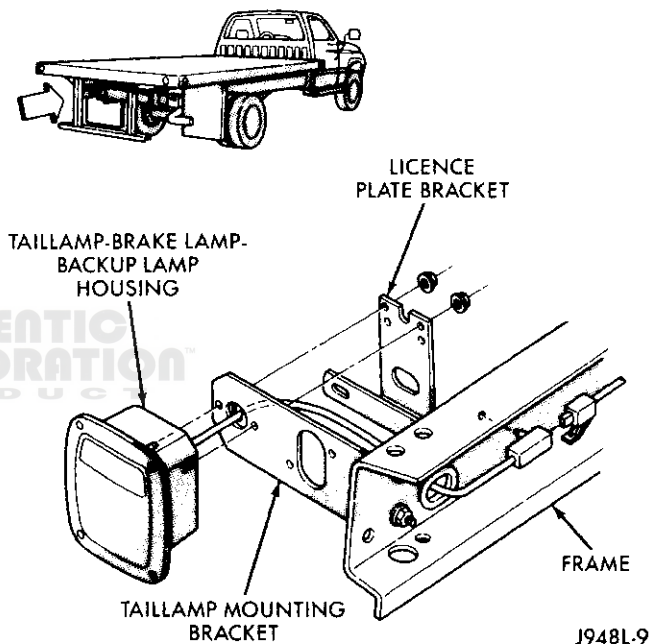


Fig. 7 Tail, Stop, Turn Signal and Back-up Lamps—Cab Chassis

INSTALLATION

Reverse the removal procedure.

REAR IDENTIFICATION (ID) LAMPS

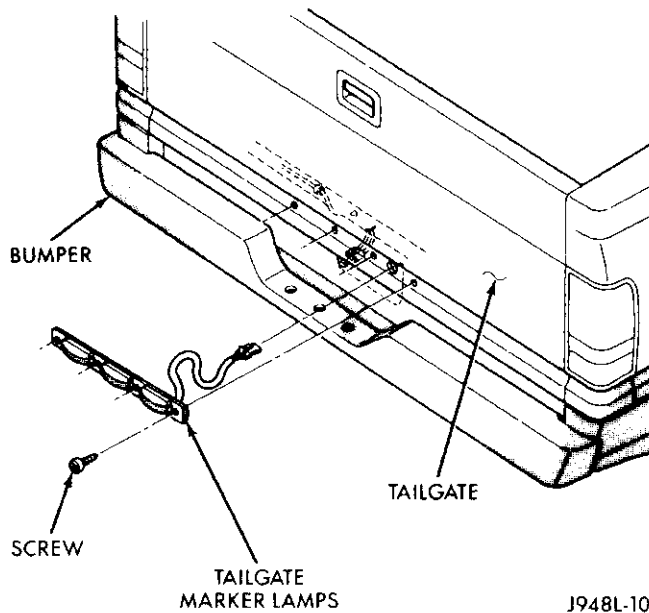
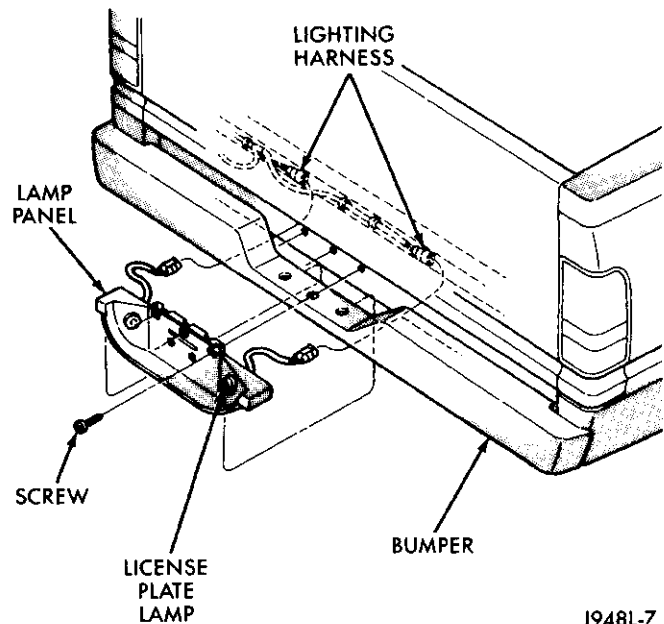
REMOVAL

Individual lamps may be replaced by removing the lamp from the light bar.

- (1) Remove screws holding rear ID lamps to tailgate (Fig. 8).
- (2) Separate ID lamps from tailgate.
- (3) Disengage ID lamp wire connector from body wire harness.
- (4) Separate ID lamp from vehicle.

INSTALLATION

Reverse the removal procedure.

REMOVAL AND INSTALLATION (Continued)**Fig. 8 Rear Identification Lamps****Fig. 9 License Plate Lamp Panel****LICENSE PLATE LAMP****REMOVAL**

- (1) Remove screws holding license plate panel to cargo box.
- (2) Disengage license plate lamp wire connector from body wire harness (Fig. 9).
- (3) Separate license plate lamp from vehicle.

INSTALLATION

Reverse the removal procedure.

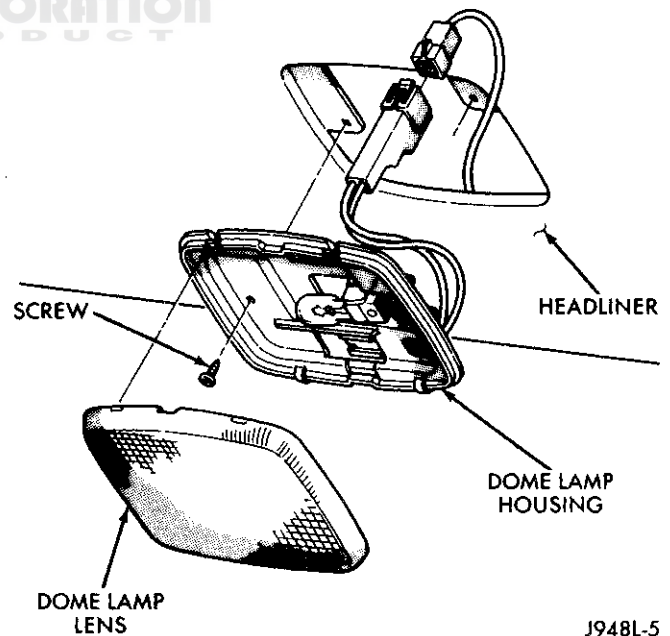
DOMELAMP**REMOVAL**

- (1) Using a suitable flat blade screw driver, pry dome lamp lens from dome lamp.
- (2) Remove screws holding dome lamp to roof reinforcement (Fig. 10).
- (3) Separate dome lamp from roof.
- (4) Disengage dome lamp wire connector from body wire harness.
- (5) Separate dome lamp from vehicle.

INSTALLATION

- (1) Position dome lamp at headliner.
- (2) Connect dome lamp wire connector to body wire harness.
- (3) Install screws holding dome lamp to roof reinforcement (Fig. 10).

- (4) Place dome lamp lens on dome lamp and snap into place.

**Fig. 10 Dome Lamp****OVERHEAD CONSOLE READING LAMP**

To service overhead console refer to Group 8C, Overhead Console.

LAMP SYSTEMS

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REMOVAL AND INSTALLATION

DAYTIME RUNNING LAMP MODULE

REMOVAL

- (1) Release hood latch and open hood.
- (2) Disconnect wire connector from DRLM (Fig. 1).
- (3) Remove screw holding DRLM to engine compartment dash panel.
- (4) Separate DRLM from dash panel.

INSTALLATION

Reverse the removal procedure.

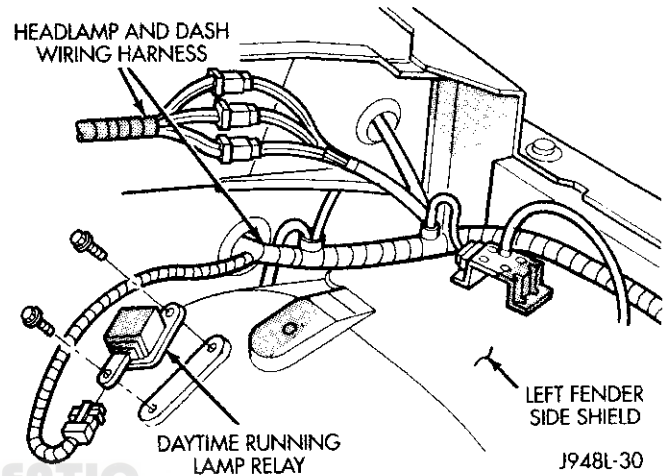


Fig. 1 Daytime Running Lamp Module (DRLM)



AUTHENTIC
RESTORATION
PRODUCT

BULB APPLICATION

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GENERAL INFORMATION

GENERAL INFORMATION

The following Bulb Application Tables lists the lamp title on the left side of the column and trade number or part number on the right.

CAUTION: Do not use bulbs that have a higher candle power than the bulb listed in the Bulb Application Table. Damage to lamp can result. Do not touch halogen bulbs with fingers or other oily surfaces. Bulb life will be reduced.

SPECIFICATIONS

EXTERIOR LAMPS

LAMP	BULB
Back-up .....	.3157
Cargo .....	.921
Center High Mounted Stop .....	.921
Clearance .....	.194
Headlamp .....	.9004
License Plate .....	.1155
License Plate—Step Bumper .....	.168
Park/Turn Signal .....	.3157NA
Snow Plow Control .....	.161
Tail/Stop/Turn Signal .....	.3157
Tail/Stop/Cab—Chassis .....	.1157
Underhood .....	.105

INTERIOR LAMPS

DIMMER CONTROLLED LAMPS

Service procedures for most of the lamps in the instrument panel, Instrument cluster and switches are located in Group 8E, Instrument Panel and Gauges. Some components have lamps that can only be serviced by a Authorized Service Center (ASC) after the component is removed from the vehicle. Contact local dealer for location of nearest ASC. When illumination goes out in the Electronic Instrument Cluster (EIC) the complete button module must

be replaced. The Mechanical Instrument Cluster (MIC) uses PC194 bulbs for illumination.

LAMP	BULB
A/C Heater Control .....	.158
Ash Receiver .....	.161
Cigar Lighter .....	.161
Headlamp Switch .....	.158
Heater Control .....	.158
Instrument Cluster	PC194
Radio	ASC

INDICATOR LAMPS

Service procedures for most of the lamps in the instrument panel, instrument cluster and switches are located in Group 8E, Instrument Panel and Gauges.

LAMP	BULB
Airbag High Line	PC194
Airbag low Line	PC74
Anti-lock Brake	PC74
Battery Voltage	PC194
Brake Warning	PC194
Check Engine	PC74
Engine Oil Pressure	PC74
Four Wheel Drive	PC194
High Beam	PC194
Low Fuel	PC194
Low Washer Fluid	PC74
Maintenance Required	PC74
Message Center	PC194
Seat Belt	PC74
Turn Signal	PC194
Upshift	PC74

NON-DIMMING LAMPS

Some components have lamps that can only be serviced by a Authorized Service Center (ASC) after the component is removed from the vehicle. Contact local dealer for location of nearest ASC.

LAMP	BULB
Dome1004
Glove Compartment1891

PASSIVE RESTRAINT SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

The driver's side airbag system is a standard equipment safety device on this model. It is designed to protect the driver from serious injury caused by a frontal impact of the vehicle. To inspect this system, refer to the Airbag System - Body Diagnostic Procedures manual. If the airbag module assembly is defective and non-deployed, refer to the Chrysler Corporation current parts return list in the Warranty Policies and Procedures manual for the proper handling procedures.

Following are general descriptions of the major components in the airbag system. Refer to 8W-43 - Airbag System in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

WARNING:

- THIS SYSTEM IS A SENSITIVE, COMPLEX ELECTRO-MECHANICAL UNIT. BEFORE ATTEMPTING TO DIAGNOSE, REMOVE OR INSTALL THE AIRBAG SYSTEM OR RELATED STEERING WHEEL AND STEERING COLUMN COMPONENTS, YOU MUST FIRST DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE. THEN WAIT TWO MINUTES FOR THE SYSTEM CAPACITOR TO DISCHARGE BEFORE FURTHER SYSTEM SERVICE. THIS IS THE ONLY SURE WAY TO DISABLE THE AIRBAG SYSTEM. FAILURE TO DO THIS COULD RESULT IN ACCIDENTAL AIRBAG SYSTEM DEPLOYMENT AND POSSIBLE PERSONAL INJURY.
- THE AIRBAG MODULE INFLATOR ASSEMBLY CONTAINS SODIUM AZIDE AND POTASSIUM NITRATE. THESE MATERIALS ARE POISONOUS

AND EXTREMELY FLAMMABLE. CONTACT WITH ACID, WATER, OR HEAVY METALS MAY PRODUCE HARMFUL AND IRRITATING GASES (SODIUM HYDROXIDE IS FORMED IN THE PRESENCE OF MOISTURE) OR COMBUSTIBLE COMPOUNDS. DO NOT ATTEMPT TO DISMANTLE THE MODULE OR TAMPER WITH ITS INFLATOR. DO NOT PUNCTURE, INCINERATE, OR BRING INTO CONTACT WITH ELECTRICITY. DO NOT STORE AT TEMPERATURES EXCEEDING 93°C (200°F).

- REPLACE AIRBAG SYSTEM COMPONENTS ONLY WITH PARTS SPECIFIED IN THE CHRYSLER MOPAR PARTS CATALOG. SUBSTITUTE PARTS MAY APPEAR INTERCHANGEABLE, BUT INTERNAL DIFFERENCES MAY RESULT IN INFERIOR OCCUPANT PROTECTION. THE FASTENERS, SCREWS, AND BOLTS ORIGINALLY USED FOR THE AIRBAG SYSTEM COMPONENTS HAVE SPECIAL COATINGS AND ARE SPECIFICALLY DESIGNED FOR THE AIRBAG SYSTEM. THEY MUST NEVER BE REPLACED WITH SUBSTITUTES. ANY TIME A NEW FASTENER IS NEEDED, REPLACE IT WITH THE CORRECT FASTENERS PROVIDED IN THE SERVICE PACKAGE OR SPECIFIED IN THE CHRYSLER MOPAR PARTS CATALOG.

- WHEN A STEERING COLUMN HAS AN AIRBAG MODULE ATTACHED, NEVER PLACE THE COLUMN ON THE FLOOR OR ANY OTHER SURFACE WITH THE STEERING WHEEL OR AIRBAG MODULE FACE DOWN.

DESCRIPTION AND OPERATION

AIRBAG MODULE

The airbag module protective cover is the most visible part of the system. The module is mounted directly to the steering wheel. Under the airbag module cover, the airbag cushion and its supporting components are contained. The airbag module contains a housing to which the cushion and inflator are attached and sealed. The airbag module cannot be repaired, and must be replaced if deployed or in any way damaged.

The inflator assembly is mounted to the back of the module. The inflator seals the hole in the airbag cushion so it can discharge the gas it produces directly into the cushion when supplied with the proper electrical signal. The protective cover is fitted to the front of the airbag module and forms a decorative cover in the center of the steering wheel. Upon airbag deployment, this cover will split horizontally.

STORAGE

The airbag module must be stored in its original, special container until used for service. Also, it must be stored in a clean, dry environment; away from sources of extreme heat, sparks, and high electrical energy. Always place or store the module on a surface with the trim cover facing up to minimize movement in case of accidental deployment.

IMPACT SENSORS

The impact sensors provide verification of the direction and severity of the impact. Three sensors are used. One is called a safing sensor. It is located inside the Airbag Control Module (ACM), which is mounted to a bracket under the instrument panel, on the top of the floor pan transmission tunnel. The other two sensors are mounted on the inner fender extension panels behind the grille opening reinforcement, on the left and right sides of the vehicle. The sensors are calibrated for the specific vehicle, and react to the severity and direction of the impact.

The impact sensors are threshold sensitive switches that complete an electrical circuit when an impact provides a sufficient deceleration force to close the switch. The safing sensor is an accelerometer that senses the rate of deceleration. The microprocessor in the ACM monitors the sensor signals. A pre-programmed decision algorithm in the microprocessor determines when the deceleration rate indicates an impact that is severe enough to require airbag system protection.

The impact sensors are available for service replacement. The safing sensor is only serviced as part of the ACM.

CLOCKSPRING

The clockspring is mounted on the steering column behind the steering wheel. It is used to maintain a continuous electrical circuit between the wiring harness and the driver's side airbag module. This assembly consists of a flat, ribbon-like electrically conductive tape that winds and unwinds with the steering wheel rotation.

AIRBAG CONTROL MODULE

The Airbag Control Module (ACM) contains the safing sensor, and a microprocessor that monitors the airbag system to determine its readiness. It also monitors the impact sensors to determine when the proper conditions exist to provide the electrical signal that deploys the airbag. The ACM contains On-Board Diagnostics (OBD), and will light the airbag warning lamp in the instrument cluster when a monitored airbag system fault occurs.

The ACM also contains an energy-storage capacitor. This capacitor stores enough electrical energy to deploy the airbag for up to two minutes following a battery disconnect or failure. The purpose of the capacitor is to provide airbag system protection in a severe secondary impact if the initial impact has damaged or disconnected the battery, but was not severe enough to deploy the airbag.

DIAGNOSIS AND TESTING

AIRBAG SYSTEM

A DRB scan tool is required for diagnosis of the airbag system. Refer to the Airbag System - Body Diagnostic Procedures manual for more information.

(1) Disconnect and isolate the battery negative cable. If the airbag system is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) Connect the DRB scan tool to the 16-way data link connector. The connector is located under the lower left corner of the instrument panel behind the steering column cover/knee blocker (Fig. 1).

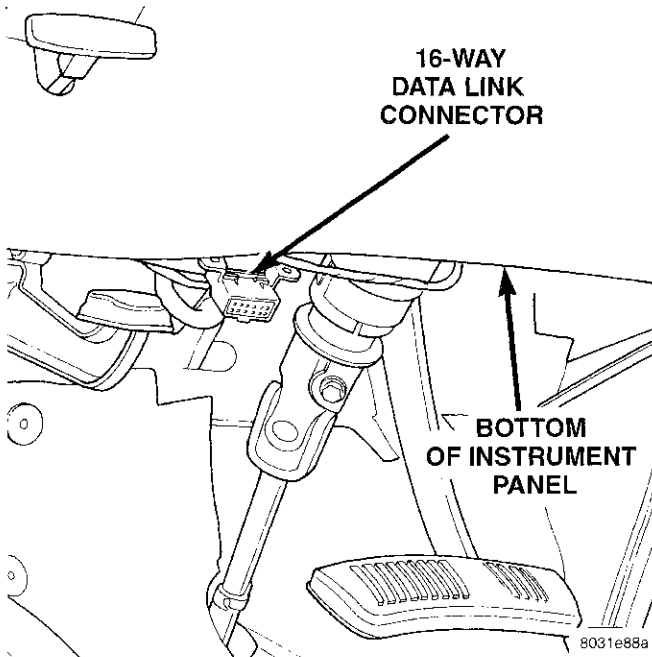
(3) From the right side of the vehicle (away from the airbag module in case of an accidental deployment), turn the ignition switch to the On position. Exit the vehicle with the DRB. Use the latest version of the proper DRB cartridge.

(4) After checking that nobody is inside the vehicle, reconnect the battery negative cable.

(5) Using the DRB, read and record the active Diagnostic Trouble Code (DTC) data.

(6) Read and record any stored DTC data.

(7) Refer to the Airbag System - Body Diagnostic Procedures manual, if any DTC is found in Step 5 or Step 6.

DIAGNOSIS AND TESTING (Continued)**Fig. 1 16-Way Data Link Connector - Typical**

(8) Erase the stored DTC data, if there are no active fault codes. If any problems remain, the stored DTC data will not erase.

(9) With the ignition switch still in the On position, make sure nobody is in the vehicle.

(10) From the right side of the vehicle turn the ignition switch to the Off position, and then back to the On position. Observe the airbag warning lamp in the instrument cluster. It should light for six to eight seconds -then go out. This indicates that the airbag system is functioning normally.

NOTE: If the airbag warning lamp fails to light, or lights and stays on, there is a system malfunction. Refer to the Airbag System - Body Diagnostic Procedures manual to diagnose the problem.

SERVICE PROCEDURES**AIRBAG SYSTEM****UNDEPLOYED**

At no time should any source of electricity be permitted near the inflator on the back of the airbag module. When carrying an undeployed airbag module, the trim cover should be pointed away from the body to minimize injury in the event of accidental deployment. If the module is placed on a bench or any other surface, the plastic trim cover should be face up to minimize movement in the event of an accidental deployment.

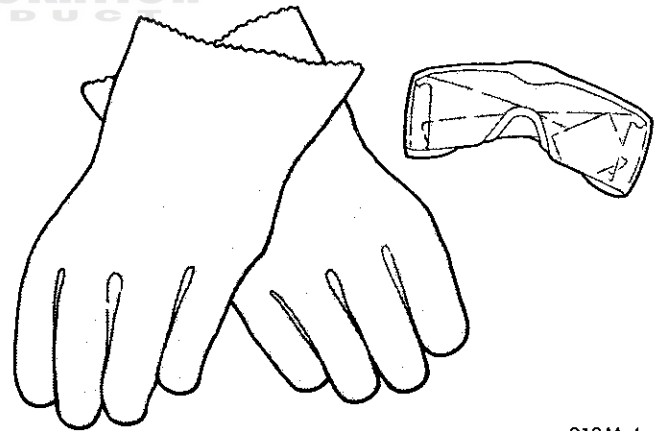
In addition, the airbag system should be disarmed whenever the steering wheel or steering column requires service or removal. Failure to observe this warning could result in accidental airbag deployment and possible personal injury. Refer to Group 19 - Steering for additional service procedures on the steering wheel and steering column.

DEPLOYED

Any vehicle which is to be returned to use after an airbag system deployment, must have the airbag module and clockspring replaced. These are one-time components and cannot be reused. Other airbag system components are replaced as required by the extent of damage.

CLEAN-UP PROCEDURE

Following an airbag system deployment, the vehicle interior will contain a powdery residue. This residue is primarily sodium bicarbonate (baking soda), used as an airbag cushion lubricant. However, there will also be traces of sodium hydroxide powder, a chemical by-product of the generant used for airbag system deployment. Since this powder can irritate the skin, eyes, nose, or throat, be sure to wear safety glasses, rubber gloves, and a long-sleeved shirt during cleanup (Fig. 2).

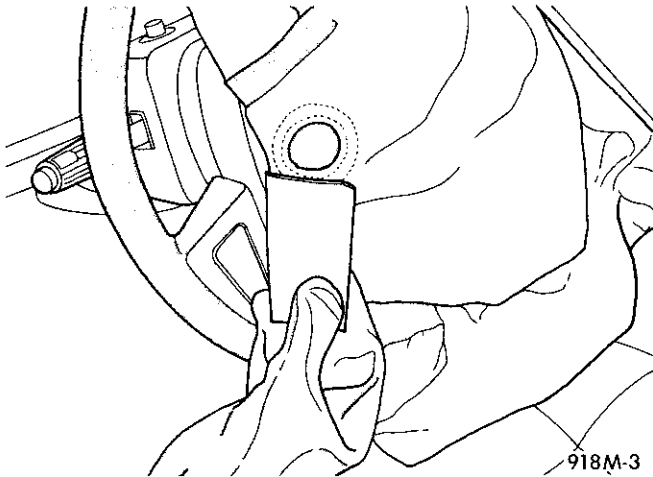


918M-4

Fig. 2 Wear Safety Glasses and Rubber Gloves

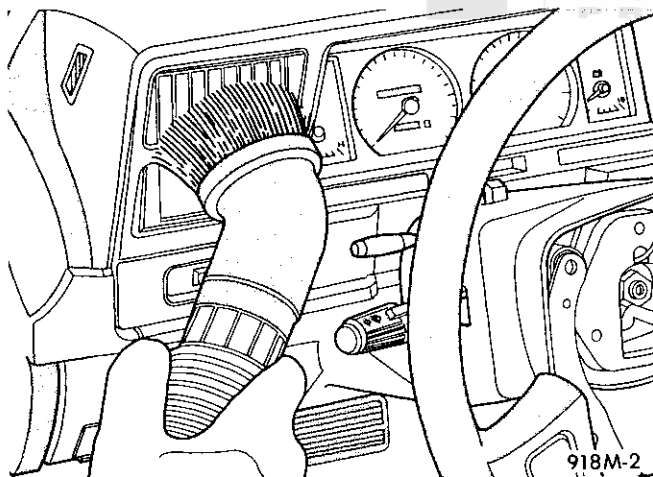
WARNING: IF YOU EXPERIENCE SKIN IRRITATION DURING CLEANUP, RUN COOL WATER OVER THE AFFECTED AREA. ALSO, IF YOU EXPERIENCE IRRITATION OF THE NOSE OR THROAT, EXIT THE VEHICLE FOR FRESH AIR UNTIL THE IRRITATION CEASES. IF IRRITATION CONTINUES, SEE A PHYSICIAN.

Begin clean-up by applying tape over the airbag exhaust vent so that no more powder will find its way into the vehicle interior (Fig. 3). Then remove the airbag module from the vehicle.

SERVICE PROCEDURES (Continued)**Fig. 3 Airbag Exhaust Vent Sealing**

Use a vacuum cleaner to remove any residual powder from the vehicle interior. Clean from outside the vehicle and work your way inside, so that you avoid kneeling or sitting on an uncleaned area.

Be sure to vacuum the heater and air conditioning outlets as well (Fig. 4). Run the heater and air conditioning blower on the lowest speed setting and vacuum any powder expelled from the outlets. You may need to vacuum the interior of the vehicle a second time to recover all of the powder.

**Fig. 4 Vacuum Heater and A/C Outlets**

Place the deployed airbag module in your vehicular scrap pile.

REMOVAL AND INSTALLATION**AIRBAG MODULE****WARNING:**

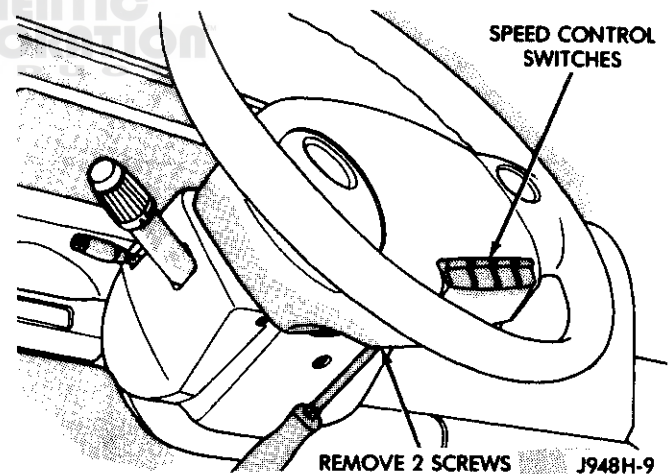
• **THIS SYSTEM IS A SENSITIVE, COMPLEX ELECTRO-MECHANICAL UNIT. BEFORE ATTEMPT-**

ING TO DIAGNOSE, REMOVE OR INSTALL THE AIRBAG SYSTEM OR RELATED STEERING WHEEL AND STEERING COLUMN COMPONENTS YOU MUST FIRST DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE. THEN WAIT TWO MINUTES FOR THE SYSTEM CAPACITOR TO DISCHARGE BEFORE FURTHER SYSTEM SERVICE. THIS IS THE ONLY SURE WAY TO DISABLE THE AIRBAG SYSTEM. FAILURE TO DO THIS COULD RESULT IN ACCIDENTAL AIRBAG SYSTEM DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

• **WHEN REMOVING A DEPLOYED AIRBAG MODULE, RUBBER GLOVES, EYE PROTECTION, AND A LONG-SLEEVED SHIRT SHOULD BE WORN. THERE MAY BE DEPOSITS ON THE AIRBAG MODULE AND OTHER INTERIOR SURFACES. IN LARGE DOSES, THESE DEPOSITS MAY CAUSE IRRITATION TO THE SKIN AND EYES.**

(1) Disconnect and isolate the battery negative cable. If the airbag module is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) From the underside of the steering wheel, remove the speed control switch or trim bar mounting screws (Fig. 5).

**Fig. 5 Speed Control Switch Remove/Install**

(3) Pull the switches or trim bar from the steering wheel. If equipped with speed control, unplug the wiring connector from the switch (Fig. 6).

(4) Remove the four nuts attaching the airbag module to the steering wheel (Fig. 7).

(5) Remove the airbag module from the steering wheel.

(6) Unplug the electrical connector from the airbag module.

(7) When installing, connect the clockspring wiring connector to the module by pressing straight in on the connector. The connector should latch securely

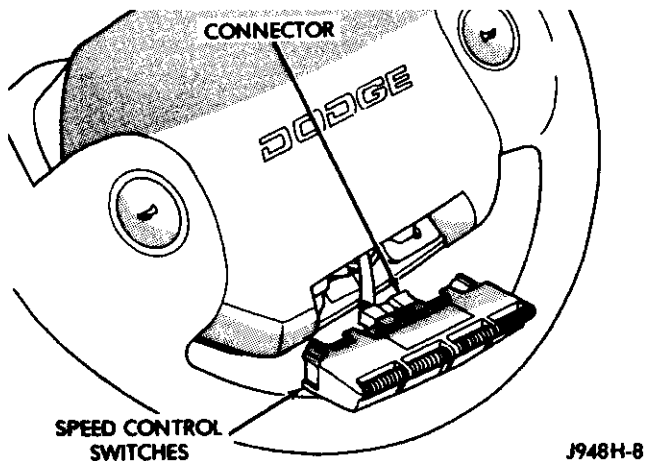
REMOVAL AND INSTALLATION (Continued)

Fig. 6 Speed Control Switch Connector Remove/Install

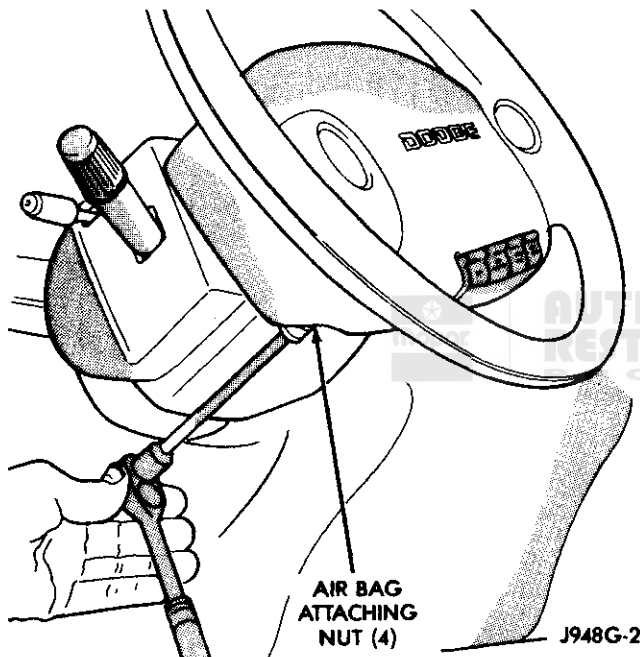


Fig. 7 Airbag Module Remove/Install

beneath the module connector locking clip arms to assure positive connection.

(8) Install the four airbag module mounting nuts and tighten to 9 to 11 N·m (80 to 100 in. lbs.).

(9) Install the speed control switch or trim bar, as equipped.

(10) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

IMPACT SENSORS**LEFT SIDE****V-6 AND V-8 ENGINE**

(1) Disconnect and isolate the battery negative cable. If the airbag module is undeployed, wait two

minutes for the system capacitor to discharge before further service.

(2) Remove the plastic retainers holding the rubber air dam to the radiator support on the driver's side.

(3) Working through the air dam opening, remove the three screws holding the sensor to the front wheelhouse extension (Fig. 8).

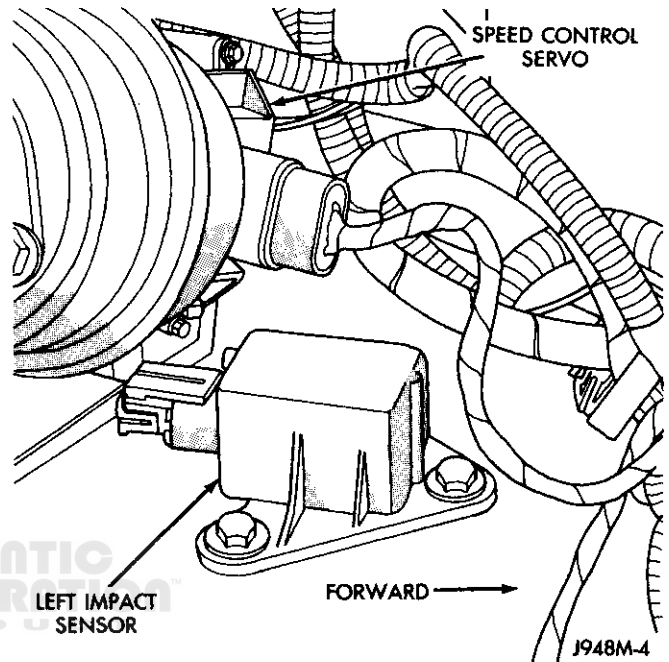


Fig. 8 Left Impact Sensor Remove/Install

(4) Unplug the wiring connector from the sensor and remove the sensor (Fig. 9).

NOTE: Do not remove the tape holding the sensor wiring harness to the connector.

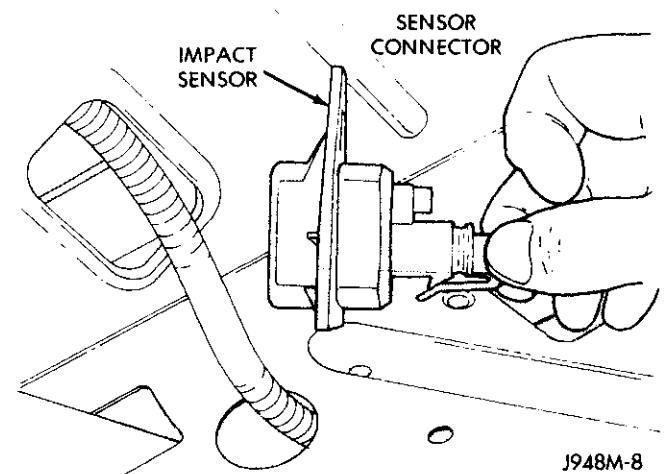


Fig. 9 Impact Sensor Connector - Typical

(5) To install, connect the sensor wiring lead to the impact sensor.

REMOVAL AND INSTALLATION (Continued)

(6) Mount the sensor (arrow pointed forward) using the three screws provided with the new sensor. Tighten screws to 4.5 - 5.6 N·m (40 -50 in. lbs.).

(7) Install the rubber air dam to the left radiator support.

(8) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

V-10 AND DIESEL ENGINE

(1) Disconnect and isolate the battery negative cable. If the airbag module is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) Remove the two battery holddown bolts (Fig. 10).

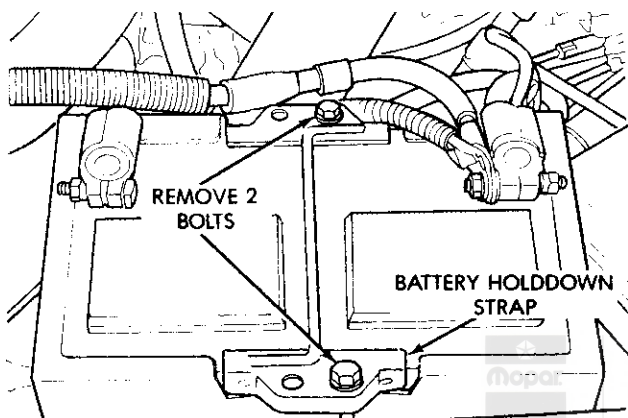


Fig. 10 Battery Holddown

(3) If equipped, pull up on the battery heat shield to remove it (Fig. 11).

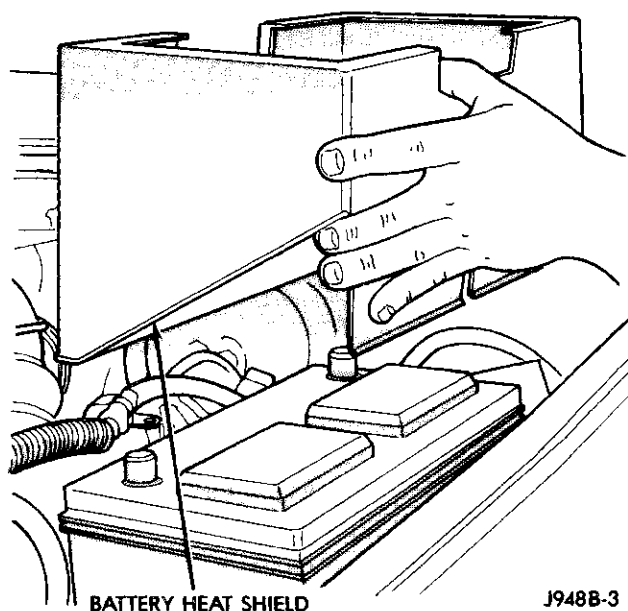


Fig. 11 Battery Heat Shield

(4) Remove the battery from the vehicle.

(5) From under the left front wheel opening, remove the two forward battery tray nuts (Fig. 12).

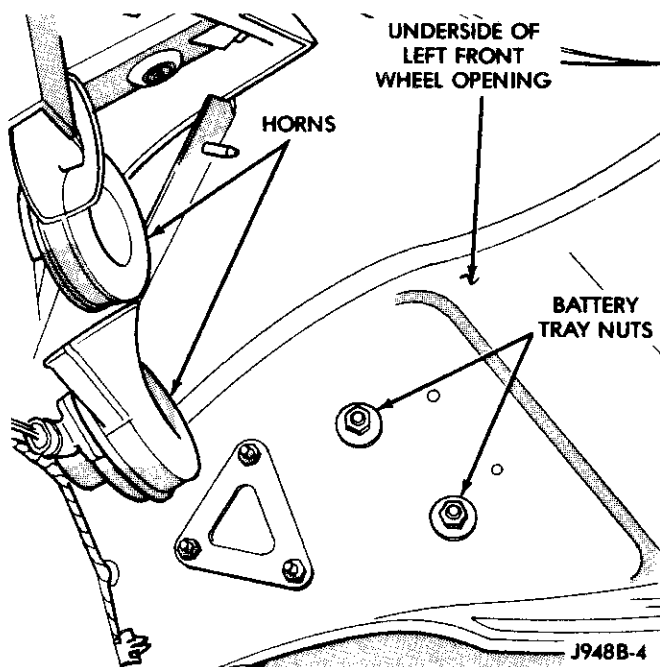


Fig. 12 Forward Battery Tray Nuts

(6) Remove the two nuts and two bolts holding the battery tray to the vehicle (Fig. 13).

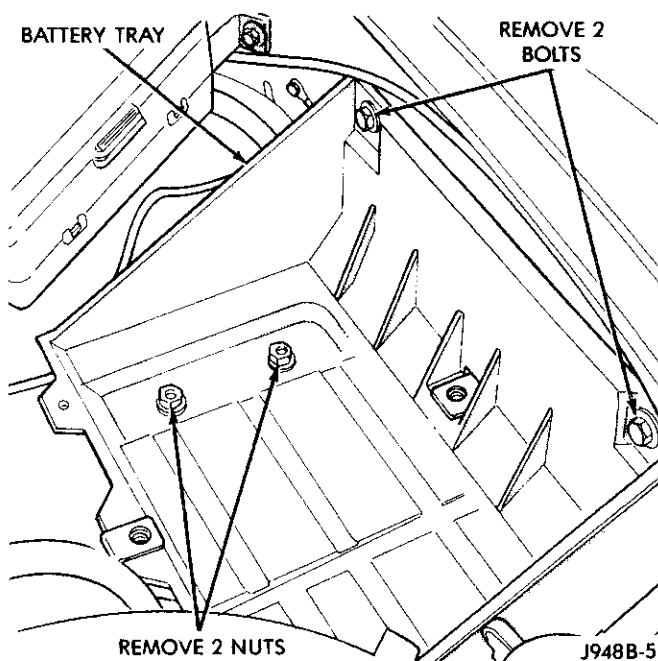


Fig. 13 Battery Tray Mounting

REMOVAL AND INSTALLATION (Continued)

(7) Lift the battery tray up far enough for access to the speed control servo electrical connector (Fig. 14).

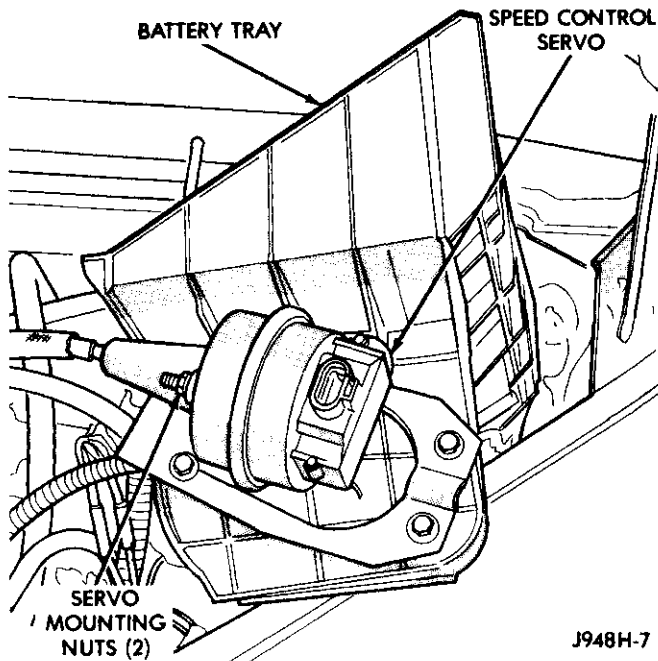


Fig. 14 Speed Control Servo Mounting

(8) Unplug the electrical connector from the speed control servo.

(9) Move the battery tray enough to access the impact sensor.

(10) Remove the three screws holding the impact sensor to the front wheelhouse extension (Fig. 15).

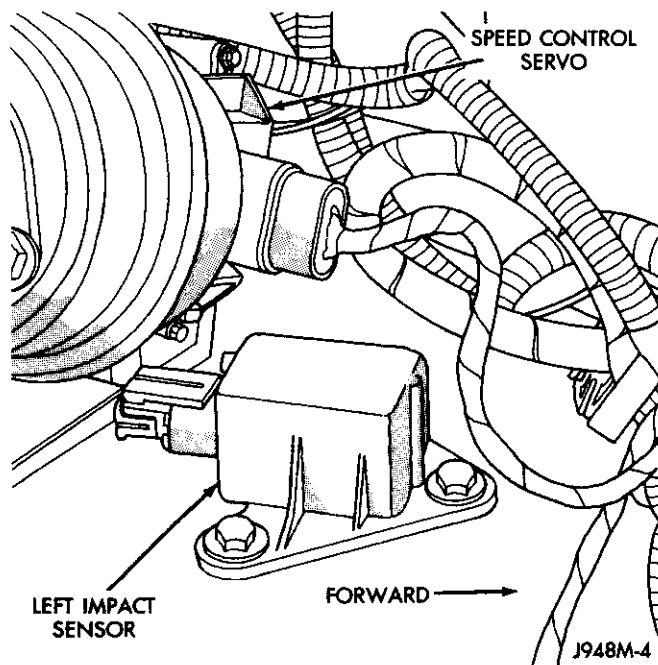


Fig. 15 Left Impact Sensor Remove/Install

(11) Unplug the connector from the impact sensor and remove the sensor (Fig. 16).

NOTE: Do not remove the tape holding the sensor wiring harness to the connector.

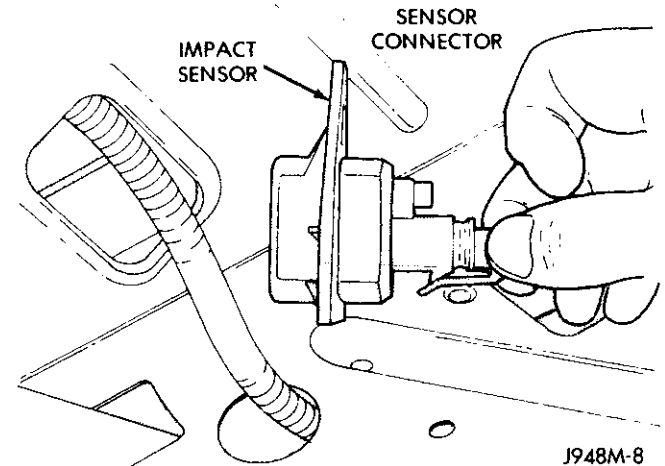


Fig. 16 Impact Sensor Connector - Typical

(12) To install, connect the sensor wiring lead to the sensor.

(13) Mount the sensor (arrow pointed forward) using the three screws provided with the new sensor. Tighten the screws to 4.5 - 5.6 N·m (40 - 50 in. lbs.).

(14) Plug the harness connector into the speed control servo.

(15) Install the battery tray. Tighten all battery tray mounting hardware to 16 N·m (140 in. lbs.).

(16) Install the battery in the vehicle, making sure that the battery is properly positioned in the battery tray.

(17) If equipped, install the battery heat shield.

(18) Install the battery holddown clamp, making sure that it is properly positioned on the battery, use the holes across from each other. Tighten the hold-down bolts to 4 N·m (35 in. lbs.).

(19) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

RIGHT SIDE**V-6 AND V-8 ENGINE**

(1) Disconnect and isolate the battery negative cable. If the airbag module is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) Remove the three screws holding the sensor to the front wheelhouse extension (Fig. 17).

(3) Unplug the connector from the impact sensor and remove the sensor (Fig. 18).

REMOVAL AND INSTALLATION (Continued)

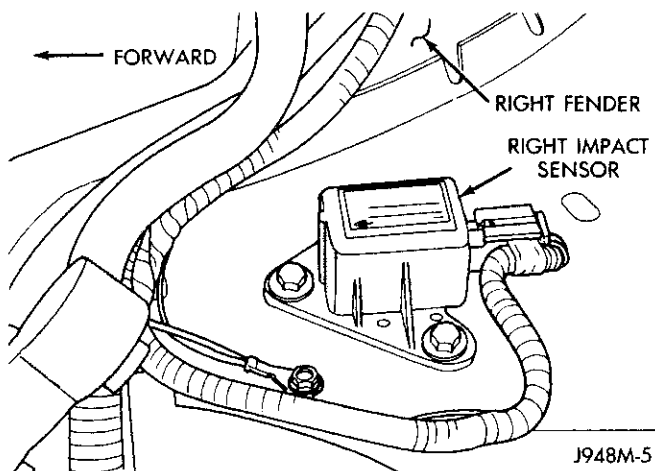


Fig. 17 Right Impact Sensor Remove/Install

NOTE: Do not remove the tape holding the sensor wiring harness to the connector.

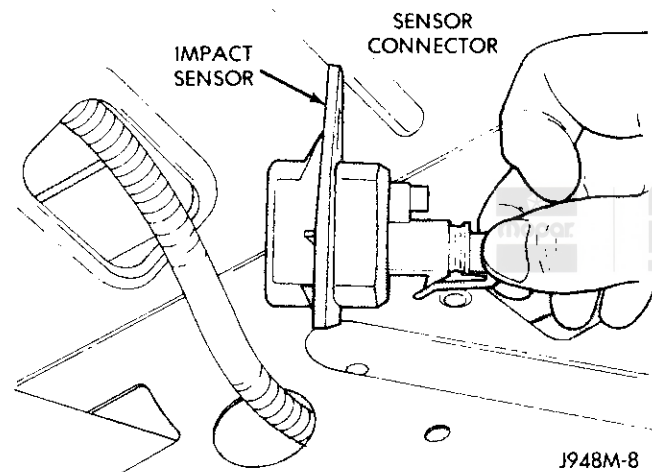


Fig. 18 Impact Sensor Connector - Typical

(4) To install, connect the sensor wiring lead to the sensor.

(5) Mount the sensor (arrow pointed forward) using the three screws provided with the new sensor. Tighten the screws to 4.5 - 5.6 N·m (40 - 50 in. lbs.).

(6) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

V-10 AND DIESEL ENGINE

(1) Disconnect and isolate the battery negative cable. If the airbag module is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) Remove the three screws holding the sensor to the front wheelhouse extension (Fig. 17).

(3) Unplug the connector from the impact sensor and remove the sensor (Fig. 18).

NOTE: Do not remove the tape holding the sensor wiring harness to the connector.

(4) To install, connect the sensor wiring lead from the harness to the connector on the body of the sensor.

(5) Mount the sensor (arrow pointed forward) using the three screws provided with new sensor. Tighten screws to 4.5 - 5.6 N·m (40 - 50 in. lbs.).

(6) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and testing for the proper procedures.

AIRBAG CONTROL MODULE

WARNING: THE ACM CONTAINS ONE OF THE IMPACT SENSORS WHICH ENABLE THE SYSTEM TO DEPLOY THE AIRBAG. TO AVOID ACCIDENTAL DEPLOYMENT, NEVER CONNECT THE ACM ELECTRICALLY TO THE SYSTEM UNLESS IT IS BOLTED TO THE VEHICLE. BEFORE BEGINNING ANY AIRBAG SYSTEM REMOVAL OR INSTALLATION PROCEDURES, DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE FROM THE VEHICLE BATTERY. THEN WAIT TWO MINUTES FOR THE SYSTEM CAPACITOR TO DISCHARGE BEFORE FURTHER SYSTEM SERVICE. THIS IS THE ONLY SURE WAY TO DISABLE THE AIRBAG SYSTEM. FAILURE TO DO THIS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT, AND POSSIBLE PERSONAL INJURY.

(1) Disconnect and isolate the battery negative cable. If the airbag system is undeployed, wait two minutes for the system capacitor to discharge before further service.

(2) Remove the two screws and the ACM cover from the bottom of the center console (Fig. 19).

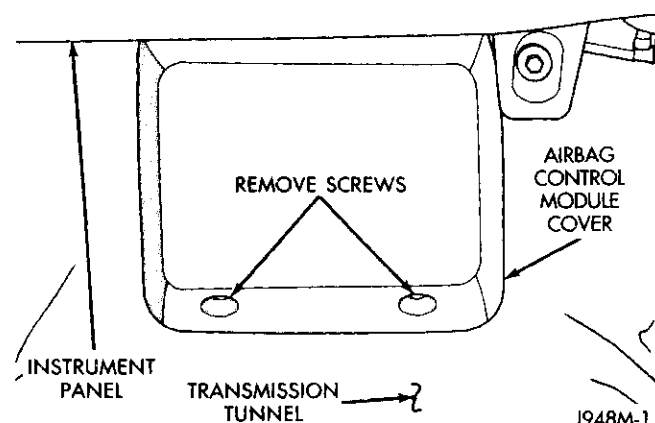


Fig. 19 ACM Cover Screws Remove/Install

REMOVAL AND INSTALLATION (Continued)

(3) Remove the four screws holding the ACM to the transmission tunnel (Fig. 20).

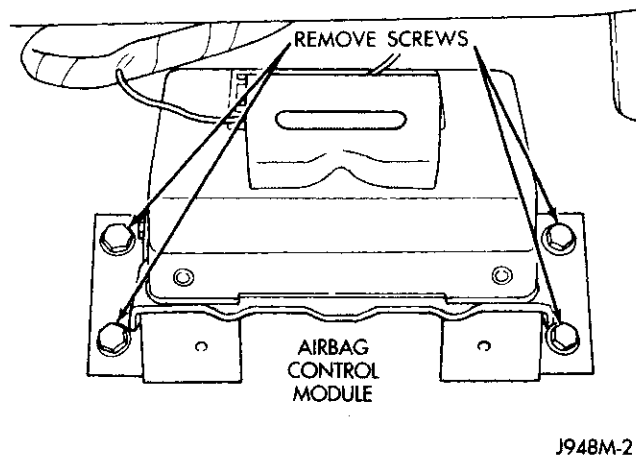


Fig. 20 Airbag Control Module Remove/Install

- (4) Disconnect the wiring at the ACM.
- (5) Remove the ACM.
- (6) To install, position the ACM with the arrow pointing forward.
- (7) Connect the wiring at the ACM, be certain that both connectors are seated and the locking tabs are engaged.
- (8) Attach the ACM to the transmission tunnel with the four screws. Tighten to 11.8 - 16.3 N·m (105 - 145 in. lbs.).
- (9) Install the ACM cover.
- (10) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

CLOCKSPRING

- (1) Turn the steering wheel until the front wheels are in the straight-ahead position before starting the repair.
- (2) Disconnect and isolate the battery negative cable. If the airbag system is undeployed, wait two minutes for the system capacitor to discharge before further service.
- (3) Remove the airbag module as described in this group.
- (4) Remove the steering wheel with a steering wheel puller (Special Tool C-3428B).
- (5) Unplug the wiring for the horn switches.
- (6) Remove the lower steering column shroud to gain access to the clockspring wiring (Fig. 21).
- (7) Remove the lower fixed column shroud.
- (8) Remove the knee blocker (Fig. 22).
- (9) Disconnect the two-way connector between the clockspring and the instrument panel wiring harness at the lower left corner of the instrument panel.
- (10) To remove, lift the locating fingers of the clockspring assembly from the steering column as

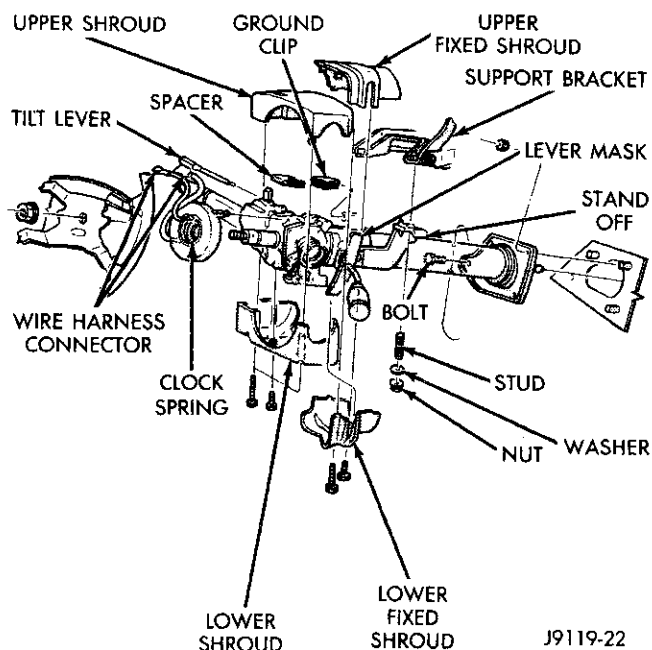


Fig. 21 Steering Column Shrouds Remove/Install

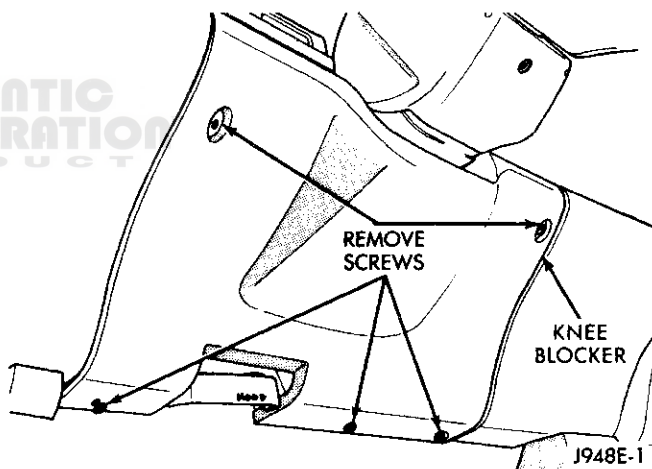


Fig. 22 Knee Blocker Remove/Install

necessary. The clockspring cannot be repaired. It must be replaced if faulty, or if the airbag system has been deployed.

(11) When installing, snap the clockspring onto the steering column. If the clockspring is not properly positioned, see Clockspring Centering in this group before installing the steering wheel.

(12) Connect the clockspring wiring to the instrument panel wiring harness. Be certain that the wiring locator clips are properly seated on the outside of the wiring trough and that the locking tabs are engaged.

(13) Install the knee blocker.

(14) Re-install the steering column shrouds. Be certain that the airbag wire is inside the shrouds.

REMOVAL AND INSTALLATION (Continued)

(15) The front wheels should still be in the straight-ahead position. Install the steering wheel being certain to fit the flats on the hub of the steering wheel with the formations on the inside of the clockspring. Pull the horn wiring through the upper, smaller hole in the steering wheel hub. Pull the airbag and speed control wiring through the bottom, larger hole in the steering wheel hub. Tighten the steering wheel nut to 61 N·m (45 ft. lbs.). Be certain not to pinch the wiring between the steering wheel and the nut.

(16) Connect the horn switch wire, then the airbag wire to the airbag module. To assure complete connection, the latching arms must be visibly on top of the airbag wiring connector housing.

(17) Install the airbag module and tighten the nuts to 9 to 11 N·m (80 to 100 in. lbs.).

(18) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

ADJUSTMENTS**CLOCKSPRING CENTERING**

If the rotating tape within the clockspring is not positioned properly in relation to the steering wheel and the front wheels, the clockspring may fail during use. The clockspring must be centered if it is not known to be properly positioned, or if the front wheels were moved from the straight-ahead position with the clockspring removed during any service procedure.

(1) Turn the steering wheel until the front wheels are in the straight-ahead position before starting the centering procedure.

(2) Disconnect and isolate the battery negative cable. If the airbag system is undeployed, wait two minutes for the system capacitor to discharge before further service.

(3) Remove the airbag module as described in this group.

(4) Remove the steering wheel with a steering wheel puller (Special Tool C-3428B).

(5) Unplug the wiring for the horn switches.

(6) Depress the two plastic auto-locking tabs (Fig. 23).

(7) Keeping the locking mechanism disengaged, rotate the clockspring rotor clockwise to the end of its travel. Do not apply excessive torque.

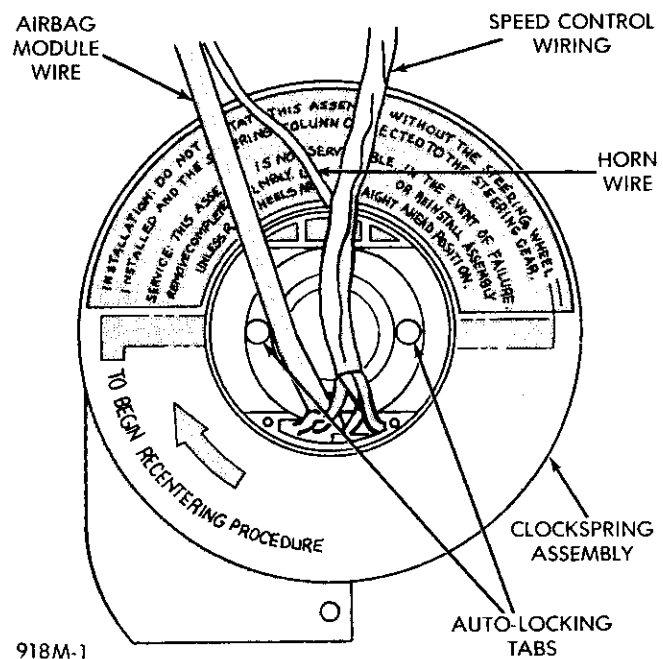


Fig. 23 Clockspring Auto-Locking Tabs

(8) From the end of the clockwise travel, rotate the rotor two and one-half turns counterclockwise. The horn wire should end up at the top, and the airbag wire at the bottom.

(9) The front wheels should still be in the straight-ahead position. Install the steering wheel being sure to fit the flats on the hub of the steering wheel with the formations on the inside of the clockspring. Pull the horn wiring through the upper, smaller hole in the steering wheel hub. Pull the airbag and speed control wiring through the bottom, larger hole in the steering wheel hub. Tighten the steering wheel nut to 61 N·m (45 ft. lbs.). Be certain not to pinch the wiring between the steering wheel and the nut.

(10) Connect the horn switch wire, then the airbag wire to the airbag module. To assure complete connection, the airbag module connector latching arms must be visibly on top of the airbag wiring connector insulator.

(11) Install the airbag module, and tighten the nuts to 9 to 11 N·m (80 to 100 in. lb.).

(12) Do not connect the battery negative cable at this time. See Airbag System in Diagnosis and Testing for the proper procedures.

POWER LOCK SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Power door locks are optional factory-installed equipment on this model. All doors can be locked and unlocked electrically by operating the switch on either front door panel. The power door locks operate with battery power supplied independent of the ignition switch.

Following are general descriptions of the major components in the power lock system. Refer to 8W-61 - Power Door Locks in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams. Refer to the owner's manual for more information on the features and use of this system.

DESCRIPTION AND OPERATION

POWER LOCK SWITCH

The power locks are controlled by a two-way switch mounted in a bezel on the trim panel of each front door. The switch controls both the battery and ground feeds to the power lock motors. The battery and ground feeds are reversed between the Lock and Unlock switch positions. The power lock switches cannot be repaired. If faulty, the entire switch must be replaced.

POWER LOCK MOTOR

In the power lock system, the locks are actuated by a reversible motor mounted within each door. The motor direction is controlled by the battery and ground feeds from the power lock switches. The power lock motor cannot be repaired. If faulty, the entire motor must be replaced.

DIAGNOSIS AND TESTING

POWER LOCK SWITCH

For circuit descriptions and diagrams, refer to 8W-61 - Power Door Locks in Group 8W - Wiring Diagrams.

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 3. If not OK, repair the open circuit as required.

(3) Remove the power lock switch from the trim panel as described in this group. Carefully separate the multiple terminal block on the wiring harness from the switch body.

(4) Check for battery voltage at the fused B(+) circuit cavity of the switch connector. If OK, go to Step 5. If not OK, repair the open circuit to the fuse in the fuseblock module.

(5) Test the switch continuity. See the Switch Continuity chart to determine if the continuity is correct in the Off, Lock, and Unlock switch positions (Fig. 1). If OK, go to Step 6. If not OK, replace the faulty switch.

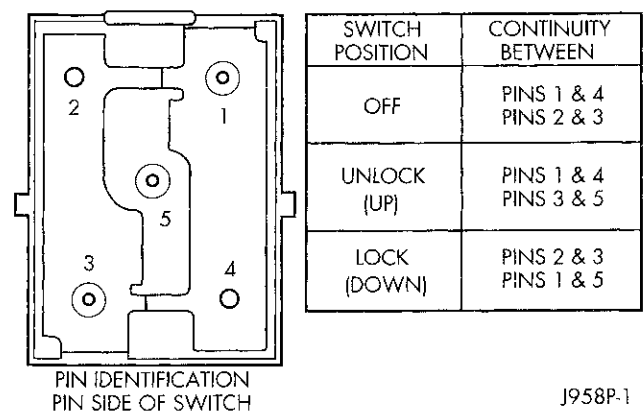


Fig. 1 Switch Continuity

DIAGNOSIS AND TESTING (Continued)

NOTE: The right power lock switch gets its ground feed through the left power lock switch.

(6) Check for continuity between both ground circuit cavities of the left switch connector and a good ground. In each case, there should be continuity. If OK, go to Step 7. If not OK, repair the open circuit(s) as required.

(7) With the left switch removed, check for continuity between both door lock switch output circuit cavities of the right switch connector and a good ground. There should be no continuity. If OK, go to Step 8. If not OK, repair the short circuit as required.

(8) Check for continuity between the door lock output (lock) circuit cavities of the right and left door switch connectors. Repeat the check between the door lock output (unlock) circuit cavities. In each case, there should be continuity. If OK, see the diagnosis for the Power Lock Motor in this group. If not OK, repair the open circuit(s) as required.

POWER LOCK MOTOR

Before you proceed with this diagnosis, confirm proper power lock switch and switch circuit operation. See Power Lock Switch in this group for the diagnostic procedures. For circuit descriptions and diagrams, refer to 8W-61 - Power Door Locks in Group 8W - Wiring Diagrams.

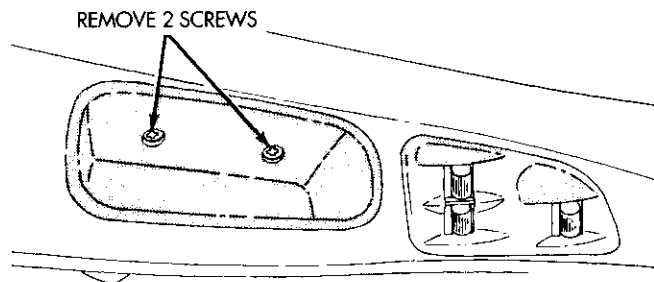
(1) Check each power lock motor for correct operation while moving the power lock switch to both the Lock and Unlock positions. If all lock motors are inoperative, go to Step 2. If one lock motor is inoperative, go to Step 3.

(2) If all lock motors are inoperative, the problem may be caused by one shorted motor. Disconnecting a shorted motor will allow the good motors to operate. Disconnect each motor connector, one at a time, and re-check both the lock and unlock functions while operating the power lock switch. If both motors are still inoperative after the above test, repair the short or open circuit between the power lock motors and the right power lock switch as required. If disconnecting one motor causes the other motors to become functional, go to Step 3.

(3) Once it is determined which lock motor is inoperative, that motor can be tested as follows. Disconnect the wire connector at the inoperative motor. Apply 12 volts to the motor terminals to check its operation in one direction. Reverse the polarity to check the operation in the other direction. If OK, repair the short or open circuit between the inoperative power lock motor and the right power lock switch as required. If not OK, replace the faulty motor.

REMOVAL AND INSTALLATION**POWER LOCK SWITCH**

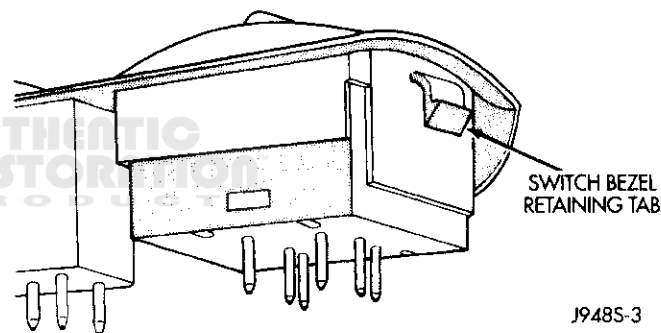
- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the two screws in the door pull cup and remove the cup (Fig. 2).



J948S-2

Fig. 2 Door Pull Cup Remove/Install - Typical

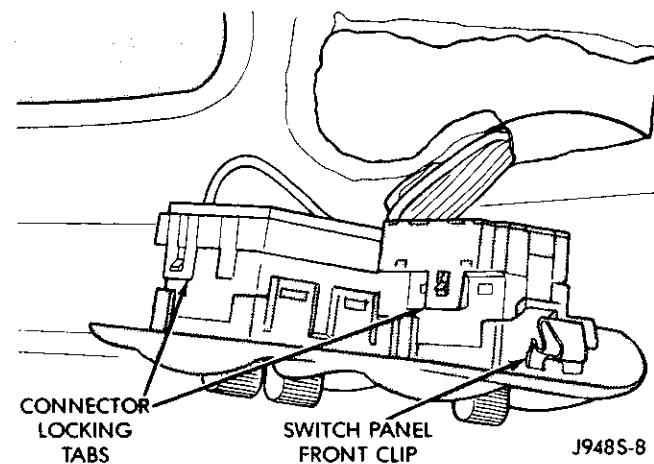
- (3) Remove the power window and lock switches by reaching through the door pull cup opening and depressing the switch bezel rear retaining tab (Fig. 3).



J948S-3

Fig. 3 Switch Bezel Rear Retaining Tab - Typical

- (4) Pull the rear of the switch bezel up and away from the door trim panel.
- (5) Unplug the wiring connectors from the switches (Fig. 4).



J948S-8

Fig. 4 Door Switch Connectors - Typical

REMOVAL AND INSTALLATION (Continued)

(6) Reverse the removal procedures to install. Install the switch bezel to the door trim panel by inserting the front of the bezel into the trim panel opening, then push down on the rear of the bezel until the retaining tab snaps into place.

POWER LOCK MOTOR

- (1) Raise the door window to its full up position.
- (2) Disconnect and isolate the battery negative cable.
- (3) Remove the power lock switch as described in this group.
- (4) On the driver's side only, if equipped with power mirrors, pull the power mirror switch control knob rearward to remove it from the switch stem (Fig. 5).

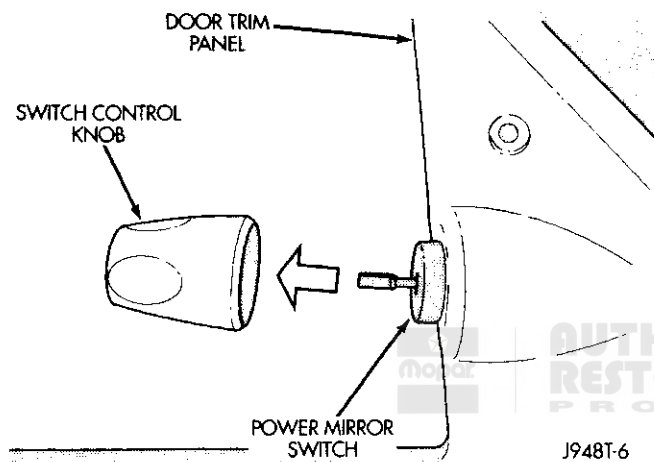


Fig. 5 Power Mirror Switch Knob Remove/Install

- (5) Remove the mirror switch retaining nut from the switch (Fig. 6).
- (6) Using a wide flat-bladed tool such as a trim stick, pry the trim panel away from the door around the perimeter and remove the trim panel.

NOTE: To aid in the removal of the trim panel, start at the bottom of the panel.

(7) Roll the door watershield away from the bottom of the inner door panel to allow access to the power lock motor (Fig. 7).

(8) Remove the three screws holding the lock motor and latch assembly to the door.

(9) Disconnect the latch linkage rods.

(10) Pull the motor and latch out far enough to unplug the electrical connector. Remove the motor and latch from the door.

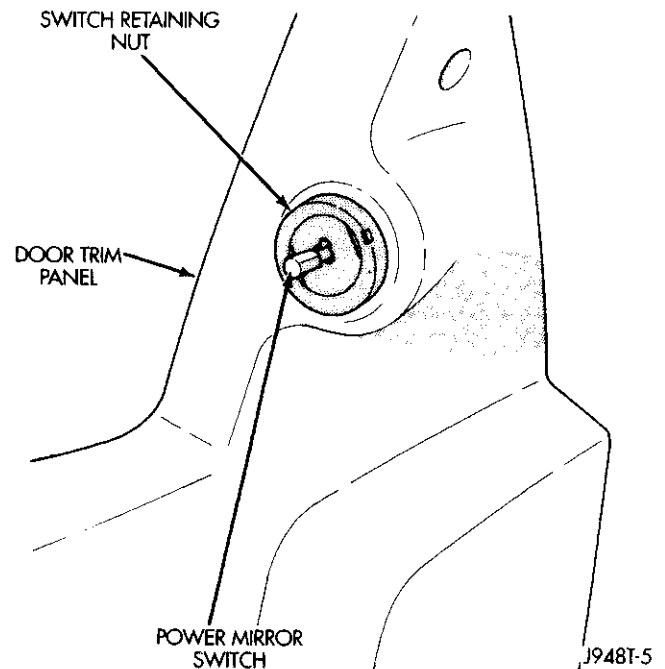


Fig. 6 Power Mirror Switch Nut

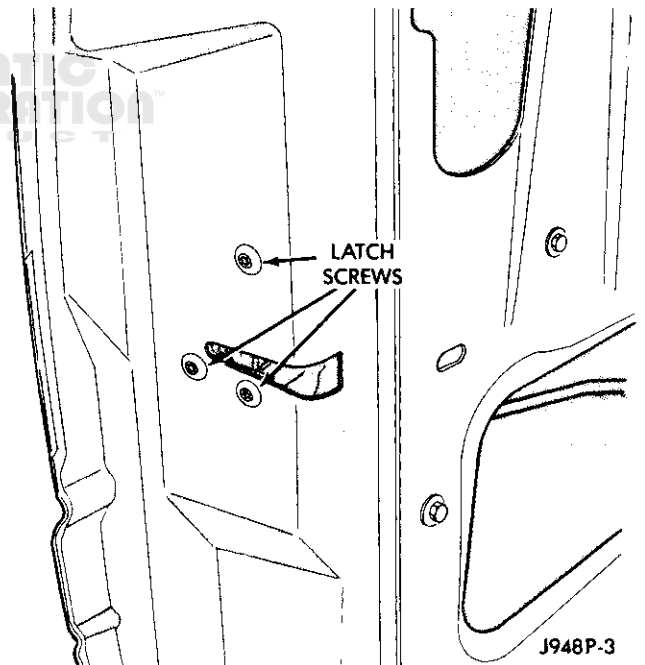


Fig. 7 Power Lock Motor and Latch Remove/Install

(11) Reverse the removal procedures to install. Tighten the motor and latch screws to 10.5 N·m (95 in. lbs.).

POWER SEAT SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

A six-way driver's side power seat is an available factory-installed option for this model. The power seat system receives battery feed through a fuse in the power distribution center and a circuit breaker in the fuseblock module at all times.

Following are general descriptions of the major components in the power seat system. Refer to 8W-63 - Power Seat in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

POWER SEAT SWITCH

The power seat can be adjusted in six different ways using the power seat switch. The switch is located on the lower outboard side of the seat cushion frame. Refer to the owner's manual for more information on power seat switch functions and seat adjusting procedures. The individual switches cannot be repaired. If one switch fails, the entire switch module must be replaced.

POWER SEAT ADJUSTER/MOTORS

There are three reversible motors that operate the power seat adjuster. The motors are connected to worm-drive gearboxes that move the seat adjuster through a combination of drive cables and screw-type drive units.

The front and rear of a seat are operated by different motors. They can be raised or lowered independently of each other. When the center seat switch is pushed to the Up or Down position, both the front and rear motors operate in unison, moving the entire seat up or down. The forward-rearward motor is

operated by pushing the center seat switch to the Forward or Rearward position.

When a switch is actuated, battery feed and a ground path are applied through the switch contacts to the motor(s). The motor(s) operate to move the seat in the selected direction until the switch is released, or until the travel limit of the power seat adjuster is reached. When the switch is moved in the opposite direction, the battery feed and ground path to the motor(s) are reversed through the switch contacts. This causes the motor to run in the opposite direction.

Each motor contains a self-resetting circuit breaker to protect it from overload. Consecutive or frequent resetting of the circuit breakers must not be allowed to continue, or the motors may be damaged. Make the necessary repairs.

The power seat adjuster and motors cannot be repaired, and are serviced only as a complete unit. If any component in this unit should fail, the entire assembly must be replaced.

CIRCUIT BREAKER

An automatic resetting circuit breaker in the fuseblock module is used to protect the power seat system circuit. The circuit breaker can protect the system from a short circuit, or from an overload condition caused by an obstructed or stuck seat adjuster. The circuit breaker cannot be repaired. If faulty, it must be replaced.

DIAGNOSIS AND TESTING

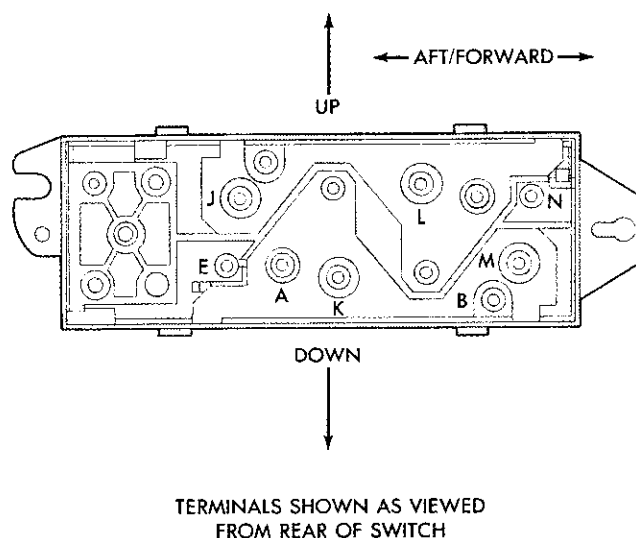
POWER SEAT SYSTEM

For circuit descriptions and diagrams, refer to 8W-63 - Power Seat in Group 8W - Wiring Diagrams.

Before any testing is attempted, the battery should be fully-charged and all connections and pins cleaned

DIAGNOSIS AND TESTING (Continued)

SWITCH POSITION	CONTINUITY BETWEEN
OFF	B-N, B-J, B-M, B-E, B-L, B-K
VERTICAL UP	A-E, A-M, B-N, B-J
VERTICAL DOWN	A-J, A-N, B-M, B-E
HORIZONTAL FORWARD	A-L, B-K
HORIZONTAL AFT	A-K, B-L
FRONT TILT UP	A-M, B-N
FRONT TILT DOWN	A-N, B-M
REAR TILT UP	A-E, B-J
REAR TILT DOWN	A-J, B-E



908R-4

Fig. 1 Power Seat Switch Continuity

and tightened to ensure proper continuity and grounds.

With the dome lamp on, apply the switch in the direction of the failure. If the dome lamp dims, the seat may be jamming. Check under the seat for binding or obstructions. If the dome lamp does not dim, proceed with the following component tests.

CIRCUIT BREAKER

For circuit descriptions and diagrams, refer to 8W-63 - Power Seat in Group 8W - Wiring Diagrams.

(1) Locate the correct circuit breaker in the fuseblock module. Pull out the circuit breaker slightly, but be sure that the terminals still contact the terminals in the fuseblock module.

(2) Connect the negative lead of a 12-volt DC voltmeter to a good ground.

(3) With the voltmeter positive lead, check both terminals of the circuit breaker for battery voltage.

If only one terminal has battery voltage, the circuit breaker is faulty and must be replaced. If neither terminal has battery voltage, repair the open circuit from the power distribution center as required.

POWER SEAT ADJUSTER/MOTORS

For circuit descriptions and diagrams, refer to 8W-63 - Power Seat in Group 8W - Wiring Diagrams.

Operate the power seat switch to move all three seat motors. The seat should move in all directions. If one or more of the motors operate, see the diagnosis for the Power Seat Switch in this group. If no motors operate, proceed as follows:

(1) Check the circuit breaker in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty circuit breaker.

(2) Remove the switch as described in this group, and check for battery voltage at the fused B(+) circuit cavity of the switch connector. If OK, go to Step 3. If not OK, repair the open circuit to the fuseblock module as required.

(3) Check for continuity between the ground circuit cavity of the switch connector and a good ground. There should be continuity. If OK, go to Step 4. If not OK, repair the open circuit to ground as required.

(4) Test the power seat switch as described in this group. If the switch tests OK, replace the faulty power seat adjuster/motors assembly.

POWER SEAT SWITCH

For circuit descriptions and diagrams, refer to 8W-63 - Power Seat in Group 8W - Wiring Diagrams. To check the power seat switch:

(1) Remove the power seat switch as described in this group.

(2) Use an ohmmeter to test the continuity of the switches in each position. See the Power Seat Switch Continuity chart (Fig. 1). If OK, see the Power Seat Adjuster/Motors diagnosis. If not OK, replace the faulty switch module.

REMOVAL AND INSTALLATION

POWER SEAT SWITCH

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the two screws holding the switch and bezel to the seat cushion frame (Fig. 2).

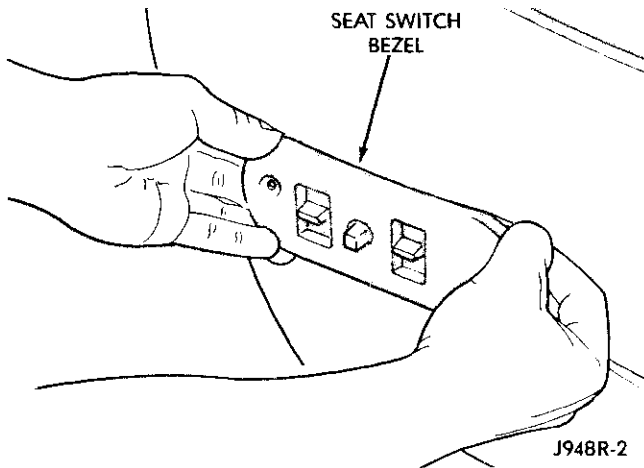


Fig. 2 Seat Switch and Bezel Remove/Install

- (3) Remove the two screws holding the switch to the bezel.
- (4) Pull the switch out from the seat far enough to access the multiple terminal block. Carefully release the locking tabs and separate the multiple terminal block on the wiring harness from the switch body (Fig. 3).
- (5) Reverse the removal procedures to install.

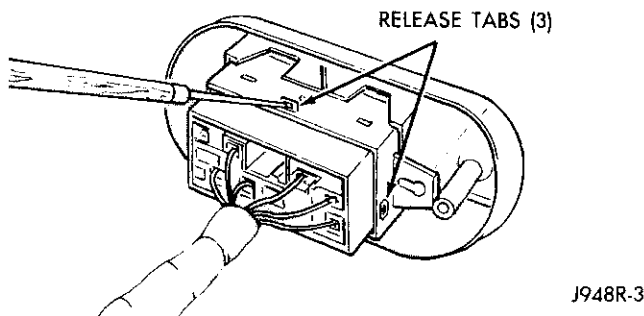


Fig. 3 Seat Switch Remove

POWER SEAT ADJUSTER/MOTORS

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the three bolts attaching the seat frame to the floor pan.
- (3) Remove the one nut from the stud locating the seat frame to the floor pan.
- (4) Remove the two bolts holding the power seat to the center seat section (Fig. 4) and (Fig. 5).

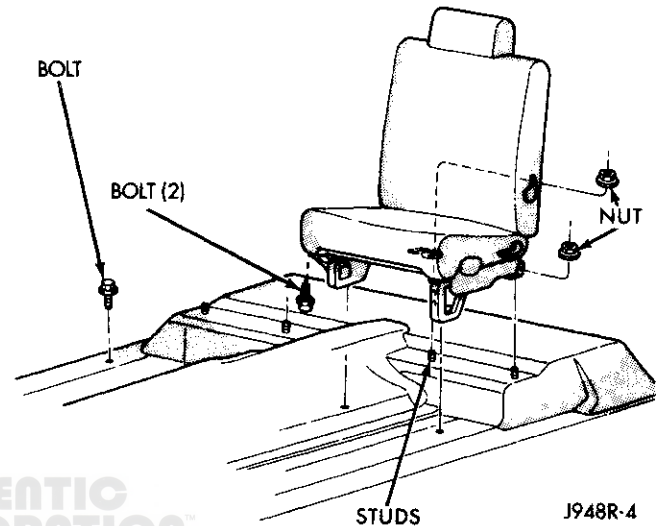


Fig. 4 Driver's Power Seat Remove

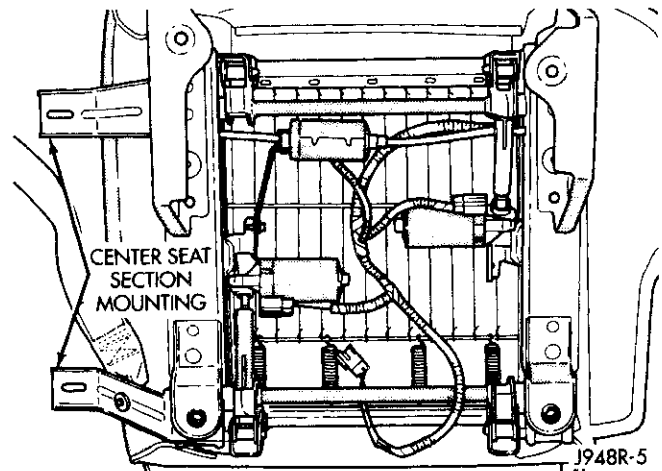


Fig. 5 Center Seat Section Attachment

REMOVAL AND INSTALLATION (Continued)

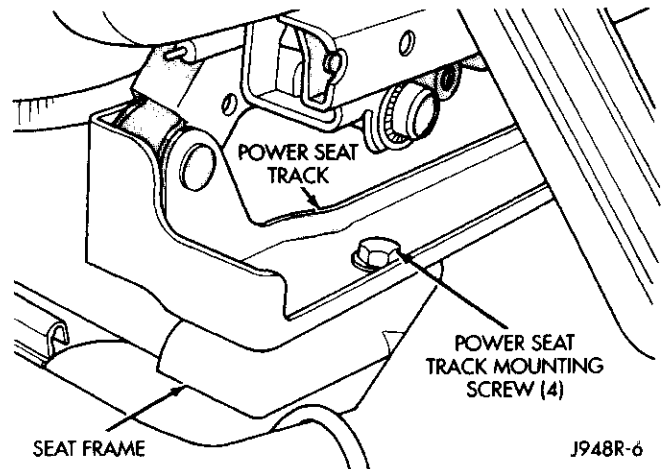
(5) Unplug the power seat wire harness connector located under the seat.

(6) Remove the driver's seat assembly from the vehicle.

(7) Remove the four screws attaching the seat adjuster to the seat cushion frame (Fig. 6).

(8) Reverse the removal procedures to install. Tighten the seat mounting hardware as follows:

- Seat cushion frame to adjuster bolts - 25 N·m (18 ft. lbs.)
- Seat adjuster to floor pan bolts - 29 N·m (20 ft. lbs.)
- Seat adjuster to floor pan nut - 41 N·m (30 ft. lbs.)
- Center seat section bolts - 25 N·m (18 ft. lbs.).



J948R-6

Fig. 6 Power Seat Adjuster Remove



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POWER WINDOW SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Power windows are available as factory-installed optional equipment on this model. The power windows operate only with the ignition switch in the On position. This group covers diagnosis and service of only the electrical components in the power window system. For service of mechanical components, such as the regulator, lift plate or window tracks, refer to Group 23 - Body Components.

Following are general descriptions of the major components in the power window system. Refer to 8W-60 - Power Windows in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

POWER WINDOW SWITCH

Both front door windows can be raised or lowered electrically by operating the dual two-way switches on the driver's door trim panel. A single two-way switch on the passenger's door trim panel operates only the window on the passenger's side. The power window switches cannot be repaired and, if faulty, must be replaced.

POWER WINDOW MOTOR

A permanent magnet reversible motor moves the window regulator through an integral gearbox mechanism. A positive and negative battery connection to the two motor terminals will cause the motor to rotate in one direction. Reversing current through these same two connections will cause the motor to rotate in the opposite direction. In addition, each power window motor is equipped with an integral self-resetting circuit breaker to protect the motor from overloads. The power window motor and gearbox assembly cannot be repaired. If faulty, the entire motor assembly must be replaced.

CIRCUIT BREAKER

An automatic resetting circuit breaker in the fuseblock module is used to protect the power window system circuit. The circuit breaker can protect the system from a short circuit, or from an overload condition caused by an obstructed or stuck window glass or regulator. The circuit breaker cannot be repaired. If faulty, it must be replaced.

DIAGNOSIS AND TESTING

POWER WINDOW SYSTEM

For circuit descriptions and diagrams, refer to 8W-60 - Power Windows in Group 8W - Wiring Diagrams.

ALL WINDOWS INOPERATIVE

(1) Check the circuit breaker in the fuseblock module, as described in this group. If OK, go to Step 2. If not OK, replace the faulty circuit breaker.

(2) Remove the left front door power window switch. Check for continuity between the ground circuit cavity of the switch connector and a good ground. If OK, go to Step 3. If not OK, repair the circuit to ground as required.

(3) Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the switch connector. If OK, see the Power Window Switch diagnosis in this group. If not OK, repair the open circuit to the fuseblock module as required.

ONE WINDOW INOPERATIVE

The window glass must be free to slide up and down for the power window motor to function properly. If the glass is not free to move up and down, the motor will overload and trip the circuit breaker. To determine if the glass is free, disconnect the regulator plate from the glass. Then slide the window up and down by hand.

There is an alternate method to check if the glass is free. Position the glass between the up and down stops. Then,

DIAGNOSIS AND TESTING (Continued)

shake the glass in the door. Check that the glass can be moved slightly from side to side, front to rear, and up and down. Then check that the glass is not bound tight in the tracks. If the glass is free, proceed with the diagnosis that follows. If the glass is not free, refer to Group 23 - Body Components for window glass service and adjustment procedures.

(1) Check the switch continuity as described in the Power Window Switch diagnosis in this group. If OK and the left front window is inoperative, see the Power Window Motor diagnosis in this group. If OK and the inoperative window is other than the left front, go to Step 2. If not OK, replace the faulty switch.

(2) With the ignition switch in the On position, check for battery voltage at the fused ignition switch output circuit cavity of the switch connector. If OK, go to Step 3. If not OK, repair the open circuit to the fuseblock module as required.

(3) Refer to the circuit diagrams in 8W-60 - Power Windows in Group 8W - Wiring Diagrams. Check the continuity in each circuit between the inoperative power window switch connector cavities and the corresponding left front power window switch connector cavities. If OK, see the Power Window Motor diagnosis in this group. If not OK, repair the open circuit(s) as required.

NOTE: All individual power window switches receive their ground feed through the left front power window switch and connector.

CIRCUIT BREAKER

For circuit descriptions and diagrams, refer to 8W-60 - Power Windows in Group 8W - Wiring Diagrams.

(1) Locate the correct circuit breaker in the fuseblock module. Pull out the circuit breaker slightly, but be sure that the terminals still contact the terminals in the fuseblock module.

(2) Connect the negative lead of a 12-volt DC voltmeter to a good ground.

(3) With the voltmeter positive lead, check both terminals of the circuit breaker for battery voltage.

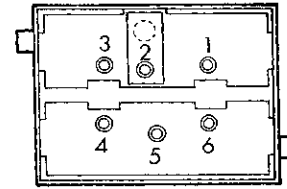
If only one terminal has battery voltage, the circuit breaker is faulty and must be replaced. If neither terminal has battery voltage, repair the open circuit from the power distribution center as required.

POWER WINDOW SWITCH

For circuit descriptions and diagrams, refer to 8W-60 - Power Windows in Group 8W - Wiring Diagrams. Before you proceed with this diagnosis, confirm proper circuit breaker operation. See the Circuit Breaker diagnosis in this group.

(1) Remove the switch from the door trim panel as described in this group. Carefully separate the multiple terminal block on the wiring harness from the switch body.

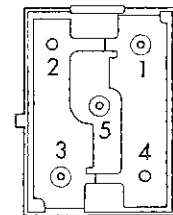
(2) Check the switch continuity in each position, as shown in the charts (Fig. 1) or (Fig. 2). If OK, see the Power Window Motor diagnosis in this group. If not OK, replace the faulty switch.



VIEW SHOWN FROM BACK OF SWITCH

SWITCH POSITION		CONTINUITY BETWEEN
OFF		PINS 1 & 2, PINS 2 & 3 PINS 3 & 4, PINS 4 & 6
UP	LEFT	PINS 1 & 5, PINS 2 & 3 PINS 3 & 4, PINS 4 & 6
	RIGHT	PINS 1 & 2, PINS 2 & 4 PINS 3 & 5, PINS 4 & 6
DOWN	LEFT	PINS 1 & 2, PINS 2 & 3 PINS 3 & 4, PINS 5 & 6
	RIGHT	PINS 1 & 2, PINS 2 & 3 PINS 3 & 6, PINS 4 & 5

J958S-2

Fig. 1 Left Side Switch Continuity

VIEW SHOWN FROM BACK OF SWITCH

SWITCH POSITION	CONTINUITY BETWEEN
OFF	PINS 1 & 4 PINS 2 & 3
UP	PINS 1 & 4 PINS 3 & 5
DOWN	PINS 2 & 3 PINS 1 & 5

J958S-1

Fig. 2 Right Side Switch Continuity

DIAGNOSIS AND TESTING (Continued)

POWER WINDOW MOTOR

For circuit descriptions and diagrams, refer to 8W-60 - Power Windows in Group 8W - Wiring Diagrams. Before you proceed with this diagnosis, confirm proper switch operation. See the Power Window Switch diagnosis in this group.

(1) Remove the door trim panel as described in this group.

(2) Disconnect the power window motor connector. Apply 12 volts across the motor terminals to check its operation in one direction. Reverse the connections across the motor terminals to check the operation in the other direction. Remember, if the window is in the full up or full down position, the motor will not operate in that direction by design. If OK, repair the circuits from the motor to the switch as required. If not OK, replace the faulty motor.

(3) If the motor operates in both directions, check the window's operation through its complete up and down travel. If not OK, refer to Group 23 - Body Components to check the window glass, tracks, and regulator for sticking, binding, or improper adjustment.

REMOVAL AND INSTALLATION

POWER WINDOW SWITCH

(1) Disconnect and isolate the battery negative cable.

(2) Remove the two screws in the door pull cup and remove the cup (Fig. 3).

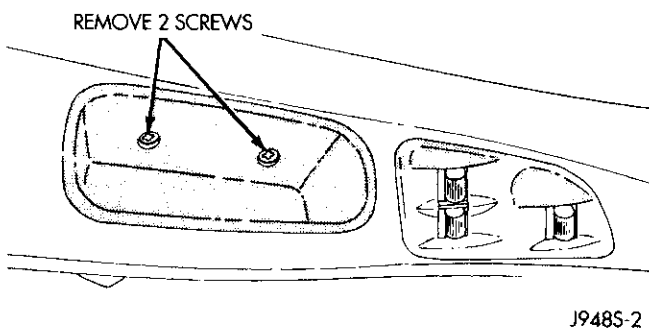


Fig. 3 Door Pull Cup Remove/Install - Typical

(3) Remove power window and lock switches by reaching through the door pull cup opening and depressing the switch bezel rear retaining tab (Fig. 4).

(4) Pull the rear of the switch bezel up and away from the door trim panel.

(5) Unplug the wiring connectors from the switches (Fig. 5).

(6) Reverse the removal procedures to install. Install the switch bezel to the door trim panel by inserting the front of the bezel into trim panel opening, then push down on the rear of the bezel until the retaining tab snaps into place.

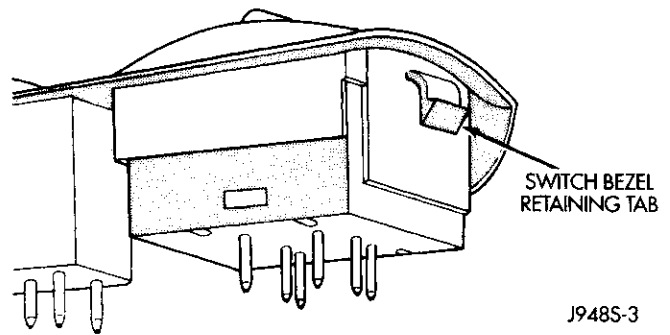


Fig. 4 Switch Bezel Rear Retaining Tab - Typical

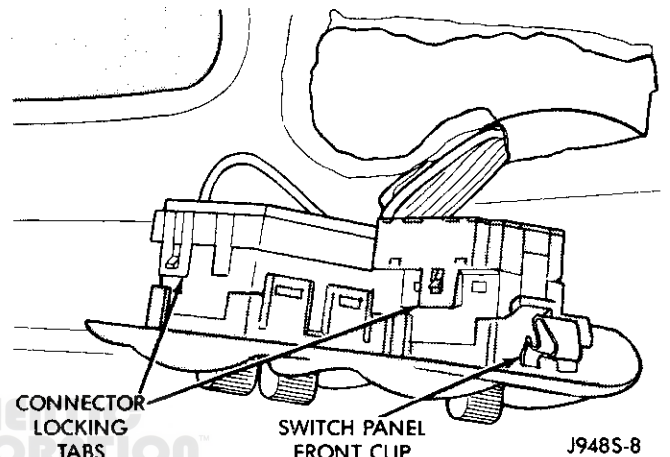


Fig. 5 Door Switch Connectors - Typical

POWER WINDOW MOTOR

(1) Remove the power window switch as described in this group.

(2) On the driver's side only, if equipped with power mirrors, pull the power mirror switch control knob rearward to remove it from the switch stem (Fig. 6).

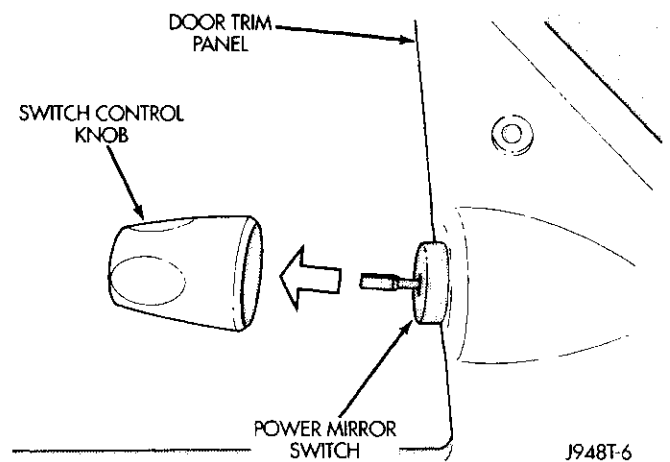


Fig. 6 Power Mirror Switch Knob Remove/Install

REMOVAL AND INSTALLATION (Continued)

(3) Remove the mirror switch retaining nut from switch the (Fig. 7).

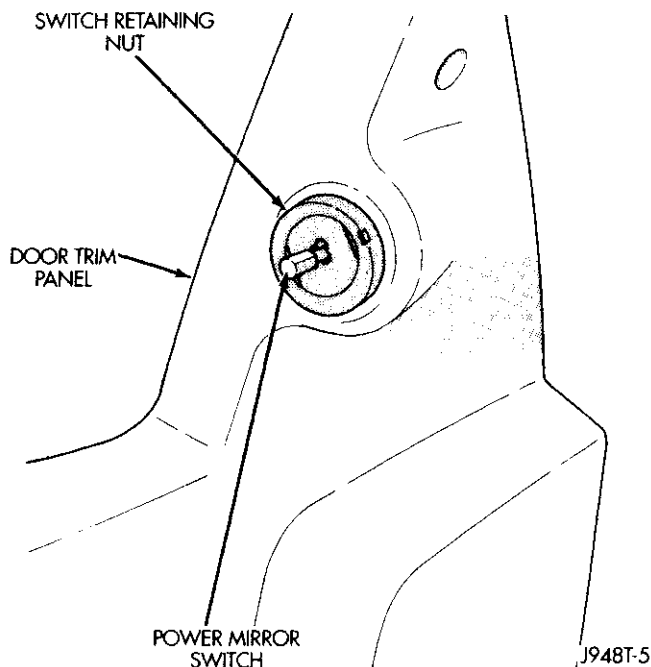


Fig. 7 Power Mirror Switch Nut

(4) Using a wide flat-bladed tool such as a trim stick, pry the trim panel away from the door around the perimeter and remove the trim panel.

NOTE: To aid in the removal of the trim panel, start at the bottom of the panel.

(5) Roll the door watershield away from the bottom of the inner door panel to allow access to the power window regulator screws (Fig. 8).

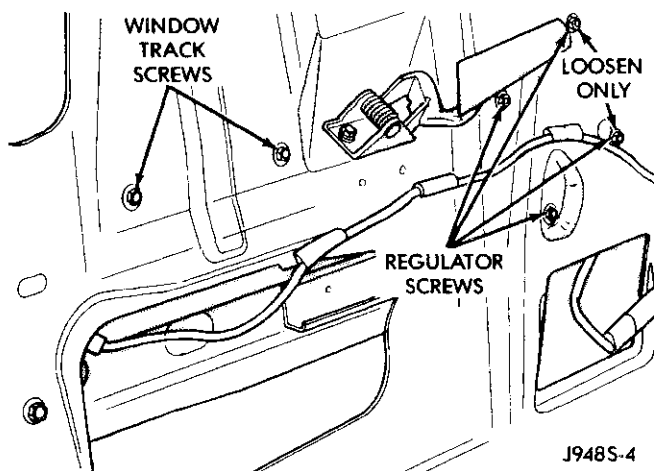


Fig. 8 Power Window Regulator Mounting Screws

(6) Move the door glass to allow access to the glass channel attaching hardware (Fig. 9) and (Fig. 10).

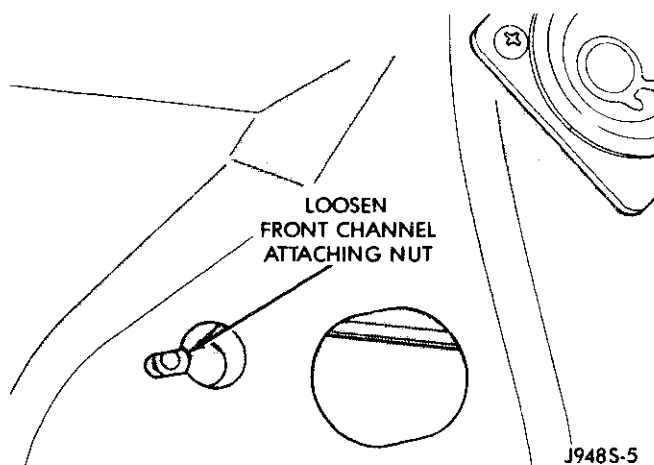


Fig. 9 Glass Channel Front Attaching Nut

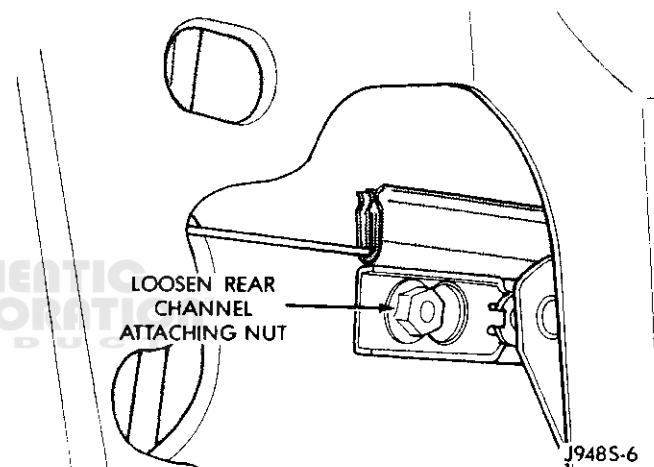


Fig. 10 Glass Channel Rear Attaching Nut

(7) Slide the glass rearward to disengage the channel nuts from the slotted holes in the regulator arm.

(8) Pull the glass to its full up position and tape it to the upper door frame.

(9) Unplug the wiring connector from the power window motor.

(10) Remove the two window track screws and the two rear regulator screws (Fig. 8).

(11) Loosen the two front regulator screws (Fig. 8).

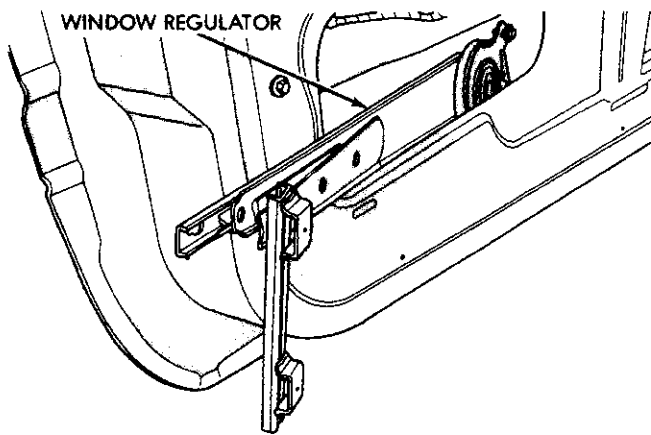
(12) Remove the power window regulator and motor unit from the door (Fig. 11).

(13) To install, place the power window regulator and motor unit inside the door and slide the two loose front regulator screws into the slotted holes in the door.

(14) Install the four remaining regulator and track screws.

(15) Tighten the regulator screws to 12 N·m (105 in. lbs.).

(16) Move the glass as far rearward into the channel as possible and push down. Tighten the two window track screws to 12 N·m (105 in. lbs.).

REMOVAL AND INSTALLATION (Continued)

J948S-7

Fig. 11 Power Window Regulator Remove

(17) Attach the door glass by sliding the two channel nuts into the slotted holes in the regulator arm

(Fig. 9) and (Fig. 10). Tighten the door glass channel nuts to 12 N·m (105 in. lbs.).

(18) Connect the wire harness connector to the power regulator motor.

(19) Using an adhesive/sealant (3M 08041 or 08044 is recommended), install the plastic water-shield to the door inner panel.

(20) Reverse the remaining removal procedures to complete the installation.



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POWER MIRROR SYSTEMS

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OUTSIDE POWER MIRRORS

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GENERAL INFORMATION

INTRODUCTION

Power outside rear view mirrors are an available factory-installed option on this model. Following are general descriptions of the major components in the power mirror system. Refer to 8W-62 - Power Mirrors in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

POWER MIRROR

The power mirrors are connected to battery feed at all times. Each mirror head contains two electric motors, two drive mechanisms and the mirror glass. One motor and drive controls mirror up-and-down movement, and the other controls right-and-left movement.

The mirror glass is the only serviced replacement part for the power mirror assembly. If any other component of the mirror unit is faulty or damaged, the entire assembly must be replaced.

POWER MIRROR SWITCH

Both the right and left outside power mirrors are controlled by a single multi-function switch. The switch knob is rotated clockwise (right mirror control) or counterclockwise (left mirror control) to select the mirror to be adjusted. The switch knob is then

moved in a joystick fashion to control movement of the selected mirror up, down, right, or left. The power mirror switch cannot be repaired and, if faulty, must be replaced as a complete unit.

DIAGNOSIS AND TESTING

POWER MIRROR SYSTEM

For circuit descriptions and diagrams, refer to 8W-62 - Power Mirrors in Group 8W - Wiring Diagrams.

(1) Check the fuses in the Power Distribution Center (PDC) and the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse(s).

(2) Check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 3. If not OK, repair the open circuit to the PDC as required.









(3) Remove the power mirror switch as described in this group.

(4) Disconnect the wiring harness connector from the switch. Check for battery voltage at the fused B(+) circuit cavity of the switch connector. If OK, go to Step 5. If not OK, repair the open circuit to the fuseblock module as required.

(5) Check for continuity between the ground circuit cavity of the switch harness connector and a good ground. There should be continuity. If OK, go to Step 6. If not OK, repair the circuit to ground as required.

DIAGNOSIS AND TESTING (Continued)

(6) Check the switch continuity as shown in (Fig. 1). If OK, go to Step 7. If not OK, replace the faulty switch.

Mirror Selector Knob in "L" Position	
MOVE LEVER	CONTINUITY BETWEEN
	YL/BK and PK, YL/PK and BK YL and PK
	YL/PK and PK, DB and BK DB/WT and BK
	YL/PK and PK, YL and BK YL/BK and BK
	YL/PK and BK, DB and PK DB/WT and PK
Mirror Selector Knob in "R" Position	
MOVE LEVER	CONTINUITY BETWEEN
	WT and BK, YL and PK YL/BK and PK
	WT and PK, DB and BK DB/WT and BK
	WT and PK, YL and BK YL/BK and BK
	WT and BK, DB and PK DB/WT and PK

J928T-5

Fig. 1 Mirror Switch Continuity

(7) Use two jumper wires, one connected to a 12-volt battery feed, and the other connected to a good body ground. See the Mirror Test Chart for the correct jumper wire connections at the power mirror switch connector (harness side, not switch side) (Fig. 2). If the mirror(s) don't respond as indicated in the chart, remove the mirror and check those circuits between the mirror and the switch for a short or open. If not OK, repair the circuits as required. If the circuits are OK, replace the faulty mirror assembly.

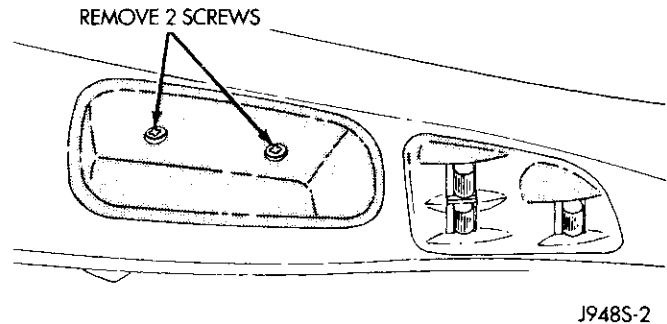
12 Volts	Ground	MIRROR REACTION	
		Right	Left
YL/BK	WT	UP	
YL	YL/PK		UP
WT	YL/BK	DOWN	
YL/PK	YL		DOWN
WT	DB	RIGHT	
YL/PK	DB/WT		RIGHT
DB	WT	LEFT	
DB/WT	YL/PK		LEFT

J928T-4

Fig. 2 Mirror Test Chart**REMOVAL AND INSTALLATION****POWER MIRROR SWITCH**

(1) Disconnect and isolate the battery negative cable.

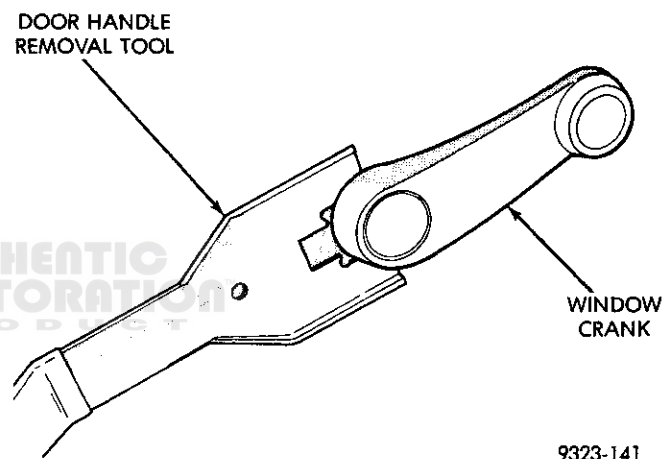
(2) Remove the two screws in the door pull cup and remove the cup (Fig. 3).



J948S-2

Fig. 3 Door Pull Cup Remove/Install

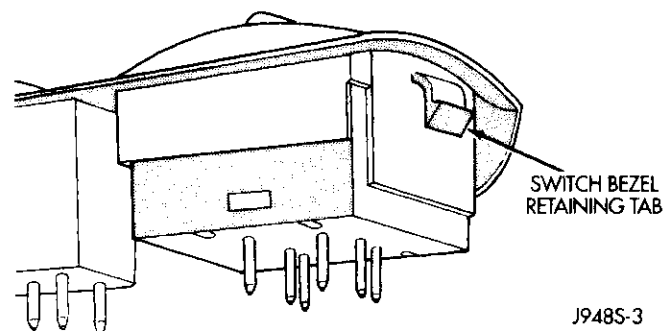
(3) If equipped, remove the manual window regulator crank handle with a removal tool (Fig. 4).



9323-141

Fig. 4 Window Regulator Crank Handle Remove - Typical

(4) If equipped, remove the power window and lock switches by reaching through the door pull cup opening and depressing the switch bezel rear retaining tab (Fig. 5).



J948S-3

Fig. 5 Switch Bezel Rear Retaining Tab

(5) Pull the rear of the switch bezel up and away from the door trim panel.

REMOVAL AND INSTALLATION (Continued)

(6) Unplug the wiring connectors from the switches (Fig. 6).

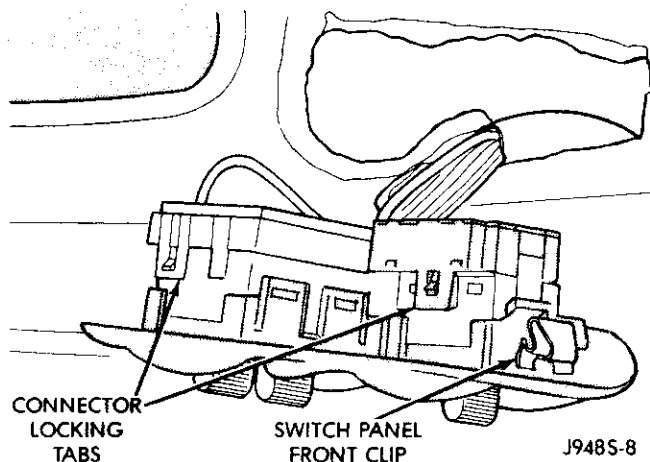


Fig. 6 Door Switch Connectors

(7) Pull the power mirror switch control knob rearward to remove it from the switch stem (Fig. 7).

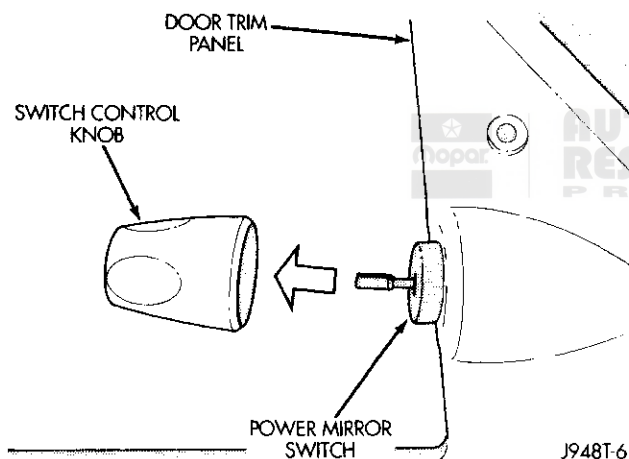


Fig. 7 Power Mirror Switch Knob Remove/Install

(8) Remove the mirror switch retaining nut from the switch (Fig. 8).

(9) Using a wide flat-bladed tool such as a trim stick, pry the trim panel away from the door around the perimeter and remove the trim panel.

NOTE: To aid in the removal of the trim panel, start at the bottom of the panel.

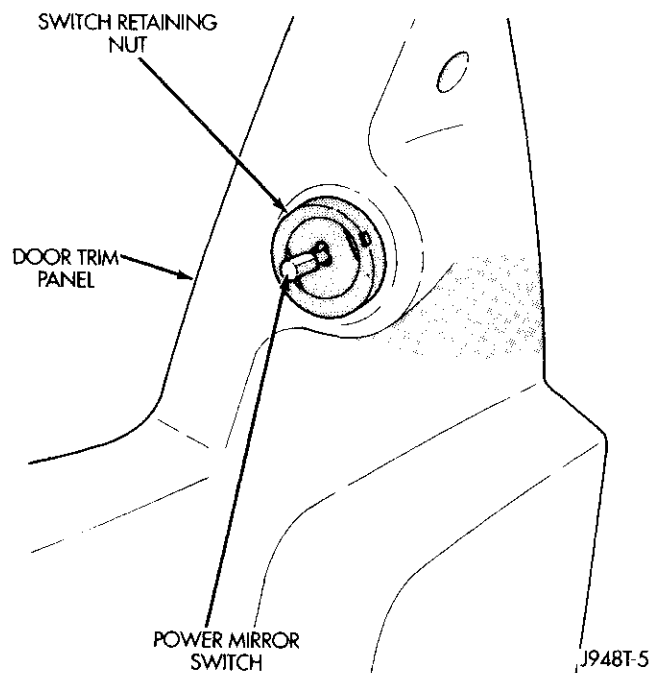


Fig. 8 Power Mirror Switch Nut

(10) Unplug the power mirror switch wiring connector (Fig. 9).

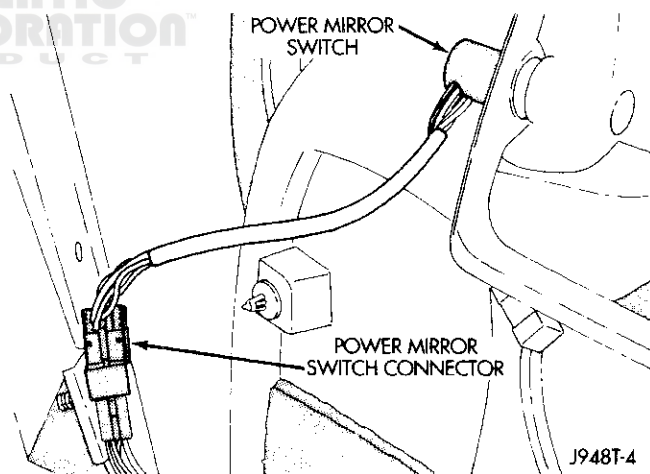
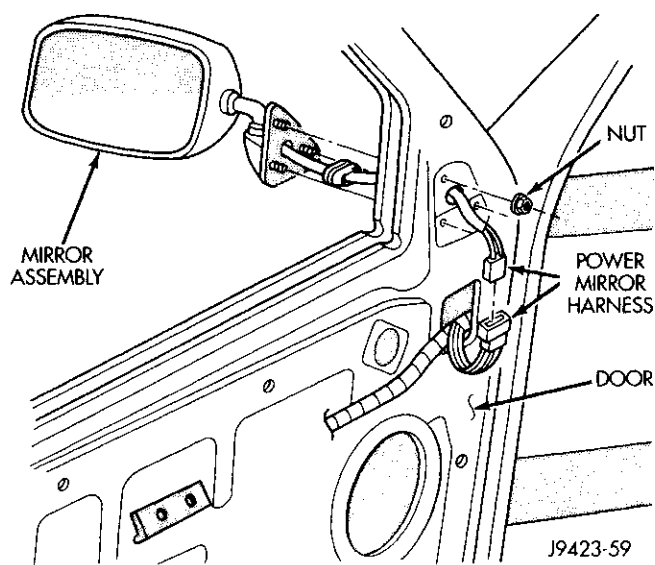


Fig. 9 Power Mirror Switch Connector

(11) Remove the power mirror switch from the door trim panel.

(12) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**Fig. 10 Power Mirror Remove/Install****POWER MIRROR**

- (1) Remove the door trim panel as described in Power Mirror Switch in this group.
- (2) Unplug the power mirror motor wiring connector (Fig. 10).
- (3) Remove the three nuts holding the mirror to the door.
- (4) Pull the mirror, wiring, and grommet from the outside of the door.
- (5) Reverse the removal procedures to install.



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AUTOMATIC DAY/NIGHT MIRROR

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GENERAL INFORMATION

INTRODUCTION

An automatic dimming inside day/night rear view mirror is an available factory-installed option on this model. Following is a general description of this optional equipment. Refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

AUTOMATIC DAY/NIGHT MIRROR

The automatic day/night mirror is able to automatically change its reflectance. A thin layer of electrochromic material between two pieces of conductive glass make up the face of the mirror. Two photocell sensors are used to monitor light levels and adjust the mirror's reflectance to reduce the glare of headlamps approaching the vehicle from the rear.

The ambient photocell sensor faces forward, to detect the outside light levels. The headlamp sensor faces rearward, to detect the light level received at the rear window side of the mirror. When the difference between the two light levels becomes too great (the light level received at the rear of the mirror is much higher than at the front of the mirror), the mirror begins to darken.

The mirror switch allows the driver a manual control of whether the automatic dimming feature is operational. When On is selected, the mirror switch is lighted by an integral Light-Emitting Diode (LED). The automatic dimming feature will only operate when the ignition switch is in the On position. The mirror also senses the back-up lamp circuit, and disables the self-dimming feature whenever the transmission (manual or automatic) gear selector is in the Reverse position.

The automatic day/night mirror cannot be repaired. If faulty, the entire assembly must be replaced.

DIAGNOSIS AND TESTING

AUTOMATIC DAY/NIGHT MIRROR

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

(1) Check the fuse in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse.

(2) Turn the ignition switch to the On position. Check for battery voltage at the fuse in the fuseblock module. If OK, go to Step 3. If not OK, repair the open circuit to the ignition switch as required.

(3) Unplug the wiring connector from the mirror (Fig. 1). Check for battery voltage at the fused ignition switch output circuit cavity of the mirror connector. If OK, go to Step 4. If not OK, repair the open circuit to the fuseblock module as required.

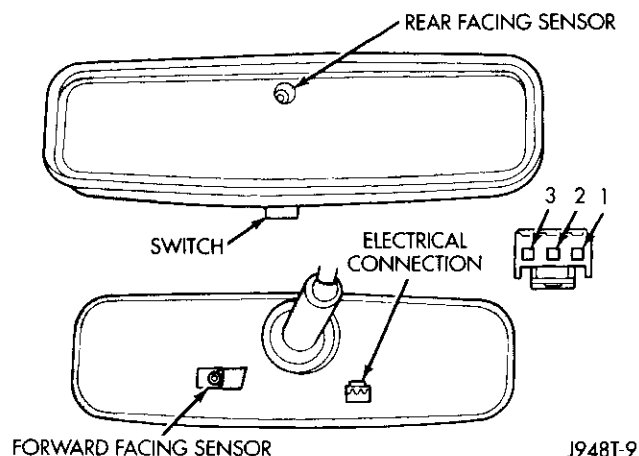


Fig. 1 Automatic Day/Night Mirror

(4) Turn the ignition switch to the Off position. Check for continuity between the ground circuit cavity of the mirror connector and a good ground. There should be continuity. If OK, go to Step 5. If not OK, repair the circuit to ground as required.

(5) Turn the ignition switch to the On position. Set the parking brake. Place the transmission gear selector lever in the Reverse position. Check for battery voltage at the back-up lamp switch output circuit

DIAGNOSIS AND TESTING (Continued)

cavity of the mirror connector. If OK, plug the mirror connector in and go to Step 6. If not OK, repair the open circuit as required.

(6) Place the transmission gear selector lever in the Neutral position. Place the mirror switch in the On (switch LED lighted) position. Cover the forward facing ambient photocell sensor to keep out any ambient light.

NOTE: The ambient photocell sensor must be covered completely, so that no light reaches the sensor. Use a finger pressed tightly against the sensor, or cover the sensor completely with electrical tape.

(7) Shine a light into the rear facing headlamp photocell sensor. The mirror should darken. If OK, go to Step 8. If not OK, replace the faulty mirror unit.

(8) With the mirror darkened, place the transmission gear selector lever in the Reverse position. The mirror should return to its normal condition. If not OK, replace the faulty mirror unit.

REMOVAL AND INSTALLATION**AUTOMATIC DAY/NIGHT MIRROR**

(1) Disconnect and isolate the battery negative cable.

(2) If so equipped, remove the wire cover by grasping the lower portion of the wire cover and sliding it into the upper portion and off of the mirror base (Fig. 2).

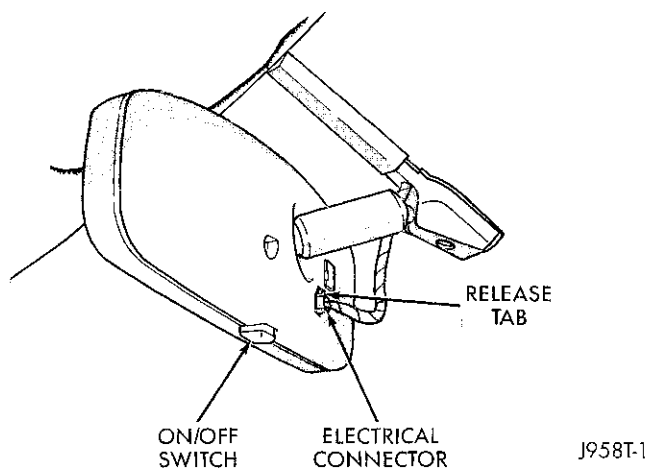


Fig. 2 Automatic Day/Night Mirror Remove/Install

- (3) Unplug the wiring connector from the mirror.
- (4) Remove the setscrew holding the mirror to the windshield support button.
- (5) Push the mirror up far enough to clear the support button and remove the mirror.
- (6) Reverse the removal procedures to install.



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CHIME/BUZZER WARNING SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

This group covers the buzzer warning system, which is standard factory-installed equipment on this model. The system provides an audible warning to the driver when it monitors the following conditions:

- The key is in the ignition switch with the driver's door open.
- The head or park lamps are on with the driver's door open.
- The driver's seat belt is not buckled with the ignition switch in the On position.

Following are general descriptions of the major components in the buzzer warning system. Refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

BUZZER MODULE

The buzzer module receives battery voltage at all times from a fuse in the fuseblock module. It also receives a second battery feed through a fuse in the fuseblock module when the ignition switch is in the On or Start position.

Other inputs to the module include the driver's door jamb switch, the driver's seat belt switch, the ignition key-in switch, and the headlamp switch. The only output of the module is a timed four to eight second feed to the seat belt reminder lamp on the instrument panel. The timer function begins after the ignition switch is turned to the On position.

The buzzer module cannot be repaired. If faulty, it must be replaced.

DRIVER'S DOOR JAMB SWITCH

The driver's door jamb switch is mounted to the driver's door hinge pillar. The switch closes a path to ground for the buzzer module through the key-in switch or the headlamp switch when the driver's door is opened, and opens when the driver's door is closed. This switch cannot be repaired and, if faulty, must be replaced. Refer to Group 8L - Lamps for the service procedures.

IGNITION KEY-IN SWITCH

The ignition key-in switch is integral to the ignition switch, which is mounted on the right side of the steering column. It closes a path to ground for the buzzer module when the ignition key is inserted in the ignition lock cylinder and the driver's door jamb switch is closed (door open). The switch opens when the key is removed from the ignition lock cylinder. This switch cannot be repaired and, if faulty, the entire ignition switch must be replaced. Refer to Group 8D - Ignition Systems for the service procedures.

HEADLAMP SWITCH

The headlamp switch is located in the instrument panel. It closes a path to ground for the buzzer module when the park or head lamps are on and the driver's door jamb switch is closed (door open). The switch opens the ground path when the park and head lamps are turned off. The headlamp switch cannot be repaired and, if faulty, must be replaced. Refer to Group 8E - Instrument Panel Systems for the service procedures.

DESCRIPTION AND OPERATION (Continued)**DRIVER'S SEAT BELT SWITCH**

The driver's seat belt switch is integral to the driver's seat belt buckle-half assembly. The switch is normally closed, providing a ground path to the buzzer module. When the tip-half of the seat belt is inserted into the seat belt buckle, the switch opens the buzzer ground path. The seat belt switch cannot be repaired. If faulty, the entire driver's seat belt buckle-half unit must be replaced. Refer to Group 23 - Body Components for the service procedures.

DIAGNOSIS AND TESTING**BUZZER MODULE**

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

(1) Check the fuse(s) in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse(s).

(2) Check for battery voltage at the hot at all times fuse in the fuseblock module. If OK, go to Step 3. If not OK, repair the open circuit from the power distribution center as required.

(3) Turn the ignition switch to the On position. Check for battery voltage at the hot in run and start fuse in the fuseblock module. If OK, go to Step 4. If not OK, repair the open circuit from the ignition switch as required.

(4) Turn the ignition switch to the Off position. Replace the buzzer module with a known good unit and test its operation. If OK, discard the faulty buzzer module. If not OK, remove the buzzer module and go to Step 5.

(5) Check for battery voltage at the fused B(+) circuit cavity of the buzzer module connector. If OK, go to Step 6. If not OK, repair the open circuit to the fuseblock module as required.

(6) Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output circuit cavity of the buzzer module connector. If OK, go to Step 7. If not OK, repair the open circuit to the fuseblock module as required.

(7) Turn the ignition switch to the Off position. Check for continuity between the ground circuit cavity of the buzzer module connector and a good ground. There should be continuity. If OK, go to the diagnosis for the switch that is related to the buzzer malfunction. If not OK, repair the circuit to ground as required.

DRIVER'S DOOR JAMB SWITCH

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

(1) Open the driver's door and note whether the interior lamps light. They should light. If OK, see the diagnosis for the Ignition Key-In Switch or the Headlamp Switch in this group. If not OK, go to Step 2.

(2) Check for continuity between the ground circuit cavity of the driver's door jamb switch connector and a good ground. There should be continuity. If OK, go to Step 3. If not OK, repair the circuit to ground as required.

(3) Check for continuity between the ground circuit terminal and each of the two courtesy lamps driver terminals of the door jamb switch. There should be continuity with the switch plunger released, and no continuity with the switch plunger depressed. If not OK, replace the faulty switch.

IGNITION KEY-IN SWITCH

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

WARNING: ON VEHICLES EQUIPPED WITH AN AIRBAG, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL OR STEERING COLUMN COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

(1) Remove the steering column shrouds. Refer to Group 8D - Ignition Systems for the procedures. Unplug the ignition key-in switch connector from the ignition switch (Fig. 1).

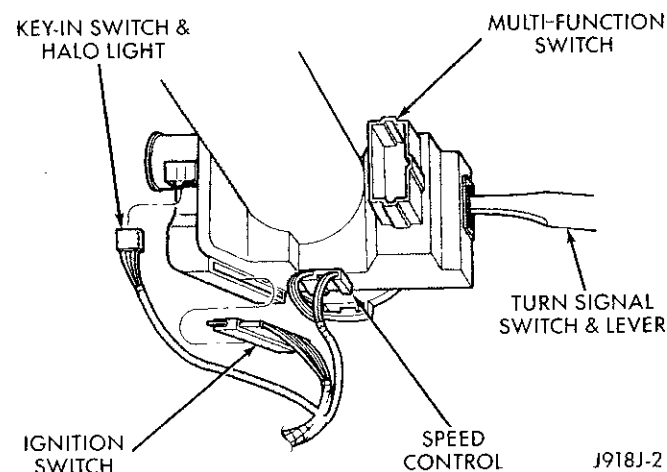


Fig. 1 Key-In Switch Connector

(2) Open the driver's door. Check for continuity between the left front door jamb switch sense circuit cavity of the key-in switch connector and a good ground. There should be continuity. If OK, go to Step

DIAGNOSIS AND TESTING (Continued)

3. If not OK, repair the open circuit to the driver's door jamb switch as required.

(3) Insert the ignition key in the ignition lock cylinder. Check for continuity between the key-in switch sense circuit and the left front door jamb switch sense circuit terminals of the key-in switch. There should be continuity until the key is removed. If OK, go to Step 4. If not OK, replace the faulty ignition switch.

(4) Check for continuity between the key-in switch sense circuit cavities of the key-in switch connector and the buzzer module connector. There should be continuity. If not OK, repair the open circuit to the buzzer module as required.

HEADLAMP SWITCH

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

(1) Remove the headlamp switch from the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures. Unplug the headlamp switch connector. Open the driver's door. Check for continuity between the left front door jamb switch sense circuit cavity of the headlamp switch connector and a good ground. There should be continuity until the driver's door is closed. If OK, go to Step 2. If not OK, repair the circuit to the driver's door jamb switch as required.

(2) Check for continuity between the key-in ignition switch sense circuit cavities of the headlamp switch connector and the buzzer module connector. There should be continuity. If OK, go to Step 3. If not OK, repair the open circuit to the buzzer module as required.

(3) Check for continuity between the left front door jamb switch sense circuit and the key-in ignition switch sense circuit terminals of the headlamp switch. There should be no continuity with the switch in the Off position, and there should be continuity with the switch in the park or head lamps On position. If not OK, replace the faulty headlamp switch.

DRIVER'S SEAT BELT SWITCH

For circuit descriptions and diagrams, refer to 8W-44 - Interior Lighting in Group 8W - Wiring Diagrams.

(1) Unplug the seat belt switch connector on the floor under the driver's seat near the seat belt buckle-half anchor. Check for continuity between the seat belt switch sense circuit and the ground circuit cavi-

ties of the seat belt half of the connector. There should be continuity with the seat belt unbuckled, and no continuity with the seat belt buckled. If OK, go to Step 2. If not OK, replace the faulty seat belt buckle-half assembly.

(2) Check for continuity between the ground circuit cavity in the harness half of the seat belt switch connector and a good ground. There should be continuity. If OK, go to Step 3. If not OK, repair the circuit to ground as required.

(3) Check for continuity between the seat belt switch sense circuit cavities in the harness half of the seat belt switch connector and the buzzer module connector. There should be continuity. If not OK, repair the open circuit as required.

REMOVAL AND INSTALLATION

BUZZER MODULE

(1) Disconnect and isolate the battery negative cable.

(2) Remove the five screws securing the knee blocker to the lower instrument panel (Fig. 2).

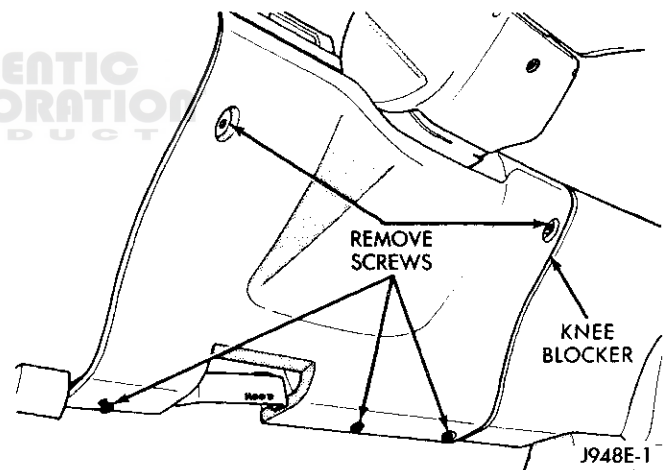


Fig. 2 Knee Blocker Remove/Install

(3) The buzzer module connector is on a bracket attached to the lower instrument panel reinforcement just inboard of the steering column. Release the connector latch from the buzzer module and unplug the module from the connector.

(4) To install, align the buzzer module terminals and latch tab with the connector cavities and latch, then push the module firmly into place.

(5) Install the knee blocker.

(6) Connect the battery negative cable.

(7) Test the buzzer module operation.

REMOVAL AND INSTALLATION (Continued)

CHIME/BUZZER WARNING SYSTEM SWITCHES

Service procedures for the various switches used in the chime/buzzer warning system can be found in the appropriate group as follows:

- Driver's door jamb switch - refer to Group 8L - Lamps
- Ignition key-in switch - refer to Group 8D - Ignition Systems

- Headlamp switch - refer to Group 8E - Instrument Panel Systems
- Driver's seat belt switch - refer to Group 23 - Body Components.



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OVERHEAD CONSOLE SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

An overhead console featuring an electronic compass and thermometer is an available factory-installed option on this model. Following are general descriptions of the major components used in the overhead console. Refer to 8W-49 Overhead Console in Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams.

DESCRIPTION AND OPERATION

COMPASS

The compass will display the direction in which the vehicle is pointed using the eight major compass headings (Examples: north is N, northeast is NE). It does not display the headings in actual degrees. The display is turned on or off using the Comp/Temp button, located to the left of the display module.

The self-calibrating compass unit requires no adjusting in normal use. The only calibration that may prove necessary is to drive the vehicle in three complete circles, on level ground, in not less than 48 seconds. This will reorient the compass unit to its vehicle.

The compass unit also will compensate for magnetism the body of the vehicle may acquire during normal use. However, avoid placing anything magnetic directly on the roof of the vehicle. Magnetic mounts for an antenna, a repair order hat, or a funeral procession flag can exceed the compensating ability of the compass unit if placed on the roof panel. Magnetic bit drivers used on the fasteners that hold the

assembly to the roof header can also affect compass operation. If the vehicle roof should become magnetized, the demagnetizing and calibration procedures found in this group may be required to restore proper compass operation.

The compass, thermometer, and display module cannot be repaired, and are only available for service as a unit. If faulty, the complete assembly must be replaced.

THERMOMETER

The thermometer displays the outside ambient temperature. The temperature display can be changed from Fahrenheit to Celsius using the US/Metric button, located to the right of the display module. The displayed temperature is not an instant reading of conditions, but an average temperature. It may take the thermometer display several minutes to respond to a major temperature change, such as driving out of a heated garage into winter temperatures.

When the ignition switch is turned to the Off position, the last displayed temperature reading stays in the thermometer unit memory. When the ignition switch is turned to the On position again, the thermometer will display the memory temperature for one minute; then update the display to the current average temperature reading within five minutes.

The thermometer function is supported by an ambient temperature sensor. The sensor is mounted outside the passenger compartment near the front and center of the vehicle. The ambient temperature sensor is available as a separate service item.

The compass, thermometer, and display module cannot be repaired, and are only available for service

DESCRIPTION AND OPERATION (Continued)

as a unit. If the module is faulty, the complete assembly must be replaced.

READING/COURTESY LAMPS

All reading and courtesy lamps located in the overhead console are activated by the door jamb switches. When the doors are closed, the lamps can be individually activated by depressing the corresponding lens. When a door is open, depressing the lamp lens switches will not turn the lamps off. Refer to Group 8L - Lamps, for diagnosis and service of the reading and courtesy lamps.

DIAGNOSIS AND TESTING**COMPASS/DISPLAY MODULE**

If the problem with the compass/display module is an inaccurate or scrambled display, use the Self-Diagnostics procedures. If the problem is a no-display condition, use the following procedures. For circuit descriptions and diagrams, refer to 8W-49 - Overhead Console in Group 8W - Wiring Diagrams.

(1) Check the fuses in the fuseblock module. If OK, go to Step 2. If not OK, replace the faulty fuse(s).

(2) Remove the overhead console as described in this group. Check for continuity between each of the two ground circuit cavities of the overhead console connector and a good ground. There should be continuity. If OK, go to Step 3. If not OK, repair the circuits to ground as required.

(3) Check for battery voltage at each of the two fused B(+) circuit cavities of the overhead console connector. If OK, go to Step 4. If not OK, repair the open circuit(s) to the fuseblock module as required.

(4) Turn the ignition switch to the On position. Check for battery voltage at the fused ignition switch output cavity of the overhead console connector. If OK, go to Step 5. If not OK, repair the open circuit to the fuseblock module as required.

(5) Check for battery voltage at the park lamp switch output circuit cavity of the overhead console connector. There should be zero volts with the headlamp switch in the Off position, and battery voltage with the park or head lamps turned on. If OK, go to Step 6. If not OK, repair the open circuit to the headlamp switch as required.

(6) Check for voltage at the fused panel lamps dimmer switch signal cavity of the overhead console connector. There should be zero volts with the headlamp switch in the Off position. When the park or head lamps are turned on, the voltage should vary as the dimmer switch is rotated. If OK, replace the faulty compass/display module. If not OK, repair the open circuit to the fuseblock module as required.

SELF-DIAGNOSTICS

A self-diagnostic test is used to determine that the compass, and all of the display module segments are operating properly electrically. Initiate the self-diagnostic test as follows:

(1) With the ignition switch in the Off position, simultaneously press and hold the Comp/Temp button and the US/Metric button.

(2) Turn the ignition switch to the On position.

(3) Continue to hold both buttons, until the display module performs a walking segment test. In this test, all of the compass points are displayed, along with various number combinations. These combinations verify that all of the display module segments are functional. If any segment should fail to light during the test, the unit is faulty and must be replaced. To repeat the test, momentarily depress and release the Comp/Temp button one time.

(4) Momentarily depress and release the US/Metric button one time. All of the display segments will light simultaneously for about two seconds. If any segment should fail to light during the test, the unit is faulty and must be replaced. To repeat the test, momentarily depress and release the Comp/Temp button one time.

(5) Momentarily depress and release the US/Metric button one time, or turn the ignition switch to the Off position to exit the self-diagnostic mode and return the compass and display module to normal operation.

NOTE: If the compass functions, but accuracy is suspect, it may be necessary to perform a variation adjustment. This procedure allows the compass unit to accommodate variations in the earth's magnetic field strength, based on geographic location. See the Compass Variation Adjustment procedures, in this group.

NOTE: If the compass reading has blanked out, and only "CAL" appears in the display module, demagnetizing may be necessary to remove excessive residual magnetic fields from the vehicle. See the Compass Demagnetizing procedure, in this group.

THERMOMETER

The thermometer function is supported by a temperature sensor, a wiring circuit, and a portion of the overhead console compass/display module display. The sensor is mounted outside the passenger compartment near the front and center of the vehicle.

If any portion of the temperature sensor circuit fails, the thermometer display will self-diagnose the circuit. An "SC" (short circuit) will appear on the display module in place of the temperature when the

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
OVERHEAD CONSOLE DISPLAY COMPLETELY DARK	<ol style="list-style-type: none"> 1. Display has been switched off. 2. Faulty fuse or headlamp delay module. 3. Faulty wiring. 4. Faulty compass/thermometer display module. 	<ol style="list-style-type: none"> 1. Depress COMP/TEMP button to switch unit to compass or thermometer display option. 2. Refer to Group 8L — Lamps, for diagnosis and service of this circuit. 3. Refer to Group 8W — Wiring Diagrams, for circuit diagrams. Check and repair wiring, if required. 4. Replace compass/thermometer display module, if required.
OVERHEAD CONSOLE DISPLAY SEGMENTS MISSING	<ol style="list-style-type: none"> 1. Faulty compass/thermometer display module. 	<ol style="list-style-type: none"> 1. See Self-Diagnostic Test, in this group. Replace compass/thermometer display module, if required.
ERRATIC COMPASS OPERATION	<ol style="list-style-type: none"> 1. Magnet or strong magnetic field near compass module. 2. Variance setting incorrect. 3. Calibration incorrect. 4. Faulty compass/thermometer display module. 	<ol style="list-style-type: none"> 1. Remove magnet and perform Demagnetizing Procedure, in this group. 2. See Variation Adjustment Procedure in this group. 3. See Calibration Procedure, in this group. 4. Replace compass/thermometer display module, if required.
ERRATIC THERMOMETER OPERATION	<ol style="list-style-type: none"> 1. Faulty sensor wiring. 2. Faulty sensor. 3. Faulty compass/thermometer display module. 	<ol style="list-style-type: none"> 1. See Sensor Circuit Test, in this group. Repair wiring, if required. 2. See Sensor Test, in this group. Replace sensor, if required. 3. Replace compass/thermometer display module, if required.

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Compass/Thermometer Diagnosis

sensor is exposed to temperatures above 55°C (131°F), or if the sensor circuit is shorted. An "OC" (open circuit) will appear in place of the temperature when the sensor is exposed too temperatures below -40°C (-40°F), or if the sensor circuit is open.

The temperature sensor circuit can also be diagnosed using the following Sensor Test, and Sensor Circuit Test. If the temperature sensor and circuit are confirmed to be OK, but the temperature display is inoperative or incorrect, see the Compass/Display Module diagnosis in this group. For circuit descriptions and diagrams, refer to 8W-49 - Overhead Console in Group 8W - Wiring Diagrams.

SENSOR TEST

(1) Turn the ignition switch to the Off position. Unplug the temperature sensor connector.

(2) Measure the resistance of the temperature sensor. At -40°C (-40°F), the sensor resistance is 336K ohms. At 55°C (140°F), the sensor resistance is 2.488K ohms. The sensor resistance should read

between these two values. If OK, go to the Sensor Circuit Test. If not OK, replace the faulty sensor.

SENSOR CIRCUIT TEST

(1) Turn the ignition switch to the Off position. Unplug the temperature sensor connector.

(2) Connect a jumper wire between the two terminals in the body half of the sensor connector.

(3) Remove the overhead console as described in this group. Disconnect the overhead console wiring connector.

(4) Check for continuity between the sensor ground circuit and the ambient temperature sensor signal circuit cavities of the overhead console connector. There should be continuity. If OK, go to Step 5. If not OK, repair the open circuit as required.

(5) Remove the jumper wire from the temperature sensor connector. Check for continuity between the sensor ground circuit cavity of the overhead console connector and a good ground. There should be no

DIAGNOSIS AND TESTING (Continued)

continuity. If OK, go to Step 6. If not OK, repair the short circuit as required.

(6) Check for continuity between the ambient temperature sensor signal circuit cavity of the overhead console connector and a good ground. There should be no continuity. If OK, see the Compass/Display Module diagnosis in this group. If not OK, repair the short circuit as required.

SERVICE PROCEDURES

COMPASS VARIATION ADJUSTMENT

Variance is the difference between magnetic north and geographic north. In some areas, the difference between magnetic and geographic north is great enough to cause the compass to give false readings. If this problem occurs, the compass variance must be set.

To set the compass variance:

(1) Using the Variance Settings map, find your geographic location and note the zone number (Fig. 1).

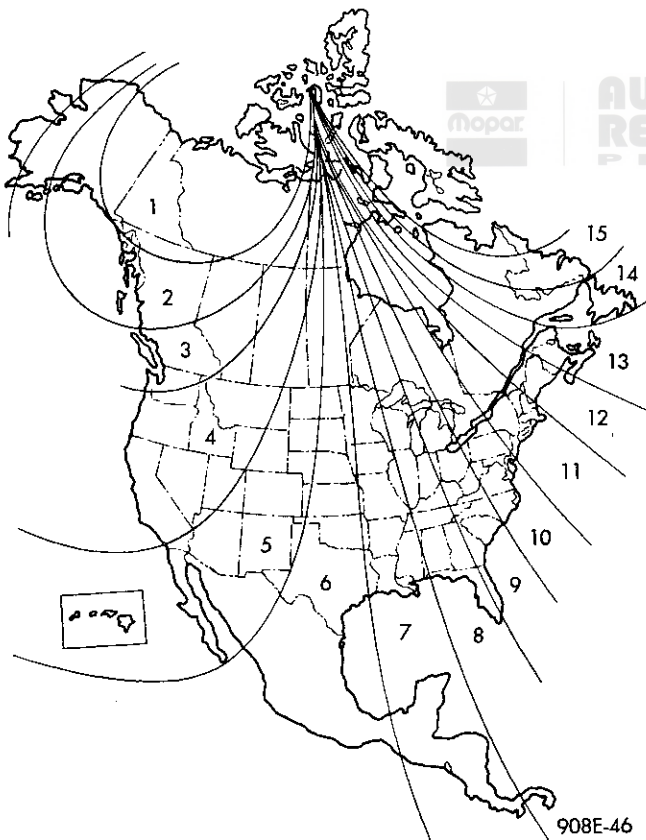


Fig. 1 Variance Settings

(2) Turn the ignition switch to the On position.
(3) Depress both the US/Metric, and the Comp/Temp buttons. Hold the buttons down until "VAR"

appears in the display module. This takes about five seconds.

(4) Release both of the buttons. The zone number will appear in the display module.

(5) Press and release the US/Metric button to step through the zone numbers, until the zone number for your area appears in the display.

(6) Press the Comp/Temp button to enter this zone number into the compass unit memory.

(7) Confirm that the correct directions are now indicated.

COMPASS CALIBRATION

CAUTION: Do not place any external magnets, such as magnetic roof mount antennas, in the vicinity of the compass. Do not use magnetic tools when servicing the overhead console.

The electronic compass unit features a self-calibrating design, which simplifies the calibration procedure. This feature automatically updates the compass calibration while the vehicle is being driven. This allows the compass unit to compensate for small changes in the residual magnetism that the vehicle may acquire during normal use. Do not attempt to calibrate the compass near large metal objects such as other vehicles, large buildings, or bridges.

NOTE: Whenever the compass is calibrated manually, the variation number must also be reset. See the Compass Variation Adjustment procedure, in this group.

Calibrate the compass manually as follows:

(1) Start the engine.

(2) Depress both the US/Metric and Comp/Temp buttons. Hold down both buttons until "CAL" appears in the display module. This takes about ten seconds, and appears about five seconds after "VAR" is displayed.

(3) Release both buttons.

(4) Drive the vehicle on a level surface, away from large metal objects, through three or more complete circles in not less than 48 seconds. The "CAL" message will disappear from the display to indicate that the compass is now calibrated.

NOTE: If the "CAL" message remains in the display, either there is excessive magnetism near the compass, or the unit is faulty. Repeat the demagnetizing and calibration procedures at least one more time.

SERVICE PROCEDURES (Continued)

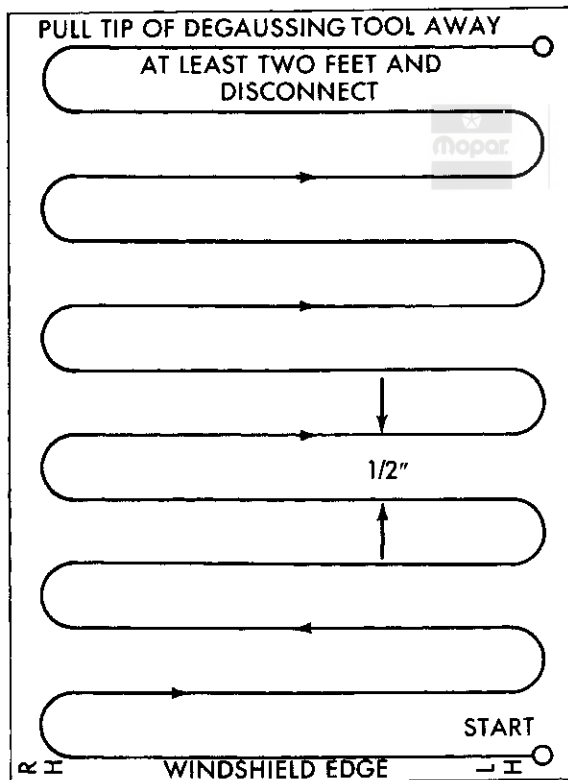
NOTE: If the wrong direction is still indicated in the compass display, the area selected for calibration may be too close to a strong magnetic field. Repeat the calibration procedure in another location.

COMPASS DEMAGNETIZING

A degaussing tool (Special Tool 6029) is used to demagnetize, or degauss, the roof panel. Equivalent units must be rated as continuous duty for 110/115 volts and 60Hz. They must also have a field strength of over 350 gauss at 1/4-inch beyond the tip of the probe.

To demagnetize the roof panel, proceed as follows:

- (1) Be certain the ignition switch is in the Off position, before you begin the demagnetizing procedure.
- (2) Place an 8-1/2 X 11-inch piece of paper, oriented on the vehicle lengthwise from front to rear, on the center line of the roof at the windshield header (Fig. 2). The purpose of the paper is to protect the roof panel from scratches, and to define the area to be demagnetized.



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Fig. 2 Roof Demagnetizing Pattern

- (3) Plug in the degaussing tool, while keeping the tool at least two feet away from the compass unit.

- (4) Slowly approach the center line of the roof panel at the windshield header, with the degaussing tool plugged in.

- (5) Contact the roof panel with the tip of the tool. Be sure the template is in place to avoid scratching the roof panel. Using a slow, back-and-forth sweeping motion, and allowing 1/2-inch between passes, move the tool at least four inches to each side of the roof center line, and eleven inches back from the windshield header.

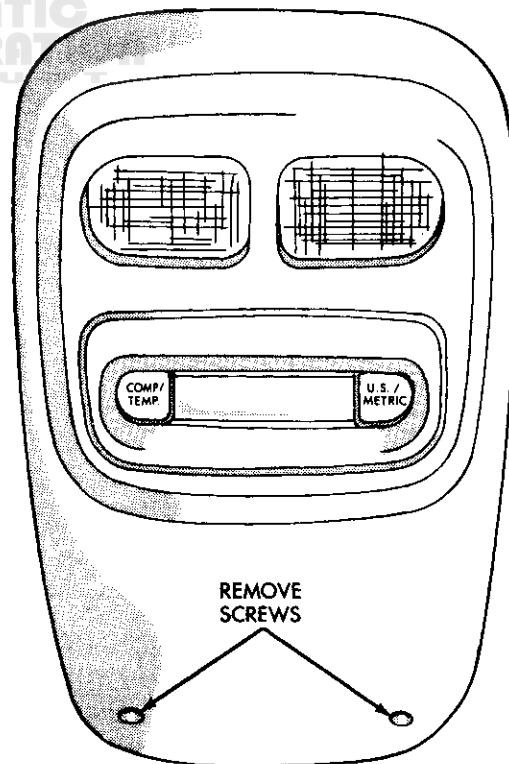
- (6) With the degaussing tool still energized, slowly back it away from the roof panel. When the tip of the tool is at least two feet from the roof panel, unplug the tool.

- (7) Calibrate the compass and adjust the compass variance as described in this group.

REMOVAL AND INSTALLATION

OVERHEAD CONSOLE

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the two console mounting screws (Fig. 3).



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Fig. 3 Console Mounting Screws

REMOVAL AND INSTALLATION (Continued)

(3) Pull the front of the console down slightly, then move it rearward until the mounting clips detach from the roof panel (Fig. 4).

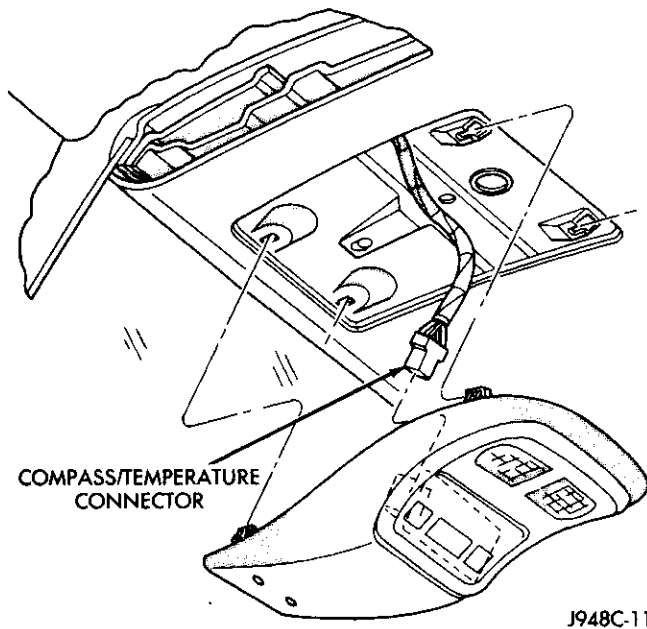


Fig. 4 Overhead Console Remove/Install

- (4) Disconnect the wire harness connector from the compass/thermometer/display module.
- (5) Reverse the removal procedures to install.

COMPASS/THERMOMETER/DISPLAY MODULE

- (1) Remove the overhead console as described in this group.
- (2) Remove the three screws securing the compass/thermometer/display module to the overhead console housing (Fig. 5).

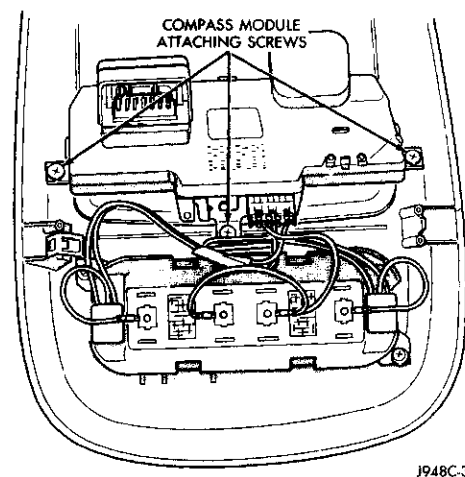


Fig. 5 Compass/Thermometer/Display Module Remove/Install

(3) Unplug the lighting harness connector from the compass/thermometer/display module (Fig. 6).

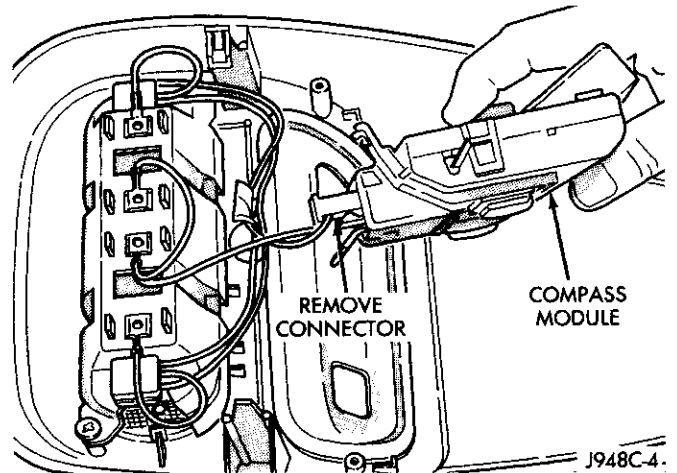


Fig. 6 Lighting Harness Connector

- (4) Remove the module from the overhead console housing.
- (5) Reverse the removal procedures to install.

TEMPERATURE SENSOR

- (1) Disconnect and isolate the battery negative cable.
- (2) Locate the temperature sensor, on the radiator support on the driver's side just behind the grille (Fig. 7).

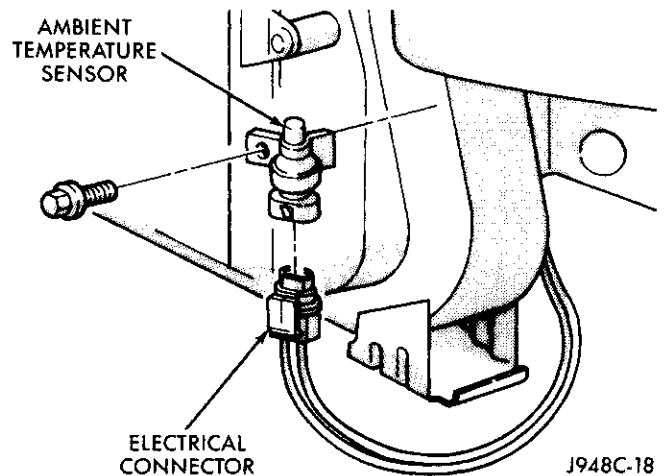


Fig. 7 Temperature Sensor

- (3) Unplug the temperature sensor wiring connector.
- (4) Remove the temperature sensor mounting bolt and remove the sensor.
- (5) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**READING/COURTESY LAMP BULBS**

(1) Insert a long flat-bladed tool at the notch on the curved edge of the lens. Carefully pry the lens downward from the housing and pivot the lens down. It may be necessary to move the tool along the edge of the lens to free the lens from the console housing.

(2) Remove the bulb by pulling it straight down.

(3) Install a new bulb by pushing it firmly into the socket.

(4) Pivot the lens up into position and press upwards until it snaps into place.

(5) Test the lamp by depressing the lens to check for proper switching and lighting.



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WIRING DIAGRAMS

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RESTORATION
PRODUCT

8W-01 GENERAL INFORMATION

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DESCRIPTION AND OPERATION

HOW TO USE THIS GROUP

The purpose of this group is to show the electrical circuits in a clear, simple fashion and to make troubleshooting easier. Components that work together are shown together. All electrical components used in a specific system are shown on one diagram. The feed for a system is shown at the top of the page. All wires, connectors, splices, and components are shown in the flow of current to the bottom of the page. Wiring which is not part of the circuit represented is referenced to another page/section, where the complete circuit is shown. In addition, all switches, components, and modules are shown in the **at rest position with the doors closed and the key removed from the ignition**.

If a component is part of several different circuits, it is shown in the diagram for each. For example, the headlamp switch is the main part of the exterior lighting, but it also affects the interior lighting and the chime warning system. **It is important to realize that no attempt is made on the diagrams to represent components and wiring as they appear on the vehicle. For example, a short piece of wire is treated the same as a long one. In addition, switches and other components are shown as simply as possible, with regard to function only.**

SECTION IDENTIFICATION

Sections in Group 8W are organized by sub-systems. The sections contain circuit operation descrip-

tions, helpful information, and system diagrams. The intention is to organize information by system, consistently from year to year.

CONNECTOR/GROUND LOCATIONS

Section 8W-90 contains connector/ground location illustrations. The illustrations contain the connector/ground number and component identification. Connector/ground location charts in Section 8W-90 reference the illustration number for components and connectors.

Section 8W-80 shows each connector and the circuits involved with that connector. The connectors are identified using the number on the Diagram pages.

SPLICE LOCATIONS

Splice Location charts in Section 8W-70 show the entire splice, and provide references to other sections the splice serves.

Section 8W-95 contains illustrations that show the general location of the splices in each harness. The illustrations show the splice by number, and provide a written location.

NOTES, CAUTIONS, and WARNINGS

Throughout this group additional important information is presented in three ways; Notes, Cautions, and Warnings.

NOTES are used to help describe how switches or components operate to complete a particular circuit. They are also used to indicate different conditions

DESCRIPTION AND OPERATION (Continued)

that may appear on the vehicle. For example, an up-to and after condition.

CAUTIONS are used to indicate information that could prevent making an error that may damage the vehicle.

WARNINGS provide information to prevent personal injury and vehicle damage. Below is a list of general warnings that should be followed any time a vehicle is being serviced.

WARNING: ALWAYS WEAR SAFETY GLASSES FOR EYE PROTECTION.

WARNING: USE SAFETY STANDS ANYTIME A PROCEDURE REQUIRES BEING UNDER A VEHICLE.

WARNING: BE SURE THAT THE IGNITION SWITCH ALWAYS IS IN THE OFF POSITION, UNLESS THE PROCEDURE REQUIRES IT TO BE ON.

WARNING: SET THE PARKING BRAKE WHEN WORKING ON ANY VEHICLE. AN AUTOMATIC TRANSMISSION SHOULD BE IN PARK. A MANUAL TRANSMISSION SHOULD BE IN NEUTRAL.

WARNING: OPERATE THE ENGINE ONLY IN A WELL-VENTILATED AREA.

WARNING: KEEP AWAY FROM MOVING PARTS WHEN THE ENGINE IS RUNNING, ESPECIALLY THE FAN AND BELTS.

WARNING: TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT PARTS SUCH AS THE RADIATOR, EXHAUST MANIFOLD(S), TAIL PIPE, CATALYTIC CONVERTER, AND MUFFLER.

WARNING: DO NOT ALLOW FLAME OR SPARKS NEAR THE BATTERY. GASES ARE ALWAYS PRESENT IN AND AROUND THE BATTERY.

WARNING: ALWAYS REMOVE RINGS, WATCHES, LOOSE HANGING JEWELRY, AND LOOSE CLOTHING.

WIRE CODE IDENTIFICATION

Each wire shown in the diagrams contains a code (Fig. 1) which identifies the main circuit, part of the main circuit, gauge of wire, and color. The color is

shown as a two letter code which can be identified by referring to the Wire Color Code Chart (Fig. 2)

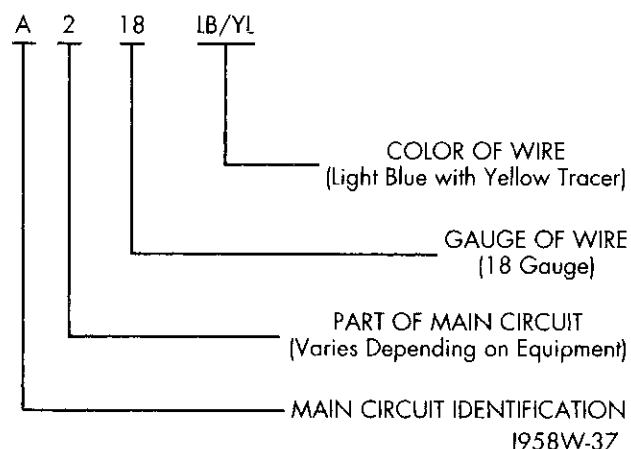


Fig. 1 Wire Code Identification

COLOR CODE	COLOR	STANDARD TRACER COLOR	COLOR CODE	COLOR	STANDARD TRACER CODE
BL	BLUE	WT	OR	ORANGE	BK
BK	BLACK	WT	PK	PINK	BK OR WT
BR	BROWN	WT	RD	RED	WT
DB	DARK BLUE	WT	TN	TAN	WT
DG	DARK GREEN	WT	VT	VIOLET	WT
GY	GRAY	BK	WT	WHITE	BK
LB	LIGHT BLUE	BK	YL	YELLOW	BK
LG	LIGHT GREEN	BK	*	WITH TRACER	

918W-136

Fig. 2 Wire Color Code Chart

CIRCUIT IDENTIFICATION

All circuits in the diagrams use an alpha/numeric code to identify the wire and its function (Fig. 3). To identify which circuit code applies to a system, refer to the Circuit Identification Code Chart. This chart shows the main circuits only and does not show the secondary codes that may apply to some models.

CONNECTORS

Connectors shown in the diagrams are identified using the international standard arrows for male and female terminals (Fig. 4). A connector identifier is

DESCRIPTION AND OPERATION (Continued)

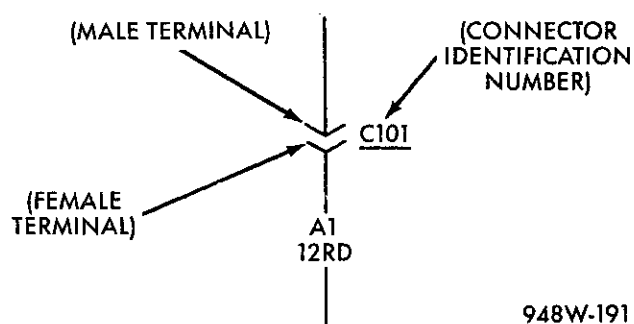
CIRCUIT	FUNCTION
A	Battery Feed
B	Brake Controls
C	Climate Controls
D	Diagnostic Circuits
E	Dimming Illumination Circuits
F	Fused Circuits (Secondary Feed)
G	Monitoring Circuits (Gauges)
H	Open
I	Not Used
J	Open
K	Powertrain Control Module
L	Exterior Lighting
M	Interior Lighting
N	ESA Module
O	Not Used
P	Power Option (Battery Feed)
Q	Power Options (Battery Feed)
R	Passive Restraint
S	Suspension/Steering
T	Transmission/Transaxle/Transfer Case
U	Open
V	Speed Control, Washer/Wiper
W	Open
X	Audio Systems
Y	Open
Z	Grounds

948W-190

Fig. 3 Circuit Identification

placed next to the arrows to indicate the connector number (Fig. 4).

For viewing connector pin outs, with two terminals or greater, refer to section 8W-80. This section iden-

**Fig. 4 Connector Identification**

tifies the connector by number and provides terminal numbering, circuit identification, wire colors, and functions.

All connectors are viewed from the terminal end unless otherwise specified. To find the connector location in the vehicle refer to section 8W-90. This section uses the connector identification number from the wiring diagrams to provide a figure number reference.

TAKE OUTS

The abbreviation T/O is used in the component location section to indicate a point in which the wiring harness branches out to a component.

SYMBOLS

Various symbols are used throughout the Wiring Diagrams. These symbols can be identified by referring to the symbol identification chart (Fig. 5).

DESCRIPTION AND OPERATION (Continued)

LEGEND OF SYMBOLS USED ON WIRING DIAGRAMS			
	POSITIVE		BY-DIRECTIONAL ZENER DIODE
	NEGATIVE		MOTOR
	GROUND		ARMATURE AND BRUSHES
	FUSE		CONNECTOR IDENTIFICATION
	GANG FUSES WITH BUSS BAR		MALE CONNECTOR
	CIRCUIT BREAKER		FEMALE CONNECTOR
	CAPACITOR		DENOTES WIRE CONTINUES ELSEWHERE
	OHMS		DENOTES WIRE GOES TO ONE OF TWO CIRCUITS
	RESISTOR		SPLICE
	VARIABLE RESISTOR		SPLICE IDENTIFICATION
	SERIES RESISTOR		THERMAL ELEMENT
	COIL		TIMER
	STEP UP COIL		MULTIPLE CONNECTOR
	OPEN CONTACT		OPTIONAL WIRING WITH WIRING WITHOUT
	CLOSED CONTACT		"Y" WINDINGS
	CLOSED SWITCH		DIGITAL READOUT
	OPEN SWITCH		SINGLE FILAMENT LAMP
	CLOSED GANGED SWITCH		DUAL FILAMENT LAMP
	OPEN GANGED SWITCH		L.E.D. — LIGHT EMITTING DIODE
	TWO POLE SINGLE THROW SWITCH		THERMISTOR
	PRESSURE SWITCH		GAUGE
	SOLENOID SWITCH		SENSOR
	MERCURY SWITCH		FUEL INJECTOR
	DIODE OR RECTIFIER		

948W-192

Fig. 5 Symbol Identification

DESCRIPTION AND OPERATION (Continued)**ELECTROSTATIC DISCHARGE (ESD) SENSITIVE DEVICES**

All ESD sensitive components are solid state and a symbol (Fig. 6) is used to indicate this. When handling any component with this symbol comply with the following procedures to reduce the possibility of electrostatic charge build up on the body and inadvertent discharge into the component. If it is not known whether the part is ESD sensitive, assume that it is.

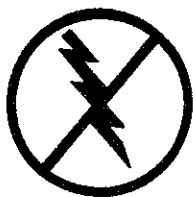
(1) Always touch a known good ground before handling the part. This should be repeated while handling the part and more frequently after sliding across a seat, sitting down from a standing position, or walking a distance.

(2) Avoid touching electrical terminals of the part, unless instructed to do so by a written procedure.

(3) When using a voltmeter, be sure to connect the ground lead first.

(4) Do not remove the part from its protective packing until it is time to install the part.

(5) Before removing the part from its package, ground the package to a known good ground on the vehicle.



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*Fig. 6 Electrostatic Discharge Symbol***DIAGNOSIS AND TESTING****TROUBLESHOOTING TOOLS**

When diagnosing a problem in an electrical circuit there are several common tools necessary. These tools are listed and explained below.

- Jumper Wire - This is a test wire used to connect two points of a circuit. It can be used to bypass an open in a circuit.

WARNING: NEVER USE A JUMPER WIRE ACROSS A LOAD, SUCH AS A MOTOR, CONNECTED BETWEEN A BATTERY FEED AND GROUND.

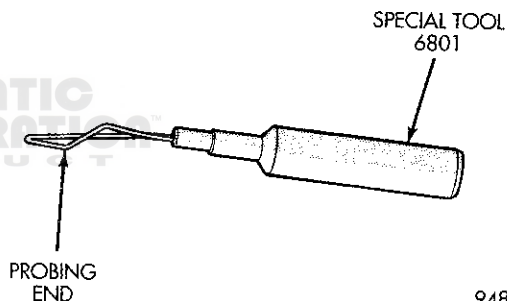
- Voltmeter - Used to check for voltage on a circuit. Always connect the black lead to a known good ground and the red lead to the positive side of the circuit.

CAUTION: Most of the electrical components used in today's vehicle are solid state. When checking voltages in these circuits use a meter with a 10-megohm or greater impedance.

- Ohmmeter - Used to check the resistance between two points of a circuit. Low or no resistance in a circuit means good continuity.

CAUTION: - Most of the electrical components used in today's vehicle are Solid State. When checking resistance in these circuits use a meter with a 10-megohm or greater impedance. In addition, make sure the power is disconnected from the circuit. Circuits that are powered up by the vehicle electrical system can cause damage to the equipment and provide false readings.

- Probing Tools - These tools are used for probing terminals in connectors (Fig. 7). Select the proper size tool from Special Tool Package 6807, and insert it into the terminal being tested. Use the other end of the tool to insert the meter probe.



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*Fig. 7 Probing Tool***INTERMITTENT AND POOR CONNECTIONS**

Most intermittent electrical problems are caused by faulty electrical connections or wiring. It is also possible for a sticking component or relay to cause a problem. Before condemning a component or wiring assembly check the following items.

- Connectors are fully seated
- Spread terminals, or terminal push out
- Terminals in the wiring assembly are fully seated into the connector/component and locked in position
- Dirt or corrosion on the terminals. Any amount of corrosion or dirt could cause an intermittent problem
- Damaged connector/component casing exposing the item to dirt and moisture
- Wire insulation that has rubbed through causing a short to ground
- Wiring broke inside of the insulation

DIAGNOSIS AND TESTING (Continued)

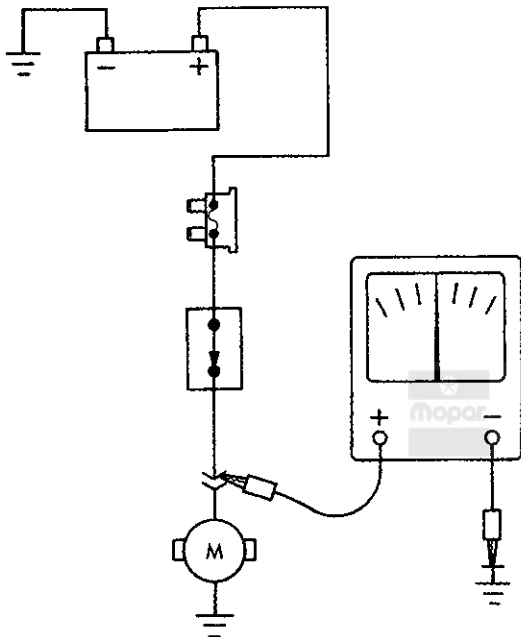
TROUBLESHOOTING TESTS

Before beginning any tests on a vehicle's electrical system use the Wiring Diagrams and study the circuit. Also refer to the Troubleshooting Wiring Problems section in this section.

TESTING FOR VOLTAGE

(1) Connect the ground lead of a voltmeter to a known good ground (Fig. 8).

(2) Connect the other lead of the voltmeter to the selected test point. The vehicle ignition may need to be turned ON to check voltage. Refer to the appropriate test procedure.



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Fig. 8 Testing for Voltage

TESTING FOR CONTINUITY

(1) Remove the fuse for the circuit being checked or, disconnect the battery.

(2) Connect one lead of the ohmmeter to one side of the circuit being tested (Fig. 9).

(3) Connect the other lead to the other end of the circuit being tested. Low or no resistance means good continuity.

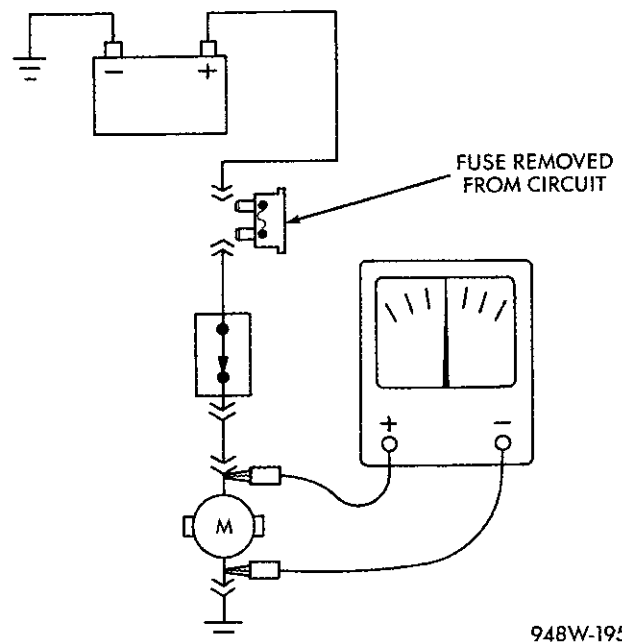
TESTING FOR A SHORT TO GROUND

(1) Remove the fuse and disconnect all items involved with the fuse.

(2) Connect a test light or a voltmeter across the terminals of the fuse.

(3) Starting at the fuse block, wiggle the wiring harness about six to eight inches apart and watch the voltmeter/test lamp.

(4) If the voltmeter registers voltage or the test lamp glows, there is a short to ground in that general area of the wiring harness.



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Fig. 9 Testing for Continuity

TESTING FOR A SHORT TO GROUND ON FUSES POWERING SEVERAL LOADS

(1) Refer to the wiring diagrams and disconnect or isolate all items on the fused circuit.

(2) Replace the blown fuse.

(3) Supply power to the fuse by turning ON the ignition switch or re-connecting the battery.

(4) Start connecting the items in the fuse circuit one at a time. When the fuse blows the circuit with the short to ground has been isolated.

TESTING FOR A VOLTAGE DROP

(1) Connect the positive lead of the voltmeter to the side of the circuit closest to the battery (Fig. 10).

(2) Connect the other lead of the voltmeter to the other side of the switch or component.

(3) Operate the item.

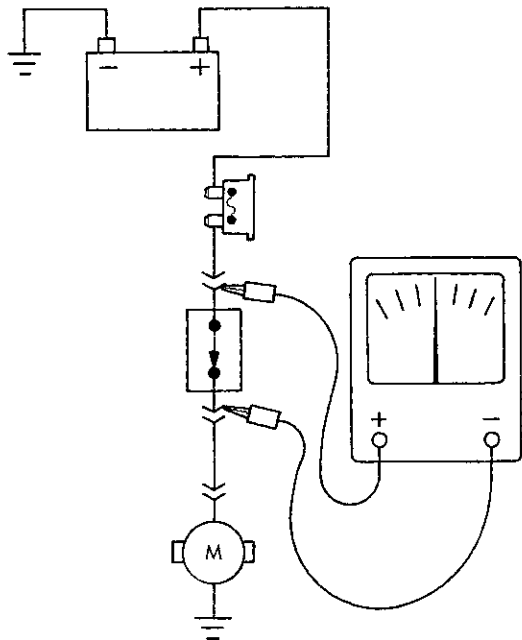
(4) The voltmeter will show the difference in voltage between the two points.

TROUBLESHOOTING WIRING PROBLEMS

When troubleshooting wiring problems there are six steps which can aid in the procedure. The steps are listed and explained below. Always check for non-factory items added to the vehicle before doing any diagnosis. If the vehicle is equipped with these items, disconnect them to verify these add-on items are not the cause of the problem.

(1) Verify the problem.

(2) Verify any related symptoms. Do this by performing operational checks on components that are in the same circuit. Refer to the wiring diagrams.

DIAGNOSIS AND TESTING (Continued)

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Fig. 10 Testing for Voltage Drop

(3) Analyze the symptoms. Use the wiring diagrams to determine what the circuit is doing, where the problem most likely is occurring and where the diagnosis will continue.

(4) Isolate the problem area.

(5) Repair the problem.

(6) Verify proper operation. For this step check for proper operation of all items on the repaired circuit. Refer to the wiring diagrams.

SERVICE PROCEDURES**WIRING REPAIR**

When replacing or repairing a wire, it is important that the correct gauge be used as shown in the wiring diagrams. The wires must also be held securely in place to prevent damage to the insulation.

(1) Disconnect battery negative cable

(2) Remove 1 inch of insulation from each end of the wire.

(3) Place a piece of heat shrink tubing over one side of the wire. Make sure the tubing will be long enough to cover and seal the entire repair area.

(4) Spread the strands of the wire apart on each part of the exposed wire (example 1). (Fig. 11)

(5) Push the two ends of wire together until the strands of wire are close to the insulation (example 2) (Fig. 11)

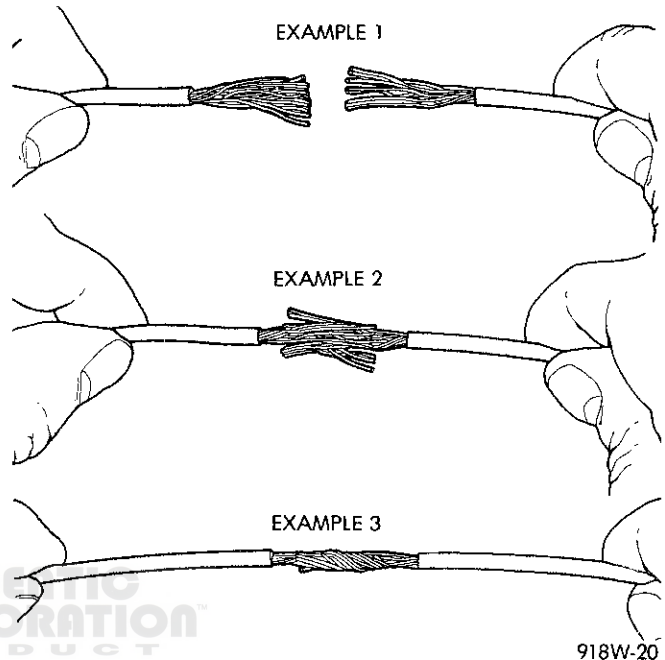
(6) Twist the wires together (example 3) (Fig. 11)

(7) Solder the connection together using rosin core type solder only. **Do not use acid core solder.**

(8) Center the heat shrink tubing over the joint, and heat using a heat gun. Heat the joint until the tubing is tightly sealed and sealant comes out of both ends of the tubing.

(9) Secure the wire to the existing ones to prevent chafing or damage to the insulation

(10) Connect battery and test all affected systems.



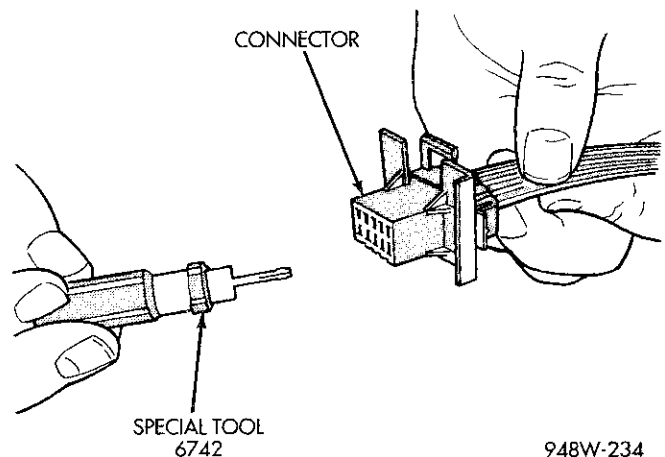
918W-20

Fig. 11 Wire Repair**TERMINAL/CONNECTOR REPAIR-MOLEX CONNECTORS**

(1) Disconnect battery.

(2) Disconnect the connector from its mating half/component.

(3) Insert the terminal releasing special tool 6742 into the terminal end of the connector (Fig. 12).



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Fig. 12 Molex Connector Repair

SERVICE PROCEDURES (Continued)

(4) Using special tool 6742 release the locking fingers on the terminal (Fig. 13).

(5) Pull on the wire to remove it from the connector.

(6) Repair or replace the connector or terminal, as necessary.

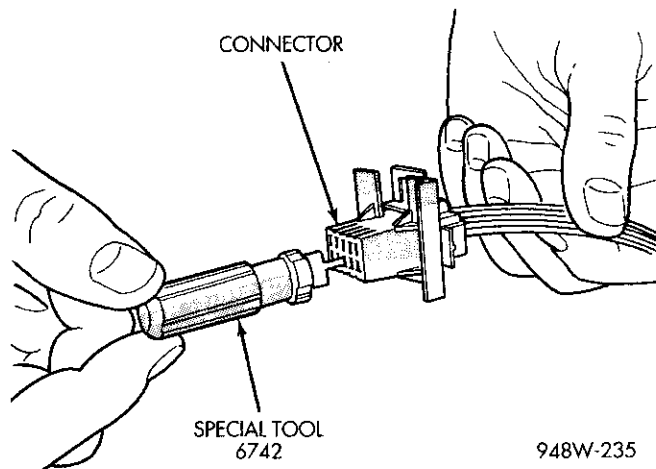


Fig. 13 Using Special Tool 6742

TERMINAL/CONNECTOR REPAIR—THOMAS AND BETTS CONNECTORS

- (1) Disconnect battery.
- (2) Disconnect the connector from its mating half/component.
- (3) Push in the two lock tabs on the side of the connector (Fig. 14).

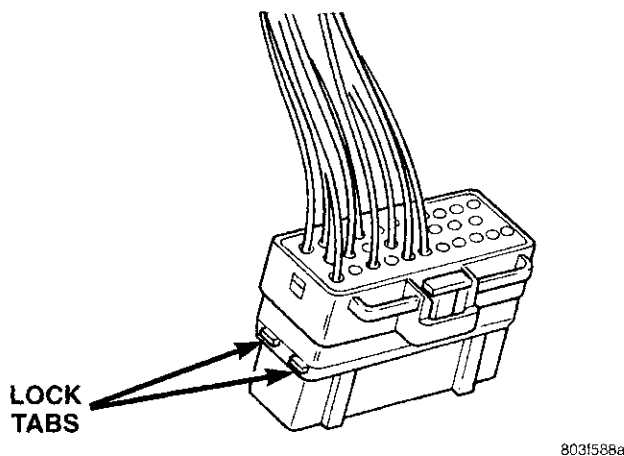


Fig. 14 Thomas and Betts Connector Lock Release Tabs

(4) Insert the probe end of special tool 6934 into the back of the connector cavity (Fig. 15).

(5) Grasp the wire and tool 6934 and slowly remove the wire and terminal from the connector.

(6) Repair or replace the terminal.

(7) Install the wire and terminal in the connector. Fully seat the terminal in the connector.

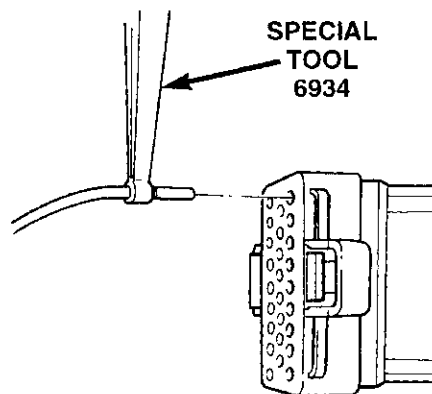


Fig. 15 Removing Wire Terminal

(8) Push in the single lock tab on the side of the connector (Fig. 16).

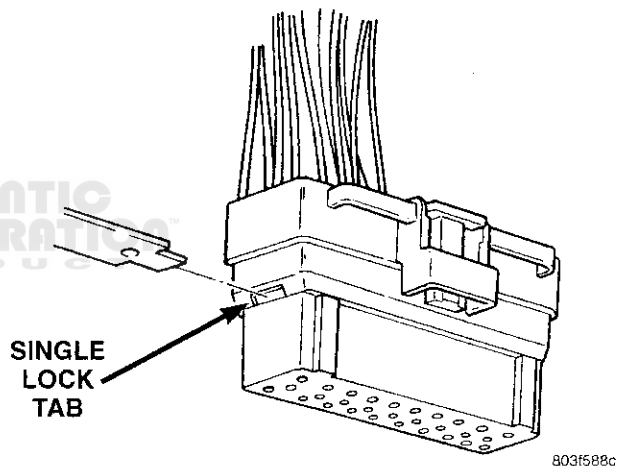
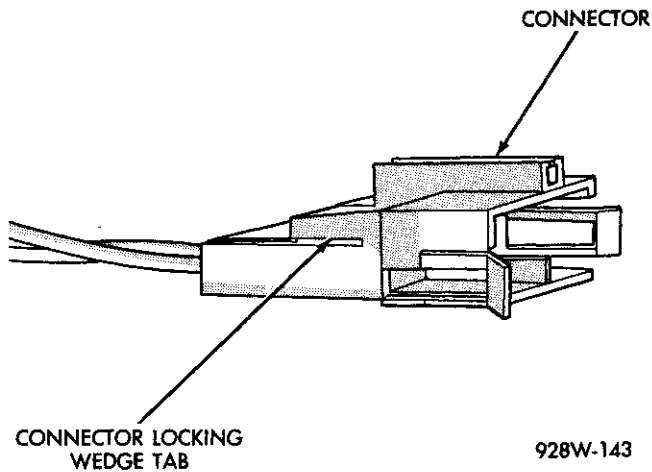


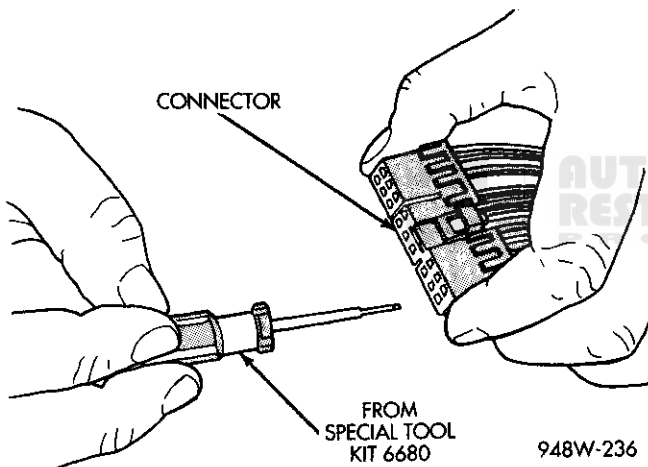
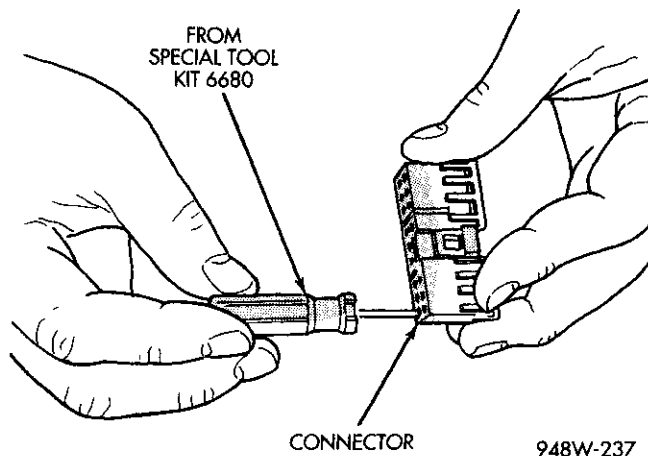
Fig. 16 Single Lock Tab

CONNECTOR REPLACEMENT

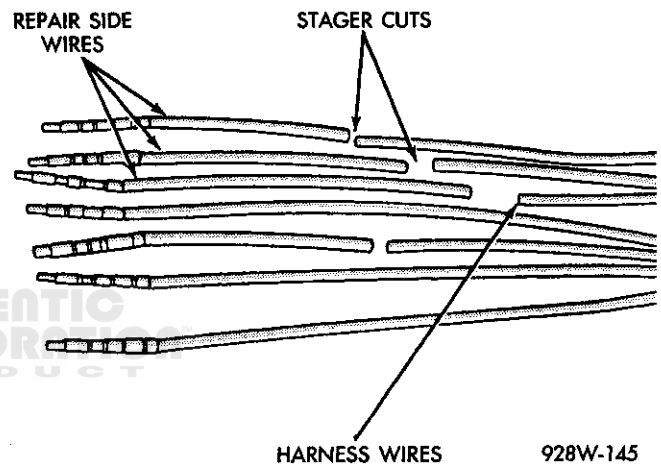
- (1) Disconnect battery.
- (2) Disconnect the connector that is to be repaired from its mating half/component.
- (3) Remove the connector locking wedge, if required (Fig. 17).
- (4) Position the connector locking finger away from the terminal using the proper pick from special tool kit 6680. Pull on the wire to remove the terminal from the connector (Fig. 18) (Fig. 19).
- (5) Reset the terminal locking tang, if it has one.
- (6) Insert the removed wire in the same cavity on the repair connector.
- (7) Repeat steps four through six for each wire in the connector, being sure that all wires are inserted into the proper cavities. For additional connector pin-out identification, refer to the wiring diagrams.
- (8) Insert the connector locking wedge into the repaired connector, if required.

SERVICE PROCEDURES (Continued)**Fig. 17 Connector Locking Wedge**

- (9) Connect connector to its mating half/component.
- (10) Connect battery and test all affected systems.

**Fig. 18 Terminal Removal****Fig. 19 Terminal Removal Using Special Tool****CONNECTOR AND TERMINAL REPLACEMENT**

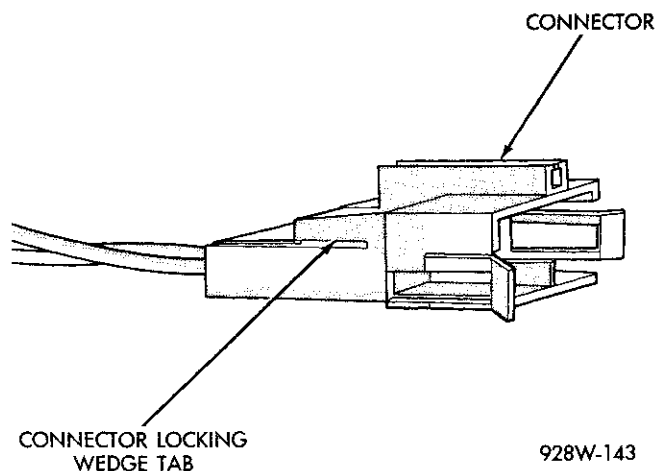
- (1) Disconnect battery.
- (2) Disconnect the connector (that is to be repaired) from its mating half/component.
- (3) Cut off the existing wire connector directly behind the insulator. Remove six inches of tape from the harness.
- (4) Stagger cut all wires on the harness side at 1/2 inch intervals (Fig. 20).
- (5) Remove 1 inch of insulation from each wire on the harness side.
- (6) Stagger cut the matching wires on the repair connector assembly in the opposite order as was done on the harness side of the repair. Allow extra length for soldered connections. Check that the overall length is the same as the original (Fig. 20).

**Fig. 20 Stagger Cutting Wires**

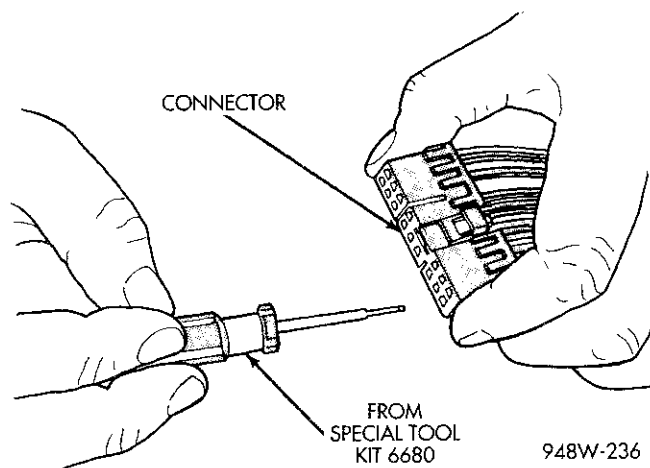
- (7) Remove 1 inch of insulation from each wire.
- (8) Place a piece of heat shrink tubing over one side of the wire. Be sure the tubing will be long enough to cover and seal the entire repair area.
- (9) Spread the strands of the wire apart on each part of the exposed wires.
- (10) Push the two ends of wire together until the strands of wire are close to the insulation.
- (11) Twist the wires together.
- (12) Solder the connection together using rosin core type solder only. **Do not use acid core solder.**
- (13) Center the heat shrink tubing over the joint and heat using a heat gun. Heat the joint until the tubing is tightly sealed and sealant comes out of both ends of the tubing.
- (14) Repeat steps 8 through 13 for each wire.
- (15) Re-tape the wire harness starting 1-1/2 inches behind the connector and 2 inches past the repair.
- (16) Re-connect the repaired connector.
- (17) Connect the battery, and test all affected systems.

SERVICE PROCEDURES (Continued)**TERMINAL REPLACEMENT**

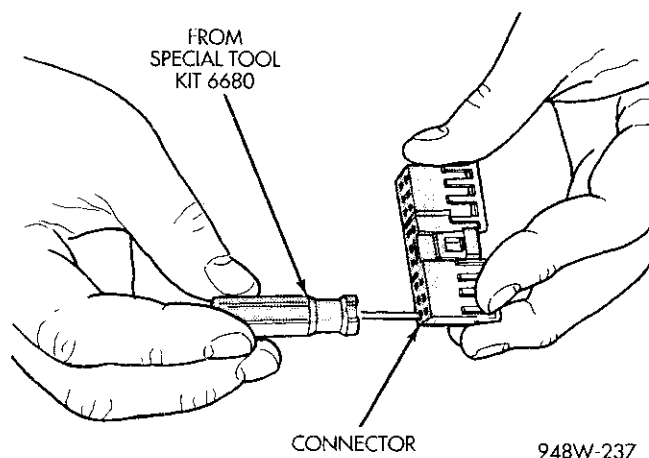
- (1) Disconnect battery.
- (2) Disconnect the connector being repaired from its mating half. Remove connector locking wedge, if required (Fig. 21).
- (3) Remove connector locking wedge, if required (Fig. 21).

**Fig. 21 Connector Locking Wedge Tab (Typical)**

- (4) Position the connector locking finger away from the terminal using the proper pick from special tool kit 6680. Pull on the wire to remove the terminal from the connector (Fig. 22) (Fig. 23).

**Fig. 22 Terminal Removal**

- (5) Cut the wire 6 inches from the back of the connector.
- (6) Remove 1 inch of insulation from the wire on the harness side.
- (7) Select a wire from the terminal repair assembly that best matches the color wire being repaired.
- (8) Cut the repair wire to the proper length and remove 1 inch of insulation.

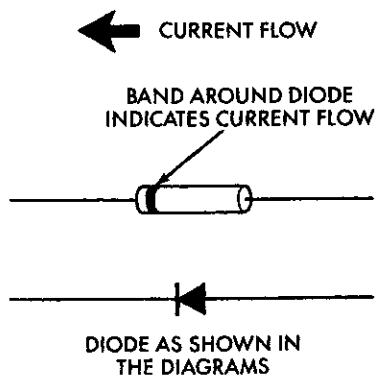
**Fig. 23 Terminal Removal Using Special Tool**

- (9) Place a piece of heat shrink tubing over one side of the wire. Make sure the tubing will be long enough to cover and seal the entire repair area.
- (10) Spread the strands of the wire apart on each part of the exposed wires.
- (11) Spread the strands of the wire apart on each part of the exposed wires.
- (12) Push the two ends of wire together until the strands of wire are close to the insulation.
- (13) Twist the wires together.
- (14) Solder the connection together using rosin core type solder only. **Do not use acid core solder.**
- (15) Center the heat shrink tubing over the joint and heat using a heat gun. Heat the joint until the tubing is tightly sealed and sealant comes out of both ends of the tubing.
- (16) Insert the repaired wire into the connector.
- (17) Install the connector locking wedge, if required, and reconnect the connector to its mating half/component.
- (18) Re-tape the wire harness starting 1-1/2 inches behind the connector and 2 inches past the repair.
- (19) Connect battery, and test all affected systems.

DIODE REPLACEMENT

- (1) Disconnect the battery.
- (2) Locate the diode in the harness, and remove the protective covering.
- (3) Remove the diode from the harness, pay attention to the current flow direction (Fig. 24).
- (4) Remove the insulation from the wires in the harness. Only remove enough insulation to solder in the new diode.
- (5) Install the new diode in the harness, making sure current flow is correct. If necessary refer to the appropriate wiring diagram for current flow.
- (6) Solder the connection together using rosin core type solder only. **Do not use acid core solder.**

SERVICE PROCEDURES (Continued)

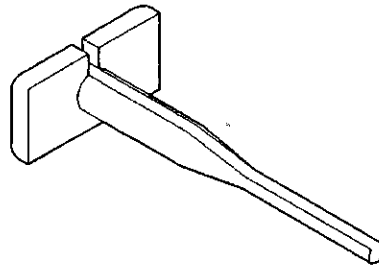
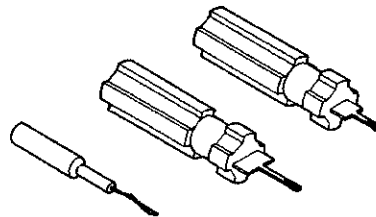


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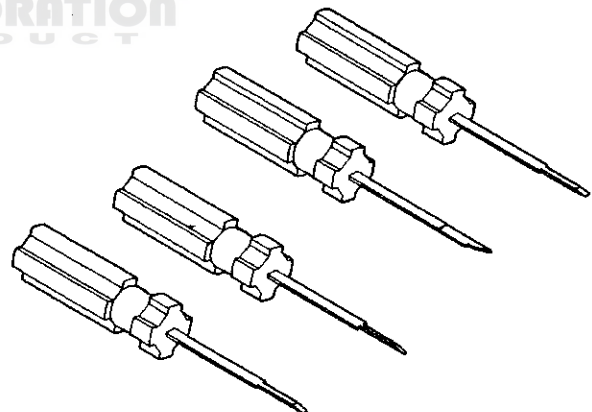
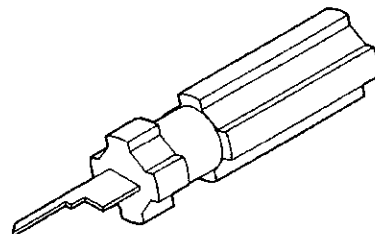
Fig. 24 Diode Identification

(7) Tape the diode to the harness using electrical tape making, sure the diode is completely sealed from the elements.

(8) Re-connect the battery, and test affected systems.

SPECIAL TOOLS**WIRING/TERMINAL****Terminal Removing Tool 6934****Probing Tool Package 6807**

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**Terminal Pick 6680****Terminal Removing Tool 6932**

8W-02 COMPONENT INDEX

GENERAL INFORMATION

on system operation, refer to the appropriate section of the wiring diagrams.

INTRODUCTION

This section provides an alphabetical listing of all the components covered in group 8W. For information



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8W-10 FUSE/FUSE BLOCK

DESCRIPTION AND OPERATION

INTRODUCTION

This section covers the Fuse Block and all circuits involved with it. For additional information on system operation, refer to the appropriate section of the wiring diagrams.



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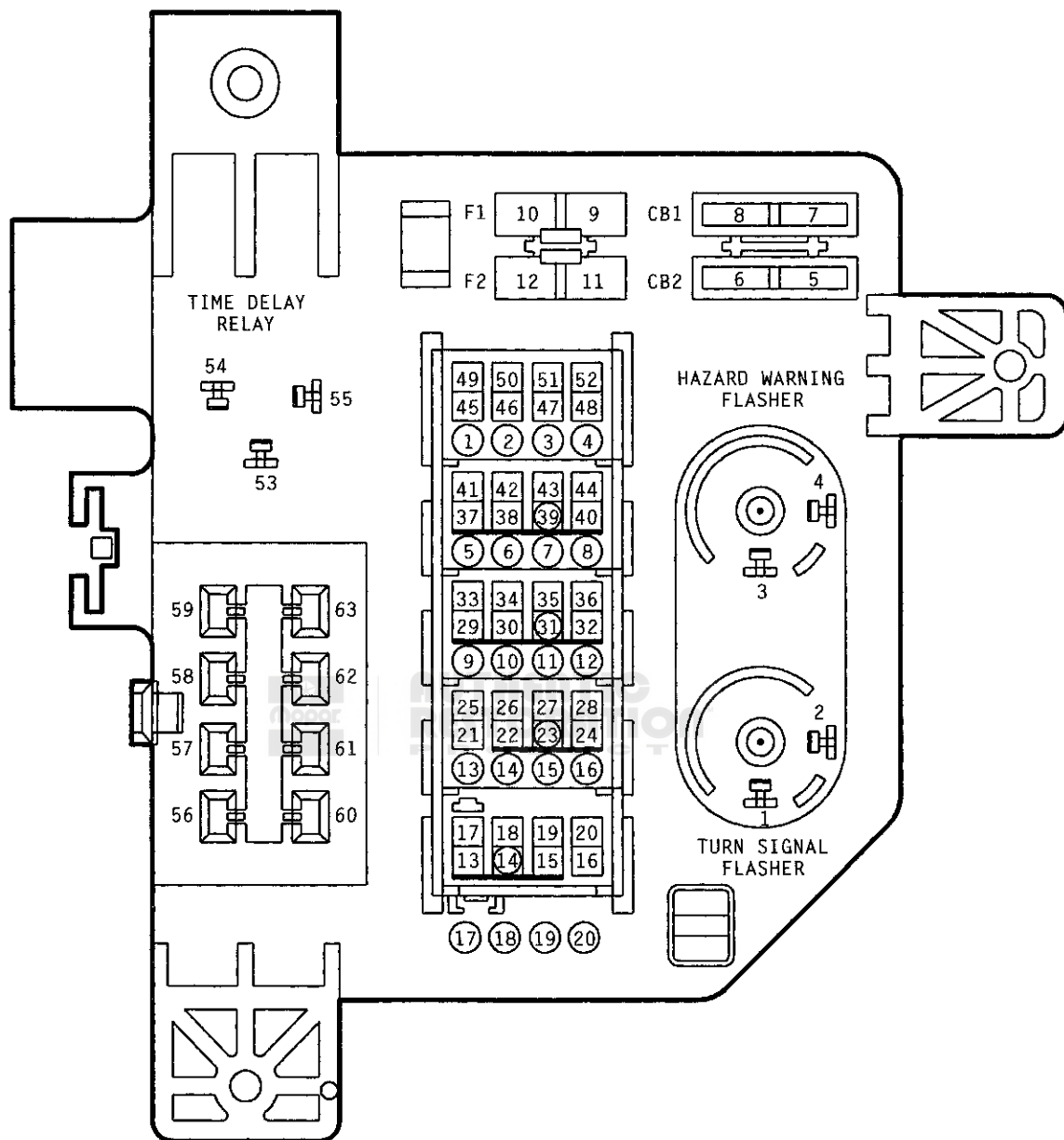
DIAGRAM INDEX

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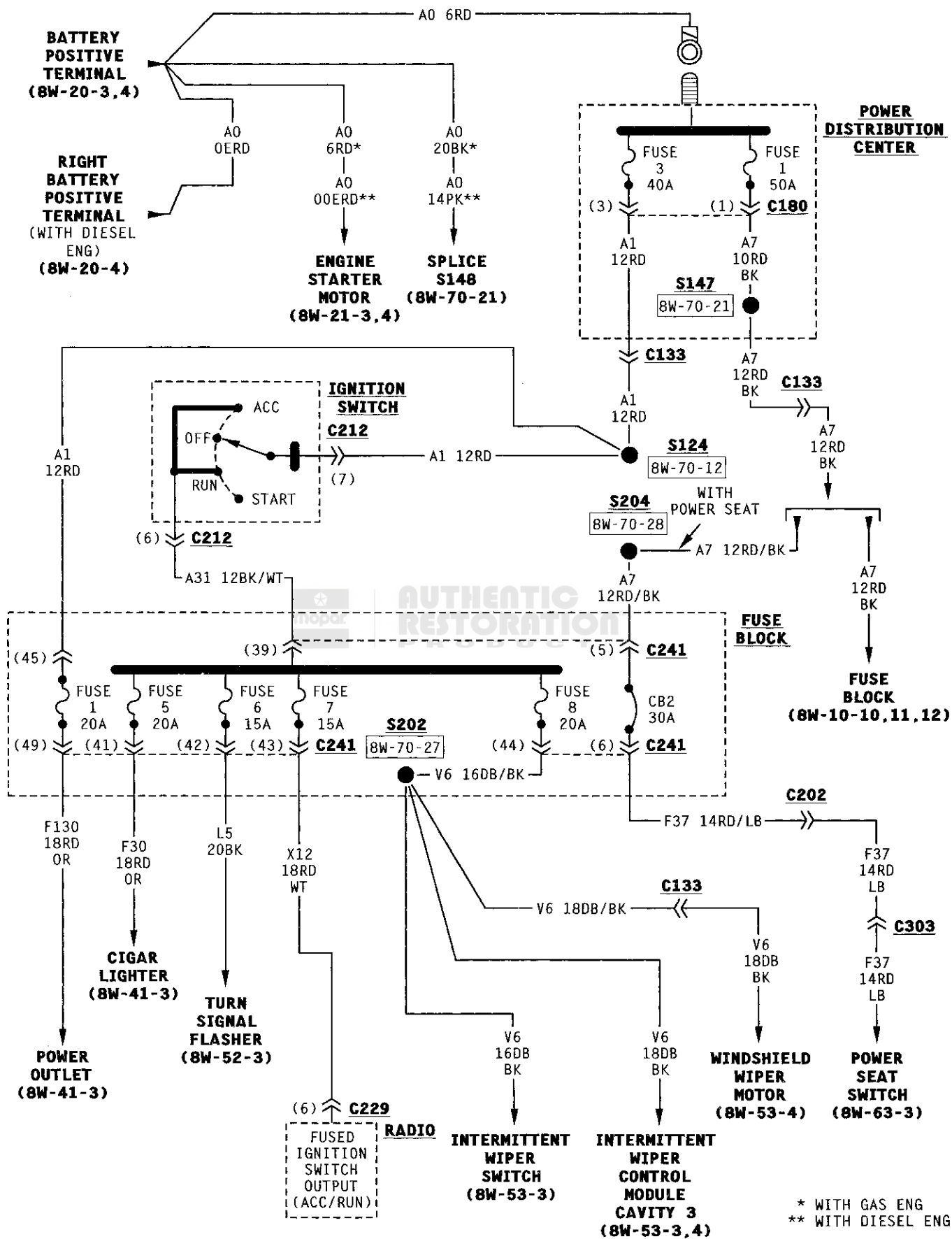
FUSE BLOCK
C241

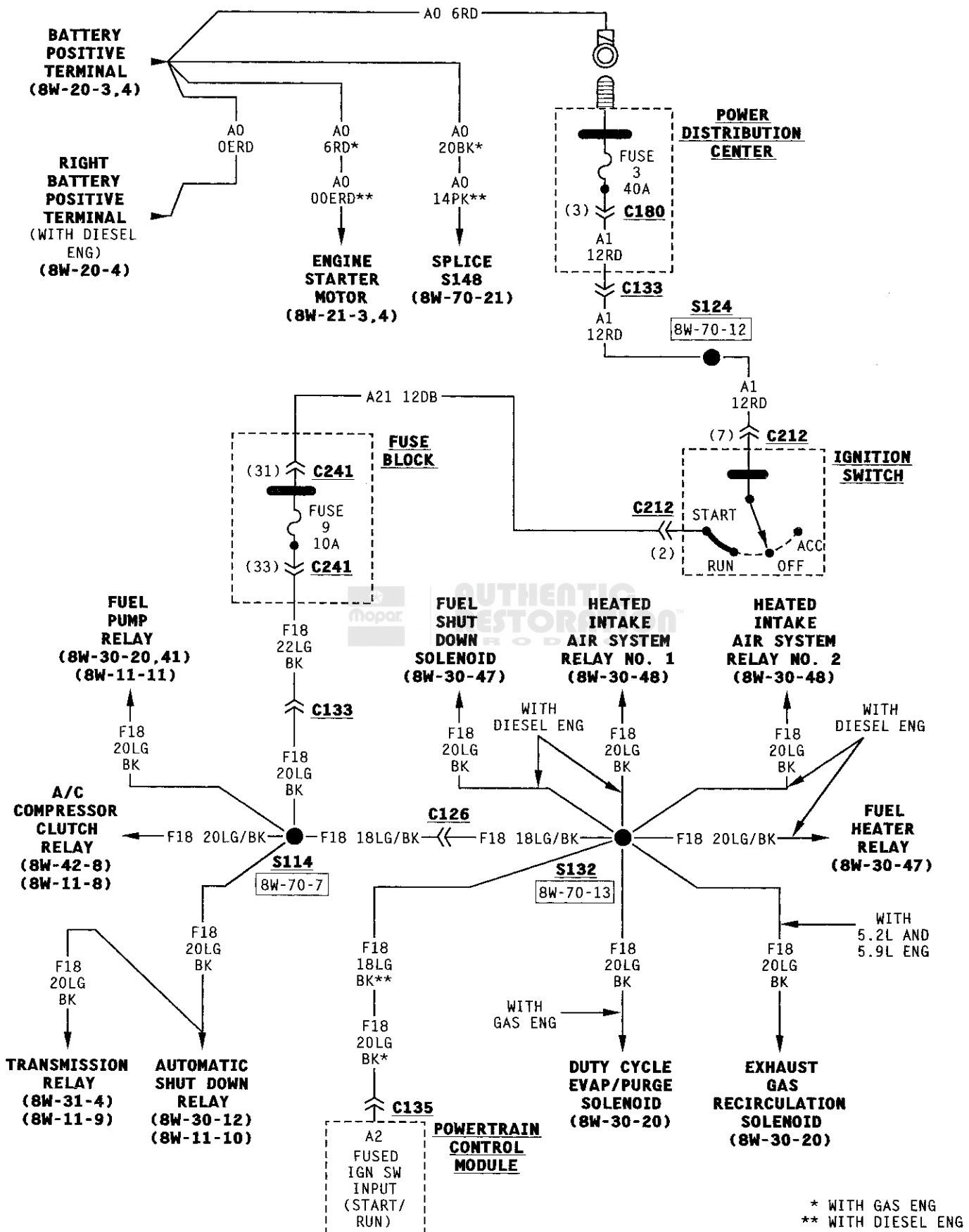
FUSE	AMPS	COLOR	SECTION/PAGE
1	20	YELLOW	8W-10-5
2	-	-	-
3	-	-	-
4	-	-	-
5	20	YELLOW	8W-10-5
6	15	LIGHT BLUE	8W-10-5
7	15	RED	8W-10-5
8	20	YELLOW	8W-10-5
9	10	RED	8W-10-6
10	-	-	-
11	10	RED	8W-10-7
12	15	LIGHT BLUE	8W-10-7
13	5	TAN	8W-10-11
14	20	YELLOW	8W-10-8
15	10	RED	8W-10-9
16	15	LIGHT BLUE	8W-10-9
17	15	LIGHT BLUE	8W-10-10
18	15	LIGHT BLUE	8W-10-11
19	20	YELLOW	8W-10-12
20	15	LIGHT BLUE	8W-10-12
F1	-	-	-
F2	30	GREEN	8W-10-9
CB1	30	CIRCUIT BREAKER	8W-10-9
CB2	30	CIRCUIT BREAKER	8W-10-5

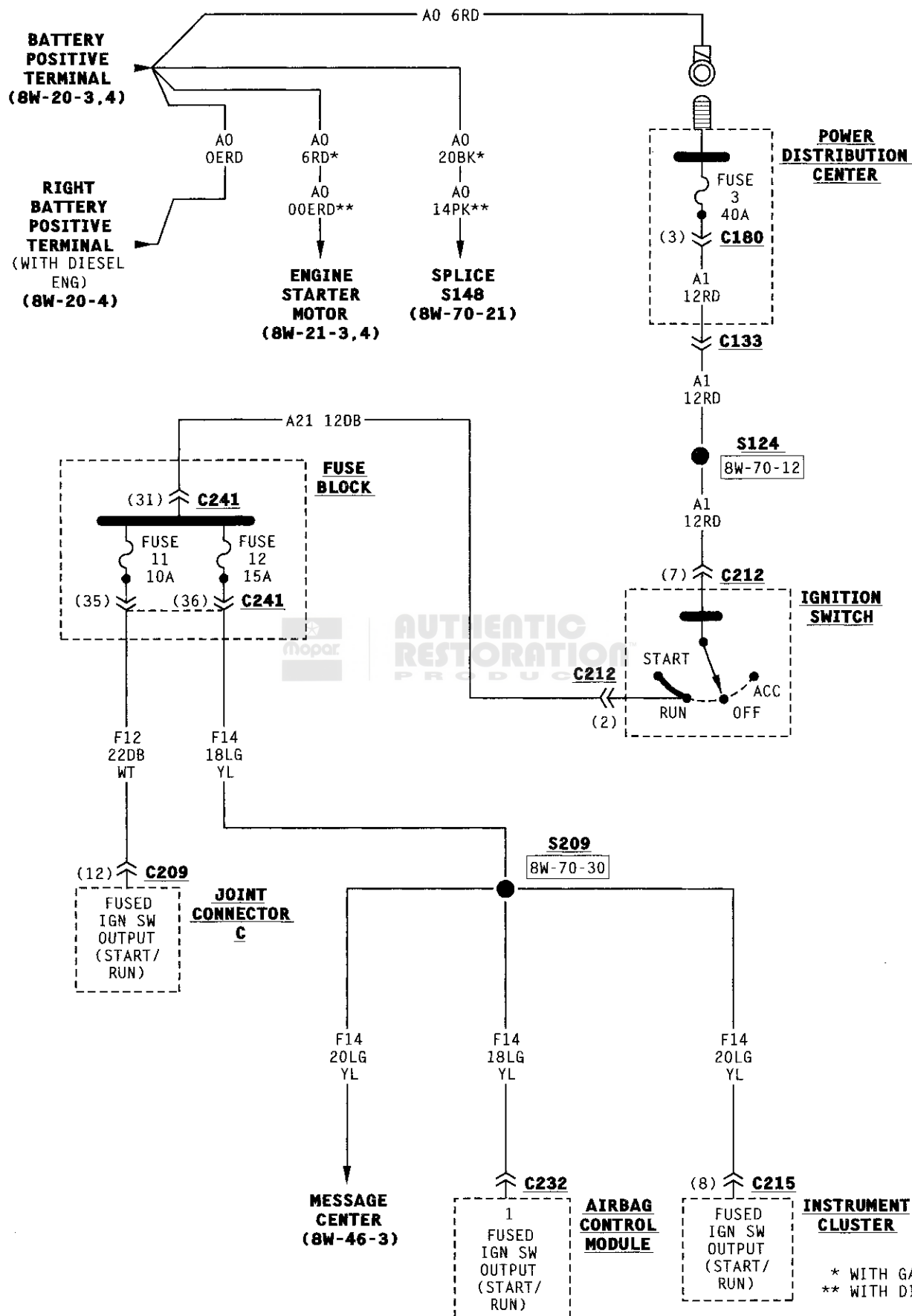
TURN SIGNAL FLASHER	CAV	CIRCUIT	FUNCTION	SECTION/PAGE
	1	L6 20RD/GY	TURN SIGNAL FLASHER OUTPUT	8W-52-3
	2	L5 20BK	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)	8W-52-3

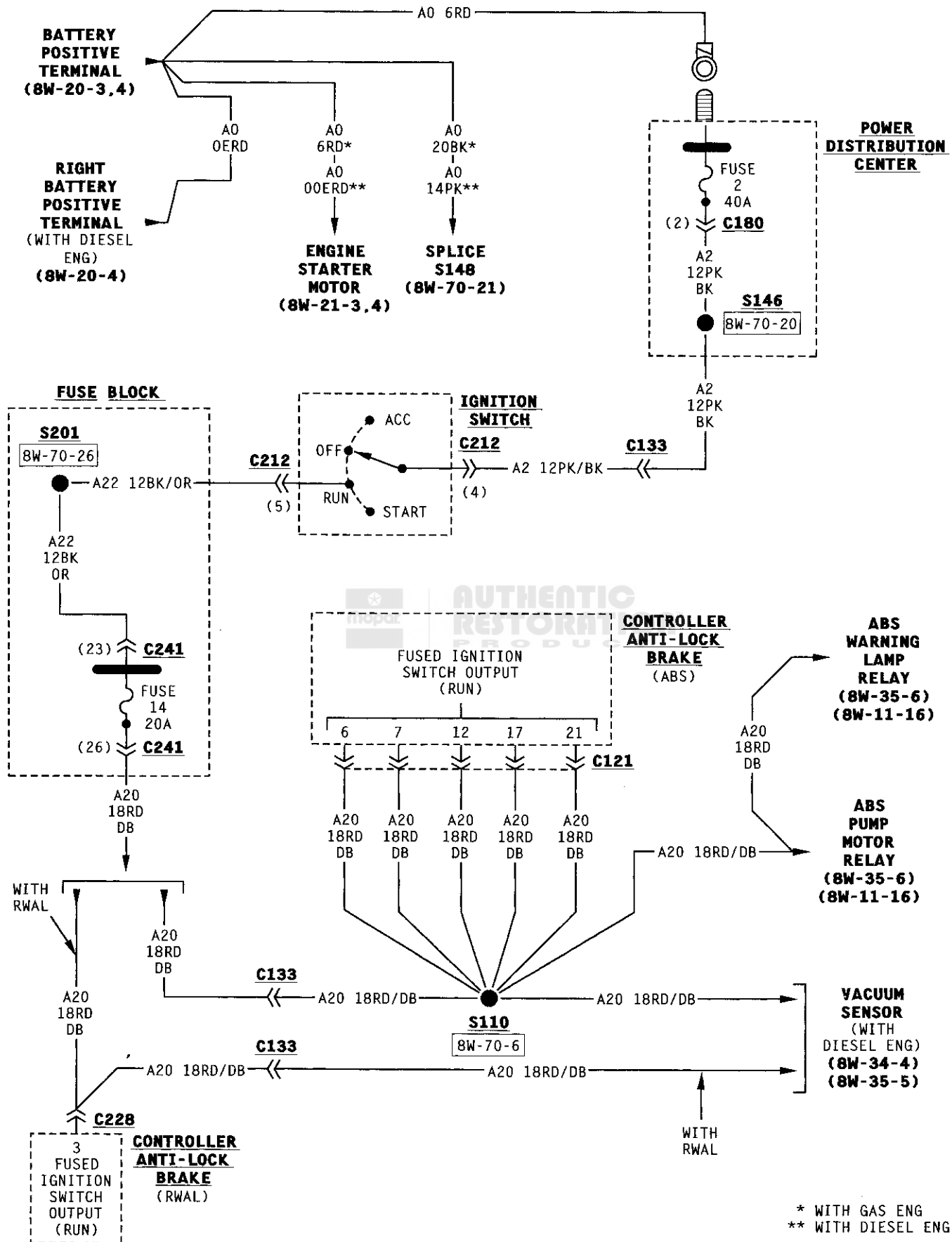
HAZARD WARNING FLASHER	CAV	CIRCUIT	FUNCTION	SECTION/PAGE
	3	L19 18PK/WT	HAZARD FLASHER OUTPUT	8W-52-3
	4	L9 18BK/VT	FUSED B(+)	8W-52-3

TIME DELAY RELAY	CAV	CIRCUIT	FUNCTION	SECTION/PAGE
	53	M2 22YL	COURTESY LAMPS DRIVER	8W-44-4,5
	54	M50 22YL/RD	KEY-IN LAMP DRIVER	8W-44-4,5
	55	M1 20PK	FUSED B(+)	8W-44-4,5

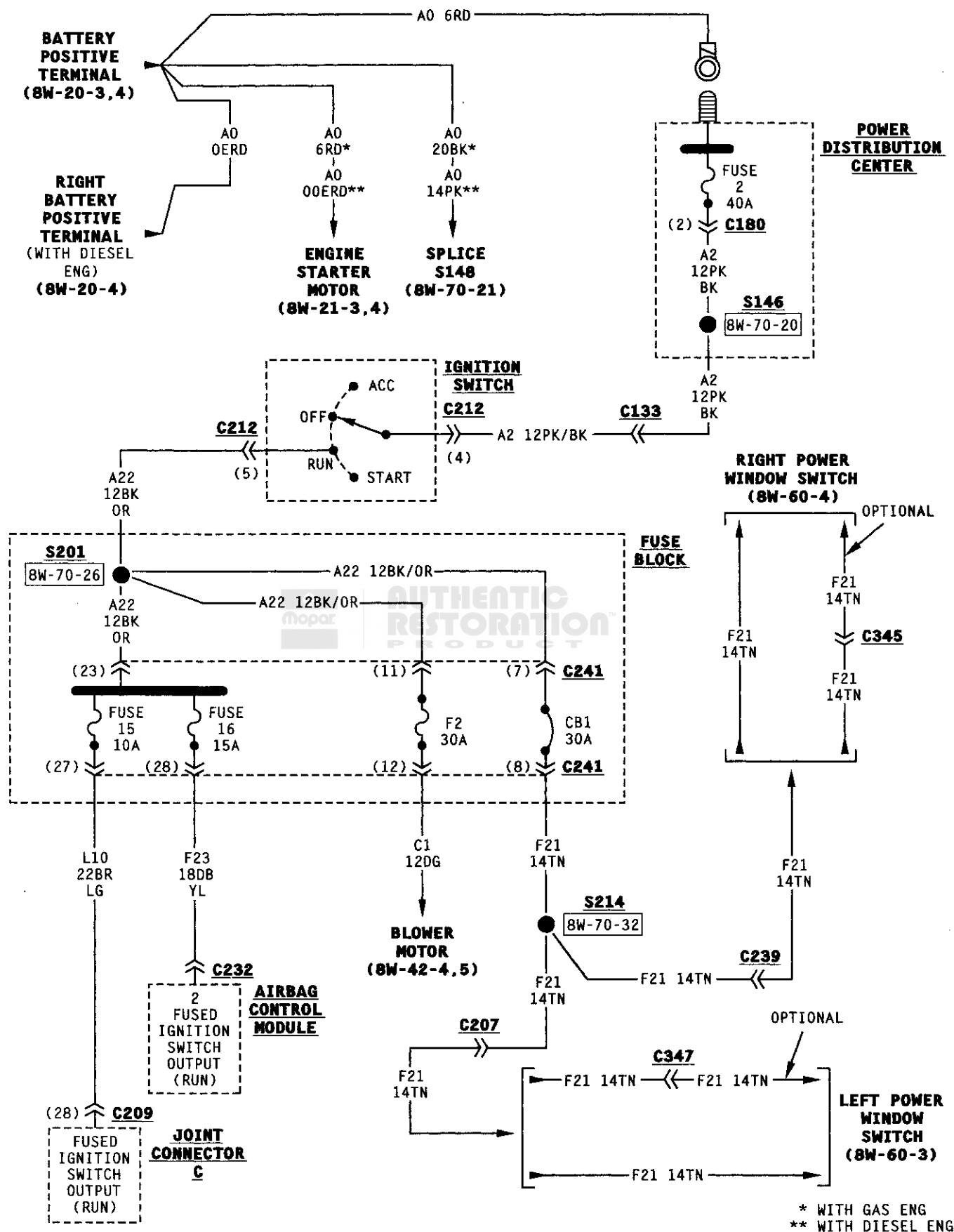


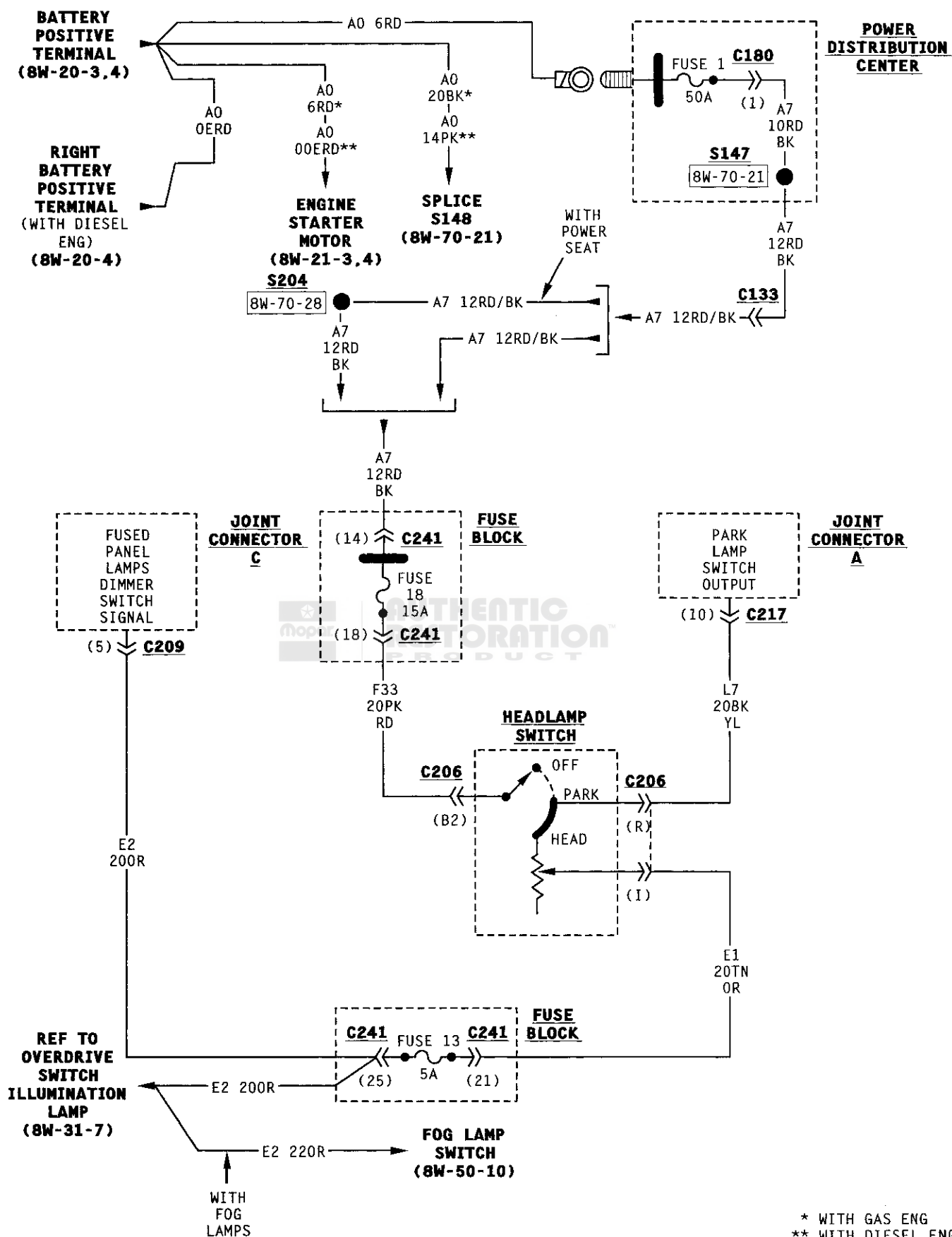


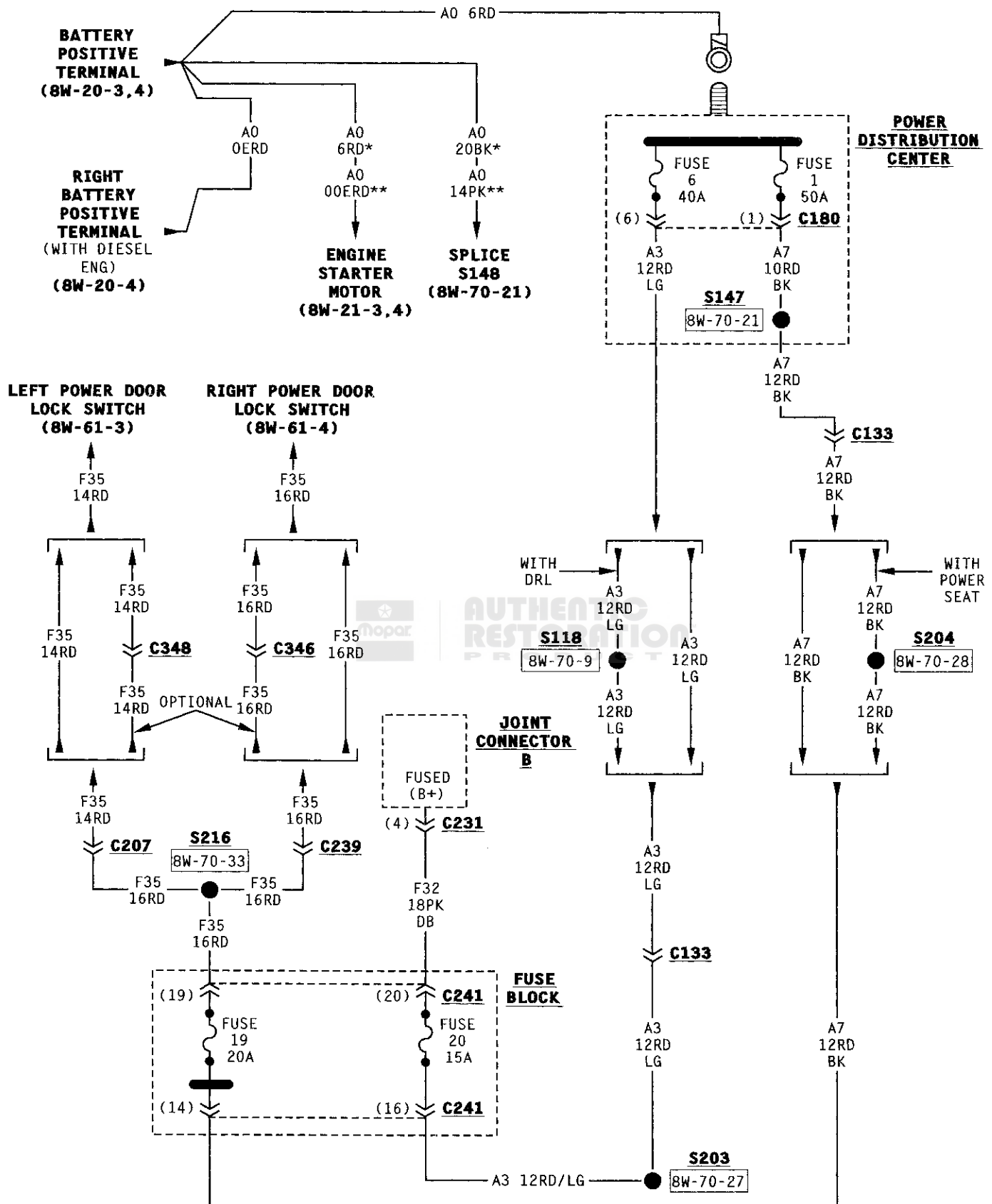




* WITH GAS ENG
 ** WITH DIESEL ENG







8W-11 POWER DISTRIBUTION

DESCRIPTION AND OPERATION

INTRODUCTION

This section covers the power distribution center and all circuits involved with it. For additional information on system operation, refer to the appropriate section of the wiring diagrams.

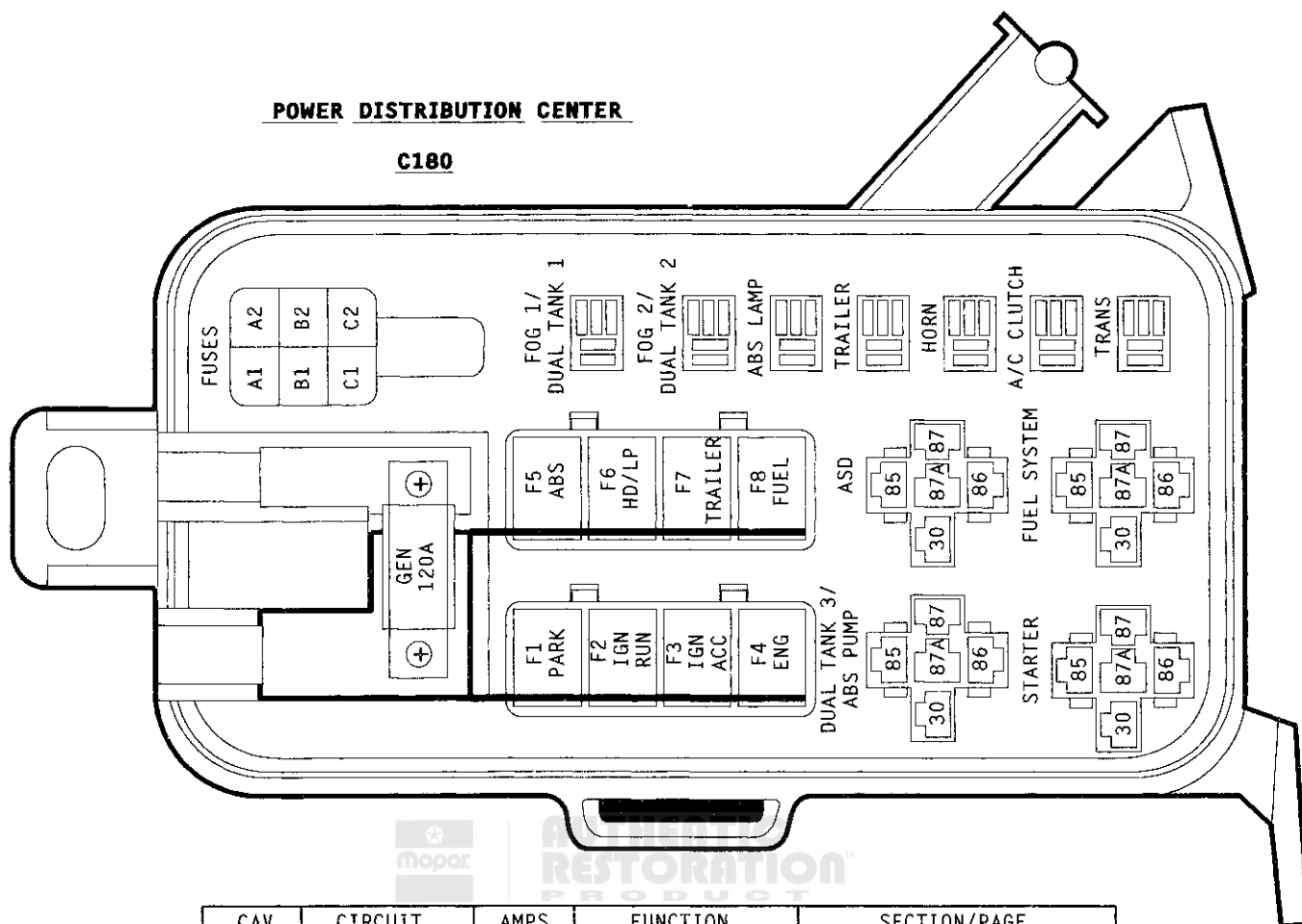


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Engine Starter Motor Relay	8W-11-17
Exhaust Gas Recirculation Solenoid	8W-11-11
Fog Lamp Relay No. 1	8W-11-13, 14
Fog Lamp Relay No. 2	8W-11-12
Fuel Pump Relay	8W-11-11
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Fuse 2 (PDC)	8W-11-15, 17, 18
Fuse 3 (PDC)	8W-11-8, 9, 10, 11, 17, 19, 20
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Fuse 6 (PDC)	8W-11-14
Fuse 7	8W-11-19
Fuse 7 (PDC)	8W-11-6
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Fuse 16	8W-11-18
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Fuse 19	8W-11-18
Fuse 20	8W-11-14
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Transmission Solenoid Assembly	8W-11-9

POWER DISTRIBUTION CENTER**C180**

FUSE

CAV	CIRCUIT	AMPS	FUNCTION	SECTION/PAGE
1	A7 10RD/BK	50	FUSED B(+)	8W-11-7,8,12,13,18
2	A2 12PK/BK	40	FUSED B(+)	8W-11-15,17,18
3	A1 12RD	40	FUSED B(+)	8W-11-8,9,10,11,17,19,20
4	A16 14GY/WT	30	FUSED B(+)	8W-11-10
5	A10 12RD/DG	40	FUSED B(+)	8W-11-16
6	A3 12RD/LG	40	FUSED B(+)	8W-11-14
7	A6 12RD/TN	40	FUSED B(+)	8W-11-6
7	A6 12RD/TN	40	FUSED B(+)	8W-11-6
8	A14 16RD/WT	20	FUSED B(+)	8W-11-9,11
8	A14 16RD/WT	20	FUSED B(+)	8W-11-9,11

FUSE A

CAV	CIRCUIT	AMPS	FUNCTION	SECTION/PAGE
A1	A7 12RD/BK	15	FUSED B(+)	8W-11-12
A2	L38 20LB/BK		FUSED B(+)	8W-11-12

FUSE B

CAV	CIRCUIT	AMPS	FUNCTION	SECTION/PAGE
B1	A7 12RD/BK	20	FUSED B(+)	8W-11-7,8
B2	F31 18VT		FUSED B(+)	8W-11-7,8

FUSE C

CAV	CIRCUIT	AMPS	FUNCTION	SECTION/PAGE
C1	A15 16PK	15	FUSED B(+)	8W-11-18
C2	L9 18BK/VT		FUSED B(+)	8W-11-18

FUSE
(GEN)

CAV	CIRCUIT	AMPS	FUNCTION	SECTION/PAGE
-	A11 6BK/GY	120	FUSED B(+)	8W-11-19

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J968W-9

ENGINE
STARTER
MOTOR
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A2 12PK/BK	FUSED B(+)	8W-11-17
85	T41 22BK/WT	ENGINE STARTER MOTOR RELAY CONTROL	8W-11-17
86	T141 14YL/RD	ENGINE STARTER MOTOR DRIVER	8W-11-17
87	T40 12BR	ENGINE STARTER MOTOR RELAY OUTPUT	8W-11-17

ABS
PUMP
MOTOR
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A10 12RD/DG	FUSED B(+)	8W-11-16
85	B116 20GY	ABS PUMP MOTOR RELAY CONTROL	8W-11-16
86	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)	8W-11-16
	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)	8W-11-16
87	B120 12BR/WT	ABS PUMP MOTOR RELAY OUTPUT	8W-11-16

ABS
WARNING
LAMP
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	G19 20LG/RD	ABS WARNING LAMP RELAY OUTPUT	8W-11-16
85	B47 20RD/LB	ABS WARNING LAMP RELAY CONTROL	8W-11-16
86	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)	8W-11-16
A87	Z1 20BK	GROUND	8W-11-16

FUEL
PUMP
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A14 16RD/WT	FUSED B(+)	8W-11-11
	A14 16RD/WT	FUSED B(+)	8W-11-11
85	K31 20BR/WT	FUEL PUMP RELAY CONTROL	8W-11-11
86	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)	8W-11-11
87	A61 16DG/BK	FUEL PUMP RELAY OUTPUT	8W-11-11

AUTOMATIC
SHUT DOWN
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A16 14GY/WT	FUSED B(+)	8W-11-10
85	K51 22DB/YL	AUTO SHUT DOWN RELAY CONTROL	8W-11-10
86	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)	8W-11-10
	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)	8W-11-10
87	A142 14DG/OR	AUTO SHUT DOWN RELAY SENSE	8W-11-10

A/C
COMPRESSOR
CLUTCH
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	F31 20VT	FUSED B(+)	8W-11-8
85	C13 22DB/OR	A/C COMPRESSOR CLUTCH RELAY CONTROL	8W-11-8
86	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)	8W-11-8
87	C3 18DB/BK	A/C COMPRESSOR CLUTCH RELAY OUTPUT	8W-11-8

HORN
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	F31 20VT	FUSED B(+)	8W-11-7
85	X3 22BK/RD	HORN RELAY CONTROL	8W-11-7
86	F31 20VT	FUSED B(+)	8W-11-7
87	X2 18DG/RD	HORN RELAY OUTPUT	8W-11-7
	X2 18DG/RD	HORN RELAY OUTPUT	8W-11-7

TRAILER
TOW
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A6 12RD/TN	FUSED B(+)	8W-11-6
85	Z1 20BK	GROUND	8W-11-6
86	L7 20BK/YL	PARK LAMP SWITCH OUTPUT	8W-11-6
87	L76 12BK/OR	TRAILER TOW RELAY OUTPUT	8W-11-6

TRANSMISSION
RELAY

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	A14 16RD/WT	FUSED B(+)	8W-11-9
85	K30 20PK	TRANSMISSION RELAY CONTROL	8W-11-9
86	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)	8W-11-9
87	T16 18RD	TRANSMISSION CONTROL RELAY OUTPUT	8W-11-9

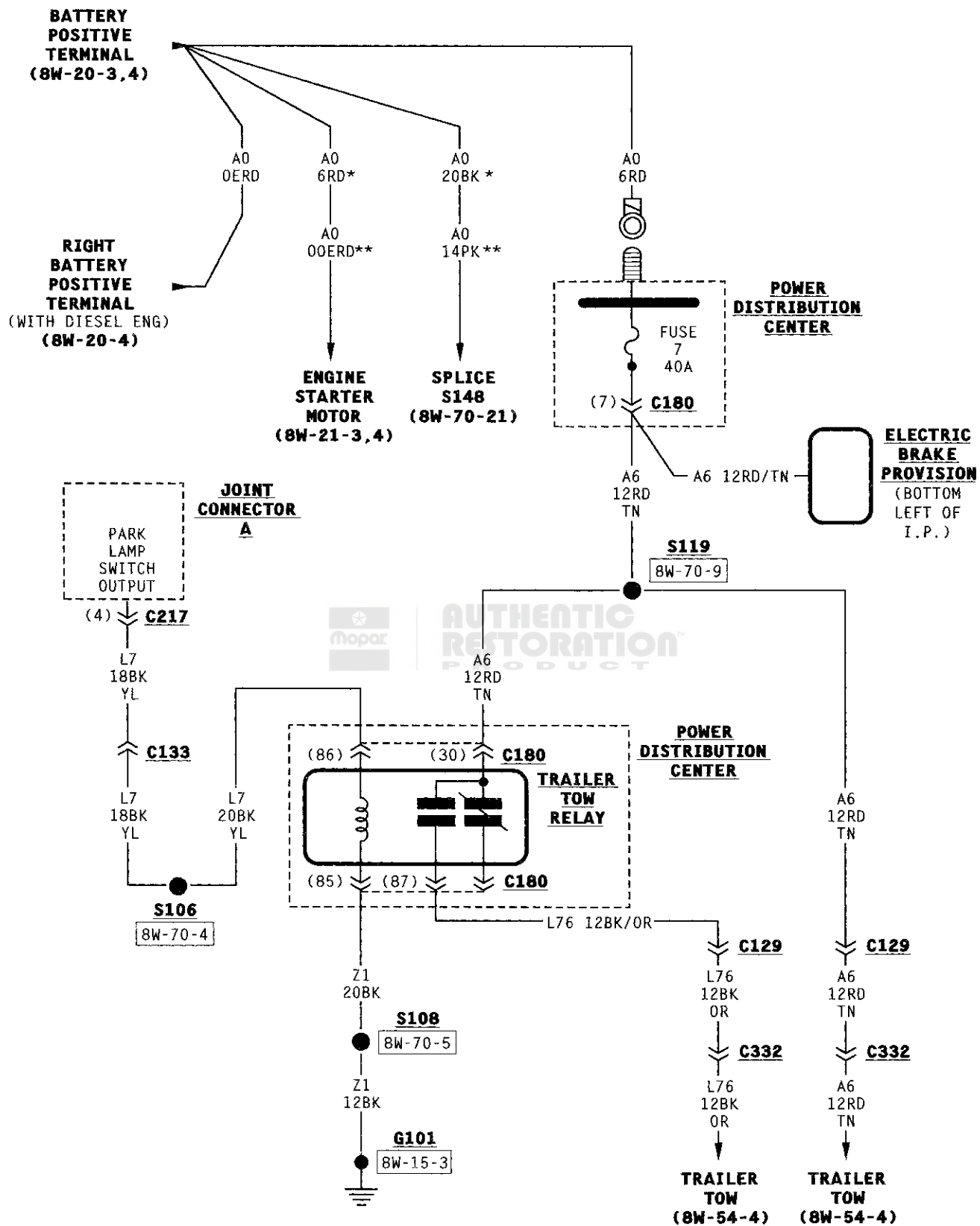
FOG
LAMP
RELAY
NO. 1

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	L7 20BK/YL	PARK LAMP SWITCH OUTPUT	8W-11-13,14
85	Z1 18BK	GROUND	8W-11-13,14
86	G34 18RD/GY*	HIGH BEAM INDICATOR LAMP DRIVER	8W-11-13,14
	L3 16RD/OR**	DIMMER SWITCH HIGH BEAM OUTPUT	8W-11-13,14
A87	L139 20LB/WT	FOG LAMP RELAY OUTPUT	8W-11-13,14

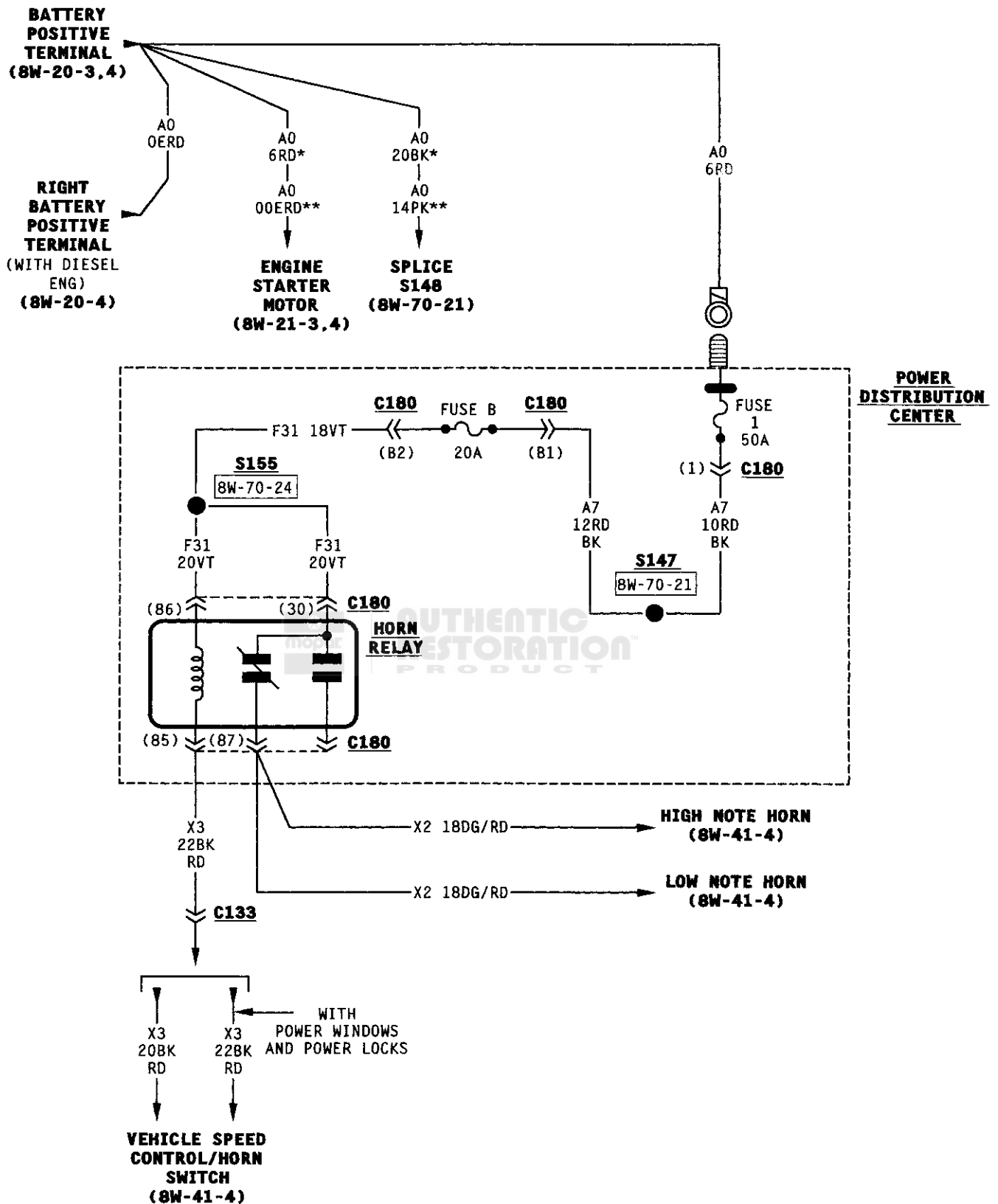
FOG
LAMP
RELAY
NO. 2

CAV	CIRCUIT	FUNCTION	SECTION/PAGE
30	L39 20LB	FRONT FOG LAMP SWITCH OUTPUT	8W-11-12
85	L35 22BR/WT	FOG LAMP RELAY CONTROL	8W-11-12
86	L139 20LB/WT	FOG LAMP RELAY OUTPUT	8W-11-12
87	L38 20LB/BK	FUSED B(+)	8W-11-12

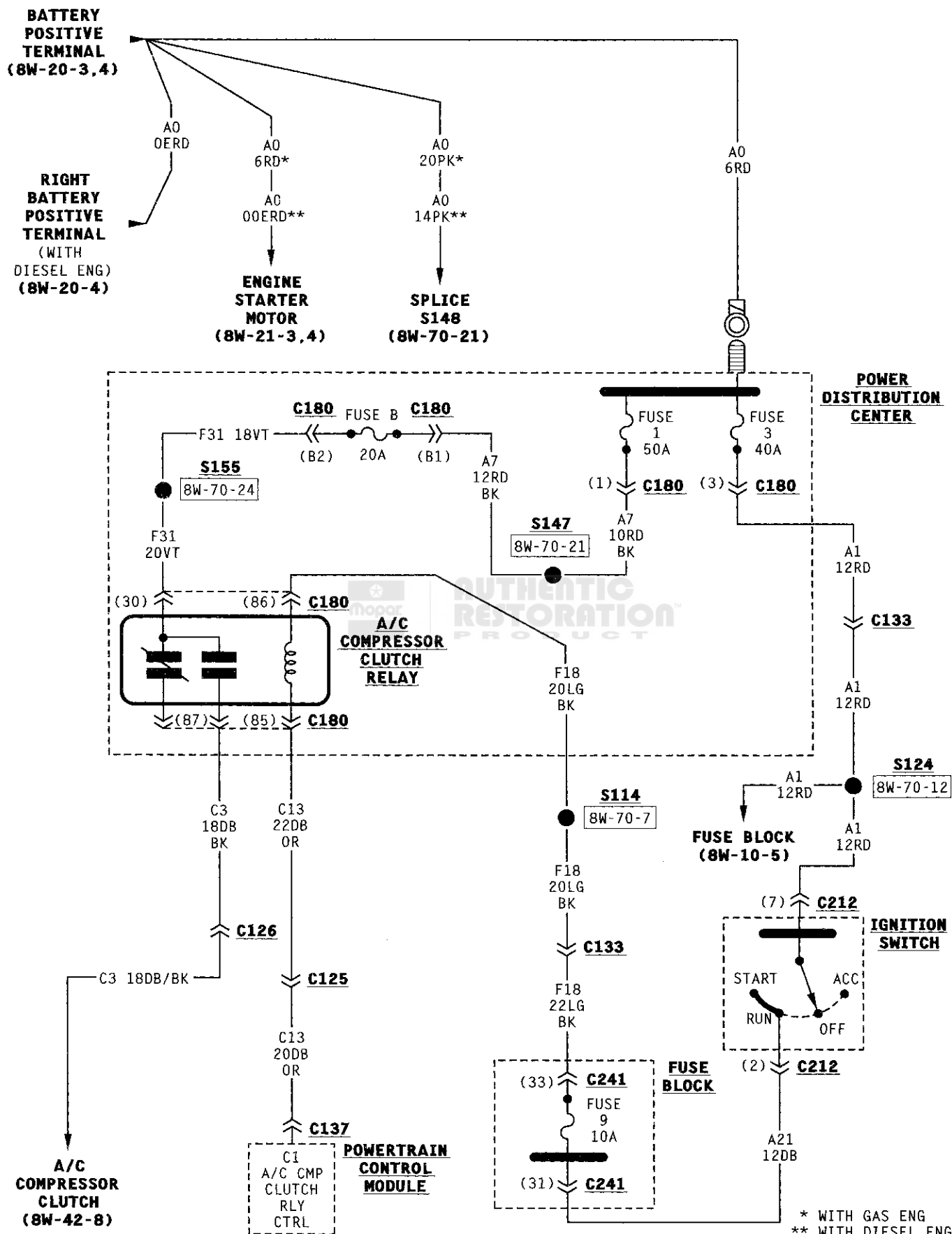
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** WITHOUT DRL



* WITH GAS ENG
 ** WITH DIESEL ENG

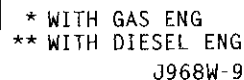


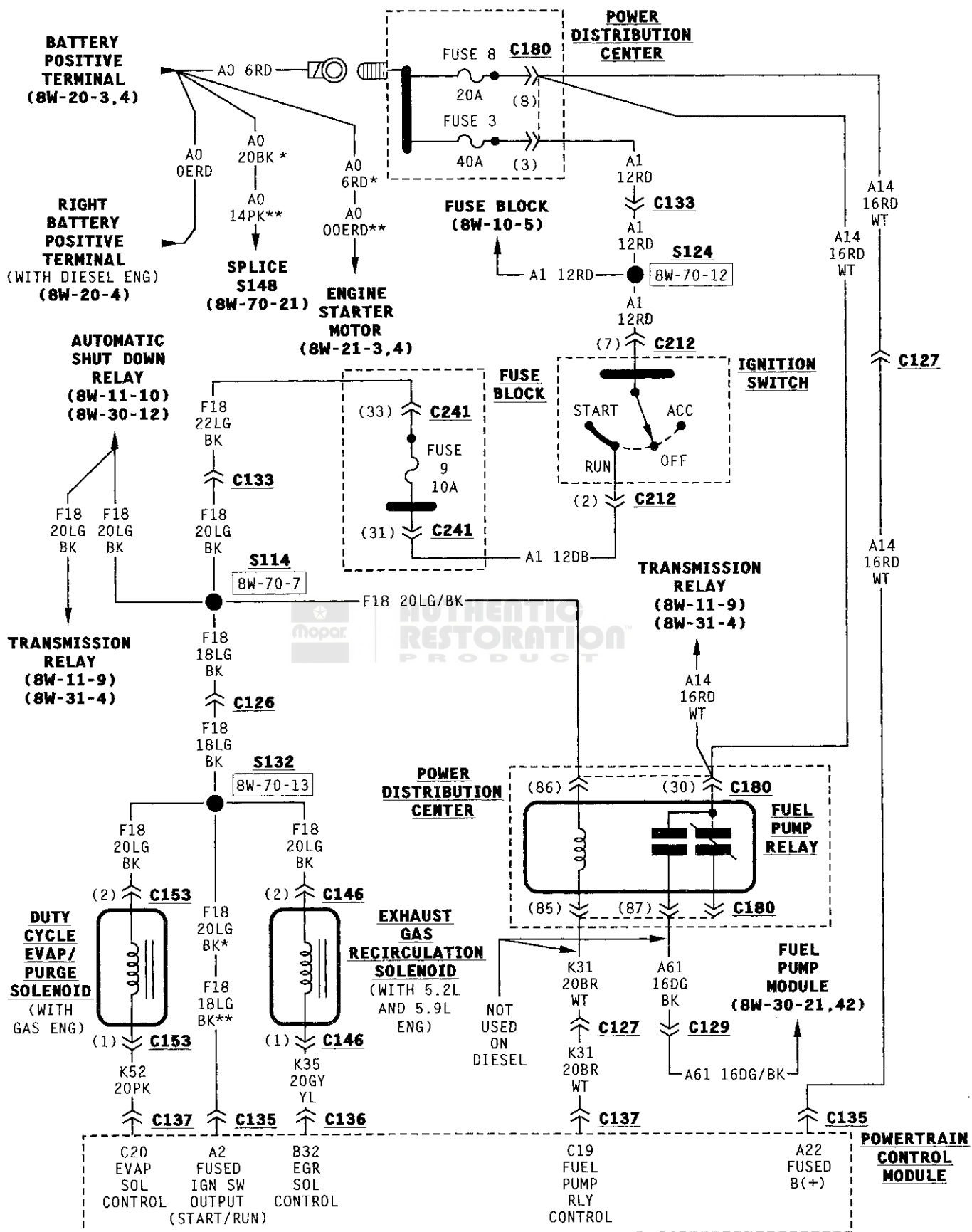
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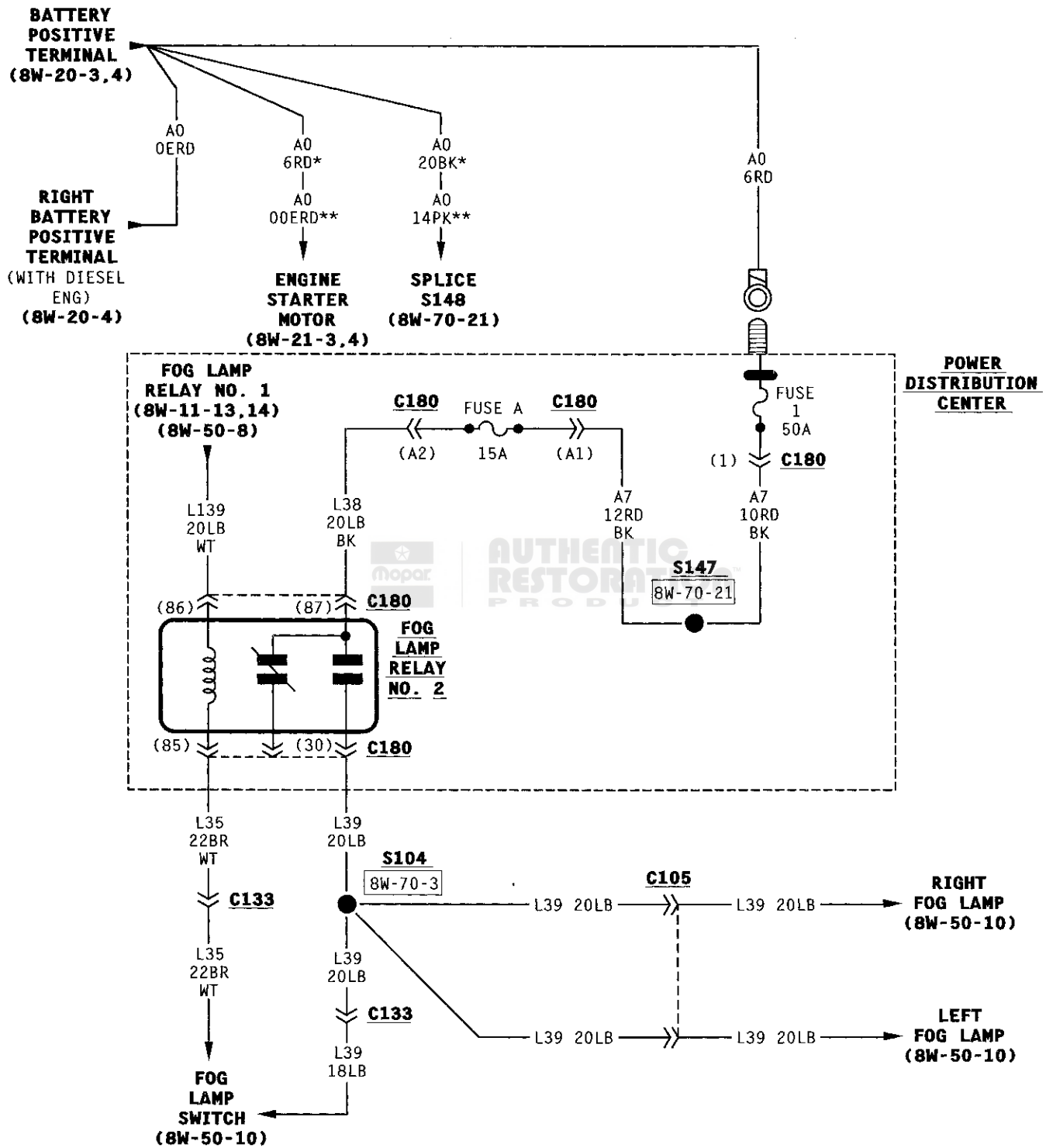
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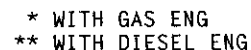


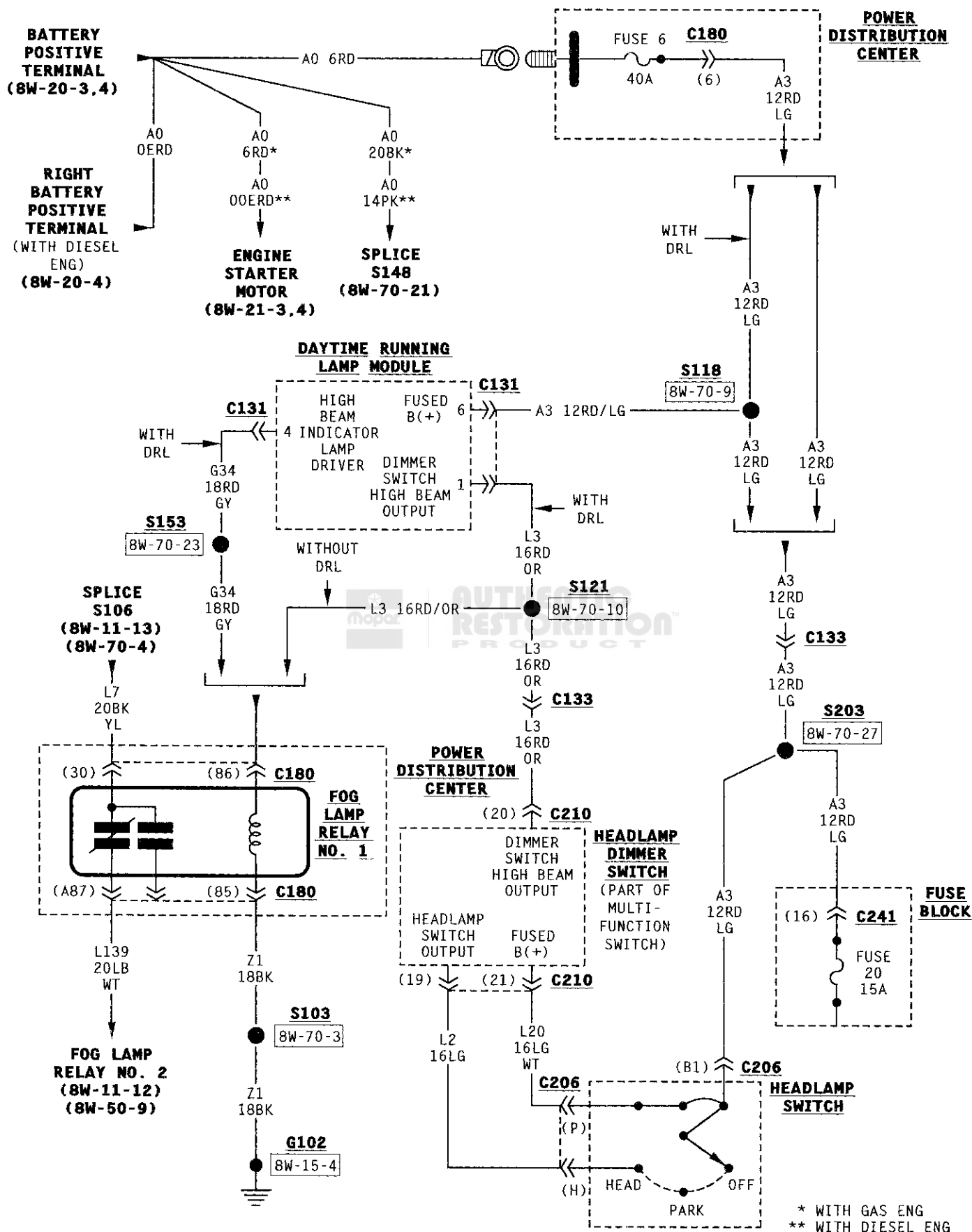


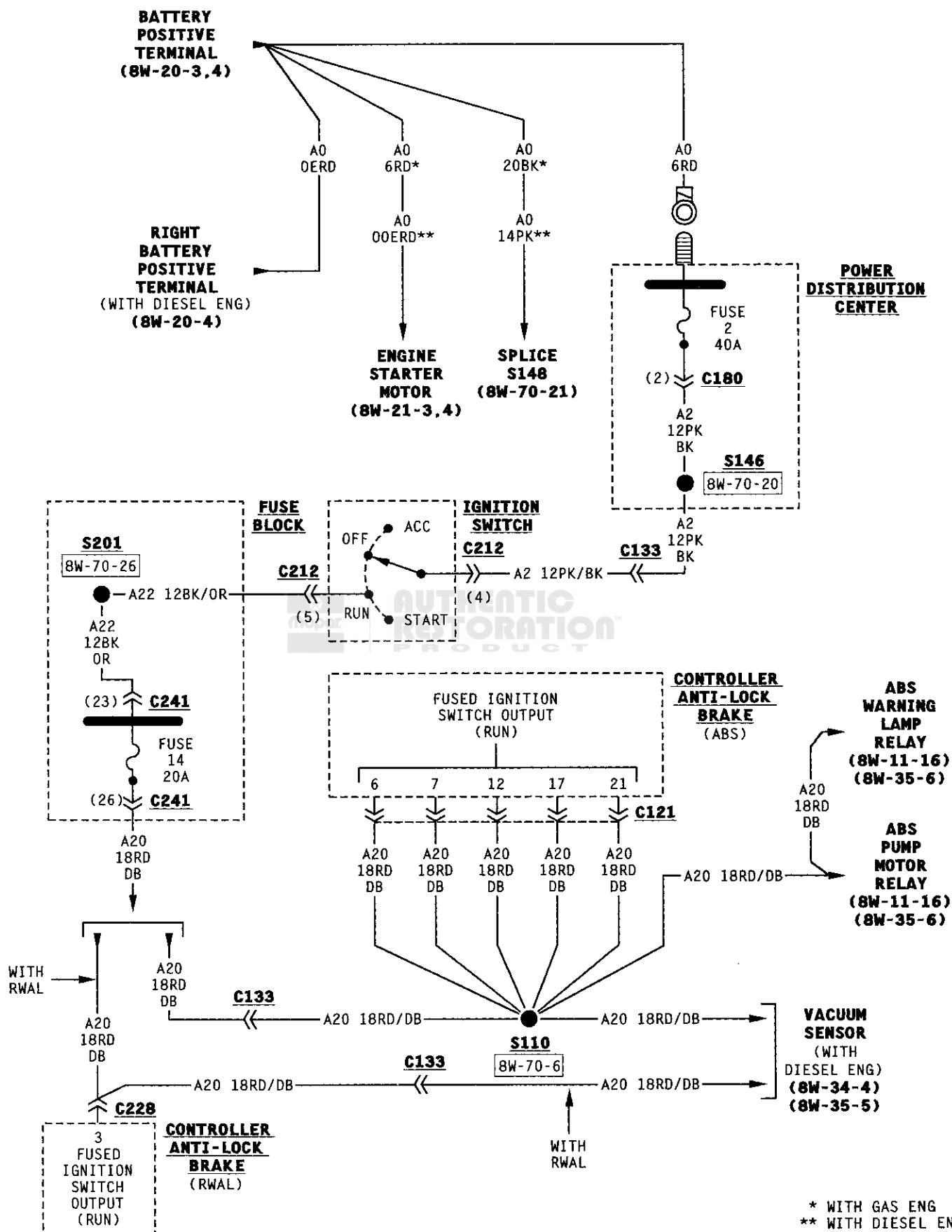
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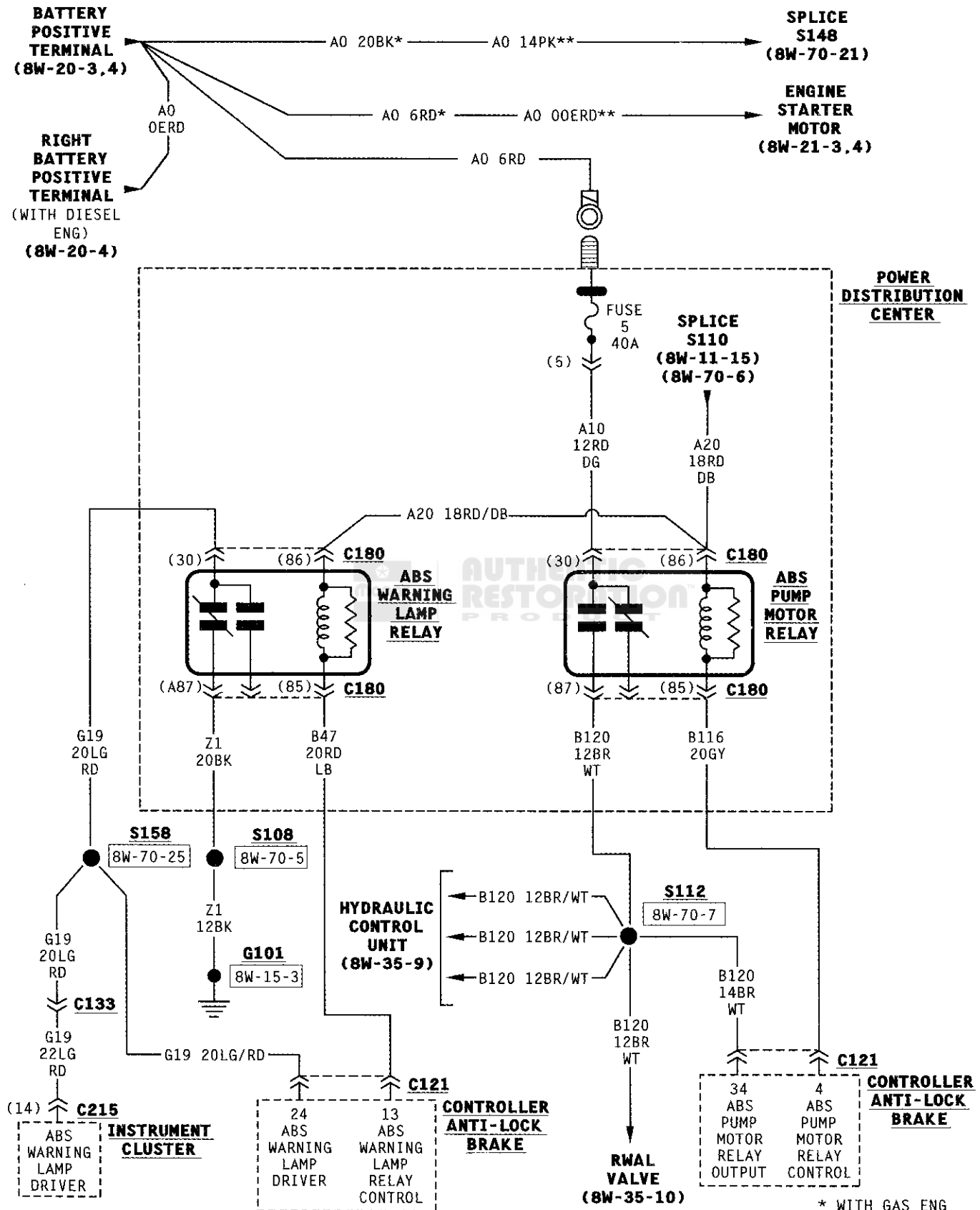
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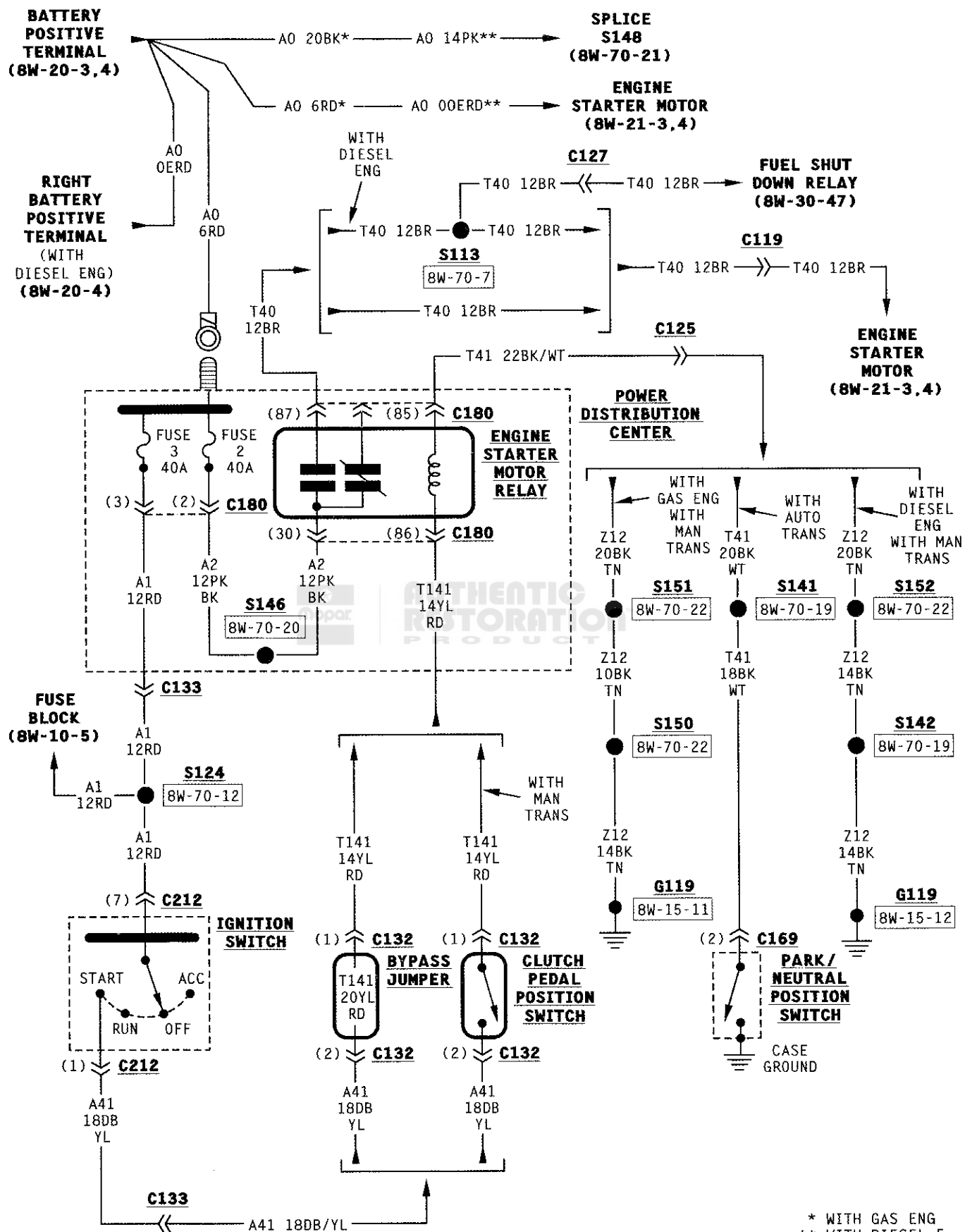




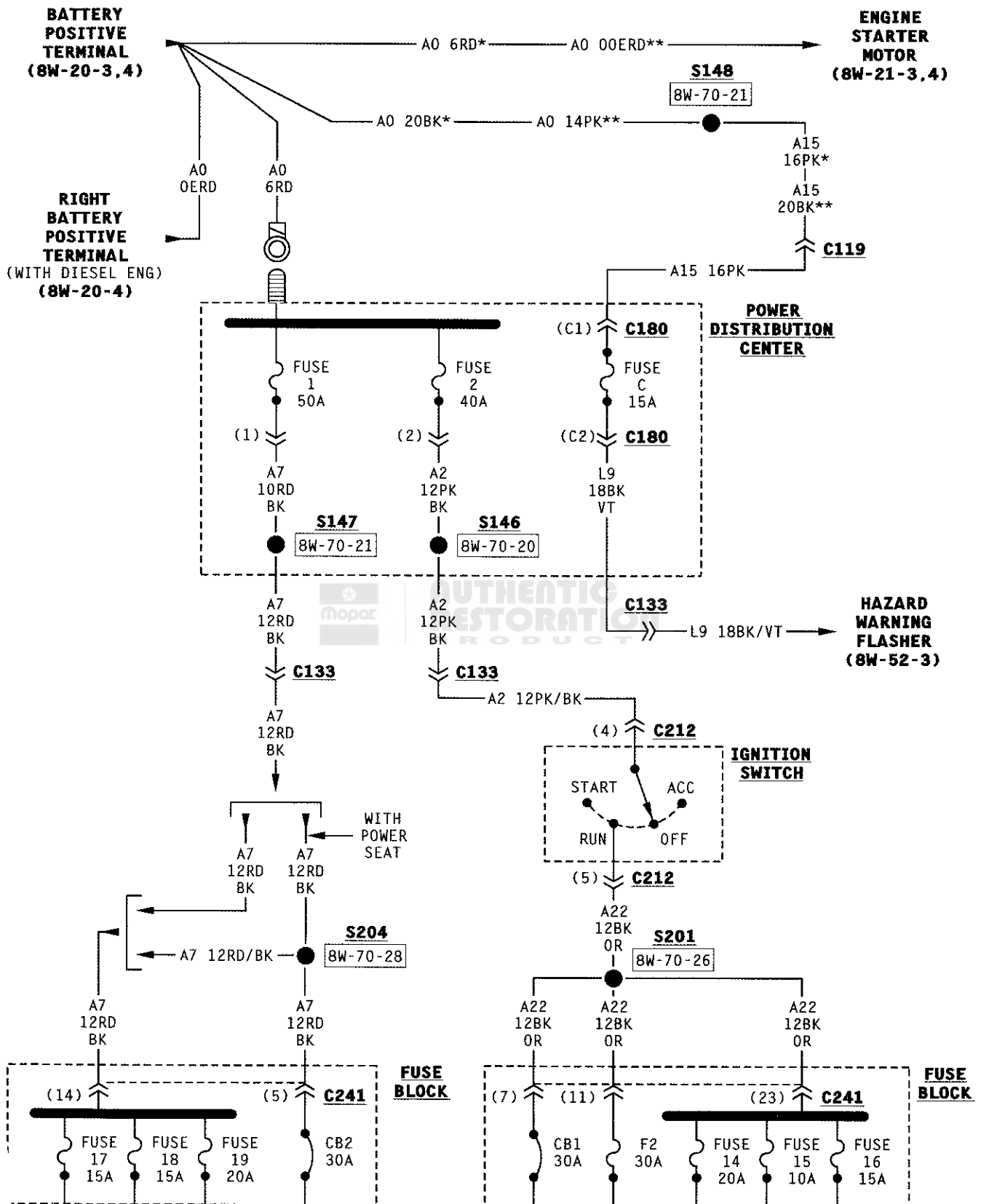
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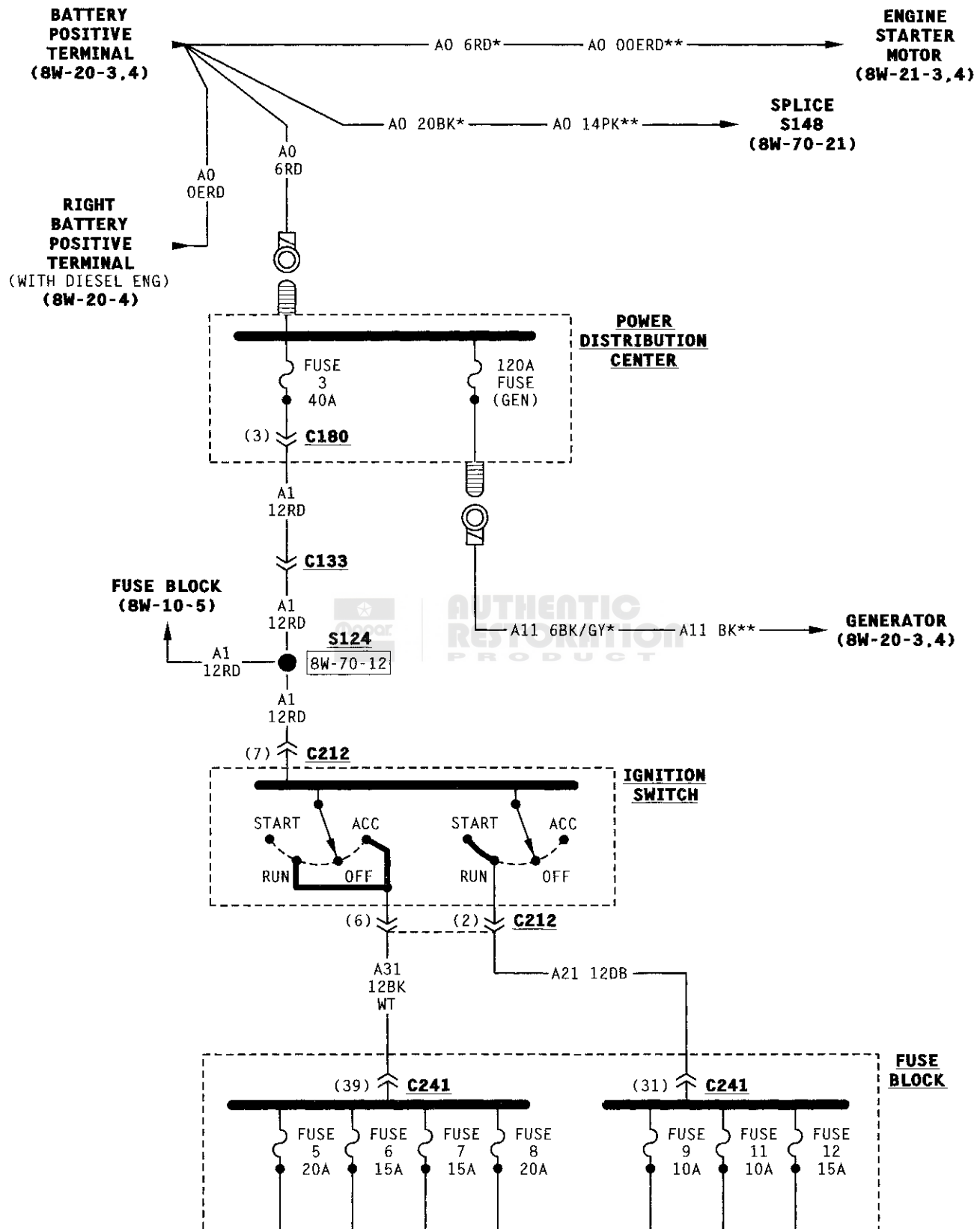
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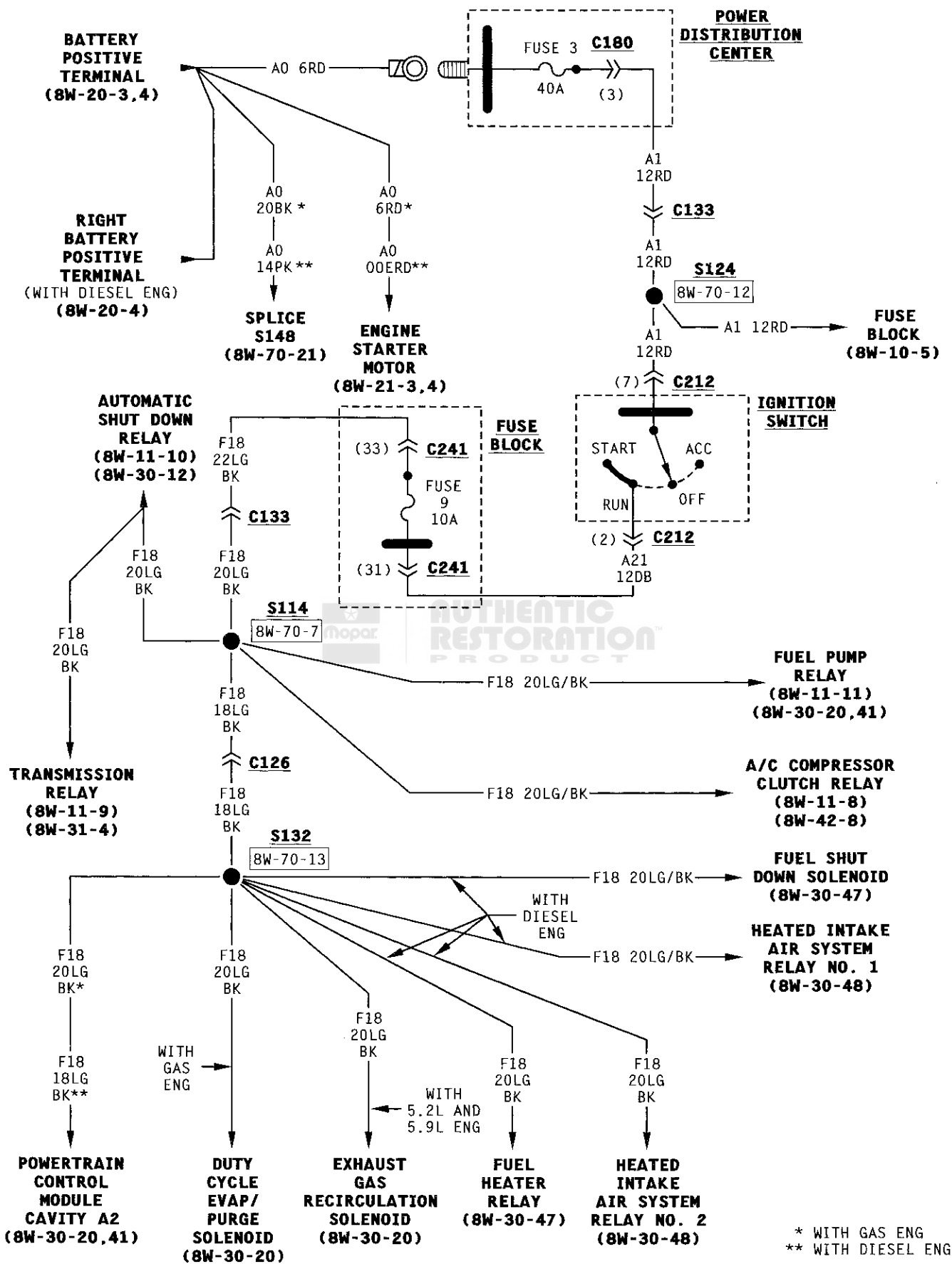
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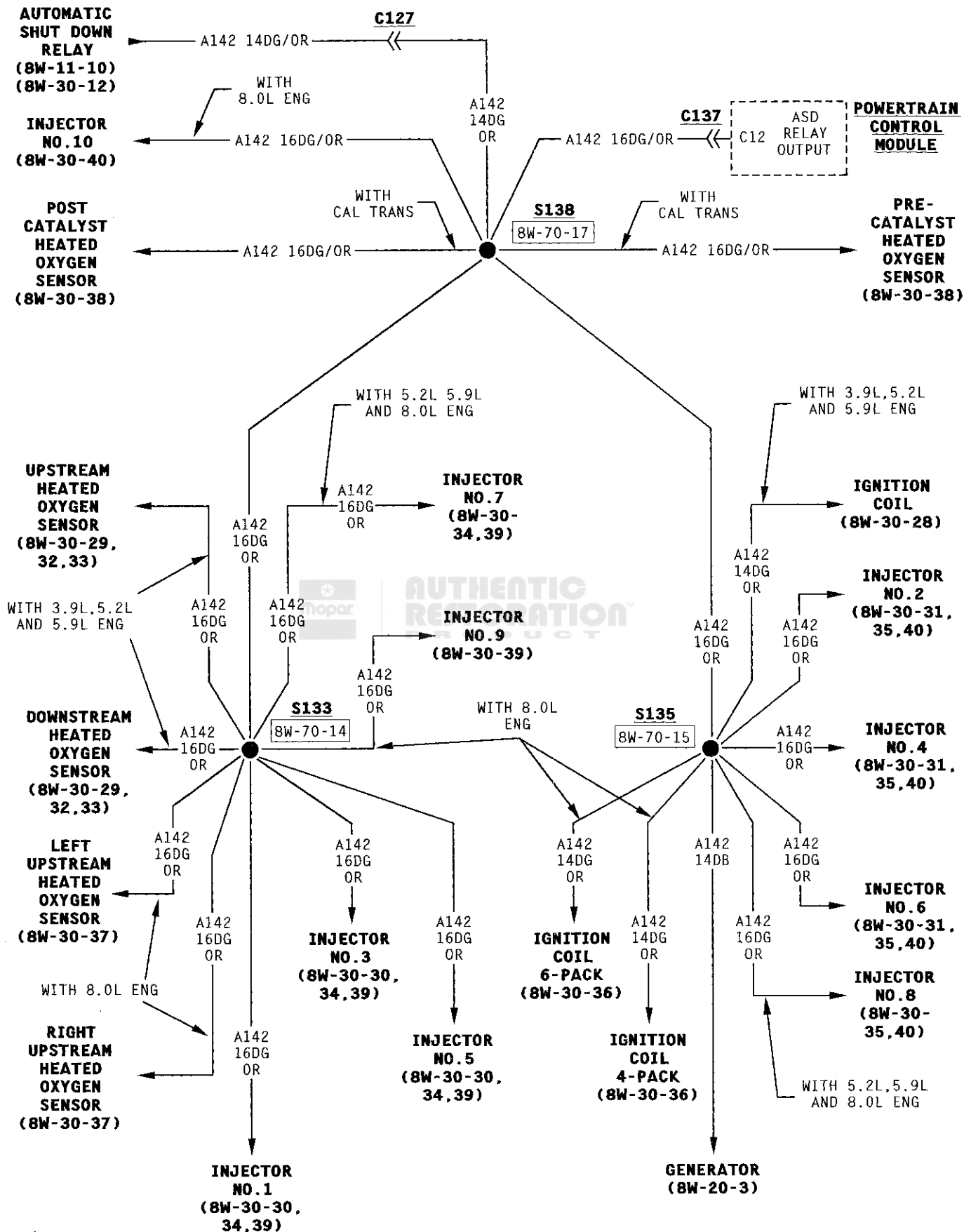
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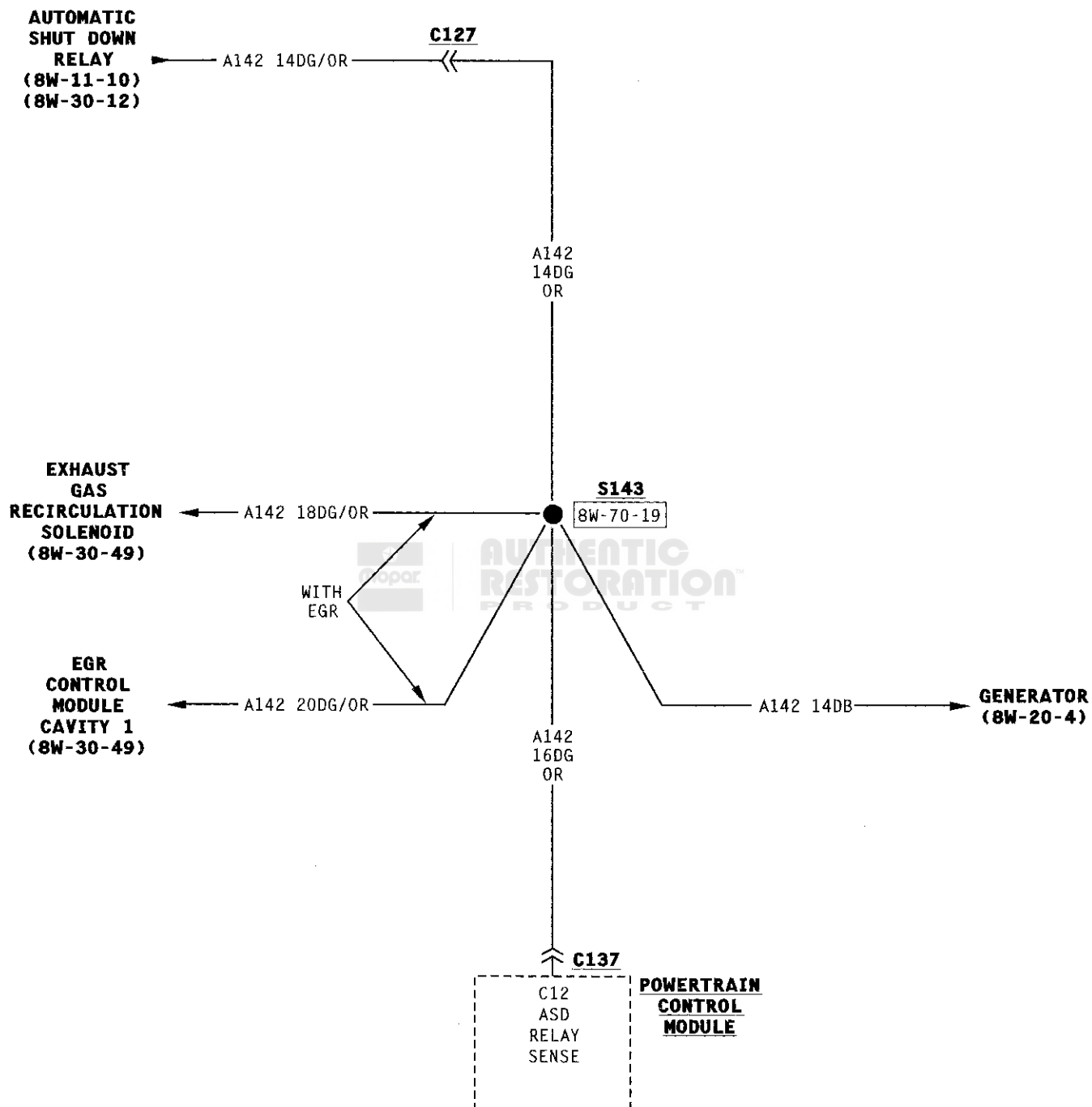


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** WITH DIESEL ENG





8W-12 JOINT CONNECTORS

DESCRIPTION AND OPERATION

INTRODUCTION

This section identifies the internal circuitry of the joint connectors. For additional information on system operation, refer to the appropriate section of the wiring diagrams.

WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.



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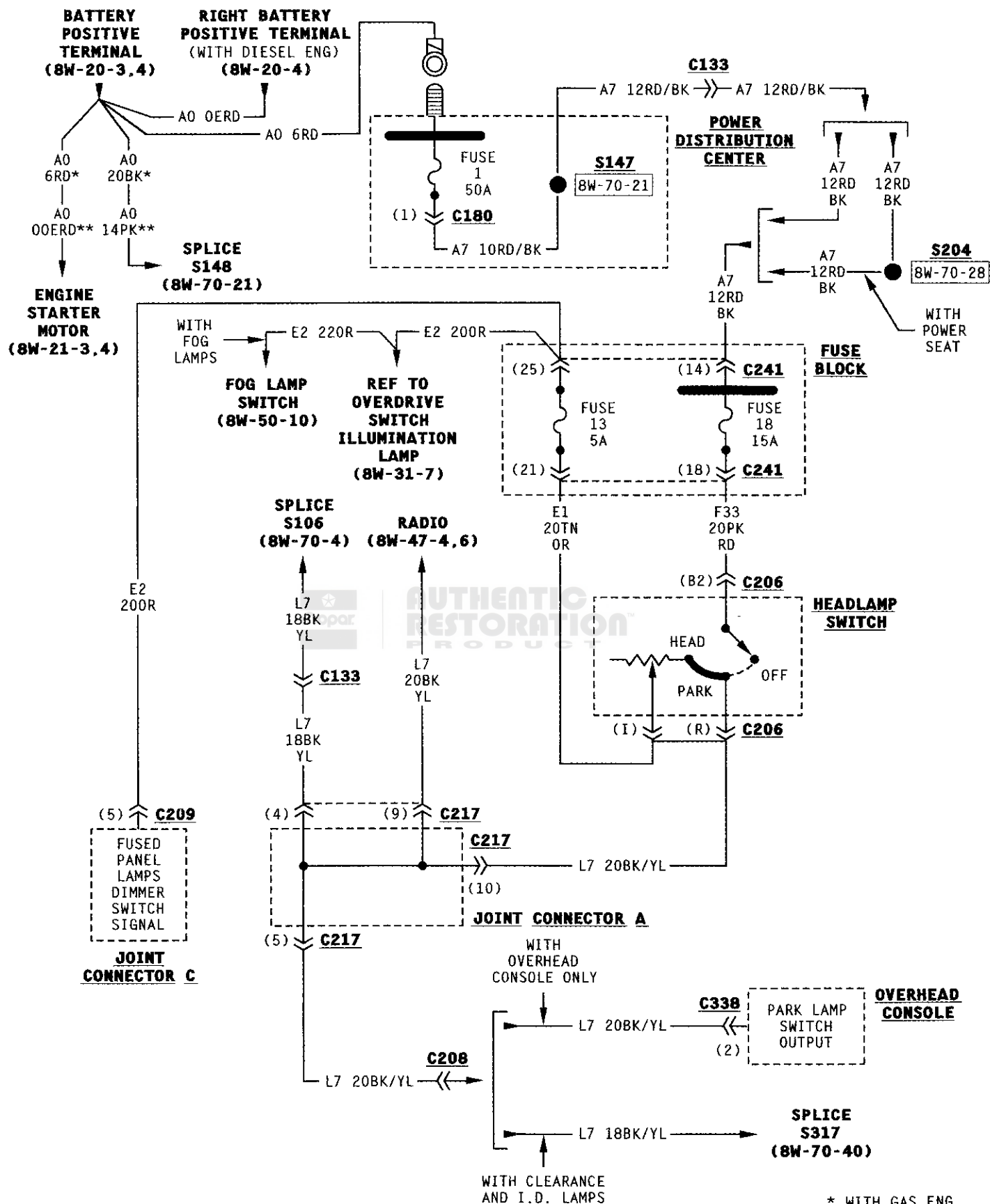
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Component	Page
Controller Anti-Lock Brake	8W-12-5, 7, 8, 10
Daytime Running Lamp Module	8W-12-7
Fuse 1 (PDC)	8W-12-3, 6
Fuse 2 (PDC)	8W-12-9
Fuse 3 (PDC)	8W-12-7
Fuse 6 (PDC)	8W-12-5
Fuse 11	8W-12-7
Fuse 13	8W-12-3, 6
Fuse 15	8W-12-9
Fuse 17	8W-12-5
Fuse 18	8W-12-3, 6

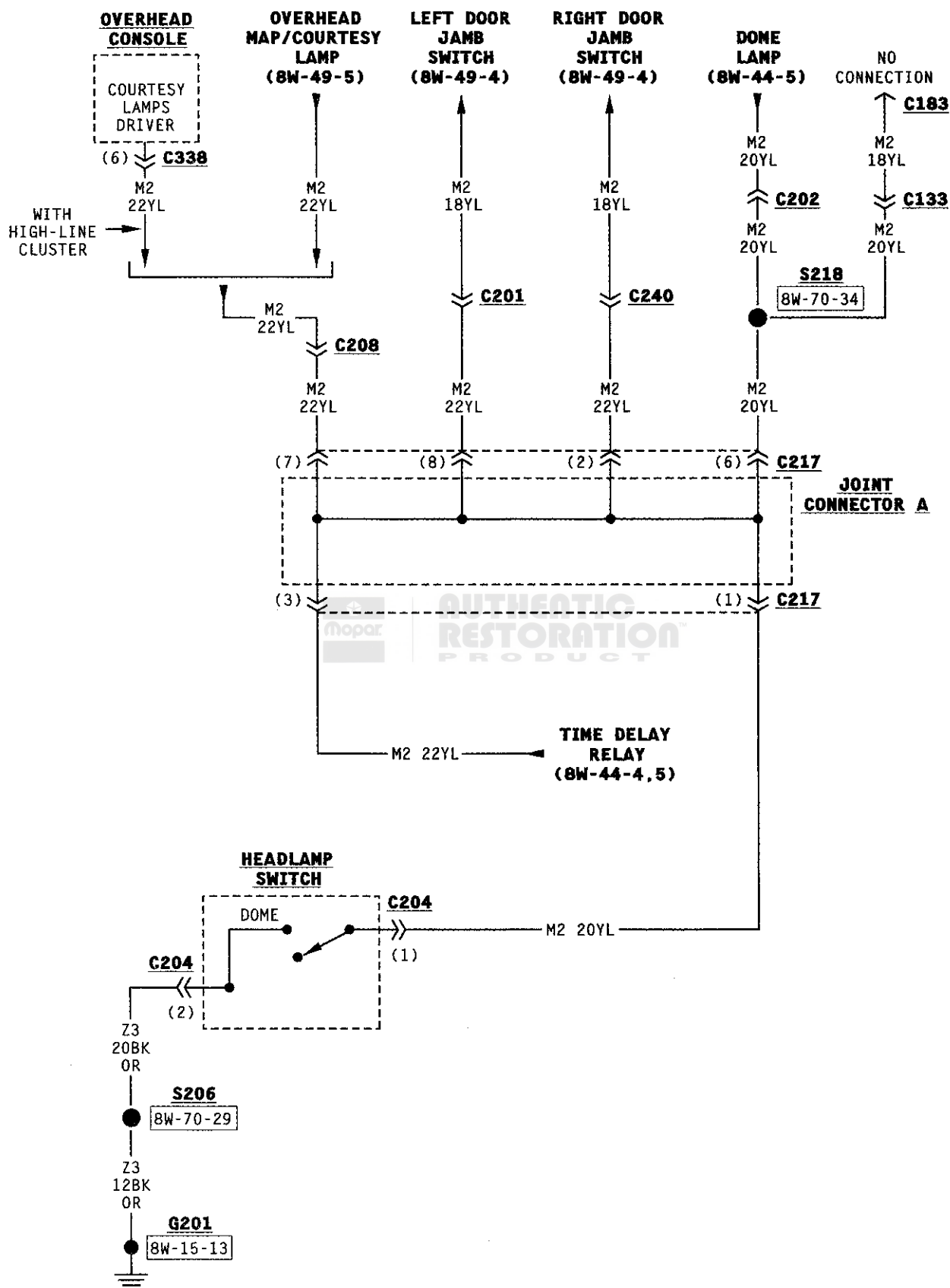
Component	Page
Fuse 20	8W-12-5
Headlamp Switch	8W-12-3, 4, 6, 8
Ignition Switch	8W-12-7, 9, 10
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Joint Connector C	8W-12-3, 6, 7, 8, 9, 10
Overhead Console	8W-12-3, 4, 6, 7
Park Brake Switch	8W-12-7
Powertrain Control Module	8W-12-6, 8

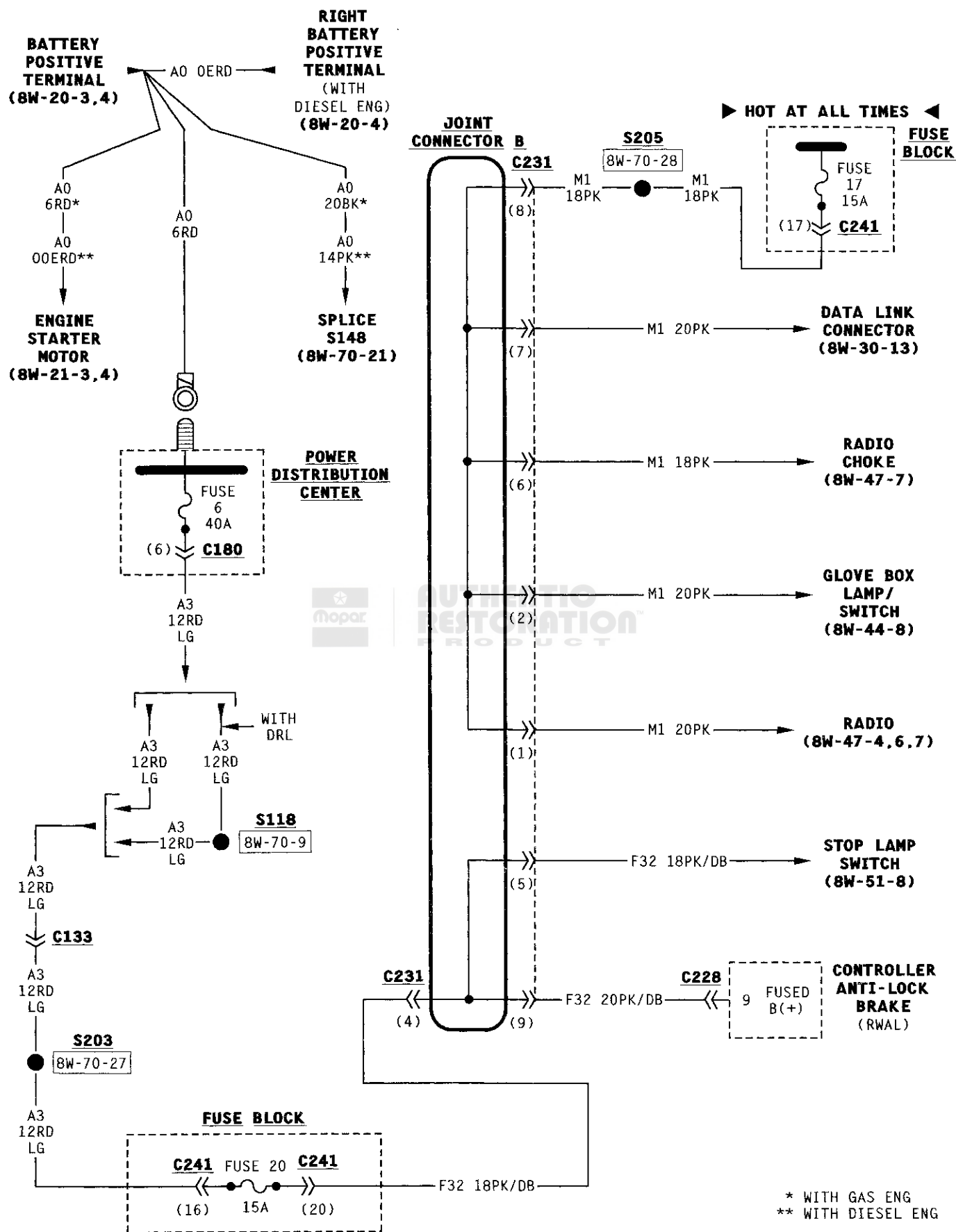


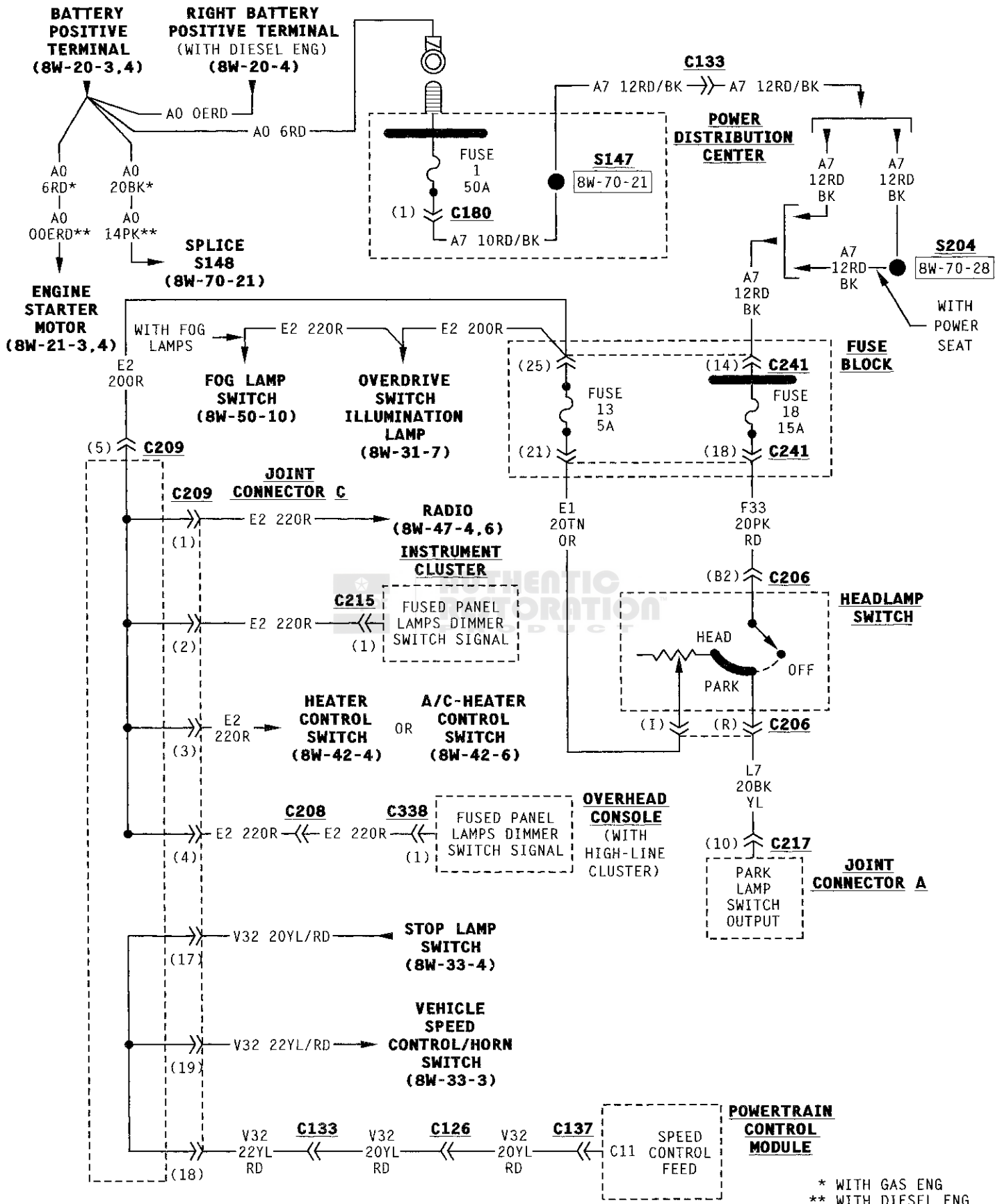
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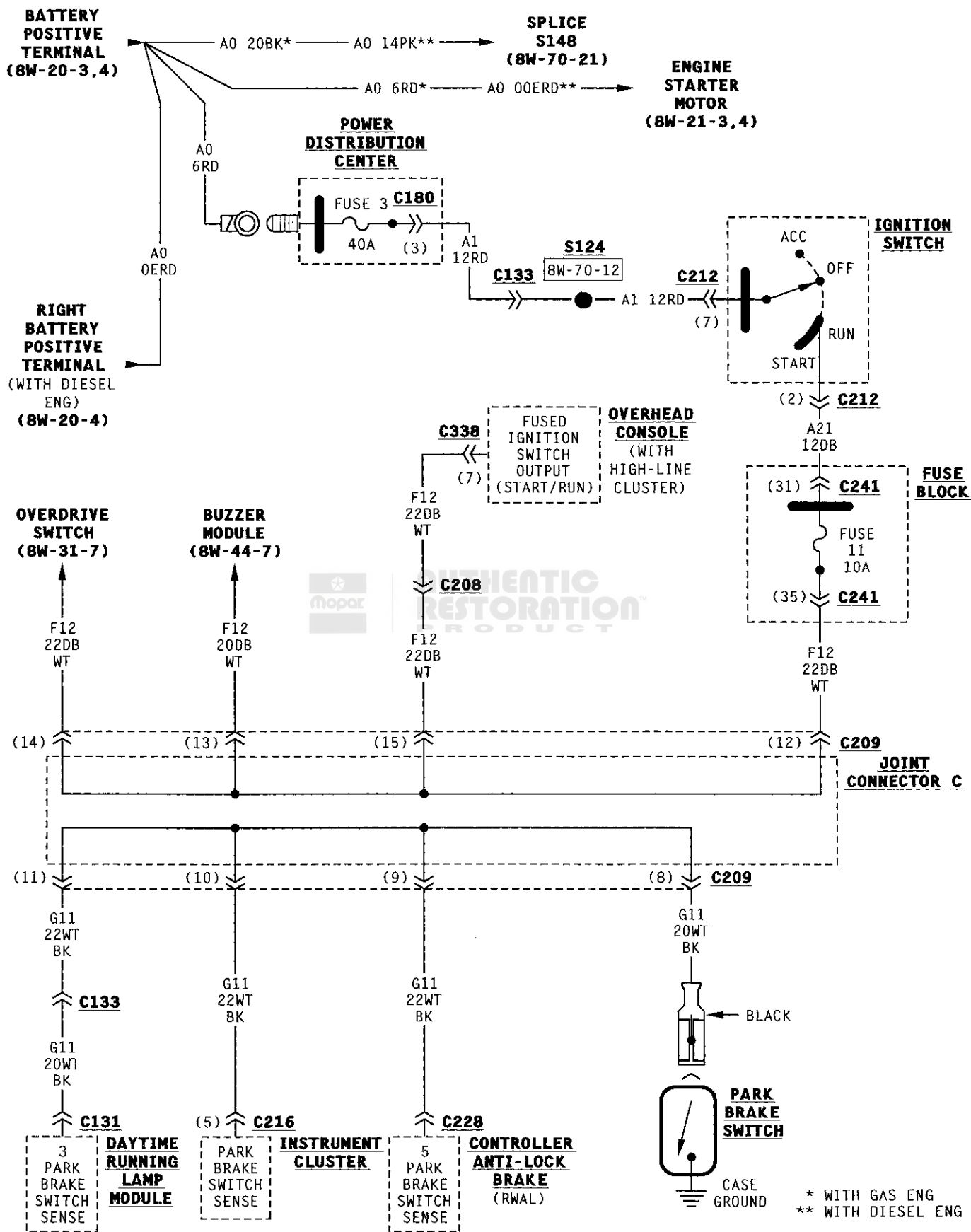
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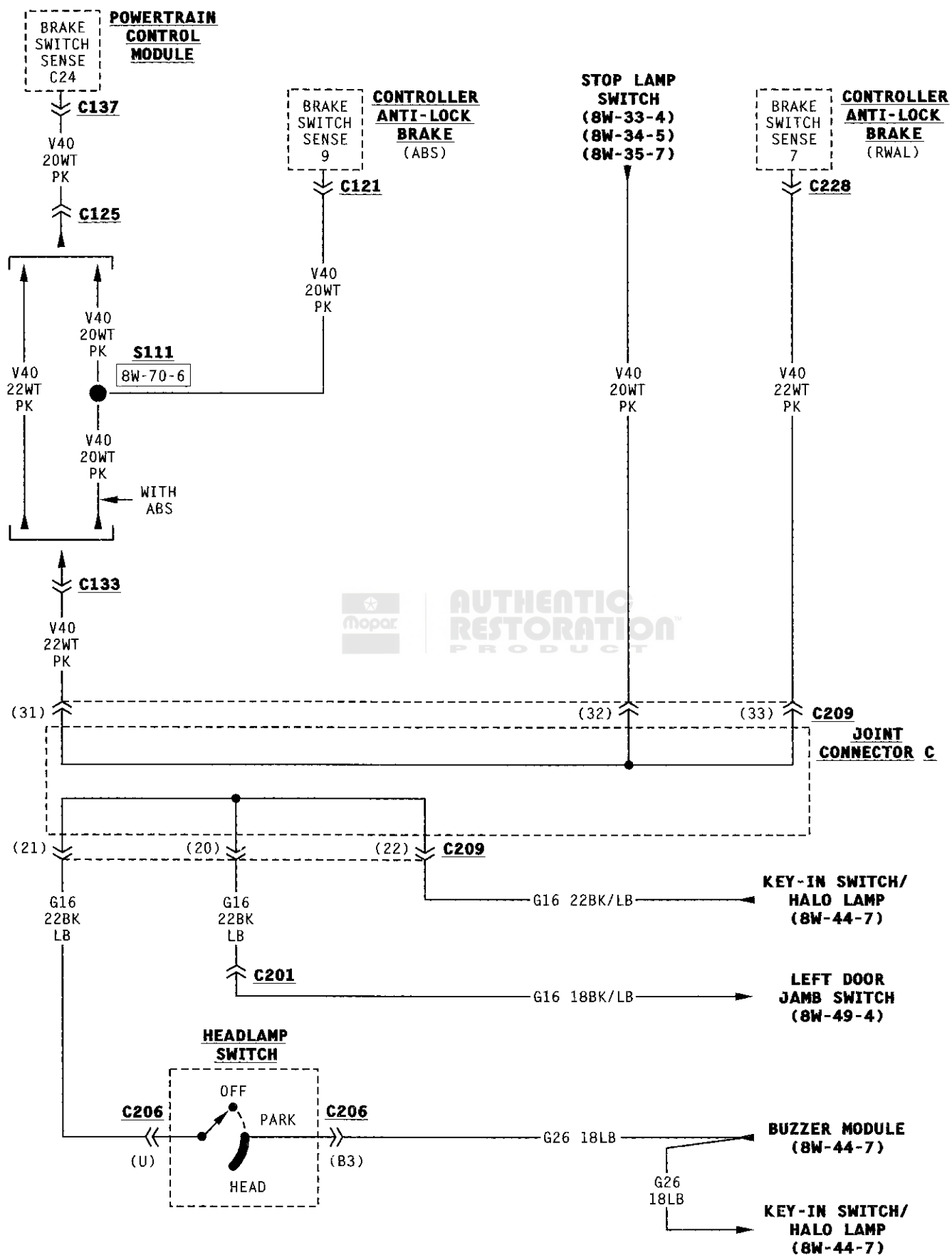


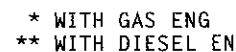


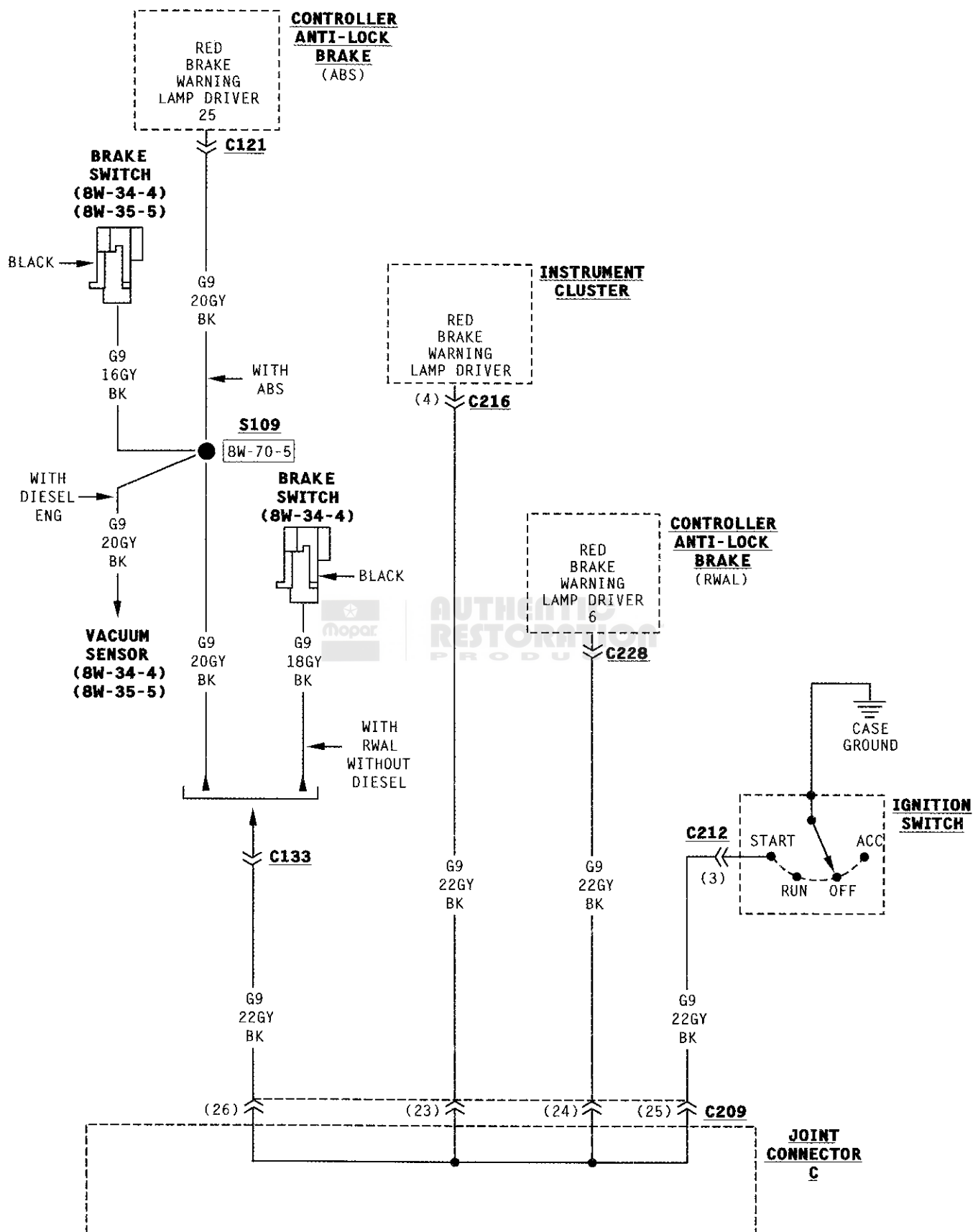


* WITH GAS ENG
 ** WITH DIESEL ENG









8W-15 GROUND DISTRIBUTION

DESCRIPTION AND OPERATION

INTRODUCTION

This section identifies the grounds, splices that connect to those grounds, and the components that connect those grounds. For additional information on system operation, refer to the appropriate section of the wiring diagrams. For an illustration of the physical location of each ground, refer to group 8W-90.



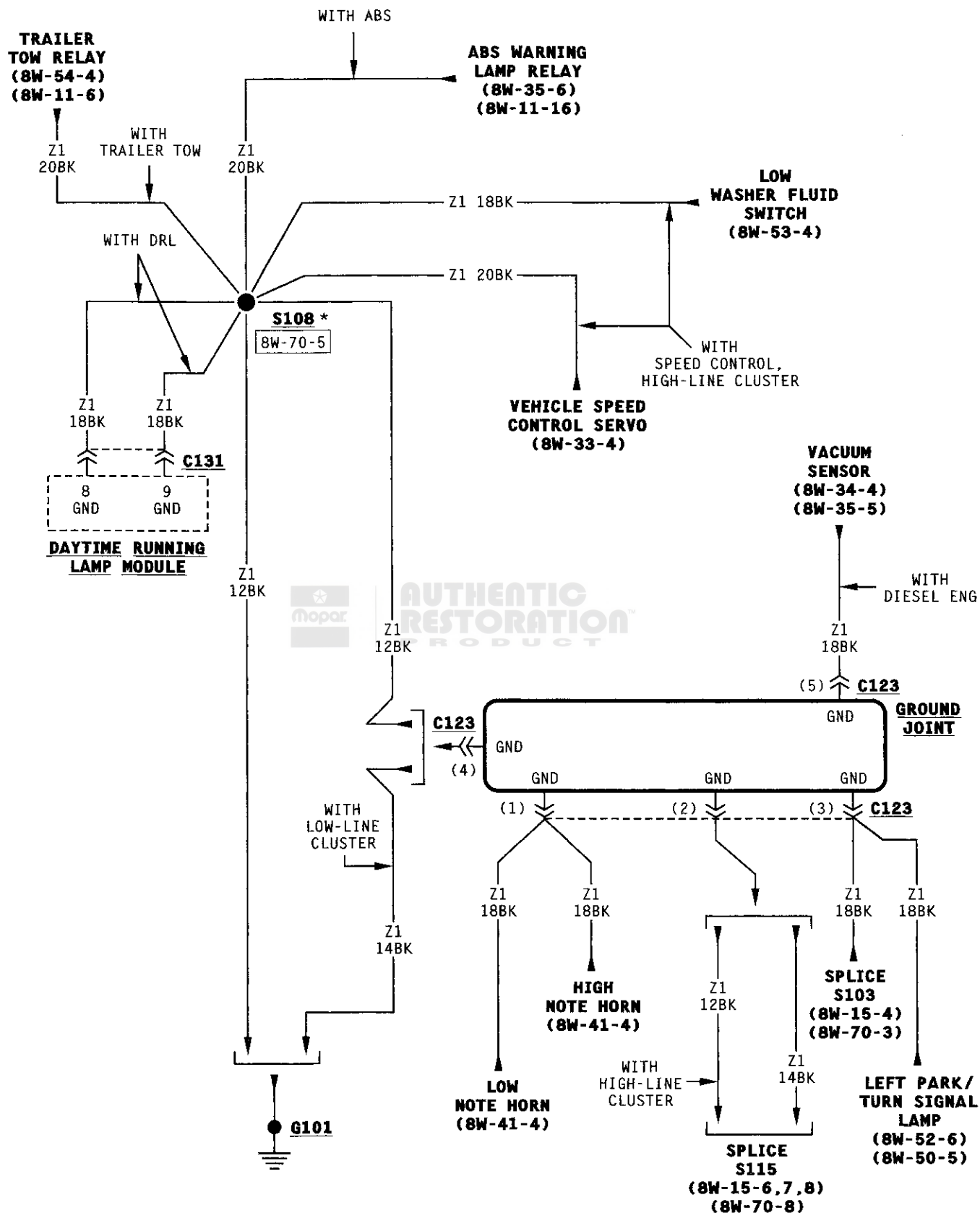
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DIAGRAM INDEX

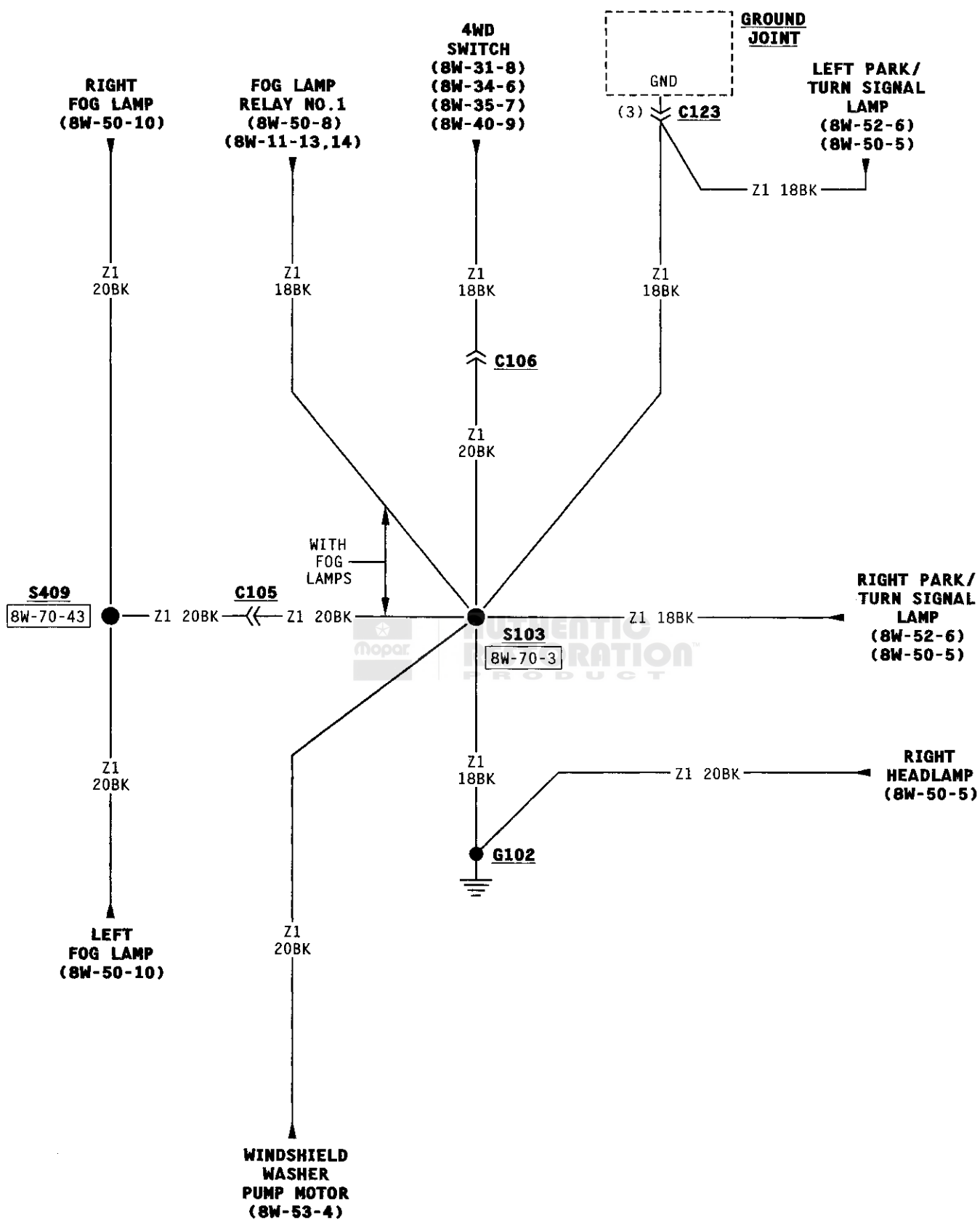
Component	Page	Component	Page
G101	8W-15-3	G114	8W-15-10
G102	8W-15-4	G115	8W-15-10
G103	8W-15-5	G116	8W-15-10
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G108	8W-15-9	G202	8W-15-13
G109	8W-15-9	G301	8W-15-14
G110	8W-15-9	G302	8W-15-14
G111	8W-15-9	G303	8W-15-15
G112	8W-15-10	G304	8W-15-15
G113	8W-15-10		

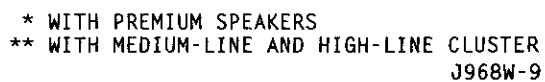


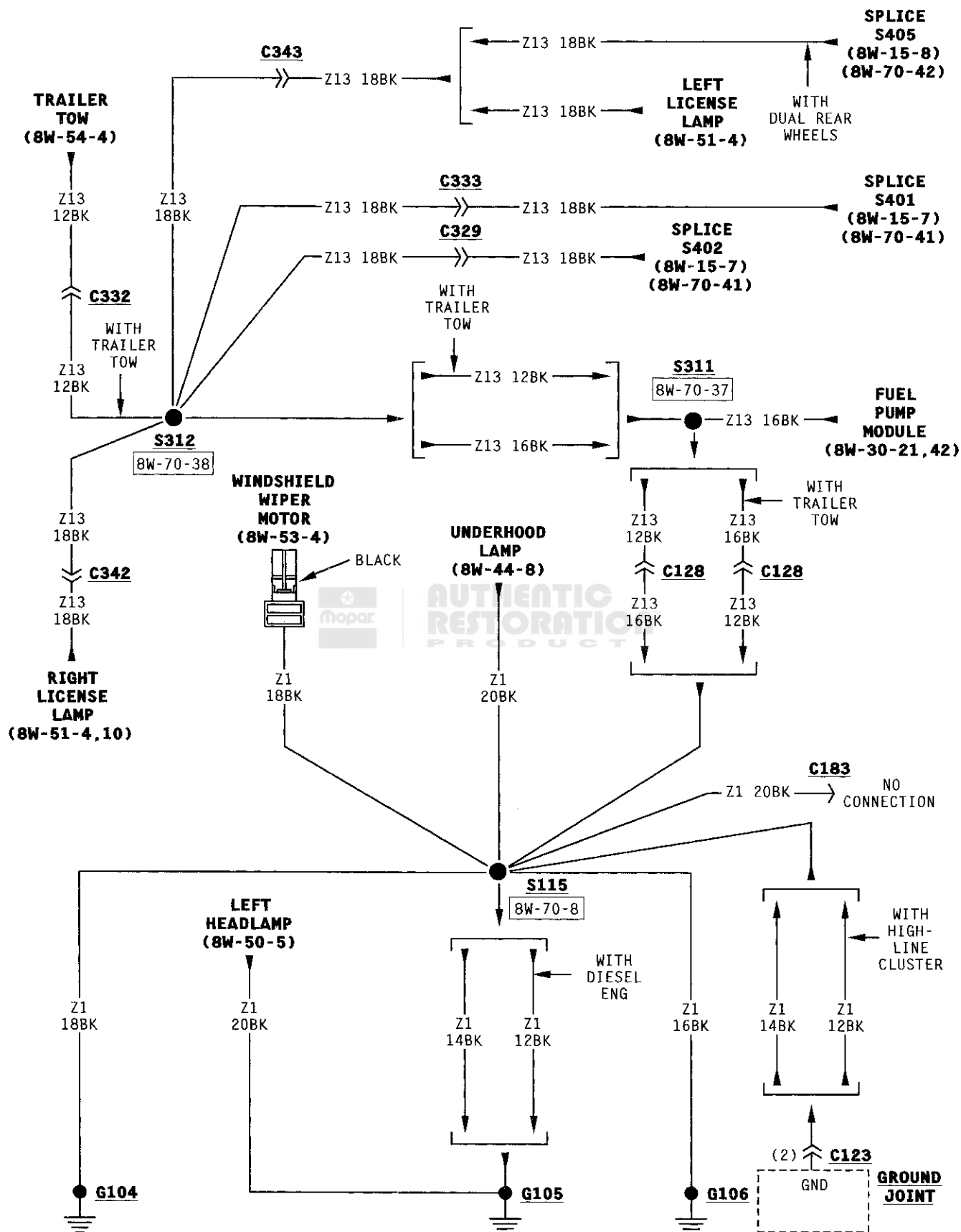
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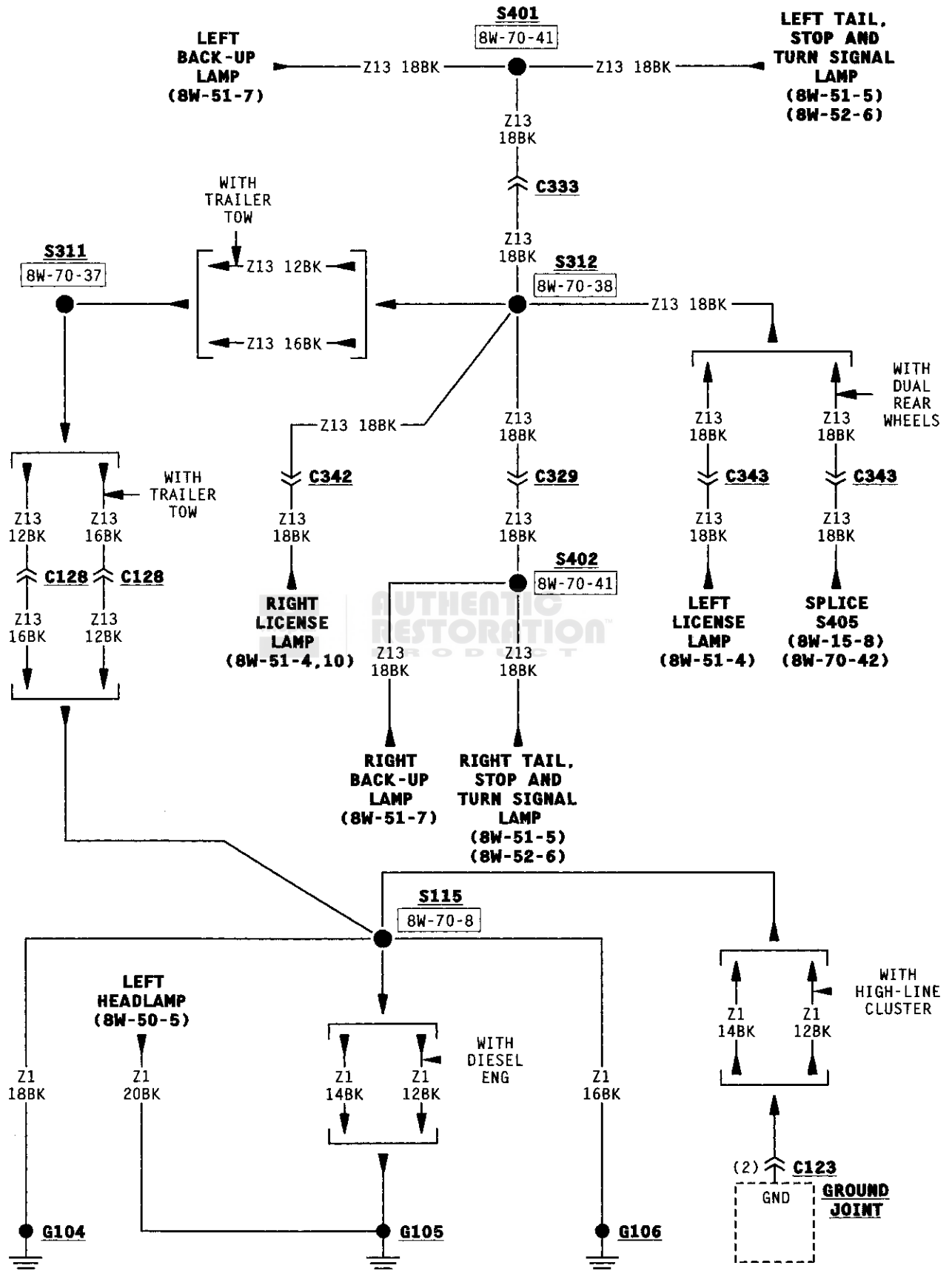


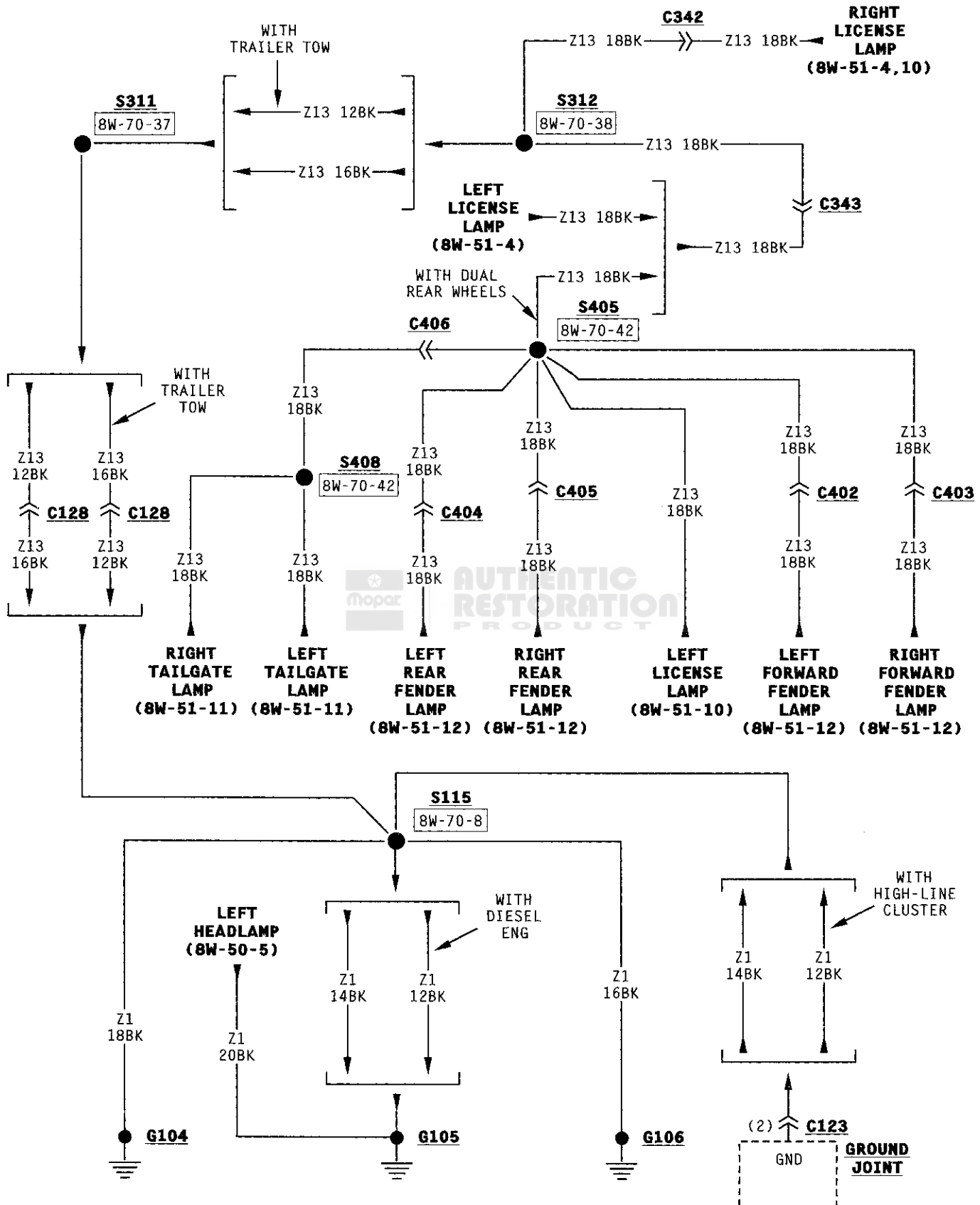
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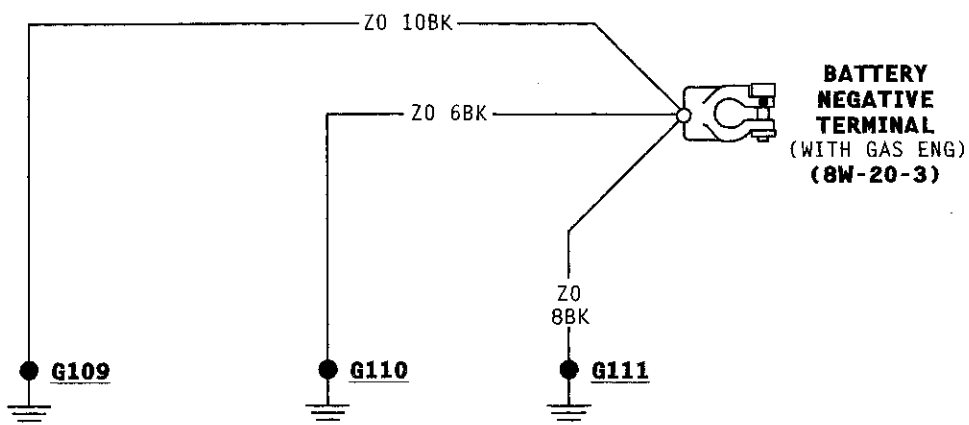
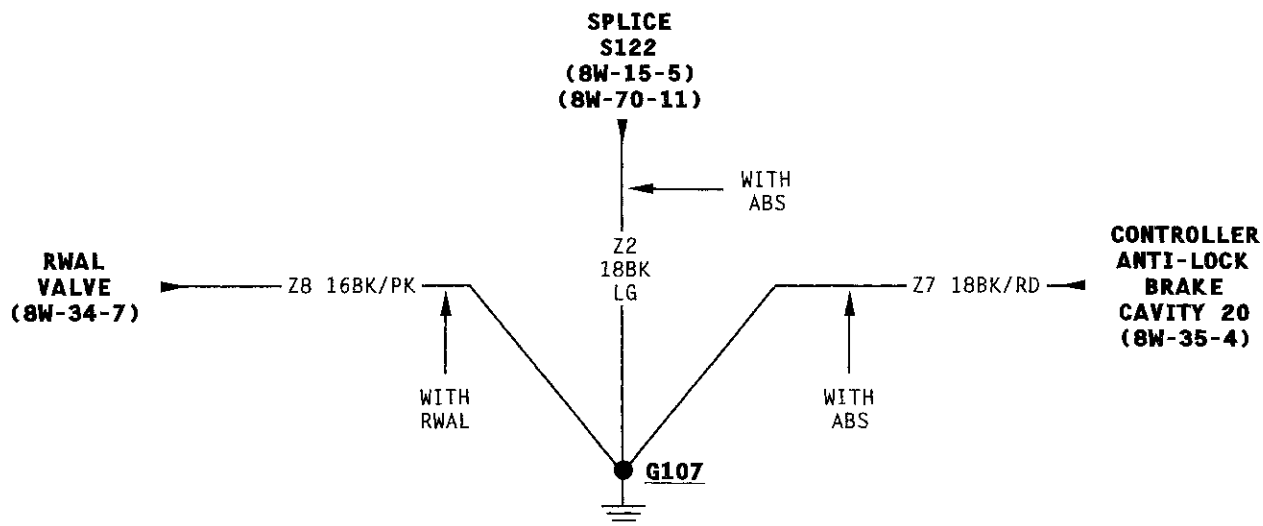


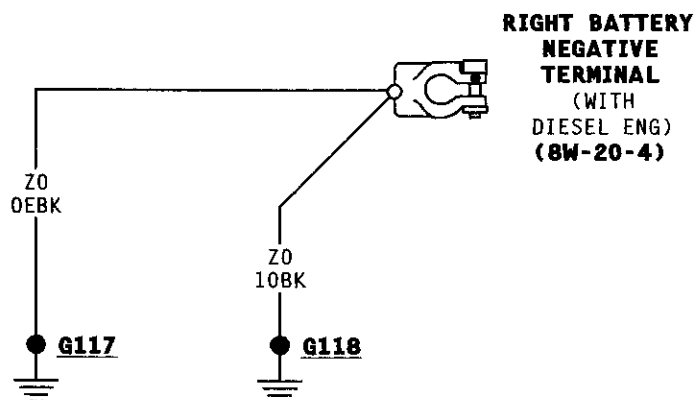
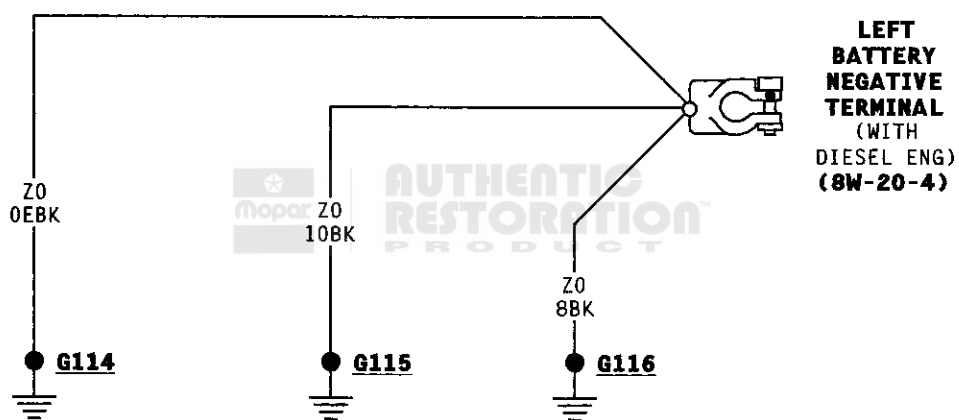
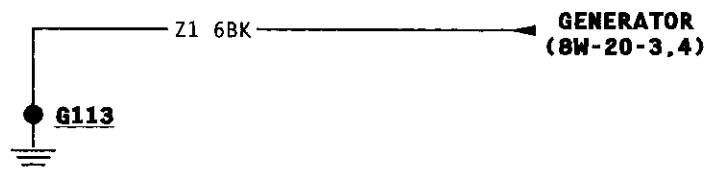
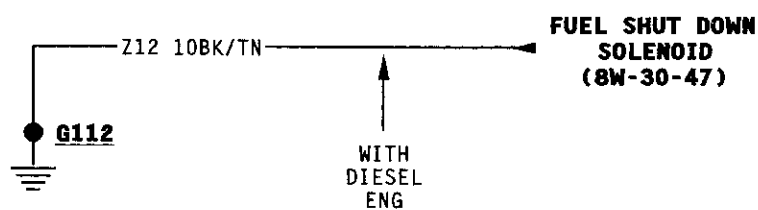


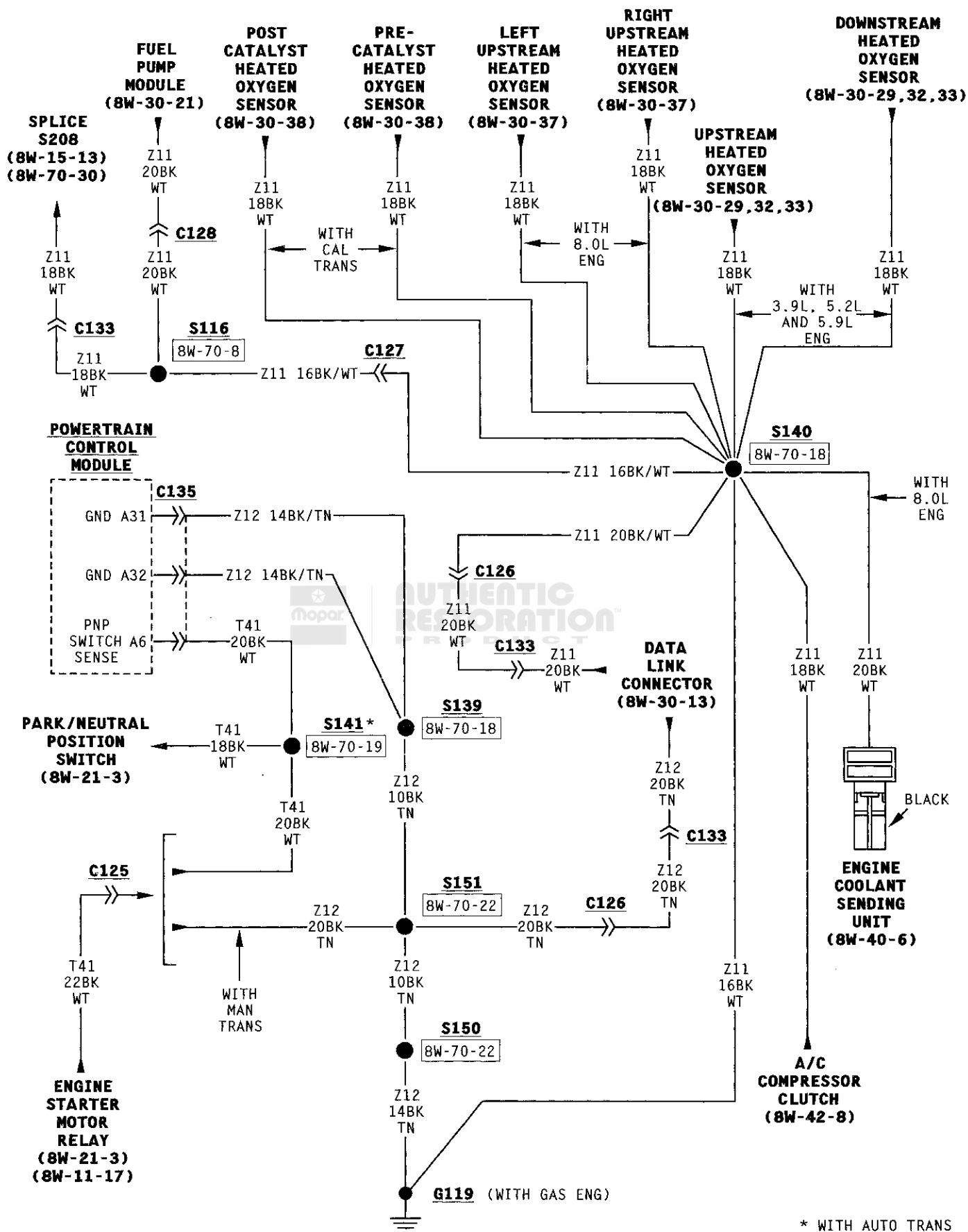




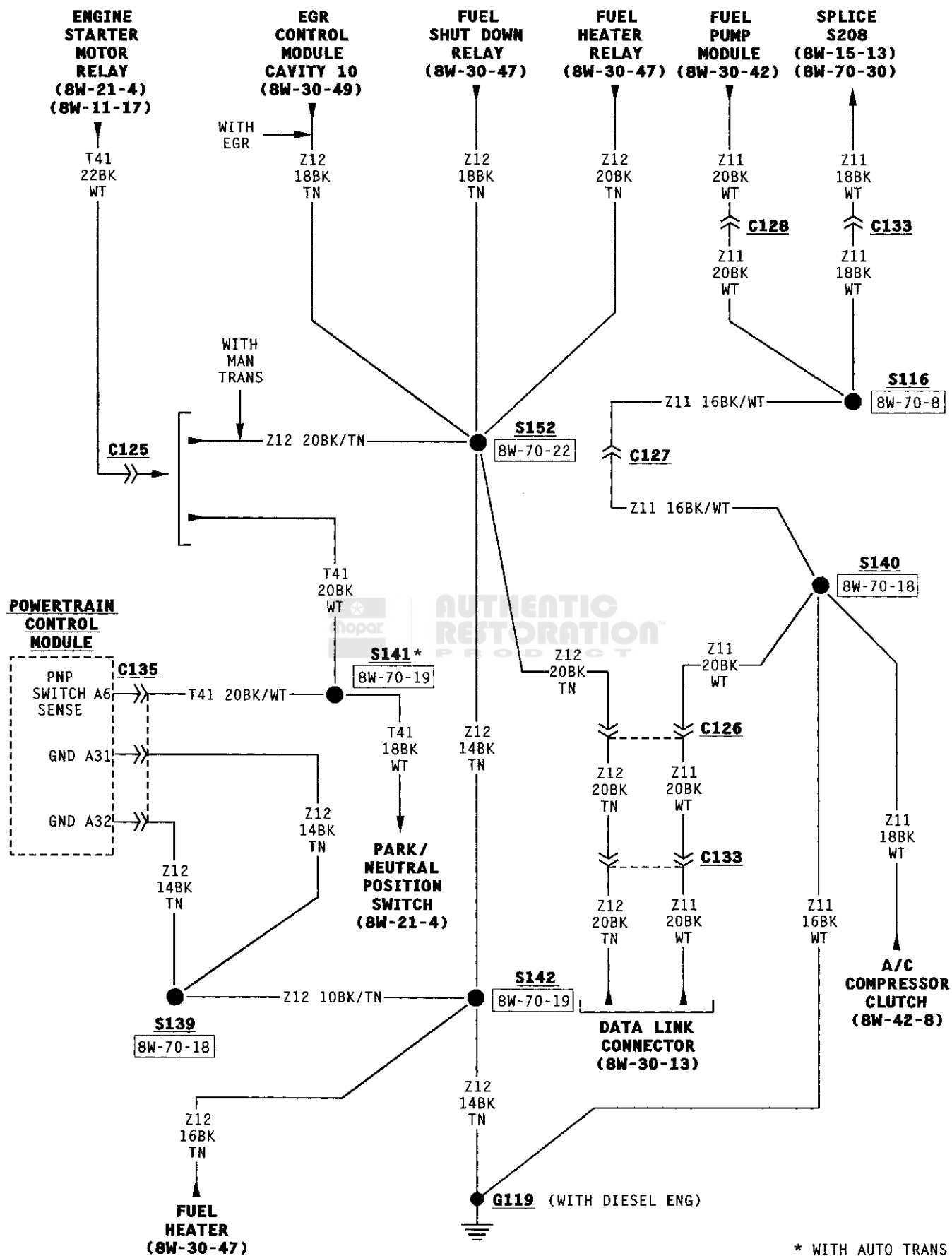






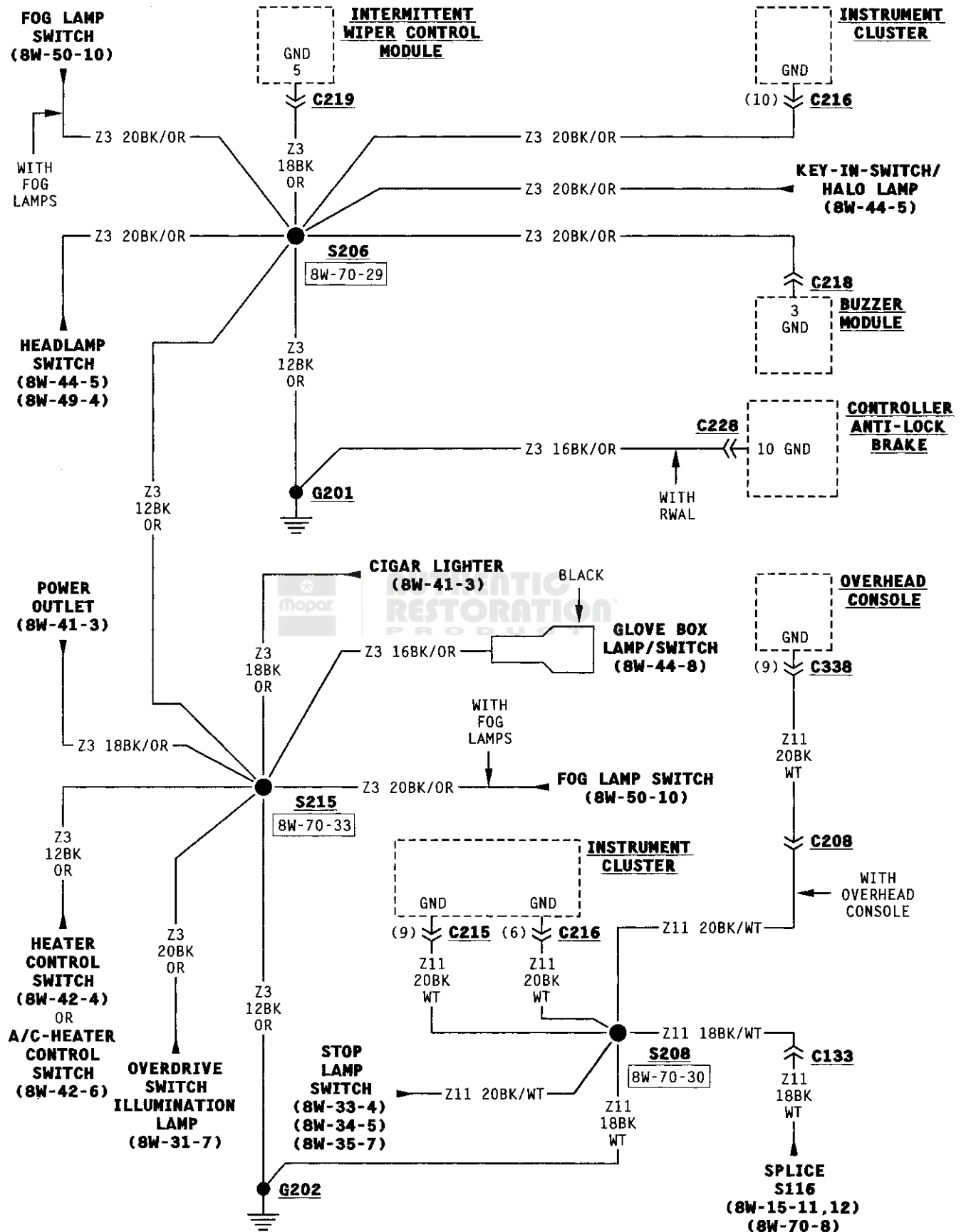


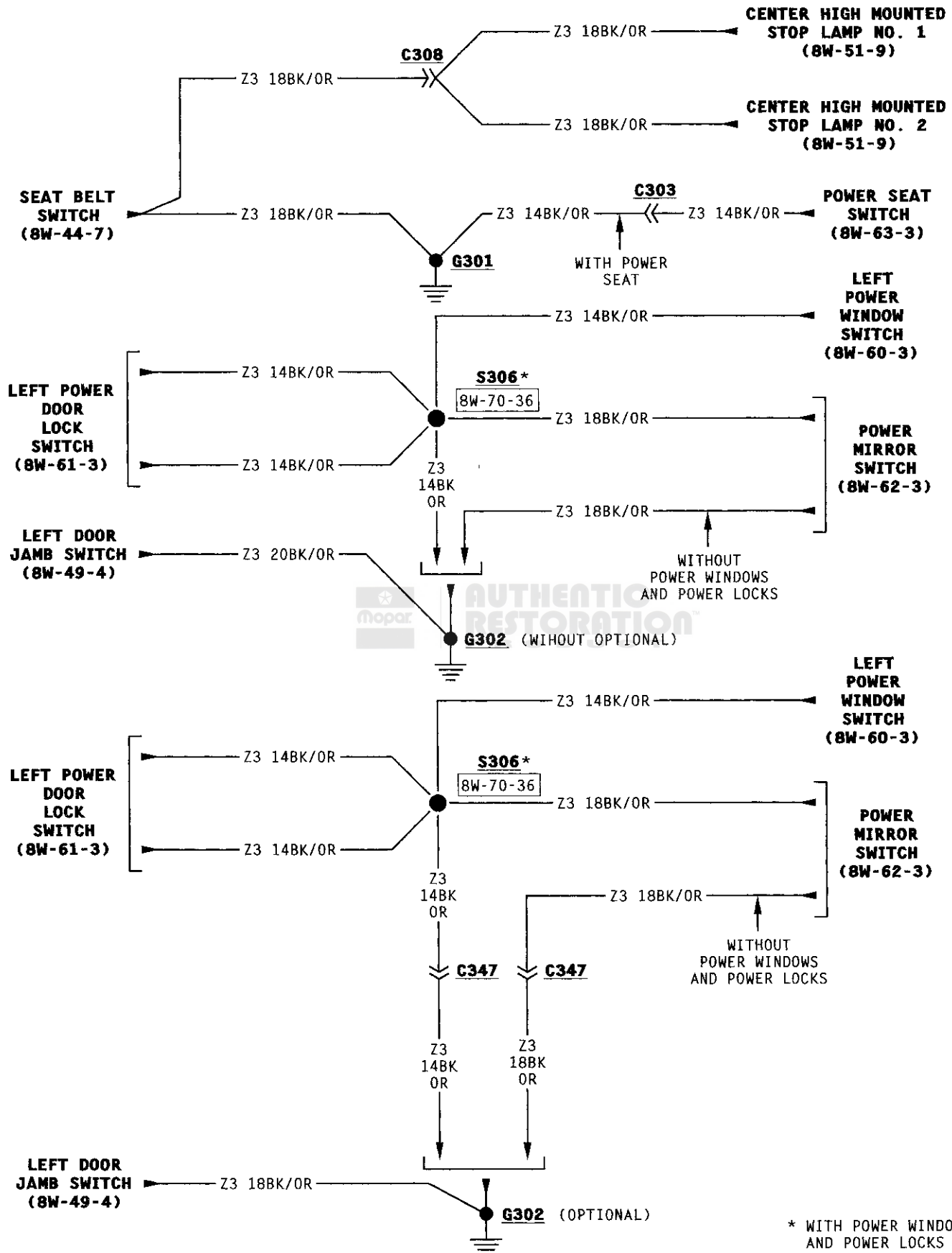
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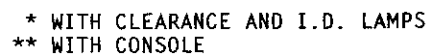


* WITH AUTO TRANS

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8W-20 CHARGING SYSTEM

DESCRIPTION AND OPERATION

CHARGING SYSTEM

The charging system is an integral part of the battery and starting systems. Because all these systems work in conjunction, diagnose and test them together.

Circuit A0 from the battery connects to a bus bar in the Power Distribution Center (PDC). Circuit A11 connects to the PDC bus bar and the output terminal of the generator. A fuse in the PDC between A0 and A11 circuits protects the charging system. Circuit Z1 provides ground for the generator.

On the diesel engine applications an additional battery is used. Circuit A0 connects between the battery positive terminals of the batteries.

When the ignition switch is in either the START or RUN positions, it connects battery voltage from circuit A1 to the A21 circuit. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 connects to the coil side of the Automatic Shut Down (ASD) relay. Circuit A1 originates in the PDC and is connected to battery voltage. A 40 amp fuse in cavity 3 of the PDC protects the A1 circuit.

When the ASD relay energizes, it connects circuit A16 from the PDC to circuit A142. Circuit A142 splices to connect to the generator connector supplying battery voltage to the generator field.

The Powertrain Control Module (PCM) has an internal voltage regulator that controls generator output. Circuit K20 connects the generator and PCM, cavity B10. The PCM controls the generator field on the K20 circuit.

When the engine operates and there is current in the generator field, the generator produces a B+ voltage. The generator supplies B+ voltage to the battery through the A11 and A0 circuits.

HELPFUL INFORMATION

- Check the 120 amp fuse located in the PDC
- From the ASD relay, circuit A142 splices to supply voltage to the fuel injectors, ignition coil, fuel pump module, and the heated oxygen sensors on gasoline powered engines

SCHEMATICS AND DIAGRAMS

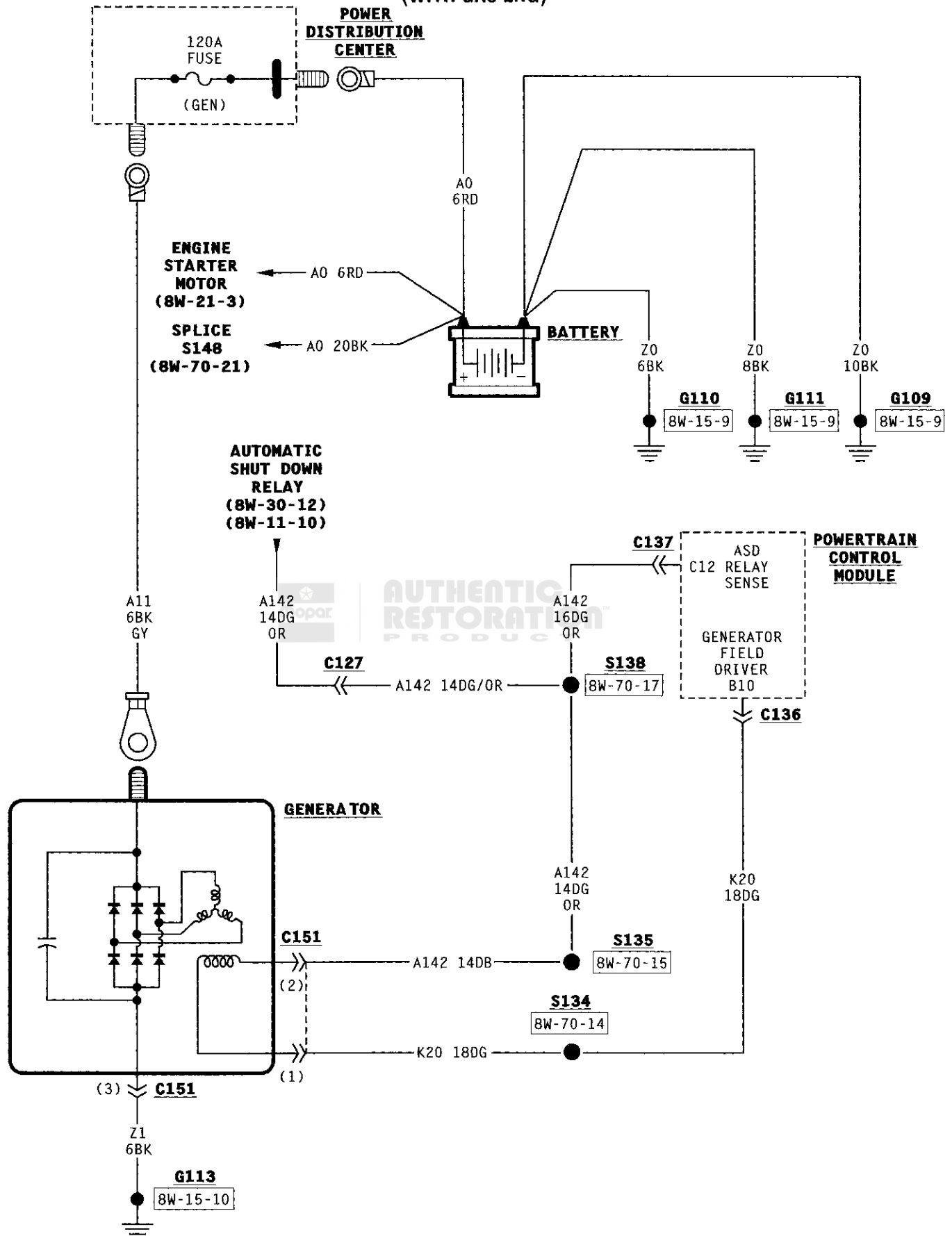
WIRING DIAGRAM INDEX

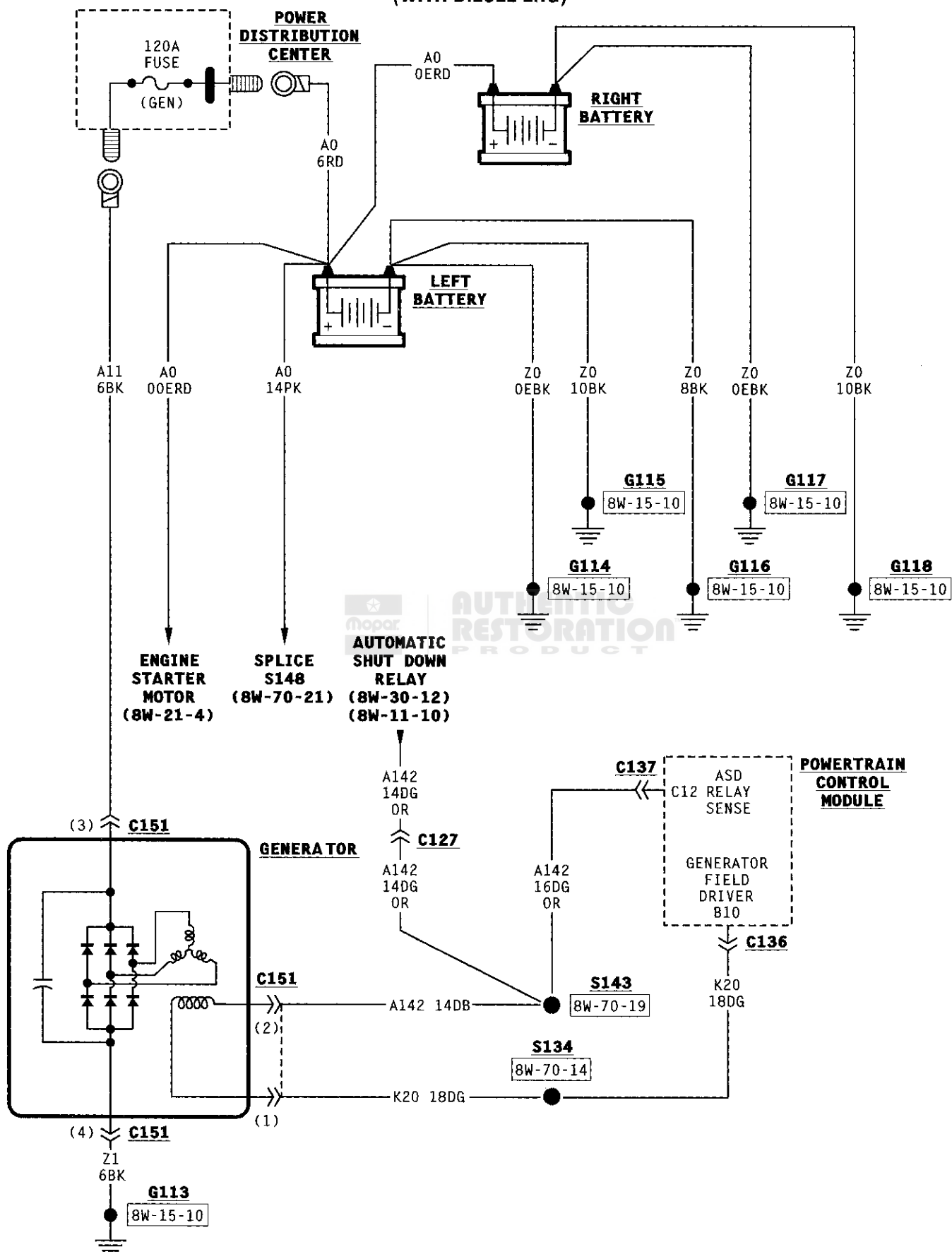
The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

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Component	Page	Component	Page
Battery	8W-20-3, 4	Powertrain Control Module	8W-20-3, 4
Fuse (Gen) (PDC)	8W-20-3, 4	Right Battery	8W-20-4
Generator	8W-20-3, 4		







8W-21 STARTING SYSTEM

DESCRIPTION AND OPERATION

AUTOMATIC TRANSMISSION

The Power Distribution Center (PDC) supplies battery voltage to the engine starter motor solenoid on circuit T40 when the coil side of the engine starter motor relay energizes.

Circuit A0 from the battery is triple crimped at the positive battery post. One branch of circuit A0 (battery positive cable) connects to the starter motor. The other A0 branch supplies voltage to a bus bar in the PDC. Fuse 2 (40 amp) connects to the bus bar and protects circuit A2. Circuit A2 connects to the contact side of the engine starter motor relay.

When the ignition switch is in the START position it connects circuit A1 from fuse 3 in the PDC to circuit A41. Circuit A41 connects to circuit T141 at the bypass jumper. Circuit T141 supplies battery voltage to the coil side of the engine starter motor relay. Ground for the coil side of the starter motor relay is supplied by the case grounded PARK/NEUTRAL position switch. Circuit T41 connects the coil side of the relay to the PARK/NEUTRAL position switch.

When the starter motor relay energizes and the contacts CLOSE, circuit T40 supplies battery voltage to the starter motor solenoid. Circuit A0 from the battery supplies voltage to the starter motor when the solenoid energizes.

HELPFUL INFORMATION

- Check the fuse located in cavity 2 of the PDC
- The PARK/NEUTRAL position switch CLOSES when the transmission is in either the PARK or NEUTRAL positions.
- On diesel engines the T40 circuit is spliced and supplies power for the fuel shut down relay.

MANUAL TRANSMISSION

The Power Distribution Center (PDC) supplies battery voltage to the engine starter motor solenoid on circuit T40 when the coil side of the engine starter motor relay energizes.

Circuit A0 from the battery is triple crimped at the positive battery post. One branch of circuit A0 (battery positive cable) connects to the engine starter motor. Another branch of circuit A0 supplies voltage to a bus bar in the PDC. Fuse 2 in the PDC connects to the bus bar and protects circuit A2. Circuit A2 splices and connects to the contact side of the engine starter motor relay.

When the ignition switch is in the START position, it connects circuit A1 from fuse 3 in the PDC to circuit A41. Circuit A41 connects to circuit T141 through the clutch pedal position switch. Circuit T141 supplies battery voltage to the coil side of the engine starter motor relay when the operator presses the clutch pedal and the clutch pedal position switch CLOSES. Ground for the coil side of the engine starter motor relay is supplied on circuit T41. This circuit is connected with circuit Z12. Circuit Z12 connects to ground.

When the starter motor relay energizes and the contacts CLOSE, circuit T40 supplies battery voltage to the starter motor solenoid. Circuit A0 from the battery supplies voltage to the starter motor when the solenoid energizes.

HELPFUL INFORMATION

- Check the fuse located in cavity 2 of the PDC.
- On diesel engines the T40 circuit is spliced and supplies power to the coil side of the fuel shut down relay.

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

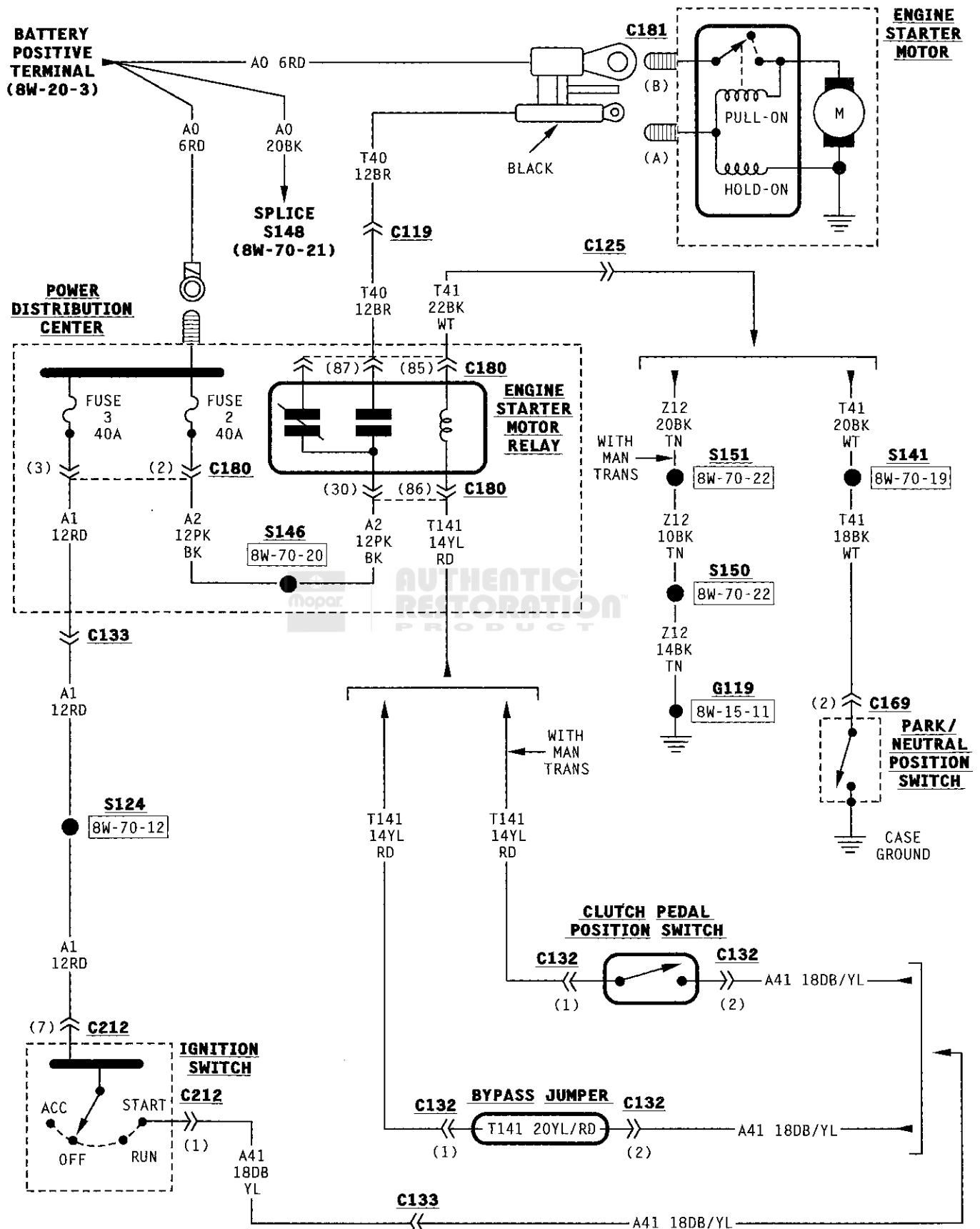
The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

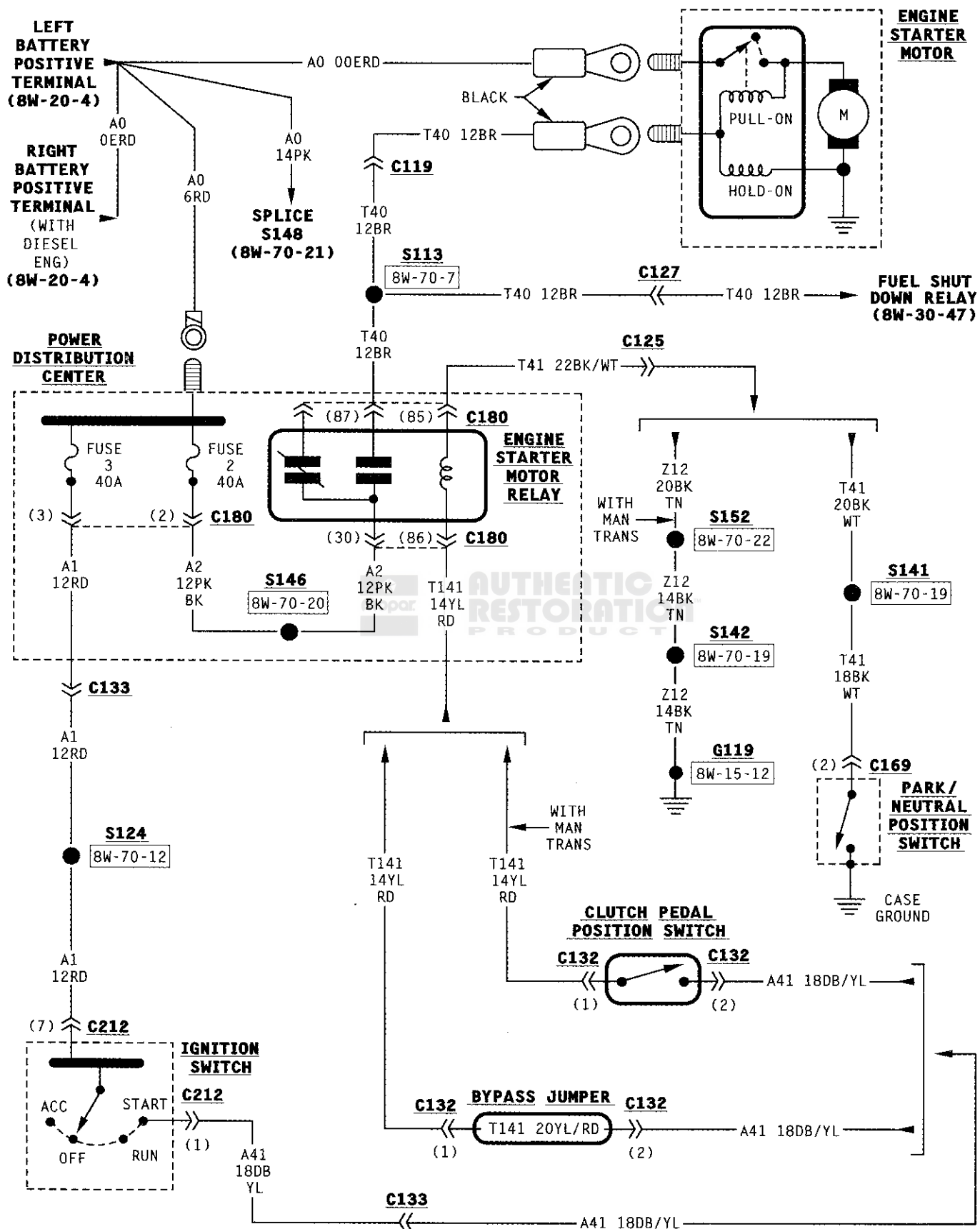
DIAGRAM INDEX

Component	Page	Component	Page
Bypass Jumper	8W-21-3, 4	Fuse 2 (PDC)	8W-21-3, 4
Clutch Pedal Position Switch	8W-21-3, 4	Fuse 3 (PDC)	8W-21-3, 4
Engine Starter Motor	8W-21-3, 4	Ignition Switch	8W-21-3, 4
Engine Starter Motor Relay	8W-21-3, 4	Park/Neutral Position Switch	8W-21-3, 4



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8W-30 FUEL/IGNITION SYSTEMS

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CRANKSHAFT POSITION SENSOR	3	INTAKE AIR TEMPERATURE SENSOR	5
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FUEL SHUT DOWN RELAY—DIESEL ENGINE	7	SCHEMATICS AND DIAGRAMS	
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DESCRIPTION AND OPERATION

IGNITION SWITCH

When the ignition switch is in the RUN position, it connects circuit A2 from fuse 2 in the Power Distribution Center (PDC) to circuit A22. Circuit A22 connects to the fuse block. Through the fuse block, circuit A22 feeds circuits A20, L10, F23, C1 and F21. Circuits A20, L10, F23, and C1 are protected by separate fuses. A circuit breaker protects circuit F21.

When the ignition switch is in the START or RUN position, it connects circuit A1 from fuse 3 in the PDC to circuit A21. Circuit A21 powers circuits F18, F12, and F14 through the fuse block. Separate fuses protect each circuit.

In the START position, the ignition switch connects circuit A1 from fuse 3 in the PDC to circuit A41. Circuit A41 connects to either the clutch pedal position sensor or the clutch pedal position switch bypass jumper. Also in the START position, the ignition switch connects circuit G9 to ground.

In the ACCESSORY or RUN position, the ignition switch connects circuit A1 to circuit A31. Circuit A31

connects to the fuse block and feeds circuits F30, L5, X12, and V6. Separate fuses protect each circuit.

BATTERY FEED

Circuit A14 from fuse 8 in the Power Distribution Center (PDC) supplies battery voltage to cavity A22 of the Powertrain Control Module (PCM).

GROUND

Circuit Z12 connects to cavities A31 and A32 of the Powertrain Control Module (PCM). The Z12 circuit provides ground for PCM internal drivers that operate high current devices like the injectors and ignition coil.

HELPFUL INFORMATION

If the system loses ground for the Z12 circuits the vehicle will not operate.

BATTERY TEMPERATURE SENSOR

The Powertrain Control Module (PCM) determines battery temperature on circuit K118. Circuit K118 connects the PCM to the battery temperature sensor. Circuit K4 provides ground for the sensor. Circuit

DESCRIPTION AND OPERATION (Continued)

K118 connects to cavity C15 of the PCM. Circuit K4 connects to cavity A4.

DATA LINK CONNECTOR

Circuit M1 supplies battery voltage to the data link connector. Circuit M1 originates at cavity 7 of Joint Connector B.

Circuit D20 connects to cavity C29 of the Powertrain Control Module (PCM). Circuit D20 is the SCI receive circuit for the PCM.

Circuit D21 connects to cavity C27 of the PCM. Circuit D21 is the SCI transmit circuit for the PCM.

Circuits Z11 and Z12 provide ground for the data link connector.

AUTOMATIC SHUT DOWN (ASD) RELAY

When the ignition switch is in the START or RUN position, it connects circuit A1 from fuse 3 in the Power Distribution Center (PDC) to circuit A21. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 supplies battery voltage to the coil side of the ASD relay. The Powertrain Control Module (PCM) provides the ground path for the coil side of the relay on circuit K51. Circuit K51 connects to cavity C3 of the PCM.

When the PCM grounds the ASD relay, the relay contacts close and connect circuit A16 from fuse 4 in the PDC to circuit A142. Circuit A142 splices to supply voltage to the fuel injectors, ignition coil, and heated oxygen sensors. Circuit A142 also connects to cavity C12 of the PCM.

FUEL PUMP RELAY

Circuit A14 from fuse 8 in the Power Distribution Center (PDC) supplies battery voltage to the contact side of the fuel pump relay. Circuit A21 from the ignition switch powers circuit F18 through 9 in the fuse block. Circuit F18 supplies battery voltage to the coil side of the Automatic Shut Down (ASD) and fuel pump relays. The Powertrain Control Module (PCM) provides the ground path for the coil side of the fuel pump relay on circuit K31. Circuit K31 connects to cavity C19 of the PCM connector.

When the PCM grounds the fuel pump relay, the contacts CLOSE and connect circuits A14 and A61. Circuit A61 supplies voltage to the fuel pump motor (part of the in-tank fuel pump module).

HELPFUL INFORMATION

Circuit A14 also connects to cavity A22 of the PCM.

FUEL PUMP MODULE

The in-tank fuel pump module contains the fuel pump motor and the fuel level sensor. For fuel pump module information, refer to Group 14, Fuel System.

FUEL PUMP MOTOR

When the fuel pump relay contacts close, circuit A61 feeds the fuel pump motor. Circuit Z13 provides ground for the fuel pump motor.

FUEL LEVEL SENSOR

The fuel level sensor is a variable resistor. Circuit G4 connects the fuel level sensor to the fuel gauge in the instrument cluster. Circuit F14 from fuse 12 in the fuse block supplies voltage to the fuel gauge. The fuel level sensor draws voltage from circuit F14 through the fuel gauge on circuit G4. Circuit Z11 provides the ground path for the fuel level sensor.

As current flows through the coils in the fuel gauge, it creates a magnetic field. One of the coils in the gauge receives fixed current. The other coil is connected to the level sensor. The magnetic field controls the position of the fuel gauge pointer.

The fuel level sensor contains a variable resistor. As the position of the float arm on the fuel level sensor changes, the resistor changes the current flow through the second coil in the fuel gauge. A change in current flow alters the magnetic field in the fuel gauge, which changes the pointer position.

Circuit K104 from the level sensor connects to circuit K226. Circuit K226 connects to cavity C26 of the Powertrain Control Module (PCM). Circuit K226 provides the fuel level input to the PCM. Circuit K4 provides ground for the level sensor signal.

FUEL PUMP MODULE—DIESEL ENGINE

The in-tank fuel pump module used with diesel engines contains the fuel level sensor. The diesel engine does not use an in-tank electrical fuel pump. For fuel pump module information, refer to Group 14, Fuel System.

FUEL LEVEL SENSOR

The fuel level sensor is a variable resistor. Circuit G4 connects the fuel level sensor to the fuel gauge in the instrument cluster. Circuit F14 from fuse 12 in the fuse block supplies voltage to the fuel gauge. The fuel level sensor draws voltage from circuit F14 through the fuel gauge on circuit G4. Circuit Z11 provides the ground path for the fuel level sensor.

As current flows through the coils in the fuel gauge, it creates a magnetic field. One of the coils in the gauge receives fixed current. The other coil is connected to the level sensor. The magnetic field controls the position of the fuel gauge pointer.

The fuel level sensor contains a variable resistor. As the position of the float arm on the fuel level sensor changes, the resistor changes the current flow through the second coil in the fuel gauge. A change in current flow alters the magnetic field in the fuel gauge, which changes the pointer position.

DESCRIPTION AND OPERATION (Continued)**VEHICLE SPEED SENSOR**

Circuit K7 supplies 5 volts from the Powertrain Control Module (PCM) to the vehicle speed sensor. The K7 circuit connects to cavity B31 of the PCM connector.

Circuit G7 from the vehicle speed sensor provides an input signal to the PCM. The G7 circuit connects to cavity B27 of the PCM.

The PCM provides a ground for the vehicle speed sensor signal (circuit G7) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Camshaft position sensor
- Crankshaft position sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Intake air temperature sensor

HEATED OXYGEN SENSORS

When the Automatic Shut Down (ASD) relay contacts CLOSE, they connect circuits A16 and A142. Circuit A142 splices to supply voltage to the heated oxygen sensors.

V-6 AND V-8 LIGHT DUTY ENGINES

Circuit K141 delivers the signal from the upstream heated oxygen sensor to the Powertrain Control Module (PCM). Circuit K141 connects to cavity A24 of the PCM. Circuit K341 delivers the signal from the downstream sensor and connects to cavity A25 of the PCM.

The PCM provides a ground for the heated oxygen sensor signals (circuits K141 and K341) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

Circuit Z11 provides a ground for the heater circuit in the sensors.

5.9L V-8 HEAVY DUTY ENGINE

Circuit K41 delivers the signal from the upstream heated oxygen sensor to the Powertrain Control Module (PCM). Circuit K41 connects to cavity A24 of the PCM. Circuit K241 delivers the signal from the downstream sensor and connects to cavity A26 of the PCM.

The PCM provides a ground for the heated oxygen sensor signals (circuits K41 and K241) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

Circuit Z11 provides a ground for the heater circuit in the sensors.

V-10 ENGINES

Vehicles with the V-10 engine built for sale in the State of California use four heated oxygen sensors. All other V-10 equipped vehicles use two heated oxygen sensors.

Circuit K141 delivers the signal from the left heated oxygen sensor to the Powertrain Control Module (PCM). Circuit K141 connects to cavity A24 of the PCM. Circuit K41 delivers the signal from the right sensor and connects to cavity A26 of the PCM.

On California vehicles, Circuit K441 delivers the signal from the pre-catalyst heated oxygen sensor to the PCM. Circuit K441 connects to cavity A29 of the PCM. Circuit K341 delivers the signal from the post catalyst sensor and connects to cavity A25 of the PCM.

The PCM provides a ground for the heated oxygen sensor signals (circuits K41, K141, K341 and K441) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

Circuit Z11 provides a ground for the heater circuit in the sensors.

HELPFUL INFORMATION

- Along with supplying voltage to the ASD relay contacts, circuit A14 connects to cavity A22 of the PCM.
- Circuit A142 splices to supply voltage to the fuel injectors and ignition coil(s).

Circuit K4 splices to supply ground for the signals from the following:

- Camshaft position sensor
- Crankshaft position sensor
- Intake air temperature sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

CRANKSHAFT POSITION SENSOR

The Powertrain Control Module (PCM) supplies 5 volts to the crankshaft position sensor on circuit K6. Circuit K6 connects to cavity A17 of the PCM.

The PCM receives the crankshaft position sensor signal on circuit K24. Circuit K24 connects to cavity A8 of the PCM.

The PCM provides a ground for the crankshaft position sensor (circuit K24) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

HELPFUL INFORMATION

- Circuit K6 splices to supply 5 volts to the camshaft position sensor.
- Circuit K4 splices to supply ground for the signals from the following:
 - Heated oxygen sensors
 - Camshaft position sensor

DESCRIPTION AND OPERATION (Continued)

- Intake air temperature sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

CAMSHAFT POSITION SENSOR

The Powertrain Control Module (PCM) supplies 5 volts to the camshaft position sensor on circuit K6. Circuit K6 connects to cavity A17 of the PCM.

The PCM receives the camshaft position sensor signal on circuit K44. Circuit K44 connects to cavity A18 of the PCM.

The PCM provides a ground for the camshaft position sensor (circuit K44) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

HELPFUL INFORMATION

• Circuit K6 splices to supply 5 volts to the crankshaft position sensor.

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Crankshaft position sensor
- Intake air temperature sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor provides an input to the Powertrain Control Module (PCM) on circuit K2. From circuit K2, the engine coolant temperature sensor draws up to 5 volts from the PCM. The sensor is a variable resistor. As engine coolant temperature changes, the resistance in the sensor changes, causing a change in current draw. The K2 circuit connects to cavity A16 of the PCM.

The PCM provides a ground for the engine coolant temperature sensor signal (circuit K2) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Camshaft position sensor
- Crankshaft position sensor
- Intake air temperature sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Vehicle speed sensor

THROTTLE POSITION SENSOR

From the Powertrain Control Module (PCM), circuit K6 supplies 5 volts to the Throttle Position Sen-

sor (TPS). Circuit K6 connects to cavity A17 of the PCM.

Circuit K22 delivers the TPS signal to the PCM. Circuit K22 connects to cavity A23 of the PCM.

The PCM provides a ground for the TPS signal (circuit K22) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Refer to Group 14 for TPS operation.

Circuit K6 splices to supply 5 volts to the manifold absolute pressure sensor, crankshaft position sensor and camshaft position sensor.

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Camshaft position sensor
- Crankshaft position sensor
- Intake air temperature sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

THROTTLE POSITION SENSOR—DIESEL ENGINE

From the Powertrain Control Module (PCM), circuit K6 supplies 5 volts to the Throttle Position Sensor (TPS). Circuit K6 connects to cavity A17 of the PCM.

Circuit K22 delivers the TPS signal to the PCM. Circuit K22 connects to cavity A23 of the PCM. Circuit K22 also splices to cavity 3 of the EGR control module.

The PCM provides a ground for the TPS signal (circuit K22) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Refer to Group 14 for TPS operation.

Circuit K4 splices to supply ground for the signals from the following:

- Battery Temperature Sensor
- Crankshaft Position Sensor
- Water-In-Fuel Sensor
- Vehicle speed sensor

MANIFOLD ABSOLUTE PRESSURE SENSOR

From the Powertrain Control Module (PCM), circuit K6 supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor. Circuit K6 connects to cavity A17 of the PCM.

Circuit K1 delivers the MAP signal to the PCM. Circuit K1 connects to cavity A27 of the PCM.

The PCM provides a ground for the MAP sensor signal (circuit K1) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

DESCRIPTION AND OPERATION (Continued)**HELPFUL INFORMATION**

Refer to Group 14 for MAP sensor operation.

Circuit K6 splices to supply 5 volts to the Throttle Position Sensor (TPS), camshaft position sensor, and crankshaft position sensor.

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Camshaft position sensor
- Crankshaft position sensor
- Intake air temperature sensor
- Throttle position sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

INTAKE AIR TEMPERATURE SENSOR

The intake air temperature sensor provides an input to the Powertrain Control Module (PCM) on circuit K21. Circuit K21 connects to cavity A15 of the PCM.

From circuit K21, the intake air temperature sensor draws voltage from the PCM. The sensor is a variable resistor. As intake air temperature changes, the resistance in the sensor changes, causing a change in current draw.

The PCM provides a ground for the intake air temperature sensor signal (circuit K21) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for the signals from the following:

- Heated oxygen sensors
- Camshaft position sensor
- Crankshaft position sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Engine coolant temperature sensor
- Vehicle speed sensor

PARK/NEUTRAL POSITION SWITCH

When closed, the case-grounded Park/Neutral position switch provides a ground path on circuit T41 for the coil side of the engine starter motor relay. Circuit A41 from the ignition switch provides battery voltage to the coil side of the relay.

Circuit T41 splices to cavity A6 of the Powertrain Control Module (PCM). The Park/Neutral position switch provides an input to the PCM.

HELPFUL INFORMATION

• In the START position, the ignition switch connects circuit A1 from the power distribution center (PDC) to circuit A41. A 40 amp fuse in cavity 3 of the PDC protects circuits A1 and A41.

• The Park/Neutral position switch and back-up lamp switch are molded together.

FUEL INJECTORS

When the Automatic Shut Down (ASD) relay contacts close, they connect circuits A16 and A142. Circuit A142 supplies voltage to the fuel injectors. Each injector has a separate ground circuit controlled by the Powertrain Control Module (PCM).

Circuit K11 provides ground for injector number one. The K11 circuit connects to cavity B4 of the PCM.

Circuit K12 provides ground for injector number two. The K12 circuit connects to cavity B15 of the PCM.

Circuit K13 provides ground for injector number three. The K13 circuit connects to cavity B5 of the PCM.

Circuit K14 provides ground for injector number four. The K14 circuit connects to cavity B16 of the PCM.

Circuit K38 provides ground for injector number five. The K38 circuit connects to cavity B6 of the PCM.

Circuit K58 provides ground for injector number six. The K58 circuit connects to cavity B12 of the PCM.

On the 5.2L and 5.9L engines, circuit K26 provides ground for injector number seven. The K26 circuit connects to cavity B2 of the PCM.

Also on the 5.2L and 5.9L engines, circuit K28 provides ground for injector number eight. The K28 circuit connects to cavity B13 of the PCM.

HELPFUL INFORMATION

• Circuit A142 splices to supply voltage to the fuel injectors, ignition coil, PCM, generator, and heated oxygen sensors.

• For information about fuel injector operation, refer to Group 14.

FUEL INJECTORS—V-10 ENGINES

When the Automatic Shut Down (ASD) relay contacts close, they connect circuits A16 and A142. Circuit A142 supplies voltage to the fuel injectors. The Powertrain Control Module (PCM) provides the ground for the injectors.

Circuit K11 provides ground for injector number one. The K11 circuit connects to cavity B4 of the PCM.

Circuit K12 provides ground for injector number two. The K12 circuit connects to cavity B15 of the PCM.

Circuit K13 provides ground for injector number three. The K13 circuit connects to cavity B5 of the PCM.

Circuit K14 provides ground for injector number four. The K14 circuit connects to cavity B16 of the PCM.

DESCRIPTION AND OPERATION (Continued)

Circuit K38 provides ground for injector number five. The K38 circuit connects to cavity B6 of the PCM.

Circuit K58 provides ground for injector number six. The K58 circuit connects to cavity B12 of the PCM.

Circuit K26 provides ground for injector number seven. The K26 circuit connects to cavity B2 of the PCM.

Circuit K28 provides ground for injector number eight. The K28 circuit connects to cavity B13 of the PCM.

Circuit K115 provides ground for injector nine. The K115 circuit connects to cavity B3 of the PCM.

Circuit K116 provides ground for injector ten. The K116 circuit connects to cavity B14 of the PCM.

IGNITION COIL—V-6 AND V-8 ENGINES

When the Automatic Shut Down (ASD) relay contacts close, they connect circuits A16 and A142. Circuit A142 splices to supply voltage to the ignition coil. The Powertrain Control Module (PCM) controls the ground path for the ignition coil on circuit K19. Circuit K19 connects to cavity A7 of the PCM.

HELPFUL INFORMATION

Circuit A142 splices to supply voltage to the fuel injectors, PCM, generator, and heated oxygen sensors.

IGNITION COIL—V-10 ENGINES

V-10 engines use two ignition coil packs. One coil pack supplies spark to cylinders 5, 8, 9, and 10. The other coil pack connects to cylinders 1, 2, 3, 4, 6, and 7.

When the Powertrain Control Module (PCM) grounds the Automatic Shut Down (ASD) relay, the contacts close and connect circuits A16 and A142. Circuit A142 supplies battery voltage to the ignition coil packs. The PCM provides ground for each individual coil.

The PCM controls the ground path for the coil that supplies spark to cylinders 1 and 6 on circuit K19. Circuit K19 connects to cavity A7 of the PCM.

The PCM controls the ground path for the coil that supplies spark to cylinders 2 and 3 on circuit K43. Circuit K43 connects to cavity A5 of the PCM.

The PCM controls the ground path for the coil that supplies spark to cylinders 8 and 9 on circuit K18. Circuit K18 connects to cavity A3 of the PCM.

The PCM controls the ground path for the coil that supplies spark to cylinders 4 and 7 on circuit K32. Circuit K32 connects to cavity A1 of the PCM.

The PCM controls the ground path for the coil that supplies spark to cylinders 5 and 10 on circuit K17. Circuit K17 connects to cavity A9 of the PCM.

IDLE AIR CONTROL MOTOR

The Powertrain Control Module (PCM) operates the Idle Air Control motor through four circuits; K39, K40, K59, and K60. Each circuit connects to separate cavities in the PCM connector.

- Circuit K39 connects to cavity A19 of the PCM connector.
- Circuit K40 connects to cavity A11 of the PCM connector.
- Circuit K59 connects to cavity A20 of the PCM connector.
- Circuit K60 connects to cavity A10 of the PCM connector.

DUTY CYCLE EVAP/PURGE SOLENOID

The Powertrain Control Module (PCM) operates the EVAP/Purge solenoid by providing a ground path on circuit K52. Circuit K52 connects to PCM cavity C20. Circuit F18 supplies battery voltage to the EVAP/Purge solenoid.

HELPFUL INFORMATION

- In the RUN or START position, the ignition switch connects circuit A1 from the Power Distribution Center (PDC) and circuit A21. Circuit A21 feeds circuit F18 through fuse 9 in the fuse block.
- Circuit F18 splices to supply battery voltage to the EGR solenoid and connects to cavity A2 of the PCM.

EGR SOLENOID

The Powertrain Control Module (PCM) operates the EGR solenoid by providing a ground path on circuit K35. Circuit K35 connects to PCM cavity B32. Circuit F18 supplies battery voltage to the EGR solenoid.

HELPFUL INFORMATION

In the RUN or START position, the ignition switch connects circuit A1 from the Power Distribution Center (PDC) to circuit A21. Circuit A21 feeds circuit F18 through fuse 9 in the fuse block.

Circuit F18 splices to supply battery voltage to the EVAP/Purge solenoid and connects to cavity A2 of the PCM.

MALFUNCTION INDICATOR LAMP (MIL)

The PCM provides ground for the instrument cluster malfunction indicator lamp on circuit G3. Circuit G3 connects to cavity C17 of the PCM. Circuit F14 provides voltage for the lamp. The MIL displays the message CHECK ENGINE when illuminated.

For information regarding diagnostic trouble code access using the MIL lamp, refer to Group 14, Fuel Systems.

DESCRIPTION AND OPERATION (Continued)**SERVICE REMINDER INDICATOR LAMP**

The Powertrain Control Module (PCM) provides ground for the Service Reminder Indicator (SRI) lamp on circuit G24. Circuit G24 connects to cavity C18 of the PCM. Circuit F14 provides voltage for the lamp. The SRI lamp displays the message MAINT REQ'D.

TACHOMETER

The tachometer module in the instrument cluster operates the tachometer. The Powertrain Control Module (PCM) supplies the signal for the tachometer on circuit G21. Circuit G21 connects to cavity C31 of the PCM.

OUTPUT SHAFT SPEED SENSOR—FOUR SPEED AUTOMATIC TRANSMISSION

The output shaft speed sensor generates a signal indicating the speed of the transmission output shaft. Circuits T13 and T14 connect the sensor to the Powertrain Control Module (PCM). Circuit T13 connects to cavity B25 of the PCM. Circuit T14 connects to cavity B28.

WATER-IN-FUEL SENSOR—DIESEL ENGINE

The water-in-fuel sensor provides an input to the Powertrain Control Module (PCM) on circuit K1. Circuit K1 connects to cavity A27 of the PCM.

From circuit K1, the water-in-fuel sensor draws voltage from the PCM. The sensor is a variable resistor. As the amount of water in the fuel separator changes, the resistance in the sensor changes, causing a change in current draw.

The PCM provides a ground for the water-in-fuel sensor signal (circuit K1) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for signals from the following:

- Intake air temperature sensor
- Vehicle speed sensor
- Battery temperature sensor
- Crankshaft position sensor
- Throttle position sensor

INTAKE AIR TEMPERATURE SENSOR—DIESEL ENGINE

The intake air temperature sensor provides an input to the Powertrain Control Module (PCM) on circuit K21. Circuit K21 connects to cavity A15 of the PCM.

From circuit K21, the intake air temperature sensor draws voltage from the PCM. The sensor is a variable resistor. As intake air temperature changes,

the resistance in the sensor changes, causing a change in current draw.

The PCM provides a ground for the intake air temperature sensor signal (circuit K21) through circuit K4. Circuit K4 connects to cavity A4 of the PCM.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for the signals from the following:

- Water-in-fuel sensor
- Engine speed sensor
- Throttle position sensor
- Battery temperature sensor
- Vehicle speed sensor

ENGINE SPEED SENSOR—DIESEL ENGINE

Circuit K6 supplies 5 volts from the Powertrain Control Module (PCM) to the engine speed sensor. The K6 circuit connects to cavity A17 of the PCM connector.

Circuit K24 from the engine speed sensor provides an input signal to the PCM. The K24 circuit connects to cavity A8 of the PCM connector.

The PCM provides a ground for the engine speed sensor signal (circuit K24) through circuit K4. Circuit K4 connects to cavity A4 of the PCM connector.

HELPFUL INFORMATION

Circuit K4 splices to supply ground for the signals from the following:

- Throttle position sensor
- Water-in-fuel sensor
- Vehicle speed sensor
- Intake air temperature sensor

FUEL HEATER RELAY—DIESEL ENGINE

When the ignition switch is in the START or RUN position, it connects circuit A1 from fuse 3 in the PDC to circuit A21. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 supplies battery voltage to the coil side of the fuel heater relay. Circuit Z12 provides ground for the coil side of the relay.

Circuit A12 from the Power Distribution Center (PDC) supplies battery voltage to the contact side of the fuel heater relay. When voltage is present on circuit F18, the relay energizes and its contacts close to connect circuits A12 and A93.

Circuit A93 supplies power to the fuel heater. Circuit Z12 provides ground for the fuel heater.

FUEL SHUT DOWN RELAY—DIESEL ENGINE

When the engine starter motor relay energizes, its contacts close and connect circuit A2 from fuse 2 in the Power Distribution Center (PDC) to circuit T40. Circuit T40 supplies battery voltage to the engine starter motor solenoid and to the coil side of the fuel

DESCRIPTION AND OPERATION (Continued)

shut down relay. Circuit Z12 provides ground for the coil side of the relay.

Circuit A18 from the Power Distribution Center (PDC) supplies battery voltage to the contact side of the fuel shut down relay. When voltage is present on circuit T40, the relay energizes and its contacts close to connect circuits A18 and A123. Circuit A123 supplies power to one of the two coils in the fuel shut down solenoid.

When circuit A123 energizes, the fuel shut down solenoid raises the injection pump shut down lever to the RUN position.

When the ignition switch is released to the RUN position, it connects circuit A1 from fuse 3 in the PDC to circuit A21. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 supplies battery voltage to the second coil in the fuel shut down lever. When Circuit F18 energizes, the fuel shut down solenoid holds the injection pump shut down lever in the RUN position.

Circuit Z12 provides ground for the fuel shut down solenoid. Refer to Group 14, Fuel Systems, for fuel shut down solenoid operation.

INTAKE MANIFOLD AIR HEATER RELAYS—DIESEL ENGINE

When the ignition switch is in the START or RUN position, it connects circuit A1 from fuse 3 in the PDC to circuit A21. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 supplies battery voltage to the coil side of each intake manifold air heater relay.

The Powertrain Control Module (PCM) provides ground for the coil in each relay on separate circuits. The PCM grounds first relay on circuit S21; it grounds the second relay on circuit S22.

When the first intake manifold air heater relay energizes, its contacts close and connect circuit A19 from the left battery positive terminal to circuit A58. Circuit A58 connects to the intake air heater.

When the second intake manifold air heater relay energizes, its contacts close and connect circuit A8 from the left battery positive terminal to circuit A122. Circuit A122 connects to the intake air heater.

The intake manifold air heaters are case grounded. Refer to Group 14, Fuel Systems, for intake manifold heater Pre-Heat and Post-Heat Cycles.

EGR SOLENOID—DIESEL ENGINE

When the Automatic Shut Down (ASD) relay energizes, it connects circuit A16 from fuse 4 in the Power Distribution Center (PDC) to circuit A142. Circuit A142 powers the EGR solenoid. The EGR control module provides ground for the solenoid on circuit K35.

EGR INTAKE AIR TEMPERATURE SENSOR—DIESEL ENGINE

The EGR intake air temperature sensor provides an input to the EGR Control Module (PCM) on circuit K321. Circuit K321 connects to cavity 4 of the EGR control module.

From circuit K321, the intake air temperature sensor draws voltage from the EGR control module. The sensor is a variable resistor. As intake air temperature changes, the resistance in the sensor changes, causing a change in current draw.

The PCM provides a ground for the intake air temperature sensor signal through circuit K204. Circuit K204 connects to cavity 5 of the EGR control module.

EGR ENGINE COOLANT TEMPERATURE SENSOR—DIESEL ENGINE

The EGR engine coolant temperature sensor provides an input to the EGR control module on circuit K2.

From circuit K2, the sensor draws voltage from the EGR control module. The sensor is a variable resistor. As coolant temperature changes, the resistance in the sensor changes, causing a change in current draw.

The EGR control module provides ground for the sensor signal (circuit K2) on circuit K304.

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

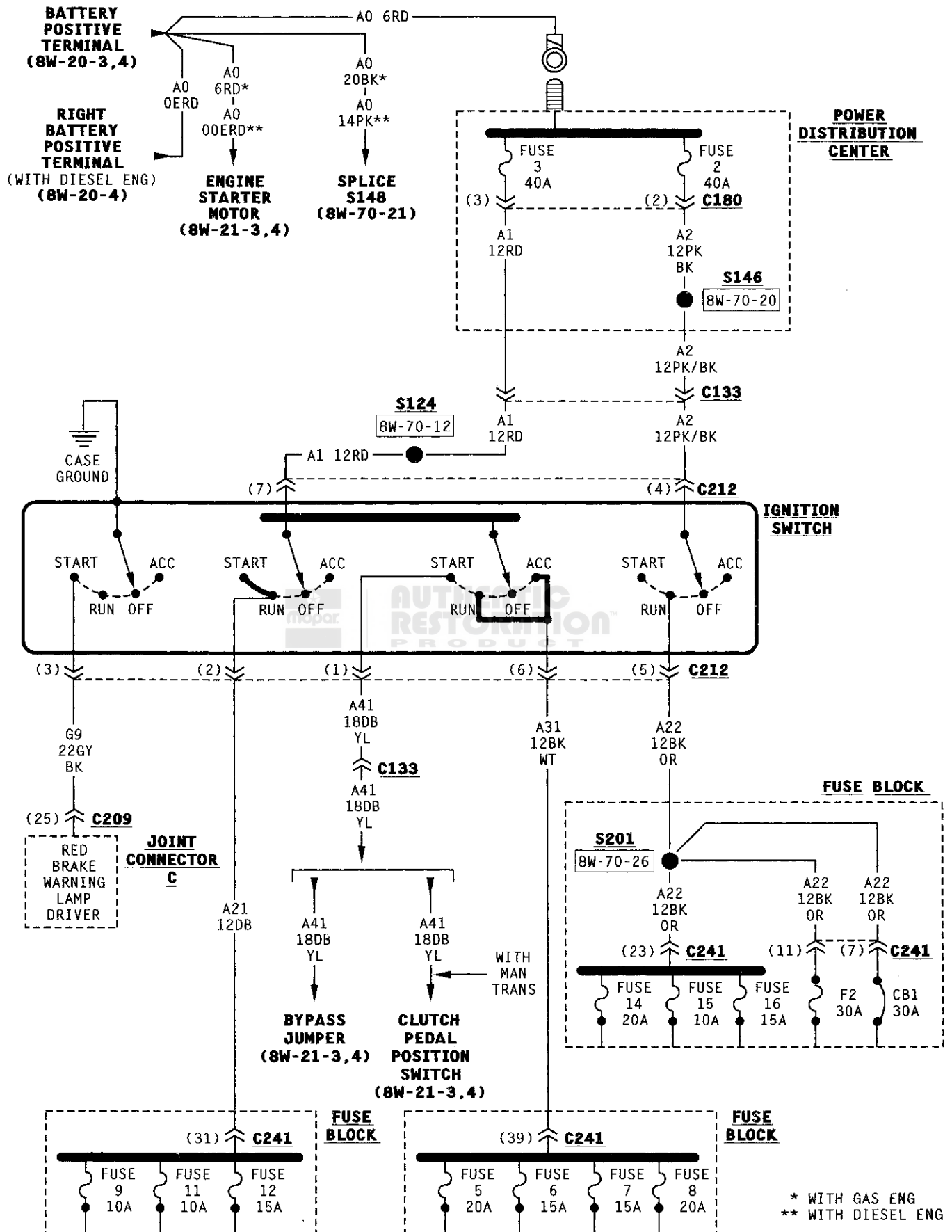
This section of the wiring diagrams has separate indexes for gasoline engines and diesel engines. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

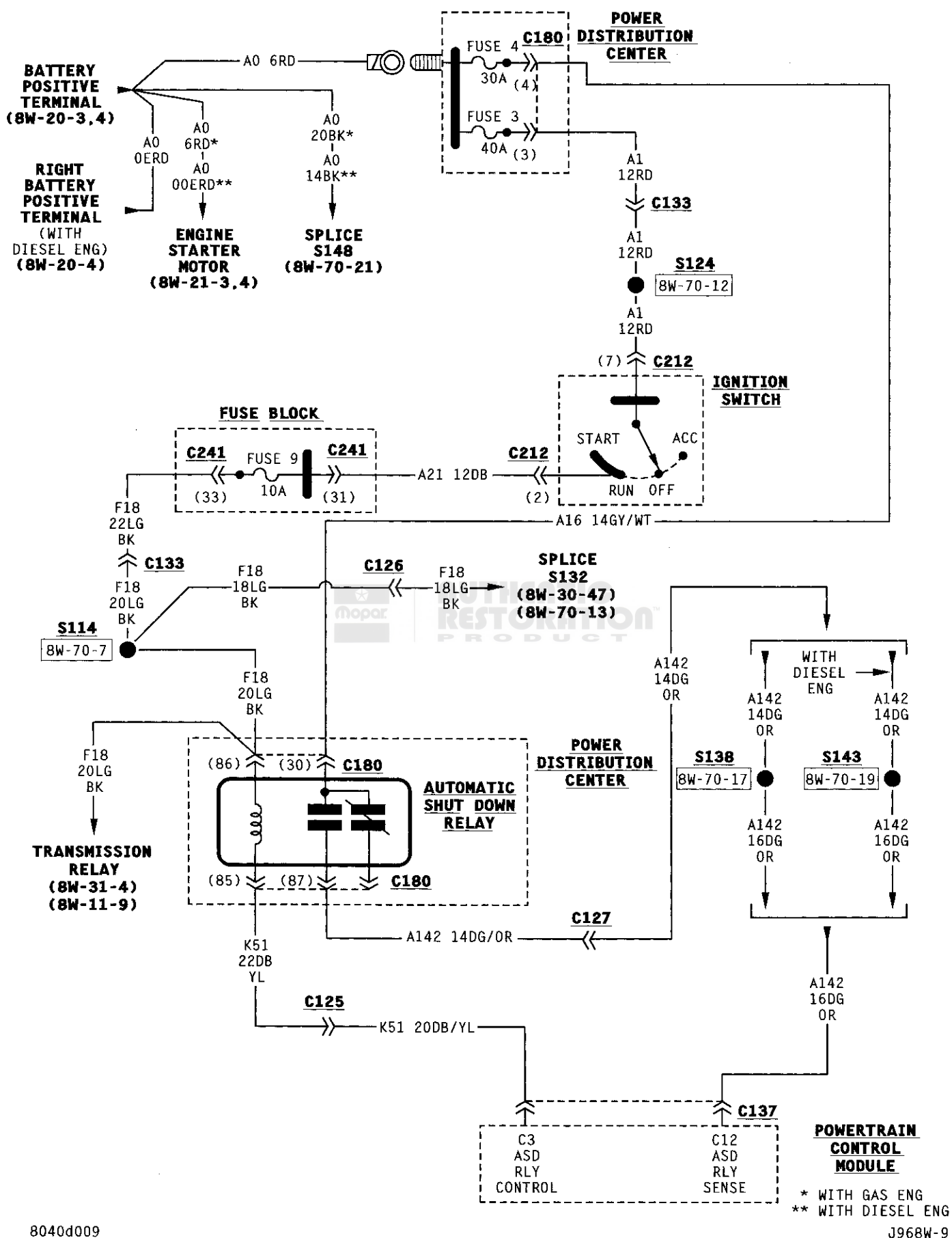
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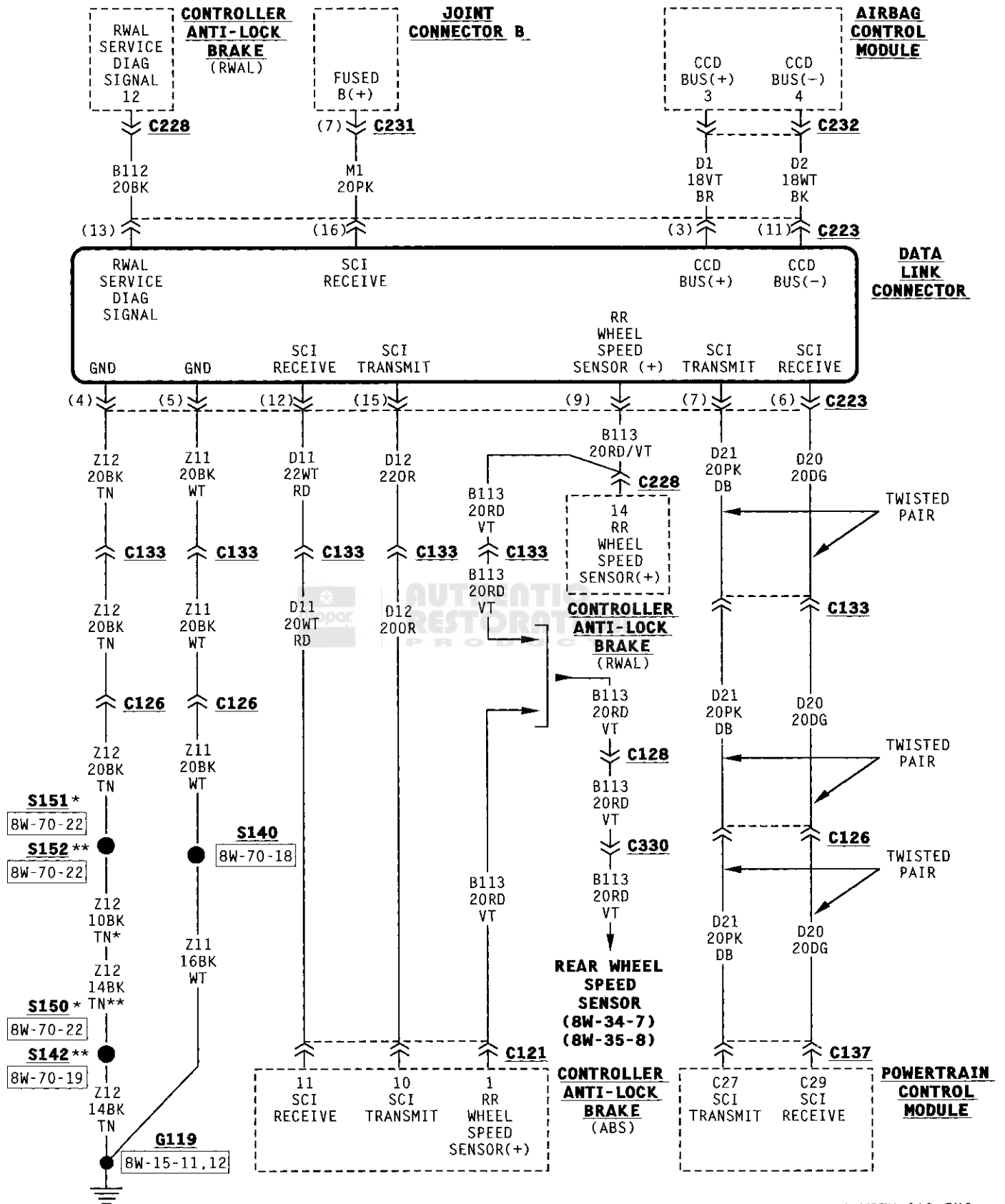
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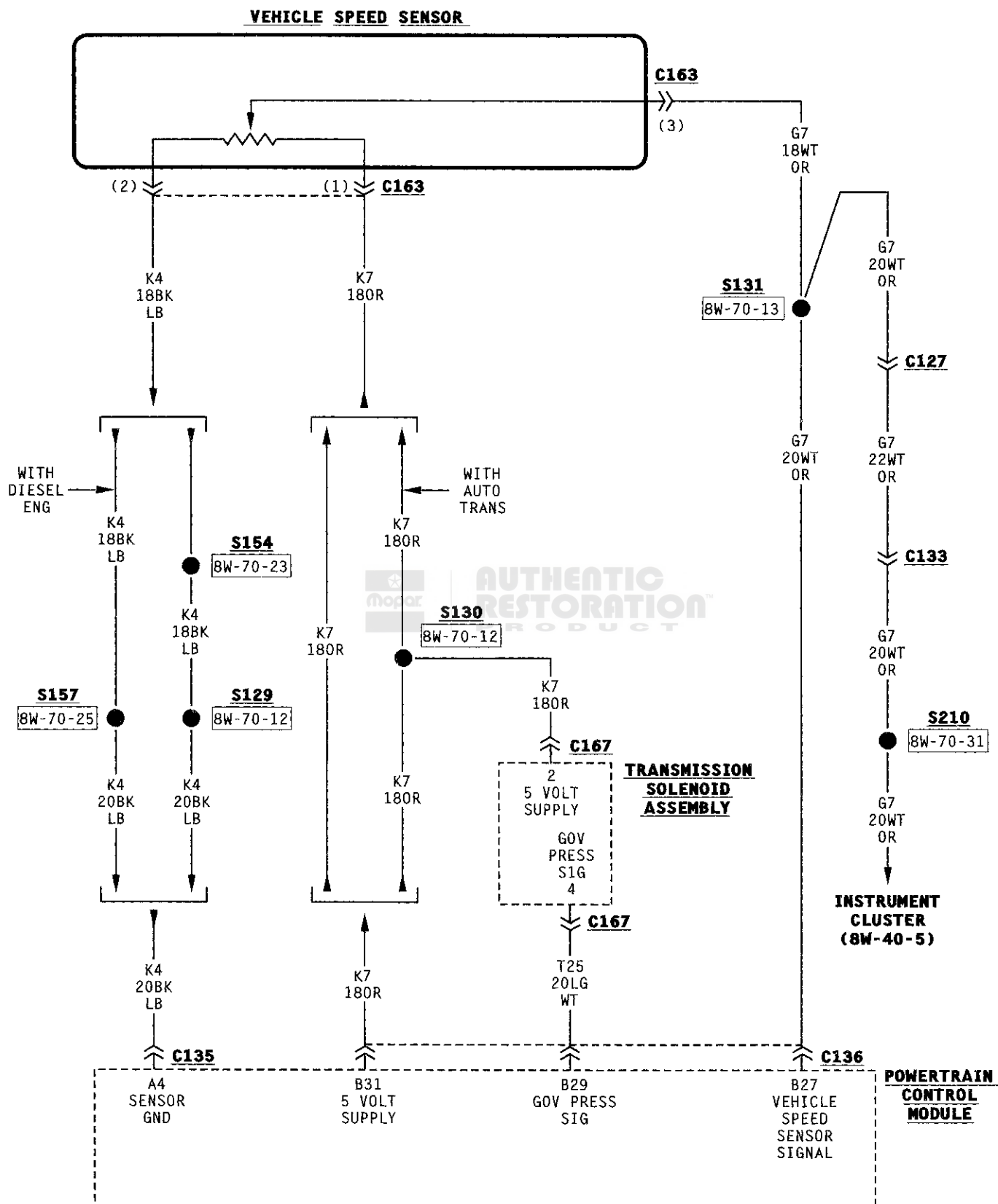
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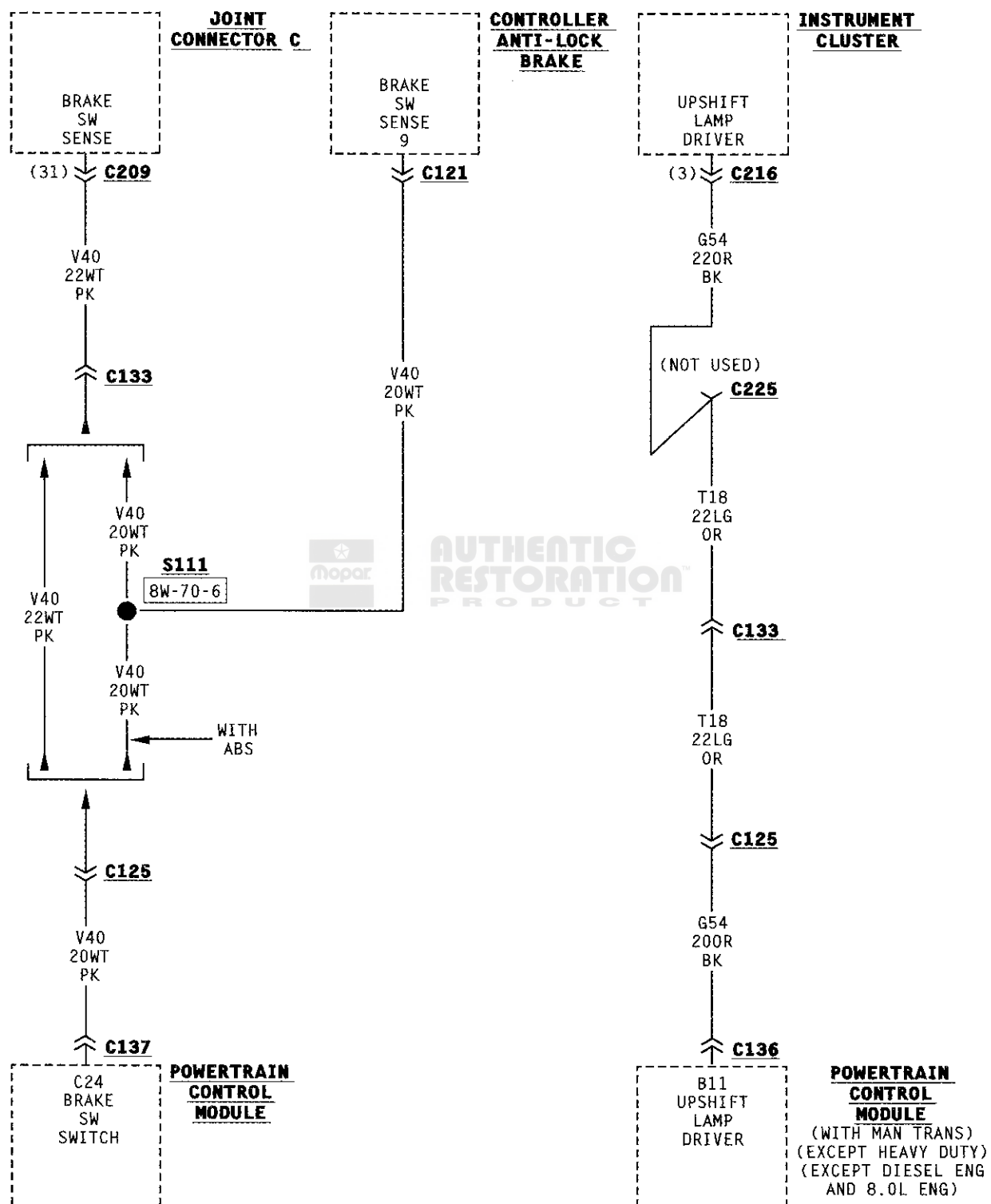


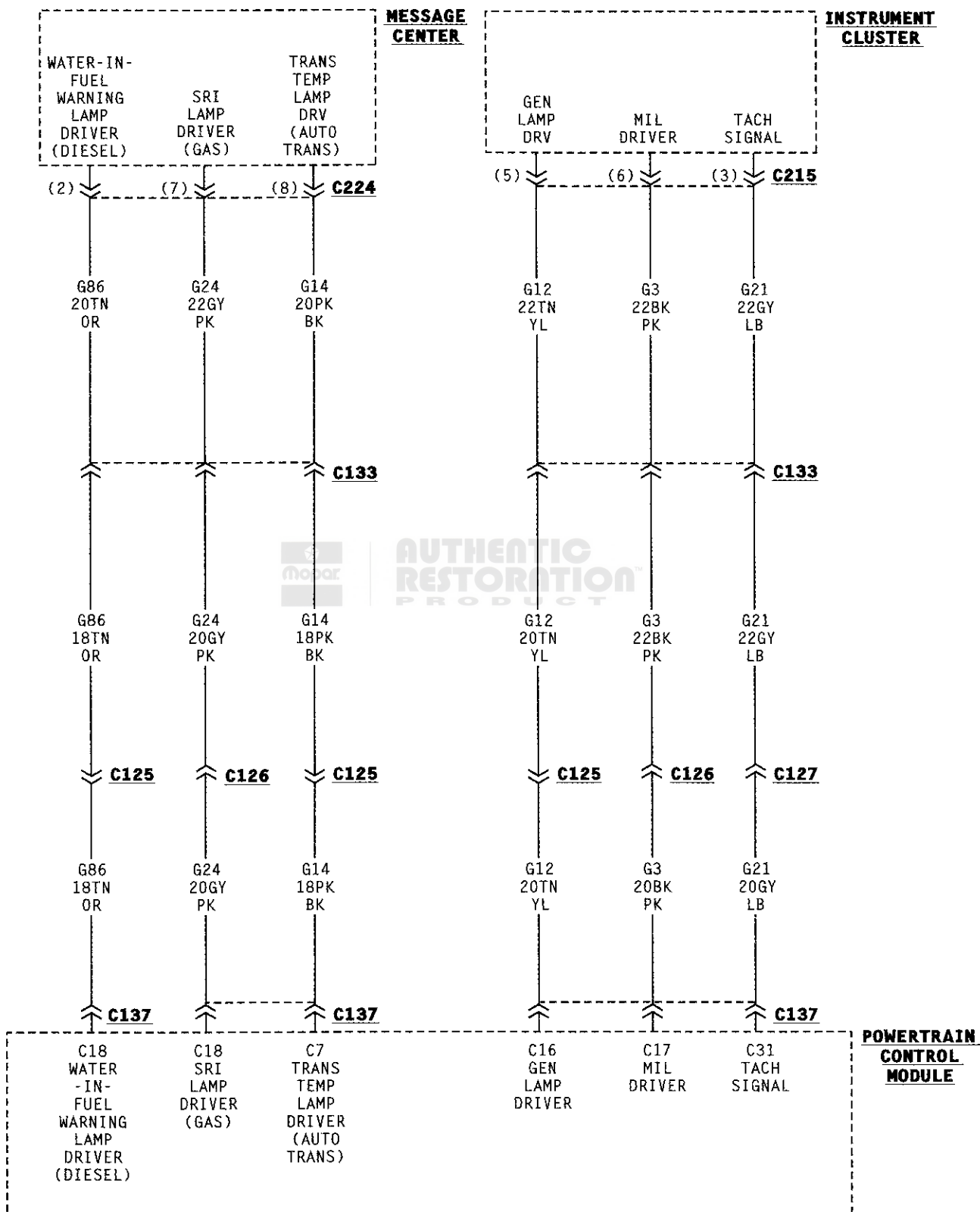


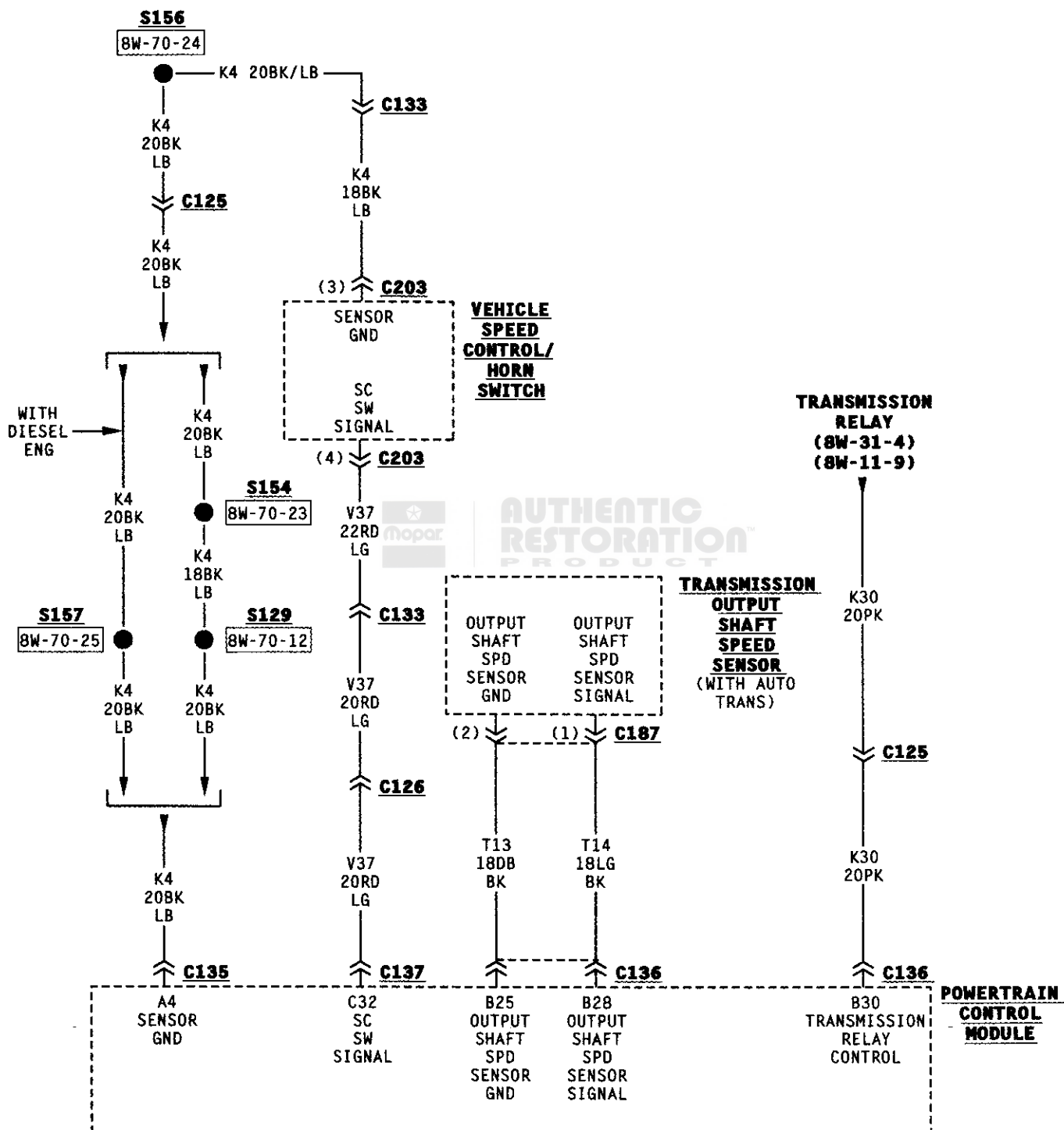


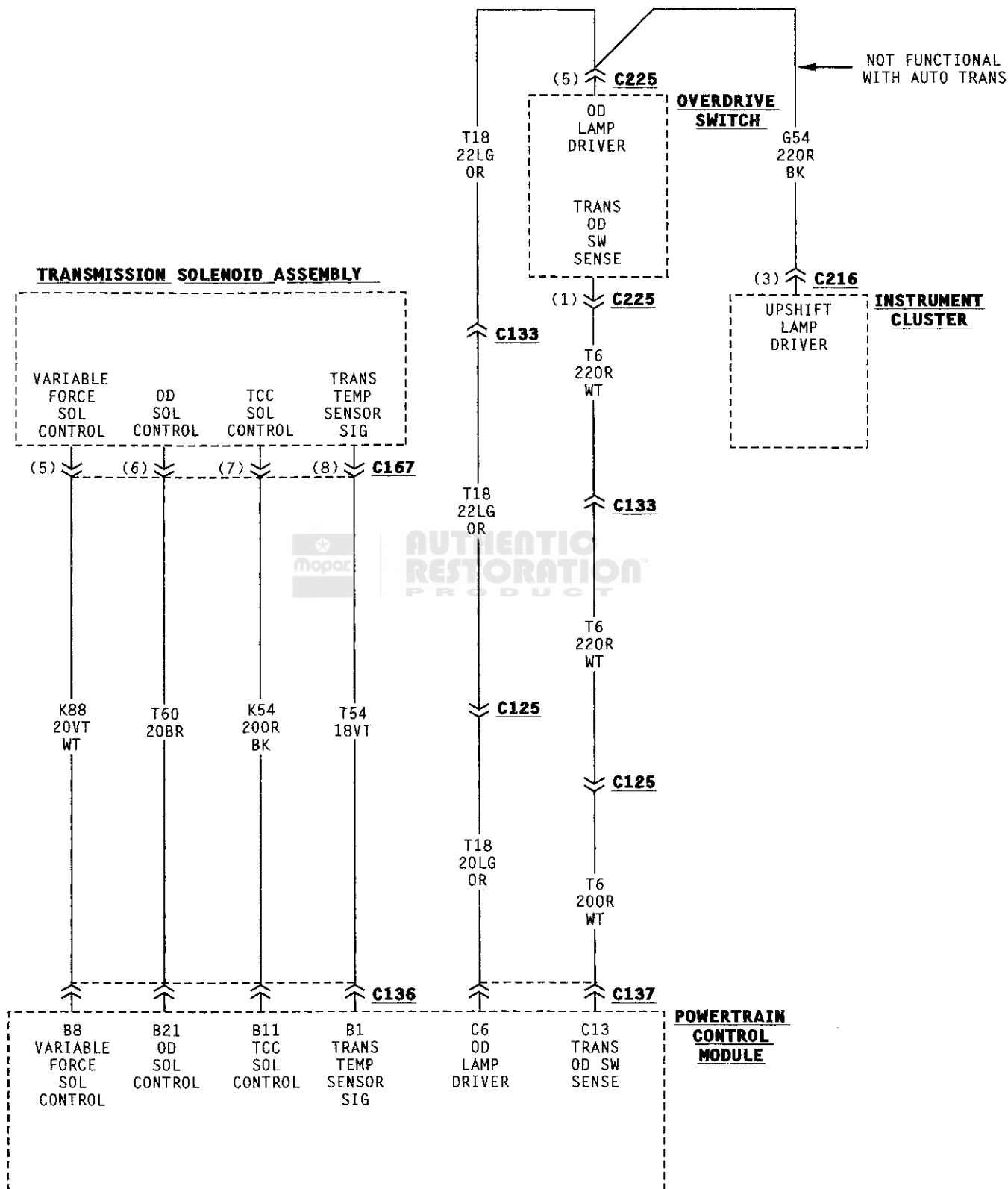
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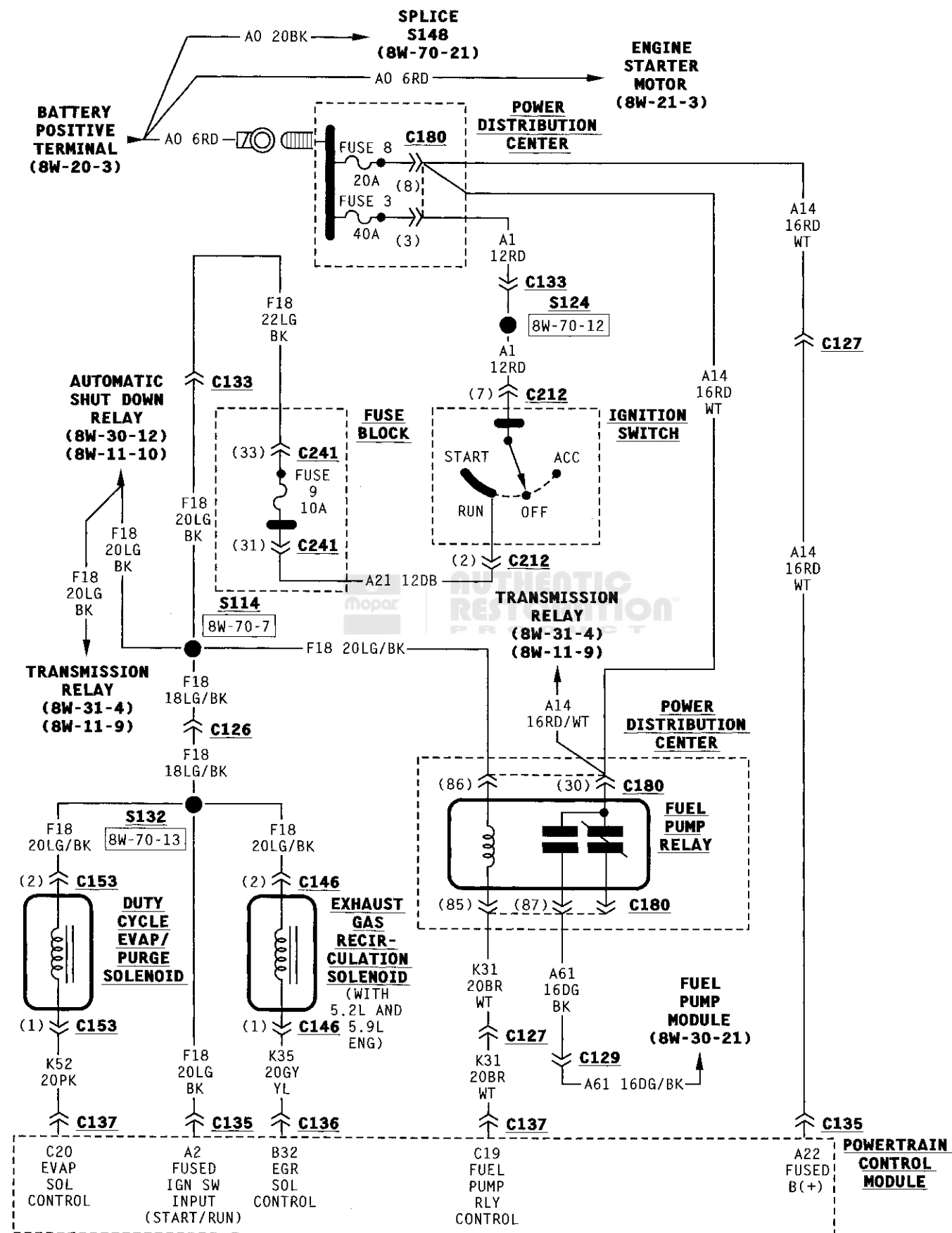


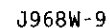


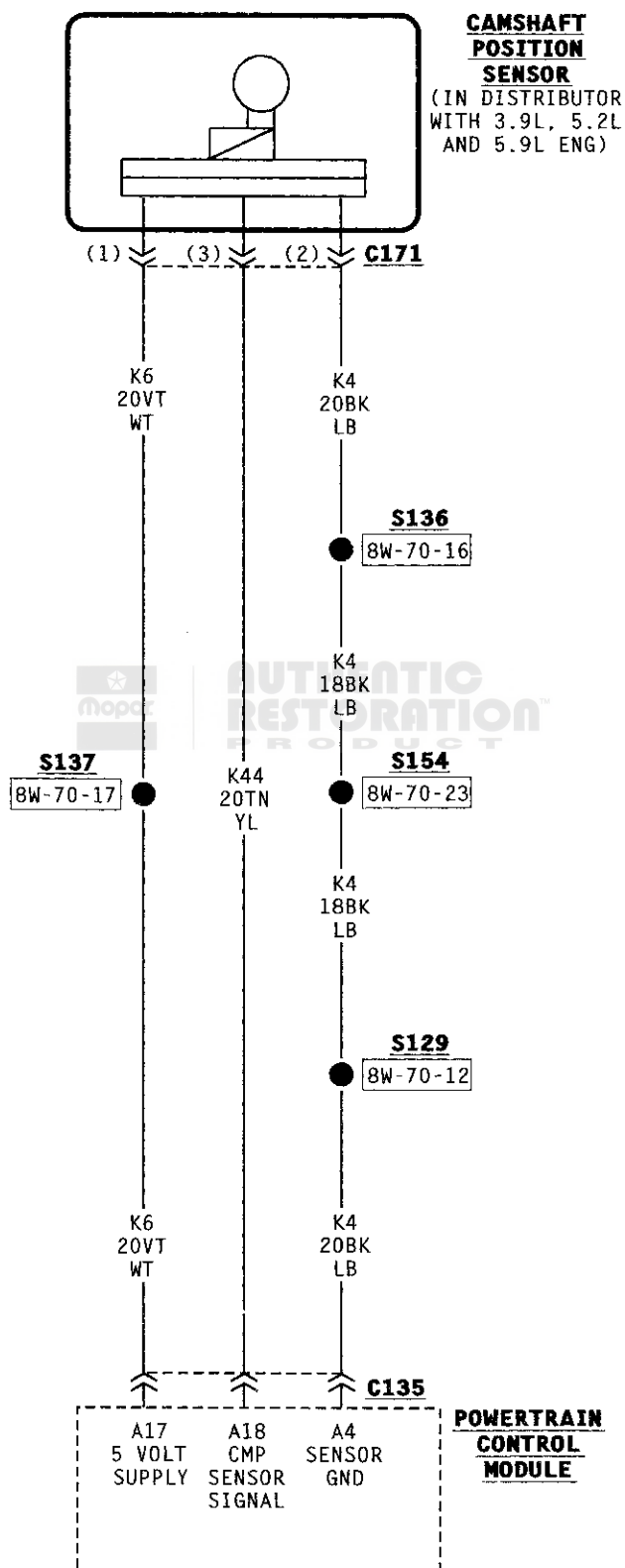


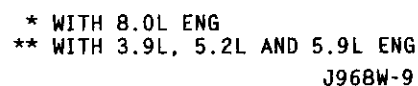


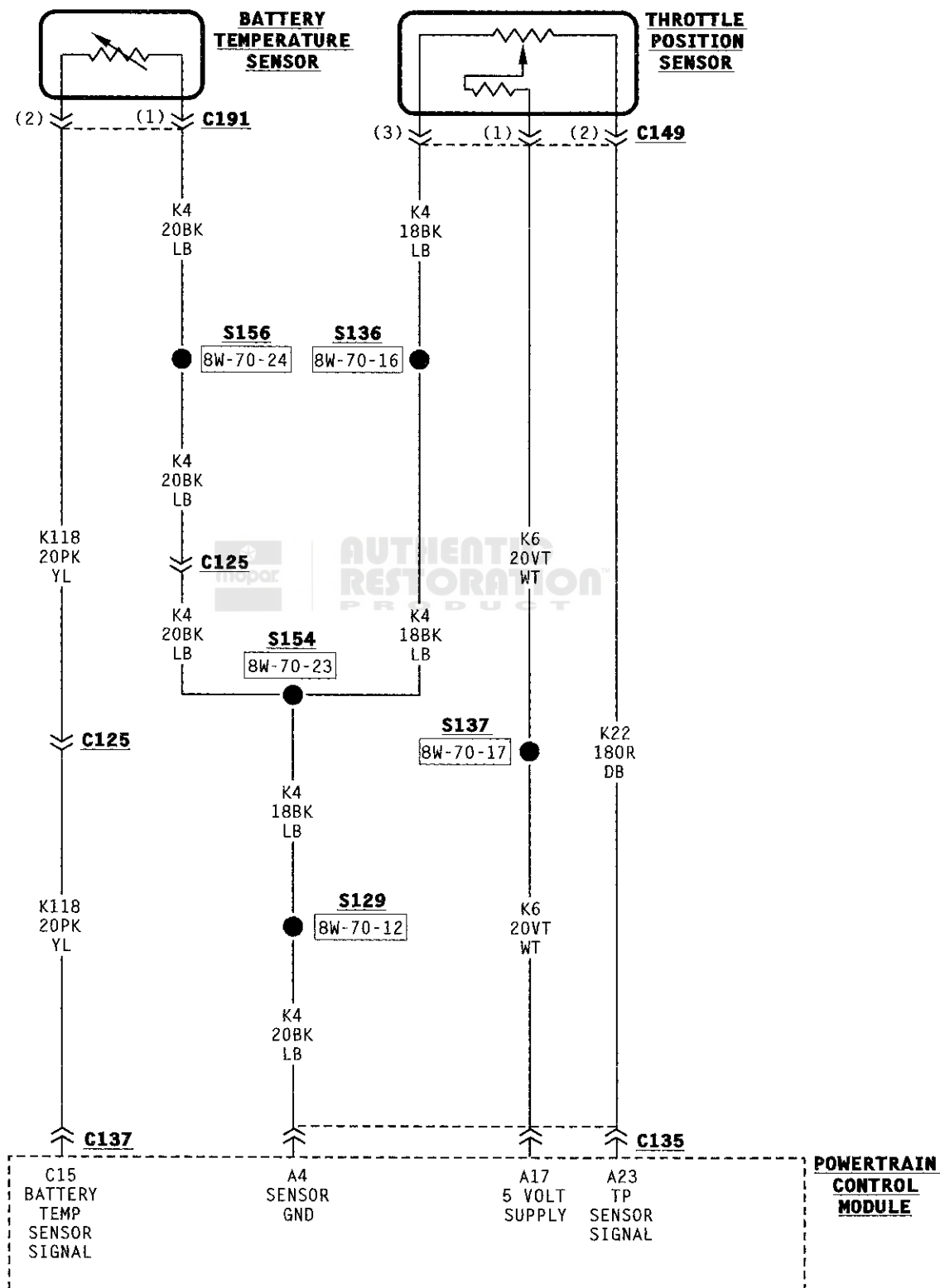


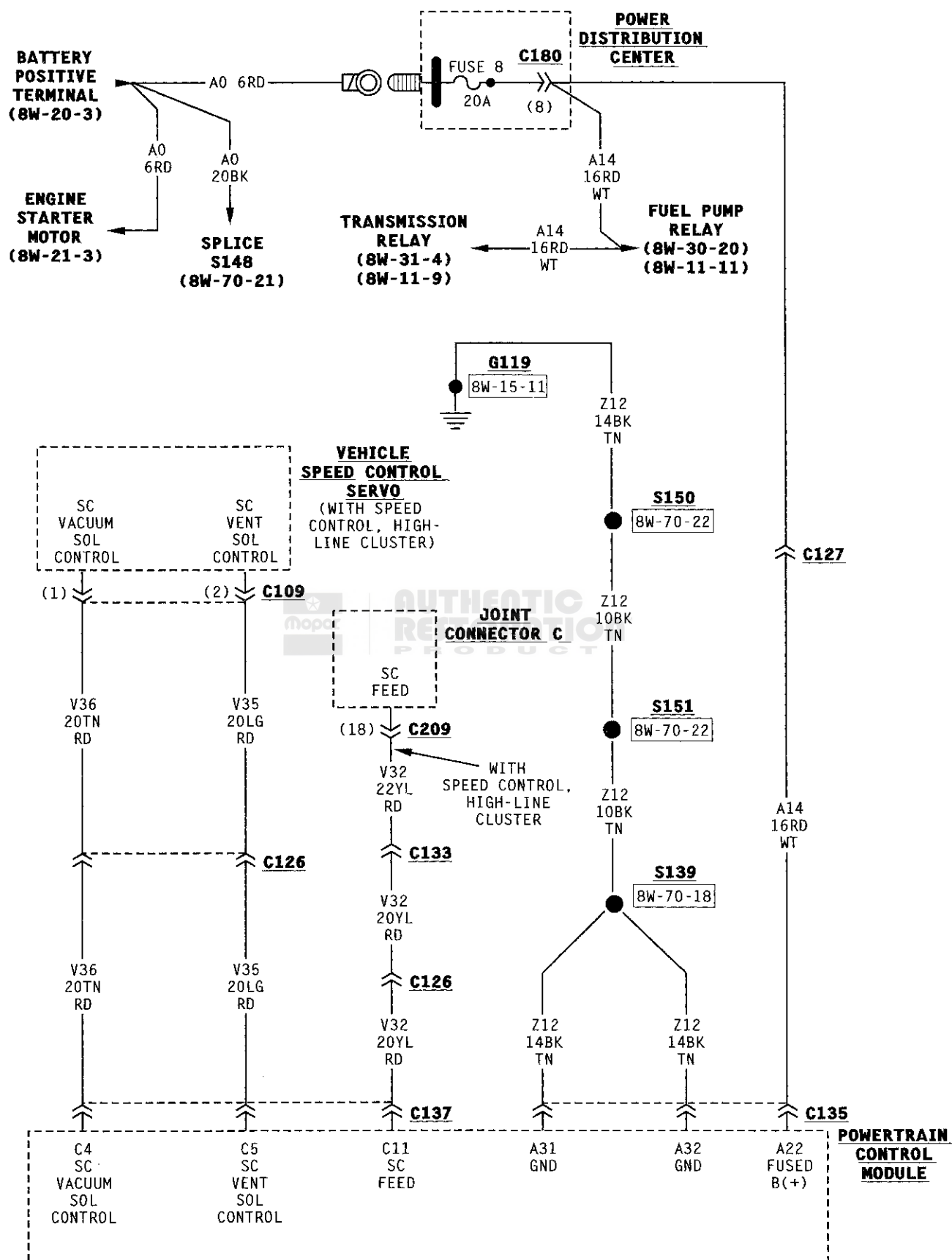


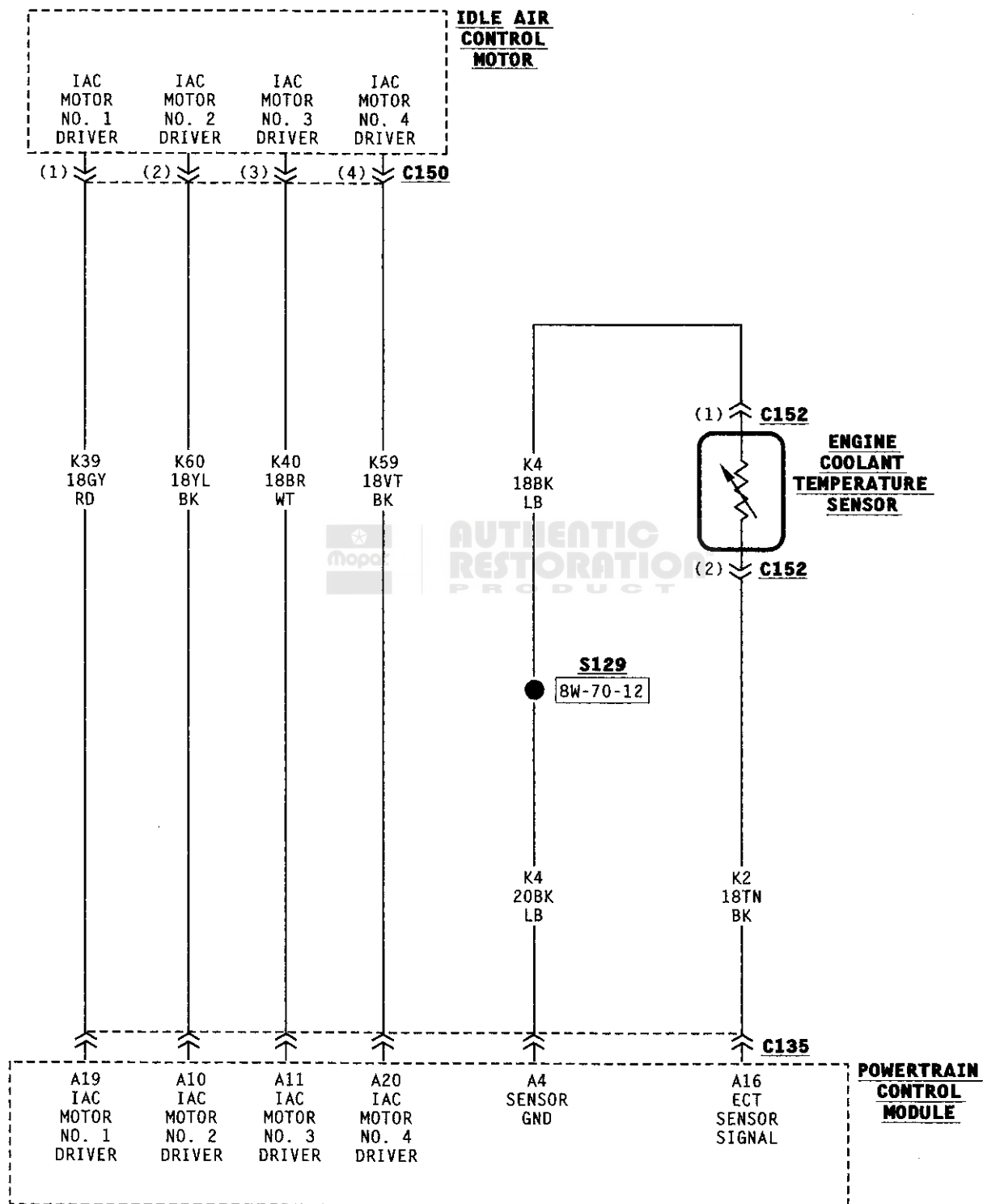


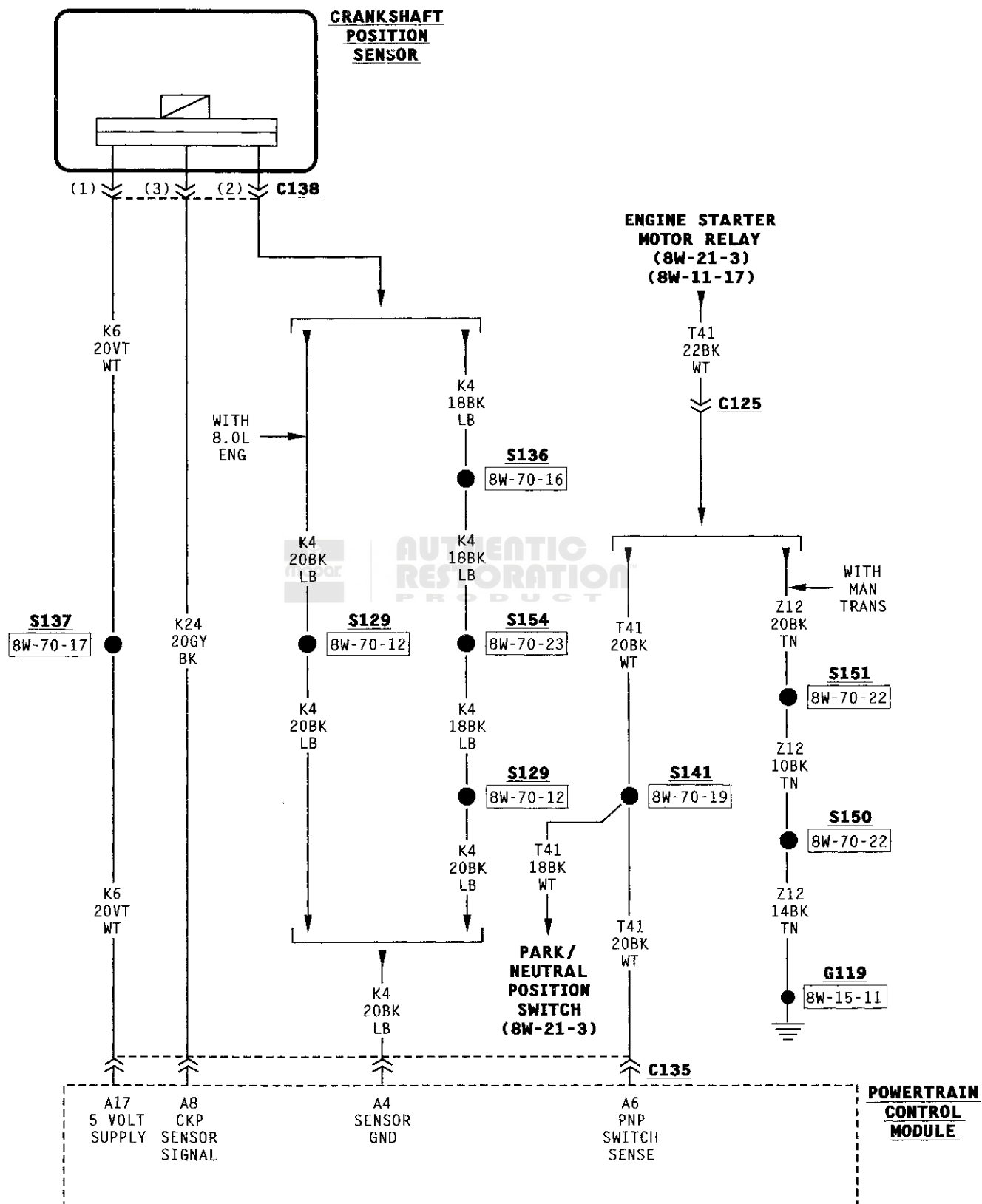


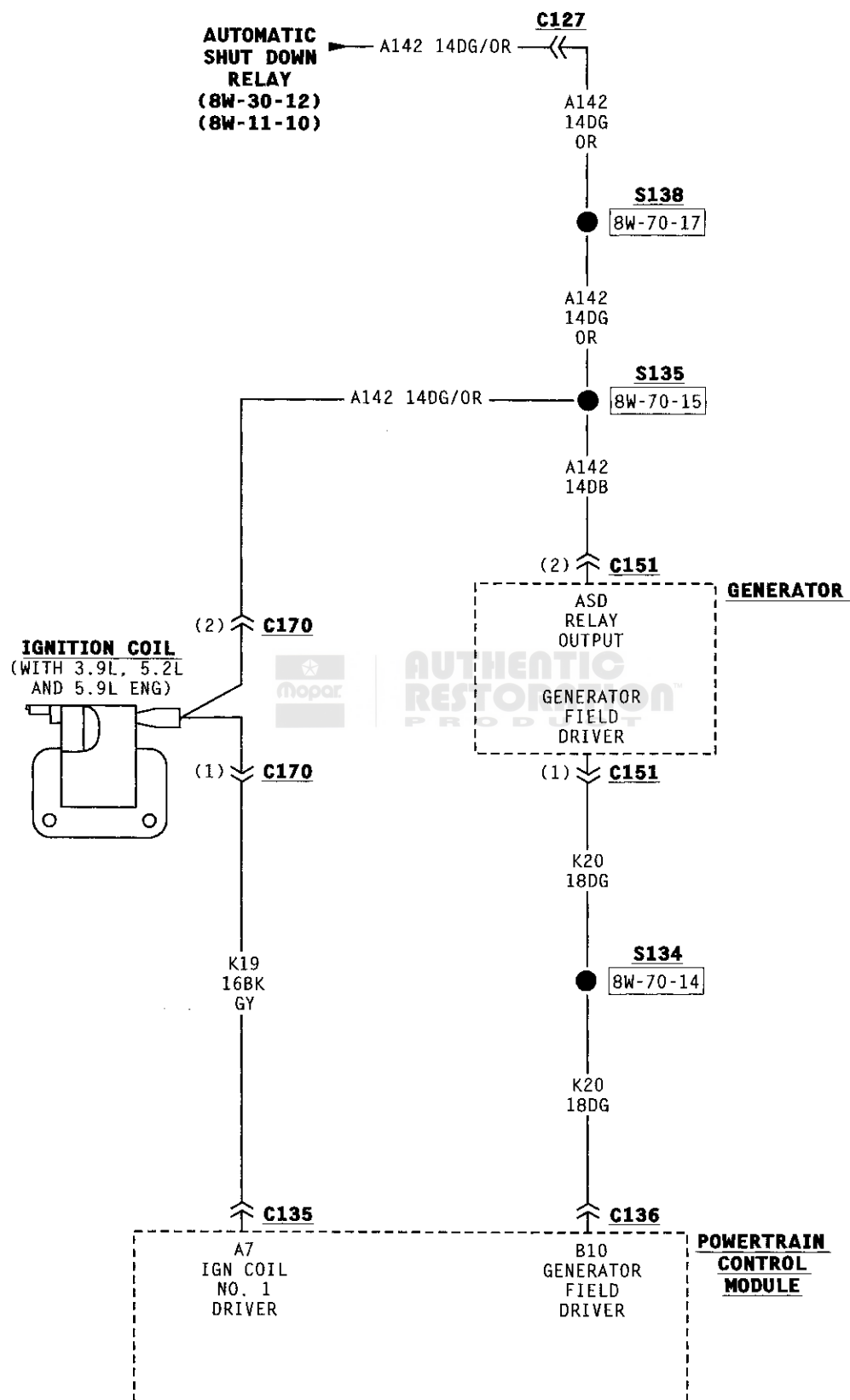


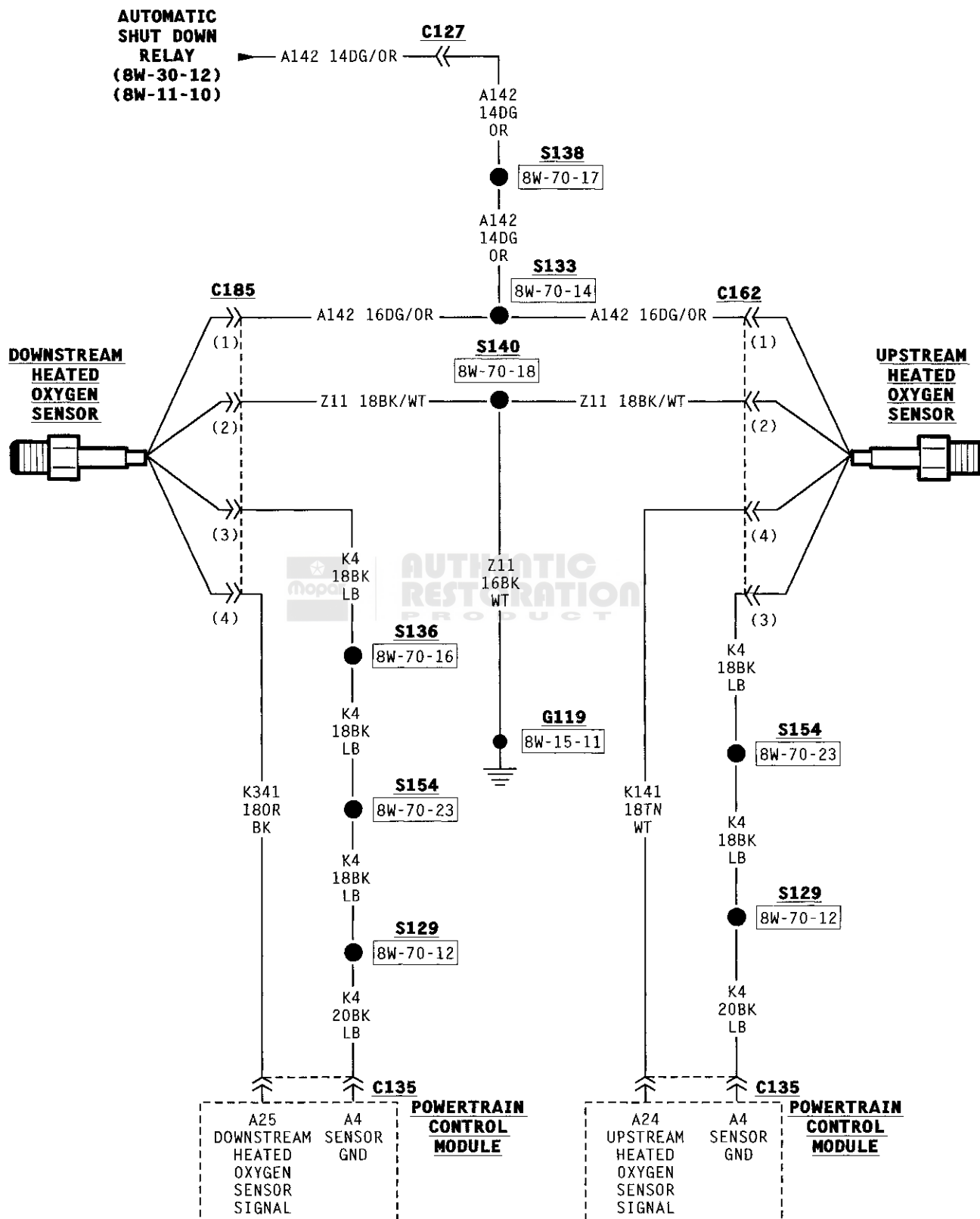




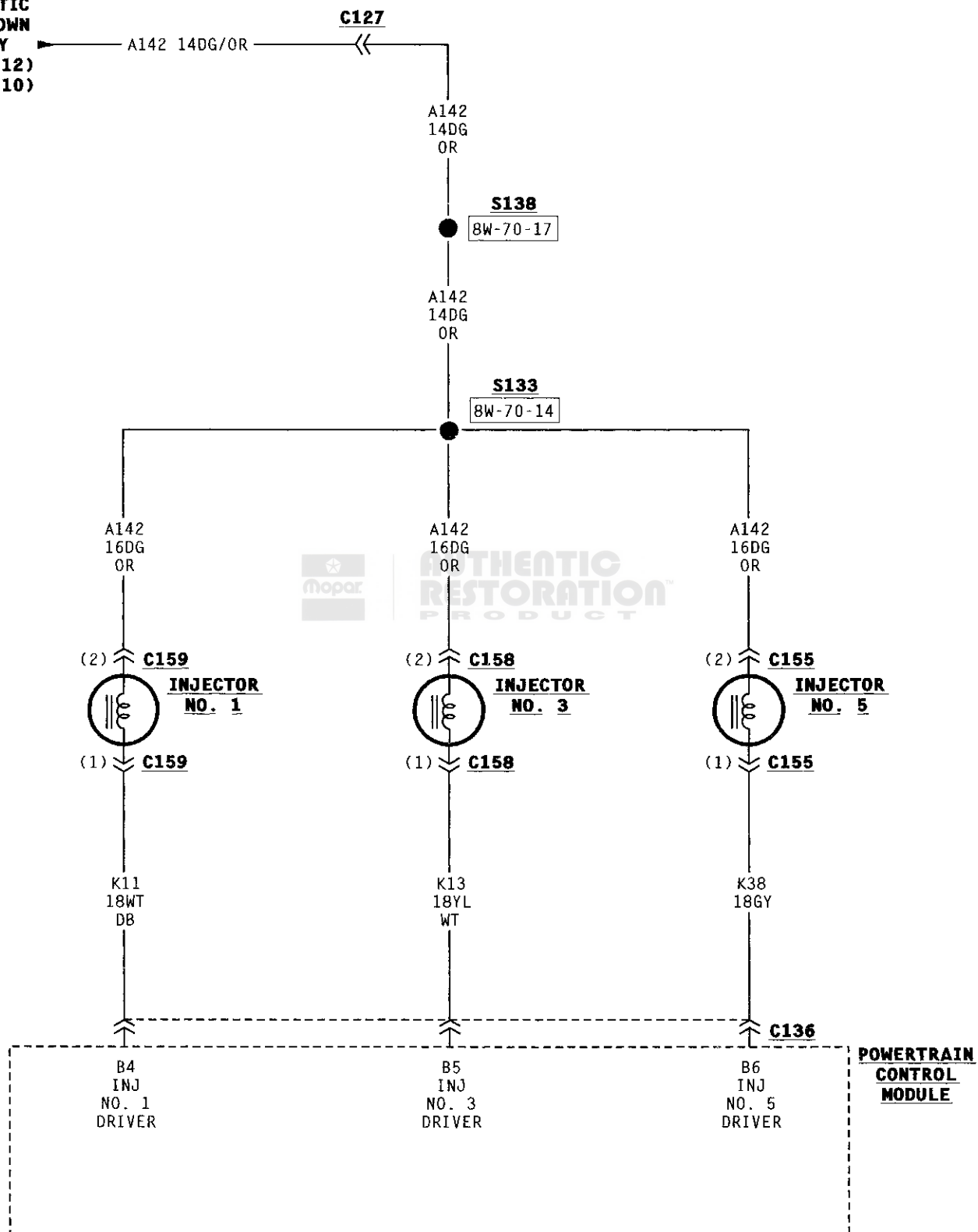


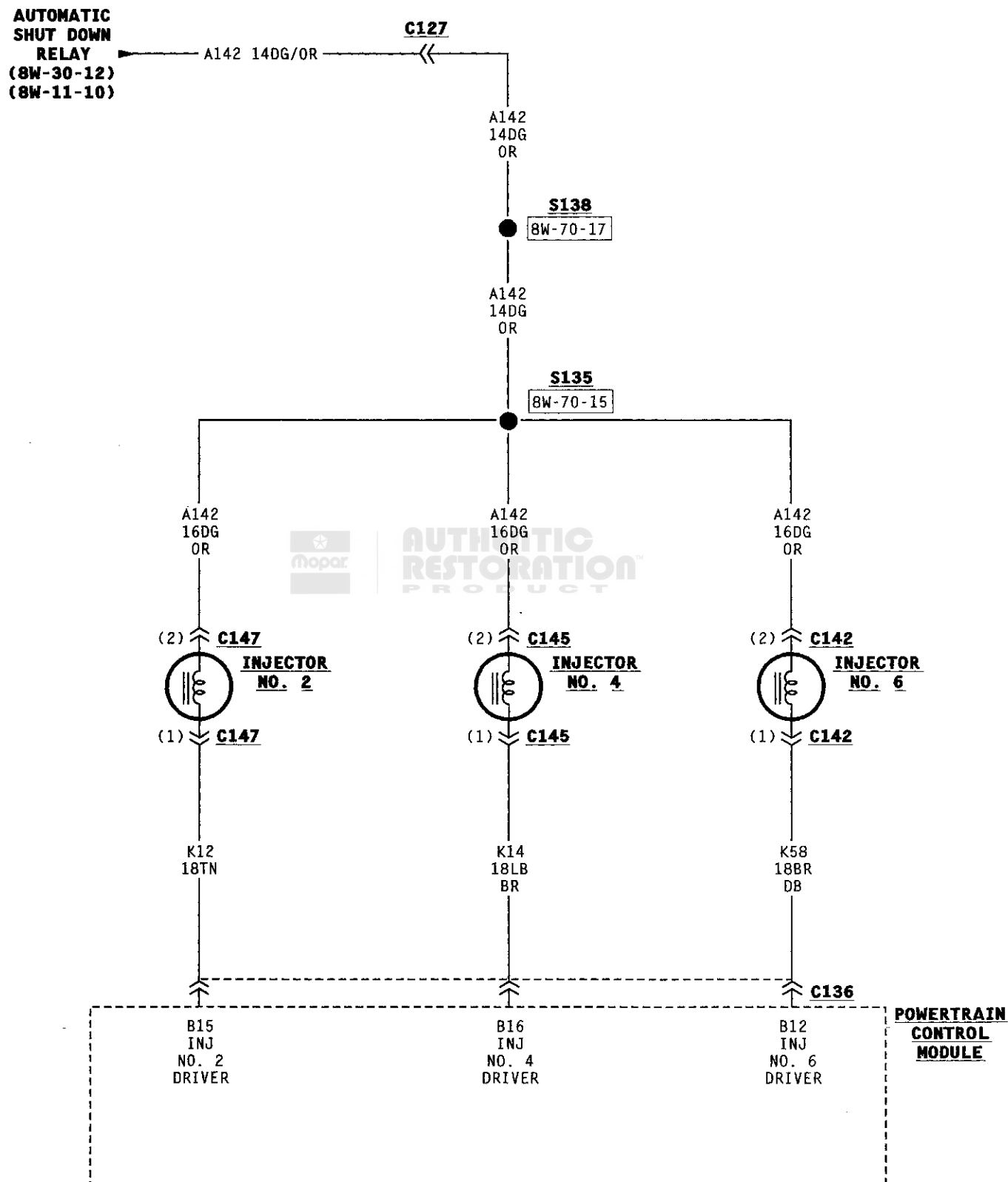


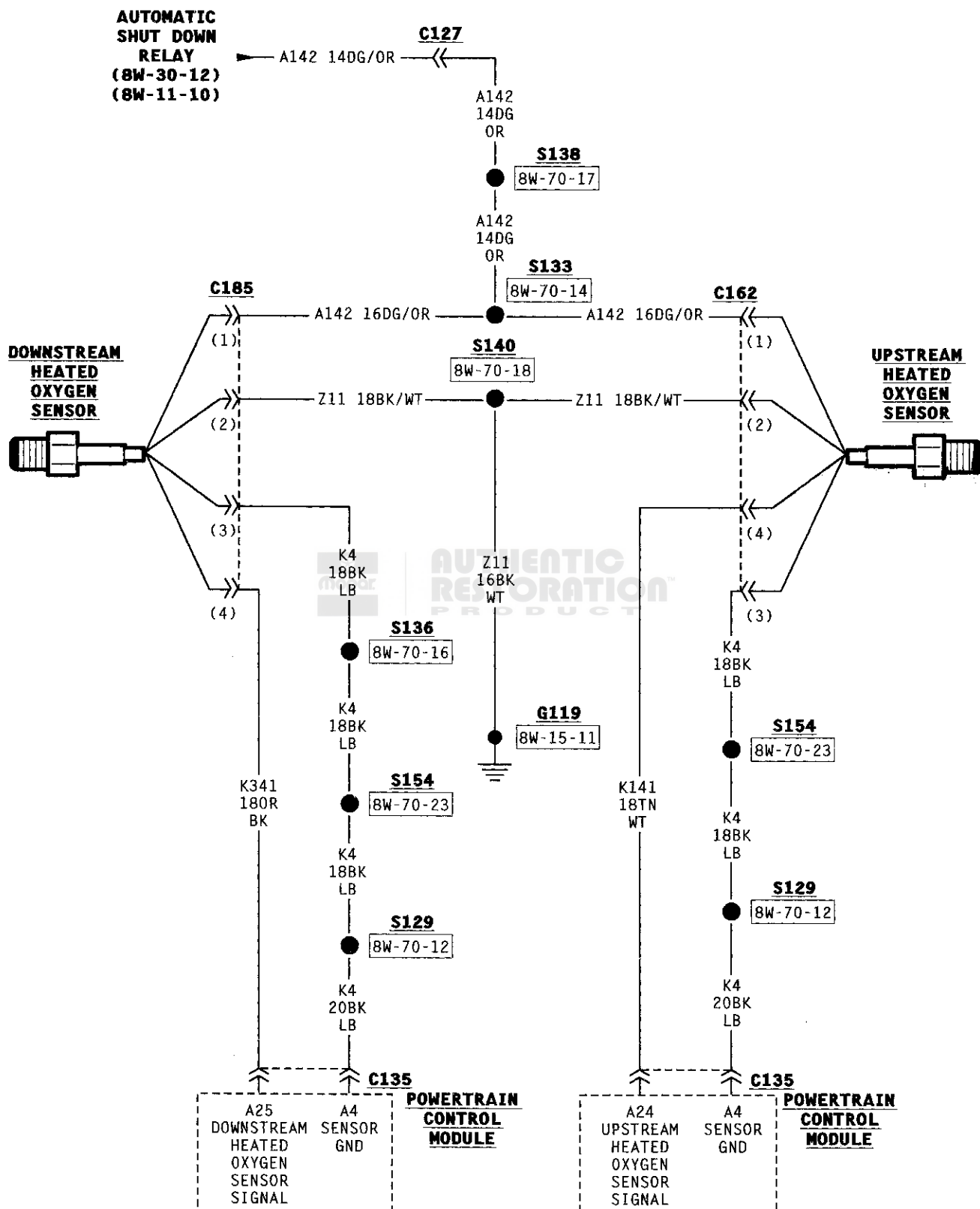


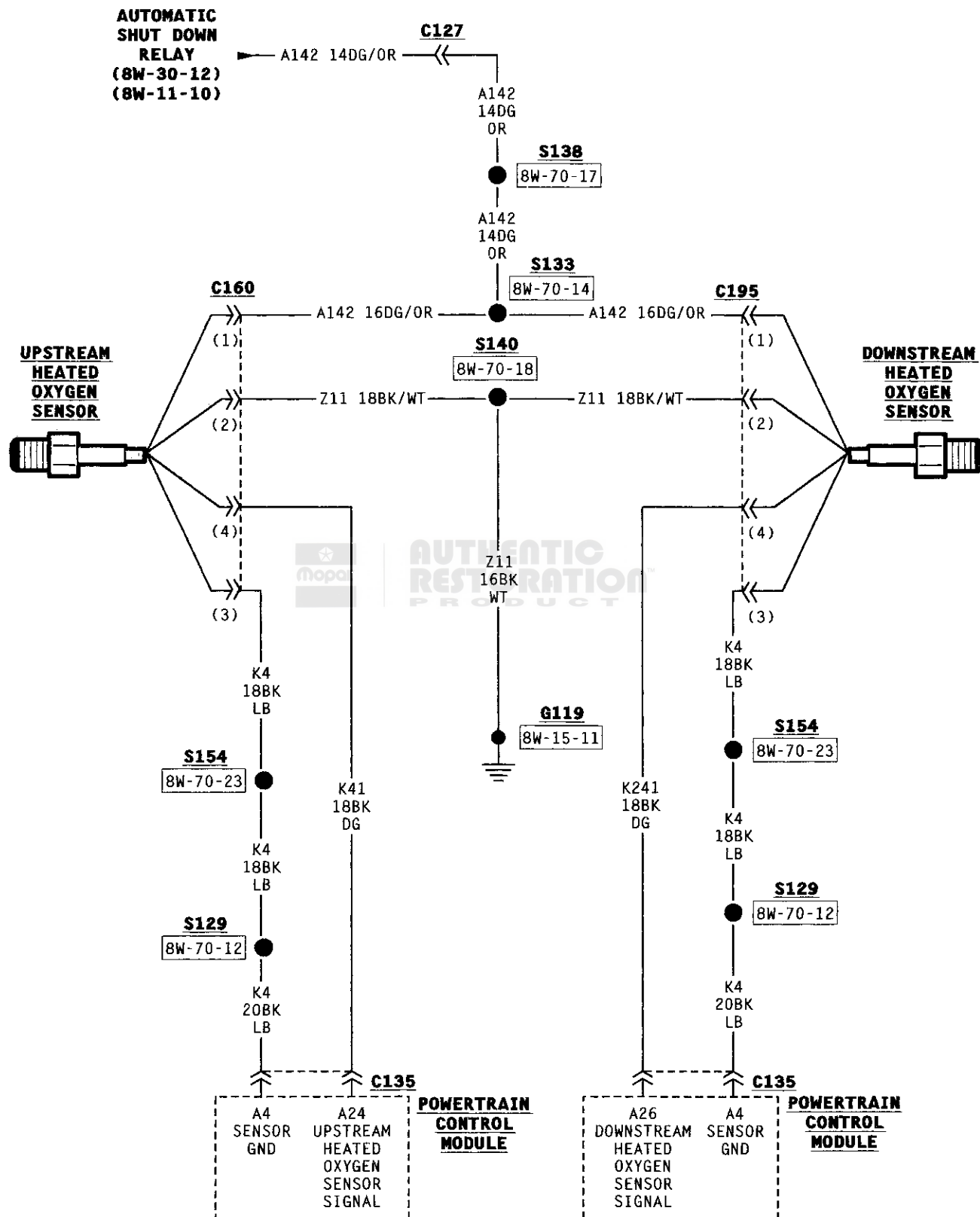


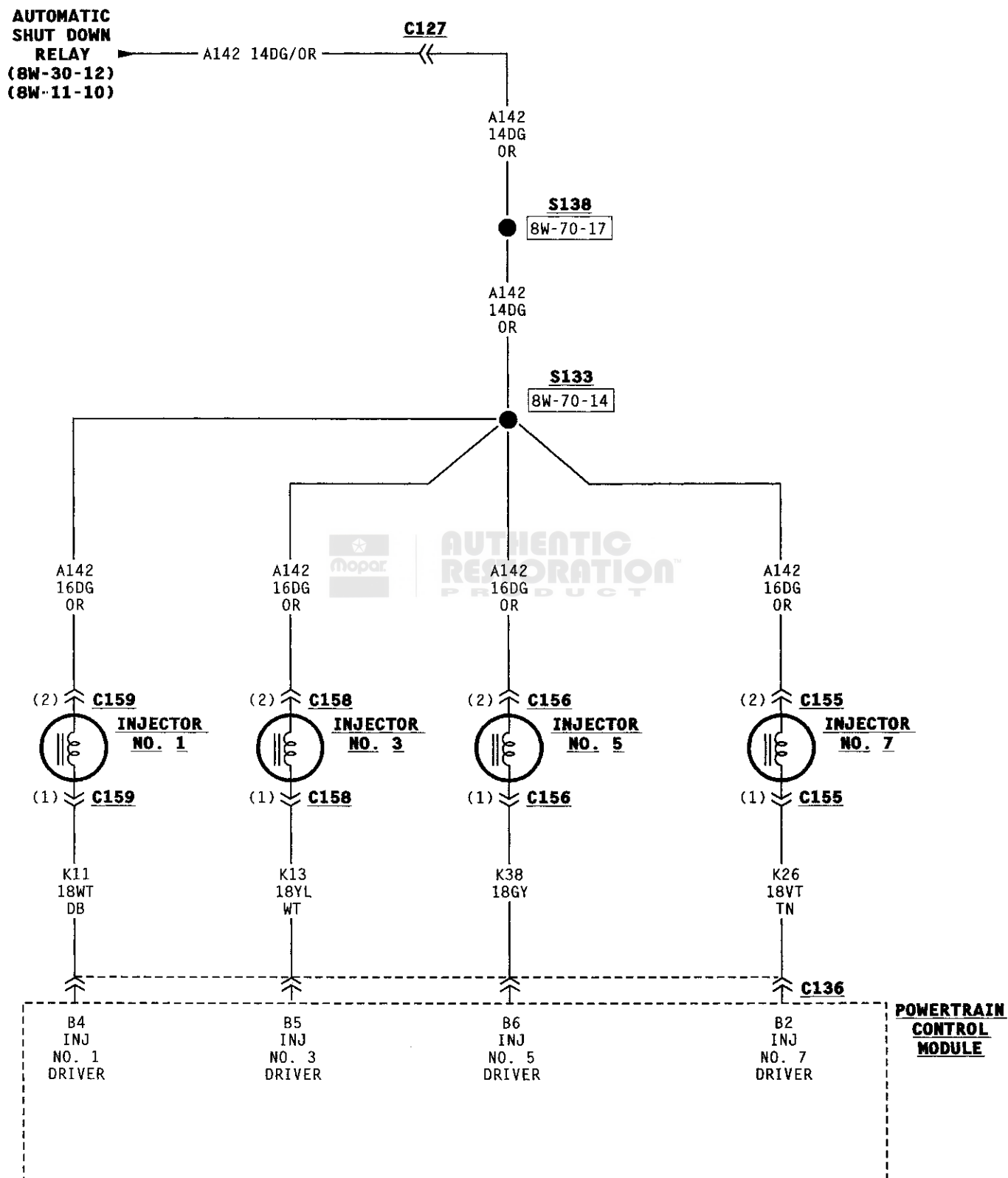
**AUTOMATIC
SHUT DOWN
RELAY**
(8W-30-12)
(8W-11-10)

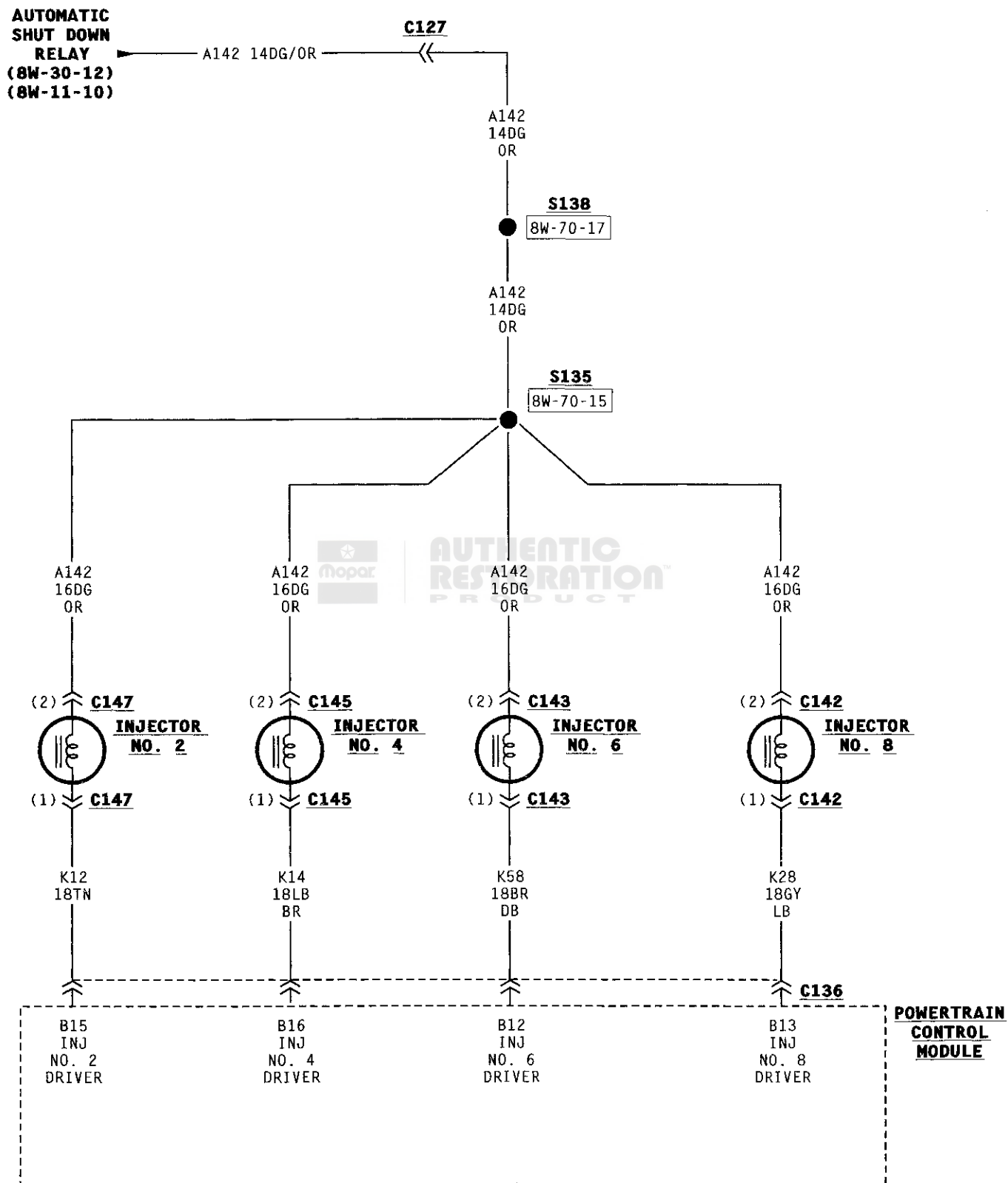




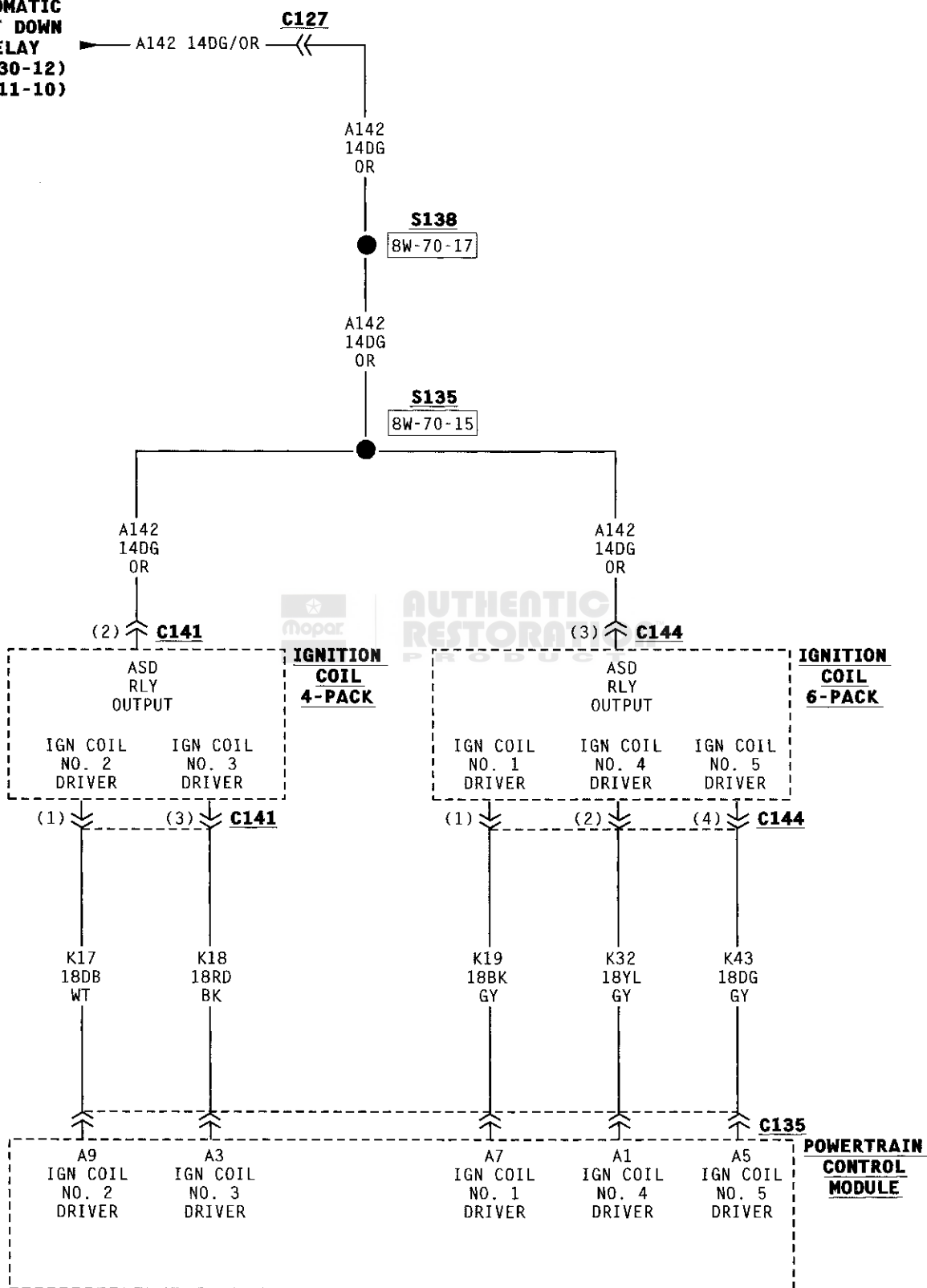


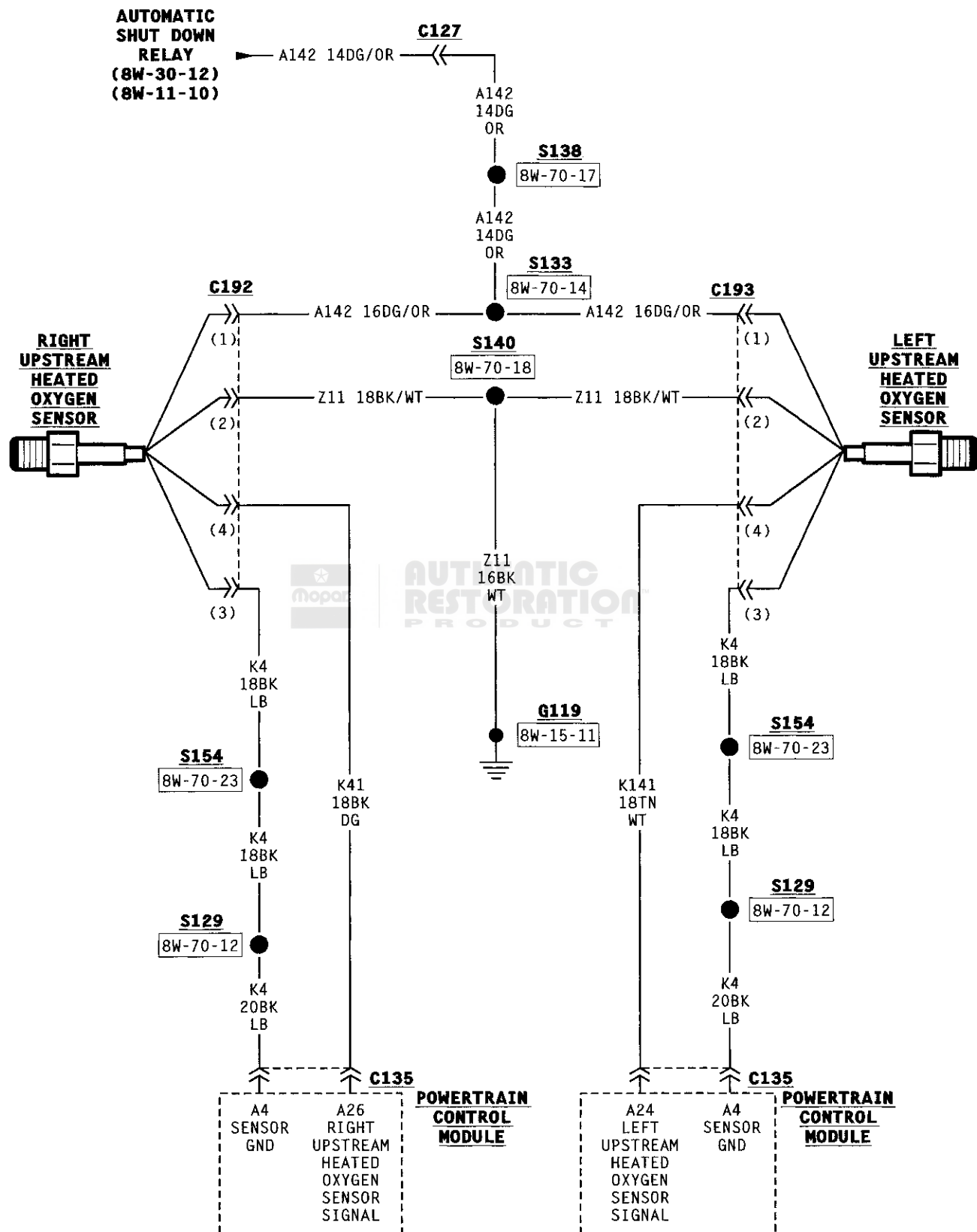


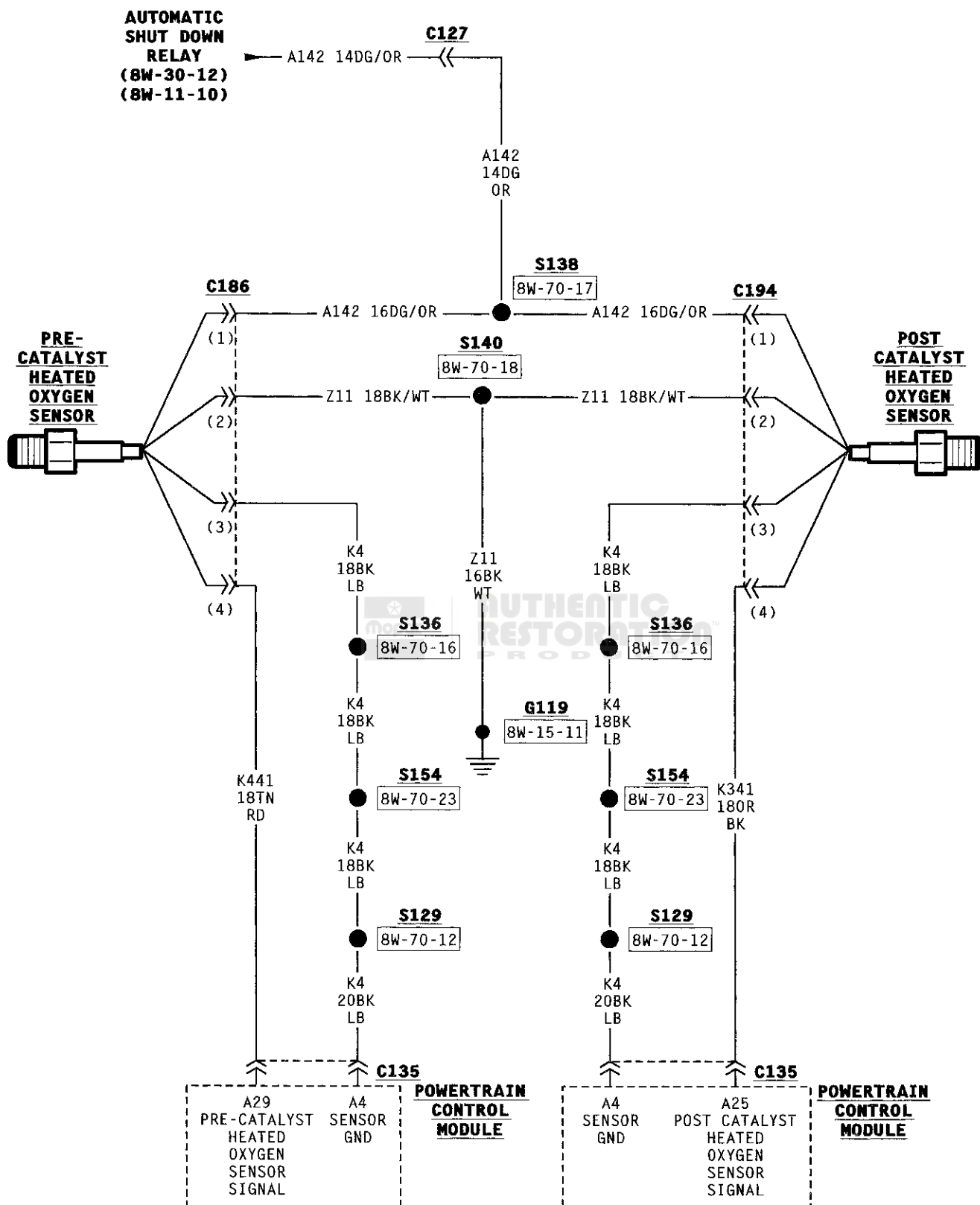


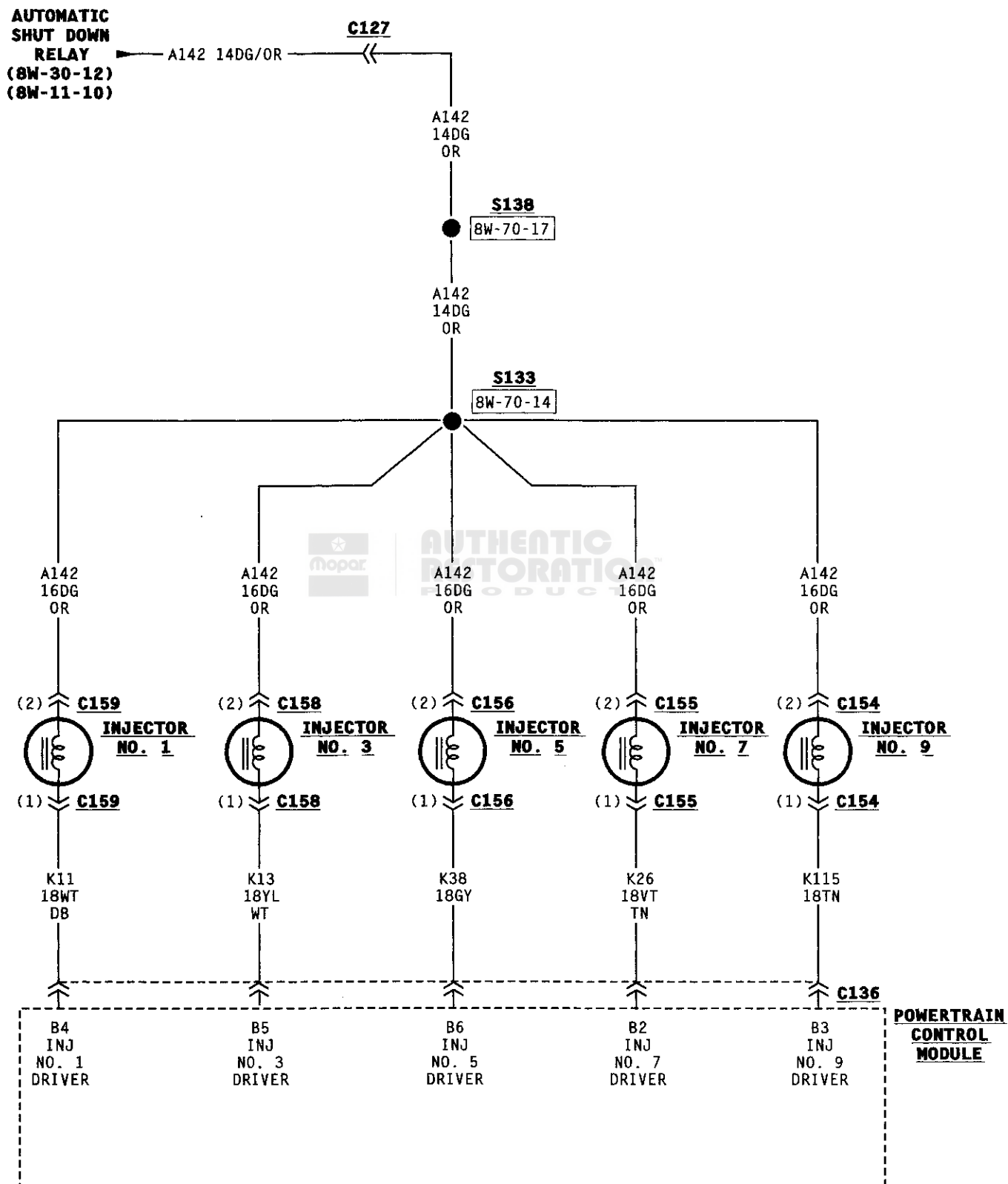


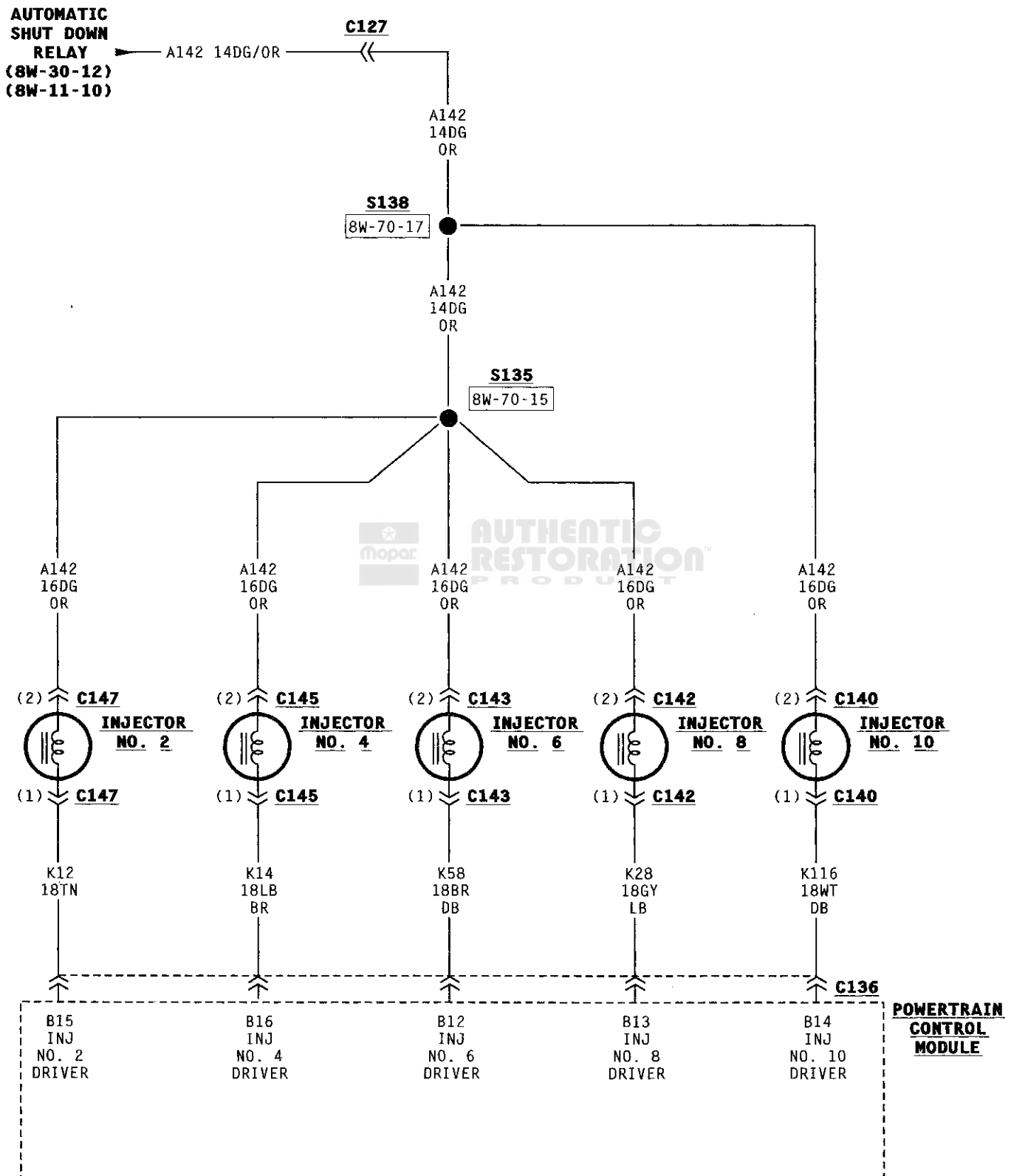
**AUTOMATIC
SHUT DOWN
RELAY**
(8W-30-12)
(8W-11-10)

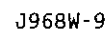


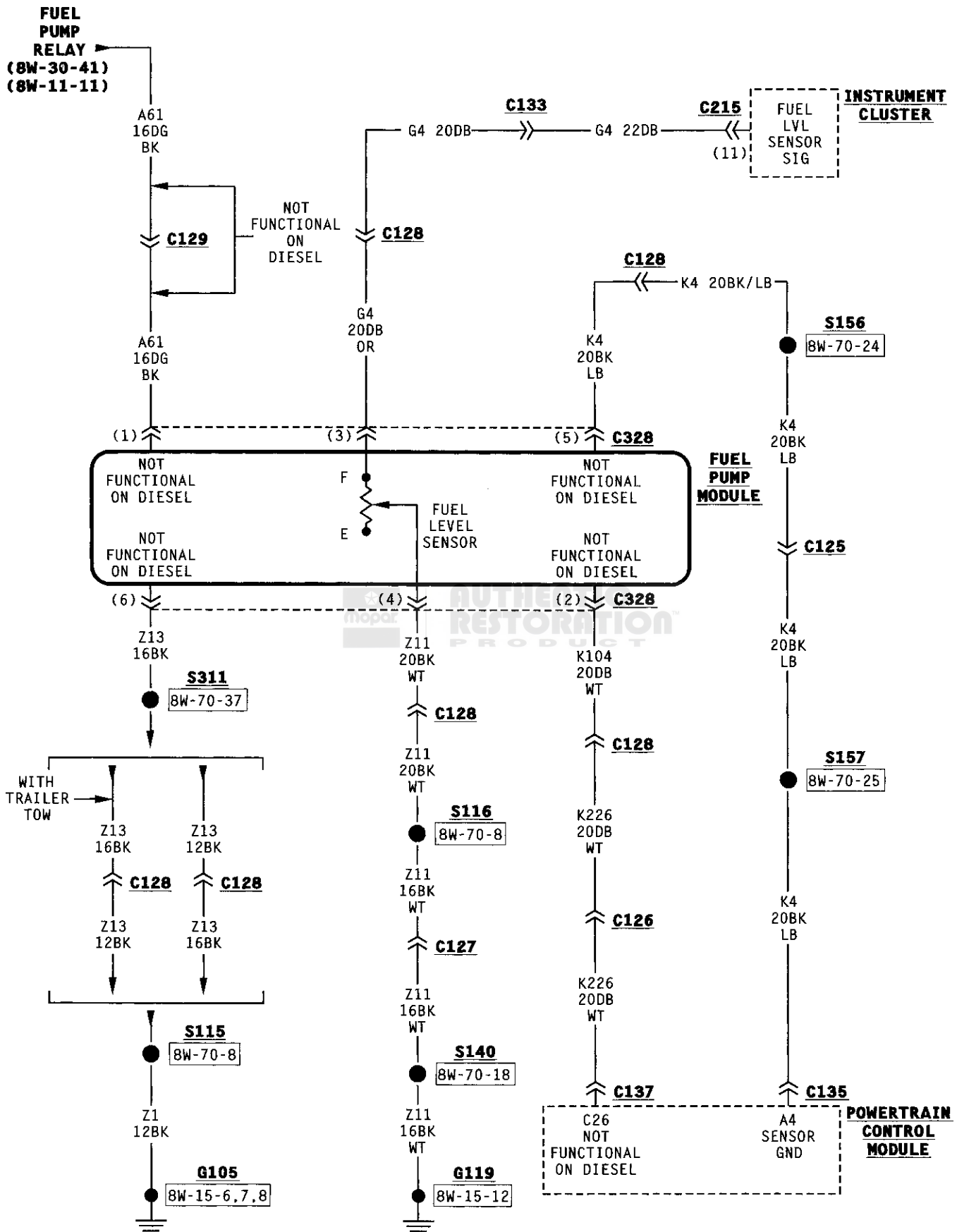


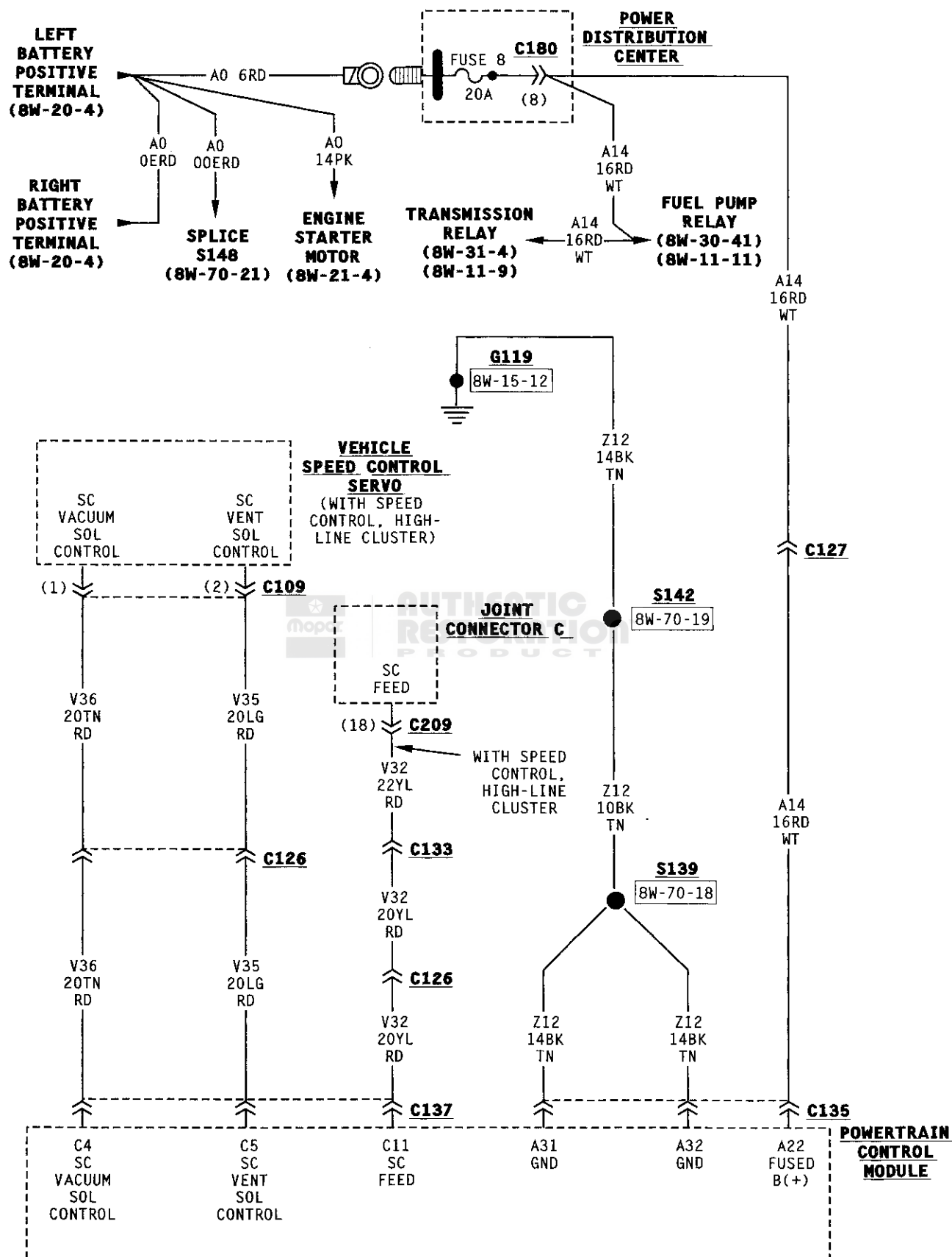


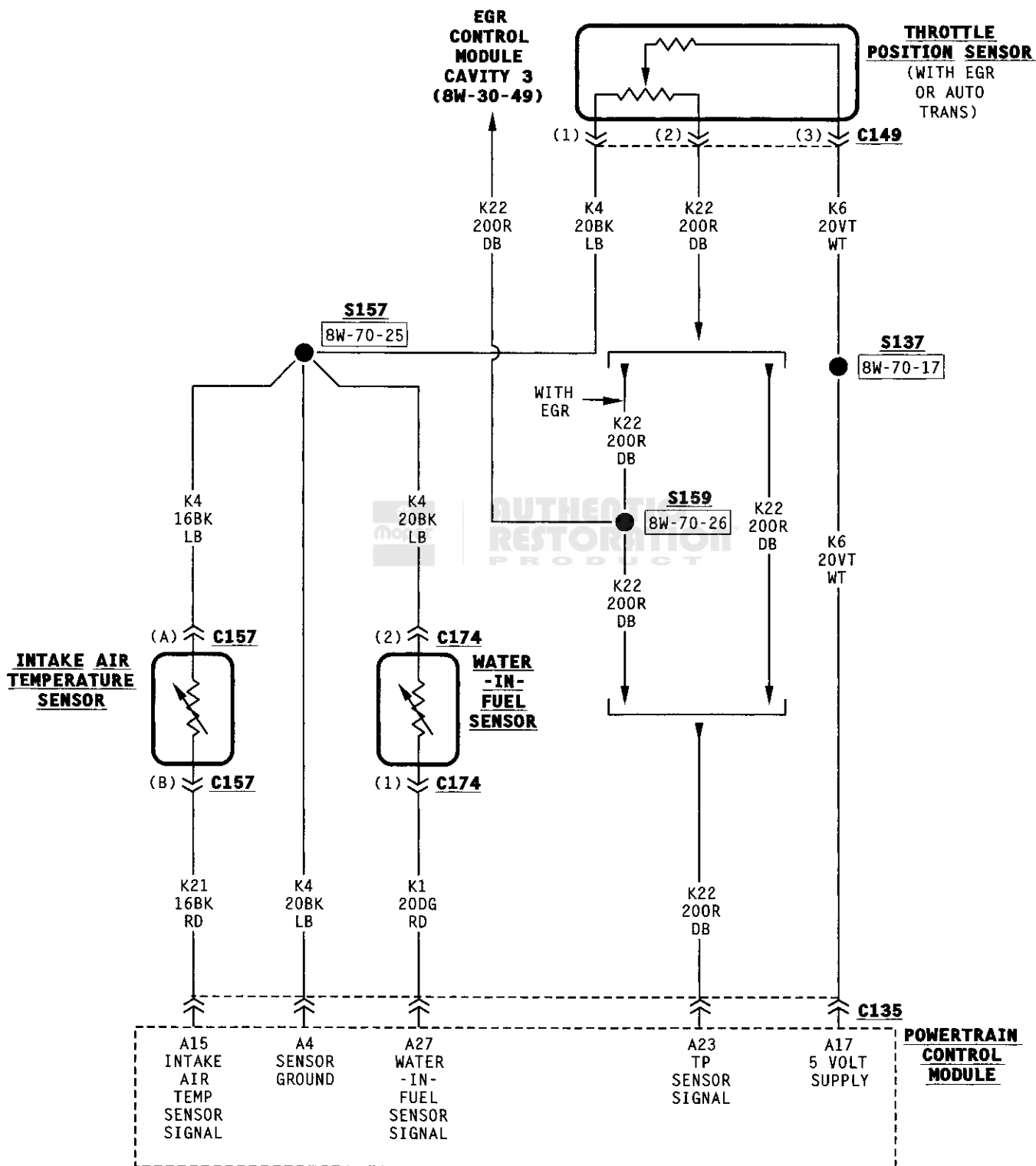


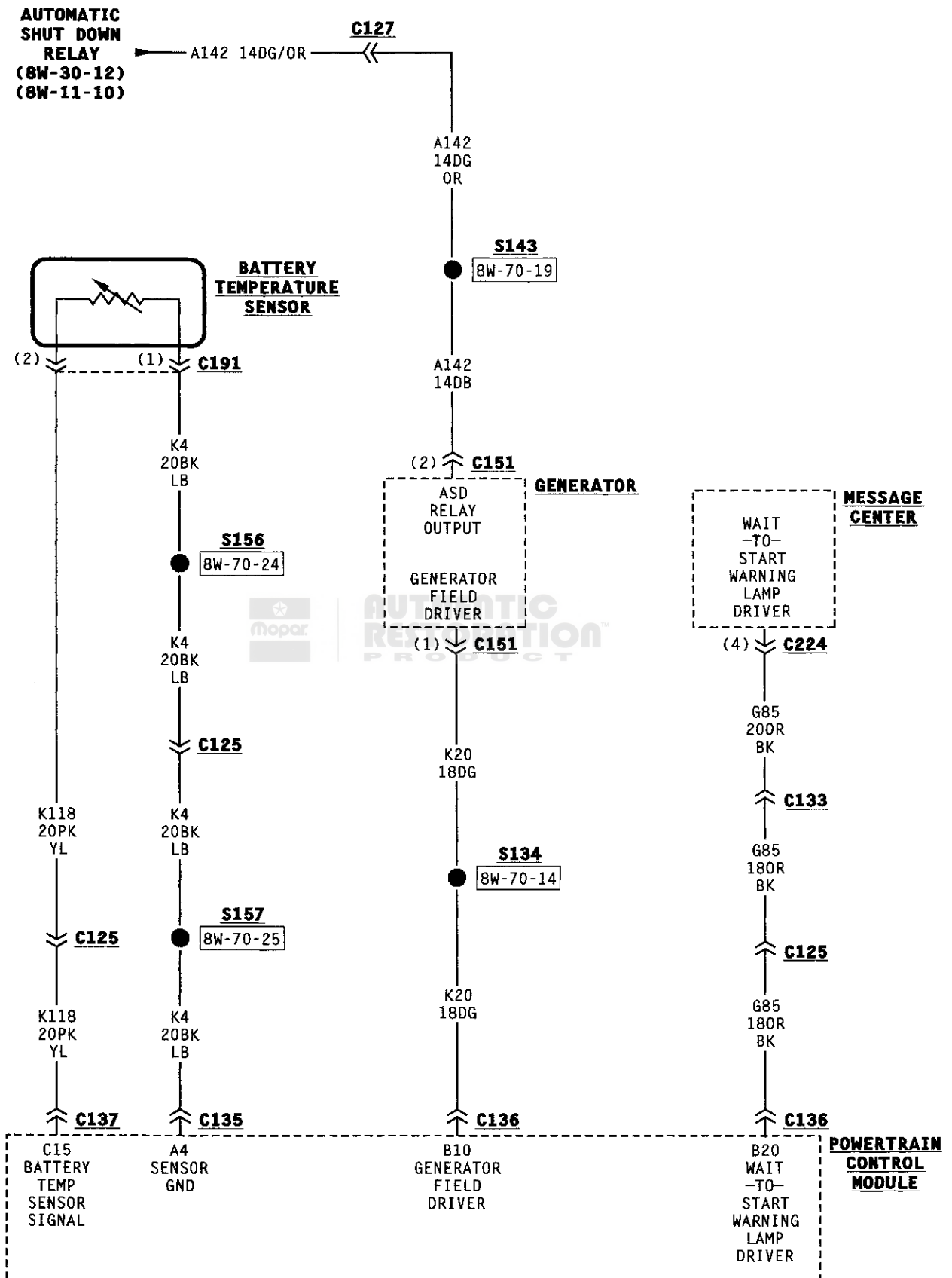


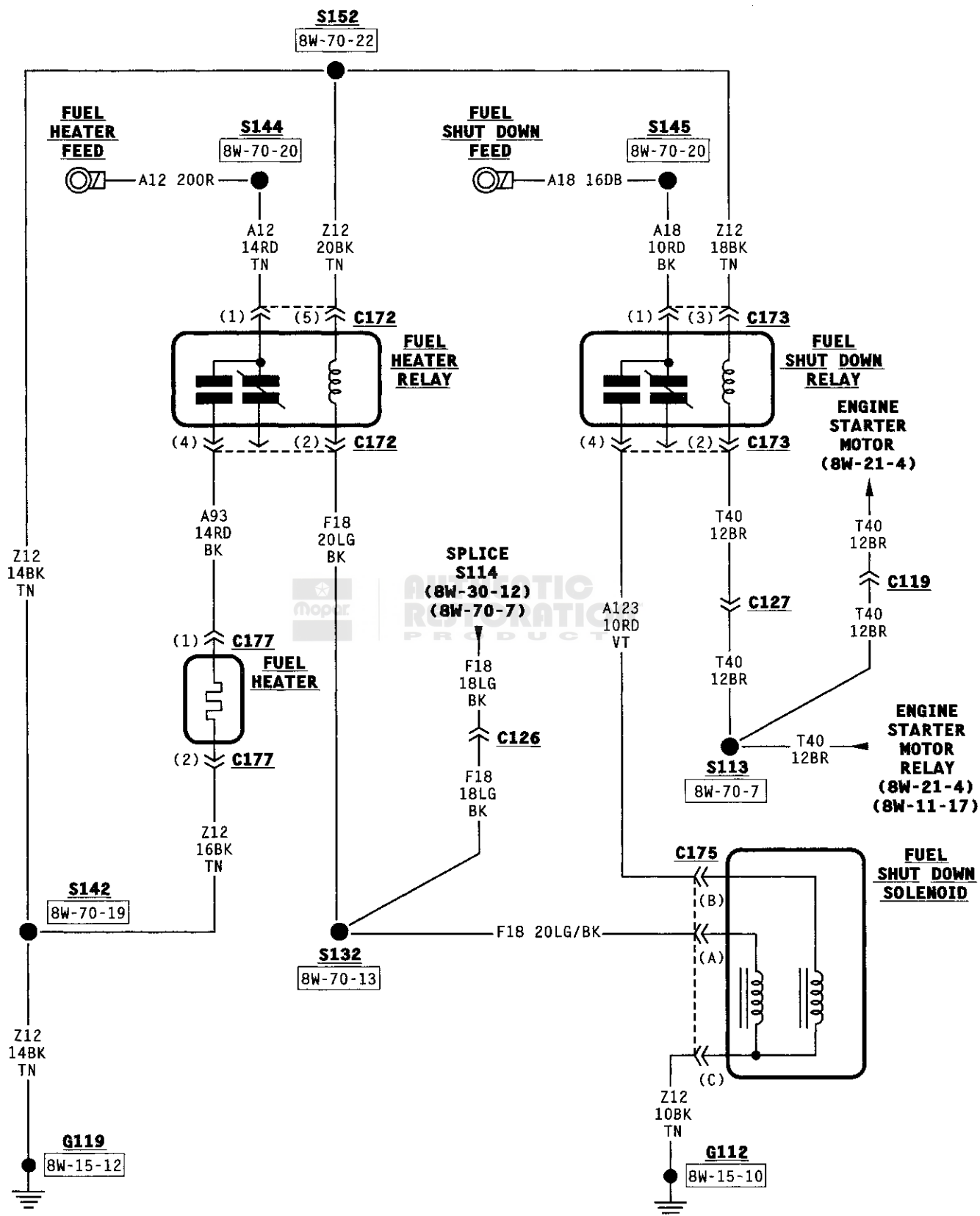


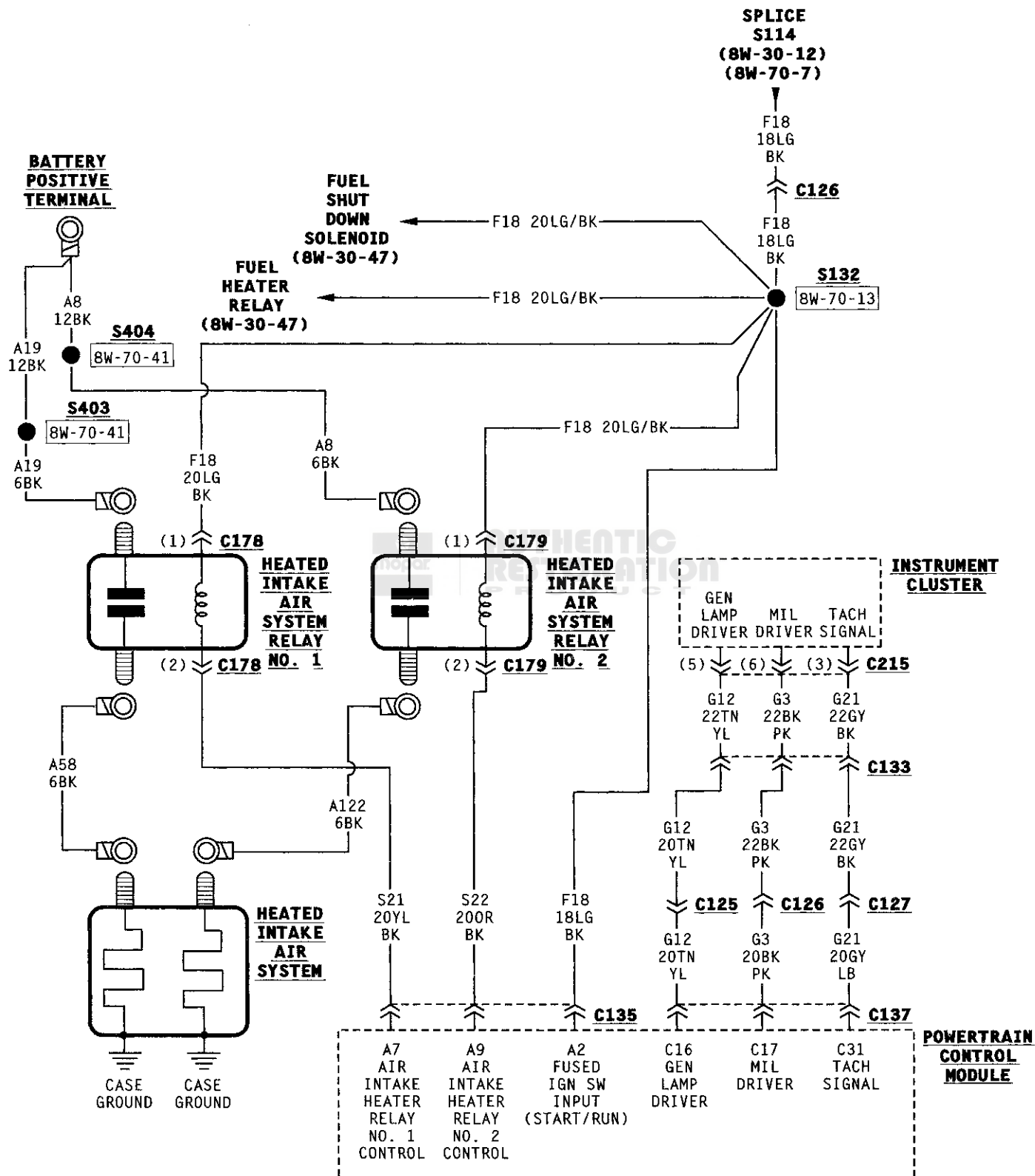


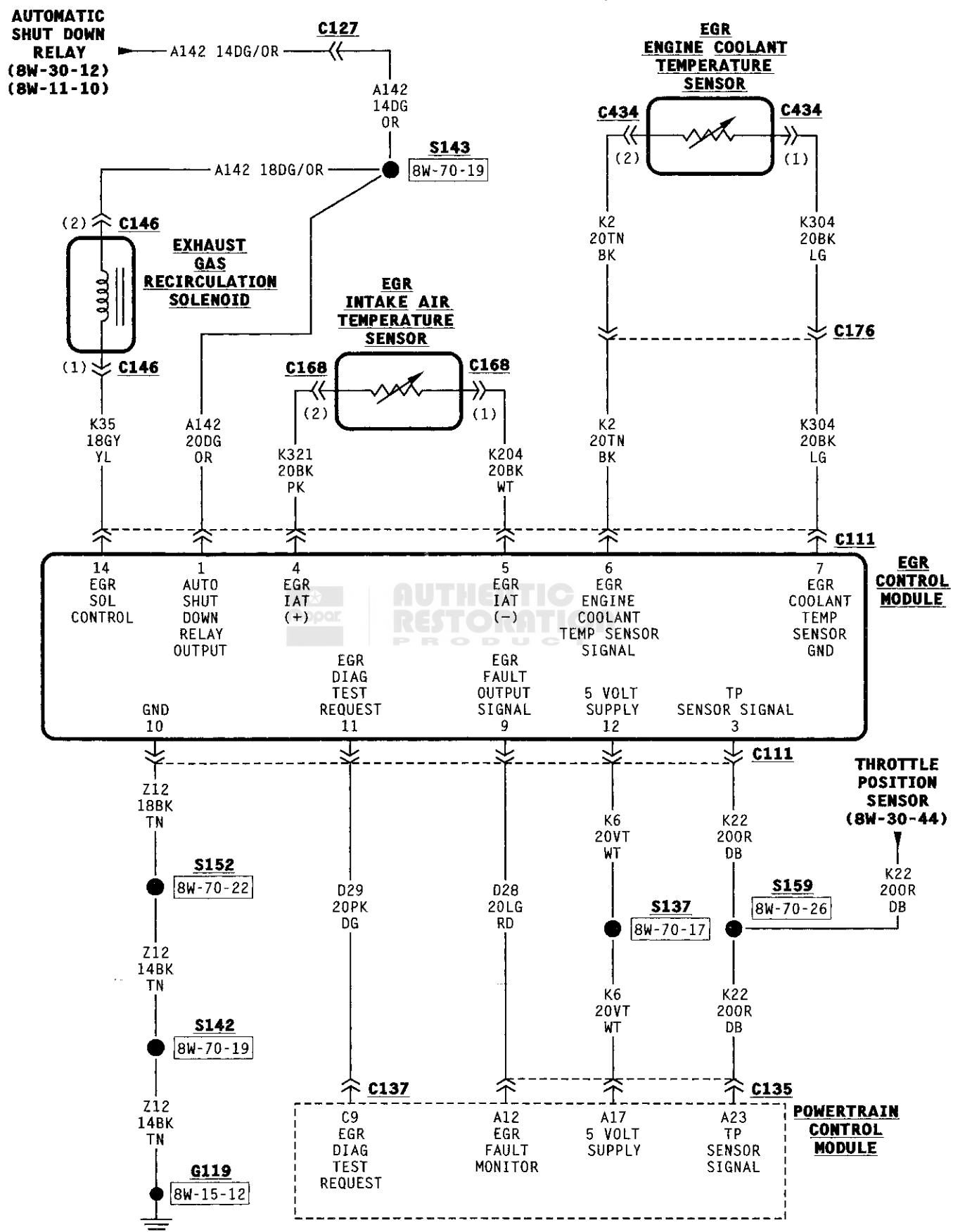












8W-31 TRANSMISSION CONTROLS

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GOVERNOR PRESSURE SENSOR—FOUR		TRANSMISSION TEMPERATURE SENSOR	2
SPEED AUTOMATIC TRANSMISSION	1	SCHEMATICS AND DIAGRAMS	
OUTPUT SHAFT SPEED SENSOR—FOUR		WIRING DIAGRAM INDEX	2

DESCRIPTION AND OPERATION

OVERDRIVE SWITCH

Automatic transmission equipped vehicles may have an overdrive switch. The operator disables or enables overdrive when the switch is depressed.

The overdrive system consists of a switch connected to the Powertrain Control Module (PCM) and an overdrive ON/OFF indicator lamp.

If overdrive is currently enabled, it is disabled when the operator depresses the overdrive switch. Also, if the operator already disabled overdrive, it is enabled when the switch is depressed.

Circuit T6 from the overdrive switch connects to cavity C13 of the PCM and provides the overdrive signal. Circuit Z1 provides ground for the switch.

In the START and RUN position, the ignition switch connects circuit A1 from fuse 3 in the Power Distribution Center (PDC) with circuit A21. Circuit A21 connects to the bus bar in the fuse block that powers circuit F12 through fuse 11. Circuit F12 supplies power for the overdrive ON/OFF indicator lamp. The PCM turns the overdrive ON/OFF indicator lamp ON or OFF by providing a ground for the lamp on circuit T18.

ELECTRONIC TRANSMISSION RELAY—FOUR SPEED AUTOMATIC TRANSMISSION

The electronic transmission relay powers the overdrive solenoid, torque convertor clutch solenoid, and variable force solenoid. All three solenoids are molded together.

When the ignition switch is in the START or RUN positions, it connects circuit A1 from fuse 3 in the Power Distribution Center (PDC) to circuit A21. Circuit A21 powers circuit F18 through fuse 9 in the fuse block. Circuit F18 powers the coil side of the electronic transmission relay. The Powertrain Control Module (PCM) provides ground for the relay on cir-

cuit K30. Circuit K30 connects to cavity B30 of the PCM.

When the PCM grounds the relay, the relay contacts connect circuit A14 from fuse 8 in the PDC to circuit T16. Circuit T16 powers the solenoids.

OUTPUT SHAFT SPEED SENSOR—FOUR SPEED AUTOMATIC TRANSMISSION

The output shaft speed sensor generates a signal indicating the speed of the transmission output shaft. Circuits T13 and T14 connect the sensor to the Powertrain Control Module (PCM). Circuit T13 connects to cavity B25 of the PCM. Circuit T14 connects to cavity B28.

TRANSMISSION SOLENOID ASSEMBLY—FOUR SPEED TRANSMISSIONS

The Torque Converter Clutch (TCC) solenoid, overdrive solenoid and variable force solenoid are molded together. They are only used on four-speed automatic transmissions. Circuit T16 from the electronic transmission relay supplies power for the solenoids. The Powertrain Control Module (PCM) operates each solenoid individually by providing ground for each solenoid on separate circuits.

- The PCM provides ground for the TCC on circuit K54. Circuit K54 connects to cavity B11 of the PCM.

- The PCM supplies ground for the overdrive solenoid on circuit T60. Circuit T60 connects to cavity B21 of the PCM.

- On circuit K88, the PCM provides ground for the variable force solenoid. Circuit K88 connects to cavity B8 of the PCM.

GOVERNOR PRESSURE SENSOR—FOUR SPEED AUTOMATIC TRANSMISSION

The governor pressure sensor supplies the transmission pressure input to the Powertrain Control Module on circuit T25. Circuit T25 connects to cavity B29 of the PCM. Circuit K7 from cavity B31 of the

DESCRIPTION AND OPERATION (Continued)

PCM supplies 5 volts to the sensor. The PCM provides ground for the governor pressure sensor on circuit K4. Circuit K4 connects to cavity A4 of the PCM.

The governor pressure sensor is part of the transmission solenoid assembly.

TRANSMISSION TEMPERATURE SENSOR

The transmission temperature sensor is located in the transmission solenoid assembly. The Powertrain Control Module (PCM) supplies 5 volts to the sensor on circuit K7. Circuit T34 from the sensor connects to cavity B1 of the PCM and provides the transmission temperature input. The PCM provides ground for the sensor on cavity K4.

The PCM grounds the transmission temperature warning lamp on circuit G14. Circuit G14 connects to cavity C7 of the PCM. The transmission temperature warning lamp is located in the message center.

HELPFUL INFORMATION

Circuit K7 also supplies 5 volts to the vehicle speed sensor.

Circuit K4 also provides ground for the signals from the following:

- Heated oxygen sensors
- Crankshaft position sensor
- Camshaft position sensor
- Engine coolant temperature sensor
- Intake air temperature sensor
- Throttle position sensor
- Manifold absolute pressure sensor
- Vehicle speed sensor

FOUR-WHEEL DRIVE INDICATOR

Power for the four-wheel drive indicator lamp is supplied on circuit F14. Circuit G107 connects the lamp to the four-wheel drive switch. When the switch closes, circuit G107 connects to ground on circuit Z1.

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

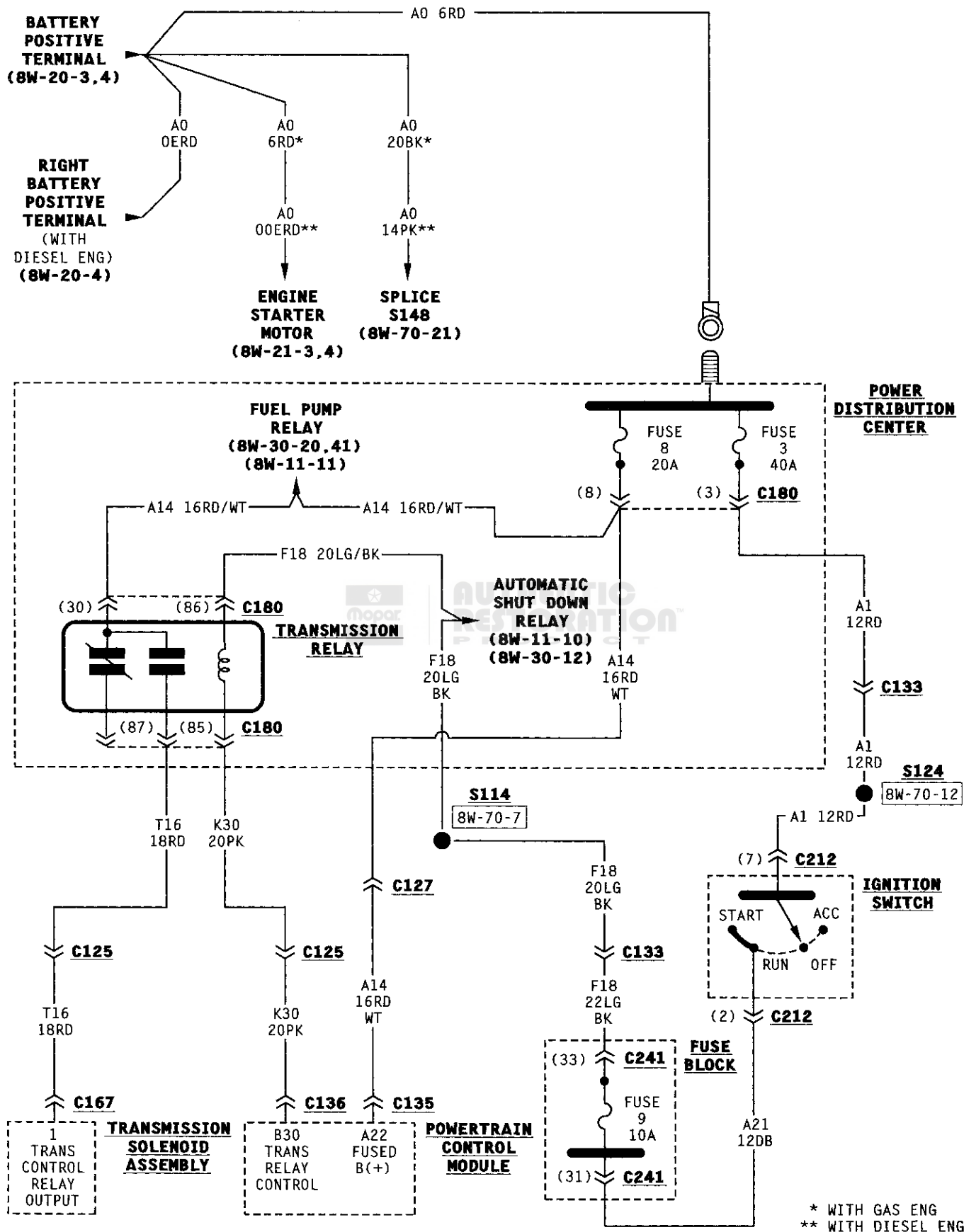


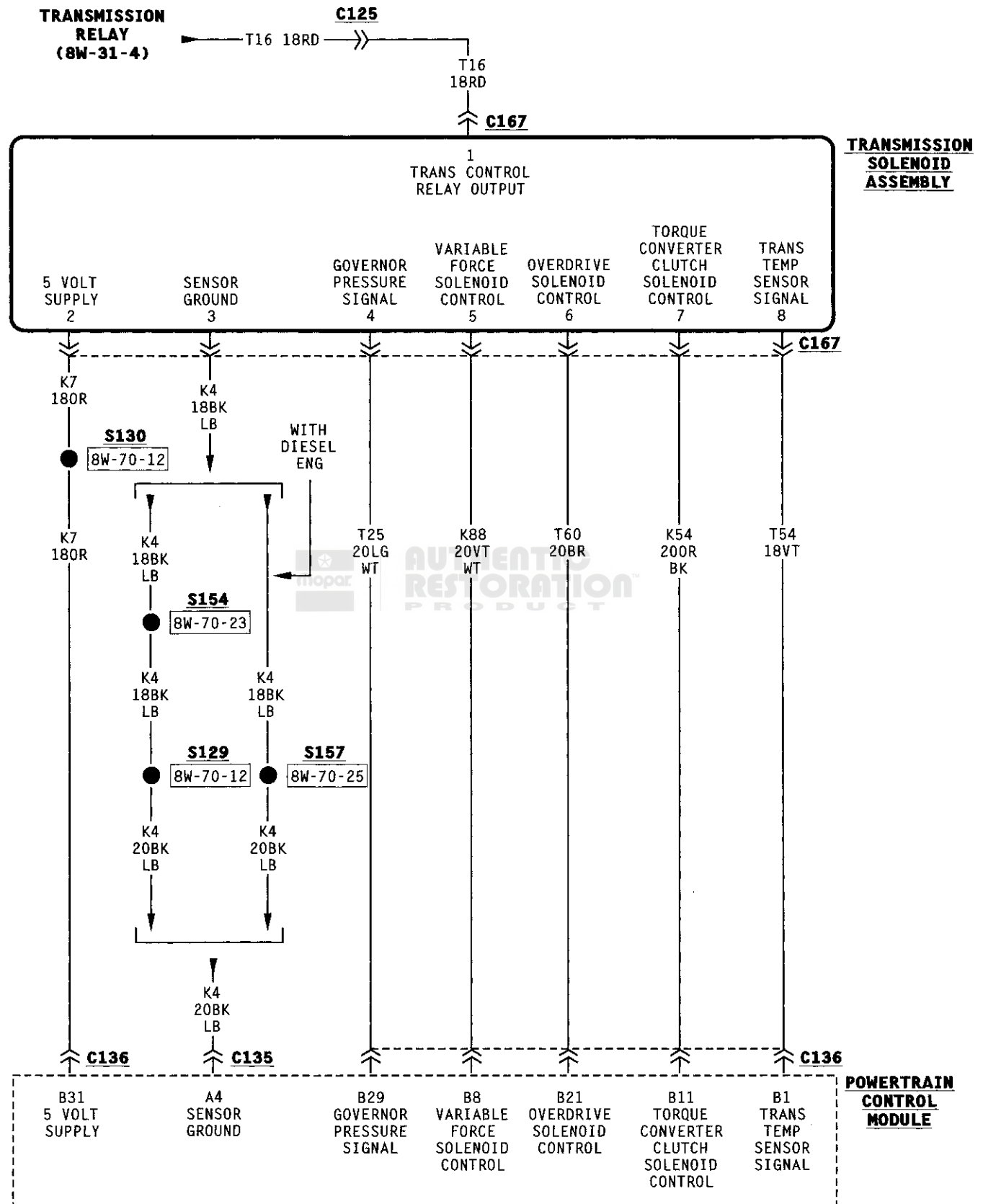
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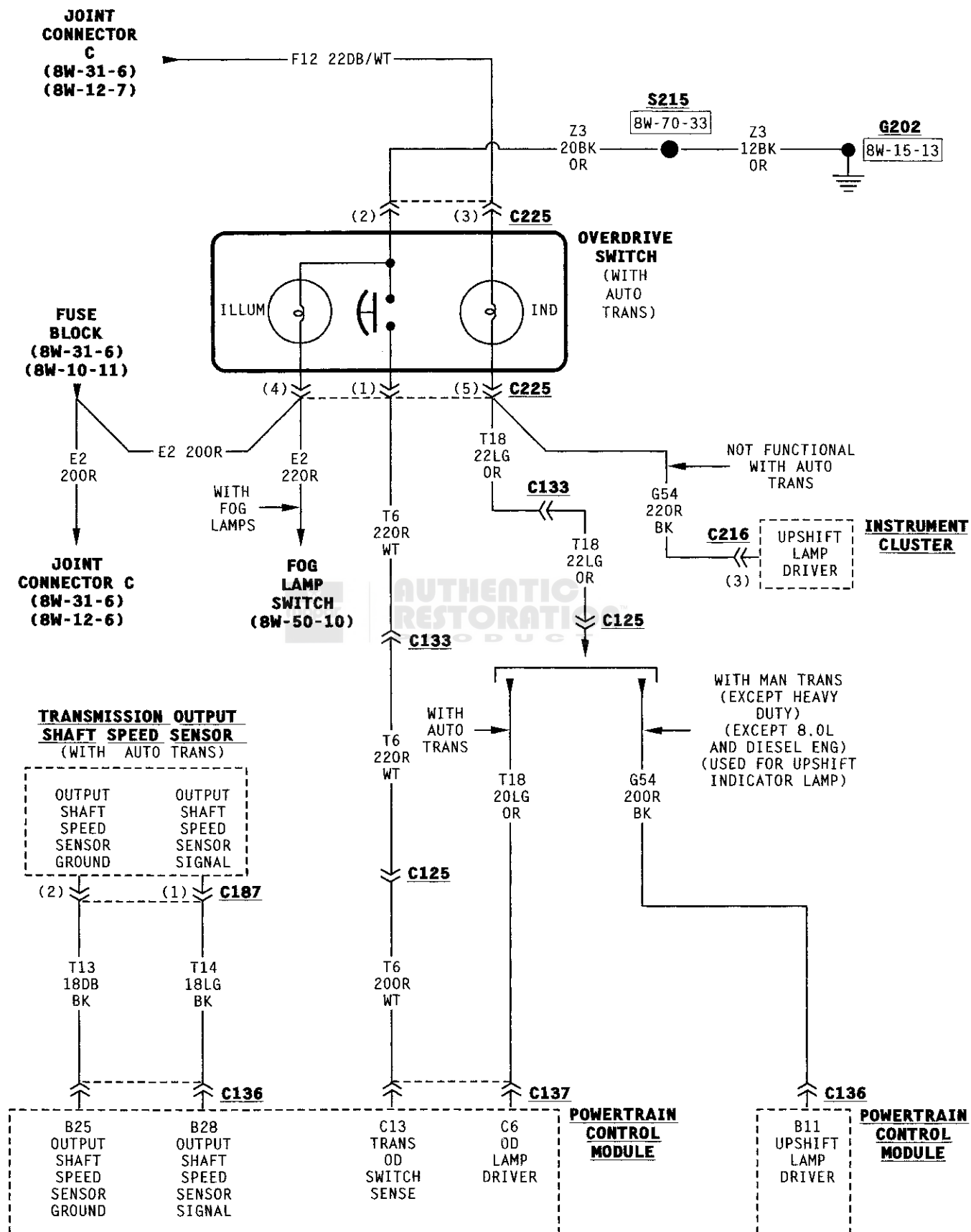
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Controller Anti-Lock Brake	8W-31-8	Ignition Switch	8W-31-4, 6
Four Wheel Drive (4WD) Switch	8W-31-8	Instrument Cluster	8W-31-7, 8
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Fuse 3 (PDC)	8W-31-4, 6	Joint Connector C	8W-31-6
Fuse 8 (PDC)	8W-31-4	Overdrive Switch	8W-31-7
Fuse 9	8W-31-4	Powertrain Control Module	8W-31-4, 5, 7
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Fuse 13	8W-31-6	Transmission Relay	8W-31-4
Fuse 18	8W-31-6	Transmission Solenoid Assembly	8W-31-4, 5
Headlamp Switch	8W-31-6		

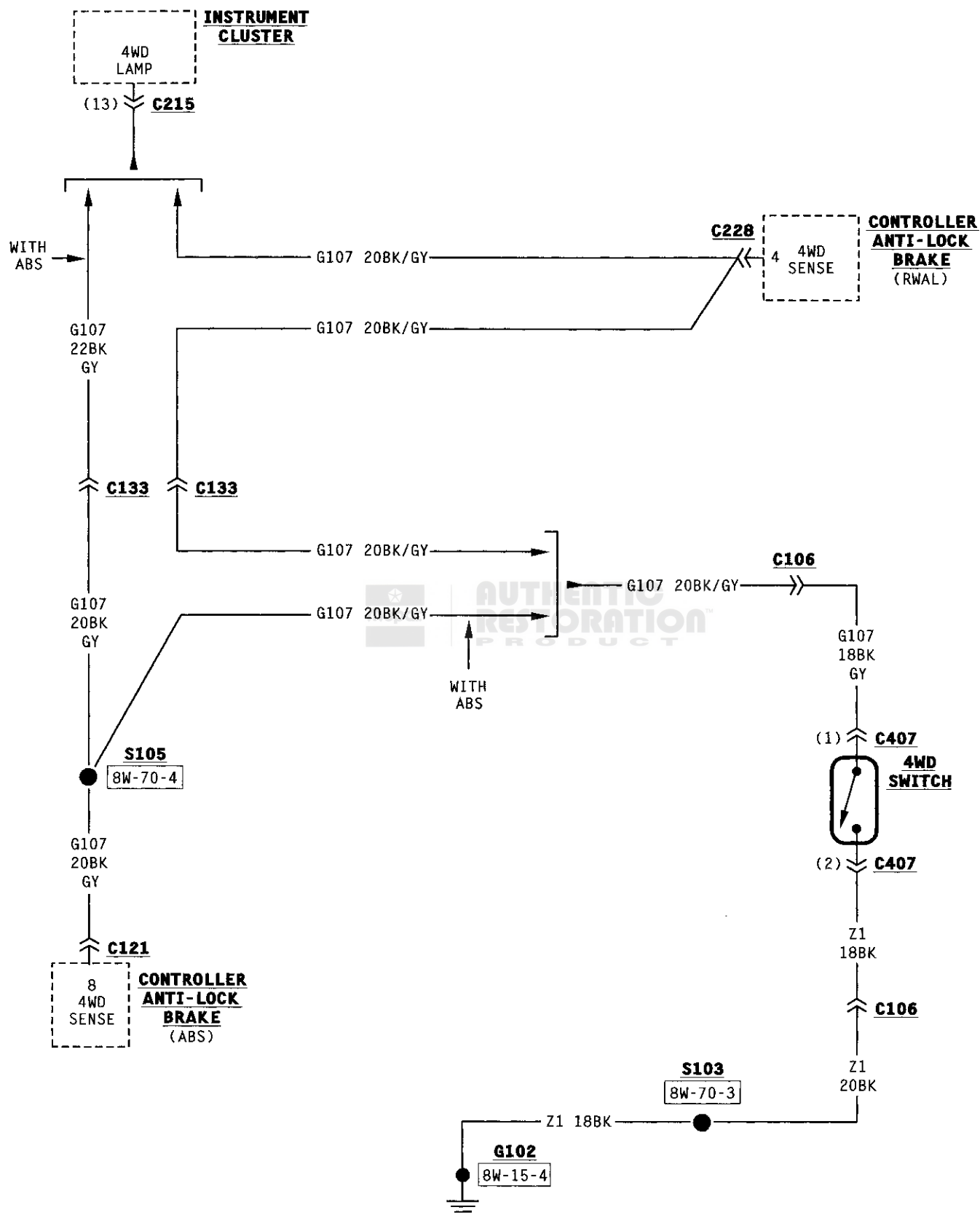


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8W-33 VEHICLE SPEED CONTROL

DESCRIPTION AND OPERATION

VEHICLE SPEED CONTROL

The Powertrain Control Module (PCM) operates the vehicle speed control system. The vehicle speed control switches are located in the steering wheel, below the airbag.

Circuit V32 from cavity C11 of the PCM supplies voltage to the Light Emitting Diode (LED) used for the speed control indicator lamp and to the speed control switches. Circuit V32 also connects to circuit V30 through the stop lamp switch. Circuit V30 powers the vehicle speed control servo.

Circuit V37 from PCM cavity C32 connects to the vehicle speed control switches. The switches are wired in parallel and each contains a separate resistor. The voltage level present on circuit V37 (at PCM cavity C32) depends on which speed control switch is selected. Circuit K4 from PCM cavity A4 supplies ground for the speed control switches.

- When the ON/OFF switch is open, the voltage level on circuit V37 at PCM cavity C32 has a nominal value of 5.0 volts with a range from 4.8 to 5.0 volts.
- When the ON/OFF switch closes, the voltage level on circuit V37 at PCM cavity C32 has nominal value of 1.51 volts with a range from 1.31 to 1.61 volts.
- When the SET/COAST switch closes, the voltage level on circuit V37 at PCM cavity C32 has nominal value of 3.8 volts with a range from 3.6 to 3.9 volts.
- When the RESUME/ACCEL switch closes, the voltage level on circuit V37 at PCM cavity C32 has

nominal value of 4.4 volts with a range from 4.2 to 4.5 volts.

The PCM controls the vent and vacuum functions of the vehicle speed control servo on circuits V35 and V36. Depending on the signal it receives from vehicle speed control switches, the PCM either applies vacuum to or vents vacuum from the servo. Circuit V36 from cavity C4 of the PCM sends the vacuum signal to the servo. Circuit V35 from cavity C5 sends the vent signal.

Circuit V40 provides the stop lamp switch sense input to the PCM at cavity C24. The stop lamp switch connects circuit V40 to ground on circuit Z11. When the brake pedal is depressed, the stop lamp switch opens and disconnects circuits V40 and Z1, and circuits V32 and V30. When the stop lamp switch disconnects circuits V32 and V30, power is removed from the speed control servo.

HELPFUL INFORMATION

Circuit K4 also provides ground for some of the engine control sensors that provide inputs to the PCM.

SCHEMATICS AND DIAGRAMS

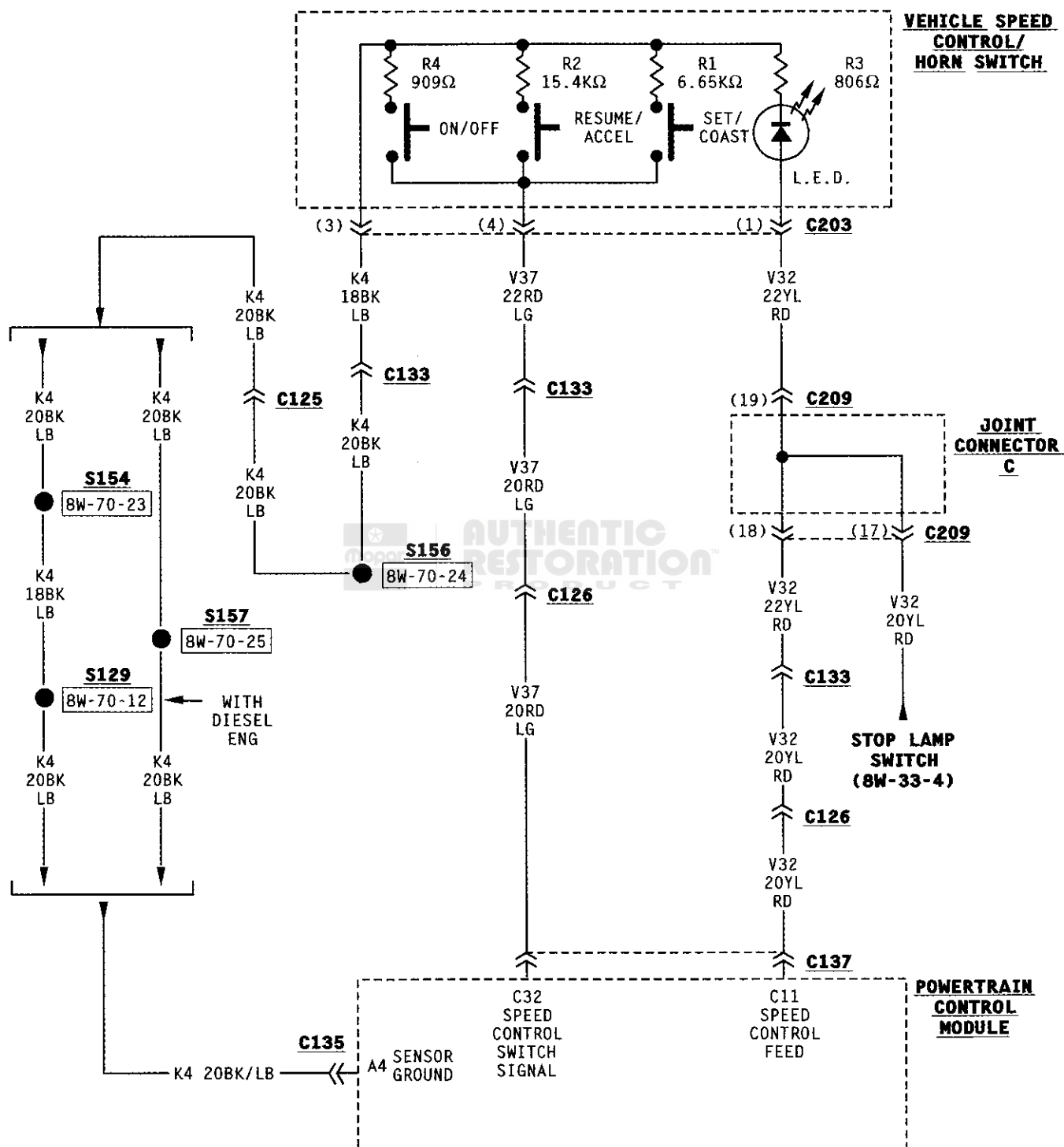
WIRING DIAGRAM INDEX

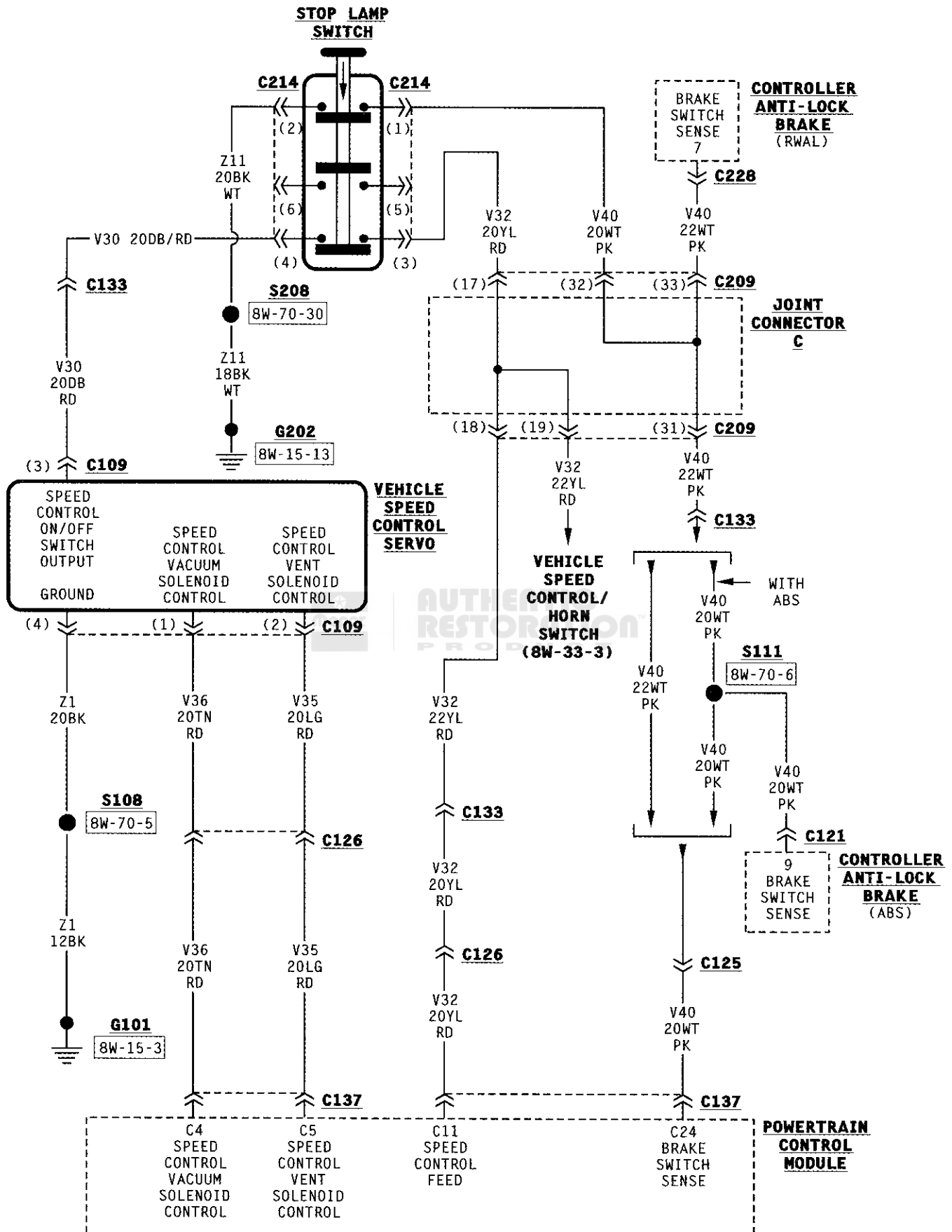
The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

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Joint Connector C	8W-33-3,4	Vehicle Speed Control Servo	8W-33-4
Powertrain Control Module	8W-33-3, 4	Vehicle Speed Control/ Horn Switch	8W-33-3







8W-34 REAR WHEEL ANTI-LOCK BRAKES

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DATA LINK CONNECTOR	1	VACUUM SENSOR	2
FOUR-WHEEL DRIVE SWITCH SENSE	1	WARNING LAMP	1
INTRODUCTION	1	SCHEMATICS AND DIAGRAMS	
PARK BRAKE SWITCH INPUT	1	WIRING DIAGRAM INDEX	2
REAR WHEEL SPEED SENSOR	1		

DESCRIPTION AND OPERATION

INTRODUCTION

Power for the Controller Anti Lock Brake (CAB) is supplied on circuit A20. This circuit is connected to the fuse block and protected by a 20 amp fuse located in cavity 14. Power for the fuse is supplied on circuit A22 from the ignition switch. This circuit is HOT in the START/RUN position only.

Power for the A22 circuit is supplied by circuit A2. This circuit originates at the Power Distribution Center (PDC) and is protected by a 40 amp fuse located in cavity 2.

On diesel engines circuit A20 is double crimped at cavity 3 of the CAB and provides battery voltage to the vacuum switch.

Circuit F32 also provides battery voltage to the CAB. Circuit F32 is HOT at all times. Fuse 20 in the fuse block protects circuit F32. Circuit A3 from the PDC feeds the fuse block bus bar that powers fuse 20 and circuit F32. Fuse 6 in the PDC protects circuit A3. Circuit Z3 provides ground for the CAB.

REAR WHEEL SPEED SENSOR

The rear wheel speed sensor is mounted on the top of the rear axle differential. The sensor converts wheel speed into an electrical signal that it transmits to the Controller Anti Lock Brake (CAB).

Circuits B113 and B114, a pair of twisted wires, connect to the sensor to provide signals to the CAB. The B113 circuit also connects to the universal data link connector.

Circuit B113 connects to cavity 14 of the CAB. Circuit B114 connects to cavity 13 of the CAB.

RWAL VALVE

The rear wheel anti-lock (RWAL) valve contains an isolation solenoid, a dump solenoid and a reset switch. Each is powered by the Controller Anti Lock Brake (CAB) on separate circuits.

Circuit B108 from cavity 8 of the CAB feeds the dump solenoid. The isolation solenoid is powered on circuit B101 from cavity 1 of the CAB. Circuit Z8 provides ground for both solenoids.

Circuit B111 from cavity 11 of the CAB connects to the reset switch. The case grounded RWAL valve provides ground for the reset switch.

WARNING LAMP

The Controller, Antilock Brake (CAB) provides ground for the instrument cluster Check Antilock warning lamp on circuit G19. Circuit F14 provides voltage to the instrument cluster to feed the warning lamp.

DATA LINK CONNECTOR

Circuit B112 from cavity 12 of the Controller Anti Lock Brake (CAB) connects to the universal data link connector. Circuit 113 also connects to the universal data link connector. This circuit is double crimped at cavity 14 of the CAB. Refer to Group 5, Brakes, for more information.

FOUR-WHEEL DRIVE SWITCH SENSE

From circuit G107, the Controller Antilock Brakes (CAB) senses when the four-wheel drive switch CLOSES. Circuit G107 connects to cavity 4 of the CAB.

STOP LAMP SWITCH INPUT

Circuit V40 provides an input to the Controller Anti Lock Brake (CAB) as to when the operator is applying the brakes. The V40 circuit connects to cavity 7 of the CAB.

PARK BRAKE SWITCH INPUT

On circuit G11, the Controller Anti Lock Brake (CAB) senses when the park brake switch CLOSES. Circuit G11 from the park brake switch connects to cavity 5 of the CAB.

DESCRIPTION AND OPERATION (Continued)**BRAKE WARNING LAMP SWITCH INPUT**

Circuit G9 provides an input to the Controller Anti Lock Brake (CAB). The CAB receives the input when either the ignition switch is in the START position, or the park brake warning lamp switch in the hydraulic combination valve CLOSES.

VACUUM SENSOR

The vacuum sensor is used on the diesel engine only. Power for the sensor is supplied on circuit A20. This circuit is HOT in the RUN position only and protected by a 20 amp fuse located in cavity 14 of the fuse block. Ground for the switch is supplied on circuit Z1.

Circuit Z1 connects to the vacuum sensor and supplies a ground path for circuit G9. If there is a prob-

lem in the system, the sensor grounds circuit G9 and the red brake warning lamp in the instrument cluster is illuminated.

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.



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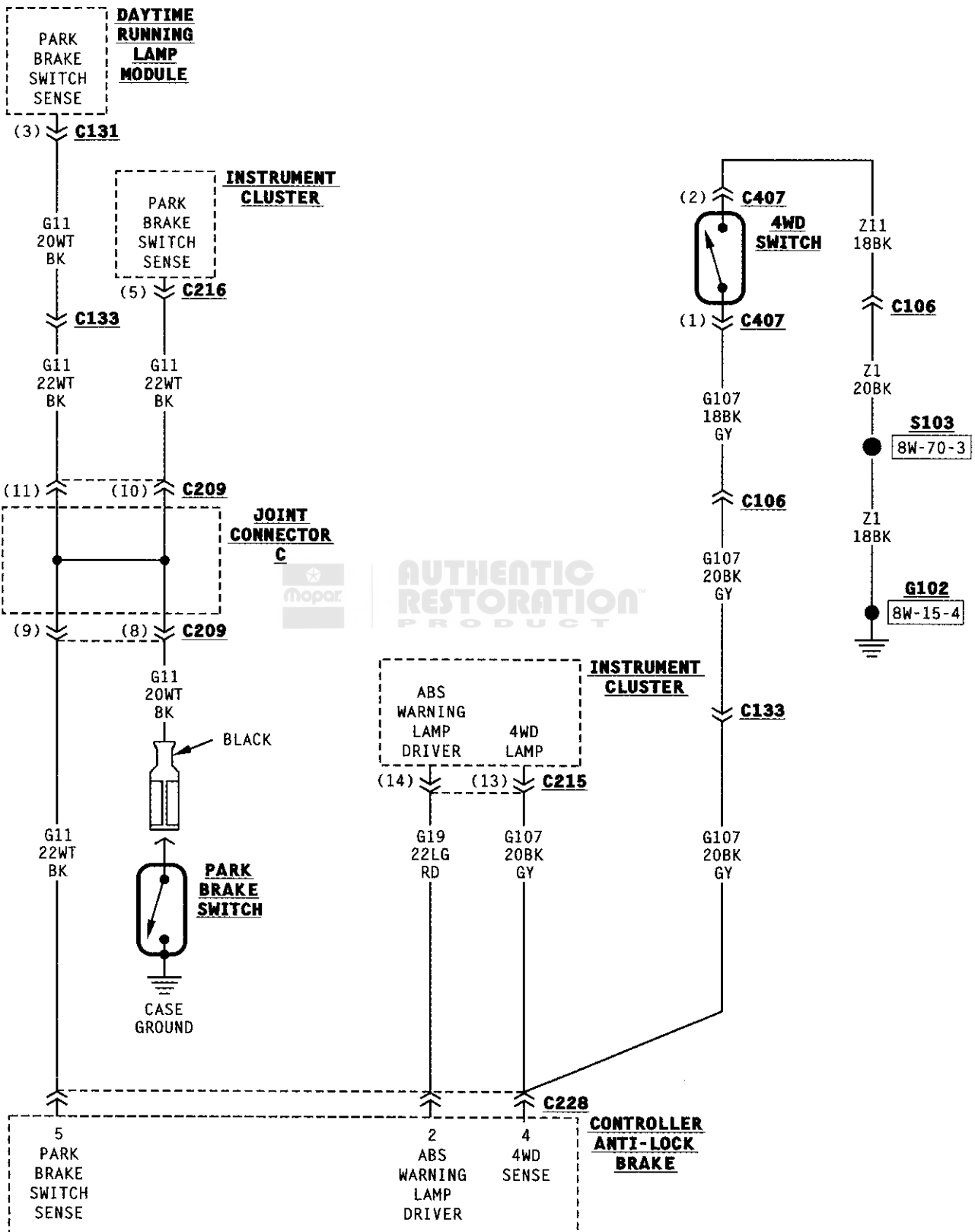
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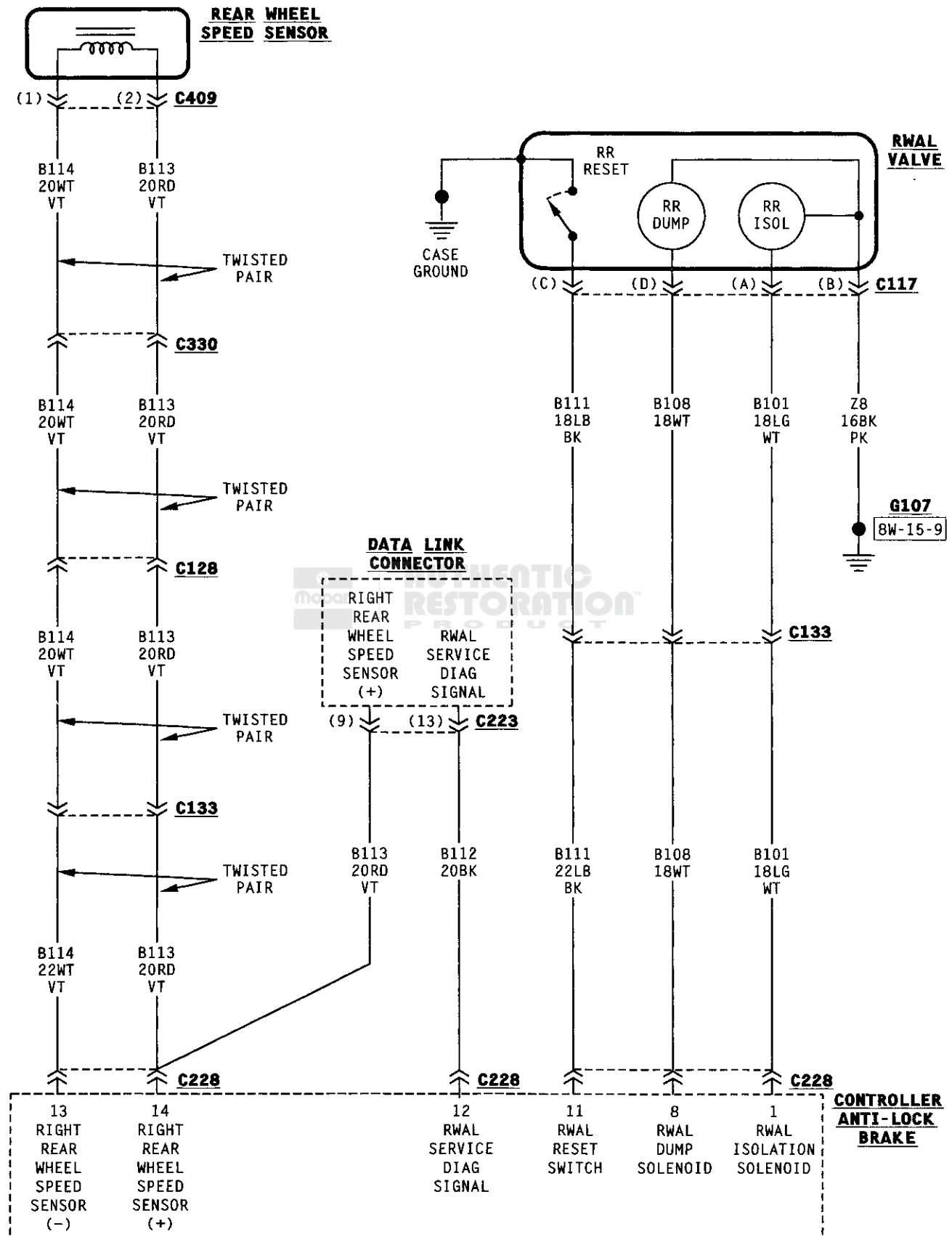
Component	Page	Component	Page
Brake Switch	8W-34-4	Ignition Switch	8W-34-4
Controller Anti-Lock Brake	8W-34-4, 5, 6, 7	Instrument Cluster	8W-34-4, 6
Data Link Connector	8W-34-7	Joint Connector B	8W-34-5
Daytime Running Lamp Module	8W-34-6	Joint Connector C	8W-34-4, 5, 6
Four Wheel Drive (4WD) Switch	8W-34-6	Park Brake Switch	8W-34-6
Fuse 2 (PDC)	8W-34-4	Powertrain Control Module	8W-34-5
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8W-35 ALL-WHEEL ANTI-LOCK BRAKES

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DESCRIPTION AND OPERATION

INTRODUCTION

Three fuses supply power for the Anti-Lock Brake System (ABS); fuses 2 and 5 in the Power Distribution Center (PDC) and fuse 14 in the fuse block. Fuses 2 and 5 in the PDC are connected directly to battery voltage and are HOT all times. Fuse 14 is HOT when the ignition switch is the RUN position.

In the RUN position, the ignition switch connects circuit A2 from a 40 amp fuse in cavity 2 of the PDC with circuit A22. Circuit A22 connects to a bus bar in the fuse block. The bus bar feeds circuit A20 through fuse 14. Fuse 14 is a 40 amp fuse.

Circuit A20 is spliced and connects to the Controller Anti Lock Brake (CAB), feeds the coil sides of the ABS pump relay and ABS warning lamp relay, and on diesel engines, feeds the vacuum sensor.

Circuit Z7 provides ground for the ABS control module. Circuit Z7 connects to cavity 20 of the CAB connector.

WHEEL SPEED SENSORS

The all wheel Anti-Lock Brake System (ABS) uses three wheel speed sensors; a single sensor for both rear wheels and individual sensors for the front wheels. The single sensor used for the rear wheels mounts on the top of the rear axle differential housing. Each sensor converts wheel speed into an electrical signal that it transmits to the Controller Anti Lock Brake (CAB). A pair of twisted wires connect to each sensor and provide signals to the CAB.

Circuits B6 and B7 provide signals to CAB from right front wheel speed sensor. Circuit B6 which provides the LOW signal, connects to cavity 15 of the CAB. Circuit B7 connects to cavity 2 of the CAB and provides the HIGH signal.

Circuits B8 and B9 provide signals to CAB from left front wheel speed sensor. Circuit B8 which provides the LOW signal, connects to cavity 16 of the

CAB. Circuit B9 connects to cavity 3 of the CAB and provides the HIGH signal.

Circuit B114 connects to cavity 14 of the CAB and to the rear wheel speed sensor. Circuit B113 connects to cavity 1 of the CAB and to the rear wheel speed sensor. Circuit B114 provides the rear wheel speed sensor LOW input while circuit B113 provides the HIGH input.

ABS PUMP RELAY

When the Controller Anti Lock Brake (CAB) grounds the ABS pump relay on circuit B116, the relay contacts CLOSE connecting circuit A10 from the Power Distribution Center (PDC) and circuit B120. Circuit A10 connects to fuse 5 in the PDC. Circuit A20 from the fuse 14 in the fuse block splices to feed the coil side of the ABS warning lamp relay and the pump motor relay.

From the ABS pump relay, circuit B120 splices to supply voltage to the ABS pump motor and all solenoids in the hydraulic control unit. Circuit B120 also supplies power to the solenoids in the Rear Wheel Anti Lock (RWAL) valve. Additionally, circuit B120 provides an input to cavity 34 of the CAB. The input tells the CAB that voltage has been supplied to the pump motor.

HYDRAULIC CONTROL UNIT

Circuit B120 from the ABS pump relay supplies voltage for the ABS pump motor plus the isolation and dump solenoids in the hydraulic control unit. The Controller Antilock Brake (CAB) activates the pump motor and the solenoids by providing separate ground paths for each.

The CAB provides a ground path for the motor on circuit B60. Circuit B60 connects to the CAB two-way connector.

The CAB cycles the isolation and dump solenoids in the front anti-lock valve by providing a ground path for each on separate circuits:

DESCRIPTION AND OPERATION (Continued)

- Circuit B248 connects to cavity 30 of the CAB and provides ground for the right front dump solenoid.
- Circuit B249 connects to cavity 33 of the CAB and provides ground for the right front isolation solenoid.
- Circuit B243 connects to cavity 35 of the CAB and provides ground for the left front dump solenoid.
- Circuit B245 connects to cavity 37 of the CAB and provides ground for the left front isolation solenoid.

There are two reset switches in the hydraulic control unit; a left switch and a right switch, both provide inputs to the CAB. Circuit B5 from the left reset switch connects to CAB cavity 5 while circuit B18 from the right reset switch connects to cavity 18.

HELPFUL INFORMATION

The front anti-lock valve is case grounded.

REAR WHEEL ANTILOCK (RWAL) VALVE

Circuit B120 from the ABS pump relay supplies voltage for the isolation and dump solenoids in the Rear Wheel Antilock (RWAL) valve. The Controller Antilock Brake (CAB) activates the solenoids by providing separate ground paths for each.

- Circuit B254 connects to cavity 26 of the CAB and provides ground for the rear dump solenoid.
- Circuit B252 connects to cavity 28 of the CAB and provides ground for the rear isolation solenoid.

The RWAL valve has one reset switch that provides an input to the CAB. Circuit B19 from the reset switch connects to CAB cavity 19.

ABS WARNING LAMP

The Controller, Antilock Brakes (CAB) provides ground for the ABS warning lamp in the message center through the normally closed contacts in the ABS warning lamp relay. When the ignition switch is in the START position, the lamp illuminates as a bulb test for approximately 3 to 5 seconds while the CAB performs a system self-test. While closed, the relay contacts complete the ground path for the ABS warning lamp by connecting circuit G19 from the lamp to ground on circuit Z1. Power for the lamp is supplied by circuit F14.

If the system self-test is successfully completed, the CAB energizes the ABS warning lamp relay by providing ground for the relay coil on circuit B47. When the relay energizes, its contacts open and disconnect circuits G19 and Z1. Circuit A20 from fuse 14 in the fuse block supplies power to the coil side of the relay.

Circuit G19 from the ABS warning splices to the ABS warning lamp and the CAB.

BRAKE WARNING LAMP SWITCH INPUT

Circuit G9 provides an input to the Controller Anti Lock Brake (CAB). The CAB receives the input when either the ignition switch is in the START position, the park brake switch CLOSES or the brake warning lamp switch in the hydraulic combination valve CLOSES.

STOP LAMP SWITCH SENSE

On circuit V40, the Controller Anti Lock Brake (CAB) senses when the brake pedal has been pressed. Circuit V40 connects to cavity 9 of the CAB and splices to the stop lamp switch and the Powertrain Control Module (PCM).

FOUR-WHEEL DRIVE SWITCH SENSE

From circuit G107, the Controller Antilock Brake (CAB) senses when the four-wheel drive indicator lamp switch closes. Circuit G107 connects to cavity 8 of the CAB and splices to the four-wheel drive indicator lamp switch and instrument panel four-wheel drive indicator lamp.

DATA LINK CONNECTOR

The DRB scan tool connects to the data link connector. Circuits D11 and D12 from the Controller Antilock Brake (CAB) connect to the data link connector. Circuit D12 connects to cavity 10 of the CAB. The CAB transmits data to the DRB scan tool on circuit D12.

The DRB scan tool receives data from the CAB on circuit D11. Circuit D11 connects to cavity 11 of the CAB.

VACUUM SENSOR

The vacuum sensor is used on the diesel engine only. Power for the sensor is supplied on circuit A20. This circuit is HOT in the RUN position only and protected by a 20 amp fuse located in cavity 14 of the fuse block. Ground for the switch is supplied on circuit Z1.

Circuit Z1 connects to the vacuum sensor and supplies a ground path for circuit G9. If there is a problem in the system, the sensor grounds circuit G9 and the red brake warning lamp in the instrument cluster is illuminated.

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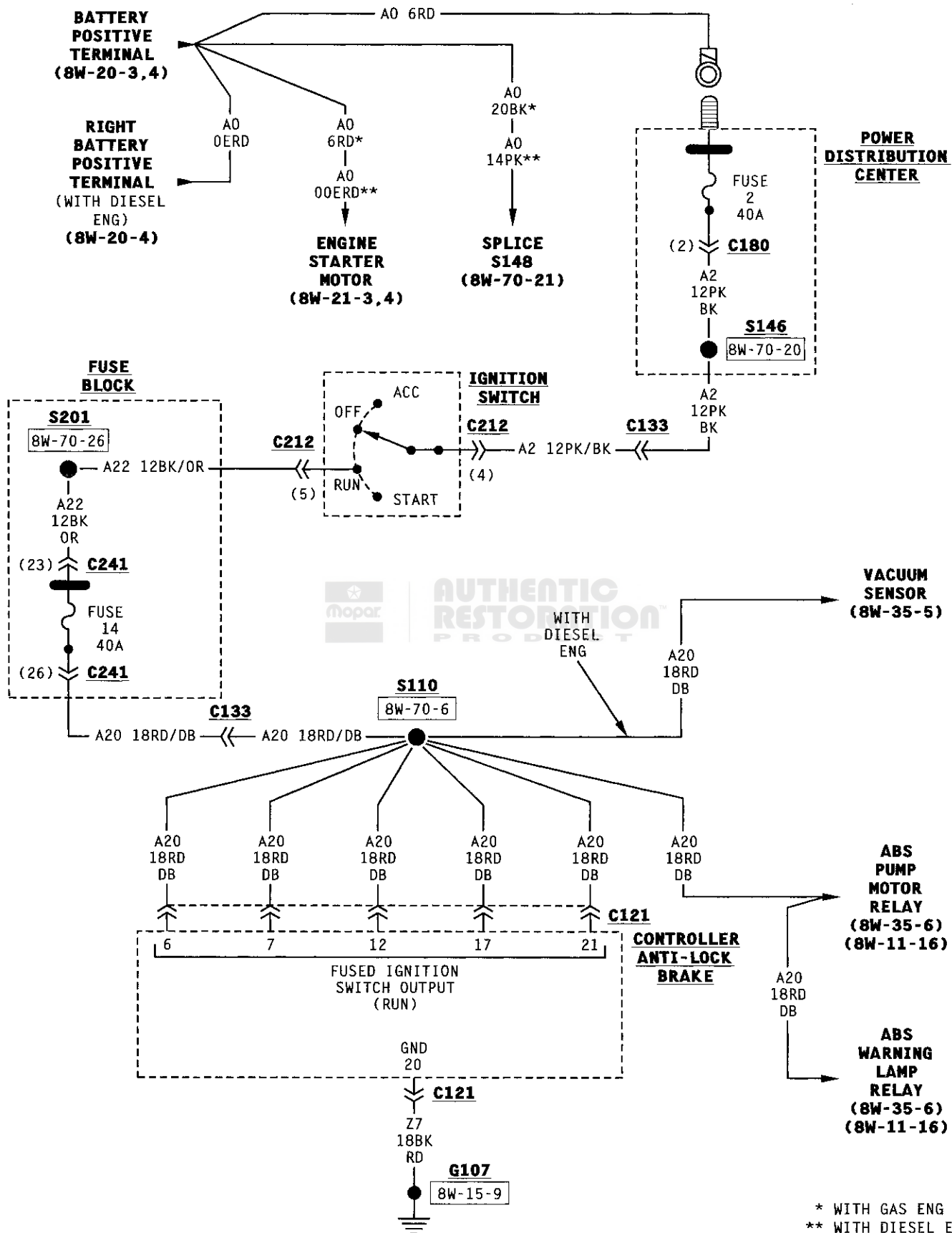
The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

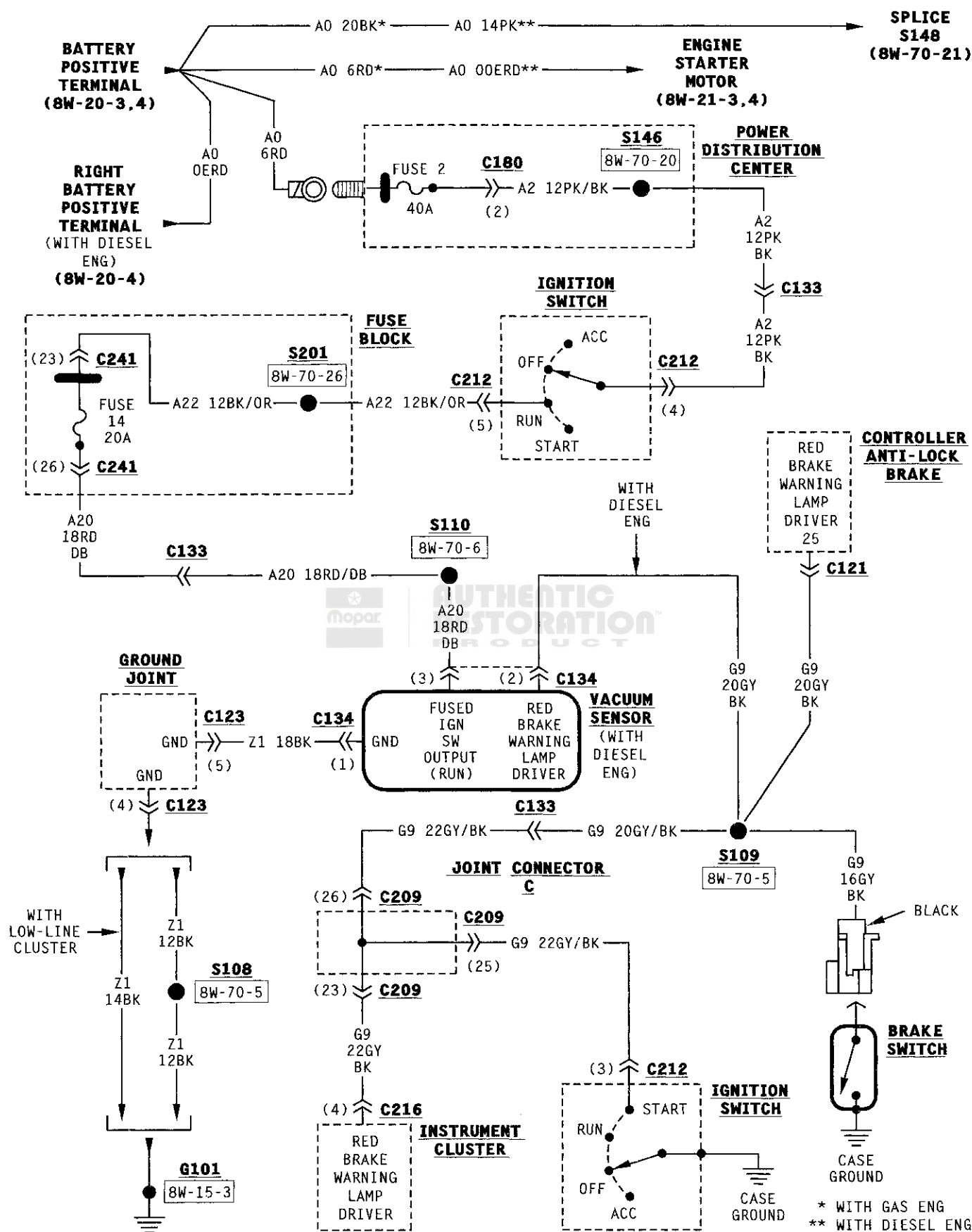
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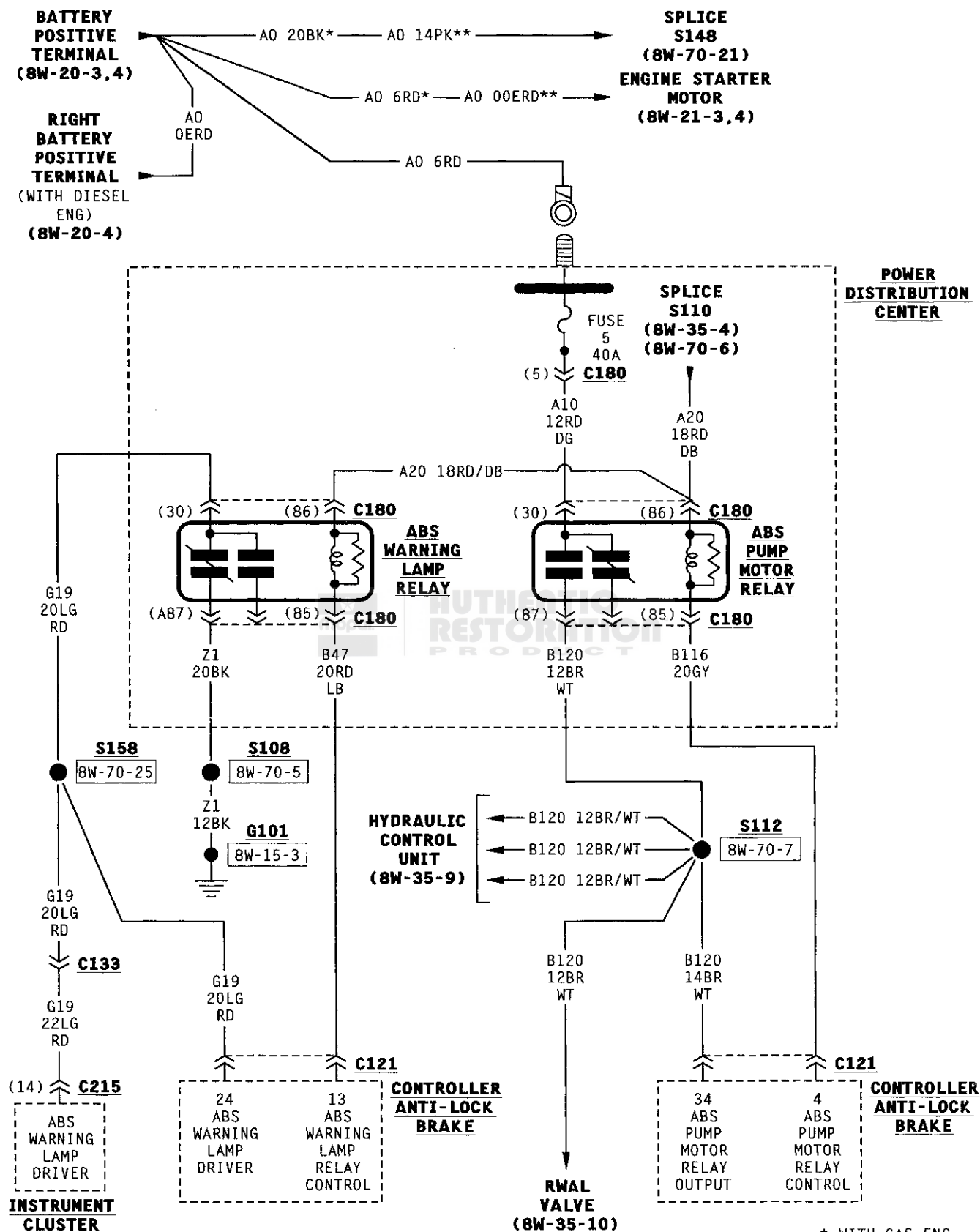
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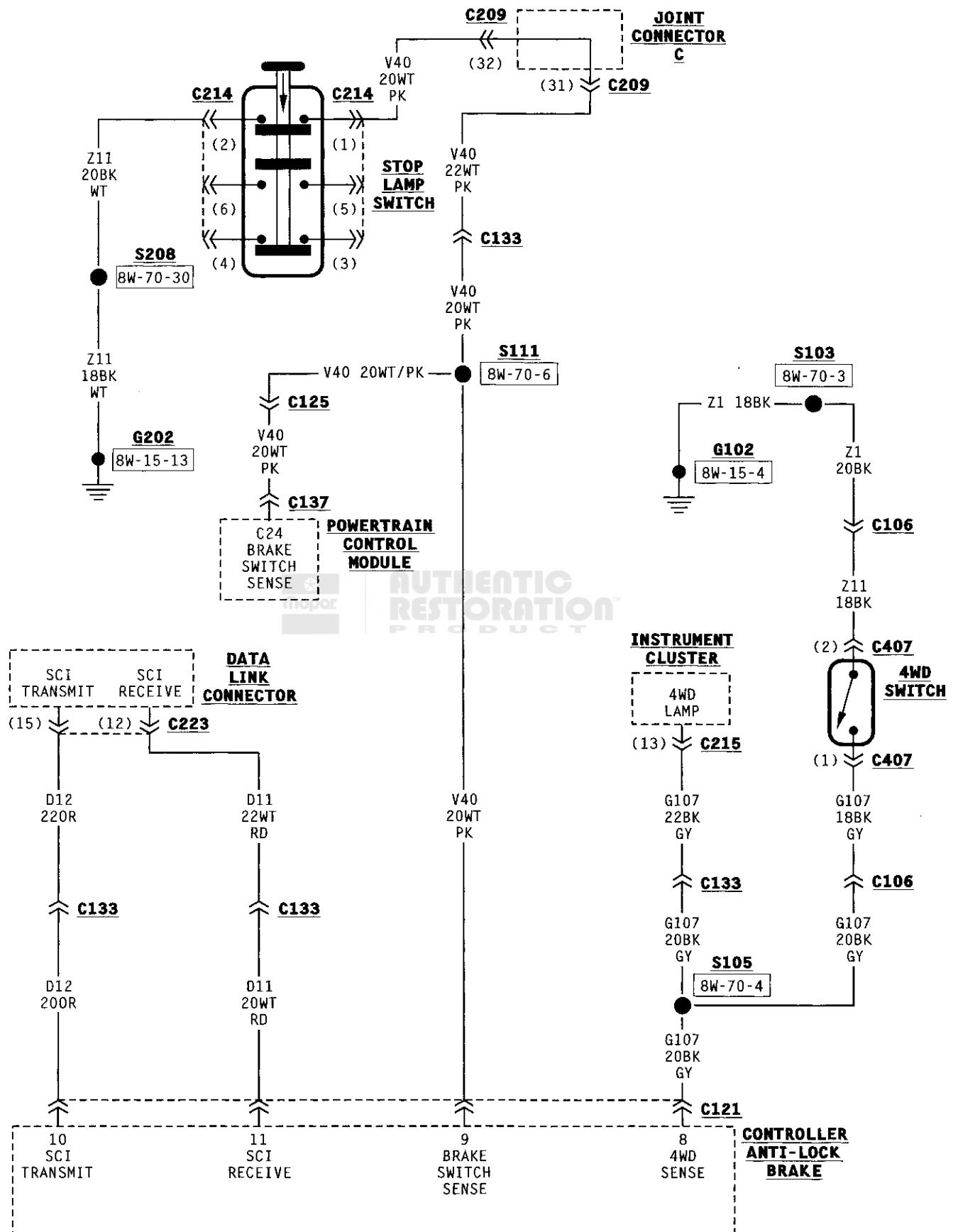
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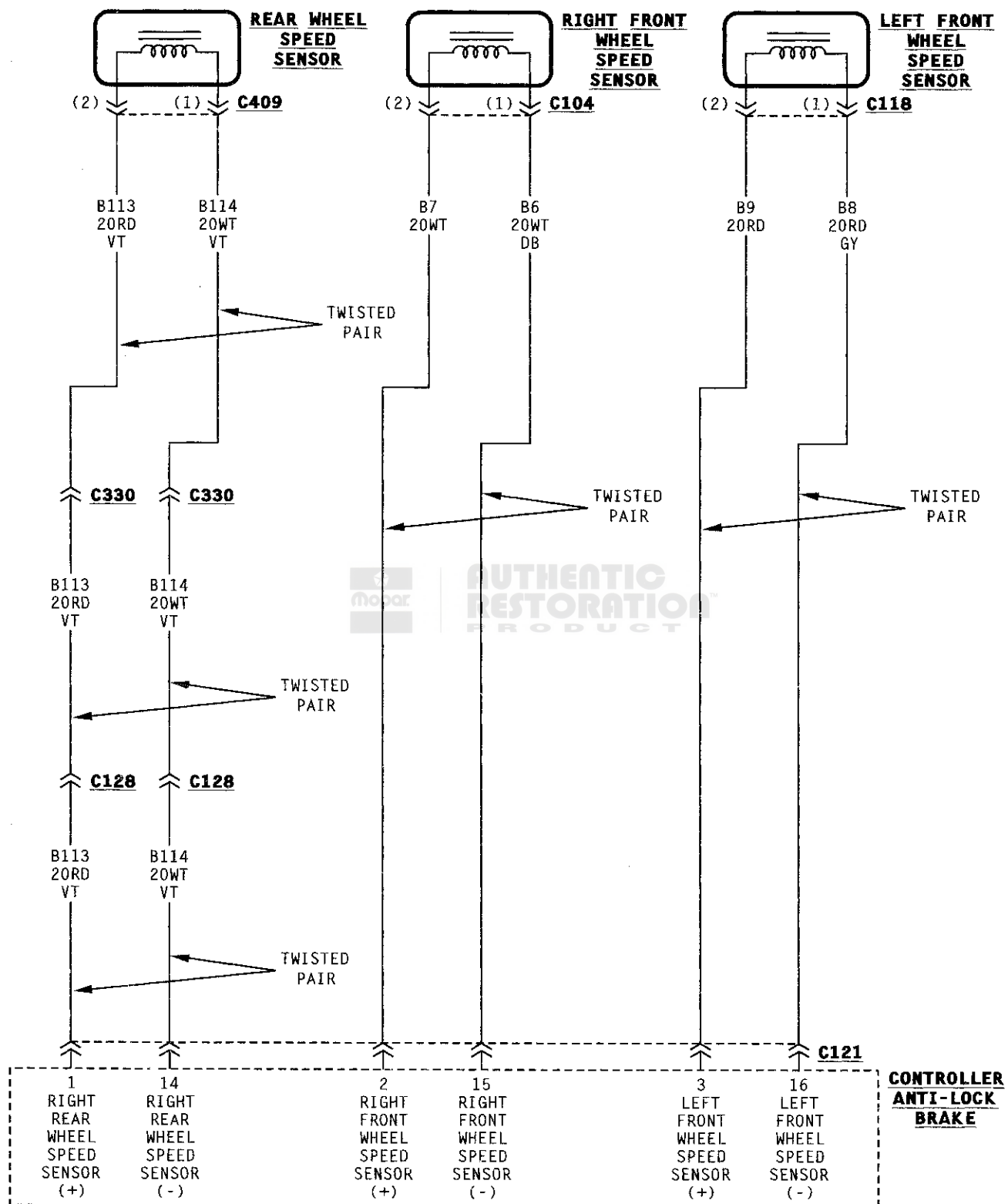


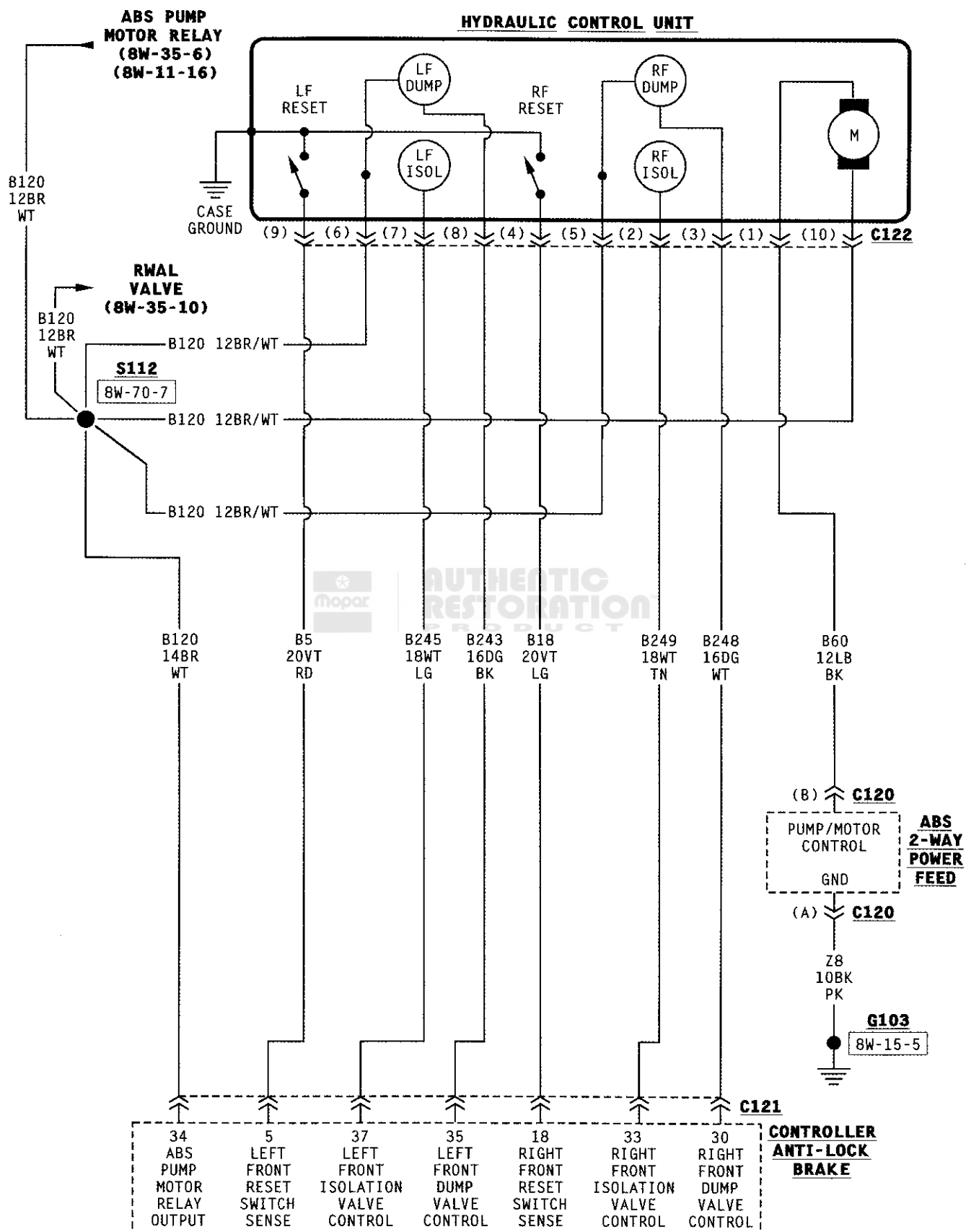


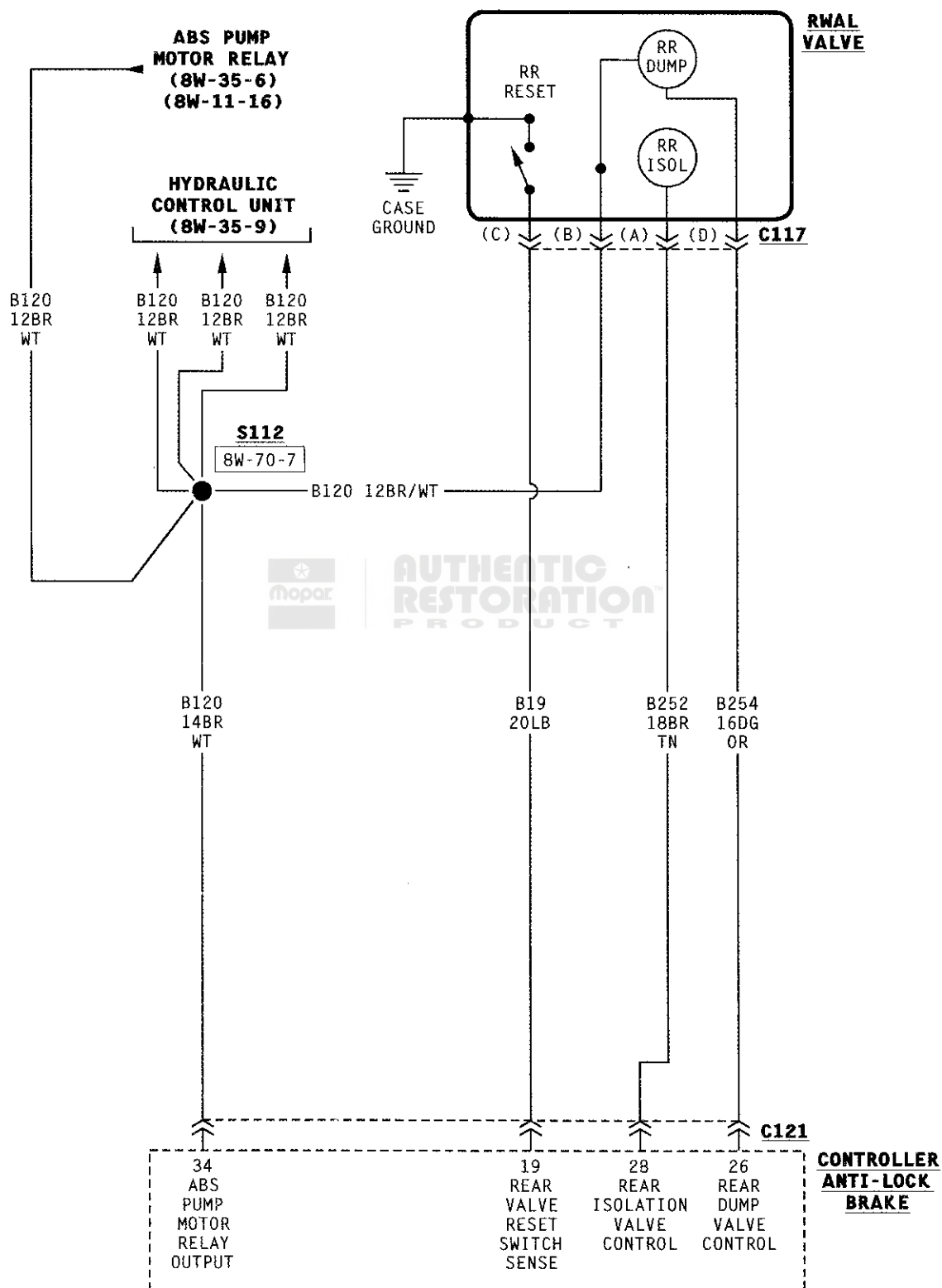


* WITH GAS ENG
 ** WITH DIESEL ENG









8W-40 INSTRUMENT CLUSTER

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DESCRIPTION AND OPERATION

INTRODUCTION

The instrument cluster contains the gauges and warning lamps. All gauges have magnetic movements.

When the ignition switch is in the START or RUN position, circuit A21 feeds circuit F14 through a bus bar in the fuse block and fuse 12. Circuit A1 from fuse 3 in the Power Distribution Center (PDC) supplies voltage to circuit A21.

Circuit F14 provides battery voltage for the warning lamps (except seat belt indicator lamp), transmission up shift lamp, and all gauges.

Circuit E2 from fuse 13 in the fuse block feeds the illumination lamps. Circuit E1 from the headlamp switch powers fuse 13 when the parking lamps or headlamps are ON.

Circuit Z3 provides ground for the indicator lamps and illumination lamps. Circuit Z11 provides the ground path for the gauges.

SPEEDOMETER

The speedometer and odometer receive a signal from the Vehicle Speed Sensor (VSS) on circuit G7. Circuit G7 is spliced and also connects to the Powertrain Control Module (PCM).

Circuit F14 from the fuse block provides voltage for the speedometer. Circuit Z11 provides ground for the speedometer.

FUEL GAUGE

Circuit G4 connects the fuel level sensor to the fuel gauge in the instrument cluster. Circuit F14 from fuse 12 in fuse block supplies voltage to the fuel

gauge. The fuel level sensor draws voltage from circuit F14 through the fuel gauge on circuit G4. The fuel level sensor is located in the fuel tank.

As current flows through the coils in the fuel gauge, it creates a magnetic field. One of the coils in the gauge receives fixed current. The other coil is connected to the level sensor. The magnetic field controls the position of the fuel gauge pointer.

The fuel level sensor contains a variable resistor. As the position of the float arm on the fuel level sensor changes, the resistor changes the current flow through the second coil in the fuel gauge. A change in current flow alters the magnetic field in the fuel gauge, which changes the pointer position.

Circuit Z11 provides the ground path for the fuel level sensor.

ENGINE COOLANT TEMPERATURE GAUGE

Circuit G20 connects the engine coolant temperature gauge to the engine coolant temperature sensor. The sensor is a variable resistor and case grounded to the engine on all engines except the 8.0L V-10. The V-10 engine coolant temperature sensor has an external ground. Circuit F14 from fuse 12 in the fuse block connects to the instrument cluster and supplies voltage for the gauge.

As current flows through the coils in the gauge, it creates a magnetic field. One of the coils in the gauge receives fixed current. The other coil is connected to the temperature gauge on circuit G20. A change in temperature changes the resistance in the sensor, which alters the current flow through the second coil in the gauge. A change in current flow alters the magnetic field in the gauge, which changes the pointer position.

DESCRIPTION AND OPERATION (Continued)**VOLTMETER**

Power for the voltmeter is supplied on circuit F14. This circuit is spliced and supplies power to all the gauges. Ground for the voltmeter is supplied on circuit Z11.

The F14 circuit is also used to measure the voltage level. The gauge reading changes based on the system voltage in the F14 circuit.

TACHOMETER

The tachometer module in the instrument cluster operates the tachometer. The Powertrain Control Module (PCM) supplies the signal for the tachometer on circuit G21. Circuit G21 connects to cavity C31 of the PCM.

OIL PRESSURE GAUGE

The case grounded oil pressure sensor is a variable resistor that connects to circuits G60 and G6. Circuit G60 connects to the oil pressure gauge. Circuit G6 connects to the oil pressure warning lamp.

Circuit F14 connects to the instrument cluster and supplies battery voltage to oil pressure gauge. The gauge uses two coils. One coil receives fixed current, circuit G60 connects the other coil to the pressure sensor. As oil pressure changes, the variable resistor in the sensor changes the current flow through the second coil in the gauge. A change in current flow alters the position of the gauge pointer

OIL PRESSURE WARNING LAMP

The case grounded oil pressure sensor is a variable resistor that connects to circuits G60 and G6. Circuit G60 connects to the oil pressure gauge. Circuit G6 connects to the oil pressure warning lamp.

Circuit F14 connects to the instrument cluster and supplies battery voltage to oil pressure lamp.

When the oil pressure is below a predetermined level the engine oil pressure sensor completes a path to ground causing the lamp to illuminate.

LOW FUEL WARNING LAMP

Circuit G4 connects the fuel level sensor to the low fuel relay in the instrument cluster. When the fuel level in the fuel tank reaches a calibrated level, the low fuel warning lamp relay illuminates the lamp.

MALFUNCTION INDICATOR LAMP (MIL)

The Powertrain Control Module (PCM) provides ground for the MIL on circuit G3. Circuit G3 connects to cavity C17 of the PCM. When illuminated, the MIL displays the message CHECK ENGINE. For information regarding diagnostic trouble code access using the MIL, refer to Group 14, Fuel Systems.

LOW WASHER FLUID LAMP

Circuit G29 connects the low washer fluid switch to the warning lamp in the instrument cluster. Circuit F14 supplies battery voltage to the lamp.

When the low washer fluid switch CLOSES, it connects circuits G29 and Z1. Circuit Z1 provides a ground path, illuminating the warning lamp. Circuit Z1 also provides ground for the windshield washer pump motor.

HIGH-BEAM INDICATOR LAMP

Circuit G34 supplies power for the high-beam indicator lamp. The ground path for the lamp is through circuit Z3. Circuit G34 splices to circuit L3. Circuit L3 feeds the high beam circuit of the headlamps.

TURN SIGNAL INDICATOR LAMPS

Circuits L61 and L60 power for the turn signal indicator lamps. Circuit L61 powers the left indicator lamp. Circuit L60 powers the right indicator lamp. Circuit Z3 provides ground for the lamps.

ABS WARNING LAMP**ALL-WHEEL ANTILOCK BRAKES**

The Controller, Antilock Brakes (CAB) provides ground for the ABS warning lamp in the message center through the normally closed contacts in the ABS warning lamp relay. When the ignition switch is in the START position, the lamp illuminates as a bulb test for approximately 3 to 5 seconds while the CAB performs a system self-test. While closed, the relay contacts complete the ground path for the ABS warning lamp by connecting circuit G19 from the lamp to ground on circuit Z1. Power for the lamp is supplied by circuit F14.

If the system self-test is successfully completed, the CAB energizes the ABS warning lamp relay by providing ground for the relay coil on circuit B47. When the relay energizes, its contacts open and disconnect circuits G19 and Z1. Circuit A20 from fuse 14 in the fuse block supplies power to the coil side of the relay.

Circuit G19 from the ABS warning lamp splices to the CAB and the ABS warning lamp relay.

REAR WHEEL ANTILOCK (RWAL) BRAKES

The Controller Anti Lock Brake (CAB) provides ground for the instrument cluster Check Antilock warning lamp on circuit G19. Circuit F14 provides voltage to the instrument cluster to feed the warning lamp.

SEAT BELT INDICATOR WARNING LAMP

The seat belt indicator warning lamp is activated by the buzzer module on circuit G13. Circuit G13

DESCRIPTION AND OPERATION (Continued)

supplies power to instrument cluster for the lamp. Circuit Z3 provides ground for the lamp.

PARKING BRAKE LAMP

Power for the parking brake lamp is supplied on circuit F14. This circuit is protected by a 15 amp fuse located in cavity 12 of the fuse block.

Ground for the lamp is supplied from two different sources. One way is on circuit G11. This circuit connects from the lamp to the park brake switch located on the park brake mechanism. This switch is normally OPEN. When the switch CLOSES, a ground path is completed through the case grounded switch. On vehicles equipped with Daytime Running Lamps (DRL), the G11 circuit is spliced and provides an input to the DRL module.

The second ground path is supplied by the brake pressure warning switch. Circuit G9 connects from the lamp in the cluster to the switch. The switch is normally OPEN. When the brake pressure is below a pre-determined pressure, the switch CLOSES and a ground path is completed through the case grounded switch.

MANUAL TRANSMISSION UP-SHIFT LAMP

Circuit F14 supplies power for the manual transmission up-shift lamp. The lamp illuminates when the Powertrain Control Module (PCM) provides ground for the lamp on circuit G54. Circuit G54 connects to cavity B11 of the PCM.

AIRBAG WARNING LAMP

Circuit F14 supplies power for the airbag warning lamp. The lamp illuminates when the Airbag Control Module (ACM) provides ground for the lamp on circuit R41.

FOUR-WHEEL DRIVE INDICATOR

Power for the four-wheel drive indicator lamp is supplied on circuit F14. Ground for the lamp is supplied on circuit G107 to the switch. The ground is passed through the CLOSED contacts in the switch to circuit Z1.

GENERATOR LAMP

Circuit F14 supplies power for the generator lamp. The lamp illuminates when the Powertrain Control Module (PCM) provides ground for the lamp on circuit G12. Circuit G12 connects to cavity C16 of the PCM.

SERVICE REMINDER INDICATOR (SRI) LAMP

Power for the SRI lamp is supplied on circuit F14. Ground for the lamp is controlled by the Powertrain Control Module (PCM) on circuit G24. This circuit connects to cavity C16 of the PCM connector.

HELPFUL INFORMATION

If the warning lamps don't operate, check fuse 12 in the fuse block.

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

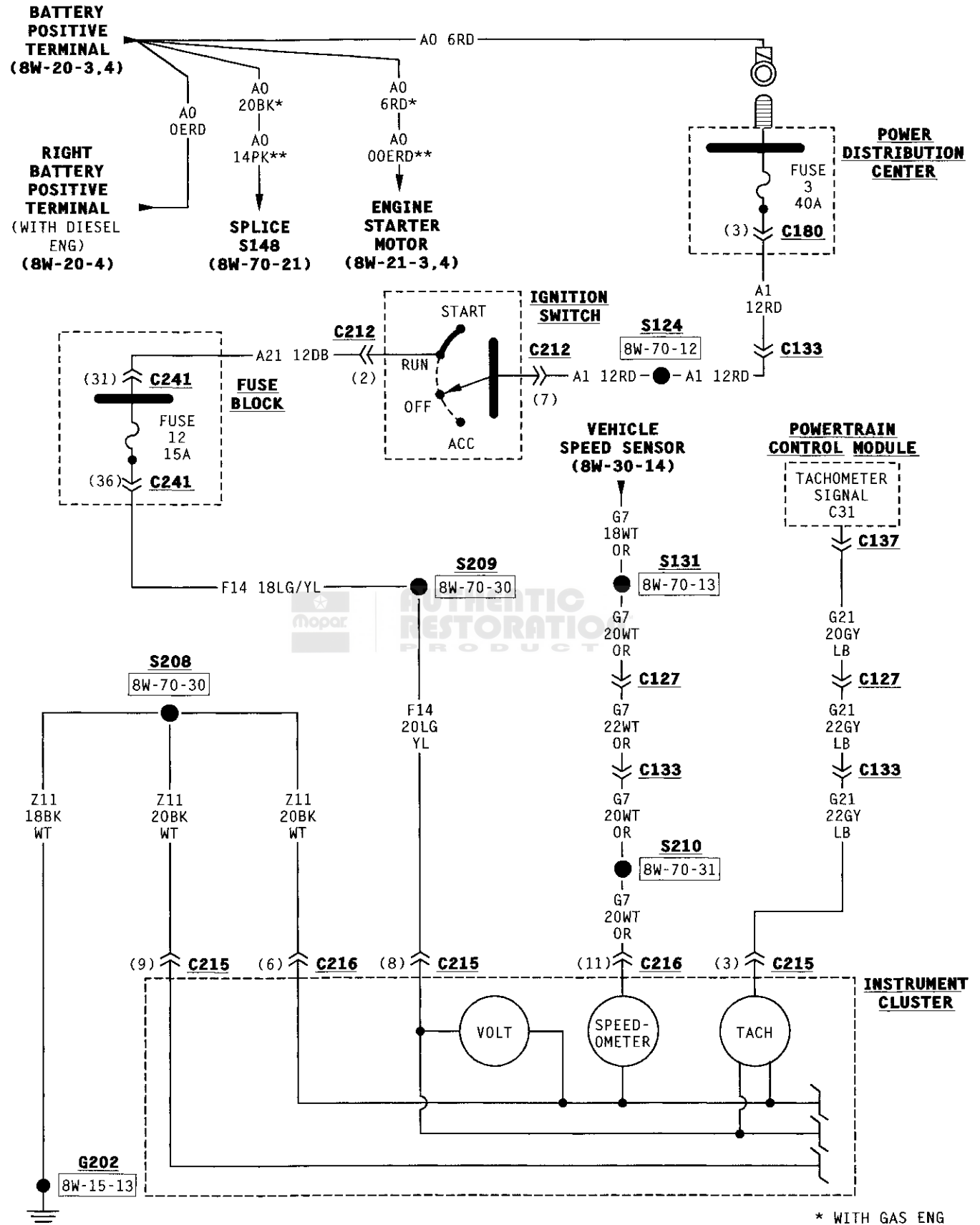
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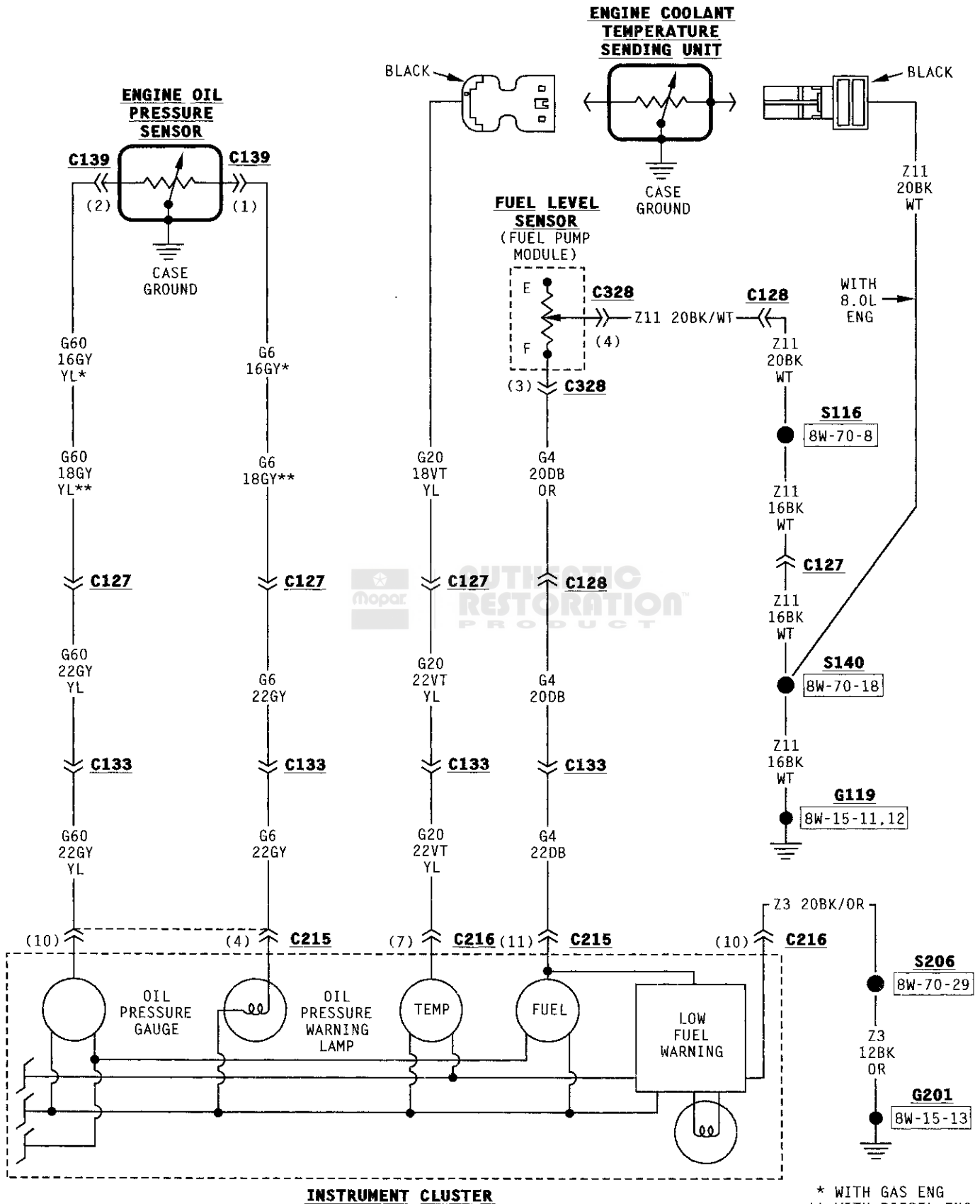
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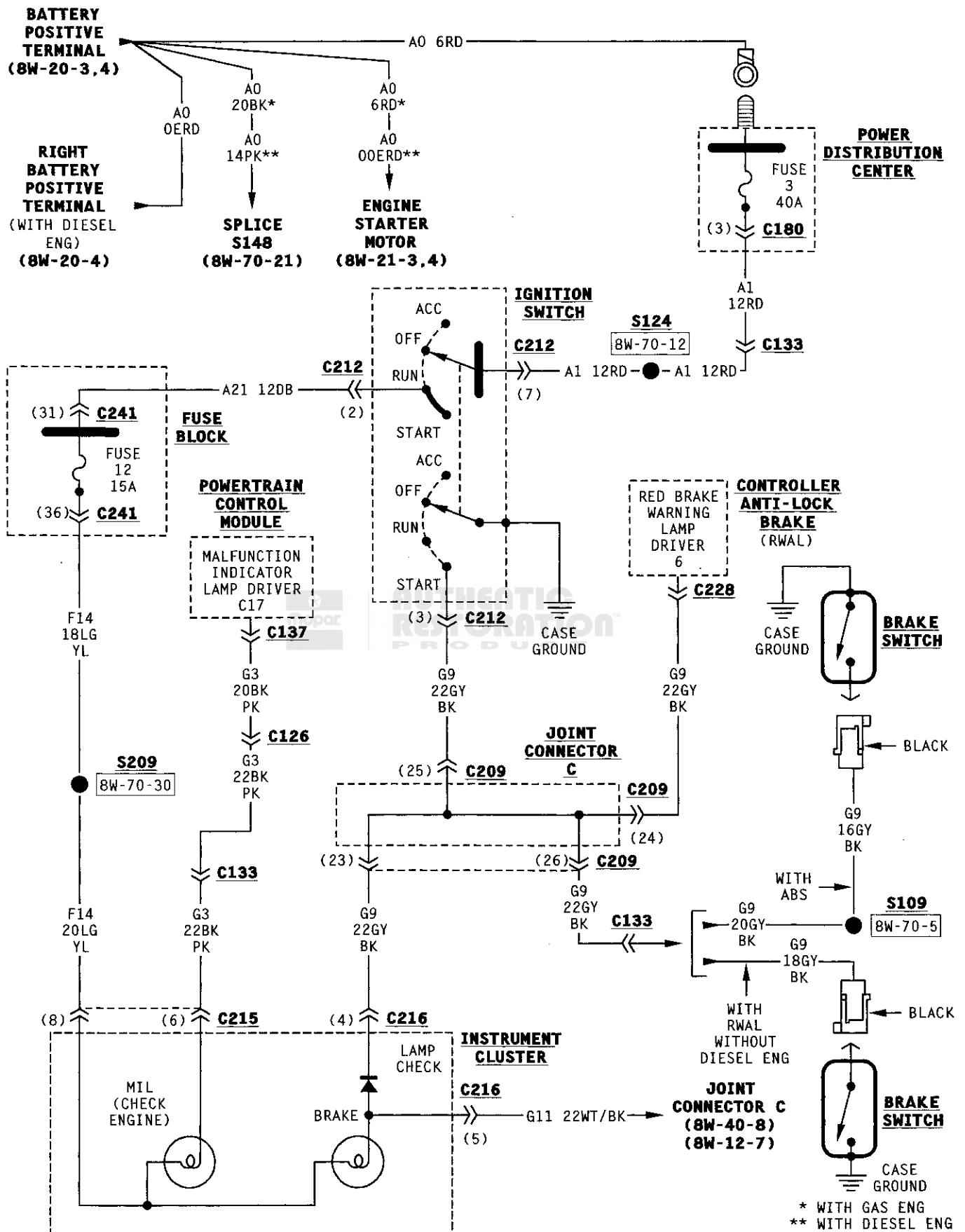
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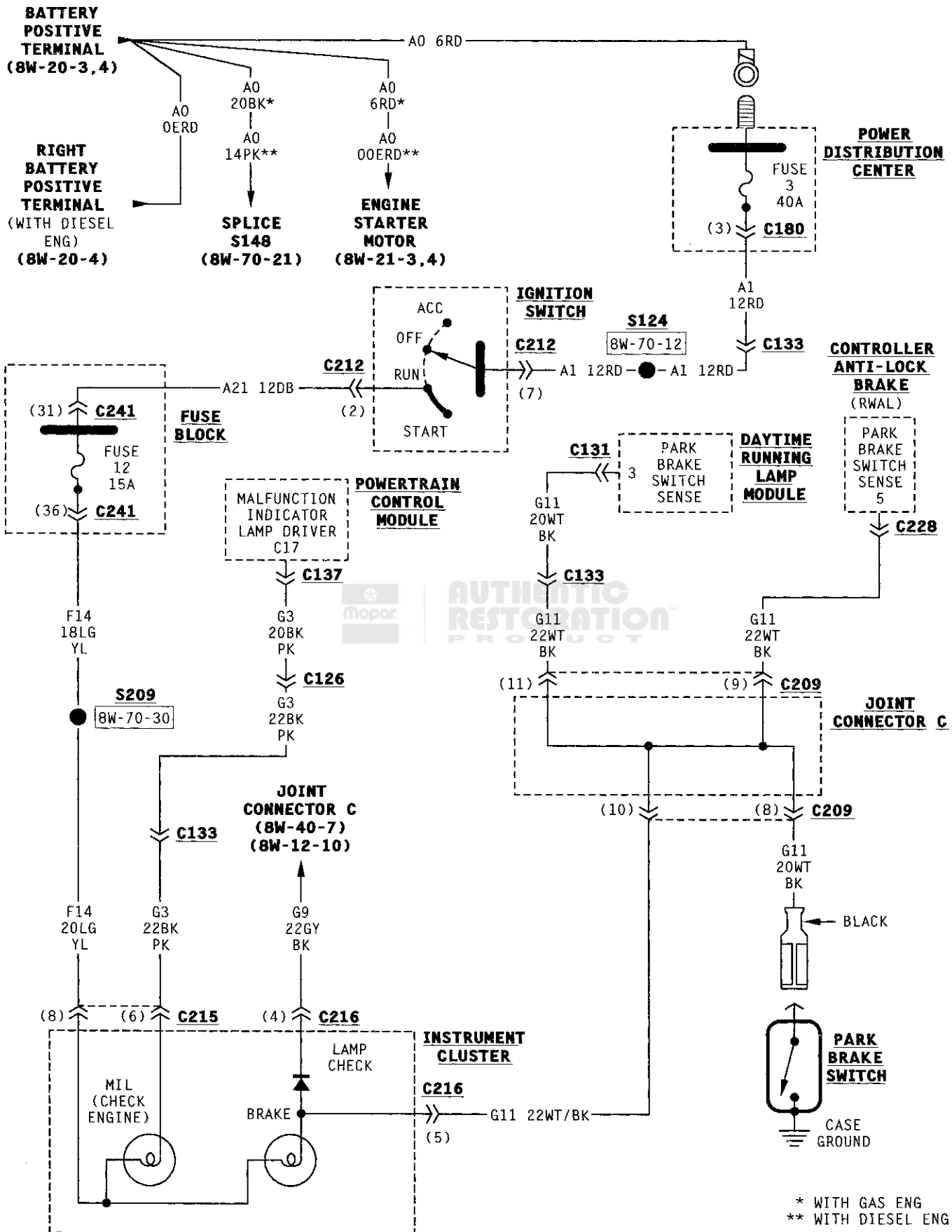


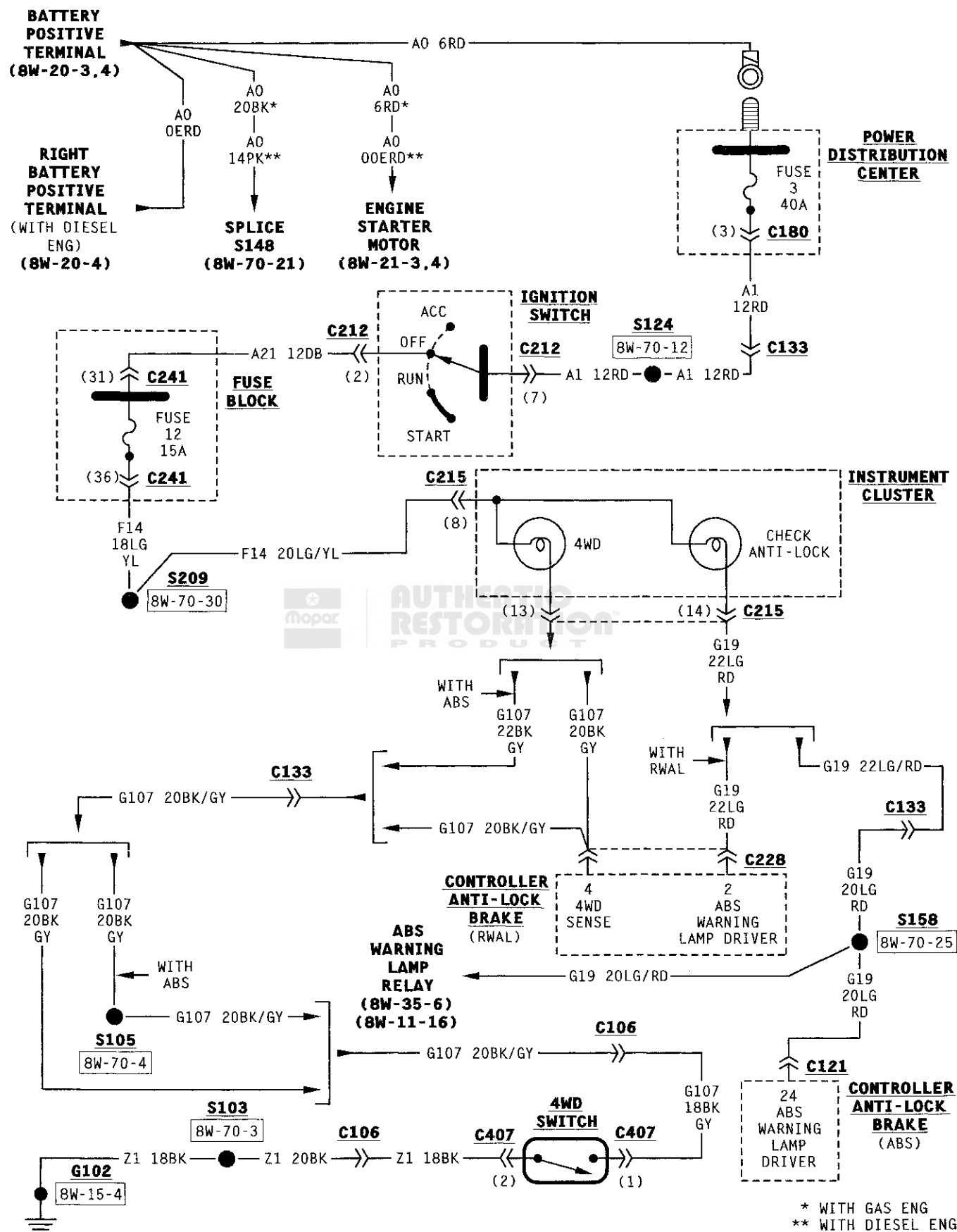
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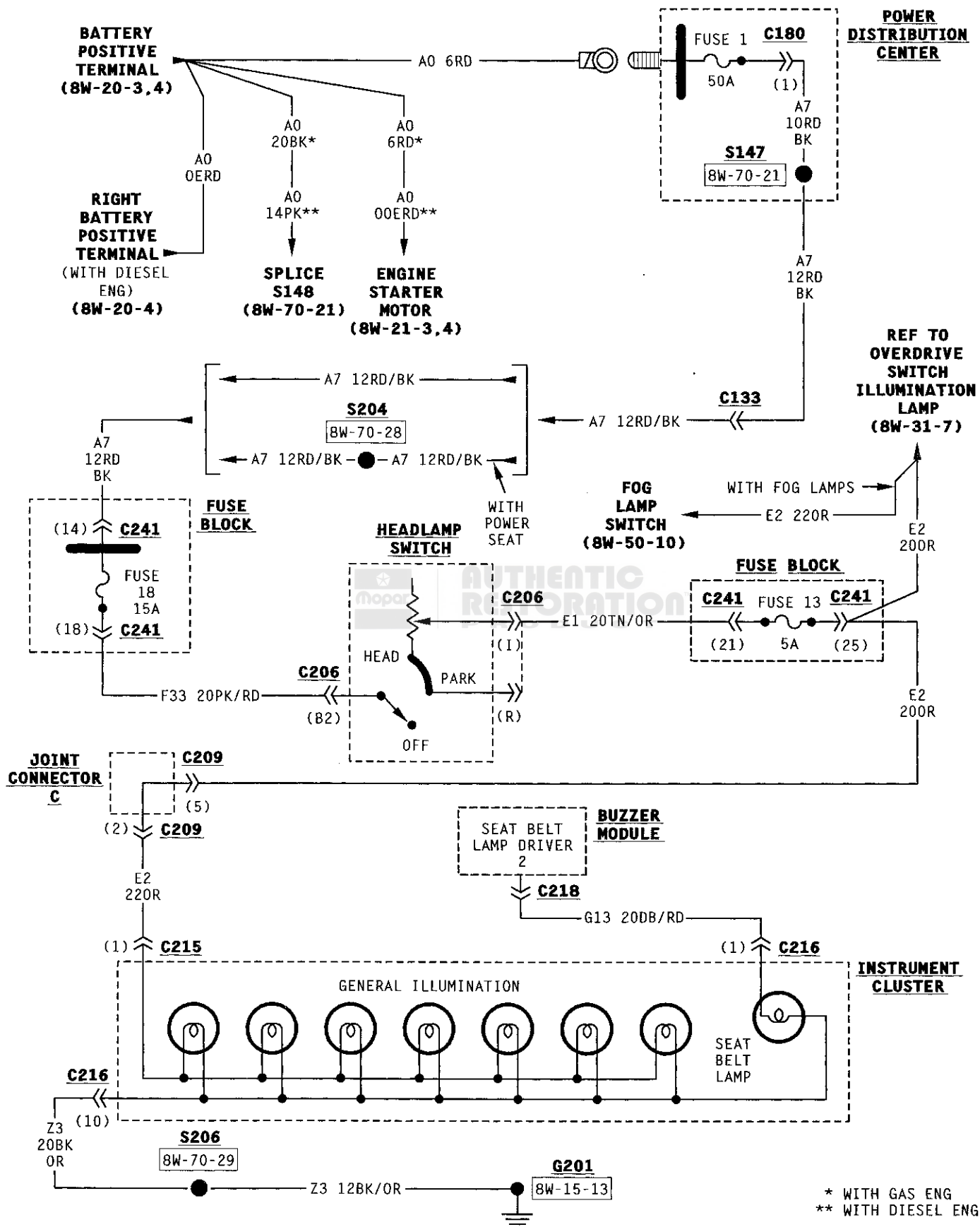


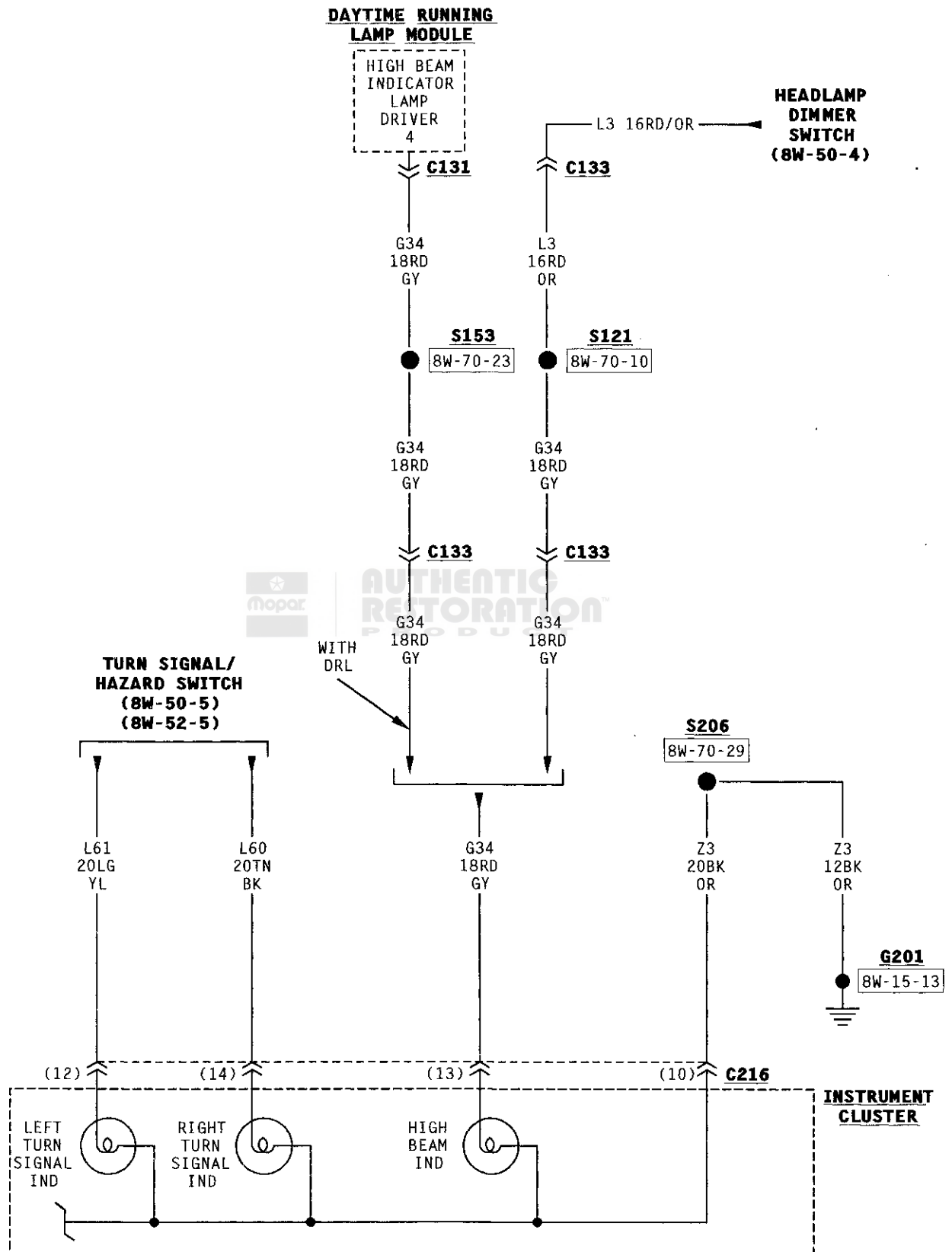
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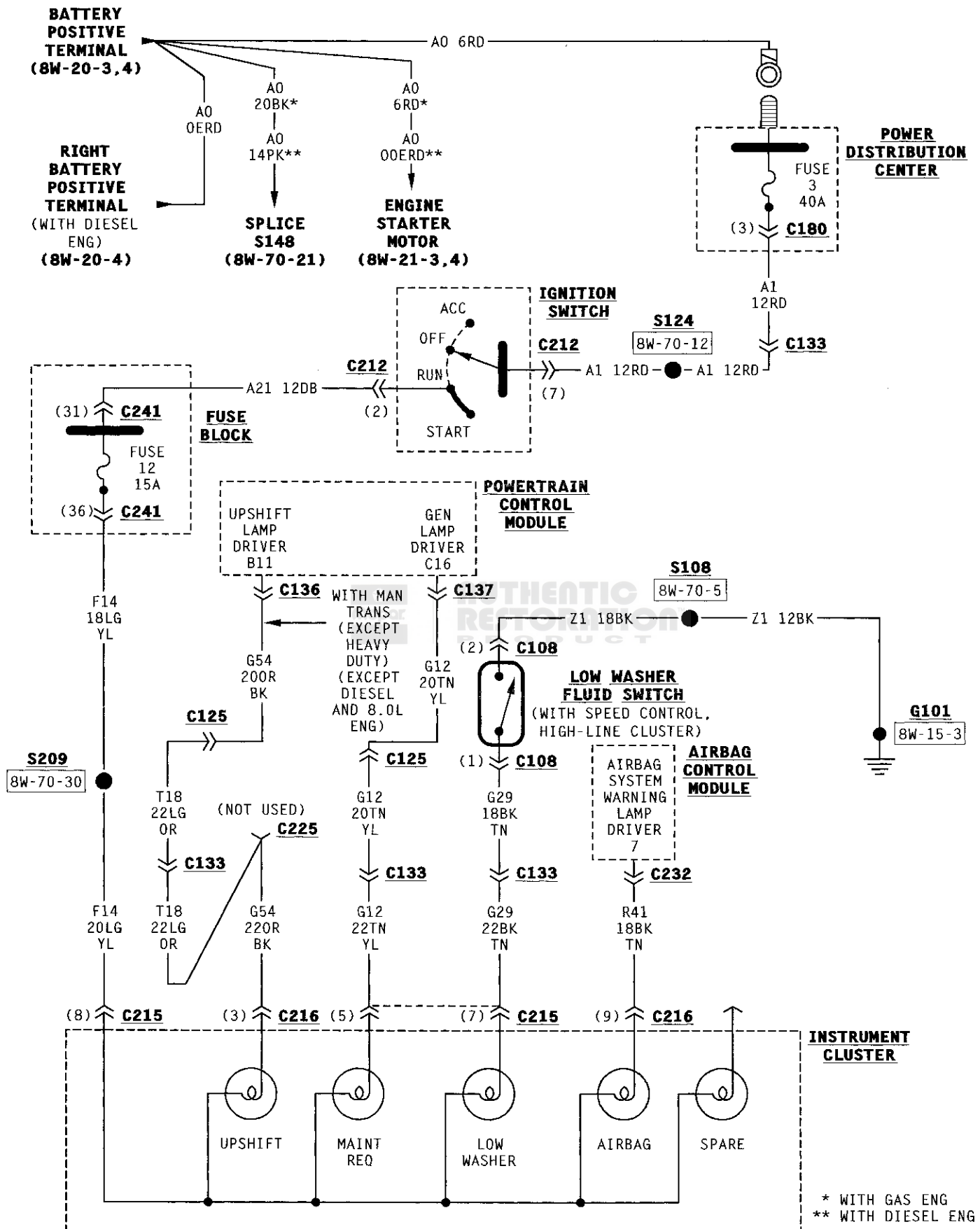












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8W-41 HORN/CIGAR LIGHTER/POWER OUTLET

DESCRIPTION AND OPERATION

HORN

The horn system is powered by a 20 amp fuse located in the Power Distribution Center (PDC), cavity B, which is HOT at all times on circuit F31. This circuit supplies voltage to the coil and contact side of the horn relay.

When the operator presses the horn switch, a ground path is completed on the coil side of the horn relay through the switch. The horn relay, located in the PDC, then CLOSES the relay contacts. Voltage is passed through the CLOSED relay contacts on circuit X2 to the horns.

HELPFUL INFORMATION

- Check the 20 amp fuse located in cavity B of the PDC.
- Press the horn switch and listen for the horn relay to click. A clicking relay indicates voltage is present up to the switch.

CIGAR LIGHTER

When the ignition switch is in the ACCESSORY or RUN position, it connects circuit A1 from fuse 3 in the Power Distribution Center (PDC) to circuit A31. Circuit A31 powers circuit F30 through fuse 5 in the fuse block. Circuit F30 supplies current to the cigar lighter.

When the operator presses the lighter, contacts inside of the lighter element CLOSE and voltage flows through the heating element to ground on circuit Z3.

HELPFUL INFORMATION

- Circuit F30 also supplies power to the power outlet.
- Check the 40 amp fuse located in cavity 3 of the PDC
- Check the 20 amp fuse located in cavity 5 of the fuse block
- Check the cigar lighter element

POWER OUTLET

Fuse 1 in the fuse block feeds the power outlet on circuit F130. Circuit F130 is HOT at all times. Circuit Z3 supplies ground for the power outlet.

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

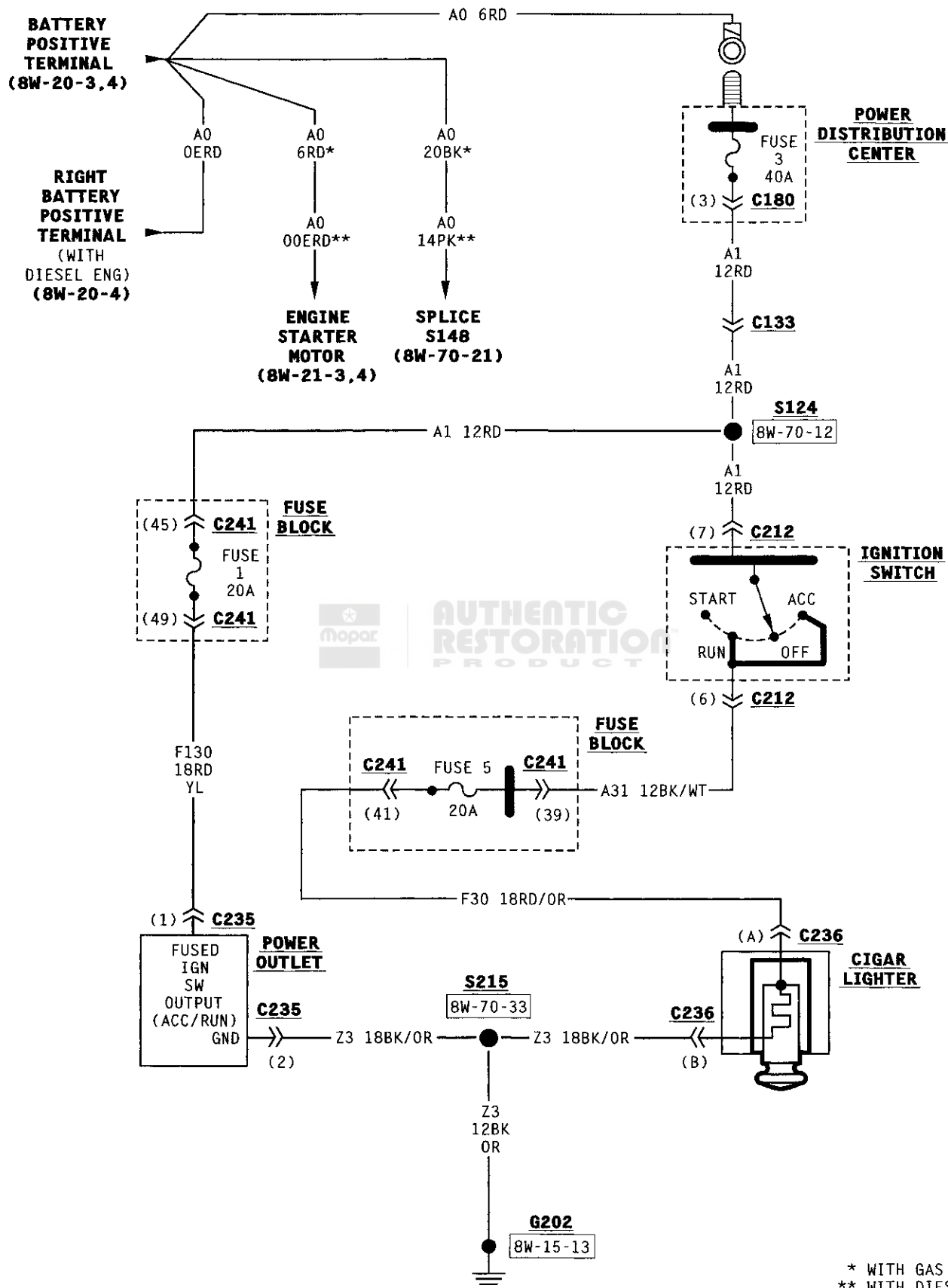
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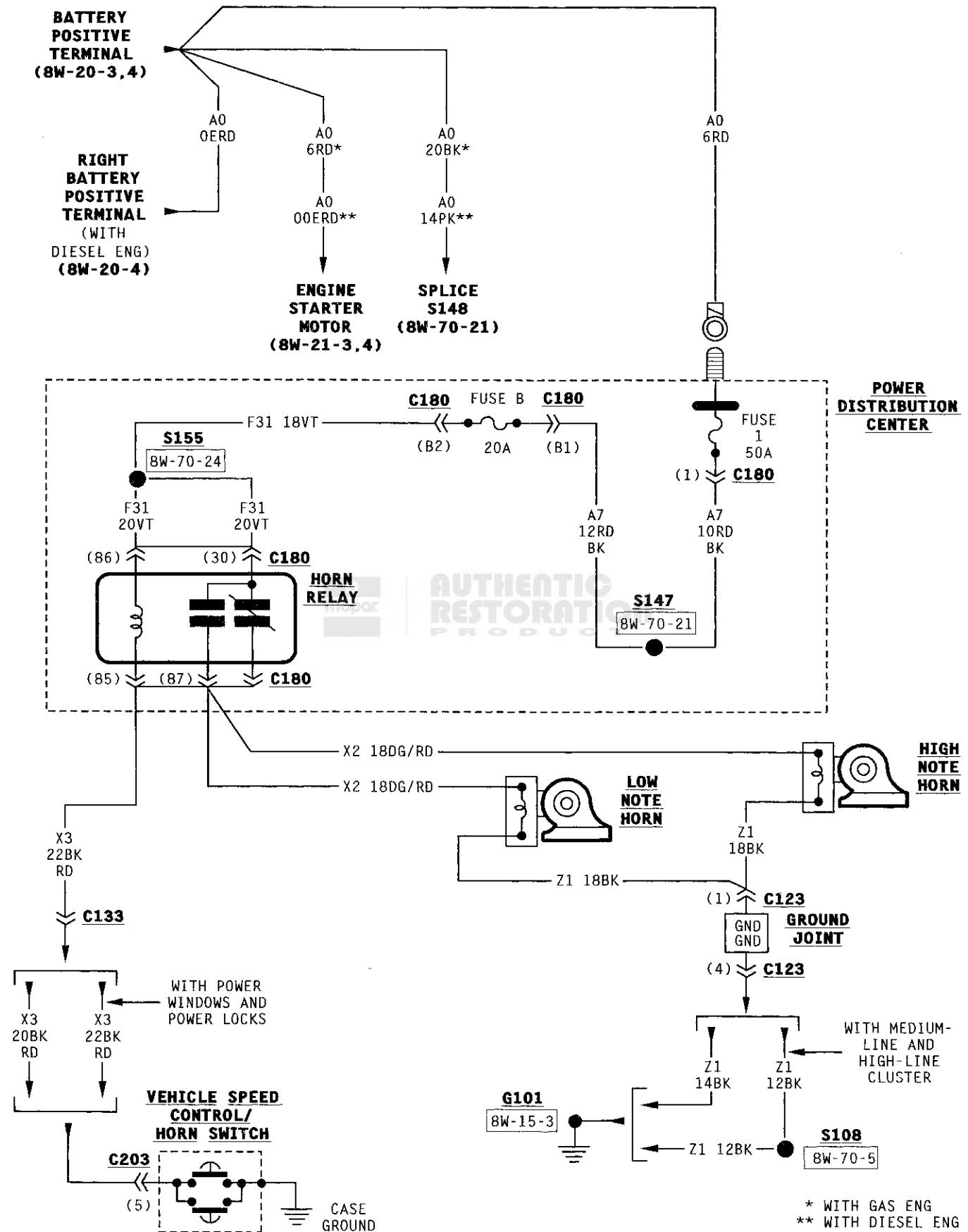
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8W-42 AIR CONDITIONING/HEATER

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	WIRING DIAGRAM INDEX 2

GENERAL INFORMATION

INTRODUCTION

This section of the wiring diagrams covers the operation of the Heater only and the Heater-A/C systems.

Several fuses supply power for the A/C-Heater system. Fuse B, a 20 amp, from the Power Distribution Center (PDC) supplies battery voltage on circuit F31 to the contact side of the A/C compressor clutch relay. Circuit F31 is HOT at all times.

In the START or RUN position, the ignition switch connects circuit A1 from fuse 3 in the PDC to circuit A21. Circuit A21 feeds fuse 9, a 10 amp, in the fuse block. Circuit F18 connects from fuse 9 to the coil side of the A/C compressor clutch relay.

In the RUN position only, the ignition switch connects circuit A2 from fuse 2, a 40 amp, in the PDC to circuit A22. Circuit A22 supplies voltage to a bus bar in the fuse block. Fuse 2, a 4 amp, connects to the bus bar and protects circuit C1 which feeds the blower motor.

Circuit E2 from fuse 13 in the fuse block powers the illumination lamps in the A/C heater control switch.

DESCRIPTION AND OPERATION

BLOWER MOTOR

When the ignition switch is in the RUN position, circuit A2 from fuse 2, a 40 amp, in the Power Distribution Center (PDC) connects with circuit A22. Circuit A22 supplies voltage to a bus bar in the fuse block that powers fuse F2. Fuse F2 protects circuit C1 which supplies battery voltage to the blower motor.

From the blower motor, circuit C7 splices to the blower motor resistor and the A/C-Heater control switch.

The ground path for the blower motor is through the circuits that connect from the blower motor resistor block and then through the fan switch in the A/C-heater controls to circuit Z3. The blower motor

resistor block consists of three resistors connected in series.

Each resistor in blower motor resistor block is spliced to the fan switch on separate circuits; C4, C5, C6, and C7. Depending on fan switch position, voltage passes through one or more resistors to ground. Blower motor fan speed is controlled by the number of resistors voltage passes through to ground.

When the fan switch is in the LOW position, circuit C4 provides the ground path. In the M1 position, circuit C5 provides ground. In the M2 position, the ground path is through circuit C6. Circuit C7 provides path for ground when the switch is in the HIGH position.

AIR CONDITIONING OPERATION

When the A/C-Heater control switch is moved to an A/C position or the defrost position, the Powertrain Control Module (PCM) receives the A/C select signal on circuit C90. Circuit C90 connects to PCM cavity C23. If the A/C low pressure and high pressure switches are CLOSED, the Powertrain Control Module (PCM) receives the A/C request signal on circuit C20. Circuit C20 connects to cavity C22 of the PCM.

After receiving the A/C request signal, the PCM supplies ground for the coil side of the A/C clutch relay on circuit C13. Circuit C13 connects to cavity C1 of the PCM. Circuit F18 supplies battery voltage to the coil side of the relay. Circuit F31 from fuse B in the Power Distribution Center (PDC) supplies voltage to the contact side of the relay.

When the PCM grounds the A/C compressor clutch relay, the contacts CLOSE and connect circuits F31 and C3. Circuit C3 supplies voltage to the A/C compressor clutch. Ground for the compressor clutch is provided on circuit Z11.

The A/C compressor clutch connector has a built-in diode. The diode controls the induced voltage that results from the magnetic field collapsing when the clutch disengages. The diode provides a current path to protect other components and systems.

DESCRIPTION AND OPERATION (Continued)

HELPFUL INFORMATION

- Check the 40 amp fuses located in cavities 2, and 3 of the PDC
- Check the 30 amp fuse located in cavity F2 of the fuse block
- Check the 10 amp fuse located in cavity 9 of the fuse block

you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

SCHEMATICS AND DIAGRAMS

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The following index covers all components found in this section of the wiring diagrams. If the component



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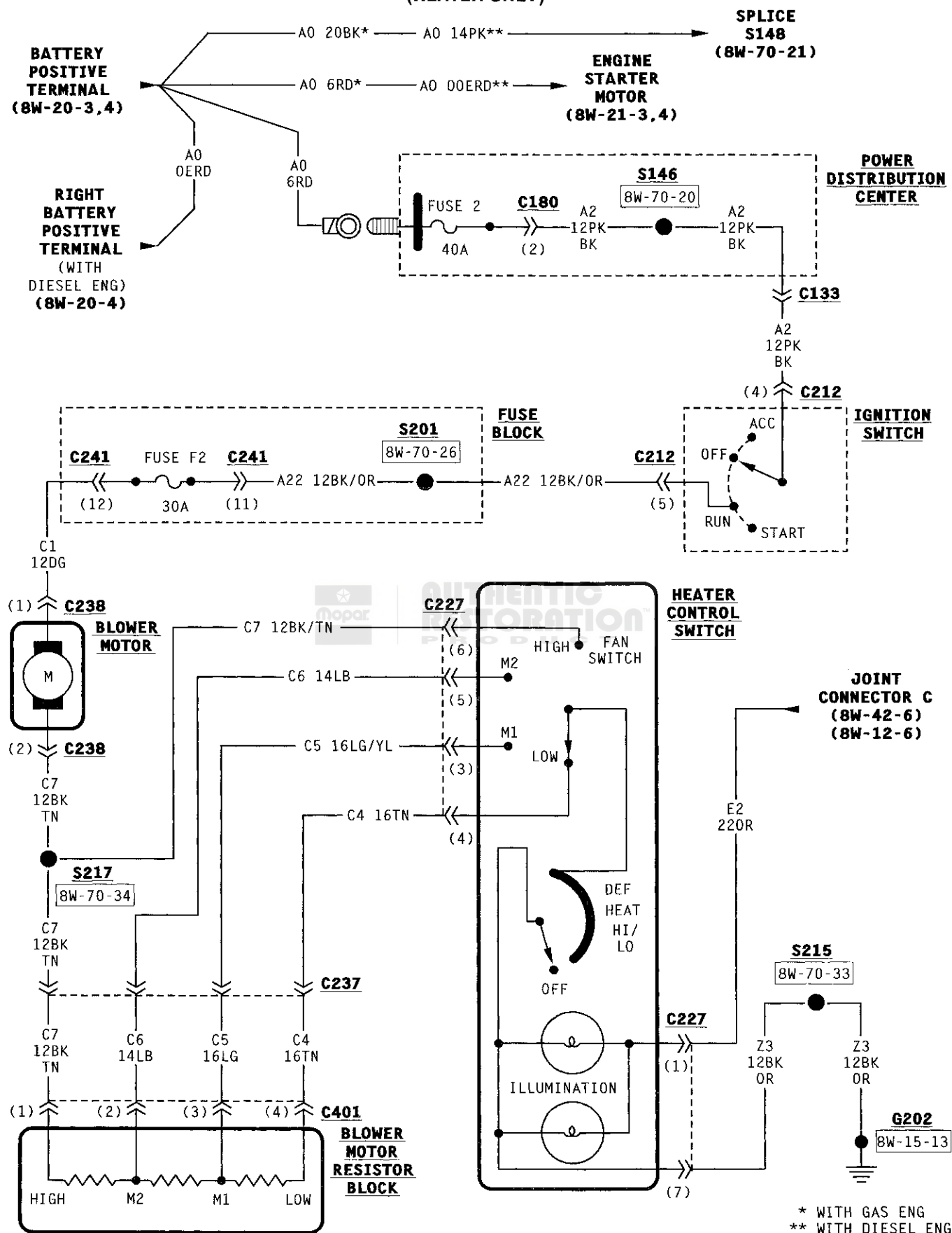
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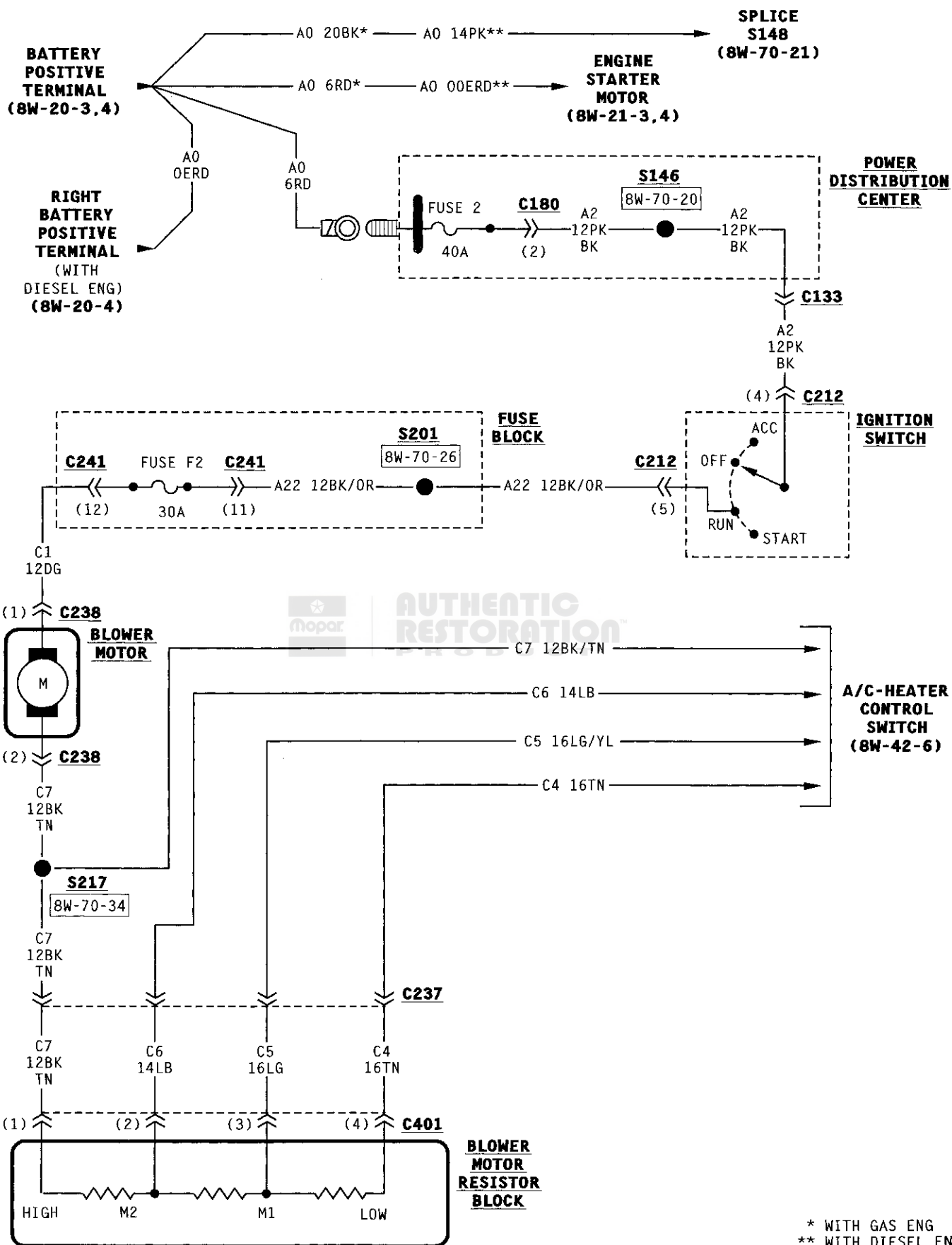
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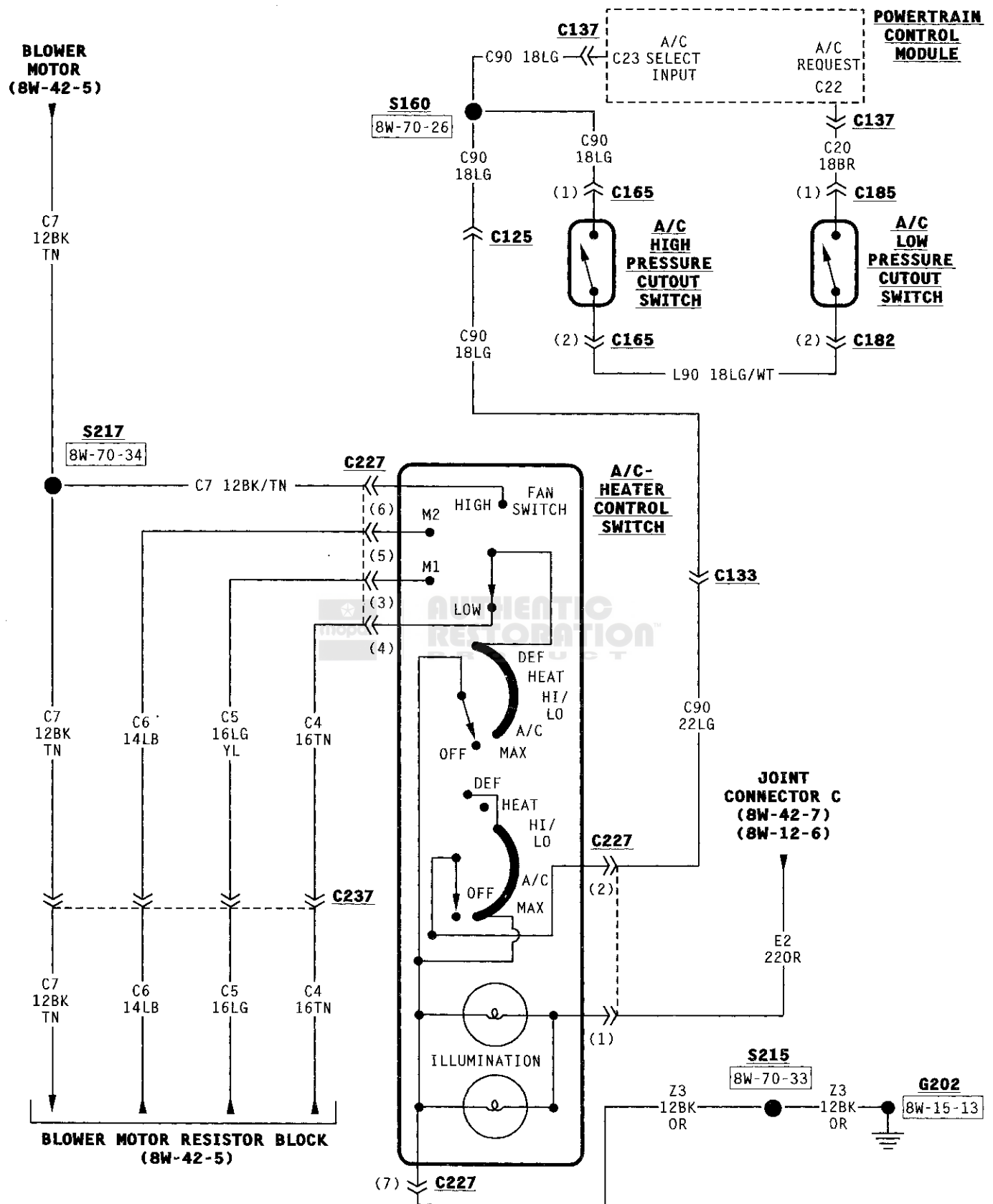


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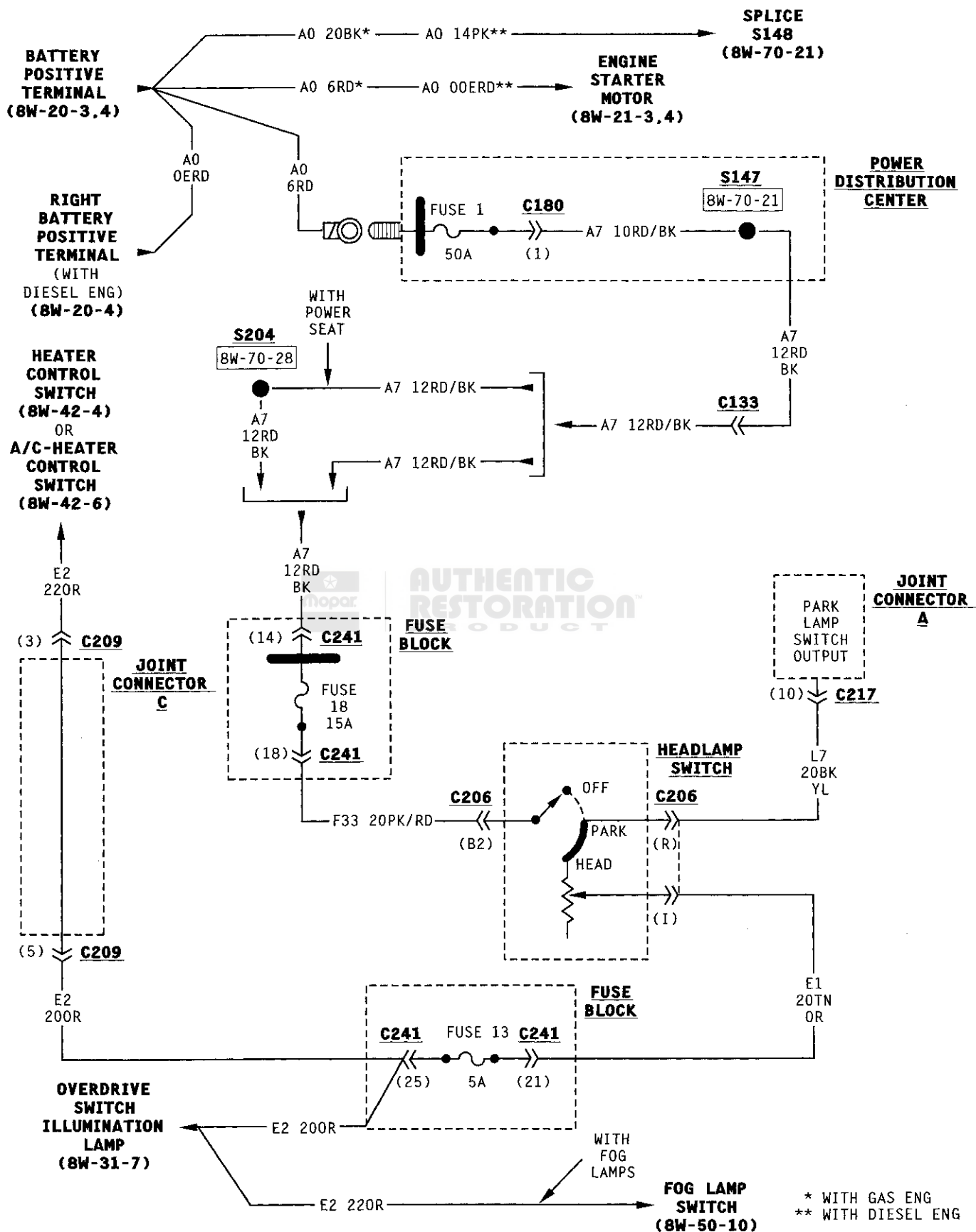


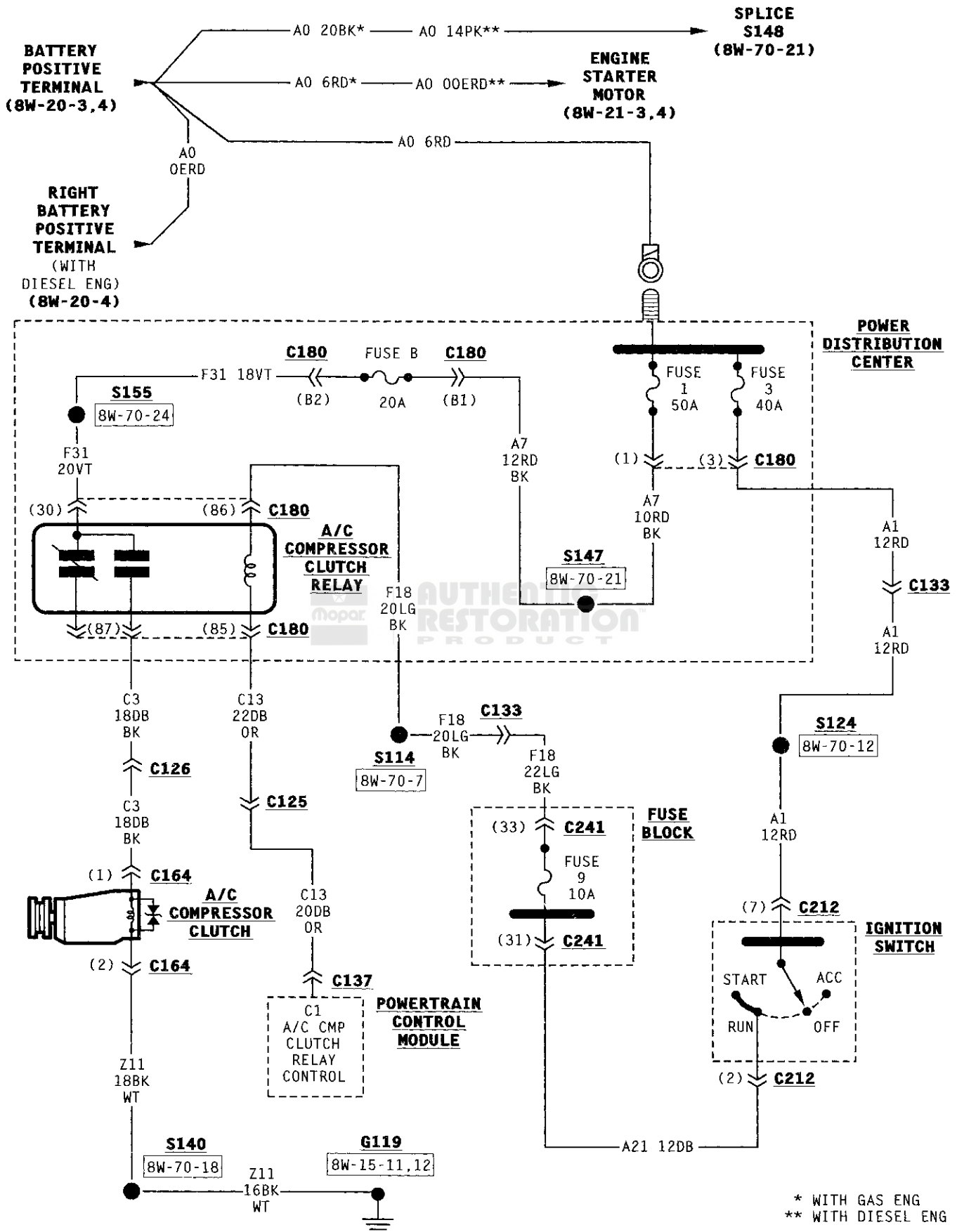


* WITH GAS ENG
 ** WITH DIESEL ENG



* WITH GAS ENG
** WITH DIESEL ENG





8W-43 AIRBAG SYSTEM

DESCRIPTION AND OPERATION

AIRBAG CONTROL MODULE (ACM)

Two circuits provide battery voltage to the Airbag Control Module (ACM); F14 and F23. Circuits F14 and F23 are connected to separate bus bars in the fuse block. Different circuits from the Power Distribution Center (PDC) and the ignition switch supply battery voltage to the fuse block bus bars.

Circuit F23 supplies battery voltage to the ACM only when the ignition switch is in the RUN position. Circuit F14 powers the ACM when the ignition switch is in either the START or RUN position.

In either the START or RUN position, the ignition switch connects circuit A1 from fuse 3 in the PDC with circuit A21. Circuit A21 circuit supplies battery voltage to the fuse block bus bar that feeds circuit F14. Fuse 12, a 15 amp, in the fuse block protects circuit F14.

When the ignition switch is in the RUN position, it connects circuit A2 from fuse 2, a 40 amp, in the PDC to circuit A22. Circuit A22 supplies battery voltage to the fuse block bus bar that feeds circuit F23. Fuse 16, a 15 amp, in the fuse block protects circuit F23.

The ACM is case grounded and has an external dedicated ground, circuit Z6.

AIRBAG IMPACT SENSORS

Two airbag impact sensors provide input to the Airbag Control Module (ACM). Each sensor has two circuits that connect to the ACM.

From the left impact sensor, Circuit R47 connects to the ACM at cavity 6 of the 13 way connector. Circuit R49 connects to cavity 5 of the 13 way connector.

From the right impact sensor, Circuit R46 connects to the ACM at cavity 13 of the 13 way connector. Circuit R48 connects to cavity 12 of the 13 way connector.

AIRBAG SQUIB (AIRBAG IGNITER)

Two circuits, R43 and R45, connect the ACM to the driver's side airbag squib (igniter) after passing through the clock spring connector. Circuit R43 connects to cavity 3 of the ACM 4 way connector; circuit R45 connects to cavity 4 of the ACM 4 way connector. R43 and R45 are a twisted pair of wires.

AIRBAG WARNING LAMP

Circuit R41 connects the airbag warning lamp to cavity 7 of the ACM 13 way connector. The airbag warning lamp is part of the instrument cluster. Refer to section 8W-40, Instrument Cluster.

DATA LINK CONNECTOR

The DRB scan tool connects to the data link connector. A twisted pair of wires, circuits D1 and D2, send and transmit data between the ACM and the DRB scan tool.

SCHEMATICS AND DIAGRAMS

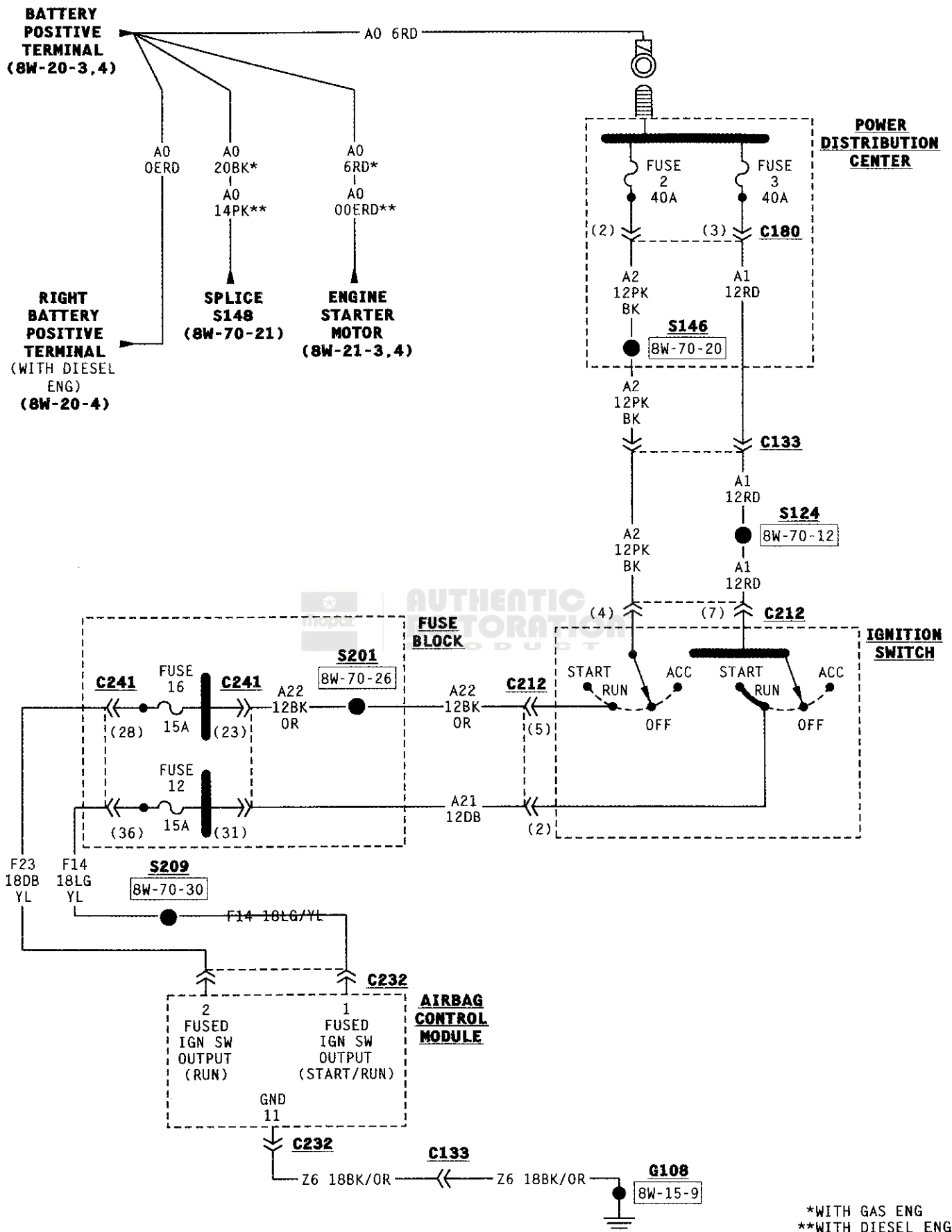
WIRING DIAGRAM INDEX

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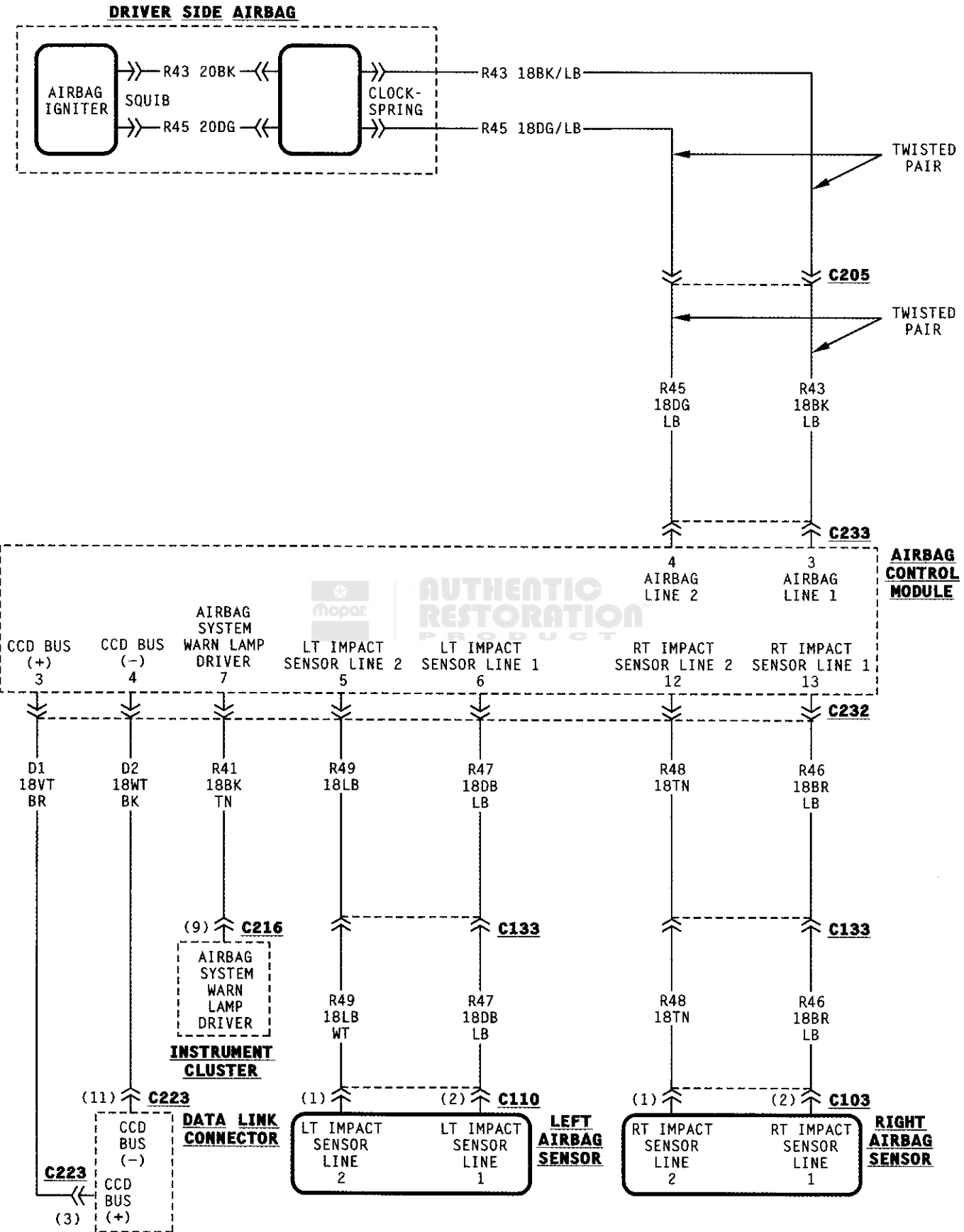
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*WITH GAS ENG
 **WITH DIESEL ENG
 J968W-9



8W-44 INTERIOR LIGHTING

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DESCRIPTION AND OPERATION

INTRODUCTION

Circuit M1 supplies power to the underhood lamp, glove box lamp, dome lamp, buzzer module, cargo lamps, vanity lamps and the time delay relay. Circuit M50 from the time delay relay powers the ignition switch lamp.

Circuit M1 is protected by the Ignition Off Draw (IOD) fuse in the fuse block, cavity 17. This fuse is a 15 amp.

Power for the M1 fuse is supplied on circuit A7. This circuit originates in the Power Distribution Center (PDC) and is protected by a 50 amp fuse located in cavity 1.

KEY-IN-SWITCH HALO LAMP

Circuit M50 from the time delay relay supplies voltage to the key-in-switch halo lamp. Circuit Z3 provides ground for the lamp.

Circuit M1 supplies voltage to the time delay relay. Circuit M2 provides ground for the relay through the headlamp switch or the door jamb switch.

TIME DELAY RELAY

The time delay relay is used to allow a time-ON function for the ignition switch lamp. Power for the relay is provided on the M1 circuit from the IOD fuse (fuse 17) in the fuse block.

Circuit M2 provides ground for the time delay relay through the right and left door jamb switches and the headlamp switch. When a door is OPENED, or the headlamp switch is moved to the dome/cargo lamp ON position, a ground path is provided for the relay on circuit M2. This energizes the relay, causing the contacts to CLOSE.

When the relay contacts CLOSE, power is provided through the relay to circuit M50. The M50 circuit supplies current to the key-in-switch halo lamp. Circuit Z3 provides ground for the lamp.

GLOVE BOX LAMP

Circuit M1 from the IOD fuse (fuse 17) in the fuse block powers the glove box lamp. A switch, in series after the lamp, CLOSES when the glove box door is OPENED. The switch completes a path to ground on circuit Z3.

UNDERHOOD LAMP

Circuit M1 from the IOD fuse (fuse 17) in the fuse block supplies battery voltage for the underhood lamp. A mercury switch, in series after the lamp, connects the lamp to ground on circuit Z1. When the hood is raised, mercury inside the switch moves to a position where it connects circuit M1 to ground circuit Z1, illuminating the lamp.

DOME LAMP

Circuit M1 from the IOD fuse (fuse 17) in the fuse block supplies power to the dome lamp. This circuit is HOT at all times. The ground path for the lamp is provided in two different ways.

One way is through the door jamb switches. Circuit M2 connects to the door jamb switches from the dome lamp. The switches are connected to ground circuit Z3. When a door is OPENED, the switch CLOSES, completing a path to ground on circuit Z3.

The second ground path is through the headlamp switch. Circuit M2 is spliced in with the headlamp switch. When the operator turns the headlamp switch to the dome lamp ON position, a ground path is provided through the switch on circuit Z3.

DAY/NIGHT MIRROR

The day/night mirror receives power from circuit L10 when the ignition switch is in the RUN position. This circuit is protected by a 10 amp fuse located in cavity 15 of the fuse block. Circuit Z4 provides ground for the day/night mirror.

When the back-up lamps switch CLOSES, circuit L1 provides a signal to the day/night mirror. The day

DESCRIPTION AND OPERATION (Continued)

night mirror turns OFF when the vehicle is in reverse.

VISOR/VANITY LAMPS

Power for the visor/vanity lamps is supplied on Circuit M1. This is the Ignition-Off Draw (IOD) circuit and is protected by a 15 amp fuse located in cavity 17 of the fuse block. Power for the fuse is supplied on circuit A7.

When the operator lifts the cover, a switch internal to the lamp CLOSES connecting the lamp to circuit Z4 illuminating the lamp. The Z4 circuit is the ground circuit.

CARGO LAMPS

Circuit M1 from the IOD fuse (fuse 17) in the fuse block supplies power to the cargo lamps. This circuit is HOT at all times. The ground path for the lamp is provided on circuits M3 and Z3.

When the operator turns the cargo lamps ON, circuit M3 connects from the lamps to the headlamp switch. The ground path passes through the switch to circuit Z3.

SEAT BELT SWITCH

For operation of the seat belt switch refer to the circuit descriptions for the buzzer module in this section.

BUZZER MODULE

The buzzer module sounds an audible warning tone. The tone sounds for seat belt warning, when the ignition key is in the ignition switch while the drivers door is OPEN, or the headlamps are left ON with the drivers door open. The tone also sounds when the ignition key is in the ON position while the drivers side seat belt is not buckled. Refer to Group 8U for buzzer module operation.

Power for the buzzer module is supplied on circuit M1 from fuse 17, a 15 amp, in the fuse block. This

fuse is the Ignition-Off Draw fuse (IOD) and is HOT at all times. Power for the fuse is supplied on circuit A7. This circuit is protected by a 50 amp fuse located in cavity 1 of the Power Distribution Center (PDC).

When the parking lamps or headlamps are ON, the headlamp switch connects circuit G16 from the drivers side door jamb switch to circuit G26. Circuit G26 connects to the buzzer module and the key-in switch. Circuit G16 from the drivers side door jamb switch also connects to the key-in switch.

Circuit G13 from the buzzer module powers the seat belt warning lamp in the instrument cluster. Circuit Z3 at the instrument cluster provides ground for the lamp.

Circuit G10 from the buzzer module connects to the seat belt switch. When the seat belt switch CLOSES a path to ground is completed on circuit Z3. Circuit Z3 also grounds the buzzer module.

HELPFUL INFORMATION

- Check the 15 amp fuse in cavity 17 of the fuse block
- Check the 50 amp fuse located in cavity 1 of the PDC
- Check the door jamb switches for a good ground
- Check the lamp filaments
- For the day/night mirror, check the back-up lamp switch, the 10 amp fuse in cavity 15 of the fuse block, and the 40 amp fuse in cavity 2 of the PDC

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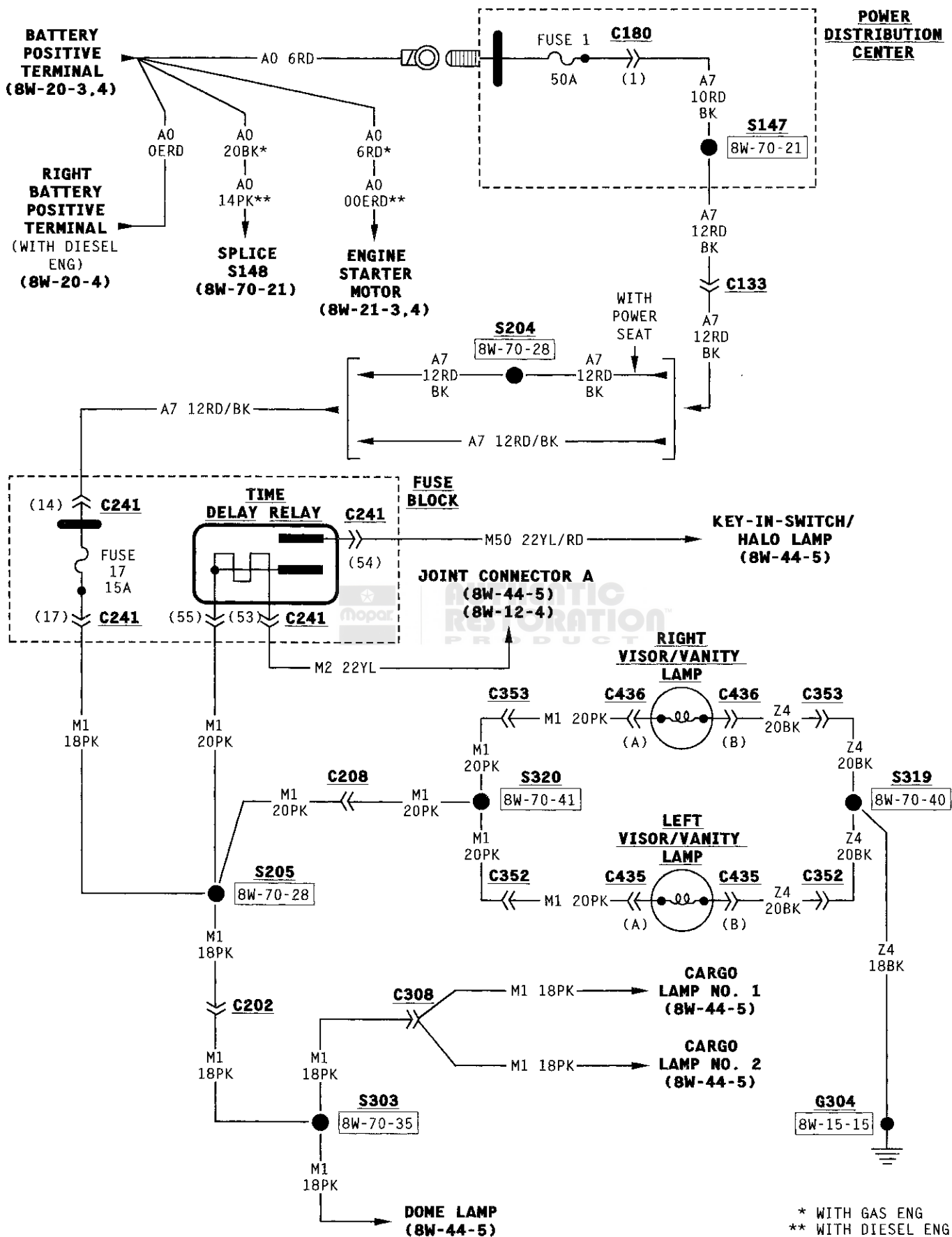
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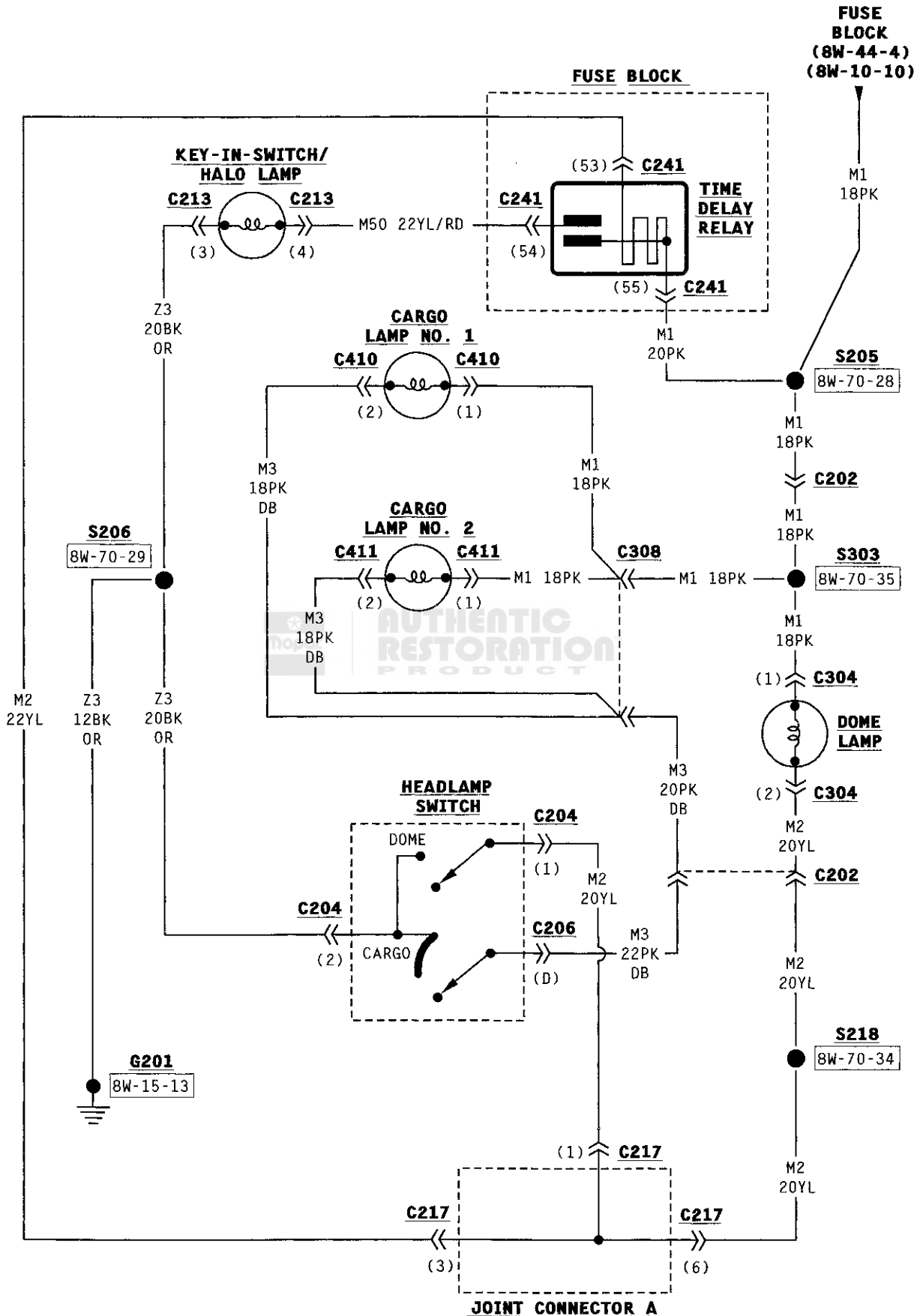
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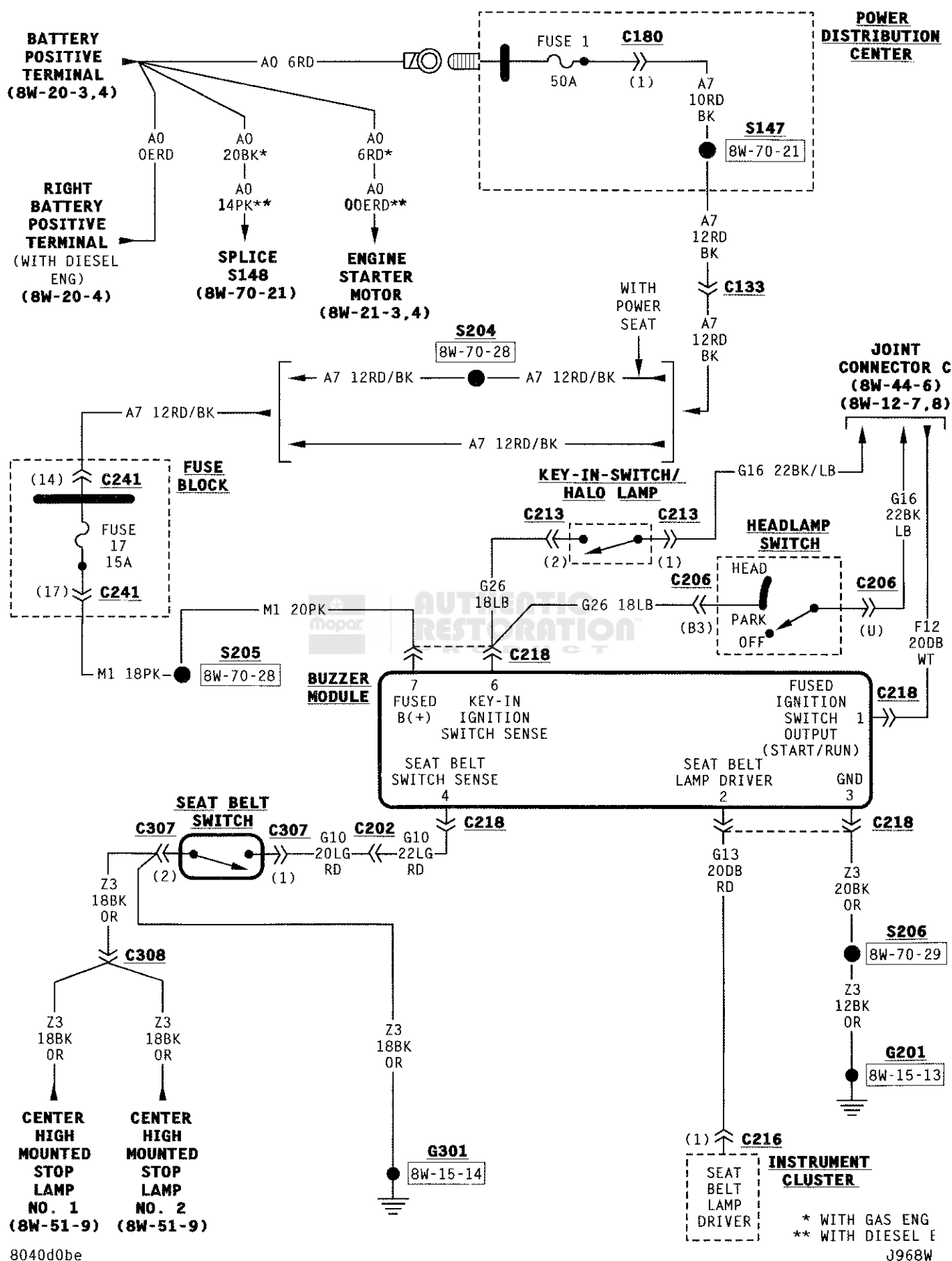
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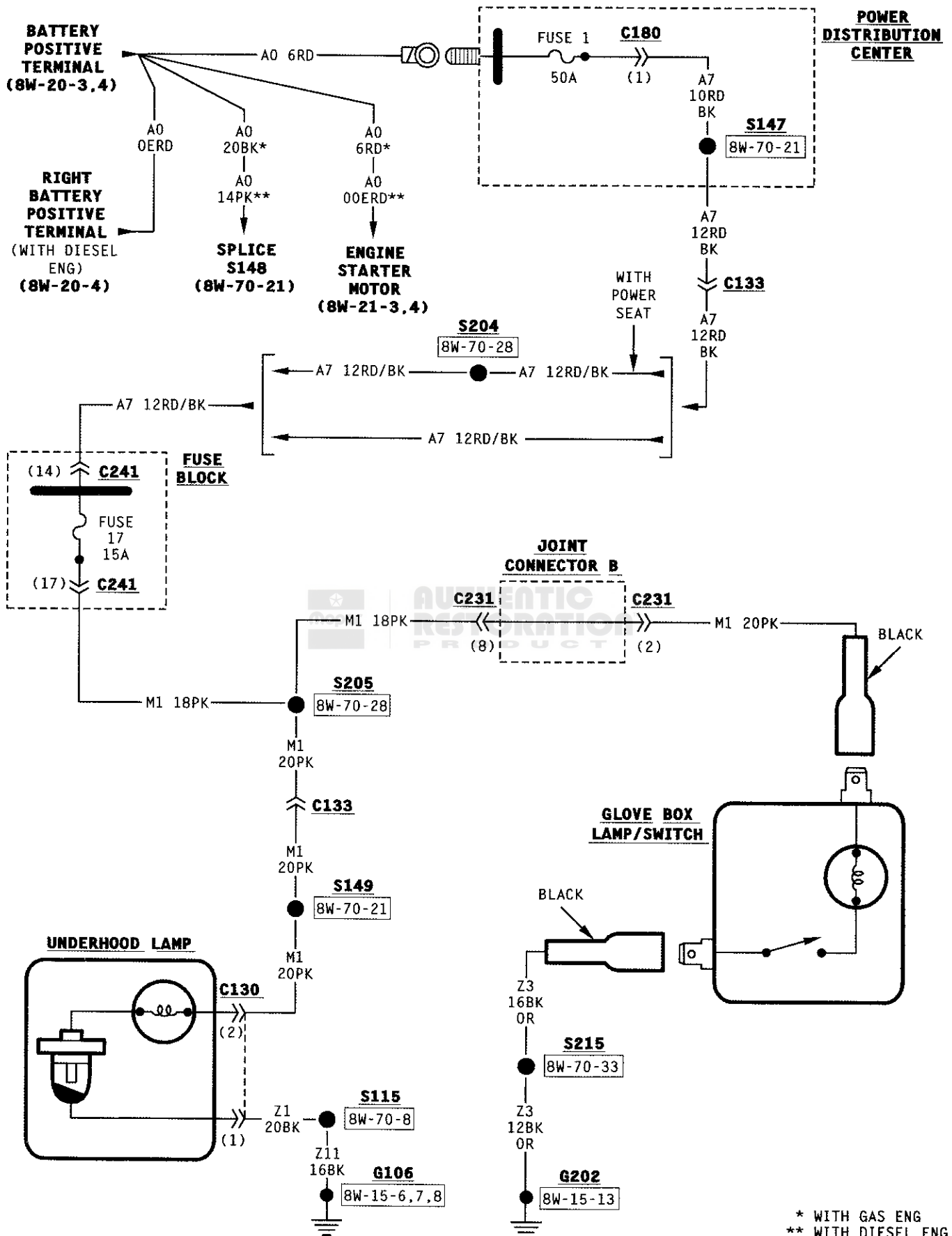


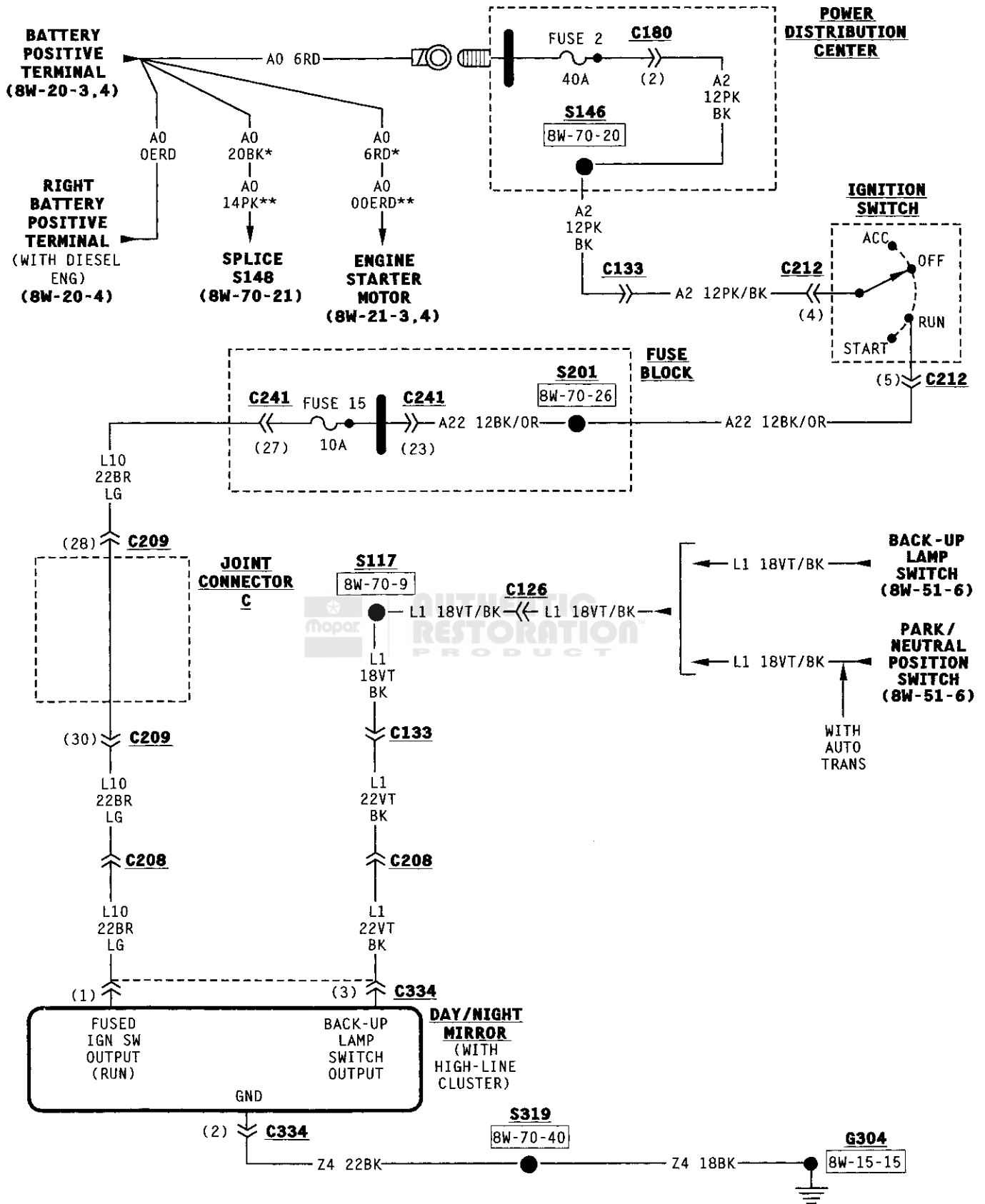
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8W-46 MESSAGE CENTER

DESCRIPTION AND OPERATION

MESSAGE CENTER

Power for the message center is supplied on circuit F14. This circuit is HOT in the START and RUN position and protected by a 15 amp fuse located in cavity 12 of the fuse block.

Power for the fuse is supplied on circuit A21 from the ignition switch. Power for the A21 circuit is supplied on circuit A1. This circuit originates in the Power Distribution Center (PDC) and is protected by a 40 amp fuse located in cavity 3.

The Powertrain Control Module (PCM) controls the ground path for the lamps in the message center.

Circuit G14 is connected from the message center to the PCM and is used for the transmission warning lamp. This circuit connects to cavity C7 of the PCM on all engine packages.

Circuit G85 is connected from the message center to the PCM and is used for the WAIT-TO-START lamp. The WAIT-TO-START lamp is only used with the diesel engines. Circuit G85 connects to cavity B20 of the PCM.

Circuit G86 is connected from the message center to the PCM and is used for the WATER IN FUEL lamp. The WATER-IN-FUEL lamp is only used on vehicles equipped with the diesel engine. Circuit G86 connects to cavity C18 of the PCM.

HELPFUL INFORMATION

- Check the 40 amp fuse located in cavity 3 of the PDC
- Check the 15 amp fuse located in cavity 12 of the fuse block
- Refer to the appropriate section of the service manual or the diagnostic test procedures manual

SCHEMATICS AND DIAGRAMS

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The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.



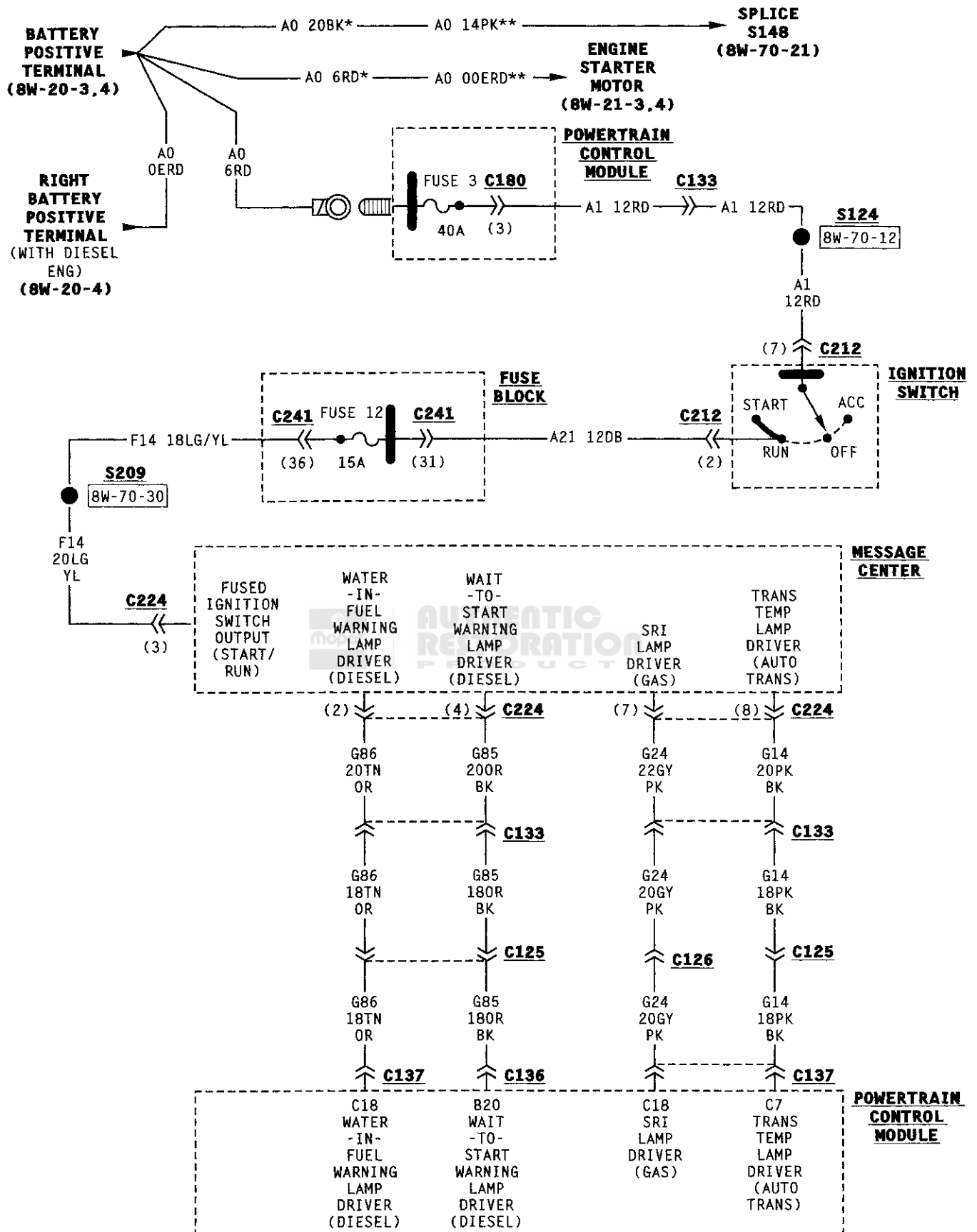
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* WITH GAS ENG
 ** WITH DIESEL ENG

8W-47 AUDIO SYSTEM

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GENERAL INFORMATION

INTRODUCTION

Two radio systems are available in this vehicle; one with a standard speaker system and a radio with premium speaker system. The premium speaker system uses power amplifiers on the speakers, and a radio choke relay not used on the standard system. When referencing the circuit descriptions or the diagrams, ensure that you use the correct ones.

DESCRIPTION AND OPERATION

RADIO OPERATION

In the ACCESSORY or RUN position, the ignition switch connects circuit A1 from fuse 3, a 40 amp, in the Power Distribution Center (PDC) with circuit A31. Circuit A31 powers a bus bar in the fuse block that feeds circuit X12 through fuse 7, a 10 amp. Circuit X12 supplies battery voltage to the radio. Circuit Z2 provides ground for the radio.

RADIO MEMORY

Circuit M1 from the Ignition Off Draw (IOD) fuse (Fuse 17) in the fuse block supplies power for the radio memory. The IOD fuse is removed during vehicle shipping to prevent excessive battery draw.

Circuit A7 from fuse 1, a 50 amp, in the Power Distribution Center (PDC) supplies voltage to the IOD fuse. Circuit A7 is HOT at all times.

RADIO ILLUMINATION

When the parking lamps or headlamps are ON, circuits E2 and L7 from the headlamp switch power the radio illumination lamps. Fuse 13, a 5 amp, in the fuse block powers circuit E2 which feeds the radio illumination lamp. Circuit E1 from the headlamp switch supplies power to fuse 13. Circuit L7 supplies voltage for the radio lamps. Circuit Z2 supplies the ground path for the illumination and park lamp circuits.

RADIO CHOKE—PREMIUM RADIO ONLY

The radio choke relay supplies voltage to the amplifier circuits in the speakers. The radio supplies power to the coil side of the relay on circuit X60. Circuit Z2 provides ground for the coil side of the relay.

The radio energizes the radio choke relay by powering circuit X60. When the relay energizes, its contacts close and connect circuit M1 from the Ignition-Off-Draw (IOD) fuse in cavity 17 of the fuse block to circuit X13. Circuit X13 supplies voltage to the amplifier circuits in the speakers.

SPEAKERS—STANDARD RADIO

Circuit X53 feeds the speaker in the left front door. Circuit X55 is the return from the speaker to the radio.

Circuit X54 feeds the right front door speaker. Circuit X56 is the return from the speaker to the radio.

Circuit X51 feeds the speaker in the left rear of the vehicle. Circuit X57 is the return from the speaker to the radio.

Circuit X52 feeds the right rear speaker. Circuit X58 is the return from the speaker to the radio.

SPEAKERS—PREMIUM RADIO

When the radio choke energizes, circuit X13 supplies voltage to the amplifier circuits in each speaker. Circuit Z2 provides the ground path for the speaker amplifiers.

Circuit X53 feeds the speakers in the left front door. Circuit X55 is the return from the speakers to the radio.

Circuit X54 feeds the right front door speakers. Circuit X56 is the return from the speakers to the radio.

Circuit X51 feeds the left rear speaker. Circuit X57 is the return from the speaker to the radio.

Circuit X52 feeds the right rear speaker. Circuit X58 is the return from the speaker to the radio.

DESCRIPTION AND OPERATION (Continued)**HELPFUL INFORMATION**

- Check the 40 amp fuse located in cavity 3 of the PDC
- Check the 10 amp fuse located in cavity 7 of the fuse block
- Check the ground at the rear of the radio
- Check the IOD fuse in the fuse block

you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

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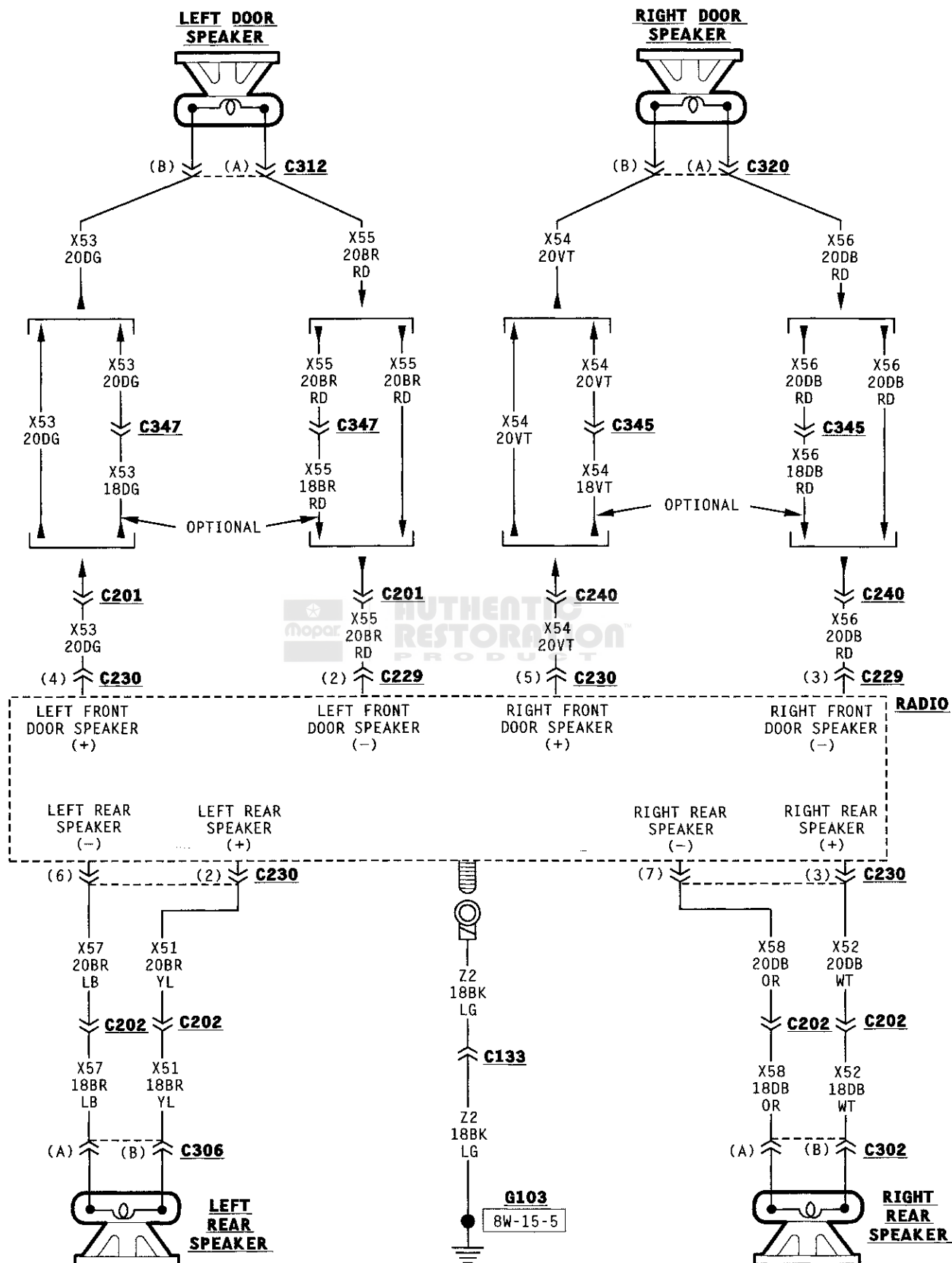
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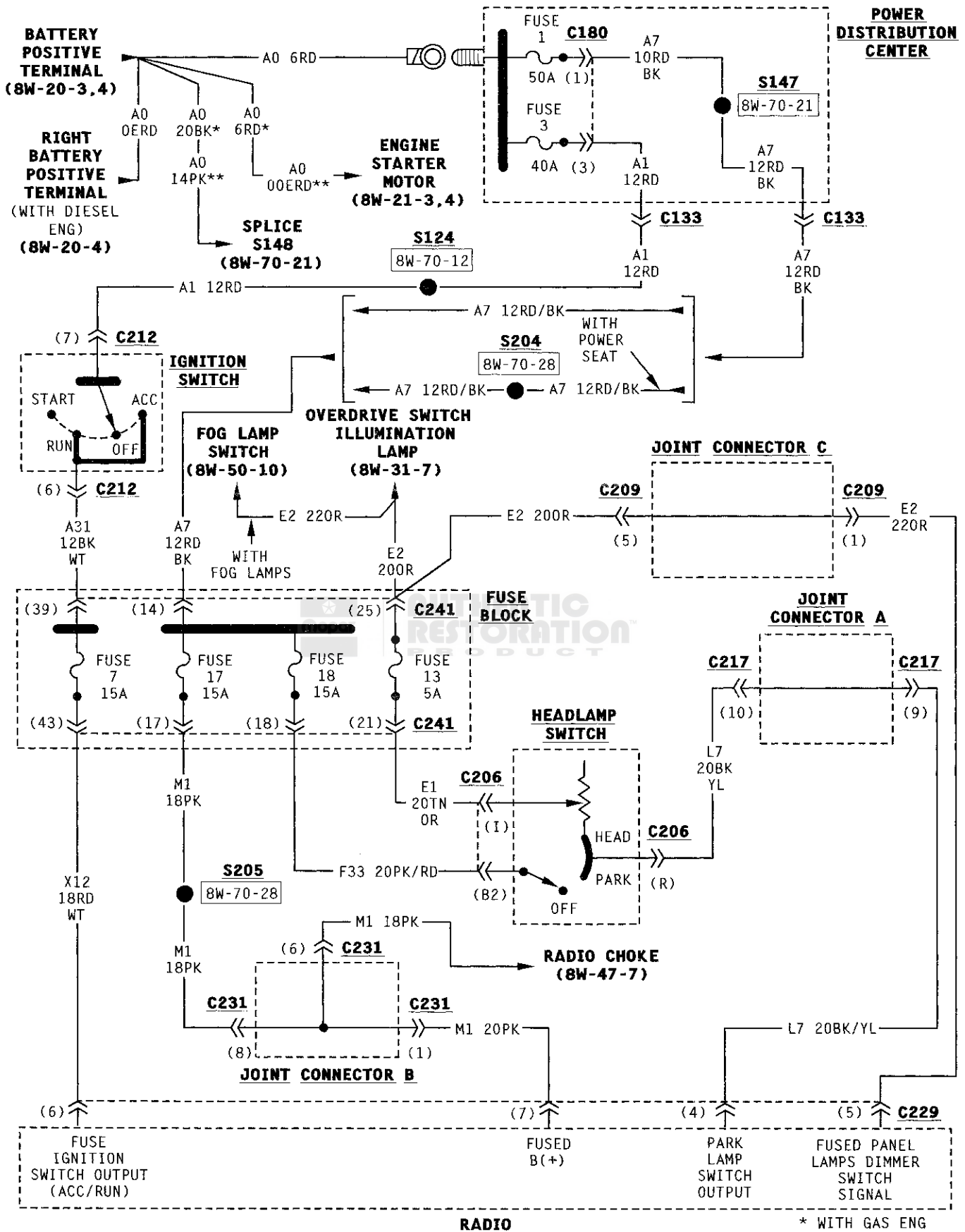
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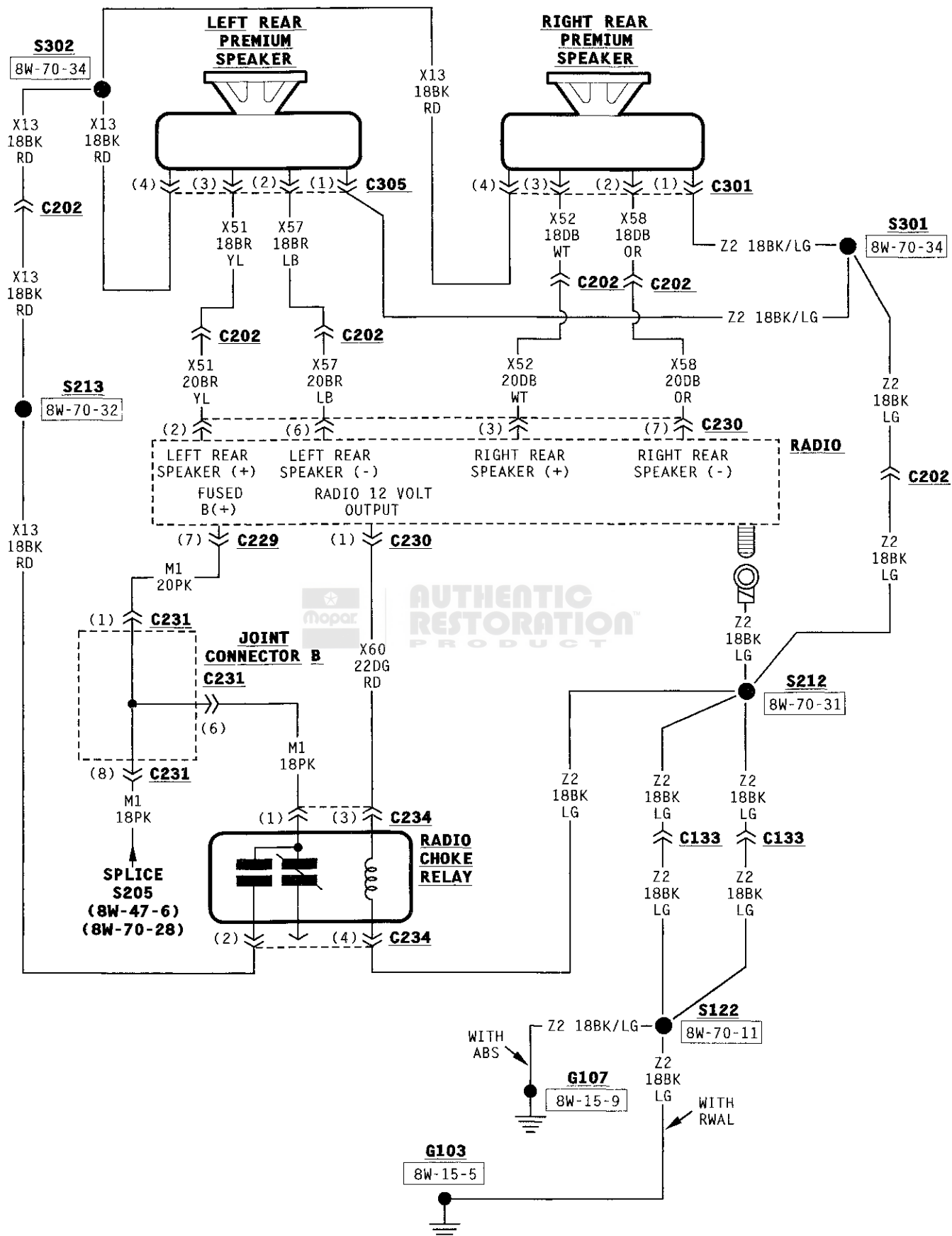
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Right Door Tweeter	8W-47-9
Right Rear Premium Speaker	8W-47-7
Right Rear Speaker	8W-47-5



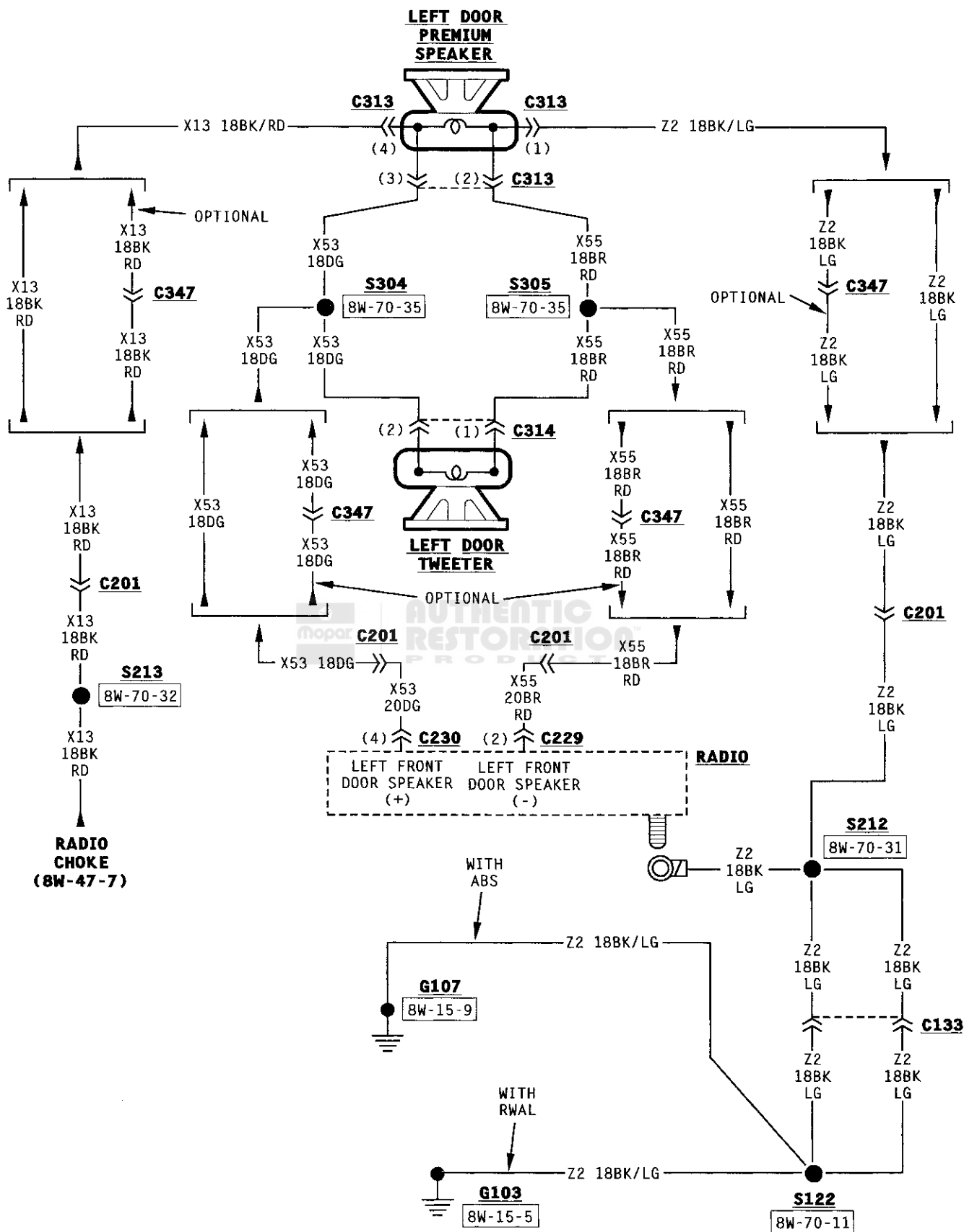
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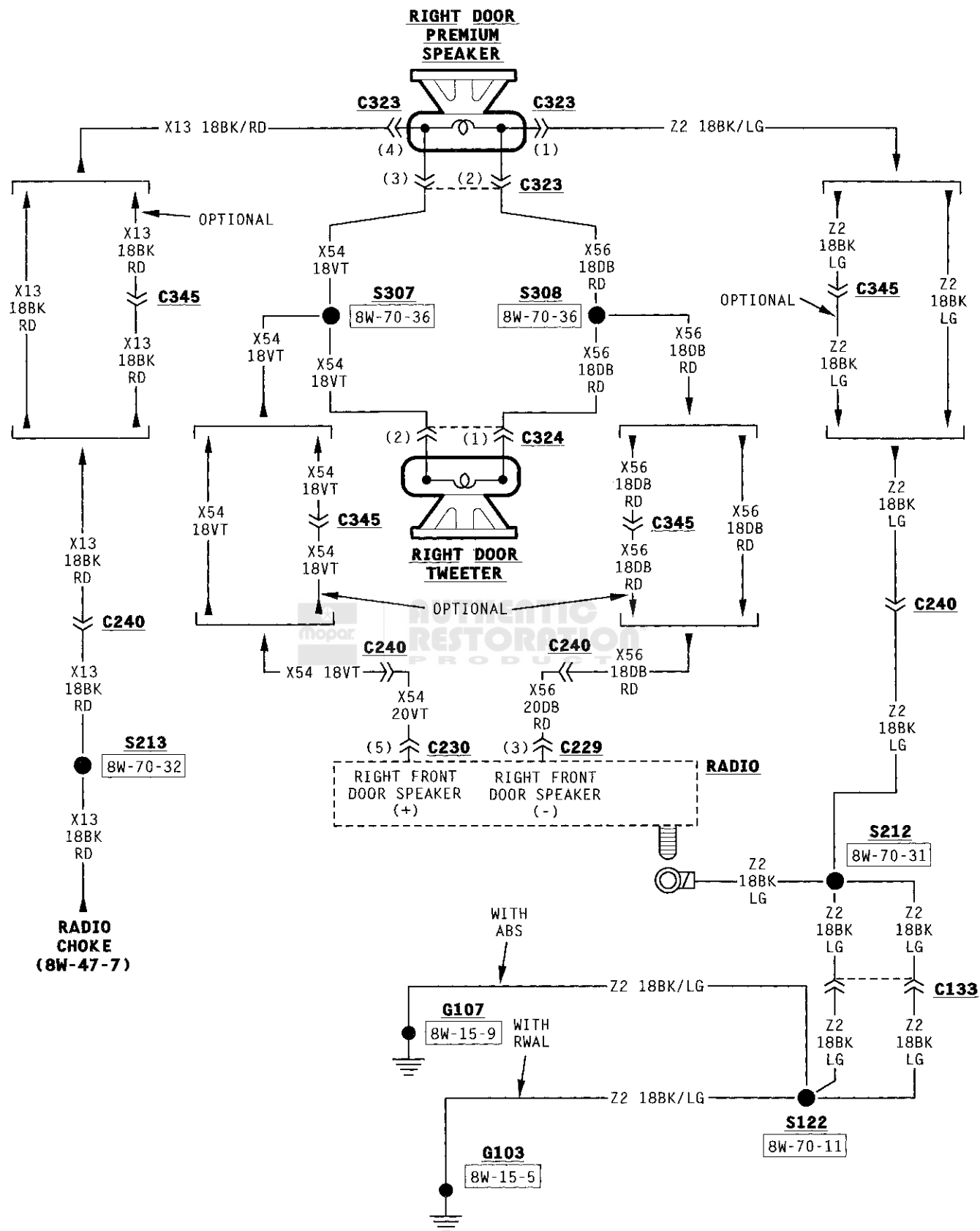






— 8W-47 AUDIO SYSTEM -
PREMIUM STEREO RADIO





8W-49 OVERHEAD CONSOLE

DESCRIPTION AND OPERATION

OVERHEAD CONSOLE

When the ignition switch is in the RUN or START position, circuit F12 from fuse 11, a 10 amp, in the fuse block supplies power to the overhead console.

When the headlamps or parking lamps are ON, circuits L7 and E2 provide voltage to the overhead console. Circuit E2 from fuse 13, a 5 amp, in the fuse block powers the illumination lamps in the overhead console. Circuit E1 from the headlamp switch feeds fuse 13 and circuit E2.

Circuit Z11 provides ground for the compass.

AMBIENT TEMPERATURE SENSOR

The ambient temperature sensor is a variable resistor. Circuit G31 supplies voltage from the overhead console to the sensor. Circuit G32 is the signal return from the sensor to the overhead console.

LAMPS

Circuit M1 supplies voltage for the reading lamps, map lamp, and dome lamp in the overhead console. The Ignition Off Draw (IOD) fuse (fuse 17) in the fuse block supplies voltage to circuit M1. Circuit A7 from fuse 1 in Power Distribution Center (PDC) feeds the IOD fuse.

Circuit Z4 grounds the reading lamps and map lamps. Circuit M2 provides ground for the dome lamp.

The M2 circuit supplies ground for the overhead console dome lamp in two ways. One way is through the door jamb switches. Circuit M2 connects to the

door jamb switches. The door jamb switches connect to ground on circuit Z3. When a door is OPENED, the plunger in the switch CLOSES, completing a path to ground.

The second ground path is through the headlamp switch. When the operator turns the headlamp switch to the dome lamp ON position, a ground path provided on circuit M2 through the switch to ground on circuit Z3.

HELPFUL INFORMATION

- Check the 15 amp fuse located in cavity 17 of the fuse block
- Circuit M1 splices to supply voltage for the radio memory, time delay relay, underhood lamp, and glove box lamp.
- Circuit E2 splices to provide voltage to the instrument cluster illumination lamps, and radio lamp.
- Check the 10 amp fuse in cavity 11 of the fuse block
- Check the grounding point for the overhead console

SCHEMATICS AND DIAGRAMS

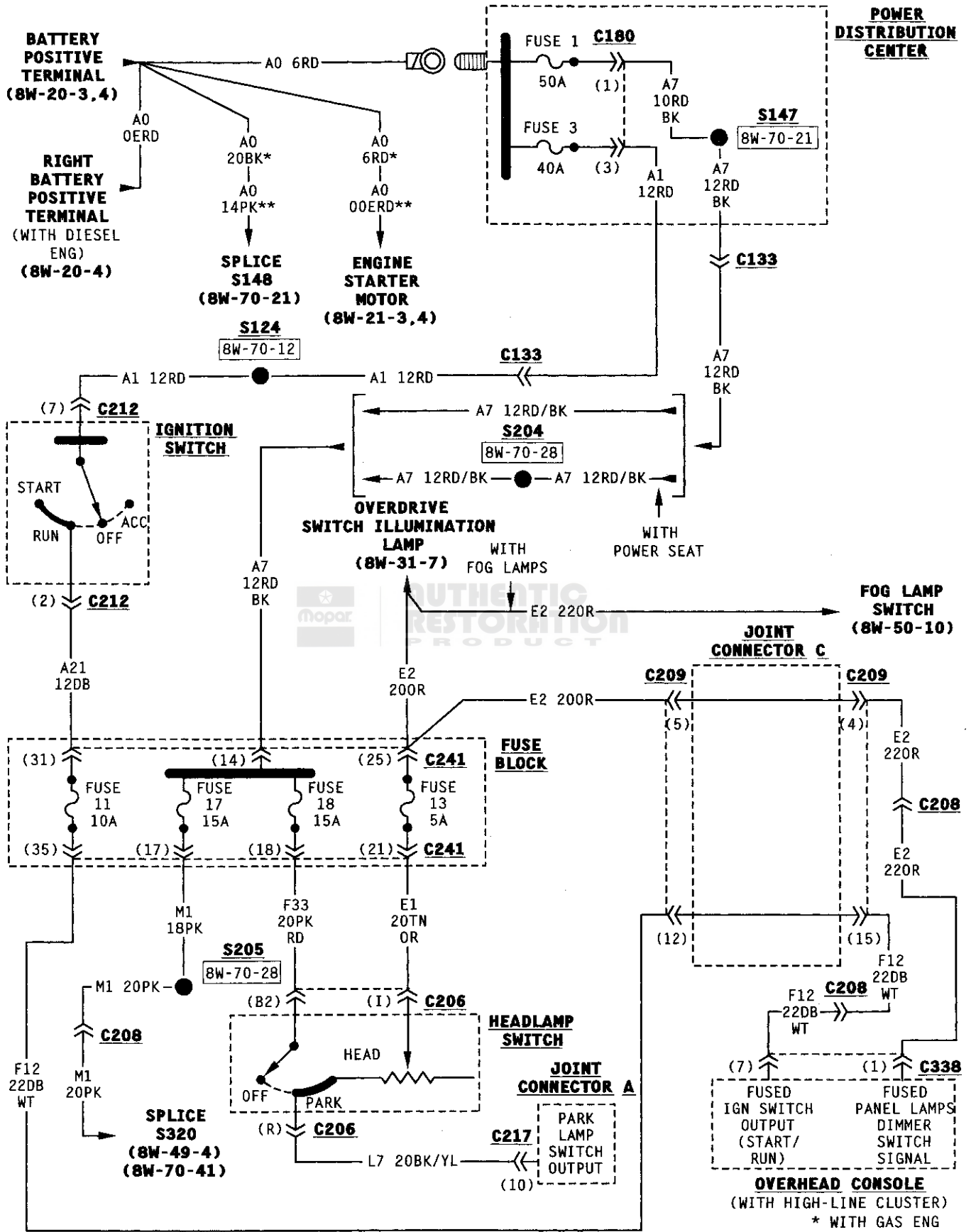
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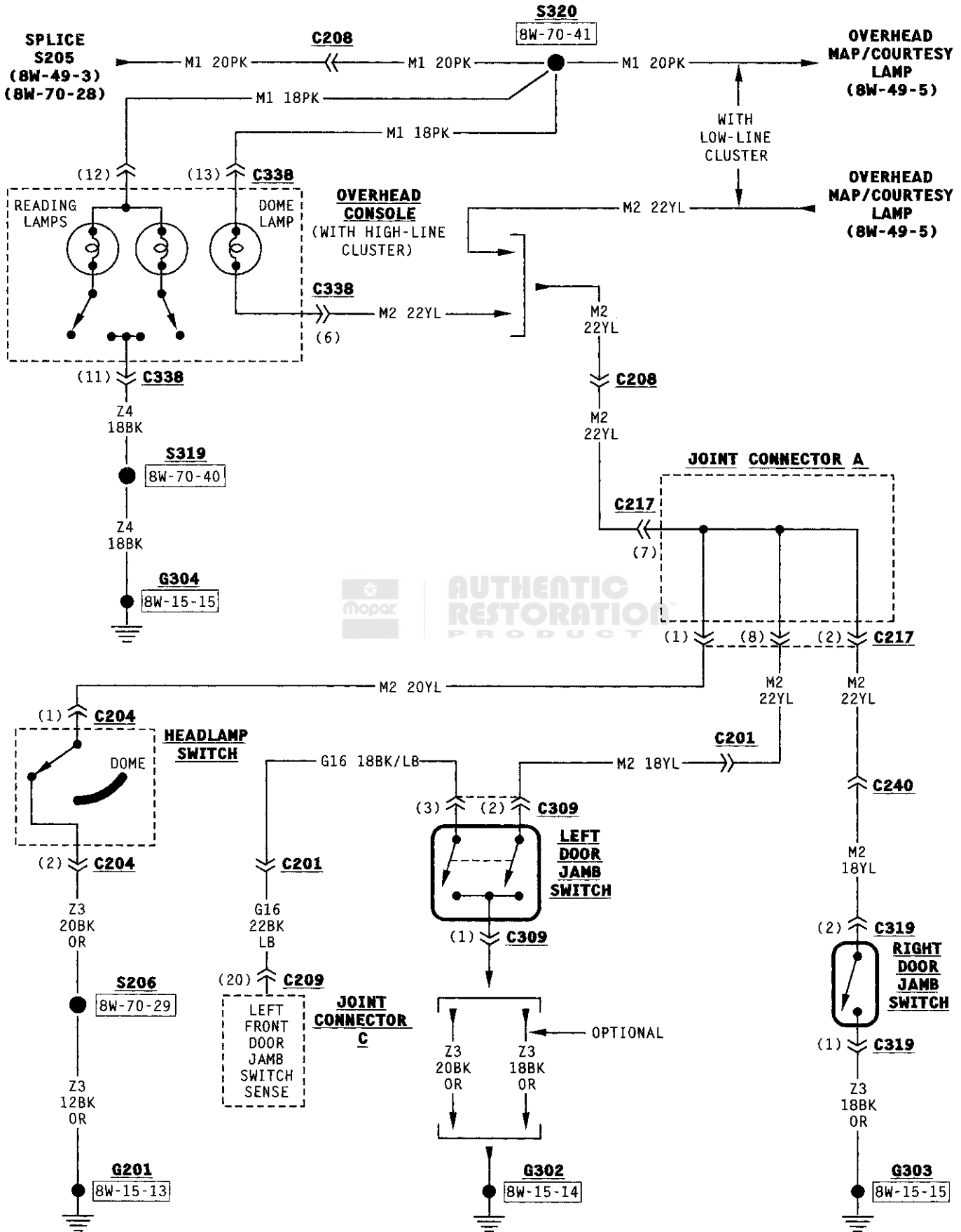
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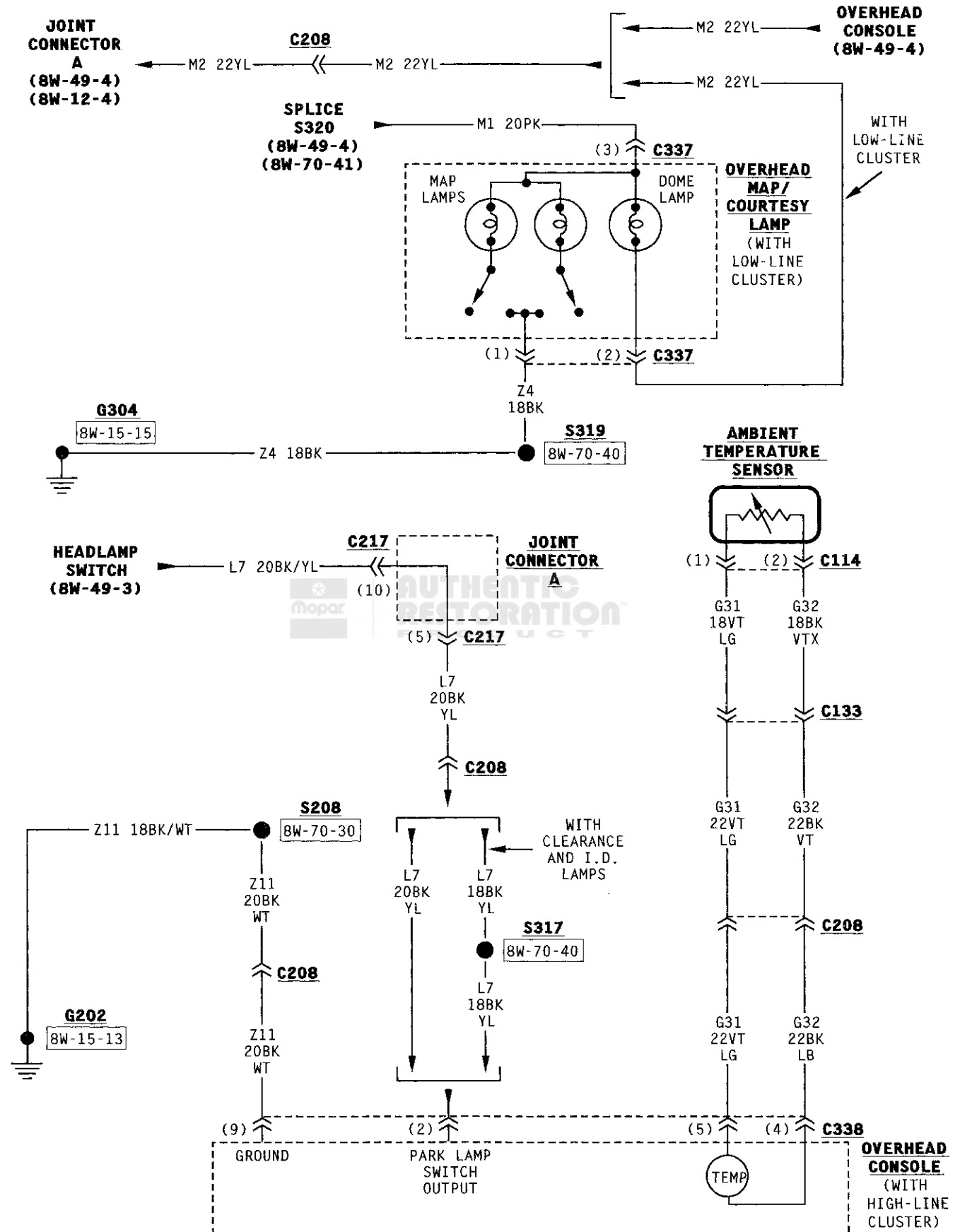
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8W-50 FRONT LIGHTING

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DESCRIPTION AND OPERATION

PARKING LAMPS

The headlamp switch has three positions: OFF, PARK (parking lamps) and ON, plus a dimmer switch. When the headlamp switch is in the PARK or ON position, the switch connects circuit F33 to circuit L7. From the headlamp switch, circuit L7 branches to power the front parking lamps and rear tail lamps, roof identification lamps, fender lamps and rear license plate lamps. Circuit Z1 provides a ground for the parking lamps. Ground for the roof clearance and identification lamps is supplied on circuit Z4.

HEADLAMPS

The headlamp switch has three positions: OFF, PARK (parking lamps) and ON. The headlamp switch powers the headlamps through the multi-function switch.

FLASH-TO-PASS (OPTICAL HORN)

Circuit A3 from fuse 6, a 40 amp, in the Power Distribution Center (PDC) supplies battery voltage to the headlamp switch. The headlamp switch has an internal circuit breaker that connects circuit A3 to circuit L20.

In the OFF or PARK position, the headlamp switch feeds circuit L20 which connects to the multi-function switch. Circuit L20 powers the high-beam on circuit L3 when the operator flashes the headlamps with the turn signal stalk of the multi-function switch.

HEADLAMP SWITCH IN ON POSITION

When the headlamp switch is in the ON position, circuit A3 connects to circuit L2. Circuit L2 connects to the multi-function switch and feeds the low beams on circuit L4.

When the operator selects high beam operation, circuit L2 connects to circuit L3.

HEADLAMP GROUND

Although circuit Z1 provides ground for both the right and left headlamps, it has different termination points for each.

FOG LAMPS

The fog lamps are controlled by the fog lamp switch and fog lamp relays. The fog lamps operate only when the headlamp switch is in the PARK or ON position, and the operator has selected low-beam operation. When the headlamps are in high-beam operation, the fog lamps will not operate.

Power for fog lamp relay #1 is supplied on circuit L7. This circuit is HOT when the headlamp switch is in the PARK or ON position only and connects to the normally CLOSED contacts of the relay.

Circuit L139 connects from the contact side of the relay #1 to the coil side of relay #2. When the operator turns the fog lamps ON a ground path is completed on circuit L35 through the fog lamp switch to circuit Z3. This causes the contacts in relay #2 to CLOSE connecting circuits L38 and L39.

Circuit L38 is the feed for the relay and protected by a 15 amp fuse located in cavity A of the Power Distribution Center (PDC). Circuit L39 connects from the relay to the lamps. Ground for the lamps is supplied on circuit Z1.

If the high beam lamps are on, circuit G34 energizes the fog lamp #1 relay. When the relay energizes, the contacts OPEN and power is not supplied to the fog lamps. Circuit Z1 provides ground for the coil side of the fog lamp #1 relay.

DAYTIME RUNNING LAMP (DRL) MODULE

On vehicles built for sale in Canada, the low-beam headlamps operate when the ignition switch is in the RUN position and the park brake switch is OPEN.

Circuit L10 from fuse 15 in the fuse block supplies voltage to the DRL module. Circuit A3 from the PDC connects to DRL module.

The DRL module receives information on park brake switch position on circuit G11.

Circuit L4 powers the low beams of the headlamps. When the headlamp switch is OFF, the DRL module

DESCRIPTION AND OPERATION (Continued)

powers the low beams on circuit L4. When the headlamps are ON, the multi-function switch powers the low beams on circuit L4.

Circuit L3 feeds the high beams of the headlamps. When the operator flashes the headlamps with the stalk of the multi-function switch, the DRL senses voltage on circuit L3 and stops supplying power to the low beams on circuit L4. Circuit Z1 provides ground for the DRL module.

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.



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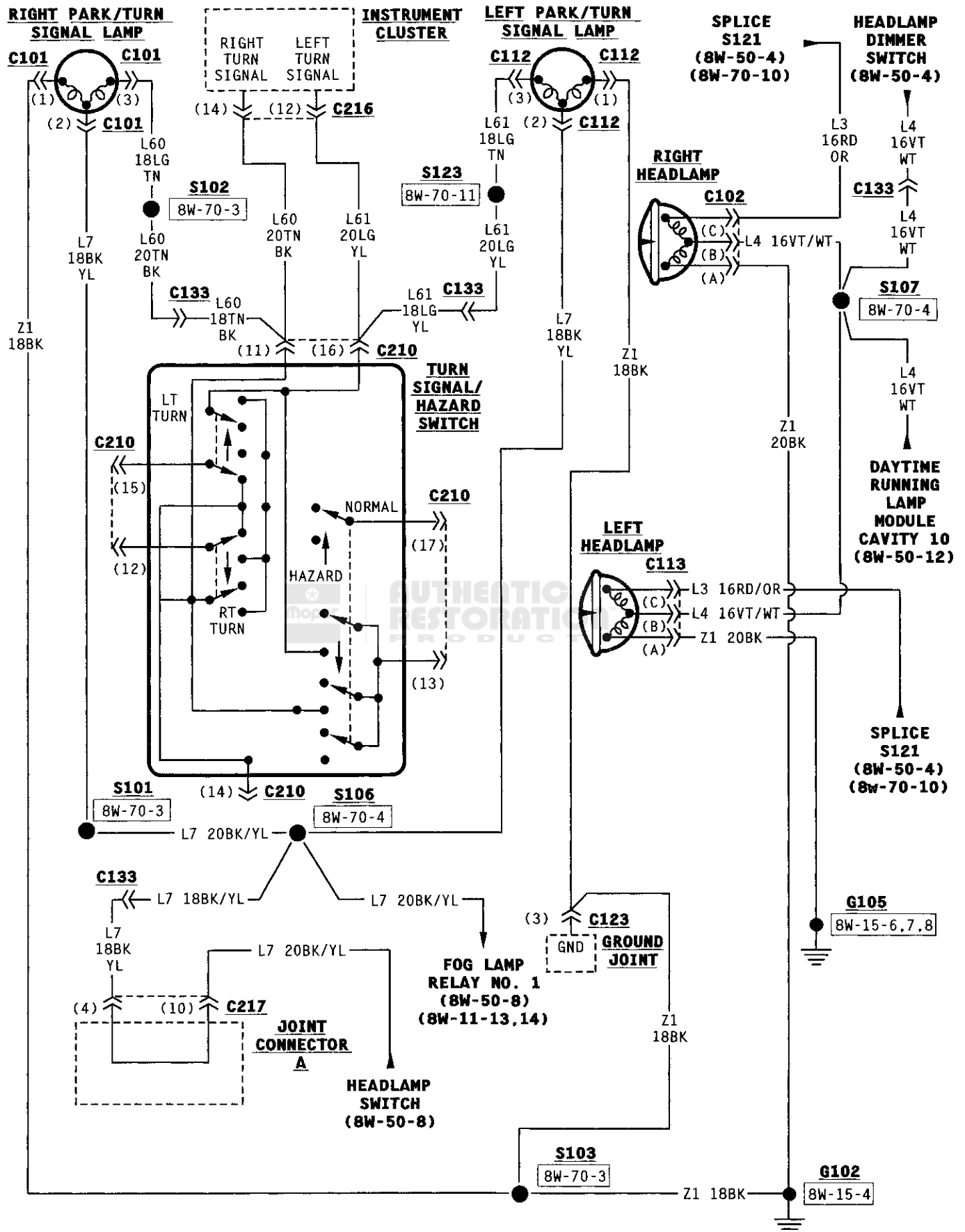
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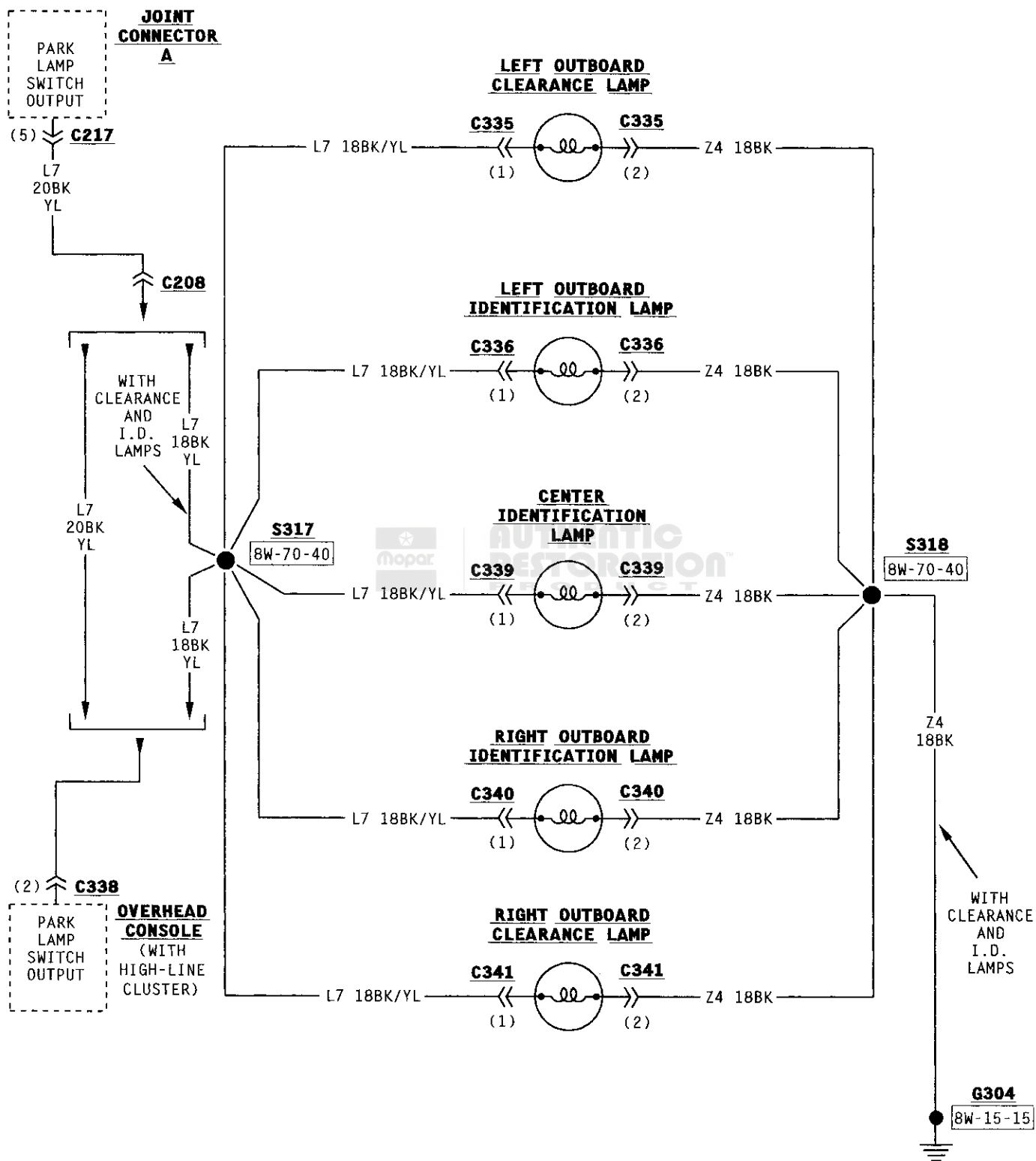
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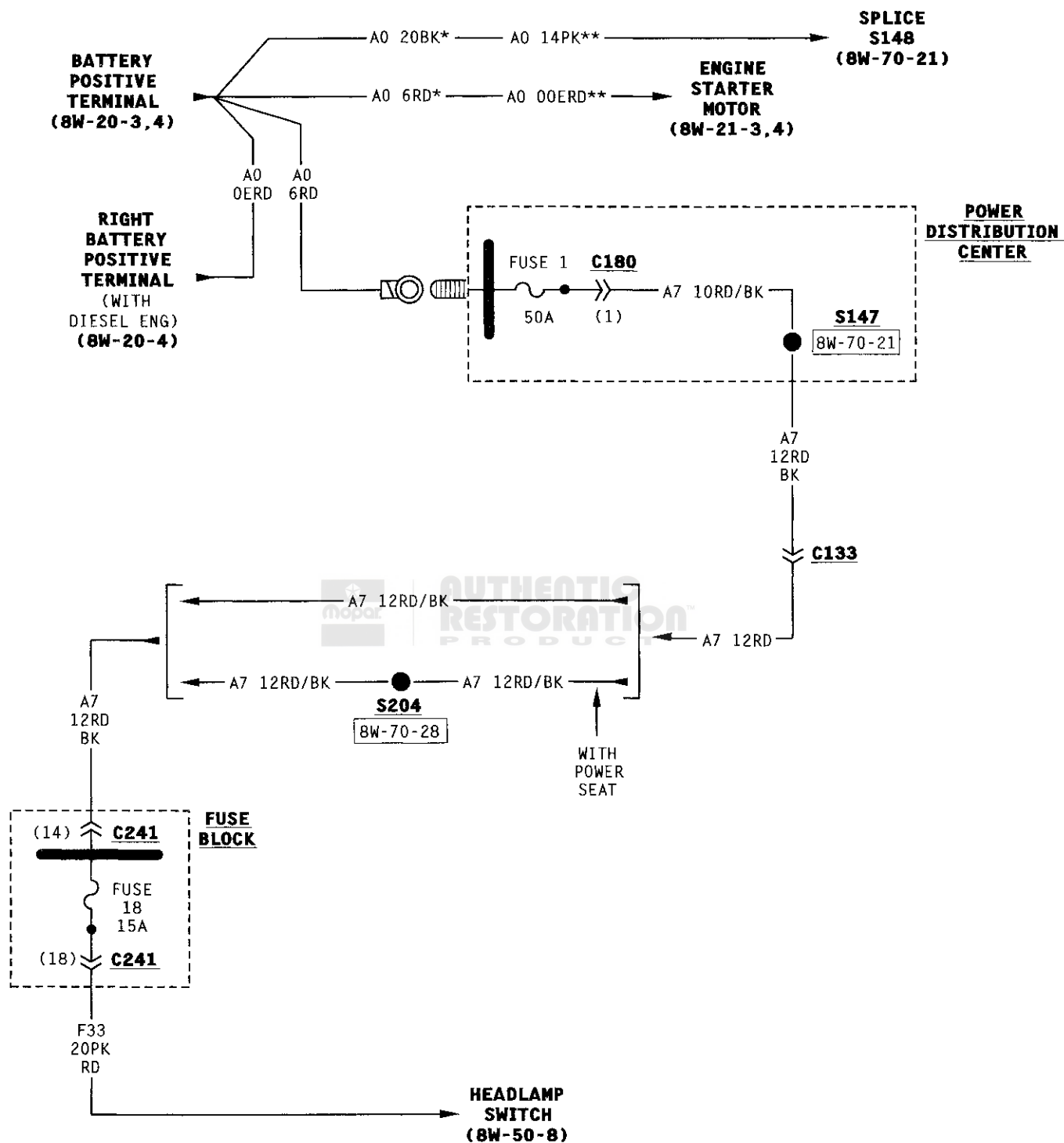
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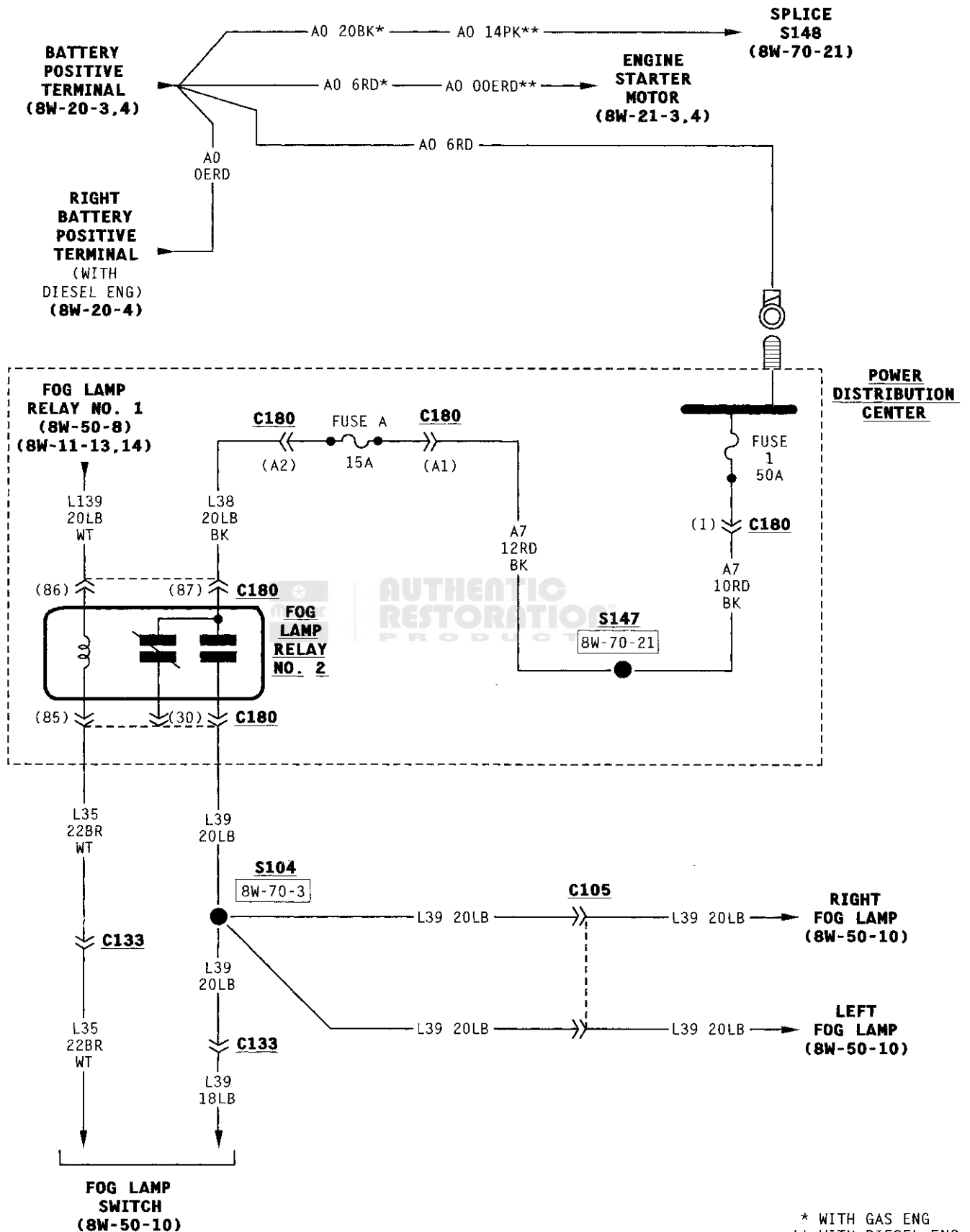
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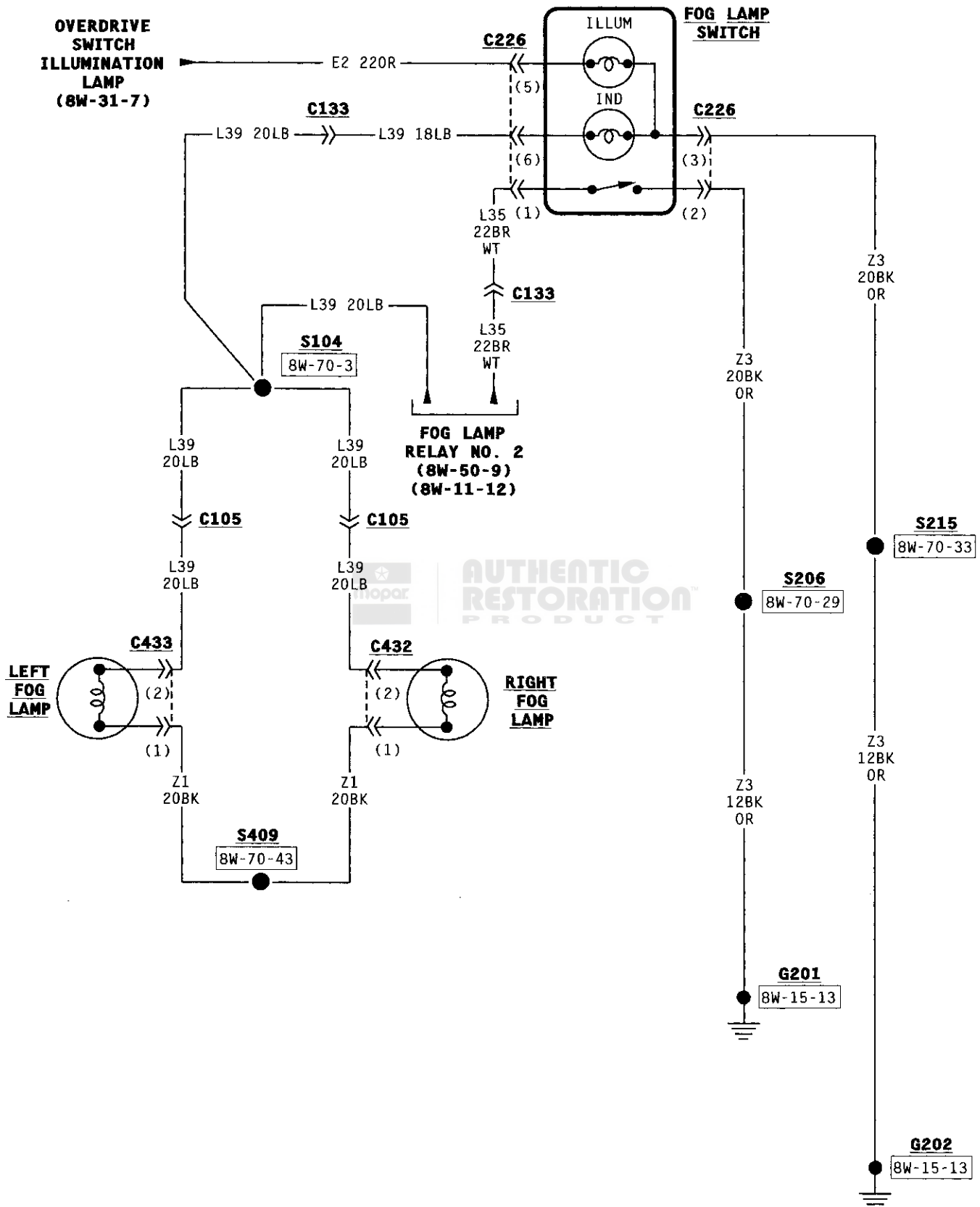


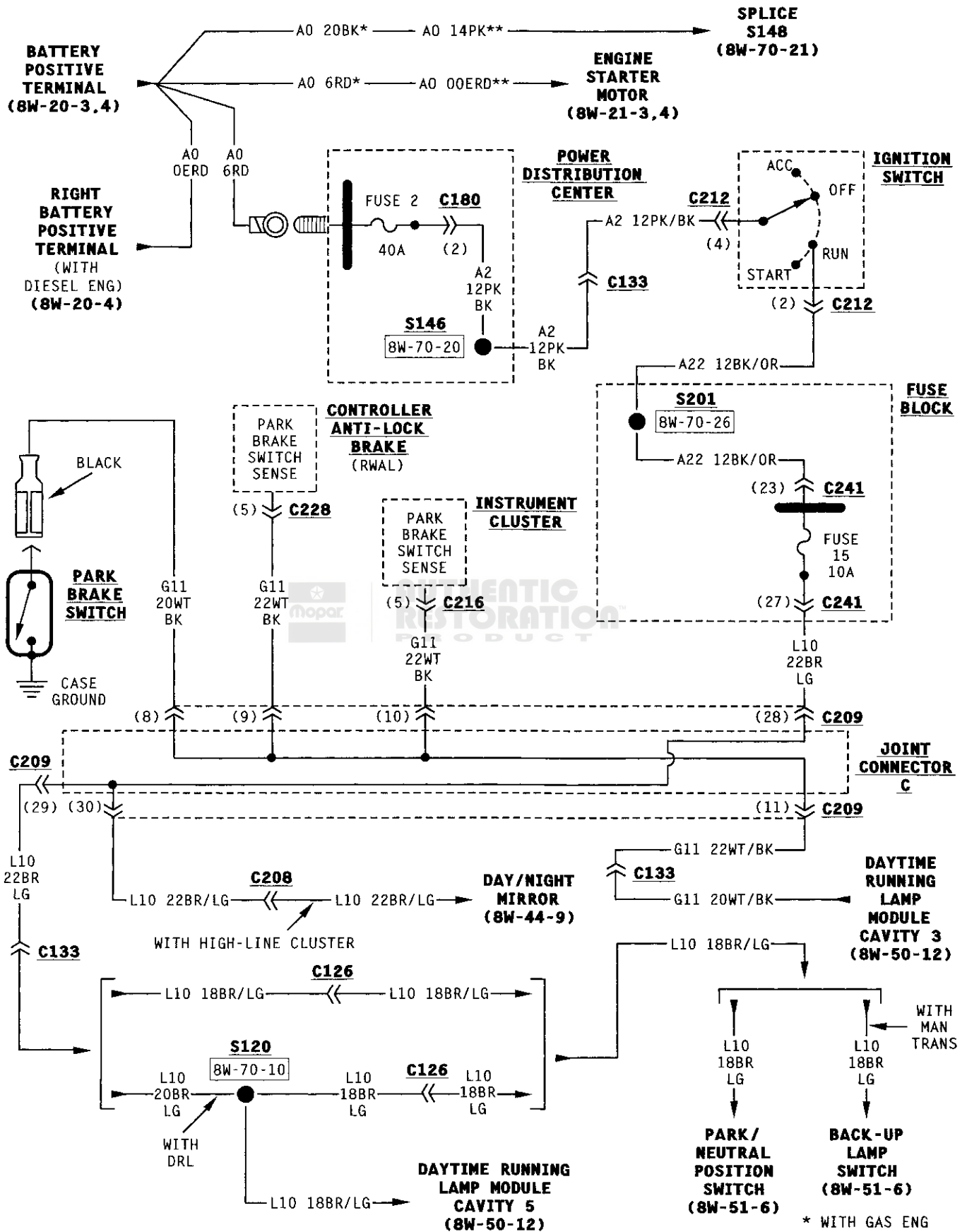


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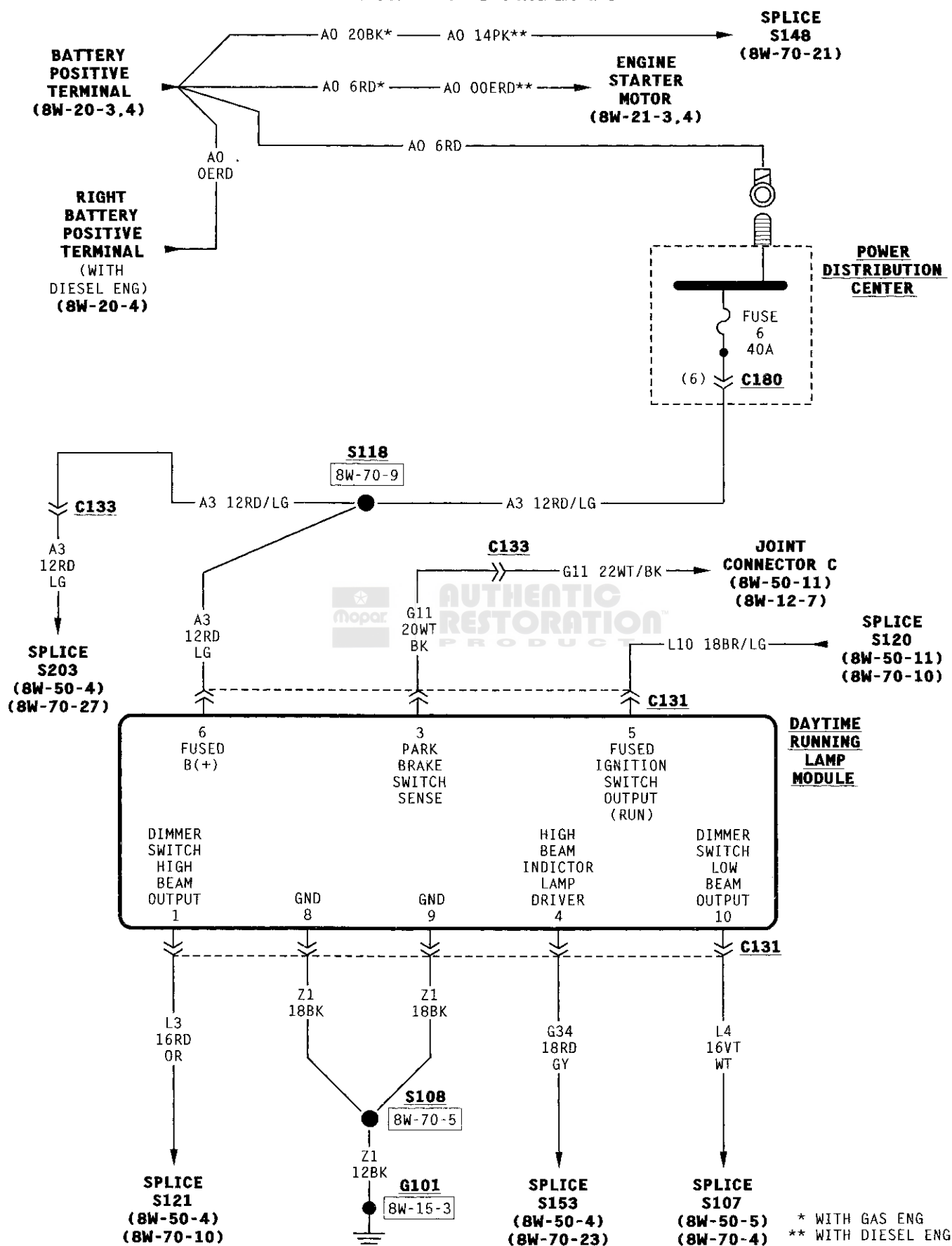
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 J968W-9

8W-50 FRONT LIGHTING WITH DAYTIME RUNNING LAMPS



8W-51 REAR LIGHTING

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DESCRIPTION AND OPERATION

TAIL LAMPS AND REAR LICENSE PLATE LAMPS

Circuit A7 in the Power Distribution Center (PDC) connects to a bus bar in the fuse block. One of the four circuits powered by the bus bar is circuit F33. Circuit F33 connects to the headlamp switch. Fuse 1 in the PDC protects the A7 circuit. Fuse 18, a 15 amp, in the fuse block protects circuit F33.

The headlamp switch has three positions: OFF, PARK (parking lamps) and ON, plus a dimmer switch. When the headlamp switch is in the PARK or ON position, the switch connects circuit F33 to circuit L7. From the headlamp switch, circuit L7 branches to power the front parking lamps and rear tail lamps, roof clearance and identification lamps, fender lamps and rear license plate lamps.

GROUND CIRCUIT

Circuit Z13 provides ground for the lamps.

HELPFUL INFORMATION

- If the vehicle is equipped with factory installed fog lamps, circuit L7 splices to feed the fog lamp #1 relay
- If the vehicle is equipped with factory installed trailer tow, circuit L7 splices to the trailer tow harness
- Check fuse 1, a 40 amp, in the PDC
- Check fuse 18, a 15 amp, in the fuse block
- Circuit L7 also feeds the radio, if equipped
- When the headlamp switch is in the PARK or ON position, the dimmer circuit, F33, also connects to circuit E1. Circuit E1 feeds circuit E2, which powers the ash receiver lamp, instrument cluster illumination lamps, under hood lamp, glove box lamp and radio lamp. Fuse 13 in the fuse block protects circuits E1 and E2

FENDER AND TAILGATE LAMPS

Circuit A7 in the Power Distribution Center (PDC) connects to a bus bar in the fuse block. One of the four circuits powered by the bus bar is circuit F33. Circuit F33 connects to the headlamp switch. Fuse 1

in the PDC protects the A7 circuit. Fuse 18, a 15 amp, in the fuse block protects circuit F33.

The headlamp switch has three positions: OFF, PARK (parking lamps) and ON, plus a dimmer switch. When the headlamp switch is in the PARK or ON position, the switch connects circuit F33 to circuit L7. From the headlamp switch, circuit L7 branches to power the front parking lamps and rear tail lamps, roof clearance and identification lamps, fender lamps and rear license plate lamps.

GROUND CIRCUIT

Circuit Z13 provides ground for the lamps.

HELPFUL INFORMATION

- If the vehicle is equipped with factory installed fog lamps, circuit L7 splices to feed the fog lamp #1 relay
- If the vehicle is equipped with factory installed trailer tow, circuit L7 splices to the trailer tow harness
- Check fuse 1, a 40 amp, in the PDC
- Check fuse 18, a 15 amp, in the fuse block
- Circuit L7 also feeds the radio, if equipped
- When the headlamp switch is in the PARK or ON position, the dimmer circuit, F33, also connects to circuit E1. Circuit E1 feeds circuit E2, which powers the ash receiver lamp, instrument cluster illumination lamps, under hood lamp, glove box lamp and radio lamp. Fuse 13 in the fuse block protects circuits E1 and E2

STOP LAMPS AND CHMSL LAMPS

Circuit A3 from fuse 6, a 40 amp, in the Power Distribution Center (PDC) supplies voltage to circuit F32 through fuse 20, a 15 amp, in the fuse block. Circuit F32 connects to the stop lamp switch.

When the operator presses the brake pedal, the stop lamp switch CLOSES and connects circuit F32 to circuit L50. Circuit L50 connects to the Center High Mounted Stop Lamps (CHMSL) and multi-function switch. The multi-function switch supplies power to the L62 and L63 circuits. Circuit L62 powers the

DESCRIPTION AND OPERATION (Continued)

right stop lamp. Circuit L63 powers the left stop lamp.

GROUND CIRCUIT

Circuit Z13 provides a ground for the stop lamps and back-up lamps. The Z13 circuit has more than one branch. Circuit Z13 also supplies ground path for the tail lamps, parking lamps, rear license plate lamp, back-up lamps, and turn signals. Circuit Z3 provides ground for the CHMSL lamps.

HELPFUL INFORMATION

- Check for blown fuse in circuit F32.
- Check for continuity across the stop lamp switch when it is CLOSED.
- If the vehicle is equipped with Rear Wheel Anti-Lock (RWAL) brakes, circuit F32 connects to the RWAL module.

BACK-UP LAMPS

In the RUN position, the ignition switch connects circuit A2 from fuse 2 in the Power Distribution Center (PDC) to circuit A22. Circuit A22 feeds a bus bar in the fuse block that powers circuit L10 through fuse 15.

Circuit L10 supplies power to the back-up lamp switch. On automatic transmission equipped vehicles,

the back-up lamp switch is part of an assembly that includes the PARK/NEUTRAL position switch.

When the operator puts the transmission in REVERSE, the back-up lamp switch connects circuit L10 to circuit L1. Circuit L1 feeds the back-up lamps.

GROUND CIRCUIT

Circuit Z13 provides ground for the back-up lamps. Circuit Z13 also supplies a ground path for the tail lamps, parking lamps, rear license plate lamp, stop lamps, and turn signals.

HELPFUL INFORMATION

- Check for blown fuses in circuits A2 and L10
- Check for continuity across the back-up lamp switch when it is CLOSED
- Circuit L1 also connects to the day/night mirror

SCHEMATICS AND DIAGRAMS**WIRING DIAGRAM INDEX**

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

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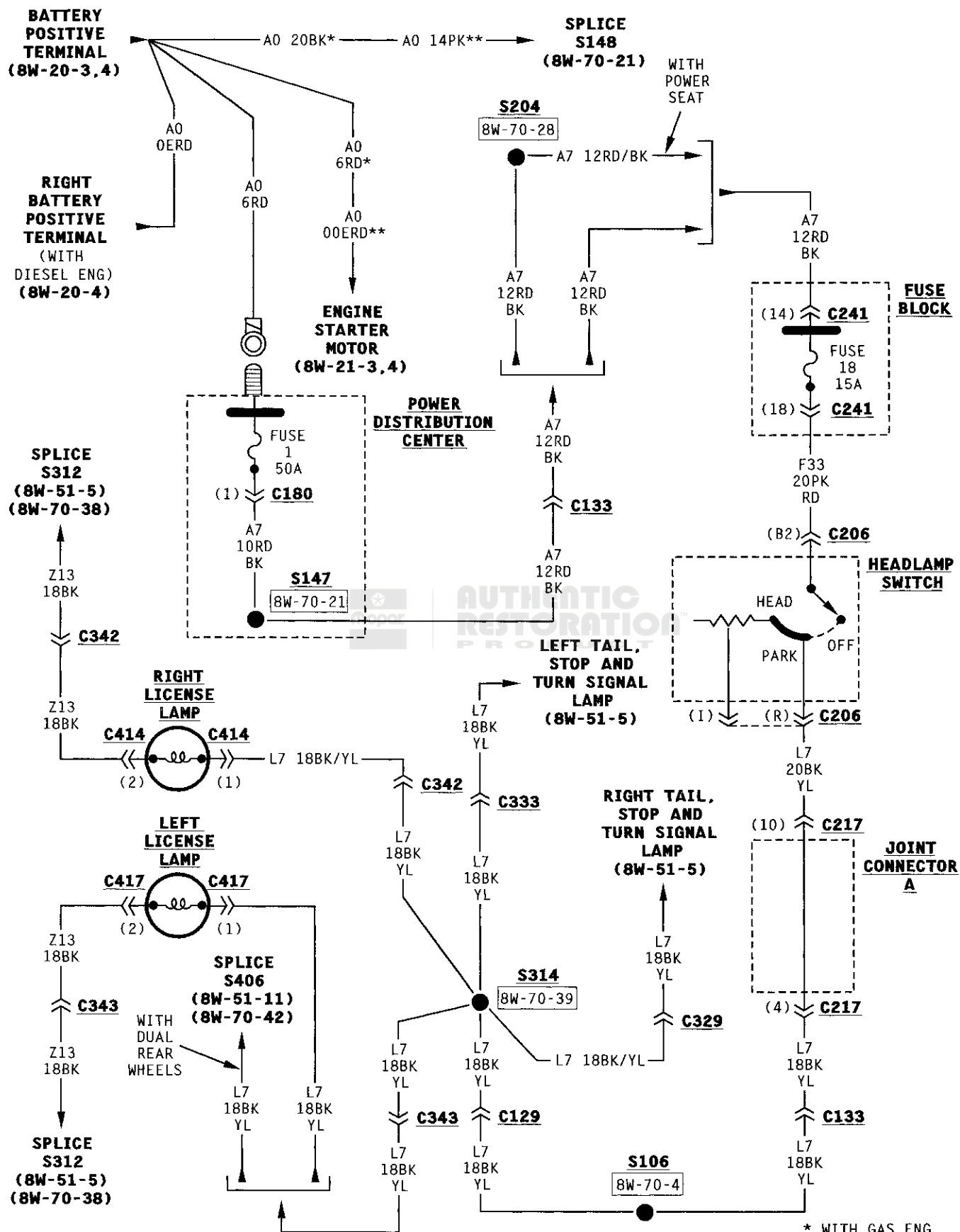
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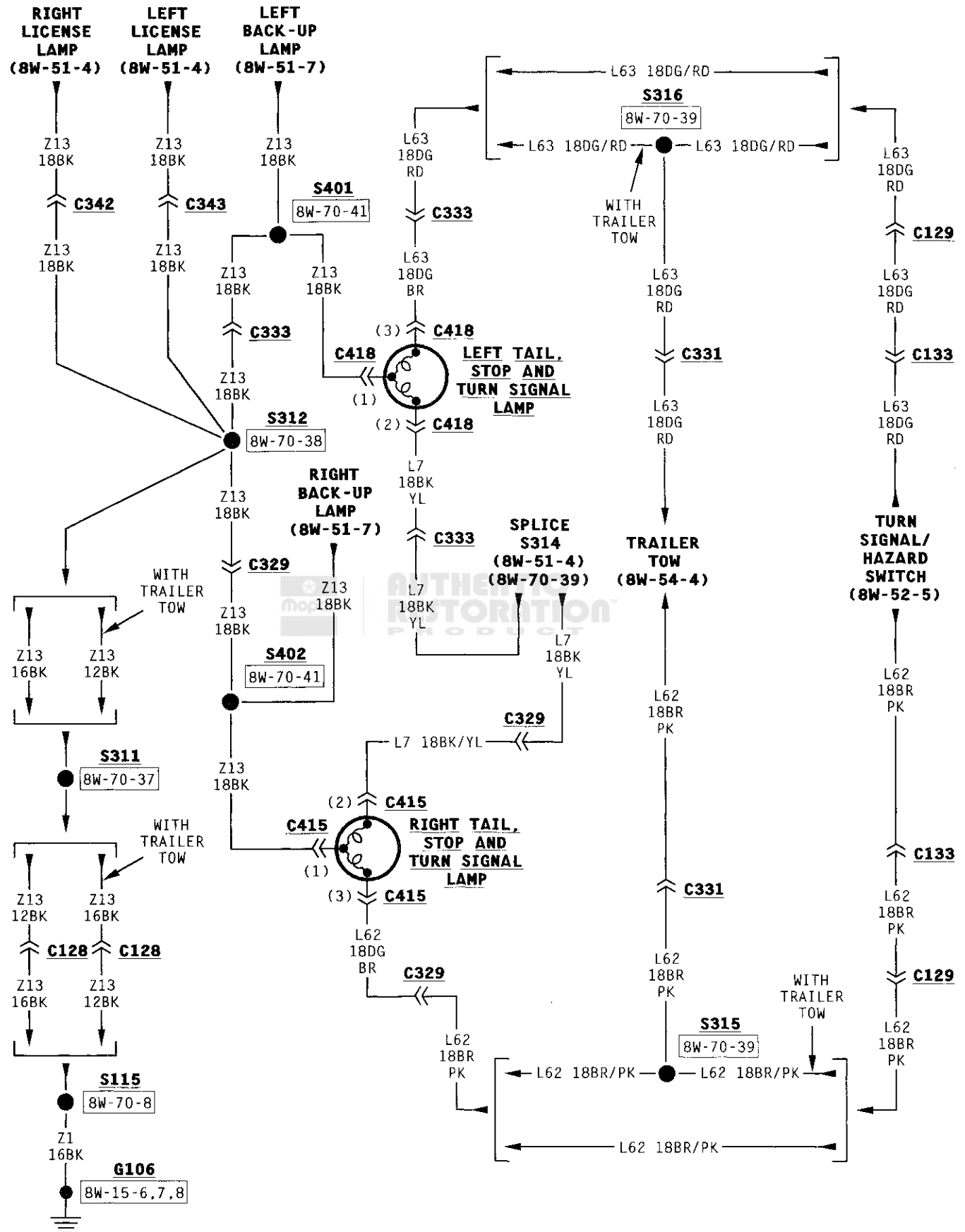
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Tail, Stop and Turn Signal Lamps	8W-51-5
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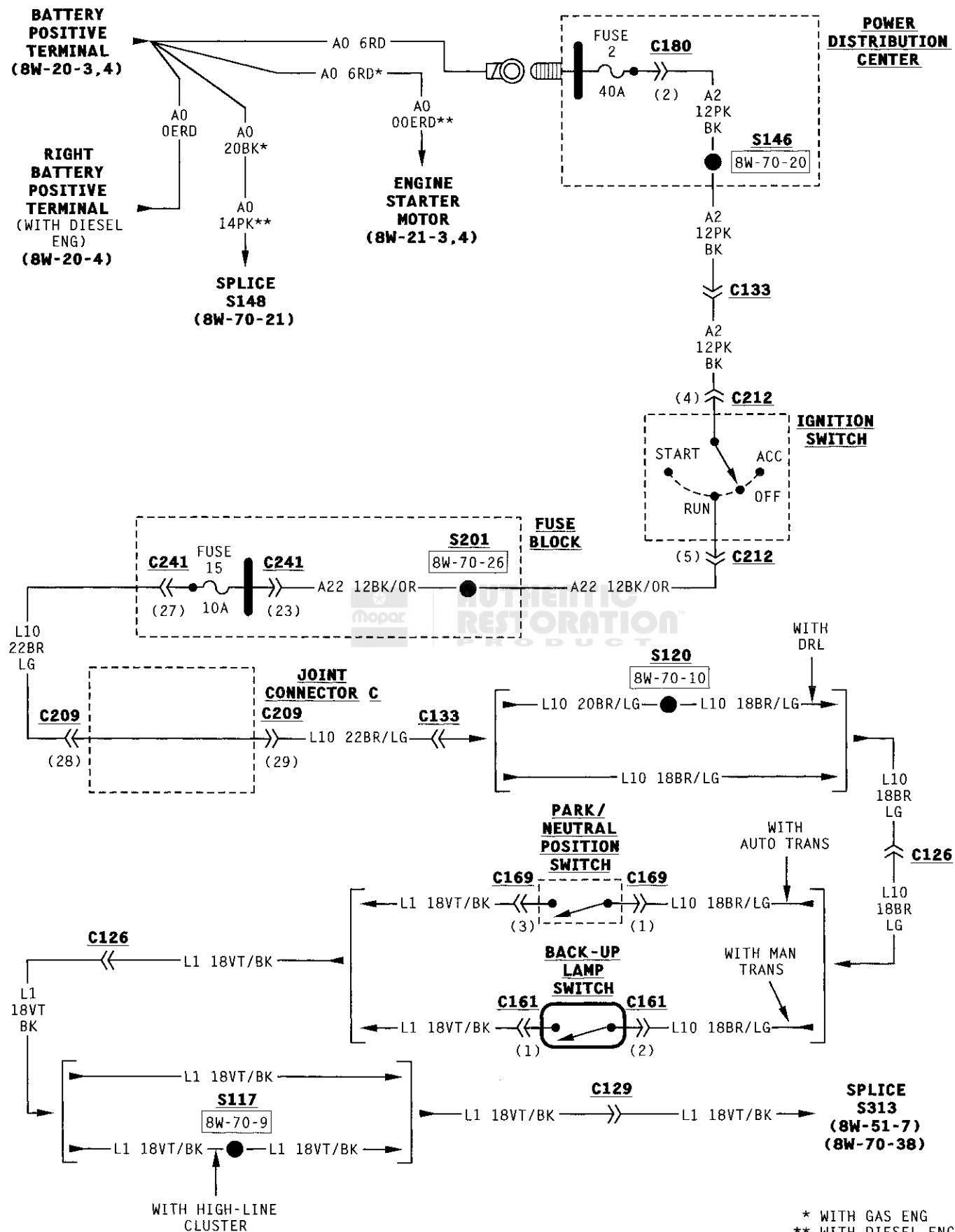


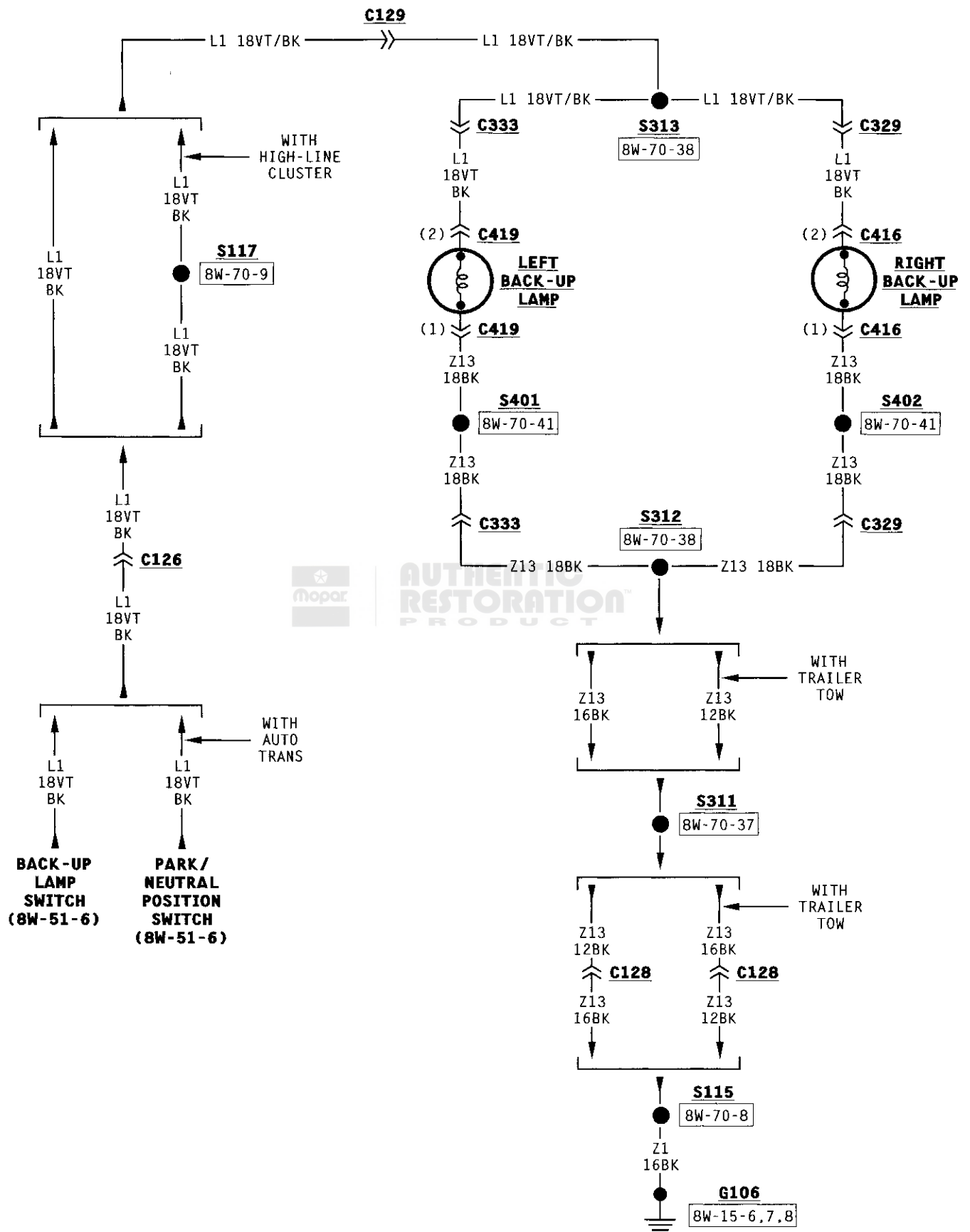
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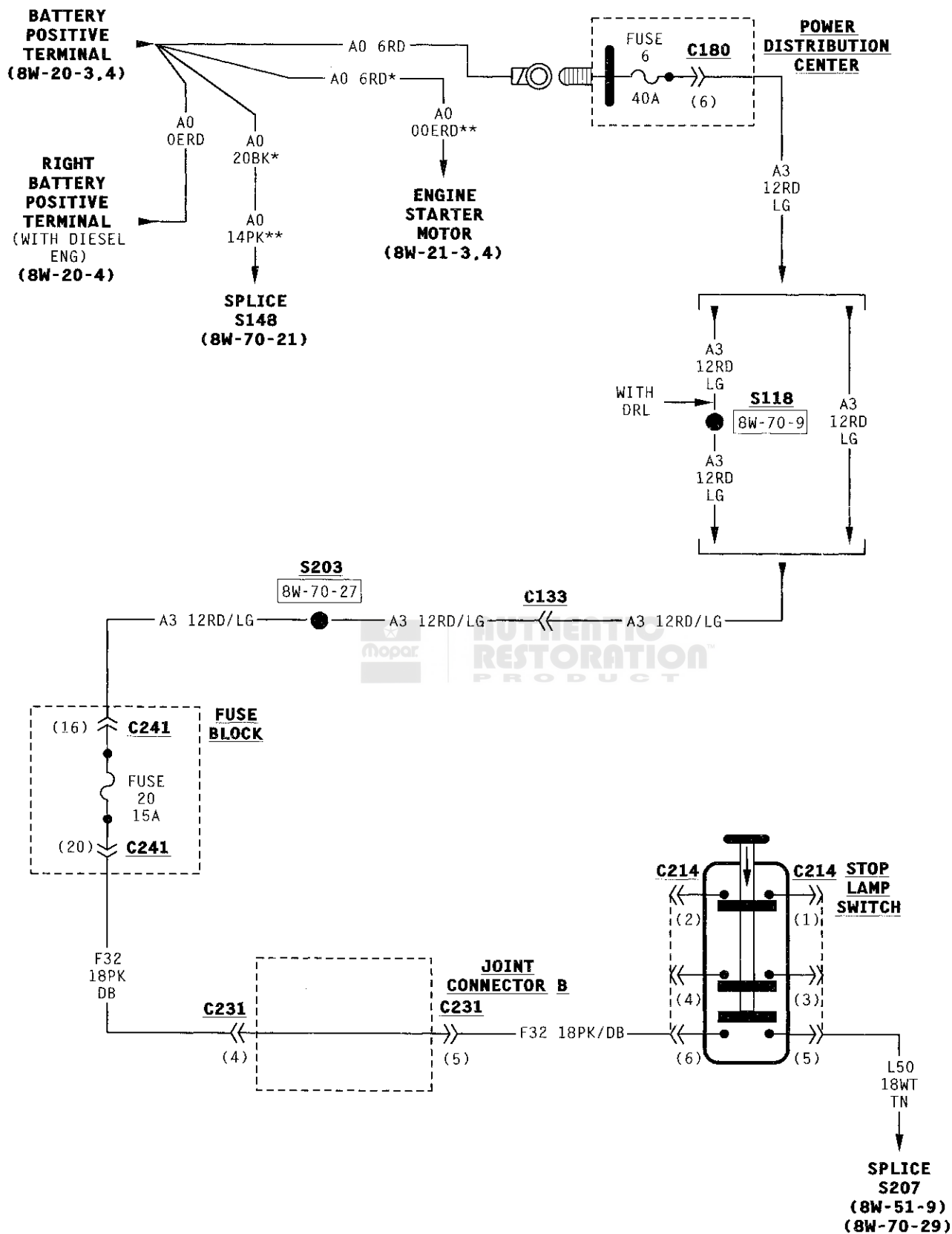


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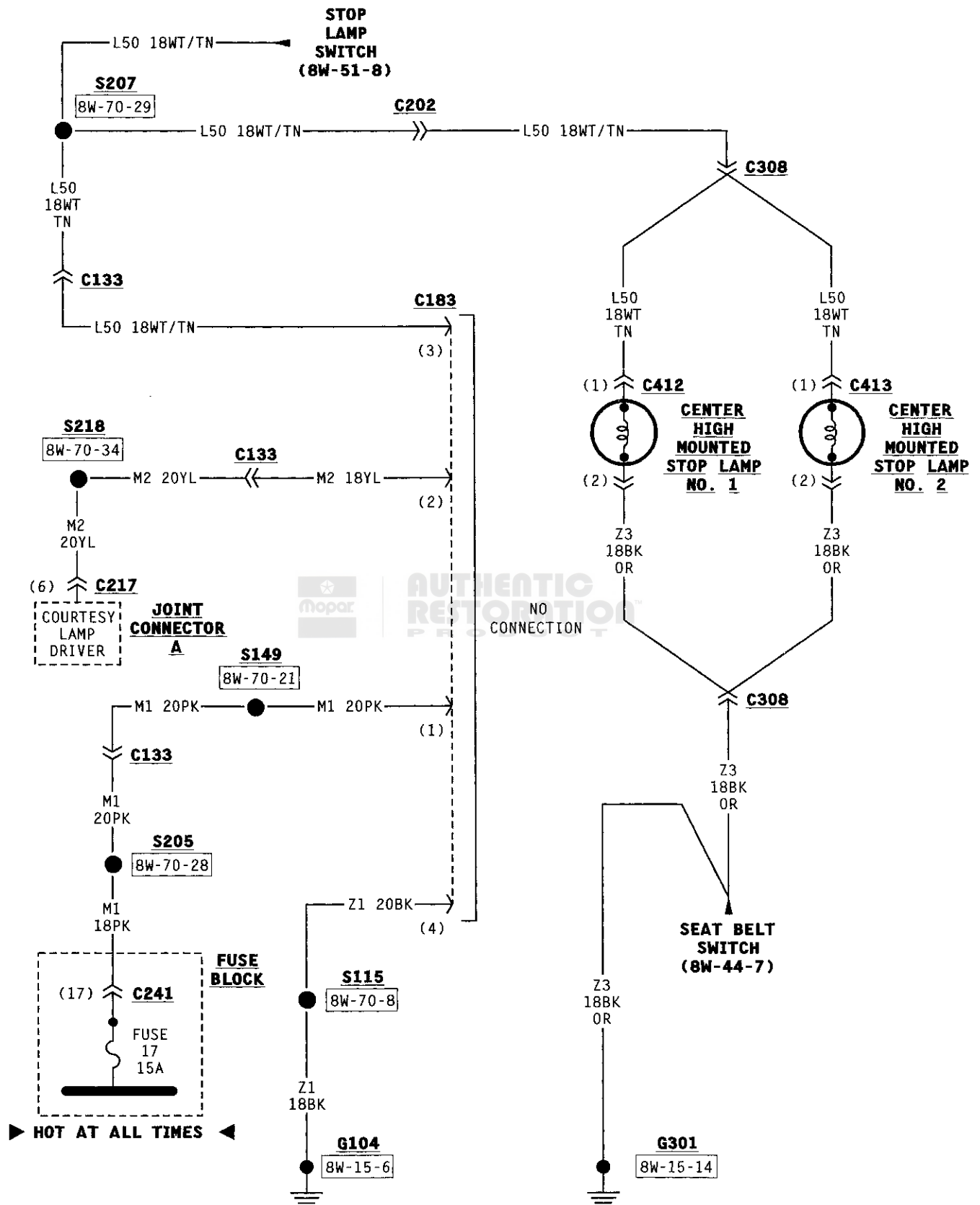


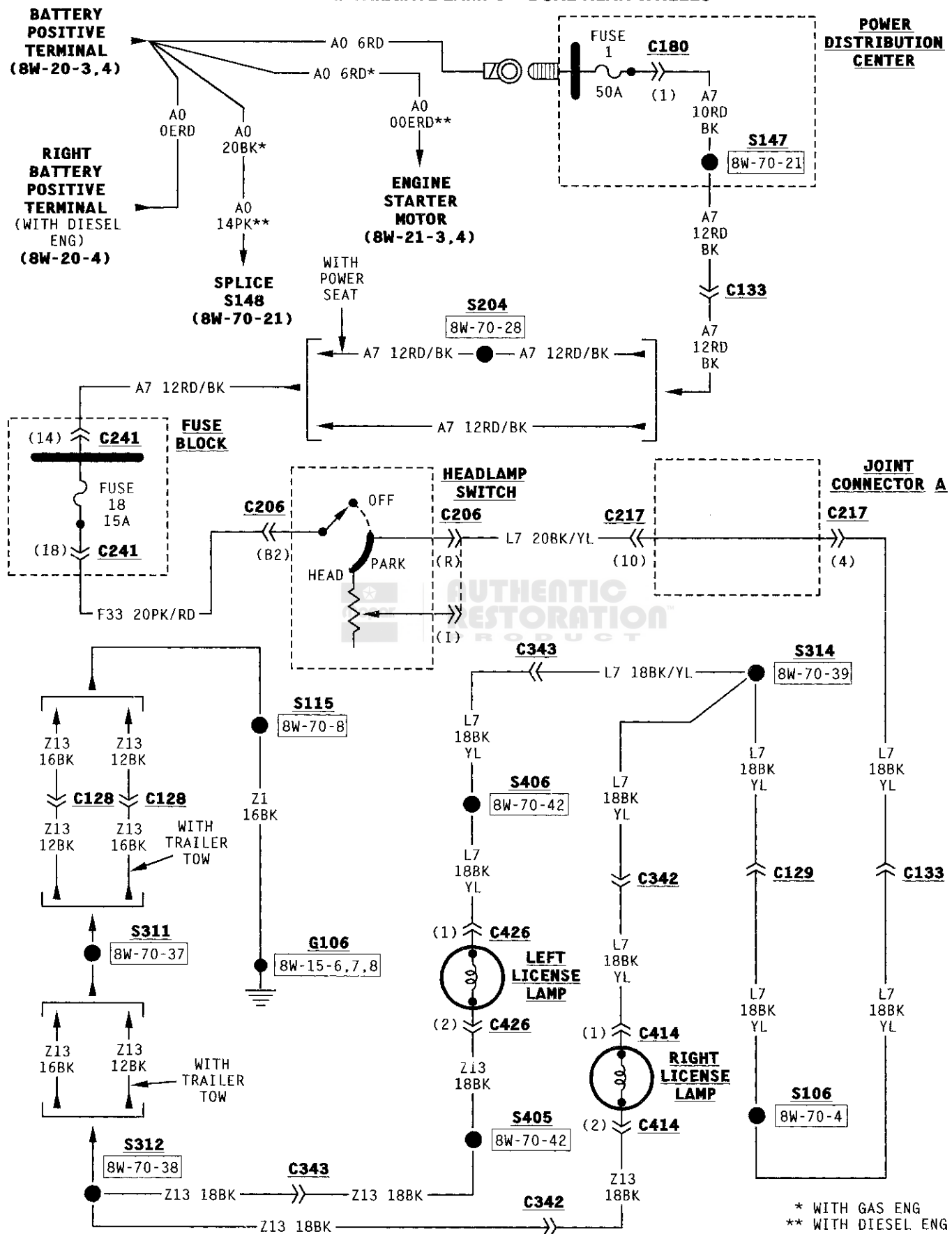


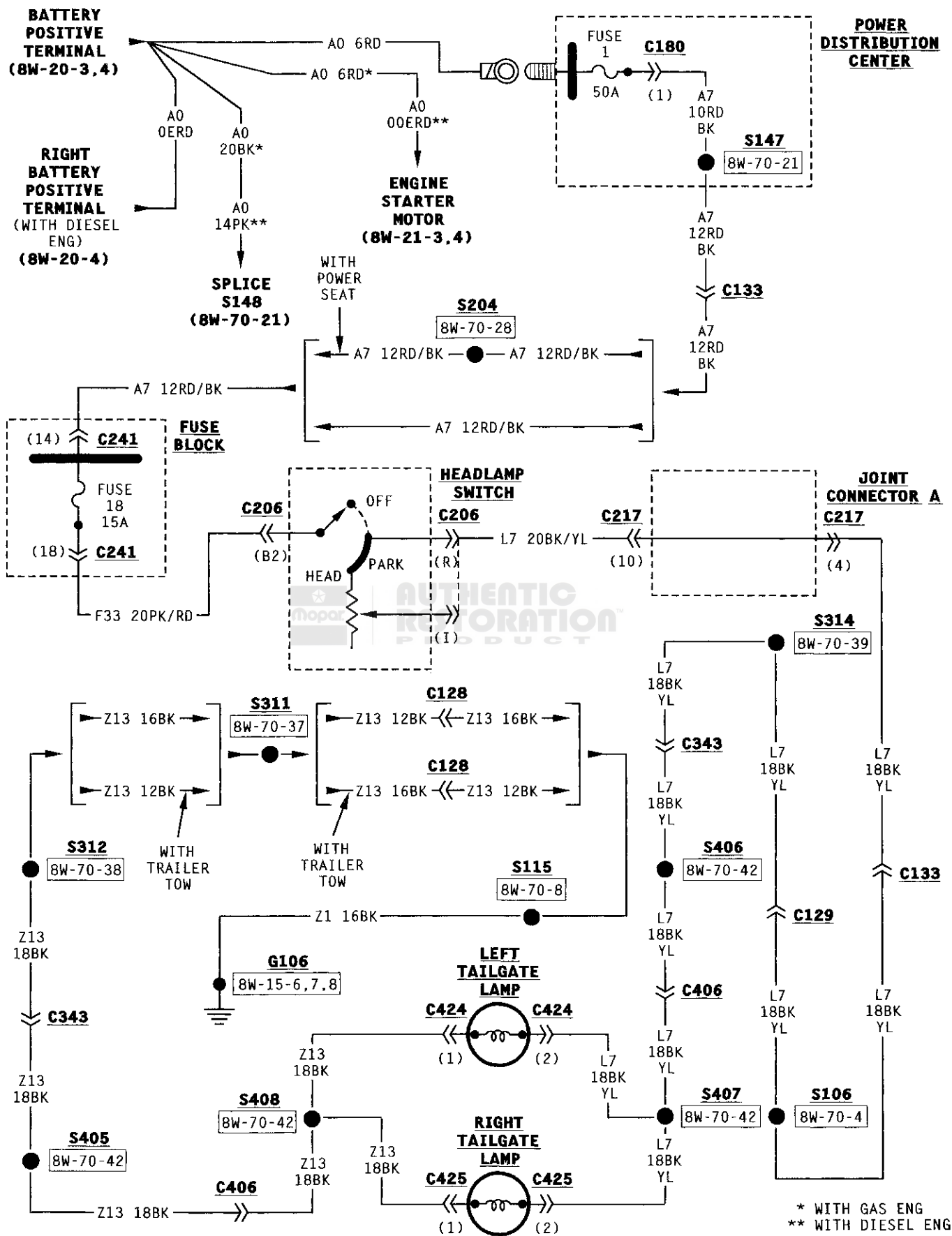


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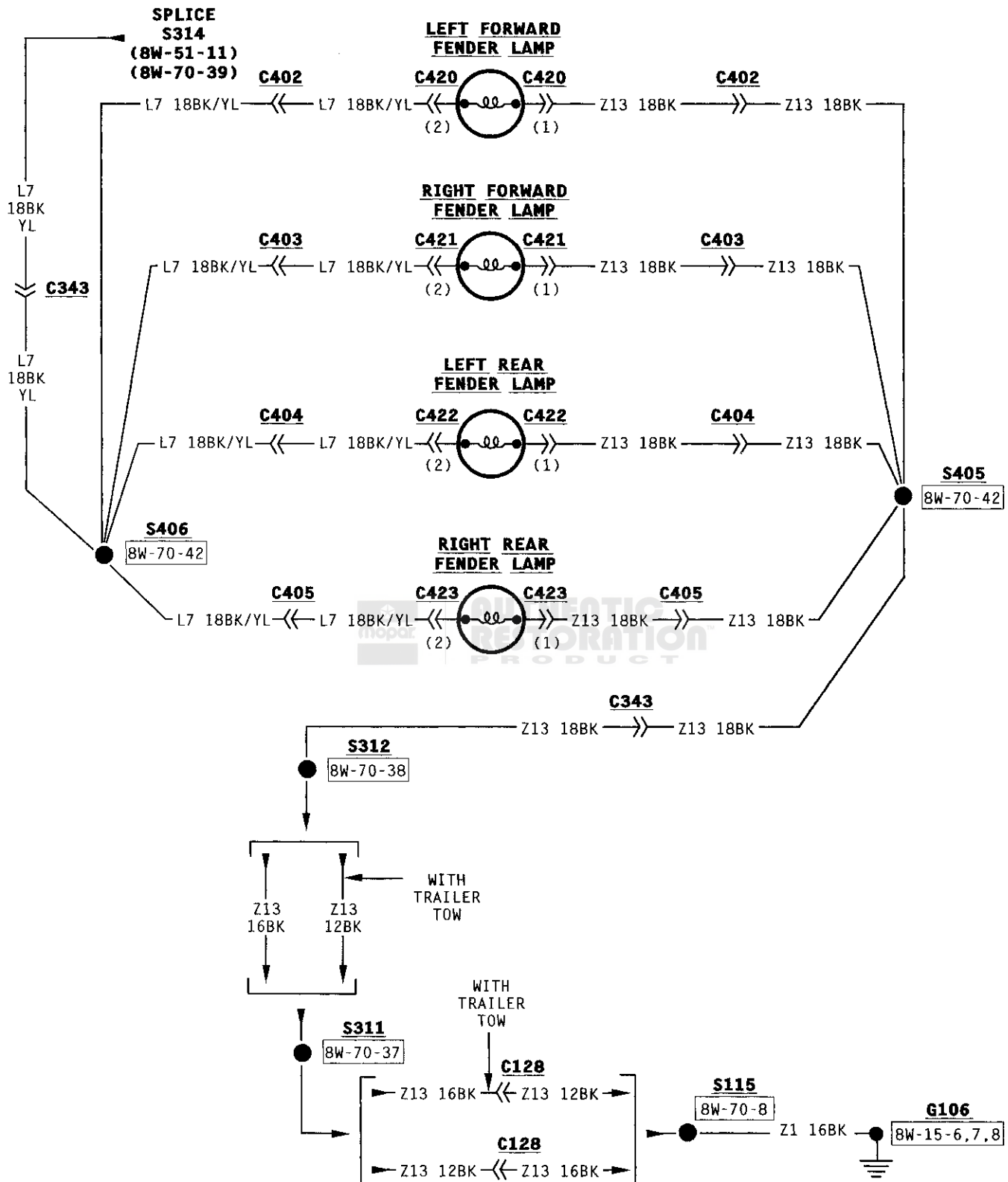
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8W-51 REAR LIGHTING FENDER AND TAILGATE LAMPS – DUAL REAR WHEELS



8W-52 TURN SIGNALS

DESCRIPTION AND OPERATION

TURN SIGNALS

In the ACCESSORY or RUN position, the ignition switch connects circuit A1 from fuse 3 in the Power Distribution Center (PDC) to circuit A31. Circuit A31 feeds circuit L5 through fuse 6 in the fuse block.

Circuit L5 powers the turn signal flasher. Circuit L6 from the flasher connects to the multi-function switch to supply power to the turn signals. The multi-function switch connects circuit L6 to the turn signal lamps on circuits L60, L61, L62 and L63.

RIGHT TURN SIGNAL

When the operator selects the right turn signal, the multi-function switch connects power from circuit L6 to circuits L60 and L62. Circuit L62 feeds the right rear turn signal/hazard flasher/stop lamp.

Circuit L60 feeds the right front turn signal/hazard flasher lamp and side marker lamp. Circuit L60 also splices to power the turn signal indicator lamp on the instrument cluster.

LEFT TURN SIGNAL

When the operator selects the left turn signal, the multi-function switch connects power from circuit L6 to circuits L61 and L63. Circuit L63 feeds the left rear turn signal/hazard flasher/stop lamp.

Circuit L61 feeds the left front turn signal/hazard flasher lamp and side marker lamp. Circuit L61 also splices to power the turn signal indicator lamp on the instrument cluster.

GROUND CIRCUIT

Circuit Z1 provides a ground for the parking lamps, turn/tail/stop lamps, and rear license plate lamps.

HELPFUL INFORMATION

- Check the 40 amp fuse located in cavity 3 of the PDC
- Check the 15 amp fuse located in cavity 6 of the fuse block
- Check the lamp filaments

HAZARD FLASHERS

Circuit A15 from the battery positive post supplies power to the hazard flasher fuse (fuse C) in the Power Distribution Center (PDC).

Circuit L9 from the hazard flasher fuse supplies battery voltage to the hazard warning flasher. Circuit L19 from the flasher connects to the multi-function switch.

When the operator presses the hazard flasher button, the multi-function switch connects circuit L19 to circuits L60, L61, L62, and L63.

Circuit L62 powers the right rear turn signal/stop lamp. Circuit L63 powers the left rear turn signal/stop lamp. Circuit L60 powers the right front lamps and circuit L61 powers the left front lamps.

Circuit L60 and L61 are double crimped at the multi-function switch and supply power for the turn signal indicator lamps in the instrument cluster.

GROUND CIRCUIT

Circuit Z1 provides a ground for the parking lamps, turn/tail/stop lamps, and rear license plate lamps.

Circuit Z1 also provides a ground for the back-up lamps and Center High Mounted Stop Lamps (CHMSL) lamps.

HELPFUL INFORMATION

- Check the 15 amp fuse located in cavity C of the PDC
- Check the ground locations for the lamps

SCHEMATICS AND DIAGRAMS

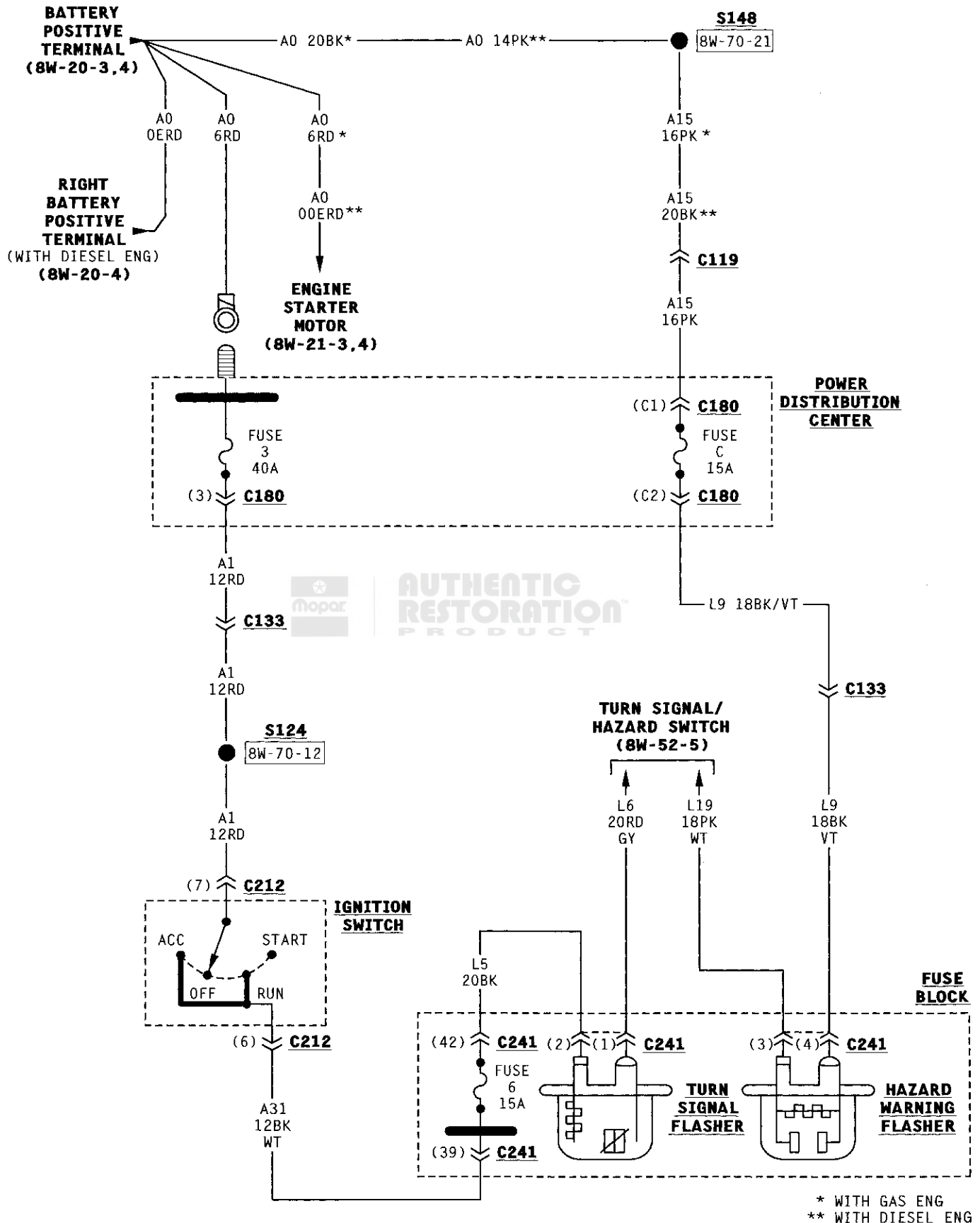
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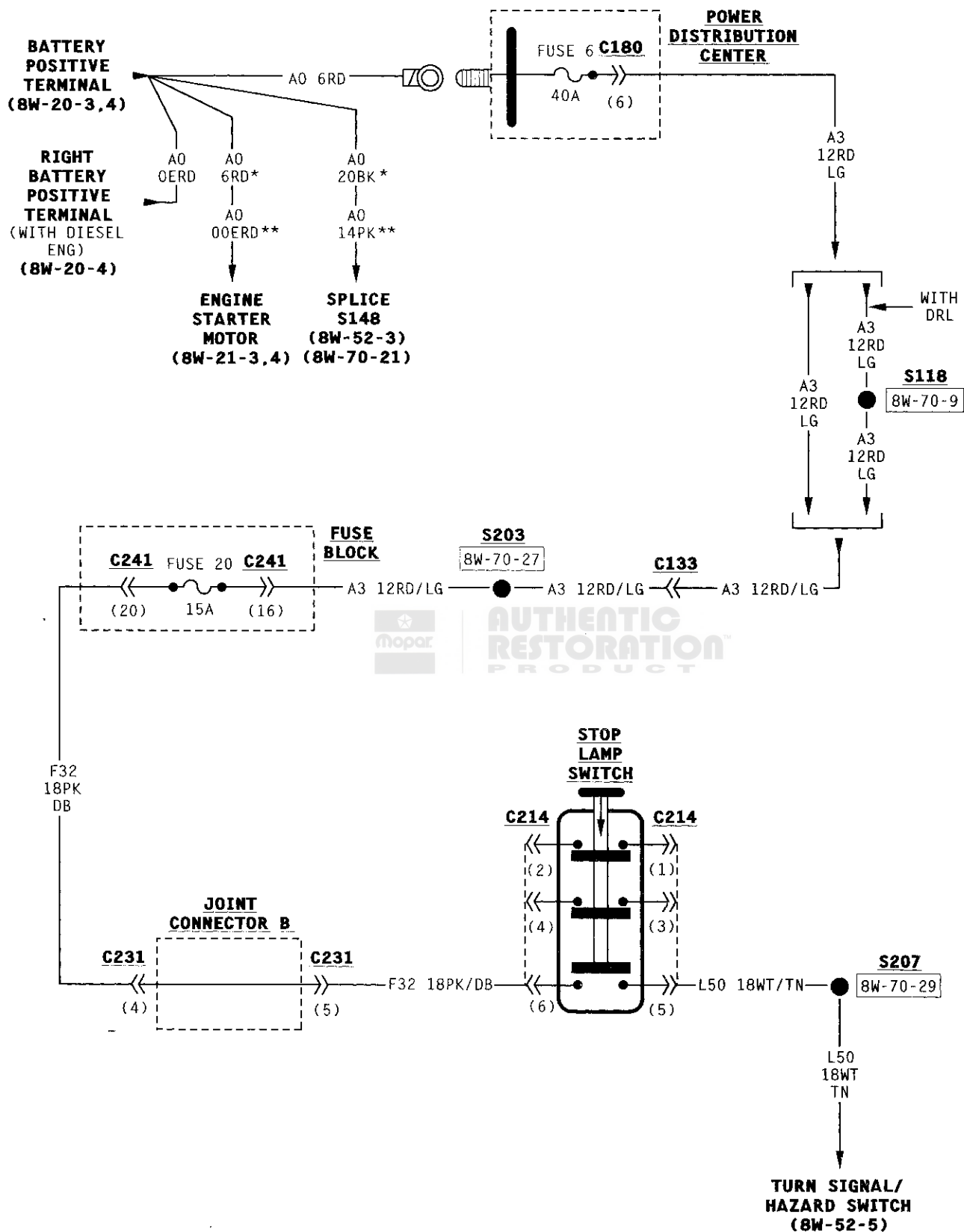
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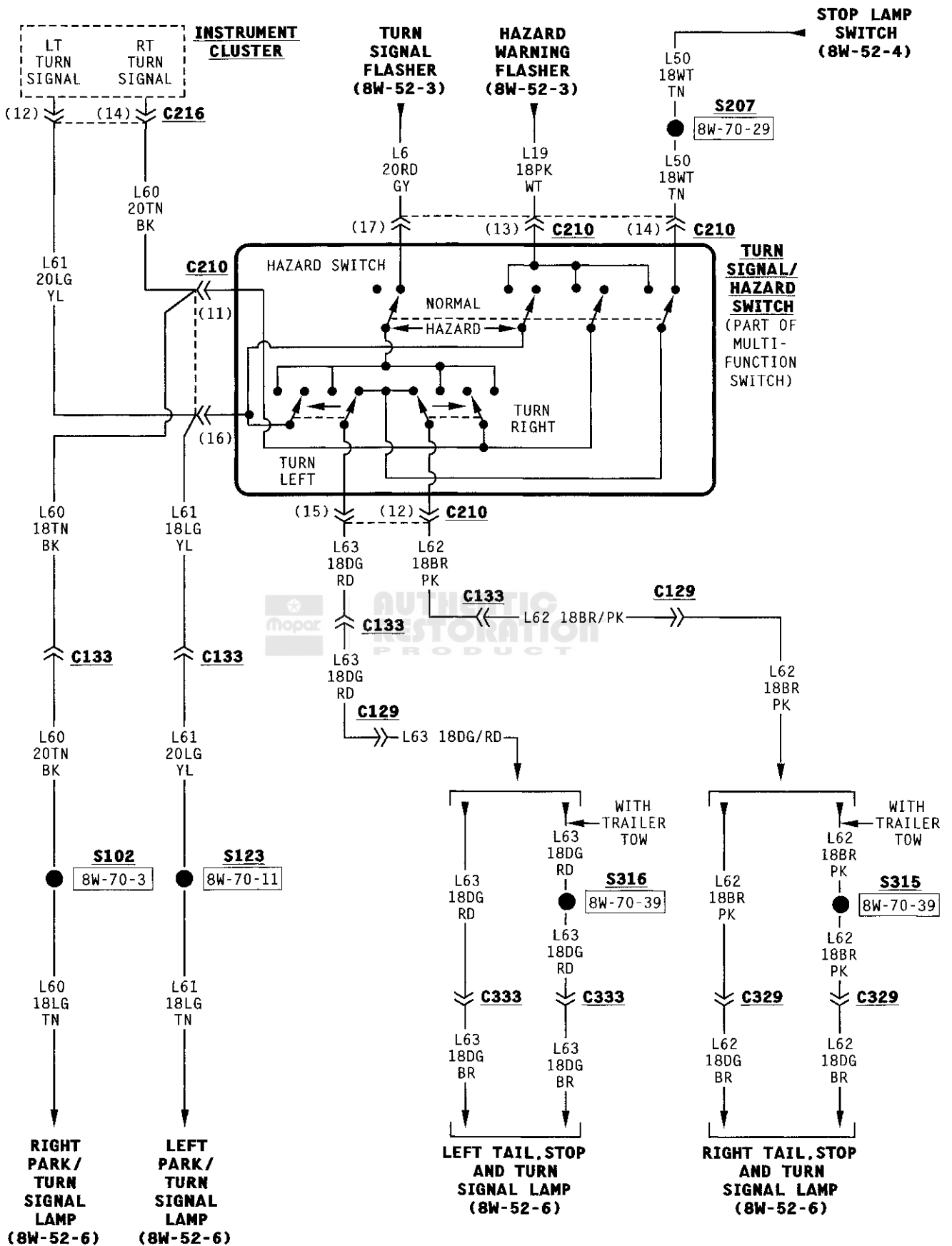


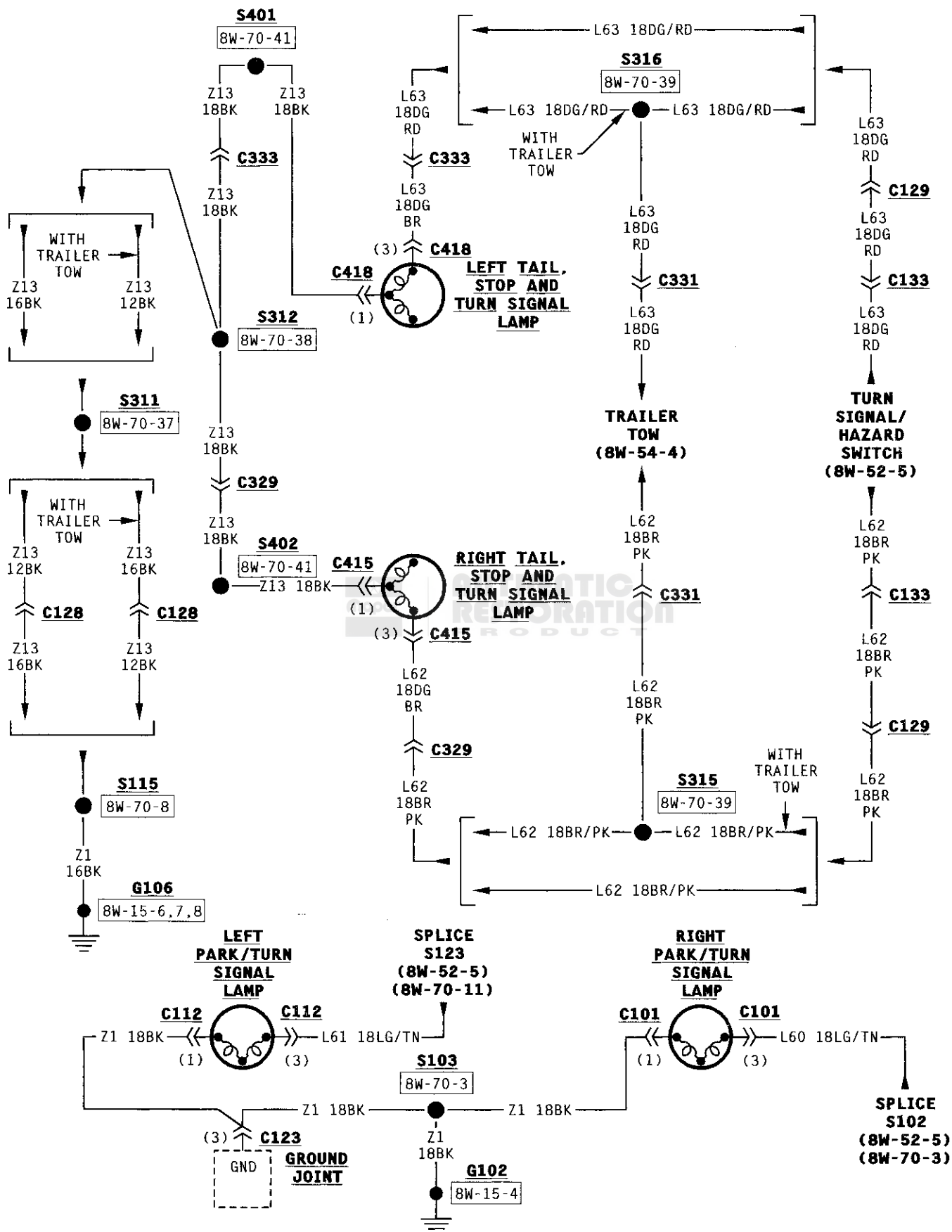




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8W-53 WIPERS

DESCRIPTION AND OPERATION

WIPERS

Fuse 8 in the fuse block powers the intermittent wiper system. The intermittent wiper system operates at either DELAY, LOW or HIGH speeds.

In the ACCESSORY or RUN position, the ignition switch connects circuit A1 from fuse 3, a 40 amp, in the Power Distribution Center (PDC) with circuit A31. Circuit A31 supplies voltage to circuit V6 through fuse 8 in the fuse block.

Circuit V6 splices to supply power to the wiper switch circuitry in the multi-function switch, the intermittent wiper control module and the park switch in the wiper motor. Ground for the wiper motor is supplied on circuit Z1. Circuit Z3 provides ground for the intermittent wiper control module.

When the operator moves the wiper switch to the LOW speed position, the switch passes voltage to circuit V3. Circuit V3 feeds the wiper motor LOW speed brushes. If the operator selects wiper HIGH speed operation, the wiper switch passes current to circuit V4. Circuit V4 feeds the wiper motor HIGH speed brushes.

If the operator selects wiper DELAY operation, the wiper switch provides an input to the intermittent wiper control module on circuit V9. The DELAY portion of the wiper switch contains a variable resistor. The variable resistor connects to the intermittent wiper module on circuit V9. Voltage for the resistor is supplied by circuit V6 through the wiper switch. The amount of delay selected by the operator determines the voltage drop through the resistor and the voltage level received by the intermittent wiper control module.

Circuit V8 is also an input to the intermittent wiper control module. This input is used by the module as a delay ON input.

After the intermittent wiper control module determines the amount of delay selected, it cycles the wipers by periodically energizing circuit V17 which connects to circuit V3 through the wiper switch. Circuit V3 powers the wiper motor LOW speed brushes.

As the windshield wiper motor turns, the park switch, internal to the motor, moves from its grounded position (down) to the powered RUN (up) position. Circuit V7 provides an input to the intermittent wiper control module when the wiper switch is in the OFF position. The intermittent wiper con-

trol module powers the park switch in the wiper motor on circuit V5.

The intermittent windshield wiper system is also equipped with a pulse wipe feature. To activate this feature, the operator presses the washer switch momentarily. When the washer switch CLOSES, voltage from circuit V6 passes through the switch to circuit V10. Circuit V10 provides a signal to the intermittent wiper control module and supplies voltage for the windshield washer pump. When the control module receives the signal on circuit V10, it cycles the wipers on circuit V3 while the washer fluid pump operates.

The washer motor operates whenever the washer switch CLOSES and supplies voltage to it on circuit V10. Circuit Z1 provides ground for the pump motor.

HELPFUL INFORMATION

- Circuit V3 is double crimped at the multi-function switch to allow either the wiper switch or intermittent wiper control module to power the wiper motor LOW speed brushes
- Check the 40 amp fuse located in cavity 3 of the PDC
- Check the 20 amp fuse located in cavity 8 of the fuse block

LOW WASHER FLUID WARNING LAMP

The low washer fluid warning lamp is located in the instrument cluster. Circuit G29 connects the warning lamp to the low washer fluid sensor in the washer fluid reservoir. The switch in the sensor CLOSES when the fluid level drops below a calibrated level. When the switch CLOSES, voltage flows through the warning lamp to ground on circuit Z1.

HELPFUL INFORMATION

- Check the grounding location for the sensor
- Check the continuity across the switch

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

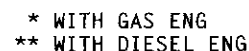
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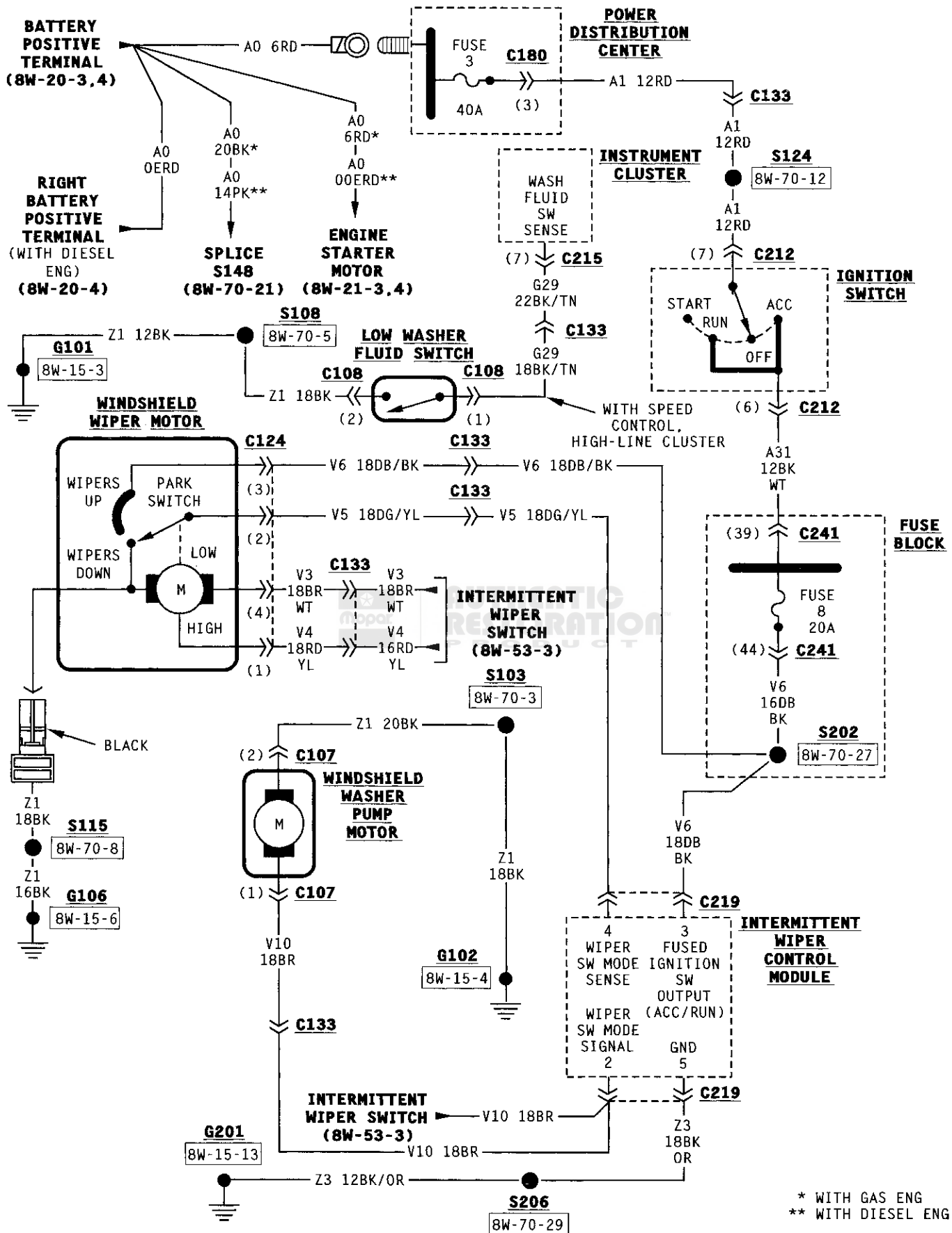
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8W-54 TRAILER TOW

DIAGNOSIS AND TESTING

TRAILER TOW

The trailer tow package consists of a relay located in the Power Distribution Center (PDC), a trailer tow connector, and an electric brake provision.

TRAILER TOW RELAY

The trailer tow relay located in the Power Distribution Center (PDC) is supplied power for the contact side on circuit A6. This circuit is protected by a 30 amp fuse located in cavity 7 of the PDC and spliced to provide power to the trailer tow connector.

Power for the coil side of the relay is supplied on circuit L7. This circuit is HOT when the headlamp switch is in the PARK or ON position. Ground for the coil side of the relay is supplied on circuit Z1.

When the relay is energized, the contacts in the relay CLOSE connecting circuits A6 and L76. Circuit L76 connects from the relay to the trailer tow connector.

TRAILER TOW CONNECTOR

The following circuits connect to the trailer tow connector:

- A6 for a battery feed
- L76 for a battery feed from the trailer tow relay for the park, license, and side marker lamps
- L1 as a back up lamp input
- L62 for the right turn signal/stop lamp
- L63 for the left turn signal/stop lamp
- Z13 for a ground
- B40 for the electric brake provision

HELPFUL INFORMATION

- Check the 30 amp fuse located in cavity 7 of the PDC
- Check the grounding location for circuit Z13.

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

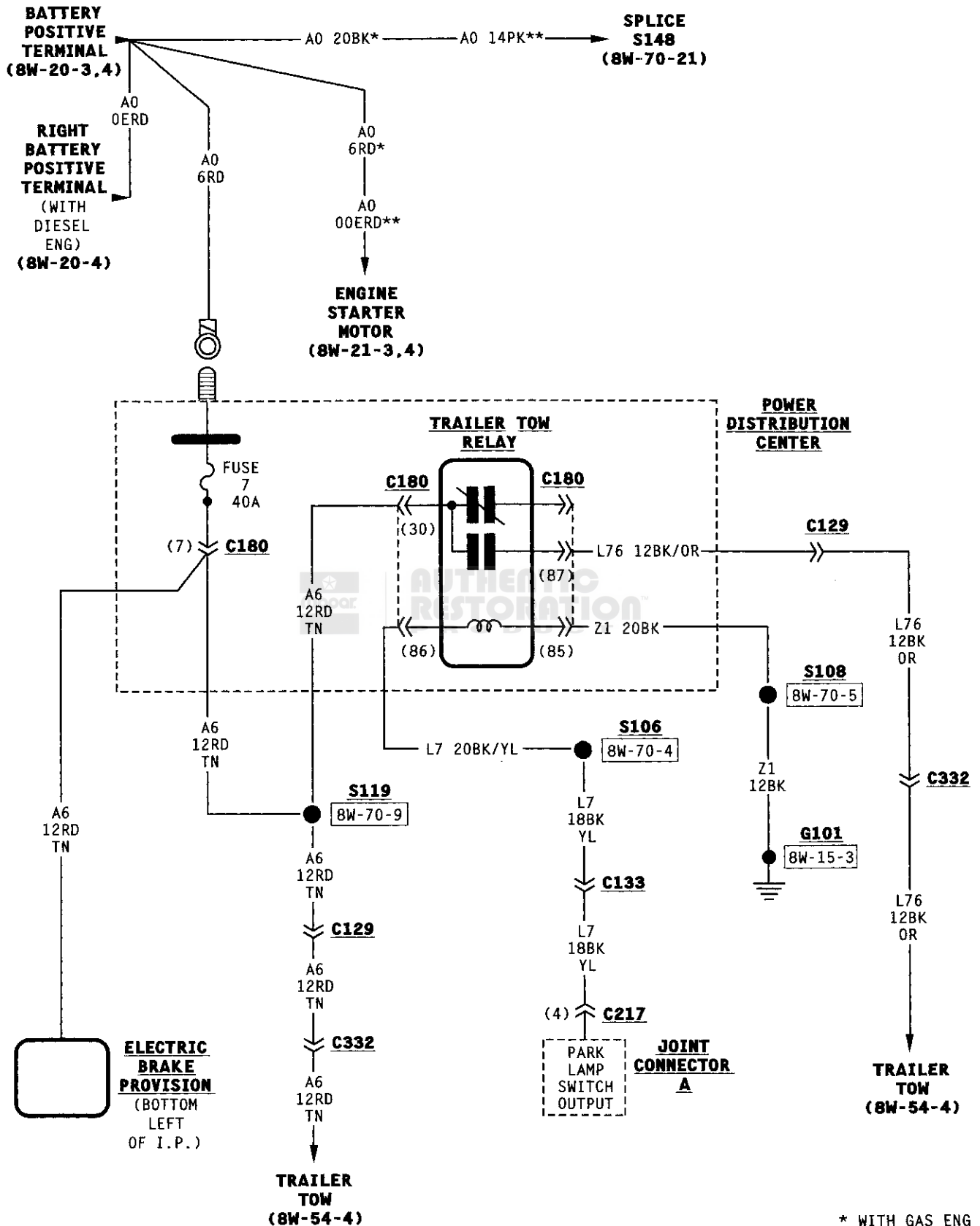


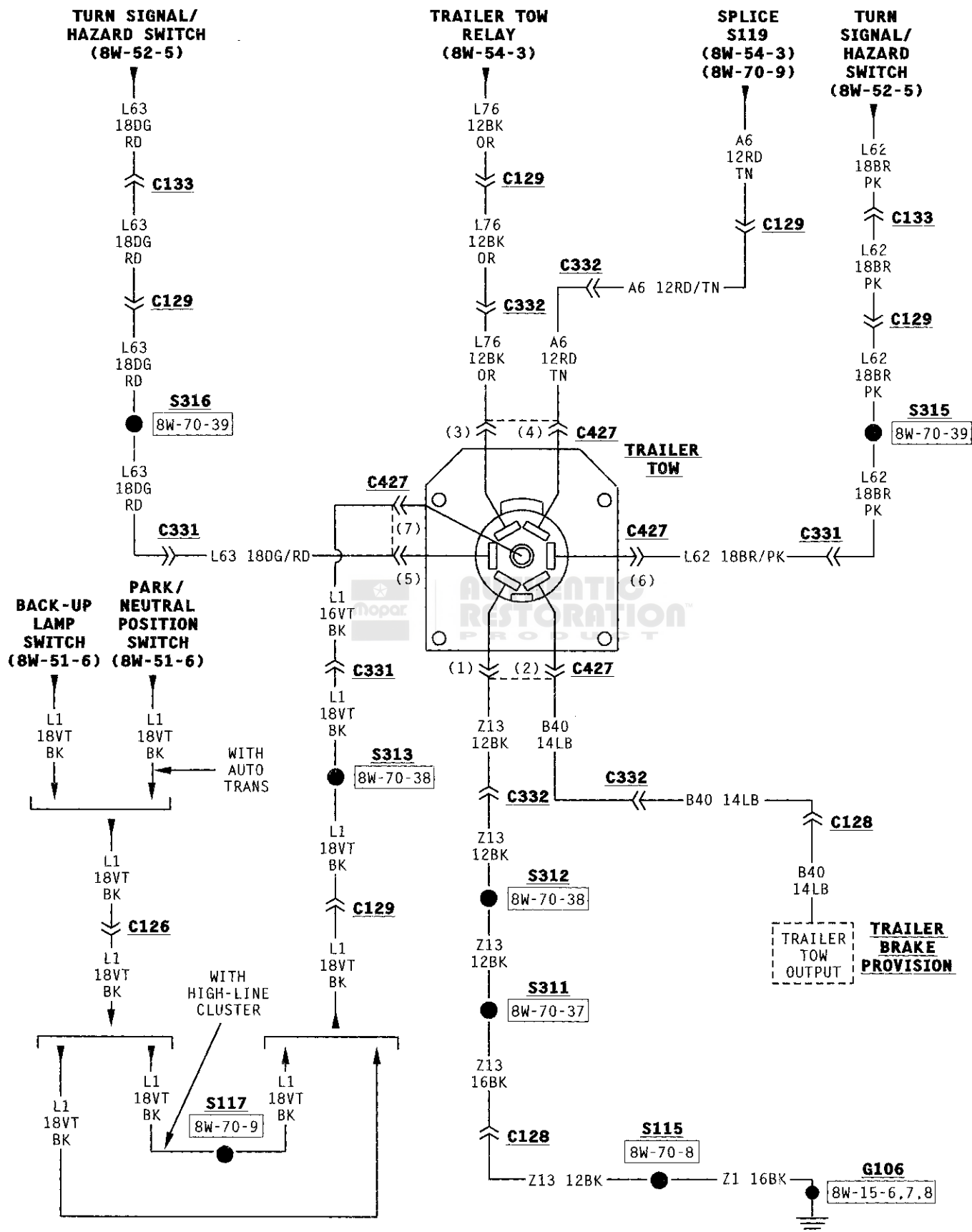
DIAGRAM INDEX

Component	Page	Component	Page
Fuse 7 (PDC)	8W-54-3	Trailer Tow	8W-54-4
Joint Connector A	8W-54-3	Trailer Tow Relay	8W-54-3
Trailer Brake Provision	8W-54-4		



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8W-60 POWER WINDOWS

DESCRIPTION AND OPERATION

POWER WINDOWS

The power window system is supplied power from the 30 amp circuit breaker located in the fuse block. Power for the circuit breaker is supplied on circuit A22 from the ignition switch. This circuit is HOT when the ignition switch is in the RUN position.

Power for the A22 circuit is supplied by the A2 circuit which is HOT at all times and protected by a 40 amp fuse located in the Power Distribution Center (PDC), cavity 2.

Circuit F21 connects from the circuit breaker to both window switches. Circuit F21 is the feed for the switches. Both switches use a bus bar to provide power for the different functions of the switch.

The ground path for the system is through the master window switch on the Z3 circuit.

MASTER WINDOW SWITCH (LEFT WINDOW OPERATION)

When the window switch is moved to the window DOWN position, voltage is supplied on the F21 circuit through the CLOSED contacts in the switch to the Q21 circuit. The Q21 circuit connects from the switch to the left front window motor. Grounding is provided on circuit Q11 from the motor back to the switch. The ground is passed through the switch to ground on the Z3 circuit.

When window UP operation is selected, the power and ground circuits are reversed. Circuit Q11 is the feed and circuit Q21 is the ground.

MASTER WINDOW SWITCH (RIGHT WINDOW OPERATION)

When the window switch is moved to the window DOWN position, voltage is supplied on the F21 circuit through the CLOSED contacts in the switch to the Q26 circuit. The Q26 circuit connects from the master switch to the right window switch. A bus bar internal to the right switch passes the voltage through the switch to circuit Q22. Circuit Q22 connects from the switch to the right window motor.

Grounding is provided on circuit Q12 from the motor back to the right switch.

The ground is passed through the switch on a bus bar to circuit Q16. Circuit Q16 then connects to the master switch. The ground is passed through the switch to ground on the Z3 circuit.

When window UP operation is selected, the power and ground circuits are reversed. Circuits Q16 and Q12 are the feeds and circuits Q22 and Q26 are the grounds.

RIGHT WINDOW SWITCH OPERATION

When the window switch is moved to the window DOWN position, voltage is supplied on the F21 circuit through the CLOSED contacts in the switch to the Q22 circuit. The Q22 circuit connects from the switch to the right front window motor. Grounding is provided on circuit Q12 from the motor back to the switch. The ground is passed through the switch to the Q16 circuit. The Q16 circuit connects from the right switch to the master switch. Ground is passed through the master switch to ground on the Z3 circuit.

When window UP operation is selected, the power and ground circuits are reversed. Circuit Q12 is the feed and circuits Q22 and Q26 are the ground.

HELPFUL INFORMATION

- Check the 40 amp fuse located cavity 2 of the PDC
- Check the 30 amp circuit breaker located in the fuse block
- Check the ground for the power window system

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

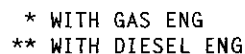
The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

DIAGRAM INDEX

Component	Page	Component	Page
Circuit Breaker 1	8W-60-3, 4	Left Power Window Switch	8W-60-3
Fuse 2	8W-60-3, 4	Right Power Window Motor	8W-60-4
Ignition Switch	8W-60-3, 4	Right Power Window Switch	8W-60-4
Left Power Window Motor	8W-60-3		



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8W-61 POWER DOOR LOCKS

DESCRIPTION AND OPERATION

POWER DOOR LOCKS

Circuit A7 from fuse 1 in the Power Distribution Center (PDC) powers circuit F35 through fuse 19 in the fuse block. Circuit F35 supplies power to both door lock switches.

The ground path for the system is through the left door lock switch on the Z3 circuit.

LEFT DOOR SWITCH OPERATION (LOCK)

When the door lock switch is moved to the LOCK position, voltage is supplied on the P35 circuit to the bus bar located inside the right door switch, LOCK side. Battery voltage is passed through the switch to the door motors on circuit P33. Grounding is provided through the P34 circuit for both door motors back to the right door switch. The ground is passed through the bus bar internal to the switch, UNLOCK side, to the P36 circuit. The P36 circuit connects to the left front switch to a bus bar, internal to the switch, and then to the Z3 circuit. The Z3 circuit provides ground.

LEFT DOOR SWITCH OPERATION (UNLOCK)

When the switch is moved to the UNLOCK position, voltage is supplied on the P36 circuit to the right door switch, UNLOCK side. The battery voltage is passed through the switch internal bus bar to the P34 circuit. The P34 circuit then connects to the door motors on the UNLOCK side. Grounding for the UNLOCK function is provided by the P33 circuit.

The P33 circuit connects back to the right door switch, LOCK side, and passes through the internal bus bar to the P35 circuit. The P35 circuit connects back to the left door switch, and passes through the switch to ground on circuit Z3.

RIGHT DOOR SWITCH OPERATION (LOCK)

When the switch is moved to the LOCK position, voltage is supplied to the P33 circuit, and then to the door lock motors. The ground path is provided on the P34 circuit back to the right door switch. The ground is passed through the switch internal bus bar to the P36 circuit. The P36 circuit connects to the left door switch and through to ground on circuit Z3.

RIGHT DOOR SWITCH OPERATION (UNLOCK)

When the switch is moved to the UNLOCK position, voltage is supplied to the P34 circuit from the switch to the door UNLOCK side of the motors. The grounding path is through the LOCK side of the motors, circuit P33, back to the switch. The ground continues through the internal bus bar of the switch on circuit P35 to the left door switch. At the left door switch, the ground passes through that switch's internal bus bar to ground on circuit Z3.

HELPFUL INFORMATION

- Check the 50 amp fuse in cavity 1 of the PDC
- Check the 20 amp fuse in cavity 19 of the fuse block
- Check the grounding point for the door lock switch

SCHEMATICS AND DIAGRAMS

WIRING DIAGRAM INDEX

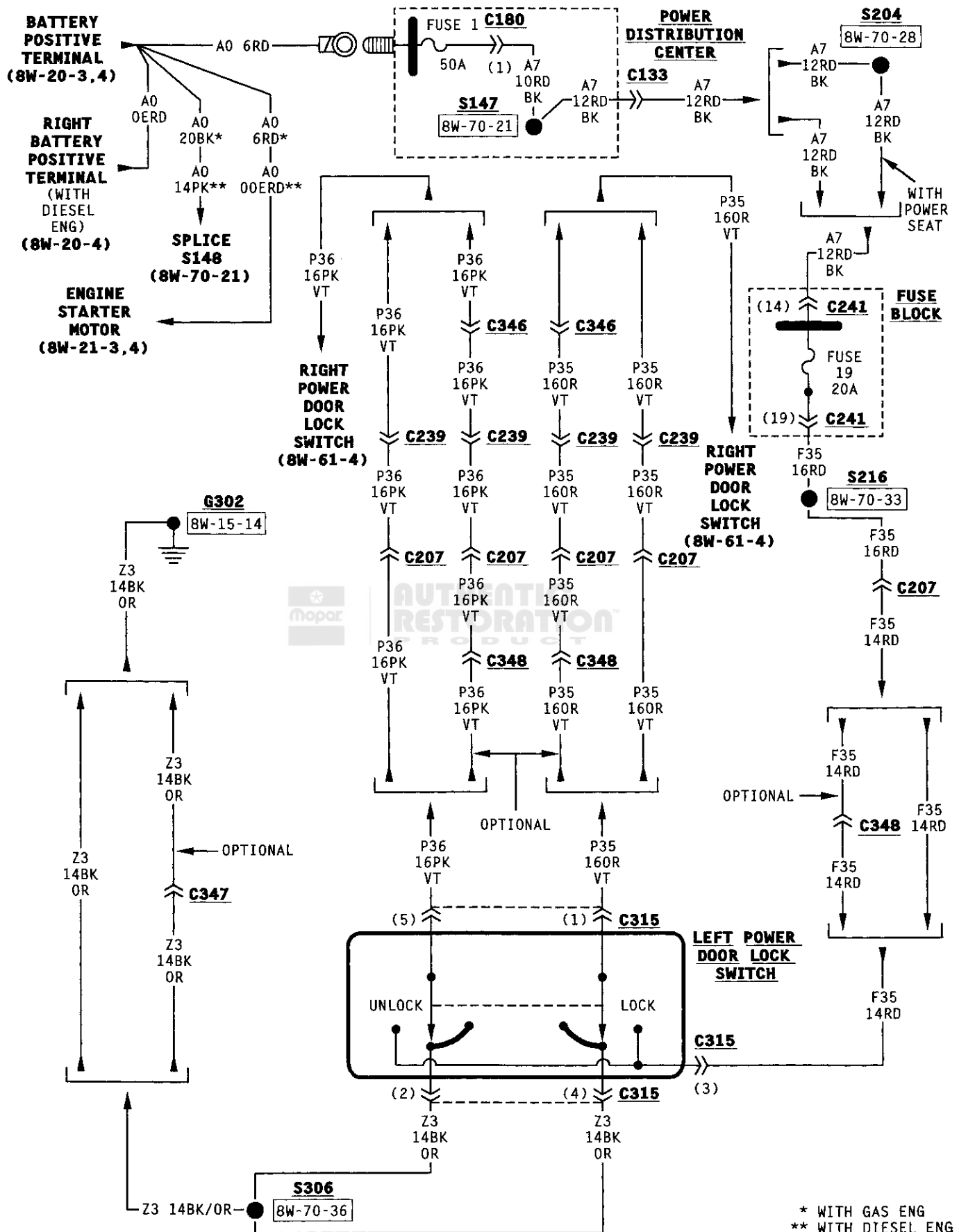
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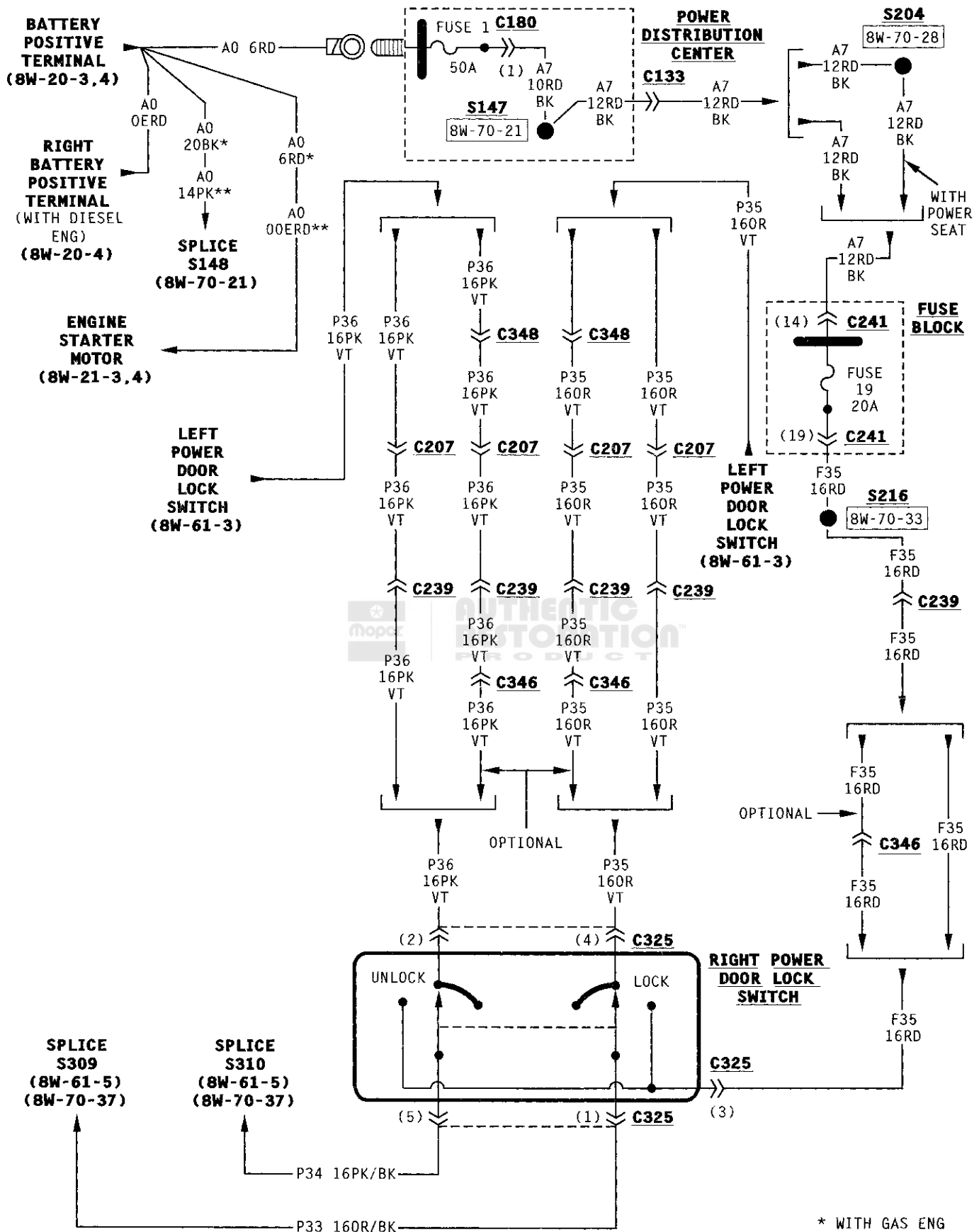
DIAGRAM INDEX

Component	Page	Component	Page
Fuse 1 (PDC)	8W-61-3, 4	Left Power Door Lock Switch	8W-61-3
Fuse 19	8W-61-3, 4	Right Power Door Lock Motor	8W-61-5
Left Power Door Lock Motor	8W-61-5	Right Power Door Lock Switch	8W-61-4



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* WITH GAS ENG
** WITH DIESEL ENG



8W-62 POWER MIRRORS

DESCRIPTION AND OPERATION

POWER MIRRORS

The power mirrors use a single switch located in the left door trim panel. The feed for the system is supplied on circuit M1 from the 15 amp Ignition-Off Draw (IOD) fuse located in the fuse block cavity 17. This fuse also supplies power for the radio, interior lamps and other components. Grounding for the power mirrors is provided through the Z3 circuit.

SWITCH AND MIRROR OPERATION

The power mirror switch has a right and a left position. Moving the switch to either of these positions changes the voltage path internal to the switch (changes polarity at the motors).

When the switch is moved to the LEFT position and mirror movement UP is selected, voltage is supplied through the P75 circuit and the ground path is through circuit P73. When the DOWN movement is selected, the power and ground are reversed.

If a LEFT door mirror movement LEFT is selected, voltage is supplied through the P71 circuit and the ground is passed through circuit P73. When the left door mirror RIGHT movement is selected, the power and ground are reversed.

When the switch is moved to the RIGHT position and mirror movement UP is selected, voltage is supplied through the P72 circuit and the ground path is

through circuit P70. When the DOWN movement is selected, the power and ground are reversed.

If a RIGHT door mirror movement LEFT is selected, voltage is supplied through the P74 circuit and the ground is passed through circuit P70. When the left door mirror RIGHT movement is selected, the power and ground are reversed.

HELPFUL INFORMATION

- Check the IOD fuse located in the fuse block
- Circuit M1 supplies voltage to the radio, cargo lamp, dome lamp, time delay relay, glove box lamp, and vanity lamps. Check for proper operation of these items
- Move the switch to its various positions and listen for the motors to click or try to move. Some movement or clicking indicates a poor connection or a mechanical problem with a mirror
- Check the ground for the power mirror switch

SCHEMATICS AND DIAGRAMS

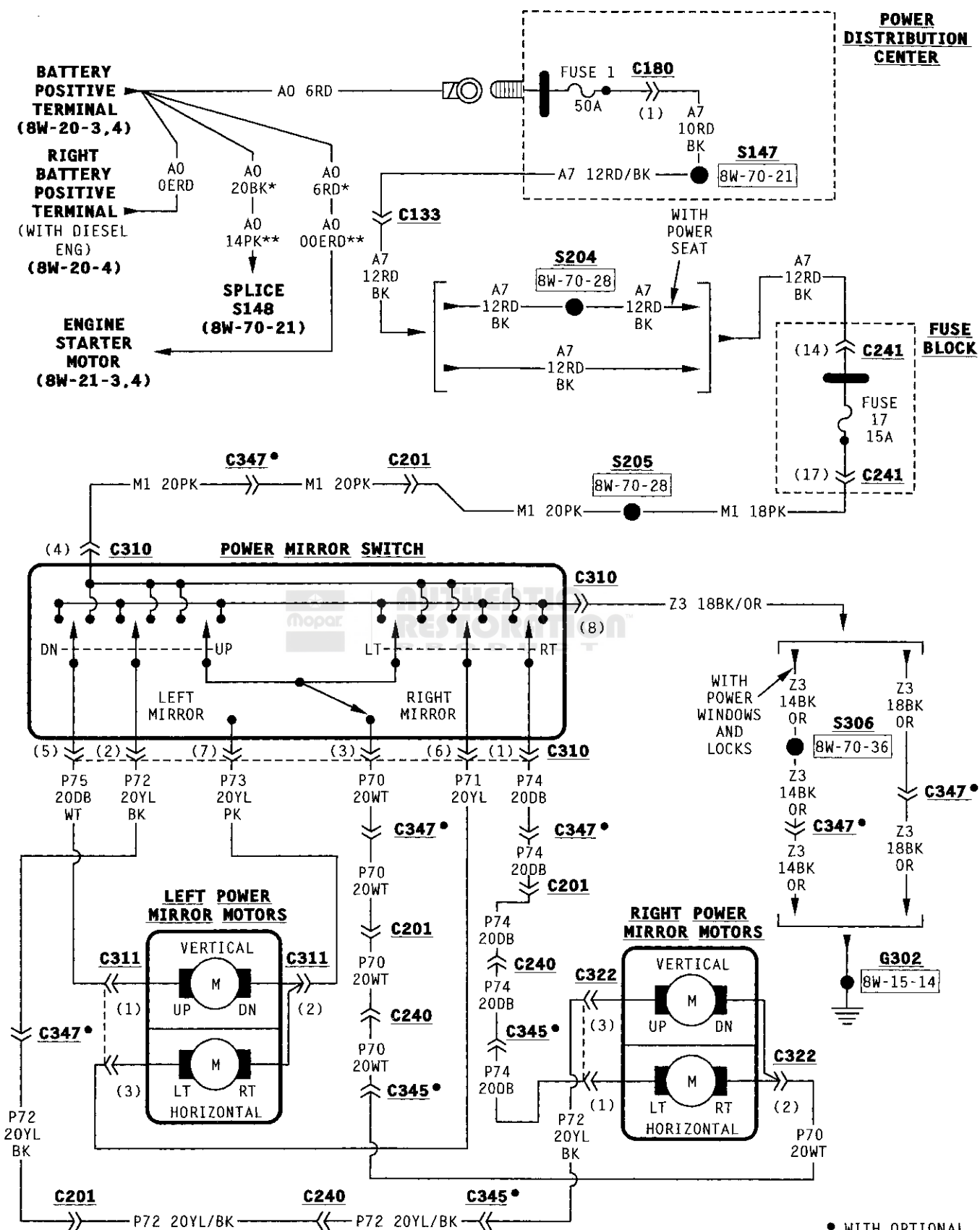
WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

DIAGRAM INDEX

Component	Page	Component	Page
Fuse 1 (PDC)	8W-62-3	Power Mirror Switch	8W-62-3
Fuse 17	8W-62-3	Right Power Mirror Motors	8W-62-3
Left Power Mirror Motors	8W-62-3		





• WITH OPTIONAL
 * WITH GAS ENG
 ** WITH DIESEL ENG

8W-63 POWER SEAT

DESCRIPTION AND OPERATION

INTRODUCTION

The power seat system is protected by a 30 amp circuit breaker located in cavity CB2 of the fuse block. This circuit breaker is HOT at all times. Circuit A7 is the power supply for the circuit breaker.

The A7 circuit originates in the Power Distribution Center (PDC) and is protected by a 50 amp fuse located in cavity 1.

Circuit F37 is the feed for the switches and the seat motors from the circuit breaker. A bus bar internal to the switches feeds all the contacts. Grounding for the seats is provided on circuit Z3.

POWER SEAT

When the operator selects the FRONT VERTICAL UP function, power is passed on the F37 circuit through the CLOSED contacts in the switch to the P19 circuit. The P19 circuit connects to the motor. Ground is provided on the P21 circuit back to the switch. A ground bus bar internal to the switch then connects it to ground on the Z3 circuit.

For FRONT VERTICAL DOWN function the circuits are reversed. P21 is the feed, and P19 is the ground.

When the operator selects the HORIZONTAL FORWARD function, power is passed on the F37 circuit

through the CLOSED contacts in the switch to the P15 circuit. The P15 circuit connects to the motor. Ground is provided on the P17 circuit back to the switch. A ground bus bar internal to the switch then connects to the Z3 circuit.

For HORIZONTAL REARWARD function the circuits are reversed. P17 is the feed, and P15 is the ground.

When the operator selects the REAR VERTICAL UP function, power is passed on the F37 circuit through the CLOSED contacts in the switch to the P11 circuit. The P11 circuit connects to the motor. Ground is provided on the P13 circuit back to the switch. A ground bus bar internal to the switch then connects to the Z3 circuit.

For VERTICAL DOWN function the circuits are reversed. P13 is the feed, and P11 is the ground.

SCHEMATICS AND DIAGRAMS

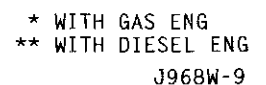
WIRING DIAGRAM INDEX

The following index covers all components found in this section of the wiring diagrams. If the component you are looking for is not found here, refer to section 8W-02 for a complete list of all components shown in the wiring diagrams.

DIAGRAM INDEX

Component	Page	Component	Page
Circuit Breaker 2	8W-63-3	Fuse 1 (PDC)	8W-63-3
Forward/Backward Seat Motor	8W-63-3	Power Seat Switch	8W-63-3
Front Up/Down Seat Motor	8W-63-3	Rear/Vertical Seat Motor	8W-63-3





8W-70 SPLICE INFORMATION

DESCRIPTION AND OPERATION

INTRODUCTION

This section identifies all splices in the wiring diagrams. It also shows the splices in their entirety. All

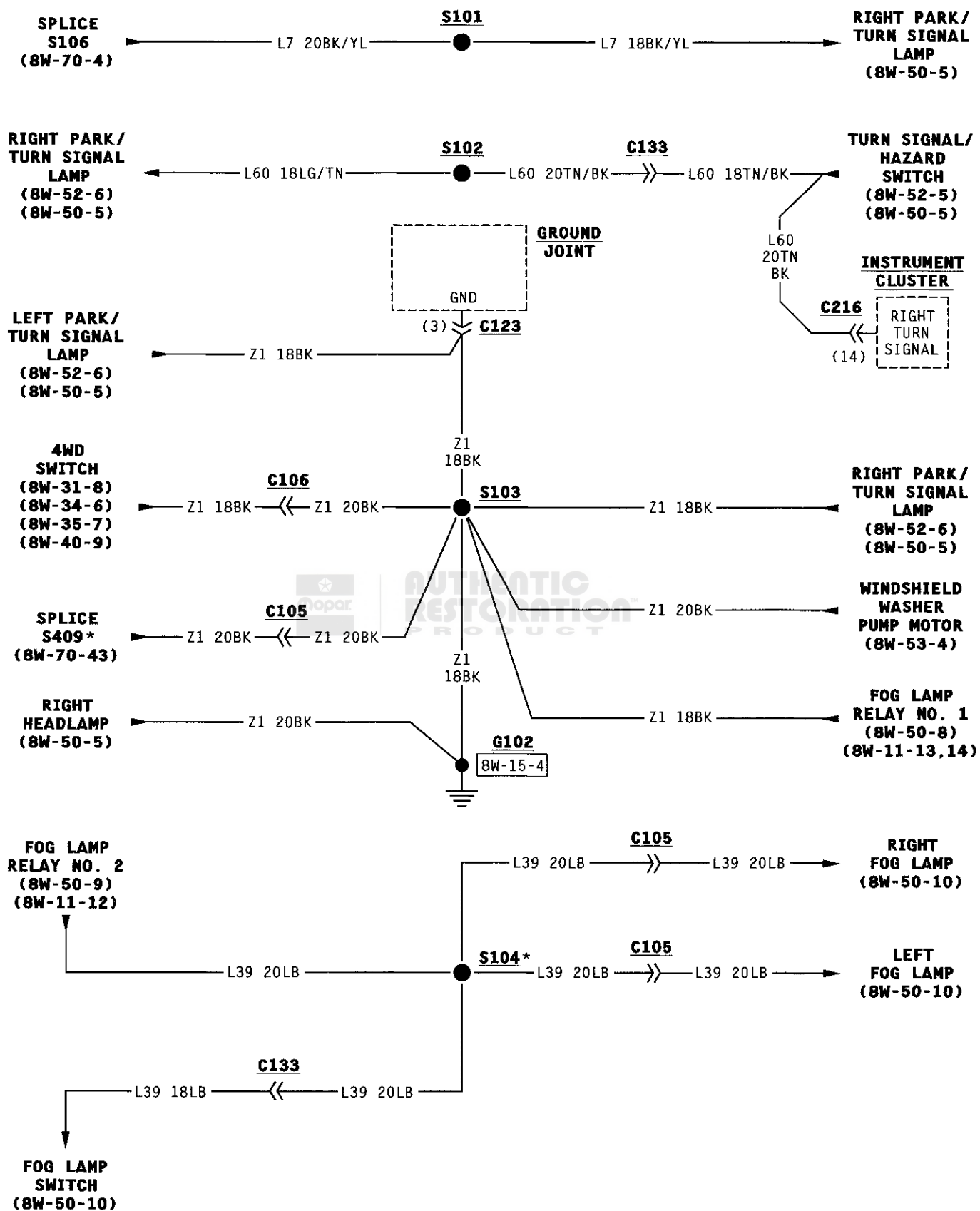
circuits that are part of the splices are shown, and the systems they affect are referenced. For viewing the location of each splice in the vehicle, refer to Section 8W-95.



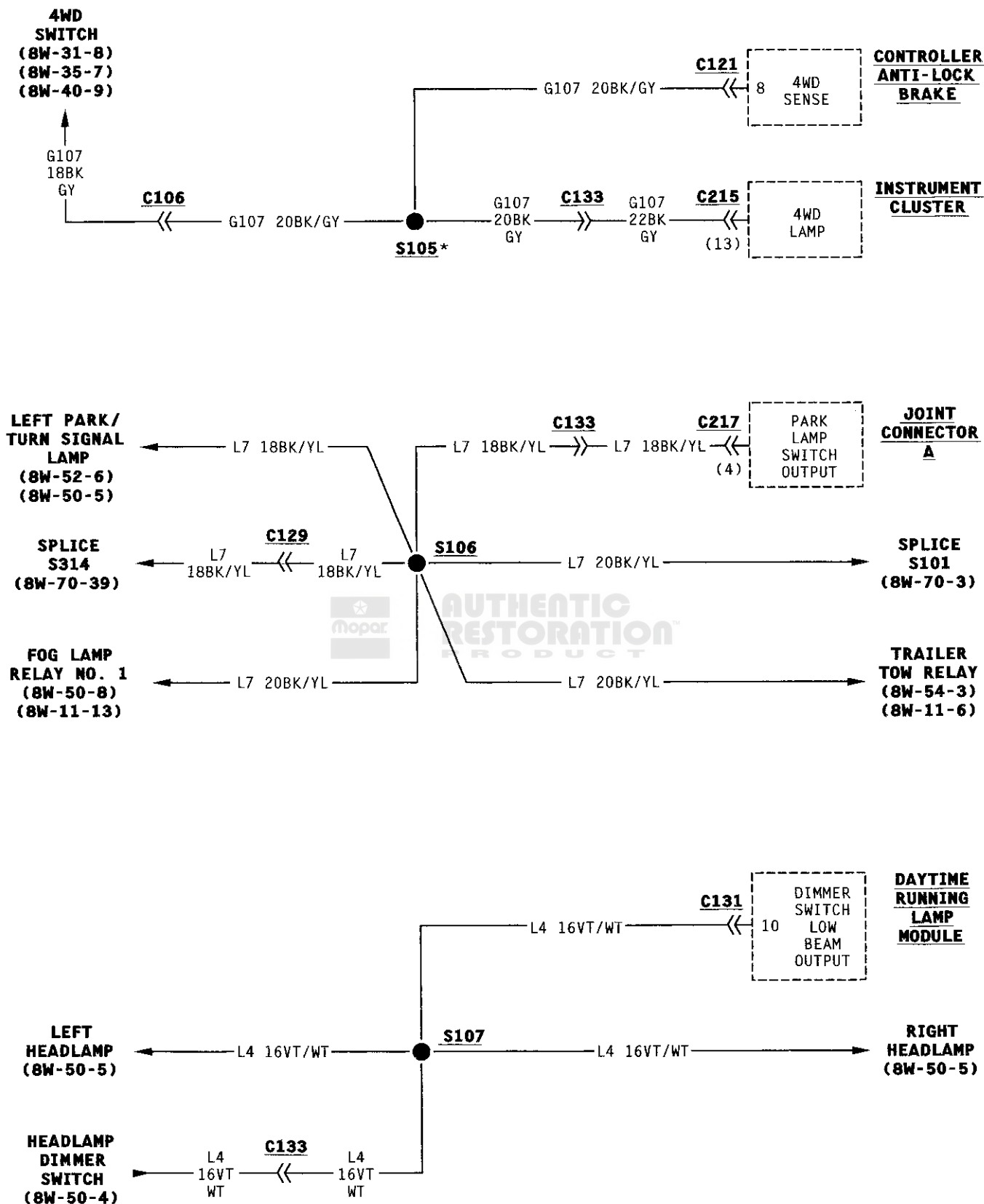
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DIAGRAM INDEX

Component	Page	Component	Page
S101	8W-70-3	S156	8W-70-24
S102	8W-70-3	S157	8W-70-25
S103	8W-70-3	S158	8W-70-25
S104	8W-70-3	S159	8W-70-26
S105	8W-70-4	S160	8W-70-26
S106	8W-70-4	S201	8W-70-26
S107	8W-70-4	S202	8W-70-27
S108	8W-70-5	S203	8W-70-27
S109	8W-70-5	S204	8W-70-28
S110	8W-70-6	S205	8W-70-28
S111	8W-70-6	S206	8W-70-29
S112	8W-70-7	S207	8W-70-29
S113	8W-70-7	S208	8W-70-30
S114	8W-70-7	S209	8W-70-30
S115	8W-70-8	S210	8W-70-31
S116	8W-70-8	S212	8W-70-31
S117	8W-70-9	S213	8W-70-32
S118	8W-70-9	S214	8W-70-32
S119	8W-70-9	S215	8W-70-33
S120	8W-70-10	S216	8W-70-33
S121	8W-70-10	S217	8W-70-34
S122	8W-70-11	S218	8W-70-34
S123	8W-70-11	S301	8W-70-34
S124	8W-70-12	S302	8W-70-34
S129	8W-70-12	S303	8W-70-35
S130	8W-70-12	S304	8W-70-35
S131	8W-70-13	S305	8W-70-35
S132	8W-70-13	S306	8W-70-36
S133	8W-70-14	S307	8W-70-36
S134	8W-70-14	S308	8W-70-36
S135	8W-70-15	S309	8W-70-37
S136	8W-70-16	S310	8W-70-37
S137	8W-70-17	S311	8W-70-37
S138	8W-70-17	S312	8W-70-38
S139	8W-70-18	S313	8W-70-38
S140	8W-70-18	S314	8W-70-39
S141	8W-70-19	S315	8W-70-39
S142	8W-70-19	S316	8W-70-39
S143	8W-70-19	S317	8W-70-40
S144	8W-70-20	S318	8W-70-40
S145	8W-70-20	S319	8W-70-40
S146	8W-70-20	S320	8W-70-41
S147	8W-70-21	S401	8W-70-41
S148	8W-70-21	S402	8W-70-41
S149	8W-70-21	S403	8W-70-41
S150	8W-70-22	S404	8W-70-41
S151	8W-70-22	S405	8W-70-42
S152	8W-70-22	S406	8W-70-42
S153	8W-70-23	S407	8W-70-42
S154	8W-70-23	S408	8W-70-42
S155	8W-70-24	S409	8W-70-43

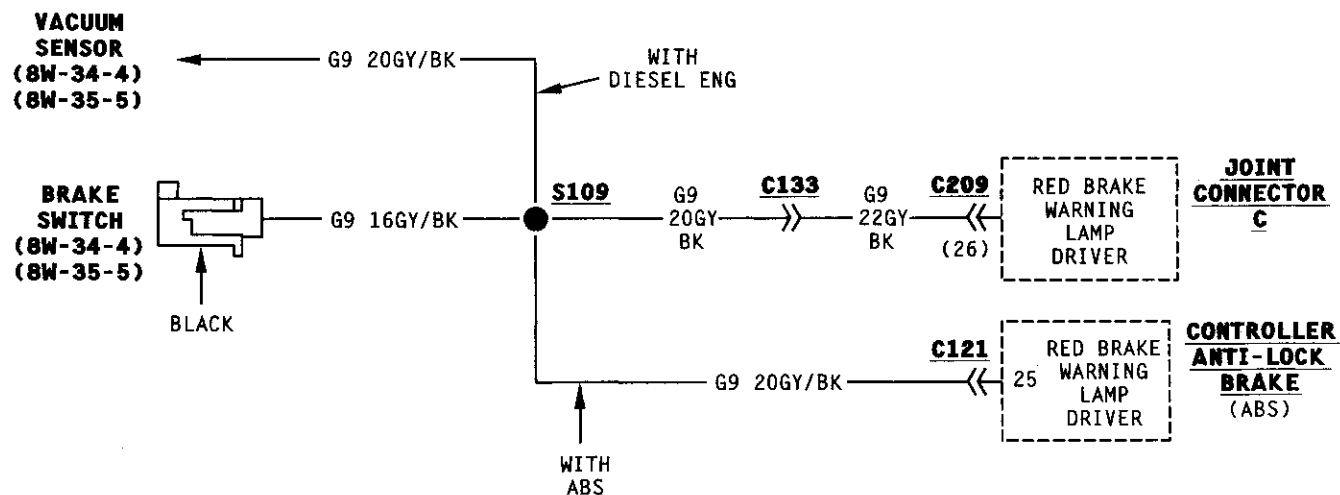
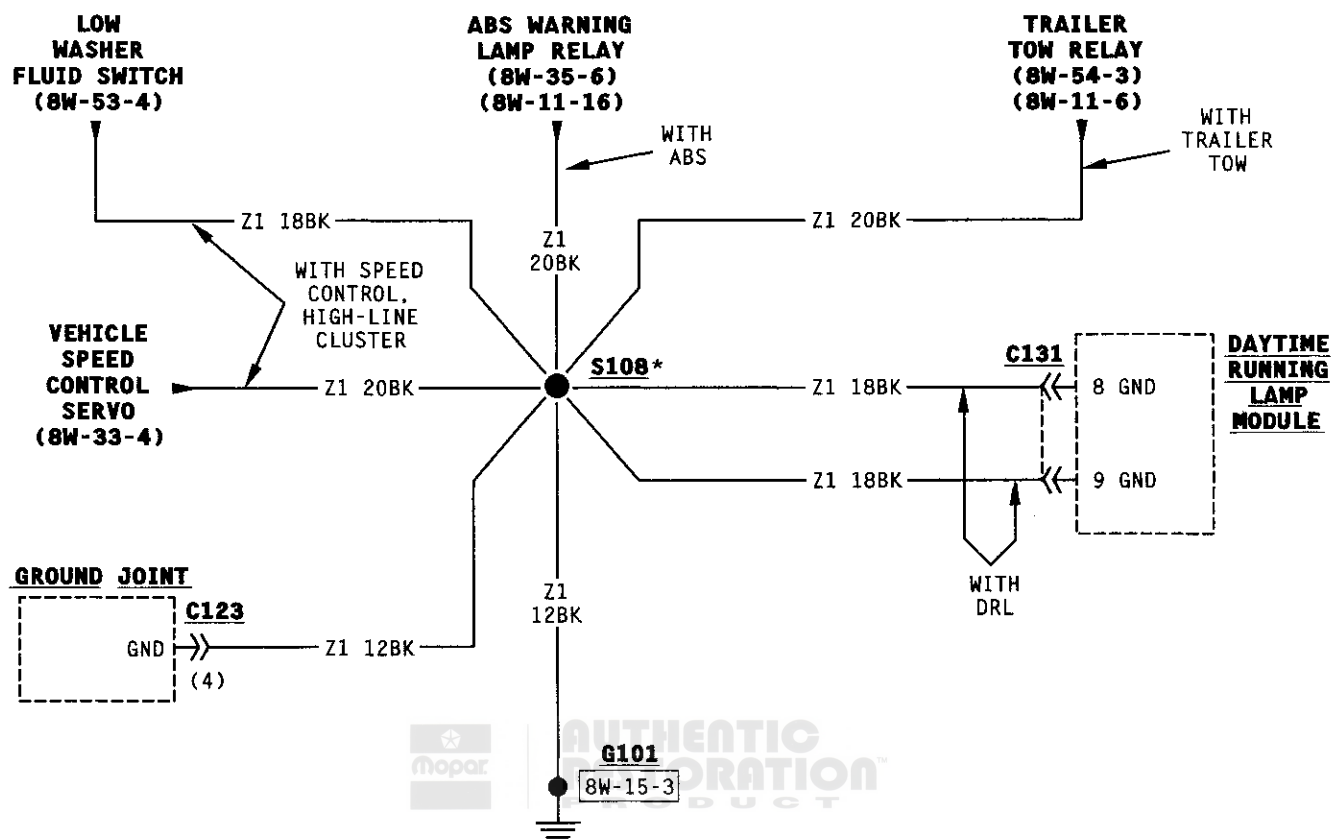


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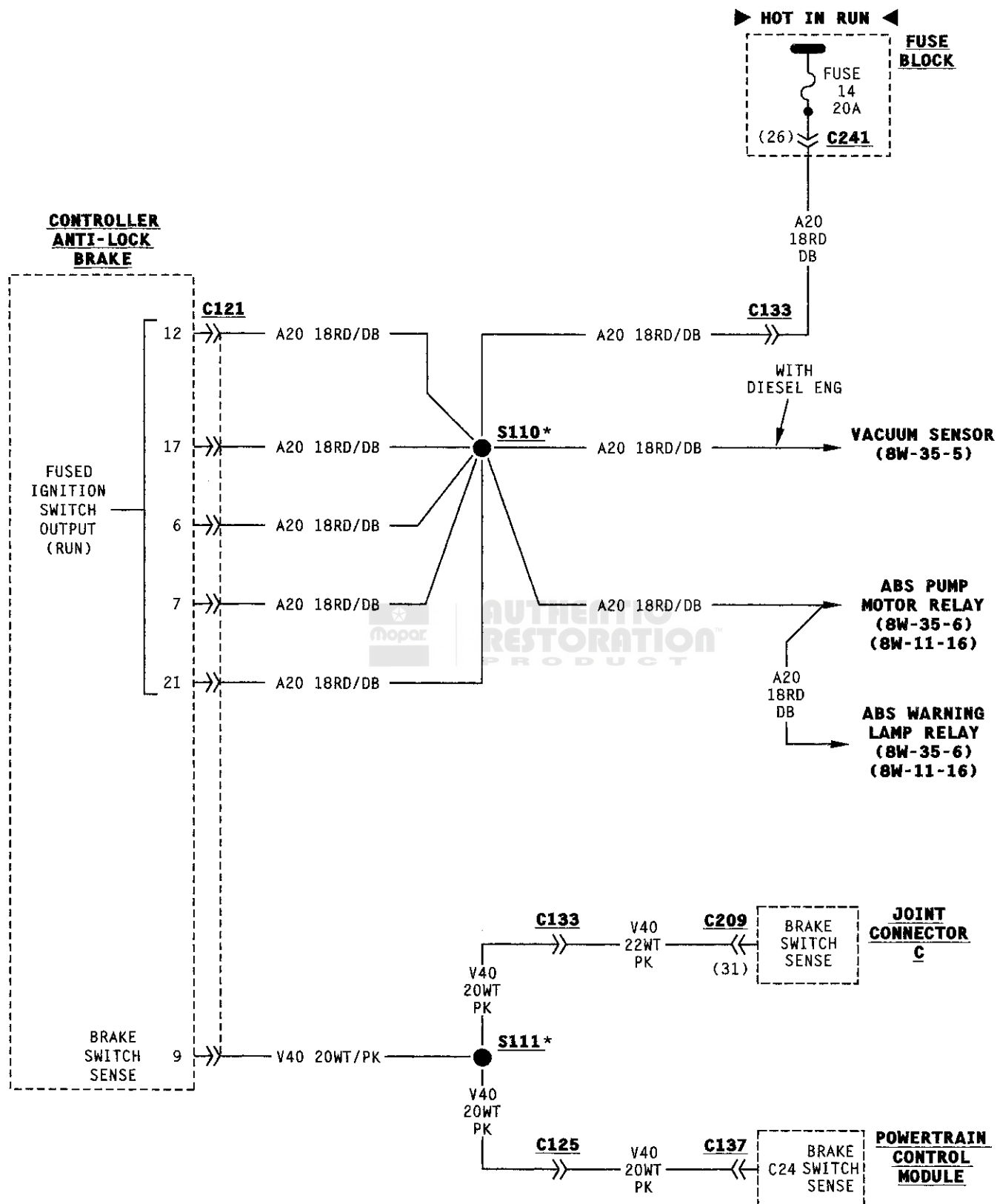


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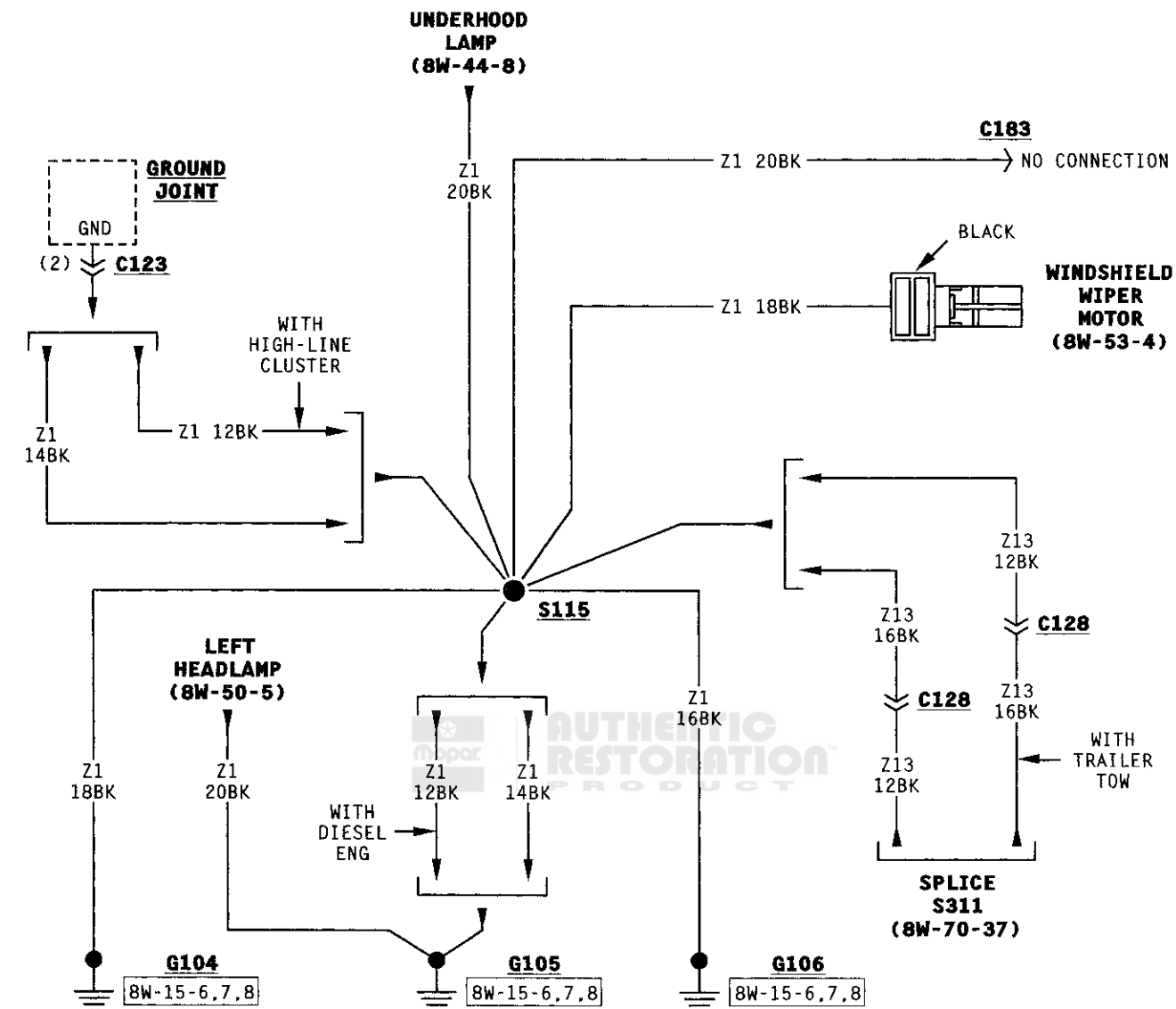


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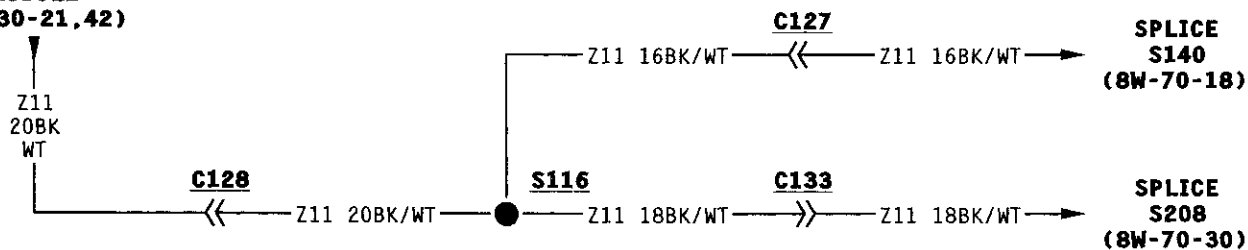


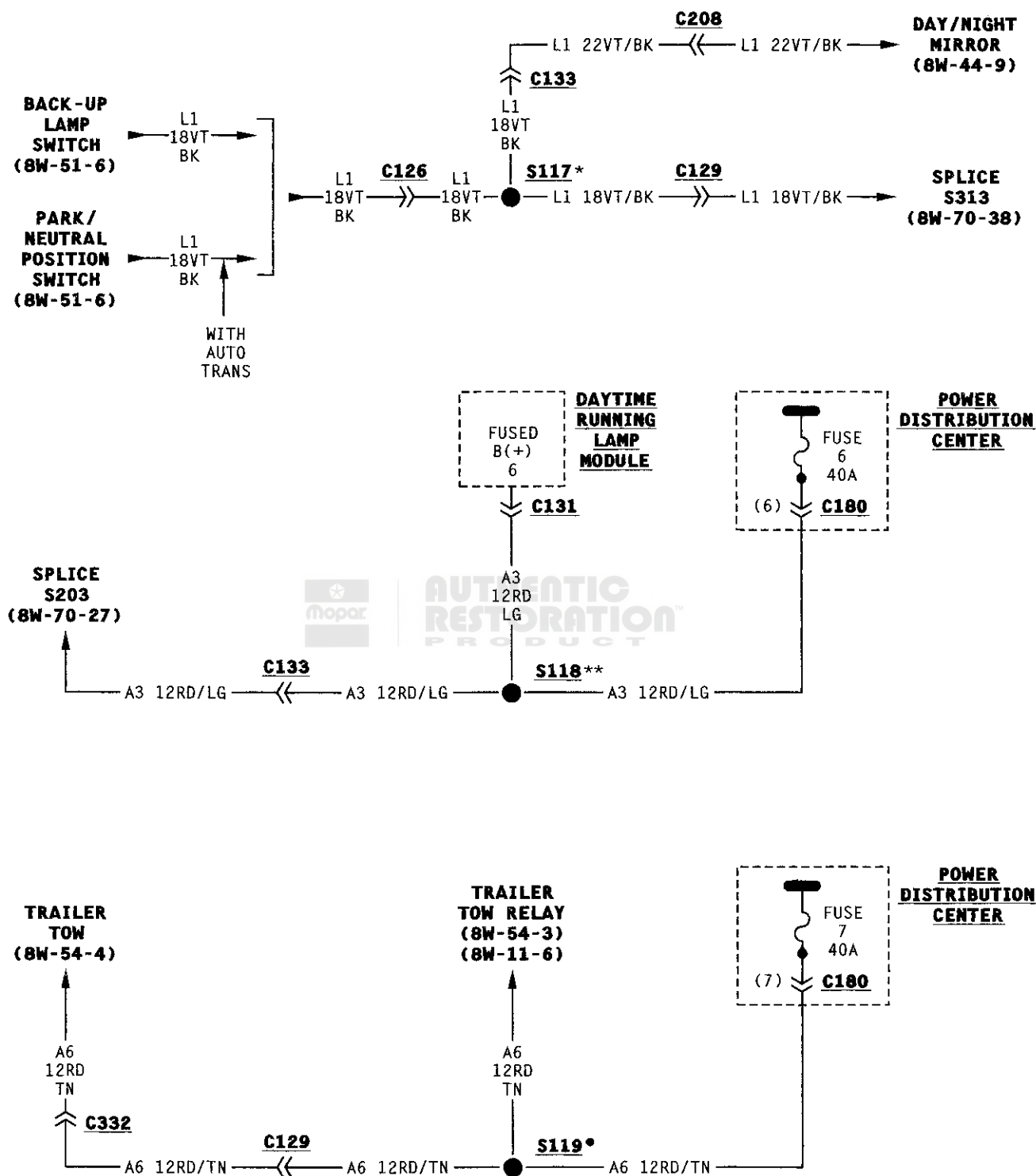
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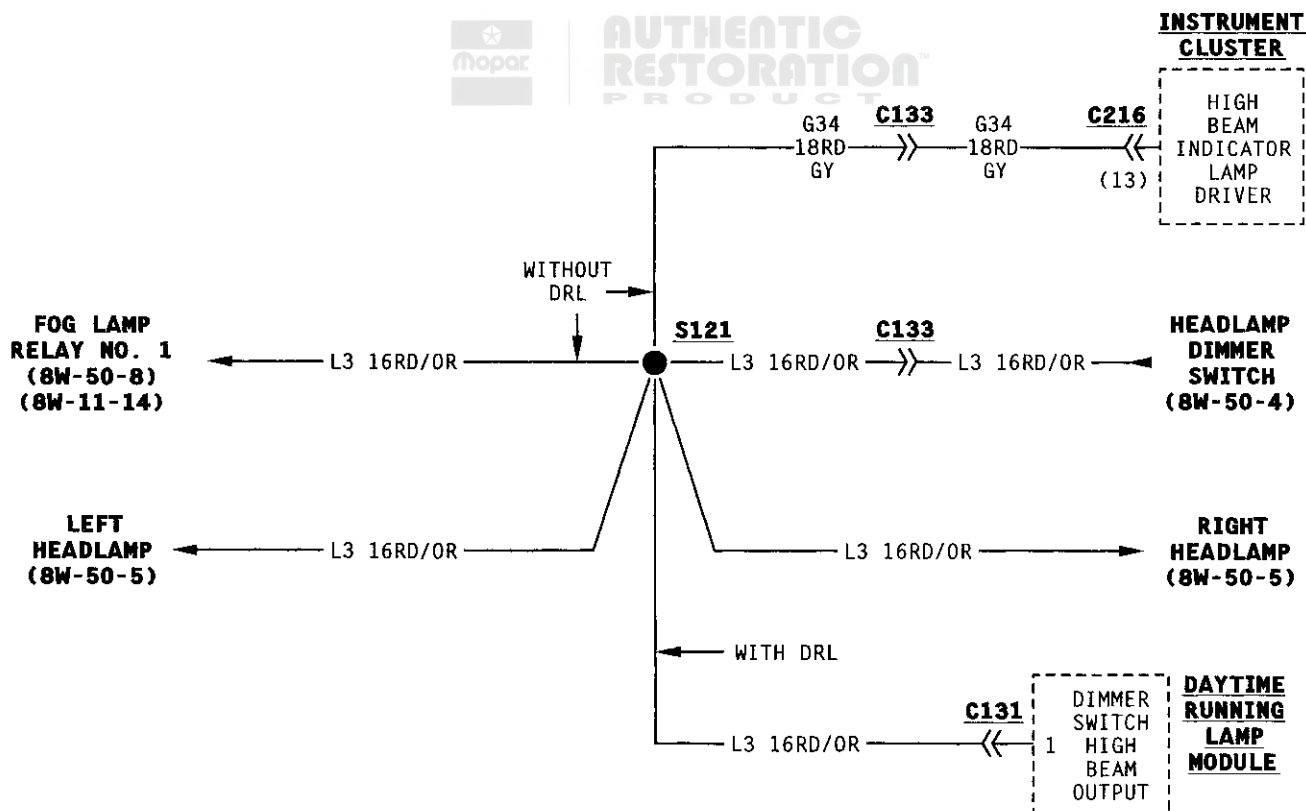
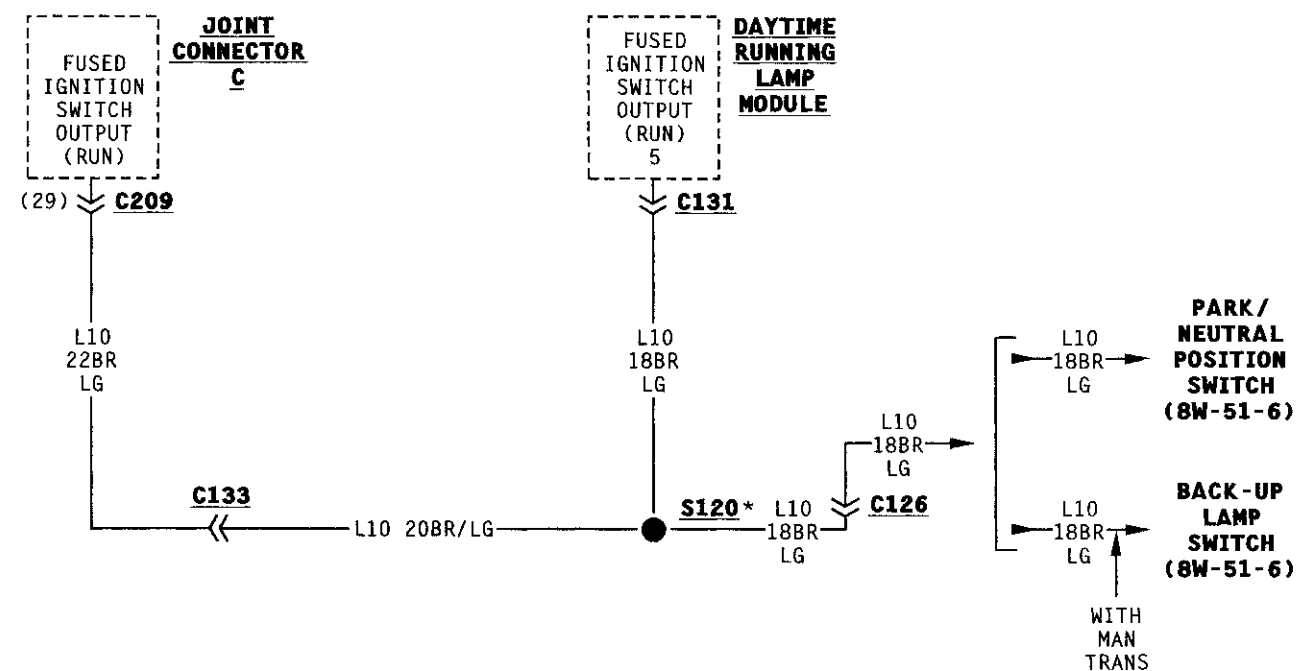


FUEL PUMP MODULE (8W-30-21,42)

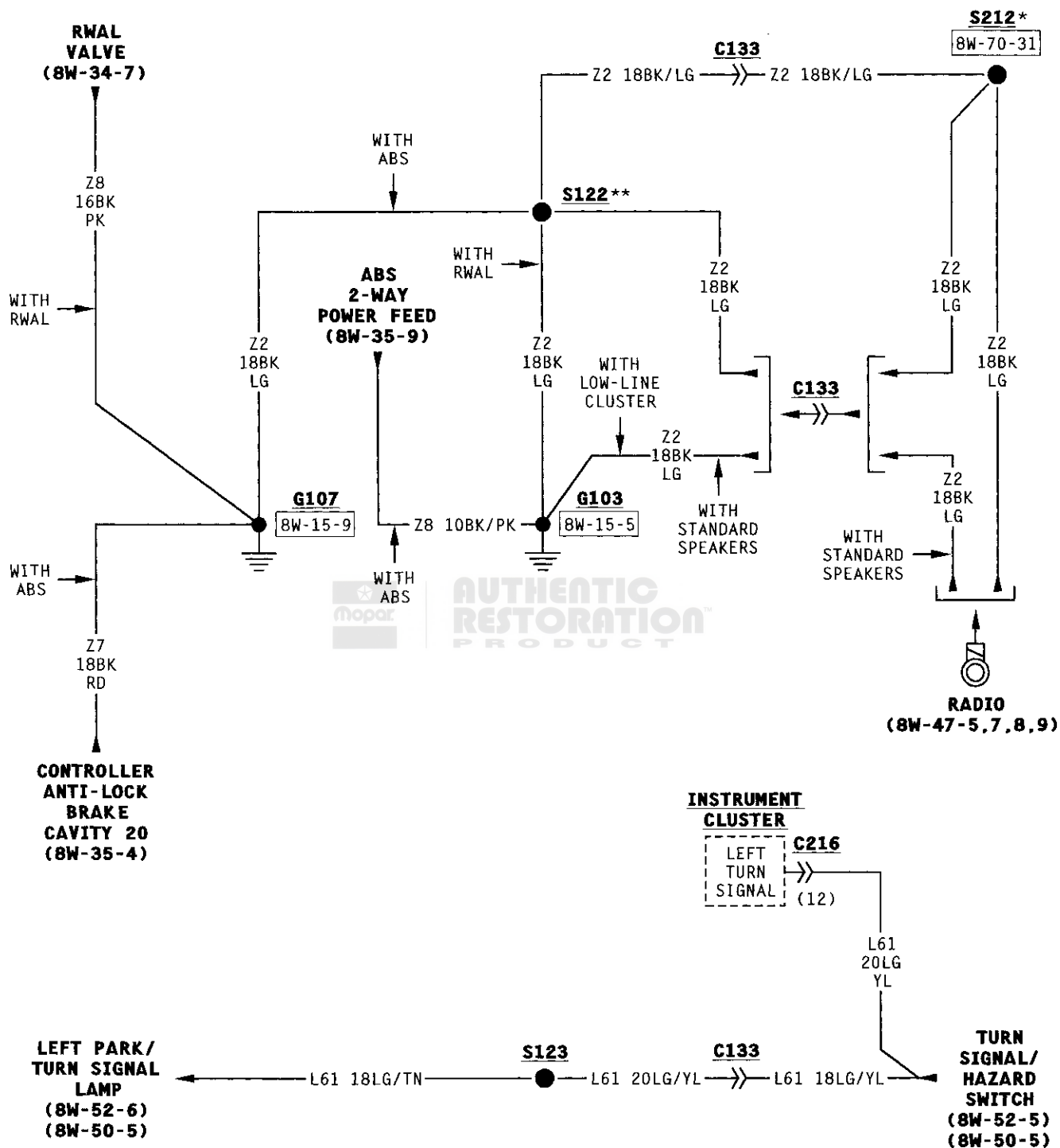




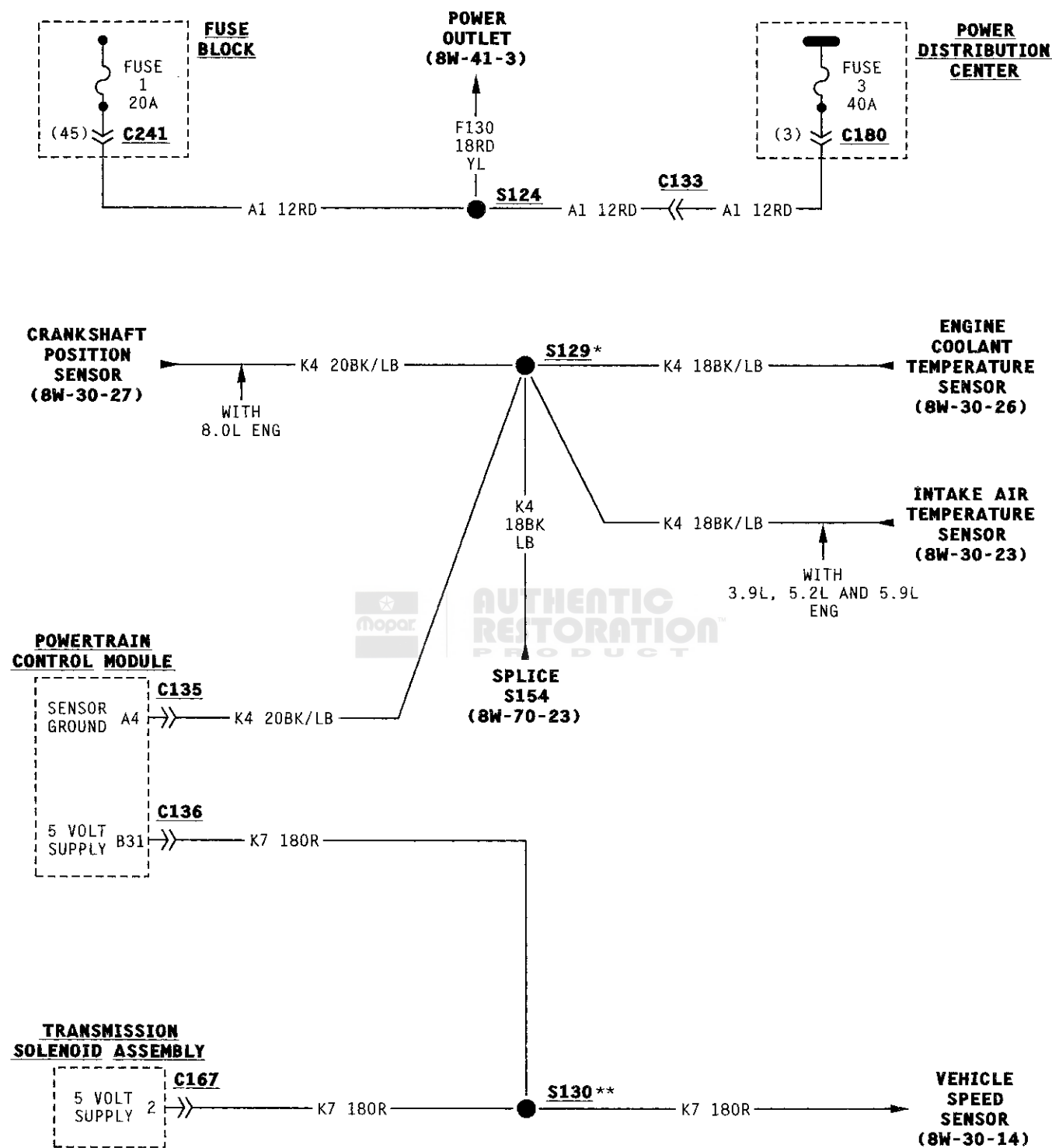
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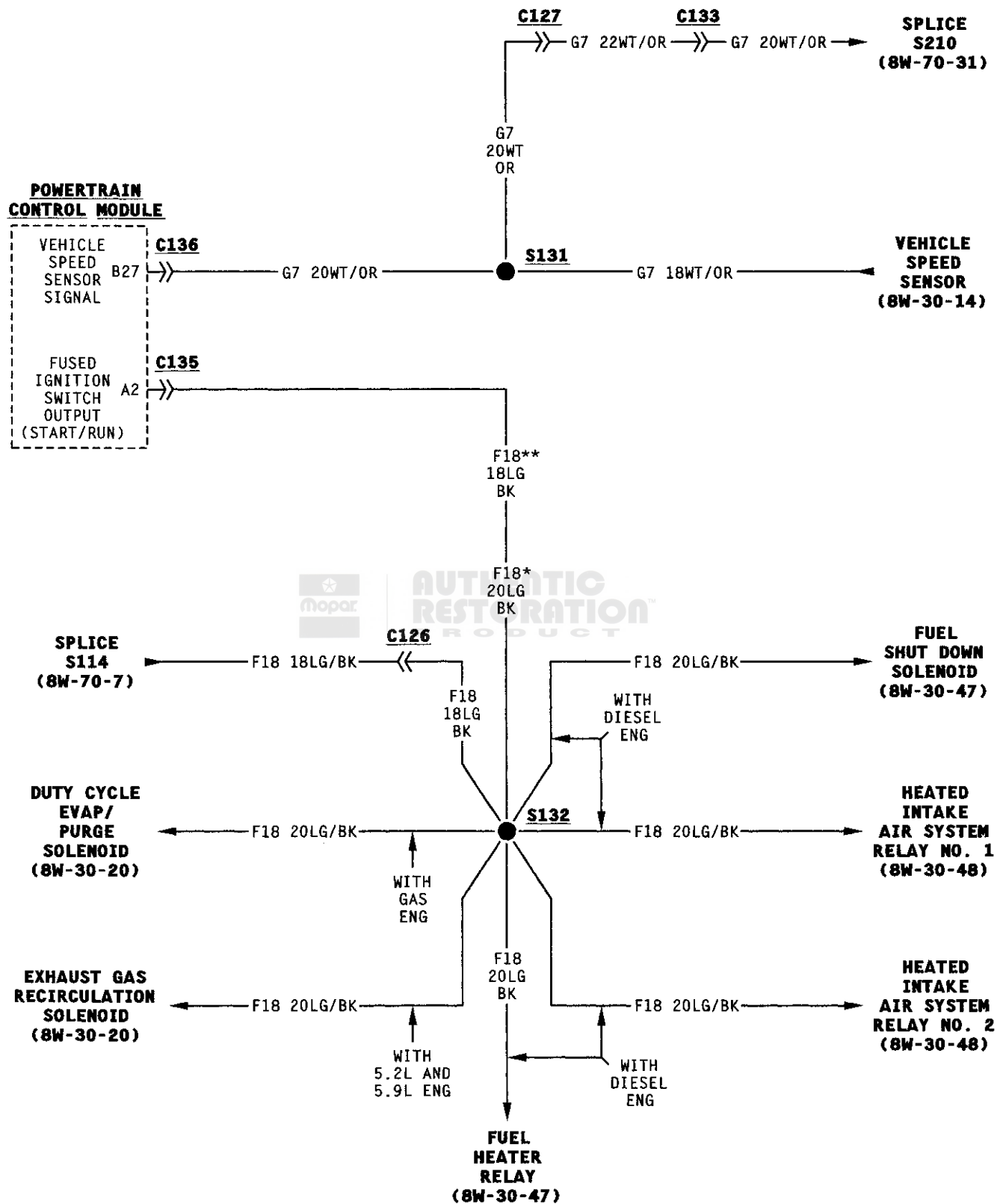
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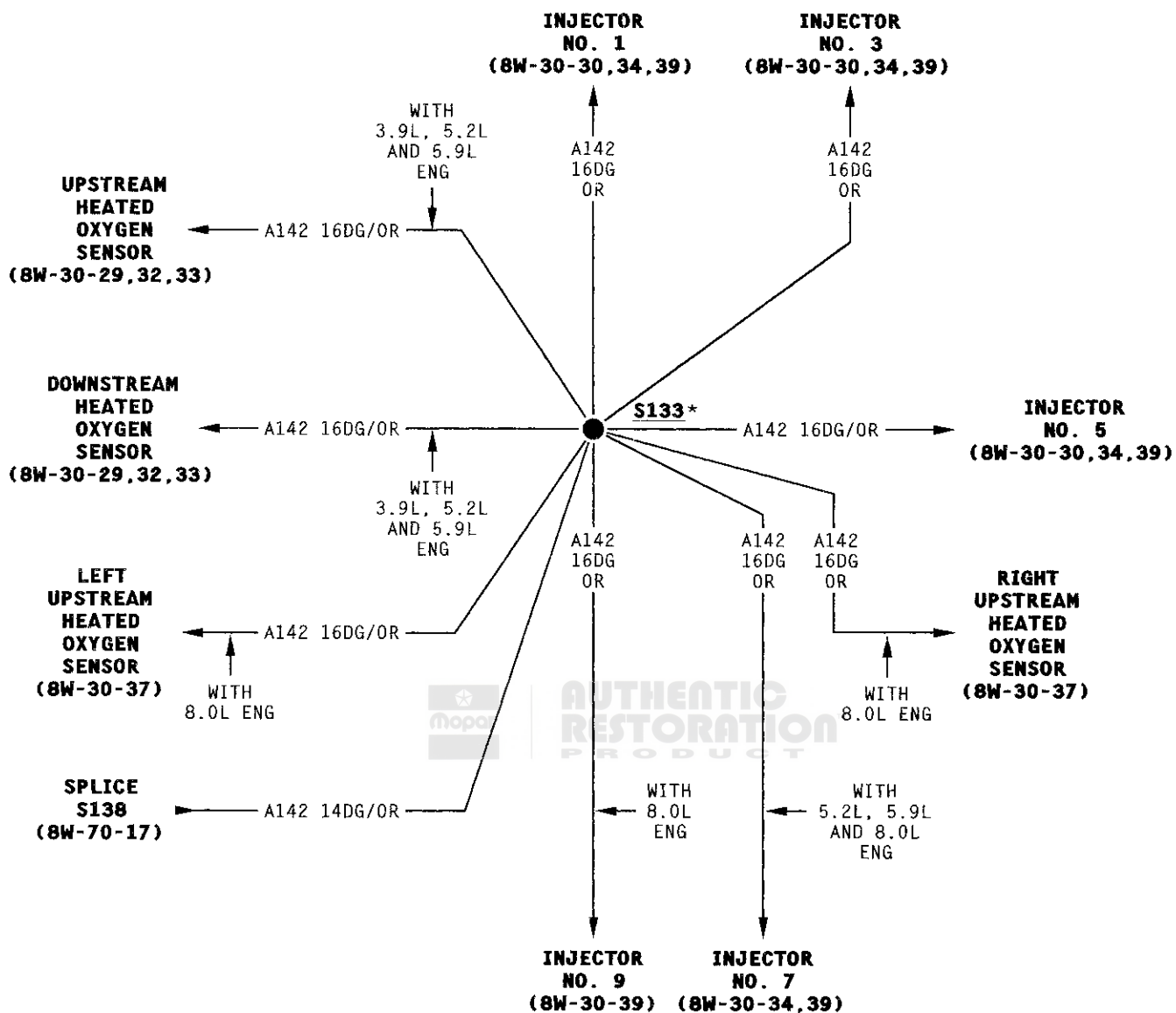
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 ** WITH MEDIUM-LINE AND HIGH-LINE CLUSTER



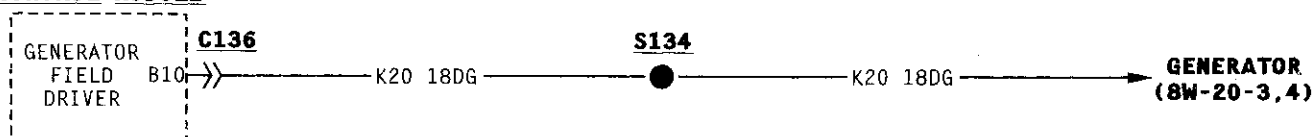
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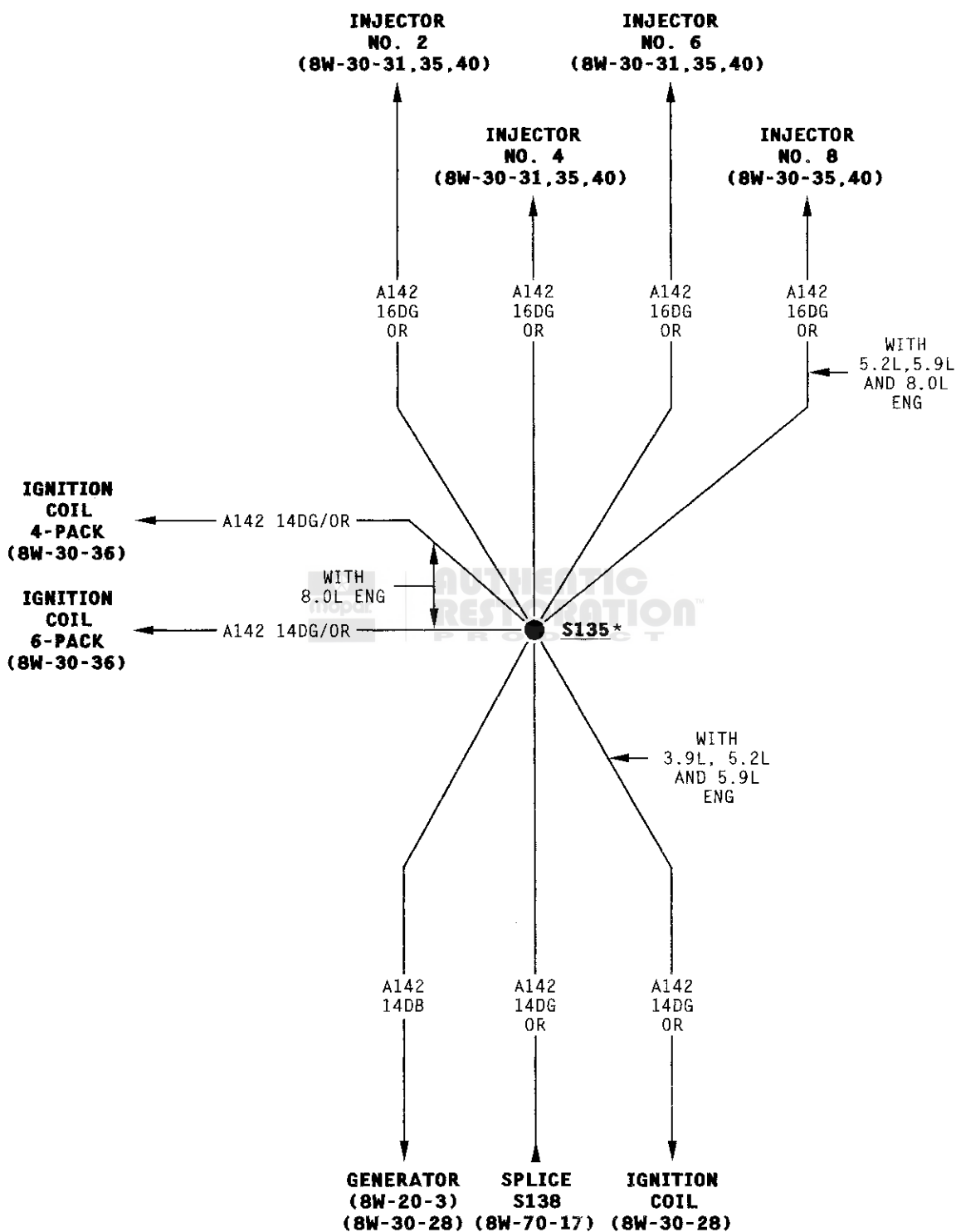
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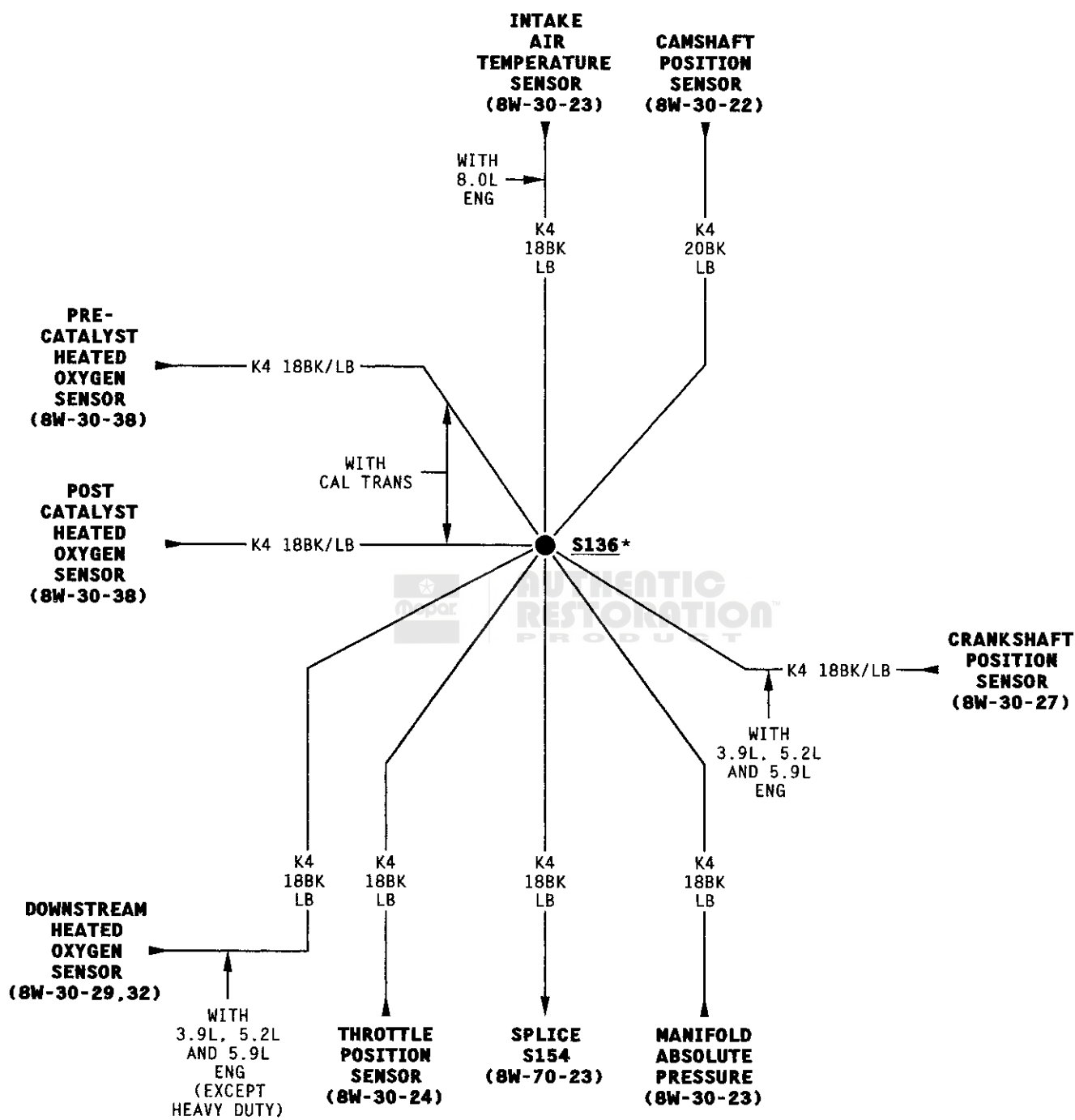
**POWERTRAIN
CONTROL MODULE**



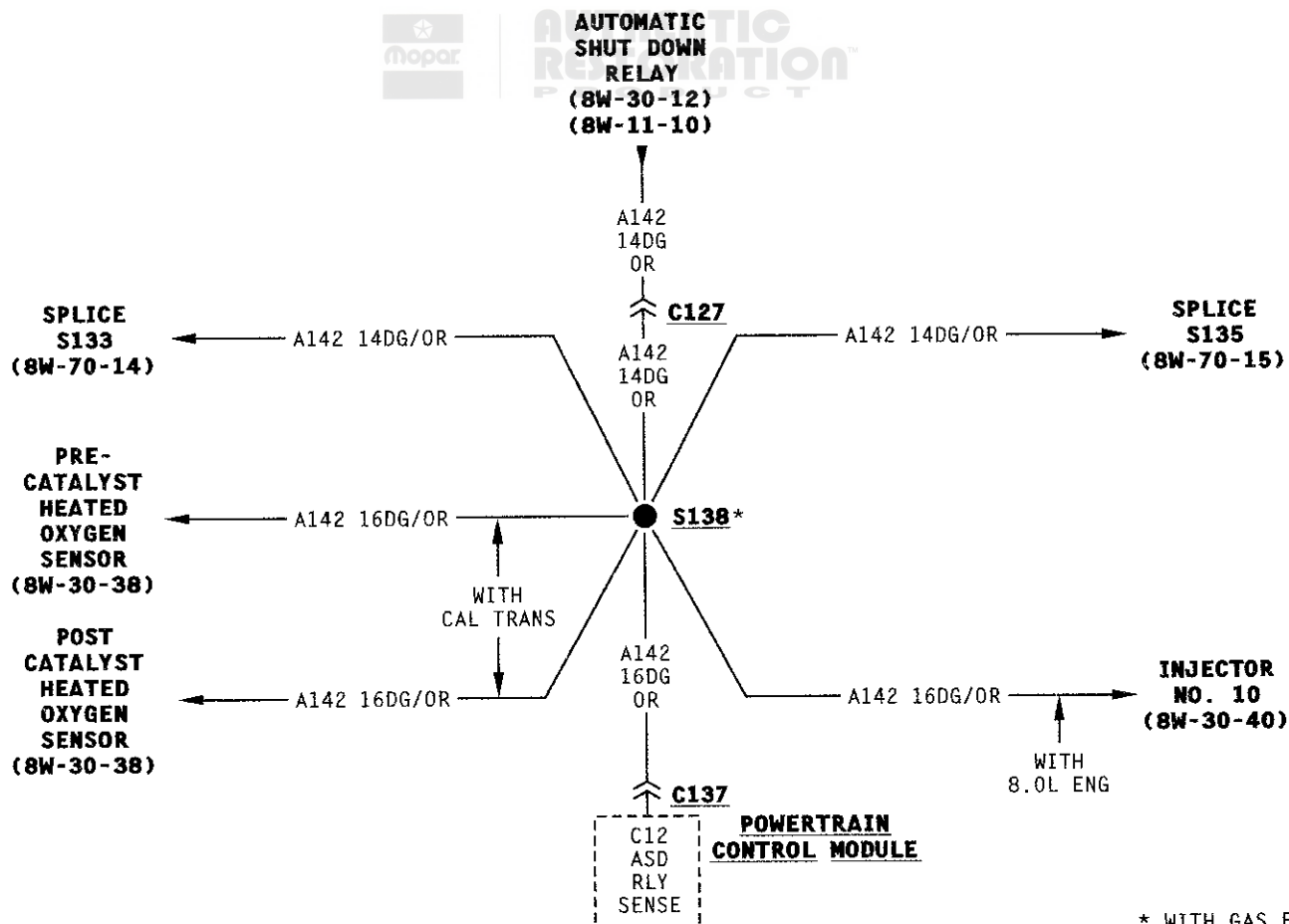
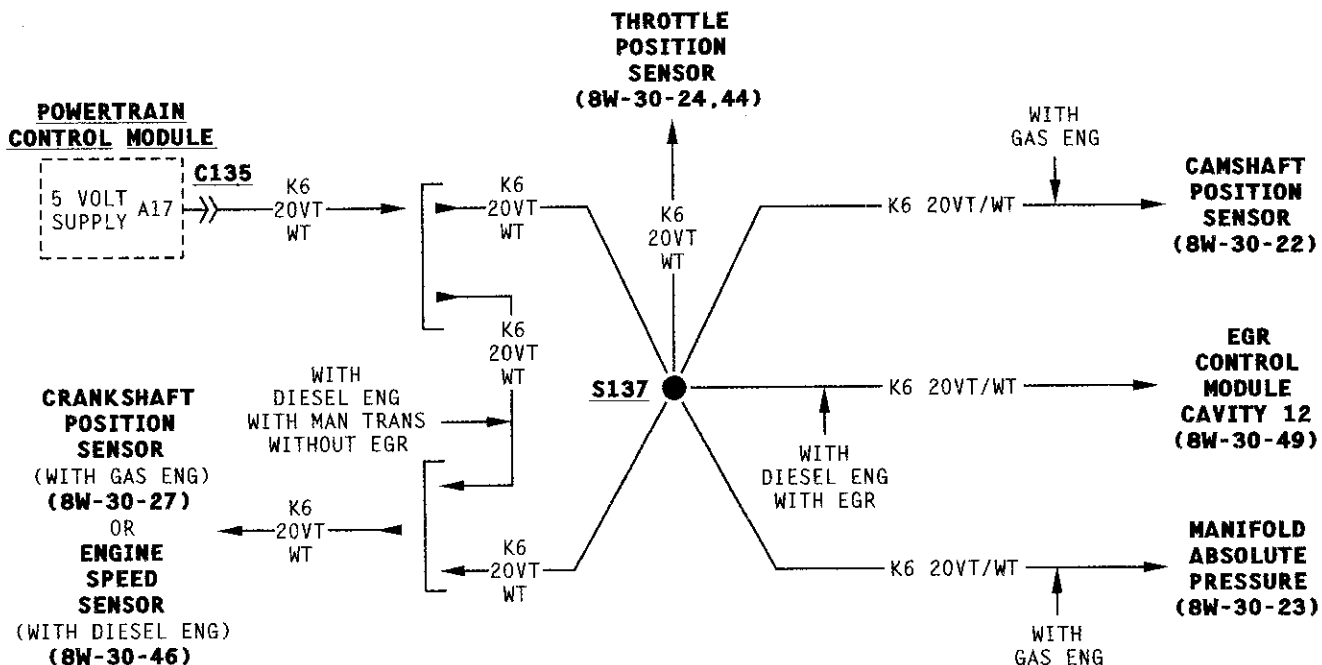
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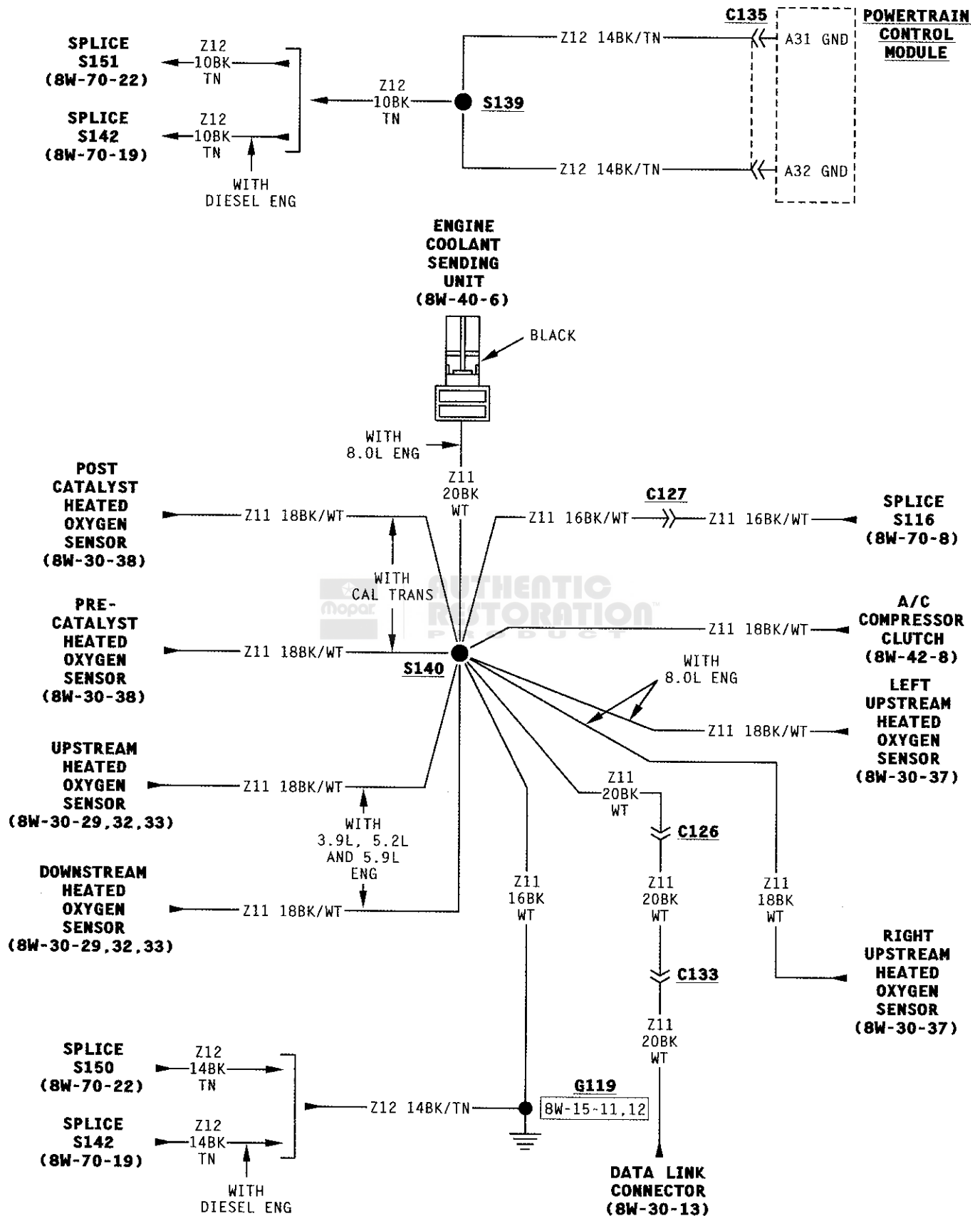
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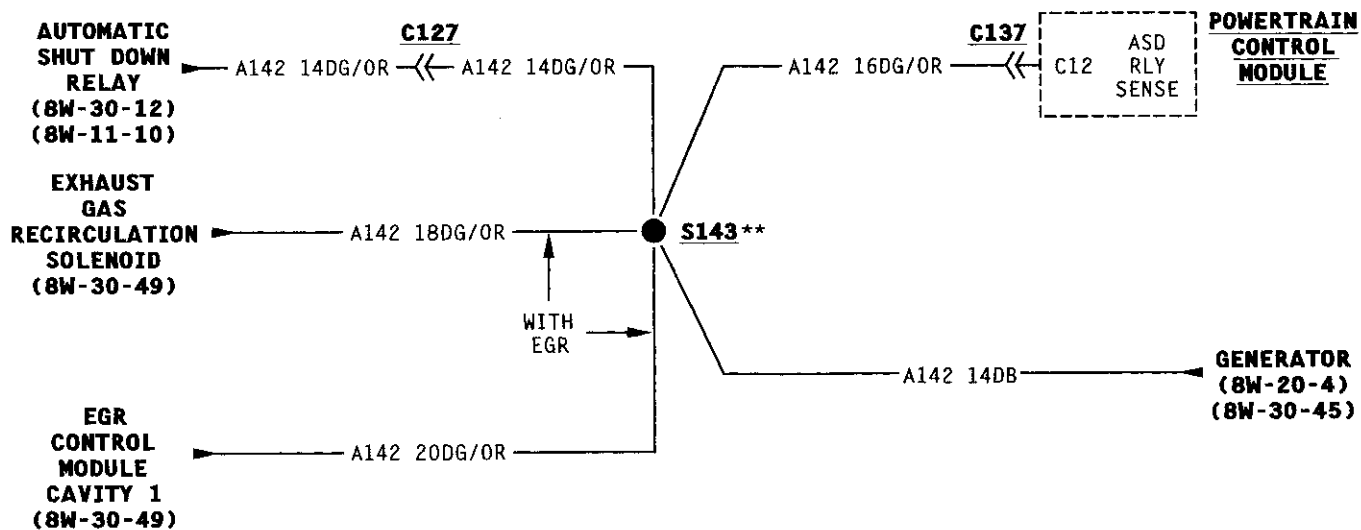
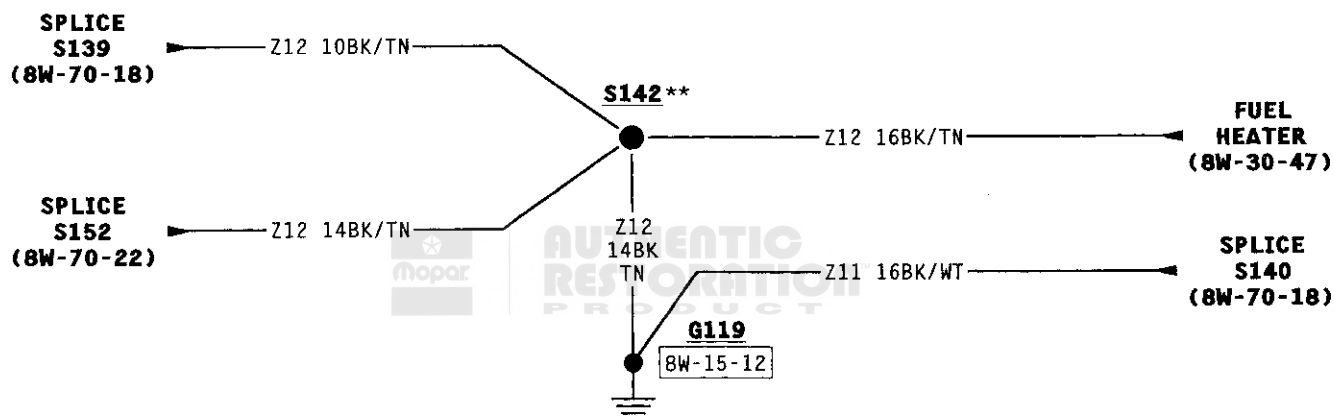
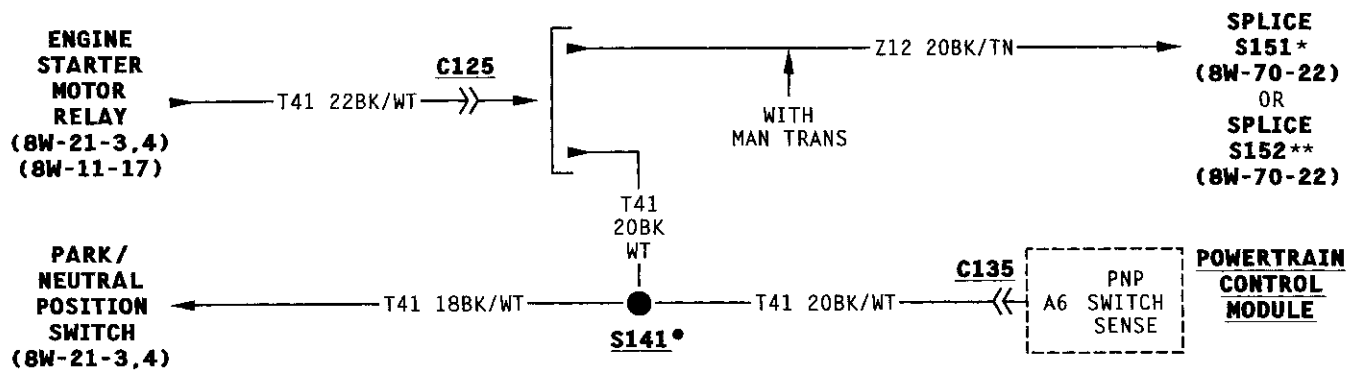


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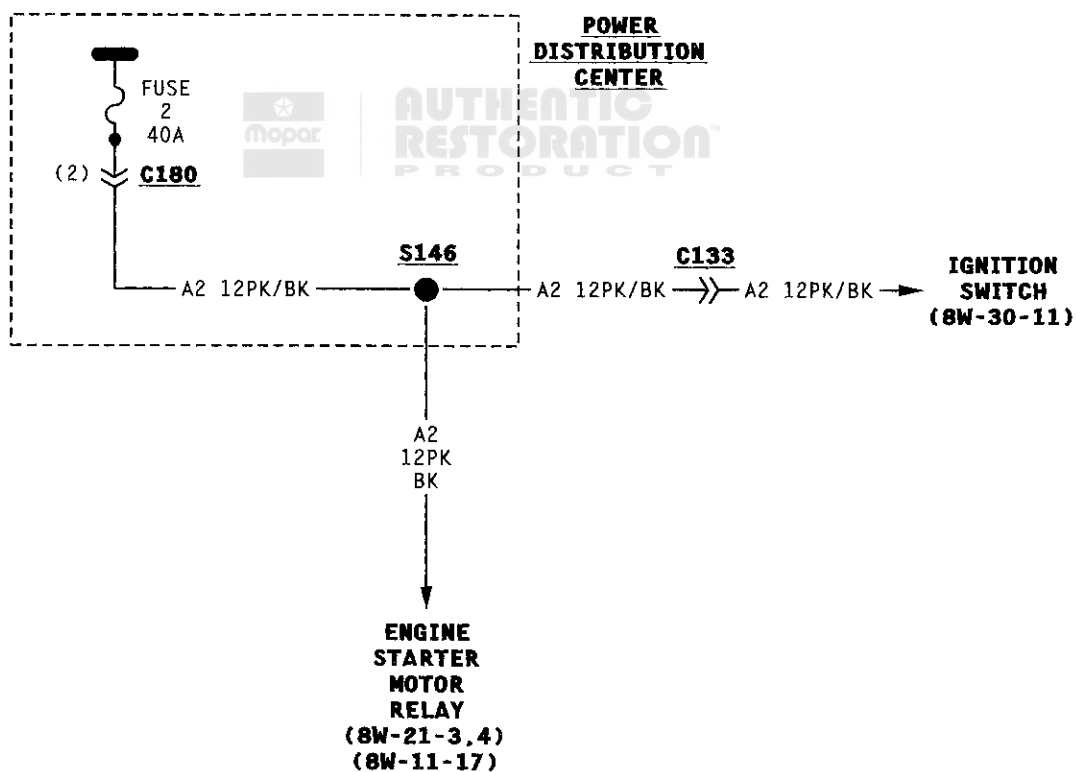
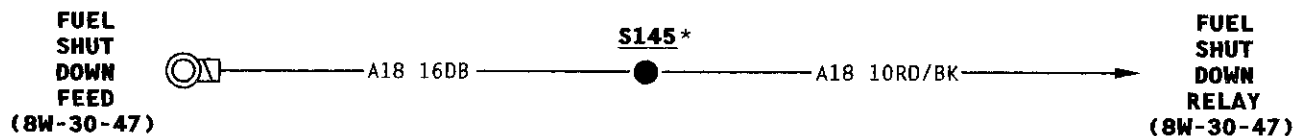
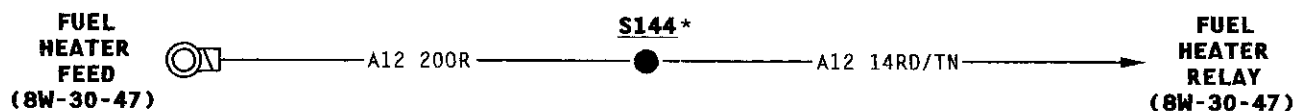


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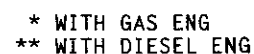


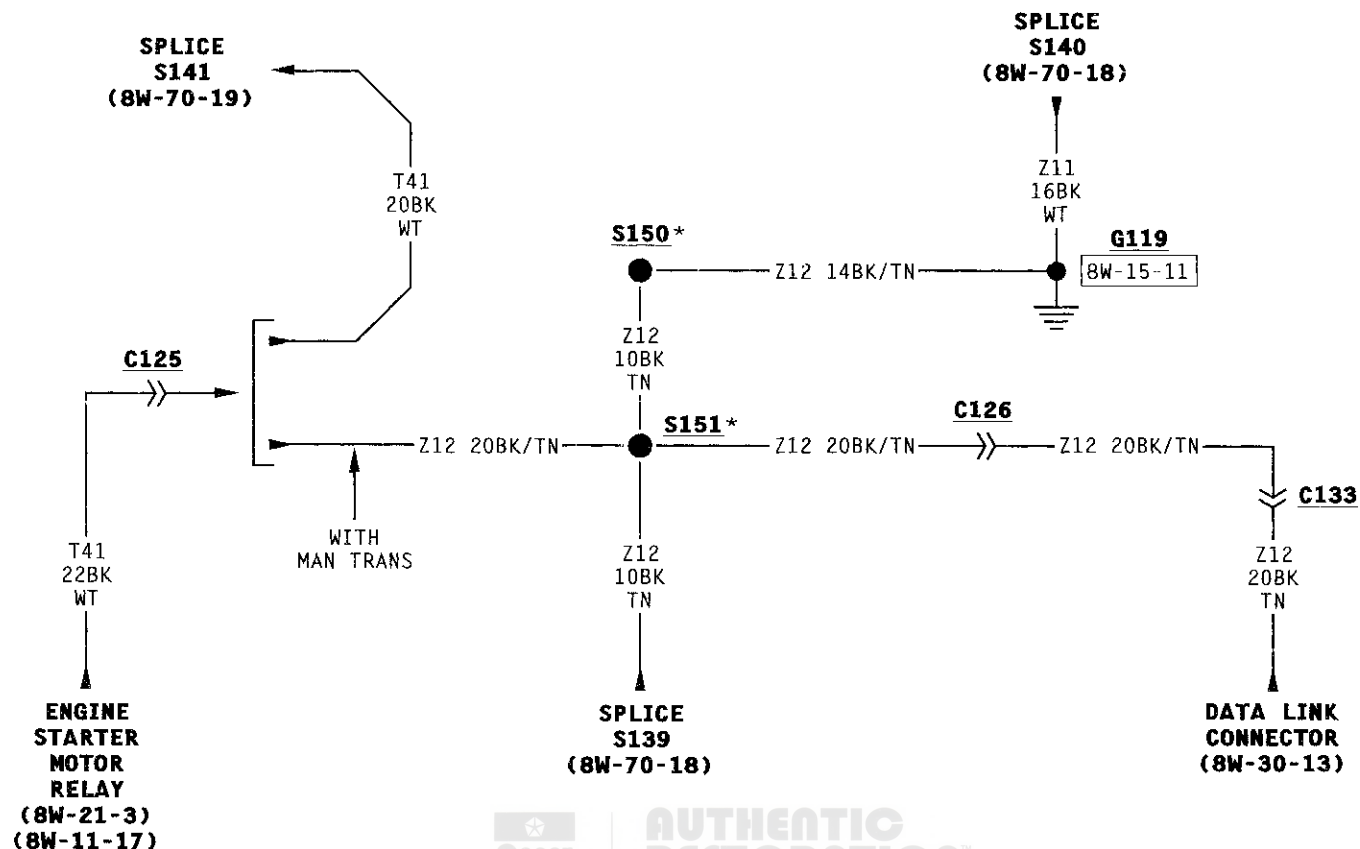


• WITH AUTO TRANS
 * WITH GAS ENG
 ** WITH DIESEL ENG
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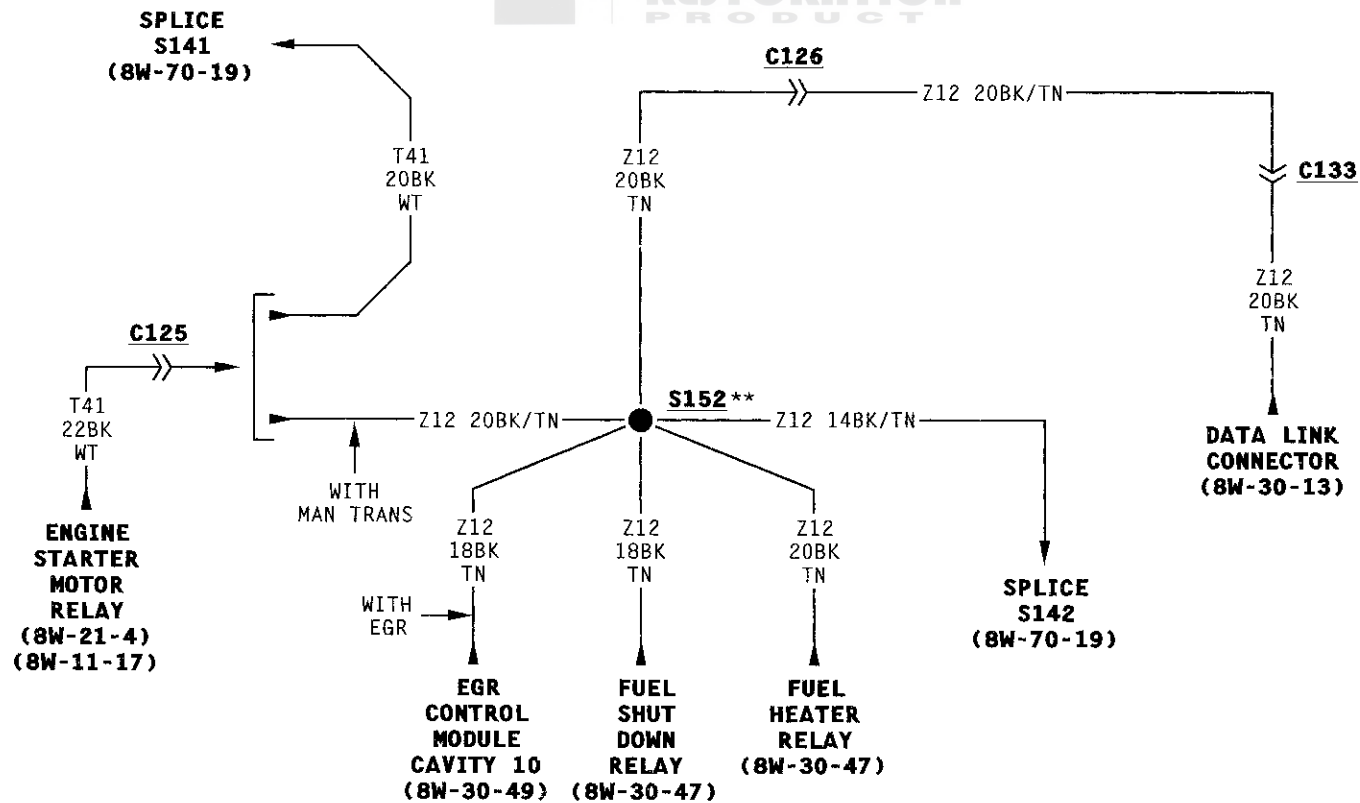


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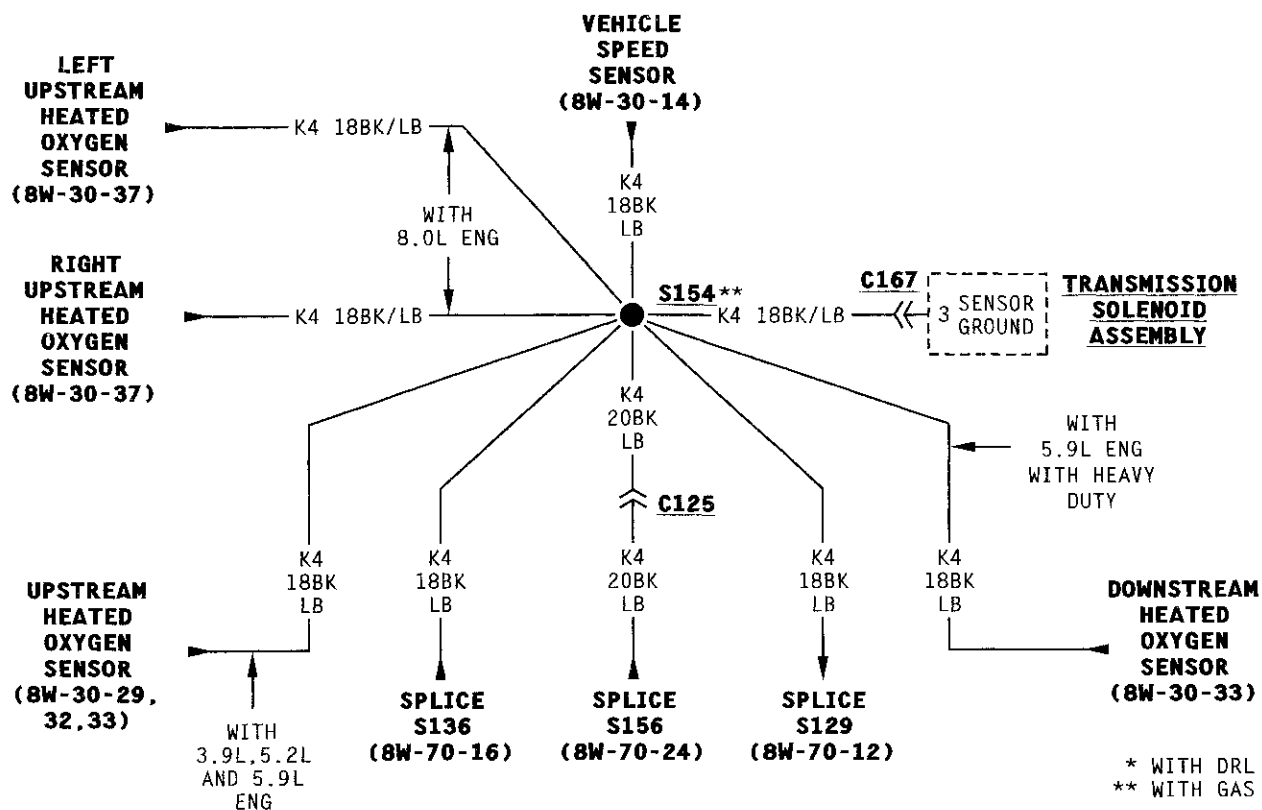
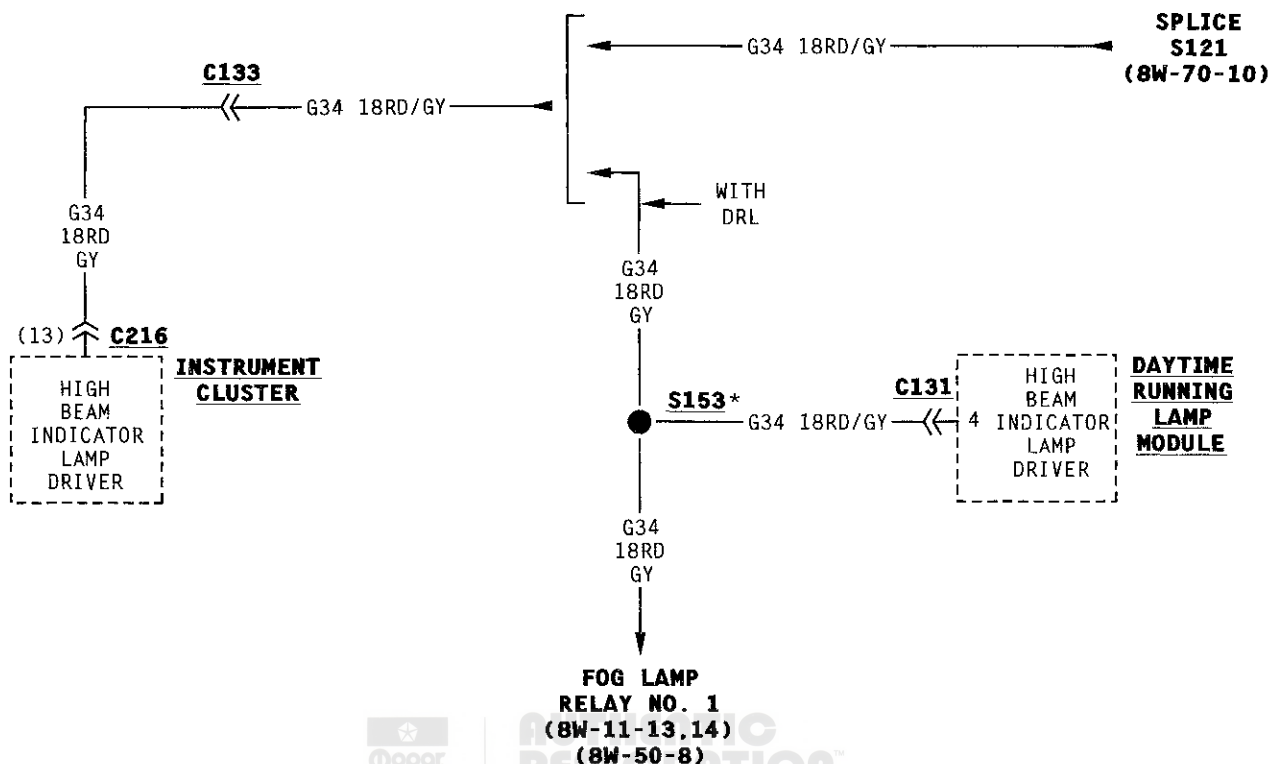


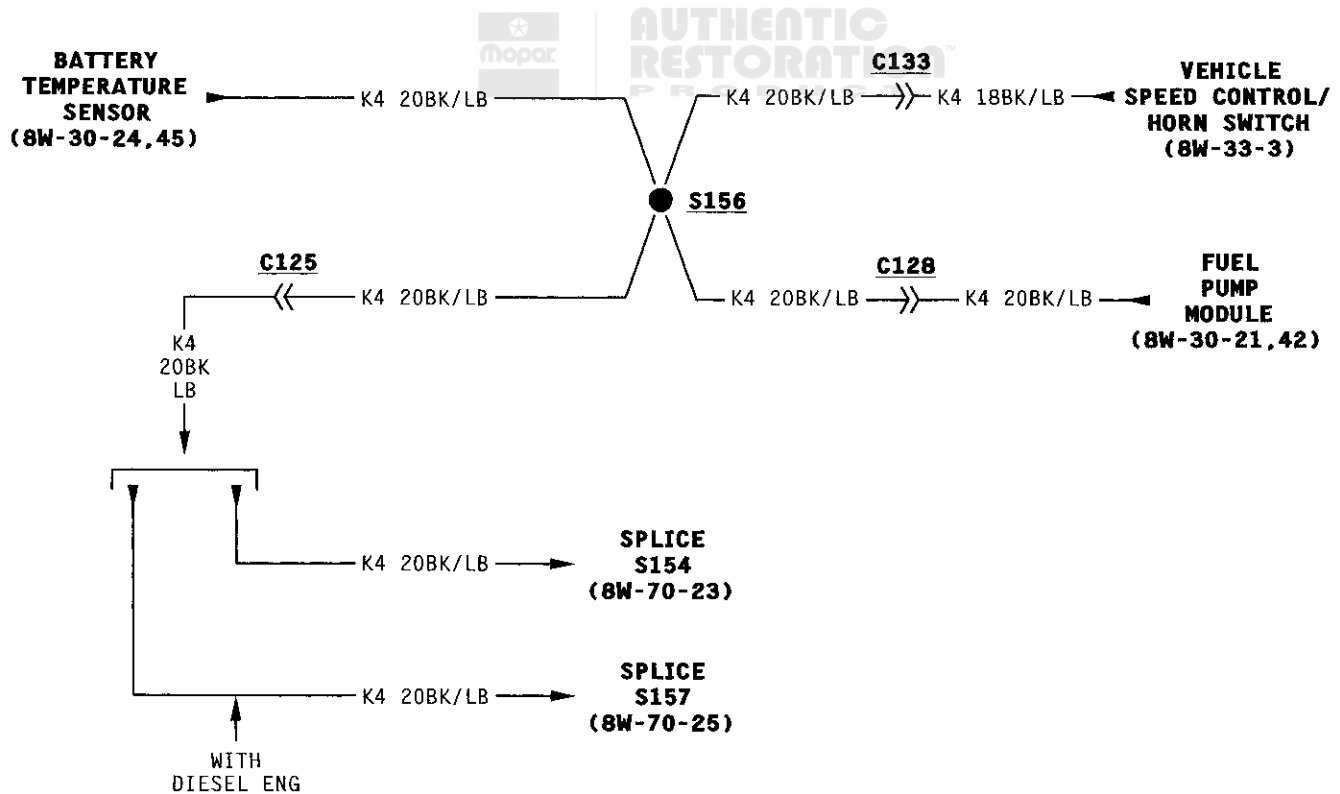
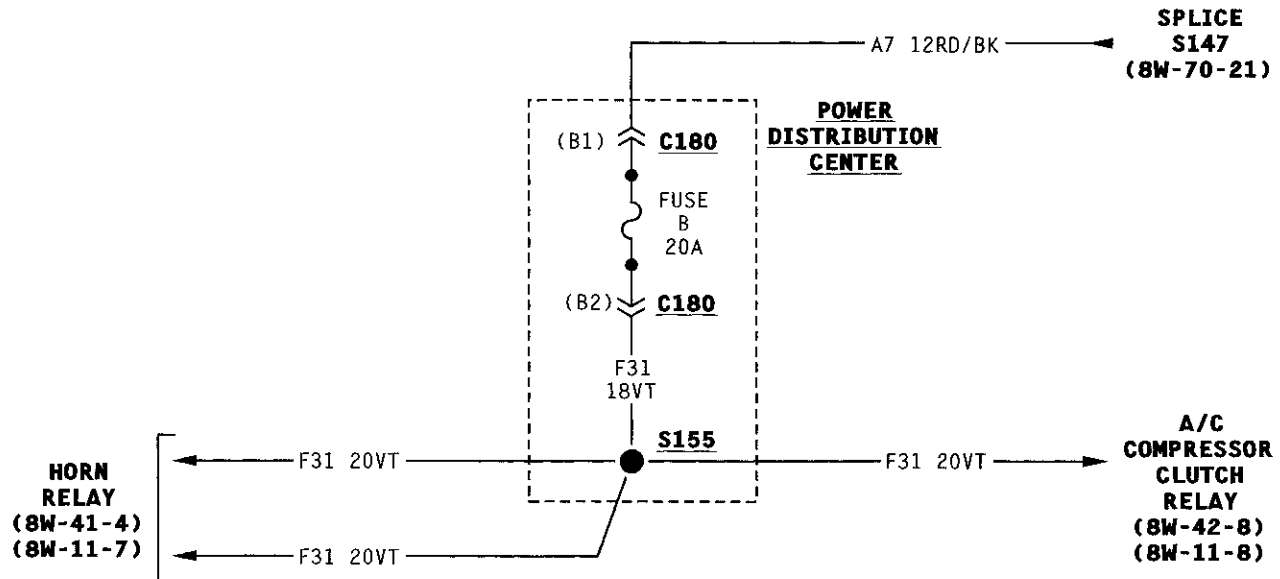


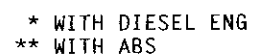
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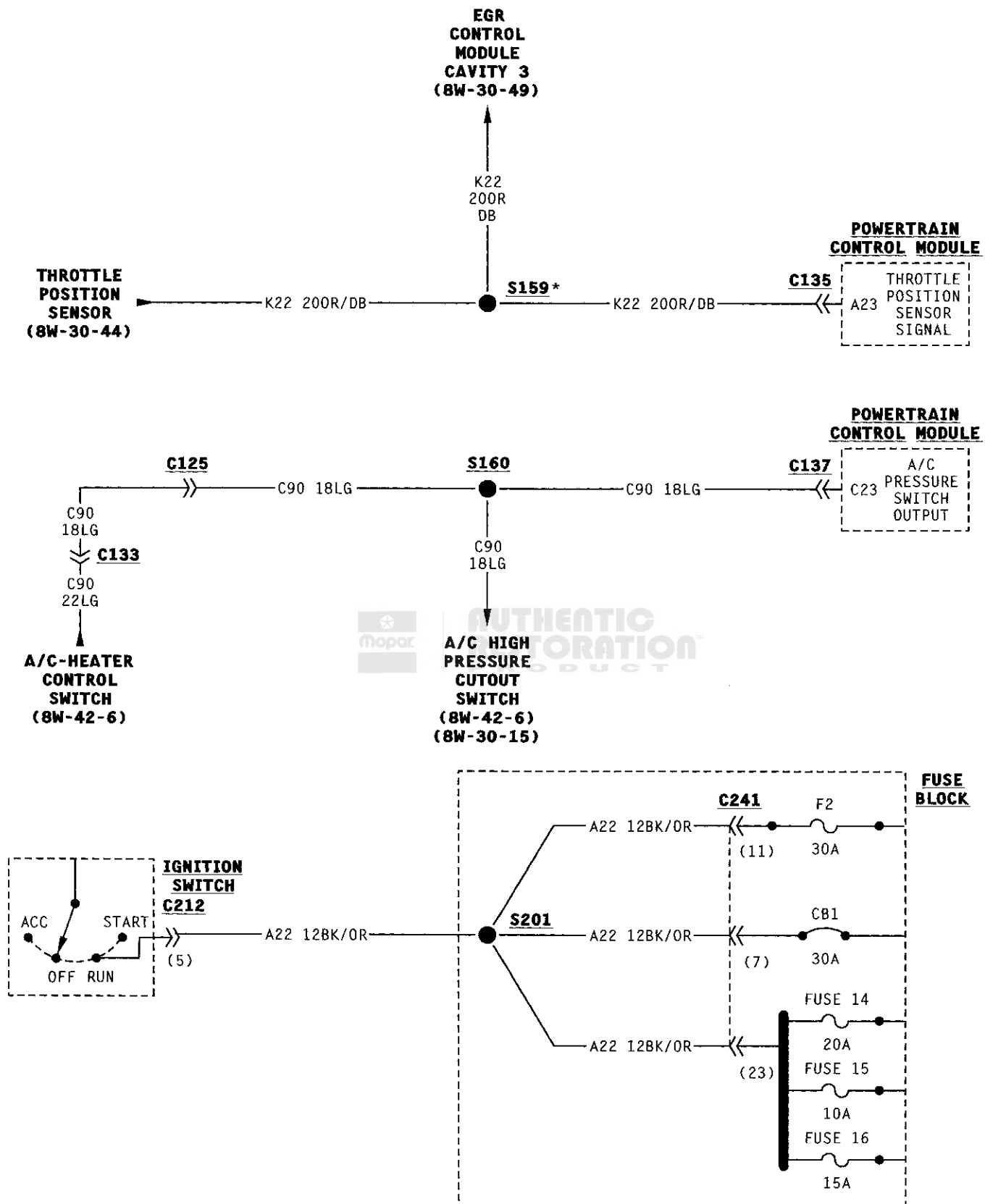


* WITH GAS ENG
** WITH DIESEL ENG

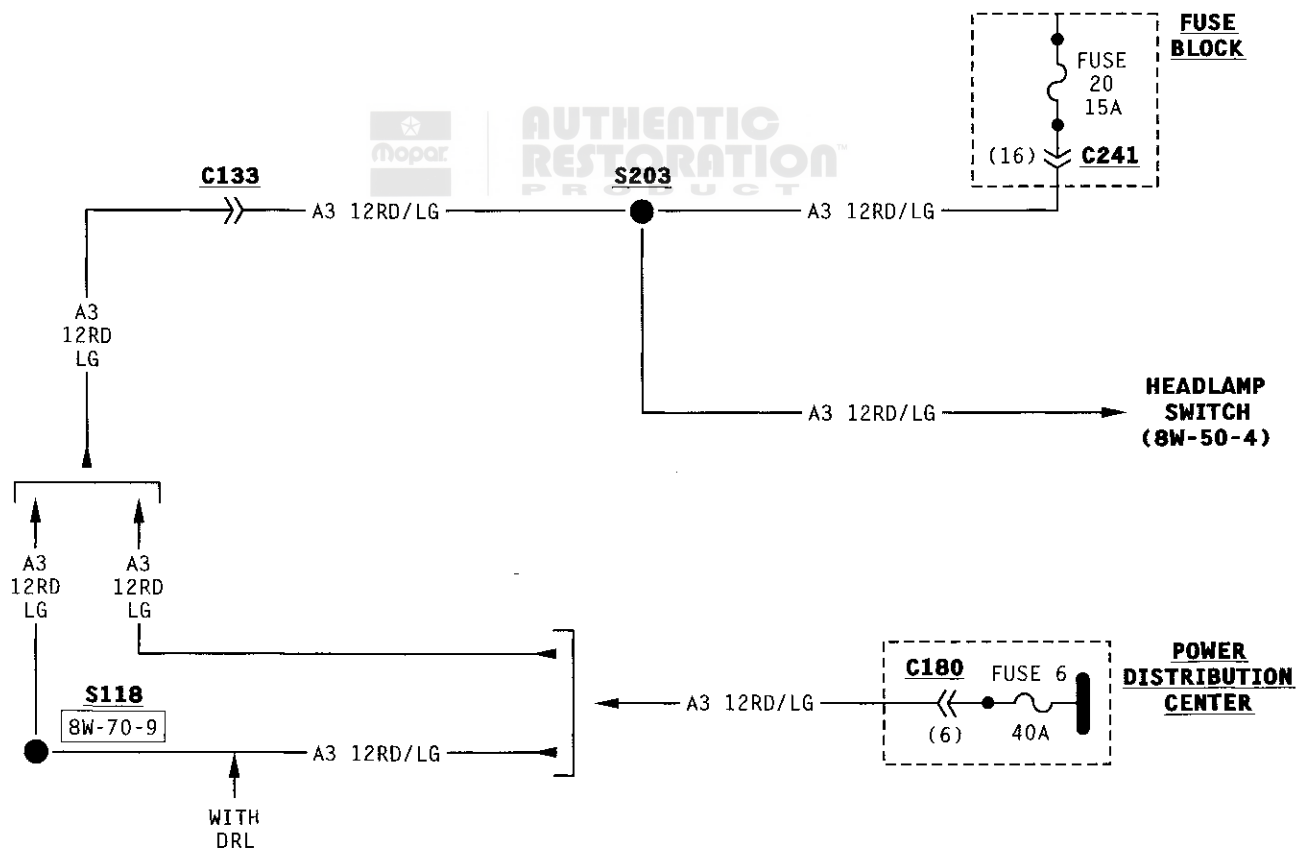
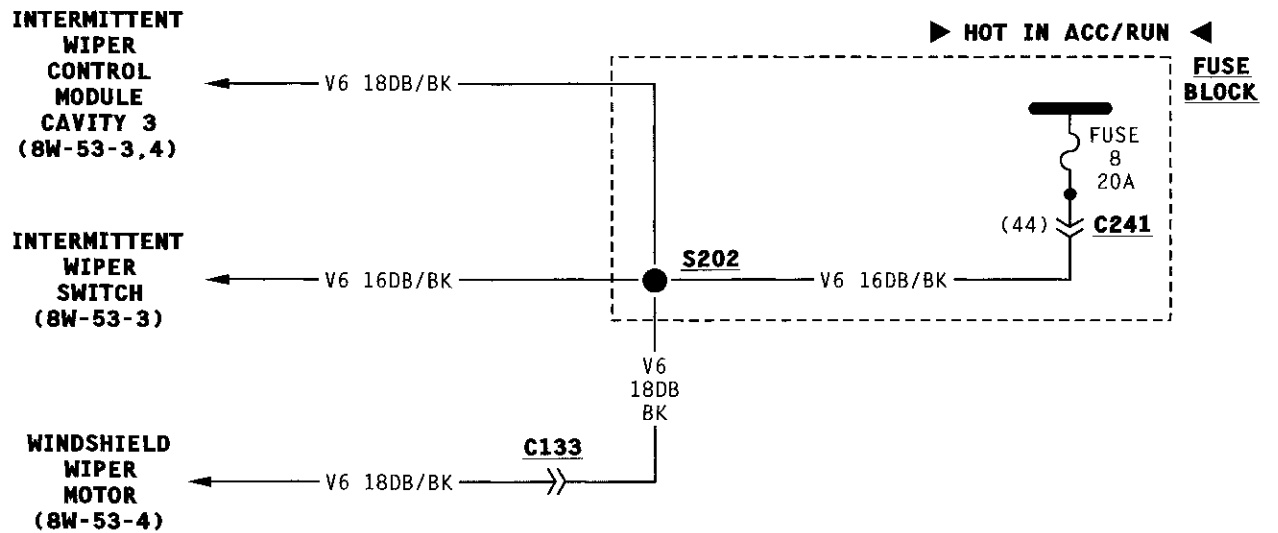


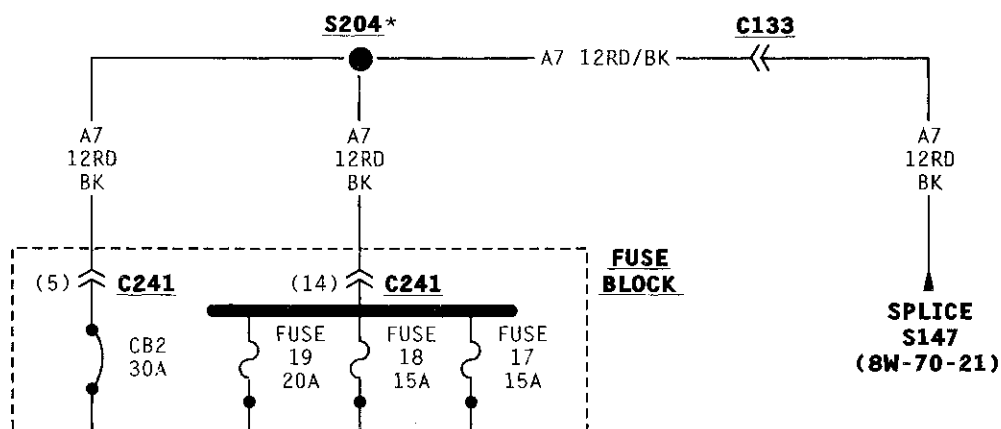
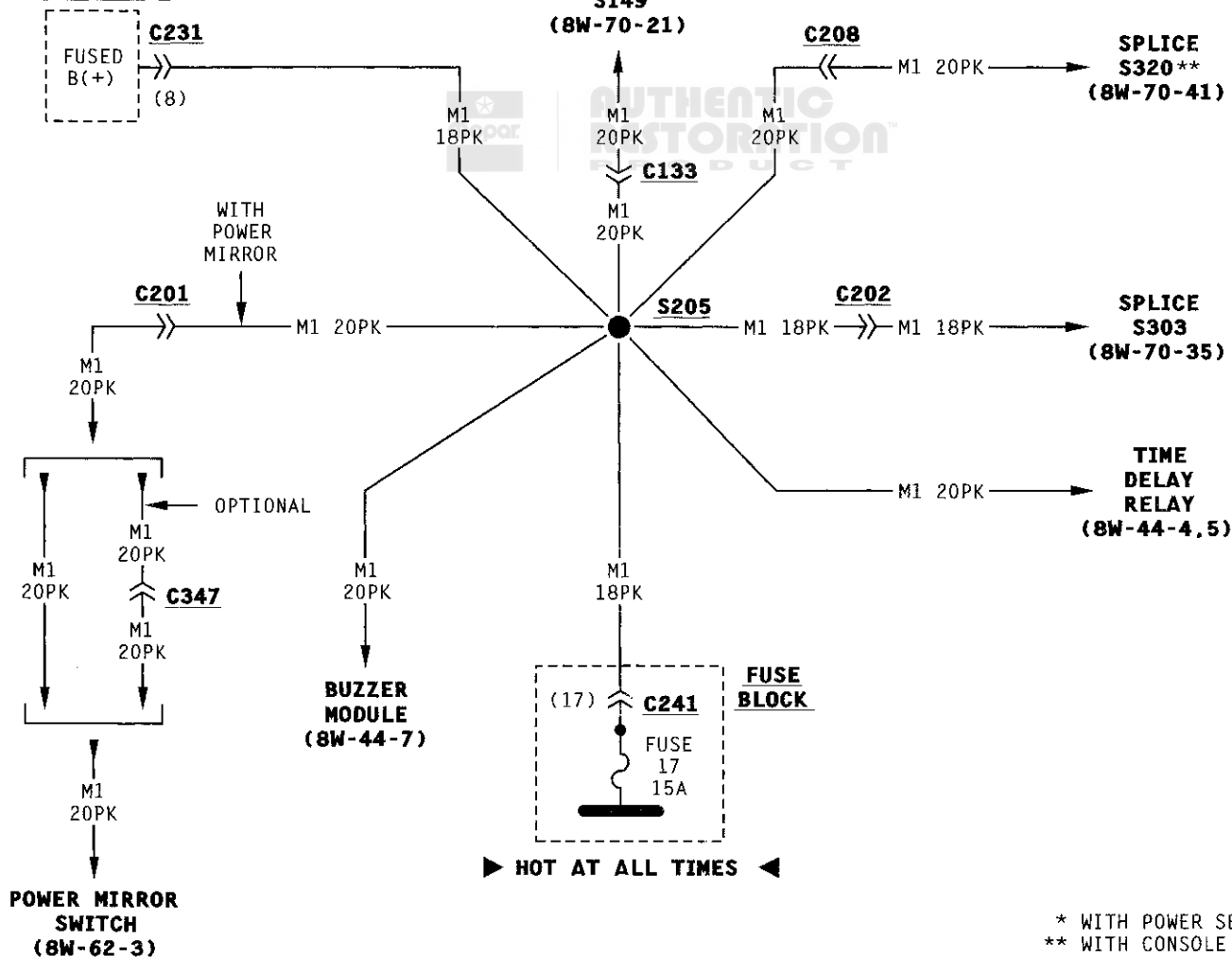






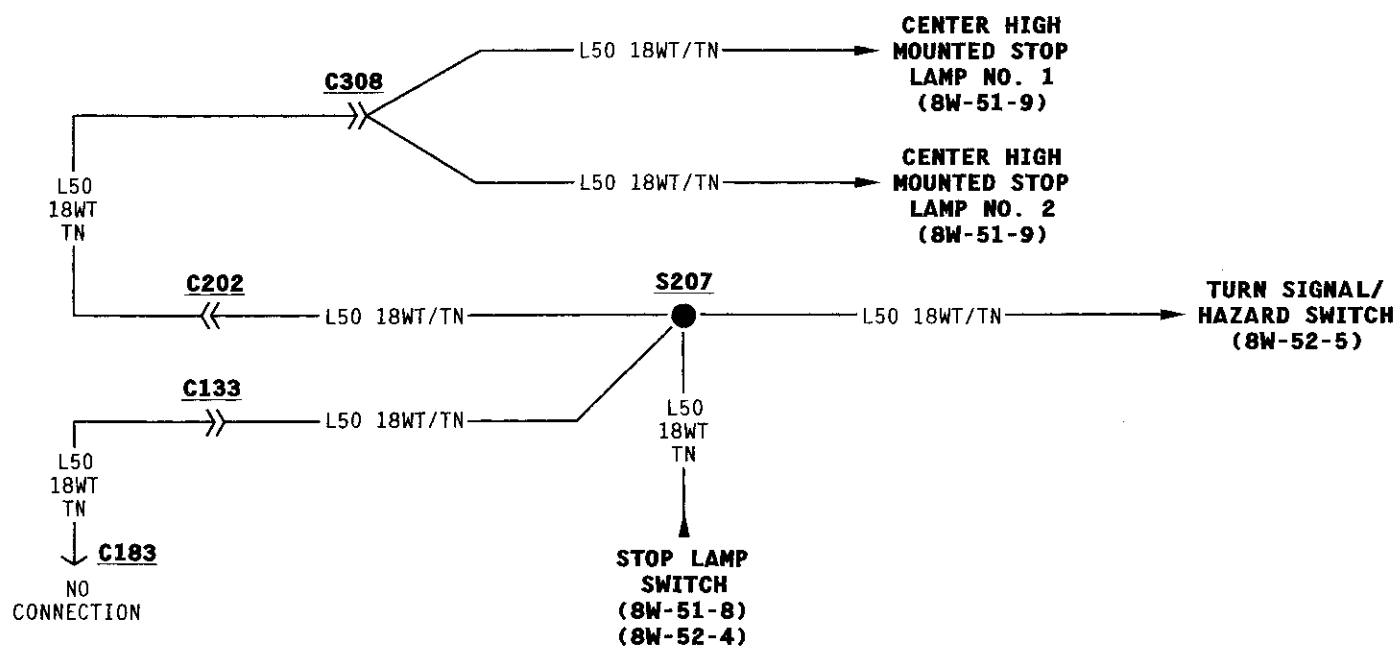
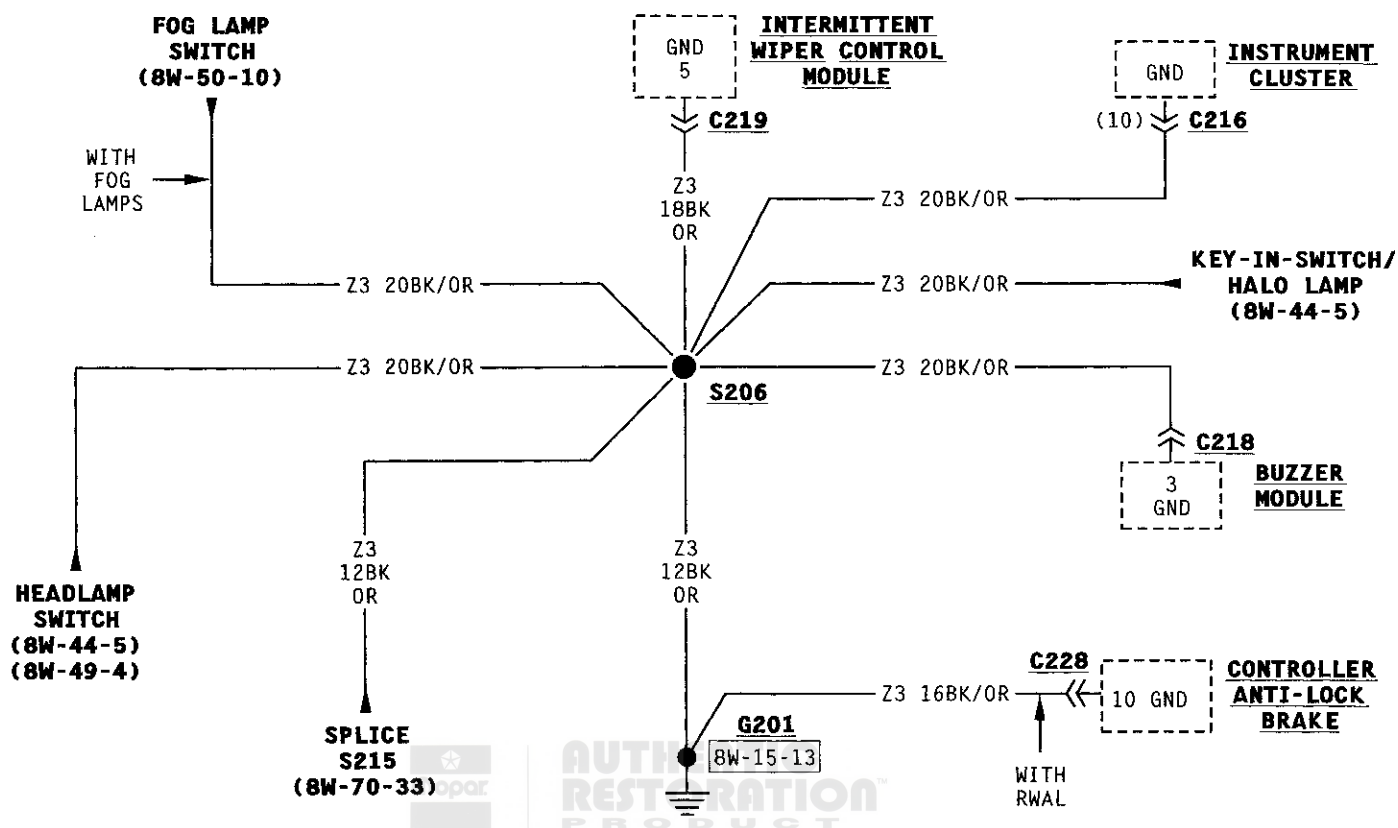
* WITH DIESEL ENG
J968W-9

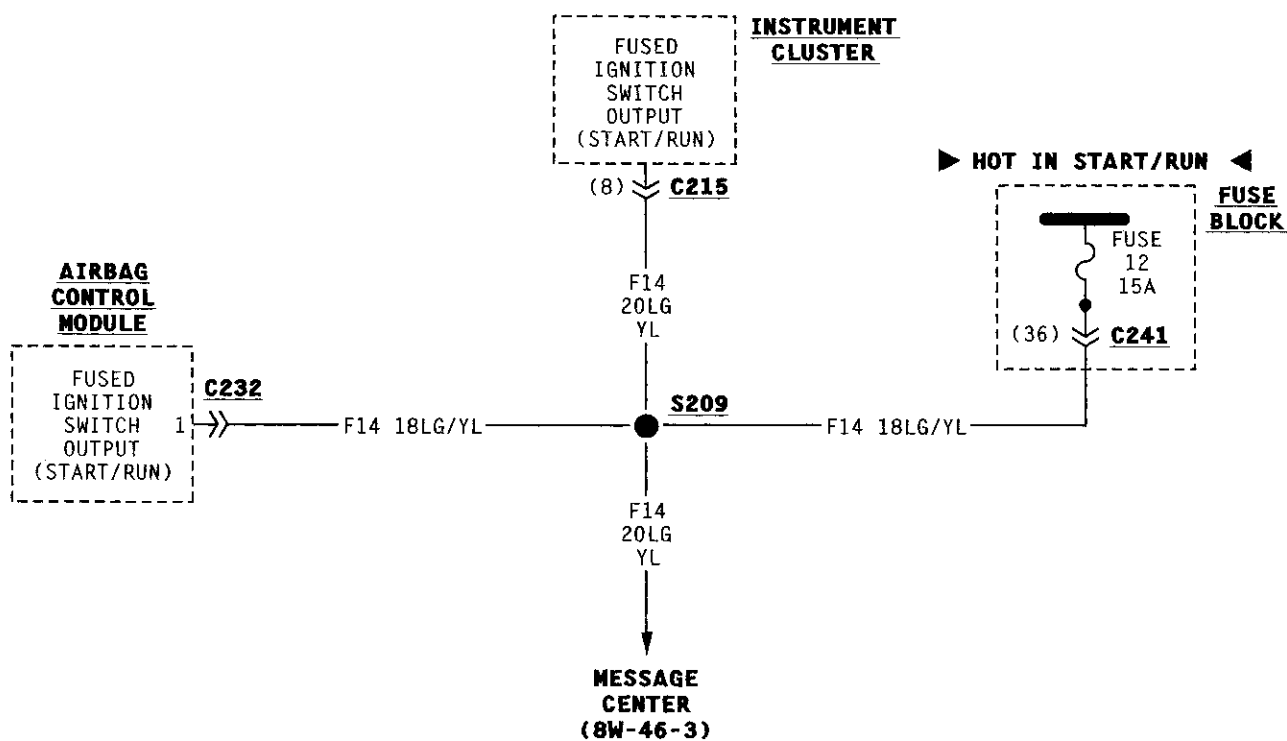
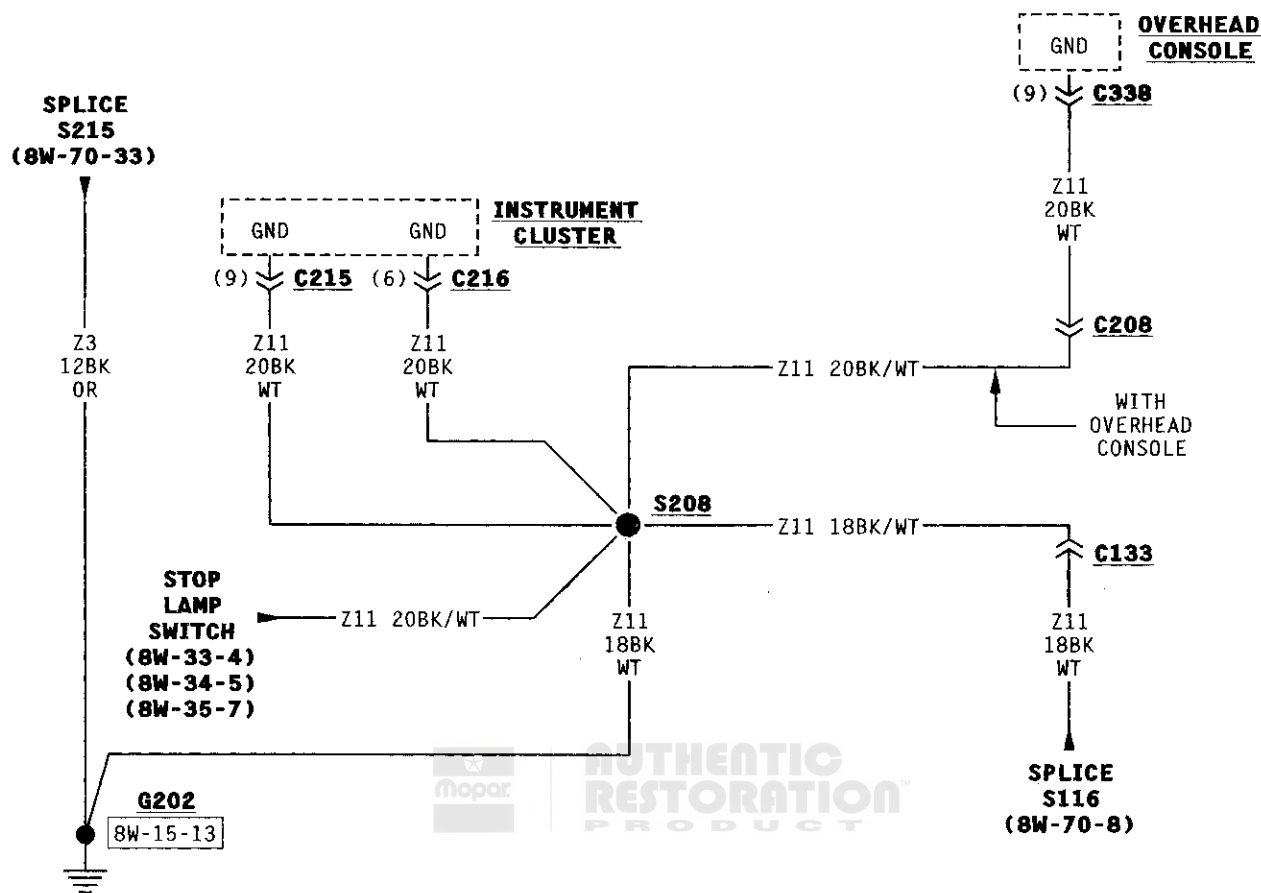


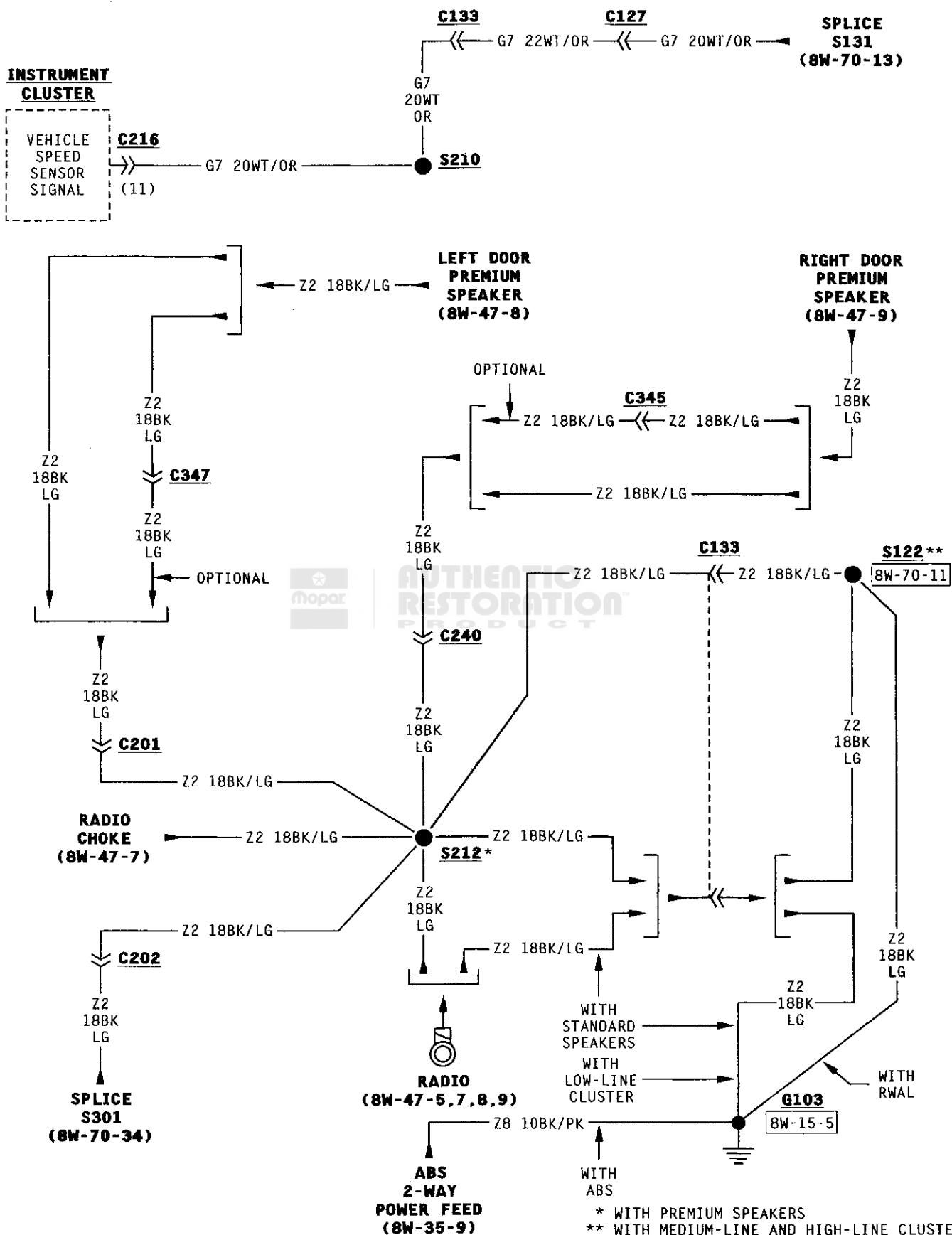
JOINT
CONNECTOR B

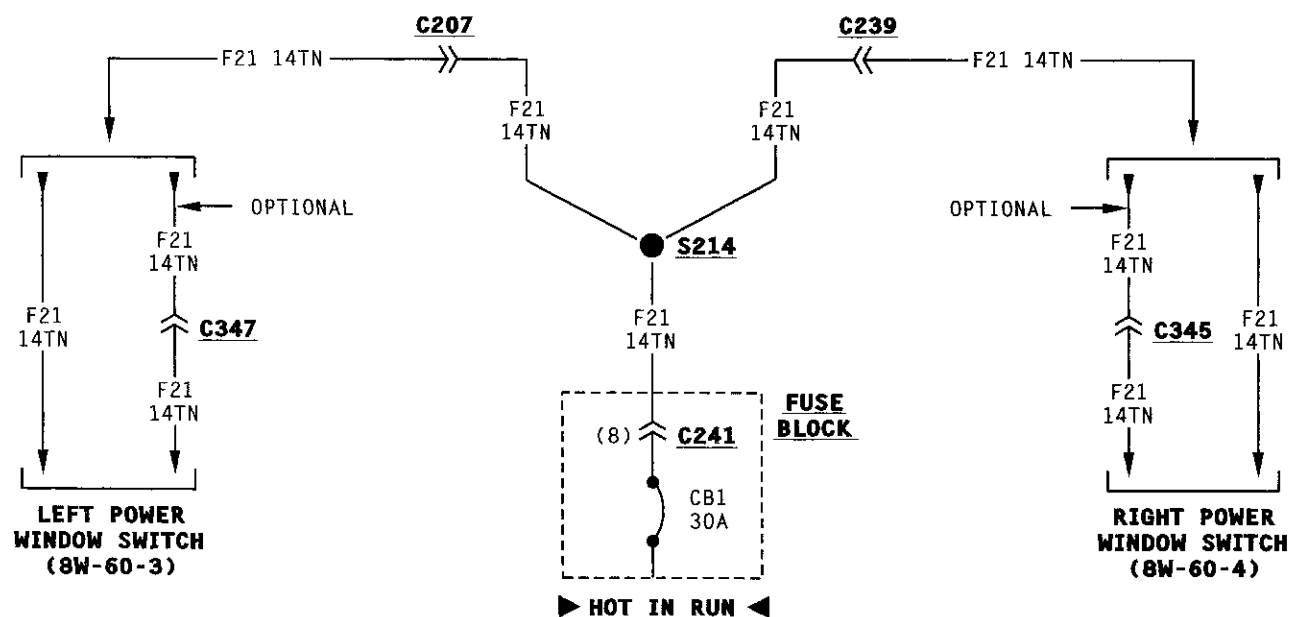
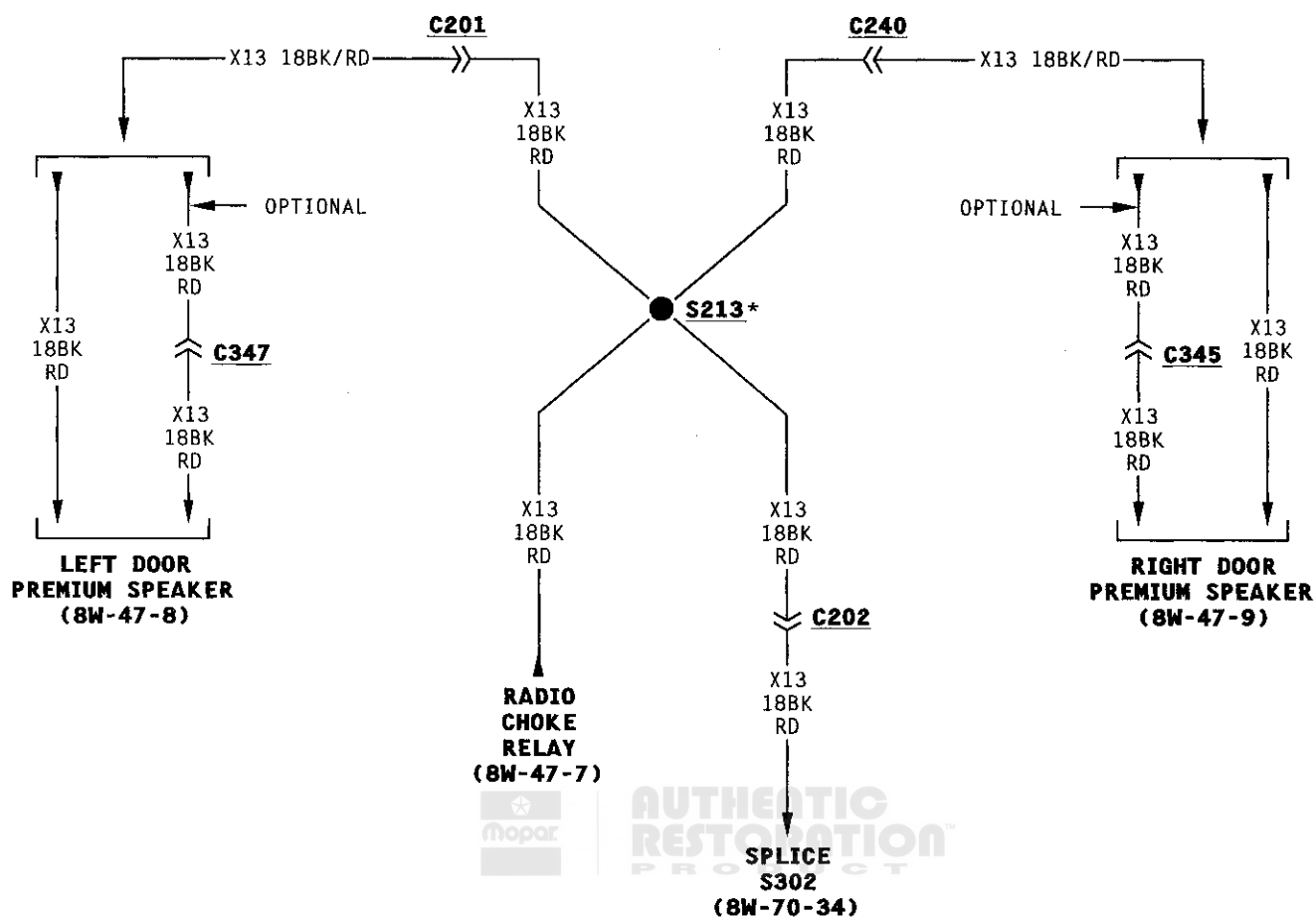
▶ HOT AT ALL TIMES ◀

* WITH POWER SEAT
 ** WITH CONSOLE

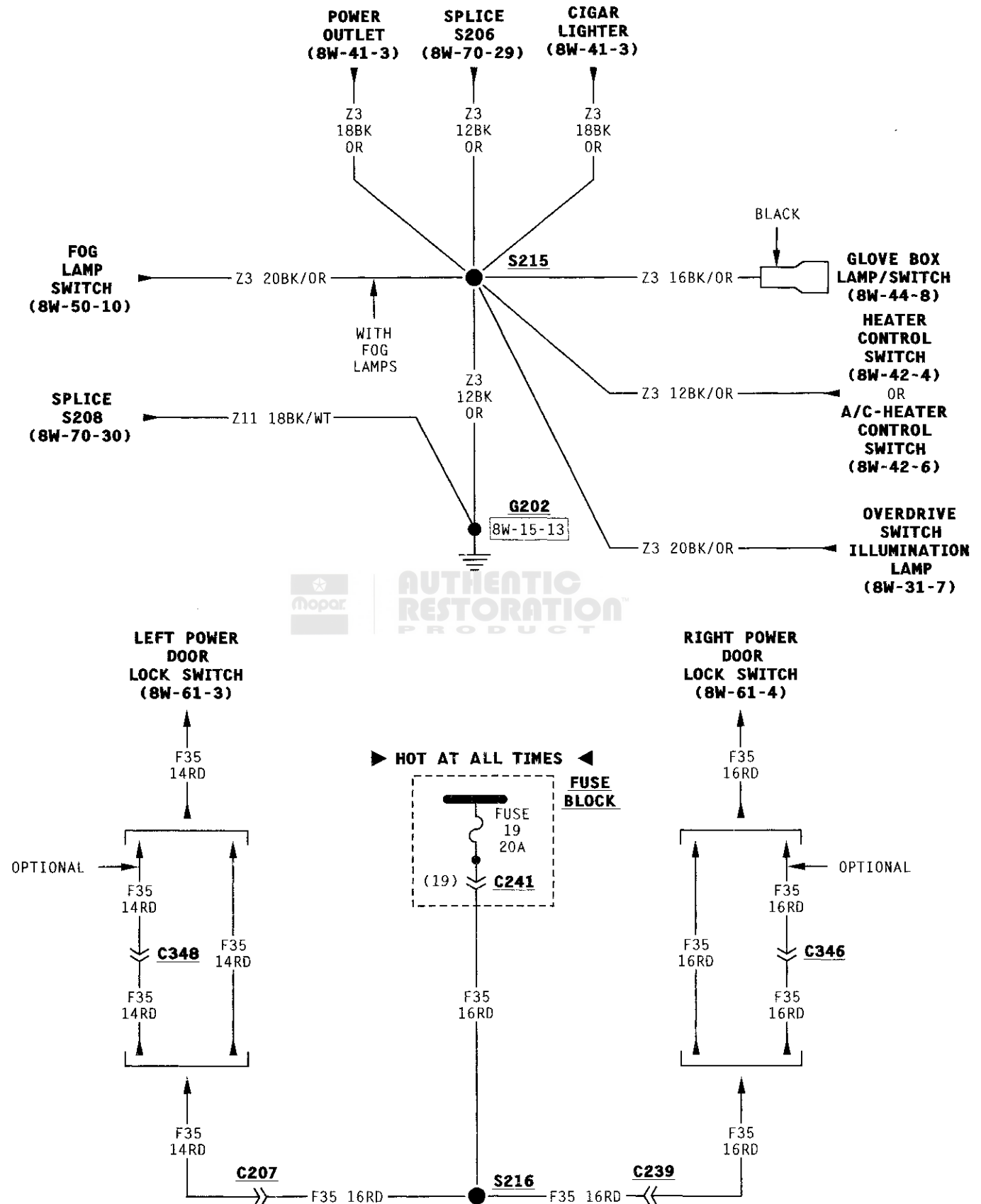


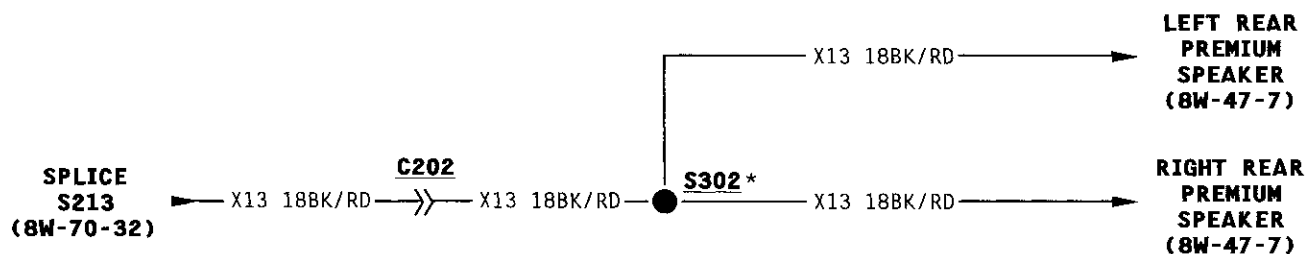
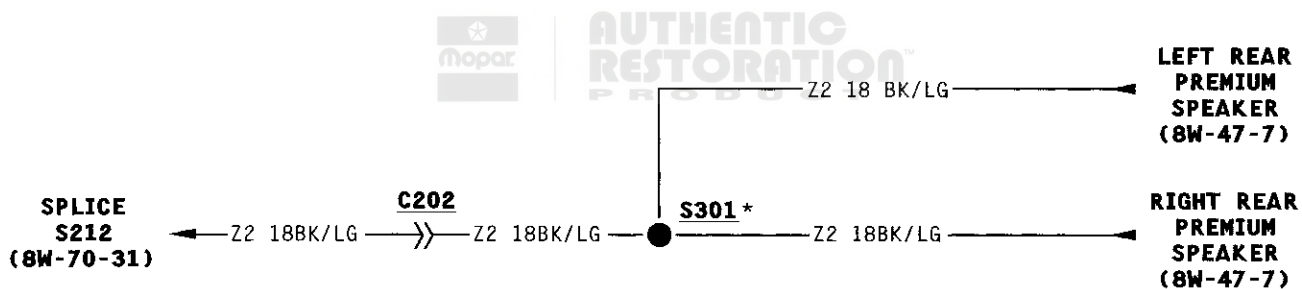
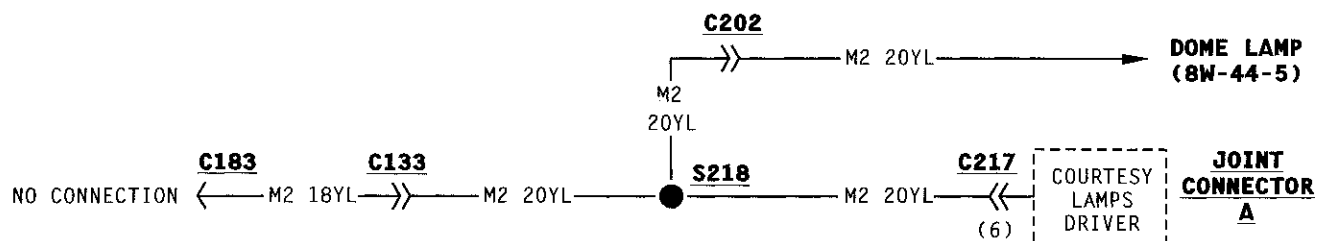
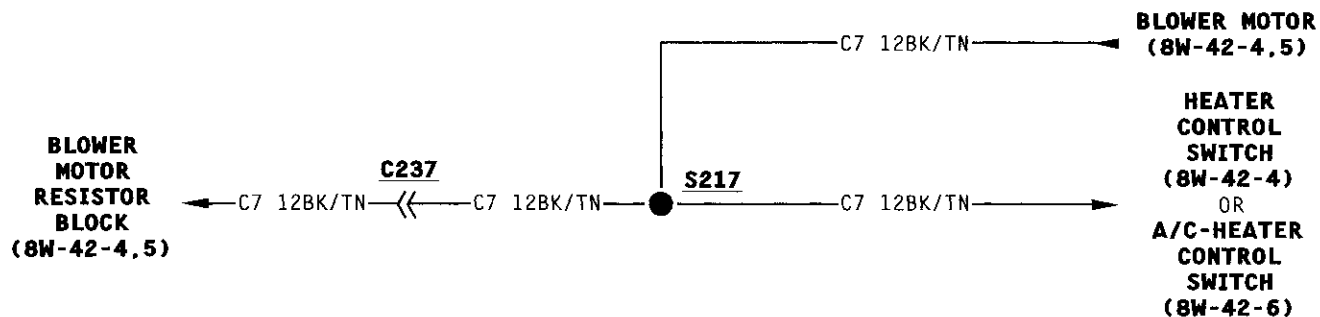




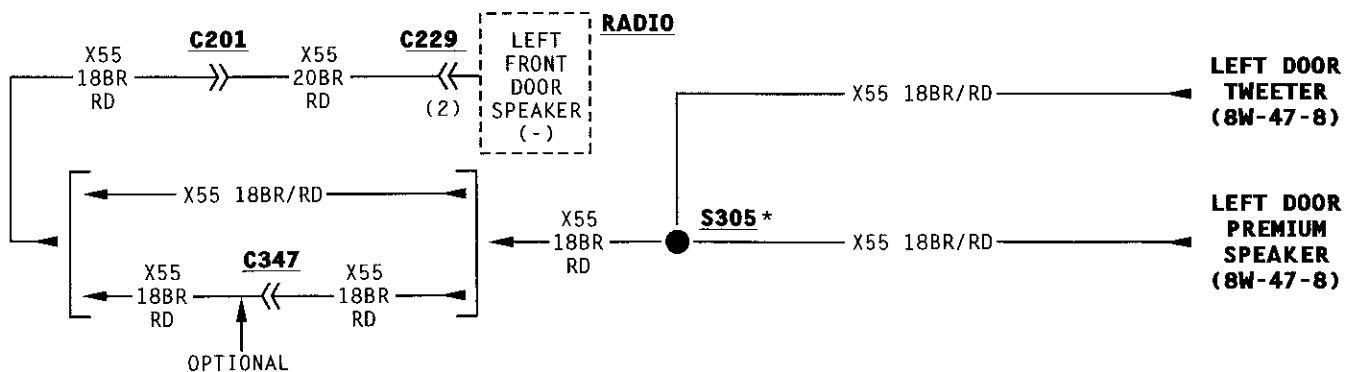
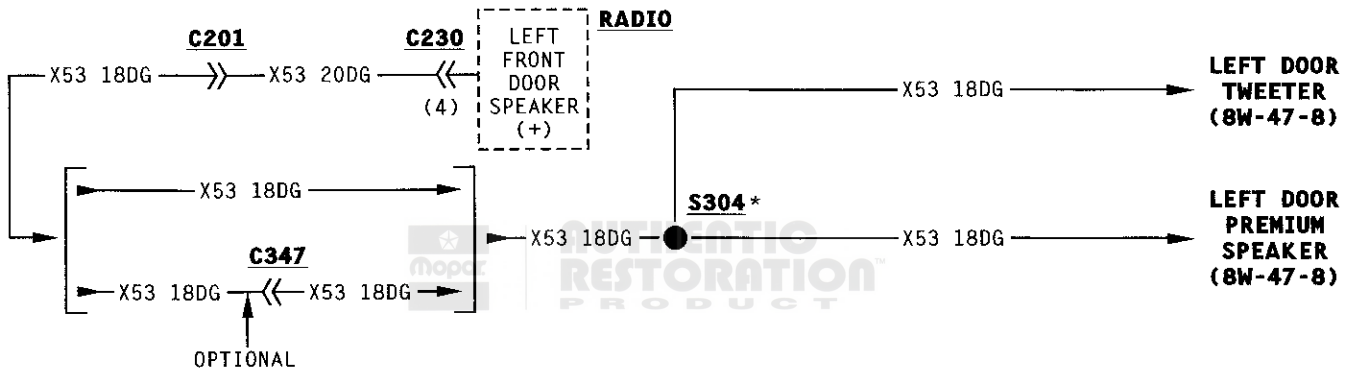
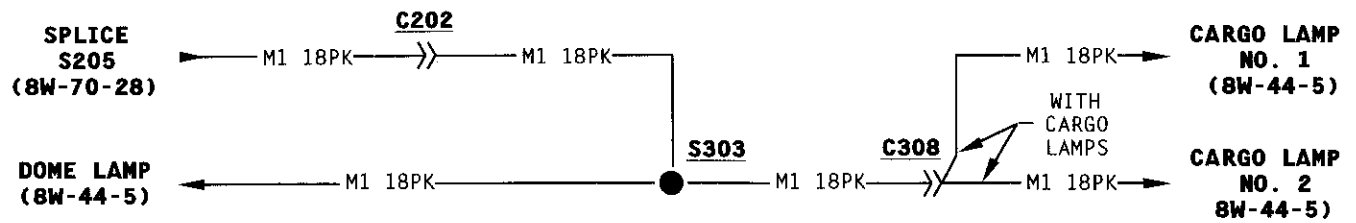


* WITH PREMIUM SPEAKERS

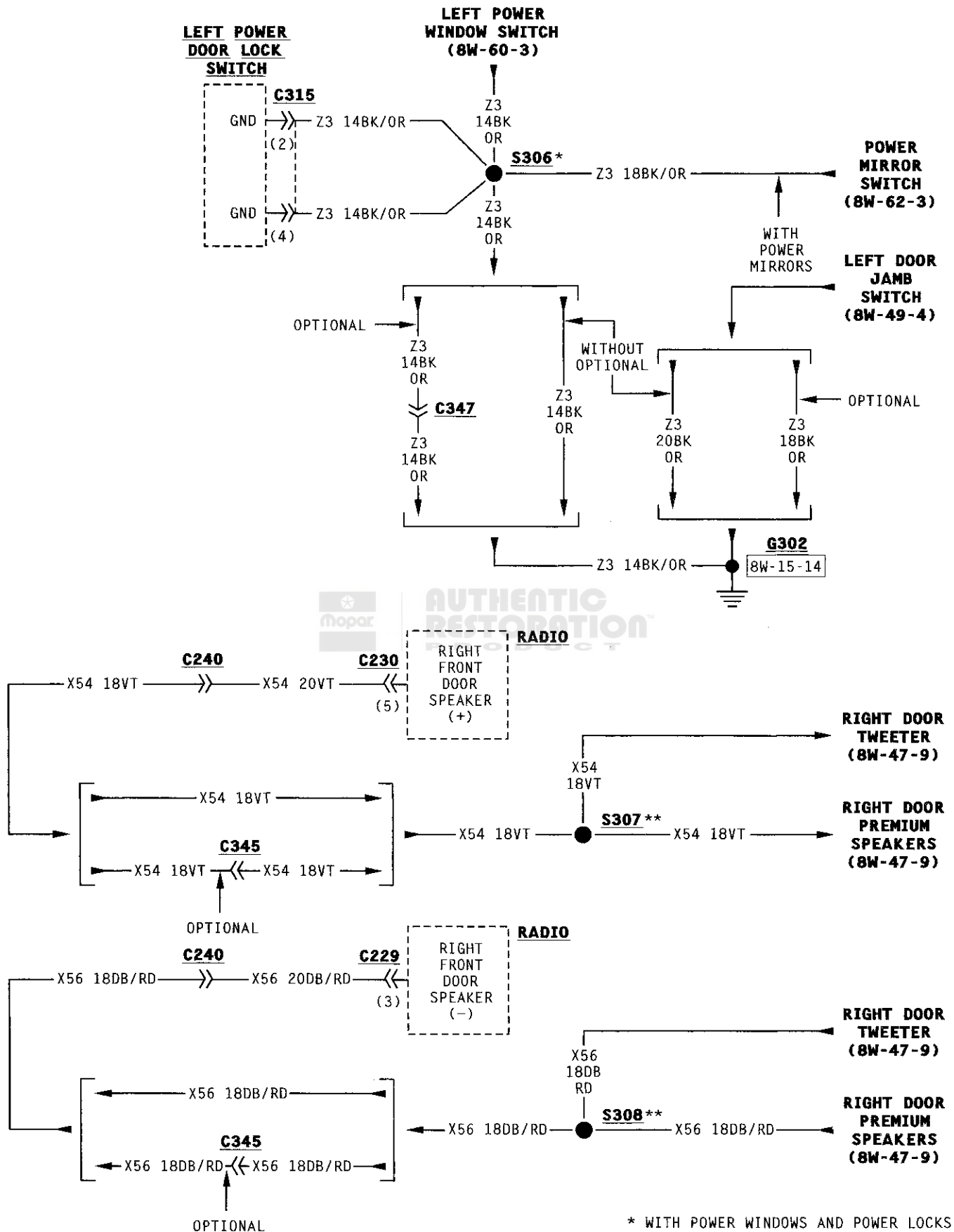


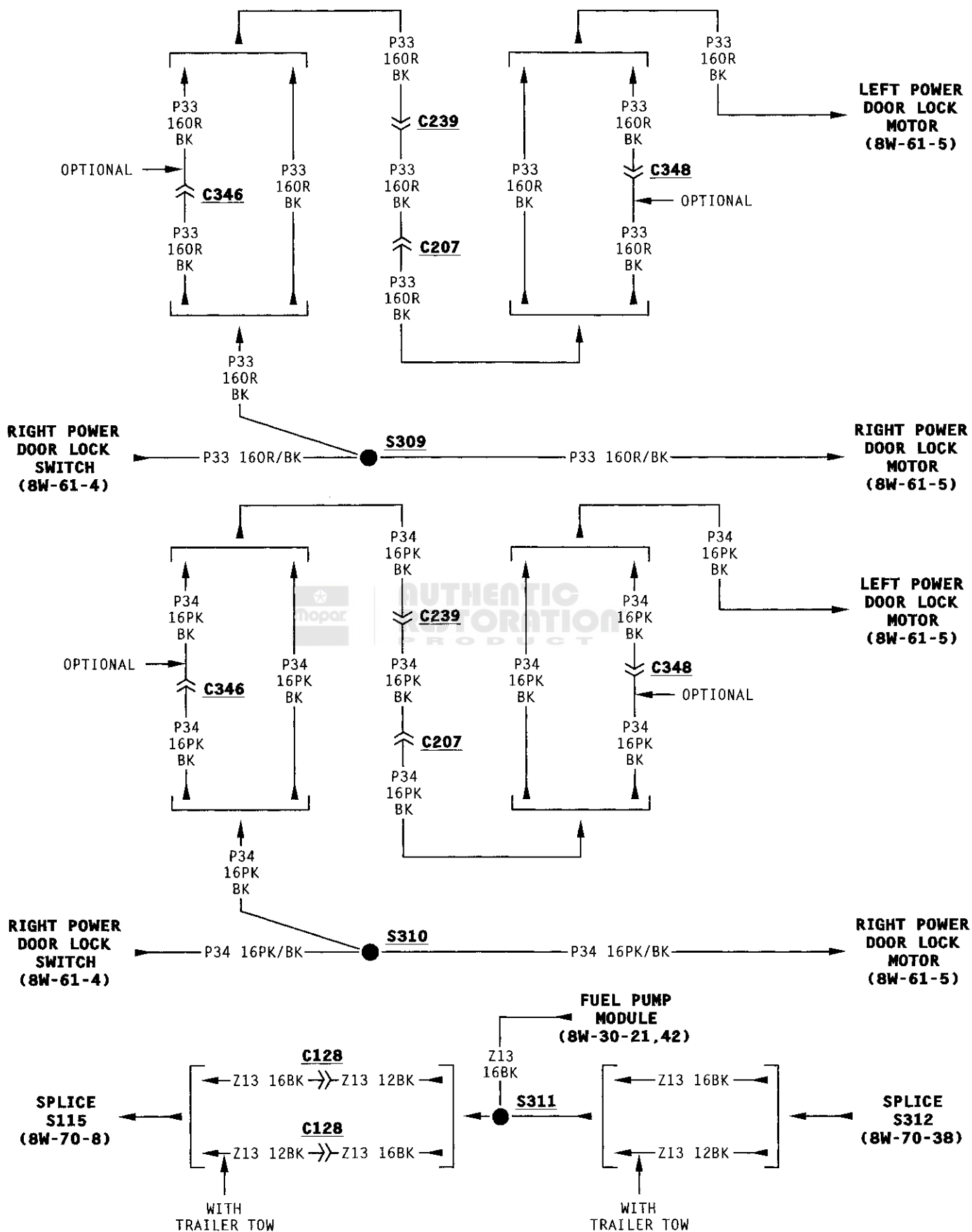


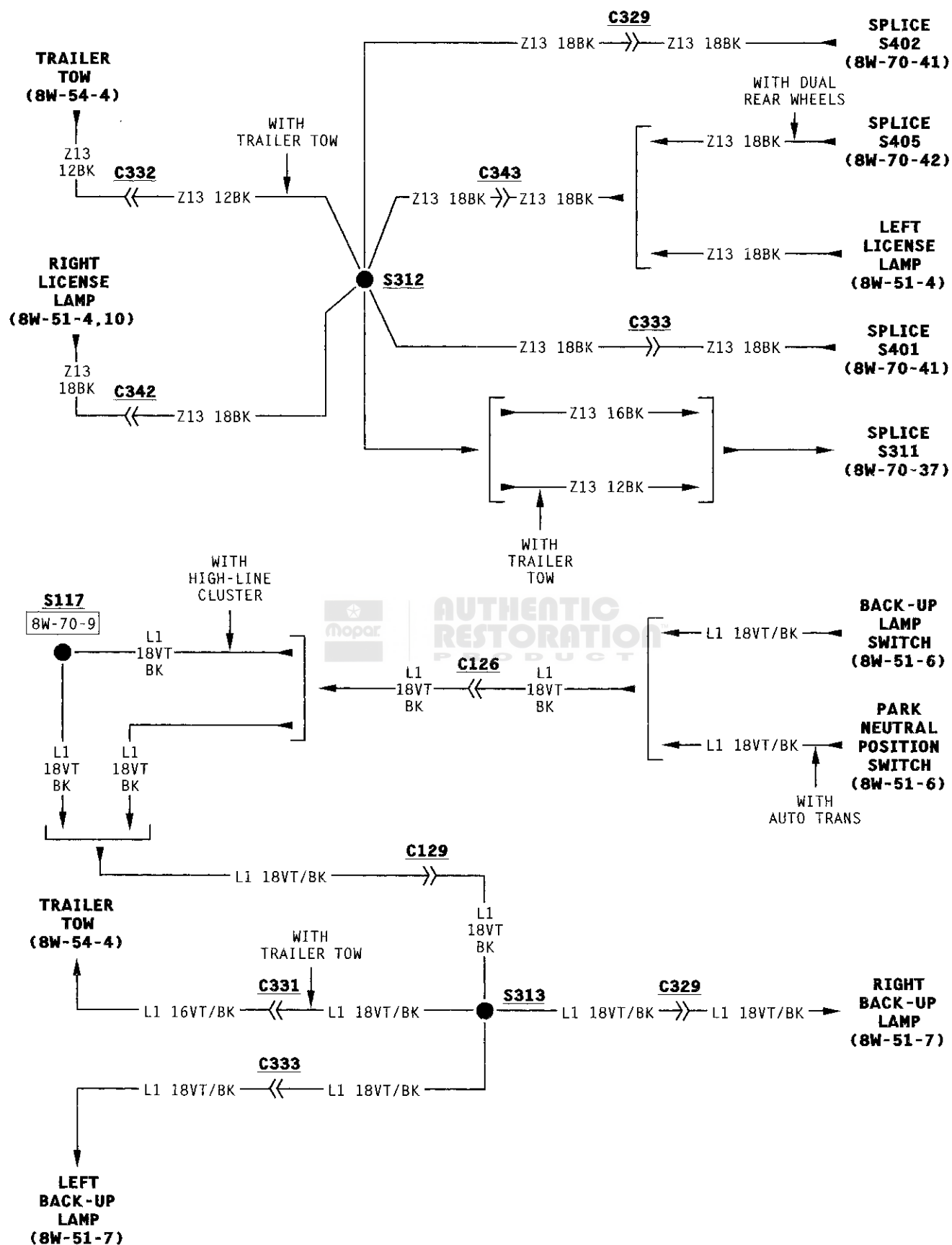
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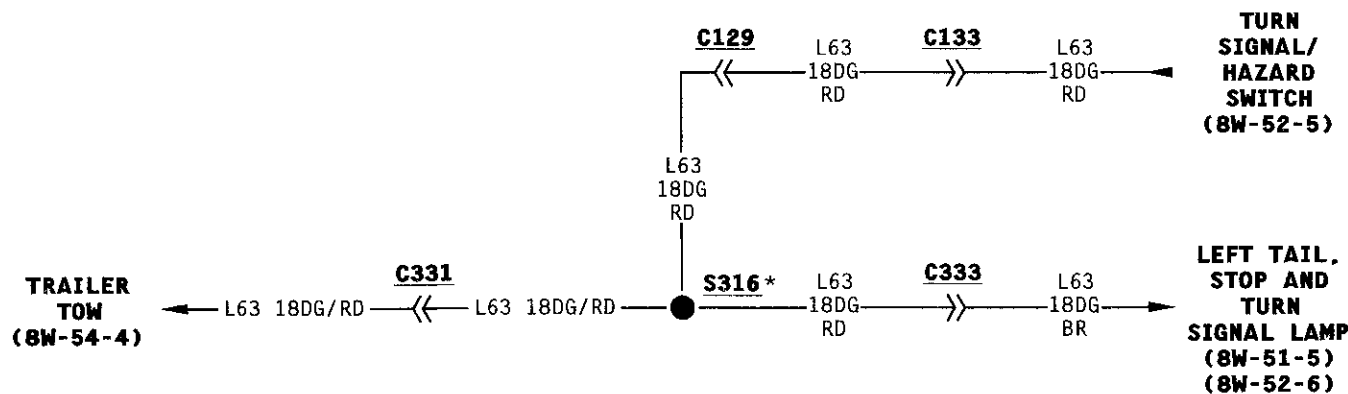
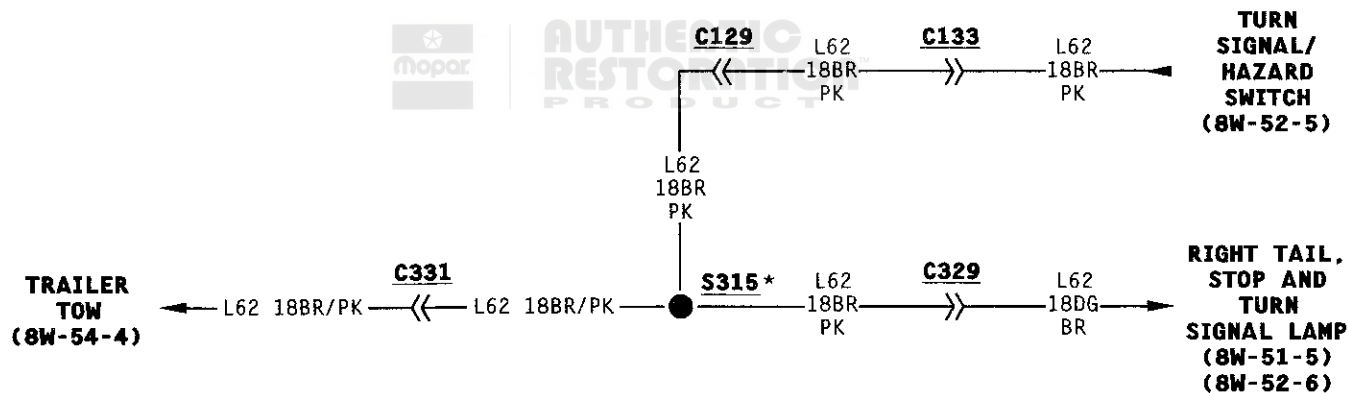
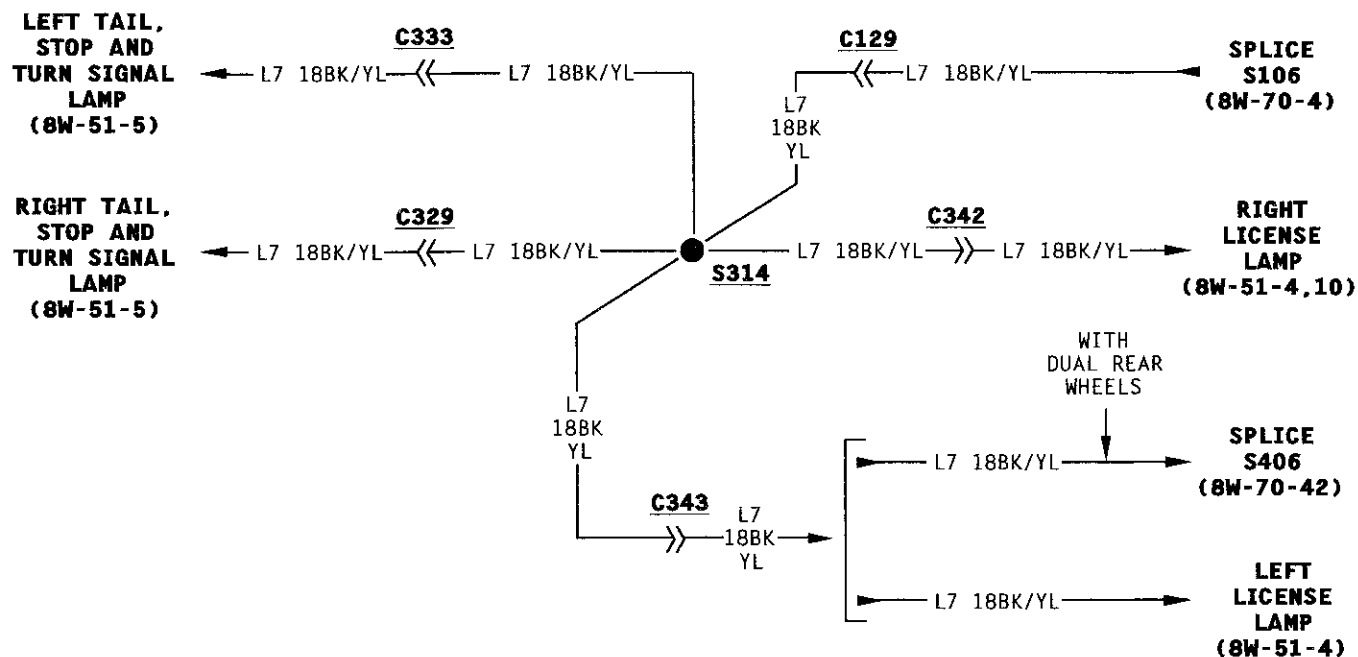


* WITH PREMIUM SPEAKERS

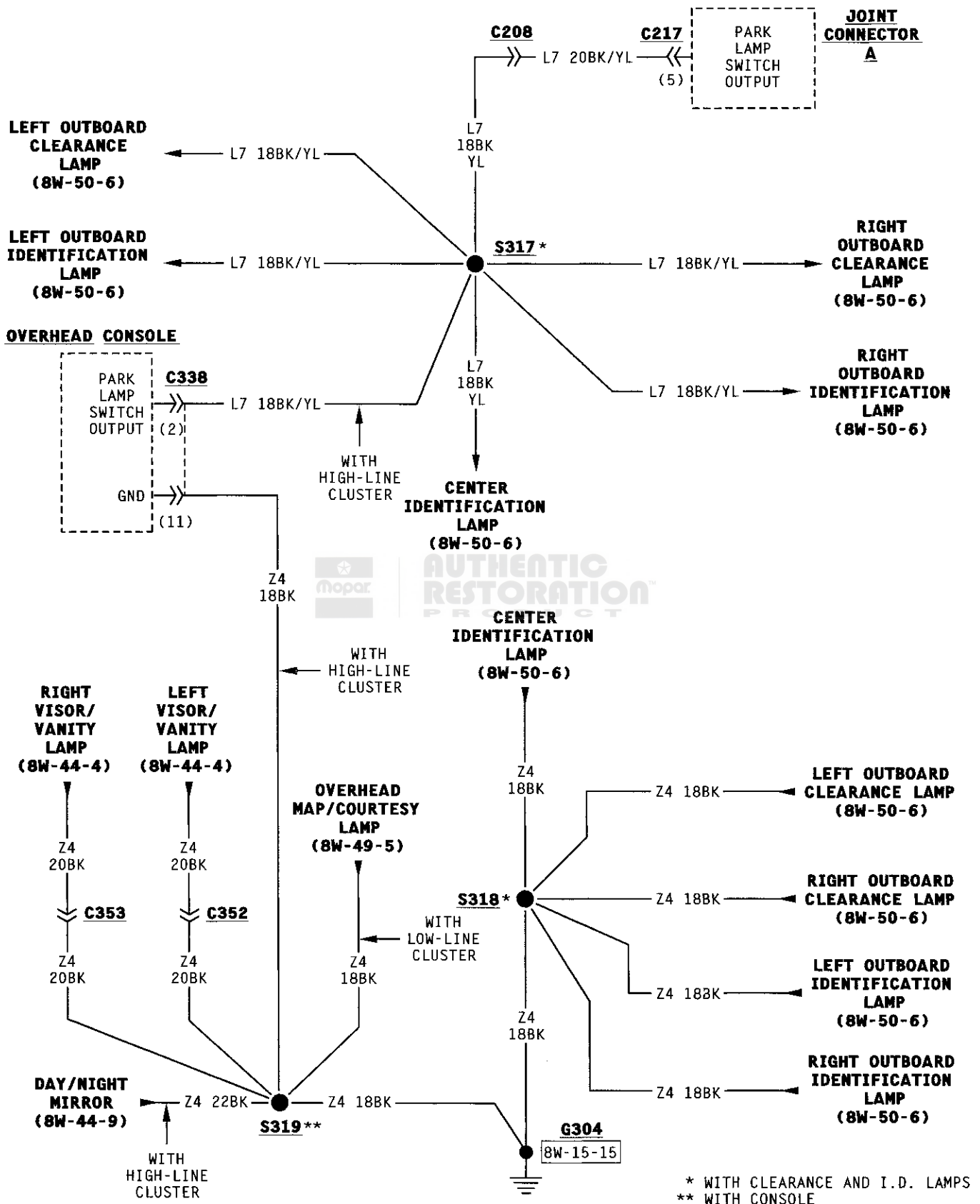


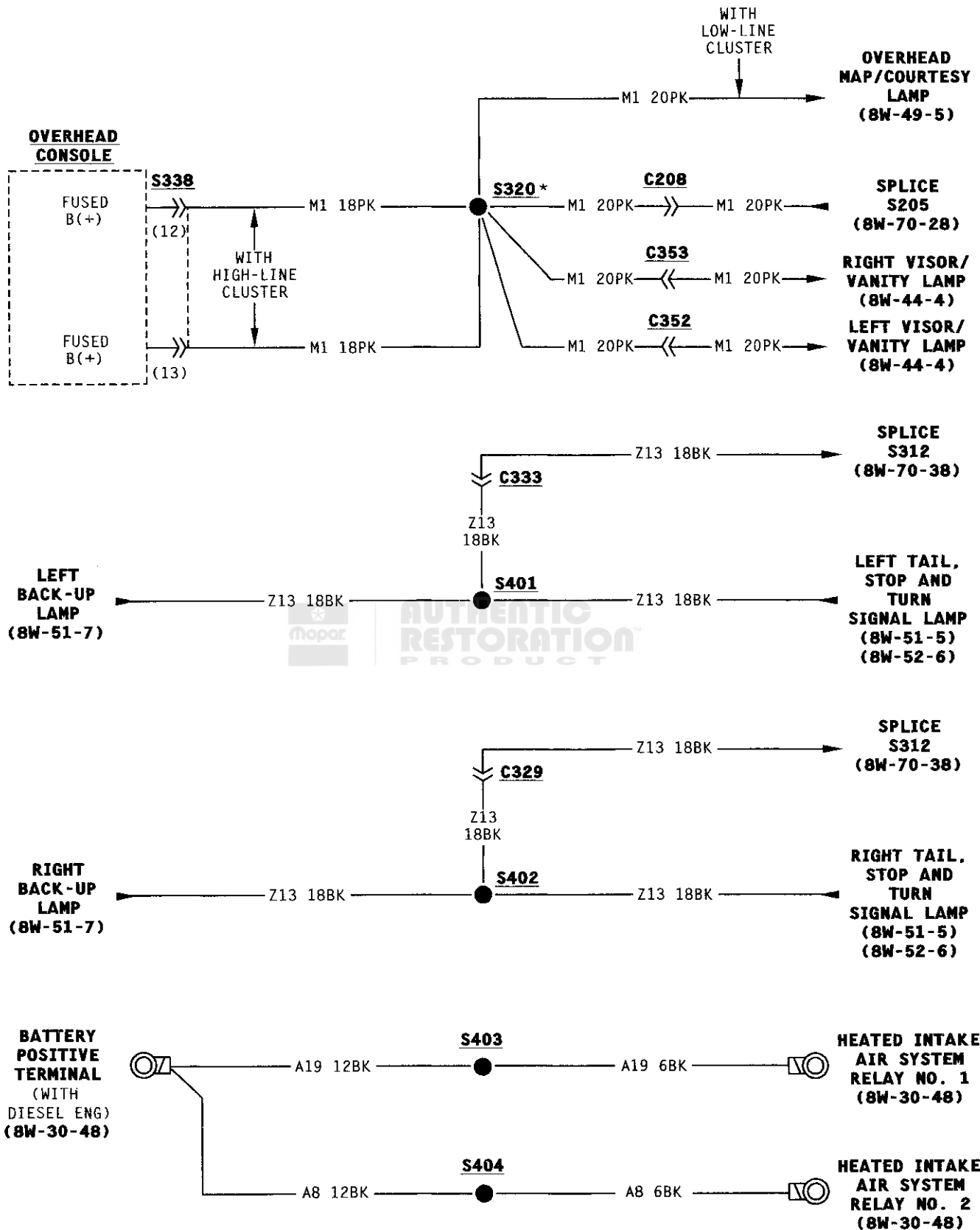




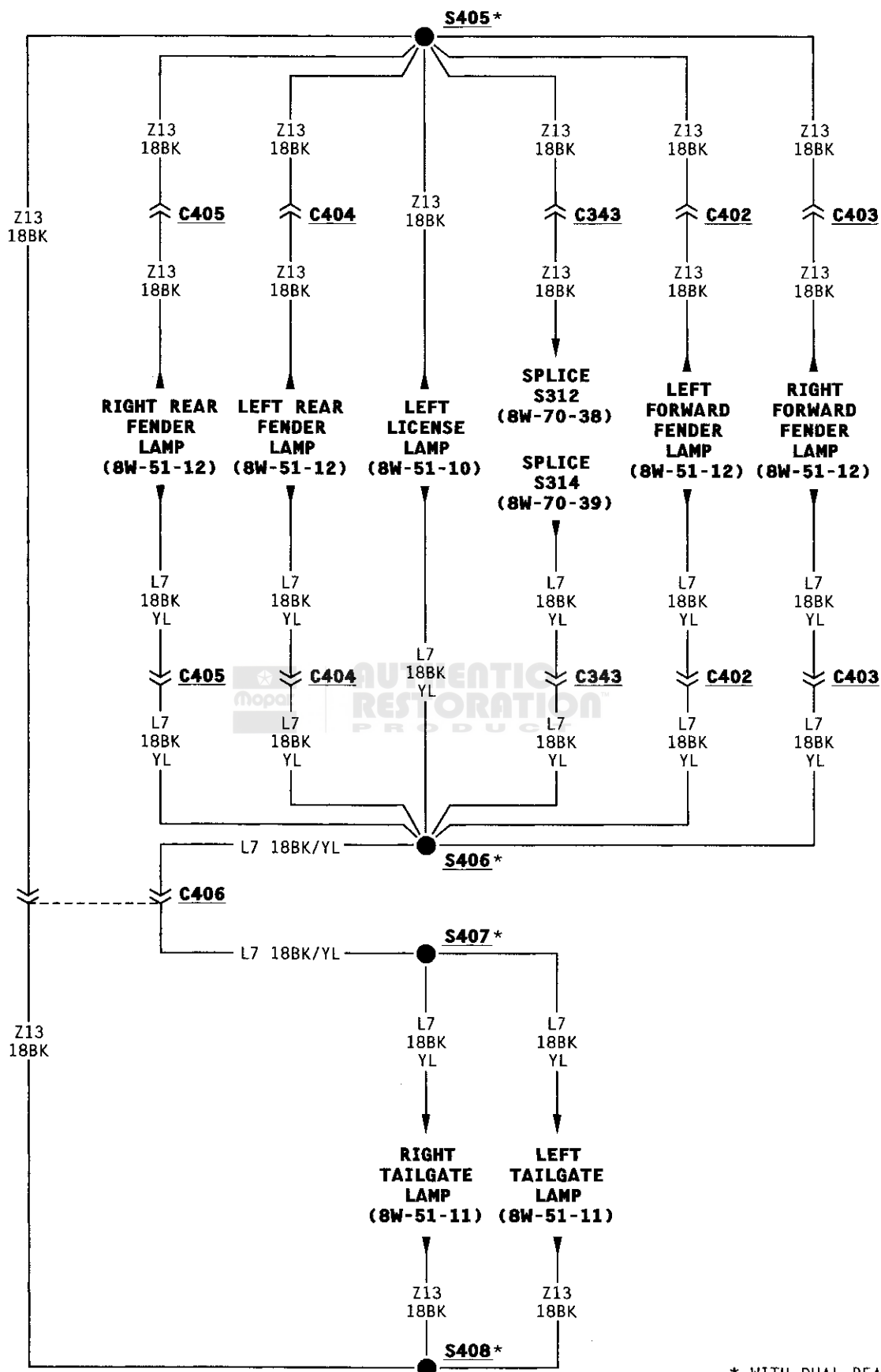


*WITH TRAILER TOW

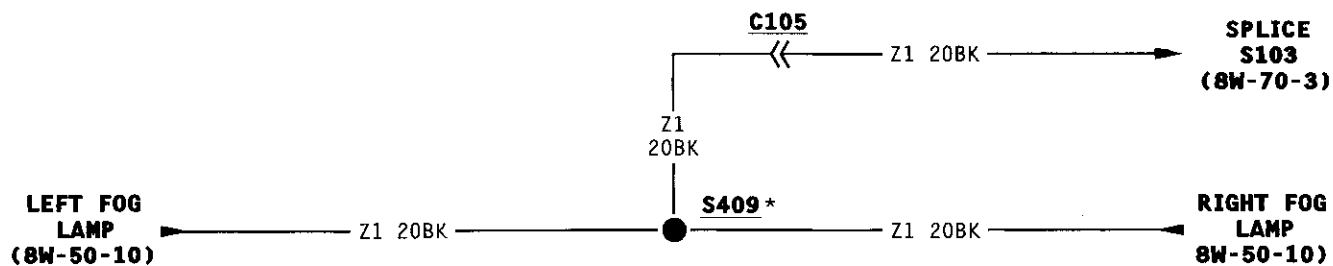




* WITH CONSOLE



* WITH DUAL REAR WHEELS



**AUTHENTIC
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PRODUCT**

8W-80 CONNECTOR PIN-OUTS

DESCRIPTION AND OPERATION

INTRODUCTION

The pages referenced in this section show the connector, the circuits in the connector, and the pin that circuit occupies. Individual connector numbers are referenced on diagram pages throughout Group 8W.



**AUTHENTIC
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PRODUCT**

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C150	8W-80-31
C151	8W-80-31
C152	8W-80-31
C153	8W-80-32
C154	8W-80-32

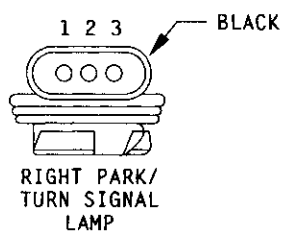
8050cd88

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C163	8W-80-34
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C165	8W-80-34
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C168	8W-80-35
C169	8W-80-35
C170	8W-80-35
C171	8W-80-35
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C177	8W-80-37
C178	8W-80-37
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C180	8W-80-37
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C182	8W-80-37
C183	8W-80-38
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C187	8W-80-39
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C192	8W-80-40
C193	8W-80-40
C194	8W-80-40
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C201	8W-80-41
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C205	8W-80-42
C206	8W-80-42
C207	8W-80-42
C208	8W-80-43
C209	8W-80-43
C210	8W-80-44
C212	8W-80-44
C213	8W-80-45
C214	8W-80-45
C215	8W-80-45

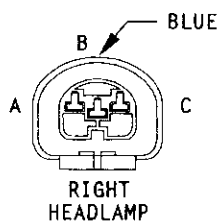
J968W-9

DIAGRAM INDEX

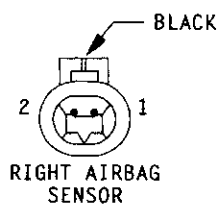
Connector	Page	Connector	Page
C216	8W-80-46	C332	8W-80-59
C217	8W-80-46	C333	8W-80-59
C218	8W-80-46	C334	8W-80-59
C219	8W-80-47	C335	8W-80-59
C223	8W-80-47	C336	8W-80-60
C224	8W-80-48	C337	8W-80-60
C225	8W-80-48	C338	8W-80-60
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C302	8W-80-53	C406	8W-80-64
C303	8W-80-53	C407	8W-80-65
C304	8W-80-53	C409	8W-80-65
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C319	8W-80-56	C424	8W-80-68
C320	8W-80-56	C425	8W-80-68
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C322	8W-80-57	C427	8W-80-69
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C325	8W-80-57	C430	8W-80-69
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C328	8W-80-58	C433	8W-80-70
C329	8W-80-58	C434	8W-80-70
C330	8W-80-58	C435	8W-80-71
C331	8W-80-59	C436	8W-80-71

**C101**

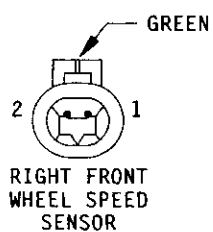
CAV	CIRCUIT	FUNCTION
1	Z1 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
3	L60 18LG/TN	RIGHT TURN SIGNAL

**C102**

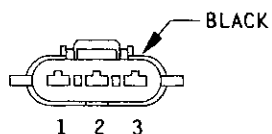
CAV	CIRCUIT	FUNCTION
A	Z1 20BK	GROUND
B	L4 16VT/WT	DIMMER SWITCH LOW BEAM OUTPUT
C	L3 16RD/OR	DIMMER SWITCH HIGH BEAM OUTPUT

**C103**

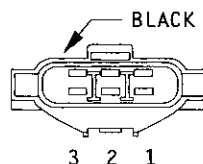
CAV	CIRCUIT	FUNCTION
1	R48 18TN	RIGHT IMPACT SENSOR LINE 2
2	R46 18BR/LB	RIGHT IMPACT SENSOR LINE 1

**C104**

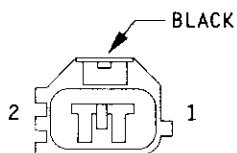
CAV	CIRCUIT	FUNCTION
1	B6 20WT/DB	RIGHT FRONT WHEEL SPEED SENSOR (-)
2	B7 20WT	RIGHT FRONT WHEEL SPEED SENSOR (+)

**C105**

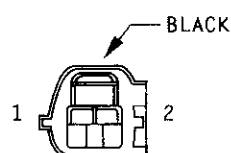
CAV	CIRCUIT
1	L39 20LB
2	L39 20LB
3	Z1 20BK



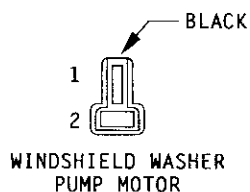
CAV	CIRCUIT
1	L39 20LB
2	L39 20LB
3	Z1 20BK

**C106**

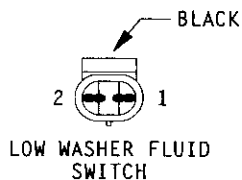
CAV	CIRCUIT
1	G107 18BK/GY
2	Z1 18BK



CAV	CIRCUIT
1	G107 20BK/GY
2	Z1 20BK

**C107**

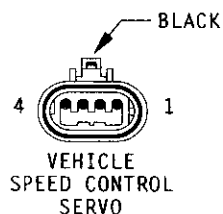
CAV	CIRCUIT	FUNCTION
1	V10 18BR	WASHER PUMP CONTROL SWITCH OUTPUT
2	Z1 20BK	GROUND

**C108**

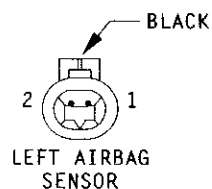
CAV	CIRCUIT	FUNCTION
1	G29 18BK/TN	WASHER FLUID SWITCH SENSE
2	Z1 18BK	GROUND



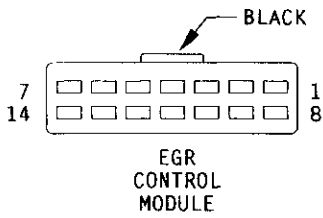
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**C109**

CAV	CIRCUIT	FUNCTION
1	V36 20TN/RD	SPEED CONTROL VACUUM SOLENOID CONTROL
2	V35 20LG/RD	SPEED CONTROL VENT SOLENOID CONTROL
3	V30 20DB/RD	SPEED CONTROL ON/OFF SWITCH OUTPUT
4	Z1 20BK	GROUND

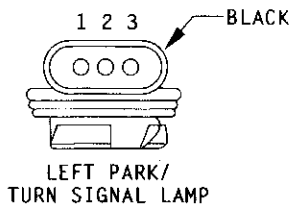
**C110**

CAV	CIRCUIT	FUNCTION
1	R49 18LB/WT	LEFT IMPACT SENSOR LINE 2
2	R47 18DB/LB	LEFT IMPACT SENSOR LINE 1



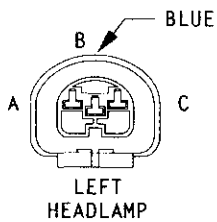
C111

CAV	CIRCUIT	FUNCTION
1	A142 20DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	-	-
3	K22 200R/DB	THROTTLE POSITION SENSOR SIGNAL
4	K321 20BK/PK	EGR IAT (+)
5	K204 20BK/WT	EGR IAT (-)
6	K2 20TN/BK	EGR ENGINE COOLANT TEMPERATURE SENSOR SIGNAL
7	K304 20BK/LG	EGR COOLANT TEMPERATURE SENSOR GROUND
8	-	-
9	D28 20LG/RD	EGR OUTPUT SIGNAL
10	Z12 18BK/TN	GROUND
11	D29 20PK/DG	EGR DIAGNOSTIC SIGNAL
12	K6 20VT/WT	5 VOLT SUPPLY
13	-	-
14	K35 18GY/YL	EGR SOLENOID CONTROL



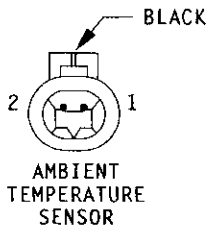
C112

CAV	CIRCUIT	FUNCTION
1	Z1 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
3	L61 18LG/TN	LEFT TURN SIGNAL



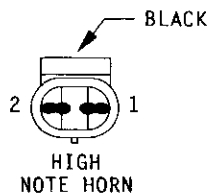
C113

CAV	CIRCUIT	FUNCTION
A	Z1 20BK	GROUND
B	L4 16VT/WT	DIMMER SWITCH LOW BEAM OUTPUT
C	L3 16RD/OR	DIMMER SWITCH HIGH BEAM OUTPUT



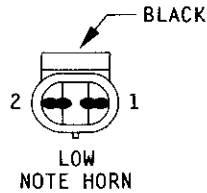
C114

CAV	CIRCUIT	FUNCTION
1	G31 18VT/LG	AMBIENT TEMPERATURE SENSOR SIGNAL
2	G32 18BK/VT	SENSOR GROUND

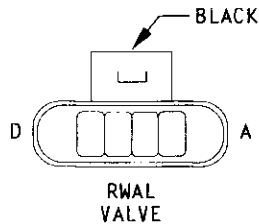


C115

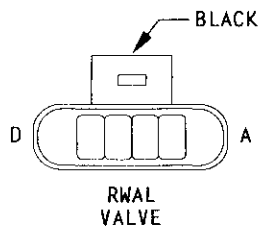
CAV	CIRCUIT	FUNCTION
1	X2 18DG/RD	HORN RELAY OUTPUT
2	Z1 18BK	GROUND


C116

CAV	CIRCUIT	FUNCTION
1	X2 18DG/RD	HORN RELAY OUTPUT
2	Z1 18BK	GROUND


C117 (WITH RWAL)

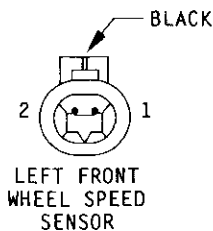
CAV	CIRCUIT	FUNCTION
A	B101 18LG/WT	RWAL ISOLATION SOLENOID
B	Z8 16BK/PK	GROUND
C	B111 18LB/BK	RWAL RESET SWITCH
D	B108 18WT	RWAL DUMP SOLENOID


C117 (WITH ABS)

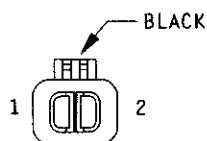
CAV	CIRCUIT	FUNCTION
A	B252 18BR/TN	REAR ISOLATION VALVE CONTROL
B	B120 12BR/WT	ABS PUMP MOTOR RELAY OUTPUT
C	B19 20LB	REAR VALVE RESET SWITCH SENSE
D	B254 16DG/OR	REAR DUMP VALVE CONTROL



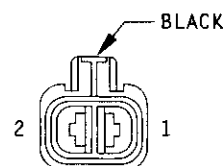
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C118 (WITH ABS)

CAV	CIRCUIT	FUNCTION
1	B8 20RD/GY	LEFT FRONT WHEEL SPEED SENSOR (-)
2	B9 20RD	LEFT FRONT WHEEL SPEED SENSOR (+)

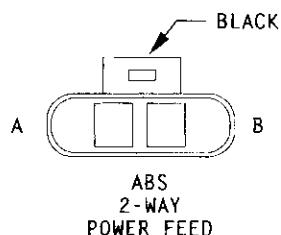

C119

CAV	CIRCUIT
1	A15 16PK*
1	A15 20BK**
2	T40 12BR

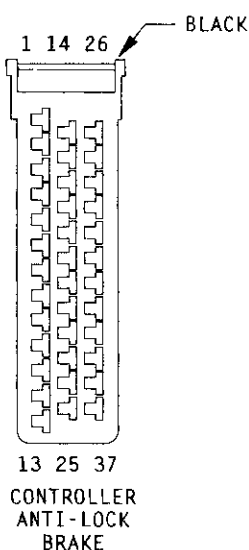


CAV	CIRCUIT
1	A15 16PK
2	T40 12BR

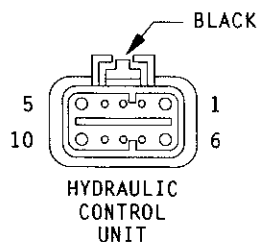
* WITH GAS ENG
** WITH DIESEL ENG

**C120**

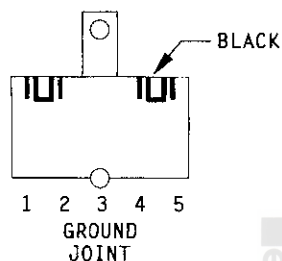
CAV	CIRCUIT	FUNCTION
A	Z8 10BK/PK	GROUND
B	B60 12LB/BK	PUMP/MOTOR CONTROL

C121 (WITH ABS)

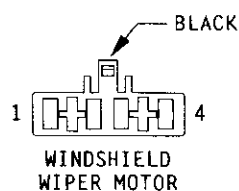
CAV	CIRCUIT	FUNCTION
1	B113 20RD/VT	RIGHT REAR WHEEL SPEED SENSOR (+)
2	B7 20WT	RIGHT FRONT WHEEL SPEED SENSOR (+)
3	B9 20RD	LEFT FRONT WHEEL SPEED SENSOR (+)
4	B116 20GY	ABS PUMP MOTOR RELAY CONTROL
5	B5 20VT/RD	LEFT FRONT RESET SWITCH SENSE
6	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
7	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
8	G107 20BK/GY	4WD SENSE
9	V40 20WT/PK	BRAKE SWITCH SENSE
10	D12 200R	SCI TRANSMIT
11	D11 20WT/RD	SCI RECEIVE
12	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
13	B47 20RD/LB	ABS WARNING LAMP RELAY CONTROL
14	B114 20WT/VT	RIGHT REAR WHEEL SPEED SENSOR (-)
15	B6 20WT/DB	RIGHT FRONT WHEEL SPEED SENSOR (-)
16	B8 20RD/GY	LEFT FRONT WHEEL SPEED SENSOR (-)
17	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
18	B18 20VT/LG	RIGHT FRONT RESET SWITCH SENSE
19	B19 20LB	REAR VALVE RESET SWITCH SENSE
20	Z7 18BK/RD	GROUND
21	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
22	-	-
23	-	-
24	G19 20LG/RD	ABS WARNING LAMP DRIVER
25	G9 20GY/BK	RED BRAKE WARNING LAMP DRIVER
26	B254 16DG/OR	REAR DUMP VALVE CONTROL
27	-	-
28	B252 18BR/TN	REAR ISOLATION VALVE CONTROL
29	-	-
30	B248 16DG/WT	RIGHT FRONT DUMP VALVE CONTROL
31	-	-
32	-	-
33	B249 18WT/TN	RIGHT FRONT ISOLATION VALVE CONTROL
34	B120 14BR/WT	ABS PUMP MOTOR RELAY OUTPUT
35	B243 16DG/BK	LEFT FRONT DUMP VALVE CONTROL
36	-	-
37	B245 18WT/LG	LEFT FRONT ISOLATION VALVE CONTROL

**C122**

CAV	CIRCUIT	FUNCTION
1	B60 12LB/BK	PUMP/MOTOR CONTROL
2	B249 18WT/TN	RIGHT FRONT ISOLATION VALVE CONTROL
3	B248 16DG/WT	RIGHT FRONT DUMP VALVE CONTROL
4	B18 20VT/LG	RIGHT FRONT RESET SWITCH SENSE
5	B120 12BR/WT	ABS PUMP MOTOR RELAY OUTPUT
6	B120 12BR/WT	ABS PUMP MOTOR RELAY OUTPUT
7	B245 18WT/LG	LEFT FRONT ISOLATION VALVE CONTROL
8	B243 16DG/BK	LEFT FRONT DUMP VALVE CONTROL
9	B5 20VT/RD	LEFT FRONT RESET SWITCH SENSE
10	B120 12BR/WT	ABS PUMP MOTOR RELAY OUTPUT

**C123**

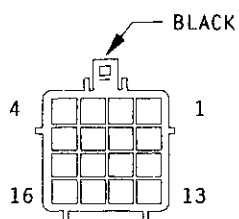
CAV	CIRCUIT	FUNCTION
1	Z1 18BK	GROUND
	Z1 18BK	GROUND
2	Z1 128K**	GROUND
2	Z1 148K*	GROUND
3	Z1 18BK	GROUND
	Z1 18BK	GROUND
4	Z1 14BK*	GROUND
4	Z1 12BK**	GROUND
5	Z1 18BK	GROUND

**C124**

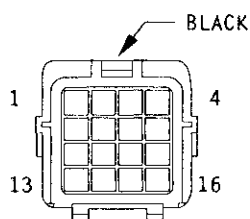
CAV	CIRCUIT	FUNCTION
1	V4 18RD/YL	WIPER SWITCH HIGH SPEED OUTPUT
2	V5 18DG/YL	WIPER SWITCH MODE SENSE
3	V6 18DB/BK	FUSED IGNITION SWITCH OUTPUT
4	V3 18BR/WT	WIPER SWITCH LOW SPEED OUTPUT

- WITH LOW-LINE CLUSTER
- WITH MEDIUM-LINE AND HIGH-LINE CLUSTER
- * WITH MEDIUM-LINE AND LOW-LINE CLUSTER
- ** WITH HIGH-LINE CLUSTER
- ' WITH DIESEL ENG

C125

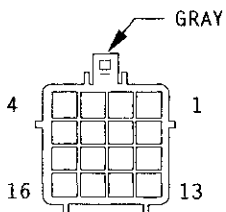


CAV	CIRCUIT
1	G14 18PK/BK*
2	T6 200R/WT*
3	G54 200R/BK**
3	T18 20LG/OR*
4	T41 20BK/WT*
	Z12 20BK/TN**
5	G86 18TN/OR**
6	G85 180R/BK**
7	C13 20DB/OR
8	K51 20DB/YL
9	V40 20WT/PK
10	C90 18LG
11	G12 20TN/YL
12	K118 20PK/YL
13	K4 20BK/LB
15	T16 18RD
16	K30 20PK

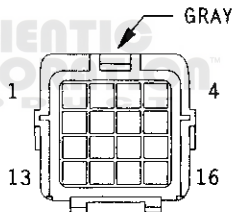


CAV	CIRCUIT
1	G14 18PK/BK
2	T6 220R/WT
3	T18 22LG/OR
4	T41 22BK/WT
5	G86 18TN/OR
6	G85 180R/BK
7	C13 22DB/OR
8	K51 22DB/YL
9	V40 20WT/PK>>
	V40 22WT/PK>
10	C90 18LG
11	G12 20TN/YL
12	K118 20PK/YL
13	K4 20BK/LB
15	T16 18RD
16	K30 20PK

C126



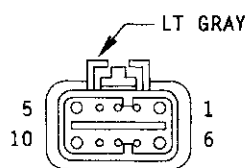
CAV	CIRCUIT
1	F18 18LG/BK
2	V32 20YL/RD
3	V37 20RD/LG
4	Z12 20BK/TN
5	C3 18DB/BK
6	L1 18VT/BK
7	V35 20LG/RD
8	G3 22BK/PK
9	V36 20TN/RD
10	L10 18BR/LG
11	D20 20DG
12	D21 20PK/DB
13	G24 20GY/PK
14	K226 20DB/WT*
15	Z11 20BK/WT



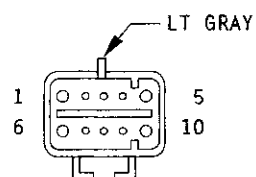
CAV	CIRCUIT
1	F18 18LG/BK
2	V32 20YL/RD
3	V37 20RD/LG
4	Z12 20BK/TN
5	C3 18DB/BK
6	L1 18VT/BK
7	V35 20LG/RD
8	G3 20BK/PK
9	V36 20TN/RD
10	L10 18BR/LG
11	D20 20DG
12	D21 20PK/DB
13	G24 20GY/PK+
14	K226 20DB/WT*
15	Z11 20BK/WT

- + WITH GAS ENG
- > WITH RWAL
- >> WITH ABS
- WITH AUTO TRANS
- WITH MAN TRANS (EXCEPT HEAVY DUTY, DIESEL ENG AND 8.0L ENG)
- * NOT FUNCTIONAL ON DIESEL ENG
- ** WITH DIESEL ENG

C127

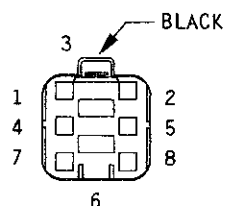


CAV	CIRCUIT
1	A142 14DG/OR
2	G21 22GY/LB
3	K31 20BR/WT
4	G60 22GY/YL
5	T40 12BR
6	A14 16RD/WT
7	G20 22VT/YL
8	G6 22GY
9	G7 22WT/OR
10	Z11 16BK/WT

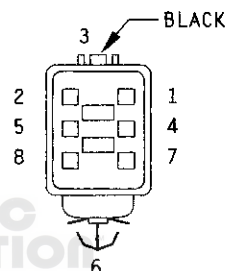


CAV	CIRCUIT
1	A142 14DG/OR
2	G21 20GY/LB
3	K31 20BR/WT*
4	G60 16GY/YL*
4	G60 18GY/YL ¹
5	T40 12BR ¹
6	A14 16RD/WT
7	G20 18VT/YL
8	G6 16GY*
8	G6 18GY ¹
9	G7 20WT/OR
10	Z11 16BK/WT

C128

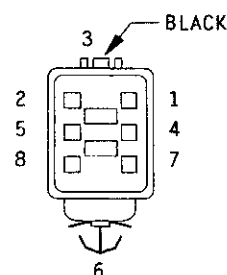


CAV	CIRCUIT
1	B113 20RD/VT
2	B114 20WT/VT
3	Z13 12BK*
3	Z13 16BK**
4	Z11 20BK/WT
5	G4 20DB/OR
6	B40 14LB
7	K4 20BK/LB
8	K104 20DB/WT**

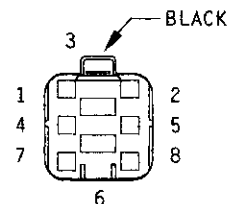


CAV	CIRCUIT
1	B113 20RD/VT
2	B114 20WT/VT
3	Z13 16BK*
3	Z13 12BK**
4	Z11 20BK/WT
5	G4 20DB
6	B40 14LB
7	K4 20BK/LB
8	K226 20DB/WT**

C129

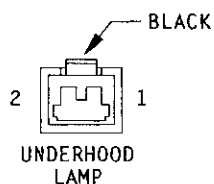


CAV	CIRCUIT
1	L7 18BK/YL
2	-
3	L76 12BK/OR
4	L63 18DG/RD
5	L1 18VT/BK
6	A6 14RD/TN
7	L62 18BR/PK
8	A61 16DG/BK**

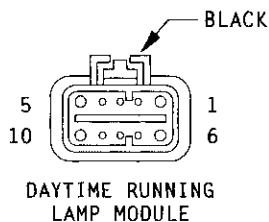


CAV	CIRCUIT
1	L7 18BK/YL
2	-
3	L76 12BK/OR
4	L63 18DG/RD
5	L1 18VT/BK
6	A6 14RD/TN
7	L62 18BR/PK
8	A61 16DG/BK**

- ¹ WITH DIESEL ENG
- ** NOT FUNCTIONAL ON DIESEL
- WITH GAS ENG
- * WITHOUT TRAILER TOW
- ** WITH TRAILER TOW

**C130**

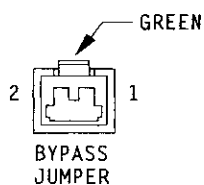
CAV	CIRCUIT	FUNCTION
1	Z1 20BK	GROUND
2	M1 20PK	FUSED B(+)

**C131**

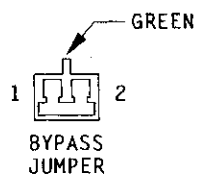
CAV	CIRCUIT	FUNCTION
1	L3 16RD/OR	DIMMER SWITCH HIGH BEAM OUTPUT
2	—	—
3	G11 20WT/BK	PARK BRAKE SWITCH SENSE
4	G34 18RD/GY	HIGH BEAM INDICATOR LAMP DRIVER
5	L10 18BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)
6	A3 12RD/LG	FUSED B(+)
7	—	—
8	Z1 18BK	GROUND
9	Z1 18BK	GROUND
10	L4 16VT/WT	DIMMER SWITCH LOW BEAM OUTPUT



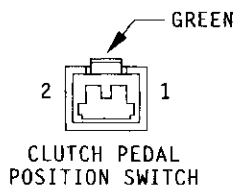
**AUTHENTIC
RESTORATION™
PRODUCT**

C132 (WITH AUTO TRANS)

CAV	CIRCUIT
1	T141 14YL/RD
2	A41 18DB/YL

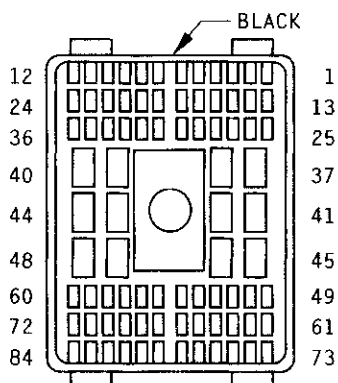


CAV	CIRCUIT
1	T141 20YL/RD
2	T141 20YL/RD

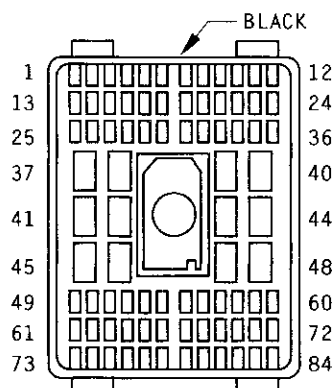
**C132 (WITH MAN TRANS)**

CAV	CIRCUIT	FUNCTION
1	T141 14YL/RD	ENGINE STARTER MOTOR RELAY DRIVER
2	A41 18DB/YL	FUSED IGNITION SWITCH OUTPUT (START)

C133



CAV	CIRCUIT
1	R47 18DB/LB
2	G12 22TN/YL
3	G4 22DB
4	L62 18BR/PK
5	L63 18DG/RD
6	T6 22OR/WT
7	T18 22LG/OR
8	G20 22VT/YL
9	G21 22GY/LB
10	G24 22GY/PK
11	L35 22BR/WT
12	R48 18TN
13	L50 18WT/TN
14	C90 22LG
15	G3 22BK/PK
16	X3 22BK/RD [▲]
16	X3 20BK/RD ^{▲▲}
17	M2 20YL
18	G6 22GY
19	G60 22GY/YL
20	G7 20WT/OR
21	Z12 20BK/TN
22	L1 22VT/BK
23	A41 18DB/YL
24	L39 18LB
25	Z11 20BK/WT
26	G107 20BK/GY ⁺
26	G107 22BK/GY ⁺⁺
27	G34 18RD/GY
28	G9 22GY/BK
29	G29 22BK/TN [*]
30	F18 22LG/BK
31	V30 20DB/RD
32	G11 22WT/BK
33	Z11 18BK/WT
34	M1 20PK
35	V40 22WT/PK
36	Z6 18BK/OR
37	V3 18BR/WT
38	L3 16RD/OR
39	L4 16VT/WT
40	L7 18BK/YL

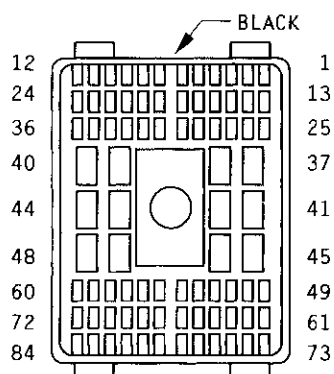


CAV	CIRCUIT
1	R47 18DB/LB
2	G12 20TN/YL
3	G4 20DB
4	L62 18BR/PK
5	L63 18DG/RD
6	T6 22OR/WT
7	T18 22LG/OR
8	G20 22VT/YL
9	G21 22GY/LB
10	G24 20GY/PK
11	L35 22BR/WT
12	R48 18TN
13	L50 18WT/TN
14	C90 18LG
15	G3 22BK/PK
16	X3 22BK/RD
17	M2 18YL
18	G6 22GY
19	G60 22GY/YL
20	G7 22WT/OR
21	Z12 20BK/TN
22	L1 18VT/BK
23	A41 18DB/YL
24	L39 20LB
25	Z11 20BK/WT
26	G107 20BK/GY
27	G34 18RD/GY
28	G9 18GY/BK [*]
28	G9 20GY/BK ^{**}
29	G29 18BK/TN [*]
30	F18 20LG/BK
31	V30 20DB/RD
32	G11 20WT/BK
33	Z11 18BK/WT
34	M1 20PK
35	V40 20WT/PK ⁺⁺
35	V40 22WT/PK ⁺
36	Z6 18BK/OR
37	V3 18BR/WT
38	L3 16RD/OR
39	L4 16VT/WT
40	L7 18BK/YL

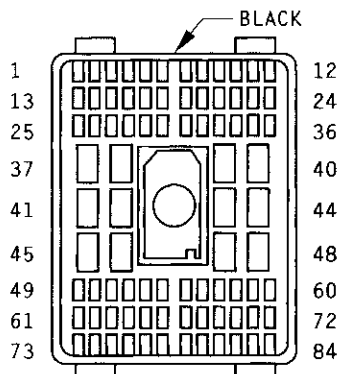
(C133 CONTINUED ON NEXT PAGE)

- WITH SPEED CONTROL, HIGH-LINE CLUSTER
- ▲ WITH POWER WINDOWS AND POWER LOCKS
- ▲▲ WITHOUT POWER WINDOWS AND POWER LOCKS
- + WITH RWAL
- ++ WITH ABS
- * WITH RWAL WITHOUT DIESEL ENG
- ** WITH DIESEL ENG OR ABS

C133 (CONTINUED)

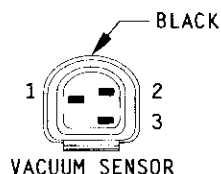


CAV	CIRCUIT
41	A20 18RD/DB
42	A1 12RD
43	A2 12PK/BK
44	L9 18BK/VT
45	V4 16RD/YL
46	B108 18WT
47	A3 12RD/LG
48	A7 12RD/BK
49	Z2 18BK/LG
50	G19 22LG/RD
51	B101 18LG/WT
52	B111 22LB/BK
53	B113 20RD/VT
54	B114 22WT/VT
55	R46 18BR/LB
56	-
57	-
58	R49 18LB
59	G31 22VT/LG '
60	G32 22BK/LB '
61	Z2 18BK/LG
62	L10 22BR/LG
63	-
64	V6 18DB/BK
65	V5 18DG/YL
66	V10 18BR
67	G14 20PK/BK
68	G86 20TN/OR
69	L61 18LG/YL
70	L60 18TN/BK
71	G85 20OR/BK
72	-
73	D21 20PK/DB
74	D20 20DG
75	-
76	D12 22OR
77	D11 22WT/RD
78	-
79	V32 22YL/RD
80	V37 22RD/LG
81	K4 18BK/LB
82	-
83	-
84	-

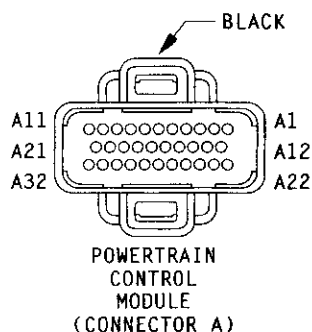


CAV	CIRCUIT
41	A20 18RD/DB
42	A1 12RD
43	A2 12PK/BK
44	L9 18BK/VT
45	V4 18RD/YL
46	B108 18WT
47	A3 12RD/LG
48	A7 12RD/BK
49	Z2 18BK/LG
50	G19 20LG/RD
51	B101 18LG/WT
52	B111 18LB/BK
53	B113 20RD/VT
54	B114 20WT/VT
55	R46 18BR/LB
56	-
57	-
58	R49 18LB/WT
59	G31 18VT/LG '
60	G32 18BK/VT '
61	Z2 18BK/LG
62	L10 20BR/LG**
62	L10 18BR/LG*
63	-
64	V6 18DB/BK
65	V5 18DG/YL
66	V10 18BR
67	G14 18PK/BK
68	G86 18TN/OR
69	L61 20LG/YL
70	L60 20TN/BK
71	G85 18OR/BK
72	-
73	D21 20PK/DB
74	D20 20DG
75	-
76	D12 20OR
77	D11 20WT/RD
78	-
79	V32 20YL/RD
80	V37 20RD/LG
81	K4 20BK/LB
82	-
83	-
84	-

' WITH OVERHEAD CONSOLE
 * WITHOUT DRL
 ** WITH DRL

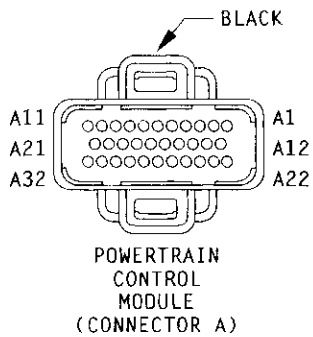
**C134** (WITH DIESEL ENG)

CAV	CIRCUIT	FUNCTION
1	Z1 18BK	GROUND
2	G9 20GY/BK	RED BRAKE WARNING LAMP DRIVER
3	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)

**C135** (3.9L ENG)

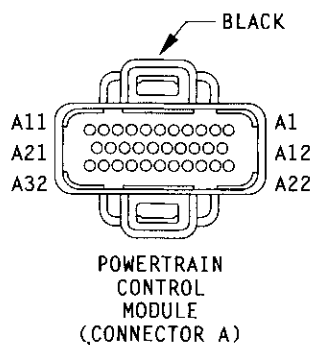
CAV	CIRCUIT	FUNCTION
A1	-	-
A2	F18 20LG/BK	FUSED IGNITION SWITCH INPUT (START/RUN)
A3	-	-
A4	K4 20BK/LB	SENSOR GROUND
A5	-	-
A6	T41 20BK/WT	PARK/NEUTRAL POSITION SWITCH SENSE
A7	K19 16BK/GY	IGNITION COIL NO. 1 DRIVER
A8	K24 20GY/BK	CRANK POSITION SENSOR SIGNAL
A9	-	-
A10	K60 18YL/BK	IDLE AIR CONTROL MOTOR NO. 2 DRIVER
A11	K40 18BR/WT	IDLE AIR CONTROL MOTOR NO. 3 DRIVER
A12	-	-
A13	-	-
A14	-	-
A15	K21 18BK/RD	INTAKE AIR TEMPERATURE SIGNAL
A16	K2 18TN/BK	ENGINE COOLANT TEMPERATURE SENSOR SIGNAL
A17	K6 20VT/WT	5 VOLT SUPPLY
A18	K44 20TN/YL	CAMSHAFT POSITION SENSOR SIGNAL
A19	K39 18GY/RD	IDLE AIR CONTROL MOTOR NO. 1 DRIVER
A20	K59 18VT/BK	IDLE AIR CONTROL MOTOR NO. 4 DRIVER
A21	-	-
A22	A14 16RD/WT	FUSED (B+)
A23	K22 18OR/DB	THROTTLE POSITION SENSOR SIGNAL
A24	K141 18TN/WT	UPSTREAM HEATED OXYGEN SENSOR SIGNAL
A25	K341 18OR/BK	DOWNSTREAM HEATED OXYGEN SENSOR SIGNAL
A26	-	-
A27	K1 18DG/RD	MAP SENSOR SIGNAL
A28	-	-
A29	-	-
A30	-	-
A31	Z12 14BK/TN	GROUND
A32	Z12 14BK/TN	GROUND

C135 (5.2L/5.9L ENG)



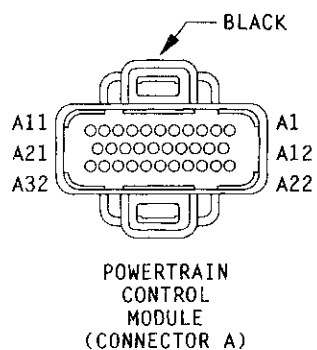
CAV	CIRCUIT	FUNCTION
A1	—	—
A2	F18 20LG/BK	FUSED IGNITION SWITCH INPUT (START/RUN)
A3	—	—
A4	K4 20BK/LB	SENSOR GROUND
A5	—	—
A6	T41 20BK/WT	PARK/NEUTRAL POSITION SWITCH SENSE
A7	K19 16BK/GY	IGNITION COIL NO. 1 DRIVER
A8	K24 20GY/BK	CRANK POSITION SENSOR SIGNAL
A9	—	—
A10	K60 18YL/BK	IDLE AIR CONTROL MOTOR NO. 2 DRIVER
A11	K40 18BR/WT	IDLE AIR CONTROL MOTOR NO. 3 DRIVER
A12	—	—
A13	—	—
A14	—	—
A15	K21 18BK/RD	INTAKE AIR TEMPERATURE SIGNAL
A16	K2 18TN/BK	ENGINE COOLANT TEMPERATURE SENSOR SIGNAL
A17	K6 20VT/WT	5 VOLT SUPPLY
A18	K44 20TN/YL	CAMSHAFT POSITION SENSOR SIGNAL
A19	K39 18GY/RD	IDLE AIR CONTROL MOTOR NO. 1 DRIVER
A20	K59 18VT/BK	IDLE AIR CONTROL MOTOR NO. 4 DRIVER
A21	—	—
A22	A14 16RD/WT	FUSED (B+)
A23	K22 18OR/DB	THROTTLE POSITION SENSOR SIGNAL
A24	K141 18TN/WT*	UPSTREAM HEATED OXYGEN SENSOR SIGNAL
A24	K41 18BK/DG**	UPSTREAM HEATED OXYGEN SENSOR SIGNAL
A25	K341 18OR/BK*	DOWNSTREAM HEATED OXYGEN SENSOR SIGNAL
A26	K241 18BK/DG**	DOWNSTREAM HEATED OXYGEN SENSOR SIGNAL
A27	K1 18DG/RD	MAP SENSOR SIGNAL
A28	—	—
A29	—	—
A30	—	—
A31	Z12 14BK/TN	GROUND
A32	Z12 14BK/TN	GROUND

* WITHOUT HEAVY DUTY
 ** WITH 5.9L HEAVY DUTY



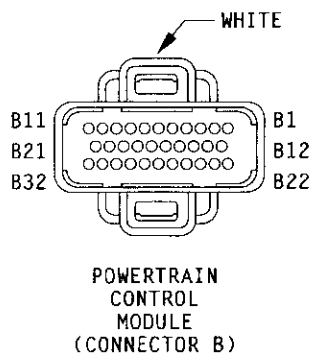
C135 (8.0L ENG)

CAV	CIRCUIT	FUNCTION
A1	K32 18YL/GY	IGNITION COIL NO. 4 DRIVER
A2	F18 20LG/BK	FUSED IGNITION SWITCH INPUT (START/RUN)
A3	K18 18RD/BK	IGNITION COIL NO. 3 DRIVER
A4	K4 20BK/LB	SENSOR GROUND
A5	K43 18DG/GY	IGNITION COIL NO. 5 DRIVER
A6	T41 20BK/WT	PARK/NEUTRAL POSITION SWITCH SENSE
A7	K19 18BK/GY	IGNITION COIL NO. 1 DRIVER
A8	K24 20GY/BK	CRANK POSITION SENSOR SIGNAL
A9	K17 18DB/WT	IGNITION COIL NO. 2 DRIVER
A10	K60 18YL/BK	IDLE AIR CONTROL MOTOR NO. 2 DRIVER
A11	K40 18BR/WT	IDLE AIR CONTROL MOTOR NO. 3 DRIVER
A12	-	-
A13	-	-
A14	-	-
A15	K21 18BK/RD	INTAKE AIR TEMPERATURE SIGNAL
A16	K2 18TN/BK	ENGINE COOLANT TEMPERATURE SENSOR SIGNAL
A17	K6 20VT/WT	5 VOLT SUPPLY
A18	K44 20TN/YL	CAMSHAFT POSITION SENSOR SIGNAL
A19	K39 18GY/RD	IDLE AIR CONTROL MOTOR NO. 1 DRIVER
A20	K59 18VT/BK	IDLE AIR CONTROL MOTOR NO. 4 DRIVER
A21	-	-
A22	A14 16RD/WT	FUSED (B+)
A23	K22 180R/DB	THROTTLE POSITION SENSOR SIGNAL
A24	K141 18TN/WT	LEFT UPSTREAM HEATED OXYGEN SENSOR SIGNAL
A25	K341 180R/BK*	POST CATALYST HEATED OXYGEN SENSOR SIGNAL
A26	K41 18BK/DG	RIGHT UPSTREAM HEATED OXYGEN SENSOR SIGNAL
A27	K1 18DG/RD	MAP SENSOR SIGNAL
A28	-	-
A29	K441 18TN/RD*	PRE-CATALYST HEATED OXYGEN SENSOR SIGNAL
A30	-	-
A31	Z12 14BK/TN	GROUND
A32	Z12 14BK/TN	GROUND



C135 (DIESEL ENG)

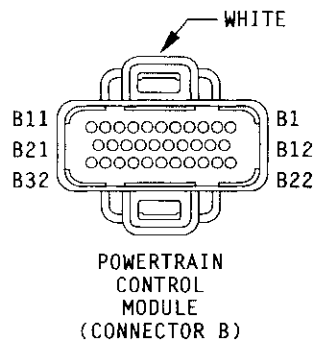
CAV	CIRCUIT	FUNCTION
A1	—	—
A2	F18 18LG/BK	FUSED IGNITION SWITCH INPUT (START/RUN)
A3	—	—
A4	K4 20BK/LB	SENSOR GROUND
A5	—	—
A6	T41 20BK/WT	PARK/NEUTRAL POSITION SWITCH SENSE
A7	S21 20YL/BK	AIR INTAKE HEATER RELAY NO. 1 CONTROL
A8	K24 20GY/BK	ENGINE SPEED SENSOR SIGNAL
A9	S22 200R/BK	AIR INTAKE HEATER RELAY NO. 2 CONTROL
A10	—	—
A11	—	—
A12	D28 20LG/RD	EGR ON/OFF SIGNAL
A13	—	—
A14	—	—
A15	K21 16BK/RD	INTAKE AIR TEMPERATURE SIGNAL
A16	—	—
A17	K6 20VT/WT	5 VOLT SUPPLY
A18	—	—
A19	—	—
A20	—	—
A21	—	—
A22	A14 16RD/WT	FUSED (B+)
A23	K22 200R/DB	THROTTLE POSITION SENSOR SIGNAL
A24	—	—
A25	—	—
A26	—	—
A27	K1 20DG/RD	WATER-IN-FUEL SENSOR SIGNAL
A28	—	—
A29	—	—
A30	—	—
A31	Z12 14BK/TN	GROUND
A32	Z12 14BK/TN	GROUND



C136 (3.9L ENG)

CAV	CIRCUIT	FUNCTION
B1	T54 18VT	TRANSMISSION TEMPERATURE SENSOR SIGNAL
B2	—	—
B3	—	—
B4	K11 18WT/DB	INJECTOR NO. 1 DRIVER
B5	K13 18YL/WT	INJECTOR NO. 3 DRIVER
B6	K38 18GY	INJECTOR NO. 5 DRIVER
B7	—	—
B8	K88 20VT/WT	VARIABLE FORCE SOLENOID CONTROL
B9	—	—
B10	—	—
B10	K20 18DG	GENERATOR FIELD DRIVER
B11	G54 200R/BK*	UPSHIFT LAMP DRIVER
B11	K54 200R/BK**	TORQUE CONVERTER CLUTCH SOLENOID CONTROL
B12	K58 18BR/DB	INJECTOR NO. 6 DRIVER
B13	—	—
B14	—	—
B15	K12 18TN	INJECTOR NO. 2 DRIVER
B16	K14 18LB/BR	INJECTOR NO. 4 DRIVER
B17	—	—
B18	—	—
B19	—	—
B20	—	—
B21	T60 20BR	OVERDRIVE SOLENOID CONTROL
B22	K221 18TN/PK	FUEL TEMPERATURE SENSOR SIGNAL
B23	—	—
B24	—	—
B25	T13 18DB/BK	OUTPUT SHAFT SPEED SENSOR GROUND
B26	—	—
B27	G7 20WT/OR	VEHICLE SPEED SENSOR SIGNAL
B28	T14 18LG/BK	OUTPUT SHAFT SPEED SENSOR SIGNAL
B29	T25 20LG/WT	GOVERNOR PRESSURE SIGNAL
B30	K30 20PK	TRANSMISSION RELAY CONTROL
B31	K7 18OR	5 VOLT SUPPLY
B32	—	—

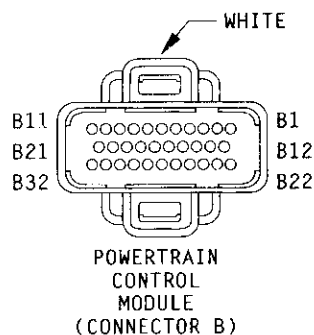
* WITH MAN TRANS (EXCEPT HEAVY DUTY AND DIESEL)
 ** WITH AUTO TRANS



C136 (5.2L/5.9L ENG)

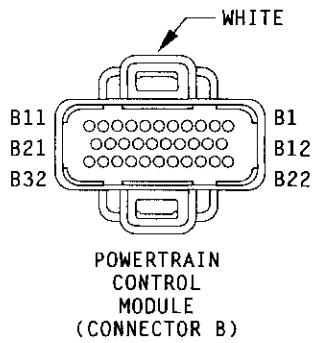
CAV	CIRCUIT	FUNCTION
B1	T54 18VT	TRANSMISSION TEMPERATURE SENSOR SIGNAL
B2	K26 18VT/TN	INJECTOR NO. 7 DRIVER
B3	—	—
B4	K11 18WT/DB	INJECTOR NO. 1 DRIVER
B5	K13 18YL/WT	INJECTOR NO. 3 DRIVER
B6	K38 18GY	INJECTOR NO. 5 DRIVER
B7	—	—
B8	K88 20VT/WT	VARIABLE FORCE SOLENOID CONTROL
B9	—	—
B10	K20 18DG	GENERATOR FIELD DRIVER
B11	G54 200R/BK*	UPSHIFT LAMP DRIVER
B11	K54 200R/BK**	TORQUE CONVERTER CLUTCH SOLENOID CONTROL
B12	K58 18BR/DB	INJECTOR NO. 6 DRIVER
B13	K28 18GY/LB	INJECTOR NO. 8 DRIVER
B14	—	—
B15	K12 18TN	INJECTOR NO. 2 DRIVER
B16	K14 18LB/BR	INJECTOR NO. 4 DRIVER
B17	—	—
B18	—	—
B19	—	—
B20	—	—
B21	T60 20BR	OVERDRIVE SOLENOID CONTROL
B22	K221 18TN/PK	FUEL TEMPERATURE SENSOR SIGNAL
B23	—	—
B24	—	—
B25	T13 18DB/BK	OUTPUT SHAFT SPEED SENSOR GROUND
B26	—	—
B27	G7 20WT/OR	VEHICLE SPEED SENSOR SIGNAL
B28	T14 18LG/BK	OUTPUT SHAFT SPEED SENSOR SIGNAL
B29	T25 20LG/WT	GOVERNOR PRESSURE SIGNAL
B30	K30 20PK	TRANSMISSION RELAY CONTROL
B31	K7 18OR	5 VOLT SUPPLY
B32	K35 20GY/YL	EGR SOLENOID CONTROL

* WITH MAN TRANS (EXCEPT HEAVY DUTY AND DIESEL)
 ** WITH AUTO TRANS



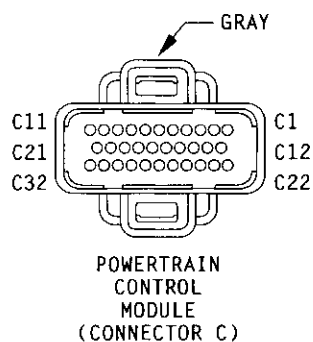
C136 (8.0L ENG)

CAV	CIRCUIT	FUNCTION
B1	T54 18VT	TRANSMISSION TEMPERATURE SENSOR SIGNAL
B2	K26 18VT/TN	INJECTOR NO. 7 DRIVER
B3	K115 18TN	INJECTOR NO. 9 DRIVER
B4	K11 18WT/DB	INJECTOR NO. 1 DRIVER
B5	K13 18YL/WT	INJECTOR NO. 3 DRIVER
B6	K38 18GY	INJECTOR NO. 5 DRIVER
B7	-	-
B8	K88 20VT/WT	VARIABLE FORCE SOLENOID CONTROL
B9	-	-
B10	K20 18DG	GENERATOR FIELD DRIVER
B11	K54 200R/BK*	TORQUE CONVERTER CLUTCH SOLENOID CONTROL
B12	K58 18BR/DB	INJECTOR NO. 6 DRIVER
B13	K28 18GY/LB	INJECTOR NO. 8 DRIVER
B14	K116 18WT/DB	INJECTOR NO. 10 DRIVER
B15	K12 18TN	INJECTOR NO. 2 DRIVER
B16	K14 18LB/BR	INJECTOR NO. 4 DRIVER
B17	-	-
B18	-	-
B19	-	-
B20	-	-
B21	T60 20BR	OVERDRIVE SOLENOID CONTROL
B22	-	-
B23	-	-
B24	-	-
B25	T13 18DB/BK	OUTPUT SHAFT SPEED SENSOR GROUND
B26	-	-
B27	G7 20WT/OR	VEHICLE SPEED SENSOR SIGNAL
B28	T14 18LG/BK	OUTPUT SHAFT SPEED SENSOR SIGNAL
B29	T25 20LG/WT	GOVERNOR PRESSURE SIGNAL
B30	K30 20PK	TRANSMISSION RELAY CONTROL
B31	K7 18OR	5 VOLT SUPPLY
B32	-	-



C136 (DIESEL ENG)

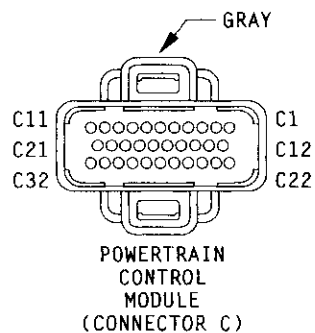
CAV	CIRCUIT	FUNCTION
B1	T54 18VT	TRANSMISSION TEMPERATURE SENSOR SIGNAL
B2	—	—
B3	—	—
B4	—	—
B5	—	—
B6	—	—
B7	—	—
B8	K88 20VT/WT	VARIABLE FORCE SOLENOID CONTROL
B9	—	—
B10	K20 18DG	GENERATOR FIELD DRIVER
B11	K54 200R/BK*	TORQUE CONVERTER CLUTCH SOLENOID CONTROL
B12	—	—
B13	—	—
B14	—	—
B15	—	—
B16	—	—
B17	—	—
B18	—	—
B19	—	—
B20	G85 180R/BK	WAIT-TO-START WARNING LAMP DRIVER
B21	T60 20BR	OVERDRIVE SOLENOID CONTROL
B22	—	—
B23	—	—
B24	—	—
B25	T13 180B/BK	OUTPUT SHAFT SPEED SENSOR GROUND
B26	—	—
B27	G7 20WT/OR	VEHICLE SPEED SENSOR SIGNAL
B28	T14 18LG/BK	OUTPUT SHAFT SPEED SENSOR SIGNAL
B29	T25 20LG/WT	GOVERNOR PRESSURE SIGNAL
B30	K30 20PK	TRANSMISSION RELAY CONTROL
B31	K7 180R	5 VOLT SUPPLY
B32	—	—



C137 (3.9L ENG)

CAV	CIRCUIT	FUNCTION
C1	C13 20DB/OR	A/C COMPRESSOR CLUTCH RELAY CONTROL
C2	-	-
C3	K51 20DB/YL	AUTO SHUT DOWN RELAY CONTROL
C4	V36 20TN/RD	SPEED CONTROL VACUUM SOLENOID CONTROL
C5	V35 20LG/RD	SPEED CONTROL VENT SOLENOID CONTROL
C6	T18 20LG/OR*	OVERDRIVE LAMP DRIVER
C7	G14 18PK/BK*	TRANSMISSION TEMPERATURE LAMP DRIVER
C8	-	-
C9	-	-
C10	-	-
C11	V32 20YL/RD*	SPEED CONTROL FEED
C12	A142 16DG/OR	AUTO SHUT DOWN RELAY SENSE
C13	T6 200R/WT	TRANSMISSION OVERDRIVE SWITCH SENSE
C14	-	-
C15	K118 20PK/YL	BATTERY TEMPERATURE SENSOR SIGNAL
C16	G12 20TN/YL	GEN LAMP DRIVER
C17	G3 20BK/PK	MALFUNCTION INDICATOR LAMP DRIVER
C18	G24 20GY/PK	SERVICE REMINDER INDICATOR LAMP DRIVER
C19	K31 20BR/WT	FUEL PUMP RELAY CONTROL
C20	K52 20PK	EVAPORATIVE EMISSION SOLENOID CONTROL
C21	-	-
C22	C20 18BR	A/C REQUEST
C23	C90 18LG	A/C SELECT INPUT
C24	V40 20WT/PK	BRAKE SWITCH SENSE
C25	-	-
C26	K226 20DB/WT	LOW FUEL SENSE
C27	D21 20PK/DB	SCI TRANSMIT
C28	-	-
C29	D20 20DG	SCI RECEIVE
C30	-	-
C31	G21 20GY/LB	TACHOMETER SIGNAL
C32	V37 20RD/LG	SPEED CONTROL SWITCH SIGNAL

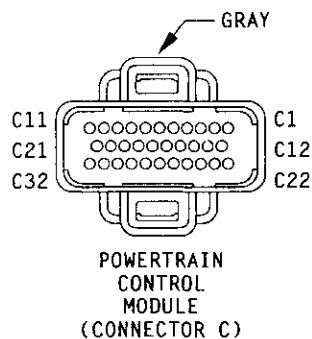
- WITH SPEED CONTROL, HIGH-LINE CLUSTER
- * WITH AUTO TRANS



C137 (5.2L/5.9L ENG)

CAV	CIRCUIT	FUNCTION
C1	C13 20DB/OR	A/C COMPRESSOR CLUTCH RELAY CONTROL
C2	-	-
C3	K51 20DB/YL	AUTO SHUT DOWN RELAY CONTROL
C4	V36 20TN/RD	SPEED CONTROL VACUUM SOLENOID CONTROL
C5	V35 20LG/RD	SPEED CONTROL VENT SOLENOID CONTROL
C6	T18 20LG/OR*	OVERDRIVE LAMP DRIVER
C7	G14 18PK/BK*	TRANSMISSION TEMPERATURE LAMP DRIVER
C8	-	-
C9	-	-
C10	-	-
C11	V32 20YL/RD*	SPEED CONTROL FEED
C12	A142 16DG/OR	AUTO SHUT DOWN RELAY SENSE
C13	T6 20OR/WT	TRANSMISSION OVERDRIVE SWITCH SENSE
C14	-	-
C15	K118 20PK/YL	BATTERY TEMPERATURE SENSOR SIGNAL
C16	G12 20TN/YL	GEN LAMP DRIVER
C17	G3 20BK/PK	MALFUNCTION INDICATOR LAMP DRIVER
C18	G24 20GY/PK	SERVICE REMINDER INDICATOR LAMP DRIVER
C19	K31 20BR/WT	FUEL PUMP RELAY CONTROL
C20	K52 20PK	EVAPORATIVE EMISSION SOLENOID CONTROL
C21	-	-
C22	C20 18BR	A/C REQUEST
C23	C90 18LG	A/C SELECT INPUT
C24	V40 20WT/PK	BRAKE SWITCH SENSE
C25	-	-
C26	K226 20DB/WT	LOW FUEL SENSE
C27	D21 20PK/DB	SCI TRANSMIT
C28	-	-
C29	D20 20DG	SCI RECEIVE
C30	-	-
C31	G21 20GY/LB	TACHOMETER SIGNAL
C32	V37 20RD/LG	SPEED CONTROL SWITCH SIGNAL

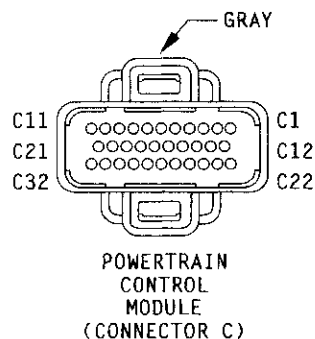
• WITH SPEED CONTROL, HIGH-LINE CLUSTER
* WITH AUTO TRANS



C137 (8.0L ENG)

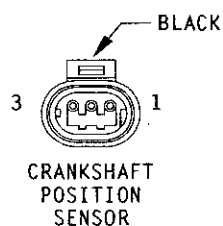
CAV	CIRCUIT	FUNCTION
C1	C13 20DB/OR	A/C COMPRESSOR CLUTCH RELAY CONTROL
C2	—	—
C3	K51 20DB/YL	AUTO SHUT DOWN RELAY CONTROL
C4	V36 20TN/RD	SPEED CONTROL VACUUM SOLENOID CONTROL
C5	V35 20LG/RD	SPEED CONTROL VENT SOLENOID CONTROL
C6	T18 20LG/OR*	OVERDRIVE LAMP DRIVER
C7	G14 18PK/BK*	TRANSMISSION TEMPERATURE LAMP DRIVER
C8	—	—
C9	—	—
C10	—	—
C11	V32 20YL/RD*	SPEED CONTROL FEED
C12	A142 16DG/OR	AUTO SHUT DOWN RELAY SENSE
C13	T6 200R/WT	TRANSMISSION OVERDRIVE SWITCH SENSE
C14	—	—
C15	K118 20PK/YL	BATTERY TEMPERATURE SENSOR SIGNAL
C16	G12 20TN/YL	GEN LAMP DRIVER
C17	G3 20BK/PK	MALFUNCTION INDICATOR LAMP DRIVER
C18	G24 20GY/PK	SERVICE REMINDER INDICATOR LAMP DRIVER
C19	K31 20BR/WT	FUEL PUMP RELAY CONTROL
C20	K52 20PK	EVAPORATIVE EMISSION SOLENOID CONTROL
C21	—	—
C22	C20 18BR	A/C REQUEST
C23	C90 18LG	A/C SELECT INPUT
C24	V40 20WT/PK	BRAKE SWITCH SENSE
C25	—	—
C26	K226 20DB/WT	LOW FUEL SENSE
C27	D21 20PK/DB	SCI TRANSMIT
C28	—	—
C29	D20 20DG	SCI RECEIVE
C30	—	—
C31	G21 20GY/LB	TACHOMETER SIGNAL
C32	V37 20RD/LG	SPEED CONTROL SWITCH SIGNAL

• WITH SPEED CONTROL, HIGH-LINE CLUSTER
* WITH AUTO TRANS

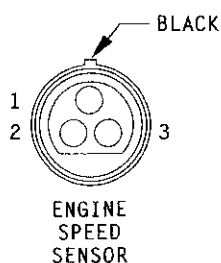
**C137** (DIESEL ENG)

CAV	CIRCUIT	FUNCTION
C1	C13 20DB/OR	A/C COMPRESSOR CLUTCH RELAY CONTROL
C2	-	-
C3	K51 20DB/YL	AUTO SHUT DOWN RELAY CONTROL
C4	V36 20TN/RD	SPEED CONTROL VACUUM SOLENOID CONTROL
C5	V35 20LG/RD	SPEED CONTROL VENT SOLENOID CONTROL
C6	T18 20LG/OR*	OVERDRIVE LAMP DRIVER
C7	G14 18PK/BK*	TRANSMISSION TEMPERATURE LAMP DRIVER
C8	-	-
C9	D29 20PK/DG	EGR DIAGNOSTIC SIGNAL
C10	-	-
C11	V32 20YL/RD*	SPEED CONTROL FEED
C12	A142 16DG/OR	AUTO SHUT DOWN RELAY SENSE
C13	T6 20OR/WT	TRANSMISSION OVERDRIVE SWITCH SENSE
C14	-	-
C15	K118 20PK/YL	BATTERY TEMPERATURE SENSOR SIGNAL
C16	G12 20TN/YL	GEN LAMP DRIVER
C17	G3 20BK/PK	MALFUNCTION INDICATOR LAMP DRIVER
C18	G86 18TN/OR	WATER-IN-FUEL WARNING LAMP DRIVER
C19	-	-
C20	-	-
C21	-	-
C22	C20 18BR	A/C REQUEST
C23	C90 18LG	A/C SELECT INPUT
C24	V40 20WT/PK	BRAKE SWITCH SENSE
C25	-	-
C26	-	-
C27	D21 20PK/DB	SCI TRANSMIT
C28	-	-
C29	D20 20DG	SCI RECEIVE
C30	-	-
C31	G21 20GY/LB	TACHOMETER SIGNAL
C32	V37 20RD/LG	SPEED CONTROL SWITCH SIGNAL

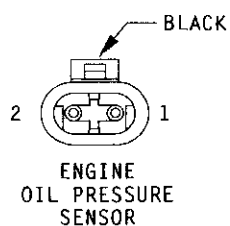
• WITH SPEED CONTROL, HIGH-LINE CLUSTER
 * WITH AUTO TRANS

C138 (WITH GAS ENG)

CAV	CIRCUIT	FUNCTION
1	K6 20VT/WT	5 VOLT SUPPLY
2	K4 18BK/LB**	SENSOR GROUND
2	K4 20BK/LB*	SENSOR GROUND
3	K24 20GY/BK	CRANK POSITION SENSOR SIGNAL

C138 (WITH DIESEL ENG)

CAV	CIRCUIT	FUNCTION
1	K6 20VT/WT	5 VOLT SUPPLY
2	K24 20GY/BK	CRANK POSITION SENSOR SIGNAL
3	K4 20BK/LB	SENSOR GROUND

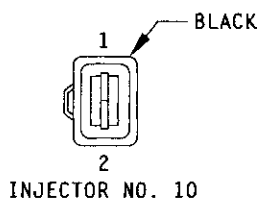
C139 (WITH GAS ENG)

CAV	CIRCUIT	FUNCTION
1	G6 16GY	OIL PRESSURE SENSE
2	G60 16GY/YL	OIL PRESSURE SENSOR SIGNAL

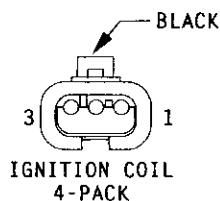
C139 (WITH DIESEL ENG)

CAV	CIRCUIT	FUNCTION
1	G6 18GY	OIL PRESSURE SENSE
2	G60 18GY/YL	OIL PRESSURE SENSOR SIGNAL

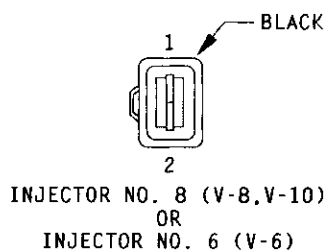
* WITH 8.0L ENG
 ** WITH 3.9L, 5.2L AND 5.9L ENG

**C140** (WITH 8.0L ENG)

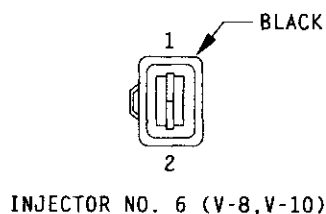
CAV	CIRCUIT	FUNCTION
1	K116 18WT/DB	INJECTOR NO. 10 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

**C141** (WITH 8.0L ENG)

CAV	CIRCUIT	FUNCTION
1	K17 18DB/WT	IGNITION COIL NO. 2 DRIVER
2	A142 14DG/OR	AUTO SHUT DOWN RELAY OUTPUT
3	K18 18RD/BK	IGNITION COIL NO. 3 DRIVER

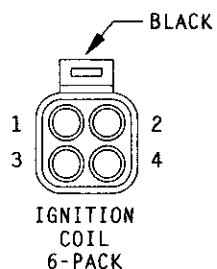
**C142**

CAV	CIRCUIT	FUNCTION
1	K28 18GY/LB**	INJECTOR NO. 8 DRIVER
1	K58 18BR/DB *	INJECTOR NO. 6 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

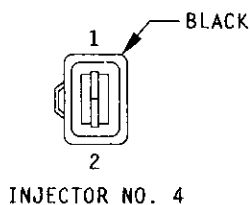
**C143** (WITH 5.2L, 5.9L AND 8.0L ENG)

CAV	CIRCUIT	FUNCTION
1	K58 18BR/DB	INJECTOR NO. 6 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

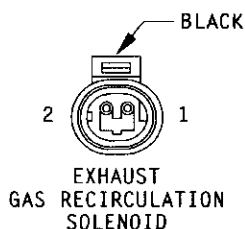
* WITH 3.9L ENG
 ** WITH 5.2L, 5.9L AND 8.0L ENG

**C144 (WITH 8.0L ENG)**

CAV	CIRCUIT	FUNCTION
1	K19 18BK/GY	IGNITION COIL NO. 1 DRIVER
2	K32 18YL/GY	IGNITION COIL NO. 4 DRIVER
3	A142 14DG/OR	AUTO SHUT DOWN RELAY OUTPUT
4	K43 18DG/GY	IGNITION COIL NO. 5 DRIVER

**C145**

CAV	CIRCUIT	FUNCTION
1	K14 18LB/BR	INJECTOR NO. 4 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

**C146 (WITH 5.2L AND 5.9L ENG)**

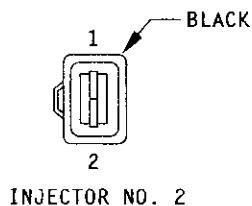
CAV	CIRCUIT	FUNCTION
1	K35 20GY/YL	EGR SOLENOID CONTROL
2	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)



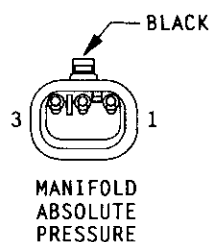
**AUTHENTIC
RESTORATION**

C146 (WITH DIESEL ENG)

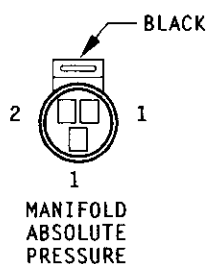
CAV	CIRCUIT	FUNCTION
1	K35 18GY/YL	EGR SOLENOID CONTROL
2	A142 18DG/OR	AUTO SHUT DOWN RELAY OUTPUT

**C147**

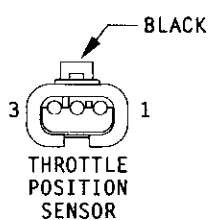
CAV	CIRCUIT	FUNCTION
1	K12 18TN	INJECTOR NO. 2 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

**C148** (WITH 3.9L, 5.2L AND 5.9L ENG)

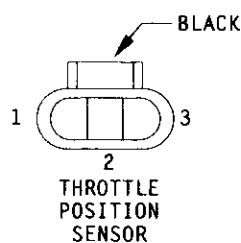
CAV	CIRCUIT	FUNCTION
1	K6 20VT/WT	5 VOLT SUPPLY
2	K1 18DG/RD	MAP SENSOR SIGNAL
3	K4 18BK/LB	SENSOR GROUND

**C148** (WITH 8.0L ENG)

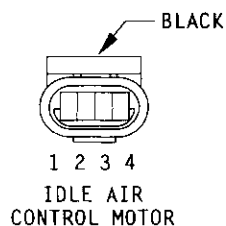
CAV	CIRCUIT	FUNCTION
1	K4 18BK/LB	SENSOR GROUND
2	K6 20VT/WT	5 VOLT SUPPLY
3	K1 18DG/RD	MAP SENSOR SIGNAL

**C149** (WITH GAS ENG)

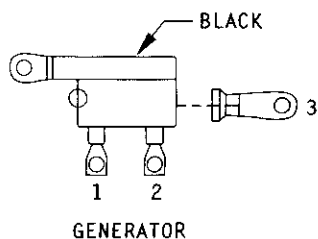
CAV	CIRCUIT	FUNCTION
1	K6 20VT/WT	5 VOLT SUPPLY
2	K22 18OR/DB	THROTTLE POSITION SENSOR
3	K4 18BK/LB	SENSOR GROUND

**C149** (WITH DIESEL ENG WITH AUTO TRANS OR EGR)

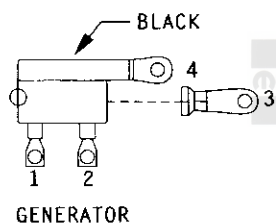
CAV	CIRCUIT	FUNCTION
1	K4 20BK/LB	SENSOR GROUND
2	K22 200R/DB	THROTTLE POSITION SENSOR SIGNAL
3	K6 20VT/WT	5 VOLT SUPPLY

**C150**

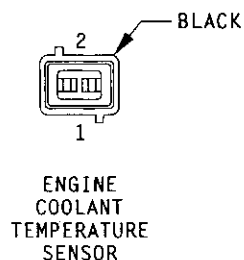
CAV	CIRCUIT	FUNCTION
1	K39 18GY/RD	IDLE AIR CONTROL MOTOR NO. 1 DRIVER
2	K60 18YL/BK	IDLE AIR CONTROL MOTOR NO. 2 DRIVER
3	K40 18BR/WT	IDLE AIR CONTROL MOTOR NO. 3 DRIVER
4	K59 18VT/BK	IDLE AIR CONTROL MOTOR NO. 4 DRIVER

**C151 (WITH GAS ENG)**

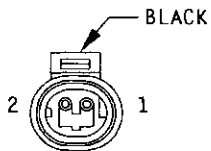
CAV	CIRCUIT	FUNCTION
1	K20 18DG	GENERATOR FIELD DRIVER
2	A142 14DB	AUTO SHUT DOWN RELAY OUTPUT
3	Z1 6BK	GROUND

**C151 (WITH DIESEL ENG)**

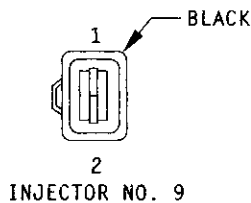
CAV	CIRCUIT	FUNCTION
1	K20 18DG	GENERATOR FIELD DRIVER
2	A142 14DB	AUTO SHUT DOWN RELAY OUTPUT
3	A11 6BK	GENERATOR OUTPUT
4	Z1 6BK	GROUND

**C152**

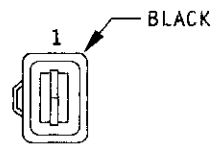
CAV	CIRCUIT	FUNCTION
1	K4 18BK/LB	SENSOR GROUND
2	K2 18TN/BK	ENGINE COOLANT TEMPERATURE SENSOR SIGNAL



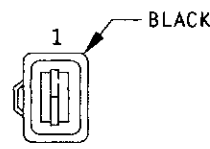
DUTY
CYCLE
EVAP/
PURGE
SOLENOID



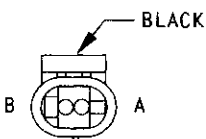
INJECTOR NO. 9



INJECTOR NO. 7 (V-8,V-10)
OR
INJECTOR NO. 5 (V-6)



INJECTOR NO. 5 (V-8,V-10)



INTAKE AIR
TEMPERATURE
SENSOR

C153

CAV	CIRCUIT	FUNCTION
1	K52 20PK	EVAPORATIVE EMISSION SOLENOID CONTROL
2	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT

C154 (WITH 8.0L ENG)

CAV	CIRCUIT	FUNCTION
1	K115 18TN	INJECTOR NO. 9 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

C155

CAV	CIRCUIT	FUNCTION
1	K26 18VT/TN**	INJECTOR NO. 7 DRIVER
1	K38 18GY*	INJECTOR NO. 5 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT



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C156 (WITH 5.2L, 5.9L AND 8.0L ENG)

CAV	CIRCUIT	FUNCTION
1	K38 18GY	INJECTOR NO. 5 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT

C157 (WITH GAS ENG)

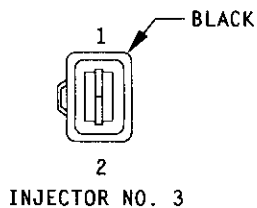
CAV	CIRCUIT	FUNCTION
A	K4 18BK/LB	SENSOR GROUND
B	K21 18BK/RD	INTAKE AIR TEMPERATURE SIGNAL

C157 (WITH DIESEL ENG)

CAV	CIRCUIT	FUNCTION
A	K4 16BK/LB	SENSOR GROUND
B	K21 16BK/RD	INTAKE AIR TEMPERATURE SENSOR SIGNAL

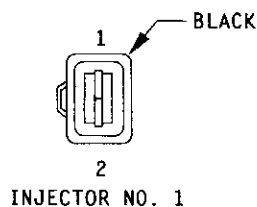
* WITH 3.9L ENG

** WITH 5.2L, 5.9L AND 8.0L ENG



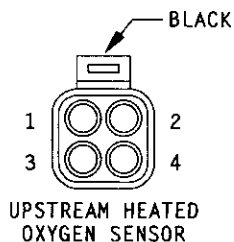
C158

CAV	CIRCUIT	FUNCTION
1	K13 18YL/WT	INJECTOR NO. 3 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT



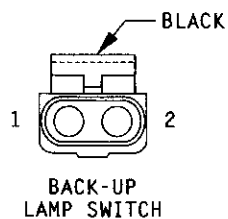
C159

CAV	CIRCUIT	FUNCTION
1	K11 18WT/DB	INJECTOR NO. 1 DRIVER
2	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT



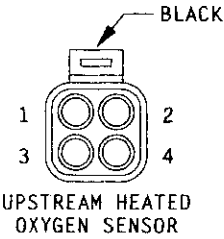
C160 (WITH 5.9L ENG HEAVY DUTY)

CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K41 18BK/DG	UPSTREAM HEATED SENSOR SIGNAL

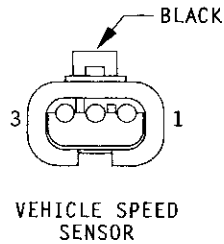


C161 (WITH MAN TRANS)

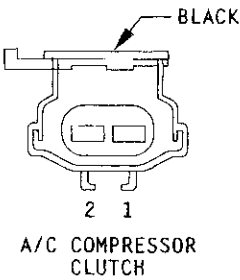
CAV	CIRCUIT	FUNCTION
1	L1 18VT/BK	BACK-UP LAMP SWITCH OUTPUT
2	L10 18BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)



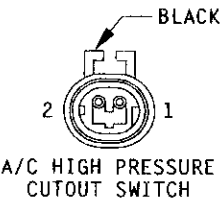
C162 (WITH 3.9L, 5.2L AND 5.9L ENG EXCEPT HEAVY DUTY)		
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K141 18TN/WT	UPSTREAM HEATED OXYGEN SENSOR



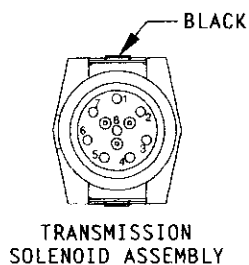
C163		
CAV	CIRCUIT	FUNCTION
1	K7 18OR	5 VOLT SUPPLY
2	K4 18BK/LB	SENSOR GROUND
3	G7 18WT/OR	VEHICLE SPEED SENSOR SIGNAL



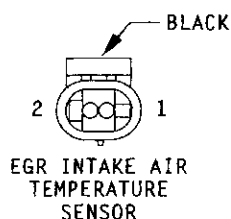
C164		
CAV	CIRCUIT	FUNCTION
1	C3 18DB/BK	A/C COMPRESSOR CLUTCH RELAY OUTPUT
2	Z11 18BK/WT	GROUND



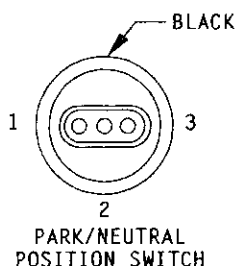
C165		
CAV	CIRCUIT	FUNCTION
1	C90 18LG	A/C PRESSURE SWITCH OUTPUT
2	C90 18LG/WT	A/C PRESSURE SWITCH OUTPUT

**C167**

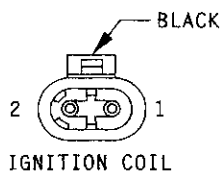
CAV	CIRCUIT	FUNCTION
1	T16 18RD	TRANSMISSION CONTROL RELAY OUTPUT
2	K7 180R	5 VOLT SUPPLY
3	K4 18BK/LB	SENSOR GROUND
4	T25 20LG/WT	GOVERNOR PRESSURE SIGNAL
5	K88 20VT/WT	VARIABLE FORCE SOLENOID CONTROL
6	T60 20BR	OVERDRIVE SOLENOID CONTROL
7	K54 200R/BK	TORQUE CONVERTER CLUTCH SOLENOID CONTROL
8	T54 18VT	TRANSMISSION TEMPERATURE SENSOR SIGNAL

**C168**

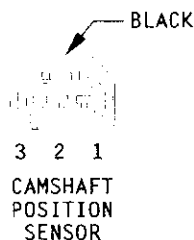
CAV	CIRCUIT	FUNCTION
1	K204 20BK/WT	EGR IAT(-)
2	K321 20BK/PK	EGR IAT(+)

**C169 (WITH AUTO TRANS)**

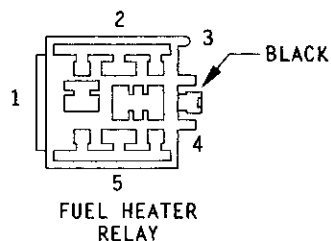
CAV	CIRCUIT	FUNCTION
1	L10 18BR/LG	FUSED IGNITION SWITCH OUTPUT
2	T41 18BK/WT	PARK/NEUTRAL POSITION SWITCH SENSOR
3	L1 18VT/BK	BACK-UP LAMP SWITCH OUTPUT

**C170 (WITH 3.9L, 5.2L AND 5.9L ENG)**

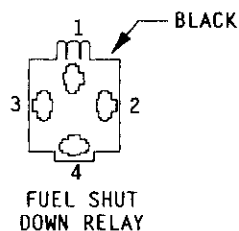
CAV	CIRCUIT	FUNCTION
1	K19 16BK/GY	IGNITION COIL NO. 1 DRIVER
2	A142 14DG/OR	AUTO SHUT DOWN RELAY OUTPUT

**C171 (IN DISTRIBUTOR WITH 3.9L, 5.2L AND 5.9L ENG)**

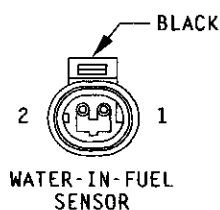
CAV	CIRCUIT	FUNCTION
1	K6 20VT/WT	5 VOLT SUPPLY
2	K4 20BK/LB	SENSOR GROUND
3	K44 20TN/YL	CAMSHAFT POSITION SENSOR SIGNAL

**C172**

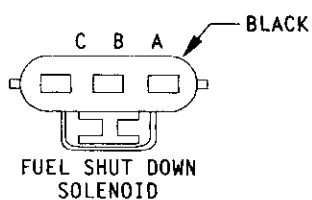
CAV	CIRCUIT	FUNCTION
1	A12 14RD/TN	FUSED B(+)
2	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)
3	-	-
4	A93 14RD/BK	FUEL HEATER RELAY OUTPUT
5	Z12 20BK/TN	GROUND

**C173**

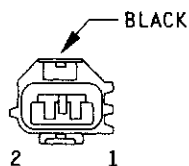
CAV	CIRCUIT	FUNCTION
1	A18 10RD/BK	FUSED B(+)
2	T40 12BR	ENGINE STARTER MOTOR RELAY OUTPUT
3	Z12 18BK/TN	GROUND
4	A123 10RD/VT	FUEL SHUT DOWN RELAY OUTPUT

**C174**

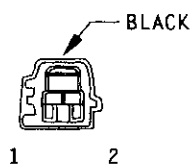
CAV	CIRCUIT	FUNCTION
1	K1 20DG/RD	WATER-IN-FUEL SENSOR SIGNAL
2	K4 20BK/LB	SENSOR GROUND

**C175**

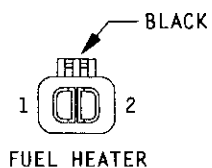
CAV	CIRCUIT	FUNCTION
A	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)
B	A123 10RD/VT	FUEL SHUT DOWN RELAY OUTPUT
C	Z12 10BK/TN	GROUND

**C176**

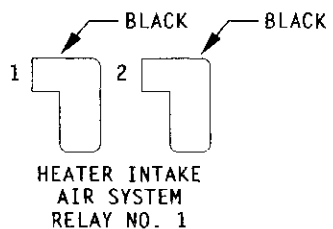
CAV	CIRCUIT
1	K304 20BK/LG
2	K2 20TN/BK



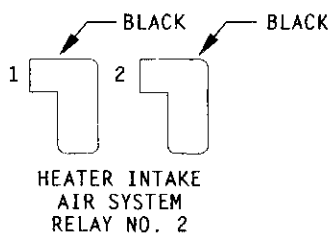
CAV	CIRCUIT
1	K304 20BK/LG
2	K2 20TN/BK

**C177**

CAV	CIRCUIT	FUNCTION
1	A93 14RD/BK	FUEL HEATER RELAY OUTPUT
2	Z12 16BK/TN	GROUND

**C178 (WITH DIESEL ENG)**

CAV	CIRCUIT	FUNCTION
1	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)
2	S21 20YL/BK	AIR INTAKE HEATER RELAY NO. 1 CONTROL

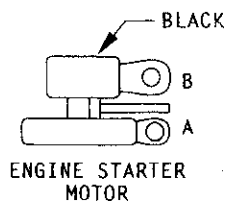
**C179 (WITH DIESEL ENG)**

CAV	CIRCUIT	FUNCTION
1	F18 20LG/BK	FUSED IGNITION SWITCH OUTPUT (START/RUN)
2	S22 20OR/BK	AIR INTAKE HEATER RELAY NO. 2 CONTROL

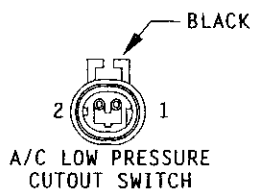


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**C180
POWER DISTRIBUTION CENTER
(SEE 8W-11-3)**

**C181**

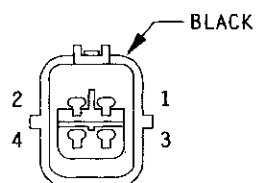
CAV	CIRCUIT	FUNCTION
A	T40 12BR	STARTER RELAY OUTPUT
B	A0 6RD	B(+)

**C182**

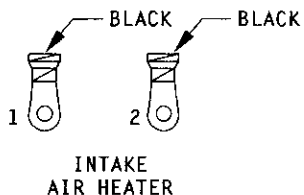
CAV	CIRCUIT	FUNCTION
1	C20 18BR	A/C SWITCH SENSE
2	C90 18LG/WT	A/C PRESSURE SWITCH OUTPUT

C183

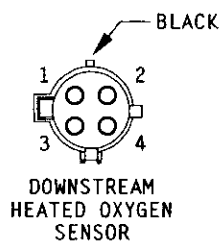
-OPTIONAL-
CHMSL JUMPER
(FOR FUTURE USE)



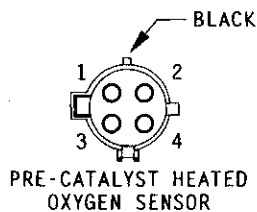
CAV	CIRCUIT
1	M1 20PK
2	M2 18YL
3	L50 18WT/TN
4	Z1 20BK

**C184**

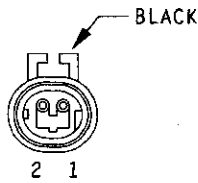
CAV	CIRCUIT	FUNCTION
1	A58 6BK	B(+)
2	A122 6BK	B(+)

**C185 (WITH 3.9L, 5.2L AND 5.9L ENG EXCEPT HEAVY DUTY)**

CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K341 18OR/BK	DOWNSTREAM HEATED OXYGEN SENSOR SIGNAL

**C186 (WITH CALIFORNIA)**

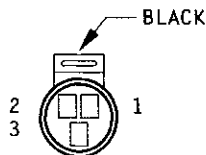
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K441 18TN/RD	PRE-CATALYST HEATED OXYGEN SENSOR SIGNAL



TRANSMISSION OUTPUT
SHAFT SPEED SENSOR

C187

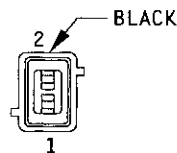
CAV	CIRCUIT	FUNCTION
1	T14 18LG/BK	OUTPUT SHAFT SPEED SENSOR SIGNAL
2	T13 18DB/BK	OUTPUT SHAFT SPEED SENSOR GROUND



FUEL PRESSURE
SENSOR

C188

CAV	CIRCUIT	FUNCTION
1	K4 18BK/LB	SENSOR GROUND
2	K6 20VT/WT	5 VOLT SUPPLY
3	K242 20DG/LB	FUEL PRESSURE SENSOR SIGNAL



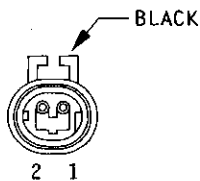
FUEL TEMPERATURE
SENSOR

C189

CAV	CIRCUIT	FUNCTION
1	K4 18BK/LB	SENSOR GROUND
2	K221 18TN/PK	FUEL TEMPERATURE SENSOR SIGNAL



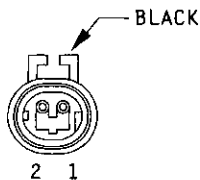
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PRODUCT**



LOW PRESSURE
FUEL SHUT OFF
SENSOR

C190

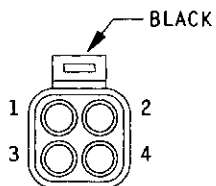
CAV	CIRCUIT	FUNCTION
1	Z12 18BK/TN	GROUND
2	A142 14DG/OR	AUTO SHUT DOWN RELAY OUTPUT



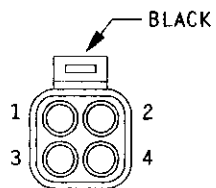
BATTERY
TEMPERATURE
SENSOR

C191

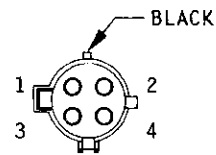
CAV	CIRCUIT	FUNCTION
1	K4 20BK/LB	SENSOR GROUND
2	K118 20PK/YL	BATTERY TEMPERATURE SENSOR SIGNAL

RIGHT UPSTREAM HEATED
OXYGEN SENSOR**C192 (WITH 8.0L ENG)**

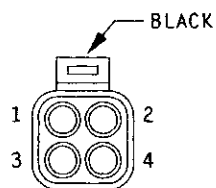
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K41 18BK/DG	RIGHT UPSTREAM HEATED SENSOR SIGNAL

LEFT UPSTREAM HEATED
OXYGEN SENSOR**C193 (WITH 8.0L ENG)**

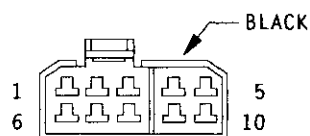
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K141 18TN/WT	LEFT UPSTREAM HEATED OXYGEN SENSOR SIGNAL

POST CATALYST HEATED
OXYGEN SENSOR**C194 (WITH CALIFORNIA)**

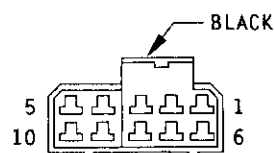
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K341 18OR/BK	POST CATALYST HEATED OXYGEN SENSOR SIGNAL

DOWNSTREAM
HEATED OXYGEN
SENSOR**C195 (WITH 5.9L ENG HEAVY DUTY)**

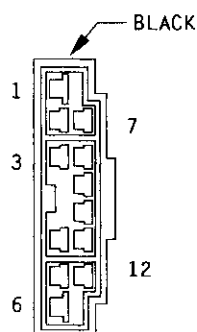
CAV	CIRCUIT	FUNCTION
1	A142 16DG/OR	AUTO SHUT DOWN RELAY OUTPUT
2	Z11 18BK/WT	GROUND
3	K4 18BK/LB	SENSOR GROUND
4	K241 18BK/DG	DOWNSTREAM HEATED OXYGEN SENSOR SIGNAL

C201

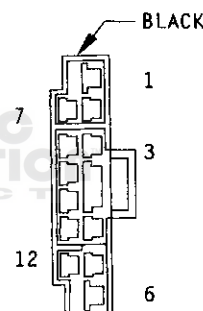
CAV	CIRCUIT
1	G16 22BK/LB
2	X13 18BK/RD
3	X53 20DG
4	M1 20PK
5	P70 20WT
6	M2 22YL
7	Z2 18BK/LG
8	X55 20BR/RD
9	P72 20YL/BK
10	P74 20DB



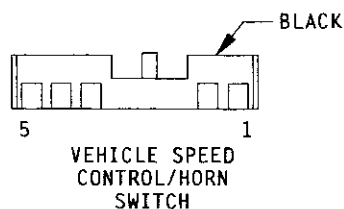
CAV	CIRCUIT
1	G16 18BK/LB
2	X13 18BK/RD
3	X53 18DG*
3	X53 20DG**
4	M1 20PK
5	P70 20WT
6	M2 18YL
7	Z2 18BK/LG
8	X55 18BR/RD*
8	X55 20BR/RD**
9	P72 20YL/BK
10	P74 20DB

C202

CAV	CIRCUIT
1	F37 14RD/LB
2	X57 18BR/LB
3	M1 18PK
4	Z2 18BK/LG
5	X51 18BR/YL
6	M3 20PK/DB
7	X58 18DB/OR
8	M2 20YL
9	G10 20LG/RD
10	L50 18WT/TN
11	X13 18BK/RD
12	X52 18DB/WT

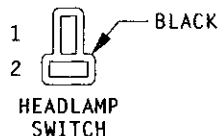


CAV	CIRCUIT
1	F37 14RD/LB
2	X57 20BR/LB
3	M1 18PK
4	Z2 18BK/LG
5	X51 20BR/YL
6	M3 22PK/DB
7	X58 20DB/OR
8	M2 20YL
9	G10 22LG/RD
10	L50 18WT/TN
11	X13 18BK/RD
12	X52 20DB/WT

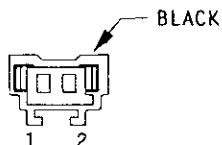
C203

CAV	CIRCUIT	FUNCTION
1	V32 22YL/RD	SPEED CONTROL ON/OFF SWITCH SENSE
2	-	-
3	K4 18BK/LB	SENSOR GROUND
4	V37 22RD/LG	SPEED CONTROL SWITCH SIGNAL
5	X3 20BK/RD*	HORN RELAY CONTROL
5	X3 22BK/RD**	HORN RELAY CONTROL

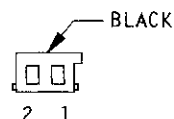
- WITH PREMIUM SPEAKERS OR OPTIONAL
- WITH STANDARD SPEAKERS
- * WITHOUT POWER LOCKS AND POWER WINDOWS
- ** WITH POWER LOCKS AND POWER WINDOWS

C204

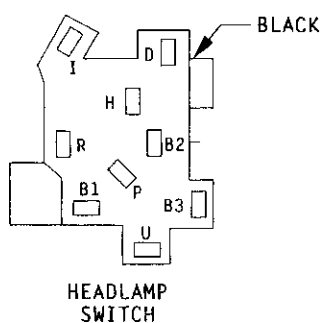
CAV	CIRCUIT	FUNCTION
1	M2 20YL	COURTESY LAMPS DRIVER
2	Z3 20BK/OR	GROUND

**C205**

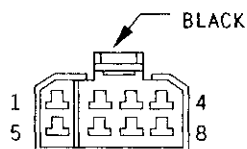
CAV	CIRCUIT
1	R43 18BK/LB
2	R45 18DG/LB



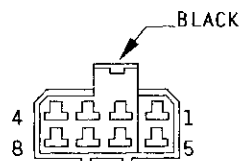
CAV	CIRCUIT
1	R43 18BK/LB
2	R45 18DG/LB

C206

CAV	CIRCUIT	FUNCTION
B1	A3 12RD/LG	FUSED B(+)
B2	F33 20PK/RD	FUSED B(+)
B3	G26 18LB	KEY-IN IGNITION SWITCH SENSE
D	M3 22PK/DB	CARGO LAMP SWITCH GROUND
H	L2 16LG	HEADLAMP SWITCH OUTPUT
I	E1 20TN/OR	PANEL LAMPS DIMMER SWITCH SIGNAL
P	L20 16LG/WT	FUSED B(+)
R	L7 20BK/YL	PARK LAMP SWITCH OUTPUT
U	G16 22BK/LB	LEFT FRONT DOOR JAMB SWITCH SENSE

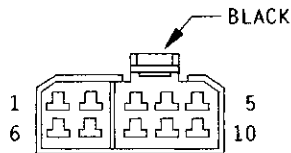
**C207**

CAV	CIRCUIT
1	F35 16RD
2	F21 14TN
3	Q16 14BR/WT
4	Q26 14VT/WT
5	P33 16OR/BK
6	P34 16PK/BK
7	P35 16OR/VT
8	P36 16PK/VT

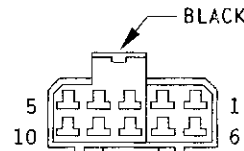


CAV	CIRCUIT
1	F35 14RD
2	F21 14TN
3	Q16 14BR/WT
4	Q26 14VT/WT
5	P33 16OR/BK
6	P34 16PK/BK
7	P35 16OR/VT
8	P36 16PK/VT

C208

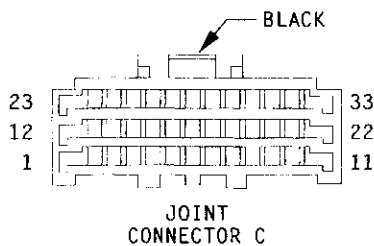


CAV	CIRCUIT
1	E2 220R
2	F12 22DB/WT
3	L7 20BK/YL
4	M1 20PK
5	M2 22YL•
6	L1 22VT/BK
7	L10 22BR/LG
8	G31 22VT/LG
9	G32 22BK/LB
10	Z11 20BK/WT



CAV	CIRCUIT
1	E2 220R
2	F12 22DB/WT
3	L7 18BK/YL*
3	L7 20BK/YL**
4	M1 20PK
5	M2 22YL•
6	L1 22VT/BK
7	L10 22BR/LG
8	G31 22VT/LG
9	G32 22BK/LB
10	Z11 20BK/WT

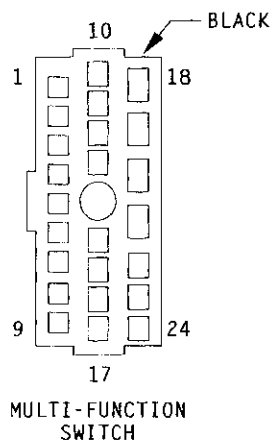
C209



CAV	CIRCUIT	FUNCTION
1	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
2	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
3	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
4	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
5	E2 200R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
6	-	-
7	-	-
8	G11 20WT/BK	PARK BRAKE SWITCH SENSE
9	G11 22WT/BK	PARK BRAKE SWITCH SENSE
10	G11 22WT/BK	PARK BRAKE SWITCH SENSE
11	G11 22WT/BK	PARK BRAKE SWITCH SENSE
12	F12 22DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
13	F12 20DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
14	F12 22DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
15	F12 22DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
16	-	-
17	V32 20YL/RD	SPEED CONTROL FEED
18	V32 22YL/RD	SPEED CONTROL FEED
19	V32 22YL/RD	SPEED CONTROL FEED
20	G16 22BK/LB	LEFT FRONT DOOR JAMB SWITCH SENSE
21	G16 22BK/LB	LEFT FRONT DOOR JAMB SWITCH SENSE
22	G16 22BK/LB	LEFT FRONT DOOR JAMB SWITCH SENSE
23	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
24	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
25	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
26	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
27	-	-
28	L10 22BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)
29	L10 22BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)
30	L10 22BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)
31	V40 22WT/PK	BRAKE SWITCH SENSE
32	V40 20WT/PK	BRAKE SWITCH SENSE
33	V40 22WT/PK	BRAKE SWITCH SENSE

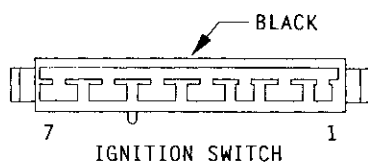
- * WITH CLEARANCE AND I.D. LAMPS
- ** WITH OVERHEAD CONSOLE ONLY
- WITH CONSOLE

C210

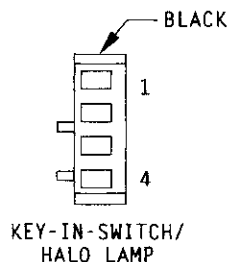


CAV	CIRCUIT	FUNCTION
1	V9 18WT/BK	WIPER SWITCH MODE SIGNAL
2	V8 18VT	WIPER SWITCH MODE SIGNAL
3	V10 18BR	WIPER SWITCH MODE SIGNAL
4	V6 16DB/BK	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)
5	V4 16RD/YL	WIPER SWITCH HIGH SPEED OUTPUT
6	V3 18BR/WT	WIPER SWITCH LOW SPEED OUTPUT
7	V7 18DG/WT	WIPER PARK SWITCH SENSE
8	V17 18DG	WIPER SWITCH DELAY OUTPUT
9	V3 18BR/WT	WIPER SWITCH LOW SPEED OUTPUT
	V3 18BR/WT	WIPER SWITCH LOW SPEED OUTPUT
10	-	-
11	L60 20TN/BK	RIGHT TURN SIGNAL
	L60 18TN/BK	RIGHT TURN SIGNAL
12	L62 18BR/PK	RIGHT REAR TURN SIGNAL
13	L19 18PK/WT	HAZARD FLASHER OUTPUT
14	L50 18WT/TN	STOP LAMP SWITCH OUTPUT
15	L63 18DG/RD	LEFT REAR TURN SIGNAL
16	L61 20LG/YL	LEFT TURN SIGNAL
	L61 18LG/YL	LEFT TURN SIGNAL
17	L6 20RD/GY	TURN SIGNAL FLASHER OUTPUT
18	L4 16VT/WT	DIMMER SWITCH LOW BEAM OUTPUT
19	L2 16LG	HEADLAMP SWITCH OUTPUT
20	L3 16RD/OR	DIMMER SWITCH HIGH BEAM OUTPUT
21	L20 16LG/WT	FUSED B(+)
22	-	-
23	-	-
24	-	-

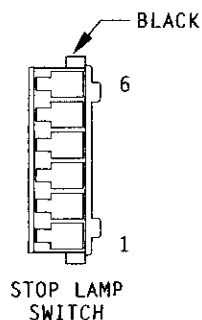
C212



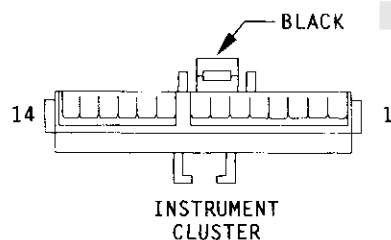
CAV	CIRCUIT	FUNCTION
1	A41 18DB/YL	IGNITION SWITCH OUTPUT (START)
2	A21 12DB	IGNITION SWITCH OUTPUT (START/RUN)
3	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER (START)
4	A2 12PK/BK	FUSED B(+)
5	A22 12BK/OR	IGNITION SWITCH OUTPUT (RUN)
6	A31 12BK/WT	IGNITION SWITCH OUTPUT (ACC/RUN)
7	A1 12RD	FUSED B(+)

**C213**

CAV	CIRCUIT	FUNCTION
1	G16 22BK/LB	LEFT FRONT DOOR JAMB SWITCH SENSE
2	G26 18LB	KEY-IN IGNITION SWITCH SENSE
3	Z3 20BK/OR	GROUND
4	M50 22YL/RD	KEY-IN LAMP DRIVER

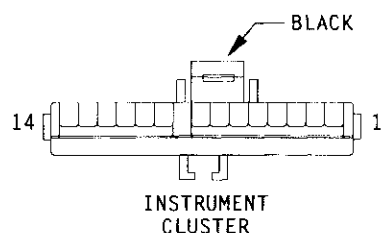
**C214**

CAV	CIRCUIT	FUNCTION
1	V40 20WT/PK	BRAKE SWITCH SENSE
2	Z11 20BK/WT	GROUND
3	V32 20YL/RD	SPEED CONTROL FEED
4	V30 20DB/RD	SPEED CONTROL ON/OFF SWITCH OUTPUT
5	L50 18WT/TN	STOP LAMP SWITCH OUTPUT
6	F32 18PK/DB	FUSED B(+)

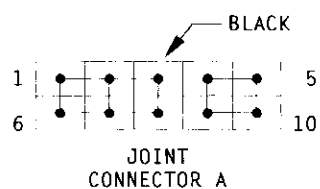
**C215**

CAV	CIRCUIT	FUNCTION
1	E2 22OR	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
2	-	-
3	G21 22GY/LB	TACHOMETER SIGNAL
4	G6 22GY	OIL PRESSURE SENSE
5	G12 22TN/YL	GEN LAMP DRIVER
6	G3 22BK/PK	MALFUNCTION INDICATOR LAMP DRIVER
7	G29 22BK/TN*	WASHER FLUID SWITCH SENSE
8	F14 20LG/YL	FUSED IGNITION SWITCH OUTPUT (START/RUN)
9	Z11 20BK/WT	GROUND
10	G60 22GY/YL	OIL PRESSURE SENSOR SIGNAL
11	G4 22DB	FUEL LEVEL SENSOR SIGNAL
12	-	-
13	G107 22BK/GY**	4WD LAMP
13	G107 20BK/GY*	4WD LAMP
14	G19 22LG/RD	ABS WARNING LAMP DRIVER

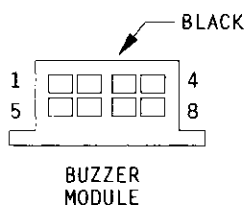
- WITH RWAL
- ** WITH ABS
- * WITH SPEED CONTROL, HIGH-LINE CLUSTER

**C216**

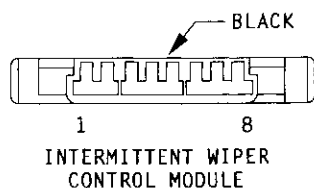
CAV	CIRCUIT	FUNCTION
1	G13 20DB/RD	SEAT BELT LAMP DRIVER
2	—	—
3	G54 22OR/BK	UPSHIFT LAMP DRIVER
4	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
5	G11 22WT/BK	PARK BRAKE SWITCH SENSE
6	Z11 20BK/WT	GROUND
7	G20 22VT/YL	ENGINE COOLANT TEMPERATURE SENDING UNIT
8	—	—
9	R41 18BK/TN	AIRBAG SYSTEM WARNING LAMP DRIVER
10	Z3 20BK/OR	GROUND
11	G7 20WT/OR	VEHICLE SPEED SENSOR SIGNAL
12	L61 20LG/YL	LEFT TURN SIGNAL
13	G34 18RD/GY	HIGH BEAM INDICATOR LAMP DRIVER
14	L60 20TN/BK	RIGHT TURN SIGNAL

**C217**

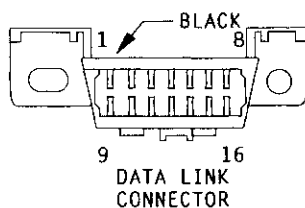
CAV	CIRCUIT	FUNCTION
1	M2 20YL	COURTESY LAMPS DRIVER
2	M2 22YL	COURTESY LAMPS DRIVER
3	M2 22YL	COURTESY LAMPS DRIVER
4	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
5	L7 20BK/YL	PARK LAMP SWITCH OUTPUT
6	M2 20YL	COURTESY LAMPS DRIVER
7	M2 22YL	COURTESY LAMPS DRIVER
8	M2 22YL	COURTESY LAMPS DRIVER
9	L7 20BK/YL	PARK LAMP SWITCH OUTPUT
10	L7 20BK/YL	PARK LAMP SWITCH OUTPUT

**C218**

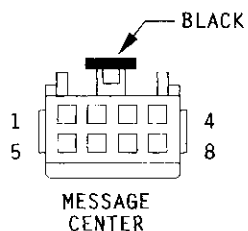
CAV	CIRCUIT	FUNCTION
1	F12 20DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
2	G13 20DB/RD	SEAT BELT LAMP DRIVER
3	Z3 20BK/OR	GROUND
4	G10 22LG/RD	SEAT BELT SWITCH SENSE
5	—	—
6	G26 18LB	KEY-IN IGNITION SWITCH SENSE
	G26 18LB	KEY-IN IGNITION SWITCH SENSE
7	M1 20PK	FUSED B(+)
8	—	—

**C219**

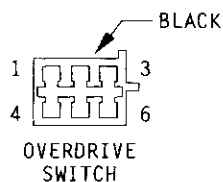
CAV	CIRCUIT	FUNCTION
1	V9 18WT/BK	WIPER SWITCH MODE SIGNAL
2	V10 18BR	WIPER SWITCH MODE SIGNAL
	V10 18BR	WIPER SWITCH MODE SIGNAL
3	V6 18DB/BK	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)
4	V5 18DG/YL	WIPER SWITCH MODE SENSE
5	Z3 18BK/OR	GROUND
6	V7 18DG/WT	WIPER PARK SWITCH SENSE
7	V17 18DG	WIPER SWITCH DELAY OUTPUT
8	V8 18VT	WIPER SWITCH MODE SIGNAL

**C223**

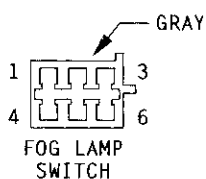
CAV	CIRCUIT	FUNCTION
1	--	--
2	--	--
3	D1 18VT/BR	CCD BUS (+)
4	Z12 20BK/TN	GROUND
5	Z11 20BK/WT	GROUND
6	D20 20DG	SCI RECEIVE
7	D21 20PK/DB	SCI TRANSMIT
8	--	--
9	B113 20RD/VT	RIGHT REAR WHEEL SPEED SENSOR (+)
10	--	--
11	D2 18WT/BK	CCD BUS (-)
12	D11 22WT/RD	SCI RECEIVE
13	B112 20BK	RWAL SERVICE DIAGNOSTIC SIGNAL
14	--	--
15	D12 22OR	SCI TRANSMIT
16	M1 20PK	FUSED B(+)

**C224**

CAV	CIRCUIT	FUNCTION
1	—	—
2	G86 20TN/OR**	WATER-IN-FUEL WARNING LAMP DRIVER
3	F14 20LG/YL	FUSED IGNITION SWITCH OUTPUT (START/RUN)
4	G85 200R/BK**	WAIT-TO-START WARNING LAMP DRIVER
5	—	—
6	—	—
7	G24 22GY/PK	SERVICE REMINDER INDICATOR LAMP DRIVER
8	G14 20PK/BK*	TRANSMISSION TEMPERATURE LAMP DRIVER

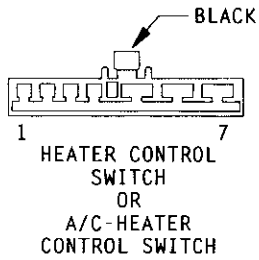
**C225**

CAV	CIRCUIT	FUNCTION
1	T6 220R/WT	TRANSMISSION OVERDRIVE SWITCH SENSE
2	Z3 20BK/OR	GROUND
3	F12 22DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
4	E2 200R	FUSED PANEL LAMPS DIMMER SWITCH SENSE
	E2 220R*	FUSED PANEL LAMPS DIMMER SWITCH SENSE
5	T18 22LG/OR	OVERDRIVE LAMP DRIVER
	G54 220R/BK**	UPSHIFT LAMP DRIVER
6	—	—

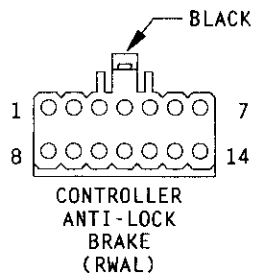
**C226**

CAV	CIRCUIT	FUNCTION
1	L35 22BR/WT	FOG LAMP RELAY CONTROL
2	Z3 20BK/OR	GROUND
3	Z3 20BK/OR	GROUND
4	—	—
5	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SENSE
6	L39 18LB	FRONT FOG LAMP SWITCH OUTPUT

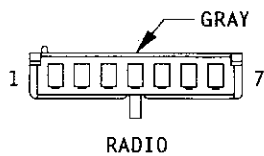
- WITH AUTO TRANS
- NOT FUNCTIONAL WITH AUTO TRANS
- * WITH FOG LAMPS
- ** WITH DIESEL ENG

**C227**

CAV	CIRCUIT	FUNCTION
1	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
2	C90 22LG*	A/C PRESSURE SWITCH OUTPUT
3	C5 16LG/YL	M1 BLOWER MOTOR DRIVER
4	C4 16TN	LO BLOWER MOTOR DRIVER
5	C6 14LB	M2 BLOWER MOTOR DRIVER
6	C7 12BK/TN	HI BLOWER MOTOR DRIVER
7	Z3 12BK/OR	GROUND

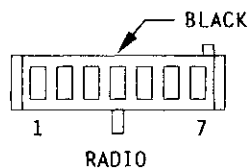
**C228**

CAV	CIRCUIT	FUNCTION
1	B101 18LG/WT	RWAL ISOLATION SOLENOID
2	G19 22LG/RD	ABS WARNING LAMP DRIVER
3	A20 18RD/DB	FUSED IGNITION SWITCH OUTPUT (RUN)
	A20 18RD/DB*	FUSED IGNITION SWITCH OUTPUT (RUN)
4	G107 20BK/GY	4WD SENSE
	G107 20BK/GY	4WD SENSE
5	G11 22WT/BK	PARK BRAKE SWITCH SENSE
6	G9 22GY/BK	RED BRAKE WARNING LAMP DRIVER
7	V40 22WT/PK	BRAKE SWITCH SENSE
8	B108 18WT	RWAL DUMP SOLENOID
9	F32 20PK/DB	FUSED B(+)
10	Z3 16BK/OR	GROUND
11	B111 22LB/BK	RWAL RESET SWITCH
12	B112 20BK	RWAL SERVICE DIAGNOSTIC SIGNAL
13	B114 22WT/VT	RIGHT REAR WHEEL SPEED SENSOR (-)
14	B113 20RD/VT	RIGHT REAR WHEEL SPEED SENSOR (+)
	B113 20RD/VT	RIGHT REAR WHEEL SPEED SENSOR (+)

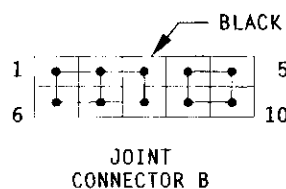
**C229**

CAV	CIRCUIT	FUNCTION
1	-	-
2	X55 20BR/RD	LEFT FRONT DOOR SPEAKER (-)
3	X56 20DB/RD	RIGHT FRONT DOOR SPEAKER (-)
4	L7 20BK/YL	PARK LAMP SWITCH OUTPUT
5	E2 220R	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
6	X12 18RD/WT	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)
7	M1 20PK	FUSED B(+)

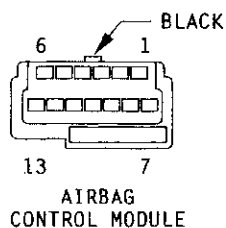
• WITH A/C ONLY
 * WITH DIESEL ENG
 J968W-9

**C230**

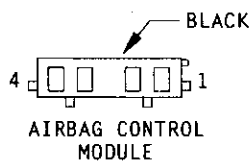
CAV	CIRCUIT	FUNCTION
1	X60 22DG/RD*	RADIO 12 VOLT OUTPUT
2	X51 20BR/YL	LEFT REAR SPEAKER (+)
3	X52 20DB/WT	RIGHT REAR SPEAKER (+)
4	X53 20DG	LEFT FRONT DOOR SPEAKER (+)
5	X54 20VT	RIGHT FRONT DOOR SPEAKER (+)
6	X57 20BR/LB	LEFT REAR SPEAKER (-)
7	X58 20DB/OR	RIGHT REAR SPEAKER (-)

**C231**

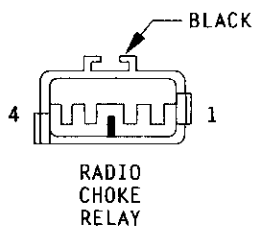
CAV	CIRCUIT	FUNCTION
1	M1 20PK	FUSED B(+)
2	M1 20PK	FUSED B(+)
3	-	-
4	F32 18PK/DB	FUSED B(+)
5	F32 18PK/DB	FUSED B(+)
6	M1 18PK	FUSED B(+)
7	M1 20PK	FUSED B(+)
8	M1 18PK	FUSED B(+)
9	F32 20PK/DB	FUSED B(+)
10	-	-

**C232**

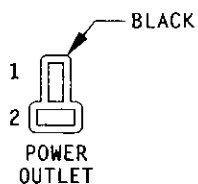
CAV	CIRCUIT	FUNCTION
1	F14 18LG/YL	FUSED IGNITION SWITCH OUTPUT (START/RUN)
2	F23 18DB/YL	FUSED IGNITION SWITCH OUTPUT (RUN)
3	D1 18VT/BR	CCD BUS (+)
4	D2 18WT/BK	CCD BUS (-)
5	R49 18LB	LEFT IMPACT SENSOR LINE 2
6	R47 18DB/LB	LEFT IMPACT SENSOR LINE 1
7	R41 18BK/TN	AIRBAG SYSTEM WARNING LAMP DRIVER
8	-	-
9	-	-
10	-	-
11	Z6 18BK/OR	GROUND
12	R48 18TN	RIGHT IMPACT SENSOR LINE 2
13	R46 18BR/LB	RIGHT IMPACT SENSOR LINE 1

**C233**

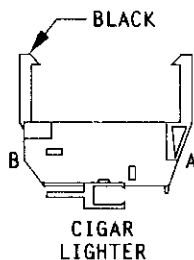
CAV	CIRCUIT	FUNCTION
1	—	—
2	—	—
3	R43 18BK/LB	AIRBAG LINE 1
4	R45 18DG/LB	AIRBAG LINE 2

**C234**

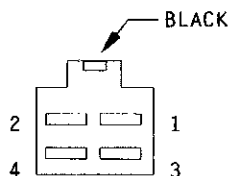
CAV	CIRCUIT	FUNCTION
1	M1 18PK	FUSED B(+)
2	X13 18BK/RD	PREMIUM SPEAKER AMPLIFIER
3	X60 22DG/RD	RADIO 12 VOLT OUTPUT
4	Z2 18BK/LG	GROUND

**C235**

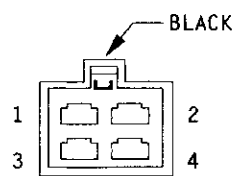
CAV	CIRCUIT	FUNCTION
1	F130 18RD/YL	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)
2	Z3 18BK/OR	GROUND

**C236**

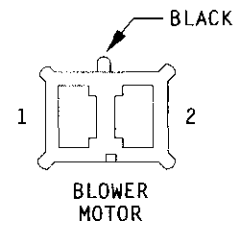
CAV	CIRCUIT	FUNCTION
A	F30 18RD/OR	FUSED IGNITION SWITCH OUTPUT (ACC/RUN)
B	Z3 18BK/OR	GROUND

**C237**

CAV	CIRCUIT
1	C7 12BK/TN
2	C6 14LB
3	C5 16LG
4	C4 16TN

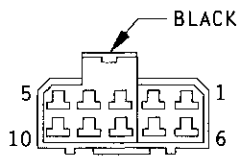


CAV	CIRCUIT
1	C7 12BK/TN
2	C6 14LB
3	C5 16LG/YL
4	C4 16TN



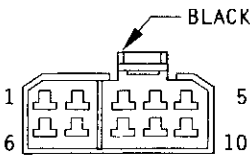
C238

CAV	CIRCUIT	FUNCTION
1	C1 12DG	FUSED IGNITION SWITCH OUTPUT (RUN)
2	C7 12BK/TN	HI BLOWER MOTOR DRIVER



C239

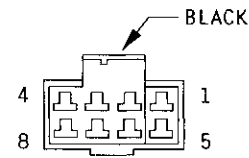
CAV	CIRCUIT
1	—
2	—
3	F21 14TN
4	Q16 14BR/WT
5	Q26 14VT/WT
6	P36 16PK/VT
7	F35 16RD
8	P33 16OR/BK
9	P34 16PK/BK
10	P35 16OR/BT



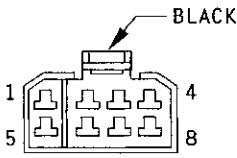
CAV	CIRCUIT
1	—
2	—
3	F21 14TN
4	Q16 14BR/WT
5	Q26 14VT/WT
6	P36 16PK/VT
7	F35 16RD
8	P33 16OR/BK
9	P34 16PK/BK
10	P35 16OR/VT



C240



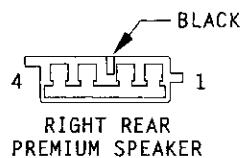
CAV	CIRCUIT
1	X13 18BK/RD
2	X54 20VT
3	P70 20WT
4	P72 20YL/BK
5	Z2 18BK/LG
6	X56 20DB/RD
7	M2 22YL
8	P74 20DB



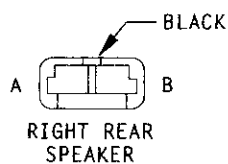
CAV	CIRCUIT
1	X13 18BK/RD
2	X54 20VT** X54 18VT*
3	P70 20WT
4	P72 20YL/BK
5	Z2 18BK/LG
6	X56 18DB/RD* X56 20DB/RD**
7	M2 18YL
8	P74 20DB

C241
FUSE BLOCK
(SEE 8W-10-3)

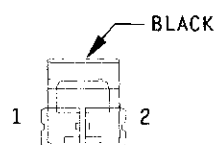
* WITH PREMIUM SPEAKERS OR OPTIONAL
** WITH STANDARD SPEAKERS

**C301**

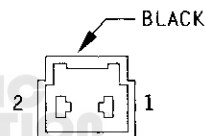
CAV	CIRCUIT	FUNCTION
1	Z2 18BK/LG	GROUND
2	X58 18DB/OR	RIGHT REAR SPEAKER (-)
3	X52 18DB/WT	RIGHT REAR SPEAKER (+)
4	X13 18BK/RD	PREMIUM SPEAKER AMPLIFIER

**C302**

CAV	CIRCUIT	FUNCTION
A	X58 18DB/OR	RIGHT REAR SPEAKER (-)
B	X52 18DB/WT	RIGHT REAR SPEAKER (+)

**C303**

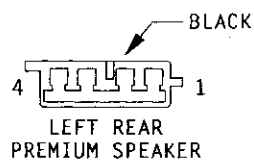
CAV	CIRCUIT
1	Z3 14BK/OR
2	F37 14RD/LB



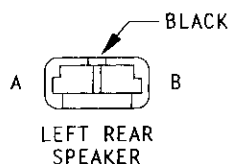
CAV	CIRCUIT
1	Z3 14BK/OR
2	F37 14RD/LB

C304

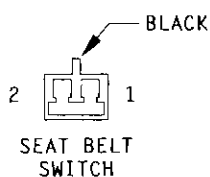
CAV	CIRCUIT	FUNCTION
1	M1 18PK	FUSED B(+)
2	M2 20YL	COURTESY LAMPS DRIVER

**C305**

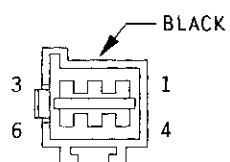
CAV	CIRCUIT	FUNCTION
1	Z2 18BK/LG	GROUND
2	X57 18BR/LB	LEFT REAR SPEAKER (-)
3	X51 18BR/YL	LEFT REAR SPEAKER (+)
4	X13 18BK/RD	PREMIUM SPEAKER AMPLIFIER

**C306**

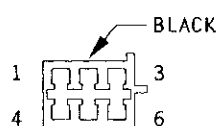
CAV	CIRCUIT	FUNCTION
A	X57 18BR/LB	LEFT REAR SPEAKER (-)
B	X51 18BR/YL	LEFT REAR SPEAKER (+)

**C307**

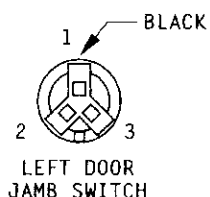
CAV	CIRCUIT	FUNCTION
1	G10 20LG/RD	SEAT BELT WARNING SWITCH SENSE
2	Z3 18BK/OR	GROUND
2	Z3 18BK/OR	GROUND

**C308**

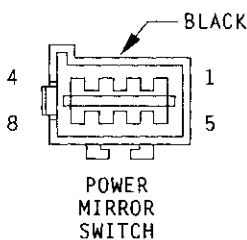
CAV	CIRCUIT
1	L50 18WT/TN
1	L50 18WT/TN
2	Z3 18BK/OR
2	Z3 18BK/OR
3	M1 18PK*
3	M1 18PK*
4	M3 18PK/DB*
4	M3 18PK/DB*
5	-
6	-



CAV	CIRCUIT
1	L50 18WT/TN
2	Z3 18BK/OR
3	M1 18PK
4	M3 20PK/DB
5	-
6	-

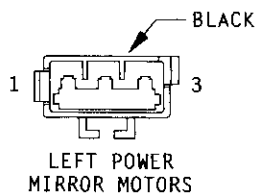
**C309**

CAV	CIRCUIT	FUNCTION
1	Z3 18BK/OR*	GROUND
1	Z3 20BK/OR**	GROUND
2	M2 18YL	COURTESY LAMPS DRIVER
3	G16 18BK/LB	DOOR JAMB SWITCH SENSE

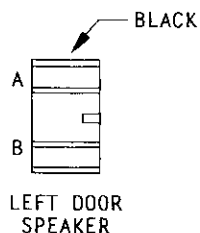
**C310**

CAV	CIRCUIT	FUNCTION
1	P74 20DB	POWER MIRROR LEFT CONTROL
2	P72 20YL/BK	POWER MIRROR UP CONTROL
3	P70 20WT	POWER MIRROR RIGHT/DOWN CONTROL
4	M1 20PK	FUSED B(+)
5	P75 20DB/WT	POWER MIRROR UP CONTROL
6	P71 20YL	POWER MIRROR LEFT CONTROL
7	P73 20YL/PK	POWER MIRROR RIGHT/DOWN CONTROL
8	Z3 18BK/OR	GROUND

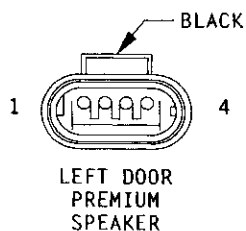
• WITH OPTIONAL
 •• WITHOUT OPTIONAL
 * WITH CARGO LAMPS

**C311**

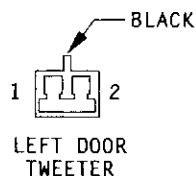
CAV	CIRCUIT	FUNCTION
1	P75 20DB/WT	POWER MIRROR UP CONTROL
2	P73 20YL/PK	POWER MIRROR RIGHT/DOWN CONTROL
3	P71 20YL	POWER MIRROR LEFT CONTROL

**C312**

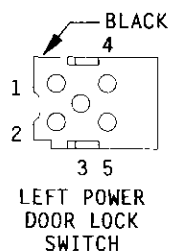
CAV	CIRCUIT	FUNCTION
A	X55 20BR/RD	LEFT DOOR SPEAKER (-)
B	X53 20DG	LEFT DOOR SPEAKER (+)

**C313**

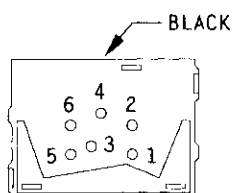
CAV	CIRCUIT	FUNCTION
1	Z2 18BK/LG	GROUND
2	X55 18BR/RD	LEFT DOOR SPEAKER (-)
3	X53 18DG	LEFT DOOR SPEAKER (+)
4	X13 18BK/RD	PREMIUM SPEAKER AMPLIFIER

**C314 (PREMIUM)**

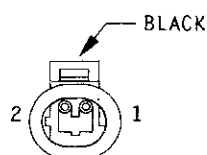
CAV	CIRCUIT	FUNCTION
1	X55 18BR/RD	LEFT DOOR SPEAKER (-)
2	X53 18DG	LEFT DOOR SPEAKER (+)

**C315**

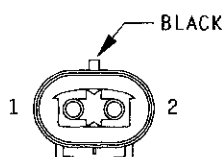
CAV	CIRCUIT	FUNCTION
1	P35 16OR/VT	DOOR LOCK SWITCH OUTPUT (LOCK)
2	Z3 14BK/OR	GROUND
3	F35 14RD	FUSED B(+)
4	Z3 14BK/OR	GROUND
5	P36 16PK/VT	DOOR LOCK SWITCH OUTPUT (UNLOCK)

LEFT POWER
WINDOW SWITCH**C316**

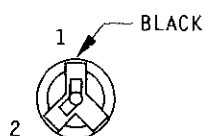
CAV	CIRCUIT	FUNCTION
1	Q11 14LB	POWER WINDOW UP CONTROL
2	Q21 14WT	POWER WINDOW DOWN CONTROL
3	Z3 14BK/OR	GROUND
4	F21 14TN	FUSED IGNITION SWITCH OUTPUT (RUN)
5	Q16 14BR/WT	POWER WINDOW SWITCH OUTPUT (UP)
6	Q26 14VT/WT	POWER WINDOW SWITCH OUTPUT (DOWN)

LEFT POWER
DOOR LOCK
MOTOR**C317**

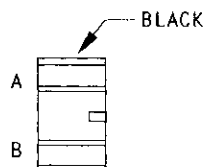
CAV	CIRCUIT	FUNCTION
1	P34 16PK/BK	DOOR UNLOCK DRIVER
2	P33 16OR/BK	DOOR LOCK DRIVER

LEFT POWER
WINDOW MOTOR**C318**

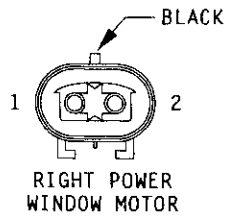
CAV	CIRCUIT	FUNCTION
1	Q11 14LB	POWER WINDOW UP CONTROL
2	Q21 14WT	POWER WINDOW DOWN CONTROL

RIGHT DOOR
JAMB SWITCH**C319**

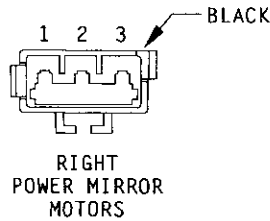
CAV	CIRCUIT	FUNCTION
1	Z3 18BK/OR	GROUND
2	M2 18YL	COURTESY LAMPS DRIVER

RIGHT DOOR
SPEAKER**C320**

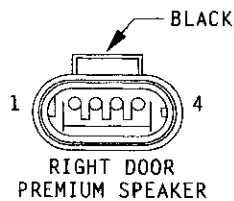
CAV	CIRCUIT	FUNCTION
A	X56 20DB/RD	RIGHT DOOR SPEAKER (-)
B	X54 20VT	RIGHT DOOR SPEAKER (+)

**C321**

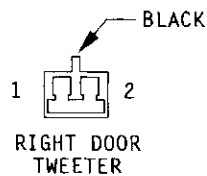
CAV	CIRCUIT	FUNCTION
1	Q12 148R	POWER WINDOW UP CONTROL
2	Q22 14VT	POWER WINDOW DOWN CONTROL

**C322**

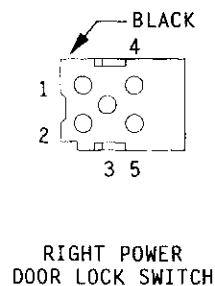
CAV	CIRCUIT	FUNCTION
1	P74 20DB	POWER MIRROR LEFT CONTROL
2	P70 20WT	POWER MIRROR RIGHT/DOWN CONTROL
3	P72 20YL/BK	POWER MIRROR UP CONTROL

**C323**

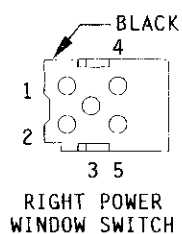
CAV	CIRCUIT	FUNCTION
1	Z2 18BK/LG	GROUND
2	X56 18DB/RD	RIGHT DOOR SPEAKER (-)
3	X54 18VT	RIGHT DOOR SPEAKER (+)
4	X13 18BK/RD	PREMIUM SPEAKER AMPLIFIER

**C324 (PREMIUM)**

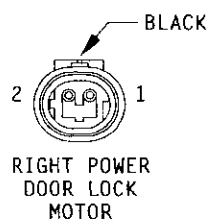
CAV	CIRCUIT	FUNCTION
1	X56 18DB/RD	RIGHT DOOR SPEAKER (-)
2	X54 18VT	RIGHT DOOR SPEAKER (+)

**C325**

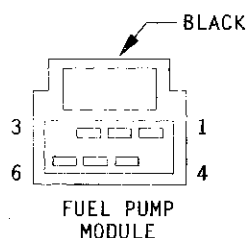
CAV	CIRCUIT	FUNCTION
1	P33 16OR/BK	DOOR LOCK DRIVER
2	P36 16PK/VT	DOOR LOCK SWITCH OUTPUT (UNLOCK)
3	F35 16RD	FUSED B(+)
4	P35 16OR/VT	DOOR LOCK SWITCH OUTPUT (LOCK)
5	P34 16PK/BK	DOOR UNLOCK DRIVER

**C326**

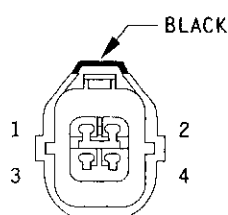
CAV	CIRCUIT	FUNCTION
1	Q22 14VT	POWER WINDOW DOWN CONTROL
2	Q16 14BR/WT	POWER WINDOW SWITCH OUTPUT (UP)
3	F21 14TN	FUSED IGNITION SWITCH OUTPUT
4	Q26 14VT/WT	POWER WINDOW SWITCH OUTPUT (DOWN)
5	Q12 14BR	POWER WINDOW UP CONTROL

**C327**

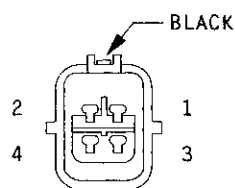
CAV	CIRCUIT	FUNCTION
1	P34 16PK/BK	DOOR UNLOCK DRIVER
2	P33 16OR/BK	DOOR LOCK DRIVER

**C328**

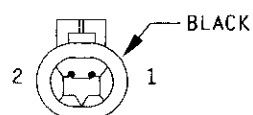
CAV	CIRCUIT	FUNCTION
1	A61 16DG/BK*	AUTO SHUT DOWN RELAY OUTPUT
2	K104 20DB/WT*	FUSED B(+)
3	G4 20DB/OR	FUEL LEVEL SENSOR SIGNAL
4	Z11 20BK/WT	GROUND
5	K4 20BK/LB*	SENSOR GROUND
6	Z13 16BK*	GROUND

**C329**

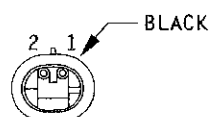
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK
3	L62 18DG/BR
4	L1 18VT/BK



CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK
3	L62 18BR/PK
4	L1 18VT/BK

**C330**

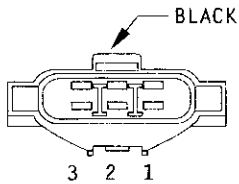
CAV	CIRCUIT
1	B113 20RD/VT
2	B114 20WT/VT



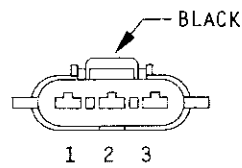
CAV	CIRCUIT
1	B113 20RD/VT
2	B114 20WT/VT

* NOT FUNCTIONAL ON DIESEL

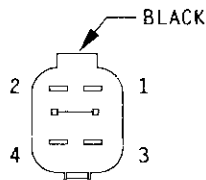
J968W-9

**C331**

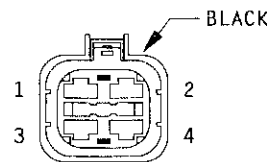
CAV	CIRCUIT
1	L1 16VT/BK
2	L62 18BR/PK
3	L63 18DG/RD



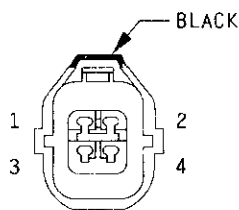
CAV	CIRCUIT
1	L1 18VT/BK
2	L62 18BR/PK
3	L63 18DG/RD

**C332**

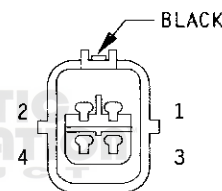
CAV	CIRCUIT
1	A6 14RD/TN
2	B40 14LB
3	Z13 12BK
4	L76 12BK/OR



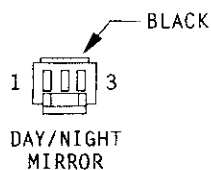
CAV	CIRCUIT
1	A6 14RD/TN
2	B40 14LB
3	Z13 12BK
4	L76 12BK/OR

**C333**

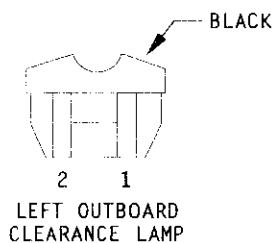
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK
3	L63 18DG/BR
4	L1 18VT/BK



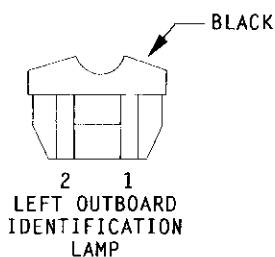
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK
3	L63 18DG/RD
4	L1 18VT/BK

**C334**

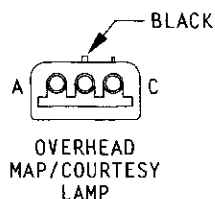
CAV	CIRCUIT	FUNCTION
1	L10 22BR/LG	FUSED IGNITION SWITCH OUTPUT (RUN)
2	Z4 22BK	GROUND
3	L1 22VT/BK	BACK-UP LAMP SWITCH OUTPUT

**C335**

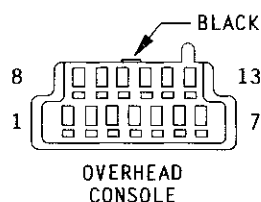
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z4 18BK	GROUND

**C336**

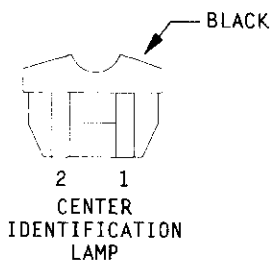
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z4 18BK	GROUND

**C337 (WITH LOW-LINE CLUSTER)**

CAV	CIRCUIT	FUNCTION
1	Z4 18BK	GROUND
2	M2 22YL	COURTESY LAMPS DRIVER
3	M1 20PK	FUSED B(+)

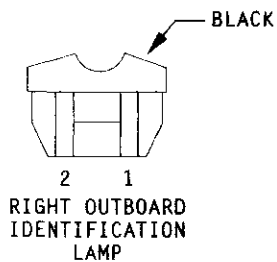
**C338 (WITH HIGH-LINE CLUSTER)**

CAV	CIRCUIT	FUNCTION
1	E2 22OR	FUSED PANEL LAMPS DIMMER SWITCH SIGNAL
2	L7 20BK/YL**	PARK LAMP SWITCH OUTPUT
2	L7 18BK/YL*	PARK LAMP SWITCH OUTPUT
3	-	-
4	G32 22BK/LB	SENSOR GROUND
5	G31 22VT/LG	AMBIENT TEMPERATURE SENSOR SIGNAL
6	M2 22YL	COURTESY LAMPS DRIVER
7	F12 22DB/WT	FUSED IGNITION SWITCH OUTPUT (START/RUN)
8	-	-
9	Z11 20BK/WT	GROUND
10	-	-
11	Z4 18BK	GROUND
12	M1 18PK	FUSED B(+)
13	M1 18PK	FUSED B(+)

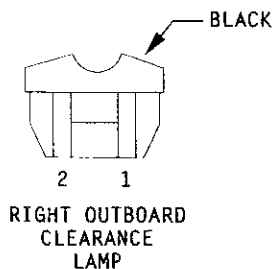
**C339**

CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z4 18BK	GROUND

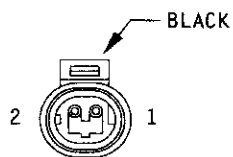
* WITH CLEARANCE AND I.D. LAMPS
** WITH OVERHEAD CONSOLE ONLY

**C340**

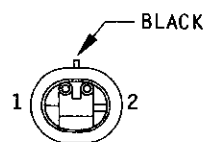
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z4 18BK	GROUND

**C341**

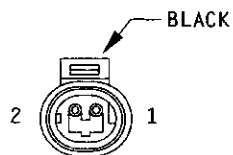
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z4 18BK	GROUND

**C342**

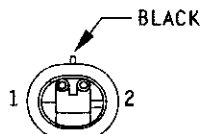
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL



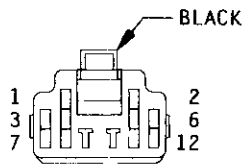
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL

**C343**

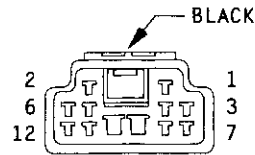
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL



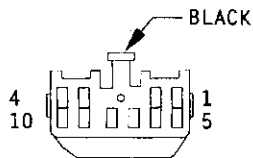
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL

**C345**

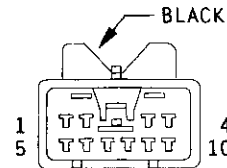
CAV	CIRCUIT
1	-
2	X54 18VT
3	P70 20WT
4	P72 20YL/BK
5	X56 18DB/RD
6	X13 18BK/RD
7	P74 20DB
8	-
9	F21 14TN
10	-
11	Z2 18BK/LG



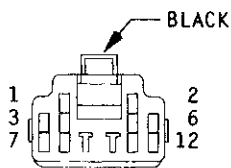
CAV	CIRCUIT
1	-
2	X54 18VT*
2	X54 20VT**
3	P70 20WT
4	P72 20YL/BK
5	X56 18DB/RD*
5	X56 20DB/RD**
6	X13 18BK/RD
7	P74 20DB
8	-
9	F21 14TN
10	-
11	Z2 18BK/LG

**C346**

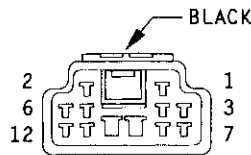
CAV	CIRCUIT
1	F35 16RD
2	Q16 14BR/WT
3	Q26 14VT/WT
4	P33 16OR/BK
5	P34 16PK/BK
6	P35 16OR/VT
7	P36 16PK/VT



CAV	CIRCUIT
1	F35 16RD
2	Q16 14BR/WT
3	Q26 14VT/WT
4	P33 16OR/BK
5	P34 16PK/BK
6	P35 16OR/VT
7	P36 16PK/VT

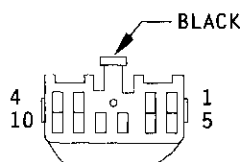
**C347**

CAV	CIRCUIT
1	M1 20PK
2	X53 18DG
3	P70 20WT
4	P72 20YL/BK
5	X55 18BR/RD
6	X13 18BK/RD
7	P74 20DB
9	F21 14TN
10	Z3 14BK/OR*
10	Z3 18BK/OR**
11	Z2 18BK/LG

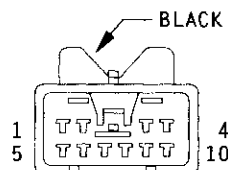


CAV	CIRCUIT
1	M1 20PK
2	X53 18DG*
2	X53 20DG**
3	P70 20WT
4	P72 20YL/BK
5	X55 18BR/RD*
5	X55 20BR/RD**
6	X13 18BK/RD
7	P74 20DB
9	F21 14TN
10	Z3 14BK/OR*
10	Z3 18BK/OR**
11	Z2 18BK/LG

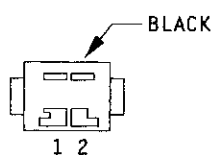
- * WITH PREMIUM SPEAKERS
- ** WITH STANDARD SPEAKERS
- * WITH POWER WINDOWS AND POWER LOCKS
- ** WITHOUT POWER WINDOWS AND POWER LOCKS

C348

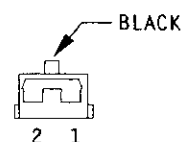
CAV	CIRCUIT
1	F35 14RD
2	Q16 14BR/WT
3	Q26 14VT/WT
4	P33 16OR/BK
5	P34 16PK/BK
6	P35 16OR/VT
7	P36 16PK/VT



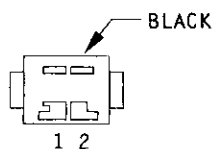
CAV	CIRCUIT
1	F35 14RD
2	Q16 14BR/WT
3	Q26 14VT/WT
4	P33 16OR/BK
5	P34 16PK/BK
6	P35 16OR/VT
7	P36 16PK/VT

C352

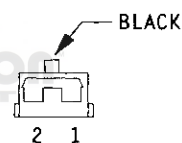
CAV	CIRCUIT
1	M1 20PK
2	Z4 20BK



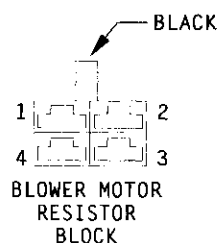
CAV	CIRCUIT
1	M1 20PK
2	Z4 20BK

C353

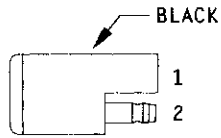
CAV	CIRCUIT
1	M1 20PK
2	Z4 20BK



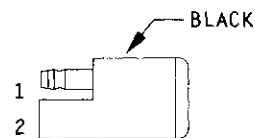
CAV	CIRCUIT
1	M1 20PK
2	Z4 20BK

C401

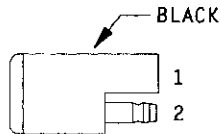
CAV	CIRCUIT	FUNCTION
1	C7 12BK/TN	HI BLOWER MOTOR DRIVER
2	C6 14LB	M2 BLOWER MOTOR DRIVER
3	C5 16LG	MI BLOWER MOTOR DRIVER
4	C4 16TN	LO BLOWER MOTOR DRIVER

**C402**

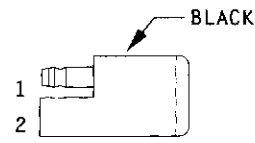
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK



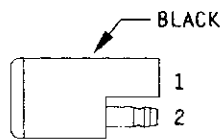
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK

**C403**

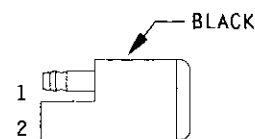
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK



CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK

**C404**

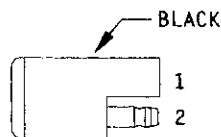
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK



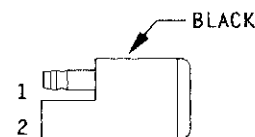
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK



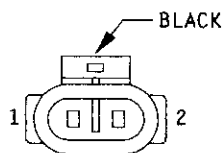
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**C405**

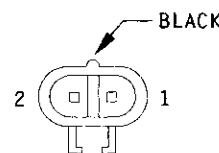
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK



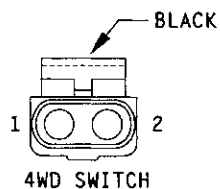
CAV	CIRCUIT
1	L7 18BK/YL
2	Z13 18BK

**C406**

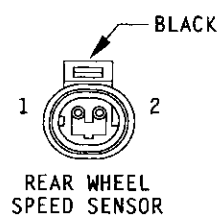
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL



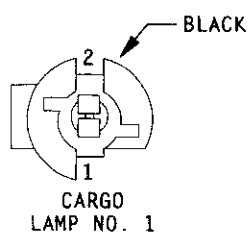
CAV	CIRCUIT
1	Z13 18BK
2	L7 18BK/YL

**C407**

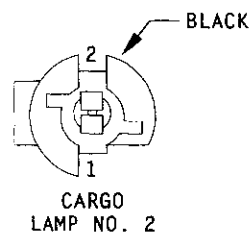
CAV	CIRCUIT	FUNCTION
1	G107 18BK/GY	4WD SENSE
2	Z1 18BK	GROUND

**C409**

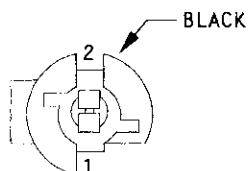
CAV	CIRCUIT	FUNCTION
1	B114 20WT/VT	RIGHT REAR WHEEL SPEED SENSOR(-)
2	B113 20RD/VT	RIGHT REAR WHEEL SPEED SENSOR(+)

**C410**

CAV	CIRCUIT	FUNCTION
1	M1 18PK	FUSED B(+)
2	M3 18PK/DB	CARGO LAMP SWITCH GROUND

**C411**

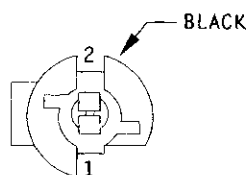
CAV	CIRCUIT	FUNCTION
1	M1 18PK	FUSED B(+)
2	M3 18PK/DB	CARGO LAMP SWITCH GROUND



CENTER HIGH
MOUNTED STOP
LAMP NO. 1

C412

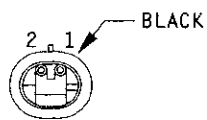
CAV	CIRCUIT	FUNCTION
1	L50 18WT/TN	STOP LAMP SWITCH OUTPUT
2	Z3 18BK/OR	GROUND



CENTER HIGH
MOUNTED STOP
LAMP NO. 2

C413

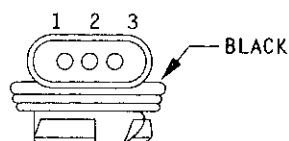
CAV	CIRCUIT	FUNCTION
1	L50 18WT/TN	STOP LAMP SWITCH OUTPUT
2	Z3 18BK/OR	GROUND



RIGHT
LICENSE
LAMP

C414

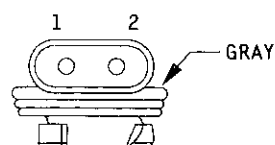
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z13 18BK	GROUND



RIGHT TAIL, STOP AND
TURN SIGNAL LAMP

C415

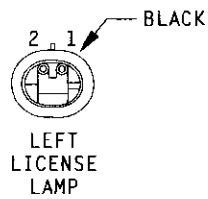
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
3	L62 18DG/BR	RIGHT REAR TURN SIGNAL



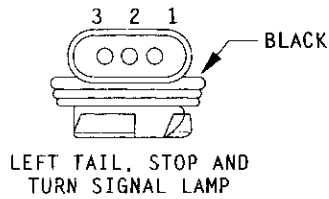
RIGHT
BACK-UP LAMP

C416

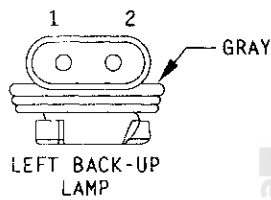
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L1 18VT/BK	BACK-UP LAMP SWITCH OUTPUT

**C417**

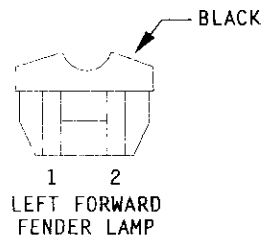
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z13 18BK	GROUND

**C418**

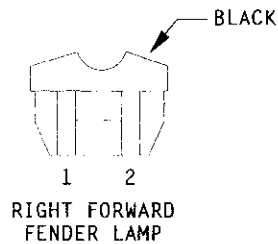
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
3	L63 18DG/BR	LEFT REAR TURN SIGNAL

**C419**

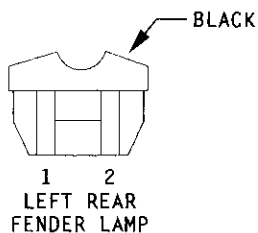
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L1 18VT/BK	BACK-UP LAMP SWITCH OUTPUT

**C420 (DUAL REAR WHEELS)**

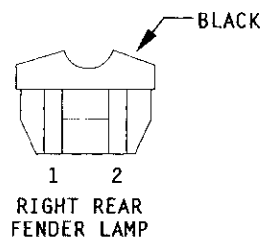
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT

**C421 (DUAL REAR WHEELS)**

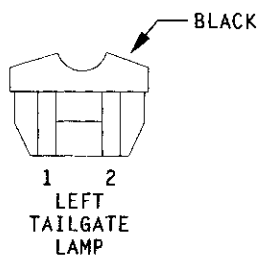
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT

**C422** (DUAL REAR WHEELS)

CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT

**C423** (DUAL REAR WHEELS)

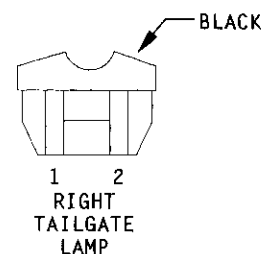
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT

**C424** (DUAL REAR WHEELS)

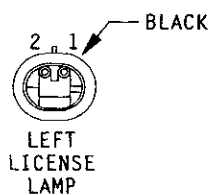
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT



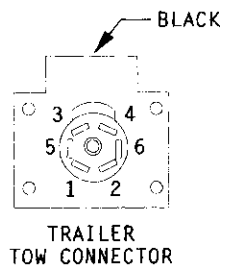
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**C425** (DUAL REAR WHEELS)

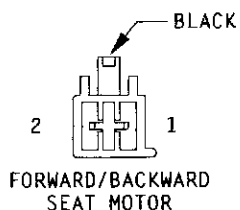
CAV	CIRCUIT	FUNCTION
1	Z13 18BK	GROUND
2	L7 18BK/YL	PARK LAMP SWITCH OUTPUT

**C426** (DUAL REAR WHEELS)

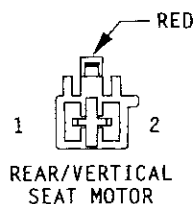
CAV	CIRCUIT	FUNCTION
1	L7 18BK/YL	PARK LAMP SWITCH OUTPUT
2	Z13 18BK	GROUND

**C427**

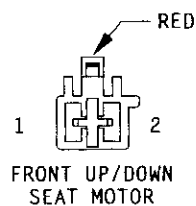
CAV	CIRCUIT	FUNCTION
1	Z13 12BK	GROUND
2	B40 14LB	TRAILER TOW ELECTRIC BRAKE OUTPUT
3	L76 12BK/OR	TRAILER TOW RELAY OUTPUT
4	A6 12RD/TN	FUSED B(+)
5	L63 18DG/RD	LEFT REAR TURN SIGNAL
6	L62 18BR/PK	RIGHT REAR TURN SIGNAL
7	L1 16VT/BK	BACK-UP LAMP SWITCH OUTPUT

**C428**

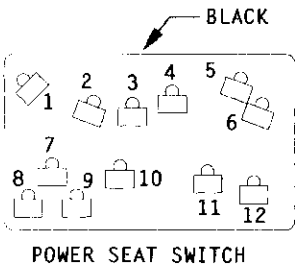
CAV	CIRCUIT	FUNCTION
1	P15 14YL/LB	POWER SEAT HORIZONTAL FORWARD
2	P17 14DB/RD	POWER SEAT HORIZONTAL BACKWARD

**C429**

CAV	CIRCUIT	FUNCTION
1	P13 14RD/WT	POWER SEAT REAR DOWN
2	P11 14YL/WT	POWER SEAT REAR UP

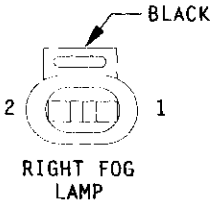
**C430**

CAV	CIRCUIT	FUNCTION
1	P21 14RD/LG	POWER SEAT FRONT DOWN
2	P19 14YL/LG	POWER SEAT FRONT UP



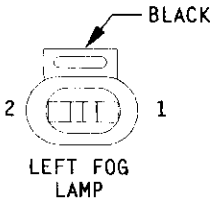
C431

CAV	CIRCUIT	FUNCTION
1	-	-
2	P11 14YL/WT	POWER SEAT REAR UP
3	F37 14RD/LB	FUSED B(+)
4	P17 14DB/RD	POWER SEAT HORIZONTAL BACKWARD
5	Z3 14BK/OR	GROUND
6	P19 14YL/LG	POWER SEAT FRONT UP
7	-	-
8	-	-
9	-	-
10	P13 14RD/WT	POWER SEAT REAR DOWN
11	P15 14YL/LB	POWER SEAT HORIZONTAL FORWARD
12	P21 14RD/LG	POWER SEAT FRONT DOWN



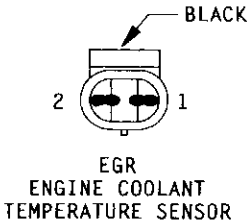
C432

CAV	CIRCUIT	FUNCTION
1	Z1 20BK	GROUND
2	L39 20LB	FRONT FOG LAMP SWITCH OUTPUT



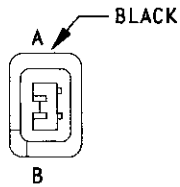
C433

CAV	CIRCUIT	FUNCTION
1	Z1 20BK	GROUND
2	L39 20LB	FRONT FOG LAMP SWITCH OUTPUT



C434

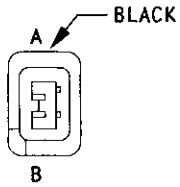
CAV	CIRCUIT	FUNCTION
1	K304 20BK/LG	EGR COOLANT TEMPERATURE SENSOR SIGNAL
2	K2 20TN/BK	EGR ENGINE COOLANT TEMPERATURE SENSOR SIGNAL



LEFT VISOR/VANITY
LAMP

C435

CAV	CIRCUIT	FUNCTION
A	M1 20PK	FUSED B(+)
B	Z4 20BK	GROUND



RIGHT VISOR/VANITY
LAMP

C436

CAV	CIRCUIT	FUNCTION
A	M1 20PK	FUSED B(+)
B	Z4 20BK	GROUND



**AUTHENTIC
RESTORATION™
PRODUCT**

8W-90 CONNECTOR/GROUND LOCATIONS

DESCRIPTION AND OPERATION

INTRODUCTION

This section provides illustrations identifying component and connector locations in the vehicle. A connector index is provided. Use the wiring diagrams in each section for connector number identification. Refer to the index for the proper figure number.

Conn #	Color	Location	Fig.
C101	BK	At Lamp	1
C102	BL	At Headlamps	1
C103	BK	Right Fender Side Shield	1
C104	GN	Right Fender Side Shield	1
C105	BK	Rear of Front Bumper	5
C106	BK	On Front Axle	23
C107	BK	Bottom of Washer Bottle	2
C108	BK	Side of Washer Bottle	2
C109	BK	Below Battery	4
C110	BK	Left Fender Side Shield	1
C111	BK	At EGR Control Module	N/S
C112	BK	At Lamp	2
C113	BL	At Headlamp	2
C114	BK	Radiator Left Support	4
C115	BK	Front Bumper Left Support	2
C116	BK	Front Bumper Left Support	2
C117	BK	Below Brake Master Cylinder	3
C118	BK	Left Fender Side Shield	3
C119	BK	Below PDC	3
C120	BK	At Controller Antilock Brakes	3
C121	BK	At Controller Antilock Brakes	3
C122	BK	Rear of ABS Pump	3
C123	BK	Near PDC	N/S
C124	BK	At Wiper Motor	N/S
C125	BK	Left Side of Dash Panel	3, 4
C126	GY	Left Side of Dash Panel	3, 4
C127	GY	Left Side of Dash Panel	3, 4
C128	BK	Above Left Front Body cushion	2, 20

SCHEMATICS AND DIAGRAMS

CONNECTOR/GROUND LOCATIONS

For items that are not shown in this section, N/S is placed in the Fig. column.

Conn #	Color	Location	Fig.
C129	BK	Above Left Front Body Cushion	2, 20
C130	BK	At Underhood Lamp	4
C131	BK	Left Fender Side Shield	2
C132	GN	Top of Clutch Pedal	N/S
C133	BK	Bottom of I.P., Near Steering Column	12
C134	BK	Left Fender Side Shield	4
C135	BK	At PCM	3
C136	WT	At PCM	3
C137	GY	At PCM	3
C138	BK	Rear of Engine Block (V-6, V-8)	6, 7
C138	BK	Right Side of Engine Block (V-10)	8
C138	BK	Front of Engine (Diesel)	9
C139	BK	Near Distributor (V-6, V-8)	6, 7
C139	BK	Near Oil Filter (V-10)	8
C139	BK	Left Side of Engine (Diesel)	9
C140	BK	Injector No. 10	8
C141	BK	Right Side of Engine	8
C142	BK	Injector No. 8	7, 8
C143	BK	Injector No. 6	6, 7, 8
C144	BK	Right Side of Engine	8
C145	BK	Injector No. 4	6, 7, 8
C146	BK	On EGR Solenoid	6, 7, 8
C147	BK	Injector No. 2	6, 7, 8
C148	BK	On Throttle Body	6, 7, 8
C149	BK	On Throttle Body (V-6, V-8, V-10)	6, 7, 8
C149	BK	On Injection Pump (Diesel)	9
C150	BK	On Throttle Body	6, 7, 8

SCHEMATICS AND DIAGRAMS (Continued)

Conn #	Color	Location	Fig.
C151	BK	Front of Engine	6, 7, 8, 9
C152	BK	Near Thermostat (V-6, V-8, V-10)	6, 7, 8
C152	BK	Left Rear of Cylinder Head (Diesel)	9
C153	BK	Rear of Intake Manifold	6, 7, 8
C154	BK	Injector No. 9	9
C155	BK	Injector No. 5 (V-6)	6
C155	BK	Injector No. 7 (V-8, V-10)	7, 8
C156	BK	Injector No. 5 (V-8, V-10)	7, 8
C157	GY	Right Side of Intake Manifold (V-6, V-8)	6, 7
C157	BK	Below Left Side of Intake Manifold (V-10)	8
C158	BK	Injector No. 3	6, 7, 8
C159	BK	Injector No. 1	6, 7, 8
C160	BK	Right Exhaust Pipe	10, 11
C161	BK	Top of Manual Transmission	10
C162	BK	Left Exhaust Pipe	10, 11
C163	BK	Rear of Transmission (2WD), Rear of Transfer Case (4WD)	10, 11
C164	BK	Rear of A/C Compressor (V-6, V-8, Diesel)	N/s
C164	BK	Rear of A/C Compressor (V-10)	8
C165	BK	On A/C Compressor (V-10)	8
C166	BK	Side of Engine Block (V-10)	8
C167	BK	Side of Transmission	11
C168	BK	Diesel, EGR Intake Temperature Sensor	N/S
C169	BK	Left Side of Transmission	11
C170	BK	Right Front of Engine	6, 7
C171	BK	Rear of Distributor	6, 7
C172	BK	On Dash Panel, Near Master Cylinder	N/S
C173	BK	On Dash Panel, Near Master Cylinder	N/S
C174	BK	Bottom of Fuel Filter/Water Separator	9
C175	BK	Near Rear of Injection Pump	9
C176	BK	Near EGR Engine Coolant Temperature Sensor	N/S

Conn #	Color	Location	Fig.
C177	BK	Above Engine Starter Motor	9
C178	BK	Below Left Battery	N/S
C179	BK	Below Left Battery	N/S
C180	BK	PDC, Near Battery	5, 24, 25
C181	BK	Starter Motor	5
C182	BK	A/C Low Pressure Cut-Out Switch	N/S
C183	BK	Near PDC	N/S
C184	BK	At Intake Air Heater	N/S
C185	BK	Rear of Catalytic Converter	26
C185	BK	Front of Catalytic Converter	26
C187	BK	Left Side of Transmission	N/S
C191	BK	Below Battery Tray	24
C192	BK	At Sensor	26
C193	BK	At Sensor	26
C194	BK	At Sensor	26
C195	BK	At Sensor	N/S
C201	BK	Left Kick Panel	19
C202	BK	Bottom Left of I.P.	14
C203	BK	Behind Switch	15
C204	BK	Near Headlamp Switch	14
C205	BK	Rear of Airbag	14, 15
C206	BK	Rear of Headlamp Switch	14
C207	BK	Left Kick Panel	12, 19
C208	BK	Near Fuse Block	13
C209	BK	Behind Knee Bolster	N/S
C210	BK	On Steering Column	13, 15
C212	BK	At Ignition Switch	13, 15
C213	BK	At Ignition Switch	13, 15
C214	BK	Top of Brake Pedal Arm	13
C215	BK	Rear of Instrument Cluster	12
C216	BK	At Instrument Cluster	12
C217	BK	Near Rear of Fuse Block	N/S
C218	BK	On I.P. Support, Right of Steering Column	13
C219	BK	Top Center of I.P.	12
C223	BK	Left Bottom of I.P.	13
C224	BK	Behind Center of I.P.	13
C225	BK	Behind Overdrive Switch	13
C226	GY	Behind Fog Lamp Switch	N/S
C227	BK	Rear of HVAC Switch	12
C228	BK	Center of I.P.	12

SCHEMATICS AND DIAGRAMS (Continued)

Conn #	Color	Location	Fig.
C229	GY	Rear of Radio	14
C230	BK	Rear of Radio	14
C231	BK	Near Rear of Fuse Block	N/S
C232	BK	Center of I.P. at Airbag Control Module	12
C233	BK	Center of I.P. at Airbag Control Module	12
C234	BK	I.P. Center Support	12
C235	BK	Center of I.P.	13
C236	BK	Rear of Cigar Lighter	12
C237	BK	Bottom Right of I.P.	13
C238	BK	Bottom Right of I.P.	13
C239	BK	Right Side of Dash, Near Right Kick Panel	12
C240	BK	Right Side of Dash, Near Right Kick Panel	12
C241	BK	At Fuse Block	16, 17
C301	BK	At Right Rear Speaker	17, 18
C302	BK	At Right Rear Speaker	17, 18
C303	BK	Below Driver's Seat	17, 18
C304	BK	Behind Dome Lamp	17, 18
C305	BK	At Left Rear Speaker	17, 18
C306	BK	At Left Rear Speaker	17, 18
C307	BK	In Body, Behind Left Door Opening	17, 18
C308	BK	Center Rear of Headliner	17, 18
C309	BK	Rear of Left Door Jamb Switch	N/S
C310	BK	Left Door	19
C311	BK	Left Door	19
C312	BK	Left Door	19
C313	BK	Left Door	19
C314	BK	Left Door	19
C315	BK	Left Door	19
C316	BK	Left Door	19
C317	BK	Left Door	19
C318	BK	Left Door	19
C319	BK	Rear of Right Door Jamb Switch	N/S
C320	BK	Right Door	19
C321	BK	Right Door	19
C322	BK	Right Door	19
C323	BK	Right Door	19
C324	BK	Right Door	19

Conn #	Color	Location	Fig.
C325	BK	Right Door	19
C326	BK	Right Door	19
C327	BK	Right Door	19
C328	BK	Top of Fuel Tank	20
C329	BK	Below Right Tail Lamp	20, 22
C330	BK	On Frame, Near Rear of Fuel Tank	20
C331	BK	Rear of Frame	20
C332	BK	Rear of Frame	20
C333	BK	Below Left Tail Lamp	20, 22
C334	BK	Day/Night Mirror	16
C335	BK	Behind Front of Headliner	16
C336	BK	Behind Front of Headliner	16
C337	BK	In Overhead Console	N/S
C338	BK	Behind Front of Headliner	16
C339	BK	Behind Front of Headliner	16
C340	BK	Behind Front of Headliner	16
C341	BK	Behind Front of Headliner	16
C342	BK	Right Rear of Frame	20, 22
C343	BK	Right Rear of Frame	20, 22
C345	BK	Right Door	N/S
C346	BK	Right Door	N/S
C347	BK	Left Door	N/S
C348	BK	Left Door	N/S
C352	BK	Left A-Pillar	16
C353	BK	Right A-Pillar	16
C401	BK	Below I.P., Right Side	N/S
C402	BK	At Forward Lamp on Left Fender	N/S
C403	BK	At Forward Lamp on Right Fender	N/S
C404	BK	At Rear Lamp on Left Fender	N/S
C405	BK	At Rear Lamp on Right Fender	N/S
C406	BK	In Tailgate	22
C407	BK	On Front of Frame	23
C409	BK	Left Frame Rail, Near Fuel Tank	20
C410	BK	Rear of Lamp	21
C411	BK	Rear of Lamp	21
C412	BK	Rear of Lamp	21
C413	BK	Rear of Lamp	21
C414	BK	At Rear Bumper	22

SCHEMATICS AND DIAGRAMS (Continued)

Conn #	Color	Location	Fig.
C415	BK	Rear of Lamp	22
C416	BK	Rear of Lamp	22
C417	BK	At Rear Bumper	22
C418	BK	Rear of Lamp	22
C419	BK	Rear of Lamp	22
C420	BK	Rear of Lamp	N/S
C421	BK	Rear of Lamp	N/S
C422	BK	Rear of Lamp	N/S
C423	BK	Rear of Lamp	N/S
C424	BK	Rear of Lamp	N/S
C425	BK	Rear of Lamp	N/S
C426	BK	Rear of Lamp	N/S
C427	BK	On Trailer Hitch	N/S
C428	BK	Below Driver's Seat	N/S
C429	RD	Below Driver's Seat	N/S
C430	RD	Below Driver's Seat	N/S
C431	BK	Left Side of Driver's Seat	N/S
C432	BK	Rear of Fog Lamp	5
C433	BK	Rear of Fog Lamp	5
C434	BK	At Sensor	N/S
C435	BK	Left A-Pillar	16
C436	BK	Right A-Pillar	16
G101		Left Fender Side Shield	2
G102		Left Fender Side Shield	2
G103		Right Fender Side Shield	1
G104		At Brake Master Cylinder	3
G105		Near PDC	3
G106		Near Horns	2

Conn #	Color	Location	Fig.
G107		Near PDC	3
G108		Near PDC	3
G109		Left Fender Side Shield	8
G110		Below A/C Compressor	8
G111		Front of Right Frame Rail	N/S
G112		Diesel, Front of Cylinder Head	9
G113		Below A/C Compressor	6, 7
G113		Rear of A/C Compressor (V-10)	8
G113		Near Thermostat Housing (Diesel)	9
G114		Left Side of Engine Block (Diesel)	N/S
G115		Near Left Battery (Diesel)	25
G116		From Left Battery (Diesel)	N/S
G117		Near Right Battery, Diesel	25
G118		Right Side of Engine Block (Diesel)	N/S
G119		Below A/C Compressor (V-6, V-8, V-10)	6, 7
G201		I.P. Right Center Support	14
G202		I.P. Right Center Support	14
G203		I.P. Left Center Support	14
G301		Below Left Rear Speaker	17, 18
G302		Left Kick Panel	19
G303		Left Kick Panel	19
G304		Front Center of Headliner	16

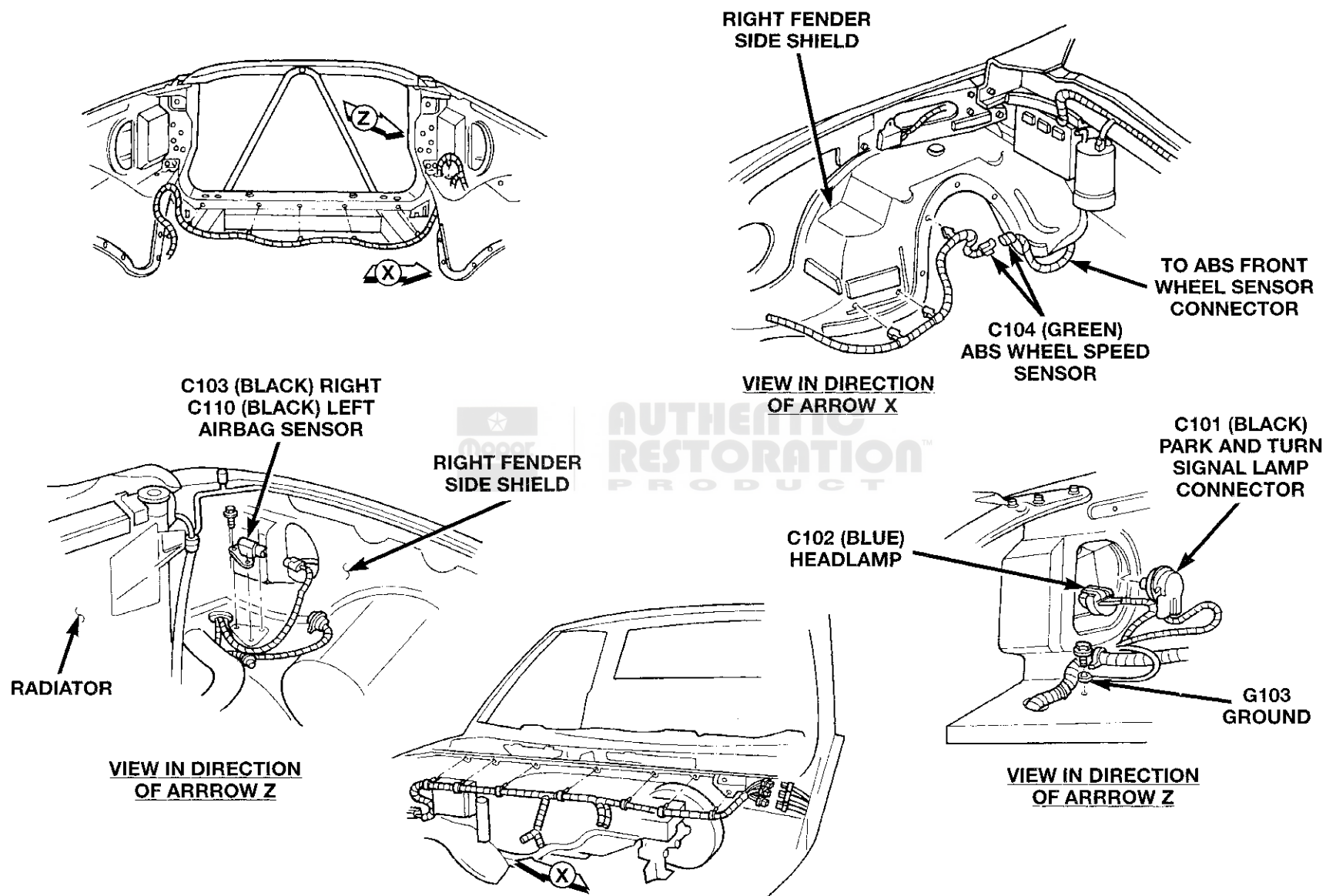


Fig. 1 Engine Compartment Connectors

804facf3

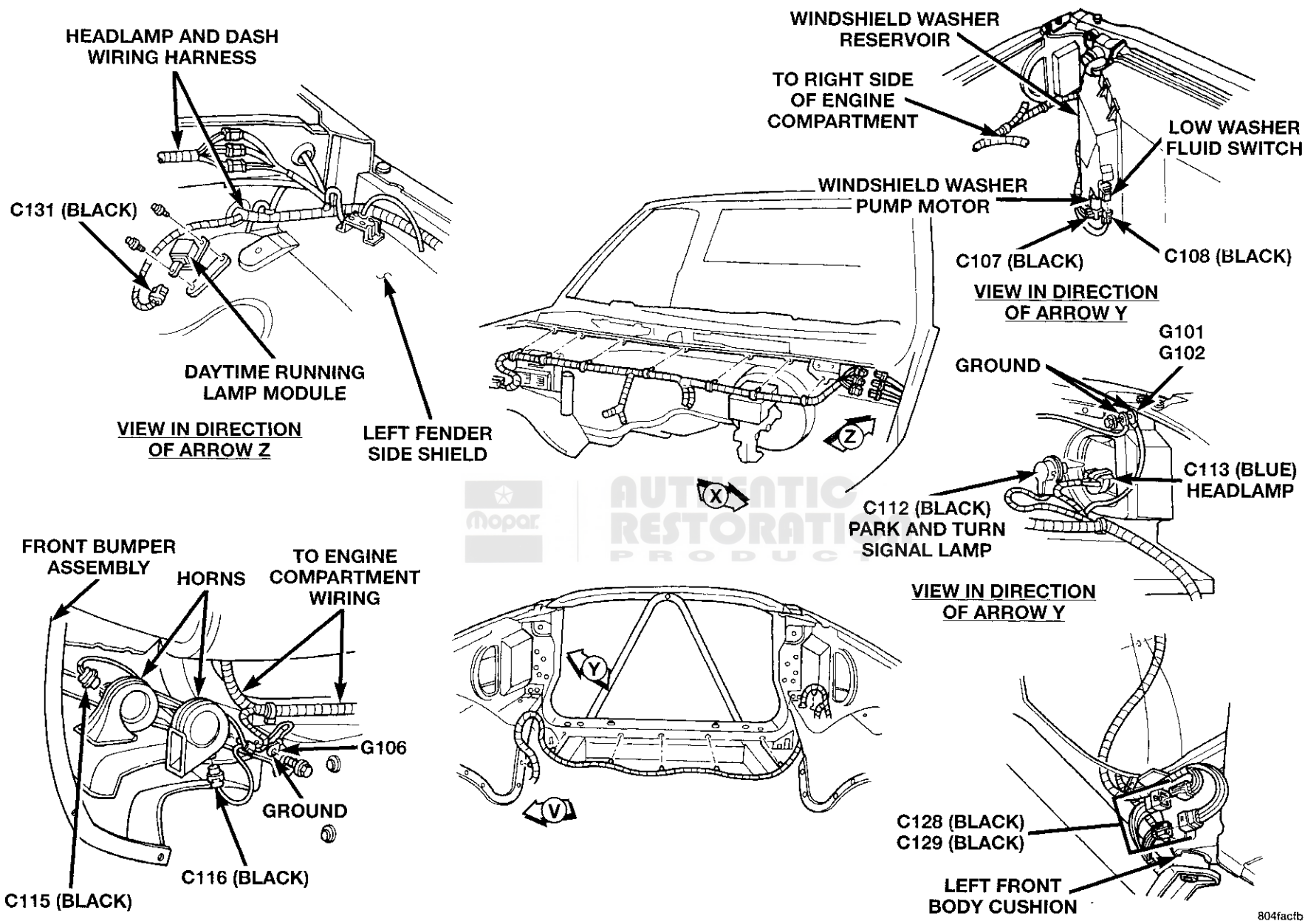


Fig. 2 Engine Compartment Connectors — Front

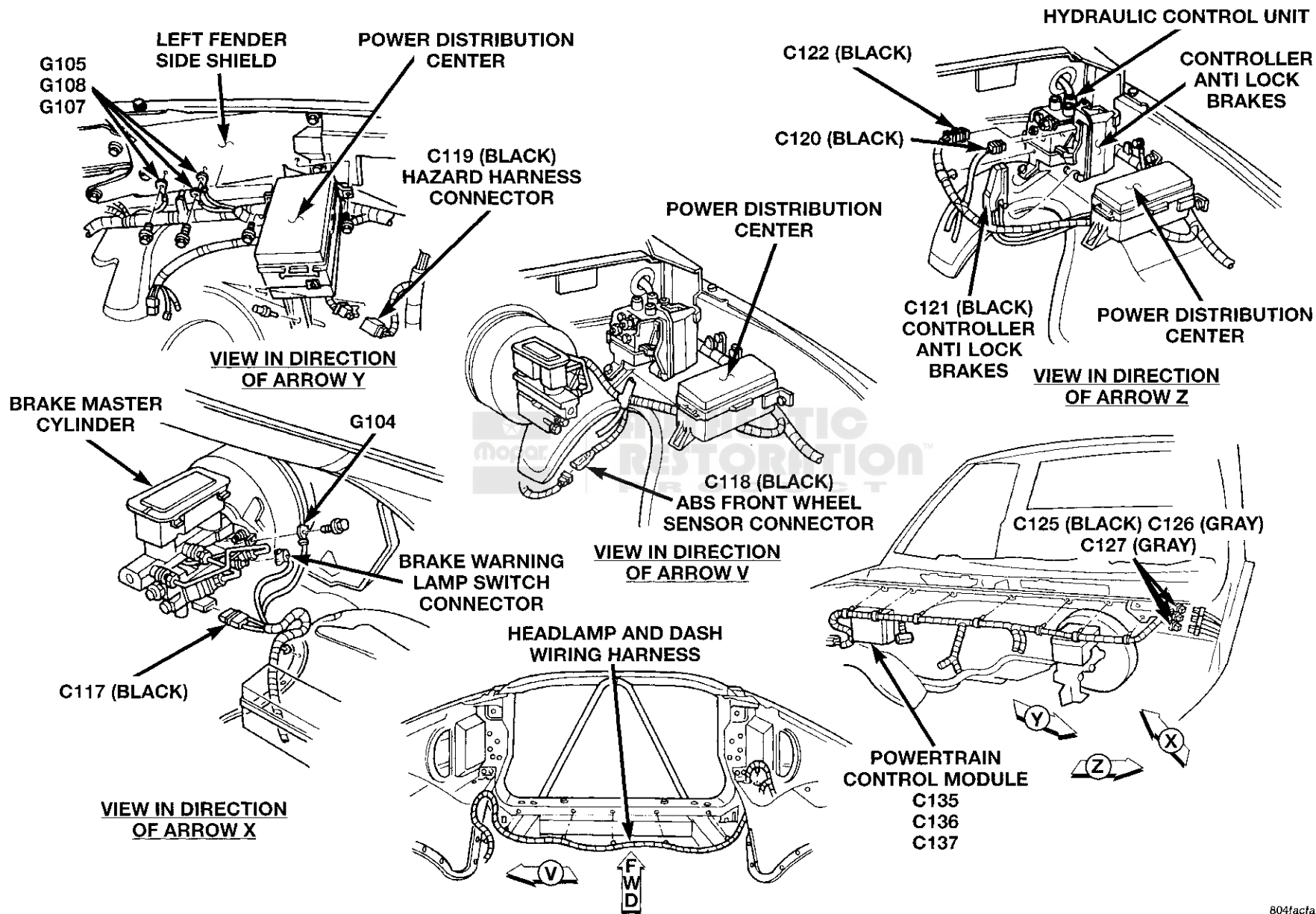
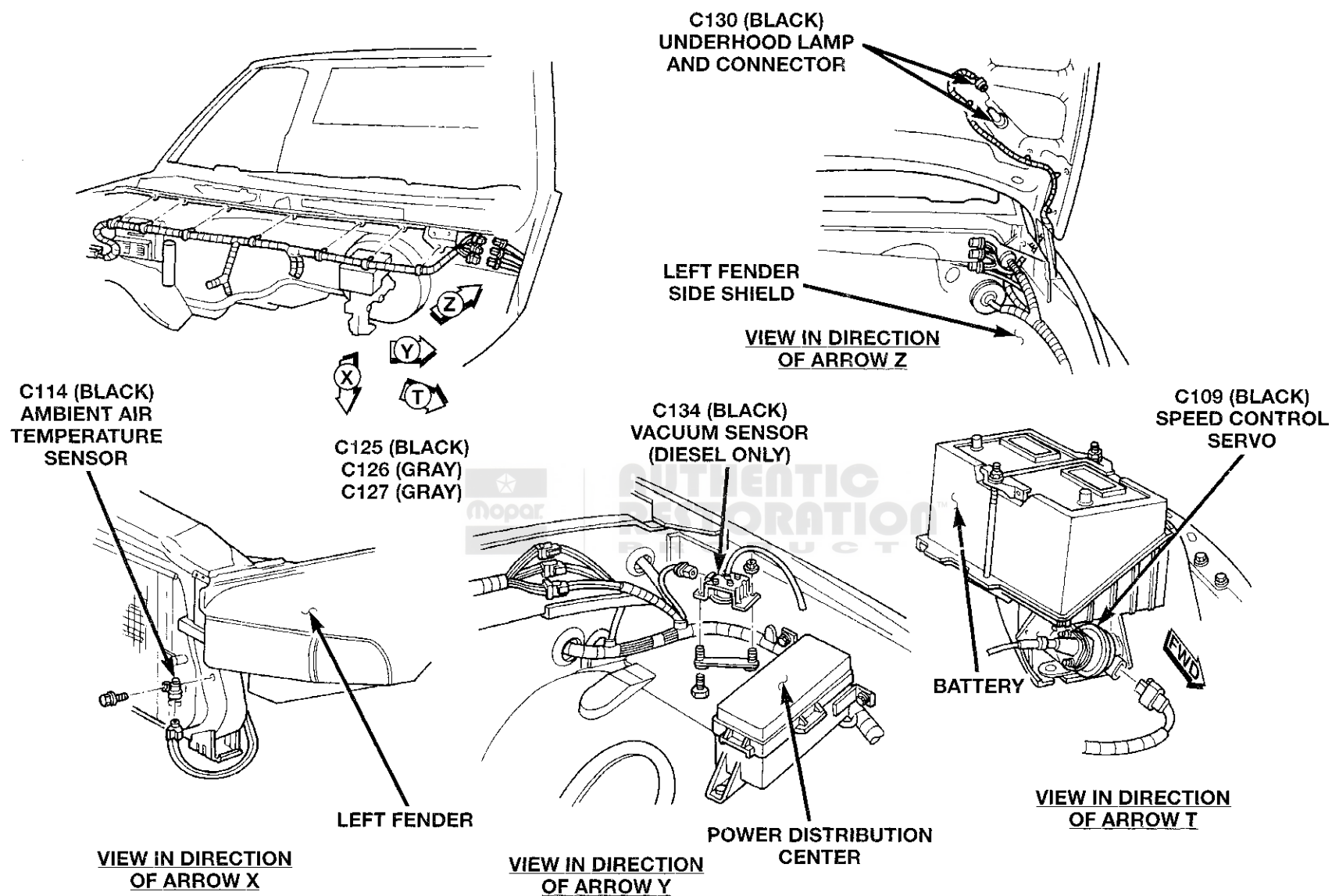


Fig. 3 Engine Compartment Connectors — Left Side

804facta

SCHEMATICS AND DIAGRAMS (Continued)



804facfc

Fig. 4 Engine Compartment Connectors — Left Side

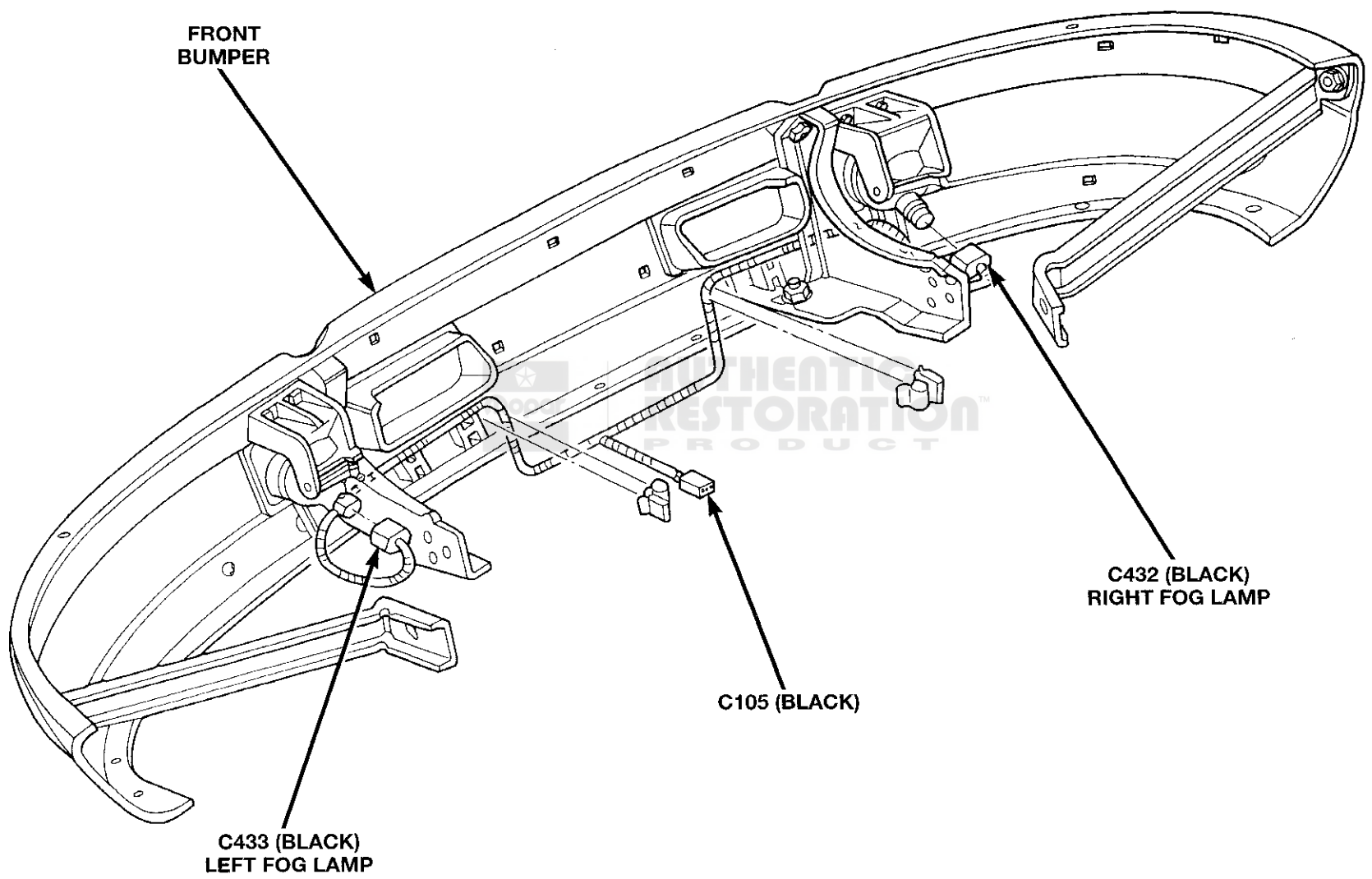


Fig. 5 Fog Lamps

804facfd

SCHEMATICS AND DIAGRAMS (Continued)

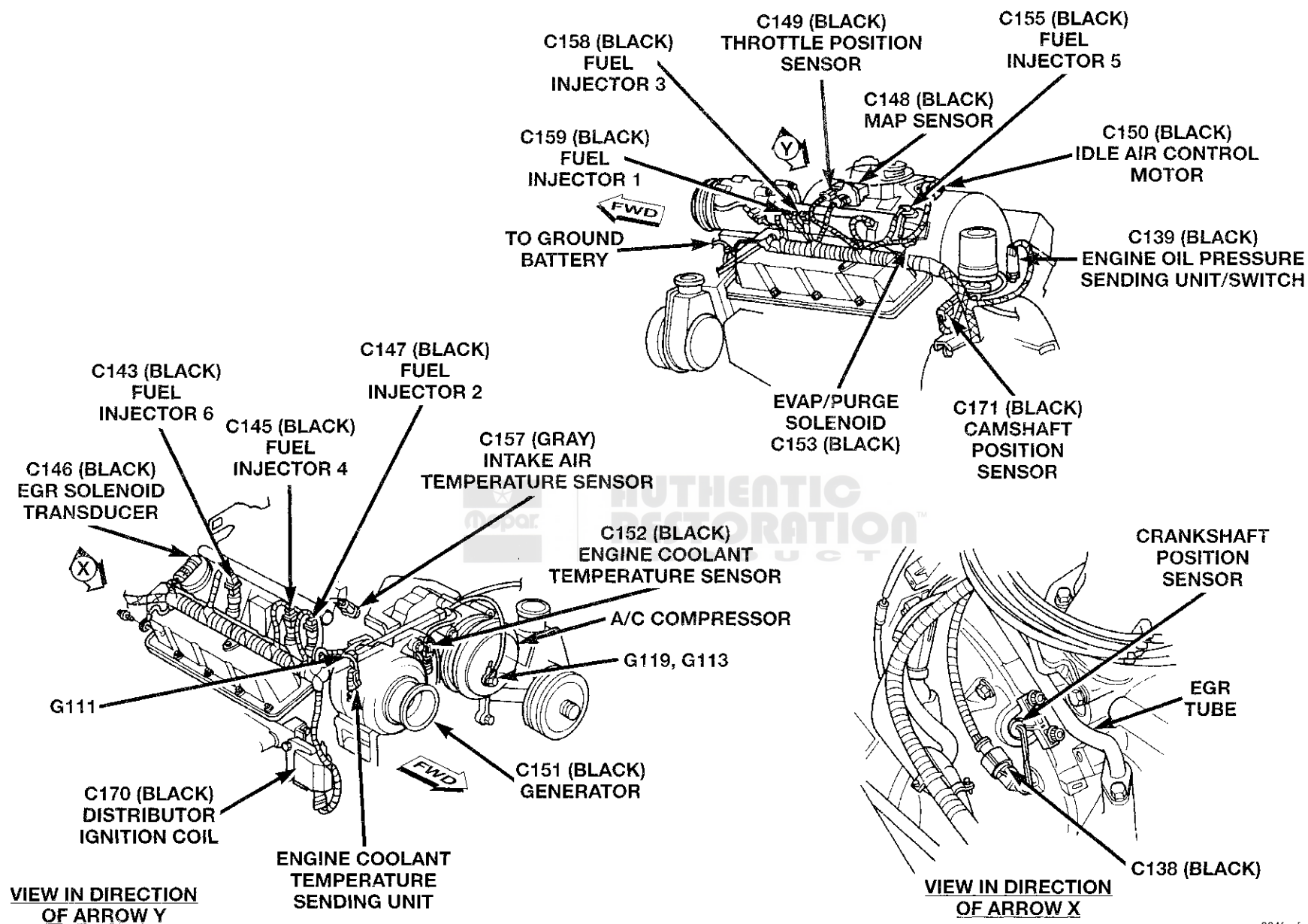


Fig. 6 Engine Connectors — V-6

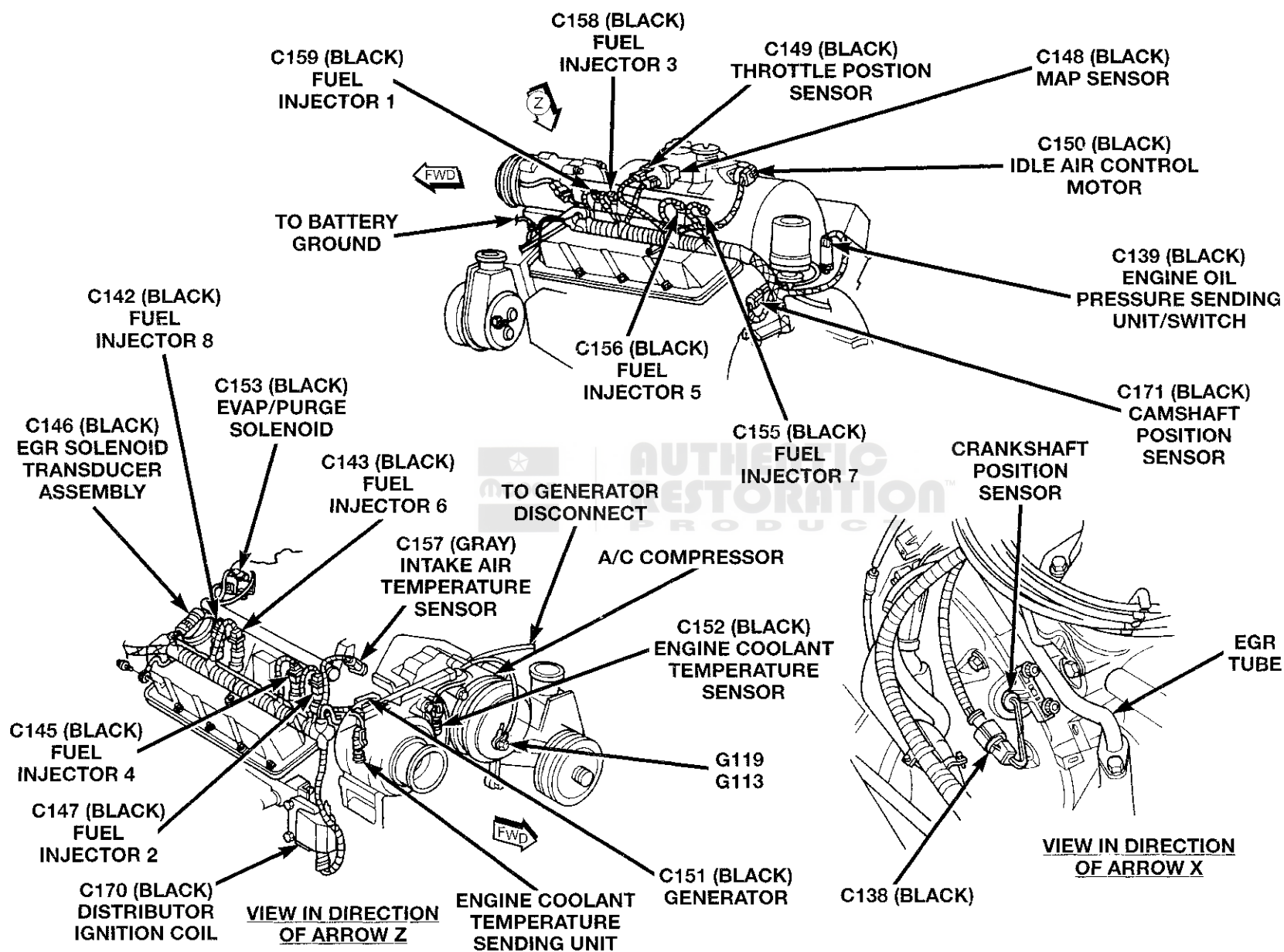
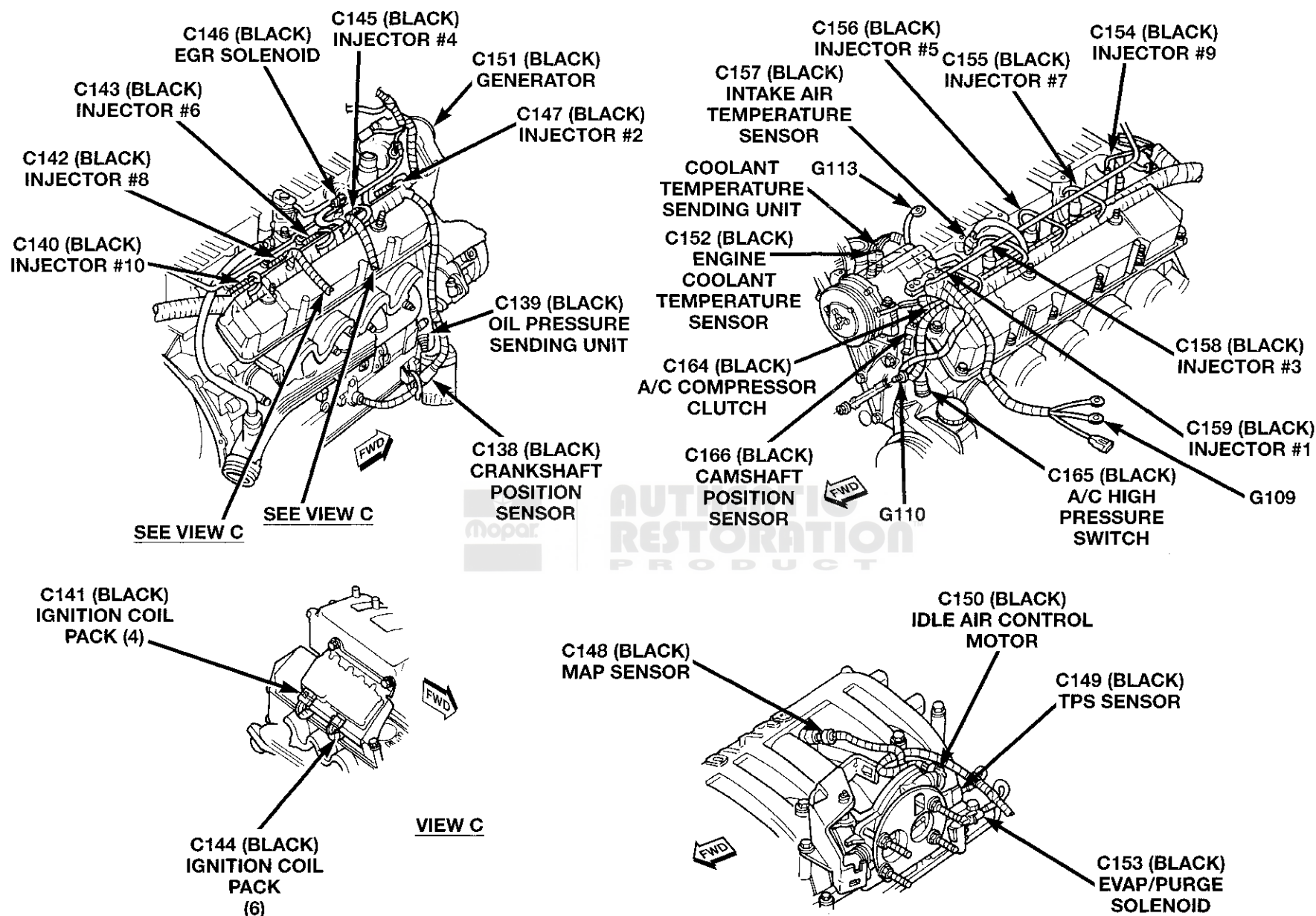


Fig. 7 Engine Connectors — V-8

SCHEMATICS AND DIAGRAMS (Continued)



80500502

Fig. 8 Engine Connectors — V-10

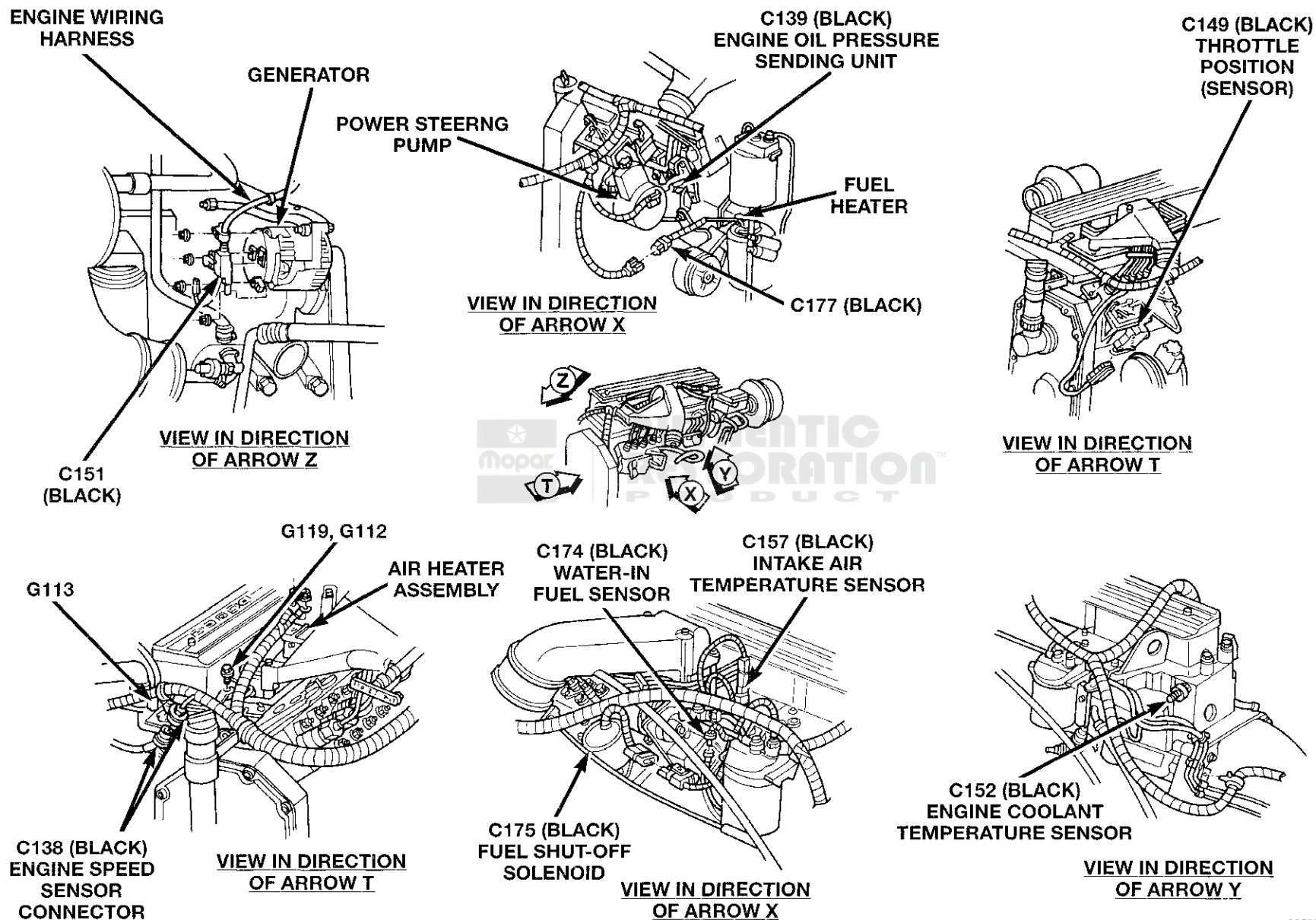
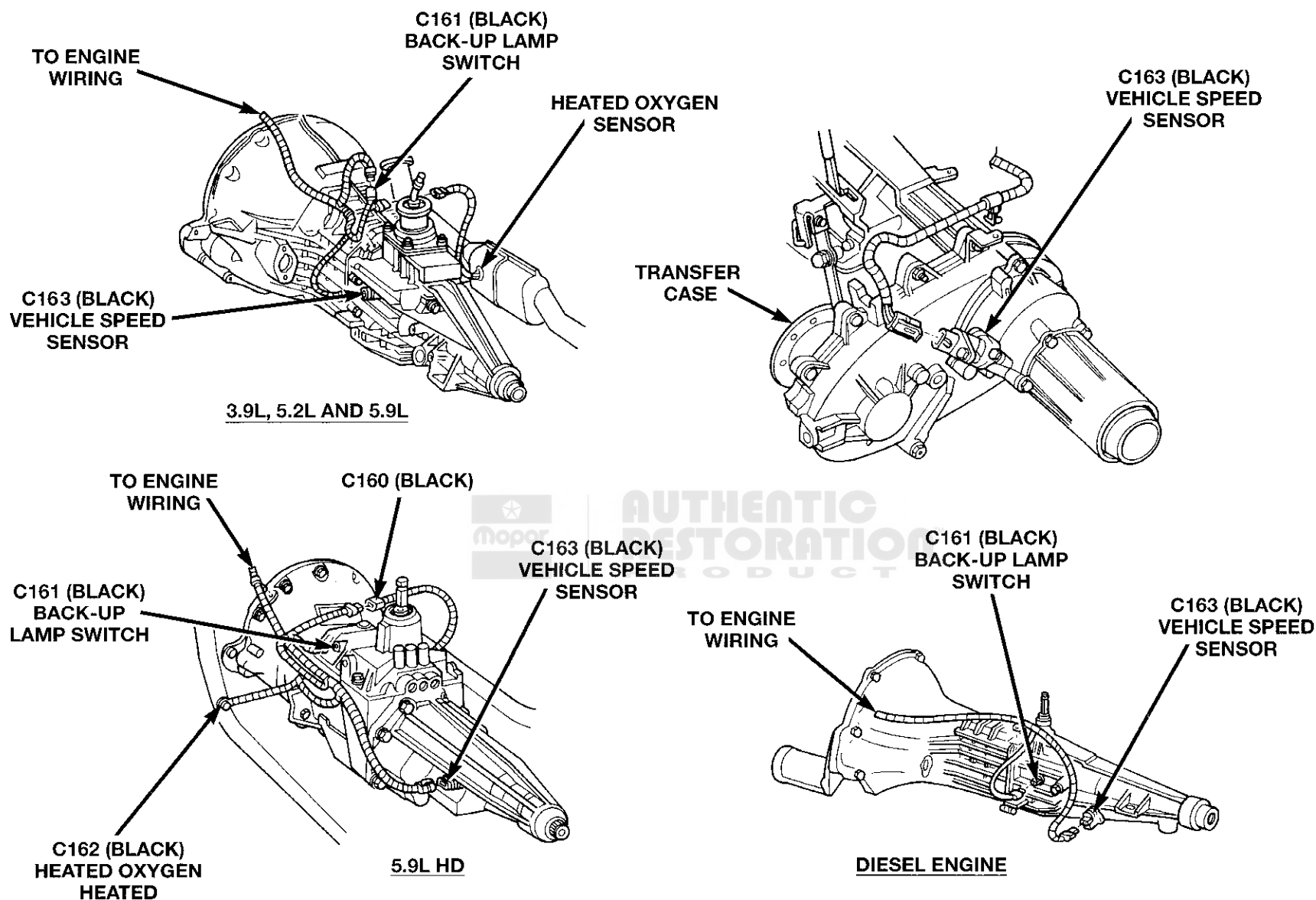


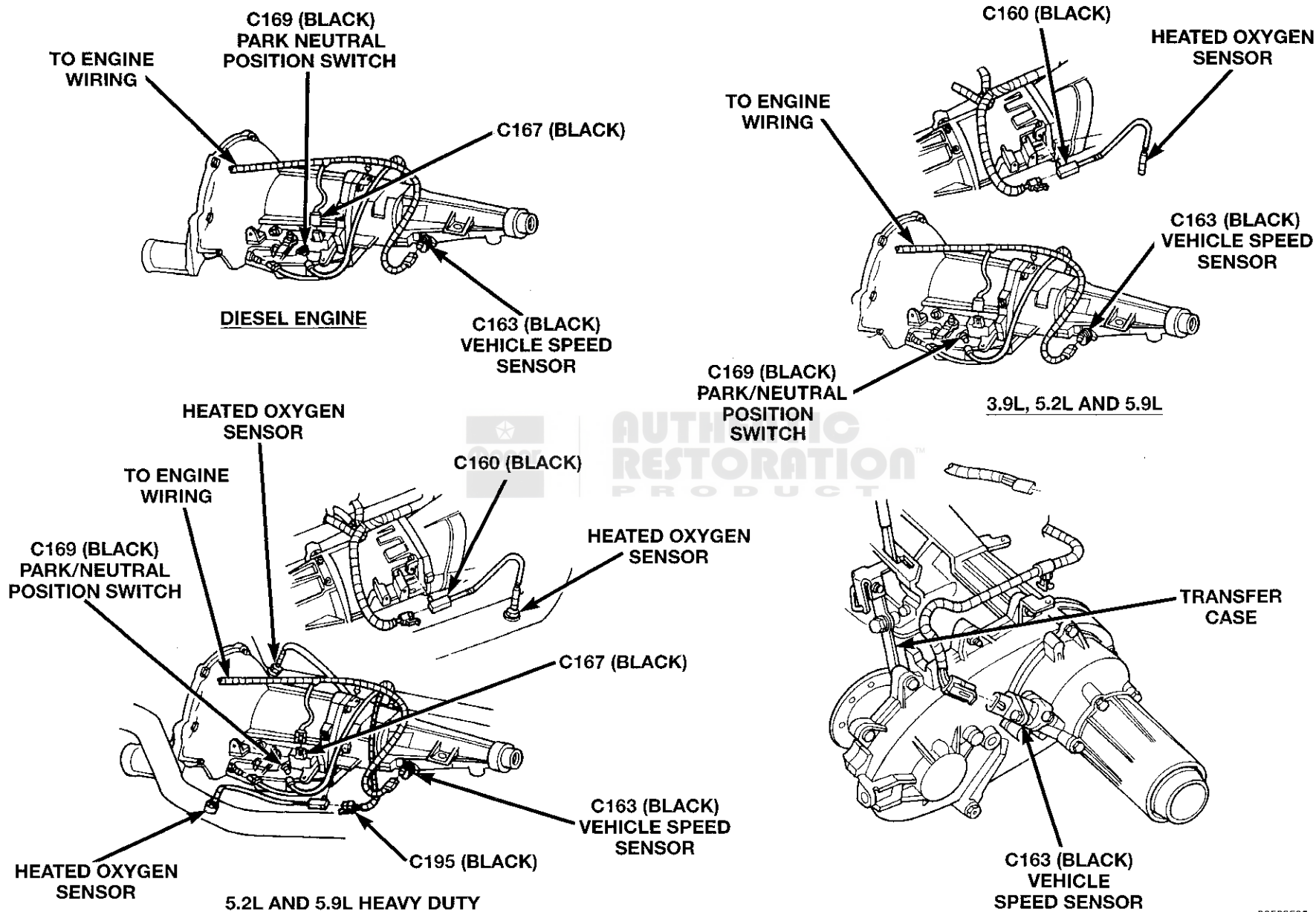
Fig. 9 Engine Connectors — Diesel

80500503



80500504

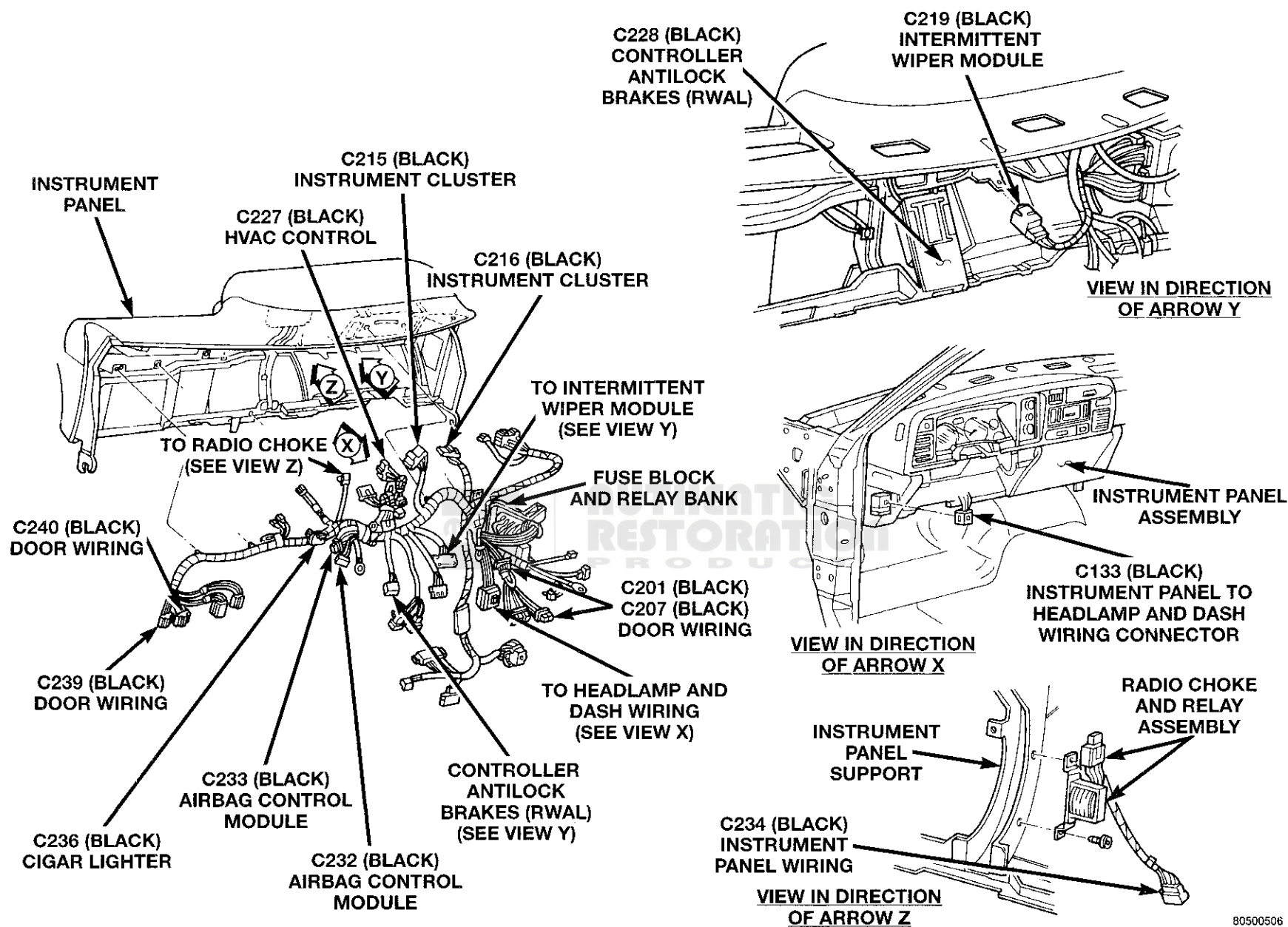
Fig. 10 Manual Transmission Connectors



80500505

Fig. 11 Automatic Transmission Connectors

SCHEMATICS AND DIAGRAMS (Continued)



80500506

Fig. 12 Instrument Panel Connectors

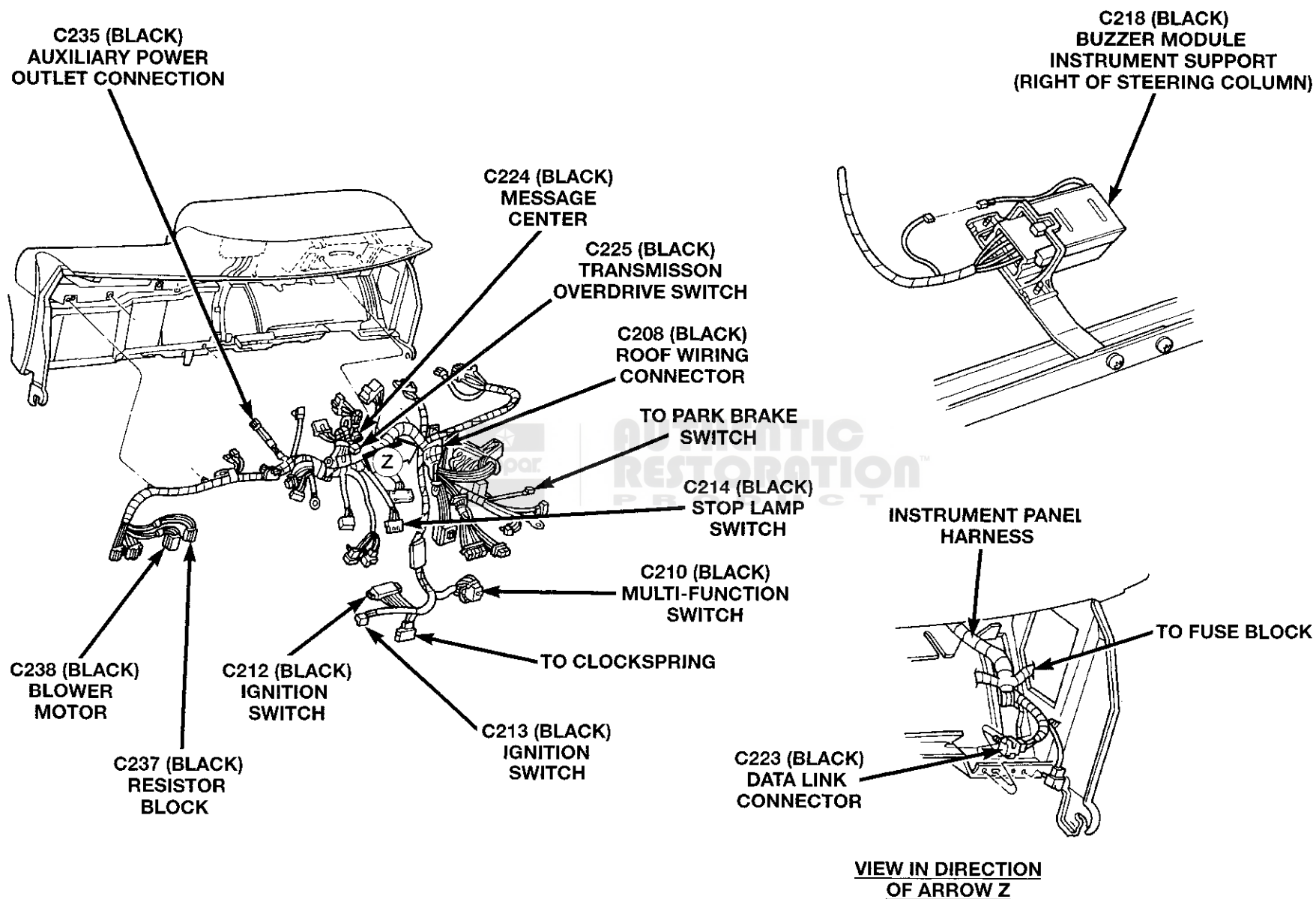
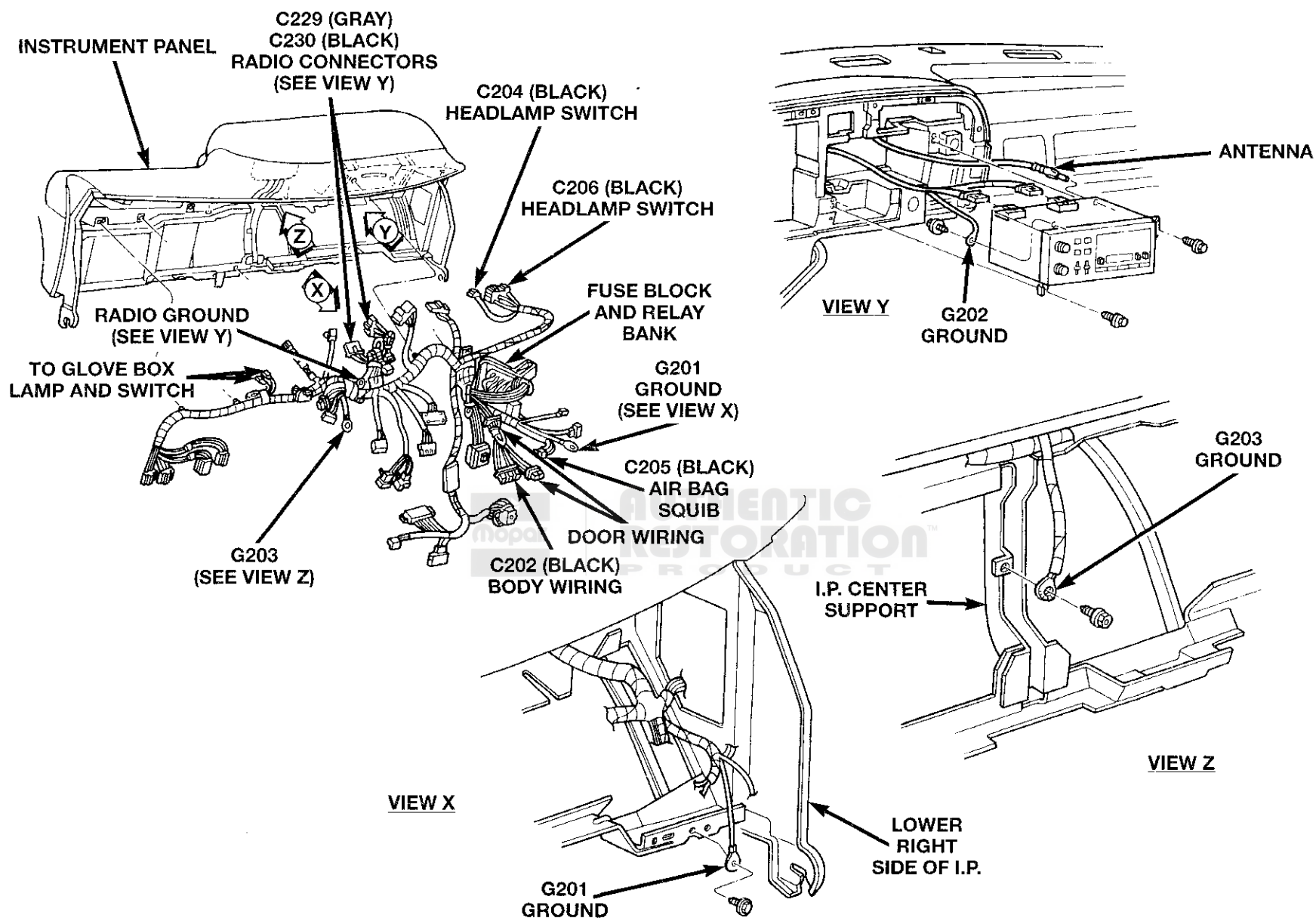


Fig. 13 Instrument Panel Connectors

SCHEMATICS AND DIAGRAMS (Continued)



80503508

Fig. 14 Instrument Panel Ground Connections

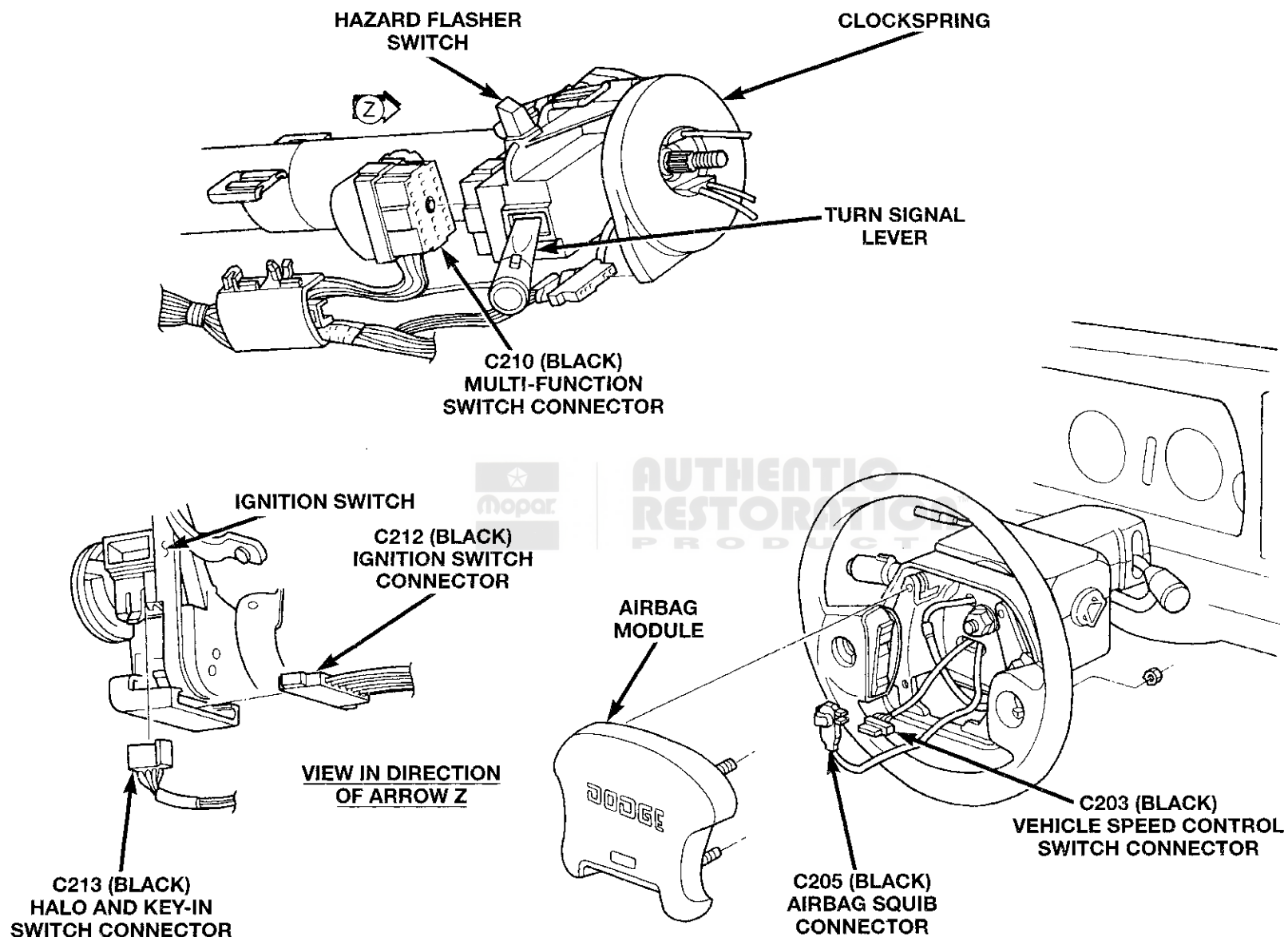


Fig. 15 Steering Column Connectors

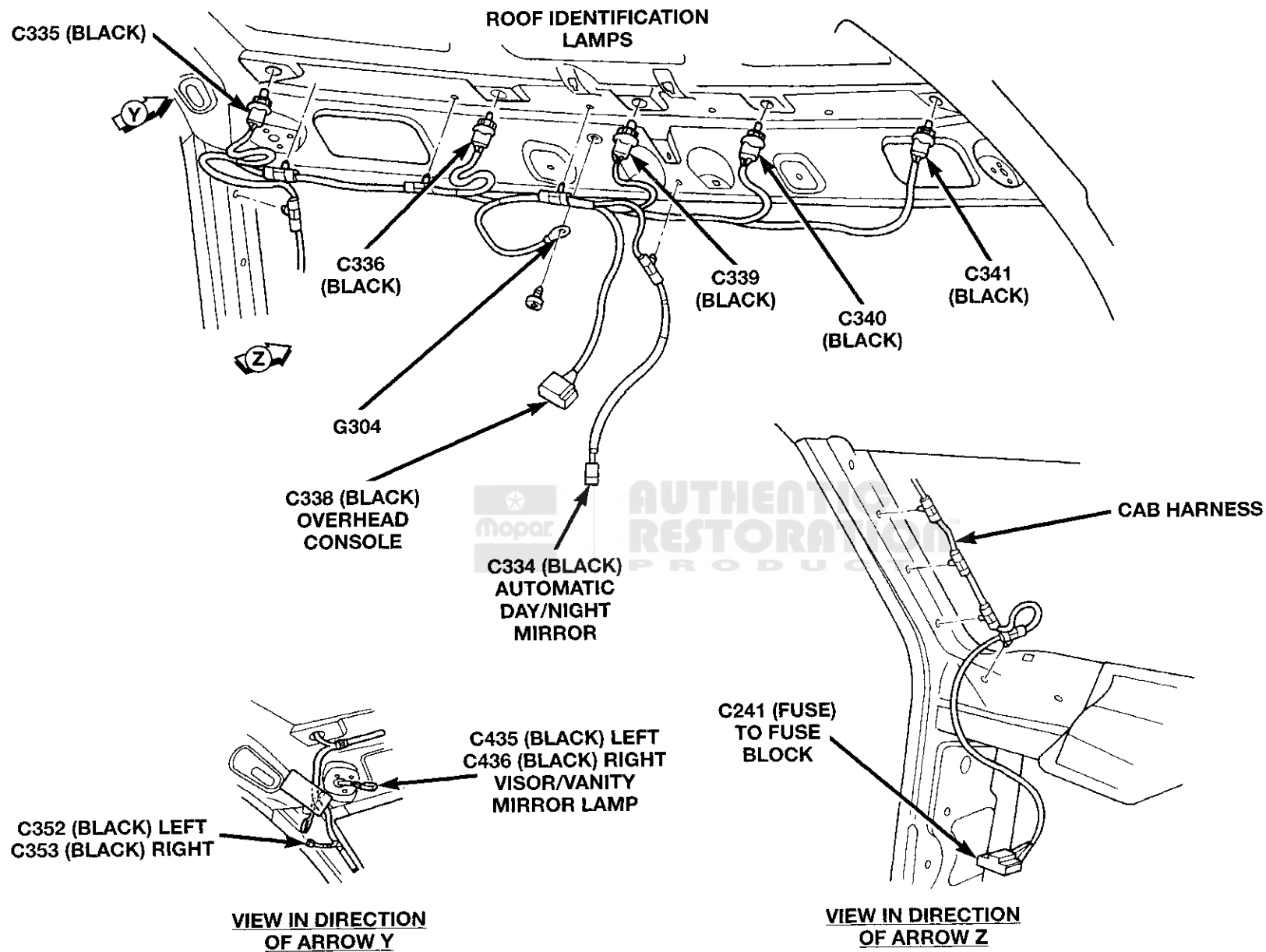
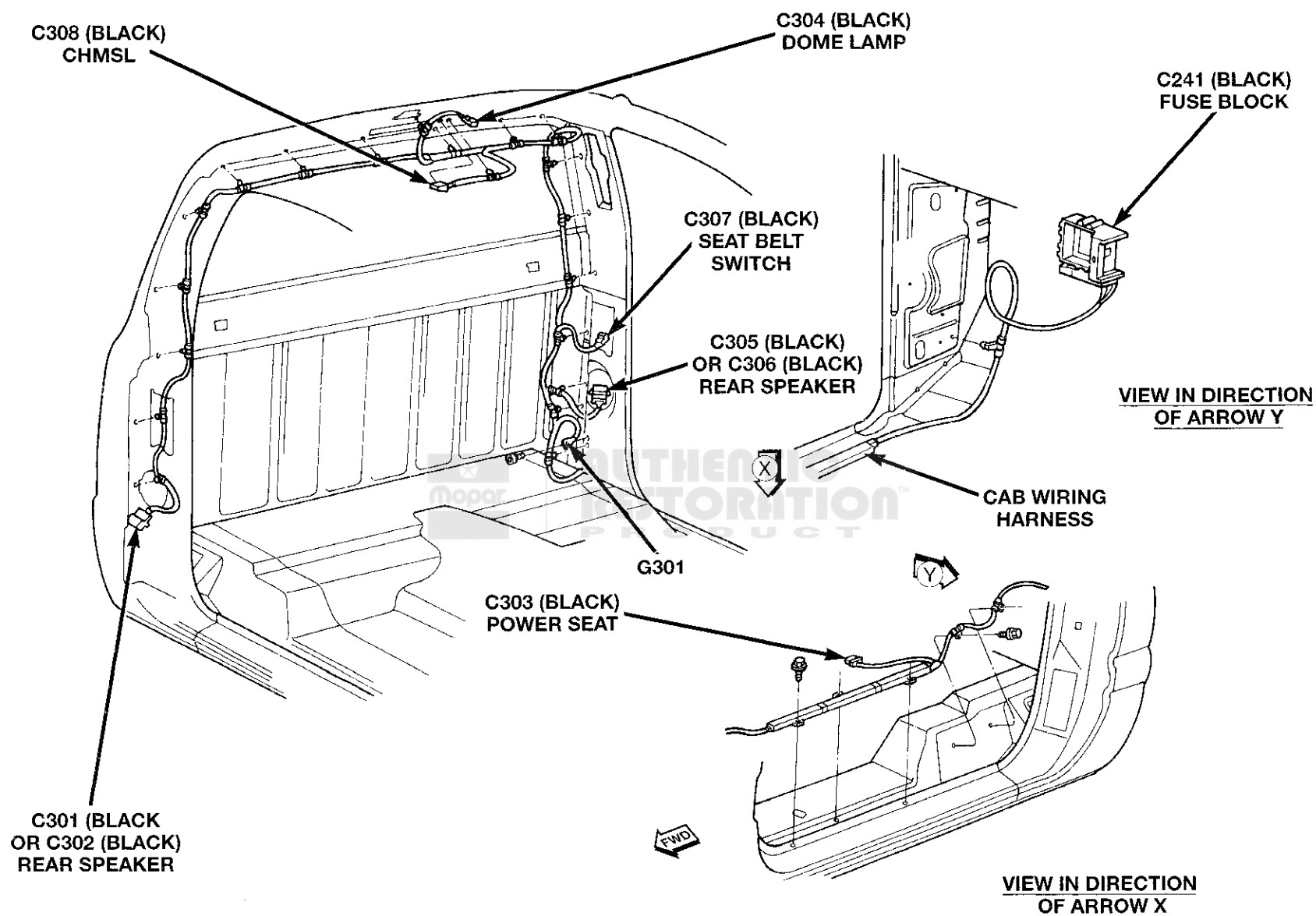


Fig. 16 Overhead Console Connectors

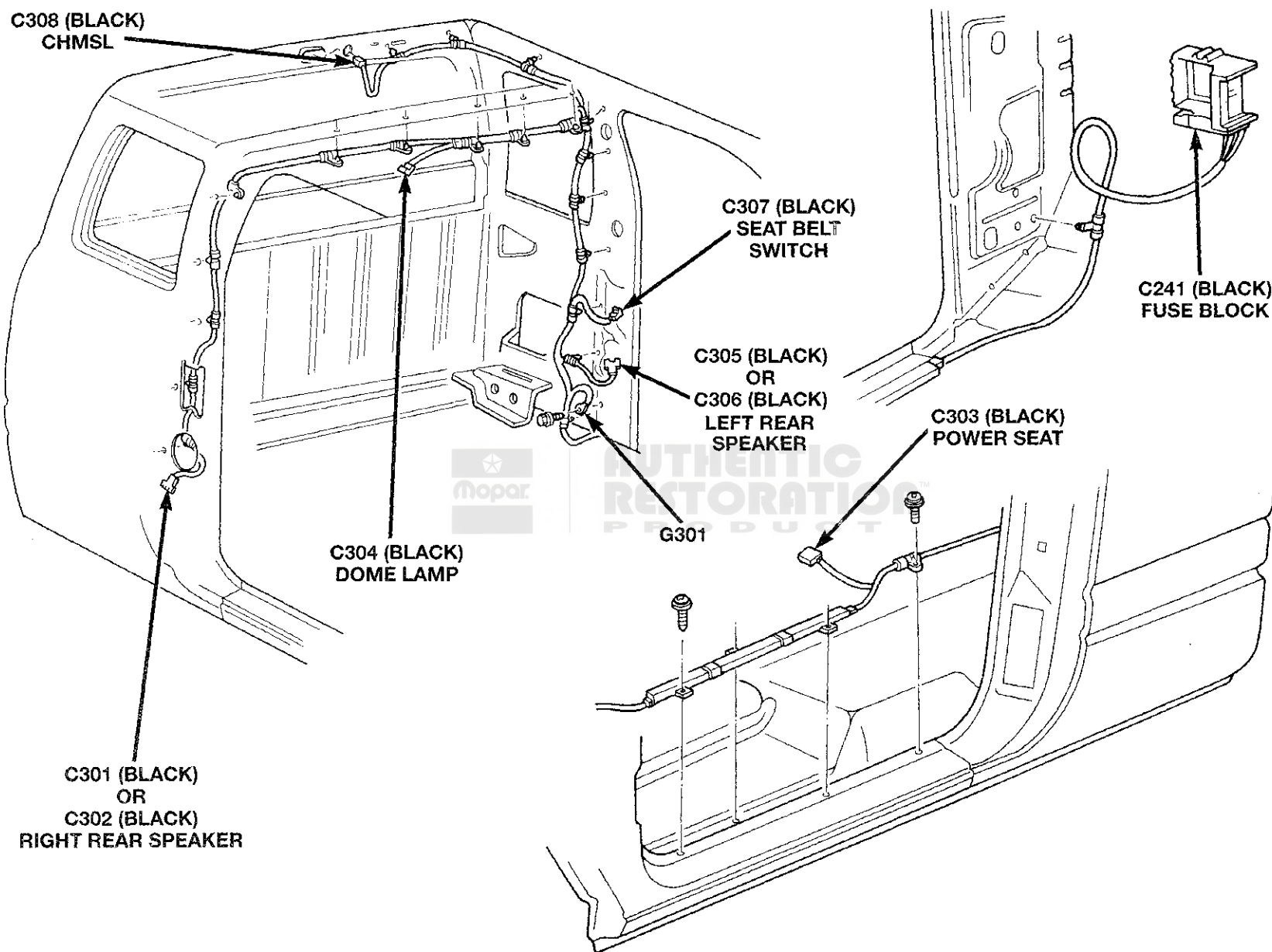
8050050a

SCHEMATICS AND DIAGRAMS (Continued)



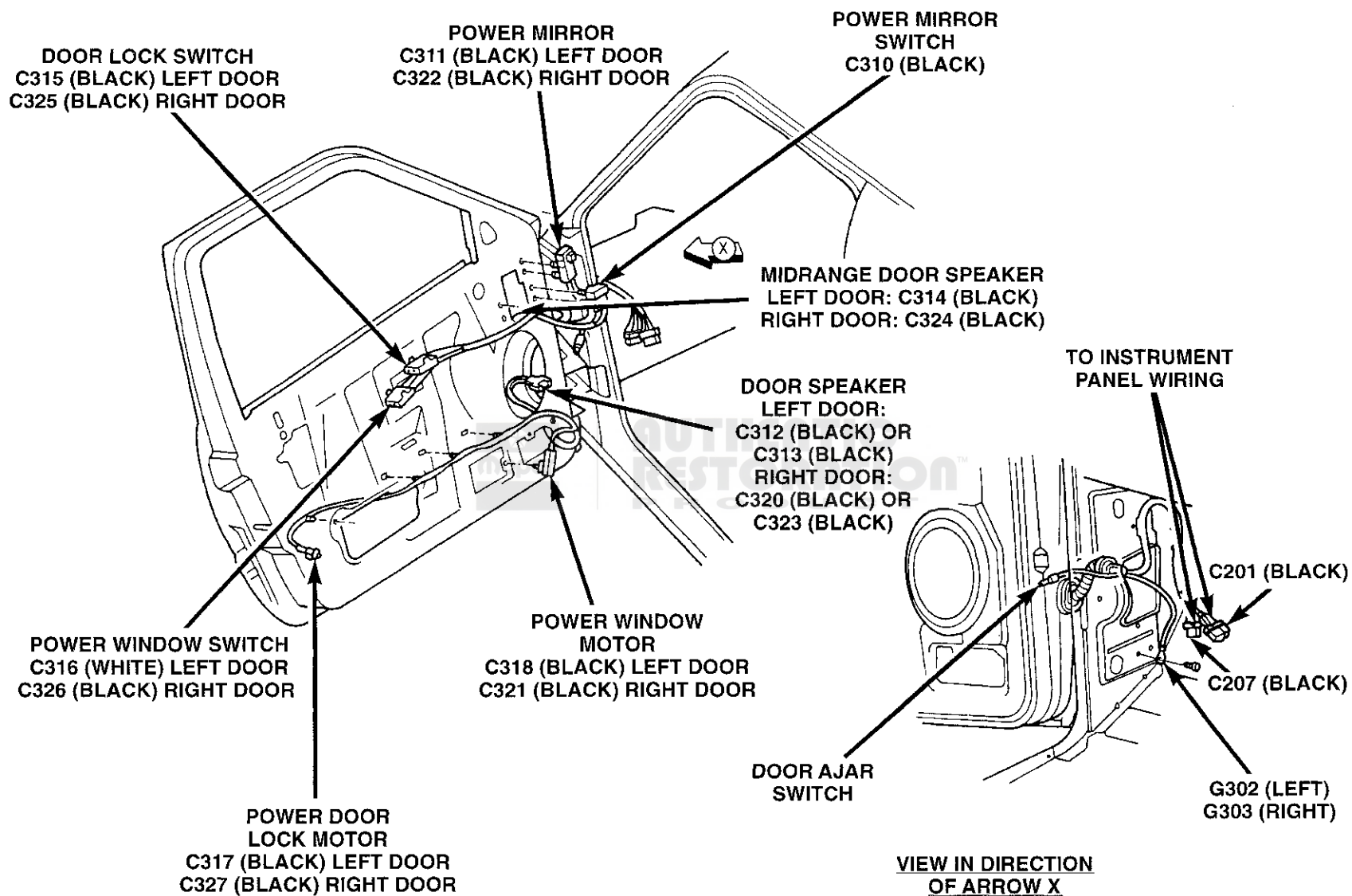
8050050b

Fig. 17 Cab Connectors



8050050c

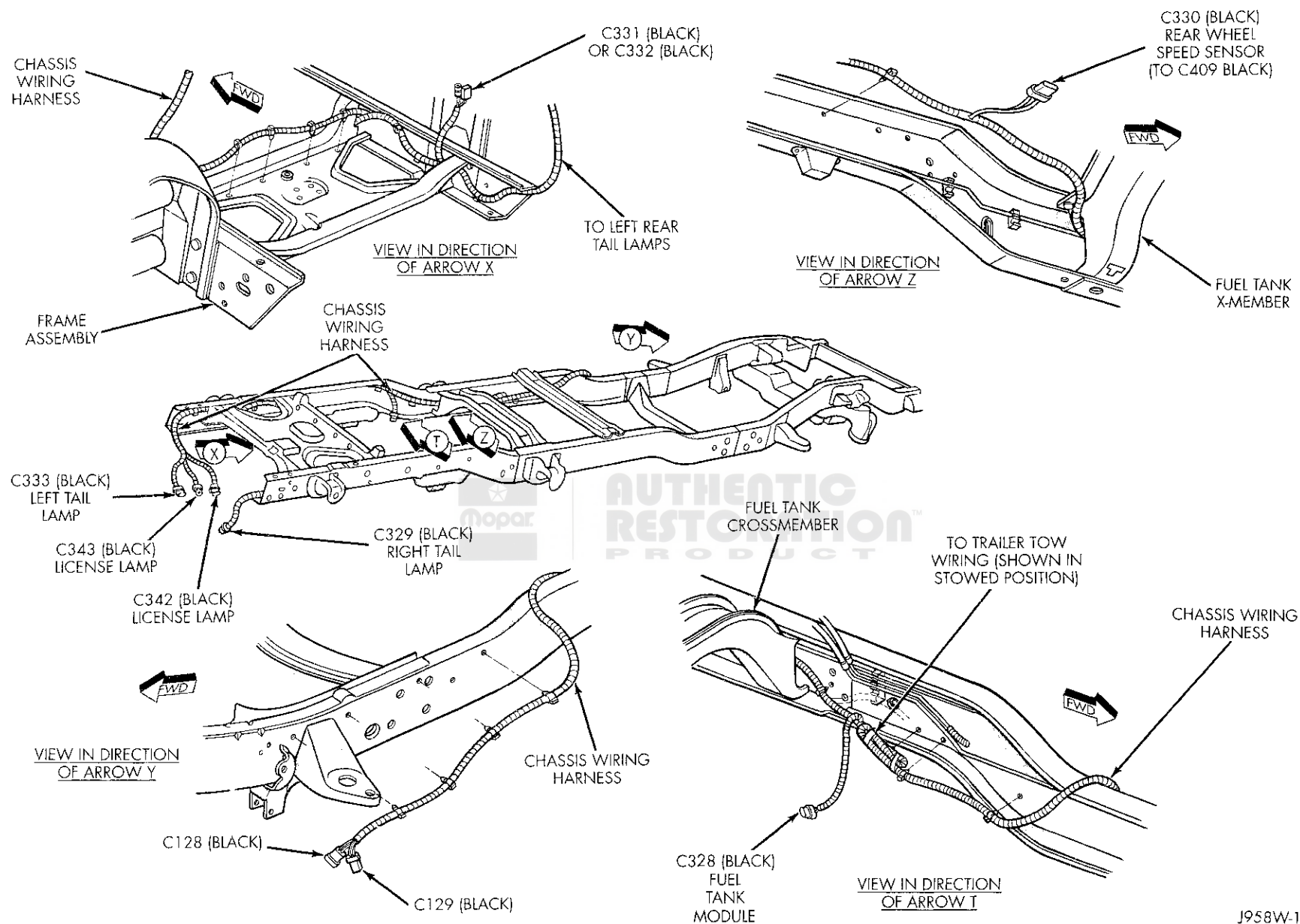
Fig. 18 Extended Cab Connectors



8050050d

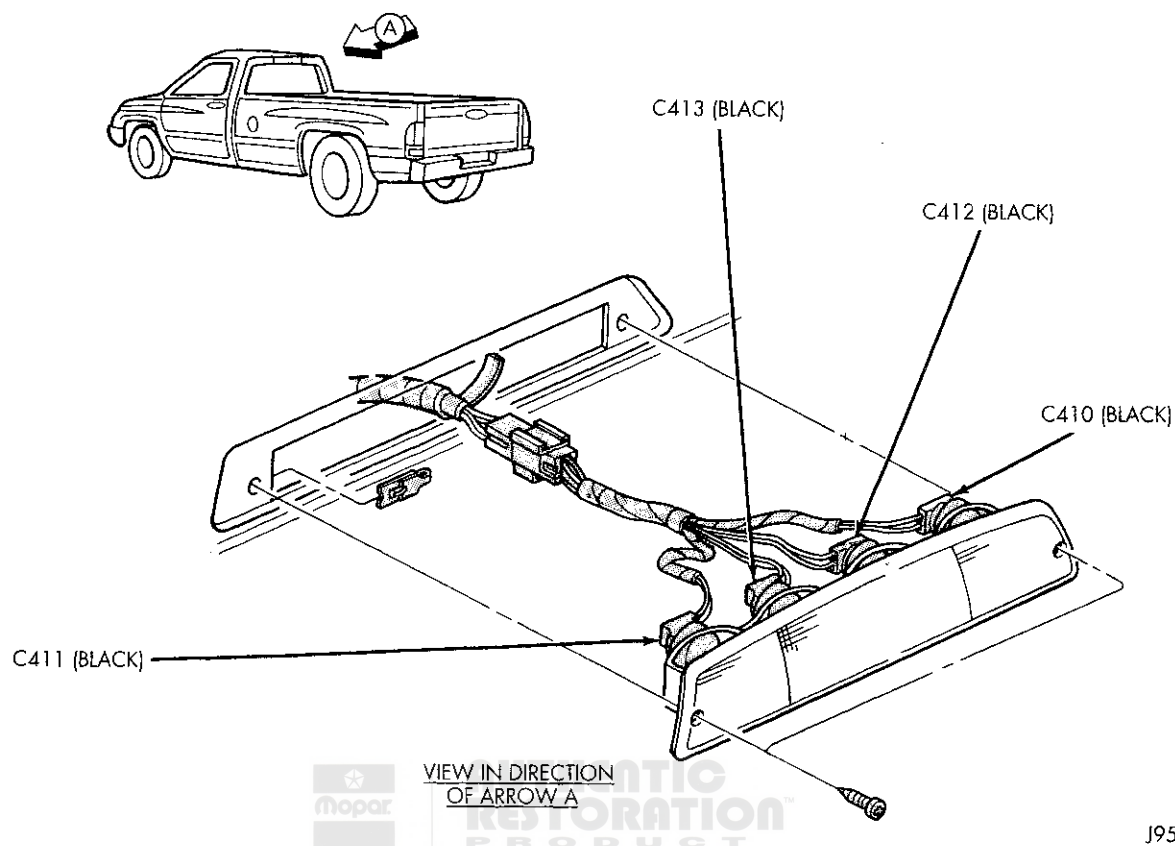
Fig. 19 Door Connectors

SCHEMATICS AND DIAGRAMS (Continued)



J958W-17

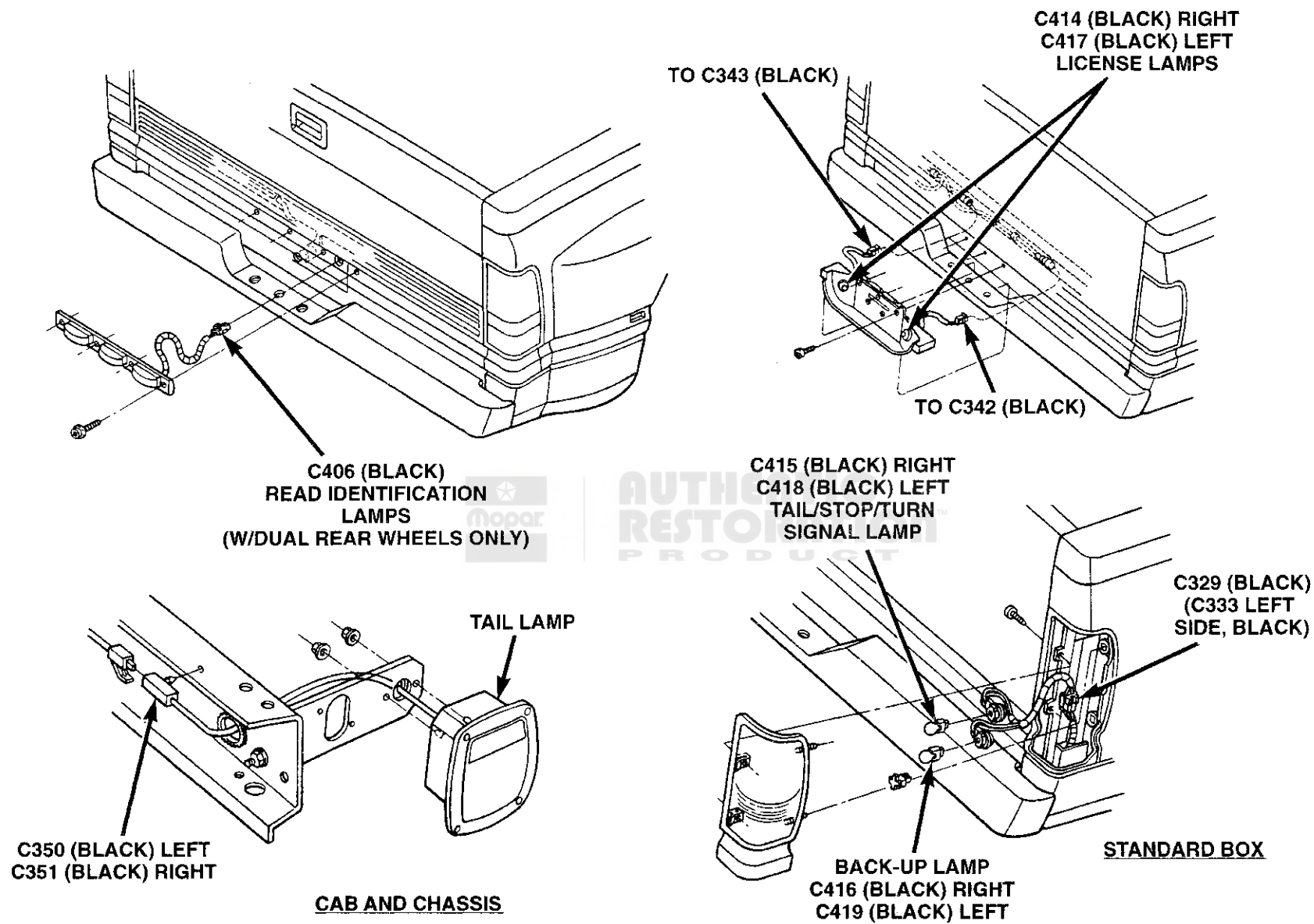
Fig. 20 Frame Connectors



J958W-236

Fig. 21 Center High Mounted Stop Lamps (CHMSL) and Cargo Lamps

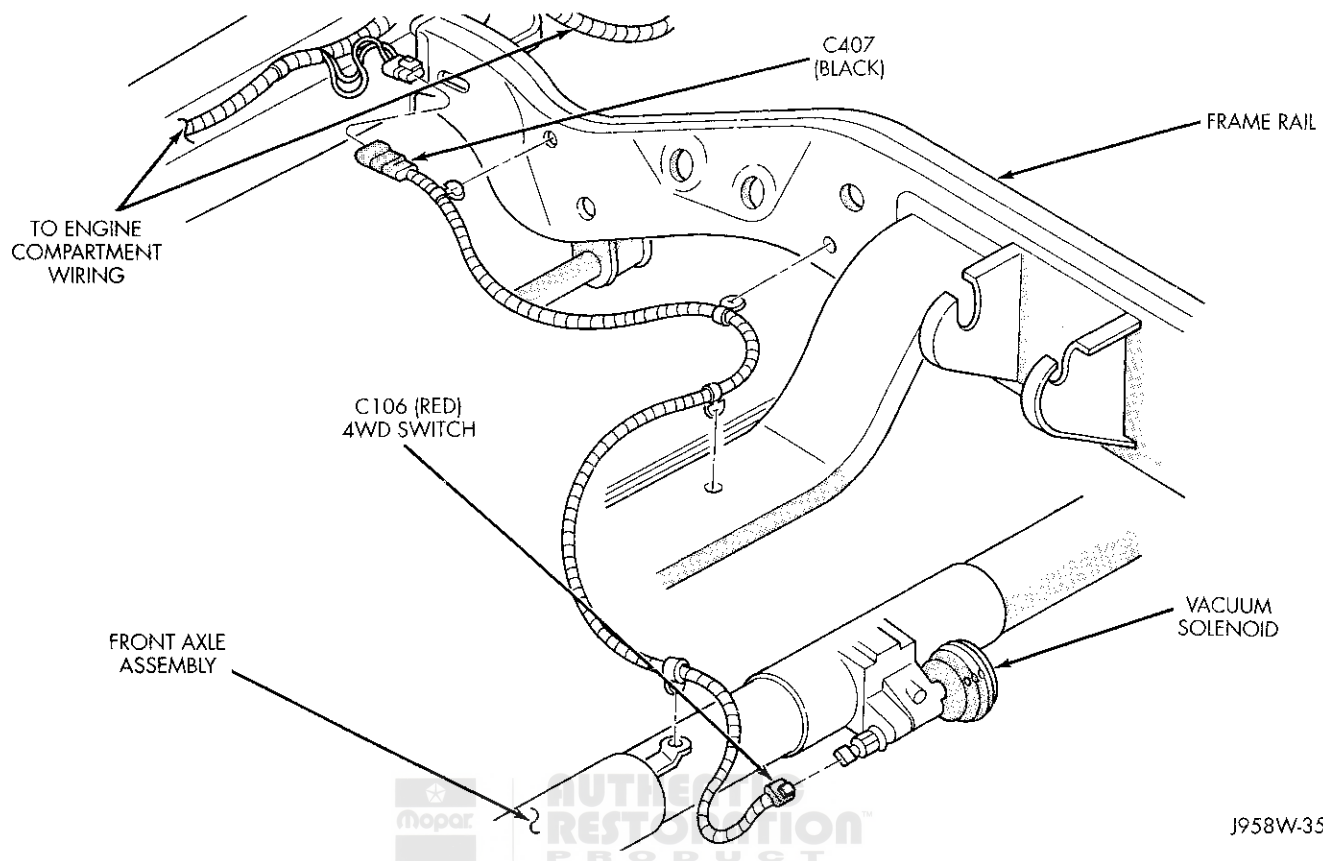
SCHEMATICS AND DIAGRAMS (Continued)



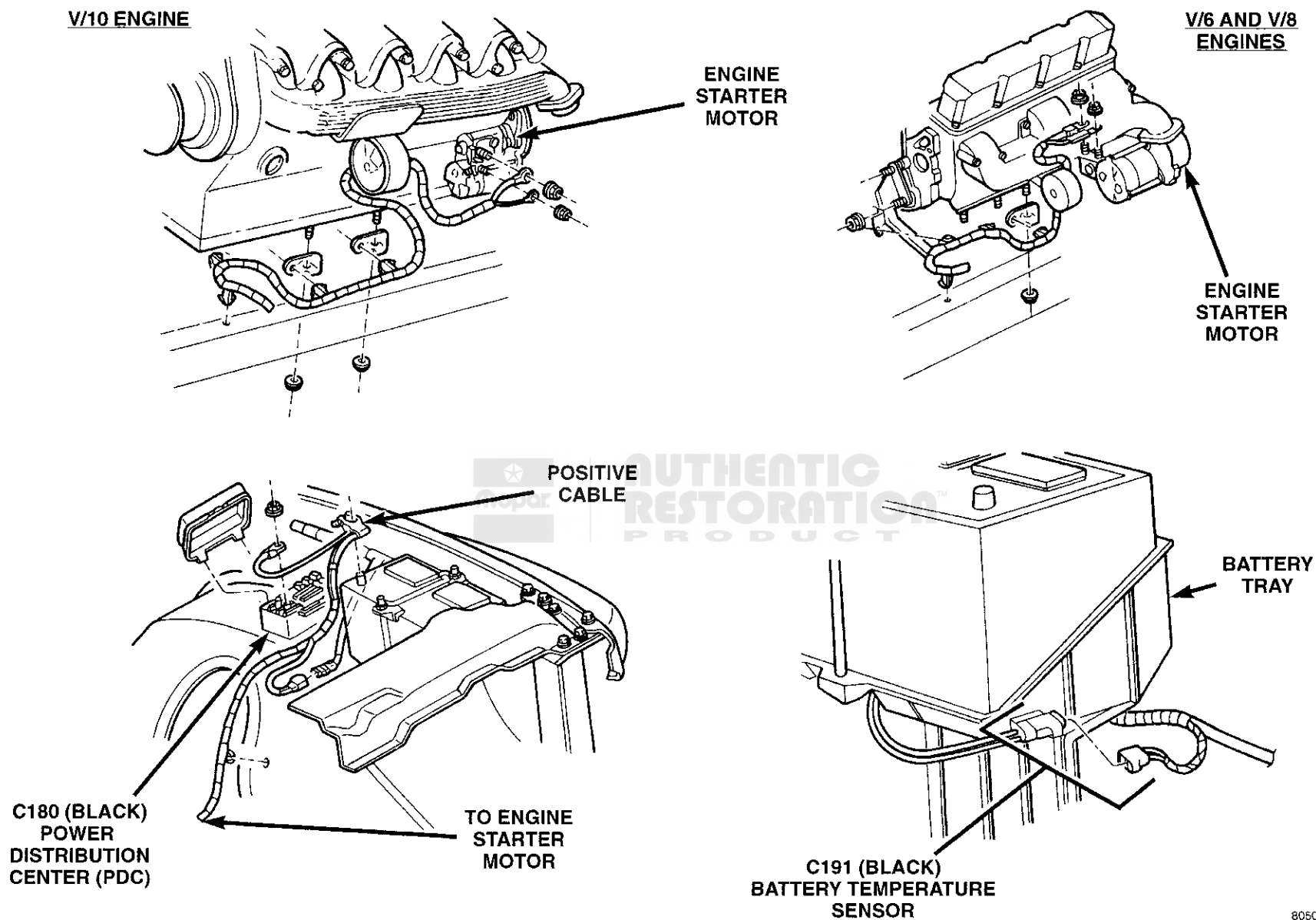
8050050e

Fig. 22 Rear Lamps

SCHEMATICS AND DIAGRAMS (Continued)



J958W-35



80500510

Fig. 24 Battery Connections

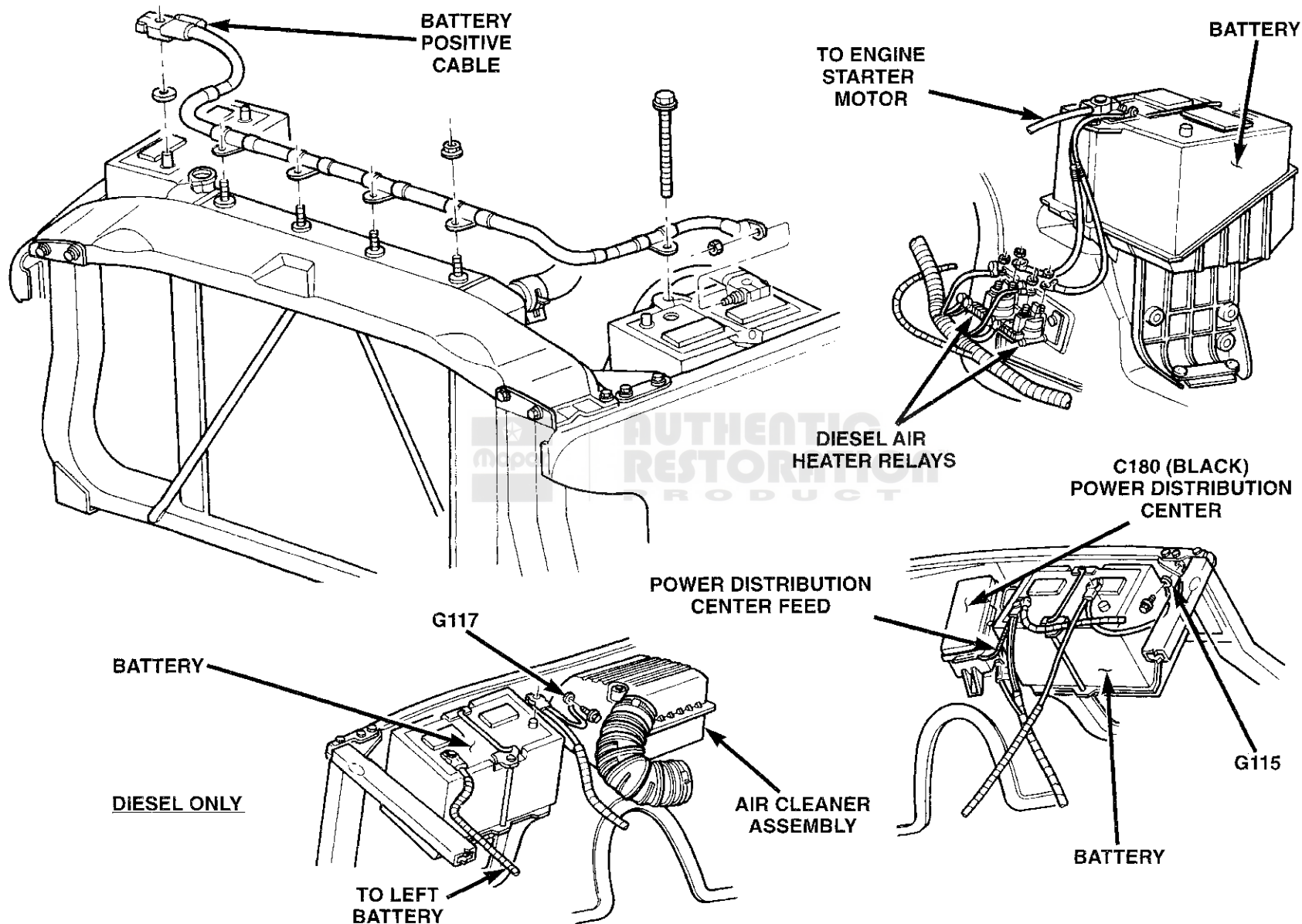
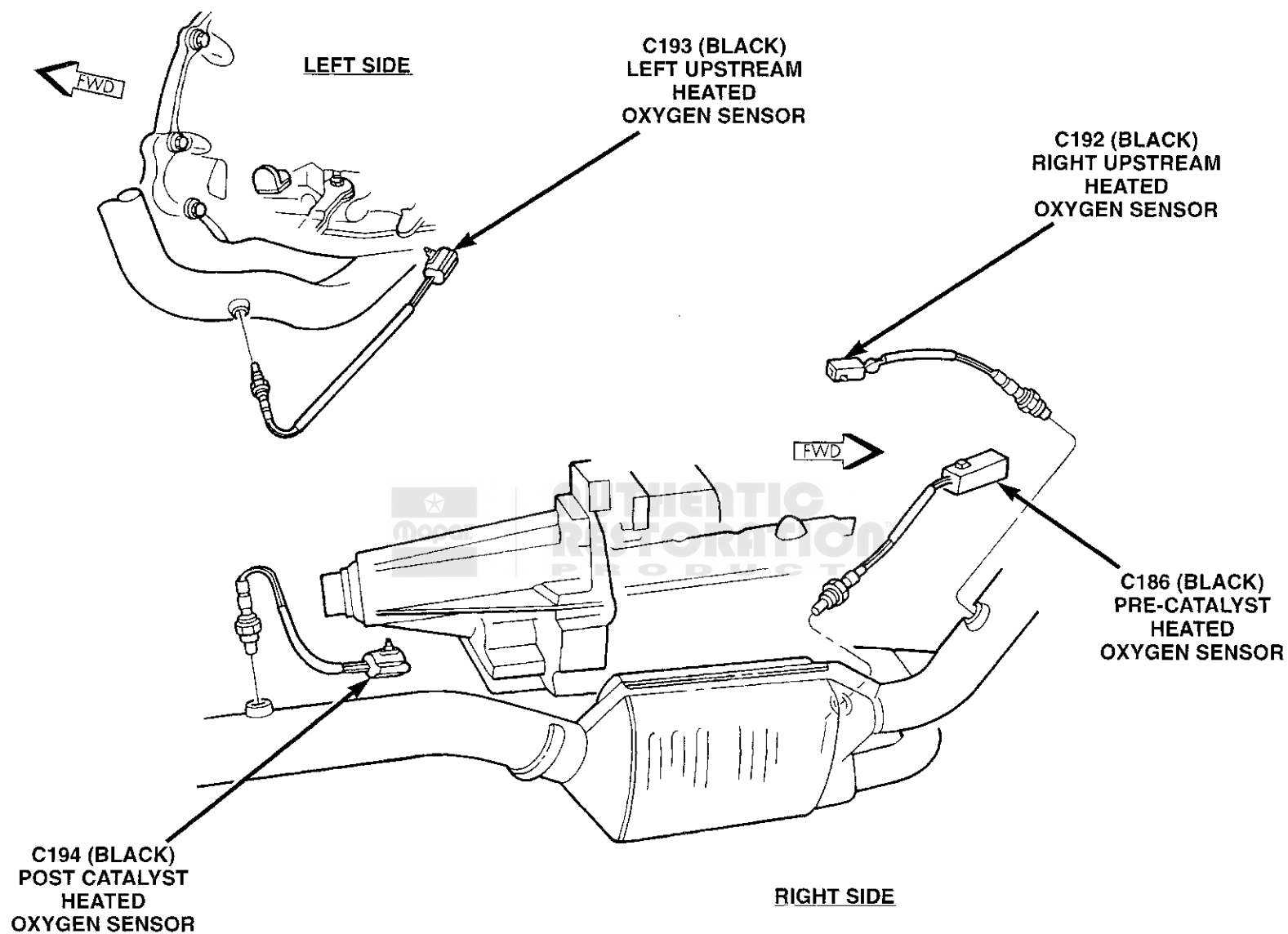


Fig. 25 Diesel Battery Connections

80500512



805C0501

Fig. 26 Heated Oxygen Sensor Connectors — V-10 Engine

8W-95 SPLICE LOCATIONS

DESCRIPTION AND OPERATION

INTRODUCTION

This section provides illustrations identifying the general location of the splices in this vehicle. A splice index is provided. Use the wiring diagrams in each section for splice number identification. Refer to the index for proper splice number.

Splice Number	Location	Fig.
S101	In T/O for Right Turn Signal Lamp	1
S102	In T/O for Right Turn Signal Lamp	1
S103	Before T/O for Right Headlamp	1
S104	Near Horn T/O	1
S105	In Branch for Horn T/O	1
S106	After Branch for Horn T/O	1
S107	Before Branch for Controller Antilock Brakes (CAB)	2
S108	Before Branch for Controller Antilock Brakes (CAB)	2
S109	Before Branch for Controller Antilock Brakes (CAB)	2
S110	In Branch to Controller Antilock Brakes	2
S111	In Branch to Controller Antilock Brakes	2
S112	In T/O to Hydraulic Control Unit	2
S113	Before T/O for PDC	2
S114	Before Branch to Engine Harness Connectors	2
S115	Before Branch to Engine Harness Connectors	2
S116	In Branch to Engine Harness Connectors	2
S117	In Branch to Engine Harness Connectors	2
S118	In T/O to Chassis Connector (C128)	1
S119	In T/O to Chassis Connector (C128)	1
S120	In T/O to Chassis Connector (C128)	1

SCHEMATICS AND DIAGRAMS

SPLICE LOCATIONS

For splices that are not shown in the figures in this section, N/S is placed in the Fig. column.

Splice Number	Location	Fig.
S121	In Branch to I.P. Harness, On I.P. Side of Grommet	2
S122	In Branch to I.P. Harness, On I.P. Side of Grommet	2
S123	In T/O for Left Turn Signal Lamp	1
S129	Near Branch to Injectors 2, 4, 6, 8 (V-6, V-8)	2
S129	Before Branch to Injectors 2, 4, 6, 8, 10 (V-10)	2
S130	Near Branch to Injectors 2, 4, 6, 8 (V-6, V-8)	2
S130	Near Branch to Injectors 2, 4, 6, 8, 10 (V-10)	2
S130	After T/O to Engine Coolant Temperature Sending Unit (Diesel)	5
S131	After Branch to Injectors 2, 4, 6, 8 (V-6, V-8)	2
S131	After Branch to Injectors 2, 4, 6, 8, 10 (V-10)	2
S131	Before PCM (Diesel)	2
S132	After Branch to Injectors 2, 4, 6, 8 (V-6, V-8)	2
S132	After Branch to Injectors 2, 4, 6, 8, 10 (V-10)	2
S132	Rear of Engine	5
S133	After T/O for Idle Air Control Motor (V-6, V-8)	3
S133	Near T/O for Injector 5 (V-10)	4
S134	Between T/Os for Injectors 4 and 6 (V-6, V-8)	3
S134	Between T/Os for Injectors 6 and 8 (V-10)	4
S134	Near Branch to Fuel Heater (Diesel)	5

SCHEMATICS AND DIAGRAMS (Continued)

Splice Number	Location	Fig.
S135	Between T/Os for Injectors 4 and 6 (V-6, V-8)	3
S135	Between T/Os for Injectors 4 and 6 (V-10)	4
S136	Near Crankshaft Position Sensor T/O (V-6, V-8)	2
S136	Between T/Os for Injectors 5 and 7 (V-10)	4
S136	Between T/Os for Intake Air Heaters and Fuel Heater (Diesel)	5
S137	Near Distributor T/O (V-6, V-8)	3
S137	Near T/O to Idle Air Control Motor (V-10)	4
S138	After T/Os for Injectors 2, 4, 6, 8 (V-6, V-8)	3
S138	After Branch to Injectors 2, 4, 6, 8, 10 (V-10)	2
S139	Near T/Os for PCM Connectors (V-6, V-8)	2
S139	Near T/Os for PCM Connectors (V-10)	2
S140	Before T/Os for Headlamp and Dash Harness Connectors (V-6, V-8)	2
S140	After Branch to Injectors 1, 3, 5, 7, 9, (V-10)	2
S140	Between T/Os for Intake Air Heaters and Fuel Heater (Diesel)	5
S141	In Branch to Transmission Wiring (V-6, V-8)	3
S141	Before Branch to Oxygen Sensors and Vehicle Speed Sensor	6
S141	Before PCM (Diesel)	2
S142	Near T/O for Fuel Shut-Off Solenoid	5
S143	Between T/Os for Intake Air Heaters and Fuel Heater (Diesel)	5
S144	In Harness to Left Battery Positive Terminal	N/S
S145	In Harness to Left Battery Positive Terminal	N/S
S146	In PDC	2
S147	In PDC	2
S148	Battery Positive Harness	N/S
S149	In T/O to Chassis Connector C128	1

Splice Number	Location	Fig.
S150	In Branch to Ground G119 (V-6, V-8)	3
S150	In Branch to Ground G119 (V-10)	4
S151	After Branch to Injectors 1, 3, 5, 7 (V-6, V-8, V-10)	2
S152	Near T/O for Fuel Heater Relay	2
S153	In T/O to Chassis Connector (C128)	1
S154	Before Branch to Injectors 1, 3, 5, 7 (V-6, V-8)	2
S154	Before Branch to Injectors 1, 3, 5, 7, 9 (V-10)	2
S155	In PDC	2
S156	In Branch to Engine Harness Connectors	2
S157	Between T/Os for Intake Air Heaters and Fuel Heater (Diesel)	5
S158	In Branch to Controller, Antilock Brakes	2
S159	Before PCM (Diesel)	2
S160	Before T/Os for Headlamp and Dash Harness Connectors	2
S201	In Fuse Block	N/S
S202	In Fuse Block	N/S
S203	In Headlamp Switch T/O	7
S204	In Headlamp Switch T/O	7
S205	Near Headlamp Switch T/O	7
S206	In Fuse Block T/O	7
S207	Between T/Os for Cluster Connectors	7
S208	Between T/Os for Cluster Connectors	7
S209	After Cluster Connector T/Os	7
S210	After Wiper Module T/O	7
S212	Near Radio Choke Relay T/O	7
S213	In Radio Choke Relay T/O	7
S214	After Power Outlet T/O	7
S215	After Airbag Control Module T/O	7
S216	Before Glove Box T/O	7
S217	After Glove Box T/O	7
S218	In Branch to Power Door Lock Switch and Power Mirror Switch	7
S301	Near T/O for Body Ground G301	9
S302	Near Left Rear Speaker T/O	9

SCHEMATICS AND DIAGRAMS (Continued)

Splice Number	Location	Fig.	Splice Number	Location	Fig.
S303	Near Body Ground (G301)	9	S317	After T/O for Left Outboard Clearance Lamp	8
S304	In Left Door Speaker T/O	10	S318	After T/O for Left Outboard Clearance Lamp	8
S305	In Left Power Mirror Motor T/O	10	S319	Before T/O to Center Identification Lamp	8
S306	In Left Door Harness	10	S320	Before T/O to Center Identification Lamp	8
S307	In Right Door Speaker T/O	10	S401	In Tail Lamp Jumper Harness	N/S
S308	In Right Door Power Window Motor T/O	10	S402	In Tail Lamp Jumper Harness	N/S
S309	Before T/O to Door Switch	10	S403	In Air Intake Heater Feed	N/S
S310	Before T/O to Door Switch	10	S404	In Air Intake Heater Feed	N/S
S311	Near Fuel Pump Module T/O	11	S405	In Fender Lamps Harness	N/S
S312	After Branch to Right Rear Lamps	11	S406	In Fender Lamps Harness	N/S
S313	After Branch to Right Rear Lamps	11	S407	In Tailgate Harness	N/S
S314	After Branch to Right Rear Lamps	11	S408	In Tailgate Harness	N/S
S315	In T/O to Trailer Tow Harness Connectors	11	S409	in Branch to Right Fog Lamp	12
S316	In T/O to Trailer Tow Harness Connectors	11			



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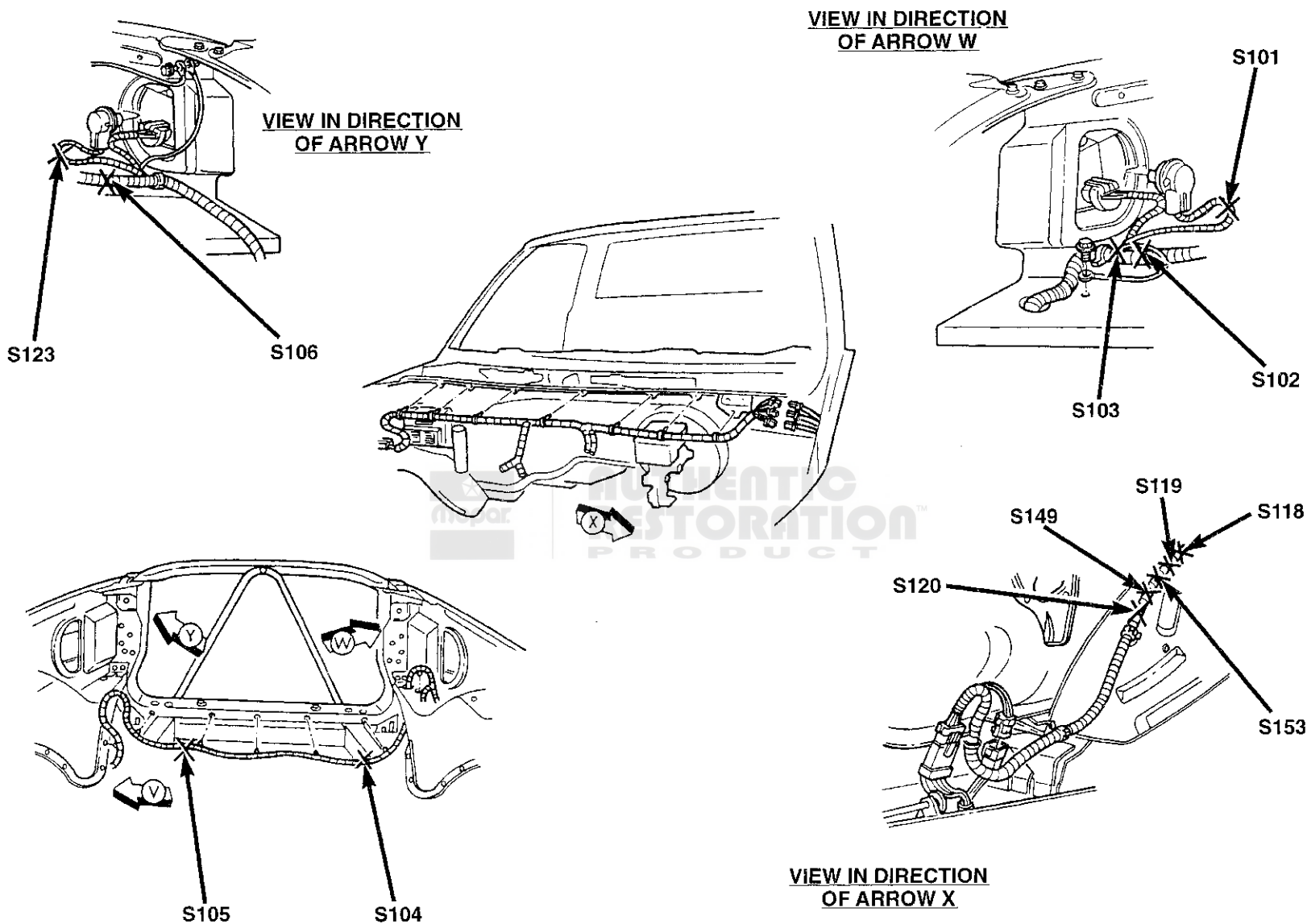
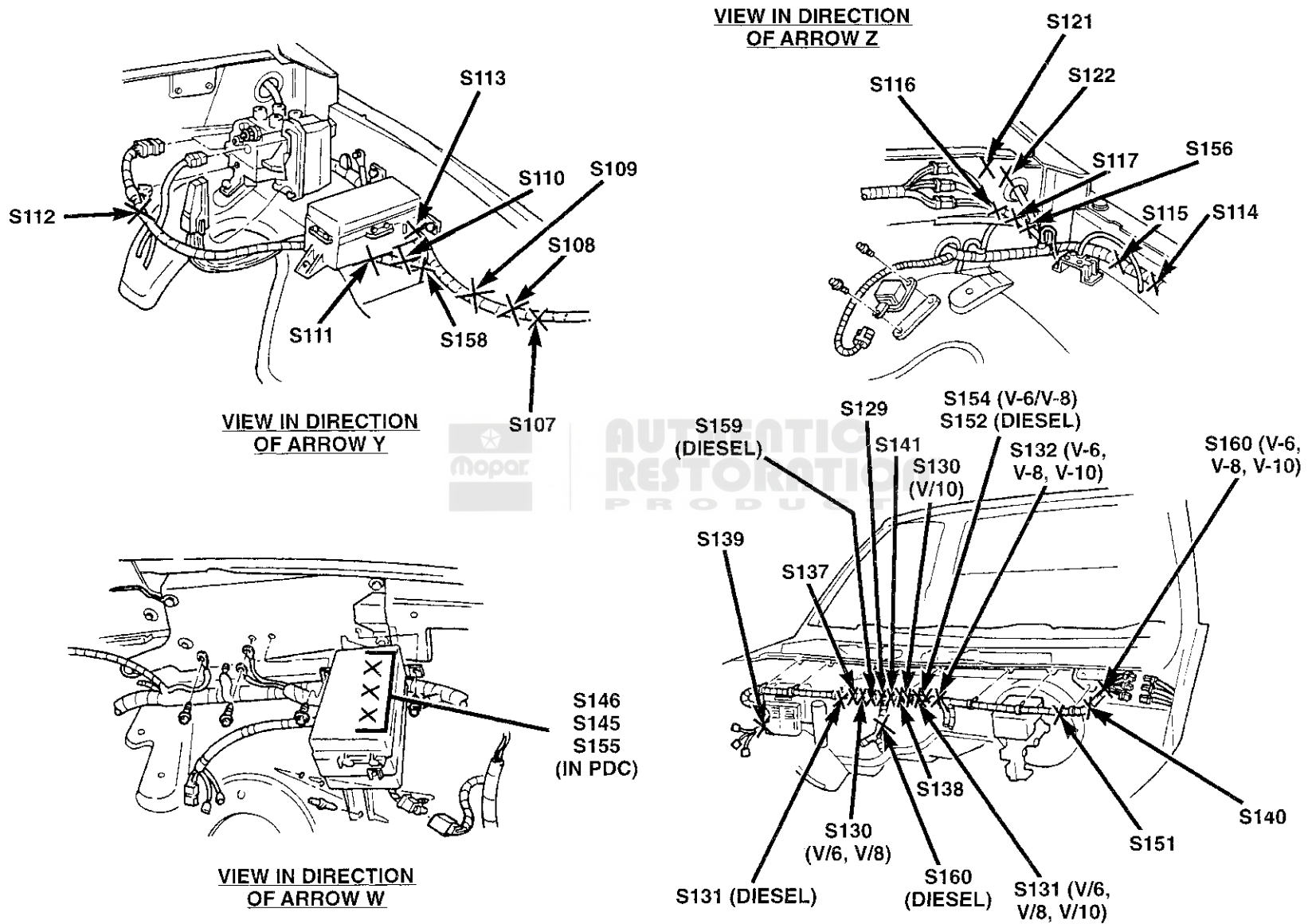


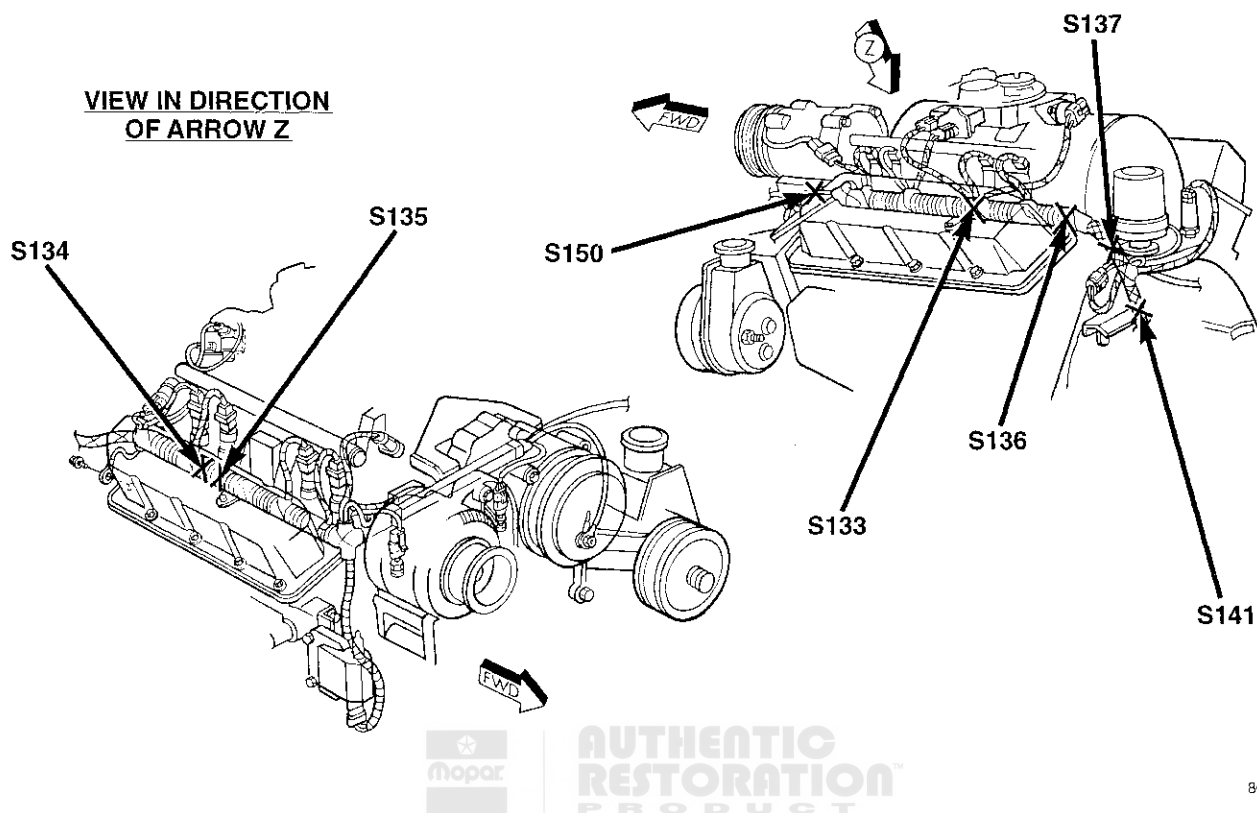
Fig. 1 Engine Compartment Wiring Splices — Front

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Fig. 2 Engine Compartment Wiring Splices — Rear



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Fig. 3 Engine Wiring Splices — V-6, V-8

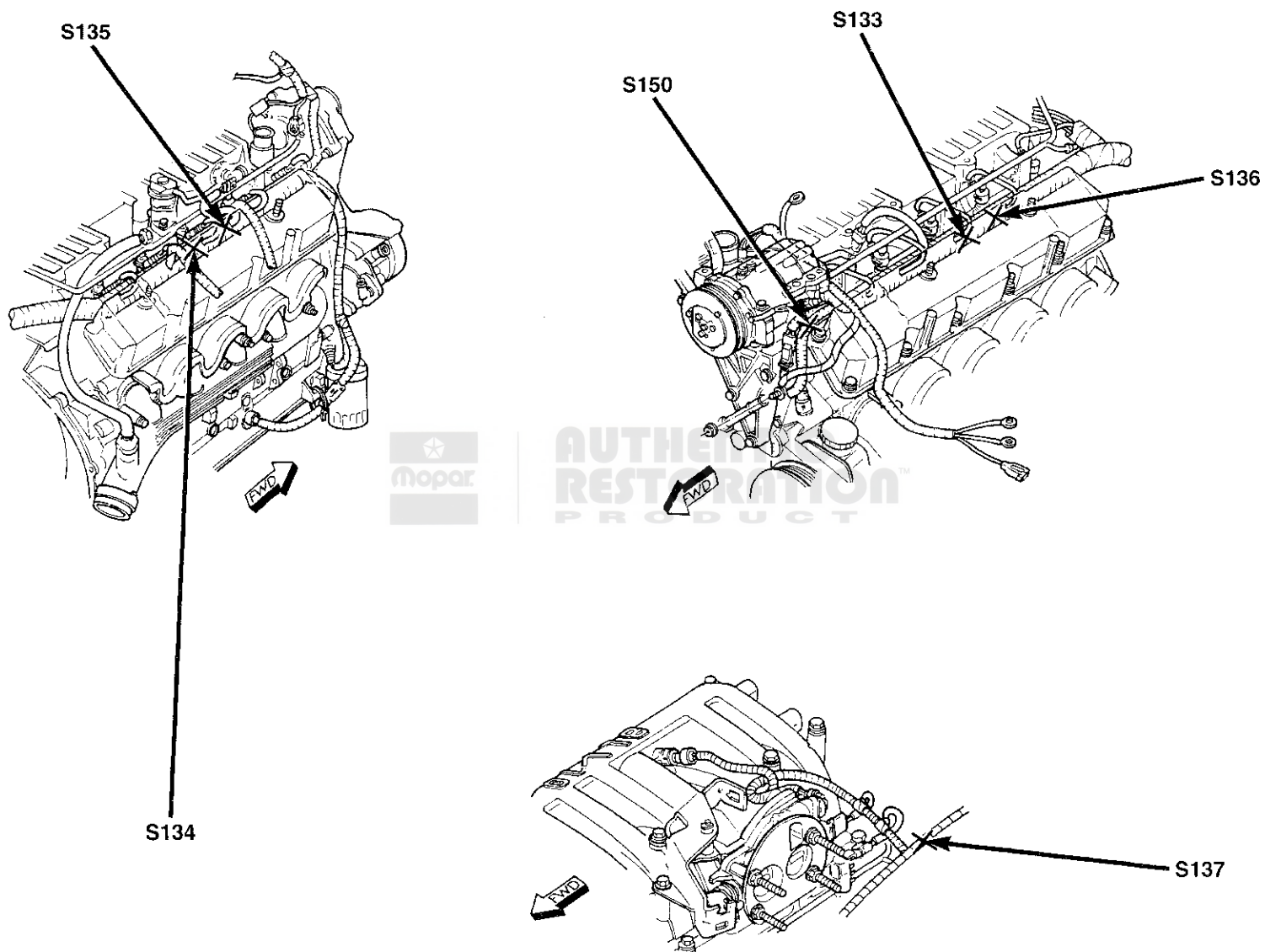
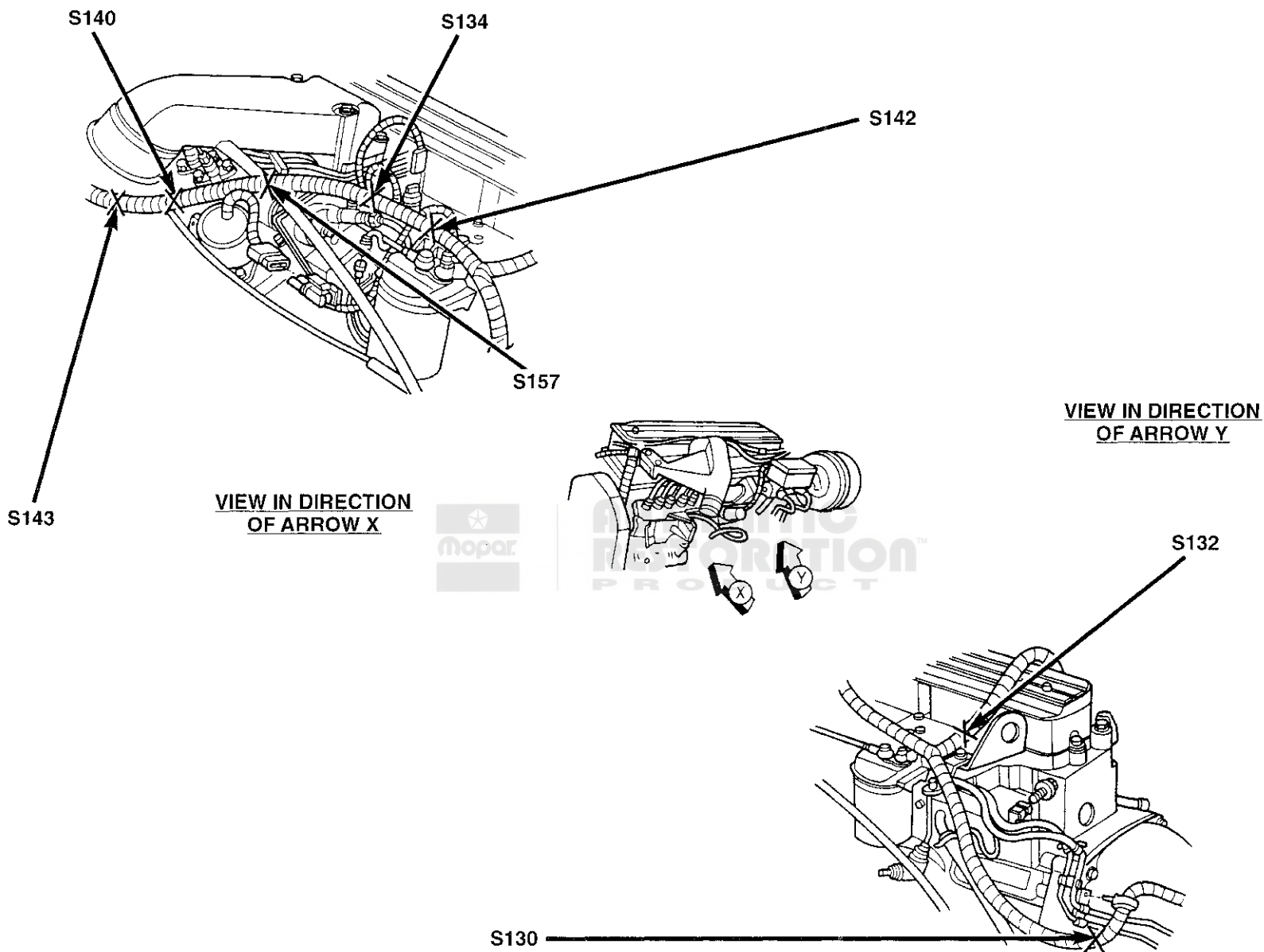


Fig. 4 Engine Wiring Splices — V-10

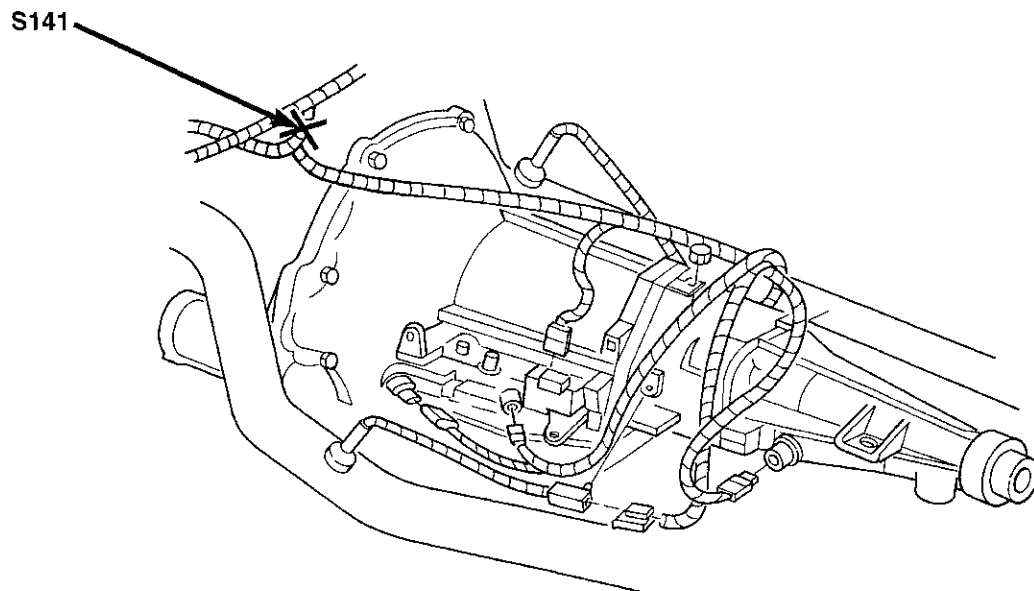
SCHEMATICS AND DIAGRAMS (Continued)



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Fig. 5 Diesel Engine Wiring Splices

SCHEMATICS AND DIAGRAMS (Continued)



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Fig. 6 Transmission Wiring Splices

SCHEMATICS AND DIAGRAMS (Continued)

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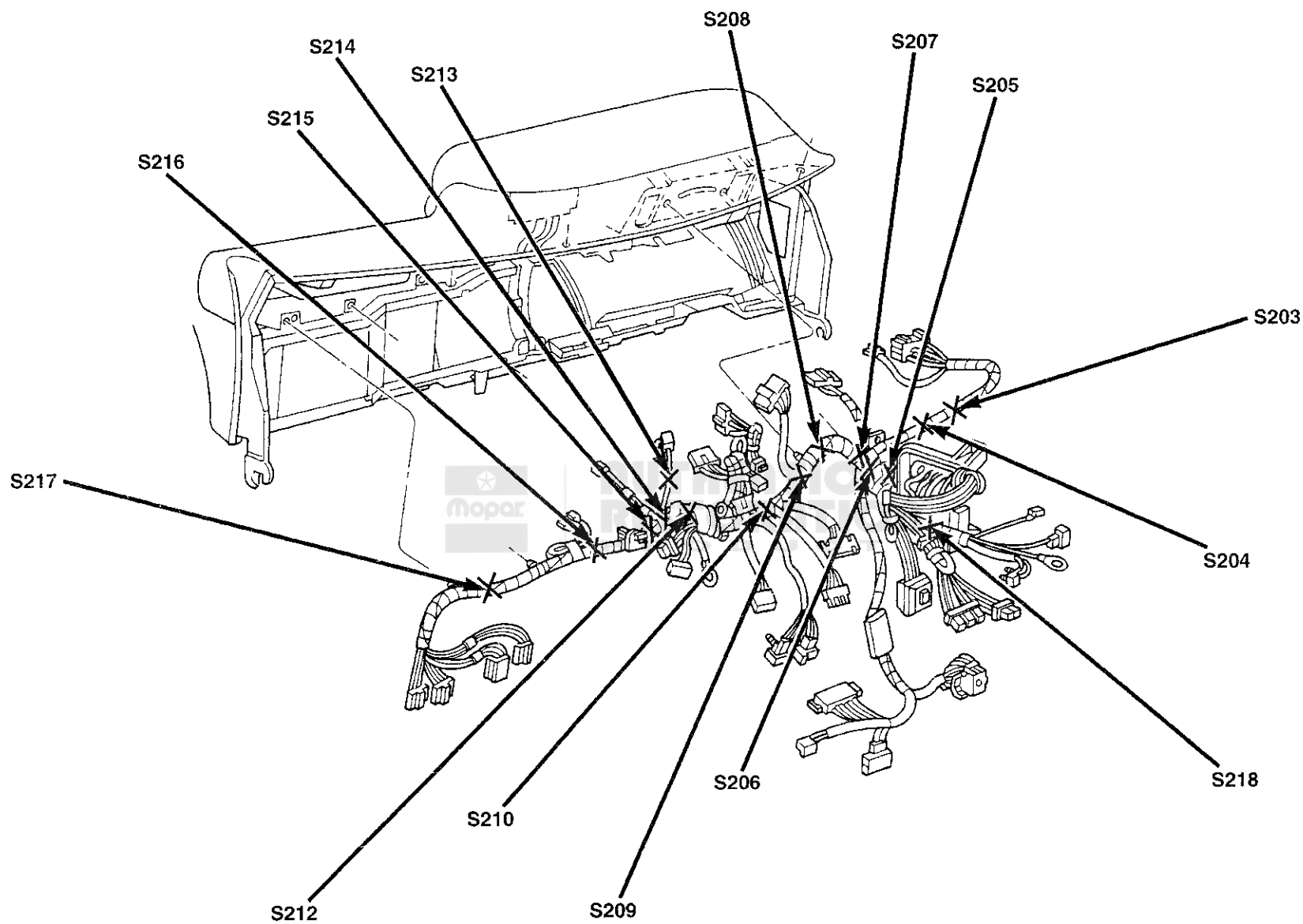
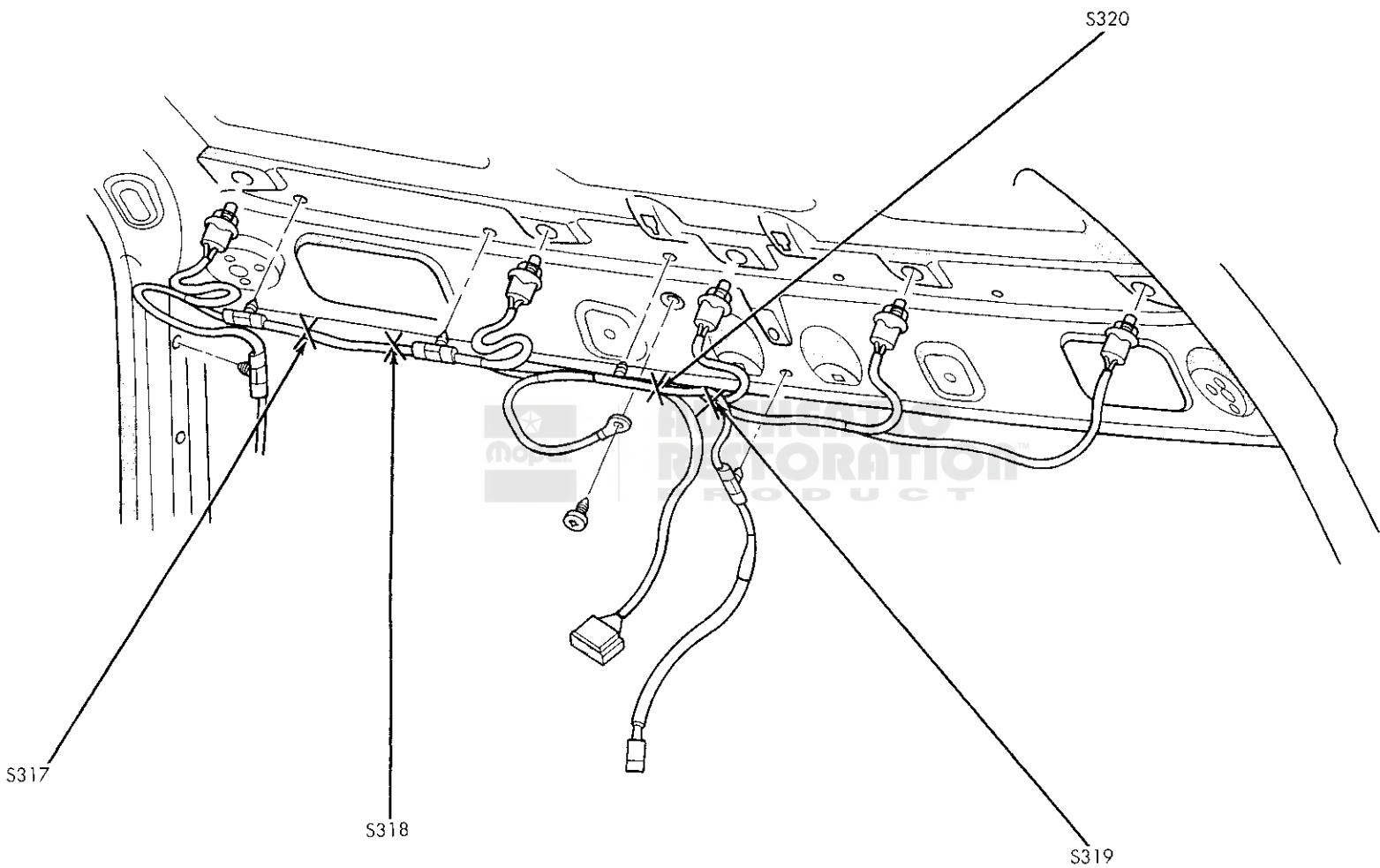


Fig. 7 Instrument Panel Wiring Splices



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Fig. 8 Roof Wiring Splices

SCHEMATICS AND DIAGRAMS (Continued)

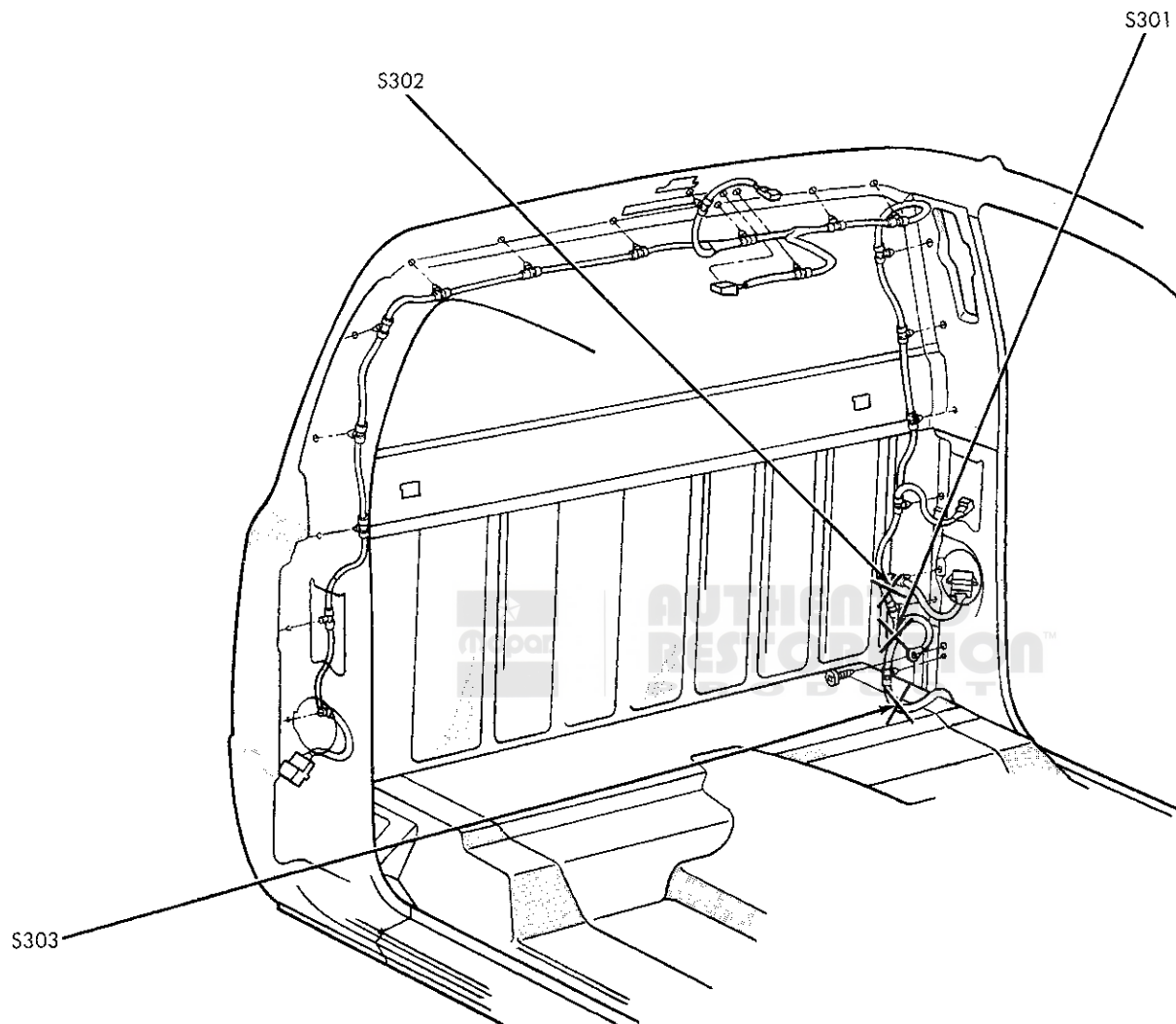


Fig. 9 Cab Wiring Splices

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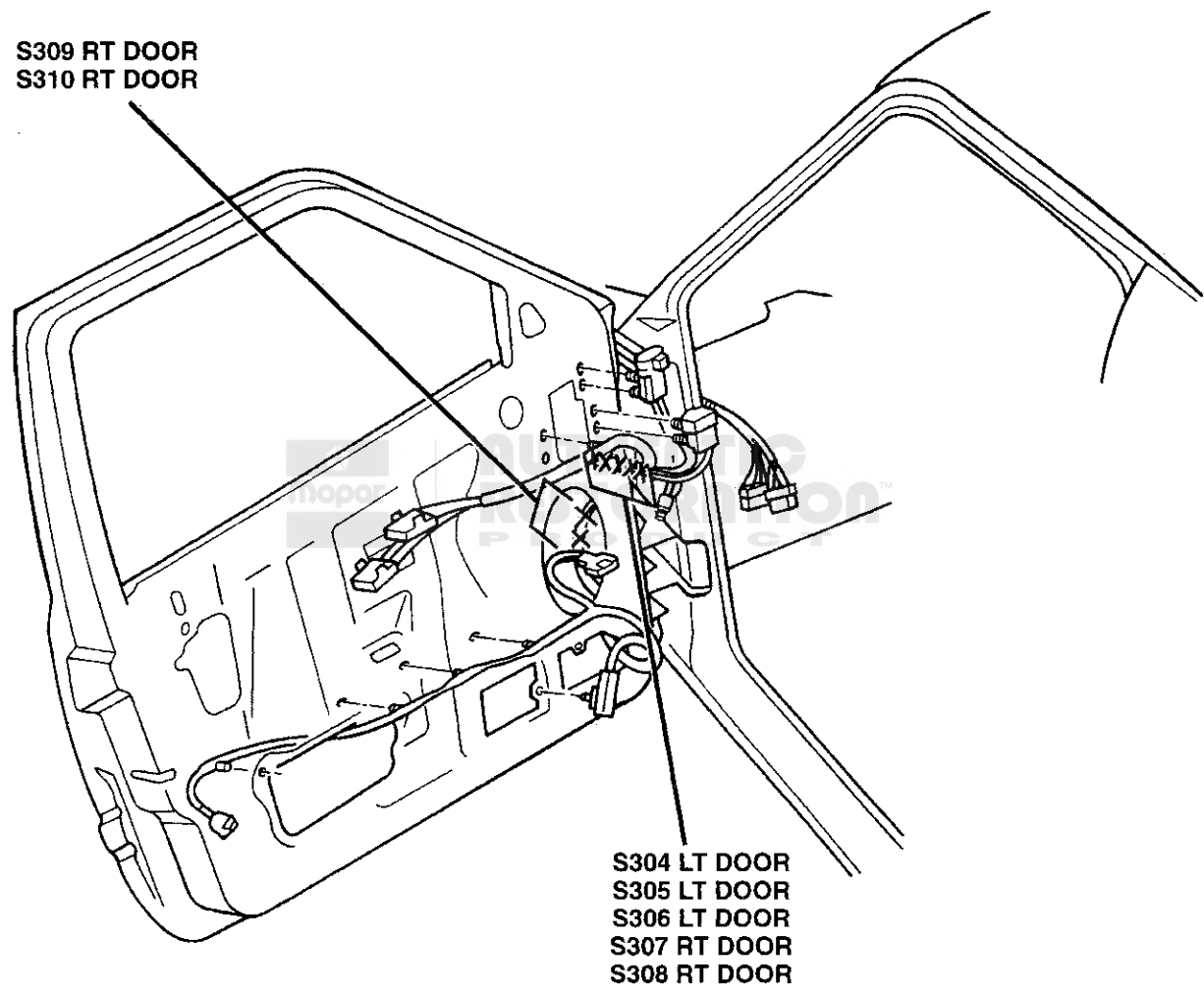


Fig. 10 Door Wiring Splices

SCHEMATICS AND DIAGRAMS (Continued)

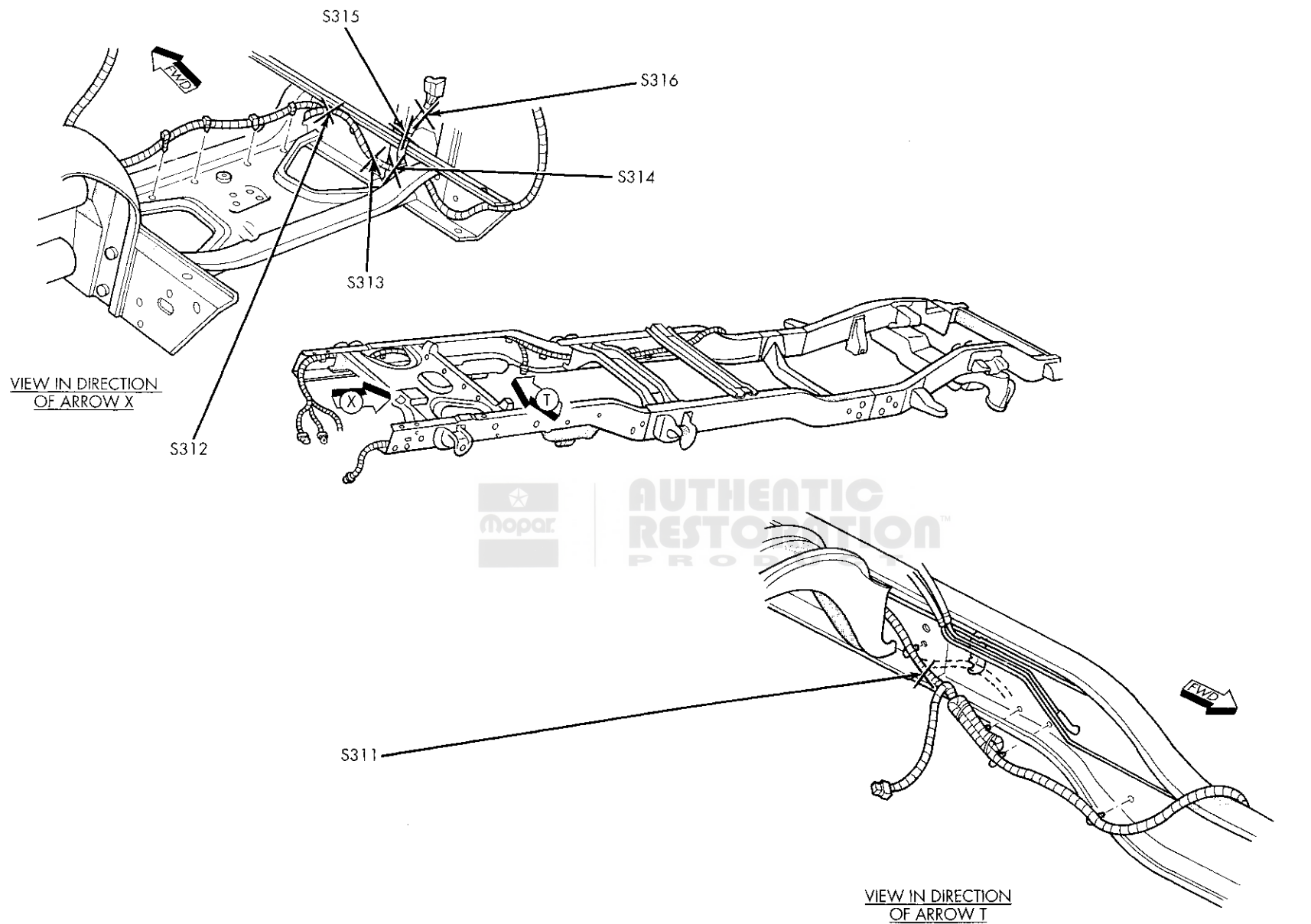


Fig. 11 Frame Wiring Splices

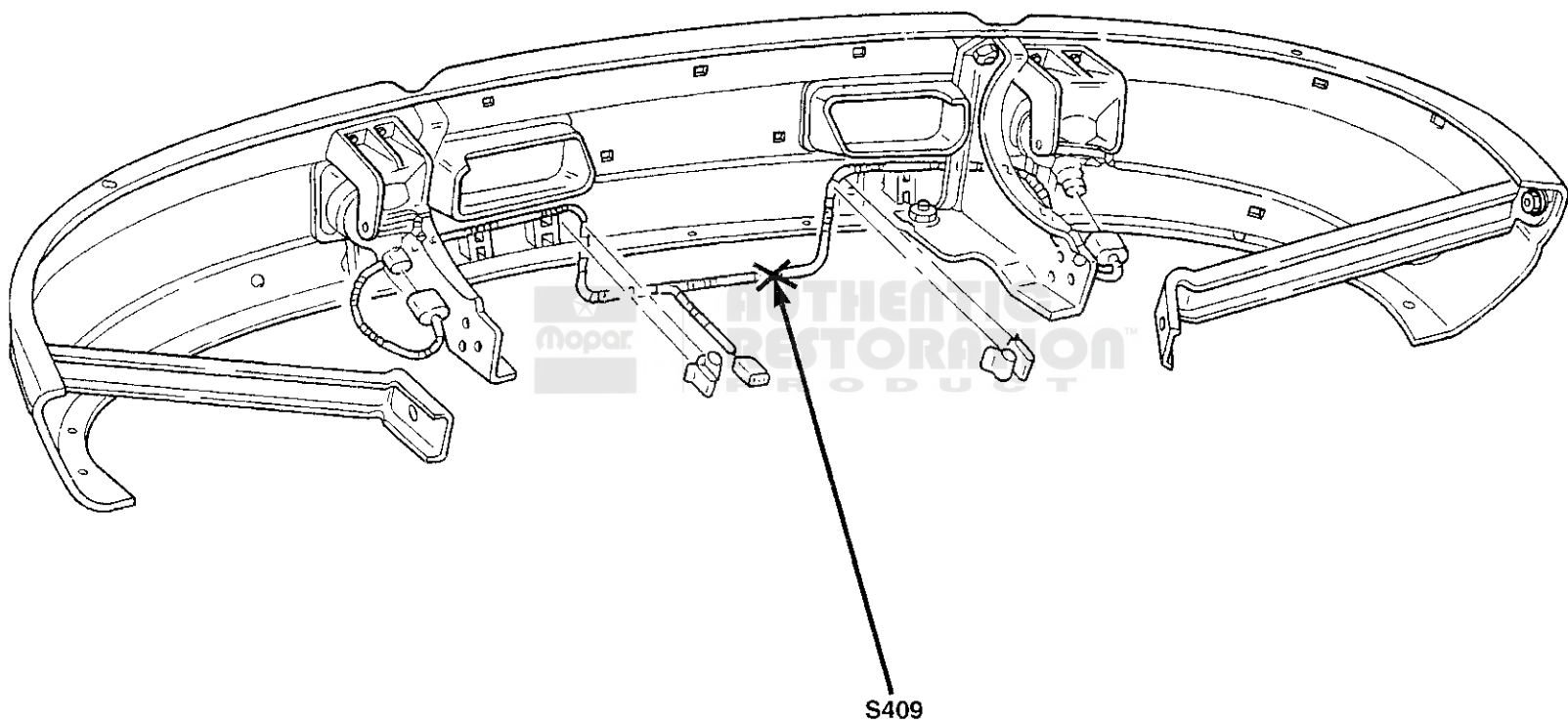


Fig. 12 Fog Lamp Harness Splice

ENGINE

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS—GASOLINE ENGINES

There are several places where form-in-place gaskets are used on the engine. **DO NOT use form-in-place gasket material unless specified.** Care must be taken when applying form-in-place gaskets. Bead size, continuity, and location are of great importance. Too-thin a bead can result in leakage, while too much can result in spill-over. A continuous bead of the proper width is essential to obtain a leak-free joint.

Two types of form-in-place gasket materials are used in the engine area (Mopar® Silicone Rubber Adhesive Sealant and Mopar® Gasket Maker). Each has different properties and they cannot be used interchangeably.

MOPAR® SILICONE RUBBER ADHESIVE SEALANT

Mopar® Silicone Rubber Adhesive Sealant, normally black in color, is available in both three ounce tubes and four and one-half ounce power tubes. Moisture in the air causes the sealant material to cure. This material is normally used on flexible metal flanges. The tubes have a shelf life of one year and the power tubes two years shelf life, and will not

properly cure if over-aged. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

Mopar® Gasket Maker, normally red in color, is available in six-cc tubes. This anaerobic type gasket material cures in the absence of air when squeezed between smooth machined metallic surfaces. It will not cure if left in the uncovered tube. **DO NOT use** on flexible metal flanges.

SURFACE PREPARATION

Parts assembled with form-in-place gaskets may be disassembled without unusual effort. In some instances, it may be necessary to lightly tap the part with a mallet, or other suitable tool, to break the seal between the mating surfaces. A flat gasket-scraper may also be lightly tapped into the joint, but care must be taken not to damage the mating surfaces.

Scrape or wire brush all gasket surfaces to remove all loose material. Inspect stamped parts to ensure that gasket rails are flat. Flatten rails with a hammer on a flat plate, if required. Gasket surfaces must be free of oil and dirt. Be sure the old gasket material is removed from blind attaching holes.

GENERAL INFORMATION (Continued)**GASKET APPLICATION**

Assembling parts using a form-in-place gasket requires care.

Mopar® Silicone Rubber Adhesive Sealant should be applied in a continuous bead approximately 3 mm (0.12 inch) in diameter. All mounting holes must be circled. For corner sealing, a 3 or 6 mm (1/8 or 1/4 inch) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within ten minutes). The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

Mopar® Gasket Maker should be applied sparingly to one gasket surface. The sealant diameter should be 1.00 mm (0.04 inch) or less. Be certain the material surrounds each mounting hole. Excess material can be easily wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

ENGINE PERFORMANCE—GASOLINE ENGINES

To provide best vehicle performance and lowest vehicle emissions, it is most important that the tune-up be done accurately. Use the specifications listed on the Vehicle Emissions Control Information label found on the engine compartment hood.

(1) Test cranking amperage draw. Refer to Group 8B, Battery/Starter/Generator Service, for the proper procedures.

(2) Tighten the intake manifold bolts. Refer to Group 11, Exhaust System and Intake Manifold, for the proper procedure and torque specifications.

CAUTION: DO NOT overspeed the engine.

(3) Perform cylinder compression test:

(a) Check engine oil level and add oil, if necessary.

(b) Drive the vehicle until engine reaches normal operating temperature.

(c) Select a route free from traffic and other forms of congestion, observe all traffic laws, and briskly accelerate through the gears several times. The higher engine speed may help clean out valve seat deposits, which can prevent accurate compression readings.

(d) Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators—fouled, hot, oily, etc. Record cylinder number of each spark plug for future reference.

(e) Disconnect coil wire from distributor or from both coil packs (V-10) and secure to good ground to prevent a spark from starting a fire.

(f) Be sure throttle blades are fully open during the compression check.

(g) Insert compression gauge adaptor into the No.1 spark plug hole. Crank engine until maximum pressure is reached on gauge. Record this pressure as No.1 cylinder pressure.

(h) Repeat Step 3g for all remaining cylinders.

(i) Compression should not be less than 689 kPa (100 psi) and not vary more than 172 kPa (25 psi) from cylinder to cylinder.

(j) If cylinder(s) have abnormally low compression pressures, repeat steps 3a through 3h.

(k) If the same cylinder(s) repeat an abnormally low reading, it could indicate the existence of a problem in the cylinder.

NOTE: The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should NOT be disassembled to determine the cause of low compression unless some malfunction is present.

(4) Clean or replace spark plugs as necessary. Adjust gap. Refer to Group 8D, Ignition System, for gap adjustment and torque specifications.

(5) Test resistance of spark plug cables. Refer to Group 8D, Ignition System, for procedure.

(6) Inspect the primary wire. Test coil output voltage, primary and secondary resistance. Replace parts as necessary. Refer to Group 8D, Ignition System, and make necessary adjustment.

(7) Set ignition timing to specifications. Refer to Specification Label on engine compartment hood. (This step does not apply to 8.0L engines.)

(8) Perform a combustion analysis.

(9) Test fuel pump for pressure and vacuum. Refer to Group 14, Fuel System, for the proper specifications.

(10) Inspect air filter element. Refer to Group 0, Lubrication and Maintenance, for the proper procedure.

(11) Inspect crankcase ventilation system. Refer to Group 0, Lubrication and Maintenance, for the proper procedure.

(12) For emissions controls, refer to Group 25, Emissions Controls System for service procedures.

(13) Inspect and adjust accessory belt drives. Refer to Group 7, Cooling System, for the proper adjustments.

(14) Road-test vehicle as a final test.

MEASURING WITH PLASTIGAGE**CRANKSHAFT MAIN BEARING CLEARANCE**

Engine crankshaft bearing clearances can be determined by use of Plastigage, or equivalent. The follow-

GENERAL INFORMATION (Continued)

ing is the recommended procedure for the use of Plastigage:

(1) Remove oil film from surface to be checked. Plastigage is soluble in oil.

(2) The total clearance of the main bearings can be determined only by removing the weight of the crankshaft. This can be accomplished by either of two methods:

METHOD - 1 (PREFERRED)

Shim the bearings adjacent to the bearing to be checked. This will remove the clearance between upper bearing shell and the crankshaft. Place a minimum of 0.254 mm (0.010 in.) shim between the bearing shell and the adjacent bearing cap. Tighten the bolts to 18 N·m (13 ft. lbs.) torque.

- **CHECK NO. 1 BEARING:** Shim No. 2 main bearing.

- **CHECK NO. 2 BEARING:** Shim No. 1 and No. 3 main bearing.

- **CHECK NO. 3 BEARING:** Shim No. 2 and No. 4 main bearing.

- **CHECK NO. 4 BEARING:** Shim No. 3 main bearing (3.9L). Shim No. 3 and No. 5 main bearing (5.2L, 5.9L, 8.0L and 5.9L-Diesel).

- **CHECK NO. 5 BEARING:** Shim No. 4 main bearing (5.2L and 5.9L). Shim No. 4 and No. 6 main bearing (8.0L and 5.9L-Diesel).

- **CHECK NO. 6 BEARING:** Shim No. 5 main bearing (8.0L). Shim No. 5 and No. 7 main bearing (5.9L-Diesel).

- **CHECK NO. 7 BEARING:** Shim No. 6 main bearing (5.9L-Diesel).

NOTE: Remove all shims before assembling engine.

METHOD - 2 (ALTERNATIVE)

Support the weight of the crankshaft with a jack placed under the counterweight adjacent to the bearing being checked.

(1) Place a piece of Plastigage across the entire width of the bearing cap shell (Fig. 1). Position the Plastigage approximately 6.35 mm (1/4 in.) off center and away from the oil holes. In addition, suspect areas can be checked by placing the Plastigage in that area. Tighten the bearing cap bolts of the bearing being checked to 115 N·m (85 ft. lbs.) torque. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

(2) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on the package (Fig. 2). Plastigage generally comes in two scales (one scale is in inches and the other is a metric scale). Locate the band closest to the same width. This band shows the amount of clearance. Dif-

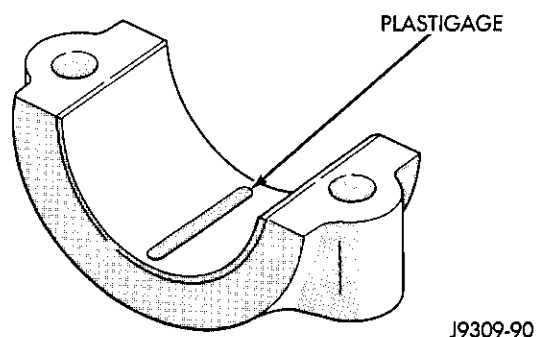


Fig. 1 Placement of Plastigage in Bearing Shell

ferences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications.

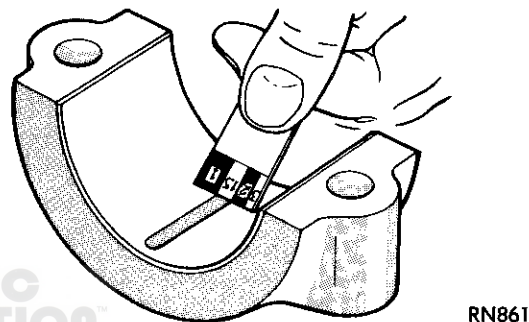


Fig. 2 Clearance Measurement

(3) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 in.) range is usually the most appropriate for checking engine bearing clearances.

CONNECTING ROD BEARING CLEARANCE

Engine connecting rod bearing clearances can be determined by use of Plastigage, or equivalent. The following is the recommended procedure for the use of Plastigage:

(1) Remove oil film from surface to be checked. Plastigage is soluble in oil.

(2) Place a piece of Plastigage across the entire width of the bearing cap shell (Fig. 1). Position the Plastigage approximately 6.35 mm (1/4 inch) off center and away from the oil holes. In addition, suspect areas can be checked by placing the Plastigage in the suspect area.

(3) The crankshaft must be rotated until the connecting rod to be checked starts moving toward the top of the engine. Only then should the rod cap, with Plastigage in place, be assembled. Tighten the rod cap nut to 61 N·m (45 ft. lbs.) torque. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

(4) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on

GENERAL INFORMATION (Continued)

the package (Fig. 2). Plastigage generally comes in two scales (one scale is in inches and the other is a metric scale). Locate the band closest to the same width. This band shows the amount of clearance. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications.

(5) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 in.) range is usually the most appropriate for checking engine bearing clearances.

ENGINE OIL SERVICE

WARNING: NEW OR USED ENGINE OIL CAN BE IRRITATING TO THE SKIN. AVOID PROLONGED OR REPEATED SKIN CONTACT WITH ENGINE OIL. CONTAMINANTS IN USED ENGINE OIL, CAUSED BY INTERNAL COMBUSTION, CAN BE HAZARDOUS TO YOUR HEALTH. THOROUGHLY WASH EXPOSED SKIN WITH SOAP AND WATER. DO NOT WASH SKIN WITH GASOLINE, DIESEL FUEL, THINNER, OR SOLVENTS. HEALTH PROBLEMS CAN RESULT. DO NOT POLLUTE. DISPOSE OF USED ENGINE OIL PROPERLY.

ENGINE OIL SPECIFICATION

CAUTION: Do not use non-detergent or straight mineral oil when adding or changing crankcase lubricant. Engine failure can result.

API SERVICE GRADE CERTIFIED

Use an engine oil that is API Service Grade Certified or an oil that conforms to the API Service Grade SH or SH/CD. MOPAR provides engine oils that conform to all of these service grades.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 30 specifies a single-viscosity engine oil. Some engine oils also have multiple viscosities. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. Select an engine oil that is best suited to your area's particular temperature range and variation (Fig. 3).

ENERGY-CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. They are designated as either ENERGY CONSERVING or ENERGY CONSERVING II.

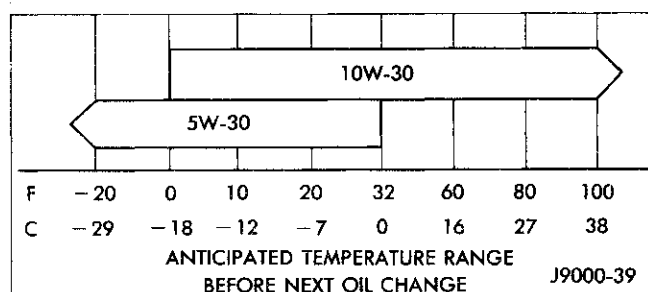


Fig. 3 Temperature/Engine Oil Viscosity

CONTAINER IDENTIFICATION

Standard engine-oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans (Fig. 4).



9400-9

Fig. 4 Engine Oil Container Standard Notations

ENGINE-OIL ADDITIVES

In some instances, such as infrequent operation, short-trip driving, and during break-in after a major overhaul, addition of special materials containing anti-rust and anti-scuff additives are beneficial. A suitable product for this purpose is MOPAR Engine Oil Supplement.

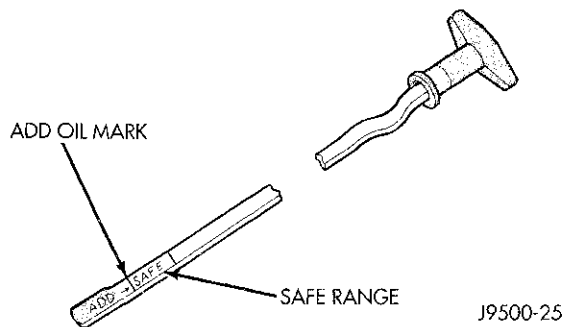
CRANKCASE OIL LEVEL INSPECTION

CAUTION: Do not overfill crankcase with engine oil, oil foaming and oil pressure loss can result.

To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable oil level is in the SAFE RANGE on the engine oil dipstick (Fig. 5).

Unless the engine has exhibited loss of oil pressure, run the engine for about five minutes before checking oil level. Checking engine oil level of a cold engine is not accurate.

- (1) Position vehicle on level surface.
- (2) With engine OFF, allow approximately ten minutes for oil to settle to bottom of crankcase, remove engine oil dipstick.
- (3) Wipe dipstick clean.

GENERAL INFORMATION (Continued)**Fig. 5 Oil Level Indicator (Dipstick)**

(4) Replace dipstick and verify it is seated in the tube.

(5) Remove dipstick, with handle held above the tip, take oil level reading.

(6) Add oil only if level is below the **SAFE RANGE** area on the dipstick.

(7) Replace dipstick

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Maintenance Schedule.

TO CHANGE ENGINE OIL

Run engine until normal operating temperature is achieved.

(1) Position the vehicle on a level surface and turn off engine.

(2) Hoist and support vehicle on safety stands. Refer to Hoisting and Jacking Recommendations.

(3) Remove oil fill cap.

(4) Place a suitable drain pan under crankcase drain.

(5) Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket, if damaged.

(6) Install drain plug in crankcase.

(7) Lower vehicle and fill crankcase with specified type and amount of engine oil described in this section.

(8) Install oil fill cap.

(9) Start engine and inspect for leaks.

(10) Stop engine and inspect oil level.

ENGINE OIL FILTER CHANGE**FILTER SPECIFICATION**

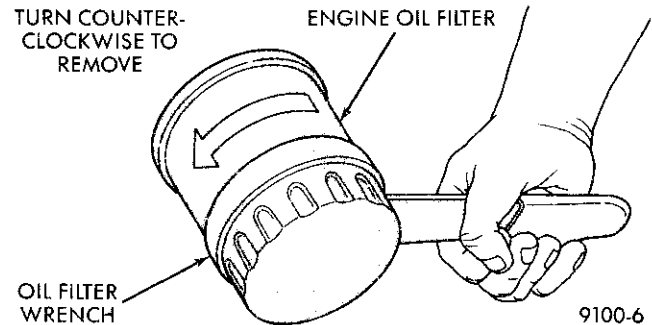
All Dodge Ram engines are equipped with a high quality full-flow, disposable type oil filter. Chrysler Corporation recommends a Mopar, or equivalent, oil filter be used.

OIL FILTER REMOVAL

(1) Position a drain pan under the oil filter.

(2) Using a suitable oil filter wrench, loosen filter.

(3) Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss (Fig. 6).

**Fig. 6 Oil Filter Removal—Typical**

(4) When filter separates from adapter nipple, tip gasket end upward to minimize oil spill. Remove filter from vehicle.

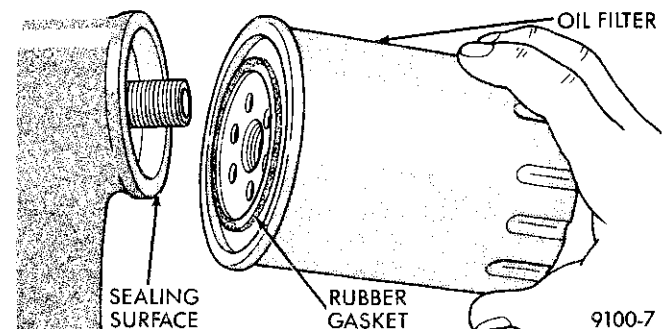
(5) With a wiping cloth, clean the gasket sealing surface (Fig. 7) of oil and grime.

OIL FILTER INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil or chassis grease.

(2) Thread filter onto adapter nipple. When gasket makes contact with sealing surface, (Fig. 7) hand tighten filter one full turn, do not over tighten.

(3) Add oil, verify crankcase oil level, and start engine. Inspect for oil leaks.

**Fig. 7 Oil Filter Sealing Surface—Typical****USED ENGINE OIL DISPOSAL**

Care should be exercised when disposing of used engine oil after it has been drained from a vehicle's engine.

SERVICE PROCEDURES**REPAIR DAMAGED OR WORN THREADS**

Damaged or worn threads can be repaired. Essentially, this repair consists of:

- Drilling out worn or damaged threads.
- Tapping the hole with a special Heli-Coil Tap, or equivalent.

SERVICE PROCEDURES (Continued)

- Installing an insert into the tapped hole to bring the hole back to its original thread size.

CAUTION: Be sure that the tapped holes maintain the original center line.

Heli-Coil tools and inserts are readily available from automotive parts jobbers.

HONING CYLINDER BORES

Before honing, stuff plenty of clean shop towels under the bores and over the crankshaft to keep abrasive materials from entering the crankshaft area.

(1) Used carefully, the Cylinder Bore Sizing Hone C-823, equipped with 220 grit stones, is the best tool for this job. In addition to deglazing, it will reduce taper and out-of-round, as well as removing light scuffing, scoring and scratches. Usually, a few strokes will clean up a bore and maintain the required limits.

CAUTION: DO NOT use rigid type hones to remove cylinder wall glaze.

(2) Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. Use a cylinder surfacing hone, Honing Tool C-3501, equipped with 280 grit stones (C-3501-3810), about 20-60 strokes, depending on the bore condition, will be sufficient to provide a satisfactory surface. Using honing oil C-3501-3880, or a light honing oil, available from major oil distributors.

CAUTION: DO NOT use engine or transmission oil, mineral spirits, or kerosene.

(3) Honing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should INTERSECT at 50° to 60° for proper seating of rings (Fig. 8).

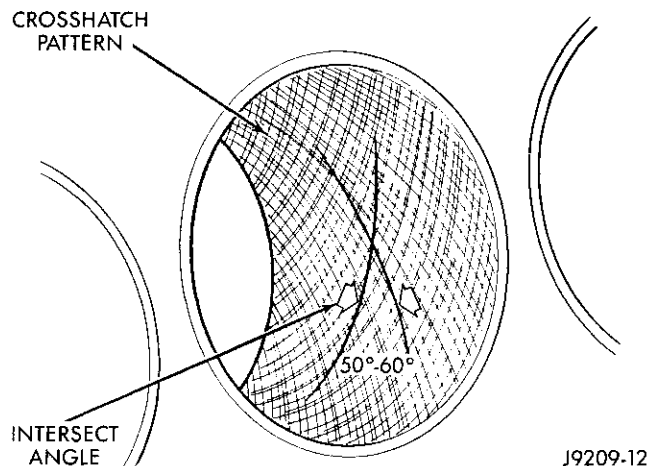


Fig. 8 Cylinder Bore Crosshatch Pattern

(4) A controlled hone motor speed between 200 and 300 RPM is necessary to obtain the proper crosshatch angle. The number of up and down strokes per minute can be regulated to get the desired 50° to 60° angle. Faster up and down strokes increase the crosshatch angle.

(5) After honing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting.

HYDROSTATIC LOCK

When an engine is suspected of hydrostatic lock (regardless of what caused the problem), follow the steps below.

(1) Perform the Fuel Pressure Release Procedure. Refer to Group 14, Fuel System.

(2) Disconnect the negative cable from the battery.

(3) Inspect air cleaner, induction system, and intake manifold to ensure system is dry and clear of foreign material.

(4) Place a shop towel around the spark plugs or fuel injectors (diesel engine) to catch any fluid that may possibly be under pressure in the cylinder head. Remove the spark plugs or fuel injectors (diesel engine).

CAUTION: DO NOT use the starter motor to rotate the crankshaft. Severe damage could occur.

(5) With all spark plugs and injectors (diesel engine) removed, rotate the crankshaft using a breaker bar and socket.

(6) Identify the fluid in the cylinders (coolant, fuel, oil, etc.).

(7) Be sure all fluid has been removed from the cylinders.

(8) Repair engine or components as necessary to prevent this problem from occurring again.

(9) Squirt engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.

(10) Install new spark plugs or fuel injectors (diesel engine). Tighten the spark plugs to 41 N·m (30 ft. lbs.) torque. Tighten the fuel injector nuts to 60 N·m (44 ft. lbs.) torque.

(11) Drain engine oil. Remove and discard the oil filter.

(12) Install the drain plug. Tighten the plug to 34 N·m (25 ft. lbs.) torque.

(13) Install a new oil filter.

(14) Fill engine crankcase with the specified amount and grade of oil. Refer to Group 0, Lubrication and Maintenance.

(15) Connect the negative cable to the battery.

(16) Start the engine and check for any leaks.

ENGINE DIAGNOSIS

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DIAGNOSIS AND TESTING

GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine tune-ups.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

Refer to the Service Diagnosis—Mechanical Chart and the Service Diagnosis—Performance Chart, for possible causes and corrections of malfunctions. Refer to Group 14, Fuel System, for the fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that cannot be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following:

- Cylinder Compression Pressure Test
- Cylinder Combustion Pressure Leakage Test
- Engine Cylinder Head Gasket Failure Diagnosis
- Intake Manifold Leakage Diagnosis

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS, OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

- (1) Start the engine.

- (2) Spray a small stream of water at the suspected leak area.

- (3) If a change in RPMs, the area of the suspected leak has been found.

- (4) Repair as required.

CYLINDER COMPRESSION PRESSURE TEST

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise, the indicated compression pressures may not be valid for diagnosis purposes.

- (1) Clean the spark plug recesses with compressed air.

- (2) Remove the spark plugs.

- (3) Secure the throttle in the wide-open position.

- (4) Disconnect the ignition coil.

- (5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.

- (6) Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

Refer to Engine Specifications for the correct engine compression pressures.

ENGINE CYLINDER HEAD GASKET FAILURE DIAGNOSIS

A leaking engine cylinder head gasket usually results in loss of power, loss of coolant, and engine misfiring.

An engine cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

DIAGNOSIS AND TESTING (Continued)

- An engine cylinder head gasket leaking between adjacent cylinders is indicated by a loss of power and/or engine misfire.
- An engine cylinder head gasket leaking between a cylinder and an adjacent water jacket is indicated by coolant foaming or overheating and loss of coolant.

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures outlined in Cylinder Compression Pressure Test. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50-70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS, OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

Remove the radiator cap.

Start the engine and allow it to warm up until the engine thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

If bubbles are not visible, install a radiator pressure tester and pressurize the coolant system.

If a cylinder is leaking combustion pressure into the water jacket, the tester pointer will pulsate with every combustion stroke of the cylinder.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating)
- Leaks between adjacent cylinders or into water jacket
- Any causes for combustion/compression pressure loss

WARNING: DO NOT REMOVE THE RADIATOR CAP WITH THE SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM HOT COOLANT CAN OCCUR.

Check the coolant level and fill as required. DO NOT install the radiator cap.

Start and operate the engine until it attains normal operating temperature, then turn OFF the engine.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1,379 kPa (200 psi) maximum and 552 kPa (80 psi) recommended.

Perform the test procedure on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe or oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

FOR EXAMPLE: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

Refer to the Cylinder Combustion Pressure Leakage Test Diagnosis chart.

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

Begin with a through visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

(1) Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.

(2) Add an oil-soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to be sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light source.

(3) Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service manual instructions.

(4) If dye is not observed, drive the vehicle at various speeds for approximately 24km (15 miles), and repeat previous step.

(5) If the oil leak source is not positively identified at this time, proceed with the air leak detection test method as follows:

(6) Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.

(7) Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.

(8) Attach an air hose with pressure gauge and regulator to the dipstick tube.

CAUTION: Do not subject the engine assembly to more than 20.6 kpa (3 PSI) of test pressure.

(9) Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the sus-

DIAGNOSIS AND TESTING (Continued)

pected source. Adjust the regulator to the suitable test pressure that provide the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.

(10) If the leakage occurs at the rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.

(11) If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose. Proceed to next step.

(12) Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

INSPECTION FOR REAR SEAL AREA LEAKS

Since it is sometimes difficult to determine the source of an oil leak in the rear seal area of the engine, a more involved inspection is necessary. The following steps should be followed to help pinpoint the source of the leak.

If the leakage occurs at the crankshaft rear oil seal area:

- (1) Disconnect the battery.
- (2) Raise the vehicle.
- (3) Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:

(a) Circular spray pattern generally indicates seal leakage or crankshaft damage.

(b) Where leakage tends to run straight down, possible causes are a porous block, distributor seal, camshaft bore cup plugs, oil galley pipe plugs, oil filter runoff, and main bearing cap to cylinder block mating surfaces. See Group 9, Engines, for proper repair procedures of these items.

(4) If no leaks are detected, pressurized the crankcase as outlined in the section, Inspection (Engine oil Leaks in general)

CAUTION: Do not exceed 20.6 kPa (3 psi).

(5) If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches that can be polished out with emery cloth.

CAUTION: Use extreme caution when crankshaft polishing is necessary to remove minor nicks or scratches. The crankshaft seal flange is specially machined to complement the function of the rear oil seal.

(6) For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled. Refer to the service Diagnosis—Mechanical, under the Oil Leak row, for components inspections on possible causes and corrections.

(7) After the oil leak root cause and appropriate corrective action have been identified, Refer to Group 9, Engines—Crankshaft Rear Oil Seals, for proper replacement procedures.

HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at the pressure sending-unit. The pressure should be between 207-552 kPa (30-80 psi) at 3,000 RPM.

Check the oil level after the engine reaches normal operating temperature. Allow 5 minutes to stabilize oil level, check dipstick. The oil level in the pan should never be above the FULL mark or below the ADD OIL mark on dipstick. Either of these two conditions could be responsible for noisy tappets.

OIL LEVEL

HIGH

If oil level is above the FULL mark, it is possible for the connecting rods to dip into the oil. With the engine running, this condition could create foam in the oil pan. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to lose length and allow valves to seat noisily.

LOW

Low oil level may allow oil pump to take in air. When air is fed to the tappets, they lose length, which allows valves to seat noisily. Any leaks on intake side of oil pump through which air can be drawn will create the same tappet action. Check the lubrication system from the intake strainer to the pump cover, including the relief valve retainer cap. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than one tappet will be noisy. When oil level and leaks have been corrected, operate the engine at fast idle. Run engine for a sufficient time to allow all of the air inside the tappets to be bled out.

TAPPET NOISE DIAGNOSIS

(1) To determine source of tappet noise, operate engine at idle with cylinder head covers removed.

(2) Feel each valve spring or rocker arm to detect noisy tappet. The noisy tappet will cause the affected spring and/or rocker arm to vibrate or feel rough in operation.

DIAGNOSIS AND TESTING (Continued)

NOTE: Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on the valve spring. If noise is not appreciably reduced, it can be assumed the noise is in the tappet. Inspect the rocker arm push rod sockets and push rod ends for wear.

(3) Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak-down around the unit plunger, or by the plunger partially sticking in the tappet body cylinder. The tappet should be replaced. A heavy click is caused by a tappet check valve not seating, or by foreign particles wedged between the plunger and the tappet body. This will cause the plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

(4) The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are making the noise. If more than one tappet seems to be noisy, it's probably not the tappets.

ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit.

(2) Install Oil Pressure Line and Gauge Tool C-3292. Start engine and record pressure. Refer to Oil Pressure in Engine Specifications for the proper pressures.



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DIAGNOSIS AND TESTING (Continued)**ENGINE DIAGNOSIS—GASOLINE—PERFORMANCE**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT START	<ol style="list-style-type: none"> 1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Moisture on ignition wires and distributor cap. 5. Faulty ignition cables. 6. Faulty coil or control unit. 7. Incorrect spark plug gap. 8. Incorrect ignition timing. 9. Dirt or water in fuel system. 10. Faulty fuel pump, relay or wiring. 	<ol style="list-style-type: none"> 1. Test battery specific gravity. Charge or replace as necessary. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals. 3. Refer to Group 8A, Battery/Starter/Charging System Diagnostics. 4. Wipe wires and cap clean and dry. 5. Replace any cracked or shorted cables. 6. Test and replace, if necessary (refer to Group 8D, Ignition System). 7. Set gap (refer to Group 8D, Ignition System). 8. Refer to Group 8D, Ignition System. 9. Clean system and replace fuel filter. 10. Refer to Group 14, Fuel System.
ENGINE STALLS OR ROUGH IDLE	<ol style="list-style-type: none"> 1. Idle speed set too low. 2. Idle mixture too lean or too rich. 3. Leak in intake manifold. 4. Worn or burned distributor rotor. 5. Incorrect ignition wiring. 6. Faulty coil. 7. EGR valve leaking. 8. Incorrect cam timing. 	<ol style="list-style-type: none"> 1. Refer to Group 14, Fuel System. 2. Refer to Group 14, Fuel System. 3. Inspect intake manifold gasket and vacuum hoses. Replace, if necessary (refer to Group 11, Exhaust System & Intake Manifold). 4. Install new distributor rotor. 5. Install correct wiring. 6. Test and replace, if necessary (refer to Group 8D, Ignition System). 7. Test and replace, if necessary (refer to Group 25, Emissions Control System). 8. Refer to Timing Belt Service.
ENGINE LOSS OF POWER	<ol style="list-style-type: none"> 1. Incorrect ignition timing. 2. Worn or burned distributor rotor. 3. Worn distributor shaft. 4. Dirty or incorrectly gapped spark plugs. 5. Dirt or water in fuel system. 6. Faulty fuel pump. 7. Incorrect valve timing. 8. Blown cylinder head gasket. 9. Low compression. 10. Burned, warped or pitted valves. 11. Plugged or restricted exhaust system. 12. Faulty ignition cables. 13. Faulty coil. 14. Incorrect cam timing. 	<ol style="list-style-type: none"> 1. Refer to Group 8D, Ignition System. 2. Install new distributor rotor. 3. Remove and repair distributor (refer to Group 8D, Ignition System). 4. Clean plugs and set gap (refer to Group 8D, Ignition System). 5. Clean system and replace fuel filter. 6. Install new fuel pump. 7. Correct valve timing. 8. Install new cylinder head gasket. 9. Test compression of each cylinder. 10. Install new valves. 11. Install new parts, as necessary. 12. Replace any cracked or shorted cables. 13. Test and replace, as necessary (refer to Group 8D, Ignition System). 14. Refer to Timing Belt Service.
ENGINE MISSES ON ACCELERATION	<ol style="list-style-type: none"> 1. Dirty or gap set too wide in spark plug. 2. Incorrect ignition timing. 3. Dirt in fuel system. 4. Burned, warped or pitted valves. 5. Faulty coil. 6. Incorrect cam timing. 	<ol style="list-style-type: none"> 1. Clean spark plugs and set gap (refer to Group 8D, Ignition System). 2. Refer to Group 8D, Ignition System. 3. Clean fuel system. 4. Install new valves. 5. Test and replace, if necessary, (refer to Group 8D, Ignition System). 6. Refer to Timing Belt Service.
ENGINE MISSES AT HIGH SPEED	<ol style="list-style-type: none"> 1. Dirty or gap set too wide in spark plug. 2. Worn distributor shaft. 3. Worn or burned distributor rotor. 4. Faulty coil. 5. Incorrect ignition timing. 6. Dirty injector in throttle body. 7. Dirt or water in fuel system. 8. Incorrect cam timing. 	<ol style="list-style-type: none"> 1. Clean spark plugs and set gap (refer to Group 8D, Ignition System). 2. Remove and repair distributor (refer to Group 8D, Ignition System). 3. Install new distributor rotor. 4. Test and replace, as necessary (refer to Group 8D, Ignition System). 5. Refer to Group 8D, Ignition System. 6. Clean injector. 7. Clean system and replace fuel filter. 8. Refer to Timing Belt Service.

DIAGNOSIS AND TESTING (Continued)**ENGINE DIAGNOSIS—GASOLINE—MECHANICAL**

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	<ol style="list-style-type: none"> 1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Low oil pressure. 4. Dirt in tappets/lash adjusters. 5. Bent push rods. 6. Worn rocker arms. 7. Worn tappets/lash adjusters. 8. Worn valve guides. 9. Excessive runout of valve seats on valve faces. 	<ol style="list-style-type: none"> 1. Check for correct oil level (refer to Group 0, Lubrication and Maintenance). 2. Change oil (refer to Group 0, Lubrication and Maintenance). 3. Check engine oil level. 4. Clean hydraulic tappets/hydraulic lash adjusters. 5. Install new push rods. 6. Inspect oil supply to rocker arms. 7. Install new hydraulic tappets/hydraulic lash adjusters. 8. Ream and install new valves with oversize stems. 9. Grind valve seats and valves.
CONNECTING ROD NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Misaligned connecting rods. 	<ol style="list-style-type: none"> 1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Replace crankshaft or grind journals. 6. Replace bent connecting rods.
MAIN BEARING NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round, worn. 7. Loose flywheel or torque converter. 	<ol style="list-style-type: none"> 1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Check No. 3 main bearing for wear on flanges. 6. Grind journals or replace crankshaft. 7. Tighten to correct torque.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—GASOLINE—LUBRICATION**

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	<ol style="list-style-type: none"> Gaskets and O-Rings. <ol style="list-style-type: none"> Misaligned, deteriorated or torn. Loose fastener, broken or porous metal part. Crankshaft Rear Seal <ol style="list-style-type: none"> Misinstalled, inverted or torn lip Torn, cut or shaved seal back bead. Crankshaft Seal Flange. Scratched, nicked or grooved. Cylinder block to Cap Mating Surface. <ol style="list-style-type: none"> Inadequate Loctite sealant. Oil hole burr. Oil Pan to Rear Main Cap Sealant (Slots 3.9 - 5.2 only). <ol style="list-style-type: none"> Inadequate or mislocated sealant. Torn, cut or misinstalled oil pan. Cracked or damaged oil pan flange. Chain Case Cover Seal. <ol style="list-style-type: none"> Misinstalled, cocked or misaligned. Torn, cut or damaged seal lips. Scratched or damaged seal casing or cover bore. Scratched or damaged vibration damper hub. 	<ol style="list-style-type: none"> <ol style="list-style-type: none"> Replace the part. Tighten, repair or replace the part. <ol style="list-style-type: none"> Replace the seal. Replace the seal. Replace or polish if necessary. <ol style="list-style-type: none"> Apply sealant per sealant per service manual. Carefully stone or chamfer hole. <ol style="list-style-type: none"> Apply sealant per service manual procedures. Replace the gasket. Replace the oil pan. <ol style="list-style-type: none"> Replace per service manual procedures. Replace the seal. Replace the seal. Minor damage can be polished out; otherwise replace the part.
OIL PRESSURE DROP	<ol style="list-style-type: none"> Low oil level. Faulty oil pressure sending unit. Low oil pressure. Clogged oil filter. Worn parts in oil pump. Thin or diluted oil. Excessive bearing clearance. Oil pump relief valve stuck. Oil pump suction tube loose; bent or cracked. Oil pump cover warped or cracked. 	<ol style="list-style-type: none"> Check engine oil level. Install new sending unit. Check sending unit and check main bearing oil clearance. Install new oil filter. Replace worn parts or pump. Change oil to correct viscosity. Measure bearings for correct clearance. Remove valve and inspect, clean and install. Remove oil pan and install new tube, if necessary. Install new oil pump.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	<ol style="list-style-type: none"> Worn, scuffed or broken rings. Carbon in oil ring slot. Rings fitted too tightly in grooves. Worn valve guides. Leaking intake gasket (3.9L & 5.2L engines). Leaking valve guide seals (3.9L & 5.2L engines). Dislodged valve guide seals (3.9L & 5.2L engines). 	<ol style="list-style-type: none"> Hone cylinder bores and install new rings. Install new rings. Remove the rings. Check grooves. If grooves are not proper width, replace piston. Ream guides and replace valves with oversize valves and seals. Replace gasket and tighten intake manifold to proper torque. Replace seals. Seat valve guide seals or replace, as needed.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK OR CRANKS SLOWLY	<ol style="list-style-type: none"> 1. Starting motor operating, but not cranking the engine. 2. Crankshaft rotation restricted. 3. Starting circuit connections loose or corroded. 4. Neutral safety switch or starter relay inoperative. 5. Battery charge low. 6. No voltage to starter solenoid. 7. Solenoid or starter motor inoperative. 	<ol style="list-style-type: none"> 1. Remove the starter motor. Check for broken flywheel teeth or a broken starting motor spring. 2. Rotate the engine to check for rotational resistance. 3. Clean and tighten connections. 4. Check starter relay supply voltage and proper operation of neutral safety switch if equipped. Replace defective parts. 5. Check battery voltage. Replace battery if a charge cannot be held. 6. Check voltage to solenoid. If necessary, replace the solenoid. 7. Replace starter motor.
ENGINE CRANKS, BUT WILL NOT START—NO SMOKE FROM EXHAUST	<ol style="list-style-type: none"> 1. No fuel in supply tank. 2. Electrical fuel shutdown solenoid not operating. 3. Air intake or exhaust plugged. 4. Fuel filter plugged. 5. Excessive fuel inlet restriction. 6. Injection pump not getting fuel or fuel is aerated. 7. Inoperative fuel transfer (Lift) pump. 8. One or more injectors worn or not operating properly. 9. Worn or inoperative injection pump. 10. Internal pump timing incorrect. 11. Camshaft out of time. 	<ol style="list-style-type: none"> 1. Fill fuel supply. 2. Check for loose wires and verify that the fuel shutdown solenoid and fuel shutdown solenoid relay are functioning. 3. Remove the obstruction. 4. Drain fuel/water separator and replace fuel filter. 5. Check fuel inlet restriction. Correct cause. 6. Check fuel flow/bleed fuel system. 7. Check fuel line for restrictions and fuel pressure. 8. Check/replace bad or improperly operating injectors. 9. Visually check delivery with externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered. 10. Time the pump (refer to Group 14, Fuel System). 11. Check/correct gear train timing alignment.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE HARD TO START, OR WILL NOT START— SMOKE FROM EXHAUST	<ol style="list-style-type: none"> 1. Incorrect starting procedure. 2. Cranking speed too slow. 3. Intake heater system not working. 4. Insufficient intake air. 5. Air in fuel system or the fuel supply is inadequate. 6. Fuel transfer (lift) pump. 7. Injection pump throttle linkage loose or damaged. 8. Contaminated fuel. 9. Fuel screen plugged. 10. One or more injectors worn or not operating properly. 11. Worn or inoperative injection pump. 12. Injection pump out of time. 13. Valves incorrectly adjusted. 14. Engine compression low. 	<ol style="list-style-type: none"> 1. The fuel shutoff solenoid control must be in the run position. Ensure proper procedure is being used. A. Verify that the transmission is not engaged. B. Check the battery, starting motor and look for loose or corroded wiring connections. C. Rotate the engine with barring tool (Snap-on Tool SP371, MTE No. 3377462, or equivalent) to check for external rotational resistance. 3. Verify system is working. Repair/replace inoperative parts. 4. Inspect or replace filter and check for obstructions to the air supply tube. 5. Check the flow through the filter and bleed the system. Locate and eliminate the air source. 6. Measure transfer pump outlet pressure. If needed, repair or replace pump. 7. Visually check the linkage. Adjust/replace linkage. 8. Verify by operating the engine with clean fuel from a temporary tank. Check for presence of gasoline. Drain and flush fuel supply tank. Replace fuel/water separator filter. 9. Check fuel screen. 10. Check/replace improperly operating injectors. 11. Visually check fuel delivery with an externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered. 12. Check/Time the pump (refer to Group 14, Fuel System). 13. Adjust valves. 14. Check compression to identify the problem.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE STARTS, BUT WILL NOT KEEP RUNNING	<ol style="list-style-type: none"> 1. Idle speed too low for the accessories. 2. Intake air or exhaust system restricted. 3. Air in the fuel system or the fuel supply is inadequate. 4. Fuel waxing due to extremely cold weather. 5. Contaminated fuel. 	<ol style="list-style-type: none"> 1. Adjust the idle speed. 2. Visually check for exhaust restriction and inspect the air intake. Repair/replace restricting parts. 3. Check flow through the filter and bleed the system. Locate and eliminate the air source. 4. Verify by inspecting the fuel filter. Clean the system and use climatized fuel. Replace fuel/water separator filter. Check fuel heater for proper operation. 5. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline. Replace fuel/water separator filter.
SURGING (SPEED CHANGE)	<ol style="list-style-type: none"> 1. If the condition occurs at idle, the idle speed is set too low for the accessories. 2. Improperly operating injection pump. 	<ol style="list-style-type: none"> 1. Adjust the idle speed. 2. Replace the injector pump.
ROUGH IDLE (IRREGULARLY FIRING OR ENGINE SHAKING)	<ol style="list-style-type: none"> 1. If engine is cold, intake heater system defective. 2. Idle speed too low for the accessories. 3. Engine mounts damaged or loose. 4. High pressure fuel leaks. 5. Air in the fuel system. 6. Sticking needle valve in an injector. 	<ol style="list-style-type: none"> 1. Refer to intake heater system (see Group 14, Fuel System). 2. Adjust idle speed. 3. Repair or replace mounts. 4. Correct leaks in the high pressure lines, fittings or delivery valves. 5. Bleed the fuel system and eliminate the source of the air. 6. Check and replace the injector with the sticking needle valve.
ENGINE RUNS ROUGH	<ol style="list-style-type: none"> 1. Fuel injection lines leaking. 2. Air in the fuel or the fuel supply is inadequate. 3. Contaminated fuel. 	<ol style="list-style-type: none"> 1. Correct leaks in the high pressure lines, fittings, injectors sealing washers or delivery valves. 2. Check the flow through the filter and bleed the system. Locate and eliminate the air source. 3. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline. Replace fuel/water separator filter.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE RUNS ROUGH CONT.	<ol style="list-style-type: none"> 4. Incorrect valve operation. 5. Injection pump timing incorrect. 6. Improperly operating injectors. 7. Defective injection pump (delivery valve). 8. Camshaft out of time. 9. Damaged camshaft or tappets. 	<ol style="list-style-type: none"> 4. Check for a bent push rod and adjust valves. Replace push rod, if necessary. 5. Check/time pump (refer to Group 14, Fuel System). 6. Replace inoperative injectors. 7. Repair or replace injection pump. 8. Check/correct gear train timing alignment. 9. Inspect camshaft valve lift. Replace camshaft and tappets.
ENGINE RPM WILL NOT REACH RATED SPEED	<ol style="list-style-type: none"> 1. Engine overload. 2. Improperly operating tachometer. 3. Throttle linkage worn or incorrectly adjusted. 4. Inadequate fuel supply. 5. Air/fuel controls leak. 6. Improperly operating injection pump. 	<ol style="list-style-type: none"> 1. Verify high idle speed without load. Investigate operation to be sure correct gear is being used. 2. Verify engine speed with hand tachometer, correct as required. 3. Adjust linkage for stop-to-stop fuel control lever travel. Replace linkage if necessary. 4. Check the fuel flow through the system to locate the reason for inadequate fuel supply, correct as required. 5. Check and repair leak. Check AFC tubing for obstruction. 6. Repair or replace injection pump.
LOW POWER	<ol style="list-style-type: none"> 1. Fuel control lever not moving to full throttle. 2. High oil level. 3. Engine overloaded. 4. Slow throttle response caused by leaking or obstructed air control tube or improperly operating control in the pump. 5. Inadequate intake air flow. 6. Inadequate fuel supply. Air in the fuel. 7. Excessive exhaust restriction. 	<ol style="list-style-type: none"> 1. Check/correct for stop-to-stop travel. 2. Check/correct oil level. 3. Check for added loading from accessories or driven units, brakes dragging and other changes in vehicle loading. Repair/replace as needed. 4. Check for leaks and obstructions. Tighten the fittings. Repair or replace the pump if the controls are not functioning. 5. Inspect/replace air cleaner element. Look for other restrictions. 6. Inspect/correct leaks in the high pressure lines, fittings injectors sealing washers or delivery valve seals. 7. Check/correct the restriction in the exhaust system.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
LOW POWER CONT.	<ul style="list-style-type: none"> 8. High fuel temperature. 9. Poor quality fuel or fuel contaminated with gasoline. 10. Air leak between the turbocharger and the intake manifold. 11. Exhaust leak at the manifold or turbocharger. 12. Improperly operating turbocharger. 13. Wastegate operation. 14. Valve not operating. 15. Worn or improperly operating injectors. 16. Incorrect injection pump timing. 17. Improperly operating injection pump. 	<ul style="list-style-type: none"> 8. Verify that fuel heater is off when engine is warm. Check for restricted fuel drain tube. Repair/replace as needed. 9. Verify by operating from a temporary tank with good fuel. Check for presence of gasoline. Replace fuel/water separator filter. 10. Check/correct leaks in hoses, gaskets, charge air cooler and around mounting capscrews or through holes in the manifold cover. 11. Check/correct leaks in the manifold or turbocharger gaskets. If manifold is cracked, replace manifold. 12. Inspect/replace turbocharger. 13. Check waste gate operation. 14. Check for bent push rod, replace if necessary. 15. Check/replace injectors. 16. Verify injection pump timing (see Group 14, Fuel System). 17. Repair or replace injection pump.
EXCESSIVE EXHAUST SMOKE	<ul style="list-style-type: none"> 1. Engine running too cold (white smoke). 2. Improper starting procedure (white smoke). 3. Fuel supply inadequate. 4. Injection pump timing. 5. Inadequate intake air. 6. Air leak between turbocharger and intake manifold. 7. Exhaust leak at the manifold or turbocharger. 8. Improperly operating turbocharger. 9. Improperly operating injectors. 	<ul style="list-style-type: none"> 1. Refer to troubleshooting for coolant temperature below normal (refer to Group 7, Cooling System). Inspect intake manifold heater system for proper operation. 2. Use proper starting procedures. 3. Check fuel supply pressure and inlet restriction. 4. Check and time pump (refer to Group 14, Fuel System). 5. Inspect/change air filter. Look for other restriction. Check charge air cooler for obstructions. 6. Check/correct leaks in the air crossover tube, hoses, gaskets, mounting capscrews or through holes in the manifold cover. 7. Check/correct leaks in the manifold or turbocharger gaskets. If cracked, replace manifold. 8. Inspect/replace turbocharger. 9. Check and replace inoperative injectors.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE EXHAUST SMOKE CONT.	<ol style="list-style-type: none"> 10. Improperly operating or overfueled injector pump. 11. Piston rings not sealing (blue smoke). 	<ol style="list-style-type: none"> 10. Repair or replace injection pump. 11. Perform blow-by check. Correct as required.
ENGINE WILL NOT SHUT OFF	<ol style="list-style-type: none"> 1. Fuel shutoff solenoid or solenoid relay inoperative. 2. Engine running on fumes drawn into the air intake. 3. Fuel injection pump malfunction. 	<ol style="list-style-type: none"> 1. Check/replace fuel shutoff solenoid or relay. 2. Check the air intake ducts for the source of fumes. WARNING: In case of engine runaway due to flammable fumes from gasoline spills or turbocharger oil leaks being sucked into the engine. Shut off engine ignition switch first then use a CO2 fire extinguisher and direct the spray under the front bumper to remove oxygen supply. The engine air intake is on the passenger side behind the bumper. The fire extinguisher must be directed at this location for emergency shutdown conditions. 3. Repair or replace fuel injection pump.
COOLANT TEMPERATURE ABOVE NORMAL	<ol style="list-style-type: none"> 1. Low coolant level. 2. Incorrect/improperly operating pressure cap. 3. Loose drive belt on water pump/fan. 4. Inadequate air flow to the radiator. 5. Radiator fins plugged. 6. Collapsed radiator hose. 7. Improperly operating temperature sensor/gauge. 8. Improperly operating, incorrect or no thermostat. 9. Air in the cooling system. 	<ol style="list-style-type: none"> 1. Check coolant level. Add coolant, if necessary. Locate and correct the source of the coolant loss, (refer to Group 7, Cooling). 2. Replace cap with the correct rating for the system. 3. Check/replace belt or belt tensioner. 4. Check/repair radiator core, fan shroud and viscous fan drive as required. 5. Blow debris from fins. 6. Replace the hose. Check cap operation, (refer to Group 7, Cooling System). 7. Verify that the gauge and temperature sensor are accurate. Replace gauge/sensor, if bad. 8. Check and replace the thermostat. 9. A. Make sure the fill rate is not being exceeded and the correct vented thermostat is installed. B. Check for loose hose clamps. Tighten if loose. C. If aeration continued, check for a compression leak through the head gasket.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—PERFORMANCE—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
COOLANT TEMPERATURE ABOVE NORMAL CONT.	<ul style="list-style-type: none">10. Inoperative water pump.11. Incorrect injection pump timing.12. Overfueled injection pump.13. Plugged cooling passages in radiator, head, head gasket or block.14. Engine overloaded.	<ul style="list-style-type: none">10. Check and replace the water pump.11. Check/time the injector pump (refer to Group 14, Fuel System).12. Repair or replace the injection pump.13. Flush the system and fill with clean coolant.14. Verify that the engine load rating is not being exceeded.
COOLANT TEMPERATURE BELOW NORMAL	<ul style="list-style-type: none">1. Too much air flow across the radiator.2. Incorrect thermostat or contamination in thermostat.3. Temperature sensor or gauge inoperative.4. Coolant not flowing by temperature sensor.	<ul style="list-style-type: none">1. Check/repair viscous fan drive as required.2. Check and replace thermostat.3. Verify that the gauge and sensor are accurate. If not, replace gauge/sensor.4. Check and clean coolant passages.



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DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—MECHANICAL**

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE LOW	<ol style="list-style-type: none"> 1. Low oil level. 2. Oil viscosity thin, diluted or wrong specification. 3. Improperly operating pressure switch/gauge. 4. Relief valve stuck open. 5. Plugged oil filter. 6. If cooler was replaced, shipping plugs left in cooler. 7. Worn oil pump. 8. Suction tube loose or seal leaking. 9. Loose main bearing cap. 10. Worn bearings or wrong bearings installed. 11. Oil jet under piston bad fit into main carrier. 	<ol style="list-style-type: none"> 1. A. Check and fill with clean engine oil. B. Check for a severe external oil leak that could reduce the pressure. 2. Verify the correct oil is being used. Check for oil dilution. Refer to Contaminated Lube Oil (Engine Diagnosis Mechanical). 3. Verify the pressure switch is functioning correctly. If not, replace switch/gauge. 4. Check/replace valve. 5. Change oil filter. Oil filter change interval may need to be revised. 6. Check/remove shipping plugs. 7. Check and replace oil pump. 8. Check and replace seal. 9. Check and install new bearing and tighten cap to proper torque. 10. Inspect and replace connecting rod or main bearings. Check and replace piston cooling nozzles. 11. Check oil jet position.
LUBRICATING OIL PRESSURE TOO HIGH	<ol style="list-style-type: none"> 1. Pressure switch/gauge not operating properly. 2. Engine running to cold. 3. Oil viscosity too thick. 4. Oil pressure relief valve stuck closed or binding. 	<ol style="list-style-type: none"> 1. Verify the pressure switch is functioning correctly. If not, replace switch/gauge. 2. Refer to Coolant Temperature Below Normal (Engine Diagnosis Performance). 3. Make sure the correct oil being used, (Refer to Group 0, Lubrication and Maintenance). 4. Check and replace valve.
LUBRICATING OIL LOSS	<ol style="list-style-type: none"> 1. External leaks. 2. Crankcase being overfilled. 3. Incorrect oil specification or viscosity. 4. Oil cooler leak. 5. High blow-by forcing oil out the breather. 6. Turbocharger leaking oil to the air intake. 7. Piston rings not sealing (oil being consumed by the engine). 	<ol style="list-style-type: none"> 1. Visually inspect for oil leaks. Repair as required. 2. Verify that the correct dipstick is being used. 3. A. Make sure the correct oil is being used. B. Look for reduced viscosity from dilution with fuel. C. Review/reduce the oil change intervals. 4. Check and replace the oil cooler. 5. Check the breather tube area for signs of oil loss. Perform the required repairs. 6. Inspect the air ducts for evidence of oil transfer. Repair as required. 7. Perform blow-by check. Repair as required.

DIAGNOSIS AND TESTING (Continued)**SERVICE DIAGNOSIS—DIESEL—MECHANICAL—CONT.**

CONDITION	POSSIBLE CAUSES	CORRECTION
COMPRESSION KNOCKS	<ol style="list-style-type: none"> 1. Air in the fuel system. 2. Poor quality fuel or water/gasoline contaminated fuel. 3. Engine overloaded. 4. Incorrect injection pump timing. 5. Improperly operating injectors. 	<ol style="list-style-type: none"> 1. Bleed the fuel system (refer to Group 14, Fuel System). 2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tanks. Replace fuel/water separator filter. 3. Verify the engine load rating is not being exceeded. 4. Check and time injection pump (refer to Group 14, Fuel System). 5. Check and replace inoperative injectors.
EXCESSIVE VIBRATION	<ol style="list-style-type: none"> 1. Loose or broken engine mounts. 2. Damaged fan or improperly operating accessories. 3. Improperly operating vibration damper. 4. Improperly operating viscous fan drive. 5. Worn or damaged generator bearing. 6. Flywheel housing misaligned. 7. Loose or broken power component. 8. Worn or unbalanced driveline components. 	<ol style="list-style-type: none"> 1. Replace engine mounts. 2. Check and replace the vibrating components. 3. Inspect/replace the vibration damper. 4. Inspect/replace the fan drive. 5. Check/replace the generator. 6. Check/correct flywheel alignment. 7. Inspect the crankshaft and rods for damage that causes an unbalance. repair/replace as required. 8. Check/repair driveline components.
EXCESSIVE ENGINE NOISES	<ol style="list-style-type: none"> 1. Drive belt squeal, insufficient tension or abnormally high loading. 2. Intake air or exhaust leaks. 3. Excessive valve lash. 4. Turbocharger noise. 5. Gear train noise. 6. Power function knock. 	<ol style="list-style-type: none"> 1. Check the automatic tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub and generator turn freely. 2. Refer to Excessive Exhaust smoke (Engine Diagnosis Performance). 3. Adjust valves. Make sure the push rods are not bent and rocker levers or adjusting screws are not severely worn. Replace bent or severely worn pads. 4. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required. 5. Visually inspect and measure gear backlash. Replace gears as required. 6. Check/replace rod and main bearings.
GENERATOR NOT CHARGING OR INSUFFICIENT CHARGING	<ol style="list-style-type: none"> 1. Loose or corroded battery. 2. Generator belt slipping. 3. Generator pulley loose on shaft. 4. Improperly operating generator. 	<ol style="list-style-type: none"> 1. Clean/tighten battery connection. 2. Check/replace automatic belt tensioner. Check/replace drive belt. 3. Tighten pulley. 4. Check/replace generator.

3.9L ENGINE

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GENERAL INFORMATION

VALVES AND VALVE SPRINGS

The valves are arranged in-line and are inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine at 3,000 RPM.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter

across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 3.9 Liter (238 CID) six-cylinder engine is a V-Type, lightweight, single cam, overhead valve engine with hydraulic roller tappets (Fig. 1).

This engine is designed to use unleaded fuel.

DESCRIPTION AND OPERATION (Continued)

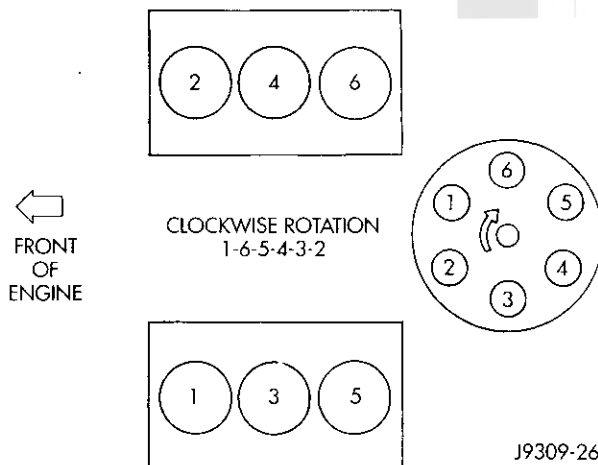
Engine Type.....	90° V-6 OHV
Bore and Stroke.....	99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement.....	3.9L (238 cu. in.)
Compression Ratio.....	9.1:1
Torque.....	312 N•m (230 ft. lbs.) @ 3,200 rpm
Firing Order.....	1-6-5-4-3-2
Lubrication.....	Pressure Feed - Full Flow Filtration
Engine Oil Capacity.....	3.8L (4.0 Qts) with Filter
Cooling System.....	Liquid Cooled - Forced Circulation
Cooling Capacity.....	14.3L (15.1 Qts)
Cylinder Block.....	Cast Iron
Crankshaft.....	Nodular Iron
Cylinder Head.....	Cast Iron
Combustion Chambers.....	"Fast Burn" Design
Camshaft.....	Nodular Cast Iron
Pistons.....	Aluminum Alloy w/Strut
Connecting Rods.....	Forged Steel

J9409-9

Fig. 1 Engine Description

Engine lubrication system consists of a rotor type oil pump and a full-flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5 on the left bank and 2, 4, 6 on the right bank. The firing order is 1-6-5-4-3-2 (Fig. 2).



J9309-26

Fig. 2 Firing Order

The engine serial number is stamped into a machined pad located on the left front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 3).

ENGINE LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the rear main bearing

X M 3.9L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

3.9L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

J9209-72

Fig. 3 Engine Identification Number

cap. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main gallery, which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block, and into the oil gallery on the left side of the engine.

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing has half a hole in it, oil passes through the hole when the rods rotate and the hole lines up, oil is then thrown off as the rod rotates. This oil throwoff lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the No. 1 main bearing cap.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets, which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components. The oil then passes down through the push rod guide holes and the oil drain-back passages in the cylinder head, past the valve tappet area, and then returns to the oil pan.

DESCRIPTION AND OPERATION (Continued)

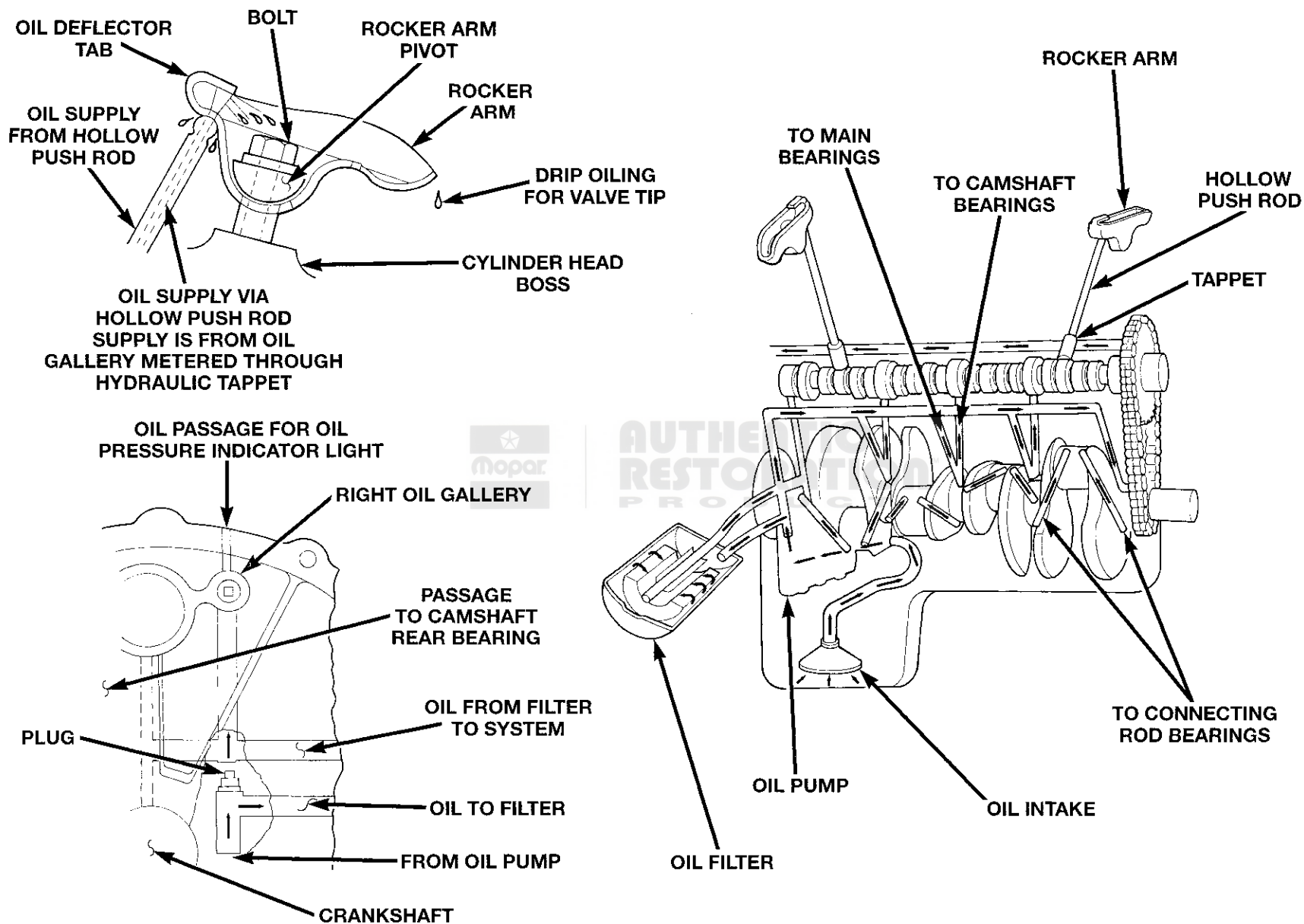


Fig. 4 Oil Lubrication System

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DESCRIPTION AND OPERATION (Continued)**ENGINE COMPONENTS****CYLINDER HEAD COVER**

A steel-backed silicone gasket is used with the cylinder head cover. This gasket is reusable.

CYLINDER HEADS

The alloy cast iron cylinder heads are held in place by eight bolts. The spark plugs are located in at peak of the wedge between the valves (Fig. 5).

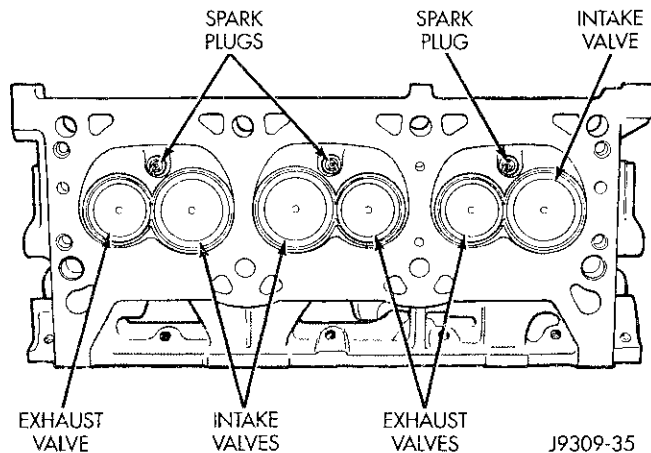


Fig. 5 Cylinder Head Assembly

VALVES AND VALVE SPRINGS

The valves are arranged in-line and inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

OIL PUMP**OIL PUMP PRESSURE**

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine at 3,000 RPM.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

CRANKSHAFT

A crankshaft that has undersize journals is stamped with 1/4 inch letters near the notch of the No. 6 crankshaft counterweight.

FOR EXAMPLE: R2 stamped on the No. 6 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No. 4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No. 3 rod journal and the No. 2 main journal are both 0.025 mm (0.001 in) undersize.

When a crankshaft is replaced, all main and connecting rod bearings, should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

CRANKSHAFT MAIN BEARINGS

Bearing caps are NOT interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No.1 and 3 are interchangeable.

Upper and lower No. 2 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine. Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

CRANKSHAFT REAR OIL SEALS

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

SERVICE PROCEDURES**VALVE TIMING**

(1) Turn crankshaft until the No. 6 exhaust valve is closing and No. 6 intake valve is opening.

(2) Insert a 6.350 mm (1/4 in.) spacer between rocker arm pad and stem tip of No. 1 intake valve. Allow spring load to bleed tappet down giving, in effect, a solid tappet.

(3) Install a dial indicator so plunger contacts valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.254 mm (0.010 inch). The timing of the crankshaft should

SERVICE PROCEDURES (Continued)

now read from 10° before top dead center to 2° after top dead center. Remove spacer.

CAUTION: DO NOT turn crankshaft any further clockwise, as valve spring might bottom and result in serious damage.

- (5) If reading is not within specified limits:
- Check sprocket index marks.
 - Inspect timing chain for wear.
 - Check accuracy of DC mark on timing indicator.

TIMING CHAIN STRETCH

(1) Place a scale next to the timing chain so that any movement of the chain can be measured.

(2) Place a torque wrench and socket over camshaft sprocket attaching bolt. Apply torque in the direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) torque with cylinder head installed or 20 N·m (15 ft. lbs.) torque with cylinder head removed. With torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 6).

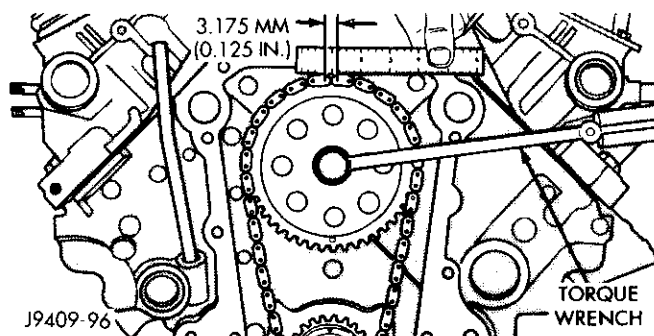


Fig. 6 Measuring Timing Chain Wear and Stretch

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

FITTING PISTONS

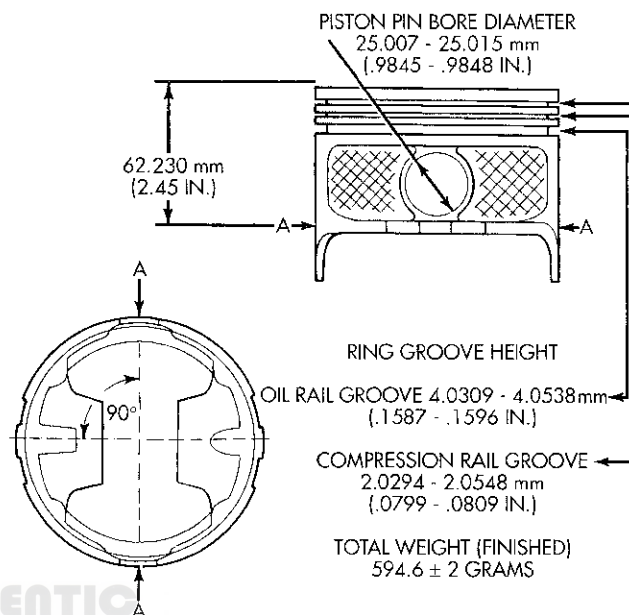
Check the cylinder block bore for out-of-round, taper, scoring, or scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 7).

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 in.) at 21°C (70°F).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).



PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm [IN.]	MAX. mm [IN.]	MIN. mm [IN.]	MAX. mm [IN.]
A	99.280 [3.9087]	99.294 [3.9092]	99.306 [3.9097]	99.319 [3.9102]
B	99.294 [3.9092]	99.306 [3.9097]	99.319 [3.9102]	99.332 [3.9107]
C	99.306 [3.9097]	99.319 [3.9102]	99.332 [3.9107]	99.344 [3.9112]
D	99.319 [3.9102]	99.332 [3.9107]	99.344 [3.9112]	99.357 [3.9117]
E	99.332 [3.9107]	99.344 [3.9112]	99.357 [3.9117]	99.370 [3.9122]

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Fig. 7 Piston Measurements

FITTING RINGS

(1) Measurement of end gaps:

(a) Measure piston ring gap 2 in. from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 in.). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 in.). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 in.).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Rings with excess gaps should not be used.

(2) Install rings, and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and

SERVICE PROCEDURES (Continued)

lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter "O", an oval depression, or the word "TOP" (Fig. 8) (Fig. 10).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 9) (Fig. 10). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word "TOP" facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 in.) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 in.) side clearance.

(e) Pistons with insufficient, or excessive, side clearance should be replaced.

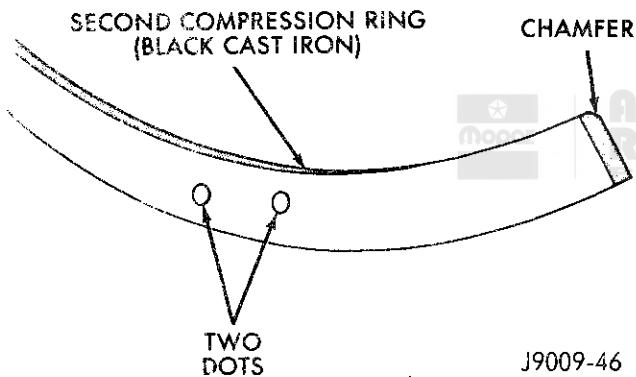


Fig. 8 Second Compression Ring Identification (Typical)

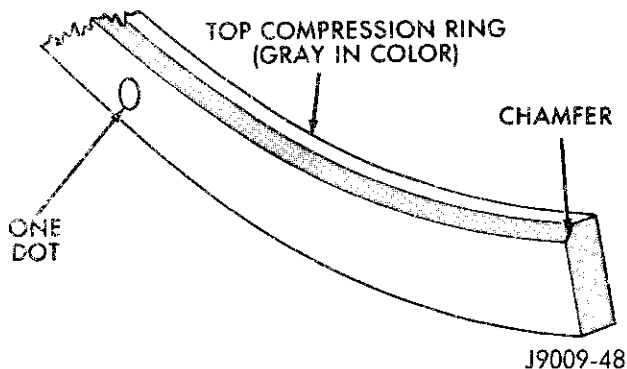


Fig. 9 Top Compression Ring Identification (Typical)

(3) Orient the rings:

(a) Arrange top compression ring 90° counter-clockwise from the oil ring rail gap (Fig. 11).

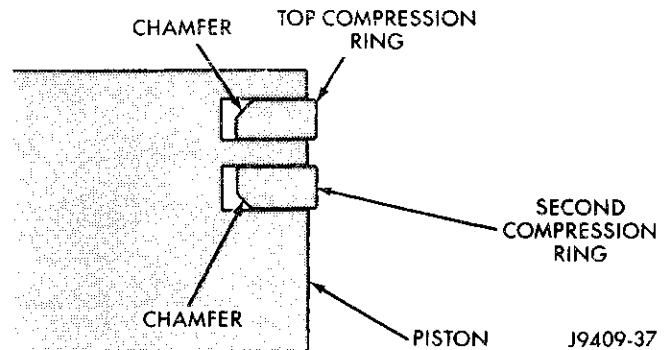


Fig. 10 Compression Ring Chamfer Location (Typical)

(b) Arrange second compression ring 90° clockwise from the oil ring rail gap (Fig. 11).

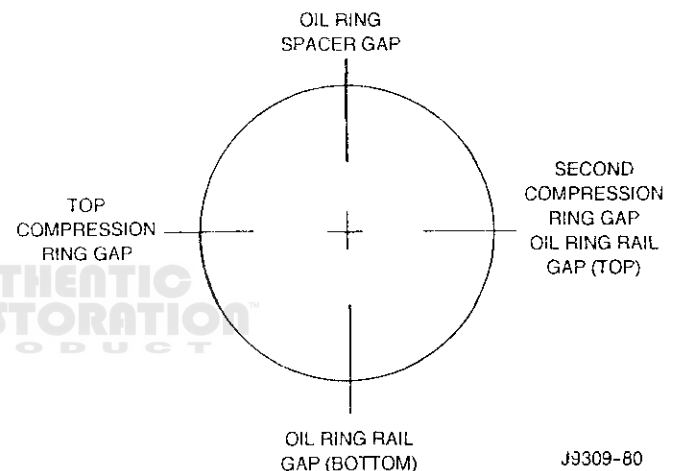


Fig. 11 Proper Ring Installation

CONNECTING ROD BEARINGS

Fit all rods on a bank until completed. **DO NOT** alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

The bearing caps are not interchangeable and should be marked at removal to ensure correct assembly.

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, be certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Bearings are available in 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.) undersize. **Install the bearings in pairs. DO NOT use a new**

SERVICE PROCEDURES (Continued)

bearing half with an old bearing half. **DO NOT** file the rods or bearing caps.

CRANKSHAFT MAIN BEARINGS

Bearing caps are **NOT** interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are **NOT** interchangeable. Lower main bearing halves of No. 1 and 3 are interchangeable.

Upper and lower No. 2 bearing halves are flanged to carry the crankshaft thrust loads. They are **NOT** interchangeable with any other bearing halves in the engine (Fig. 12). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

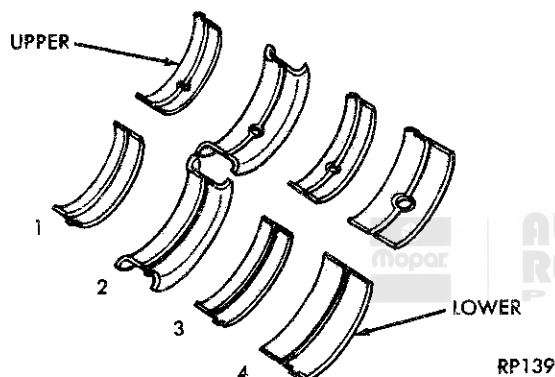


Fig. 12 Main Bearing Identification

CRANKSHAFT

A crankshaft that has undersize journals will be stamped with 1/4 inch letters near the notch of the No. 6 crankshaft counterweight (Fig. 13).

FOR EXAMPLE: R2 stamped on the No. 6 crankshaft counterweight indicates that the No. 2 rod journal is 0.025 mm (0.001 in.) undersize. M4 indicates that the No. 4 main journal is 0.025 mm (0.001 in.) undersize. R3 M2 indicates that the No. 3 rod journal and the No. 2 main journal are 0.025 mm (0.001 in.) undersize.

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

Undersize Journal	Identification Stamp
ROD - 0.025mm (0.001 in.)	R1-R2-R3-Etc.
MAIN - 0.025mm (0.001 in.)	M1-M2-M3 or M4

STEEL STAMP IDENTIFICATION
R (ROD) AND/OR M (MAIN) FOLLOWED
BY THE ROD OR MAIN NUMBER

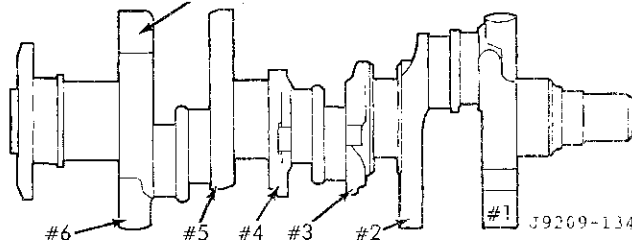


Fig. 13 Location of Crankshaft Identification

REMOVAL AND INSTALLATION

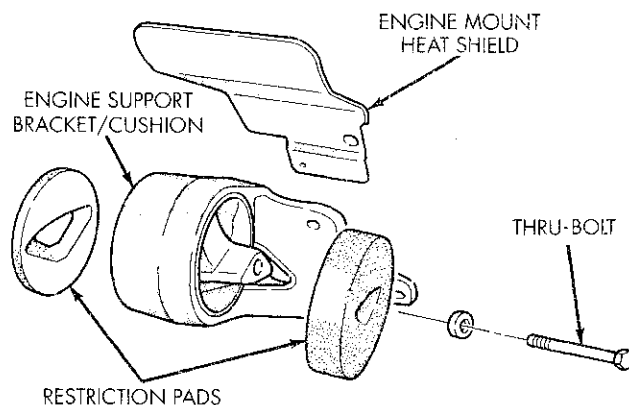
ENGINE FRONT MOUNTS

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to ensure clearance for radiator top tank and hose.

CAUTION: **DO NOT** lift the engine by the intake manifold.

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine **SLIGHTLY** and remove the thru-bolt and nut (Fig. 14).
- (6) Remove engine support bracket/cushion bolts (Fig. 14). Remove the support bracket/cushion and heat shields.



J9409-144

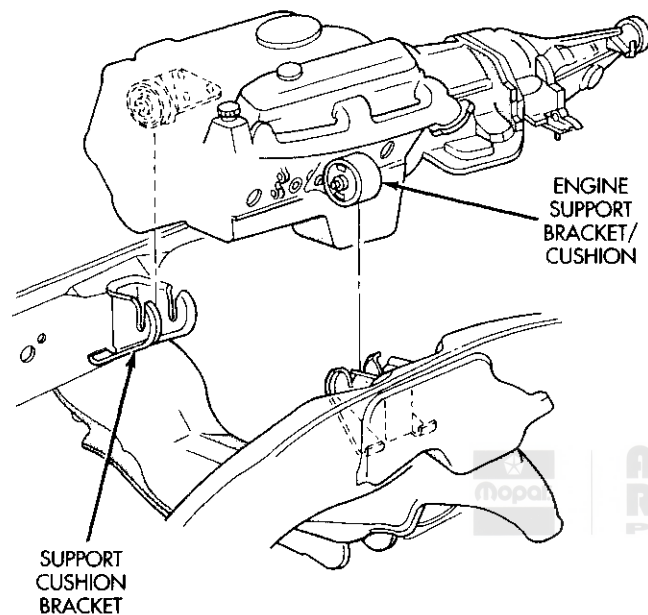
Fig. 14 Engine Front Mounts

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

(1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.

(2) Install the through-bolt into the engine support bracket/cushion.

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and through-bolt into support cushion brackets (Fig. 15).



J9409-54

Fig. 15 Positioning Engine Front Mounts

(4) Install through-bolt nuts and tighten the nuts to 102 N·m (75 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

ENGINE REAR MOUNT**REMOVAL**

(1) Raise the vehicle on a hoist.

(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 16).

(4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 88 N·m (65 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 41 N·m (30 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 16).

(4) Install the support cushion bolts and tighten to 41 N·m (30 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Remove the battery.

(2) Drain cooling system. Refer to Group 7, Cooling System, for the proper procedure.

(3) Remove the upper crossmember and top core support.

(4) Remove the transmission oil cooler.

(5) Discharge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for service procedures.

(6) Remove the serpentine belt. Refer to Group 7, Cooling System.

(7) Remove the A/C compressor with the lines attached. Set aside.

(8) If equipped, remove the condenser.

(9) Remove the washer bottle.

(10) Disconnect the top radiator hose.

(11) Remove the fan.

(12) Remove the fan shroud.

(13) Disconnect the lower radiator hose.

(14) Remove radiator. Refer to Group 7, Cooling System.

(15) Remove the generator with the wire connections. Refer to Group 8B, Battery/Starter/Generator Service.

(16) Remove the air cleaner box.

(17) Disconnect the throttle linkage.

(18) Remove throttle body.

(19) Remove the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

(20) Remove the distributor cap and wiring.

(21) Disconnect the heater hoses.

(22) Disconnect the power steering hoses, if equipped.

(23) Disconnect the transmission cooler lines.

(24) Perform the Fuel System Pressure release procedure. Refer to group 14, Fuel system. Disconnect the fuel lines.

(25) On Manual Transmission vehicles, remove the shift lever. Refer to Group 21, Transmissions.

(26) Raise and support the vehicle on a hoist.

(27) Remove the drain plug and drain the engine oil.

(28) Remove engine front mount through-bolt nuts.

REMOVAL AND INSTALLATION (Continued)

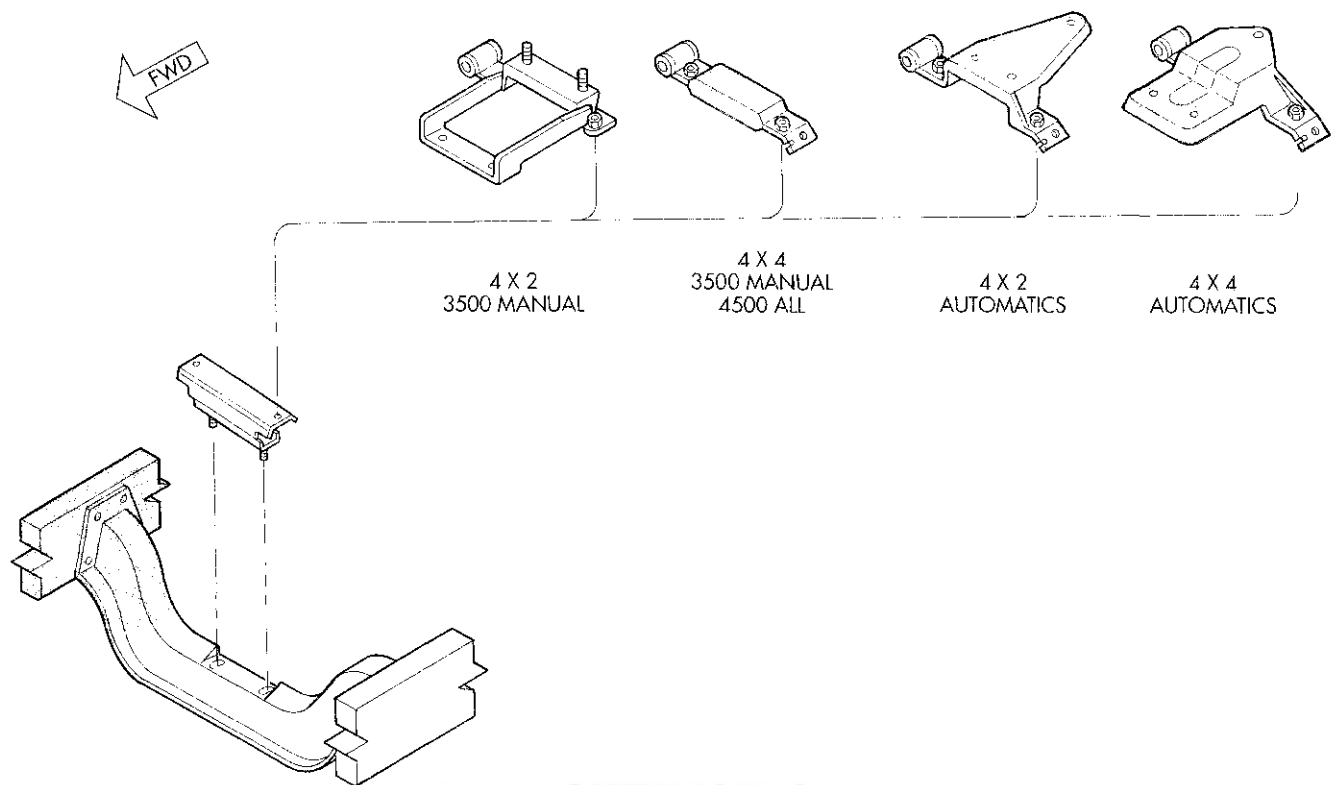


Fig. 16 Engine Rear Support Cushion Assemblies

J9509-126

(29) Remove the transmission cooler line brackets from oil pan.

(30) Disconnect exhaust pipe at manifold.

(31) Disconnect the starter wires. Remove starter motor. Refer to Group 8B, Battery/Starter/Generator Service.

(32) Remove the dust shield and transmission cover.

(33) Refer to Group 21, Transmissions for transmission removal.

(34) Lower the vehicle.

CAUTION: DO NOT lift the engine by the intake manifold.

(35) Install an engine lifting fixture.

(36) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the through-bolt into the support cushion brackets.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group 21, Transmissions for transmission installation.

(5) Install the prop shaft. Refer to Group 16, Propeller Shaft.

(6) Install the dust shield and transmission cover.

(7) Install the starter and connect the starter wires. Refer to Group 8B, Battery/Starter/Generator Service.

(8) Install exhaust pipe to manifold.

(9) Install the transmission cooler line brackets from oil pan.

(10) Install engine front mount through-bolt nuts. Tighten the nuts.

(11) Install the drain plug and tighten to 34 N·m (25 ft. lbs.) torque.

(12) Lower the vehicle.

(13) Remove engine-lifting fixture.

(14) On Manual Transmission vehicles, install the shift lever. Refer to Group 21, Transmissions.

(15) Connect the fuel lines.

(16) Connect the transmission cooler lines.

(17) Connect the power steering hoses, if equipped.

(18) Connect the heater hoses.

(19) Install the distributor cap and wiring.

(20) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

(21) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.

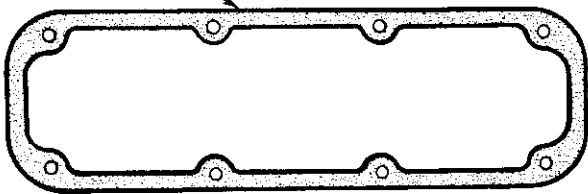
REMOVAL AND INSTALLATION (Continued)

- (22) Connect the throttle linkage.
- (23) Install the air cleaner box.
- (24) Install the generator and wire connections. Refer to Group 8B, Battery/Starter/Generator Service.
- (25) Install radiator. Refer to Group 7, Cooling System.
- (26) Connect the lower radiator hose.
- (27) Install the fan shroud.
- (28) Install the fan.
- (29) Connect the top radiator hose.
- (30) Install the washer bottle.
- (31) If equipped, install the condenser.
- (32) Install the A/C compressor with the lines attached.
- (33) Install the serpentine belt. Refer to Group 7, Cooling System.
- (34) Evacuate and charge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for service procedures.
- (35) Install the transmission oil cooler.
- (36) Install the upper crossmember and top core support.
- (37) Add coolant to the cooling system. Refer to Group 7, Cooling System for the proper procedure.
- (38) Install the battery.
- (39) Road test vehicle.

CYLINDER HEAD COVER

A steel-backed silicone gasket is used with the cylinder head cover (Fig. 17). This gasket can be used again.

CYLINDER HEAD COVER GASKET



J9209-104

Fig. 17 Cylinder Head Cover Gasket**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
- (3) Remove cylinder head cover and gasket. The gasket may be used again.

INSTALLATION

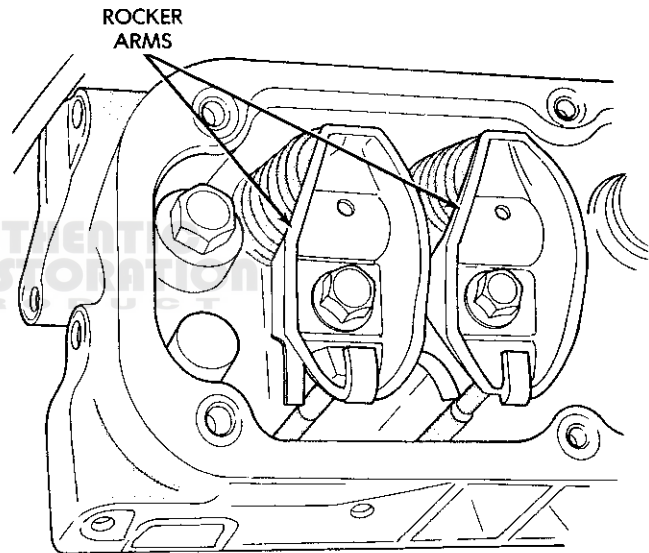
- (1) Install the cylinder head cover gasket onto the head rail.
- (2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

- (3) Install closed crankcase ventilation system and evaporation control system.

- (4) Connect the negative cable to the battery.

CYLINDER HEAD COMPONENTS—IN VEHICLE SERVICE**ROCKER ARMS AND PUSH RODS****REMOVAL**

- (1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (2) Remove cylinder head cover and gasket.
- (3) Remove the rocker arm bolts and pivots (Fig. 18). Place them on a bench in the same order as removed.
- (4) Remove the push rods and place them on a bench in the same order as removed.



J9209-66

Fig. 18 Rocker Arms**INSTALLATION**

- (1) Rotate the crankshaft until the V6 mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.

CAUTION: DO NOT rotate or crank the engine during or immediately after rocker arm installation. Allow the hydraulic roller tappets adequate time to bleed down (about 5 minutes).

- (2) Install the push rods in the same order as removed.

REMOVAL AND INSTALLATION (Continued)

(3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

(4) Install cylinder head cover.

(5) Connect spark plug wires.

VALVE STEM SHIELDS AND SPRINGS

REMOVAL

(1) Set engine basic timing to Top Dead Center (TDC).

(2) Remove the air cleaner.

(3) Remove cylinder head covers and spark plugs.

(4) Remove coil wire from distributor and secure to good ground to prevent engine from starting.

(5) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.

(6) Remove rocker arms.

(7) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.

(8) Using Valve Spring Compressor Tool MD-998772A, compress valve spring and remove retainer valve locks and valve spring.

INSTALLATION

(1) Install seals on the exhaust valve stem and position down against valve guides.

(2) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.

(3) Follow the same procedure on the remaining 5 cylinders using the firing sequence 1-6-5-4-3-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.

(4) Remove adapter from the No.1 spark plug hole.

(5) Install rocker arms.

(6) Install covers and coil wire to distributor.

(7) Install air cleaner.

(8) Road test vehicle.

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 19) are held in place by eight bolts. The spark plugs are located at the peak of the wedge between the valves.

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system. Refer to Group 7, Cooling System for the proper procedures.

(3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

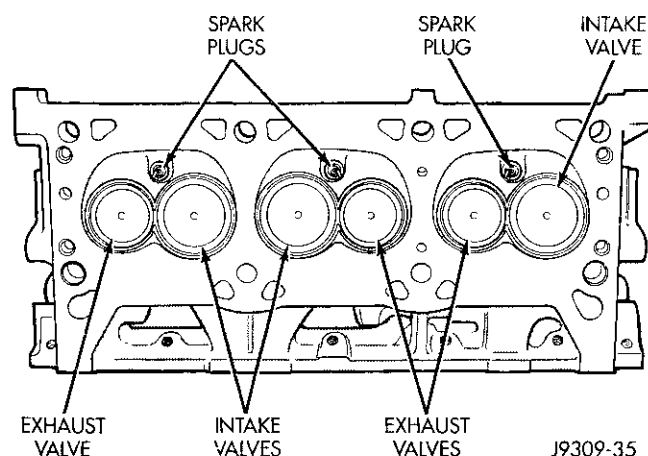


Fig. 19 Cylinder Head Assembly

(6) Remove the air cleaner.

(7) Perform fuel system pressure release procedure. Before attempting any repairs refer to Group 14, Fuel Systems.

(8) Disconnect the fuel lines.

(9) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(10) Remove the return spring.

(11) Remove distributor cap and wires.

(12) Disconnect the coil wires.

(13) Disconnect heat indicator sending unit wire.

(14) Disconnect heater hoses and bypass hose.

(15) Remove cylinder head covers and gaskets.

(16) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.

(17) Remove exhaust manifolds.

(18) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.

(19) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.

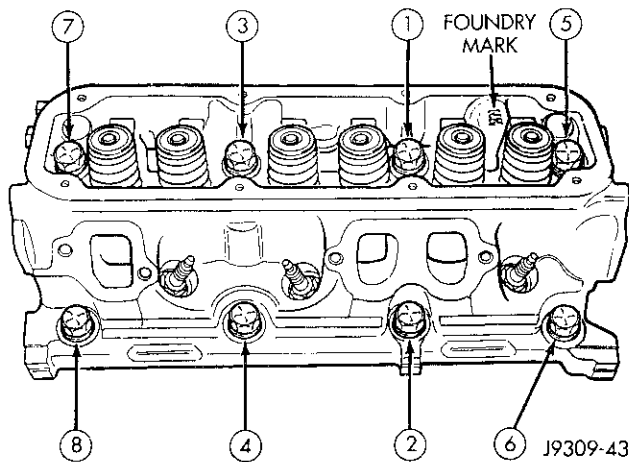
(20) Remove spark plugs.

INSTALLATION

(1) Position the new cylinder head gaskets onto the cylinder block.

(2) Position the cylinder heads onto head gaskets and cylinder block.

(3) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 20). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)**Fig. 20 Cylinder Head Bolt -Tightening Sequence**

CAUTION: When tightening the rocker arm bolts, be sure the piston in that cylinder is **NOT** at TDC. Contact between the valves and piston could occur.

(4) Install push rods and rocker arm assemblies in their original positions. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.

(5) Install the intake manifold and throttle body assembly. Refer to Group 11, Exhaust System and Intake Manifold.

(6) Install exhaust manifolds. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

(7) Adjust spark plugs to specifications. Refer to Group 8D, Ignition System. Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(8) Install coil wires.

(9) Connect heat indicator sending unit wire.

(10) Connect the heater hoses and bypass hose.

(11) Install distributor cap and wires.

(12) Hook up the return spring.

(13) Connect the accelerator linkage and, if so equipped, the speed control and transmission kick-down cables.

(14) Install the fuel lines.

(15) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

(16) Install the intake manifold-to-generator bracket support rod. Tighten the bolts.

(17) Place the cylinder head cover gaskets in position and install cylinder head covers. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(18) Install closed crankcase ventilation system.

(19) Connect the evaporation control system.

(20) Install the air cleaner.

(21) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(22) Fill cooling system. Refer to Group 7, Cooling System for proper procedure.

(23) Connect the negative cable to the battery.

VALVES AND VALVE SPRINGS—CYLINDER HEAD REMOVED**REMOVAL**

(1) Compress valve springs using Valve Spring Compressor Tool MD-998772-A.

(2) Remove valve retaining locks, valve spring retainers, valve stem seals, and valve springs.

(3) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the valve guides. Identify valves to ensure installation in original locations.

INSTALLATION

(1) Coat valve stems with lubrication oil and insert them in cylinder head.

(2) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.

(3) Install new seals on all valve guides. Install valve springs and valve retainers.

(4) Compress valve springs with Valve Spring Compressor Tool MD-998772A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Be sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 in.) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 in.).

HYDRAULIC TAPPETS**REMOVAL**

(1) Remove the air cleaner.

(2) Remove cylinder head cover.

(3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original locations.

(4) Remove intake manifold.

(5) Remove yoke retainer and aligning yokes.

(6) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.

(7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

(8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) Lubricate tappets.
- (2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).
- (3) Install aligning yokes with ARROW toward camshaft.
- (4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.
- (5) Install push rods in original positions.
- (6) Install rocker arms.
- (7) Install cylinder head cover.
- (8) Start and operate engine. Warm up to normal operating temperature.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

- (1) Remove distributor. Refer to Group 8D, Ignition Systems for the proper procedure.
- (2) Remove the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.
- (3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 21).
- (4) Hold puller screw and tighten puller nut until bushing is removed.

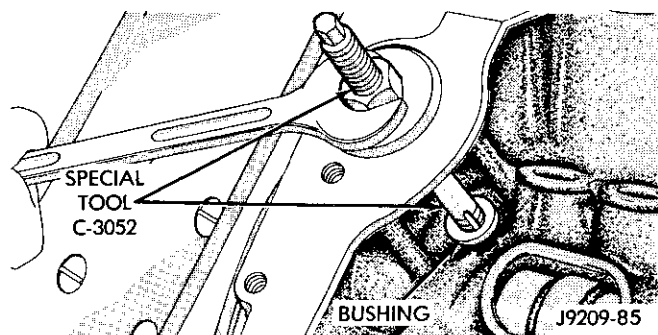


Fig. 21 Distributor Driveshaft Bushing Removal

INSTALLATION

- (1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.
- (2) Drive bushing and tool into position, using a hammer (Fig. 22).
- (3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 23). **DO NOT** ream this bushing.

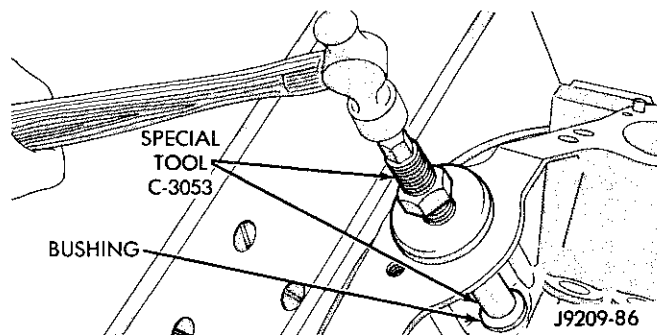


Fig. 22 Distributor Driveshaft Bushing Installation

CAUTION: This procedure **MUST** be followed when installing a new bushing or seizure to shaft may occur.

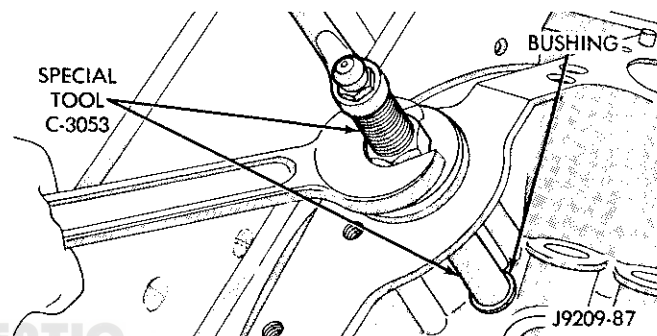


Fig. 23 Burnishing Distributor Driveshaft Bushing

- (4) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

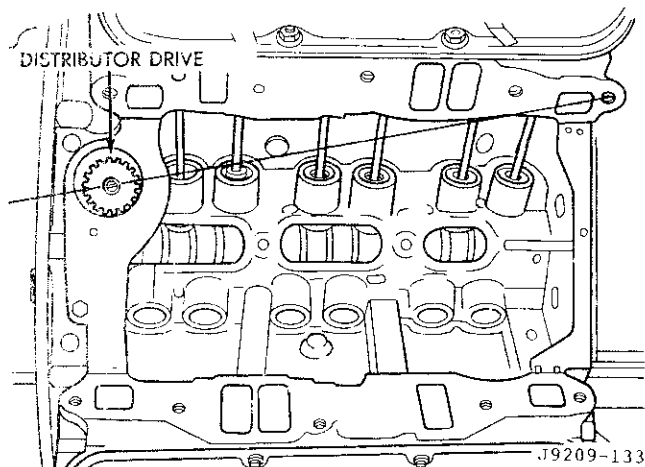
DISTRIBUTOR INSTALLATION

NOTE: Before installing the distributor, the oil pump drive shaft must be aligned to number one cylinder.

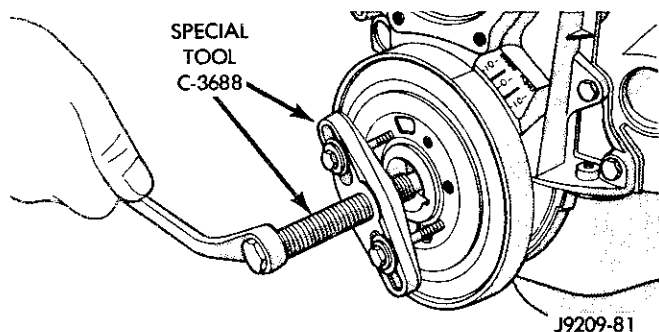
- (1) Rotate crankshaft until No. 1 cylinder is at top dead center on the firing stroke.
- (2) When in this position, the timing mark of vibration damper should be under "0" on the timing indicator.
- (3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned toward the left front intake manifold attaching bolt hole (Fig. 24).
- (4) Install distributor. Refer to Group 8D, Ignition Systems for the proper procedure.

After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition System.

Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on ignition timing. Adjusting distributor position will affect fuel synchronization only.

REMOVAL AND INSTALLATION (Continued)**Fig. 24 Position of Oil Pump Shaft Slot****VIBRATION DAMPER****REMOVAL**

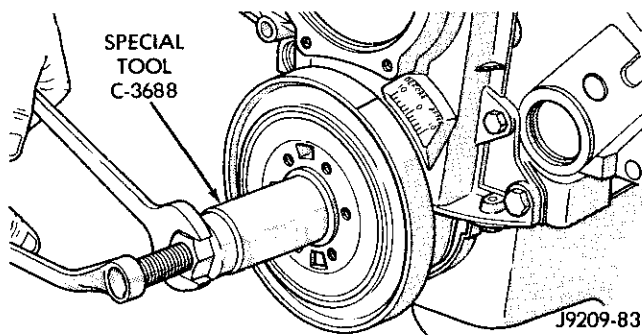
- (1) Disconnect the negative cable from the battery.
- (2) Remove fan shroud retainer bolts and set shroud back over engine.
- (3) Remove the cooling system fan.
- (4) Remove the serpentine belt. Refer to Group 7, Cooling System.
- (5) Remove the vibration damper pulley.
- (6) Remove vibration damper bolt and washer from end of crankshaft.
- (7) Install bar and screw from Puller Tool Set C-3688. Install two bolts with washers through the puller tool and into the vibration damper (Fig. 25).

**Fig. 25 Vibration Damper Assembly**

- (8) Pull vibration damper off of the crankshaft.

INSTALLATION

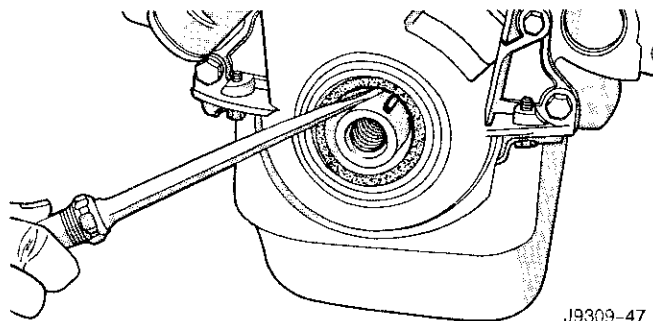
- (1) Position the vibration damper onto the crankshaft.
- (2) Place installing tool, part of Puller Tool Set C-3688, in position and press the vibration damper onto the crankshaft (Fig. 26).
- (3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

**Fig. 26 Installing Vibration Damper**

- (4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.
- (5) Install the serpentine belt. Refer to Group 7, Cooling System.
- (6) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.
- (7) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.
- (8) Connect the negative cable to the battery.

TIMING CHAIN COVER**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Drain cooling system. Refer to Group 7, Cooling System.
- (3) Remove the serpentine belt. Refer to Group 7, Cooling System.
- (4) Remove water pump. Refer to Group 7, Cooling System.
- (5) Remove power steering pump. Refer to Group 19, Steering.
- (6) Remove vibration damper.
- (7) Loosen oil pan bolts and remove the front bolt at each side.
- (8) Remove the cover bolts.
- (9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 27).

**Fig. 27 Removal of Front Crankshaft Oil Seal**

REMOVAL AND INSTALLATION (Continued)

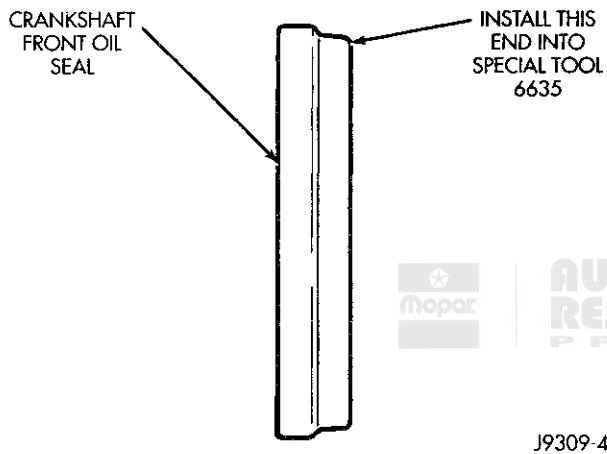
INSTALLATION

(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

(2) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

CAUTION: If chain cover is replaced for any reason, be sure the oil hole (passenger side of cover) is plugged.

(3) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 28). Seat the oil seal in the groove of the tool.



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Fig. 28 Placing Oil Seal on Installation Tool 6635

(4) Position the seal and tool onto the crankshaft (Fig. 29).

(5) Tighten the four lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.

(6) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 30).

(7) Loosen the four bolts tightened in Step 4 to allow realignment of front cover assembly.

(8) Tighten chain case cover bolts to 41 N·m (30 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(9) Remove the vibration damper bolt and seal installation tool.

(10) Inspect the seal flange on the vibration damper.

(11) Install vibration damper.

(12) Install water pump and housing assembly using new gaskets. Refer to Group 7, Cooling System. Tighten bolts to 41 N·m (30 ft. lbs.) torque.

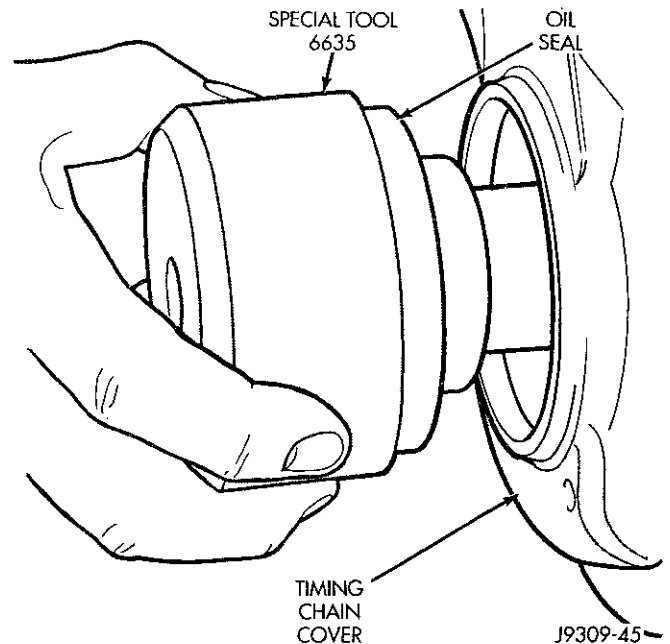


Fig. 29 Position Tool and Seal onto Crankshaft

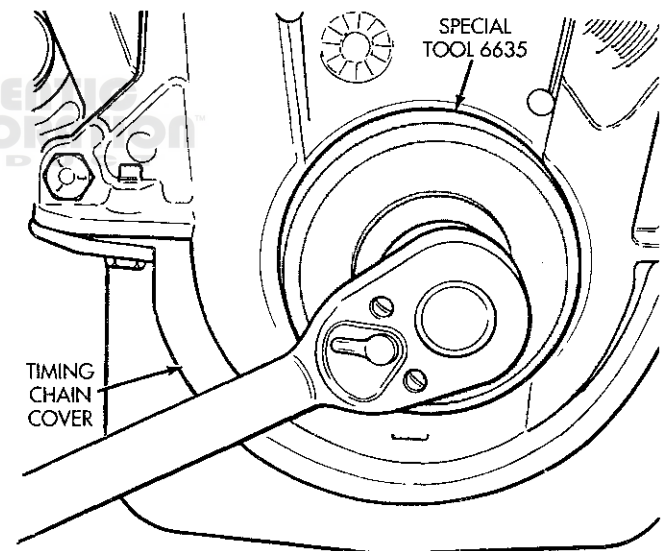


Fig. 30 Installing Oil Seal

(13) Install power steering pump. Refer to Group 19, Steering.

(14) Install the serpentine belt. Refer to Group 7, Cooling System.

(15) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(16) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(17) Fill cooling system. Refer to Group 7, Cooling System for the proper procedure.

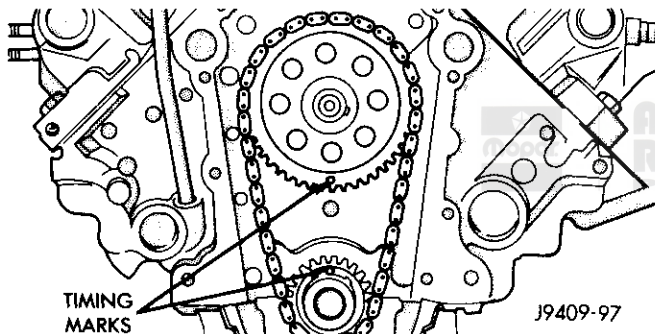
(18) Connect the negative cable to the battery.

REMOVAL AND INSTALLATION (Continued)**TIMING CHAIN****REMOVAL**

- (1) Remove timing chain cover.
- (2) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

INSTALLATION

- (1) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on an exact imaginary center line through both camshaft and crankshaft bores.
- (2) Place timing chain around both sprockets.
- (3) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.
- (4) Lift sprockets and chain (keep sprockets tight against the chain in position as described).
- (5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 31).

**Fig. 31 Alignment of Timing Marks**

- (6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.
- (7) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 in.) with a new thrust plate and up to 0.254 mm (0.010 in.) with a used thrust plate. If not within these limits install a new thrust plate.

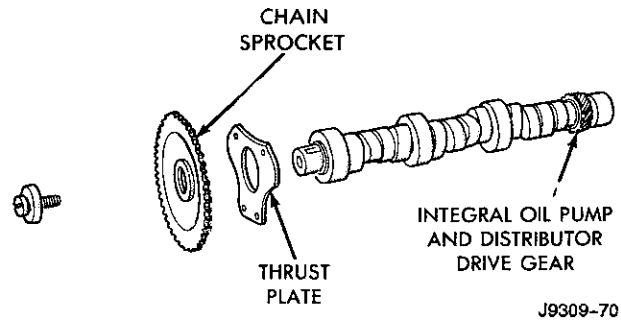
CAMSHAFT

This procedure requires that the engine is removed from the vehicle.

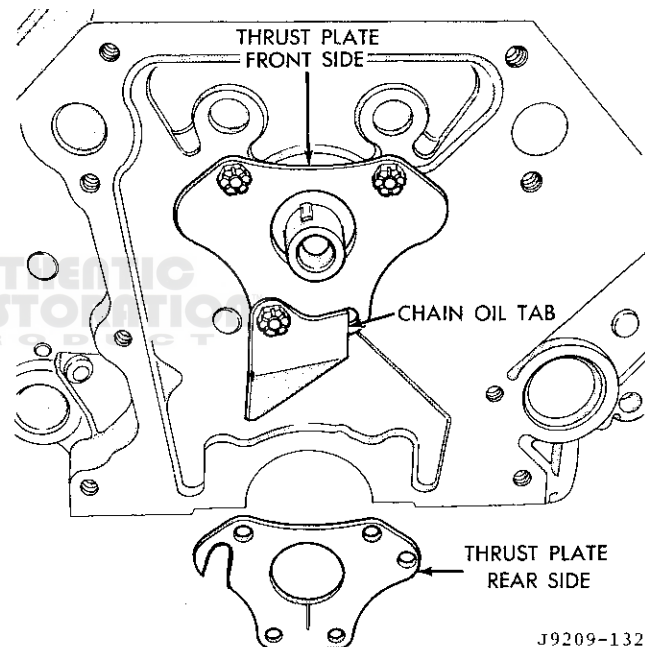
The camshaft has an integral oil pump and distributor drive gear (Fig. 32).

REMOVAL

- (1) Remove intake manifold.
- (2) Remove cylinder head covers.
- (3) Remove timing case cover and timing chain.
- (4) Remove rocker arms.
- (5) Remove push rods and tappets. Identify each part so it can be installed in the original locations.

**Fig. 32 Camshaft and Sprocket Assembly**

- (6) Remove distributor and lift out the oil pump and distributor drive shaft.
- (7) Remove camshaft thrust plate and note location of oil tab (Fig. 33).

**Fig. 33 Timing Chain Oil Tab Installation**

- (8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

- (1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

NOTE: Whenever an engine has been rebuilt, a new camshaft and/or new tappets installed, add one pint of Mopar Crankcase Conditioner, or equivalent. The oil mixture should be left in engine for a minimum of 805 km (500 miles). Drain at the next normal oil change.

REMOVAL AND INSTALLATION (Continued)

(2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 34).

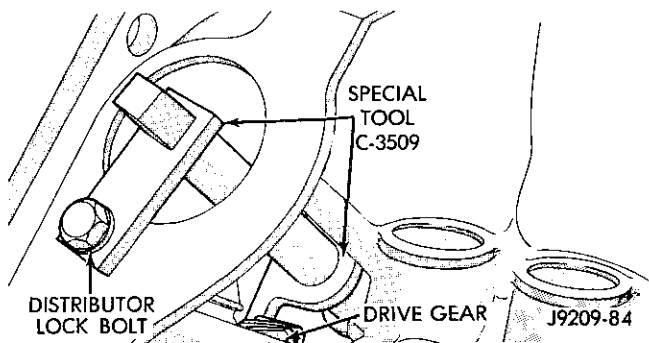


Fig. 34 Camshaft Holding Tool C-3509 (Installed Position)

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the Welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install camshaft thrust plate and chain oil tab. **Be sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

(5) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on an exact imaginary center line through both camshaft and crankshaft bores.

(6) Place timing chain around both sprockets.

(7) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(8) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 35).

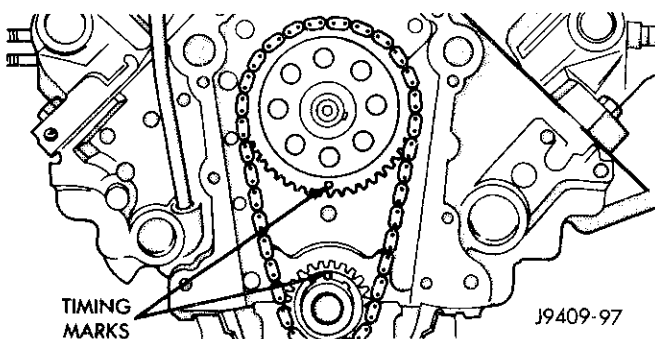


Fig. 35 Alignment of Timing Marks

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits, install a new thrust plate.

(12) Each tappet reused must be installed in the same position at which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

CAMSHAFT BEARINGS

REMOVAL

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 36).

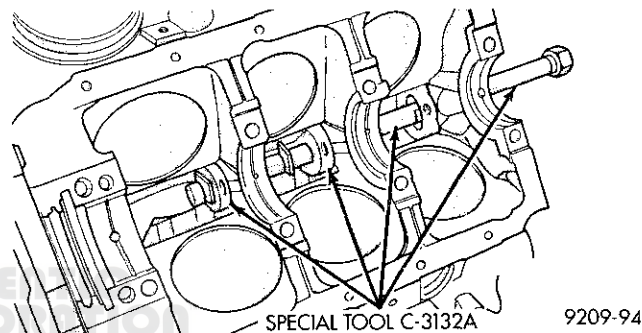


Fig. 36 Camshaft Bearings Removal and Installation with Tool C-3132-A

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and, by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

REMOVAL AND INSTALLATION (Continued)

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 37).

(5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

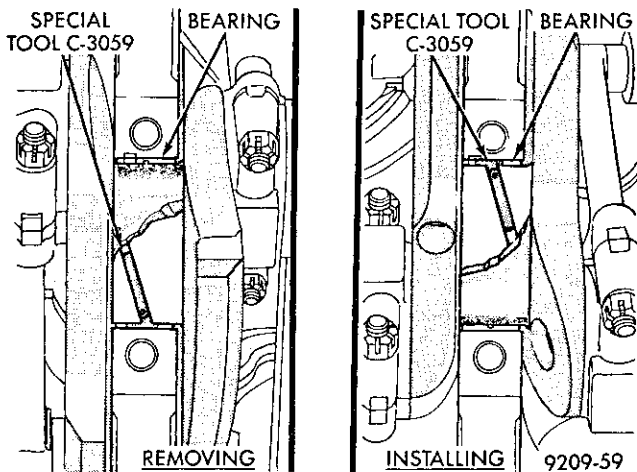


Fig. 37 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation. **DO NOT** use a new bearing half with an old bearing half.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 37).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

OIL PAN**REMOVAL**

(1) Disconnect the negative cable from the battery.

(2) Remove engine oil dipstick.

(3) Raise vehicle.

(4) Drain engine oil.

(5) Remove exhaust pipe.

(6) Remove left engine to transmission strut.

(7) Loosen the right side engine support bracket cushion through-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.

(8) Remove the one-piece gasket.

INSTALLATION

(1) Clean the block and pan gasket surfaces.

(2) Fabricate four alignment dowels from 5/16 X 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 38).

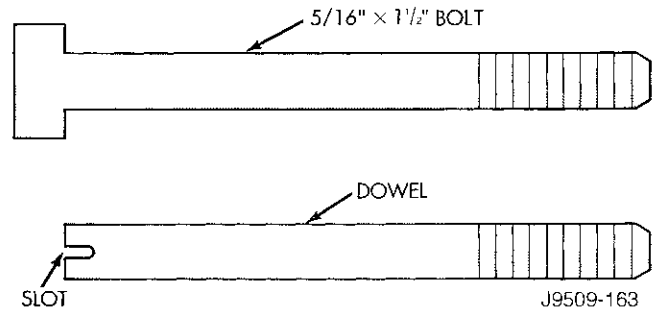


Fig. 38 Fabrication of Alignment Dowels

(3) Install the dowels in the cylinder block (Fig. 39).

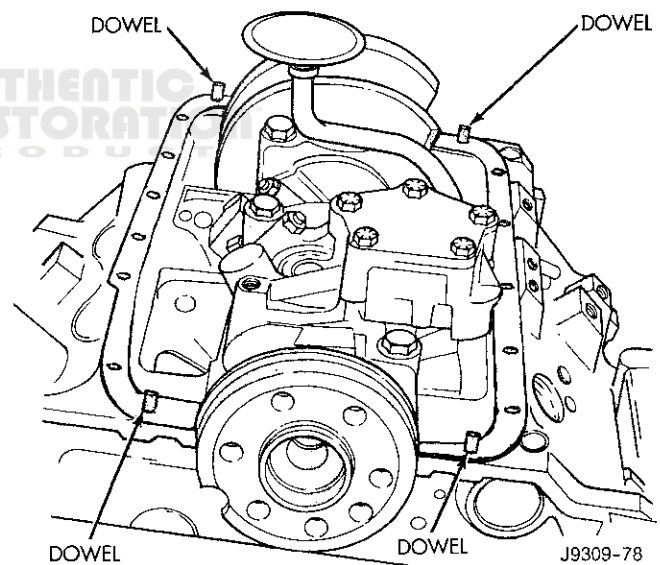


Fig. 39 Position of Dowels in Cylinder Block

(4) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, in the corner of the cap and the cylinder block.

(5) Slide the one-piece gasket over the dowels and onto the block.

(6) Position the oil pan over the dowels and onto the gasket.

(7) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.

(8) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(9) Lower the engine into the support cushion brackets and tighten the through-bolt nut to the proper torque.

(10) Install the drain plug. Tighten drain plug to 34 N·m (27 ft. lbs.) torque.

(11) Install the engine to transmission strut.

(12) Install exhaust pipe.

(13) Lower vehicle.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

(16) Fill crankcase with oil to proper level.

OIL PUMP

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from rear main bearing cap.

INSTALLATION

(1) Install oil pump. During installation, slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.

(2) Hold the oil pump base flush against mating surface on No. 4 main bearing cap. Finger-tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

(1) Remove the engine from the vehicle.

(2) Remove the cylinder head.

(3) Remove the oil pan.

(4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.

(5) Be sure each connecting rod and connecting rod cap is identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing the assemblies from the engine, rotate crankshaft so that the connecting rod is centered in cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

(7) After removal, install bearing cap on the mating rod.

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.

(2) Before installing the ring compressor, be sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 40).

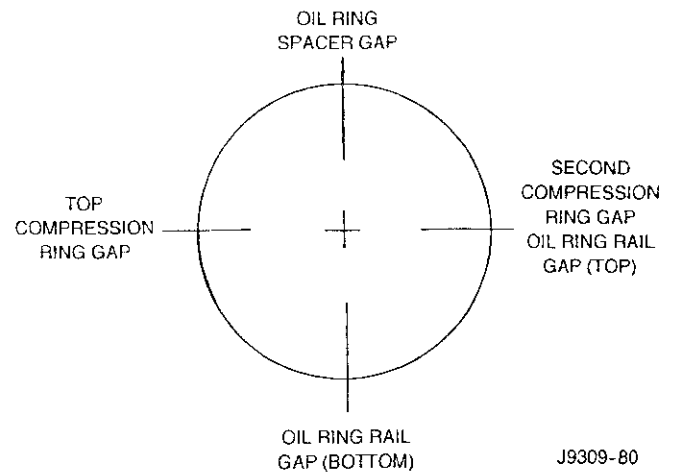


Fig. 40 Proper Ring Installation

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts. The long protector should be installed on the numbered side of the connecting rod.

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on crankshaft journal.

(7) The notch, or groove, on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap, and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.

(4) Lift the crankshaft out of the block.

(5) Remove and discard the crankshaft rear oil seals.

REMOVAL AND INSTALLATION (Continued)

(6) Remove and discard the front crankshaft oil seal.

INSTALLATION

- (1) Lightly oil the new upper seal lips with engine oil.
- (2) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (3) Position the crankshaft into the cylinder block.
- (4) Lightly oil the new lower seal lips with engine oil.
- (5) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(6) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 41). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

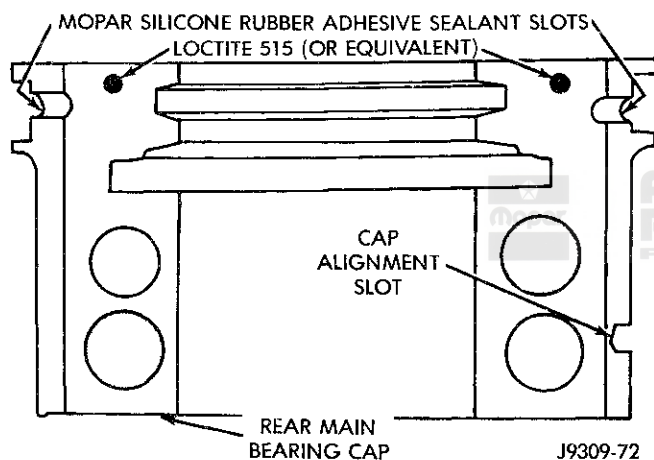


Fig. 41 Sealant Application to Bearing Cap

(7) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

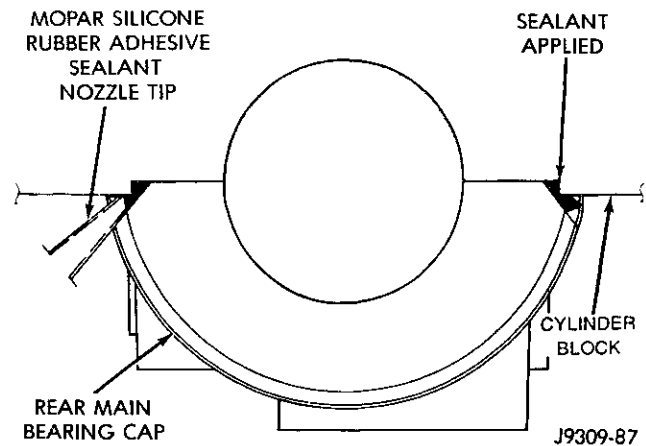
(8) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(9) Install oil pump.

(10) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 42). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(11) Install new front crankshaft oil seal.

(12) Immediately install the oil pan.



**Fig. 42 Apply Sealant to Bearing Cap-to-Block Joint
FRONT CRANKSHAFT OIL SEAL**

REMOVAL

The oil seal can be replaced without removing the timing chain cover, provided that the cover is not misaligned.

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment Tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

(4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.

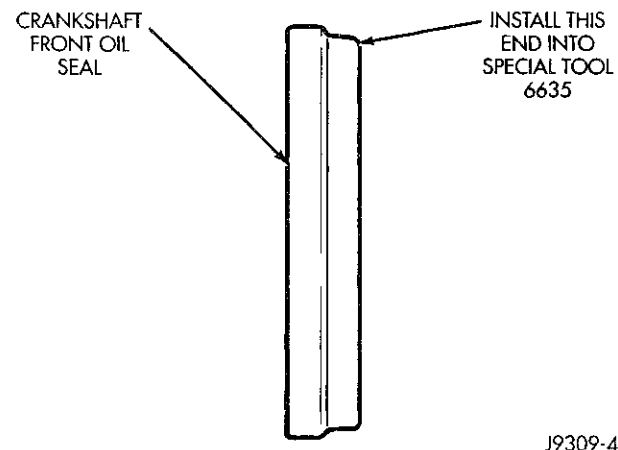


Fig. 43 Placing Oil Seal on Installation Tool 6635

INSTALLATION

(1) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 43). Seat the oil seal in the groove of the tool.

(2) Position the seal and tool onto the crankshaft (Fig. 44).

REMOVAL AND INSTALLATION (Continued)

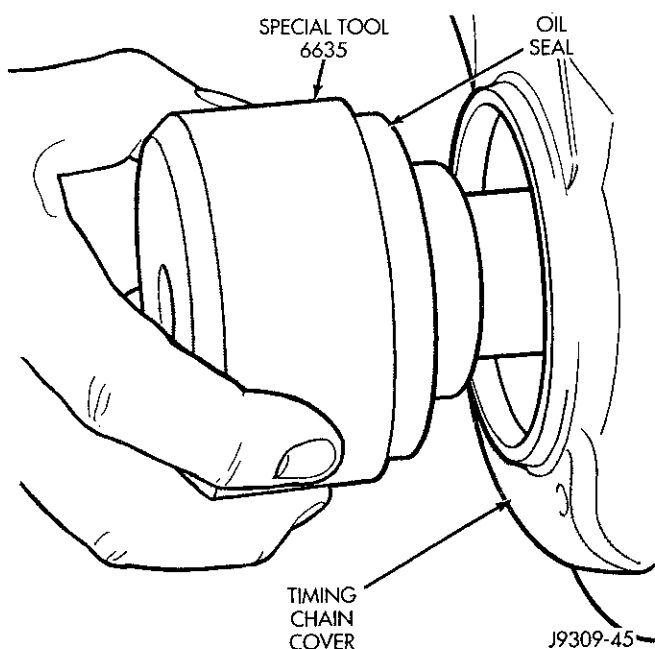


Fig. 44 Position Tool and Seal onto Crankshaft

(3) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 45).

(4) Remove the vibration damper bolt and seal installation tool.

(5) Inspect the seal flange on the vibration damper.

(6) Install the vibration damper.

(7) Connect the negative cable to the battery.

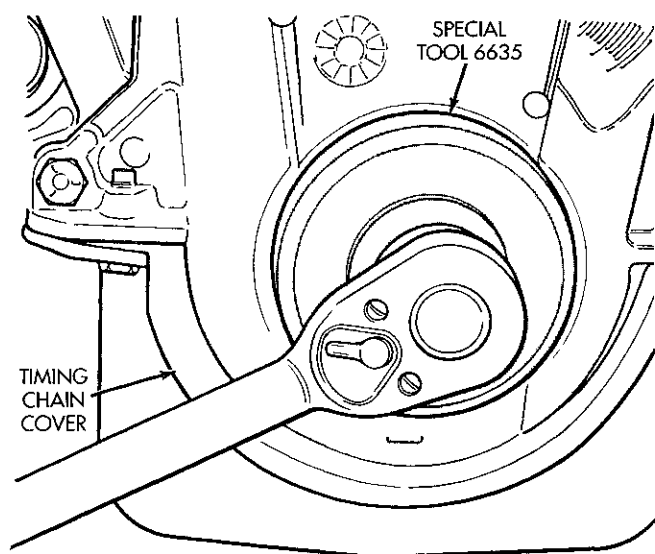


Fig. 45 Installing Oil Seal

CRANKSHAFT REAR OIL SEALS

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

(1) Remove the crankshaft. Discard the old upper seal.

INSTALLATION

(1) Clean the cylinder block rear cap mating surface. Be sure the seal groove is free of debris. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing toward the rear of the engine.

(4) Position the crankshaft into the cylinder block.

(5) Lightly oil the new lower seal lips with engine oil.

(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(7) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

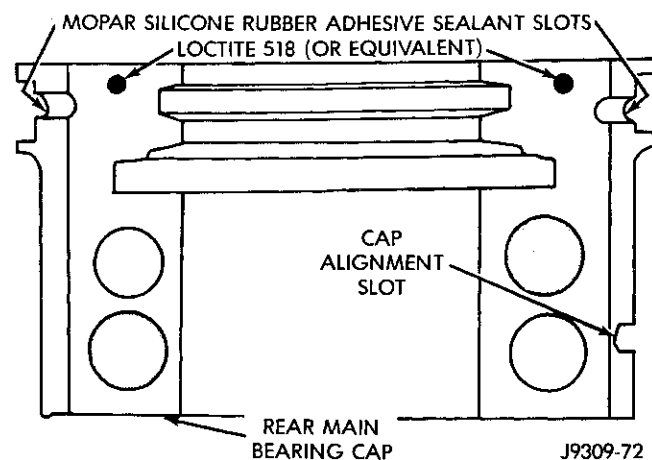


Fig. 46 Sealant Application to Bearing Cap

(8) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

REMOVAL AND INSTALLATION (Continued)

(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump.

(11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing (Fig. 47). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Install new front crankshaft oil seal.

(13) Immediately install the oil pan.

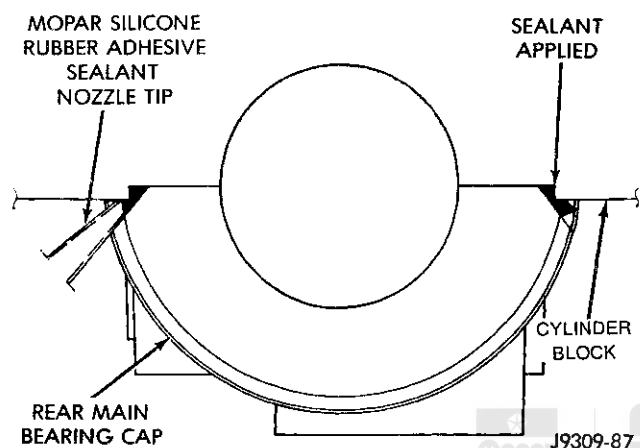


Fig. 47 Apply Sealant to Bearing Cap-to-Block Joint

UPPER SEAL—CRANKSHAFT INSTALLED**REMOVAL**

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
- (4) Carefully remove and discard the old upper oil seal.

INSTALLATION

- (1) Clean the cylinder block mating surfaces before oil seal installation. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.
- (2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the two main bearing caps forward of the rear bearing cap.
- (3) Rotate the new upper seal into the cylinder block, being careful not to shave or cut the outer surface of the seal. To ensure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing toward the rear of the engine.

(4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing toward the rear of the engine.

(5) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

(6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 47). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

LOWER SEAL**REMOVAL**

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

- (1) Clean the rear main cap mating surfaces including the oil pan gasket groove.
- (2) Carefully install a new upper seal. Refer to Upper Seal Replacement — Crankshaft Installed procedure above.
- (3) Lightly oil the new lower seal lips with engine oil.
- (4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.
- (5) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.
- (6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

REMOVAL AND INSTALLATION (Continued)

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten the cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing. Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 48). This will reduce internal leakage and help maintain higher oil pressure at idle.

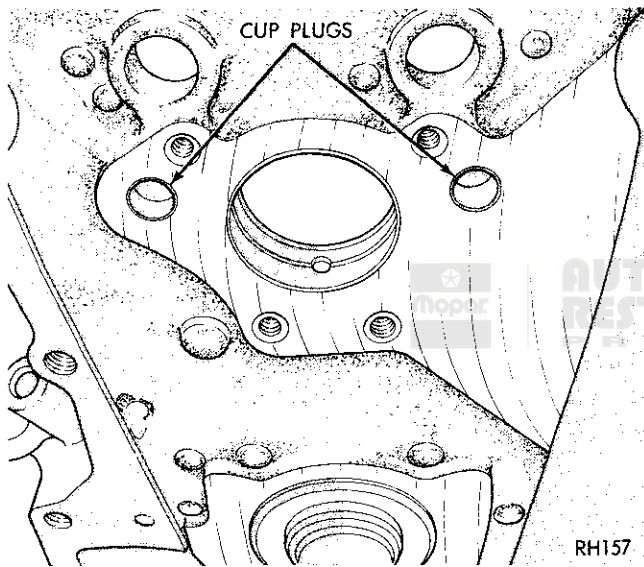


Fig. 48 Location of Cup Plugs in Oil Galleries

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 49).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 49).

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Be certain the new plug is cleaned of all oil or grease.

(1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting, as restricted coolant flow can result and cause serious engine problems.

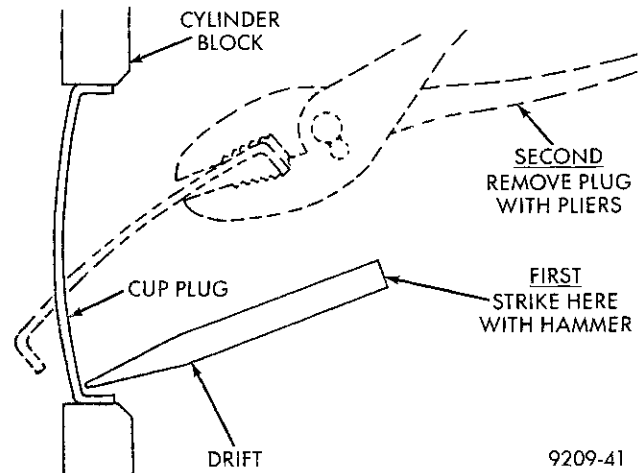


Fig. 49 Core Hole Plug Removal

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 in.) inside the lead-in chamfer.

(3) It is not necessary to wait for curing of the sealant. The cooling system can be filled and the vehicle placed in service immediately.

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

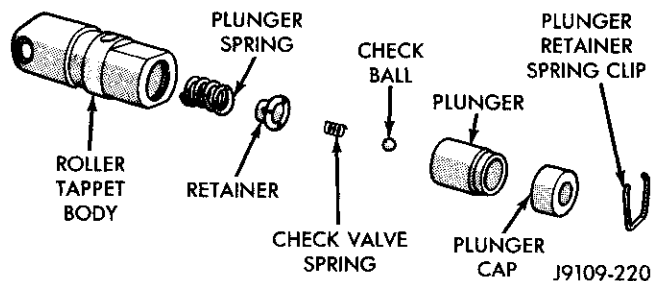
CAUTION: The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. DO NOT disassemble a tappet on a dirty work bench.

DISASSEMBLE

- (1) Pry out plunger retainer spring clip (Fig. 50).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer, and plunger spring (Fig. 50). Check valve could be flat or ball.

ASSEMBLE

- (1) Clean all tappet parts in a solvent that will remove all varnish and carbon.
- (2) Replace tappets that are unfit for further service with new assemblies.
- (3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.
- (4) Assemble tappets (Fig. 50).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 50 Hydraulic Tappet Assembly****VALVES, GUIDES AND SPRINGS****VALVE CLEANING**

Clean valves thoroughly. Discard burned, warped, or cracked valves.

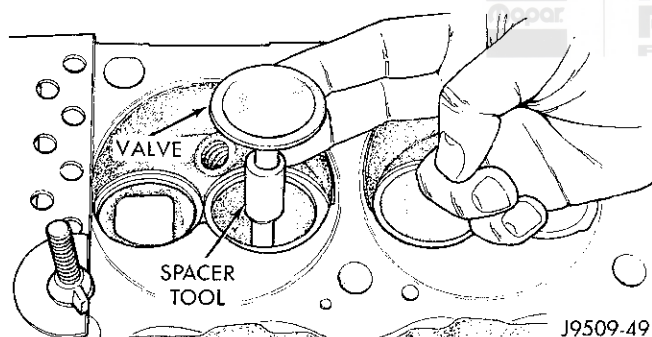
Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

VALVE GUIDES

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 in.), replace the valve.

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 51). The special sleeve places the valve at the correct height for checking with a dial indicator.

**Fig. 51 Positioning Valve with Tool C-3973**

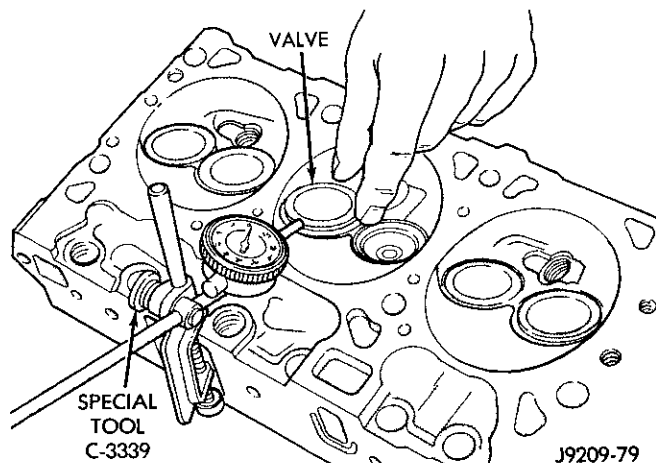
(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 52).

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 in.). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

VALVE GUIDES

Service valves with oversize stems are available (Fig. 53).

(1) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 in.). Use a two step procedure so the valve guides are reamed true in relation to the valve seat:**

**Fig. 52 Measuring Valve Guide Wear**

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

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Fig. 53 Reamer Sizes

- Step 1—Ream to 0.0763 mm (0.003 inch).
- Step 2—Ream to 0.381 mm (0.015 inch).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 54).

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 55). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

VALVE SEATS

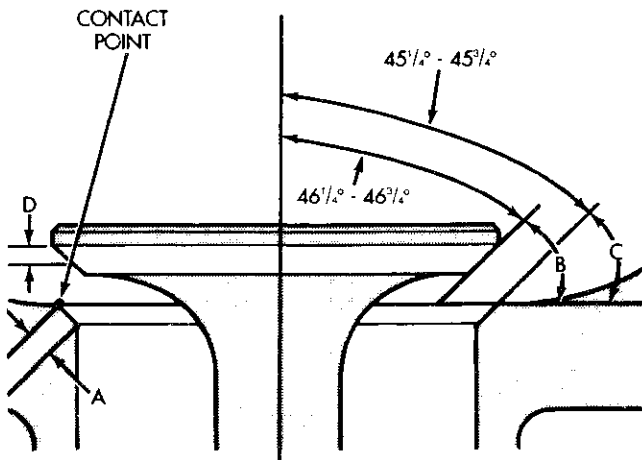
CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 56).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 in.) total indicator reading.

(3) Inspect the valve seat with Prussian blue, to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light

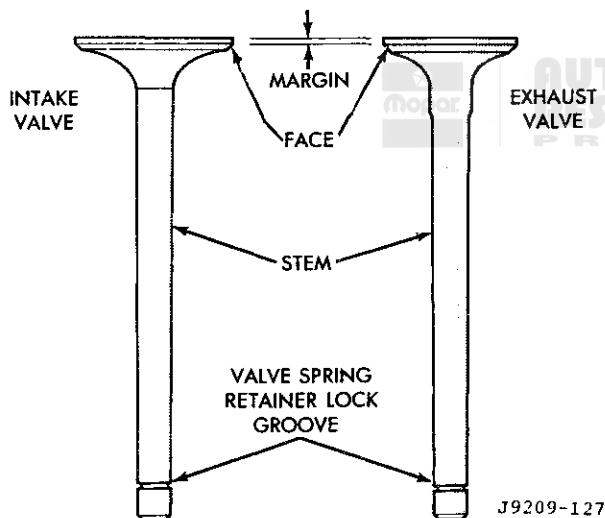
DISASSEMBLY AND ASSEMBLY (Continued)



- A - SEAT WIDTH - INTAKE 1.016 - 1.524 mm (0.040 - 0.060 in.)
EXHAUST 1.524 - 2.032 mm (0.060 - 0.080 in.)
B - FACE ANGLE (INTAKE & EXHAUST) 43 1/2° - 43 3/4°
C - SEAT ANGLE (INTAKE & EXHAUST) 44 1/2° - 44 3/4°
D - CONTACT SURFACE

J9309-95

Fig. 54 Valve Face and Seat Angles



J9209-127

Fig. 55 Intake and Exhaust Valves

pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 in.). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 in.).

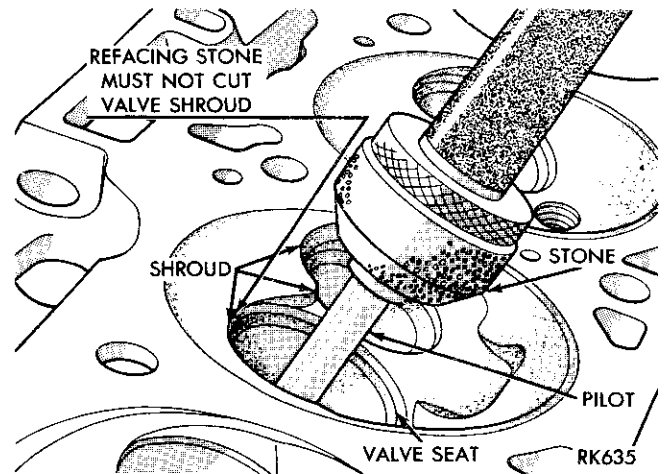
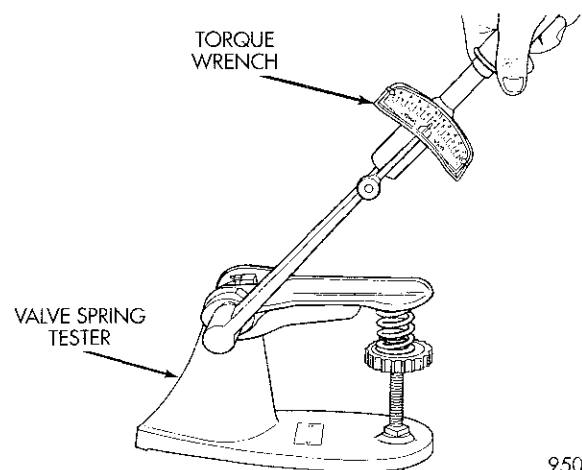


Fig. 56 Refacing Valve Seats

VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 in.. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 in. mark on the threaded stud. Be sure the zero mark is to the front (Fig. 57). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.



9509-79

Fig. 57 Testing Valve Spring for Compressed Length

DISASSEMBLY AND ASSEMBLY (Continued)**OIL PUMP****DISASSEMBLE**

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 in.) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 58).

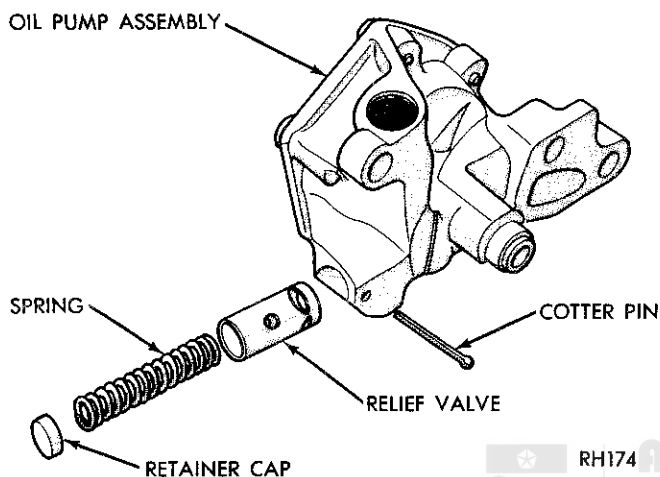


Fig. 58 Oil Pressure Relief Valve

(2) Remove oil pump cover (Fig. 59).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 59).

(4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

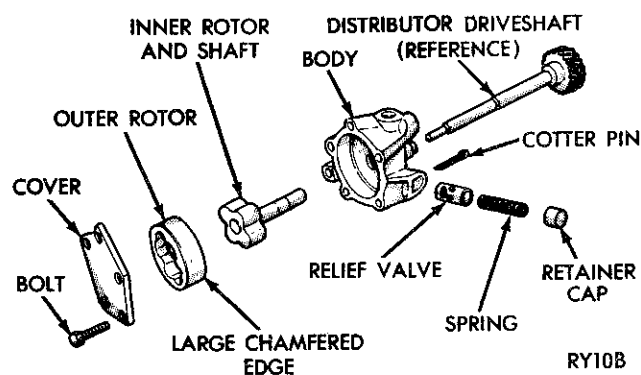


Fig. 59 Oil Pump

ASSEMBLE

(1) Install pump rotors and shaft, using new parts as required.

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

(5) Prime oil pump before installation by filling rotor cavity with engine oil.

CYLINDER BLOCK**DISASSEMBLE**

Engine assembly removed from vehicle:

(1) Remove the cylinder head.

(2) Remove the oil pan.

(3) Remove the piston and connecting rod assemblies.

ASSEMBLE

(1) Install the piston and connecting rod assembly.

(2) Install the oil pan.

(3) Install the cylinder head.

(4) Install the engine into the vehicle.

CLEANING AND INSPECTION**CYLINDER HEAD COVER****CLEANING**

Clean cylinder head cover gasket surface.

Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

Check the gasket for use in head cover installation. If damaged, use a new gasket.

CYLINDER HEAD**CLEANING**

Clean all surfaces of cylinder block and cylinder heads.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 in./in.) times the span length in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE:—A 305 mm (12 in.) span is 0.102 mm (0.004 in.) out-of-flat. The allowable out-of-flat is 305×0.00075 (12 \times 0.00075) equals 0.23 mm (0.009 in.). This amount of out-of-flat is acceptable.

The cylinder head surface finish should be 1.78-3.00 microns (70-125 microinches).

Inspect push rods. Replace worn or bent rods.

CLEANING AND INSPECTION (Continued)

PISTON AND CONNECTING ROD INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 60).

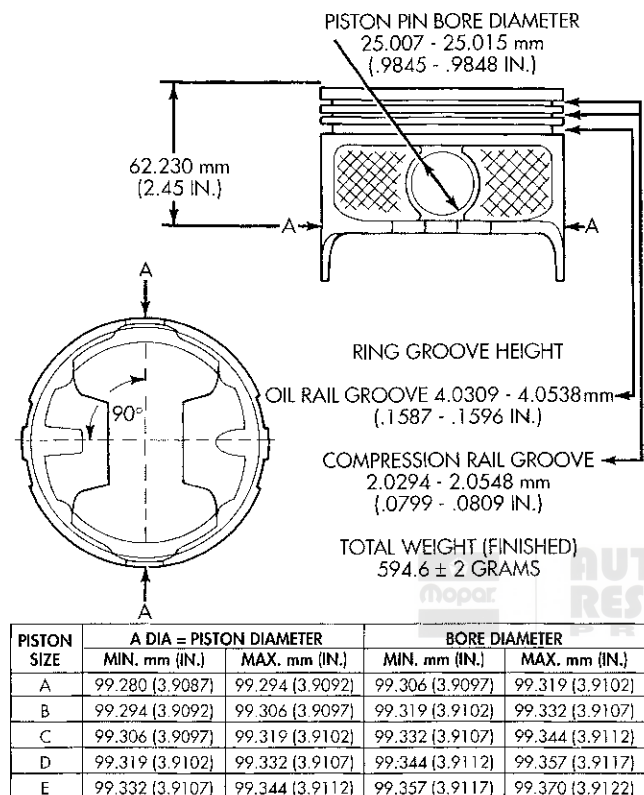


Fig. 60 Piston Measurements

CRANKSHAFT INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper or scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 in.).

Journal grinding should not exceed 0.305 mm (0.012 in.) under the standard journal diameter. DO NOT grind thrust faces of No. 2 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction that the engine rotates.

OIL PUMP

OIL PUMP PRESSURE

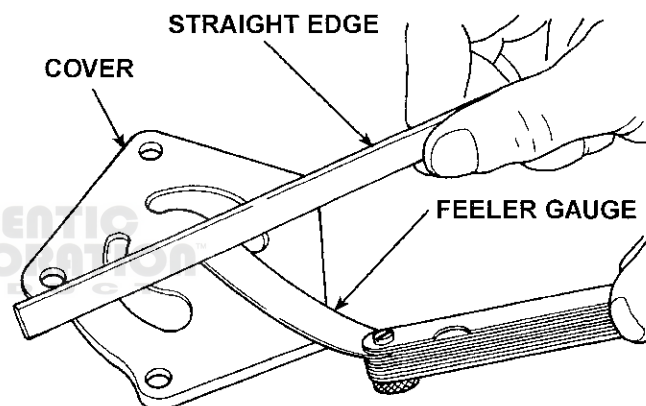
The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine at 3,000 RPM.

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

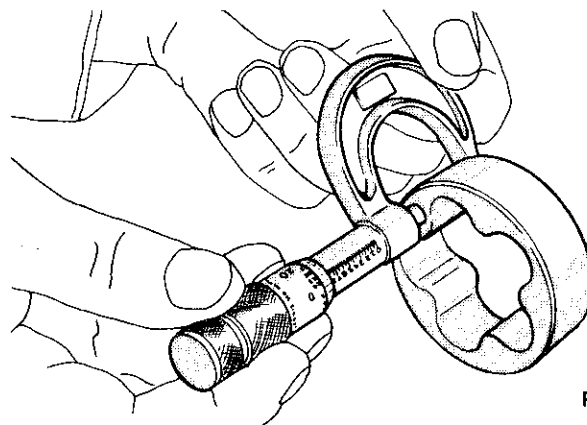
Lay a straightedge across the pump cover surface (Fig. 61). If a 0.038 mm (0.0015 in.) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.



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Fig. 61 Checking Oil Pump Cover Flatness

Measure thickness and diameter of outer rotor. If outer rotor thickness measures 20.9 mm (0.825 in.) or less, or if the diameter is 62.7 mm (2.469 in.) or less, replace outer rotor (Fig. 62).



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Fig. 62 Measuring Outer Rotor Thickness

CLEANING AND INSPECTION (Continued)

If inner rotor measures 20.9 mm (0.825 in.) or less, replace inner rotor and shaft assembly (Fig. 63).

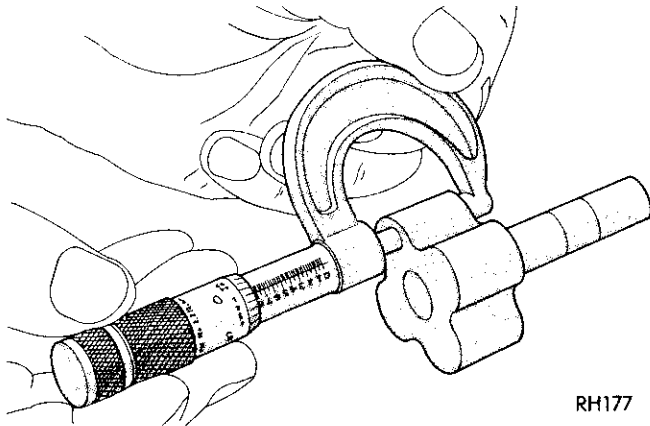


Fig. 63 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 64). If clearance is 0.356 mm (0.014 in.) or more, replace oil pump assembly.

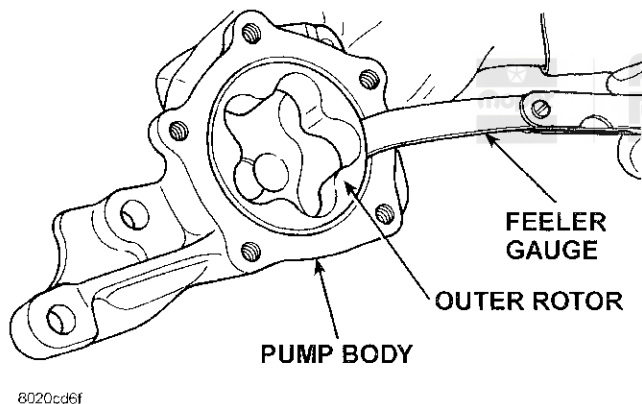


Fig. 64 Measuring Outer Rotor Clearance in Housing

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 in.) or more, replace shaft and both rotors (Fig. 65).

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 66).

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 in.). The spring should test between 19.5 and 20.5 pounds when compressed to

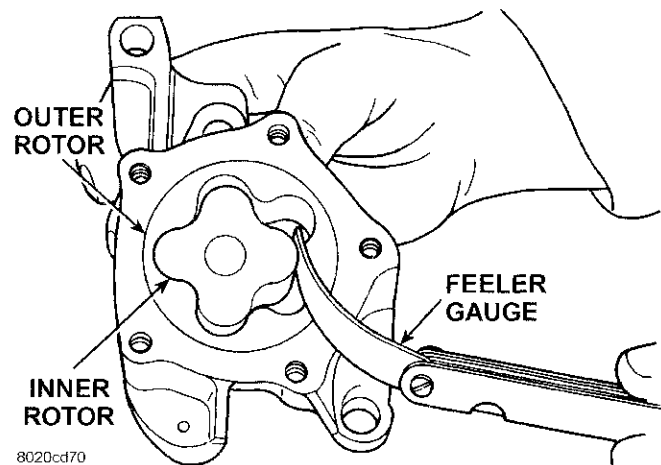


Fig. 65 Measuring Clearance Between Rotors

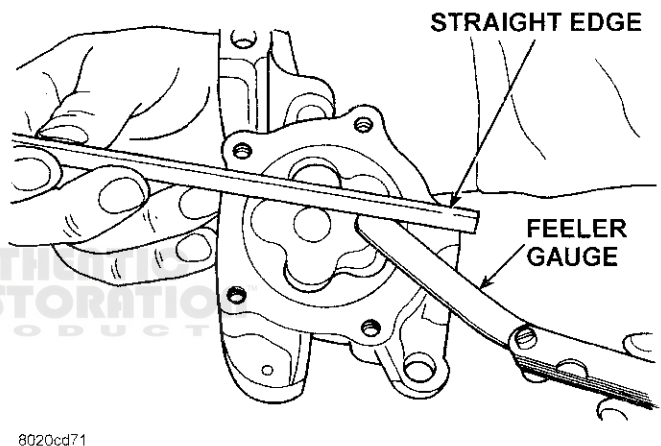


Fig. 66 Measuring Clearance Over Rotors

34 mm (1-11/32 in.). Replace spring that fails to meet these specifications (Fig. 67).

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

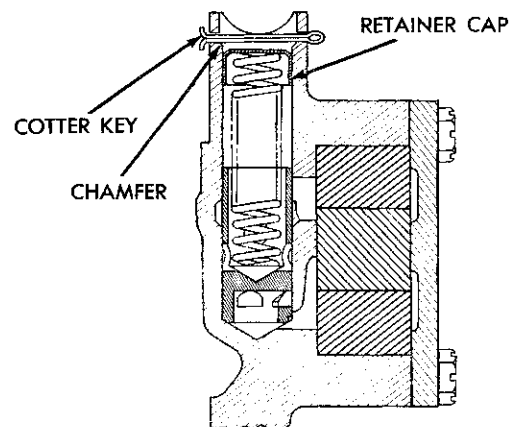


Fig. 67 Proper Installation of Retainer Cap

CLEANING AND INSPECTION (Continued)

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

CYLINDER BLOCK

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 in.) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 in.).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings, so that specified clearances can be maintained.

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and oil-from-filter passages (Fig. 68). Improper installation or plug missing could cause erratic, low, or no oil pressure.

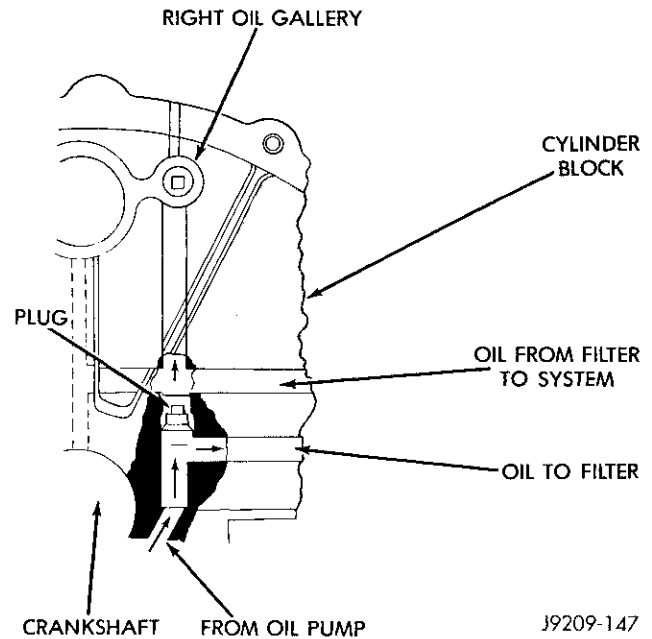
The oil plug must come out the bottom. Use flat dowel, down the oil pressure sending unit hole from the top, to remove oil plug.

(1) Remove oil pressure sending unit from back of block.

(2) Insert a 3.175 mm (1/8 in.) finish wire, or equivalent, into passage.

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 68).

If plug is too high, use a suitable flat dowel to position properly.



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Fig. 68 Oil Line Plug

(4) If plug is too low, remove oil pan and No. 4 main bearing cap. Use suitable flat dowel to position properly. Coat outside diameter of plug with Mopar Stud and Bearing Mount Adhesive, or equivalent. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 in.) from bottom of the block.

SPECIFICATIONS**ENGINE SPECIFICATIONS****Camshaft**

Bearing Diameter	
No. 1	50.800-50.825 mm (2.000-2.001 in)
No. 2	50.394-50.419 mm (1.984-1.985 in)
No. 3	49.606-49.632 mm (1.953-1.954 in)
No. 4	39.688-39.713 mm (1.5625-1.5635 in)
Diametrical Clearance	0.0254-0.0762 mm (0.001-0.003 in)
Max. Allowable	0.127 mm (0.005 in)
End Play	0.051-0.254 mm (0.002-0.010 in)
Bearing Journal Diameter	
No. 1	50.749-50.775 mm (1.998-1.999 in)
No. 2	50.343-50.368 mm (1.982-1.983 in)
No. 3	49.555-49.581 mm (1.951-1.952 in)
No. 4	39.637-39.662 mm (1.5605-1.5615 in)

Connecting Rods

Bearing Clearance	0.013-0.056 mm (0.0005-0.0022 in)
Max. Allowable	0.08 mm (0.003 in)
Piston Pin Bore Diameter	24.940-24.978 mm (0.9819-0.9834 in)
Side Clearance (Two Rods)	0.152-0.356 mm (0.006-0.014 in)
Total Weight (Less Bearing)	726 grams (25.61 oz)

Crankshaft

Connect Rod Journal	
Diameter	53.950-53.975 mm (2.124-2.125 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)
Diametrical Clearance	
No. 1	0.013-0.038 mm (0.0005-0.0015 in)
Nos. 2, 3, and 4	0.013-0.051 mm (0.0005-0.0020 in)
Max. Allowable (Nos. 2, 3, & 4)	0.064 mm (0.0025 in)

End Play	0.051-0.178 mm (0.002-0.007 in)
Max. Allowable	0.254 mm (0.010 in)
Main Bearing Journals	
Diameter	63.487-63.513 mm (2.4995-2.5005 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)

Cylinder Block

Cylinder Bore	
Diameter	99.314-99.365 mm (3.910-3.912 in)
Out-of-Round (Max.)	0.127 mm (0.005 in)
Taper (Max.)	0.254 mm (0.010 in)
Oversize (Max.)	1.016 mm (0.040 in)
Distributor Lower Drive Shaft	
Bushing (Press Fit in Block)	0.0127-0.3556 mm (0.0005-0.0140 in)
Shaft-to-Bushing Clearance	0.0178-0.0686 mm (0.0007-0.0027 in)
Tappet Bore Diameter	22.99-23.01 mm (0.9051-0.9059 in)

Cylinder Head

Compression Pressure	689 kPa (100 psi)
Gasket Thickness (Compressed)	1.2065 mm (0.0475 in)
Valve Seat	
Angle	44.25° - 44.75°
Runout (Max.)	0.0762 mm (0.003 in)
Width (Finish) - Intake	1.016-1.542 mm (0.040-0.060 in)
Width (Finish) - Exhaust	1.524-2.032 mm (0.060-0.080 in)

Hydraulic Tappets

Body Diameter	22.949-22.962 mm (0.9035-0.9040 in)
Clearance in Block	0.0279-0.0610 mm (0.0011-0.0024 in)
Dry Lash	1.524-5.334 mm (0.060-0.210 in)
Push Rod Length	175.64-176.15 mm (6.915-6.935 in)

SPECIFICATIONS (Continued)**Oil Pump**

Clearance Over Rotors (Max.)	0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.)	0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in)
Outer Rotor	
Clearance (Max.)	0.3556 mm (0.014 in)
Diameter (Min.)	62.7126 mm (2.469 in)
Thickness (Min.)	20.955 mm (0.825 in)
Tip Clearance Between Rotors (Max.)	0.2032 mm (0.008 in)

Oil Pressure

At Curb Idle Speed (Minimum)*	41.4 kPa (6 psi)
At 3000 rpm	207-552 kPa (30-80 psi)
Oil Pressure Switch	
Actuating Pressure (Min.)	34.5-48.3 kPa (5-7 psi)

*CAUTION: If pressure is ZERO at curb idle,
DO NOT run engine at 3,000 rpm.

Oil Filter

Bypass Valve Setting	62-103 kPa (9-15 psi)
----------------------	--------------------------

Pistons

Clearance at Top of Skirt	0.0127-0.0381 mm (0.0005-0.0015 in)
Land Clearance (Diametrical)	0.635-1.016 mm (0.025-0.040 in)
Piston Length	86.360 mm (3.40 in)
Piston Ring Groove Depth	
Nos. 1 and 2	4.572-4.826 mm (0.180-0.190 in)
No. 3	3.810-4.064 mm (0.150-0.160 in)
Weight	592.6-596.6 grams (20.90-21.04 oz)

Piston Pins

Clearance	
In Piston	0.00635-0.01905 mm (0.00025-0.00075 in)
In Rod (Interference)	0.0178-0.0356 mm (0.0007-0.0014 in)
Diameter	24.996-25.001 mm (0.9841-0.9843 in)
End Play	NONE
Length	75.946-76.454 mm (2.990-3.010 in)

Piston Rings

Ring Gap	
Compression Rings	0.254-0.508 mm (0.010-0.020 in)
Oil Control (Steel Rails)	0.254-1.270 mm (0.010-0.050 in)
Ring Side Clearance	
Compression Rings	0.038-0.076 mm (0.0015-0.0030 in)
Oil Ring (Steel Rails)	0.06-0.21 mm (0.002-0.008 in)
Ring Width	
Compression Rings	1.971-1.989 mm (0.0776-0.0783 in)
Oil Ring (Steel Rails)	3.848-3.975 mm (0.1515-0.1565 in)

Valves

Face Angle	43.25°-43.75°
Head Diameter	
Intake	48.666 mm (1.916 in)
Exhaust	41.250 mm (1.624 in)
Length (Overall)	
Intake	124.28-125.92 mm (4.893-4.918 in)
Exhaust	124.64-125.27 mm (4.907-4.932 in)
Lift (Zero Lash)	10.973 mm (0.432 in)
Stem Diameter	7.899-7.925 mm (0.311-0.312 in)
Stem-to-Guide Clearance	0.0254-0.0762 mm (0.001-0.003 in)
Max. Allowable (Rocking Method)	0.4318 mm (0.017 in)
Guide Bore Diameter (Std)	7.950-7.976 mm (0.313-0.314 in)

SPECIFICATIONS (Continued)**Valve Springs**

Free Length (Approx.)	49.962 mm (1.967 in)
Spring Tension (Valve Closed)	@ 41.66 mm = 378 N (@ 1.64 in = 85 lbs)
Spring Tension (Valve Open)	@ 30.89 mm = 890 N (@ 1.212 in = 200 lbs)
Number of Coils	6.8
Installed Height (Spring Seat to Retainer)	41.66 mm (1.64 in)
Wire Diameter	4.50 mm (0.177 in)

Valve Timing

Exhaust Valve	
Closes (ATC)	16°
Opens (BBC)	52°
Duration	248°
Intake Valve	
Closes (ABC)	50°
Opens (BTC)	10°
Duration	240°
Valve Overlap	26°

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ENGINE SPECIFICATIONS—CONT.

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Steel stamped (near notch) on no. 6 crankshaft counterweight.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	◆	Diamond-shaped stamp Top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

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OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Adjusting Strap Bolt.....	23 N•m (200 in. lbs.)
Camshaft Bolt.....	68 N•m (50 ft. lbs.)
Camshaft Thrust Plate Bolts.....	24 N•m (210 in. lbs.)
Chain Case Cover Bolts.....	41 N•m (30 ft. lbs.)
Connecting Rod Cap Bolts.....	61 N•m (45 ft. lbs.)
Crankshaft Main Bearing Cap Bolts.....	115 N•m (85 ft. lbs.)
Cylinder Head Bolts	
1st Step.....	68 N•m (50 ft. lbs.)
2nd Step.....	143 N•m (105 ft. lbs.)
Cylinder Head Cover Bolts.....	11 N•m (95 in. lbs.)
Exhaust Manifold-to-Cylinder	
Head Bolts/Nuts.....	34 N•m (25 ft. lbs.)
Flywheel Bolts.....	75 N•m (55 ft. lbs.)
Front Insulated Attaching Bolts.....	41 N•m (30 ft. lbs.)
Front Insulator Stud Nuts.....	102 N•m (75 ft. lbs.)
Front Mount Adaptor-to-Block Bolts.....	41 N•m (30 ft. lbs.)
Generator Mounting Bolt.....	41 N•m (30 ft. lbs.)
Intake Manifold Bolts.....	Refer to Procedure in Service Manual.
Oil Pan Bolts.....	24 N•m (21.5 in. lbs.)
Oil Pan Drain Plug.....	34 N•m (25 ft. lbs.)
Oil Pump Attaching Bolts.....	41 N•m (30 ft. lbs.)
Oil Pump Cover Bolts.....	11 N•m (95 in. lbs.)

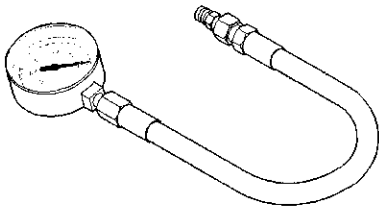
DESCRIPTION	TORQUE
Rear Insulator-to-Bracket	
Through-Bolt.....	68 N•m (50 ft. lbs.)
Rear Insulator-to-Crossmember	
Support Bracket Nut.....	41 N•m (30 ft. lbs.)
Rear Support Bracket-to-Crossmember	
Flange Nuts.....	41 N•m (30 ft. lbs.)
Rocker Arm Bolts.....	28 N•m (21 ft. lbs.)
Spark Plugs.....	41 N•m (30 ft. lbs.)
Starter Mounting Bolts.....	68 N•m (50 ft. lbs.)
Thermostat Housing Bolts.....	25 N•m (225 in. lbs.)
Throttle Body Bolts.....	23 N•m (200 in. lbs.)
Torque Converter Drive Plate Bolts.....	31 N•m (270 in. lbs.)
Transmission Support	
Bracket Bolts.....	68 N•m (50 ft. lbs.)
Transmission Support Spacer-to-	
Insulator Mounting Plate Nuts (4WD) ...	204 N•m (150 ft. lbs.)
Vibration Damper Retainer Bolt.....	183 N•m (135 ft. lbs.)
Water Pump-to-Chain Case	
Cover Bolt.....	41 N•m (30 ft. lbs.)

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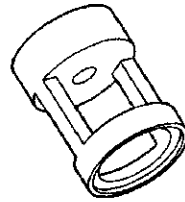
TORQUE SPECIFICATIONS

SPECIAL TOOLS

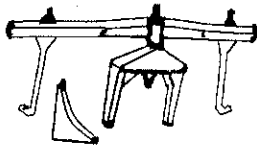
3.9L ENGINE



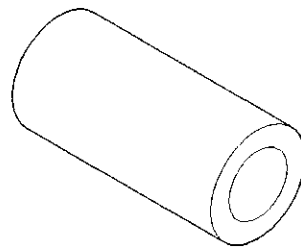
Oil Pressure Gauge C-3292



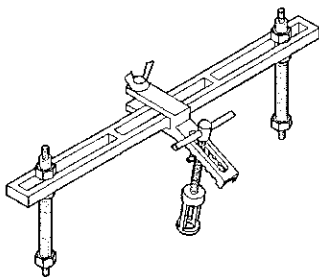
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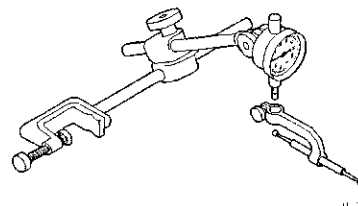
Engine Support Fixture C-3487-A



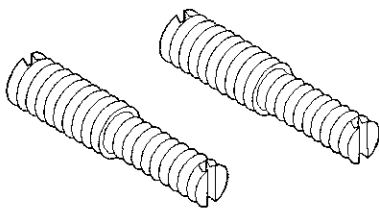
Valve Guide Sleeve C-3973



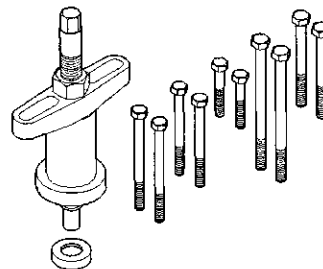
Valve Spring Compressor MD-998772-A



Dial Indicator C-3339

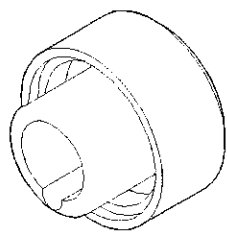
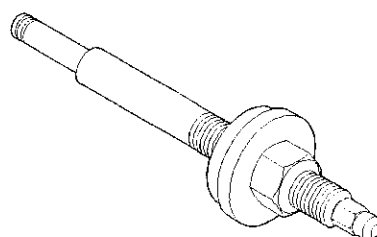
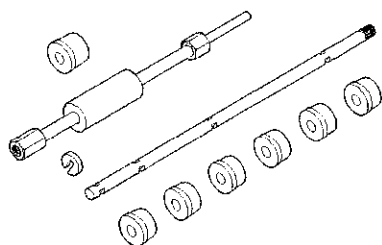
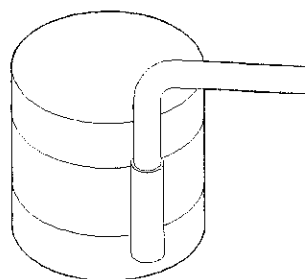
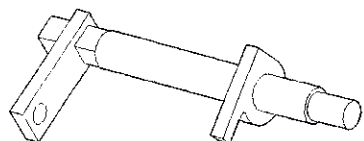
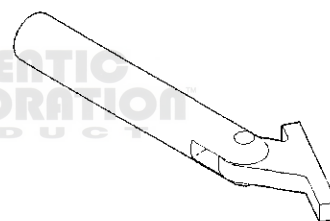
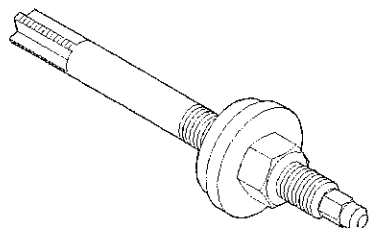
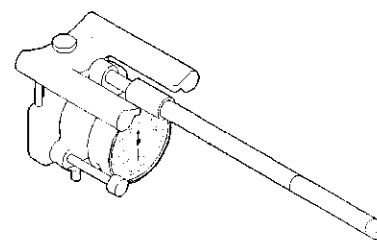


Adapter 6633



Puller C-3688



SPECIAL TOOLS (Continued)**Front Oil Seal Installer 6635****Distributor Bushing Driver/Burnisher C-3053****Cam Bearing Remover/Installer C-3132-A****Piston Ring Compressor C-385****Camshaft Holder C-3509****AUTHENTIC
RESTORATION
PRODUCT****Crankshaft Main Bearing Remover C-3059****Distributor Bushing Puller C-3052****Cylinder Bore Gauge C-119**

5.2L ENGINE

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GENERAL INFORMATION

VALVES AND VALVE SPRINGS

The valves are arranged in-line and inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine at 3,000 RPM.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter

across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

GENERAL INFORMATION

The 5.2 Liter (318 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets (Fig. 1).

This engine is designed for unleaded fuel.

DESCRIPTION AND OPERATION (Continued)

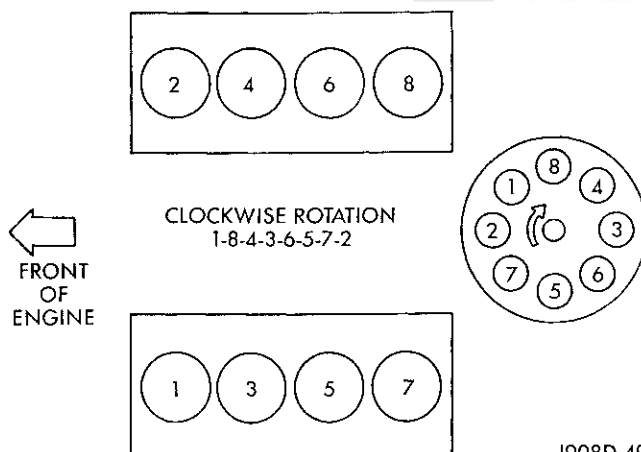
Engine Type.....	90° V-8 OHV
Bore and Stroke.....	99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement.....	5.2L (318 cu. in.)
Compression Ratio.....	9.1:1
Torque.....	407 N•m (300 ft. lbs.) @ 3,200 rpm
Firing Order.....	1-8-4-3-6-5-7-2
Lubrication.....	Pressure Feed - Full Flow Filtration
Engine Oil Capacity.....	4.7L (5.0 Qts) with Filter
Cooling System.....	Liquid Cooled - Forced Circulation
Cooling Capacity.....	16.1L (17.0 Qts)
Cylinder Block.....	Cast Iron
Crankshaft.....	Nodular Iron
Cylinder Head.....	Cast Iron
Combustion Chambers.....	Wedge-High Swirl Valve Shrouding
Camshaft.....	Nodular Cast Iron
Pistons.....	Aluminum Alloy w/Strut
Connecting Rods.....	Forged Steel

J9409-10

Fig. 1 Engine Description

Engine lubrication system consists of a rotor type oil pump and a full flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5, 7 on the left bank and 2, 4, 6, 8 on the right bank. The firing order is 1-8-4-3-6-5-7-2 (Fig. 2).



J908D-49

Fig. 2 Firing Order

The engine serial number is stamped into a machined pad located on the left, front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 3).

LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the rear main bearing

X M 5.2L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

5.2L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

J9209-73

Fig. 3 Engine Identification Number

cap. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main gallery which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block and into the oil gallery on the left side of the engine.

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing has half a hole in it, oil passes through the hole when the rods rotate and the hole lines up, oil is then thrown off as the rod rotates. This oil throw off lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the number one main bearing cap.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components. The oil then passes down through the push rod guide holes, and the oil drain back passages in the cylinder head past the valve tappet area, and returns to the oil pan.

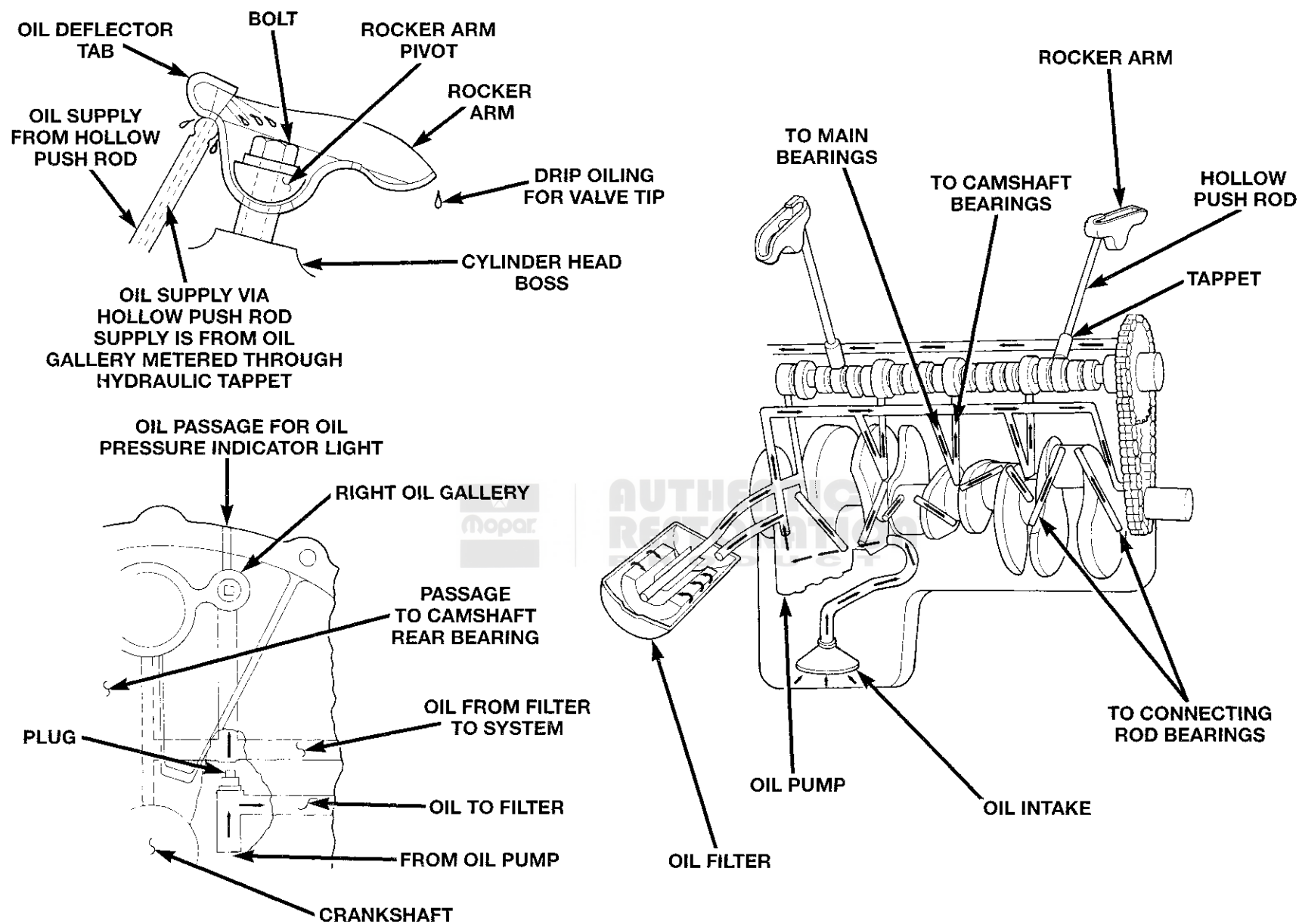


Fig. 4 Oil Lubrication System

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DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEAD

The alloy cast iron cylinder heads (Fig. 5) are held in place by 10 bolts. The spark plugs are located in the peak of the wedge between the valves.

The 5.2L cylinder head is identified by the foundry mark NH.

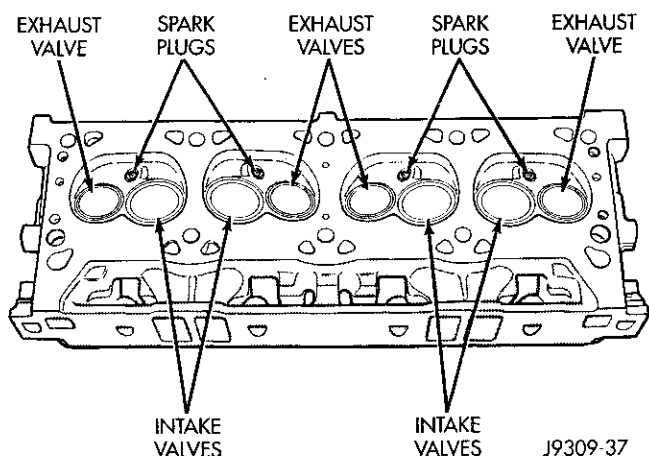


Fig. 5 Cylinder Head Assembly

PISTONS

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

SERVICE PROCEDURES

VALVE TIMING

(1) Turn crankshaft until the No.6 exhaust valve is closing and No.6 intake valve is opening.

(2) Insert a 6.350 mm (1/4 inch) spacer between rocker arm pad and stem tip of No.1 intake valve. Allow spring load to bleed tappet down giving in effect a solid tappet.

(3) Install a dial indicator so plunger contacts valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should

now read from 10° before top dead center to 2° after top dead center. Remove spacer.

CAUTION: DO NOT turn crankshaft any further clockwise as valve spring might bottom and result in serious damage.

If reading is not within specified limits:

- Check sprocket index marks.
- Inspect timing chain for wear.
- Check accuracy of DC mark on timing indicator.

MEASURING TIMING CHAIN STRETCH

NOTE: To access timing chain Refer to Timing Chain Cover in Removal and Installation Section.

(1) Place a scale next to the timing chain so that any movement of the chain may be measured.

(2) Place a torque wrench and socket over camshaft sprocket attaching bolt. Apply torque in the direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) torque with cylinder head installed or 20 N·m (15 ft. lbs.) torque with cylinder head removed. With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 6).

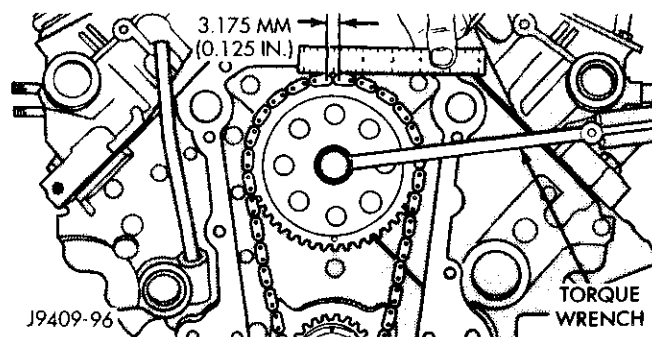


Fig. 6 Measuring Timing Chain Wear and Stretch

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

(5) If chain is not satisfactory, remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

(6) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(7) Place timing chain around both sprockets.

SERVICE PROCEDURES (Continued)

(8) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(9) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 7).

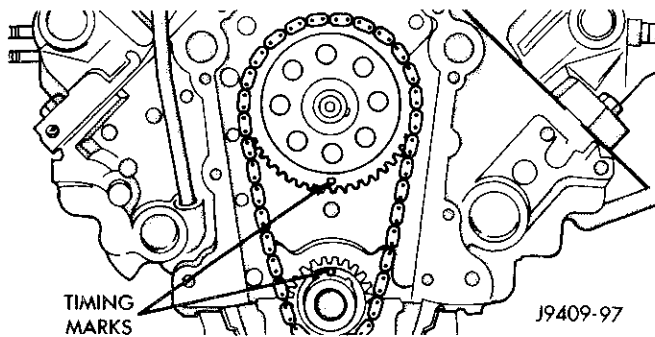


Fig. 7 Alignment of Timing Marks

(11) Install the camshaft bolt. Tighten the bolt to 47 N·m (35 ft. lbs.) torque.

(12) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 inch) at 21°C (70°F).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis location A in (Fig. 8). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

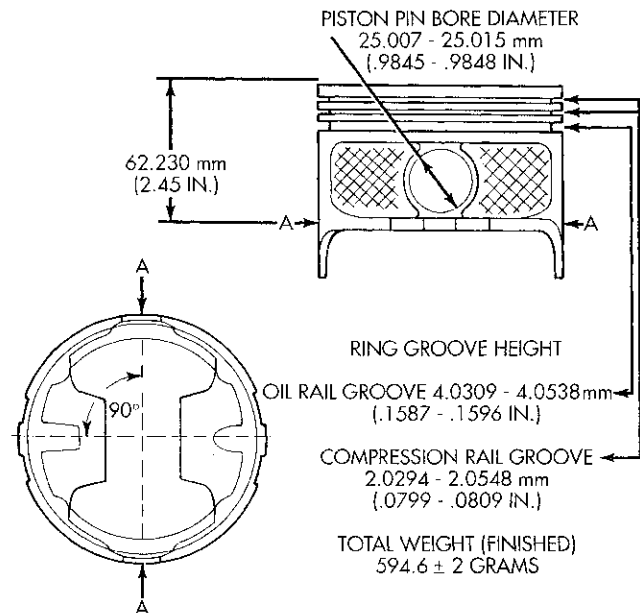
Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

FITTING PISTON RINGS

(1) Measurement of end gaps:

(a) Measure piston ring gap 2 inches from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 inch). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 inch). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 inch).



PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (IN.)	MAX. mm (IN.)	MIN. mm (IN.)	MAX. mm (IN.)
A	99.280 [3.9087]	99.294 [3.9092]	99.306 [3.9097]	99.319 [3.9102]
B	99.294 [3.9092]	99.306 [3.9097]	99.319 [3.9102]	99.332 [3.9107]
C	99.306 [3.9097]	99.319 [3.9102]	99.332 [3.9107]	99.344 [3.9112]
D	99.319 [3.9102]	99.332 [3.9107]	99.344 [3.9112]	99.357 [3.9117]
E	99.332 [3.9107]	99.344 [3.9112]	99.357 [3.9117]	99.370 [3.9122]

J9509-80

Fig. 8 Piston Measurements

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Rings with excess gaps should not be used.

(2) Install rings and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP (Fig. 9) (Fig. 11).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 10) (Fig. 11). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but

SERVICE PROCEDURES (Continued)

should not exceed 0.246 mm (0.0097 inch) side clearance.

(e) Pistons with insufficient or excessive side clearance should be replaced.

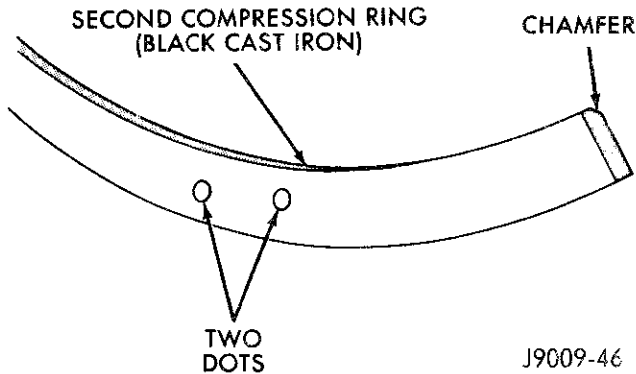


Fig. 9 Second Compression Ring Identification (Typical)

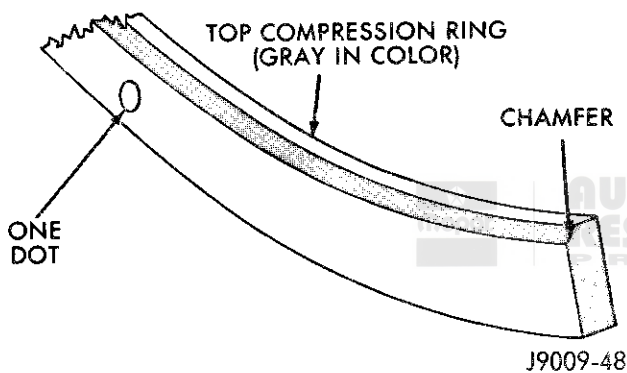


Fig. 10 Top Compression Ring Identification (Typical)

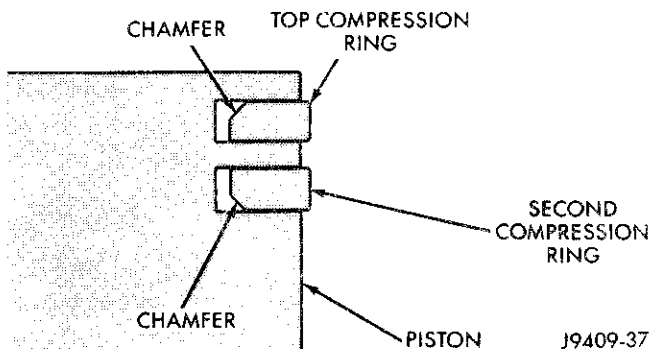


Fig. 11 Compression Ring Chamfer Location (Typical)

FITTING CONNECTING ROD BEARINGS

Fit all rods on a bank until completed. DO NOT alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

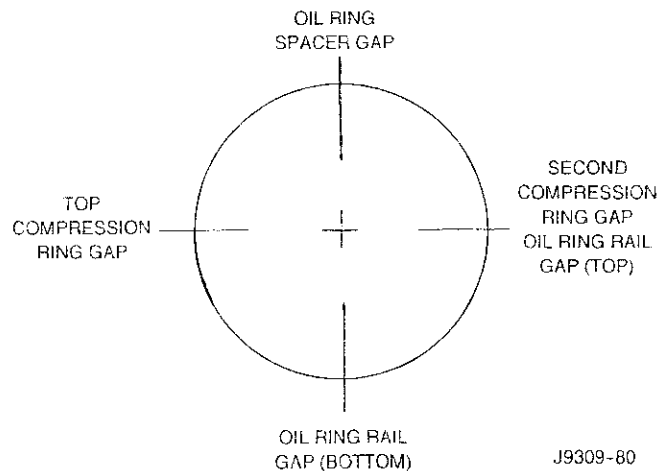


Fig. 12 Proper Ring Installation

The bearing caps are not interchangeable and should be marked at removal to ensure correct assembly.

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, make certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

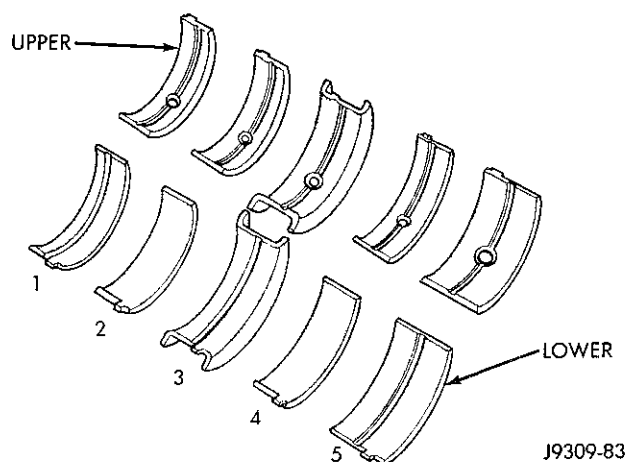
The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch). Bearings are available in 0.025 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch) under-size. **Install the bearings in pairs. DO NOT use a new bearing half with an old bearing half. DO NOT file the rods or bearing caps.**

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No.2 and 4 are interchangeable.

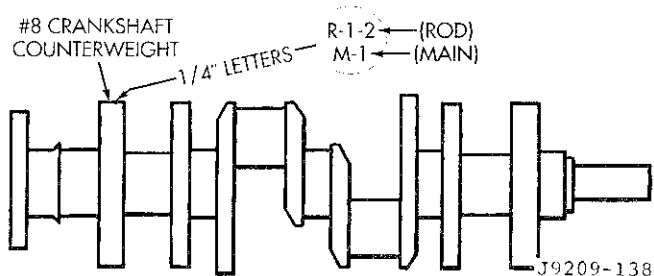
Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 13). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

SERVICE PROCEDURES (Continued)**Fig. 13 Main Bearing Identification****CRANKSHAFT**

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.8 crankshaft counterweight (Fig. 14).

FOR EXAMPLE: R2 stamped on the No.8 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

Undersize Journal	Identification Stamp
0.025 mm (0.001 in.) (Rod)	R1-R2-R3 or R4
0.025 mm (0.001 in.) (Main)	M1-M2-M3-M4 or M5

**Fig. 14 Location of Crankshaft Identification**

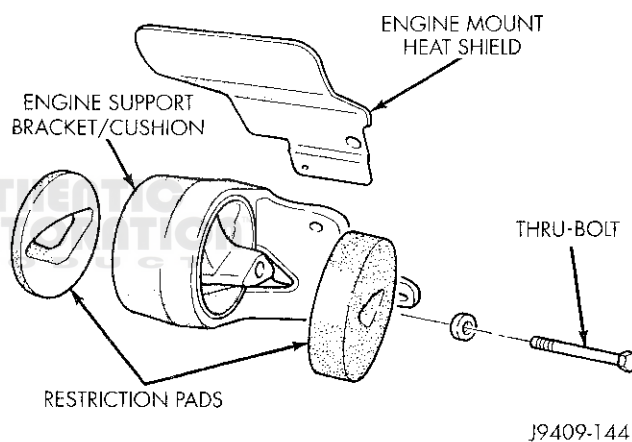
When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

REMOVAL AND INSTALLATION**ENGINE FRONT MOUNTS****REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

CAUTION: DO NOT lift the engine by the intake manifold.

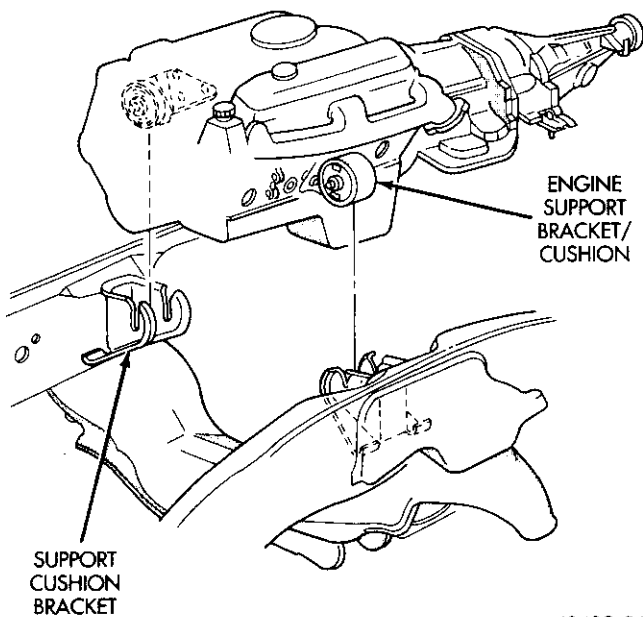
- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 15).
- (6) Remove engine support bracket/cushion bolts (Fig. 15). Remove the support bracket/cushion and heat shields.

**Fig. 15 Engine Front Mounts****INSTALLATION**

- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N-m (60 ft. lbs.) torque.
- (2) Install the thru-bolt into the engine support bracket/cushion.
- (3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 16).
- (4) Install thru-bolt nuts and tighten the nuts to 68 N-m (50 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Remove lifting fixture.

ENGINE REAR MOUNT**REMOVAL**

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.

REMOVAL AND INSTALLATION (Continued)

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Fig. 16 Positioning Engine Front Mounts

- (3) Remove support cushion stud nuts (Fig. 17).
- (4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 17).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

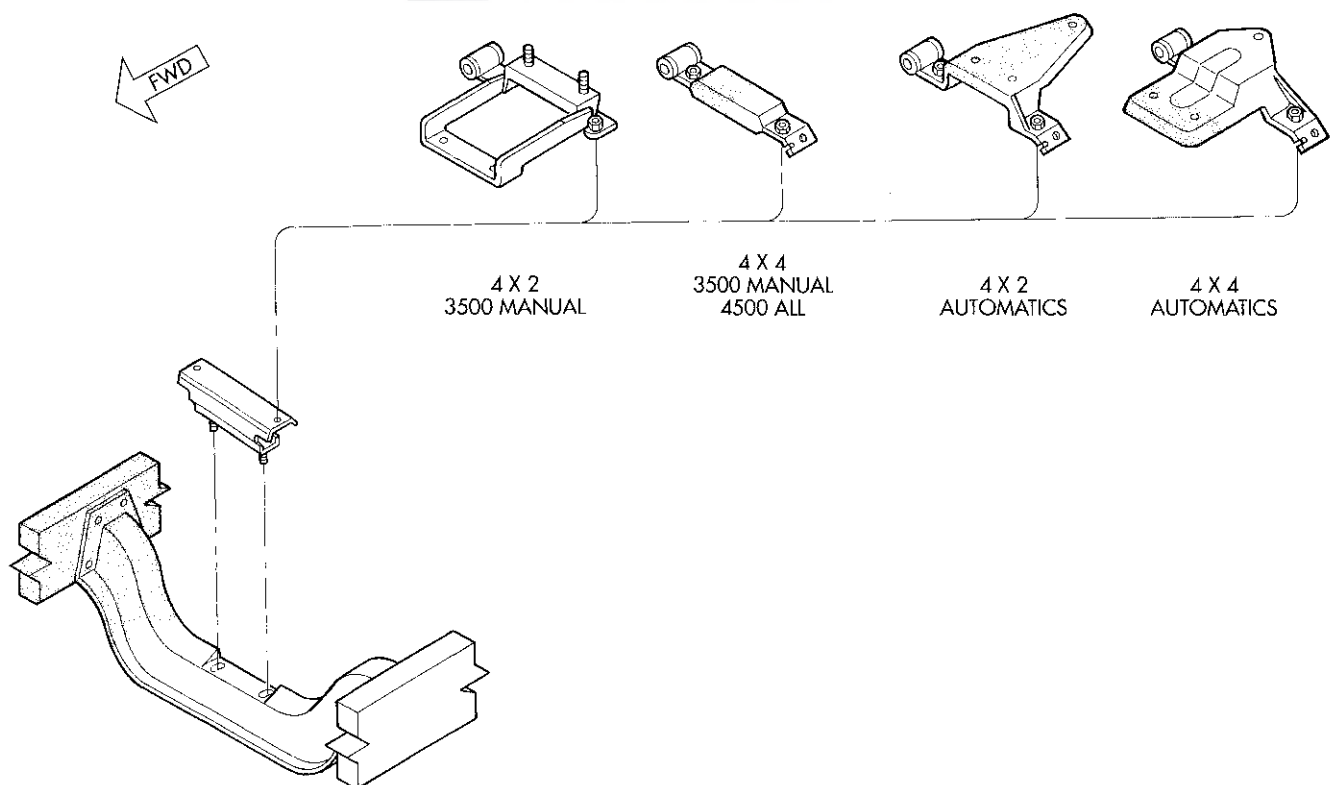
(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Remove the battery.

(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedure).



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Fig. 17 Engine Rear Support Cushion Assemblies

REMOVAL AND INSTALLATION (Continued)

(3) Remove the upper crossmember and top core support.

(4) Remove the transmission oil cooler.

(5) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(6) Remove the serpentine belt (refer to Group 7, Cooling System).

(7) Remove the A/C compressor with the lines attached. Set aside.

(8) If equipped, remove the condenser.

(9) Remove the washer bottle.

(10) Disconnect the top radiator hose.

(11) Remove the fan.

(12) Remove the fan shroud.

(13) Disconnect the lower radiator hose.

(14) Remove radiator (refer to Group 7, Cooling System).

(15) Remove the generator with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(16) Remove the air cleaner box.

(17) Disconnect the throttle linkage.

(18) Remove throttle body.

(19) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(20) Remove the distributor cap and wiring.

(21) Disconnect the heater hoses.

(22) Disconnect the power steering hoses, if equipped.

(23) Disconnect the transmission cooler lines.

(24) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System).

(25) Disconnect the fuel lines.

(26) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(27) Raise and support the vehicle on a hoist.

(28) Remove the drain plug and drain the engine oil.

(29) Remove engine front mount thru-bolt nuts.

(30) Remove the transmission cooler line brackets from oil pan.

(31) Disconnect exhaust pipe at manifold.

(32) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(33) Remove the dust shield and transmission cover.

(34) Refer to group 21, Transmissions for transmission removal.

(35) Remove the prop shaft (refer to Group 16, Propeller Shaft).

(36) Lower the vehicle.

(37) Install an engine lifting fixture.

(38) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the thru-bolt into the support cushion brackets.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group, 21 Transmissions for transmission installation

(5) Install rear transmission support.

(6) Install the prop shaft (refer to Group 16, Propeller Shaft).

(7) Install the dust shield and transmission cover.

(8) Install the starter and connect the starter wires (refer to Group 8B, Battery/Starter/Generator Service).

(9) Install exhaust pipe to manifold.

(10) Install the transmission cooler line brackets from oil pan.

(11) Install engine front mount thru-bolt nuts. Tighten the nuts.

(12) Install the drain plug and tighten to 34 N-m (25 ft. lbs.) torque.

(13) Lower the vehicle.

(14) Remove engine lifting fixture.

(15) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).

(16) Connect the fuel lines.

(17) Connect the transmission cooler lines.

(18) Connect the power steering hoses, if equipped.

(19) Connect the heater hoses.

(20) Install the distributor cap and wiring.

(21) Install the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(22) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N-m (200 in. lbs.) torque.

(23) Connect the throttle linkage.

(24) Install the air cleaner box.

(25) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(26) Install radiator (refer to Group 7, Cooling System).

(27) Connect the lower radiator hose.

(28) Install the fan shroud.

(29) Install the fan.

(30) Connect the top radiator hose.

(31) Install the washer bottle.

(32) If equipped, install the condenser.

(33) Install the A/C compressor with the lines attached.

(34) Install the serpentine belt (refer to Group 7, Cooling System).

CAUTION: DO NOT lift the engine by the intake manifold.

REMOVAL AND INSTALLATION (Continued)

(35) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(36) Install the transmission oil cooler.

(37) Install the upper crossmember and top core support.

(38) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).

(39) Install the battery.

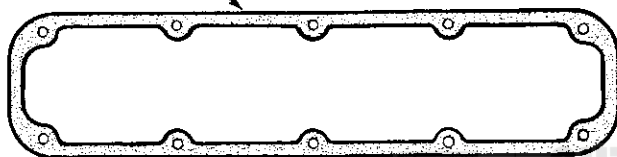
(40) Warm engine and adjust.

(41) Road test vehicle.

CYLINDER HEAD COVER

NOTE: A steel backed silicon gasket is used with the cylinder head cover (Fig. 18). This gasket can be used again.

CYLINDER HEAD COVER GASKET



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Fig. 18 Cylinder Head Cover Gasket

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
- (3) Remove cylinder head cover and gasket. The gasket may be used again.

NOTE: CLEANING

Clean cylinder head cover gasket surface.

Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

Check the gasket for use in head cover installation. If damaged, use a new gasket.

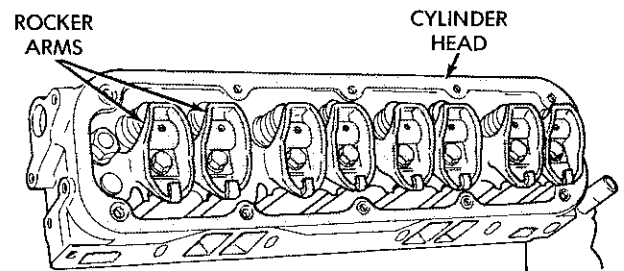
INSTALLATION

- (1) The cylinder head cover gasket can be used again. Install the gasket onto the head rail.
- (2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install closed crankcase ventilation system and evaporation control system.
- (4) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS

REMOVAL

- (1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (2) Remove cylinder head cover and gasket.
- (3) Remove the rocker arm bolts and pivots (Fig. 19). Place them on a bench in the same order as removed.
- (4) Remove the push rods and place them on a bench in the same order as removed.



J9209-65

Fig. 19 Rocker Arms

INSTALLATION

- (1) Rotate the crankshaft until the "V8" mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.
- (2) Install the push rods in the same order as removed.
- (3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

CAUTION: DO NOT rotate or crank the engine during or immediately after rocker arm installation. Allow the hydraulic roller tappets adequate time to bleed down (about 5 minutes).

- (4) Install cylinder head cover.
- (5) Connect spark plug wires.

VALVE SPRING AND STEM SEAL REPLACEMENT- IN VEHICLE

- (1) Set engine basic timing to Top Dead Center (TDC).
- (2) Remove the air cleaner.
- (3) Remove cylinder head covers and spark plugs.
- (4) Remove coil wire from distributor and secure to good ground to prevent engine from starting.
- (5) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.
- (6) Remove rocker arms.

REMOVAL AND INSTALLATION (Continued)

(7) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.

(8) Using Valve Spring Compressor Tool MD-998772A with adaptor 6633, compress valve spring and remove retainer valve locks and valve spring.

(9) Install seals on the exhaust valve stem and position down against valve guides.

(10) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.

(11) Follow the same procedure on the remaining 7 cylinders using the firing sequence 1-8-4-3-6-5-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.

(12) Remove adapter from the No.1 spark plug hole.

(13) Install rocker arms.

(14) Install covers and coil wire to distributor.

(15) Install air cleaner.

(16) Road test vehicle.

CYLINDER HEADS**REMOVAL**

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).

(3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

(6) Remove the air cleaner.

(7) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.

(8) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(9) Remove the return spring.

(10) Remove distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Remove cylinder head covers and gaskets.

(15) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.

(16) Remove exhaust manifolds.

(17) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.

(18) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.

(19) Remove spark plugs.

INSTALLATION

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Clean cylinder block front and rear gasket surfaces using a suitable solvent.

(3) Position the new cylinder head gaskets onto the cylinder block.

(4) Position the cylinder heads onto head gaskets and cylinder block.

(5) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 20). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

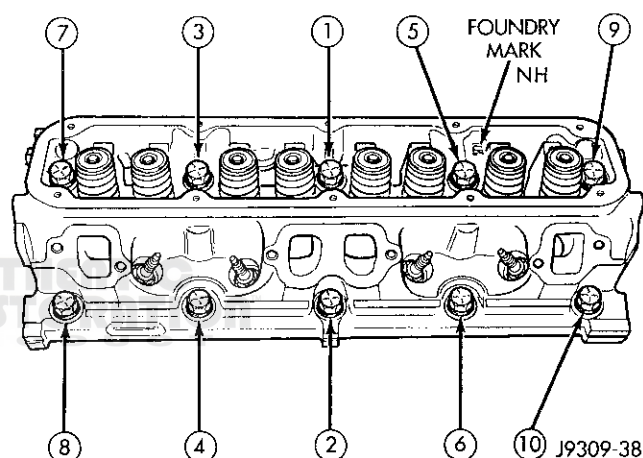


Fig. 20 Cylinder Head Bolt Tightening Sequence

CAUTION: When tightening the rocker arm bolts, make sure the piston in that cylinder is NOT at TDC. Contact between the valves and piston could occur.

(6) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.

(7) Install the intake manifold and throttle body assembly (refer to Group 11, Exhaust System and Intake Manifold).

(8) Install exhaust manifolds. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

(9) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(10) Install coil wires.

(11) Connect heat indicator sending unit wire.

(12) Connect the heater hoses and bypass hose.

(13) Install distributor cap and wires.

(14) Hook up the return spring.

REMOVAL AND INSTALLATION (Continued)

(15) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(16) Install the fuel lines.

(17) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

(18) Install the intake manifold-to-generator bracket support rod. Tighten the bolts.

(19) Place the cylinder head cover gaskets in position and install cylinder head covers. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(20) Install closed crankcase ventilation system.

(21) Connect the evaporation control system.

(22) Install the air cleaner.

(23) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(24) Fill cooling system (refer to Group 7, Cooling System for proper procedure).

(25) Connect the negative cable to the battery.

VALVES AND VALVE SPRINGS

REMOVAL

(1) Remove the cylinder head.

(2) Compress valve springs using Valve Spring Compressor Tool MD- 998772A.

(3) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(4) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the valve guides. Identify valves to ensure installation in original location.

INSTALLATION

(1) Clean valves thoroughly. Discard burned, warped and cracked valves.

(2) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.

(4) Coat valve stems with lubrication oil and insert them in cylinder head.

(5) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.

(6) Install new seals on all valve guides. Install valve springs and valve retainers.

(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the

top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS

REMOVAL

(1) Remove the air cleaner.

(2) Remove cylinder head cover.

(3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original location.

(4) Remove intake manifold.

(5) Remove yoke retainer and aligning yokes.

(6) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.

(7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

(8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

INSTALLATION

(1) Lubricate tappets.

(2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.

(5) Install push rods in original positions.

(6) Install rocker arm.

(7) Install cylinder head cover.

(8) Start and operate engine. Warm up to normal operating temperature.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove fan shroud retainer bolts and set shroud back over engine.

(3) Remove the cooling system fan.

(4) Remove the serpentine belt (refer to Group 7, Cooling System).

(5) Remove the vibration damper pulley.

REMOVAL AND INSTALLATION (Continued)

(6) Remove vibration damper bolt and washer from end of crankshaft.

(7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 21).

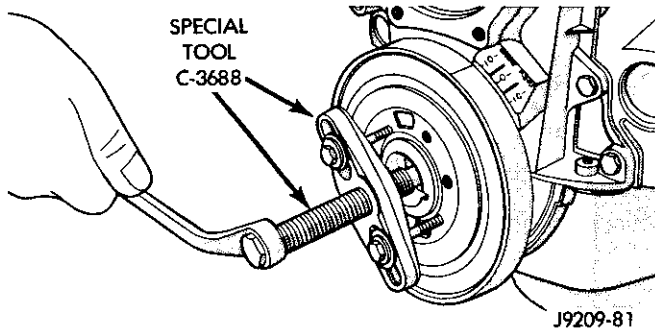


Fig. 21 Vibration Damper Assembly

(8) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

(2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 22).

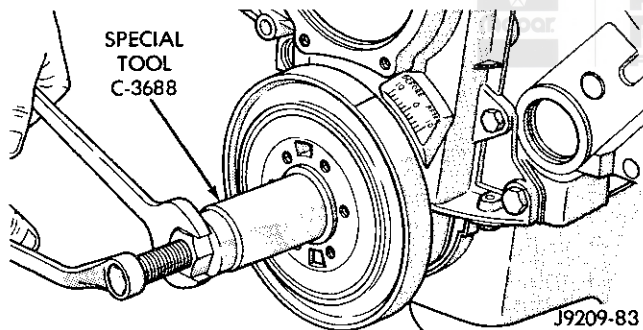


Fig. 22 Installing Vibration Damper

(3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

(4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.

(5) Install the serpentine belt (refer to Group 7, Cooling System).

(6) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(7) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.

(8) Connect the negative cable to the battery.

TIMING CHAIN COVER**REMOVAL**

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System).

(3) Remove the serpentine belt (refer to Group 7, Cooling System).

(4) Remove water pump (refer to Group 7, Cooling System).

(5) Remove power steering pump (refer to Group 19, Steering).

(6) Remove vibration damper.

(7) Loosen oil pan bolts and remove the front bolt at each side.

(8) Remove the cover bolts.

(9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.

(10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 23).

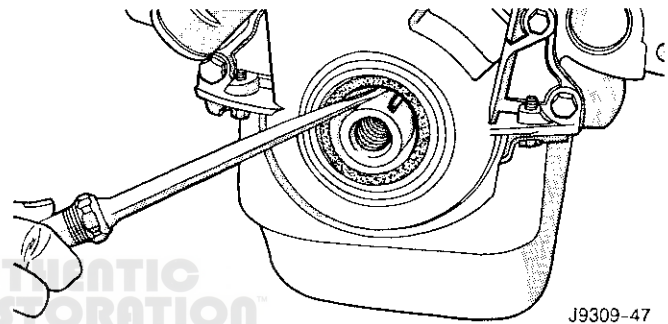


Fig. 23 Removal of Front Crankshaft Oil Seal

INSTALLATION

(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

(2) The water pump mounting surface must be cleaned.

(3) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

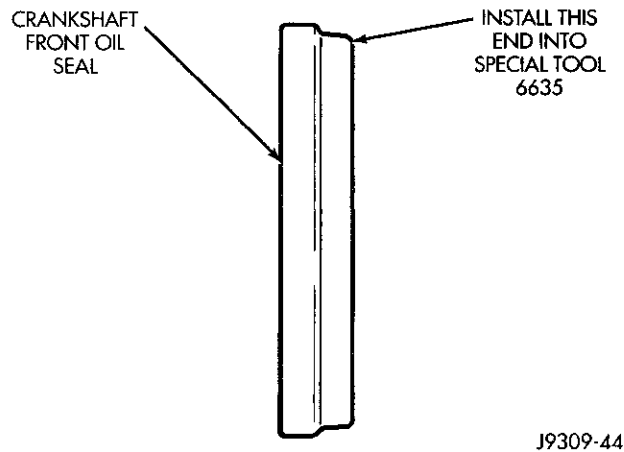
(4) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 24). Seat the oil seal in the groove of the tool.

(5) Position the seal and tool onto the crankshaft (Fig. 25).

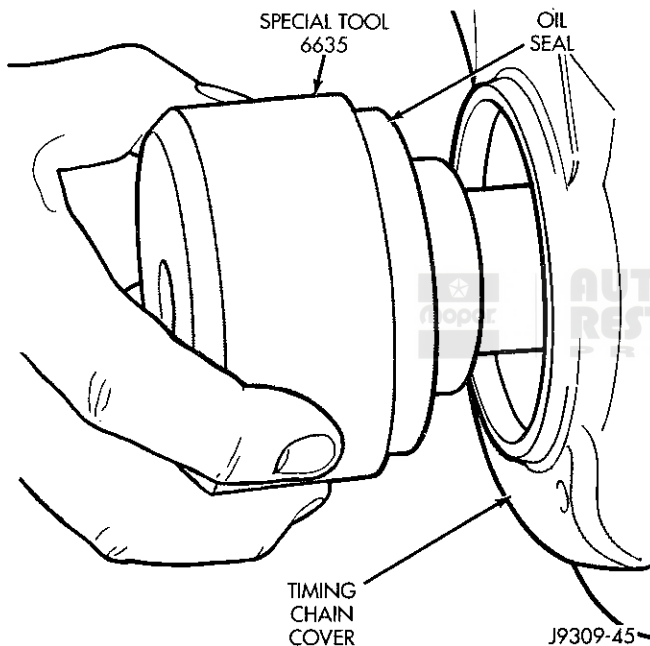
(6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 26).

(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

REMOVAL AND INSTALLATION (Continued)

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Fig. 24 Placing Oil Seal on Installation Tool 6635

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Fig. 25 Position Tool and Seal onto Crankshaft

(9) Tighten chain case cover bolts to 41 N·m (30 ft.lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(10) Remove the vibration damper bolt and seal installation tool.

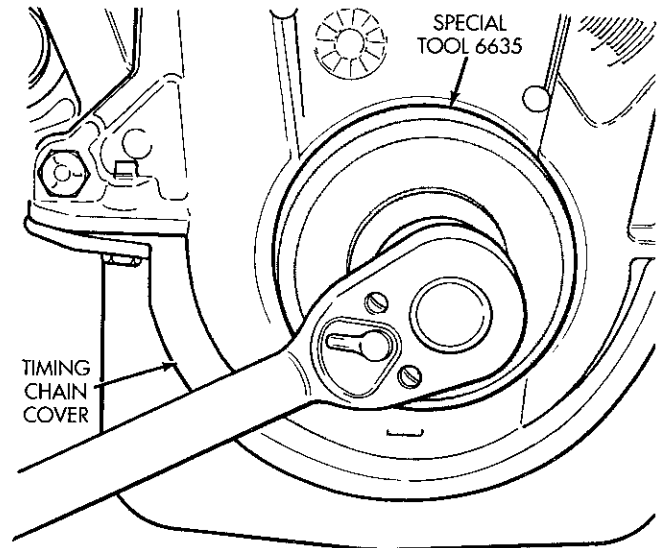
(11) Inspect the seal flange on the vibration damper.

(12) Install vibration damper.

(13) Install water pump and housing assembly using new gaskets (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(14) Install power steering pump (refer to Group 19, Steering).

(15) Install the serpentine belt (refer to Group 7, Cooling System).



J9309-46

Fig. 26 Installing Oil Seal

(16) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(17) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(18) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).

(19) Connect the negative cable to the battery.

TIMING CHAIN**REMOVAL**

(1) Remove Timing Chain Cover Refer to procedure in this section.

(2) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

INSTALLATION

(1) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

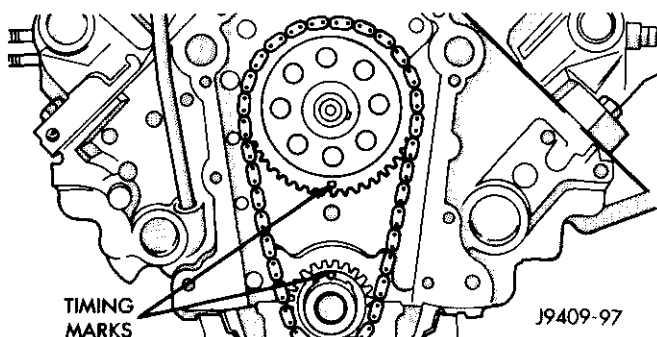
(2) Place timing chain around both sprockets.

(3) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(4) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 27).

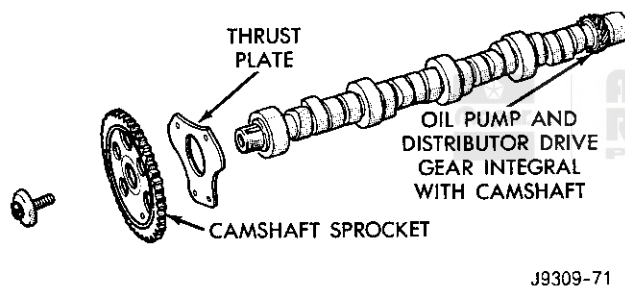
(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)**Fig. 27 Alignment of Timing Marks**

(7) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

CAMSHAFT

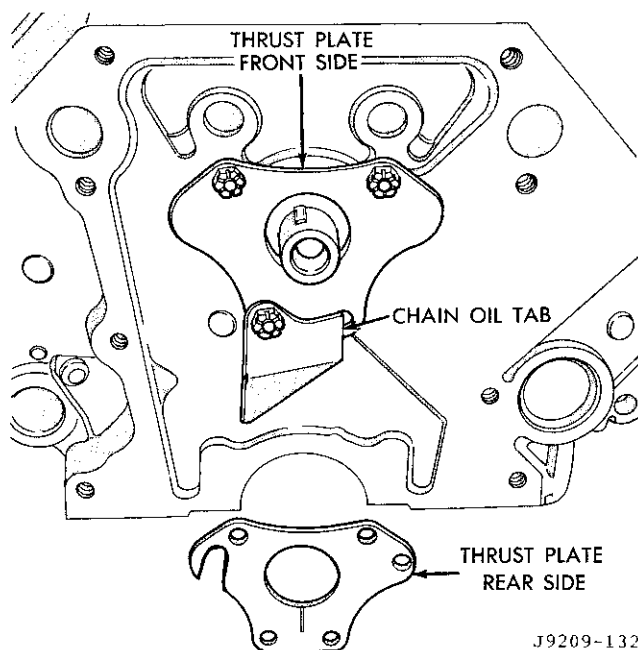
NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 28).

**Fig. 28 Camshaft and Sprocket Assembly****REMOVAL**

- (1) Remove intake manifold.
- (2) Remove cylinder head covers.
- (3) Remove timing case cover and timing chain.
- (4) Remove rocker arms.
- (5) Remove push rods and tappets. Identify each part so it can be installed in its original location.
- (6) Remove distributor and lift out the oil pump and distributor drive shaft.
- (7) Remove camshaft thrust plate, note location of oil tab (Fig. 29).
- (8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

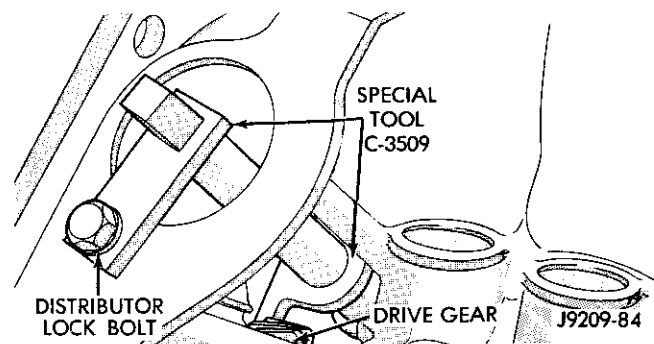
INSTALLATION

- (1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

**Fig. 29 Timing Chain Oil Tab Installation**

NOTE: Whenever an engine has been rebuilt, a new camshaft and/or new tappets installed, add 1 pint of Mopar Crankcase Conditioner, or equivalent. The oil mixture should be left in engine for a minimum of 805 km (500 miles). Drain at the next normal oil change.

- (2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 30).

**Fig. 30 Camshaft Holding Tool C-3509 (Installed Position)**

- (3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the Welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

- (4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.)

REMOVAL AND INSTALLATION (Continued)

torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

(5) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(6) Place timing chain around both sprockets.

(7) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(8) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 31).

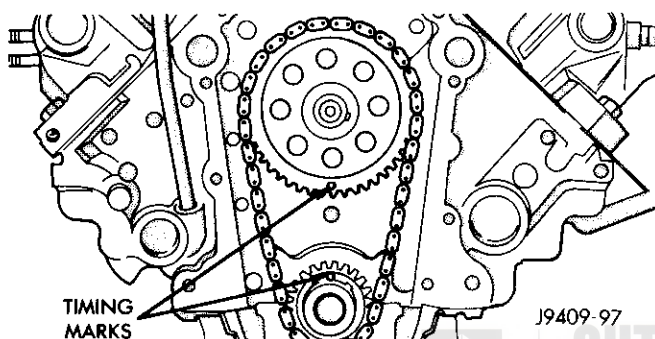


Fig. 31 Alignment of Timing Marks

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

CAMSHAFT BEARINGS

REMOVAL

NOTE: This procedure requires that the engine is removed from the vehicle.

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 32).

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

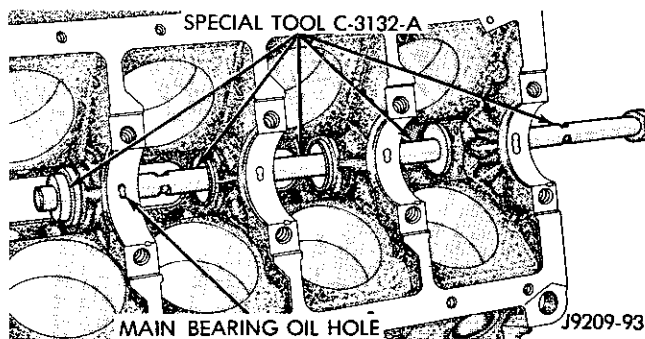


Fig. 32 Camshaft Bearings Removal/Installation with Tool C-3132-A

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 33).

(5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 33).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

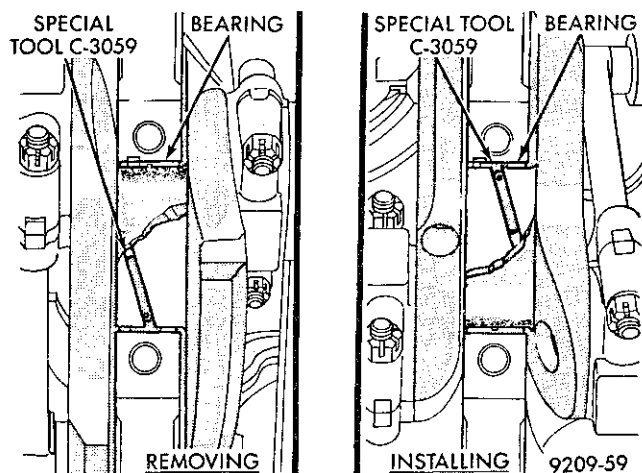
REMOVAL AND INSTALLATION (Continued)

Fig. 33 Upper Main Bearing Removal and Installation with Tool C-3059

DISTRIBUTOR DRIVE SHAFT BUSHING**REMOVAL**

- (1) Remove distributor, refer to Group 8D, Ignition Systems for the proper procedure.
- (2) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 34).
- (4) Hold puller screw and tighten puller nut until bushing is removed.

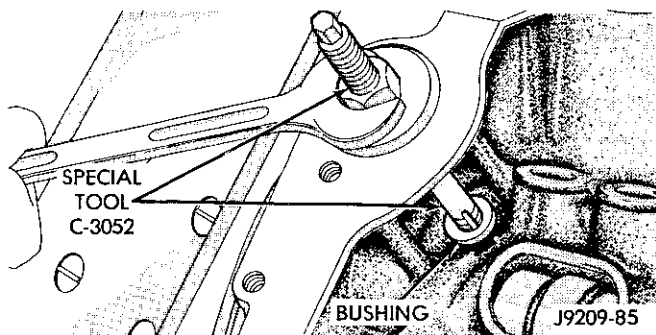


Fig. 34 Distributor Driveshaft Bushing Removal

INSTALLATION

- (1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.
- (2) Drive bushing and tool into position, using a hammer (Fig. 35).
- (3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 36). **DO NOT** ream this bushing.

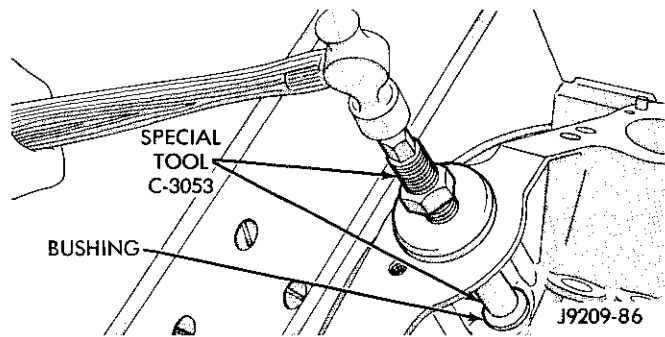


Fig. 35 Distributor Driveshaft Bushing Installation

CAUTION: This procedure **MUST** be followed when installing a new bushing or seizure to shaft may occur.

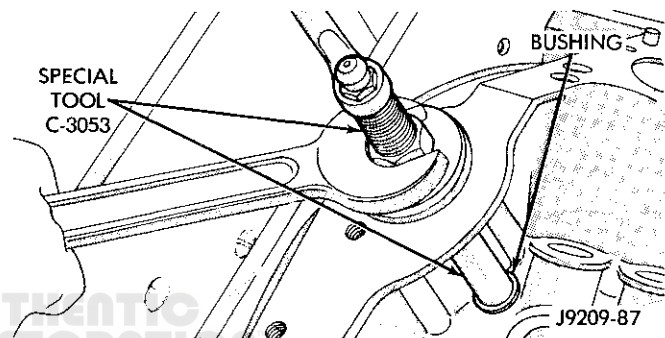


Fig. 36 Burnishing Distributor Driveshaft Bushing

- (4) Install the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

DISTRIBUTOR INSTALLATION

NOTE: Before installing the distributor, the oil pump drive shaft must be aligned to number one cylinder.

- (1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.
 - (2) When in this position, the timing mark of vibration damper should be under "0" on the timing indicator.
 - (3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned towards the left front intake manifold attaching bolt hole (Fig. 37).
 - (4) Install distributor, refer to Group 8D, Ignition Systems for the proper procedure.
- After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition system.
- Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on igni-**

REMOVAL AND INSTALLATION (Continued)

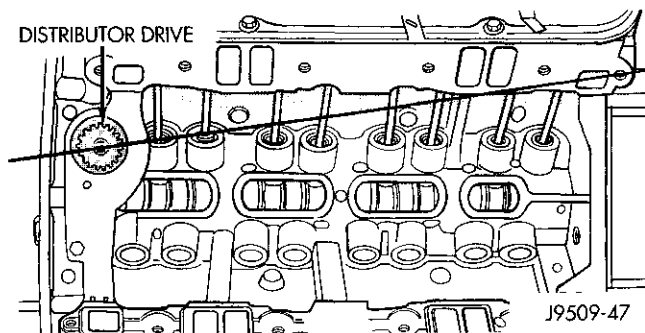


Fig. 37 Position of Oil Pump Shaft Slot

tion timing. Adjusting distributor position will effect fuel synchronization only.

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion thru-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

INSTALLATION

- (1) Clean the block and pan gasket surfaces.
- (2) Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**
- (3) If present, trim excess sealant from inside the engine.
- (4) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 38).

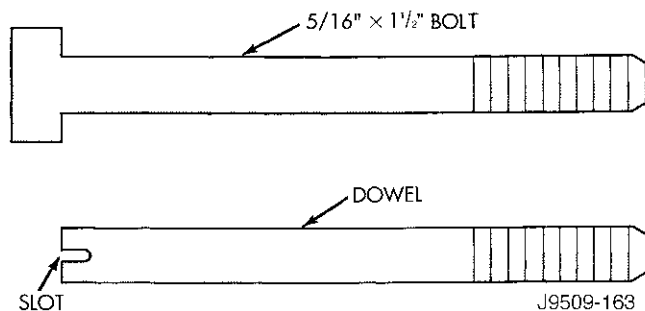


Fig. 38 Fabrication of Alignment Dowels

- (5) Install the dowels in the cylinder block (Fig. 39).

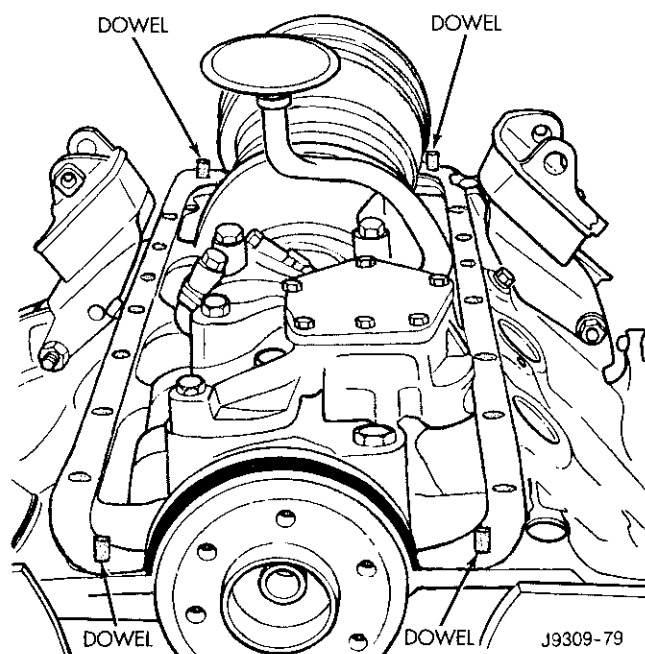


Fig. 39 Position of Dowels in Cylinder Block

- (6) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
- (7) Slide the one-piece gasket over the dowels and onto the block.
- (8) Position the oil pan over the dowels and onto the gasket.
- (9) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.
- (10) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.
- (11) Lower the engine into the support cushion brackets and tighten the thru bolt nut to the proper torque.
- (12) Install the drain plug. Tighten drain plug to 34 N·m (25 ft. lbs.) torque.
- (13) Install the engine to transmission strut.
- (14) Install exhaust pipe.
- (15) Lower vehicle.
- (16) Install dipstick.
- (17) Connect the negative cable to the battery.
- (18) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

- (1) Remove the engine from the vehicle.
- (2) Remove the cylinder head.
- (3) Remove the oil pan.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cyl-

REMOVAL AND INSTALLATION (Continued)

inder block. Be sure to keep tops of pistons covered during this operation.

(5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft to center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

(7) After removal, install bearing cap on the mating rod.

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in-line with oil ring rail gap.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 40).

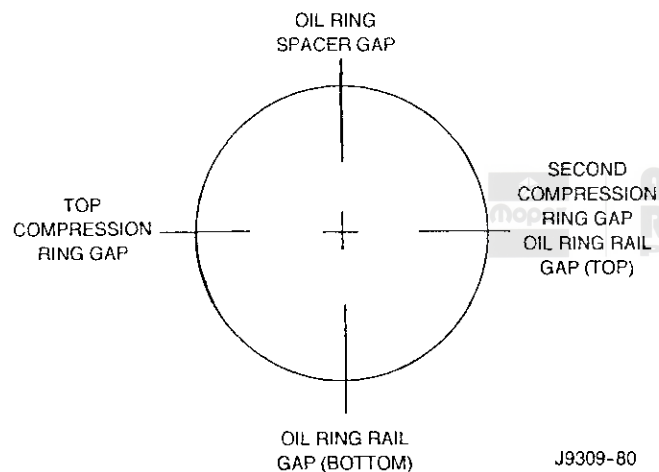


Fig. 40 Proper Ring Installation

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts, the long protector should be installed on the numbered side of the connecting rod.

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on crankshaft journal.

(7) The notch or groove on top of piston must be pointing toward front of engine. The larger chamfer

of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT**REMOVAL**

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Remove the vibration damper.

(4) Remove the timing chain cover.

(5) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.

(6) Lift the crankshaft out of the block.

(7) Remove and discard the crankshaft rear oil seals.

(8) Remove and discard the front crankshaft oil seal.

INSTALLATION

(1) Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.

(4) Position the crankshaft into the cylinder block.

(5) Lightly oil the new lower seal lips with engine oil.

(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 41). **DO NOT** over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

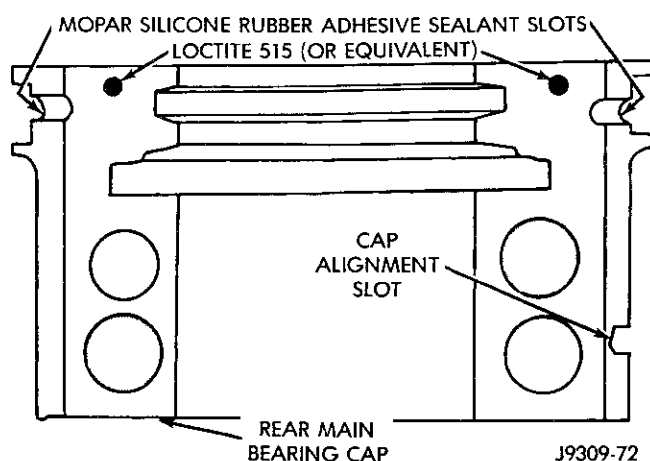
(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. **DO NOT** remove excess material after assembly. **DO NOT** strike rear cap more than 2 times for proper engagement.

(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump.

(11) Install the timing chain cover.

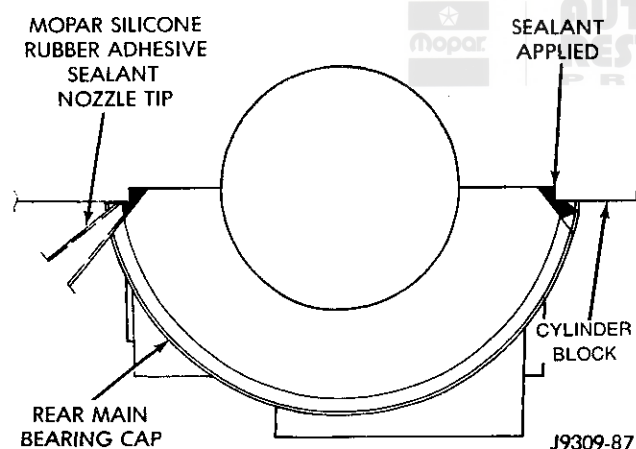
(12) Install the vibration damper.

REMOVAL AND INSTALLATION (Continued)**Fig. 41 Sealant Application to Bearing Cap**

(13) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 42). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(14) Install new front crankshaft oil seal.

(15) Immediately install the oil pan.

**Fig. 42 Apply Sealant to Bearing Cap to Block Joint****REMOVAL**

- (1) Remove the oil pan.
- (2) Remove the oil pump from rear main bearing cap.

INSTALLATION

(1) Install oil pump. During installation slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.

(2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten

pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan.

FRONT CRANKSHAFT OIL SEAL

The oil seal can be replaced without removing the timing chain cover provided the cover is not misaligned.

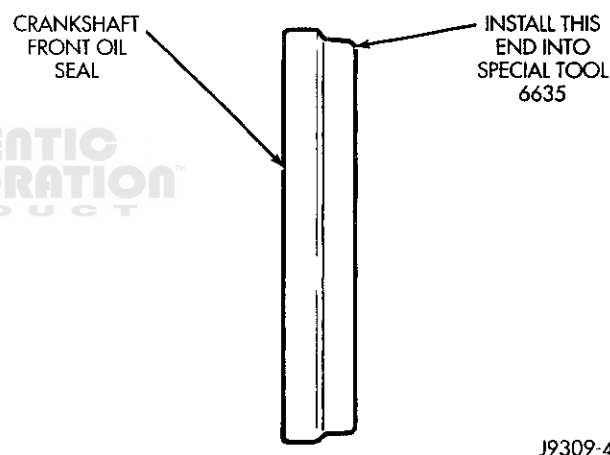
(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper.

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

(4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.

(5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 43). Seat the oil seal in the groove of the tool.

**Fig. 43 Placing Oil Seal on Installation Tool 6635**

(6) Position the seal and tool onto the crankshaft (Fig. 44).

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 45).

(8) Remove the vibration damper bolt and seal installation tool.

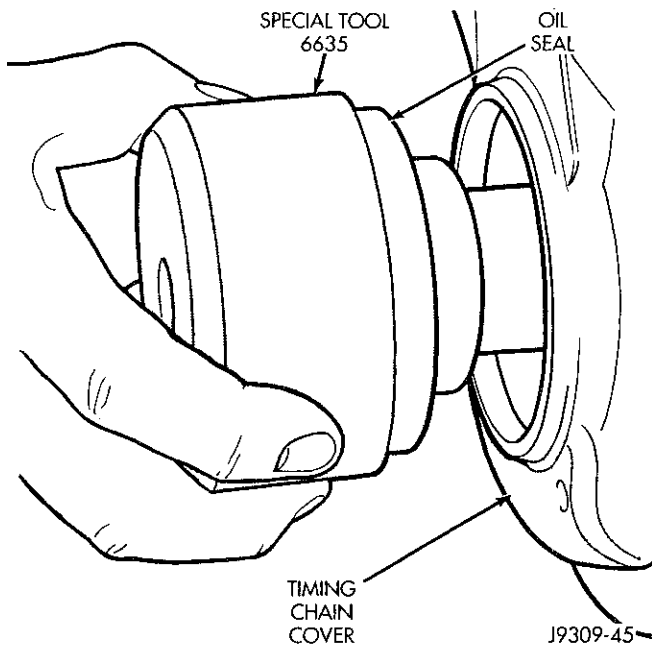
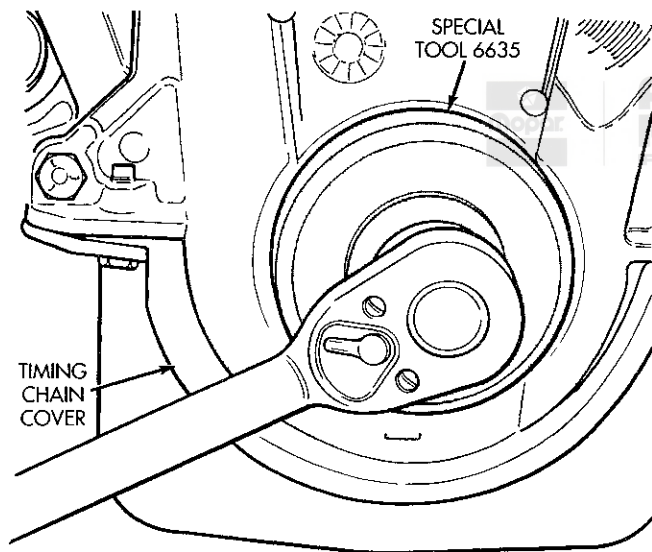
(9) Inspect the seal flange on the vibration damper.

(10) Install the vibration damper.

(11) Connect the negative cable to the battery.

CRANKSHAFT REAR OIL SEALS

The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal.

REMOVAL AND INSTALLATION (Continued)**Fig. 44 Position Tool and Seal onto Crankshaft****Fig. 45 Installing Oil Seal**

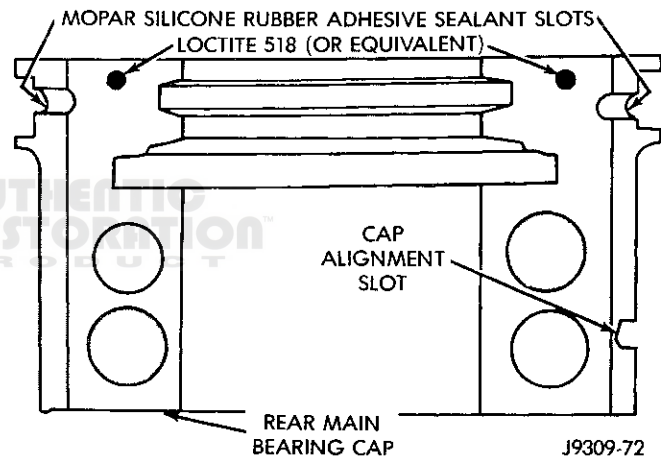
The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED**REMOVAL**

- (1) Remove the crankshaft. Discard the old upper seal.

INSTALLATION

- (1) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.
- (2) Lightly oil the new upper seal lips with engine oil.
- (3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (4) Position the crankshaft into the cylinder block.
- (5) Lightly oil the new lower seal lips with engine oil.
- (6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

**Fig. 46 Sealant Application to Bearing Cap**

- (8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
- (9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.
- (10) Install oil pump.
- (11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 47). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
- (12) Install new front crankshaft oil seal.
- (13) Immediately install the oil pan.

REMOVAL AND INSTALLATION (Continued)

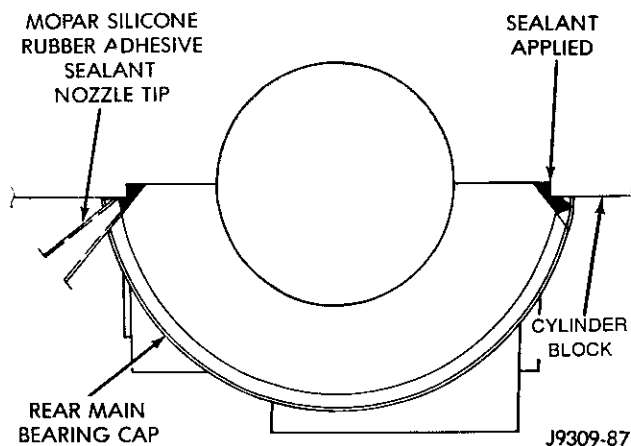


Fig. 47 Apply Sealant to Bearing Cap to Block Joint
UPPER SEAL —CRANKSHAFT INSTALLED

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
- (4) Carefully remove and discard the old upper oil seal.

INSTALLATION

- (1) Clean the cylinder block mating surfaces before oil seal installation. Check for burr at the oil hole on the cylinder block mating surface to rear cap.
- (2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.
- (3) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing towards the rear of the engine.
- (4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (5) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.
- (6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 47). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

- (1) Clean the rear main cap mating surfaces including the oil pan gasket groove.
- (2) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).
- (3) Lightly oil the new lower seal lips with engine oil.
- (4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.
- (5) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.
- (6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
- (7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten the cap bolts to 115 N·m (85 ft. lbs.) torque.
- (8) Install oil pump.
- (9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 47). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
- (10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 48).

REMOVAL AND INSTALLATION (Continued)

This will reduce internal leakage and help maintain higher oil pressure at idle.

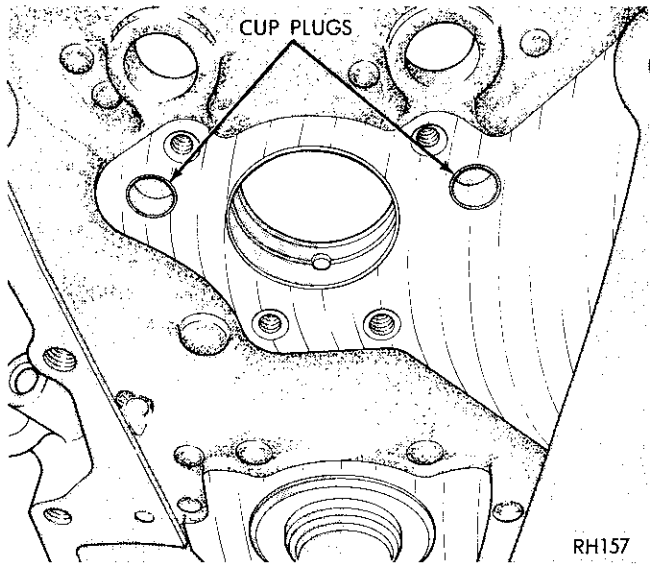


Fig. 48 Location of Cup Plugs in Oil Galleries

REMOVAL

- (1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 49).
- (2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 49).

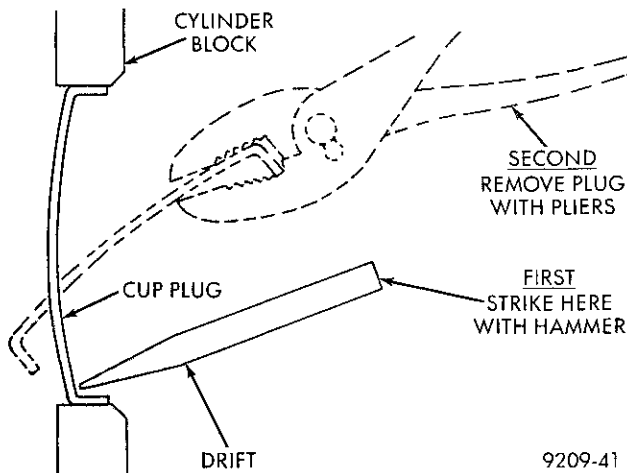


Fig. 49 Core Hole Plug Removal

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Be certain the new plug is cleaned of all oil or grease.

- (1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting, as restricted coolant flow can result and cause serious engine problems.

- (2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 in.) inside the lead-in chamfer.

- (3) It is not necessary to wait for curing of the sealant. The cooling system can be filled and the vehicle placed in service immediately.

DISASSEMBLY AND ASSEMBLY**HYDRAULIC TAPPETS**

CAUTION: The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. DO NOT disassemble a tappet on a dirty work bench.

DISASSEMBLE

- (1) Pry out plunger retainer spring clip (Fig. 50).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 50). Check valve could be flat or ball.

ASSEMBLE

- (1) Clean all tappet parts in a solvent that will remove all varnish and carbon.
- (2) Replace tappets that are unfit for further service with new assemblies.
- (3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.
- (4) Assemble tappets (Fig. 50).

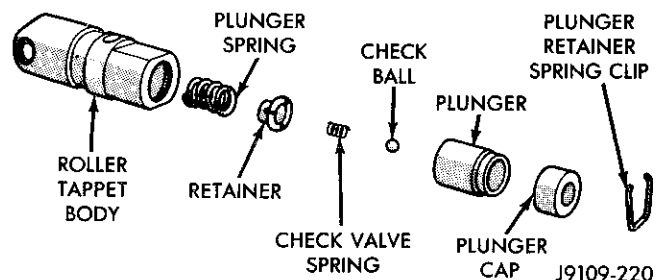


Fig. 50 Hydraulic Tappet Assembly

DISASSEMBLY AND ASSEMBLY (Continued)**VALVE SERVICE****VALVE GUIDES**

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 51). The special sleeve places the valve at the correct height for checking with a dial indicator.

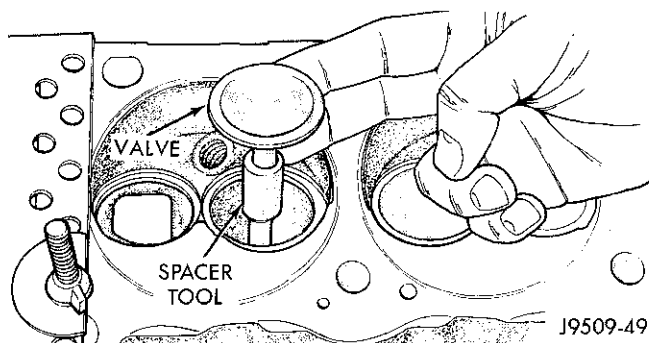


Fig. 51 Positioning Valve with Tool C-3973

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 52).

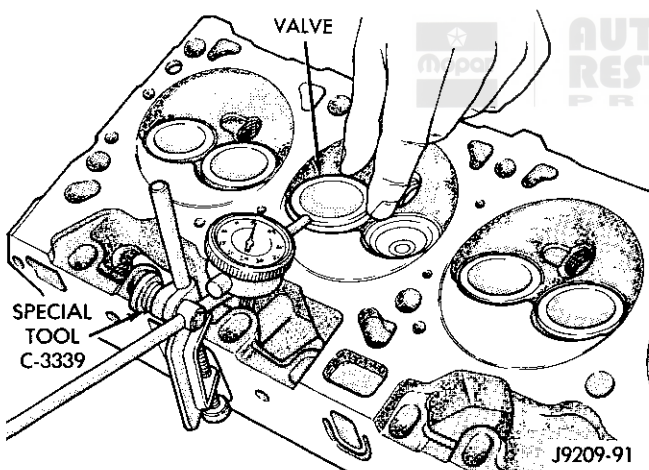


Fig. 52 Measuring Valve Guide Wear

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 inch). Ream the guides for valves with over-size stems if dial indicator reading is excessive or if the stems are scuffed or scored.

(4) Service valves with oversize stems are available (Fig. 53).

(5) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 inch). Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:**

- Step 1—Ream to 0.0763 mm (0.003 inch).

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

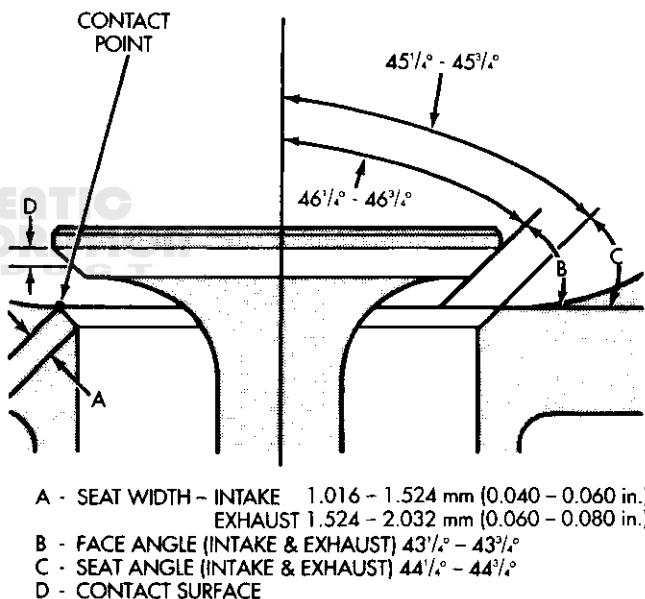
J9309-30

Fig. 53 Reamer Sizes

- Step 2—Ream to 0.381 mm (0.015 inch).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 54).



J9309-95

Fig. 54 Valve Face and Seat Angles

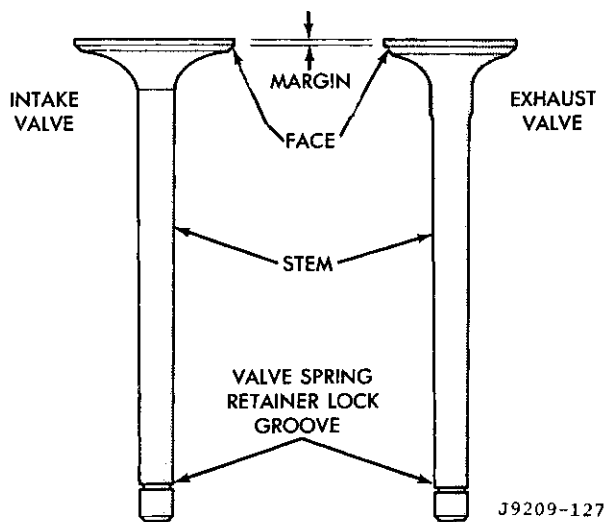
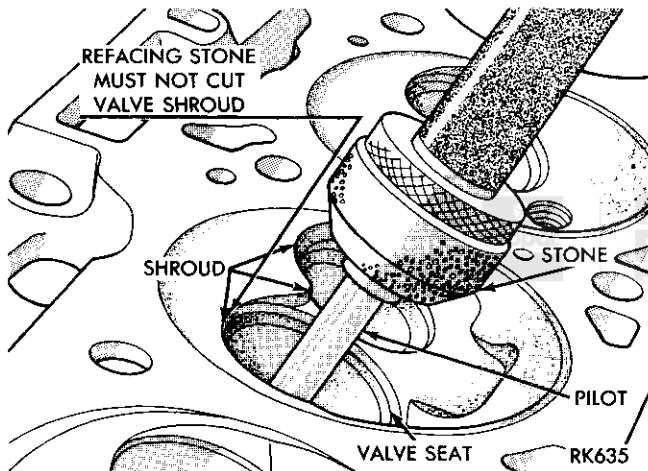
VALVES

Inspect the remaining margin after the valves are refaced (Fig. 55). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 56).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 55 Intake and Exhaust Valves****Fig. 56 Refacing Valve Seats**

(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 inch) total indicator reading.

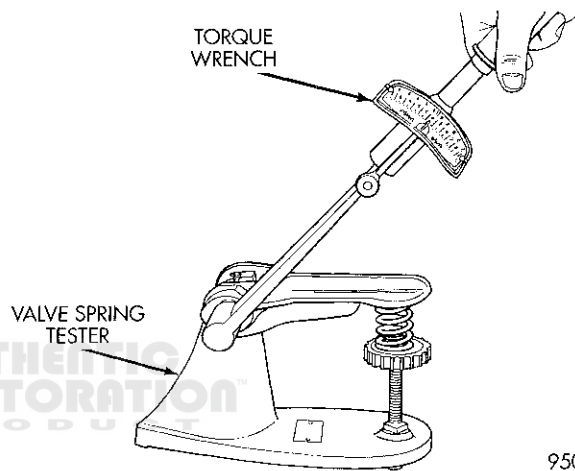
(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 inch). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 inch).

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should

be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 57). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.



9509-79

Fig. 57 Testing Valve Spring for Compressed Length**OIL PUMP****DISASSEMBLE**

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw.

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 58).

(2) Remove oil pump cover (Fig. 59).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 59).

(4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

ASSEMBLE

(1) Install pump rotors and shaft, using new parts as required.

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.

DISASSEMBLY AND ASSEMBLY (Continued)

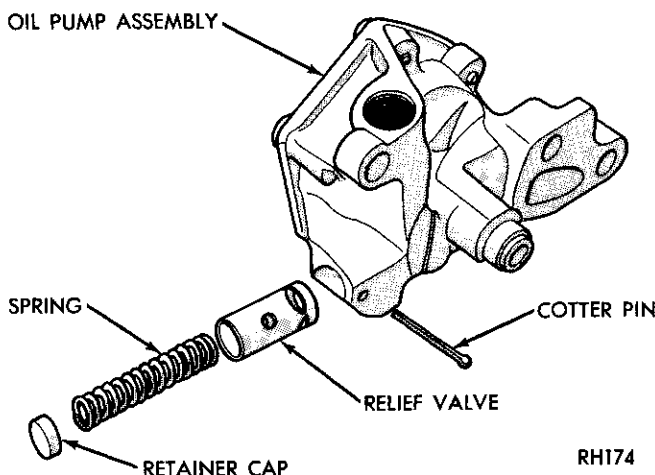


Fig. 58 Oil Pressure Relief Valve

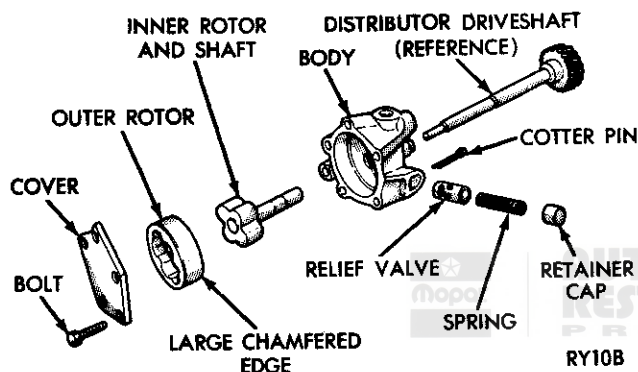


Fig. 59 Oil Pump

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

(5) Prime oil pump before installation by filling rotor cavity with engine oil.

CYLINDER BLOCK

DISASSEMBLE

Engine assembly removed from vehicle:

- (1) Remove the cylinder head.
- (2) Remove the oil pan.
- (3) Remove the piston and connecting rod assemblies.

ASSEMBLE

- (1) Install the piston and connecting rod assembly.
- (2) Install the oil pan.
- (3) Install the cylinder head.
- (4) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEADS

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 inch/inch) times the span length in inches in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE: A 305 mm (12 inch) span is 0.102 mm (0.004 inch) out-of-flat. The allowable out-of-flat is 305×0.00075 (12 x 0.00075) equals 0.23 mm (0.009 inch). This amount of out-of-flat is acceptable.

The cylinder head surface finish should be 1.78-3.00 microns (70-125 micro inches).

Inspect push rods. Replace worn or bent rods.

PISTON AND CONNECTING ROD ASSEMBLY

INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 60).

CRANKSHAFT INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

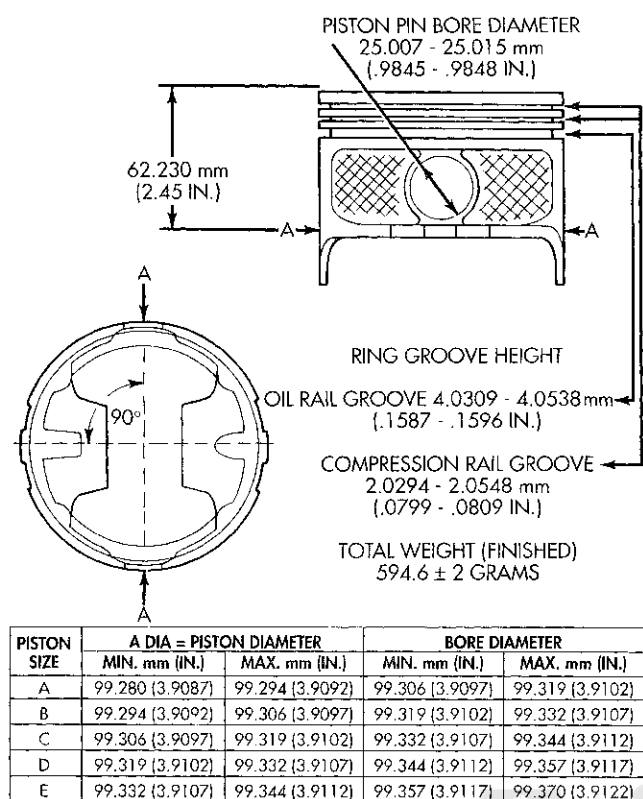
Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

CLEANING AND INSPECTION (Continued)**Fig. 60 Piston Measurements**

Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT** remove the sealant inside the rear main cap slots.

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

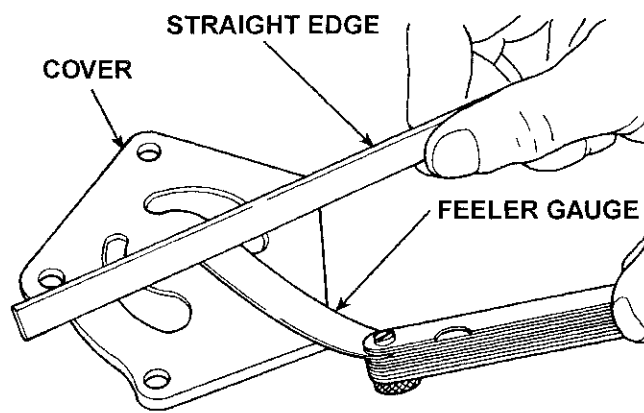
Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

OIL PUMP**INSPECTION**

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 61). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

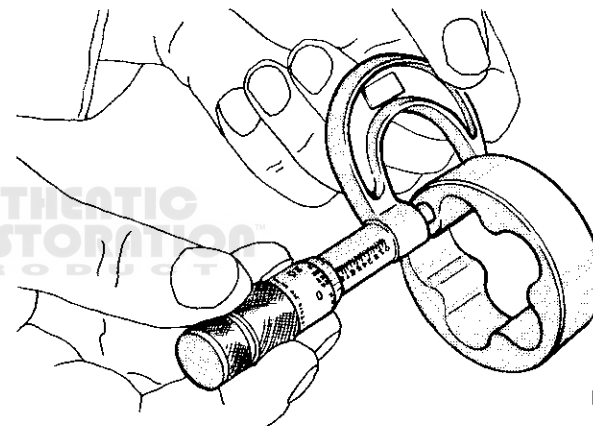
Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825



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Fig. 61 Checking Oil Pump Cover Flatness

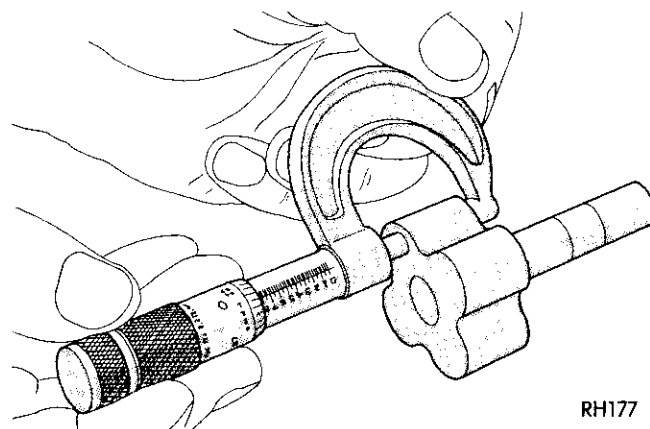
inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 62).



RH176

Fig. 62 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 63).



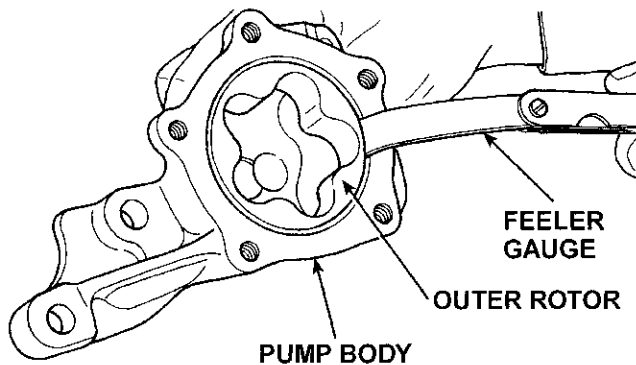
RH177

Fig. 63 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 64). If clearance

CLEANING AND INSPECTION (Continued)

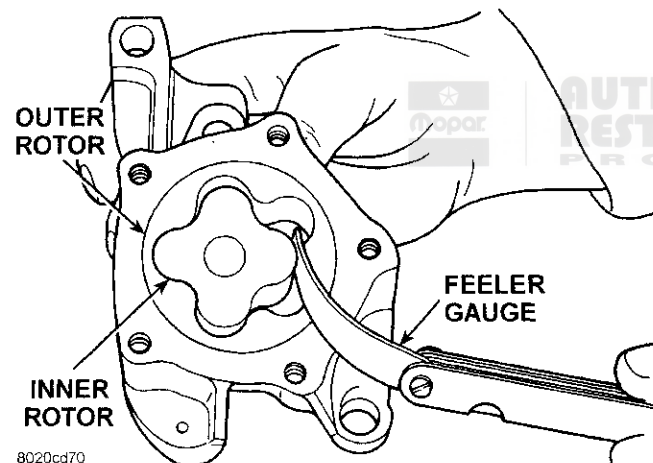
is 0.356 mm (0.014 inch) or more, replace oil pump assembly.



8020cd6f

Fig. 64 Measuring Outer Rotor Clearance in Housing

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 65).



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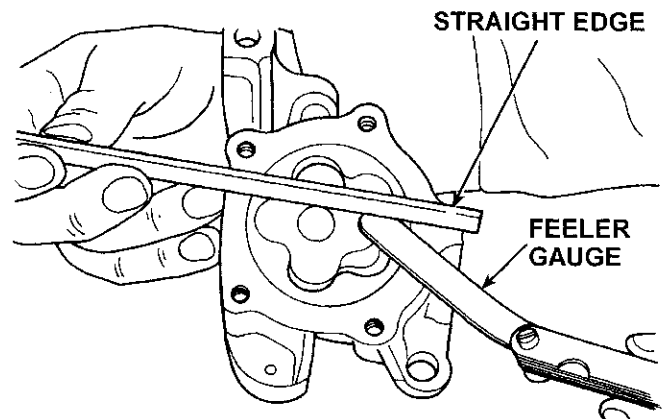
Fig. 65 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 66).

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

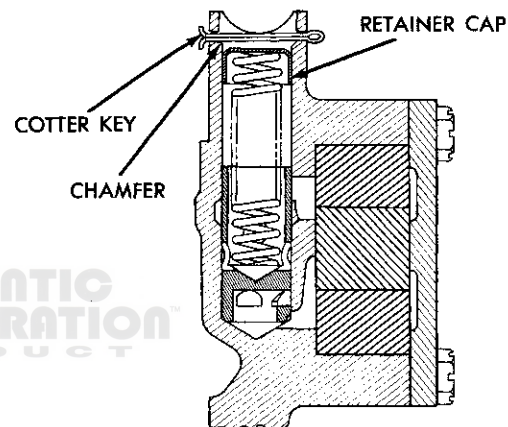
The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 67).

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.



8020cd71

Fig. 66 Measuring Clearance Over Rotors



RN98

**Fig. 67 Proper Installation of Retainer Cap
CYLINDER BLOCK**

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 in.) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 in.).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings, so that specified clearances can be maintained.

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and

CLEANING AND INSPECTION (Continued)

oil-from-filter passages (Fig. 68). Improper installation or plug missing could cause erratic, low, or no oil pressure.

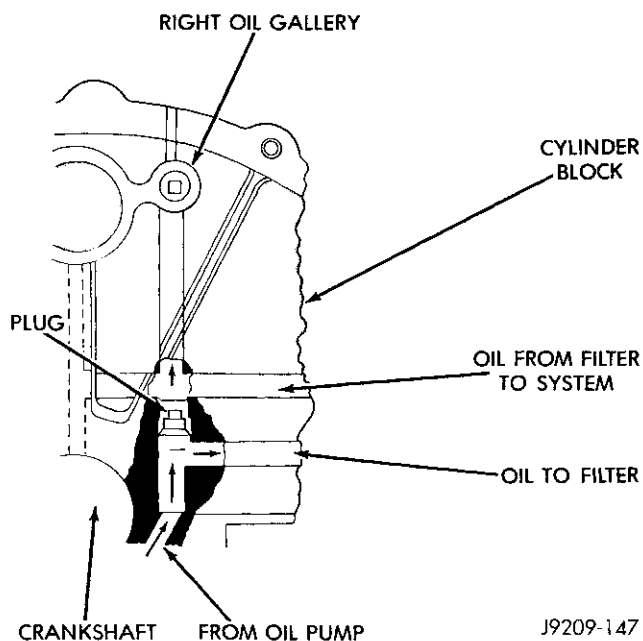
The oil plug must come out the bottom. Use flat dowel, down the oil pressure sending unit hole from the top, to remove oil plug.

(1) Remove oil pressure sending unit from back of block.

(2) Insert a 3.175 mm (1/8 in.) finish wire, or equivalent, into passage.

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 68). If plug is too high, use a suitable flat dowel to position properly.

(4) If plug is too low, remove oil pan and No. 4 main bearing cap. Use suitable flat dowel to position properly. Coat outside diameter of plug with Mopar Stud and Bearing Mount Adhesive, or equivalent. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 in.) from bottom of the block.



J9209-147

Fig. 68 Oil Line Plug**AUTHENTIC
RESTORATION
PRODUCT**

SPECIFICATIONS

5.2L ENGINE SPECIFICATIONS

Camshaft

Bearing Diameter

No. 1	50.800-50.825 mm (2.000-2.001 in)
No. 2	50.394-50.419 mm (1.984-1.985 in)
No. 3	50.013-50.038 mm (1.969-1.970 in)
No. 4	49.606-49.632 mm (1.953-1.954 in)
No. 5	39.688-39.713 mm (1.5625-1.5635 in)

Diametrical Clearance 0.0254-0.0762 mm
(0.001-0.003 in)

Max. Allowable 0.127 mm
(0.005 in)

End Play 0.051-0.254 mm
(0.002-0.010 in)

Bearing Journal Diameter

No. 1	50.749-50.775 mm (1.998-1.999 in)
No. 2	50.343-50.368 mm (1.982-1.983 in)
No. 3	49.962-49.987 mm (1.967-1.968 in)
No. 4	49.555-49.581 mm (1.951-1.952 in)
No. 5	39.637-39.662 mm (1.5605-1.5615 in)

Connecting Rods

Bearing Clearance 0.013-0.056 mm
(0.0005-0.0022 in)

Max. Allowable 0.08 mm (0.003 in)

Piston Pin Bore Diameter 24.966-24.978 mm
(0.9829-0.9834 in)

Side Clearance (Two Rods) 0.152-0.356 mm
(0.006-0.014 in)

Total Weight (Less Bearing) 726 grams
(25.61 oz)

Crankshaft

Connect Rod Journal

Diameter 53.950-53.975 mm
(2.124-2.125 in)

Out-of-Round (Max.) 0.0254 mm
(0.001 in)

Taper (Max.) 0.0254 mm
(0.001 in)

Diametrical Clearance

No. 1 0.013-0.038 mm
(0.0005-0.0015 in)

Nos. 2, 3, 4 and 5 0.013-0.051 mm
(0.005-0.0020 in)

Max. Allowable (Nos. 2, 3, 4 & 5) 0.064 mm
(0.0025 in)

End Play 0.051-0.178 mm
(0.002-0.007 in)

Max. Allowable 0.254 mm
(0.010 in)

Main Bearing Journals

Diameter 63.487-63.513 mm
(2.4995-2.5005 in)

Out-of-Round (Max.) 0.0254 mm
(0.001 in)

Taper (Max.) 0.0254 mm
(0.001 in)

Cylinder Block

Cylinder Bore

Diameter 99.314-99.365 mm
(3.910-3.912 in)

Out-of-Round (Max.) 0.127 mm
(0.005 in)

Taper (Max.) 0.254 mm
(0.010 in)

Oversize (Max.) 1.016 mm
(0.040 in)

Distributor Lower Drive Shaft

Bushing (Press Fit in Block) 0.0127-0.3556 mm
(0.0005-0.0140 in)

Shaft-to-Bushing Clearance 0.0178-0.0686 mm
(0.0007-0.0027 in)

Tappet Bore Diameter 22.99-23.01 mm
(0.9051-0.9059 in)

Cylinder Head

Compression Pressure 689 kPa
(100 psi)

Gasket Thickness (Compressed) 1.2065 mm
(0.0475 in)

Valve Seat

Angle 44.25° - 44.75°

Runout (Max.) 0.0762 mm
(0.003 in)

Width (Finish) - Intake 1.016-1.524 mm
(0.040-0.060 in)

Width (Finish) - Exhaust 1.524-2.032 mm
(0.060-0.080 in)

Hydraulic Tappets

Body Diameter 22.949-22.962 mm
(0.9035-0.9040 in)

Clearance in Block 0.0279-0.0610 mm
(0.0011-0.0024 in)

Dry Lash 1.524-5.334 mm
(0.060-0.210 in)

Push Rod Length 175.64-176.15 mm
(6.915-6.935 in)

SPECIFICATIONS (Continued)**Oil Pump**

Clearance Over Rotors (Max.)	0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.)	0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in)
Outer Rotor	
Clearance (Max.)	0.3556 mm (0.014 in)
Diameter (Min.)	62.7126 mm (2.469 in)
Thickness (Min.)	20.955 mm (0.825 in)
Tip Clearance Between Rotors (Max.)	0.2032 mm (0.008 in)

Oil Pressure

At Curb Idle Speed (Minimum)*	41.4 kPa (6 psi)
At 3000 rpm	207-552 kPa (30-80 psi)
Oil Pressure Switch	
Actuating Pressure (Min.)	34.5-48.3 kPa (5-7 psi)

*CAUTION: If pressure is ZERO at curb idle,
DO NOT run engine at 3,000 rpm.

Oil Filter

Bypass Valve Setting	62-103 kPa (9-15 psi)
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Pistons

Clearance at Top of Skirt	0.0127-0.0381 mm (0.0005-0.0015 in)
Land Clearance (Diametrical)	0.635-1.016 mm (0.025-0.040 in)
Piston Length	86.360 mm (3.40 in)
Piston Ring Groove Depth	
Nos. 1 and 2	4.572-4.826 mm (0.180-0.190 in)
No. 3	3.810-4.064 mm (0.150-0.160 in)
Weight	592.6-596.6 grams (20.90-21.04 oz)

Piston Pins

Clearance	
In Piston	0.00635-0.01905 mm (0.00025-0.00075 in)
In Rod (Interference)	0.0178-0.0356 mm (0.0007-0.0014 in)
Diameter	24.996-25.001 mm (0.9841-0.9843 in)
End Play	NONE
Length	75.946-76.454 mm (2.990-3.010 in)

Piston Rings

Ring Gap	
Compression Rings	0.254-0.508 mm (0.010-0.020 in)
Oil Control (Steel Rails)	0.254-1.270 mm (0.010-0.050 in)
Ring Side Clearance	
Compression Rings	0.038-0.076 mm (0.0015-0.0030 in)
Oil Ring (Steel Rails)	0.06-0.21 mm (0.002-0.008 in)
Ring Width	
Compression Rings	1.971-1.989 mm (0.0776-0.0783 in)
Oil Ring (Steel Rails)	3.848-3.975 mm (0.1515-0.1565 in)

Valves

Face Angle	43.25°-43.75°
Head Diameter	
Intake	48.666 mm (1.916 in)
Exhaust	41.250 mm (1.624 in)
Length (Overall)	
Intake	124.28-125.92 mm (4.893-4.918 in)
Exhaust	124.64-125.27 mm (4.907-4.932 in)
Lift (Zero Lash)	10.973 mm (0.432 in)
Stem Diameter	7.899-7.925 mm (0.311-0.312 in)
Stem-to-Guide Clearance	0.0254-0.0762 mm (0.001-0.003 in)
Max. Allowable (Rocking Method)	0.4318 mm (0.017 in)
Guide Bore Diameter (Std)	7.950-7.976 mm (0.313-0.314 in)

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SPECIFICATIONS (Continued)**Valve Springs**



Free Length (Approx.)	49.962 mm (1.967 in)
Spring Tension (Valve Closed)	@ 41.66 mm = 378 N (@ 1.64 in = 85 lbs)
Spring Tension (Valve Open)	@ 30.89 mm = 890 N (@ 1.212 in = 200 lbs)
Number of Coils	6.8
Installed Height (Spring Seat to Retainer)	41.66 mm (1.64 in)
Wire Diameter	4.50 mm (0.177 in)

Valve Timing

Exhaust Valve	
Closes (ATC)	21°
Opens (BBC)	60°
Duration	264°
Intake Valve	
Closes (ABC)	61°
Opens (BTC)	10°
Duration	250°
Valve Overlap	31°

J9409-99

ENGINE SPECIFICATIONS—CONT.

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Milled flat on no. 8 crankshaft counterweight.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	  AUTHENTIC RESTORATION PRODUCT	Diamond-shaped stamp top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

J9309-82

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

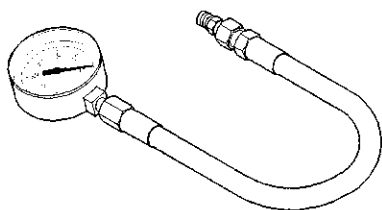
SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Adjusting Strap Bolt	23 N•m (200 in. lbs.)
Camshaft Bolt	68 N•m (50 ft. lbs.)
Camshaft Thrust Plate Bolts	24 N•m (210 in. lbs.)
Chain Case Cover Bolts	41 N•m (30 ft. lbs.)
Connecting Rod Cap Bolts	61 N•m (45 ft. lbs.)
Crankshaft Main Bearing Cap Bolts	115 N•m (85 ft. lbs.)
Cylinder Head Bolts	
1st Step	68 N•m (50 ft. lbs.)
2nd Step	143 N•m (105 ft. lbs.)
Cylinder Head Cover Bolts	11 N•m (95 in. lbs.)
Exhaust Manifold-to-Cylinder Head Bolts/Nuts	34 N•m (25 ft. lbs.)
Front Mount - Thru-Bolt Nut	68 N•m (50 ft. lbs.)
Front Mount - Engine Support Bracket/Cushion Bolts	81 N•m (60 ft. lbs.)
Generator Mounting Bolt	41 N•m (30 ft. lbs.)
Intake Manifold Bolts	Refer to Procedure in Service Manual.
Oil Pan Bolts	23 N•m (200 in. lbs.)
Oil Pan Drain Plug	34 N•m (25 ft. lbs.)
Oil Pump Attaching Bolts	41 N•m (30 ft. lbs.)
Oil Pump Cover Bolts	11 N•m (95 in. lbs.)

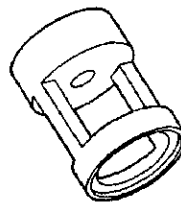
DESCRIPTION	TORQUE
Rear Mount - Support Cushion-to- Crossmember Nut	47 N•m (35 ft. lbs.)
Rear Mount - Support Cushion-to- Trans. Support Bracket Nuts	47 N•m (35 ft. lbs.)
Rear Mount - Transmission Support Bracket Bolts	102 N•m (75 ft. lbs.)
Rear Support Plate-to-Transfer Case Bolts	41 N•m (30 ft. lbs.)
Rocker Arm Bolts	23 N•m (200 in. lbs.)
Spark Plugs	41 N•m (30 ft. lbs.)
Starter Mounting Bolts	68 N•m (50 ft. lbs.)
Throttle Body Bolts	23 N•m (200 in. lbs.)
Torque Converter Drive Plate Bolts	31 N•m (270 in. lbs.)
Transfer Case-to-Insulator Mounting Plate Nuts	204 N•m (150 ft. lbs.)
Vibration Damper Retainer Bolt	183 N•m (135 ft. lbs.)
Water Pump-to-Chain Case Cover Bolt	41 N•m (30 ft. lbs.)

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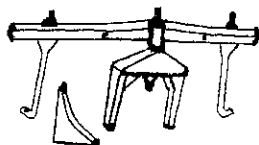
TORQUE SPECIFICATIONS

SPECIAL TOOLS**5.2L ENGINE**

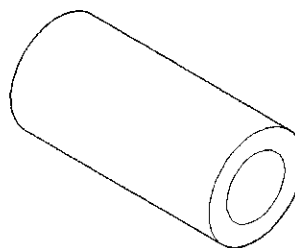
Oil Pressure Gauge C-3292



Adapter 6716A



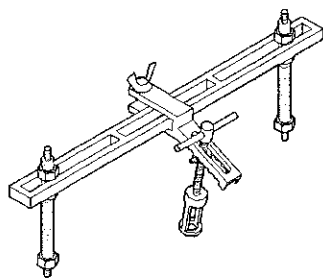
Engine Support Fixture C-3487-A



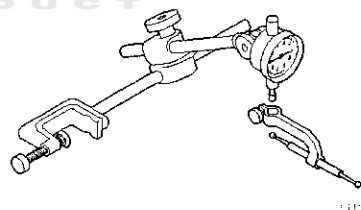
Valve Guide Sleeve C-3973



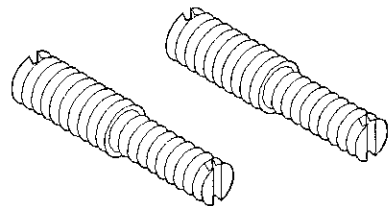
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RESTORATION
PRODUCT**



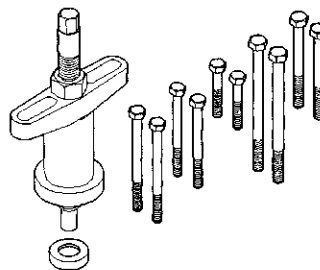
Valve Spring Compressor MD-998772-A



Dial Indicator C-3339

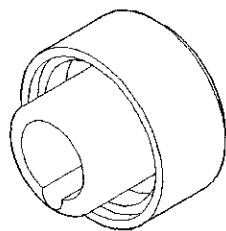


Adapter 6633

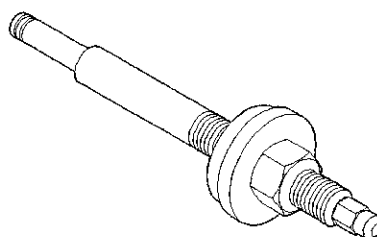


Puller C-3688

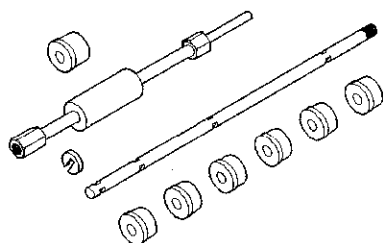
SPECIAL TOOLS (Continued)



Front Oil Seal Installer 6635

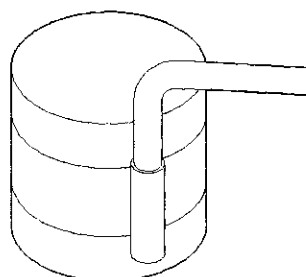


Distributor Bushing Driver/Burnisher C-3053

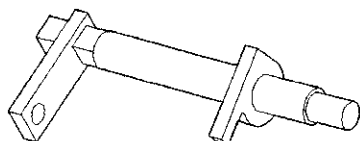


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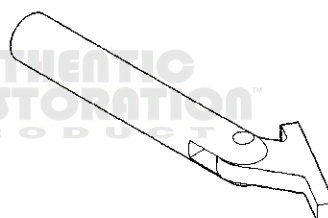
Cam Bearing Remover/Installer C-3132-A



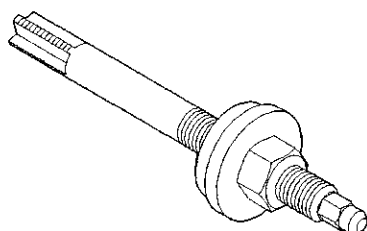
Piston Ring Compressor C-385



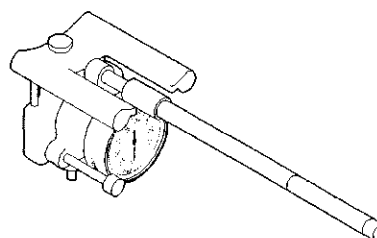
Camshaft Holder C-3509



Crankshaft Main Bearing Remover C-3059



Distributor Bushing Puller C-3052



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Cylinder Bore Gauge C-119

5.9L ENGINE

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GENERAL INFORMATION

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine at 3,000 RPM.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 5.9 Liter (360 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets (Fig. 1).

This engine is designed for unleaded fuel.

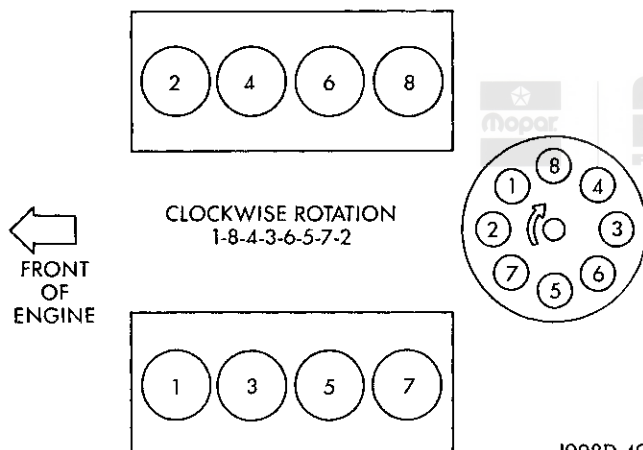
Engine lubrication system consists of a rotor type oil pump and a full flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5, 7 on the left bank and 2, 4, 6, 8 on the right bank. The firing order is 1-8-4-3-6-5-7-2 (Fig. 2).

DESCRIPTION AND OPERATION (Continued)

Engine Type.....	90° V-8 OHV
Bore and Stroke.....	101.6 x 90.9 mm (4.00 x 3.58 in.)
Displacement.....	5.9L (360 cu. in.)
Compression Ratio.....	9.1:1
Torque.....	448 N•m (330 ft. lbs.) @ 3,250 rpm
Firing Order.....	1-8-4-3-6-5-7-2
Lubrication.....	Pressure Feed - Full Flow Filtration
Engine Oil Capacity.....	4.7L (5.0 Qts) w/filter
Cooling System.....	Liquid Cooled - Forced Circulation
Cooling Capacity.....	14.7L (15.5 Qts)
Cylinder Block.....	Cast Iron
Crankshaft.....	Nodular Iron
Cylinder Head.....	Cast Iron
Combustion Chambers.....	Wedge-High Swirl Valve Shrouding
Camshaft.....	Nodular Cast Iron
Pistons.....	Cast Aluminum Alloy
Connecting Rods.....	Forged Steel

J9409-11

Fig. 1 Engine Description

J908D-49

Fig. 2 Firing Order

The engine serial number is stamped into a machined pad located on the left, front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 3).

LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the rear main bearing cap. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears

X M 5.9L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

5.9L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 3 Engine Identification Number

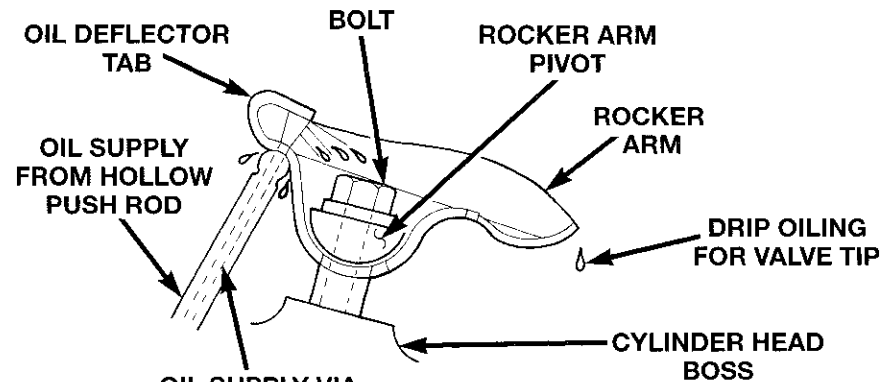
and pump body, then forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main gallery which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block and into the oil gallery on the left side of the engine.

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing has half a hole in it, oil passes through the hole when the rods rotate and the hole lines up, oil is then thrown off as the rod rotates. This oil throw off lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the number one main bearing cap.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components. The oil then passes down through the push rod guide holes, and the oil drain back passages in the cylinder head past the valve tappet area, and returns to the oil pan.

DESCRIPTION AND OPERATION (Continued)



OIL SUPPLY VIA HOLLOW PUSH ROD SUPPLY IS FROM OIL GALLERY METERED THROUGH HYDRAULIC TAPPET

OIL PASSAGE FOR OIL PRESSURE INDICATOR LIGHT

RIGHT OIL GALLERY

PASSAGE TO CAMSHAFT REAR BEARING

OIL FROM FILTER TO SYSTEM

OIL TO FILTER

FROM OIL PUMP

CRANKSHAFT

PLUG

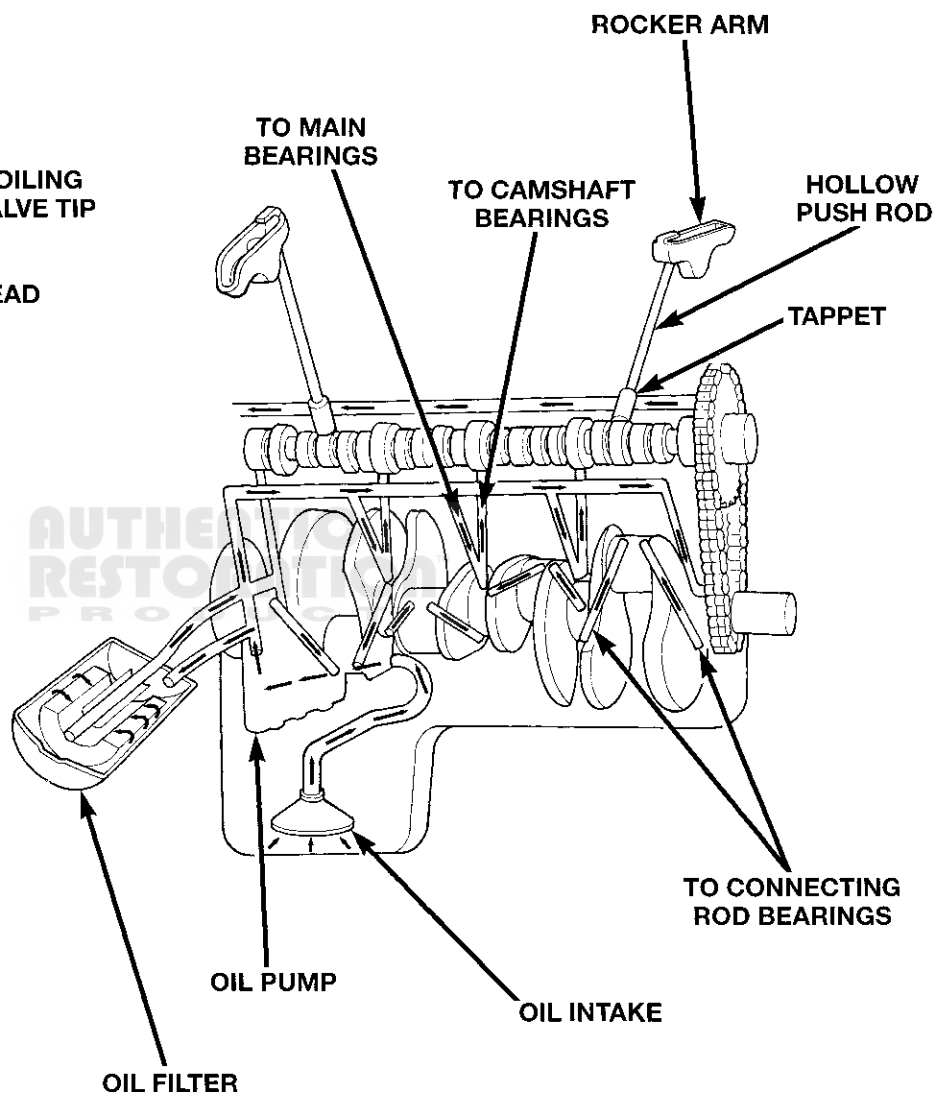


Fig. 4 Oil Lubrication System

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DESCRIPTION AND OPERATION (Continued)**ENGINE COMPONENTS****CYLINDER HEADS**

The alloy cast iron cylinder heads (Fig. 5) are held in place by 10 bolts. The spark plugs are located in the peak of the wedge between the valves.

The 5.9L cylinder head is identified by the foundry mark CF.

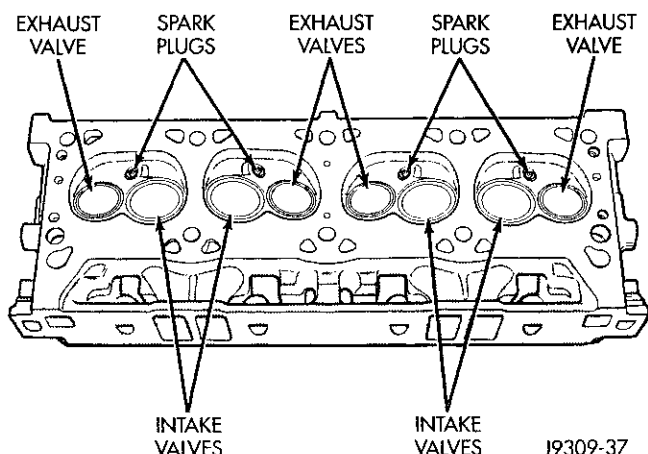


Fig. 5 Cylinder Head Assembly

PISTONS

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

VALVES AND VALVE SPRINGS

The valves are arranged in-line and inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

SERVICE PROCEDURES**VALVE TIMING**

(1) Turn crankshaft until the No.6 exhaust valve is closing and No.6 intake valve is opening.

(2) Insert a 6.350 mm (1/4 inch) spacer between rocker arm pad and stem tip of No.1 intake valve. Allow spring load to bleed tappet down giving in effect a solid tappet.

(3) Install a dial indicator so plunger contacts valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should now read from 10° before top dead center to 2° after top dead center. Remove spacer.

CAUTION: DO NOT turn crankshaft any further clockwise as valve spring might bottom and result in serious damage.

If reading is not within specified limits:

- Check sprocket index marks.
- Inspect timing chain for wear.
- Check accuracy of DC mark on timing indicator.

MEASURING TIMING CHAIN STRETCH

NOTE: To access timing chain Refer to Timing Chain Cover in Removal and Installation Section.

(1) Place a scale next to the timing chain so that any movement of the chain may be measured.

(2) Place a torque wrench and socket over camshaft sprocket attaching bolt. Apply torque in the direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) torque with cylinder head installed or 20 N·m (15 ft. lbs.) torque with cylinder head removed. With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 6).

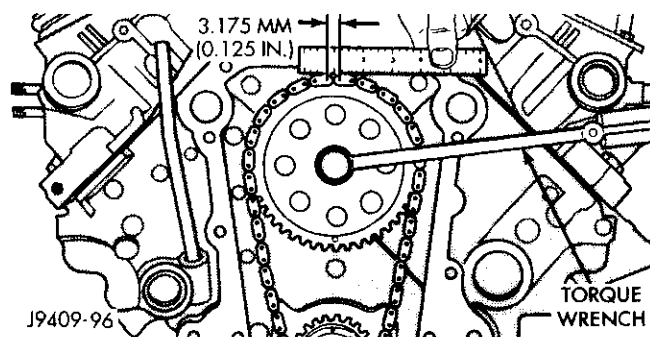


Fig. 6 Measuring Timing Chain Wear and Stretch

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

(5) If chain is not satisfactory, remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

(6) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact

SERVICE PROCEDURES (Continued)

imaginary center line through both camshaft and crankshaft bores.

(7) Place timing chain around both sprockets.

(8) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(9) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 7).

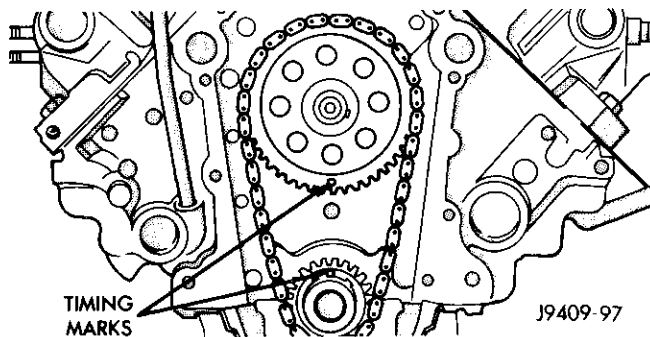


Fig. 7 Alignment of Timing Marks

(11) Install the camshaft bolt. Tighten the bolt to 47 N·m (35 ft. lbs.) torque.

(12) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 inch) at 21°C (70°F).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 8).

FITTING PISTON RINGS

(1) Measurement of end gaps:

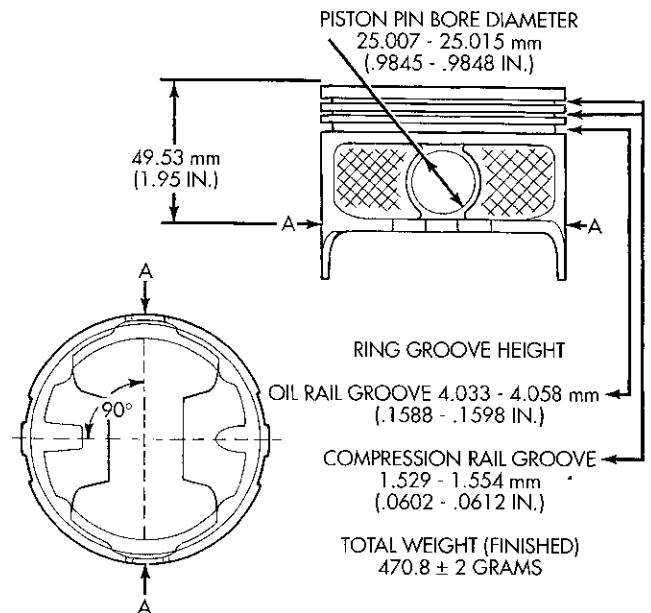


Fig. 8 Piston Measurements

PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (IN.)	MAX. mm (IN.)	MIN. mm (IN.)	MAX. mm (IN.)
A				
B	101.580 (3.9992)	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)
C	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)
D	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)	101.643 (4.0017)
E				

J9509-79

(a) Measure piston ring gap 2 inches from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 inch). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 inch). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 inch).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Rings with excess gaps should not be used.

(2) Install rings and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification

SERVICE PROCEDURES (Continued)

mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP (Fig. 9) (Fig. 11).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 10) (Fig. 11). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 inch) side clearance.

(e) Pistons with insufficient or excessive side clearance should be replaced.

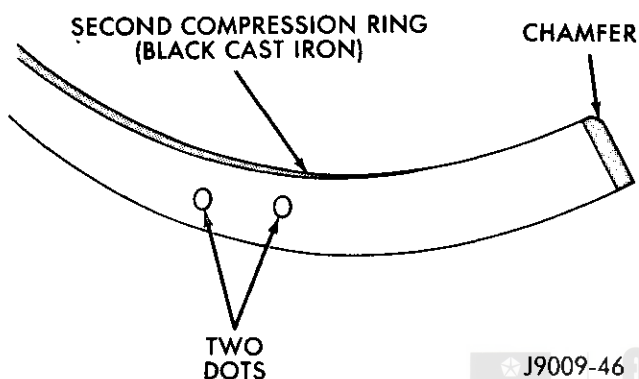


Fig. 9 Second Compression Ring Identification (Typical)

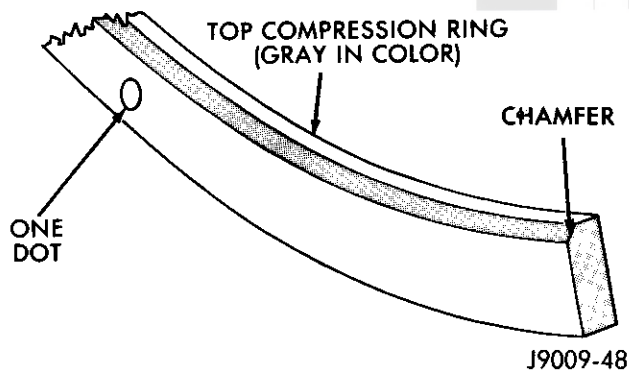


Fig. 10 Top Compression Ring Identification (Typical)

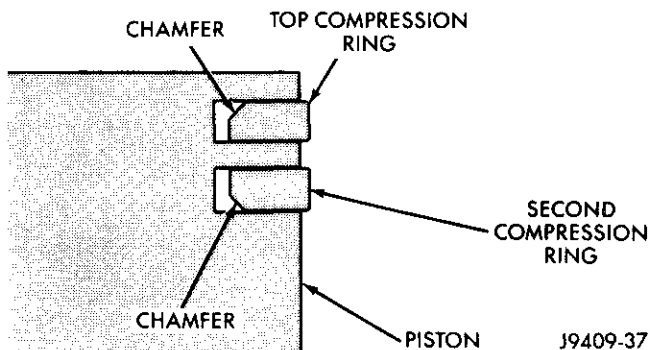


Fig. 11 Compression Ring Chamfer Location (Typical)

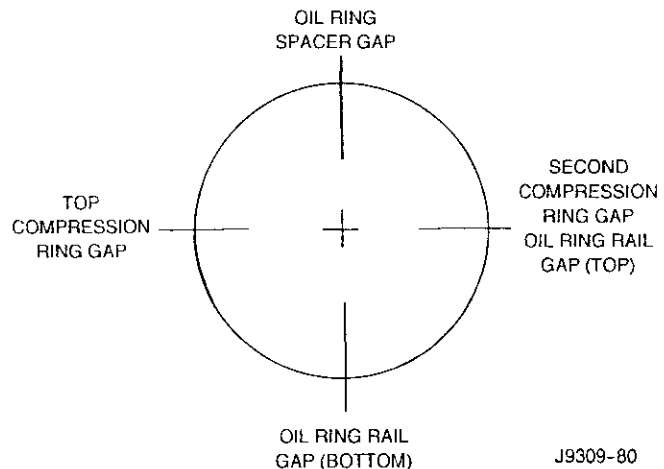


Fig. 12 Proper Ring Installation

FITTING CONNECTING ROD BEARINGS

Fit all rods on a bank until completed. **DO NOT** alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

The bearing caps are not interchangeable and should be marked at removal to ensure correct assembly.

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, make certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch). Bearings are available in 0.025 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch) under-size. **Install the bearings in pairs. DO NOT use a new bearing half with an old bearing half. DO NOT file the rods or bearing caps.**

FITTING CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are **NOT** interchangeable. Lower main bearing halves of No.2 and 4 are interchangeable.

Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are **NOT** interchangeable with any other bearing halves in the engine (Fig. 13). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

SERVICE PROCEDURES (Continued)

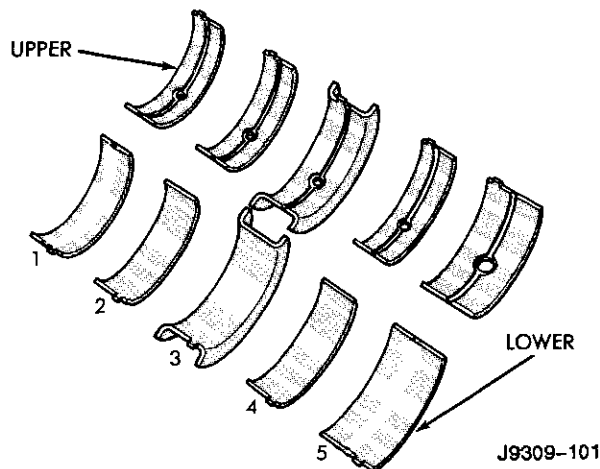


Fig. 13 Main Bearing Identification

CRANKSHAFT SERVICE

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.3 crankshaft counterweight (Fig. 14).

FOR EXAMPLE: R2 stamped on the No.3 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

Undersize Journal	Identification Stamp
0.025 mm (0.001 inch) (Rod)	R1-R2-R3 or R4
0.025 mm (0.001 inch) (Main)	M1-M2-M3-M4 or M5

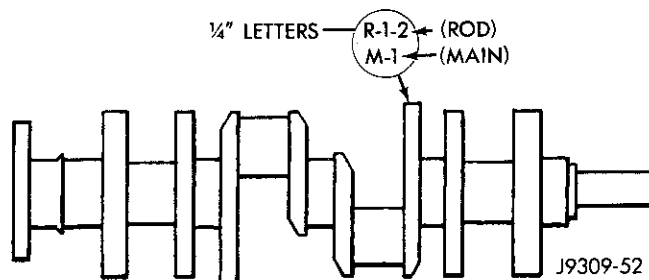


Fig. 14 Location of Crankshaft Identification

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scor-

ing. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

REMOVAL AND INSTALLATION

ENGINE FRONT MOUNTS

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

CAUTION: DO NOT lift the engine by the intake manifold.

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 15).
- (6) Remove engine support bracket/cushion bolts (Fig. 15). Remove the support bracket/cushion and heat shields.

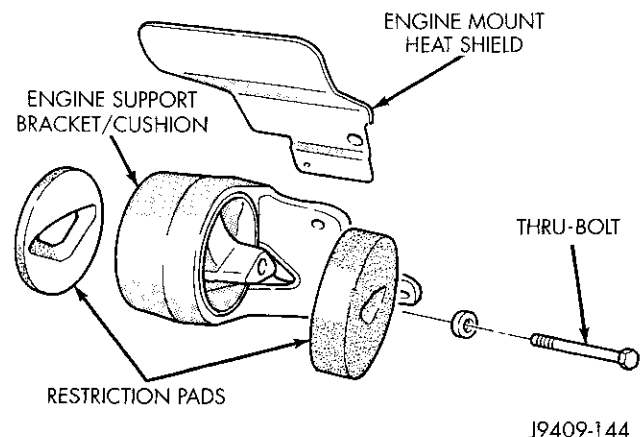


Fig. 15 Engine Front Mounts

INSTALLATION

- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(2) Install the thru-bolt into the engine support bracket/cushion.

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 16).

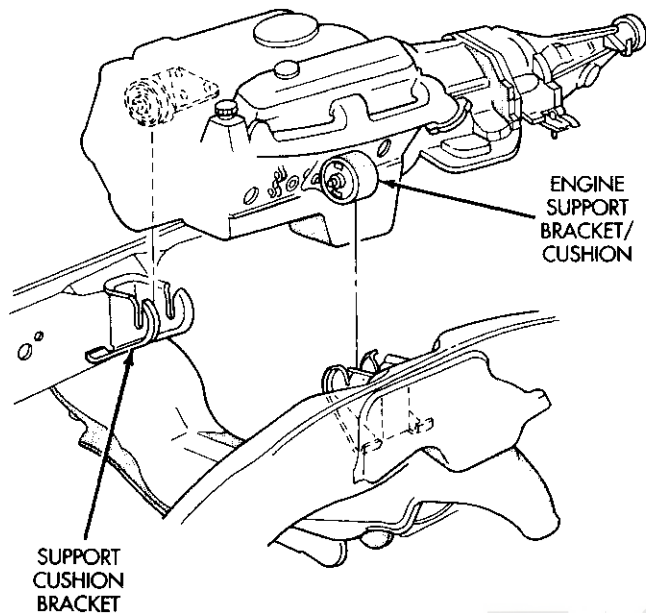


Fig. 16 Positioning Engine Front Mounts

- (4) Install thru-bolt nuts and tighten the nuts to 102 N·m (75 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Remove lifting fixture.

ENGINE REAR MOUNT**REMOVAL**

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 17).
- (4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 17).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

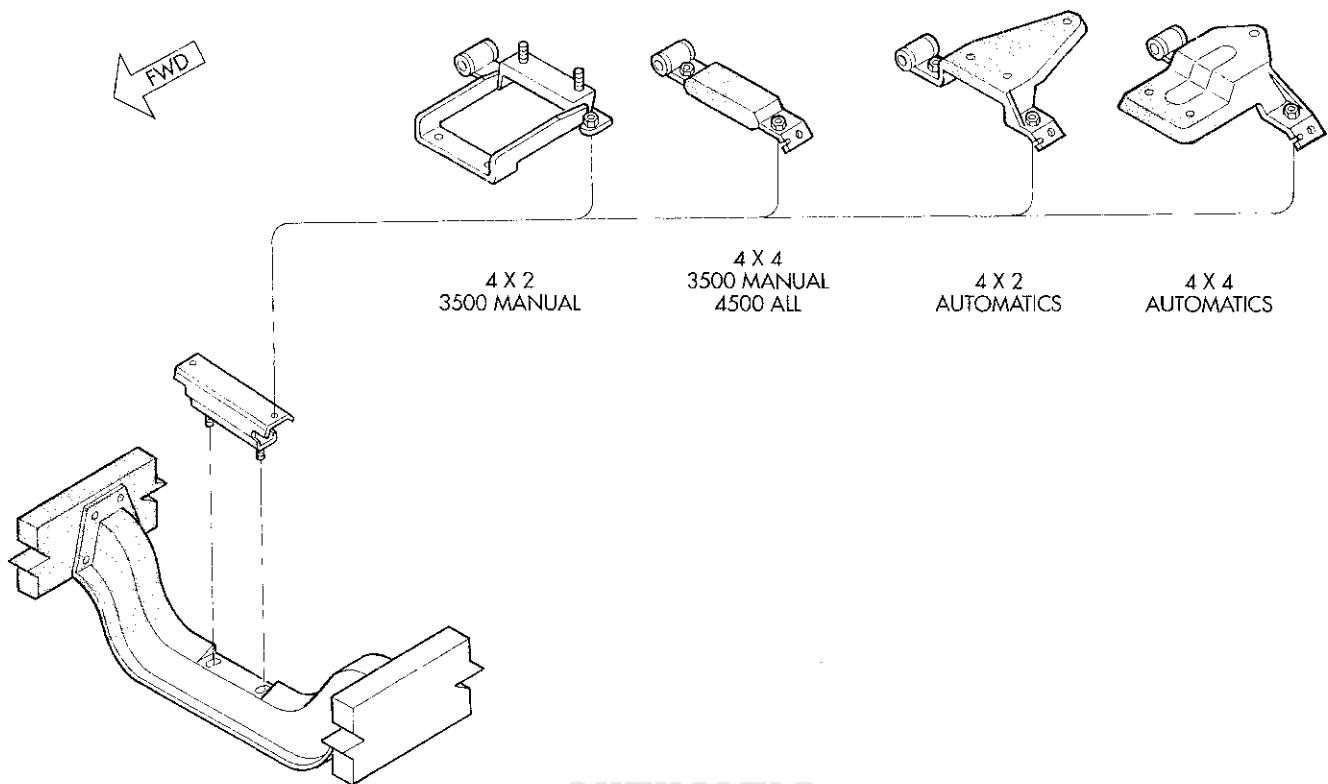
(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

- (1) Remove the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System for the proper procedure).
- (3) Remove the upper crossmember and top core support.
- (4) Remove the transmission oil cooler.
- (5) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
- (6) Remove the serpentine belt (refer to Group 7, Cooling System).
- (7) Remove the A/C compressor with the lines attached. Set aside.
- (8) If equipped, remove the condenser.
- (9) Remove the washer bottle.
- (10) Disconnect the top radiator hose.
- (11) Remove the fan.
- (12) Remove the fan shroud.
- (13) Disconnect the lower radiator hose.
- (14) Remove radiator (refer to Group 7, Cooling System).
- (15) Remove the generator with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).
- (16) Remove the air cleaner.
- (17) Disconnect the throttle linkage.
- (18) Remove throttle body.
- (19) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (20) Remove the distributor cap and wiring.
- (21) Disconnect the heater hoses.
- (22) Disconnect the power steering hoses, if equipped.
- (23) Disconnect the transmission cooler lines.
- (24) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.
- (25) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).
- (26) Raise and support the vehicle on a hoist.
- (27) Remove the drain plug and drain the engine oil.
- (28) Remove engine front mount thru-bolt nuts.
- (29) Remove the transmission cooler line brackets from oil pan.
- (30) Disconnect exhaust pipe at manifold.

REMOVAL AND INSTALLATION (Continued)



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Fig. 17 Engine Rear Support Cushion Assemblies

(31) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(32) Remove the dust shield and transmission cover.

(33) Refer to group 21, Transmissions for transmission removal.

(34) Remove the prop shaft (refer to Group 16, Propeller Shaft).

(35) Lower the vehicle.

(36) Install a jack stand under the automatic transmission.

CAUTION: DO NOT lift the engine by the intake manifold.

(37) Install an engine lifting fixture.

(38) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the thru-bolt into the support cushion brackets.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group, 21 Transmissions for transmission installation

(5) Install rear transmission support.

(6) Install the prop shaft (refer to Group 16, Propeller Shaft).

(7) Install the dust shield and transmission cover.

(8) Install the starter and connect the starter wires (refer to Group 8B, Battery/Starter/Generator Service).

(9) Install exhaust pipe to manifold.

(10) Install the transmission cooler line brackets from oil pan.

(11) Install engine front mount thru-bolt nuts. Tighten the nuts.

(12) Install the drain plug and tighten to 34 N-m (25 ft. lbs.) torque.

(13) Lower the vehicle.

(14) Remove engine lifting fixture.

(15) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).

(16) Connect the fuel lines.

(17) Connect the transmission cooler lines.

(18) Connect the power steering hoses, if equipped.

(19) Connect the heater hoses.

(20) Install the distributor cap and wiring.

(21) Install the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

REMOVAL AND INSTALLATION (Continued)

(22) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.

(23) Connect the throttle linkage.

(24) Install the air cleaner box.

(25) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(26) Install radiator (refer to Group 7, Cooling System).

(27) Connect the lower radiator hose.

(28) Install the fan shroud.

(29) Install the fan.

(30) Connect the top radiator hose.

(31) Install the washer bottle.

(32) If equipped, install the condenser.

(33) Install the A/C compressor with the lines attached.

(34) Install the serpentine belt (refer to Group 7, Cooling System).

(35) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(36) Install the transmission oil cooler.

(37) Install the upper crossmember and top core support.

(38) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).

(39) Install the battery.

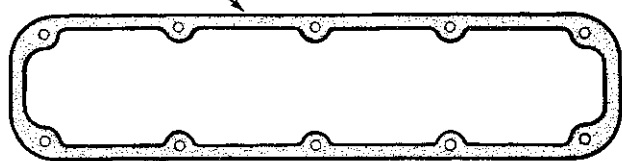
(40) Warm engine and adjust.

(41) Road test vehicle.

CYLINDER HEAD COVER

A steel backed silicon gasket is used with the cylinder head cover (Fig. 18). This gasket can be used again.

CYLINDER HEAD
COVER GASKET



J9209-105

Fig. 18 Cylinder Head Cover Gasket

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.

(3) Remove cylinder head cover and gasket. The gasket may be used again.

INSTALLATION

(1) Clean cylinder head cover gasket surface.

(2) Clean head rail, if necessary.

(3) Inspect cover for distortion and straighten, if necessary.

(4) Check the gasket for use in head cover installation. If damaged, use a new gasket.

(5) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(6) Install closed crankcase ventilation system and evaporation control system.

(7) Connect the negative cable to the battery.

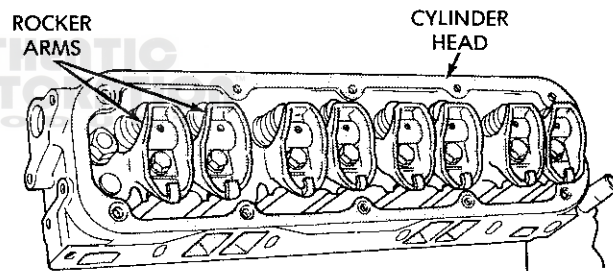
ROCKER ARMS AND PUSH RODS**REMOVAL**

(1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.

(2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and pivots (Fig. 19). Place them on a bench in the same order as removed.

(4) Remove the push rods and place them on a bench in the same order as removed.



J9209-65

Fig. 19 Rocker Arms

INSTALLATION

(1) Rotate the crankshaft until the "V8" mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.

(2) Install the push rods in the same order as removed.

(3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

CAUTION: DO NOT rotate or crank the engine during or immediately after rocker arm installation. Allow the hydraulic roller tappets adequate time to bleed down (about 5 minutes).

(4) Install cylinder head cover.

(5) Connect spark plug wires.

REMOVAL AND INSTALLATION (Continued)

VALVE SPRING AND STEM SEAL REPLACEMENT- IN VEHICLE

- (1) Set engine basic timing to Top Dead Center (TDC).
- (2) Remove the air cleaner.
- (3) Remove cylinder head covers and spark plugs.
- (4) Remove coil wire from distributor and secure to good ground to prevent engine from starting.
- (5) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.
- (6) Remove rocker arms.
- (7) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.
- (8) Using Valve Spring Compressor Tool MD-998772A with adaptor 6633, compress valve spring and remove retainer valve locks and valve spring.
- (9) Install seals on the exhaust valve stem and position down against valve guides.
- (10) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.
- (11) Follow the same procedure on the remaining 7 cylinders using the firing sequence 1-8-4-3-6-5-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.
- (12) Remove adapter from the No.1 spark plug hole.
- (13) Install rocker arms.
- (14) Install covers and coil wire to distributor.
- (15) Install air cleaner.
- (16) Road test vehicle.

CYLINDER HEADS

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).
- (3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.
- (4) Remove closed crankcase ventilation system.
- (5) Disconnect the evaporation control system.
- (6) Remove the air cleaner.
- (7) Disconnect the fuel lines.
- (8) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
- (9) Remove the return spring.
- (10) Remove distributor cap and wires.
- (11) Disconnect the coil wires.
- (12) Disconnect heat indicator sending unit wire.

- (13) Disconnect heater hoses and bypass hose.
- (14) Remove cylinder head covers and gaskets.
- (15) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.
- (16) Remove exhaust manifolds.
- (17) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.
- (18) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.
- (19) Remove spark plugs.

INSTALLATION

- (1) Position the new cylinder head gaskets onto the cylinder block.
- (2) Position the cylinder heads onto head gaskets and cylinder block.
- (3) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 20). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

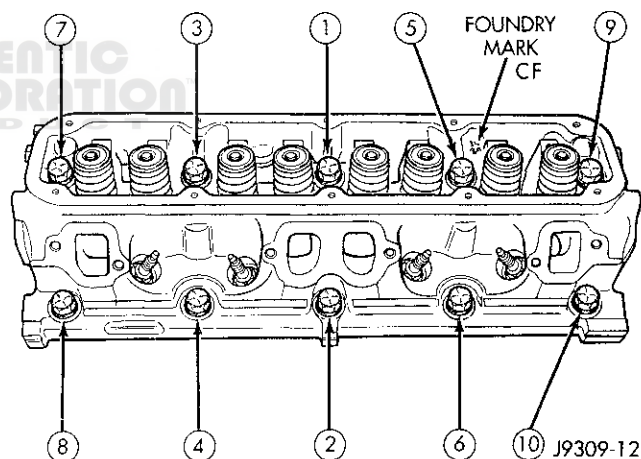


Fig. 20 Cylinder Head Bolt Tightening Sequence

CAUTION: When tightening the rocker arm bolts, make sure the piston in that cylinder is NOT at TDC. Contact between the valves and piston could occur.

- (4) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.
- (5) Install the intake manifold and throttle body assembly (refer to Group 11, Exhaust System and Intake Manifold).
- (6) Install exhaust manifolds. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(7) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(8) Install coil wires.

(9) Connect heat indicator sending unit wire.

(10) Connect the heater hoses and bypass hose.

(11) Install distributor cap and wires.

(12) Hook up the return spring.

(13) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(14) Install the fuel lines.

(15) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

(16) Install the intake manifold-to-generator bracket support rod. Tighten the bolts.

(17) Place the cylinder head cover gaskets in position and install cylinder head covers. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(18) Install closed crankcase ventilation system.

(19) Connect the evaporation control system.

(20) Install the air cleaner.

(21) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(22) Fill cooling system (refer to Group 7, Cooling System for proper procedure).

(23) Connect the negative cable to the battery.

VALVES AND VALVE SPRINGS**REMOVAL**

(1) Remove the cylinder head.

(2) Compress valve springs using Valve Spring Compressor Tool MD-998772A.

(3) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(4) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the valve guides. Identify valves to ensure installation in original location.

INSTALLATION

(1) Coat valve stems with lubrication oil and insert them in cylinder head.

(2) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.

(3) Install new seals on all valve guides. Install valve springs and valve retainers.

(4) Compress valve springs with Valve Spring Compressor Tool MD-998772A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in

cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS**REMOVAL**

(1) Remove the air cleaner.

(2) Remove cylinder head cover.

(3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original location.

(4) Remove intake manifold.

(5) Remove yoke retainer and aligning yokes.

(6) Slide Hydraulic Tappet Remover/Installer tool through opening in cylinder head and seat tool firmly in the head of tappet.

(7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

(8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

INSTALLATION

(1) Lubricate tappets.

(2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.

(5) Install push rods in original positions.

(6) Install rocker arm.

(7) Install cylinder head cover.

(8) Install distributor, start engine and reset timing.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

VIBRATION DAMPER**REMOVAL**

(1) Disconnect the negative cable from the battery.

(2) Remove fan shroud retainer bolts and set shroud back over engine.

(3) Remove the cooling system fan.

REMOVAL AND INSTALLATION (Continued)

(4) Remove the serpentine belt (refer to Group 7, Cooling System).

(5) Remove the vibration damper pulley.

(6) Remove vibration damper bolt and washer from end of crankshaft.

(7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 21).

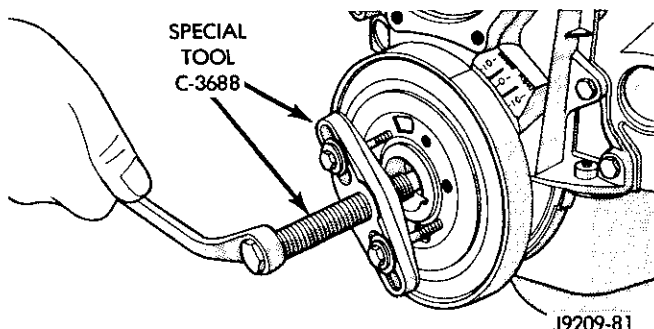


Fig. 21 Vibration Damper Assembly

(8) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

(2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 22).

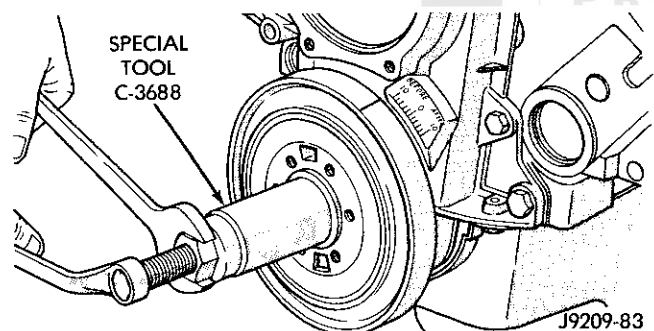


Fig. 22 Installing Vibration Damper

(3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

(4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.

(5) Install the serpentine belt (refer to Group 7, Cooling System).

(6) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(7) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.

(8) Connect the negative cable to the battery.

TIMING CHAIN COVER**REMOVAL**

(1) Disconnect the negative cable from the battery.
(2) Drain cooling system (refer to Group 7, Cooling System).

(3) Remove the serpentine belt (refer to Group 7, Cooling System).

(4) Remove water pump (refer to Group 7, Cooling System).

(5) Remove power steering pump (refer to Group 19, Steering).

(6) Remove vibration damper.

(7) Loosen oil pan bolts and remove the front bolt at each side.

(8) Remove the cover bolts.

(9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.

(10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 23).

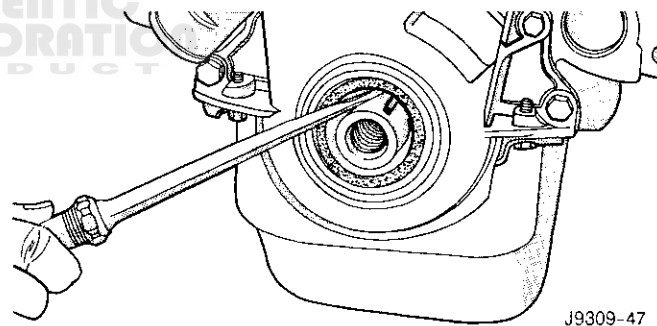


Fig. 23 Removal of Front Crankshaft Oil Seal

INSTALLATION

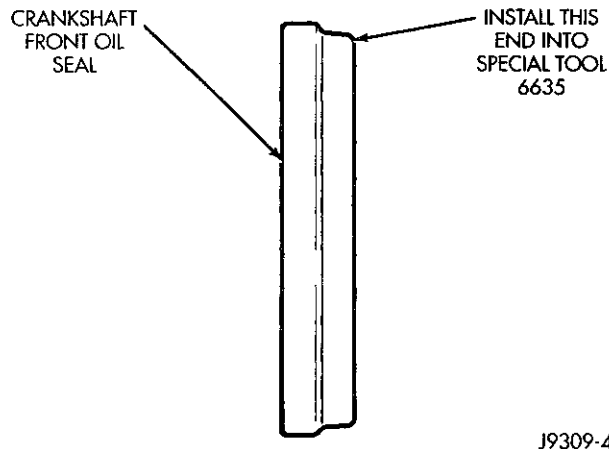
(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

(2) The water pump mounting surface must be cleaned.

(3) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

REMOVAL AND INSTALLATION (Continued)

(4) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 24). Seat the oil seal in the groove of the tool.

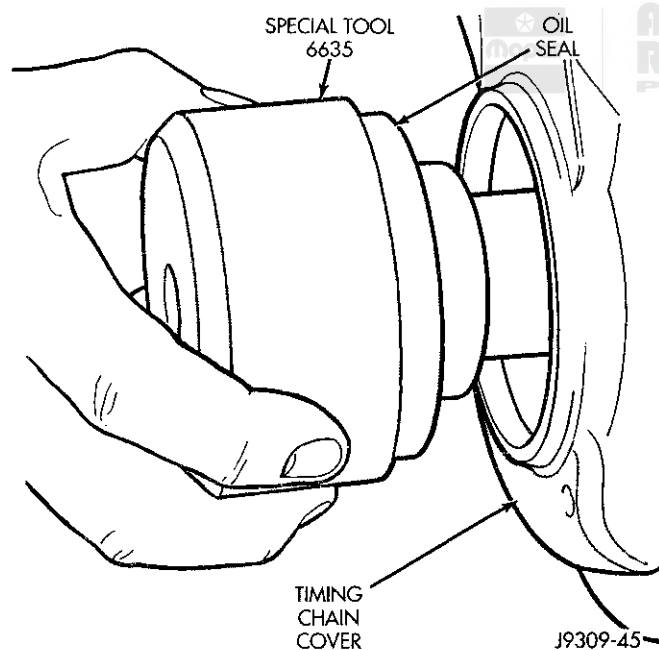


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Fig. 24 Placing Oil Seal on Installation Tool 6635

(5) Position the seal and tool onto the crankshaft (Fig. 25).

(6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.



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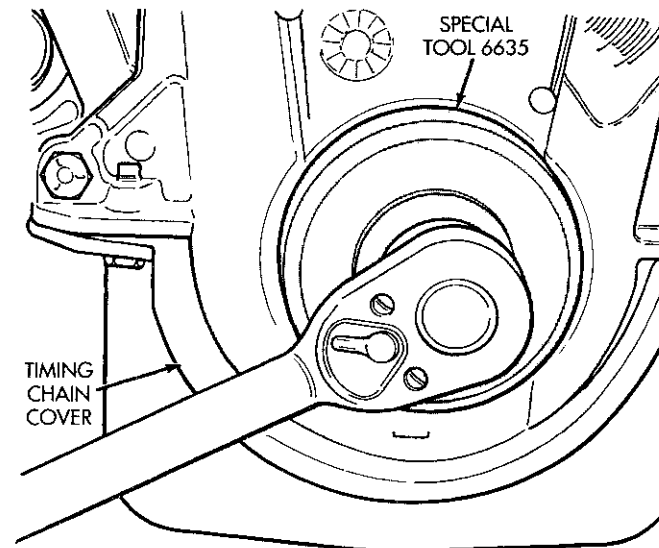
Fig. 25 Position Tool and Seal onto Crankshaft

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 26).

(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

(9) Tighten chain case cover bolts to 41 N·m (30 ft.lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(10) Remove the vibration damper bolt and seal installation tool.



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Fig. 26 Installing Oil Seal

(11) Inspect the seal flange on the vibration damper.

(12) Install vibration damper.

(13) Install water pump and housing assembly using new gaskets (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(14) Install power steering pump (refer to Group 19, Steering).

(15) Install the serpentine belt (refer to Group 7, Cooling System).

(16) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(17) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(18) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).

(19) Connect the negative cable to the battery.

TIMING CHAIN**REMOVAL**

(1) Remove Timing Chain Cover Refer to procedure in this section.

(2) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

INSTALLATION

(1) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

REMOVAL AND INSTALLATION (Continued)

- (2) Place timing chain around both sprockets.
- (3) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.
- (4) Lift sprockets and chain (keep sprockets tight against the chain in position as described).
- (5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 27).

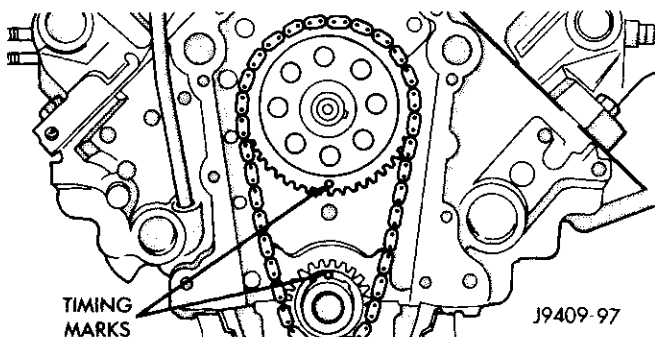


Fig. 27 Alignment of Timing Marks

- (6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.
- (7) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

CAMSHAFT

NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 28).

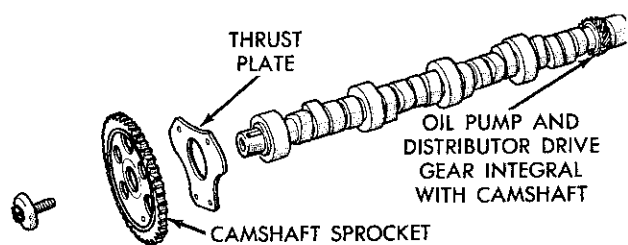


Fig. 28 Camshaft and Sprocket Assembly

REMOVAL

- (1) Remove intake manifold.
- (2) Remove cylinder head covers.
- (3) Remove timing case cover and timing chain.
- (4) Remove rocker arms.
- (5) Remove push rods and tappets. Identify each part so it can be installed in its original location.
- (6) Remove distributor and lift out the oil pump and distributor drive shaft.

- (7) Remove camshaft thrust plate, note location of oil tab (Fig. 29).

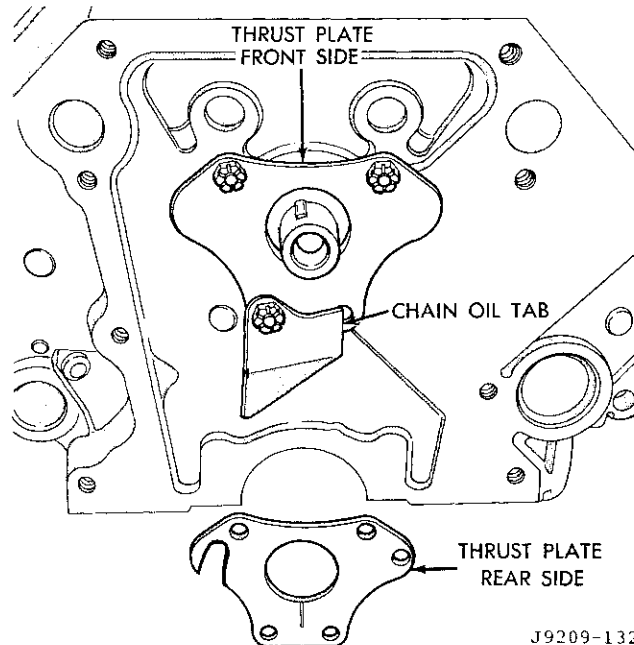


Fig. 29 Timing Chain Oil Tab Installation

- (8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

- (1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

NOTE: Whenever an engine has been rebuilt, a new camshaft and/or new tappets installed, add 1 pint of Mopar Crankcase Conditioner, or equivalent. The oil mixture should be left in engine for a minimum of 805 km (500 miles). Drain at the next normal oil change.

- (2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 30).

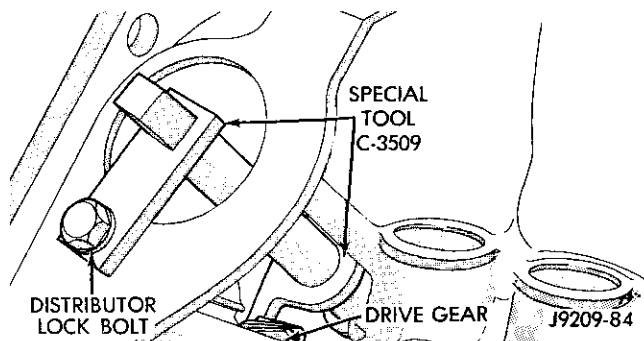


Fig. 30 Camshaft Holding Tool C-3509 (Installed Position)

REMOVAL AND INSTALLATION (Continued)

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the Welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

(5) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(6) Place timing chain around both sprockets.

(7) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(8) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 31).

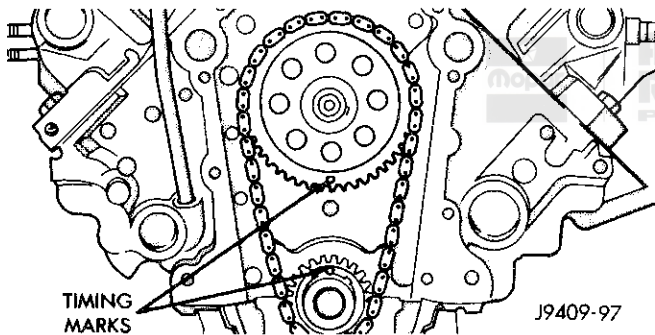


Fig. 31 Alignment of Timing Marks

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

CAMSHAFT BEARINGS**REMOVAL**

NOTE: This procedure requires that the engine is removed from the vehicle.

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer

Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 32).

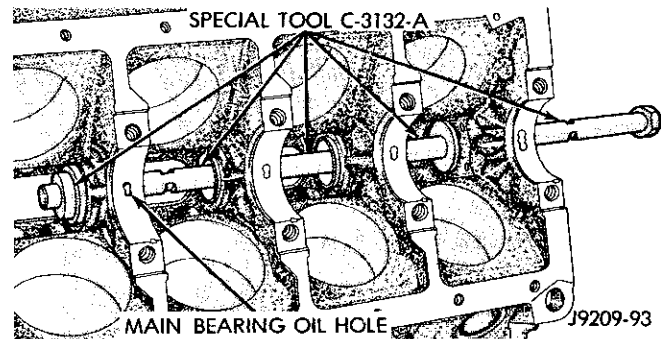


Fig. 32 Camshaft Bearings Removal/Installation with Tool C-3132-A

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CAMSHAFT BEARINGS**REMOVAL**

NOTE: This procedure requires that the engine is removed from the vehicle.

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

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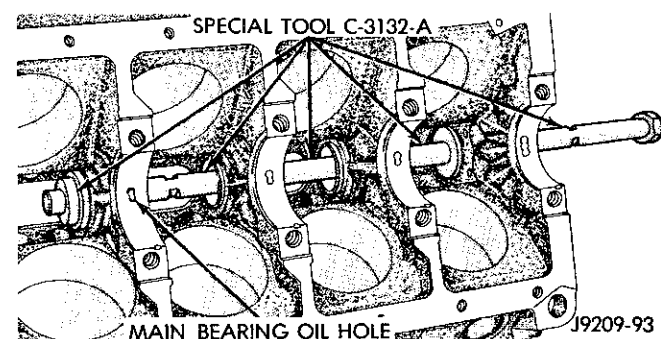


Fig. 33 Camshaft Bearings Removal/Installation with Tool C-3132-A

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion thru-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

INSTALLATION

- (1) Clean the block and pan gasket surfaces.
- (2) Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**
- (3) If present, trim excess sealant from inside the engine.
- (4) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 34).

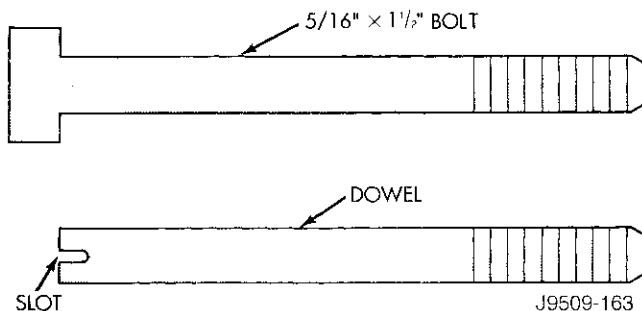


Fig. 34 Fabrication of Alignment Dowels

- (5) Install the dowels in the cylinder block (Fig. 35).

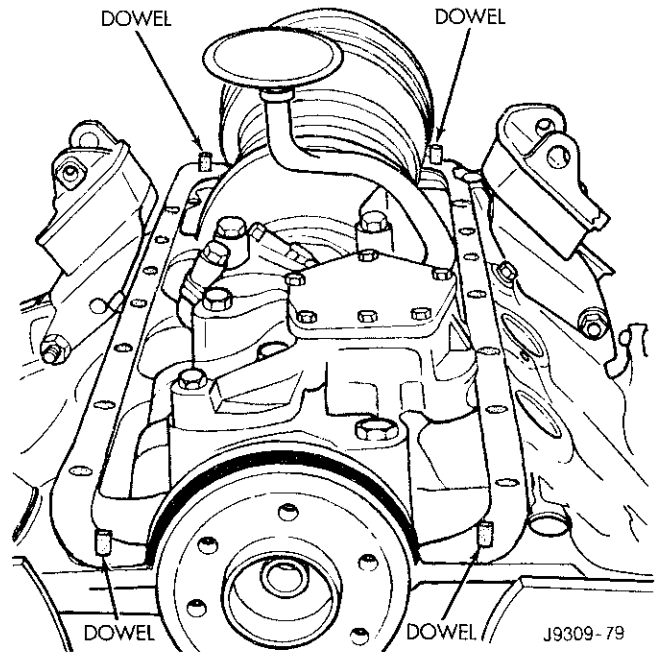


Fig. 35 Position of Dowels in Cylinder Block

- (6) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
- (7) Slide the one-piece gasket over the dowels and onto the block.
- (8) Position the oil pan over the dowels and onto the gasket.
- (9) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.
- (10) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.
- (11) Lower the engine into the support cushion brackets and tighten the thru bolt nut to the proper torque.
- (12) Install the drain plug. Tighten drain plug to 34 N·m (25 ft. lbs.) torque.
- (13) Install the engine to transmission strut.
- (14) Install exhaust pipe.
- (15) Lower vehicle.
- (16) Install dipstick.
- (17) Connect the negative cable to the battery.
- (18) Fill crankcase with oil to proper level.

CRANKSHAFT MAIN BEARINGS

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Identify bearing caps before removal. Remove bearing caps one at a time.

REMOVAL AND INSTALLATION (Continued)

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 36).

(5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

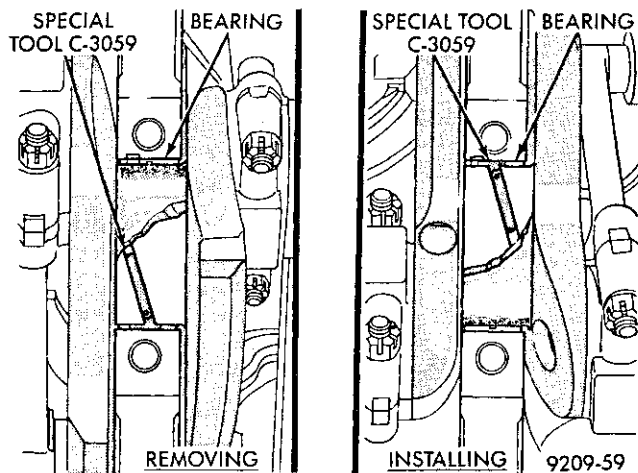


Fig. 36 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 36).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Install the bearing cap. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

PISTON AND CONNECTING ROD ASSEMBLY**REMOVAL**

(1) Remove the engine from the vehicle.

(2) Remove the cylinder head.

(3) Remove the oil pan.

(4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.

(5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft to center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

(7) After removal, install bearing cap on the mating rod.

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in-line with oil ring rail gap.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 37).

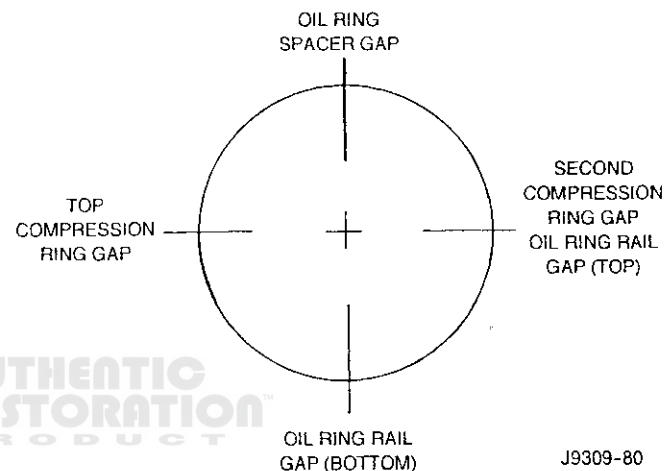


Fig. 37 Proper Ring Installation

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts, the long protector should be installed on the numbered side of the connecting rod.

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on crankshaft journal.

(7) The notch or groove on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

REMOVAL AND INSTALLATION (Continued)

- (10) Install the cylinder head.
- (11) Install the engine into the vehicle.

CRANKSHAFT

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.3 crankshaft counterweight (Fig. 38).

FOR EXAMPLE: R2 stamped on the No.3 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

Undersize Journal	Identification Stamp
0.025 mm (0.001 inch) (Rod)	R1-R2-R3 or R4
0.025 mm (0.001 inch) (Main)	M1-M2-M3-M4 or M5

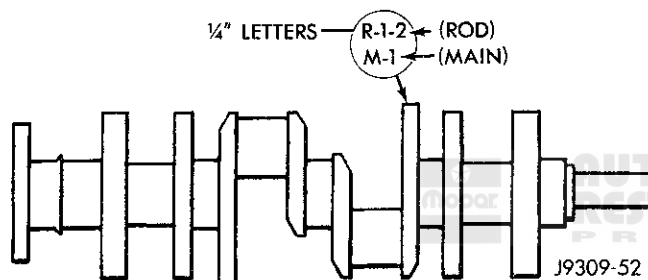


Fig. 38 Location of Crankshaft Identification

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the vibration damper.
- (4) Remove the timing chain cover.
- (5) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.
- (6) Lift the crankshaft out of the block.
- (7) Remove and discard the crankshaft rear oil seals.
- (8) Remove and discard the front crankshaft oil seal.

INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

CLEANING

Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.

INSTALLATION

- (1) Lightly oil the new upper seal lips with engine oil.
- (2) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (3) Position the crankshaft into the cylinder block.
- (4) Lightly oil the new lower seal lips with engine oil.
- (5) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (6) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 39). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

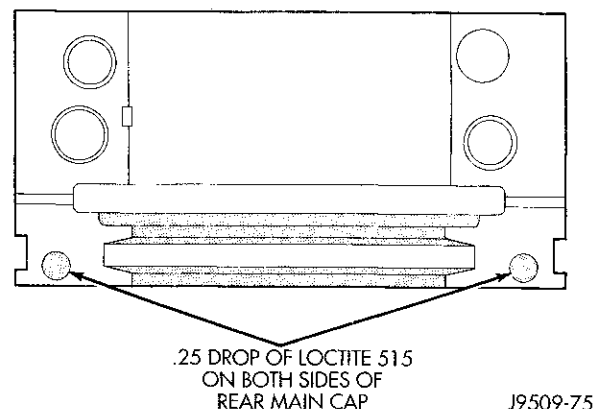


Fig. 39 Sealant Application to Bearing Cap

- (7) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

REMOVAL AND INSTALLATION (Continued)

(8) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(9) Install oil pump.

Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 40). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Install new front crankshaft oil seal.

(11) Immediately install the oil pan.

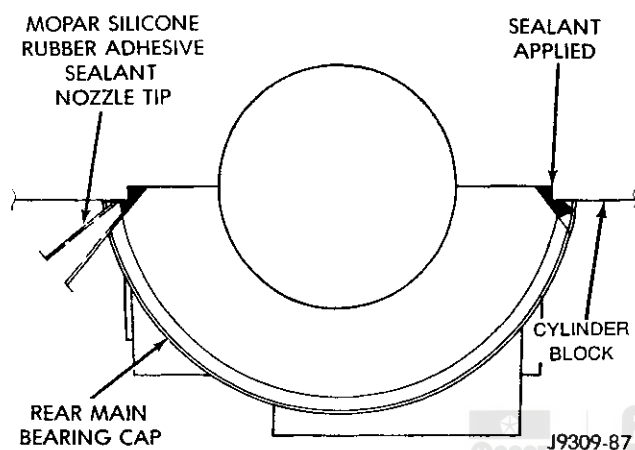


Fig. 40 Apply Sealant to Bearing Cap to Block Joint OIL PUMP

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from rear main bearing cap.

INSTALLATION

- (1) Install oil pump. During installation slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.
- (2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.
- (3) Install the oil pan.

FRONT CRANKSHAFT OIL SEAL

The oil seal can be replaced without removing the timing chain cover provided the cover is not misaligned.

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum

interference. If tool does not fit, the cover must be removed and installed properly.

(4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.

(5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 41). Seat the oil seal in the groove of the tool.

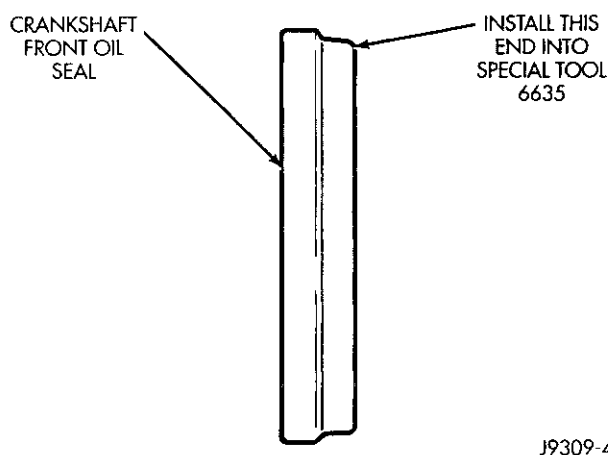


Fig. 41 Placing Oil Seal on Installation Tool 6635

(6) Position the seal and tool onto the crankshaft (Fig. 42).

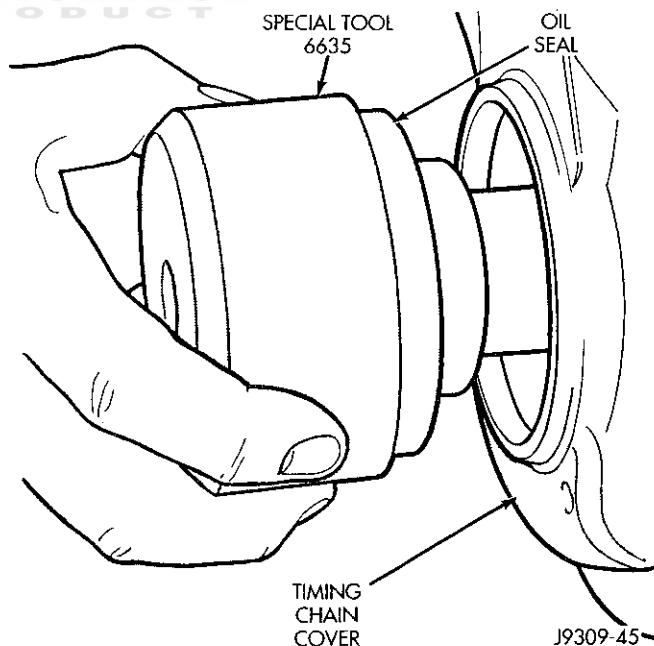
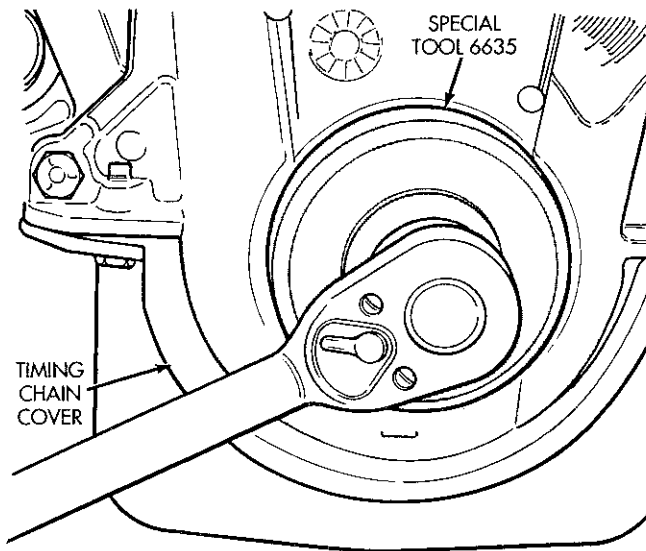


Fig. 42 Position Tool and Seal onto Crankshaft

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 43).

(8) Remove the vibration damper bolt and seal installation tool.

REMOVAL AND INSTALLATION (Continued)

J9309-46

Fig. 43 Installing Oil Seal

- (9) Inspect the seal flange on the vibration damper.
- (10) Install the vibration damper.
- (11) Connect the negative cable to the battery.

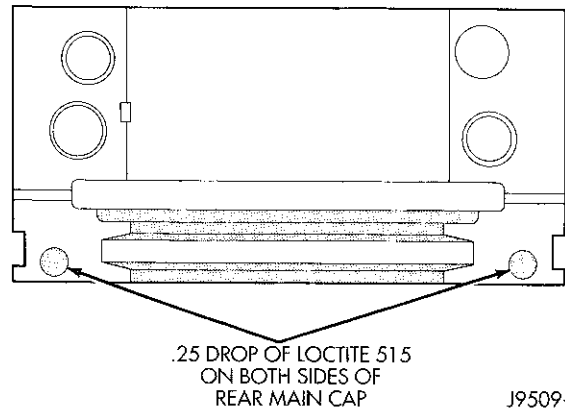
CRANKSHAFT REAR OIL SEALS

The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL REPLACEMENT—CRANKSHAFT REMOVED

- (1) Remove the crankshaft. Discard the old upper seal.
- (2) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.
- (3) Lightly oil the new upper seal lips with engine oil.
- (4) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (5) Position the crankshaft into the cylinder block.
- (6) Lightly oil the new lower seal lips with engine oil.
- (7) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (8) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap

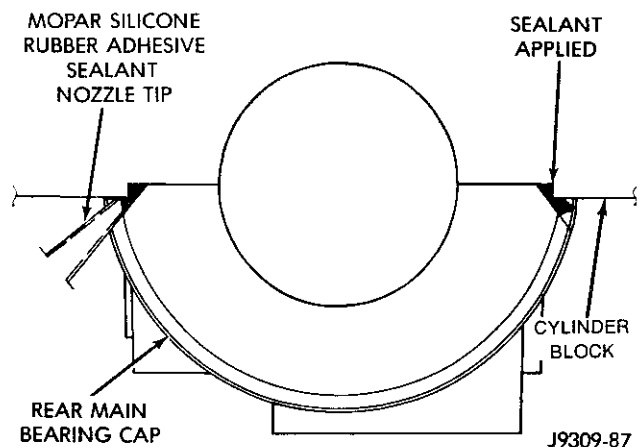
(Fig. 44). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.



J9509-75

Fig. 44 Sealant Application to Bearing Cap

- (9) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
- (10) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.
- (11) Install oil pump.
- (12) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 45). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.



J9309-87

Fig. 45 Apply Sealant to Bearing Cap to Block Joint

- (13) Install new front crankshaft oil seal.
- (14) Immediately install the oil pan.

REMOVAL AND INSTALLATION (Continued)**UPPER SEAL REPLACEMENT—CRANKSHAFT INSTALLED**

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
- (4) Carefully remove and discard the old upper oil seal.
- (5) Clean the cylinder block mating surfaces before oil seal installation.
- (6) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.
- (7) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing towards the rear of the engine.
- (8) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (9) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 44). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.
- (10) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
- (11) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.
- (12) Install oil pump.
- (13) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 45) (Fig. 8). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
- (14) Immediately install the oil pan.

LOWER SEAL REPLACEMENT

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap and discard the old lower seal.
- (4) Clean the rear main cap mating surfaces including the oil pan seal grooves.
- (5) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).

(6) Lightly oil the new lower seal lips with engine oil.

(7) Install a new lower seal in bearing cap with white paint facing the rear of engine.

(8) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 44). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(9) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(10) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten the cap bolts to 115 N·m (85 ft. lbs.) torque.

(11) Install oil pump.

(12) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 45). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(13) Immediately install the oil pan.

ENGINE CORE PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 46). This will reduce internal leakage and help maintain higher oil pressure at idle.

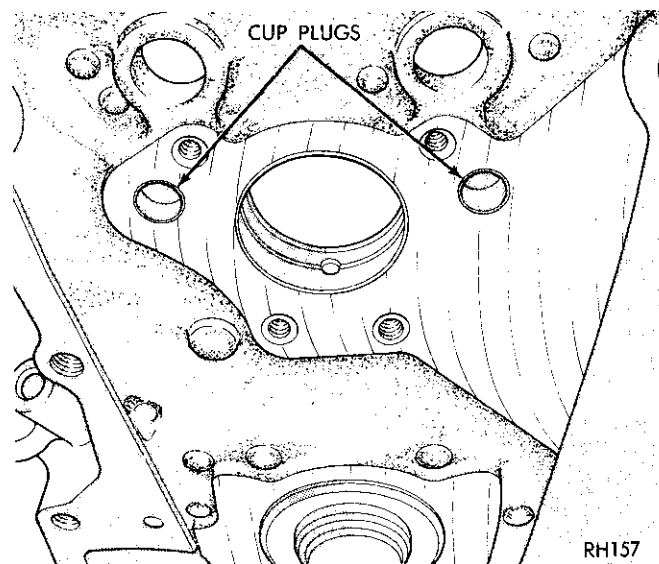


Fig. 46 Location of Cup Plugs in Oil Galleries

REMOVAL

- (1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 47).
- (2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 47).

REMOVAL AND INSTALLATION (Continued)

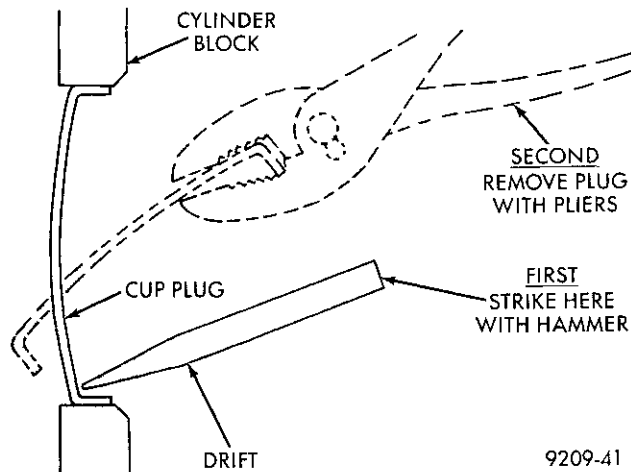


Fig. 47 Core Hole Plug Removal

CLEANING

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Make certain the new plug is cleaned of all oil or grease.

INSTALLATION

(1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting as restricted coolant flow can result and cause serious engine problems.

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 inch) inside the lead-in chamfer.

(3) It is not necessary to wait for curing of the sealant. The cooling system can be filled and the vehicle placed in service immediately.

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

CAUTION: The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. DO NOT disassemble a tappet on a dirty work bench.

DISASSEMBLE

- (1) Pry out plunger retainer spring clip (Fig. 48).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 48). Check valve could be flat or ball.

ASSEMBLE

(1) Clean all tappet parts in a solvent that will remove all varnish and carbon.

(2) Replace tappets that are unfit for further service with new assemblies.

(3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.

(4) Assemble tappets (Fig. 48).

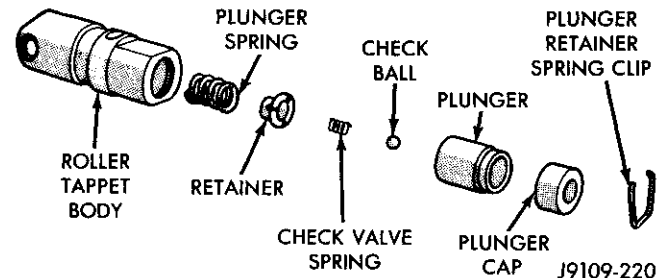


Fig. 48 Hydraulic Tappet Assembly

CYLINDER BLOCK

DISASSEMBLE

- (1) Remove the cylinder head.
- (2) Remove the oil pan.
- (3) Remove the piston/connecting rod assembly.

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the Oil-To-Filter and Oil-From-Filter passages (Fig. 49). Improper installation or plug missing could cause erratic, low or no oil pressure.

(1) Remove oil pressure sending unit from back of block.

(2) Insert a 3.175 mm (1/8 inch) finish wire or equivalent into passage.

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 inches) from machined surface of block (Fig. 49). If plug is too high, use a suitable flat dowel drift to position properly.

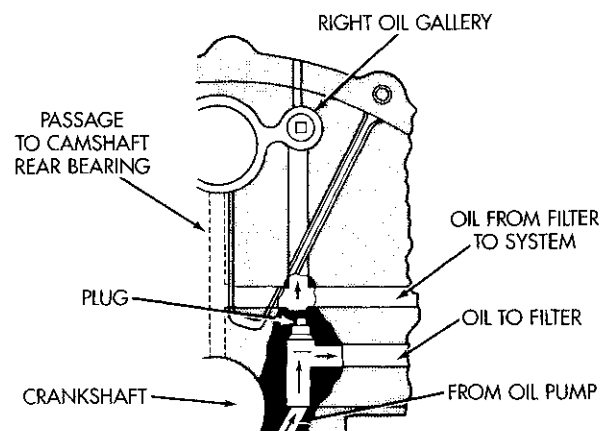


Fig. 49 Oil Line Plug

DISASSEMBLY AND ASSEMBLY (Continued)

(4) If plug is too low, remove oil pan and rear main bearing cap. Use suitable flat dowel to properly position. Coat outside diameter of plug with Mopar[®] (stud and bearing mount adhesive), or equivalent. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 inches) from bottom of the block.

(5) Assemble engine and check oil pressure.

ASSEMBLE

- (1) Install the piston/connecting rod assembly.
- (2) Install the oil pan.
- (3) Install the cylinder head.
- (4) Install the engine into the vehicle.

VALVE SERVICE**VALVE CLEANING**

Clean valves thoroughly. Discard burned, warped and cracked valves.

Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

VALVE INSPECTION

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 50). The special sleeve places the valve at the correct height for checking with a dial indicator.

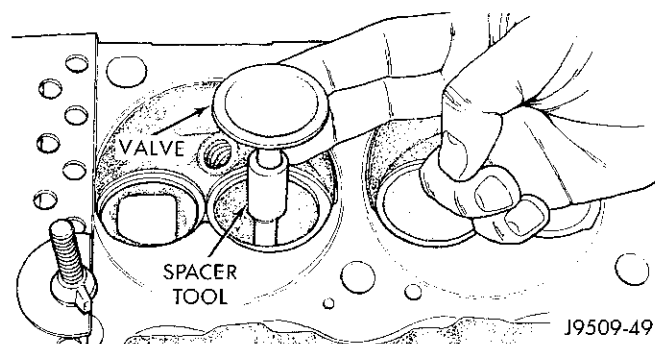


Fig. 50 Positioning Valve with Tool C-3973

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 51).

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 inch). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

Service valves with oversize stems are available (Fig. 52).

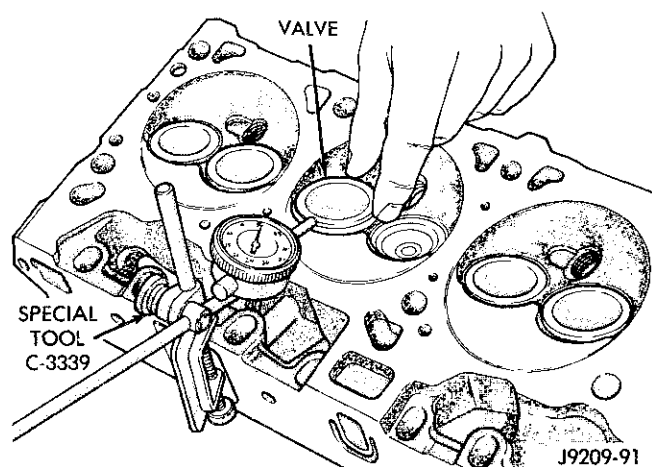


Fig. 51 Measuring Valve Guide Wear

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 - 8.052 mm (0.316 - 0.317 in.)
0.381 mm (0.015 in.)	8.331 - 8.357 mm (0.328 - 0.329 in.)

Fig. 52 Reamer Sizes

Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 inch).** Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:

- Step 1—Ream to 0.0763 mm (0.003 inch).
- Step 2—Ream to 0.381 mm (0.015 inch).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 53).

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 54). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

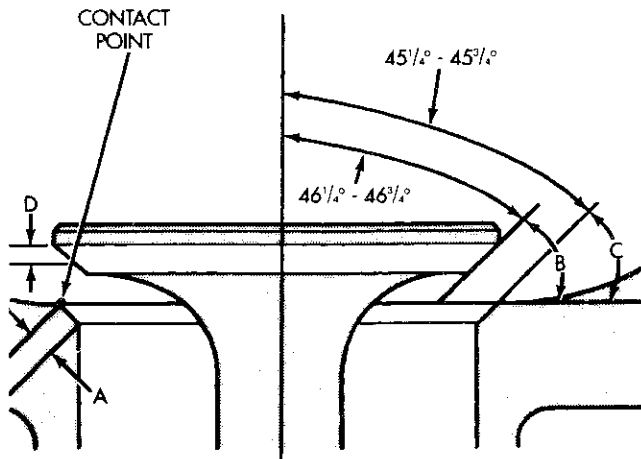
VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 55).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

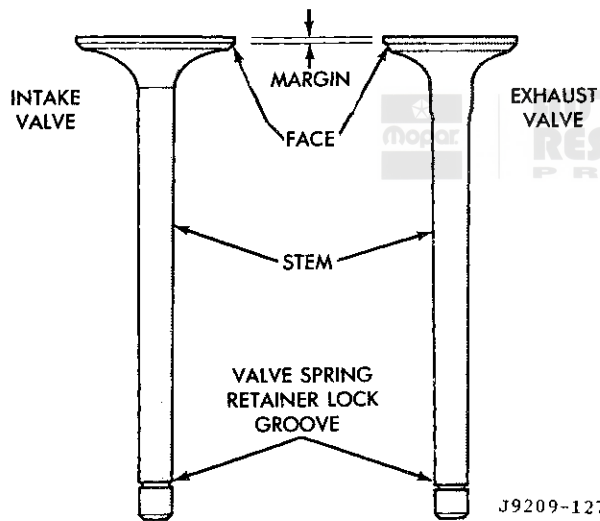
(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 inch) total indicator reading.

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat

DISASSEMBLY AND ASSEMBLY (Continued)

- A - SEAT WIDTH - INTAKE 1.016 - 1.524 mm (0.040 - 0.060 in.)
 EXHAUST 1.524 - 2.032 mm (0.060 - 0.080 in.)
 B - FACE ANGLE (INTAKE & EXHAUST) $43\frac{1}{2}^{\circ}$ - $43\frac{3}{4}^{\circ}$
 C - SEAT ANGLE (INTAKE & EXHAUST) $44\frac{1}{2}^{\circ}$ - $44\frac{3}{4}^{\circ}$
 D - CONTACT SURFACE

J9309-95

Fig. 53 Valve Face and Seat Angles

J9209-127

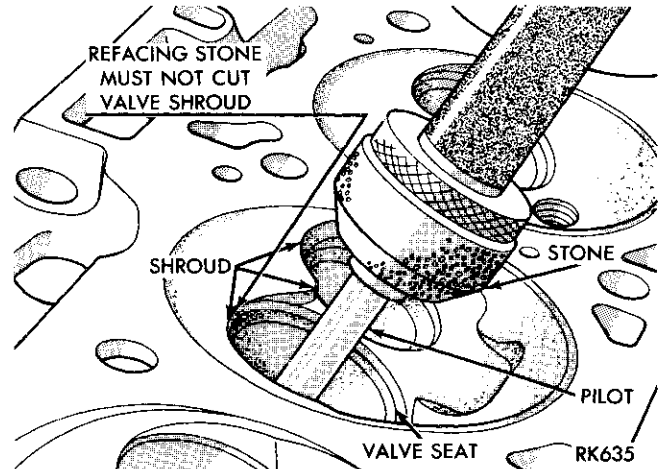
Fig. 54 Intake and Exhaust Valves

valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

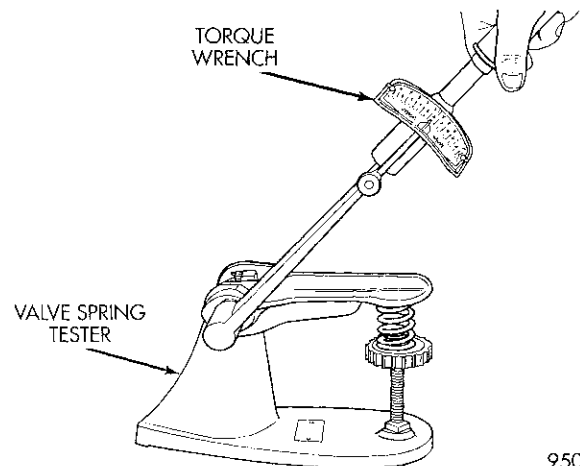
(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 inch). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 inch).

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should

**Fig. 55 Refacing Valve Seats**

be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 56). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.



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Fig. 56 Testing Valve Spring for Compressed Length
OIL PUMP**DISASSEMBLE**

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw.

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body

DISASSEMBLY AND ASSEMBLY (Continued)

using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 57).

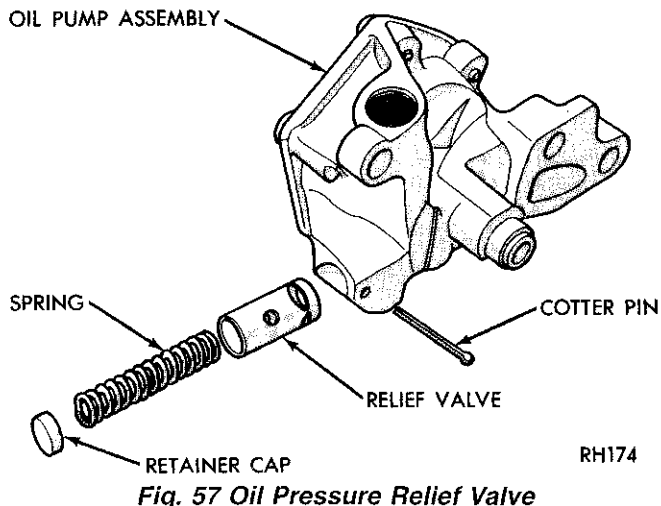


Fig. 57 Oil Pressure Relief Valve

- (2) Remove oil pump cover (Fig. 58).
- (3) Remove pump outer rotor and inner rotor with shaft (Fig. 58).
- (4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

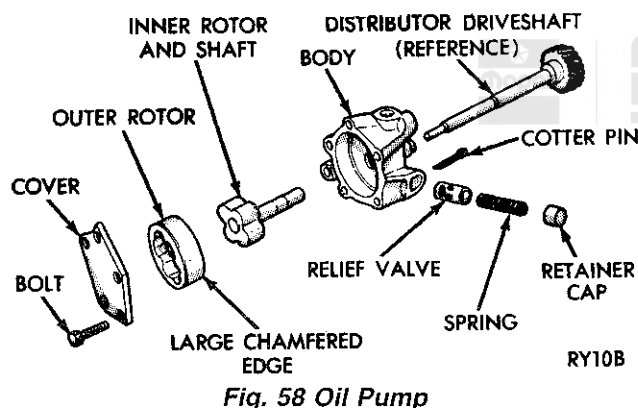


Fig. 58 Oil Pump

ASSEMBLE

- (1) Install pump rotors and shaft, using new parts as required.
- (2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install the relief valve and spring. Insert the cotter pin.
- (4) Tap on a new retainer cap.
- (5) Prime oil pump before installation by filling rotor cavity with engine oil.

CLEANING AND INSPECTION**CYLINDER HEAD ASSEMBLY****CLEANING**

Clean all surfaces of cylinder block and cylinder heads.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 inch/inch) times the span length in inches in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE: A 305 mm (12 inch) span is 0.102 mm (0.004 inch) out-of-flat. The allowable out-of-flat is 305×0.00075 (12 \times 0.00075) equals 0.23 mm (0.009 inch). This amount of out-of-flat is acceptable.

The cylinder head surface finish should be 1.78-3.00 microns (70-125 microinches).

PISTON AND CONNECTING ROD ASSEMBLY**INSPECTION**

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 59).

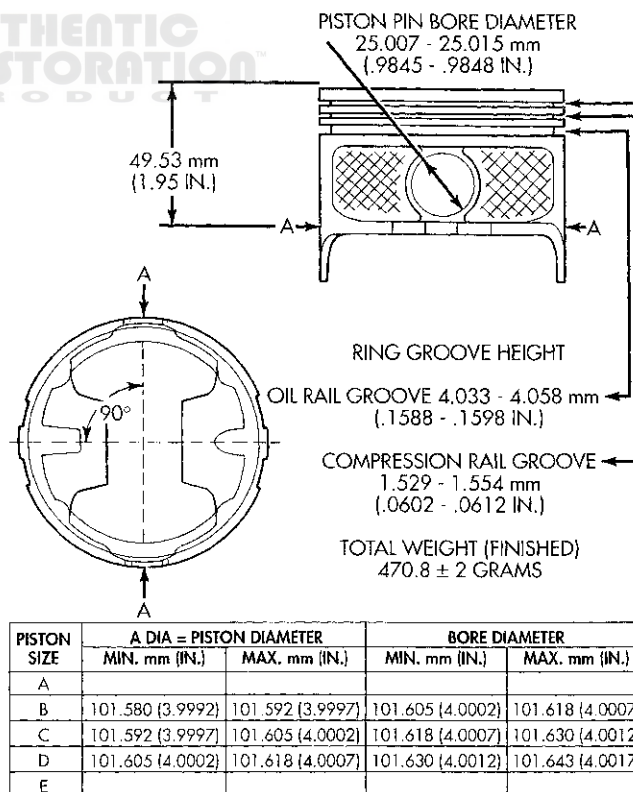


Fig. 59 Piston Measurements

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CLEANING AND INSPECTION (Continued)

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

OIL PUMP

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 60). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

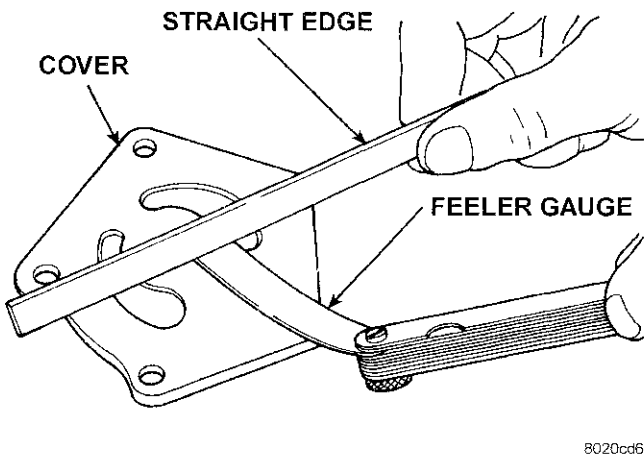


Fig. 60 Checking Oil Pump Cover Flatness

Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 61).

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 62).

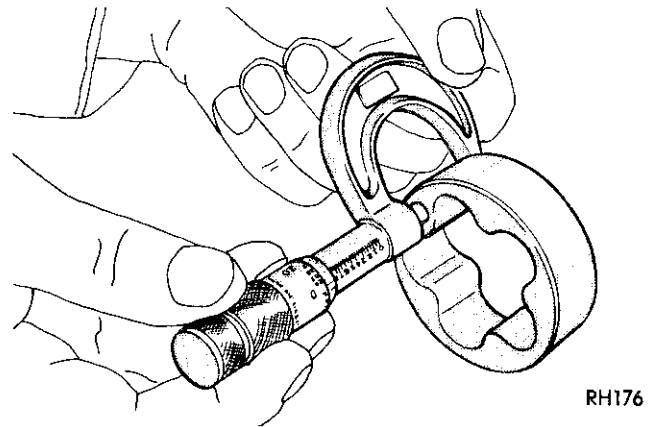


Fig. 61 Measuring Outer Rotor Thickness

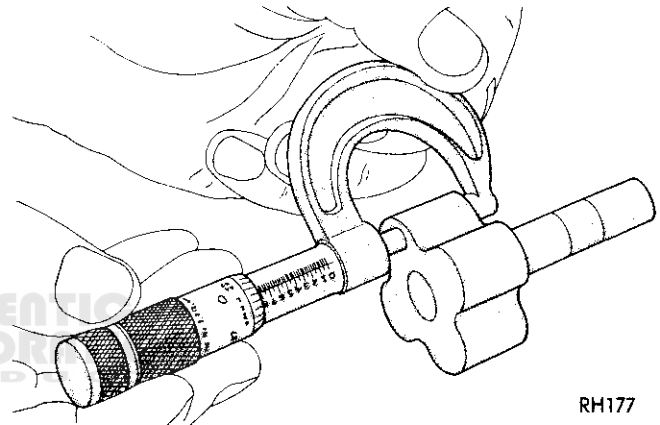


Fig. 62 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 63). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.

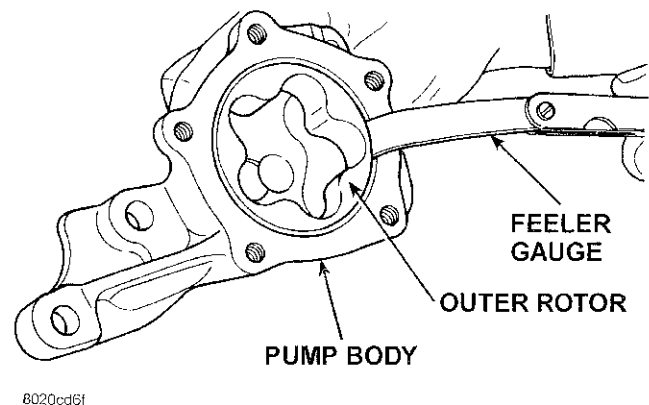


Fig. 63 Measuring Outer Rotor Clearance in Housing

CLEANING AND INSPECTION (Continued)

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 64).

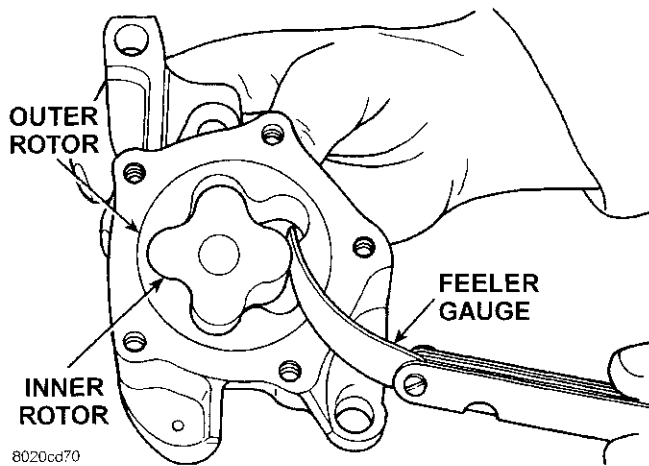


Fig. 64 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 65).

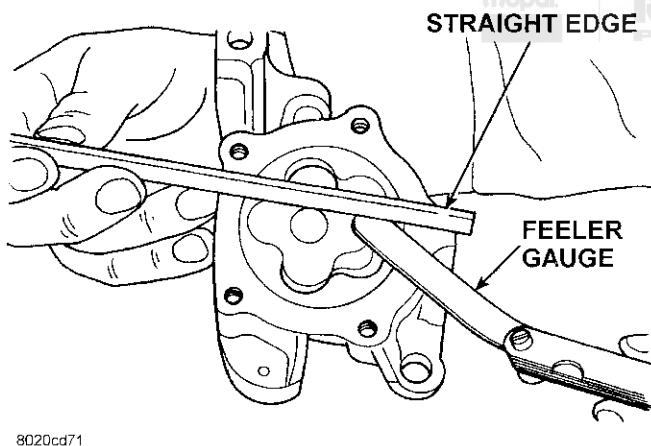


Fig. 65 Measuring Clearance Over Rotors

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 66).

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

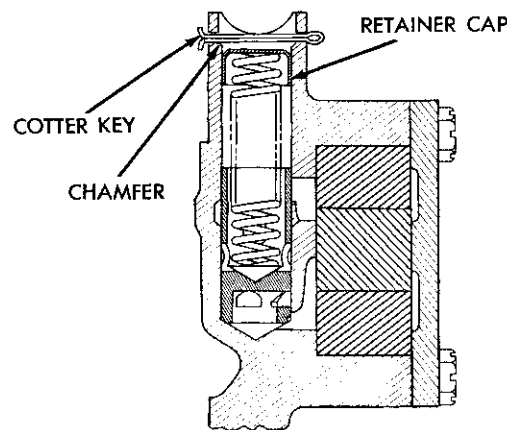


Fig. 66 Proper Installation of Retainer Cap

CYLINDER BLOCK**CLEANING**

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 inch) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 inch).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings so specified clearances may be maintained.

Refer to Standard Service Procedures in the beginning of this Group for the proper honing of cylinder bores.

SPECIFICATIONS

5.9L ENGINE

Camshaft

Bearing Diameter	
No. 1	50.800 - 50.825 mm (2.000 - 2.001 in)
No. 2	50.394 - 50.419 mm (1.984 - 1.985 in)
No. 3	50.013 - 50.038 mm (1.969 - 1.970 in)
No. 4	49.606 - 49.632 mm (1.953 - 1.954 in)
No. 5	39.688 - 39.713 mm (1.5625 - 1.5635 in)
Diametrical Clearance	0.0254 - 0.0762 mm (0.001 - 0.003 in)
Max. Allowable	0.127 mm (0.005 in)
End Play	0.051 - 0.254 mm (0.002 - 0.010 in)
Bearing Journal Diameter	
No. 1	50.749 - 50.775 mm (1.998 - 1.999 in)
No. 2	50.343 - 50.368 mm (1.982 - 1.983 in)
No. 3	49.962 - 49.987 mm (1.967 - 1.968 in)
No. 4	49.555 - 49.581 mm (1.951 - 1.952 in)
No. 5	39.637 - 39.662 mm (1.5605 - 1.5615 in)

Connecting Rods

Bearing Clearance	0.013 - 0.056 mm (0.0005 - 0.0022 in)
Max. Allowable	0.08 mm (.003 in)
Piston Pin Bore Diameter	24.966 - 24.978 mm (0.9829 - 0.9834 in)
Side Clearance (Two Rods)	0.152 - 0.356 mm (0.006 - 0.014 in)
Total Weight (Less Bearing)	758 grams (25.74 oz)

Crankshaft

Connecting Rod Journal	
Diameter	53.950 - 53.975 mm (2.124 - 2.125 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)
Diametrical Clearance	
No. 1	0.013 - 0.038 mm (0.0005 - 0.0015 in)
Max. Allowable (No. 1)	0.0381 mm (0.0015 in)
Nos. 2, 3, 4 and 5	0.013 - 0.051 mm (0.005 - 0.0020 in)
Max. Allowable (Nos. 2, 3, 4 & 5)	0.064 mm (0.0025 in)

End Play	0.051 - 0.178 mm (0.002 - 0.007 in)
Max. Allowable	0.254 mm (0.010 in)

Main Bearing Journals

Diameter	71.361 - 71.387 mm (2.8095 - 2.8105 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)

Cylinder Block

Cylinder Bore	
Diameter	101.60 - 101.65 mm (4.000 - 4.002 in)
Out-of-Round (Max.)	0.127 mm (0.005 in)
Taper (Max.)	0.254 mm (0.010 in)
Distributor Lower Drive Shaft	
Bushing (Press Fit in Block)	0.0127 - 0.3556 mm (0.0005 - 0.0140 in)
Shaft-to-Bushing Clearance	0.0178 - 0.0686 mm (0.0007 - 0.0027 in)
Tappet Bore Diameter	22.99 - 23.01 mm (0.9051 - 0.9059 in)

Cylinder Head

Compression Pressure	689 kPa (100 psi)
Gasket Thickness (Compressed)	1.2065 mm (0.0475 in)
Valve Seat	
Angle	44.25° - 44.75°
Runout (Max.)	0.0762 mm (0.003 in)
Width (Finish) - Intake	1.016 - 1.524 mm (0.040 - 0.060 in)
Width (Finish) - Exhaust	1.524 - 2.032 mm (0.060 - 0.080 in)

Hydraulic Tappets

Body Diameter	22.949 - 22.962 mm (0.9035 - 0.9040 in)
Clearance in Block	0.0279 - 0.0610 mm (0.0011 - 0.0024 in)
Dry Lash	1.524 - 5.334 mm (0.060 - 0.210 in)
Push Rod Length	175.64 - 176.15 mm (6.915 - 6.935 in)

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SPECIFICATIONS (Continued)**Oil Pump**

Clearance over Rotors (Max.)	0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.)	0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in)
Outer Rotor	
Clearance (Max.)	0.3556 mm (0.014 in)
Diameter (Min.)	62.7126 mm (2.469 in)
Thickness (Min.)	20.955 mm (0.825 in)
Tip Clearance between Rotors (Max.)	0.2032 mm (0.008 in)

Oil Pressure

At Curb Idle Speed (Minimum)*	41.4 kPa (6 psi)
At 3000 rpm	207 - 552 kPa (30 - 80 psi)
Switch Actuating Pressure (Min.)	34.5 - 48.3 kPa (5-7 psi)

* CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

Oil Filter

Bypass Valve Setting	62 -103 kPa (9-15 psi)
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Pistons

Clearance at Top of Skirt	0.013 - 0.038 mm (0.0005 - 0.0015 in)
Land Clearance (Diametrical)	0.508 - 0.660 mm (0.020 - 0.026 in)
Piston Length	81.03 mm (3.19 in)
Piston Ring Groove Depth	
Nos.1 and 2	4.761 -4.912 mm (0.187 - 0.193 in)
No.3	3.996 - 4.177 mm (0.157 - 0.164 in)
Weight	582 - 586 grams (20.53 - 20.67 oz)

Piston Pins

Clearance In Piston	0.006 - 0.019 mm (0.00023 - 0.00074 in)
Diameter	25.007 - 25.015 mm (0.9845 - 0.9848 in)
End Play	NONE
Length	67.8 - 68.3 mm (2.67 - 2.69 in)

Piston Rings

Ring Gap	
Compression Ring (Top)	0.30 - 0.55 mm (0.012 - 0.022 in)
Compression Rings (2nd)	0.55 - 0.80 mm (0.022 - 0.031 in)
Oil Control (Steel Rails)	0.381 - 1.397 mm (0.015 - 0.055 in)
Ring Side Clearance	
Compression Rings	0.040 - 0.085 mm (0.0016 - 0.0033 in)
Oil Ring (Steel Rails)	0.05 - 0.21 mm (0.002 - 0.008 in)
Ring Width	
Compression Rings	1.530 - 1.555 mm (0.060 - 0.061 in)
Oil Ring (Steel Rails) - Max.	0.447 - 0.473 mm (0.018 - 0.019 in)

Valves

Face Angle	43.25° - 43.75°
Head Diameter	
Intake	47.752 mm (1.88 in)
Exhaust	41.072 mm (1.617 in)
Length (Overall)	
Intake	126.21 - 126.85 mm (4.969 - 4.994 in)
Exhaust	126.44 - 127.30 mm (4.978 - 5.012 in)
Lift (Zero Lash)	10.414 mm (0.410 in)
Stem Diameter	
Intake	9.449 - 9.474 mm (0.372 - 0.373 in)
Exhaust	9.423 - 9.449 mm (0.371 - 0.372 in)
Stem-to-Guide Clearance	
Intake	0.0254 - 0.0762 mm (0.001 - 0.003 in)
Exhaust	0.0508 - 0.1016 mm (0.002 - 0.004 in)
Max. Allowable (Rocking Method)	0.4318 mm (0.017 in)
Guide Bore Diameter (Std)	9.500 - 9.525 mm (0.374 - 0.375 in)

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ENGINE SPECIFICATIONS—CONT.

SPECIFICATIONS (Continued)**Valve Springs**

Free Length (Approx.)	49.962 mm (1.967 in)
Spring Tension	@ 41.66 mm = 378 N (Valve Closed) (@ 1.64 in = 85 lbs)
Spring Tension	@ 30.89 mm = 890 N (Valve Open) (@ 1.212 in = 200 lbs)
Number of Coils	6.8
Installed Height	41.66 mm (Spring Seat to Retainer) (1.64 in)
Wire Diameter	4.50 mm (0.177 in)

Valve Timing

Exhaust Valve	
Closes (ATC)	23°
Opens (BBC)	61°
Duration	264°
Intake Valve	
Closes (ABC)	80°
Opens (BTC)	13°
Duration	274°
Valve Overlap	36.5°

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OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
0.025 mm (0.001 inch) U/S Crankshaft	R or M M-2-3 etc. (Indicating No. 2 & 3 main bearing journal) and/or R-1-4 etc. (Indicating No. 1 & 4 connecting rod journal)	Milled flat on number three crankshaft counterweight
0.508 mm (0.020 inch) O/S Cylinder Bores	A	Following engine serial number.
0.203 mm (0.008 inch) O/S Tappets	◆	3/8" diamond-shaped stamp Top pad — Front of engine and flat ground on outside surface of each O/S tappet bore.
0.127 mm (0.005 inch) O/S Valve Stems	X	Milled pad adjacent to two 3/8" tapped holes on each end of cylinder head.

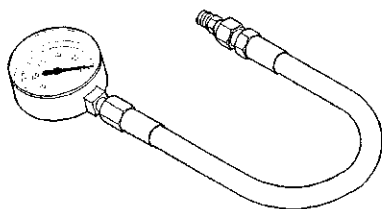
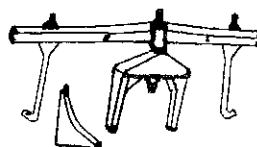
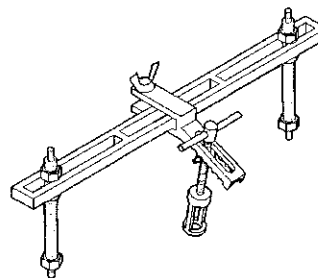
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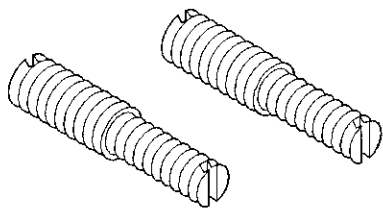
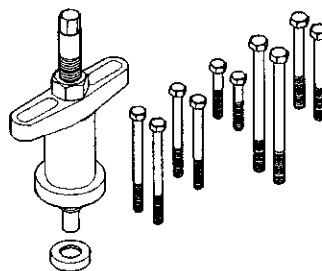
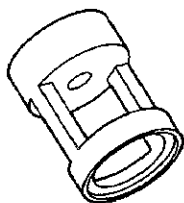
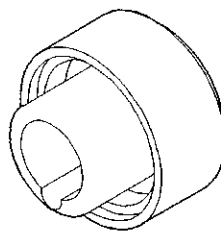
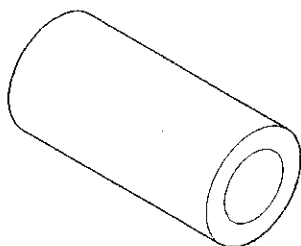
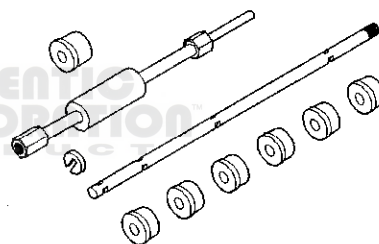
SPECIFICATIONS (Continued)**TORQUE**

DESCRIPTION	TORQUE
Adjusting Strap Bolt	23 N•m (200 in. lbs.)
Camshaft Bolt	68 N•m (50 ft. lbs.)
Camshaft Thrust Plate Bolts	24 N•m (210 in. lbs.)
Chain Case Cover Bolts	41 N•m (30 ft. lbs.)
Connecting Rod Cap Bolts	61 N•m (45 ft. lbs.)
Crankshaft Main Bearing Cap Bolts	115 N•m (85 ft. lbs.)
Cylinder Head Bolts	
1st Step	68 N•m (50 ft. lbs.)
2nd Step	143 N•m (105 ft. lbs.)
Cylinder Head Cover Bolts	11 N•m (95 in. lbs.)
Exhaust Manifold-to-Cylinder Head Bolts/Nuts	34 N•m (25 ft. lbs.)
Front Mount - Thru-Bolt Nut	68 N•m (50 ft. lbs.)
Front Mount - Engine Support Bracket/Cushion Bolts	81 N•m (60 ft. lbs.)
Generator Mounting Bolt	41 N•m (30 ft. lbs.)
Intake Manifold Bolts	Refer to Procedure in Service Manual.
Oil Pan Bolts	23 N•m (200 in. lbs.)
Oil Pan Drain Plug	34 N•m (25 ft. lbs.)
Oil Pump Attaching Bolts	41 N•m (30 ft. lbs.)
Oil Pump Cover Bolts	11 N•m (95 in. lbs.)

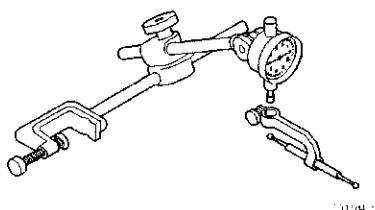
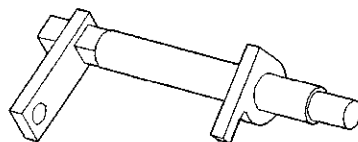
DESCRIPTION	TORQUE
Rear Mount - Support Cushion-to- Crossmember Nut	47 N•m (35 ft. lbs.)
Rear Mount - Support Cushion-to- Trans. Support Bracket Nuts	47 N•m (35 ft. lbs.)
Rear Mount - Transmission Support Bracket Bolts	102 N•m (75 ft. lbs.)
Rear Support Plate-to-Transfer Case Bolts	41 N•m (30 ft. lbs.)
Rocker Arm Bolts	23 N•m (200 in. lbs.)
Spark Plugs	41 N•m (30 ft. lbs.)
Starter Mounting Bolts	68 N•m (50 ft. lbs.)
Throttle Body Bolts	23 N•m (200 in. lbs.)
Torque Converter Drive Plate Bolts	31 N•m (270 in. lbs.)
Transfer Case-to-Insulator Mounting Plate Nuts	204 N•m (150 ft. lbs.)
Vibration Damper Retainer Bolt	183 N•m (135 ft. lbs.)
Water Pump-to-Chain Case Cover Bolt	41 N•m (30 ft. lbs.)

J9509-140

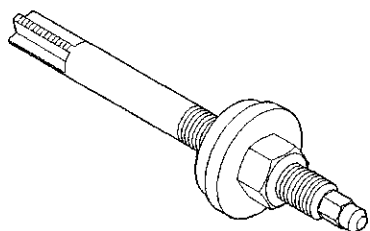
SPECIAL TOOLS**5.9L ENGINE****Oil Pressure Gauge C-3292****Engine Support Fixture C-3487-A****Valve Spring Compressor MD-998772-A**

SPECIAL TOOLS (Continued)**Adaptor 6633****Puller C-3688****Adaptor 6716A****Front Oil Seal Installer 6635****Valve Guide Sleeve C-3973**AUTHENTIC
RESTORATION
PROJECT

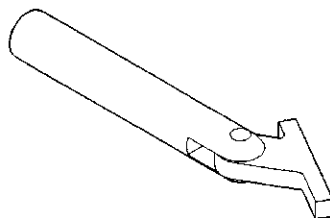
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Cam Bearing Remover/Installer C-3132-A**Dial Indicator C-3339****Camshaft Holder C-3509**

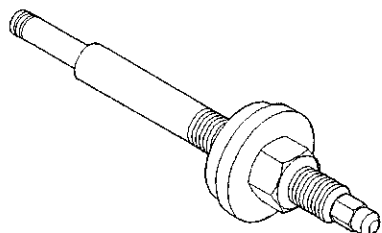
SPECIAL TOOLS (Continued)



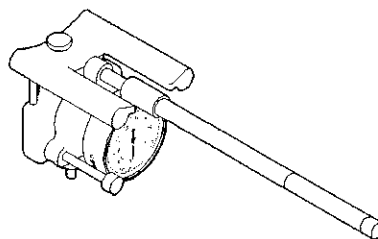
Distributor Bushing Puller C-3052



Crankshaft Main Bearing Remover C-3059

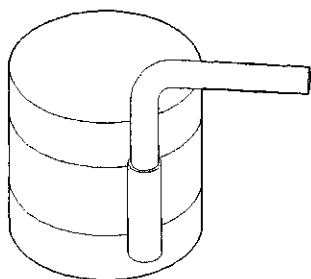


Distributor Bushing Driver/Burnisher C-3053



8010c97a

Cylinder Bore Gauge C-119



Piston Ring Compressor C-385



**AUTHENTIC
RESTORATION™
PRODUCT**

8.0L ENGINE

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DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 8.0 Liter (488 CID) ten-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets (Fig. 1).

This engine is designed for unleaded fuel.

Engine lubrication system consists of a gerotor type oil pump mounted in the timing chain cover and driven by the crankshaft. The V-10 uses a full flow oil filter.

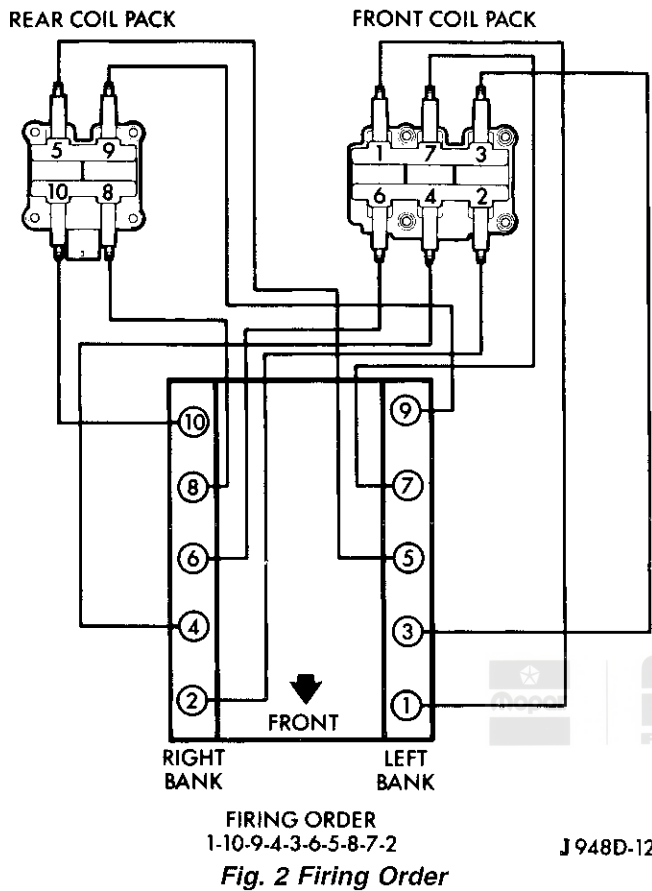
Engine Type.....	90° V-10 OHV
Bore and Stroke.....	101.6 x 98.6 mm (4.00 x 3.88 in.)
Displacement.....	8.0L (488 cu. in.)
Compression Ratio	8.4:1
Torque.....	617 N•m (450 ft. lbs.) @ 2,400 rpm
Firing Order.....	1-10-9-4-3-6-5-8-7-2
Lubrication	Pressure Feed - Full Flow Filtration (Direct Crankshaft Driven Pump)
Engine Oil Capacity	6.6L (7.0 Qts) w/filter
Cooling System	Liquid Cooled - Forced Circulation
Cooling Capacity.....	20.5L (21.75 Qts)
Cylinder Block.....	Cast Iron
Crankshaft.....	Nodular Cast Iron
Cylinder Head	Cast Iron
Combustion Chambers	Wedge-High Swirl
Camshaft.....	Nodular Cast Iron
Pistons	Cast Aluminum Alloy
Connecting Rods	Forged Steel

Fig. 1 Engine Description

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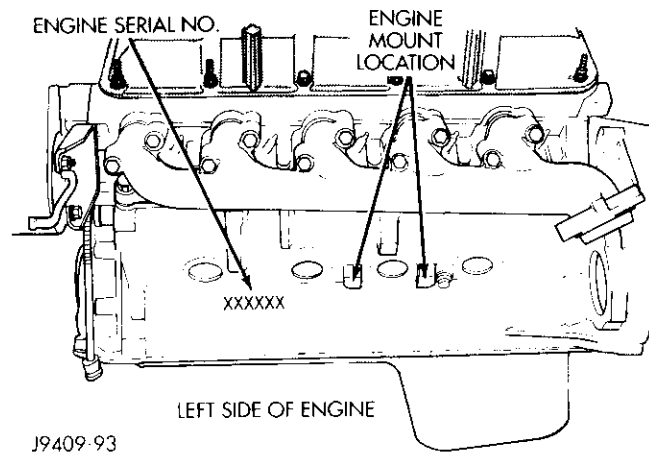
DESCRIPTION AND OPERATION (Continued)

The cylinders are numbered from front to rear; 1, 3, 5, 7, 9 on the left bank and 2, 4, 6, 8, 10 on the right bank. The firing order is 1-10-9-4-3-6-5-8-7-2 (Fig. 2).



J 948D-12

The engine serial number is located on the lower left front of the cylinder block in front of the engine mount (Fig. 3). When component part replacement is necessary, use the engine type and serial number for reference.

**Fig. 3 Engine Identification****LUBRICATION SYSTEM**

The lubrication system is a full flow filtration pressure feed type. Oil stored in the oil pan is taken in and discharged by an internal gear pump directly coupled to the crankshaft. Its pressure is regulated by the relief valve located in the chain case cover. The oil is pump through an oil filter and feeds three main oil gallery. This oil gallery feeds oil under pressure to the main and rod bearings and camshaft bearings. Passages in the cylinder block feed oil to the hydraulic lifters through hollow push rods which feeds the rocker arm sockets.

DESCRIPTION AND OPERATION (Continued)

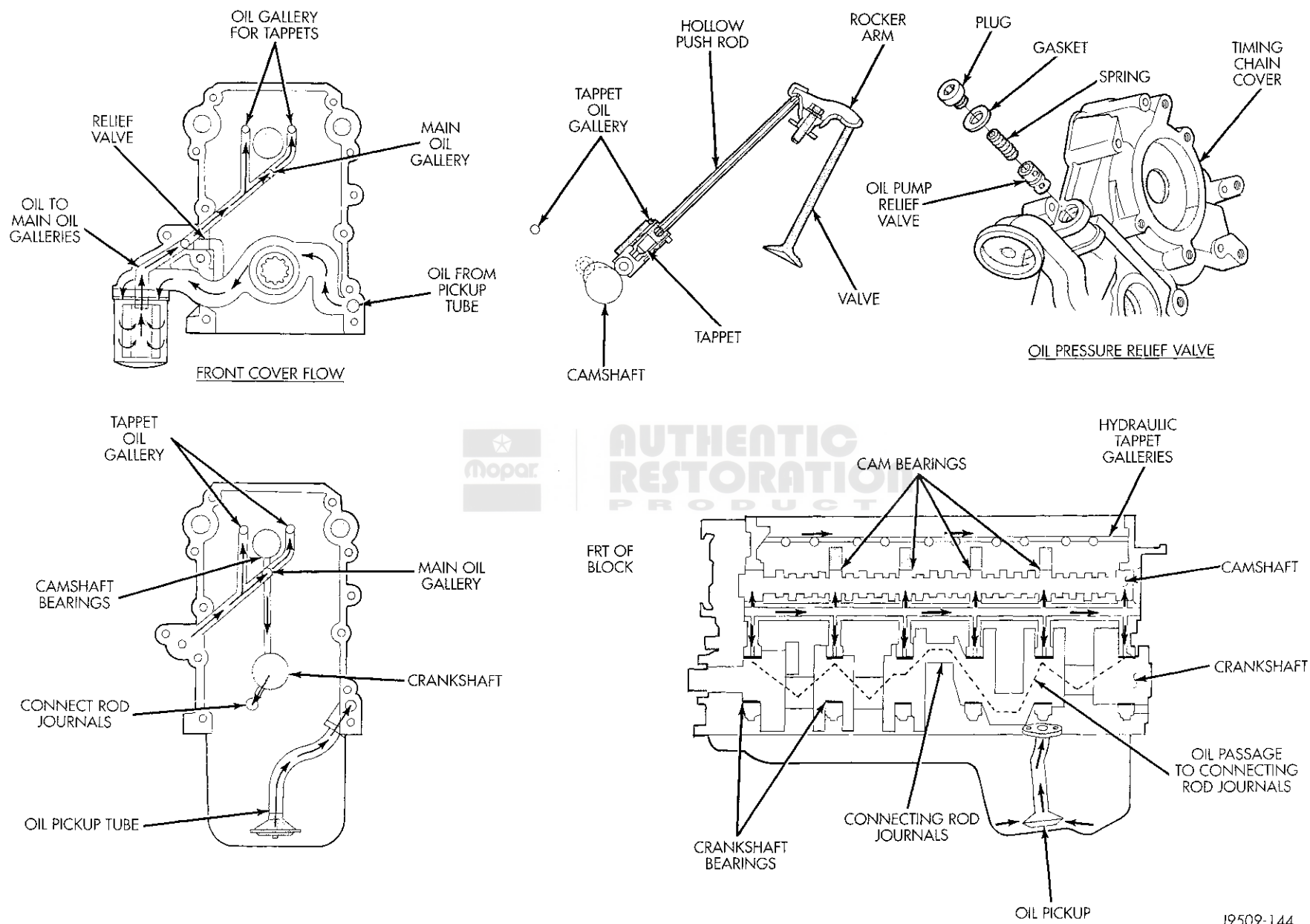


Fig. 4 Engine Lubrication System

J9509-144

DESCRIPTION AND OPERATION (Continued)**ENGINE COMPONENTS****CYLINDER HEAD COVER**

Die-cast magnesium cylinder head covers reduce noise and provide a good sealing surface. A steel backed silicon gasket is used with the cylinder head cover. This gasket can be used again.

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 5) are held in place by 12 bolts. The spark plugs are located in the peak of the wedge between the valves.

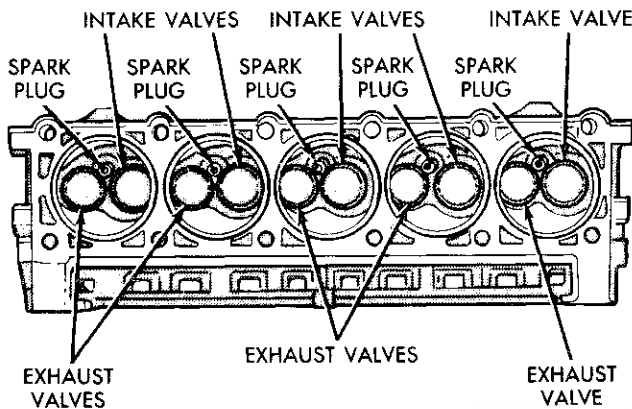


Fig. 5 Cylinder Head Assembly

VALVES AND VALVE SPRINGS

The valves are arranged in-line and inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

The pistons have a unique dry-film lubricant coating baked onto the skirts to reduce friction. The lubricant is particularly effective during engine break-in, but with time, the material becomes embedded into cylinder bore walls and continues to reduce friction.

SERVICE PROCEDURES**VALVE TIMING**

(1) Turn crankshaft until the No.6 exhaust valve is closing and No.6 intake valve is opening.

(2) Insert a 6.350 mm (1/4 inch) spacer between rocker arm pad and stem tip of No.1 intake valve. Allow spring load to bleed tappet down giving in effect a solid tappet.

(3) Install a dial indicator so plunger contacts valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should now read from 10° before top dead center to 2° after top dead center. Use a protractor as there are no timing marks on the engine.

CAUTION: DO NOT turn crankshaft any further clockwise as valve spring might bottom and result in serious damage.

(5) If reading is not within specified limits:

- (a) Check sprocket index marks.
- (b) Inspect timing chain for wear.
- (c) Check accuracy of TDC mark on timing indicator.

MEASURING TIMING CHAIN STRETCH

(1) Place a scale next to the timing chain so that any movement of the chain may be measured.

(2) Place a torque wrench and socket over camshaft sprocket attaching bolt. Apply torque in the direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) torque with cylinder head installed or 20 N·m (15 ft. lbs.) torque with cylinder head removed. With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 6).

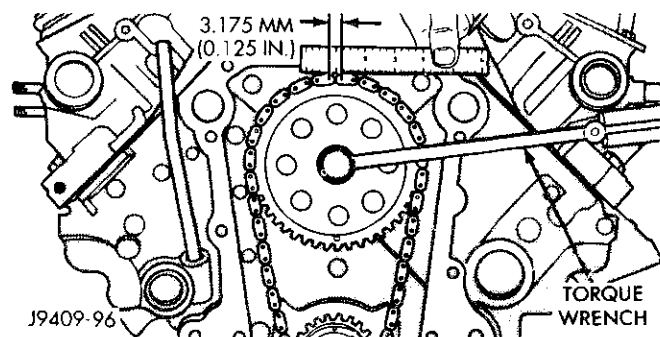


Fig. 6 Measuring Timing Chain Wear and Stretch

SERVICE PROCEDURES (Continued)

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 inch).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

(1) To correctly select the proper size piston, a cylinder bore gauge, capable of reading in .0001" INCREMENTS is required (Fig. 7). If a bore gauge is not available, do not use an inside micrometer.

(2) The coating material is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results. Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY**. To correctly select the proper size piston, a cylinder bore gauge capable of reading in .0001" increments is required.

(3) Piston installation into the cylinder bore require slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

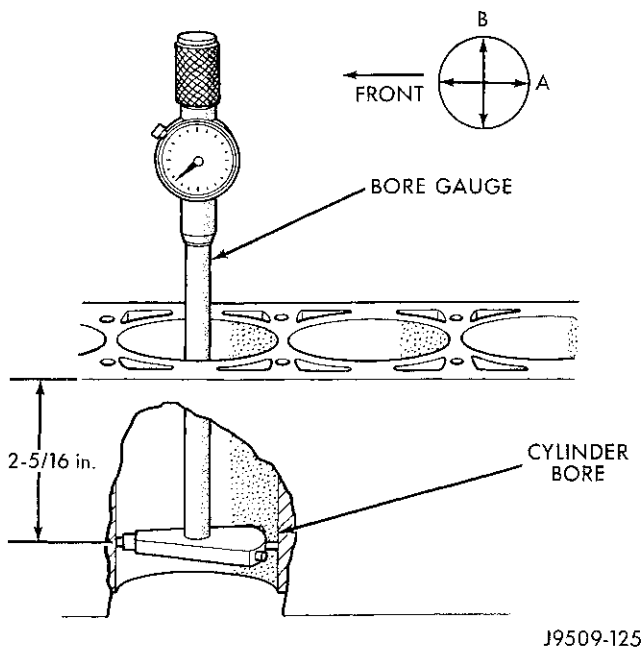


Fig. 7 Bore Gauge

FITTING RINGS

(1) Measurement of end gaps:

(a) Measure piston ring gap 2 inches from bottom of cylinder bore. An inverted piston can be

used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler stock in the gap. Gap for compression rings should be between 0.254-0.508 mm (0.010-0.020 inch). The oil ring gap should be 0.381-1.397 mm (0.015-0.055 inch).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Ends should be stoned smooth after filing with Arkansas White Stone. Rings with excess gaps should not be used.

(2) Install rings and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter O, an oval depression or the word TOP (Fig. 8) (Fig. 10).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 10). An identification mark on the ring is a drill point, a stamped letter O, an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 inch) side clearance.

(e) Pistons with insufficient or excessive side clearance should be replaced.

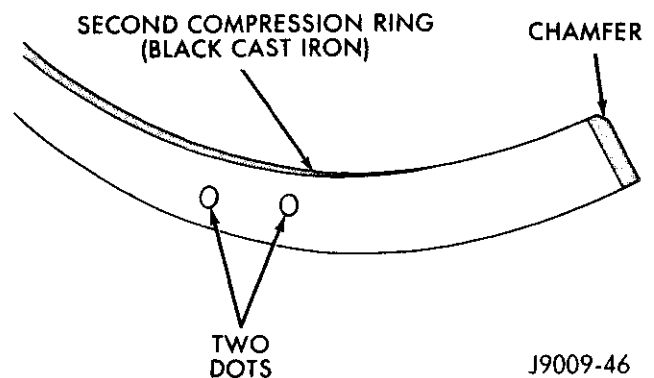
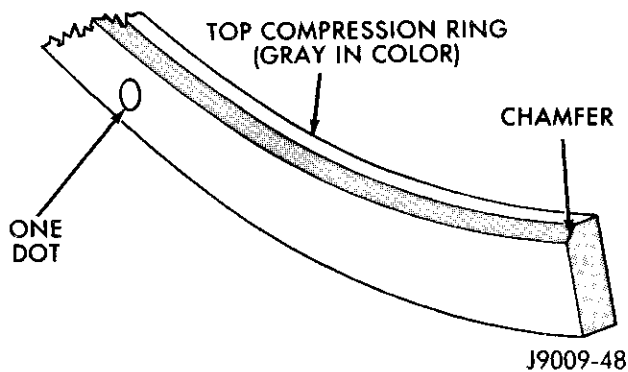
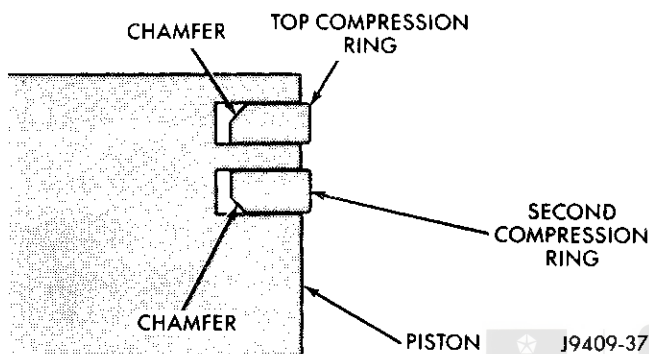
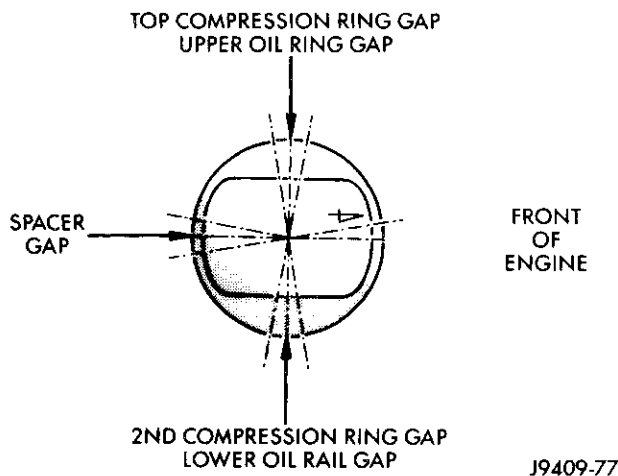


Fig. 8 Second Compression Ring Identification—Typical

(3) Arrange ring gaps 180° apart as shown in (Fig. 11).

SERVICE PROCEDURES (Continued)**Fig. 9 Top Compression Ring Identification—Typical****Fig. 10 Compression Ring Chamfer Location—Typical****Fig. 11 Proper Ring Installation****FITTING CONNECTING ROD BEARINGS**

Fit all rods on a bank until completed. **DO NOT** alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

The bearing caps are not interchangeable and should be marked at removal to ensure correct assembly.

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, make certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch). Bearings are available in 0.025 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch) under-size. **Install the bearings in pairs. DO NOT use a new bearing half with an old bearing half. DO NOT file the rods or bearing caps.**

FITTING CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are **NOT** interchangeable. All lower main bearing halves are interchangeable. Upper main bearing halves of No. 2, 4, and 5 are interchangeable. Upper main bearing halves of No. 1 and 6 are interchangeable, this also applies to the lower bearing halves.

The No.3 main bearing is flanged to carry the crankshaft thrust loads. This bearing is **NOT** interchangeable with any other bearing halves in the engine. Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

CRANKSHAFT SERVICE

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. **DO NOT** grind thrust faces of No.3 main bearing. **DO NOT** nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

SERVICE PROCEDURES (Continued)

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

CAUTION: DO NOT lift the engine by the intake manifold.

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut and rubber engine restrictors. (Fig. 12).
- (6) Remove engine support bracket/cushion bolts (Fig. 12). Remove the support bracket/cushion and heat shields.

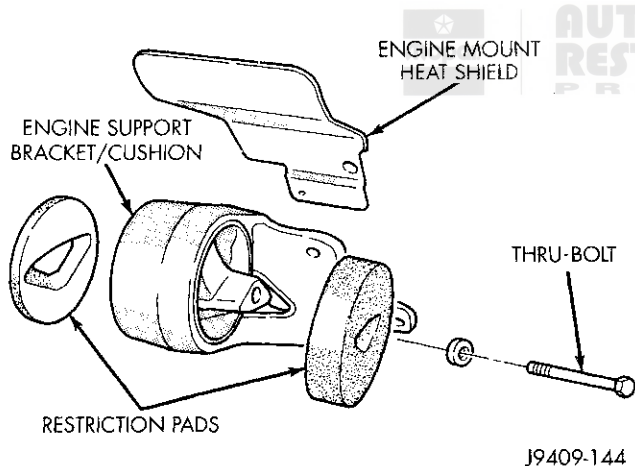


Fig. 12 Engine Mounts—Front

INSTALLATION

- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.
- (2) Install the thru-bolt and 2 piece rubber engine rubber restrictors onto the engine support bracket/cushion.
- (3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 13).
- (4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.
- (5) Lower the vehicle.

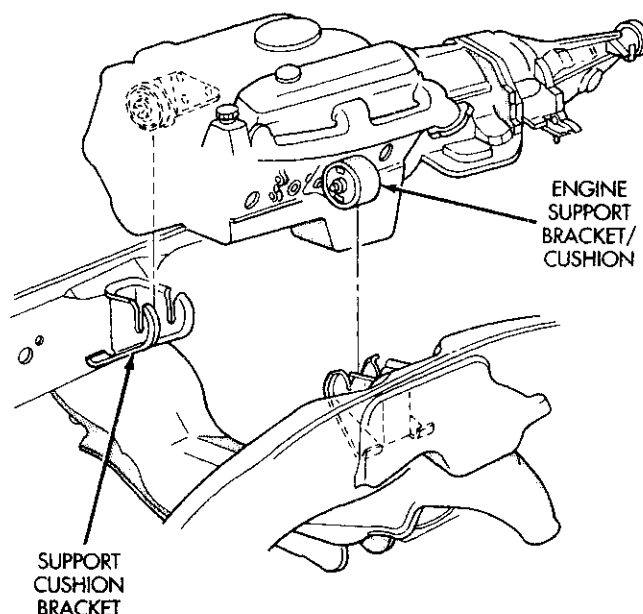


Fig. 13 Positioning Engine Mounts—Front

- (6) Remove lifting fixture.

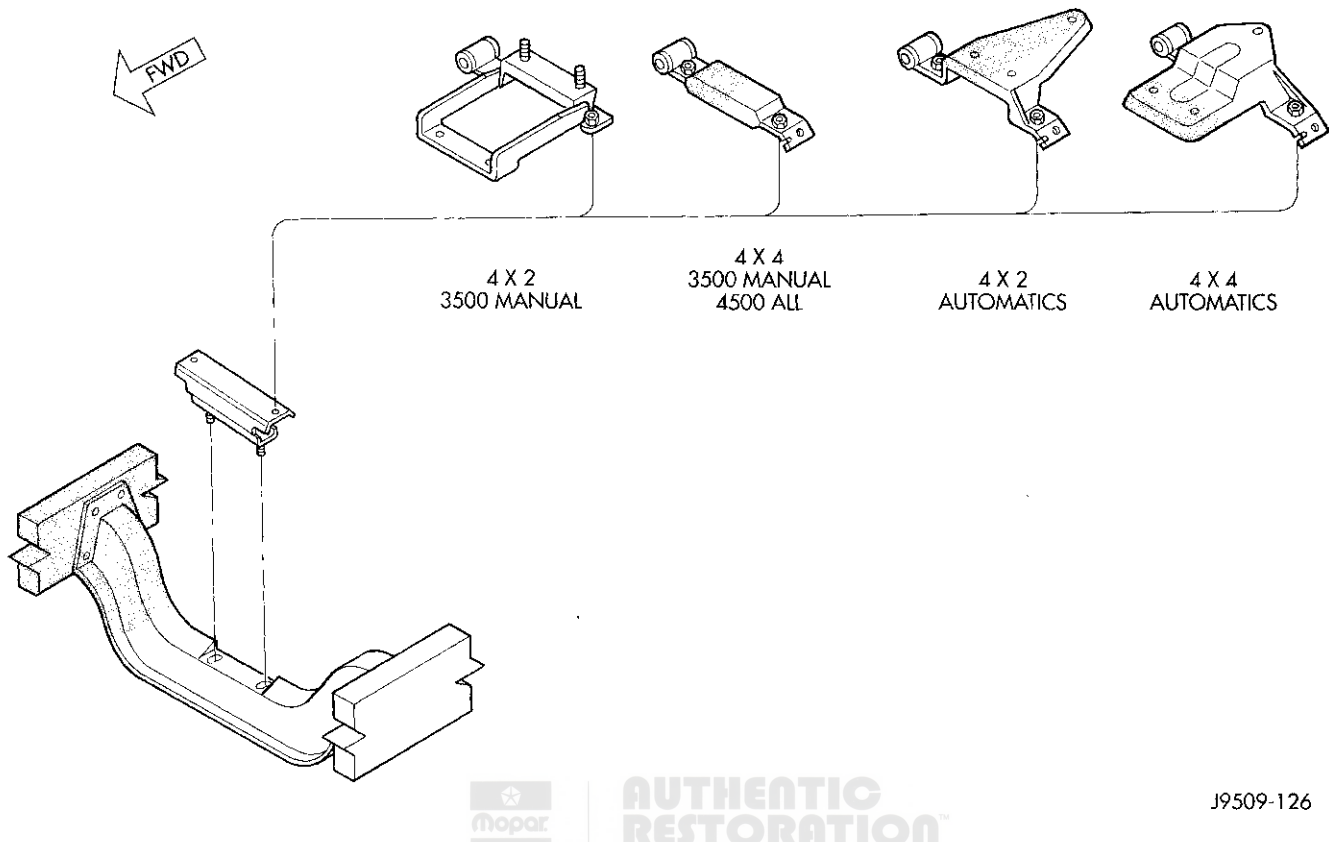
ENGINE MOUNT—REAR

REMOVAL

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 14).
- (4) Raise rear of transmission and engine SLIGHTLY.
- (5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.
- (6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

- (1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.
- (2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.
- (3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 14).
- (4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.
- (5) Remove the transmission jack.
- (6) Lower the vehicle.

REMOVAL AND INSTALLATION (Continued)**Fig. 14 Engine Rear Support Cushion Assembly**

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ENGINE ASSEMBLY**REMOVAL**

- (1) Remove the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System for the proper procedure).
- (3) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
- (4) Remove the upper crossmember.
- (5) Remove the transmission oil cooler.
- (6) Remove the serpentine belt (refer to Group 7, Cooling System).
- (7) Remove the A/C compressor with the lines attached. Set aside.
- (8) If equipped, remove the condenser.
- (9) Remove the washer bottle.
- (10) Disconnect the top radiator hose.
- (11) Remove the fan.
- (12) Remove the fan shroud.
- (13) Disconnect the lower radiator hose.
- (14) Disconnect the transmission cooler lines.
- (15) Remove radiator (refer to Group 7, Cooling System).
- (16) Remove the generator with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).

- (17) Remove the air cleaner.
- (18) Disconnect the throttle linkage.
- (19) Remove throttle body.
- (20) Remove the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (21) Remove the coil assemblies with the ignition cables.
- (22) Disconnect the heater hoses.
- (23) Disconnect the power steering hoses, if equipped.
- (24) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel line.
- (25) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).
- (26) Raise and support the vehicle on a hoist.
- (27) Remove the drain plug and drain the engine oil.
- (28) Loosen front engine mount thru-bolt nuts.
- (29) Remove the transmission cooler line brackets from oil pan.
- (30) Disconnect exhaust pipe at manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (31) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

REMOVAL AND INSTALLATION (Continued)

(32) Refer to Group 21, Transmissions for transmission removal.

(33) Lower vehicle.

CAUTION: DO NOT lift the engine by the intake manifold.

(34) Install an engine lifting fixture.

(35) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the thru-bolt into the support cushion brackets.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group 21, Transmissions for transmission installation.

(5) Install the prop shaft (refer to Group 16, Propeller Shaft).

(6) Install the starter and connect the starter wires (refer to Group 8B, Battery/Starter/Generator Service).

(7) Install exhaust pipe to manifold (refer to Group 11, Exhaust System and Intake Manifold).

(8) Install the transmission cooler line brackets from oil pan.

(9) Tighten the Front mount thru-bolts and nuts to 102N·m (75 ft. lbs.).

(10) Install the drain plug and tighten to 34 N·m (25 ft. lbs.) torque.

(11) Prime oil pump by squirting oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(12) Lower the vehicle.

(13) Remove engine lifting fixture.

(14) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).

(15) Connect the fuel lines.

(16) Connect the heater hoses.

(17) Install the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(18) Install the coil assemblies with the ignition cables.

(19) Using a new gasket, install throttle body. Tighten the throttle body nuts to 23 N·m (200 in. lbs.) torque.

(20) Connect the throttle linkage.

(21) Install the air cleaner box.

(22) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(23) Install the upper crossmember.

(24) Install radiator (refer to Group 7, Cooling System).

(25) Connect the lower radiator hose.

(26) Install the transmission oil cooler.

(27) Connect the transmission cooler lines.

(28) Connect the power steering hoses, if equipped.

(29) Install the fan shroud.

(30) Install the fan.

(31) Connect the top radiator hose.

(32) Install the washer bottle.

(33) If equipped, install the condenser.

(34) Install the A/C compressor with the lines attached.

(35) Install the serpentine belt (refer to Group 7, Cooling System).

(36) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(37) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).

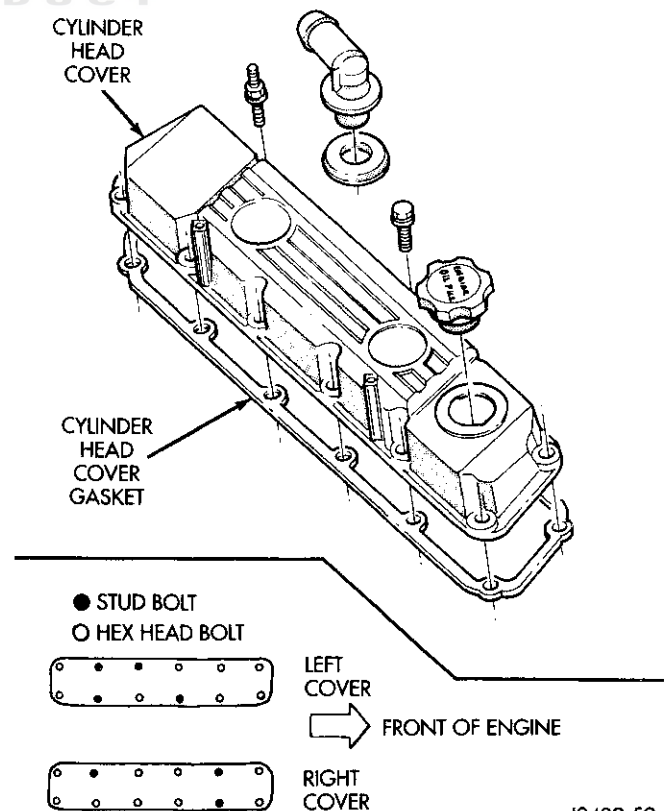
(38) Install the battery.

(39) Warm engine and adjust.

(40) Road test vehicle.

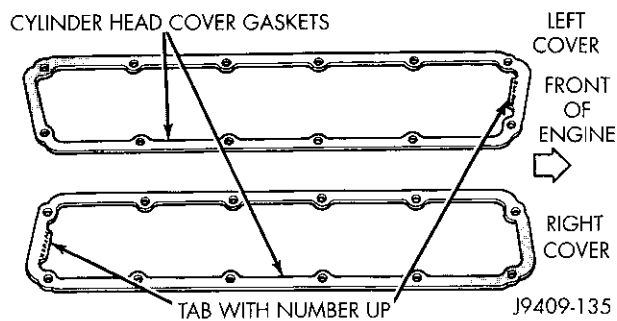
CYLINDER HEAD COVER

Die-cast magnesium cylinder head covers (Fig. 15) reduce noise and provide a good sealing surface. A steel backed silicon gasket is used with the cylinder head cover (Fig. 16).



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Fig. 15 Cylinder Head Covers

REMOVAL AND INSTALLATION (Continued)**Fig. 16 Cylinder Head Cover Gaskets****REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Disconnect closed ventilation system and evaporation control system from cylinder head cover. Identify each system for installation.
- (3) Remove the upper intake manifold to remove the right side head cover (refer to Group 11, Exhaust System and Intake Manifold).
- (4) Remove cylinder head cover bolts and stud bolts. Remove the covers and gaskets. The gasket may be used again.

INSTALLATION

- (1) Clean cylinder head cover gasket surface.
- (2) Clean head rail, if necessary.
- (3) Check the gasket for use in head cover installation. If damaged, use a new gasket.
- (4) Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. **DO NOT** use alternative fasteners.

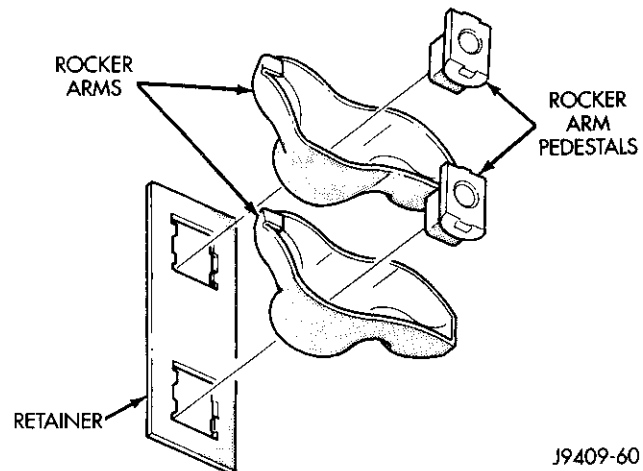
- (5) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 15). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.
- (6) If removed, install the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (7) Install closed crankcase ventilation system and evaporation control system onto the proper head cover. **DO NOT** switch the systems.
- (8) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS**REMOVAL**

- (1) Disconnect spark plug wires by pulling the boot straight out in line with plug.
- (2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and the rocker arm assembly (Fig. 17). Place rocker arm assemblies on a bench in the same order as removed.

(4) Remove the push rods and place them on a bench in the same order as removed.

**Fig. 17 Rocker Arm Assembly****INSTALLATION**

CAUTION: **DO NOT** rotate or crank the engine during or immediately after rocker arm installation. Allow the hydraulic roller tappets adequate time to bleed down (about 5 minutes).

- (1) Install the push rods in the same order as removed.
- (2) Install rocker arm assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.
- (3) Install cylinder head cover and gasket. **DO NOT** use alternative fasteners.
- (4) Connect spark plug wires.

VALVE STEM SEAL AND SPRING REPLACEMENT

This procedure is done with the cylinder head installed.

- (1) Disconnect the negative cable from the battery.
- (2) Set engine basic timing to Top Dead Center (TDC) and remove air cleaner.
- (3) Remove cylinder head covers and spark plugs.
- (4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.
- (5) Remove rocker arms.
- (6) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.
- (7) Using Valve Spring Compressor Tool MD-998772A with adapter 6716A, compress valve spring and remove retainer valve locks and valve spring.

REMOVAL AND INSTALLATION (Continued)

(8) Install seals on the exhaust valve stem and position down against valve guides. The exhaust valve stem seal is brown.

(9) The black intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. **DO NOT** force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.

(10) Follow the same procedure on the remaining 9 cylinders using the firing sequence 1-10-9-4-3-6-5-8-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.

(11) Remove adapter from the No.1 spark plug hole.

(12) Install rocker arms.

(13) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. **DO NOT** use alternative fasteners.

(14) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 18). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(15) Install closed crankcase ventilation system.

(16) Connect the evaporation control system.

(17) Install air cleaner.

(18) Connect the negative cable to the battery.

(19) Road test vehicle and check for leaks.

CYLINDER HEADS

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).

(3) Remove the heat shields (Fig. 19).

(4) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(5) Remove closed crankcase ventilation system.

(6) Disconnect the evaporation control system.

(7) Remove the air cleaner.

(8) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel line.

(9) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(10) Remove coil pack and bracket (Fig. 20).

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

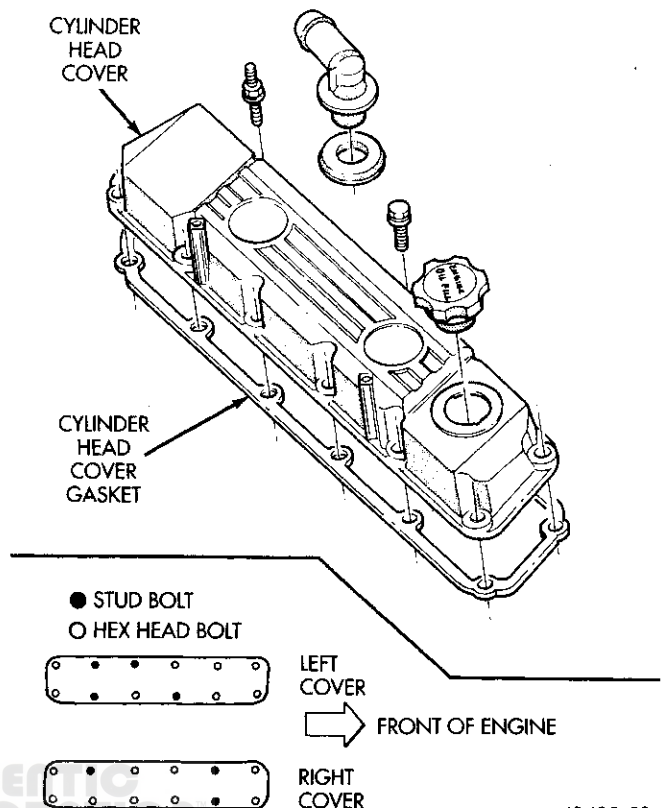


Fig. 18 Cylinder Head Covers

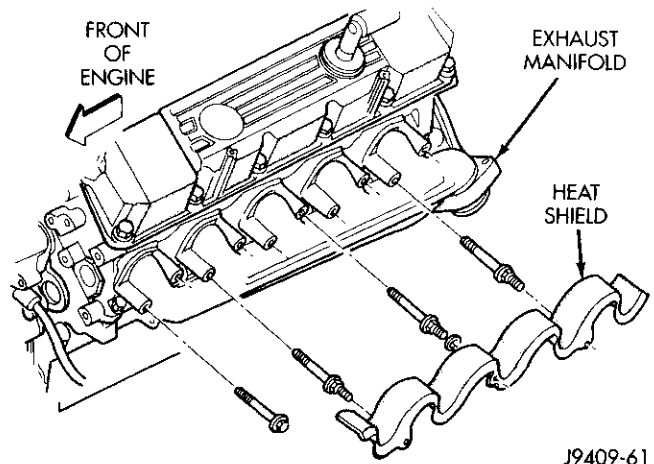


Fig. 19 Spark Plug Wire Heat Shields (Left Side Shown)

(14) Remove upper intake manifold and throttle body as an assembly.

(15) Remove cylinder head covers and gaskets.

(16) Remove the EGR tube. Discard the gasket, for right side only.

(17) Remove lower intake manifold. Discard the flange side gaskets and the front and rear cross-over gaskets.

REMOVAL AND INSTALLATION (Continued)

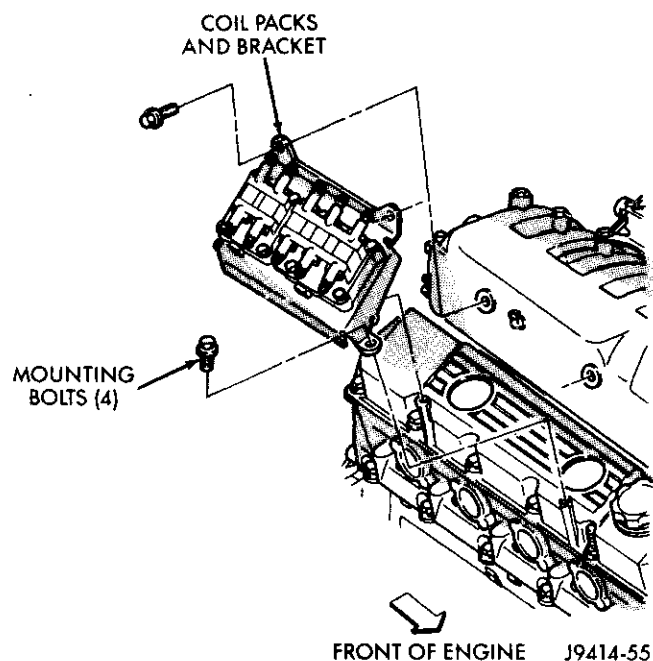


Fig. 20 Coil Pack and Bracket

(18) Disconnect exhaust pipe from exhaust manifold (refer to Group 11, Exhaust System and Intake Manifold).

(19) Remove exhaust manifolds and gaskets (refer to Group 11, Exhaust System and Intake Manifold).

(20) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.

(21) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.

(22) Remove spark plugs.

INSTALLATION

(1) Position the new cylinder head gaskets onto the cylinder block.

(2) Position the cylinder heads onto head gaskets and cylinder block.

(3) Tighten the cylinder head bolts in two steps (Fig. 21):

- Step 1—Tighten all cylinder head bolts, in sequence, to 58 N·m (43 ft. lbs.) torque.
- Step 2—Tighten all cylinder head bolts, in sequence, to 143 N·m (105 ft. lbs.) torque.

CAUTION: When tightening the rocker arm bolts, make sure the piston in that cylinder is **NOT** at TDC. Contact between the valves and piston could occur.

(4) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.

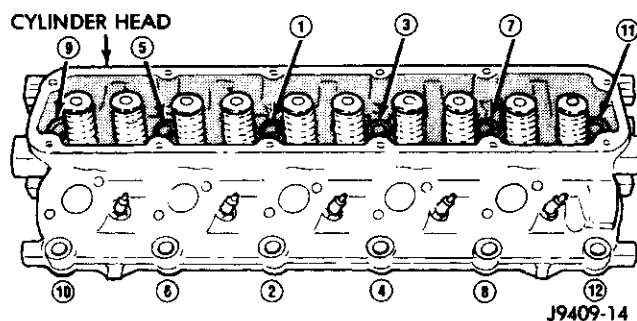


Fig. 21 Cylinder Head Bolt Tightening Sequence

(5) Install the side intake manifold gaskets. Be sure that the locator dowels are positioned in the head (Fig. 22).

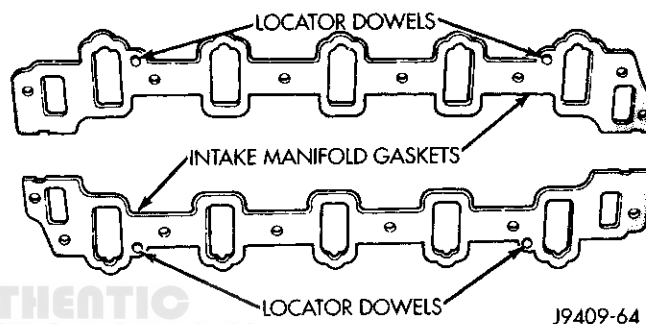


Fig. 22 Intake Manifold Flange Gasket Alignment

(6) Peel off the protective paper (blue - rear and brown - front) and press firmly onto the block (Fig. 23). **BE SURE THE BLOCK IS OIL FREE.** Aligning slots in end seals with notches in intake manifold gaskets.

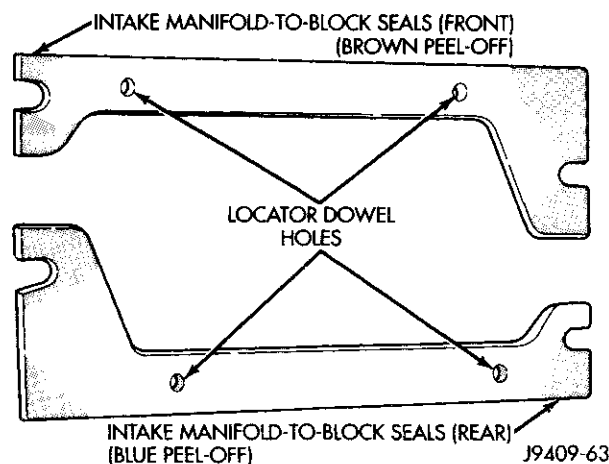


Fig. 23 Intake Manifold-to-Block Seals

(7) Insert Mopar® Silicone Rubber Adhesive Sealant, or equivalent, into the four corner pockets (Fig. 24). **Fill the pocket, but DO NOT overfill.**

REMOVAL AND INSTALLATION (Continued)

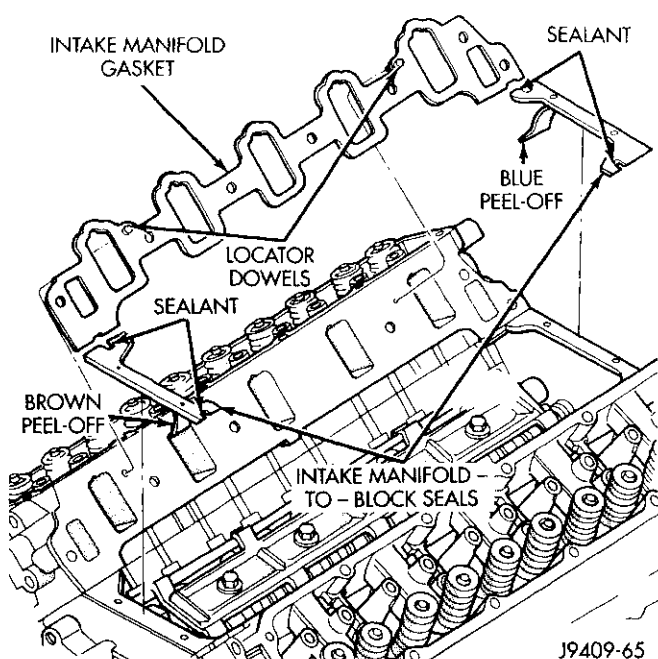


Fig. 24 Mopar® Silicone Rubber Adhesive Sealant Application Locations

(8) The lower intake manifold **MUST** be installed within 3 minutes of sealant application. Carefully lower intake manifold into position on the cylinder block and cylinder heads. After intake manifold is in place, inspect to make sure seals and gaskets are in place.

(9) Finger start all bolts, alternate one side to the other.

(10) Tighten the lower intake manifold bolts to 54 N·m (40 ft. lbs.) torque.

(11) Using a new gasket, position the upper intake manifold onto the lower intake manifold.

(12) Tighten upper intake manifold bolts to 22 N·m (16 ft. lbs.) torque.

(13) Install the exhaust manifolds and new gaskets. Tighten the bolts and stud bolts to 22 N·m (16 ft. lbs.) torque.

(14) Install exhaust pipe to the exhaust manifold. Tighten the bolts to 34 N·m (25 ft. lbs.) torque.

(15) Using a new gasket, position the EGR tube to the intake manifold and the exhaust manifold. Tighten the EGR tube nut to 34 N·m (25 ft. lbs.) torque. Tighten the bolts to 20 N·m (174 in. lbs.) torque.

(16) Install the heat shields and the washers. **Make sure that heat shields tabs hook over the exhaust gasket.** Tighten the nuts to 15 N·m (132 in. lbs.) torque.

(17) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(18) Install coil packs and bracket. Tighten the bracket bolts to 21 N·m (190 in. lbs.) torque. Connect the coil wires.

(19) Connect heat indicator sending unit wire.

(20) Connect the heater hoses and bypass hose.

(21) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(22) Install the fuel line.

(23) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

(24) Install the intake manifold-to-generator bracket support rod. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(25) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. **DO NOT** use alternative fasteners.

(26) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 1). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(27) Install closed crankcase ventilation system.

(28) Connect the evaporation control system.

(29) Install the air cleaner.

(30) Fill cooling system (refer to Group 7, Cooling System for proper procedure).

(31) Connect the negative cable to the battery.

(32) Check for leaks (fuel, oil, antifreeze, etc.).

VALVES AND VALVE SPRINGS

REMOVAL

(1) Remove the cylinder head.

(2) Special studs must be used to adapt the Valve Spring Compressor Tool to the V-10 cylinder head (Fig. 25). Install the metric end into the Special Tool MD998772A and the 5/16 end into the cylinder head.

(3) Compress valve springs using Valve Spring Compressor Tool MD-998772A with Adapter 6716A and Screw 6765 (Fig. 26). Tap the retainer using a brass drift and ball peen hammer to loosen locks away from retainer.

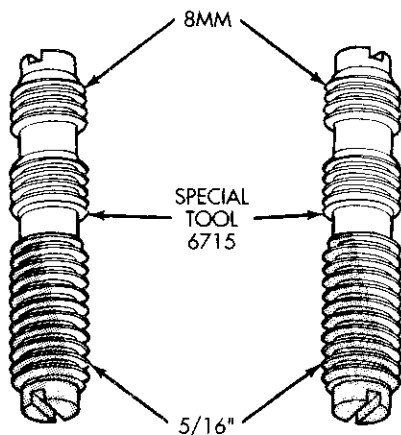
(4) Remove valve retaining locks, valve spring retainers and valve springs. Check for abnormal wear, replace as required.

(5) Remove the valve stem seals.

(6) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the

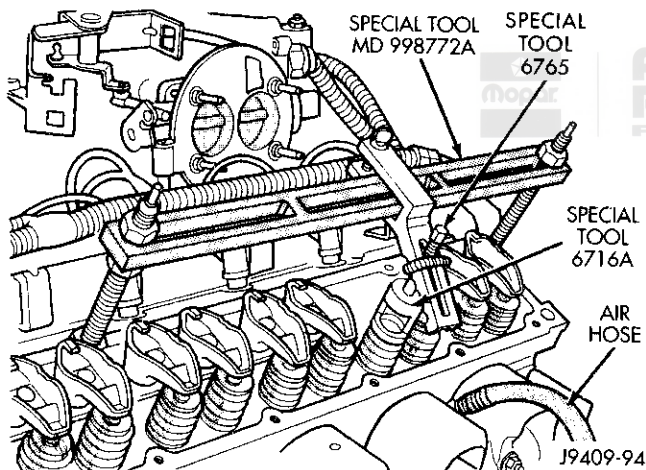
REMOVAL AND INSTALLATION (Continued)

FITS INTO TOOL MD 998772A



FITS INTO CYLINDER HEAD

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Fig. 25 Special Studs 6715 for V-10 Engine**Fig. 26 Valve Spring Compressor MD-998772A with Adaptor 6716-A and Screw 6765**

valve guides. Identify valves to ensure installation in original location.

INSTALLATION

- (1) Clean valves thoroughly. Discard burned, warped and cracked valves.
- (2) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
- (3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.
- (4) Make sure there are no burrs on valve stems.
- (5) Coat valve stems with lubrication oil. Insert valves into valve guides in cylinder head.

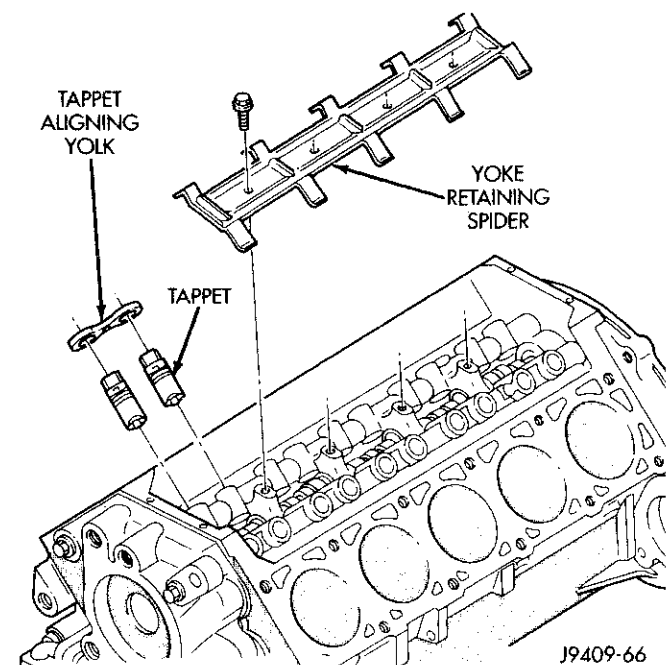
(6) Install new seals on all valve guides (**BLACK on intake and BROWN on exhaust**). Install valve springs and valve retainers.

(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. Tap the retainer with a brass or heavy plastic hammer to ensure locks have been seated.

(8) If valves and/or seats were ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. Ensure this brings spring height back to normal, 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Remove the air cleaner.
- (3) Remove cylinder head cover.
- (4) Remove rocker arm assembly and push rods. Identify push rods to ensure installation in original location.
- (5) Remove upper and lower intake manifold.
- (6) Cut the cylinder head gasket for accessibility if the end tappets are to be removed.
- (7) Remove yoke retainer spider and tappet aligning yokes (Fig. 27).

**Fig. 27 Tappets, Aligning Yoke and Yoke Retaining Spider**

REMOVAL AND INSTALLATION (Continued)

(8) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

(9) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

(10) Check camshaft lobes for abnormal wear.

INSTALLATION

(1) Lubricate tappets.

(2) Install tappets in their original positions.

Ensure that the oil bleed hole (if so equipped) faces forward.

(3) Install tappet aligning yokes. Position the yoke retainer spider over the tappet aligning yokes (Fig. 27) Install the yoke retaining spider bolts and tighten to 22 N·m (16 ft. lbs.) torque.

(4) Install the push rods in their original location.

(5) Position the rocker arm assembly on the pedestal and align to the push rods. Install the bolts and tighten to 28 N·m (21 ft. lbs.) torque.

(6) Install lower and upper intake manifold.

(7) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

(8) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 27). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(9) Install the air cleaner.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

(10) Connect the negative cable to the battery.

(11) Road test vehicle and check for leaks.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove fan shroud retainer bolts and set shroud back over engine.

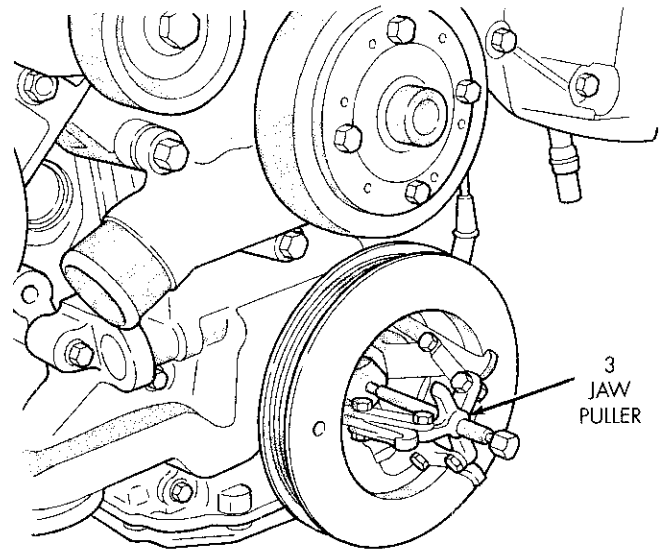
(3) Remove the cooling system fan.

(4) Remove the serpentine belt (refer to Group 7, Cooling System).

(5) Remove crankshaft pulley/damper bolt and washer from end of crankshaft (Fig. 28).

(6) Using a 3-prong puller tool, pull pulley—damper off of the crankshaft.

(7) Inspect crankshaft oil seal (Fig. 29).



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Fig. 28 Crankshaft Pulley—Damper

INSTALLATION

(1) Position the crankshaft pulley/damper onto the crankshaft.

(2) Use tool C-3688 to press the pulley/damper onto the crankshaft. Install crankshaft bolt and washer and tighten to 183 N·m (135 ft. lbs.) torque (Fig. 29).

(3) Install the serpentine belt (refer to Group 7, Cooling System).

(4) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(5) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(6) Connect the negative cable to the battery.

TIMING CHAIN COVER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System).

(3) Remove the serpentine belt (refer to Group 7, Cooling System).

(4) Remove fan shroud.

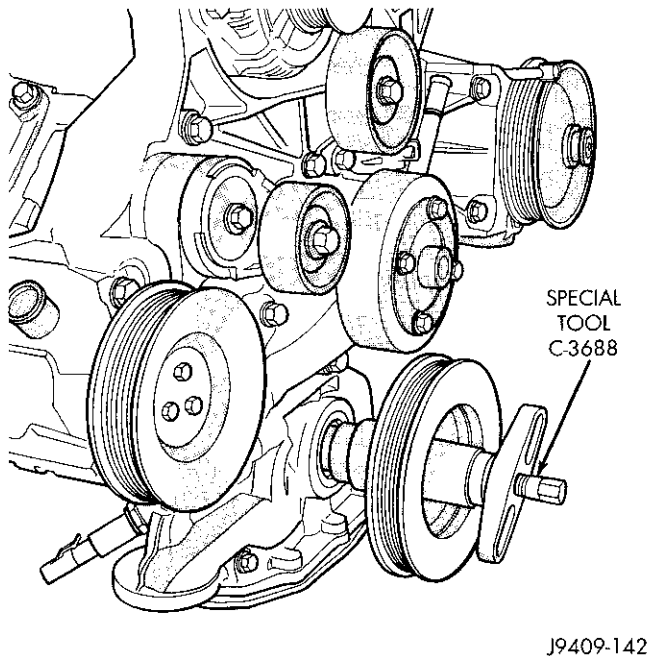
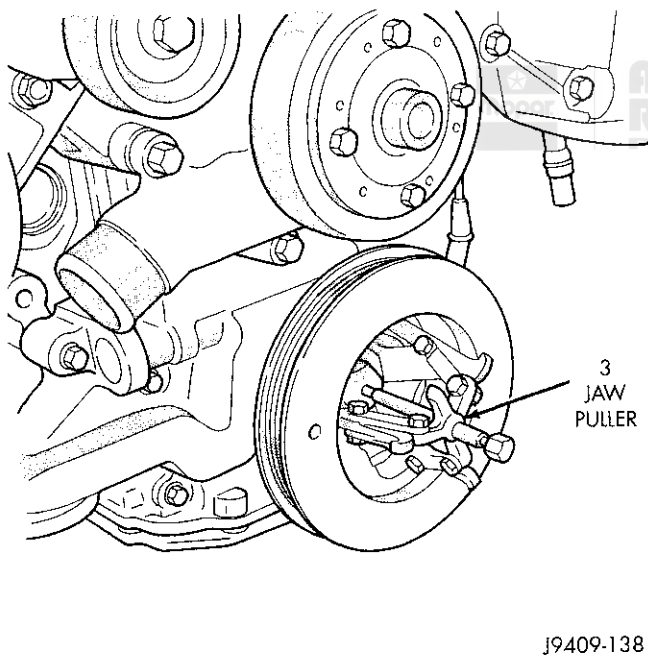
(5) Remove fan.

(6) Unbolt A/C compressor and set on top of engine.

(7) Remove generator, air pump, and bracket assembly.

(8) Remove water pump (refer to Group 7, Cooling System).

(9) Using a 3-prong puller to remove pulley/damper from the crankshaft. (Fig. 30)

REMOVAL AND INSTALLATION (Continued)**Fig. 29 Installing Crankshaft Pulley—Damper****Fig. 30 Pulley—Damper Removal**

(10) Loosen oil pan bolts and remove the front oil pan bolts that mount the pan to the timing chain cover.

(11) Remove the cover bolts.

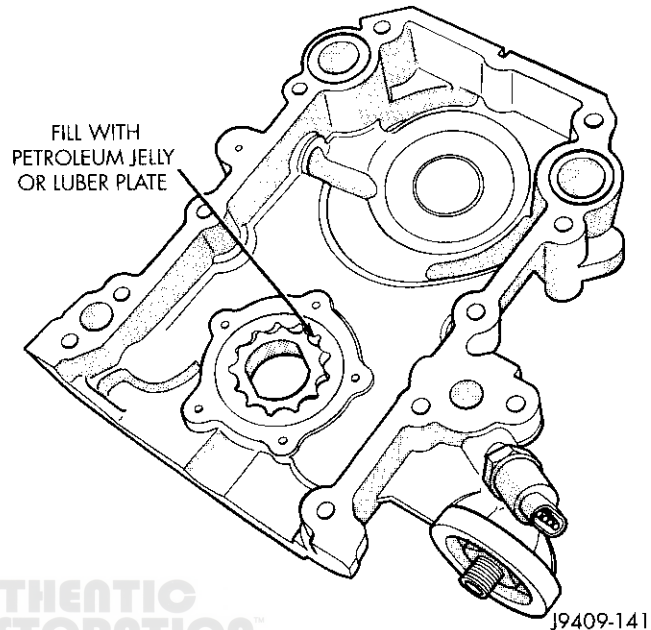
(12) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket.

(13) Inspect surface of cover. Remove any burrs or high spots.

INSTALLATION

(1) Be sure mating surfaces of timing chain cover and cylinder block are clean and free from burrs.

(2) Lubricate the pump rotors using petroleum jelly or lubriplate and install in the timing chain cover (Fig. 31).

**Fig. 31 Priming Oil Pump.**

(3) Using a new cover gasket, carefully install timing chain cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

(4) Tighten timing chain cover bolts to 47 N·m (35 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(5) Install pulley/vibration damper use tool C-3688 (Fig. 32)

(6) Prime oil pump by squirt oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(7) Install water pump and housing assembly using o-ring (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

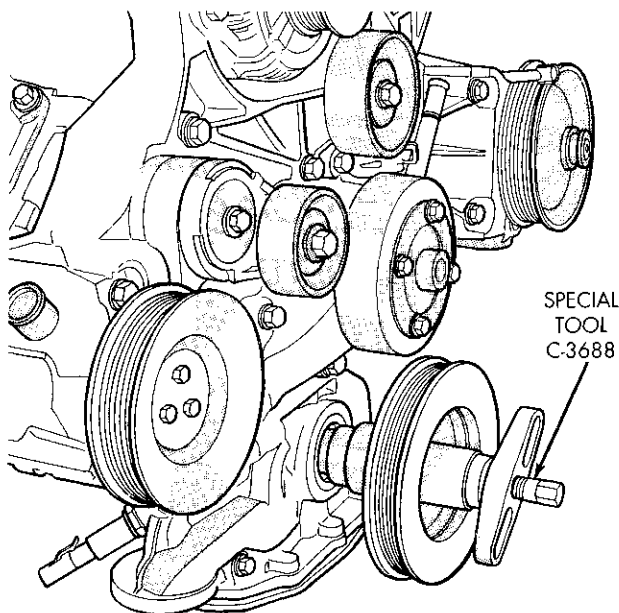
(8) Install generator, air pump, and bracket assembly.

(9) Install A/C compressor.

(10) (10) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(11) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(12) Install the serpentine belt (refer to Group 7, Cooling System).

REMOVAL AND INSTALLATION (Continued)

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Fig. 32 Installing Crankshaft Pulley/Damper

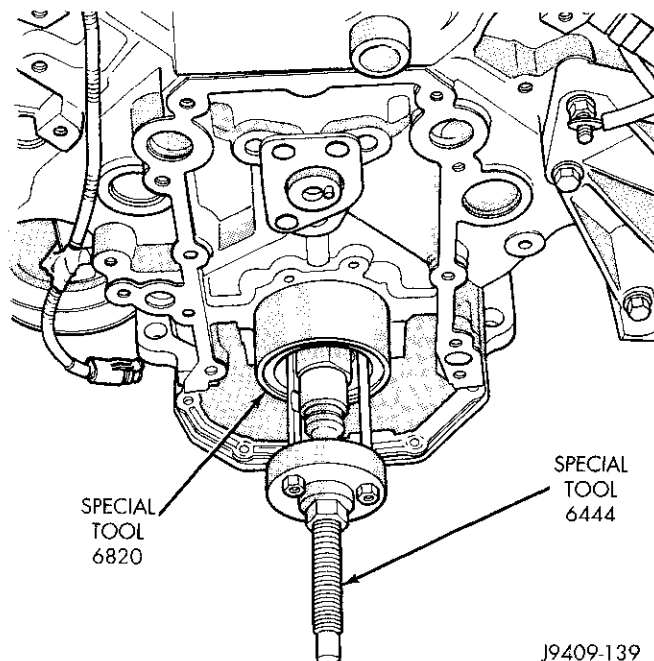
- (13) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
- (14) Connect the negative cable to the battery.
- (15) Road test vehicle and check for leaks.

TIMING CHAIN**REMOVAL**

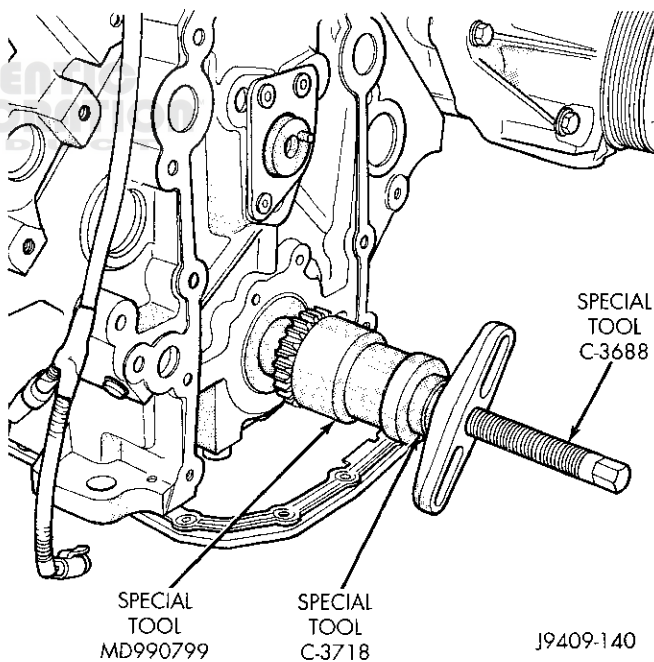
- (1) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (2) Aline camshaft and crankshaft centerline. Remove camshaft sprocket attaching bolt and remove timing chain and camshaft sprockets.
- (3) Use puller 6444 and jaws 6820 to remove crankshaft sprocket (Fig. 33).

INSTALLATION

- (1) Line up key in crankshaft with keyway in sprocket, press on crankshaft timing sprocket, use tools C-3688, C-3718 and MB-990799, seat sprocket against crankshaft shoulder (Fig. 34).
- (2) Turn crankshaft to line up the timing mark with the crankshaft and camshaft centerline.
- (3) Put chain on camshaft sprocket.
- (4) Take chain and camshaft sprocket, align timing marks and install chain and cam sprocket onto crankshaft sprocket. Check to see that timing marks are on the centerline of the crankshaft and camshaft centerline (Fig. 35).
- (5) Install the camshaft bolt. Tighten the bolt to 61 N·m (45 ft. lbs.) torque.
- (6) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new



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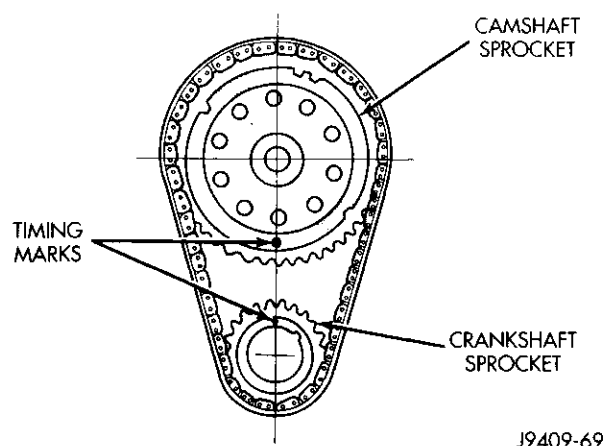
Fig. 33 Crankshaft Sprocket Removal.

J9409-140

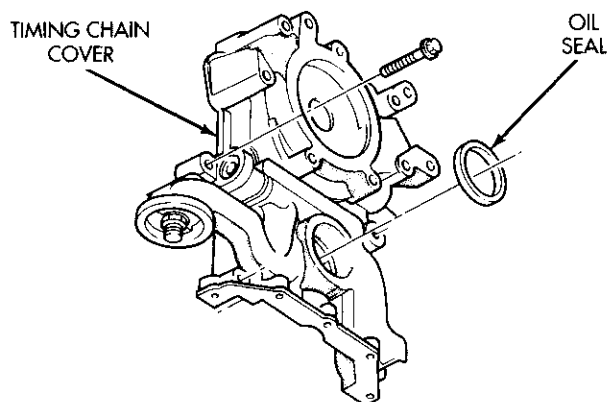
Fig. 34 Crankshaft Sprocket Installation

thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

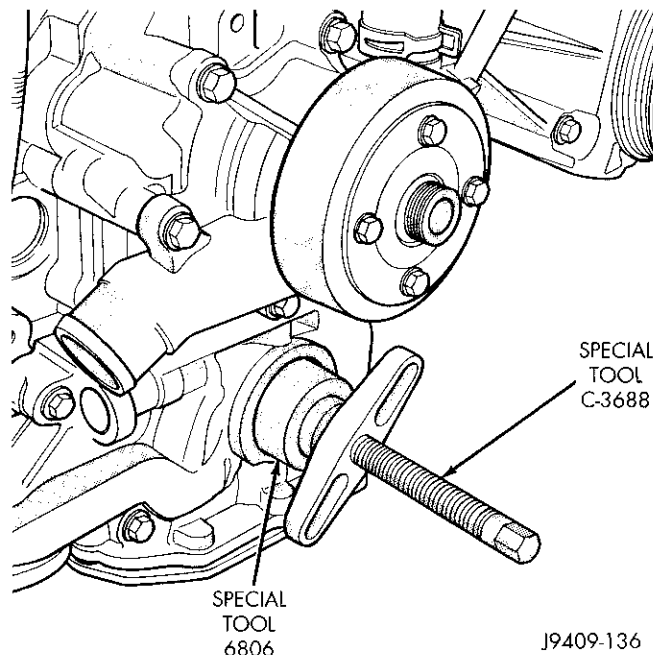
- (7) Install timing chain cover.

REMOVAL AND INSTALLATION (Continued)**Fig. 35 Alignment of Timing Marks****TIMING CHAIN COVER OIL SEAL (COVER NOT REMOVED)****REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Remove the cooling fan and shroud.
- (3) Remove the serpentine belt (refer to Group 7, Cooling Systems).
- (4) Using a 3-jaw puller tool, pull pulley/damper off of the crankshaft.
- (5) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover (Fig. 36).

**Fig. 36 Timing Chain Cover and Oil Seal****INSTALLATION**

- (1) Position the crankshaft front oil seal onto seal installer special tool 6806 and C-3688 (Fig. 37). Install seal.
- (2) Install crankshaft pulley/damper using tool C-3688.

**Fig. 37 Timing Chain Cover and Oil Seal**

- (3) Install serpentine belt (refer to Group 7, Cooling System).
- (4) Install cooling fan and shroud.
- (5) Connect negative cable to the battery.

TIMING CHAIN COVER OIL SEAL (COVER REMOVED)**REMOVAL**

- (1) With timing cover removed from engine place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover.

INSTALLATION

- (1) Position the crankshaft front oil seal onto seal installer special tool 6806.
- (2) Use tool 6761 to support timing chain cover when installing oil seal with tool 6806 (Fig. 38), install seal.

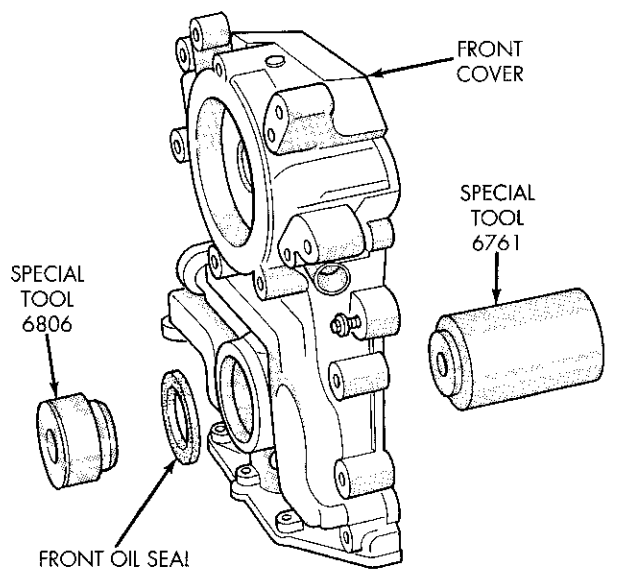
CAMSHAFT

The camshaft has an integral oil pump and distributor drive gear (Fig. 40).

REMOVAL

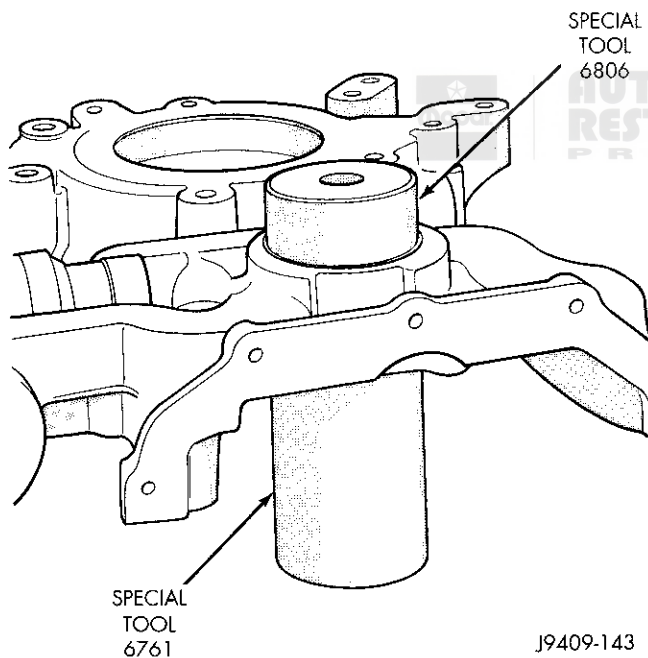
- (1) Remove cylinder head covers.
- (2) Remove rocker arm assemblies, identify each part so it can be installed in its original location..
- (3) Remove push rods and tappets. Identify each part so it can be installed in its original location.

REMOVAL AND INSTALLATION (Continued)



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Fig. 38 Oil Seal, Tools—6806 and 6761



J9409-143

Fig. 39 Oil Seal Installed

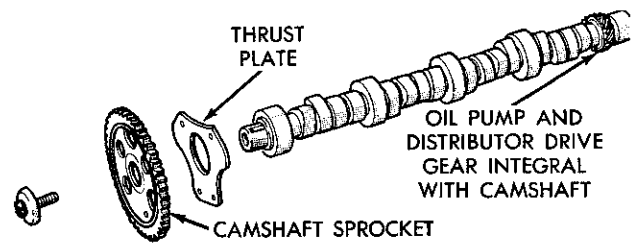
(4) The 4 corner tappets can not be removed without removing the cylinder heads and gaskets. They can be lifted and retained for camshaft removal.

(5) Remove upper and lower intake manifold (refer to Group 11 Intake and Exhaust Systems).

(6) Remove timing chain cover and timing chain.

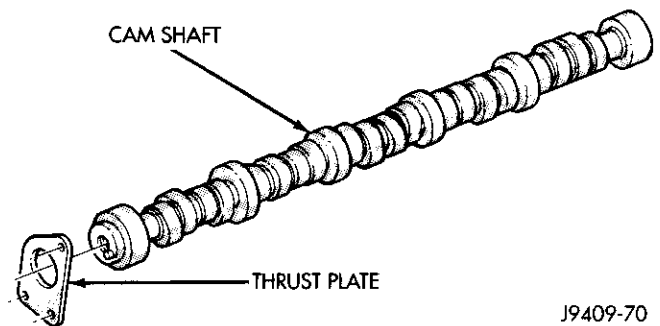
(7) Remove camshaft thrust plate (Fig. 41).

(8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft,



J9309-71

Fig. 40 Camshaft and Sprocket Assembly



J9409-70

Fig. 41 Camshaft

being careful not to damage cam bearings with the cam lobes.

INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals. Using a long bolt, insert the camshaft into the cylinder block.

NOTE: Whenever an engine has been rebuilt, a new camshaft and/or new tappets installed, add 1 pint of Mopar® Crankcase Conditioner, or equivalent. The oil mixture should be left in engine for a minimum of 805 km (500 miles). Drain at the next normal oil change.

(2) Install camshaft thrust plate. Tighten the torx bolts to 22 N·m (16 ft. lbs.) torque.

(3) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

(4) Line up key with keyway in sprocket, press on crankshaft timing sprocket, use tools C-3688, C-3718 and MB990799, to seat sprocket against crankshaft shoulder (Fig. 42).

(5) Align timing mark on crankshaft sprocket with center line of crankshaft and camshaft.

(6) Put chain on camshaft sprocket.

(7) Take chain and camshaft sprocket and align mark with centerline of crankshaft and camshaft install camshaft sprocket and chain to camshaft.

REMOVAL AND INSTALLATION (Continued)

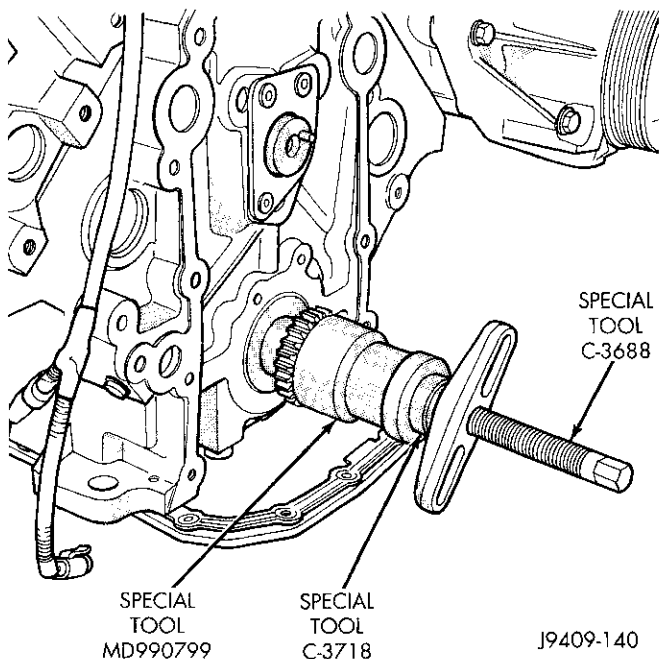


Fig. 42 Crankshaft Sprocket Installation

(8) Install the camshaft bolt. Tighten bolt to 75 N·m (55 ft. lbs.) torque.

(9) Install the timing chain cover.

(10) Install the crankshaft pulley/damper use tool C-3688.

(11) Prime oil pump by squirt oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

(13) Install tappets and push rods in their original location.

(14) Install the rocker arms.

(15) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. **DO NOT** use alternative fasteners.

(16) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 43). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(17) Install the intake manifolds, (refer to Group 11 Intake and Exhaust Systems).

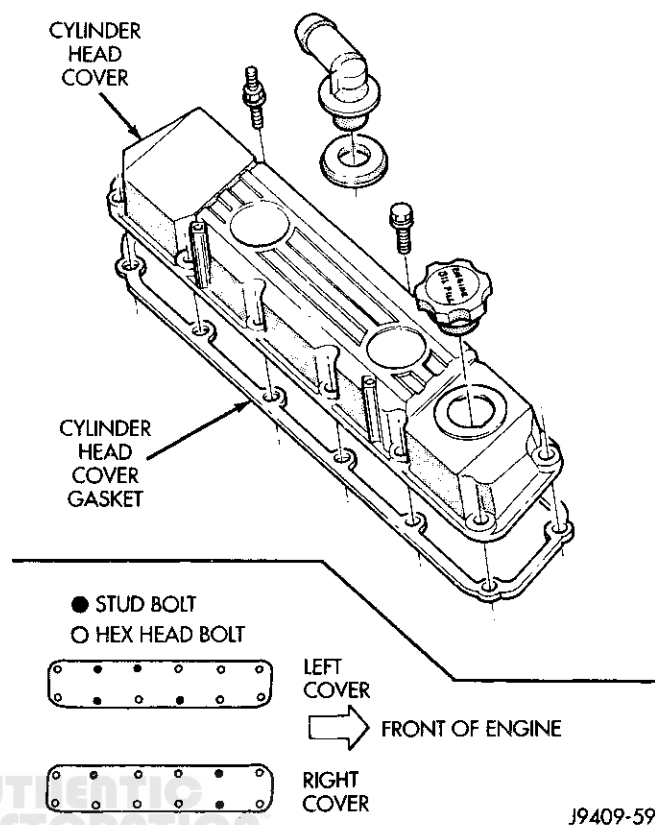


Fig. 43 Cylinder Head Cover

CAMSHAFT BEARING

REMOVAL

This procedure requires that the engine is removed from the vehicle.

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 44).

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

REMOVAL AND INSTALLATION (Continued)

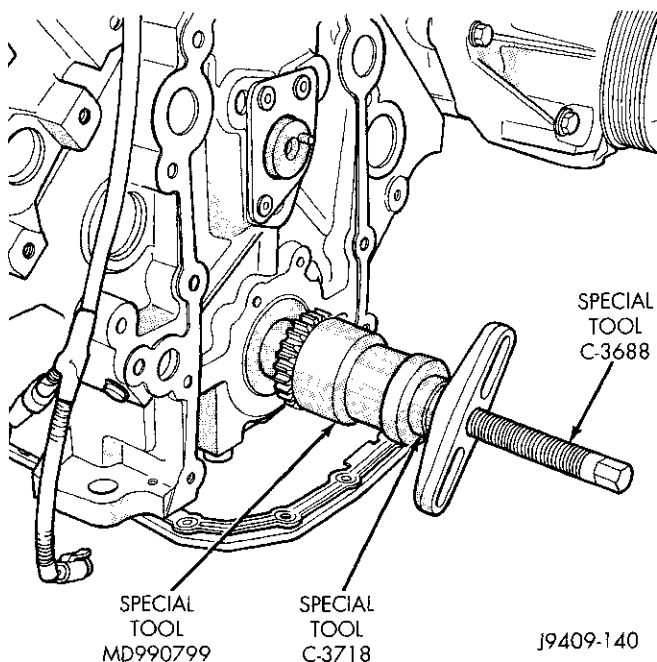


Fig. 44 Camshaft Bearings Removal and Installation with Tool C-3132-A

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Raise vehicle.
- (3) Drain engine oil.
- (4) Remove left engine to transmission strut.
- (5) Remove oil pan and one-piece gasket. The engine may have to be raised slightly on 2WD vehicles.
- (6) Remove the oil pick-up tube assembly (Fig. 45). Discard the gasket.

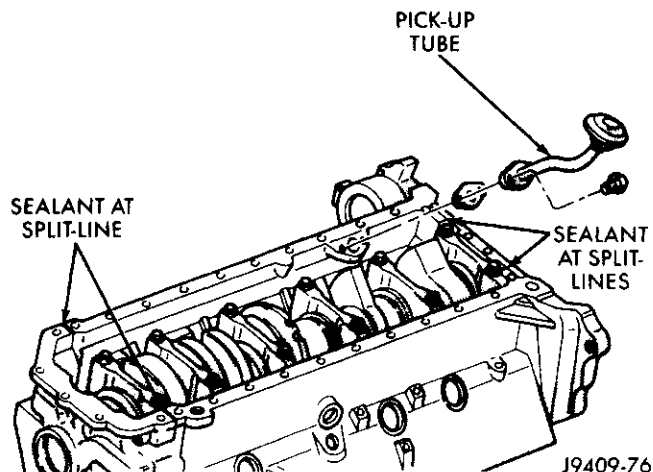


Fig. 45 Oil Pick-Up Tube

INSTALLATION

- (1) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 46).

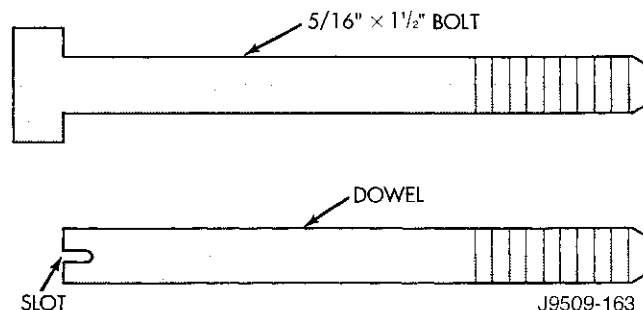


Fig. 46 Fabrication of Alignment Dowels

- (2) Install the dowels in the cylinder block at the four corners.
- (3) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent at the split lines. The split lines are between the cylinder block, the timing chain cover and the rear crankshaft seal assembly (Fig. 45). **After the sealant is applied you have 3 minutes to install the gasket and oil pan.**
- (4) Slide the one-piece gasket over the dowels and onto the block.
- (5) Position the oil pan over the dowels and onto the gasket. The engine may have to be slightly raised on 2WD vehicles.
- (6) Install the oil pan bolts (Fig. 47). Tighten the 1/4 inch bolts to 11 N·m (96 in. lbs.) torque. Tighten the stud bolts to 16 N·m (144 in. lbs.) torque. Tighten the 5/16 inch bolts to 16 N·m (144 in. lbs.) torque.

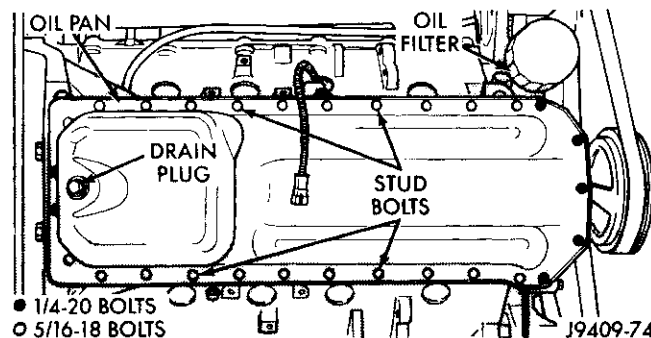


Fig. 47 Oil Pan Bolt Location

- (7) Remove the dowels. Install the remaining 5/16 inch oil pan bolts. Tighten these bolts to 16 N·m (144 in. lbs.) torque.
- (8) Install the drain plug. Tighten drain plug to 34 N·m (25 ft. lbs.) torque.
- (9) Install the engine to transmission strut.
- (10) Lower vehicle.

REMOVAL AND INSTALLATION (Continued)

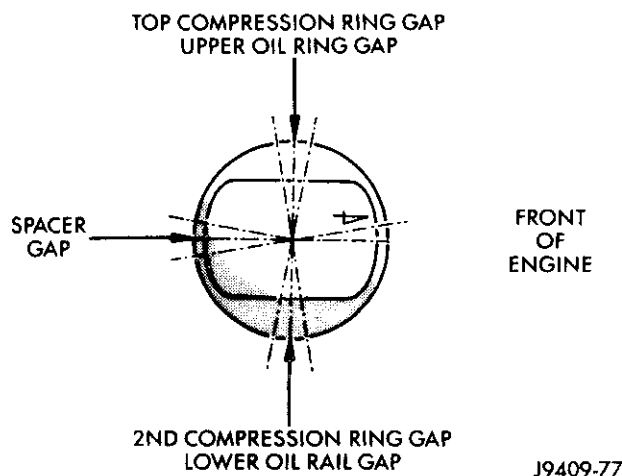
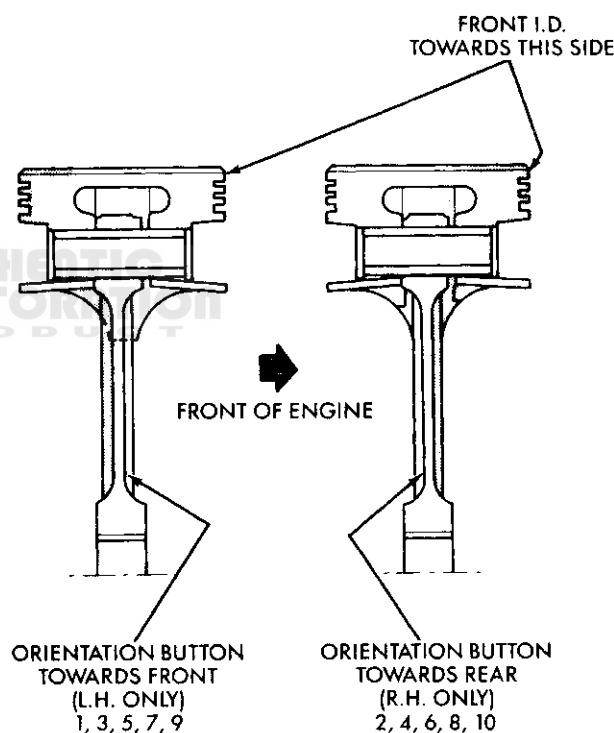
- (11) Connect the negative cable to the battery.
- (12) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY**REMOVAL**

- (1) Remove the engine from the vehicle (refer to Engine Removal of this manual).
- (2) Remove the valve cover, rocker arms, push rods and cylinder head. Mark parts as removed.
- (3) Remove the oil pan and oil pump pick-up tube.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.
- (5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.
- (6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals. DO NOT try to remove black coating on skirt. This is the dry film lubricant.**
- (7) After removal, install bearing cap on the mating rod.

INSTALLATION

- (1) Check the crankshaft connecting rod journal for excessive wear, taper and scoring.
- (2) Check the cylinder block bore for out-of-round, taper, scoring and scuffing.
- (3) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.
- (4) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 48).
- (5) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**
- (6) Install connecting rod bolt protectors on rod bolts, a long protector should be installed on the numbered side of the connecting rod.
- (7) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore in the bottom dead center position. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore. Be sure the piston and rod assemblies are installed in the proper orientation (Fig. 49).
- (8) The notch, groove or arrow on top of piston must be pointing toward front of engine. The larger

**Fig. 48 Proper Ring Installation****Fig. 49 Piston and Rod Orientation**

chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(9) While tapping the piston down in cylinder bore with the handle of a hammer, guide the connecting rod over the crankshaft journal.

(10) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(11) Install the oil pump pick-up tube and oil pan.

REMOVAL AND INSTALLATION (Continued)

(12) Install the cylinder head, push rods, rocker arms and valve cover.

(13) Install lower intake manifold.

(14) Install the engine into the vehicle.(refer to Engine Installation of this manual).

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan and oil pump pick-up tube.

(2) Identify bearing caps before removal. Remove bearing caps one at a time.

(3) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 50).

(4) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

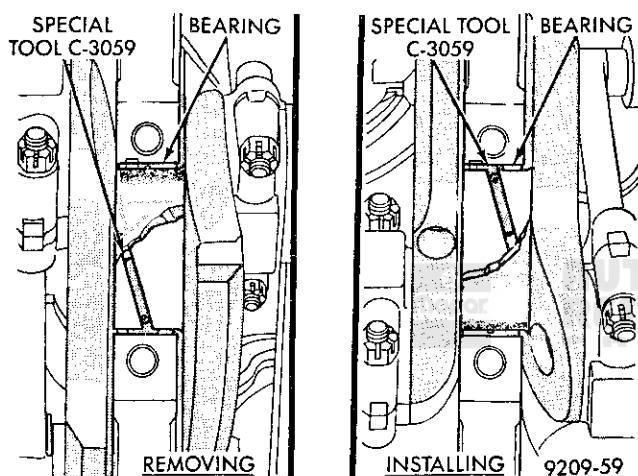


Fig. 50 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 50).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Lubricate the main journals with clean engine oil. Install main bearing caps and bolts. Follow the 2 step tightening sequence.

- Step 1—Starting with bearing cap No.1, tighten the bolts to 27 N·m (20 ft. lbs.) torque.

- Step 2—Starting with bearing cap No.1, tighten the bolts to 115 N·m (85 ft. lbs.) torque.

(4) Apply a rearward axial load of 667 N (150 lbs-f) on crankshaft centerline, driving No.3 main cap and thrust bearing against No.3 bulkhead. Repeat procedure, driving crankshaft forward to align rear flange of thrust bearings in a common plane. Front face of No.1 main cap must not extend forward in front of face of No.1 bulkhead.

(5) Install the oil pump pick-up tube and oil pan.

CRANKSHAFT

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

REMOVAL

(1) Remove the oil pan.

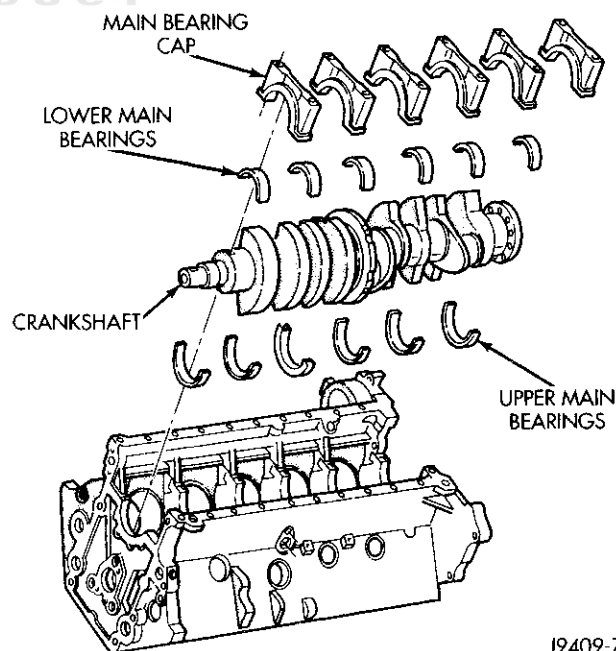
(2) Remove the oil pickup tube.

(3) Remove the timing chain cover and gasket. Remove and discard the front crankshaft oil seal and cover gasket.

(4) Remove Transmission (refer to Group 21, Transmission).

(5) Remove the rear seal retainer. Remove and discard the crankshaft rear oil seal and retainer gasket.

(6) Identify main bearing caps before removal (Fig. 51). Remove bearing caps and bearings one at a time.



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Fig. 51 Main Bearing Identification

(7) Remove the connecting rod bearing caps.

(8) Lift the crankshaft straight out of the block.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

(1) Lubricate crankshaft main bearings with clean engine oil.

(2) Install the crankshaft into the cylinder block.

(3) Lubricate the main journals with clean engine oil. Install main bearing caps and bolts. Follow the 2 step tightening sequence.

- Step 1—Starting with bearing cap No.1, tighten the bolts to 27 N·m (20 ft. lbs.) torque.

- Step 2—Starting with bearing cap No.1, tighten the bolts to 115 N·m (85 ft. lbs.) torque.

(4) Lubricate the connecting rod bearings and journals with clean engine oil. Carefully install connecting rods to the crankshaft.

(5) Install the rear seal retainer with a new gasket and oil seal. Use seal installer 6687 when installing the oil seal.

(6) Install the timing chain cover with a new gasket and oil seal.

(7) Prime oil pump by squirt oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(8) Apply a rearward axial load of 667 N (150 lbs-f) on crankshaft centerline, driving No.3 main cap and thrust bearing against No.3 bulkhead. Repeat procedure, driving crankshaft forward to align rear flange of thrust bearings in a common plane. Front face of No.1 main cap must not extend forward in front of face of No.1 bulkhead.

(9) Install the oil pickup tube. Tighten the bolts to 16 N·m (144 in. lbs.) torque.

(10) Install the oil pan.

OIL PUMP**REMOVAL**

(1) Remove the timing chain cover.

(2) Remove the relief valve plug, gasket, spring and valve (Fig. 52). Discard the gasket.

(3) Remove oil pump cover (Fig. 53).

(4) Remove pump rotors (Fig. 53).

INSTALLATION

(1) Lubricate the pump rotors using petroleum jelly or lubriplate and install in the timing chain cover. Use new parts as required (Fig. 54).

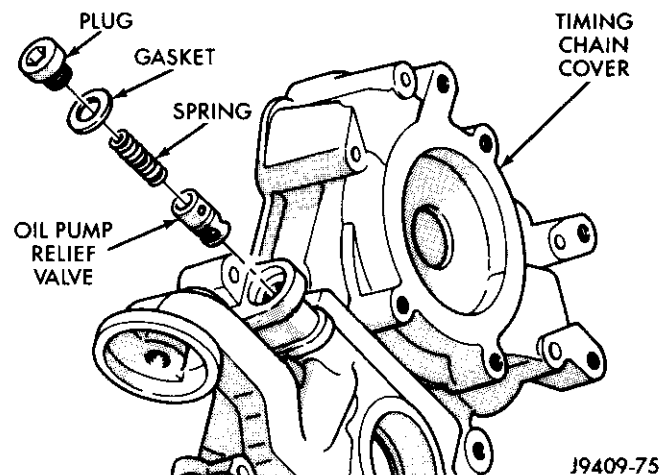
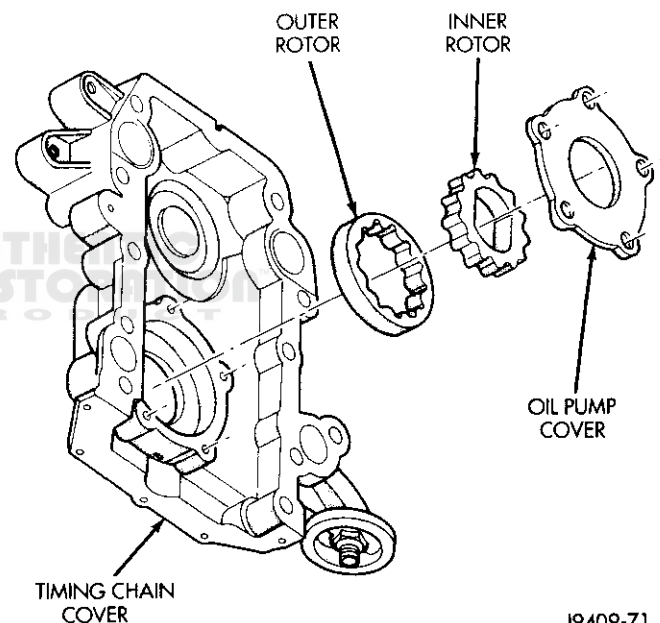
(2) Position the oil pump cover onto the timing chain cover. Tighten cover bolts to 14 N·m (125 in. lbs.) torque.

(3) Make sure that inner ring moves freely after cover is installed.

(4) Install the timing chain cover.

(5) Squirt oil into relief valve hole until oil runs out.

(6) Install the relief valve and spring.

**Fig. 52 Oil Pressure Relief Valve****Fig. 53 Oil Pump**

(7) Using a new pressure relief valve gasket, install the relief valve plug. Tighten the plug to 20 N·m (15 ft. lbs.) torque.

(8) Install oil filter that has been filled with oil.

CRANKSHAFT REAR SEAL/ RETAINER**REMOVAL**

(1) Remove the transmission (refer to Group 21, Transmissions).

(2) Remove the oil pan.

(3) Remove the rear seal retainer. Discard the oil seal and the gasket (Fig. 55).

REMOVAL AND INSTALLATION (Continued)

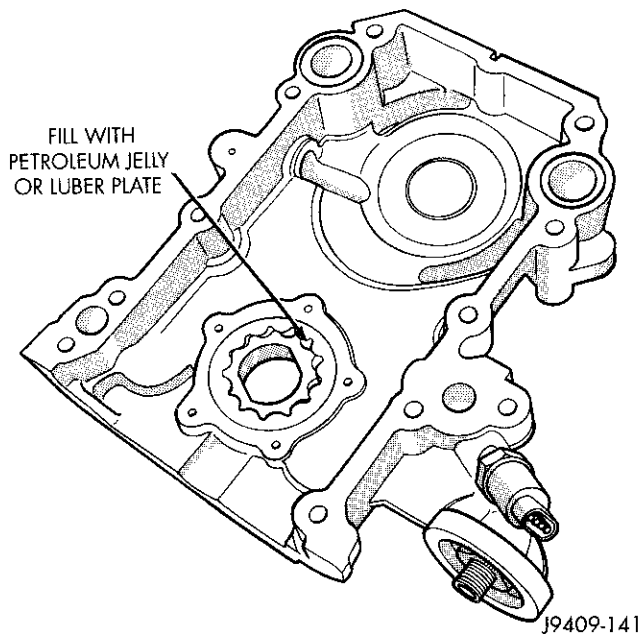


Fig. 54 Priming Oil Pump.

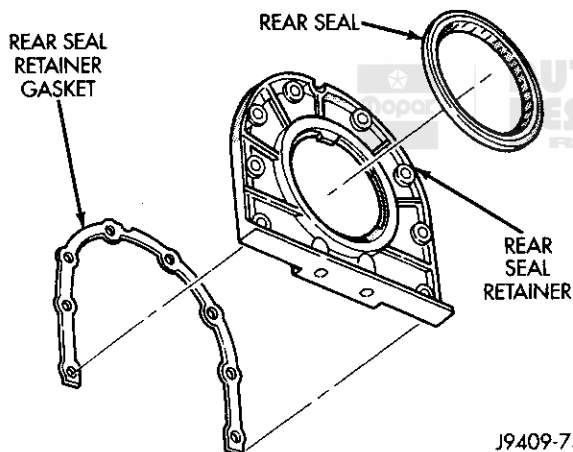


Fig. 55 Crankshaft Rear Seal Retainer

INSTALLATION

- (1) Wash all parts in a suitable solvent and inspect carefully for damage or wear.
- (2) Position the rear seal in the retainer.
- (3) Using Special Tool 6687, position the retainer and oil seal over the crankshaft. Install the bolts and tighten to 22 N·m (16 ft. lbs.) torque.
- (4) The seal face surface must be within 0.508 mm (0.020 in) full indicator movement relative to rear face of crankshaft. If out of limits, gently tap the high side into the retainer.
- (5) Add a small amount of Mopar® Silicone Rubber Adhesive Sealant at split-line.
- (6) Install the oil pan.

- (7) Install the transmission (refer to group 21, Transmissions).

ENGINE CORE OIL—CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate. This will reduce internal leakage and help maintain higher oil pressure at idle.

REMOVAL

- (1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 56).
- (2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 56).

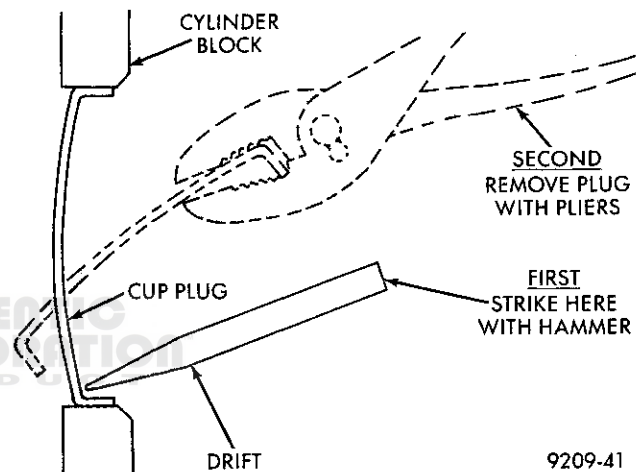


Fig. 56 Core Hole Plug Removal

INSTALLATION

- (1) Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.
- (2) Make certain the new plug is cleaned of all oil or grease.
- (3) Coat edges of plug and core hole with Mopar® Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting as restricted coolant flow can result and cause serious engine problems.

- (4) Using proper drive plug, drive plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 inch) inside the lead-in chamfer.

It is not necessary to wait for curing of the sealant. The cooling system can be filled and the vehicle placed in service immediately.

DISASSEMBLY AND ASSEMBLY

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

- (1) Install Black Valve Guide Sleeve Tool C-6819 over valve stem for the **INTAKE** valve and install valve (Fig. 57). The special sleeve places the valve at the correct height for checking with a dial indicator.
- (2) Install Silver Valve Guide Sleeve Tool C-6818 over valve stem for the **EXHAUST** valve and install valve. The special sleeve places the valve at the correct height for checking with a dial indicator.

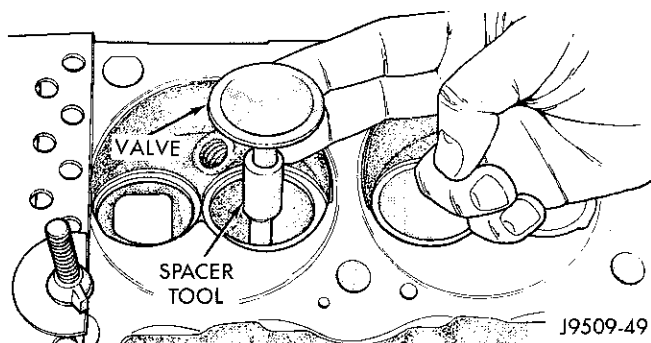


Fig. 57 Positioning Valve Spacer Tool (Typical)

- (3) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 58).

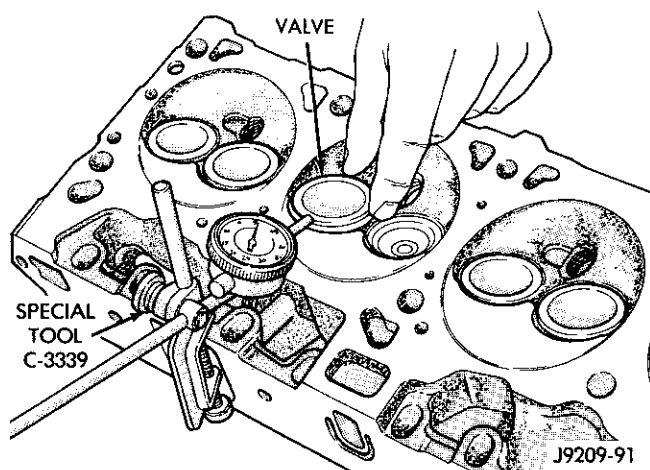


Fig. 58 Measuring Valve Guide Wear

- (4) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 inch). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

Service valves with oversize stems are available (Fig. 59).

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

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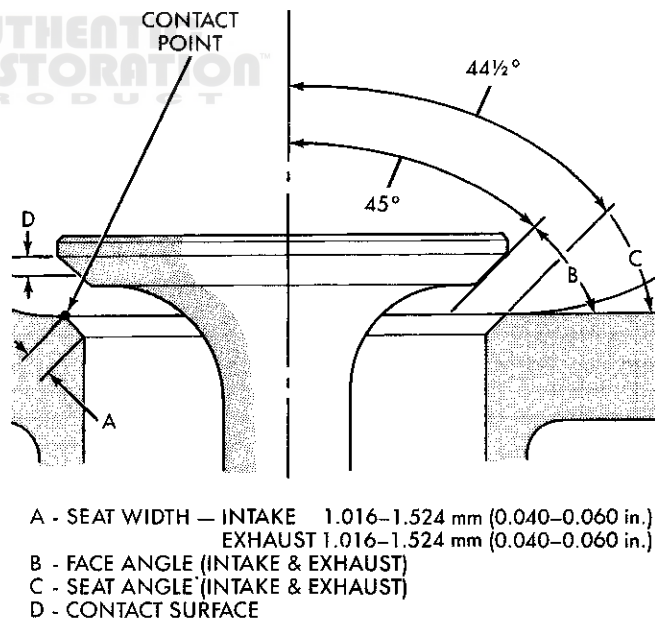
Fig. 59 Reamer Sizes

- (5) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 inch). Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:**

- Step 1—Ream to 0.0763 mm (0.003 inch).
- Step 2—Ream to 0.381 mm (0.015 inch).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 45° face angle and a 45° to 44 1/2° seat angle (Fig. 60).



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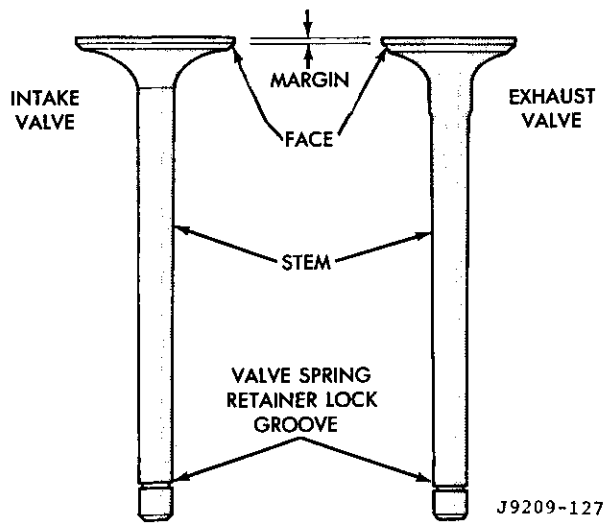
Fig. 60 Valve Face and Seat Angles

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 17). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

- (1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 61 Intake and Exhaust Valves**

ing stones. A true and complete surface must be obtained.

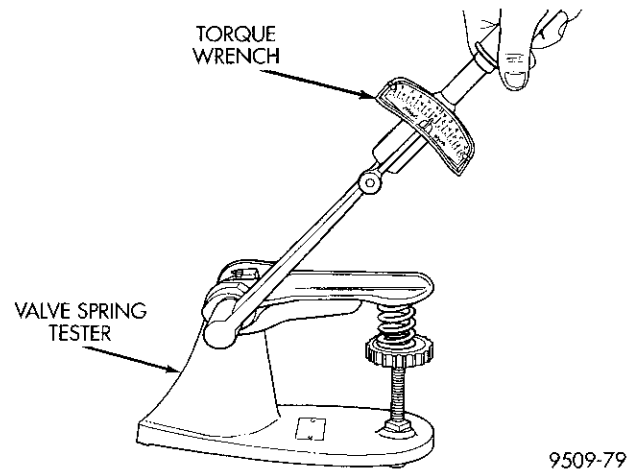
(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.038 mm (0.0015 inch) total indicator reading.

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of valve seats should be 1.016-1.524 mm (0.040-0.060 inch).

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 62). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

**Fig. 62 Testing Valve Spring for Compressed Length****CYLINDER BLOCK**

Remove the engine assembly from the vehicle.

DISASSEMBLE

- (1) Remove the cylinder head and valve train.
- (2) Remove the intake system.
- (3) Remove the timing cover and timing chain with sprockets.
- (4) Remove the oil pan.
- (5) Remove the piston-connecting rod assemblies.
- (6) Remove the crankshaft and bearings.

ASSEMBLE

- (1) Install crankshaft and bearings.
- (2) Install the piston/connecting rod assembly.
- (3) Install the oil pan.
- (4) Install timing cover, timing chain and sprockets.
- (5) Install the cylinder head and valve train.
- (6) Install the engine into the vehicle.
- (7) Install intake system.

CLEANING AND INSPECTION**CYLINDER HEADS****CLEANING**

Clean all surfaces of cylinder block and cylinder heads. Be sure material does not fall into the lifters and surrounding valley.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

Clean the exhaust manifold to cylinder head mating areas.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. The out-of-flatness

CLEANING AND INSPECTION (Continued)

specifications are 0.0007 mm/mm (0.0004 inch/inch), 0.127 mm/152 mm (0.005 inch/6 inches) any direction or 0.254 mm (0.010 inch) overall across head. If exceeded, either replace head or lightly machine the head surface.

The cylinder head surface finish should be 1.78-4.57 microns (15-80 microinches).

Inspect push rods. Replace worn or bent rods.

Inspect rocker arms. Replace if worn or scored.

OIL PAN**CLEANING**

Clean the block and pan gasket surfaces.

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

OIL PUMP**CLEANING**

Wash all parts in a suitable solvent and inspect carefully for damage or wear.

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump cover if scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 63). If a 0.076 mm (0.003 inch) feeler gauge can be inserted between cover and straightedge, cover should be replaced.

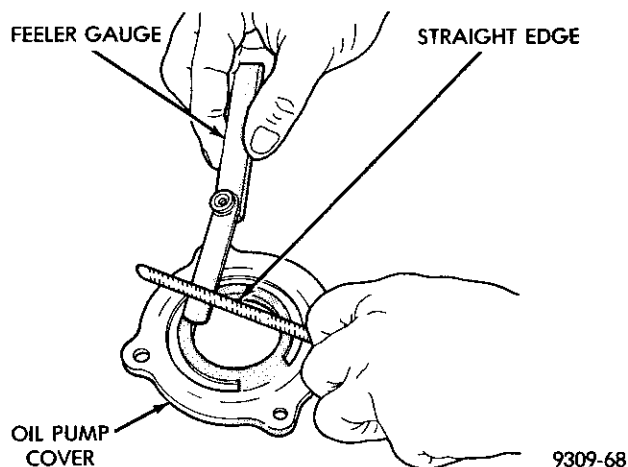


Fig. 63 Checking Oil Pump Cover Flatness

Measure thickness (Fig. 64) (Fig. 65) and diameter of rotors. If either rotor thickness measures 14.956 mm (0.5876 inch) or less, or if the diameter is 82.45 mm (3.246 inches) or less, replace rotor set.

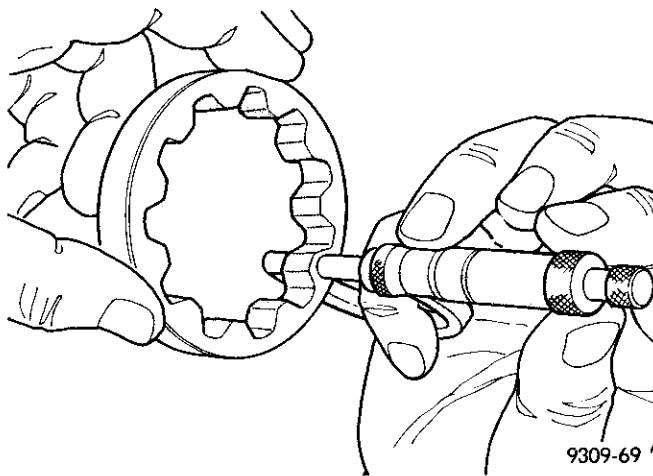


Fig. 64 Measuring Outer Rotor Thickness

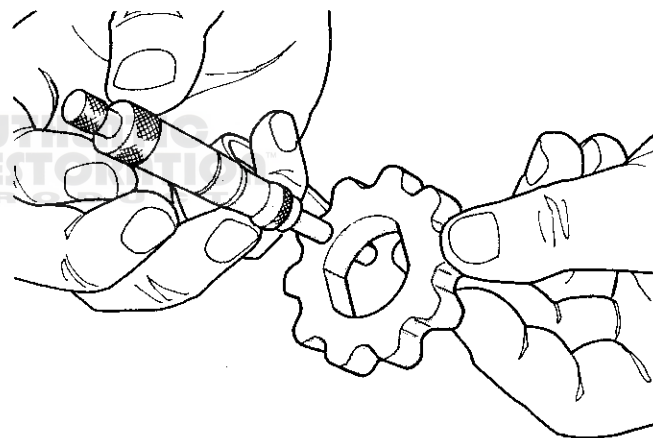
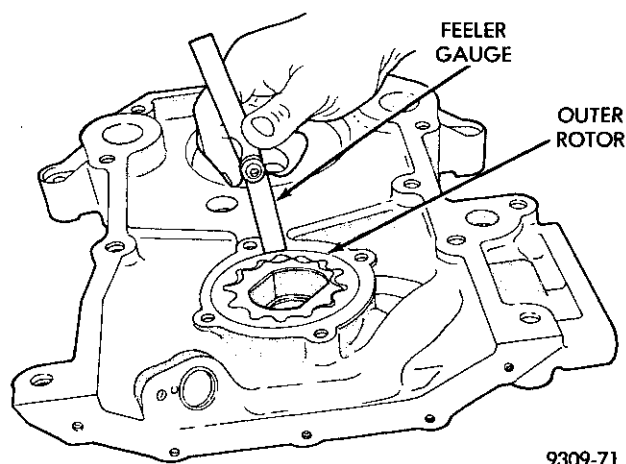
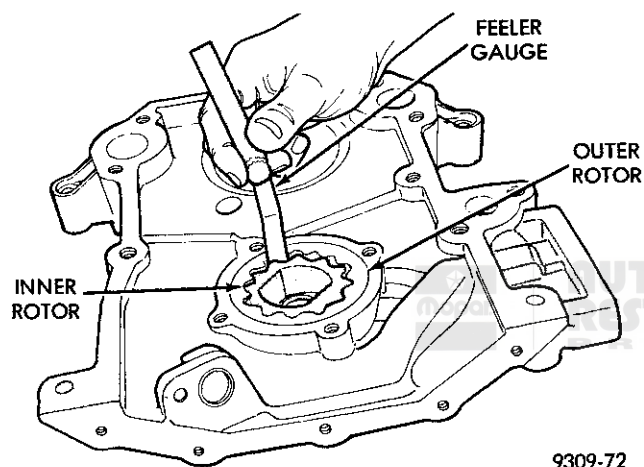


Fig. 65 Measuring Inner Rotor Thickness

Slide outer rotor into timing chain cover pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 66). If clearance is 0.19 mm (0.007 inch) or more, and outer rotor is within specifications, replace timing chain cover.

Install inner rotor into timing chain cover pump body (Fig. 67). Inner rotor should be positioned with chamfer up or toward engine when cover is installed. This allows easy installation over crankshaft. If clearance between inner and outer rotors is 0.150 mm (0.006 inch) or more, replace both rotors.

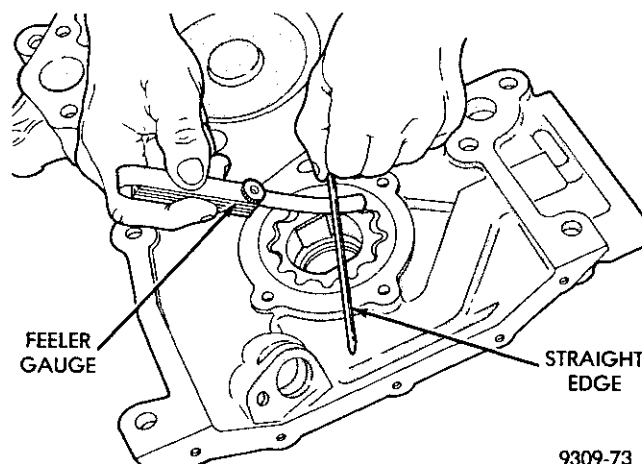
Place a straightedge across the face of the timing chain cover pump body, between bolt holes (Fig. 68). If a feeler gauge of 0.077 mm (0.003 inch) or more can be inserted between rotors and the straightedge,

CLEANING AND INSPECTION (Continued)**Fig. 66 Measuring Outer Rotor Clearance in Cover****Fig. 67 Measuring Inner Rotor Clearance in Cover**

and the rotors are within specifications, replace timing chain cover.

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 100 and 109 N (22.5 and 24.5 pounds) when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications.

**Fig. 68 Measuring Clearance Over Rotors**

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

CYLINDER BLOCK**CLEANING**

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool, Special tool 6879 or equivalent. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 inch) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 inch).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings so specified clearances may be maintained.

SPECIFICATIONS

8.0L ENGINE

SPECIFICATIONS—8.0L ENGINE

Camshaft

Bore Diameter	
No.1	53.16 - 53.19 mm (2.093 - 2.094 in)
No.2	52.76 - 52.78 mm (2.077 - 2.078 in)
No.3	52.35 - 52.37 mm (2.061 - 2.062 in)
No.4	51.94 - 51.97 mm (2.045 - 2.046 in)
No.5	51.54 - 51.56 mm (2.029 - 2.030 in)
No.6	48.74 - 48.77 mm (1.919 - 1.920 in)

Diametrical Clearance

No.1 & No.3 - No.6	0.0254 - 0.0762 mm (0.001 - 0.003 in)
No.2	0.0381 - 0.0889 mm (0.0015 - 0.0035 in)
End Play	0.127 - 0.381 mm (0.005 - 0.015 in)

Bearing Journal Diameter

No.1	53.11 - 53.14 mm (2.091 - 2.092 in)
No.2	52.69 - 52.72 mm (2.0745 - 2.0755 in)
No.3	52.30 - 52.32 mm (2.059 - 2.060 in)
No.4	51.89 - 51.92 mm (2.043 - 2.044 in)
No.5	51.49 - 51.51 mm (2.027 - 2.028 in)
No.6	48.69 - 48.72 mm (1.917 - 1.918 in)

Connecting Rods

Bearing Clearance	0.005 - 0.074 mm (0.0002 - 0.0029 in)
Piston Pin Bore Diameter	24.940 - 24.978 mm (0.9819 - 0.9834 in)
Side Clearance (Two Rods)	0.25 - 0.46 mm (0.010 - 0.018 in)
Total Weight (Less Bearing)	744 grams (26.24 oz)

Crankshaft

Connecting Rod Journal	
Diameter	53.950 - 53.975 mm (2.124 - 2.125 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)

Crankshaft (Cont.)

Main Bearing Diametrical Clearance	
No.1 - No.6	0.0051 - 0.058 mm (0.0002 - 0.0023 in)
Max. Allowable	0.071 mm (0.0028 in)
End Play	0.076 - 0.305 mm (0.003 - 0.012 in)
Max. Allowable	0.381 mm (0.015 in)
Main Bearing Journals	
Diameter	76.187 - 76.213 mm (2.9995 - 3.0005 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)

Cylinder Block

Cylinder Bore	
Diameter	101.60 - 101.61 mm (4.0000 - 4.0005 in)
Out-of-Round (Max.)	0.127 mm (0.005 in)
Taper (Max.)	0.254 mm (0.010 in)
Tappet Bore Diameter	22.982 - 23.010 mm (0.9048 - 0.9059 in)

Cylinder Head

Compression Pressure	1172 - 1310 kPa (170 - 190 psi)
Gasket Thickness (Compressed)	0.991 - 1.118 mm (0.039 - 0.044 in)
Valve Seat	
Angle	44.5°
Runout (Max.)	0.076 mm (0.003 in)
Width (Finish)	
Intake & Exhaust	1.02 - 1.52 mm (0.040 - 0.060 in)
Guide Bore Diameter (Std.)	7.95 - 7.98 mm (0.313 - 0.314 in)

Hydraulic Tappets

Body Diameter	22.949 - 22.962 mm (0.9035 - 0.9040 in)
Clearance in Block (Diametrical)	0.2030 - 0.0610 mm (0.0008 - 0.0024 in)
Plunger Travel Minimum (Dry)	4.24 mm (0.167 in)
Push Rod Length	195.52 - 196.02 mm (7.698 - 7.717 in)

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SPECIFICATIONS (Continued)**Oil Pump**

Clearance over Rotors (Max.)	0.1906 mm (0.0075 in)
Cover Out-of-Flat (Max.)	0.051 mm (0.002 in)
Inner Rotor Thickness (Min.)	14.925 - 14.950 mm (0.5876 - 0.5886 in)
Outer Rotor Clearance (Max.)	0.1626 mm (0.006 in)
Diameter (Min.)	82.461 mm (3.246 in)
Thickness (Min.)	14.925 mm (0.5876 in)
Tip Clearance between Rotors (Max.)	0.584 mm (0.0230 in)

Oil Pressure (Engine Hot)

At Curb Idle Speed *	83 - 172 kPa (12 - 25 psi)
At 3000 rpm	345 - 414 kPa (50 - 60 psi)

*CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

Pistons

Land Clearance (Diametrical)	0.013 - 0.038 mm (0.0005 - 0.0015 in)
Piston Length	82.5 mm (3.25 in)
Piston Ring Groove Diameter	
No.1 & No.2	91.30 - 91.55 mm (3.594 - 3.604 in)
No.3	92.90 - 93.15 mm (3.657 - 3.667 in)
Weight	463 - 473 grams (16.33 - 16.68 oz)

Piston Pins

Clearance	
In Piston	0.2489 - 0.5537 mm (0.0098 - 0.0218 in)
In Rod (Interference)	0.018 - 0.061 mm (0.0007 - 0.0024 in)
Diameter	24.996 - 25.001 mm (0.9841 - 0.9843 in)
End Play	NONE
Length	67.818 - 68.326 mm (2.670 - 2.690 in)

Piston Rings

Ring Gap	
Compression Rings	0.254 - 0.508 mm (0.010 - 0.020 in)
Oil Control (Steel Rails)	0.381 - 1.397 mm (0.015 - 0.055 in)
Ring Side Clearance	
Compression Rings	0.074 - 0.097 mm (0.0029 - 0.0038 in)
Oil Ring (Steel Rails)	0.185 - 0.246 mm (0.0073 - 0.0097 in)
Ring Width	
Compression Rings	4.115 - 4.369 mm (0.162 - 0.172 in)
Oil Ring (Steel Rails)	2.591 - 2.743 mm (0.102 - 0.108 in)

Valves

Face Angle	45°
Head Diameter	
Intake	48.640 - 48.900 mm (1.915 - 1.925 in)
Exhaust	41.123 - 41.377 mm (1.619 - 1.629 in)
Length (Overall)	
Intake	145.19 - 145.82 mm (5.716 - 5.741 in)
Exhaust	145.54 - 146.18 mm (5.730 - 5.755 in)
Lift (Zero Lash)	
Intake	9.91 mm (0.390 in)
Exhaust	10.34 mm (0.407 in)
Valve Stem Tip Height	47.50 - 48.13 mm (1.870 - 1.895 in)
Stem Diameter	7.900 - 7.920 mm (0.311 - 0.312 in)
Stem-to-Guide Clearance	
Intake & Exhaust	0.025 - 0.076 mm (0.001 - 0.003 in)
Max. Allowable (Rocking Method)	0.4318 mm (0.017 in)

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SPECIFICATIONS (Continued)**Valve Springs**

Free Length (Approx.)	49.962 mm (1.967 in)
Spring Tension	
Valve Closed	369 - 405 N @41.66 mm (81 - 89 lbs @1.640 in)
Valve Open	865 - 956 N @30.89 mm (190 - 210 lbs @1.216 in)
Number of Coils	6.79
Wire Diameter	4.496 mm (0.177 in)

Valve Timing

Exhaust Valve	
Closes (ATC)	25°
Opens (BBC)	60°
Duration	265°
Intake Valve	
Closes (ABC)	61°
Opens (BTC)	6°
Duration	246°
Valve Overlap	31°

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ENGINE SPECIFICATIONS—CONT.

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Milled flat on no. 8 crankshaft counterweight.
CYLINDER BORES (OVERSIZE) 0.508 mm (0.020 in.)	A	Following engine serial number.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	◆	Diamond-shaped stamp top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

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ENGINE SPECIFICATIONS—CONT.

SPECIFICATIONS (Continued)**TORQUE**

DESCRIPTION	TORQUE
Camshaft Bolt	75 N•m (55 ft. lbs.)
Camshaft Thrust Plate Torx Bolts.....	22 N•m (16 ft. lbs.)
Coil Pack Bracket Bolts.....	21 N•m (190 in. lbs.)
Connecting Rod Cap Bolts.....	61 N•m (45 ft. lbs.)
Crankshaft Main Bearing Cap Bolts	
1st Step	27 N•m (20 ft. lbs.)
2nd Step	115 N•m (85 ft. lbs.)
Crankshaft Pulley/Damper Bolt.....	183 N•m (135 ft. lbs.)
Crankshaft Rear Seal Retainer Bolts	22 N•m (16 ft. lbs.)
Cylinder Head Bolts	
1st Step	58 N•m (43 ft. lbs.)
2nd Step	143 N•m (105 ft. lbs.)
Cylinder Head Cover Bolts/Studs.....	16 N•m (144 in. lbs.)
Drive Plate-to-Crankshaft Bolts.....	75 N•m (55 ft. lbs.)
Drive Plate-to-Torque Converter Bolts	75 N•m (55 ft. lbs.)
EGR Tube Nut	34 N•m (25 ft. lbs.)
EGR Bolts	20 N•m (174 in. lbs.)
Engine Support Bracket/Cushion	
Thru-Bolt.....	68 N•m (50 ft. lbs.)
Engine Support Bracket/Cushion	
Mounting Bolts	47 N•m (35 ft. lbs.)
Exhaust Manifold-to-Cylinder	
Head Bolts	22 N•m (16 ft. lbs.)
Flywheel-to-Crankshaft Bolts.....	75 N•m (55 ft. lbs.)
Generator Mounting Bolt	41 N•m (30 ft. lbs.)
Generator-to-Intake Manifold	
Bracket Bolts	41 N•m (30 ft. lbs.)
Heat Shield Nuts	20 N•m (175 in. lbs.)
Hydraulic Tappet Yoke Retaining	
Spider Bolts	22 N•m (16 ft. lbs.)
Intake Manifold Bolts (Lower).....	54 N•m (40 ft. lbs.)

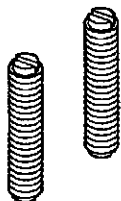
DESCRIPTION	TORQUE
Intake Manifold Bolts (Upper)	22 N•m (16 ft. lbs.)
Oil Filter	9 N•m (80 in. lbs.) +45°
Oil Filter Connector	46 N•m (34 ft. lbs.)
Oil Pan Bolts (1/4-20).....	11 N•m (96 in. lbs.)
Oil Pan Stud Bolts.....	16 N•m (144 in. lbs.)
Oil Pan Bolts (5/16-18).....	16 N•m (144 in. lbs.)
Oil Pan Drain Plug	34 N•m (25 ft. lbs.)
Oil Pan Pick-Up Tube Bolts	16 N•m (144 in. lbs.)
Oil Pump Attaching Bolts	41 N•m (30 ft. lbs.)
Oil Pump Cover Bolts.....	14 N•m (125 in. lbs.)
Oil Pump Pressure Relief Plug	20 N•m (15 ft. lbs.)
Rear Oil Seal Retainer Bolts	22 N•m (16 ft. lbs.)
Rocker Arm Bolts	28 N•m (21 ft. lbs.)
Spark Plugs	41 N•m (30 ft. lbs.)
Starter Mounting Bolts	68 N•m (50 ft. lbs.)
Timing Chain Cover Bolts	47 N•m (35 ft. lbs.)
Thermostat Housing Bolts	25 N•m (220 in. lbs.)
Throttle Body Nuts	11 N•m (96 in. lbs.)
Torque Converter Drive Plate Bolts	31 N•m (270 in. lbs.)
Transfer Case-to-Insulator Mounting	
Plate Nuts	204 N•m (150 ft. lbs.)
Transmission Support Bracket Bolts	102 N•m (75 ft. lbs.)
Transmission Support Cushion Bolts	47 N•m (35 ft. lbs.)
Transmission Support Cushion	
Stud Nuts	47 N•m (35 ft. lbs.)
Water Pump-to-Chain Case Cover Bolt....	41 N•m (30 ft. lbs.)
Water Pump Pulley Bolts	22 N•m (16 ft. lbs.)

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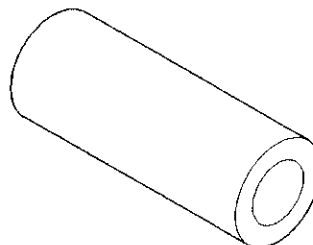
TORQUE SPECIFICATIONS

SPECIAL TOOLS

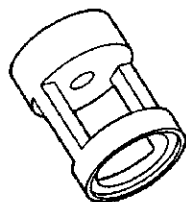
8.0L ENGINE



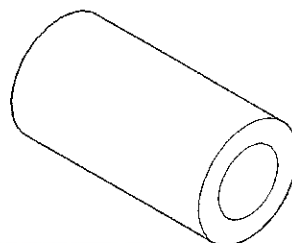
Valve Compressor Adapting Stud Tool 6715



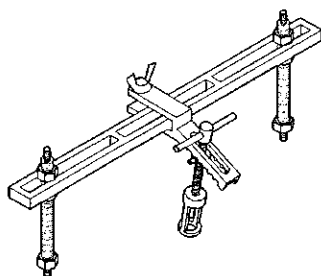
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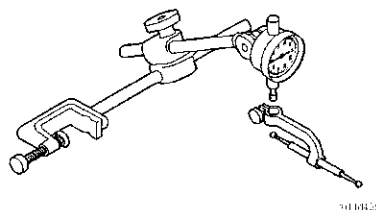
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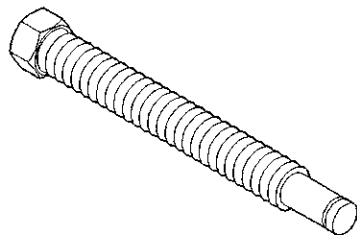
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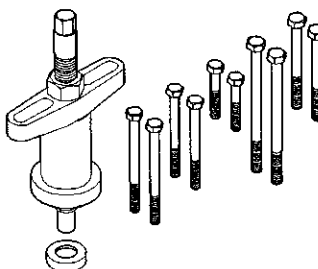
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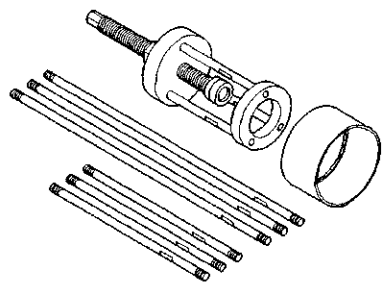
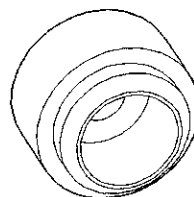
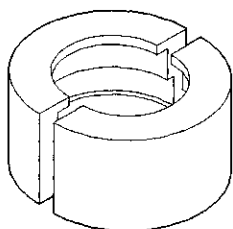
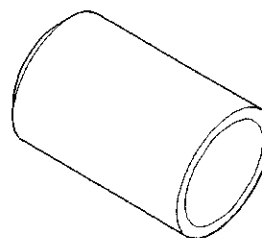
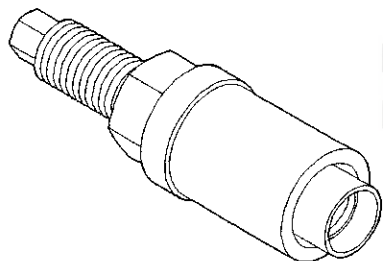
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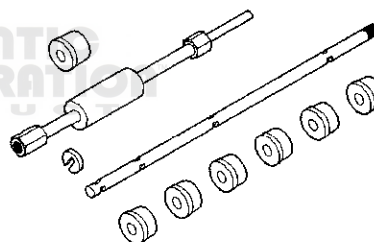
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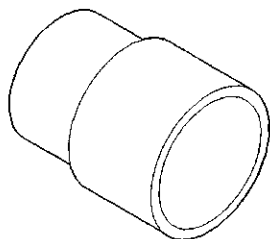
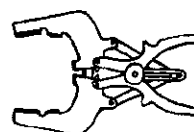
Crankshaft Pulley/Damper Installer Tool C3688

SPECIAL TOOLS (Continued)***Crankshaft Sprocket Puller Tool 6444******Front Oil Seal Installer Tool 6806******Crankshaft Sprocket Puller Jaws Tool 6820******Front Oil Seal Installer Tool 6761******Crankshaft Sprocket Installer Tool 3718***

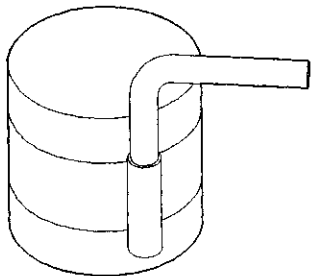
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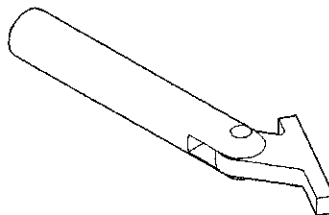
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Camshaft Bearing Installer Tool C3132A***Crankshaft Sprocket Installer Tool MD990799******Compression Ring Installer Tool C4184***

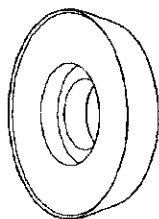
SPECIAL TOOLS (Continued)



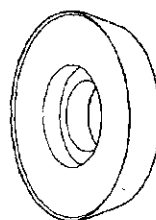
Piston Ring Compressor Tool C385



*Crankshaft Main Bearing Remover/Installer Tool
C3059*



Seal Installer Tool 6687



Seal Installer Tool 6687



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5.9L (DIESEL) ENGINE

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GENERAL INFORMATION

PISTON GRADING

When rebuilding an engine with the original cylinder block, crankshaft and pistons, make sure the pistons are installed in the original cylinder.

If replacing the piston(s), make sure the replacement piston(s) are the same grade as the original piston.

If a new cylinder block or crankshaft is used, the piston grading procedure **MUST** be performed to determine the proper piston grade for each cylinder.

OIL FILTER

When replacing the oil filter, use replacement filter specified in your Operator's Manual.

CAUTION: The internal filtering medium of some filters has been known to disintegrate. Debris from failed filters may plug the piston oil cooling nozzles, resulting in scuffed pistons and eventual engine failure.

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 5.9 Liter (359 CID) six-cylinder diesel engine is an In-line valve in head type (Fig. 1).

Engine Type.....	In-line 6 (Diesel-Turbo)
Bore and Stroke.....	102.0 x 120.0 mm (4.02 x 4.72 in.)
Displacement.....	5.9L (359 cu. in.)
Compression Ratio	17.5:1
Torque (Automatic).....	542 N•m (400 ft. lbs.) @ 1600 rpm
(Manual).....	569 N•m (420 ft. lbs.) @ 1600 rpm
Firing Order.....	1-5-3-6-2-4
Lubrication.....	Pressure Feed - Full Flow Filtration w/Bypass Valve
Engine Oil Capacity	9.5L (10.0 Qts) w/Filter
Cooling System	Liquid Cooled - Forced Circulation
Cooling Capacity	23L (24 Qts)
Cylinder Block.....	Cast Iron
Crankshaft.....	Induction Hardened Forged Steel
Cylinder Head	Cast Iron
Combustion Chambers	High Swirl Bowl
Camshaft.....	Chilled Ductile Iron
Pistons.....	Cast Aluminum
Connecting Rods	Forged Steel

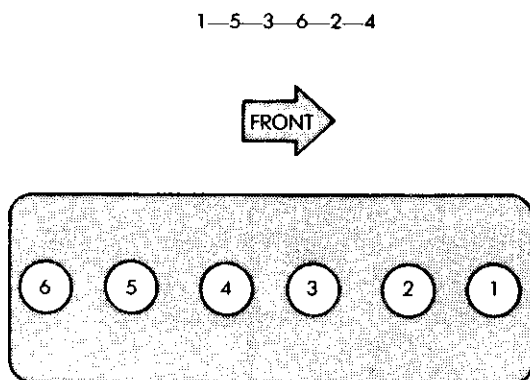
J9409-12

Fig. 1 Diesel Engine Description

This engine is designed for No.2 Diesel Fuel. Only use No.1 Diesel Fuel where extended arctic conditions exist (below -23°C or -10°F).

Engine lubrication system consists of a gerotor type oil pump and a full flow oil filter with a bypass valve.

The cylinders are numbered from front to rear; 1 to 6. The firing order is 1-5-3-6-2-4 (Fig. 2).



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Fig. 2 Firing Order

The engine data plate is located on the driver side of the engine forward of the fuel injection pump.

LUBRICATION SYSTEM

The engine uses a gerotor type lubricating pump. The machined cavity in the block is the same for all engines. The pressure regulating valve is designed to keep the lubricating oil pressure from exceeding 449kPa (65 PSI). When the lubricating oil pressure from the pump is greater the 499kPa (65 PSI), The valve opens uncovering the dump port so part of the lubricating oil is routed to the oil pan. Because of manufacturing tolerances of the components and the oil passages, the lubricating oil pressure can differ as much as 69 kPa (10 PSI) between engines.

The engines use full flow, plate type oil coolers. The oil flows through a cast passage in the cooler cover and through the element where it is cooled by the engine coolant flowing past the plates of the elements. After the oil is cooled, it flows through the full flow oil filter.

The lubricating oil cooler cover contains a bypass valve the will let the lubricating oil flow bypass a plugged filter. The valve is designed to open when the pressure drop across the filter is more than 138 kPa (20 PSI), as with a plugged filter and lets the lubricating oil continue on through the engine. When a filter becomes plugged, an oil pressure decrease of 60 kPa (10 PSI) or less from normal operating pressure can be observed on the vehicle lubricating oil pressure gauge. This allows unfiltered oil into the engine. This condition should be avoided by changing the filter at each oil change.

The turbocharger receives filtered, cooled and pressurized lubricating oil through a supply line from the filter head. A drain line connected to the bottom of the turbocharger housing returns the lubricating oil to the lubricating oil pan through a fitting in the cylinder block.

The main bearings and the valve train are lubricated by pressurized oil directly from the main oil gallery. the other power components, connecting rods, pistons, and camshaft receive pressurized oil directly from the main oil gallery. Passages in the crankshaft supply oil to the connecting rods bearings. The oil is supplied to the camshaft journals through passages in the main bearings saddles. Smaller passages in the main bearings saddles supply oil to the pistons cooling nozzles. The spray from the nozzles also provides lubrication for the piston pins.

Lubrication for the valve train is supplied through separate passages in the cylinder block. Oil flows through the passages and across the oil transfer slot in the cylinder head gasket. From the transfer slot, the oil flows around the outside diameter at the cylinder capscrew, across a slot in the bottom of the rocker lever support, and up the vertical passage in the support. From these passages, oil flows through passages in the rocker lever shaft to lubricate the rocker levers. The oil from the channel lubricates the valves stems, push rods, and tappets.

DESCRIPTION AND OPERATION (Continued)

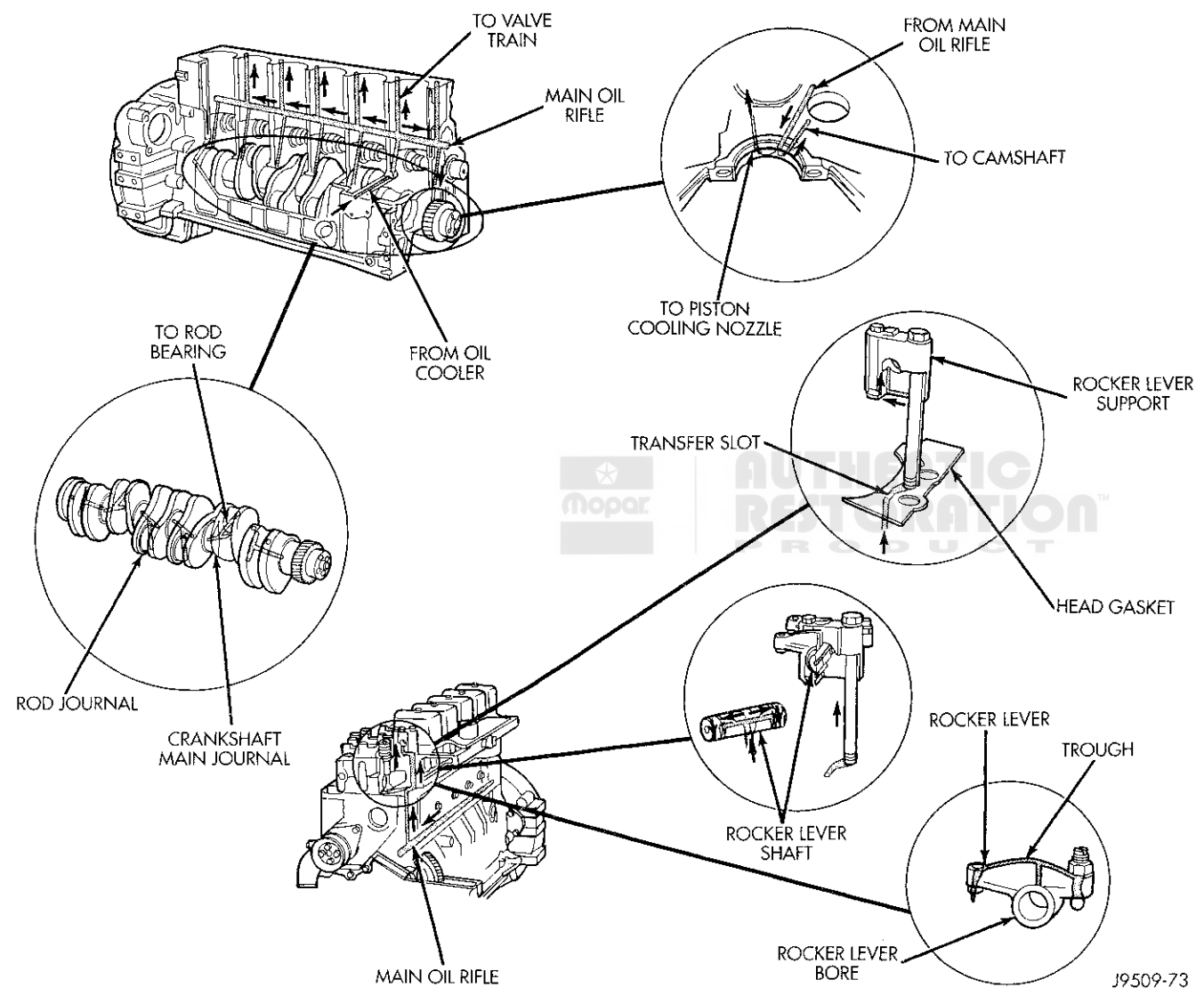
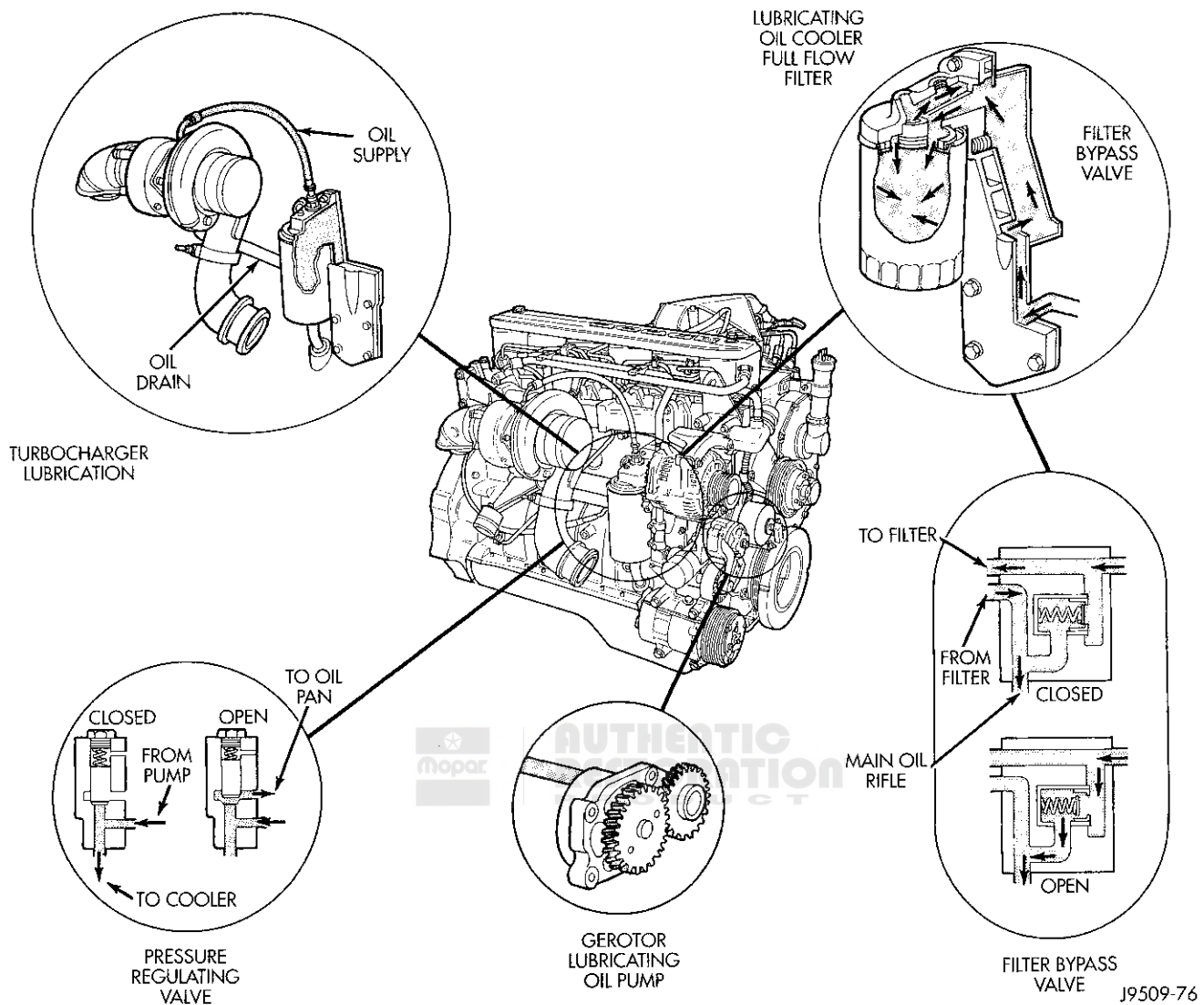


Fig. 3 Lubricating System Components

DESCRIPTION AND OPERATION (Continued)**Fig. 4 Lubricating System Passages****OIL PRESSURE REGULATOR VALVE**

When oil pressure from the oil pump exceeds 448 kPa (65 psi), the regulator valve opens to allow oil to drain back into the pan.

TIMING PIN

The timing pin is used for three different procedures:

- Valve adjustment
- Top Dead Center (TDC) location
- Fuel injector pump timing procedure

SERVICE PROCEDURES**OIL FILTER**

When replacing the oil filter, use replacement filter specified in your Operator's Manual.

CAUTION: The internal filtering medium of some filters has been known to disintegrate. Debris from failed filters may plug the piston oil cooling nozzles, resulting in scuffed pistons and eventual engine failure.

SERVICE PROCEDURES (Continued)**REMOVAL**

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

(1) Operate the engine until the water temperature reaches 60°C (140°F). Shut the engine off.

(2) Use a container that can hold at least 14 liters (15 quarts) to hold the used oil. Remove the oil drain plug and drain the used engine oil into the container.

(3) Always check the condition of the used oil. This can give you an indication of some engine problems that might exist.

- Thin, black oil indicates fuel dilution.
- Milky discoloration indicates coolant dilution.

(4) Clean the area around the lubricating oil filter head. Remove the filter using a 90-95 mm filter wrench.

(5) Clean the gasket surface of the filter head. The filter canister O- Ring seal can stick on the filter head. Make sure it is removed.

INSTALLATION

(1) Fill the oil filter element with clean oil before installation. Use the same type oil that will be used in the engine.

(2) Apply a light film of lubricating oil to the sealing surface before installing the filter.

CAUTION: Mechanical over-tightening may distort the threads or damage the filter element seal.

(3) Install the filter as specified by the filter manufacturer.

(4) Clean the drain plug and the sealing surface of the pan. Check the condition of the threads and sealing surface on the oil pan and drain plug.

(5) Install the drain plug using a new sealing washer. Tighten the plug to 80 N·m (60 ft. lbs.) torque.

(6) Use only High-Quality Multi-Viscosity lubricating oil in the Cummins Turbo Diesel engine. Choose the correct oil for the operating conditions outlined in Group 0, Lubrication and Maintenance.

(7) Fill the engine with the correct grade of new oil. The engine capacity is 9.46 liters (10 quarts) in the crankcase and 0.95 liters (1 quart) in the lubricating oil filter.

(8) Start the engine and operate it at idle for several minutes. Check for leaks at the filter and drain plug.

(9) Stop the engine. Wait approximately 15 minutes to let the oil in the upper parts of the engine to drain back to the oil pan. Check the oil level again. Add oil as necessary to bring the level to the H (High) mark on the dipstick.

VALVE SERVICE**VALVE GUIDE INSTALLATION****THIN WALL—SERVICE GUIDES**

Machine the cylinder head valve guide bores to 11.125 ± 0.013 mm (0.4380 ± 0.0005 inch) in diameter (Fig. 5).

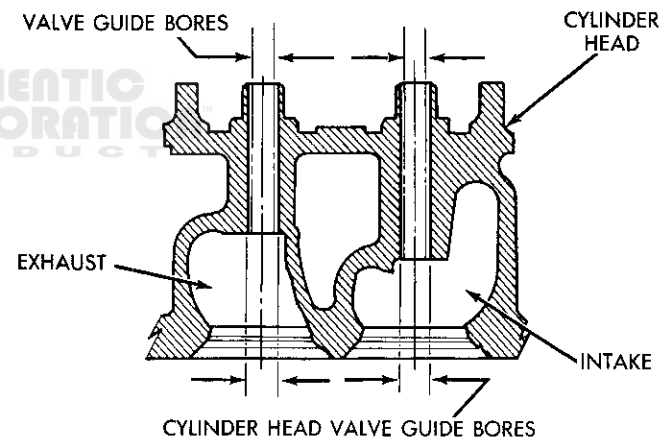
Service valve guides must be centered with valve seats within 0.35 mm (0.01378 inch) diameter. They must also be square with the combustion face within 0.10 mm (0.004 inch) at 50.0 mm (1.9685 inch) radius.

Lubricate the valve guides with oil and press the guides flush to the bottom of the bosses.

Trim off the top of the valve guides flush to top of guide bosses, if necessary.

Machine the valve guide bores to 8.029 ± 0.010 mm (0.3161 ± 0.0004 inch) - (Fig. 5).

The valve guide bore must be centered with the valve seat within 0.35 mm (0.0138 inch) diameter. It also must be square with the combustion face within 0.010 mm (0.0004 inch) at 50.0 mm (2.0 inch) radius.

**CYLINDER HEAD VALVE GUIDE BORES**

11.125 ± 0.013 mm (0.438 ± 0.0005 in)

VALVE GUIDE BORES

8.029 ± 0.010 mm (0.3161 ± 0.0004 in)

J9109-136

Fig. 5 Service Valve Guides—Thin Wall

THICK WALL—SERVICE GUIDES

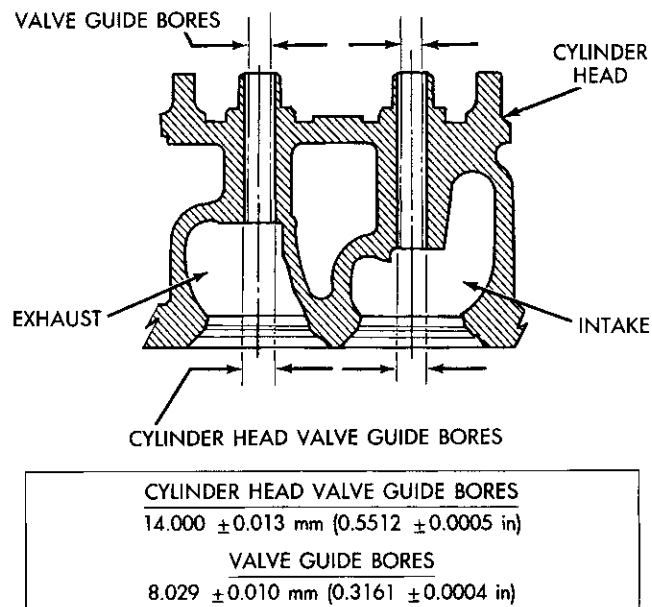
Machine the cylinder head valve guide bores to 14.000 ± 0.013 mm (0.5512 ± 0.0005 inch) diameter (Fig. 6).

Valve guides must be centered with valve seats within 0.35 mm (0.01378 inch) diameter. Valve guides must also be square with the combustion face within 0.10 mm (0.004 inch) at 50.0 mm (2.0 inch) radius.

SERVICE PROCEDURES (Continued)

Lubricate the valve guides with oil and press in the guides to 12.25 ± 0.50 mm (0.4823 ± 0.020 inch) protrusion above the cylinder head.

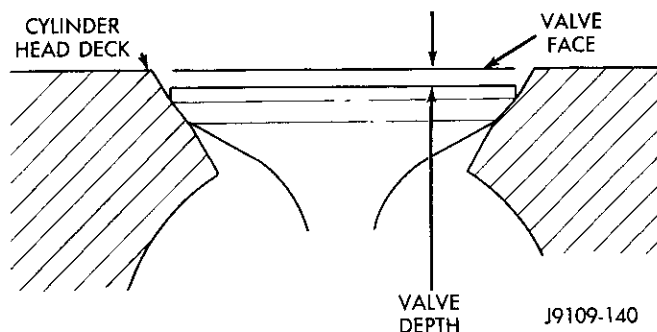
Ream the bores to 8.029 ± 0.010 mm (0.3161 ± 0.0004 inch) - (Fig. 6).



J9109-137

Fig. 6 Service Valve Guides—Thick Wall**VALVE SEATS****INTEGRAL VALVE SEAT GRINDING**

After resurfacing the valves and determining that all valves meet specifications, install the valves in their designated locations and measure valve depth (Fig. 7). The valve depth is the distance from the valve face to the head deck. Record the depth of each valve.



J9109-140

Fig. 7 Valve Depth

Grind the valve seats to remove scores, scratches and burns. The seat angle should be—Intake 30° and Exhaust 45° .

Install the valves in their respective bores and measure the depth again (Fig. 7). Record the depth of each valve.

The grinding depth is the difference between the measurement before grinding and the measurement after grinding. The grinding depth maximum limit (integral seats only) is 0.254 mm (0.010 inch). Service valve seats are available for over limit integral valve seats.

Identify ground valve seats by stamping the cylinder head.

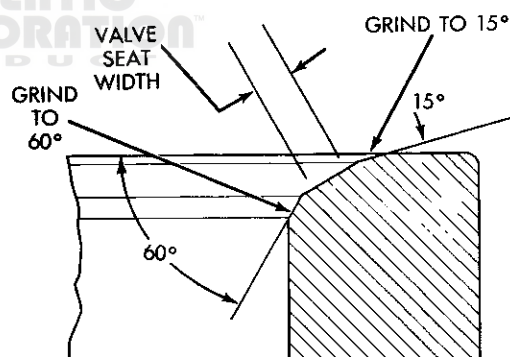
Install the valves in their designated locations and measure the depth of each. The valve depth limit (Integral and Inserted Seats) is 0.99 mm to 1.52 mm (0.039 inch to 0.060 inch). Replace the valve if the depth is over this limit.

Apply a light coat of valve lapping compound to each valve and lap each valve to its mating seat.

Remove the valves and clean lapping compound from the valves and seats.

Measure the valve seat width indicated by the lapping surface. The valve seat width limit is 1.50-2.00 mm (0.060-0.080 inch).

If required, grind the areas with a 60° stone and a 15° stone to center the seat on the valve face. Maintain the valve seat width limits (Fig. 8).



J9109-141

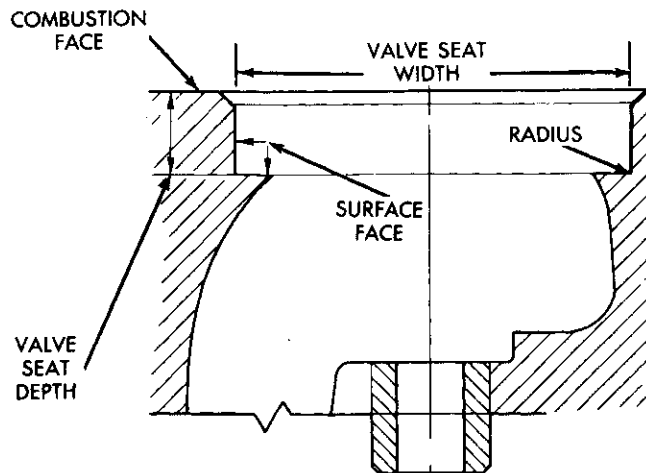
Fig. 8 Grind Valve Seat**SERVICE VALVE SEAT INSTALLATION**

Inspect the valve guide bores as described in the Cleaning and Inspection section of this group. If it is necessary to install valve guides, install the guides before installing the service seats.

Replacement valve seat inserts must be installed if the valve seats have been ground previously. The illustrated marks indicate valve seats have been ground previously.

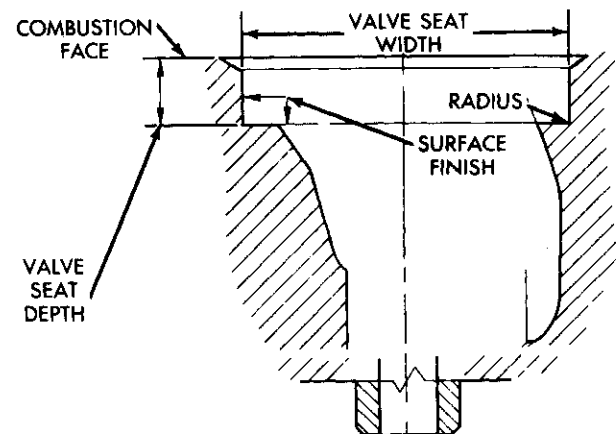
Machine the cylinder head to install the service valve seats (Fig. 9) (Fig. 10).

Press service seats into the machined pockets. Stake the valve seats into the pockets.

SERVICE PROCEDURES (Continued)

VALVE SEAT DEPTH
$10.40 \pm 0.10 \text{ mm } (0.4094 \pm 0.004 \text{ inch})$
VALVE SEAT WIDTH
$47.0 \pm 0.013 \text{ mm } (1.8504 \pm 0.0005 \text{ in})$
MAXIMUM RADIUS
$0.40 \text{ mm } (0.0157 \text{ inch}) \text{ MAX.}$
SURFACE FINISH
$3.2 \text{ micrometers } (128.0 \text{ microinch})$

J9409-115

Fig. 9 Machining for Service Valve Seats—Intake Valve

VALVE SEAT DEPTH
$10.20 \pm 0.10 \text{ mm } (0.4015 \pm 0.004 \text{ inch})$
VALVE SEAT WIDTH
$43.65 \pm 0.013 \text{ mm } (1.7185 \pm 0.0005 \text{ in})$
MAXIMUM RADIUS
$0.40 \text{ mm } (0.0157 \text{ inch}) \text{ MAX.}$
SURFACE FINISH
$3.2 \text{ micrometers } (128.0 \text{ microinch})$

J9409-116

Fig. 10 Machining for Service Valve Seats—Exhaust Valve**SERVICE VALVE SEAT GRINDING**

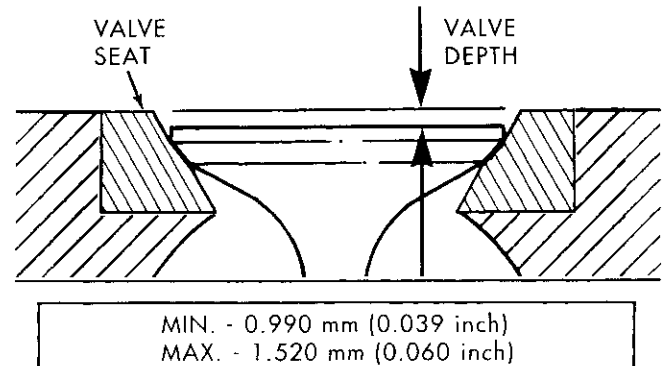
Install the valves in their designated location and measure the valve depth. The valve depth is the distance from the valve face to the head deck.

Record the depth of each valve (Fig. 11). The depth is 0.99-1.52 mm (0.039-0.060 inch).

Grind the valve seats to remove scores, scratches and burns. The valve seat angle is 30° (Intake) and 45° (Exhaust).

Install the valves in their respective bores and measure the depth again (Fig. 11). The valve depth limit is 0.99-1.52 mm (0.039-0.060 inch). Replace the valve if the depth is over the limit.

Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat. Remove the valves and clean the lapping compound from the valve and seats.



J9109-44

Fig. 11 Valve Depth with Seat Insert

SERVICE PROCEDURES (Continued)

Measure the valve seat width indicated by the lapped surface (Fig. 12). The width limits are 1.5-2.0 mm (0.060-0.080 inch). If required, grind lower area with 60° stone and upper area with 15° stone (Fig. 12). Be sure to center the seat on the valve face. Maintain the valve seat within limits.

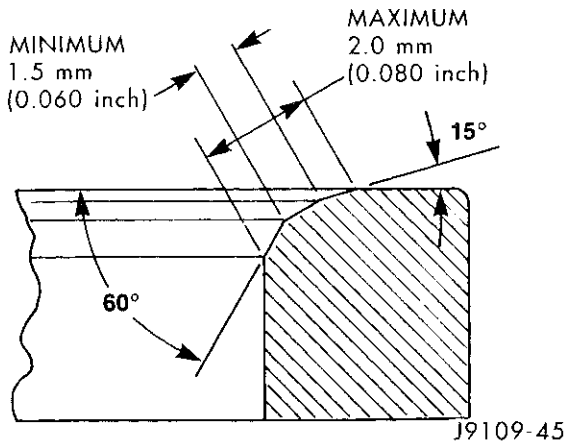


Fig. 12 Valve Seat Width

SERVICE VALVE SEAT REPLACEMENT

To replace service seat inserts, machine the insert in the same manner as if machining out the internal seat. Hold the same tolerances and follow the same installation procedures.

CYLINDER BORES—DE-GLAZE

- (1) New piston rings may not seat in glazed cylinder bores.
- (2) De-glazing gives the bore the correct surface finish required to seat the rings. The size of the bore is not changed by proper de-glazing.
- (3) Cover the lube holes in the top of the block with waterproof tape.
- (4) A correctly honed surface will have a cross-hatch appearance with the lines at 15° to 25° angles (Fig. 13). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

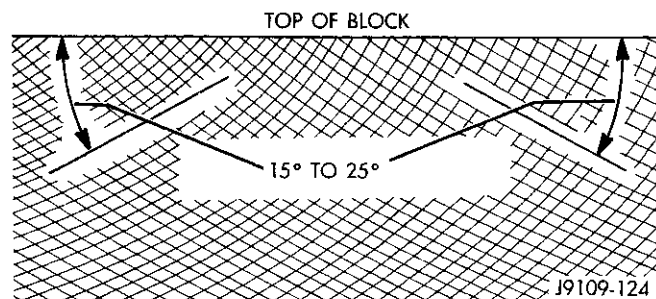


Fig. 13 Cylinder Bore Crosshatch Pattern

- (5) Use a drill, a fine grit Flex-hone and a mixture of equal parts of mineral spirits and SAE 30W engine oil to de-glaze the bores.

- (6) The crosshatch angle is a function of drill speed and how fast the hone is moved vertically (Fig. 14).

- (7) Vertical strokes **MUST** be smooth continuous passes along the full length of the bore (Fig. 14).

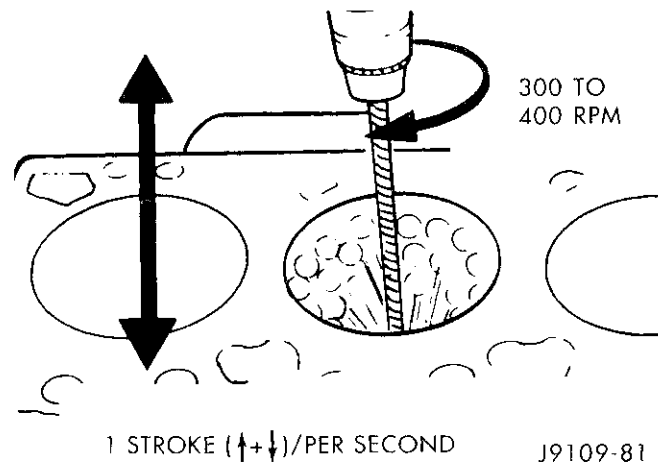
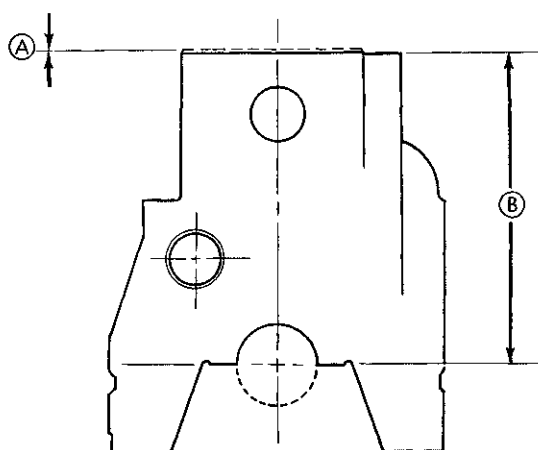


Fig. 14 De-Glazing Drill Speed and Vertical Speed

- (8) Inspect the bore after 10 strokes.
- (9) Use a strong solution of hot water and laundry detergent to clean the bores. Clean the cylinder bores immediately after de-glazing.
- (10) Rinse the bores until the detergent is removed and blow the block dry with compressed air.
- (11) Check the bore cleanliness by wiping with a white, lint free, lightly oiled cloth. If grit residue is still present, repeat the cleaning process until all residue is removed. Wash the bores and the complete block assembly with solvent and dry with compressed air.
- (12) Be sure to remove the tape covering the lube holes after the cleaning process is complete.

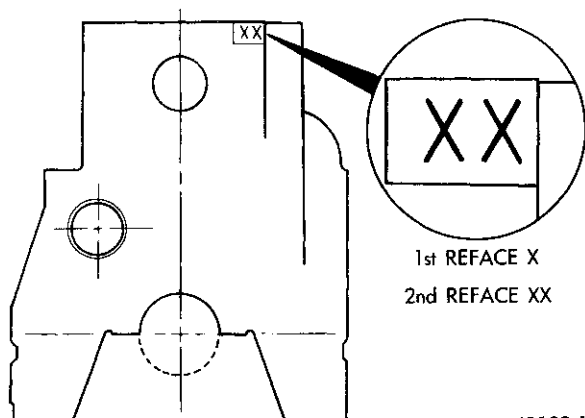
CYLINDER BLOCK REFACING

- (1) The combustion deck can be refaced twice. The first reface should be 0.25 mm (0.0098 inch). If additional refacing is required, an additional 0.25 mm (0.0098 inch) can be removed. Total allowed refacing is 0.50 mm (0.0197 inch) - (Fig. 15).
- (2) The upper right corner of the rear face of the block must be stamped with a X when the block is refaced to 0.25 mm (0.0098 inch). A second X must be stamped beside the first when the block is refaced to 0.50 mm (0.0197 inch) - (Fig. 16).
- (3) Consult the parts catalog for the proper head gaskets which must be used with refaced blocks to ensure proper piston-to-valve clearance.

SERVICE PROCEDURES (Continued)

1st	REFACE	0.15 mm	(0.0058 inch)
2nd	REFACE	0.35 mm	(0.0138 inch)
Ⓐ	Total	0.50 mm	(0.0197 inch)
Ⓑ	Standard	323.00 mm ± 0.10 mm	(12.7165 inch ± 0.0039 inch)
	1st REFACE	322.85 mm ± 0.10 mm	(12.7106 inch ± 0.0039 inch)
	2nd REFACE	322.50 mm ± 0.10 mm	(12.6968 inch ± 0.0039 inch)

J9109-118

Fig. 15 Refacing Dimensions of the Cylinder Block

J9109-116

Fig. 16 Stamp Block after Reface**CYLINDER BORE REPAIR**

Cylinder bore(s) can be repaired by one of two methods:

- Method 1:—Over boring and using oversize pistons and rings.
- Method 2:—Boring and installing a repair sleeve to return the bore to standard dimensions.

METHOD 1—OVERSIZE BORE

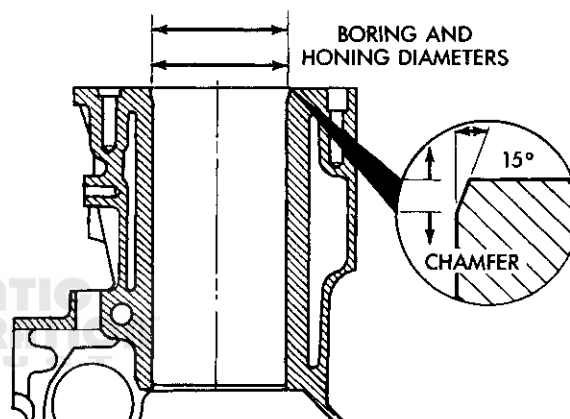
Oversize pistons and rings are available in two sizes - 0.50 mm (0.0197 inch) and 1.00 mm (0.0393 inch).

Any combination of standard, 0.50 mm (0.0197 inch) or 1.00 mm (0.0393 inch) overbore may be used in the same engine.

If more than 1.00 mm (0.0393 inch) overbore is needed, a repair sleeve can be installed (refer to Method 2—Repair Sleeve).

Cylinder block bores may be bored twice before use of a repair sleeve is required (Fig. 17). The first bore is 0.50 mm (0.0197 inch) oversize. The second bore is 1.00 mm (0.0393 inch) oversize.

After boring to size, use a honing stone to chamfer the edge of the bore (Fig. 17).



BORING DIAMETER DIMENSION	
1st REBORE	102.469 mm (4.0342 inch)
2nd REBORE	102.969 mm (4.0539 inch)
HONING DIAMETER DIMENSIONS	
STANDARD	102.020 ± 0.020 mm (4.0165 ± 0.0008 inch)
1st REBORE	102.520 ± 0.020 mm (4.0362 ± 0.0008 inch)
2nd REBORE	103.020 ± 0.020 mm (4.0559 ± 0.0008 inch)
CHAMFER DIMENSIONS	
Approx. 1.25 mm (0.049 inch) by 15°	

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Fig. 17 Cylinder Bore Dimensions

SERVICE PROCEDURES (Continued)

A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles with the top of the cylinder block (Fig. 18). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

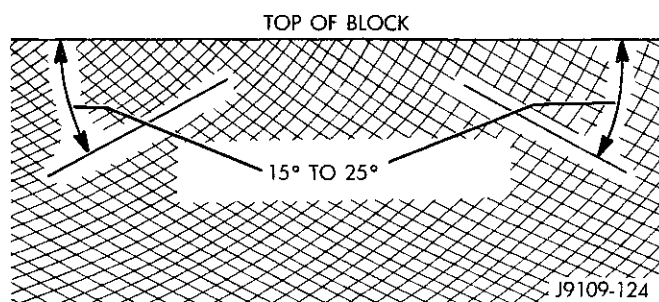


Fig. 18 Crosshatch Pattern of Repaired Sleeve(s)

A maximum of 1.2 micrometer (48 microinch) surface finish must be obtained.

After finish honing is complete, immediately clean the cylinder bores with a strong solution of laundry detergent and hot water.

After rinsing, blow the block dry.

Check the bore cleanliness by wiping with a white, lint-free, lightly-oiled cloth. There should be no grit residue present.

If the block is not to be used right away, coat it with a rust-preventing compound.

METHOD 2—REPAIR SLEEVE

If more than a 1.00 mm (0.03937 inch) diameter oversize bore is required, the block must be bored and a repair sleeve installed.

Bore the block cylinder bore to 104.500-104.515 mm (4.1142-4.1148 inch) - (Fig. 19).

Repair sleeves can be replaced by using a boring bar to bore out the old sleeve. DO NOT cut the cylinder bore beyond the oversize limit.

After machining the block for the new repair sleeve, thoroughly clean the bore of all metal chips, debris and oil residue before installing the sleeve.

Cool the repair sleeve(s) to a temperature of -12°C (10°F) or below for a minimum of one hour. Be ready to install the sleeve immediately after removing it from the freezer.

Apply a coat of Loctite 620, or equivalent to the bore that is to be sleeved.

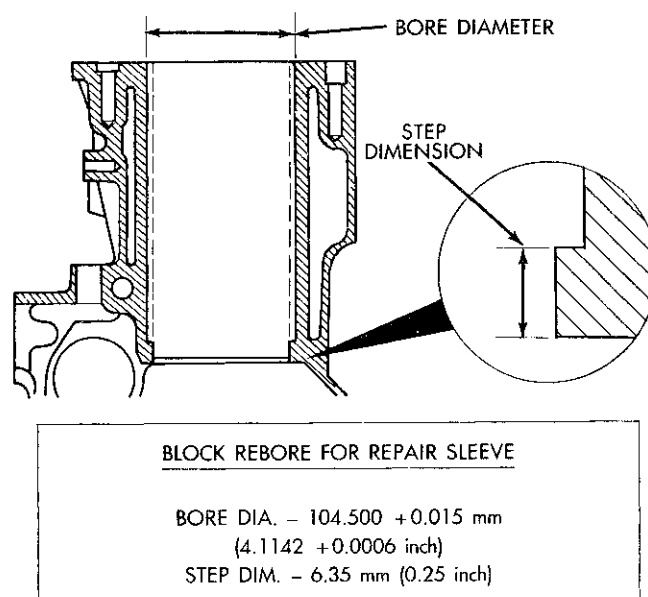


Fig. 19 Block Bore for Repair Sleeve Dimensions

Wear protective gloves to push the cold sleeve into the bore as far as possible.

Using a sleeve driver, drive the sleeve downward until it contacts the step at the bottom of the bore (Fig. 20).

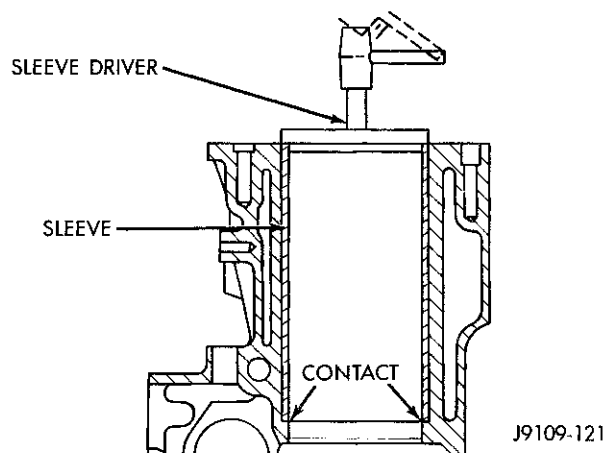
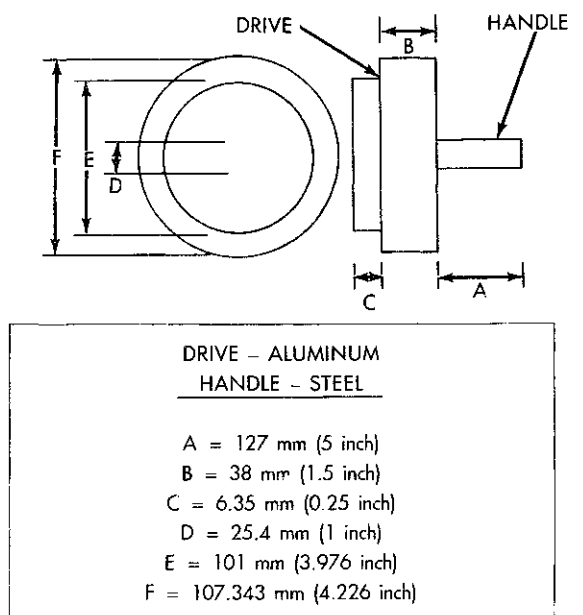


Fig. 20 Sleeve Installation

SERVICE PROCEDURES (Continued)

A sleeve driver can be constructed as follows (Fig. 21).

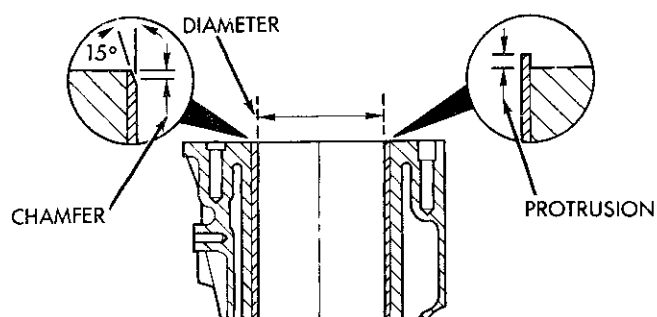


J9109-122

Fig. 21 Sleeve Driver Construction

Set up a boring bar and machine the sleeve to 101.956 mm (4.014 inch) - (Fig. 22).

After removing the boring bar, use a honing stone to chamfer the corner of the repair sleeve(s) - (Fig. 22).



SLEEVE DIAMETER	101.956 mm (4.014 inch)
SLEEVE PROTRUSION	
MIN. - FLUSH WITH BLOCK	
MAX. -	0.050 mm (0.0019 inch)
SLEEVE CHAMFER	
APPROX. 1.25 mm (0.049 inch)	
BY 15°	

J9109-123

Fig. 22 Sleeve Machining Dimensions

A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles with the top of the cylinder block. For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

Finished bore inside dimension is 102.020 \pm 0.020 mm (4.0165 \pm 0.0008 inch).

A maximum of 1.2 micrometer (48 microinch) surface finish must be obtained.

After finish honing is complete, immediately clean the cylinder bores with a strong solution of laundry detergent and hot water.

After rinsing, blow the block dry with compressed air.

Wipe the bore with a white, lint-free, lightly oiled cloth. Make sure there is no grit residue present.

Apply a rust-preventing compound if the block will not be used immediately.

A standard diameter piston and a piston ring set must be used with a sleeved cylinder bore.

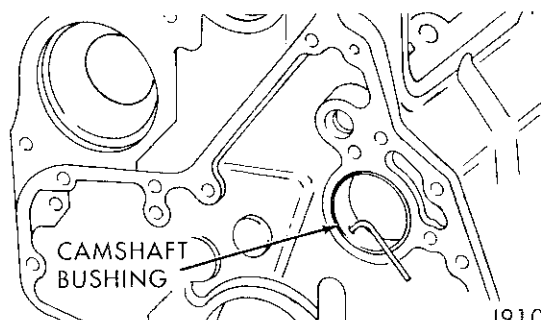
CAM BORE REPAIR

The front cam bushing bore can be bored to 57.740 Mm \pm 0.018 mm (2.273 inch \pm 0.0007 inch) oversize. DO NOT bore the intermediate or rear cam bore to the front cam bore oversize dimensions. Intermediate and rear cam bores may be bored to 57.240 mm \pm 0.018 mm (2.253 inch \pm 0.0007 inch) oversize.

A surface finish of 2.3 micrometers (92 microinch) must be maintained. Not more than 20% of an area of any one bore may be 3.2 micrometers (126 microinch).

Camshaft bores can be repaired individually. It is not necessary to repair undamaged cam bores in order to repair individually damaged cam bores. The standard front bushing cannot be used to repair intermediate or rear bores.

Install all cam bushings flush or below the front cam bore surface. The oil hole must align to allow a 3.2 mm (0.125 inch) rod to pass through freely (Fig. 23).

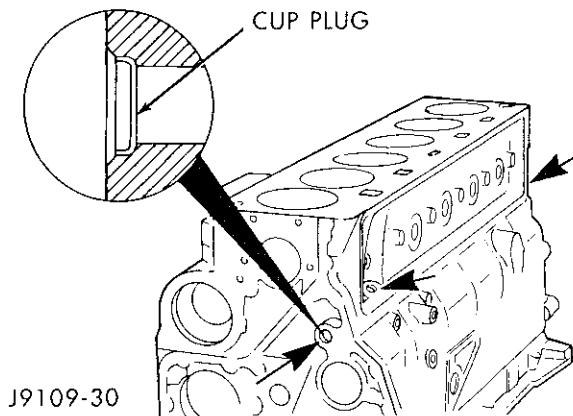


J9109-54

Fig. 23 Oil Hole Alignment

SERVICE PROCEDURES (Continued)**CYLINDER BLOCK CUP PLUG REPLACEMENT**

- (1) Remove the cup plugs from the oil passages (Fig. 24).
- (2) Apply a bead of Loctite 277 around the outside diameter of the oil passage cup plugs.
- (3) Drive the cup plugs in until they bottom in the bore (Fig. 24).
- (4) Fill the engine with oil. Run the engine and check for leaks.
- (5) Stop the engine and check the oil level with the dipstick.

**Fig. 24 Cup Plug Locations in Cylinder Block****CONNECTING ROD BEARING AND CRANKSHAFT JOURNAL CLEARANCE**

Measure the connecting rod bore with the bearings installed and the bolts tightened to 100 N·m (73 ft. lbs.) torque.

Record the smaller diameter.

Measure the diameter of the rod journal at the location shown (Fig. 25). Calculate the average diameter for each side of the journal.

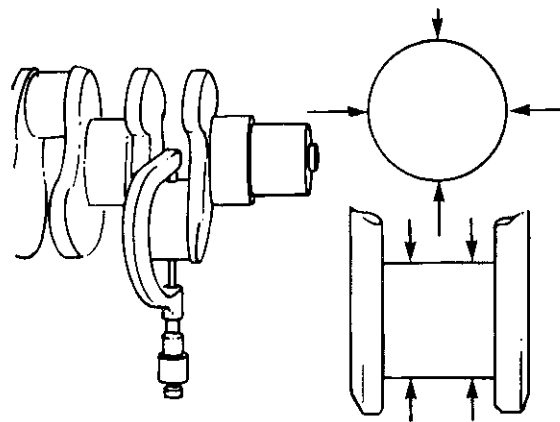
The clearance is the difference between the connecting rod bore (smallest diameter) and the average diameter for each side of the crankshaft journal.

If the crankshaft is within limits, replace the bearing. If the crankshaft is out of limits, grind the crankshaft to the next smaller size and use oversize rod bearings.

PISTON GRADING PROCEDURE

(1) Install any of the original connecting rod and piston assemblies into the No.1 cylinder. **DO NOT** install the piston rings.

(2) Install the upper bearing shell in the connecting rod with the tang of the bearing in the slot of the connecting rod. The connecting rod bearing shell must be installed in the original connecting rod and



MIN.	68.962 mm	(2.715 inch)
MAX.	69.013 mm	(2.717 inch)

Out-of-Round - Max.
0.050 mm (0.002 inch)

Taper - Max.
0.013 mm (0.0005 inch)

Bearing Clearance - Max.
0.089 mm (0.0035 inch)

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Fig. 25 Connecting Rod Journal Diameter Limits

cap. Use clean lubricating oil to coat the inside diameter of the connecting rod bearing shell.

(3) Install the bearing shell in the connecting rod cap with the tang of the bearing in the slot to the cap. Use clean lubricating oil to coat the inside diameter of the bearing shell.

(4) The four digit number stamped on the connecting rod and cap at the parting line must match and be installed on the oil cooler side of the engine. Install the connecting rod cap and capscrews. Tighten the capscrews to 35 N·m (26 ft. lbs.) torque.

(5) Use a fine grit stone to remove any burrs from the cylinder block head deck. Zero the dial indicator to the cylinder block head deck.

(6) Move the dial indicator directly over the piston pin to eliminate any side-to-side movement.

(7) Rotate the crankshaft to top dead center (TDC). Rotate the crankshaft clockwise and counter-clockwise to find the highest dial indicator reading. Record the reading.

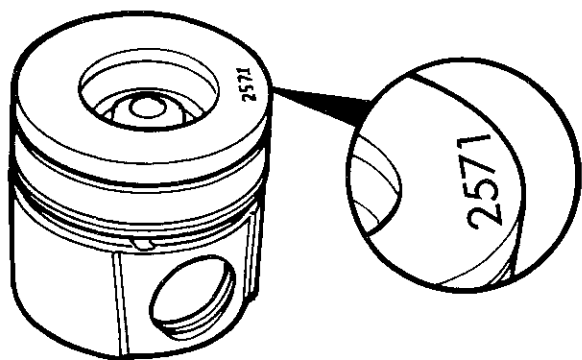
(8) Remove the piston and connecting rod assembly from the No.1 cylinder and install the assembly into the No.2 cylinder. Repeat the procedure for every cylinder using the same piston and connecting rod assembly.

SERVICE PROCEDURES (Continued)

(9) Determine the grade of the piston being used by referring to the Piston Protrusion Chart (Fig. 26). Four digits on top of the piston can be cross referenced to a Chrysler part number for replacement (Fig. 27). If the number on the piston cannot be seen, measure from the top of the piston to the top of the piston pin to see what grade piston is used (Fig. 28).

MEASURING PISTON	PROTRUSION	USE GRADE
2571	0.609-0.711 mm (0.024-0.028 in.)	A
2571	0.508-0.609 mm (0.020-0.024 in.)	B
2571	0.406-0.508 mm (0.016-0.020 in.)	C
2572	0.711-0.813 mm (0.028-0.032 in.)	A
2572	0.609-0.711 mm (0.024-0.028 in.)	B
2572	0.508-0.609 mm (0.020-0.024 in.)	C
2573	0.813-0.914 mm (0.032-0.036 in.)	A
2573	0.711-0.813 mm (0.028-0.032 in.)	B
2573	0.609-0.711 mm (0.024-0.028 in.)	C

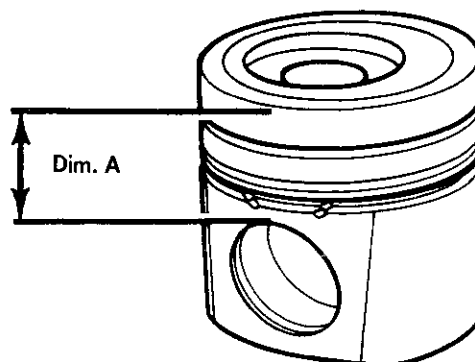
Fig. 26 Piston Protrusion Chart



J9509-2

Fig. 27 Piston Grading Number Location

Dimension A	Ref. Number	Grade
51.554 to 51.607mm (2.029 to 2.031 in)	2571	A
51.654 to 51.707mm (2.033 to 2.035 in)	2572	B
51.754 to 51.807mm (2.037 to 2.039 in)	2573	C



J9509-1

Fig. 28 Piston Grading Measurement

CRANKSHAFT REWORK

Crankshaft main and rod journals may be ground in increments of 0.25 mm (0.0098 inch) up to a total of 1.00 mm (0.0394 inch).

The only exception is the main journal thrust width surface. This journal must be ground in increments of 0.50 mm (0.0197 inch) up to a total of 1.00 mm (0.0394 inch). The thrust surface is located on the No.6 main bearing. When the thrust surface requires grinding, the main journal must be ground to the same undersize dimension.

CAUTION: Welding of the crankshaft is not allowed. Failure of the crankshaft will result.

MAIN JOURNAL

All main journals are to be ground in the opposite direction of engine rotation (clockwise as viewed from the front of crankshaft). Polish the journals in the same direction as engine rotation.

The main bearing grinding specifications are shown in (Fig. 29).

SERVICE PROCEDURES (Continued)

STANDARD MAIN JOURNAL DIAMETER	
83.000 \pm 0.013 mm (3.2677 \pm 0.0005 inch)	
WORN MAIN JOURNAL DIAMETER LIMIT	
82.962 (3.2662 inch)	
UNDERSIZES	REGRIND TO
0.25 mm (0.0098 inch)	82.750 \pm 0.013 mm (3.2579 \pm 0.0005 inch)
0.50 mm (0.0197 inch)	82.500 \pm 0.013 mm (3.2480 \pm 0.0005 inch)
0.75 mm (0.0295 inch)	82.250 \pm 0.013 mm (3.2381 \pm 0.0005 inch)
1.00 mm (0.0394 inch)	82.000 \pm 0.013 mm (3.2283 \pm 0.0005 inch)
OUT-OF ROUND & TAPER (MAX.)	
0.005 mm (0.0002 inch)	
ALL MAIN JOURNALS ARE TO BE PARALLEL TO THE FRONT AND REAR MAINS WITHIN: 0.030 mm (0.001 inch)	

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Fig. 29 Crankshaft Main Journal Dimensions

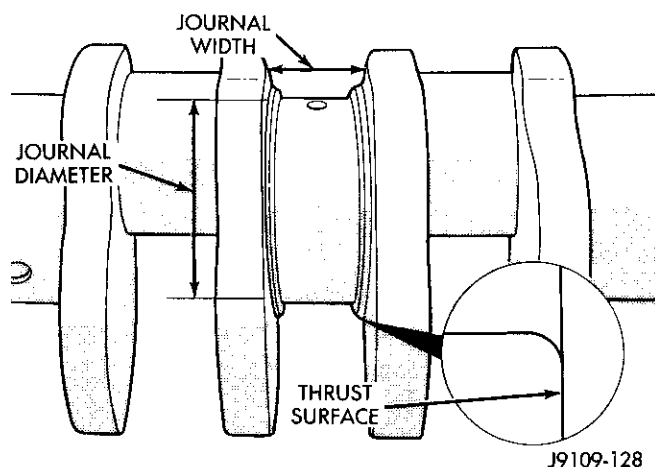
Thrust journals can be ground in the same increments and using the same specifications as all other main journals. The main journal radius may be ground using either the preferred or the alternative procedure providing the thrust surface width is not being ground. The preferred procedure must be used when the main bearing thrust width surface is ground. When the thrust surface width requires grinding, the main journal must be ground to the same undersize dimension (Fig. 30).

THRUST JOURNAL WIDTH	
37.500 \pm 0.025 mm (1.4764 \pm 0.001 inch)	
UNDERSIZES	REGRIND WIDTH TO
0.50 mm (0.0197 inch)	38.000 \pm 0.025 mm (1.4961 \pm 0.001 inch)
1.00 mm (0.0394 inch)	38.500 \pm 0.025 mm (1.5158 \pm 0.001 inch)

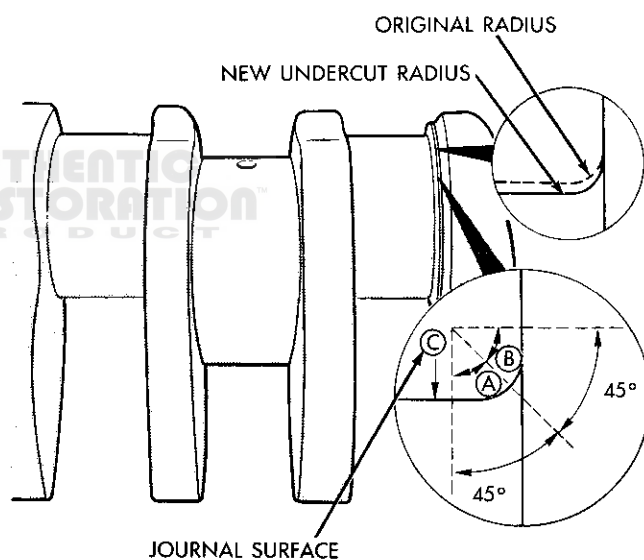
J9109-127

Fig. 30 Crankshaft Thrust Journal Width Dimensions

The thrust surface is to be ground on center within 0.10 mm (0.004 inch). It also must be perpendicular to the front and rear mains within 0.0015 mm (0.00006 inch) per radial inch on the thrust area (Fig. 31). The surface finish requirement is 0.04 micrometer (16.0 microinch).

**Fig. 31 Crankshaft Thrust Surface****PREFERRED PROCEDURE:**

Smoothly blend a 4.20 \pm 0.020 mm (0.1654 \pm 0.0008 inch) radius to the ground diameters (Fig. 32).

**SURFACE FINISH**

- (A) 0.8 micrometer (32.0 microinch)
for a minimum of 45° into the
fillet beyond journal surface
- (B) 1.6 micrometer (64.0 microinch)
for remainder of fillet
- (C) 0.4 micrometer (16.0 microinch)

J9109-129

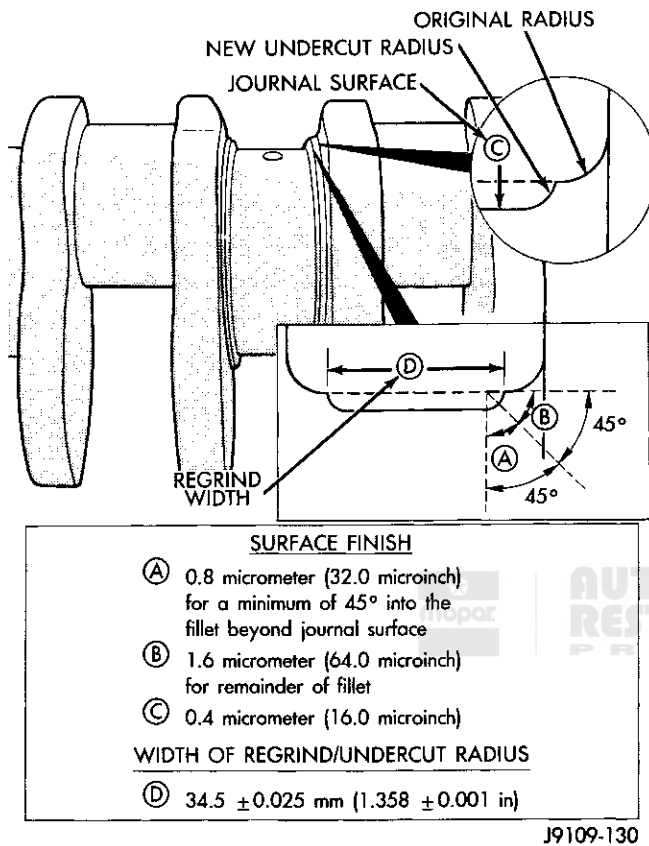
Fig. 32 Grind Crankshaft Main Journal—Preferred Method

SERVICE PROCEDURES (Continued)

CAUTION: DO NOT use the Alternative Procedure when the thrust surface width is ground.

ALTERNATIVE PROCEDURE:

Smoothly blend a 1.25 ± 0.020 mm (0.0492 ± 0.0008 inch) radius to the ground diameters (Fig. 33).



J9109-130

Fig. 33 Grind Crankshaft Main Journal—Alternative Method

ROD JOURNAL

All rod journals are to be ground in the opposite direction of engine rotation (clockwise as viewed from the front of crankshaft). Polish the journals in the same direction as engine rotation.

The rod bearing grinding specifications are shown in (Fig. 34).

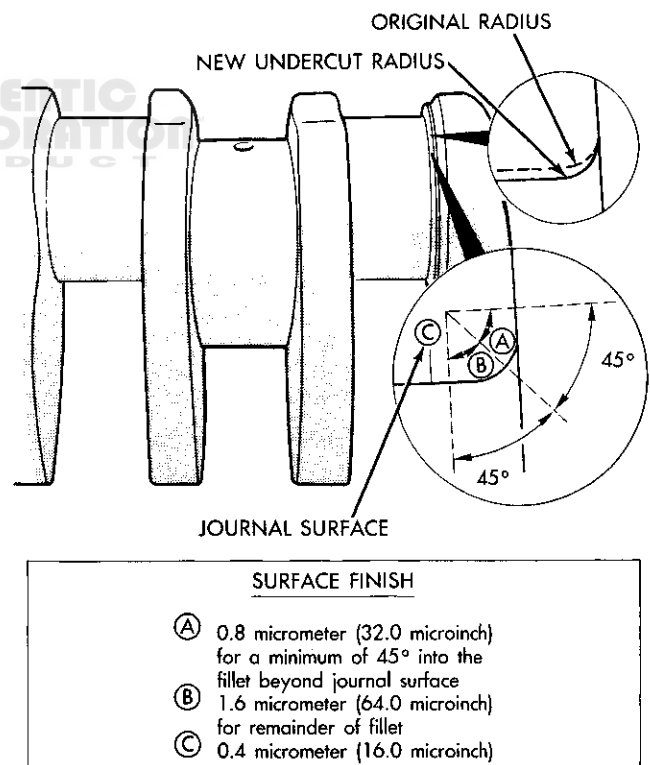
PREFERRED PROCEDURE:

Smoothly blend a 4.00 ± 0.020 (0.1575 ± 0.0008 inch) radius to the ground diameters and side faces (Fig. 35).

STANDARD ROD JOURNAL DIAMETER	
69.000 ± 0.013 mm (2.7165 ± 0.0005 inch)	
WORN ROD JOURNAL DIAMETER LIMIT	
68.962 (2.7150 inch)	
UNDERSIZES	REGRIND TO
0.25 mm (0.0098 inch)	68.750 ± 0.013 mm (2.7067 ± 0.0005 inch)
0.50 mm (0.0197 inch)	68.500 ± 0.013 mm (2.6969 ± 0.0005 inch)
0.75 mm (0.0295 inch)	68.250 ± 0.013 mm (2.6870 ± 0.0005 inch)
1.00 mm (0.0394 inch)	68.000 ± 0.013 mm (2.6772 ± 0.0005 inch)
OUT-OF ROUND & TAPER (MAX.)	
0.005 mm (0.0002 inch)	
ALL MAIN JOURNALS ARE TO BE PARALLEL TO THE FRONT AND REAR MAINS WITHIN: 0.030 mm (0.001 inch)	

J9109-126

Fig. 34 Crankshaft Rod Journal Dimensions

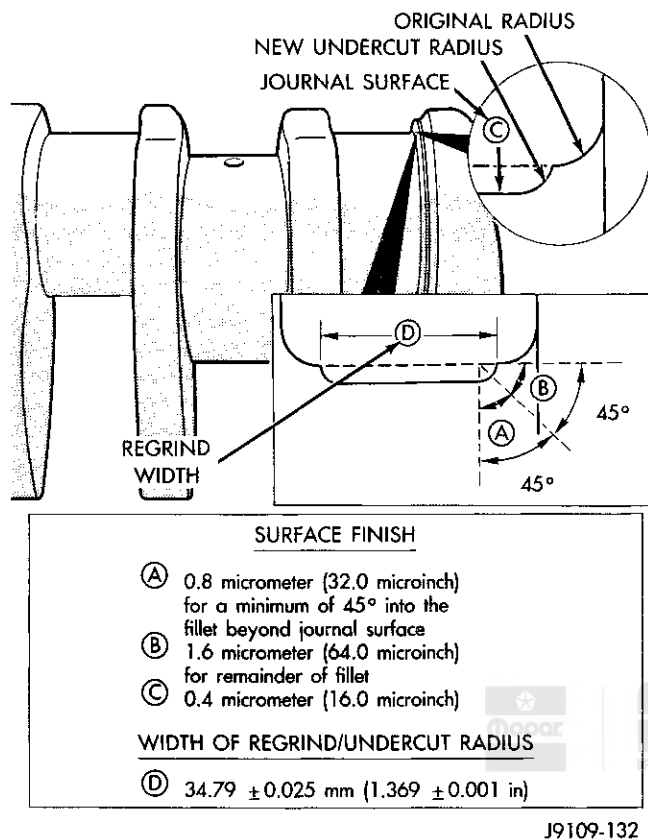


J9109-131

Fig. 35 Crankshaft Rod Journal Grind—Preferred Method

SERVICE PROCEDURES (Continued)**ALTERNATIVE PROCEDURE:**

Smoothly blend a 1.25 ± 0.020 mm (0.0492 ± 0.0008 inch) radius to the ground journals (Fig. 36).



J9109-132

Fig. 36 Grind Crankshaft Rod Journal—Alternative Method

MAIN BEARING CLEARANCE

Inspect the main bearing bores for damage or abnormal wear.

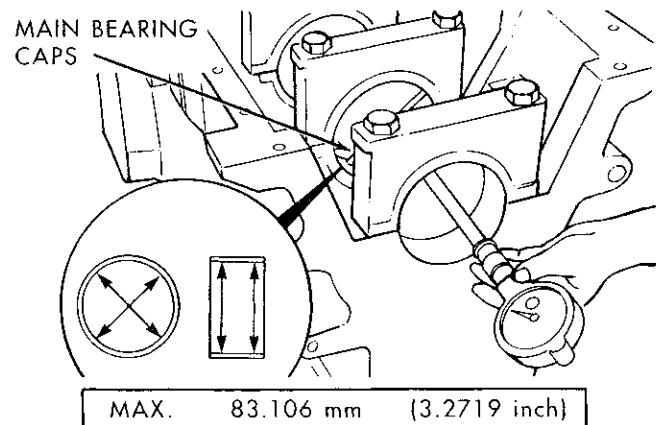
Install the crankshaft main bearings and measure main bearing bore diameter with the main bolts tightened to 176 N·m (130 ft. lbs.) torque (Fig. 37).

Measure the diameter of the main journal at the locations shown (Fig. 38). Calculate the average diameter for each side of the journal.

Calculate the main bearing journal to bearing clearance. the clearance specifications are 0.119 mm (0.00475 inch). If the crankshaft journal is within limits, replace the main bearings. If not within specifications, grind the crankshaft to next size and use oversize bearings.

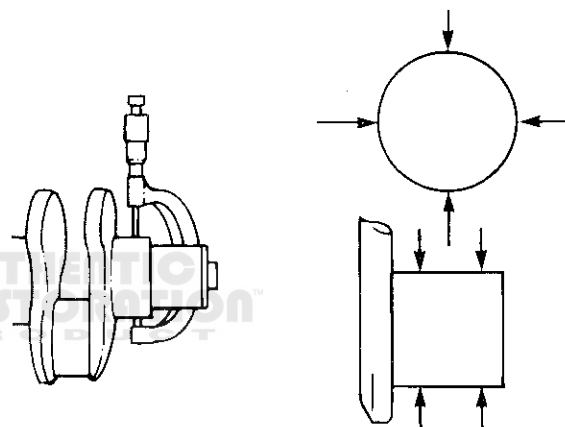
REMOVAL AND INSTALLATION**ENGINE FRONT MOUNTS****REMOVAL**

- (1) Disconnect the negative cable from the battery.



J9109-92

Fig. 37 Crankshaft Main Bearing Bore Diameter



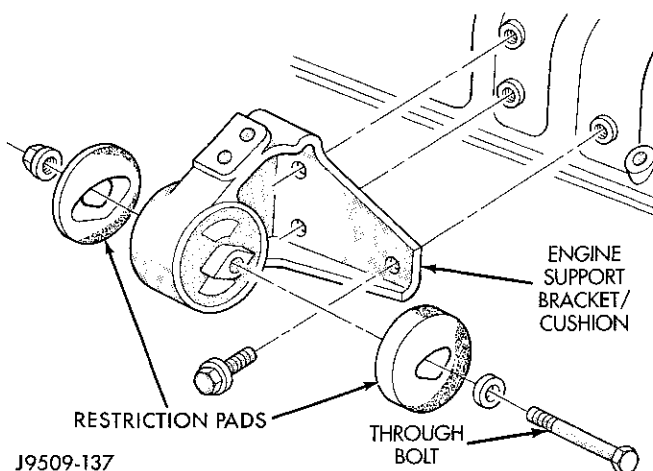
J9109-93

Fig. 38 Crankshaft Main Journal Diameter

- (2) Position fan to assure clearance for radiator top tank and hose.
- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 39).
- (6) Remove engine support bracket/cushion bolts (Fig. 39). Remove the support bracket/cushion.

INSTALLATION

- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion to the block. Install new bolts and tighten to 189 N·m (140 ft. lbs.) torque.
- (2) Install the thru-bolt into the engine support bracket/cushion.

REMOVAL AND INSTALLATION (Continued)

J9509-137

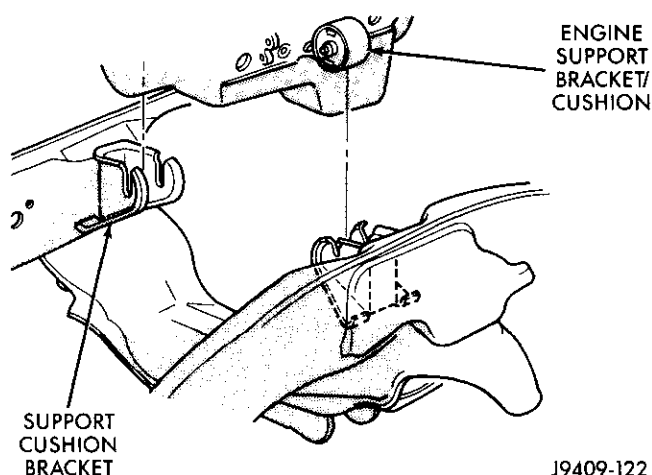
Fig. 39 Front Engine Mounts

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 40).

(4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.

(5) Lower the vehicle.

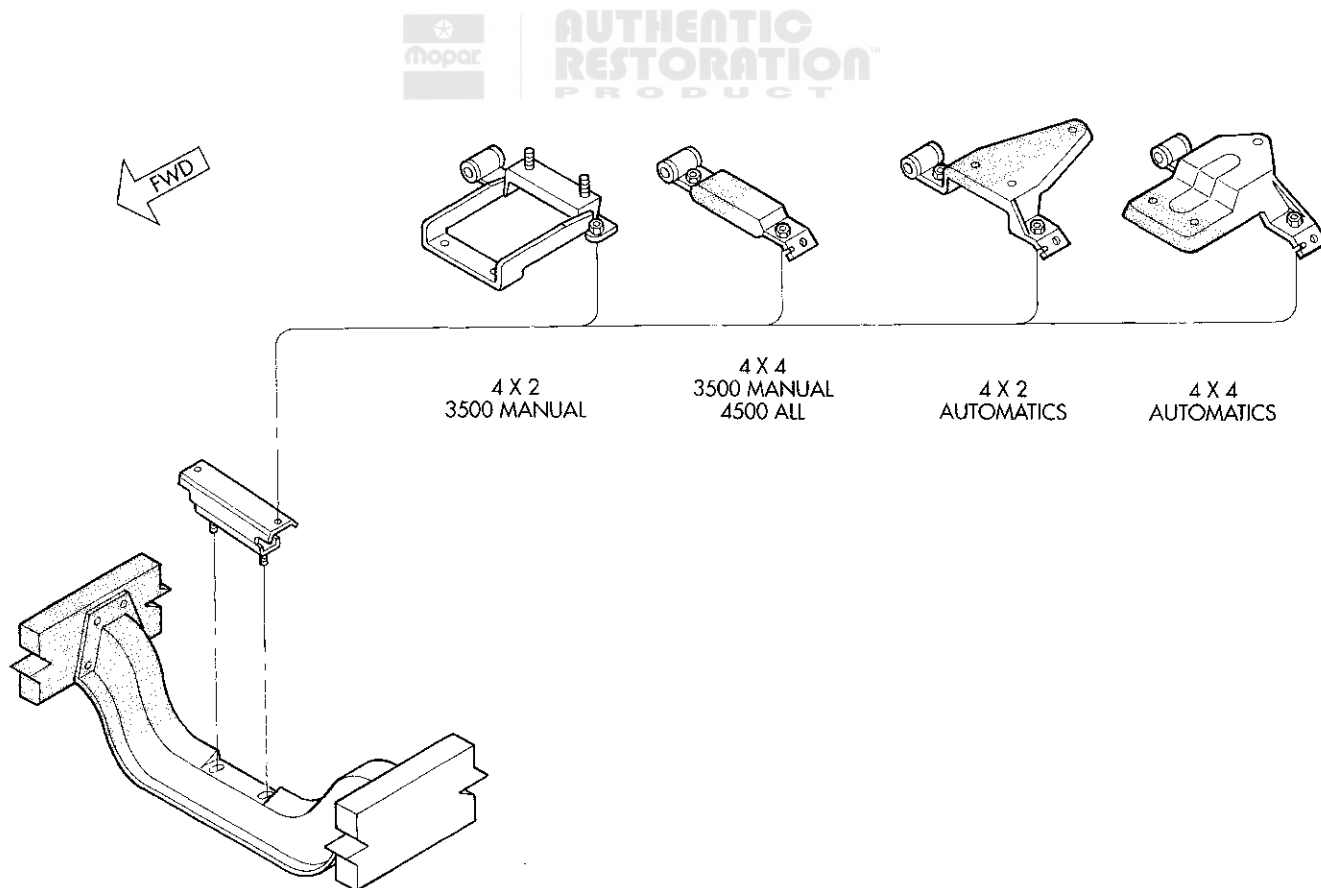
(6) Remove lifting fixture.



J9409-122

Fig. 40 Positioning Engine Front Mounts**ENGINE REAR MOUNT****REMOVAL**

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 41).
- (4) Raise rear of transmission and engine SLIGHTLY.



J9509-126

Fig. 41 Engine Rear Support Cushion Assemblies

REMOVAL AND INSTALLATION (Continued)

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 41).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Remove the battery.

(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedure).

(3) Remove the upper crossmember and top core support.

(4) Remove the transmission oil cooler.

(5) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(6) Remove the serpentine belt (refer to Group 7, Cooling System).

(7) Remove the A/C compressor with the lines attached. Set aside.

(8) If equipped, remove the condenser.

(9) Remove the washer bottle.

(10) Remove the radiator overflow bottle.

(11) Disconnect the top radiator hose.

(12) Remove the fan.

(13) Remove the fan shroud.

(14) Disconnect the lower radiator hose.

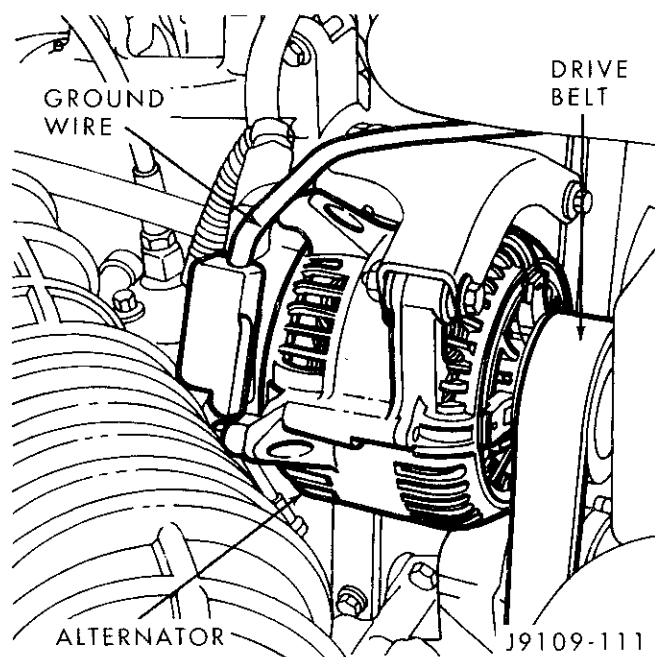
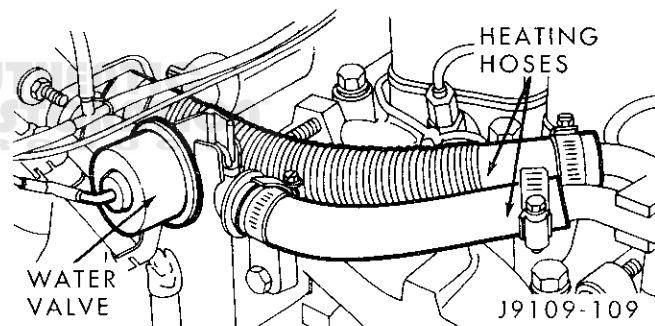
(15) Remove radiator (refer to Group 7, Cooling System).

(16) Remove the generator (Fig. 42) with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(17) Disconnect the heater hoses at the dash panel and at the water valve (Fig. 43).

(18) Disconnect the air inlet tube from the turbocharger (Fig. 44) and the air intake housing. Remove the tube.

(19) Remove the exhaust pipe from the turbocharger outlet flange (Fig. 44).

**Fig. 42 Generator Removal****Fig. 43 Heater Hoses**

(20) Disconnect the intercooler inlet duct from the turbocharger and the intercooler. Remove the inlet duct.

(21) Disconnect the intercooler outlet duct from the air inlet housing and the intercooler. Remove the outlet duct.

(22) Disconnect the accelerator linkage, the speed control linkage and the throttle valve linkage.

(23) Disconnect the power steering hoses, if equipped.

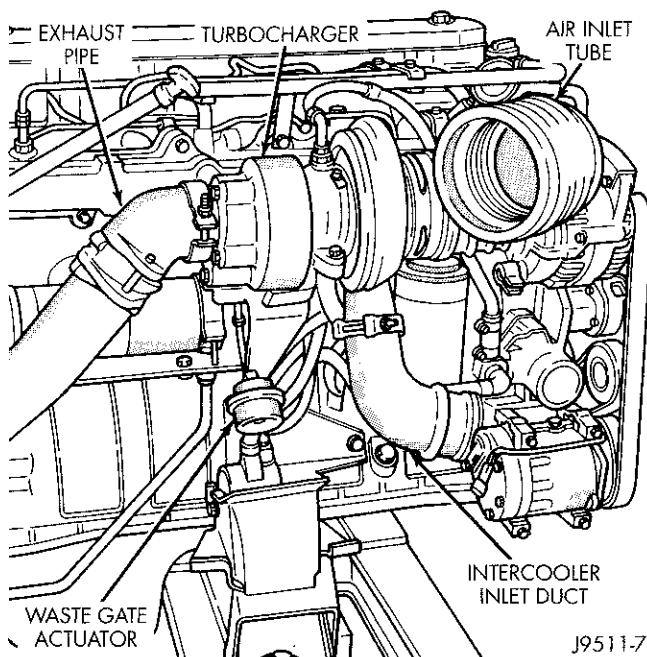
(24) Disconnect the transmission cooler lines.

(25) Disconnect all electrical connections from the engine. Put tags on the connections to identify their locations.

(26) Disconnect the fuel lines to the lift pump and fuel return. Use tags to identify the lines.

(27) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(28) Raise and support the vehicle on a hoist.

REMOVAL AND INSTALLATION (Continued)**Fig. 44 Air Inlet Tube and Exhaust Pipe Connection**

- (29) Drain the engine lubricating oil. Dispose of the oil according to all applicable regulations.
- (30) Remove the oil pan.
- (31) Remove engine front mount thru-bolt nuts.
- (32) Remove the transmission cooler line brackets from oil pan.
- (33) Disconnect exhaust pipe at manifold.
- (34) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).
- (35) Remove the dust shield and transmission cover.
- (36) Refer to Group 21, Transmissions for transmission removal.
- (37) Lower the vehicle.
- (38) Put a cover or tape over all engine openings.
- (39) Lift the engine out of the vehicle.
- (40) Install the engine on a suitable stand.
- (41) Remove all accessories and brackets not previously removed for use with the replacement engine.

INSTALLATION

- (1) Check the data plate to verify that the replacement engine is the same model and rating as the engine that was removed.
- (2) Install all accessories and brackets that had been removed from the previous engine.
- (3) Use the lifting brackets to lift the engine off of the stand.
- (4) Position the engine in the chassis with the thru-bolt installed.
- (5) Remove the covers or tape covering the engine openings.
- (6) Raise and support the vehicle.
- (7) Refer to Group 21, Transmissions for transmission installation.
- (8) Install the dust shield and transmission cover.
- (9) Install the prop shaft (refer to Group 16, Propeller Shaft).
- (10) Install the starter motor (refer to Group 8B, Battery/Starter/Generator Service). Connect the starter wires.
- (11) Install the transmission cooler line brackets to oil pan.
- (12) Install and tighten engine front mount thru-bolt nuts.
- (13) Install the oil pan. Install the drain plug.
- (14) Lower the vehicle.
- (15) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).
- (16) Connect the fuel lines to the lift pump and fuel return. Use tags to identify the lines.
- (17) Connect all electrical connections to the engine. Use tags to identify their locations.
- (18) Connect the transmission cooler lines.
- (19) Connect the power steering hoses, if equipped.
- (20) Connect the accelerator linkage, the speed control linkage and the throttle valve linkage.
- (21) Install the outlet duct. Connect the intercooler outlet duct to the air inlet housing and the intercooler.
- (22) Install the inlet duct. Connect the intercooler inlet duct to the turbocharger and the intercooler.
- (23) Install the exhaust pipe to the turbocharger outlet flange.
- (24) Install the air inlet tube. Connect the air inlet tube to the turbocharger and the air intake housing.
- (25) Connect the heater hoses at the dash panel and at the water valve.
- (26) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).
- (27) Install the radiator (refer to Group 7, Cooling System).
- (28) Connect the lower radiator hose.
- (29) Install the fan shroud.
- (30) Install the fan.
- (31) Connect the top radiator hose.
- (32) Install the radiator overflow bottle.
- (33) Install the washer bottle.
- (34) If equipped, install the condenser.
- (35) Install the A/C compressor with the lines attached.
- (36) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
- (37) Install the transmission oil cooler.
- (38) Install the upper crossmember and top core support.
- (39) Install the serpentine belt (refer to Group 7, Cooling System).

REMOVAL AND INSTALLATION (Continued)

(40) Fill the cooling system with a mixture of 50% water and 50% ethylene-glycol base antifreeze (refer Group 7, Cooling System for the proper procedure).

(41) Fill the engine with the required amount of clean engine lubricating oil (refer to Group 0, Lubrication and Maintenance).

(42) Install the battery and connect the battery cables.

(43) Check the oil level after the engine has run for 2 or 3 minutes. Oil held in the oil filter and oil passages will cause the oil level in the pan to be lower than normal for a short period of time.

(44) Operate the engine at idle for 5 to 10 minutes and check for leaks and loose parts.

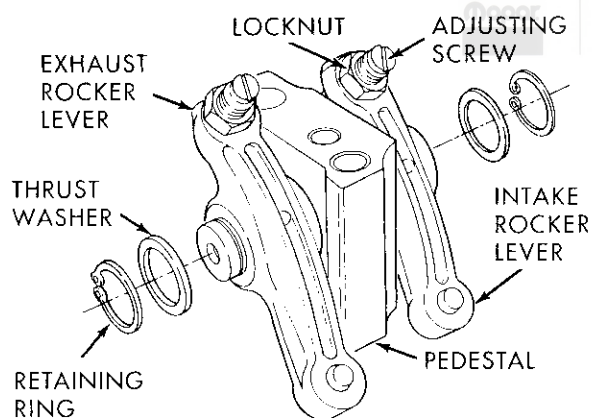
ROCKER LEVERS AND PUSH RODS**REMOVAL**

(1) Remove the valve covers.

(2) Loosen the adjusting screw locknuts. Loosen the adjusting screws until they stop (Fig. 45).

(3) Remove the bolts from the rocker lever pedestals. Remove the pedestals and rocker lever assemblies (Fig. 45).

(4) Remove the push rods. The rear two push rods must be raised through holes in cab overhang.



J9109-31

Fig. 45 Location of Rocker Lever Components**INSTALLATION**

(1) Make sure the dowel rings in the pedestals are installed into the dowel bores in the cylinder head.

(2) If the push rod is holding pedestal off head, bar the engine until the pedestal will set on the head surface without interference.

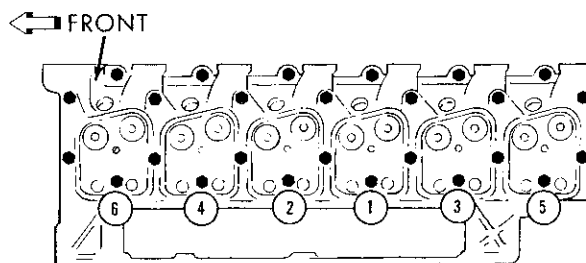
(3) Use clean engine oil to lubricate the cylinder head bolt threads and under the bolt heads.

(4) Install the long bolts (12 mm) into the rocker lever pedestals. Tighten the bolts as follows:

- Step 1—Tighten the bolts, in sequence (Fig. 46), to 90 N·m (66 ft. lbs.) torque. Check the torque. If lower than 90 N·m (66 ft. lbs.), tighten to this torque.

- Step 2—Tighten the bolts, in sequence (Fig. 46), to 120 N·m (89 ft. lbs.) torque. Check the torque. If lower than 120 N·m (89 ft. lbs.), tighten to this torque.

- Step 3—Tighten the bolts, in sequence (Fig. 46), an additional 90°.



J9109-32

Fig. 46 Rocker Lever (Head Bolts) Tightening Sequence

(5) Tighten the 8 mm bolts to 24 N·m (18 ft. lbs.) torque.

(6) Install the valve cover. Tighten the valve cover bolt to 24 N·m (18 ft. lbs.) torque.

CYLINDER HEAD

These cylinder heads can only be used on engines with an intercooler. DO NOT interchange with earlier models.

REMOVAL

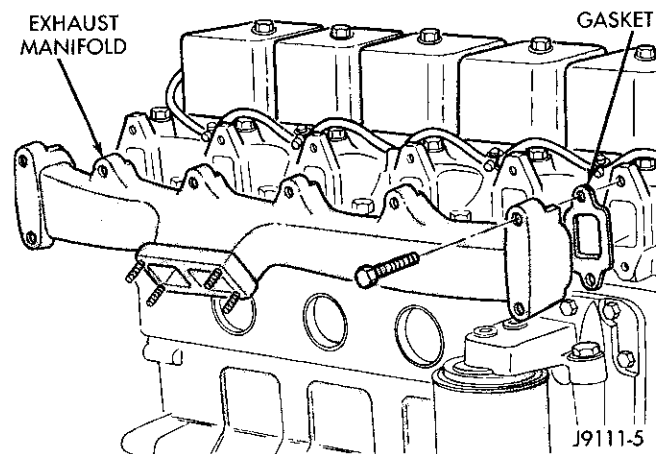
(1) Drain the coolant. DO NOT waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(2) Drain the engine oil. Dispose of the used oil properly.

(3) Disconnect the radiator and heater hoses (refer to Group 7, Cooling System).

(4) Remove the turbocharger.

(5) Remove the exhaust manifold (Fig. 47).

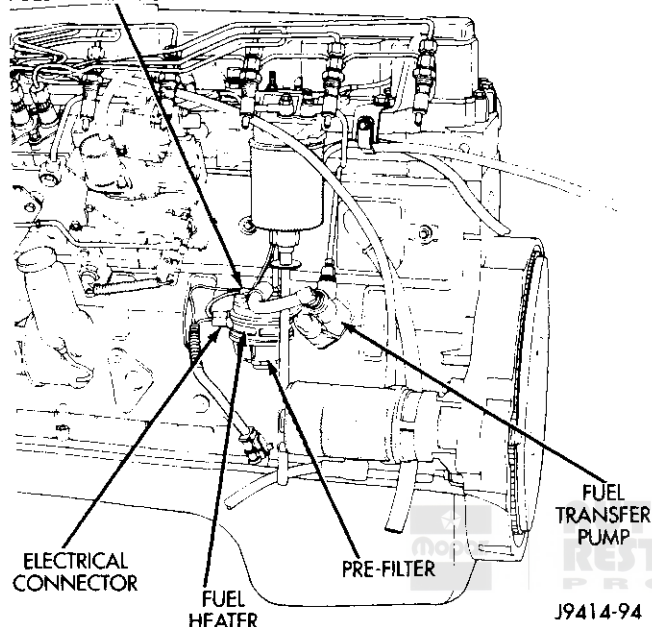


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Fig. 47 Exhaust Manifold

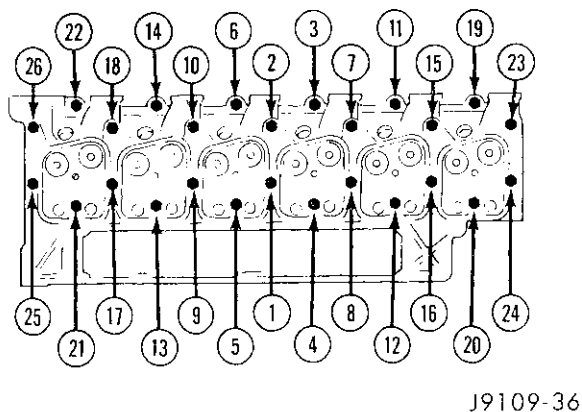
REMOVAL AND INSTALLATION (Continued)

- (6) Remove the fuel lines and injector nozzles (refer to Group 14, Fuel System).
- (7) Remove the valve covers.
- (8) Remove the rocker levers and push rods.
- (9) Remove the fuel filter/water separator (Fig. 48). Refer to Group 14, Fuel System, for the proper procedures. Remove the remote fuel filter/water separator head.

FUEL TEMPERATURE SENSOR**Fig. 48 Fuel/Water Separator Filter**

(10) If the engine is hot, remove the cylinder head bolts in the sequence shown in (Fig. 49). The removal sequence is not important if the engine is cold. There are 3 sizes of head bolts. Note the position of each bolt for future installation.

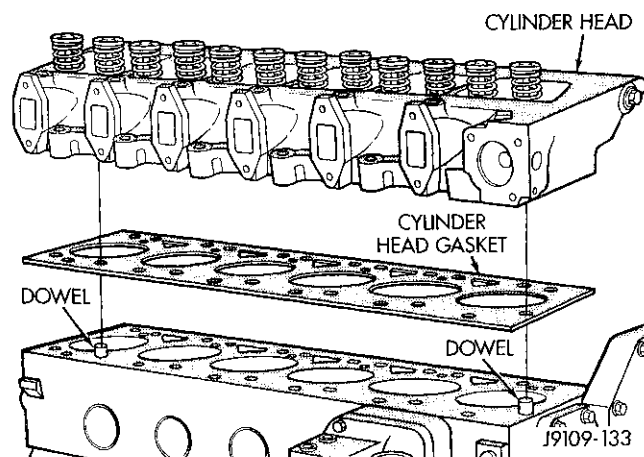
(11) Remove the cylinder head and gasket from the cylinder block.



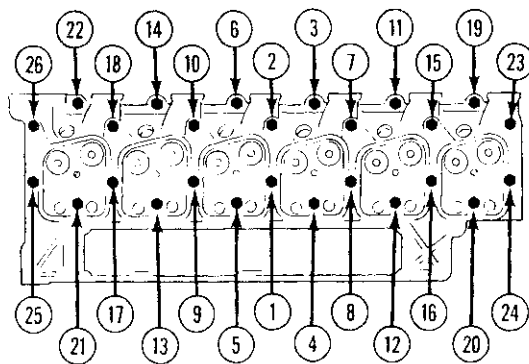
J9109-36

Fig. 49 Cylinder Head Bolt Removal Sequence—Cylinder Head Hot**INSTALLATION**

- (1) The cylinder block and head must be clean and dry.
- (2) Position the gasket onto the dowels (Fig. 50). Make sure the gasket is correctly aligned with the holes in the cylinder block.
- (3) Carefully put the cylinder head onto the gasket and cylinder block. Make sure the cylinder head is installed onto the dowels in the cylinder block (Fig. 50).

**Fig. 50 Cylinder Head/Gasket Alignment**

- (4) Install the push rods and rocker levers.
- (5) Use clean engine oil to lubricate the cylinder head bolt threads and under the bolt heads.
- (6) The cylinder head bolts are 3 different sizes. Install the bolts in the proper hole. Tighten the bolts as follows:
 - Step 1—Tighten all bolts, in sequence (Fig. 10), to 90 N·m (66 ft. lbs.) torque. Check the torque. If lower than 90 N·m (66 ft. lbs.), tighten to this torque.
 - Step 2—Tighten all long 12 mm bolts (Nos. 4, 5, 12, 13, 20 and 21), in sequence (Fig. 51), to 120 N·m (89 ft. lbs.) torque. Check the torque. If lower than 120 N·m (89 ft. lbs.), tighten to this torque.
 - Step 3—Tighten all bolts, in sequence (Fig. 51), an additional 90°.



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Fig. 51 Cylinder Head Tightening Sequence

REMOVAL AND INSTALLATION (Continued)

(7) Be sure to lubricate the push rod sockets with clean engine oil. Be sure push rod is seated properly in the tappet.

(8) Install the rocker lever pedestal bolts and tighten to 24 N·m (18 ft. lbs.) torque.

(9) Adjust the valve clearance.

(10) Install the valve covers. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(11) Install the injector nozzles and fuel lines (refer to Group 14, Fuel System).

(12) Install the remote fuel filter/water separator head. Install the fuel filter/water separator (refer to Group 14, Fuel System for the proper procedures).

(13) Install the exhaust manifold (refer to Group 11, Exhaust System and Intake Manifold).

(14) Install the turbocharger.

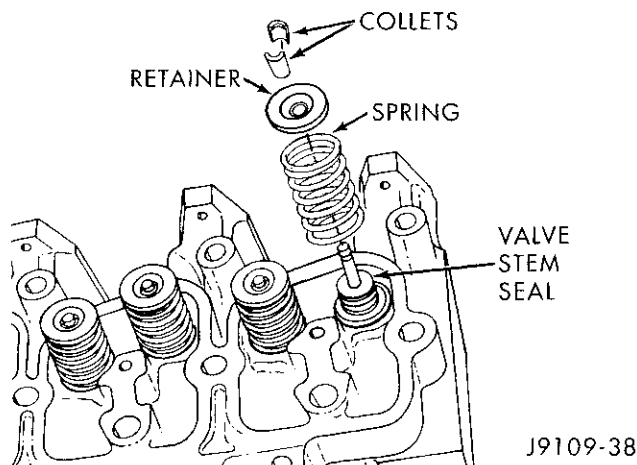
(15) Connect the radiator and heater hoses.

(16) Fill the engine with new coolant or the clean drained coolant (refer to Group 7, Cooling System for the proper procedure).

(17) Fill the engine with clean lubricating oil (refer to Group 0, Lubrication and Maintenance).

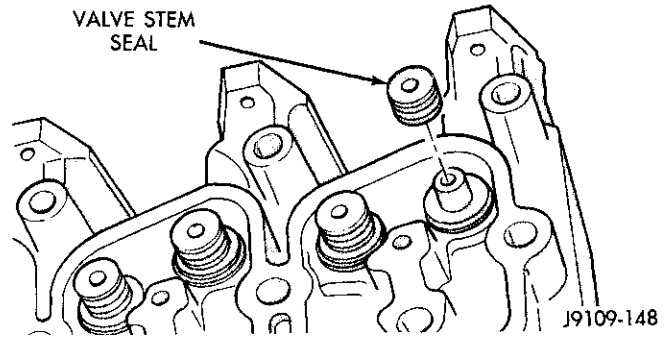
VALVES AND VALVE SPRINGS**REMOVAL**

- (1) Remove the cylinder head.
- (2) Mark the valves to identify their position.
- (3) Compress the valve spring and remove the valve stem collets (Fig. 52).
- (4) Release valve spring and remove the retainer and spring (Fig. 52).
- (5) Remove the remaining collets, retainers, springs and valves. Keep the valves in a labeled rack.
- (6) Remove the valve stem seals (Fig. 52).

**Fig. 52 Valve Removal****INSTALLATION**

(1) Clean all cylinder head components before assembling.

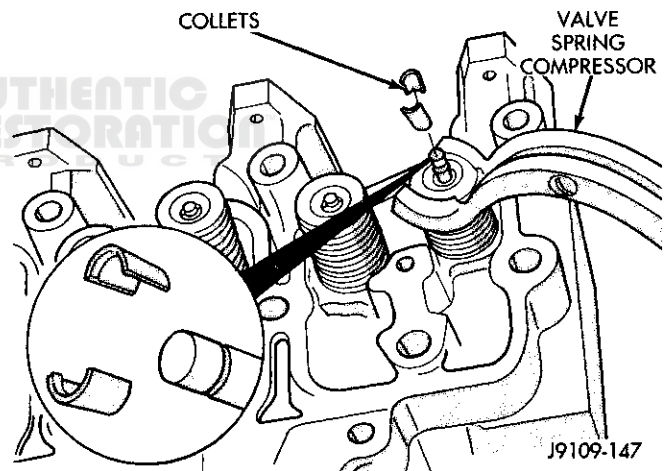
(2) Install the valve stem seals (Fig. 53). The intake and exhaust valve seals are the same.

**Fig. 53 Valve Stem Seal Installation**

(3) Lubricate the stems with SAE 90W oil before installing the valves. Install the valves in the same positions as removed.

(4) Compress the valve spring after installing the spring and retainer (Fig. 54).

(5) Install new valve collets and release the spring tension (Fig. 54).

**Fig. 54 Valve, Valve Spring and Collet Installation**

WARNING: WEAR PROTECTIVE EQUIPMENT AND DO NOT STAND IN LINE WITH THE VALVE STEM WHEN TAPPING THE VALVES.

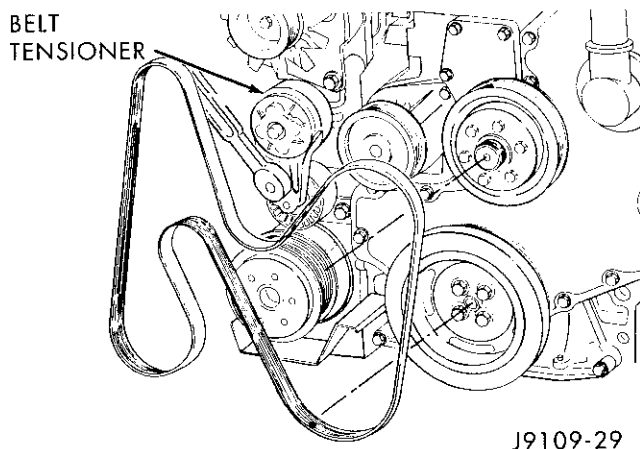
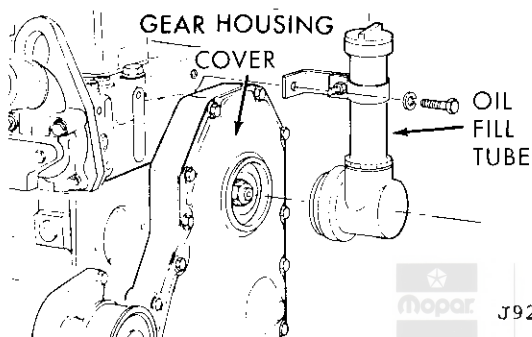
(6) Tap the ends of the valve stems with a mallet to verify the collets are seated.

(7) Install the cylinder head.

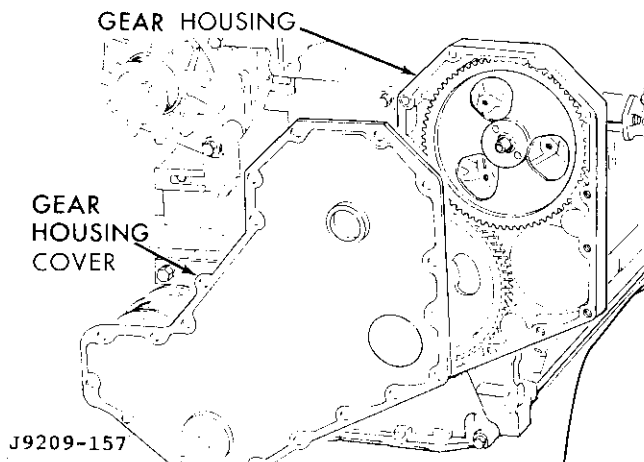
(8) Check the valve clearance adjustment.

GEAR HOUSING COVER**REMOVAL**

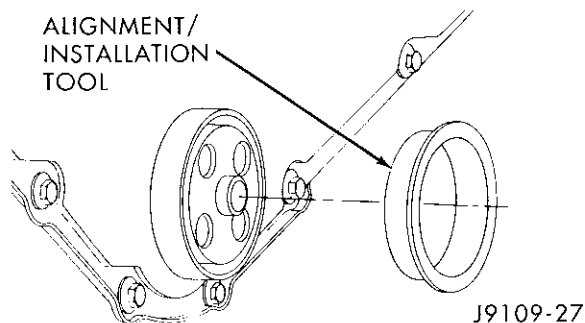
- (1) Remove fan drive assembly.
- (2) Remove the fan belt (Fig. 55).
- (3) Remove belt tensioner (Fig. 55).
- (4) Remove oil fill tube and adaptor (Fig. 56).

REMOVAL AND INSTALLATION (Continued)**Fig. 55 Drive Belt Installation****Fig. 56 Oil Fill Tube**

- (5) Remove vibration damper.
- (6) Remove the bolts that hold the gear cover to the gear housing.
- (7) Gently pry the cover away from the housing, taking care not to mar the gasket surfaces (Fig. 57).
- (8) Clean the old gasket residue from the back of the gear cover and front of the gear housing.

**Fig. 57 Gear Housing and Cover****INSTALLATION**

- (1) Lubricate the front gear train with clean engine oil.
- (2) Thoroughly clean the front seal area of the crankshaft. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.
- (3) Install the gear housing cover and a new gasket.
- (4) Install the bolts but DO NOT tighten them at this time.
- (5) Use the alignment/installation tool from the seal kit to align the cover to the crankshaft (Fig. 58).

**Fig. 58 Alignment/Installation Tool**

- (6) Tighten the gear housing cover bolts to 24 N·m (18 ft. lbs.) torque.
- (7) Remove the alignment/installation tool. Always use a seal pilot when you install a seal.
- (8) Apply a bead of Loctite 277 to the outside diameter of the seal. Install the pilot from the seal kit onto the crankshaft. Install the seal onto the pilot and start into the gear housing cover. Remove the pilot.
- (9) Use the alignment/installation tool and a plastic hammer to install the seal to the correct depth. To prevent damage to the seal carrier, hit the alignment/installation tool alternately at the 12, 3, 6 and 9 o'clock positions.
- (10) Install the oil fill tube and mounting bolts. Tighten the bolts to 43 N·m (32 ft. lbs.) torque.
- (11) Install the vibration damper. DO NOT tighten the bolts to the correct torque value at this time.
- (12) Install the belt tensioner. Tighten the mounting bolts to 43 N·m (32 ft. lbs.) torque.
- (13) Raise the belt tensioner to install the belt.
- (14) Tighten the vibration damper bolts to 125 N·m (92 ft. lbs.) torque. Use an engine barring tool to keep the engine from rotating during tightening operation.

GEAR HOUSING**REMOVAL**

- (1) Remove the engine assembly from the vehicle.

REMOVAL AND INSTALLATION (Continued)

(2) Remove the front end components and the gear housing cover (refer to Gear Housing Cover Removal for the proper procedures).

(3) Remove the following:

- Camshaft
- Gear driven accessories
- Fuel injection pump (refer to Group 14, Fuel System)
- Fan hub assembly (refer to Group 7, Cooling System)

(4) Remove the gear housing and gasket (Fig. 59).

(5) Clean the gasket material from the cylinder block.

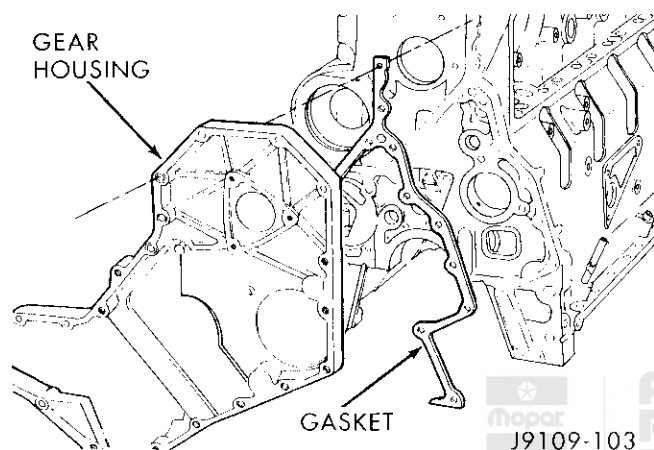


Fig. 59 Gear Housing/Gasket

INSTALLATION

(1) Install a new gasket and the gear housing. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(2) Install the camshaft. Make sure the alignment marks on the camshaft and crankshaft gears are aligned (Fig. 60).

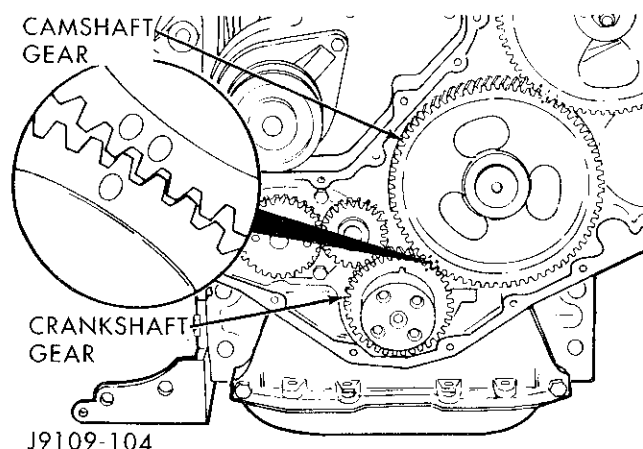


Fig. 60 Camshaft/Crankshaft Gear Alignment

(3) If a new housing is installed, the timing pin assembly must be accurately located.

(4) Install the following:

- Fan hub assembly (refer to Group 7, Cooling System)
- Fuel injection pump (refer to Group 14, Fuel System)
- Gear driven accessories

(5) Install the gear housing cover (refer to Gear Housing Cover Installation for the proper procedures).

(6) Install the front end components.

(7) Install the engine assembly into the vehicle.

TIMING PIN

The timing pin can be replaced without removing the assembly from the gear housing.

REMOVAL

(1) Remove the timing pin by prying the retaining ring out with a small screwdriver. Replace the retaining ring if it is damaged during removal.

INSTALLATION

(1) If timing pin assembly is removed from gear housing, it must be precisely reset to obtain exact TDC.

(2) Install a new O-Ring, lubricate the pin and position in the housing (Fig. 61). Install the new retaining ring to 1.5 mm (0.059 inch).

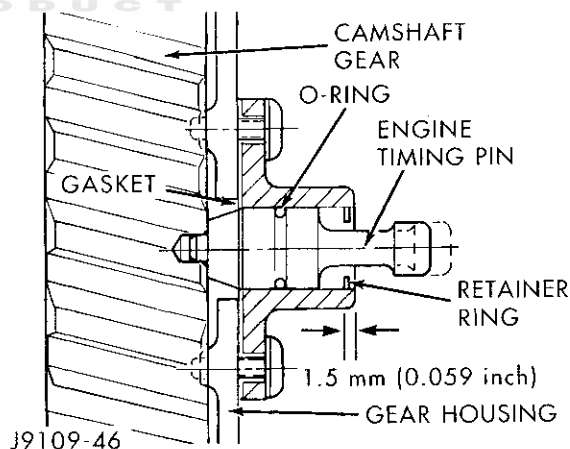


Fig. 61 Engine Timing Pin Location

TIMING PIN HOUSING ASSEMBLY**REMOVAL**

(1) Locate TDC for cylinder No.1.

(2) Remove the timing pin housing assembly and gasket.

(3) Clean any gasket material from the gear housing and from the timing pin housing assembly.

INSTALLATION—CYLINDER HEAD ON

The location of the timing pin assembly on the gear housing is critical for correct engine adjustment.

REMOVAL AND INSTALLATION (Continued)

Follow this procedure to install the assembly so that it corresponds to TDC for cylinder No.1.

(1) Look through the hole in the gear housing and rotate the engine until the hole in the cam gear can be seen.

(2) Remove the injector nozzles from all of the cylinders. This step is important to vent the cylinders so the crankshaft can be rotated smoothly to locate TDC for cylinder No.1.

(3) Temporarily install the vibration damper.

(4) Fabricate and install a wire pointer (Fig. 62). This can be done by forming a piece of wire that can be tightened under one of the gear housing capscrews. The wire should extend from the gear cover to a place on the crankshaft vibration damper that is easily seen.

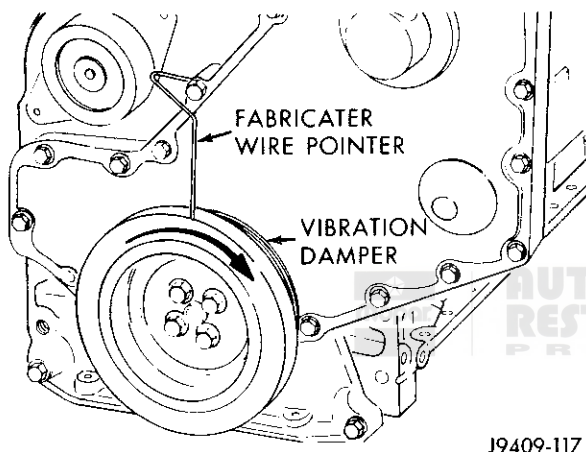


Fig. 62 Fabricated Wire Pointer

(5) Rotate the crankshaft one-quarter rotation in the direction of engine rotation.

(6) Tighten the adjusting screw for the No.1 intake valve to zero lash plus 5 turns.

CAUTION: Use extreme care when rotating the crankshaft. Use of too much force could damage the valve or push rod (Fig. 63).

(7) Rotate the crankshaft slowly in the opposite direction of normal engine rotation until the piston touches the intake valve (Fig. 63).

(8) Mark the vibration damper at the wire pointer (Fig. 63).

(9) Rotate the crankshaft in the direction of normal engine rotation until the piston touches the intake valve (Fig. 64). **Make sure that the piston touches the intake valve with approximately the same amount of force as in the previous step (Fig. 64).**

(10) Mark the vibration damper at the wire pointer (Fig. 64).

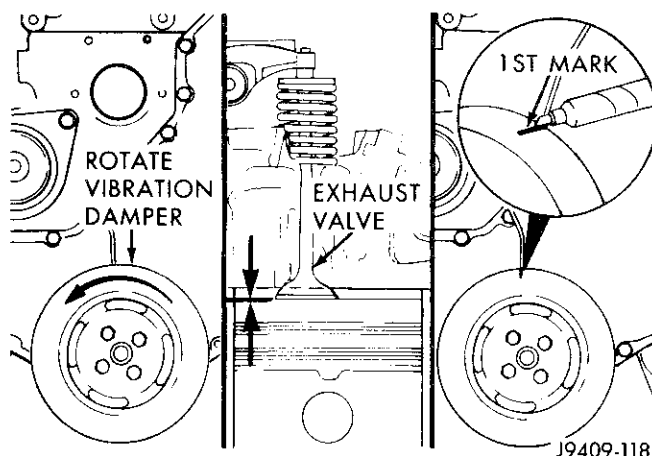


Fig. 63 Locate and Mark Vibration Damper—First Mark

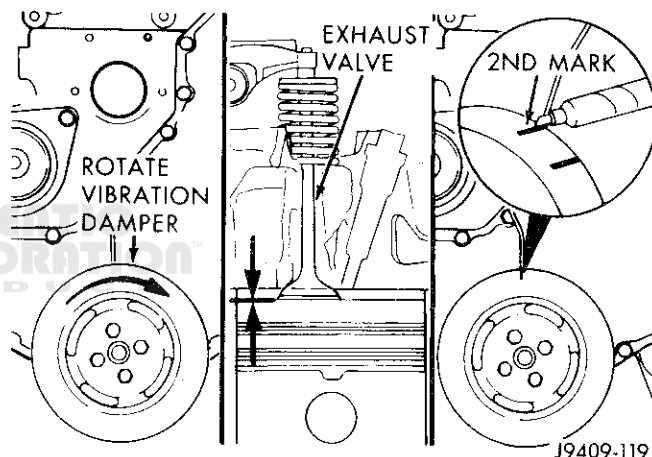


Fig. 64 Mark Vibration Damper—Second Mark

(11) Measure the distance and mark the vibration damper at one-half that distance between the two marks. This mark is the TDC mark (Fig. 65).

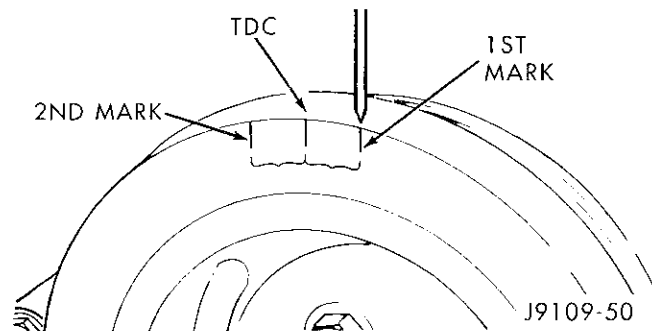


Fig. 65 Location of Top Dead Center (TDC)

(12) Completely loosen the intake valve adjusting screw. If not done, damage to the intake valve or push rod could occur when the crankshaft is rotated.

REMOVAL AND INSTALLATION (Continued)

(13) Rotate the crankshaft in the direction of normal engine rotation until the pointer is aligned with the TDC mark. Rotate crankshaft one additional turn.

(14) The timing pin hole in the cam gear should be visible or felt through the back side of the gear housing. If not, the crankshaft must be rotated one revolution in the direction of engine rotation.

(15) Apply a coat of Loctite[®] 59241 (Liquid Teflon), or equivalent to the threads of the Torx head bolts. Install the timing pin assembly and new O-ring.

(16) Hold the timing pin in the hole to align the housing and install the Torx head bolts. Tighten the Torx bolts to 5 N·m (44 in. lbs.) torque.

(17) Install the remaining rocker lever pedestal assemblies. Tighten the rocker lever pedestal mounting capscrews.

(18) Adjust the valves.

(19) Install the injectors and bleed the fuel system (refer to Group 14, Fuel System).

(20) Install the fuel pump (refer to Group 14, Fuel System).

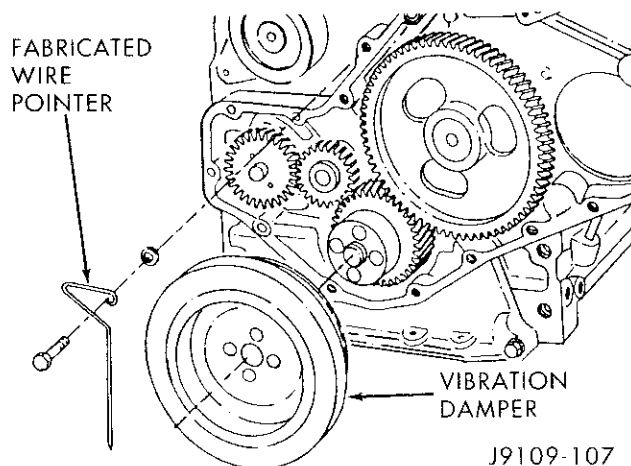
(21) Install the gear cover.

(22) Remove the pointer. Install the crankshaft vibration damper.

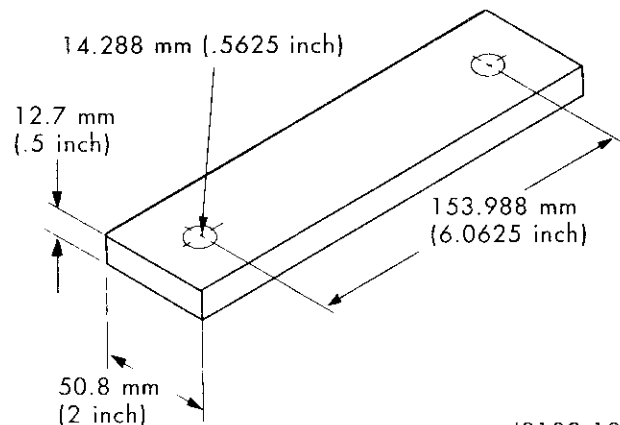
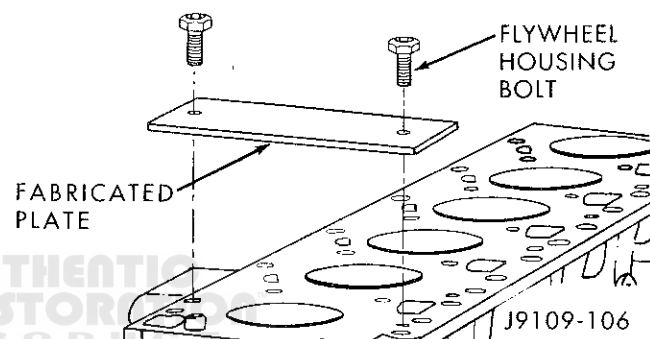
INSTALLATION—CYLINDER HEAD REMOVED

The timing pin assembly is precisely located on the gear housing to correspond to TDC for Cylinder No.1. The timing pin assembly must be relocated if the gear housing is interchanged.

(1) Temporarily install the vibration damper and a fabricated wire pointer (Fig. 66). Put a flat washer between the pointer and gear housing to prevent damage to the gear housing.

**Fig. 66 Fabricated Wire Pointer**

- (2) Fabricate a steel plate (Fig. 67).
- (3) Use two flywheel housing bolts to assemble the plate over No.1 cylinder (Fig. 68).

**Fig. 67 Fabricated Steel Plate****Fig. 68 Fabricated Plate Location on No.1 Cylinder**

(4) Rotate the crankshaft in the direction of rotation until the piston contacts the plate.

(5) Mark the vibration damper (Fig. 65).

(6) Rotate the engine in the opposite direction until the piston contacts the plate.

(7) Mark the vibration damper (Fig. 65).

(8) Mark the vibration damper for TDC. TDC will be one-half the distance between the first two marks (Fig. 65).

(9) Remove the plate and rotate the engine in the direction of rotation until the pointer aligns with the TDC mark.

(10) Look for the timing pin hole in the camshaft gear. If it is not visible, rotate the crankshaft one complete rotation. Align the pointer with the TDC mark.

(11) Install the timing pin housing assembly with a new gasket.

(12) Apply a coat of Loctite 59241 liquid teflon, or equivalent to the threads of the torx head bolts.

(13) Push the pin into the hole in the cam gear to align the timing pin housing.

(14) Hold the pin in while tightening the torx head bolts to 5 N·m (44 in. lbs.) torque. Be sure timing pin is disengaged before rotating the engine.

(15) Remove the vibration damper and wire pointer.

REMOVAL AND INSTALLATION (Continued)**CAMSHAFT****REMOVAL**

(1) Remove the following parts:

- Valve covers
- Rocker lever assemblies
- Push rods
- Drive belt
- Fan hub assembly
- Vibration damper
- Gear housing cover
- Lift pump

(2) Insert the dowels through the push tube holes and into the top of each tappet. When properly installed, the dowels can be used to pull the tappets up (Fig. 69).

(3) Pull the tappets up and wrap a rubber band around the top of the dowel rods (Fig. 69). This will prevent the tappets from dropping down.

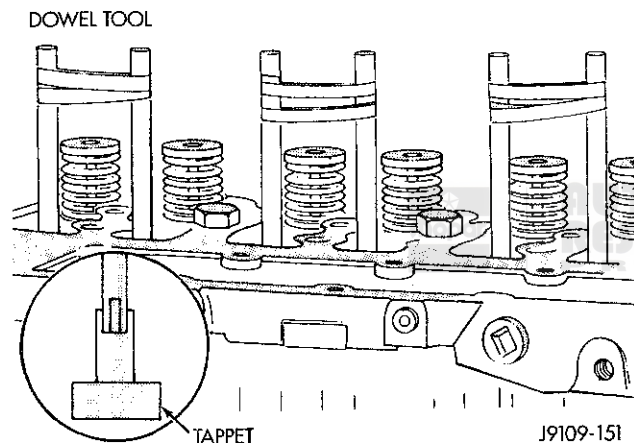


Fig. 69 Holding Tappets in Place

(4) Rotate the crankshaft to align the crankshaft to camshaft timing marks. (Fig. 70)

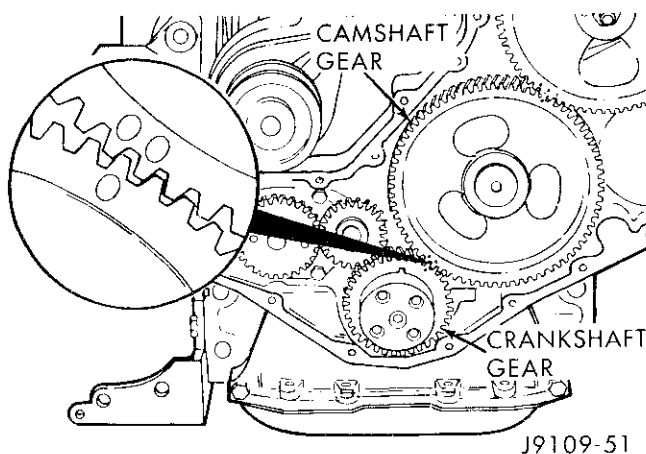


Fig. 70 Align Crankshaft to Camshaft

(5) Remove the bolts from the thrust plate (Fig. 71).

(6) Remove the camshaft, gear and thrust plate.

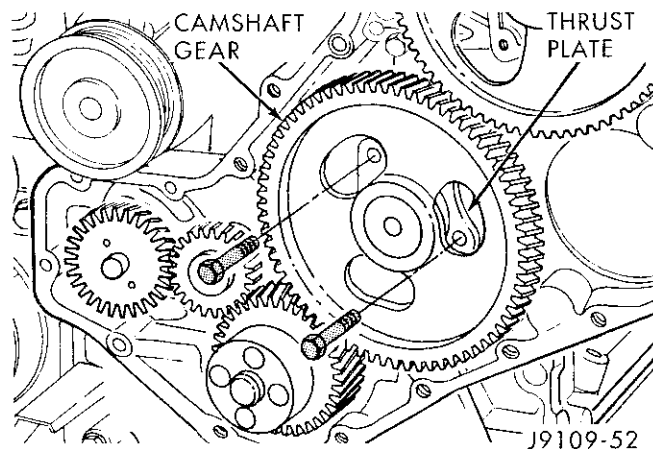


Fig. 71 Thrust Plate Bolt Location

BUSHING REPLACEMENT

(1) Measure the diameter of each bore. (The limit for the bushing in the No.1 bore is the same as for the other bores without bushings). The limit of the inside diameter is 54.133 mm (2.1312 inch). If the camshaft bore for the first cam bushing is worn beyond the limit, install a new service bushing. Inspect the rest of the camshaft bores for damage or excessive wear.

(2) If the bores without a bushing are worn beyond the limit, the engine must be removed for machining and installation of service bushings. If badly worn, replace the cylinder block.

(3) Remove the bushing from the No.1 bore, using a universal cam bushing tool.

(4) Mark the cylinder block so you can align the oil hole in the cylinder block with the oil hole in the bushing.

Apply a coating of loctite® 609 to the backside of the new bushing. Avoid getting loctite® in the oil hole.

(5) Use a universal cam bushing installation tool and install the bushing so that it is even with the front face of the cylinder block. The oil hole must be aligned. A 3.2 mm (0.128 inch) diameter rod must be able to pass through the hole (Fig. 72).

(6) Measure the installed bushing. The limit of the inside diameter is 54.133 mm (2.1312 inch).

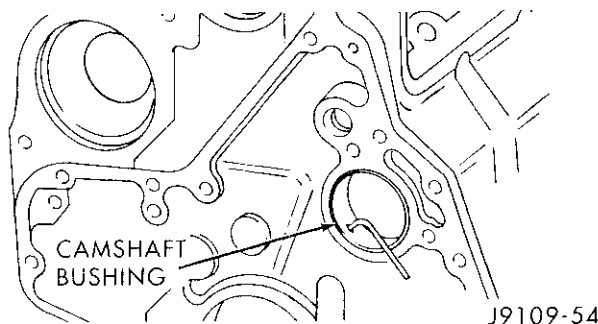


Fig. 72 Oil Hole Alignment

REMOVAL AND INSTALLATION (Continued)**GEAR REPLACEMENT**

- (1) Press the camshaft out of the gear.
- (2) Remove all burrs and smooth any rough surfaces caused by removing the gear.
- (3) Install the camshaft key.
- (4) Lubricate the camshaft surface with Lubriplate 105, or equivalent.

CAUTION: The camshaft gear will be permanently distorted if overheated. The oven temperature should never exceed 177°C (350°F).

- (5) Heat the gear in an oven at 177°C (350°F) for 45 minutes.

WARNING: WEAR PROTECTIVE GLOVES TO HANDLE THE HOT GEAR.

- (6) Install the gear with the timing marks visible. Be sure the gear is seated against the camshaft shoulder.
- (7) If the camshaft is not to be used immediately, lubricate the lobes and journals to prevent rust.

INSTALLATION

- (1) Apply a coat of Lubriplate 105 to the camshaft bores.
- (2) Lubricate the camshaft lobes, journals and thrust washer with Lubriplate 105, or equivalent.

CAUTION: When installing the camshaft, **DO NOT** push it in farther than it will go with the thrust washer in place. Pushing it too far can dislodge the plug in the rear of the camshaft bore and cause an oil leak.

- (3) Install the camshaft/thrust washer. Align the timing marks as illustrated (Fig. 70).
- (4) Install the thrust washer bolts and tighten to 24 N·m (18 ft. lbs.) torque.
- (5) Verify the camshaft has the correct amount of backlash and end clearance (Fig. 73).
- (6) Install the following parts:
 - Lift pump
 - Gear housing cover
 - Vibration damper
 - Fan hub assembly
 - Drive belt
 - Push rods
 - Rocker lever assemblies
 - Valve covers
- (7) Install the engine in the vehicle.
- (8) Operate the engine at idle for five to ten minutes and check for leaks and loose parts.

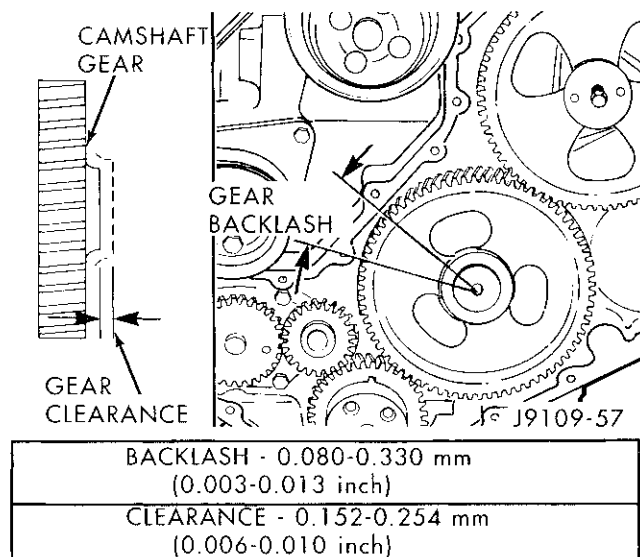


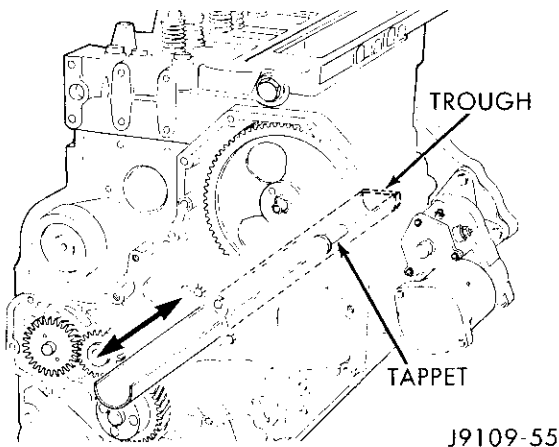
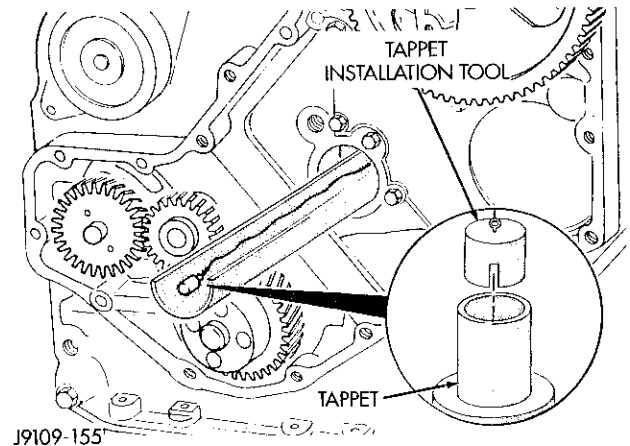
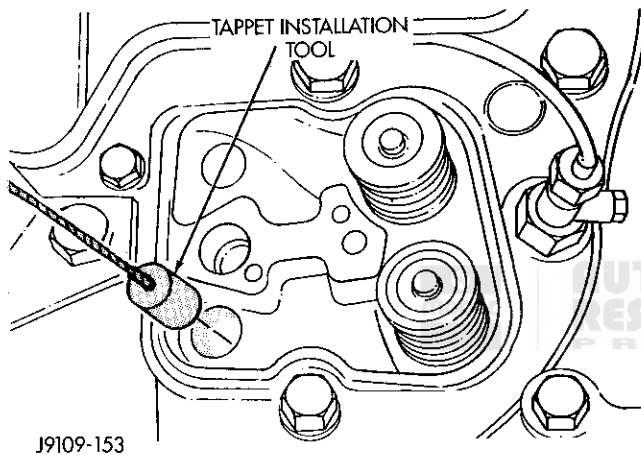
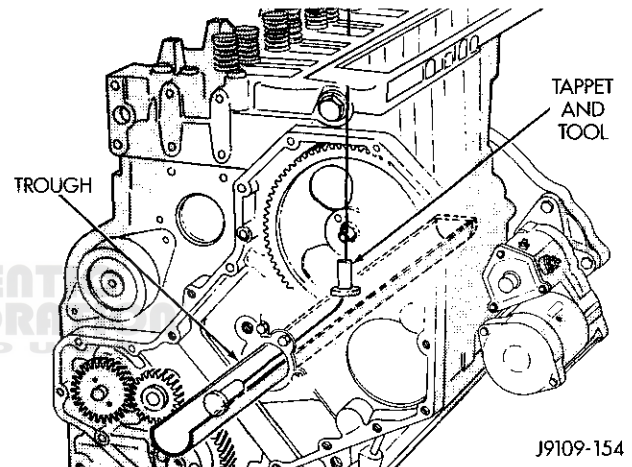
Fig. 73 Camshaft Backlash and End Clearance

TAPPET**REMOVAL**

- (1) Remove the camshaft.
- (2) Insert a trough the full length of the cam bore (Fig. 74). Cummins Tappet Changing Tool 3822513 is available for this job.
- (3) Make sure the trough is positioned so it will catch the tappet when the wooden dowel is removed.
- (4) Identify the location of each tappet as it is removed. The tappets must be installed in their original locations.
- (5) Only remove one tappet at a time. Remove the rubber band from the two companion tappets, securing the tappet not to be removed with the rubber band.
- (6) Pull the wooden dowel from the tappet bore allowing the tappet to fall into the trough (Fig. 74).
- (7) Normally the tappet will fall over when it drops into the trough. Use a flashlight to determine this. If the tappet does not fall over, shake the trough gently to get it to do so.
- (8) Special care should be taken, when removing the No.6 cylinder tappets. **DO NOT** knock or shake the tappet over the end barrier of the trough.
- (9) Carefully pull the trough and tappet from the cam bore and remove the tappet. Repeat the process until all tappets are removed.

INSTALLATION

- (1) Insert the trough the full length of the cam bore.
- (2) Feed the installation tool down the tappet bore and into the trough (Fig. 75).
- (3) Feed the installation tool cord through the cam bores. Carefully pull the trough and installation tool

REMOVAL AND INSTALLATION (Continued)**Fig. 74 Tappet Removal using a Trough****Fig. 76 Insert Installation Tool into Tappet****Fig. 75 Tappet Installation Tool****Fig. 77 Pull Tappet/Tool into Position**

out the front. The barrier at the rear of the trough will assure the tool will be pulled out with it.

(4) Lubricate the tappets with Lubriplate 105, or equivalent.

(5) Insert the installation tool into the tappet (Fig. 76). To aid in removing the installation tool after the tappets is installed, work the tool in and out of the tappet several times before installing the tappets.

(6) Place the tappet and tool in the trough and slide the trough back into the cam bore (Fig. 76).

(7) Pull the tool/tappet through the cam bore and up into the tappet bore (Fig. 77).

(8) Difficulty could be experienced in getting the tappet to make the bend from the trough up to the tappet bore (due to the webbing of the block). If this occurs, pull the trough out enough to allow the tappet to drop down and align itself. Now pull the tappet up into the bore carefully.

(9) After the tappet has been pulled up into position, slide the trough back into the cam bore and rotate it 1/2 turn. This will position the round side of the trough up, which will hold the tappet in place.

- (10) Remove the installation tool from the tappet.
- (11) Install a wooden dowel into the top of the tappet and secure it with a rubber band.
- (12) Repeat this process until all tappets have been installed.
- (13) Install the camshaft.

OIL PAN AND SUCTION TUBE**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Remove transmission from vehicle, refer to Group 21 Transmission and Transfer Case.
- (3) Remove flywheel ring gear assembly.
- (4) Disconnect starter cables from starter motor.
- (5) Remove transmission oil cooler bolts.
- (6) Remove starter motor and spacer plate assembly.

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

REMOVAL AND INSTALLATION (Continued)

(7) Drain the used engine oil. Dispose of the used oil properly.

(8) Remove oil pan bolts, lower pan slightly and remove oil suction tube.

(9) Remove oil pan.

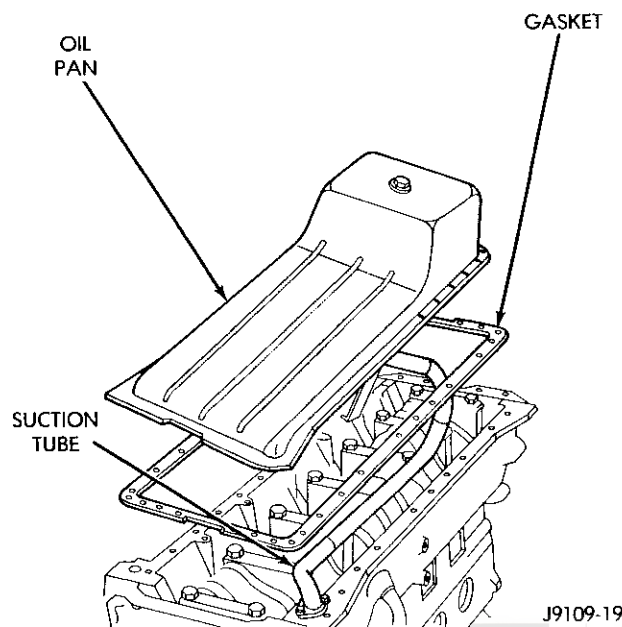


Fig. 78 Oil Pan, Suction Tube and Gasket

INSTALLATION

(1) Clean the sealing surface.

(2) Install the suction tube and gasket. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(3) Fill the joint between the pan rail/gear housing and pan rail/rear cover with sealant. Use Three Bond 1207-C, or equivalent.

(4) Install the pan and gasket (Fig. 78). Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(5) Install the drain plug with a new sealing washer and tighten to 80 N·m (60 ft. lbs.) torque.

(6) Fill the engine with clean lubrication oil. Run the engine and check for leaks.

(7) Stop the engine and let it set for five minutes. Check the oil level, and add oil if needed.

PISTON AND CONNECTING ROD ASSEMBLY

The turbocharged intercooler piston has a Ni-Resist insert with a keystone profile for the top compression ring. The new piston has a new design bowl and a 7 mm longer piston pin. These pistons can not be interchanged with earlier models.

REMOVAL

(1) Remove the engine assembly from the vehicle.

(2) Remove the cylinder head from the block.

(3) Remove the oil pan and suction pump.

(4) If the cylinder bores have ridges, use a ridge reamer to cut the ridge from the top of the cylinder bore before removing the piston. Make sure the ridge reamer does not make a deep cut into the bore. DO NOT remove more metal than is necessary to remove the ridge.

(5) If cylinders have ridges, the cylinders are over-size and will need boring.

(6) Use a hammer and a steel stamp to mark the cylinder number onto each connecting rod cap. Mark the cylinder number onto the top of each piston.

(7) Remove the connecting rod bolts and rod caps. Use care so the cylinder bores and connecting rods are not damaged.

(8) Use a hammer handle or similar object to push the piston and connecting rod through the cylinder bore.

(9) Store the piston/rod assemblies in a rack.

(10) If a piston must be replaced, replace with the same part number (grading) that was removed.

INSTALLATION

(1) Lubricate the cylinder bore with clean engine oil.

(2) Generously lubricate the rings and piston skirts with clean engine oil.

(3) Compress the rings using a piston ring compressor tool (Fig. 79). If using a strap-type ring compressor, make sure the inside end of the strap does not hook on a ring gap and break the ring.

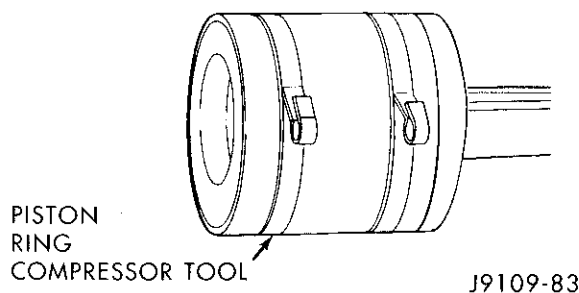


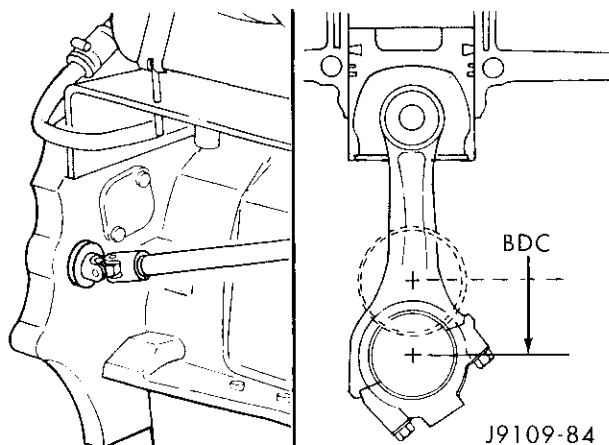
Fig. 79 Piston Ring Compressor Tool

(4) Bar the crankshaft so the rod journal for the piston to be installed is at BDC (Bottom Dead Center) - (Fig. 80).

(5) Be sure the FRONT marking on the piston and the numbers on the rod and cap are oriented as illustrated.

(6) Position the piston and rod assembly into the cylinder bore with the word FRONT on the piston towards the front of the cylinder block. Use care when you install the piston and connecting rod so the cylinder bore is not damaged.

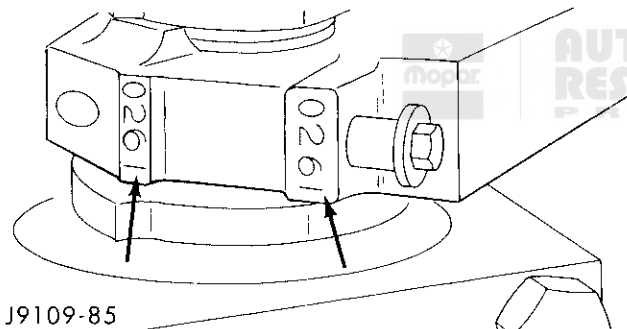
(7) Push the piston into the bore until the top of the piston is approximately 50 mm (2 inch) below the

REMOVAL AND INSTALLATION (Continued)**Fig. 80 Piston/Rod Assembly at BDC**

top of the block. Carefully pull the connecting rod onto the crankshaft journal.

(8) Use clean engine oil to lubricate the threads and under the heads of the connecting rod bolts.

(9) The 4 digit number stamped on the rod cap at the parting line must match and be installed towards the oil cooler side of the engine (Fig. 81).

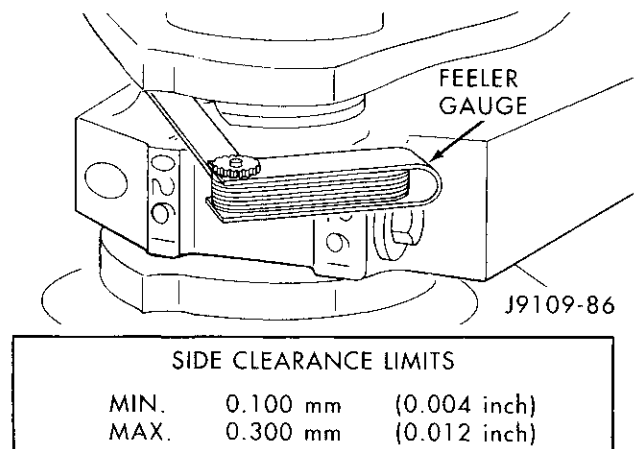
**Fig. 81 Correct Rod Cap Installation**

(10) Install the rod cap and bolts to the connecting rod. Tighten the connecting rod and bolt evenly in 3 steps.

- Tighten the bolts to 35 N·m (26 ft. lbs.) torque.
- Tighten the bolts to 70 N·m (51 ft. lbs.) torque.
- Tighten the bolts to 100 N·m (73 ft. lbs.) torque.

(11) The crankshaft must rotate freely. Check for freedom of rotation as the caps are installed. If the crankshaft does not rotate freely, check the installation of the rod bearing and the bearing size.

(12) Measure the side clearance between the connecting rod and the crankshaft (Fig. 82). DO NOT measure the clearance between the cap and crankshaft.

**Fig. 82 Side Clearance between Connecting Rod/Crankshaft**

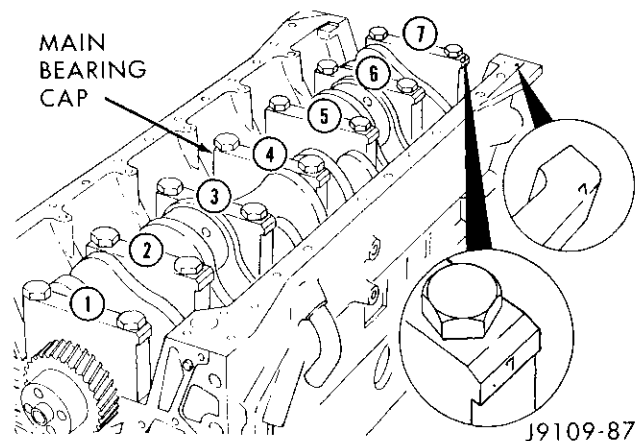
(13) Install the suction tube and oil pan.

(14) Install the cylinder head onto the block.

(15) Install the engine assembly into the vehicle.

CRANKSHAFT**REMOVAL**

- (1) Remove the rear crankshaft seal housing.
- (2) Remove the gear housing.
- (3) Rotate the engine to a horizontal position and remove the main bearing bolts.
- (4) The main bearing caps should be numbered. If they are not, be sure to mark them, beginning with number one at the front and ending with number seven at the rear (Fig. 83).

**Fig. 83 Numbering Main Bearing Caps**

CAUTION: DO NOT pry on the main caps to free them from the cylinder block.

REMOVAL AND INSTALLATION (Continued)

(5) Use two of the main bearing cap bolts to wiggle the main cap loose, being careful not to damage the bolt threads (Fig. 84). Remove the caps.

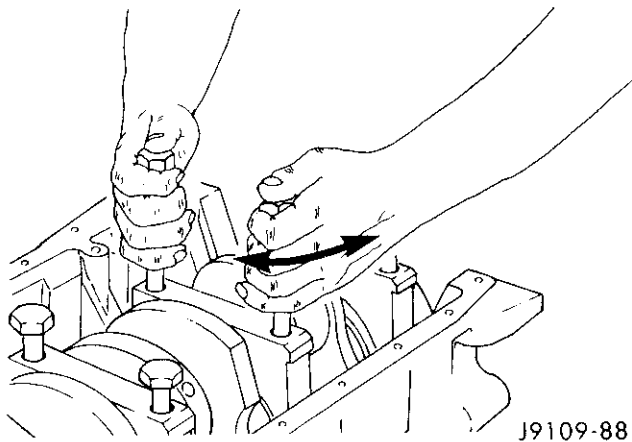


Fig. 84 Main Bearing Cap Removal

WARNING: USE A HOIST TO AVOID INJURY.

(6) Lift the crankshaft and gear from the cylinder block (Fig. 85).

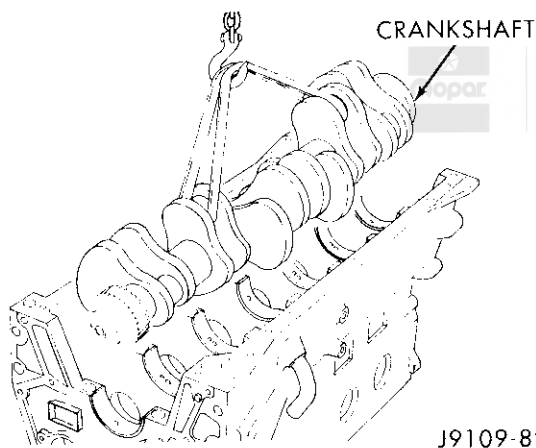


Fig. 85 Lifting Crankshaft out of Cylinder Block

(7) Remove the main bearings from the block and the main caps.

(8) Remove the piston cooling nozzles by using a 3/16 inch pin punch to push them out (Fig. 86).

INSTALLATION

CAUTION: Use only hand force to push the nozzle in place. If driven with a hammer, the nozzle will be damaged.

(1) Use a center punch to push the piston cooling nozzle into place. Install nozzles so they are even with or slightly below the saddle surface.

(2) Make sure the saddle surface is clean and dry. Install the upper main bearings.

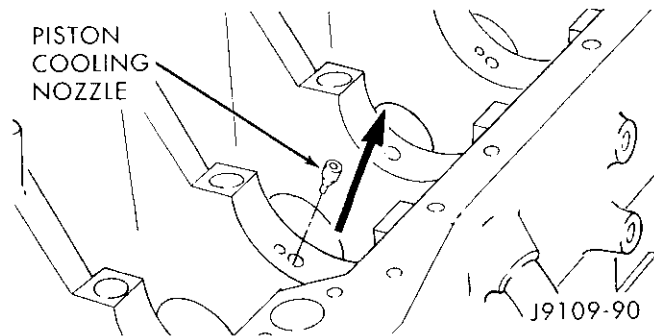


Fig. 86 Piston Cooling Nozzles

(3) Install the combination thrust/main bearing in the number six main bearing location.

(4) Lubricate the bearings with Lubriplate 105, or equivalent.

WARNING: TO AVOID INJURY, USE A HOIST TO INSTALL THE CRANKSHAFT.

(5) Install the crankshaft.

CAUTION: Crankshaft must be lowered onto the bearings straight to prevent damage to thrust bearings.

(6) Install the ring dowels in the main bearing caps (Fig. 87).

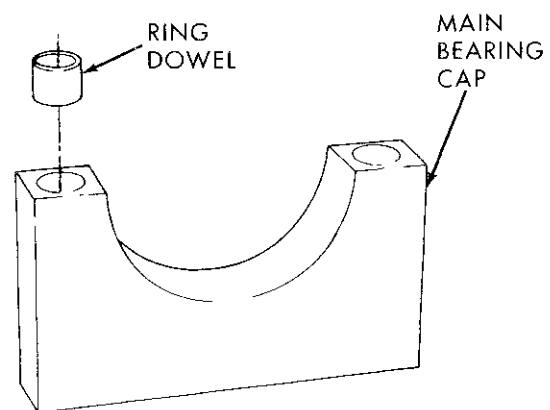


Fig. 87 Install Ring Dowels

(7) Install the lower main bearings in the caps.

(8) Lubricate the bearings with Lubriplate, or equivalent.

(9) Numbers on the main bearings caps face the oil cooler side of the engine with number one at the front of the engine.

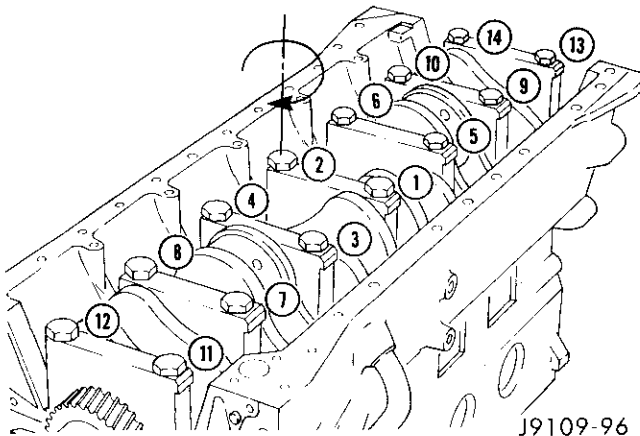
(10) Place the caps in their respective positions.

(11) Lubricate the main bearing bolt threads and underside of the bolt head with clean engine oil.

(12) Tighten the bolts evenly in the sequence shown using the following torque steps (Fig. 88).

REMOVAL AND INSTALLATION (Continued)

- STEP 1—Tighten all bolts in sequence to 60 N·m (44 ft. lbs.) torque.
- STEP 2—Tighten all bolts in sequence to 119 N·m (88 ft. lbs.) torque.
- STEP 3—Tighten all bolts in sequence to 176 N·m (129 ft. lbs.) torque.

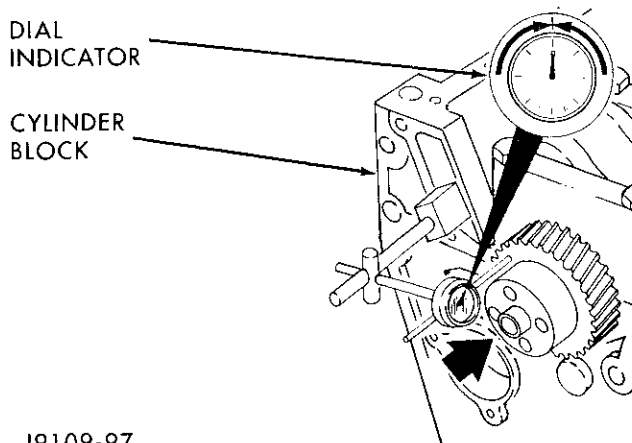


J9109-96

Fig. 88 Main Bearing Bolt Tightening Sequence

(13) Turn the crankshaft to determine that it will rotate freely all 360°. Check the main bearing cap installations and/or the bearing sizes if the shaft does not turn easily.

(14) Push the crankshaft towards one end of its thrust and place a dial indicator as shown (Fig. 89).



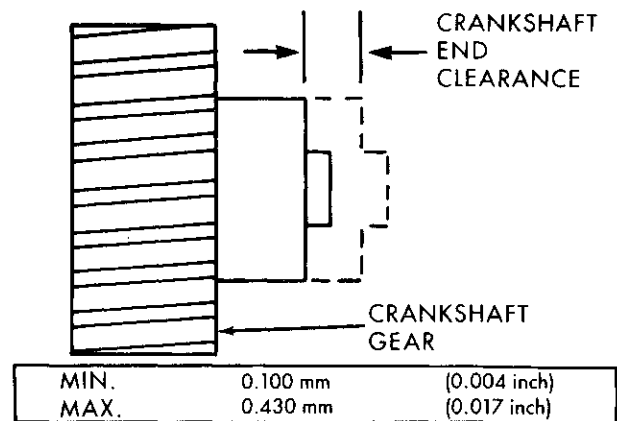
J9109-97

Fig. 89 Position of Dial Indicator

(15) Zero the indicator needle and push the crankshaft towards the other end of its thrust and record the crankshaft end clearance (Fig. 90).

CRANKSHAFT FRONT SEAL**REMOVAL**

- (1) Remove the drive belt.
- (2) Remove the vibration damper.



J9409-120

Fig. 90 Crankshaft End Clearance

(3) Drill two 1/8th inch holes into the seal face, 180° apart.

(4) Use a slide hammer tool with a #10 metal screw. Pull alternating from side-to-side until the seal is free.

INSTALLATION

(1) The sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

(2) If the gear cover was replaced, use the alignment tool from the seal kit to make sure the cover is aligned with the crankshaft.

(3) Apply a bead of Loctite 277 to the outside diameter of the seal.

(4) Install the pilot from the seal kit onto the crankshaft.

(5) Install the seal onto the pilot and start it into the gear housing cover seal bore.

(6) Remove the pilot.

(7) Use the alignment/installation tool and a plastic hammer to install the seal to the correct depth.

(8) Install the vibration damper, but DO NOT tighten the damper bolt until the belt is installed.

(9) Install the drive belt.

(10) Tighten the vibration damper bolts to 125 N·m (92 ft. lbs.) torque. Use the engine barring tool to keep the engine from rotating during torquing operation.

CRANKSHAFT REAR SEAL**REMOVAL**

(1) Remove the transmission (refer to Group 21, Transmission for the proper procedure).

(2) Remove the clutch cover.

(3) Remove the clutch plate.

(4) Remove the flywheel.

(5) Drill holes 180° apart into the seal. Be careful not to get the drill against the crankshaft.

REMOVAL AND INSTALLATION (Continued)

(6) Install #10 sheet metal screws in the drilled holes and remove the rear seal with a slide hammer (Fig. 91).

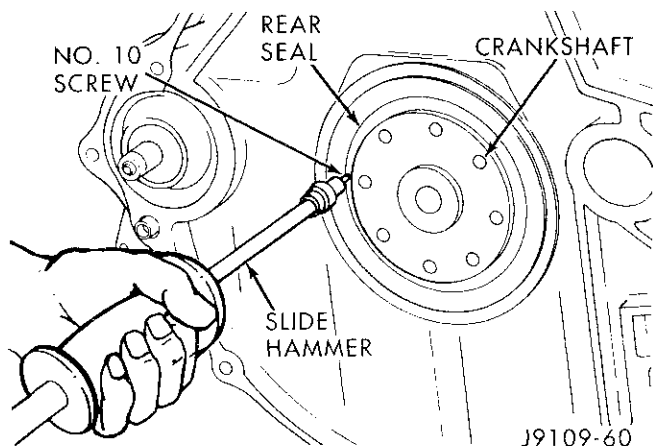


Fig. 91 Crankshaft Rear Seal Removal

INSTALLATION

CAUTION: The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

The crankshaft and seal must be dry when the seal is installed.

(1) Install the seal pilot, provided in the replacement kit, on the crankshaft. Push the seal on the pilot and crankshaft.

(2) Remove the seal pilot.

(3) Seal O.D. lubricant/sealant:

- Rubber O.D. rear crankshaft seals are lubricated with soapy water.
- Seals without rubber O.D. use Loctite 277 or equivalent sealant.

(4) Use the alignment tool to install the seal to the correct depth in the housing. Use a hammer to drive the seal into the housing until the alignment tool stops against the housing (Fig. 92).

(5) Hit the tool at the 12, 3, 6 and 9 o'clock positions to drive the seal evenly and prevent bending the seal housing.

CRANKSHAFT REAR SEAL HOUSING**REMOVAL**

(1) Remove the rear seal housing and gasket (Fig. 93).

(2) Support the seal area of the rear seal housing and press/drive out the seal using a hammer and a pin pinch.

(3) Clean the rear seal housing.

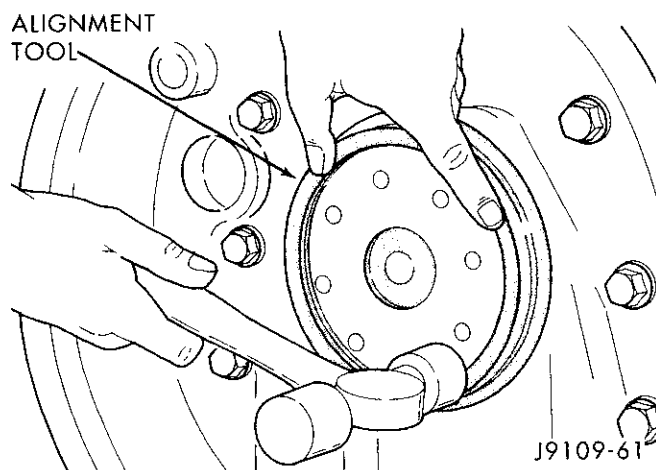


Fig. 92 Seal Installation using Alignment Tool

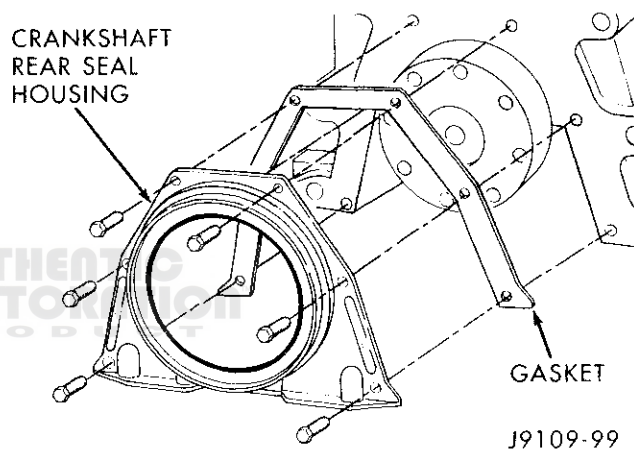


Fig. 93 Crankshaft Rear Seal Housing/Gasket

INSTALLATION

(1) Clean and dry the rear crankshaft sealing surface. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

(2) Assemble the rear seal housing and gasket to the cylinder block with the bolts.

(3) Align the seal housing to the crankshaft with the alignment tool provided in the seal kit (Fig. 14). Make sure the seal housing is level with both sides of the block oil pan rail. Tighten the bolts to 9 N·m (7 ft. lbs.) torque.

(4) Remove the alignment tool and trim the gasket even with the oil pan mounting surface (Fig. 94).

(5) The rubber O.D. rear crankshaft seals are lubricated with soapy water. Seals without rubber O.D. use Loctite 277, or equivalent.

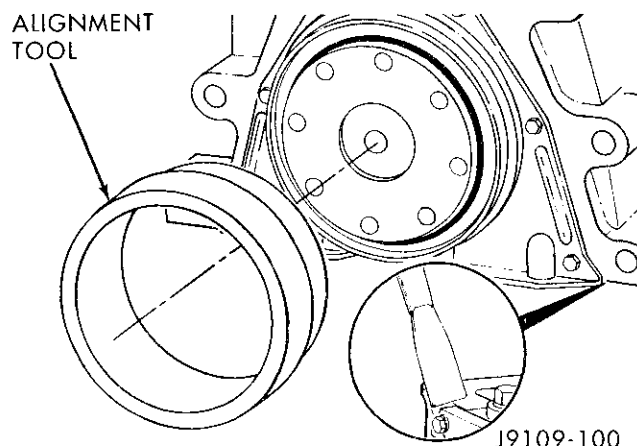
REMOVAL AND INSTALLATION (Continued)

Fig. 94 Crankshaft Rear Seal Housing Alignment Tool

(6) Install the seal pilot (provided with the replacement kit) onto the crankshaft. Push the seal onto the crankshaft (Fig. 95).

(7) Remove the seal pilot.

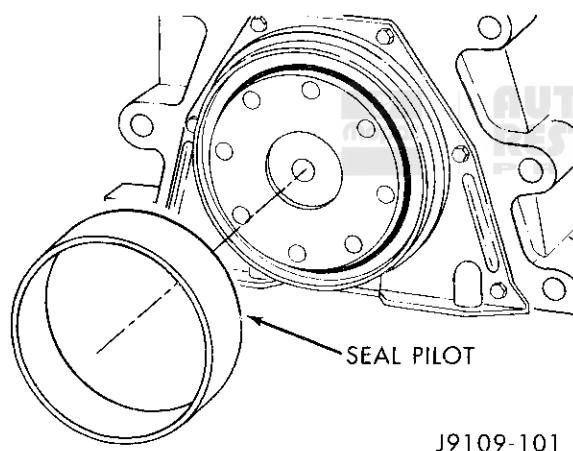


Fig. 95 Crankshaft Rear Seal Pilot

(8) Use alignment and installation tool packaged in the seal kit (Fig. 96). Alternately, drive the seal at the 12, 3, 6 and 9 o'clock positions to prevent bending the seal carrier during installation.

FLYWHEEL RING GEAR**REMOVAL**

- (1) Remove the transmission.
- (2) Remove the clutch cover.
- (3) Remove the clutch plate.
- (4) Remove the flywheel.
- (5) Use a drift pin to drive the ring gear from the flywheel (Fig. 19). Strike the gear at several points around the wheel until it is off.
- (6) Heat the new ring for 20 minutes in an oven preheated to 127°C (250°F).

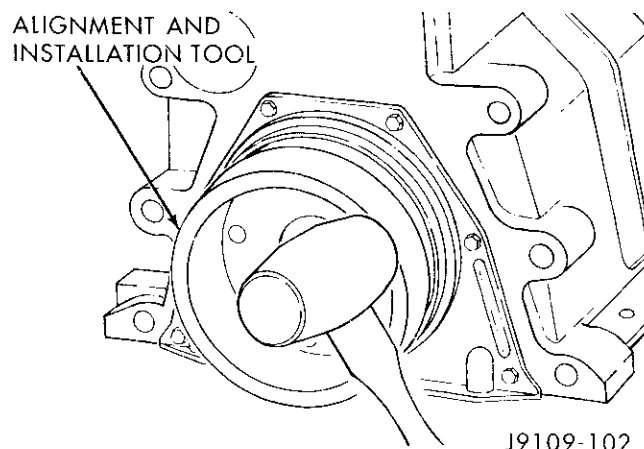


Fig. 96 Crankshaft Rear Seal Alignment/Installation Tool

(7) Install the gear. The gear must be installed so the bevel on the teeth is towards the crankshaft side of the flywheel (Fig. 97).

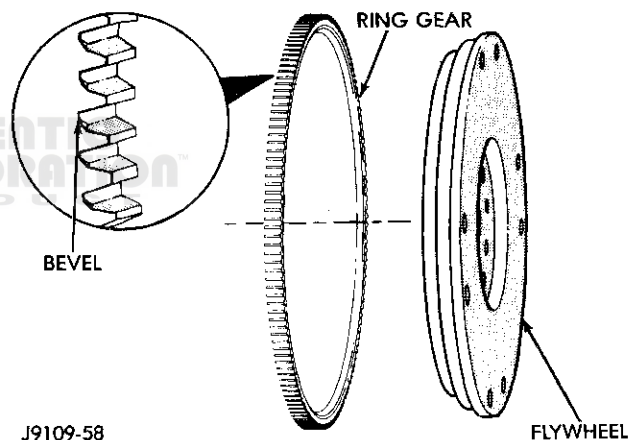


Fig. 97 Flywheel/Ring Gear Position

INSTALLATION

CAUTION: Never use the timing pin to hold the crankshaft in position.

- (1) Use the engine barring tool to hold the crankshaft when the flywheel bolts are being tightened.
- (2) Tighten the bolts in a criss-cross pattern to 137 N-m (101 ft. lbs.) torque.

CRANKSHAFT GEAR**REMOVAL**

Remove the crankshaft gear using a heavy duty puller.

INSTALLATION

Remove all burrs and make sure the gear surface on the end of the crankshaft is smooth.

REMOVAL AND INSTALLATION (Continued)

If removed, install a new alignment pin. Drive the pin in using a ball-peen hammer, leaving it protruding 1.60 mm (0.063 inch) to 2.39 mm (0.094 inch) above the crankshaft (Fig. 98).

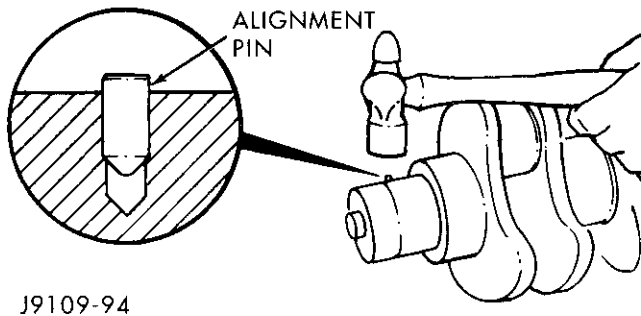


Fig. 98 Installing Alignment Pin

Heat the crankshaft gear for 45 minutes at a temperature of 121°C (250°F).

CAUTION: DO NOT heat the gear longer than 45 minutes.

WARNING: WEAR PROTECTIVE GLOVES TO PREVENT INJURY.

Position the gear with the timing mark out and install it on the crankshaft using the alignment pin. Make sure the gear contacts the shoulder.

OIL PUMP

The non-intercooled turbocharged engine oil pumps can not be used on intercooled engines.

REMOVAL

- (1) Remove the radiator (refer to Group 7, Cooling System for the proper procedure).
- (2) Loosen the crankshaft vibration damper and remove the drive belt.
- (3) Remove the fan clutch assembly.
- (4) Remove the fan hub.
- (5) Remove the oil fill tube.
- (6) Remove the crankshaft vibration damper.
- (7) Remove the gear housing cover.
- (8) Remove the four mounting bolts and pull the pump from the bore in the cylinder block (Fig. 99).

INSTALLATION

- (1) Lubricate the pump with clean engine oil. Filling the pump with clean engine oil during installation will help to prime the pump at engine start up. Make sure the idler gear pin is installed in the locating bore in the cylinder block.
- (2) Install the pump. Tighten the oil pump mounting bolts in two steps and in the sequence shown (Fig. 99).

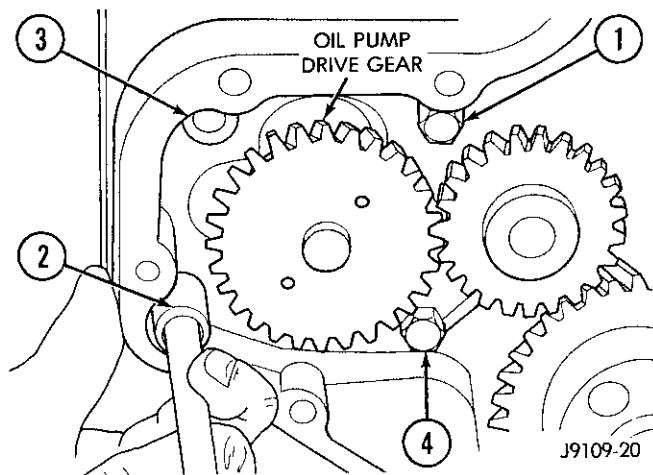


Fig. 99 Oil Pump Removal

- Step 1—Tighten to 5 N·m (44 in. lbs.) torque.
- Step 2—Tighten to 24 N·m (18 ft. lbs.) torque.

(3) The back plate on the pump seats against the bottom of the bore in the cylinder block. When the pump is correctly installed, the flange on the pump will not touch the cylinder block.

(4) Measure the idler gear to pump drive gear backlash and the idler gear to crankshaft gear backlash (Fig. 100). The backlash should be 0.080- 0.330 mm (0.003-0.013 inch). If the backlash is out of limits, replace the oil pump drive gear and the idler gear.

(5) If the adjoining gear moves when you measure the backlash, the reading will be incorrect.

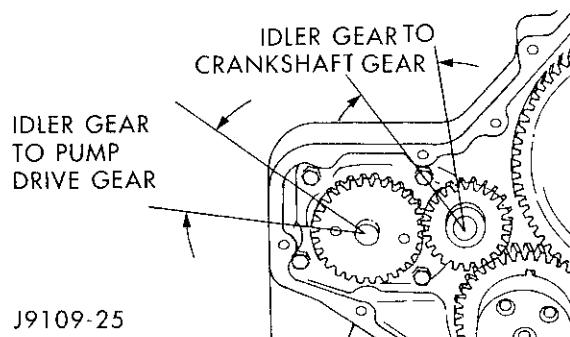


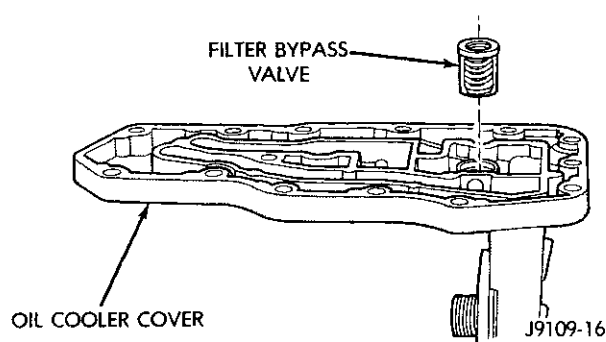
Fig. 100 Idler Gear to Pump Drive Gear and Crankshaft Gear Backlash

OIL FILTER BYPASS VALVE**REMOVAL**

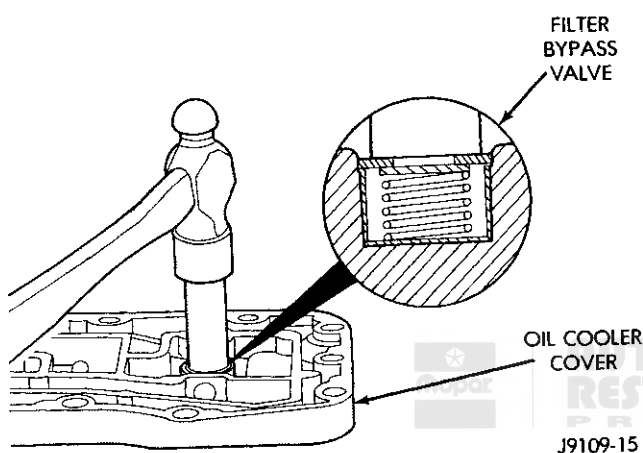
- (1) Remove the oil cooler cover (Fig. 101).
- (2) Remove the valve from the cooler cover (Fig. 101).

INSTALLATION

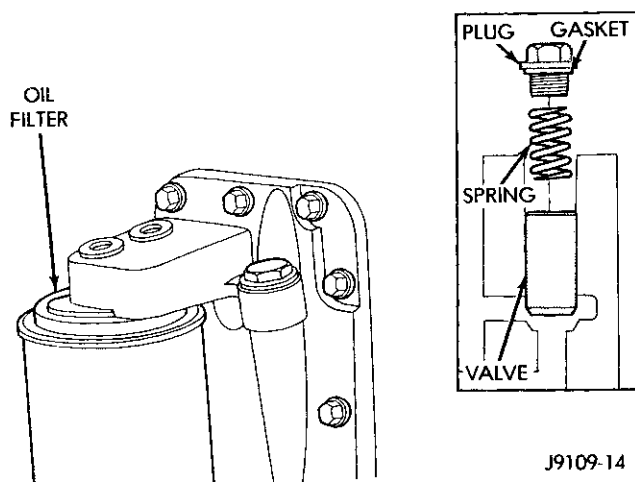
- (1) Drive the new valve in until it bottoms against the step in the bypass valve bore (Fig. 102).

REMOVAL AND INSTALLATION (Continued)**Fig. 101 Removing Filter Bypass Valve**

(2) Install the oil cooler cover.

**Fig. 102 Installing New Filter Bypass Valve****OIL PRESSURE REGULATOR VALVE AND SPRING****REMOVAL**

(1) Remove the threaded plug, gasket, spring and valve (Fig. 103).

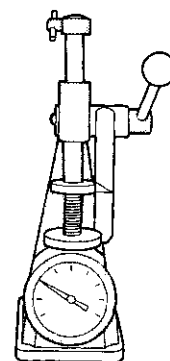
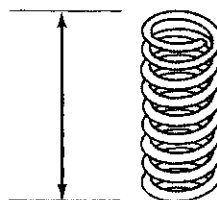
**Fig. 103 Oil Pressure Regulator**

(2) Check the spring for height and load limitations (Fig. 104). Replace the spring if out of limits.

VALVE OPEN

- HEIGHT: 41.25mm (1.62 inch)
- LOAD: 126 N (28.4 lb)

FREE LENGTH: 66mm (2.6 inch)



J9509-161

Fig. 104 Oil Pressure Regulator Spring Check**INSTALLATION**

(1) Clean and inspect the plunger, bore and seat before assembly. The plunger must move freely in the valve bore.

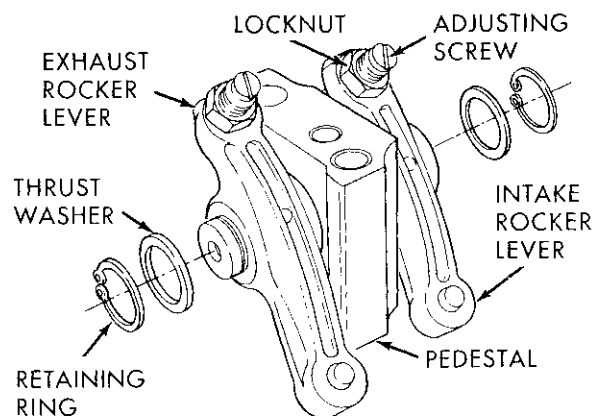
(2) Install the valve, spring, gasket and plug. Tighten the plug to 80 N·m (60 ft. lbs.) torque.

DISASSEMBLY AND ASSEMBLY**ROCKER LEVERS****DISASSEMBLE**

(1) Remove the retaining rings and thrust washers (Fig. 105).

(2) Remove the rocker levers (Fig. 105). DO NOT disassemble the rocker lever shaft and pedestal. The pedestal and shaft must be replaced as an assembly.

(3) Remove the locknut and adjusting screw (Fig. 105).



J9109-31

Fig. 105 Rocker Lever Components

DISASSEMBLY AND ASSEMBLY (Continued)

(4) Clean all parts in a strong solution of laundry detergent in hot water.

(5) Use compressed air to dry the parts after rinsing in clean hot water. The pedestals are made from powdered metal and may continue to show wetness after they have been cleaned and dried.

(6) Inspect for excessive wear in the bore and the contact surface for the valve stem.

(7) Measure the rocker lever bore diameter. The maximum diameter is 19.05 mm (0.75 inch). Replace if out of limits.

(8) Inspect the pedestal and shaft.

(9) Measure the shaft diameter. The minimum diameter is 18.94 mm (0.746 inch). Replace if out of limits.

ASSEMBLE

(1) Install the adjusting screw and locknut.

(2) Lubricate the shaft with clean engine oil. Be sure to assemble the intake and exhaust rocker levers in the correct location.

(3) Position the levers on the rocker shaft. Install the thrust washers.

(4) Clean the push rods in the hot soapy water.

(5) Inspect the push rod ball and socket for signs of scoring or cracks where the ball and the socket are pressed into the tube.

(6) Check the push rods for roundness and straightness.

(7) Install the push rods into the sockets of the valve tappets. Lubricate the push rod sockets with clean engine oil.

(8) Make sure the rocker lever adjusting screws are completely backed out.

PISTON AND CONNECTING ROD ASSEMBLY**DISASSEMBLE**

(1) Remove the retainer rings from the piston (Fig. 106).

(2) Remove the piston pin. Heating the piston is not required.

(3) Remove the piston rings (Fig. 106).

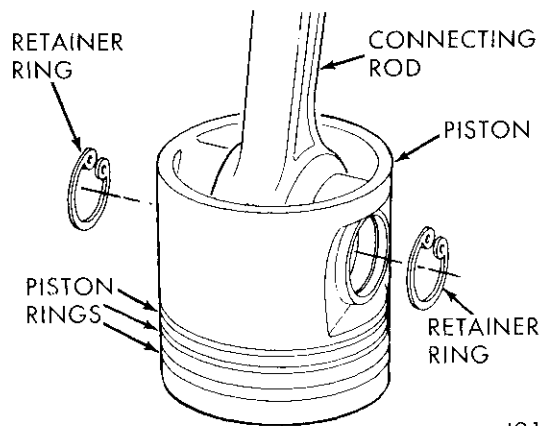
ASSEMBLE

(1) Be sure the FRONT marking on the piston and the numbers on the rod and cap are oriented (Fig. 107). Install the retaining ring into the pin groove on the FRONT side of the piston.

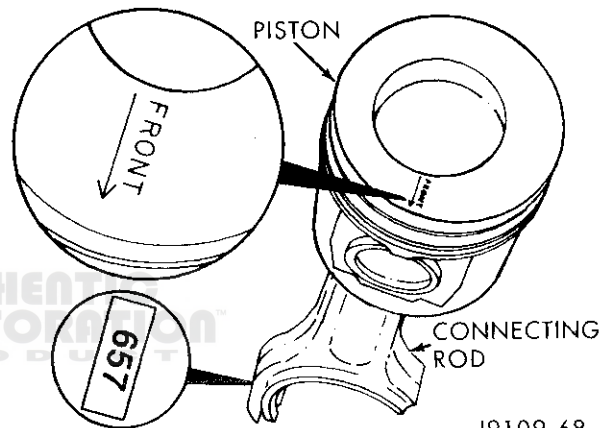
(2) Lubricate the pin and bore with engine oil.

(3) Install the piston pin in the opposite side of the installed retaining pin. Pistons do not require heating to install the pin, however, the piston does need to be at room temperature or above.

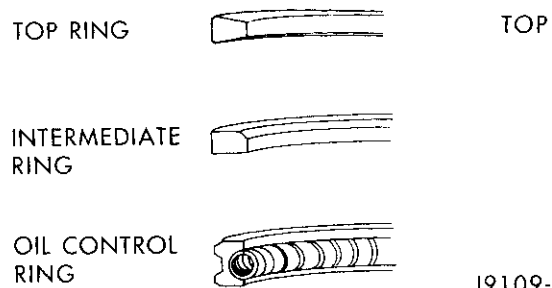
(4) Determine the piston diameter and obtain the appropriate ring set. The piston rings can be identified as shown in (Fig. 108).



J9109-62

Fig. 106 Retainer Rings

J9109-68

Fig. 107 Proper Markings on the Piston and Connecting Rod

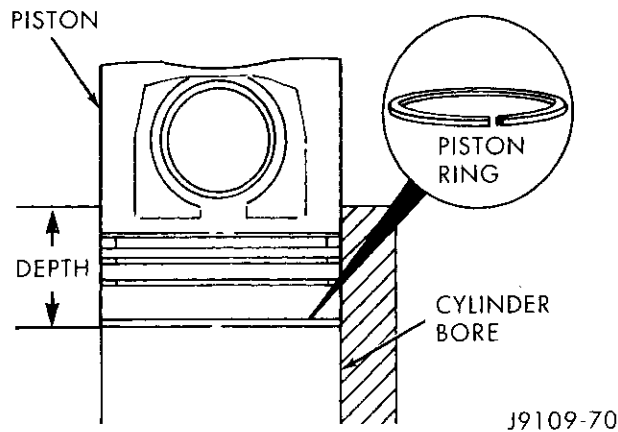
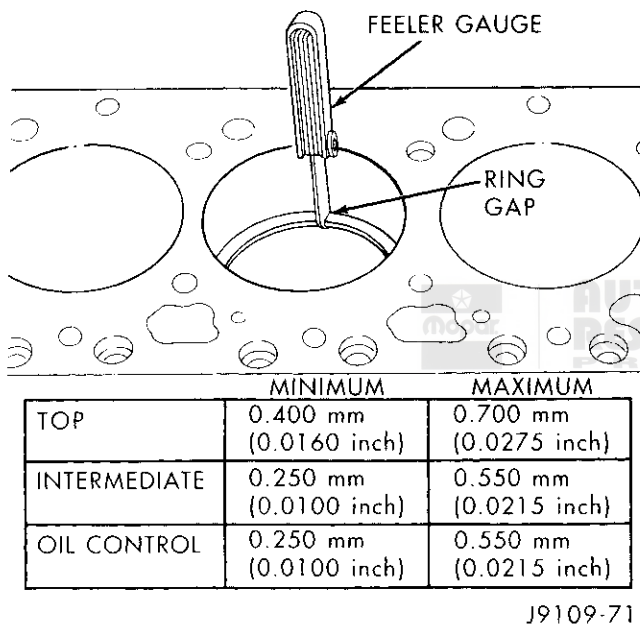
J9109-69

Fig. 108 Piston Ring Identification

(5) Position each ring in the cylinder and use a piston to square it with the bore at a depth of 89.0 mm (3.5 inch) - (Fig. 109).

(6) Use a feeler gauge to measure the piston ring gap (Fig. 110).

(7) The top surface of all of the rings are identified with the word TOP or the supplier's MARK. Assemble the rings with the word TOP or the supplier's MARK up.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 109 Position of Ring in Cylinder Bore****Fig. 110 Piston Ring Gap**

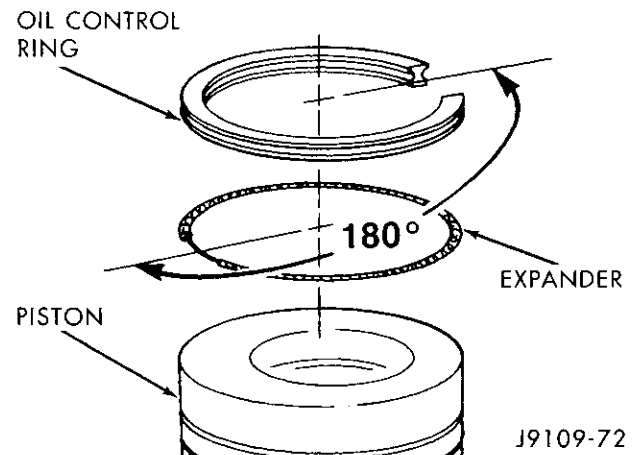
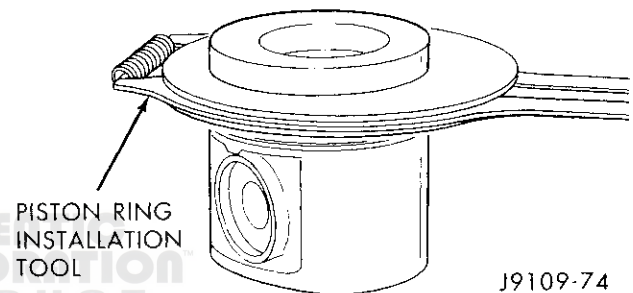
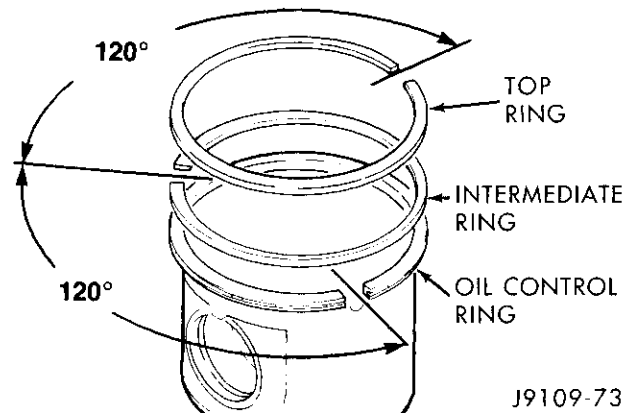
(8) Position the oil ring expander in the oil control ring groove (bottom groove).

(9) Install the oil control ring with the end gap OPPOSITE the ends on the expander (Fig. 111).

(10) Install the intermediate piston ring in the second groove (Fig. 109).

(11) Install the top piston ring in the top groove (Fig. 112).

(12) Position the rings as shown in (Fig. 113).

**Fig. 111 Oil Control Ring/Expander Location in Groove****Fig. 112 Piston Ring Installation Tool****Fig. 113 Piston Ring Positioning**

(13) Install the original bearings as removed or install new bearings. If new bearings are used, be sure to obtain the proper bearing clearance (Fig. 114).

DISASSEMBLY AND ASSEMBLY (Continued)

(14) DO NOT lubricate the side of the bearing that is against the connecting rod or cap. Apply a coat of Lubriplate 105, or equivalent to the new upper and lower connecting rod bearings.

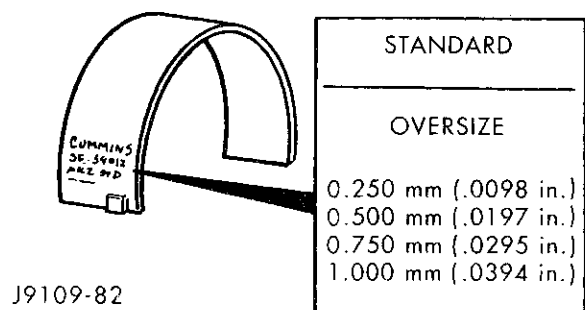


Fig. 114 Connecting Rod Bearing Size Location

CLEANING AND INSPECTION**OIL COOLER ELEMENT AND GASKET****CLEANING AND INSPECTION**

Clean the sealing surfaces.

Apply 483 kPa (70 psi) air pressure to the element to check for leaks. If the element leaks, replace the element.

CYLINDER HEAD**INSPECTION**

Remove the cup plugs and inspect the coolant passages. A large build up of rust and lime will require removal of the cylinder block for cleaning in a hot tank.

Inspect the cylinder bores for damage or excessive wear. Rotate the crankshaft so the piston is at Bottom Dead Center (BDC) to inspect the bores.

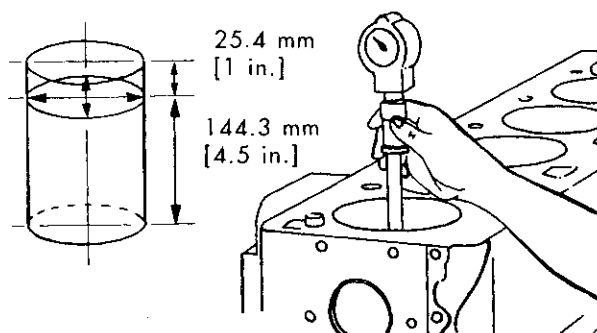
Measure the cylinder bores (Fig. 115). DO NOT proceed with in-chassis repair if the bores are damaged or worn beyond the limits (refer to Cylinder Bore Repair - Cylinder Block).

Check the top surface for damage caused by the cylinder head gasket leaking between cylinders.

Inspect the block and head surface for nicks, erosion, etc.

Check the head distortion (Fig. 116). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.8 mm (2.00 inch) diameter. Overall variation end to end or side to side 0.30 mm (0.012 inch).

DO NOT proceed with the in-chassis overhaul if the cylinder head or block surface is damaged or not flat (within specifications).



MIN.	102.0 mm	(4.0157 inch)
MAX.	102.116 mm	(4.0203 inch)
Out-of-Round	0.038 mm	(0.0015 inch)
Taper	0.76 mm	(0.003 inch)
Oversize pistons and rings are available for bored cylinder blocks.		

J9109-75

Fig. 115 Cylinder Bore Diameter

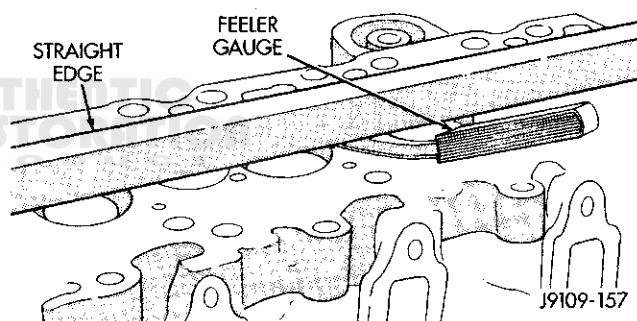
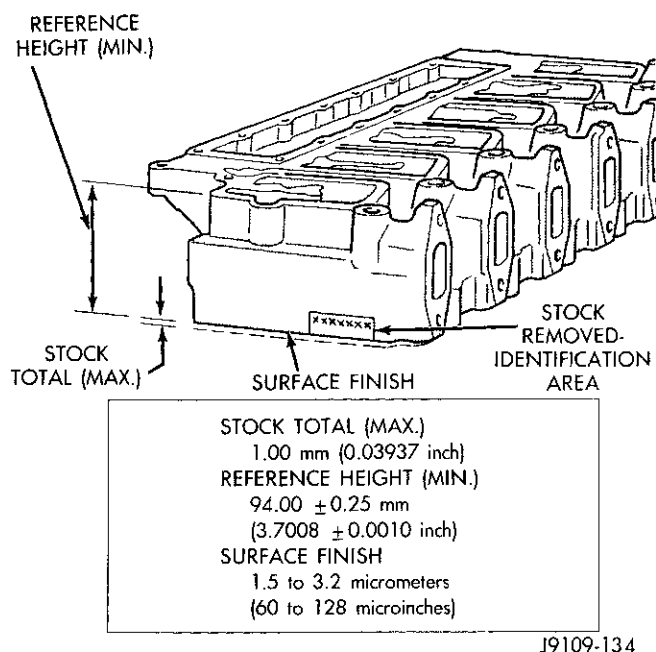


Fig. 116 Cylinder Head Combustion Deck Face Measurement

REFACING HEAD SURFACE

The cylinder head combustion deck may be refaced in whatever increments necessary to clean up the surface and maintain the surface finish and flatness tolerances. The combined total of stock removed must not exceed 1.00 mm (0.03937 inch). The amount of stock removed each time must be steel stamped above combustion deck edge, on the lower right hand corner of the rear face (Fig. 117). Check valve protrusion after head surface refacing.

Surface finish requirements are 1.5-3.2 micrometers (60-126 microinch).

CLEANING AND INSPECTION (Continued)**Fig. 117 Cylinder Head Stock Removal****CLEANING**

Clean the carbon from the injector nozzle seat with a nylon or brass brush.

Scrape the gasket residue from all gasket surfaces.

Wash the cylinder head in hot soapy water solution (88°C or 140°F).

After rinsing, use compressed air to dry the cylinder head.

Polish the gasket surface with 400 grid paper. Use an orbital sander or sanding block to maintain a flat surface.

VALVES AND VALVE SPRINGS**VALVES****CLEANING AND INSPECTION**

Before cleaning, note the valve number. Clean the valve heads with a soft wire wheel. Mark the valve with the number noted above.

Polish the valve stems with crocus cloth.

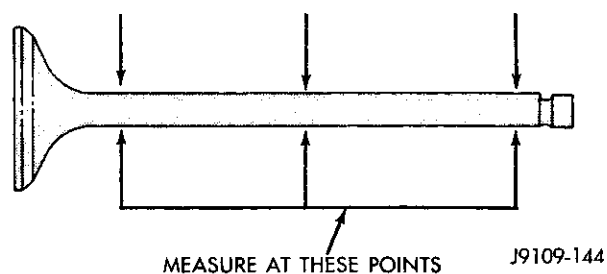
Inspect for abnormal wear on the valve heads and stems. Replace badly worn valves.

Check for bent valves. Replace bent valves.

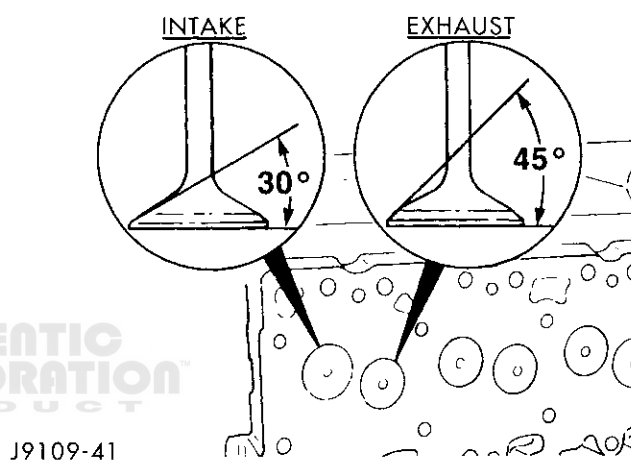
Measure the valve stem diameter (Fig. 118). The valve stem diameter should be 7.935-7.960 mm (0.3126-0.3134 inch). If out of limits, replace the valve. Mark the new valves with the replacement location.

Inspect the end of the valve stem for flatness.

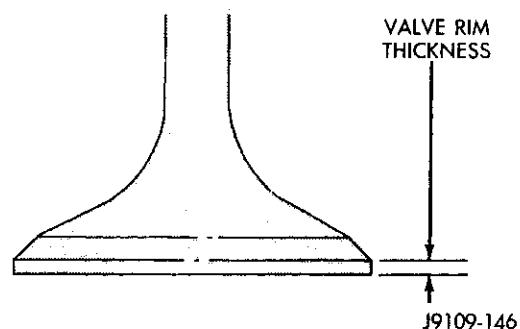
If required, resurface the valve end.

**Fig. 118 Measure Valve Stem Diameter****VALVE GRINDING**

The valve seat angle should be 30° (Intake Valve) and 45° (Exhaust Valve) - (Fig. 119).

**Fig. 119 Valve Seat Angle**

Measure the rim thickness (Fig. 120). The minimum valve rim thickness is 0.79 mm (0.031 inch).

**Fig. 120 Valve Rim Thickness**

Grind the face of valves to be reused.

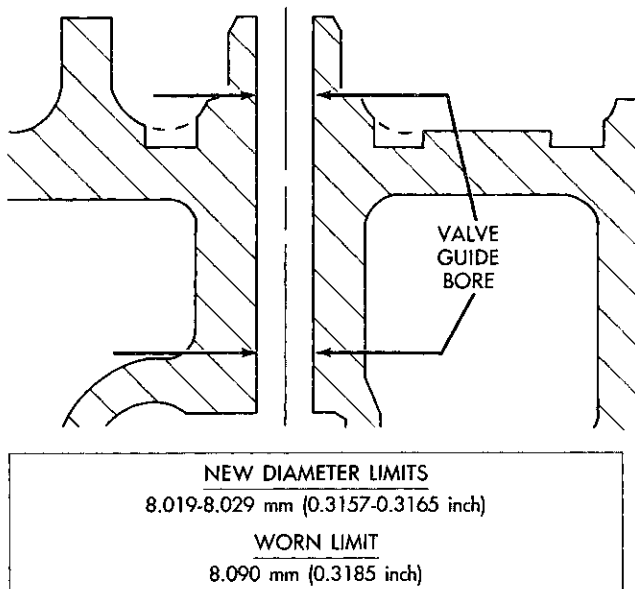
Check the valve stem tip for flatness. If required, re-surface the tip.

VALVE GUIDES**INSPECTION**

Inspect the valve guides for scuffing or scoring.

CLEANING AND INSPECTION (Continued)

Measure the valve guide bore (Fig. 121). The bore diameter should be 8.019-8.089 mm (0.3157-0.3185 inch).



J9109-135

Fig. 121 Valve Guide Bore

If the valve guide bores are larger than the worn limit, the cylinder head must be machined for service valve guides. New valve guides must be reamed to size after they are installed.

If the cylinder head needs service valve guides and valve seat inserts, the valve guides should be installed first.

VALVE SPRINGS**INSPECTION**

Measure the valve spring length. The approximate free length is 60 mm (2.36 inch) with the maximum inclination of 1.0 mm (0.039 inch).

Measure the valve spring force. 359 N (81 lbs.) is the minimum acceptable load required to compress the spring to a height of 49.25 mm (1.94 inch).

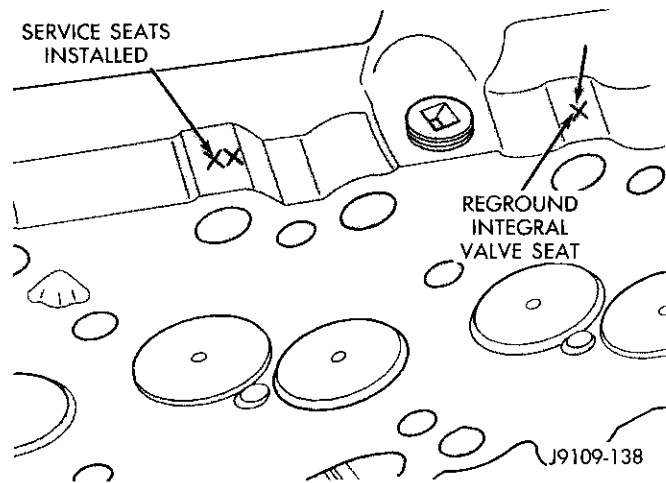
If the valve spring does not meet the limits above, replace the spring.

VALVE SEATS**INSPECTION**

Cylinder head with integral valve seats can be ground only once. Previously ground integral seats must be replaced with service seats.

One X stamped into the head casting identify seats that have been ground previously (Fig. 122).

Two X's stamped on the head indicate service seats have been installed (Fig. 122). Service seats can be ground.

**Fig. 122 Reworked Cylinder Head Seats—Stamped Identification**

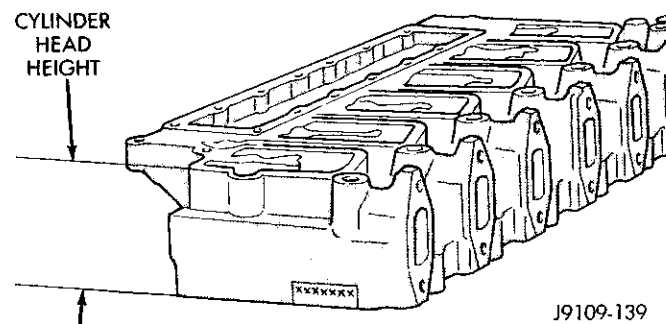
On the integral seat head, if 0.254 mm (0.010 inch) or more has been removed from the head combustion surface, service seats must be installed.

To determine if the head has been previously resurfaced, before calculating valve depth, process as follows:

(1) Check the rear lower right corner of the head for a stamping that would indicate previous resurfacing (.003).

(2) To verify the information, or if no amount is indicated, measure the head height (Fig. 123).

(3) If the head height is 94.75 mm (3.730 inch) or greater, the valve seats may be ground, if they have not been ground previously.

**Fig. 123 Cylinder Head Height****TAPPET****INSPECTION**

Inspect the tappet socket, stem and face for excessive wear, cracks and other damage (Fig. 124).

CLEANING AND INSPECTION (Continued)

The minimum tappet stem diameter is 15.925 mm (0.627 inch) - (Fig. 124). If the tappet is out of limits, replace the tappet.

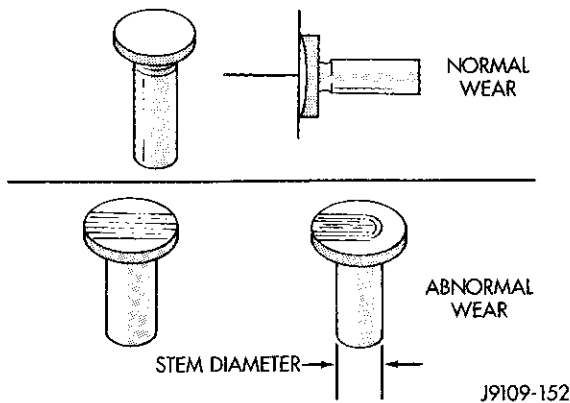


Fig. 124 Tappet Inspection

CAMSHAFT

INSPECTION

Inspect the lift pump lobe, valve lobes and bearing journals for wear, cracking, pitting and other damage.

Clean the camshaft and gear with solvent and a lint free cloth.

Inspect the gear teeth for wear and damage. Look for cracks at the root of the teeth.

Measure the bearing journals, lift pump lobe and valve lobes (Fig. 125).

OIL PUMP

CLEAN AND INSPECT

Visually inspect the lube pump gears for chips, cracks or excessive wear.

Remove the back plate (Fig. 126).

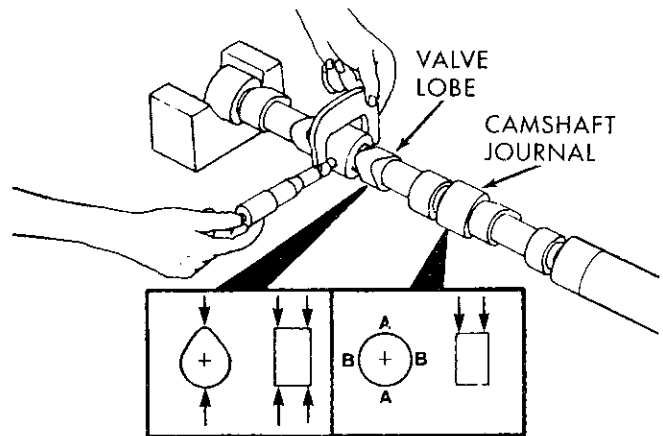
Mark TOP on the gerotor planetary using a felt tip pen (Fig. 126).

Remove the gerotor planetary (Fig. 126).

Inspect for excessive wear or damage.

Clean all parts in solvent and dry with compressed air.

Inspect the pump housing and gerotor drive for damaged and excessive wear.



CAMSHAFT JOURNAL DIAMETER (MIN.)
53.962 mm (2.1245 inch)

VALVE LOBE HEIGHT (MIN.)
INTAKE - 47.040 mm (1.852 inch)
EXHAUST - 46.770 mm (1.841 inch)

LIFT PUMP LOBE DIAMETER (MIN.)
35.500 mm (1.398 inch)

J9109-53

Fig. 125 Bearing Journal/Valve Lobe Measurements

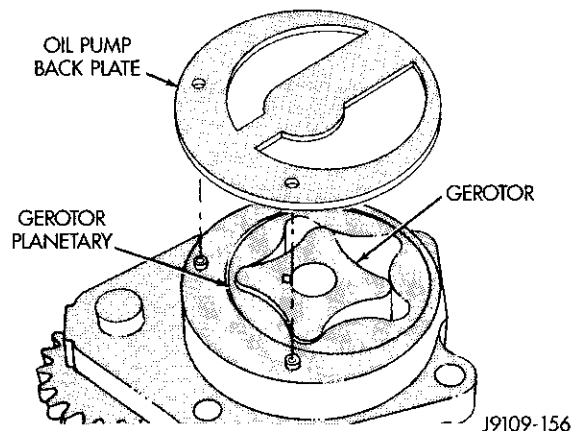
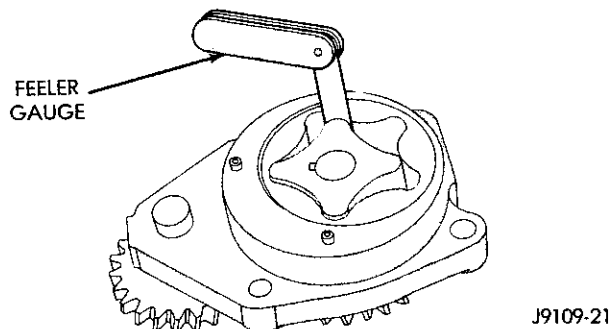


Fig. 126 Gerotor Planetary and Gerotor

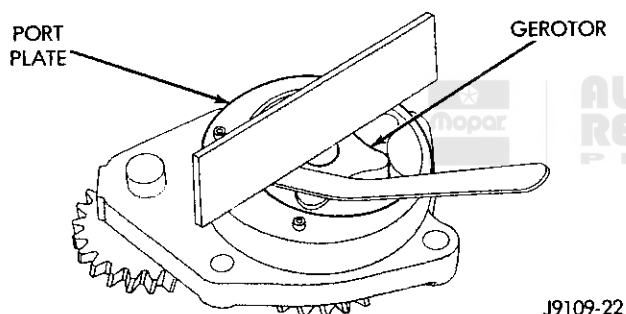
CLEANING AND INSPECTION (Continued)

Install the gerotor planetary in the original position. The chamfer must be on the O.D. and down.

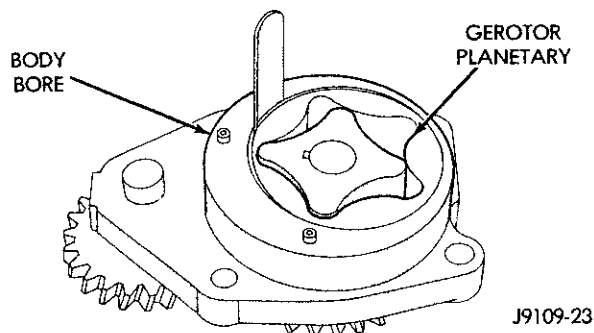
Measure the tip clearance (Fig. 127). Maximum clearance is 0.1778 mm (0.007 inch). If the oil pump is out of limits, replace the pump.

**Fig. 127 Tip Clearance**

Measure the clearance of the gerotor drive/gerotor planetary to port plate (Fig. 128). Maximum clearance is 0.127 mm (0.005 inch). If the oil pump is out of limits, replace the pump.

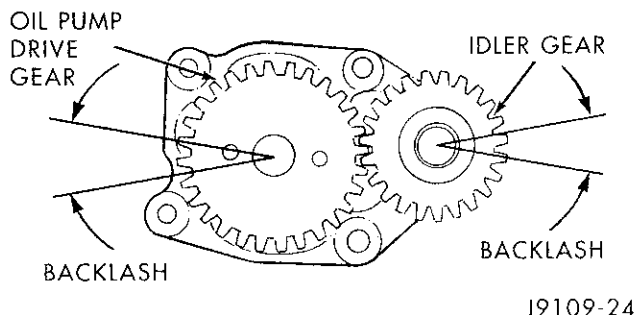
**Fig. 128 Gerotor to Port Plate Clearance**

Measure the clearance of the gerotor planetary to the body bore (Fig. 129). Maximum clearance is 0.381 mm (0.015 inch). If the oil pump is out of limits, replace the pump.

**Fig. 129 Gerotor Planetary to Body Bore Clearance**

Measure the gears backlash (Fig. 130). The limits of a used pump is 0.080- 0.380 mm (0.003-0.015

inch). If the backlash is out of limits, replace the oil pump.

**Fig. 130 Measure Gear Backlash**

Install the back plate.

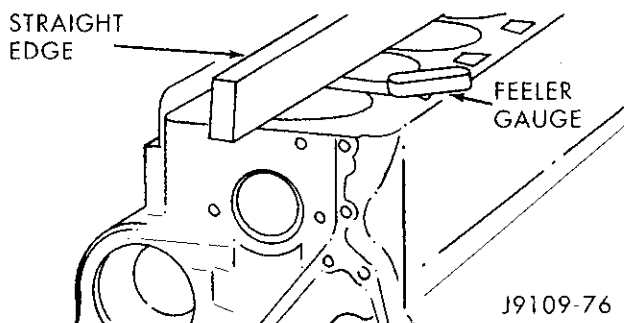
CYLINDER BLOCK

- (1) Remove the engine assembly from the vehicle.
- (2) Remove the cylinder head from the block.
- (3) Remove the camshaft.
- (4) Remove the piston/connecting rod assemblies.

INSPECTION

Measure the combustion deck face using a straight edge and a feeler gauge (Fig. 131). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.00 mm (2.0 inch) diameter. Overall variation end to end or side to side is 0.075 mm (0.003 inch).

If the surface exceeds the limit, refer to Cylinder Block Refacing.

**Fig. 131 Combustion Deck Face Measurement**

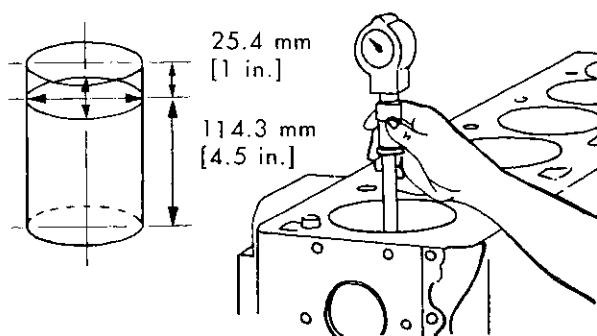
Inspect the cylinder bores for damage or excessive wear.

Measure the cylinder bores (Fig. 132). If the cylinder bores exceeds the limit, refer to Cylinder Bore Repair.

Inspect the camshaft bores for scoring or excessive wear.

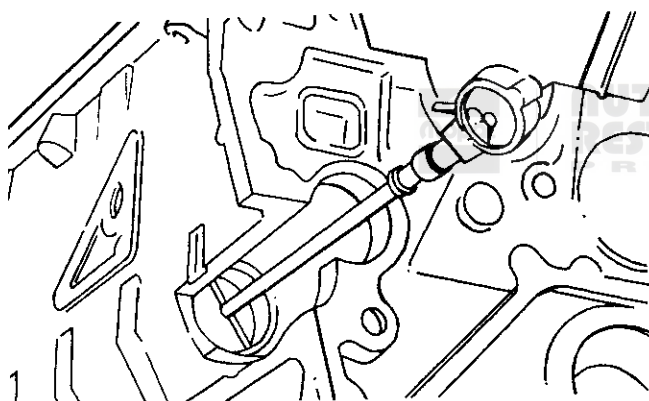
Measure the camshaft bores (Fig. 133). Limit for the No.1 bore applies to the ID of the bushing.

If a bore exceeds the limit, refer to Camshaft Bore Repair.

CLEANING AND INSPECTION (Continued)

MIN.	102.0 mm	(4.0157 inch)
MAX.	102.116 mm	(4.0203 inch)
Out-of-Round	0.038 mm	(0.0015 inch)
Taper	0.076 mm	(0.003 inch)
Oversize pistons and rings are available for bored cylinder blocks.		

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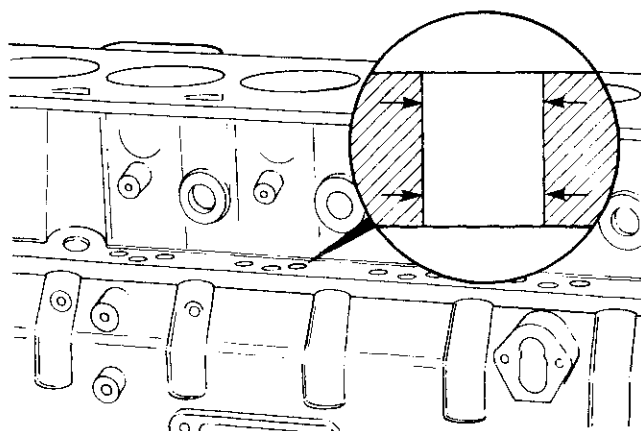
Fig. 132 Cylinder Bore Diameter

<u>CAMSHAFT BORE DIAMETER</u>		
MAX.	54.133 mm	(2.1312 inch)

J9109-78

Fig. 133 Camshaft Bores

Inspect the tappet bores for scoring or excessive wear (Fig. 134). If out of limits, replace the cylinder block.



<u>TAPPET BORE DIAMETER</u>		
MAX.	16.055 mm	(0.632 inch)

J9109-79

Fig. 134 Tappet Bore Diameter**PISTON AND CONNECTING ROD ASSEMBLY****CLEANING**

CAUTION: DO NOT use bead blast to clean the pistons. DO NOT clean the pistons and rods in an acid tank.

Soak the pistons in cold parts cleaner. Soaking the pistons overnight will usually loosen the carbon deposits.

Wash the pistons and rods in a strong solution of laundry detergent and hot water.

Clean the remaining deposits from the ring grooves with the square end of a broken ring. DO NOT use a ring groove cleaner and be sure not to scratch the ring sealing surface in the piston groove.

Wash the pistons again in a detergent solution or solvent.

Rinse the pistons. Use compressed air to dry.

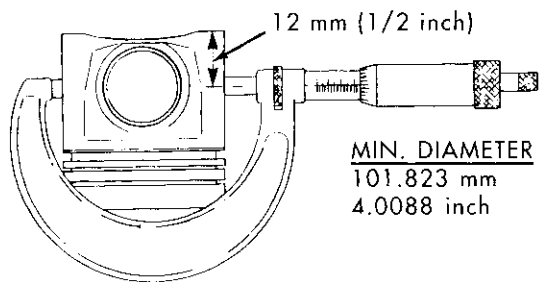
INSPECTION

Inspect the rod journals for deep scratches, indication of overheating and other damage.

Inspect the pistons for damage and excessive wear. Check top of the piston, ring grooves, skirt and pin bore.

CLEANING AND INSPECTION (Continued)

Measure the piston skirt diameter (Fig. 135). If the piston is out of limits, replace the piston.



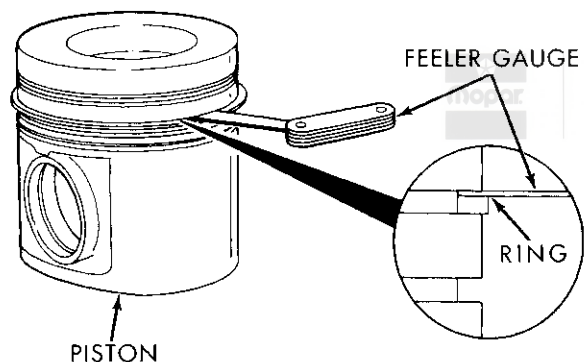
J9109-63

Fig. 135 Piston Skirt Diameter

The upper groove only needs to be inspected for damage.

Use a new piston ring to measure the clearance in the intermediate ring groove (Fig. 136). If the clearance of the intermediate ring exceeds 0.152 mm (0.006 inch), replace the piston.

Use a new oil ring to measure the clearance in the oil groove (Fig. 136). If the clearance exceeds 0.127 mm (0.005 inch), replace the piston.



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Fig. 136 Intermediate and Oil Ring Clearances

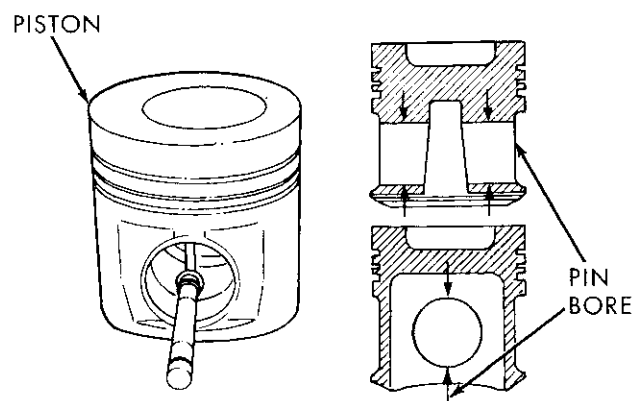
Measure the pin bore (Fig. 137). The maximum diameter is 40.025 mm (1.5758 inch). If the bore is over limits, replace the piston.

Inspect the piston pin for nicks, gouges and excessive wear.

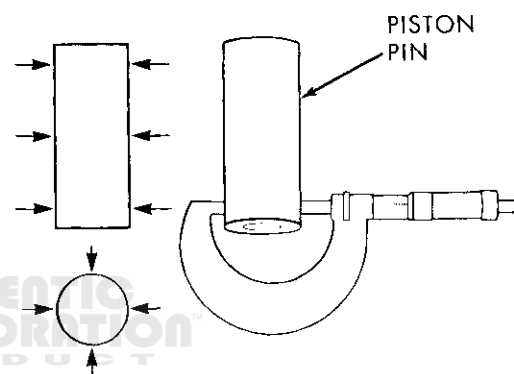
Measure the pin diameter (Fig. 138). The minimum diameter is 39.990 mm (1.5744 inch). If the diameter is out of limits, replace the pin.

Inspect the rod for damage and wear. The I-Beam section of the connecting rod cannot have dents or other damage. Damage to this part can cause stress risers which will progress to breakage.

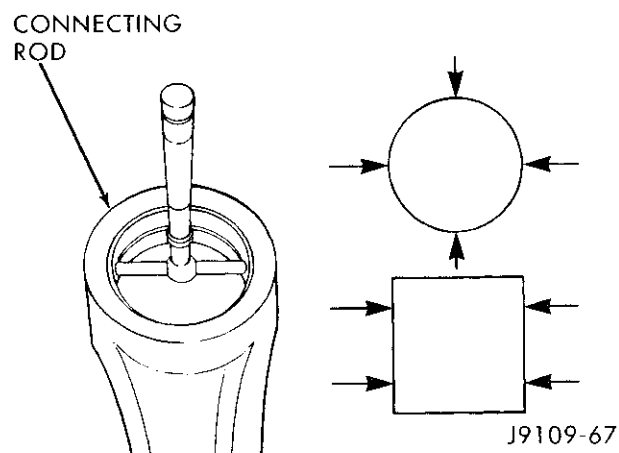
Measure the connecting rod pin bore (Fig. 139). The maximum diameter is 40.042 mm (1.5764 inch). If out of limits, replace the connecting rod.



J9109-65

Fig. 137 Piston Pin Bore

J9109-66

Fig. 138 Piston Pin Diameter

J9109-67

Fig. 139 Connecting Rod Pin Bore**CRANKSHAFT****CLEANING AND INSPECTION**

Clean the crankshaft oil galley holes with a nylon brush.

Rinse in clean solvent and dry with compressed air.

CLEANING AND INSPECTION (Continued)

Inspect the front and rear seal contact areas of the crankshaft for scratches or grooving.

The service seal kit will position the seal slightly deeper into the seal bore so it will contact the crankshaft at a different location. If this has already been done and the crankshaft has two worn areas, install a wear sleeve to provide a new contact surface for the seal.

Inspect the rod and main journal for deep scores, signs of overheating and other abnormal marks.

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Use the timing pin to locate Top Dead Center (TDC) for cylinder No.1 (Fig. 140). The timing pin is located at the back of the gear housing and below the injection pump. **Be sure to disengage the timing pin after locating top dead center. Refer to TIMING PIN for more information.**

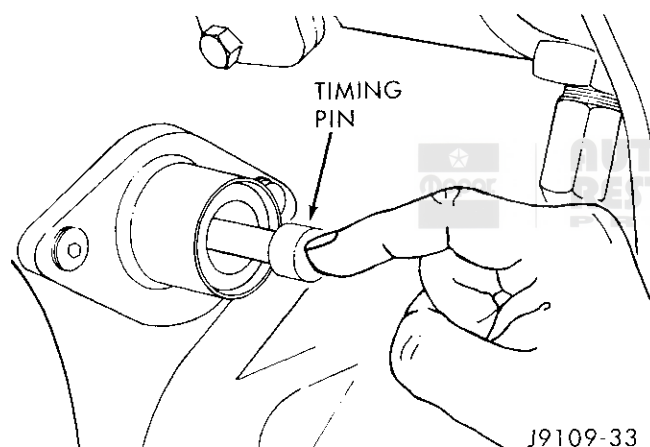


Fig. 140 Locating TDC using Timing Pin

Adjust the valves when the engine is cold, below 60°C (140°F).

STEP 1

Adjust the clearance for the valves shown in (Fig. 141). The valve lash adjustment is 0.254 mm (0.010 inch) for the intake valve. The valve lash adjustment is 0.508 mm (0.020 inch) for the exhaust valve.

Tighten the valve adjusting nuts to 24 N·m (18 ft. lbs.) torque. **Be sure timing pin is disengaged before rotating the crankshaft.** Mark the pulley and rotate the crankshaft 360°.

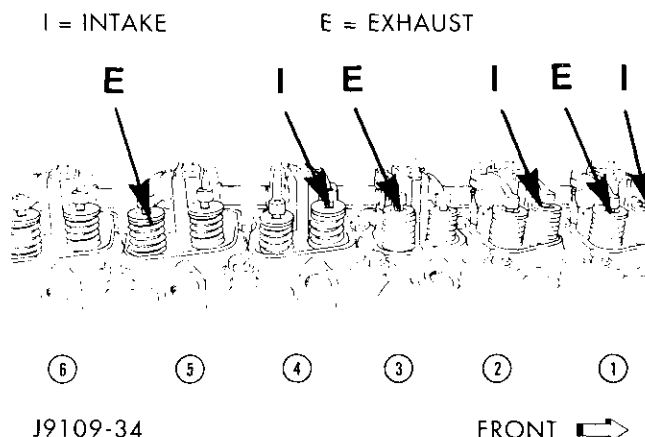


Fig. 141 Adjust Valve Clearance—Step 1

STEP 2

Adjust the clearance for the valves shown in (Fig. 142). The valve lash adjustment is 0.254 mm (0.010 inch) for the intake valve. The valve lash adjustment is 0.508 mm (0.020 inch) for the exhaust valve.

Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

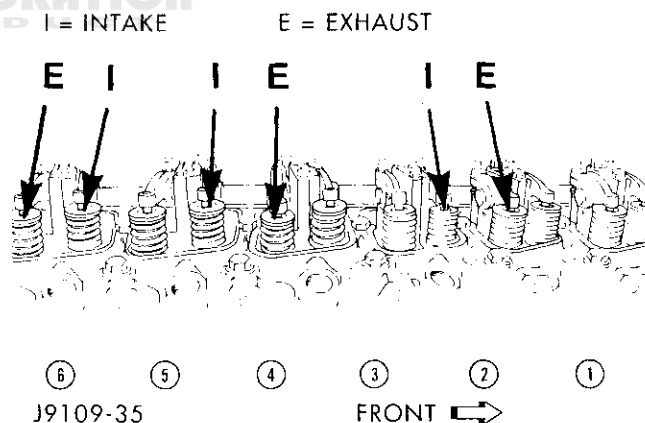


Fig. 142 Adjust Valve Clearance—Step 2

SPECIFICATIONS**5.9L (DIESEL) ENGINE****Camshaft**

Journal Diameter (Min.) 53.962 mm
(2.1245 in)

Valve Lobes (Min. Diameter @ Peak of Lobe)

Intake 47.040 mm
(1.852 in)

Exhaust 46.770 mm
(1.841 in)

Lift Pump Lobe (Min. Diameter @ Peak of Lobe) .. 35.500 mm
(1.398 in)

End Clearance 0.152–0.254 mm
(0.006–0.010 in)

Gear Backlash 0.080–0.330 mm
(0.003–0.013 in)

Connecting Rods

Pin Bore Diameter (Max.) 40.042 mm
(1.5764 in)

Side Clearance 0.100–0.300 mm
(0.004–0.012 in)

Crankshaft

Main Bearing Journal Diameter

Standard 82.962 mm
(3.2662 in)

Machined 0.25 mm 82.712 mm
(0.0098 in) (3.2564 in)

Machined 0.50 mm 82.462 mm
(0.0197 in) (3.2465 in)

Machined 0.75 mm 82.212 mm
(0.0295 in) (3.2367 in)

Machined 1.00 mm 81.962 mm
(0.0394 in) (3.2269 in)

Out-of-Round (Max.) 0.050 mm
(0.002 in)

Taper (Max.) 0.013 mm
(0.0005 in)

Oil Clearance (Max.) 0.119 mm
(0.0047 in)

Connecting Rod Journal Diameter

Standard 68.962 mm
(2.7150 in)

Machined 0.25 mm 68.712 mm
(0.0098 in) (2.7052 in)

Machined 0.50 mm 68.462 mm
(0.0197 in) (2.6954 in)

Machined 0.75 mm 68.212 mm
(0.0295 in) (2.6855 in)

Machined 1.00 mm 67.962 mm
(0.0394 in) (2.6757 in)

Out-of-Round (Max.) 0.050 mm
(0.002 in)

Taper (Max.) 0.013 mm
(0.0005 in)

Oil Clearance 0.089 mm
(0.0035 in)

End Clearance 0.100–0.430 mm
(0.004–0.017 in)

Crankshaft (Cont.)

Gear Backlash 0.080–0.330 mm
(0.003–0.013 in)

Cylinder Block

Cylinder Bore

Diameter 102.116 mm
(4.0203 in)

Out-of-Round (Max.) 0.038 mm
(0.0015 in)

Taper (Max.) 0.076 mm
(0.003 in)

Tappet Bore Diameter 16.055 mm
(0.632 in)

Top Surface Flatness (Max. Overall Variation) 0.075 mm
(0.003 in)

Max. Variation any 50 mm (2 in) Diameter Area 0.010 mm
(0.0004 in)

Refacing Combustion Deck

First Reface 0.250 mm
(0.0098 in)

Second Reface 0.250 mm
(0.0098 in)

Total Reface 0.500 mm
(0.0197 in)

Surface Finish 1.50–3.20 micrometers
(60–126 microinches)

Main Bearing Bore Diameter (Max.) 83.106 mm
with Bearing Installed (3.2719 in)

Camshaft Bore Diameter (Max.)

No. 1 without Bushing 57.258 mm
(2.2543 in)

Nos. 1–7 with Bushing 54.133 mm
(2.1312 in)

Cylinder Head

Flatness Max. Overall 0.030 mm
(0.012 in)

Max. Variation within 0.01 mm (0.0004 in) in any
50.8 mm (2.00 in) diameter area.

Valve Seat Angle

Intake 30°

Exhaust 45°

Valve Seat Width

Minimum 1.52 mm
(0.060 in)

Maximum 2.03 mm
(0.080 in)

Tappets

Stem Diameter 15.925 mm
(0.627 in)

SPECIFICATIONS (Continued)**Oil Pump**

Tip Clearance (Max.)	0.1778 mm (0.007 in)
Gerotor Drive/Planetary to Port Plate Clearance (Max)	0.127 mm (0.005 in)
Gerotor Planetary to Body Clearance (Max.)	0.381 mm (0.015 in)
Gear Backlash (Used Pump)	0.080–0.380 mm (0.003–0.015 in)

Oil Pressure (minimum)

At Idle Speed*	69 kPa (10 psi)
At 2,500 rpm	207 kPa (30 psi)
Regulating Valve Opening Pressure	448 kPa (65 psi)

*** CAUTION: If pressure is ZERO at curb idle,
DO NOT run engine at 2,500 rpm.**

Oil Filter

Differential Pressure to Open Filter Bypass	172.3 kPa (25 psi)
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Pistons

Skirt Diameter	101.880–101.823 mm (4.0110–4.0088 in)
Ring Groove Depth	
Intermediate	0.150 mm (0.006 in)
Oil Control	0.130 mm (0.005 in)

Piston Pins

Diameter (Min.)	39.990 mm (1.5744 in)
Bore Diameter (Max.)	40.025 mm (1.5758 in)

Piston Rings

Ring End Gap	
Top Ring	0.400–0.700 mm (0.016–0.0275 in)
Intermediate Ring	0.250–0.550 mm (0.010–0.0215 in)
Oil Control Ring	0.250–0.550 mm (0.010–0.0215 in)

Valves

Clearance — Intake	0.25 mm (0.010 in)
Exhaust	0.51 mm (0.020 in)
Guide Diameter	8.019–8.089 mm (0.3157–0.3185 in)
Stem Diameter	7.935–7.960 mm (0.3126–0.3134 in)
Depth (Installed)	0.99–1.52 mm (0.039–0.060 in)

Valve Springs

Free Standing Length	60 mm (2.36 in)
Inclination (Max.)	1.00 mm (0.039 in)
Minimum Load	@49.25 mm–359 N (@1.94 in–81 lbs)

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ENGINE SPECIFICATIONS—CONT.

SPECIFICATIONS (Continued)**TORQUE SPECIFICATIONS**

DESCRIPTION	TORQUE
Air Fuel Control Fitting (In Head)	8 N•m (6 ft. lbs.)
Battery Cable (Negative) Mounting to Block	77 N•m (57 ft. lbs.)
Belt Tensioner Mounting	43 N•m (32 ft. lbs.)
Block Heater Mounting	12 N•m (9 ft. lbs.)
Cab Heater Hose Clamp	4 N•m (35 in. lbs.)
Cab Heater Tubing Clamp Mounting	9 N•m (7 ft. lbs.)
Camshaft Thrust Plate Bolts	24 N•m (18 ft. lbs.)
Clutch Cover Mounting to Flywheel Bolts	23 N•m (17 ft. lbs.)
Connecting Rod Bolts Step 1 (Alternately Tighten)	35 N•m (26 ft. lbs.)
Step 2 (Alternately Tighten)	70 N•m (51 ft. lbs.)
Step 3 (Alternately Tighten)	100 N•m (73 ft. lbs.)
Cooling Fan Mounting to Fan Clutch	20 N•m (15 ft. lbs.)
Crankshaft Main Bearing Bolts Step 1	60 N•m (45 ft. lbs.)
Step 2	119 N•m (88 ft. lbs.)
Step 3	176 N•m (129 ft. lbs.)
Cylinder Head Bolts All Bolts	90 N•m (66 ft. lbs.)
All Long Bolts	120 N•m (89 ft. lbs.)
Tighten All Bolts an Additional	90°
Exhaust Manifold Bolts	43 N•m (32 ft. lbs.)
Fan Clutch Mounting/Fan Hub (Left Hand Threads)	57 N•m (42 ft. lbs.)
Fan Hub Bracket Mounting	24 N•m (18 ft. lbs.)
Fan Hub Bearing Retaining Capscrew	77 N•m (57 ft. lbs.)
Fan Pulley to Fan Hub	9 N•m (7 ft. lbs.)
Fan Shroud Mounting Nuts	11 N•m (95 in. lbs.)
Flywheel Bolts	137 N•m (101 ft. lbs.)
Flywheel Housing Adaptor	77 N•m (57 ft. lbs.)
Front Mount — Thru-Bolt Nut	68 N•m (50 ft. lbs.)
Front Mount — Engine Support Bracket/Cushion Bolts	176 N•m (140 ft. lbs.)
Generator Mounting Bolts	41 N•m (30 ft. lbs.)
Generator Pulley	80 N•m (59 ft. lbs.)
Generator Support (Upper)	24 N•m (18 ft. lbs.)
Gear Cover	24 N•m (18 ft. lbs.)
Gear Housing Bolts	24 N•m (18 ft. lbs.)
Intake Manifold Cover Bolts	24 N•m (18 ft. lbs.)

DESCRIPTION	TORQUE
Intercooler Attaching Bolts	2 N•m (17 in. lbs.)
Intercooler Duct Clamp Nuts	8 N•m (72 in. lbs.)
Lifting Bracket (Rear)	77 N•m (57 ft. lbs.)
Oil Cooler Assembly	24 N•m (18 ft. lbs.)
Oil Fill Tube Bracket Bolt	43 N•m (32 ft. lbs.)
Oil Filter	3/4 Turn After Contact
Oil Pan Drain Plug	80 N•m (60 ft. lbs.)
Oil Pan Bolts	24 N•m (18 ft. lbs.)
Oil Pressure Regulator Plug	80 N•m (60 ft. lbs.)
Oil Pressure Sender/Switch	16 N•m (12 ft. lbs.)
Oil Pump Mounting Bolts	24 N•m (18 ft. lbs.)
Oil Suction Tube (Flange)	24 N•m (18 ft. lbs.)
Oil Suction Tube Brace Bolt	24 N•m (18 ft. lbs.)
Oil Supply Fitting for Vacuum Pump	10 N•m (7 1/2 ft. lbs.)
Rear Mount — Support Cushion-to-Crossmember Nut	47 N•m (35 ft. lbs.)
Rear Mount — Support Cushion-to-Trans. Support Bracket Nuts	47 N•m (35 ft. lbs.)
Rear Mount — Transmission Support Bracket Bolts	102 N•m (75 ft. lbs.)
Rear Support Plate-to-Transfer Case Bolts	41 N•m (30 ft. lbs.)
Rocker Arm Bolts	24 N•m (18 ft. lbs.)
Starter Mounting Bolts	68 N•m (50 ft. lbs.)
Torque Converter Drive Plate Bolts	31 N•m (270 in. lbs.)
Transfer Case-to-Insulator Mounting Plate Nuts	204 N•m (150 ft. lbs.)
Transmission Support Bracket Bolts (2WD)	68 N•m (50 ft. lbs.)
Transmission Support Spacer Bolts (4WD)	68 N•m (50 ft. lbs.)
Transmission Support Spacer-to-Insulator Mounting Plate Nuts (4WD)	204 N•m (150 ft. lbs.)
Vacuum Pump Oil Supply Line	10 N•m (7 1/2 ft. lbs.)
Vibration Damper Retainer Bolts	125 N•m (92 ft. lbs.)
Water Pump	24 N•m (18 ft. lbs.)

EXHAUST SYSTEM AND INTAKE MANIFOLD

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GENERAL INFORMATION

EXHAUST SYSTEM

The gasoline engine exhaust system consists of engine exhaust manifolds, exhaust pipes, catalytic converter(s), extension pipe (if needed), exhaust heat shields, muffler and exhaust tailpipe (Fig. 1).

The diesel engine exhaust system consists of an engine exhaust manifold, turbocharger, exhaust pipe, catalytic converter, extension pipe (if needed), muffler and exhaust tailpipe (Fig. 2).

The engine exhaust manifolds on gasoline engines are equipped with ball flange outlets to assure a tight seal and strain free connections.

The exhaust system must be properly aligned to prevent stress, leakage and body contact. If the system contacts any body panel, it may amplify objectionable noises from the engine or body.

When inspecting an exhaust system, critically inspect for cracked or loose joints, stripped screw or

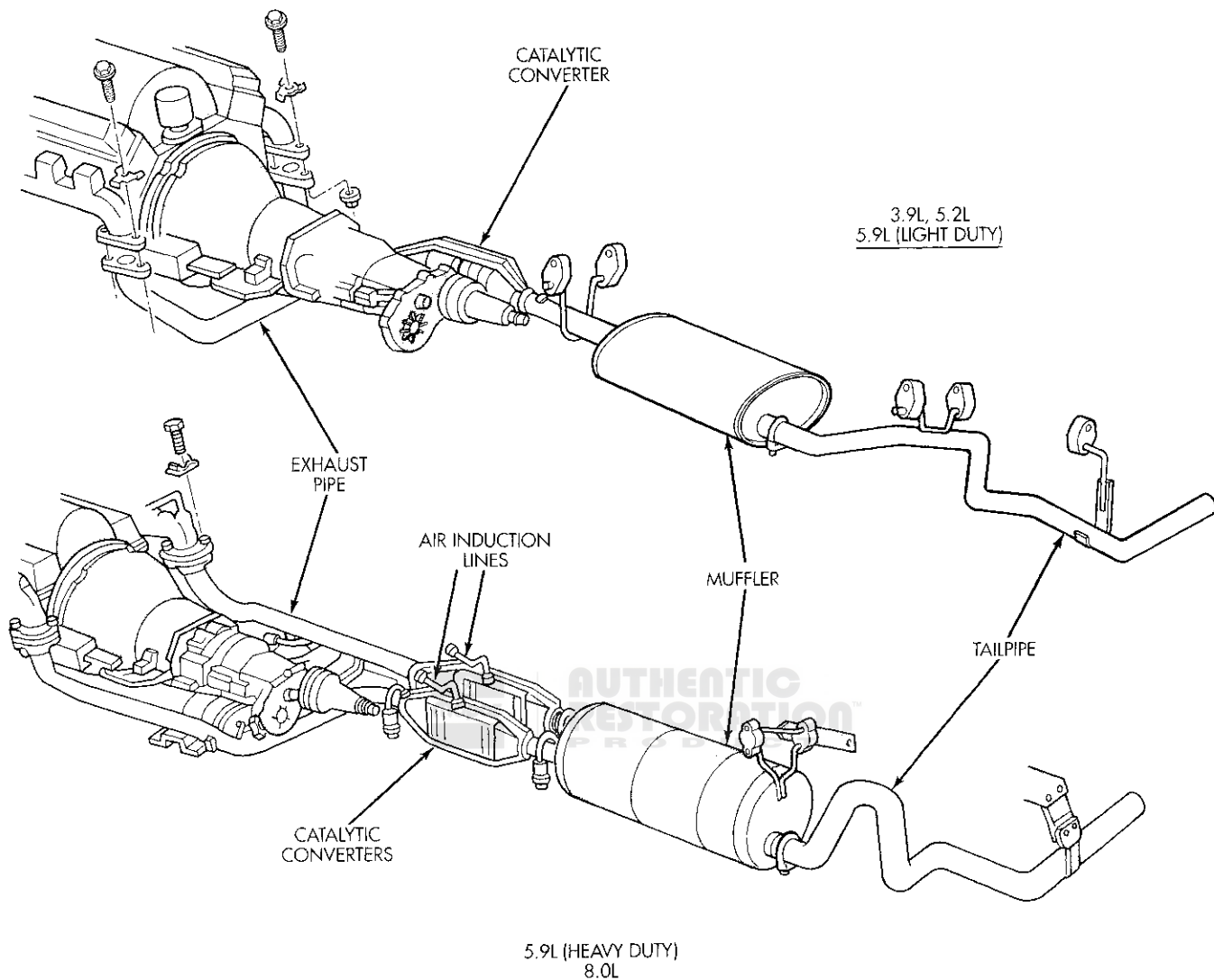
bolt threads, corrosion damage and worn, cracked or broken hangers. Replace all components that are badly corroded or damaged. DO NOT attempt to repair.

When replacement is required, use original equipment parts (or their equivalent). This will assure proper alignment and provide acceptable exhaust noise levels.

CAUTION: Avoid application of rust prevention compounds or undercoating materials to exhaust system floor pan exhaust heat shields. Light overspray near the edges is permitted. Application of coating will result in excessive floor pan temperatures and objectionable fumes.

CATALYTIC CONVERTER

There is no regularly scheduled maintenance on any Mopar® stainless steel catalytic converter body.

GENERAL INFORMATION (Continued)

J9511-4

Fig. 1 Exhaust System—Gasoline Engines (Typical)

Excessive heat can result in bulging or other distortion, but excessive heat will not be the fault of the converter. If unburned fuel enters the converter, overheating may occur. If a converter is heat-damaged, correct the cause of the damage at the same time the converter is replaced. Also, inspect all other components of the exhaust system for heat damage.

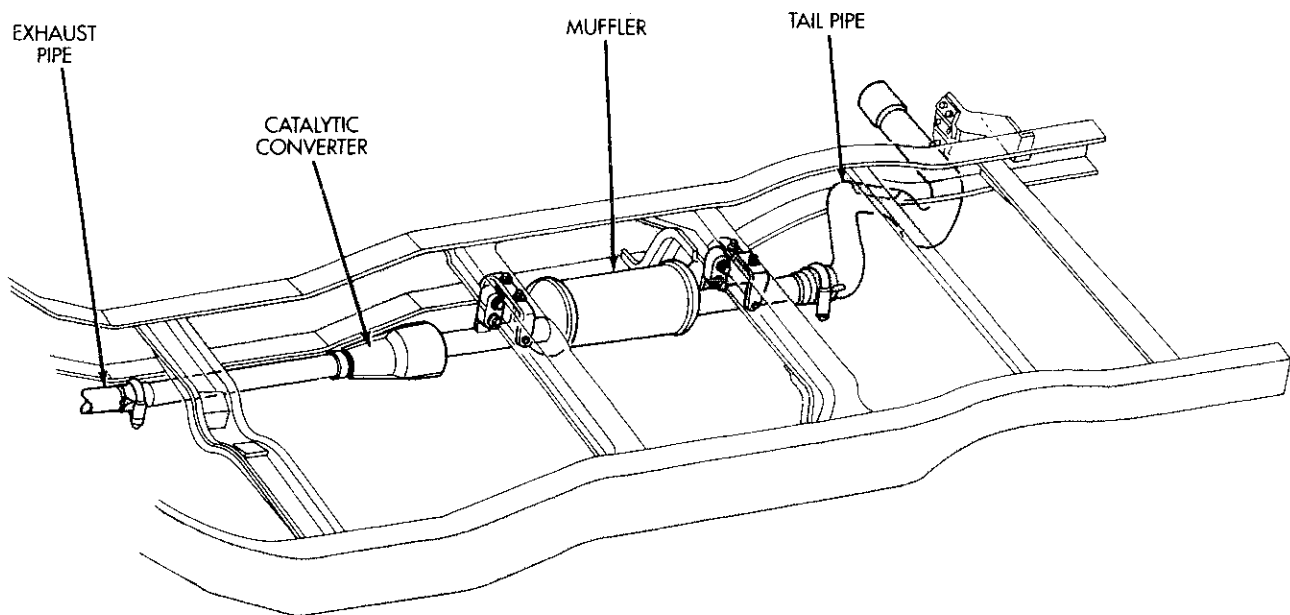
Unleaded gasoline must be used in gas engines to avoid contaminating the catalyst core.

EXHAUST HEAT SHIELDS

Exhaust heat shields are needed to protect both the vehicle and the environment from the high temperatures developed by the catalytic converter. The combustion reaction facilitated by the catalyst

releases additional heat in the exhaust system. Under severe operating conditions, the temperature increases in the area of the reactor. Such conditions can exist when the engine misfires or otherwise does not operate at peak efficiency. DO NOT remove spark plug wires from plugs or by any other means short out cylinders. Failure of the catalytic converter can occur due to a temperature increase caused by unburned fuel passing through the converter.

DO NOT allow the engine to operate at fast idle for extended periods (over 5 minutes). This condition may result in excessive temperatures in the exhaust system and on the floor pan.



J9411-28

Fig. 2 Exhaust System—Diesel Engines (Typical)

DESCRIPTION AND OPERATION

TURBOCHARGER—5.9L DIESEL ENGINE

A turbocharger is used to force more air into the engine cylinders. Exhaust gas energy is used to turn the turbine wheel and shaft. At the other end of the shaft is the compressor wheel. The compressor wheel draws air in and forces it into the engine cylinders through the intake manifold.

NOTE: Supplying increased air flow to the engine provides:

- Improved engine performance
- Lower exhaust smoke density
- Improved operating economy
- Altitude compensation
- Noise reduction.

INTERCOOLER—CHARGE AIR COOLER

Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressurized air from the turbocharger then flows forward through the charge air cooler (intercooler) located in front of the radiator. From the charge air cooler (Intercooler) the air flows back into the intake manifold.

The charge air cooler (Intercooler) is a heat exchanger that uses air flow to dissipate heat from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases engine efficiency and power.

INTAKE MANIFOLD—V-6 and V-8 ENGINES

The aluminum intake manifold is a single plane design with equal length runners. The manifold is sealed by flange side gaskets with front and rear cross-over gaskets.

INTAKE MANIFOLD—V-10 ENGINE

The aluminum intake manifold has two plenum chambers an upper and lower which supply air to five runners each. Passages across the longitudinal center of the manifold feed air from the throttle body to the plenum chambers.

ENGINE EXHAUST MANIFOLD—V-6 and V-8 ENGINES

Engine exhaust manifolds are LOG type with porting for air injection into the LOG.

EXHAUST MANIFOLD—V-10 ENGINE

Engine exhaust manifolds are made of high molybdenum ductile cast iron. A special ribbed design helps control permanent dimensional changes during heat cycles.

DIAGNOSIS AND TESTING

EXHAUST SYSTEM DIAGNOSIS

CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE EXHAUST NOISE	<ol style="list-style-type: none"> 1. Leaks at pipe joints. 2. Burned or blown-out muffler. 3. Burned or rusted-out exhaust pipe. 4. Exhaust pipe leaking at manifold flange. 5. Exhaust manifold cracked or broken. 6. Leak between exhaust manifold and cylinder head. 7. Restriction in muffler or tail pipe. 	<ol style="list-style-type: none"> 1. Tighten clamps at leaking joints. 2. Replace muffler assembly. Check exhaust system. 3. Replace exhaust pipe. 4. Tighten connection attaching nuts. 5. Replace exhaust manifold. 6. Tighten exhaust manifold to cylinder head stud nuts or bolts. 7. Remove restriction, if possible. Replace muffler or tail pipe, as necessary.
LEAKING EXHAUST GASES	<ol style="list-style-type: none"> 1. Leaks at pipe joints. 2. Damaged or improperly installed gaskets. 	<ol style="list-style-type: none"> 1. Tighten clamps at leaking joints. 2. Replace gaskets, as necessary.
ENGINE HARD TO WARM UP OR WILL NOT RETURN TO NORMAL IDLE	<ol style="list-style-type: none"> 1. Blocked crossover passage in intake manifold. 	<ol style="list-style-type: none"> 1. Remove restriction or replace intake manifold.

J9211-3

INTAKE MANIFOLD DIAGNOSIS

An intake manifold leak is characterized by lower than normal manifold vacuum. Also, one or more cylinder may not be functioning.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

- (1) Start the engine allowing it to warm up.
- (2) Inspect for disconnected vacuum hoses or hardened or cracked vacuum lines.
- (3) With a spray bottle, spray a small stream of water on the suspect area.
- (4) If there is a change in RPM'S, the suspected leak has been found.
- (5) Repair as required.

REMOVAL AND INSTALLATION

EXHAUST PIPE

REMOVAL

- (1) Raise and support the vehicle.
- (2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Remove exhaust manifold bolts, retainers and nuts (Fig. 3) (Fig. 4).
- (4) Remove the clamp nuts (Fig. 3) (Fig. 5).

- (5) Disconnect the exhaust pipe from the support hangers on the 5.9L (Heavy Duty) and the 8.0L engines (Fig. 4).

- (6) Remove the exhaust pipe.

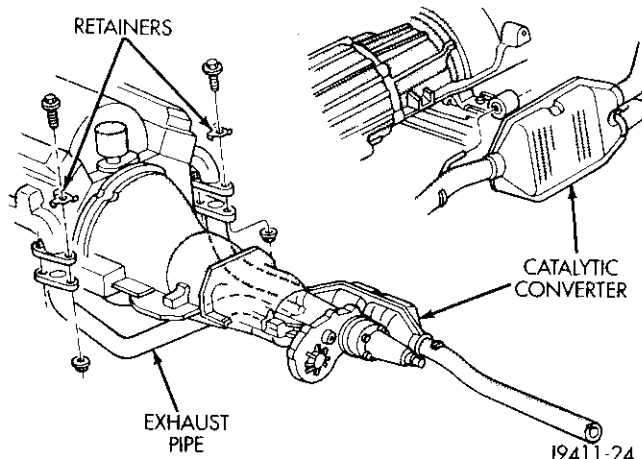
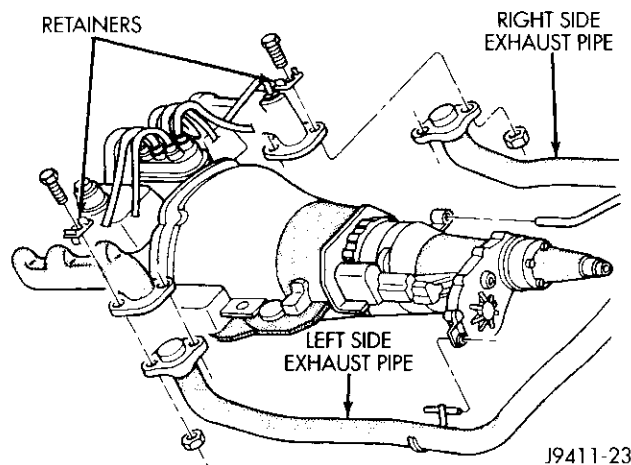
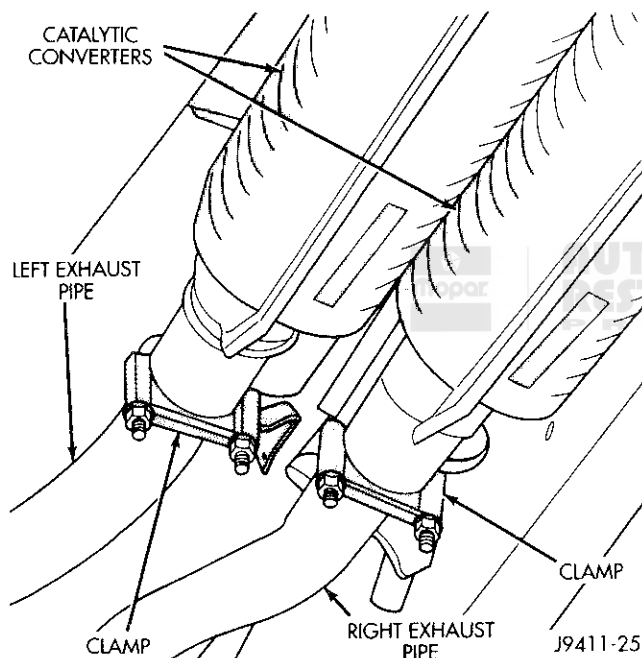


Fig. 3 Exhaust Pipe for 3.9L, 5.2L and 5.9L—Light Duty

INSTALLATION

- (1) Connect the exhaust pipe support hangers on the 5.9L (Heavy Duty) and the 8.0L engine (Fig. 4).
- (2) Position the exhaust pipe for proper clearance with underbody parts.

REMOVAL AND INSTALLATION (Continued)**Fig. 4 Exhaust Pipe for 5.9L—Heavy Duty and 8.0L****Fig. 5 Exhaust Pipe Clamp Location for 5.9L—Heavy Duty and 8.0L**

(3) Position the exhaust pipe to manifold. Install the bolts, retainers and nuts. Tighten the nuts to 34 N·m (25 ft. lbs.) torque.

(4) Tighten the clamp nuts to 43 N·m (32 ft. lbs.) torque.

(5) Lower the vehicle.

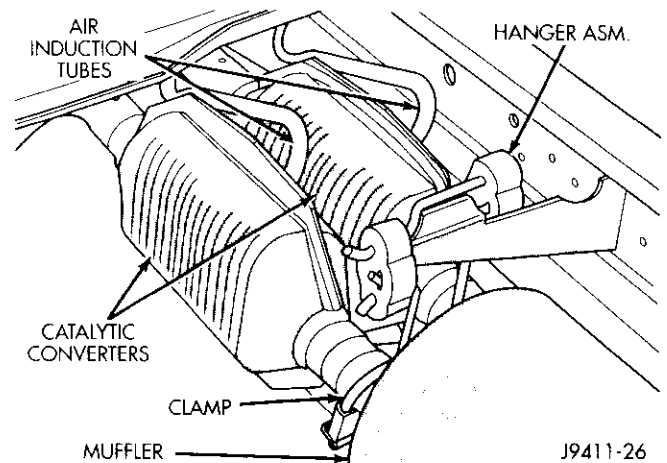
(6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

CATALYTIC CONVERTERS**REMOVAL**

(1) Raise and support vehicle.

(2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.

(3) Remove clamps and nuts (Fig. 3) (Fig. 5) (Fig. 6).

**Fig. 6 Catalytic Converter Clamp Location for 5.9L—Heavy Duty and 8.0L**

(4) Disconnect the catalytic converter from the support hanger on the 3.9L, 5.2L and 5.9L—Light Duty engines (Fig. 3).

(5) Remove the catalytic converter.

INSTALLATION

(1) Connect the support hanger on the 3.9L, 5.2L and 5.9L—Light Duty engines (Fig. 3).

(2) Assemble converter and clamps loosely to permit proper clearance with exhaust heat shields and underbody parts.

(3) Tighten all clamp nuts to 43 N·m (32 ft. lbs.) torque.

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

MUFFLERS**REMOVAL**

(1) Raise and support the vehicle.

(2) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.

(3) Disconnect the muffler hanger (Fig. 6) (Fig. 7).

(4) Remove clamps and nuts (Fig. 6) (Fig. 7).

(5) Remove the muffler.

INSTALLATION

(1) Assemble muffler and clamps loosely to permit proper alignment of all parts.

(2) Connect the muffler hanger.

(3) Tighten the clamp nuts to 43 N·m (32 ft. lbs.) torque.

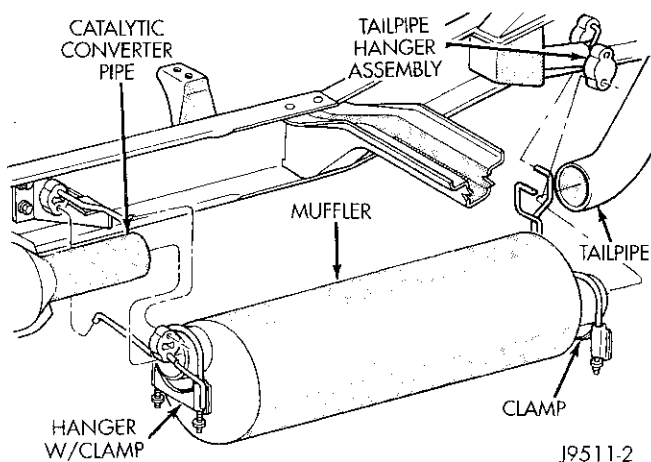
REMOVAL AND INSTALLATION (Continued)

Fig. 7 Muffler for 3.9L, 5.2L and 5.9L-Light Duty Engines

(4) Lower the vehicle.

(5) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

EXHAUST TAILPIPE**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Disconnect the exhaust tailpipe support hanger (Fig. 8). If used, disconnect the extension pipe support hanger (Fig. 9).
- (4) Remove clamps and nuts (Fig. 8).
- (5) Remove the exhaust tailpipe and extension pipe, if used.

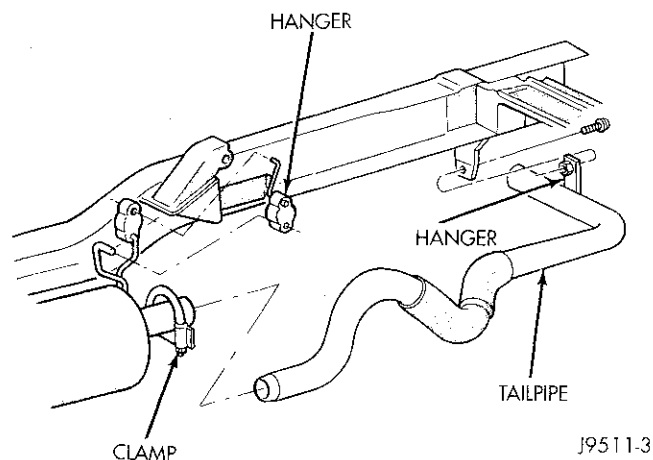


Fig. 8 Exhaust Tailpipe

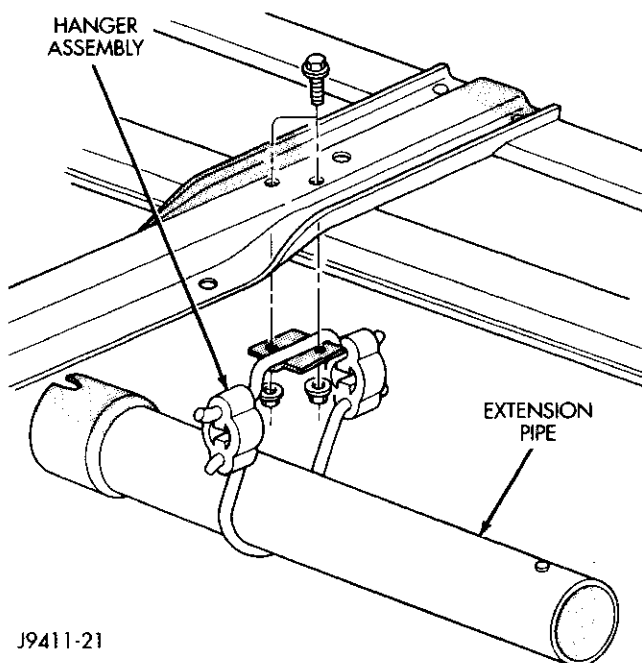


Fig. 9 Extension Pipe

INSTALLATION

- (1) Loosely assemble exhaust tailpipe and extension pipe, if used, to permit proper alignment of all parts.
- (2) Connect the support hangers (Fig. 8) (Fig. 9).
- (3) Position the exhaust tailpipe and extension pipe, if used, for proper clearance with the underbody parts.
- (4) Tighten all clamp nuts to 43 N·m (32 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

EXHAUST HEAT SHIELDS**REMOVAL**

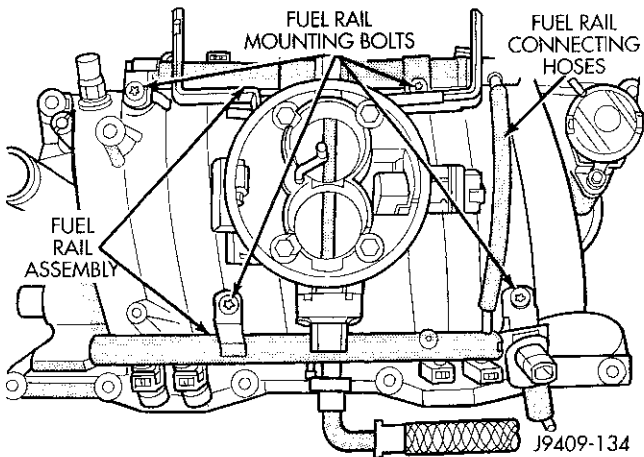
- (1) Raise and support the vehicle.
- (2) Remove the nuts or bolts holding the exhaust heat shield to the floor pan, crossmember or bracket.
- (3) Slide the shield out around the exhaust system.

INSTALLATION

- (1) Position the exhaust heat shield to the floor pan, crossmember or bracket and install the nuts or bolts.
- (2) Tighten the nuts and bolts.
- (3) Lower the vehicle.

REMOVAL AND INSTALLATION (Continued)**INTAKE MANIFOLD—V-6 and V-8 ENGINES****REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Drain the cooling system (refer to Group 7, Cooling System for the proper procedures).
- (3) Remove the generator.
- (4) Remove the air cleaner.
- (5) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.
- (6) Disconnect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
- (7) Remove the return spring.
- (8) Remove the distributor cap and wires.
- (9) Disconnect the coil wires.
- (10) Disconnect the heat indicator sending unit wire.
- (11) Disconnect the heater hoses and bypass hose.
- (12) Remove the closed crankcase ventilation and evaporation control systems.
- (13) Remove intake manifold bolts.
- (14) Lift the intake manifold and throttle body out of the engine compartment as an assembly.
- (15) Remove and discard the flange side gaskets and the front and rear cross-over gaskets.
- (16) Remove the throttle body bolts and lift the throttle body off the intake manifold (Fig. 10). Discard the gasket.

**Fig. 10 Throttle Body Assembly**

- (17) Remove the plenum pan as follows:
 - (a) Turn the intake manifold upside down. Support the manifold.
 - (b) Remove the bolts and lift the pan off the manifold. Discard the gasket.

INSTALLATION

- (1) Install the plenum pan, if removed, as follows:

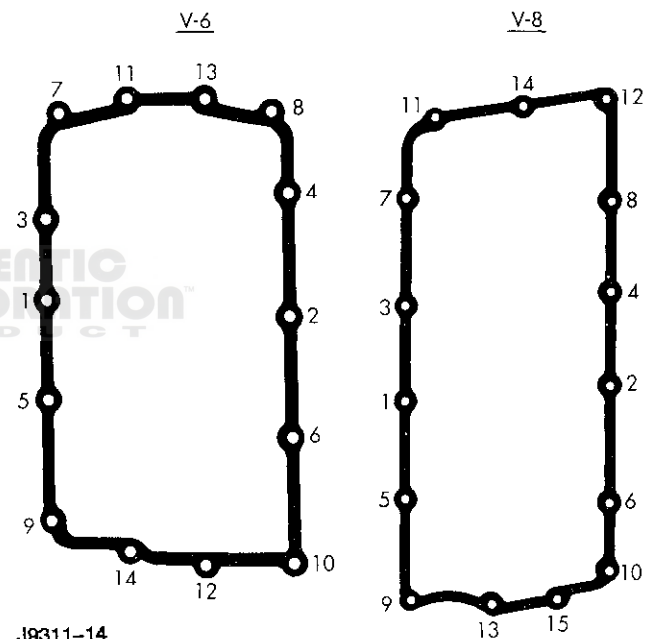
(a) Turn the intake manifold upside down. Support the manifold.

(b) Place a new plenum pan gasket onto the seal rail of the intake manifold. Position the pan over the gasket. Align all the gasket and pan holes with the intake manifold.

(c) Hand start all bolts.

(d) Tighten the bolts, in sequence (Fig. 11), as follows:

- Step 1—Tighten bolts to 2.7 N·m (24 in. lbs.) torque.
- Step 2—Tighten bolts to 5.4 N·m (48 in. lbs.) torque.
- Step 3—Tighten bolts to 9.5 N·m (84 in. lbs.) torque.
- Step 4—Check that all bolts are tighten to 9.5 N·m (84 in. lbs.) torque.

**Fig. 11 Plenum Pan Bolt Tightening Sequence**

(2) Using a new gasket, install the throttle body onto the intake manifold. Tighten the bolts to 23 N·m (200 in. lbs.) torque.

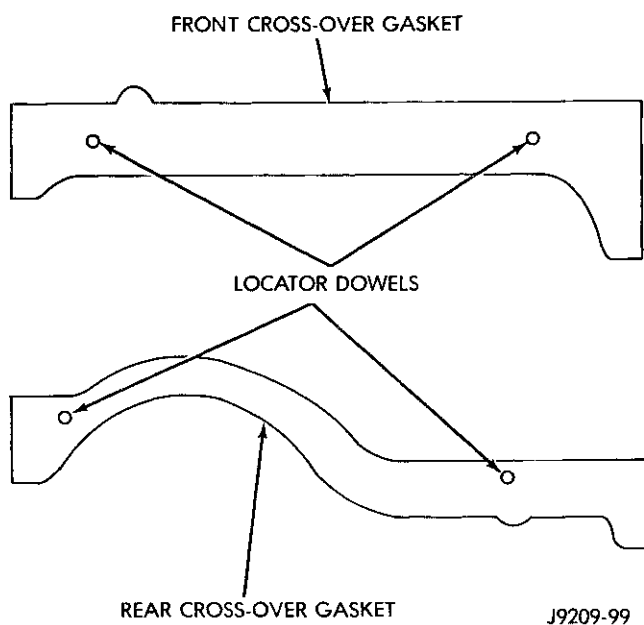
(3) Place the 4 plastic locator dowels into the holes in the block (Fig. 12).

(4) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, to the four corner joints. An excessive amount of sealant is not required to ensure a leak proof seal. However, an excessive amount of sealant may reduce the effectiveness of the flange gasket. The sealant should be slightly higher than the cross-over gaskets, approximately 5 mm (0.2 in).

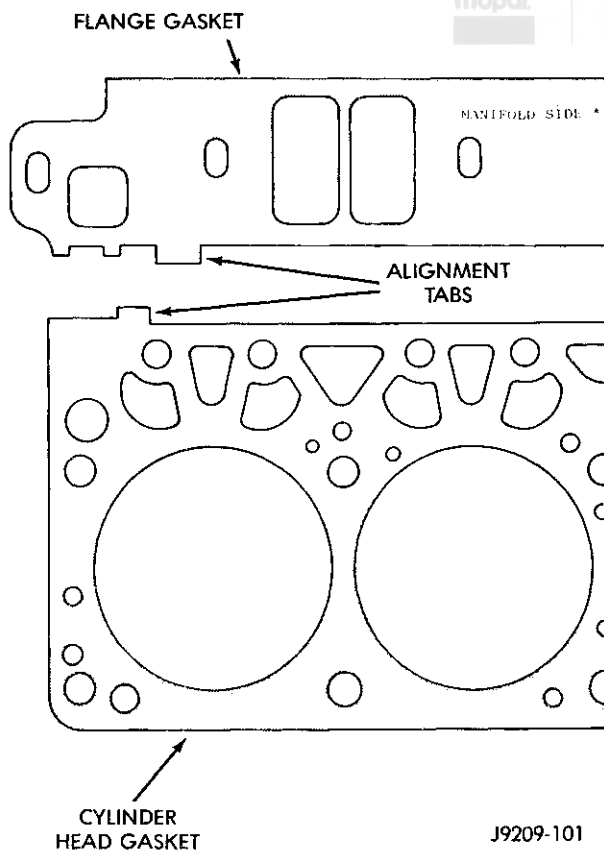
(5) Install the front and rear cross-over gaskets onto the dowels (Fig. 12).

(6) Install the flange gaskets. Ensure that the vertical port alignment tab is resting on the deck face of

REMOVAL AND INSTALLATION (Continued)

**Fig. 12 Cross-Over Gaskets and Locator Dowels**

the block. Also the horizontal alignment tabs must be in position with the mating cylinder head gasket tabs (Fig. 13). The words MANIFOLD SIDE should be visible on the center of each flange gasket.

**Fig. 13 Intake Manifold Flange Gasket Alignment**

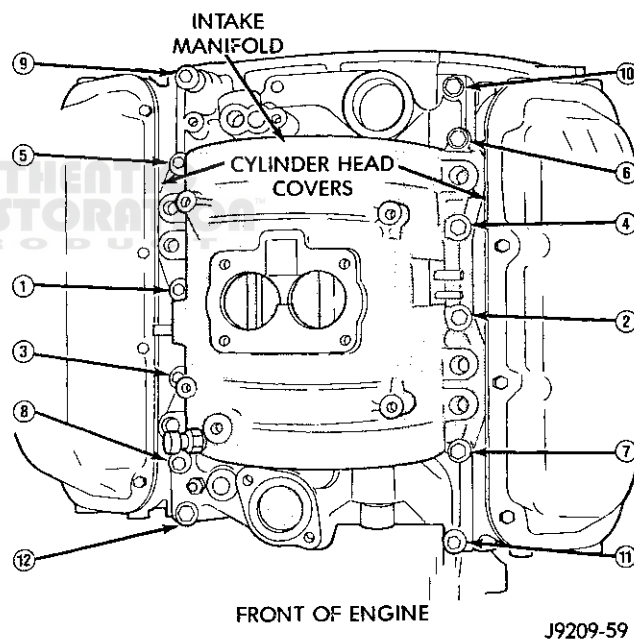
(7) Carefully lower intake manifold into position on the cylinder block and cylinder heads. Use the alignment dowels in the cross-over gaskets to position the intake manifold. After intake manifold is in place, inspect to make sure seals are in place.

(8) Install the intake manifold bolts and tighten as follows:

(a) V-6 ENGINE— (Fig. 14)

- Step 1—Tighten bolts 1 and 2 to 8 N·m (72 in. lbs.) torque. Tighten in alternating steps 1.4 N·m (12 in. lbs.) torque at a time.
- Step 2—Tighten bolts 3 through 12, in sequence, to 8 N·m (72 in. lbs.) torque.
- Step 3—Check that all bolts are tighten to 8 N·m (72 in. lbs.) torque.
- Step 4—Tighten all bolts, in sequence, to 16 N·m (12 ft. lbs.) torque.
- Step 5—Check that all bolts are tighten to 16 N·m (12 ft. lbs.) torque.

(b) V-8 ENGINE— (Fig. 15)

**Fig. 14 Intake Manifold Bolt Tightening Sequence—V-6**

- Step 1—Tighten bolts 1 through 4, in sequence, to 8 N·m (72 in. lbs.) torque. Tighten in alternating steps 1.4 N·m (12 in. lbs.) torque at a time.
- Step 2—Tighten bolts 5 through 12, in sequence, to 8 N·m (72 in. lbs.) torque.
- Step 3—Check that all bolts are tighten to 8 N·m (72 in. lbs.) torque.
- Step 4—Tighten all bolts, in sequence, to 16 N·m (12 ft. lbs.) torque.
- Step 5—Check that all bolts are tighten to 16 N·m (12 ft. lbs.) torque.

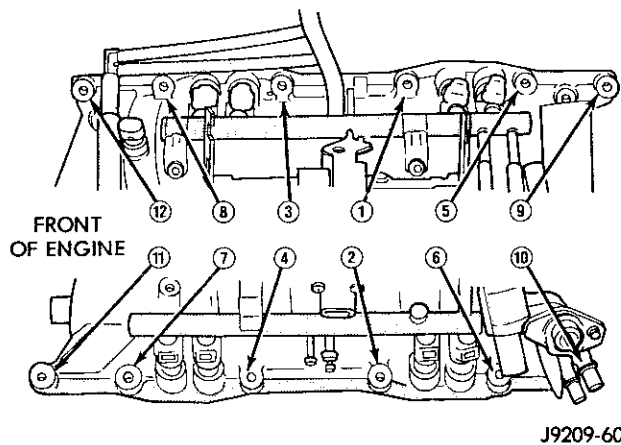
REMOVAL AND INSTALLATION (Continued)

Fig. 15 Intake Manifold Bolt Tightening Sequence—V-8

- (9) Install closed crankcase ventilation and evaporation control systems.
- (10) Connect the coil wires.
- (11) Connect the heat indicator sending unit wire.
- (12) Connect the heater hoses and bypass hose.
- (13) Install distributor cap and wires.
- (14) Hook up the return spring.
- (15) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
- (16) Install the fuel lines.
- (17) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for the proper adjusting of belt tension.
- (18) Install the air cleaner.
- (19) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
- (20) Connect the negative cable to the battery.

INTAKE MANIFOLD V-10**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Drain the cooling system (refer to Group 7, Cooling System for the proper procedures).
- (3) Remove the accessory drive belt (refer to Group 7, Cooling System for the proper procedures).
- (4) Remove the generator brace and generator (Fig. 16).
- (5) Remove the A/C compressor brace (Fig. 16). Remove the compressor and set aside.
- (6) Remove the air cleaner cover and filter. Remove the air cleaner housing (Fig. 17). Discard the gasket.
- (7) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.

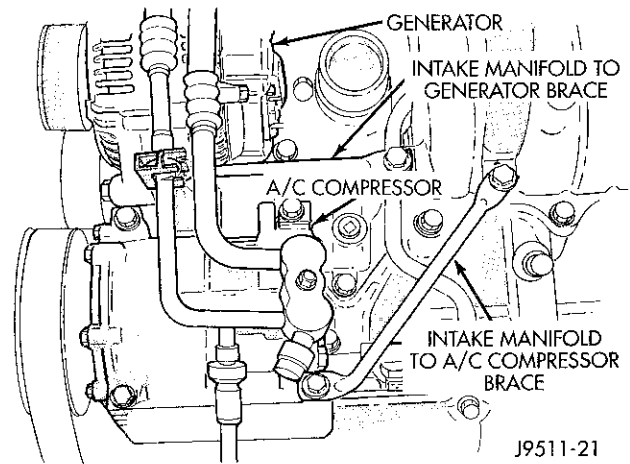


Fig. 16 Generator and A/C Compressor Braces

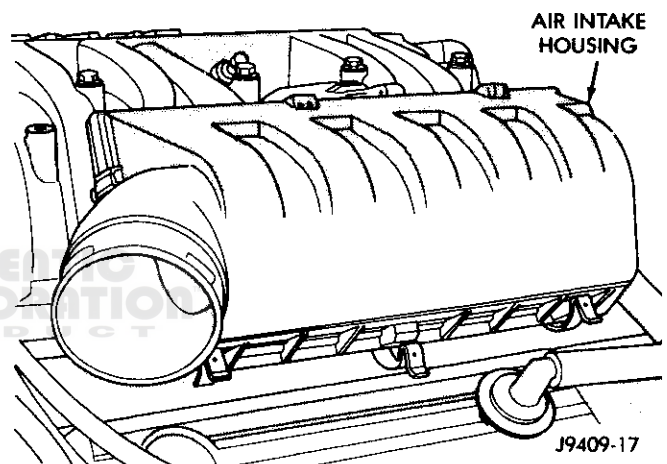


Fig. 17 Air Intake Housing

- (8) Disconnect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
- (9) Remove the coil assemblies with the ignition cables.
- (10) Disconnect the vacuum lines.
- (11) Disconnect the heater hoses and bypass hose.
- (12) Remove the closed crankcase ventilation and evaporation control systems.
- (13) Remove the throttle body bolts and lift the throttle body off the upper intake manifold (Fig. 18). Discard the gasket.
- (14) Remove upper intake manifold bolts.
- (15) Lift the upper intake manifold out of the engine compartment (Fig. 18). Discard the gasket.
- (16) Remove the lower intake manifold bolts and remove the manifold (Fig. 19).
- (17) Discard the lower intake manifold gaskets (Fig. 20).

REMOVAL AND INSTALLATION (Continued)

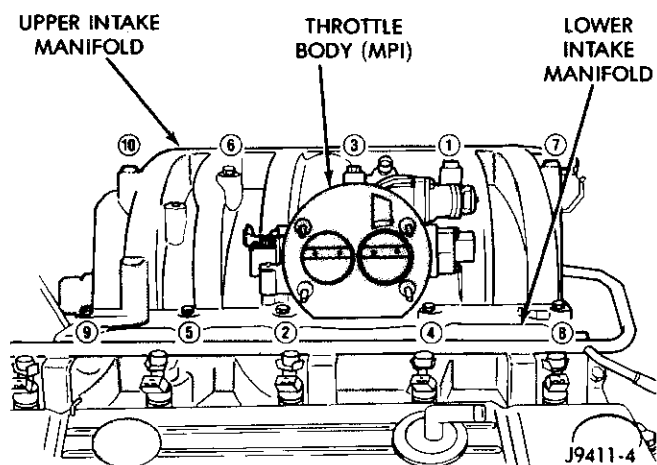


Fig. 18 Upper Intake Manifold and Throttle Body

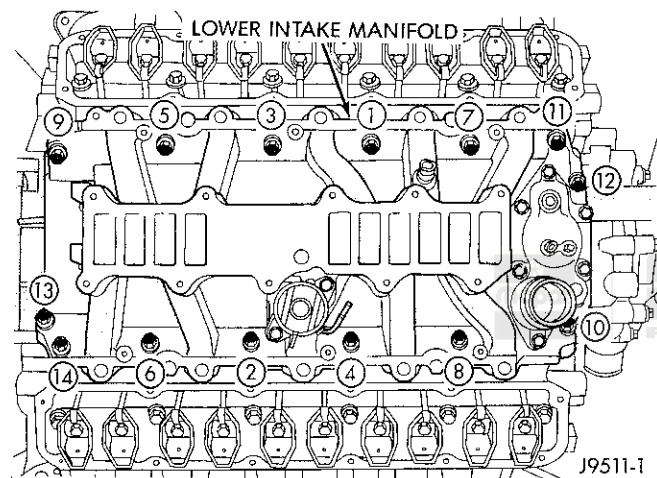


Fig. 19 Lower Intake Manifold

INSTALLATION

(1) Install the intake manifold side gaskets. Be sure that the locator dowels are positioned in the head (Fig. 21).

(2) Peel off the protective paper (blue - rear and brown - front) and press firmly onto the block (Fig. 20). **BE SURE THE BLOCK IS OIL FREE.** Aligning slots in end seals with notches in intake manifold gaskets.

(3) Insert Mopar[®] Silicone Rubber Adhesive Sealant, or equivalent, into the four corner pockets (Fig. 20). **Fill the pocket, but DO NOT overfill.**

(4) The lower intake manifold **MUST** be installed within 3 minutes of sealant application. Carefully lower intake manifold into position on the cylinder block and heads. After intake manifold is in place, inspect to make sure seals and gaskets are in place. Finger start all the lower intake bolts.

(5) Tighten the lower intake manifold bolts in sequence to 54 N·m (40 ft. lbs.) torque (Fig. 19).

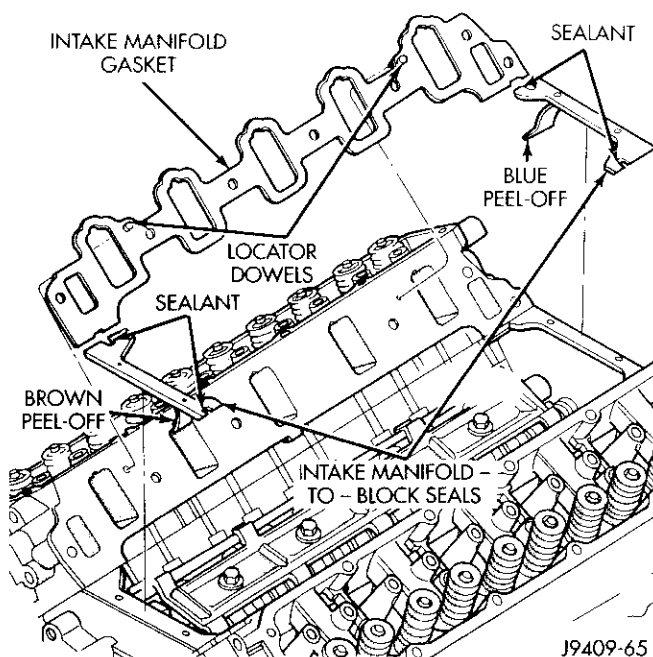


Fig. 20 Lower Intake Manifold Gaskets

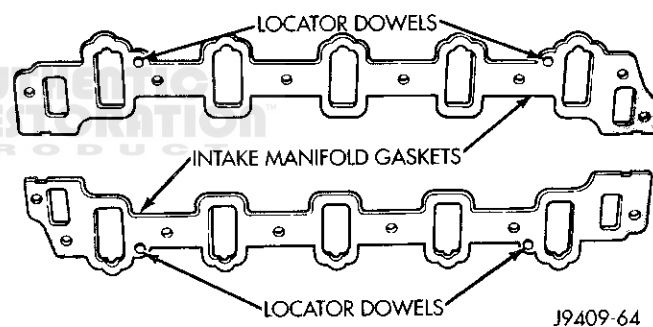


Fig. 21 Intake Manifold Flange Gasket Alignment

(6) Using a new gasket, position the upper intake manifold onto the lower intake manifold.

(7) Finger start all bolts, alternate one side to the other.

(8) Tighten upper intake manifold bolts in sequence to 22 N·m (16 ft. lbs.) torque (Fig. 18).

(9) Using a new gasket, install the throttle body onto the upper intake manifold. Tighten the bolts to 23 N·m (200 in. lbs.) torque.

(10) Install closed crankcase ventilation and evaporation control systems.

(11) Connect the heater hoses and bypass hose.

(12) Connect the vacuum lines.

(13) Install the coil assemblies and the ignition cables.

(14) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(15) Install the fuel lines.

REMOVAL AND INSTALLATION (Continued)

(16) Using a new gasket, install the air cleaner housing. Tighten the nuts to 11 N·m (96 in. lbs.) torque. Install the air cleaner filter and cover.

(17) Install the A/C compressor. Position the compressor brace and install the bolts. Tighten the brace bolts to 41 N·m (30 ft. lbs.) torque.

(18) Install the generator. Position the generator brace and install the bolts. Tighten the brace bolts to 41 N·m (30 ft. lbs.) torque.

(19) Install the accessory drive belt (refer to Group 7, Cooling System).

(20) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).

(21) Connect the negative cable to the battery.

ENGINE EXHAUST MANIFOLD—V-6 and V-8 ENGINES

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Raise and support the vehicle.
- (3) Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold.
- (4) Lower the vehicle.
- (5) Remove the exhaust heat shields.
- (6) Remove bolts, nuts and washers attaching manifold to cylinder head.
- (7) Remove manifold from the cylinder head.

INSTALLATION

CAUTION: If the studs came out with the nuts when removing the engine exhaust manifold, install new studs. Apply sealer on the coarse thread ends. Water leaks may develop at the studs if this precaution is not taken.

(1) Position the engine exhaust manifolds on the two studs located on the cylinder head. Install conical washers and nuts on these studs (Fig. 22) (Fig. 23).

(2) Install two bolts and conical washers at the inner ends of the engine exhaust manifold outboard arms. Install two bolts **WITHOUT** washers on the center arm of engine exhaust manifold (Fig. 22) (Fig. 23). Starting at the center arm and working outward, tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

(3) Install the exhaust heat shields.

(4) Raise and support the vehicle.

(5) Assemble exhaust pipe to manifold and secure with bolts, nuts and retainers. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

(6) Lower the vehicle.

(7) Connect the negative cable to the battery.

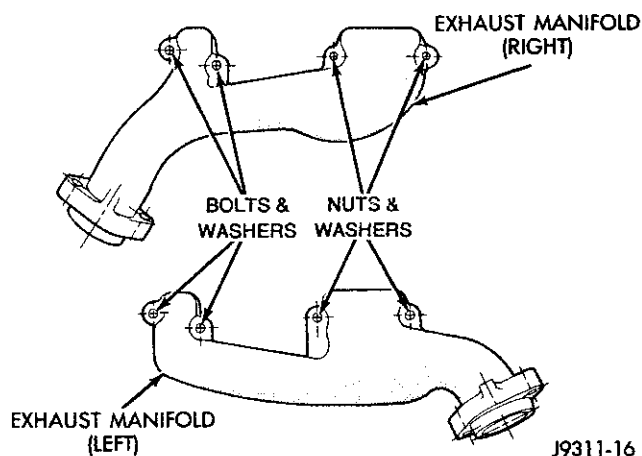


Fig. 22 Engine Exhaust Manifold Installation—3.9L Engine

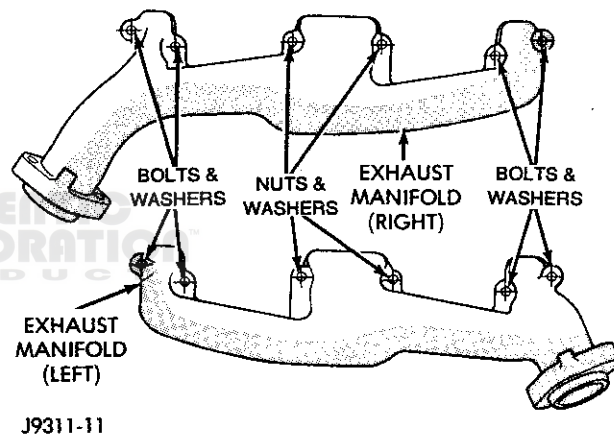


Fig. 23 Engine Exhaust Manifold Installation—5.2L/5.9L Engines

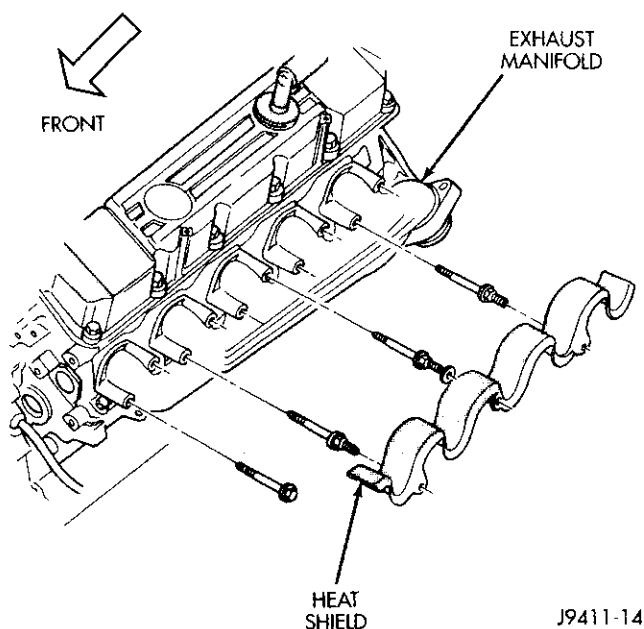
EXHAUST MANIFOLD V-10

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Raise and support the vehicle.
- (3) Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold.
- (4) Lower the vehicle.
- (5) Remove the exhaust heat shields (Fig. 24).
- (6) Right exhaust manifold and discard the gasket.
- (7) Right exhaust manifold—Remove the dipstick bracket from the manifold.
- (8) Remove bolts attaching manifold to cylinder head.
- (9) Remove manifold from the cylinder head. Discard the gasket.

INSTALLATION

(1) Using a new gasket position the engine exhaust manifold onto the cylinder head. Install bolts

REMOVAL AND INSTALLATION (Continued)**Fig. 24 Left Engine Exhaust Manifold**

and stud bolts in the proper position. (Fig. 24) Tighten the bolts to 22 N·m (16 ft. lbs.) torque.

(2) Right exhaust manifold—Install the dipstick bracket to the manifold.

(3) Position washers and exhaust heat shields onto the manifold stud bolts (Fig. 24). Be sure the tabs on the heat shields are hooked over the top of the exhaust gasket. Install the nuts and tighten to 20 N·m (175 in. lbs.) torque.

(4) Raise and support the vehicle.

(5) Assemble exhaust pipe to manifold and secure with bolts. Tighten the bolts to 34 N·m (25 ft. lbs.) torque.

(6) Lower the vehicle.

(7) Connect the negative cable to the battery.

EXHAUST PIPE—DIESEL**REMOVAL**

(1) Raise and support the vehicle on a hoist.

(2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.

(3) Remove the bolts and nuts from the exhaust pipe to turbocharger exhaust pipe (Fig. 25).

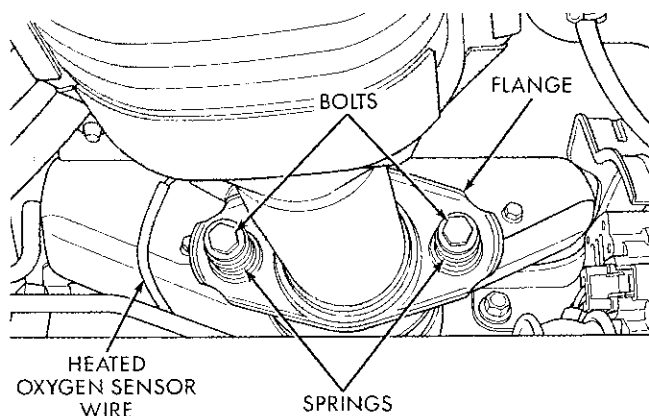
(4) Remove the clamp nuts.

(5) Disconnect the exhaust pipe support hanger.

INSTALLATION

(1) Connect the exhaust pipe support hangers.

(2) Align the exhaust pipe with the turbocharger exhaust pipe and the catalytic converter. Install the bolts and nuts. Tighten the nuts to 34 N·m (25 ft. lbs.) torque.



9411-18

Fig. 25 Exhaust Pipe Mounting

(3) Tighten the clamp nuts to 43 N·m (32 ft. lbs.) torque.

(4) Install the exhaust pipe support clamps and nuts. Tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

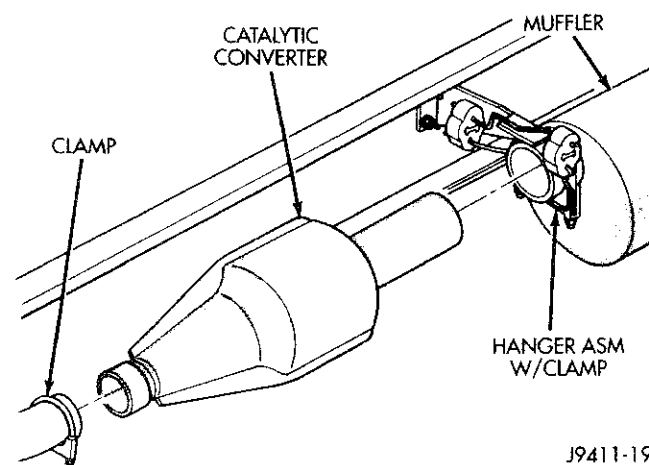
CATALYTIC CONVERTERS—DIESEL**REMOVAL**

(1) Raise and support vehicle.

(2) Saturate the bolts and nuts with heat valve lubricant. Allow 5 minutes for penetration.

(3) Remove clamps and nuts (Fig. 26).

(4) Remove the catalytic converter.



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Fig. 26 Catalytic Converter**INSTALLATION**

(1) Assemble converter and clamps loosely to permit proper clearance with exhaust heat shields and underbody parts.

REMOVAL AND INSTALLATION (Continued)

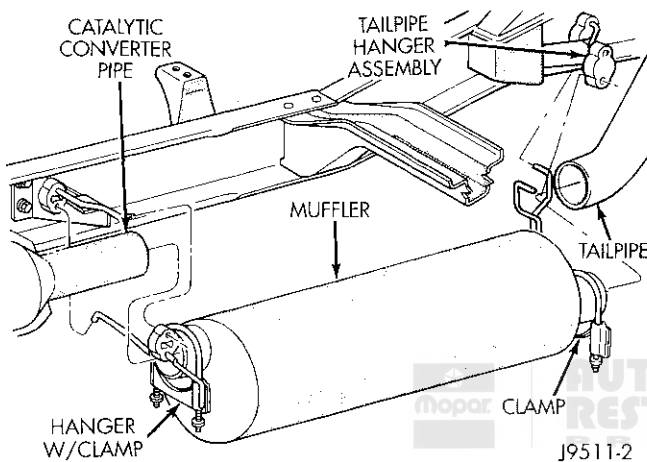
(2) Tighten all clamp nuts to 43 N·m (32 ft. lbs.) torque.

(3) Lower the vehicle.

(4) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

MUFFLER—DIESEL**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove the clamps and nuts.
- (3) Disconnect the support hanger (Fig. 27).
- (4) Remove the muffler.

**Fig. 27 Muffler****INSTALLATION**

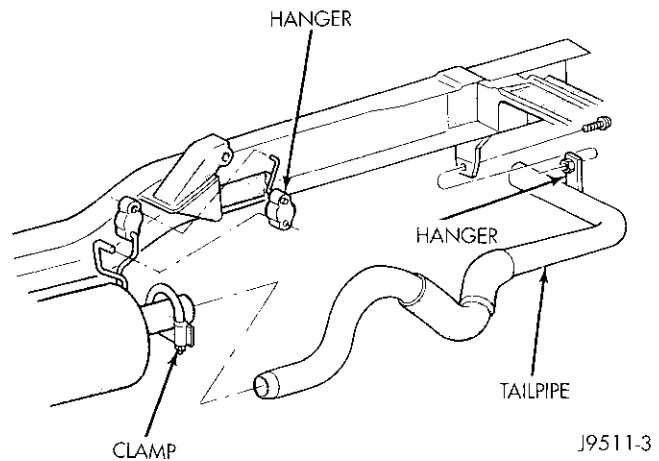
- (1) Connect the support hanger.
- (2) Install the clamps and nuts. Tighten the nuts to 43 N·m (32 ft. lbs.) torque.
- (3) Lower the vehicle.
- (4) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

EXHAUST TAILPIPE—DIESEL**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Saturate the clamp nuts with heat valve lubricant. Allow 5 minutes for penetration.
- (3) Disconnect the exhaust tailpipe support hanger (Fig. 28). If used, disconnect the extension pipe support hanger (Fig. 27).
- (4) Remove clamps and nuts (Fig. 28).
- (5) Remove the exhaust tailpipe and extension pipe, if used.

INSTALLATION

- (1) Loosely assemble exhaust tailpipe and extension pipe, if used, to permit proper alignment of all parts.

**Fig. 28 Exhaust Tailpipe HD**

- (2) Connect the support hangers.
- (3) Position the exhaust tailpipe and extension pipe, if used, for proper clearance with the underbody parts.
- (4) Tighten all clamp nuts to 43 N·m (32 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Start the engine and inspect for exhaust leaks and exhaust system contact with the body panels. Adjust the alignment, if needed.

HEAT SHIELDS—DIESEL**REMOVAL**

- (1) Raise and support the vehicle.
- (2) Remove the nuts or bolts holding the exhaust heat shield to the floor pan, crossmember or bracket.
- (3) Slide the shield out around the exhaust system.

INSTALLATION

- (1) Position the exhaust heat shield to the floor pan, crossmember or bracket and install the nuts or bolts.
- (2) Tighten the nuts and bolts.
- (3) Lower the vehicle.

EXHAUST MANIFOLD—DIESEL**REMOVAL**

- (1) Disconnect the air intake and exhaust pipes (Fig. 29).
- (2) Disconnect the turbocharger oil supply line and the oil drain tube from the turbocharger (Fig. 30).
- (3) Disconnect the charge air cooler (Intercooler) inlet duct from the turbocharger (Fig. 30).
- (4) Remove the turbocharger and gasket.
- (5) Remove the cab heater supply and return lines.
- (6) Remove the engine exhaust manifold and gaskets (Fig. 31).
- (7) Clean the sealing surfaces.

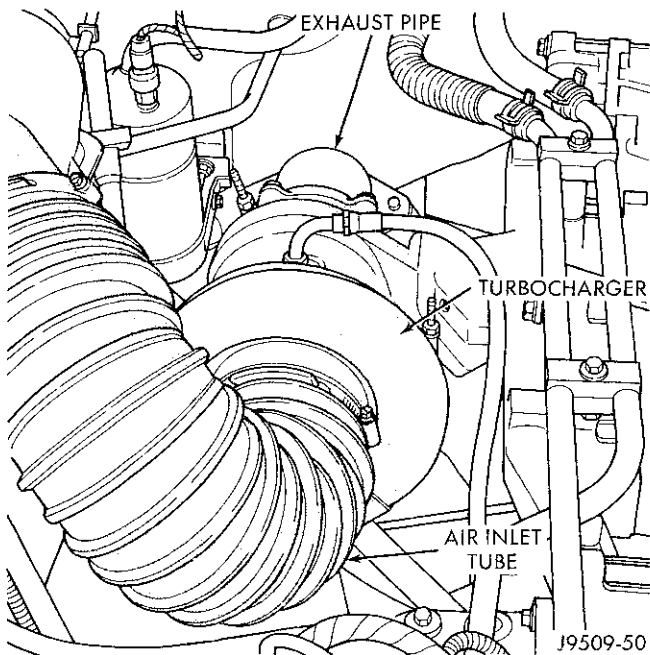
REMOVAL AND INSTALLATION (Continued)

Fig. 29 Air Intake Pipe, Exhaust Pipe and Turbocharger

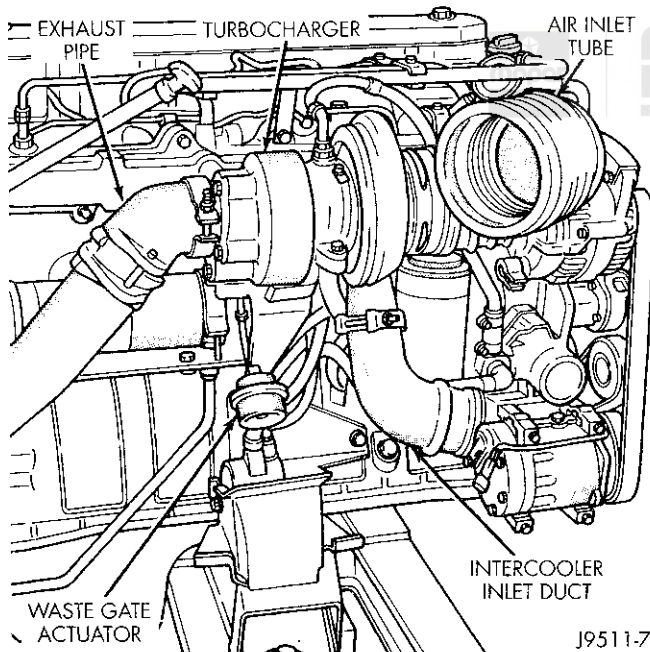


Fig. 30 Oil Supply Line and Charge Air Cooler (Intercooler) Inlet Duct

INSTALLATION

(1) Install the engine exhaust manifold and gaskets use anti-seize on capscrews. Tighten the exhaust manifold bolts in sequence to 43 N·m (32 ft. lbs.) torque (Fig. 32).

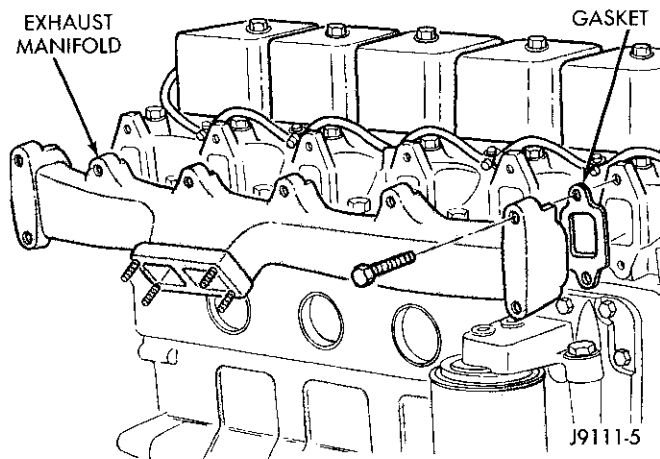


Fig. 31 Engine Exhaust Manifold and Gaskets

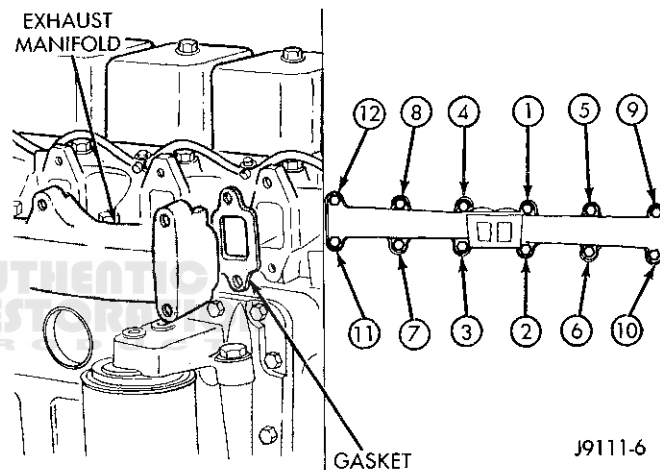


Fig. 32 Engine Exhaust Manifold Bolt Tightening Sequence

(2) Install the turbocharger. Apply anti-seize to the studs and then tighten the turbocharger mounting nuts to 32 N·m (24 ft. lbs.) torque.

(3) Position the charge air cooler (intercooler) inlet duct to the turbocharger. With the clamp in position, tighten the clamp nut to 8 N·m (72 in. lbs.) torque.

(4) Position the air intake pipe and the exhaust pipe onto the turbocharger. Tighten the clamps to 8 N·m (74 in. lbs.) torque.

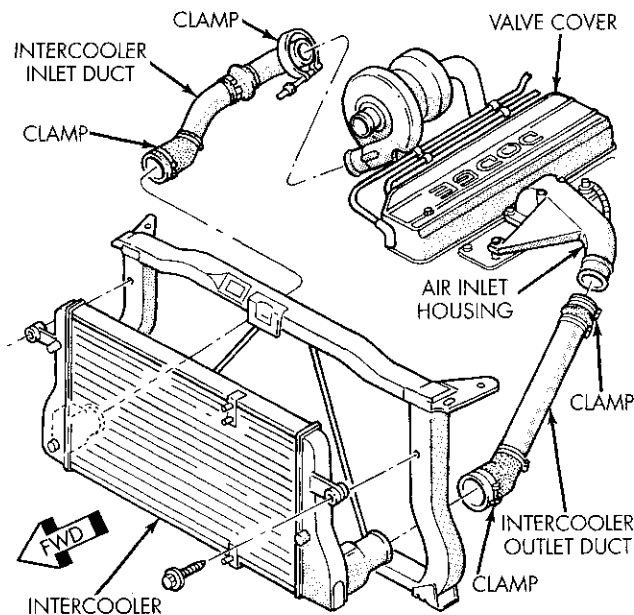
(5) Install the oil drain tube and oil supply line to the turbocharger. Tighten the drain tube bolts to 24 N·m (18 ft. lbs.) torque. Tighten the oil supply line fitting nut to 15 N·m (11 ft. lbs.) torque.

(6) Connect the cab heater supply and return lines. Tighten the line nuts to 24 N·m (18 ft. lbs.) torque.

(7) Operate the engine to check for leaks.

REMOVAL AND INSTALLATION (Continued)**INTAKE MANIFOLD COVER—AIR INTAKE HEATER****REMOVAL**

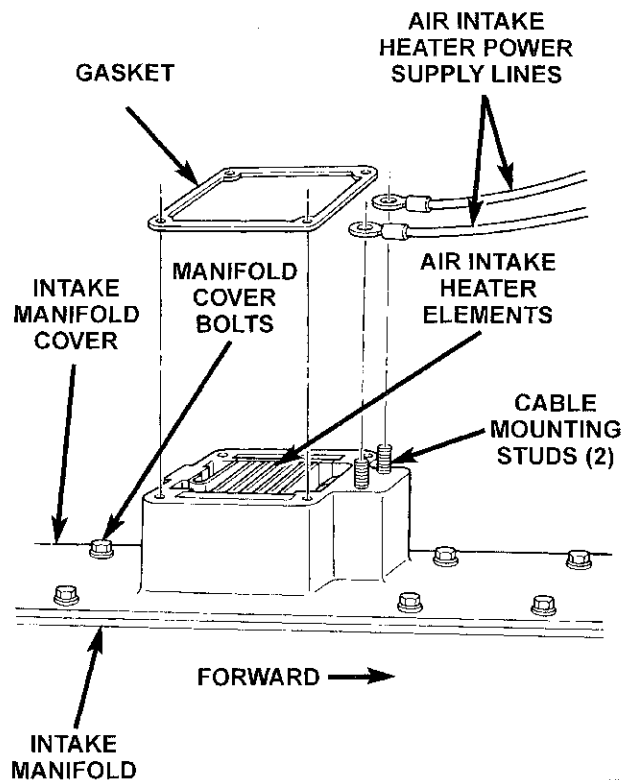
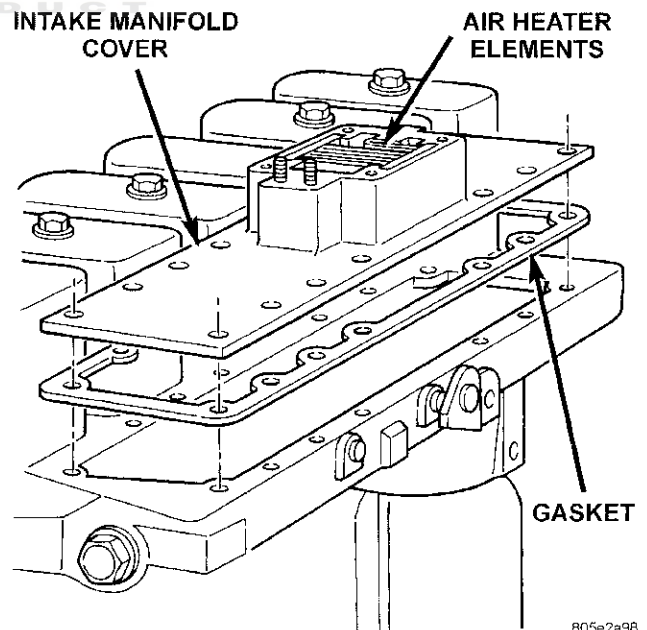
(1) Remove the charge air cooler (intercooler) outlet duct from the air inlet housing (Fig. 33).

**Fig. 33 Intercooler Outlet Duct**

- (2) Remove air inlet housing.
- (3) Remove the high pressure fuel lines.
- (4) Disconnect the air intake heater power supply lines (Fig. 34).
- (5) Disconnect the charge air temperature sensor from the intake manifold cover.
- (6) Disconnect the air temperature switch from the intake manifold cover.
- (7) Remove the manifold intake cover and gasket (Fig. 35). Keep the gasket material and any other material out of the air intake.
- (8) Clean the sealing surface.

INSTALLATION

- (1) Using a new gasket, install the intake manifold cover.
- (2) Connect the air temperature switch to the intake manifold cover.
- (3) Connect the charge air temperature sensor to the intake manifold cover.
- (4) Some of the intake manifold bolt holes are drilled through and must be sealed. Apply liquid teflon sealant to the bolts. Install the intake manifold cover bolts. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.
- (5) Install a new gasket on top of the air intake heater.

**Fig. 34 Air Intake Heater****Fig. 35 Manifold Intake Cover**

- (6) Install the air inlet housing. Tighten the air inlet housing bolts to 24 N·m (18 ft. lbs.) torque.
- (7) Install and tighten the air intake heater power supply nuts to 14 N·m (10 ft. lbs.) torque.
- (8) Position the charge air cooler (intercooler) outlet duct onto the air inlet housing. Tighten the

REMOVAL AND INSTALLATION (Continued)

charge air cooler (intercooler) outlet duct clamps to 8 N·m (74 in. lbs.) torque.

(9) Install and bleed the high pressure fuel lines. Tighten the high pressure fuel line nuts to 24 N·m (18 ft. lbs.) torque.

TURBOCHARGER DIESEL**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Disconnect the air intake pipe and exhaust pipe (Fig. 36).

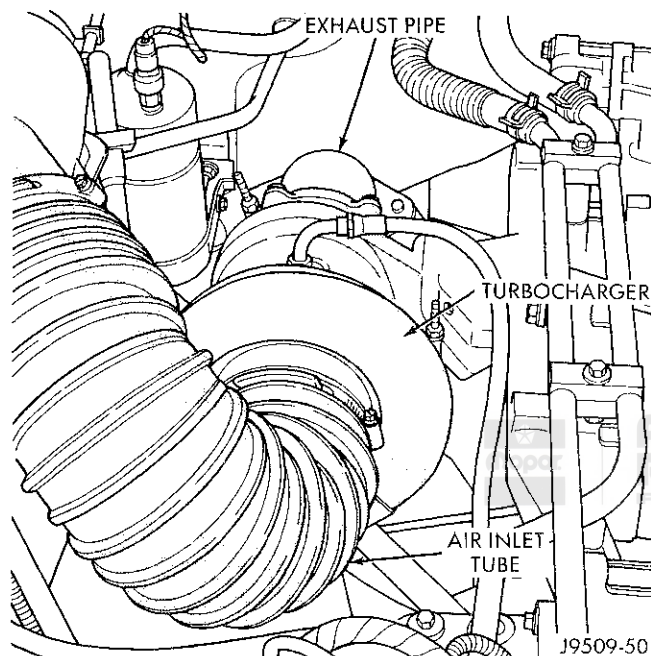


Fig. 36 Air Intake Pipe, Exhaust Pipe and Turbocharger

- (3) Remove the oil drain tube bolts.
- (4) Remove the oil supply line.
- (5) Disconnect the charge air cooler (intercooler) inlet duct from the turbocharger (Fig. 37).
- (6) Remove the turbocharger mounting nuts and the turbocharger.
- (7) If the turbocharger is not to be installed immediately, cover the opening to prevent material from entering into the manifold.
- (8) Clean and inspect the sealing surface.

CAUTION: The turbocharger is a precision piece of equipment and should only be repaired by an authorized facility. Disassembly is not recommended, as engine/turbo failure could result.

INSTALLATION

- (1) Install a new gasket and apply anti-seize compound to the mounting studs.

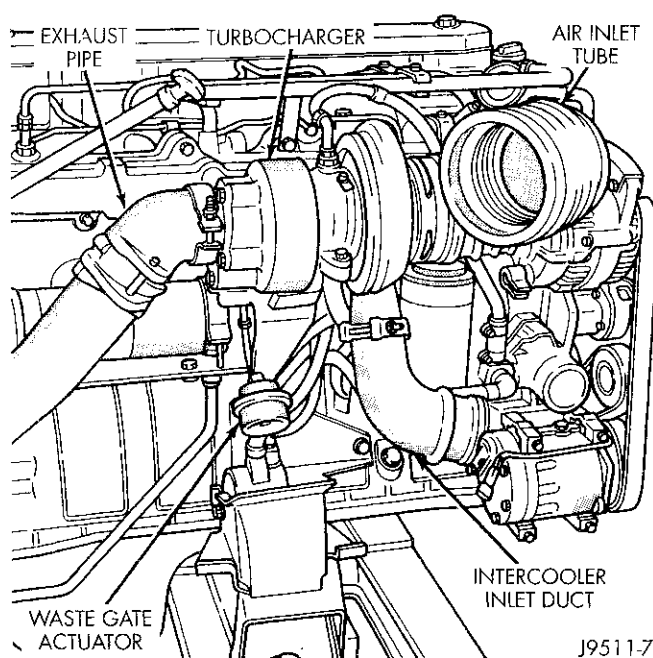


Fig. 37 Air Cooler (Intercooler) Inlet Duct

- (2) Install the turbocharger. Tighten the turbocharger mounting nuts to 32 N·m (24 ft. lbs.) torque.
- (3) Use a new gasket and connect the drain line. Tighten the drain line connection bolts to 24 N·m (18 ft. lbs.) torque.
- (4) New turbocharger must be pre-lubricated with clean engine lubricating oil before start up. Pour 50-60 cc (2-3 ounces) of oil into supply fitting.

WARNING: DO NOT USE YOUR FINGER TO TURN THE TURBINE WHEEL.

- (5) Rotate the turbine wheel to allow oil to enter the turbocharger.
- (6) Install the oil supply line. Tighten the oil supply line fitting nut to 15 N·m (11 ft. lbs.) torque.
- (7) Position the Charge air cooler (intercooler) inlet duct to the turbocharger. With the clamp in position, tighten the clamp nut to 8 N·m (72 in. lbs.) torque.
- (8) Position the air intake pipe and the exhaust pipe onto the turbocharger. Tighten the clamps to 8 N·m (72 in. lbs.) torque.
- (9) Connect the negative cable to the battery.
- (10) Operate the engine and check for leaks.

WASTEGATE ADJUSTMENT

The wastegate turbocharger provides additional low speed boost without over-boost at high speeds. This increases low speed torque and better driveability.

Proper adjustment of the wastegate assembly is critical to the operation of the wastegate turbocharger (Fig. 38). The control rod is set at the factory

REMOVAL AND INSTALLATION (Continued)

and no adjustment should be necessary, unless wastegate assembly is damaged.

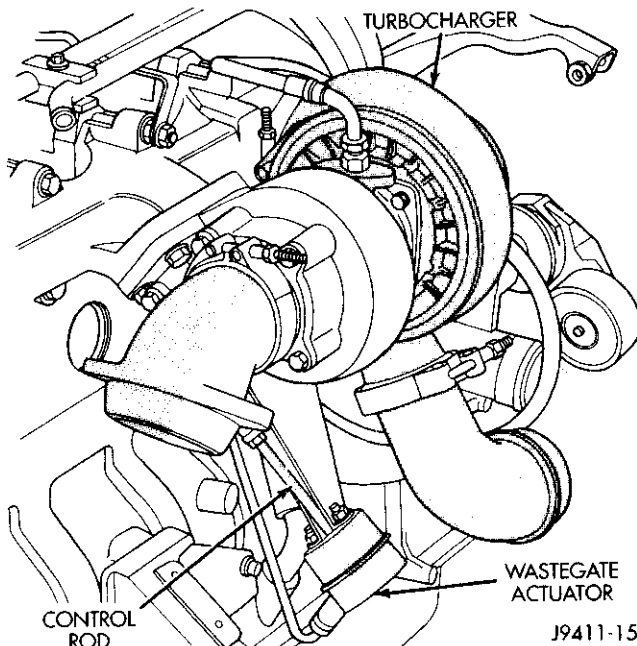


Fig. 38 Wastegate Turbocharger

CAUTION: DO NOT adjust the wastegate so that higher pressures are required to open the wastegate valve. The turbocharger speed will be increased and can cause damage to the turbocharger and cause a loss of engine performance.

(1) Connect regulated air pressure to the wastegate actuator (Fig. 39). Install a dial indicator to measure the control rod movement. Apply 103 - 138 kPa (15 - 20 psi) to seat the components and take any slack out of the control rod. Release the air pressure and zero the dial indicator gauge.

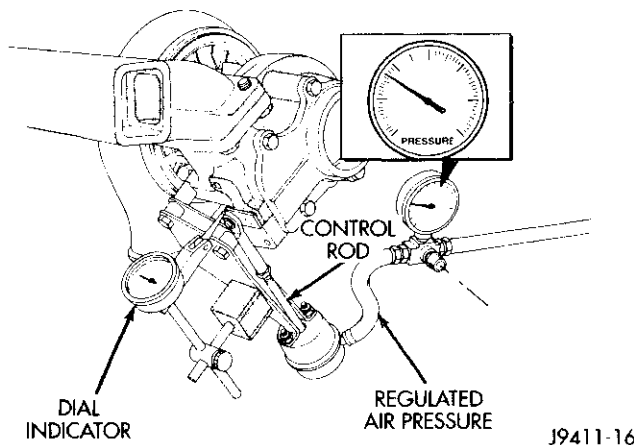


Fig. 39 Wastegate and Dial Indicator

(2) Apply 133 kPa (19.3 psi) air pressure to the actuator. The control rod should move 0.33 - 1.27 mm (0.013 - 0.050 in) total travel. If the rod travel is out of limits, the wastegate linkage must be adjusted.

(3) To adjust the wastegate linkage, apply air pressure to the actuator to release the spring tension on the lever. Remove the control rod from the wastegate lever (Fig. 40). Pull the wastegate lever toward the actuator (closed position).

(4) Adjust the length of the clevis end of the control rod to align the clevis pin hole to the wastegate lever. Install the adjusting link and retaining clip (Fig. 40).

CAUTION: DO NOT pull, push or force the alignment of the clevis pin.

(5) After the adjustment is complete, tighten the actuator rod jam nut.

(6) Recheck the travel on the wastegate control rod. Adjust, if necessary.

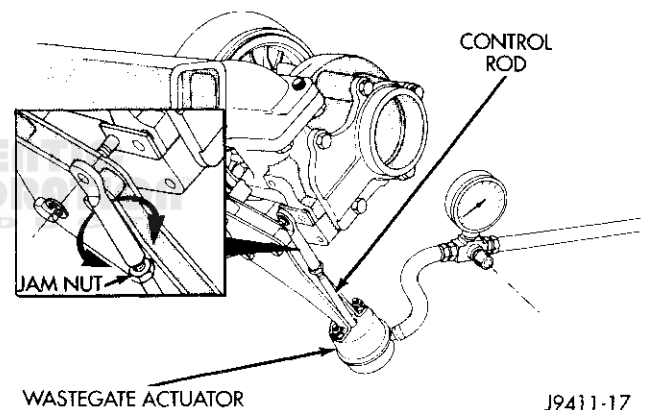


Fig. 40 Adjustment of Wastegate Actuator
INTERCOOLER—DIESEL

REMOVAL

WARNING: IF THE ENGINE WAS JUST TURNED OFF, THE INTAKE AND OUTLET DUCTS MAY BE HOT.

(1) Remove the grille (refer to Group 23, Body for the proper procedure).

(2) Remove the front support bracket (Fig. 41).

(3) If the vehicle is equipped with air conditioning, remove the condenser as follows:

(a) Discharge the air conditioning system (refer to Group 24, Heating and Air Conditioning for the proper procedures).

(b) Remove the bolt from the sealing plate.

(c) Remove the nuts holding the condenser to the charge air cooler (intercooler). Lift the con-

REMOVAL AND INSTALLATION (Continued)

denser and sealing plate assembly away from the charge air cooler (intercooler).

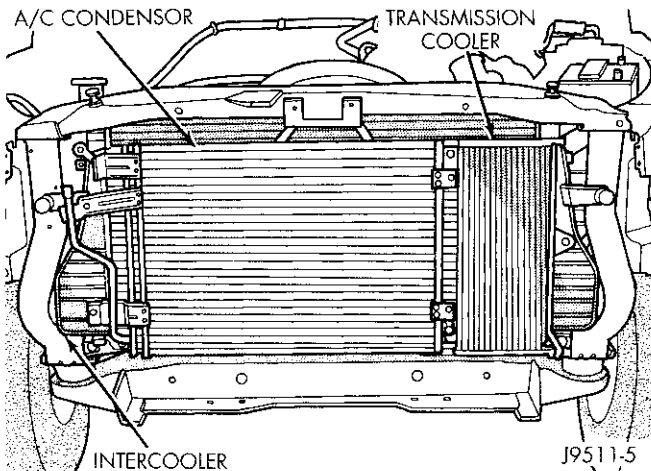


Fig. 41 Condenser and Charge Air Cooler—Intercooler

(4) Remove the inlet and outlet ducts from the charge air cooler (intercooler) (Fig. 42).

(5) Remove the charge air cooler (intercooler) bolts. Pivot the charge air cooler (intercooler) forward and up to remove.

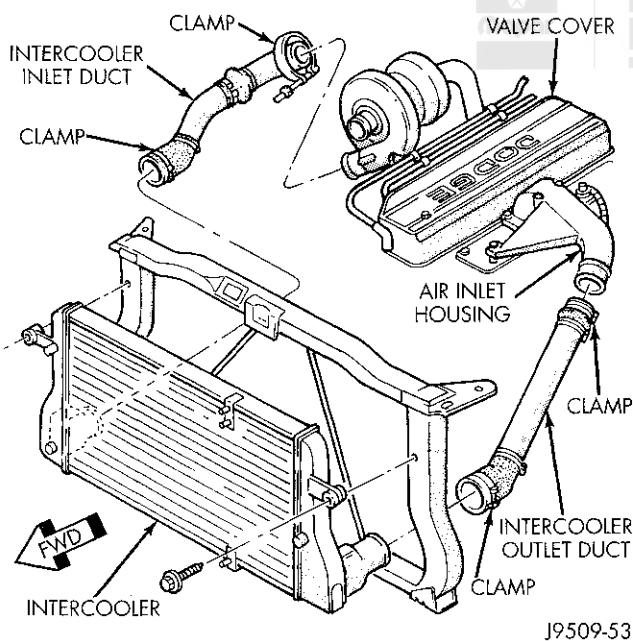


Fig. 42 Charge Air Cooler Intercooler Ducts

INSTALLATION

(1) Position the charge air cooler (intercooler). Install the bolts and tighten to 2 N·m (17 in. lbs.) torque.

(2) Install the inlet and outlet ducts to the charge air cooler (intercooler). With the clamps in position, tighten the clamp nut to 8 N·m (72 in. lbs.) torque.

(3) If the vehicle is equipped with air conditioning, install the condenser as follows:

(a) Position the condenser and sealing plate assembly onto the charge air cooler (intercooler) studs. Install the nuts and tighten.

(b) Connect the halves of the sealing plate. Install the bolt and tighten.

(c) Charge the air conditioning system (refer to Group 24, Heating and Air Conditioning for the proper procedures).

(4) Install the front support bracket. Install and tighten the bolts.

(5) Install the grille (refer to Group 23, Body for the proper procedure).

CLEANING AND INSPECTION**EXHAUST PIPE****INSPECTION**

Discard rusted clamps, broken or worn supports and attaching parts. Replace a component with original equipment parts, or equivalent. This will assure proper alignment with other parts in the system and provide acceptable exhaust noise levels.

CLEANING

Clean ends of pipes to assure mating of all parts.

INTAKE MANIFOLD**CLEANING INTAKE**

Clean manifold in solvent and blow dry with compressed air.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

The plenum pan rail must be clean and dry (free of all foreign material).

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straightedge.

EXHAUST MANIFOLD**CLEANING**

Clean mating surfaces on cylinder head and manifold. Wash with solvent and blow dry with compressed air.

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straight edge. Gasket surfaces must be flat within 0.2 mm per 300 mm (0.008 inch per foot).

CLEANING AND INSPECTION (Continued)**INTERCOOLER—CHARGE AIR COOLER****CLEANING**

If the engine experiences a turbocharger failure or any other occasion where oil or debris is put into the charge air cooler, the charge air cooler must be cleaned.

(1) Remove the charge air cooler from the vehicle, refer Charge Air Cooler in this section.

(2) Flush the charge air cooler internally with a non caustic solvent in the opposite direction of normal air flow. Shake the charge air cooler and **LIGHTLY** tap on the end tanks with a rubber mallet to dislodge trapped debris. Continue flushing until all debris or oil is removed.

(3) Use a flashlight and mirror to visually inspect the charge air cooler for internal debris.

CAUTION: If internal debris cannot be removed, scrap the charge air cooler. **DO NOT USE CAUSTIC CLEANERS TO CLEAN THE CHARGE AIR COOLER. DAMAGE TO THE CHARGE AIR COOLER WILL RESULT.**

(4) After the charge air cooler has been thoroughly cleaned of all oil and debris with the non caustic solvent, wash the charge air cooler internally with hot soapy water to remove the remaining solvent.

(5) Rinse thoroughly with clean water.

(6) Blow compressed air into the charge air cooler in the opposite direction of normal air flow until the charge air cooler is dry internally.

INSPECTION

(1) Visually inspect the charge air cooler

(2) Inspect the tubes, fins and welds for tears, breaks or other damage. If any damage causes the charge air cooler to fail, the charge air cooler must be replaced.

CATALYTIC CONVERTOR**INSPECTION**

Look at the stainless steel body of the catalytic, inspect for bulging or other distortion that could be a result of overheating. If the catalytic has a heat shield attached make sure it is not bent or loose.

WARNING: UNLEADED FUEL MUST BE USED TO PREVENT BLOCKAGE OR CONTAMINATION TO THE CATALYST CORE.

If you suspect internal damage to the catalyst, tapping the bottom of the catalyst with a rubber mallet may indicate a damaged core.

CLEANING

Clean ends of pipes and muffler to assure a good seal at mating surfaces.

ADJUSTMENTS**WASTEGATE ADJUSTMENT**

The wastegate turbocharger provides additional low speed boost without over-boost at high speeds. This increases low speed torque and better driveability.

Proper adjustment of the wastegate assembly is critical to the operation of the wastegate turbocharger (Fig. 43). The control rod is set at the factory and no adjustment should be necessary, unless wastegate assembly is damaged.

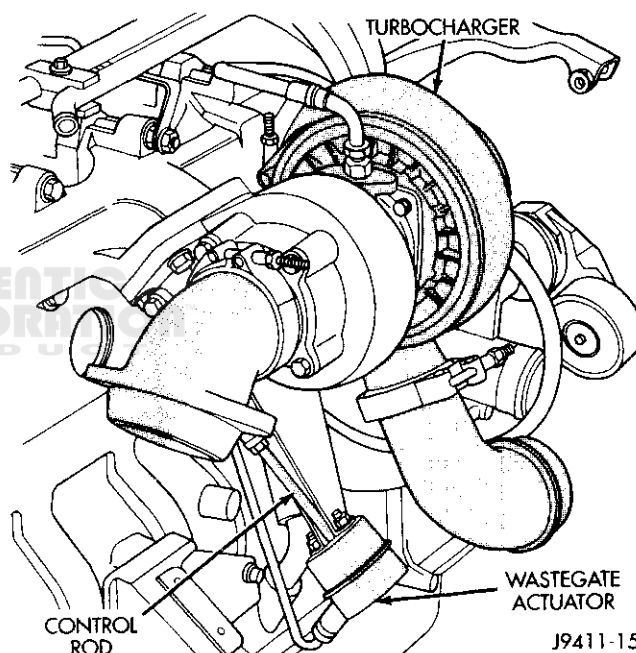
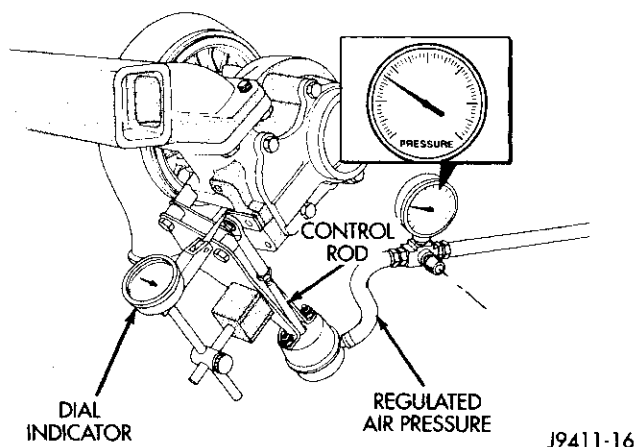


Fig. 43 Wastegate Turbocharger

CAUTION: **DO NOT** adjust the wastegate so that higher pressures are required to open the wastegate valve. The turbocharger speed will be increased and can cause damage to the turbocharger and cause a loss of engine performance.

(1) Connect regulated air pressure to the wastegate actuator (Fig. 44). Install a dial indicator to measure the control rod movement. Apply 103 - 138 kPa (15 - 20 psi) to seat the components and take any slack out of the control rod. Release the air pressure and zero the dial indicator gauge.

(2) Apply 133 kPa (19.3 psi) air pressure to the actuator. The control rod should move 0.33 - 1.27 mm (0.013 - 0.050 in) total travel. If the rod travel is out of limits, the wastegate linkage must be adjusted.

ADJUSTMENTS (Continued)**Fig. 44 Wastegate and Dial Indicator**

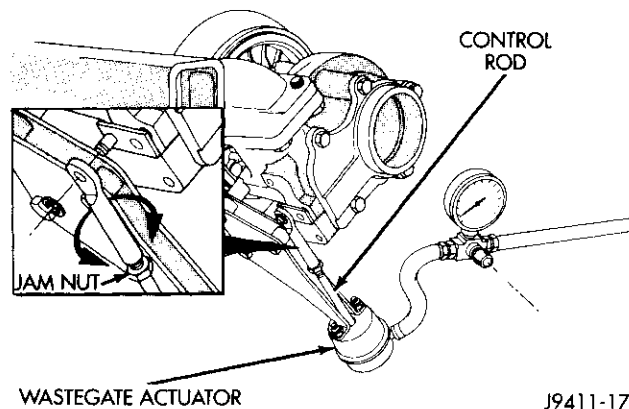
(3) To adjust the wastegate linkage, apply air pressure to the actuator to release the spring tension on the lever. Remove the control rod from the wastegate lever (Fig. 45). Pull the wastegate lever toward the actuator (closed position).

(4) Adjust the length of the clevis end of the control rod to align the clevis pin hole to the wastegate lever. Install the adjusting link and retaining clip (Fig. 45).

CAUTION: DO NOT pull, push or force the alignment of the clevis pin.

(5) After the adjustment is complete, tighten the actuator rod jam nut.

(6) Recheck the travel on the wastegate control rod. Adjust, if necessary.

**Fig. 45 Adjustment of Wastegate Actuator**

**AUTHENTIC
RESTORATION
PRODUCT**

SPECIFICATIONS**TURBOCHARGER SPECIFICATIONS**

COMPONENT	DIMENSIONS
Air Intake Restrictions	635 mm Water (25 in. Water) Max.
Turbo Radial Clearance	0.300–0.460 mm (0.012–0.018 inch)
Turbo Rotor Assembly End Play	
Before S/N 840638	0.102–0.152 mm (0.004–0.006 inch)
S/N 840638 AND AFTER	0.026–0.076 mm (0.001–0.003 inch)

J9511-23

TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
Adjusting Strap Bolt	23 N•m (200 in. lbs.)
Air Heater Power Supply Nuts	14 N•m (10 ft. lbs.)
Cab Heater Supply/Return Line Nuts	24 N•m (18 ft. lbs.)
Catalytic Converter-to-Muffler Clamp Nuts	43 N•m (32 ft. lbs.)
Exhaust Manifold-to-Cylinder Head Bolts (5.9L Diesel)	43 N•m (32 ft. lbs.)
Exhaust Pipe-to-Catalytic Converter Clamp Nuts	43 N•m (32 ft. lbs.)
Exhaust Pipe-to-Exhaust Manifold Bolts/Nuts	26 N•m (19 ft. lbs.)
Fuel Heater Ground Bolt	12 N•m (110 in. lbs.)
Fuel Line Nuts	24 N•m (18 ft. lbs.)
Generator Mounting Bolt	41 N•m (30 ft. lbs.)

DESCRIPTION	TORQUE
Intake Manifold Capbolts	Refer to Procedure in Service Manual.
Intake Manifold Cover Bolts	24 N•m (18 ft. lbs.)
Intercooler Attaching Bolts	2 N•m (17 in. lbs.)
Intercooler Duct Clamp Nuts	8 N•m (72 in. lbs.)
Muffler-to-Tail Pipe Clamp Nuts	43 N•m (32 ft. lbs.)
Throttle Control Bracket Mounting Bolts	24 N•m (18 ft. lbs.)
Turbocharger Mounting Nuts	32 N•m (24 ft. lbs.)
Turbocharger Oil Drain Tube Bolts	24 N•m (18 ft. lbs.)
Turbocharger Oil Supply Line Fitting Nut	15 N•m (11 ft. lbs.)
Turbocharger V-Band Clamp	8.5 N•m (75 in. lbs.)

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FRAME AND BUMPERS

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BUMPERS

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FRONT BUMPER AIR DAM	2	REAR BUMPER	3

GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

REMOVAL AND INSTALLATION

FRONT BUMPER

REMOVAL

- (1) Support front bumper on a suitable lifting device.
- (2) Remove bolt holding front bumper brace to frame rail (Fig. 1).
- (3) Remove nuts and stud plates holding front bumper to end of frame rail.
- (4) Disengage wire connectors from horns.
- (5) Disengage wire connectors from fog lamps, if equipped.
- (6) Separate front bumper from vehicle.

INSTALLATION

Reverse the preceding operation.

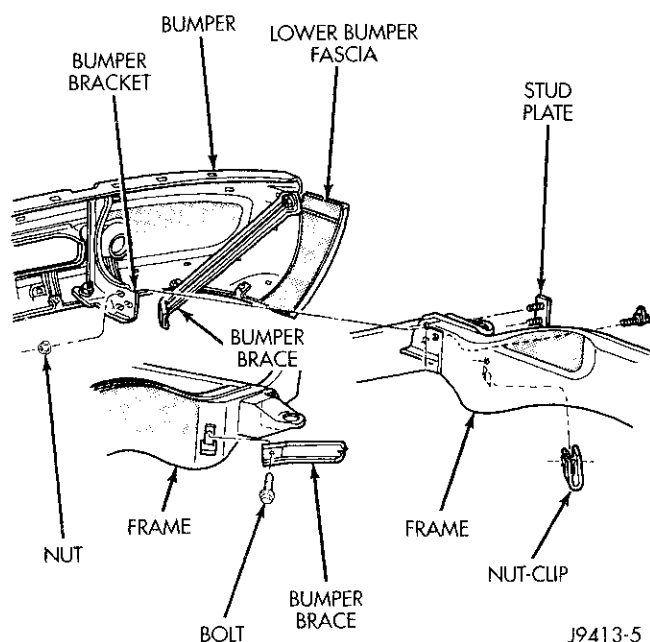
FRONT BUMPER UPPER FASCIA

REMOVAL

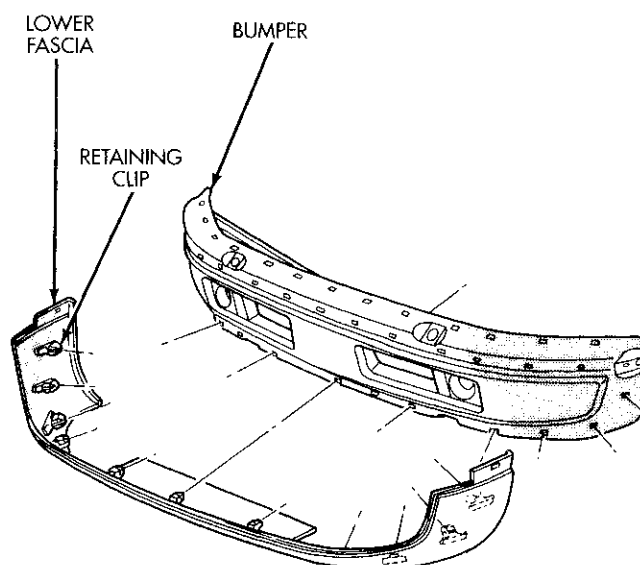
- (1) Remove bumper.
- (2) Disengage clips holding upper fascia to bumper face bar (Fig. 2).
- (3) Separate fascia from bumper.

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 1 Front Bumper****INSTALLATION**

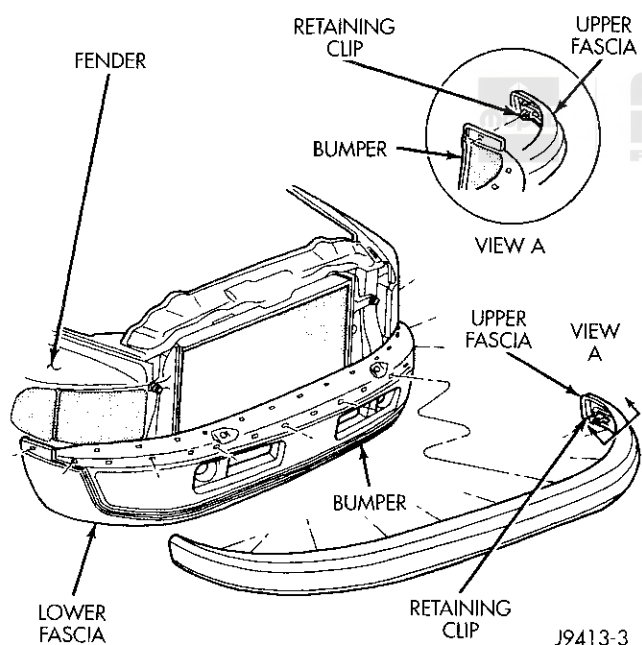
Reverse the preceding operation.



J9413-2

Fig. 3 Front Bumper Lower Fascia**FRONT BUMPER AIR DAM****REMOVAL**

- (1) Remove Pin-type fasteners holding air dam to bottom of front bumper (Fig. 4).
- (2) Remove screws holding air dam to bottom of front bumper.
- (3) Separate air dam from vehicle.



J9413-3

Fig. 2 Front Bumper Upper Fascia**FRONT BUMPER LOWER FASCIA****REMOVAL**

- (1) Remove bumper.
- (2) Disengage clips holding end of upper fascia to bumper face bar (Fig. 3).
- (3) Disengage clips holding lower fascia to bumper face bar.
- (4) Separate lower fascia from bumper.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

Reverse the preceding operation.

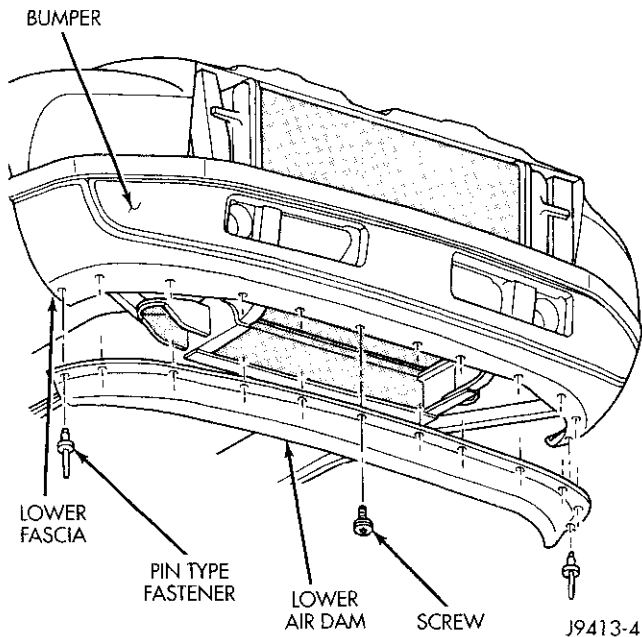


Fig. 4 Front Bumper Air Dam

REAR BUMPER**REMOVAL**

(1) Support rear bumper on a suitable lifting device.

(2) Remove bolts holding rear bumper braces to frame rails (Fig. 5).

(3) Disengage license plate lamp wire connector from body wire harness, if equipped.

(4) Separate rear bumper from vehicle.

INSTALLATION

Reverse the preceding operation.

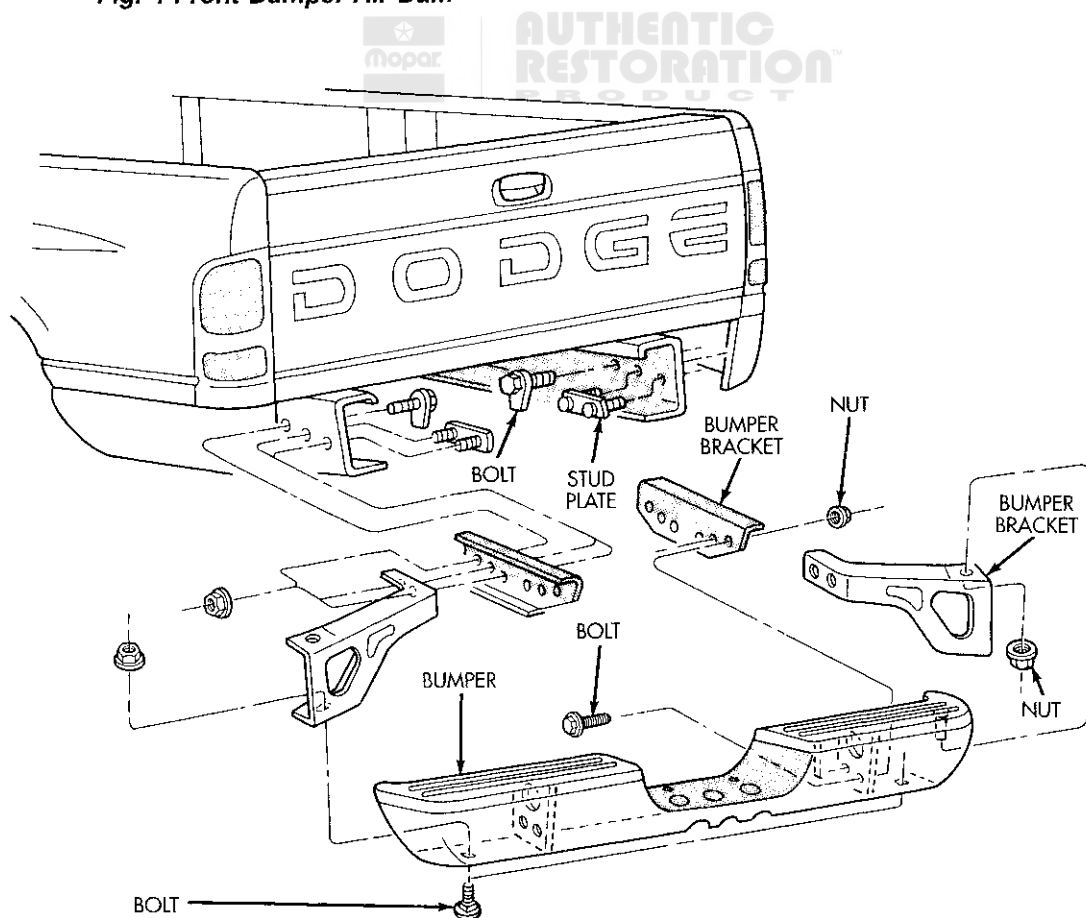


Fig. 5 Rear Bumper

FRAME

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GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

GENERAL INFORMATION

BR trucks have a ladder-type frame (Fig. 1) with Box-section front rails, dropped center section and open-channel side rails in the rear.

Cross members attached to the frame side rails with rivets, welds or bolts form a ladder-type construction (Fig. 1). The cab is isolated from the frame with rubber load cushions (Fig. 2) with through-bolts. The cargo box or bed is attached to the frame with bolts. Refer to Group 23, Body for cargo box service procedures.

The frame is designed to absorb and dissipate flexing and twisting due to acceleration, braking, corner-

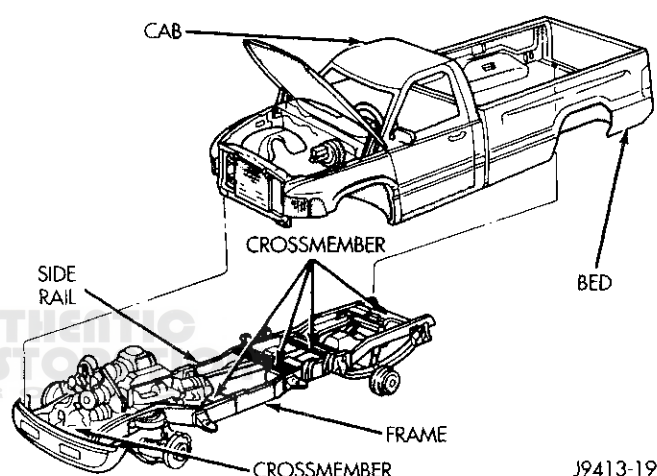


Fig. 1 Frame

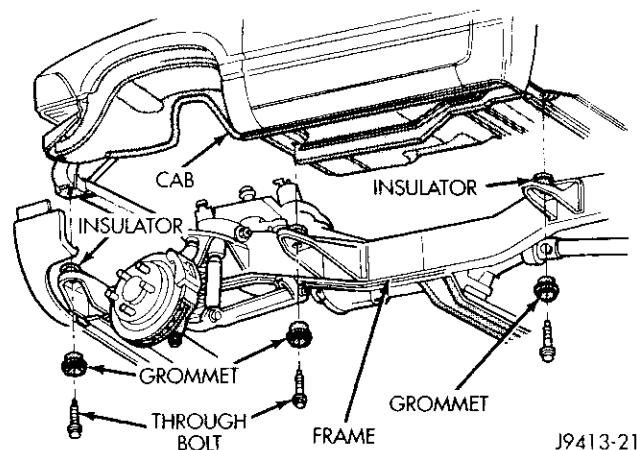


Fig. 2 Cab Mounts

ing and road surface variances without bending when subjected to normal driving conditions. The frame is the mounting platform for the following systems and components:

- Front and rear suspension systems.
- Engine, transmission, and transfer case.
- Steering gear and linkage.

GENERAL INFORMATION (Continued)

- Exhaust system and heat shields.
- Fuel cell and fuel line tubing.
- Front end sheet metal and radiator closure panel.
- Skid plate.
- Passenger cab.
- Cargo box or bed.
- Spare tire winch.
- Front and rear bumper systems.

SERVICE PROCEDURES

FRAME SERVICE

SAFETY PRECAUTIONS AND WARNINGS

WARNING: USE EYE PROTECTION WHEN GRINDING OR WELDING METAL, SERIOUS EYE INJURY CAN RESULT. BEFORE PROCEEDING WITH FRAME REPAIR INVOLVING GRINDING OR WELDING, VERIFY THAT VEHICLE FUEL SYSTEM IS NOT LEAKING OR IN CONTACT WITH REPAIR AREA, PERSONAL INJURY CAN RESULT. DO NOT ALLOW OPEN FLAME TO CONTACT PLASTIC BODY PANELS. FIRE OR EXPLOSION CAN RESULT. WHEN WELDED FRAME COMPONENTS ARE REPLACED, 100% PENETRATION WELD MUST BE ACHIEVED DURING INSTALLATION. IF NOT, DANGEROUS OPERATING CONDITIONS CAN RESULT. STAND CLEAR OF CABLES OR CHAINS ON PULLING EQUIPMENT DURING FRAME STRAIGHTENING OPERATIONS, PERSONAL INJURY CAN RESULT. DO NOT VENTURE UNDER A HOISTED VEHICLE THAT IS NOT SUPPORTED ON SAFETY STANDS, PERSONAL INJURY CAN RESULT.

CAUTION: Do not reuse damaged fasteners, quality of repair would be suspect. Do not drill holes in top or bottom frame rail flanges, frame rail failure can result. Do Not use softer than Grade 3 bolts to replace production fasteners, loosening or failure can result. When using heat to straighten frame components do not exceed 566°C (1050°F), metal fatigue can result. Welding the joints around riveted cross members and frame side rails can weaken frame.

FRAME STRAIGHTENING

When necessary, a conventional frame that is bent or twisted can be straightened by application of heat. The temperature must not exceed 566°C (1050°F). The metal will have a dull red glow at the desired temperature. Excessive heat will decrease the strength of the metal and result in a weakened frame.

Welding the joints around riveted cross members and frame side rails is not recommended.

A straightening repair process should be limited to frame members that are not severely damaged. The replacement bolts, nuts and rivets that are used to join the frame members should conform to the same specifications as the original bolts, nuts and rivets.

FRAME REPAIRS

DRILLING HOLES

Do not drill holes in frame side rail top and bottom flanges, metal fatigue can result causing frame failure. Holes drilled in the side of the frame rail must be at least 38 mm (1.5 in.) from the top and bottom flanges.

Additional drill holes should be located away from existing holes.

WELDING

Use MIG, TIG or arc welding equipment to repair welded frame components.

Frame components that have been damaged should be inspected for cracks before returning the vehicle to use. If cracks are found in accessible frame components perform the following procedures.

(1) Drill a hole at each end of the crack with a 3 mm (0.125 in.) diameter drill bit.

(2) Using a suitable die grinder with 3 inch cut off wheel, V-groove the crack to allow 100% weld penetration.

(3) Weld the crack.

(4) If necessary when a side rail is repaired, grind the weld smooth and install a reinforcement channel (Fig. 3) over the repaired area.

NOTE: If a reinforcement channel is required, the top and bottom flanges should be 0.250 inches narrower than the side rail flanges. Weld only in the areas indicated (Fig. 3).

FRAME FASTENERS

Bolts, nuts and rivets can be used to repair frames or to install a reinforcement section on the frame. Bolts can be used in place of rivets. When replacing rivets with bolts, install the next larger size diameter bolt to assure proper fit. If necessary, ream the hole out just enough to sufficiently receive the bolt.

Conical-type washers are preferred over the splitting type lock washers. Normally, grade-5 bolts are adequate for frame repair. **Grade-3 bolts or softer should not be used.** Tightening bolts/nuts with the correct torque, refer to the Introduction Group at the front of this manual for tightening information.

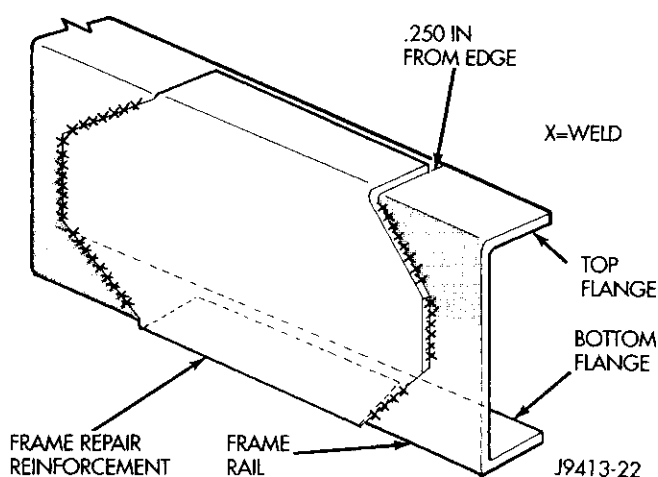


Fig. 3 Frame Reinforcement

REMOVAL AND INSTALLATION

CAB CHASSIS ADAPTER BRACKET

REMOVAL

- (1) Remove nuts attaching cab chassis adapter bracket to frame rail (Fig. 4) and (Fig. 5).
- (2) Separate cab chassis adapter bracket from frame rail

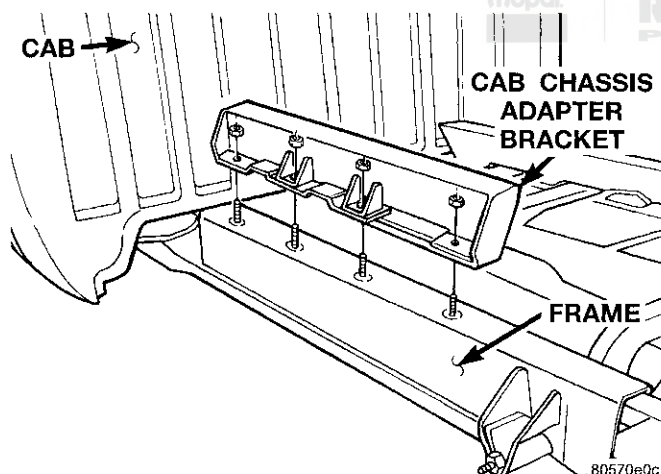


Fig. 4 Cab Chassis Adapter Bracket—Front

INSTALLATION

- (1) Position cab chassis adapter bracket on frame rail
- (2) Install nuts attaching cab chassis adapter bracket to frame rail.

TRANSFER CASE SKID PLATE

REMOVAL

- (1) Hoist and support vehicle on safety stands.
- (2) Remove bolts holding skid plate to frame rails (Fig. 6).

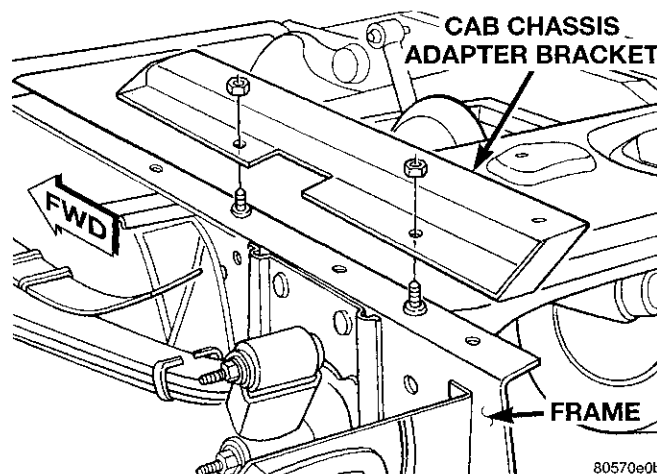


Fig. 5 Cab Chassis Adapter Bracket—Rear

- (3) Separate skid plate from vehicle.

INSTALLATION

- (1) Position skid plate on vehicle.
- (2) Install bolts holding skid plate to frame rails.
- (3) Remove safety stands and lower vehicle.

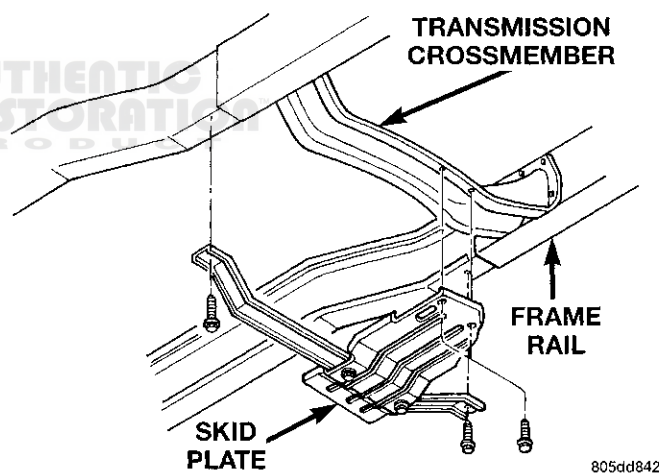


Fig. 6 Skid Plate

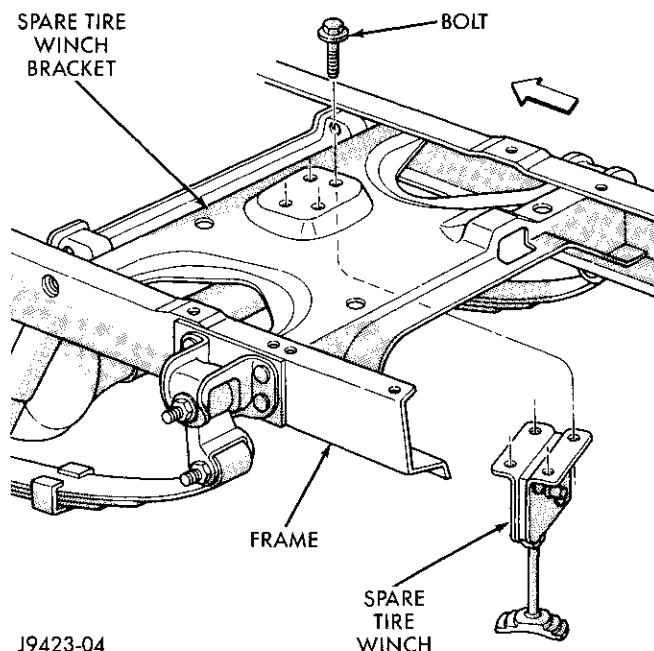
SPARE TIRE WINCH

REMOVAL

- (1) Remove spare tire from under vehicle.
- (2) Remove bolts holding spare tire winch to spare tire bracket (Fig. 7).
- (3) Separate spare tire winch from vehicle.

INSTALLATION

- (1) Position spare tire winch on vehicle.
- (2) Install bolts holding spare tire winch to spare tire bracket.
- (3) Install spare tire.

REMOVAL AND INSTALLATION (Continued)

J9423-04

Fig. 7 Spare Tire Winch**TRAILER HITCH****REMOVAL**

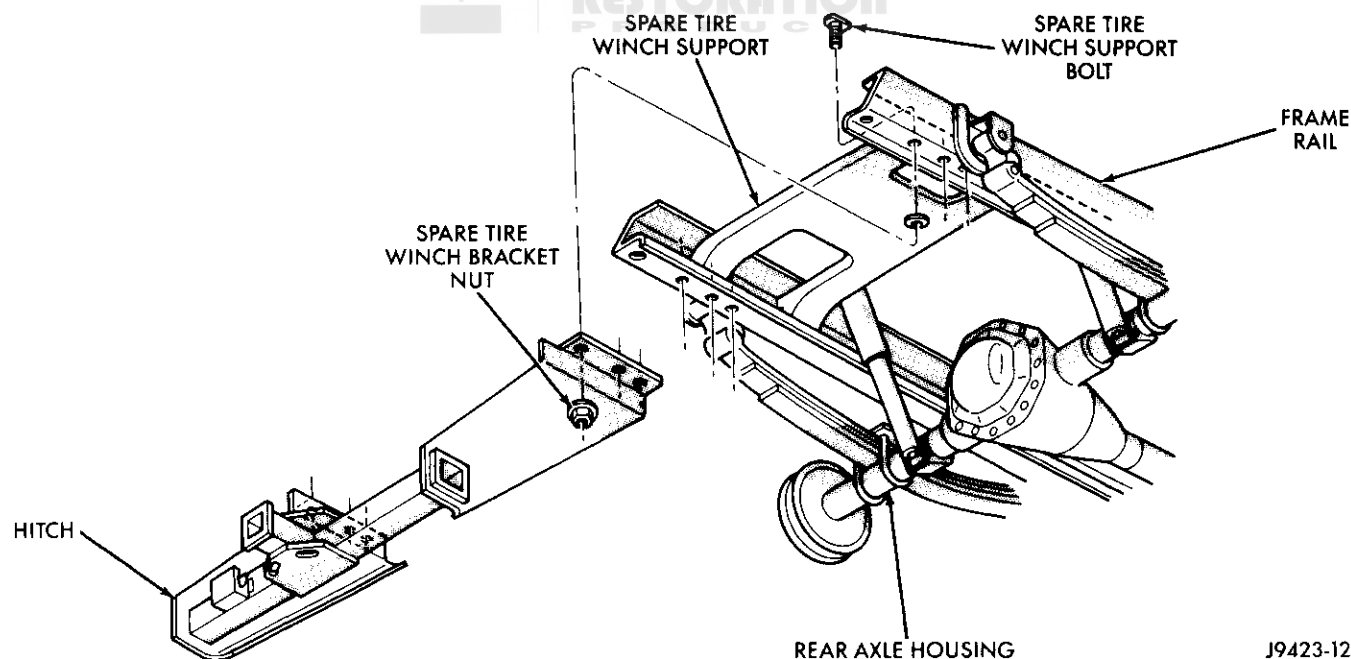
- (1) Support trailer hitch on a suitable lifting device.
- (2) Remove fasteners holding trailer wiring connector to trailer hitch, if equipped.
- (3) Remove bolts holding trailer hitch to frame rails (Fig. 8).
- (4) Separate trailer hitch from vehicle.

INSTALLATION

- (1) Position trailer hitch on vehicle.
- (2) Install the bolts holding trailer hitch to frame rails and remove lifting device.
- (3) Install fasteners holding trailer wiring connector to trailer hitch, if equipped.

SPECIFICATIONS**VEHICLE DIMENSIONS**

Frame dimensions are listed in inch scale. All dimensions are from center to center of Principal Locating Point (PLP), or from center to center of PLP and fastener location (Fig. 9), (Fig. 10), (Fig. 11), (Fig. 12) and (Fig. 13).



J9423-12

Fig. 8 Trailer Hitch

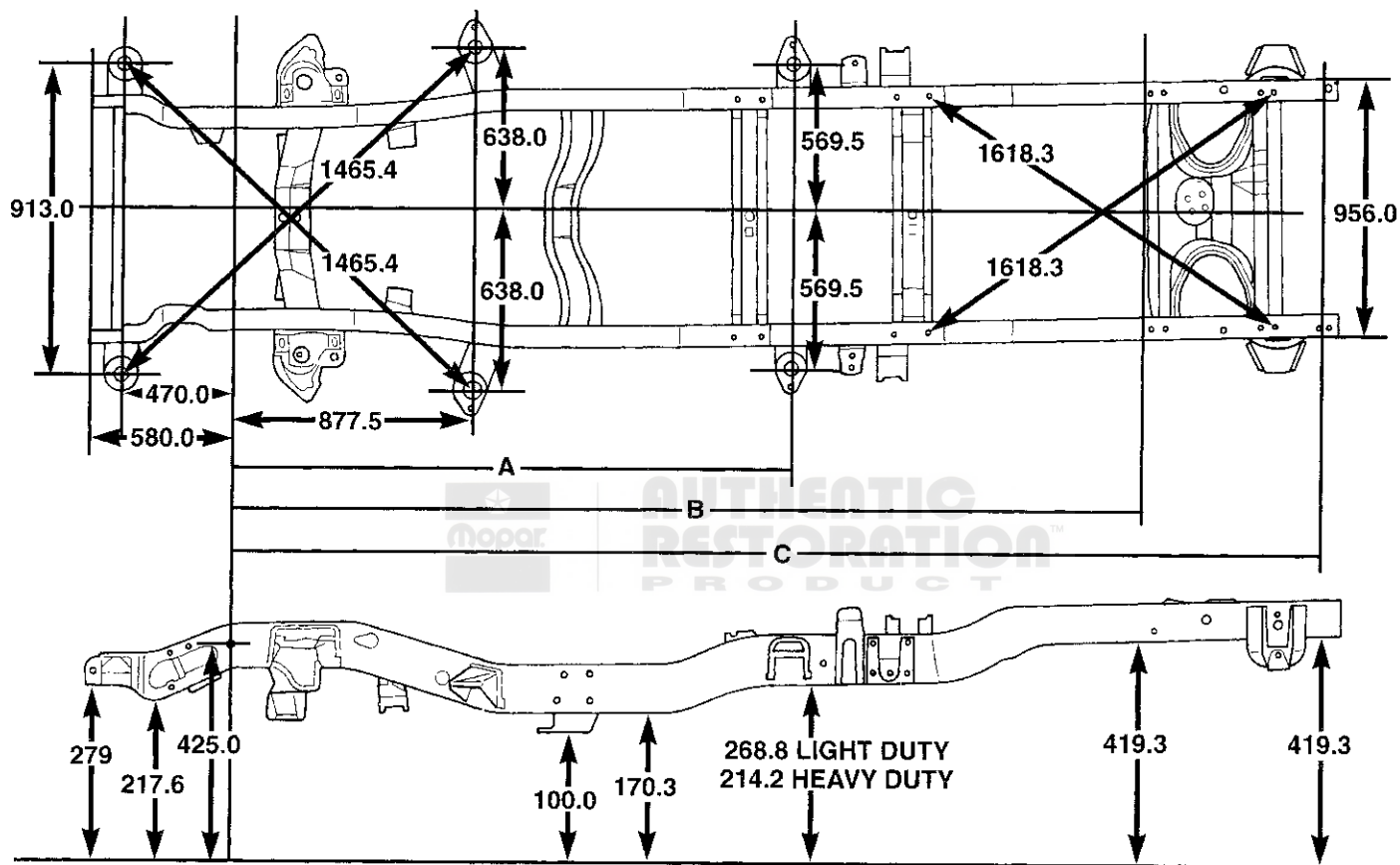


Fig. 9 Frame Dimensions

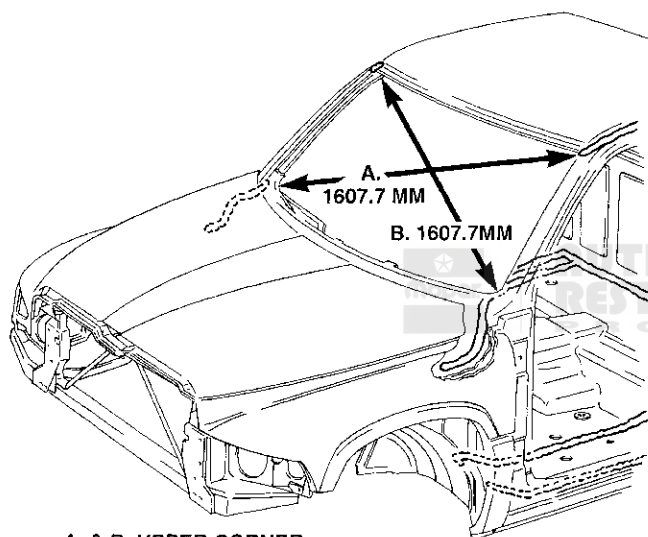
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SPECIFICATIONS (Continued)

*Measurements are in Millimeters (mm).

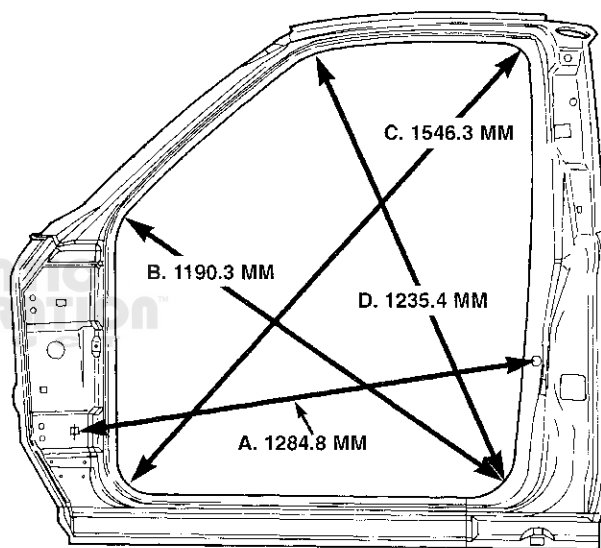
LENGTH DIMENSIONS FOR DIFFERING WHEELBASES*

WHEELBASE	LENGTH A	LENGTH B	LENGTH C
118	2118.0	3663.6	4185.4
134	2118.0	3994.5	4693.4
138	2626.0	4096.1	4693.4
154	2626.0	4502.5	5201.4
162	2118.0	4705.0	5042.5



A. & B. UPPER CORNER
OF WINDSHIELD OPENING
TO TOP OF RADIUS AT LOWER
CORNER OF OPENING.

8031586c

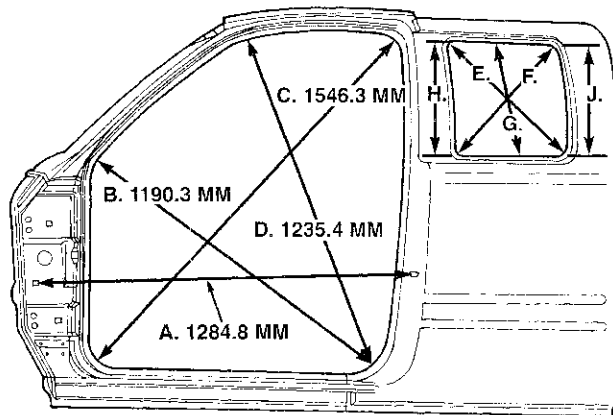
Fig. 10 Body Dimensions—Front View**LH SIDE VIEW**

- A. Centerline of A-Pillar gaging hole to centerline of seat belt retractor hole at B-Pillar.
- B. Centerline of radius at rear lower door opening flange inner edge to center of radius at cowl flange edge.
- C. Centerline of radius at front lower door opening flange inner edge to center of radius at upper opening rear flange inner edge.
- D. Centerline of radius at rear lower door opening flange inner edge to center of radius at upper front flange inner edge.

8031586t

Fig. 11 Body Dimensions—Conventional Cab

SPECIFICATIONS (Continued)



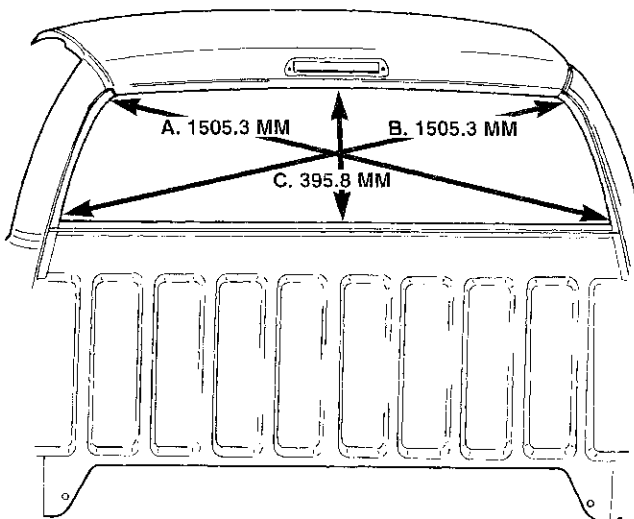
A. 1284.8 MM	D. 1235.4 MM	G. 436.2 MM
B. 1190.3 MM	E. 582.6 MM	H. 440.5 MM
C. 1546.3 MM	F. 538.8 MM	J. 426.8 MM

LH SIDE VIEW

- A. Centerline of A-Pillar gaging hole to centerline of seat belt retractor hole at B-Pillar.
 B. Center of radius at rear lower door opening flange inner edge to center of radius at cowl flange edge.
 C. Center of radius at front lower door opening flange inner edge to center of radius at upper opening rear flange inner edge.
 D. Center of radius at rear lower door opening flange inner edge to center of radius at upper front flange inner edge.
 E. Lower rear corner inner flange edge to upper front corner inner flange edge of quarter glass opening.
 F. Lower front corner inner flange edge to upper rear corner inner flange edge of quarter glass opening.
 G. Upper inner flange lower edge to lower flange upper edge of quarter glass opening.

603f586e

Fig. 12 Body Dimensions—Club Cab



REAR VIEW

- A. & B. Center of radius at top corner to center of radius at lower corner of glass mounting flange.
 C. Lower edge of upper back glass mounting flange to upper edge of lower back glass mounting flange measurement taken at centerline of rear glass opening.

803f586d

Fig. 13 Body Dimensions—Rear View

TORQUE SPECIFICATIONS

WAX COATED FRAME

DESCRIPTION	TORQUE
Cab Chassis adapter nut.	108 N·m (80 ft. lbs.)
Front bumper brkt-to-frame nut. . . . .	.68 N·m (50 ft. lbs.)
Front bumper outer brace bolt . . . . .	.68 N·m (50 ft. lbs.)
Rear bumper-to-brace nut. . . . .	.40 N·m (30 ft. lbs.)
Rear bumper brace-to-brkt nut . . . . .	.101 N·m (75 ft. lbs.)
Rear bumper brkt-to-frame nut . . . . .	.101 N·m (75 ft. lbs.)
Skid plate crossmember-to-frame bolt . . . . .	.54 N·m (40 ft. lbs.)
Skid plate-to-skid plate crossmember bolt. . . . .	.40 N·m (30 ft. lbs.)
Skid plate-to-trans crossmember bolt . . . . .	.54 N·m (40 ft. lbs.)
Spare tire winch bolt . . . . .	.27 N·m (20 ft. lbs.)
Trailer hitch nut. . . . .	.88 N·m (65 ft. lbs.)

E-COATED FRAME

DESCRIPTION	TORQUE
Cab Chassis adapter nut.	108 N·m (80 ft. lbs.)
Front bumper brkt-to-frame nut. . . . .	.68 N·m (50 ft. lbs.)
Front bumper outer brace bolt . . . . .	.68 N·m (50 ft. lbs.)
Rear bumper-to-brace nut. . . . .	.40 N·m (30 ft. lbs.)
Rear bumper brace-to-brkt nut . . . . .	.101 N·m (75 ft. lbs.)
Rear bumper brkt-to-frame nut . . . . .	.101 N·m (75 ft. lbs.)
Skid plate crossmember-to-frame bolt . . . . .	.54 N·m (40 ft. lbs.)
Skid plate-to-crossmember bolt. . . . .	.40 N·m (30 ft. lbs.)
Skid plate-to-trans crossmember bolt . . . . .	.54 N·m (40 ft. lbs.)
Spare tire winch bolt27 N·m (20 ft. lbs.)
Trailer hitch nut.108 N·m (80 ft. lbs.)

FUEL SYSTEM

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GENERAL INFORMATION

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GENERAL INFORMATION

INTRODUCTION

Throughout this group, references are made to particular vehicle models by alphabetical designation or by the particular vehicle nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section at the beginning of this manual.

All vehicles are equipped with either a 3.9L (V-6) engine, a 5.2L (V-8) engine, two different 5.9L (V-8) engines, two different 8.0L (V-10) engines, or a 5.9L Cummins in-line 6 cylinder diesel engine.

- The 3.9L (V-6) and 5.2L (V-8) engines will be referred to in this group as: LDC (Light Duty Emission Cycle) engines.
- The 5.9L (V-8) gas powered engine will be referred to as either: LDC (Light Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The 8.0L (V-10) engine will be referred to as either: MDC (Medium Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The diesel engine will be referred to as: HDC (Heavy Duty Emission Cycle) engine.

Either of the HDC gas powered engines can be easily identified by the use of an engine mounted air injection pump. The 3.9L/5.2L/5.9L LDC gas engines or the diesel engine will not use an air injection pump.

The **Fuel System** consists of: the fuel tank, an electric fuel tank mounted fuel pump (gas powered

engines), a fuel injection pump (diesel engine), a mechanical fuel transfer (lift) pump (diesel) and a fuel filter. It also consists of fuel tubes/lines/hoses and fittings, vacuum hoses, throttle body and fuel injector(s). The powertrain control module (PCM) will either directly operate or regulate certain components of the fuel system. Refer to the Powertrain Control Module sections for additional information.

The **Fuel Delivery System** consists of: the electric fuel pump (gas), fuel injection pump (diesel), fuel transfer pump (diesel), fuel filter, fuel tubes/lines/hoses, fuel rail, fuel injectors and fuel pressure regulator.

A **Fuel Return System** is used on all vehicles (all engines). On gas powered engines, fuel is returned through the fuel pump module and back to the fuel tank. A separate fuel return line from the tank to the engine is not used on any gas powered engine.

On diesel powered engines, a separate fuel return line from the tank to the engine is used.

The **Fuel Tank Assembly** consists of: the fuel tank, filler tube, fuel gauge sending unit/electric fuel pump module (electric fuel pump on gas powered engines only), a pressure relief/rollover valve and a pressure-vacuum filler cap.

Also to be considered part of the fuel system is the **Evaporation Control System**. This is designed to reduce the emission of fuel vapors into the atmosphere. The description and function of the Evaporative Control System is found in Group 25, Emission Control Systems.

GENERAL INFORMATION (Continued)**FUEL REQUIREMENTS**

Light spark knock at low engine speeds is not harmful to your engine. However, continued heavy spark knock at high speeds can cause damage and should be reported to your dealer immediately. Engine damage resulting from operating with a heavy spark knock may not be covered by the new vehicle warranty.

In addition to using unleaded gasoline with the proper octane rating, gasolines that contain detergents, corrosion and stability additives are recommended. Using gasolines that have these additives will help improve fuel economy, reduce emissions, and maintain vehicle performance. Generally, premium unleaded gasolines contain more additive than regular unleaded.

Poor quality gasoline can cause problems such as hard starting, stalling, and stumble. If you experience these problems, try another brand of gasoline before considering service for the vehicle.

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend gasoline with materials that contain oxygen such as alcohol, MTBE (Methyl Tertiary Butyl Ether) and ETBE (Ethyl Tertiary Butyl Ether). Oxygenates are required in some areas of the country during winter months to reduce carbon monoxide emissions. The type and amount of oxygenate used in the blend is important.

The following are generally used in gasoline blends:

Ethanol - (Ethyl or Grain Alcohol) properly blended, is used as a mixture of 10 percent ethanol and 90 percent gasoline. Gasoline blended with ethanol may be used in your vehicle.

Methanol - (Methyl or Wood Alcohol) is used in a variety of concentrations when blended with unleaded gasoline. You may find fuels containing 3 percent or more methanol along with other alcohols called cosolvents.

Do not use gasolines containing Methanol.

Use of methanol/gasoline blends may result in starting and driveability problems and damage critical fuel system components.

Problems that are the result of using methanol/gasoline blends are not the responsibility of Chrysler Motors and may not be covered by the new vehicle warranty.

MTBE/ETBE - Gasoline and MTBE (Methyl Tertiary Butyl Ether) blends are a mixture of unleaded gasoline blended and up to 15 percent MTBE. Gasoline and ETBE (Ethyl Tertiary Butyl Ether) are blends of gasoline and up to 17 percent ETBE. Gasoline blended with MTBE or ETBE may be used in your vehicle.

Many gasolines are now being blended that contribute to cleaner air, especially in those areas of the country where pollution levels are high. These new blends provide a cleaner burning fuel and some are referred to as reformulated gasoline.

Reformulated Gasoline

Many areas of the country are requiring the use of cleaner-burning fuel referred to as **Reformulated Gasoline**. Reformulated gasolines are specially blended to reduce vehicle emissions and improve air quality.

Chrysler Corporation strongly supports the use of reformulated gasolines whenever available. Although your vehicle was designed to provide optimum performance and lowest emissions operating on high quality unleaded gasoline, it will perform equally well and produce even lower emissions when operating on reformulated gasoline.

Materials Added to Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these materials intended for gum and varnish removal may contain active solvents of similar ingredients that can be harmful to fuel system gasket and diaphragm materials.

FUEL REQUIREMENTS—DIESEL ENGINE

WARNING: Do not use alcohol or gasoline as a fuel blending agent. They can be unstable under certain conditions and hazardous or explosive when mixed with diesel fuel.

Use good quality diesel fuel from a reputable supplier in your Dodge truck. For most year-round service, number 2 diesel fuel meeting ASTM specification D-975 will provide good performance. If the vehicle is exposed to extreme cold (below 0°F/-18°C), or is required to operate at colder-than-normal conditions for prolonged periods, use climatized No. 2 diesel fuel or dilute the No. 2 diesel fuel with 50% kerosene or No. 1 diesel fuel. This will provide better protection from fuel gelling or wax-plugging of the fuel filters.

Diesel fuel is seldom completely free of water. To prevent fuel system trouble, drain the accumulated water from the fuel/water separator using the fuel/water separator drain provided. If you buy good-quality fuel and follow the cold-weather advice above, fuel conditioners should not be required in your vehicle. If available in your area, a high cetane "premium" diesel fuel may offer improved cold starting and warm-up performance.

FUEL DELIVERY SYSTEM-GASOLINE ENGINE

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DESCRIPTION AND OPERATION

FUEL DELIVERY SYSTEM

The fuel delivery system consists of: the electric fuel pump, fuel filter/fuel pressure regulator, fuel tubes/lines/hoses, fuel rail, fuel injectors, fuel tank, accelerator pedal and throttle cable.

A fuel return system is used on all models (all gas powered engines). Fuel is returned through the fuel pump module and back into the fuel tank through the fuel filter/fuel pressure regulator. A separate fuel return line from the engine to the tank is no longer used with any gas powered engine.

The fuel tank assembly consists of: the fuel tank, filler tube, fuel gauge sending unit/electric fuel pump module, a pressure relief/rollover valve and a pressure-vacuum filler cap.

Also to be considered part of the fuel system is the evaporation control system. This is designed to reduce the emission of fuel vapors into the atmosphere. The description and function of the Evaporative Control System is found in Group 25, Emission Control Systems.

FUEL PUMP MODULE

The fuel pump module on all gas powered engines is installed in the top of the fuel tank (Fig. 1). The fuel pump module (Fig. 1) or (Fig. 2) contains the following:

- A combination fuel filter/fuel pressure regulator
- Electric fuel pump
- Fuel pump reservoir
- A separate in-tank fuel filter
- Pressure relief/rollover valve
- Fuel gauge sending unit
- Fuel supply line connection
- Auxiliary fuel supply fitting (not all engines)

FUEL PUMP

The fuel pump used in this system has a permanent magnet electric motor. The pump is part of the fuel pump module (Fig. 1). The fuel pump module is suspended in fuel in the fuel tank. Fuel is drawn in through a filter and pushed through the electric motor to the outlet. The pump contains a check valve. This valve is located near the pump outlet. It restricts fuel movement in either direction to maintain fuel supply line pressure when the pump is not

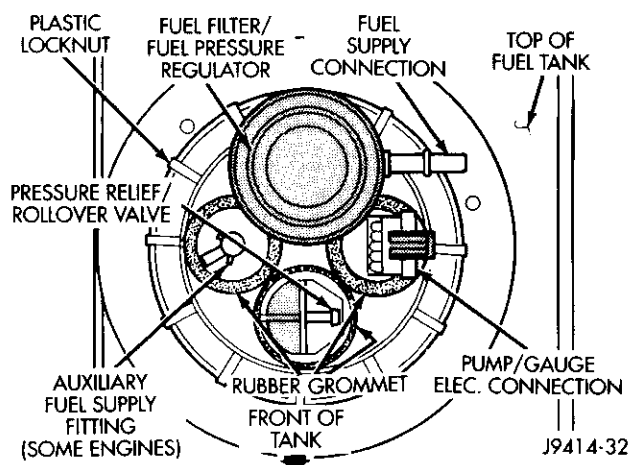
DESCRIPTION AND OPERATION (Continued)

Fig. 1 Top View Fuel Pump Module—Gas Powered Engines—Typical

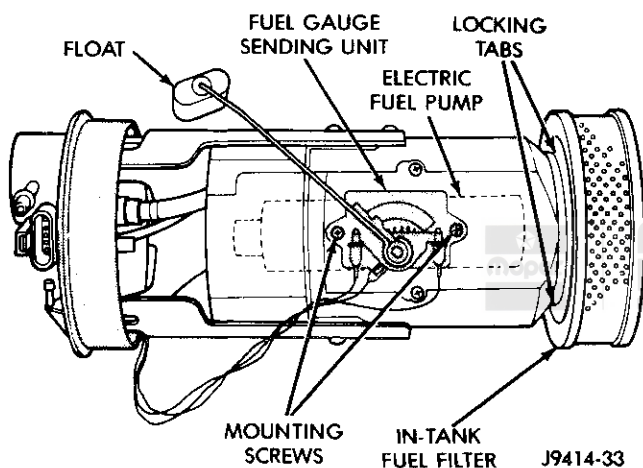


Fig. 2 Fuel Pump Module Components—Gas Powered Engines—Typical

operational. Voltage to operate the pump is supplied through the fuel pump relay.

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit is attached to the side of the fuel pump module. The sending unit consists of a float, an arm, and a variable resistor (track). The track is used to send an electrical signal for fuel gauge operation.

As the fuel level increases, the float and arm move up. This decreases the sending unit resistance, causing the fuel gauge on the instrument panel to read full. As the fuel level decreases, the float and arm move down. This increases the sending unit resistance, causing the fuel gauge on the instrument panel to read empty.

A reed type switch is also used to monitor fuel level in fuel tank. An electrical signal is sent to the PCM from this switch to indicate fuel level. The pur-

pose of this feature is to prevent a false setting of misfire and fuel system monitor trouble codes if the fuel level in the tank is less than 15 percent of its rated capacity. This switch is mounted in the fuel reservoir within the fuel pump module.

FUEL FILTER/FUEL PRESSURE REGULATOR

A combination fuel filter and fuel pressure regulator is used on all engines. It is pressed into a rubber grommet located on the top of the fuel pump module (Fig. 3). A separate frame mounted fuel filter is not used with any engine.

Fuel Pressure Regulator Operation: The pressure regulator is a mechanical device that is not controlled by engine vacuum or the powertrain control module (PCM).

The regulator is calibrated to maintain fuel system operating pressure of approximately 339 kPa \pm 34 kPa (49.2 psi \pm 5 psi) at the fuel injectors. It contains a diaphragm, calibrated springs and a fuel return valve. The internal fuel filter (Fig. 3) is also part of the assembly.

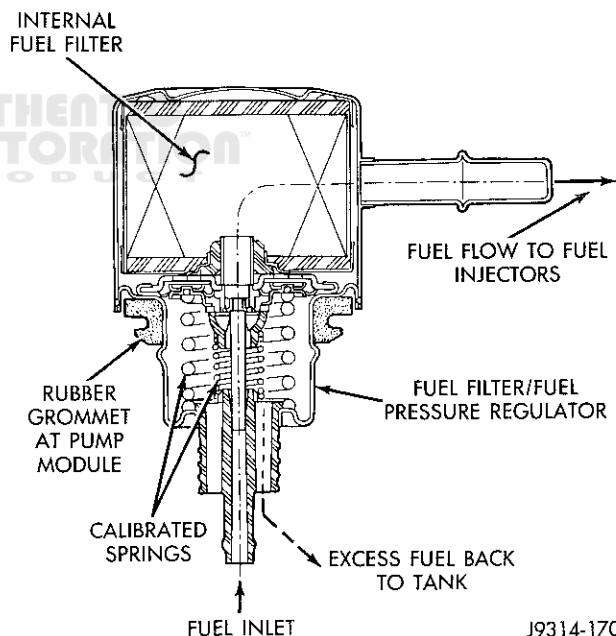


Fig. 3 Side View—Filter/Regulator

Fuel is supplied to the filter/regulator by the electric fuel pump through an opening tube at the bottom of filter/regulator (Fig. 3).

The fuel pump module contains a check valve to maintain some fuel pressure when the engine is not operating. This will help to start the engine.

If fuel pressure at the pressure regulator exceeds approximately 49.2 psi, an internal diaphragm closes and excess fuel pressure is routed back into the tank through the pressure regulator. A separate fuel return line is not used with any engine.

DESCRIPTION AND OPERATION (Continued)

FUEL TANK

All models pass a full 360 degree rollover test without fuel leakage. To accomplish this, fuel and vapor flow controls are required for all fuel tank connections.

All models have a pressure relief/rollover valve mounted in the top of the fuel tank.

An evaporation control system is used to reduce emissions of fuel vapors into atmosphere by evaporation and to reduce unburned hydrocarbons emitted by vehicle engine. When fuel evaporates from fuel tank, vapors pass through vent hoses or tubes to a charcoal canister. The are temporarily held in the canister. When the engine is running, the vapors are drawn into intake manifold. Refer to Group 25, Emission Control System for additional information.

FUEL INJECTORS—3.9L/5.2L/5.9L ENGINES

The fuel injectors are attached to the fuel rail (Fig. 4). 3.9L engines use six injectors. 5.2L and 5.9L engines use eight injectors.

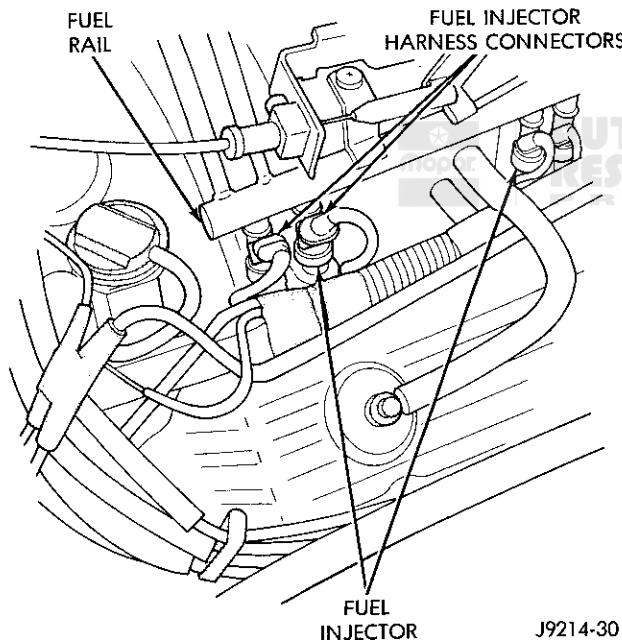


Fig. 4 Fuel Injectors—3.9L/5.2L/5.9L Engines—Typical

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by

switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

FUEL INJECTORS—8.0L ENGINE

The fuel injectors are attached to the fuel rail (Fig. 5). Ten individual injectors are used on the 8.0L V-10 engine.

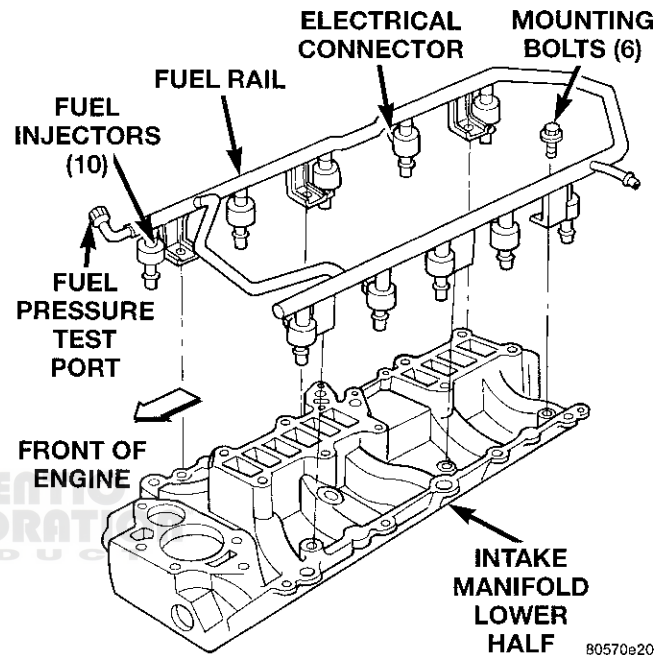


Fig. 5 Fuel Injectors—8.0L Engine—Typical

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

FUEL RAIL—3.9L/5.2L/5.9L ENGINES

The fuel rail supplies the necessary fuel to each individual fuel injector and is mounted to the intake manifold (Fig. 6). The fuel pressure regulator is no longer mounted to the fuel rail on any engine. It is now located on the fuel tank mounted fuel pump module. Refer to Fuel Filter/Fuel Pressure Regulator

DESCRIPTION AND OPERATION (Continued)

in the Fuel Delivery System section of this group for information. The fuel rail is not repairable.

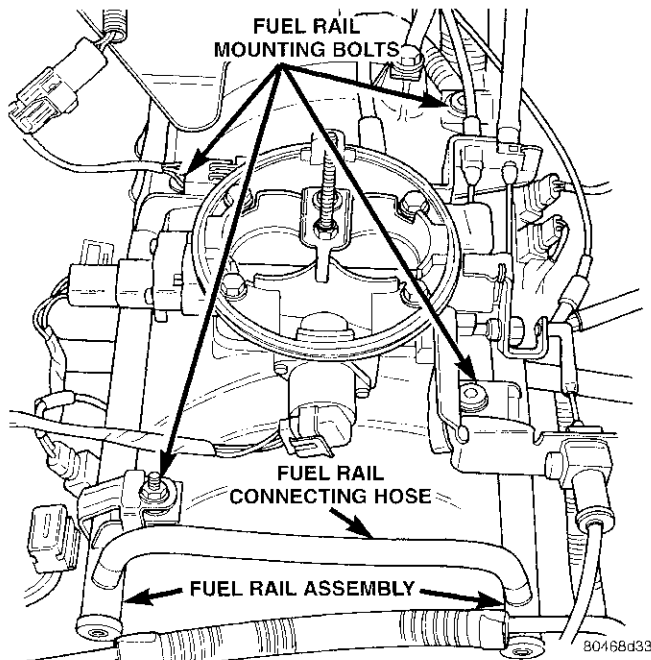


Fig. 6 Fuel Rail—3.9L/5.2L/5.9L Engines—Typical

CAUTION: The left and right sections of the fuel rail are connected with a flexible connecting hose. Do not attempt to separate the rail halves at this connecting hose. Due to the design of this connecting hose, it does not use any clamps. Never attempt to install a clamping device of any kind to the hose. When removing the fuel rail assembly for any reason, be careful not to bend or kink the connecting hose.

FUEL RAIL—8.0L ENGINE

The fuel rail supplies the necessary fuel to each individual fuel injector and is mounted to the lower half of the two-piece intake manifold (Fig. 5). The metal, one-piece fuel rail is not repairable.

FUEL TANK FILLER TUBE CAP

The loss of any fuel or vapor out of filler neck is prevented by the use of a pressure-vacuum fuel tank filler tube cap. Relief valves inside cap will release only under significant pressure of 6.58 to 8.44 kPa (1.95 to 2.5 psi). The vacuum release for all gas caps is between .97 and 2.0 kPa (.14 and .29 psi). This cap must be replaced by a similar unit if replacement is necessary. This is in order for the system to remain effective.

CAUTION: Remove fuel tank filler tube cap before servicing any fuel system component. This is done to help relieve tank pressure.

QUICK-CONNECT FITTINGS

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type or a plastic retainer ring type. Some are equipped with safety latch clips. Refer to the Removal/Installation section for more information.

CAUTION: The interior components (o-rings, spacers) of quick-connect fitting are not serviced separately, but new pull tabs are available for some types. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

DIAGNOSIS AND TESTING**FUEL PUMP PRESSURE TEST—ALL ENGINES WITH PRESSURE TEST PORT**

NOTE: The fuel pressure test port is used on certain engines only. On 3.9L/5.2L/5.9L engines, and when equipped, the test port will be located on the fuel rail near the throttle position sensor on (Fig. 7). On 8.0L V-10 engines, this test port is located on the end of the fuel rail near the engine thermostat housing (Fig. 5). A sealing cap is screwed onto the test port.

NOTE: The vacuum assisted fuel pressure regulator located at the rear of the fuel rail on 3.9L/5.2L/5.9L engines is no longer used on any engine.

All fuel systems are equipped with a fuel tank module mounted, combination fuel filter/fuel pressure regulator. The fuel pressure regulator is not controlled by engine vacuum.

With engine at idle speed, system fuel pressure should be 339 kPa \pm 34 kPa (49.2 psi \pm 5 psi).

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER AND AROUND THE PRESSURE PORT TO ABSORB FUEL.

WARNING: WEAR PROPER EYE PROTECTION WHEN TESTING FUEL SYSTEM PRESSURE.

(1) Remove the protective cap at the fuel rail test port (Fig. 5) or (Fig. 7). Connect the 0–414 kPa (0–60 psi) fuel pressure gauge (from gauge set 5069) to the test port pressure fitting on the fuel rail (Fig. 7).

DIAGNOSIS AND TESTING (Continued)

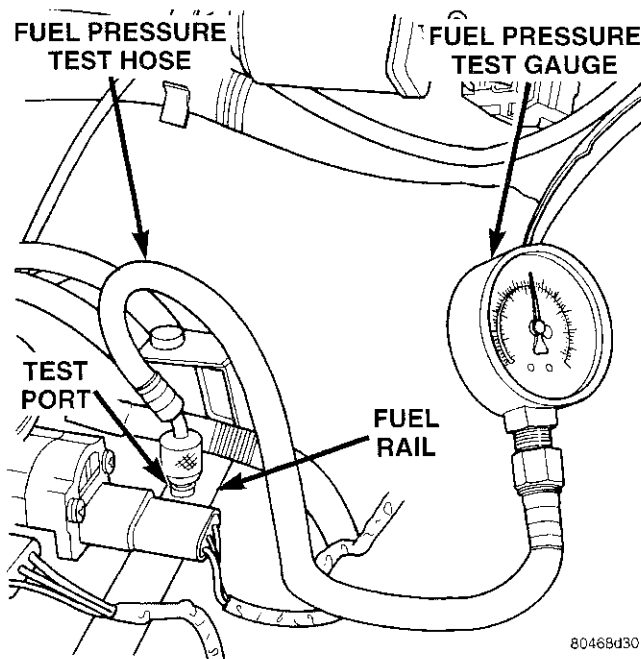


Fig. 7 Fuel Pressure Test Port—3.9L/5.2L/5.9L Engines—Typical

(2) Start the engine and note pressure gauge reading. Fuel pressure should be $339 \text{ kPa} \pm 34 \text{ kPa}$ ($49.2 \text{ psi} \pm 5 \text{ psi}$) at idle.

(3) If pressure is at 0 psi, connect DRB scan tool and refer to operating instructions in the appropriate Powertrain Diagnostics Procedures service manual.

(4) If operating pressure is above 54.2 psi, fuel pump is OK but fuel pressure regulator is defective. Fuel pressure regulator is not serviced separately. Replace fuel pump module assembly.

FUEL PUMP PRESSURE TEST-ALL ENGINES WITHOUT PRESSURE TEST PORT

NOTE: The fuel pressure test port is used on certain engines only. If equipped, the test port will be located on the fuel rail near the throttle position sensor (Fig. 7). If not equipped, refer to the following procedure:

All fuel systems are equipped with a fuel tank module mounted, combination fuel filter/fuel pressure regulator. The fuel pressure regulator is not controlled by engine vacuum.

With engine at idle speed, system fuel pressure should be $339 \text{ kPa} \pm 34 \text{ kPa}$ ($49.2 \text{ psi} \pm 5 \text{ psi}$).

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. BEFORE DISCONNECTING FUEL LINE AT FUEL RAIL, THIS PRESSURE MUST BE RELEASED.

REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE.

(1) Release fuel pressure. Refer to the Fuel System Pressure Release Procedure—Without Pressure Test Port.

(2) Disconnect latch clip and fuel line at fuel rail. Refer to Quick-Connect Fittings for procedures. This can be found in this section of the group.

(3) Connect adapter tool number 6923 into the fuel rail (Fig. 8). Be sure adapter tool is fully seated into fuel rail.

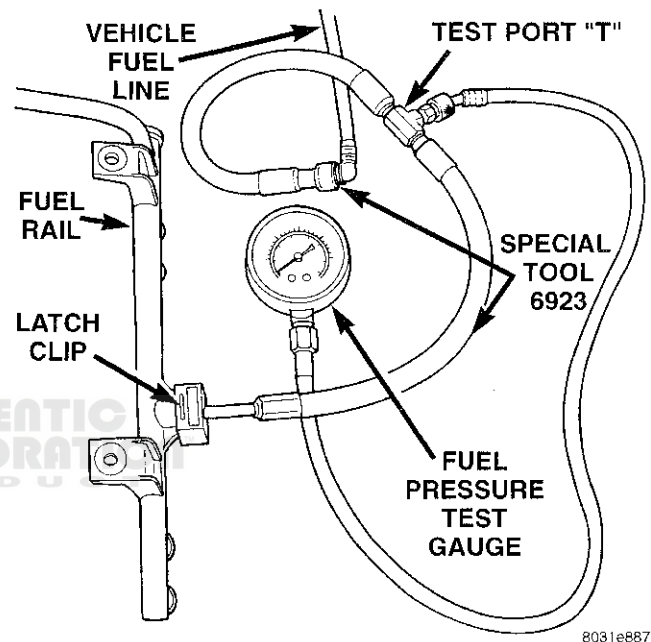


Fig. 8 Installing Adapter Tool and Pressure Gauge

(4) Install latch clip to fuel rail. If latch clip can not be fully seated into fuel rail, check for adapter tool not fully seated to fuel rail.

(5) Connect vehicle fuel line into adapter tool 6923 (Fig. 8). Be sure fuel line is fully seated into adapter tool 6923.

(6) Remove protective cap at test port "T" on adapter tool number 6923.

(7) Connect the 0–414 kPa (0–60 psi) fuel pressure gauge (from gauge set 5069) to the test port "T" (Fig. 8).

(8) Start engine and note pressure gauge reading. Fuel pressure should be $339 \text{ kPa} \pm 34 \text{ kPa}$ ($49.2 \text{ psi} \pm 5 \text{ psi}$) at idle.

(9) If pressure is at 0 psi, connect DRB scan tool and refer to operating instructions in the appropriate Powertrain Diagnostics Procedures service manual.

(10) If operating pressure is above 54.2 psi, fuel pump is OK but fuel pressure regulator is defective. Fuel pressure regulator is not serviced separately. Replace fuel pump module assembly.

DIAGNOSIS AND TESTING (Continued)

(11) After performing pressure test, install fuel line into fuel rail. Install latch clip into fuel rail. Refer to Quick-Connect Fittings for procedures. This can be found in this section of the group.

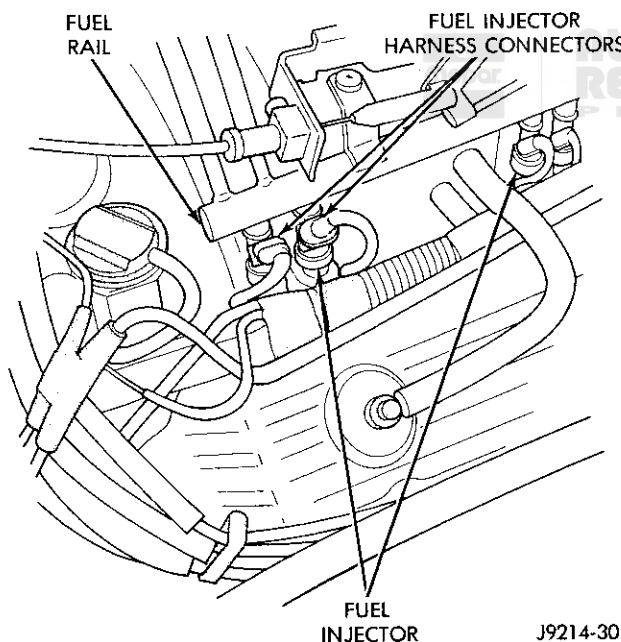
FUEL GAUGE SENDING UNIT

For fuel gauge diagnosis, refer to Group 8E, Instrument Panel and Gauges.

FUEL INJECTORS

To perform a complete test of the fuel injectors and their circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the injector only, refer to the following:

Disconnect the fuel injector wire harness connector from the injector (Fig. 9). Place an ohmmeter across the injector terminals. Resistance reading should be approximately $14.5 \text{ ohms} \pm 1.2 \text{ ohms}$ at 20°C (68°F). Proceed to following Injector Diagnosis chart. **When performing the following tests from the chart, do not leave electrical current applied to the injector for longer than five seconds. Damage to injector coil or internal injector seals (Fig. 10) could result.**

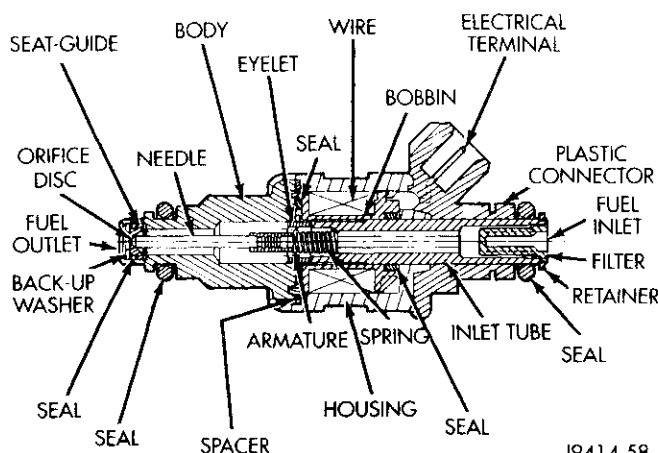


J9214-30

Fig. 9 Fuel Injector Wiring Connector—Typical

SERVICE PROCEDURES**FUEL SYSTEM PRESSURE RELEASE PROCEDURE—WITH PRESSURE TEST PORT**

NOTE: The fuel pressure test port is used on certain engines only. If equipped, the test port will be located on the fuel rail near the throttle position



J9414-58

Fig. 10 Fuel Injector Internal Components—Typical sensor (Fig. 7). A sealing cap is screwed onto the test port.

The fuel system is under constant fuel pressure (even with the engine off).

WARNING: BECAUSE THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE, THE PRESSURE MUST BE RELEASED BEFORE SERVICING ANY FUEL SYSTEM COMPONENT. THIS DOES NOT APPLY TO THROTTLE BODY REMOVAL.

- (1) Disconnect negative battery cable.
- (2) Remove the fuel tank filler tube cap to release fuel tank pressure.
- (3) Remove protective cap from pressure test port on the fuel rail. This is located on top of fuel rail near the throttle position sensor.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER AND AROUND THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

WARNING: WEAR PROPER EYE PROTECTION WHEN RELEASING FUEL SYSTEM PRESSURE.

- (4) Obtain the fuel pressure gauge/hose assembly from fuel pressure gauge tool set 5069. Remove the gauge from the hose.

- (5) Place one end of hose (gauge end) into an approved gasoline container.

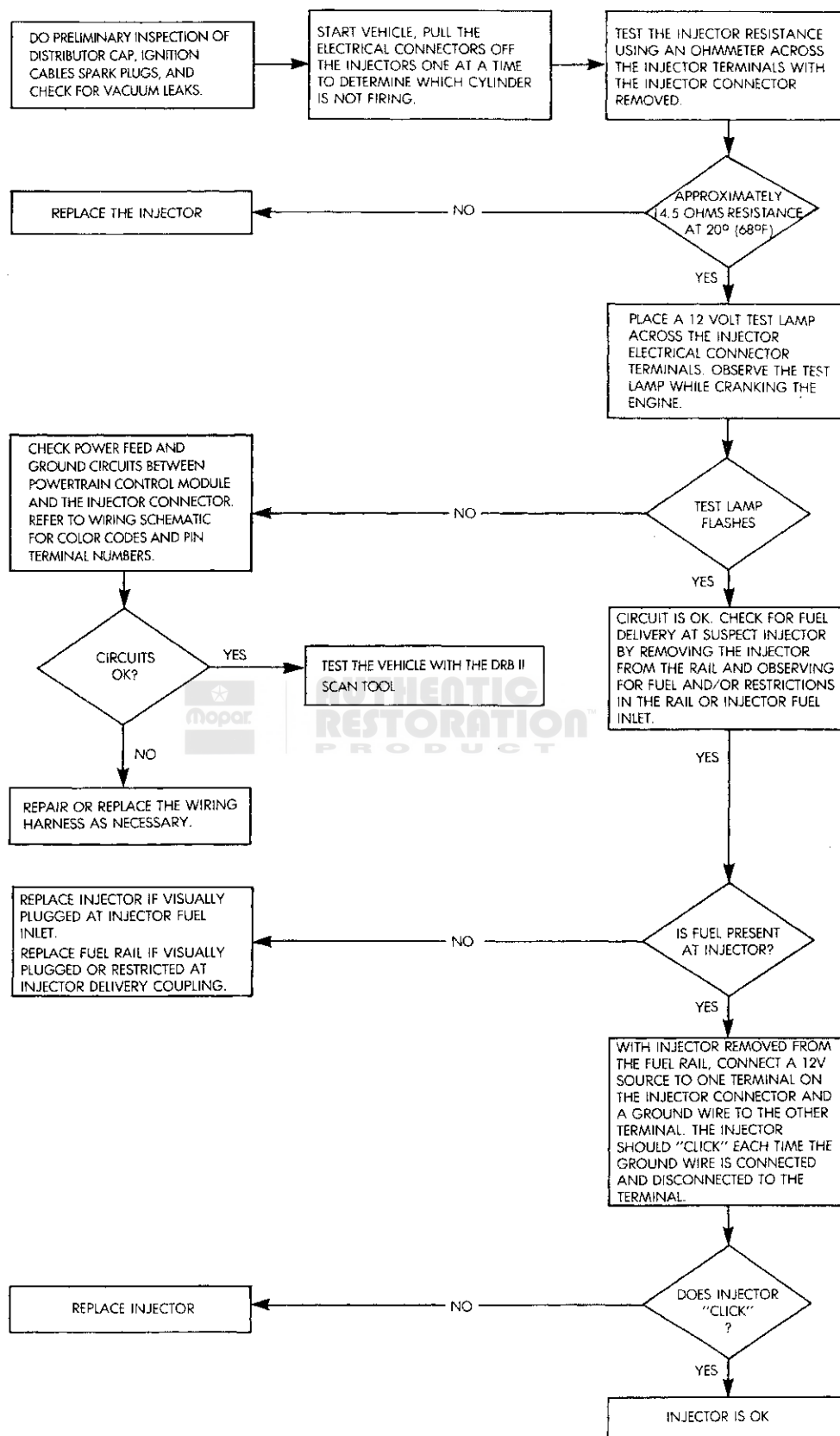
- (6) Place a shop towel under the test port.

- (7) To release fuel pressure, screw the other end of hose onto the fuel pressure test port.

- (8) After fuel pressure has been released, remove the hose from the test port.

- (9) Install protective cap to fuel test port.

SERVICE PROCEDURES (Continued)



J9314-114

INJECTOR DIAGNOSIS—VEHICLE RUNS ROUGH AND/OR HAS A MISS

SERVICE PROCEDURES (Continued)**FUEL SYSTEM PRESSURE RELEASE****PROCEDURE—WITHOUT PRESSURE TEST PORT**

Use the following procedure if the fuel rail is not equipped with a fuel pressure test port.

- (1) Remove the Fuel Pump relay from the Power Distribution Center (PDC). For location of the relay, refer to the label on the underside of the PDC cover.
- (2) Start and run engine it stalls.
- (3) Attempt restarting engine until it will no longer run.
- (4) Turn ignition key to OFF position.

CAUTION: Steps 1, 2, 3 and 4 must be performed to relieve high pressure fuel from within the fuel rail. Do not attempt to use the following steps to relieve this pressure as excessive fuel will be forced into a cylinder chamber.

- (5) Unplug connector from any injector.
- (6) Attach one end of a jumper wire with alligator clips (18 gauge or smaller) to either injector terminal.
- (7) Connect the other end of the jumper wire to the positive side of the battery.
- (8) Connect one end of a second jumper wire to the remaining injector terminal.

CAUTION: Supplying power to an injector for more than 4 seconds will permanently damage the injector. Do not leave the injector connected to power for more than 4 seconds.

- (9) Momentarily touch the other end of this jumper wire to the negative terminal of the battery for no more than 4 seconds.

- (10) Place a rag or towel below the fuel line at the quick connect to the rail.

- (11) Disconnect the quick connect fitting to the rail. Refer to Quick-Connect Fittings in this section.

- (12) Return the fuel pump relay to the PDC.

- (13) One or more Diagnostic Trouble Codes (DTC's) may have been stored in the PCM memory due to fuel pump relay removal. The DRB scan tool must be used to erase a DTC. Refer to Group 25, Emission Control System. See On-Board Diagnostics.

FUEL TUBES/LINES/HOSES AND CLAMPS

Also refer to the section on Quick-Connect Fittings.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

Inspect all hose connections such as clamps, couplings and fittings to make sure they are secure and

leaks are not present. The component should be replaced immediately if there is any evidence of degradation that could result in failure.

Never attempt to repair a plastic fuel line/tube. Replace as necessary.

Avoid contact of any fuel tubes/hoses with other vehicle components that could cause abrasions or scuffing. Be sure that the plastic fuel lines/tubes are properly routed to prevent pinching and to avoid heat sources.

The lines/tubes/hoses used on fuel injected vehicles are of a special construction. This is due to the higher fuel pressures and the possibility of contaminated fuel in this system. If it is necessary to replace these lines/tubes/hoses, only those marked EFM/EFI may be used.

The hose clamps used to secure rubber hoses on fuel injected vehicles are of a special rolled edge construction. This construction is used to prevent the edge of the clamp from cutting into the hose. Only these rolled edge type clamps may be used in this system. All other types of clamps may cut into the hoses and cause high-pressure fuel leaks.

Use new original equipment type hose clamps. Tighten hose clamps to 1 N·m (15 in. lbs.) torque.

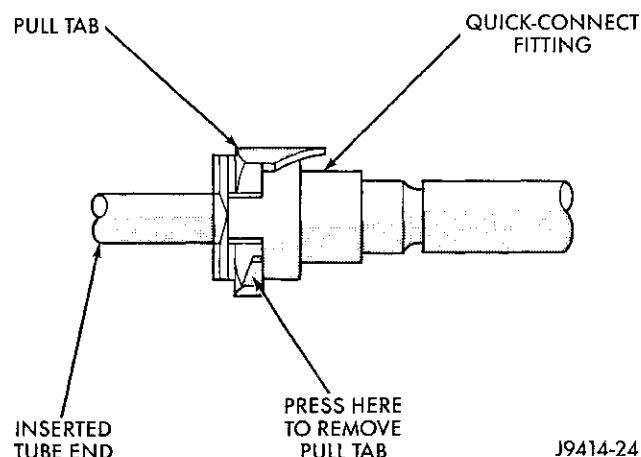
QUICK-CONNECT FITTINGS

Also refer to the Fuel Tubes/Lines/Hoses and Clamps section.

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type, a plastic retainer ring type or a latch clip type. Certain fittings may require the use of a special tool for disconnection.

SINGLE-TAB TYPE

This type of fitting is equipped with a single pull tab (Fig. 11). The tab is removable. After the tab is removed, the quick-connect fitting can be separated from the fuel system component.



J9414-24

Fig. 11 Single-Tab Type Fitting

SERVICE PROCEDURES (Continued)

CAUTION: The interior components (o-rings, spacers) of this type of quick-connect fitting are not serviced separately, but new pull tabs are available. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

- (1) Disconnect negative battery cable from battery.
- (2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.
- (3) Clean the fitting of any foreign material before disassembly.
- (4) Press the release tab on the side of fitting to release pull tab (Fig. 12).

CAUTION: If this release tab is not pressed prior to releasing the pull tab, the pull tab will be damaged.

- (5) While pressing the release tab on the side of the fitting, use a screwdriver to pry up the pull tab (Fig. 12).

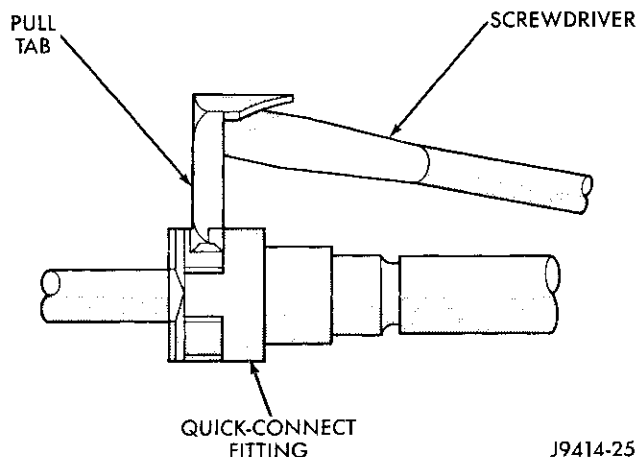


Fig. 12 Disconnecting Single-Tab Type Fitting

- (6) Raise the pull tab until it separates from the quick-connect fitting (Fig. 13). Discard the old pull tab.
- (7) Disconnect the quick-connect fitting from the fuel system component being serviced.
- (8) Inspect the quick-connect fitting body and fuel system component for damage. Replace as necessary.

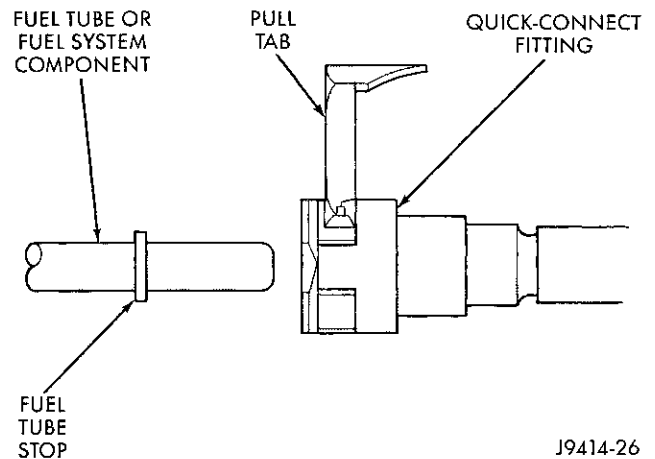


Fig. 13 Removing Pull Tab

- (9) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.
- (10) Insert the quick-connect fitting into the fuel tube or fuel system component until the built-on stop on the fuel tube or component rests against back of fitting.
- (11) Obtain a new pull tab. Push the new tab down until it locks into place in the quick-connect fitting.
- (12) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).
- (13) Connect negative cable to battery.
- (14) Start engine and check for leaks.

TWO-TAB TYPE FITTING

This type of fitting is equipped with tabs located on both sides of the fitting (Fig. 14). These tabs are supplied for disconnecting the quick-connect fitting from component being serviced.

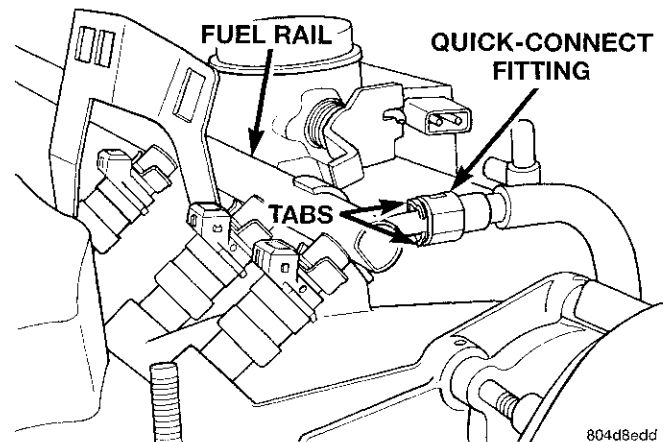


Fig. 14 Typical Two-Tab Type Quick-Connect Fitting

SERVICE PROCEDURES (Continued)

CAUTION: The interior components (o-rings, spacers) of this type of quick-connect fitting are not serviced separately, but new plastic retainers are available. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

- (1) Disconnect negative battery cable from the battery.
- (2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.
- (3) Clean the fitting of any foreign material before disassembly.
- (4) To disconnect the quick-connect fitting, squeeze the plastic retainer tabs (Fig. 14) against the sides of the quick-connect fitting with your fingers. Tool use is not required for removal and may damage plastic retainer. Pull the fitting from the fuel system component being serviced. The plastic retainer will remain on the component being serviced after fitting is disconnected. The o-rings and spacer will remain in the quick-connect fitting connector body.
- (5) Inspect the quick-connect fitting body and component for damage. Replace as necessary.

CAUTION: When the quick-connect fitting was disconnected, the plastic retainer will remain on the component being serviced. If this retainer must be removed, very carefully release the retainer from the component with two small screwdrivers. After removal, inspect the retainer for cracks or any damage.

- (6) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(7) Insert the quick-connect fitting to the component being serviced and into the plastic retainer. When a connection is made, a click will be heard.

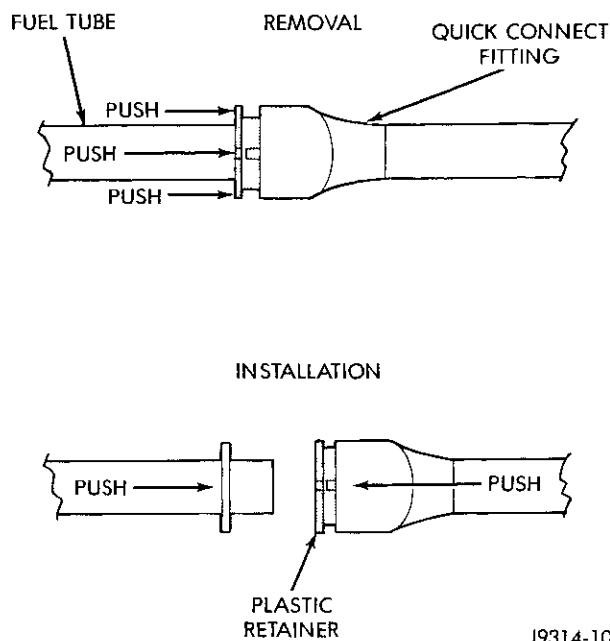
(8) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).

(9) Connect negative cable to battery.

(10) Start engine and check for leaks.

PLASTIC RETAINER RING TYPE FITTING

This type of fitting can be identified by the use of a full-round plastic retainer ring (Fig. 15) usually black in color.



J9314-100

Fig. 15 Plastic Retainer Ring Type Fitting

CAUTION: The interior components (o-rings, spacers, retainers) of this type of quick-connect fitting are not serviced separately. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

- (1) Disconnect negative battery cable from the battery.
- (2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.
- (3) Clean the fitting of any foreign material before disassembly.
- (4) To release the fuel system component from the quick-connect fitting, firmly push the fitting towards the component being serviced while firmly pushing the plastic retainer ring into the fitting (Fig. 15). With the plastic ring depressed, pull the fitting from

SERVICE PROCEDURES (Continued)

the component. The plastic retainer ring must be pressed squarely into the fitting body. If this retainer is cocked during removal, it may be difficult to disconnect fitting. Use an open-end wrench on the shoulder of the plastic retainer ring to aid in disconnection.

(5) After disconnection, the plastic retainer ring will remain with the quick-connect fitting connector body.

(6) Inspect fitting connector body, plastic retainer ring and fuel system component for damage. Replace as necessary.

(7) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(8) Insert the quick-connect fitting into the component being serviced until a click is felt.

(9) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).

(10) Connect negative battery cable to battery.

(11) Start engine and check for leaks.

FUEL LINE AT FUEL RAIL—3.9L/5.2L/5.9L ENGINES

Use the following procedure if the fuel rail is equipped with a fuel pressure test port.

A latch clip is used to secure the fuel line to the fuel rail on certain engines (Fig. 16). A special tool will be necessary to separate the fuel line from the fuel rail after the latch clip is removed.

DISCONNECTION/CONNECTION AT FUEL RAIL

(1) Disconnect the negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) Pry up on the latch clip with a screwdriver (Fig. 17).

(5) Slide the latch clip toward the fuel rail while lifting with the screwdriver.

(6) Insert special fuel line removal tool (Snap-On number FIH 9055-1 or equivalent) into the fuel line (Fig. 18). Use this tool to release the locking fingers in the end of the line.

(7) With the special tool still inserted, pull the fuel line from the fuel rail.

(8) After disconnection, the locking fingers will remain within the quick-connect fitting at the end of the fuel line.

(9) Inspect fuel line fitting, locking fingers and fuel rail fitting for damage. Replace as necessary.

(10) Prior to connecting the fuel line to the fuel rail, check condition of both fittings. Clean the parts

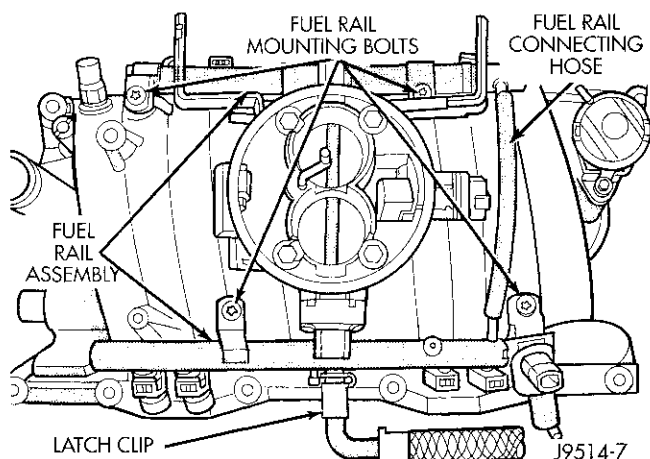


Fig. 16 Latch Clip Location—Typical

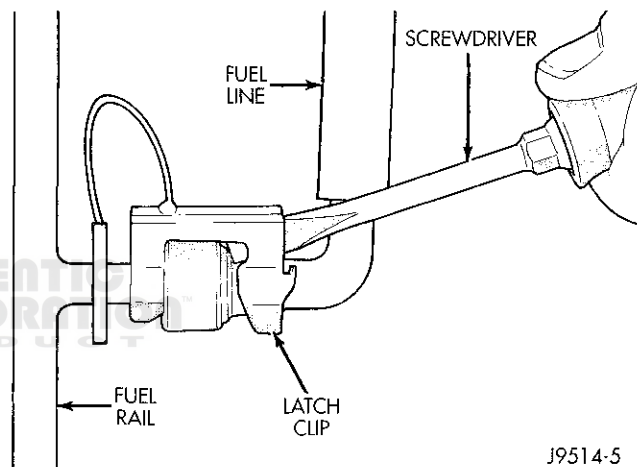


Fig. 17 Latch Clip Removal—Typical

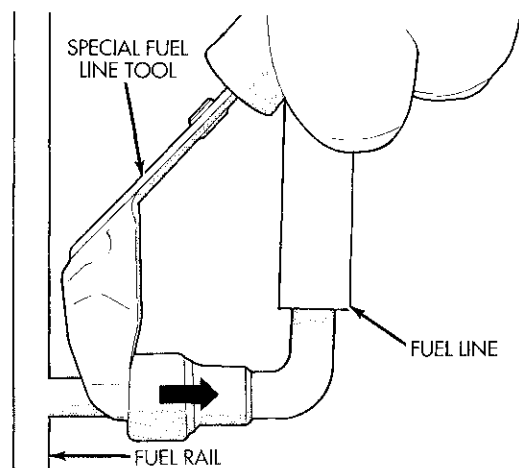


Fig. 18 Fuel Line Disconnection—Typical

with a lint-free cloth. Lubricate them with clean engine oil.

(11) Insert the fuel line onto the fuel rail until a click is felt.

SERVICE PROCEDURES (Continued)

(12) Verify a locked condition by firmly pulling on fuel line and fitting (15-30 lbs.).

(13) Install latch clip (snaps into position). **If the latch clip will not fit, this indicates the fuel line is not properly installed to the fuel rail. Recheck the fuel line connection.**

(14) Connect negative battery cable to battery.

(15) Start engine and check for leaks.

FUEL LINE AT FUEL RAIL—3.9L/5.2L/5.9L ENGINES

Use the following procedure if the fuel rail is not equipped with a fuel pressure test port.

A special latch clip is used to secure the fuel line to the fuel rail on this particular engine (Fig. 19).

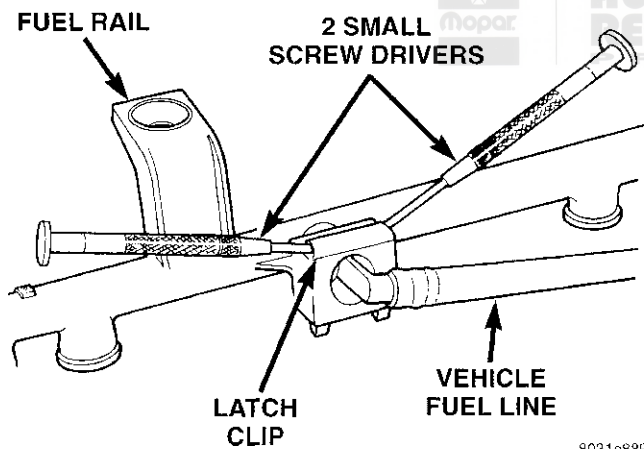
DISCONNECTION/CONNECTION AT FUEL RAIL

(1) Disconnect the negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) Pry up on the latch clip with two small screwdrivers (Fig. 19).

**Fig. 19 Latch Clip Removal**

(5) Pull the fuel line from the fuel rail.

(6) After disconnection, the locking fingers will remain within the quick-connect fitting in the fuel rail.

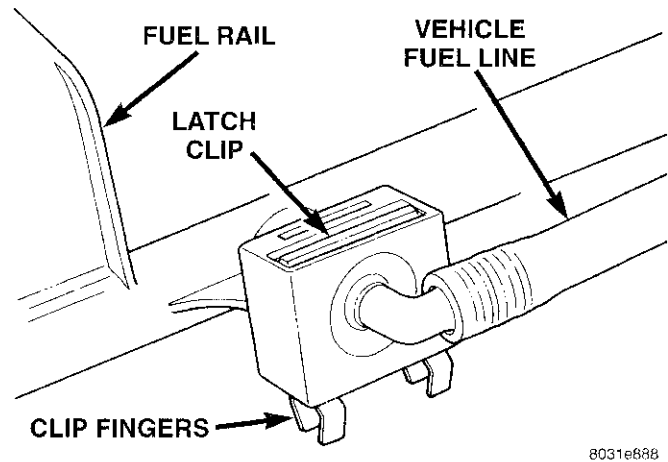
(7) Inspect fuel line fitting, locking fingers and fuel rail fitting for damage. Replace as necessary.

(8) Prior to connecting the fuel line to the fuel rail, check condition of both fittings. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(9) Insert the fuel line into the fuel rail.

(10) Install latch clip with fingers down (snaps into position). The fingers should protrude below the

fuel rail if properly installed (Fig. 20). **If the latch clip will not fit, this indicates the fuel line is not properly installed to the fuel rail. Recheck the fuel line connection.**

**Fig. 20 Latch Clip Installation**

(11) Verify a locked condition by firmly pulling on fuel line and fitting (15-30 lbs.).

(12) Connect negative battery cable to battery.

(13) Start engine and check for leaks.

FUEL LINE AT FUEL RAIL—8.0L V-10 ENGINE

A special tool will be necessary to separate the fuel line at the rear of fuel rail. The tool is designed to release the locking fingers within the fittings. Use OTC® fuel line release tool number 7660 or equivalent.

(1) Disconnect the negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Remove the air cleaner housing.

(4) Clean the fitting of any foreign material before disassembly.

(5) Install special fuel line tool to fuel line to unlock fuel line fingers.

(6) Pull the fuel line from the fuel rail.

(7) After disconnection, the locking fingers will remain within the quick-connect fitting in the fuel rail.

(8) Inspect fuel line fitting, locking fingers and fuel rail fitting for damage. Replace as necessary.

(9) Prior to connecting the fuel line to the fuel rail, check condition of both fittings. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(10) Insert the fuel line into the fuel rail.

(11) Verify a locked condition by firmly pulling on fuel line and fitting (15-30 lbs.).

(12) Connect negative battery cable to battery.

SERVICE PROCEDURES (Continued)

- (13) Start engine and check for leaks.

REMOVAL AND INSTALLATION

FUEL FILTER/FUEL PRESSURE REGULATOR

If the filter or regulator needs service, the Fuel Pump Module assembly must be replaced. Refer to Fuel Pump Module for procedures.

FUEL PUMP RELAY

The fuel pump and automatic shutdown (ASD) relays are located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 21). Refer to label on PDC cover for relay location. Check the terminals in the PDC relay connector for corrosion or damage before installation.

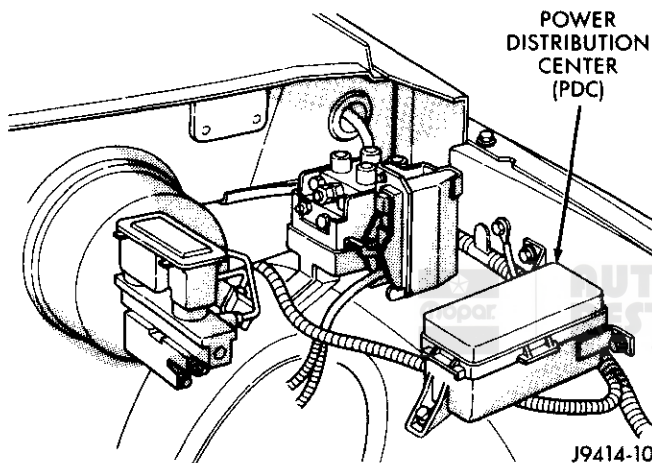


Fig. 21 Power Distribution Center

FUEL PUMP MODULE

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING THE FUEL PUMP MODULE, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

CAUTION: Whenever the fuel pump module is serviced, the locknut and gasket must be replaced.

- (1) Drain the fuel tank. Refer to Draining Fuel Tank in the Fuel Tank section of this group.

- (2) Remove fuel tank. Refer to the Fuel Tank section of this group.

- (3) The plastic fuel pump module locknut is threaded onto the fuel tank (Fig. 22). Install Special Tool 6856 to the fuel pump module locknut and

remove locknut (Fig. 24). The fuel pump module will spring up when the locknut is removed.

- (4) Remove module from fuel tank.

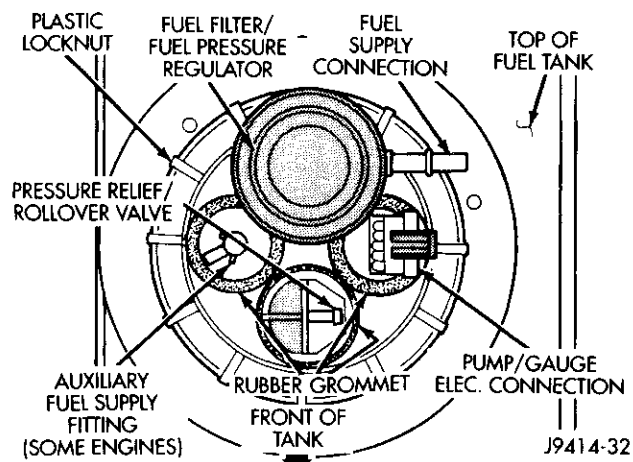


Fig. 22 Top View of Fuel Pump Module

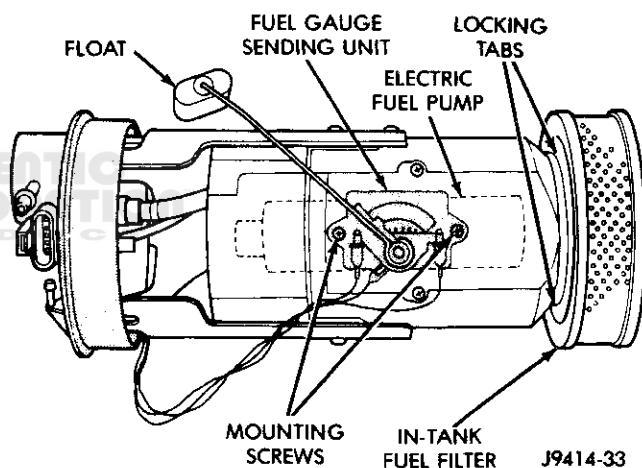


Fig. 23 Fuel Pump Module Components—Typical

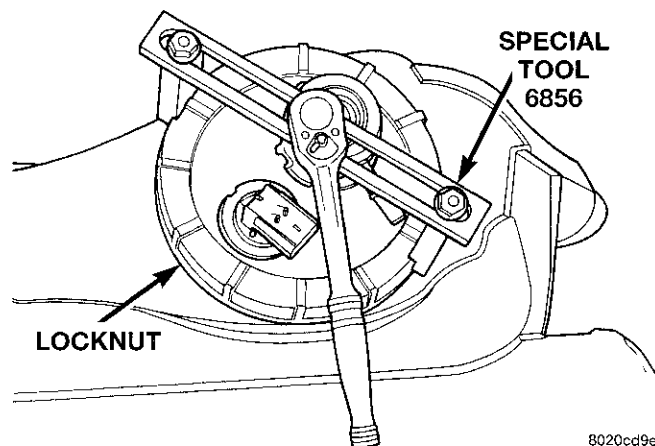


Fig. 24 Locknut Removal/Installation—Typical

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

CAUTION: Whenever the fuel pump module is serviced, the locknut and gasket must be replaced.

- (1) Using a new gasket, position fuel pump module into opening in fuel tank.
- (2) Position new locknut over top of fuel pump module.
- (3) Install Special Tool 6856 to locknut.
- (4) Tighten locknut to 54 N·m (40 ft. lbs.) torque.
- (5) Install fuel tank. Refer to Fuel Tank Installation in this section.

FUEL PUMP INLET STRAINER

The fuel pump inlet strainer (in-tank fuel filter) is not serviced separately. If it needs service, the fuel pump module assembly must be replaced. Refer to Fuel Pump Module Removal/Installation.

FUEL LEVEL SENSOR

The fuel level sensor (fuel gauge sending unit) is not serviced separately. If it needs service, the fuel pump module assembly must be replaced. Refer to Fuel Pump Module Removal/Installation.

FUEL INJECTOR RAIL—3.9L/5.2L/5.9L ENGINES

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL RAIL ASSEMBLY, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel System Pressure Release Procedure found in this group.

CAUTION: The left and right fuel rails are replaced as an assembly. Do not attempt to separate the rail halves at the connecting hose (Fig. 25). Due to the design of this connecting hose, it does use any clamps. Never attempt to install a clamping device of any kind to the hose. When removing the fuel rail assembly for any reason, be careful not to bend or kink the connecting hose.

REMOVAL

- (1) Remove negative battery cable at battery.
- (2) Remove air cleaner.
- (3) Perform the fuel pressure release procedure.
- (4) Remove throttle body from intake manifold. Refer to Throttle Body removal in this group.
- (5) If equipped with air conditioning, remove the A-shaped A/C compressor-to-intake manifold support bracket (three bolts) (Fig. 26).
- (6) Disconnect electrical connectors at all fuel injectors (Fig. 27). The factory fuel injection wiring

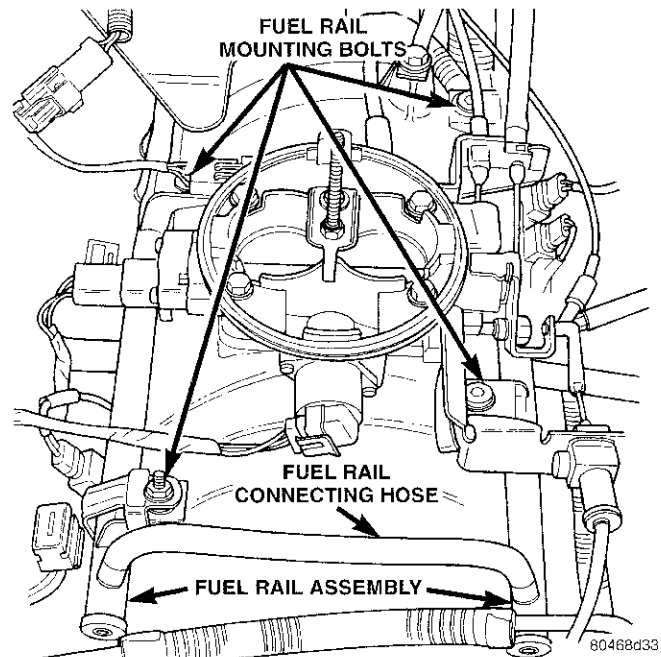


Fig. 25 Fuel Rail Assembly—Typical

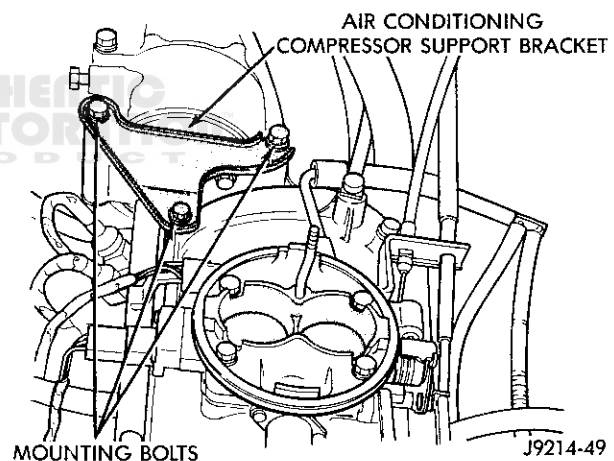


Fig. 26 A/C Compressor Support Bracket—Typical

harness is numerically tagged (INJ 1, INJ 2, etc.) for injector position identification.

(7) 3.9L (V-6) engine only: Disconnect electrical connector at intake manifold air temperature sensor. Do not remove sensor.

(8) Remove duty cycle EVAP canister purge solenoid/bracket assembly (Fig. 28) from intake manifold.

(9) Disconnect fuel tube (line) at side of fuel rail. Refer to Quick-Connect Fittings for procedures.

(10) Remove the remaining fuel rail mounting bolts.

(11) Gently rock and pull the **left** fuel rail until the fuel injectors just start to clear the intake manifold. Gently rock and pull the **right** fuel rail until the fuel injectors just start to clear the intake mani-

REMOVAL AND INSTALLATION (Continued)

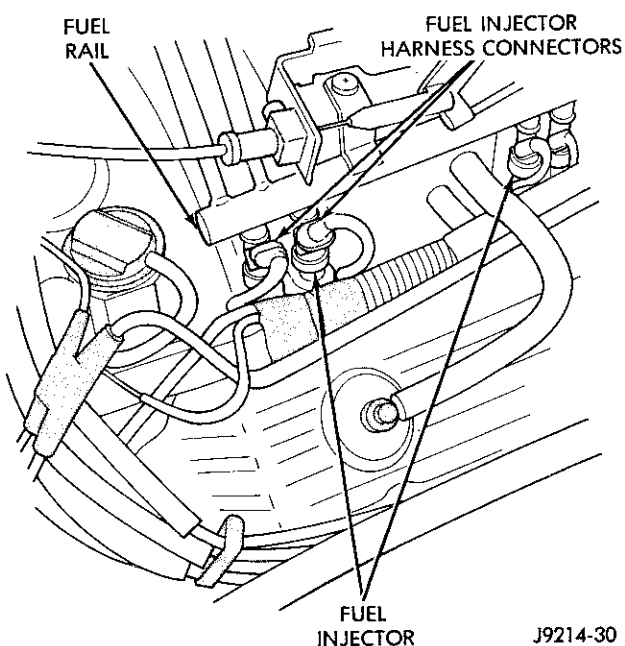


Fig. 27 Fuel Injector Connectors—Typical

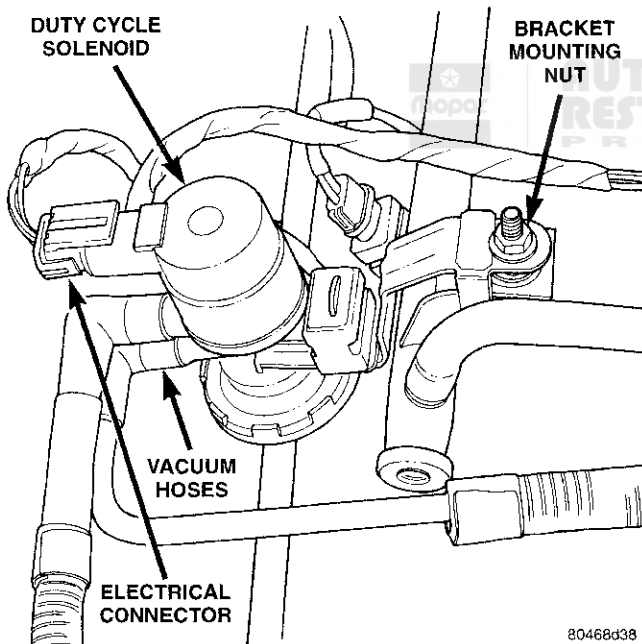


Fig. 28 EVAP Canister Purge Solenoid—Typical

fold. Repeat this procedure (left/right) until all fuel injectors have cleared the intake manifold.

(12) Remove fuel rail (with injectors attached) from engine.

(13) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 29) or (Fig. 30).

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector o-ring. This will help in fuel rail installation.

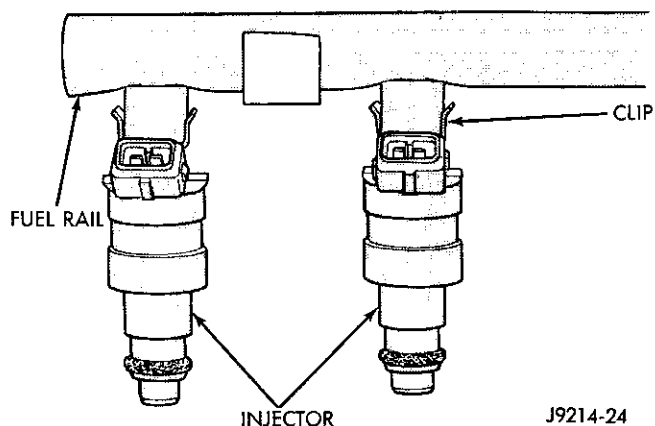


Fig. 29 Fuel Injector Mounting—Typical

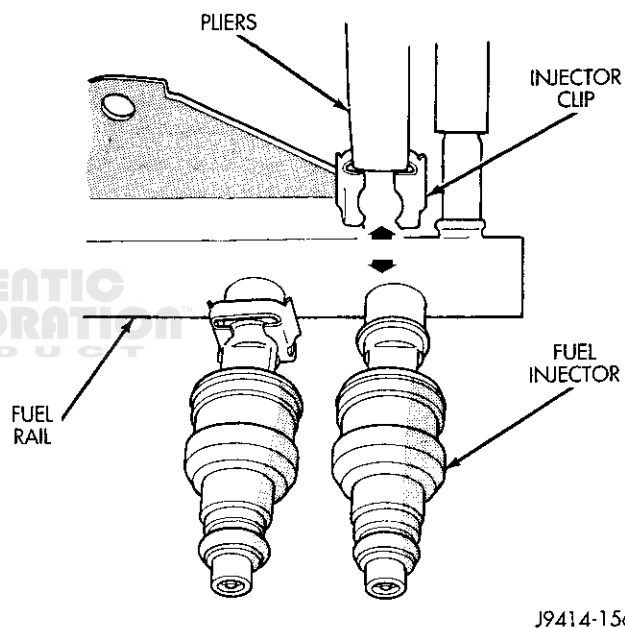


Fig. 30 Injector Retaining Clips—Typical Injector

(2) Install injector(s) and injector clip(s) to fuel rail.

(3) Position the fuel rail/fuel injector assembly to the injector openings on the intake manifold.

(4) Guide each injector into the intake manifold. Be careful not to tear the injector o-ring.

(5) Push the **right** fuel rail down until fuel injectors have bottomed on injector shoulder. Push the **left** fuel rail down until fuel injectors have bottomed on injector shoulder.

(6) Install fuel rail mounting bolts.

(7) Install EVAP canister purge solenoid to intake manifold.

(8) Connect electrical connector to intake manifold air temperature sensor.

(9) Connect wiring to all fuel injectors. The injector wiring harness is numerically tagged.

REMOVAL AND INSTALLATION (Continued)

- (10) Install the A/C support bracket (if equipped).
- (11) Install throttle body to intake manifold. Refer to Throttle Body installation in this section of the group.
- (12) Install fuel tube (line) at side of fuel rail. Refer to Quick-Connect Fittings for procedures.
- (13) Install air cleaner.
- (14) Connect battery cable to battery.
- (15) Start engine and check for leaks.

FUEL INJECTOR RAIL—8.0L V-10 ENGINE**REMOVAL**

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE EVEN WITH THE ENGINE OFF. BEFORE SERVICING THE FUEL RAIL, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

- (1) Remove negative battery cable at battery.
- (2) Remove air cleaner housing and tube.
- (3) Perform the fuel pressure release procedure. Refer to the Fuel Delivery System section of this group.
- (4) Disconnect throttle body linkage and remove throttle body from intake manifold. Refer to Throttle Body removal in this group.
- (5) Remove ignition coil pack and bracket assembly (Fig. 31) at intake manifold and right engine valve cover (four bolts).

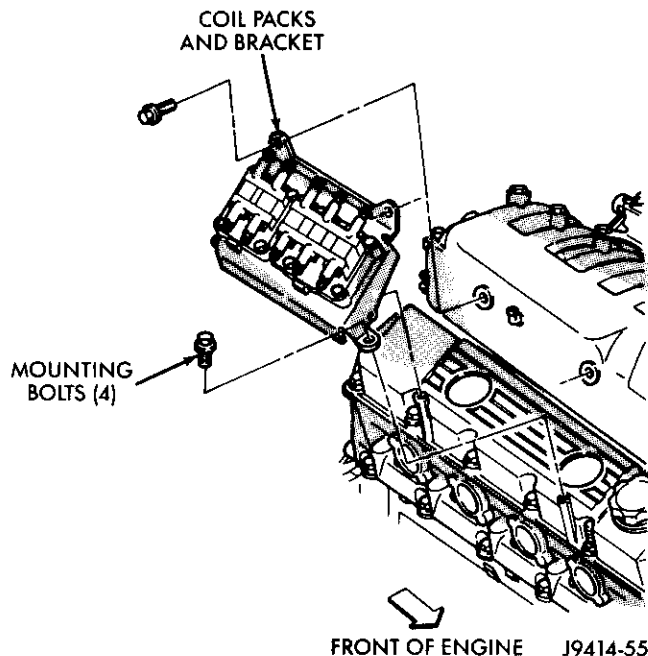


Fig. 31 Ignition Coil Pack and Mounting Bracket—8.0L V-10 Engine

(6) Remove upper half of intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedures.

(7) Disconnect electrical connectors at all fuel injectors. The factory fuel injection wiring harness is numerically tagged (INJ 1, INJ 2, etc.) for injector position identification.

(8) Disconnect main fuel line at fuel rail. On the 8.0L V-10 engine, the fuel line-to-fuel rail connection is made at the rear of the engine. A special tool will be necessary for disconnection. Refer to Quick-Connect Fittings for procedures.

(9) Remove the six fuel rail mounting bolts from the lower half of intake manifold (Fig. 32).

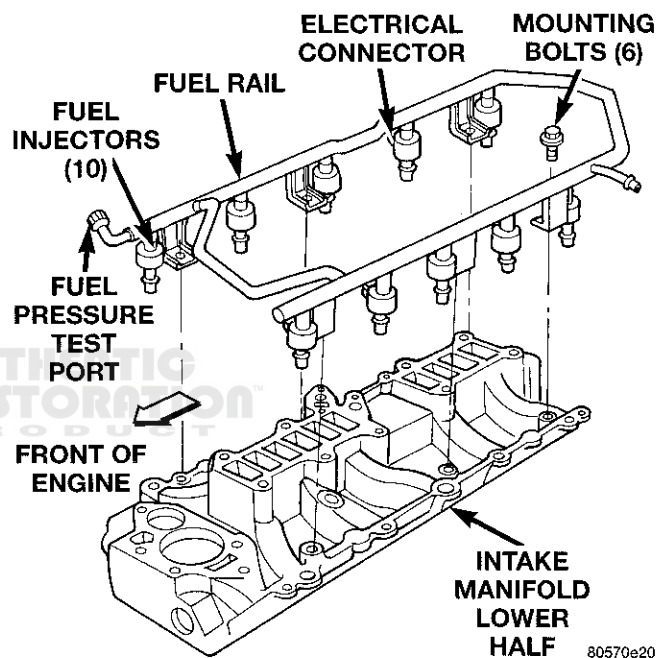


Fig. 32 Fuel Rail Mounting Bolts—8.0L V-10 Engine—Typical

(10) Gently rock and pull the **left** fuel rail until the fuel injectors just start to clear the intake manifold. Gently rock and pull the **right** fuel rail until the fuel injectors just start to clear the intake manifold. Repeat this procedure (left/right) until all fuel injectors have cleared the intake manifold.

(11) Remove fuel rail (with injectors attached) from engine.

(12) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 29) or (Fig. 30).

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector o-ring. This will help in fuel rail installation.

(2) Install injector(s) and injector clip(s) to fuel rail.

REMOVAL AND INSTALLATION (Continued)

NOTE: The fuel injector electrical connectors on all 10 injectors should be facing to the right (passenger) side of the vehicle (Fig. 32).

(3) Position the fuel rail/fuel injector assembly to the injector openings on the intake manifold.

(4) Guide each injector into the intake manifold. Be careful not to tear the injector o-ring.

(5) Push the **right** fuel rail down until fuel injectors have bottomed on injector shoulder. Push the **left** fuel rail down until fuel injectors have bottomed on injector shoulder.

(6) Install the six fuel rail mounting bolts into the lower half of intake manifold. Tighten bolts to 15 N·m (136 in. lbs.) torque.

(7) Connect wiring to all fuel injectors. The injector wiring harness is numerically tagged.

(8) Install upper half of intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for procedures.

(9) Connect main fuel line at fuel rail. Refer to Quick-Connect Fittings for procedures.

(10) Install ignition coil pack and bracket assembly at intake manifold and right engine valve cover (four bolts).

(11) Install throttle body to intake manifold. Refer to Throttle Body removal in this group.

(12) Install throttle body linkage to throttle body.

(13) Install air cleaner tube and housing.

(14) Install negative battery cable at battery.

(15) Start engine and check for leaks.

FUEL INJECTOR(S)—ALL GAS ENGINES

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE EVEN WITH THE ENGINE TURNED OFF. BEFORE SERVICING THE FUEL INJECTOR(S), THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel System Pressure Release Procedure.

To remove one or more fuel injectors, the fuel rail assembly must be removed from engine.

REMOVAL

(1) Remove air cleaner assembly.

(2) Remove fuel injector rail assembly. Refer to Fuel Injector Rail removal in this section.

(3) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 29) or (Fig. 30).

(4) Remove injector(s) from fuel rail.

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector o-ring. This will help in fuel rail installation.

(2) Install injector(s) and injector clip(s) to fuel rail.

(3) Install fuel rail assembly. Refer to Fuel Injector Rail installation.

(4) Install air cleaner.

(5) Start engine and check for leaks.

FUEL TANK—ALL ENGINES

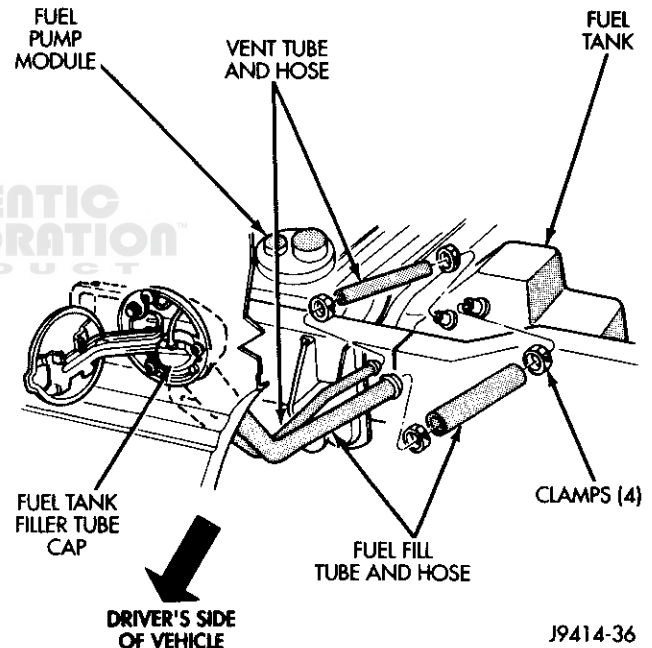
DRAINING FUEL TANK

(1) Remove fuel tank filler tube cap to release fuel tank pressure.

(2) Perform Fuel System Pressure Release procedure as described in this group.

(3) Raise vehicle on hoist.

(4) While working over the left rear tire/wheel, disconnect the rubber fuel fill hose and clamp at fuel tank (Fig. 33). Position fuel siphoning/drain hose into this opening at tank.



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Fig. 33 Fuel Tank Fill and Vent Hoses

(5) Drain fuel into an approved portable holding tank or a properly labeled gasoline safety container.

TANK REMOVAL

(1) Disconnect negative battery cable at battery.

(2) Remove fuel tank filler tube cap.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE EVEN WITH THE ENGINE OFF. BEFORE SERVICING THE FUEL TANK, FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL TANK.

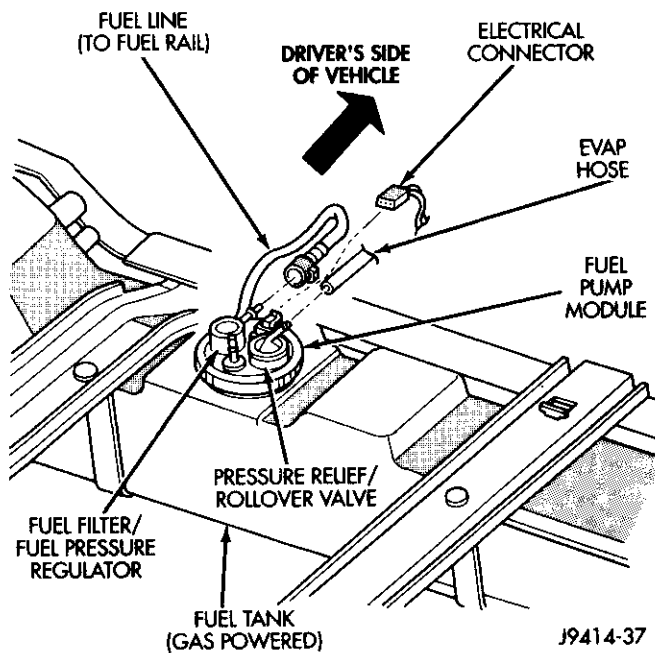
REMOVAL AND INSTALLATION (Continued)

Fig. 34 Fuel Tank Connections—Gas Powered Engines

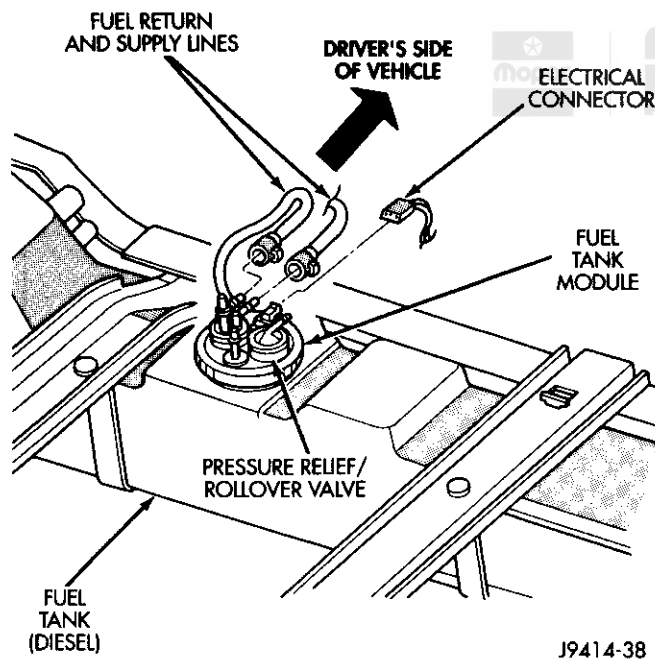


Fig. 35 Fuel Tank Connections—Diesel Powered Engines

(3) Drain fuel tank. Refer to the previous Draining Fuel Tank section.

(4) Disconnect both the fuel fill and fuel vent rubber hoses at the fuel tank (Fig. 33).

(5) **Gas Powered Engines:**

(a) While working over the left rear tire/wheel, disconnect the electrical connector from the fuel pump module (Fig. 34).

(b) Disconnect the EVAP hose at the pressure relief/rollover valve (Fig. 34).

(c) Disconnect the fuel supply line at the fuel filter/fuel pressure regulator (Fig. 34). Refer to Quick-Connect Fittings for procedures.

(6) **Diesel Powered Engines:**

(a) While working over the left rear tire/wheel, disconnect the electrical connector from the fuel tank module (Fig. 35).

(b) Disconnect the fuel supply and fuel return lines at the fuel tank module (Fig. 35). Refer to Quick-Connect Fittings for procedures.

(7) Place a transmission jack under the center of the fuel tank. Apply a slight amount of pressure to fuel tank with transmission jack.

WARNING: WRAP SHOP TOWELS AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

(8) Remove the fuel tank mounting strap nuts at the mounting straps (Fig. 36). If equipped, remove the fuel tank heat shield bolts (Fig. 36).

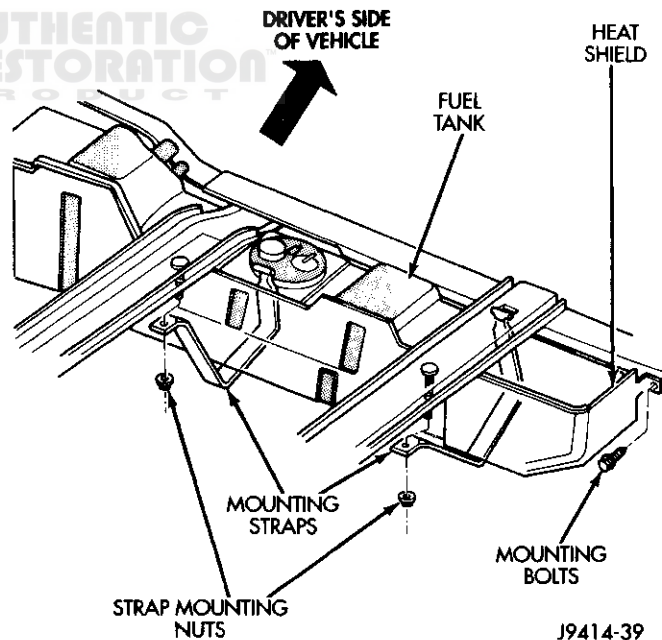


Fig. 36 Fuel Tank Mounting—Typical

(9) Lower fuel tank for removal.

TANK INSTALLATION

(1) Place fuel tank on top of transmission jack.

(2) Raise tank into position in the frame crossmembers.

(3) Connect the two mounting straps and mounting strap nuts.

REMOVAL AND INSTALLATION (Continued)

(4) Remove transmission jack. Tighten strap nuts to 41 N·m (30 ft. lbs.) torque. Do not over tighten retaining strap nuts.

(5) Gas Powered Engines:

(a) Connect the electrical connector to the fuel pump module (Fig. 34).

(b) Connect the EVAP hose at the pressure relief/rollover valve (Fig. 34).

(c) Connect the fuel supply line at the fuel filter/fuel pressure regulator (Fig. 34). Refer to Quick-Connect Fittings for procedures.

Diesel Powered Engines:

(d) Connect the electrical connector to the fuel tank module (Fig. 35).

(e) Connect the fuel supply and fuel return lines at the fuel tank module (Fig. 35). Refer to Fuel Tubes/Lines/Hoses and Clamps in this group for additional information about fuel line removal and installation. Also refer to Quick-Connect Fittings in this group.

(6) Install the rubber fill and vent lines to tank. Tighten hose clamps to 2.3 N·m (20 in. lbs.) torque.

(7) Refill fuel tank and inspect all hoses and lines for leaks.

(8) Connect negative battery cable to battery.

ACCELERATOR PEDAL

REMOVAL

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing accelerator pedal or cables.

(1) From inside the vehicle, hold up the accelerator pedal. Remove the plastic cable retainer and throttle cable core wire from upper end of pedal arm (Fig. 37). The plastic cable retainer snaps into the pedal arm.

(2) Insert a small screwdriver into the square holes located on the pivots/bushings (Fig. 38). Twist the screwdriver to disengage the pivot locks from the pivot pin. Pivots will be damaged when removing. Discard old pivots.

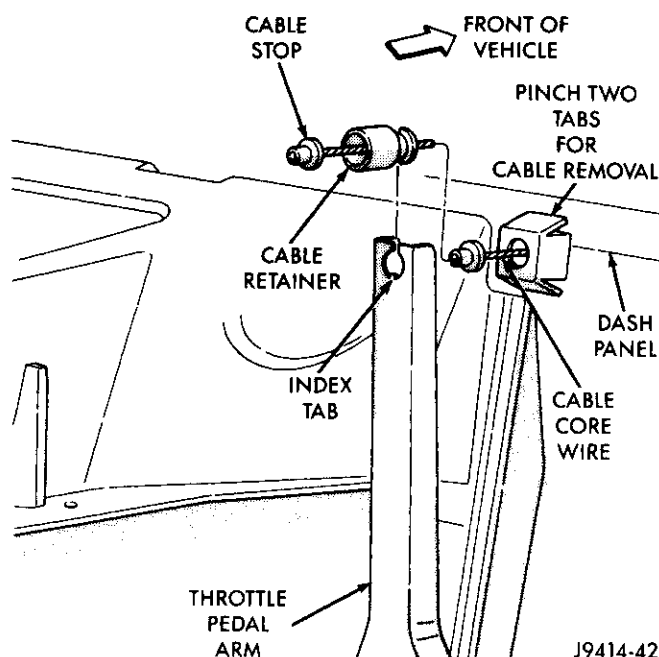
(3) Remove pedal/bracket assembly from vehicle.

INSTALLATION

(1) Position pedal/bracket assembly over the pivot pin (Fig. 38).

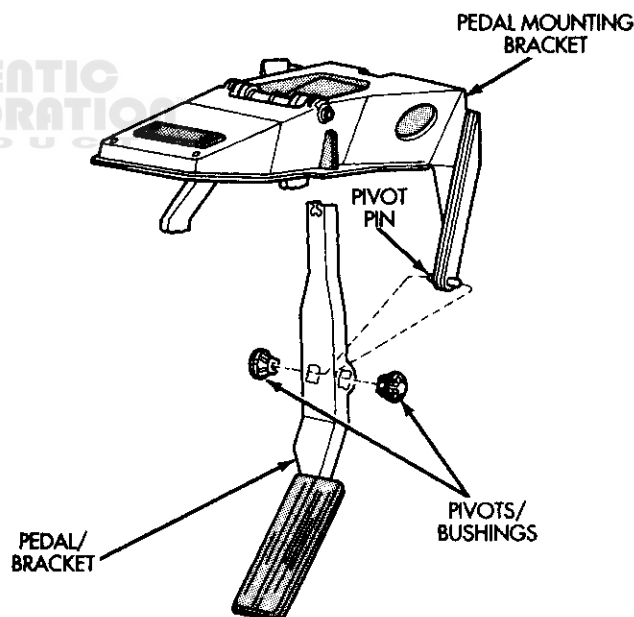
(2) Install two new pivots/bushings. Using large pliers, press both of the bushings together until they bottom on the sides of the pedal/bracket assembly. Bushing retaining ears will snap into position when properly installed.

(3) From inside the vehicle, hold up the accelerator pedal. Install the throttle cable core wire and plastic cable retainer into and through the upper end of the



J9414-42

Fig. 37 Cable Removal/Installation



J9414-40

Fig. 38 Accelerator Pedal—Removal or Installation

pedal arm (the plastic retainer is snapped into the pedal arm). When installing the plastic retainer to the accelerator pedal arm, note the index tab on the pedal arm (Fig. 37). Align the index slot on the plastic cable retainer to this index tab.

REMOVAL AND INSTALLATION (Continued)**THROTTLE CABLE**

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing accelerator pedal or cables.

REMOVAL

(1) From inside the vehicle, hold up the accelerator pedal. Remove the plastic cable retainer and throttle cable core wire from upper end of pedal arm (Fig. 37). The plastic cable retainer snaps into pedal the arm.

(2) Remove the cable core wire at the pedal arm.

(3) Remove the air cleaner housing.

(4) From inside the vehicle, pinch both sides of the plastic cable housing retainer tabs at the dash panel (Fig. 37).

(5) Remove cable housing from dash panel and pull the cable into the engine compartment.

(6) **3.9L/5.2L/5.9L Engines:** Disconnect the cable from the routing/holddown clip at the radiator fan shroud.

(7) **8.0L V-10 Engine:** Remove the throttle cable socket at throttle lever ball. (Fig. 40) (snaps off).

(8) **3.9L/5.2L/5.9L Engines:** Slip the cable end rearward from pin on throttle body (Fig. 39).

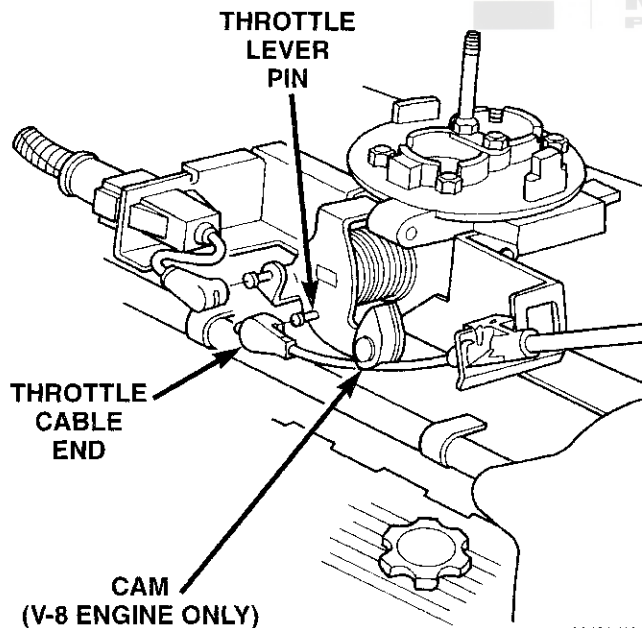


Fig. 39 Throttle Cable at Throttle Body—3.9L/5.2L/5.9L Engines—Typical

(9) Remove cable housing at throttle body mounting bracket by pressing on release tab with a small screwdriver (Fig. 41) or (Fig. 40). **To prevent cable housing breakage, press on the tab only enough to release the cable from the bracket.** Lift the

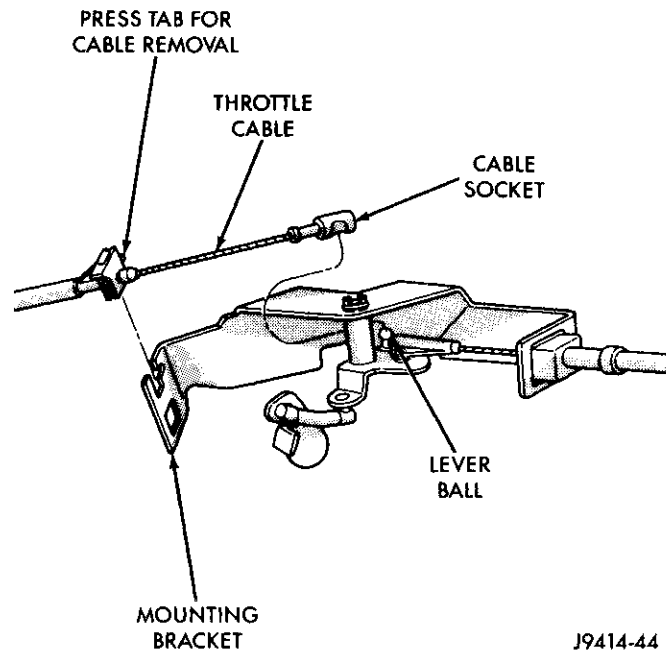


Fig. 40 Throttle Cable at Throttle Body—8.0L V-10 Engine

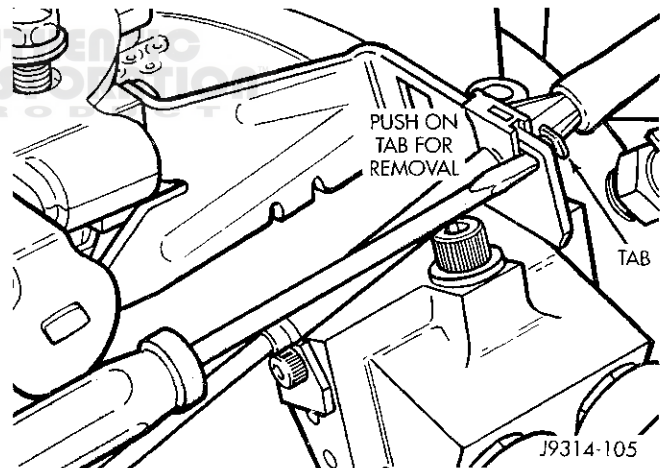


Fig. 41 Cable Release Tab—3.9L/5.2L/5.9L Engines—Typical

cable housing straight up from bracket while pressing on release tab. Remove throttle cable from vehicle.

INSTALLATION

(1) **3.9L/5.2L/5.9L Engines:**

(a) Rotate and hold the throttle cam in the full wide open position. Snap the cable end onto lever pin (Fig. 39).

(b) Connect cable to throttle body mounting bracket (push down and lock).

(c) Connect cable to fan shroud routing clip.

(2) **8.0L V-10 Engine:**

REMOVAL AND INSTALLATION (Continued)

(a) Connect cable end socket to throttle body lever ball (snaps on) (Fig. 40).

(b) Connect cable to throttle body mounting bracket (push down and lock).

(3) Install the remaining cable housing end into and through the dash panel opening (snaps into position). The two plastic pinch tabs (Fig. 37) should lock the cable to dash panel.

(4) From inside the vehicle, hold up the accelerator pedal. Install the throttle cable core wire and plastic cable retainer into and through the upper end of the pedal arm (the plastic retainer is snapped into the pedal arm). When installing the plastic retainer to the accelerator pedal arm, note the index tab on the pedal arm (Fig. 37). Align the index slot on the plastic cable retainer to this index tab.

SPECIFICATIONS**VECI LABEL SPECIFICATIONS**

If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label. The VECI label is located in the engine compartment.

FUEL TANK CAPACITY

Models	Liters	U.S. Gallons
118" Wheelbase	98	26
All Other Models	132	35
Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.		

FUEL SYSTEM PRESSURE

All Engines: 339 kPa \pm 34 kPa (49.2 psi \pm 5 psi)

TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
Fuel Pump Module Locknut . . . . .	.54 N·m (40 ft. lbs.)
Fuel Rail Mounting Bolts—	
3.9L/5.2L/5.9L Engines . . . . .	.23 N·m (200 in. lbs.)
Fuel Rail Mounting Bolts—	
8.0L Engine . . . . .	.15 N·m (136 in. lbs.)
Fuel Tank Mounting Nuts . . . . .	.41 N·m (30 ft. lbs.)
Fuel Hose Clamps . . . . .	.1 N·m (15 in. lbs.)



**AUTHENTIC
RESTORATION
PRODUCT**

FUEL INJECTION SYSTEM-GASOLINE ENGINES

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GENERAL INFORMATION

INTRODUCTION

All engines are equipped with sequential Multi-Port Fuel Injection (MFI). The MFI system provides precise air/fuel ratios for all driving conditions.

The powertrain control module (PCM) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM (Fig. 1) is a pre-programmed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement

and idle speed. The PCM can adapt its programming to meet changing operating conditions.

Powertrain Control Module (PCM) Inputs represent the instantaneous engine operating conditions. Air-fuel mixture and ignition timing calibrations for various driving and atmospheric conditions are pre-programmed into the PCM. The PCM monitors and analyzes various inputs. It then computes engine fuel and ignition timing requirements based on these inputs. Fuel delivery control and ignition timing will then be adjusted accordingly.

Other inputs to the PCM are provided by the brake light switch, air conditioning select switch and the

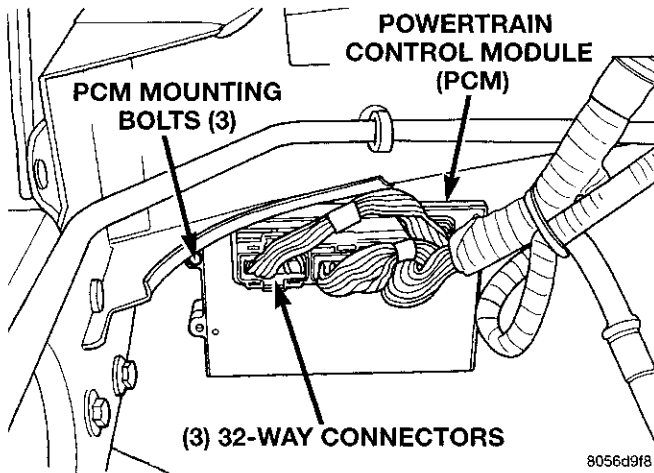
GENERAL INFORMATION (Continued)

Fig. 1 Powertrain Control Module (PCM)

speed control switches. All inputs to the PCM are converted into signals.

Electrically operated fuel injectors spray fuel in precise metered amounts into the intake port directly above the intake valve. The injectors are fired in a specific sequence by the PCM. The PCM maintains an air/fuel ratio of 14.7 to 1 by constantly adjusting injector pulse width. Injector pulse width is the length of time that the injector opens and sprays fuel into the chamber. The PCM adjusts injector pulse width by opening and closing the ground path to the injector.

Manifold absolute pressure (air density) and engine rpm (speed) are the primary inputs that determine fuel injector pulse width. The PCM also monitors other inputs when adjusting air-fuel ratio.

MODES OF OPERATION

As input signals to the powertrain control module (PCM) change, the PCM adjusts its response to the output devices. For example, the PCM must calculate different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT).

The PCM will operate in two different modes: **Open Loop and Closed Loop.**

During Open Loop modes, the powertrain control module (PCM) receives input signals and responds only according to preset PCM programming. Input from the oxygen (O₂S) sensors is not monitored during Open Loop modes.

During Closed Loop modes, the PCM will monitor the oxygen (O₂S) sensors input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air-fuel ratio. This ratio is 14.7 parts air-to-1 part fuel. By monitoring the exhaust oxygen content through the O₂S sensor, the PCM can fine tune the injector pulse width. This is done to achieve optimum fuel economy combined with low emission engine performance.

The fuel injection system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Acceleration
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch On, engine start-up (crank), engine warm-up, acceleration, deceleration and wide open throttle modes are Open Loop modes. The idle and cruise modes, (with the engine at operating temperature) are Closed Loop modes.

IGNITION SWITCH (KEY-ON) MODE

This is an Open Loop mode. When the fuel system is activated by the ignition switch, the following actions occur:

- The powertrain control module (PCM) pre-positions the idle air control (IAC) motor.
- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the engine coolant temperature sensor input. The PCM modifies fuel strategy based on this input.
- Intake manifold air temperature sensor input is monitored.
- Throttle position sensor (TPS) is monitored.
- The auto shutdown (ASD) relay is energized by the PCM for approximately three seconds.
- The fuel pump is energized through the fuel pump relay by the PCM. The fuel pump will operate for approximately three seconds unless the engine is operating or the starter motor is engaged.
- The O₂S sensor heater element is energized through the fuel pump relay. The O₂S sensor input is not used by the PCM to calibrate air-fuel ratio during this mode of operation.

ENGINE START-UP MODE

This is an Open Loop mode. The following actions occur when the starter motor is engaged.

The powertrain control module (PCM) receives inputs from:

- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Starter motor relay
- Camshaft position sensor signal

GENERAL INFORMATION (Continued)

The PCM monitors the crankshaft position sensor. If the PCM does not receive a crankshaft position sensor signal within 3 seconds of cranking the engine, it will shut down the fuel injection system.

The fuel pump is activated by the PCM through the fuel pump relay.

Voltage is applied to the fuel injectors with the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

The PCM determines the proper ignition timing according to input received from the crankshaft position sensor.

ENGINE WARM-UP MODE

This is an Open Loop mode. During engine warm-up, the powertrain control module (PCM) receives inputs from:

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto. trans. only)

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)

Based on these inputs the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
- The PCM adjusts engine idle speed through the idle air control (IAC) motor and adjusts ignition timing.
- The PCM operates the A/C compressor clutch through the clutch relay. This is done if A/C has been selected by the vehicle operator and requested by the A/C thermostat.
- When engine has reached operating temperature, the PCM will begin monitoring O2S sensor input. The system will then leave the warm-up mode and go into closed loop operation.

IDLE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At idle speed, the powertrain control module (PCM) receives inputs from:

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor

- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Battery voltage
- Park/neutral switch (gear indicator signal—auto. trans. only)

- Oxygen sensors

Based on these inputs, the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
- The PCM monitors the O2S sensor input and adjusts air-fuel ratio by varying injector pulse width. It also adjusts engine idle speed through the idle air control (IAC) motor.
- The PCM adjusts ignition timing by increasing and decreasing spark advance.
- The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

CRUISE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At cruising speed, the powertrain control module (PCM) receives inputs from:

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto. trans. only)

- Oxygen (O2S) sensors

Based on these inputs, the following occurs:

- Voltage is applied to the fuel injectors with the PCM. The PCM will then adjust the injector pulse width by turning the ground circuit to each individual injector on and off.
- The PCM monitors the O2S sensor input and adjusts air-fuel ratio. It also adjusts engine idle speed through the idle air control (IAC) motor.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.
- The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

GENERAL INFORMATION (Continued)**ACCELERATION MODE**

This is an Open Loop mode. The powertrain control module (PCM) recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased throttle opening.

DECELERATION MODE

When the engine is at operating temperature, this is an Open Loop mode. During hard deceleration, the powertrain control module (PCM) receives the following inputs.

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto. trans. only)

If the vehicle is under hard deceleration with the proper rpm and closed throttle conditions, the PCM will ignore the oxygen sensor input signal. The PCM will enter a fuel cut-off strategy in which it will not supply battery voltage to the injectors. If a hard deceleration does not exist, the PCM will determine the proper injector pulse width and continue injection.

Based on the above inputs, the PCM will adjust engine idle speed through the idle air control (IAC) motor.

The PCM adjusts ignition timing by turning the ground path to the coil on and off.

The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This is done until the vehicle is no longer under deceleration (if the A/C system is operating).

WIDE OPEN THROTTLE MODE

This is an Open Loop mode. During wide open throttle operation, the powertrain control module (PCM) receives the following inputs.

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)

During wide open throttle conditions, the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off. The PCM ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel. This is done by adjusting injector pulse width.

- The PCM adjusts ignition timing by turning the ground path to the coil on and off.

- The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This will be done for approximately 15 seconds (if the air conditioning system is operating).

IGNITION SWITCH OFF MODE

When ignition switch is turned to OFF position, the PCM stops operating the injectors, ignition coil, ASD relay and fuel pump relay.

DESCRIPTION AND OPERATION**SYSTEM DIAGNOSIS**

The PCM can test many of its own input and output circuits. If the PCM senses a fault in a major system, the PCM stores a Diagnostic Trouble Code (DTC) in memory.

Technicians can display stored DTC's by two different methods. The first is to cycle the ignition switch On - Off - On - Off - On within 5 seconds. Then count the number of times the malfunction indicator (check engine) lamp on the instrument panel flashes on and off. The number of flashes represents the DTC. There is a slight pause between the flashes representing the first and second digits of the code. Longer pauses separate individual trouble codes.

The second method of reading DTC's uses the DRB scan tool. For DTC information, refer to Group 25, Emission Control Systems. See On-Board Diagnostics.

POWERTRAIN CONTROL MODULE (PCM)

The powertrain control module (PCM) (Fig. 1) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a pre-programmed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as Powertrain Control Module

DESCRIPTION AND OPERATION (Continued)

(PCM) Outputs. The sensors and switches that provide inputs to the PCM are considered Powertrain Control Module (PCM) Inputs.

The PCM adjusts ignition timing based upon inputs it receives from sensors that react to: engine rpm, manifold absolute pressure, engine coolant temperature, throttle position, transmission gear selection (automatic transmission), vehicle speed and the brake switch.

The PCM adjusts idle speed based on inputs it receives from sensors that react to: throttle position, vehicle speed, transmission gear selection, engine coolant temperature and from inputs it receives from the air conditioning clutch switch and brake switch.

Based on inputs that it receives, the PCM adjusts ignition coil dwell. The PCM also adjusts the generator charge rate through control of the generator field and provides speed control operation.

NOTE: PCM Inputs:

- Generator output
- A/C request (if equipped with factory A/C)
- A/C select (if equipped with factory A/C)
- Auto shutdown (ASD) sense
- Intake manifold air temperature sensor
- Battery voltage
- Brake switch
- Engine coolant temperature sensor
- Crankshaft position sensor
- Ignition circuit sense (ignition switch in run position)
- Manifold absolute pressure (MAP) sensor
- Overdrive/override switch
- Oxygen sensor
- Park/neutral switch (auto. trans. only)
- SCI receive (DRB scan tool connection)
- Speed control resume switch
- Speed control set switch
- Speed control on/off switch
- Camshaft position sensor signal
- Throttle position sensor
- Vehicle speed sensor
- Sensor return
- Power ground
- Signal ground

NOTE: PCM Outputs:

- A/C clutch relay
- Idle air control (IAC) motor
- Auto shutdown (ASD) relay
- Generator field
- Malfunction indicator lamp (Check engine lamp)
- EGR valve control solenoid
- Fuel injectors
- Fuel pump relay

- Ignition coil
- EVAP canister purge solenoid
- SCI transmit (DRB scan tool connection)
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer (on instrument panel, if equipped)

The powertrain control module (PCM) contains a voltage convertor. This converts battery voltage to a regulated 5.0 volts. It is used to power the crankshaft position sensor, camshaft position sensor and vehicle speed sensor. The PCM also provides a five (5) volt supply for the manifold absolute pressure (MAP) sensor and throttle position sensor (TPS).

AIR CONDITIONING (A/C) CONTROLS—PCM INPUT

The A/C control system information applies to factory installed air conditioning units.

A/C SELECT SIGNAL: When the A/C switch is in the ON position, an input signal is sent to the powertrain control module (PCM). The signal informs the PCM that the A/C has been selected. The PCM adjusts idle speed to a pre-programmed rpm through the idle air control (IAC) motor to compensate for increased engine load.

A/C REQUEST SIGNAL: Once A/C has been selected, the powertrain control module (PCM) receives the A/C request signal from the evaporator switch. The input indicates that the evaporator temperature is in the proper range for A/C application. The PCM uses this input to cycle the A/C compressor clutch (through the A/C relay). It will also determine the correct engine idle speed through the idle air control (IAC) motor position.

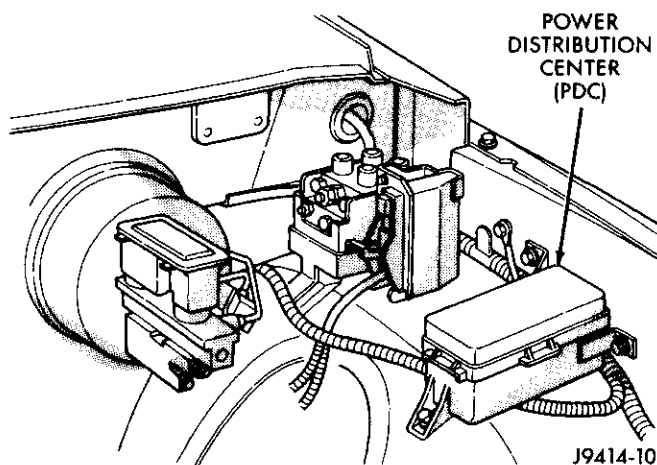
If the A/C low-pressure switch opens (indicating a low refrigerant level), the PCM will not receive an A/C receive signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch.

If the evaporator switch opens, (indicating that evaporator is not in proper temperature range), the PCM will not receive the A/C request signal. The PCM will then remove the ground from the A/C relay, deactivating the A/C compressor clutch.

AUTOMATIC SHUTDOWN (ASD) RELAY—PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The ASD relay is located in the Power Distribution Center (PDC) (Fig. 2). Refer to label on PDC cover for relay location. The relay is used to connect the oxygen sensor heater element, ignition coil, generator field winding and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the powertrain control module (PCM) does not see 12 volts at this input when the ASD

DESCRIPTION AND OPERATION (Continued)**Fig. 2 Power Distribution Center (PDC)**

should be activated, it will set a diagnostic trouble code (DTC).

BATTERY TEMPERATURE SENSOR—PCM INPUT

Provides a signal to the PCM corresponding to the battery temperature. Refer to Group 8C, Charging System for additional information.

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the powertrain control module (PCM). It also informs the PCM what voltage level is supplied to the ignition coil and fuel injectors.

If battery voltage is low, the PCM will increase injector pulse width (period of time that the injector is energized). This is done to compensate for the reduced flow through injector caused by the lowered voltage.

FIVE VOLT SENSOR SUPPLY—PRIMARY

Supplies the required 5 volt power source to the crankshaft position sensor, camshaft position sensor, MAP sensor and throttle position sensor.

FIVE VOLT SENSOR SUPPLY—SECONDARY

Supplies the required 5 volt power source to the transmission pressure sensor and the vehicle speed sensor.

FUEL LEVEL SENSOR—PCM INPUT

The fuel level sensor sends a variable voltage to the PCM to indicate fuel level. The purpose of this feature is to prevent a false setting of misfire and fuel system monitor trouble codes if the fuel level is less than 15 percent of its rated capacity.

BRAKE SWITCH—PCM INPUT

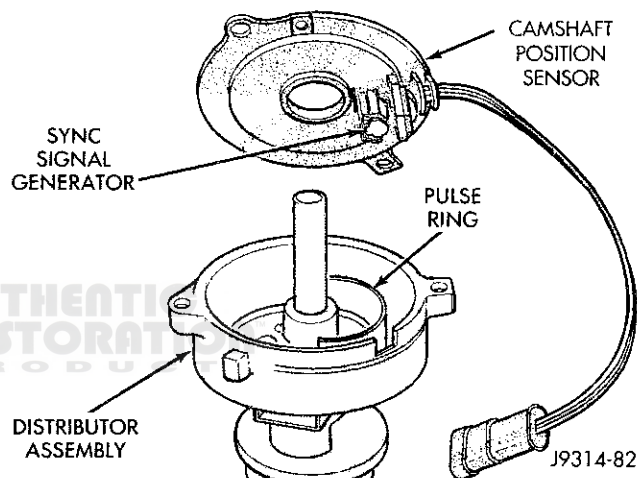
When the brake light switch is activated, the powertrain control module (PCM) receives an input indi-

cating that the brakes are being applied. After receiving this input, the PCM maintains idle speed to a scheduled rpm through control of the idle air control (IAC) motor. The brake switch input is also used to operate the speed control system.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES—PCM INPUT

A sync signal is provide by the camshaft position sensor located in the distributor (Fig. 3). The sync signal from this sensor works in conjunction with the crankshaft position sensor to provide the powertrain control module (PCM) with inputs. This is done to establish and maintain correct injector firing order.

Refer to Camshaft Position Sensor in Group 8D, Ignition System for more information.

**Fig. 3 Camshaft Position Sensor—3.9L/5.2L/5.9L Engines****CAMSHAFT POSITION SENSOR—8.0L ENGINE—PCM INPUT**

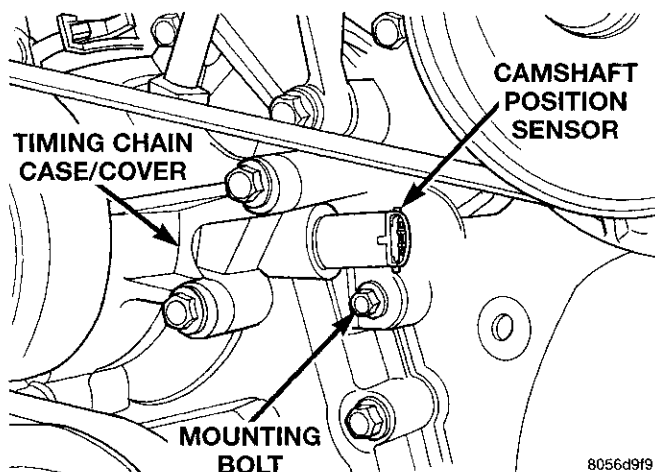
A sync signal is provide by the camshaft position sensor. The sensor is located on the side of the timing chain case/cover (Fig. 4). The sync signal from this sensor works in conjunction with the crankshaft position sensor to provide the powertrain control module (PCM) with inputs. This is done to establish and maintain correct injector firing order.

Refer to Camshaft Position Sensor in Group 8D, Ignition System for more information.

CRANKSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES—PCM INPUT

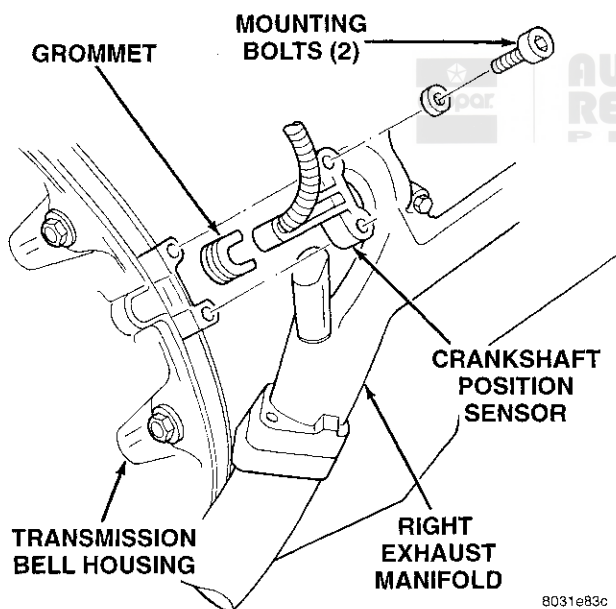
This sensor is a hall effect device that detects notches in the flywheel (manual transmission) or flexplate (automatic transmission).

This sensor is used to indicate to the powertrain control module (PCM) that a spark and or fuel injection event is to be required. The output from this

DESCRIPTION AND OPERATION (Continued)**Fig. 4 Camshaft Position Sensor—8.0L Engine**

sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the cylinder block near the rear of the right cylinder head (Fig. 5).

**Fig. 5 Crankshaft Position Sensor—3.9L/5.2L/5.9L Engines—Typical**

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

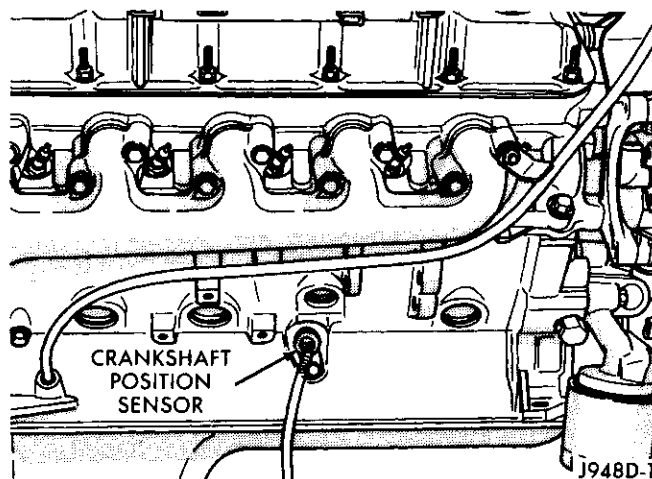
The engine will not operate if the PCM does not receive a crankshaft position sensor input.

CRANKSHAFT POSITION SENSOR—8.0L ENGINE—PCM INPUT

This sensor is a hall effect device that detects notches in the engine crankshaft.

It is used to indicate to the powertrain control module (PCM) that a spark and or fuel injection event is to be required. The output from this sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the side of the cylinder block (Fig. 6).

**Fig. 6 Crankshaft Position Sensor—8.0L Engine—Typical**

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

ENGINE COOLANT TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES—PCM INPUT

The engine coolant temperature sensor is installed next to the thermostat housing (Fig. 7) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor resistance will change. This change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

ENGINE COOLANT TEMPERATURE SENSOR—8.0L ENGINE—PCM INPUT

The engine coolant temperature sensor is installed in the thermostat housing (Fig. 8) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating

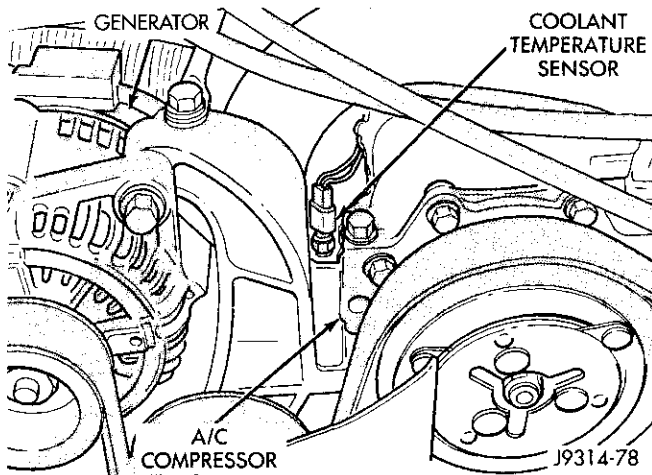
DESCRIPTION AND OPERATION (Continued)

Fig. 7 Engine Coolant Temperature Sensor—3.9L/5.2L/5.9L Engines—Typical

coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor resistance will change. This change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

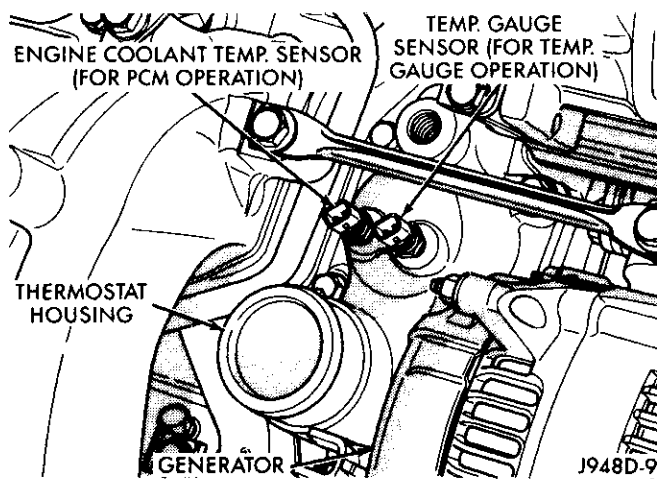


Fig. 8 Engine Coolant Temperature Sensor—8.0L Engine—Typical

HEATED OXYGEN SENSOR (O₂S)—3.9L/5.2L/5.9L LDC ENGINES—PCM INPUT

Two heated O₂S sensors are used (upstream and downstream). The sensors produce voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air/fuel mixture), the sensors produces a low voltage. When there is a lesser amount present (rich air/fuel

mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensors act as a rich-lean switch.

The oxygen sensors are equipped with a heating element that keeps the sensors at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation, the PCM monitors the O₂S sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation, the PCM ignores the O₂ sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The Automatic Shutdown (ASD) relay supplies battery voltage to both the upstream and downstream heated oxygen sensors. The oxygen sensors are equipped with a heating element. The heating elements reduce the time required for the sensors to reach operating temperature.

UPSTREAM HEATED OXYGEN SENSOR

The upstream O₂S sensor is located in the exhaust downpipe (Fig. 9). It provides an input voltage to the PCM. The input tells the PCM the oxygen content of the exhaust gas. The PCM uses this information to fine tune fuel delivery to maintain the correct oxygen content at the downstream oxygen sensor. The PCM will change the air/fuel ratio until the upstream sensor inputs a voltage that the PCM has determined will make the downstream sensor output (oxygen content) correct.

The upstream oxygen sensor also provides an input to determine catalyst efficiency. Refer to Group 25 Emissions, On-Board Diagnostics, Catalyst Monitor for more information.

DOWNSTREAM HEATED OXYGEN SENSOR

The downstream heated oxygen sensor is located near the outlet end of the catalytic convertor (Fig. 9). The downstream is also used to determine the correct air fuel ratio. As the oxygen content changes at the downstream the PCM calculates how much air fuel ratio change is required. The PCM then looks at the upstream oxygen sensor voltage and changes fuel delivery until the upstream sensor voltage changes enough to correct the downstream sensor voltage (oxygen content).

The downstream oxygen sensor also provides an input to determine catalyst efficiency. Refer to Group 25 Emissions Control Systems, On-Board Diagnostics, Catalyst Monitor for more information.

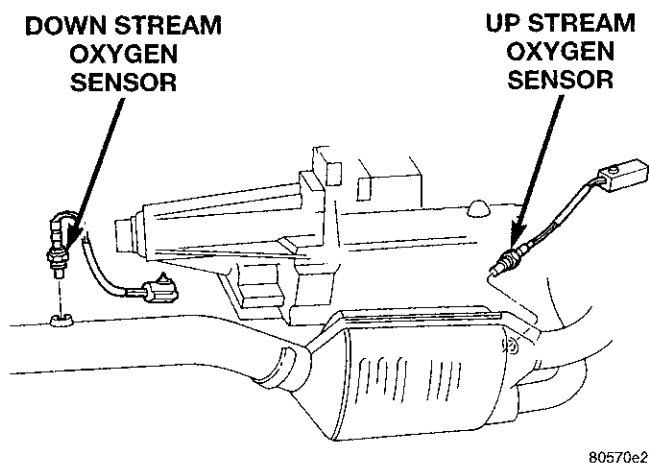
DESCRIPTION AND OPERATION (Continued)

Fig. 9 Upstream/Downstream Oxygen Sensors—LDC Engines

HEATED OXYGEN SENSOR (O2S)—HDC ENGINES—PCM INPUT

A total of two heated O2S sensors are used (left and right) on HDC engines. On the 5.9L HDC engine, the left O2S sensor will monitor cylinders 1, 3, 5 and 7. The right sensor will monitor cylinders 2, 4, 6 and 8. On the 8.0L V-10 HDC engine, the left O2S sensor will monitor cylinders 1, 3, 5, 7 and 9. The right sensor will monitor cylinders 2, 4, 6, 8 and 10.

The sensors produce voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air/fuel mixture), the sensors produces a low voltage. When there is a lesser amount present (rich air/fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensors act as a rich-lean switch.

The oxygen sensors are equipped with a heating element that keeps the sensors at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation, the PCM monitors the O2S sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation, the PCM ignores the O2 sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The Automatic Shutdown (ASD) relay supplies battery voltage to both oxygen sensors. The oxygen sensors are equipped with a heating elements. The heating elements reduce the time required for the sensors to reach operating temperature.

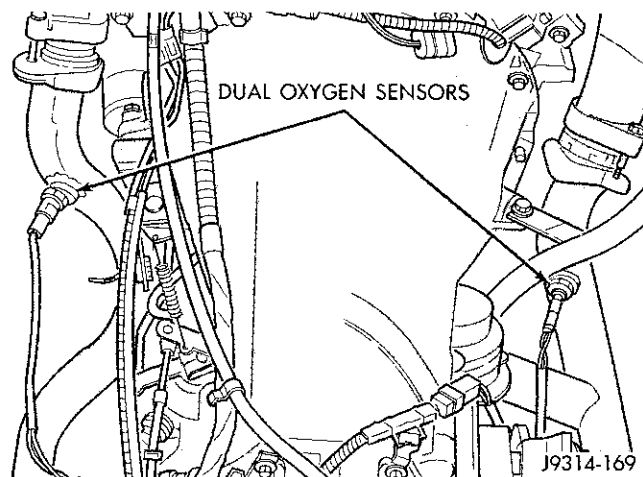


Fig. 10 Left/Right Heated Oxygen Sensors—HDC Engines

HEATED OXYGEN SENSOR (O2S)—8.0L MDC ENGINES—PCM INPUT

The 8.0L V-10 engine, when equipped with a Medium Duty Emission Cycle (MDC) package, will use four heated O2S sensors. They are: Left, right, pre-catalyst and post catalyst. The left, right and post catalyst sensors will fine-tune air-fuel ratio. The pre-catalyst and post catalyst sensors will determine catalytic converter efficiency.

Two of these sensors are installed into the left and right exhaust manifold downpipes (Fig. 10). On the 8.0L V-10 MDC engine, the left O2S sensor will monitor cylinders 1, 3, 5, 7 and 9. The right sensor will monitor cylinders 2, 4, 6, 8 and 10.

The sensors produce voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air/fuel mixture), the sensors produces a low voltage. When there is a lesser amount present (rich air/fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensors act as a rich-lean switch.

The oxygen sensors are equipped with a heating element that keeps the sensors at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation, the PCM monitors the O2S sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation, the PCM ignores the O2 sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

DESCRIPTION AND OPERATION (Continued)

The Automatic Shutdown (ASD) relay supplies battery voltage to both oxygen sensors. The oxygen sensors are equipped with a heating elements. The heating elements reduce the time required for the sensors to reach operating temperature.

PRE-CATALYST OXYGEN SENSOR

The pre-catalyst O₂S sensor is located in the inlet end of the catalytic converter (Fig. 11). It provides an input voltage to the PCM. By comparing the input from the pre-catalyst O₂S sensor, with the input from the post catalyst oxygen sensor, the PCM calculates catalytic converter efficiency.

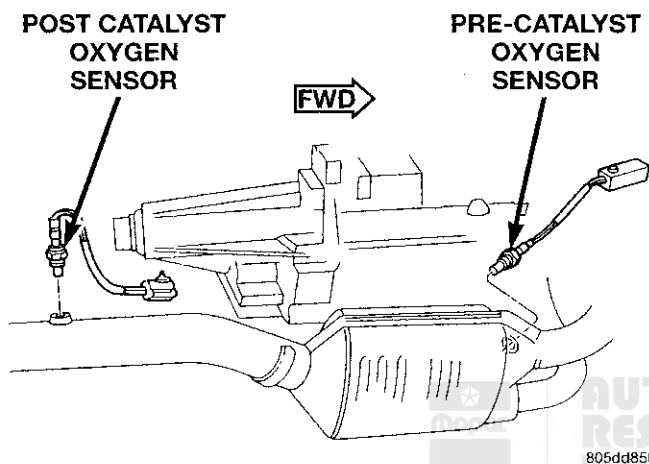


Fig. 11 Pre-Catalyst/Post Catalyst Oxygen Sensors—MDC Engines

POST CATALYST OXYGEN SENSOR

The post catalyst heated oxygen sensor threads into the outlet end of the catalytic converter (Fig. 11). The post catalyst heated oxygen sensor input is used to detect catalytic converter deterioration and fine tune the air fuel ratio. As the converter deteriorates, the input from this sensor begins to match the pre-catalyst sensor input except for a slight time delay. By comparing the inputs from both of these sensors, the PCM calculates catalytic converter efficiency.

When the catalytic converter efficiency drops below emission standards, the PCM stores a diagnostic trouble code and illuminates the Malfunction Indicator Lamp (MIL). For more information, refer to Group 25, Emission Control Systems.

IGNITION CIRCUIT SENSE—PCM INPUT

The ignition circuit sense input tells the Powertrain Control Module (PCM) the ignition switch has energized the ignition circuit. Refer to the wiring diagrams for circuit information.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES—PCM INPUT

The intake manifold air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 12) or (Fig. 13). The sensor provides an input voltage to the powertrain control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

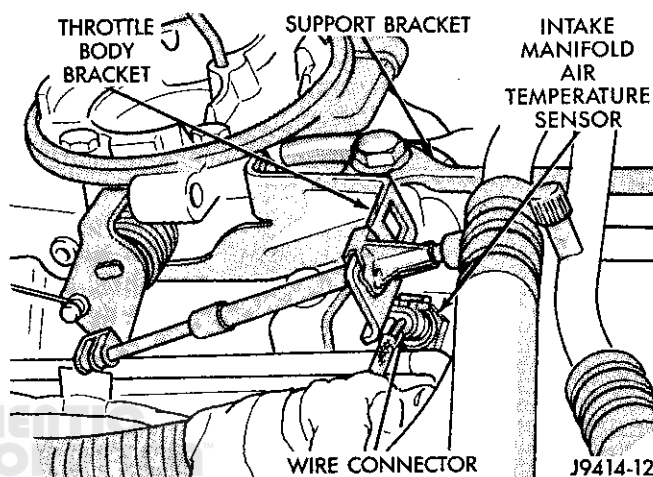


Fig. 12 Intake Manifold Air Temperature Sensor—3.9L Engine—Typical

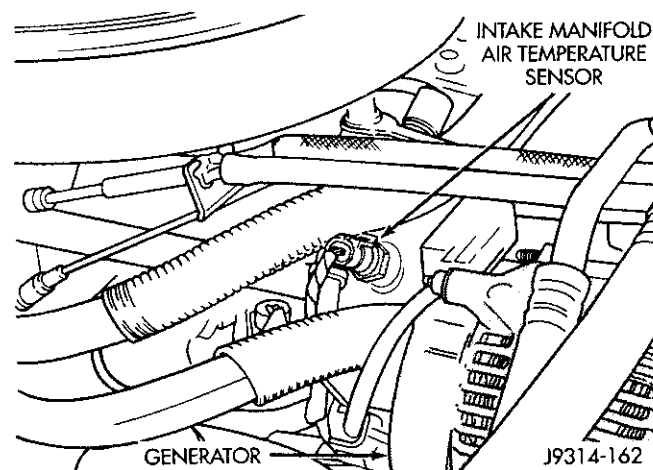


Fig. 13 Intake Manifold Air Temperature Sensor—5.2L/5.9L Engines—Typical

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—8.0L ENGINE—PCM INPUT

The intake manifold air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 14). The sensor provides an input voltage to the powertrain

DESCRIPTION AND OPERATION (Continued)

control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

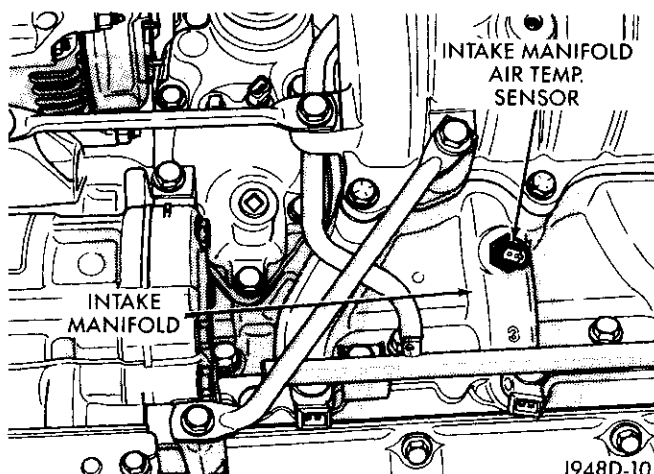


Fig. 14 Intake Manifold Air Temperature Sensor—8.0L Engine—Typical

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.9L/5.2L/5.9L ENGINES—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is running. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted on the side of the engine throttle body (Fig. 15). The sensor is connected to the throttle body with a rubber L-shaped fitting.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—8.0L ENGINE—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is run-

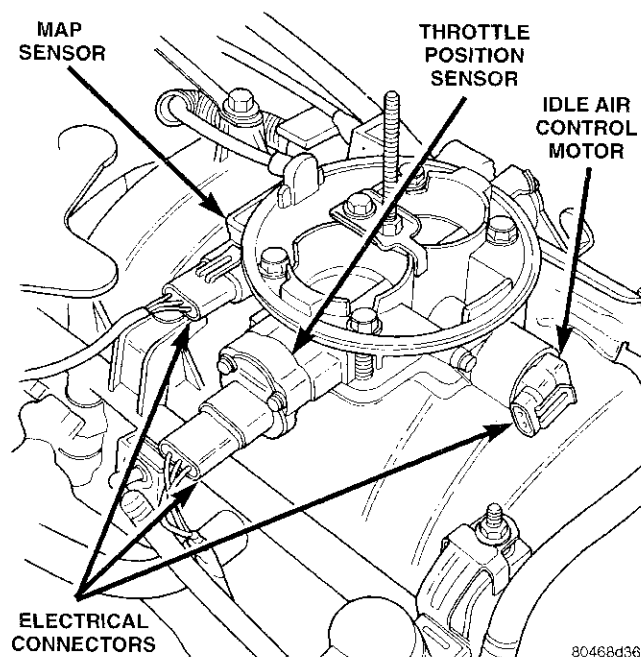


Fig. 15 MAP and Throttle Position Sensor Location—3.9L/5.2L/5.9L Engines—Typical

ning. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted into the right side of the intake manifold. (Fig. 16).

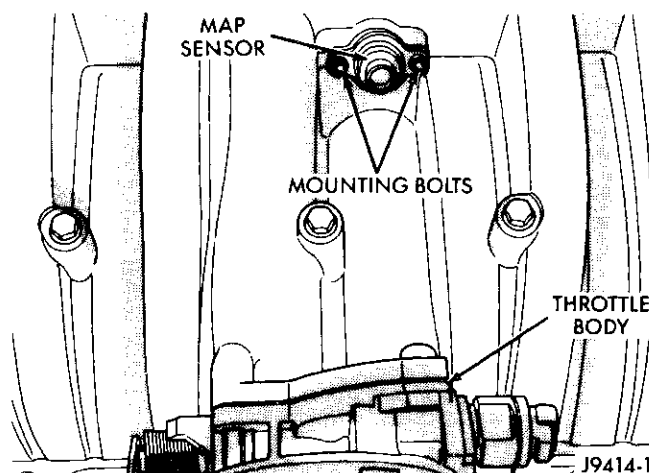


Fig. 16 MAP Sensor Location—8.0L Engine—Typical

OUTPUT SHAFT SPEED SENSOR—PCM INPUT

This sensor generates a signal to the PCM relating to the speed of the transmission main drive shaft. This input is used with 4-speed electronic transmissions only. Also refer to Vehicle Speed Sensor—PCM Input for additional information.

DESCRIPTION AND OPERATION (Continued)**OVERDRIVE/OVERRIDE SWITCH-PCM INPUT**

On vehicles equipped with an automatic transmission and overdrive, the powertrain control module (PCM) regulates the 3-4 overdrive up-shift and down-shift through the overdrive solenoid. This solenoid is located in the transmission. An overdrive/override push-button switch is located on the instrument panel.

The PCM circuit for overdrive is controlled by inputs from the engine coolant temperature sensor and vehicle speed sensor. If coolant temperature and vehicle speed are not within the preset PCM specifications, the PCM will not allow the transmission to shift into overdrive. These preset PCM specifications must be met before the push-button switch will be allowed to control overdrive operation.

The overdrive/override push-button switch is normally closed (overdrive allowed) when the lamp is not illuminated. It opens (overdrive not allowed) when the operator presses the switch and the lamp is illuminated. The switch will revert to its normally closed position (lamp off) each time the ignition switch is turned on. The transmission downshifts if the operator presses the override switch while in overdrive.

Refer to Group 21 for more transmission information.

SPEED CONTROL SWITCH—PCM INPUT

Six different speed control functions, using three momentary contact switches, are monitored through this **multiplexed** input. The resistance monitored at this input, in combination with the length of time the PCM measures the resistance, determines which switch feature has been selected. The three switches are: On/Off, Set/Coast and Resume/Accelerate.

Refer to Group 8H, Vehicle Speed Control System for further speed control information.

TRANSMISSION PARK/NEUTRAL SWITCH—PCM INPUT

The park/neutral switch is located on the transmission housing and provides an input to the powertrain control module (PCM). This will indicate that the automatic transmission is in Park, Neutral or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width, ignition timing advance and vehicle speed control operation. Refer to Group 21, Transmissions, for testing, replacement and adjustment information.

TRANSMISSION GOVERNOR PRESSURE SENSOR—PCM INPUT

Provides a signal proportional to the transmission governor pressure. It provides feedback for control of

the variable force solenoid, which regulates transmission governor pressure. This input is used with 4-speed electronic transmissions only.

TRANSMISSION TEMPERATURE SENSOR—PCM INPUT

This input is used in the shift operation for 4-speed electronic transmissions only. The temperature data is used for: torque converter clutch operation, overdrive shift, low temperature shift compensation, wide open throttle shift strategy and governor pressure transducer calibration.

TRANSMISSION PRESSURE SENSOR—PCM INPUT

Provides a signal proportional to the transmission governor pressure. It provides feedback for control of the variable force solenoid, which regulates transmission governor pressure. This is used with 4-speed automatic transmissions only.

THROTTLE POSITION SENSOR (TPS)—3.9L/5.2L/5.9L ENGINES—PCM INPUT

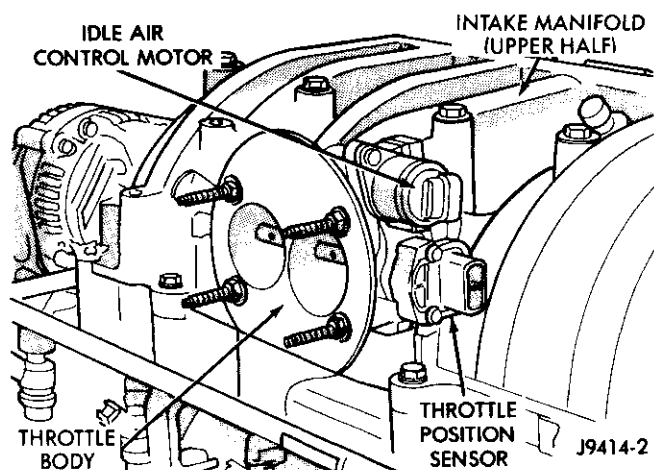
The throttle position sensor (TPS) is mounted on the throttle body (Fig. 15). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from 1 volt at minimum throttle opening (idle), to 4 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

THROTTLE POSITION SENSOR (TPS)—8.0L ENGINE—PCM INPUT

The throttle position sensor (TPS) is mounted on the throttle body (Fig. 17). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

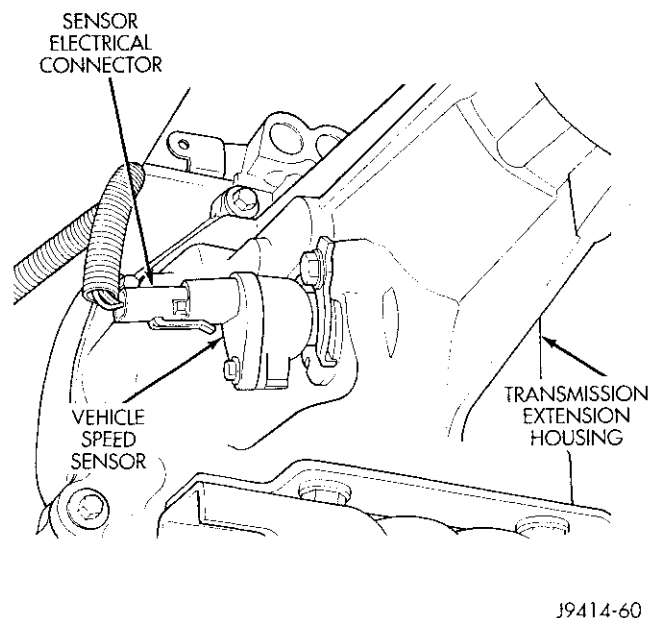
The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from 1 volt at minimum throttle opening (idle), to 4 volts at wide

DESCRIPTION AND OPERATION (Continued)**Fig. 17 Sensor Location—8.0L Engine**

open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

VEHICLE SPEED AND DISTANCE SENSOR—PCM INPUT

The vehicle speed sensor is located on the speedometer pinion gear adapter (Fig. 18). The pinion gear adapter is located on the extension housing of the transmission (drivers side). The sensor input is used by the powertrain control module (PCM) to determine vehicle speed and distance traveled.

**Fig. 18 Vehicle Speed Sensor Location—Typical**

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the throttle position sensor, indicate a closed throttle deceleration to the PCM. When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received).

Under deceleration conditions, the PCM adjusts the idle air control (IAC) motor to maintain a desired MAP value. Under idle conditions, the PCM adjusts the IAC motor to maintain a desired engine speed.

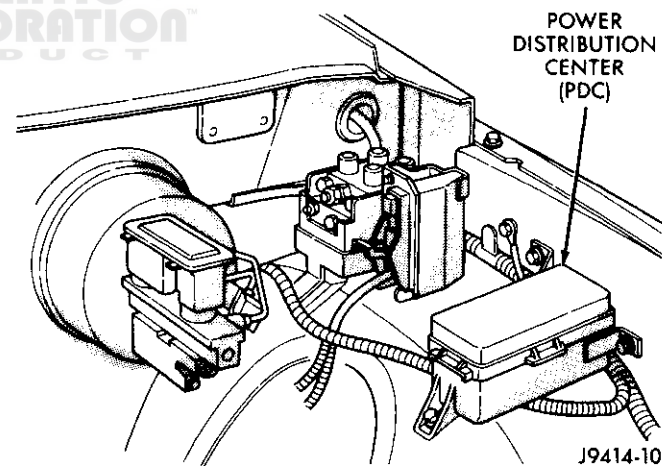
POWER GROUND

The power ground is used to control ground circuits for the following powertrain control module (PCM) loads:

- Generator field winding
- 8 volt (PCM) power supply
- Fuel injectors
- Ignition coil

AIR CONDITIONING (A/C) CLUTCH RELAY—PCM OUTPUT

The A/C relay is located in the Power Distribution Center (PDC) (Fig. 19). Refer to label on PDC cover for relay location.

**Fig. 19 Power Distribution Center (PDC)**

The powertrain control module (PCM) activates the A/C compressor through the A/C clutch relay. The PCM regulates A/C compressor operation by switching the ground circuit for the A/C clutch relay on and off.

When the PCM receives a request for A/C from A/C evaporator switch, it will adjust idle air control (IAC) motor position. This is done to increase idle speed. The PCM will then activate the A/C clutch through the A/C clutch relay. The PCM adjusts idle air control (IAC) stepper motor position to compensate for increased engine load from the A/C compressor.

DESCRIPTION AND OPERATION (Continued)

By switching the ground path for the relay on and off, the PCM is able to cycle the A/C compressor clutch. This is based on changes in engine operating conditions. If, during A/C operation, the PCM senses low idle speeds or a wide open throttle condition, it will de-energize the relay. This prevents A/C clutch engagement. The relay will remain de-energized until the idle speed increases or the wide open throttle condition exceeds 15 seconds or no longer exists. The PCM will also de-energize the relay if coolant temperature exceeds 125°C (257°F).

AUTO SHUTDOWN (ASD) RELAY—PCM OUTPUT

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 19).

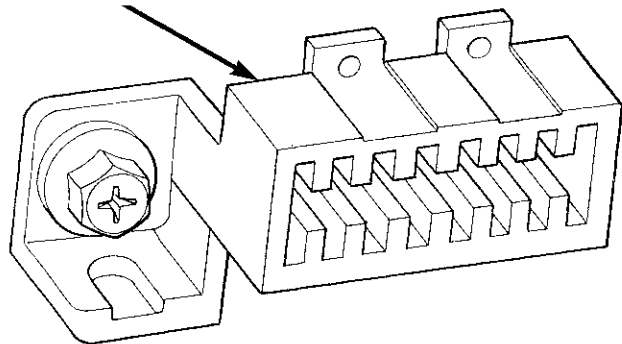
The ASD supplies battery voltage to the fuel pump, fuel injector, ignition coil, generator field winding and oxygen (O₂S) sensor heating element. The ground circuit for the coil in the ASD relay is controlled by the powertrain control module (PCM). The PCM operates the relay by switching the ground circuit on and off.

The fuel pump relay is controlled by the PCM through same circuit that the ASD relay is controlled.

DATA LINK CONNECTOR—PCM INPUT AND OUTPUT

The 16-way data link connector (diagnostic scan tool connector) links the Diagnostic Readout Box (DRB) scan tool or the Mopar Diagnostic System (MDS) with the powertrain control module (PCM). The data link connector (Fig. 20) is located at lower edge of instrument panel near steering column. For operation of the DRB scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

**16-WAY DATA
LINK CONNECTOR**



805dd852

Fig. 20 16-Way Data Link Connector

DUTY CYCLE EVAP PURGE SOLENOID VALVE-PCM OUTPUT

Refer to Group 25, Emission Control System for information.

FUEL INJECTORS—3.9L/5.2L/5.9L ENGINES—PCM OUTPUT

The fuel injectors are attached to the fuel rail (Fig. 21). 3.9L engines use six injectors. 5.2L and 5.9L engines use eight injectors.

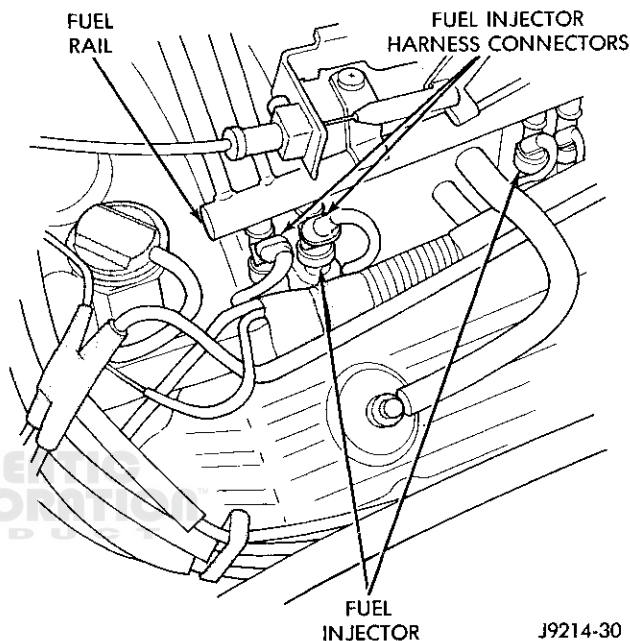


Fig. 21 Fuel Injectors—3.9L/5.2L/5.9L Engines—Typical

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

DESCRIPTION AND OPERATION (Continued)

FUEL INJECTORS—8.0L ENGINE—PCM OUTPUT

The fuel injectors are attached to the fuel rail (Fig. 22). 8.0L V-10 engines use 10 injectors.

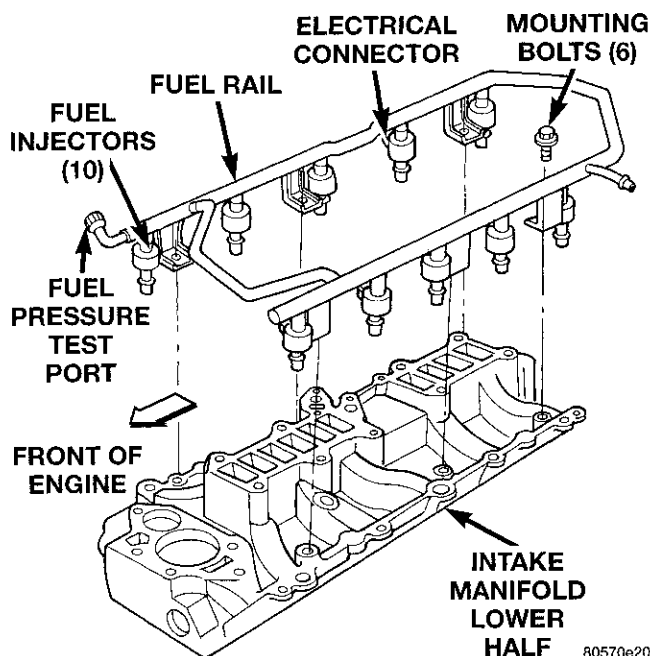


Fig. 22 Fuel Injectors—8.0L Engine—Typical

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The 10 injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

FUEL PUMP RELAY-PCM OUTPUT

The PCM energizes the electric fuel pump and the oxygen sensor (O₂S) heating element through the fuel pump relay. Battery voltage is applied to the fuel pump relay when the ignition key is ON. The relay is energized when a ground signal is provided by the PCM.

Refer to Automatic Shutdown Relay—PCM Output for additional information.

The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.

The fuel pump relay is located in the Power Distribution Center (PDC) (Fig. 19).

GENERATOR FIELD—PCM OUTPUT

The powertrain control module (PCM) regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Groups 8A and 8C for charging system information.

GENERATOR LAMP—PCM OUTPUT

If the powertrain control module (PCM) senses a low charging condition in the charging system, it will illuminate the generator lamp (if equipped) on the instrument panel. For example, during low idle with all accessories turned on, the lamp may momentarily go on. Once the PCM corrects idle speed to a higher rpm, the lamp will go out. Refer to Groups 8A and 8C for charging system information.

IDLE AIR CONTROL (IAC) MOTOR—3.9L/5.2L/5.9L ENGINES—PCM OUTPUT

The IAC motor is mounted to the back of the throttle body (Fig. 15) and is controlled by the powertrain control module (PCM).

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the air control passage (Fig. 23) and regulates air flow through it. Based on various sensor inputs, the powertrain control module (PCM) adjusts engine idle speed by moving the IAC motor pintle in and out of the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

IDLE AIR CONTROL (IAC) MOTOR—8.0L ENGINE—PCM OUTPUT

The IAC motor is mounted to the side of the throttle body (Fig. 24) and is controlled by the powertrain control module (PCM).

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the air control passage (Fig. 25) and regulates air flow through it. Based on various sensor inputs, the powertrain control module (PCM) adjusts engine idle speed by moving the IAC motor pintle in and out of

DESCRIPTION AND OPERATION (Continued)

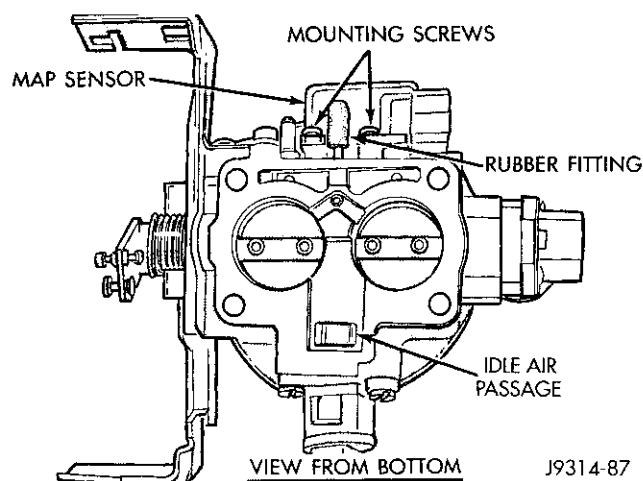


Fig. 23 Throttle Body Air Control Passage—3.9L/5.2L/5.9L Engines

the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

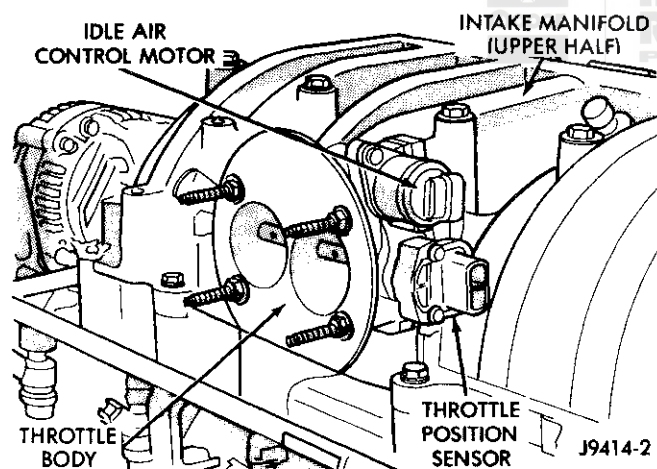


Fig. 24 Idle Air Control Motor Location—8.0L Engine
IGNITION COIL—3.9L/5.2L/5.9L ENGINES—PCM OUTPUT

System voltage is supplied to the ignition coil positive terminal. The powertrain control module (PCM) operates the ignition coil. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil is located near the front of the right cylinder head (Fig. 26).

Refer to Group 8D, Ignition System for additional information.

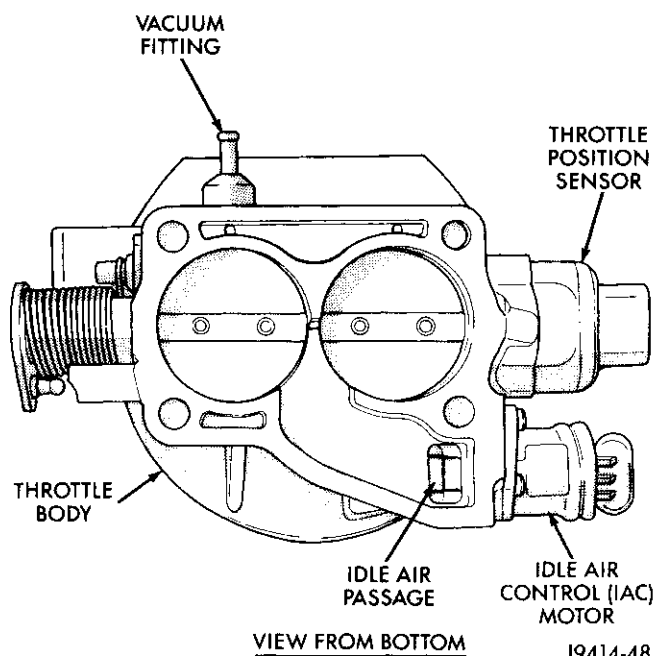


Fig. 25 Idle Air Control Passage—8.0L Engine

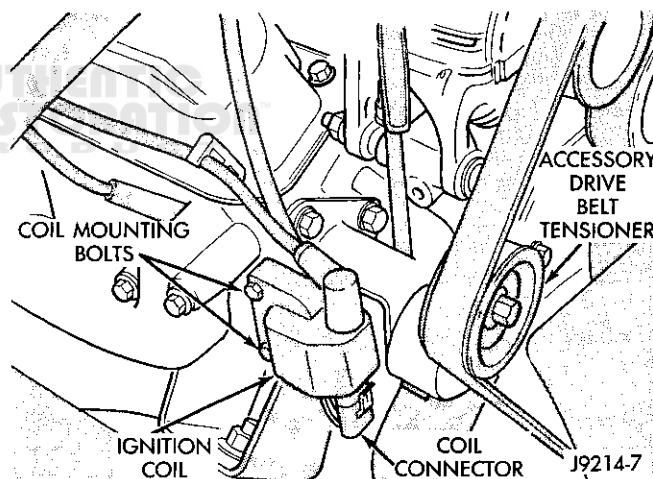


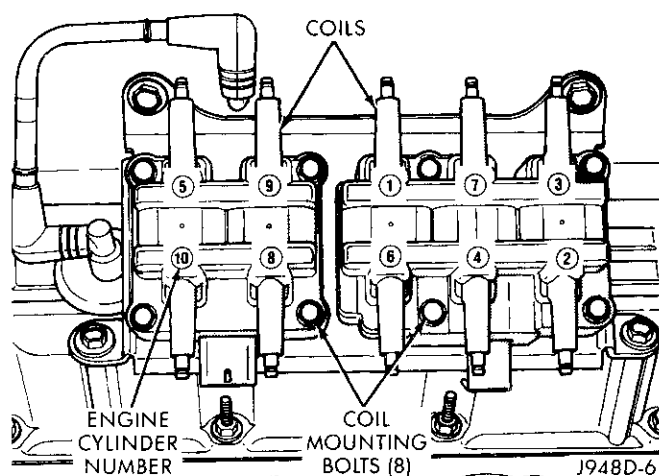
Fig. 26 Ignition Coil—3.9L/5.2L/5.9L Engines—Typical (3.9L Shown)

IGNITION COILS—8.0L ENGINE—PCM OUTPUTS

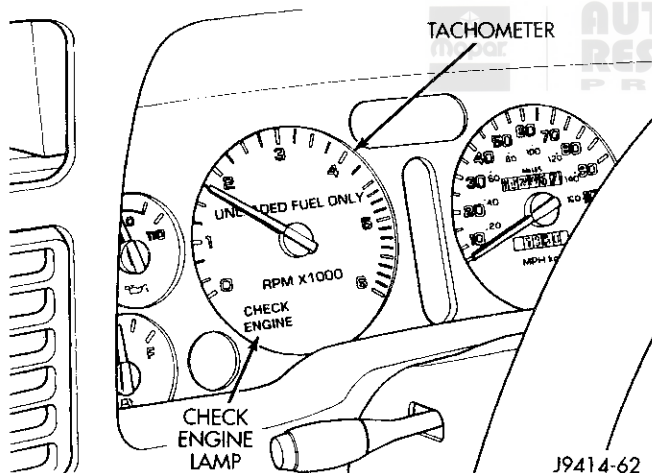
System voltage is supplied to each of the five ignition coil positive terminals. The powertrain control module (PCM) operates the 5 paired ignition coils. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil pack is located above the right engine valve cover (Fig. 27).

Refer to Group 8D, Ignition System for additional information.

DESCRIPTION AND OPERATION (Continued)**Fig. 27 Ignition Coil Packs—8.0L Engine****MALFUNCTION INDICATOR (CHECK ENGINE) LAMP—PCM OUTPUT**

The malfunction indicator lamp illuminates each time the ignition key is turned on. It will stay on for approximately three seconds as a bulb test. The lamp is displayed on the instrument panel as the CHECK ENGINE lamp (Fig. 28).

**Fig. 28 Check Engine Lamp Location—Typical**

If the powertrain control module (PCM) receives an incorrect signal, or no signal from certain sensors or emission related systems, the lamp is turned on. This is a warning that the PCM has recorded a system or sensor malfunction. In some cases, when a problem is declared, the PCM will go into a limp-in mode. This is an attempt to keep the system operating. It signals an immediate need for service.

The lamp can also be used to display a Diagnostic Trouble Code (DTC). Cycle the ignition switch On-Off-On-Off-On within three seconds and any codes stored in the PCM memory will be displayed. This is done in a series of flashes representing digits.

The lamp is also used to detect certain engine misfires. Refer to Group 25, Emission Control System for more information.

OVERDRIVE LAMP—PCM OUTPUT

This circuit controls a signal for the operation of the instrument panel mounted push-button overdrive lamp switch. When the lamp is illuminated, the overdrive is disengaged.

SPEED CONTROL SOLENOIDS—PCM OUTPUT

Speed control operation is regulated by the powertrain control module (PCM). The PCM controls the vacuum to the throttle actuator through the speed control vacuum and vent solenoids. Refer to Group 8H for Speed Control Information.

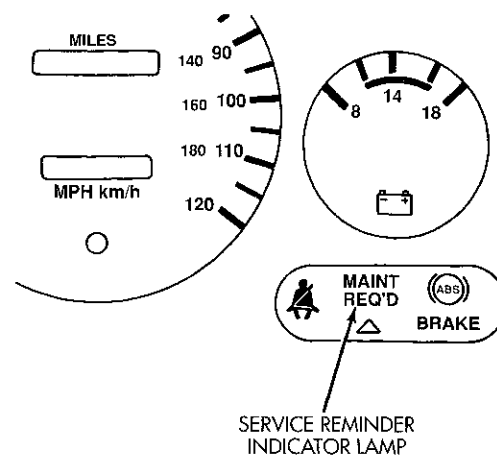
SERVICE REMINDER INDICATOR (SRI) LAMP—PCM OUTPUT

This circuit controls operation of the SRI lamp.

The instrument panel mounted service reminder indicator (SRI) lamp is used only on vehicles equipped with 5.9L V-8 or 8.0L V-10 heavy duty cycle (HDC) engines. The lamp is displayed on the instrument panel as the MAINT REQ'D lamp (Fig. 29). When the lamp has been activated, certain service/maintenance must be performed.

For required service/maintenance stated in time or mileage, refer to Group 0, Lubrication and Maintenance. Also refer to Group 25, Emission Control System for additional information.

The SRI lamp is not used with diesel engines.

**Fig. 29 SRI Lamp Location****TACHOMETER—PCM OUTPUT**

The powertrain control module (PCM) supplies engine rpm values to the instrument cluster tachometer. Refer to Group 8E for tachometer information.

DESCRIPTION AND OPERATION (Continued)**THREE-FOUR SHIFT SOLENOID—PCM OUTPUT**

This output is used to control the transmission three-four shift solenoid. It is used on 4-speed electronically controlled automatic transmissions only.

TORQUE CONVERTOR CLUTCH (TCC) SOLENOID—PCM OUTPUT

This circuit controls operation of the transmission mounted torque convertor clutch (TCC) solenoid used for torque convertor engagement.

The powertrain control module (PCM) will determine when to engage and disengage the solenoid by monitoring vehicle miles per hour (mph) versus the output voltage of the throttle position sensor. Also needed are various inputs from:

- Engine coolant temperature
- Module timer
- Engine rpm
- MAP sensor

MANUAL TRANSMISSION

If equipped with a manual transmission, this PCM output will control operation of the shift indicator lamp (if equipped with lamp). The lamp is controlled by the powertrain control module (PCM). The lamp illuminates on the instrument panel to indicate when the driver should shift to the next highest gear for best fuel economy. The PCM will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed. The lamp will remain off until vehicle stops accelerating and is brought back to range of up-shift lamp operation. This will also happen if vehicle is shifted into fifth gear.

The indicator lamp is normally illuminated when the ignition switch is turned on and it is turned off when the engine is started up. With the engine running, the lamp is turned ON/OFF depending upon engine speed and load.

TRANSMISSION RELAY—PCM OUTPUT

The output to this relay provides battery voltage to the overdrive (OD), torque converter clutch (TCC) and variable force (VSS) solenoids. Once battery voltage is applied to the solenoids, they are individually activated by the PCM through OD, TCC and VSS outputs. The relay is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

VARIABLE FORCE SOLENOID—PCM OUTPUT

This solenoid regulates the transmission fluid line pressure to produce the governor pressure necessary for transmission shift control. It is used on 4-speed electronic transmissions only.

THROTTLE BODY—3.9L/5.2L/5.9L ENGINES

Filtered air from the air cleaner enters the intake manifold through the throttle body (Fig. 30). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage (Fig. 31) controlled by an idle air control (IAC) motor. The air control passage is used to supply air for idle conditions. A throttle valve (plate) is used to supply air for above idle conditions.

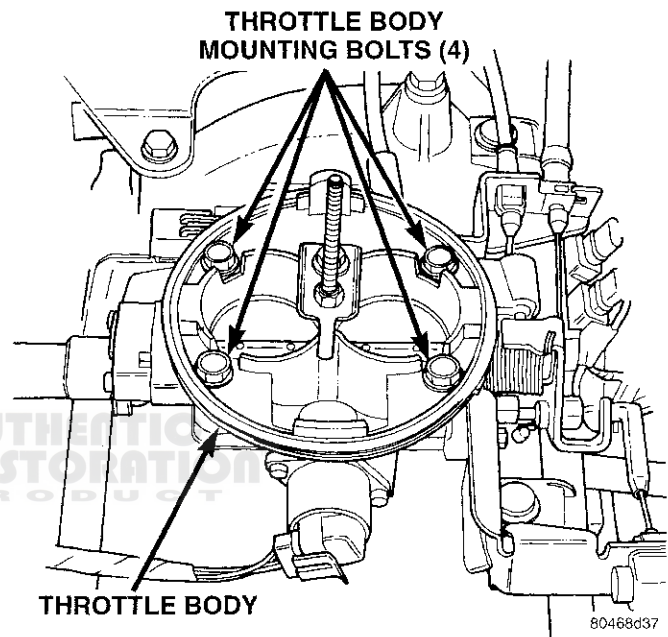


Fig. 30 Throttle Body—3.9L/5.2L/5.9L Engines

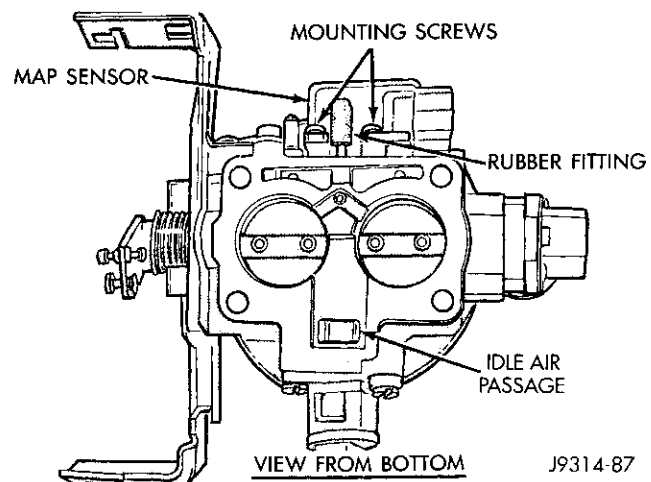


Fig. 31 Air Control Passage—3.9L/5.2L/5.9L Engines

The throttle position sensor (TPS), idle air control (IAC) motor and manifold absolute pressure sensor (MAP) are attached to the throttle body. The acceler-

DESCRIPTION AND OPERATION (Continued)

ator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

THROTTLE BODY—8.0L ENGINE

Filtered air from the air cleaner enters the intake manifold through the side mounted throttle body (Fig. 32). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage (Fig. 33) controlled by an idle air control (IAC) motor. The air control passage is used to supply air for idle conditions. A throttle valve (plate) is used to supply air for above idle conditions.

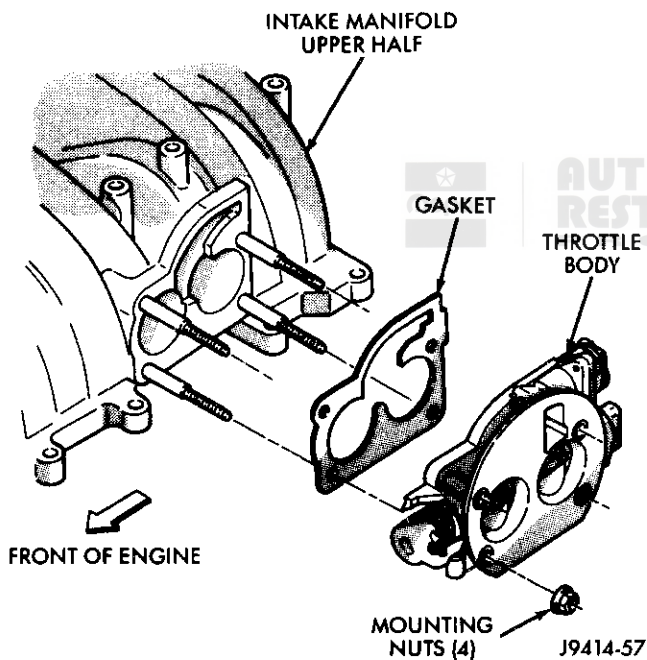


Fig. 32 Throttle Body—8.0L Engine

The throttle position sensor (TPS) and idle air control (IAC) motor are attached to the throttle body. The accelerator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

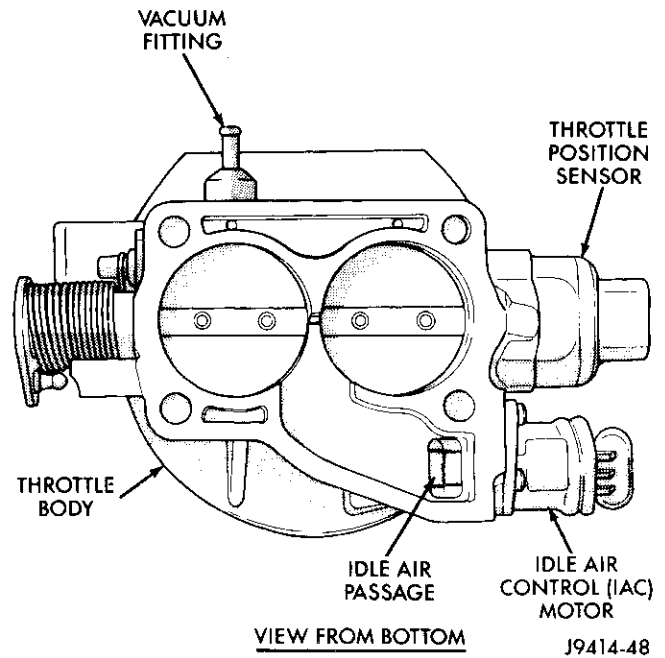


Fig. 33 Air Control Passage—8.0L Engine

DIAGNOSIS AND TESTING

VISUAL INSPECTION—3.9L/5.2L/5.9L ENGINES

A visual inspection for loose, disconnected or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the three 32-way electrical connectors are fully inserted into the connector of the powertrain control module (PCM) (Fig. 34).

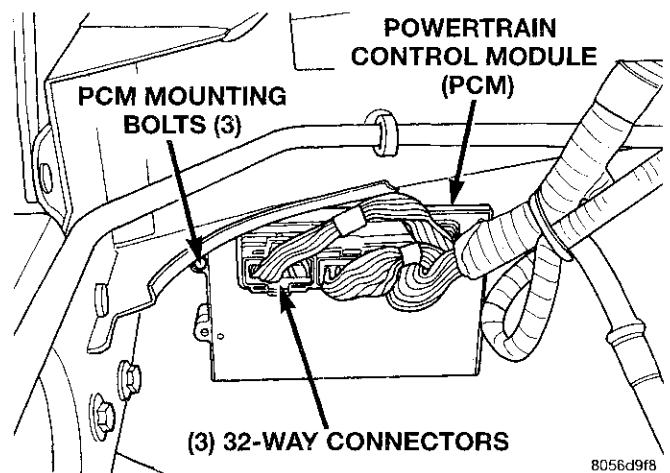


Fig. 34 Powertrain Control Module (PCM)

DIAGNOSIS AND TESTING (Continued)

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay and air conditioning compressor clutch relay (if equipped). Inspect the ASD relay connections. Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion. The relays are located in the Power Distribution Center (PDC) (Fig. 35). Refer to label on PDC cover for relay location.

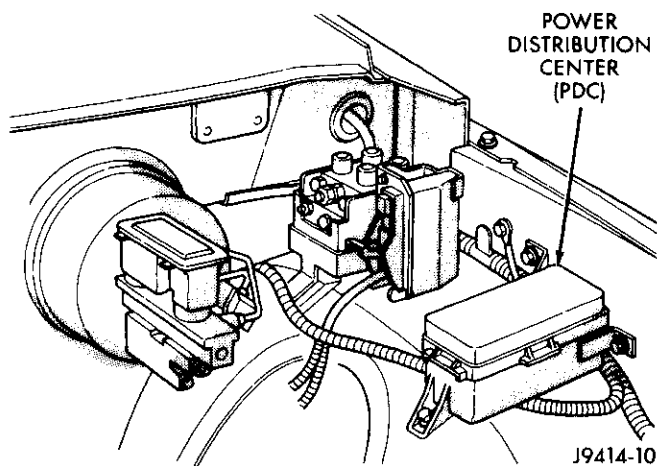


Fig. 35 Power Distribution Center (PDC)

(4) Inspect ignition coil connections. Verify that coil secondary cable is firmly connected to coil (Fig. 36).

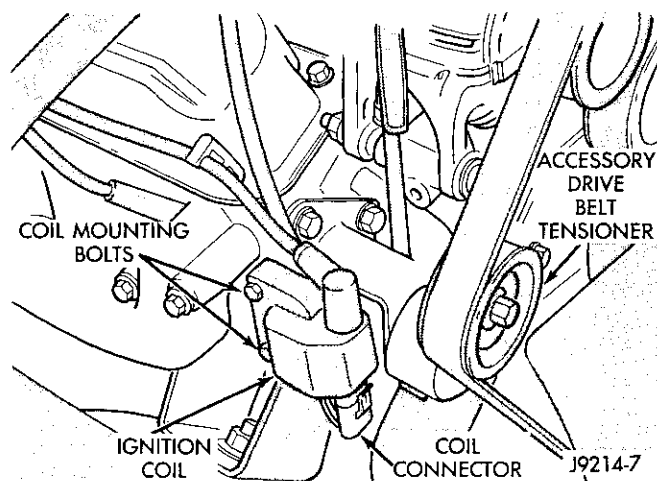


Fig. 36 Ignition Coil—3.9L/5.2L/5.9L Engines—Typical

(5) Verify that distributor cap is correctly attached to distributor. Be sure that spark plug cables are firmly connected to the distributor cap and the spark plugs are in their correct firing order. Be sure that coil cable is firmly connected to distributor cap and coil. Be sure that camshaft position sensor wire connector (at the distributor) is firmly connected to harness connector. Inspect spark plug condition. Refer to Group 8D, Ignition. Connect vehicle to an oscilloscope

and inspect spark events for fouled or damaged spark plugs or cables.

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator.

(7) Inspect the system body grounds for loose or dirty connections. Refer to Group 8, Wiring for ground locations.

(8) Verify positive crankcase ventilation (PCV) valve operation. Refer to Group 25, Emission Control System for additional information. Verify PCV valve hose is firmly connected to PCV valve and manifold (Fig. 37).

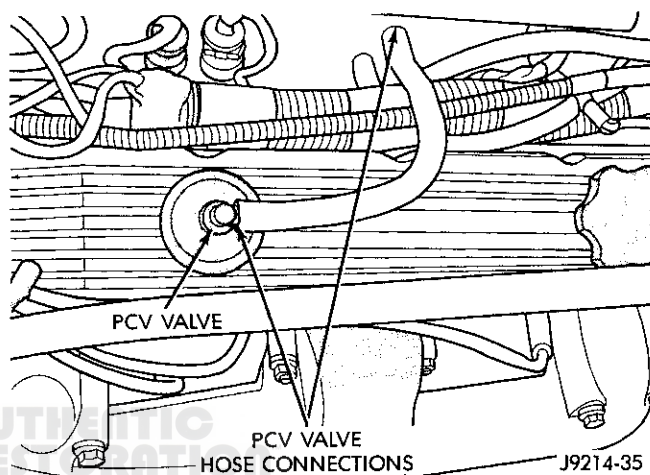


Fig. 37 PCV Valve Hose Connections—3.9L/5.2L/5.9L Engines—Typical

(9) Inspect fuel tube quick-connect fitting-to-fuel rail connections.

(10) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

(11) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable connections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions.

(12) If equipped with vacuum brake booster, verify that vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(13) Inspect the air cleaner inlet and air cleaner element for dirt or restrictions.

(14) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(15) Verify that the intake manifold air temperature sensor wire connector is firmly connected to harness connector (Fig. 38) or (Fig. 39).

(16) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 40). Also verify that rubber L-shaped fitting from MAP sensor to the throttle body is firmly connected (Fig. 41).

DIAGNOSIS AND TESTING (Continued)

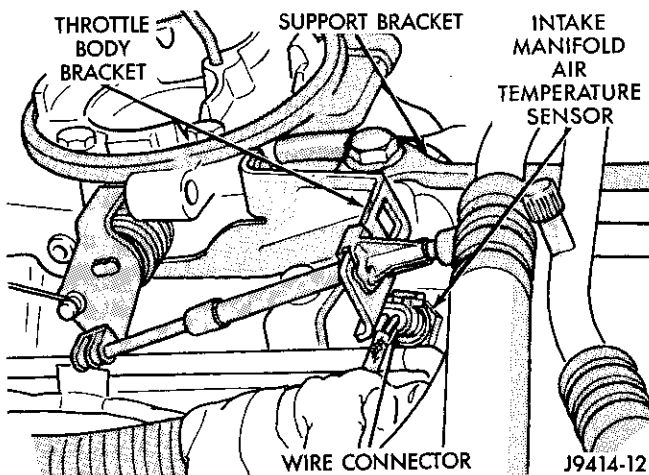


Fig. 38 Air Temperature Sensor—3.9L (V-6) Engine

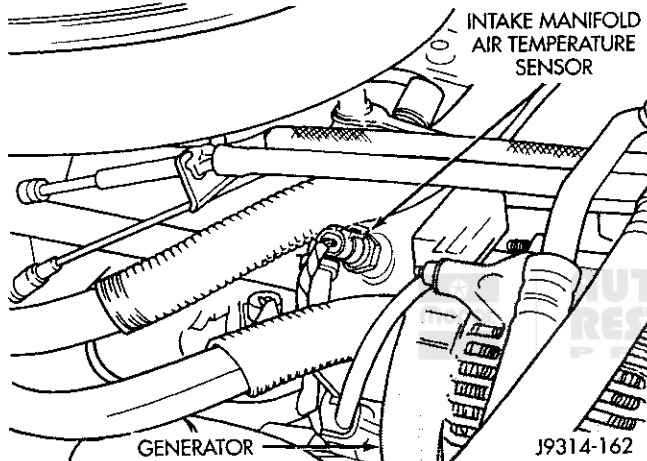


Fig. 39 Air Temperature Sensor—5.2L/5.9L (V-8) Engines

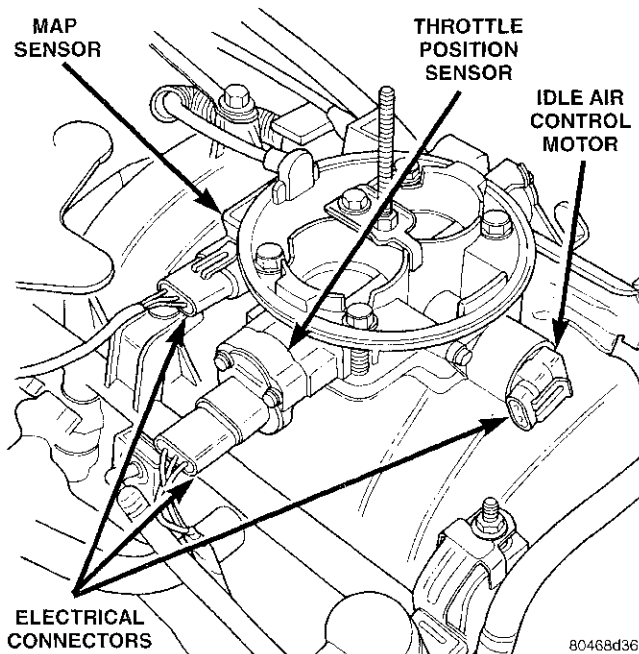


Fig. 40 Sensor and IAC Motor Location—Typical (V-8 Shown)

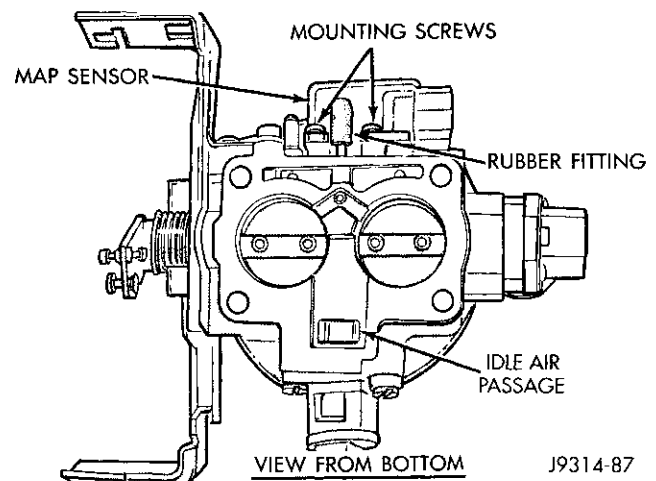


Fig. 41 Rubber L-Shaped Fitting—MAP Sensor-to-Throttle Body—3.9L/5.2L/5.9L Engines

(17) Verify that fuel injector wire harness connectors are firmly connected to injectors in the correct order. Each harness connector is numerically tagged with the injector number (INJ 1, INJ 2 etc.) of its corresponding fuel injector and cylinder number.

(18) Verify harness connectors are firmly connected to idle air control (IAC) motor, throttle position sensor (TPS) and manifold absolute pressure (MAP) sensor (Fig. 40).

(19) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 42).

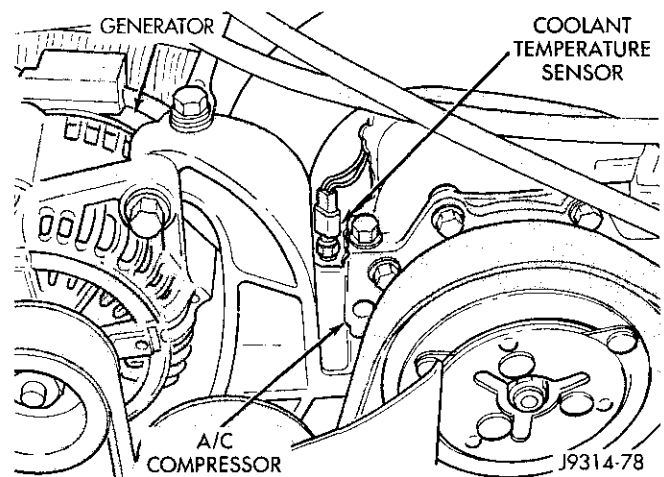


Fig. 42 Engine Coolant Temperature Sensor—3.9L/5.2L/5.9L Engines—Typical

(20) Raise and support the vehicle.

(21) On 3.9L/5.2L/5.9L LDC engines, verify that both the upstream and downstream oxygen sensor wire connectors are firmly connected to the sensors. Inspect sensors and connectors for damage (Fig. 43).

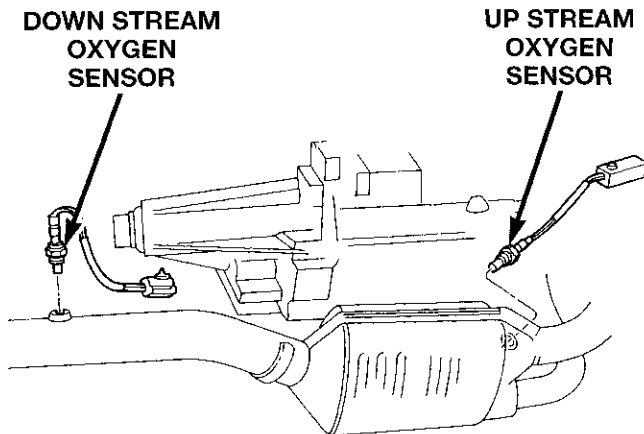
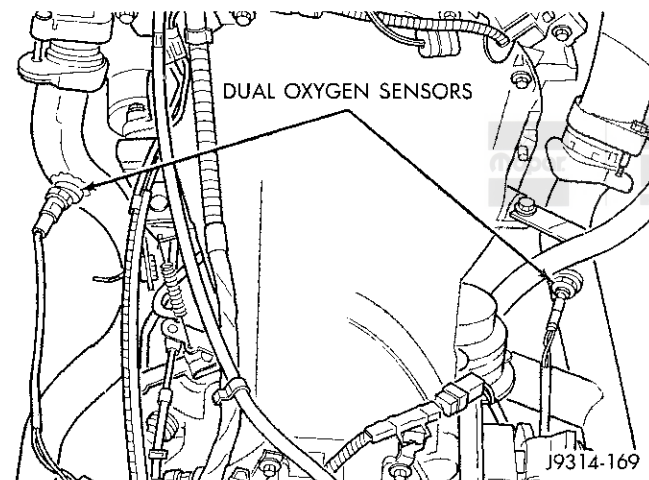
DIAGNOSIS AND TESTING (Continued)

Fig. 43 Upstream/Downstream Oxygen Sensors—3.9L/5.2L/5.9L LDC Engines

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(22) On 5.9L HDC engines, verify that both the left and right oxygen sensor wire connectors are firmly connected to the sensors. Inspect sensors and connectors for damage (Fig. 44).



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Fig. 44 Left/Right Oxygen Sensors—5.9L HDC Engines

(23) Inspect for pinched or leaking fuel tubes. Inspect for pinched, cracked or leaking fuel hoses.

(24) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic converter.

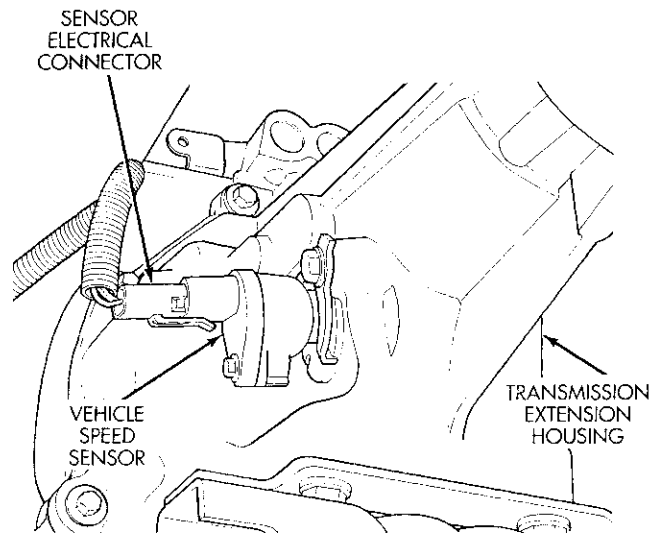
(25) If equipped with automatic transmission, verify that electrical harness is firmly connected to park/neutral switch. Refer to Automatic Transmission section of Group 21.

(26) Verify that the electrical harness connector is firmly connected to the vehicle speed sensor (Fig. 45).

(27) Verify that fuel pump/gauge sender unit wire connector is firmly connected to harness connector.

(28) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks.

(29) Inspect transmission torque converter housing (automatic transmission) or clutch housing (manual



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Fig. 45 Vehicle Speed Sensor—Typical

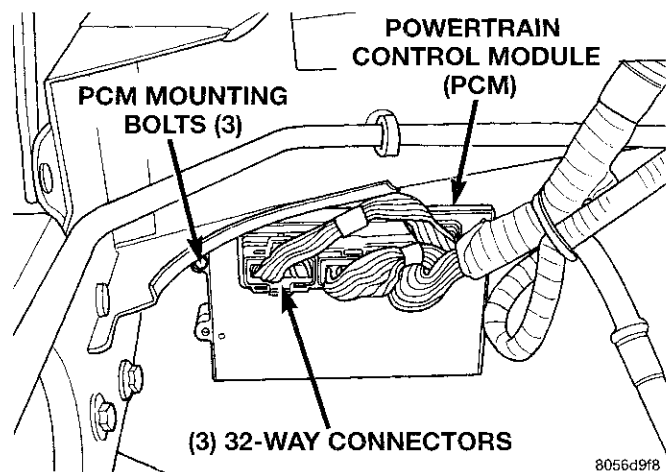
transmission) for damage to timing ring on drive plate/flywheel.

(30) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components.

VISUAL INSPECTION—8.0L ENGINE

A visual inspection for loose, disconnected or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the three 32-way electrical connectors are fully inserted into the connector of the powertrain control module (PCM) (Fig. 46).



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Fig. 46 Powertrain Control Module (PCM)

DIAGNOSIS AND TESTING (Continued)

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay and air conditioning compressor clutch relay (if equipped). Inspect the ASD relay connections. Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion. The relays are located in the Power Distribution Center (PDC) (Fig. 47). Refer to label on PDC cover for relay location.

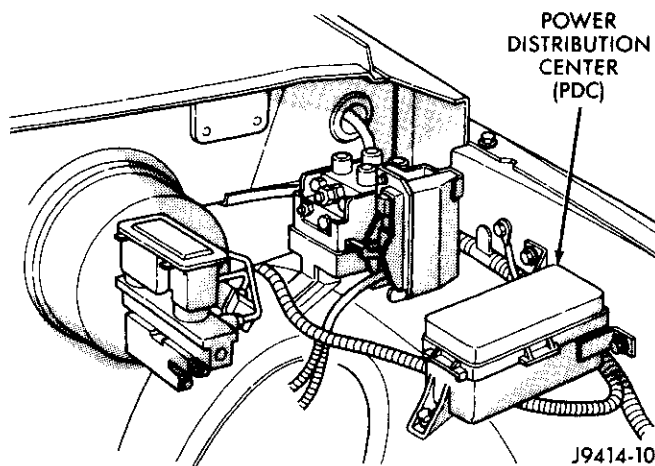


Fig. 47 Power Distribution Center (PDC)

(4) Inspect ignition coil pack primary connections. Verify that secondary cables are firmly connected to coils (Fig. 48).

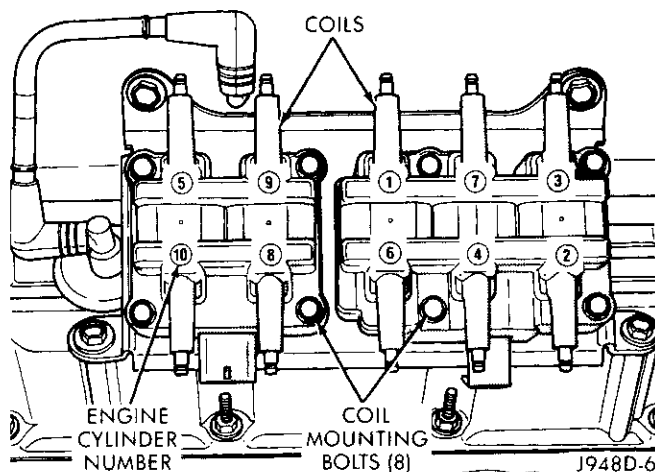


Fig. 48 Ignition Coil Pack—8.0L Engine

(5) Be sure that spark plug cables are firmly connected and the spark plugs are in their correct firing order. Be sure that camshaft position sensor wire connector is firmly connected to harness connector. Inspect spark plug condition. Refer to Group 8D, Ignition. Connect vehicle to an oscilloscope and inspect spark events for fouled or damaged spark plugs or cables.

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator.

(7) Inspect the system body grounds for loose or dirty connections. Refer to Group 8, Wiring for ground locations.

(8) Verify crankcase ventilation (CCV) operation. Refer to Group 25, Emission Control System for additional information.

(9) Inspect fuel tube quick-connect fitting-to-fuel rail connections.

(10) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

(11) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable connections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions.

(12) If equipped with vacuum brake booster, verify that vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(13) Inspect the air cleaner inlet and air cleaner element for dirt or restrictions.

(14) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(15) Verify that the intake manifold air temperature sensor wire connector is firmly connected to harness connector (Fig. 49).

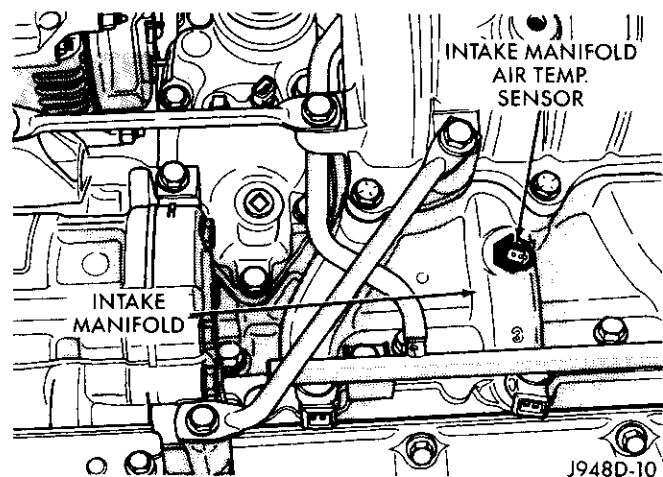
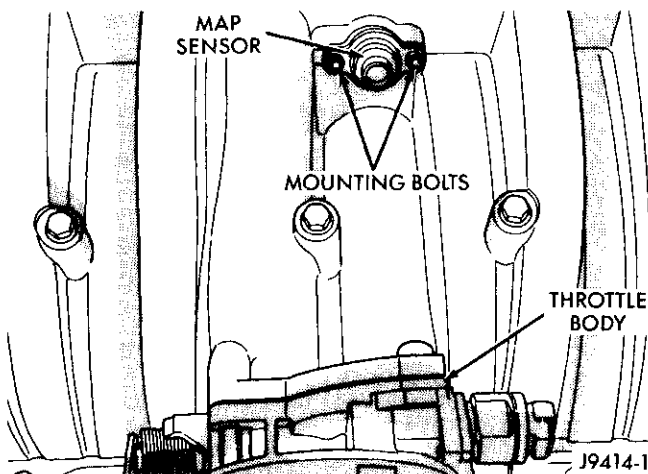


Fig. 49 Air Temperature Sensor—8.0L Engine

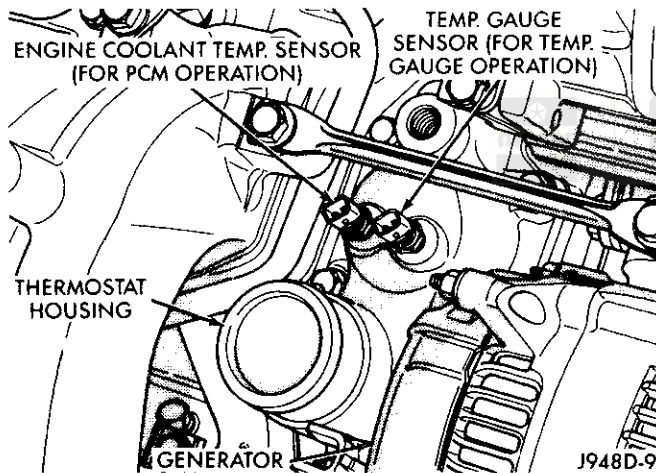
(16) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 50).

(17) Verify that fuel injector wire harness connectors are firmly connected to injectors in the correct order. Each harness connector is numerically tagged with the injector number (INJ 1, INJ 2 etc.) of its corresponding fuel injector and cylinder number.

DIAGNOSIS AND TESTING (Continued)**Fig. 50 Map Sensor —8.0L Engine**

(18) Verify harness connectors are firmly connected to idle air control (IAC) motor and throttle position sensor (TPS).

(19) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 51).

**Fig. 51 Engine Coolant Temperature Sensor—8.0L Engine**

(20) Raise and support the vehicle.

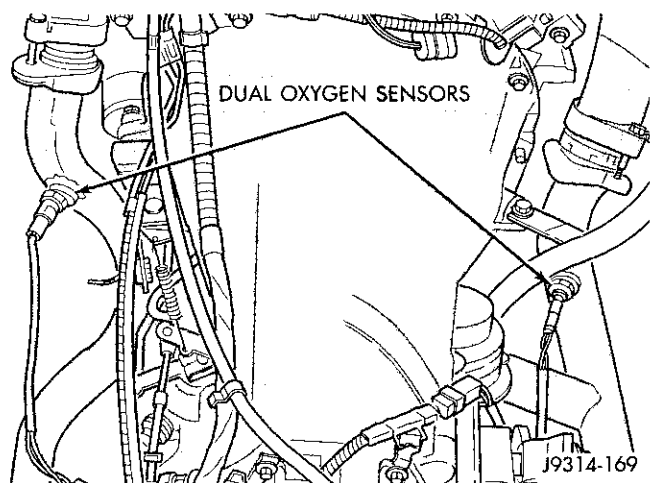
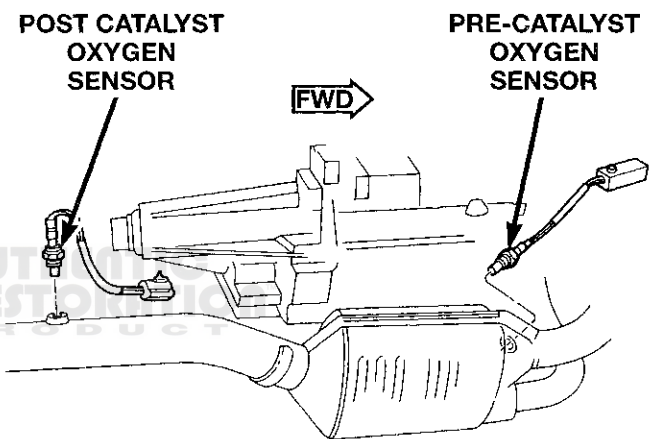
(21) On all 8.0L engines (HDC or MDC), verify that the left and right oxygen sensor wire connectors are firmly connected to the sensors. Inspect sensors and connectors for damage (Fig. 52).

(22) On 8.0L MDC engine, verify that the pre-catalyst and post catalyst oxygen sensor wire connectors are firmly connected to the sensors. Inspect sensors and connectors for damage (Fig. 53).

(23) Inspect for pinched or leaking fuel tubes. Inspect for pinched, cracked or leaking fuel hoses.

(24) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic converter.

(25) If equipped with automatic transmission, verify that electrical harness is firmly connected to park/

**Fig. 52 Left/Right Oxygen Sensors****Fig. 53 Pre-Catalyst/Post Catalyst Oxygen Sensors**

neutral switch. Refer to Automatic Transmission section of Group 21.

(26) Verify that the electrical harness connector is firmly connected to the vehicle speed sensor (Fig. 54).

(27) Verify that fuel pump/gauge sender unit wire connector is firmly connected to harness connector.

(28) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks.

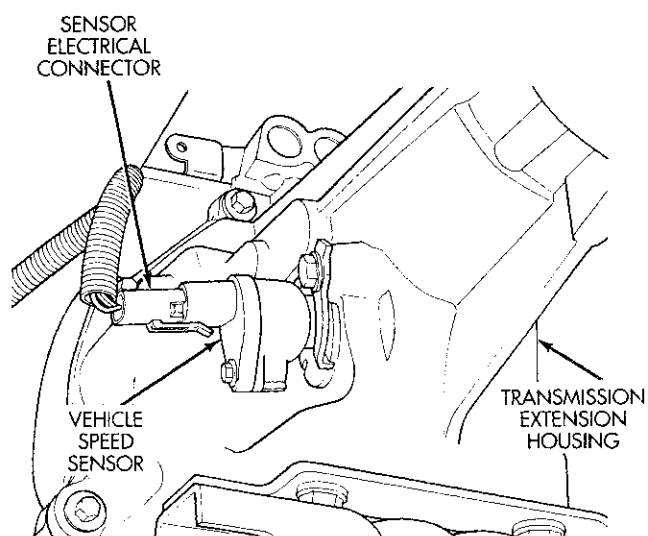
(29) Inspect transmission torque converter housing (automatic transmission) or clutch housing (manual transmission) for damage to timing ring on drive plate/flywheel.

(30) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chafed wires or wires rubbing up against other components.

ASD AND FUEL PUMP RELAYS

The following operations/tests apply to these relays only: Automatic Shutdown (ASD) and Fuel Pump. For operations/tests on all other relays, refer to the appropriate section of this service manual.

DIAGNOSIS AND TESTING (Continued)

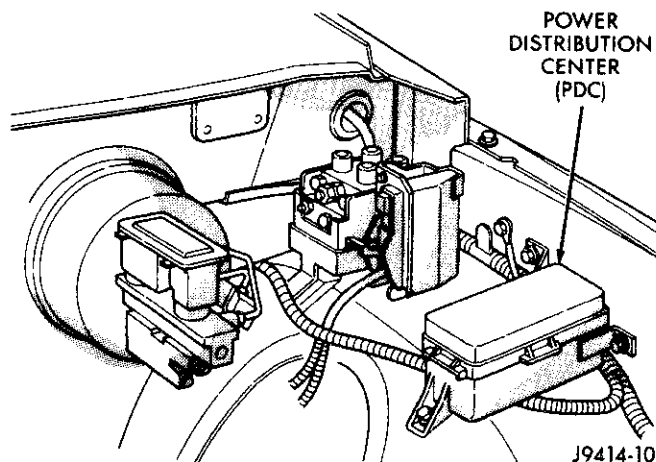


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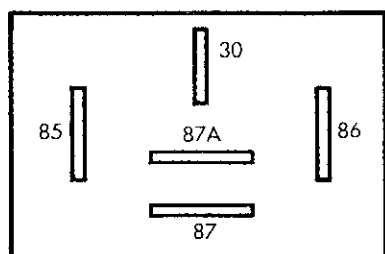
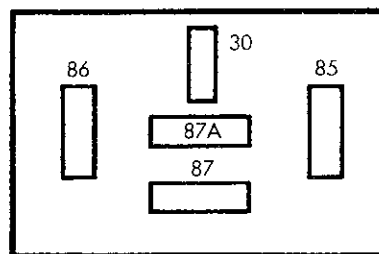
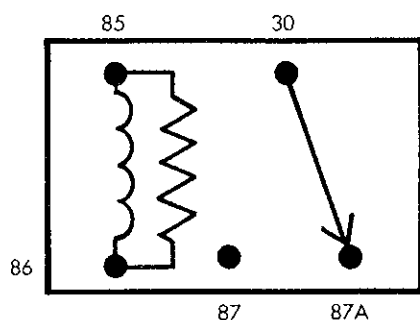
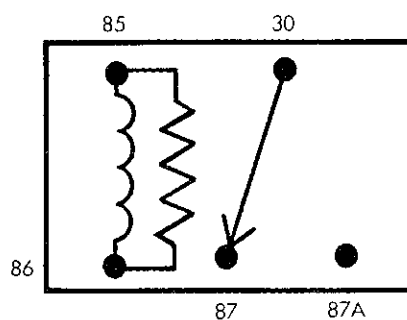
Fig. 54 Vehicle Speed Sensor—Typical

These relays are located in the Power Distribution Center (PDC) (Fig. 55). Refer to label on PDC cover for relay location.

The relay terminal numbers from (Fig. 56) can be found on the bottom of the relay.

**Fig. 55 Power Distribution Center**

- Terminal number 30 is connected to battery voltage and can be switched or B+ (hot) at all times.
- The center terminal number 87A is connected (a circuit is formed) to terminal 30 in the de-energized (normally OFF) position.
- Terminal number 87 is connected (a circuit is formed) to terminal 30 in the energized (ON) position. Terminal number 87 then supplies battery voltage to the component being operated.
- Terminal number 86 is connected to a switched (+) power source.

**BOTTOM VIEW
OF RELAY****RELAY
CONNECTOR****DE-ENERGIZED
RELAY****ENERGIZED
RELAY****Fig. 56 Relay Terminals**

9214-157

DIAGNOSIS AND TESTING (Continued)

- Terminal number 85 is grounded by the powertrain control module (PCM).

TESTING

- (1) Remove relay before testing.
- (2) Using an ohmmeter, perform a resistance test between terminals 85 and 86. Resistance value (ohms) should be 75 ± 5 ohms for resistor equipped relays.
- (3) Connect the ohmmeter between terminals number 87A and 30. Continuity should be present at this time.
- (4) Connect the ohmmeter between terminals number 87 and 30. Continuity should not be present at this time.
- (5) Use a set of jumper wires (16 gauge or smaller). Connect one jumper wire between terminal number 85 (on the relay) to the ground side (-) of a 12 Volt power source.
- (6) Attach the other jumper wire to the positive side (+) of a 12V power source. Do not connect this jumper wire to relay at this time.

CAUTION: Do not allow the ohmmeter to contact terminals 85 or 86 during these tests. Damage to ohmmeter may result.

- (7) Attach the other jumper wire (12V +) to terminal number 86. This will activate the relay. Continuity should now be present between terminals number 87 and 30. Continuity should not be present between terminals number 87A and 30.

- (8) Disconnect jumper wires from relay and 12 Volt power source.

- (9) If continuity or resistance tests did not pass, replace relay. If tests passed, refer to Group 8W, Wiring Diagrams for (fuel system) relay wiring schematics and for additional circuit information.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST—3.9L/5.2L/5.9L ENGINES

To perform a complete test of MAP sensor (Fig. 57) and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the MAP sensor only, refer to the following:

- (1) Inspect the rubber L-shaped fitting from the MAP sensor to the throttle body (Fig. 58). Repair as necessary.

CAUTION: When testing the MAP sensor, be sure that the harness wires are not damaged by the test meter probes.

- (2) Test the MAP sensor output voltage at the MAP sensor connector between terminals A and B (Fig. 59). With the ignition switch ON and the engine OFF, output voltage should be 4-to-5 volts. The volt-

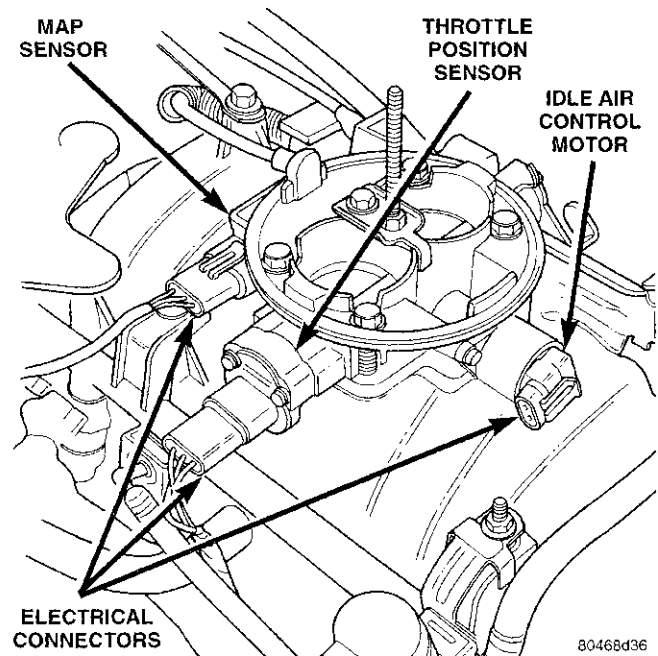


Fig. 57 Manifold Absolute Pressure (MAP) Sensor—3.9L/5.2L/5.9L Engines

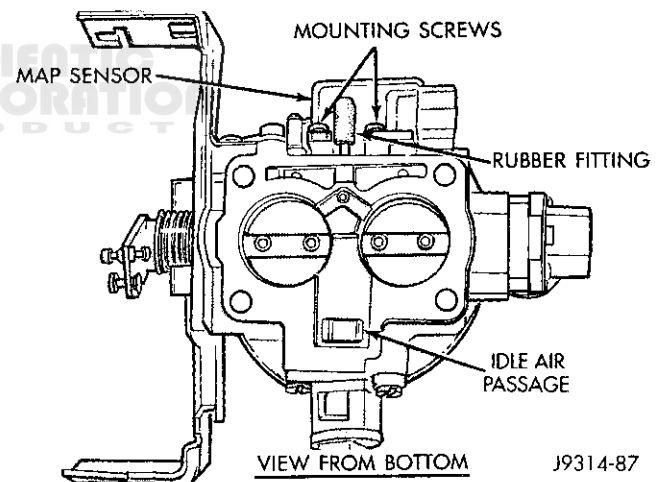


Fig. 58 Rubber L-Shaped Fitting—MAP Sensor-to-Throttle Body—3.9L/5.2L/5.9L Engines

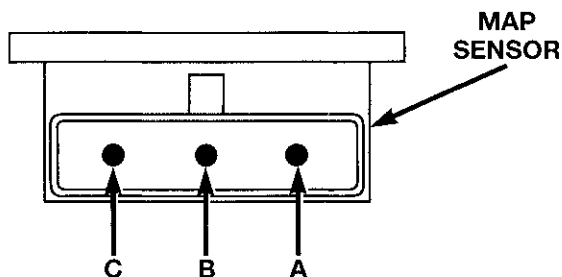
age should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.

- (3) Test powertrain control module (PCM) cavity A-27 for the same voltage described above to verify the wire harness condition. Repair as necessary.

- (4) Test MAP sensor supply voltage at sensor connector between terminals A and C (Fig. 59) with the ignition ON. The voltage should be approximately 5 volts ($\pm 0.5V$). Five volts ($\pm 0.5V$) should also be at cavity A-17 of the PCM wire harness connector. Repair or replace the wire harness as necessary.

DIAGNOSIS AND TESTING (Continued)

A = GROUND
B = OUTPUT VOLTAGE SIGNAL
C = 5-VOLT SUPPLY



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Fig. 59 MAP Sensor Connector Terminals—3.9L/5.2L/5.9L Engines

(5) Test the MAP sensor ground circuit at sensor connector terminal—A (Fig. 59) and PCM connector A-4. Repair the wire harness if necessary.

Refer to Group 8W, Wiring Diagrams for cavity locations.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST—8.0L ENGINE

To perform a complete test of the MAP sensor (Fig. 60) and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the MAP sensor only, refer to the following:

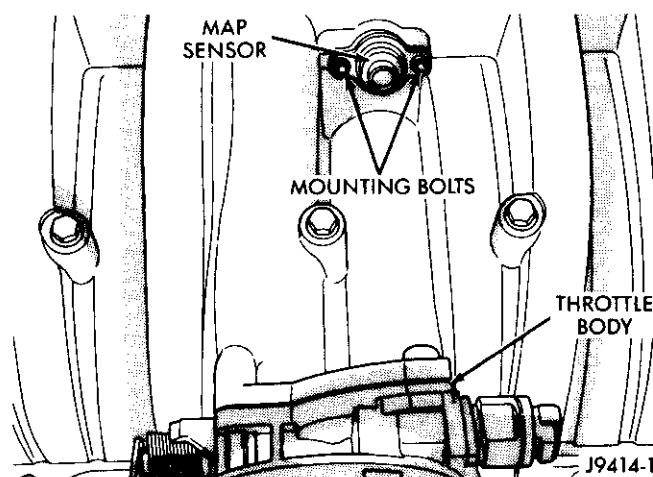
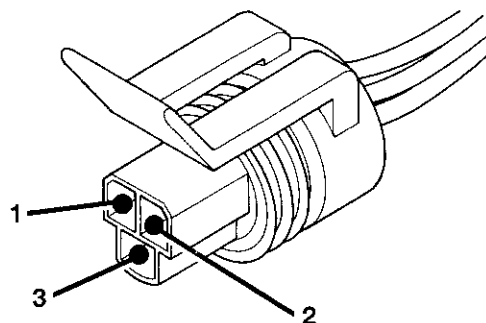


Fig. 60 Manifold Absolute Pressure (MAP) Sensor—8.0L Engine

CAUTION: When testing the MAP sensor, be sure that the harness wires are not damaged by the test meter probes.

(1) Test the MAP sensor output voltage at the MAP sensor connector between terminals 1 and 3

(Fig. 61). With the ignition switch ON and the engine OFF, output voltage should be 4-to-5 volts. The voltage should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.



CAVITY	FUNCTION
1	5-Volt Supply
2	Sensor Ground
3	Map Sensor Signal

805dd851

Fig. 61 MAP Sensor Connector Terminals—8.0L Engine

(2) Test powertrain control module (PCM) cavity A-27 for the same voltage described above to verify the wire harness condition. Repair as necessary.

(3) Test MAP sensor supply voltage at sensor connector between terminals 1 and 2 (Fig. 61) with the ignition ON. The voltage should be approximately 5 volts ($\pm 0.5V$). Five volts ($\pm 0.5V$) should also be at cavity A-17 of the PCM wire harness connector. Repair or replace the wire harness as necessary.

(4) Test the MAP sensor ground circuit at sensor connector terminal—2 (Fig. 61) and PCM connector A-4. Repair the wire harness if necessary.

Refer to Group 8W, Wiring Diagrams for cavity locations.

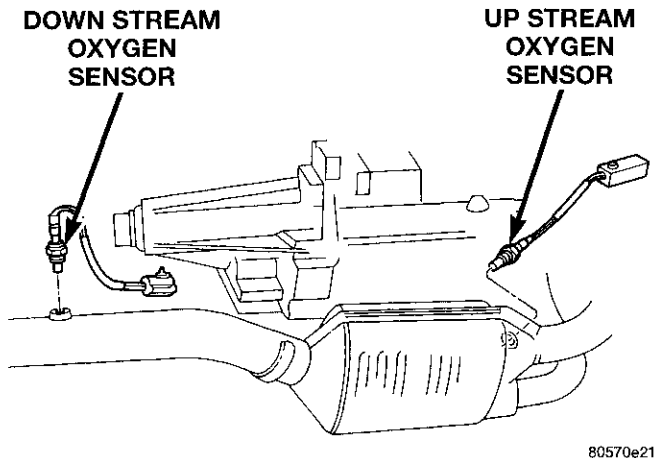
HEATED OXYGEN (O2S) SENSORS—3.9L/5.2L/5.9L LCD ENGINES

To perform a complete test of the O2S sensors and their circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the O2S sensors only, refer to the following:

The upstream O2S sensor is located on the inlet end of the catalytic converter (Fig. 62).

The downstream O2S sensor is located on the outlet end of the catalytic converter (Fig. 62).

Each O2S heating element can be tested with an ohmmeter as follows:

DIAGNOSIS AND TESTING (Continued)

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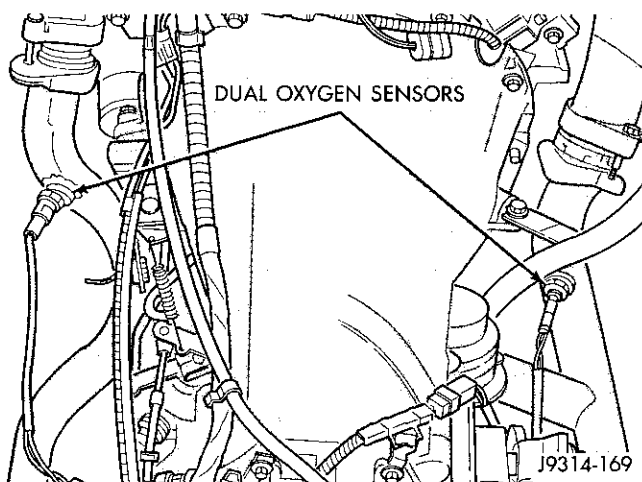
Fig. 62 Upstream/Downstream Oxygen Sensor Location—3.9L/5.2L/5.9L LDC Engines

Disconnect the O₂S sensor connector. Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

HEATED OXYGEN (O₂S) SENSORS—5.9L HDC ENGINE

To perform a complete test of the dual (left and right) O₂S sensors and their circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the O₂S sensors only, refer to the following:

The left and right O₂S sensors are located on the left and right exhaust downpipes (Fig. 63).



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Fig. 63 Left/Right Oxygen Sensor Location—5.9L HDC Engine

Each O₂S heating element can be tested with an ohmmeter as follows:

Disconnect the O₂S sensor connector. Connect the ohmmeter test leads across the white wire terminals

of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

HEATED OXYGEN (O₂S) SENSORS—8.0L HDC/MDC ENGINES

To perform a complete test of the O₂S sensors and their circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the O₂S sensors only, refer to the following:

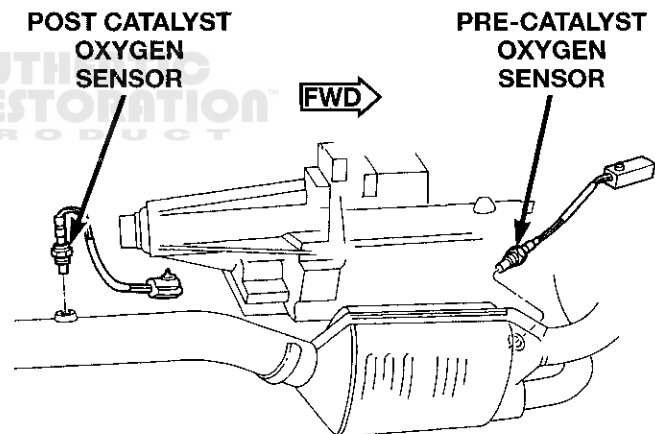
A total of 4 oxygen sensors (left, right, pre-catalyst and post catalyst) are used with the 8.0L engine when equipped with the Medium Duty Emission Cycle (MDC) engine package.

Only 2 oxygen sensors (left and right) are used with the 8.0L engine when equipped with the Heavy Duty Emission Cycle (HDC) engine.

The pre-catalyst O₂S sensor is located on the inlet end of the catalytic converter (Fig. 64).

The post catalyst O₂S sensor is located on the outlet end of the catalytic converter (Fig. 64).

The left and right sensors are located on the left and right exhaust downpipes (Fig. 65).



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Fig. 64 Pre-Catalyst/Post Catalyst Oxygen Sensor Locations—HDC/MDC Engines

Each O₂S heating element can be tested with an ohmmeter as follows:

Disconnect the O₂S sensor connector. Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

CAMSHAFT AND CRANKSHAFT POSITION SENSORS

Refer to Group 8D, Ignition System for information.

DIAGNOSIS AND TESTING (Continued)

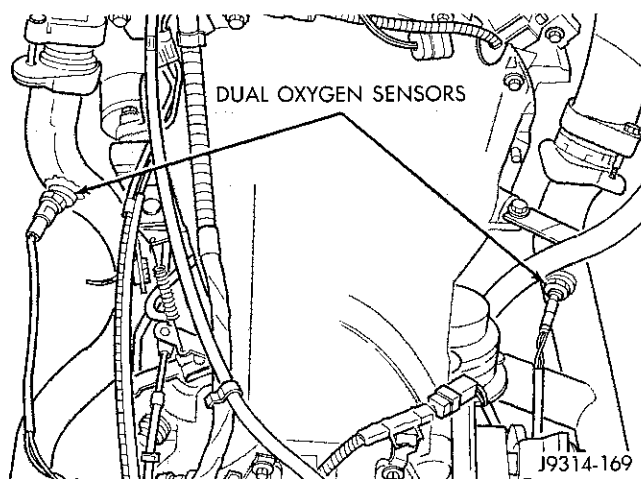


Fig. 65 Left/Right Oxygen Sensor Locations—HDC/MDC Engines

ENGINE COOLANT TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES

To perform a complete test of the engine coolant temperature sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor (Fig. 66).

(2) **Engines with air conditioning:** When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

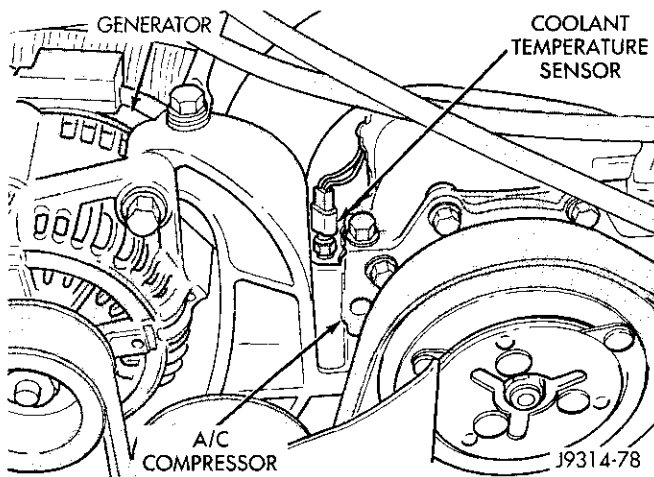


Fig. 66 Engine Coolant Temperature Sensor—3.9L/5.2L/5.9L Engines

(3) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resis-

tance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/Intake Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
-40	-40	291,490	381,710
-20	-4	85,850	108,390
-10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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SENSOR RESISTANCE (OHMS)—COOLANT TEMPERATURE SENSOR/INTAKE AIR TEMPERATURE SENSOR

(4) Test continuity of the wire harness between the PCM wire harness connector and the coolant sensor connector terminals. Refer to Group 8, Wiring for terminal/cavity locations. Repair the wire harness if an open circuit is indicated.

(5) After tests are completed, connect electrical connector to sensor. The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.

ENGINE COOLANT TEMPERATURE SENSOR—8.0L ENGINE

To perform a complete test of the engine coolant temperature sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor (Fig. 67).

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/In-

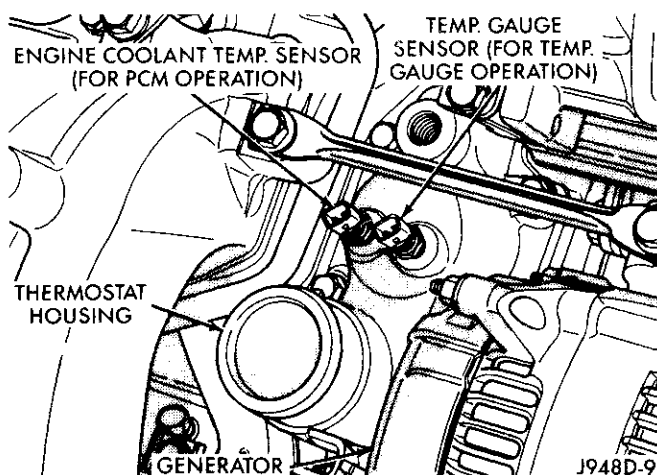
DIAGNOSIS AND TESTING (Continued)

Fig. 67 Engine Coolant Temperature Sensor—8.0L Engine

take Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test continuity of the wire harness between the PCM wire harness connector and the coolant sensor connector terminals. Refer to Group 8, Wiring for terminal/cavity locations. Repair the wire harness if an open circuit is indicated.

(4) After tests are completed, connect electrical connector to sensor.

IDLE AIR CONTROL (IAC) MOTOR—3.9L/5.2L/5.9L ENGINES

To perform a complete test of the IAC motor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

IDLE AIR CONTROL (IAC) MOTOR—8.0L ENGINE

To perform a complete test of the IAC motor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES

To perform a complete test of the intake manifold air temperature sensor and its circuitry, refer to DRB tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the intake manifold air temperature sensor (Fig. 68) or (Fig. 69).

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/Intake Air Temperature

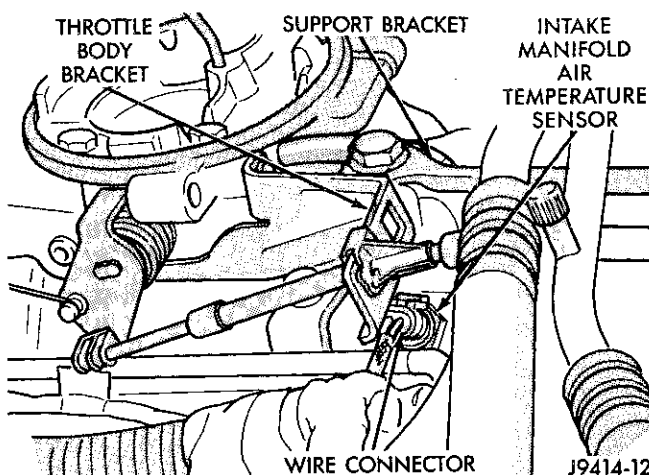


Fig. 68 Intake Manifold Air Temperature Sensor—3.9L V-6 Engines

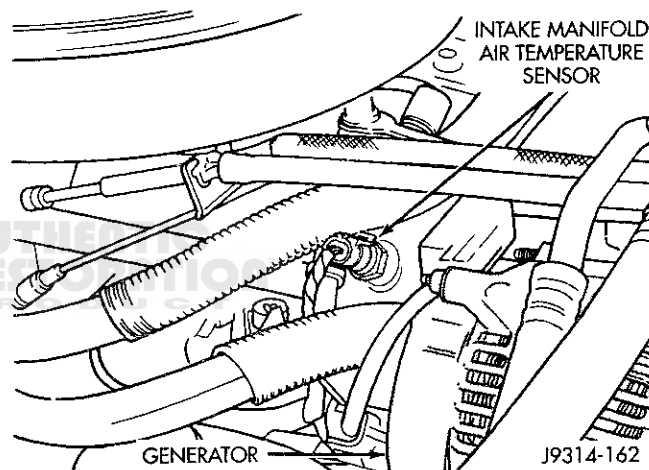


Fig. 69 Intake Manifold Air Temperature Sensor—5.2L/5.9L V-8 Engines

sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the PCM wire harness connector A-15 and the sensor connector terminal. Also check between PCM connector A-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—8.0L ENGINE

To perform a complete test of the intake manifold air temperature sensor and its circuitry, refer to DRB tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the intake manifold air temperature sensor (Fig. 70).

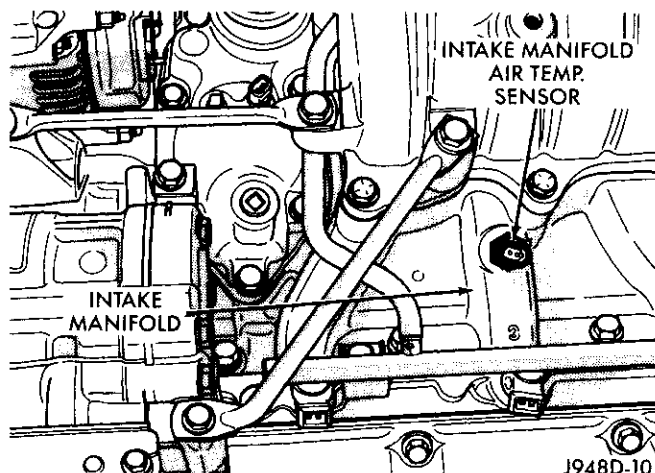
DIAGNOSIS AND TESTING (Continued)

Fig. 70 Intake Manifold Air Temperature Sensor—8.0L Engine

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/Intake Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the PCM wire harness connector A-15 and the sensor connector terminal. Also check between PCM connector A-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

VEHICLE SPEED SENSOR

To perform a complete test of the sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

THROTTLE POSITION SENSOR (TPS)—3.9L/5.2L/5.9L ENGINES

To perform a complete test of the TPS and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the TPS only, refer to the following:

The TPS can be tested with a digital voltmeter. The center terminal of the TPS is the output terminal (Fig. 71).

With the ignition key in the ON position, check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should must be greater than 200 millivolts. At wide open throttle, TPS output voltage must be less than 4.8 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

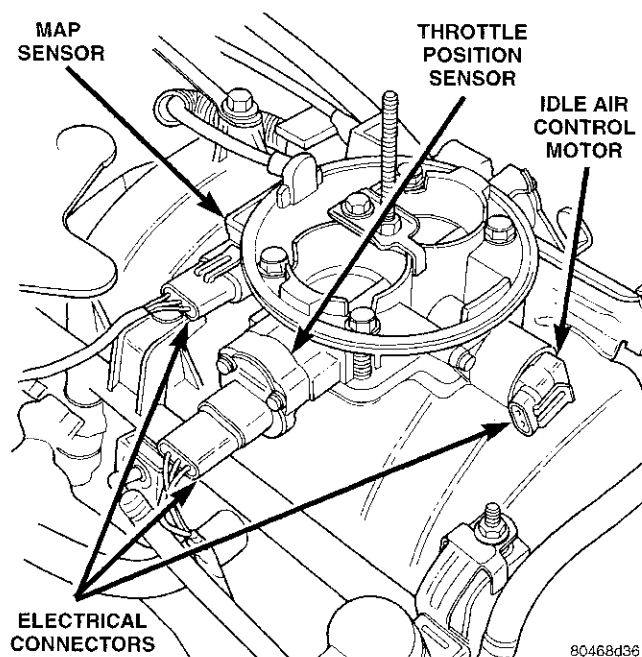


Fig. 71 TPS—3.9L/5.2L/5.9L Engines

THROTTLE POSITION SENSOR (TPS)—8.0L ENGINE

To perform a complete test of the TPS and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the TPS only, refer to the following:

The TPS can be tested with a digital voltmeter. The center terminal of the TPS is the output terminal (Fig. 72).

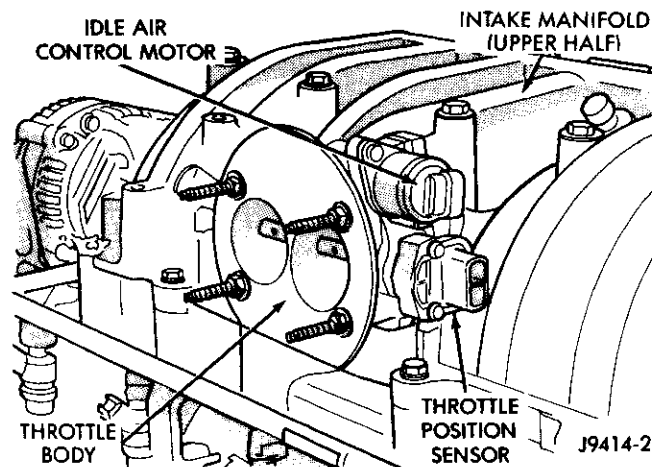


Fig. 72 TPS—8.0L Engine

With the ignition key in the ON position, check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should must be greater than 200 millivolts. At wide open throttle, TPS output voltage must be

DIAGNOSIS AND TESTING (Continued)

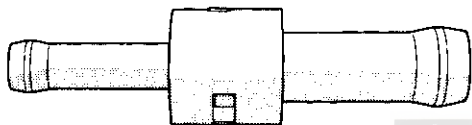
less than 4.8 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE—3.9L/5.2L/5.9L ENGINES

The following test procedure has been developed to check throttle body calibrations for correct idle conditions. The procedure should be used to diagnose the throttle body for conditions that may cause idle problems. **This procedure should be used only after normal diagnostic procedures have failed to produce results that indicate a throttle body related problem. Be sure to check for proper operation of the idle air control motor before performing this test.**

A special fixed orifice tool (number 6714) (Fig. 73) must be used for the following test.

SPECIAL TOOL 6714



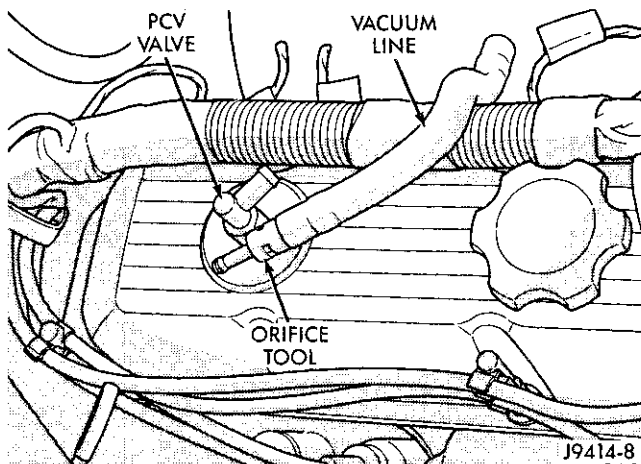
J9414-7

Fig. 73 Fixed Orifice Tool

(1) Start the engine and bring to operating temperature. Be sure all accessories are off before performing this test.

(2) Shut off the engine and remove the air cleaner element housing.

(3) Disconnect the vacuum line at the PCV valve (Fig. 74).

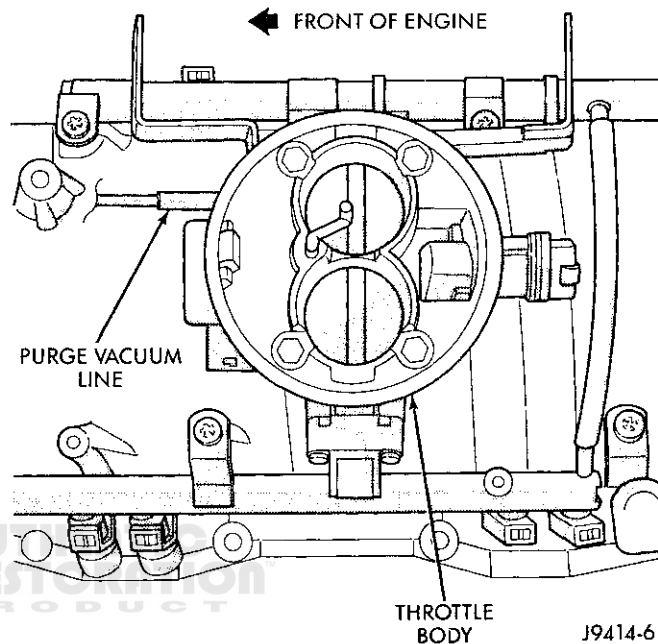


J9414-8

Fig. 74 Install Orifice Tool

(4) Install the 0.185 inch orifice tool (number 6714) into the disconnected vacuum line in place of the PCV valve (Fig. 74).

(5) Disconnect the idle purge vacuum line from fitting at throttle body. This vacuum line is located on the front of throttle body next to the MAP sensor (Fig. 75). Cap the fitting at throttle body after vacuum line has been removed.



J9414-6

Fig. 75 Idle Purge Line

(6) Connect the DRB scan tool to the 16-way data link connector. This connector is located under the instrument panel to the left of the steering column. Refer to the appropriate Powertrain Diagnostic Procedures service manual for DRB operation.

(7) Start the engine.

(8) Using the DRB scan tool, scroll through the menus as follows: select—System, select—Engine, select—Fuel and Ignition, select—Actuator Tests, select—Engine rpm and select—Minimum Air Flow.

(9) The DRB scan tool will count down to stabilize the idle rpm and display the minimum air flow idle rpm. The idle rpm should be between **500 and 900 rpm**. If the idle speed is outside of these specifications, replace the throttle body. Refer to Throttle Body in the Component Removal/Installation section of this group.

(10) Disconnect the DRB scan tool from the vehicle.

(11) Remove cap from idle purge fitting at throttle body and install vacuum line.

(12) Remove orifice tool and connect vacuum line to PCV valve.

(13) Install air cleaner element housing.

REMOVAL AND INSTALLATION

AUTOMATIC SHUTDOWN (ASD) RELAY

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 76). Refer to label on PDC cover for relay location. Check terminal connections at PDC and relay for damage/corrosion before installation. Repair as necessary.

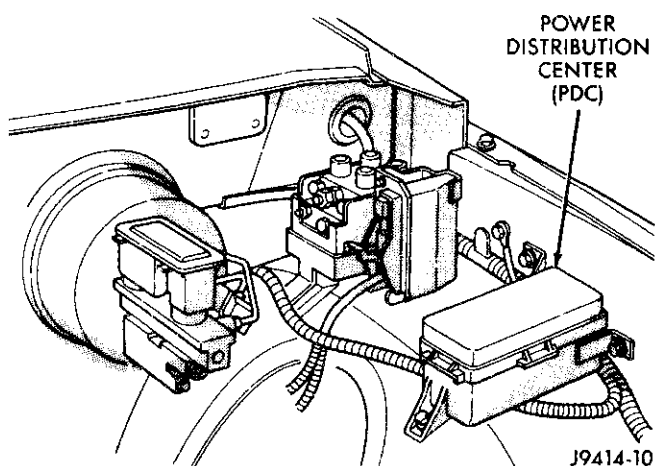


Fig. 76 Power Distribution Center (PDC)

FUEL PUMP RELAY

The fuel pump relay is located in the Power Distribution Center (PDC) (Fig. 76). Refer to label on PDC cover for relay location. Check terminal connections at relay and PDC for damage/corrosion before installation. Repair as necessary.

THROTTLE BODY—3.9L/5.2L/5.9L ENGINES

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the powertrain control module (PCM).

REMOVAL

- (1) Remove the air cleaner.
- (2) Disconnect throttle body electrical connectors at MAP sensor, IAC motor and TPS (Fig. 77).
- (3) Remove vacuum line at throttle body.
- (4) Remove all control cables from throttle body (lever) arm. Refer to the Accelerator Pedal and Throttle Cable section of this group for additional information.
- (5) Remove four throttle body mounting bolts (Fig. 78).
- (6) Remove throttle body from intake manifold.
- (7) Discard old throttle body-to-intake manifold gasket.

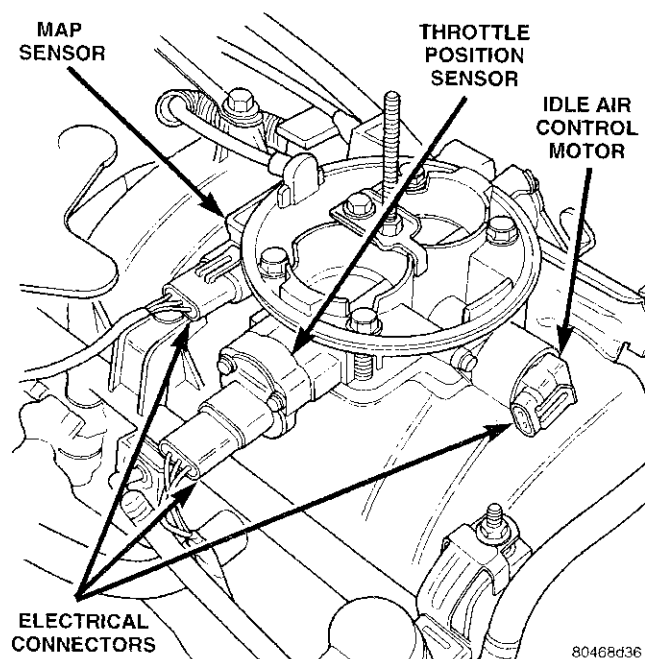


Fig. 77 Sensor Electrical Connectors—3.9L/5.2L/5.9L ENGINES—Typical

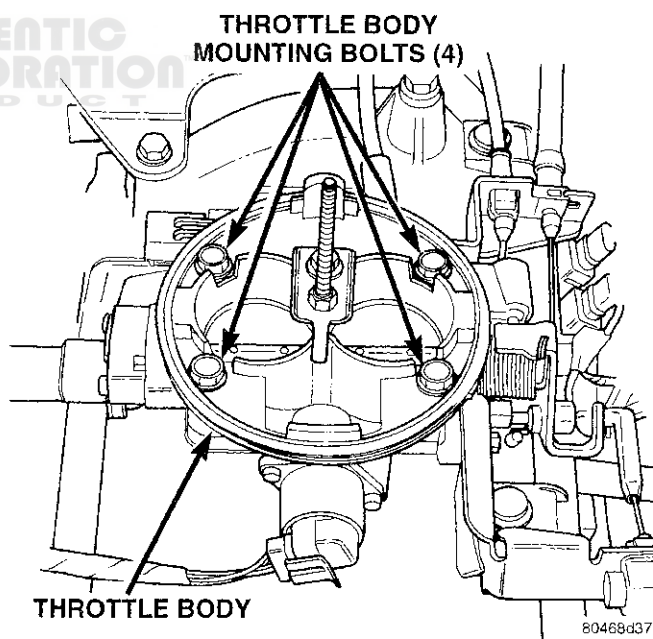


Fig. 78 Throttle Body Mounting Bolts—3.9L/5.2L/5.9L ENGINES—Typical

INSTALLATION

- (1) Clean the mating surfaces of the throttle body and the intake manifold.
- (2) Install new throttle body-to-intake manifold gasket.
- (3) Install throttle body to intake manifold.
- (4) Install four mounting bolts. Tighten bolts to 23 N·m (200 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

- (5) Install control cables.
- (6) Install vacuum line to throttle body.
- (7) Install electrical connectors.
- (8) Install air cleaner.

THROTTLE BODY—8.0L ENGINE

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the powertrain control module (PCM).

REMOVAL

- (1) Remove the air cleaner cover.
- (2) Remove the 4 air cleaner housing mounting nuts and remove housing from throttle body.
- (3) Disconnect throttle body electrical connectors at the IAC motor and TPS.
- (4) Remove all control cables from throttle body (lever) arm. Refer to the Accelerator Pedal and Throttle Cable section of this group for additional information.
- (5) Remove four throttle body mounting nuts (Fig. 79).

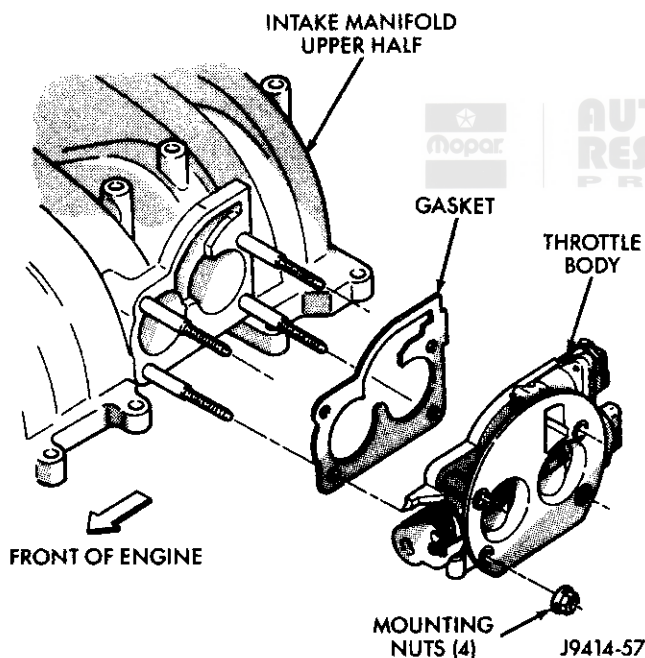


Fig. 79 Throttle Body Mounting Nuts—8.0L Engine

- (6) Remove throttle body from intake manifold.
- (7) Discard old throttle body-to-intake manifold gasket.

INSTALLATION

- (1) Clean the mating surfaces of the throttle body and the intake manifold.
- (2) Install new throttle body-to-intake manifold gasket.
- (3) Install throttle body to intake manifold.
- (4) Install four mounting nuts. Tighten nuts to 22 N·m (192 in. lbs.) torque.

- (5) Install control cables.
- (6) Install electrical connectors.
- (7) Install air cleaner housing to throttle body.
- (8) Install 4 air cleaner housing mounting nuts. Tighten nuts to 11 N·m (96 in. lbs.) torque.
- (9) Install air cleaner housing cover.

THROTTLE POSITION SENSOR (TPS)—3.9L/5.2L/5.9L ENGINES**REMOVAL**

The TPS is located on the side of the throttle body.

- (1) Remove air intake tube at throttle body.
- (2) Disconnect TPS electrical connector.
- (3) Remove two TPS mounting bolts (Fig. 80).

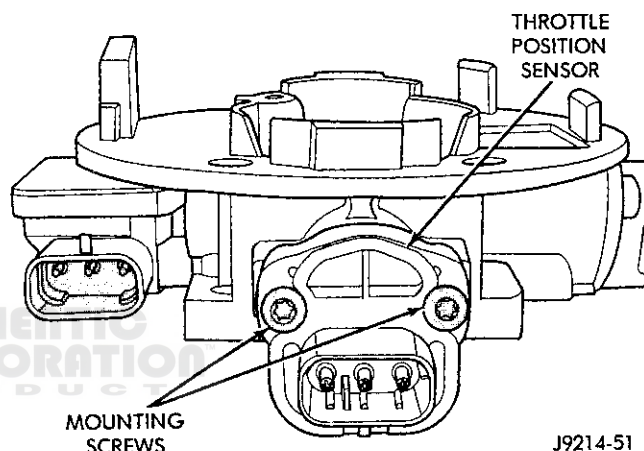


Fig. 80 TPS Mounting Bolts—3.9L/5.2L/5.9L Engines

- (4) Remove TPS from throttle body.

INSTALLATION

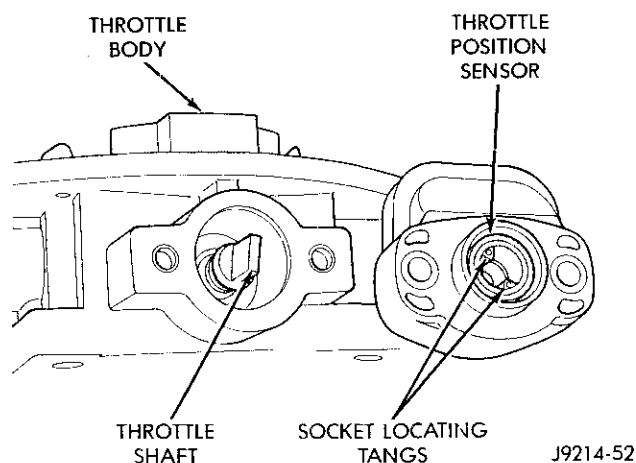
The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 81). The TPS must be installed so that it can be rotated a few degrees. If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs. The TPS will be under slight tension when rotated.

- (1) Install the TPS and two retaining bolts.
- (2) Tighten bolts to 7 N·m (60 in. lbs.) torque.
- (3) Manually operate the throttle control lever by hand to check for any binding of the TPS.
- (4) Connect TPS electrical connector to TPS.
- (5) Install air intake tube.

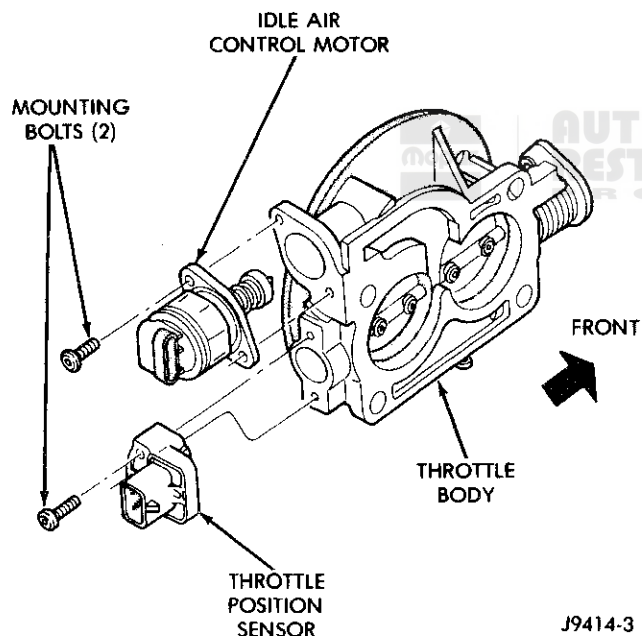
THROTTLE POSITION SENSOR (TPS)—8.0L ENGINE**REMOVAL**

The TPS is located on the side of the throttle body (Fig. 82).

- (1) Remove air intake tube at air cleaner housing.
- (2) Remove the air cleaner cover.

REMOVAL AND INSTALLATION (Continued)**Fig. 81 Installation—3.9L/5.2L/5.9L Engines—Typical**

- (3) Remove the 4 air cleaner housing mounting nuts and remove housing from throttle body.
- (4) Disconnect TPS electrical connector.
- (5) Remove two TPS mounting bolts (Fig. 82).

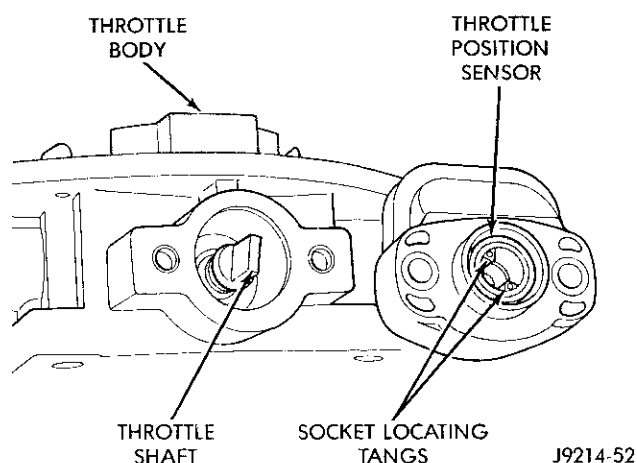
**Fig. 82 TPS Mounting Bolts—8.0L Engine**

- (6) Remove TPS from throttle body.

INSTALLATION

The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 83). The TPS must be installed so that it can be rotated a few degrees. If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs. The TPS will be under slight tension when rotated.

- (1) Install the TPS and two retaining bolts.
- (2) Tighten bolts to 7 N·m (60 in. lbs.) torque.

**Fig. 83 Installation—Typical Mounting**

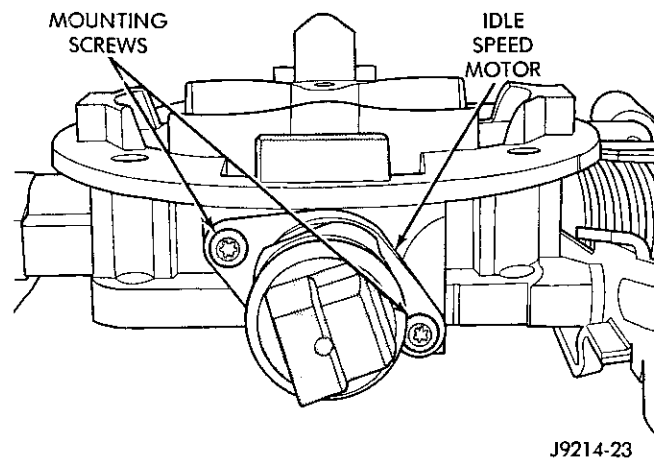
- (3) Manually operate the throttle control lever by hand to check for any binding of the TPS.
- (4) Connect TPS electrical connector to TPS.
- (5) Install air cleaner housing to throttle body.
- (6) Install 4 air cleaner housing mounting nuts. Tighten nuts to 11 N·m (96 in. lbs.) torque.
- (7) Install air cleaner housing cover.
- (8) Install air intake tube to cover.

IDLE AIR CONTROL (IAC) MOTOR—3.9L/5.2L/5.9L ENGINES

The IAC motor is located on the back of the throttle body (Fig. 84).

REMOVAL

- (1) Remove air cleaner assembly.
- (2) Disconnect electrical connector from IAC motor.
- (3) Remove two mounting bolts (screws) (Fig. 84).
- (4) Remove IAC motor from throttle body.

**Fig. 84 Mounting Bolts (Screws)—IAC Motor—3.9L/5.2L/5.9L Engines**

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

- (1) Install IAC motor to throttle body.
- (2) Install and tighten two mounting bolts (screws) to 7 N·m (60 in. lbs.) torque.
- (3) Install electrical connector.
- (4) Install air cleaner assembly.

IDLE AIR CONTROL (IAC) MOTOR—8.0L ENGINE

The IAC motor is located on the back of the throttle body (Fig. 85).

REMOVAL

- (1) Remove the air cleaner cover.
- (2) Remove the 4 air cleaner housing mounting nuts and remove housing from throttle body.
- (3) Disconnect electrical connector from IAC motor.
- (4) Remove two mounting bolts (screw).

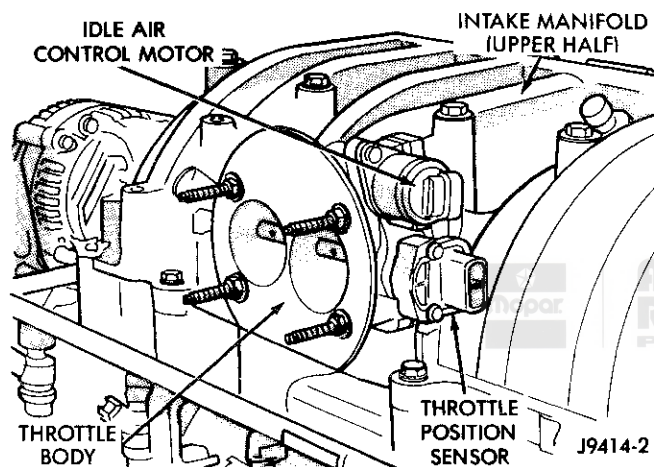


Fig. 85 IAC Motor—8.0L Engine

- (5) Remove IAC motor from throttle body.

INSTALLATION

- (1) Install IAC motor to throttle body.
- (2) Install and tighten two mounting bolts (screws) to 7 N·m (60 in. lbs.) torque.
- (3) Install electrical connector.
- (4) Install air cleaner housing to throttle body.
- (5) Install 4 air cleaner housing mounting nuts. Tighten nuts to 11 N·m (96 in. lbs.) torque.
- (6) Install air cleaner housing cover.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.9L/5.2L/5.9L ENGINES

The MAP sensor is located on the front of the throttle body. An L-shaped rubber fitting is used to connect the MAP sensor to throttle body (Fig. 86).

REMOVAL

The throttle body must be removed from the intake manifold for MAP sensor removal.

- (1) Remove air cleaner assembly.

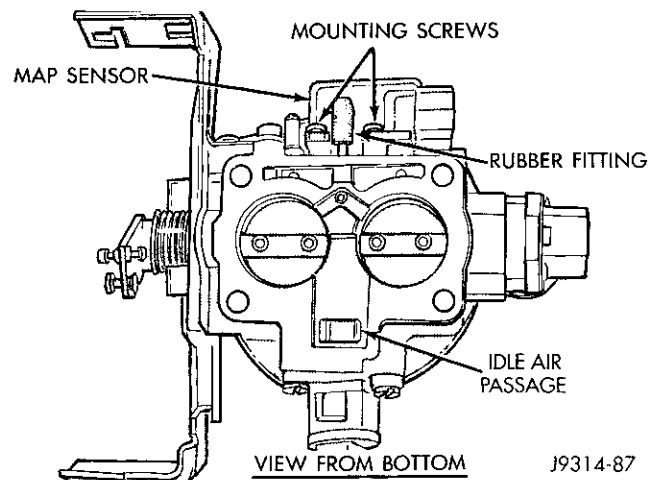


Fig. 86 MAP Sensor L-Shaped Rubber Fitting—3.9L/5.2L/5.9L Engines

- (2) Remove throttle body. Refer to Throttle Body removal in this section.
- (3) Remove two MAP sensor mounting bolts (screws) (Fig. 86).
- (4) While removing MAP sensor, slide the vacuum rubber L-shaped fitting (Fig. 86) from the throttle body.
- (5) Remove rubber L-shaped fitting from MAP sensor.

INSTALLATION

- (1) Install rubber L-shaped fitting to MAP sensor.
- (2) Position sensor to throttle body while guiding rubber fitting over throttle body vacuum nipple.
- (3) Install MAP sensor mounting bolts (screws). Tighten screws to 3 N·m (25 in. lbs.) torque.
- (4) Install throttle body. Refer to Throttle Body installation in this section.
- (5) Install air cleaner.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—8.0L ENGINE

The MAP sensor is mounted into the right upper side of the intake manifold (Fig. 87). A rubber gasket is used to seal the sensor to the intake manifold. The rubber gasket is part of the sensor and is not serviced separately.

REMOVAL

- (1) Remove the electrical connector at the sensor.
- (2) Clean the area around the sensor before removal.
- (3) Remove the two sensor mounting bolts.
- (4) Remove the sensor from the intake manifold.

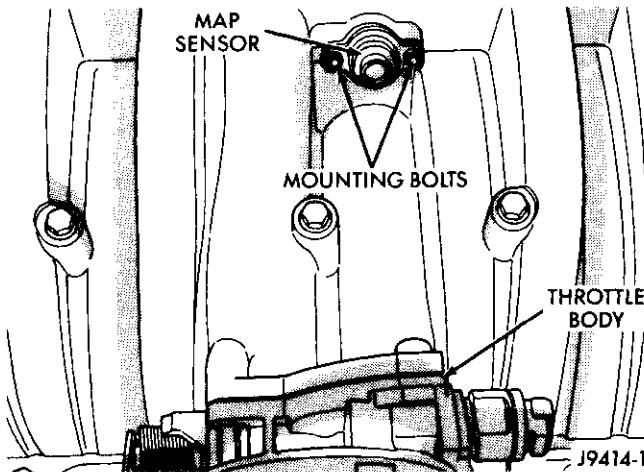
REMOVAL AND INSTALLATION (Continued)

Fig. 87 MAP Sensor Location—8.0L V-10 Engine—Typical

INSTALLATION

- (1) Check the condition of the sensor seal. Clean the sensor and lubricate the rubber gasket with clean engine oil.
- (2) Clean the sensor opening in the intake manifold.
- (3) Install the sensor into the intake manifold.
- (4) Install sensor mounting bolts. Tighten bolts to 2 N·m (20 in. lbs.) torque.
- (5) Install the electrical connector to sensor.

DUTY CYCLE EVAP CANISTER PURGE SOLENOID—3.9L/5.2L/5.9L ENGINES
REMOVAL

- (1) Remove air cleaner housing.
- (2) Disconnect wiring connector at solenoid (Fig. 88).
- (3) Disconnect vacuum harness at solenoid (Fig. 88).
- (4) Remove solenoid and its support bracket from intake manifold.
- (5) Remove EVAP canister purge solenoid from engine.

INSTALLATION

- (1) Install EVAP canister purge solenoid and its mounting bracket to intake manifold.
- (2) Connect vacuum harness and wiring connector.
- (3) Install air cleaner housing.

DUTY CYCLE EVAP CANISTER PURGE SOLENOID—8.0L ENGINE

The solenoid is located at the rear of the throttle body (Fig. 89).

REMOVAL

- (1) Remove the air cleaner cover.

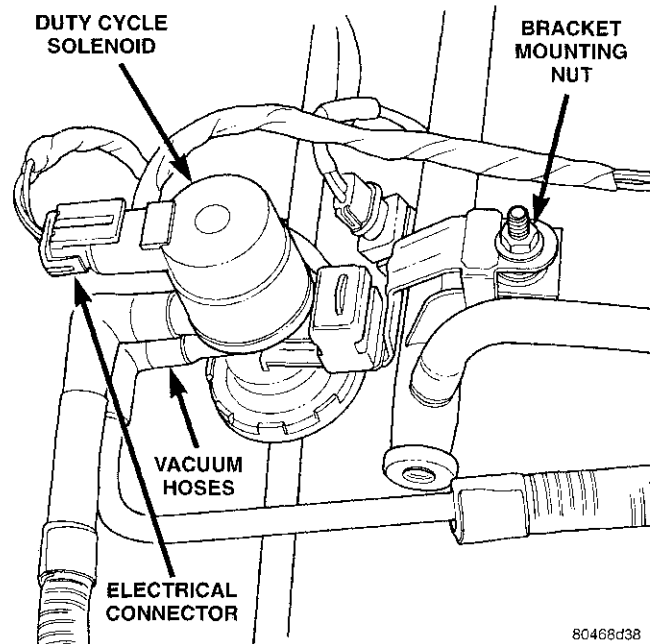


Fig. 88 EVAP Canister Purge Solenoid—3.9L/5.2L/5.9L Engines—Typical

- (2) Remove the 4 air cleaner housing mounting nuts and remove housing from throttle body.

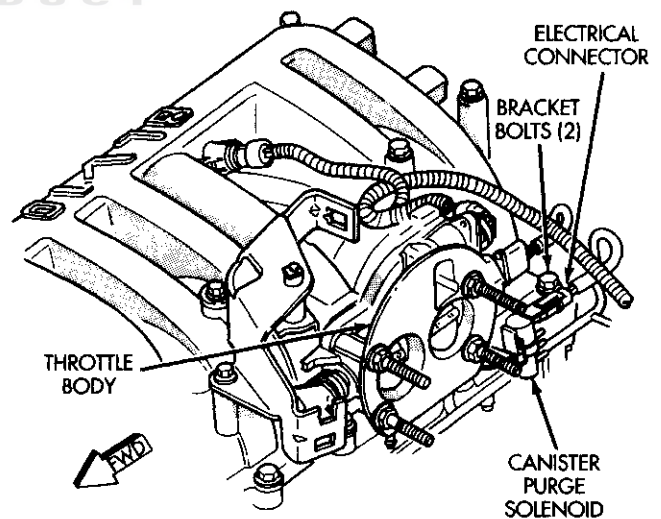


Fig. 89 EVAP Canister Purge Solenoid—8.0L Engine

- (3) Disconnect vacuum harness at solenoid.
- (4) Disconnect wiring connector at solenoid.
- (5) Lift solenoid and rubber grommet from mounting bracket.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

- (1) Install solenoid to mounting bracket.
- (2) Install wiring connector to solenoid.
- (3) Install vacuum harness to solenoid.
- (4) Install air cleaner housing to throttle body.
- (5) Install 4 air cleaner housing mounting nuts. Tighten nuts to 11 N·m (96 in. lbs.) torque.
- (6) Install air cleaner housing cover.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is located in the engine compartment (Fig. 90).

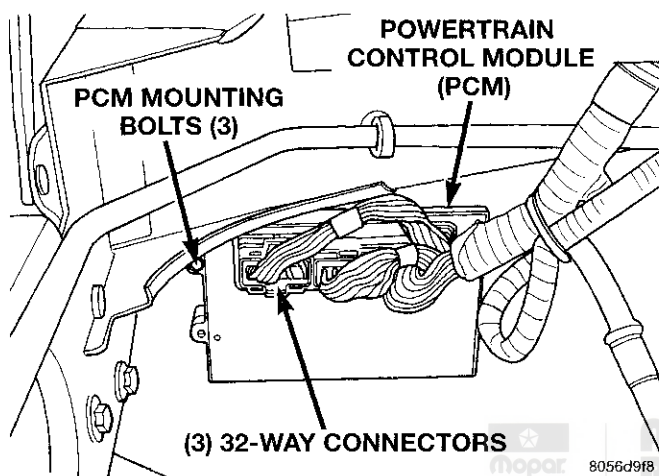


Fig. 90 PCM Location and Mounting

REMOVAL

- (1) Disconnect the negative battery cable at battery.
- (2) Carefully unplug the three 32-way connectors from PCM.
- (3) Remove three PCM mounting bolts and remove PCM from vehicle.

INSTALLATION

- (1) Install PCM and mounting bolts to vehicle.
- (2) Tighten bolts to 4 N·m (35 in. lbs.).
- (3) Check pin connectors in the PCM and the three 32-way connectors for corrosion or damage. Repair as necessary.
- (4) Install three 32-way connectors.
- (5) Install battery cable.

CRANKSHAFT POSITION SENSOR

Refer to Group 8D, Ignition System for removal/installation procedures.

CAMSHAFT POSITION SENSOR

For removal/installation procedures, refer to Group 8D, Ignition System. See Camshaft Position Sensor.

OXYGEN SENSORS—3.9L/5.2L/5.9L LDC/HDC ENGINES

On 3.9L/5.2L/5.9L LDC engines, the upstream and downstream O₂S sensors are located at the inlet and outlet ends of the catalytic converter (Fig. 91).

On 5.9L HDC engines, the left and right O₂S sensors are located on the left and right exhaust downpipes (Fig. 92).

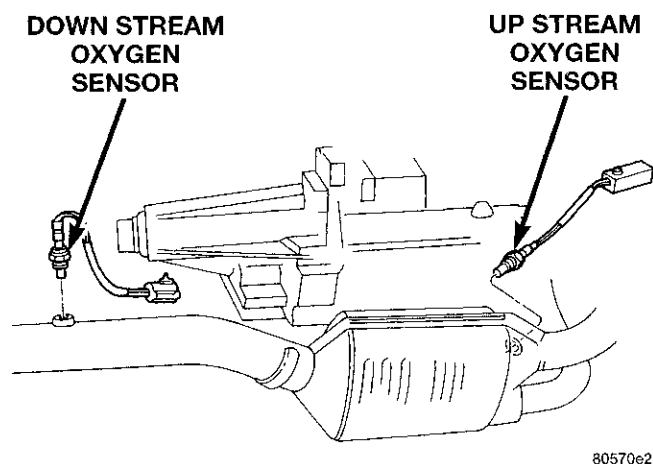


Fig. 91 Oxygen Sensor Location—3.9L/5.2L/5.9L LDC ENGINES

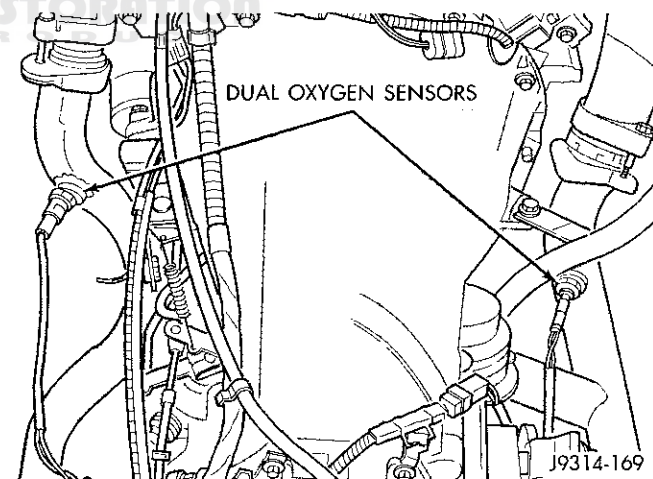


Fig. 92 Oxygen Sensor Location—5.9L HDC ENGINES

REMOVAL

WARNING: THE EXHAUST MANIFOLD, EXHAUST PIPES AND CATALYTIC CONVERTER BECOME VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

- (1) Raise and support the vehicle.
- (2) Disconnect the wire connector from the O₂S sensor.

REMOVAL AND INSTALLATION (Continued)

CAUTION: When disconnecting the sensor electrical connector, do not pull directly on wire going into sensor.

(3) Remove the O₂S sensor. Snap-On oxygen sensor wrench (number YA 8875) may be used for removal and installation.

INSTALLATION

Threads of new oxygen sensors are factory coated with anti-seize compound to aid in removal. **DO NOT add any additional anti-seize compound to the threads of a new oxygen sensor.**

- (1) Install the O₂S sensor. Tighten to 30 N·m (22 ft. lbs.) torque.
- (2) Connect the O₂S sensor wire connector.
- (3) Lower the vehicle.

OXYGEN SENSORS—8.0L ENGINES

On 8.0L MDC engines, the pre-catalyst and post catalyst O₂S sensors are located at the inlet and outlet ends of the catalytic converter (Fig. 93).

On 8.0L MDC or HDC engines, the left and right O₂S sensors are located on the left and right exhaust downpipes (Fig. 94).

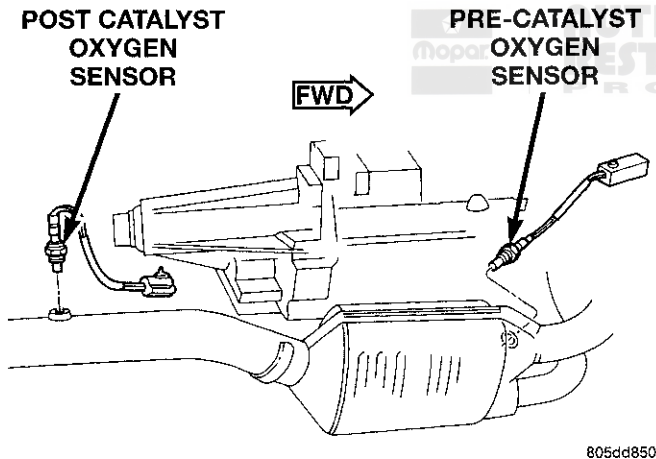


Fig. 93 Pre-Catalyst/Post Catalyst Oxygen Sensor Location—8.0L MDC Engines Only

REMOVAL

WARNING: THE EXHAUST MANIFOLD, EXHAUST PIPES AND CATALYTIC CONVERTER BECOME VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

- (1) Raise and support the vehicle.
- (2) Disconnect the wire connector from the O₂S sensor.

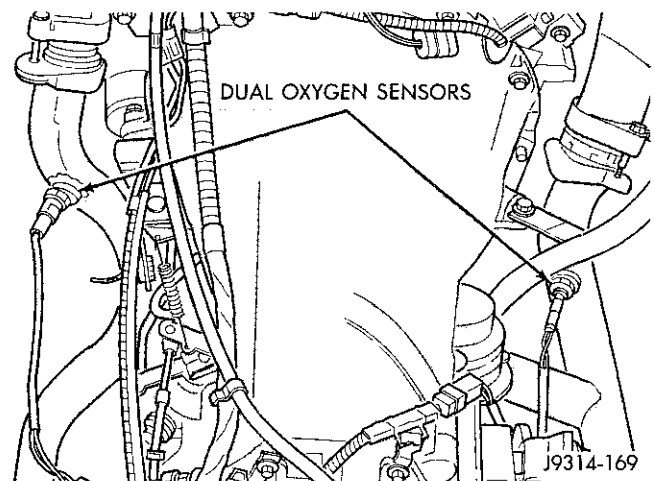


Fig. 94 Left/Right Oxygen Sensor Location—All 8.0L Engines

CAUTION: When disconnecting the sensor electrical connector, do not pull directly on wire going into sensor.

(3) Remove the O₂S sensor. Snap-On oxygen sensor wrench (number YA 8875) may be used for removal and installation.

INSTALLATION

Threads of new oxygen sensors are factory coated with anti-seize compound to aid in removal. **DO NOT add any additional anti-seize compound to the threads of a new oxygen sensor.**

- (1) Install the O₂S sensor. Tighten to 30 N·m (22 ft. lbs.) torque.
- (2) Connect the O₂S sensor wire connector.
- (3) Lower the vehicle.

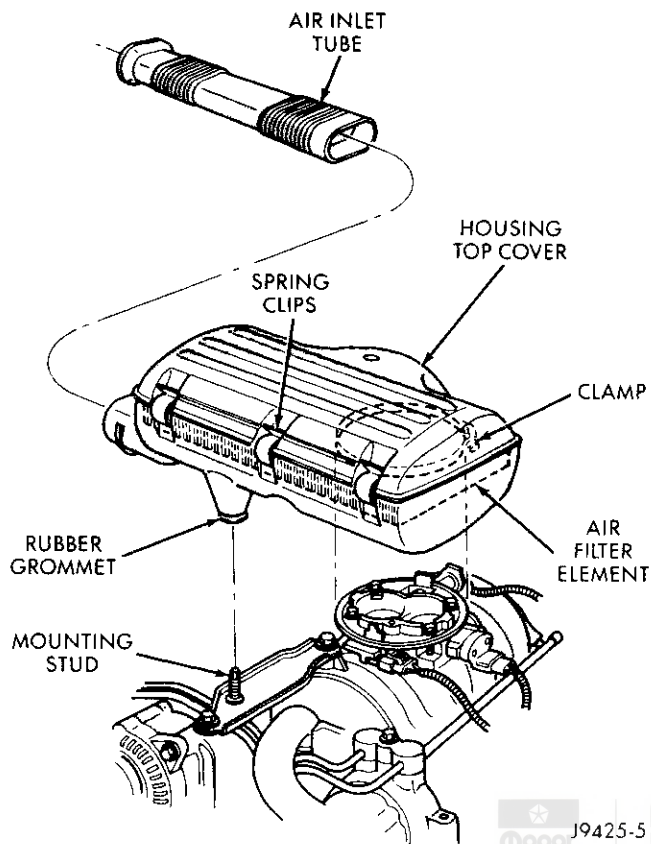
AIR CLEANER HOUSING/AIR CLEANER ELEMENT (FILTER)—3.9L/5.2L/5.9L ENGINES

For air cleaner element required maintenance schedules (listed in time or mileage intervals), refer to Group 0, Lubrication and Maintenance.

REMOVAL/INSTALLATION

CAUTION: Do not attempt to remove the air cleaner element (filter) from the housing by removing the top cover only. To prevent damage to the air cleaner housing, the entire air cleaner housing assembly must be removed from the engine for air cleaner element replacement.

- (1) Remove the air inlet tube (Fig. 95) at the side of the air cleaner housing.
- (2) A band-type screw clamp secures the air cleaner housing to the throttle body. Loosen, but do

REMOVAL AND INSTALLATION (Continued)**Fig. 95 Air Cleaner Housing—3.9L/5.2L/5.9L Engines**

not remove, this screw clamp (Fig. 95). Note the clamp positioning tabs on the air cleaner housing.

(3) All Engines: Disconnect the breather hose at the rear of air cleaner housing.

(4) 5.9L V-8 HDC Engine Only: Disconnect the air pump hose at the air cleaner housing.

(5) The bottom/front of the air cleaner housing is equipped with a rubber grommet (Fig. 95). A mounting stud is attached to the intake manifold (Fig. 95) and is used to position the air cleaner housing into this grommet. Lift the assembly from the throttle body while slipping the assembly from the mounting stud (Fig. 95).

(6) Check condition of gasket at throttle body and replace as necessary.

(7) The housing cover is equipped with three (3) spring clips (Fig. 95) and is hinged at the rear with plastic tabs. Unlatch the clips from the top of air cleaner housing and tilt the housing cover up and rearward for cover removal.

(8) Remove the air cleaner element from air cleaner housing.

(9) Before installing a new air cleaner element, clean inside of air cleaner housing.

(10) Position air cleaner cover to tabs on rear of air cleaner housing. Latch the three spring clips to seal cover to housing.

(11) Position the air cleaner housing assembly to the throttle body while guiding the rubber grommet over the mounting stud. The lower part of the screw clamp should be below the top lip of the throttle body.

(12) Push down on air cleaner housing at rubber grommet to seat housing at intake manifold.

(13) Tighten throttle body-to-air cleaner housing clamp to 4 N·m (35 in. lbs.) torque.

(14) Install the air inlet tube at air cleaner housing inlet.

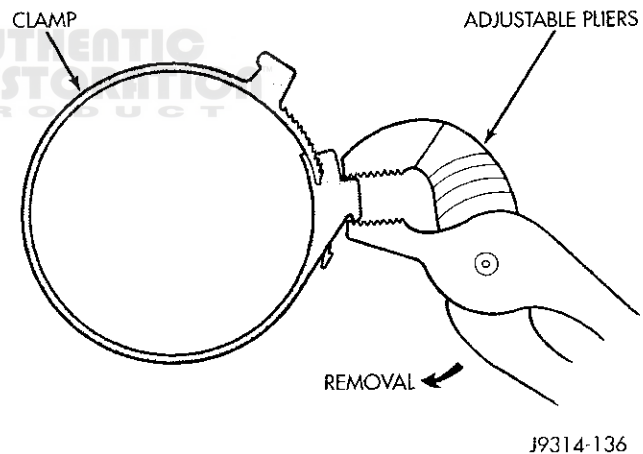
AIR CLEANER HOUSING/AIR CLEANER ELEMENT (FILTER)—8.0L V-10 ENGINE

For air cleaner element required maintenance schedules (listed in time or mileage intervals), refer to Group 0, Lubrication and Maintenance.

A small amount of engine oil wetting the inside of the air cleaner housing is normal. When servicing, wipe out the oil from the air cleaner housing.

REMOVAL/INSTALLATION

(1) Loosen the clamp (Fig. 96) and remove the air inlet tube (Fig. 97) at the front of the air cleaner housing cover.

**Fig. 96 Clamp Removal—8.0L Engine**

(2) The air cleaner housing and air cleaner element cover are equipped with spring clips to seal the cover to housing (Fig. 97). Unlatch the clips from the air cleaner cover and remove cover from air cleaner housing.

(3) Remove the air cleaner element from air cleaner cover.

(4) Before installing a new air cleaner element, clean inside of air cleaner housing.

(5) If housing removal is necessary, remove the 4 housing-to-throttle body nuts.

(6) After installing housing, tighten 4 nuts to 11 N·m (96 in. lbs.) torque.

(7) Position air cleaner element (filter) into air cleaner cover. Latch the spring clips to seal cover to housing.

REMOVAL AND INSTALLATION (Continued)

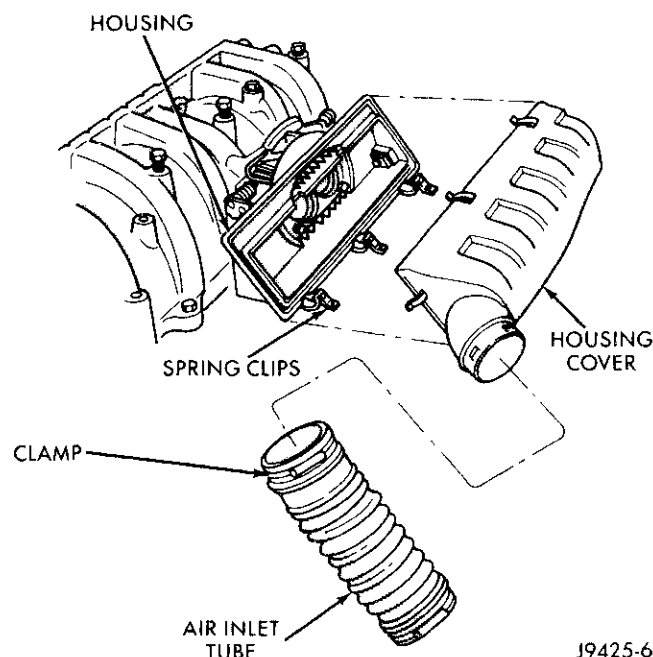


Fig. 97 Air Cleaner Housing—8.0L V-10 Engine

- (8) Install the air inlet tube at air cleaner housing inlet.
- (9) Install and tighten clamp at air inlet tube (Fig. 98).

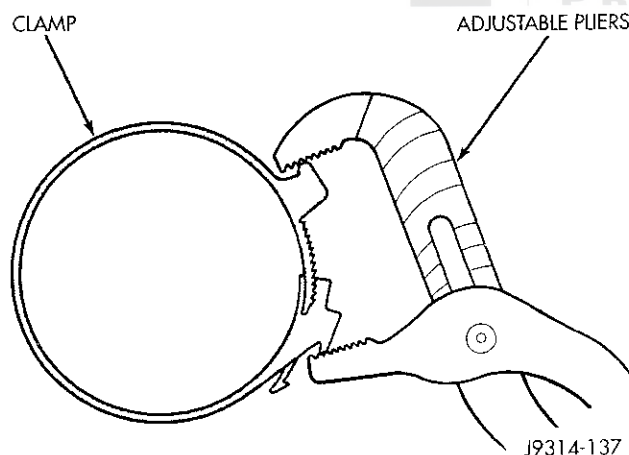


Fig. 98 Clamp Installation—8.0L Engine

ENGINE COOLANT TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES

REMOVAL

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

- (1) Partially drain cooling system. Refer to Group 7, Cooling.

- (2) Remove air cleaner assembly.

- (3) Disconnect electrical connector from sensor (Fig. 99).

- (4) **Engines with air conditioning:** When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

- (5) Remove sensor from intake manifold.

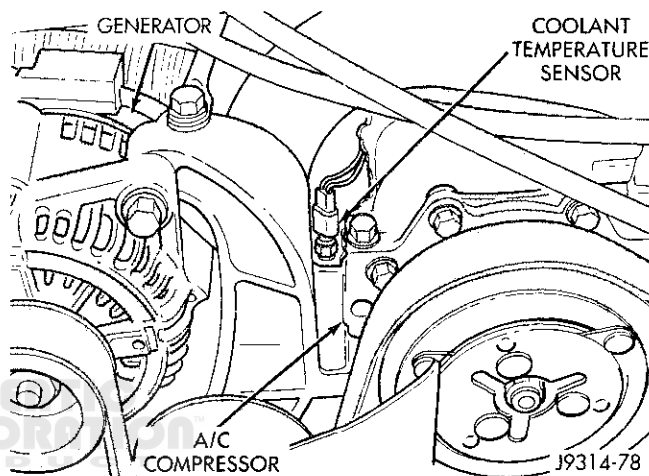


Fig. 99 Engine Coolant Temperature Sensor—3.9L/5.2L/5.9L Engines—Typical

INSTALLATION

- (1) Install sensor.
- (2) Tighten to 11 N·m (8 ft. lbs.) torque.
- (3) Connect electrical connector to sensor. The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.
- (4) Install air cleaner assembly.
- (5) Replace any lost engine coolant. Refer to Group 7, Cooling System.

ENGINE COOLANT TEMPERATURE SENSOR—8.0L ENGINE

REMOVAL

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

- (1) Partially drain cooling system. Refer to Group 7, Cooling.

- (2) Disconnect electrical connector from sensor (Fig. 100).

REMOVAL AND INSTALLATION (Continued)

- (3) Remove sensor from intake manifold.

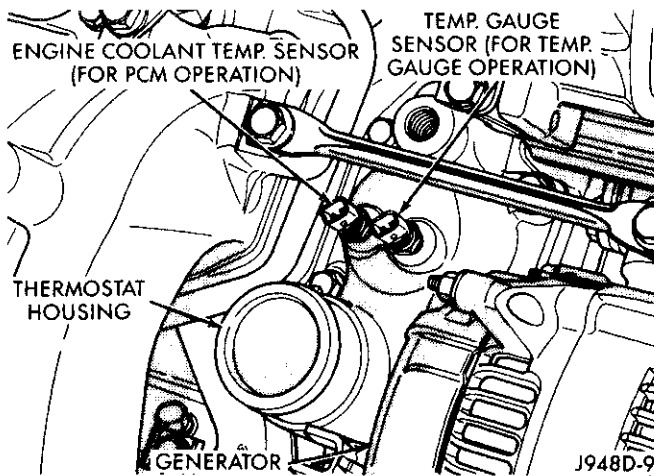


Fig. 100 Engine Coolant Temperature Sensor—8.0L Engine

INSTALLATION

- (1) Install sensor.
- (2) Tighten to 11 N·m (8 ft. lbs.) torque.
- (3) Connect electrical connector to sensor.
- (4) Replace any lost engine coolant. Refer to Group 7, Cooling System.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—3.9L/5.2L/5.9L ENGINES

The intake manifold air temperature sensor is located in the front/side of the intake manifold (Fig. 101) or (Fig. 102).

REMOVAL

- (1) Remove air cleaner assembly.
- (2) Disconnect electrical connector at sensor (Fig. 101) or (Fig. 102).
- (3) Remove sensor from intake manifold.

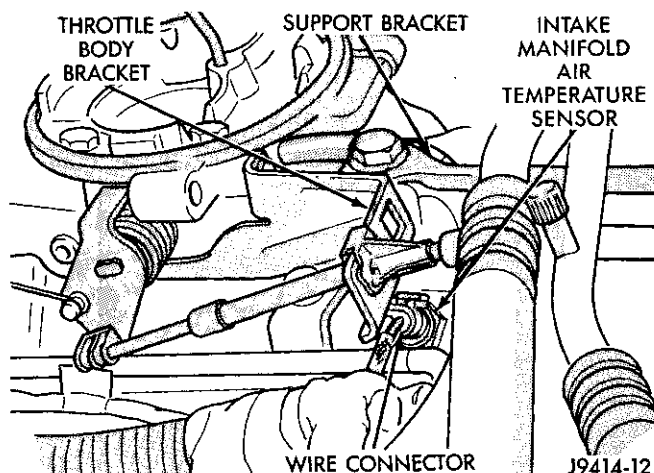


Fig. 101 Air Temperature Sensor—3.9L (V-6) Engine

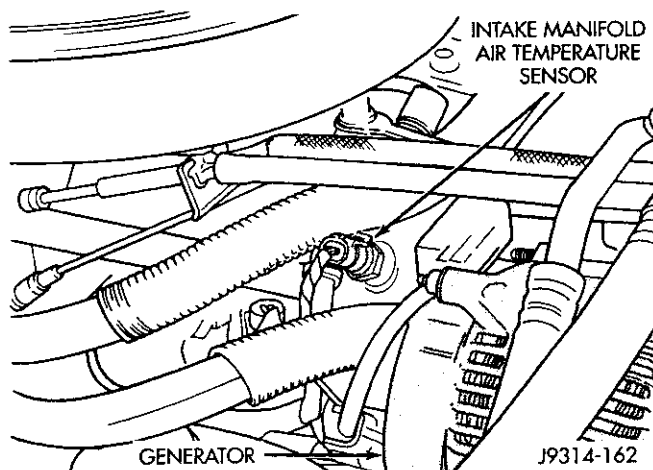


Fig. 102 Air Temperature Sensor—5.2L/5.9L (V-8) Engines

INSTALLATION

- (1) Install sensor to intake manifold. Tighten to 28 N·m (20 ft. lbs.) torque.
- (2) Install electrical connector.
- (3) Install air cleaner.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—8.0L ENGINE

The intake manifold air temperature sensor is located in the side of the intake manifold near the front of throttle body (Fig. 103).

REMOVAL

- (1) Disconnect electrical connector at sensor.
- (2) Remove sensor from intake manifold.

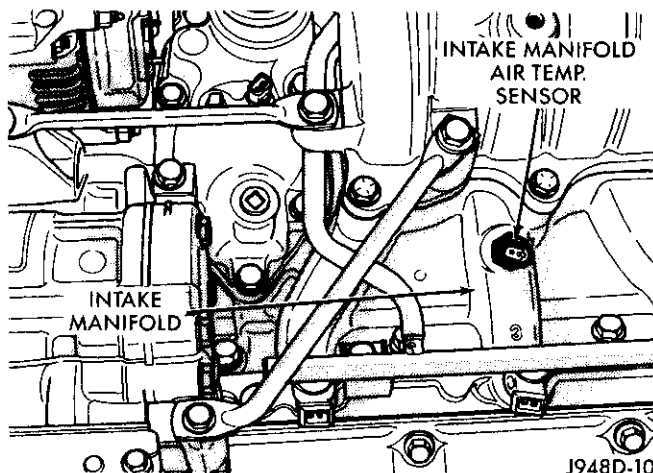


Fig. 103 Air Temperature Sensor—8.0L Engine

INSTALLATION

- (1) Install sensor to intake manifold. Tighten to 28 N·m (20 ft. lbs.) torque.
- (2) Install electrical connector.

REMOVAL AND INSTALLATION (Continued)

VEHICLE SPEED SENSOR

The vehicle speed sensor is located on the speedometer pinion gear adapter (Fig. 104). The pinion gear adapter is located on the extension housing of the transmission (drivers side).

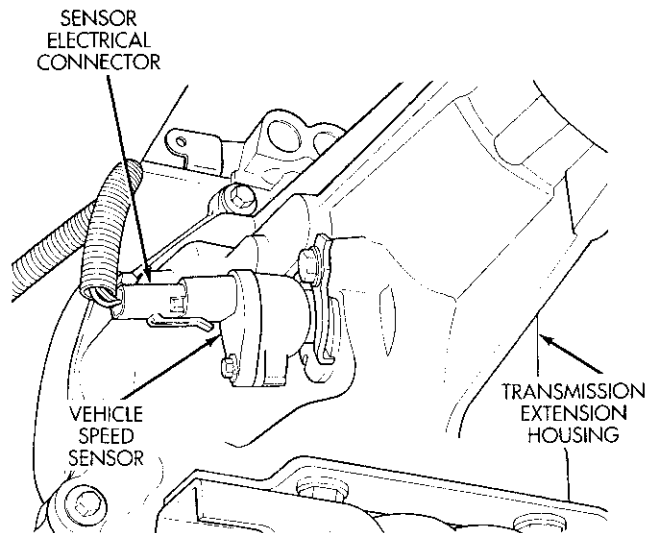


Fig. 104 Vehicle Speed Sensor Location—Typical

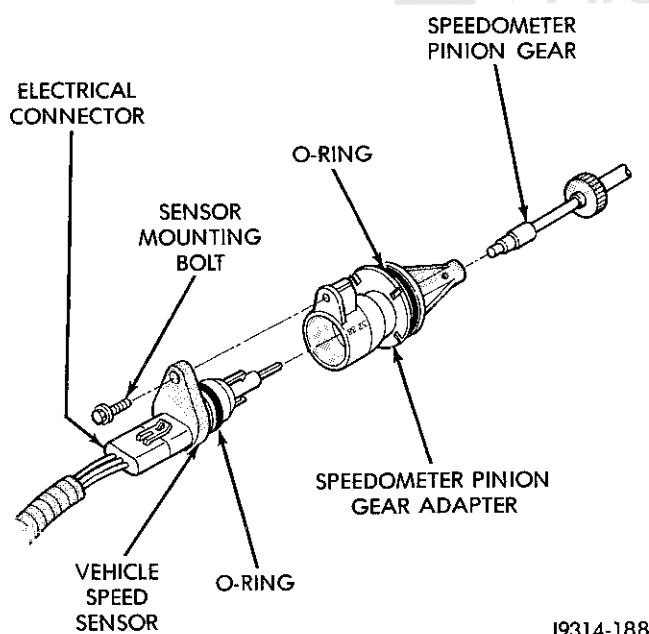


Fig. 105 Sensor Removal/Installation

REMOVAL

- (1) Raise and support vehicle.
- (2) Disconnect the electrical connector from the sensor.
- (3) Remove the sensor mounting bolt (Fig. 105).

- (4) Remove the sensor (pull straight out) from the speedometer pinion gear adapter (Fig. 105). Do not remove the gear adapter from the transmission.

INSTALLATION

- (1) Clean the inside of speedometer pinion gear adapter before installing speed sensor.
- (2) Install sensor into speedometer gear adapter and install mounting bolt. **Before tightening bolt, verify speed sensor is fully seated (mounted flush) to speedometer pinion gear adapter.**
- (3) Tighten sensor mounting bolt to 2.2 N·m (20 in. lbs.) torque.
- (4) Connect electrical connector to sensor.

SPECIFICATIONS

VECI LABEL SPECIFICATIONS

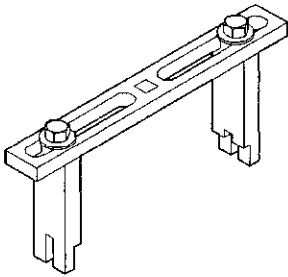
If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label. The VECI label is located in the engine compartment.

TORQUE SPECIFICATIONS

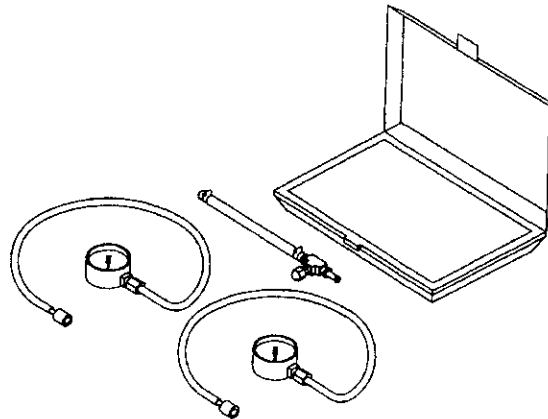
DESCRIPTION	TORQUE
Air Cleaner Housing Mount.	
Nuts—8.0L Engine	11 N·m (96 in. lbs.)
Air Cleaner Housing Metal Clamp—	
3.9L/5.2L/5.9L Engines . . . . .	.4 N·m (35 in. lbs.)
Crankshaft Position Sensor Mounting	
Bolts—All Engines	8 N·m (70 in. lbs.)
Camshaft Position Sensor Mounting—	
8.0L Engine . . . . .	.6 N·m (50 in. lbs.)
Engine Coolant Temperature	
Sensor—All Engines	11 N·m (96 in. lbs.)
Fuel Tank Mounting Nuts . . . . .	.41 N·m (30 ft. lbs.)
Fuel Hose Clamps . . . . .	.1 N·m (10 in. lbs.)
IAC Motor-To-Throttle Body Bolts . . . . .	.7 N·m (60 in. lbs.)
Intake Manifold Air Temp. Sensor—	
All Engines . . . . .	.28 N·m (20 ft. lbs.)
MAP Sensor Mounting Screws—	
3.9L/5.2L/5.9L Engines	3 N·m (25 in. lbs.)
MAP Sensor Mounting Screws—	
8.0L Engine . . . . .	.2 N·m (20 in. lbs.)
Oxygen Sensor—All Engines . . . . .	.30 N·m (22 ft. lbs.)
Powertrain Control Module Mounting	
Screws . . . . .	.4 N·m (35 in. lbs.)
Throttle Body Mounting Bolts—	
3.9L/5.2L/5.9L Engines	23 N·m (200 in. lbs.)
Throttle Body Mounting Bolts—	
8.0L Engine . . . . .	.22 N·m (192 in. lbs.)
Throttle Position Sensor Mounting	
Screws—All Engines	7 N·m (60 in. lbs.)
Vehicle Speed Sensor Mounting	
Bolt	2.2 N·m (20 in. lbs.)

SPECIAL TOOLS

FUEL SYSTEM



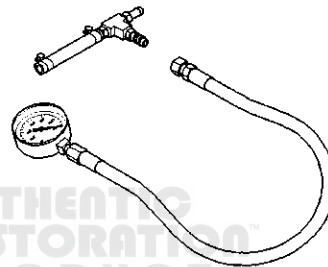
Spanner Wrench—6856



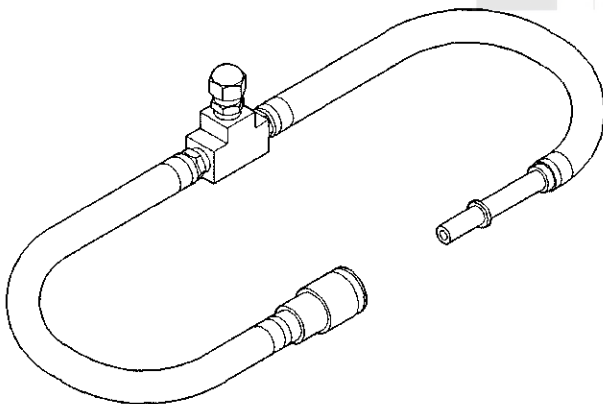
Test Kit, Fuel Pressure—5069



Fitting, Air Metering—6714



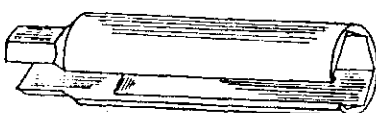
Test Kit, Fuel Pressure—C-4799-B



Adapters, Fuel Pressure Test—6541, 6539, 6631 or 6923



Fuel Line Removal Tool—6782



O2S (Oxygen Sensor) Remover/Installer—C-4907

FUEL DELIVERY SYSTEM-DIESEL ENGINE

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DESCRIPTION AND OPERATION

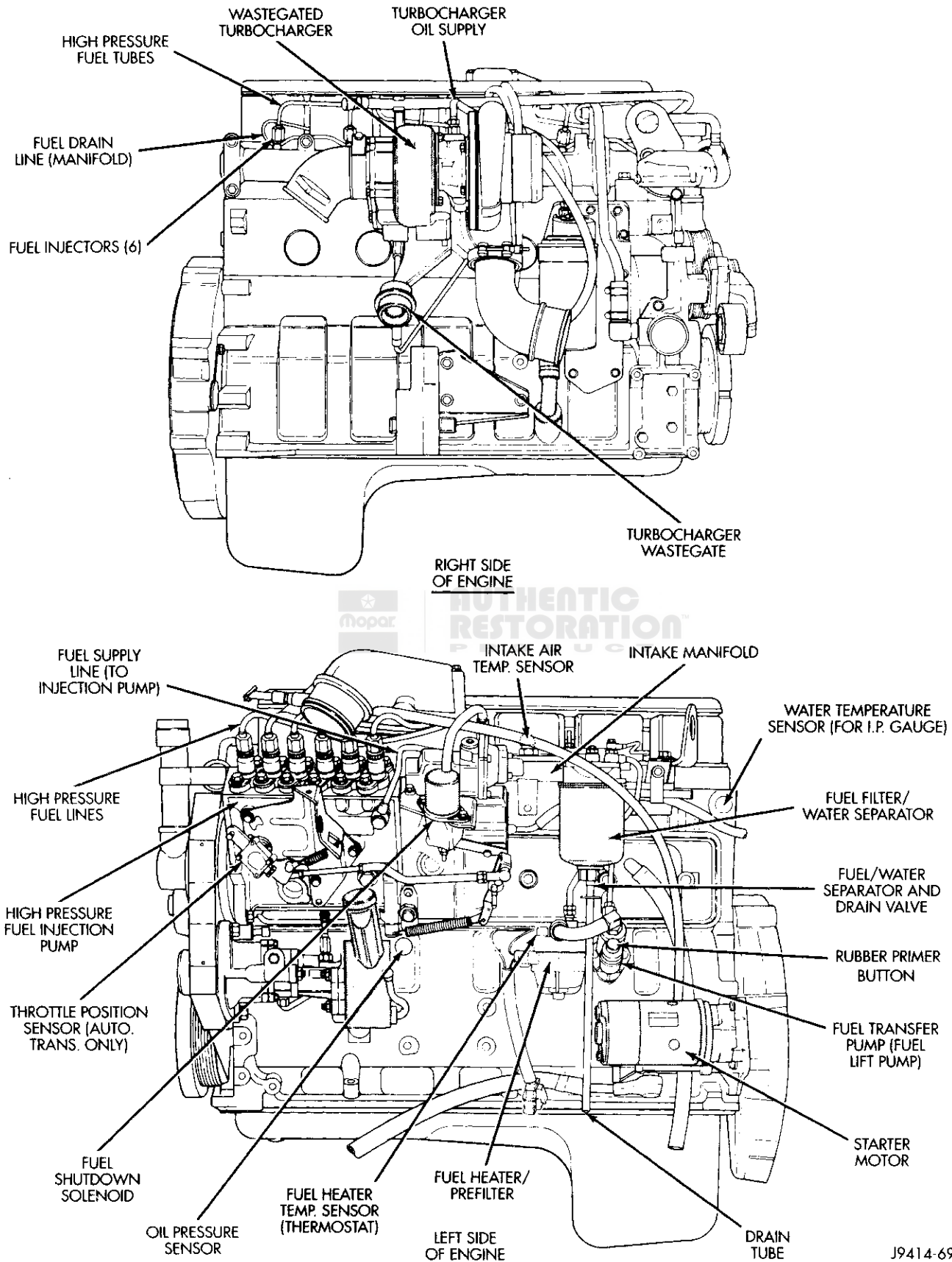
FUEL DELIVERY SYSTEM

This section of the group will cover diesel fuel delivery components **not controlled** by the powertrain control module (PCM). Various components, relays and switches are operated by the PCM. Refer to the Fuel Injection System—Diesel Engine sections of this group for components that are operated by the PCM.

NOTE: Diesel fuel delivery (except for operation of the intake manifold air heater and manifold air heater relays) is not directly regulated by the PCM.

The fuel delivery system of the 5.9L turbo-diesel engine consists of the:

- Fuel tank
- Fuel tank module
- Low and high-pressure fuel supply lines
- Low-pressure, mechanical, fuel transfer pump (fuel lift pump)
- High-pressure fuel injection pump
- Fuel heater
- Fuel heater relay
- Fuel shutdown solenoid
- Fuel shutdown solenoid relay
- High-pressure fuel injectors
- Fuel return line
- Fuel filter/water separator
- In-tank fuel filter
- Pre-filter (in fuel heater)
- Fuel drain manifold

DESCRIPTION AND OPERATION (Continued)**Fig. 1 Fuel System Components—Diesel Engine**

J9414-69

DESCRIPTION AND OPERATION (Continued)

FUEL TANK MODULE

An electric fuel pump is not used in the fuel tank module for diesel powered engines. Fuel is supplied by the fuel transfer pump and the fuel injection pump.

The fuel tank module is installed in the top of the fuel tank (Fig. 2). The fuel tank module (Fig. 2) or (Fig. 3) contains the following components:

- Fuel reservoir
- A separate in-tank fuel filter
- Pressure relief/rollover valve
- Fuel gauge sending unit
- Fuel supply line connection
- Fuel return line connection
- Auxiliary fuel supply fitting

The electric fuel pump, normally mounted in the fuel pump module on gas powered engines, is **not used** with diesel powered engines.

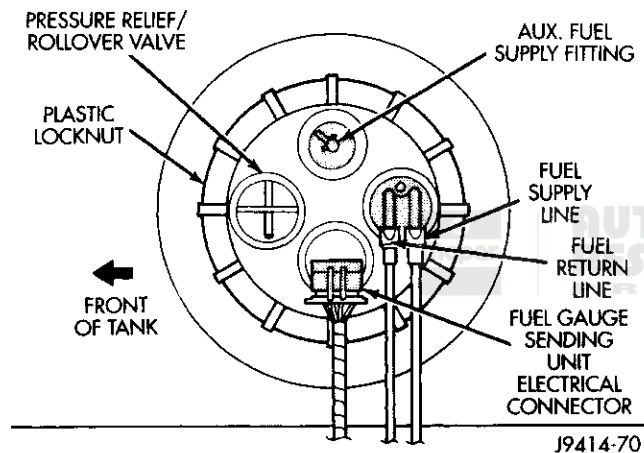


Fig. 2 Top View of Fuel Tank Module—Diesel

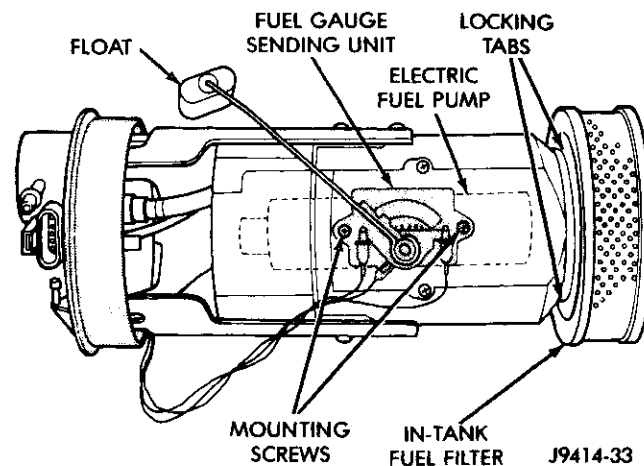


Fig. 3 Fuel Gauge Sending Unit—Typical

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit is attached to the side of the fuel pump module. The sending unit consists of

a float, an arm, and a variable resistor (track). The track is used to send an electrical signal used for fuel gauge operation.

As the fuel level increases, the float and arm move up. This decreases the sending unit resistance, causing the fuel gauge on the instrument panel to read full. As the fuel level decreases, the float and arm move down. This increases the sending unit resistance, causing the fuel gauge on the instrument panel to read empty.

FUEL HEATER

The fuel heater is used to prevent diesel fuel from waxing during cold weather operation. The fuel heater is located on the left side of the engine above the starter motor (Fig. 4).

The heater assembly is equipped with a built-in sensor (thermostat) (Fig. 4) that senses fuel temperature. When the temperature is below 40 degrees F, the built-in sensor allows current to flow to the built-in heater element warming the fuel. When the temperature is above 80 degrees F, the sensor stops current flow to the heater element.

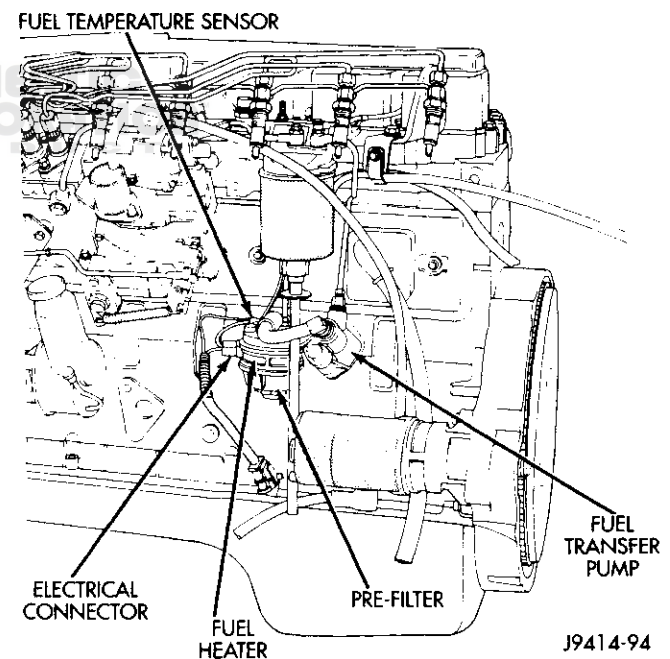


Fig. 4 Fuel Heater and Temperature Sensor Location

Voltage to operate the fuel heater is supplied from the ignition switch and through the fuel heater relay. Also refer to Fuel Heater Relay.

The fuel heater and fuel heater relay are not controlled by the powertrain control module (PCM).

The built-in heater element operates on 12 volts, 300 watts at 0 degrees F.

The fuel heater assembly contains a pre-filter to prevent contaminants from entering the fuel transfer pump.

DESCRIPTION AND OPERATION (Continued)**FUEL HEATER RELAY**

Voltage to operate the fuel heater is supplied from the ignition switch through the fuel heater relay. The powertrain control module (PCM) is **not used** to control this relay.

The fuel heater relay is located in the engine compartment near the brake master cylinder (Fig. 5).

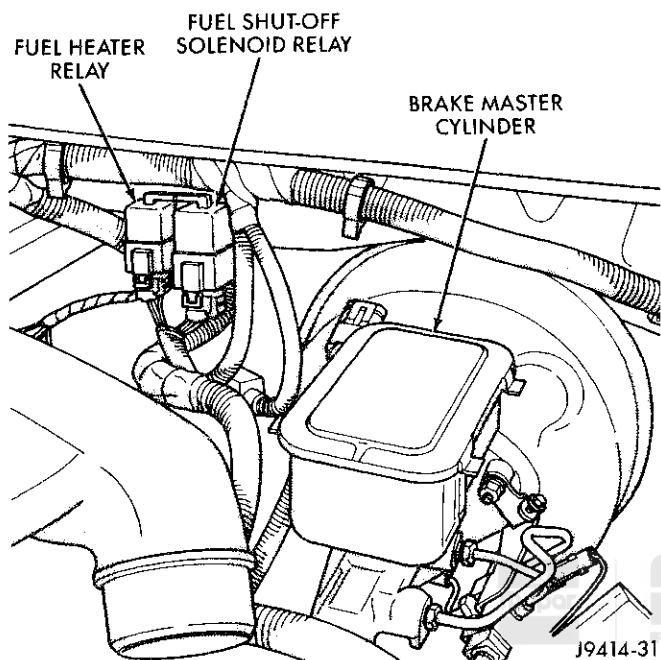


Fig. 5 Fuel Heater Relay—Diesel

FUEL TRANSFER PUMP

The fuel transfer pump (fuel lift pump) is located on the left-rear side of the engine cylinder block above the starter motor (Fig. 1). This mechanically operated pump is not controlled by the powertrain control module (PCM).

The purpose of the fuel transfer pump is to supply (transfer) a low-pressure fuel source of approximately 172 Kpa (25 psi) to the injection pump and fuel filter/water separator from the fuel tank. Here, the low-pressure is raised by the fuel injection pump for operation of the high-pressure fuel injectors. The transfer pump is driven by an eccentric on the engine camshaft that actuates a spring loaded piston within the pump (Fig. 6). Check valves within the pump, control direction of fuel flow and prevent fuel bleed-back during engine shut down.

The fuel transfer pump should never be operated without the pre-filter installed.

The fuel volume of the transfer pump will vary with engine rpm, but will always provide more fuel than the fuel injection pump requires. Excess fuel is returned to the fuel tank through an overflow valve. The valve is located on the side of the injection pump (Fig. 7) and is used to connect the fuel return line to

the side of the injection pump. This valve opens at approximately 152 kPa (22 psi) and returns fuel to the fuel tank through the fuel return line.

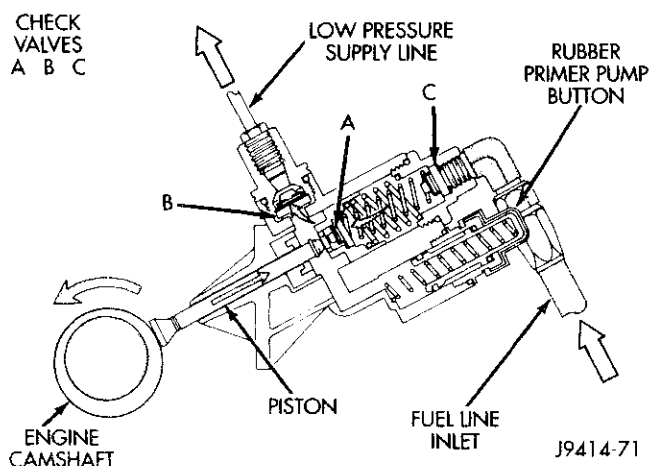


Fig. 6 Transfer Pump Operation

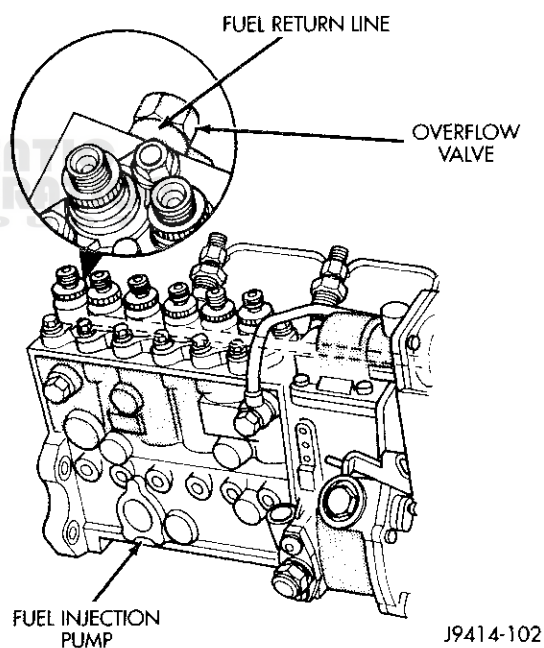


Fig. 7 Injection Pump Overflow Valve

The transfer pump has a primer button (Fig. 8). This rubber primer button is located on the pump housing. The purpose of the button is to prime and bleed air from the fuel system if the vehicle has run out of fuel. To prime the system up to the fuel injector pump, continually press on the button (Fig. 8) until resistance is felt. This resistance will indicate that priming is completed and air has been removed.

If the primer button feels as if it is not pumping, rotate (crank) the engine approximately 90 degrees. This will position the engine camshaft lobe away

DESCRIPTION AND OPERATION (Continued)

from the pump piston (Fig. 6). Continue pumping until air is removed.

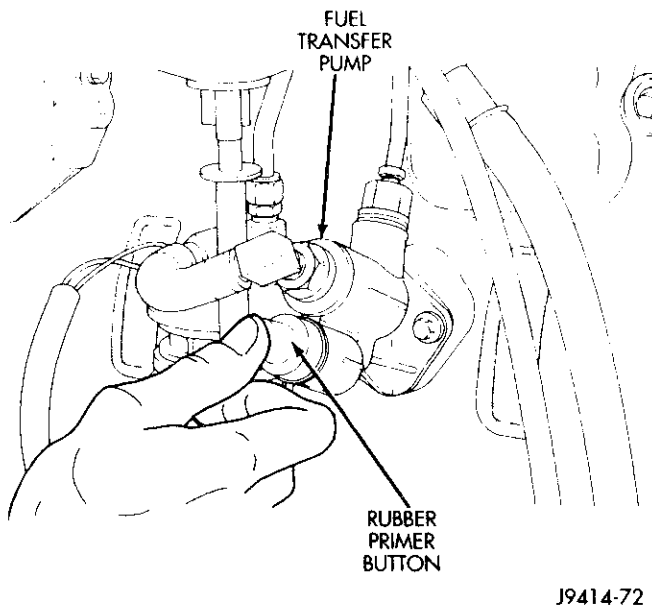


Fig. 8 Fuel Transfer Pump—Manual Operation

FUEL TANK

Refer to Fuel Tank in the Fuel Delivery System—Gasoline section of this group for information.

FUEL TANK FILLER TUBE CAP

The loss of any fuel or vapor out of filler neck is prevented by the use of a pressure-vacuum fuel tank filler tube cap. Relief valves inside cap will release only under significant pressure of 6.58 to 8.44 kPa (1.95 to 2.5 psi). The vacuum release for all gas caps is between .97 and 2.0 kPa (.14 and .29 psi). This cap must be replaced by a similar unit if replacement is necessary. This is in order for the system to remain effective.

CAUTION: Remove fuel tank filler tube cap before servicing any fuel system component. This is done to help relieve tank pressure.

FUEL TANK PRESSURE RELIEF/ROLLOVER VALVE

The pressure relief/rollover valve will relieve fuel tank pressure and prevent fuel flow through fuel tank vent hoses during rollover. All vehicles pass a full 360 degree rollover without fuel leakage.

The pressure relief/rollover valve is mounted at the top of fuel tank module.

On diesel powered engines, the top of the valve is open to atmosphere. Refer to Group 25, Emission Control Systems for more information.

FUEL FILTER/WATER SEPARATOR

The fuel filter/water separator protects the fuel injection pump by removing water and contaminants from the fuel. The separator filter construction allows fuel to pass through it, but prevents moisture (water) from doing so. Moisture collects at the bottom of the separator filter.

The fuel filter/water separator is located on the left side of the engine above the starter motor (Fig. 1).

Refer to the maintenance schedules in Group 0 in this manual for the recommended fuel filter/water separator replacement intervals.

For draining of water, refer to the Removal/Installation section of this group. See Fuel Filter/Water Separator.

FUEL SYSTEM PRESSURE WARNING

WARNING: HIGH-PRESSURE FUEL LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 120,000 KPA (17,405 PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH-PRESSURE FUEL LEAKS. INSPECT FOR HIGH-PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

QUICK-CONNECT FITTINGS

Refer to Quick-Connect Fittings in the Fuel Delivery System—Gasoline section for information. Also refer to the Fuel Tubes/Lines/Hoses and Clamps section.

HIGH-PRESSURE FUEL LINES

CAUTION: The high-pressure fuel lines must be held securely in place in their holders. The lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high-pressure fuel line is necessary.

High-pressure fuel lines deliver fuel under pressure of up to approximately 120,000 kPa (17,405 PSI) from the injection pump to the fuel injectors. The lines expand and contract from the high-pressure fuel pulses generated during the injection process. All high-pressure fuel lines are of the same length and inside diameter. Correct high-pressure fuel line usage and installation is critical to smooth engine operation.

DESCRIPTION AND OPERATION (Continued)

WARNING: USE EXTREME CAUTION WHEN INSPECTING FOR HIGH-PRESSURE FUEL LEAKS. INSPECT FOR HIGH-PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

FUEL INJECTION PUMP

The fuel injection pump is a Bosch P7100 series in-line type (Fig. 9). The injection pump is driven by the engine camshaft. A gear on the end of the pump shaft meshes with the camshaft gear. The pump is timed to the engine. Fuel injection occurs near the end of the compression stroke for each cylinder.

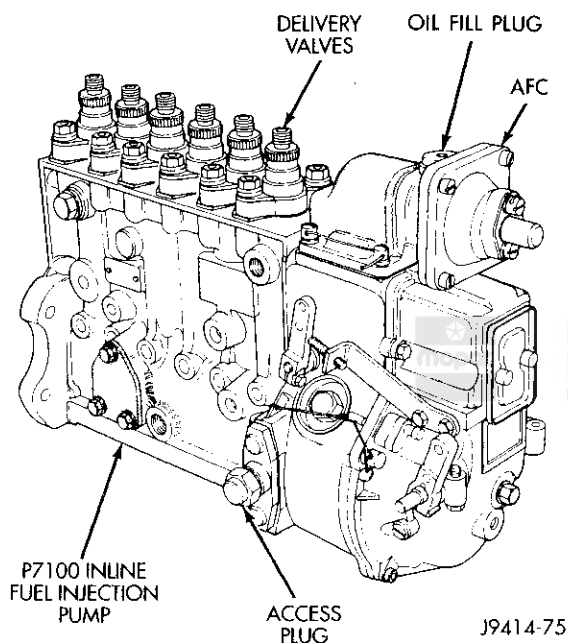


Fig. 9 Fuel Injection Pump

The RQV-K governor (Fig. 9) has a pump timing feature. This will allow the pump shaft to be oriented in a position corresponding to top dead center (TDC) for the compression stroke of cylinder number one. Indexing the governor flyweight assembly to the shaft during assembly establishes pump timing.

As engine speed increases, the internal pump pressure increases. An air-fuel control (AFC) (Fig. 10) on the governor ensures that regulated fuel delivery is matched to intake manifold pressure (turbocharger boost) for emission control.

The mechanical fuel transfer pump delivers fuel under a low-pressure of approximately 172 Kpa (25 psi) to the injection pump through the fuel filter/water separator. The injection pump then supplies high-pressure fuel of approximately 120,000 kPa (17,400 psi) to each injector in precise metered amounts at the correct time.

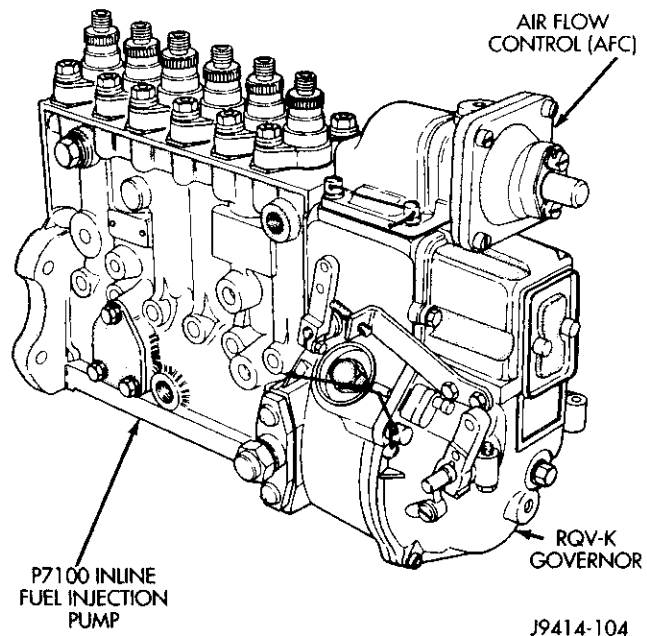


Fig. 10 Injection Pump Governor and AFC

Excess fuel is returned to the fuel tank by an overflow valve (Fig. 7) on the injection pump. This vent opens at approximately 152 kPa (22 psi) and returns fuel to the fuel tank through the fuel return line.

Diesel fuel and engine oil are used to cool the fuel injection pump. A separate oil feed line from the engine supplies engine oil to the pump. The oil returns to the engine through an opening at the front of pump.

A KSB (cold start) solenoid is not used.

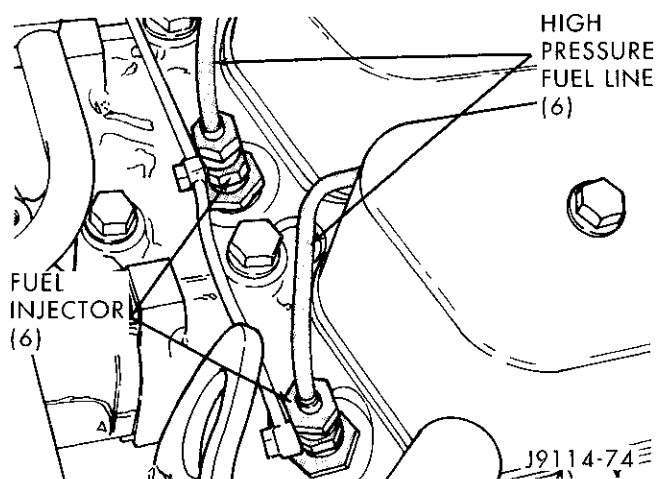
The injection pump high idle speed is factory-sealed and is not adjustable. The low idle speed is adjustable. Refer to Idle Speed Adjustment.

For injection pump timing, refer to Fuel Injection Pump Timing.

FUEL INJECTORS

The fuel injectors are mounted on the left side of the cylinder head (Fig. 11). The injectors are connected to the fuel injection pump by the high-pressure fuel lines. A separate injector is used for each cylinder.

The injectors consist of the nozzle holder, o-ring water seal, shims, spring, needle valve and nozzle. Fuel enters the injector at the fuel inlet (top of injector) and is routed to the needle valve bore. When fuel pressure rises to approximately 26,252 kPa (3,822 psi), the needle valve spring tension is overcome. The needle valve rises and fuel flows through the spray holes in the nozzle tip into the combustion chamber. The pressure required to lift the needle valve is the operating pressure setting. This is sometimes referred to as the "pop" pressure setting.

DESCRIPTION AND OPERATION (Continued)**Fig. 11 Fuel Injectors—Typical**

Fuel pressure in the injector circuit decreases after injection. The injector needle valve is immediately closed by the needle valve spring and fuel flow into the combustion chamber is stopped. Exhaust gases are prevented from entering the injector nozzle by the needle valve.

FUEL SHUTDOWN SOLENOID

The fuel shutdown solenoid and fuel shutdown solenoid relay are not controlled by the powertrain control module (PCM).

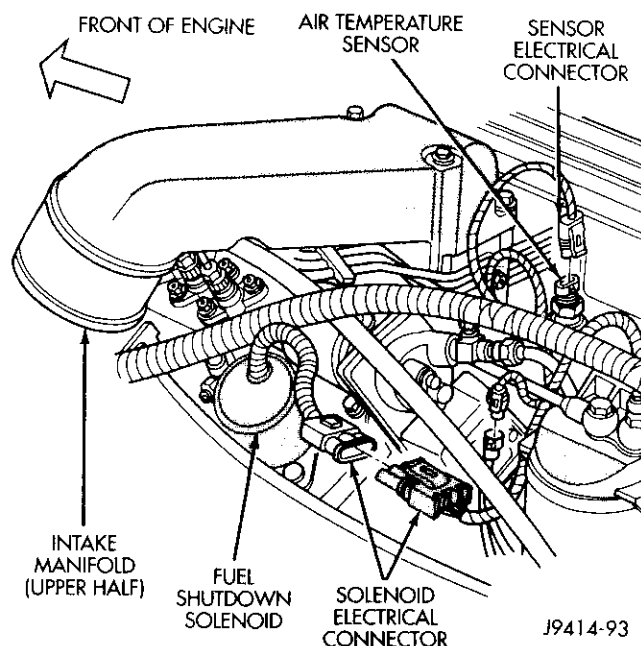
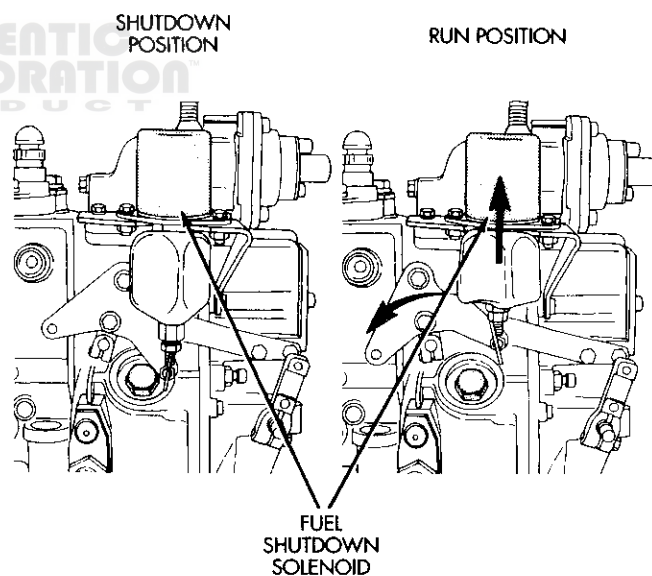
The fuel shutdown (shut-off) solenoid is used to electrically shut off the diesel fuel supply to the high-pressure fuel injection pump. The solenoid is mounted to the side of the pump and is connected to the pump with a lever (Fig. 12).

The solenoid controls starting and stopping of the engine regardless of the position of the accelerator pedal. When the ignition switch is off, the solenoid plunger is spring loaded (down) in the shutdown position (Fig. 13) and fuel is shut off to the injection pump.

Two different coils are located within the solenoid and a three-wire pigtail wire harness is attached to the solenoid.

When the ignition switch is turned to the CRANK (starter engaged) position, high-amperage current (approximately 40 amps at 12 volts) is supplied to one of the coils in the shutdown solenoid from the fuel shutdown solenoid relay. This high-amperage current allows the solenoid shaft to pull up on the injection pump lever. The injection pump shutdown lever is then positioned to the run position (Fig. 13).

When the ignition key is released to the ON position, a low-amperage current is supplied to the other coil in the solenoid. This is used to hold the solenoid shaft in the up position. Accelerator pedal position then controls fuel lever position for fuel control at the injection pump.

**Fig. 12 Fuel Shutdown Solenoid Location****Fig. 13 Fuel Shutdown Solenoid Positions**

Voltage to operate the solenoid is supplied from the ignition switch and through the fuel shutdown solenoid relay. Also refer to Fuel Shutdown Solenoid Relay.

If the shutdown solenoid is being replaced, its shaft length must be adjusted. For fuel shutdown solenoid removal, installation and solenoid shaft adjustment procedures, refer to the Component Removal/Installation section of this group.

DESCRIPTION AND OPERATION (Continued)**FUEL SHUTDOWN SOLENOID RELAY**

Voltage to operate the fuel shutdown (shut-off) solenoid is supplied from the ignition switch and through the fuel shutdown solenoid relay. The Powertrain Control Module (PCM) has no control over the solenoid. The fuel shutdown solenoid relay is located in the engine compartment near the brake master cylinder (Fig. 14).

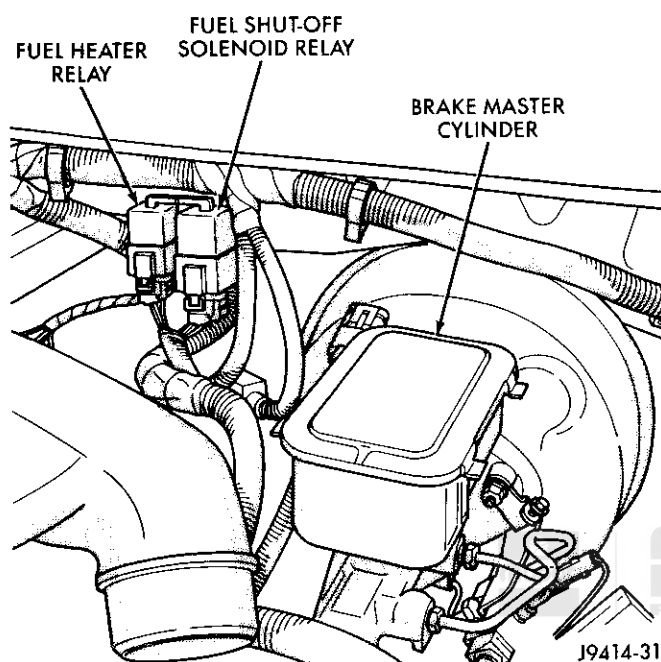


Fig. 14 Fuel Shutdown (Shut-Off) Solenoid Location

FUEL DRAIN MANIFOLD

Some fuel is continually vented from the fuel injection pump to cool the pump and the fuel injectors. During injection, a small amount of fuel flows past the injector nozzle and is not injected into the combustion chamber. This fuel drains into the fuel drain manifold (Fig. 15). Fuel in the drain manifold is then routed back to the fuel filter/water separator.

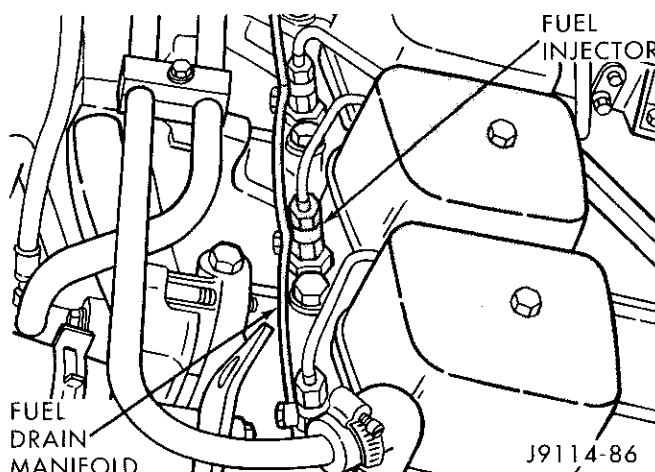


Fig. 15 Fuel Drain Manifold—Typical

seals. Air can also enter the fuel system between the fuel tank and the transfer pump. Inspect the fuel tank and fuel lines for damage that might allow air into the system.

For air bleeding, refer to the Air Bleed Procedure.

FUEL SUPPLY RESTRICTIONS**LOW-PRESSURE LINES**

Fuel supply line restrictions or a defective fuel transfer pump can cause starting problems and prevent the engine from revving up. The starting problems include; low power and blue or white fog like exhaust. Test all fuel supply lines for restrictions or blockage. Flush or replace as necessary. Bleed the fuel system of air once a fuel supply line has been replaced. Refer to the Air Bleed Procedure section of this group for procedures. Also refer to the Fuel Transfer Pump Pressure Test section of this group for restriction tests.

HIGH-PRESSURE LINES

Restricted (kinked or bent) high-pressure lines can cause starting problems, poor engine performance and black smoke from exhaust.

Examine all high-pressure lines for any damage. Each radius on each high-pressure line must be smooth and free of any bends or kinks.

Replace damaged, restricted or leaking high-pressure fuel lines with the correct replacement line.

CAUTION: The high-pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high-pressure fuel line is necessary.

DIAGNOSIS AND TESTING**AIR IN FUEL SYSTEM**

Air will enter the fuel system whenever fuel supply lines, separator filters, injection pump, high-pressure lines or injectors are removed or disconnected. Air trapped in the fuel system can result in hard starting, a rough running engine, engine misfire, low power, excessive smoke and fuel knock. After service is performed, air must be bled from the system before starting the engine.

Inspect the fuel system from the fuel transfer pump to the injectors for loose connections. Leaking fuel is an indicator of loose connections or defective

DIAGNOSIS AND TESTING (Continued)

FUEL TRANSFER PUMP PRESSURE/CAPACITY TEST

For operation of the fuel transfer pump primer button, refer to Fuel Transfer Pump in the Fuel Delivery—Diesel Engine section of this group.

The fuel transfer pump is located on the left side of the engine and above the starter motor (Fig. 16).

FUEL TEMPERATURE SENSOR

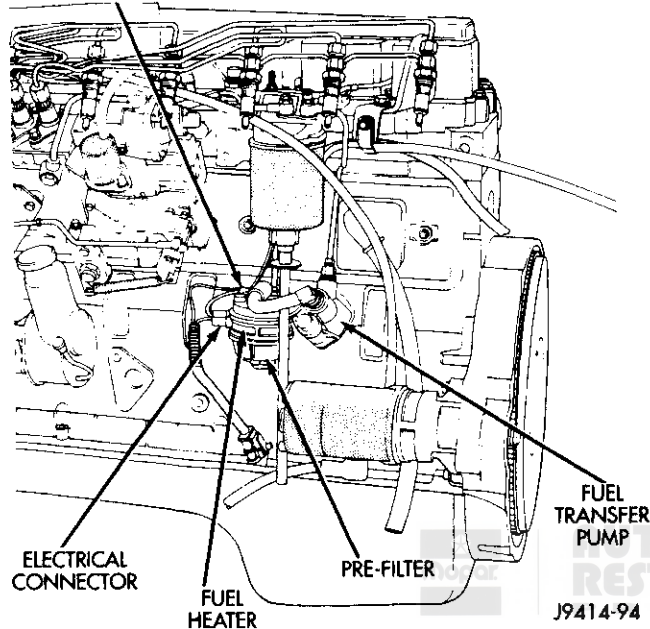


Fig. 16 Fuel Transfer Pump Location

An improperly operating fuel transfer pump can cause low engine power and/or hard engine starting. Inspect the fuel supply line to the pump for restrictions, kinks or leaks.

Fuel leaking from the weep hole in the pump casing indicates a leaking pump. The transfer pump must then be replaced or rebuilt.

Do not operate the fuel system with a fuel line or component suction restriction of more than approximately 100 MM Hg (4.0 inch Hg).

Low transfer pump output can be caused by a worn eccentric on the engine camshaft.

The maximum allowable fuel pressure drop across the fuel filter/water separator is 35 kPa (5 psi). As the filter removes contaminants in the fuel, the pressure drop across the fuel filter/water separator will increase. Frequent replacement of the filter may indicate a worn transfer pump. The filter/separator can be checked with a fuel pressure gauge. For test procedures, refer to Fuel Filter/Water Separator Tests in this section of the group.

Refer to Group 0, Lubrication and Maintenance at the front of this manual for recommended replacement intervals.

OUTPUT PRESSURE TEST

(1) Remove the clamp bolt retaining the fuel drain manifold line to the cylinder head (Fig. 17).

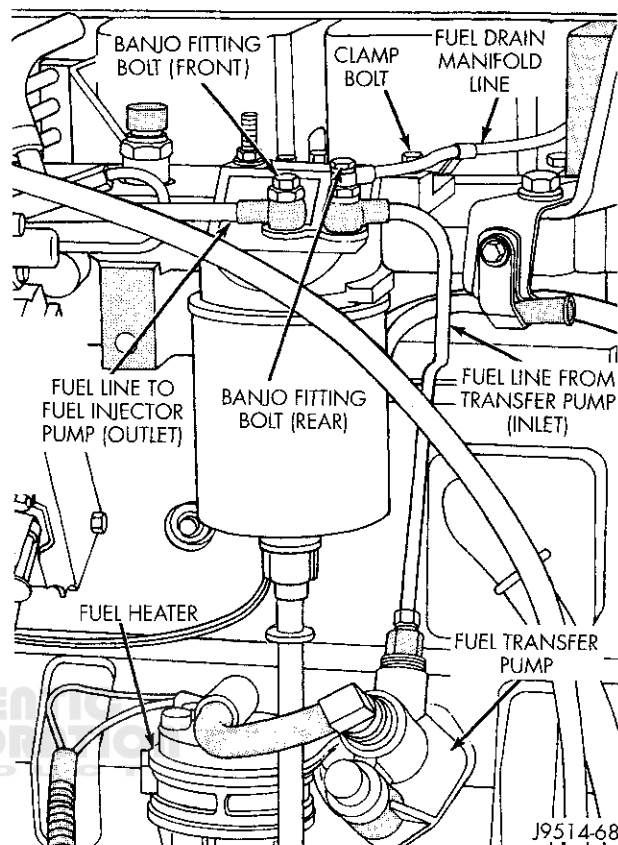


Fig. 17 Fuel Line Fittings

(2) Remove the rear banjo fitting bolt at the inlet line (Fig. 17).

(3) Position the fuel drain manifold line (Fig. 17) to the rear.

(4) Install and tighten special adapter tool 6829 into the top of the fuel inlet line (Fig. 18).

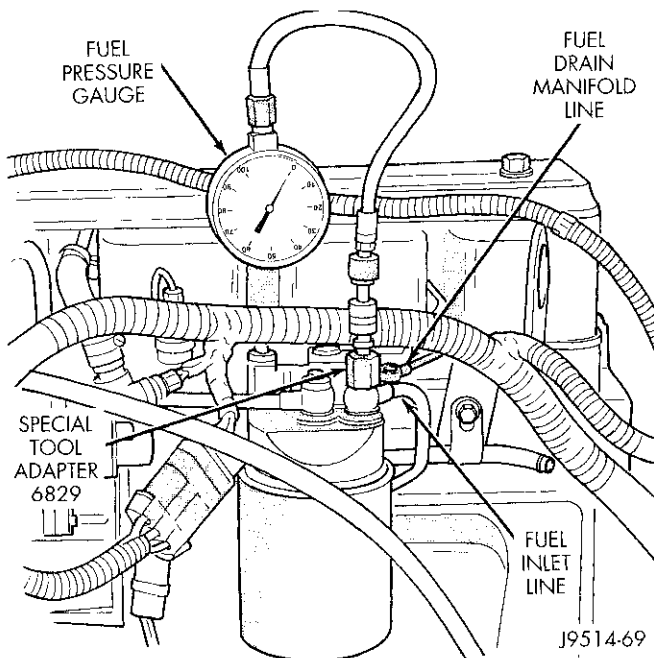
(5) Install a 0-60 or 0-100 psi fuel pressure gauge to adapter tool 6829 (Fig. 18).

(6) Start engine and record fuel pressure. Minimum pressure should be 172 kPa (25 psi) at rated speed.

(7) If fuel pressure falls below specifications, test for fuel line inlet restrictions and overflow valve operation before condemning the fuel transfer pump. Proceed to step (a).

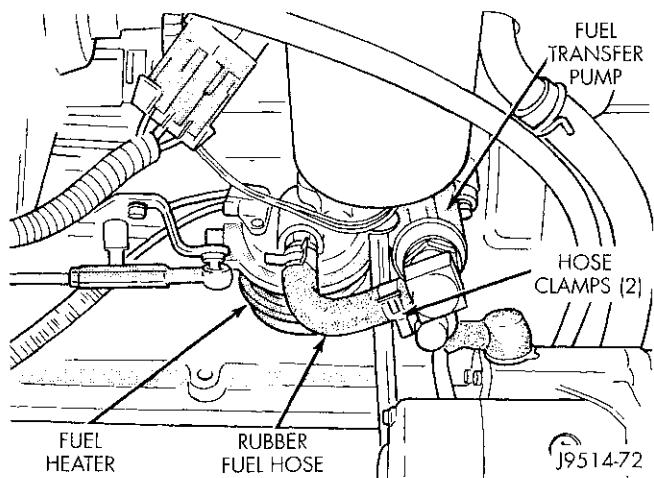
(a) Remove the rubber fuel hose and clamps located between the fuel heater and fuel transfer pump (Fig. 19).

(b) Install special hose adapter tool 6837 between the disconnected fittings on the heater and transfer pump (Fig. 20). Install clamps to hose tool 6837.

DIAGNOSIS AND TESTING (Continued)**Fig. 18 Installing Special Tools**

(c) Connect vacuum gauge 6828 to T-fitting (Fig. 21).

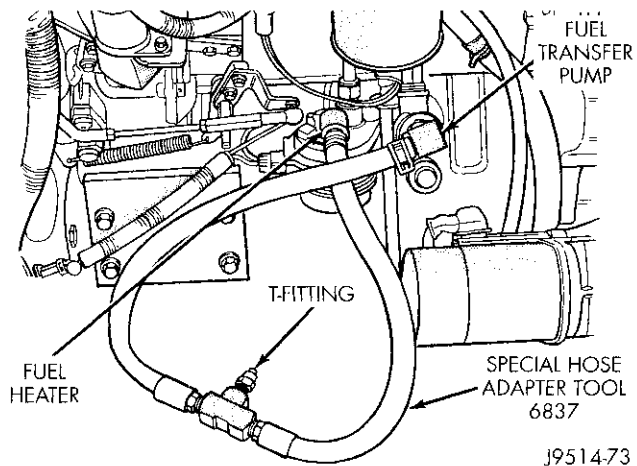
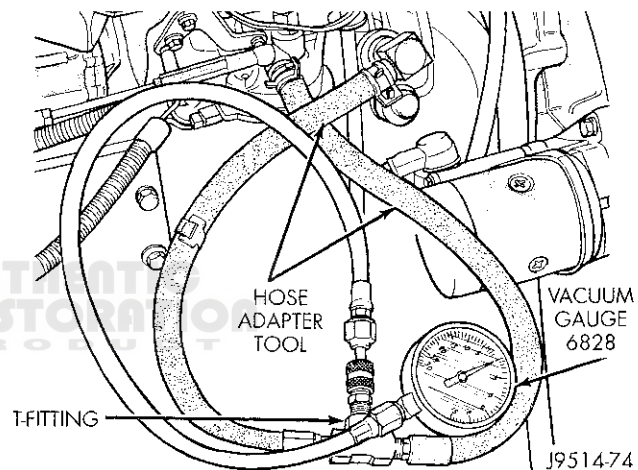
(d) Start the engine and observe the vacuum gauge. The vacuum gauge will not indicate a vacuum until the transfer pump begins to operate at full capacity.

**Fig. 19 Rubber Fuel Hose—Pump to Heater**

NOTE: Under load, maximum inlet restriction must not exceed approximately 100 mm Hg (4 in. Hg).

(8) If the restriction is higher than the specifications, check for a kinked fuel line or a plugged fuel tank vent. A partially clogged in-tank fuel filter can also cause excess vacuum. Repair as necessary.

(9) Remove vacuum gauge and adapter hose tool.

**Fig. 20 Installing Hose Adapter****Fig. 21 Installing Vacuum Gauge**

(10) Install rubber fuel hose and clamps between heater and pump.

FUEL VOLUME TEST

Fuel volume-versus-engine cranking rpm are used for the test.

WARNING: TO PREVENT THE ENGINE FROM STARTING, DISCONNECT THE PIGTAIL HARNESS AT THE FUEL SHUTDOWN SOLENOID (Fig. 22). USE CAUTION AS RESIDUAL FUEL MAY CAUSE THE ENGINE TO START AND RUN TEMPORARILY. ATTEMPT TO START THE ENGINE A FEW TIMES UNTIL IT QUILTS BEFORE PERFORMING THE FUEL VOLUME TEST.

(1) Connect a hand held tachometer to the engine. Use Cummins part number 3377462 or an equivalent.

(2) Remove the clamp bolt retaining the fuel drain manifold line to the cylinder head (Fig. 17).

DIAGNOSIS AND TESTING (Continued)

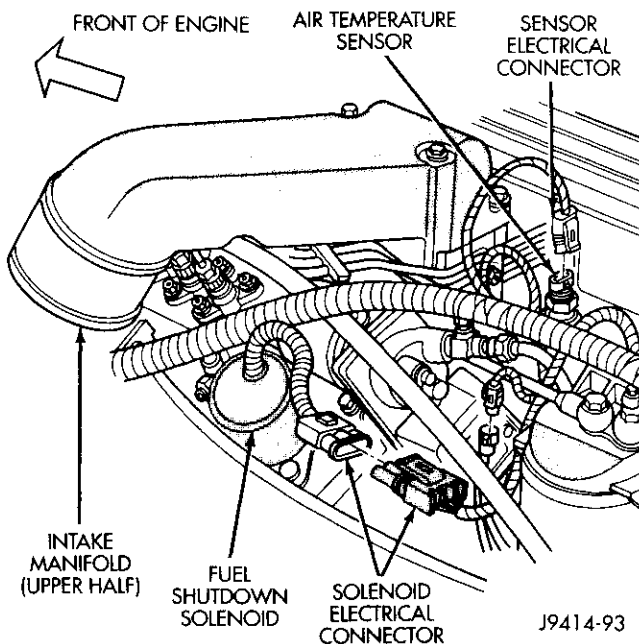


Fig. 22 Fuel Shutdown Solenoid Electrical Connector

- (3) Remove the rear banjo fitting bolt at the inlet line (Fig. 17).
- (4) Position the fuel drain manifold line (Fig. 17) to the rear.
- (5) Install and tighten special adapter tool 6836 into the top of the fuel inlet line (Fig. 23).
- (6) Connect a temporary rubber fuel hose to adapter 6836 (Fig. 23).

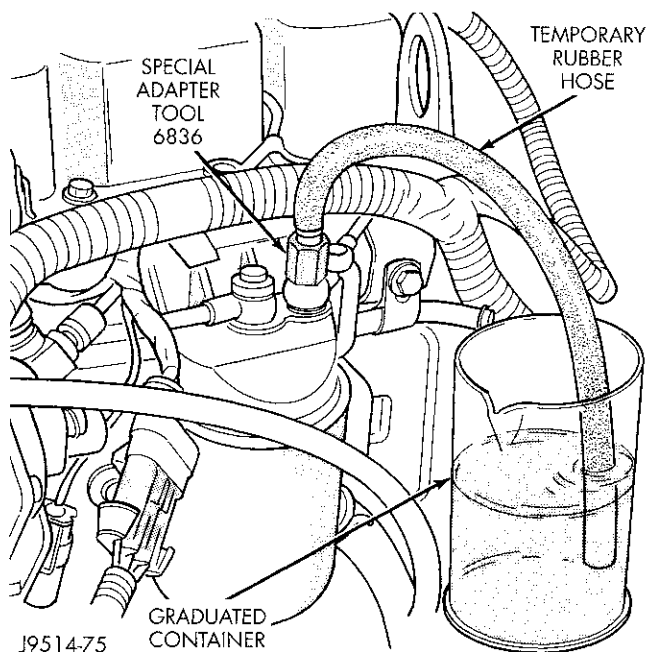


Fig. 23 Performing Fuel Volume Test

(7) Place the other end of this temporary hose into a graduated container (Fig. 23).

(8) Crank the engine for 30 seconds. Measure the fuel volume in the container after 30 seconds of engine cranking time. **Do not crank the engine for more than 30 seconds at a time. Starter motor damage may result.**

(9) To determine the correct fuel volume, refer to for Fuel Volume Specification. To use the chart in (Fig. 24), refer to the following procedure:

- Draw a straight vertical line at the measured rpm.
- Draw a straight horizontal line at the measured fuel volume.
- If these two lines intersect below the flow line (Fig. 24), this indicates a defective transfer pump or a line restriction.
- If these two lines intersect above the flow line (Fig. 24), this indicates acceptable fuel flow.

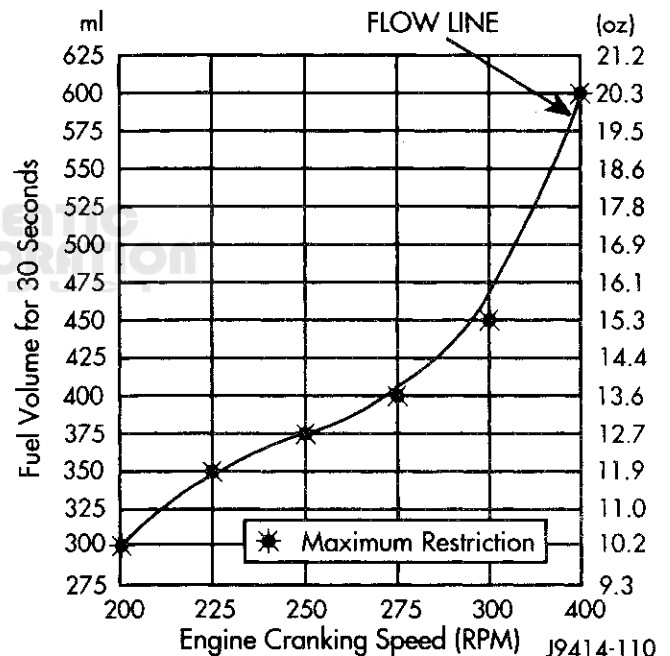


Fig. 24 Fuel Volume Specifications

FUEL FILTER/WATER SEPARATOR TEST

A blocked or clogged fuel filter/water separator can cause starting problems and prevent the engine from revving up. It can also cause, low power and blue or white fog like exhaust.

The maximum allowable fuel pressure drop across the fuel filter/water separator is 35 kPa (5 psi). This can be checked with a fuel pressure gauge connected to the inlet and outlet sides of the upper part of the filter base with special fuel line adapter fittings.

To test fuel pressure drop:

- (1) Remove the clamp bolt retaining the fuel drain manifold line to the cylinder head (Fig. 25).

DIAGNOSIS AND TESTING (Continued)

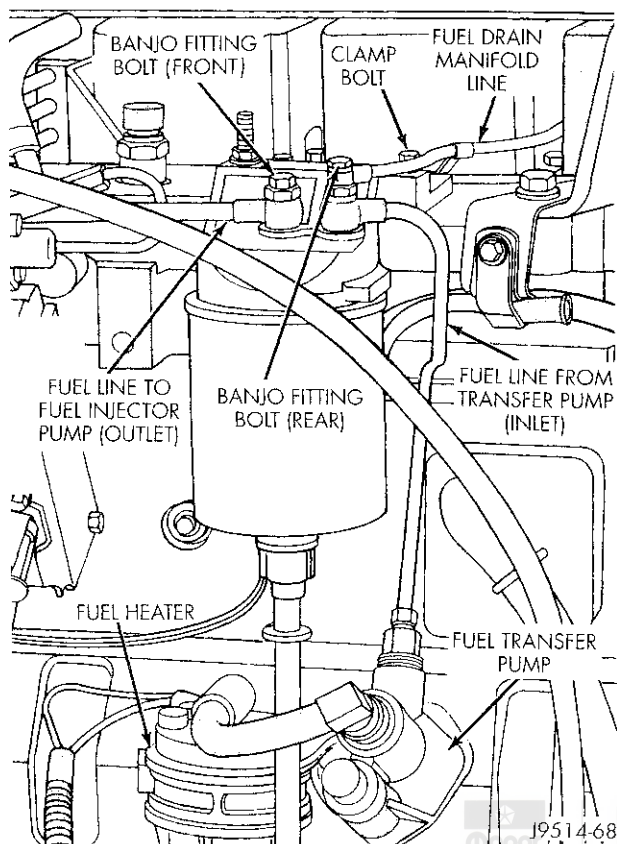


Fig. 25 Fuel Line Fittings

(2) Remove the rear banjo fitting bolt at the inlet line (Fig. 25).

(3) Position the fuel drain manifold line (Fig. 25) to the rear.

(4) Install and tighten special adapter tool 6829 into the top of the fuel inlet line (Fig. 26).

(5) Install a 0-60 or 0-100 psi fuel pressure gauge to adapter tool 6829 (Fig. 26).

(6) Start engine and record fuel pressure. Minimum pressure should be 172 kPa (25 psi). If not, refer to Fuel Transfer Pump Pressure Test for more information.

(7) Remove fuel pressure gauge and adapter tool.

(8) Connect banjo fittings together at fuel inlet line with bolt.

(9) Remove the front banjo fitting bolt at the outlet line (Fig. 25).

(10) Install and tighten special adapter tool 6829 into the top of the fuel outlet line (Fig. 27).

(11) Install fuel pressure gauge to adapter tool 6829 (Fig. 27).

(12) Start engine and record fuel pressure.

(13) Compare the 2 pressures. It must not exceed 35 kPa (5 psi).

(14) If pressure specification has been exceeded, replace fuel filter and check for line restrictions.

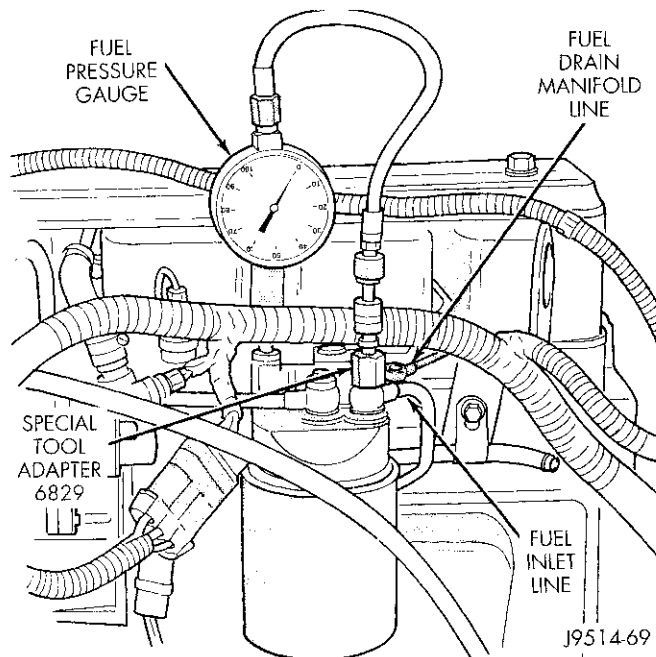


Fig. 26 Installing Special Tools

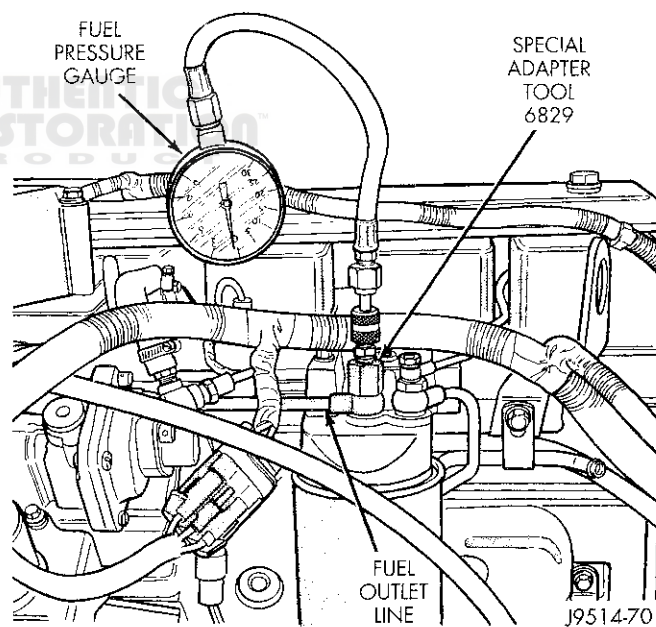


Fig. 27 Installing Special Tools

(15) If the instrument panel mounted water-in-fuel warning lamp is illuminated with the ignition key ON, it indicates that excess water has collected in the fuel filter/water separator. Excess water can be drained. Refer to Fuel Filter/Water Separator in the Component Removal/Installation section of this group for water draining procedures.

(16) If excess water gathers in the filter/separator in a short period of time, the fuel tank must be removed, drained and cleaned.

DIAGNOSIS AND TESTING (Continued)

FUEL HEATER TEST

The fuel heater is used to prevent diesel fuel from waxing during cold weather operation.

NOTE: The fuel heater element, fuel heater relay and fuel heater temperature sensor are not controlled by the powertrain control module (PCM).

A malfunctioning fuel heater can cause a wax build-up in the fuel filter/water separator. Wax build-up in the filter/separator can cause engine starting problems and prevent the engine from revving up. It can also cause blue or white fog-like exhaust. If the heater is not operating in cold temperatures, the engine may not operate due to fuel waxing.

The fuel heater is located on the left side of the engine above the starter motor (Fig. 28).

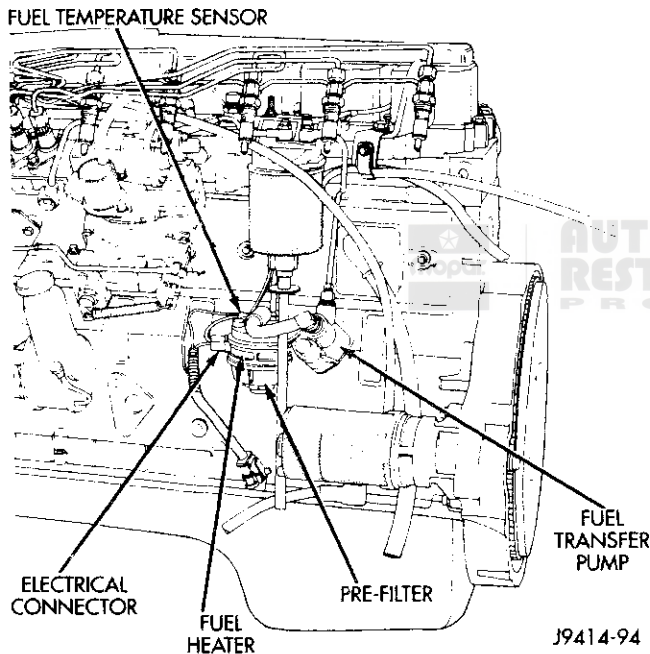


Fig. 28 Fuel Heater Location

The heater assembly is equipped with a built-in fuel temperature sensor (thermostat) (Fig. 29) or (Fig. 28) that senses fuel temperature. When the fuel temperature is below 40 degrees F, the sensor allows current to flow to the built-in heater element to warm the fuel. When the fuel temperature is above 80 degrees F, the sensor stops current flow to the heater element (circuit is open).

Voltage to operate the fuel heater element is supplied from the ignition switch, through the fuel heater relay (Fig. 30) (also refer to Fuel Heater Relay), to the fuel temperature sensor and on to the fuel heater element.

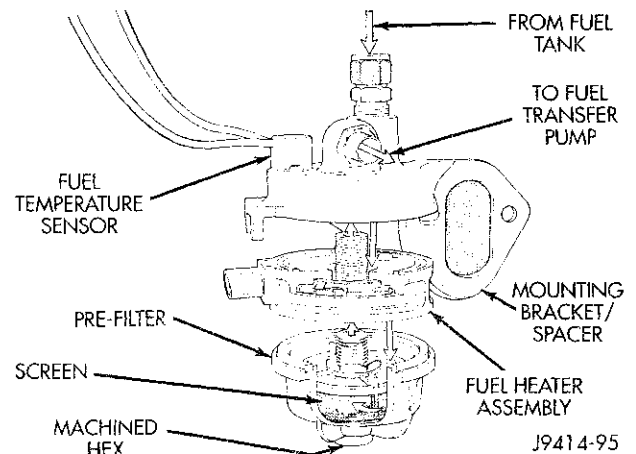


Fig. 29 Fuel Heater Assembly

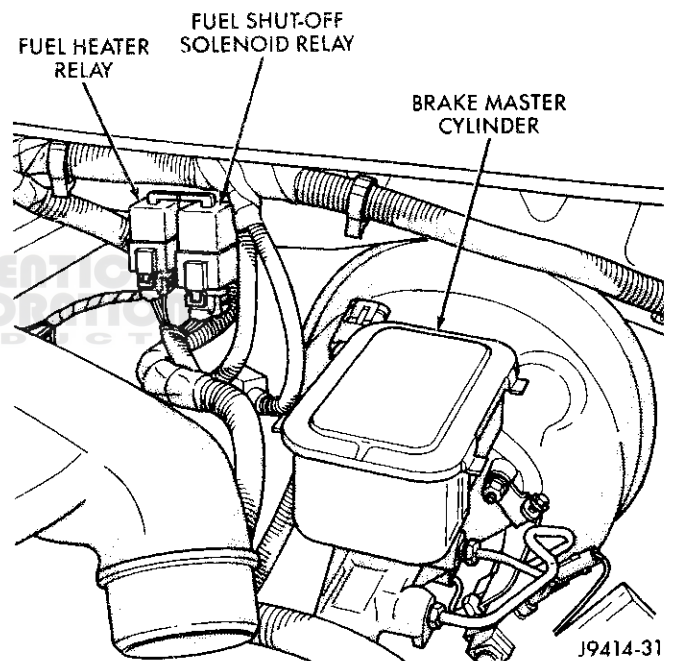


Fig. 30 Fuel Heater Relay—Diesel

The built-in heater element operates on 12 volts, 300 watts at 0 degrees F. As temperature increases, power requirements decrease.

The fuel heater assembly contains a pre-filter (Fig. 29) to prevent contaminants from entering the fuel transfer pump.

A minimum of 7 volts is required to operate the fuel heater. The resistance value of the heater element is less than 1 ohm (cold) and up to 1000 ohms warm.

TESTING

(1) Remove the electrical connector at the side of the fuel heater (Fig. 28).

(2) Using an ohmmeter, check the resistance across the two terminals on the side of the heater.

DIAGNOSIS AND TESTING (Continued)

Resistance should be approximately 1 ohm (cold) to 1000 ohms (warm).

(3) With the electrical connector still unplugged from the fuel heater, check the electrical operation of the fuel temperature sensor (Fig. 29). Proceed to next step:

(4) Using an ohmmeter, check the resistance across the two terminals in the pigtail wire harness coming from the fuel temperature sensor. The sensor circuit should be open if the fuel temperature is above 80 degrees. The sensor circuit should be closed if the fuel temperature is below 40 degrees.

(5) Check for 12 volts at the disconnected temperature sensor connector with the ignition key ON. Refer to Group 8W, Wiring for electrical schematics.

(6) With ignition ON, check for 12 volts at the fuel heater relay connector. Refer to Group 8W, Wiring for electrical schematics.

(7) Check operation of the fuel heater relay (Fig. 30). Refer to Relays—Operation/Testing in this section of the group.

FUEL HEATER RELAY TEST

The fuel heater relay is located in the engine compartment near the brake master cylinder (Fig. 30).

To test the relay only, refer to Relays—Operation/Testing in this section of the group.

To test the fuel heater, refer to Fuel Heater Test in this section of the group.

FUEL INJECTOR TEST

A leaking fuel injector can cause fuel knock, poor performance, black smoke, poor fuel economy and rough engine idle. If the fuel injector needle valve does not operate properly, the engine may misfire and produce low power.

A leak in the injection pump-to-injector high-pressure fuel line can cause many of the same symptoms as a malfunctioning injector. Inspect for a leak in the high-pressure lines before checking for a malfunctioning fuel injector.

WARNING: THE INJECTION PUMP SUPPLIES HIGH-PRESSURE FUEL OF UP TO APPROXIMATELY 120,000 KPA (17,400 PSI) TO EACH INDIVIDUAL INJECTOR THROUGH THE HIGH-PRESSURE LINES. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE THE SKIN AND CAUSE PERSONAL INJURY. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING. AVOID CONTACT WITH FUEL SPRAY WHEN BLEEDING HIGH-PRESSURE FUEL LINES.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL

TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

To determine which fuel injector is malfunctioning, run the engine and loosen the high-pressure fuel line nut at the injector (Fig. 31). Listen for a change in engine speed. After testing, tighten the line nut to 30 N·m (22 ft. lbs.) torque. If engine speed drops, the injector was operating normally. If engine speed remains the same, the injector may be malfunctioning. Test all injectors in the same manner, one at a time.

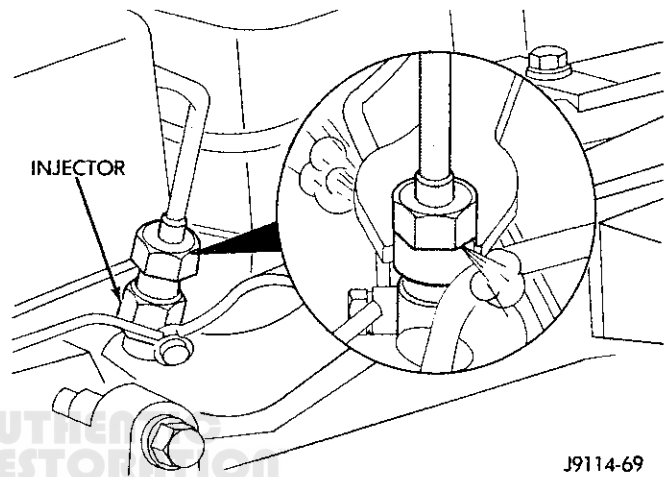


Fig. 31 Inspecting Injector Operation

Once an injector has been found to be malfunctioning, remove it from the engine and test it. Refer to the Diesel Engine—Component Removal/Installation section of this group for procedures.

After the injector has been removed, install it to a bench-mount injector tester (Cummins part number 3376946 or equivalent) (Fig. 32). Position a container below the injector before testing. Refer to operating instructions supplied with tester for procedures.

The opening pressure or “pop” pressure should be approximately 26,252 kPa (3822 psi). If the fuel injector needle valve is opening (popping) too early or too late, replace the injector.

FUEL INJECTION PUMP TEST

The fuel shutdown solenoid, breakover throttle lever, mounting o-ring, banjo washers and oil supply fittings are the only serviceable components of the fuel injection pump. **The injection pump is not to be serviced or the warranty may be voided. If the injection pump requires service, the complete assembly must be replaced.**

Incorrect injection pump timing can cause poor performance, excessive smoke and emissions and poor fuel economy.

DIAGNOSIS AND TESTING (Continued)

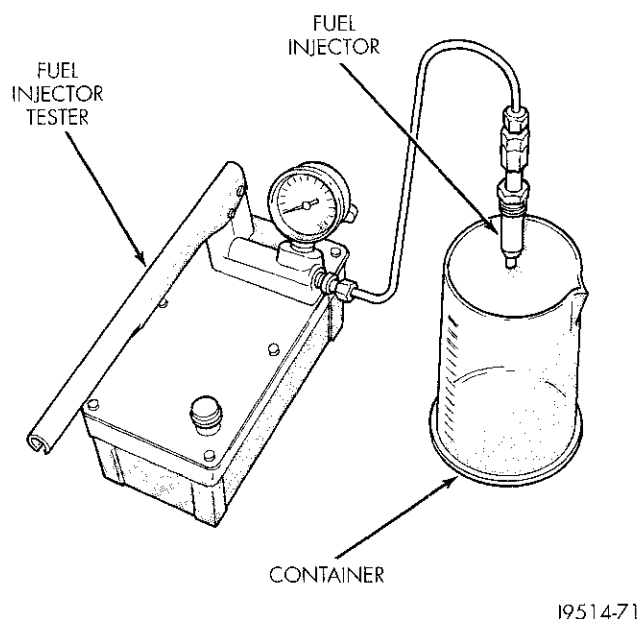


Fig. 32 Typical Fuel Injector Tester

A defective fuel injection pump or misadjusted pump timing can cause starting problems or prevent the engine from revving up. It can also cause:

- Engine surge at idle
- Rough idle (warm engine)
- Low power
- Excessive fuel consumption
- Poor performance
- Low power
- Black smoke from the exhaust
- Blue or white fog like exhaust
- Incorrect idle or maximum speed

Engine power is also effected by the governor setting and performance. **Do not attempt to adjust the governor. If the governor seals on the external adjustment screw are broken, the fuel rate may be out of adjustment. The warranty of the injection pump and the engine may be void if the seals have been tampered with or removed.**

FUEL SHUTDOWN SOLENOID TEST

NOTE: The fuel shutdown (shut-off) solenoid (Fig. 33) and fuel shutdown solenoid relay (Fig. 35) are not controlled by the powertrain control module (PCM).

(1) With the ignition switch off, the solenoid shaft should be down and the injection pump lever should be in the shutdown position (no fuel supply to injection pump) (Fig. 34).

(2) Turn the ignition switch to the CRANK (starter engage) position and observe the solenoid shaft and injection pump lever. The shaft should pull up (shaft

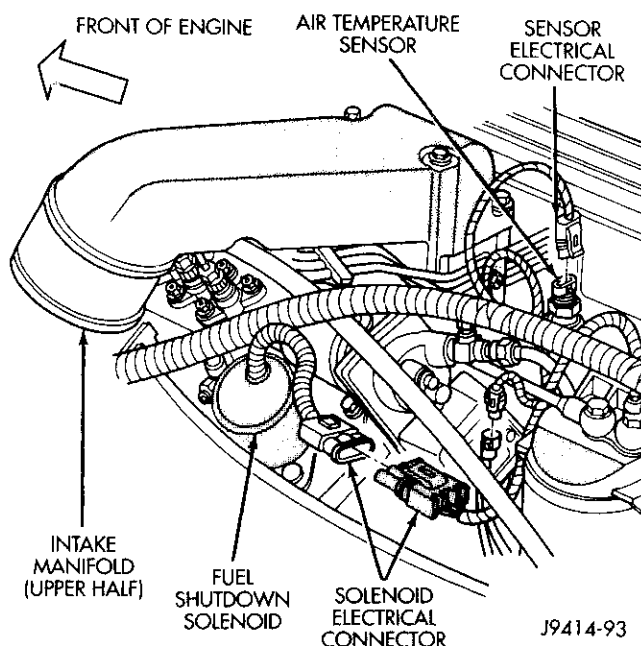


Fig. 33 Fuel Shutdown Solenoid Location

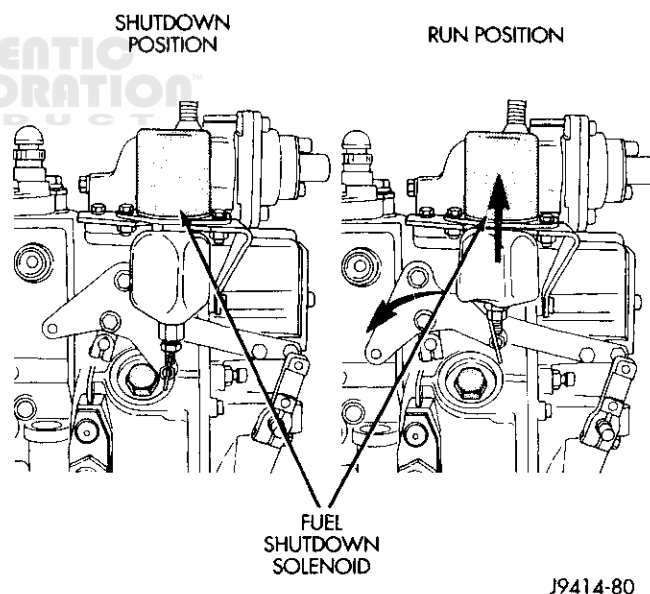
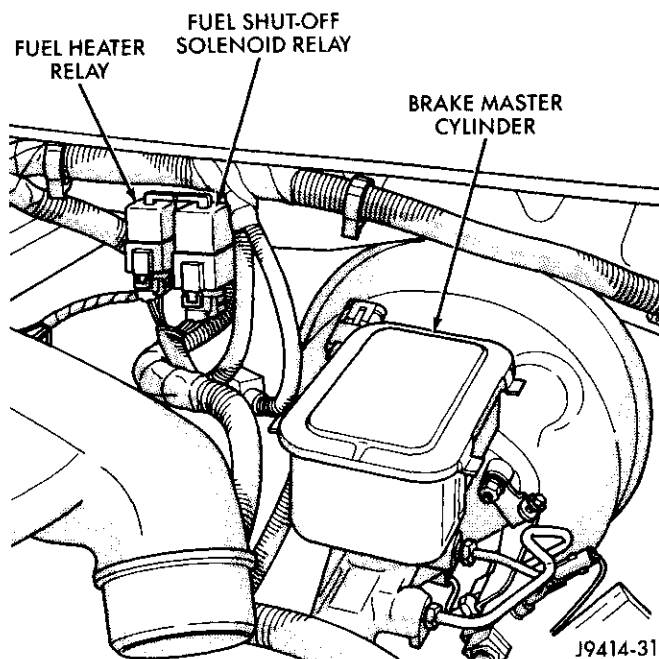


Fig. 34 Fuel Shutdown Solenoid Positions

retracted into the solenoid) and the pump lever should be in the run position (fuel being supplied to injection pump) (Fig. 34).

(3) Release the ignition key from the CRANK to the ON position. The shaft should remain in the up position and the pump lever should remain in the run position (fuel being supplied to injection pump) (Fig. 34). If the solenoid shaft is not moving, refer to the following:

DIAGNOSIS AND TESTING (Continued)**Fig. 35 Fuel Shutdown Solenoid Relay Location**

(4) Disconnect the solenoid three-wire pigtail wire harness from the main engine harness.

(5) If the solenoid shaft did not move up when the ignition switch was in the CRANK position, check for 12 volts at the three-way connector. This will be the circuit coming from the fuel shutdown solenoid relay. Refer to Group 8W, for wire connector pin location and circuit identification. If 12 volts is not present at this circuit when the key is in the CRANK position, check the fuel shutdown solenoid relay. Refer to Relays—Operation/Testing in this section of the group. Also check the wiring between the relay and the solenoid.

(6) If the solenoid shaft moves up when the ignition switch is in the CRANK position, but moves down when the key is released from the CRANK to the ON position, check the circuit coming from the ignition switch for 12 volts. Refer to Group 8W, for wire connector pin location and circuit identification.

(7) If the shutdown solenoid is being replaced, its shaft length must be adjusted. Refer to Fuel Shutdown Solenoid removal, installation and solenoid shaft adjustment for procedures.

FUEL SHUTDOWN SOLENOID RELAY TEST

Voltage to operate the fuel shutdown solenoid is supplied from the ignition switch and through the fuel shutdown solenoid relay. The fuel shutdown solenoid relay is located in the engine compartment near the brake master cylinder (Fig. 35).

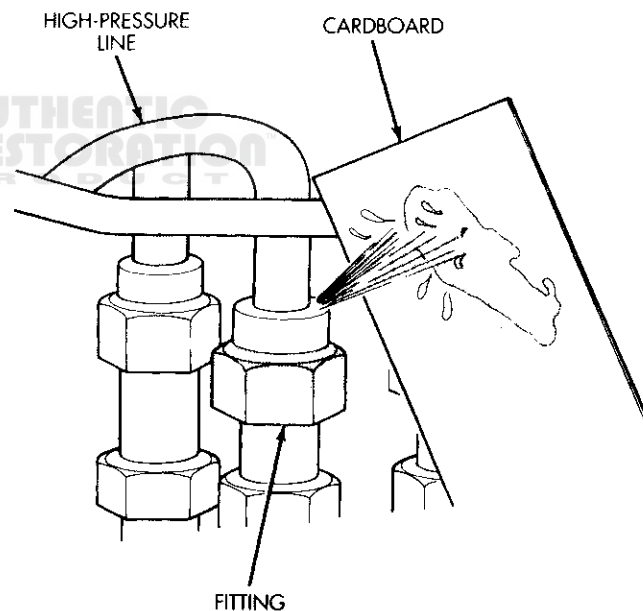
To test the relay, refer to Relays—Operation/Testing in this section of the group.

HIGH-PRESSURE FUEL LINE LEAK TEST

High-pressure fuel line leaks can cause starting problems and poor engine performance.

WARNING: DUE TO EXTREME FUEL PRESSURES OF UP TO 120,000 kPa (17,400 PSI), USE EXTREME CAUTION WHEN INSPECTING FOR HIGH-PRESSURE FUEL LEAKS. DO NOT GET YOUR HAND NEAR A SUSPECTED LEAK. INSPECT FOR HIGH-PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

Start the engine. Move the cardboard over the high-pressure fuel lines and check for fuel spray onto the cardboard (Fig. 36). If a high-pressure line connection is leaking, bleed the system and tighten the connection. Refer to the Air Bleed Procedure in this group for procedures. Replace damaged, restricted or leaking high-pressure fuel lines with the correct replacement line.



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Fig. 36 Typical Test for Leaks with Cardboard

CAUTION: The high-pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high-pressure fuel line is necessary.

DIAGNOSIS AND TESTING (Continued)

IDLE SPEED ADJUSTMENT

The high idle stop screw is factory sealed and cannot be adjusted. Low-speed idle can be adjusted.

(1) Use an optical tachometer such as Snap-on No. MT139 or MTE (Cummins tool division) No. 3377462 to read the engine rpm.

(2) Bring the engine to normal operating temperature.

(3) Adjust the low idle speed at the low idle speed screw. The screw and locknut are located at the rear of the fuel injection pump (Fig. 37).

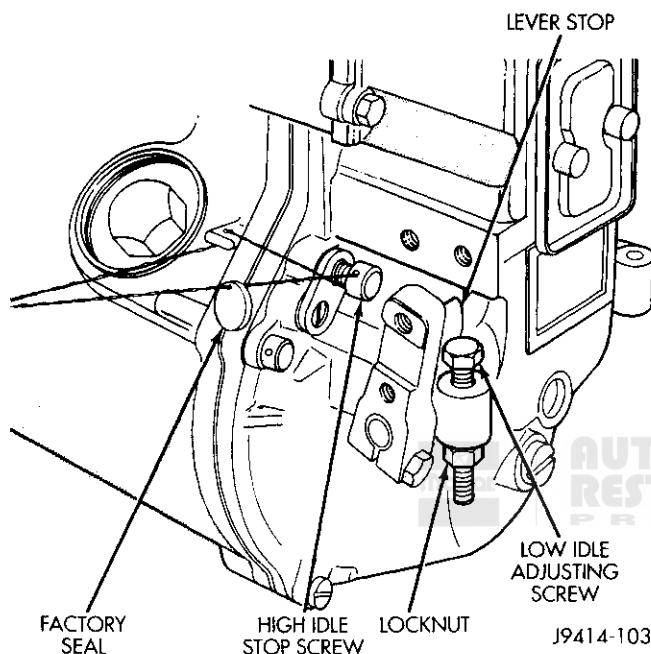


Fig. 37 Low Idle Speed Screw

(4) Loosen the idle screw lock nut (Fig. 37). Adjust idle screw to obtain specified rpm (Fig. 38).

(5) Tighten the locknut after adjustment.

LOW IDLE SPEED	HIGH IDLE SPEED
With automatic transmission...	Do not attempt to adjust high idle speed. High idle speed adjustment screw is factory sealed. Breaking seal will void injection pump warranty.
*750-800 RPM with transmission in drive and air conditioning on.	
With manual transmission...	
*780 RPM with transmission in neutral and air conditioning on.	
* With engine at normal operating temperature. Refer to text for idle adjustment procedures.	

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Fig. 38 Idle Speeds—Diesel Engine

SERVICE PROCEDURES

AIR BLEED PROCEDURE

A certain amount of air becomes trapped in the fuel system when fuel system components are serviced or replaced. Bleed the system after fuel system service according to the following procedures.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

MANUAL BLEEDING

Some air enters the fuel system when the filters or injection pump supply line are changed. This small amount of air is vented automatically from the injection pump through the fuel drain manifold. This is if the filter was changed according to instructions.

The system will have to be bleed manually if:

- The fuel filter is not filled before installation
- The fuel injection pump is replaced
- High-pressure fuel line connections are loosened or lines replaced
- Initial engine start-up or start-up after an extended period of no engine operation.

(1) Loosen the low-pressure bleed bolt (Fig. 39).

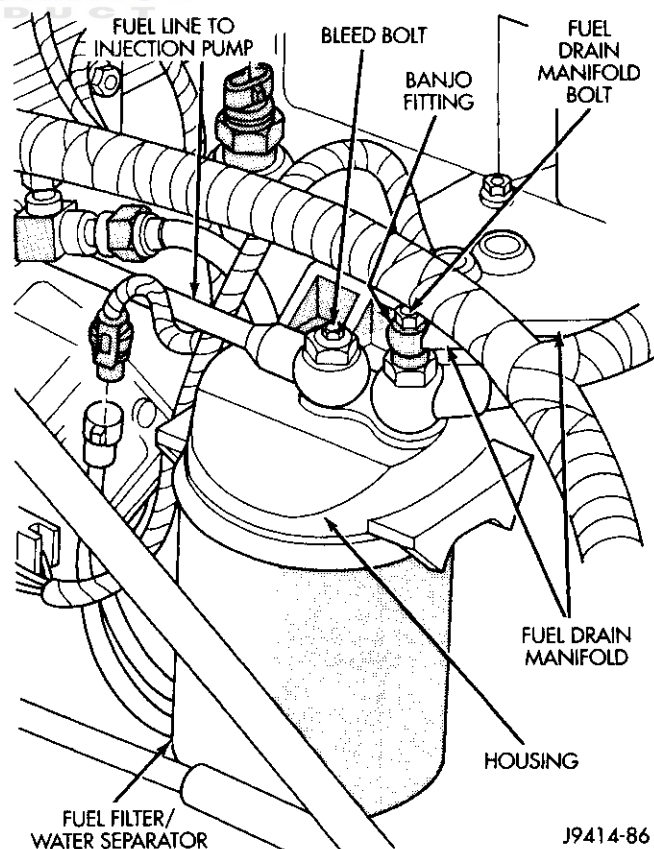


Fig. 39 Low-Pressure Bleed Bolt

SERVICE PROCEDURES (Continued)

(2) Operate the rubber push-button primer on the fuel transfer pump (Fig. 40). Do this until the fuel exiting the low-pressure bleed bolt is free of air.

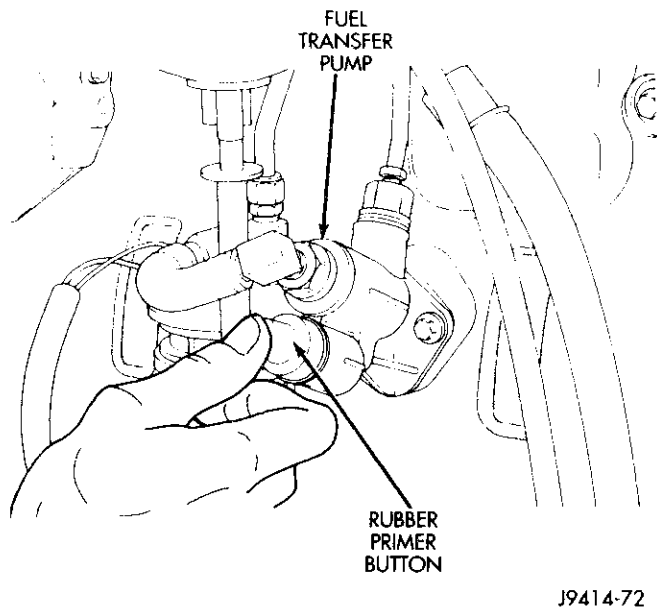


Fig. 40 Fuel Transfer Pump—Manual Operation

(3) Tighten low-pressure bleed screw to 8 N·m (6 ft. lbs.) torque.

FUEL INJECTION PUMP BLEEDING

WARNING: THE ENGINE MAY START WHEN CRANKING TO BLEED AIR FROM THE INJECTION PUMP. PLACE THE TRANSMISSION IN NEUTRAL OR PARK AND SET PARKING BRAKE BEFORE ENGAGING THE STARTER MOTOR.

CAUTION: Do not engage the starter motor for more than 30 seconds at a time. Allow two minutes between cranking intervals.

(1) Perform the previous procedure: Manual Bleeding.

(2) Crank the engine for 30 seconds at a time to allow air trapped in the injection pump to vent out the drain manifold. Observe the previous WARNING and CAUTION.

HIGH-PRESSURE FUEL LINE BLEEDING

WARNING: THE FUEL INJECTION PUMP SUPPLIES HIGH-PRESSURE FUEL OF AS HIGH AS 120,000 KPA (17,405 PSI) TO EACH INDIVIDUAL INJECTOR THROUGH THE HIGH-PRESSURE LINES. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE THE SKIN AND CAUSE PERSONAL INJURY.

WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING AND AVOID CONTACT WITH FUEL SPRAY WHEN BLEEDING HIGH-PRESSURE FUEL LINES.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

Bleed air from one injector at time.

(1) Loosen the high-pressure fuel line fitting at the injector (Fig. 41).

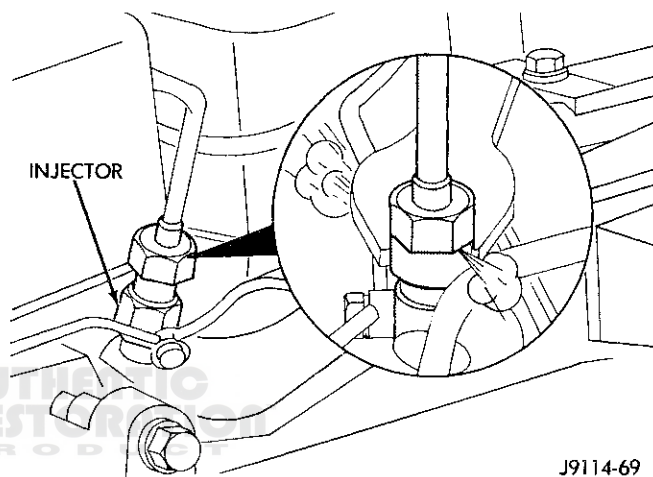


Fig. 41 Bleeding High-Pressure Fuel Lines

(2) Crank the engine until all air is bled from the line. **Do not operate the starter motor for longer than 30 seconds. Wait two minutes between cranking intervals.**

(3) Start the engine and bleed one injector at a time until the engine runs smoothly.

(4) Tighten fuel line(s) at injector(s) to 30 N·m (22 ft. lbs.) torque.

FUEL INJECTION PUMP TIMING

(1) Thoroughly clean the engine and fuel system before attempting to remove any components. Pay special attention to the top of the fuel injection pump. Use compressed air to remove any water remaining on the fuel pump after the cleaning process.

CAUTION: DO NOT ALLOW ANY DIRT, DEBRIS, OR PAINT CHIPS TO ENTER THE FUEL SYSTEM WHILE IT IS OPEN. IF FOREIGN MATERIAL OF ANY TYPE IS ALLOWED INTO THE PUMP, LINES OR INJECTORS DURING THIS PROCESS IT COULD RESULT IN AN INJECTION PUMP OR FUEL INJECTOR MALFUNCTION.

SERVICE PROCEDURES (Continued)

NOTE: Locate top dead center (TDC) on cylinder #1.

(2) Remove the rubber access plug located in the rear flange of the engine on the exhaust manifold side. (Fig. 42).

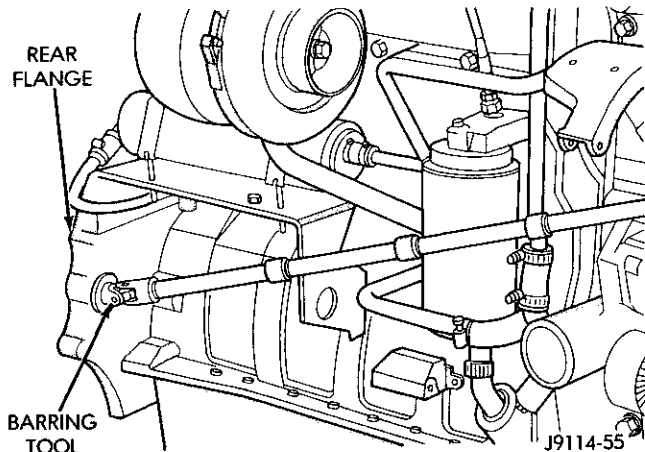


Fig. 42 Rotating Engine With Barring Tool

NOTE: Removing the #1 cylinder valve cover and first barring (rotating) the engine clockwise until both intake and exhaust valves are closed will speed up locating engine TDC as described later in step 4.

(3) Insert the barring tool number 7471B through the access hole and into the flywheel housing (Fig. 42).

(4) While holding tension on the timing pin (toward front of engine), slowly rotate the engine counterclockwise with the barring tool. Hold a slight rearward (pushing) pressure on the barring tool and continue to rotate the tool counterclockwise until the timing pin drops into the machined hole in the back of the camshaft gear. **When the barring tool is rotated counterclockwise, the vibration damper should be rotating clockwise as viewed from front.** When the pin aligns to the gear (Fig. 43), and the intake and exhaust valves are closed at the #1 cylinder, the engine is at the TDC position (compression stroke) at cylinder number 1. Place a paint mark on the dampener to indicate TDC. **Remove the pin.** This will prevent damage when barring (rotating) the engine in later steps.

NOTE: The pin is located above the power steering pump, below and to the inside of the fuel injection pump, on the rear of the cam gear housing (Fig. 44).

(5) Remove #1 fuel injection line from the fuel pump (Fig. 45).

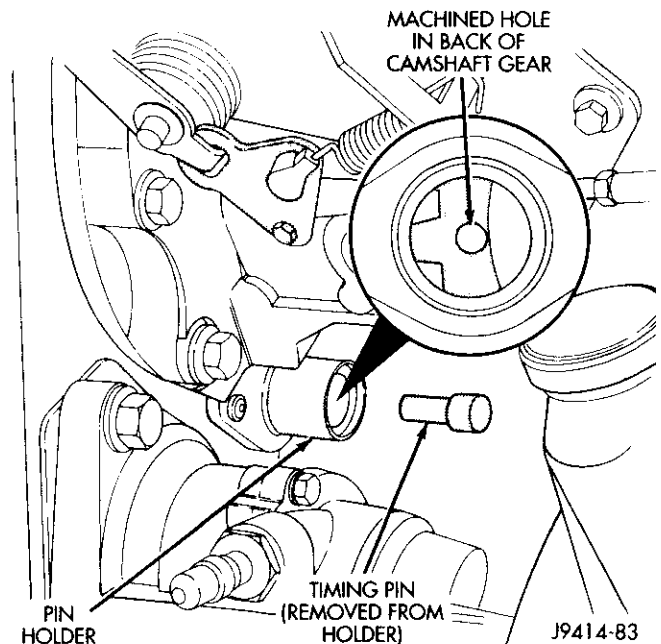


Fig. 43 Back of Camshaft Gear

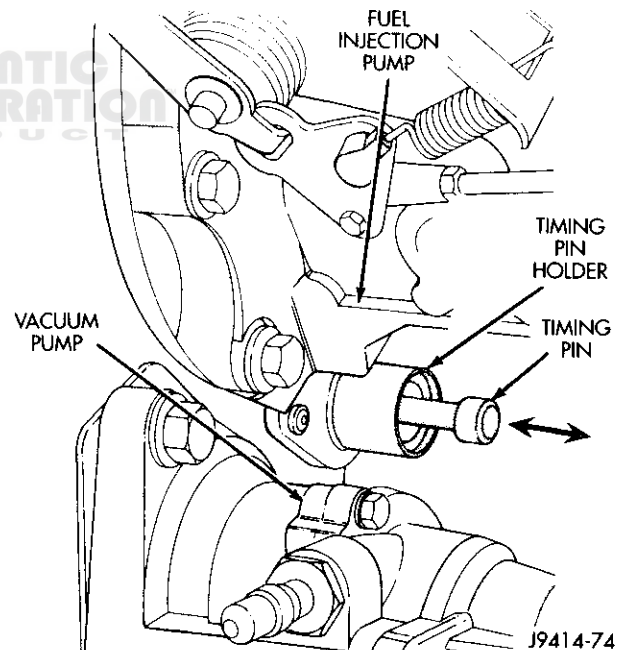
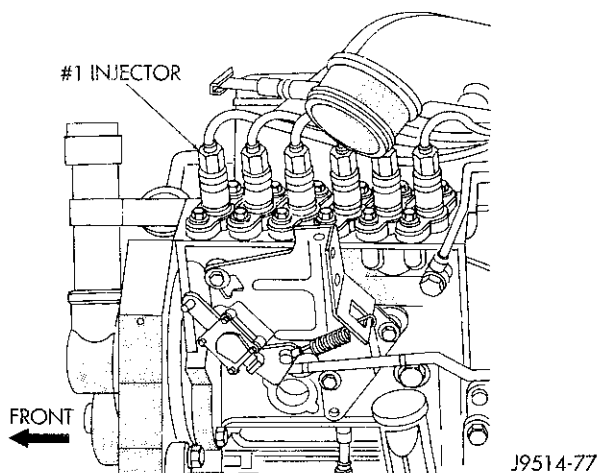


Fig. 44 Timing Pin and Location

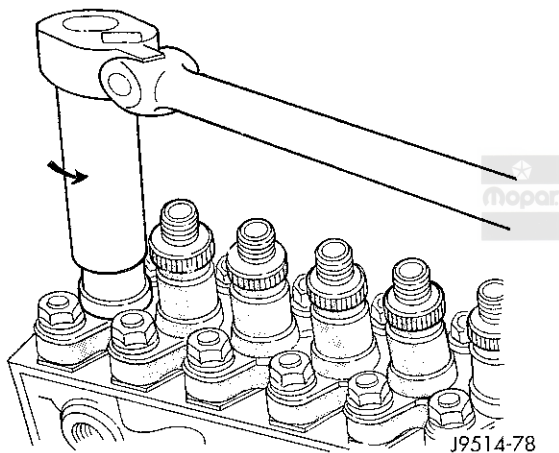
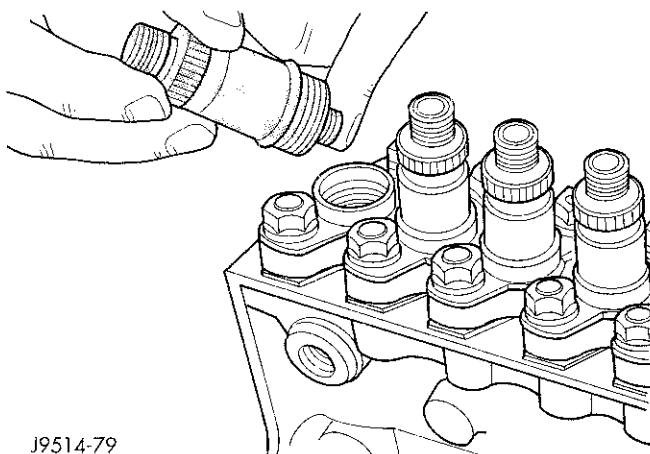
CAUTION: DO NOT BEND THE FUEL LINE. BENDING THE LINE WILL CAUSE LINE OR INJECTOR FAILURE.

(6) With the engine at TDC, loosen but do not remove, the front (#1) delivery valve holder using special socket #6840 (Fig. 46). Remove the socket from the valve holder prior to removing the holder from the injection pump.

SERVICE PROCEDURES (Continued)

**Fig. 45 Number 1 Injection Line**

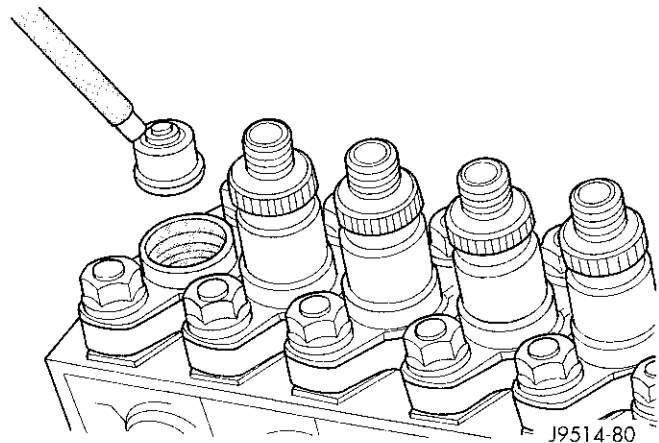
There is an external o-ring on the holder to help prevent debris from getting into the pump. This may create a slight resistance as the holder is unscrewed.

**Fig. 46 Delivery Valve Holder Removal****Fig. 47 Delivery Valve Holder**

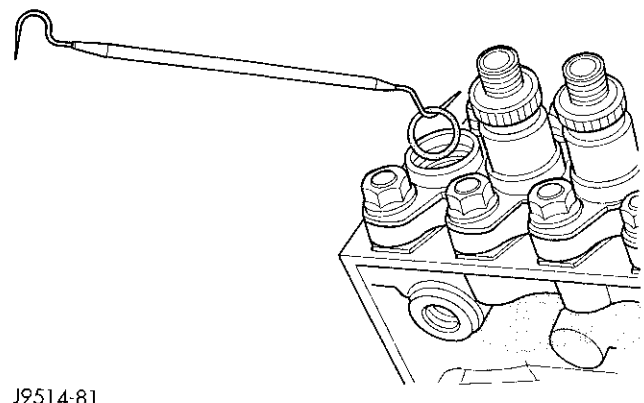
(7) Remove the delivery valve holder by carefully tipping the holder outboard with one hand while using the other hand to hold the spring, fill piece,

and any shims from slipping out of the holder. Place these parts (Fig. 47) as an assembly on a clean surface.

(8) Using a magnet, remove the two piece delivery valve assembly from the pump (Fig. 48). Place these parts on a clean surface.

**Fig. 48 Delivery Valve Assembly**

(9) Using a pick, remove the metal delivery valve washer (Fig. 49) from the top of the pumping element. Be careful not to scratch the top of the plunger/barrel assembly during this process. Discard the used delivery valve washer. A new washer will be used during reassembly.

**Fig. 49 Delivery Valve Washer**

(10) Install the dial indicator adaptor tool #6842 (Fig. 50) in place of the #1 delivery valve holder and tighten finger tight.

(11) Loosen the set screw on the dial indicator adaptor (Fig. 50). Install the dial indicator #6859 and dial indicator tip #6843 into the adapter. Position the dial indicator to read between 7.0 and 9.0 mm and tighten the set screw (Fig. 50). The dial indicator is capable of measuring from 0-20.00 mm lift. The small inner dial is marked in increments of 1 mm. The large outer dial is marked in increments of 0.01 mm. One revolution of the outer dial is equal to 1 mm.

SERVICE PROCEDURES (Continued)

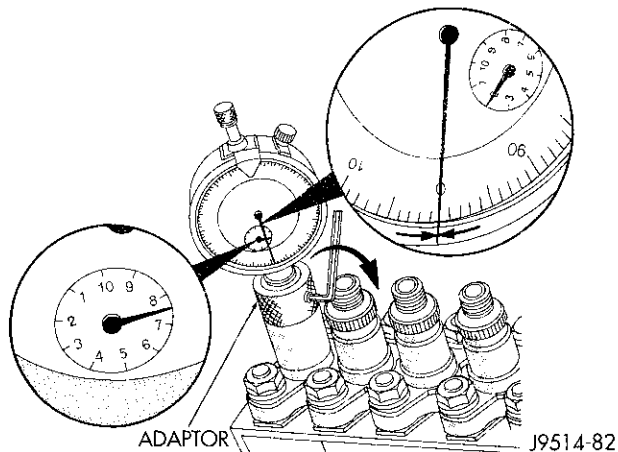


Fig. 50 Installing Special Adapter Tool

The inner dial only indicates 0-10 mm, but will rotate twice as the indicator goes through the full range.

(12) Be sure the timing pin is disengaged before rotating the engine to avoid damage to the timing pin.

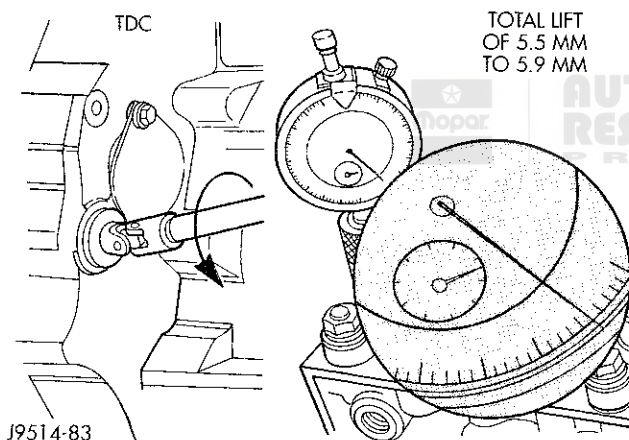


Fig. 51 Setting Dial Indicator

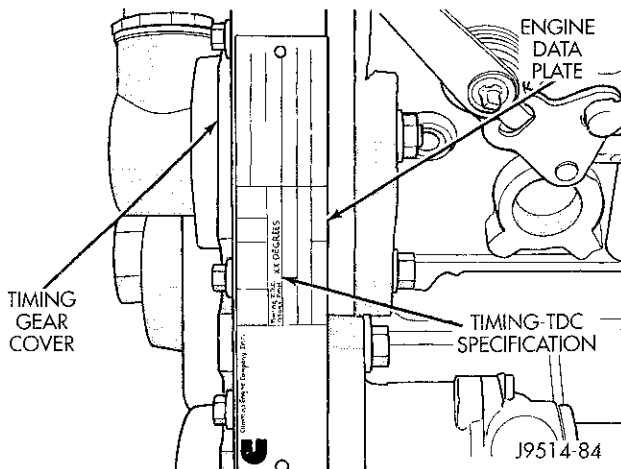


Fig. 52 Engine Data Plate

(13) Using the engine barring tool #7471B, rotate the engine in the direction opposite normal direction of engine rotation (counterclockwise from front of engine) 1/4 turn or until you see the dial indicator reading stop dropping. This is the inner base circle of the injection pump cam. Zero the indicator and note the reading on the small inner dial (Fig. 51).

(a) Rotate the engine clockwise slowly to TDC.

(b) Note the pump lift setting on the dial indicator (Fig. 51).

(c) Note the "Timing-TDC" specification (in degrees) stamped into the engine data plate. The engine data plate is located on the left side of the timing gear cover (Fig. 52).

(d) Compare these specifications to the Fuel Injection Pump Plunger Lift chart (Fig. 53).

(e) If specifications match, a fuel timing adjustment will not be necessary. Proceed to step 27.

(f) If the specifications do not match, a fuel timing adjustment will be necessary. Proceed to next step.

FUEL INJECTION PUMP PLUNGER LIFT-
49 STATE AUTOMATIC TRANSMISSION

Degrees before top dead center (TDC)	Pump plunger lift setting (mm)
12.0	4.1
12.5	4.2
13.0	4.3
13.5	4.4
14.0	4.5

FUEL INJECTION PUMP PLUNGER LIFT-
49 STATE MANUAL TRANSMISSION

Degrees before top dead center (TDC)	Pump plunger lift setting (mm)
11.5	4.7
12.0	4.8
12.5	4.9
13.0	5.0
13.5	5.1

FUEL INJECTION PUMP PLUNGER LIFT-
ALL CALIFORNIA - EGR EQUIPPED

Degrees before top dead center (TDC)	Pump plunger lift setting (mm)
11.5	4.0
12.0	4.1
12.5	4.2
13.0	4.3
13.5	4.4

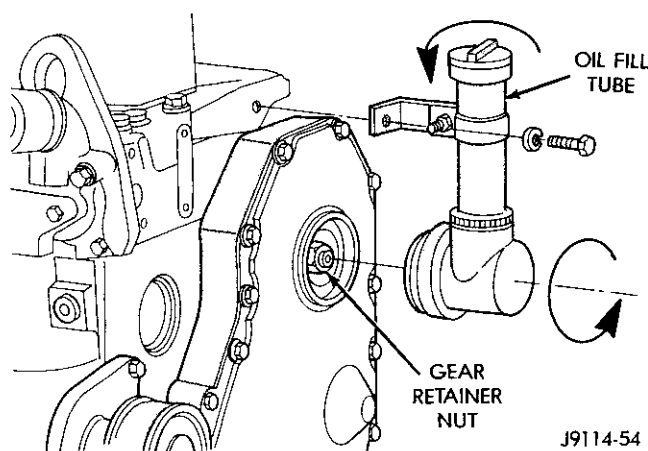
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Fig. 53 Fuel Injection Pump Plunger Lift

Adjusting Timing:

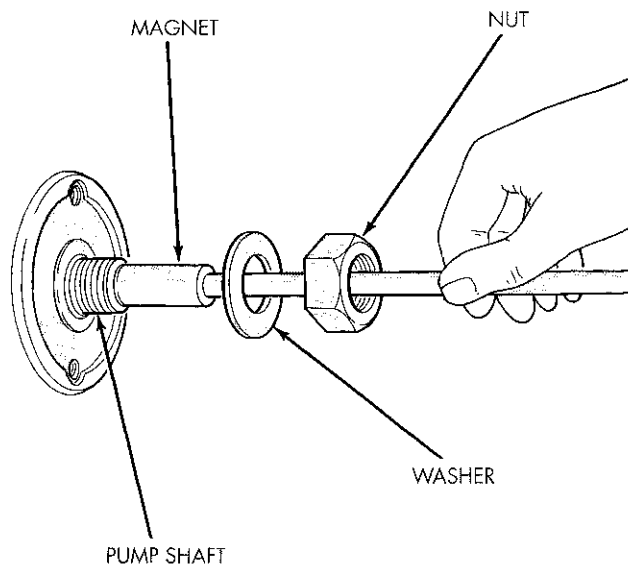
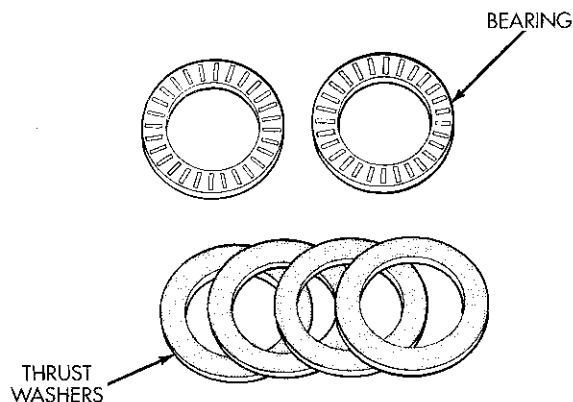
(14) Remove the oil filler tube (Fig. 54) and adapter elbow from the front of the timing gear housing.

(15) Loosen the injection pump shaft nut (use the barring tool to keep the engine from rotating). Before

SERVICE PROCEDURES (Continued)**Fig. 54 Oil Filler Tube**

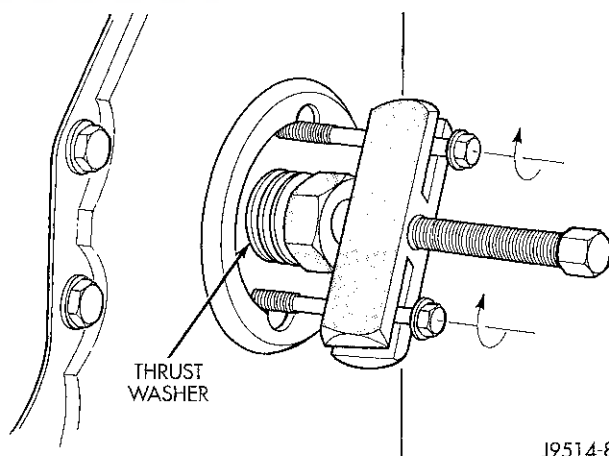
removing pump nut or washer, place a magnet to the end of the injection pump shaft (Fig. 55). This will prevent the nut or washer from falling into the timing gear cover which will require engine disassembly for recovery.

(16) Position a magnet to the end of the injection pump shaft. Install the special bearing and thrust washer kit #6862 (Fig. 56) over the injection pump shaft in this order: 1 thrust washer-1 bearing-1 thrust washer. The thrust washer/bearing kit is used to prevent the pump gear from rotating on the pump shaft when tightening the pump nut (step 22). Reinstall pump shaft nut allowing some clearance between the thrust washers. Do not tighten nut at this time.

**Fig. 55 Positioning Magnet to Pump Shaft****Fig. 56 Bearing/Thrust Washer Tools**

(17) Slowly rotate the engine clockwise until reaching the required lift setting on the dial indicator. Refer to Fuel Injection Pump Plunger Lift chart (Fig. 53). The injection pump should rotate with the engine since the injection pump gear is still locked to the injection pump shaft.

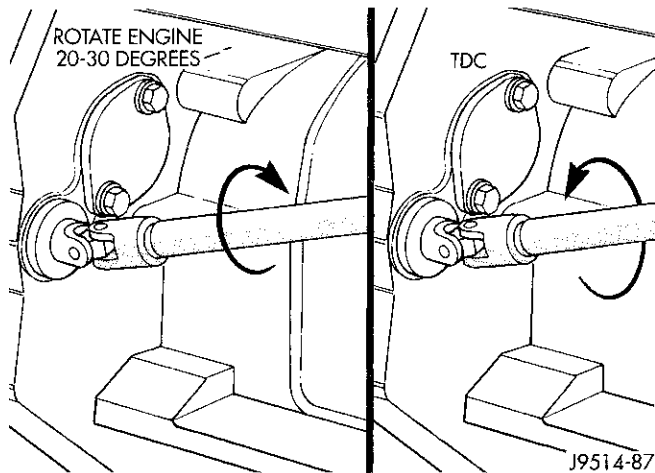
(18) With the injection pump at the correct plunger lift setting, use special gear puller tool #L-4407A to pull the injection pump gear off the taper of the injection pump input shaft. Leave the gear puller installed (Fig. 57). After the gear has been pulled, ensure the lift setting has not changed.

**Fig. 57 Gear Puller Tool Installed**

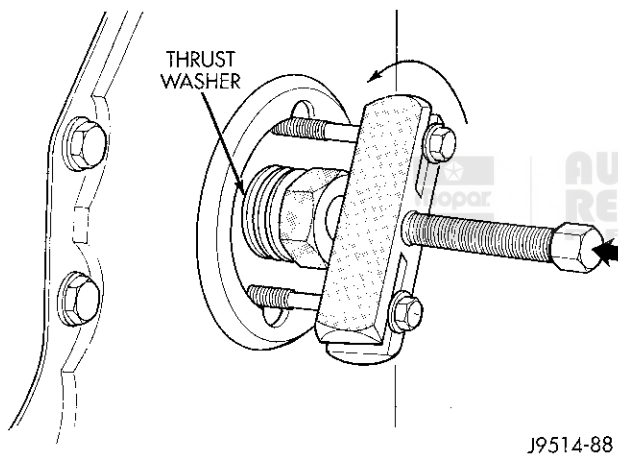
(19) Rotate the engine 20 to 30 degrees counter-clockwise, then rotate the engine back clockwise to TDC (Fig. 58). This removes backlash from the geartrain.

The fuel pump gear and pump shaft tapers must be absolutely clean, dry and free of any oil or dirt. Oil or dirt will prevent seating of the taper and will result in possible slippage of the gear.

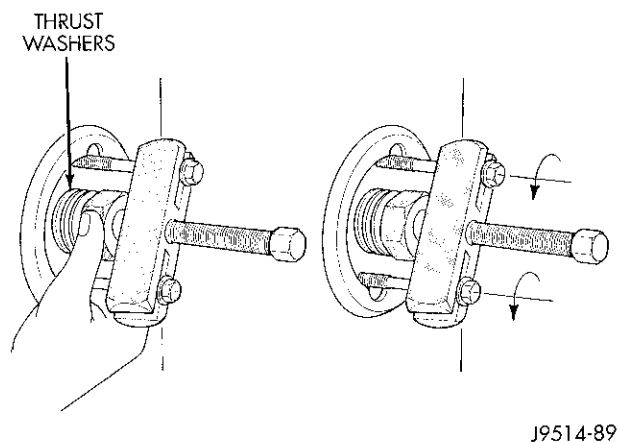
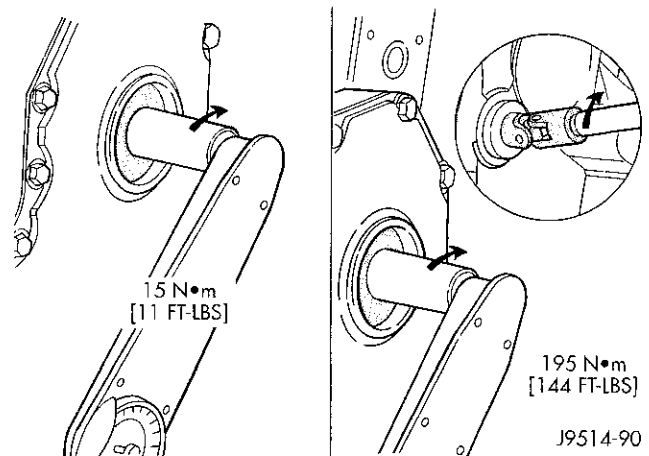
(20) Loosen, but do not remove the gear puller tool bolts. Using the gear puller, rotate pump gear coun-

SERVICE PROCEDURES (Continued)**Fig. 58 Rotating Crankshaft**

terclockwise by hand (Fig. 59), while pushing the gear onto the pump shaft. This will remove backlash between the injection pump and camshaft gears.

**Fig. 59 Rotating Injection Pump Gear**

(21) Hand tighten the pump shaft nut (Fig. 60). Remove the gear puller (Fig. 60).

**Fig. 60 Removing Gear Puller Tool****Fig. 61 Tightening Pump Nut**

(22) Tighten the pump shaft nut to 15 N·m (11 lb. ft.) torque to seat the gear to the pump shaft taper (Fig. 61).

(23) Remove injection pump shaft nut. Use a magnet on the end of the shaft while removing (Fig. 55).

(24) Remove special bearing and thrust washers #6862 from pump shaft. Use a magnet on the end of the shaft while removing.

(25) While preventing the engine from rotating with the barring tool, tighten the shaft nut to 165 N·m (122 lb. ft.) torque (Fig. 61).

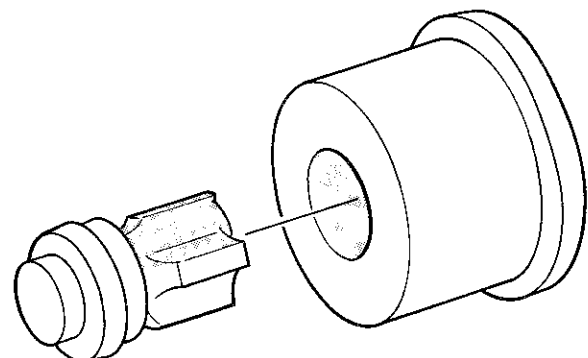
(26) Repeat steps 12 and 13 to verify that the final timing setting is correct. If the setting is not correct, repeat steps 15 through 25.

(27) Remove the dial indicator and adaptor from the injection pump.

CAUTION: THE FOLLOWING INSTALLATION AND TORQUING PROCEDURE MUST BE FOLLOWED EXACTLY. IMPROPER INSTALLATION OF THE DELIVERY VALVE WILL RESULT IN DAMAGE OR LEAKS.

(28) Install a new metal delivery valve washer into the fuel pump.

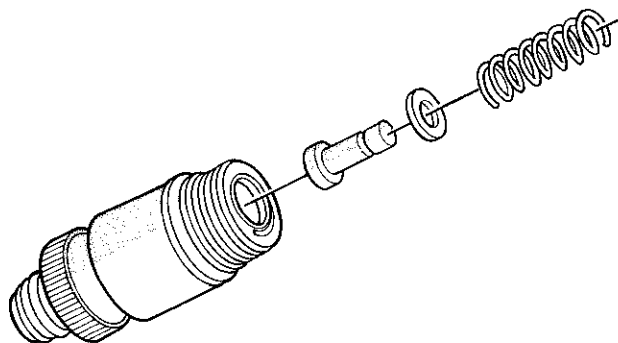
(29) Install the delivery valve assembly on top of the sealing washer (Fig. 62) or (Fig. 48).

**Fig. 62 Delivery Valve Assembly**

SERVICE PROCEDURES (Continued)

(30) Lubricate the threads and clamping surface of the delivery valve holder with a few drops of SAE 90 hypoid gear oil. **Do not lubricate the metal delivery valve washer or its seating area.**

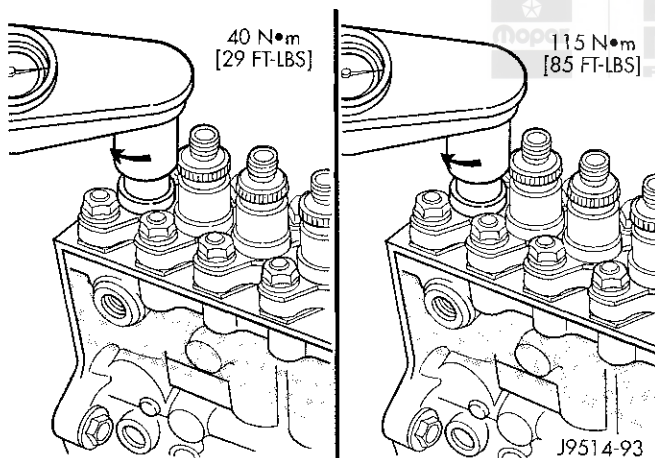
(31) Install the delivery valve holder assembly taking care not to displace the delivery valve spring, fill piece, or any shims (Fig. 63).



J9514-92

Fig. 63 Delivery Valve Holder

(32) Pre-tighten the delivery valve holder to 40 N·m (29 lb. ft.) torque (Fig. 64). Next, in one motion, tighten the holder to 115 N·m (85 ft. lbs.) torque (Fig. 64).



J9514-93

Fig. 64 Tightening Delivery Valve Holder

(33) Install remaining engine components removed during the timing process. Leave the injector end of the #1 high-pressure fuel line loose to facilitate bleeding the air out of the system.

WARNING: THE PRESSURE OF THE FUEL IN THE LINE IS SUFFICIENT TO PENETRATE THE SKIN AND CAUSE SERIOUS BODILY HARM.

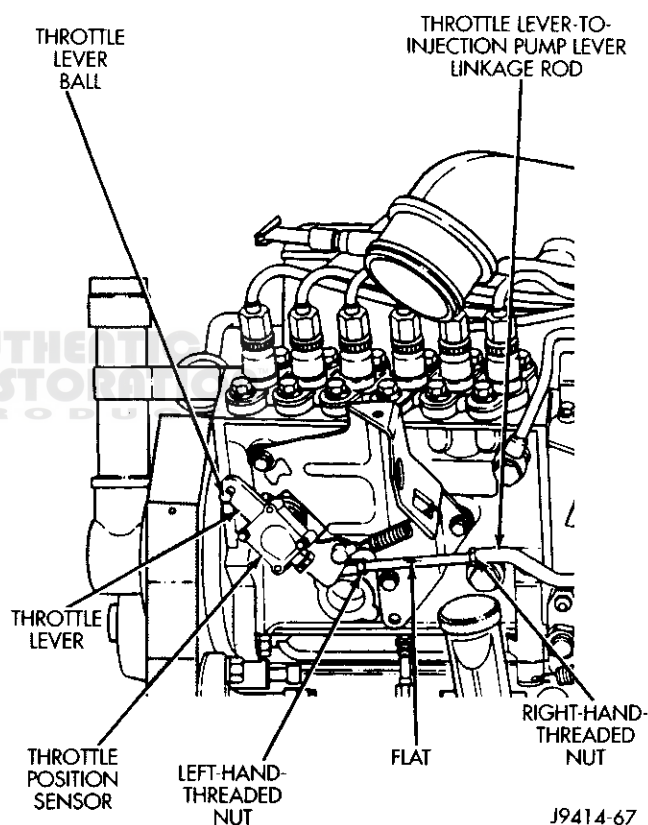
(34) Crank the engine until fuel is observed at the #1 injector. Tighten the high-pressure line at the injector. Start the engine and check for leaks.

THROTTLE LINKAGE ADJUSTMENT—DIESEL ENGINE

The linkage rod (Fig. 65) connecting the throttle lever to the fuel injection pump lever is adjustable.

CAUTION: Before adjusting the fuel injection pump throttle linkage, verify that engine is set at correct low idle speed. Refer to Idle Speed Adjustment. This can be found in the Diesel Engine—General Diagnosis section of this group.

- (1) Verify low idle speed.
- (2) Disconnect throttle cable socket from lever ball stud on throttle lever (Fig. 66).



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Fig. 65 Diesel Throttle Lever Linkage Adjustment—Typical

(3) Measure the distance between the center of the lever ball and the rear face of the cable mounting bracket (Fig. 67). Dimension should be 126.5 mm (5.0 inches.) If not, proceed to following step.

(4) To prevent damage to ends of linkage, attach locking-type pliers to the flat (Fig. 65) located on the linkage rod before loosening locknuts.

(5) Loosen the right-hand-threaded nut (Fig. 65).

(6) Loosen the left-hand-threaded nut (Fig. 65).

SERVICE PROCEDURES (Continued)

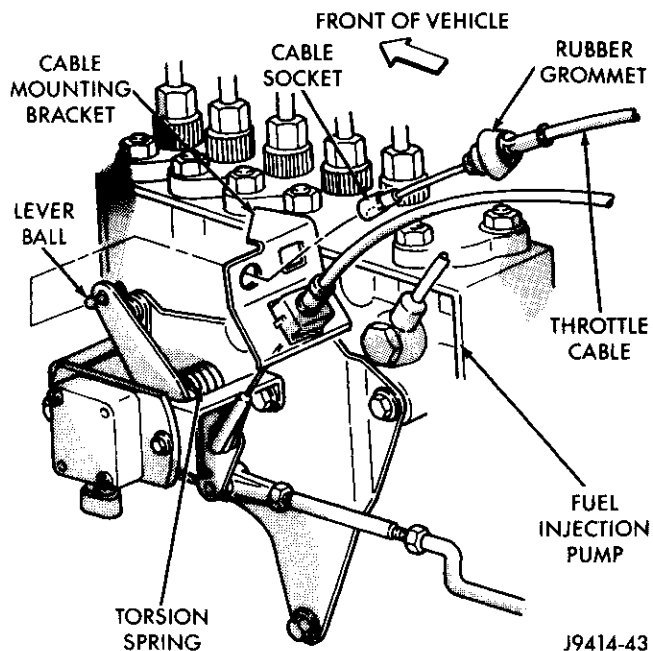


Fig. 66 Diesel Throttle Cable at Injection Pump—Typical

(7) Rotate the flat on the linkage rod (lengthen or shorten) to achieve proper linkage adjustment (Fig. 67). Tighten both nuts after adjustment.

(8) With the engine OFF, operate the throttle from accelerator pedal and check for throttle lever action and binding. Be sure throttle lever stop is against the low idle speed screw after throttle is released.

(9) Be sure of wide open throttle (WOT) when accelerator pedal is pressed to the floor. This is checked by observing throttle lever breakover position. Proceed to the following:

(a) Key OFF and engine OFF for this test.

(b) Two people are needed for this test. From inside of the vehicle, press the accelerator pedal about half-way to the floor. Movement of both the throttle lever and throttle lever-to-injection pump lever linkage rod (Fig. 65) should be observed.

(c) Continue to press the accelerator pedal to the floor. If throttle lever breakover is operating correctly, the throttle lever-to-injection pump lever linkage rod should have stopped moving while the throttle lever continues to move towards the rear of vehicle.

(10) Again, check and verify low idle speed. Adjust if necessary.

(11) **Diesel engines equipped with an automatic transmission:** A throttle position sensor (TPS) is used with this driveline combination. TPS voltage must now be tested. Refer to Throttle Position Sensor Removal/Installation.

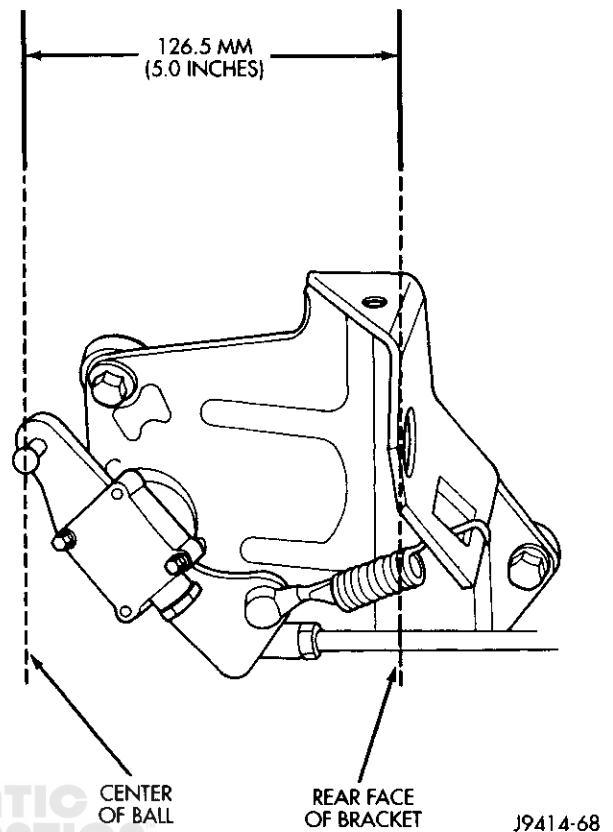


Fig. 67 Diesel Linkage Measurement—Typical

REMOVAL AND INSTALLATION

ACCELERATOR PEDAL

Refer to the Fuel Delivery System—Gasoline Engine section for procedures.

FUEL DRAIN MANIFOLD

REMOVAL

(1) Remove the two nuts retaining the nameplate/cover to the top of the six engine valve covers (Fig. 68). Remove nameplate/cover from engine.

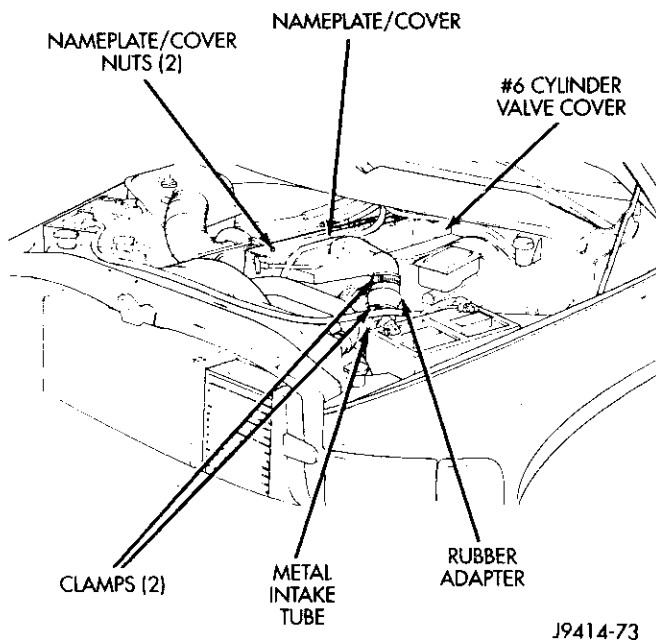
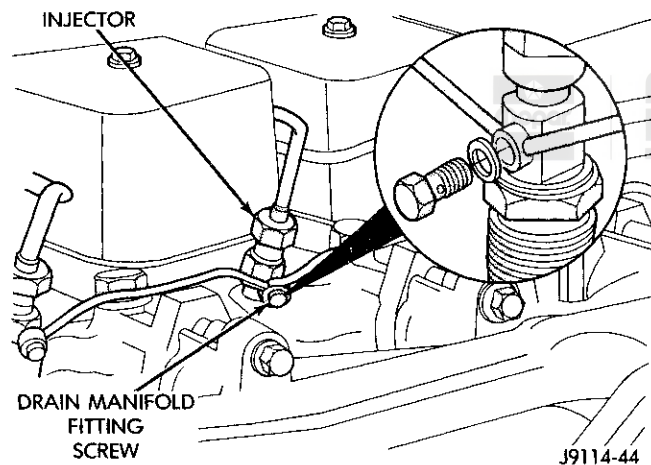
(2) Remove drain manifold fitting screws (bolts) at each of the six injectors (Fig. 69).

(3) Remove the fuel drain manifold holddown clamp mounting bolt at the top/rear of intake manifold.

(4) Remove the fuel drain manifold banjo fitting at the top of fuel filter/water separator (one bolt) (Fig. 70).

(5) Remove fuel drain manifold fitting washers at each fuel injector.

(6) Remove manifold from engine.

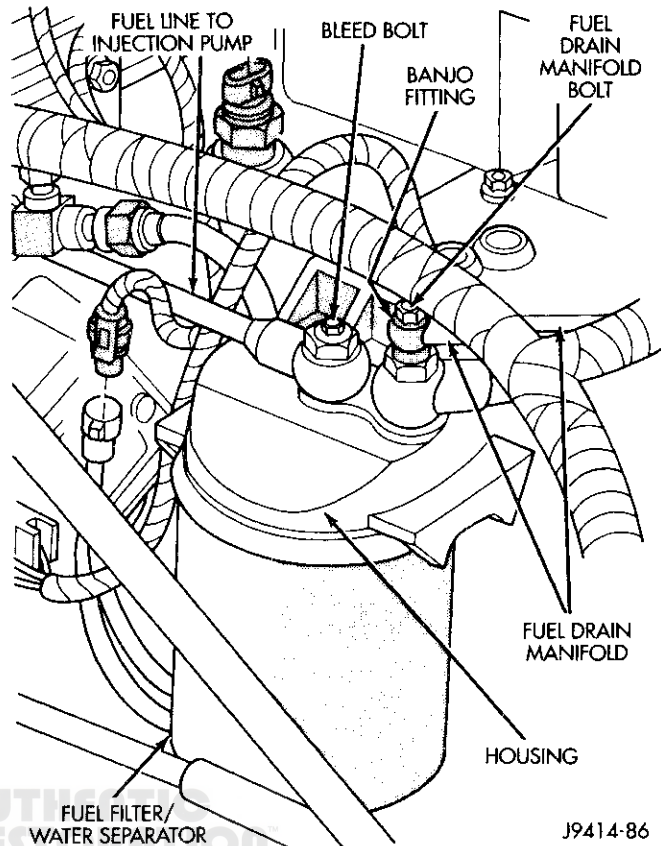
REMOVAL AND INSTALLATION (Continued)**Fig. 68 Nameplate/Cover—Diesel****Fig. 69 Fuel Drain Manifold Fittings—Typical****INSTALLATION**

- (1) Using new seals/washers on all fittings, assemble fuel drain manifold in reverse order of disassembly.
- (2) Tighten drain manifold fitting screws (bolts) at the injectors to 8 N·m (6 ft. lbs.) torque.
- (3) Tighten drain manifold hold-down clamp screws (bolts) to 13 N·m (10 ft. lbs.) torque.
- (4) Install nameplate/cover.

FUEL FILTER/WATER SEPARATOR

Refer to the maintenance schedules in Group 0 in this manual for the recommended fuel filter/water separator replacement intervals.

The combination water-in-fuel sensor and fuel filter/water separator is screwed onto a metal housing

**Fig. 70 Drain Manifold and Fuel Filter/Water Separator**

located on the left/rear side of the engine and below the intake manifold (Fig. 70).

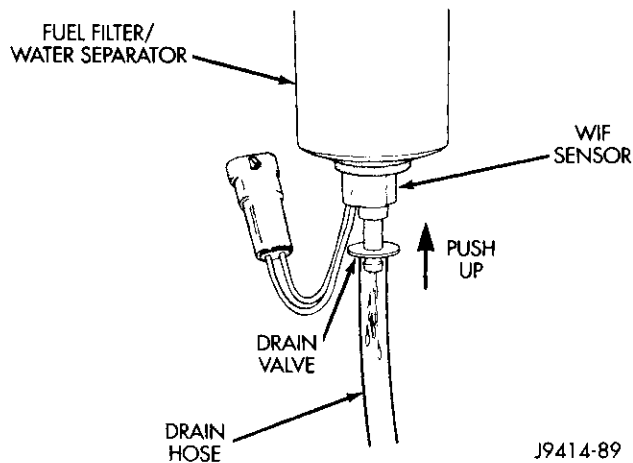
REMOVAL

- (1) Partially drain the filter/separator. Refer to the following: Draining Water from Filter.

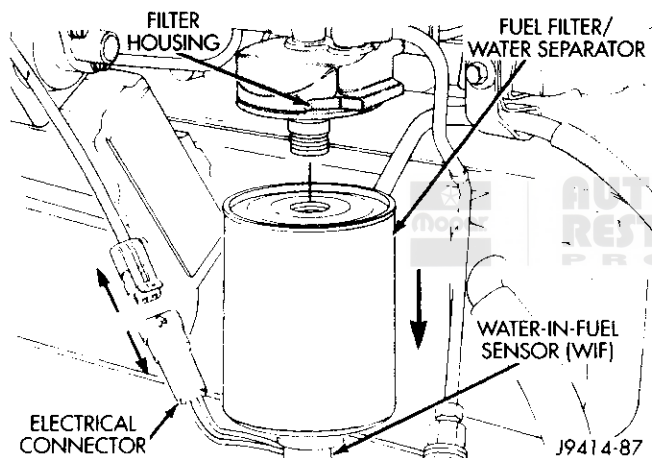
DRAINING WATER FROM FILTER: The filter should be drained whenever the water-in-fuel warning lamp remains illuminated. (Note that the lamp will be illuminated for approximately two seconds when the ignition key is initially placed in the ON position for a bulb check). The drain valve can also be used to drain excess fuel from the filter when replacement of the filter is necessary.

There is a drain valve and drain hose located at the bottom of the water-in-fuel (WIF) sensor (Fig. 71). Place a drain pan under the drain hose. **With the engine not running**, push up on the drain valve (Fig. 71) to remove the water from the filter/separator. Hold the drain valve open until all water and contaminants have been removed and clean fuel exits the drain. Dispose of mixture in drain pan according to applicable regulations.

- (2) Remove the drain hose at the drain valve (Fig. 71).

REMOVAL AND INSTALLATION (Continued)**Fig. 71 Drain Valve at Fuel Filter/Water Separator**

(3) Disconnect the electrical connector from the WIF sensor at the bottom of the filter (Fig. 72).

**Fig. 72 Electrical Connector—WIF Sensor**

(4) Remove (unscrew) the filter/separator and WIF sensor as one assembly from the filter housing (Fig. 72).

(5) Remove the o-ring seal from the filter housing (Fig. 73).

(6) Drain the filter/separator.

(7) Remove the WIF sensor, o-ring and drain valve assembly from the filter/separator (Fig. 74).

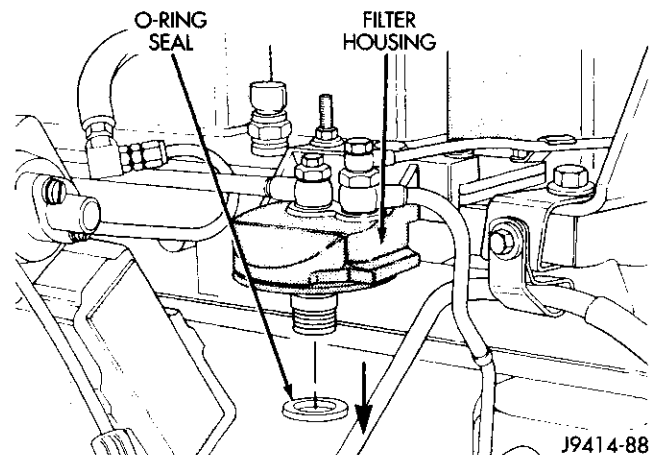
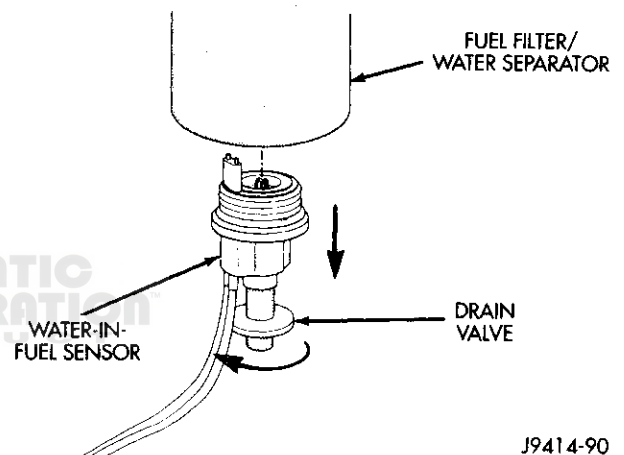
(8) Inspect the WIF sensor probes. Clean contaminants from sensor probes if necessary. Replace sensor if probes will not clean up.

INSTALLATION

(1) Install a new o-ring seal on WIF sensor.

(2) Install WIF sensor/drain valve assembly into new filter/separator.

If the new fuel filter/water separator is not filled with clean fuel before it is installed, manual air bleeding of the fuel system may be nec-

**Fig. 73 Fuel Filter/Water Separator O-ring****Fig. 74 WIF Sensor and Drain Valve Assembly**

essary (temporary rough engine running may occur). If necessary, refer to the Air Bleed Procedure in this section of the group for procedures.

(3) Fill filter/separator with clean fuel.

(4) Apply a light film of clean unused engine oil to the filter/separator seal.

(5) Install a new o-ring seal to the filter/separator housing (Fig. 73).

(6) Install filter/separator to housing. Tighten filter/separator one-half turn after it makes contact with the housing. **Tighten by hand only.**

(7) Connect electrical connector to WIF sensor.

(8) Connect drain hose to drain valve.

FUEL TANK

Refer to Fuel Tank—All Engines in the Fuel Delivery System—Gasoline engines section for procedures.

REMOVAL AND INSTALLATION (Continued)**FUEL TANK MODULE****REMOVAL**

CAUTION: Whenever the fuel tank module is serviced, the plastic locknut and rubber gasket must be replaced.

(1) Drain the fuel tank. Refer to Draining Fuel Tank in Fuel Tanks—All Engines for procedures.

(2) Remove fuel tank. Refer to Fuel Tanks—All Engines for procedures.

(3) Note the direction of the: fuel line connectors, the pressure relief/rollover valve and the fuel gauge electrical connector. These should all be pointed to the drivers side of the vehicle.

(4) The plastic locknut on the fuel tank module is threaded onto the fuel tank. Remove the locknut (Fig. 75). The tank module will spring up when the locknut is removed.

(5) Remove module from fuel tank.

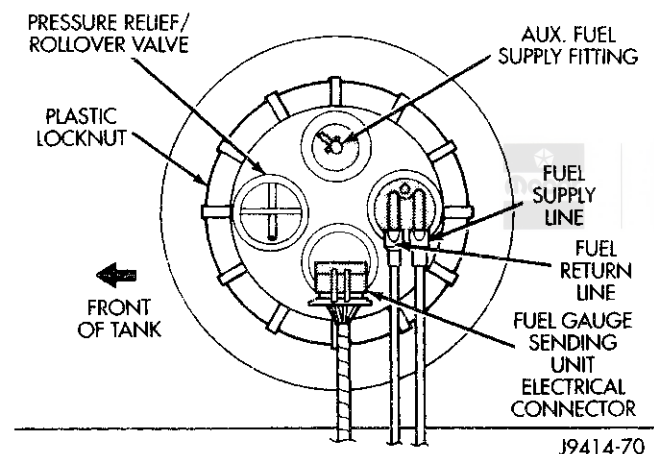


Fig. 75 Top View of Fuel Tank Module—Diesel

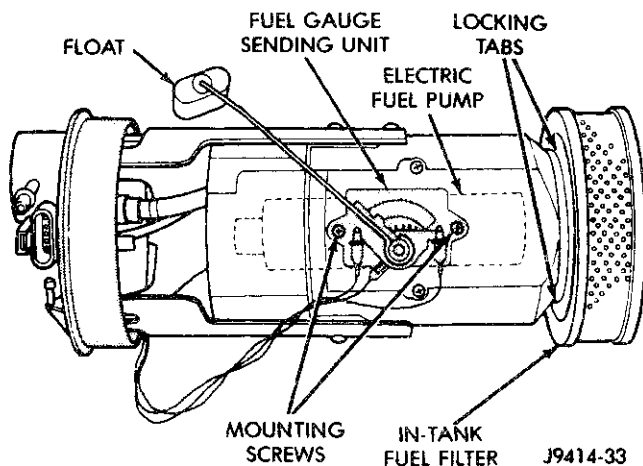


Fig. 76 Fuel Gauge Sending Unit—Typical

INSTALLATION

CAUTION: Whenever the fuel tank module is serviced, the locknut and rubber gasket must be replaced.

(1) Using a new gasket, position the fuel tank module into the opening in fuel tank. The fuel line connectors, the pressure relief/rollover valve and the fuel gauge electrical connector should all be pointed to the drivers side of the vehicle before tightening locknut.

(2) Position new locknut over top of fuel tank module.

(3) Tighten locknut.

(4) Install fuel tank. Refer to Fuel Tanks—All Engines for procedures.

AUXILIARY FUEL SUPPLY FITTING

An auxiliary (capped) fuel supply fitting is located on the top of the fuel tank module (Fig. 75). This fitting will be available only on: diesel powered models, and models with either a 5.9L V-8 heavy duty or 8.0L V-10 engine, and all cab-chassis models. This fitting supplies a non-pressurized auxiliary fuel source.

FUEL HEATER

The fuel heater element assembly is located inside of the fuel heater housing and above the pre-filter (Fig. 77). The fuel temperature sensor is located at the top of the fuel heater housing (Fig. 77).

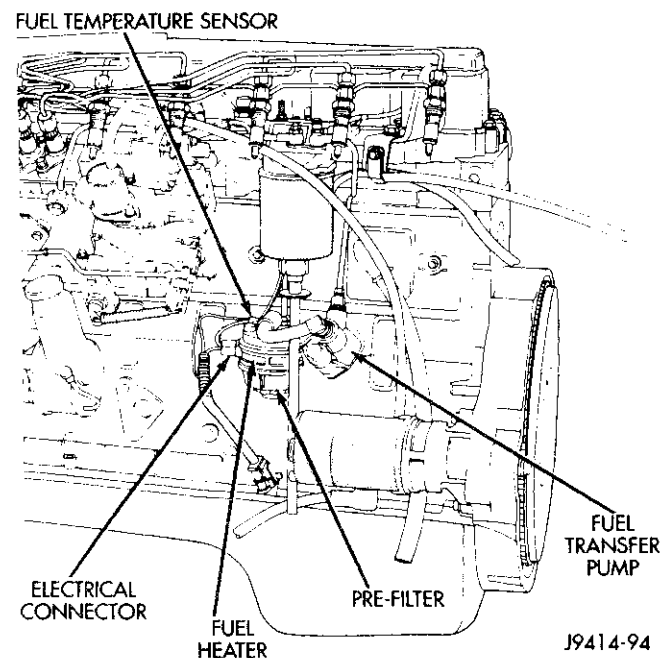


Fig. 77 Fuel Heater and Temperature Sensor Location

REMOVAL AND INSTALLATION (Continued)

REMOVAL

- (1) Disconnect both negative battery cables at both batteries.
- (2) Remove starter motor. Refer to Group 8B for procedures.
- (3) Disconnect the electrical connector at the front of fuel heater housing (Fig. 77).
- (4) Place a drain pan below the fuel heater.
- (5) A machined hex is located on the bottom of the pre-filter housing (Fig. 78). From under the vehicle, attach a socket to this hex and remove (unscrew) the pre-filter.
- (6) Remove the fuel heater assembly from housing.

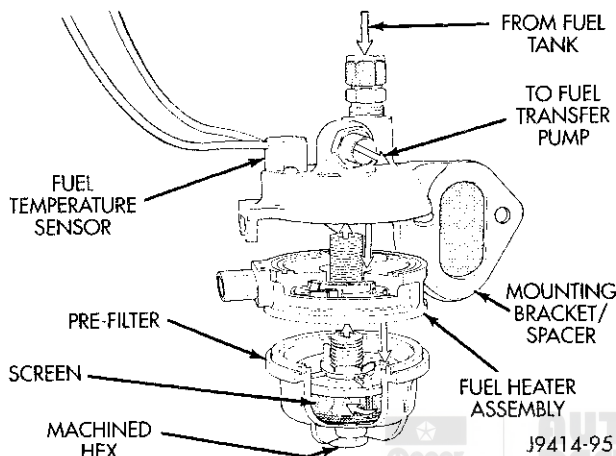


Fig. 78 Fuel Heater and Pre-Filter

INSTALLATION

Reverse the removal procedure for heater element installation.

FUEL HEATER RELAY

The fuel heater relay is located in the engine compartment near the brake master cylinder (Fig. 79).

REMOVAL

- (1) Disconnect both negative battery cables at both batteries.
- (2) Disconnect the electrical connector at the relay.
- (3) Remove the relay from the mounting bracket.

INSTALLATION

- (1) Install the relay to the mounting bracket.
- (2) Connect the electrical connector.
- (3) Connect battery cables to both batteries.

FUEL INJECTION PUMP

REMOVAL

- (1) Disconnect both negative battery cables at both batteries.
- (2) Disconnect electrical connector at throttle position sensor on side of injection pump (if equipped with automatic transmission) (Fig. 80).

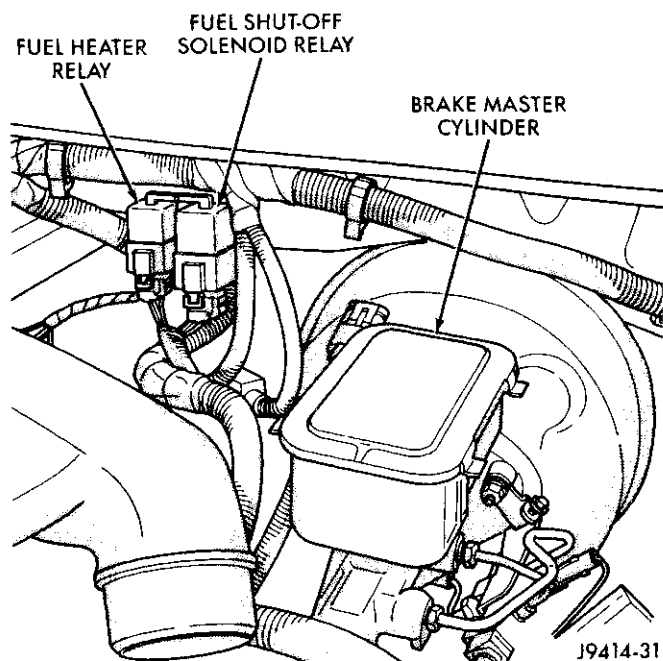


Fig. 79 Fuel Heater Relay—Diesel

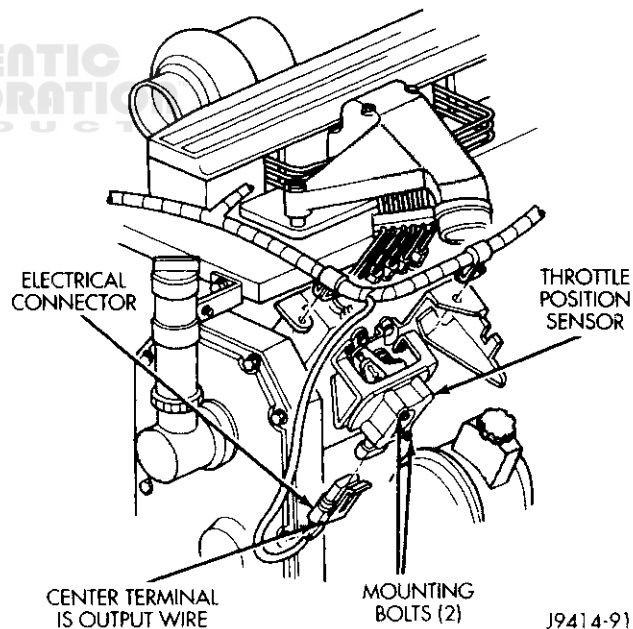
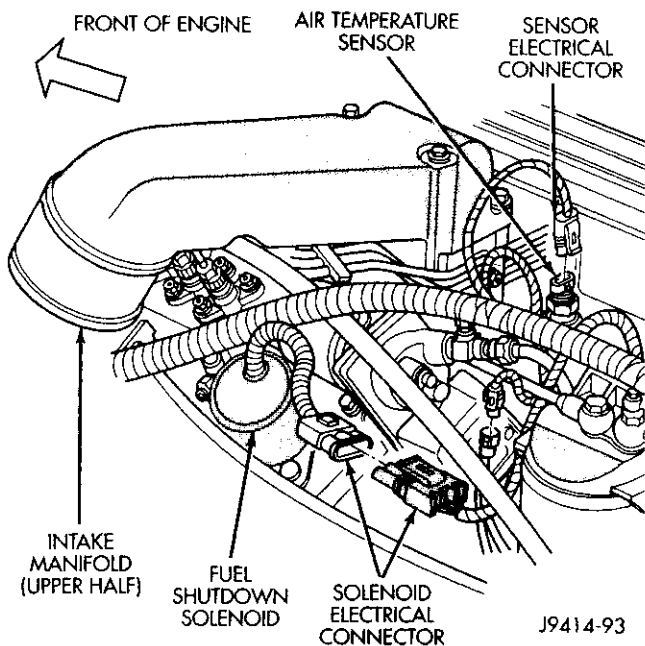
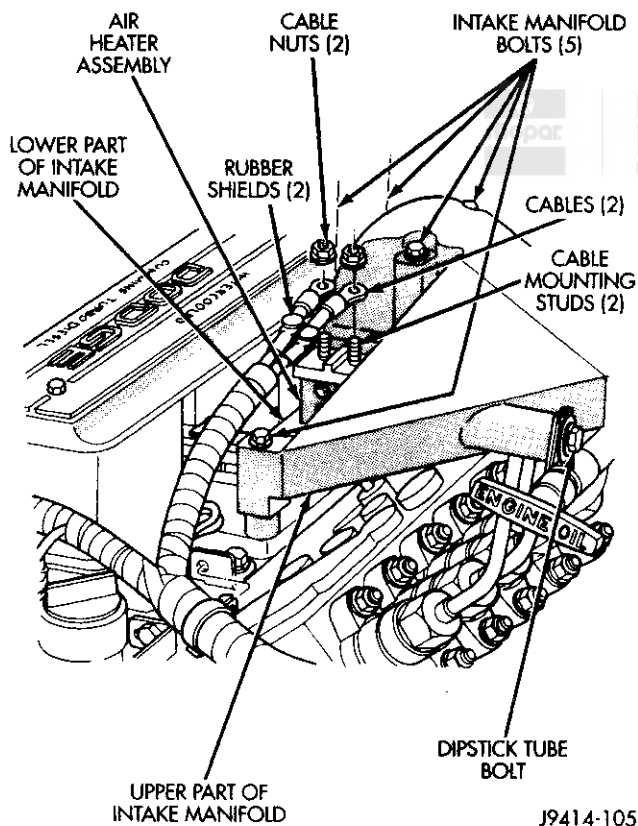


Fig. 80 Throttle Position Sensor—Diesel

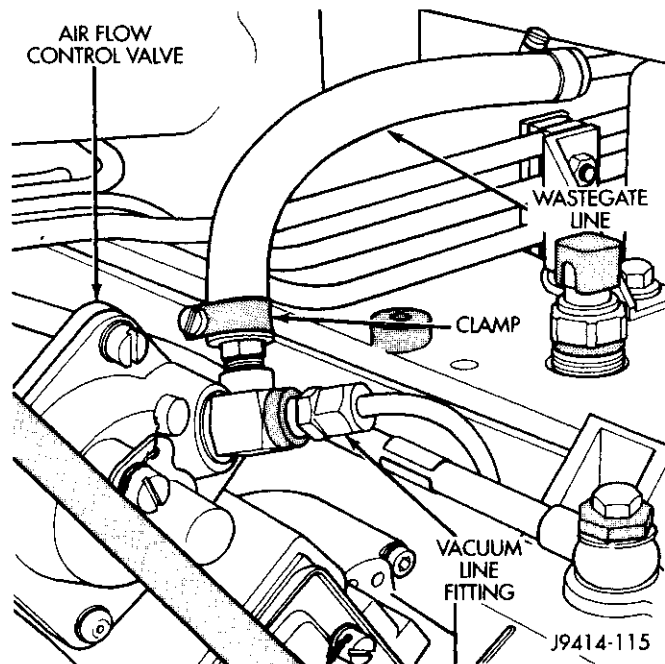
- (3) Disconnect the electrical connector at fuel shut-down solenoid. (Fig. 81).
- (4) Disconnect the main engine wiring harness at top of injection pump and position to the side.
- (5) Remove the metal intake manifold-to-inter-cooler connecting tube.
- (6) Remove the engine oil dipstick tube mounting clamp and bolt (Fig. 82). Position dipstick tube to the side.
- (7) Disconnect the two air heater cable nuts (Fig. 82).

REMOVAL AND INSTALLATION (Continued)**Fig. 81 Fuel Shutdown Solenoid Location****Fig. 82 Intake Manifold Air Heater**

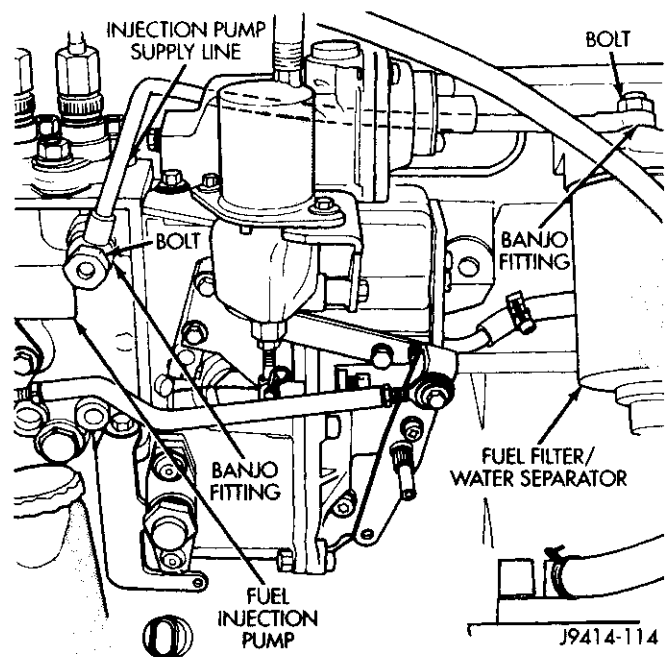
(8) Remove the five intake manifold bolts (Fig. 82). Discard both of the old air heater base gaskets.

(9) Remove the throttle control bracket, cables and linkage assembly from the side of pump (three bolts). Position the assembly to the side.

(10) Disconnect turbocharger wastegate line and vacuum line from air fuel control (AFC) valve at rear of injection pump (Fig. 83).

**Fig. 83 Wastegate and Vacuum Lines**

(11) Remove the fuel supply line at both ends (injection pump and fuel filter/water separator) (Fig. 84). For procedures, refer to Fuel Injection Pump Supply Line in this group. Place a rag beneath the fitting to catch excess fuel.

**Fig. 84 Fuel Injection Pump Supply Line**

REMOVAL AND INSTALLATION (Continued)

(12) Remove the overflow valve and fuel return line at pump (Fig. 85). Place a rag beneath the fitting to catch excess fuel.

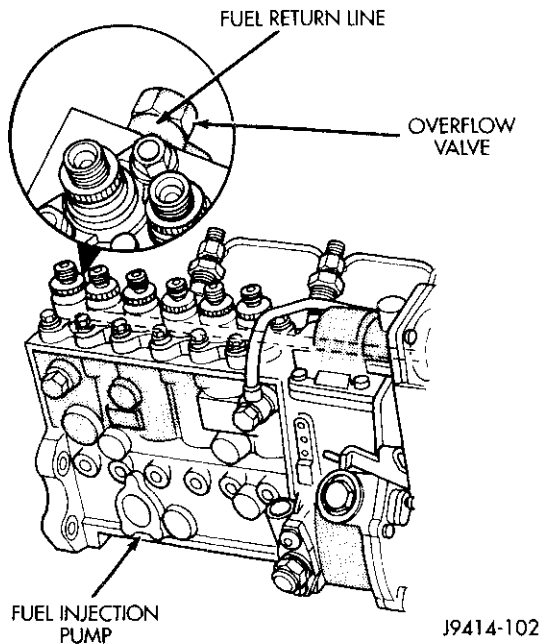


Fig. 85 Injection Pump Overflow Valve

(13) Disconnect the six (6) high-pressure fuel lines from the fuel delivery valve holders at the top of injection pump (Fig. 86). For procedures, refer to High-Pressure Fuel Lines in this group. Place a rag beneath the fittings to catch excess fuel.

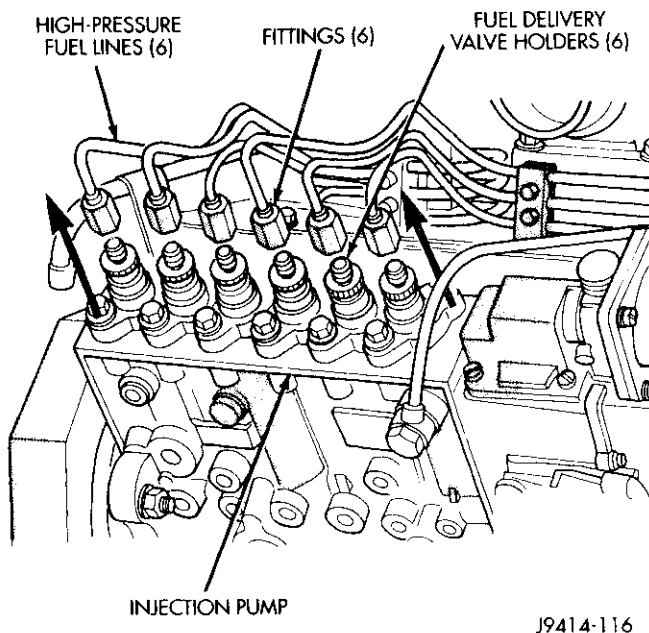


Fig. 86 Fuel Delivery Valve Holders and Pressure Lines

(14) Disconnect the engine oil supply line at side of pump (Fig. 87).

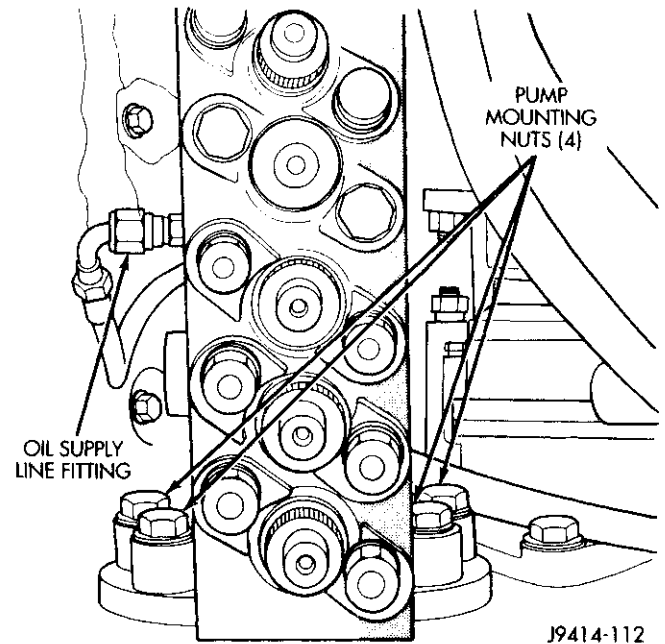


Fig. 87 Engine Oil Supply Line—Pump Mounting Nuts

(15) Remove the oil fill tube bracket mounting bolt (Fig. 88).

(16) Remove oil fill tube from tube-to-gear housing adapter (Fig. 88). Tube is removed by screwing counterclockwise from adapter.

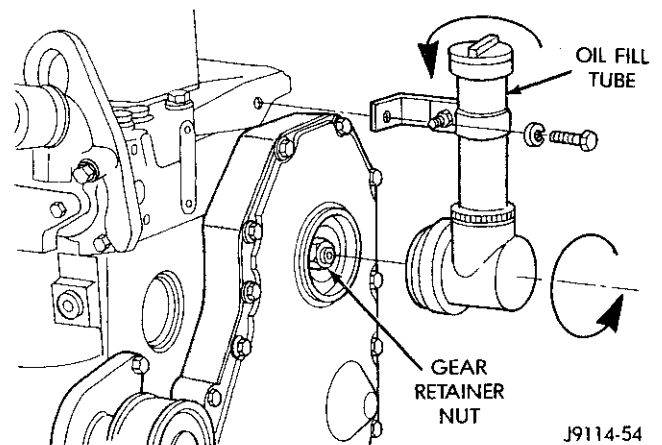


Fig. 88 Oil Fill Tube, Adapter and Mounting Bracket

(17) Remove oil fill tube adapter from gear housing (Fig. 88). Adapter is removed by screwing counterclockwise from gear housing.

(18) **The engine is equipped with a built-in moveable timing pin.** This pin is located above the power steering pump, below and to the inside of the fuel injection pump, on the rear of the cam gear housing (Fig. 89). The pin will engage into a

REMOVAL AND INSTALLATION (Continued)

machined hole in the back of the camshaft gear (Fig. 90). It is designed to position the engine to TDC (Top Dead Center) on the compression stroke of number 1 cylinder.

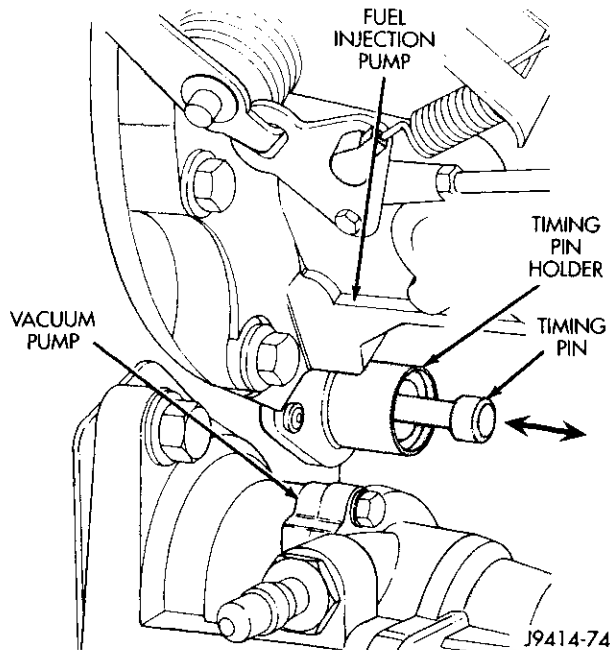


Fig. 89 Timing Pin and Location

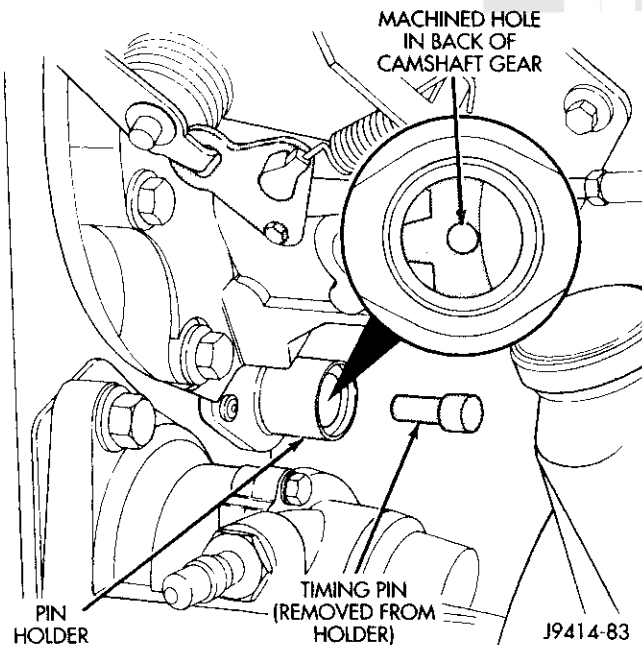


Fig. 90 Back of Camshaft Gear—Typical

(19) Remove the rubber air tube connecting the turbocharger to the air cleaner housing.

(20) The engine can be rotated with a barring tool such as Snap-On No. SP371, MTE No. 3377371 (Cummins Tool Division), or an equivalent.

(21) The opening for the barring tool is located in the rear flange of engine on exhaust manifold side (Fig. 91). Remove the rubber access plug covering this opening.

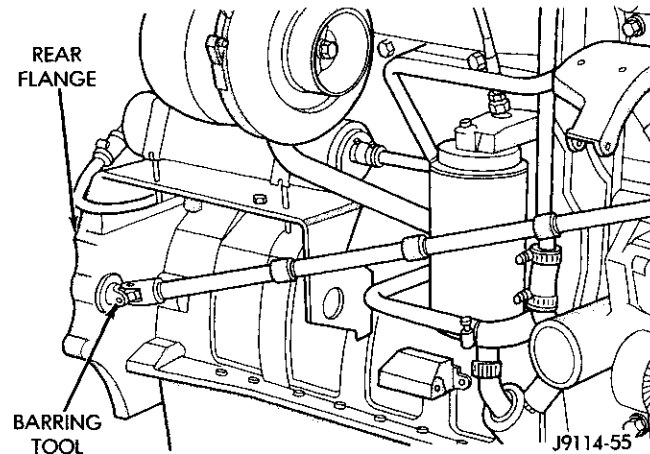


Fig. 91 Rotating Engine with Barring Tool—Typical

(22) Insert the barring tool into the flywheel housing opening (Fig. 91).

(23) While holding tension on the timing pin (towards front of engine), very slowly rotate the engine (counterclockwise as viewed from front) with the barring tool. Rotating the barring tool counterclockwise will rotate the crankshaft clockwise. Continue to rotate until the timing pin drops into the machined hole in the back of the camshaft gear. When the pin aligns to the gear, the engine is now at the TDC position (compression stroke) at cylinder number 1.

CAUTION: When installing the fuel injection pump and to achieve proper injection pump timing, the engine **MUST** be in the TDC position (compression stroke) at cylinder number 1.

Before proceeding to the next step, and to prevent shearing of the timing pin, temporarily remove the timing pin from the back of the gear.

(24) Remove the nut and washer retaining the injection pump gear to the injection pump shaft (Fig. 92).

(25) Place a shop towel below the retainer nut in the gear housing cover opening to prevent the nut or washer from falling into the gear housing.

CAUTION: If the gear retainer nut or washer drops into gear housing, cover must be removed to retrieve them before engine is started.

(26) Use a T-bar type puller (Fig. 93) to separate the injection pump gear from the injection pump shaft. Attach two M8 X 1.24 MM (metric) screws

REMOVAL AND INSTALLATION (Continued)

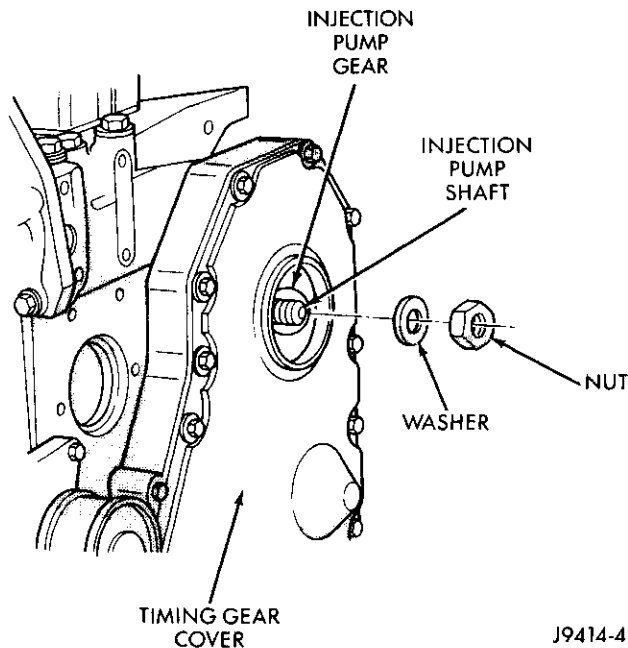


Fig. 92 Injection Pump Gear Washer and Nut

through the puller and into the two threaded holes supplied in the pump gear. Pull the injection pump gear forward until it loosens from the injection pump shaft. **Pull on the gear only enough to loosen it from the injection pump shaft. Pulling the gear too far may cause damage or breakage to the gear cover.**

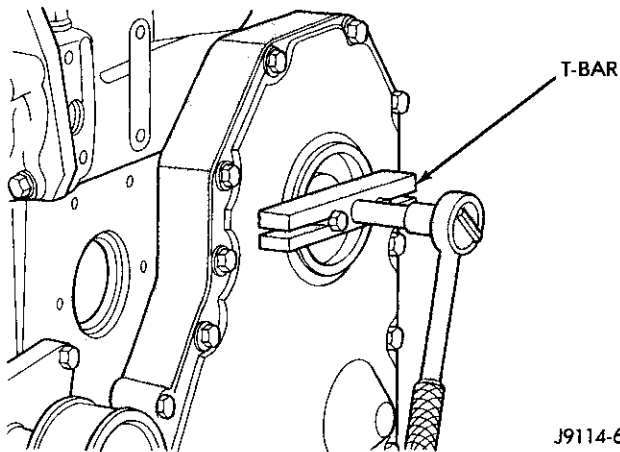


Fig. 93 Separating Injection Pump Gear from Pump Shaft

(27) Remove the two (2) injection pump-to-lower mounting bracket bolts (Fig. 94).

(28) Remove the four (4) injection pump-to-gear housing mounting nuts (Fig. 87).

(29) Remove the injection pump from gear housing. **Take care not to nick the injection pump**

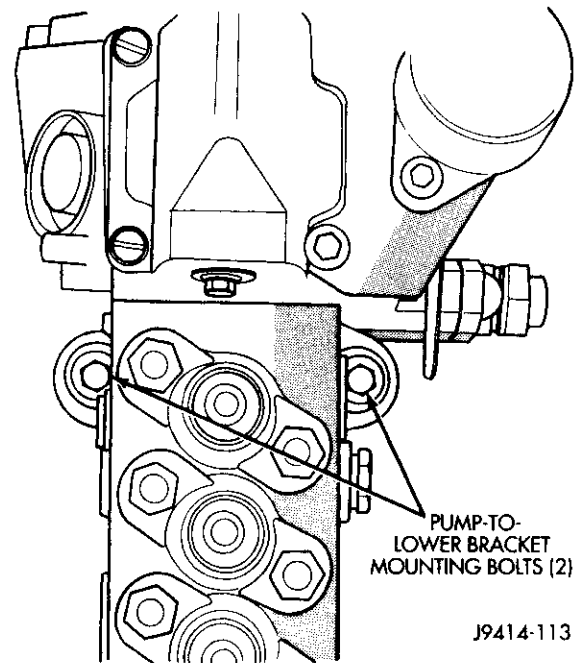


Fig. 94 Pump Mounting Bolts

shaft on the aluminum gear housing when removing pump.

(30) Clean the injection pump o-ring mounting surfaces on both the gear housing and pump.

INSTALLATION

CAUTION: Before installing the injection pump, be sure that number 1 cylinder is at the Top Dead Center (compression stroke) position. Engage the timing pin on the rear of the gear cover (Fig. 89) into the rear of the camshaft gear. Rotate crankshaft if necessary.

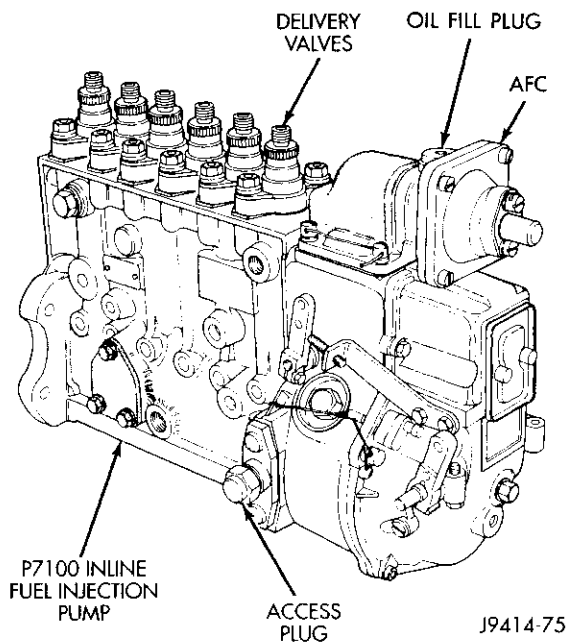
Before injection pump installation, it must be set (pump shaft rotated) to a certain position to attain accurate pump timing. Remove the access plug from the side of pump (Fig. 95). Stored behind this access plug is a plastic timing pin tool (Fig. 96). This tool is used to align the injection pump timing tooth (Fig. 97) to the center of access hole.

Installing Original Pump: If the original pump is being reinstalled, the pin tool should already be mounted with the slotted end facing outward (Fig. 96). When the position of this tool has been reversed, with the slotted end facing inward, it is used as a pump timing pin tool.

Installing New or Rebuilt Pump: If a new or rebuilt pump is being installed, the pump should have been shipped with the slotted end of the timing pin tool engaged to the timing tooth in the pump.

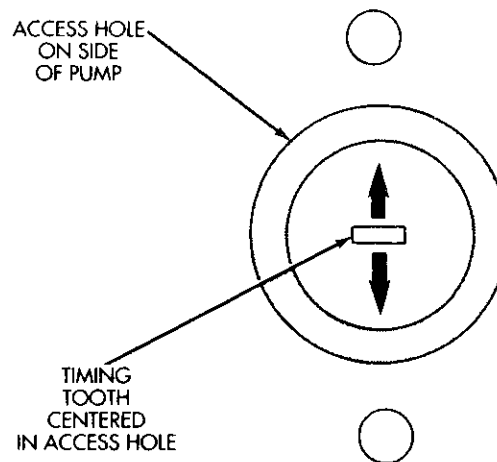
To set injection pump timing on an original pump or when checking timing on a new pump, rotate the

REMOVAL AND INSTALLATION (Continued)

**Fig. 95 Injection Pump Access Plug**

pump shaft until the timing tooth appears in the center of the plug opening (Fig. 97). Install the slotted end of the timing pin tool over the timing tooth. The pump shaft may have to be rotated slightly to align the tool to the tooth. Do not force the slots in the tool over the timing tooth.

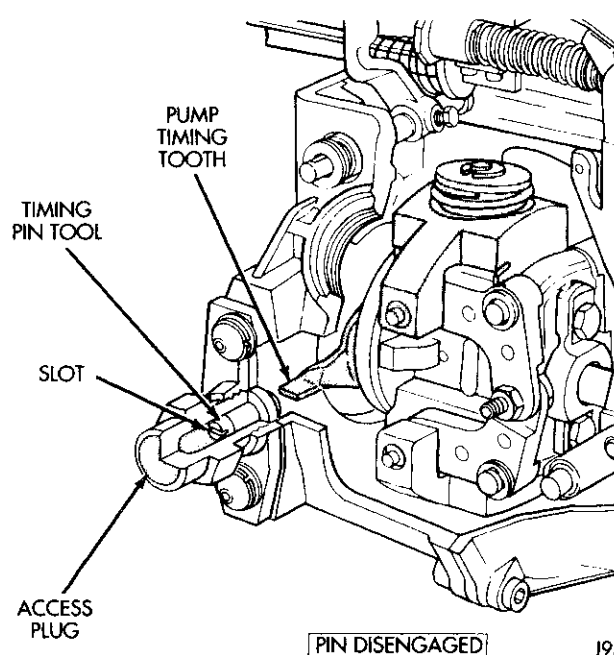
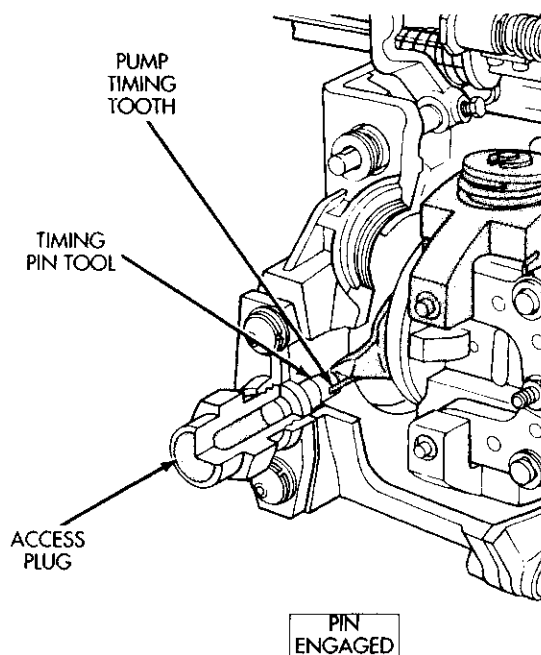
After the tool has been temporarily installed to the timing tooth, install and loosely tighten the

**Fig. 97 Injection Pump Timing Tooth**

access plug. New pumps should have been shipped with this tool already engaged.

(1) If the original pump is being installed, check the condition of the rubber o-ring at pump mounting area.

(2) Apply clean engine oil to the injection pump mounting flange opening in gear cover housing to allow easier pump installation (Fig. 98). Also apply engine oil to the pump o-ring seal at pump mounting area. **The machined tapers on both the injection pump shaft and injection pump gear must be dry, clean and free of any dirt or oil. This will ensure proper gear-to-shaft tightening.**

**Fig. 96 Injection Pump Timing Pin Tool**

REMOVAL AND INSTALLATION (Continued)

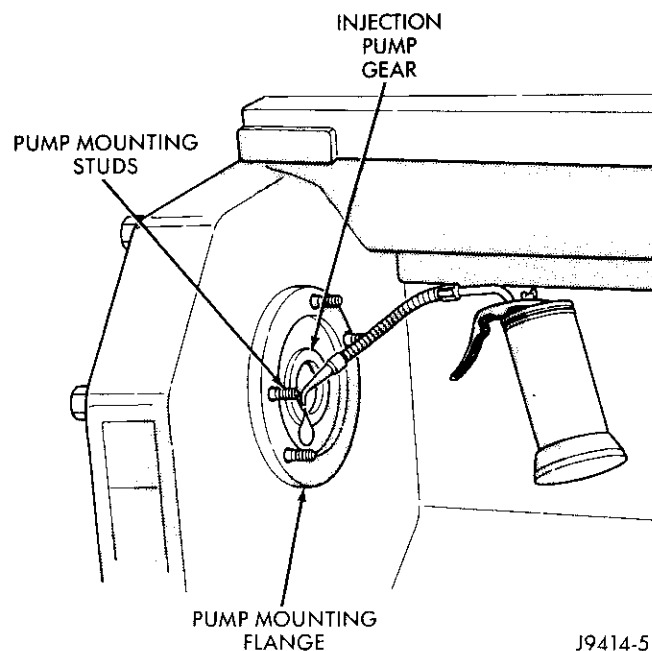


Fig. 98 Apply Oil to Gear Cover

(3) Position the pump assembly to the mounting flange on gear cover while aligning the injection pump shaft through the back of injection pump gear.

(4) Install the four pump mounting nuts finger tight. **Do not attempt to tighten (pull) the pump to the gear cover using the mounting nuts. Damage to pump or gear cover may occur. The pump must be positioned flat to its mounting flange before attempting to tighten mounting nuts.**

(5) Install two (vertical) pump mounting bracket bolts finger tight.

(6) Tighten the four pump mounting nuts to 24 N·m (18 ft. lbs.) torque. Tighten the two pump mounting bracket bolts. **To prevent damage to pump and mounting flange, tighten the pump mounting nuts first.**

(7) Install injection pump drive shaft-to-injection pump gear retaining nut and washer. **Do a preliminary tightening of this nut to 10 to 15 N·m (7 to 11 ft. lbs.) torque. Do not over tighten. This is not the final tightening torque. To prevent damage to the timing pin, do not exceed this torque.**

(8) Disengage the timing pin from the rear of camshaft gear by pulling it straight back.

(9) Remove the access plug from injection pump (Fig. 95) and remove timing pin tool from pump.

(10) Do a final tightening of the injection pump gear-to-injection pump shaft nut. Tighten to 165 N·m (122 ft. lbs.) torque. Use the barring tool to prevent the engine from rotating when tightening gear.

(11) After the injection pump gear has received a final tightening, verify injection pump timing.

(a) Rotate the engine counterclockwise with the barring tool (clockwise as observed at the crankshaft from the front of vehicle). Continue rotating engine until the timing pin aligns into hole at rear of camshaft gear (Fig. 90). The engine is now at TDC of number cylinder 1.

(b) With the timing pin aligned into the rear of the camshaft gear, the timing tooth should also be centered in the access hole on the side of the injection pump (Fig. 97). Install timing pin tool (Fig. 96) to verify.

(c) If the timing pin tool will not fit into the timing tooth in the pump, the pump gear nut must be removed. Loosen the pump gear from the pump shaft with the T-bar puller tool. With the gear loosened, rotate the injection pump shaft until it aligns to the center of access hole on side of pump. Tighten injection gear nut and remove barring tool.

(12) Remove the timing pin tool from the pump. Reverse the position of this tool (Fig. 96). The slotted part of tool should be facing outward and will be stored in pump in this direction. Place tool back into pump. Install access plug and its sealing washer. Tighten plug to 15 N·m (11 ft. lbs.) torque.

(13) Install the engine oil supply line and fuel return line/overflow valve to pump.

(14) Install the six high-pressure fuel lines to the top of pump. Tighten lines to 30 N·m (22 ft. lbs.) torque.

(15) Install the low-pressure fuel supply line to pump.

(16) Install the turbocharger wastegate line and AFC sensing line at the pump.

(17) **New or rebuilt P7100 series fuel injection pumps must be pre-lubricated before operation. Failure to do so may result in pre-mature governor wear.**

(a) Remove the 10 mm hex plug (oil fill plug) on the top of the injection pump governor (Fig. 95).

(b) Add 750 ml (25 ounces) of clean engine oil through this opening.

(c) Install oil fill plug and tighten to 28 N·m (21 ft. lbs.) torque.

(18) Install the throttle linkage assembly to pump. Tighten bolts to 24 N·m (18 ft. lbs.) torque.

(19) Connect electrical connector to fuel solenoid.

(20) Connect the main engine wiring harness at top of injection pump.

(21) Install the engine oil dipstick tube mounting clamp and bolt at the opening to the intake manifold.

(22) Install oil fill tube and tube adapter.

(23) Install oil fill tube bracket and mounting bolt.

(24) Install electrical connector to throttle position sensor (if equipped).

REMOVAL AND INSTALLATION (Continued)

(25) Install air cleaner housing-to-turbocharger tube at air cleaner housing.

(26) Using a new gasket, install air heater assembly (five bolts).

(27) Install intake manifold-to-intercooler tube.

(28) Check and adjust throttle linkage. Refer to Throttle Position Sensor in this group.

(29) Bleed air from fuel system. Refer to the Air Bleed Procedure in this section of the group.

(30) Adjust the low idle speed if required. Refer to Idle Speed Adjustment.

(31) Inspect throttle linkage to be sure that the control lever is opening to the full open position.

(32) Some engine oil was lost when removing pump. Check and adjust engine oil level.

FUEL INJECTORS**REMOVAL**

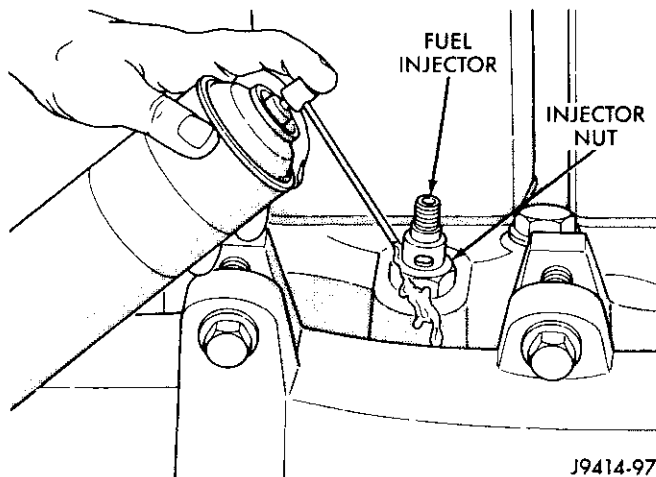
(1) Disconnect both negative battery cables from both batteries.

(2) Remove the high-pressure fuel lines. Refer to High-Pressure Fuel Lines in this section.

(3) Remove the fuel drain manifold. Refer to Fuel Drain Manifold in this section.

(4) Thoroughly clean the area around the injector.

CAUTION: When rust has formed on the fuel injector nut (Fig. 99), the injector (when being removed) can rotate in the cylinder head. This may cause damage to the cylinder head bore. Use a rust penetrating solvent before attempting to loosen a rusted holddown nut.

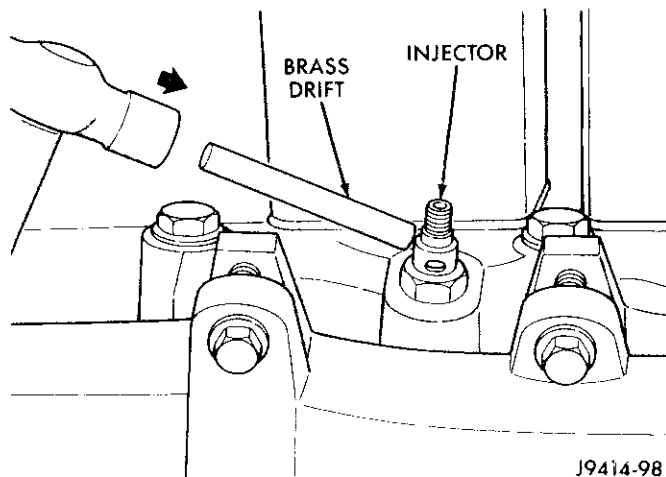


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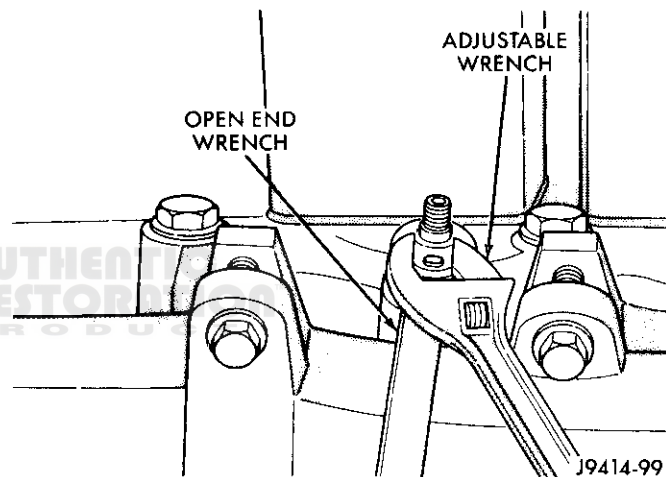
Fig. 99 Loosening Injector Nut

(5) Hit the injector body with a brass drift to loosen it (Fig. 100).

(6) Hold the injector body with one wrench while removing the injector nut with another (Fig. 101).



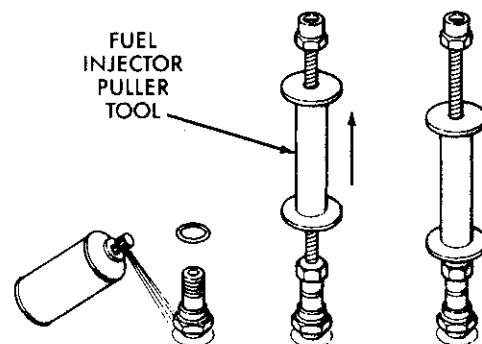
J9414-98

Fig. 100 Loosening Injector Body

J9414-99

Fig. 101 Loosening Injector

(7) It may be necessary to tap the injector with an injector puller tool (Fig. 102). Use Cummins Tool number 3823276 or equivalent.



J9414-100

Fig. 102 Removing Injector with Puller Tool

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Clean the injector cylinder head bore with special Cummins wire brush tool or equivalent (Fig. 103).

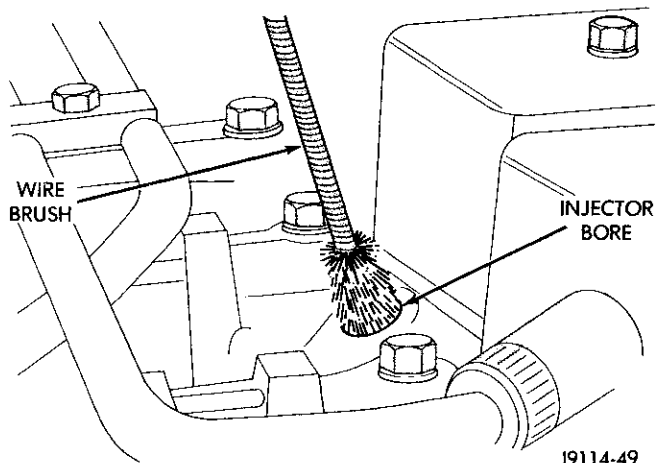


Fig. 103 Cleaning Cylinder Head Injector Bore

(2) Install a new copper washer on injector (Fig. 104).

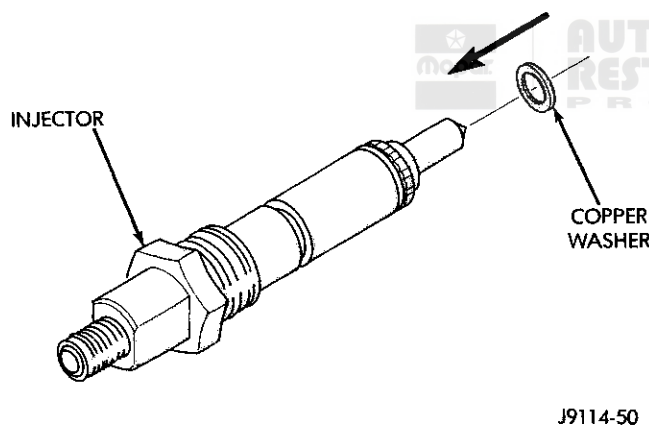


Fig. 104 Injector Washer

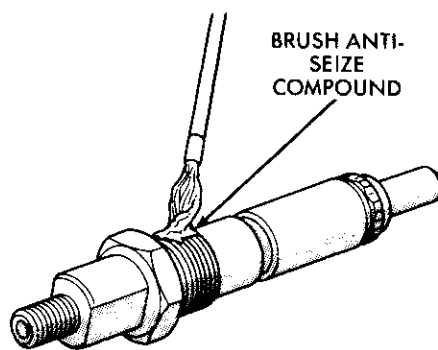
(3) Apply a coating of anti-seize compound to the threads of the injector holddown nut and between the top of the nut and injector body (Fig. 105).

(4) Install the injector into the cylinder head. Align the tab on the injector to the notch in the cylinder bore (Fig. 106). Certain types of injectors **may** have an o-ring located above the holddown nut (Fig. 106). After tightening the injector, push the o-ring into the groove on the top of the injector.

(5) Tighten the injector holddown nut to 60 N·m (44 ft. lbs.) torque.

(6) Connect the fuel drain manifold to the injectors. Refer to Fuel Drain Manifold in this section.

(7) Connect the high-pressure fuel lines. Refer to High-Pressure Fuel Lines in this section.



J9414-101

Fig. 105 Apply Anti-Seize Compound

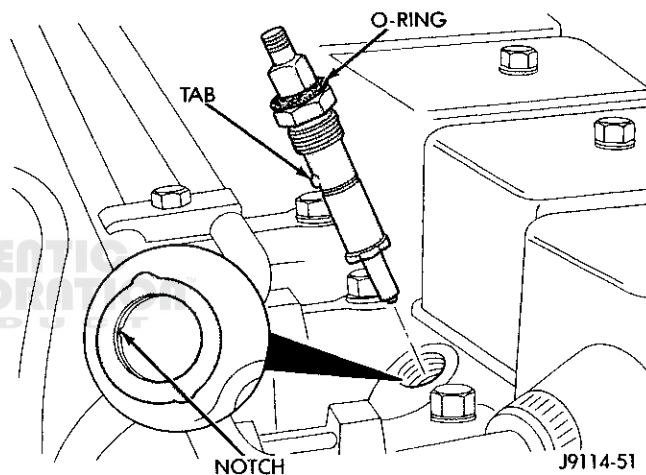


Fig. 106 Installing Injector

(8) Connect the negative battery cables to both batteries.

(9) Bleed the air from the high-pressure lines. Refer to High- Pressure Line Bleeding in the Air Bleed Procedure section at the front of this section of the group.

FUEL SHUTDOWN SOLENOID

REMOVAL

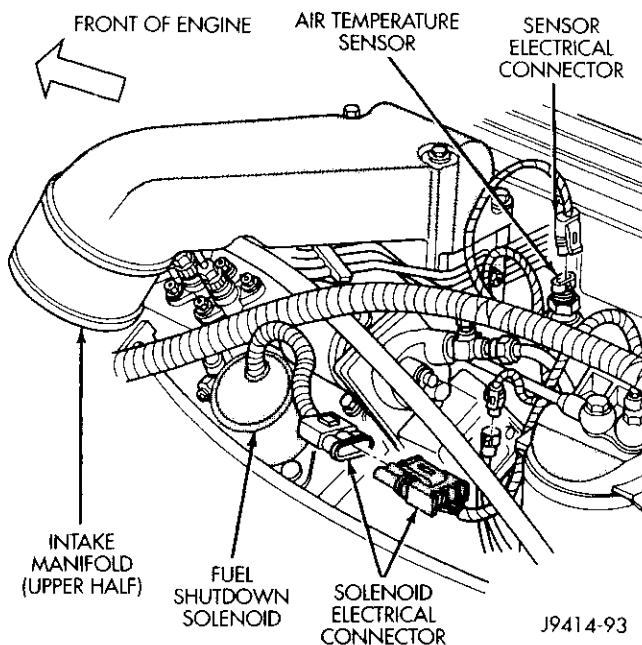
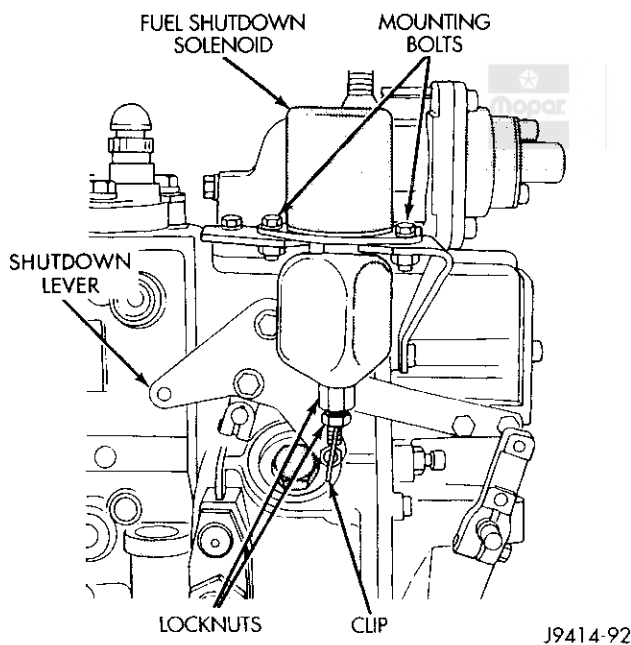
The fuel shutdown solenoid is mounted to a bracket located on the side of the fuel injection pump (Fig. 107).

(1) Disconnect the solenoid electrical connector (Fig. 107).

(2) Disconnect clip at injection pump shutdown lever (Fig. 108).

(3) Remove two solenoid mounting bolts.

(4) Remove solenoid from mounting bracket.

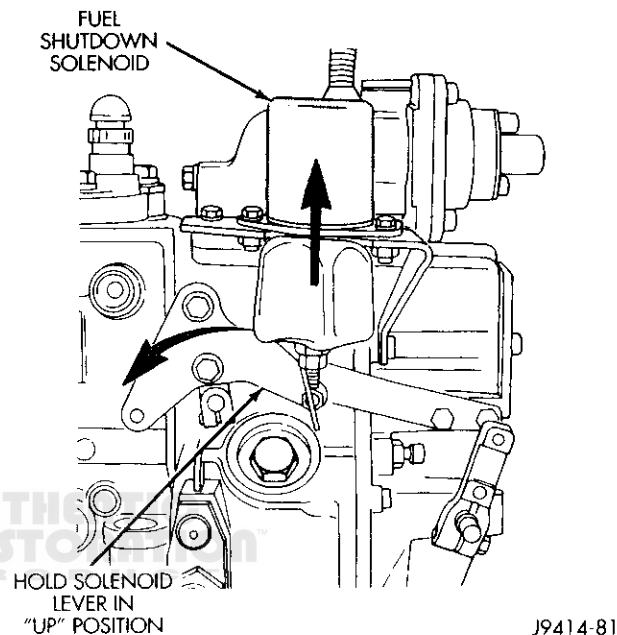
REMOVAL AND INSTALLATION (Continued)**Fig. 107 Fuel Shutdown Solenoid Location****Fig. 108 Fuel Shutdown Solenoid Removal/Installation****INSTALLATION**

- (1) Position solenoid to mounting bracket and injection pump lever.
- (2) Install clip at injection pump lever.
- (3) Install and tighten two mounting bolts.
- (4) Check and adjust the shaft length of the solenoid. Refer to the following procedure:

SOLENOID SHAFT ADJUSTMENT

After replacing the fuel shutdown solenoid, the solenoid shaft length must be checked and if necessary, adjusted.

- (1) Turn the ignition switch ON.
- (2) Pull up (by hand) and hold on the solenoid lever (Fig. 109). If the solenoid is operating correctly, it should remain in the UP position with the key in the ON position.

**Fig. 109 Fuel Shutdown Solenoid Lever in Up Position**

- (3) Take a measurement from the bottom of the solenoid mounting bracket to the top of the injection pump shutdown lever pin (Fig. 110).

- (4) Dimension should be 66.9 mm (2.64 inches).

- (5) If adjustment is necessary, loosen the shaft locknut and rotate the adjustment nut (Fig. 111) to attain dimension.

FUEL SHUTDOWN SOLENOID RELAY

The fuel shutdown solenoid relay is located in the engine compartment near the brake master cylinder (Fig. 112).

REMOVAL

- (1) Disconnect both negative battery cables at both batteries.
- (2) Disconnect the electrical connector at the relay.
- (3) Remove the relay from the mounting bracket.

INSTALLATION

- (1) Install the relay to the mounting bracket.
- (2) Connect the electrical connector.
- (3) Connect battery cables to both batteries.

REMOVAL AND INSTALLATION (Continued)

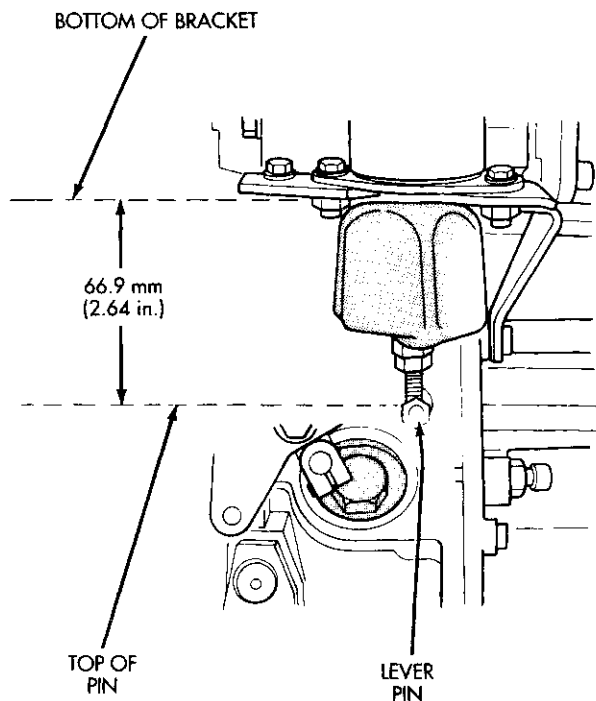


Fig. 110 Solenoid Measurement

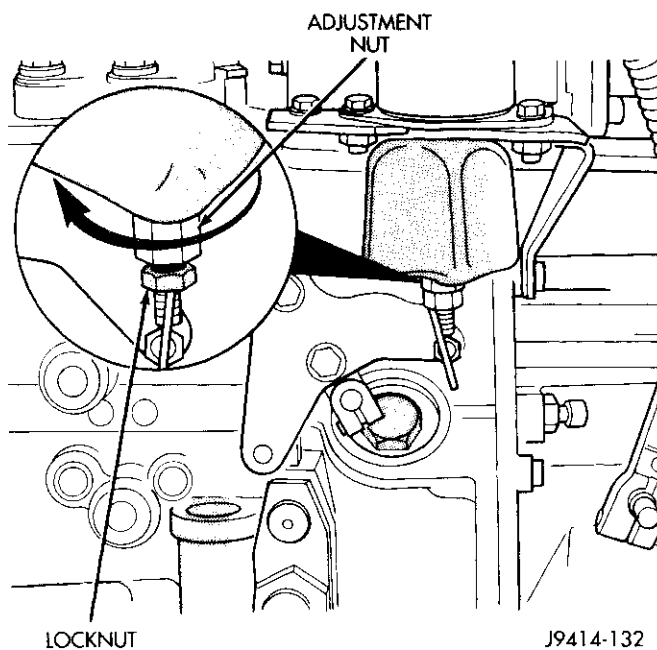


Fig. 111 Solenoid Adjustment

FUEL TRANSFER PUMP

For operation of the fuel transfer pump primer button, refer to Fuel Transfer Pump Description/Operation.

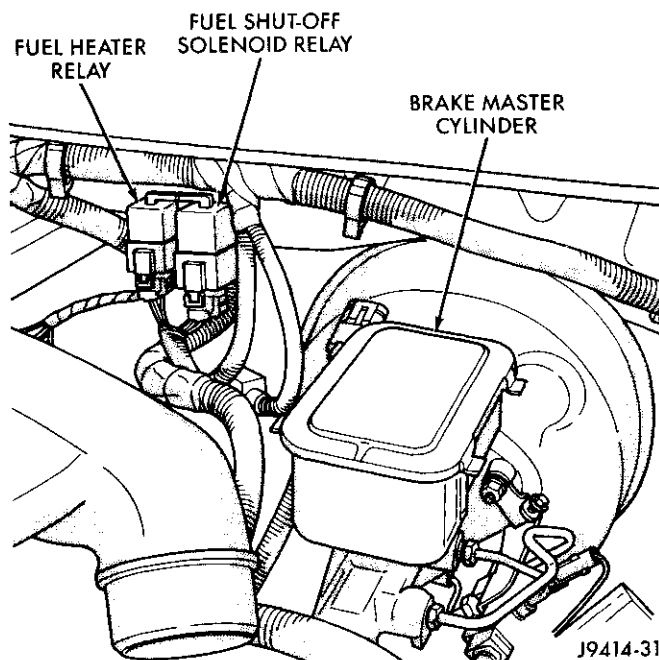


Fig. 112 Fuel Shutdown Solenoid Relay—Diesel

The fuel transfer pump is located on the left side of the engine and above the starter motor (Fig. 113). The mounting bracket/spacer for the fuel heater assembly is located between the engine block and the fuel transfer pump (Fig. 114). The fuel heater housing and its bracket assembly must also be removed when removing fuel pump.

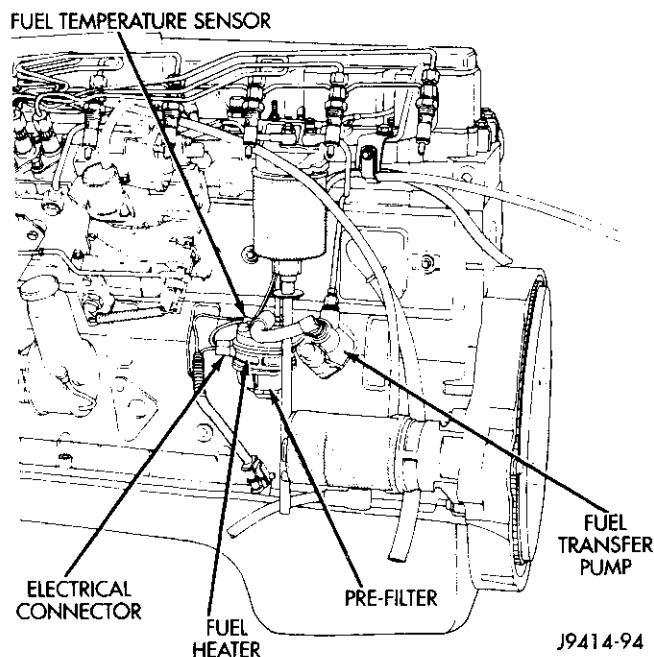
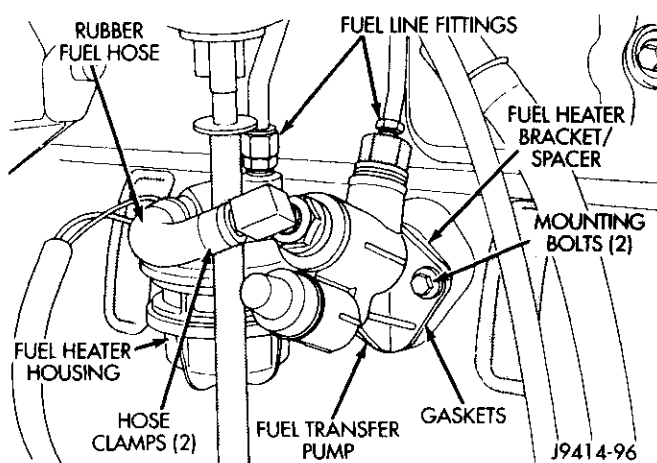


Fig. 113 Fuel Transfer Pump Location

REMOVAL AND INSTALLATION (Continued)**Fig. 114 Pump Removal/Installation****REMOVAL**

- (1) Disconnect both negative battery cables at both batteries.
- (2) Remove starter motor. Refer to Group 8B for procedures.
- (3) Place a drain pan below the pump.
- (4) Remove the fuel line fittings at the top of both the fuel pump and fuel heater housing (Fig. 114).
- (5) Remove the fuel hose clamps and rubber fuel hose (fuel heater housing-to-fuel pump) (Fig. 114).
- (6) Remove the two mounting bolts (Fig. 114).
- (7) Remove the fuel pump and fuel heater assembly from the engine as one unit.

CAUTION: Do not allow pump plunger to catch on edge of hole in cylinder block during removal. Plunger may slide out and drop into engine.

INSTALLATION

- (1) Clean the mating surfaces of the fuel heater mounting bracket, the fuel pump and the engine block of any gasket material.
- (2) Position the new gaskets, the fuel heater housing mounting bracket and the fuel pump to the engine.
- (3) Install the two mounting bolts into the engine. Tighten to 24 N·m (18 ft. lbs.) torque. **As these bolts are tightened, the plunger within the fuel pump is being compressed. Tighten these two bolts alternately to prevent damage to the fuel pump housing.**
- (4) Install fuel line fittings to pump and fuel heater. Tighten to 24 N·m (18 ft. lbs.) torque.
- (5) Install starter motor. Refer to Group 8B for procedures.
- (6) Connect battery cables at both batteries.
- (7) Bleed air from fuel system. Refer to the Air Bleed Procedure.

FUEL TANK PRESSURE RELIEF/ROLLOVER VALVE

Refer to Fuel Tank Module for procedures.

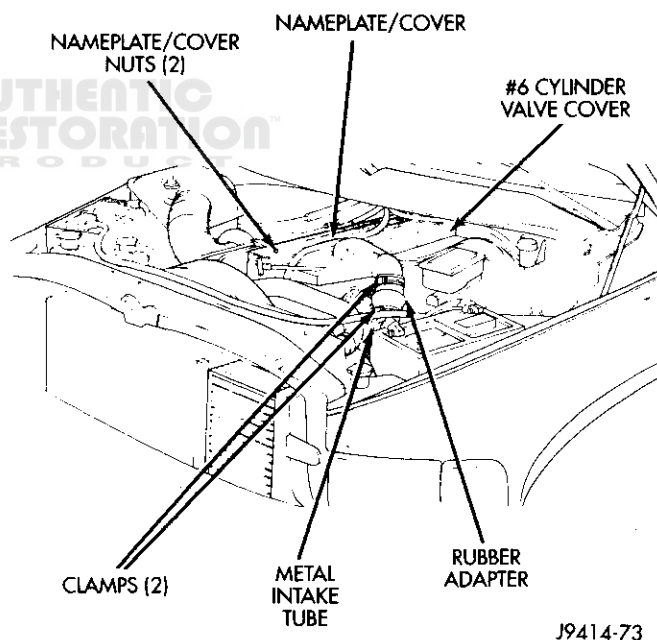
HIGH-PRESSURE FUEL LINES

All high-pressure fuel lines are of the same length and inside diameter. Correct high-pressure fuel line usage and installation is critical to smooth engine operation.

CAUTION: The high-pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high-pressure fuel line is necessary.

REMOVAL

- (1) Disconnect both negative battery cables from both batteries.
- (2) Remove the nameplate/cover from the top of the six engine valve covers (two nuts) (Fig. 115).

**Fig. 115 Nameplate/Cover—Diesel**

- (3) Remove the necessary clamps holding the lines to the engine.
- (4) Clean the area around each line. Disconnect each line at the top of each fuel injector (Fig. 116).
- (5) Disconnect each high-pressure line fitting at each fuel injection pump delivery valve holder (Fig. 117).
- (6) Very carefully remove each line from the engine. **Do not bend the line while removing.**

REMOVAL AND INSTALLATION (Continued)

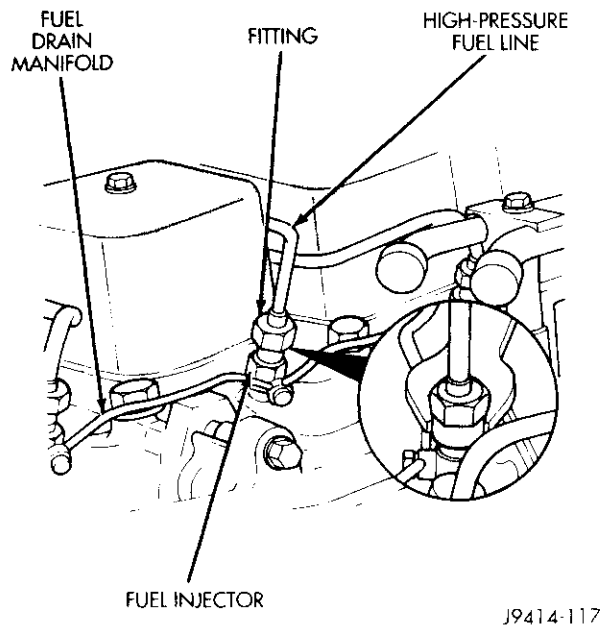


Fig. 116 Fuel Lines at Fuel Injectors

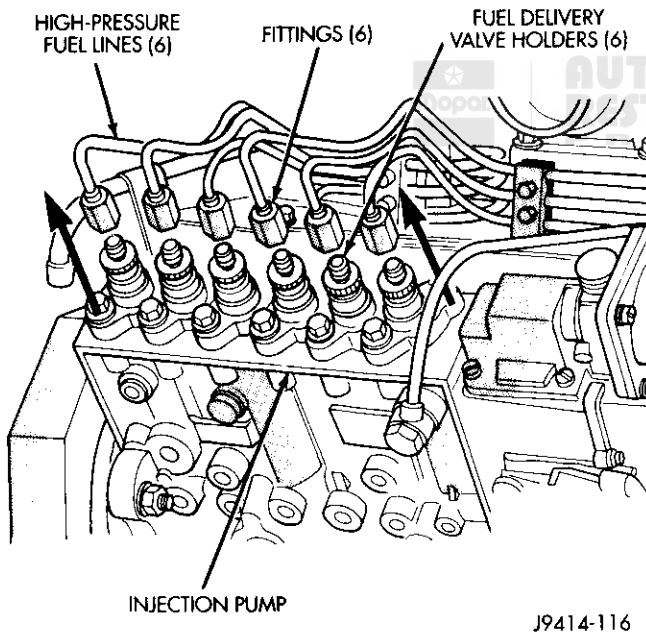


Fig. 117 Fuel Delivery Valve Holders and Pressure Lines

CAUTION: Be sure that the high-pressure fuel lines are installed in the same order that they were removed. Prevent the injection pump delivery valve holders from turning when removing or installing high-pressure lines from injection pump.

INSTALLATION

(1) Carefully position each high-pressure fuel line to the fuel injector and fuel injection pump delivery valve holder in the correct firing order. Also position each line in the correct line holder.

(2) Loosely install the line clamp isolator and bracket holder bolts.

(3) Tighten each line at the delivery valve holder to 24 N·m (18 ft. lbs.) torque.

(4) Tighten each line at the fuel injector to 24 N·m (18 ft. lbs.) torque.

CAUTION: Be sure the lines are not contacting each other or any other component.

(5) Tighten the clamp bracket bolts to 24 N·m (18 ft. lbs.) torque.

(6) Bleed air from the fuel system. Refer to High-Pressure Fuel Line Bleeding in the Air Bleed Procedure portion of this section.

THROTTLE CABLE

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing accelerator pedal or cables.

REMOVAL

(1) From inside the vehicle, hold up the accelerator pedal. Remove the plastic cable retainer and throttle cable core wire from upper end of pedal arm (Fig. 118). The plastic cable retainer snaps into pedal the arm.

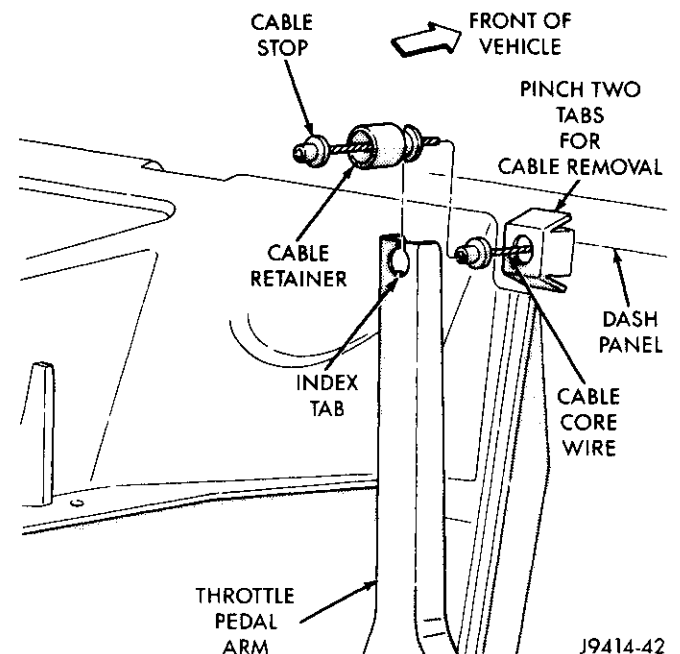


Fig. 118 Cable Removal/Installation

REMOVAL AND INSTALLATION (Continued)

- (2) Remove the cable core wire at the pedal arm.
- (3) From inside the vehicle, pinch both sides of the plastic cable housing retainer tabs at the dash panel (Fig. 118).
- (4) Remove cable housing from dash panel and pull the cable into the engine compartment.
- (5) Remove the throttle cable socket at fuel injection lever ball (Fig. 119).

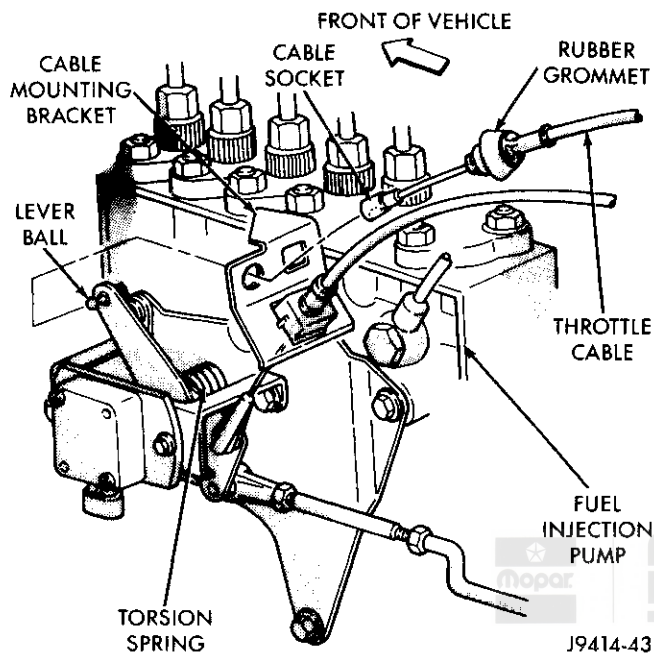


Fig. 119 Throttle Cable at Injection Pump—Diesel Engine

- (6) A rubber/plastic grommet is molded to the cable (Fig. 119). This grommet is pressed into the back of the cable mounting bracket. Apply lubricant to the rubber grommet (Fig. 119) on both sides of the cable mounting bracket. Work the rubber grommet (rearward) through the mounting bracket with two small screwdrivers. Remove throttle cable from vehicle.

INSTALLATION

- (1) Feed the cable through the rear of its mounting bracket (Fig. 119) until the rubber/plastic grommet locks into position on the bracket.
- (2) Connect cable end socket to the fuel injection pump lever ball (snaps on).
- (3) Install the remaining cable housing end into and through the dash panel opening (snaps into position). The two plastic pinch tabs (Fig. 118) should lock the cable to dash panel.
- (4) From inside the vehicle, hold up the accelerator pedal. Install the throttle cable core wire and plastic cable retainer into and through the upper end of the pedal arm (the plastic retainer is snapped into the pedal arm). When installing the plastic retainer

to the accelerator pedal arm, note the index tab on the pedal arm (Fig. 118). Align the index slot on the plastic cable retainer to this index tab.

SPECIFICATIONS**ENGINE DATA PLATE SPECIFICATIONS**

If anything differs between the specifications found on the Engine Data Plate, and the specifications used in this manual, use specifications on data plate. The Engine Data Plate is located on the engine timing gear cover (Fig. 120).

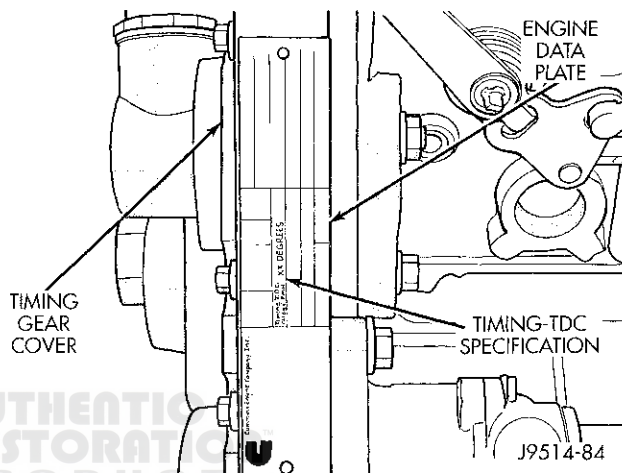


Fig. 120 Engine Data Plate Location

FUEL TANK CAPACITY



Models	Liters	U.S. Gallons
118" Wheelbase	98	26
All Other Models	132	35
Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.		

FUEL SYSTEM PRESSURES—DIESEL ENGINES

DESCRIPTION	PRESSURE
Fuel Pressure Drop Across Fuel Filter . . . . .	.35 kPa (5 psi) maximum
Fuel Return Line or Component Restriction (vacuum)	Approx. 100mm (4 in Hg)
Fuel Transfer Pump Pressure	Will vary. See manual text for procedures.
Fuel Injector "pop off" Pressure . . . . .	.3822 kPa (26,352 psi)
Maximum Injection Pump Pressure . . . . .	.120,000 kPa (17,405)

SPECIFICATIONS (Continued)**TORQUE—DIESEL ENGINES**

DESCRIPTION	TORQUE
Air-Fuel Control (AFC) Line	
Fitting . . . . .	.24 N·m (18 ft. lbs.)
Banjo Fitting at top of	
Filter/Separator . . . . .	.24 N·m (18 ft. lbs.)
Banjo Fitting at side of	
Fuel Injector . . . . .	.8 N·m (6 ft. lbs.)
Banjo Fitting—Fuel Supply Line at	
side of Injector Pump . . . . .	.24 N·m (18 ft. lbs.)
Engine Speed Sensor Nuts/Bolts . . . . .	.24 N·m (18 ft. lbs.)
Fuel Drain Manifold Fitting Bolts	
at Injectors . . . . .	.8 N·m (6 ft. lbs.)
Fuel Filter	1/2 Turn After Contact
Fuel Hose Clamps . . . . .	.1 N·m (15 in. lbs.)
Fuel Injector Retaining Nut . . . . .	.60 N·m (44 ft. lbs.)
Fuel Pump Module Locknut . . . . .	.54 N·m (40 ft. lbs.)
Fuel Tank Mounting Nuts . . . . .	.41 N·m (30 ft. lbs.)
Fuel Transfer Pump Mounting	
Bolts . . . . .	.24 N·m (18 ft. lbs.)
High-Pressure Fuel Line	
Fittings . . . . .	.24 N·m (18 ft. lbs.)
High-Pressure Fuel Line Fitting	
Clamps . . . . .	.6 N·m (4 ft. lbs.)
Injector Pump Access Plug . . . . .	.15 N·m (11 ft. lbs.)
Injection Pump-to-Injection	
Pump Gear Nut . . . . .	.165 N·m (122 ft. lbs.)
Injection Pump Mounting Nuts . . . . .	.24 N·m (18 ft. lbs.)
Injection Pump Oil Fill Plug . . . . .	.28 N·m (21 ft. lbs.)
Intake Manifold Air Temp.	
Sensor . . . . .	.28 N·m (20 ft. lbs.)
Intake Manifold Air Heater	
Relay Bolts . . . . .	.45 N·m (40 in. lbs.)
Low-Pressure Bleed Bolt (Screw)8 N·m (6 ft. lbs.)

FUEL INJECTION SYSTEM-DIESEL ENGINE

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GENERAL INFORMATION

INTRODUCTION

Various components, relays and switches are operated by the powertrain control module (PCM). **This section of the group will cover a description and operation of components controlled by the**

PCM for vehicles equipped with diesel powered engines.

Diesel fuel injection system components, except for the intake manifold air heater elements, are **not** directly regulated by the PCM.

Refer to the Fuel Delivery System—Diesel Engine section of this group for fuel components **not** oper-

GENERAL INFORMATION (Continued)

ated or regulated by the PCM. These components are the:

- Fuel tank
- Fuel tank module
- Low and high-pressure fuel supply lines
- Low-pressure, mechanical, fuel transfer pump (fuel lift pump)
- High-pressure fuel injection pump
- Fuel filter/water separator
- Fuel heater
- Fuel heater relay
- Fuel shutdown solenoid
- Fuel shutdown solenoid relay
- High-pressure fuel injectors
- Fuel return line
- Fuel filter (strainer)
- Fuel drain manifold

DESCRIPTION AND OPERATION

SYSTEM DIAGNOSIS

The PCM can test many of its own input and output circuits. If the PCM senses a fault in a major system, the PCM stores a Diagnostic Trouble Code (DTC) in memory.

Technicians can display stored DTC's by two different methods. The first is to cycle the ignition switch On - Off - On - Off - On within 5 seconds. Then count the number of times the malfunction indicator (check engine) lamp on the instrument panel flashes on and off. The number of flashes represents the DTC. There is a slight pause between the flashes representing the first and second digits of the code. Longer pauses separate individual trouble codes.

The second method of reading DTC's uses the DRB scan tool. For DTC information, refer to Group 25, Emission Control Systems. See On-Board Diagnostics.

POWERTRAIN CONTROL MODULE (PCM)—DIESEL

The powertrain control module (PCM) is located in the right-rear side of the engine compartment (Fig. 1). It is mounted to the dash panel cowl with three bolts. The PCM was formerly referred to as the SBEC or engine controller. Except for operation of the intake manifold air heater elements, the PCM does not regulate or control fuel system operation on the diesel engine.

The PCM is a pre-programmed, dual micro-processor digital computer. Although it does not regulate or control the fuel system on the diesel powered engine, it does operate or regulate the:

- Speed control system
- Charging system
- Certain warning lamps
- Transmission overdrive solenoid

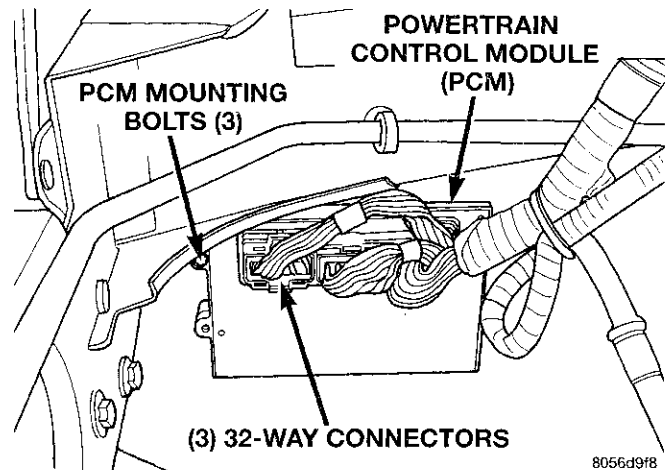


Fig. 1 PCM Location

- Torque convertor engagement
- ASD relay
- Air conditioning operation
- Tachometer
- Intake manifold air heater

The PCM can adapt its programming to meet changing operating conditions.

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as **PCM Outputs**. The sensors and switches that provide inputs to the PCM are considered **PCM Inputs**.

NOTE: PCM Inputs:

- Air conditioning selection
- Battery voltage
- Brake light switch
- Engine speed sensor (rpm)
- Speed control switch position
- Auto shutdown (ASD) sense
- Battery voltage input used to measure generator output
- Intake manifold air temperature sensor
- Overdrive/override switch
- Park/neutral switch (auto. trans. only)
- Power ground
- SCI receive (DRB scan tool connection)
- Sensor return
- Throttle position sensor (auto. trans. only)
- Transmission temperature sensor (auto. trans. only)
- Vehicle speed sensor
- Water-in-fuel sensor
- Ignition switch sense

NOTE: PCM Outputs:

DESCRIPTION AND OPERATION (Continued)

After inputs are received by the PCM, certain sensors, switches and components are controlled or regulated by the PCM. These are considered **PCM Outputs**. These outputs are for:

- A/C clutch relay (A/C clutch operation)
- Auto shutdown (ASD) relay
- Data link connectors (for DRB and MDS test equipment)
- Generator field (charging system operation)
- Malfunction indicator lamp (check engine lamp)
- Overdrive solenoid electrical operation (auto. trans. only)
- Overdrive/Override warning lamp (auto. trans. only)
- SCI transmit (DRB scan tool connection)
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer
- Torque convertor electrical operation (auto. trans. only)
- Transmission oil temperature warning lamp (auto. trans. only)
- Wait-to-start lamp
- Water-in-fuel lamp
- Intake Manifold Air Heater Element #1
- Intake Manifold Air Heater Element #2

AIR CONDITIONING (A/C) CONTROLS—PCM INPUT

The A/C control system information applies to factory installed air conditioning units.

A/C SELECT SIGNAL: When the A/C switch is in the ON position, an input signal is sent to the powertrain control module (PCM). The signal informs the PCM that the A/C has been selected. The PCM adjusts idle speed to a pre-programmed rpm through the idle air control (IAC) motor to compensate for increased engine load.

A/C REQUEST SIGNAL: Once A/C has been selected, the powertrain control module (PCM) receives the A/C request signal from the evaporator switch. The input indicates that the evaporator temperature is in the proper range for A/C application. The PCM uses this input to cycle the A/C compressor clutch (through the A/C relay). It will also determine the correct engine idle speed through the idle air control (IAC) motor position.

If the A/C low-pressure switch opens (indicating a low refrigerant level), the PCM will not receive an A/C receive signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch.

If the evaporator switch opens, (indicating that evaporator is not in proper temperature range), the PCM will not receive the A/C request signal. The PCM will then remove the ground from the A/C relay, deactivating the A/C compressor clutch.

AUTOMATIC SHUTDOWN (ASD) SENSE—PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The ASD relay is located in the power distribution center (PDC). The PDC is located in the engine compartment. For the location of the relay within the PDC, refer to PDC cover.

This input is used only to sense that the ASD relay is energized. If the powertrain control module (PCM) does not see 12 volts + at this input when the ASD should be activated, it will set a diagnostic trouble code (DTC).

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the powertrain control module (PCM). It also informs the PCM what voltage level is being supplied by the generator once the vehicle is running.

The battery input also provides the voltage that is needed to keep the PCM memory alive. The memory stores diagnostic trouble code (DTC) messages, minimum and maximum TPS value from the previous key-on and speed control adaptive memory.

BATTERY TEMPERATURE SENSOR—PCM INPUT

Provides a signal to the PCM corresponding to the battery temperature. Refer to Group 8C, Charging System for additional information.

BRAKE SWITCH—PCM INPUT

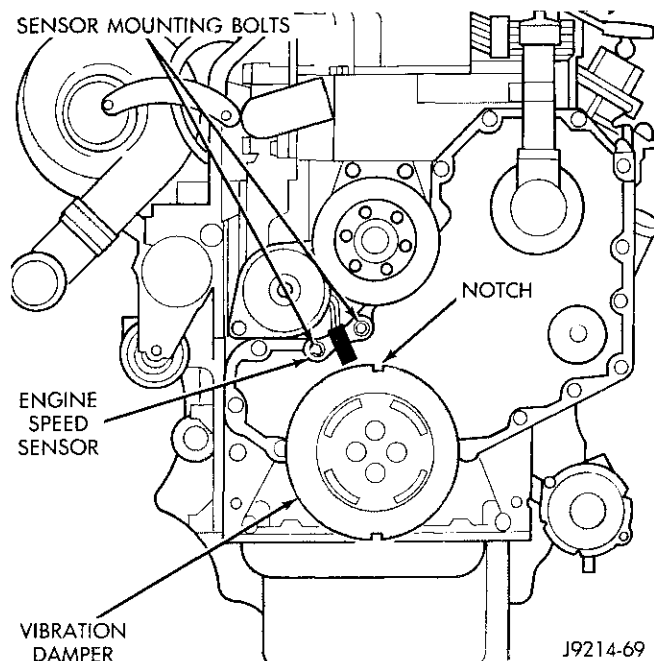
When the brake light switch is activated, the powertrain control module (PCM) receives an input indicating that the brakes are being applied. After receiving this input, the PCM is used to control the speed control system. It is also used for electrical operation of the transmission torque converter.

ENGINE SPEED SENSOR—PCM INPUT

The engine speed (rpm) sensor is mounted to the front of engine (Fig. 2). It generates an rpm signal to the PCM. The engine speed sensor input is used along with the vehicle speed sensor and throttle position sensor (TPS) inputs to determine when to shift the automatic transmission into and out of overdrive. The speed sensor signal is also used as an input for the ASD relay (for control of generator field), vehicle speed control, torque convertor electrical engagement and instrument panel mounted tachometer.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—PCM INPUT

The intake manifold air temperature sensor is a variable, thermistor type. It reacts to temperature changes. At cold air temperatures, its resistance is

DESCRIPTION AND OPERATION (Continued)**Fig. 2 Engine Speed Sensor—Diesel**

high. As temperatures increase, its resistance will decrease.

The air temperature sensor element extends into the intake manifold air stream. It provides an input voltage to the PCM indicating intake manifold air temperature. The input from this sensor is used by the PCM to determine if and how long to activate the intake manifold air heater relays. When the relays are activated, current will flow through the relays to the intake manifold air heater element.

As the temperature of the air-fuel stream in the manifold varies, the sensor resistance will change. This will result in a different input voltage to the PCM.

The sensor is located on the top of the intake manifold and to the rear of the intake manifold air heater (Fig. 3).

Also refer to Intake Manifold Air Heater Relays for additional information.

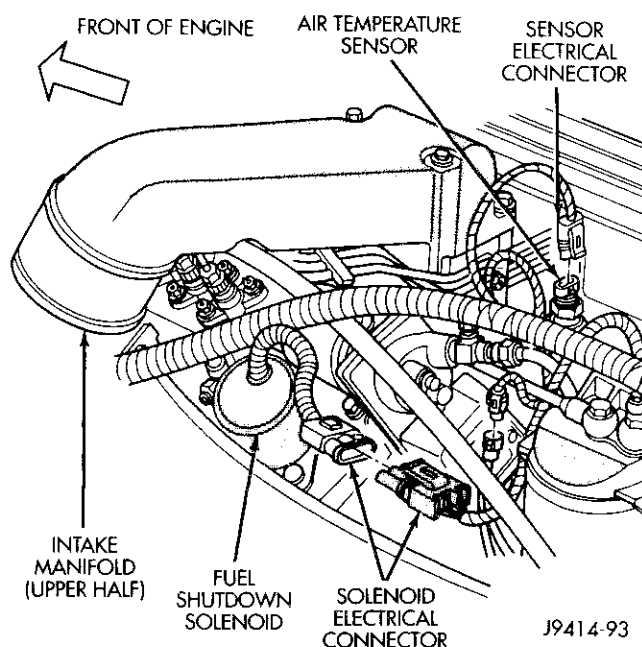
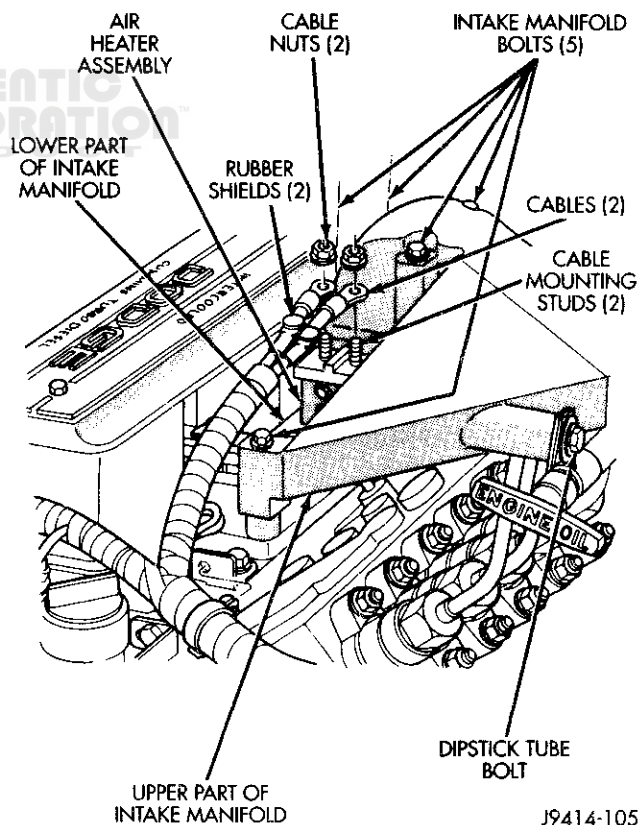
INTAKE MANIFOLD AIR HEATER

The intake manifold air heater element assembly is located in the top of the intake manifold (Fig. 4).

The air heater is used to heat incoming air to the intake manifold to help engine starting and improve driveability with cool or cold outside temperatures.

Two heavy-duty cables (Fig. 5) connect the 2 air heater elements to the 2 air heater relays. Each of these cables will supply approximately 95 amps at 12 volts to an individual heating element within the heater block assembly.

Electrical supply for the 2 air heater elements (Fig. 5) is controlled by the powertrain control module

**Fig. 3 Air Temperature Sensor Location—Diesel****Fig. 4 Air Heater Location**

(PCM) through the 2 air heater relays. Refer to Intake Manifold Air Heater Relays for more information.

DESCRIPTION AND OPERATION (Continued)

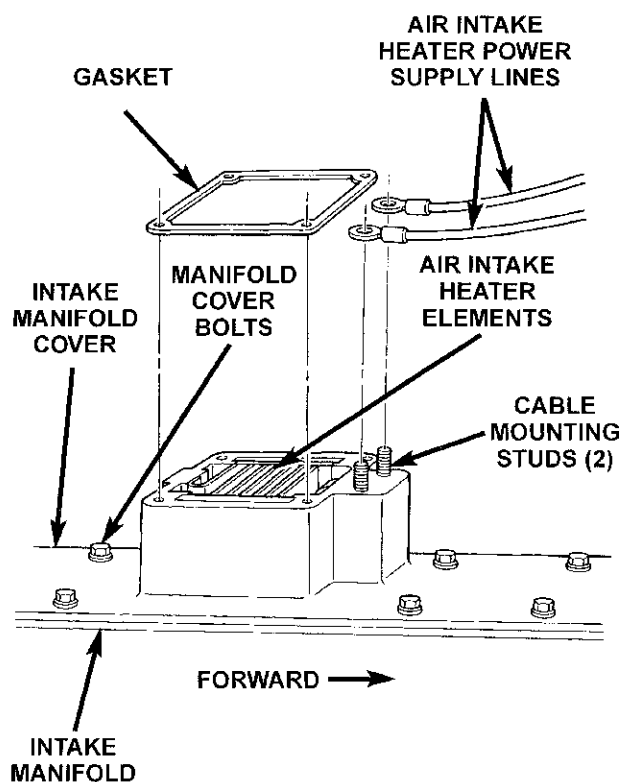


Fig. 5 Air Heater Elements

INTAKE MANIFOLD AIR HEATER RELAYS—PCM OUTPUT

The 2 relays are located in the engine compartment below the left battery (Fig. 6).

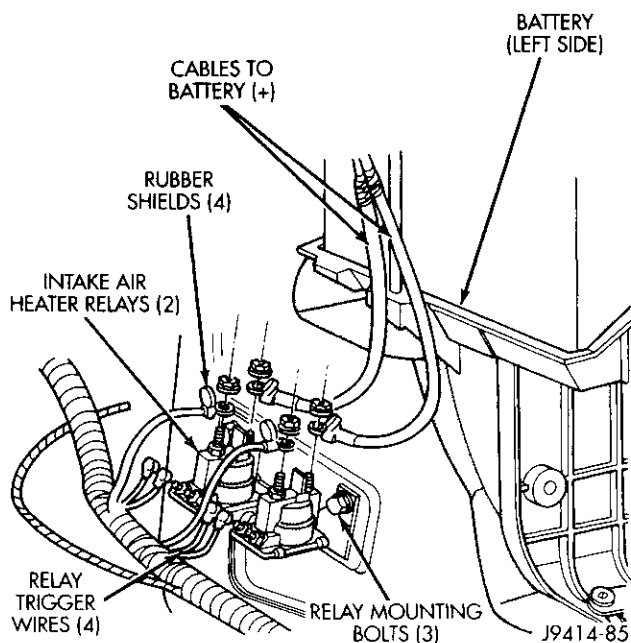


Fig. 6 Intake Manifold Air Heater Relays

The powertrain control module (PCM) operates the 2 heating elements within the air heater assembly through the 2 intake manifold air heater relays. The air heater elements are used to heat incoming air flowing into the intake manifold. This will help engine starting and improve driveability with cool or cold outside temperatures.

The relays may be energized by the PCM before and after cranking. This will depend on inputs the PCM receives from: the intake manifold air temperature sensor, the engine speed sensor and the vehicle speed sensor.

With a cool or cold engine, the air heater relays and the air heater elements may be activated for a maximum time of approximately 3 1/2 minutes. Refer to the following Air Heater Cycle Chart for a temperature/time comparison of relay engagement.

In this chart, Pre-Heat and Post-Heat times are mentioned. Pre-heat is the amount of time the relay circuits are activated when the ignition (key) switch is ON, but the engine has yet to be started. Post-heat is the amount of time the relay circuits are activated after the engine is operating.

The wait-to-start warning lamp is tied to this circuit. Lamp operation is also controlled by the PCM. The wait-to-start warning lamp **will not** be illuminated during the post-heat cycle.

The relays are not energized during engine cranking. When initially energized, they will make a clicking noise.

PREHEAT CYCLE

The PCM will supply a signal to the 2 relays when the ignition (key) switch is initially turned to the ON position. When this signal is supplied, electrical current is passed through the relays for operation of the 2 heating elements.

If the intake manifold air temperature is 15°C (59°F) or below, the air heater elements are energized and the wait-to-start warning lamp is illuminated. The heater is energized for a specific amount of time. Refer to the following Air Heater Cycle Chart (Fig. 7) for a temperature/time comparison of relay engagement.

Once the heater has cycled, the wait-to-start warning lamp goes out.

While the engine is cranked, the heater relays are not energized.

POST-HEAT CYCLE

After the pre-heat cycle is completed, the PCM must receive an engine crank signal (engine speed between 32 and 475 rpm) followed by an engine run signal (engine speed above 475 rpm). Intake manifold air temperature must also be below 15°C (59°F). All of these signals must be seen by the PCM before initiating the post-heat cycle.

DESCRIPTION AND OPERATION (Continued)

Depending upon intake manifold air temperature, engine rpm and predetermined PCM values, one or both of the relays and one or both of the heating elements may be activated. This may be observed as a large needle swing on the vehicle voltmeter and is due to the high-amperage draw of the heating elements. Each heating element will draw approximately 95 amps at 12 volts. **This voltmeter movement is a normal condition during the post-heat cycle.**

Refer to the following Air Heater Cycle Chart (Fig. 7) for a temperature/time comparison of relay engagement.

The PCM is also programmed with battery saving features. It will shut down the air heater relays if:

- the engine starter is operated during the pre-heat cycle.
- the engine stalls during the post-heat cycle.
- the engine starter is operated for more than 10 seconds during the post-heat cycle.
- the vehicle speed is above 10 mph during the post-heat cycle.

The post-heat cycle will continue for up to 3 1/2 minutes unless the PCM determines one or more of these preceding features interrupts the cycle strategy.

INTAKE MANIFOLD TEMPERATURE—KEY ON POSITION	PRE-HEAT CYCLE TIME—IGNITION ON, ENGINE NOT RUNNING	POST-HEAT CYCLE—IGNITION ON, ENGINE RUNNING
Above 15° C (59° F)	0 seconds	No
-10° C to 15° C (15° F to 59° F)	10 seconds	Yes
-18° C to -10° F (0° F to 15° F)	15 seconds	Yes
Below -18° C (0° F)	30 seconds	Yes
J9414-133		

Fig. 7 Air Heater Cycle Chart

SPEED CONTROL SWITCH—PCM INPUT

Six different speed control functions, using three momentary contact switches, are monitored through this **multiplexed** input. The resistance monitored at this input, in combination with the length of time the PCM measures the resistance, determines which

switch feature has been selected. The three switches are: On/Off, Set/Coast and Resume/Accelerate.

The speed control operating range is from approximately 56 km/h to 137 km/h (35 to 85 mph). Inputs that effect speed control operation are:

- Brake switch position
- Park/neutral switch
- Vehicle speed sensor
- Engine speed sensor
- Throttle position sensor (auto. trans. only)

Refer to Group 8H for further speed control information.

PARK/NEUTRAL POSITION SWITCH—PCM INPUT

The park/neutral switch provides an input to the powertrain control module (PCM). This will indicate that the automatic transmission is in Park, Neutral or a Drive gear selection. This input is used to determine speed control strategy and electrical operation of both the overdrive and torque convertor solenoids. Refer to Group 21, Transmissions, for testing, replacement and adjustment information.

THROTTLE POSITION SENSOR—PCM INPUT

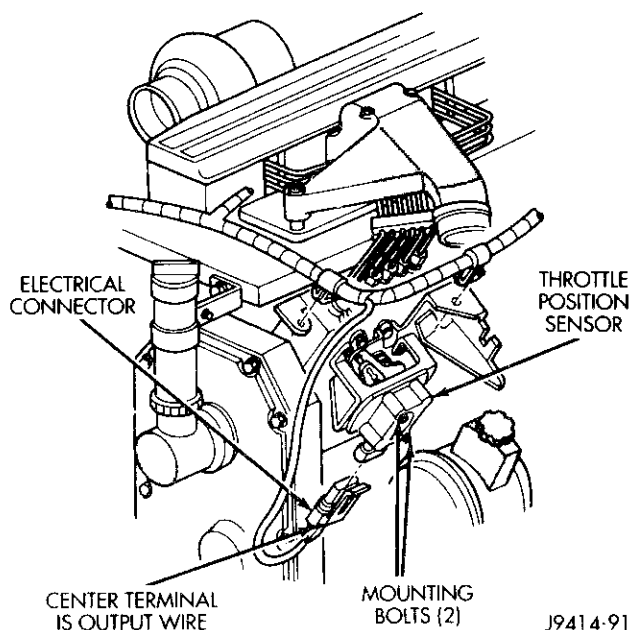
The throttle position sensor (TPS) is used only on vehicles equipped with an automatic transmission if equipped with a diesel engine. It is not used with the manual transmission.

The TPS is mounted on the side of the fuel injection pump (Fig. 8). The TPS provides an input to the PCM. It senses how far the throttle is open (past the idle position). The PCM uses the TPS input, along with vehicle speed sensor and engine speed sensor inputs to determine 3-4 upshift (overdrive) and 4-3 downshift. It is also used with the vehicle speed sensor and engine speed sensor inputs to engage and disengage the torque convertor solenoid. This solenoid is used for torque convertor engagement.

The TPS is a linear potentiometer. The PCM supplies 5 volts to the sensor. TPS output voltage to the PCM will vary. At idle speed, the voltage should be 1.0 volt ($\pm .2$ volts). At wide open throttle (WOT), the output voltage must be 2.2-to-2.9 volts higher than at idle speed.

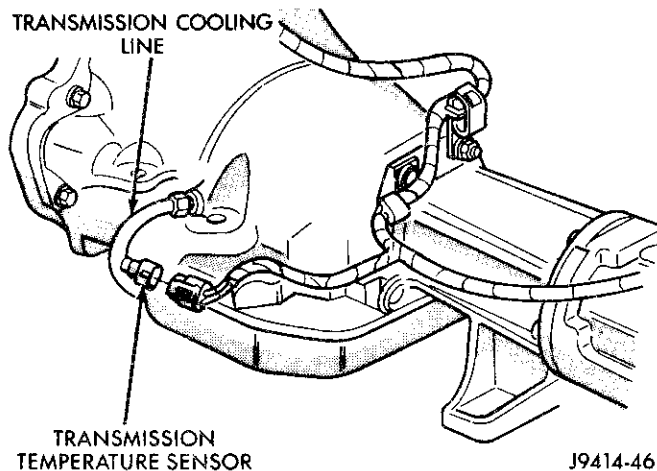
TRANSMISSION TEMPERATURE SENSOR—PCM INPUT**DIESEL WITH AUTOMATIC TRANSMISSIONS ONLY**

The transmission temperature sensor is a variable, thermistor type. It reacts to temperature changes. At cold transmission oil temperatures, its resistance is high. As temperatures increase, its resistance will decrease.

DESCRIPTION AND OPERATION (Continued)**Fig. 8 Throttle Position Sensor Location—Diesel**

The transmission temperature sensor is used on models equipped with an automatic transmission. Its purpose is to help control transmission fluid overheating. If transmission overheating has been determined by this sensor (temp. above approximately 280 degrees F), an input is sent to the powertrain control module (PCM). The PCM will then force a 4-3 downshift. Once transmission temperature has cooled below specifications, a 3-4 upshift will be allowed. An instrument panel mounted transmission temperature warning lamp is also used.

This sensor is located in the transmission cooling line on the side of the transmission (Fig. 9).

**Fig. 9 Transmission Temperature Sensor Location—Typical****TRANSMISSION GOVERNOR PRESSURE SENSOR—PCM INPUT**

Provides a signal proportional to the transmission governor pressure. It provides feedback for control of the variable force solenoid, which regulates transmission governor pressure. This input is used with 4-speed electronic transmissions only.

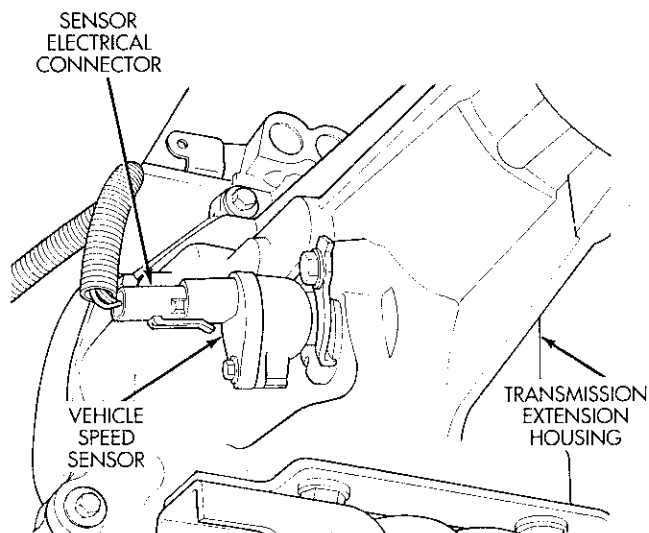
VEHICLE SPEED SENSOR AND DISTANCE—PCM INPUT

The speed sensor (Fig. 10) is located in the extension housing of the transmission (2WD) or on the transfer case extension housing (4WD). The sensor input is used by the powertrain control module (PCM) to determine vehicle speed and distance traveled.

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the throttle position sensor (auto. trans. only), indicate a closed throttle deceleration to the PCM. When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received).

In addition to determining distance and vehicle speed, the output from the sensor is used to help control:

- Speed control operation
- Transmission overdrive operation
- Transmission torque converter electrical operation

**Fig. 10 Vehicle Speed Sensor—Typical**

DESCRIPTION AND OPERATION (Continued)

WATER-IN-FUEL SENSOR—PCM INPUT

The water-in-fuel (WIF) sensor is located at the bottom of the fuel filter/water separator (Fig. 11).

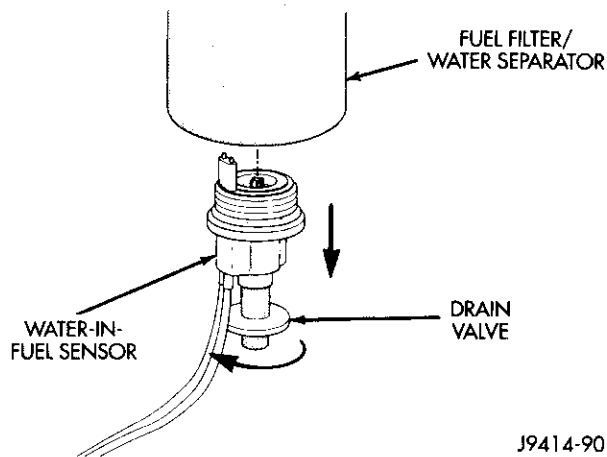


Fig. 11 Water-in-Fuel Sensor

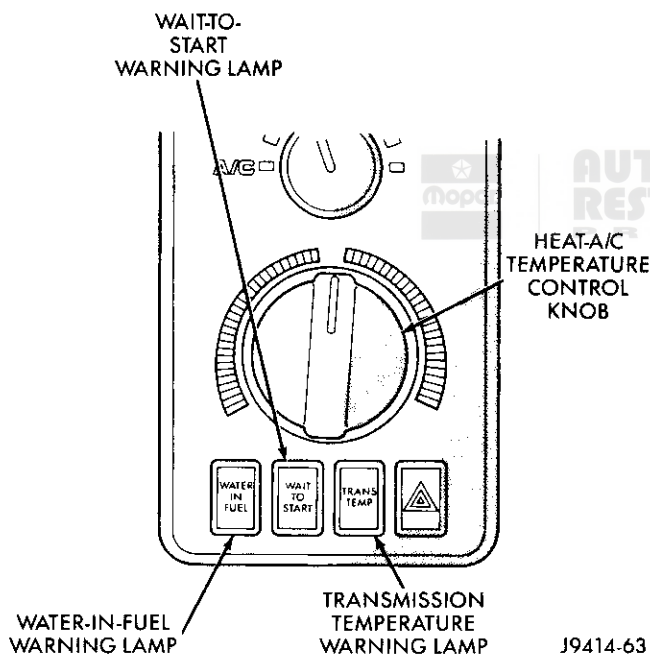


Fig. 12 Wait-to-Start and Water-in-Fuel Warning Lamp Location

The sensor sends an input to the powertrain control module (PCM) when it senses water in the fuel filter/water separator. As the water level in the filter/separators increases, the resistance across the WIF sensor decreases. This decrease in resistance is sent as a signal to the PCM and compared to a high water standard value. Once the value reaches 30 to 40 kilohms, the PCM will activate the instrument panel mounted, water-in-fuel warning lamp (Fig. 12). This all takes place when the ignition key is initially put in the ON position. The PCM continues to monitor

the input at the end of the intake manifold air heater post-heat cycle.

WATER-IN-FUEL WARNING LAMP—PCM INPUT

The PCM turns the water-in-fuel indicator lamp to the ON position if water is detected in the fuel. The water-in-fuel indicator lamp is located in the instrument panel (Fig. 12). The lamp will illuminate for about two seconds each time the ignition key is initially turned to the ON position as a bulb check.

Also refer to Water-In-Fuel Sensor—PCM Input for additional information.

AIR CONDITIONING CLUTCH RELAY—PCM OUTPUT

The A/C relay is located in the Power Distribution Center (PDC) (Fig. 13). Refer to label on PDC cover for relay location.

The powertrain control module (PCM) activates the A/C compressor through the A/C clutch relay. The PCM regulates A/C compressor operation by switching the ground circuit for the A/C clutch relay on and off.

The PCM will also de-energize the relay if coolant temperature exceeds 125°C (257°F).

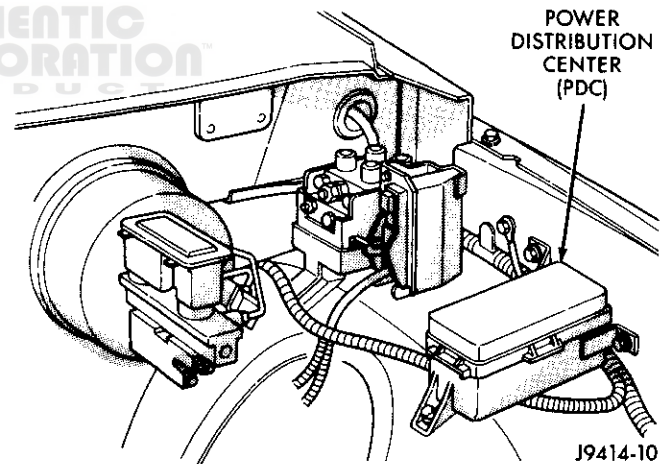


Fig. 13 Power Distribution Center (PDC) Location

AUTOMATIC SHUTDOWN (ASD) RELAY—PCM OUTPUT

This circuit controls operation of the ASD relay. It provides the necessary power to operate the generator field control for charging system operation.

The ASD relay is located in the power distribution center (PDC). The PDC is located in the engine compartment. For location of relay within the PDC, refer to PDC cover.

GENERATOR LAMP-PCM OUTPUT

If the powertrain control module (PCM) senses a low charging condition in the charging system, it will

DESCRIPTION AND OPERATION (Continued)

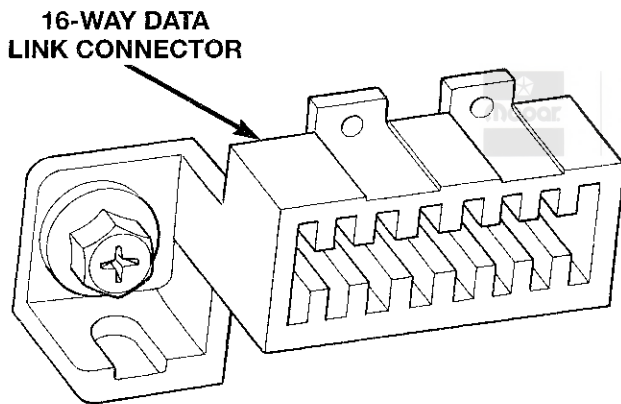
illuminate the generator lamp (if equipped) on the instrument panel. For example, during low idle with all accessories turned on, the lamp may momentarily go on. Refer to Groups 8A and 8C for charging system information.

GENERATOR FIELD—PCM OUTPUT

The powertrain control module (PCM) regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Groups 8A and 8C for charging system information.

DATA LINK CONNECTOR—PCM INPUT AND OUTPUT

The 16-way data link connector (diagnostic scan tool connector) links the Diagnostic Readout Box (DRB) scan tool or the Mopar Diagnostic System (MDS) with the powertrain control module (PCM). The data link connector (Fig. 14) is located at lower edge of instrument panel near steering column. For operation of the DRB scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.



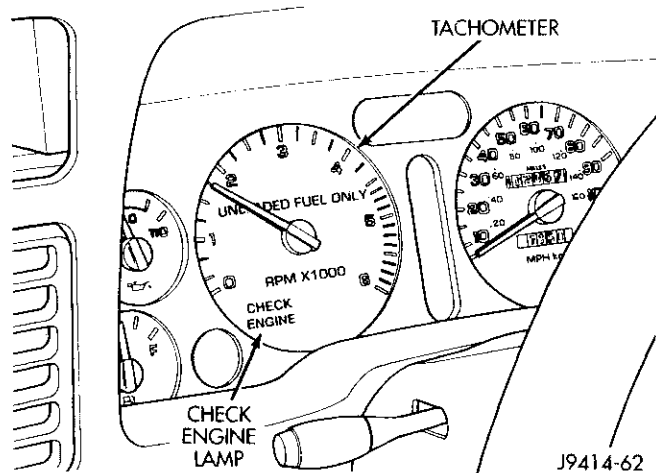
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Fig. 14 16-Way Data Link Connector**MALFUNCTION INDICATOR LAMP—PCM OUTPUT**

The malfunction indicator lamp illuminates on the instrument panel each time the ignition key is turned on. This lamp is displayed on the instrument panel as the CHECK ENGINE lamp (Fig. 15). Note that the lamp will illuminate for approximately two seconds each time the key is initially turned to the ON position. This feature is used as a bulb check.

If the powertrain control module (PCM) receives an incorrect signal, or no signal from certain sensors or components, the lamp is turned on. This is a warning that the PCM has recorded a system or sensor malfunction. It signals an immediate need for service.

The lamp can also be used to display a diagnostic trouble code (DTC). Cycle the ignition switch On-Off-

**Fig. 15 Check Engine Lamp—Typical Location**

On-Off-On within three seconds and any codes stored in the PCM memory will be displayed. This is done in a series of flashes representing digits. Refer to On-Board Diagnostics in the General Diagnosis section of this group for more information.

OVERDRIVE LAMP—PCM OUTPUT

This circuit controls a signal for the operation of the instrument panel mounted push-button overdrive lamp switch. When the lamp is illuminated, the overdrive is disengaged.

OVERDRIVE/OVERRIDE SWITCH-PCM INPUT

On vehicles equipped with an automatic transmission and overdrive, the powertrain control module (PCM) regulates the 3-4 overdrive up-shift and down-shift through the overdrive solenoid. This solenoid is located in the transmission. An overdrive/override push-button switch is located on the instrument panel.

The PCM circuit for overdrive is controlled by inputs from the engine coolant temperature sensor and vehicle speed sensor. If coolant temperature and vehicle speed are not within the preset PCM specifications, the PCM will not allow the transmission to shift into overdrive. These preset PCM specifications must be met before the push-button switch will be allowed to control overdrive operation.

The overdrive/override push-button switch is normally closed (overdrive allowed) when the lamp is not illuminated. It opens (overdrive not allowed) when the operator presses the switch and the lamp is illuminated. The switch will revert to its normally closed position (lamp off) each time the ignition switch is turned on. The transmission downshifts if the operator presses the override switch while in overdrive.

Refer to Group 21 for more transmission information.

DESCRIPTION AND OPERATION (Continued)

SPEED CONTROL SOLENOIDS—PCM OUTPUT

Speed control operation is regulated by the powertrain control module (PCM). The PCM controls the vacuum to the throttle actuator through the speed control vacuum and vent solenoids. Refer to Group 8H for Speed Control Information.

TACHOMETER—PCM OUTPUT

The powertrain control module (PCM) supplies engine rpm values to the instrument cluster tachometer. Refer to Group 8E for tachometer information.

TORQUE CONVERTOR CLUTCH (TCC) SOLENOID—PCM OUTPUT

AUTOMATIC TRANSMISSION ONLY

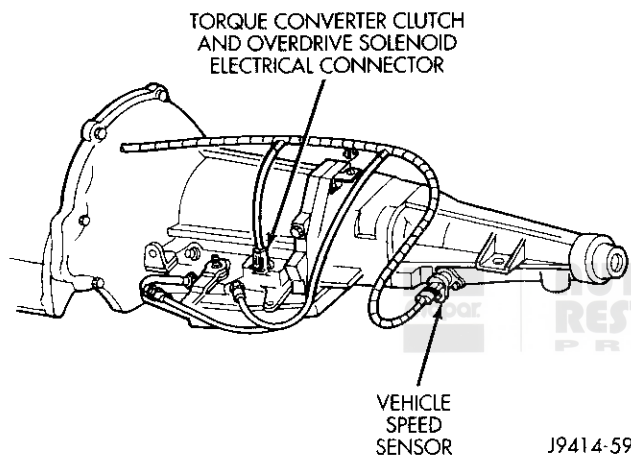


Fig. 16 Electrical Connections at Transmission—TCC and Overdrive Solenoids

The powertrain control module (PCM) will determine when to engage and disengage the solenoid by monitoring vehicle miles per hour (mph). Also needed are various inputs from the module timer, engine rpm and throttle position sensor.

TRANSMISSION TEMPERATURE WARNING LAMP—PCM OUTPUT

AUTOMATIC TRANSMISSION ONLY

An instrument panel mounted lamp (Fig. 17) is used to warn of a possible transmission fluid overheating condition. When transmission fluid temperature has been determined to be above approximately 280 degrees F by the transmission temperature sensor, a signal is sent to the powertrain control module (PCM). The PCM will then control warning lamp operation. The lamp will illuminate for about two seconds each time the ignition key is initially turned to the ON position as a bulb check.

This feature is used with certain heavy-duty automatic transmissions only.

Also refer to Transmission Temperature Sensor—PCM Input for additional information.

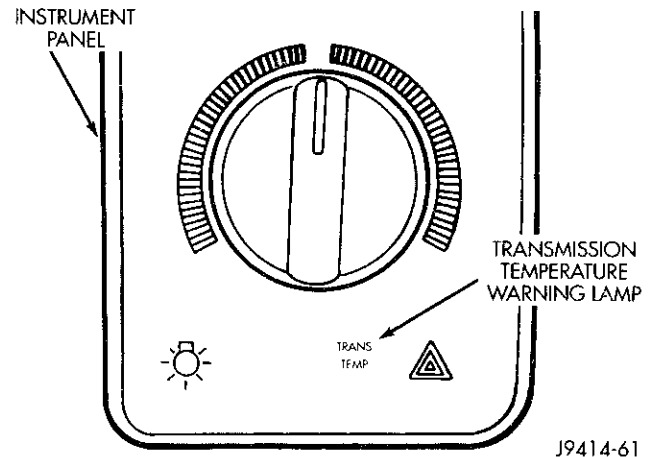


Fig. 17 Transmission Temperature Warning Lamp—Typical Location

WAIT-TO-START LAMP WARNING LAMP—PCM OUTPUT

The wait-to-start warning lamp is turned on and off by the PCM based on the intake manifold air temperature sensor input. The lamp is located on the instrument panel.

The lamp is turned on when the ignition is first activated. If the PCM reads intake manifold air temperature below 15°C (59°F), it will turn the wait-to-start warning lamp on for the air heater preheat cycle. The lamp stays on until the preheat cycle is over.

The wait-to-start lamp will flash on and off if the intake manifold air temperature sensor input to the PCM is below minimum value or above maximum value. The PCM stores a DTC when these conditions occur.

Refer to Intake Manifold Air Heater for additional information.

DIAGNOSIS AND TESTING

VISUAL INSPECTION

A visual inspection for loose, disconnected, or incorrectly routed wires and hoses should be made before attempting to diagnose or service the diesel fuel injection system. A visual check will help find these conditions. It also saves unnecessary test and diagnostic time. A thorough visual inspection of the fuel injection system includes the following checks:

(1) Be sure that the battery connections (on both batteries) are tight and not corroded.

DIAGNOSIS AND TESTING (Continued)

(2) Be sure that the three 32-way connectors are fully engaged into the powertrain control module (PCM) (Fig. 18).

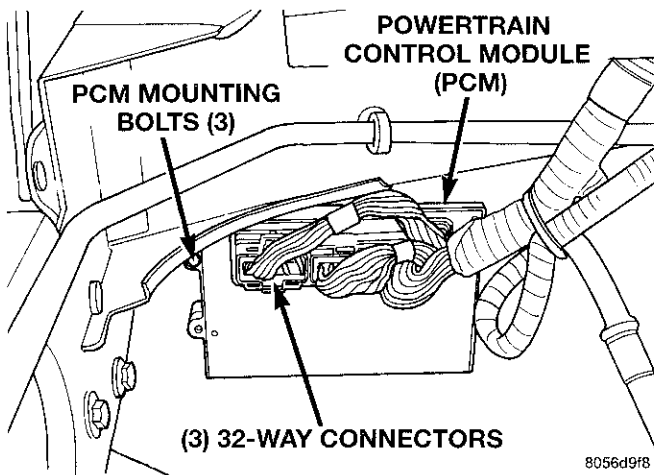


Fig. 18 PCM Location—Typical

(3) Be sure that the electrical connections at the intake manifold air heater relays (Fig. 19) are tight and not corroded.

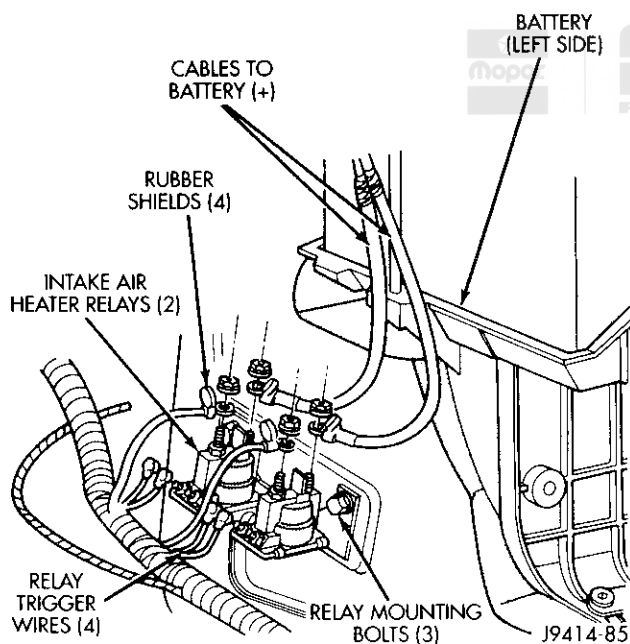


Fig. 19 Intake Manifold Air Heater Relays

(4) Inspect the starter motor and starter solenoid connections for tightness and corrosion.

(5) Verify that the electrical connector is firmly connected to the intake manifold air temperature sensor. Inspect the connector for corrosion or damaged wires. The sensor is located on the top of the intake manifold (Fig. 20).

(6) Verify that the water-in-fuel (WIF) sensor electrical connector is firmly attached to the sensor (Fig.

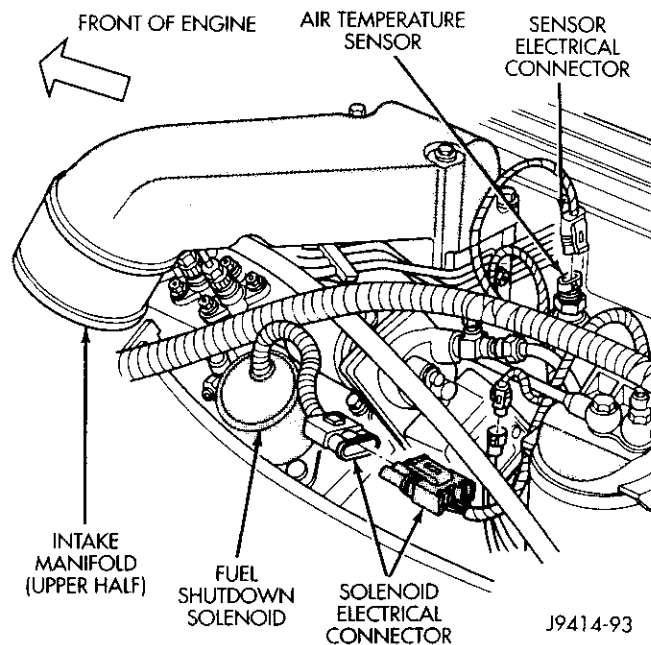


Fig. 20 Air Temperature Sensor and Fuel Shutdown Solenoid

21). Inspect the connector for corrosion or damaged wires.

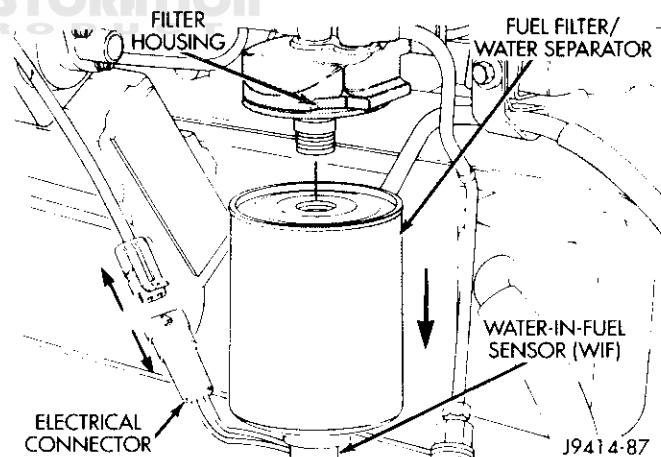


Fig. 21 Water-in-Fuel (WIF) Sensor

(7) Check for water in the fuel filter/water separator. A water drain is supplied on the filter/separator. Refer to Fuel Filter/Water Separator in the Diesel Engine—Component Removal/Installation section of this group for draining water.

(8) Verify that the electrical connector is firmly connected to the fuel shutdown solenoid on the injection pump (Fig. 20). Inspect the connector for corrosion or damage.

DIAGNOSIS AND TESTING (Continued)

(9) Be sure that the intake manifold air heater electrical cable connections at the intake manifold are tight and free of corrosion (Fig. 22).

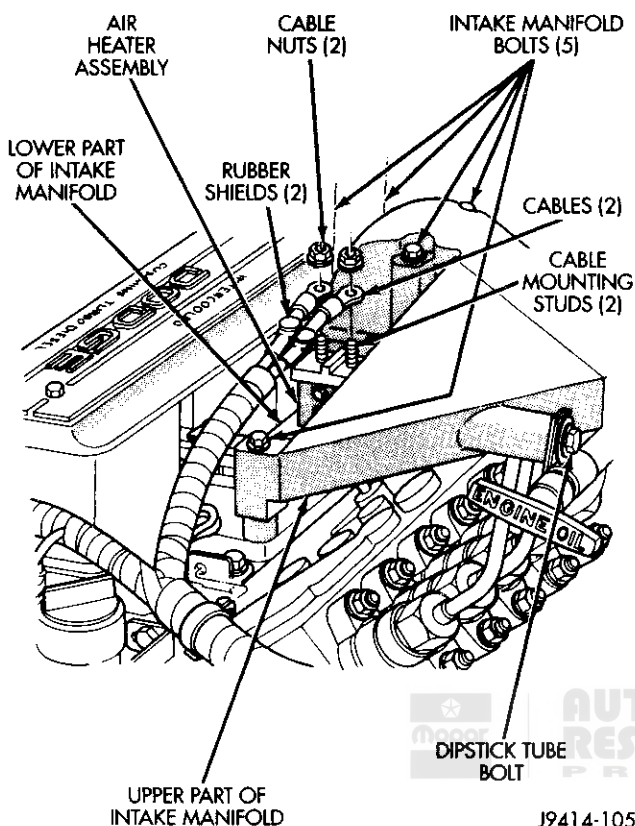


Fig. 22 Air Heater Cable Connections

(10) Inspect the throttle linkage and accelerator linkage for binding.

(11) Be sure that the throttle return spring is connected.

(12) Inspect all fuel supply and return lines for signs of leakage.

(13) Be sure that the ground connections are tight and free of corrosion. Refer to Group 8, Wiring for locations of ground connections.

(14) Inspect the air cleaner element (filter) for restrictions by using the built-on Filter Minder[®]. Do not remove the top of air cleaner housing to inspect condition of air cleaner element. Refer to Diesel Engine Component Removal/Installation section for Filter Minder information.

(15) Be sure that the turbocharger output hose is connected to the charge air cooler (intercooler) inlet tube. Verify that the charge air cooler output hose is connected to the cooler and the intake manifold.

(16) Be sure that the vacuum pump-to-brake booster hose is connected and not damaged.

(17) Be sure that the accessory drive belt is not damaged or slipping.

(18) Automatic Transmission Only: Raise the vehicle and check the electrical connection at the transmission temperature sensor (Fig. 23).

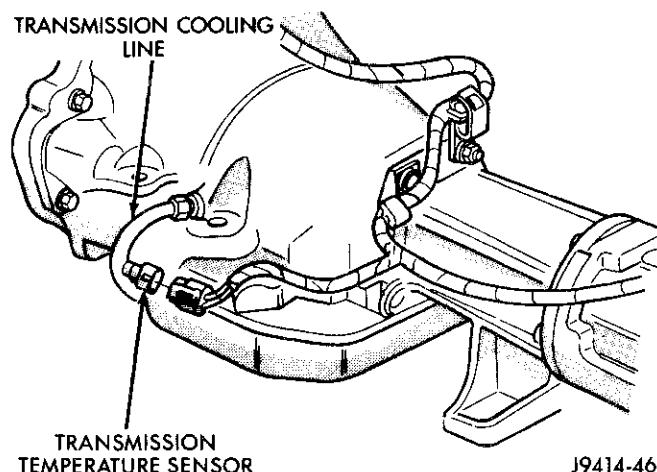


Fig. 23 Transmission Temperature Sensor Location—Typical

(19) Automatic Transmission Only: Be sure the electrical connector is firmly connected to the plug leading to the overdrive solenoid in the transmission.

AUTOMATIC SHUTDOWN (ASD) RELAY TEST

To perform a complete test of the ASD relay and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the relay only, refer to Relays—Operation/Testing in this section of the group.

ENGINE SPEED SENSOR TEST

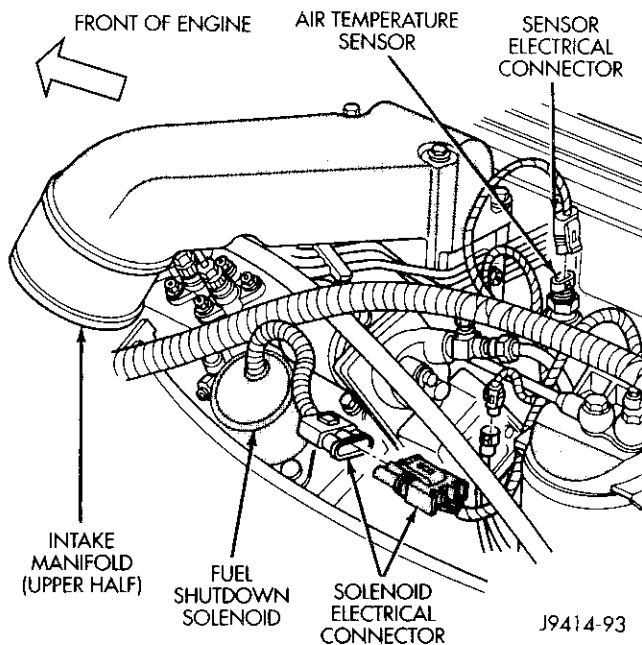
To perform a complete test of this sensor and its circuitry, refer to the appropriate Powertrain Diagnostic Procedures manual.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR TEST

To perform a complete test of this sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the intake manifold air temperature sensor. The sensor is located on the top of the intake manifold and to the rear of the air heater (Fig. 24).

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Sensor Resistance (OHMS)—Intake Manifold Air Temperature resistance chart (Fig. 25). Replace the sensor if it is not within the range of resistance specified in the chart.

DIAGNOSIS AND TESTING (Continued)**Fig. 24 Air Temperature Sensor Location—Diesel**

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
-40	-40	291,490	381,710
-20	-4	85,850	108,390
-10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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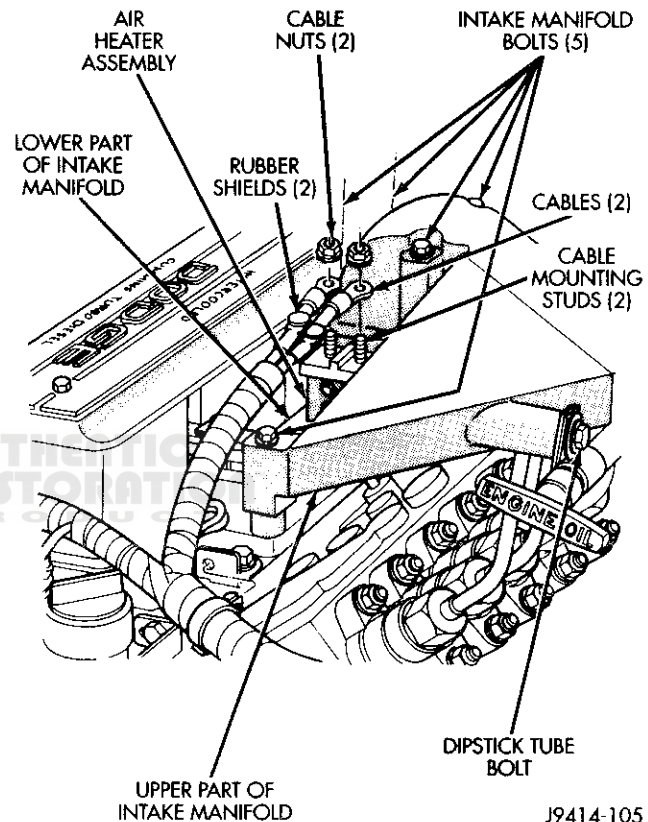
Fig. 25 SENSOR RESISTANCE (OHMS)—INTAKE MANIFOLD AIR TEMPERATURE SENSOR

(3) Test the resistance of the wire harness. Do this between the powertrain control module (PCM) wire harness connector terminal A-15 and the sensor connector terminal. Also check between PCM terminal A-4 (sensor return) to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

INTAKE MANIFOLD AIR HEATER TEST

The intake manifold air heater (Fig. 26) is controlled by the powertrain control module (PCM) through the intake manifold air heater relays (Fig. 27). This is done after a specified signal is sent to the PCM from the intake manifold air temperature sensor.

Two heating elements are located within the air heater assembly. A separate heavy-duty cable is connected to a separate terminal to supply power for each element.

**Fig. 26 Intake Manifold Air Heater****PREHEAT/POST-HEAT CYCLE**

Refer to the Intake Manifold Air Heater Relays—PCM Output for preheat/post heat cycle information.

The PCM provides a ground path for the intake manifold air heater relays. The ground path is provided if intake manifold air temperature is 15°C (59°F) when the ignition key is initially placed in the ON position. When the ground is provided, the air heater is energized to start the preheat cycle.

The preheat-cycle can be tested with a voltmeter or test light. If the intake manifold air temperature is above 15°C (59°F), the wait-to-start warning lamp will not illuminate and the air heater will not be energized.

DIAGNOSIS AND TESTING (Continued)

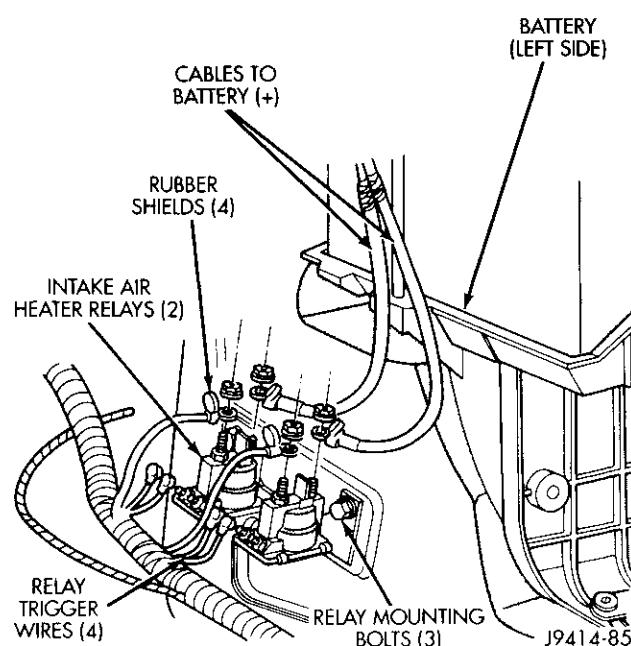


Fig. 27 Intake Manifold Air Heater Relays

(1) With the engine not running and ambient air temperature below 15°C (59°F), turn the ignition key to the ON position.

(2) The wait-to-start warning lamp will come on and the air heater relays should click ON signaling the start of the preheat cycle. **If the engine starter is engaged before the preheat cycle of the heaters is complete, the PCM will stop the remaining preheat cycle.**

(3) Check for battery voltage at both air heater terminals (Fig. 26). **The heater will only be energized for 10 to 30 seconds.** Refer to the following Air Heater Cycle Chart (Fig. 28) for a time/temperature comparison.

INTAKE MANIFOLD TEMPERATURE-KEY ON POSITION	PRE-HEAT CYCLE TIME-IGNITION ON, ENGINE NOT RUNNING	POST-HEAT CYCLE-IGNITION ON, ENGINE RUNNING
Above 15° C (59° F)	0 seconds	No
-10° C to 15° C (15° F to 59° F)	10 seconds	Yes
-18° C to -10° F (0° F to 15° F)	15 seconds	Yes
Below -18° C (0° F)	30 seconds	Yes

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Fig. 28 AIR HEATER CYCLE CHART

HEATER TEST

(1) Disconnect both negative battery cables at both batteries.

(2) Lift the rubber shields from each of the cable connectors at the intake manifold air heater (Fig. 26) to expose the cable terminals. Do not disconnect cable nuts.

(3) Use an ohmmeter to test the resistance between the cable terminal (not the mounting stud) and a ground. The resistance should be zero (0). If not, inspect for corroded or dirty cable connections. Clean or repair the connections and retest before replacing heater. If resistance is now anything other than zero (0), proceed to next step.

(4) Disconnect both cables from the intake manifold heater (two nuts) (Fig. 26).

(5) Measure the resistance from each of the air heater terminal threaded studs to a ground. The resistance should be zero (0). If the ohmmeter is still reading anything other than zero (0), replace the intake manifold air heater elements. The heater elements are part of the intake manifold and will require manifold replacement.

(6) After testing and repairing, connect battery cables to both batteries.

INTAKE MANIFOLD AIR HEATER RELAY TEST

To test the intake manifold air heater, refer to the previous Intake Manifold Air Heater Test.

To test the intake manifold air heater relays, refer to the following:

(1) Disconnect both negative battery cables at both batteries.

(2) Disconnect the four small relay trigger wires at both relays (Fig. 27). Note position of wires before removal.

(3) Disconnect the four large cables at each of the relay terminals (four nuts) (Fig. 27). Note position of cables before removal.

(4) Attach an ohmmeter across two of the large studs on one of the relays.

(5) Attach a jumper wire (+ and -) to each of the small terminals on one of the relays. Polarity is not important.

(6) Momentarily touch the jumper wires to the vehicle battery (+ and -). The relay should click and the ohmmeter should show a closed circuit across the large terminals. If not, replace relay and bracket assembly.

(7) Repeat the same test on the opposite relay.

(8) After testing and repairing, connect battery cables to both batteries.

DIAGNOSIS AND TESTING (Continued)**THROTTLE POSITION SENSOR TEST**

The throttle position sensor (TPS) is used on diesel engines only when equipped with an automatic transmission.

Refer to Throttle Position Sensor in the Component Removal/Installation section. This will give adjustment, testing and removal/installation procedures.

TRANSMISSION TEMPERATURE SENSOR TEST**AUTOMATIC TRANSMISSION ONLY**

To perform a complete test of this sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the temperature sensor. The sensor is located on the side of the transmission in the transmission cooling line (Fig. 29).

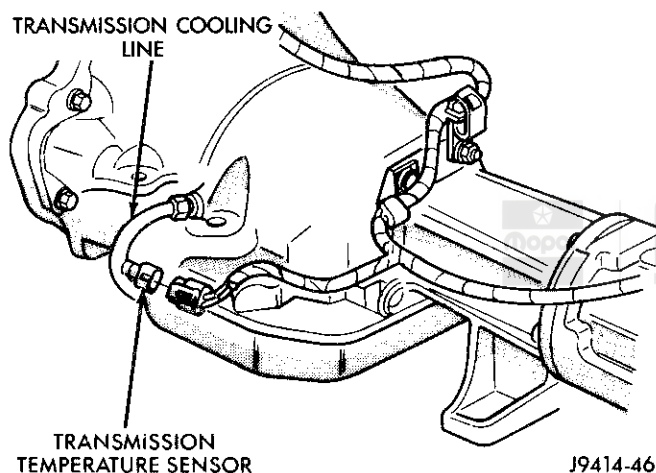


Fig. 29 Transmission Temperature Sensor Location—Typical

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Sensor Resistance (OHMS)—Transmission Temperature Sensor resistance chart (Fig. 30). Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the powertrain control module (PCM) wire harness connector terminal B-1 and the sensor connector terminal. Also check between PCM terminal A-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
-40	-40	291,490	381,710
-20	-4	85,850	108,390
-10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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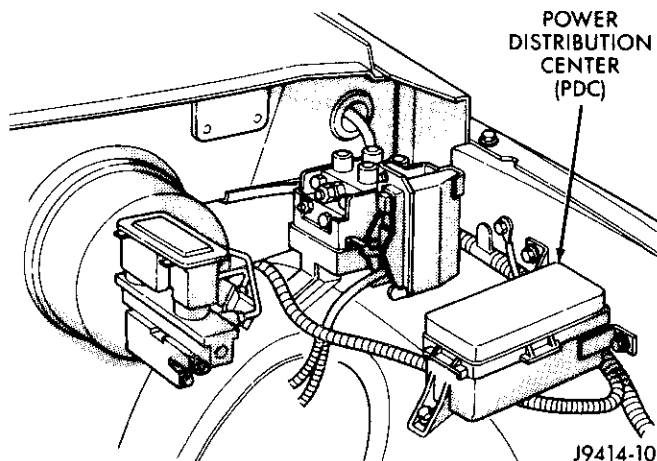
Fig. 30 SENSOR RESISTANCE (OHMS)—TRANSMISSION TEMPERATURE SENSOR

VEHICLE SPEED SENSOR

To perform a complete test of the sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

REMOVAL AND INSTALLATION**AUTOMATIC SHUTDOWN (ASD) RELAY**

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 31). Refer to label on PDC cover for relay location. Check terminal connections at PDC and relay for damage/corrosion before installation. Repair as necessary.



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Fig. 31 Power Distribution Center (PDC)

REMOVAL AND INSTALLATION (Continued)

ENGINE SPEED SENSOR

The engine speed (rpm) sensor is located on the front of engine (Fig. 32). Spacers located behind the sensor are used to position sensor over the vibration damper.

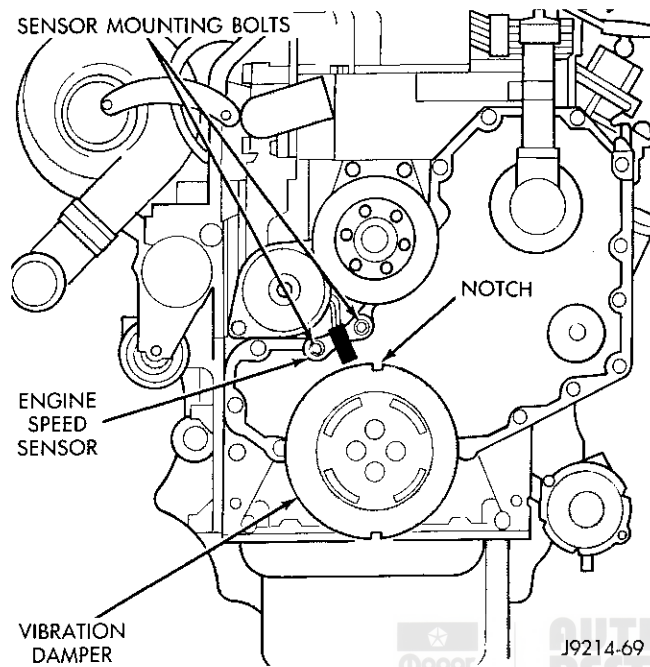


Fig. 32 Engine Speed Sensor—Diesel

REMOVAL

Before removing the sensor, note the position and routing of the sensor wiring harness. This routing must be maintained to prevent wiring from contacting belt or pulleys.

- (1) Disconnect the speed sensor pigtail harness from the main engine wiring harness near the front/top of engine.
- (2) Remove the clip bolts from the sensor pigtail wiring harness.
- (3) Remove the two speed sensor mounting nuts (Fig. 32).
- (4) Remove the speed sensor and its mounting spacers from the vehicle.

INSTALLATION/ADJUSTMENT

The engine speed sensor uses a slotted hole on one side (Fig. 33) to adjust its depth. A brass (non-magnetic) feeler gauge must be used to adjust the sensor.

Sensor-to-vibration damper air gap is: 1.25 MM (.049 in.) minimum to 1.30 MM (.051 in.) maximum.

- (1) Position speed sensor, its mounting spacers and two mounting nuts to the engine. Install mounting nuts finger tight.
- (2) Route sensor wiring harness behind engine pulleys. Install and tighten wiring harness clip bolts.

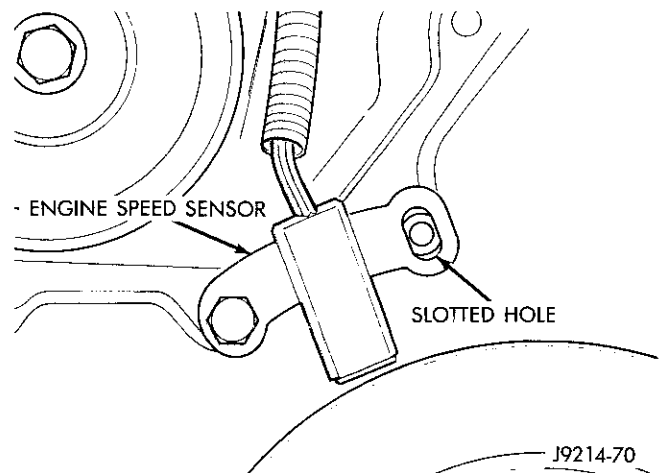


Fig. 33 Engine Speed Sensor—Installation

(3) Place the feeler gauge between the sensor and the vibration dampener.

(4) Gently seat (push down) the sensor until it contacts the feeler gauge. **Be sure the sensor is not near either of the notches (Fig. 32) on the vibration damper. If sensor is adjusted at or near these notches, it will be damaged when engine is started.**

(5) Tighten sensor mounting nuts to 24 N·m (18 ft. lbs.) torque.

(6) Remove feeler gauge.

(7) Connect the sensor electrical connector to the main engine wiring harness.

THROTTLE POSITION SENSOR

AUTOMATIC TRANSMISSION ONLY

The throttle position sensor (TPS) is used on the diesel powered engine only when equipped with an automatic transmission. If the TPS is to be replaced on a diesel engine, it must be test-adjusted after replacement.

REMOVAL

- (1) Disconnect the electrical connector on bottom of TPS (Fig. 34).
- (2) Remove the two TPS mounting bolts.
- (3) Remove the sensor from bracket.

INSTALLATION

(1) Position the TPS to the mounting bracket. The electrical connector should be facing downward.

NOTE: The TPS is spring loaded. After positioning the TPS to its mounting bracket, rotate the TPS on the bracket in a counterclockwise direction until the two bolt holes align.

- (2) Install and tighten two bolts.

REMOVAL AND INSTALLATION (Continued)

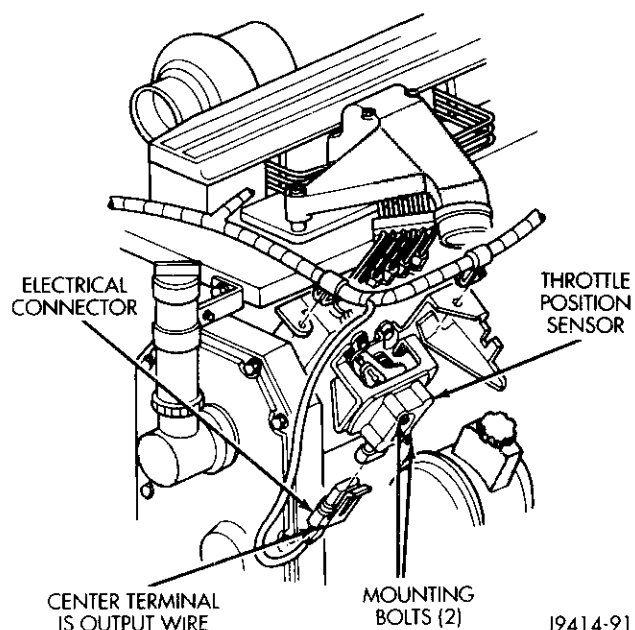


Fig. 34 Throttle Position Sensor—Diesel

(3) Connect the electrical connector on bottom of TPS.

(4) Operate the throttle by hand to check for binding.

(5) The TPS voltage must now be tested and (if necessary) adjusted. Refer to the following: Throttle Position Sensor Testing.

THROTTLE POSITION SENSOR TESTING

CAUTION: Before attempting to test the TPS, verify the linkage adjustment dimension (Fig. 35). This dimension **MUST** be 126.5 mm (5.0 inches) **BEFORE** testing. For linkage adjustment procedures, refer to Throttle Linkage Adjustment—Diesel Engine. This can be found in the Accelerator Pedal and Throttle Cable section of this group.

CAUTION: Before testing the TPS, verify that the engine is set at correct low idle speed. Refer to Idle Speed Adjustment.

(1) After confirming the correct linkage adjustment and idle speed, proceed to the following:

(2) Attach a paper clip into the center terminal (Fig. 34) of the TPS electrical connector. Do not remove the connector from the TPS for this test.

(3) Attach the positive lead of a voltmeter to this paper clip and the negative lead to a good ground.

(4) Turn the ignition switch to the ON position. Do not start engine.

(5) The voltage at the TPS center terminal should be 1.0 volt ($\pm .2$ volt) with linkage at idle position. At

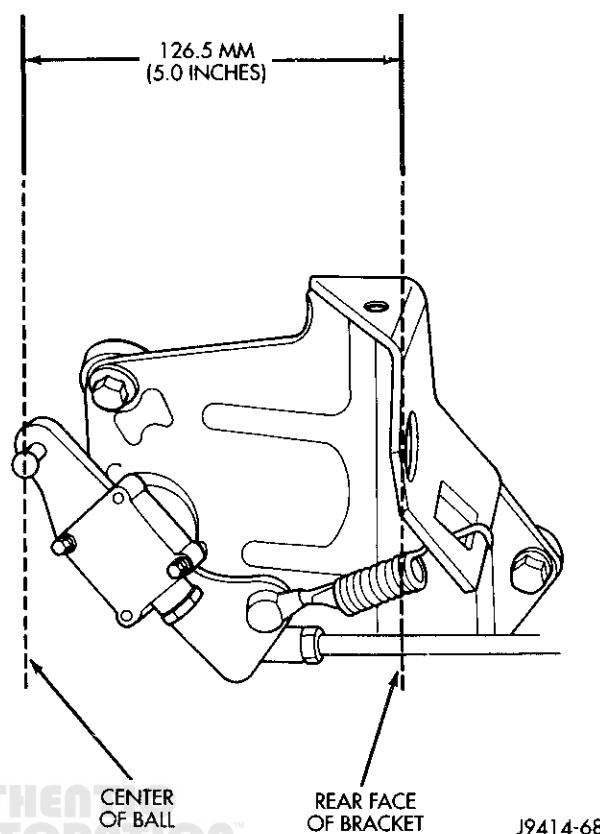


Fig. 35 Linkage Measurement—Diesel

wide open throttle (WOT), the output voltage must be 2.2-to-2.9 volts higher than at idle speed. If voltage is not correct, proceed to adjusting linkage.

(6) The linkage rod (Fig. 36) connecting the throttle lever to the fuel injection pump lever is adjustable. To prevent damage to the ends of linkage, attach locking-type pliers to the flat (Fig. 36) located on the linkage rod before loosening locknuts.

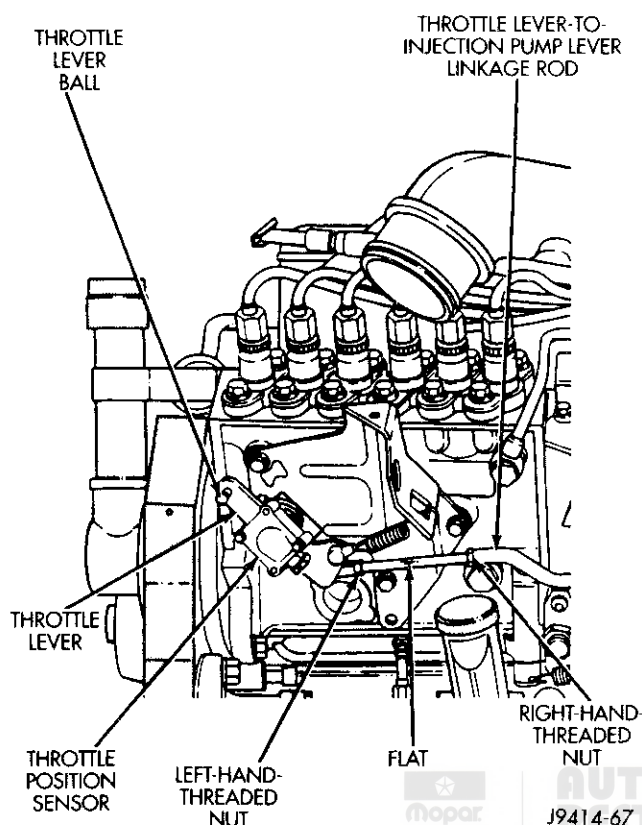
(7) Loosen the right-hand-threaded nut (Fig. 36).

(8) Loosen the left-hand-threaded nut (Fig. 36).

(9) Slowly rotate the flat (Fig. 36) on the linkage rod (lengthen or shorten) to achieve 1.0 volt ($\pm .2$ volts) on the voltmeter with the linkage in the idle position. At wide open throttle (WOT), the output voltage must be 2.2-to-2.9 volts higher than at idle speed. **DO NOT** lengthen or shorten the linkage rod more than 1 mm from the dimension shown in (Fig. 35). If voltage requirements cannot be met by linkage adjustment (125.6 to 127.6 mm), replace the TPS.

(10) Tighten both nuts after adjustment.

(11) With the engine OFF, operate the throttle from accelerator pedal and check for throttle lever action and binding. Be sure throttle lever stop is against the low idle speed screw after throttle is released.

REMOVAL AND INSTALLATION (Continued)**Fig. 36 Throttle Lever Linkage Adjustment—Diesel**

(12) Be sure of wide open throttle (WOT) when accelerator pedal is pressed to the floor. This is checked by observing throttle lever breakover position. Proceed to the following:

(a) Key OFF and engine OFF for this test.

(b) Two people are needed for this test. From inside of the vehicle, press the accelerator pedal about half-way to the floor. Movement of both the throttle lever and throttle lever-to-injection pump lever linkage rod (Fig. 36) should be observed.

(c) Continue to press the accelerator pedal to the floor. If throttle lever breakover is operating correctly, the throttle lever-to-injection pump lever linkage rod should have stopped moving while the throttle lever continues to move towards the rear of vehicle.

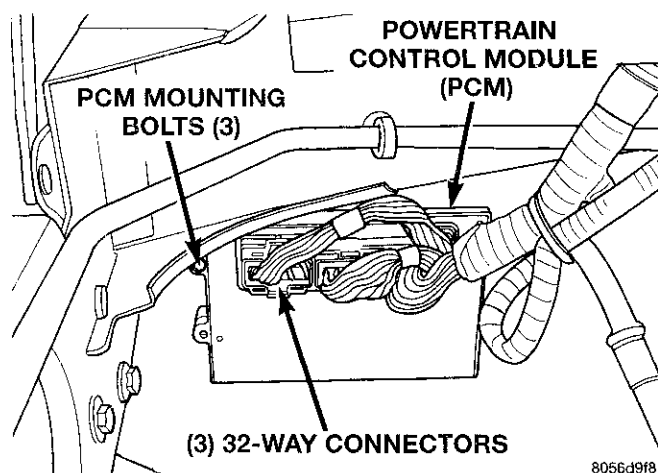
(13) Again, check and verify low idle speed. Adjust if necessary.

POWERTRAIN CONTROL MODULE

The PCM is located in the engine compartment (Fig. 37).

REMOVAL

(1) Disconnect the negative battery cable at battery.

**Fig. 37 PCM Location and Mounting**

(2) Carefully unplug the three 32-way connectors from PCM.

(3) Remove three PCM mounting bolts and remove PCM from vehicle.

INSTALLATION

(1) Install PCM and mounting bolts to vehicle.

(2) Tighten bolts to 4 N·m (35 in. lbs.).

(3) Check pin connectors in the PCM and the three 32-way connectors for corrosion or damage. Repair as necessary.

(4) Install three 32-way connectors.

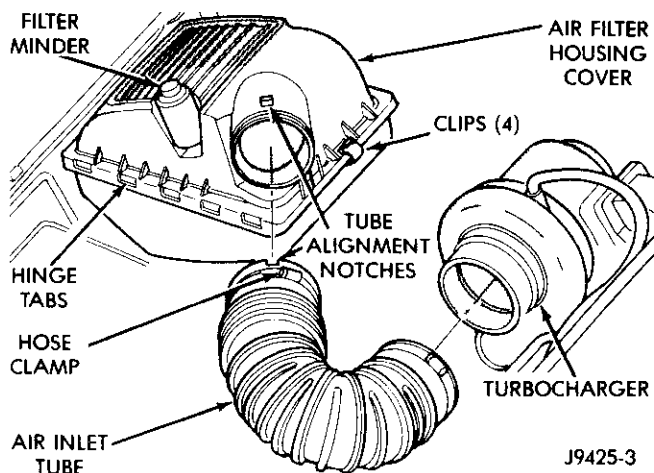
(5) Install battery cable.

AIR CLEANER HOUSING/AIR CLEANER ELEMENT**TESTING AIR CLEANER ELEMENT**

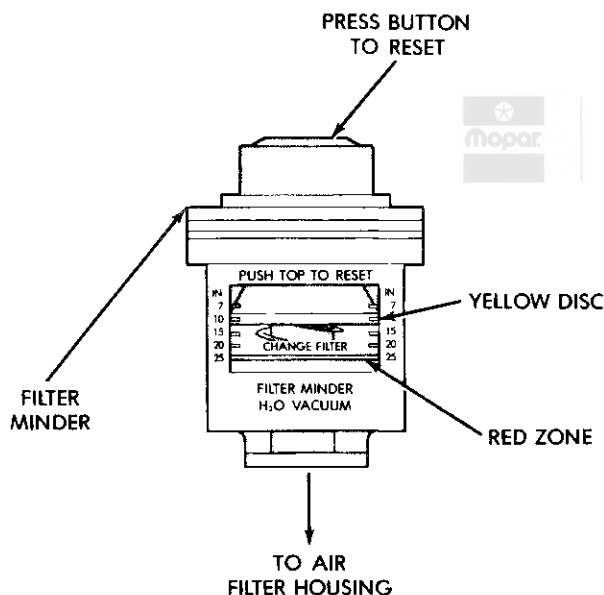
Do not attempt to unnecessarily remove the top of the air cleaner housing for air cleaner element inspection on diesel engines.

The air cleaner (filter) housing is equipped with an air Filter Minder[®] gauge (Fig. 38). This air flow restriction gauge will determine when the air cleaner element is restricted and should be replaced.

The Filter Minder[®] consists of a diaphragm and calibrated spring sealed inside of a plastic housing (Fig. 39). A yellow colored disc attached to the diaphragm moves along a graduated scale on the side of the Filter Minder. After the engine has been shut off, a ratcheting device located within the Filter Minder will hold the yellow disc at the highest restriction that the air cleaner element has experienced. A drop in air pressure due to an air cleaner element restriction moves the diaphragm and the yellow disc will indicate the size of the air drop.

REMOVAL AND INSTALLATION (Continued)**Fig. 38 Filter Minder—Location—Diesel Engine**

CAUTION: Certain engine degreasers or cleaners may discolor or damage the plastic housing of the Filter Minder. Cover and tape the Filter Minder if any engine degreasers or cleaners are to be used.

**Fig. 39 Filter Minder[®]—Diesel Engine**

To test, turn the engine off. If the yellow disc (Fig. 39) has reached the red colored zone on the graduated scale, the air cleaner element should be replaced. Refer to the preceding removal/installation paragraphs.

Resetting the Filter Minder: After the air cleaner (filter) element has been replaced, press the rubber button on the top of the Filter Minder (Fig. 39). This will allow the yellow colored disc to reset. After the button has been pressed, the yellow disc should spring back to the UP position.

If the Filter Minder gauge has reached the red colored zone, and after an examination of the air cleaner (filter) element, the element appears to be clean, the high reading may be due to a temporary condition such as snow build-up at the air intake. Temporary high restrictions may also occur if the air cleaner (filter) element has gotten wet such as during a heavy rain or snow. If this occurs, allow the element to dry out during normal engine operation. Reset the rubber button on the top of the Filter Minder and retest after the element has dried.

REMOVAL/INSTALLATION

(1) Loosen the air inlet tube clamp at air cleaner housing inlet (Fig. 38). Remove this tube at air cleaner housing cover.

(2) The housing cover is equipped with four (4) spring clips (Fig. 38) and is hinged at the front with plastic tabs. Unlatch the clips from the top of air cleaner housing and tilt the housing cover up and forward for cover removal.

(3) Remove the air cleaner element from air cleaner housing.

(4) Before installing a new air cleaner element, clean inside of air cleaner housing.

(5) Position air cleaner cover to tabs on front of air cleaner housing. Latch the four spring clips to seal cover to housing.

(6) Install the air inlet tube at air cleaner housing inlet. Note the hose alignment notches at both the inlet hose and air cleaner cover (Fig. 38).

(7) Position the tube clamp to the inlet tube and tighten to 3 N·m (25 in. lbs.) torque.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

The intake manifold air temperature sensor is located on the top of intake manifold and to the rear of the intake manifold heater (Fig. 40).

REMOVAL

(1) Disconnect the electrical connector at the sensor.

(2) Remove the sensor (Fig. 40) the from intake manifold.

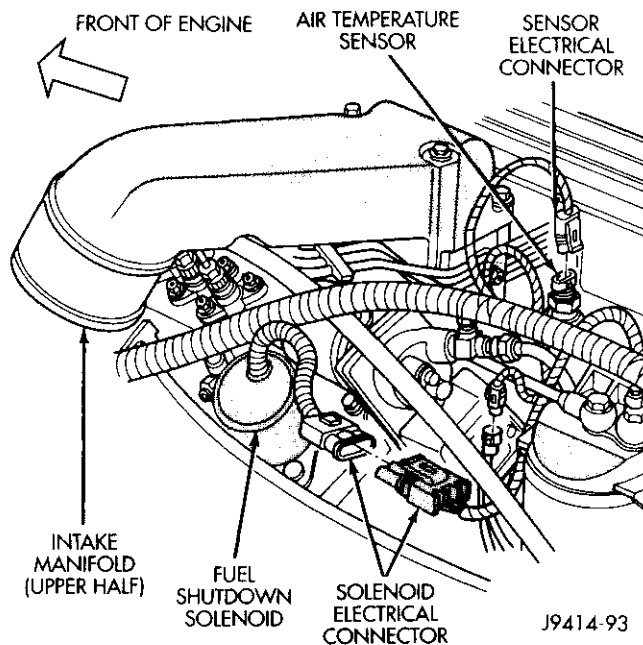
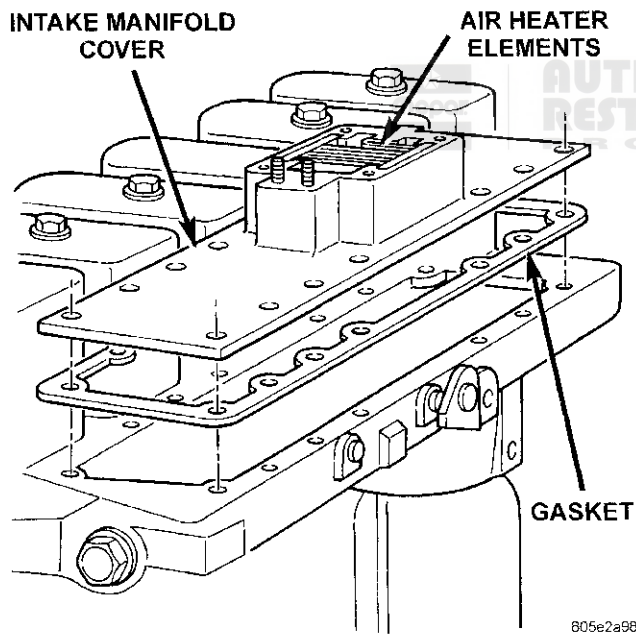
INSTALLATION

(1) Install sensor to intake manifold. Tighten to 28 N·m (20 ft. lbs.) torque.

(2) Install electrical connector.

INTAKE MANIFOLD AIR HEATER ELEMENTS

The intake manifold air heater elements are located within the top cover of the intake manifold (Fig. 41). If replacement of the elements is necessary, the intake manifold cover must be removed. Refer to Intake Manifold Removal/Installation in Group 11.

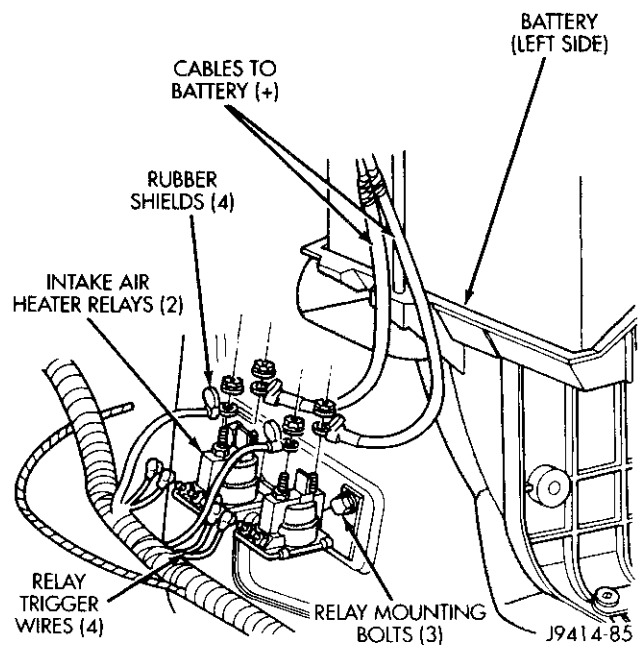
REMOVAL AND INSTALLATION (Continued)**Fig. 40 Air Temperature Sensor Location—Diesel****Fig. 41 Intake Manifold Air Heater Elements****INTAKE MANIFOLD AIR HEATER RELAYS**

The relays are located in the engine compartment, bolted to the left inner fender below the left battery (Fig. 42).

REMOVAL

The mounting bracket and both relays are replaced as an assembly.

(1) Disconnect both negative battery cables at both batteries.

**Fig. 42 Intake Manifold Air Heater Relays**

(2) Disconnect the four relay trigger wires at both relays (Fig. 42). Note the position of wiring before removing.

(3) Lift the four rubber shields from the four cables (Fig. 42).

(4) Remove the four nuts at the cable connectors (Fig. 42). Note the position of wiring before removing.

(5) Remove the three relay mounting bracket bolts (Fig. 42) and remove relay assembly.

INSTALLATION

(1) Install the relay assembly to the inner fender. Tighten mounting bolts to 4.5 N·m (40 in. lbs.) torque.

(2) Connect the eight electrical connectors to the relays.

(3) Connect battery cables to both batteries.

VEHICLE SPEED SENSOR

The vehicle speed sensor is located on the speedometer pinion gear adapter (Fig. 43). The pinion gear adapter is located on the extension housing of the transmission (drivers side).

REMOVAL

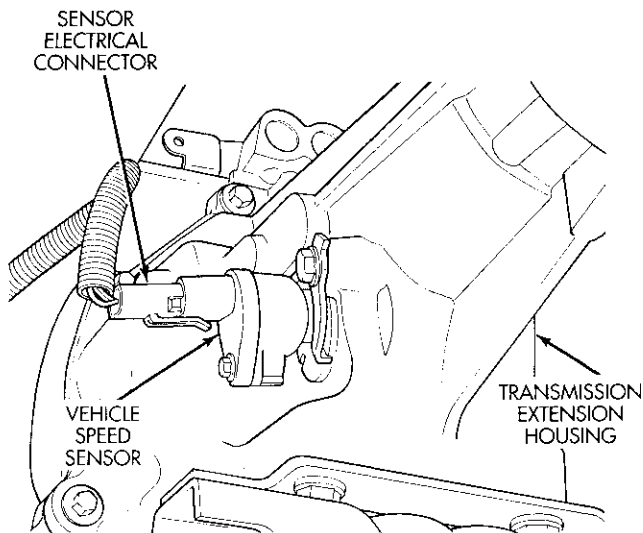
(1) Raise and support vehicle.

(2) Disconnect the electrical connector from the sensor.

(3) Remove the sensor mounting bolt (Fig. 44).

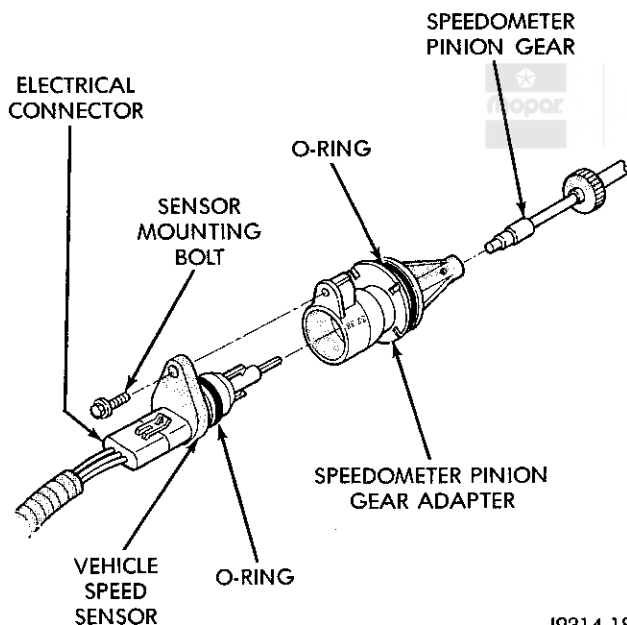
(4) Remove the sensor (pull straight out) from the speedometer pinion gear adapter (Fig. 44). Do not remove the gear adapter from the transmission.

REMOVAL AND INSTALLATION (Continued)



J9414-60

Fig. 43 Vehicle Speed Sensor Location—Typical



J9314-188

Fig. 44 Sensor Removal/Installation

INSTALLATION

(1) Clean the inside of speedometer pinion gear adapter before installing speed sensor.

(2) Install sensor into speedometer gear adapter and install mounting bolt. **Before tightening bolt,**

verify speed sensor is fully seated (mounted flush) to speedometer pinion gear adapter.

(3) Tighten sensor mounting bolt to 2.2 N·m (20 in. lbs.) torque.

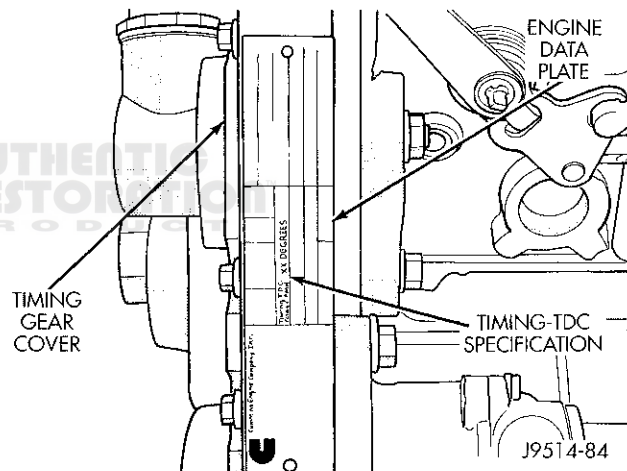
(4) Connect electrical connector to sensor.

WATER-IN-FUEL SENSOR

The water-in-fuel sensor is located at the bottom of the fuel filter/water separator. Refer to Fuel Filter/Water Separator in this section of the group for removal and installation procedures.

SPECIFICATIONS**ENGINE DATA PLATE SPECIFICATIONS**

If anything differs between the specifications found on the Engine Data Plate, and the specifications used in this manual, use specifications on data plate. The Engine Data Plate is located on the engine timing gear cover (Fig. 45).



J9514-84

Fig. 45 Engine Data Plate Location

TORQUE SPECIFICATIONS—DIESEL

DESCRIPTION	TORQUE
Engine Speed Sensor	
Nuts/Bolts . . . . .	.24 N·m (18 ft. lbs.)
Intake Manifold Air Temp.	
Sensor . . . . .	.28 N·m (20 ft. lbs.)
Intake Manifold Air Heater	
Relay Bolts . . . . .	.45 N·m (40 in. lbs.)
PCM Mounting Bolts4 N·m (35 in. lbs.)
Vehicle Speed Sensor	
Mounting Bolt22 N·m (20 in. lbs.)

STEERING

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POWER STEERING

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DIAGNOSIS AND TESTING

POWER STEERING SYSTEM DIAGNOSIS CHARTS

There is some noise in all power steering systems. One of the most common is a hissing sound evident at a standstill parking. Or when the steering wheel is at

the end of it's travel. Hiss is a high frequency noise similar to that of a water tap being closed slowly. The noise is present in all valves that have a high velocity fluid passing through an orifice. There is no relationship between this noise and steering performance.

STEERING NOISE

CONDITION	POSSIBLE CAUSES	CORRECTION
OBJECTIONAL HISS OR WHISTLE	1. Damaged steering coupler to dash panel seal. 2. Noisy valve in power steering gear.	1. Check and repair seal at dash panel. 2. Replace steering gear.
RATTLE OR CLUNK	1. Gear mounting bolts loose. 2. Loose or damaged suspension components. 3. Loose or damaged steering linkage. 4. Internal gear noise. 5. Pressure hose in contact with other components.	1. Tighten bolts to specification. 2. Inspect and repair suspension. 3. Inspect and repair steering linkage. 4. Replace gear. 5. Reposition hose.
CHIRP OR SQUEAL	1. Loose belt.	1. Adjust or replace.
WHINE OR GROWL	1. Low fluid level. 2. Pressure hose in contact with other components. 3. Internal pump noise.	1. Fill to proper level. 2. Reposition hose. 3. Replace pump.
SUCKING AIR SOUND	1. Loose return line clamp. 2. O-ring missing or damaged on hose fitting. 3. Low fluid level. 4. Air leak between pump and reservoir.	1. Replace clamp. 2. Replace o-ring. 3. Fill to proper level. 4. Repair as necessary.
SCRUBBING OR KNOCKING	1. Wrong tire size. 2. Wrong gear.	1. Verify tire size. 2. Verify gear.

DIAGNOSIS AND TESTING (Continued)**BINDING AND STICKING**

CONDITION	POSSIBLE CAUSE	CORRECTION
DIFFICULT TO TURN WHEEL STICKS OR BINDS	<ol style="list-style-type: none"> 1. Low fluid level. 2. Tire pressure. 3. Steering components. 4. Loose belt. 5. Pump flow control valve. 6. Column coupler binding. 7. Steering gear worn or out of adjustment. 	<ol style="list-style-type: none"> 2. Fill to proper level. 2. Adjust tire pressure. 3. Inspect and lube. 4. Adjust or replace. 5. Test and replace if necessary. 6. Replace coupler. 7. Repair or replace gear.

INSUFFICIENT ASST. OR POOR RETURN TO CENTER

CONDITION	POSSIBLE CAUSE	CORRECTION
HARD TURNING OR MOMENTARY INCREASE IN TURNING EFFORT	<ol style="list-style-type: none"> 1. Tire pressure. 2. Low fluid level. 3. Loose belt. 4. Lack of lubrication. 5. Low pump pressure. 6. Internal gear leak. 	<ol style="list-style-type: none"> 1. Adjust tire pressure. 2. Fill to proper level. 3. Adjust or replace. 4. Inspect and lubricate steering and suspension components. 5. Test and repair as necessary. 6. Test and repair as necessary.
STEERING WHEEL DOES NOT WANT TO RETURN TO CENTER POSITION	<ol style="list-style-type: none"> 1. Tire pressure. 2. Wheel alignment. 3. Lack of lubrication. 4. High friction in steering gear. 	<ol style="list-style-type: none"> 1. Adjust tire pressure. 2. Align front end. 3. Inspect and lubricate steering and suspension components. 4. Test and repair as necessary.

LOOSE STEERING AND VEHICLE LEAD

CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE PLAY IN STEERING WHEEL	<ol style="list-style-type: none"> 1. Worn or loose suspension or steering components. 2. Worn or loose wheel bearings. 3. Steering gear mounting. 4. Gear out of adjustment. 5. Worn or loose steering coupler. 	<ol style="list-style-type: none"> 1. Inspect and repair as necessary. 2. Inspect and repair or adjust bearings. 3. Tighten gear to specification. 4. Adjust gear to specification. 5. Inspect and replace as necessary.
VEHICLE PULLS OR LEADS TO ONE SIDE.	<ol style="list-style-type: none"> 1. Radial tire lead. 2. Brakes dragging. 3. Wheel alignment. 	<ol style="list-style-type: none"> 1. Rotate tires. 2. Repair as necessary. 3. Align front end.

POWER STEERING PUMP

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DESCRIPTION AND OPERATION

POWER STEERING PUMP

The Saginaw P-Series pump is used on these vehicles (Fig. 1).

Hydraulic pressure is provided for the power steering gear by the belt driven power steering pump. The power steering pump is a constant flow rate and displacement, vane-type pump.

The pump is connected to the steering gear via the pressure hose and the return hose. The pump shaft has a pressed-on pulley that is belt driven by the crankshaft pulley.

Trailer tow option vehicles are equipped with a power steering pump oil cooler. The oil cooler is mounted to the radiator support.

NOTE: Power steering pumps are not interchangeable with pumps installed on other vehicles.

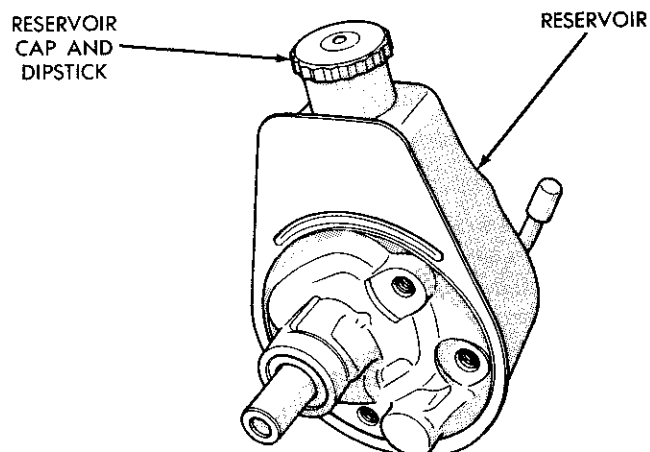


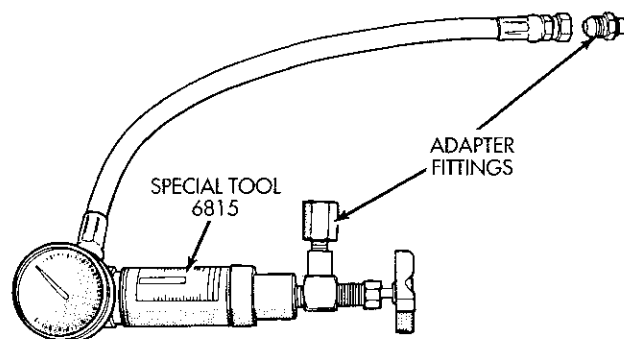
Fig. 1 Saginaw Pump—P-Series

RH13

DIAGNOSIS AND TESTING

POWER STEERING PUMP FLOW RATE AND PRESSURE TEST

The following procedure is used to test the operation of the power steering system on the vehicle. This test will provide the flow rate of the power steering pump along with the maximum relief pressure. Perform test any time a power steering system problem is present. This test will determine if the power steering pump or power steering gear is not functioning properly. The following pressure and flow test is performed using Pressure/Flow tester, Special Tool 6815 (Fig. 2).



9519-1

Fig. 2 Pressure Test Gauge

POWER STEERING PUMP FLOW AND PRESSURE TEST PROCEDURE

- (1) Check belt tension and adjust as necessary.
- (2) Disconnect high pressure hose at gear or pump. Use a container for dripping fluid.

DIAGNOSIS AND TESTING (Continued)

(3) Connect pressure gauge from Power Steering Analyzer Tool kit 6815 to both hoses using appropriate adapter. Connect spare pressure hose to gear or pump.

(4) Open the test valve completely.

(5) Start engine and let idle long enough to circulate power steering fluid through flow/pressure test gauge and to get air out of the fluid. Then shut off engine.

(6) Check fluid level, add fluid as necessary. Start engine again and let idle.

(7) Gauge should read below 1034 kPa (150 psi), if above, inspect the hoses for restrictions and repair as necessary. The initial pressure reading should be in the range of 345-552 kPa (50-80 psi). The flow meter should read between 1.3 and 1.9 GPM.

CAUTION: The following test procedure involves testing maximum pump pressure output and flow control valve operation. Do not leave valve closed for more than five seconds as the pump could be damaged.

(8) Close valve fully three times and record highest pressure indicated each time. **All three readings must be above specifications and within 345 kPa (50 psi) of each other.**

- Pressures above specifications but not within 345 kPa (50 psi) of each other, replace pump.

- Pressures within 345 kPa (50 psi) of each other but below specifications, replace pump.

NOTE: Refer to pump relief pressure chart.

CAUTION: Do not force the pump to operate against the stops for more than 2 to 4 seconds at a time because, pump damage will result.

(9) Open the test valve, turn steering wheel extreme left and right positions against the stops. Record the highest indicated pressure at each position. Compare readings to specifications chart. If highest output pressures are not the same against either stop, the gear is leaking internally and must be repaired.

PUMP SPECIFICATION CHART

ENGINE	RELIEF PRESSURE (P.S.I.)	FLOW (G.P.M.)
3.9L	1400 to 1500	2.4 to 2.8
5.2L	1400 to 1500	2.4 to 2.8
5.9L	1400 to 1500	2.7 to 3.1
8.0L	1450 to 1550	3.1 to 3.5
5.9L Diesel	1400 to 1500	2.7 to 3.1

PUMP LEAKAGE DIAGNOSIS**SERVICE PROCEDURES****POWER STEERING PUMP—INITIAL OPERATION**

CAUTION: The fluid level should be checked with engine off to prevent injury from moving components. Use MOPAR Power Steering Fluid or equivalent. Do not use automatic transmission fluid and do not overfill.

Wipe filler cap clean, then check the fluid level. The dipstick should indicate **COLD** when the fluid is at normal temperature.

(1) Fill the pump fluid reservoir to the proper level and let the fluid settle for at least two (2) minutes.

(2) Start the engine and let run for a few seconds then turn engine off.

(3) Add fluid if necessary. Repeat the above procedure until the fluid level remains constant after running the engine.

(4) Raise the front wheels off the ground.

(5) Slowly turn the steering wheel right and left, lightly contacting the wheel stops at least 20 times.

(6) Check the fluid level add if necessary.

(7) Lower the vehicle, start the engine and turn the steering wheel slowly from lock to lock.

(8) Stop the engine and check the fluid level and refill as required.

(9) If the fluid is extremely foamy, allow the vehicle to stand a few minutes and repeat the procedure.

REMOVAL AND INSTALLATION**POWER STEERING PUMP—GASOLINE ENGINE**

WARNING: DO NOT REMOVE THE WATER PUMP COOLANT TUBE UNLESS THE COOLANT SYSTEM HAS BEEN DEPRESSURIZED AND DRAINED.

REMOVAL

(1) Remove the serpentine drive belt, refer to Group 7 Cooling.

(2) Remove the hoses from the power steering pump and cap the fittings.

(3) Remove battery ground cable and unthread stud from cylinder head, do not remove from bracket.

(4) Loosen upper bracket bolt and remove the lower bracket to engine block bolts.

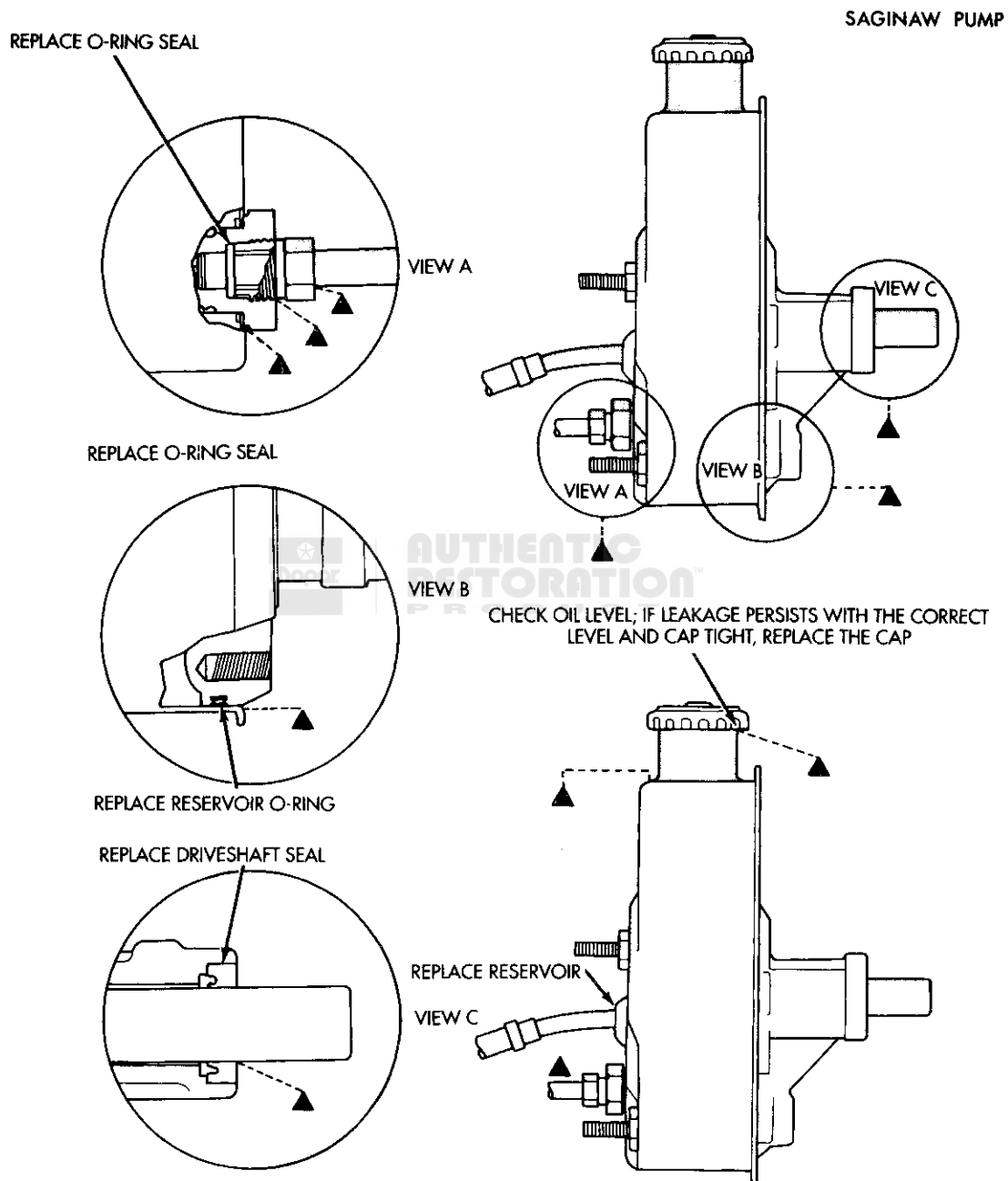
(5) Pivot the pump assembly past the coolant tube.

(6) Remove the upper stud and remove upper bolt from cylinder head.

(7) Remove steering pump and mounting bracket from engine as an assembly.

REMOVAL AND INSTALLATION (Continued)

PUMP LEAKAGE



REMOVAL AND INSTALLATION (Continued)

(8) Remove the pump pulley, to access pump attaching bolts.

(9) Remove the front pump bracket (Fig. 3). On 8.0L engine remove rear pump bracket (Fig. 4).

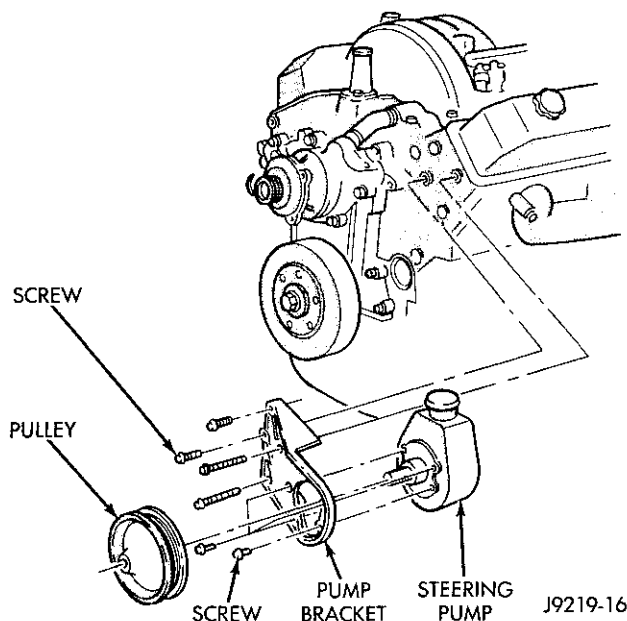


Fig. 3 Pump Mounting 3.9L, 5.2L and 5.9L

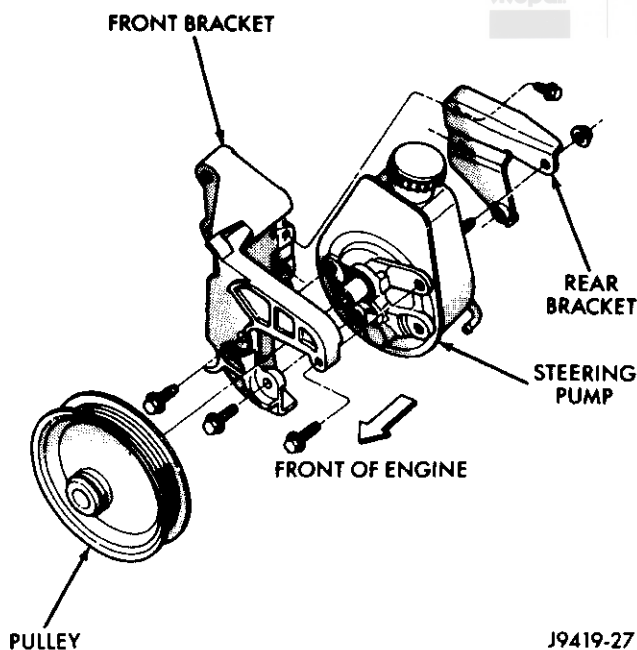


Fig. 4 Pump Mounting 8.0L

INSTALLATION

(1) Install the front pump bracket and tighten bolts to 47 N·m (35 ft. lbs.). On 8.0L engine install rear pump bracket and tighten nut to 47 N·m (35 ft. lbs.), tighten bolts to 24 N·m (18 ft. lbs.).

(2) Install the pump pulley.

(3) Install steering pump assembly on the engine block. Install the upper stud and bolt in bracket.

(4) Pivot the pump down past the coolant tube and install the lower bolts in bracket.

(5) Tighten the bolts and nut to 41 N·m (30 ft. lbs.).

(6) Connect the hoses to the pump.

(7) Install the serpentine drive belt refer to Group 7, Cooling for belt routing.

(8) Fill the reservoir with power steering fluid, refer to Pump Initial Operation

POWER STEERING PUMP—DIESEL ENGINE**REMOVAL**

(1) Remove and cap steering pump hoses and vacuum pump vacuum line.

(2) Remove the sender unit from engine block and plug hole in block (Fig. 5).

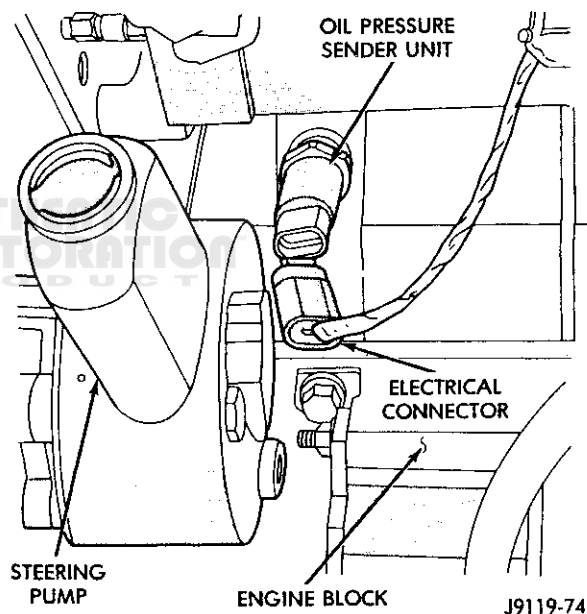


Fig. 5 Oil Pressure Sending Unit

(3) Remove and cap the oil feed line from the bottom of the vacuum pump (Fig. 6).

(4) Remove the lower bolt that attaches the vacuum/steering pump assembly to the engine block. Remove the nut from the steering pump attaching bracket (Fig. 6).

(5) Remove upper bolt from the pump assembly (Fig. 7) and remove the assembly.

(6) Remove the mounting gasket.

(7) Remove the steering pump to vacuum pump bracket attaching nuts (Fig. 8).

(8) Slide the steering pump from the bracket. Use care not to damage the internal oil seal in the vacuum pump (Fig. 9).

(9) Remove the two pump body spacers.

REMOVAL AND INSTALLATION (Continued)

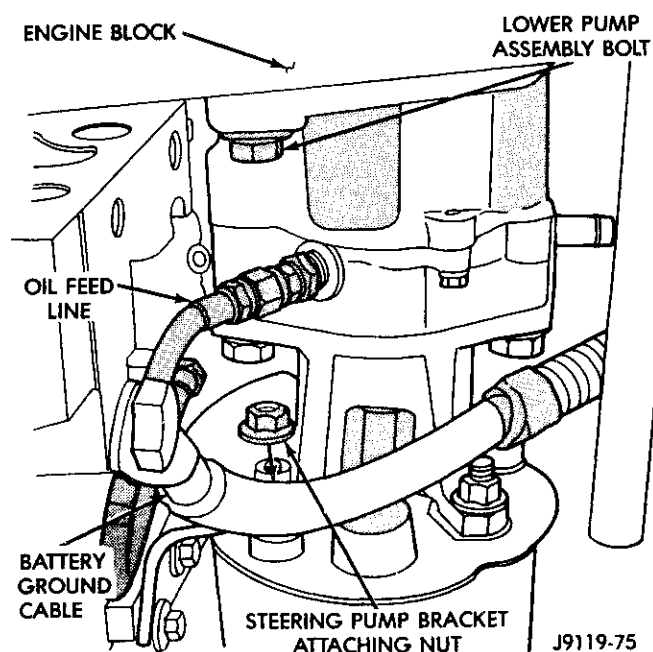


Fig. 6 Oil Feed Line

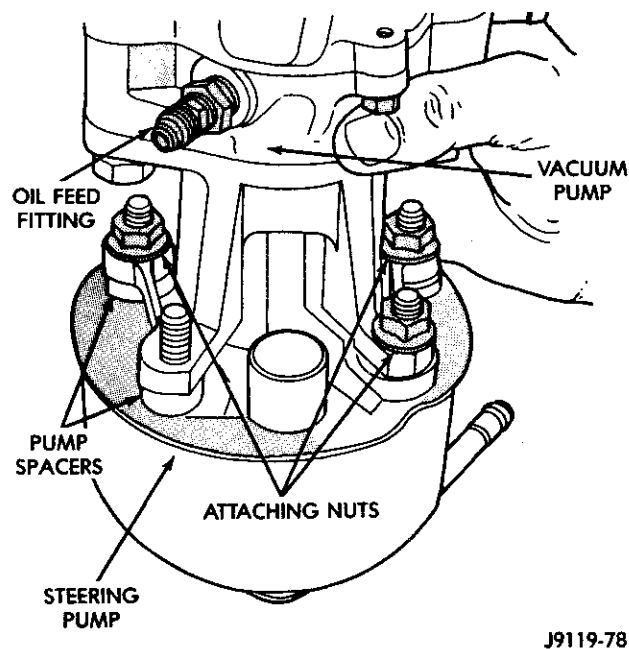


Fig. 8 Bracket Mounting Nuts

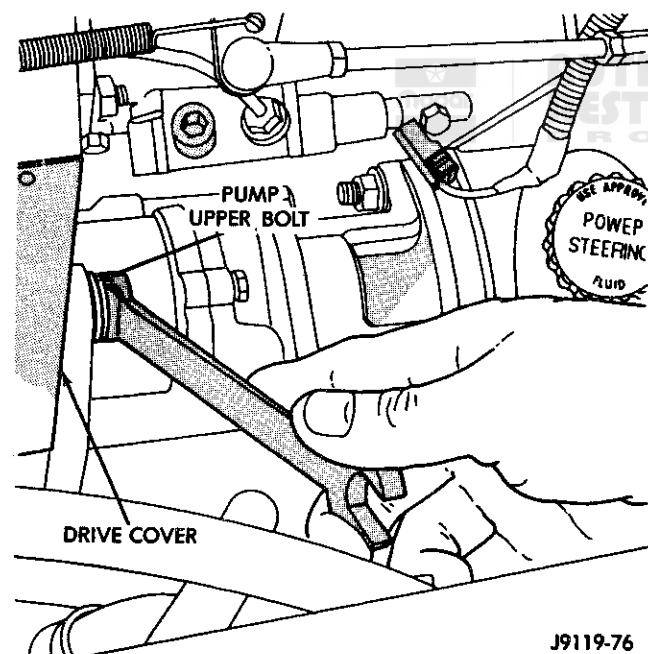


Fig. 7 Pump Assembly Upper Bolt

INSTALLATION

- (1) Install the two pump body spacers.
- (2) Rotate the drive gear until the steering pump and vacuum pump drive dogs align. Install the steering pump onto the vacuum pump bracket. Use care to avoid damaging the oil seal in the vacuum pump during installation. **The steering pump housing and spacers must mate completely with the vacuum pump bracket.**

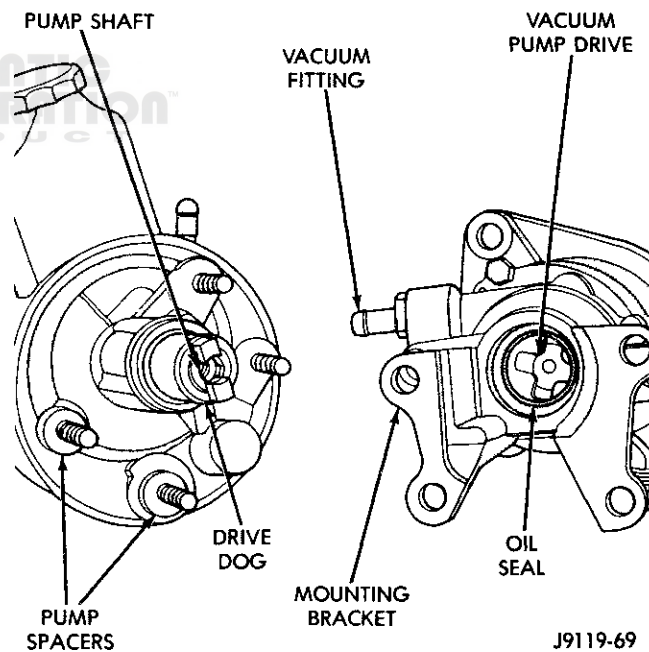


Fig. 9 Steering Pump & Vacuum Pump

- (3) Install the vacuum pump bracket to steering pump nuts and tighten to 24 N·m (18 ft. lbs.).
- (4) Position new gasket on vacuum pump assembly. Use sealer if necessary to retain the gasket.
- (5) Align and install the pump assembly on the engine. Ensure the steering pump stud is inserted into the block bracket. Tighten the pump-to-engine attaching bolts to 77 N·m (57 ft. lbs.).
- (6) Install the steering pump to attaching bracket nut and tighten to 24 N·m (18 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

(7) Remove plug and install the oil pressure sending unit and electrical connector.

(8) Install the oil feed line to the vacuum pump. Tighten the oil line connection to 7 N·m (60 in. lbs./ 5 ft. lbs.).

(9) Install the fluid hoses to the power steering pump. Tighten the pressure fitting at the pump to 31 N·m (23 ft. lbs.).

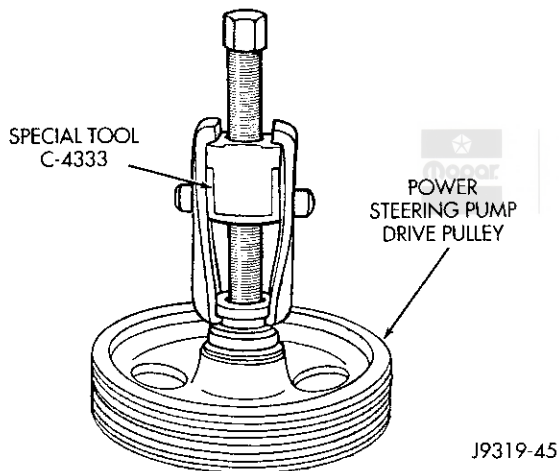
(10) Install and clamp the hose on the vacuum pump.

(11) Fill the reservoir with power steering fluid, refer to Pump Initial Operation.

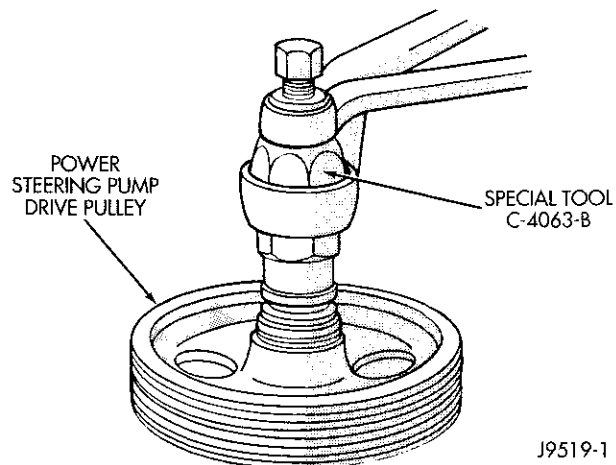
(12) Start the engine and check the operation of the brakes.

PUMP PULLEY**REMOVAL**

- (1) Remove pump assembly.
- (2) Remove pulley from pump with Puller C-4333 (Fig. 10).

**Fig. 10 Pulley Removal****INSTALLATION**

- (1) Replace pulley if bent, cracked, or loose.
- (2) Install pulley on pump with Installer C-4063-B (Fig. 11) flush with the end of the shaft. Ensure the tool and pulley remain aligned with the pump shaft.
- (3) Install pump assembly.
- (4) With Serpentine Belts; Run engine until warm (5 min.) and note any belt chirp. If chirp exists, move

**Fig. 11 Pulley Installation**

pulley outward approximately 0.5 mm (0.020 in.). If noise increases, press on 1.0 mm (0.040 in.). **Be careful that pulley does not contact mounting bolts.**

P-SERIES PUMP RESERVOIR**REMOVAL**

NOTE: Discard all O-ring seals during disassembly, they are not re-usable.

- (1) Remove pump assembly.
- (2) Remove mounting studs and pressure fitting. Rock reservoir by hand or use a soft face mallet and remove reservoir (Fig. 12).
- (3) Remove O-ring seals from housing and discard.
- (4) Remove flow control valve and spring from housing (Fig. 13).

INSTALLATION

NOTE: Clean all parts before installation. Lubricate new O-ring seals with MOPAR Power Steering Fluid or an equivalent product.

- (1) Install flow control valve and spring.
- (2) Install new O-ring seals on housing and install reservoir.
- (3) Install mounting studs and tighten to 48 N·m (35 ft. lbs.).
- (4) Install fitting in flow control valve bore tighten to 75 N·m (55 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

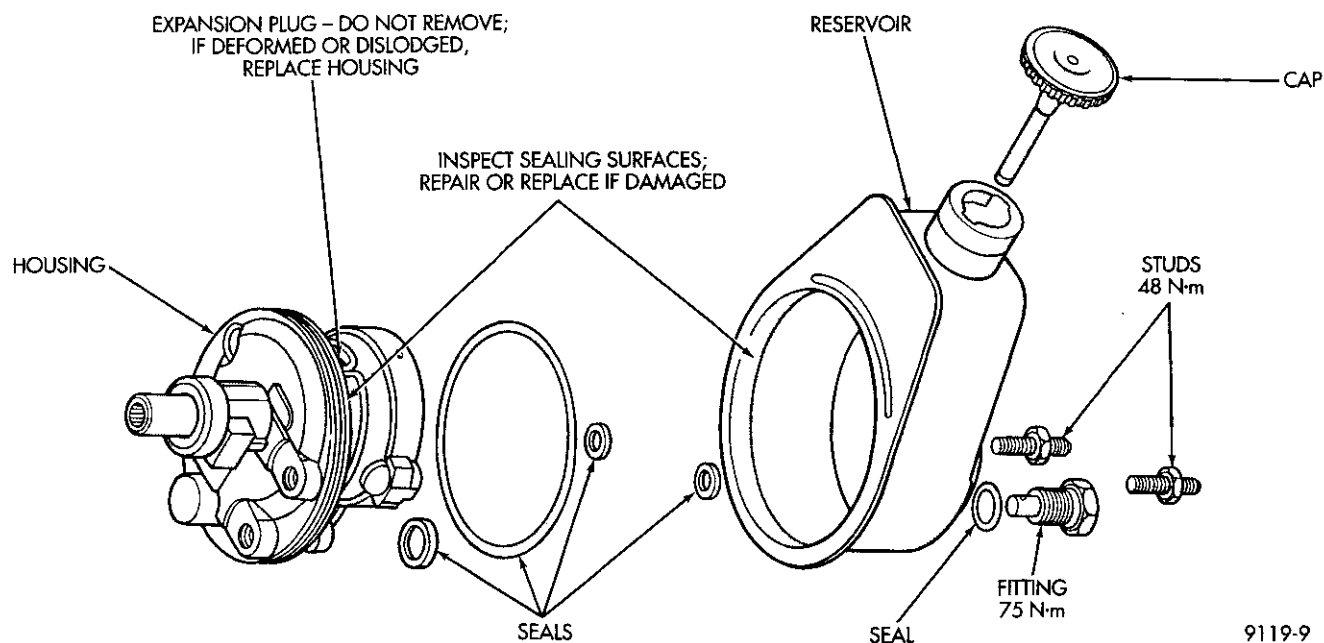


Fig. 12 Pump Reservoir

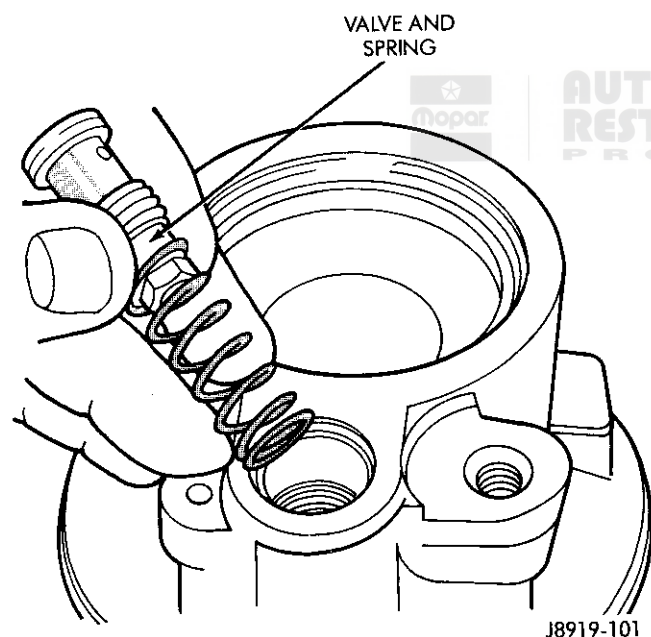


Fig. 13 Flow Control Valve

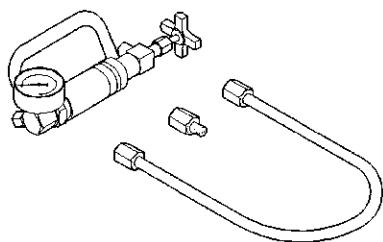
SPECIFICATIONS

TORQUE CHART

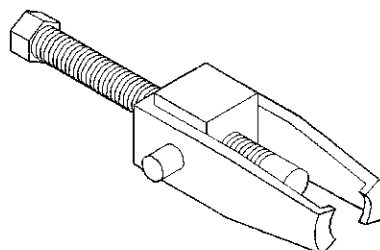
DESCRIPTION	TORQUE
Reservoir Bolts . . . . .	.56 N·m (42 ft. lbs.)
Flow Control Valve . . . . .	.75 N·m (55 ft. lbs.)
Pressure Line . . . . .	.31 N·m (23 ft. lbs.)
Oil Cooler Bolt. . . . .	.20 N·m (15 ft. lbs.)
Pump Mounting—3.9L, 5.2L & 5.9L	
Bracket to Pump . . . . .	.47 N·m (35 ft. lbs.)
Bracket to Engine . . . . .	.41 N·m (30 ft. lbs.)
Pump Mounting—8.0L	
Rear Bracket to Pump. . . . .	.47 N·m (35 ft. lbs.)
Rear Bracket to Front Bracket . . . . .	.24 N·m (18 ft. lbs.)
Bracket to Engine . . . . .	.41 N·m (30 ft. lbs.)
Pump Mounting—Diesel	
Pump to Vacuum Pump. . . . .	.24 N·m (18 ft. lbs.)
Pump Assembly to Engine. . . . .	.77 N·m (57 ft. lbs.)
Pump to Support Bracket . . . . .	.24 N·m (18 ft. lbs.)

SPECIAL TOOLS

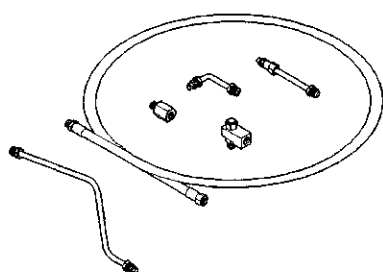
POWER STEERING PUMP



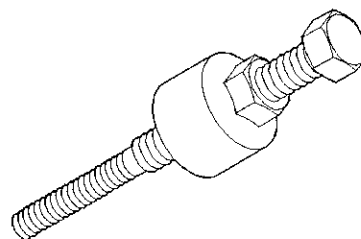
Analyzer Set, Power Steering Flow/Pressure 6815



Puller C-4333



Adapters, Power Steering Flow/Pressure Tester 6893



Installer, Power Steering Pulley C-4063-B



POWER STEERING GEAR

INDEX

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POWER STEERING GEAR	11		

GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

DESCRIPTION AND OPERATION

POWER STEERING GEAR

The power steering gear is a recirculating ball type gear. The gear acts as a rolling thread between the worm shaft and rack piston. The worm shaft is supported by a thrust bearing at the lower end and a bearing assembly at the upper end. When the worm shaft is turned the rack piston moves. The rack piston teeth mesh with the pitman shaft. Turning the

worm shaft turns the pitman shaft, which turns the steering linkage.

The steering gear can be adjusted, but it is serviced as an assembly, no internal parts are serviced.

DIAGNOSIS AND TESTING

POWER STEERING GEAR LEAKAGE DIAGNOSIS

REMOVAL AND INSTALLATION

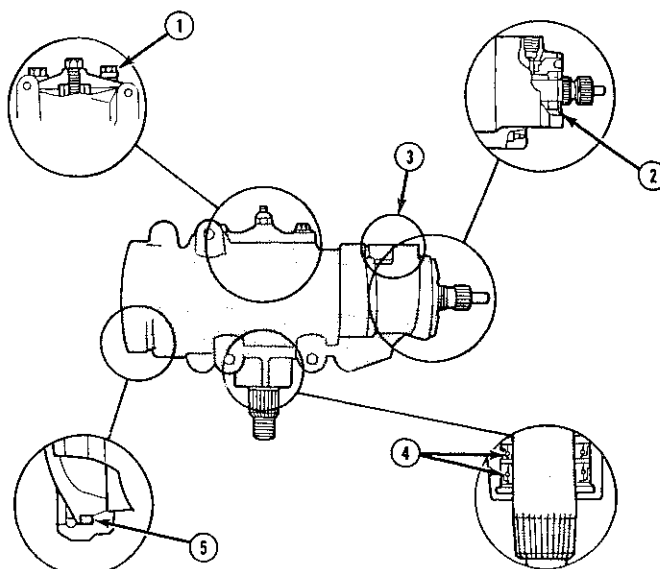
POWER STEERING GEAR

REMOVAL

- (1) Place the front wheels in a straight-ahead position.
- (2) Disconnect and cap the fluid hoses from steering gear.
- (3) Remove coupler pinch bolt at the steering gear and slide shaft off gear (Fig. 1).
- (4) Mark the pitman shaft and pitman arm for installation reference. Remove the pitman arm from the shaft with Puller C-4150A (Fig. 2).
- (5) Remove steering gear retaining bolts and nuts. Remove the steering gear from the vehicle.

INSTALLATION

- (1) Position the steering gear on the frame rail and install the bolts. Tighten mounting bolts to specifications.
- (2) Align steering coupler on gear shaft. Install pinch bolt and tighten to 49 N·m (36 ft. lbs.) torque.
- (3) Align and install the pitman arm.
- (4) Install the washer and retaining nut on the pitman shaft. Tighten the nut to 251 N·m (185 ft. lbs.).
- (5) Connect fluid hoses to steering gear, tighten to 31 N·m (23 ft. lbs.). Add fluid, refer to Power Steering Pump Initial Operation.



1. SIDE COVER LEAK - TORQUE SIDE COVER BOLTS TO 60 N•m (45 FT. LBS.). REPLACE THE SIDE COVER SEAL IF THE LEAKAGE PERSISTS.

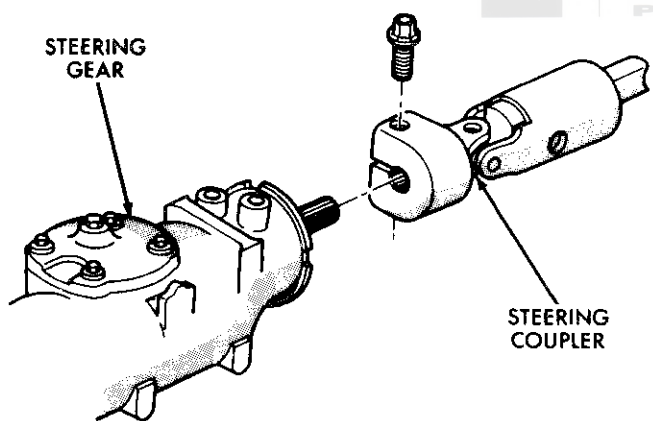
2. ADJUSTER PLUG SEAL - REPLACE THE ADJUSTER PLUG SEALS.

3. PRESSURE LINE FITTING - TORQUE THE HOSE FITTING NUT TO 27 N•m (20 FT. LBS.). IF LEAKAGE PERSISTS, REPLACE THE SEAL.

4. PITMAN SHAFT SEALS - REPLACE THE SEALS.

5. TOP COVER SEAL - REPLACE THE SEAL.

J9219-29



J9419-20

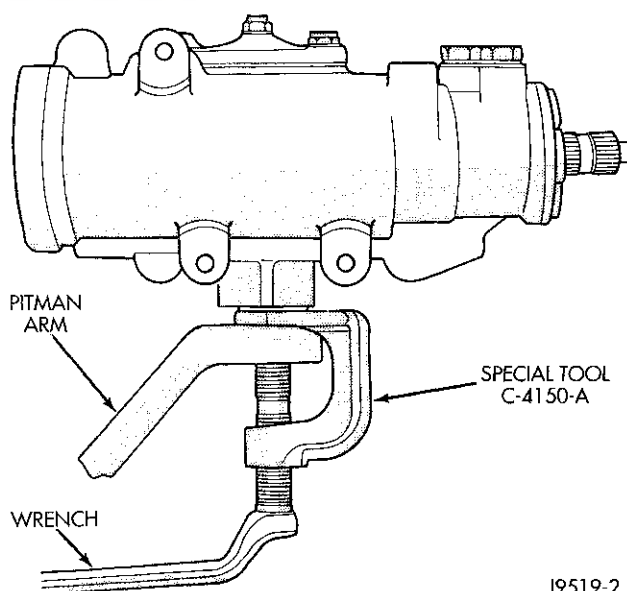
Fig. 1 Column Shaft

ADJUSTMENTS

STEERING GEAR

CAUTION: Steering gear must be adjusted in the proper order. If adjustments are not performed in order, gear damage and improper steering response may result.

NOTE: Adjusting the steering gear in the vehicle is not recommended. Remove gear from the vehicle



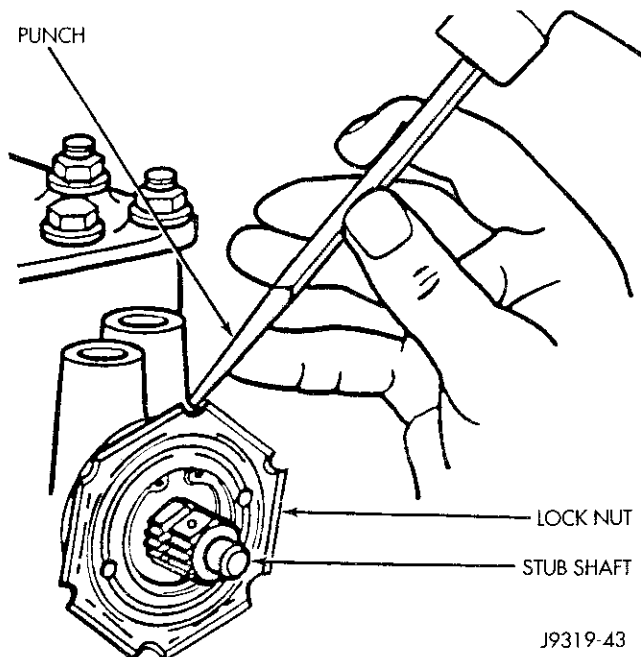
J9519-2

Fig. 2 Pitman Arm

and drain the fluid. Then mount gear in a vise to perform adjustments.

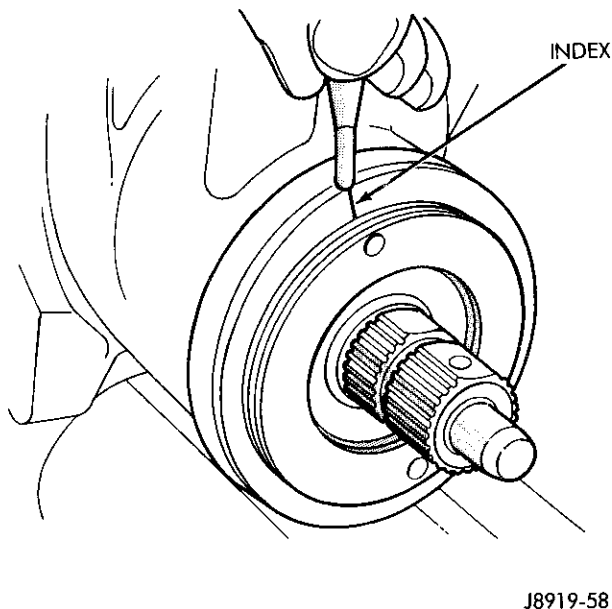
WORM THRUST BEARING PRELOAD

(1) Remove adjuster plug locknut (Fig. 3).

ADJUSTMENTS (Continued)**Fig. 3 Loosening the Adjuster Plug**

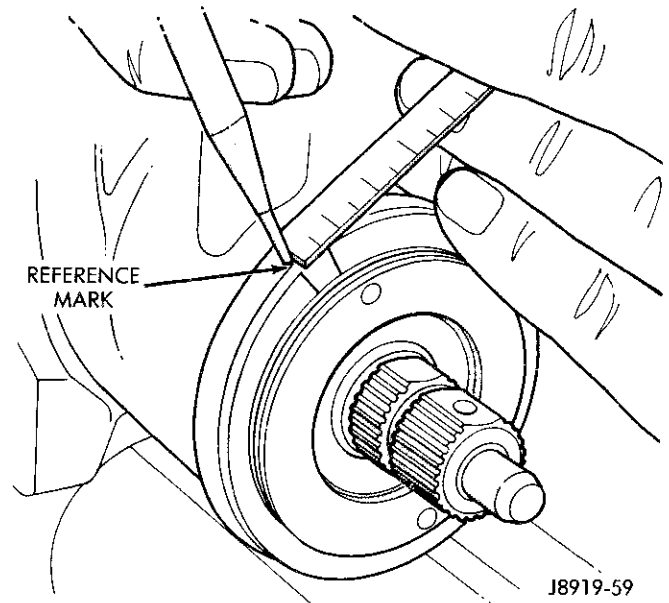
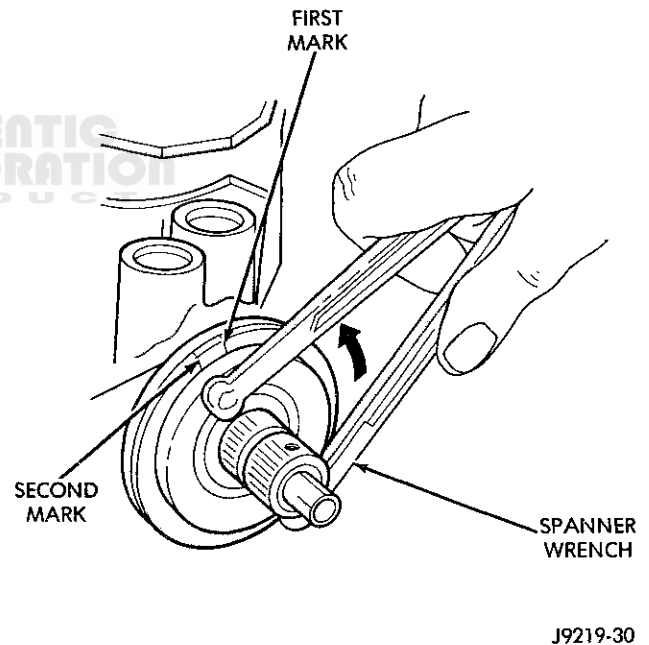
(2) Turn the adjuster in with Spanner Wrench C-4381. Tighten the plug and thrust bearing in the housing until firmly bottomed in housing.

(3) Place an index mark on the housing even with one of the holes in adjuster plug (Fig. 4).

**Fig. 4 Alignment Marking On Housing**

(4) Measure back (counterclockwise) 13 mm (0.50 in) and mark housing (Fig. 5).

(5) Rotate adjustment cap back (counterclockwise) with spanner wrench until hole is aligned with the second mark (Fig. 6).

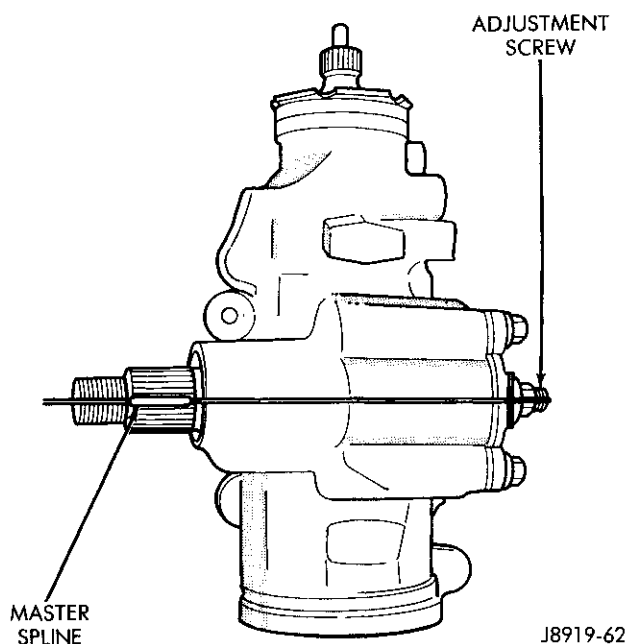
**Fig. 5 Remarking The Housing****Fig. 6 Aligning To The Second Mark**

(6) Install and tighten locknut to 108 N·m (80 ft. lbs.). Be sure adjustment cap does not turn while tightening the locknut.

OVER-CENTER

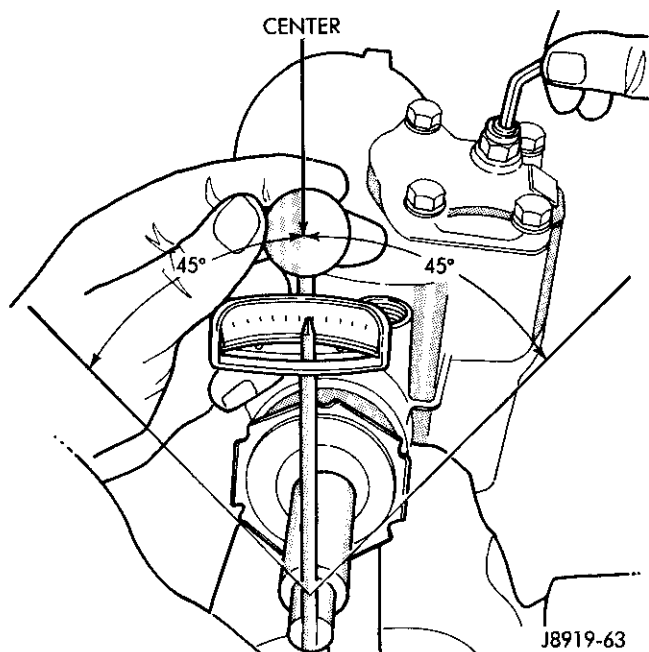
(1) Rotate the stub shaft from stop to stop and count the number of turns.

(2) Starting at either stop turn the stub shaft back 1/2 the total number of turns. This is the center of the gear travel (Fig. 7).

ADJUSTMENTS (Continued)**Fig. 7 Steering Gear Centered**

(3) Turn the pitman shaft adjuster screw back (COUNTERCLOCKWISE) until extended, then turn back in (CLOCKWISE) one full turn.

(4) Place the torque wrench in the vertical position on the stub shaft. Rotate the wrench 45 degrees each side of the center and record the highest rotational torque on center (Fig. 8).

**Fig. 8 Checking Over-center Rotation Torque**

(5) Turn the adjuster in until torque to turn stub shaft is 0.6 to 1.2 N·m (6.0 to 10.0 in. lbs.) more than previous reading recorded.

(6) Prevent the adjuster screw from turning while tightening adjuster lock nut. Tighten the adjuster lock nut to 27 N·m (20 ft. lbs.).

SPECIFICATIONS**POWER STEERING GEAR SPECIFICATION****Steering Gear**

Type Recirculating Ball

Gear Code & Ratio

BN 17.5:1

HF 16-13:1

Wormshaft Bearing

Preload 0.45–1.13 N·m (10–15 in. lbs.)

Pitman Shaft Overcenter Drag

New Gear (under 400 miles) 0.45–0.90 N·m
(6–10 in. lbs.) + Wormshaft Preload

Used Gear (over 400 miles) 0.5–0.6 N·m
(4–5 in. lbs.) + Wormshaft Preload

TORQUE CHART**DESCRIPTION****TORQUE****Steering Gear Mounting**

E-Coat Frame Bolts 190 N·m (140 ft. lbs.)

Wax Coat Frame Bolts 244 N·m (180 ft. lbs.)

Line Fittings

Pressure 31 N·m (23 ft. lbs.)

Return 31 N·m (23 ft. lbs.)

Steering Gear

Adjustment Cap Locknut 108 N·m (80 ft. lbs.)

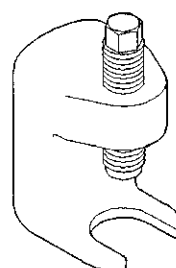
Adjustment Screw Locknut 58 N·m (43 ft. lbs.)

Pitman Shaft Nut 251 N·m (185 ft. lbs.)

Rack Piston Plug 149 N·m (110 ft. lbs.)

Side Cover Bolts 61 N·m (45 ft. lbs.)

Return Guide Clamp Bolt 5 N·m (4 ft. lbs.)

SPECIAL TOOLS**POWER STEERING GEAR****Remover, Pitman Arm C-4150A**

STEERING COLUMN

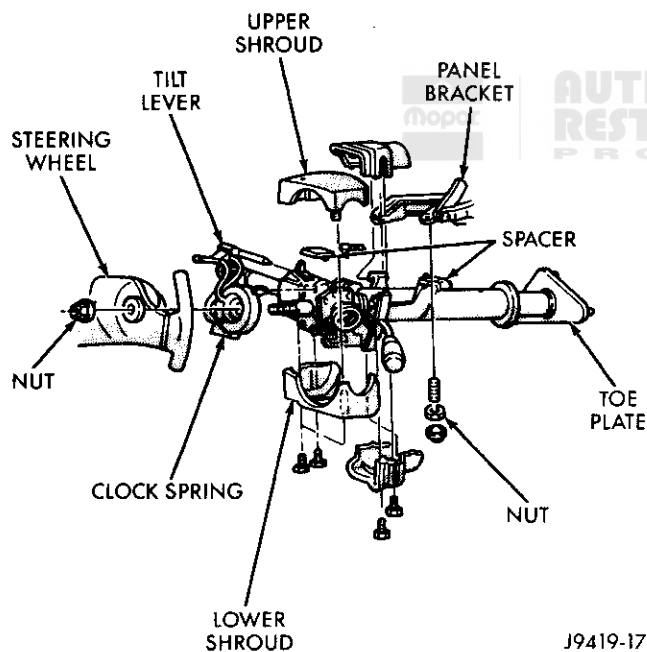
INDEX

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GENERAL INFORMATION

STEERING COLUMN

The Acustar tilt and standard column (Fig. 1) has been designed to be serviced as an assembly; less wiring, switches, shrouds, steering wheel, etc. Most steering column components can be serviced without removing the steering column from the vehicle.



J9419-17

Fig. 1 Acustar Steering Column

SERVICE PRECAUTIONS

Safety goggles should be worn at all times when working on steering columns.

To service the steering wheel, switches or the airbag, refer to the appropriate section of Group 8. Follow all WARNINGS.

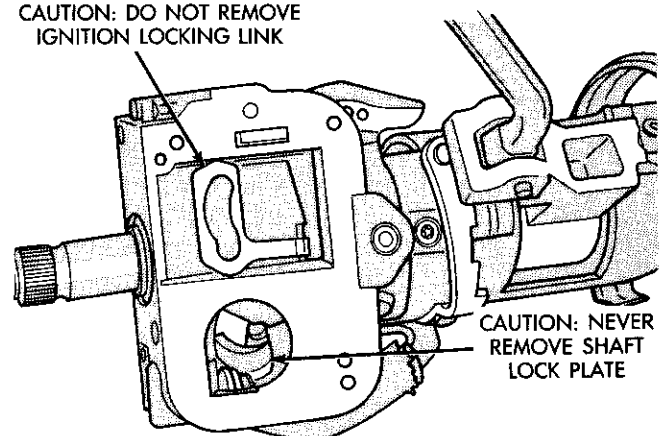
WARNING: THE AIRBAG SYSTEM IS A SENSITIVE, COMPLEX ELECTRO-MECHANICAL UNIT. BEFORE ATTEMPTING TO DIAGNOSE, REMOVE OR INSTALL

THE AIRBAG SYSTEM COMPONENTS YOU MUST FIRST DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE. FAILURE TO DO SO COULD RESULT IN ACCIDENTAL DEPLOYMENT OF THE AIRBAG AND POSSIBLE PERSONAL INJURY. THE FASTENERS, SCREWS, AND BOLTS, ORIGINALLY USED FOR THE AIRBAG COMPONENTS, HAVE SPECIAL COATINGS AND ARE SPECIFICALLY DESIGNED FOR THE AIRBAG SYSTEM. THEY MUST NEVER BE REPLACED WITH ANY SUBSTITUTES. ANYTIME A NEW FASTENER IS NEEDED, REPLACE WITH THE CORRECT FASTENERS PROVIDED IN THE SERVICE PACKAGE OR FASTENERS LISTED IN THE PARTS BOOKS.

CAUTION: Do not hammer on steering column shaft or shift tube.

CAUTION: Do not attempt to remove the pivot pins to disassemble the tilting mechanism. Do not remove ignition locking link, shaft lock plate or plate retainer. This will damage the column (Fig. 2) and (Fig. 3).

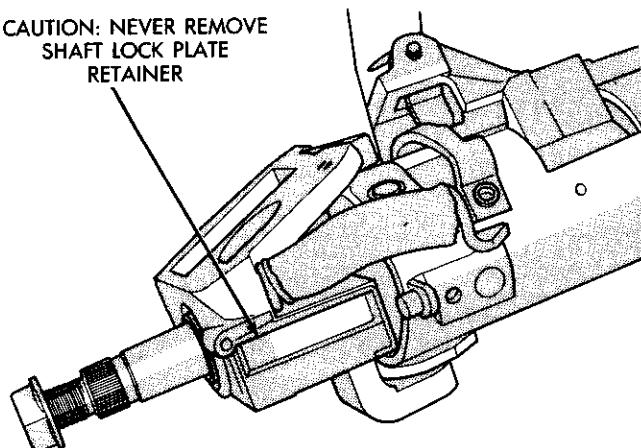
CAUTION: DO NOT REMOVE IGNITION LOCKING LINK



9019-5

Fig. 2 Observe Cautions

CAUTION: NEVER REMOVE
SHAFT LOCK PLATE
RETAINER



9019-6

Fig. 3 Observe Cautions

DIAGNOSIS AND TESTING

IGNITION SWITCH

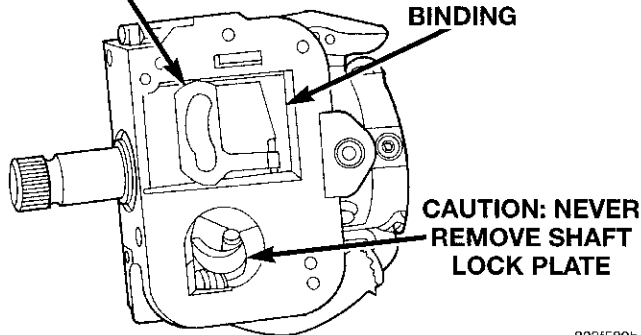
TEST AND REPAIR

If the ignition switch effort is excessive, remove the ignition switch from the steering column. Refer to Group 8D Ignition System. Using a key cylinder, check the turning effort of the switch. If the ignition switch binds look for the following conditions.

(1) Look for rough areas or flash in the casting and if found remove with a file (Fig. 4).

CAUTION: DO NOT
REMOVE IGNITION
LOCKING LINK

FILE THIS AREA TO REMOVE
FLASHING AND PROVIDE
CLEARANCE TO ELIMINATE
BINDING



803f589b

Fig. 4 Steering Column Flash Removal And
Non-Serviceable Components

(2) Remove the link and slider and check the link to see if it is bent. If so replace with a new part.

(3) Put the slider in its slot in the sleeve and verify a loose fit over the length of the slot. If the slider binds in the slot at any point lightly file the slider until clearance is achieved.

(4) If no binding is found, lightly file the ramp on the ignition switch, (The ramp fits into the casting) until binding no longer occurs.

REMOVAL AND INSTALLATION

STEERING COLUMN

WARNING: REMOVE AND ISOLATE THE NEGATIVE (-) BATTERY CABLE (GROUND) FROM THE BATTERY. THIS IS THE ONLY SURE WAY TO DISABLE THE AIRBAG SYSTEM. FAILURE TO DO THIS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

WARNING: WHEN A STEERING COLUMN HAS AN AIRBAG MODULE ATTACHED, NEVER PLACE THE COLUMN ON THE FLOOR OR OTHER SURFACE WITH THE STEERING WHEEL OR MODULE FACE DOWN.

CAUTION: Bumping, jolting and hammering on steering column shaft and gear shift tube must be avoided during service procedures.

REMOVAL

(1) Turn front wheels straight ahead and center steering wheel.

(2) Disconnect the negative (ground) cable from the battery.

(3) Remove steering wheel and clock spring from column, refer to Group 8.

(4) Disconnect link rod in engine compartment if equipped with column shift. Pry rod out from grommet in the shift lever.

(5) Scribe or paint reference mark on the column shaft-to-coupler. This will aid in column shaft installation alignment. Remove the steering column shaft-to-coupler bolt (Fig. 5).

(6) Remove the dash panel cover under column.

(7) For column shift vehicles, make sure shift lever is in **Park** position. Pull cable and twist to remove from position arm. Push tab on bottom of cable retainer, then squeeze sides to remove retainer from column (Fig. 6).

(8) Remove tilt lever (if equipped) from column.

(9) Remove the upper and lower lock housing shroud and remove the lower fixed shroud.

(10) Remove the turn signal multi-function switch with a 7mm socket (Fig. 7).

(11) Loosen the upper Support Bracket nuts to allow some slack. This will aid in removal of the upper fixed shroud.

REMOVAL AND INSTALLATION (Continued)

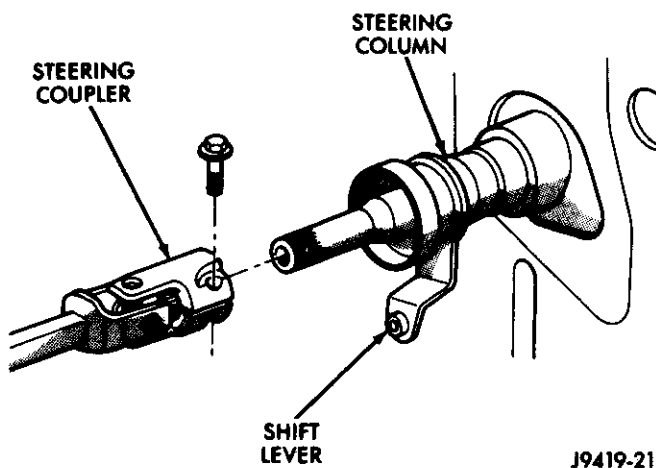


Fig. 5 Steering Coupler

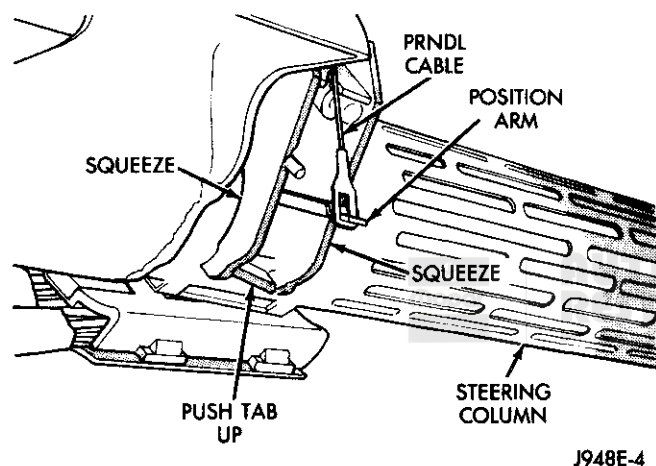


Fig. 6 PRNDL Drive Cable

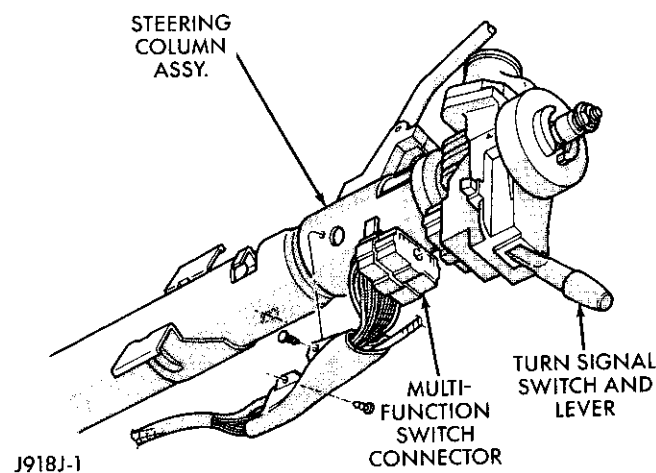


Fig. 7 Multi-function Switch

(12) Remove electrical connections from Key-in light, Ignition Switch, Horn and Clock Spring (Speed Control) (Fig. 8).

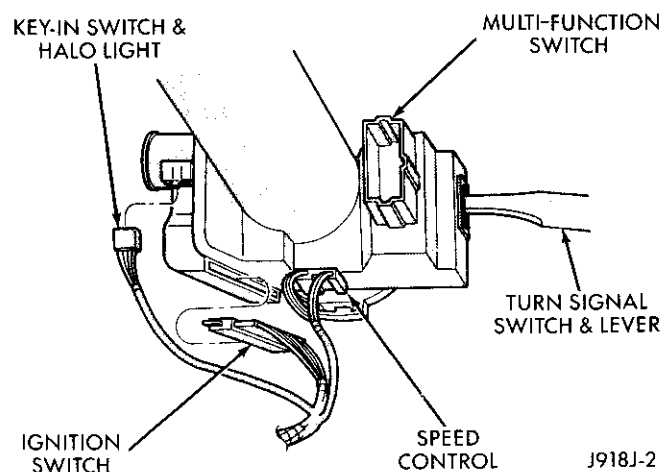


Fig. 8 Steering Column Wiring

(13) Remove the wiring harness from the column by prying out the plastic retainer buttons.

(14) Remove lower dash panel and toe plate fasteners.

(15) Remove column from vehicle. Use care to avoid damaging the paint or trim.

INSTALLATION

(1) Column shift vehicles, install a new grommet. Use MOPAR® Multipurpose Lubricant, or equivalent, to aid installation of the grommet. **A new grommet should be used when ever the rod is disconnected from the lever.**

(2) Remove the shipping lock pin if necessary.

(3) Install the ground clip on the left spacer slot.

(4) Install column through floor pan.

(5) Position the column bracket shear pins on the attaching studs. Install, but **loose assemble** the two upper bracket nuts.

(6) With the front wheels in the straight-ahead position. Align steering column shaft to the coupler. Install pinch bolt and tighten to 49 N·m (36 ft. lbs.).

(7) Clip the wiring harness on the steering column. Connect the multi-function switch wiring and tighten with 7mm socket.

(8) Install the upper fixed shroud.

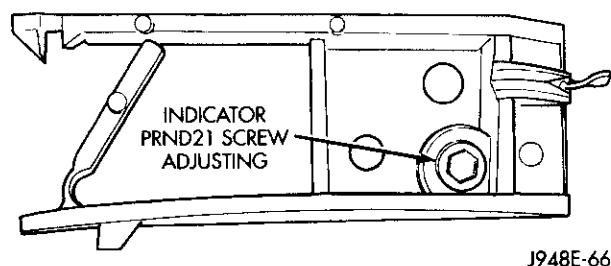
(9) Be sure both breakaway capsules are fully seated in the slots in the column support bracket. Tighten upper bracket nuts to 12 N·m (105 in. lbs.).

(10) Tighten the toe plate to floor pan attaching nuts to 22.5 N·m (200 in. lbs.).

(11) Install the wiring connections to the column. Install the lower fixed shroud.

(12) Column shift vehicles, install the PRNDL driver cable. Place shifter in Park position. If indicator needs adjusting turn recessed hex head screw underneath cable retainer (Fig. 9).

(13) Install the lock housing shrouds. Install the tilt lever (if equipped).

REMOVAL AND INSTALLATION (Continued)**Fig. 9 PRNDL Adjuster**

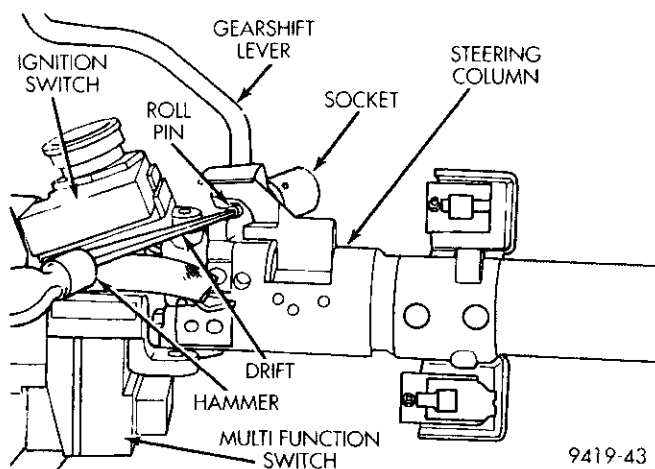
- (14) Install the lower dash panel column cover.
- (15) Install steering wheel on column, refer to Steering Wheel- Installation.
- (16) Column shift vehicles, connect the shift link rod to the transmission shift lever. Use MOPAR® Multipurpose Lubricant, or an equivalent product, to aid the installation.
- (17) Check operation of the transmission shift linkage and adjust as necessary. Refer to Group 21, Transmission for the shift linkage adjustment.
- (18) Connect the battery ground (negative) cable.

GEAR SHIFT LEVER**REMOVAL**

- (1) Support the steering column assembly as shown in (Fig. 10) using a suitable size socket.
- (2) Using a drift of the appropriate size drive the roll pin out of the steering column and gear shift lever. Remove the gear shift lever from the steering column assembly.

INSTALLATION

- (1) Support the steering column using a suitable size socket.
- (2) Install the gear shift lever into the steering column assembly. Align the roll pin holes in the gear shift lever and the steering column assembly.

**Fig. 10 Gear Shift Lever**

- (3) Carefully install the roll pin into the steering column assembly and through the shift lever. If the roll pin binds check the alignment on the holes. Be sure roll pin is fully installed into the steering column assembly.

SPECIFICATIONS**TORQUE CHART**

DESCRIPTION	TORQUE
Steering Wheel	
Nut . . . . .	.61 N·m (45 ft. lbs.)
Steering Coupler	
Bolt . . . . .	.49 N·m (36 ft. lbs.)
Steering Column	
Upper Bracket12 N·m (105 in. lbs.)
Toe Plate23 N·m (200 in. lbs.)

STEERING LINKAGE

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SERVICE PROCEDURES

STEERING LINKAGE

Before removing any steering component, the boot seals should be closely inspected for damage. If a seal

is damaged, it should be replaced. Before installing a new seal, inspect ball stud. Replace ball stud if worn and lubricate the ball studs with MOPAR Multi-Mile-age Lubricant, or an equivalent.



STEERING LINKAGE—IFS SUSPENSION

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IFS—STEERING LINKAGE	20	SPECIAL TOOLS	
REMOVAL AND INSTALLATION		STEERING LINKAGE	21
STEERING LINKAGE	20		

GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

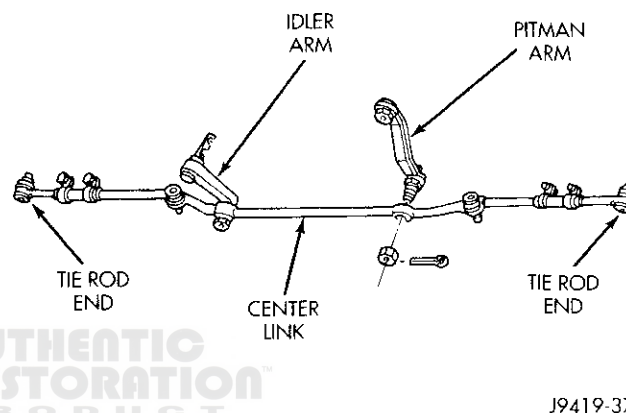
IFS—STEERING LINKAGE

Standard and heavy duty steering linkage is used with IFS suspensions (Fig. 1). Heavy duty linkage is used on 8,800 and 10,500 GVW vehicles. Vehicles with 10,500 GVW rating have a steering damper mounted from a frame bracket to the centerlink.

REMOVAL AND INSTALLATION

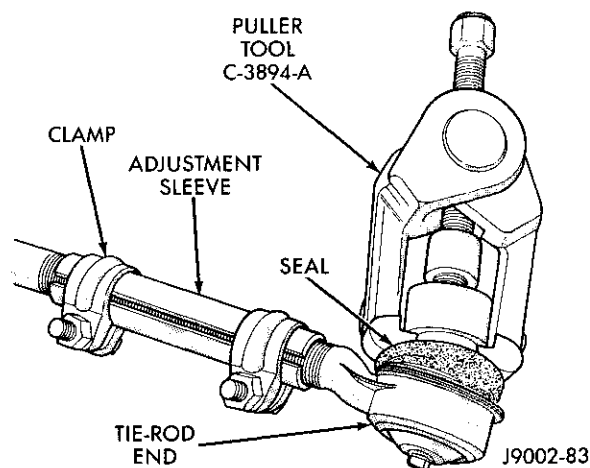
STEERING LINKAGE

NOTE: When servicing the steering linkage, use care to avoid damaging ball stud seals. Use puller C-3894-A to remove tie rod ends (Fig. 2).



J9419-37

Fig. 1 IFS—Steering Linkage



J9002-83

Fig. 2 Tie Rod End

REMOVAL

- (1) Remove the cotter pin and nut from the tie-rod.
- (2) Remove the tie-rod end ball studs from steering knuckles.
- (3) Remove inner tie-rod ends from center link.
- (4) If equipped remove steering damper from center link and frame bracket.

REMOVAL AND INSTALLATION (Continued)

(5) Remove idler arm ball stud from center link. Remove idler arm stud plate from frame side rail.

(6) Remove pitman arm ball stud from center link.

(7) Mark the pitman arm and shaft positions for installation reference. Remove pitman arm with Puller C-4150A (Fig. 3).

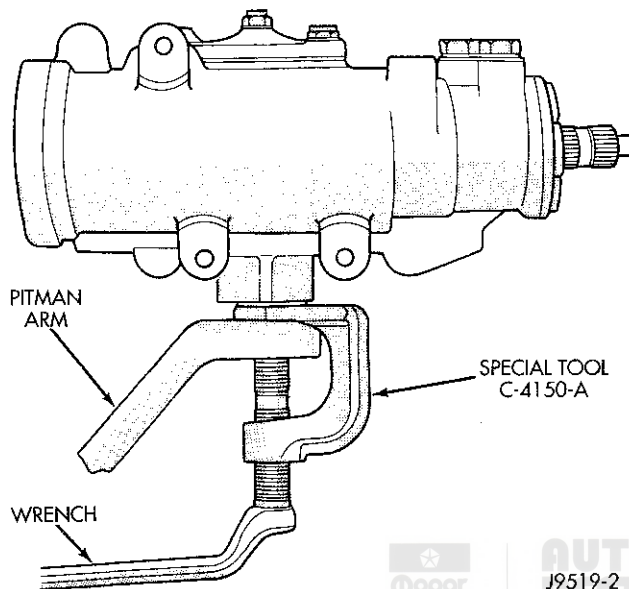


Fig. 3 Pitman Arm

INSTALLATION

(1) Position idler arm on the frame side rail and tighten to specification.

(2) Center steering gear to alignment marks and install pitman arm.

(3) Install the lock washer and retaining nut on the pitman shaft. Tighten the nut to 251 N·m (185 ft. lbs.).

(4) Install center link to ball studs and tighten retaining nuts to 88 N·m (65 ft. lbs.). Install new cotter pins.

(5) Install tie-rod ends into center link and tighten the nuts to 88 N·m (65 ft. lbs.). Install new cotter pins.

(6) Install steering damper to frame bracket and center link (if equipped). Tighten nuts to 68 N·m (50 ft. lbs.). Install new cotter pins.

(7) Install tie-rod ends into steering knuckles and tighten nuts to 88 N·m (65 ft. lbs.). Install new cotter pins.

(8) Remove the supports and lower the vehicle to the surface. Center steering wheel and adjust toe (refer to the Alignment Specifications chart within Group 2, Front Suspension).

NOTE: Position the clamp on the sleeve so retaining bolt is located on the bottom side of the sleeve.

(9) After adjustment, tighten the tie-rod adjustment sleeve clamp bolt to 54 N·m (40 ft. lbs.).

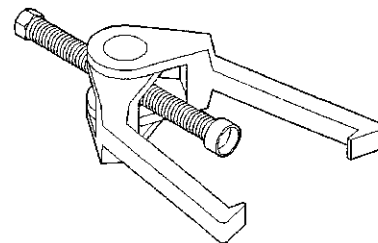
SPECIFICATIONS

TORQUE SPECIFICATIONS

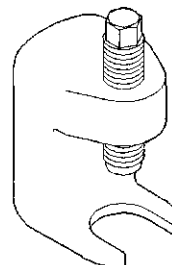
DESCRIPTION	TORQUE
Pitman Arm	
Ball Stud Nut . . . . .	.88 N·m (65 ft. lbs.)
Shaft Nut. . . . .	.251 N·m (185 ft. lbs.)
Idler Arm with Wax Coat Frame	
Ball Stud Nut . . . . .	.88 N·m (65 ft. lbs.)
Mounting Nuts LD . . . . .	.68 N·m (50 ft. lbs.)
Mounting Bolts HD . . . . .	.271 N·m (200 ft. lbs.)
Idler Arm with E-Coat Frame	
Ball Stud Nut . . . . .	.88 N·m (65 ft. lbs.)
Mounting Nuts LD . . . . .	.94 N·m (70 ft. lbs.)
Mounting Bolts HD . . . . .	.284 N·m (210 ft. lbs.)
Steering Damper with Wax Coat Frame	
Frame Nut. . . . .	.68 N·m (50 ft. lbs.)
Center Link Nut . . . . .	.68 N·m (50 ft. lbs.)
Steering Damper with E-Coat Frame	
Frame Nut. . . . .	.88 N·m (65 ft. lbs.)
Center Link Nut . . . . .	.68 N·m (50 ft. lbs.)
Tie Rod	
Ball Stud Nut . . . . .	.88 N·m (65 ft. lbs.)
Tie Rod Clamp. . . . .	.54 N·m (40 ft. lbs.)

SPECIAL TOOLS

STEERING LINKAGE



Puller C-3894-A



Remover Pitman C-4150A

STEERING LINKAGE—LINK/COIL SUSPENSION

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GENERAL INFORMATION

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

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St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

LINK/COIL—STEERING LINKAGE

The steering linkage is comprised of a tie rod end, tie rod, drag link, steering damper and pitman arm (Fig. 1).

REMOVAL AND INSTALLATION

STEERING LINKAGE

NOTE: When servicing the steering linkage, use care to avoid damaging ball stud seals. Use puller C-3894-A to remove tie rod ends (Fig. 2).

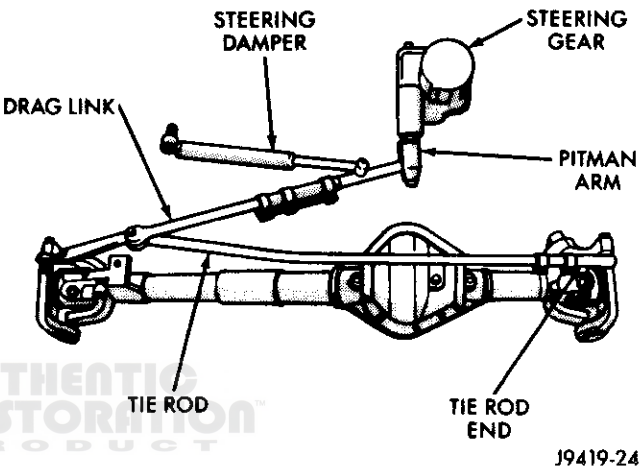


Fig. 1 Link/Coil—Steering Linkage

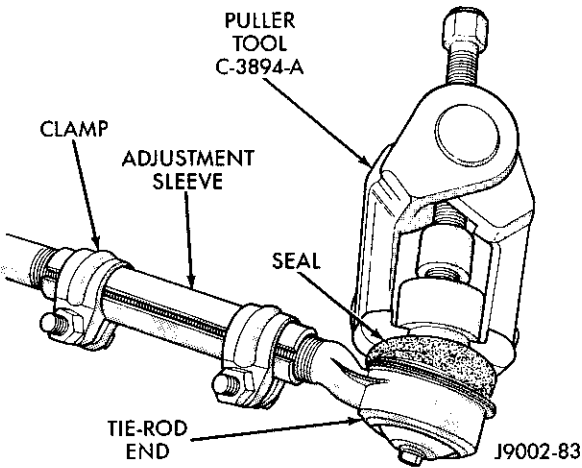


Fig. 2 Tie Rod End

REMOVAL

- (1) Remove tie rod and steering damper from drag link.
- (2) Remove drag link tie-rod end from steering knuckle and pitman arm.
- (3) Mark the pitman arm and shaft positions for installation reference. Remove the nut and washer

REMOVAL AND INSTALLATION (Continued)

from the pitman arm. Remove the pitman arm with Puller C- 4150A.

(4) Remove tie rod from steering knuckle.

INSTALLATION

NOTE: When installing linkage tighten nuts to proper torque, then align cotter pin slot by tightening nut if necessary.

(1) Align reference marks and install pitman arm.

(2) Install the lock washer and retaining nut on the pitman shaft and tighten nut to 251 N·m (185 ft. lbs.).

(3) Install drag-link ball studs to steering knuckle and pitman arm. Install the retaining nuts and tighten to 88 N·m (65 ft. lbs.). Install new cotter pins.

(4) Install tie-rod on steering knuckle and drag-link. Tighten the nuts to 88 N·m (65 ft. lbs.). Install new cotter pins.

(5) Install steering damper on drag-link and tighten nut to 68 N·m (50 ft. lbs.). Install new cotter pin.

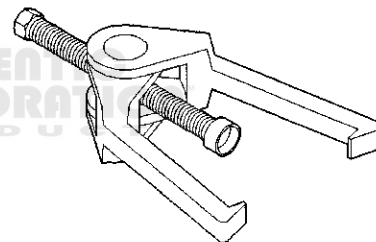
(6) Remove the supports and lower the vehicle to the surface. Center steering wheel and adjust toe, refer to Group 2 Suspension.

(7) After adjustment tighten tie-rod adjustment sleeve clamp bolts to 54 N·m (40 ft. lbs.).

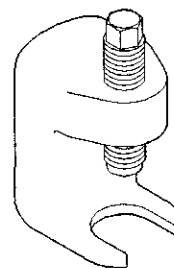
NOTE: Position the clamp on the sleeve so retaining bolt is located on the bottom side of the sleeve.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

DESCRIPTION	TORQUE
Pitman Arm	
Shaft	251 N·m (185 ft. lbs.)
Drag Link	
Ball Stud	88 N·m (65 ft. lbs.)
Tie Rod End	
Ball Stud	88 N·m (65 ft. lbs.)
Clamp	54 N·m (40 ft. lbs.)
Tie Rod	
Ball Stud	88 N·m (65 ft. lbs.)
Steering Damper	
Wax Coat Frame	68 N·m (50 ft. lbs.)
E-Coat Frame	88 N·m (65 ft. lbs.)
Drag Link	68 N·m (50 ft. lbs.)

SPECIAL TOOLS**STEERING LINKAGE**

Puller C-3894-A



Remover Pitman C-4150A

TRANSMISSION AND TRANSFER CASE

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NV3500 MANUAL TRANSMISSION

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GENERAL INFORMATION

GENERAL INFORMATION

The NV3500 is a medium-duty, 5-speed, constant mesh, fully synchronized manual transmission. Fifth gear is an overdrive range with a ratio of 0.0729:1. The NV3500 is used with 3.9L and 5.2L engines and is available in two and four-wheel drive configurations.

The transmission gear case consists of two aluminum housings (Fig. 1). The clutch housing is not a removable component. It is an integral part of the transmission front housing.

Roller bearings are used to support the transmission shafts in the two housings. The transmission gears all rotate on caged type needle bearings.

The NV3500 has a single shaft shift mechanism. The three shift forks are all mounted on a one shift shaft. The shaft is supported in the front and rear housings by bushings and one bearing. Internal shift components consist of the forks, shaft, shift lever socket, and detent components (Fig. 2).

TRANSMISSION LUBRICANT

Required lubricant for the NV3500 is Mopar Manual Transmission Lubricant, P/N 4761526. This is the **only** lubricant to be used in NV3500 transmissions. No other lubricants are acceptable, or recommended.

TRANSMISSION LUBRICANT LEVEL AND CAPACITY

The correct transmission lubricant level is to the bottom edge of the fill plug hole (Fig. 3).

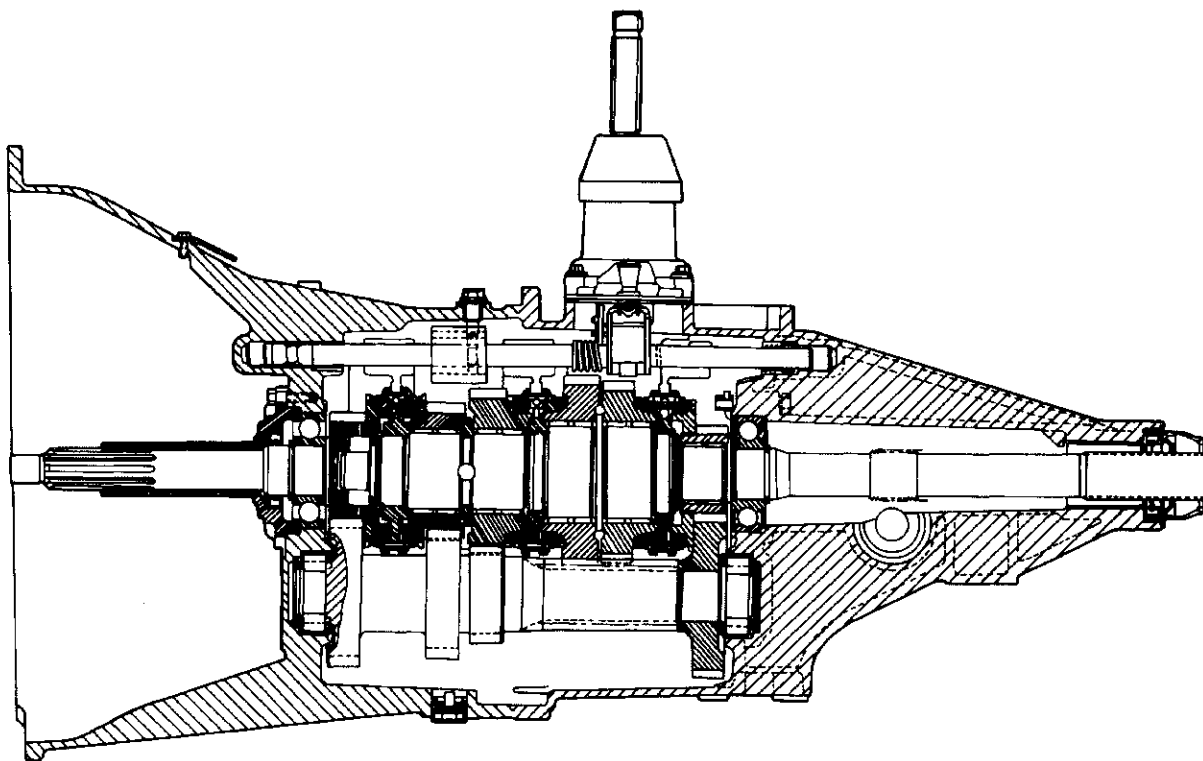
The transmission must be level to obtain an accurate lubricant level check. A drive-on type of hoist is recommended for this purpose.

Lubricant capacity of the NV3500 is approximately 1.98 liters (4.2 pints). This represents the approximate quantity needed to refill the transmission after a lubricant change or overhaul.

DRAIN AND FILL PLUG LOCATIONS

The NV3500 fill and drain plugs are both located in the front housing. The fill plug is at the passenger

GENERAL INFORMATION (Continued)



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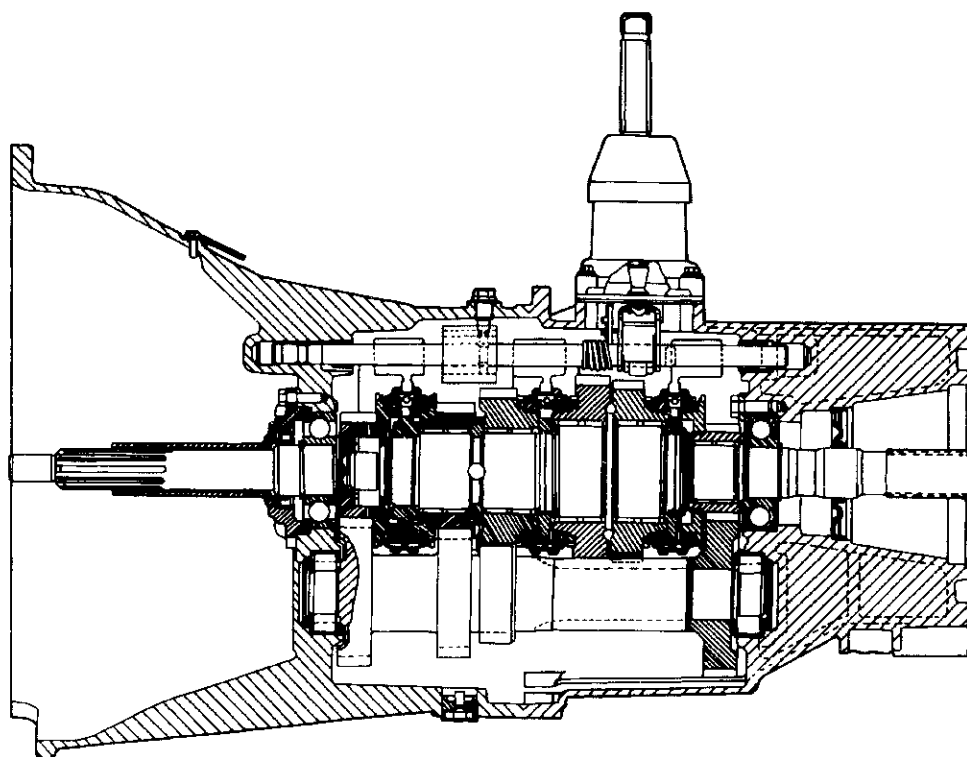
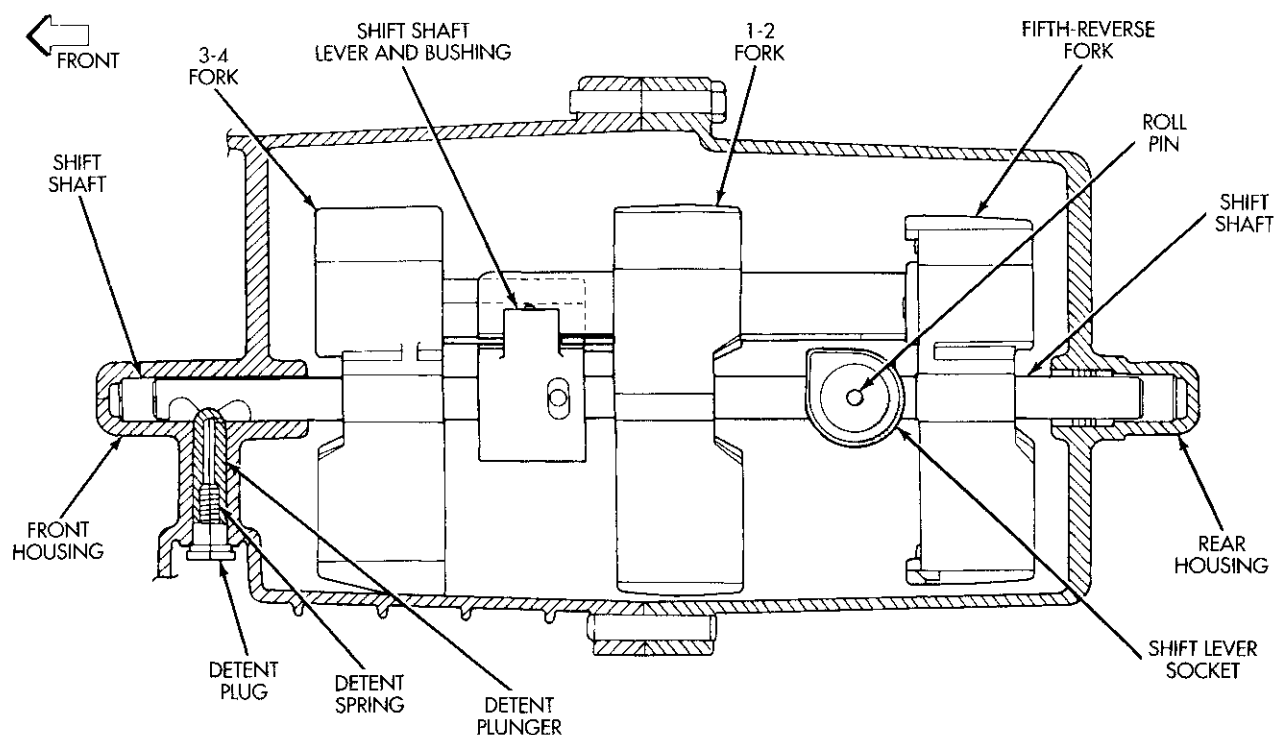


Fig. 1 NV3500 Manual Transmission

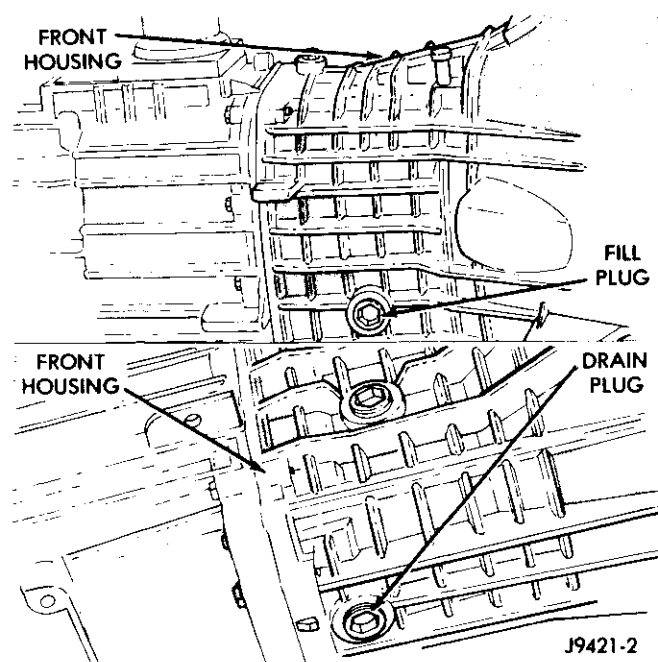
GENERAL INFORMATION (Continued)

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Fig. 2 NV3500 Shift Mechanism

side of the housing. The drain plug is at the bottom of the housing (Fig. 3).

**Fig. 3 Drain and Fill Plug Locations****TRANSMISSION GEAR RATIOS**

Two versions of the NV3500 are now available. The original wide ratio version introduced last year, has a 4.01 first gear and 2.318 second gear. The new close ratio NV3500 has a 3.49 first gear and 2.16 second gear.

WIDE RATIO VERSION

RANGE	RATIO
FIRST	4.016:1
SECOND	2.318:1
THIRD =	1.401:1
FOURTH =	1:1
FIFTH =	0.729:1
REVERSE =	3.55:1

DIAGNOSIS AND TESTING**NV3500 TRANSMISSION****LOW LUBRICANT LEVEL**

A low transmission lubricant level is generally the result of a leak, inadequate lubricant fill, or an incorrect lubricant level check.

DIAGNOSIS AND TESTING (Continued)**CLOSE RATIO VERSION**

RANGE	RATIO
FIRST	3.49:1
SECOND	2.16:1
THIRD =	1.401:1
FOURTH =	1:1
FIFTH =	0.729:1
REVERSE =	3.55:1

Leaks can occur at the mating surfaces of the housings, or from the front/rear seals. A suspected leak could also be the result of an overfill condition.

Leaks at component mating surfaces will probably be the result of inadequate sealer, gaps in the sealer, incorrect bolt tightening, or use of a non-recommended sealer.

A leak at the front of the transmission will be from either a loose or damaged, front bearing retainer or retainer seal. Lubricant may also drip from the transmission clutch housing after extended operation. If the leak is severe, it will contaminate the clutch disc causing slip, grab and chatter.

Transmissions filled from air or electrically powered lubricant containers can be under filled. This generally happens when the container delivery mechanism is improperly calibrated. Always check the lubricant level after filling to avoid an under fill condition.

A correct lubricant level check can only be made when the vehicle is level; use a drive-on hoist to ensure this. Also allow the lubricant to settle for a minute or so before checking. These recommendations will ensure an accurate check and avoid an under-or-overfill condition.

HARD SHIFTING

Hard shifting is usually caused by a low lubricant level, improper or contaminated lubricants, transmission component damage, clutch linkage malfunction, or by a damaged clutch pressure plate or disc.

Substantial lubricant leaks can result in gear, shift component, synchro and bearing damage. If a leak goes undetected for an extended period, the first indications of a problem are usually hard shifting and noise.

Incorrect or contaminated lubricants can also contribute to hard shifting. The consequence of using non-recommended lubricants is noise, excessive wear, internal bind and hard shifting.

Improper clutch release is a frequent cause of hard shifting. Incorrect adjustment or a worn, damaged pressure plate or disc can cause incorrect release. If the clutch problem is advanced, gear clash during shifts can result.

Worn or damaged synchro rings can cause gear clash when shifting into any forward gear. In some new or rebuilt transmissions, new synchro rings may tend to stick slightly causing stiff and/or noisy shifts. In most cases, this condition will decline as the rings wear in.

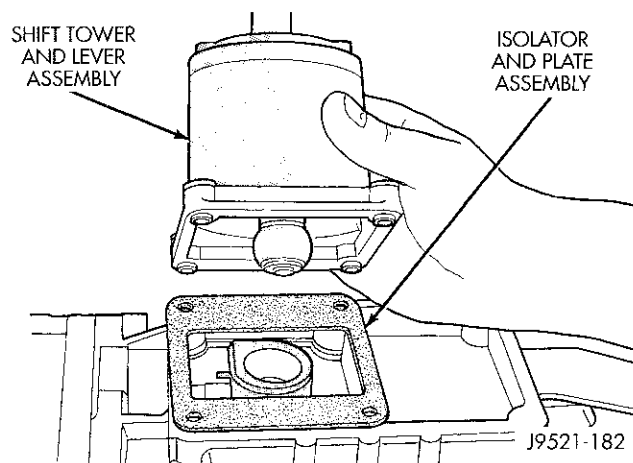
TRANSMISSION NOISE

Most manual transmissions make some noise during normal operation. Rotating gears can generate a mild whine that may only be audible at extreme speeds.

Severe, obviously audible transmission noise is generally the result of a lubricant problem. Insufficient, improper, or contaminated lubricant can promote rapid wear of gears, synchros, shift rails, forks and bearings. The overheating caused by a lubricant problem, can also lead to gear breakage.

REMOVAL AND INSTALLATION**TRANSMISSION—2WD****REMOVAL**

- (1) Disconnect battery negative cable.
- (2) Shift transmission into Neutral.
- (3) Remove shift boot bezel screws and slide boot upward on shift lever extension.
- (4) Remove bolts attaching shift tower and lever assembly to rear case. Then remove shift tower and shift lever extension as assembly (Fig. 4).
- (5) If isolator and plate came off during shift tower removal (Fig. 4), remove assembly from shift housing. Note that plate is one-way fit. Narrow side of plate goes toward driver side of transmission.

**Fig. 4 Shift Tower Removal**

- (6) Raise vehicle on hoist.
- (7) Remove crankshaft position sensor. Retain sensor attaching bolts.

REMOVAL AND INSTALLATION (Continued)

- (8) Remove skid plate, if equipped.
- (9) Drain transmission lubricant if transmission will be disassembled for service.
- (10) Mark propeller shaft and U-joint for installation reference. Then disconnect and remove propeller shaft.
- (11) Disconnect vehicle speed sensor wires.
- (12) Disengage harness from clips on transmission housing.
- (13) Support engine with adjustable jack stand.
- (14) Remove nuts attaching rear mount to crossmember (Fig. 5). Then remove insulator from extension housing if necessary.
- (15) Remove bolts and nuts attaching crossmember to frame rails. Rotate crossmember diagonally and remove crossmember.
- (16) Disconnect exhaust pipes at manifold and at converter or muffler connections as needed. Then remove Y-pipe, converter and tail pipe.
- (17) Remove slave cylinder attaching nuts and remove cylinder from clutch housing.
- (18) Remove starter motor.
- (19) Support transmission with transmission jack. Secure transmission to jack with safety chains.
- (20) Remove nuts/bolts attaching transmission front housing to engine.

(21) Move transmission rearward until clear of engine. Then lower jack and remove transmission from under vehicle.

(22) Remove transmission from jack and position transmission on workbench.

(23) If transmission will be overhauled, remove release bearing and fork from front housing.

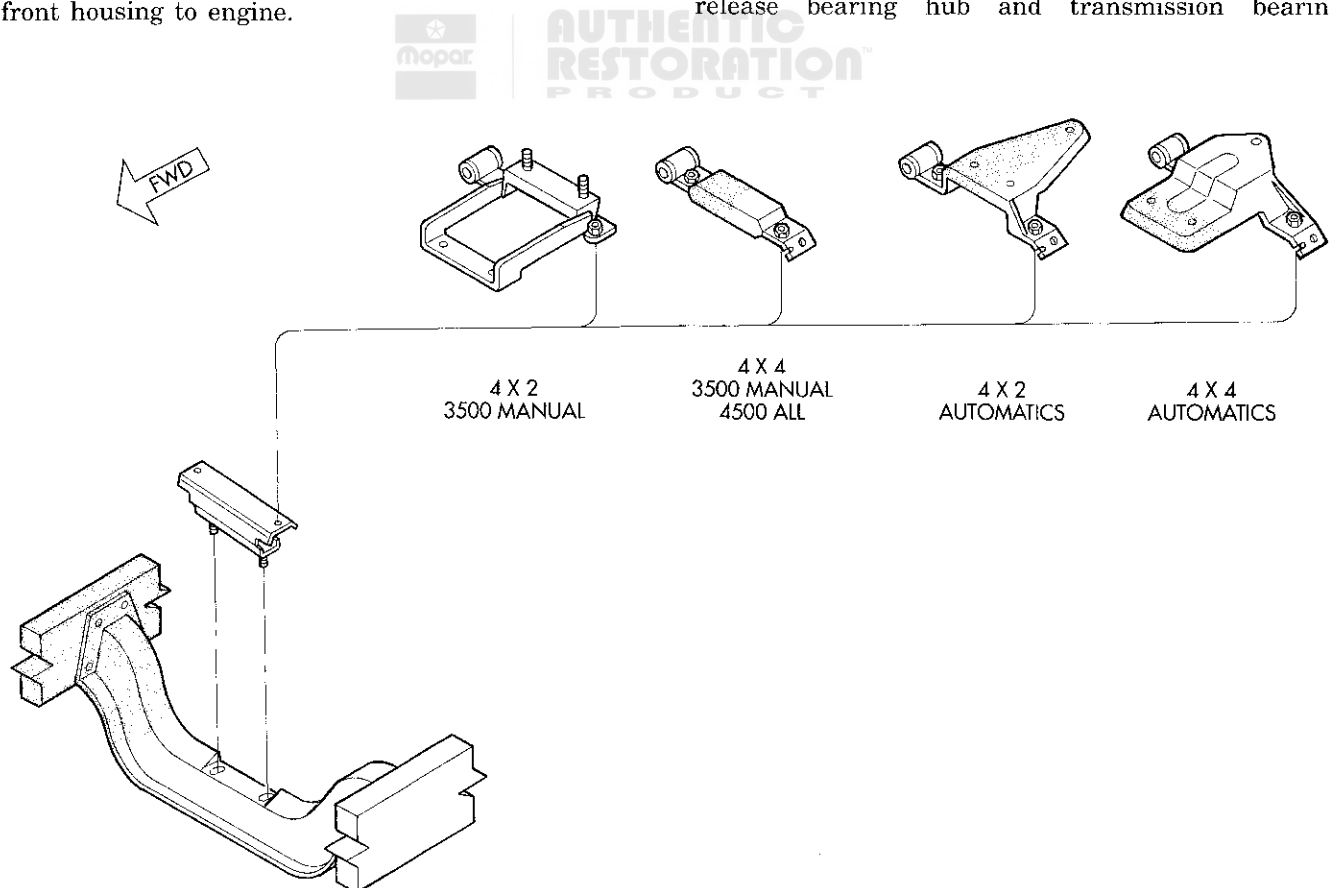
(24) If shift lever extension is press-on style and must be removed from shift lever, refer to following procedure:

- (a) Obtain Remover/Installer Tool 6783.
- (b) Scribe mark position of extension on shank of shift lever.
- (c) Position notched, lower end of tool just under square shank of shift lever (Fig. 6).
- (d) Position tool upper jaws **under** flange on shift lever extension (Fig. 6).
- (e) Tighten tool screw to pull extension off square shank of shift lever.
- (f) Remove lever extension and tool.

TRANSMISSION INSTALLATION

(1) Make sure transmission front housing mounting surface is clean before installation.

(2) Lubricate release fork pivot ball, release fork, release bearing hub and transmission bearing



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Fig. 5 Transmission Rear Support Brackets

REMOVAL AND INSTALLATION (Continued)

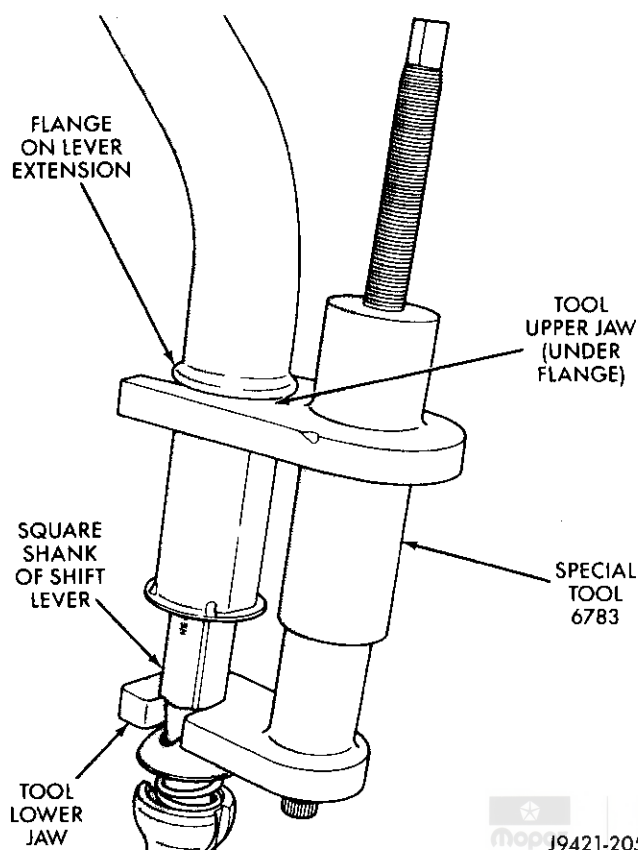


Fig. 6 Removing Shift Lever Extension With Tool 6783

retainer surface with Mopar high temperature grease.

(3) Mount transmission on jack. Secure transmission to jack with safety chains.

(4) Lubricate transmission input shaft pilot hub and splines with light coat of Mopar high temperature grease.

(5) Align transmission input shaft with release bearing and clutch disc. Then slide transmission into place on engine block.

(6) Install and tighten transmission attaching bolts to 54-61 N·m (40-45 ft. lbs.) torque. Be sure front housing is fully seated before tightening bolts. Install front dust cover after all bolts are tightened.

(7) Fill transmission with Mopar lubricant P/N 4761526. Correct fill level is to bottom edge of fill plug hole.

(8) Connect backup light switch wires.

(9) Connect transmission harnesses to clips on case.

(10) Install crossmember. Tighten crossmember-to-frame bolts to 68 N·m (50 ft. lbs.) torque.

(11) Tighten crossmember-to-transmission insulator nuts to 68 N·m (50 ft. lbs.) torque.

(12) Install slave cylinder. Tighten cylinder nuts to 23 N·m (200 in. lbs.) torque.

(13) Remove jack used to support transmission.

(14) Install strut bolts/nuts, if removed. Also install oil filter if removal was necessary.

(15) Connect vehicle speed sensor wires.

(16) Install and connect exhaust system. Align exhaust components before tightening clamp and bracket bolts and nuts. Be sure exhaust components are clear of all chassis and driveline components.

(17) Align and install propeller shaft. Tighten U-joint clamp bolts to 19 N·m (170 in. lbs.) torque.

(18) Verify that all linkage components, hoses and electrical wires have been connected.

(19) Remove any remaining support stands and lower vehicle.

(20) Install crankshaft position sensor.

(21) Connect battery negative cable.

(22) Apply Mopar Gasket Maker, or Loctite 518 to mounting surface of shift tower, isolator plate, and transmission case.

(23) Install isolator plate on shift tower, or rear case. Then install shift tower and lever assembly. Tighten shift tower bolts to 7-10 N·m (5-7 ft. lbs.) torque. Note that isolator plate is one-way fit. Narrow side goes toward driver side of transmission.

(24) If shift lever extension was removed from shift lever, reinstall with Tool 6783 as follows:

(a) Reposition upper jaw of Remover/Installer Tool 6783 **above** flange on lever extension (Fig. 7). Tool will now be used to press extension back onto shift lever.

(b) Tighten tool screw to press extension back onto lever. Press extension to scribe mark made during removal.

(c) Remove special tool.

(25) Install shift boot and bezel.

TRANSMISSION—4WD

REMOVAL

(1) Disconnect battery negative cable.

(2) Shift transmission into Neutral.

(3) Remove screws attaching shift boot bezel and slide boot upward on shift lever extension. Then loosen extension locknut and unscrew extension from shift lever.

(4) Remove bolts attaching shift tower and lever assembly to rear case. Then remove shift tower and lever along with shift lever extension as an assembly.

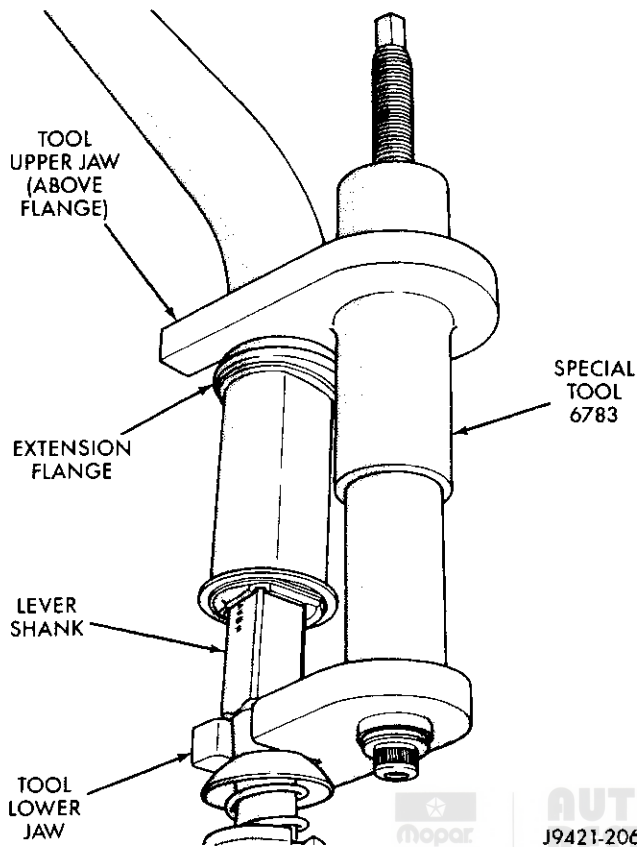
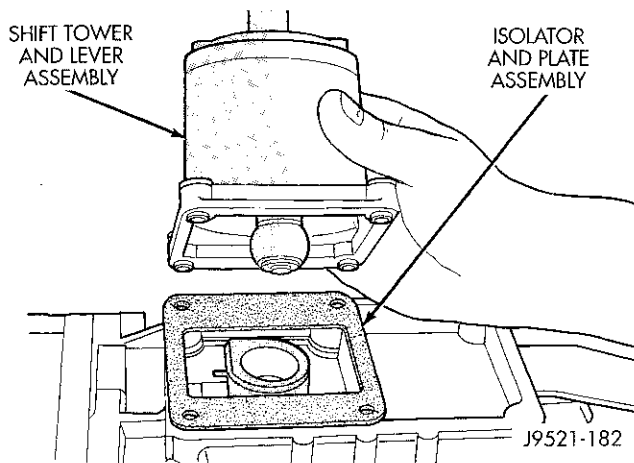
(5) If isolator and plate came off shift tower during removal, remove assembly from rear housing (Fig. 8). Note that plate is one-way fit. Narrow side of plate goes toward driver side of transmission.

(6) Remove crankshaft position sensor. Retain sensor attaching bolts.

(7) Raise vehicle on hoist.

(8) Remove skid plate, if equipped.

(9) Drain transmission lubricant if transmission will be disassembled for service.

REMOVAL AND INSTALLATION (Continued)**Fig. 7 Installing Shift Lever Extension With Tool 6783****Fig. 8 Shift Tower Removal**

(10) Mark propeller shafts and U-joints for installation reference. Then disconnect and remove propeller shafts.

(11) Disconnect vehicle speed sensor wires.

(12) Disconnect transfer case shift linkage at transfer case range lever.

(13) Remove bolts attaching shift linkage bracket to transfer case and move linkage and bracket aside.

(14) Remove nuts attaching transfer case to transmission adapter housing.

(15) Remove transfer case with aid of helper. Support transfer case with transmission jack. Move transfer case rearward, tilt it away from fixed (welded) rear crossmember and work it out from between transmission and crossmember.

(16) Support engine with adjustable jack stand.

(17) Remove nuts and bolts attaching support bracket and cushions to fixed crossmember.

(18) Remove nuts and bolts attaching removable crossmember to frame rails. Rotate crossmember diagonally to remove it.

(19) Disconnect exhaust pipes at manifold and at converter or muffler connections as needed. Then remove Y-pipe, converter and tail pipe.

(20) Remove slave cylinder attaching nuts and remove cylinder from clutch housing. Move cylinder aside for working clearance.

(21) Remove clutch housing dust cover.

(22) On some models, it may be necessary to remove front axle struts and oil filter for access and removal clearance. Remove these components if necessary.

(23) Support transmission with transmission jack. Secure transmission to jack with safety chains.

(24) Remove bolts attaching transmission clutch housing to engine block.

(25) Move transmission rearward until transmission clutch housing is clear of engine. Then lower jack and remove transmission from under vehicle.

(26) Remove transmission from jack and position transmission on workbench.

(27) If transmission will be disassembled for service, remove release bearing and fork.

(28) If shift lever extension is press-on style and must be removed from shift lever, refer to following procedure:

(a) Obtain Remover/Installer Tool 6783.

(b) Scribe mark position of extension on shank of shift lever.

(c) Position notched, lower end of tool just under square shank of shift lever (Fig. 9).

(d) Position tool upper jaws **under** flange on shift lever extension (Fig. 9).

(e) Tighten tool screw to pull extension off square shank of shift lever.

(f) Remove lever extension and tool.

TRANSMISSION INSTALLATION

(1) Make sure transmission front housing and engine block contact surfaces are clean.

(2) Lubricate release fork pivot ball, release fork, release bearing hub and transmission bearing retainer surface with Mopar high temperature grease.

REMOVAL AND INSTALLATION (Continued)

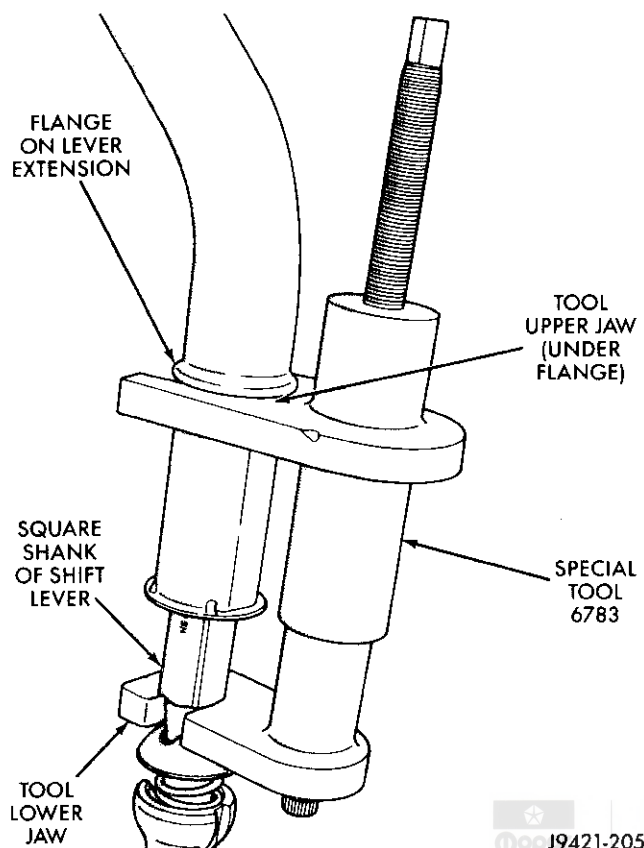


Fig. 9 Removing Shift Lever Extension With Tool 6783

(3) Mount transmission on jack. Secure transmission to jack with safety chains.

(4) Lubricate transmission input shaft pilot hub and splines with light coat of Mopar high temperature grease.

(5) Align transmission input shaft with release bearing and clutch disc. Then slide clutch housing into place on engine block.

(6) Install and tighten transmission attaching bolts to 54-61 N·m (40-45 ft. lbs.) torque. Be sure housing is fully seated before tightening bolts. If equipped, install dust cover after tightening housing bolts.

(7) Fill transmission with Mopar lubricant, P/N 4761526. Correct fill level is to bottom edge of fill plug hole.

(8) Connect backup light switch wires.

(9) Connect transmission harnesses and vent line to retainer clips on housing.

(10) Install center crossmember. Tighten crossmember-to-frame bolts to 67 N·m (50 ft. lbs.) torque.

(11) Tighten crossmember-to-support bracket nuts to 54-61 N·m (40-45 ft. lbs.) torque.

(12) Install slave cylinder in transmission clutch housing. Tighten cylinder attaching nuts to 23 N·m (200 in. lbs.) torque.

(13) Remove jack used to support transmission.

(14) Install strut bolts/nuts, if removed.

(15) Install transfer case. Align and position transfer case with transmission jack or aid of helper. Tilt case upward and work into position on transmission mounting studs.

(16) Install and tighten transfer case attaching nuts to 47 N·m (35 ft. lbs.) torque.

(17) Install and connect transfer case shift linkage.

(18) Connect vehicle speed sensor harness wire to sensor.

(19) Align and connect exhaust system components. Be sure exhaust components are clear of all chassis and driveline components.

(20) Align and install front and rear propeller shafts. Tighten U-joint clamp bolts to 19 N·m (170 in. lbs.) torque.

(21) Verify that all linkage components, hoses and electrical wires have been connected.

(22) Check transfer case fluid level. Add Mopar Dexron II, or ATF Plus if necessary. Correct level is to edge of fill plug hole. Be sure transfer case is level before checking or adding fluid.

(23) Check and adjust transfer case shift linkage if necessary.

(24) Install transfer case skid plate, if equipped.

(25) Fill transmission with Mopar lubricant, P/N 4761526. Correct fill level is to bottom edge of fill plug hole.

(26) Install crankshaft position sensor.

(27) Remove any remaining support stands and lower vehicle.

(28) Connect battery negative cable.

(29) Apply Mopar Gasket Maker, or Loctite 518 to mounting surfaces of shift tower, isolator plate, and lever mounting surface on transmission front housing.

(30) Install isolator plate on shift tower, or rear case. Then install shift tower and lever assembly. Tighten shift tower bolts to 7-10 N·m (5-7 ft. lbs.) torque. Note that isolator plate is one way fit. Narrow side goes toward driver side of transmission.

(31) If shift lever extension was removed from shift lever, reinstall with Tool 6783 as follows:

(a) Reposition upper jaw of Remover/Installer Tool 6783 **above** flange on lever extension (Fig. 10). Tool will now be used to press extension back onto shift lever.

(b) Tighten tool screw to press extension back onto lever. Press extension to scribe mark made during removal.

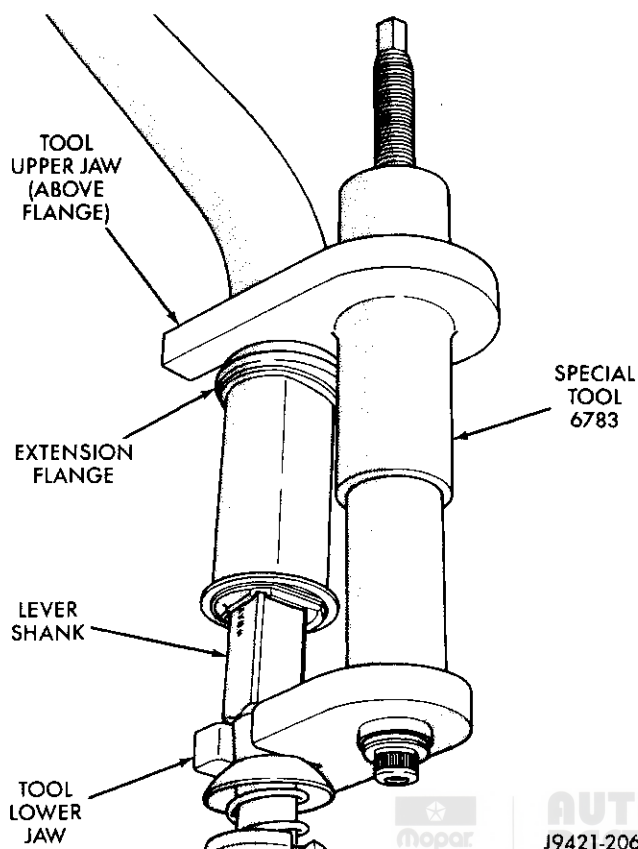
(c) Remove special tool.

(32) Install shift boot and bezel.

DISASSEMBLY AND ASSEMBLY

TRANSMISSION

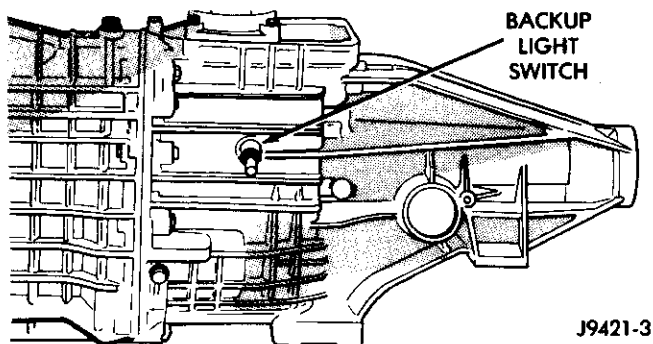
The following disassemble and assemble procedures require removing the transmission from the vehicle.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 10 Installing Shift Lever Extension With Tool 6783****FRONT HOUSING REMOVAL**

(1) If necessary, temporarily reinstall isolator plate and shift lever assembly. Then shift transmission into Neutral.

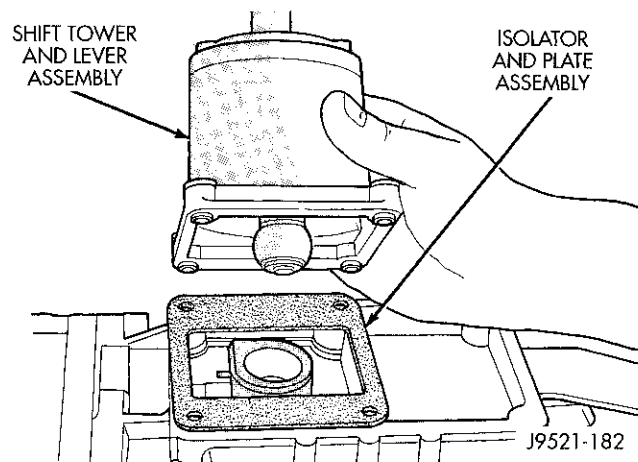
(2) If lubricant was not drained out of transmission during removal, remove drain plug and drain lubricant into container at this time.

(3) Remove backup light switch. Switch is located on driver side of rear housing (Fig. 11).

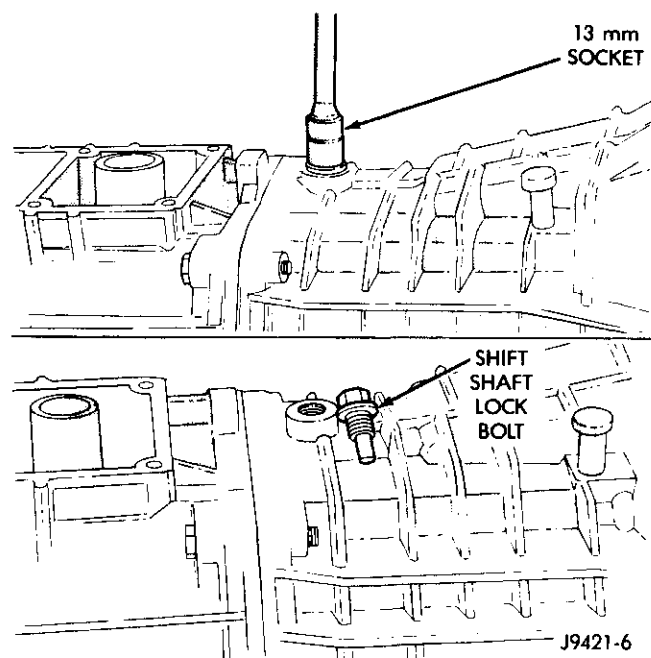
**Fig. 11 Backup Light Switch Location**

(4) Remove shift tower bolts and remove tower and lever assembly (Fig. 12). Use 8 mm socket to tower remove bolts.

(5) If isolator and plate assembly came off shift tower during removal, remove plate assembly from rear housing (Fig. 12). Note that plate assembly is one-way fit. Narrow side of plate goes toward driver side of transmission and rubber coated side faces upward.

**Fig. 12 Shift Tower Removal**

(6) Remove shift shaft lock bolt (Fig. 13). Bolt is located at top of front housing just forward of shift tower. Bolt is a hex head, shoulder bolt that secures shift shaft bushing and lever. Use 13 mm socket to remove bolt.

**Fig. 13 Shift Shaft Lock Bolt Removal**

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Remove bolts attaching input shaft bearing retainer in front housing (Fig. 14). Use 10 mm socket to remove bolts.

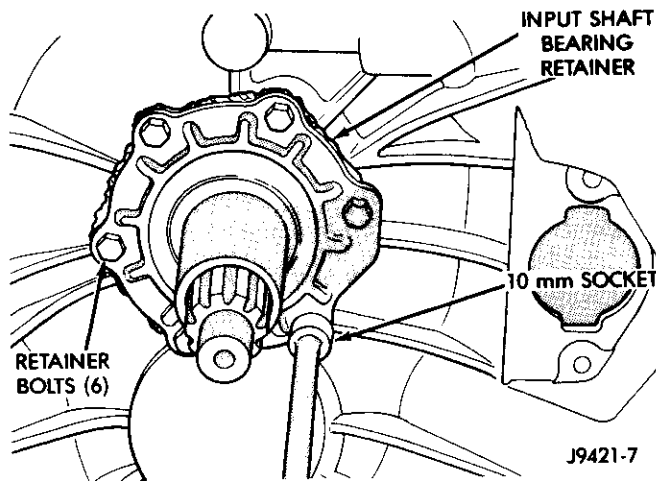


Fig. 14 Input Shaft Bearing Retainer Bolt Removal

(8) Remove input shaft bearing retainer. Use pry tool to carefully lift retainer and break sealer bead (Fig. 15).

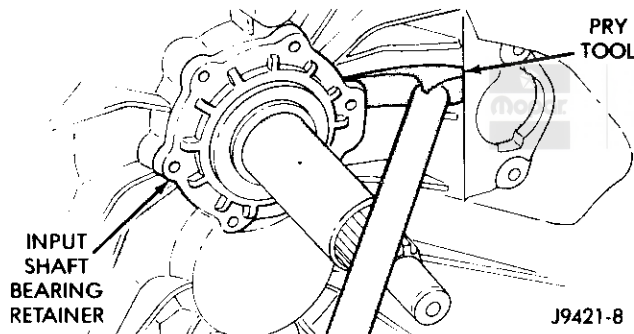


Fig. 15 Loosening Bearing Retainer Sealer Bead

(9) Remove bearing retainer from input shaft (Fig. 16). Note position of retainer lube channel for installation reference.

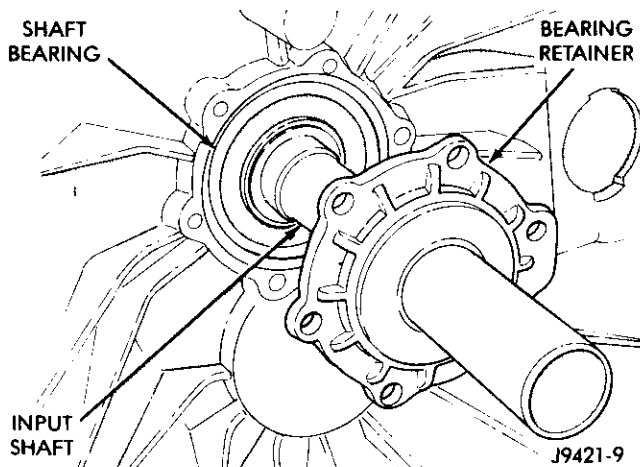


Fig. 16 Input Shaft Bearing Retainer Removal

(10) Remove snap ring that secures input shaft in front bearing (Fig. 17).

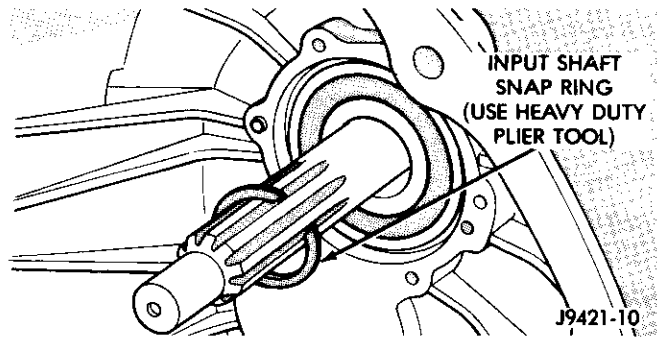


Fig. 17 Input Shaft Snap Ring Removal

(11) Remove shift shaft detent plug (Fig. 18). Use crowfoot bar and hammer to lightly pry and tap plug out of housing.

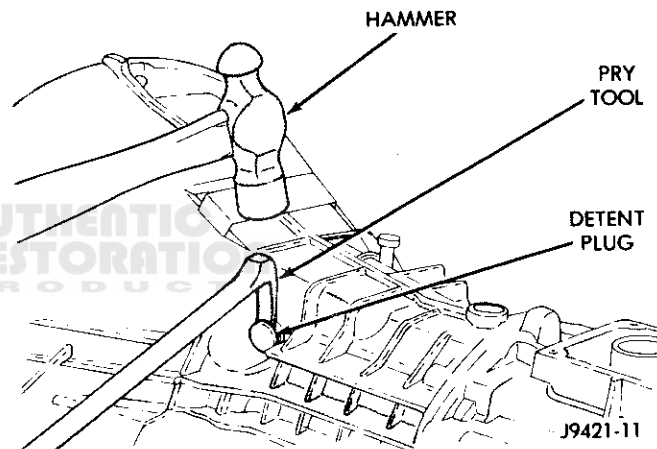


Fig. 18 Shift Shaft Detent Plug Removal

(12) Remove shift shaft detent plunger and spring (Fig. 19). Use pencil magnet to remove spring then plunger.

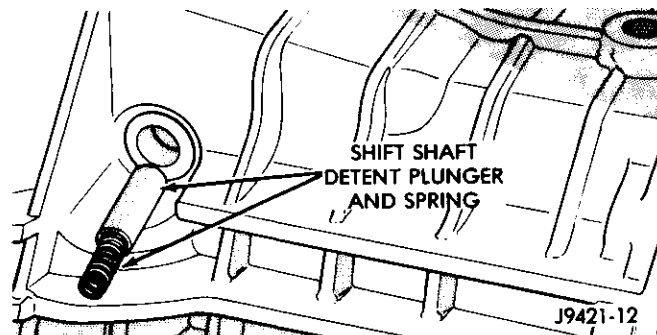


Fig. 19 Detent Plunger And Spring Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(13) Remove bolts that attach front housing to rear housing (Fig. 20). **Three bolts at extreme rear of housing are actually for the output shaft bearing retainer.** It is not necessary to remove all three bolts at this time. Leave at least one bolt in place until rear case is ready to be removed.

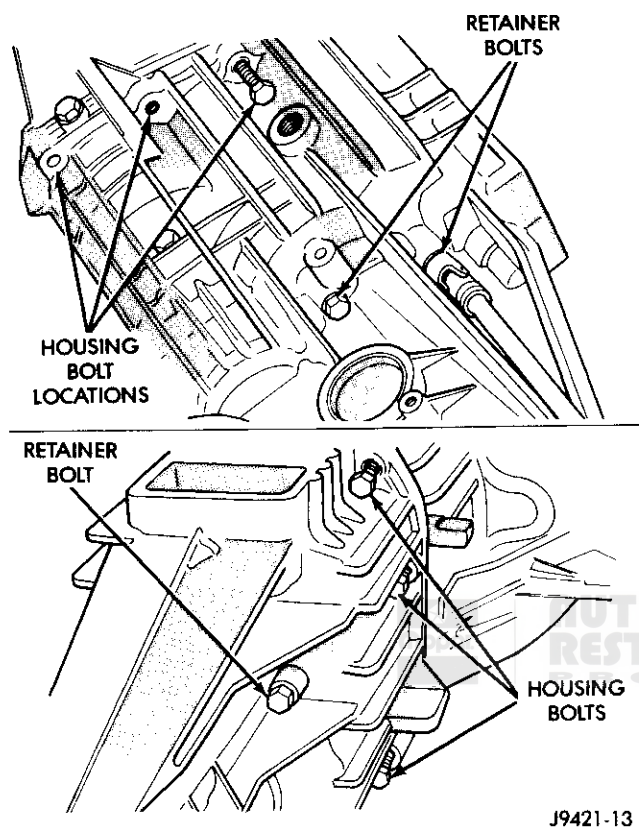


Fig. 20 Housing And Bearing Retainer Bolt Locations

(14) Separate front housing from rear housing (Fig. 21). Use plastic mallet to tap front housing off alignment dowels.

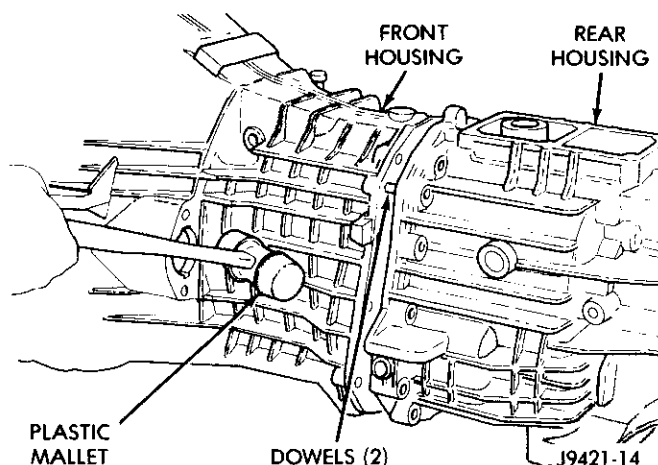


Fig. 21 Front Housing Removal

(15) Remove input shaft bearing and countershaft front bearing from front case (Fig. 22). Use hammer handle to tap input shaft bearing out of case. Countershaft bearing can be removed by hand.

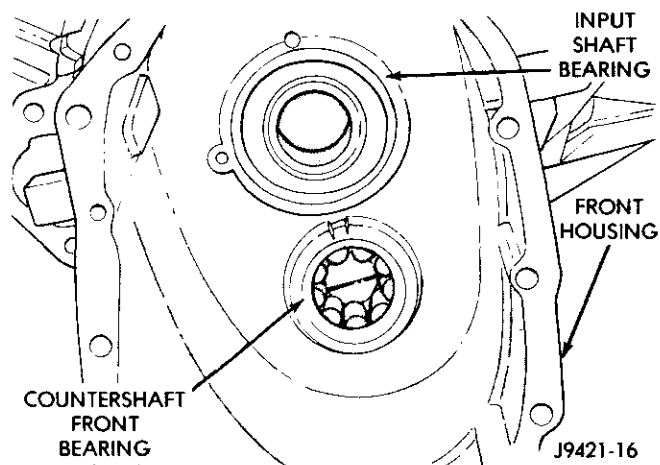


Fig. 22 Input Shaft And Countershaft Front Bearing Location

(16) Note position of input shaft, shift shaft and forks, and geartrain components in housing (Fig. 23).

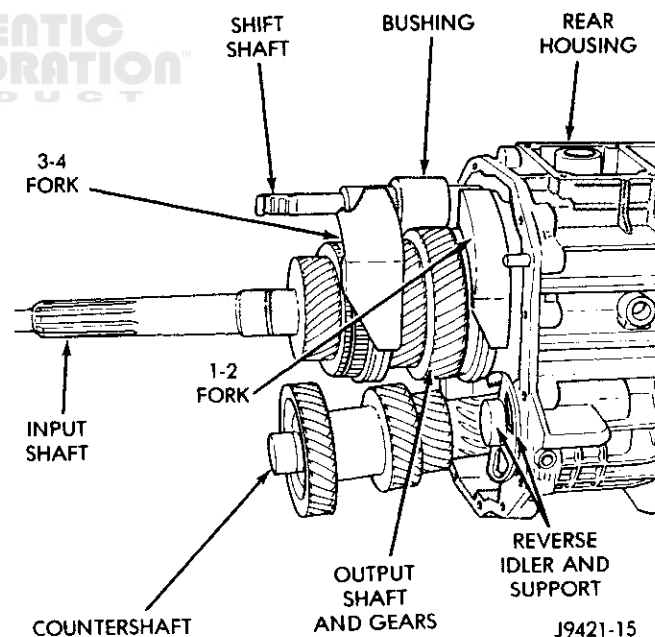


Fig. 23 Geartrain And Shift Component Identification

DISASSEMBLY AND ASSEMBLY (Continued)**SHIFT SHAFT, SHIFT FORKS AND REVERSE IDLER SEGMENT REMOVAL**

(1) Place shop towel over shaft lever and bushing to contain lever detent ball and spring. Then rotate lever and bushing upward out of shift forks and catch ball and spring as they exit shaft lever (Fig. 24).

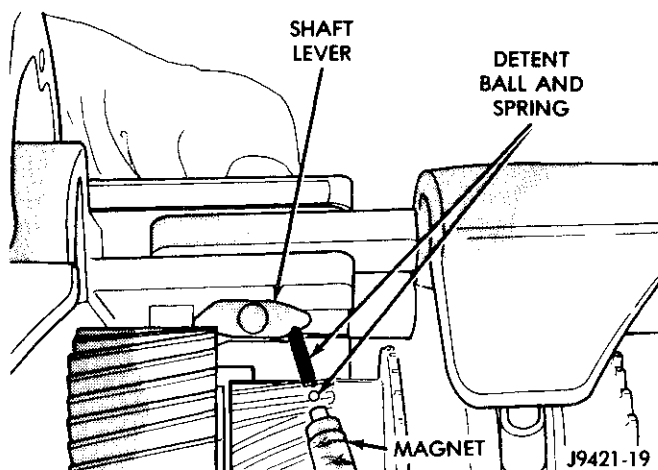


Fig. 24 Removing Shift Shaft Lever Detent Ball And Spring

(2) Unseat roll pin that secures shift socket to shift shaft with Special Tool 6858 as follows:

(a) Position Tool 6858 on shift socket. Then center tool over roll pin. Be sure tool legs are firmly seated on shift socket (Fig. 25).

(b) Tilt socket toward passenger side of case. This places roll pin at slight angle to avoid trapping pin between gear teeth.

(c) Tighten tool punch to press roll pin downward and out of shift socket (Fig. 25). Roll pin does not have to come completely out of shift shaft; it only has to clear shift socket.

(d) If roll pin accidentally becomes jammed between gear teeth locking socket and shaft in place, proceed to alternate disassembly method in next step.

(3) If shift socket roll pin becomes jammed, alternate disassembly method is as follows:

(a) Remove rear bearing retainer bolts.

(b) Remove reverse idler segment (but leave gear in case).

(c) Remove input shaft, bearing, and 3-4 synchro ring.

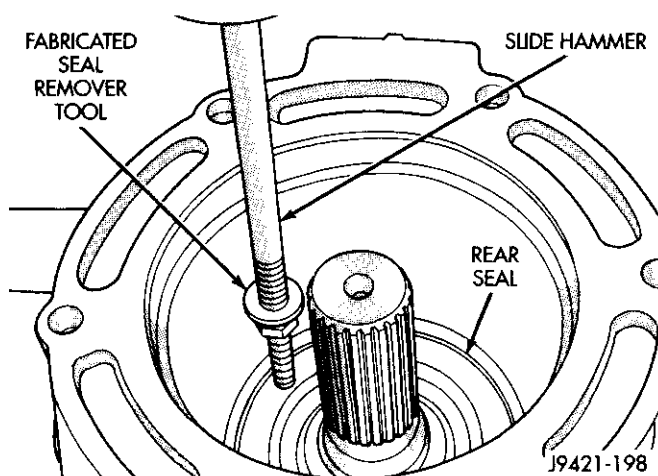


Fig. 25 Unseating Shift Socket Roll Pin With Tool 6858

(d) Remove 3-4 shift fork and 3-4 synchro sleeve simultaneously. Use shop rag to catch struts, balls, and springs as sleeve comes off hub.

(e) Slide shift shaft bushing off shaft lever. Then rotate lever out of shift fork arms and catch ball and spring as lever clears notches.

(f) Push shift shaft rearward, tap out pin (if needed) and pull shaft out of rear housing and shift forks. Use plastic mallet to assist shaft removal.

(4) Drive out roll pin that secures shift bushing and lever to shift shaft (Fig. 26).

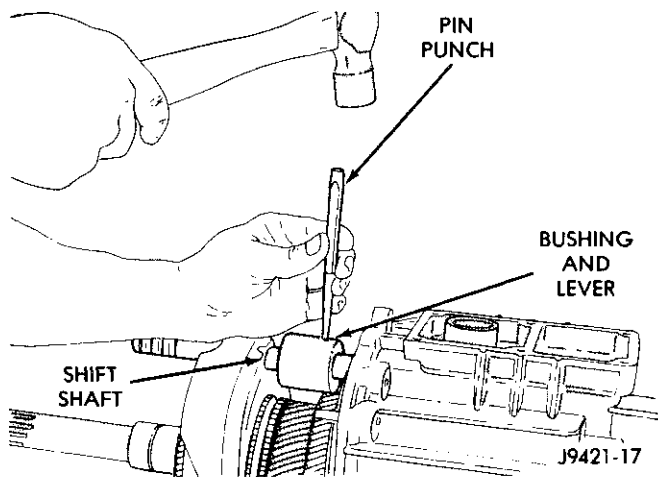


Fig. 26 Removing Shift Shaft Lever And Bushing Roll Pin

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Pull shift shaft out of rear housing, shift socket, fifth-reverse fork, and 1-2 fork (Fig. 27). Tap shift socket rearward with mallet to help remove shaft.

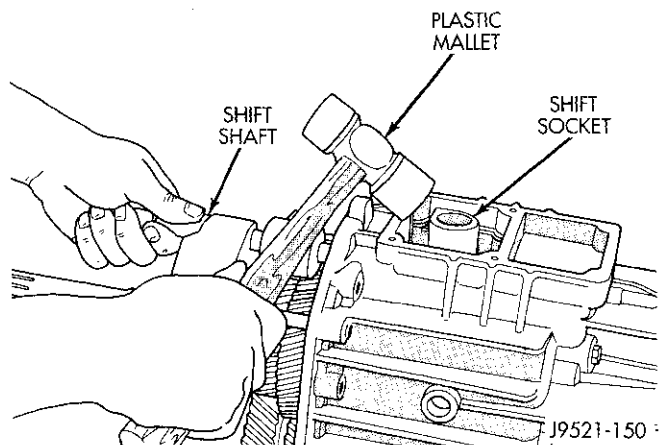


Fig. 27 Pulling Shift Shaft Out Of Housing, Shift Socket, And Shift Forks

(6) Remove shift socket from rear housing (Fig. 28).

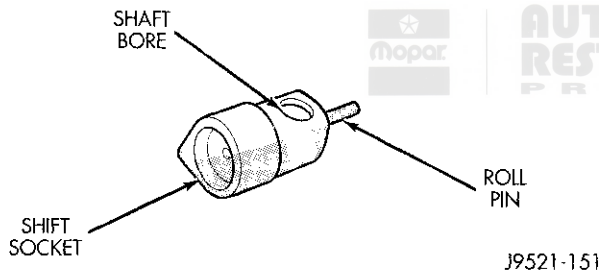


Fig. 28 Shift Socket And Roll Pin

(7) Remove lever and bushing from shift shaft (Fig. 29).

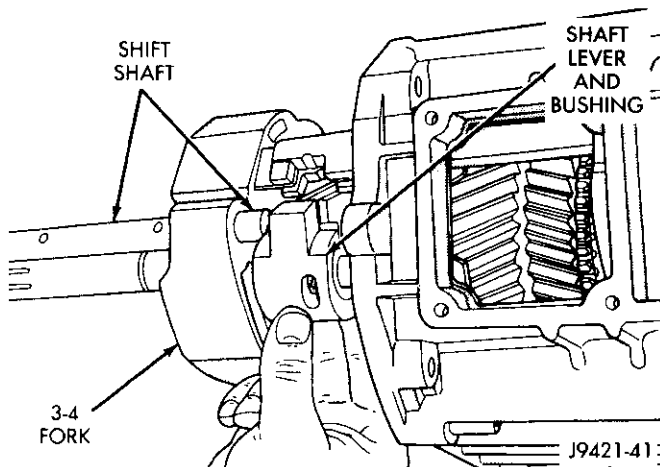


Fig. 29 Removing Shift Shaft Lever And Bushing

(8) Remove shift shaft (Fig. 30). Pull shaft straight out of fork.

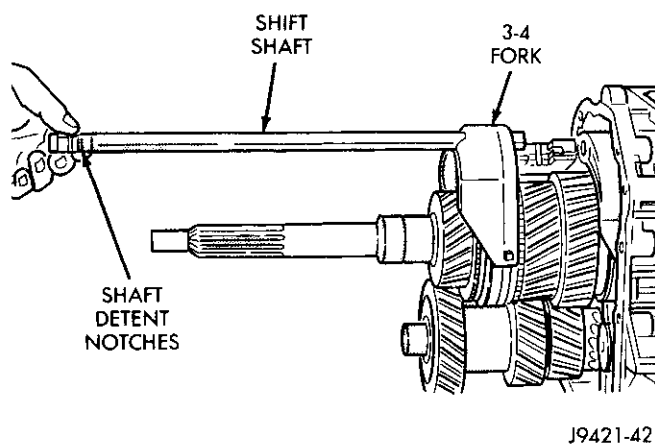


Fig. 30 Shift Shaft Removal

(9) Remove 3-4 fork. Rotate 3-4 fork around synchro sleeve fork clears shift arms on 1-2 and fifth-reverse forks. Then remove 3-4 fork (Fig. 31).

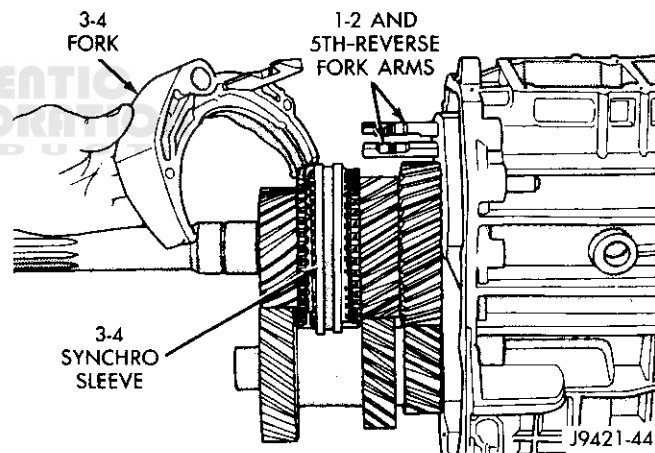


Fig. 31 Removing 3-4 Shift Fork

(10) Support geartrain and rear housing on Assembly Fixture Tool 6747 (with aid of helper) as follows:

(a) Adjust height of reverse idler pedestal rod to 18.42 cm (7-1/4 in.) Then position Adapters 6747-1 and 6747-2 on Assembly Fixture 6747.

(b) Slide fixture tool onto input shaft, counter-shaft and idler gear (Fig. 32). **The pedestal rod on the fixture tool is used to support the reverse idler.**

(c) Stand geartrain and rear housing upright on fixture (Fig. 33). Have helper hold fixture tool in place while housing and geartrain is being rotated into upright position.

(d) Position 5 x 10 cm (2 x 4 in.) wood blocks under legs of fixture tool. Blocks are needed to

DISASSEMBLY AND ASSEMBLY (Continued)

raise fixture high enough for input shaft to clear workbench surface.

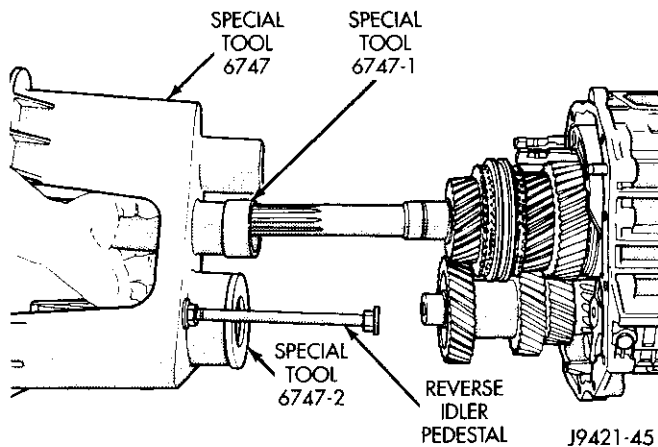


Fig. 32 Installing Assembly Fixture On Geartrain

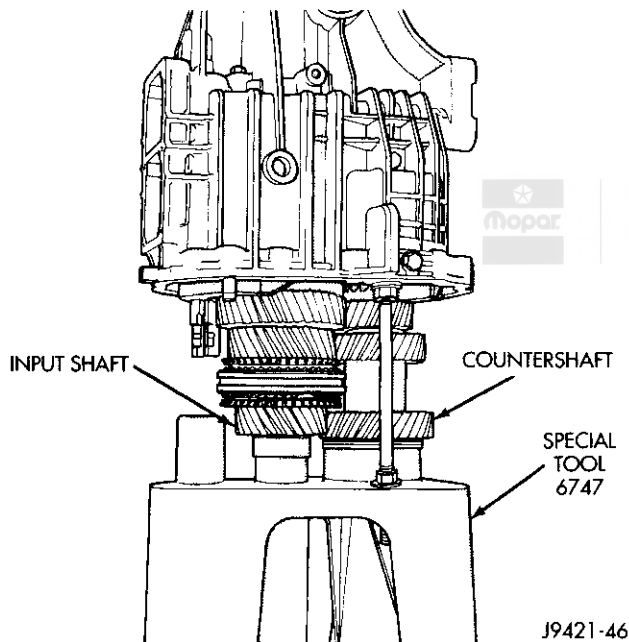


Fig. 33 Geartrain And Housing Mounted On Fixture Tool

(11) Remove bolts attaching reverse idler shaft and shaft support segment to rear housing (Fig. 34).

(12) Remove reverse idler shaft support segment by sliding it straight out of housing (Fig. 35).

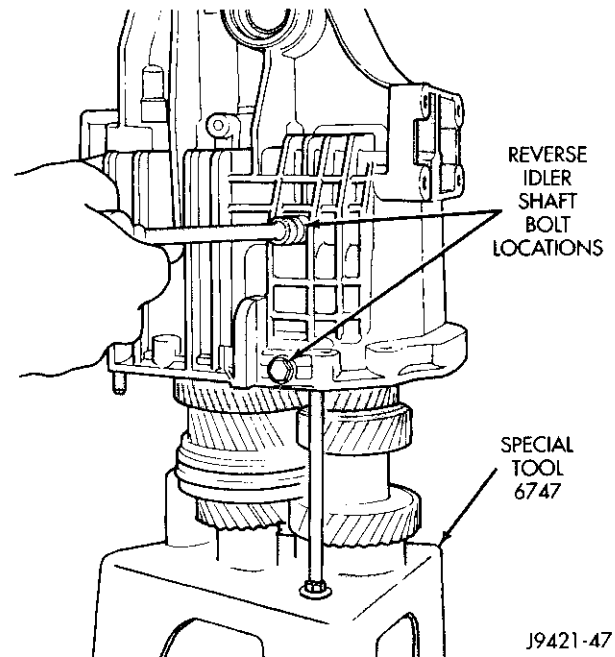


Fig. 34 Removing/Installing Reverse Idler Shaft Bolts

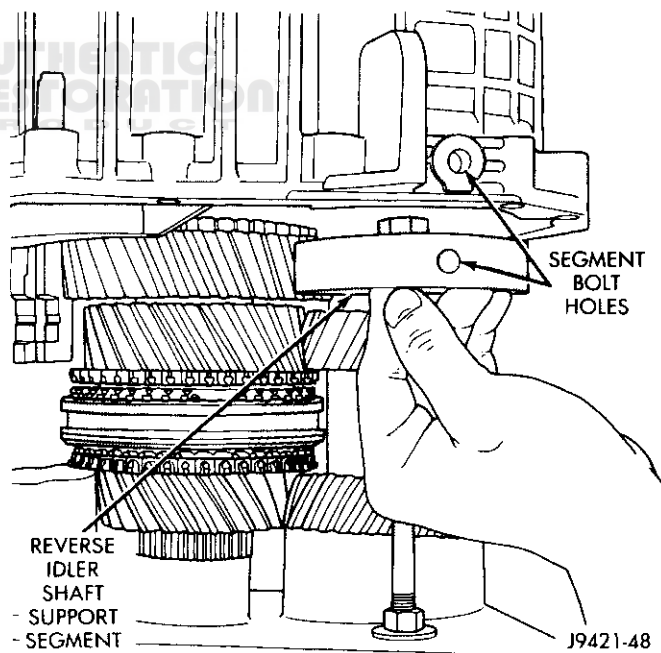
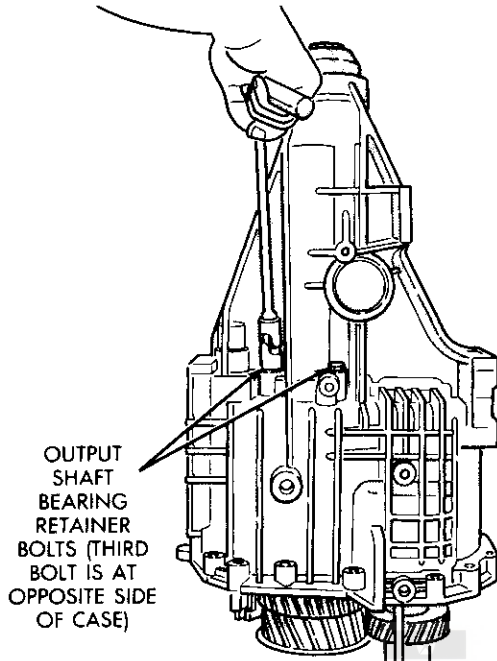


Fig. 35 Reverse Idler Shaft Support Segment Removal/Installation

DISASSEMBLY AND ASSEMBLY (Continued)**REAR HOUSING REMOVAL—2WD**

(1) On 2-wheel drive transmission, remove three bolts that attach output shaft bearing retainer to rear case (Fig. 36). Bolts are to rear of shift tower opening.



J9421-50

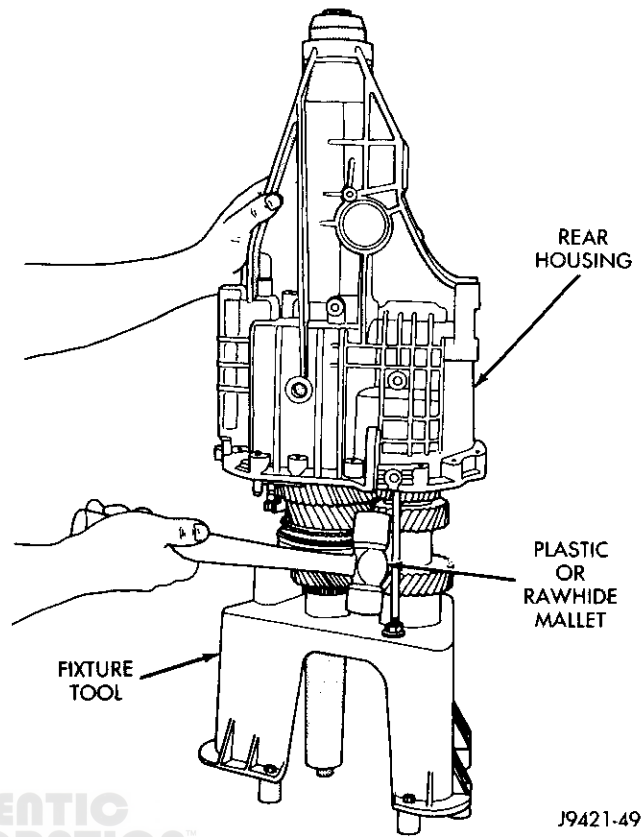
Fig. 36 Removing/Installing Output Shaft Bearing Retainer Bolts—2WD

(2) Unseat output shaft bearing from bearing bore in rear housing. Use plastic or rawhide mallet to tap rear housing upward and off output shaft bearing as shown (Fig. 37).

(3) Lift rear housing up and off geartrain (Fig. 38).

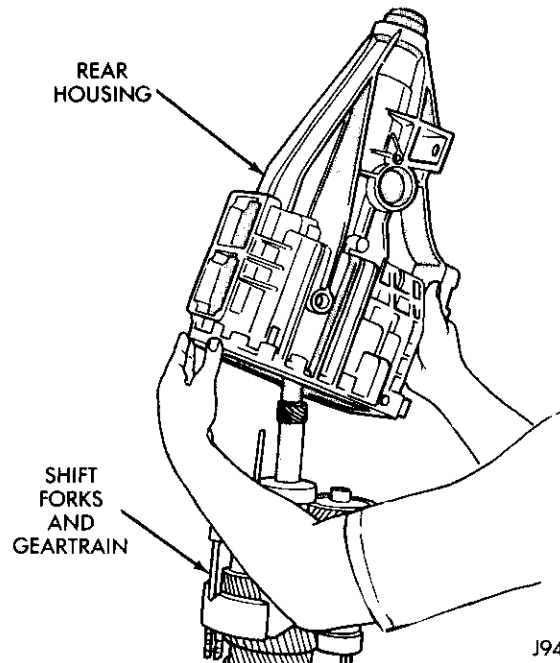
(4) Remove countershaft rear bearing from rear housing (Fig. 39).

(5) Examine condition of oil tube, bearing bore and idler shaft notch in rear housing (Fig. 39). Replace housing if any of these components are damaged.



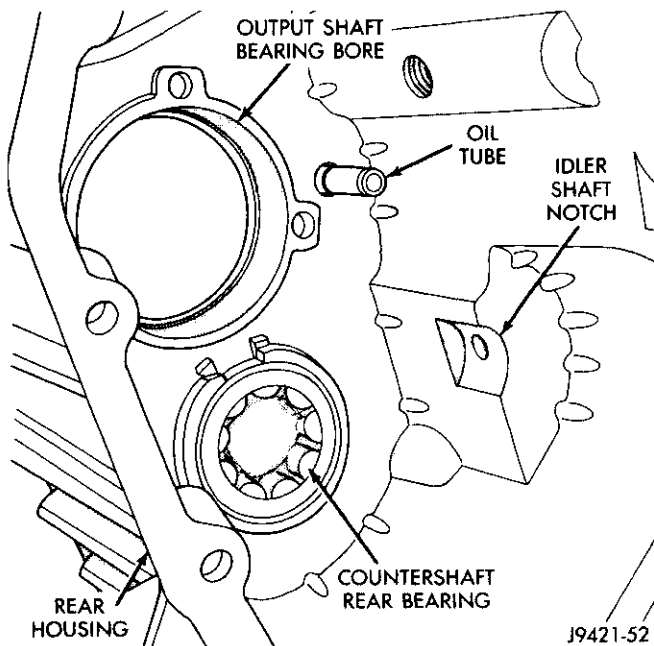
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Fig. 37 Unseating Rear Housing From Output Shaft Bearing—2WD



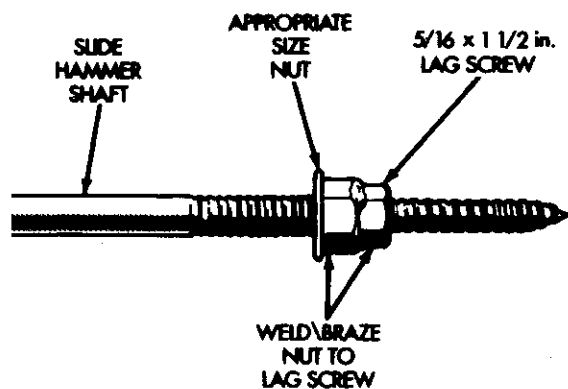
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Fig. 38 Rear Housing Removal—2WD

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 39 Rear Housing Components—2WD****REAR ADAPTER HOUSING REMOVAL—4WD**

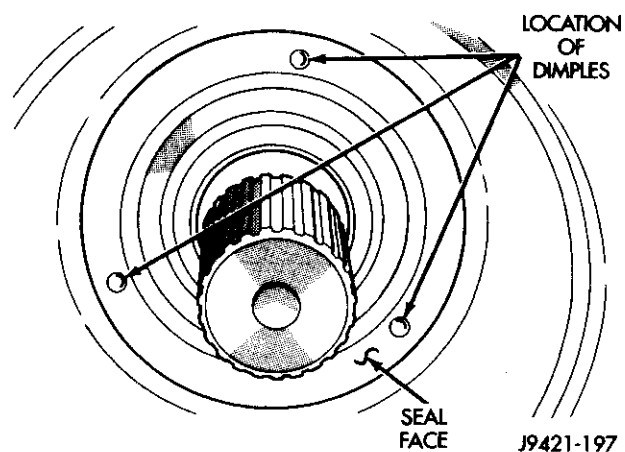
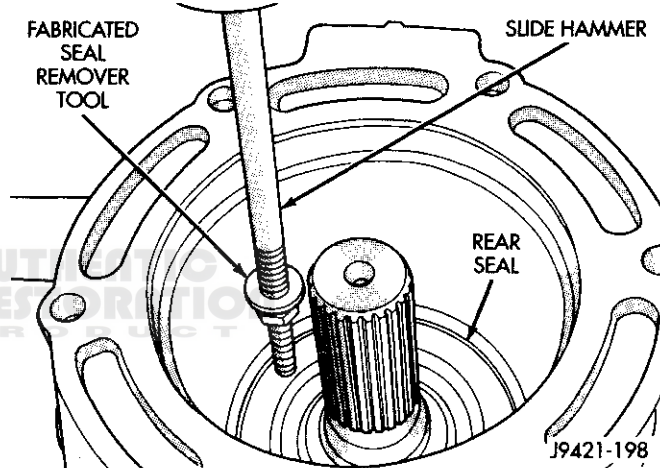
(1) A tool is required to remove the rear seal from the adapter housing. Use either a dent puller, or fabricate a remover tool from 5/16 x 1-1/2 in. long lag screw and appropriate size hex nut. Use hex nut that will fit on a slide hammer. Tack weld, braze or silver solder nut to lag screw (Fig. 40).

(2) Install fabricated seal remover tool on slide hammer shaft (Fig. 40).

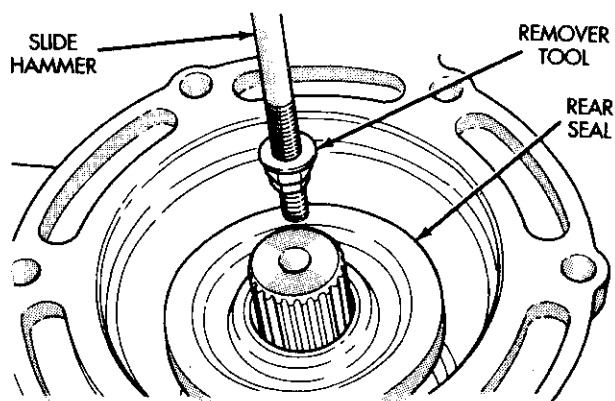
**Fig. 40 Rear Seal Remover Tool—4WD**

(3) Locate dimples in face of rear seal (Fig. 41). Fabricated seal remover tool will be threaded into one of these dimples.

(4) Thread fabricated seal remover tool into one of the dimples in the seal face (Fig. 42).

**Fig. 41 Location Of Dimples In Seal Face—4WD****Fig. 42 Remover Tool Threaded Into Seal—4WD**

(5) Remove rear seal with slide hammer. Seal should only require 2-3 light bumps with slide hammer to remove it (Fig. 43).

**Fig. 43 Rear Seal Removal—4WD**

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Remove rear bearing snap ring from output shaft with heavy duty snap ring pliers (Fig. 44).

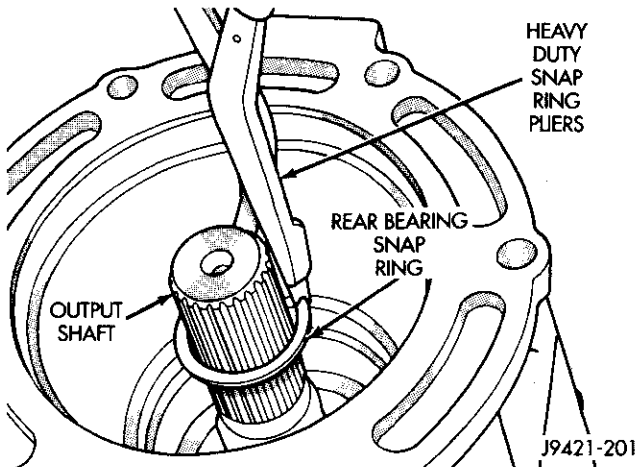


Fig. 44 Rear Bearing Snap Ring Removal—4WD

(7) Lift rear adapter or extension housing upward and off geartrain (Fig. 45).

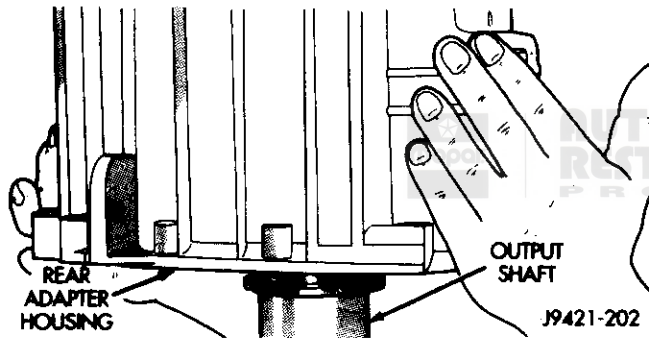


Fig. 45 Rear Adapter/Extension Housing Removal

(8) Remove bearing retainer bolts and remove rear bearing retainer and rear bearing (Fig. 46). Use hammer handle to push or tap bearing out of housing if needed.

(9) Examine condition of bearing bore, countershaft rear bearing race and idler shaft notch in rear housing. Replace housing if race, bore or notch are worn or damaged.

REMOVING GEARTRAIN FROM FIXTURE TOOL 6747

(1) Slide reverse idler gear assembly off assembly fixture pedestal.

(2) Remove 1-2 and fifth-reverse forks from synchro sleeves.

(3) Slide countershaft out of fixture tool.

(4) Remove output shaft bearing retainer from rear surface of fifth gear (retainer will drop onto gear after bolts are removed).

(5) Lift and remove output shaft and gears off input shaft.

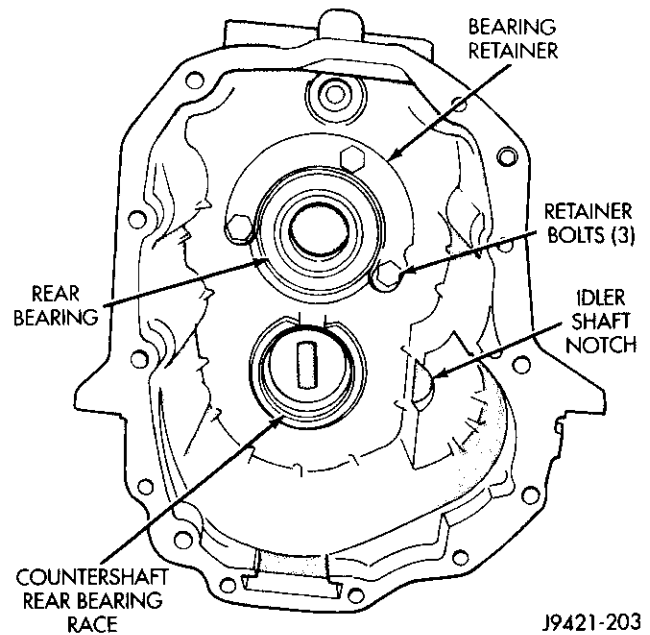


Fig. 46 Rear Adapter/Extension Housing Components

(6) Lift and remove input shaft, pilot bearing and fourth gear synchro ring from assembly fixture tool.

OUTPUT SHAFT GEARTRAIN DISASSEMBLY

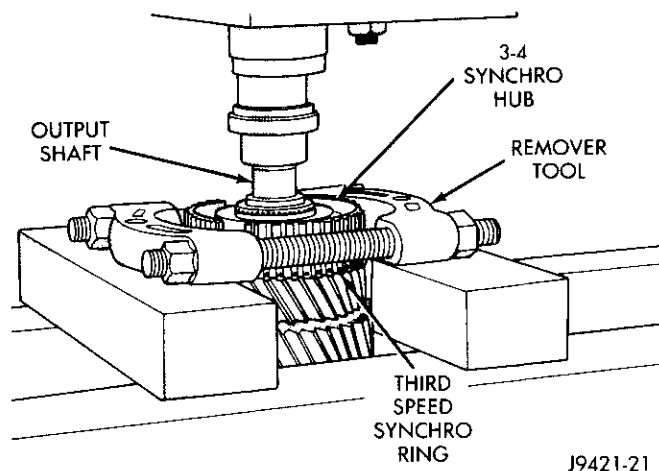
NOTE: The synchronizer hubs and sleeves are different and must not be intermixed. It is recommended that each synchronizer unit be removed as an assembly to avoid intermixing parts. It is also recommended that each synchro hub and sleeve be marked with a scribe or paint for correct assembly reference.

(1) Remove snap ring that secures 3-4 synchro hub on output shaft.

(2) Remove 3-4 synchro assembly and third speed synchro ring with shop press and Remover Tool 1130 (Fig. 47).

(a) If remover tool has fairly thick jaws, position tool jaws behind third speed synchro ring. Inspect synchro ring afterward as remover tool may damage ring during removal.

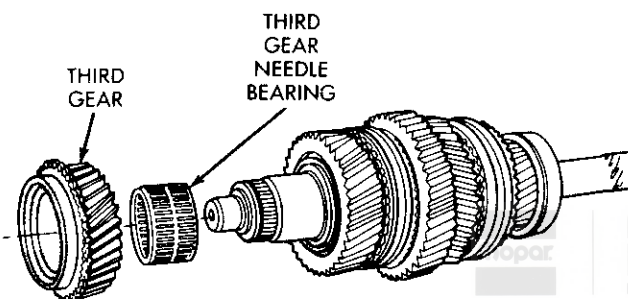
(b) If remover tool has fairly thin jaws, position tool jaws behind third gear. Then remove synchro assembly and gear simultaneously.

DISASSEMBLY AND ASSEMBLY (Continued)

J9421-21

Fig. 47 Removing 3-4 Synchro Assembly

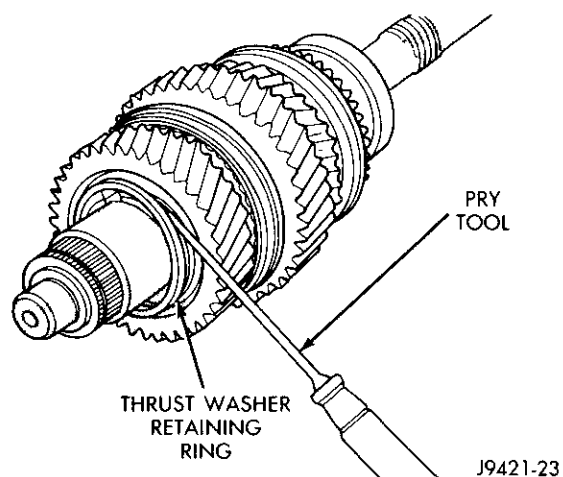
(3) Remove third gear and needle bearing (Fig. 48).



J9421-22

Fig. 48 Third Gear And Needle Bearing Removal

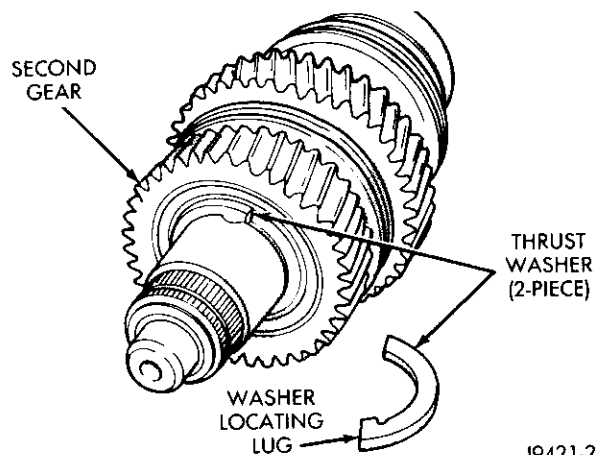
(4) Remove retaining ring that secures two-piece thrust washer on shaft (Fig. 49). Use small pry tool to remove retaining ring.



J9421-23

Fig. 49 Thrust Washer Retaining Ring Removal

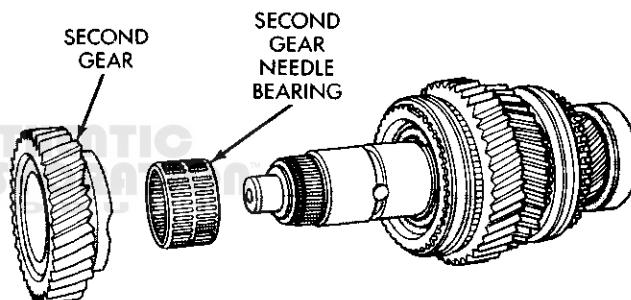
(5) Remove two-piece thrust washer (Fig. 50). Note position of washer locating lugs in shaft notches for installation reference.



J9421-24

Fig. 50 Two-Piece Thrust Washer Removal

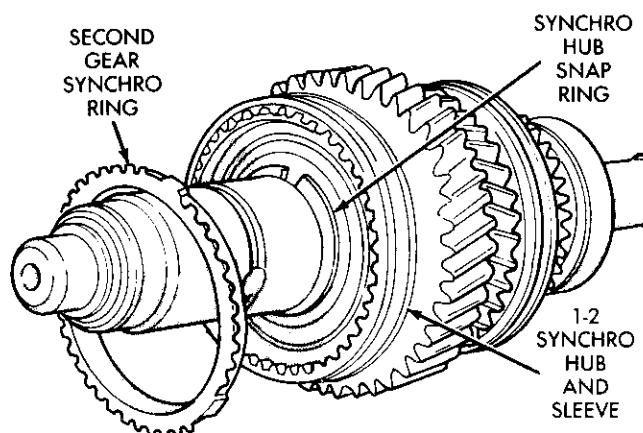
(6) Remove second gear and needle bearing (Fig. 51).



J9421-25

Fig. 51 Second Gear And Needle Bearing Removal

(7) Remove second speed synchro ring. Then remove 1-2 synchro hub snap ring (Fig. 52).

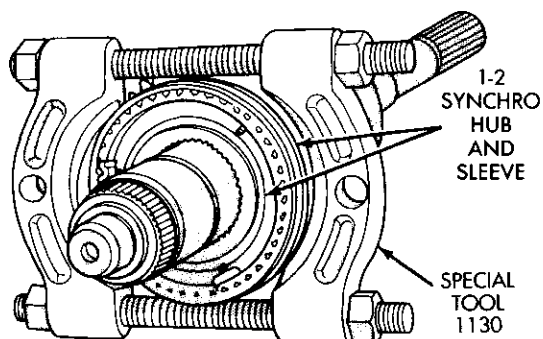


J9421-26

Fig. 52 Second Speed Synchro Ring And Synchro Hub Snap Ring Removal

DISASSEMBLY AND ASSEMBLY (Continued)

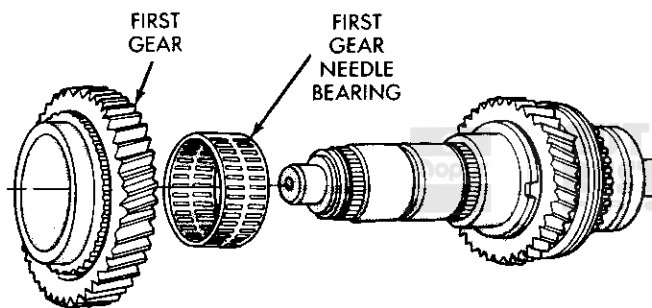
(8) Remove 1-2 synchro hub and sleeve from output shaft with shop press and Remover Tool 1130 (Fig. 53).



J9421-27

Fig. 53 Hub And Sleeve Removal—1-2 Synchro

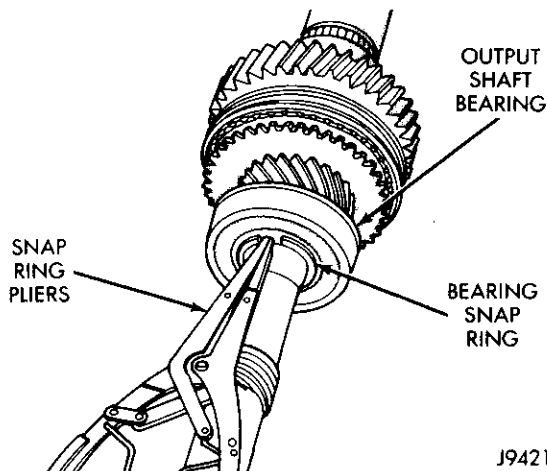
(9) Remove first gear and needle bearing (Fig. 54).



J9421-28

Fig. 54 First Gear And Needle Bearing Removal

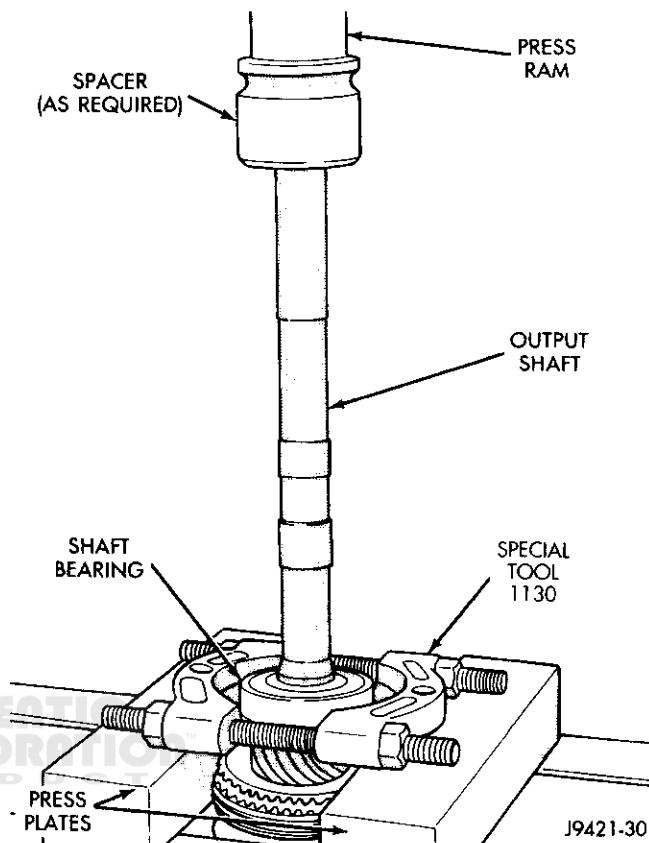
(10) Remove output shaft bearing snap ring (Fig. 55).



J9421-29

Fig. 55 Output Shaft Bearing Snap Ring Removal

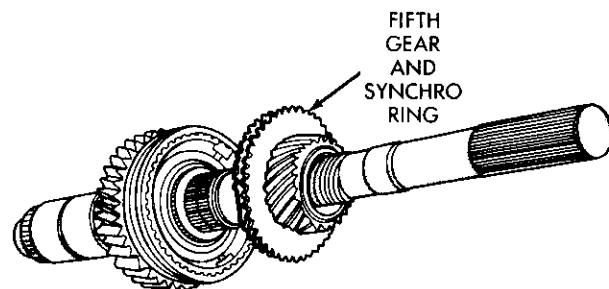
(11) On 2-wheel drive models, remove output shaft bearing with Remover Tool 1130 and shop press (Fig. 56).



J9421-30

Fig. 56 Output Shaft Bearing Removal—2WD

(12) Remove fifth gear (Fig. 57).



J9421-31

Fig. 57 Fifth Gear Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(13) Remove fifth gear needle bearing. Spread bearing apart just enough to clear shoulder on output shaft (Fig. 58).

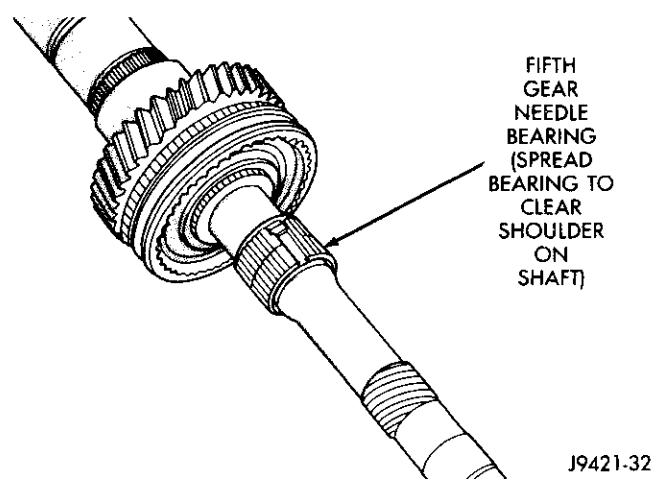


Fig. 58 Fifth Gear Needle Bearing Removal

(14) Remove fifth-reverse synchro hub snap ring (Fig. 59).

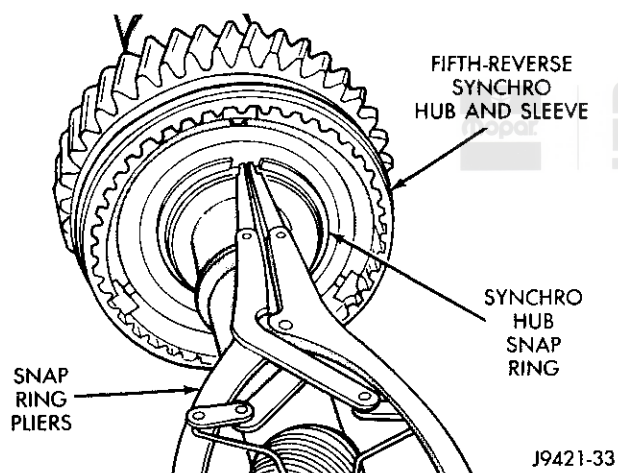


Fig. 59 Fifth-Reverse Synchro Hub Snap Ring Removal

(15) Remove fifth reverse synchro hub and sleeve with shop press and standard type remover tool (Fig. 60).

(16) Remove reverse gear and needle bearing (Fig. 61).

REVERSE IDLER DISASSEMBLY

- (1) Remove idler gear snap rings (Fig. 62).
- (2) Remove thrust washer, wave washer, thrust plate and idler gear from shaft.
- (3) Remove idler gear needle bearing from shaft.

TRANSMISSION ASSEMBLY INFORMATION

Gaskets are not used in the NV3500 transmission. Sealers are used at all flange joints. Recommended

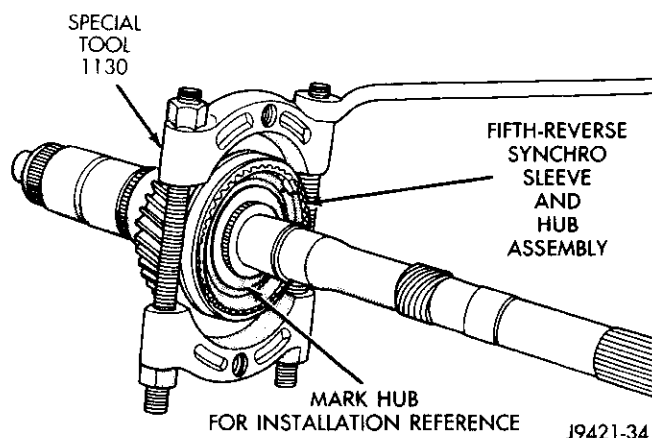


Fig. 60 Fifth-Reverse Synchro Hub And Sleeve Removal

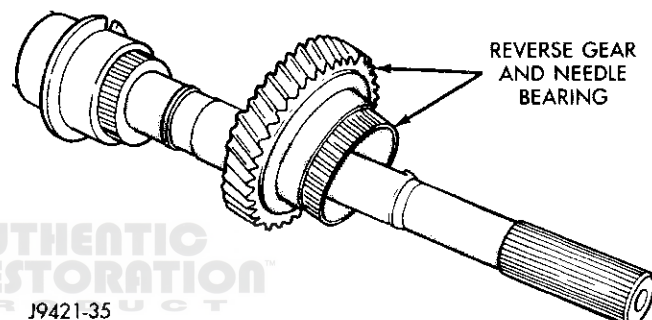


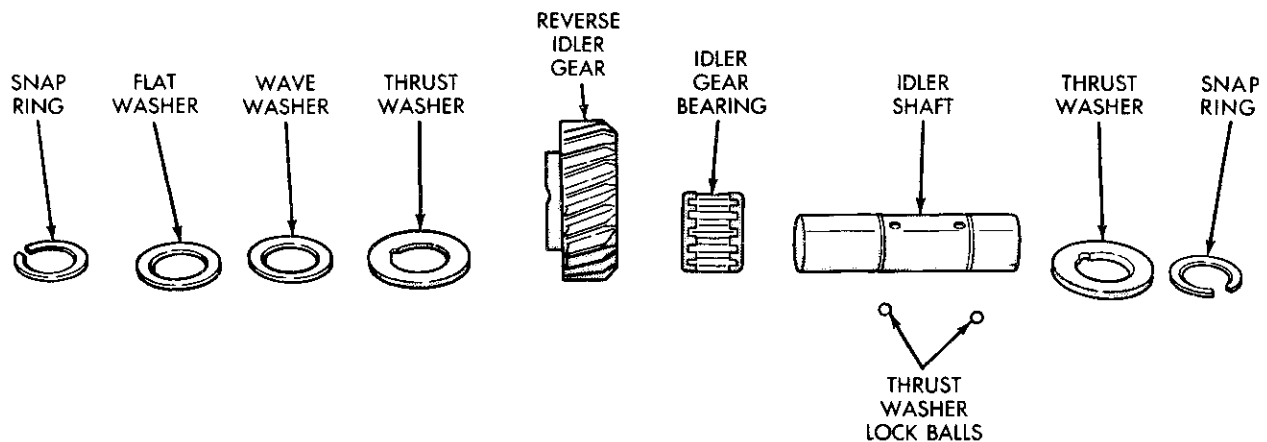
Fig. 61 Reverse Gear And Needle Bearing Removal

sealers are Mopar Gasket Maker (or Loctite 518) for all flange joints and Loctite Ultra, heavy body silicone (black) sealer (or Mopar equivalent) for the input shaft bearing retainer. Apply these products as indicated in the reassembly procedures.

NOTE: It is very important that the transmission shift components be in Neutral position during assembly. This is necessary to prevent damaging synchro and shift components when the housings are installed.

Transmission gears, shafts, and synchro components should all be lubricated with recommended gear lubricant during assembly operations. Petroleum jelly can be used to prelubricate bearings and to hold parts in place during assembly. Only petroleum jelly should be used. **Do not use chassis or bearing grease. This type of heavy grease will plug oil channels in the housings and gears resulting in failure.**

The 3-4, 1-2 and fifth-reverse synchro hub snap rings can be fitted selectively. New snap rings are available in 0.05 mm (0.0019 in.) thickness incre-

DISASSEMBLY AND ASSEMBLY (Continued)

J9421-53

Fig. 62 Reverse Idler Components

ments. Use the thickest snap ring that will fit in each snap ring groove.

Proper reassembly of the NV3500 requires some special service tools. Geartrain Assembly Fixture 6747 is especially important. The entire geartrain and shift mechanism must be assembled in this fixture before either transmission housing can be properly installed. The tools are needed to avoid damaging the gears, housing, or shift components.

CORRECT ASSEMBLY OF SYNCHRONIZER COMPONENTS

The synchronizer sleeves, hubs and struts are different and must be kept in sets. Only the synchro detent balls and springs are interchangeable.

The 3-4 and 1-2 synchro rings are all made of cast metal and are interchangeable. However, the reverse gear synchro ring is made of solid brass and must not be interchanged.

A total of three detent springs, struts and balls are used in all three synchro assemblies. The balls and springs are interchangeable.

The synchro sleeves and hubs must also be correctly positioned on the shaft in order to operate properly. Assemble and install each synchro according to the following instructions.

3-4 SYNCHRO POSITION

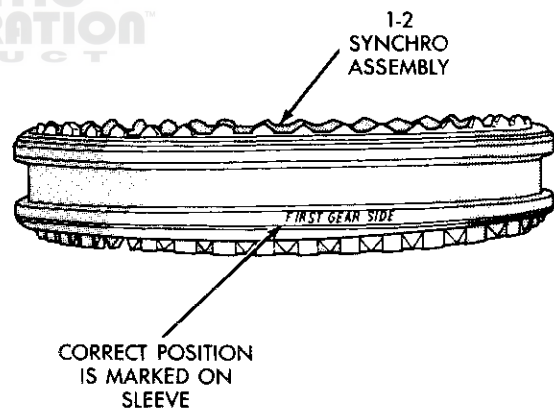
Some 3-4 synchro hubs may have a raised shoulder on one side of the spline bore. If so, this side of the hub must face the front of the output shaft after installation. However, if both hub sides are the same, the hub can be installed in either direction.

The 3-4 synchro sleeve has grooves machined on one side. Be sure this side also faces the front of the output shaft.

1-2 SYNCHRO POSITION

The 1-2 synchro hub has raised shoulders on one side of the spline bore. This side of the hub must face the **rear** of the output shaft after installation.

The top surface of the 1-2 synchro sleeve is marked for correct installation (Fig. 63). One side of the sleeve is marked "first gear side". Be sure this side is facing the first gear after installation.



J9421-56

Fig. 63 Location Of Position Marks On 1-2 Synchro Sleeve**FIFTH-REVERSE SYNCHRO POSITION**

The fifth-reverse synchro hub has raised shoulders on one side of the spline bore. This side of the hub must face the **rear** of the output shaft after installation.

The fifth-reverse sleeve has a large taper on one side. Be sure the sleeve is installed so the taper faces toward **front** of the output shaft.

DISASSEMBLY AND ASSEMBLY (Continued)**SYNCHRO COMPONENT ASSEMBLY**

The easiest method of assembling each synchro is to install the springs, struts and detent balls one at a time as follows:

(1) Slide the sleeve part way onto the hub. Leave enough room to install the spring in the hub and the strut in the hub groove.

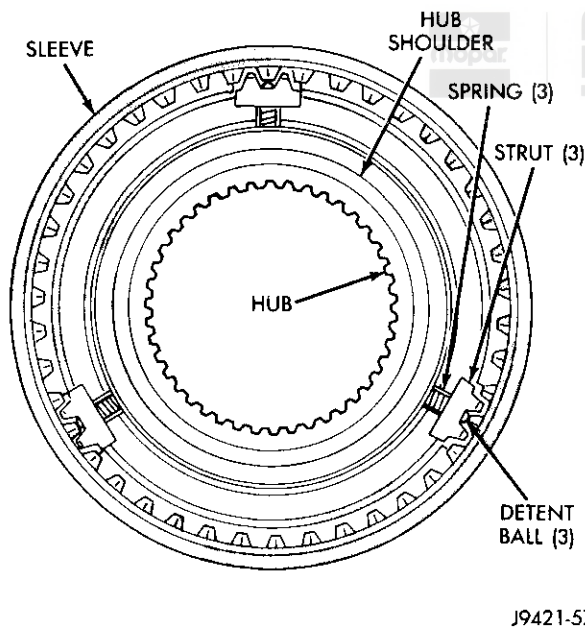
(2) Install the first spring in the hub. Then install a strut over the spring. Be sure the spring is seated in the spring bore in the strut.

(3) Slide the sleeve onto the hub just far enough to hold the first strut and spring in place.

(4) Place the detent ball in the top of the strut. Then carefully work the sleeve over the ball to hold it in place. A small flat blade screwdriver can be used to press the ball into place while moving the sleeve over it.

(5) Repeat the procedure for the remaining springs, struts and balls. Tape, or a rubber band can be used to temporarily secure each strut and ball as they are installed.

(6) Verify synchro assembly. Be sure the three springs, struts and detent balls are all in place (Fig. 64).



J9421-57

Fig. 64 Assembled View Of Synchro Components**OUTPUT SHAFT AND GEARTRAIN ASSEMBLY**

Because the synchro hubs and rear bearing must be pressed onto the output shaft, it is easier (and faster), to assemble the entire geartrain while mounted in a shop press. This method of reassembly is demonstrated in the following procedure. **Two versions of the NV3500 are used. If any gears have been replaced, compare them to the new parts**

before installation to ensure a proper match. The original and new versions have different ratio first and second gears.

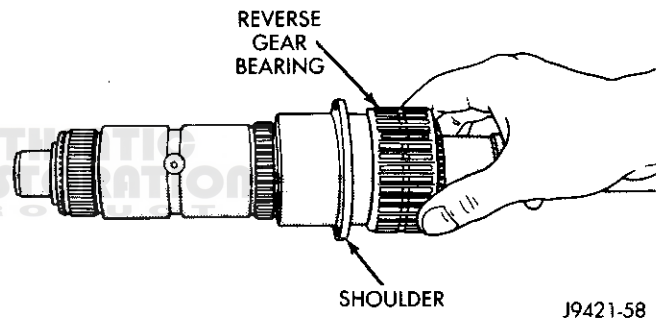
(1) Lubricate shaft, gears and bearings with recommended lubricant during assembly. Petroleum jelly can be used to hold parts in place.

(2) Check bearing surfaces of output shaft for nicks or scratches. Smooth surfaces with 320/400 grit emery cloth if necessary. Apply oil to emery cloth and shaft surface before polishing.

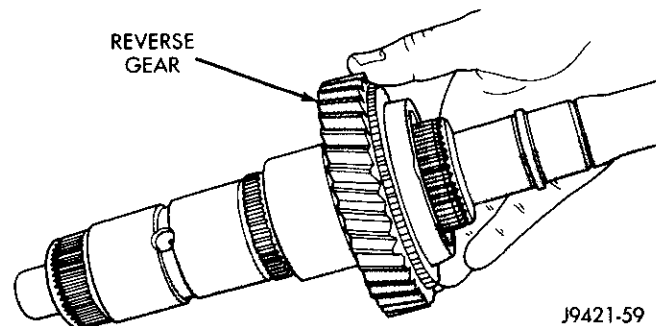
(3) Inspect and replace any synchro ring that exhibits wear or damage. Completely immerse each synchro ring in lubricant before installation.

(4) Recheck needle bearings once again before assembly. replace any bearing exhibiting wear, or damage to the bearing rollers or plastic bearing cage. Petroleum jelly can be used to prelubricate bearings if desired.

(5) Lubricate and install reverse gear needle bearing on shaft (Fig. 65). Slide bearing up against shoulder on output shaft as shown.

**Fig. 65 Reverse Gear Bearing Installation**

(6) Install reverse gear over needle bearing (Fig. 66).

**Fig. 66 Reverse Gear Installation**

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Install solid brass synchro ring on reverse gear (Fig. 67).

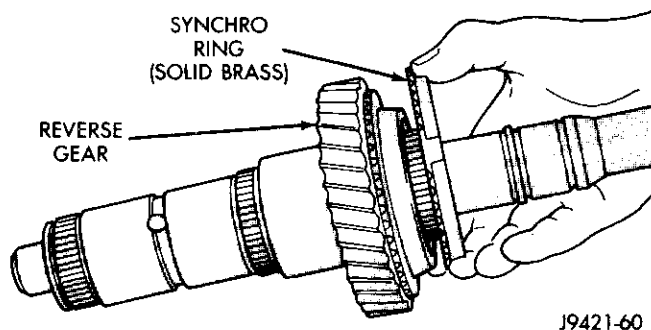


Fig. 67 Reverse Gear Synchro Ring Installation

(8) Assemble fifth-reverse synchro hub, sleeve, struts, springs and detent balls, if not previously done.

CAUTION: The fifth-reverse synchro hub and sleeve can be installed backwards if care is not exercised. One side of the hub has shoulders around the hub bore. Make sure this side of the hub is facing the rear of the shaft. In addition, one side of the sleeve is tapered. Be sure the sleeve is installed so the tapered side will be facing the front of the shaft.

(9) Start fifth-reverse synchro assembly on output shaft splines by hand. Then seat synchro onto shaft with shop press and suitable size pipe tool (Fig. 68).

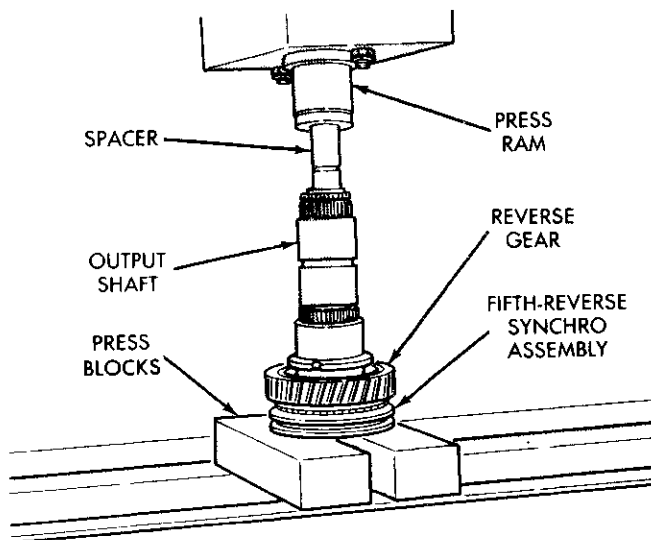


Fig. 68 Fifth-Reverse Synchro Assembly Installation

(10) Install new fifth-reverse hub snap ring (Fig. 69) as follows:

(a) Snap rings are available in thicknesses from 2.00 mm to 2.20 mm (0.078 to 0.086 in.).

(b) Install thickest snap ring that will fit in shaft groove.

(c) Verify that snap ring is completely seated in groove before proceeding.

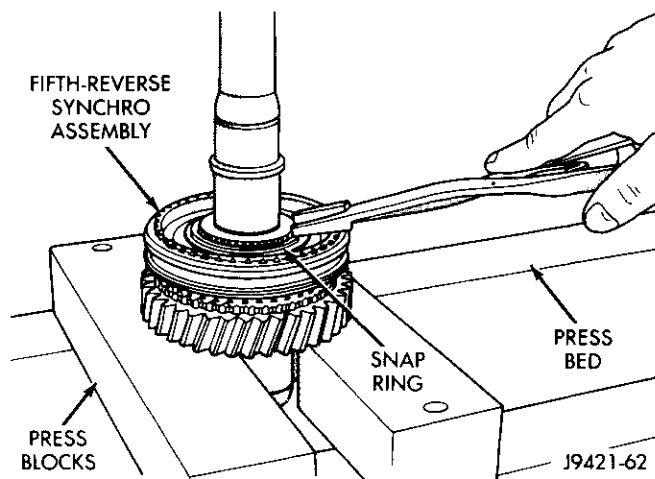


Fig. 69 Installing Fifth-Reverse Synchro Hub Snap Ring

(11) Install fifth speed synchro ring in synchro hub and sleeve (Fig. 70).

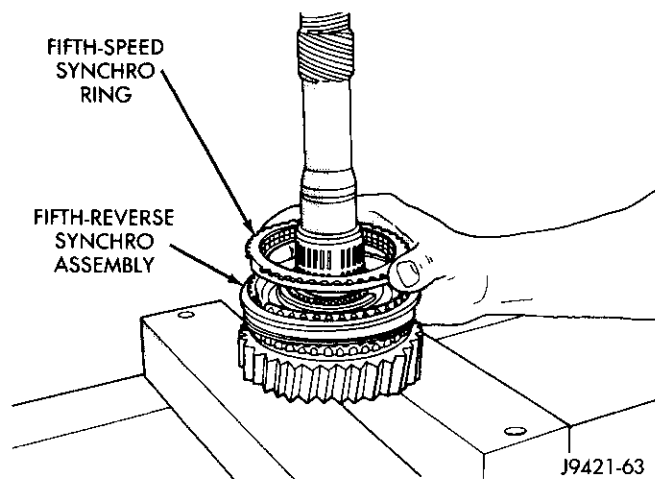


Fig. 70 Installing Fifth Speed Synchro Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(12) Install fifth gear bearing. Spread bearing only enough to clear shoulder on output shaft (Fig. 71). Be sure bearing is properly seated after installation.

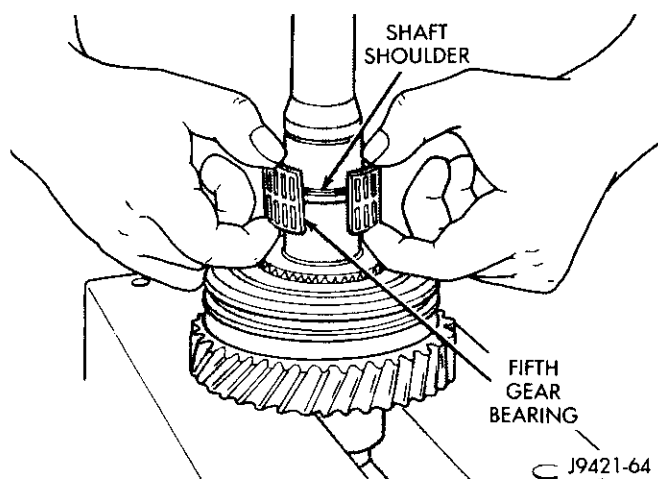


Fig. 71 Installing Fifth Gear Bearing

(13) Install fifth gear on shaft and onto bearing (Fig. 72).

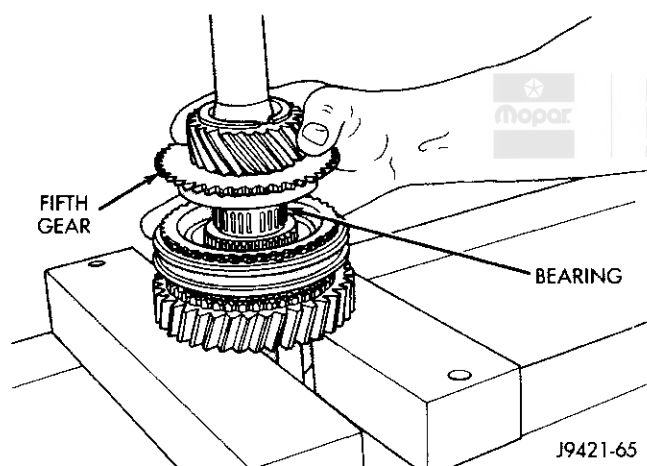


Fig. 72 Fifth Gear Installation

(14) Install output shaft bearing with shop press and suitable size pipe tool (Fig. 73).

(15) Install output shaft bearing snap ring (Fig. 74). Use heavy duty snap ring pliers and spread snap ring only enough to install it. Be sure snap ring is completely seated in shaft groove before proceeding.

(16) Turn output shaft over so it is supported on press blocks by output shaft bearing (Fig. 75). Remainder of geartrain can now be installed on shaft while it is still mounted in shop press.

(17) Install first gear bearing on output shaft (Fig. 75). Be sure bearing is seated on shaft shoulder and is properly joined.

(18) Install first gear on shaft and over bearing (Fig. 76). Make sure bearing synchro cone is facing up as shown.

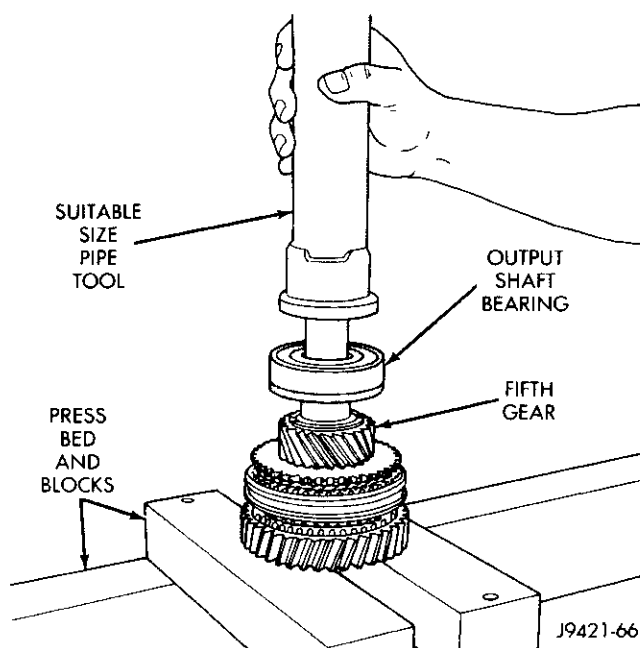


Fig. 73 Output Shaft Bearing Installation

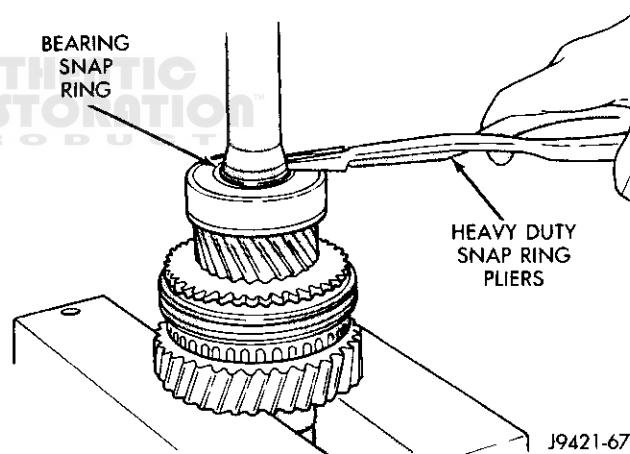


Fig. 74 Installing Output Shaft Bearing Snap Ring

(19) Install first speed synchro ring (Fig. 77).

(20) Assemble 1-2 synchro hub sleeve, springs, struts and detent balls.

CAUTION: The 1-2 synchro hub and sleeve can be installed backwards if care is not exercised. One side of the hub has a small diameter shoulder around the hub bore. Make sure this side of the hub faces the forward end of the output shaft. In addition, one side of the synchro sleeve is marked First Gear Side. Be sure this side of the sleeve will face the first gear after installation.

(21) Start 1-2 synchro assembly on shaft by hand (Fig. 78). Be sure synchro sleeve is properly posi-

DISASSEMBLY AND ASSEMBLY (Continued)

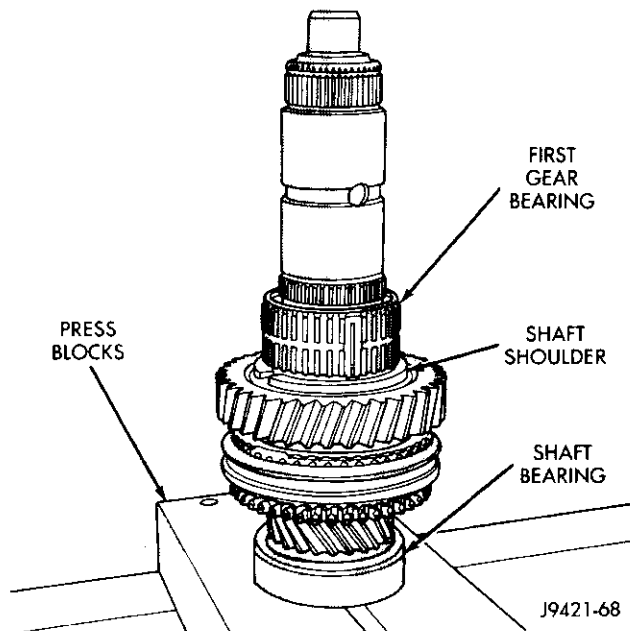


Fig. 75 First Gear Bearing Installation

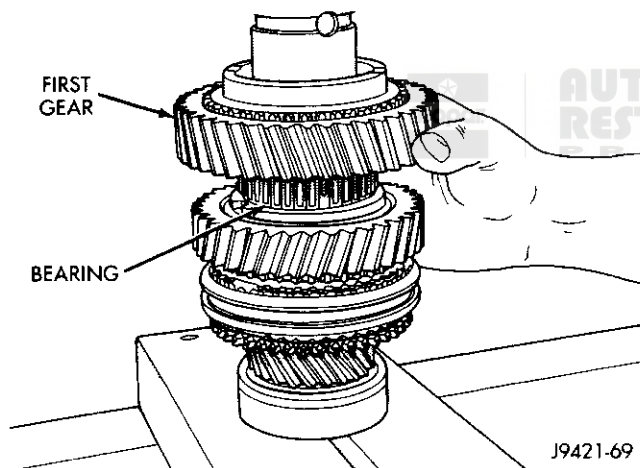


Fig. 76 First Gear Installation

tioned. Side marked first side must be facing first gear.

(22) Press 1-2 synchro onto output shaft using suitable size pipe tool and shop press (Fig. 79).

CAUTION: Take time to align the synchro ring and sleeve as hub the is being pressed onto the shaft. The synchro ring can be cracked if it becomes misaligned.

(23) Install new 1-2 synchro hub snap ring (Fig. 80) as follows:

- (a) Snap rings are available in thicknesses from 1.80 mm to 2.00 mm (0.070 to 0.078 in.).
- (b) Install thickest snap ring that will fit in shaft groove.

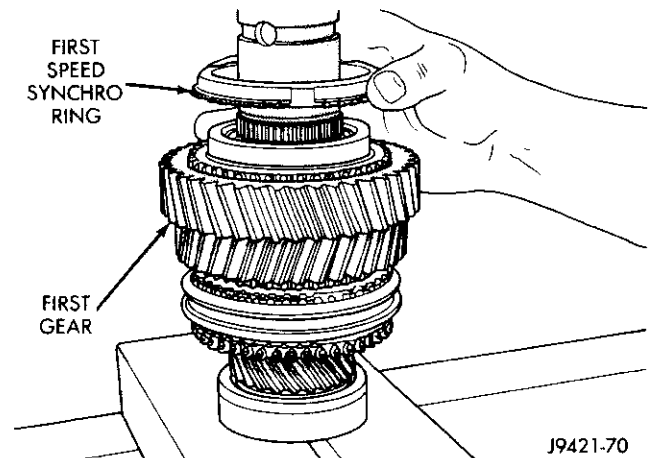


Fig. 77 First Speed Synchro Ring Installation

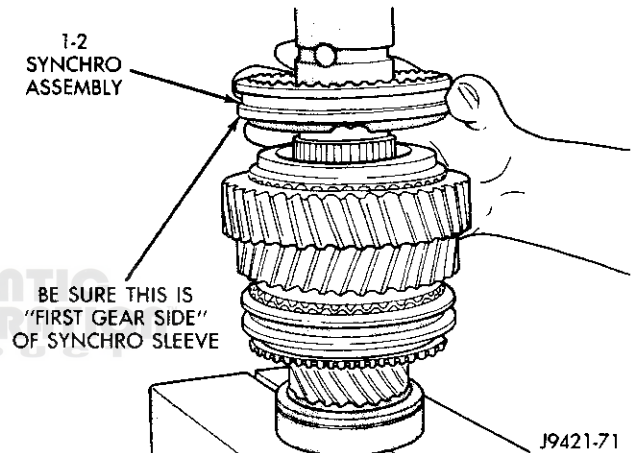


Fig. 78 Starting 1-2 Synchro On Shaft

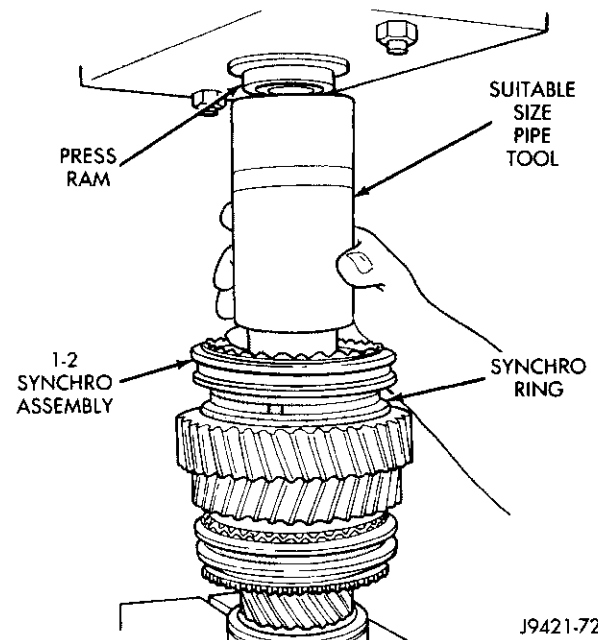


Fig. 79 Pressing 1-2 Synchro Assembly Onto Output Shaft

DISASSEMBLY AND ASSEMBLY (Continued)

(c) Verify that snap ring is completely seated in groove before proceeding.

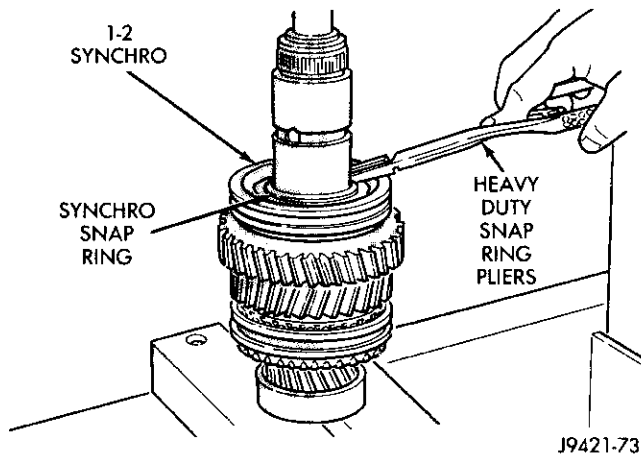


Fig. 80 Installing 1-2 Synchro Hub Snap Ring

(24) Install second speed synchro ring in 1-2 synchro hub and sleeve (Fig. 81). Be sure synchro ring is properly seated in sleeve.

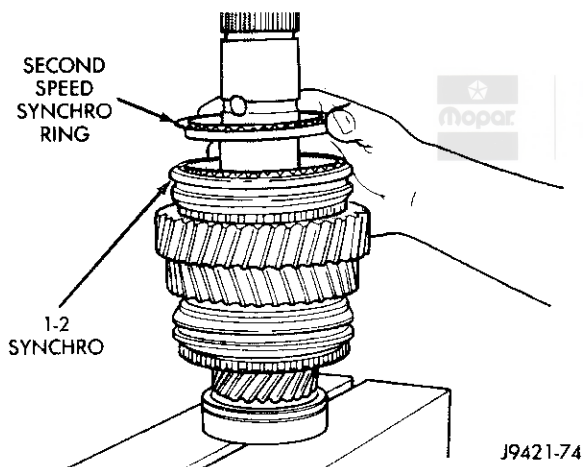


Fig. 81 Second Speed Synchro Ring Installation

(25) Install second gear needle bearing on shaft (Fig. 82).

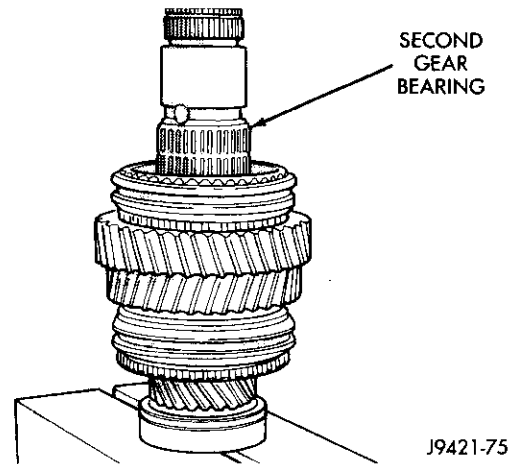


Fig. 82 Second Gear Bearing Installation

(26) Install second gear onto shaft and bearing (Fig. 83).

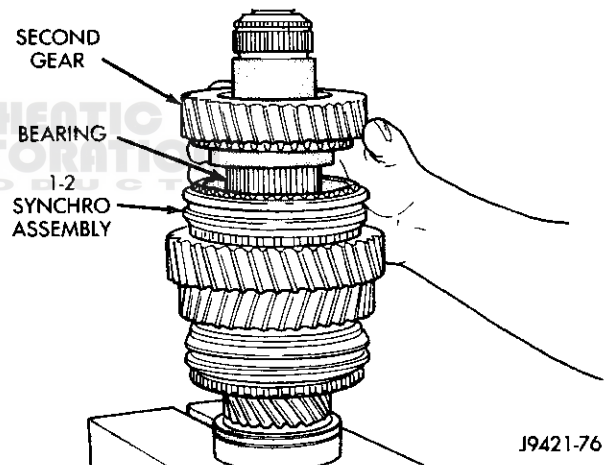


Fig. 83 Second Gear Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(27) Install two-piece thrust washer (Fig. 84). Be sure washer halves are seated in shaft groove and that washer lugs are seated in shaft lug bores.

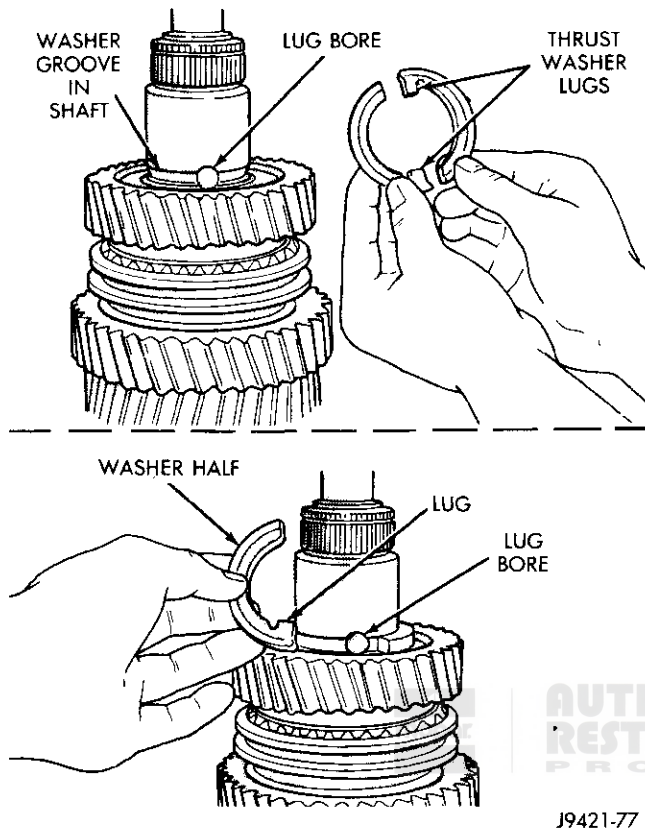


Fig. 84 Installing Two-Piece Thrust Washer

(28) Start retaining ring around two-piece thrust washer (Fig. 85).

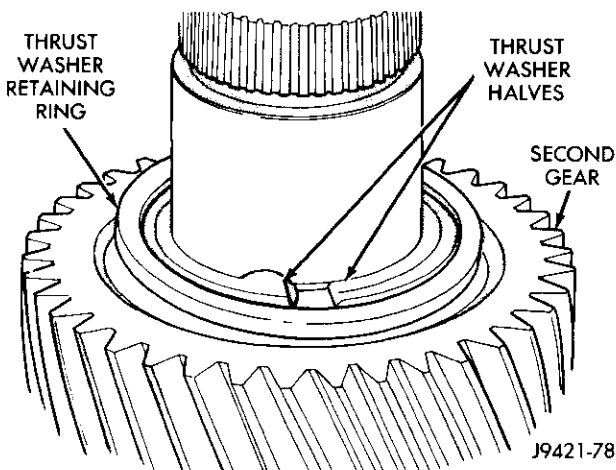


Fig. 85 Starting Retaining Ring Over Two-Piece Thrust Washer

(29) Seat thrust washer retaining ring with plastic mallet (Fig. 86).

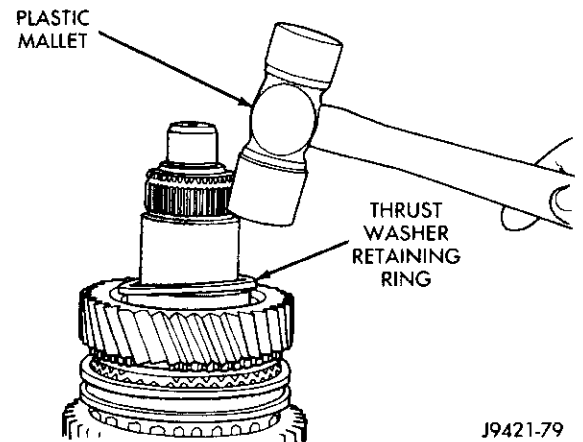


Fig. 86 Seating Thrust Washer Retaining Ring

(30) Install third gear needle bearing on shaft (Fig. 87).

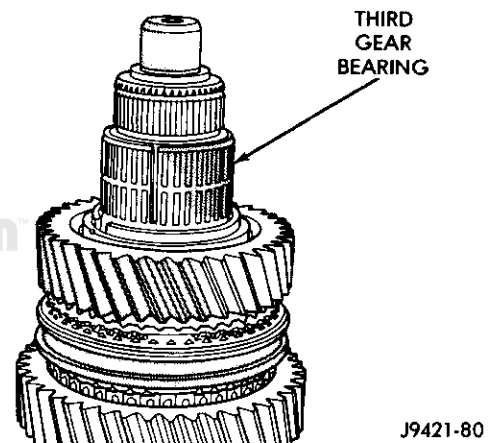


Fig. 87 Third Gear Bearing Installation

(31) Install third gear on shaft and bearing (Fig. 88).

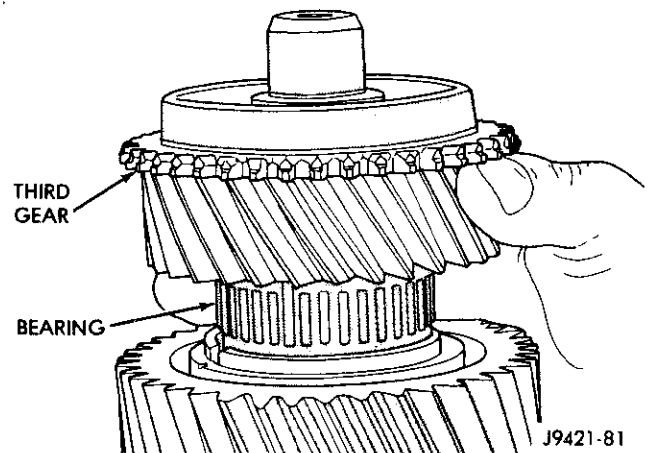


Fig. 88 Installing Third Gear

DISASSEMBLY AND ASSEMBLY (Continued)

(32) Install third speed synchro ring on third gear (Fig. 89).

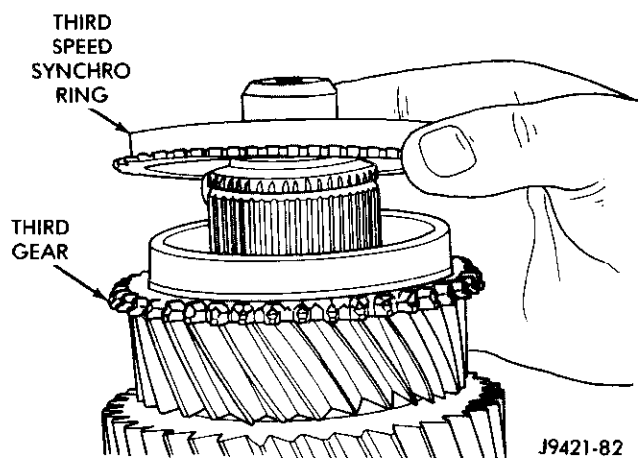


Fig. 89 Third Speed Synchro Ring Installation

(33) Assemble 3-4 synchro hub, sleeve, springs, struts and detent balls.

CAUTION: The 3-4 synchro hub and sleeve can be installed backwards if care is not exercised. One side of the hub has shoulders around the hub bore. Make sure this side of the hub is facing the front of the shaft. In addition, one side of the sleeve has grooves in it. Be sure this side of sleeve is also facing the front of the shaft.

(34) Start 3-4 synchro hub on output shaft splines by hand (Fig. 90).

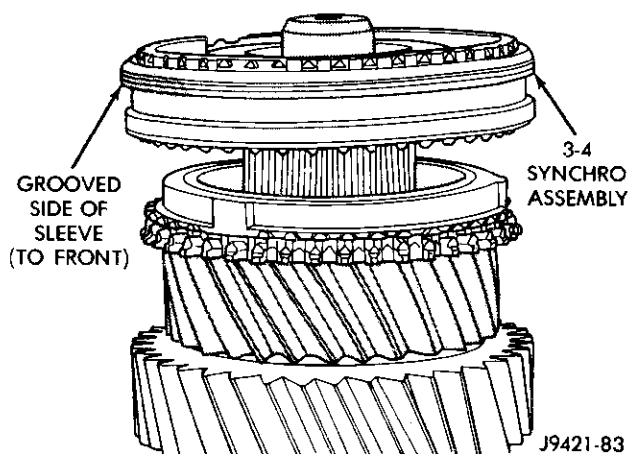


Fig. 90 Starting 3-4 Synchro Hub On Output Shaft

(35) Press 3-4 synchro assembly onto output shaft with shop press and suitable size pipe tool (Fig. 91).

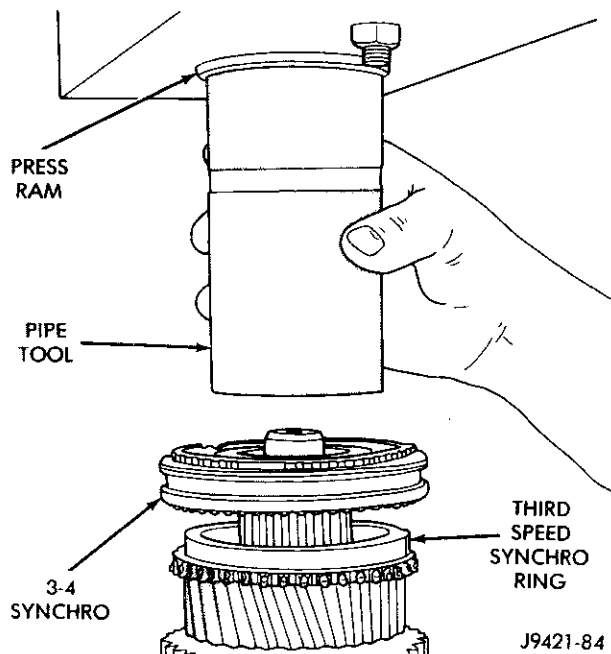


Fig. 91 Pressing 3-4 Synchro Assembly On Output Shaft

(36) Install 3-4 synchro hub snap ring (Fig. 92) as follows:

(a) Snap rings are available in thicknesses from 2.00 mm to 2.30 mm (0.078 to 0.090 in.).

(b) Install thickest snap ring that will fit in shaft groove. Use heavy duty snap ring pliers to install new ring.

(c) Verify that snap ring is completely seated in groove before proceeding.

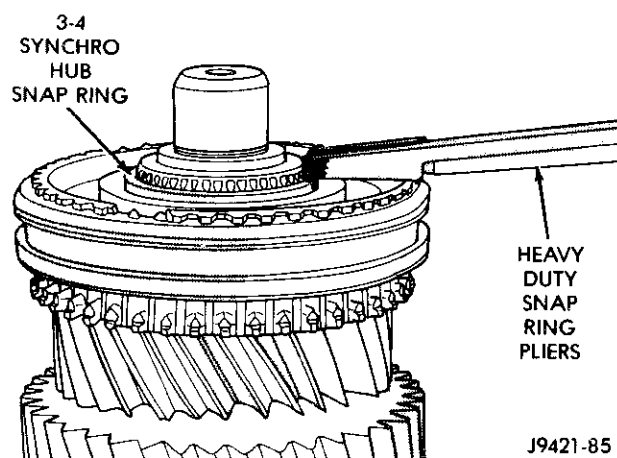
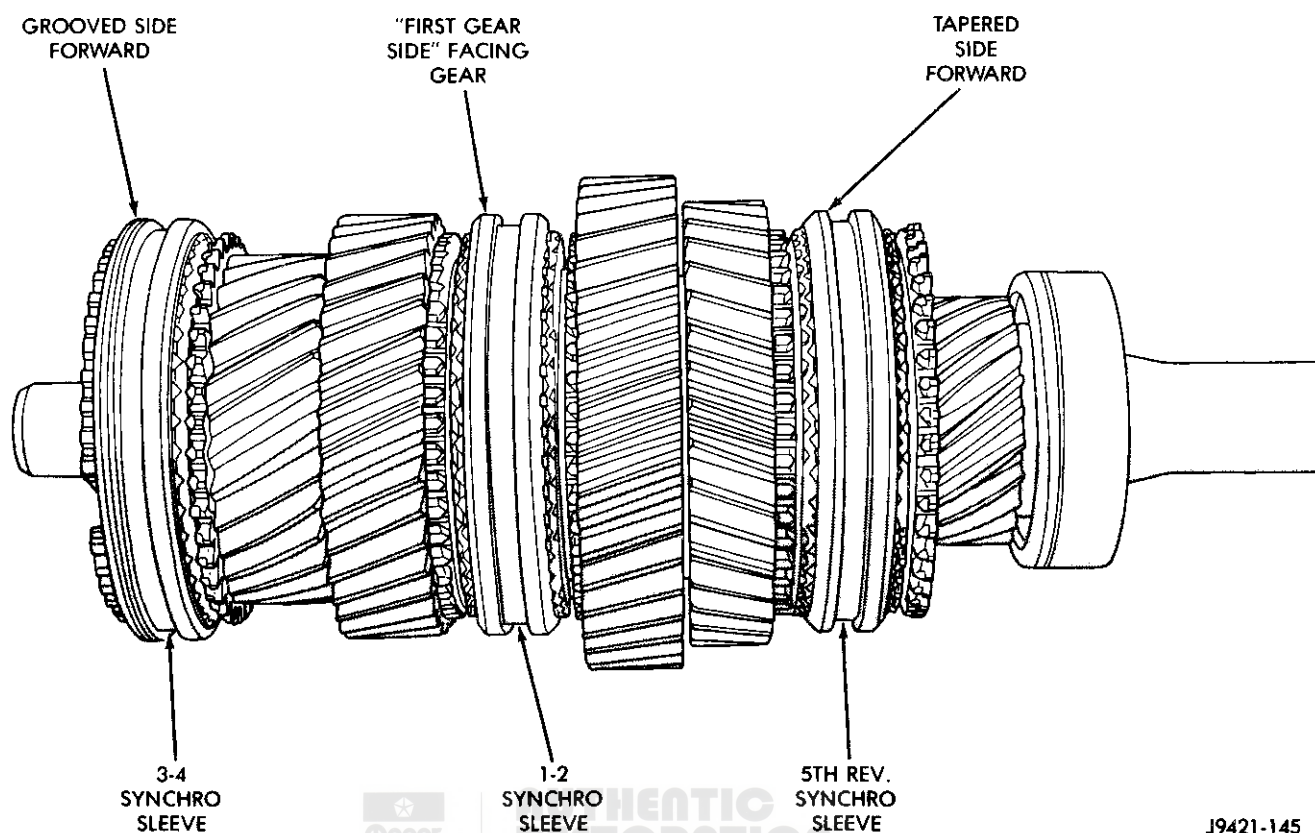


Fig. 92 Installing 3-4 Synchro Hub Snap Ring

DISASSEMBLY AND ASSEMBLY (Continued)

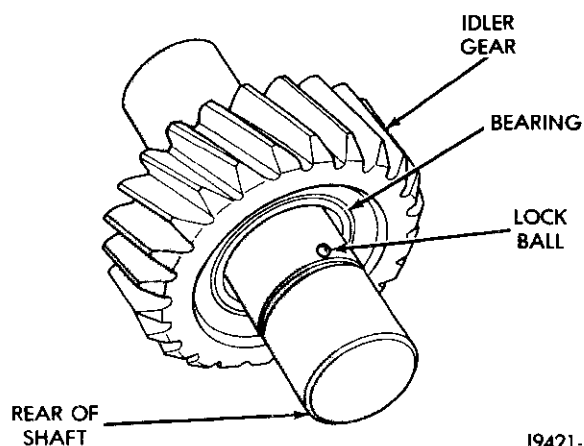
J9421-145

Fig. 93 Correct Synchro Sleeve Position

(37) Verify correct position of synchro sleeves before proceeding with assembly operations (Fig. 93). Grooved side of 3-4 sleeve should be facing forward. First gear side of 1-2 sleeve should be facing first gear. Tapered side of fifth-reverse sleeve should be facing forward.

REVERSE IDLER ASSEMBLY

- (1) Lubricate idler components with gear lube.
- (2) Slide idler gear bearing on shaft (Fig. 94). Bearing fits either way on shaft.
- (3) Slide gear onto shaft. Side of gear with recess goes to rear (Fig. 94).
- (4) Place first lock ball in dimple at rear end of idler shaft (Fig. 94). Petroleum jelly can be used to hold ball in place if desired.



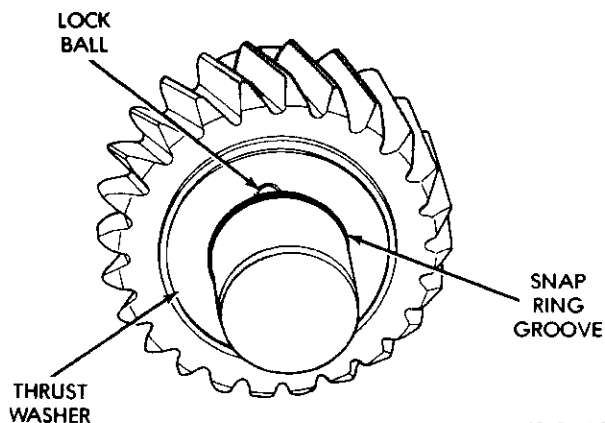
J9421-87

Fig. 94 Idler Gear And Bearing Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Slide thrust rear thrust washer onto shaft and over lock ball (Fig. 95).

(6) Install snap ring in groove at rear of shaft (Fig. 95).



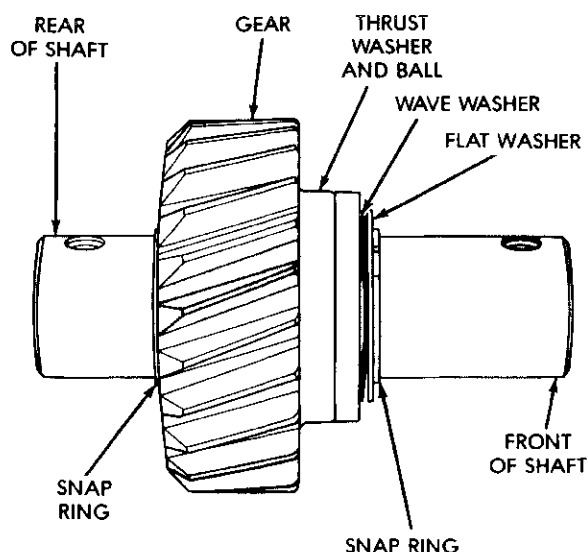
J9421-89

Fig. 95 Idler Gear Rear Thrust Washer Installation

(7) Install lock ball in dimple at front of shaft. Hold ball in place with petroleum jelly if desired.

(8) Install front thrust washer on shaft and slide washer up against gear and over lock ball (Fig. 96).

(9) Install wave washer, flat washer and remaining snap ring on idler shaft (Fig. 96). Be sure snap ring is fully seated.

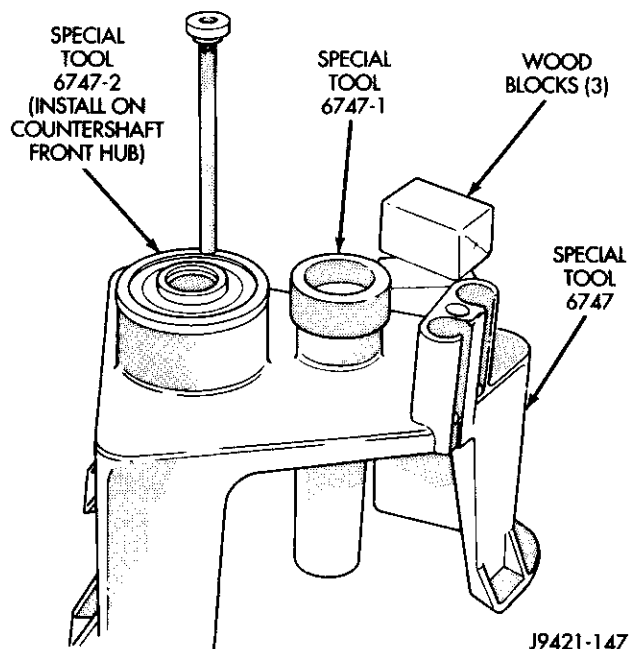


J9421-90

Fig. 96 Idler Gear And Shaft Assembly**GEARTRAIN BUILDUP—ASSEMBLY FIXTURE TOOL**

(1) Install Adapter 6747-1 on input shaft hub of fixture tool (Fig. 97). Then install Adapter 6747-2 on front bearing hub of countershaft. **Adapter 6747-2**

has a raised shoulder on one side. Be sure the shoulder is seated against the countershaft.

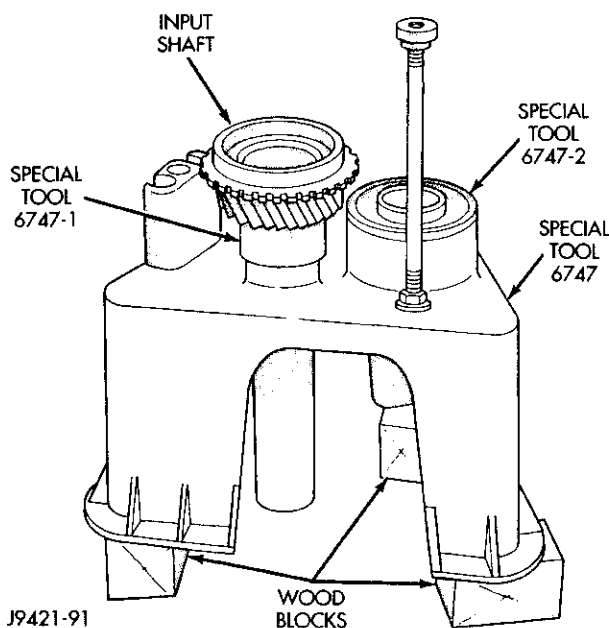


J9421-147

Fig. 97 Preparing Assembly Fixture For Geartrain Build-up

(2) Position wood block under each leg of assembly fixture (Fig. 98). Blocks are needed to provide clearance for input shaft and can be made from 2 x 4 lumber.

(3) Install input shaft in fixture tool (Fig. 98). Make sure Adapter Tool 6747-1 is positioned under shaft as shown.



J9421-91

Fig. 98 Installing Input Shaft In Assembly Fixture

DISASSEMBLY AND ASSEMBLY (Continued)

- (4) Install pilot bearing in input shaft (Fig. 99).

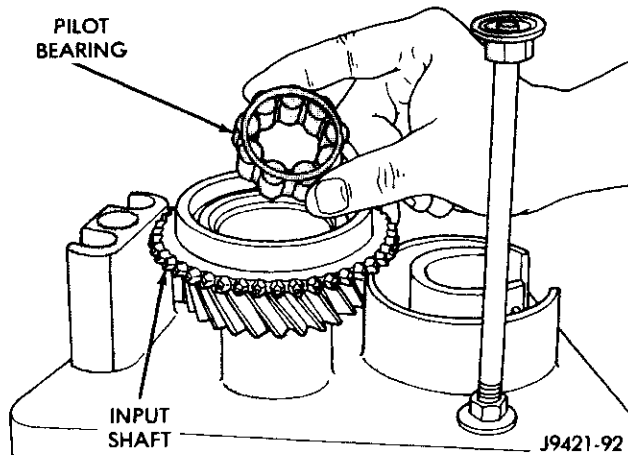


Fig. 99 Installing Pilot Bearing In Input Shaft

- (5) Install fourth speed synchro ring on input shaft (Fig. 100).

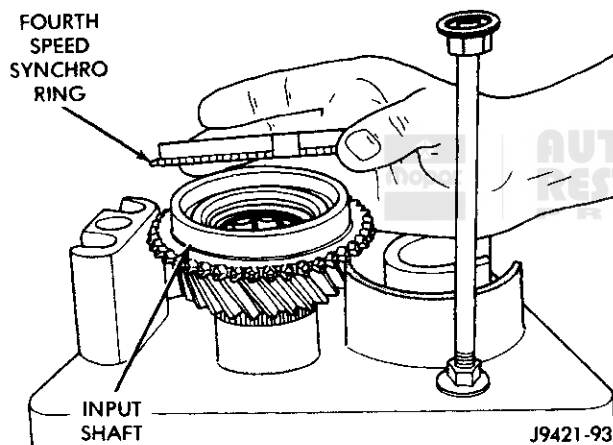


Fig. 100 Installing Fourth Speed Synchro Ring On Input Shaft

- (6) Adjust height of idler gear pedestal on assembly fixture (Fig. 101). **Start with a basic height of 18.4 cm (7-1/4 in.).** Final adjustment can be made after gear is positioned on pedestal.

- (7) Install assembled output shaft and geartrain in input shaft (Fig. 102). Carefully rotate output shaft until fourth speed synchro ring seats in synchro hub and sleeve.

- (8) Install Adapter 6747-2 on front bearing hub of countershaft, if not previously done. The adapter has a shoulder on one side. The shoulder goes toward the countershaft.

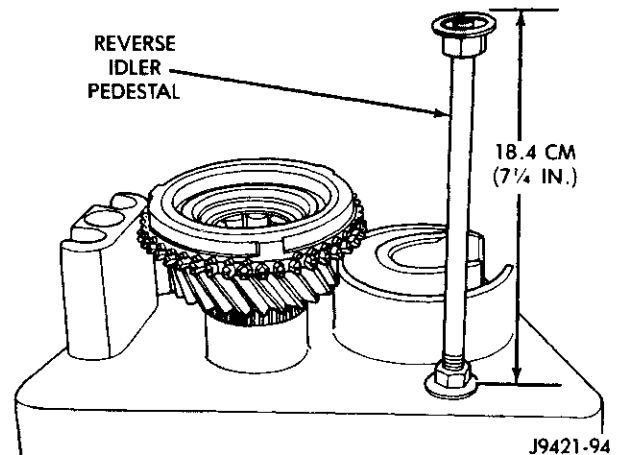


Fig. 101 Idler Pedestal Basic Height Adjustment

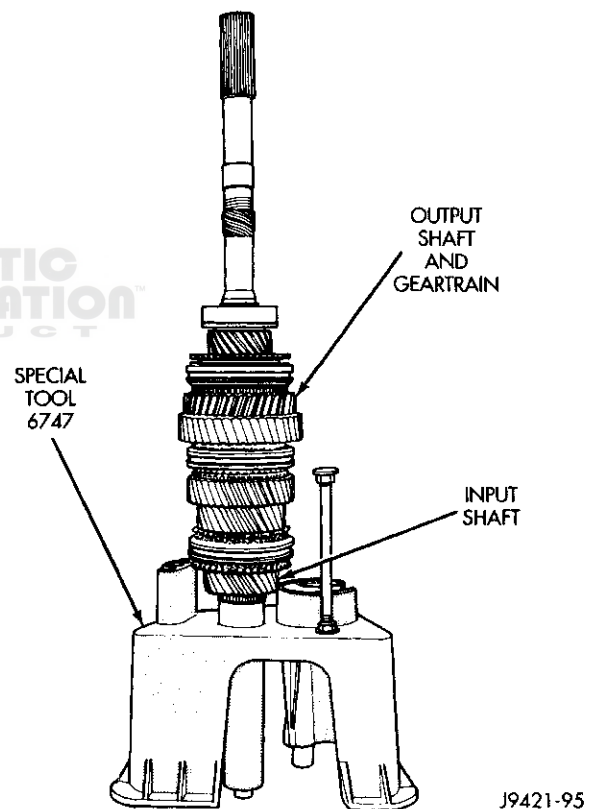


Fig. 102 Output Shaft And Geartrain Installed In Input Shaft

DISASSEMBLY AND ASSEMBLY (Continued)

(9) Slide countershaft (and adapter) into fixture slot. Verify that countershaft and output shaft gears are fully meshed before proceeding (Fig. 103).

(10) Check alignment of countershaft and output shaft gear teeth. Note that gears may not align perfectly. A difference in height of 1.57 to 3.18 mm (1/16 to 1/8 in.) will probably exist. This difference will not interfere with assembly. However, if the difference is greater than this, the countershaft adapter tool is probably upside down. Remove countershaft, reverse adapter tool, reinstall countershaft and check alignment again.

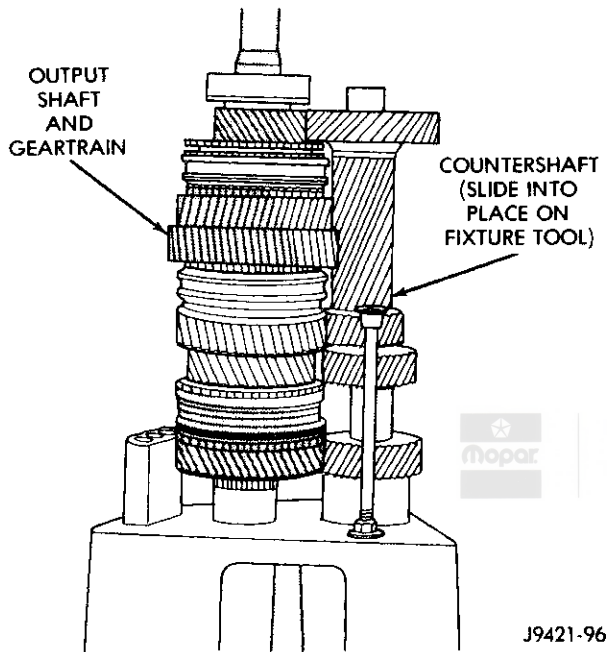


Fig. 103 Countershaft Installed On Fixture Tool

(11) Position reverse idler on pedestal of assembly fixture (Fig. 104). **Be sure idler gear is properly meshed and aligned with shaft gear teeth and that bolt holes are facing out and not toward geartrain.** Adjust pedestal up or down if necessary. Also be sure that short end of idler shaft is facing up as shown.

(12) On 2-wheel drive transmission, thread one Pilot Stud C-3288-B in center or passenger side hole of output shaft bearing retainer. Then position retainer on fifth gear as shown (Fig. 105). Cut a screwdriver slot at the end of the pilot stud with a hacksaw if necessary (slot makes for easy stud removal after housing is installed).

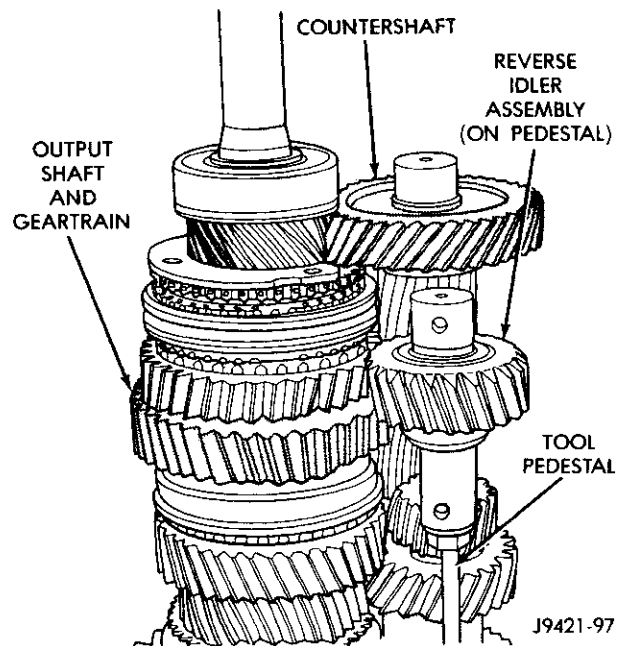


Fig. 104 Reverse Idler Assembly Positioned On Assembly Fixture Pedestal

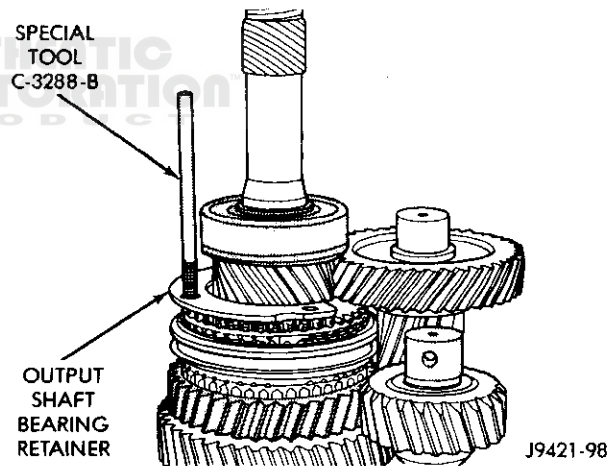


Fig. 105 Positioning Output Shaft Bearing Retainer For Rear Housing Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(13) Assemble 1-2 and fifth reverse-shift forks (Fig. 106). Arm of fifth-reverse fork goes through slot in 1-2 fork.

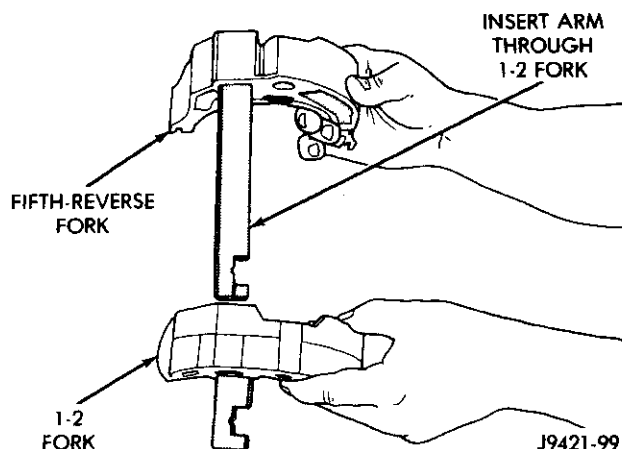


Fig. 106 Assembling 1-2 And Fifth-Reverse Shift Forks

(14) Install assembled shift forks in synchro sleeves (Fig. 107). Be sure forks are properly seated in sleeves.

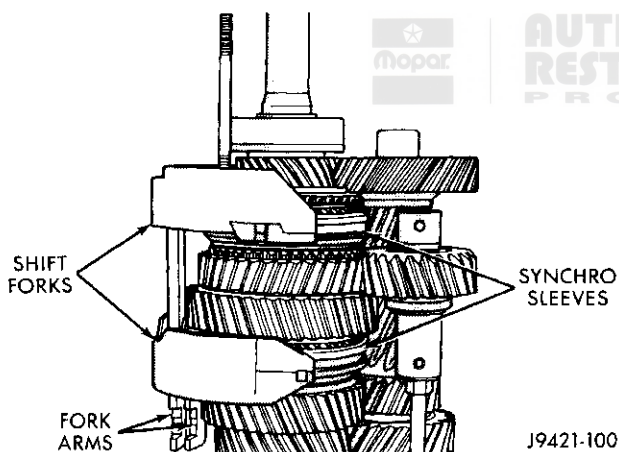


Fig. 107 Shift Forks Installed In Synchro Sleeves

REAR HOUSING INSTALLATION—2WD

(1) Drive adapter housing alignment dowels back into housing until dowels are flush with mounting surface (Fig. 108).

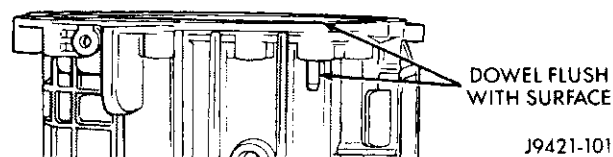
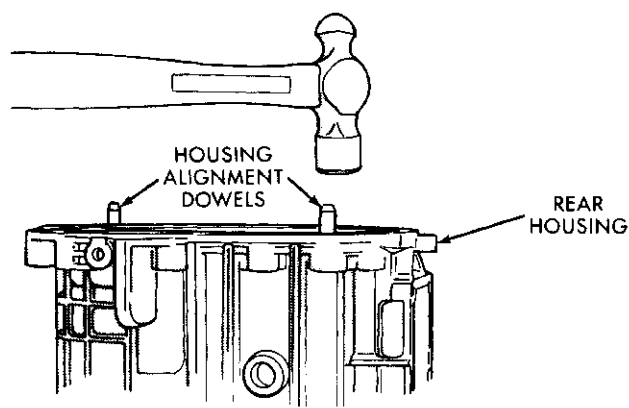


Fig. 108 Preparing Rear Housing Dowels For Installation

(2) Apply liberal quantity of petroleum jelly to countershaft rear bearing and bearing race.

(3) Install countershaft rear bearing in bearing race (Fig. 109).

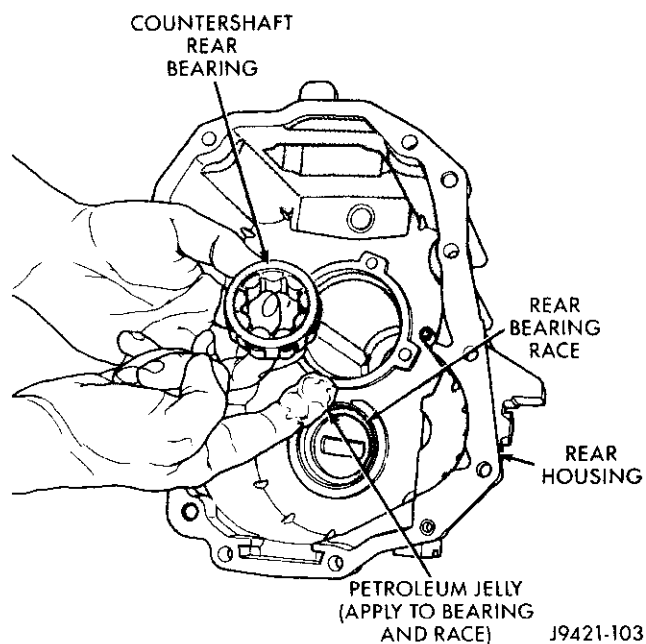


Fig. 109 Lubricating Countershaft Rear Bearing

DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: The countershaft bearings can be installed backwards if care is not exercised. Be sure the large diameter side of the roller retainer faces the countershaft and the small diameter side faces the race and housing (Fig. 110).

(4) Apply extra petroleum jelly to hold countershaft rear bearing in place when housing is installed.

(5) Apply light coat of petroleum jelly to shift shaft bushing/bearing in rear housing (Fig. 110).

(6) Reach into countershaft rear bearing with finger, and push each bearing roller outward against race. Then apply extra petroleum jelly to hold rollers in place. This avoids having rollers becoming displaced during housing installation. This will result in misalignment between bearing and countershaft bearing hub.

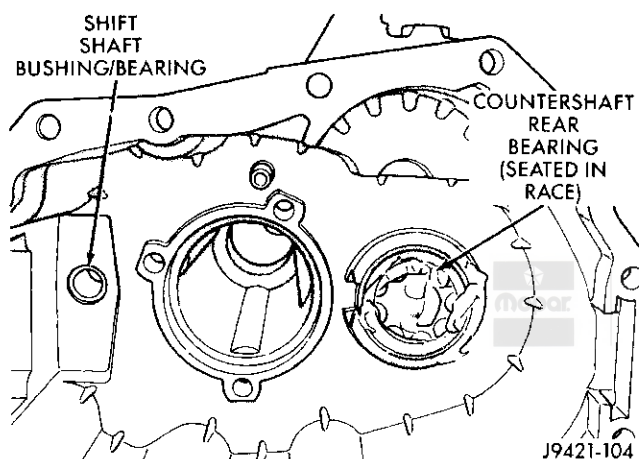


Fig. 110 Countershaft Rear Bearing Seated In Seated in Race

(7) Install rear housing onto geartrain (Fig. 111). Be sure bearing retainer pilot stud is in correct bolt hole in housing. Also be sure countershaft and output shaft bearings are aligned in housing and on countershaft.

(8) Seat rear housing on output shaft rear bearing and countershaft. Use plastic or rawhide mallet to tap housing into place.

(9) Install three bolts that secure rear bearing retainer to rear housing as follows:

(a) Apply Mopar Gasket Maker, or Loctite 518 to bolt threads, bolt shanks and under bolt heads (Fig. 112).

(b) Start first two bolts in retainer (Fig. 113). It may be necessary to move retainer rearward (with pilot stud) in order to start bolts in retainer.

(c) Remove pilot stud C-3288-B and install last retainer bolt (Fig. 113). Use screwdriver to remove pilot stud.

(d) Tighten all three retainer bolts to 30-35 N·m (22-26 ft. lbs.) torque.

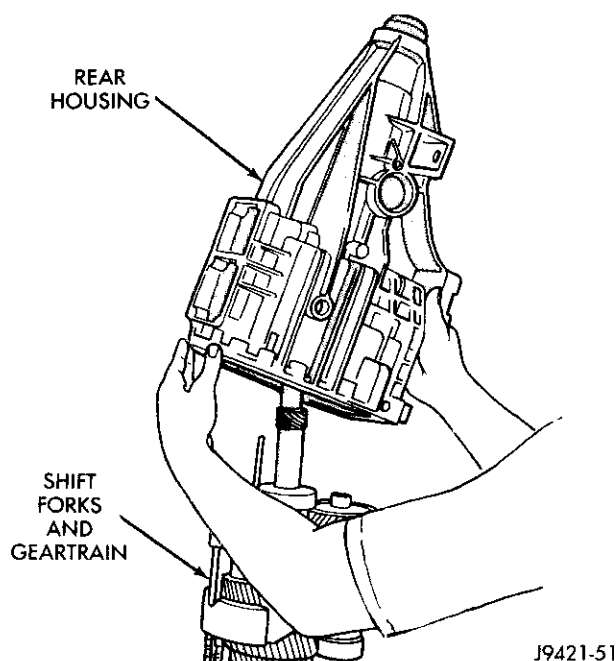


Fig. 111 Rear Housing Installation—2WD

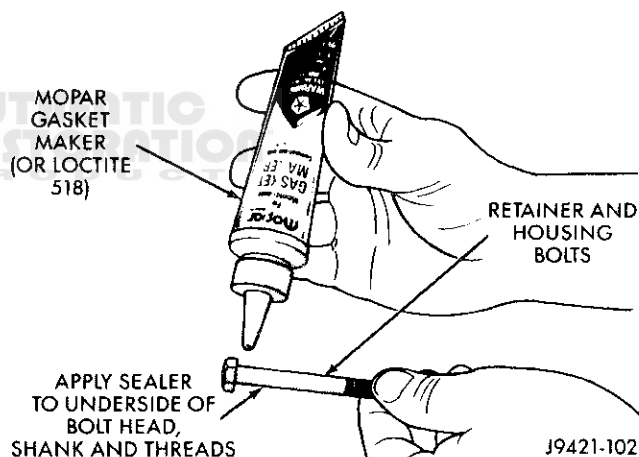


Fig. 112 Applying Sealer To Retainer And Housing Bolts

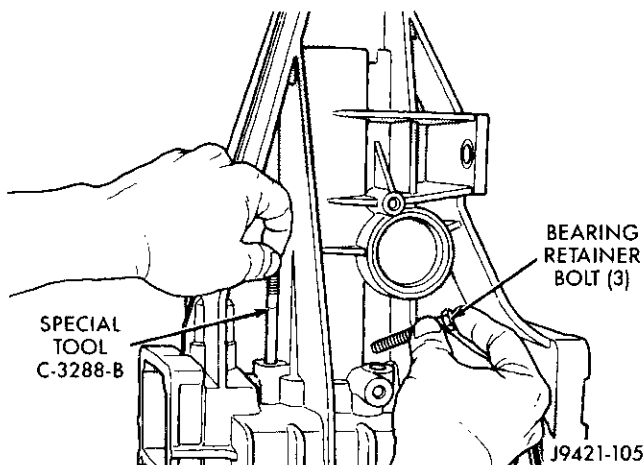


Fig. 113 Removing Pilot Stud Tool And Installing Retainer Bolts—2WD

DISASSEMBLY AND ASSEMBLY (Continued)**REAR ADAPTER HOUSING INSTALLATION
(4-WHEEL DRIVE TRANSMISSION)**

(1) Install rear bearing in adapter housing. Use wood hammer handle or wood dowel to tap bearing into place.

(2) Position rear bearing retainer in adapter housing (Fig. 114).

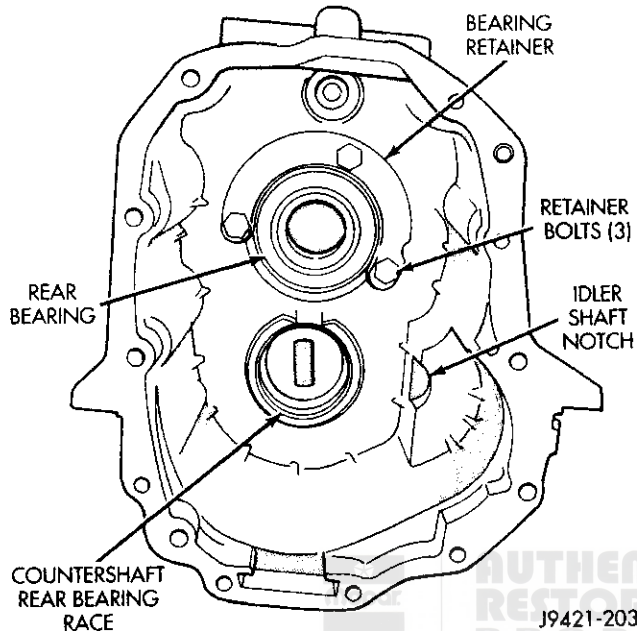


Fig. 114 Preparing Adapter Housing For Installation—4WD

(3) Apply Mopar Gasket Maker, or Loctite 518 to threads, bolt shanks and under hex heads of bearing retainer bolts (Fig. 115).

(4) Apply liberal quantity of petroleum jelly to countershaft rear bearing and bearing race.

(5) Install countershaft rear bearing in bearing race (Fig. 110).

CAUTION: The countershaft bearings can be installed backwards if care is not exercised. Be sure the large diameter side of the roller retainer faces the countershaft and the small diameter side faces the race and housing (Fig. 110).

(6) Apply extra petroleum jelly to hold countershaft rear bearing in place when housing is installed.

(7) Apply light coat of petroleum jelly to shift shaft bushing/bearing in adapter housing (Fig. 110).

(8) Install adapter housing on geartrain.

(9) Install rear bearing snap ring on output shaft (Fig. 115).

(10) Lubricate lip of new rear seal (Fig. 116) with Mopar Door Ease, or transmission fluid.

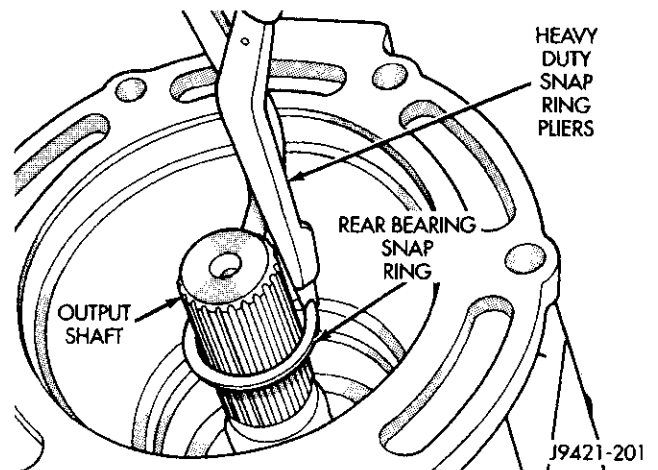


Fig. 115 Installing Rear Bearing Snap Ring—4WD

(11) Install new rear seal in adapter housing bore with suitable size tool. Be sure seal is fully seated in housing bore (Fig. 116).

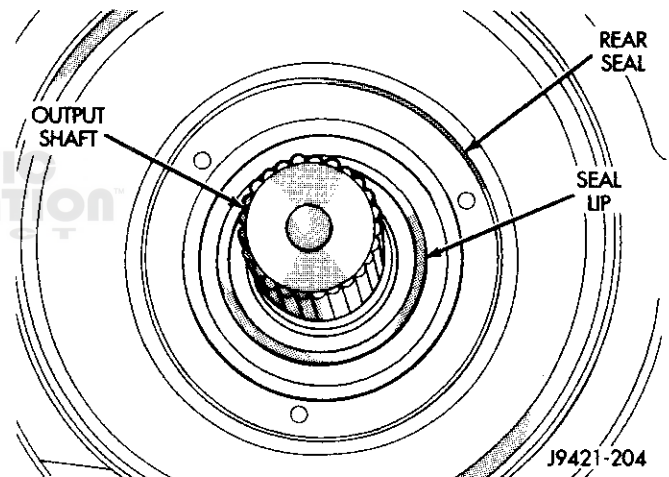


Fig. 116 Rear Seal Installation—4WD

REVERSE IDLER SEGMENT INSTALLATION

(1) Apply Mopar Gasket Maker, or Loctite 518 sealer to underside of idler shaft bolt heads, bolt shanks and bolt threads (Fig. 112).

(2) Align idler shaft and rear housing bolt holes with drift, pin punch, or phillips screwdriver.

(3) Work segment upward into housing and onto idler shaft (Fig. 117).

(4) Verify that idler shaft is seated in housing notch before proceeding. Segment and housing can be damaged if idler shaft is misaligned.

(5) Insert idler shaft retaining bolts through housing and segment and into shaft. Long bolt goes through segment and short bolt goes through housing and directly into rear of shaft (Fig. 118). Start both bolts by hand to avoid cross threading.

(6) Tighten idler shaft bolts to 19-25 N·m (14-18 ft. lbs.) torque.

DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Make sure the idler shaft and support segment are properly seated and held firmly in place while tightening the shaft bolts. The segment, housing or shaft threads can be damaged if the idler shaft is allowed to shift out of position in the housing.

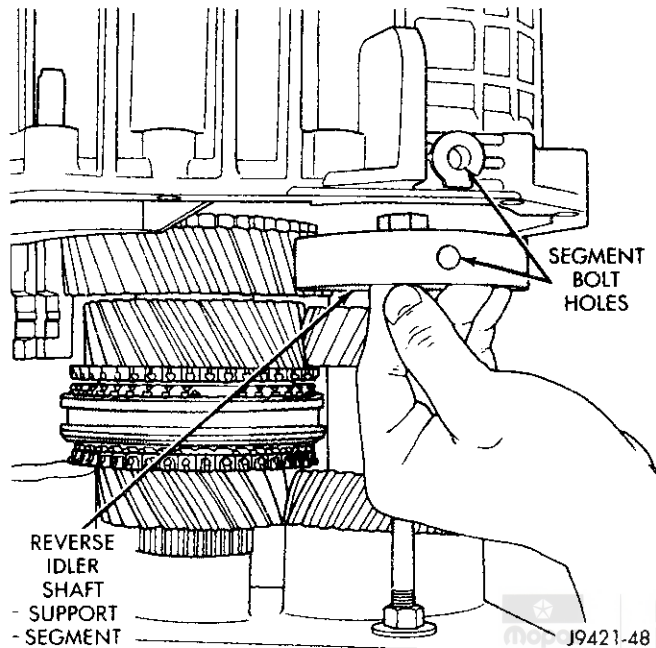


Fig. 117 Installing Reverse Idler Shaft Support Segment

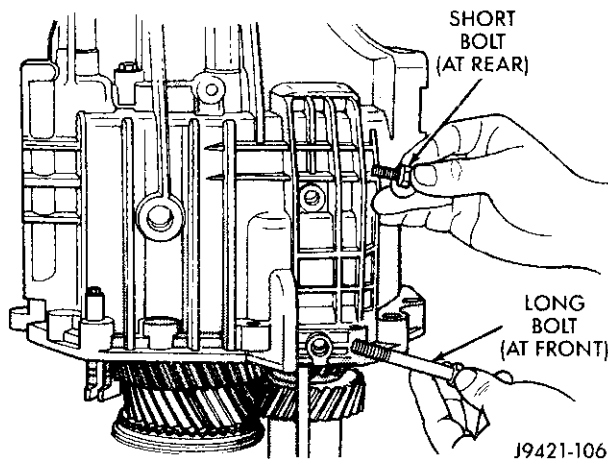


Fig. 118 Installing Reverse Idler Shaft Bolts

SHIFT SHAFT, SHAFT LEVER AND BUSHING AND SHIFT SOCKET INSTALLATION

(1) Remove geartrain and housing assembly from fixture with aid of helper.

(2) Before proceeding, verify that all synchro sleeves are in Neutral position (centered on hub). Move sleeves into neutral if necessary.

CAUTION: The transmission synchros must all be in Neutral position for proper reassembly. Otherwise, the housings, shift forks and gears can be damaged during installation of the two housings.

(3) Install 3-4 shift fork in synchro sleeve (Fig. 119). Verify that groove in fork arm is aligned with grooves in 1-2 and fifth-reverse fork arms as shown.

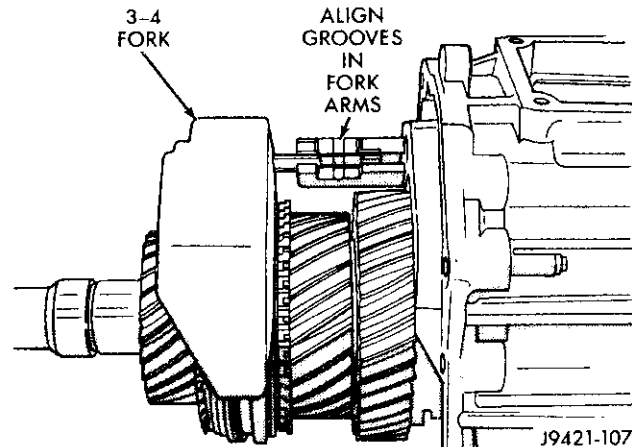


Fig. 119 Installing 3-4 Shift Fork

(4) Check surface of shift shaft before proceeding. Small nicks or scratches can be smoothed off with oil soaked 320-400 grit emery cloth if necessary.

(5) Slide shift shaft through 3-4 shift fork (Fig. 120). Be sure shaft detent notches are to front.

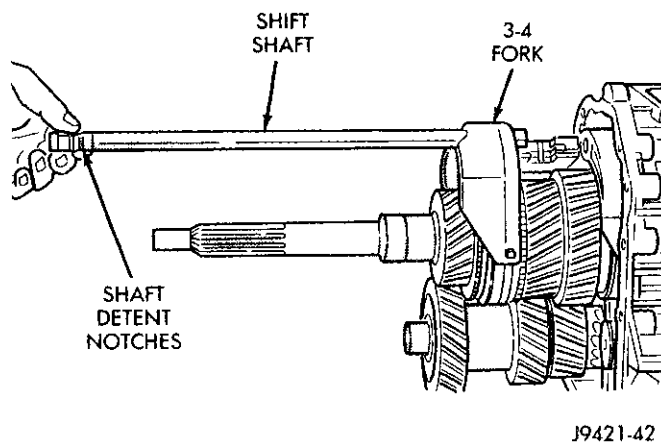
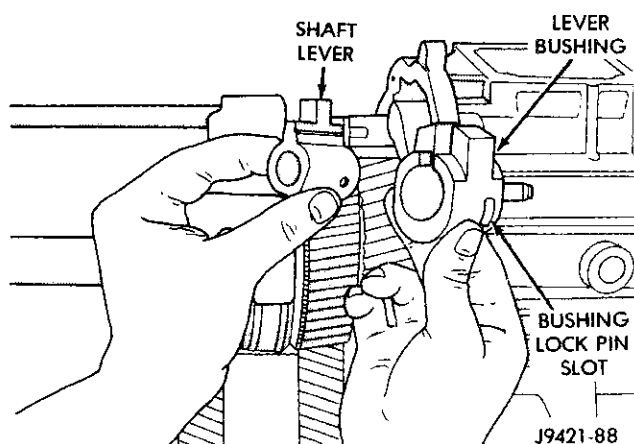
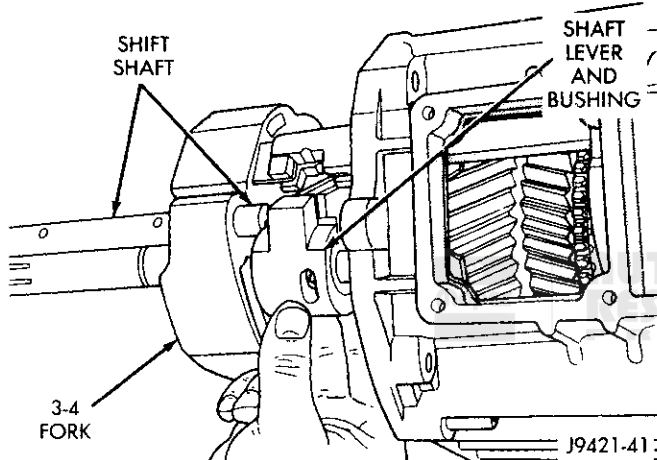
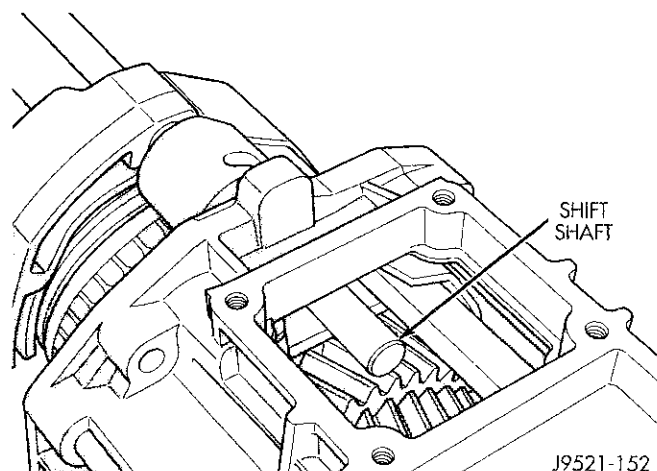


Fig. 120 Shift Shaft Installation

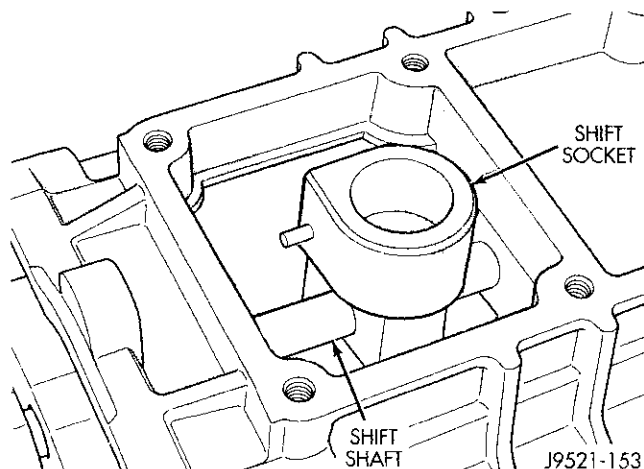
(6) Assemble shift shaft shift lever and bushing (Fig. 121). Be sure slot in bushing is facing up and roll pin hole for lever is aligned with hole in shaft.

(7) Install assembled lever and bushing on shift shaft (Fig. 122).

(8) Slide shift shaft through 1-2 fork and part way into shift lever opening in rear housing (Fig. 123).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 121 Assembling Shift Shaft Lever And Bushing****Fig. 122 Installing Shift Shaft Lever And Bushing****Fig. 123 Inserting Shaft Into Lever Opening In Housing**

(9) Align shift socket with shaft and slide shaft through socket and part-way into housing (Fig. 124).

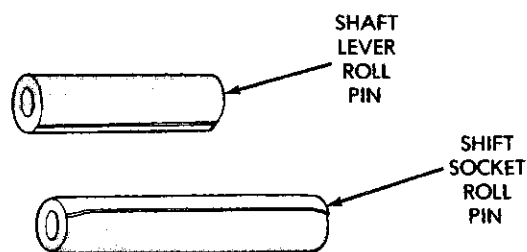
**Fig. 124 Shift Socket Installation**

(10) Push shift shaft through fifth-reverse fork and into bushing in rear housing. Use plastic mallet to tap shaft into place if necessary.

(11) Rotate shift shaft so **detent notches in shaft are facing driver side of housing**.

CAUTION: Correct positioning of the shift shaft detent notch is important. Both of the shaft roll pins can be installed even when the shaft is 180° off. If this occurs, the transmission will have to be disassembled again to correct shaft alignment.

(12) Select correct new roll pin for shift shaft lever (Fig. 125). Shaft lever roll pin is approximately 22 mm (7/8 in.) long. Shift socket roll pin is approximately 33 mm (1-1/4 in.) long.



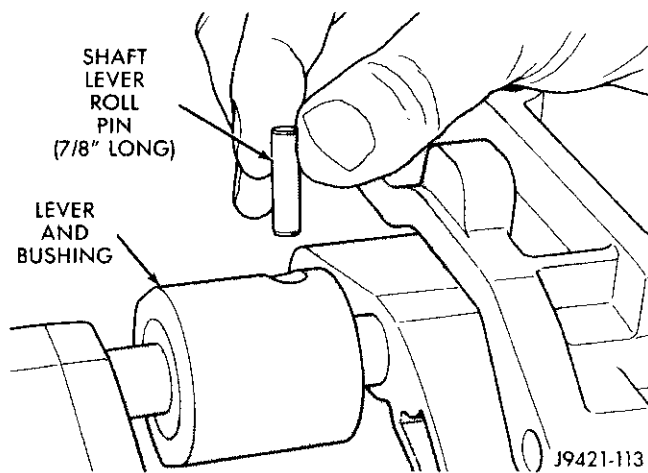
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Fig. 125 Roll Pin Identification—Shaft Lever And Shift Socket

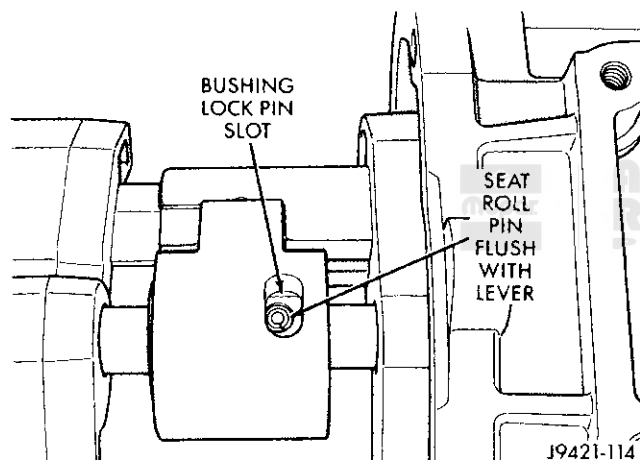
(13) Align roll pin holes in shift shaft, lever and bushing. Then start roll pin into shaft lever by hand (Fig. 126).

(14) Seat shaft lever roll pin with pin punch (Fig. 127).

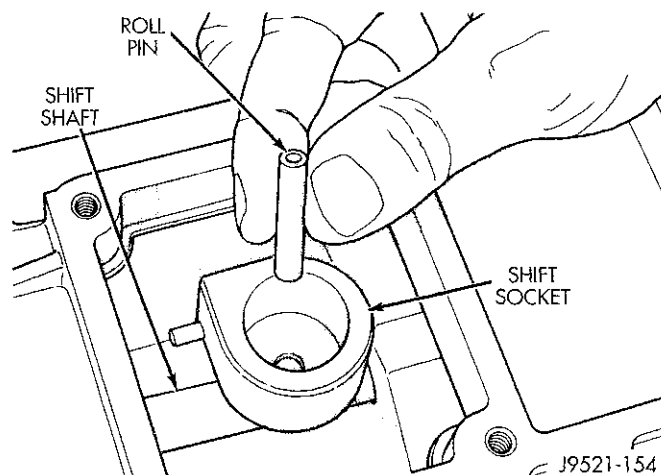
CAUTION: The shaft lever roll pin must be flush with the surface of the lever. The lever bushing will bind on the roll pin if the pin is not seated flush.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 126 Starting Roll Pin In Shift Shaft Lever**

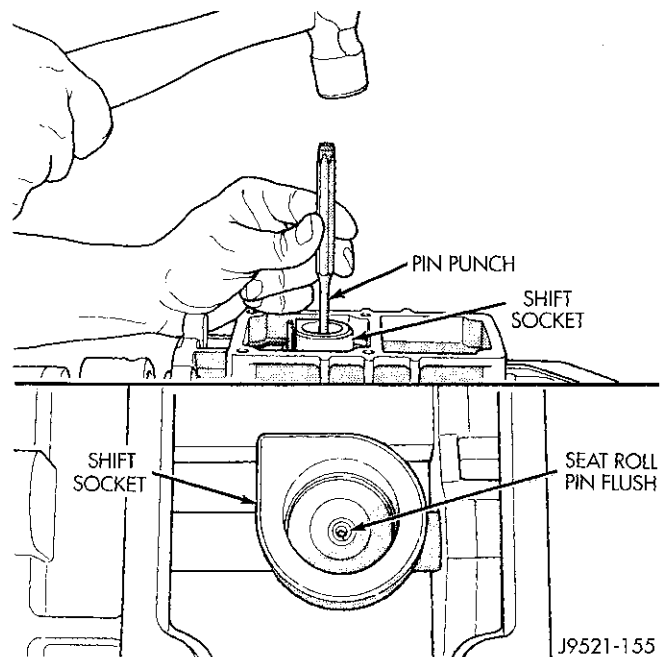
(15) Before proceeding, verify that lock pin slot in lever bushing is positioned as shown (Fig. 127).

**Fig. 127 Correct Seating Of Shift Shaft Lever Roll Pin**

(16) Align roll pin holes in shift socket and shift shaft. Then start roll pin into shift shaft by hand (Fig. 128).

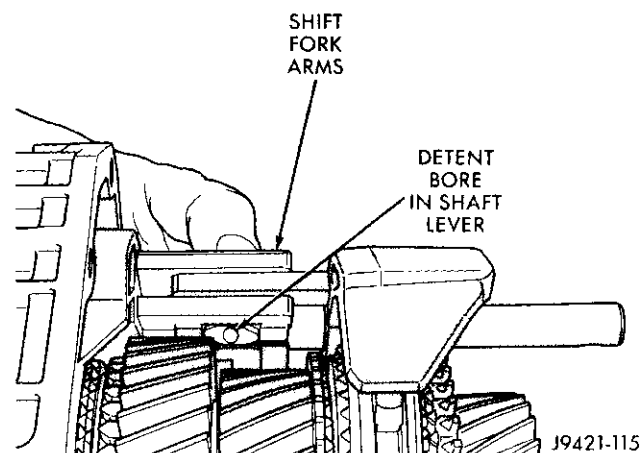
**Fig. 128 Starting Roll Pin In Shift Socket**

(17) Seat roll pin in shift socket with pin punch. Roll pin must be flush with socket after installation (Fig. 129).

**Fig. 129 Seating Shift Socket Roll Pin**

(18) Verify that notches in shift fork arms are aligned (Fig. 130). Realign arms if necessary.

(19) Rotate shaft lever and bushing downward (out of fork arms), to expose detent bore in lever (Fig. 130).

**Fig. 130 Shaft Lever Positioned For Detent Ball and Spring Installation**

DISASSEMBLY AND ASSEMBLY (Continued)

(20) Insert detent spring in lever bore with pencil magnet (Fig. 131).

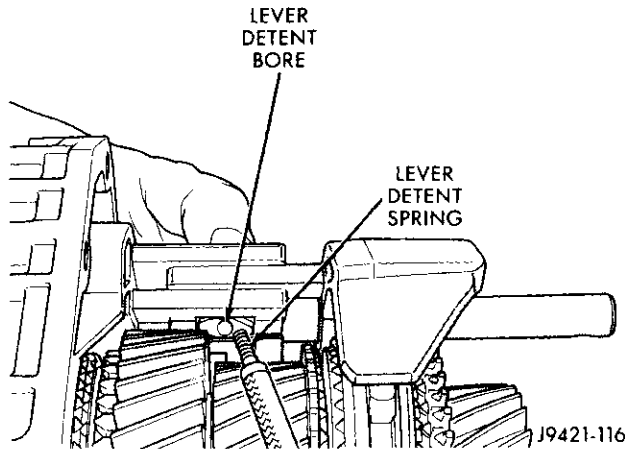


Fig. 131 Installing Detent Spring In Shaft Lever

(21) Install detent ball on top of spring in lever bore (Fig. 132). Use pencil magnet to hold ball in place.

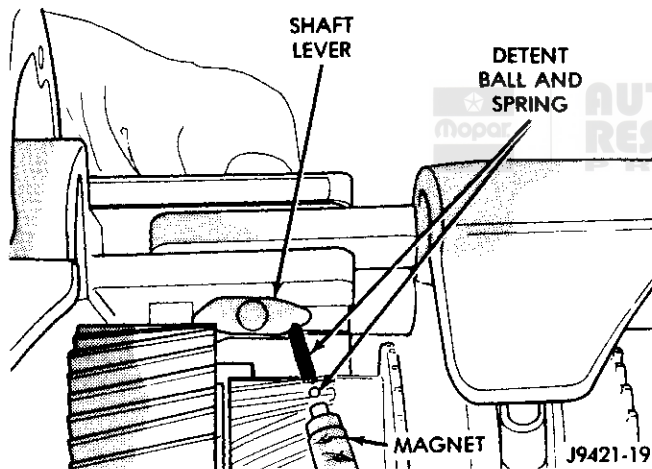


Fig. 132 Installing Detent Ball In Shaft Lever

(22) Press and hold detent ball in lever with magnet. Then carefully rotate lever upward into fork arm notches. Be sure ball is seated in fork arms before proceeding (Fig. 133).

FRONT HOUSING AND INPUT SHAFT BEARING RETAINER INSTALLATION

(1) Before proceeding, verify that all synchro are in Neutral position (centered on hub). Move sleeves into neutral if necessary.

CAUTION: The transmission synchros must all be in Neutral position during reassembly. Otherwise, the housings, shift forks and gears can be damaged during housing installation.

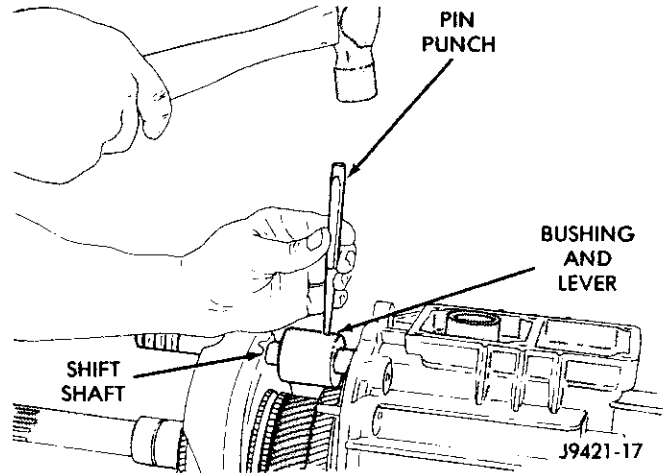


Fig. 133 Correct Seating Of Lever Detent Ball In Shift Fork Arms

(2) Apply liberal quantity of petroleum jelly to countershaft front bearing. Then insert bearing in front housing race (Fig. 134). **Large diameter side of bearing cage goes toward countershaft (Fig. 135). Small diameter side goes toward bearing race in housing.**

(3) Reach into countershaft front bearing with finger, and push each bearing roller outward against race. Then apply extra petroleum jelly to hold rollers in place. This avoids having rollers becoming displaced during housing installation. This will result in misalignment between bearing and countershaft bearing hub.

(4) Install input shaft bearing in front housing bore (Fig. 135). Use plastic mallet to seat bearing. **Bearing goes in from front side of housing only.**

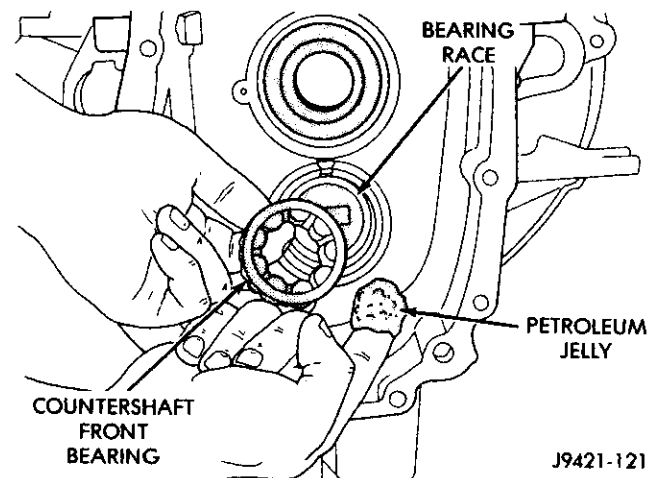


Fig. 134 Lubricating/Positioning Countershaft Front Bearing

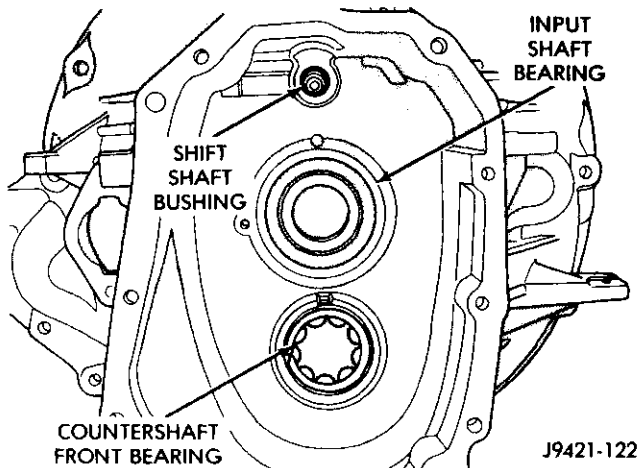
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 135 Input Shaft Bearing And Countershaft Front Bearing Installation

(5) Apply small amount of petroleum jelly to shift shaft bushing in front housing (Fig. 136).

(6) Apply 1/8 in. wide bead of Mopar Gasket Maker, or Loctite 518 to mating surfaces of front and rear housings (Fig. 136).

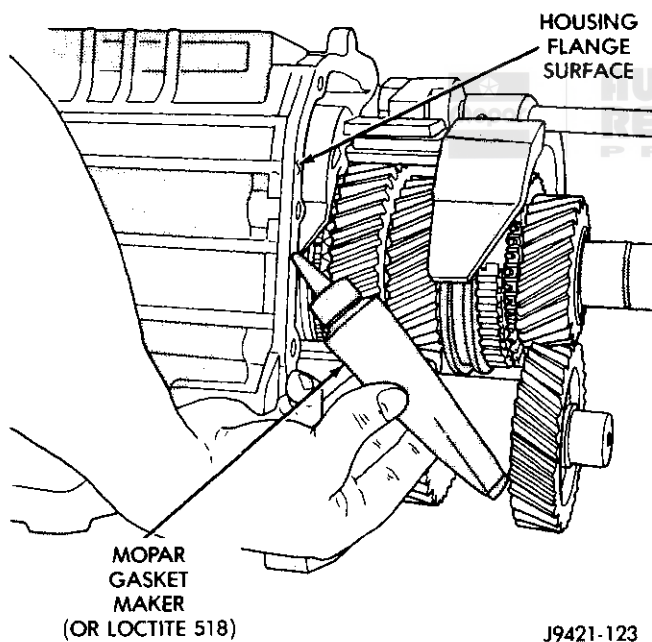


Fig. 136 Applying Sealer To Front/Rear Housings

(7) Have helper hold rear housing and geartrain in upright position. Then install front housing on rear housing and geartrain (Fig. 137).

(8) Work front housing downward onto geartrain until seated on rear housing.

CAUTION: If the front housing will not seat on the rear housing, either the shift components are not in Neutral, or one or more components are mis-

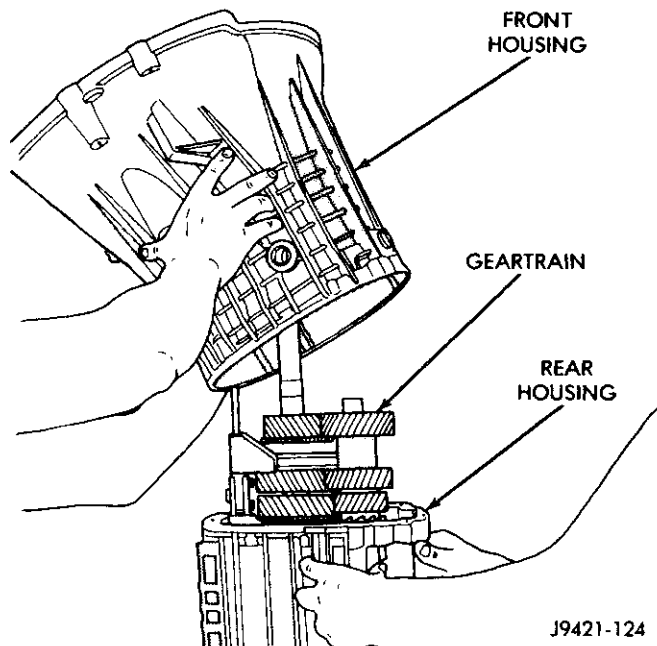


Fig. 137 Front Housing Installation

aligned. Do not force the front housing into place. This will only result in damaged components.

(9) Tap rear housing alignment dowels back into place with hammer and pin punch (Fig. 138). Both dowels should be flush fit in each housing. Have helper hold transmission upright while dowels are tapped back into place.

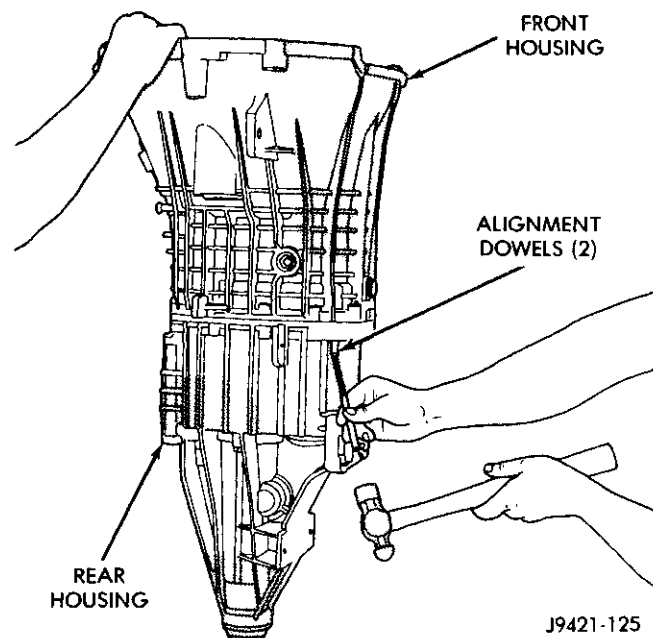


Fig. 138 Reseating Housing Alignment Dowels

(10) Place transmission in horizontal position.

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Apply Mopar Gasket Maker, or Loctite 518 to housing attaching bolts. Apply sealer material sealer to underside of bolt heads and to bolt shanks and threads (Fig. 139).

(12) Install and start housing attaching bolts by hand (Fig. 139). Then tighten bolts to 30-35 N·m (22-26 ft. lbs.) torque.

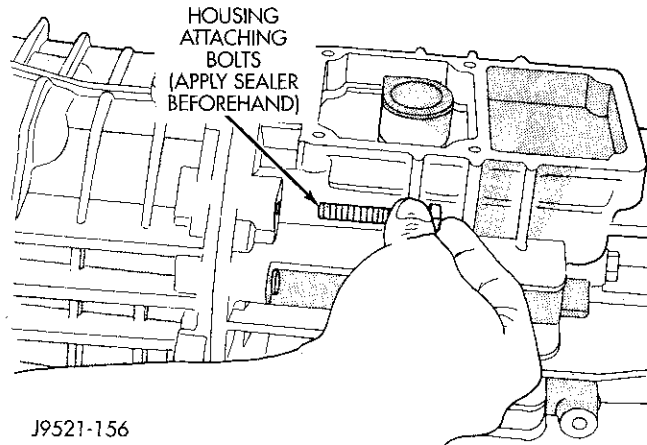


Fig. 139 Installing Housing Attaching Bolts

(13) Install shift shaft bushing lock bolt (Fig. 140). Apply Mopar Gasket Maker, or Loctite 518 to bolt threads, shank and underside of bolt head before installation.

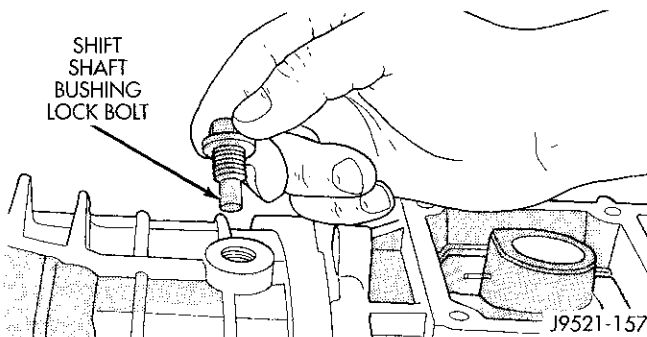


Fig. 140 Installing Shift Shaft Bushing Lock Bolt

CAUTION: If the lock bolt cannot be fully installed, do not try to force it into place. Either the shift shaft is not in Neutral, or the shaft bushing (or lever) is misaligned (Fig. 141).

(14) Lubricate then install shift shaft detent plunger in housing bore (Fig. 142). Lubricate plunger with petroleum jelly or gear lubricant. **Be sure plunger is fully seated in detent notch in shift shaft.**

(15) Install detent spring inside plunger (Fig. 143).

(16) Install detent plug (Fig. 144). Start plug in bore by hand. Then seat plug with brass punch.

(17) Install backup light switch (Fig. 145).

(18) Install input shaft snap ring (Fig. 146).

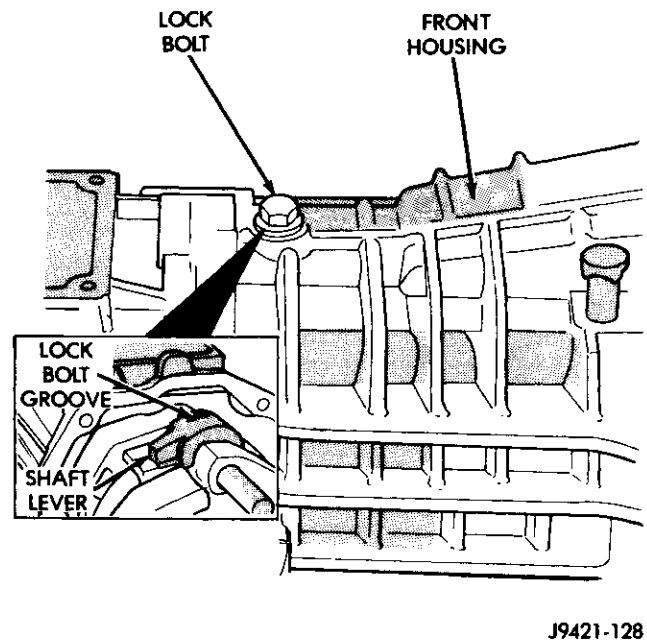


Fig. 141 Correct Alignment Of Lock Bolt And Shaft Bushing

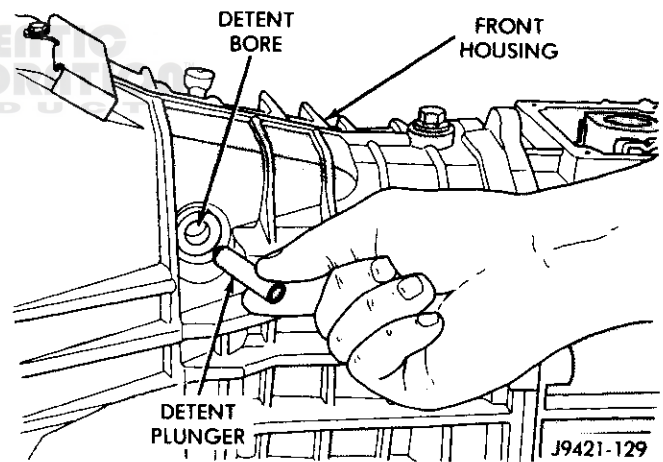
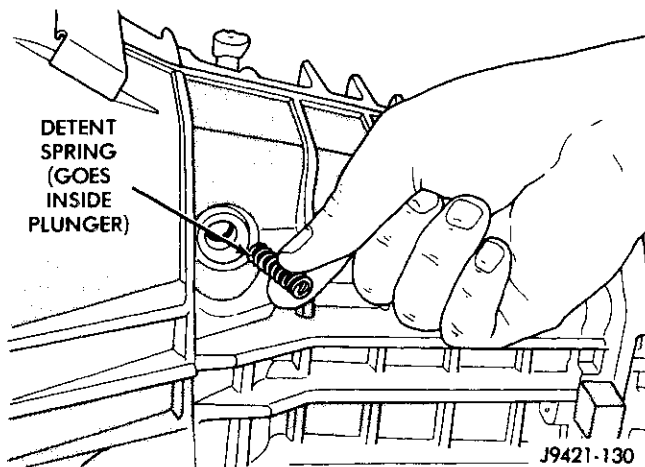
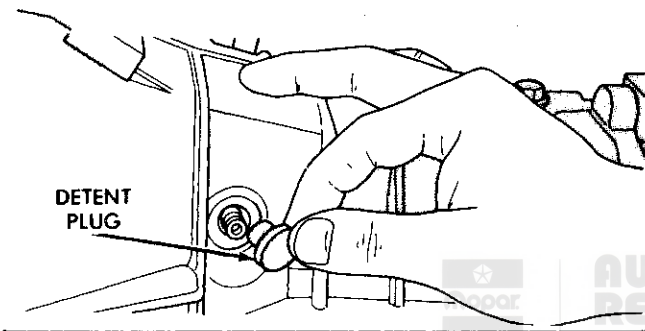
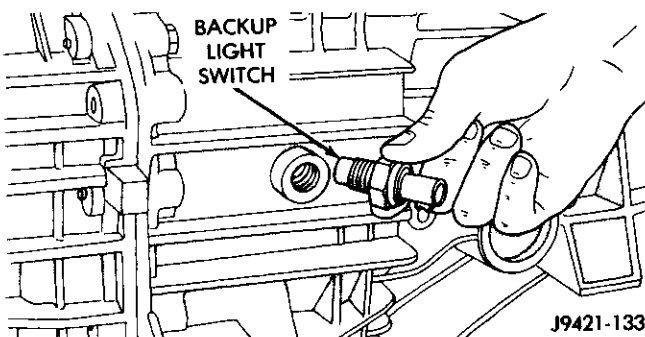
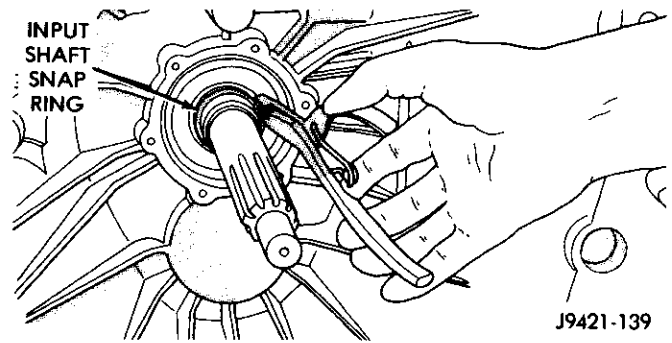
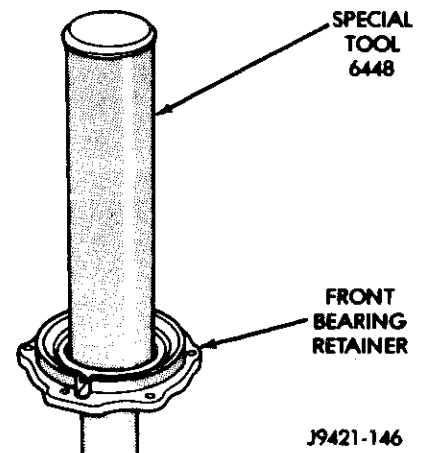
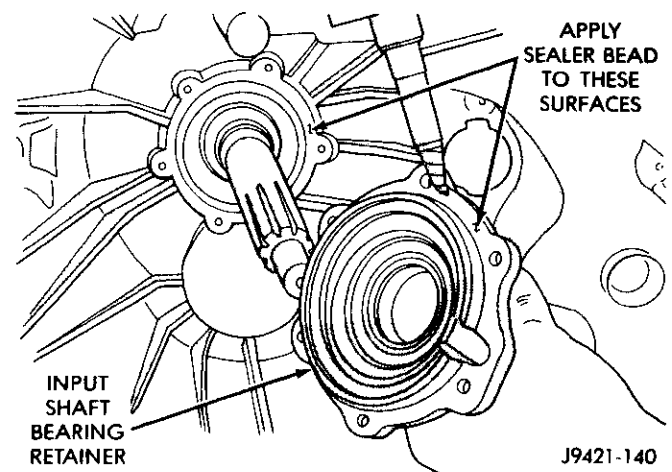


Fig. 142 Installing Shift Shaft Detent Plunger

(19) Install new oil seal in front bearing retainer with Installer Tool 6448 (Fig. 147).

(20) Apply bead of Loctite Ultra (heavy body), black silicone sealer (or Mopar equivalent), to flange surface of front bearing retainer. Then apply bead of same sealer to retainer mounting surface of front housing (Fig. 148).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 143 Installing Detent Plunger Spring****Fig. 144 Detent Plug Installation****Fig. 145 Installing Backup Light Switch****Fig. 146 Installing Input Shaft Snap Ring****Fig. 147 Installing Oil Seal In Front Bearing Retainer****Fig. 148 Applying Sealer To Bearing Retainer And Housing**

DISASSEMBLY AND ASSEMBLY (Continued)

(21) Align and install front bearing retainer over input shaft and onto housing mounting surface (Fig. 149). **Although retainer is one-way fit on housing, be sure bolt holes are aligned before seating retainer.**

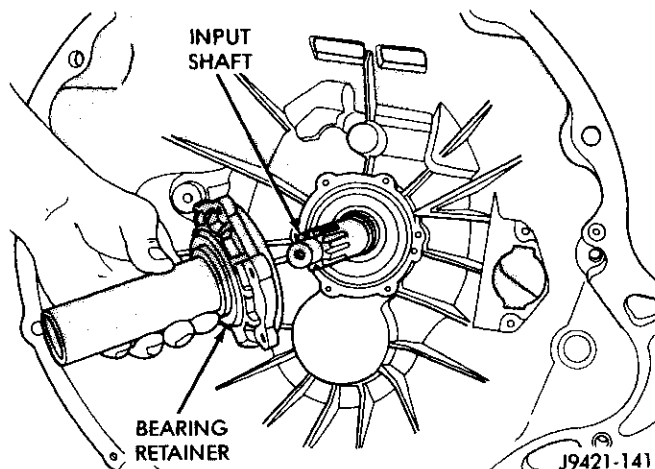


Fig. 149 Installing Input Shaft Bearing Retainer

(22) Install and tighten bearing retainer bolts to 7-10 N·m (5-7 ft. lbs.) torque (Fig. 150).

(23) Install transmission in vehicle. Then refer to shift lever installation procedure.

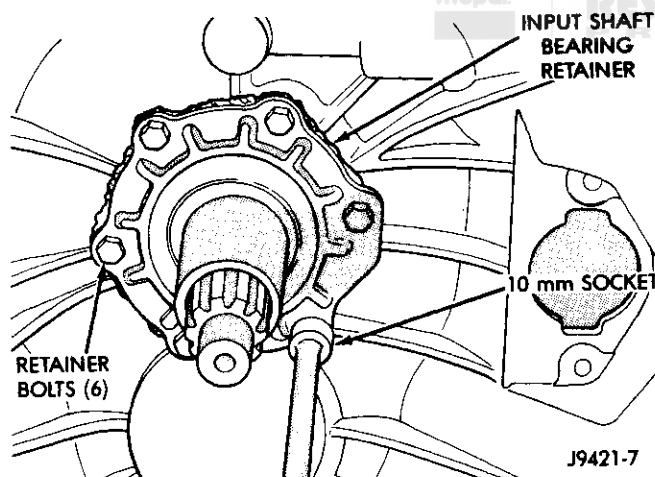


Fig. 150 Installing Input Shaft Bearing Retainer Bolts

SHIFT TOWER AND LEVER ASSEMBLY INSTALLATION

(1) Apply 1/8 to 3/16 in. wide bead of Mopar Gasket Maker, or Loctite 518 to isolator and plate mating surface of rear housing (Fig. 151).

(2) If isolator and plate separated from shift tower, apply sealer to plate and position it on tower. Or, position it on rear housing (Fig. 152). **Plate assembly is a one-way fit. Narrow side of plate goes**

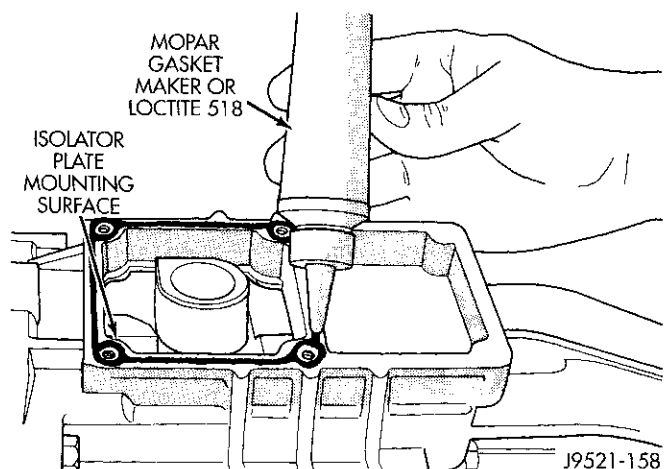


Fig. 151 Applying Sealer To Shift Tower Mounting Surface

toward driver side of housing as shown (Fig. 152).

(3) Apply petroleum jelly to ball end of shift lever and interior of shift socket.

(4) Align and install shift tower and lever assembly (Fig. 152). If isolator and plate was installed before tower, be sure tower and plate assembly are securely fitted together. Also be sure shift ball is seated in socket before installing tower bolts.

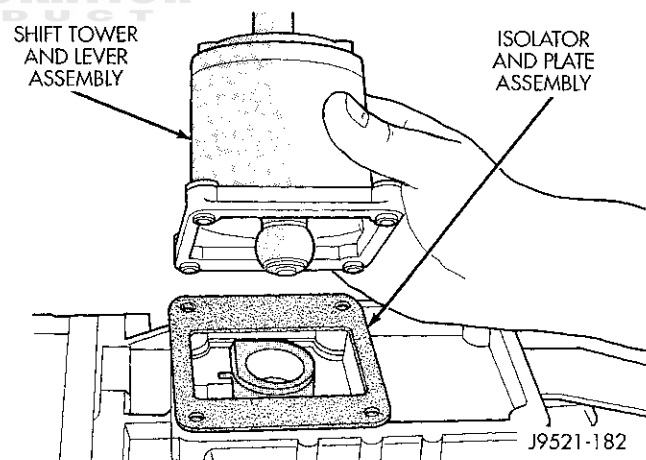


Fig. 152 Shift Tower Installation

(5) Install shift tower bolts (Fig. 153). Tighten bolts to 7-10 N·m (5-7 ft. lbs.) torque. Bolts require an 8 mm socket.

(6) Fill transmission to bottom edge of fill plug hole with Mopar Transmission Lubricant, P/N 4761526.

(7) Install and tighten fill plug to 19-27 N·m (14-20 ft. lbs.) torque.

(8) Check transmission vent (Fig. 154). Be sure vent is open and not restricted.

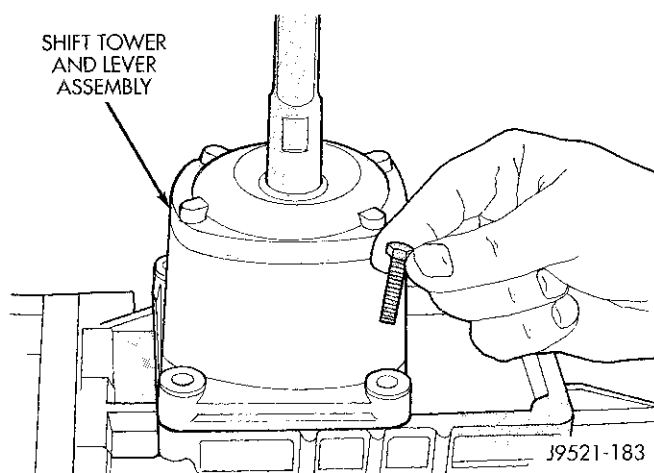


Fig. 153 Shift Tower Bolt Installation

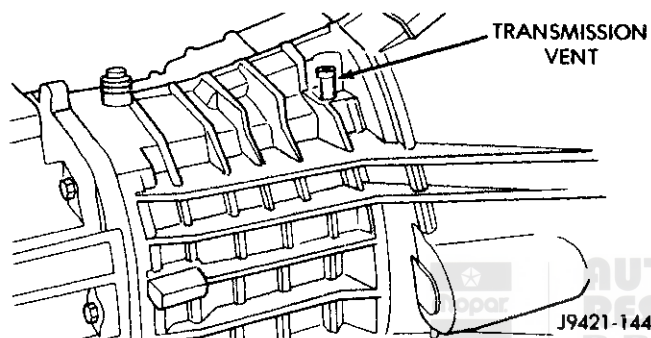


Fig. 154 Vent Location

CLEANING AND INSPECTION

TRANSMISSION COMPONENTS

Clean the gears, shafts, shift components and transmission housings with a standard parts cleaning solvent. Do not use acid or corrosive base solvents. Dry all parts except bearings with compressed air.

Clean the shaft bearings with a mild solvent such as Mopar degreasing solvent, Gunk, or similar solvents. Do not dry the bearings with compressed air. Allow the bearings to either air dry, or wipe them dry with clean shop towels.

SHIFT LEVER ASSEMBLY

The shift lever assembly is not serviceable. Replace the lever and shift tower as an assembly if the tower, lever, lever ball, or internal components are worn, or damaged.

SHIFT SHAFT AND FORKS

Inspect the shift fork interlock arms and synchro sleeve contact surfaces (Fig. 155). Replace any fork exhibiting wear or damage in these areas. Do not attempt to salvage shift forks.

NOTE: Inspect the shift shaft bushings and front bearing carefully. The bushings and bearing are not serviceable items. The front or rear housing will have to be replaced if these components are damaged in any way.

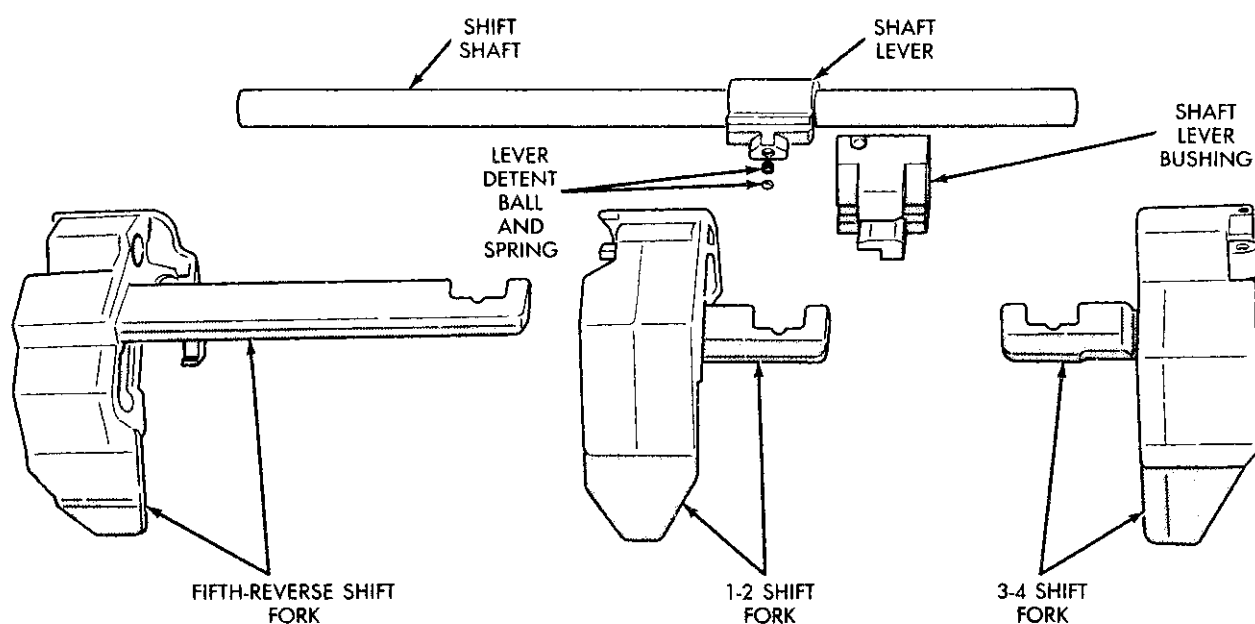


Fig. 155 Shift Forks And Shaft

CLEANING AND INSPECTION (Continued)

Check condition of the shift shaft detent plunger and spring. The plunger should be smooth and free of nicks, or scores. The plunger spring should be straight and not collapsed, or distorted. Minor scratches, or nicks on the plunger can be smoothed with 320/400 grit emery soaked in oil. Replace the plunger and spring if in doubt about condition.

Inspect the shift shaft, the shaft lever and the lever bushing that fits over the lever. Replace the shaft if bent, cracked, or severely scored. Minor burrs, nicks, or scratches can be smoothed off with 320/400 grit emery cloth followed by polishing with crocus cloth.

Replace the shaft lever and bushing if either part is deformed, or worn. Do not attempt to salvage these parts as shift fork binding will occur. Replace the small detent ball and spring that goes in the lever if the ball is worn, or if the spring is bent or collapsed. Replace the roll pin that secures the lever to the shaft.

FRONT/REAR HOUSINGS AND BEARING RETAINERS

Inspect the housings carefully. Look for cracks, stripped threads, scored mating surfaces, damaged bearing bores, or worn dowel pin holes. Minor nicks on mating surfaces can be dressed off with a fine file, or emery cloth. Damaged threads can be renewed by either re-tapping or installing Helicoil inserts.

Check condition of the oil tube in the rear housing. The tube must not be bent or loose. The housing will have to be replaced if the tube is loose or damaged.

NOTE: Pay particular attention to the bushings and bearings in the front and rear housings. The front housing contains the shift shaft front bearing and bushing, the countershaft front bearing race and the detent plunger bushing. The rear housing contains the shift shaft rear bushing and the countershaft rear bearing race. Be advised that these components are NOT serviceable items. The front housing will have to be replaced if the shift shaft bearing and bushing, detent plunger bushing, or countershaft bearing race is loose, worn, or damaged. The rear housing will have to be replaced if the shift shaft rear bushing, or the countershaft rear bearing race is loose, worn, or damaged.

Inspect the input shaft bearing retainer. Be sure the release bearing slide surface of the retainer is in good condition. Minor nicks on the surface can be smoothed off with 320/420 grit emery cloth and final polished with oil coated crocus cloth. Replace the retainer seal if necessary.

Inspect the output shaft bearing retainer. Be sure the U-shaped retainer is flat and free of distortion.

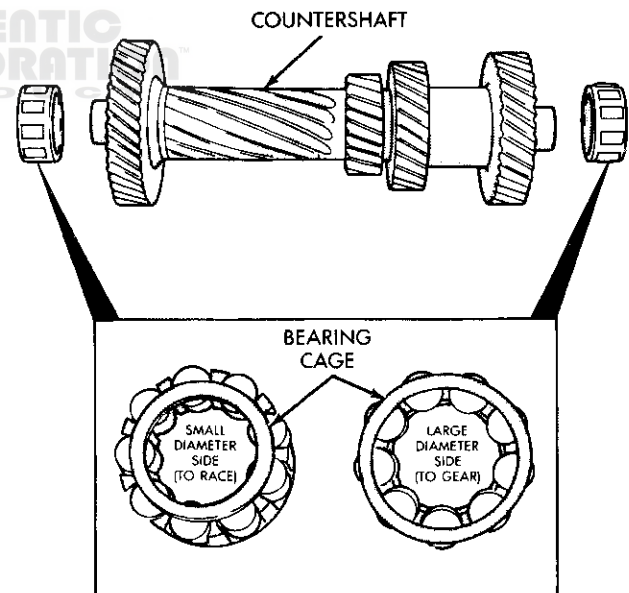
Replace the retainer if the threads are damaged, or if the retainer is bent, or cracked.

COUNTERSHAFT BEARINGS AND RACES

The countershaft bearings and races are machine lapped during manufacture to form matched sets. The bearings and races should not be interchanged.

NOTE: The bearing races are a permanent press fit in the housings and are NOT serviceable. If a bearing race becomes damaged, it will be necessary to replace the front or rear housing as necessary. In addition, if a countershaft bearing becomes damaged, it will be necessary to replace not only the bearing but the applicable housing as well. A new countershaft bearing will be supplied with each new housing for service use.

The countershaft bearings can be installed backwards if care is not exercised. The bearing roller cage is a different diameter on each side. **Be sure the bearing is installed so the large diameter side of the cage is facing the countershaft gear (Fig. 156).** The small diameter side goes in the bearing race.



J9421-55

Fig. 156 Correct Countershaft Bearing Installation
REVERSE IDLER COMPONENTS

Inspect the idler gear, bearing, shaft, thrust washer, wave washer and thrust plate. Replace the bearing if any of the needle bearing rollers are worn, chipped, cracked, flat-spotted, or brinnelled. Also replace the bearing if the plastic bearing cage is damaged or distorted.

CLEANING AND INSPECTION (Continued)

Replace the thrust washer, wave washer, or thrust plate if cracked, chipped, or worn. Replace the idler gear if the teeth are chipped, cracked or worn thin. Replace the shaft if worn, scored, or the bolt threads are damaged beyond repair. Replace the support segment if cracked, or chipped and replace the idler attaching bolts if the threads are damaged.

Shift Socket

Inspect the shift socket for wear or damage. replace the socket if the roll pin, or shift shaft bores are damaged. Minor nicks in the shift lever ball seat in the socket can be smoothed down with 400 grit emery or wet/dry paper. Replace the socket if the ball seat is worn, or cracked. Do not reuse the original shift socket roll pin. Install a new pin during reassembly. The socket roll pin is approximately is approximately 33 mm (1-1/4 in.) long.

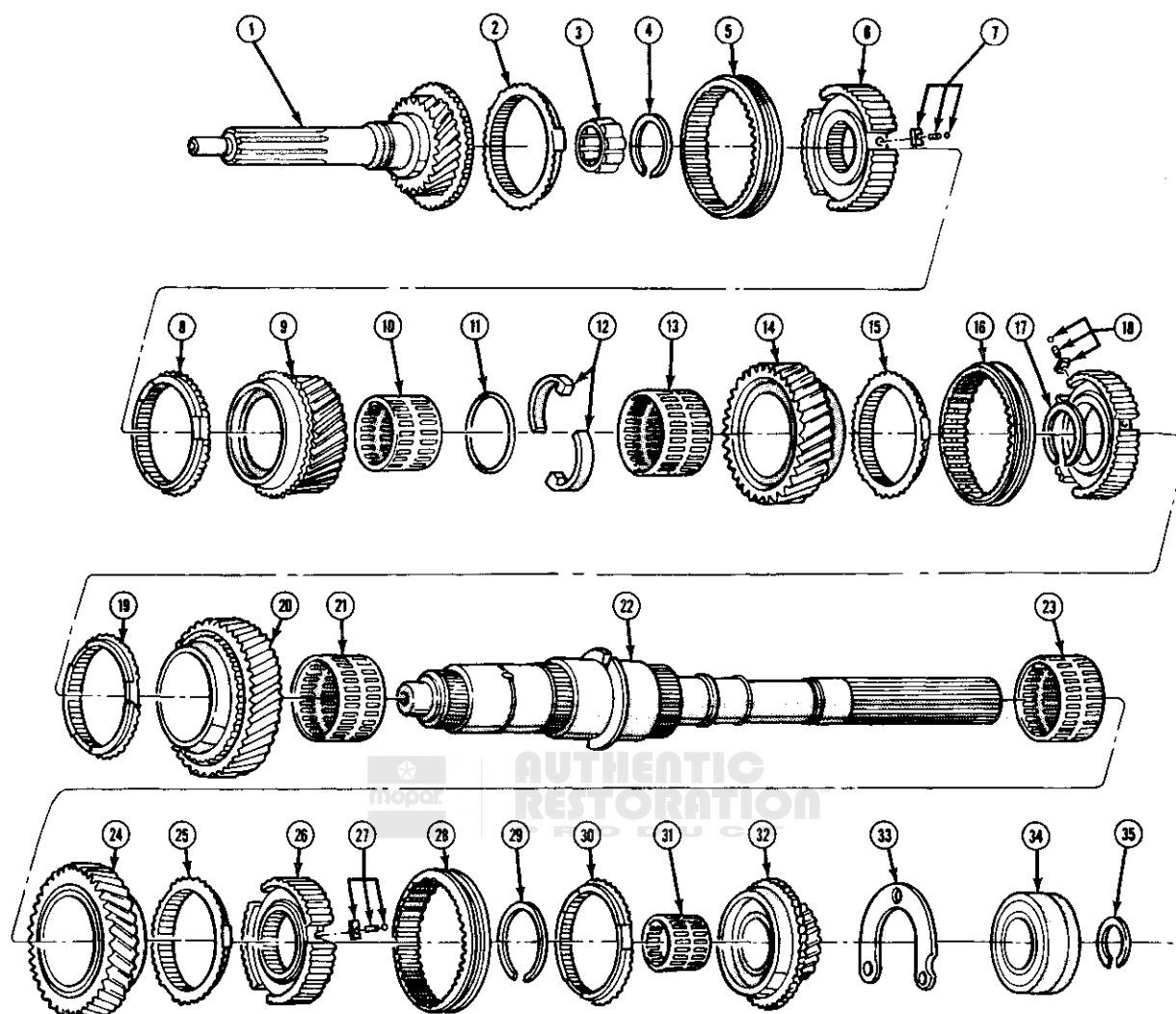
Output Shaft And Geartrain

Inspect all of the gears (Fig. 157) for worn, cracked, chipped, or broken teeth. Also check condition of the bearing bore in each gear. The bores should be smooth and free of surface damage. Discoloration of the gear bores is a normal occurrence and is not a reason for replacement. Replace gears only when tooth damage has occurred, or if the bores are brinnelled or severely scored.

Inspect the shaft splines and bearings surfaces. Minor nicks on the bearing surfaces can be smoothed with 320/420 grit emery and final polished with crocus cloth. Replace the shaft if the splines are damaged or bearing surfaces are deeply scored, worn, or brinnelled.



**AUTHENTIC
RESTORATION™
PRODUCT**



- ① INPUT SHAFT
- ② FOURTH SPEED SYNCHRO RING
- ③ OUTPUT SHAFT PILOT BEARING
- ④ SNAP RING, 3-4 SYNCHRO HUB
- ⑤ SLEEVE, 3-4 SYNCHRO
- ⑥ HUB, 3-4 SYNCHRO
- ⑦ STRUT, SPRING, DETENT BALL (3 SETS), 3-4 SYNCHRO
- ⑧ THIRD SPEED SYNCHRO RING
- ⑨ THIRD GEAR
- ⑩ THIRD GEAR NEEDLE BEARING
- ⑪ RETAINING RING
- ⑫ THRUST WASHER (2-PIECE)
- ⑬ SECOND GEAR NEEDLE BEARING
- ⑭ SECOND GEAR
- ⑮ SECOND SPEED SYNCHRO RING
- ⑯ SLEEVE, 1-2 SYNCHRO
- ⑰ SNAP RING, 1-2 SYNCHRO HUB
- ⑱ STRUT, SPRING, DETENT BALL (3 SETS), 1-2 SYNCHRO

- ⑲ FIRST SPEED SYNCHRO RING
- ⑳ FIRST GEAR
- ㉑ FIRST GEAR NEEDLE BEARING
- ㉒ OUTPUT SHAFT
- ㉓ REVERSE GEAR NEEDLE BEARING
- ㉔ REVERSE GEAR
- ㉕ REVERSE SYNCHRO RING (SOLID BRASS)
- ㉖ FIFTH-REVERSE SYNCHRO HUB
- ㉗ STRUT, SPRING, DETENT BALL (3 SETS), FIFTH-REVERSE SYNCHRO
- ㉘ SLEEVE, FIFTH-REVERSE SYNCHRO
- ㉙ SNAP RING, FIFTH-REVERSE SYNCHRO HUB
- ㉚ FIFTH SPEED SYNCHRO RING
- ㉛ FIFTH GEAR NEEDLE BEARING
- ㉜ FIFTH GEAR
- ㉝ BEARING RETAINER (IN HOUSING)
- ㉞ OUTPUT SHAFT BEARING
- ㉟ SNAP RING, SHAFT BEARING

Fig. 157 Output Shaft And Geartrain

SPECIFICATIONS

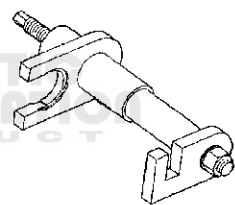
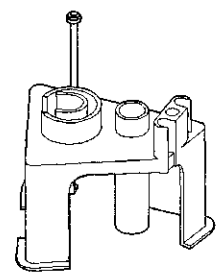
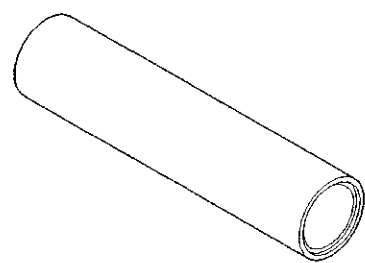
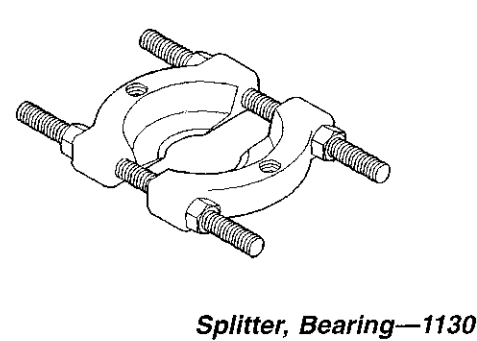
TORQUE

Description	Torque
Clutch Housing Bolts	54–61 N•m (40–45 ft. lbs.)
Crossmember-To-Frame Bolts . . .	61–75 N•m (44–55 ft. lbs.)
Crossmember-To-Insulator Nuts . .	54–61 N•m (40–45 ft. lbs.)
Drain/Fill Plug	9–27 N•m (14–20 ft. lbs.)
Front-To-Rear Housing Bolts	30–35 N•m (22–26 ft. lbs.)
Front Bearing Retainer Bolts	7–10 N•m (5–7 ft. lbs.)
Idler Shaft Bolts	19–25 N•m (14–18 ft. lbs.)
Rear Bearing Retainer Bolts	30–35 N•m (22–26 ft. lbs.)
Shift Tower Bolts	7–10 N•m (5–7 ft. lbs.)
Slave Cylinder Attaching Nuts	23 N•m (200 in. lbs.)
Transfer Case Attaching Nuts	47 N•m (35 ft. lbs.)
U-Joint Clamp Bolts	19 N•m (170 in. lbs.)

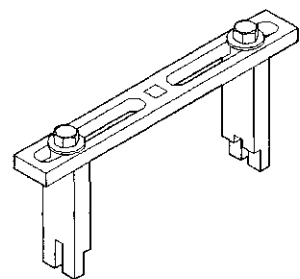
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SPECIAL TOOLS

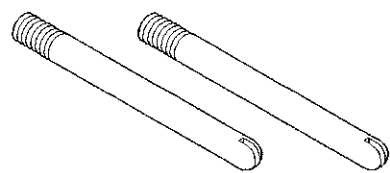
NV3500



Remover/Installer, Gear Shift Lever—6783



Remover/Installer, NV3500 Shift Rail Roll Pin—6858



Pilots, Ext.housing Aligning (Pair)—C-3288B

NV4500 MANUAL TRANSMISSION

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GENERAL INFORMATION

GENERAL INFORMATION

The NV4500 is a five-speed, constant mesh manual transmission (Fig. 1). All gear ranges including reverse are synchronized. Fifth gear is an overdrive range with a ratio of 0.74:1. The transmission has a cast iron gear case and aluminum shift cover.

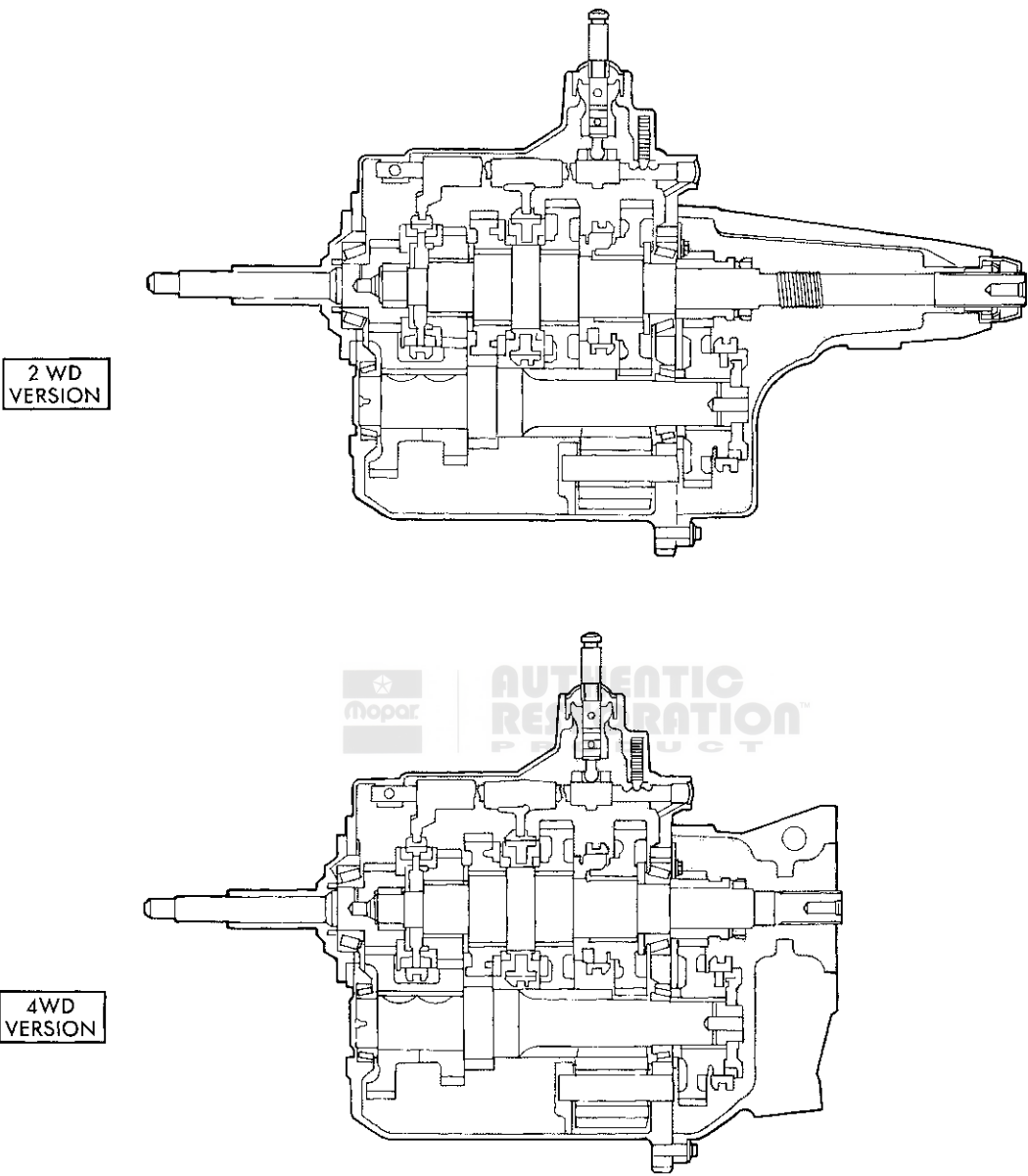
Two versions of the NV4500 are used. A standard duty version is used for 5.2L and 5.9L applications and a heavy duty version for V10/Cummins diesel applications. Main differences are the larger diameter input shaft, output shaft, and mainshaft fifth gear in the heavy duty model. The different size shafts and gear do not affect service. Overhaul procedures for the two versions are the same.

The NV4500 is a top loader style transmission. The shift lever is located in the shift cover and operates the shift forks and rails directly. The shift forks and rails are all located within the aluminum cover which is bolted to the top of the gear case.

A reverse gear inhibitor mechanism prevents reverse gear engagement when shifting into forward gear ranges. The inhibitor mechanism is located in the shift cover.

Tapered roller bearings support the drive gear, mainshaft and countershaft in the gear case. Pilot roller bearings in the drive gear hub support the forward end of the mainshaft. The mainshaft gears are all supported on caged type roller bearings. Drive gear thrust reaction is controlled by a needle type thrust bearing. The bearing is located at the forward end of the mainshaft.

GENERAL INFORMATION (Continued)



J9521-10

Fig. 1 NV4500 Manual Transmission

GENERAL INFORMATION (Continued)

TRANSMISSION IDENTIFICATION

The NV4500 transmission identification tag is attached to the driver side PTO cover (Fig. 2).

The tag provides the transmission model number, build date and part number. Be sure to reinstall the I.D. tag if removed during service. The information on the tag is essential to correct parts ordering.

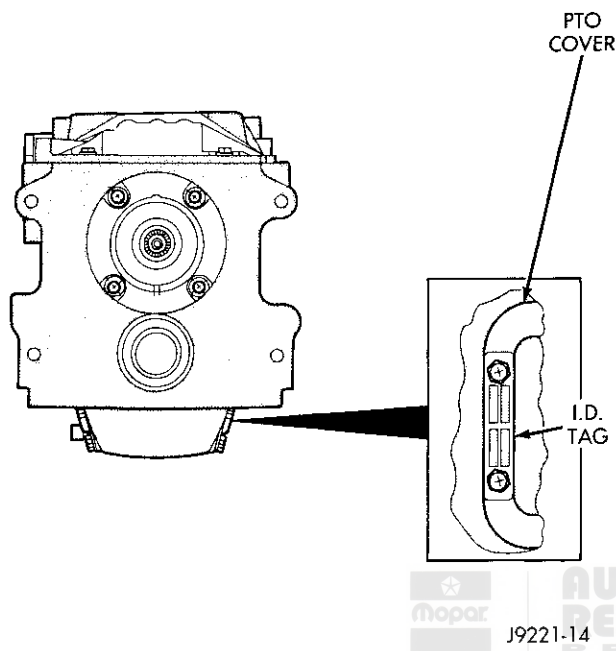


Fig. 2 NV4500 Identification Tag Location

LUBRICANT LEVEL AND CAPACITY

Required lubricant for the NV4500 is Mopar Manual Transmission Lubricant, P/N 4637579. This is the only lubricant recommended for use.

Dry fill lubricant capacity is approximately 3.78 liters (8 pints).

Correct lubricant fill level is to the bottom edge of the fill plug hole (Fig. 3). Check fill level only when the transmission is level.

The transmission lubricant is drained through the PTO cover bottom bolt hole (Fig. 3). It will be necessary to apply sealer to the bolt threads before installing it during a lubricant change.

GEAR RATIOS

SHIFT PATTERN

The NV4500 shift pattern is in a modified H pattern (Fig. 4). Overdrive fifth and reverse gears are in line and outboard of the first through fourth gear positions.

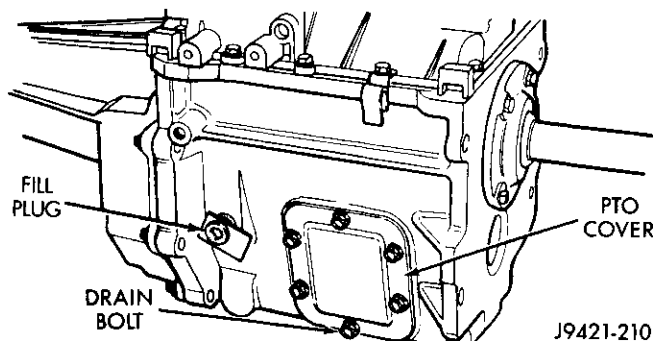
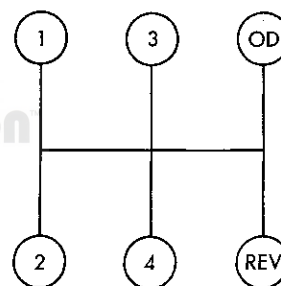


Fig. 3 NV4500 Fill Plug And Drain Bolt

RANGE	RATIO
First gear	5.61:1
Second Gear	3.04:1
Third Gear	1.67:1
Fourth Gear	1.00:1
Fifth Gear	0.74:1
Reverse gear	5.61:1



J9221-13

Fig. 4 NV4500 Shift Pattern

DIAGNOSIS AND TESTING

COMMON PROBLEM CAUSES

The majority of transmission malfunctions are a result of:

- insufficient lubricant
- incorrect lubricant
- misassembled or damaged internal components
- improper operation.

HARD SHIFTING

A low lubricant level, loose or worn shift lever, or loose, damaged shift housing components are common causes of hard shifting. If hard shifting is also accompanied by gear clash, synchronizer clutch and stop rings, or mainshaft gear teeth may be worn or damaged.

Hard shifting may also be caused by a loose, or misaligned shift cover, or alignment dowels. Worn, or damaged shift cover components will also cause hard

DIAGNOSIS AND TESTING (Continued)

shifting. Any of the foregoing faults will cause component bind and high shift efforts.

Misassembled synchro components will also cause shift problems. Incorrectly installed synchro sleeves, struts, or springs will all cause shift problems.

NOISY OPERATION

Transmission noise is most often a result of worn or damaged components. Chipped, broken gear or synchronizer teeth and brinnelled, spalled bearings all cause noise.

Abnormal wear and damage to internal components is frequently the end result of insufficient lubricant, non-recommended lubricants, or improper operation.

SLIPS OUT OF GEAR

Transmission disengagement may be caused by misaligned or damaged shift components, or worn teeth on the mainshaft gears or synchro components. Incorrect assembly will also contribute to gear disengagement.

LOW LUBRICANT LEVEL

Insufficient transmission lubricant is usually the result of leaks, or inaccurate fluid level check or refill method.

Leaks will be evident by the presence of gear oil around the leak point. If leakage is not evident, the condition is probably the result of an under fill condition.

If air powered lubrication equipment is used to fill a transmission, be sure the equipment is properly calibrated. Equipment out of calibration can lead to an underfill condition.

CLUTCH PROBLEMS

Worn, damaged, or misaligned clutch components can cause difficult shifting, gear clash and noise.

A damaged pilot bearing will cause noise. If bearing damage is severe, drive gear misalignment and hard shifting can also occur.

A worn or damaged clutch disc, pressure plate, or release bearing can cause hard shifting and gear clash.

Damaged or worn clutch hydraulic components, or leaks in the fluid lines or cylinders will cause hard shifting and gear clash. Failure of one of the clutch hydraulic cylinders can result in incomplete clutch release or engagement.

Verify that clutch components are all in good condition before removing the transmission for repair.

SERVICE PROCEDURES**SHIFT COVER COMPONENTS**

The only serviceable shift cover components are:

- fifth–reverse shift fork pads
- reverse inhibitor
- vent components
- backup light switch
- expansion plugs
- shift lever components

The shift cover, shift forks, shift rails and detent components are not serviced individually. The cover must be replaced as an assembly if the cover, or any shift components are worn or damaged.

SHIFT COVER INSPECTION

Inspect the cover and shift components whenever the cover is removed from the gear case. Or, whenever diagnosis indicates inspection is necessary.

Check the forks for wear, distortion, cracks, or being loose on the shift rails. Also check fit of the shift rails in the cover. Replace the cover assembly if the rails are loose in the cover bores.

Inspect and replace the pads on the fifth–reverse shift fork if worn. The reverse inhibitor should also be replaced if worn, or faulty. The expansion plugs at the rear of the cover can be replaced if loose or leaking.

A gasket is not used between the shift cover and gear case. Use Mopar Gasket Maker, or Loctite 518 to seal the cover.

Procedures for the serviceable components in the shift cover as follows:

FIFTH-REVERSE SHIFT FORK PAD REPLACEMENT

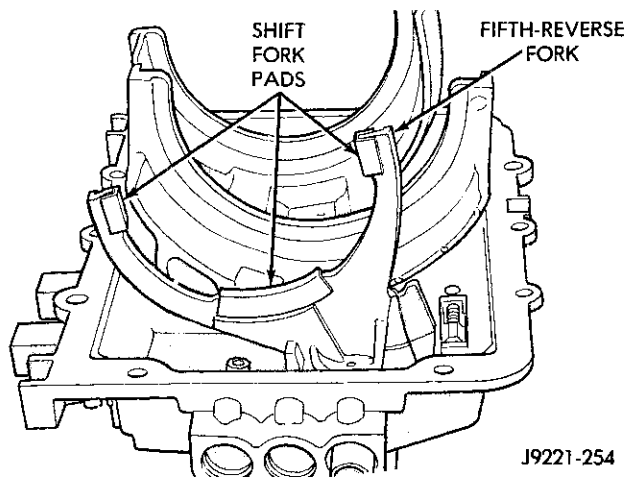
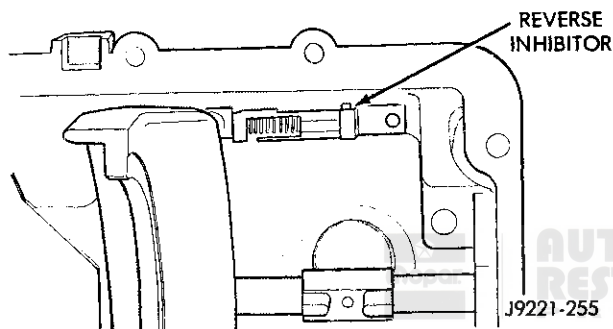
The plastic shift fork pads are held in place by a combination of tension and a small locating tang. Three pads are used on the fork (Fig. 5).

The pads can be removed either by hand or with a narrow blade screwdriver. To remove the pads by hand, grasp each pad and tilt it out and off the fork. If the pads prove difficult to remove by hand, insert a screwdriver blade between the pad and fork and pry the pad off.

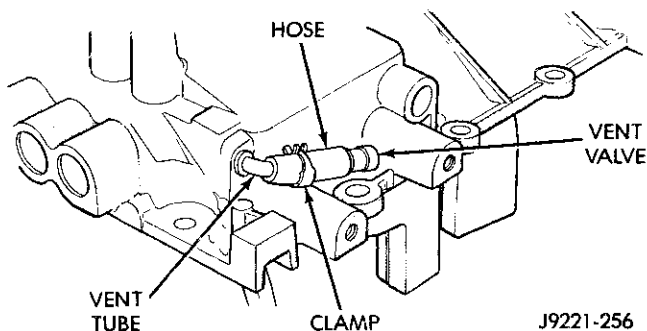
REVERSE INHIBITOR REPLACEMENT

The reverse inhibitor mechanism should be checked for wear or damage whenever diagnosis indicates this is necessary.

The inhibitor mechanism is attached to the cover with two screws (Fig. 6). Attaching screw torque is 8–14 N·m (75–115 in. lbs.).

SERVICE PROCEDURES (Continued)**Fig. 5 Shift Fork Pad Locations****Fig. 6 Reverse Inhibitor Mounting****VENT COMPONENT REPLACEMENT**

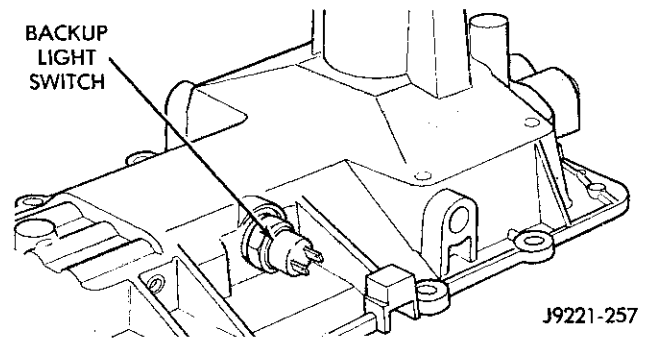
The shift cover vent assembly consists of the vent tube, connecting hose, hose clamps, and vent valve (Fig. 7).

**Fig. 7 Shift Cover Vent Components**

If the vent tube is removed for replacement or service access, apply Mopar silicone adhesive/sealer to the tube to help secure it in the cover.

BACKUP LIGHT SWITCH REPLACEMENT

The backup light switch is located at the left (driver) side of the cover (Fig. 8). The switch plunger is operated by the fifth-reverse shift rail.

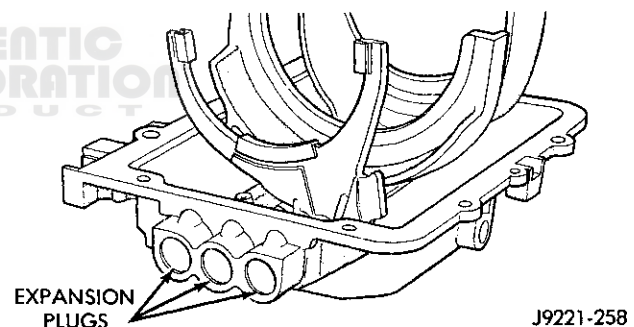
**Fig. 8 Backup Light Switch Location**

The switch can be replaced with the transmission in, or out of the vehicle. A gasket may, or may not be used with the switch.

Apply sealer to the switch threads before installation. Tightening torque for the switch is 22–34 N·m (192–300 in. lbs.).

EXPANSION PLUG REPLACEMENT

The expansion plugs at the rear of the shift rail bores (Fig. 9) can be replaced if loose and/or leaking. Replacement procedure is as follows:

**Fig. 9 Expansion Plug Location**

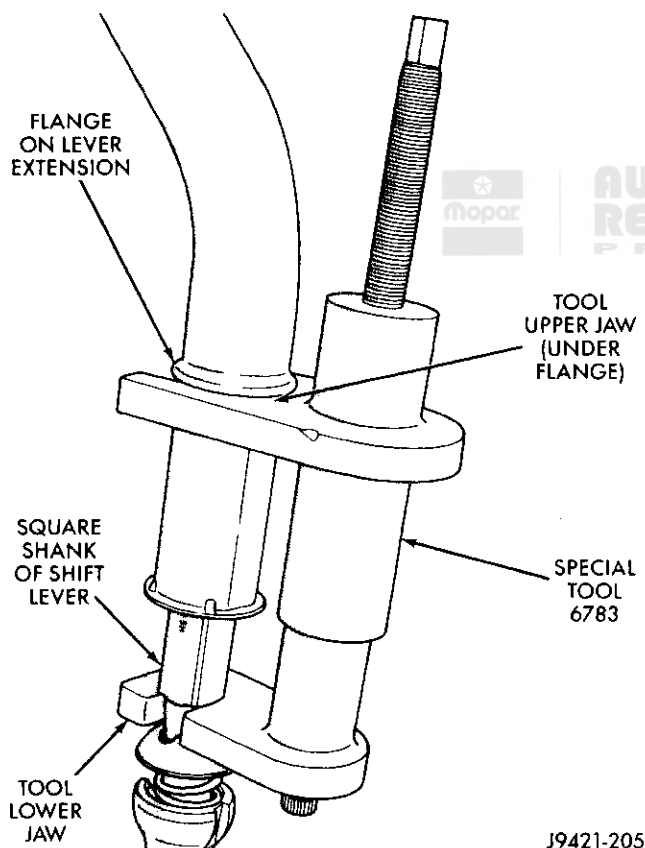
- (1) Drill 6 mm (1/4 in.) diameter hole in each plug to be removed.
- (2) Pry plug out of cover with tapered punch.
- (3) Clean all chips from shift cover and plug bores. Then clean plug bores with solvent and dry with clean shop towel.
- (4) Apply small bead of sealer to outer edge of each new plug. Use Mopar silicone adhesive/sealer, or equivalent.
- (5) Position each new plug in bore and tap into place with hammer and suitable size punch or socket.

REMOVAL AND INSTALLATION

TRANSMISSION—2WD

REMOVAL

- (1) Disconnect battery negative cable.
- (2) Shift transmission into Neutral.
- (3) Remove screws attaching shift boot to floorpan. Then slide boot upward on lever extension.
- (4) Remove shift lever extension with Remover/Installer Tool 6783 as follows:
 - (a) Scribe mark position of extension on shank of shift lever.
 - (b) Position notched, lower end of tool just under square shank of shift lever (Fig. 10).
 - (c) Position tool upper jaws **under** flange on shift lever extension (Fig. 10).
 - (d) Tighten tool screw to pull extension off square shank of shift lever.
 - (e) Remove lever extension and tool.



J9421-205

Fig. 10 Removing Shift Lever Extension With Tool 6783

- (5) Raise and support vehicle.
- (6) Mark propeller shaft and axle yokes for alignment reference. Use paint, scribe, or chalk to mark yokes.

- (7) Remove U-joint clamp strap screws and remove clamps.
- (8) Remove propeller shaft.
- (9) Disconnect and remove exhaust system Y-pipe.
- (10) Disconnect wires at speed sensor and backup light switch.
- (11) Support engine with adjustable safety stand and wood block.
- (12) If transmission is to be disassembled for repair, remove drain bolt at bottom of PTO cover and drain lubricant from transmission.
- (13) Remove bolts/nuts attaching transmission to rear mount.
- (14) Support transmission with a transmission jack. Secure transmission to jack with safety chains.
- (15) Remove rear crossmember.
- (16) Remove bolts attaching clutch slave cylinder to clutch housing. Then move cylinder aside for working clearance.
- (17) Remove transmission harness wires from clips on transmission shift cover.
- (18) Remove bolts attaching transmission to clutch housing.
- (19) Slide transmission and jack rearward until drive gear clears clutch housing.
- (20) Lower transmission jack and remove transmission from under vehicle.
- (21) If transmission will be overhauled, clean transmission exterior with solvent or with steam gun.

TRANSMISSION INSTALLATION—2WD

- (1) Apply light coat of Mopar high temperature bearing grease to contact surfaces of following components:

- drive gear splines and pilot bearing hub
- release bearing slide surface of front retainer
- pilot bearing
- release bearing bore
- release fork
- release fork ball stud
- propeller shaft slip yoke

- (2) Apply sealer to threads of bottom PTO cover bolt and install bolt in case.
- (3) Mount transmission on jack and position transmission under vehicle.
- (4) Raise transmission until drive gear is centered in release bearing and clutch disc hub.
- (5) Move transmission forward and start drive gear in release bearing, clutch disc and pilot bushing.
- (6) Work transmission forward until seated against clutch housing. Do not allow transmission to remain unsupported after drive gear has entered clutch disc.
- (7) Install and tighten transmission-to-clutch housing bolts to 108 N·m (80 ft. lbs.) torque.
- (8) Install clutch slave cylinder.

REMOVAL AND INSTALLATION (Continued)

(9) Connect speed sensor and backup light switch wires.

(10) Fill transmission with recommended lubricant. Correct fill level is bottom edge of fill plug hole.

(11) Position transmission harness wires in clips on shift cover.

(12) Install transmission mount on transmission or rear crossmember.

(13) Install rear crossmember.

(14) Remove transmission jack and engine support fixture.

(15) Align and connect propeller shaft.

(16) Lower vehicle.

(17) Install lever extension on shift lever with Tool 6783 as follows:

(a) Reposition upper jaw of Remover/Installer Tool 6783 **above** flange on lever extension (Fig. 11). Tool will now be used to press extension back onto shift lever.

(b) Tighten tool screw to press extension back onto lever. Press extension to scribe mark made during removal. A 3-5 mm (0.12-0.20 in.) space should exist between shift lever isolator and top edge of stub shaft and tool lower jaw.

(c) Remove special tool.

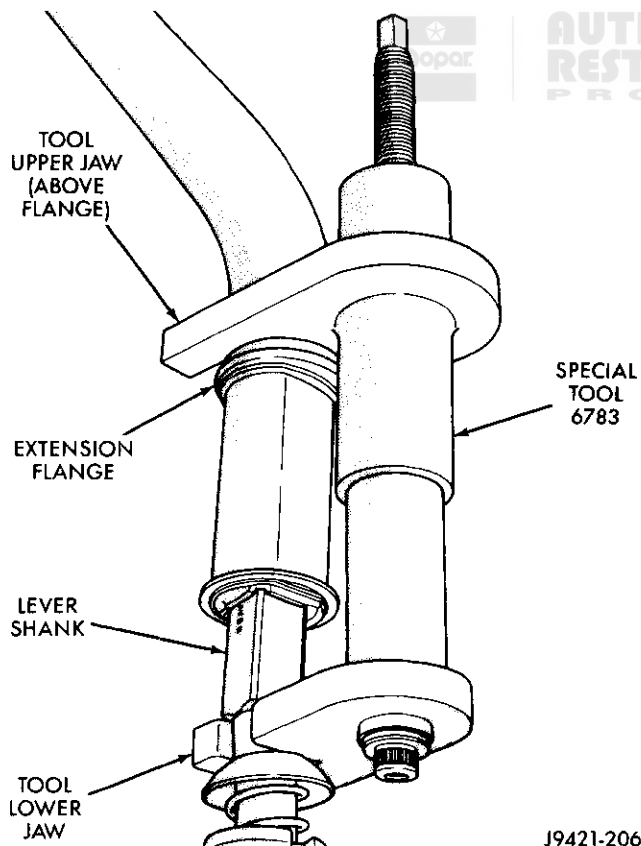


Fig. 11 Installing Shift Lever Extension With Tool 6783

(18) Install shift boot and bezel.

(19) Connect battery negative cable.

TRANSMISSION—4WD**REMOVAL**

(1) Disconnect battery negative cable.

(2) Shift transmission into Neutral.

(3) Remove shift lever boot and bezel.

(4) Remove shift lever extension with Remover/Installer Tool 6783 as follows:

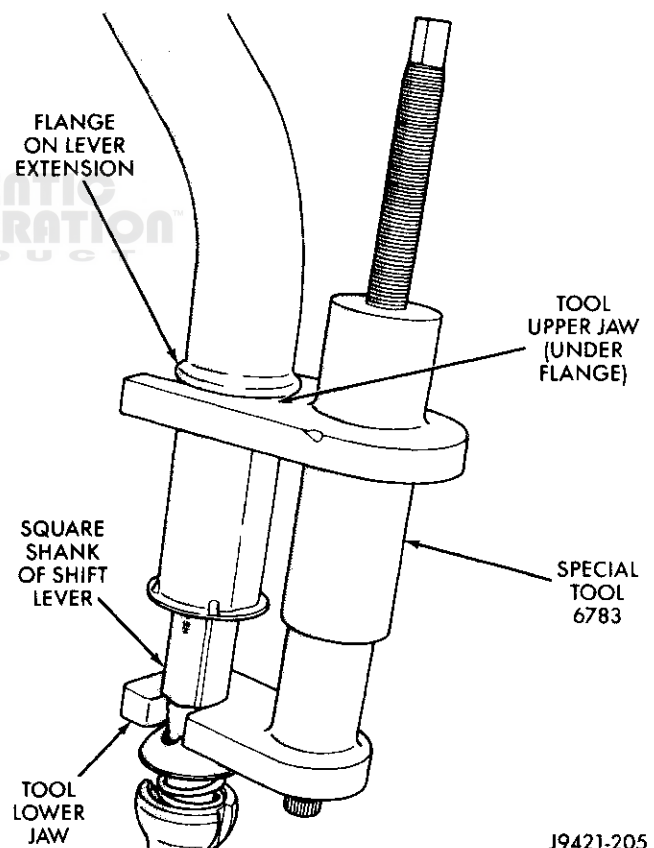
(a) Scribe mark position of extension on shank of shift lever.

(b) Position notched, lower end of tool just under square shank of shift lever (Fig. 12).

(c) Position tool upper jaws **under** flange on shift lever extension (Fig. 12).

(d) Tighten tool screw to pull extension off square shank of shift lever.

(e) Remove lever extension and tool.



J9421-205

Fig. 12 Removing Shift Lever Extension With Tool 6783

(5) Raise vehicle.

(6) Remove skid plate if equipped.

(7) If transmission will be disassembled for repair, remove drain bolt at bottom of PTO cover and drain lubricant from transmission.

REMOVAL AND INSTALLATION (Continued)

(8) Mark propeller shafts and yokes for assembly reference.

(9) Disconnect propeller shafts and remove propeller shafts.

(10) Disconnect and remove exhaust system Y-pipe. Then disconnect and lower remaining exhaust pipes for clearance as necessary.

(11) Support engine with adjustable safety stand.

(12) Disconnect speed sensor wires and disconnect speedometer cable, if equipped.

(13) Disconnect backup light switch wires.

(14) Disconnect transfer case shift linkage at transfer case range lever. Then remove transfer case shift mechanism from transmission (Fig. 13).

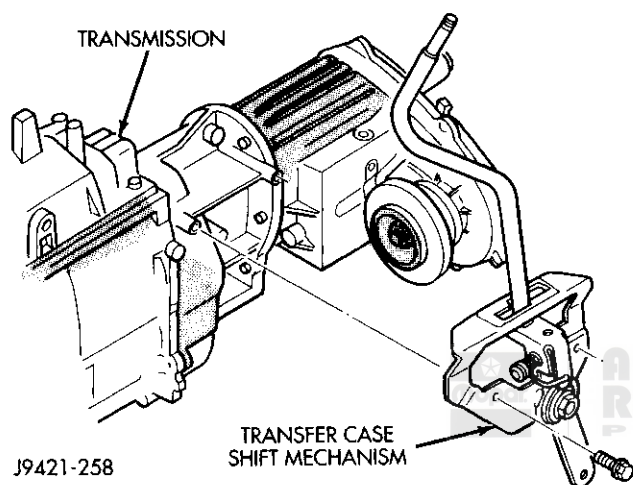


Fig. 13 Transfer Case Shift Mechanism

(15) Remove bolts/nuts attaching transmission to rear support.

(16) Remove crossmember bolts/nuts and remove crossmember.

(17) Support transfer case with transmission jack. Secure transfer case to jack with safety chains.

(18) Remove transfer case attaching nuts.

(19) Move transfer case rearward until input gear clears transmission mainshaft.

(20) Lower transfer case assembly and move it from under vehicle.

(21) If transmission is being removed for repair, remove drain bolt at bottom of PTO cover and drain lubricant from transmission.

(22) Support transmission with transmission jack. Secure transmission to jack with safety chains.

(23) Remove transmission harness from retaining clips on transmission shift cover.

(24) Remove bolts/nuts attaching transmission mount to rear crossmember.

(25) Remove rear crossmember.

(26) Remove clutch slave cylinder splash shield, if equipped.

(27) Loosen clutch slave cylinder attaching nuts until cylinder piston rod is clear of release lever. This reduces pressure on lever and release bearing making transmission removal/installation easier. Cylinder does not have to be removed completely.

(28) Remove bolts attaching transmission to clutch housing.

(29) Move transmission rearward until drive pinion clears clutch disc and release bearing.

(30) Lower transmission and remove it from under vehicle.

(31) If transmission will be overhauled, thoroughly clean transmission exterior with solvent or steam gun.

TRANSMISSION INSTALLATION—4WD

(1) Apply light coat of Mopar high temperature bearing grease to contact surfaces of following components:

- drive gear splines and pilot bearing hub
- release bearing slide surface of front retainer
- pilot bearing
- release bearing bore
- release fork
- release fork ball stud
- propeller shaft slip yoke

(2) Apply sealer to threads of PTO cover bottom drain bolt then install bolt in case.

(3) Mount transmission on jack and position transmission under vehicle. Secure transmission to jack with safety chains.

(4) Raise transmission until drive gear is centered in release bearing and clutch disc hub.

(5) Move transmission forward and start drive gear in release bearing and clutch disc.

(6) Work transmission forward until seated against clutch housing. Do not allow transmission to remain unsupported after drive gear has entered clutch disc.

(7) Install and tighten transmission-to-clutch housing bolts to 108 N·m (80 ft. lbs.) torque.

(8) Connect speed sensor and backup light switch wires.

(9) Position transmission harness wires in clips on shift cover.

(10) Tighten slave cylinder attaching nuts and install slave cylinder shield, if equipped.

(11) Install transmission mount on transmission or rear crossmember.

(12) Install transfer case shift mechanism on transmission (Fig. 13).

(13) Install rear crossmember.

(14) Remove transmission jack and engine support fixture.

(15) Install transfer case on transmission jack. Secure transfer case to jack with safety chains.

REMOVAL AND INSTALLATION (Continued)

(16) Install new gasket on transmission adapter, or coat adapter sealing surface with Mopar Gasket Maker, or silicone adhesive sealer.

(17) Raise jack and align transfer case input gear with transmission mainshaft.

(18) Move transfer case forward and seat it on adapter.

(19) Install and tighten transfer case attaching nuts. Tighten nuts to 41-47 N·m (30-35 ft. lbs.) if case has 3/8 studs, or 30-41 N·m (22-30 ft. lbs.) if case has 5/16 studs.

(20) Connect transfer case shift lever to range lever on transfer case.

(21) Align and connect propeller shafts. Tighten U-joint clamp strap bolts to 19 N·m (170 in. lbs.) torque.

(22) Fill transmission with required lubricant. Check lubricant level in transfer case as well and add lubricant if necessary.

(23) Install transfer case skid plate and crossmember. Tighten attaching bolts/nuts to 41 N·m (30 ft. lbs.) torque.

(24) Install exhaust system components.

(25) Lower vehicle.

(26) Install lever extension on shift lever with Tool 6783 as follows:

(a) Reposition upper jaw of Remover/Installer Tool 6783 **above** flange on lever extension (Fig. 14). Tool will now be used to press extension back onto shift lever.

(b) Tighten tool screw to press extension back onto lever. Press extension to scribe mark made during removal. A 3-5 mm (0.12-0.20 in.) space should exist between shift lever isolator and top edge of stub shaft and tool lower jaw.

(c) Remove special tool.

(27) Install shift lever boot and bezel.

(28) Connect battery negative cable.

SHIFT LEVER

REMOVAL

(1) If transmission is in vehicle, remove shift lever boot. Then remove shift lever extension with Remover/Installer Tool 6783 as follows:

(a) Position notched, lower end of tool just under square shank of shift lever (Fig. 15).

(b) Position tool upper jaws **under** flange on shift lever extension (Fig. 15).

(c) Tighten tool screw to pull extension off square shank of shift lever.

(d) Remove lever extension and tool.

(2) If transmission is out of vehicle, temporarily mount cover on gear case.

(3) Remove shift lever lower boot. Unseat boot from shift tower and slide it off shift lever.

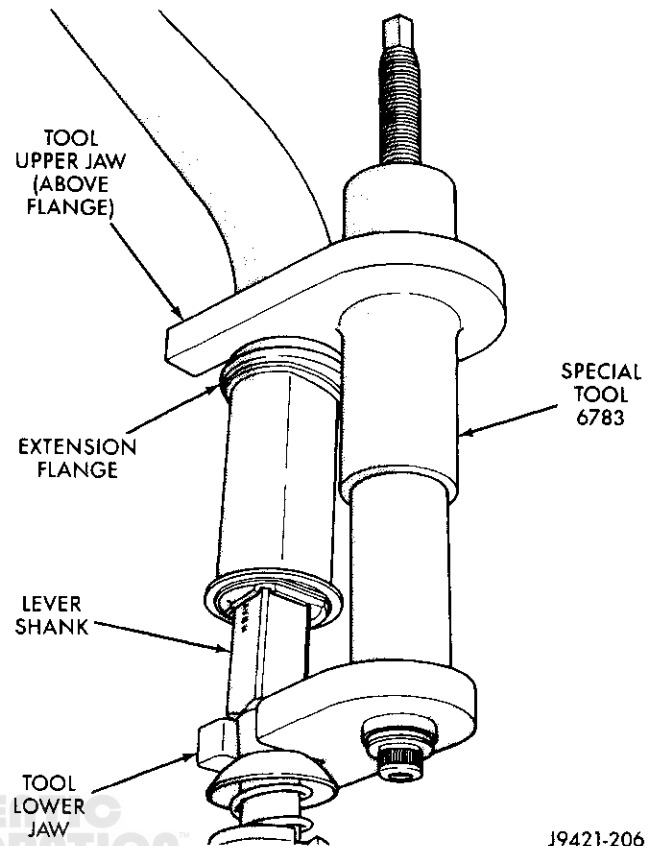


Fig. 14 Installing Shift Lever Extension With Tool 6783

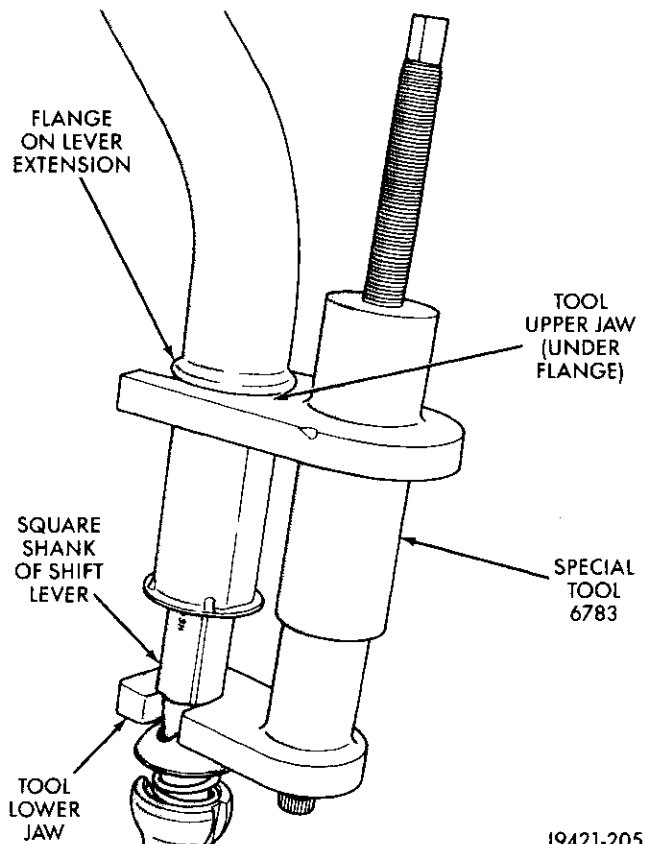
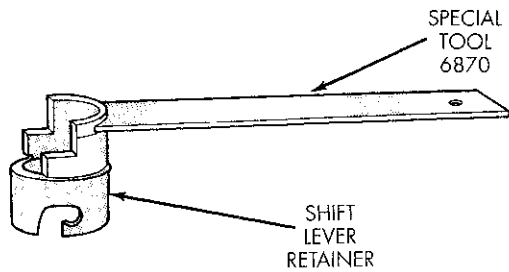


Fig. 15 Removing Shift Lever Extension With Tool 6783

REMOVAL AND INSTALLATION (Continued)

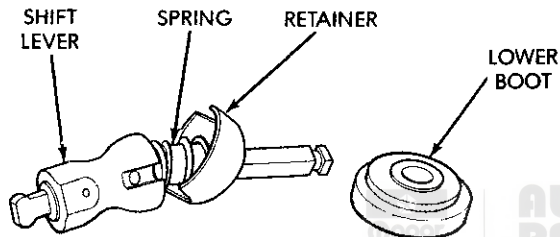
(4) Unlock shift lever retainer with Special Tool 6870 (Fig. 16). Insert Tool 6870 in retainer. Then press tool downward and turn retainer counterclockwise to release it from locking pins in shift tower.



J9521-199

Fig. 16 Shift Lever Retainer Unlocking Tool

(5) Lift shift lever upward and remove lever, retainer and spring as assembly (Fig. 17).



J9521-14

Fig. 17 Shift Lever Components**SHIFT LEVER INSTALLATION**

(1) Lubricate shift lever and retainer contact surfaces with petroleum jelly or transmission lubricant.

(2) If transmission is out of vehicle, temporarily mount shift cover on gear case.

(3) Install shift lever as follows:

(a) Note offset on shift lever (Fig. 18). **Although one shift lever is used for all applications, lever is offset and must be positioned differently in standard and heavy duty transmissions.**

(b) On heavy duty transmissions, install lever so offset is forward (Fig. 18).

(c) On standard duty transmissions, install lever so offset is rearward (Fig. 18).

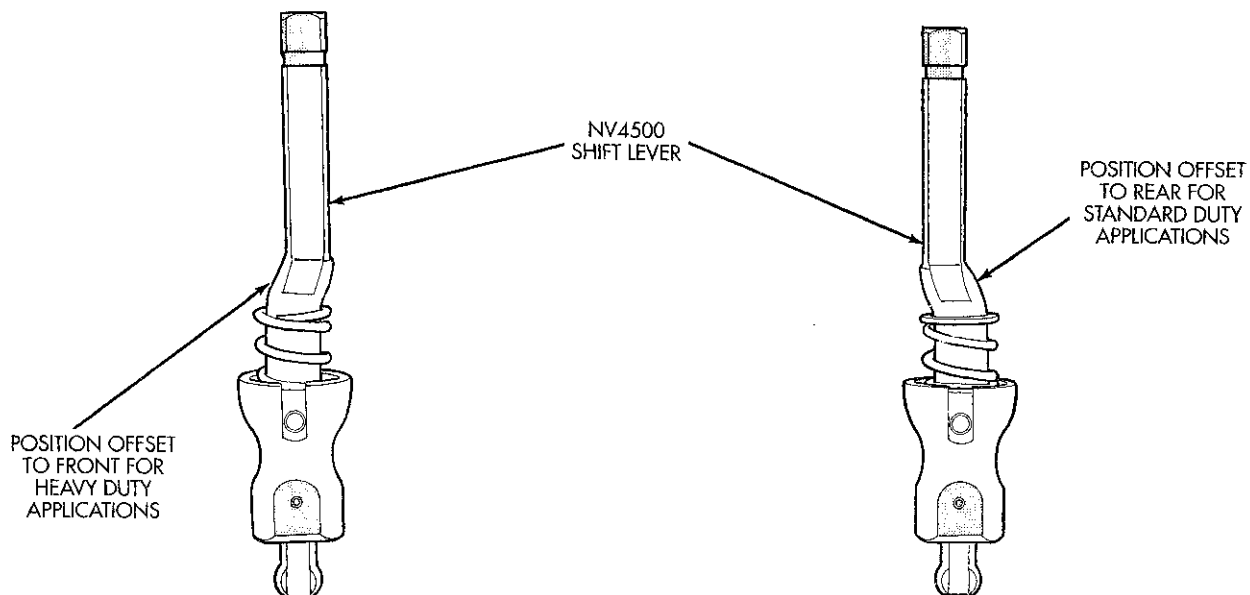
CAUTION: Verify correct lever installation before proceeding. This is important because if the shift lever offset is mispositioned, it will result in interference between the shift lever and floorpan.

(4) Lock lever retainer in shift tower with two long screwdrivers. Use screwdrivers to push and turn retainer until it engages both locking pins in tower.

(5) Install lower boot on shift lever. Seat boot securely on shift tower.

(6) If transmission is in vehicle, install lever extension on shift lever with Tool 6783 as follows:

(a) Reposition upper jaw of Remover/Installer Tool 6783 **above** flange on lever extension (Fig. 19). Tool will now be used to press extension back onto shift lever.



J9521-130

Fig. 18 Shift Lever Position

REMOVAL AND INSTALLATION (Continued)

(b) Tighten tool screw to press extension back onto lever. Press extension to scribe mark made during removal. A 3–5 mm (0.12 – 0.20 in.) space should exist between shift lever isolator and top edge of stub shaft and tool lower jaw.

(c) Remove special tool.

(d) Install shift lever boot and bezel.

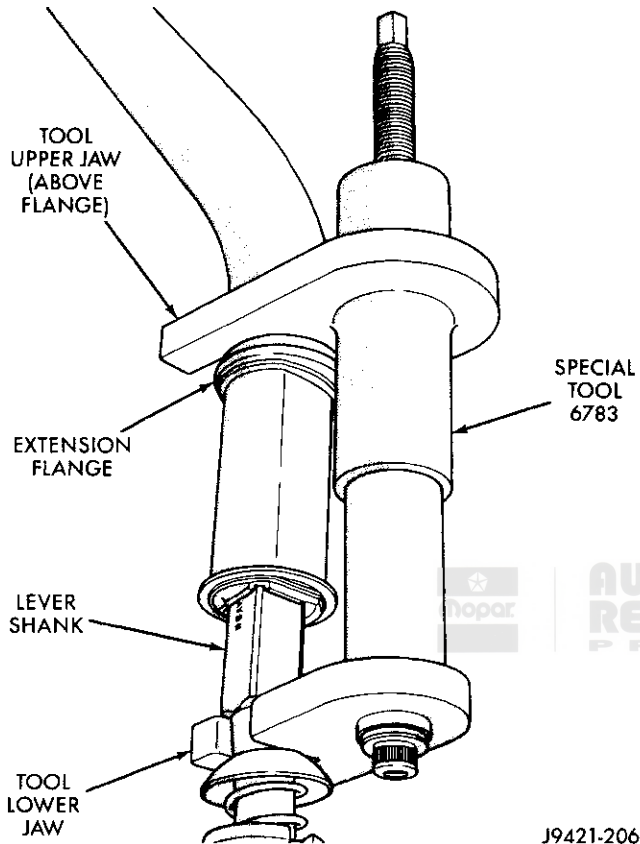


Fig. 19 Installing Shift Lever Extension With Tool 6783

SHIFT COVER

REMOVAL

- (1) Remove transmission from vehicle.
- (2) Remove shift cover bolts (Fig. 20).
- (3) Loosen shift cover with pry tool. To avoid damaging cover seal surface, insert pry tool only in slots provided in cover (Fig. 21).
- (4) Raise cover enough to disengage it from alignment dowels in gear case (Fig. 22).
- (5) Raise front of shift cover and lift cover up and off gear case (Fig. 22).
- (6) Set cover assembly aside for inspection. If cover components are damaged, refer to shift cover service information.

SHIFT COVER INSTALLATION

- (1) Clean mating surfaces of shift cover and gear case with wax and grease remover.

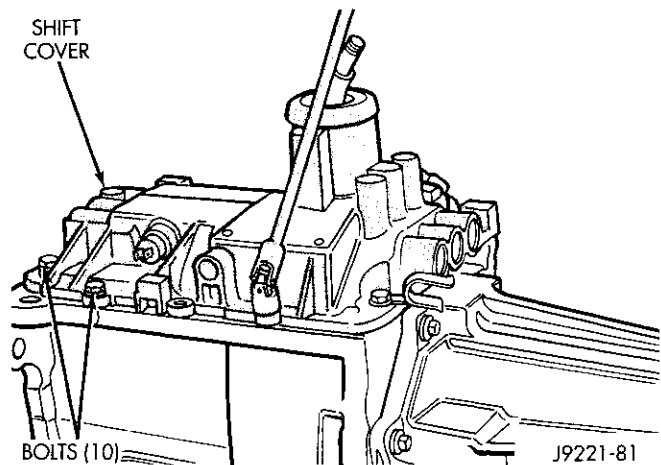


Fig. 20 Shift Cover Bolt Removal/Installation

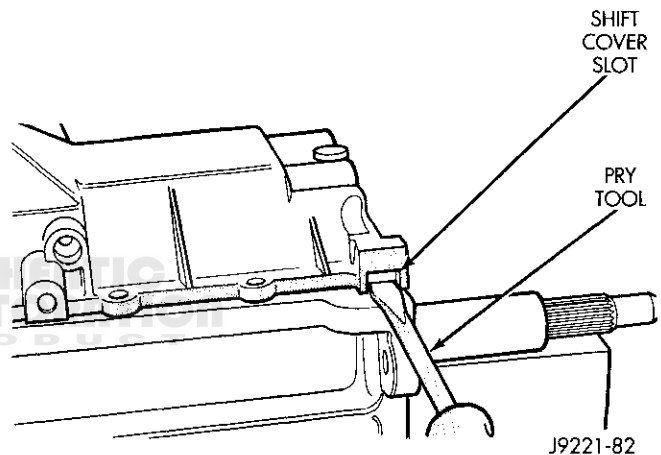


Fig. 21 Loosening Shift Cover

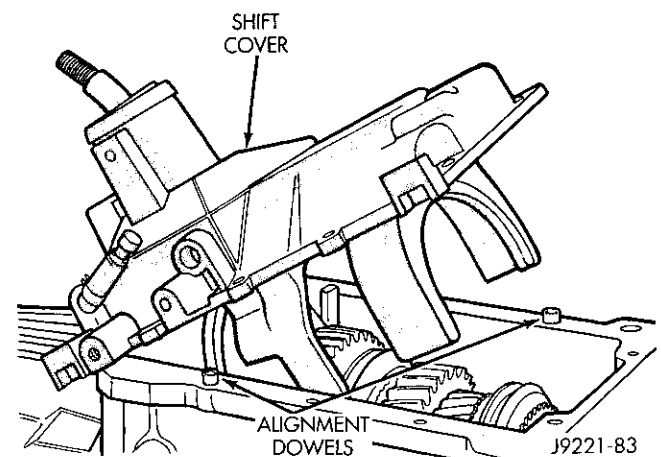


Fig. 22 Shift Cover Removal/Installation

- (2) Apply Mopar Gasket Maker, or Loctite 518 to sealing surface of shift cover or gear case. Do not over-apply sealer material. Excess can be squeezed into gear case and could block lubricant feed holes in time.

REMOVAL AND INSTALLATION (Continued)

(3) Lubricate synchro sleeves with Castrol Syntorg gear lubricant. Then apply light coat of petroleum jelly to shift fork contact surfaces.

(4) Verify that 1-2 and 3-4 synchro sleeves are in neutral position. Also verify that forks in shift cover are in neutral position.

(5) Align and install shift cover (Fig. 22). If cover will not seat, it is either not aligned on gear case dowels, or shift forks are not aligned with sleeves and shift lug.

(6) Apply Mopar Lock N' Seal or Loctite 242 to threads of shift cover bolts.

(7) Install and tighten shift cover bolts to 27-31 N·m (216-276 in. lbs.) torque.

(8) Install backup light switch in cover. Apply sealer to switch threads before installation and tighten switch to 22-34 N·m (193-265 in. lbs.).

(9) Install vent assembly, if removed. Apply an adhesive/sealer to vent tube to help secure it in cover.

DISASSEMBLY AND ASSEMBLY**EXTENSION/ADAPTER HOUSING****REMOVAL**

(1) Remove bolts attaching extension/adapter housing to gear case (Fig. 23). Use 10 mm, 12 point socket to remove housing bolts. Loosen bolts 4-5 threads with socket and ratchet first. An air wrench can then be used to complete removal but only after bolts are loose.

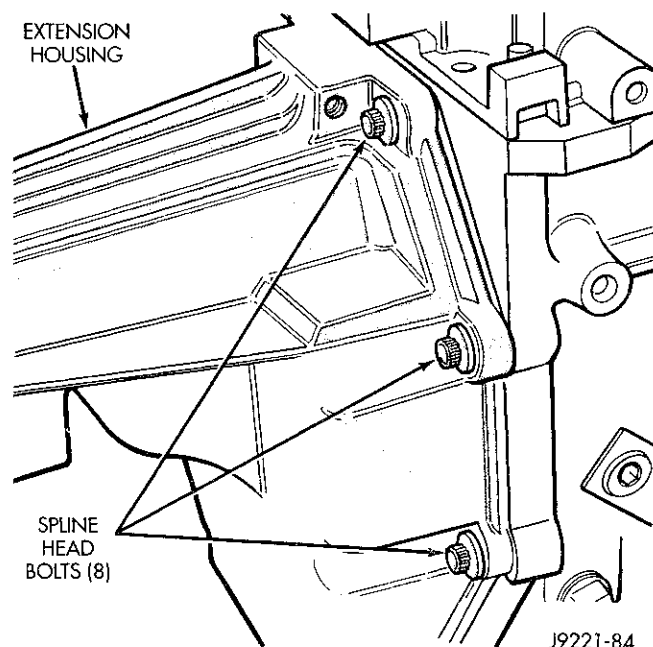


Fig. 23 Extension/Adapter Housing Bolts

CAUTION: Spline head bolts are used to attach the extension or adapter housing to the gear case. The bolt splines are easily damaged if the wrong tool is used to loosen and remove them. Use a 10 mm, 12 point socket or box end wrench only.

(2) Remove extension/adapter housing (Fig. 24). Tap housing with rubber mallet to loosen it. Then break sealer bead with putty knife and work housing off alignment dowels with two pry tools. One alignment dowel is in case. Other dowel is in housing.

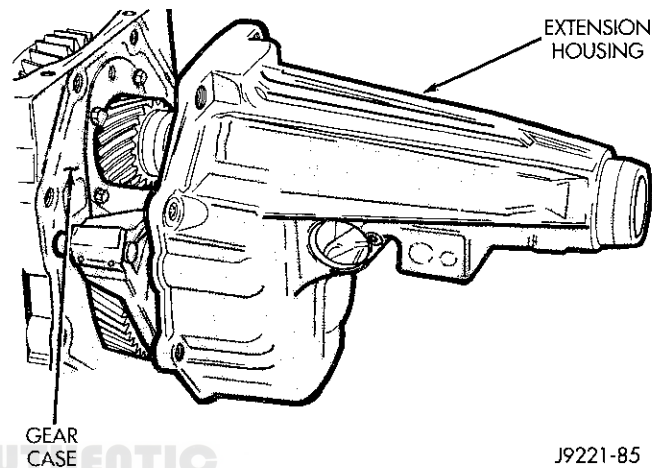


Fig. 24 Extension/Adapter Housing Removal/Installation

(3) Remove spline seal from end of mainshaft (Fig. 25). The seal can be reused or discarded as desired. The seal is not an essential part and can be reused or discarded as desired. The seal is mainly used to prevent lubricant loss during shipping and does not have to be replaced if damaged.

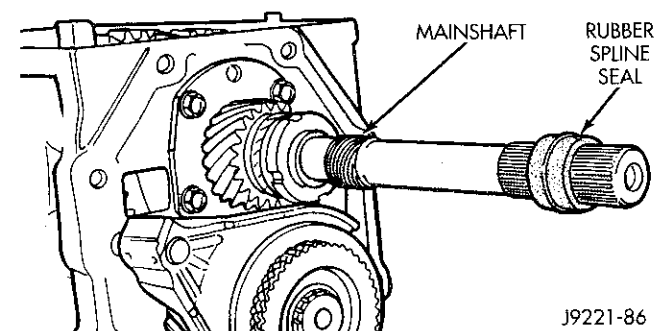


Fig. 25 Mainshaft Spline Seal

DISASSEMBLY AND ASSEMBLY (Continued)

(4) On 2-wheel drive models, remove extension housing seal (Fig. 26). Seal can be removed by collapsing one side with punch then prying seal out with suitable tool.

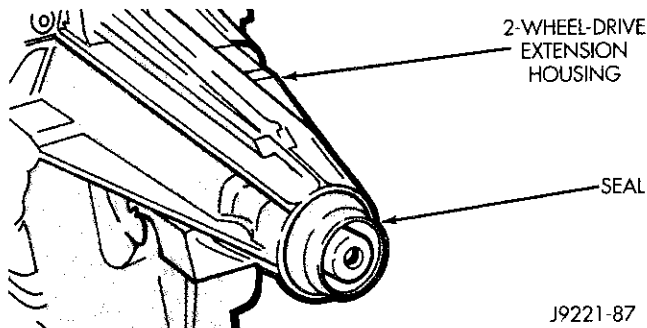


Fig. 26 Extension Housing And Seal (2-Wheel Drive Models)

(5) Note that 4-wheel drive adapter housing does not have a seal (Fig. 27).

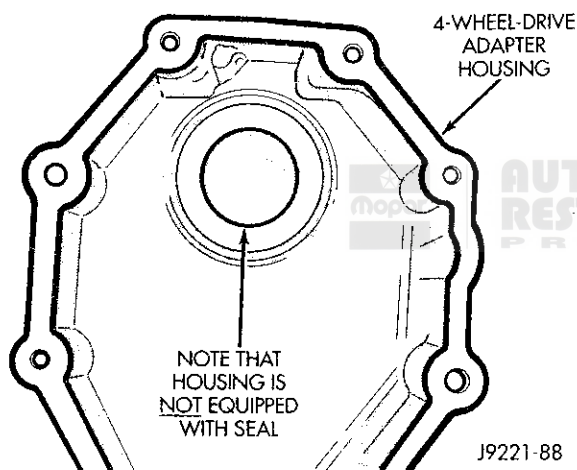


Fig. 27 Adapter Housing (4-Wheel Drive Models)

EXTENSION/ADAPTER HOUSING INSTALLATION

(1) If extension housing seal needs replacement, remove it collapsing with a punch and chisel. Then pry seal out of housing with crowfoot pry bar.

(2) If extension housing bushing must be replaced, collapse old bushing with tapered drift (Fig. 28). Position drift in slot provided at end of housing. Then tap drift into slot and against bushing to collapse and remove it.

(3) Remove any burrs from housing bushing bore with a file and emery cloth.

(4) Install new bushing in extension housing (Fig. 29). Use Tool Handle C-4171 and Installer Tool SP5559 to install bushing. Note that installer tool SP5559 is part of tool set C-4469.

(5) Install extension housing seal with Tool C-4660-3 (Fig. 30).

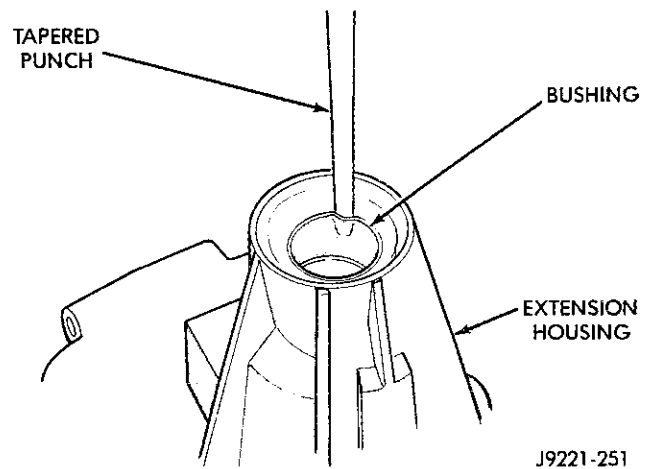


Fig. 28 Removing Extension Housing Bushing

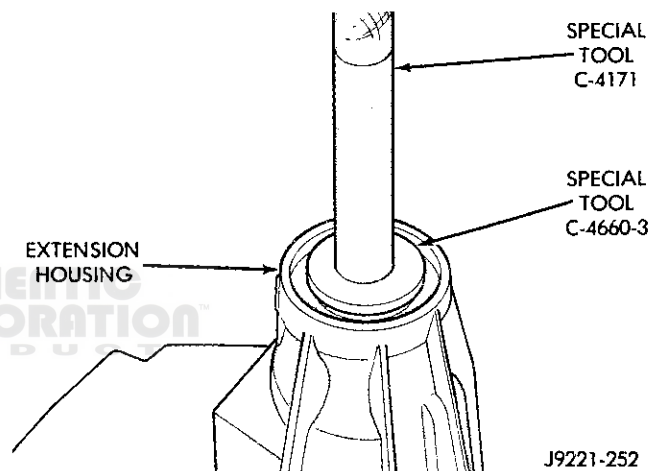


Fig. 29 Installing Extension Housing Bushing

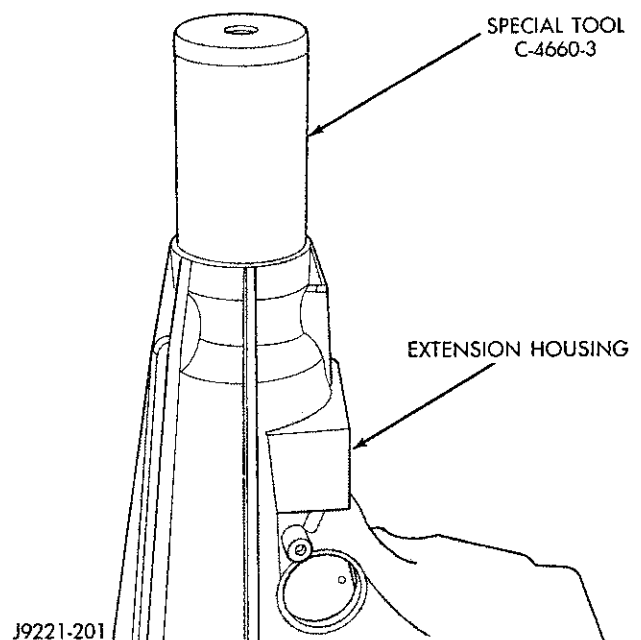


Fig. 30 Installing Extension Housing Seal

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Clean mating surfaces of extension/adapter housing and gear case with a wax and grease remover.

(7) Check alignment dowels in gear case and housing or adapter. Be sure dowels are in position and seated.

(8) Apply Mopar Gasket Maker to gear case and housing mating surfaces.

(9) Align and install extension/adapter housing on gear case (Fig. 31).

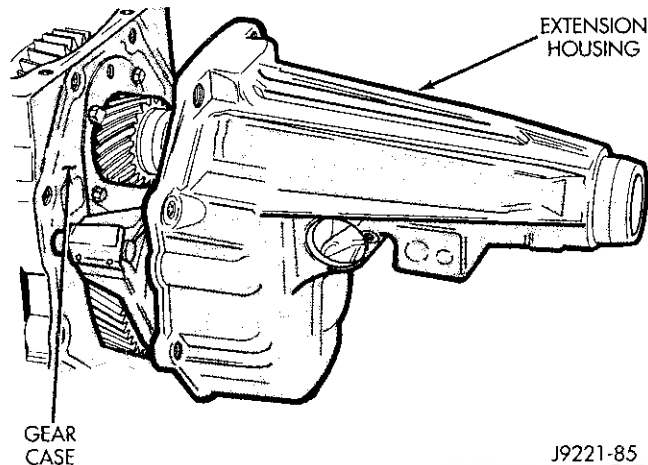


Fig. 31 Installing Extension/Adapter Housing

(10) Apply Mopar Lock N' Seal or Loctite 242 to threads of extension/adapter housing bolts.

(11) Install and tighten housing bolts to 54 N·m (40 ft. lbs.) torque. **Use a twelve point 10 mm socket, a ratchet wrench and necessary extensions to install bolts. Do not use any other type of socket and do not use an impact wrench. Splines on bolt heads can be damaged if impact wrench or wrong type of socket is used for tightening purposes.**

TRANSMISSION**REMOVING COUNTERSHAFT FIFTH GEAR**

(1) Remove snap ring that secures fifth speed clutch gear on countershaft (Fig. 32).

(2) Remove roll pins that secure countershaft fifth gear shift fork to shift rail with pin punch (Fig. 33). **Roll pins are driven out from bottom of fork and not from top.**

(3) Remove shift fork and fifth gear components as assembly. Rotate mainshaft as needed to allow countershaft fifth gear to clear mainshaft fifth gear.

REMOVING COUNTERSHAFT FIFTH GEAR COMPONENTS INDIVIDUALLY

(1) Remove snap ring that secures fifth speed clutch gear on countershaft (Fig. 32).

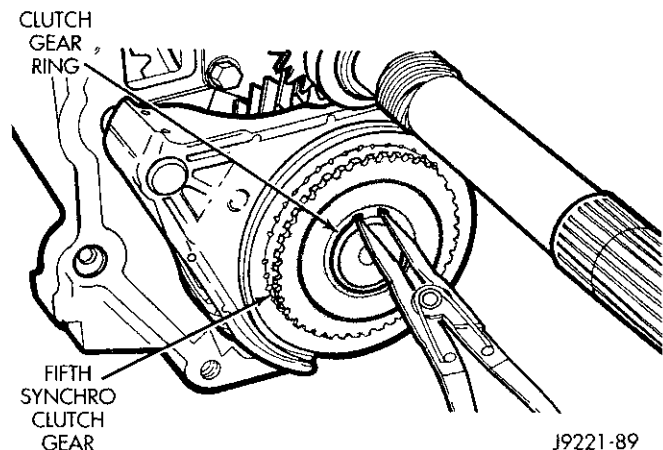


Fig. 32 Removing Countershaft Fifth Speed Clutch Gear Snap Ring

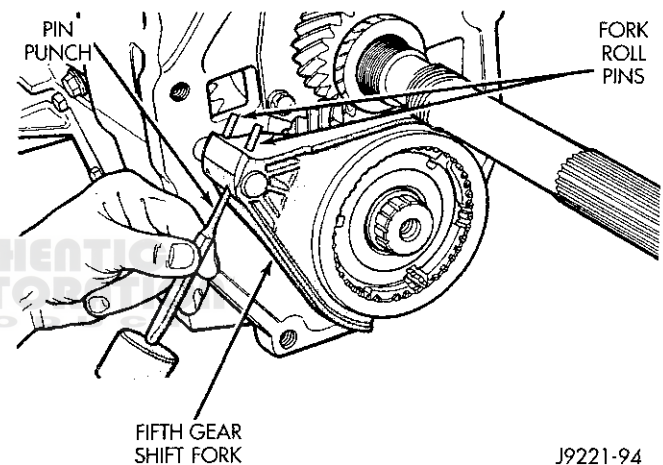


Fig. 33 Removing Fifth Gear Shift Fork Roll Pins

(2) Remove countershaft fifth speed clutch gear, stop ring and bearing spacer (Fig. 34).

(3) Remove three struts and strut springs from countershaft fifth gear hub and sleeve (Fig. 34).

(4) Remove mainshaft fifth gear nut and washer as follows:

(a) Install nut wrench on fifth gear nut (Fig. 35). Use Nut Wrench 6443 on standard duty models and Wrench 6743 on heavy duty models.

(b) Note that wrench only fits one way on nut. Be sure wrench is fully engaged in nut slots and is not cocked.

(c) On 2-wheel drive models, install Socket Wrench 6441 on mainshaft splines. On 4-wheel drive models, install Socket Wrench 6442 on mainshaft splines. Then install breaker bar in socket wrench (Fig. 36). Wedge breaker bar handle against workbench. Purpose of socket wrench and breaker bar is to prevent mainshaft from turning while nut is loosened.

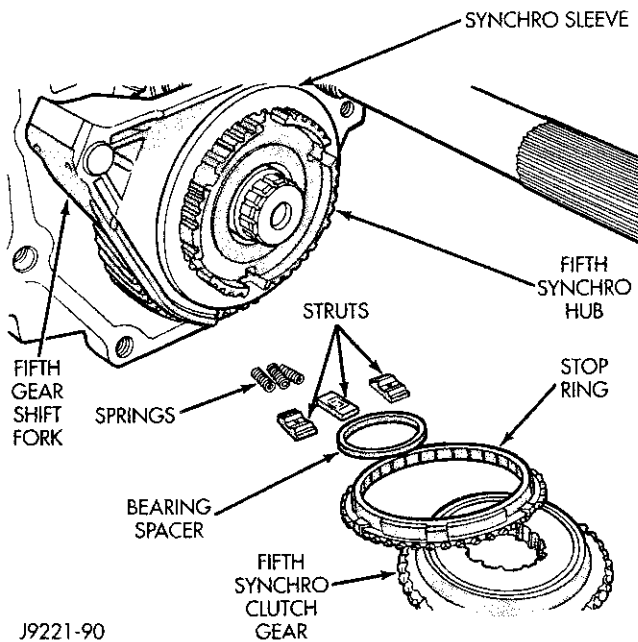
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 34 Removing Countershaft Fifth Gear Synchro Components

(d) Position small end of Nut Wrench 6443 at approximately 10 o'clock position (Fig. 35).

(e) Strike small end of nut wrench with heavy copper hammer to break nut loose. Nut is secured by interference fit thread plus Loctite adhesive and will require several firm blows to loosen it (nut torque is in 300 ft. lb. range).

(f) Once nut is loose, it can be removed by holding nut wrench with breaker bar and rotating output shaft with socket wrench and ratchet.

(g) Remove fifth gear nut and coned washer from shaft (Fig. 37). Note position of washer for assembly reference (coned side of washer faces rear).

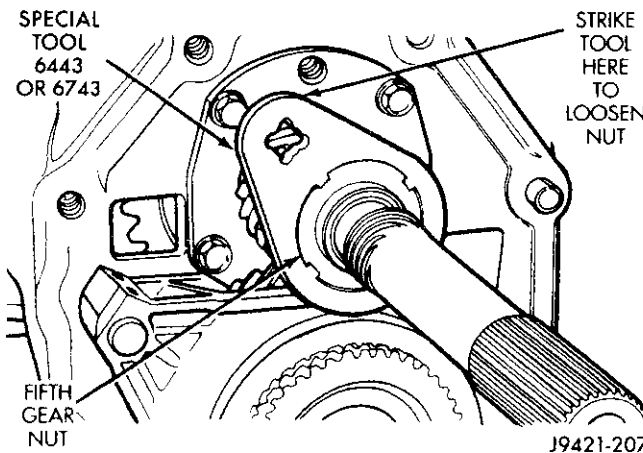


Fig. 35 Installing Nut Wrench On Mainshaft Fifth Gear

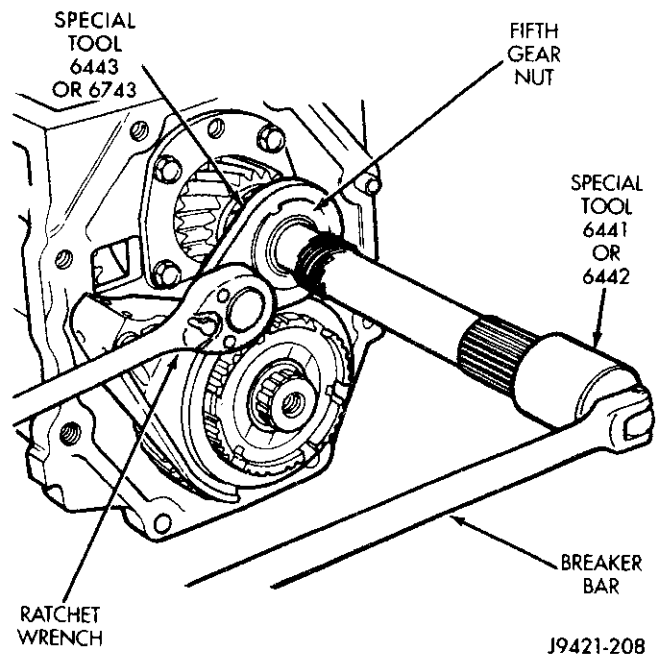


Fig. 36 Removing Mainshaft Fifth Gear Nut From Shaft Threads

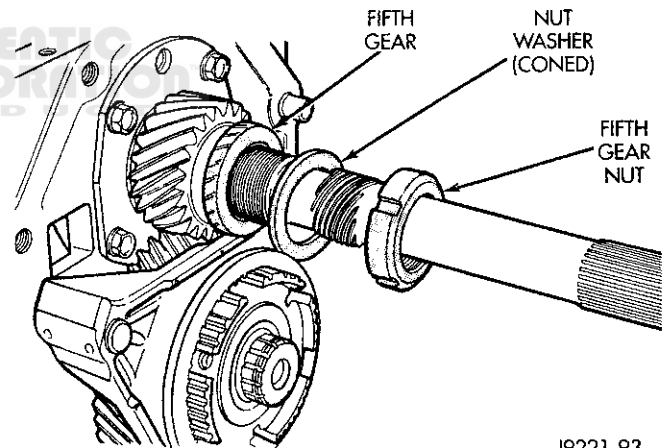


Fig. 37 Mainshaft Fifth Gear Nut And Washer Removal

(5) Remove roll pins that secure countershaft fifth gear shift fork to shift rail with pin punch (Fig. 33). Roll pins are driven out from bottom of fork and not from top.

(6) Remove fifth gear shift fork and sleeve as assembly (Fig. 38). Remove fork by tapping it off rail with plastic mallet. Leave sleeve engaged in fork or note position of sleeve for assembly reference.

(7) Remove countershaft fifth gear and hub assembly (Fig. 39).

(8) Remove countershaft fifth gear needle bearing assemblies (Fig. 40).

DISASSEMBLY AND ASSEMBLY (Continued)

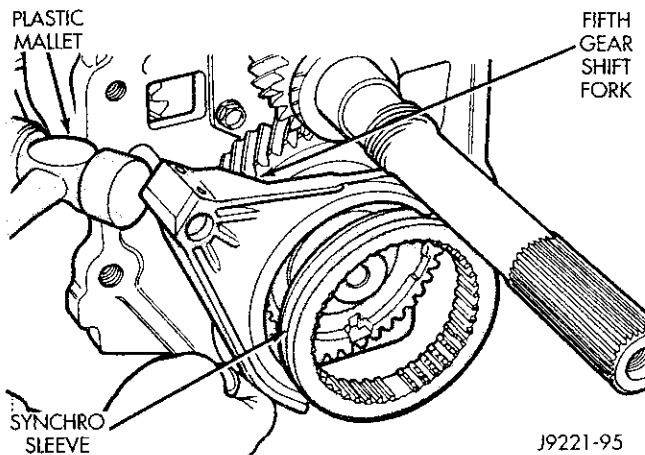


Fig. 38 Fifth Gear Shift Fork And Sleeve Removal

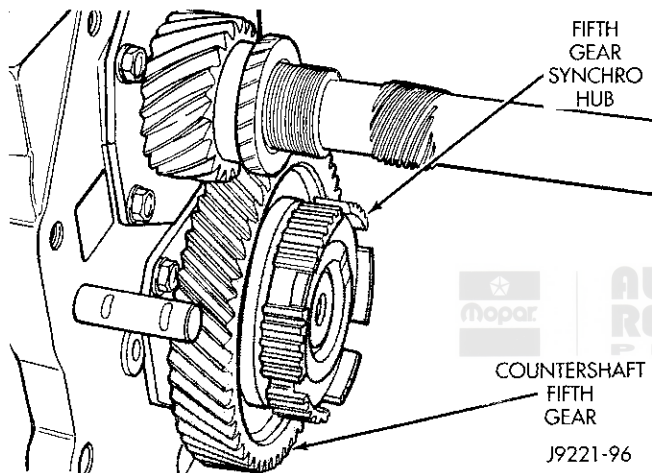


Fig. 39 Removing Countershaft Fifth Gear And Synchro Hub Assembly

(9) Remove cone shaped rear bearing thrust washer from end of countershaft (Fig. 41). Note position of washer for assembly reference. Also note that washer bore has notch for locating pin.

(10) Remove and retain thrust washer locating pin from countershaft (Fig. 42).

(11) Remove mainshaft overdrive fifth gear with Puller Tool Set 6444. **Note that puller set can be used on both standard and heavy duty transmissions.** Gear removal procedure is as follows:

(a) Position first puller jaw on gear (Fig. 42). **Use Puller Jaws 6459 on standard duty models and Puller Jaws 6820 on heavy duty models.**

(b) Assemble Puller Flange 6444-1 and Puller Rods 6444-3 (Fig. 43).

(c) Slide assembled puller flange and rods onto output shaft. Then seat flange in notch of puller jaw (Fig. 43).

(d) Position second puller jaw (6459 or 6820) on gear and in notch of puller flange (Fig. 44).

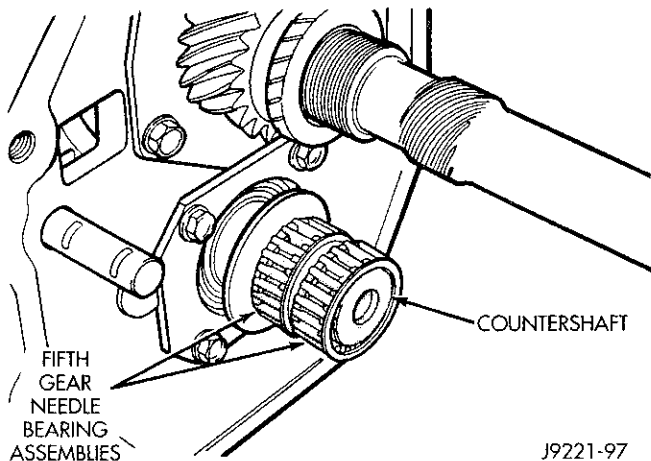


Fig. 40 Countershaft Fifth Gear Needle Bearing Removal

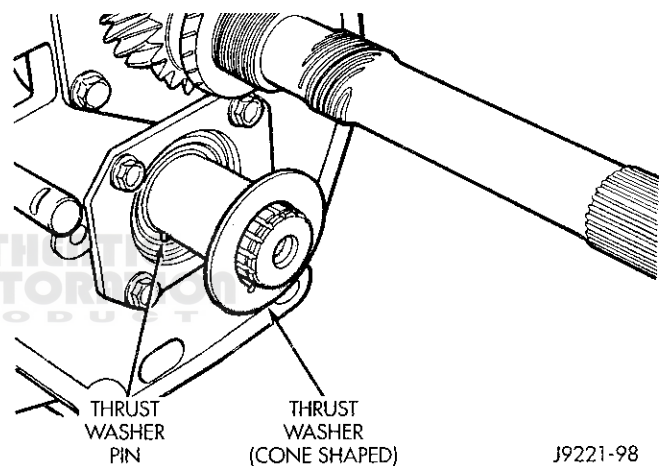


Fig. 41 Countershaft Rear Bearing Thrust Washer Removal

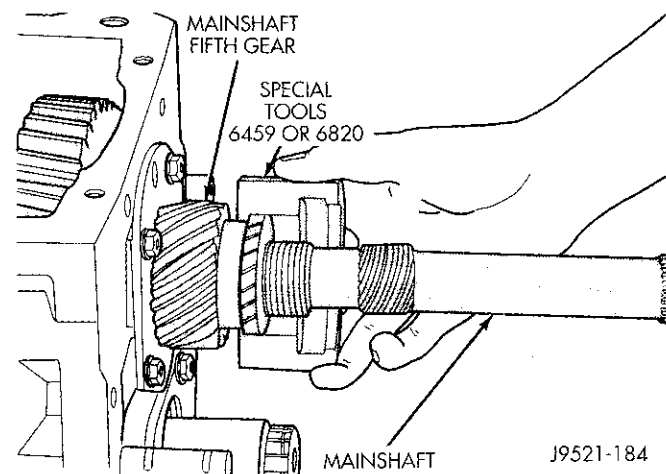
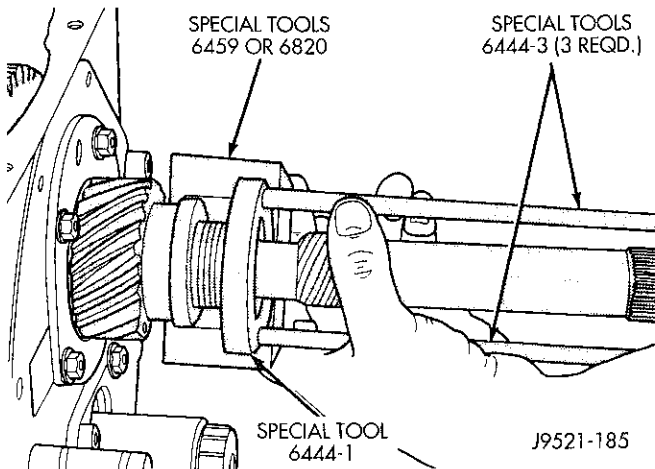
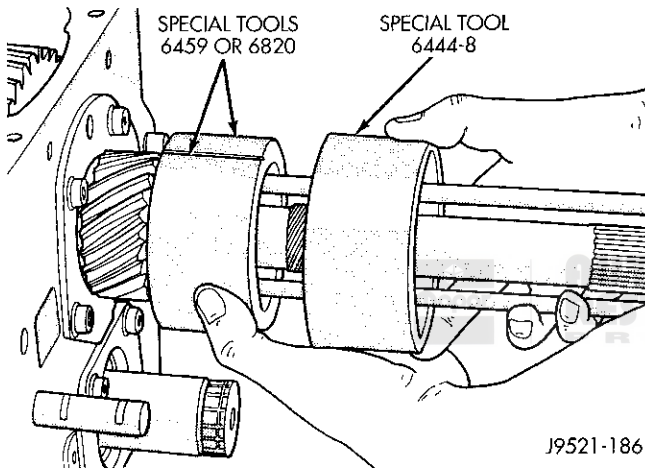


Fig. 42 Installing First Puller Jaw On Mainshaft Fifth (Overdrive) Gear

(e) Slide Retaining Collar 6444-8 over puller jaws to hold them in place (Fig. 44).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 43 Seating Puller Flange In First Puller Jaw****Fig. 44 Installing Retaining Collar Over Puller Jaws**

(f) Install Puller and Bolt 6444 on puller rods. Then secure puller to rods with retaining nuts (Fig. 45).

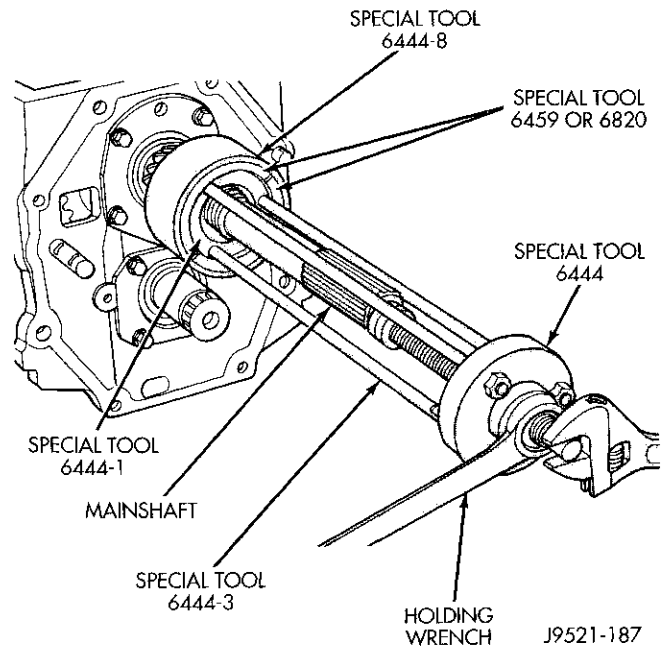
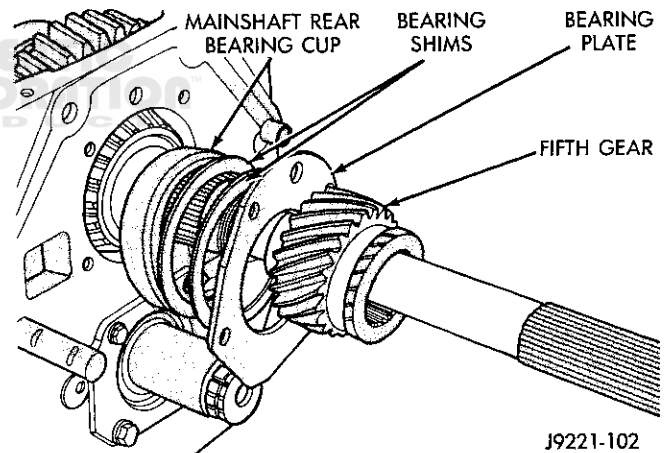
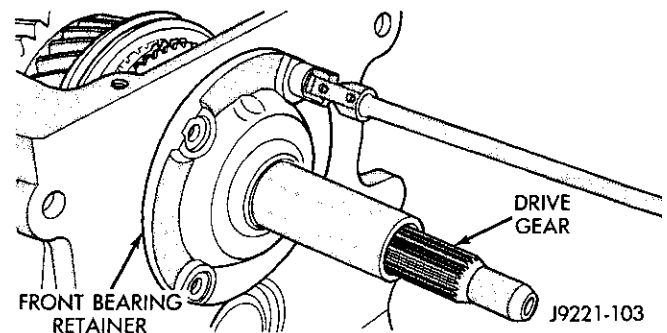
(g) Tighten puller bolt to remove gear from shaft splines (Fig. 45).

(12) Remove bolts attaching mainshaft rear bearing plate to gear case and remove fifth gear, plate, end play shims and bearing cup (Fig. 46).

FRONT RETAINER REMOVAL AND DISASSEMBLY

(1) Remove front retainer bolts (Fig. 47). **Discard retainer bolts. They should not be reused.**

(2) Remove front retainer by lightly tapping it back and forth with plastic mallet to loosen it. Then rock retainer back and forth by hand to work it out of gear case. Note that retainer flange extends into and is fairly snug fit in case bore.

**Fig. 45 Removing Fifth Gear From Mainshaft Splines****Fig. 46 Removing Mainshaft Fifth Gear, Bearing Plate, Bearing Shims And Rear Bearing Cup****Fig. 47 Removing Front Bearing Retainer Bolts**

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Remove seal from front retainer (Fig. 48). Use small chisel to collapse one side of seal then pry it out with suitable tool.

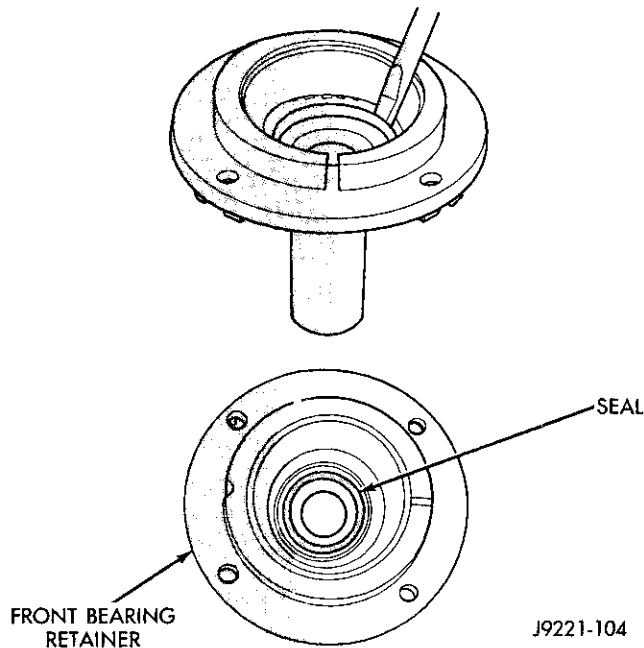


Fig. 48 Removing Bearing Retainer Seal

(4) Remove bearing cup from front retainer as follows:

(a) Assemble Puller Flange 6444-1 and Puller Rods 6444-6 (Fig. 49).

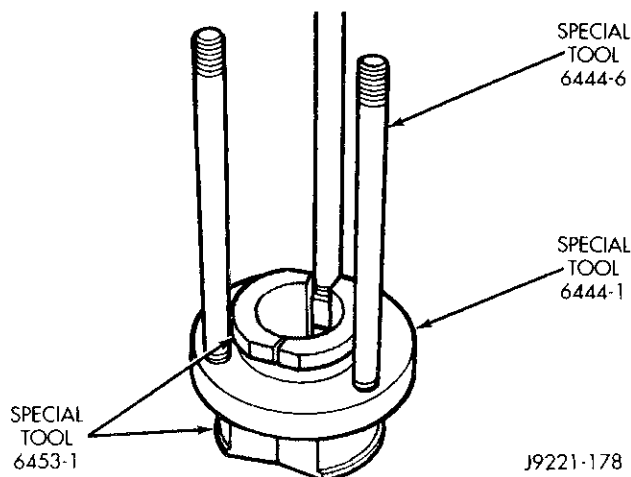


Fig. 49 Assembling Puller Rods, Flange And Jaws

(b) Insert Puller Jaws 6453-1 in puller flange (Fig. 49). Narrow lip of puller jaws will go under bearing cup.

(c) Install assembled tools in front retainer (Fig. 50). Be sure puller jaws are seated under bearing cup.

(d) Place Insert Tool 6453-2 in center of puller jaws (Fig. 50). Insert tool is used to hold puller jaws in place.

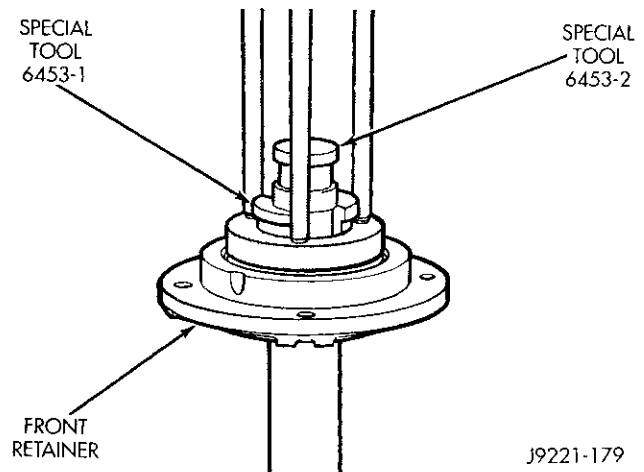


Fig. 50 Installing Puller Tools In Front Retainer

(e) Install Puller 6444 on puller rods (Fig. 51). Then install retaining nuts on puller rods.

(f) Tighten puller bolt to draw bearing cup out of retainer (Fig. 51). Use holding wrench on puller and turn puller bolt with adjustable wrench.

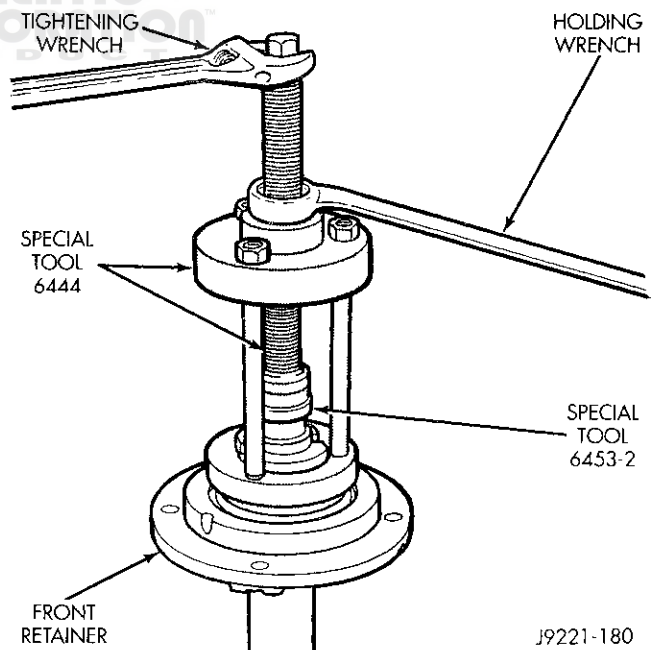


Fig. 51 Removing Bearing Cup From Front Retainer

DISASSEMBLY AND ASSEMBLY (Continued)**DRIVE GEAR REMOVAL AND DISASSEMBLY**

(1) Remove drive gear. Tilt gear downward and out of case (Fig. 52).

(2) Remove pilot bearing from drive gear (Fig. 53).

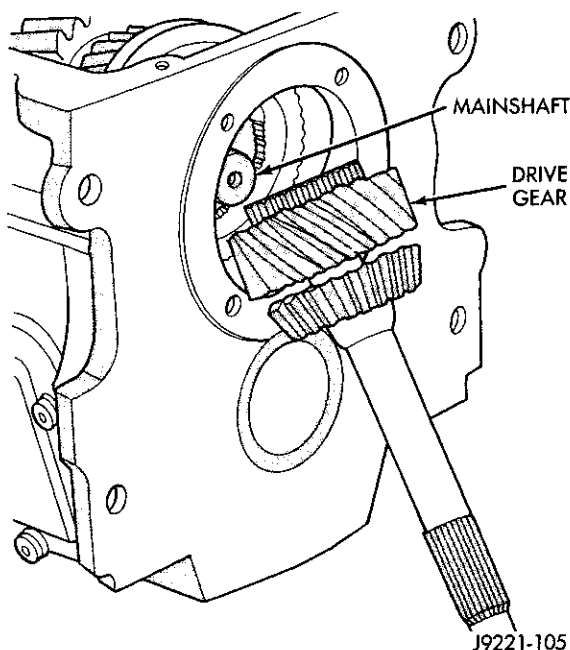


Fig. 52 Drive Gear Removal

(3) Remove bearing from drive gear as follows:

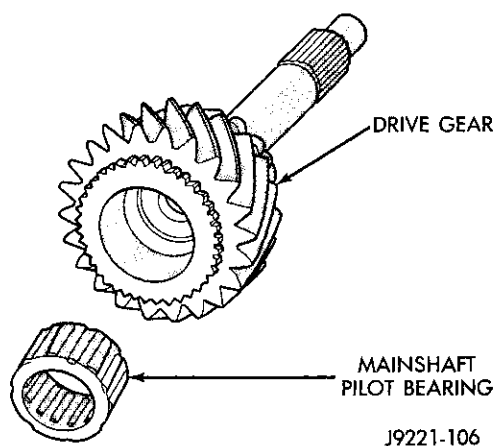


Fig. 53 Pilot Bearing Removal/Installation

(a) Note that puller tool assembly and setup is similar to that used for removing fifth gear from mainshaft.

(b) Assemble Puller Flange 6444-1 and Puller Rods 6444-4. Then position first Puller Jaw 6447 on gear (Fig. 54).

(c) Slide assembled puller flange and rod tools onto output shaft. Then seat flange in notch of puller jaw (Fig. 54).

(d) Position second Puller Jaw 6447 on gear and in notch of puller flange (Fig. 54).

(e) Slide Retaining Collar 6444-8 over puller jaws to hold them in place (Fig. 54).

(f) Install Puller 6444 on puller rods. Then secure puller to rods with retaining nuts (Fig. 54).

(g) Tighten puller bolt to remove bearing cone from drive gear (Fig. 54).

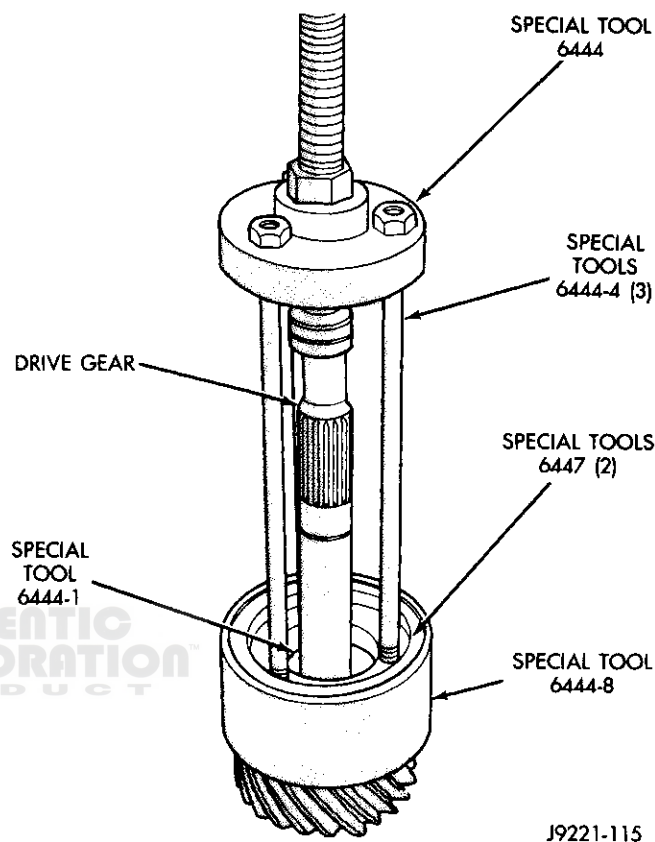


Fig. 54 Removing Front Bearing From Drive Gear
MAINSHAFT AND GEARTRAIN REMOVAL

(1) Remove countershaft rear bearing plate (Fig. 55).

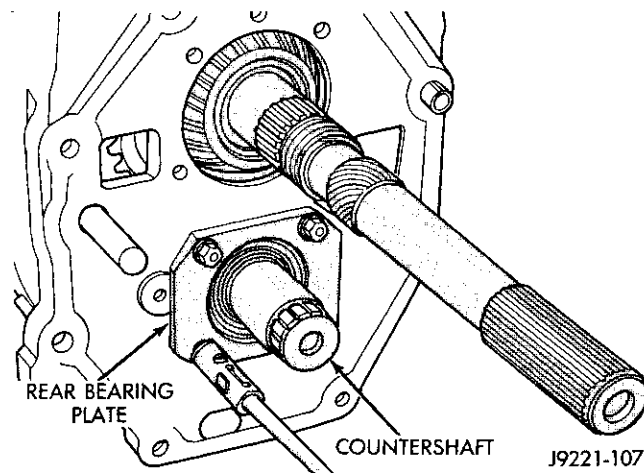


Fig. 55 Removing Countershaft Rear Bearing Plate

DISASSEMBLY AND ASSEMBLY (Continued)

(2) Remove countershaft end play shim and rear bearing cup (Fig. 56).

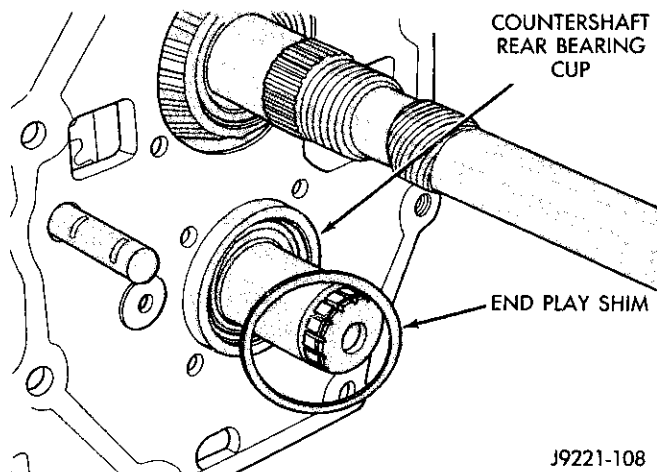


Fig. 56 Countershaft End Play Shim And Rear Bearing Cup Removal

(3) Remove reverse idler shaft. Thread a shift cover bolt into shaft and withdraw shaft from case (Fig. 57).

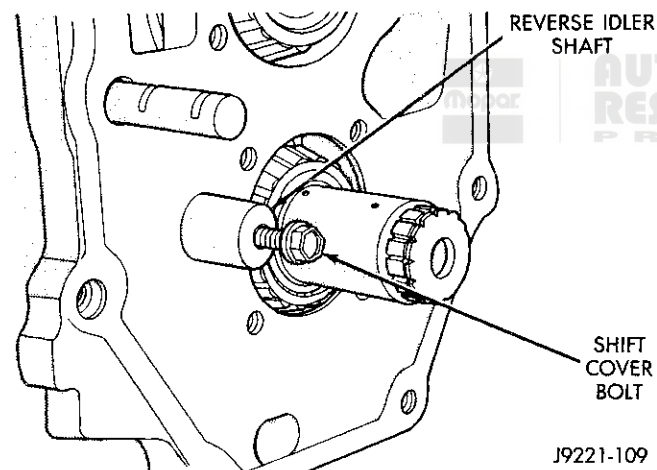


Fig. 57 Removing Reverse Idler Shaft

(4) Move 1-2 and 3-4 synchro sleeves into Neutral, if necessary.

(5) Remove drive gear thrust bearing from forward end of mainshaft (Fig. 58).

(6) Remove fourth speed clutch gear and synchro stop ring from mainshaft (Fig. 59).

(7) Roll gear case onto left side (Fig. 60).

(8) Reach into gear case and push reverse idler gear away from mainshaft gears.

(9) Remove mainshaft assembly as follows (Fig. 60):

(a) Lift front end of mainshaft slightly.

(b) Grasp mainshaft rear splines. Then turn spline end of mainshaft in counterclockwise direction to rotate shaft and geartrain out of case.

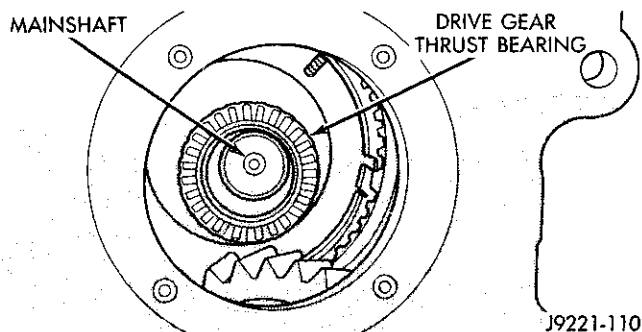


Fig. 58 Drive Gear Thrust Bearing Removal

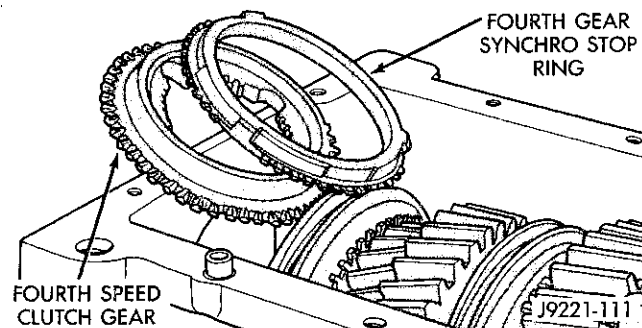


Fig. 59 Fourth Speed Clutch Gear Stop Ring Removal

(c) Once mainshaft gears roll clear of countershaft gears, shaft and gear assembly can be tilted outward and removed from gear case (Fig. 60).

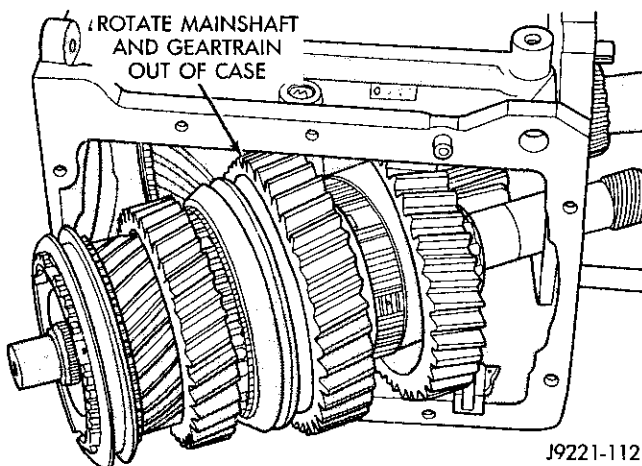


Fig. 60 Mainshaft And Geartrain Removal

(10) Refer to mainshaft disassembly procedures if any gears or synchro components must be replaced.

REVERSE IDLER GEAR AND COUNTERSHAFT REMOVAL/DISASSEMBLY

(1) Rotate countershaft outward and push reverse idler gear away from countershaft and toward front of case (Fig. 61).

DISASSEMBLY AND ASSEMBLY (Continued)

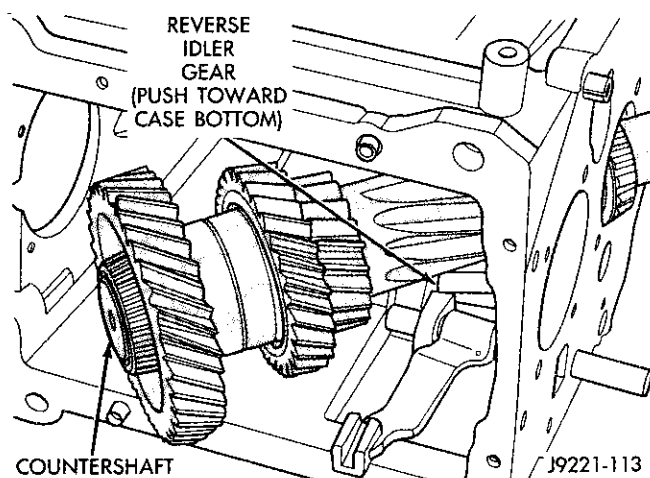


Fig. 61 Idler Gear Moved Away From Countershaft

(2) Remove idler gear through drive gear bore at front of case (Fig. 62).

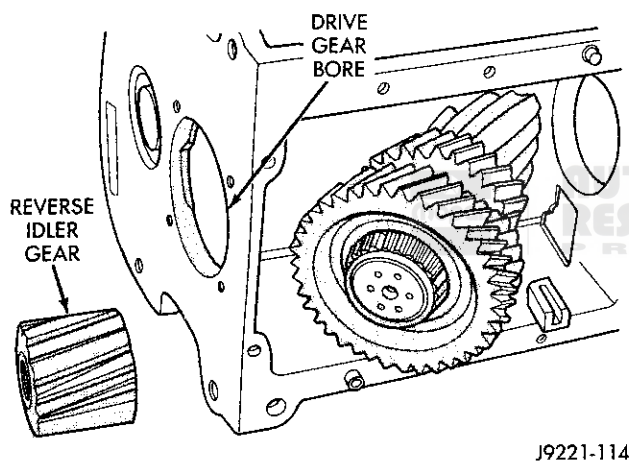


Fig. 62 Reverse Idler Gear Removal

(3) Keep reverse idler gear bearings and spacer together for cleaning and inspection (Fig. 63). Insert idler shaft through gear and bearings to keep them in place.

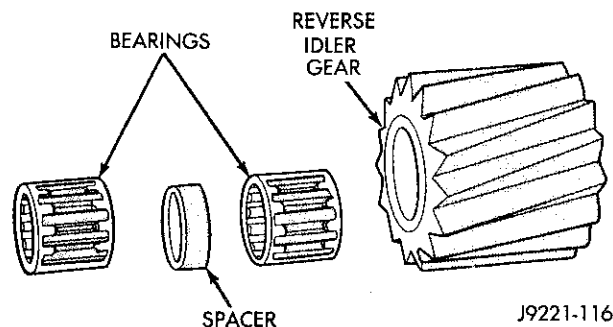


Fig. 63 Reverse Idler Gear Components

(4) Remove idler gear thrust washers from gear case. Install washers on idler shaft to keep them together for cleaning and inspection.

(5) Remove countershaft **rear** bearing. Shaft cannot be removed from case until rear bearing has been removed. Bearing removal procedure is as follows:

(a) Assemble Puller Flange 6444-1 and Puller Rods 6444-6 (Fig. 64).

(b) Position first Puller Jaw 6449 on bearing cone (Fig. 64).

(c) Seat puller flange in notch of puller jaw just installed on bearing cone (Fig. 64).

(d) Install second Puller Jaw 6449 on bearing and in notch of puller flange (Fig. 64).

(e) Slide Retaining Collar 6444-8 over puller jaws to hold them in place (Fig. 64). Note that retaining collar has small lip on one end and only fits one way over jaws.

(f) Install Puller 6444 on puller rods. Then secure puller to rods with retaining nuts (Fig. 64).

(g) Tighten puller bolt to remove bearing from shaft (Fig. 64). If bearing is exceptionally tight, tap end of puller bolt with copper mallet to help loosen bearing.

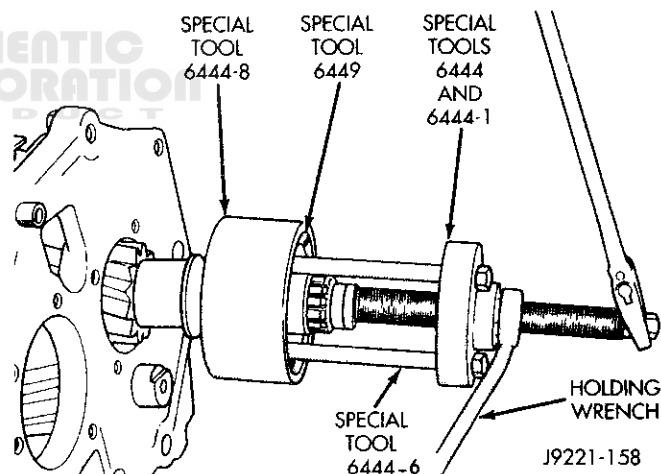


Fig. 64 Removing Countershaft Rear Bearing

(6) Remove bearing puller tools.

(7) Rotate countershaft out of gear case (Fig. 65).

(8) Remove countershaft **front** bearing as follows:

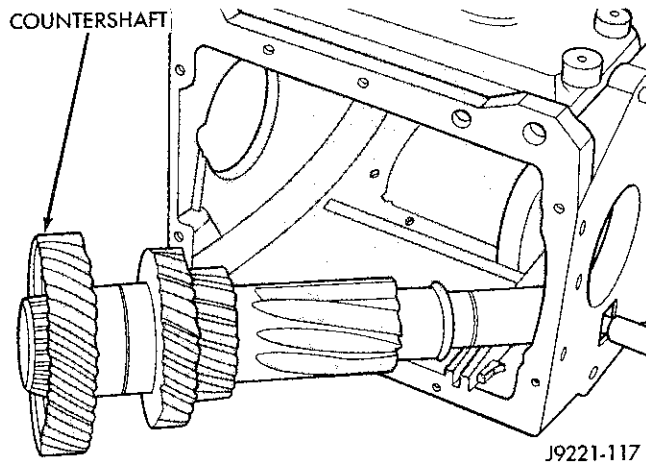
(a) Assemble Puller Flange 6444-1 and Puller Bolts 6444-6 (Fig. 66).

(b) Position first Puller Jaw 6451 on bearing.

(c) Seat puller flange in notch of puller jaw.

(d) Install second Puller Jaw 6451 on bearing and in notch of puller flange.

(e) Slide Retaining Collar 6444-8 over puller jaws to hold them in place (Fig. 66). Note that retaining collar has small lip on one end and only fits one way over jaws.

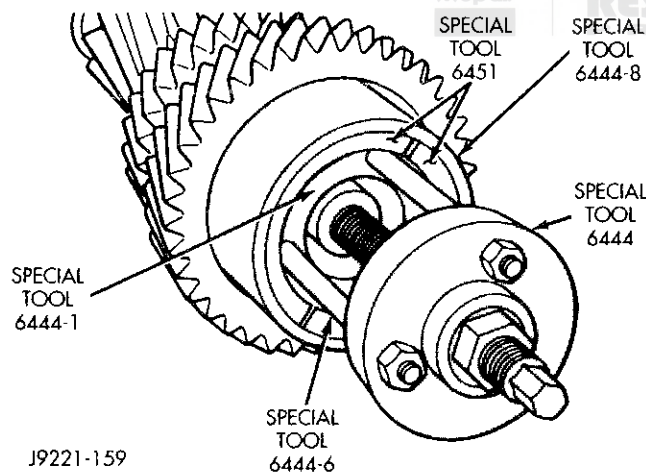
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 65 Removing Countershaft From Gear Case**

(f) Install Puller Bridge And Bolt Assembly 6444 on puller bolts. Then secure bridge to bolts with retaining nuts (Fig. 66).

(g) Tighten puller bolt to remove bearing from shaft (Fig. 66). If bearing is exceptionally tight, tap end of puller bolt with mallet to help loosen bearing.

(9) Remove bearing puller tools.

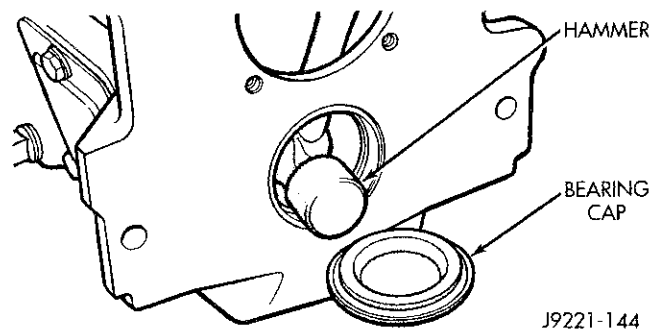
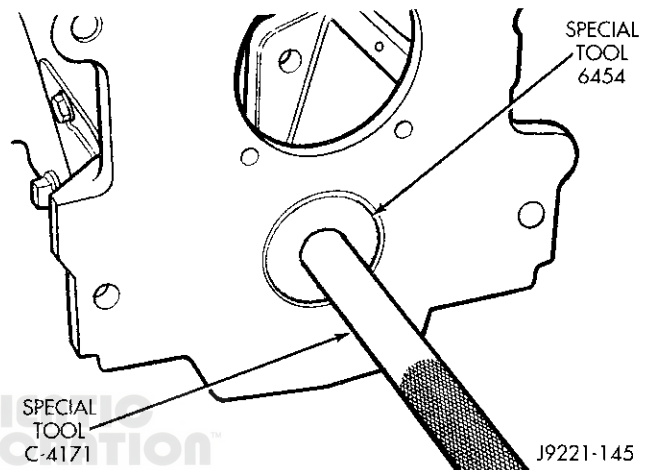
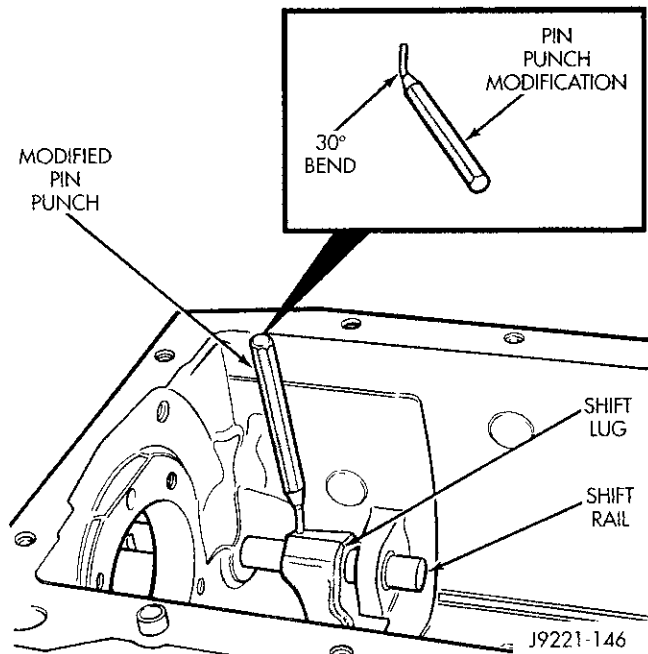
(10) Set countershaft and idler gear aside for cleaning and inspection.

**Fig. 66 Removing Countershaft Front Bearing****GEAR CASE DISASSEMBLY**

(1) Remove countershaft front bearing cap. Use mallet or hammer to remove cap from inside case (Fig. 67).

(2) Remove countershaft front bearing cup with Remover Tool 6454 and Tool Handle C-4171 (Fig. 68).

(3) Remove roll pin that secures shift lug on shift rail in case (Fig. 69). A small pin punch can be modified by putting a slight bend in it to drive pin completely out of shift rail (Fig. 69).

**Fig. 67 Countershaft Front Bearing Cap Removal****Fig. 68 Countershaft Front Bearing Cup Removal****Fig. 69 Removing Shift Lug Roll Pin**

DISASSEMBLY AND ASSEMBLY (Continued)

(4) Remove shift lug rail by tapping it out of case and shift lug with tapered punch (Fig. 70). Note position of rail and lug for assembly reference.

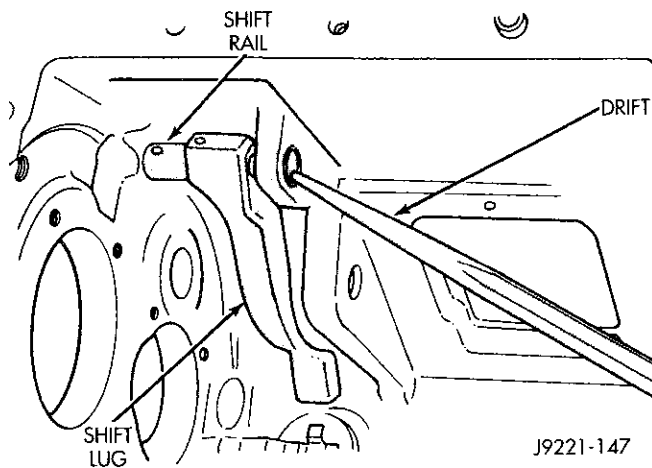


Fig. 70 Removing Shift Lug Rail

(5) Remove lug rail bushings from gear case with Special Tool 6456 (Fig. 71).

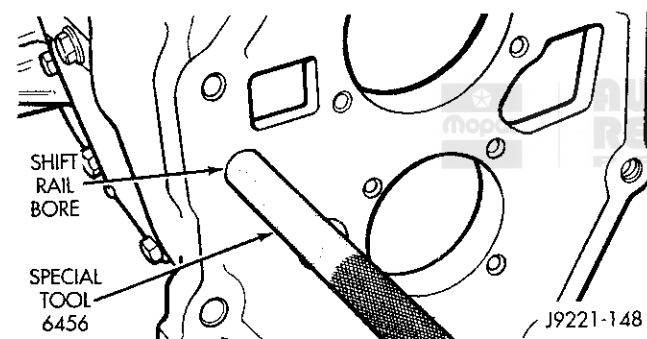


Fig. 71 Removing Shift Lug Rail Bushings

(6) Unclip and remove magnet from bottom of gear case (Fig. 72).

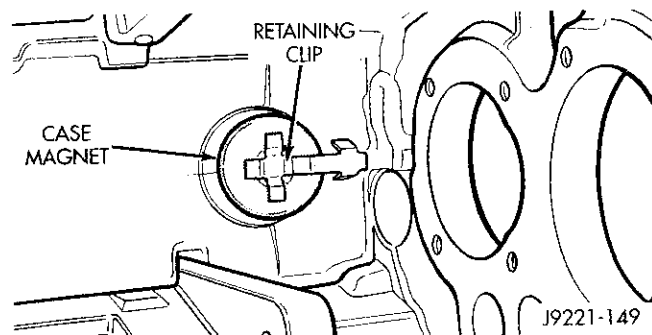


Fig. 72 Gear Case Magnet Location

MAINSHAFT DISASSEMBLY

NOTE: Not all of the mainshaft gear and synchro components are a one-way fit. Some gear and synchro components can be installed backwards. To avoid reassembly problems, mark the speed gears, clutch gears, synchro hubs, and sleeves for reference during teardown. Use paint or a scribe for marking purposes. Then stack the geartrain parts in order of removal. This practice will help avoid incorrect assembly and lost time.

(1) Remove drive gear thrust bearing from end of mainshaft, if not previously removed.

(2) Remove fourth gear synchro struts and springs from 3-4 hub and sleeve (Fig. 73). Three struts and springs are used. Keep springs and struts together for inspection and cleaning. Store parts in a paper cup to avoid losing them.

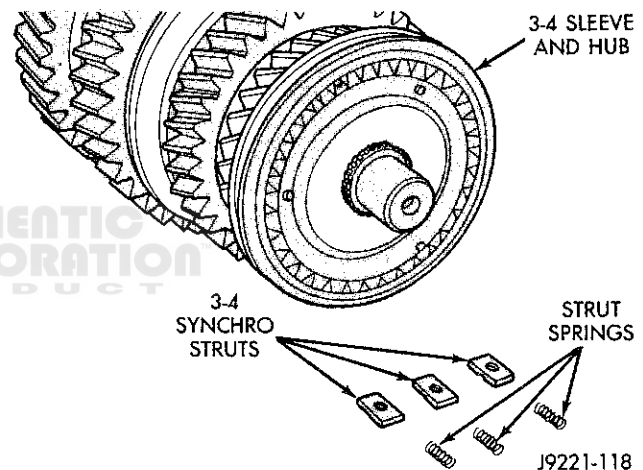


Fig. 73 Synchro Strut And Spring Removal

(3) Remove 3-4 sleeve from 3-4 synchro hub (Fig. 74).

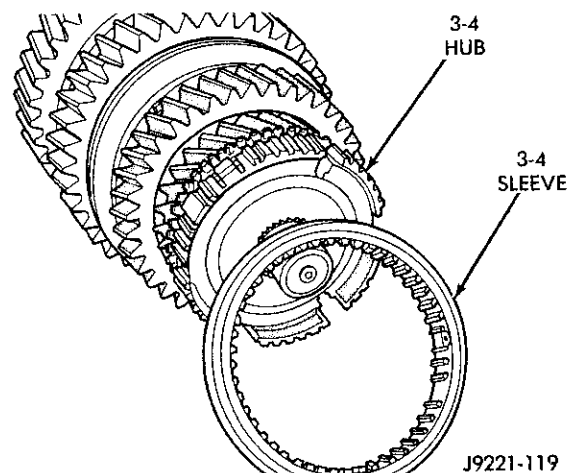
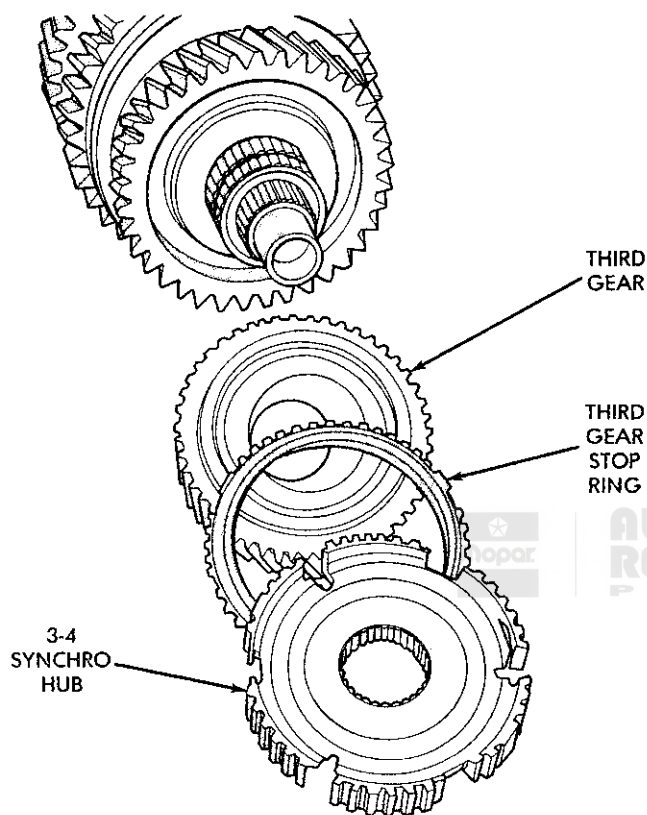


Fig. 74 Removing 3-4 Sleeve From Hub

DISASSEMBLY AND ASSEMBLY (Continued)

(4) Remove 3-4 synchro hub from mainshaft splines with suitable size bearing splitter, or with two tapered drifts. Position splitter or drifts between third gear stop ring to start moving hub off shaft. Then complete hub removal by tapping it off shaft with plastic mallet. Tap hub at 6-8 different points to remove hub evenly.

(5) Remove 3-4 synchro hub, third gear stop ring and third gear (Fig. 75).



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Fig. 75 Third Gear, Stop Ring And 3-4 Hub Removal

(6) Remove third gear bearing assemblies from mainshaft (Fig. 76).

(7) Remove third gear bearing spacer (Fig. 77).

(8) Remove snap ring that retains second gear thrust washer on mainshaft (Fig. 77).

(9) Remove second gear thrust washer (Fig. 78). Note that washer is notched for locating pin.

(10) Remove second gear (Fig. 79).

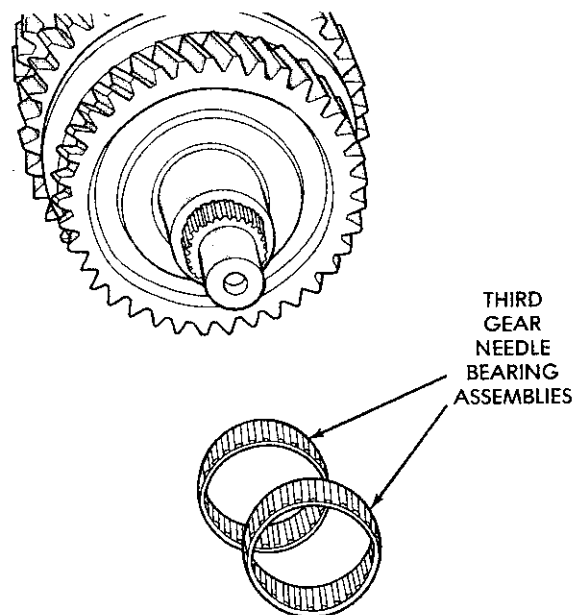
(11) Remove second gear bearing assembly (Fig. 80).

(12) Remove thrust washer locating pin (Fig. 81). Use needle nose pliers to grip and remove pin.

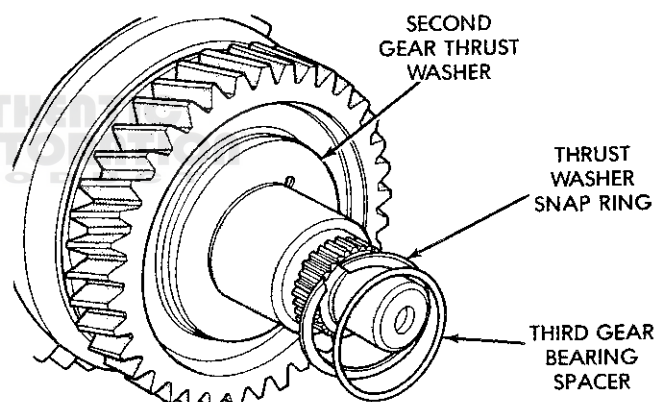
(13) Remove snap ring that retains second speed clutch gear (Fig. 82). Snap ring is seated in mainshaft synchro hub groove.

(14) Remove second speed clutch gear, synchro clutch ring and synchro stop ring (Fig. 83).

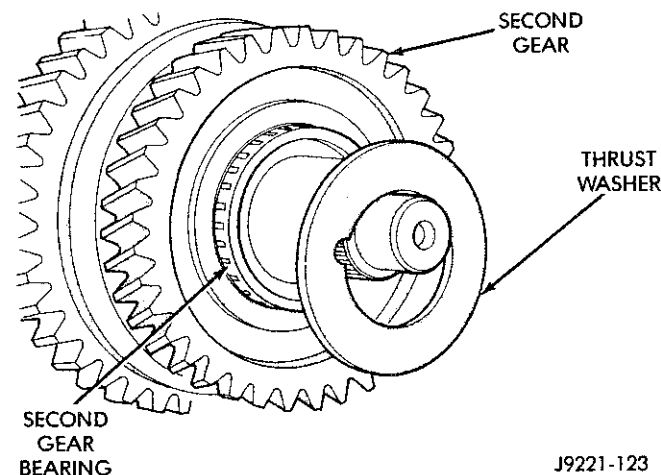
(15) Remove 1-2 synchro hub snap ring (Fig. 84).



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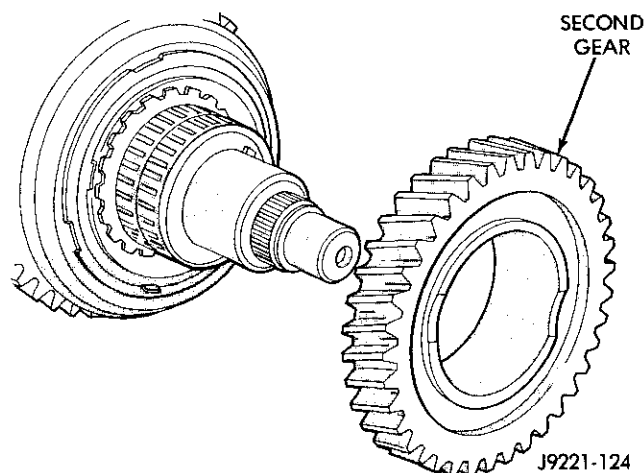
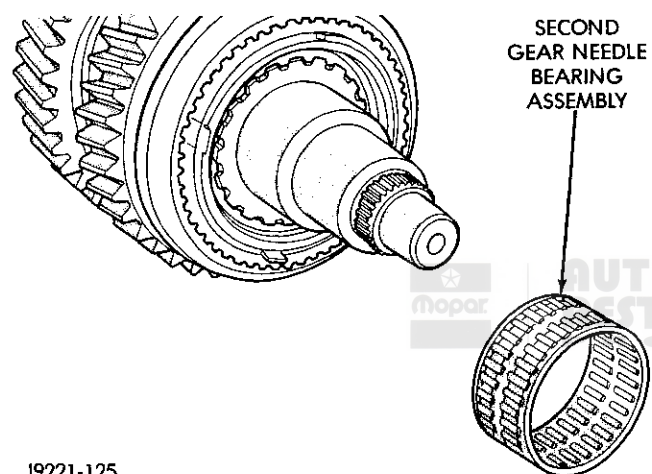
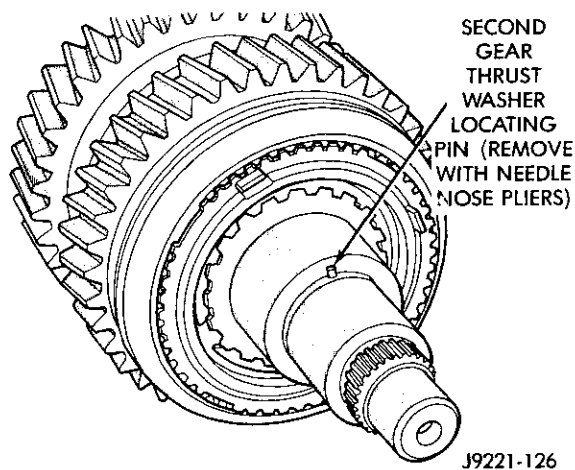
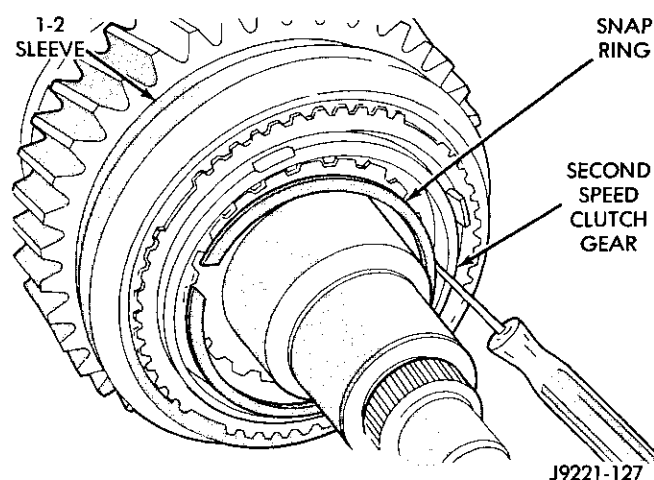
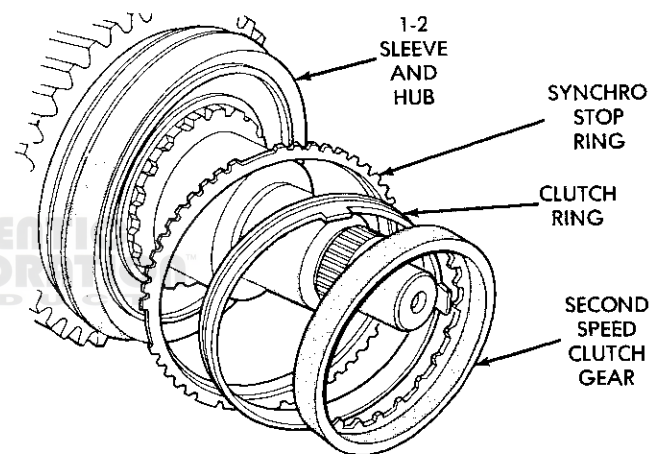
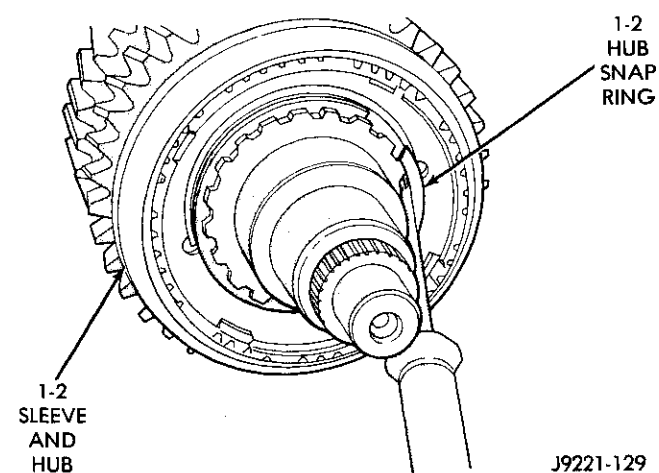
Fig. 76 Third Gear Needle Bearing Removal

J9221-122

Fig. 77 Bearing Spacer And Snap Ring Location

J9221-123

Fig. 78 Second Gear Thrust Washer Removal

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 79 Second Gear Removal****Fig. 80 Second Gear Bearing Removal****Fig. 81 Thrust Washer Locating Pin Removal****Fig. 82 Removing Second Speed Clutch Gear Snap Ring****Fig. 83 Second Speed Clutch Gear, Clutch Ring And Stop Ring Removal****Fig. 84 Removing 1-2 Sleeve And Hub Snap Ring**

DISASSEMBLY AND ASSEMBLY (Continued)

(16) Mark position of 1-2 synchro sleeve and hub for assembly reference. Side of hub with flat hub spring goes toward front (Fig. 85). Note that tapered side of sleeve also goes toward front.

(17) Remove 1-2 synchro sleeve, hub, struts and springs as an assembly (Fig. 85). It is not necessary to disassemble synchro components unless worn, or damaged.

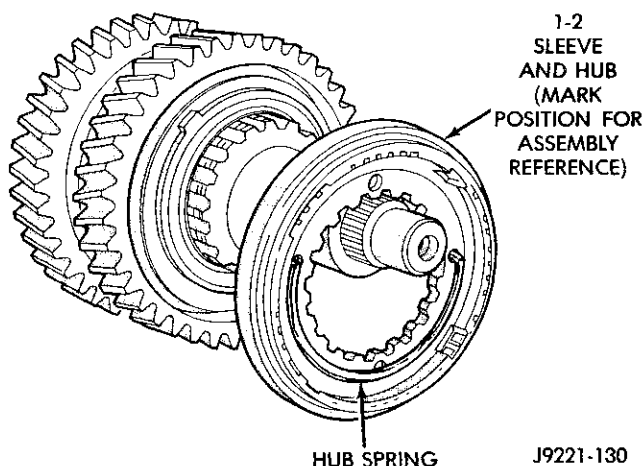


Fig. 85 Removing 1-2 Synchro Sleeve And Hub

(18) Remove first gear synchro stop ring and clutch ring (Fig. 86).

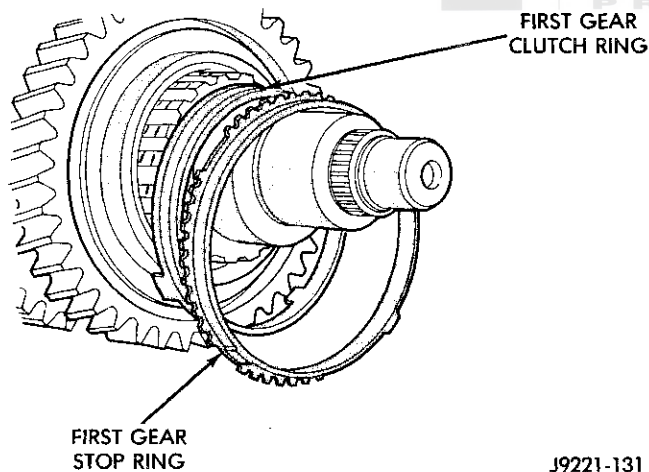


Fig. 86 First Gear Stop And Clutch Ring Removal

(19) Remove first speed clutch gear front snap ring from mainshaft hub (Fig. 87).

(20) Remove first speed clutch gear (Fig. 88).

(21) Remove first speed clutch gear rear snap ring from mainshaft hub (Fig. 88). It is not really necessary to remove this snap ring unless it, or the mainshaft is to be replaced.

(22) Remove mainshaft rear bearing as follows:

(a) Assemble Puller Flange 6444-1 and Puller Rods 6444-3 (Fig. 89).

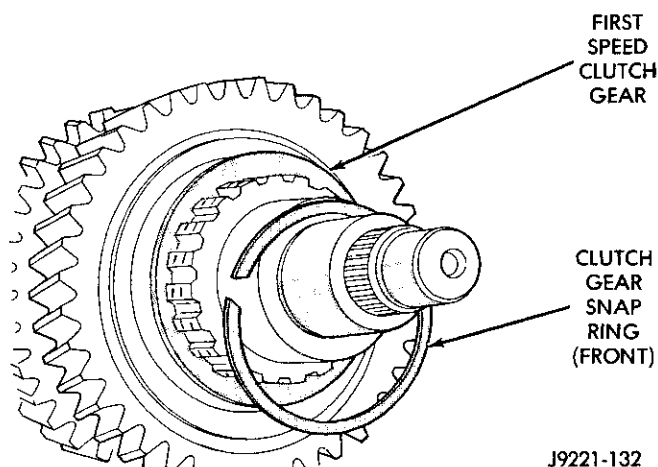


Fig. 87 First Speed Clutch Gear Front Snap Ring Removal

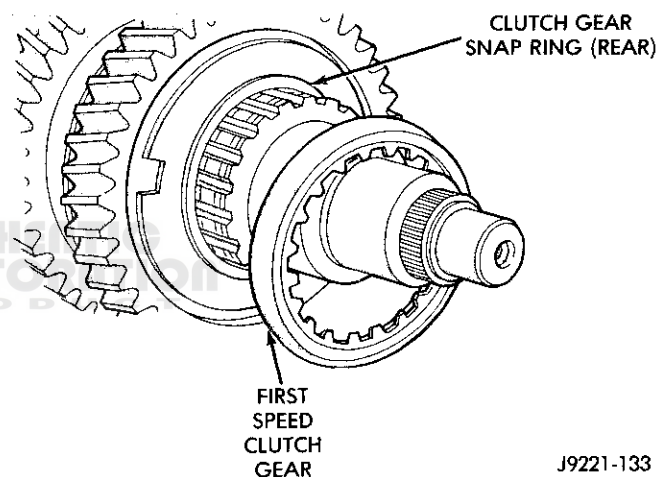


Fig. 88 First Speed Clutch Gear Removal

(b) Position first Puller Jaw 6445 on bearing cone (Fig. 89).

(c) Seat Puller Flange 6444-1 in notch of first puller jaw (Fig. 89).

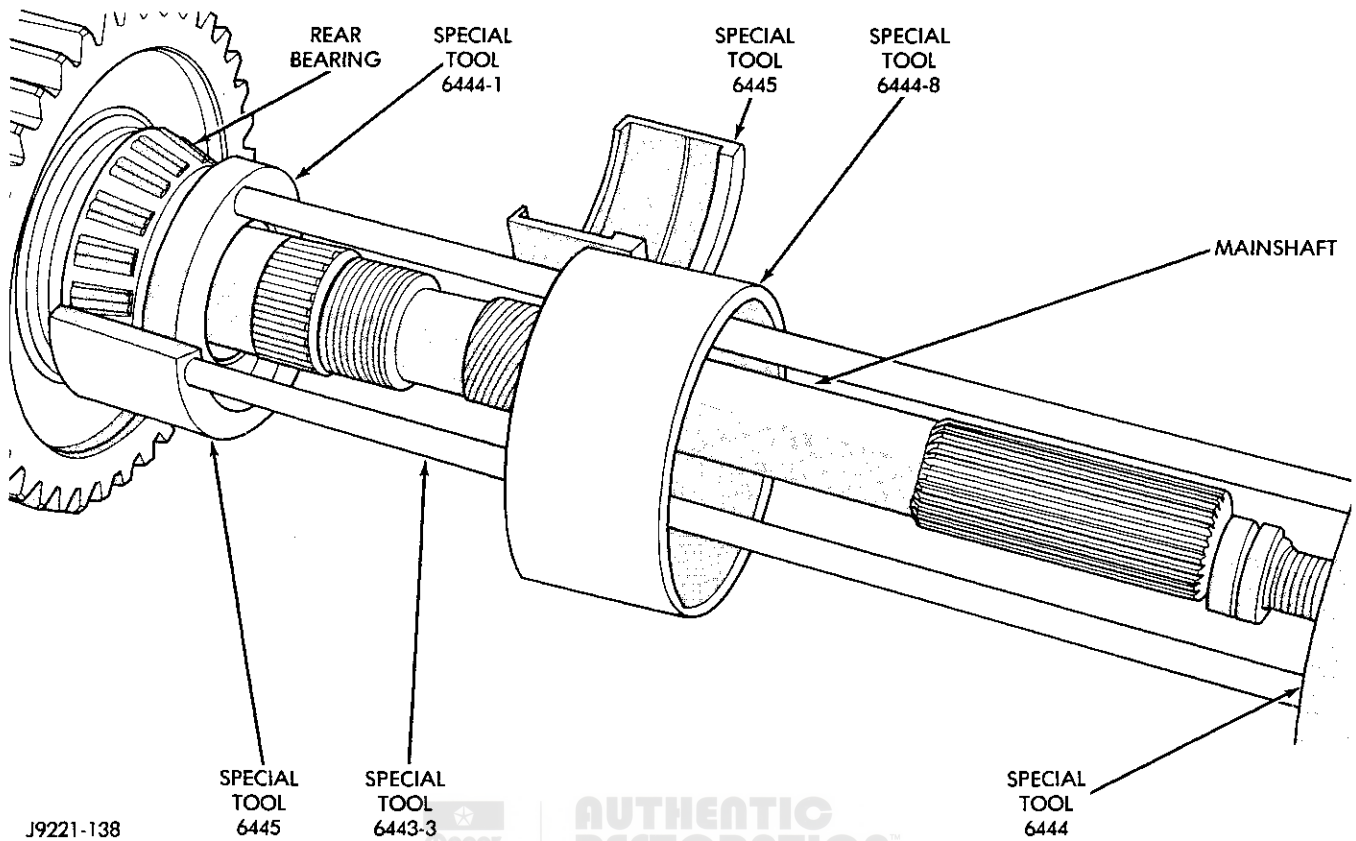
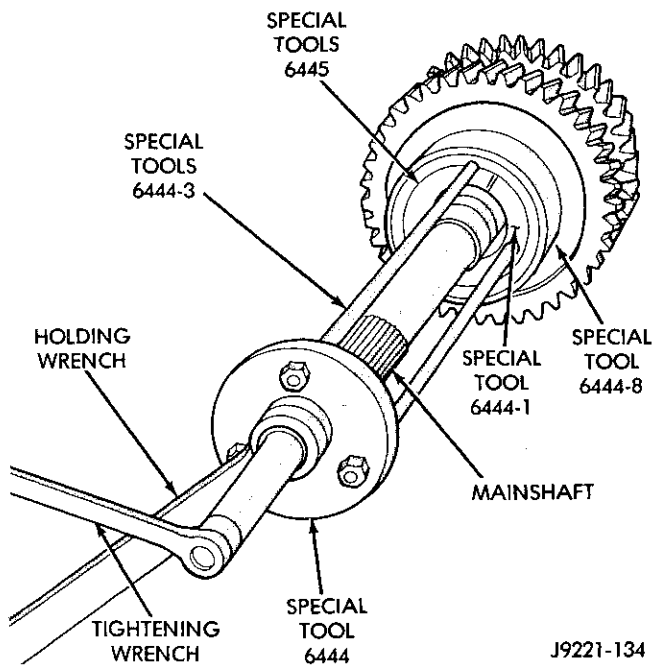
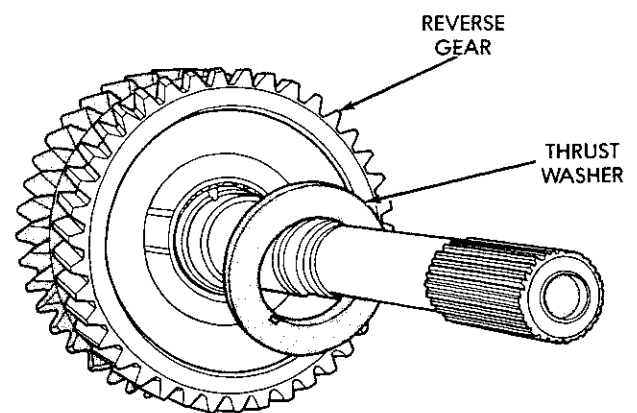
(d) Install second Puller Jaw 6445 on bearing cone and on puller flange (Fig. 89).

(e) Install Puller 6444 on puller rods. Then secure puller to rods with retaining nuts (Fig. 90).

(f) Place holding wrench on hex at top of puller (Fig. 90). Then tighten puller bolt with adjustable wrench to remove bearing from shaft (Fig. 90). If bearing proves difficult to remove, tap end of puller bolt with copper hammer after each turn of bolt. This will help loosen bearing on shaft and ease removal.

(23) Remove bearing puller tools.

(24) Remove reverse gear thrust washer (Fig. 91).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 89 Assembling Mainshaft Rear Bearing Puller Tools****Fig. 90 Removing Mainshaft Rear Bearing**

J9221-135

Fig. 91 Reverse Gear Thrust Washer Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(25) Remove reverse gear thrust washer locating pin (Fig. 92).

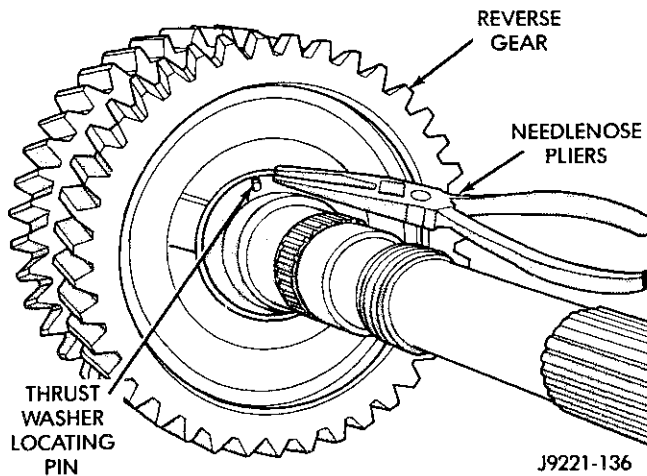


Fig. 92 Removing Thrust Washer Locating Pin

(26) Remove reverse gear and synchro components as assembly (Fig. 93). It is not necessary to remove or disassemble synchro components unless they are damaged and need to be replaced. If synchro sleeve or struts require service, mark position of sleeve on hub before removal. Correct sleeve position is important as sleeve can be installed backwards causing shift problems.

(27) Remove reverse gear bearing assembly from mainshaft (Fig. 93).

(28) Remove reverse gear synchro stop ring and clutch gear (Fig. 93).

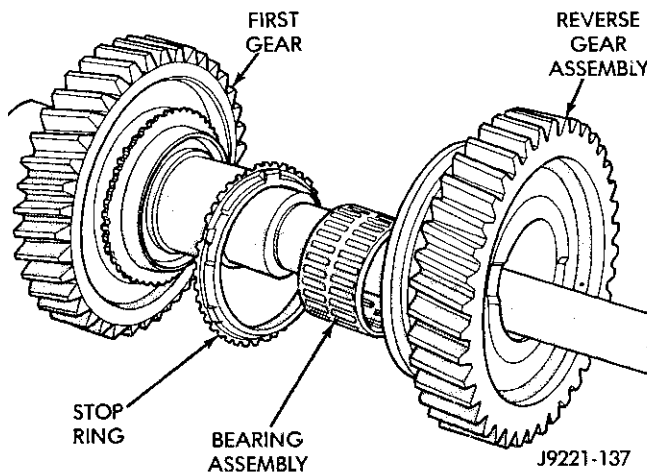


Fig. 93 Reverse Gear, Bearing And Stop Ring Removal

(29) Remove reverse gear bearing spacer from mainshaft (Fig. 94).

(30) Remove first gear snap ring (Fig. 94). Tension of this snap ring is considerable. Heavy duty snap ring pliers will be required to spread the ring far enough to remove it.

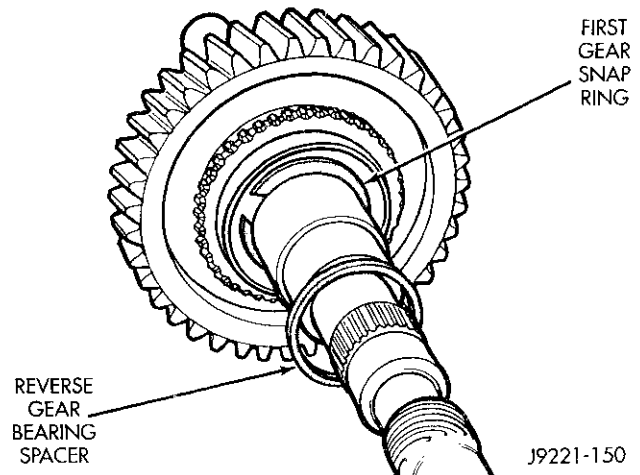


Fig. 94 Reverse Gear Bearing Spacer And First Gear Snap Ring Removal

(31) Remove reverse clutch gear (Fig. 95).

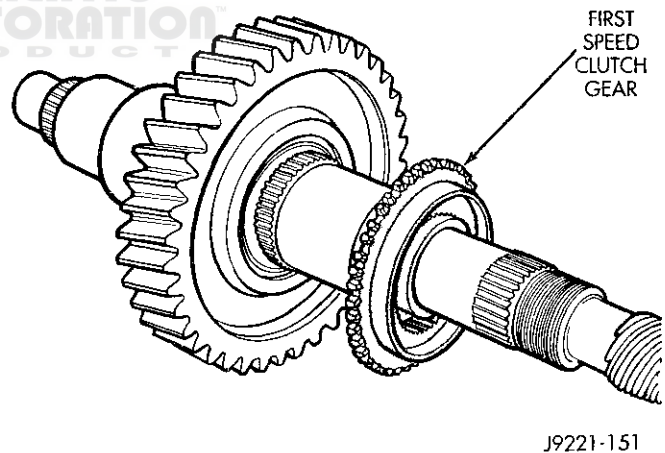
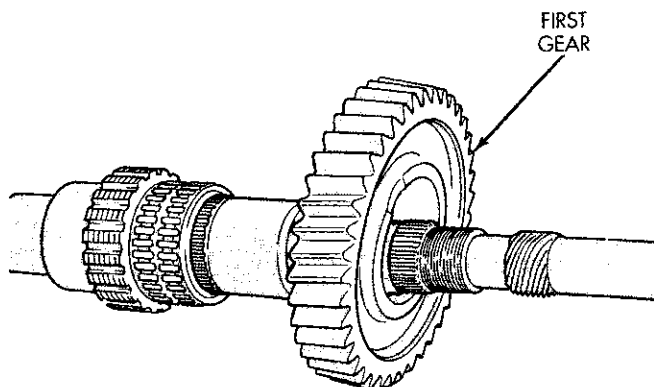


Fig. 95 Removing Reverse Clutch Gear

DISASSEMBLY AND ASSEMBLY (Continued)

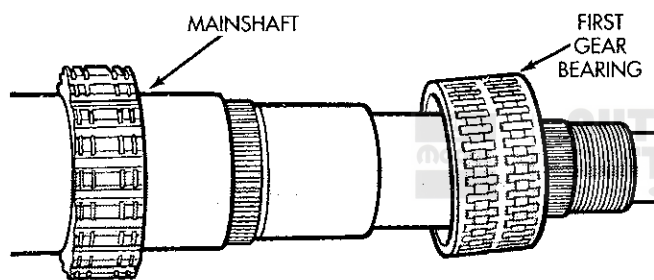
(32) Remove first gear from bearing and mainshaft (Fig. 96).



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Fig. 96 Removing First Gear

(33) Remove first gear bearing from mainshaft (Fig. 97).



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Fig. 97 Removing First Gear Bearing**TRANSMISSION ASSEMBLY INFORMATION**

NOTE: Gaskets are not used in the NV4500 transmission. Use Mopar Gasket Maker, silicone adhesive/sealer, or Loctite 518 on all gear case and extension housing sealing surfaces.

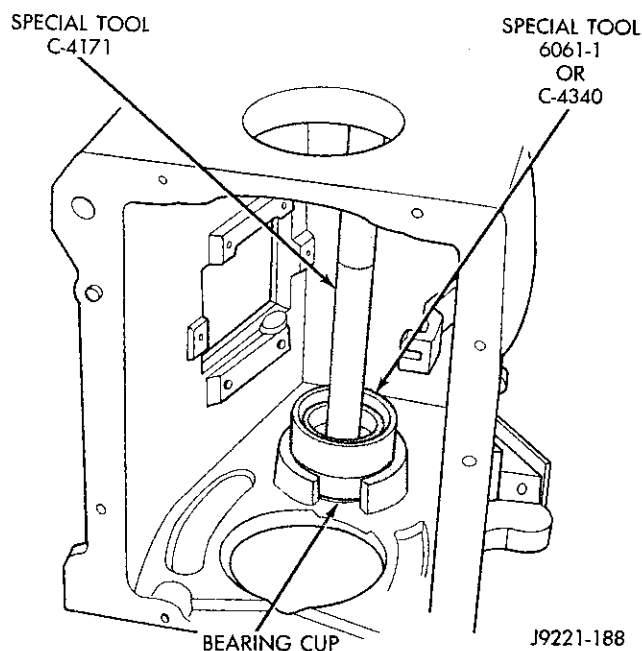
ADJUSTMENT SPECIFICATIONS

- Countershaft End Play: 0.051-0.15 mm (0.002-0.006 in.)
- Mainshaft End Play: 0.051-0.15 mm (0.002-0.006 in.)

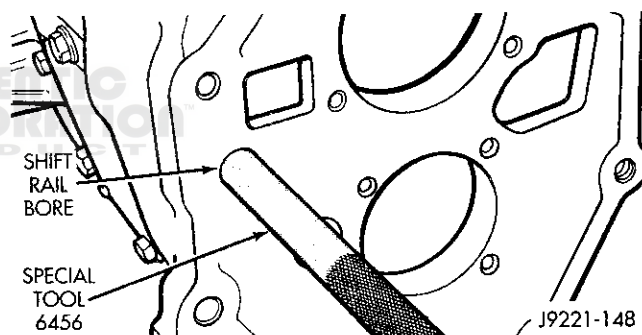
GEAR CASE ASSEMBLY

(1) Install countershaft front bearing cup in case with Tool Handle C-4171 and Installer Tool 6061-1 or C-4340 (Fig. 98).

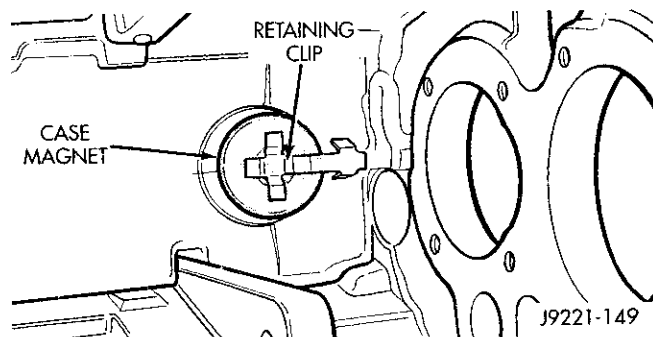
(2) Install new bushings in shift lug rail bores with Tool 6456 (Fig. 99). Seat bushings flush with bores.



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Fig. 98 Installing Countershaft Front Bearing Cup**Fig. 99 Installing Shift Lug Rail Bushings**

(3) If case magnet was removed, install and secure magnet in clip at bottom of case (Fig. 100).

**Fig. 100 Gear Case Magnet Installation**

DISASSEMBLY AND ASSEMBLY (Continued)**COUNTERSHAFT AND REVERSE IDLER GEAR INSTALLATION**

(1) Install front bearing on countershaft with Installer Tool 6446 (Fig. 101).

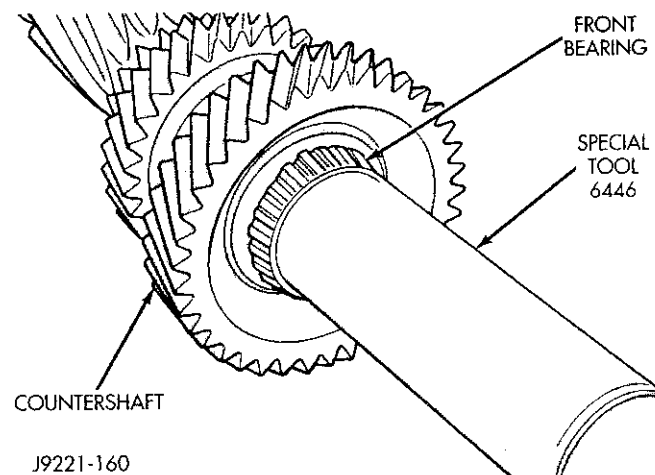


Fig. 101 Countershaft Front Bearing Installation

(2) Lubricate countershaft front bearing cup and cone with petroleum jelly.

(3) Position gear case on end with rear of case facing up (Fig. 102).

(4) Install countershaft in gear case (Fig. 102). **Do not install rear bearing on countershaft rear at this time.**

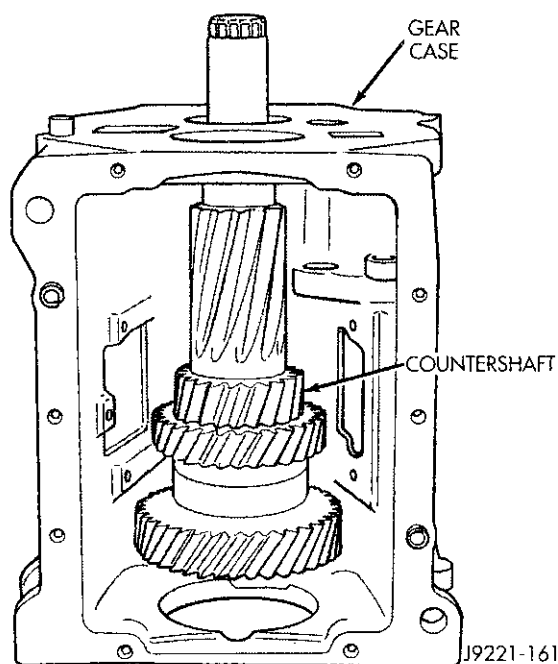


Fig. 102 Positioning Countershaft In Gear Case

(5) Lubricate reverse idler gear bearings with petroleum jelly and install first bearing, bearing spacer and second bearing (Fig. 103).

(6) Install idler gear front thrust washer on boss in gear case (Fig. 103). Coat thrust washer with liberal quantity of petroleum jelly to hold it in place.

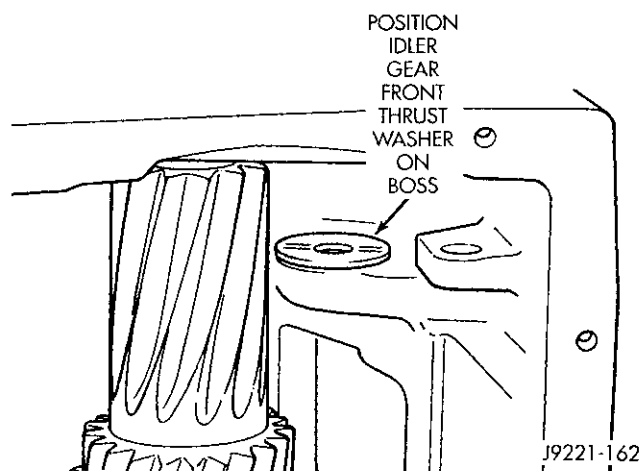


Fig. 103 Positioning Idler Gear Front Thrust Washer In Case

(7) Install reverse idler gear in case (Fig. 104).

(8) Install idler gear rear thrust washer between idler gear and case boss (Fig. 104).

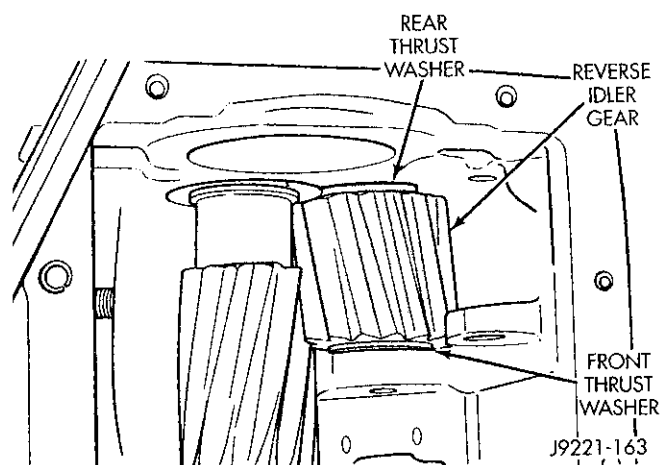


Fig. 104 Idler Gear And Thrust Washer Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(9) Align idler gear bearings and thrust washers with drift.

(10) Install reverse idler shaft (Fig. 105). Be sure notched end of shaft is facing countershaft as shown. Use shift cover bolt to hold and insert shaft in case bore.

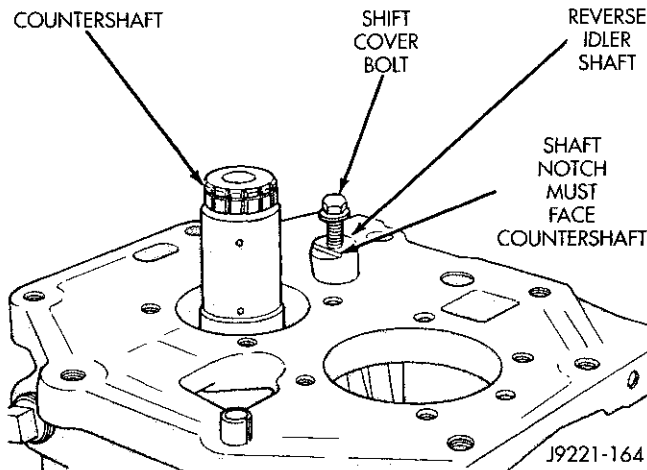


Fig. 105 Reverse Idler Shaft Installation

(11) Lift countershaft upward and position wood block between front of shaft and case (Fig. 106).

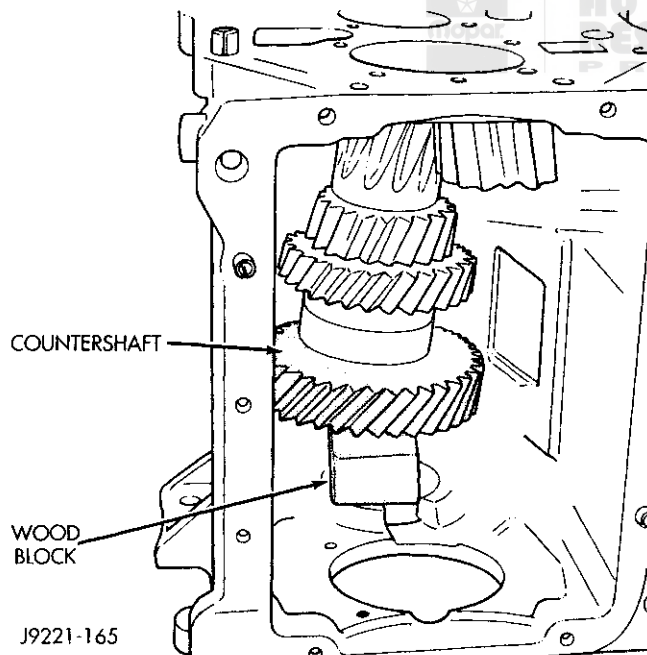


Fig. 106 Supporting Countershaft With Wood Block

(12) Install rear bearing cone on countershaft with Installer Tool C-4040 or 6446 (Fig. 107).

(13) Remove wood block from under countershaft and lower countershaft front bearing into front bearing cup.

(14) Install new front bearing cap in gear case (Fig. 108). Apply Mopar silicone adhesive/sealer to

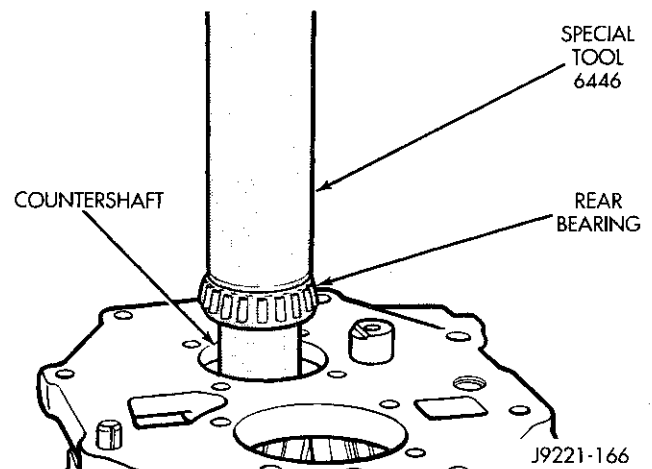


Fig. 107 Installing Countershaft Rear Bearing

flange and lip of new cap. Then seat cap in case bore with wood block and mallet.

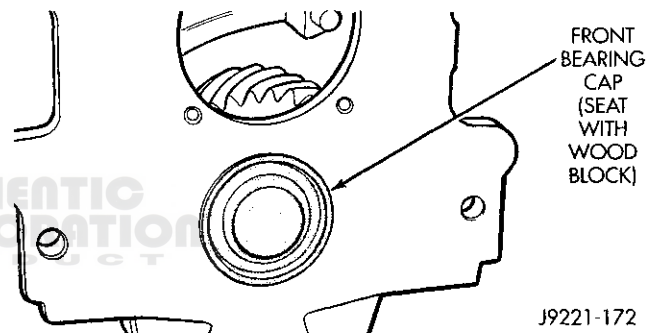


Fig. 108 Countershaft Front Bearing Cap Installation

(15) Lubricate countershaft rear bearing cup and cone with petroleum jelly.

(16) Install countershaft rear bearing cup in gear case and over rear bearing (Fig. 109). Tap cup into place with plastic mallet if necessary.

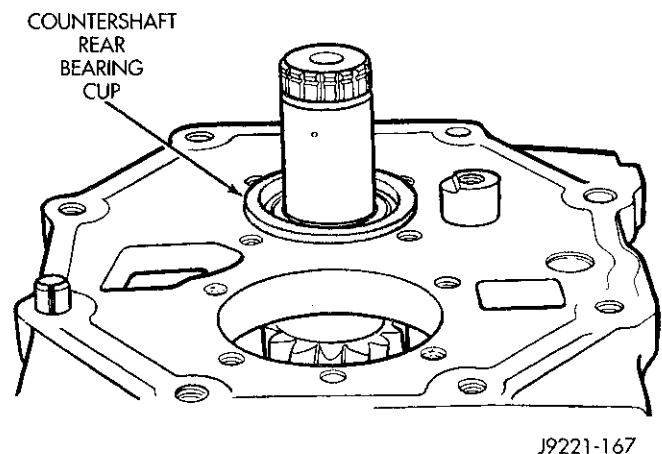


Fig. 109 Countershaft Rear Bearing Cup Installation

DISASSEMBLY AND ASSEMBLY (Continued)**ADJUSTING COUNTERSHAFT END PLAY**

(1) Install countershaft rear bearing plate (Fig. 110). Be sure plate is seated in notch in reverse idler shaft before tightening bearing plate bolts.

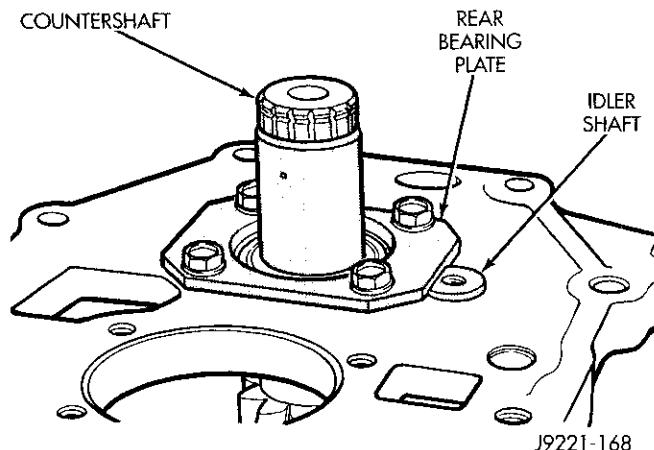


Fig. 110 Countershaft Rear Bearing Plate Installation

(2) Rotate countershaft 4-5 times to seat bearings.

(3) Mount dial indicator on case. Then position indicator plunger on end of countershaft and zero indicator dial needle (Fig. 111).

(4) Raise countershaft with screwdriver and note end play reading on dial indicator. End play should be 0.051 - 0.15 mm (0.002 - 0.006 in.).

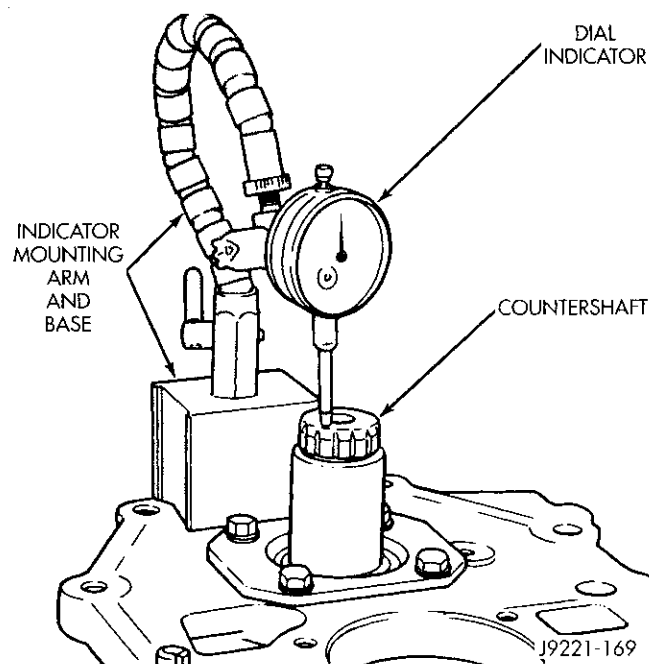


Fig. 111 Measuring Countershaft End Play

(5) Remove countershaft rear bearing plate.

(6) Select and install end play shim that will provide minimum countershaft end play. Position shim on rear bearing cup (Fig. 112).

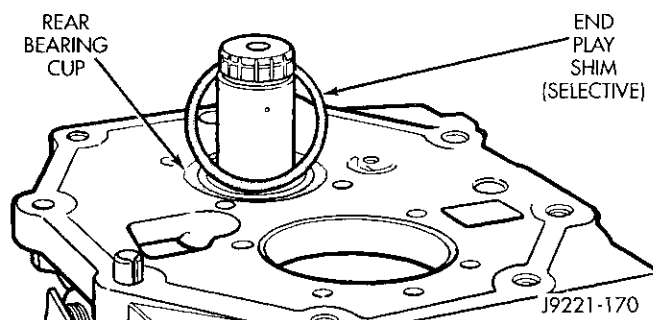


Fig. 112 Installing Countershaft End Play Shim

(7) Reinstall countershaft rear bearing plate (Fig. 110). Be sure plate is seated in reverse idler shaft notch before installing bolts. Also be sure end play shims are still in position before tightening bearing plate bolts.

(8) Apply 1-2 drops Mopar Loc N' Seal or Loctite 242 to threads of rear bearing plate bolts. Then install and tighten bearing plate bolts to 23 N·m (200 in. lbs.) torque.

SHIFT LUG AND RAIL INSTALLATION

(1) Lubricate shift lug, rail and bushings with Castrol Syntorq.

(2) Insert shift lug rail part way into case.

(3) Install shift lug on rail. Note position of

(4) Position shift rail so roll pin notches are at approximately 5 o'clock position (Fig. 113).

(5) Install roll pin that secures lug to rail (Fig. 113).

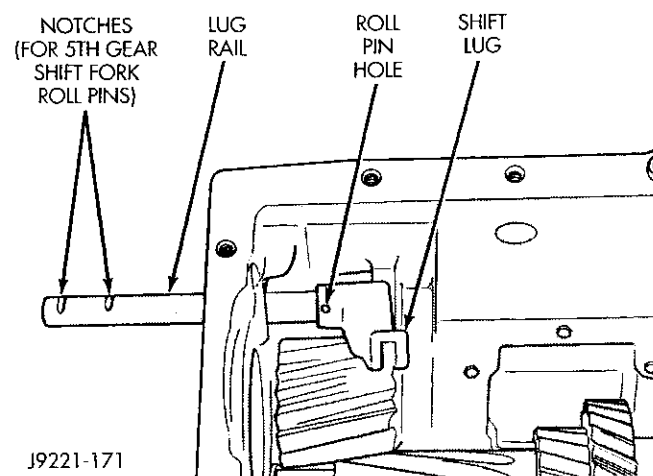


Fig. 113 Shift Lug And Rail Installation

DISASSEMBLY AND ASSEMBLY (Continued)

MAINSHAFT AND GEARTRAIN ASSEMBLY

CAUTION: The reverse, 1-2 and 3-4 synchro components can be assembled and installed incorrectly if care is not exercised. Some components can be installed backwards resulting in shift problems. Refer to the assembly procedures for component identification and location.

(1) Lubricate mainshaft bearing surfaces and all bearing assemblies with Castrol Syntorq or with petroleum jelly.

(2) Install first snap ring in rearmost groove of mainshaft hub (Fig. 114). This snap ring locates first speed clutch gear on shaft. A total of four of these snap rings are used to secure various components on the mainshaft 1-2 synchro hub. The snap rings are all the same size and are interchangeable.

(3) Install first gear bearing assembly on mainshaft (Fig. 114).

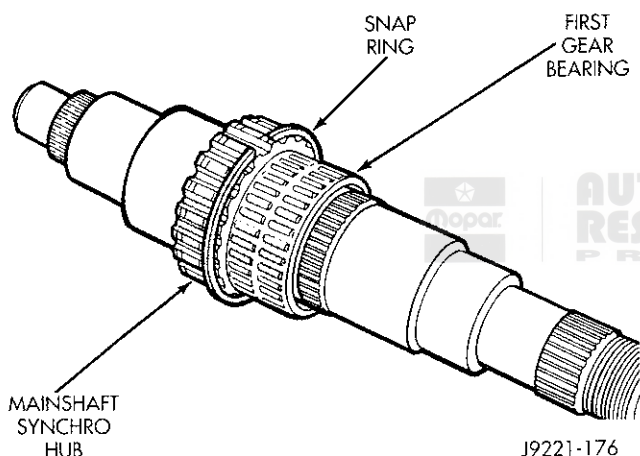


Fig. 114 First Gear Bearing and Snap Ring Installation

(4) If desired, mainshaft can be placed in upright (vertical) position and supported with wood blocks (Fig. 115). Reverse gear components are easier to install with shaft upright.

(5) Install first gear and bearing on shaft (Fig. 115). Clutch hub side of gear faces front of shaft.

(6) Install clutch gear on first gear (Fig. 115). Be sure clutch gear is seated on shaft splines.

(7) Install first gear snap ring (Fig. 115). Use heavy duty snap ring pliers to install this snap ring as ring tension is considerable. **Do not overspread snap ring and make sure it is fully seated in groove. Reverse gear will not fit properly if snap ring is not fully seated.**

(8) Install stop ring on clutch gear (Fig. 116). Be sure stop ring is fully seated on gear taper.

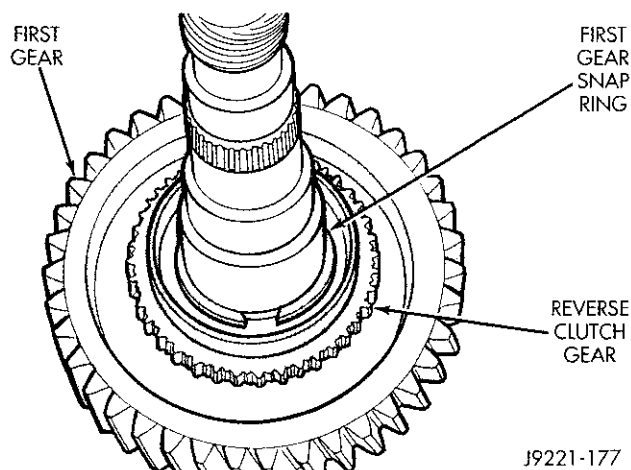


Fig. 115 First Gear, Clutch Gear And Snap Ring Installation

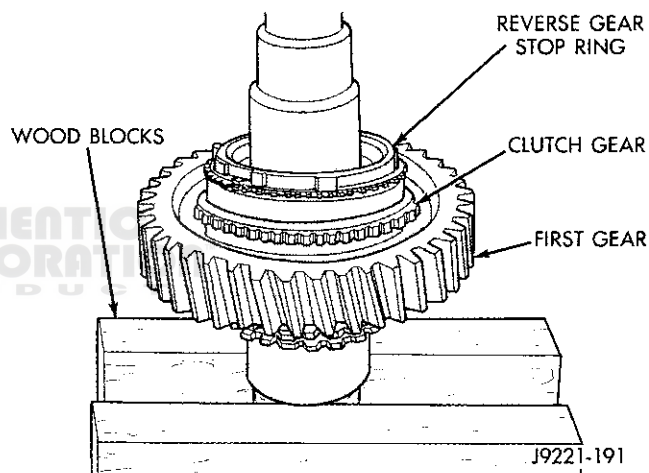


Fig. 116 Clutch Gear Stop Ring Installation

(9) Install reverse gear bearing spacer on mainshaft (Fig. 117). Bearing spacer seats against first gear snap ring.

(10) Install reverse gear bearing on mainshaft (Fig. 117).

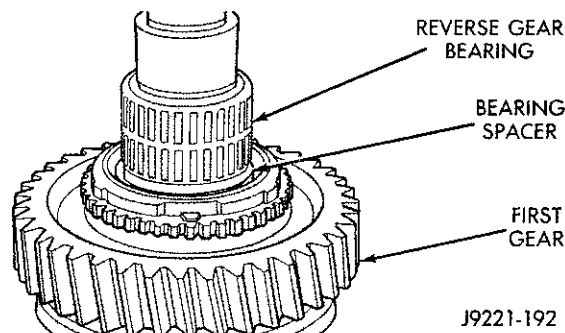


Fig. 117 Reverse Gear Bearing And Spacer Installation

DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: The reverse sleeve will fit either way on the hub. This means the sleeve can be installed backwards if care is not exercised. Be sure the tapered side of the sleeve faces rearward after installation.

(11) If reverse gear sleeve and struts were disassembled for service, reassemble sleeve, struts and springs as follows:

(a) Position sleeve on hub so **tapered side of sleeve faces rearward**. Sleeve will fit either way but will cause shift problems if installed backwards (Fig. 118).

(b) Rotate sleeve to align teeth on sleeve and hub. Sleeve will slide easily into place on hub when properly aligned.

(c) Install springs in gear hub (Fig. 118). Use petroleum jelly to hold springs in place if desired.

(d) Compress first spring with flat blade screwdriver and slide strut into position in hub slot. Then work spring into seat in strut with small hooked tool, or screwdriver.

(e) Install second and third struts in same manner as described in step (d).

(f) Work sleeve upward on hub until struts are centered and seated in sleeve. Sleeve should be in neutral position after seating struts.

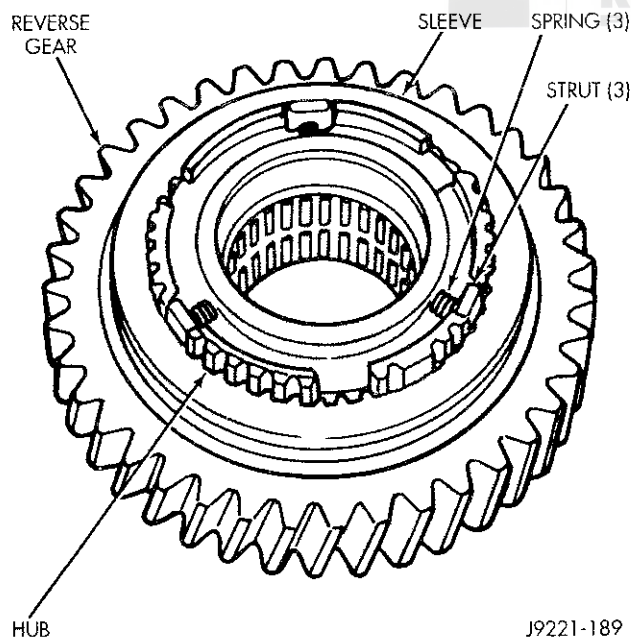


Fig. 118 Reverse Gear Synchro Assembly

(12) Install reverse gear and synchro assembly on mainshaft (Fig. 119). Rotate assembly until stop ring lugs engage in hub slots and gear drops into fully seated position.

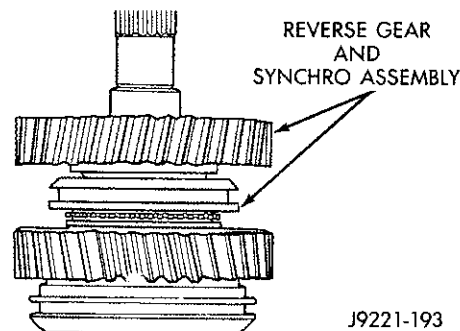


Fig. 119 Reverse Gear Installation

(13) Install reverse gear thrust washer pin in mainshaft (Fig. 120). Use needle nose pliers to install pin.

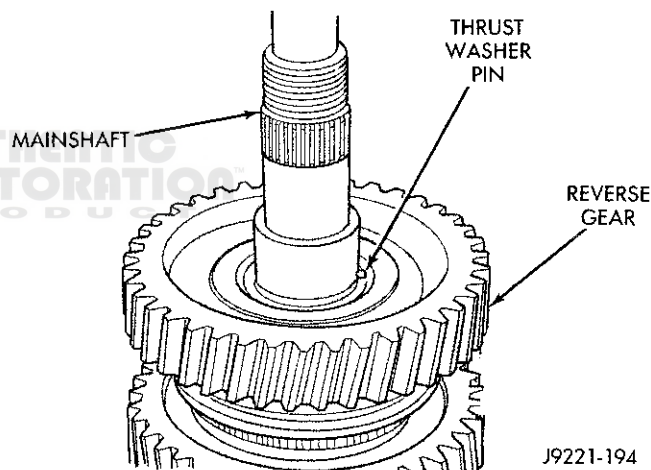


Fig. 120 Thrust Washer Pin Installation

(14) Install reverse gear thrust washer (Fig. 121). Be sure locating pin is seated in thrust washer notch.

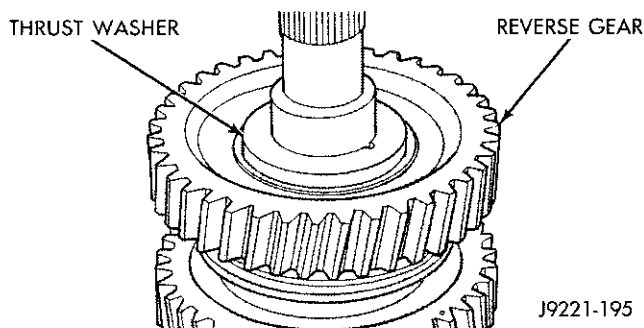


Fig. 121 Reverse Gear Thrust Washer Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(15) Install rear bearing on mainshaft. Use Installer Tool 6446 to seat bearing on shaft and against thrust washer (Fig. 122). If bearing is not fully seated on shaft, seat bearing by tapping inner race with small brass punch and hammer. Bearing inner race should be flush with shaft.

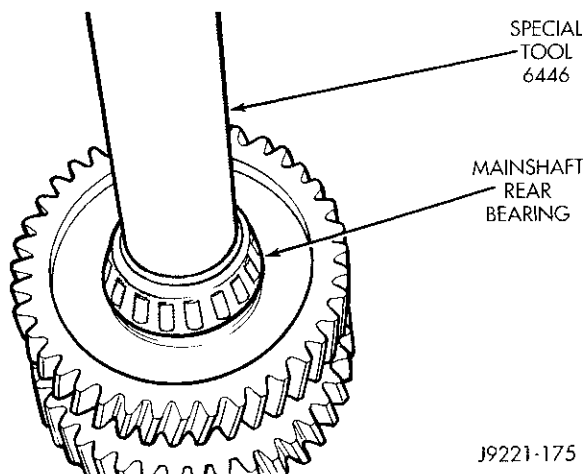


Fig. 122 Installing Mainshaft Rear Bearing

(16) Turn mainshaft over and place it in horizontal position on workbench.

(17) Install first speed clutch gear on mainshaft 1-2 synchro hub (Fig. 123). Recessed side of gear faces front. Be sure gear is seated against snap ring previously installed on hub.

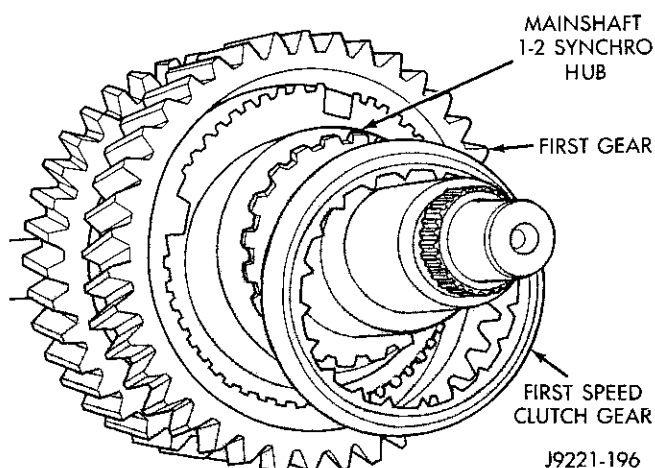


Fig. 123 Installing First Speed Clutch Gear

(18) Install snap ring on mainshaft 1-2 synchro hub to secure clutch gear (Fig. 124). Be sure snap ring is fully seated in hub groove and against clutch gear. Note that this is second of four snap rings used to secure synchro components on shaft hub.

(19) Assemble first speed clutch ring and stop ring (Fig. 125).

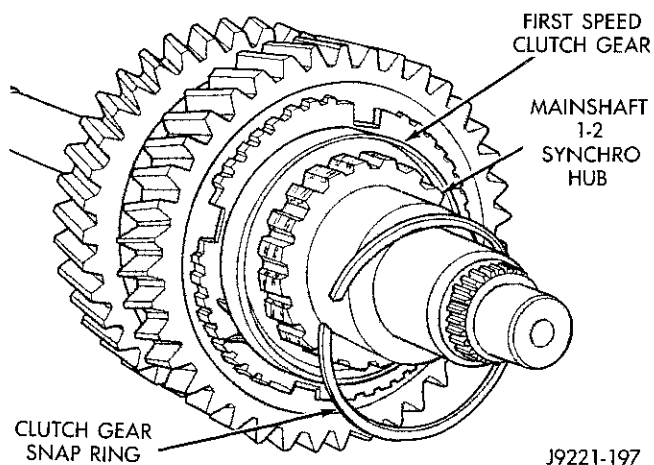


Fig. 124 Installing First Speed Clutch Gear Snap Ring

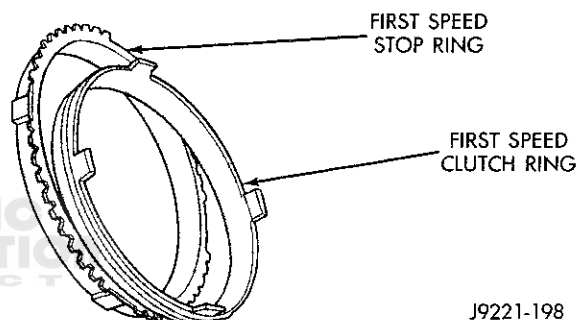


Fig. 125 Assembling First Speed Clutch And Stop Rings

(20) Install assembled first speed clutch and stop rings on clutch gear (Fig. 126). Be sure tabs on clutch ring are aligned and seated in first gear hub. 1-2 synchro hub will not seat properly if clutch ring tabs are misaligned.

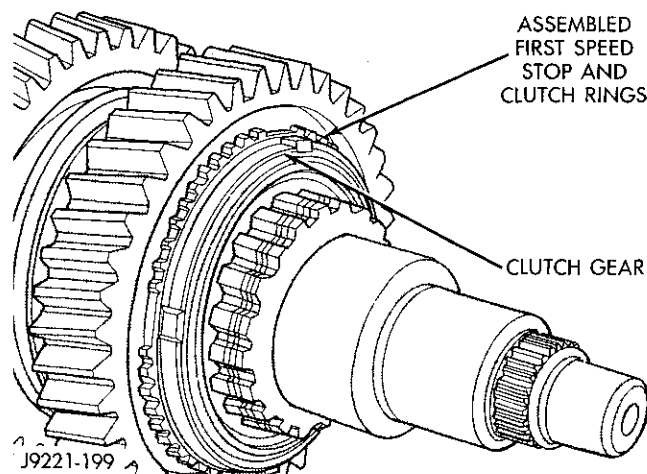


Fig. 126 First Speed Clutch And Stop Ring Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(21) Support mainshaft in upright position (Fig. 127). Remaining gears, snap rings and synchro components are easier to install with shaft in upright position. Shaft can be supported in gear case as shown, or hole can be cut in workbench to support shaft.

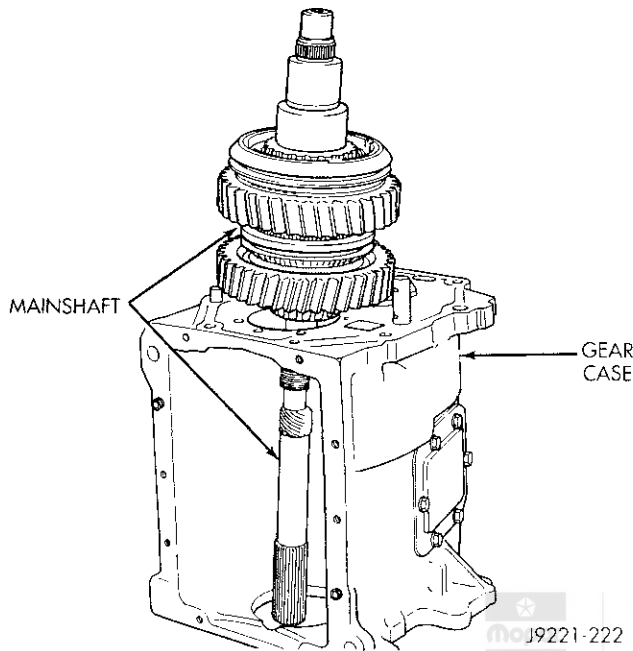


Fig. 127 Mainshaft Positioned For Gear And Synchro Installation

(22) If 1-2 synchro hub and sleeve were disassembled for service, reassemble hub, sleeve, struts and springs as follows:

(a) Install weights in hub (Fig. 128). Use petroleum jelly to hold weights in place if desired.

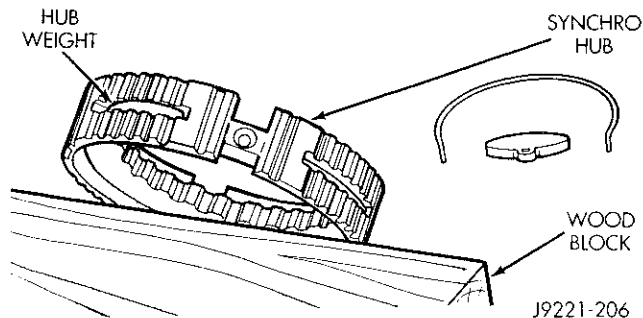


Fig. 128 Installing Weights In 1-2 Synchro Hub

(b) Install weight retainer springs. Flat spring goes at front side of hub (Fig. 129). Be sure retainer spring ends are securely engaged in weight slots as shown.

(c) Place synchro hub on bench so side of hub with square spring is facing up (Fig. 130).

(d) Align and install sleeve on hub. Be sure tapered side of sleeve faces upward (toward front).

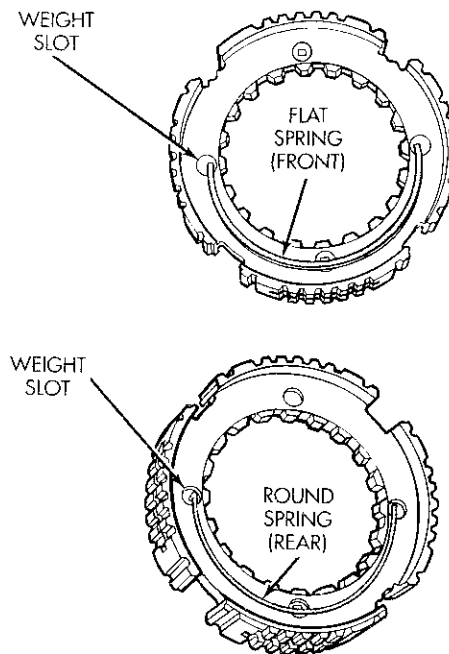


Fig. 129 Installing Weight Retainer Springs In 1-2 Synchro Hub

Rotate sleeve until it slides onto hub. Sleeve only fits one way and will easily slide onto hub when long slot in sleeve, aligns with long shoulder on hub (Fig. 130).

(e) Place wood blocks under hub that will raise hub about 3.5 cm (1.375 in.) above surface of workbench. Then allow sleeve to drop down on hub (Fig. 131).

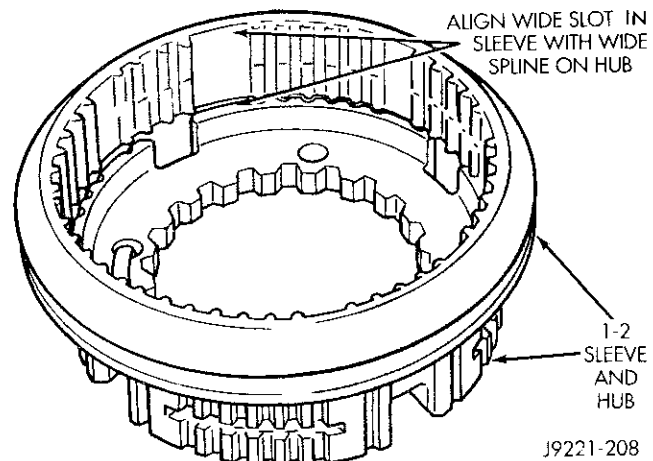


Fig. 130 Installing 1-2 Synchro Sleeve On Hub

(f) Install springs and struts in hub (Fig. 131). Use lots of petroleum jelly to hold them in place. Then compress struts with your fingers and move sleeve upward until struts are started in sleeve. Verify that struts are engaged in sleeve before proceeding.

DISASSEMBLY AND ASSEMBLY (Continued)

(g) Turn synchro assembly upright. Then move sleeve into neutral position on hub and work struts into sleeve at same time. Be sure struts are seated and springs are not displaced during assembly.

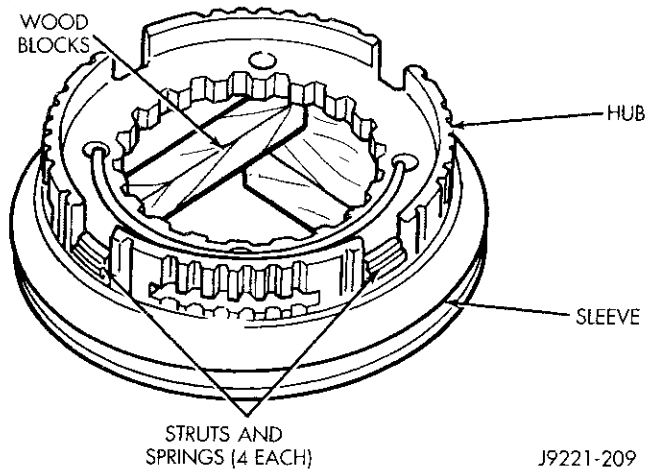


Fig. 131 Installing 1-2 Synchro Struts And Springs

(23) Install first speed stop ring in 1-2 synchro hub and sleeve (Fig. 132). Be sure stop ring is fully seated and engaged in hub and sleeve.

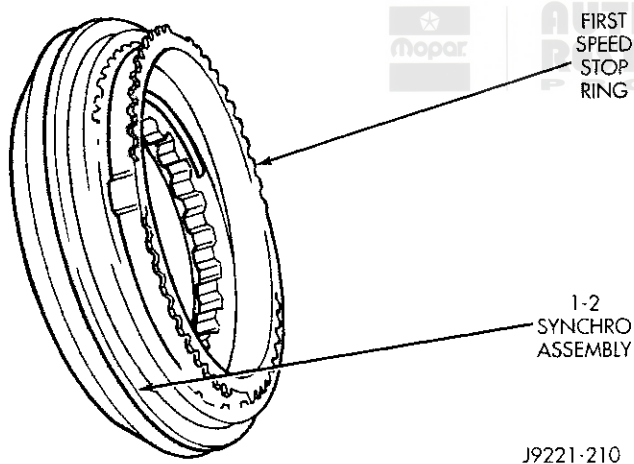


Fig. 132 Installing First Speed Stop Ring In Synchro Hub

(24) Install 1-2 synchro assembly and stop ring on mainshaft. Rotate sleeve to align it with stop ring lugs if necessary. Then seat assembly on shaft (Fig. 133).

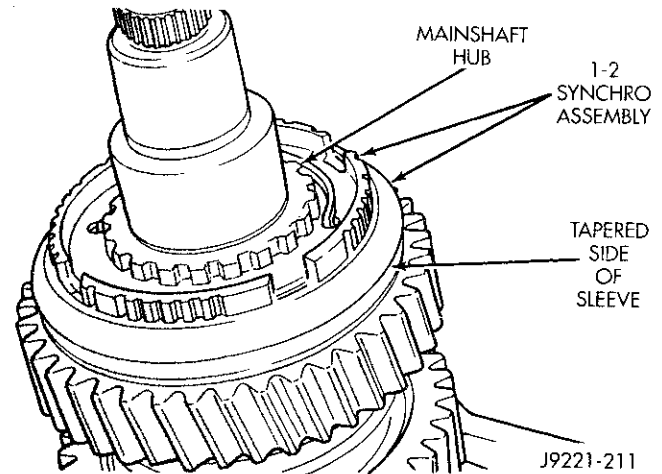


Fig. 133 1-2 Synchro Installation

(25) Check position of 1-2 and reverse synchro sleeves. Be sure tapered side of 1-2 sleeve faces front and tapered side of reverse sleeve faces rear (Fig. 134). Also be sure square spring is visible at forward side of 1-2 synchro hub. **Do not skip this check as transmission will not shift properly if either synchro sleeve is installed backwards.**

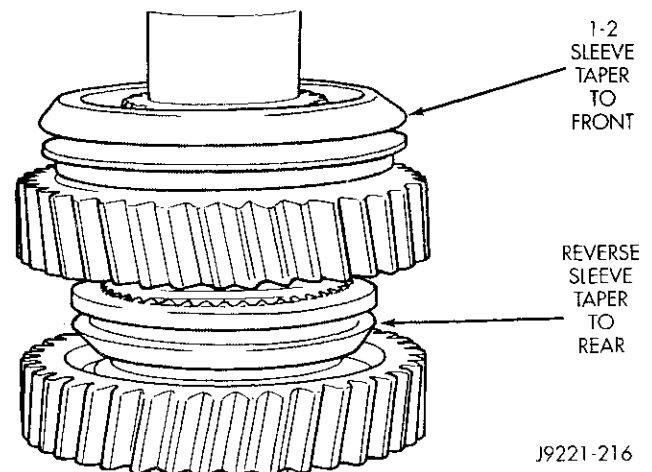


Fig. 134 Correct Position Of Reverse And 1-2 Synchro Sleeves

(26) Temporarily remove flat weight spring from front side of 1-2 synchro hub. Removing spring makes installation of 1-2 hub snap ring easier.

DISASSEMBLY AND ASSEMBLY (Continued)

(27) Install snap ring that secures 1-2 synchro on mainshaft hub (Fig. 135). Be sure snap ring is fully seated in ring groove in mainshaft hub. **If snap ring will not seat in groove, round weight spring at rear of 1-2 synchro hub is probably not seated in recess at front of first speed clutch gear. Or first speed clutch gear is slightly misaligned. Realign as needed to fully seat snap ring.**

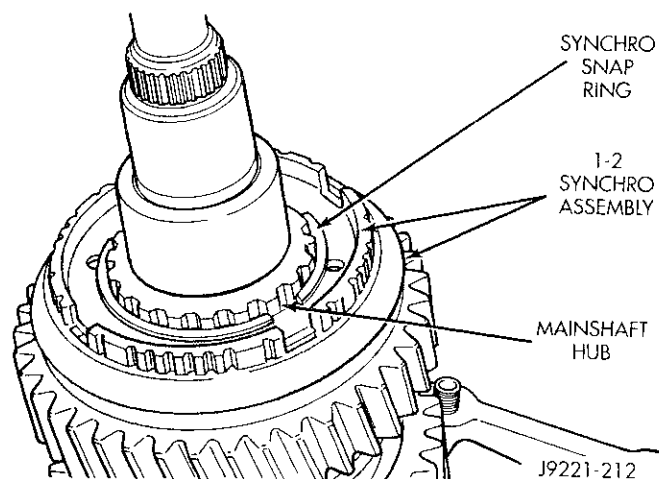


Fig. 135 Installing 1-2 Synchro Snap Ring

(28) Reinstall flat weight spring in 1-2 synchro hub (Fig. 136). Be sure spring ends are securely engaged in weight slots.

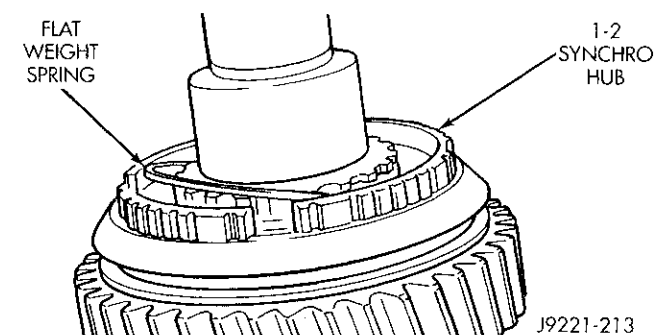
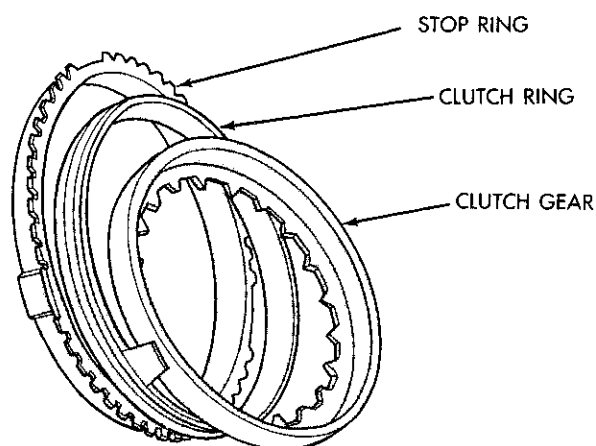


Fig. 136 Reinstalling Flat Weight Spring

(29) Assemble second speed clutch gear, clutch ring and stop ring (Fig. 137).

(30) Install assembled second speed clutch gear and rings on mainshaft and in 1-2 synchro hub (Fig. 138).

(31) Install snap ring that secures second speed clutch gear on mainshaft (Fig. 139). Use narrow blade screwdriver to work snap ring into hub groove as shown. **Be sure snap ring is fully engaged in mainshaft groove before proceeding. If snap ring will not fit in groove, clutch gear is slightly misaligned. Or, flat weight spring at front of 1-2 synchro hub is probably not seated in recess in front of second speed clutch gear.**



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Fig. 137 Assembling Second Speed Clutch Gear, Clutch Ring And Stop Ring

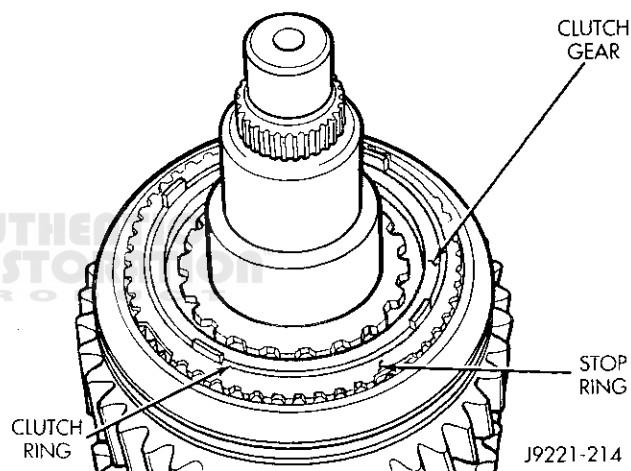


Fig. 138 Second Speed Clutch Gear, Clutch Ring And Stop Ring Installation

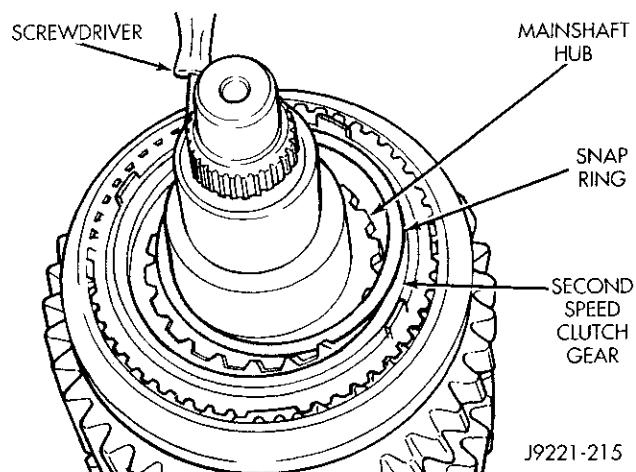


Fig. 139 Installing Second Speed Clutch Gear Snap Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(32) Install second gear bearing on mainshaft (Fig. 140).

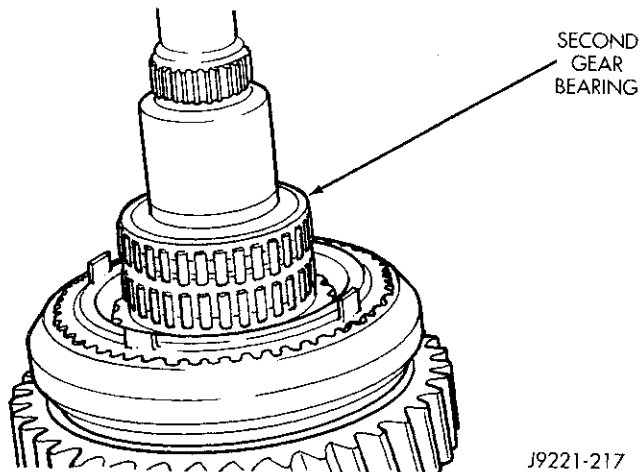


Fig. 140 Second Gear Bearing Installation

(33) Install second gear on mainshaft and bearing. Rotate gear until tabs of second speed clutch ring are fully seated in tab slots in gear (Fig. 141).

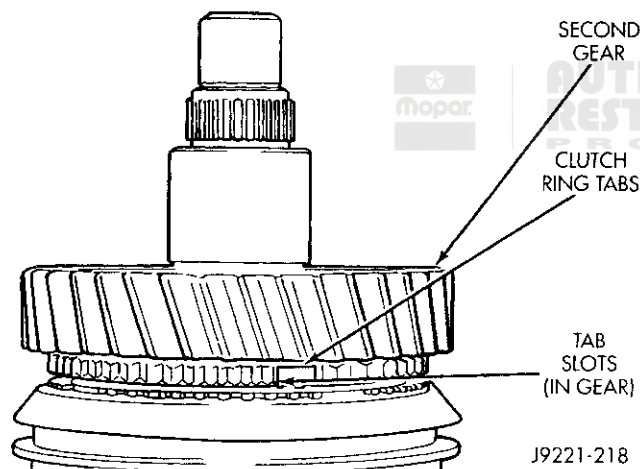


Fig. 141 Second Gear Installation

(34) Install thrust washer pin in shaft (Fig. 142). Use needle nose pliers to insert pin in shaft hole.

(35) Install second gear thrust washer. Be sure washer is seated on gear and pin (Fig. 143).

(36) Install second gear thrust washer snap ring (Fig. 144). Be sure snap ring is fully seated in mainshaft groove.

(37) Install third gear bearing spacer on shaft and seat it against thrust washer snap ring (Fig. 144).

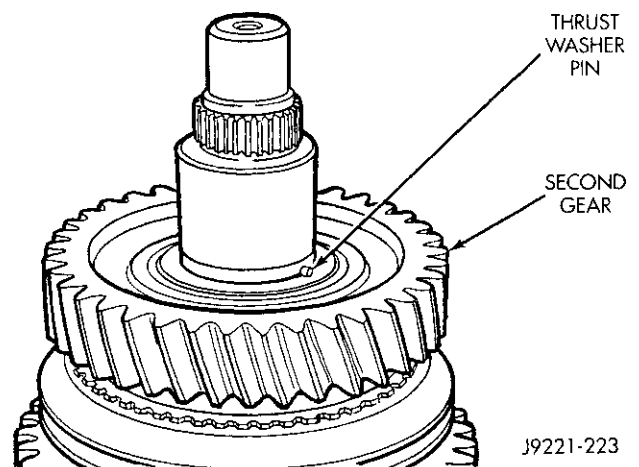


Fig. 142 Thrust Washer Pin Installation

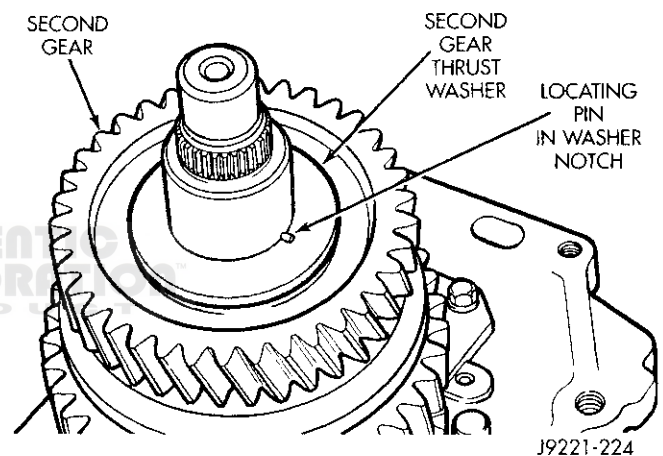


Fig. 143 Second Gear Thrust Washer Installation

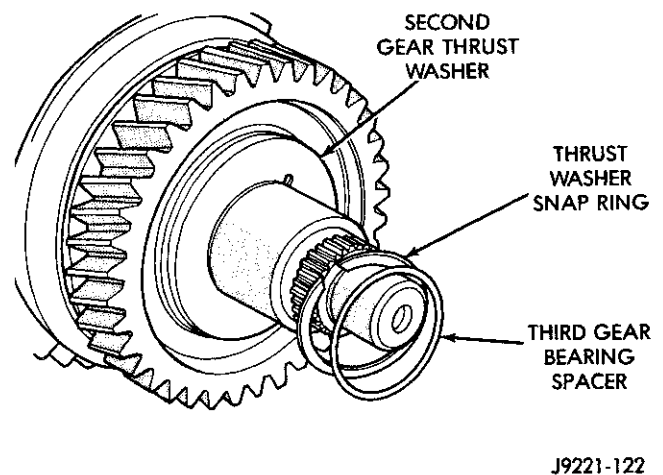


Fig. 144 Installing Snap Ring And Third Gear Bearing Spacer

DISASSEMBLY AND ASSEMBLY (Continued)

(38) Install third gear bearings on mainshaft (Fig. 145). Upper bearing should be flush with mainshaft hub. **If upper bearing is not flush with hub, either bearing spacer or snap ring was not installed.** Check and correct if necessary.

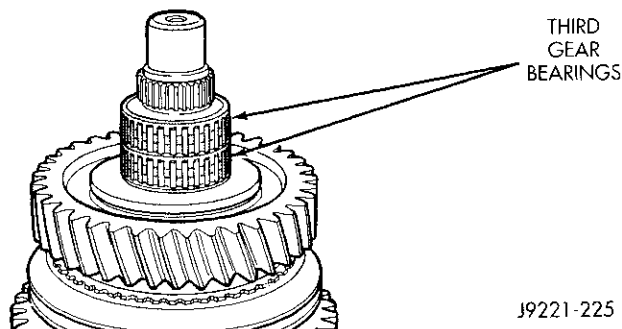


Fig. 145 Third Gear Bearing Installation

(39) Install third gear over bearings and on mainshaft (Fig. 146).

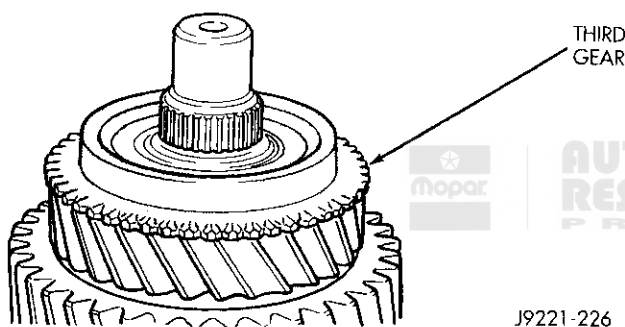


Fig. 146 Third Gear Installation

(40) Install synchro stop ring on third gear (Fig. 147). Be sure stop ring is fully seated on gear taper.

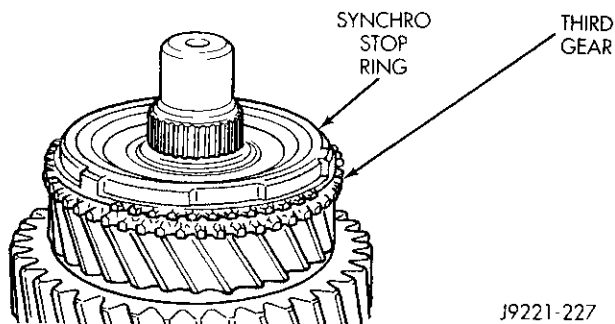


Fig. 147 Third Gear Stop Ring Installation

(41) If 3-4 synchro was disassembled for service, reassemble synchro components as follows:

(a) Align and install synchro sleeve on hub (Fig. 148). **Front side of hub has a narrow groove machined in it.**

(b) Insert all three synchro struts in slots machined in sleeve and hub (Fig. 148).

(c) Install and seat synchro springs (Fig. 148). Use flat blade or phillips screwdriver to compress springs and seat them in struts and hub as shown.

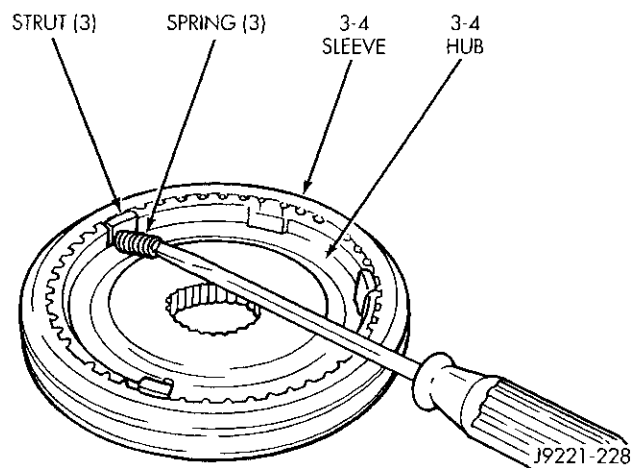


Fig. 148 Synchro Assembly (3-4)

(42) Remove mainshaft and geartrain from gear case or from workbench.

(43) Start 3-4 synchro assembly on mainshaft. Tap assembly onto shaft splines until hub is about 3 mm (0.125 in.) away from third speed stop ring. Then align stop ring with synchro sleeve and hub and seat synchro assembly with Tool C-4040 (Fig. 149).

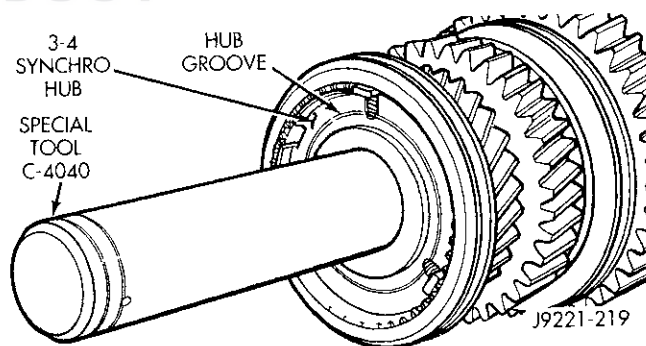


Fig. 149 Seating 3-4 Synchro Assembly On Mainshaft

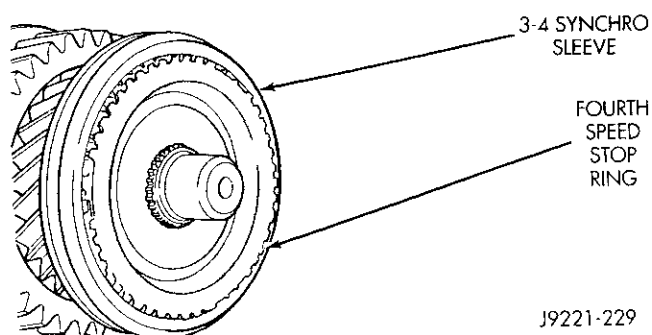
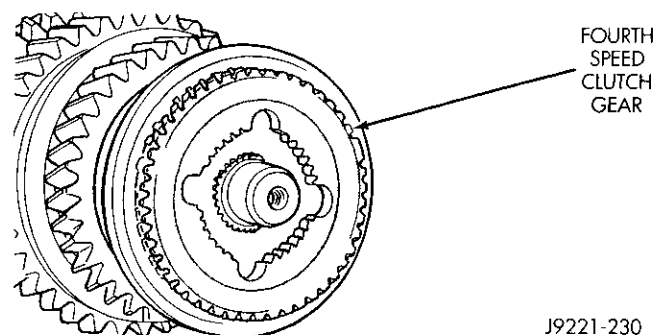
(44) Verify that 3-4 synchro hub is fully seated on shaft. Approximately 3 mm (0.125 in.) of shaft spline should be visible. If hub is not seated, stop ring lugs are misaligned. Rotate ring until lugs are fully engaged in 3-4 hub slots.

(45) Install fourth speed stop ring in 3-4 synchro sleeve (Fig. 150).

(46) Install fourth speed clutch gear in stop ring (Fig. 151).

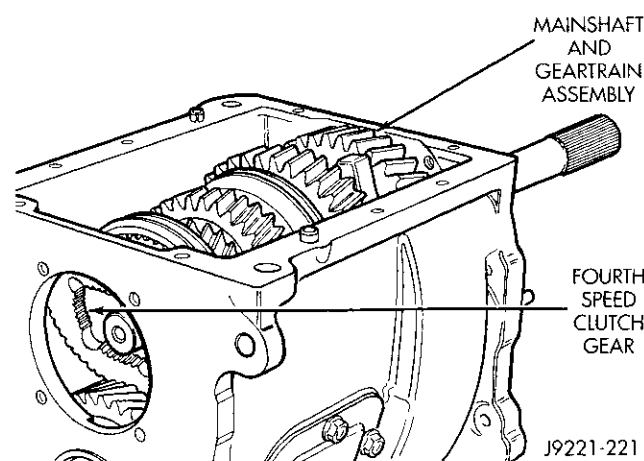
MAINSHAFT AND GEARTRAIN INSTALLATION

(1) Position gear case so case opening is facing up (Fig. 152).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 150 Fourth Speed Stop Ring Installation****Fig. 151 Fourth Speed Clutch Gear Installation**

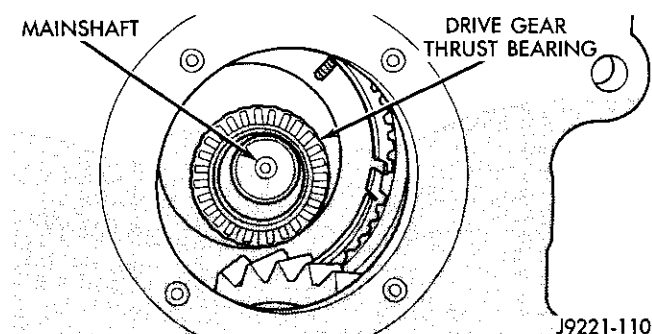
(2) Grip mainshaft at pilot bearing hub and just behind rear bearing. Then lift assembly and guide rear of shaft through bearing bore at rear of case.

(3) Continue holding front of shaft but switch grip at rear to shaft output splines. Lift mainshaft assembly slightly, align gears and seat assembly in case. Be sure fourth speed clutch gear and stop ring were not displaced during installation (Fig. 152).

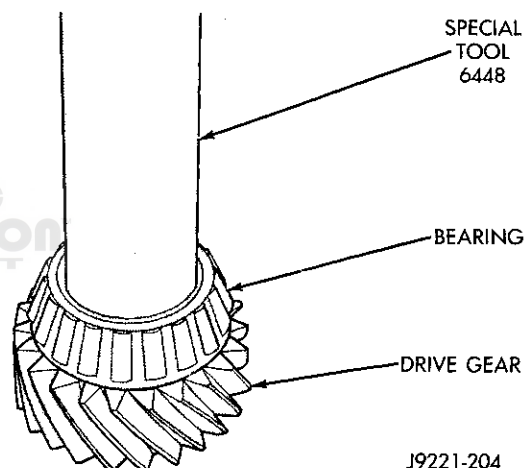
**Fig. 152 Mainshaft And Geartrain Installed In Case**

(4) Install drive gear thrust bearing on mainshaft (Fig. 153). Use plenty of petroleum jelly to hold bearing in place.

(5) Check alignment and mesh of mainshaft gears. If gears are not aligned, roll case on side and realign shaft and gears in case.

**Fig. 153 Drive Gear Thrust Bearing Installation****DRIVE GEAR AND RETAINER INSTALLATION**

(1) Install bearing on drive gear with Installer Tool 6448 (Fig. 154).

**Fig. 154 Installing Front Bearing On Drive Gear**

(2) Lubricate pilot bearing with petroleum jelly and install it in drive gear bore.

(3) Install drive gear on mainshaft. Work gear rearward until mainshaft hub is fully seated in pilot bearing.

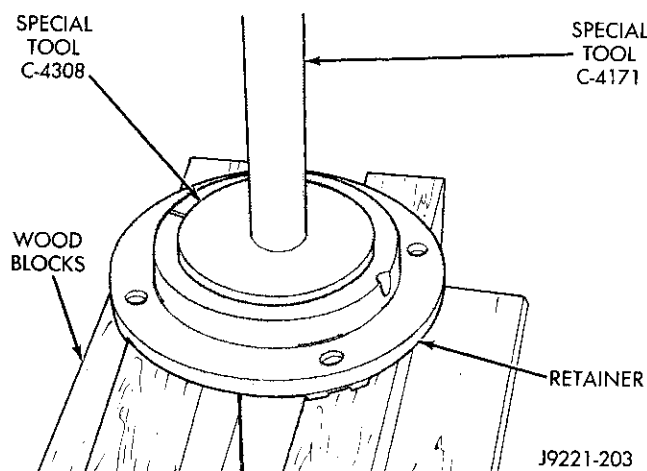
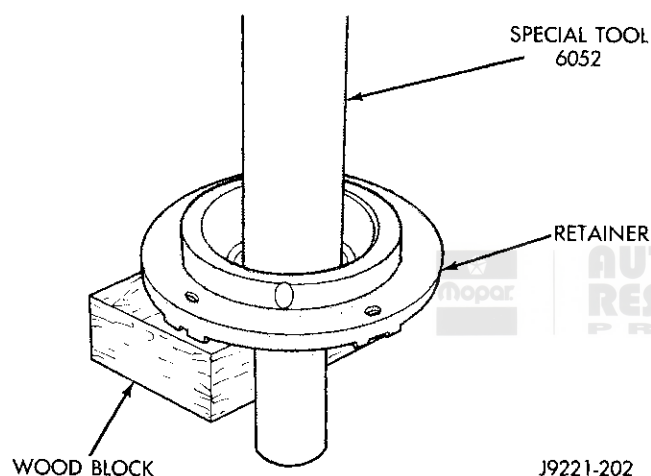
(4) Install bearing cup in front retainer with Driver Handle C-4171 and Installer C-4308 (Fig. 155).

(5) Install new oil seal in front bearing retainer with Tool C-4595 or 6052 (Fig. 156). Use one or two wood blocks to support retainer as shown. Lubricate seal lip with petroleum jelly after installation.

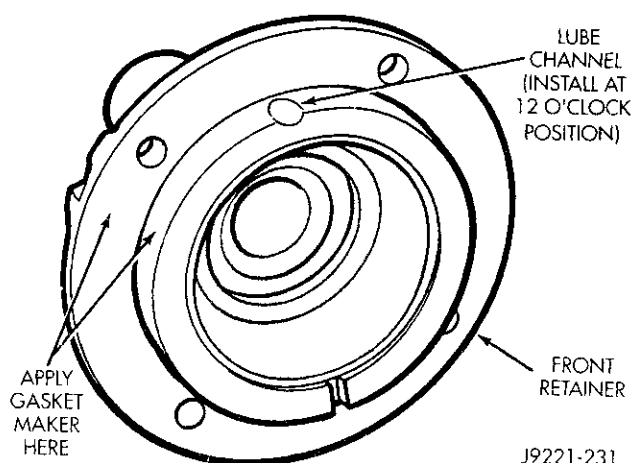
(6) Clean contact surfaces of gear case and front bearing retainer with a wax and grease remover.

(7) Apply Mopar Gasket Maker to flange surface of front bearing retainer (Fig. 157).

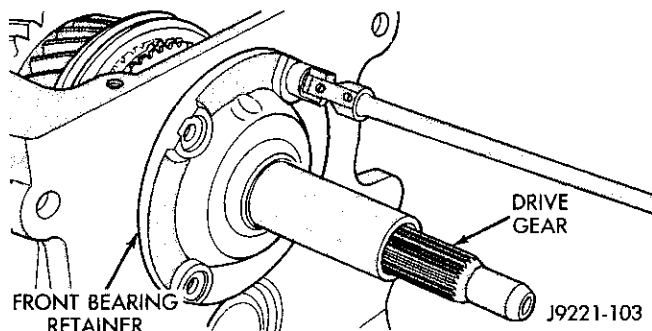
(8) Install front bearing retainer over drive gear and start it into case.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 155 Installing Front Bearing Cup In Retainer****Fig. 156 Installing Bearing Retainer Oil Seal**

(9) Start front bearing retainer in gear case. **Verify that retainer lube channel is at top-center (12 O'clock) position (Fig. 157).** Adjust retainer position before proceeding, if necessary.

**Fig. 157 Location Of Front Retainer Lube Channel**

(10) Align front bearing retainer bolt holes and tap retainer into place with plastic mallet. Install and tighten retainer bolts to 30 N·m (265 in. lbs.) torque (Fig. 158). **Use new retainer bolts. Do not reuse the old ones.**

**Fig. 158 Installing Front Bearing Retainer****MAINSHAFT END PLAY ADJUSTMENT**

(1) Install mainshaft rear bearing cup in case and over bearing. Tap bearing cup into place with plastic mallet.

(2) Install rear bearing plate to hold mainshaft and rear bearing in position (Fig. 159). Do not install any end play shims at this time.

(3) Tighten rear bearing plate bolts securely.

(4) Place gear case in upright position on bench. Either cut hole in bench to accept drive gear and front retainer, or use C-clamps to secure transmission on bench. Do not leave transmission unsupported.

(5) Mount dial indicator on rear of gear case and position indicator plunger against inner race of rear bearing (Fig. 159).

(6) Move mainshaft forward to remove all play. Then zero dial indicator.

(7) Move mainshaft upward and observe dial indicator reading. Move mainshaft with pry tool positioned between drive gear and case.

(8) End play should be 0.051-0.15 mm (0.002-0.006 in.). Select fit shims are available to adjust end play if necessary.

(9) If end play adjustment is required, remove bearing plate and install necessary shim.

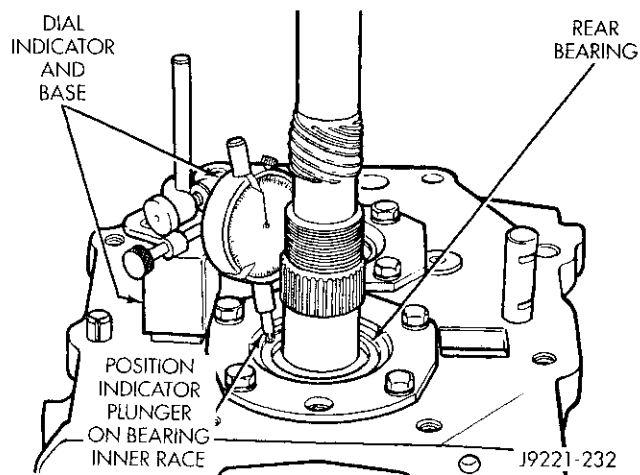
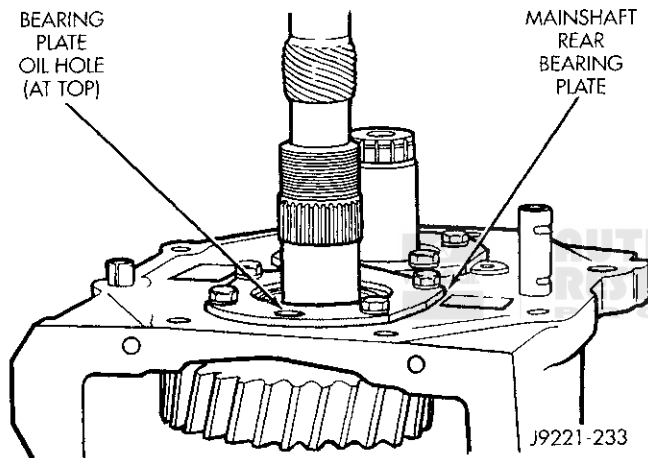
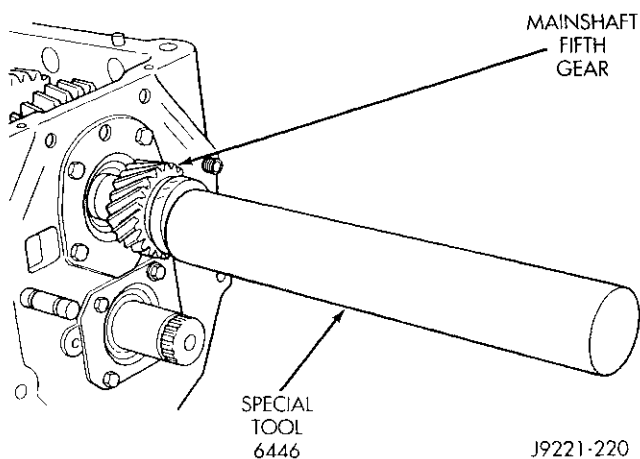
(10) Reinstall rear bearing plate (Fig. 160).

(11) Apply Mopar Lock N' Seal or Loctite 242 to bearing plate bolt threads. Then install and tighten bolts to 23 N·m (200 in. lbs.) torque. **Be sure oil hole in bearing plate is at top as shown.**

MAINSHAFT FIFTH GEAR INSTALLATION

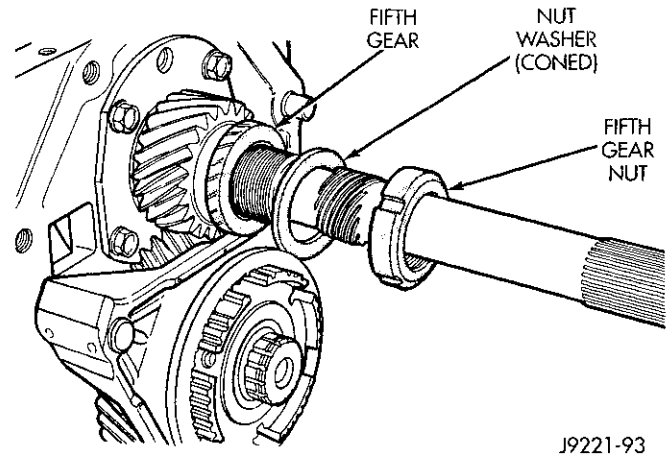
(1) Install mainshaft fifth gear. Use Installer Tool 6446 to seat gear on shaft (Fig. 161). Gear is seated when it contacts rear bearing.

(2) Install fifth gear nut washer (Fig. 162). Coned side of washer faces end of shaft.

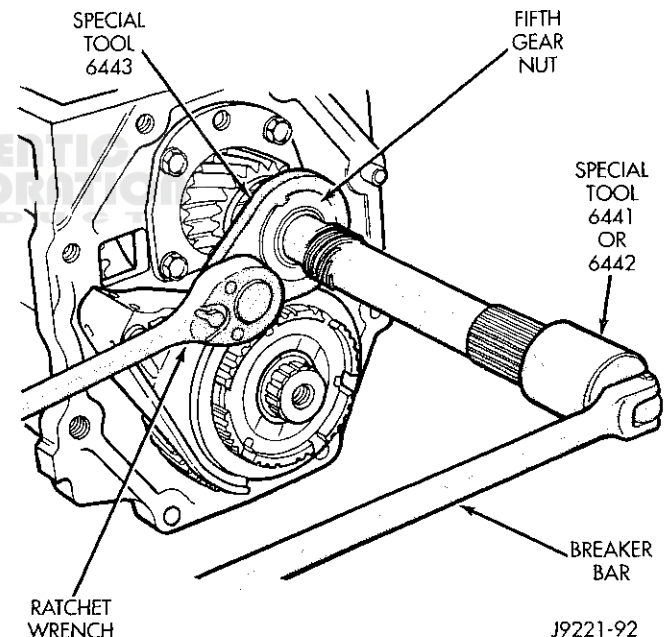
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 159 Checking Mainshaft End Play****Fig. 160 Rear Bearing Plate Installation****Fig. 161 Installing Mainshaft Fifth Gear**

(3) Apply 3-4 drops Mopar Lock N' Seal, or Loctite 242 to nut threads on mainshaft.

(4) Install fifth gear nut on mainshaft (Fig. 162).

**Fig. 162 Installing Fifth Gear Nut And Washer**

(5) Tighten fifth gear nut as much as possible with Nut Wrench 6443 or 6743, long handle ratchet, breaker bar and Socket Wrench 6441 or 6442 (Fig. 163).

**Fig. 163 Fifth Gear Nut Installation**

(6) Lock mainshaft gears by shifting all synchro sleeves into engaged position.

(7) Position Spline Socket Wrench 6441 or 6442 on mainshaft splines. Then install breaker bar in socket wrench and wedge bar against workbench.

(8) Tighten fifth gear nut with Nut Wrench 6443 and high capacity torque wrench. Required torque on nut is 339-475 N·m (250-350 ft. lbs.). Have helper hold transmission steady if necessary. Nut can also be tightened by striking Wrench 6443 with heavy copper mallet then checking with torque wrench.

DISASSEMBLY AND ASSEMBLY (Continued)**COUNTERSHAFT FIFTH GEAR AND SYNCHRO INSTALLATION**

(1) Install thrust washer pin in countershaft (Fig. 164).

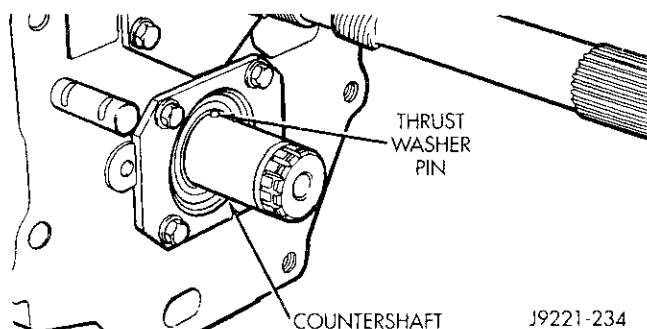


Fig. 164 Installing Fifth Gear Thrust Washer Pin

(2) Install thrust washer on countershaft. Turn washer until pin engages in washer notch (Fig. 165). Flat side of washer faces rear and cone side to front as shown.

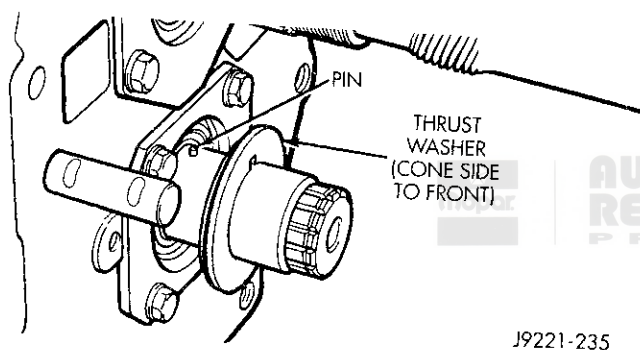


Fig. 165 Installing Fifth Gear Thrust Washer

(3) Lubricate and install fifth gear bearings on countershaft (Fig. 166).

(4) Install bearing spacer on countershaft and seat it against bearings (Fig. 166). Coat spacer with petroleum jelly to hold it in place.

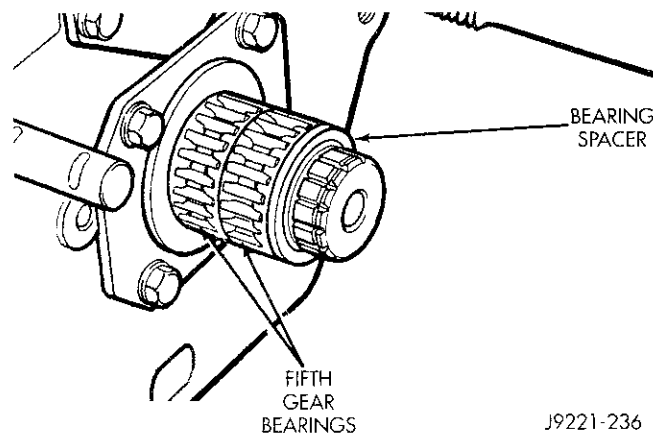


Fig. 166 Countershaft Fifth Gear Bearing And Spacer Installation

(5) Install synchro sleeve on hub of countershaft fifth gear. Tapered side of sleeve faces front and flat side faces rear (Fig. 167).

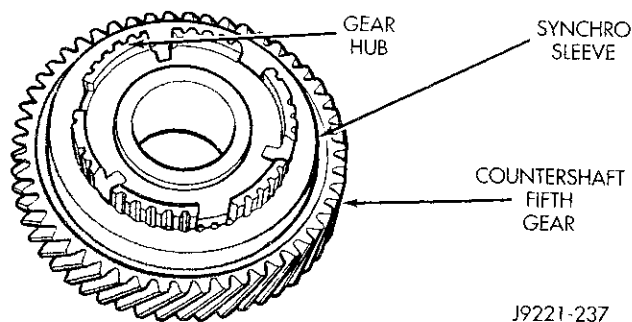


Fig. 167 Installing Synchro Sleeve On Countershaft Fifth Gear Hub

(6) Install shift fork in synchro sleeve (Fig. 168).

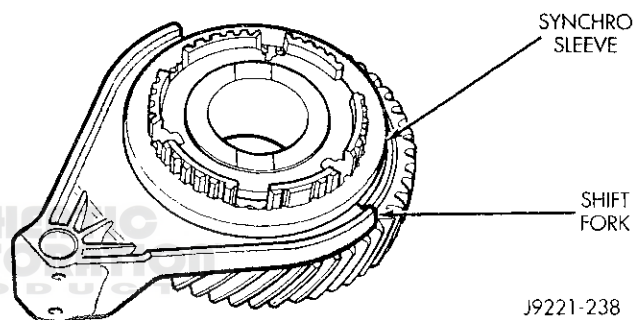


Fig. 168 Installing Fifth Gear Shift Fork In Synchro Sleeve

(7) Install assembled fifth gear, synchro sleeve and shift fork (Fig. 169). Align fork with shift lug rail and align gear with bearings and countershaft. Start components onto shaft and rail. Then tap gear and fork into place with plastic or rawhide mallet.

(8) Align roll pin holes in shift fork with notches in shift lug rail. Then install roll pins from top side of fork (Fig. 169). Note that roll pins are one way fit due to small shoulder at one end of each pin.

(9) Install synchro struts and springs in fifth gear hub (Fig. 170). Install struts in hub slots first. Then install springs by compressing them with screwdriver and working springs into hub and struts.

(10) Assemble and install fifth synchro clutch gear and stop ring in fifth gear hub (Fig. 171). Make sure both parts are seated in fifth gear hub.

(11) Install clutch gear snap ring (Fig. 172).

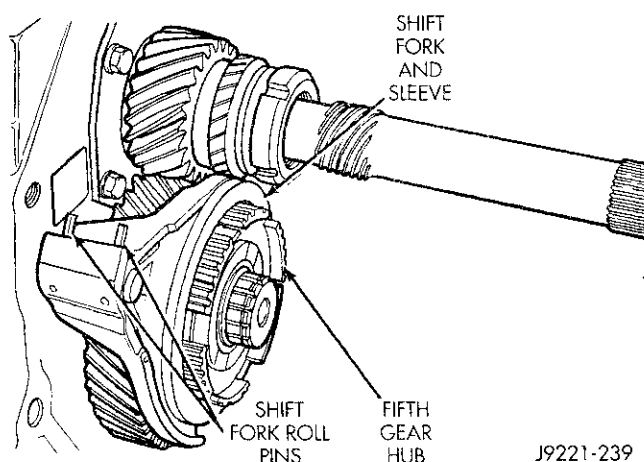
CLEANING AND INSPECTION (Continued)

Fig. 169 Installing Assembled Countershaft Fifth Gear, Shift Fork And Synchro Sleeve

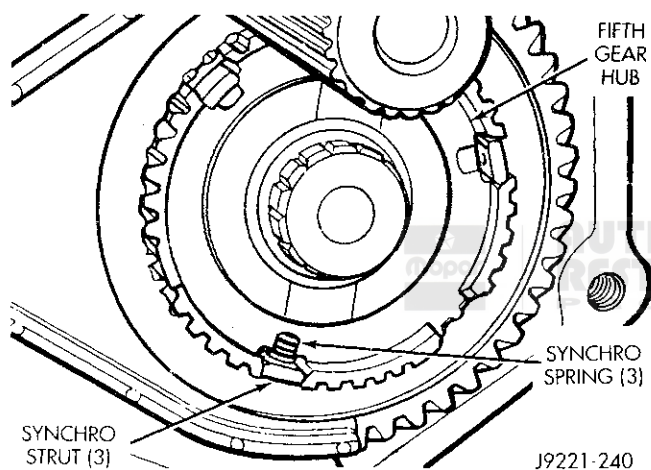


Fig. 170 Installing Fifth Gear Synchro Struts And Springs

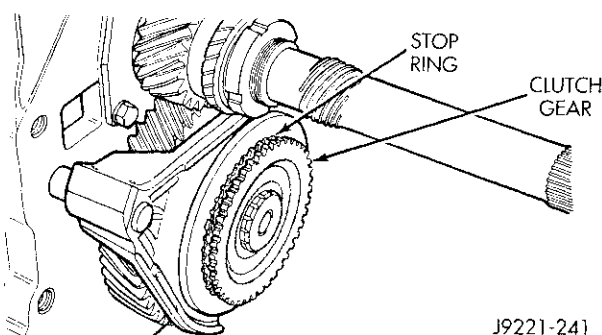


Fig. 171 Fifth Synchro Clutch Gear And Stop Ring Installation

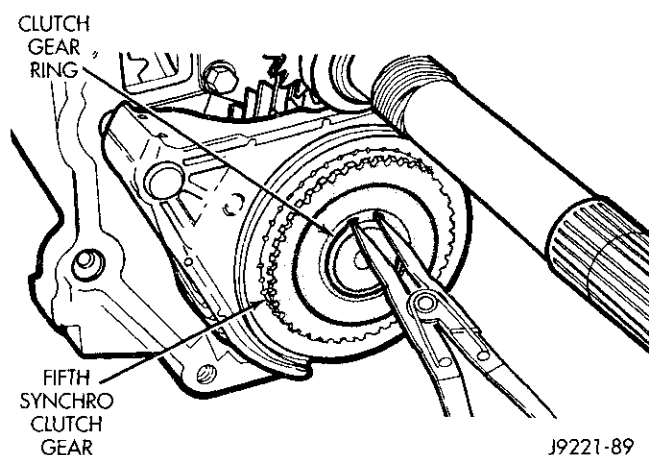


Fig. 172 Installing Fifth Synchro Clutch Snap Ring

TRANSMISSION

Clean the gears, bearings shafts, extension/adaptor housing and gear case with solvent. Dry all parts except the bearings with compressed air. Allow the bearings to either air dry or wipe them dry with clean shop towels.

Inspect the reverse idler gear, bearings, shaft and thrust washers (Fig. 173). Replace the bearings if the rollers are worn, chipped, cracked, flat-spotted, or brinnelled. Or if the bearing cage is damaged or distorted. Replace the thrust washers if cracked, chipped, or worn. Replace the gear if the teeth are chipped, cracked or worn thin.

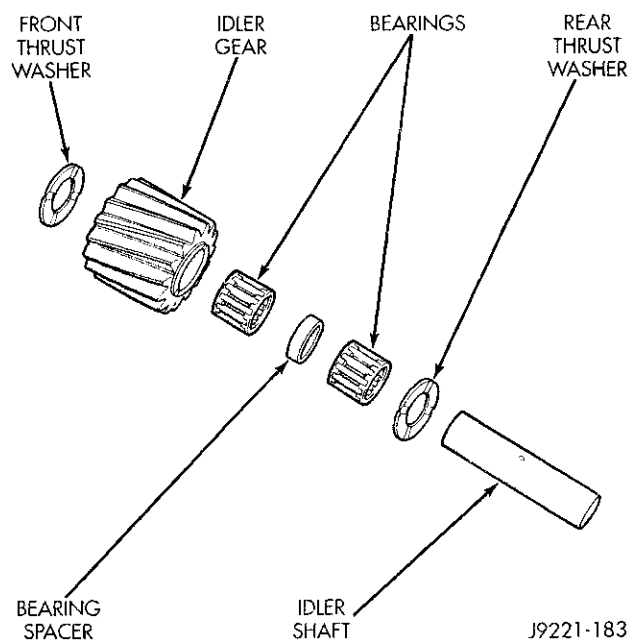
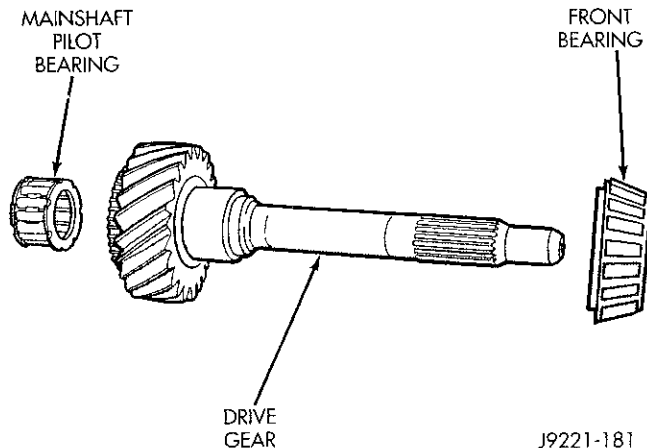


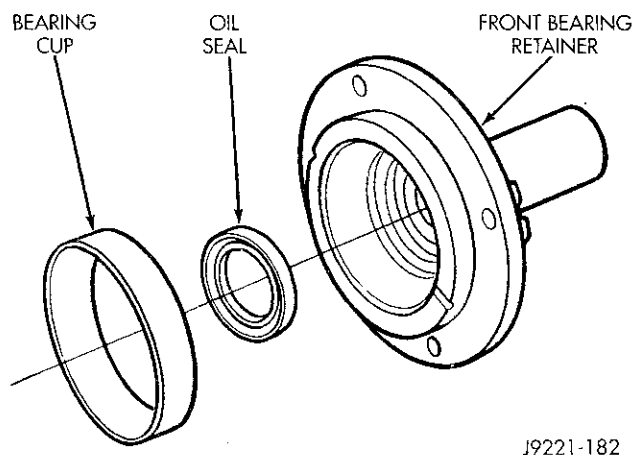
Fig. 173 Reverse Idler Components

CLEANING AND INSPECTION (Continued)

Inspect the drive gear and bearings (Fig. 174). Minor scratches and burrs on the gear surfaces can be reduced with an oil stone and 400 grit paper wetted with oil. Replace either bearing if worn, or damaged. Replace the gear if any teeth, splines, or bearing surfaces are also worn or damaged.

**Fig. 174 Drive Gear Components**

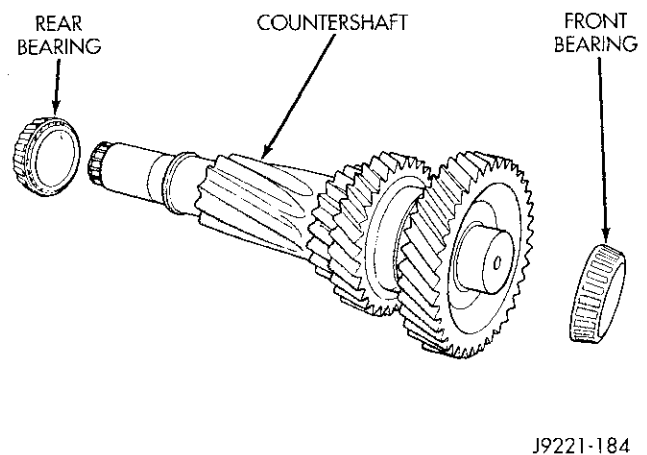
Inspect the front bearing retainer and bearing cup (Fig. 175). Replace the bearing cup if scored, cracked, brinnelled, or rough. Check the release bearing slide surface of the retainer carefully. Minor corrosion, nicks, or pitting can be smoothed with 400 grit emery and polished out with crocus cloth. Wet the abrasive paper and crocus cloth with oil when smoothing/polishing. Replace the retainer if worn or damaged in any way. **Do not reuse the original retainer bolts. Install new bolts during assembly.**

**Fig. 175 Front Bearing Retainer Components**

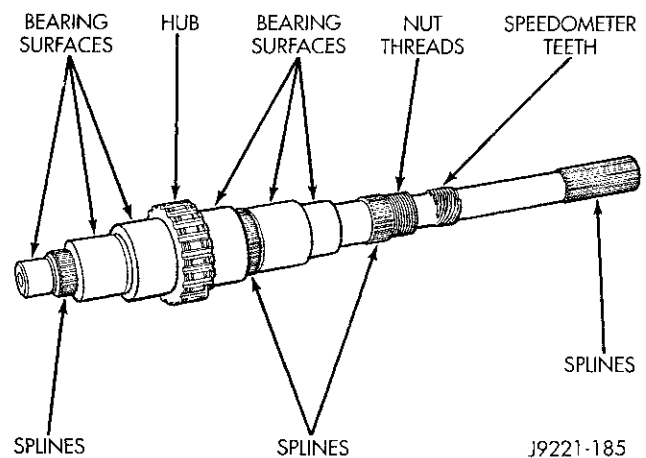
Inspect the countershaft and bearings (Fig. 176). Replace the bearings if worn, rough, flat spotted, or heat checked. Check the countershaft gear teeth carefully. Small nicks, scratches, or burrs can be removed with an oil stone and 400 grit paper wetted

with oil. However, replace the shaft as an assembly if the forward gear is loose, or any of the teeth are worn, cracked, broken, or severely chipped.

Be sure to check condition of the countershaft bearing cups. Replace either bearings cup if worn, or damaged.

**Fig. 176 Countershaft And Bearings**

Check condition of the mainshaft. Inspect all the bearing surfaces, splines and threads. Also check condition of the snap ring grooves in the hub area and the speedometer drive gear teeth (Fig. 177). Minor scratches or burrs can be removed with an oil stone and polished with crocus cloth. However, replace the shaft if any surfaces exhibit considerable wear or damage.

**Fig. 177 Mainshaft Bearing And Spline Surfaces**

Check condition of the gear case and extension or adapter housing. Be sure the alignment dowels in the case top surface and in the housing/adapter are tight and in good condition.

Run a tap through the gear case bolt holes if the threads need minor cleanup. Helicoil inserts can be

CLEANING AND INSPECTION (Continued)

used to repair seriously damaged threaded holes if necessary.

Be sure all case and housing/adaptor sealing and mating surfaces are free of burrs and nicks. This is especially important as gaskets are not used in the NV4500. Minor nicks and scratches on the sealing surfaces can be dressed off with a fine tooth file or oil stone.

Replace the gear case or housing/adaptor if cracked or broken. Do not attempt to repair this type of damage by welding or brazing.

Check condition of the countershaft fifth gear components (Fig. 179). This includes the shift lug and rail located in the gear case and the rail bushings.

Inspect the gear and hub assembly. Minor burrs can be cleaned up with an oil stone. However, the gear and hub assembly should be replaced if the teeth or splines are excessively worn, or damaged. The synchro sleeve should also be replaced if worn or damaged in any way. Do not reuse synchro struts that are worn, or springs that are collapsed or severely distorted. Replace worn distorted synchro parts to avoid shift problems after assembly and installation.

The shift fork should be inspected for evidence of wear and distortion. Check fit of the sleeve in the fork to be sure the two parts fit and work smoothly.

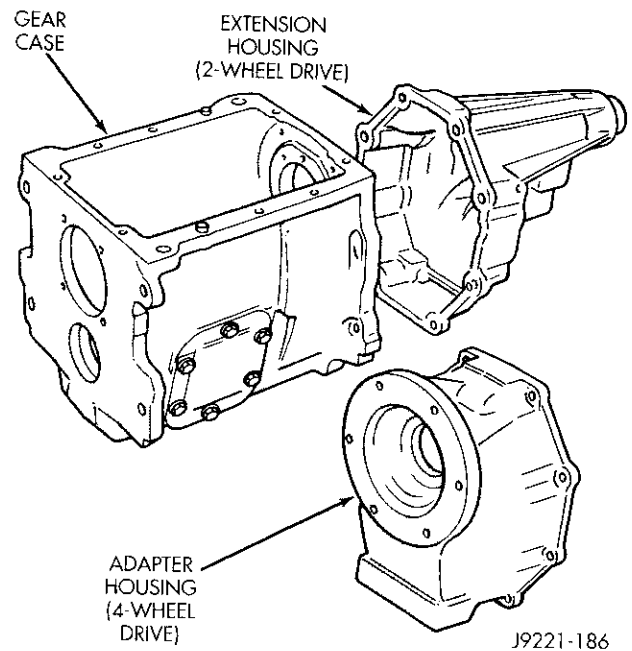


Fig. 178 Gear Case And Extension/Adapter Housings

Replace the fork if the roll pin holes are worn over-size or damaged. Do not attempt to salvage a worn fork. It will cause shift problems later on. Replace

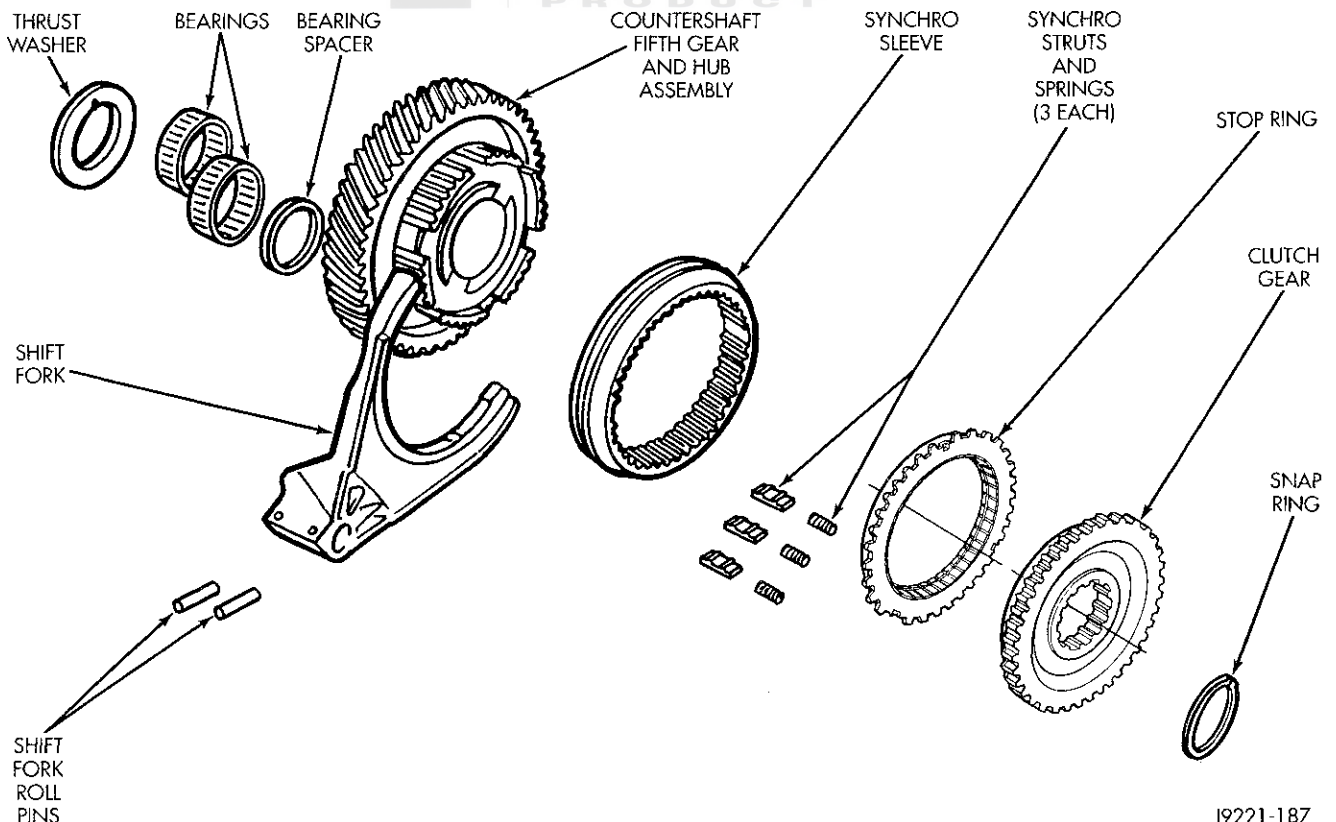
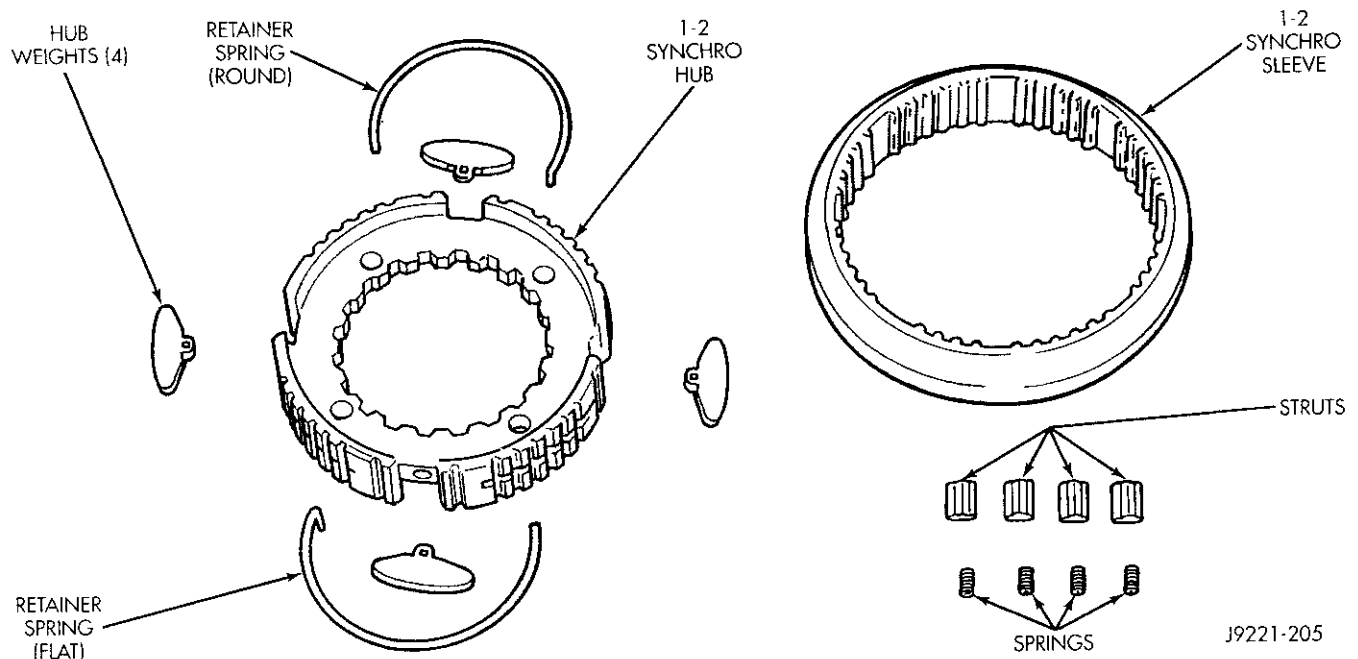


Fig. 179 Countershaft Fifth Gear Components

CLEANING AND INSPECTION (Continued)**Fig. 180 Synchro Components**

the shift fork roll pins if necessary, or if doubt exists about their condition.

The bearings should be examined carefully for wear, roughness, flat spots, pitting, or other damage. Replace the bearings if necessary.

Inspect the stop ring and clutch gear. replace either part if worn or damaged in any way. Also be sure replacement parts fit properly before proceeding with assembly.

Inspect the 1-2 synchro components (Fig. 180). The hub weights and retainer springs are reusable if in good condition. However, replace the springs if distorted, or broken and replace the weights if worn or damaged.

Examine the hub and sleeve for wear or damage. Replace the sleeve and hub if the splines are worn, chipped or damaged.

Replace the synchro struts if worn, or chipped. Also replace the springs if collapsed, distorted, or broken.

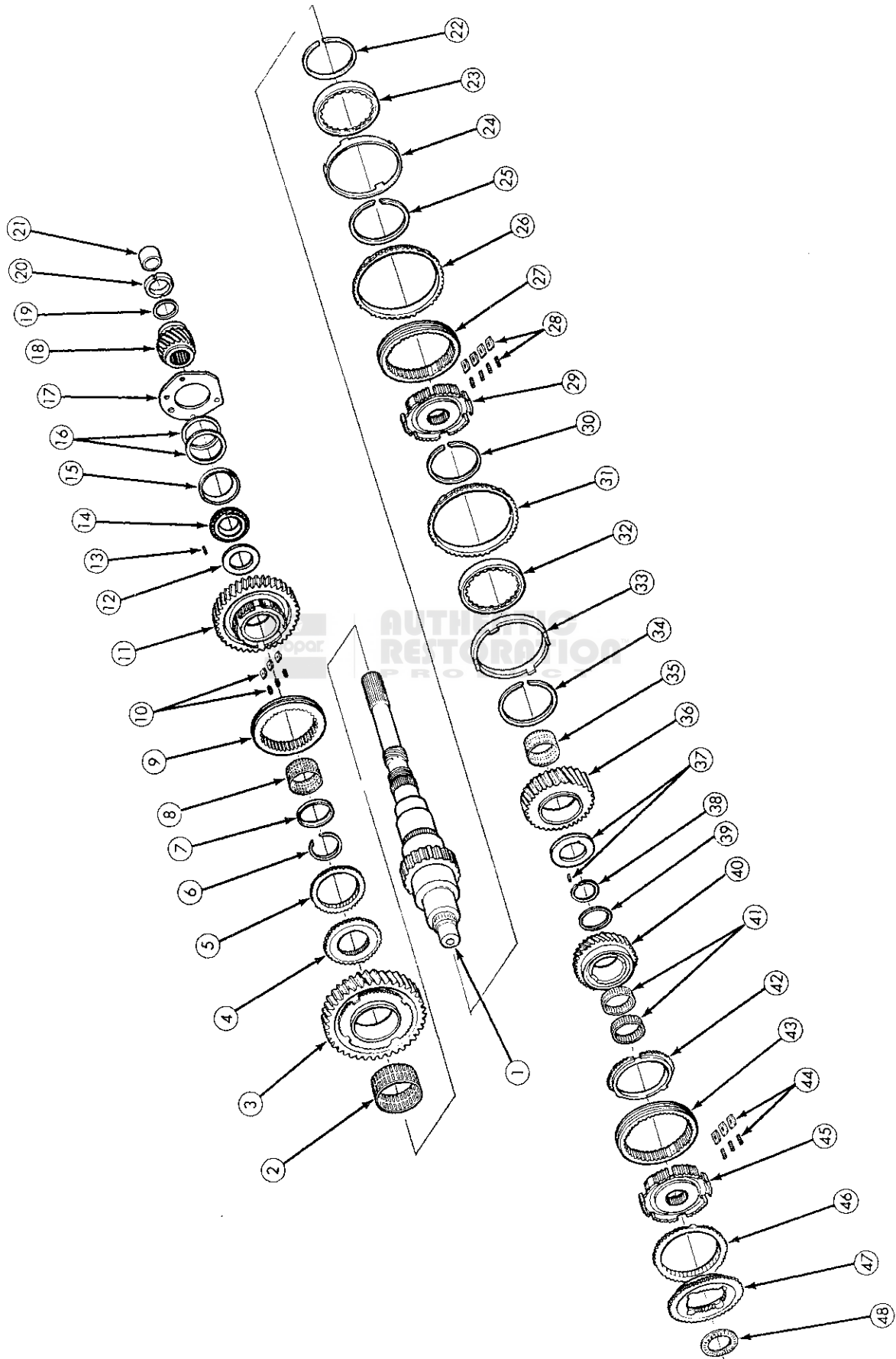
Inspect the mainshaft geartrain components (Fig. 181). Check the teeth on all gears, hubs, clutch gears, stop rings and clutch rings. The teeth must be in good condition and not worn, cracked, or chipped. Replace any component that exhibits wear or damage.

Examine the synchro stop rings, clutch rings and clutch gears. Replace any part that exhibits wear, distortion, or damage. Replace the clutch rings if the friction material is burned, flaking off, or worn.

Inspect all of the thrust washers and locating pins. Replace the pins if bent, or worn. Replace the washers if worn, or the locating pin notches are distorted.

Check condition of the synchro struts and springs. Replace these parts if worn, cracked, or distorted.

CLEANING AND INSPECTION (Continued)



J9321-99

Fig. 181 Mainshaft Geartrain

SPECIFICATIONS

- | | |
|---|---|
| 1. MAINSHAFT | 25. SYNCHRO HUB SNAP RING |
| 2. FIRST GEAR BEARING | 26. FIRST GEAR SYNCHRO STOP RING |
| 3. FIRST GEAR | 27. 1-2 SYNCHRO SLEEVE |
| 4. CLUTCH GEAR | 28. SYNCHRO STRUTS AND SPRINGS (4 EACH) |
| 5. SYNCHRO STOP RING | 29. 1-2 SYNCHRO HUB (INC. RETAINER SPRINGS AND WEIGHTS) |
| 6. FIRST GEAR SNAP RING | 30. SYNCHRO HUB SNAP RING |
| 7. REVERSE GEAR BEARING SPACER | 31. SECOND GEAR SYNCHRO STOP RING |
| 8. REVERSE GEAR BEARING | 32. SECOND SPEED CLUTCH GEAR |
| 9. REVERSE SYNCHRO SLEEVE | 33. SECOND GEAR SYNCHRO CLUTCH RING |
| 10. SYNCHRO STRUTS AND SPRINGS (3 EACH) | 34. CLUTCH GEAR SNAP RING |
| 11. REVERSE GEARLINES | 35. SECOND GEAR BEARING |
| 12. THRUST WASHER | 36. SECOND GEAR |
| 13. THRUST WASHER LOCATING PIN | 37. THRUST WASHER AND LOCATING PIN |
| 14. MAINSHAFT REAR BEARING | 38. THRUST WASHER SNAP RING |
| 15. MAINSHAFT REAR BEARING CUP | 39. THIRD GEAR BEARING SPACER |
| 16. MAINSHAFT END PLAY SHIMS | 40. THIRD GEAR |
| 17. MAINSHAFT REAR BEARING PLATE | 41. THIRD GEAR BEARING ASSEMBLIES (2) |
| 18. MAINSHAFT FIFTH GEAR | 42. THIRD GEAR SYNCHRO STOP RING |
| 19. THRUST WASHER | 43. 3-4 SYNCHRO SLEEVE |
| 20. FIFTH GEAR NUT | 44. SYNCHRO STRUTS AND SPRINGS (3 EACH) |
| 21. MAINSHAFT SPLINE SEAL | 45. 3-4 SYNCHRO HUB |
| 22. CLUTCH GEAR SNAP RING | 46. FOURTH GEAR SYNCHRO STOP RING |
| 23. FIRST SPEED CLUTCH GEAR | 47. FOURTH SPEED CLUTCH GEAR |
| 24. FIRST GEAR SYNCHRO CLUTCH RING | 48. DRIVE GEAR THRUST BEARING |

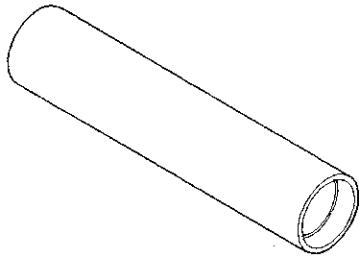
J9321-98

Legend For Mainshaft Geartrain

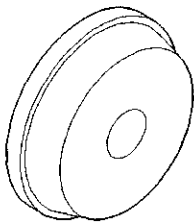
TORQUE

DESCRIPTION	TORQUE
Backup Light Switch	22-34 N·m (193-300 in. lbs.)
Countershaft Bearing	
Plate Bolts	19-26 N·m (170-230 in. lbs.)
Fifth Gear Nut	339-475 N·m (250-350 ft. lbs.)
Drain and Fill Plugs	34-47 N·m (25-35 ft. lbs.)
Front Bearing Retainer Bolts	27-34 N·m (235-305 in. lbs.)
Mainshaft Bearing Plate Bolts	19-26 N·m (170-230 in. lbs.)
PTO Cover Bolts	27-54 N·m (20-40 ft. lbs.)
Extension/Adapter Housing Bolts	41-68 N·m (30-50 ft. lbs.)
Reverse Inhibitor Screws	8-14 N·m (75-115 in. lbs.)
Shift Cover Bolts	27-31 N·m (216-276 in. lbs.)

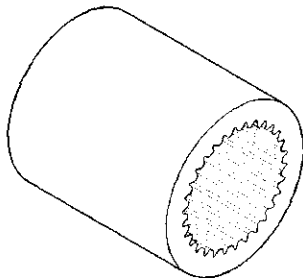
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SPECIAL TOOLS**NV4500 MANUAL TRANSMISSION**

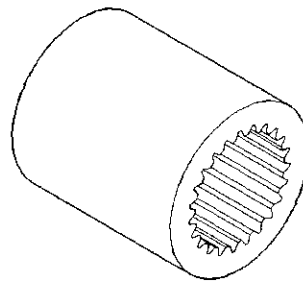
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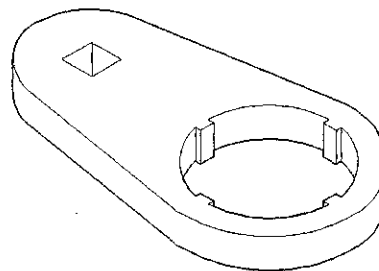
Installer—6061



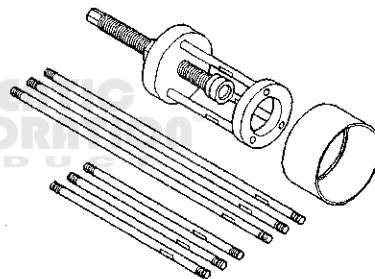
Wrench, Splined Socket—6441



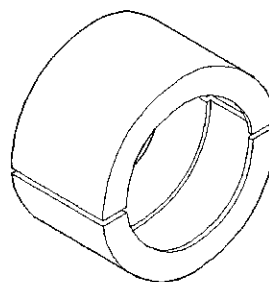
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Wrench, 5th Gear Nut—6443

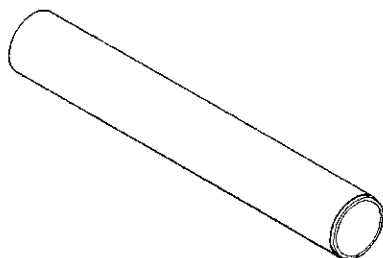


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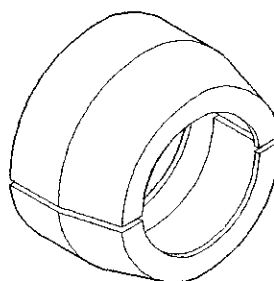


Jaws, Bearing Cone (For Puller 6444)—6445

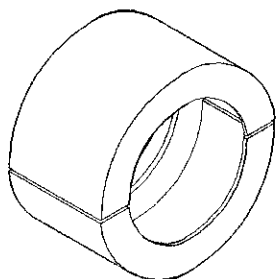
SPECIAL TOOLS (Continued)



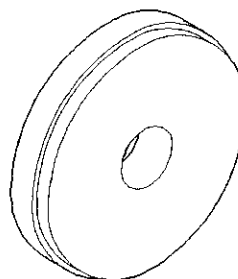
Installer, Bearing Cone & 5th Gear—6446



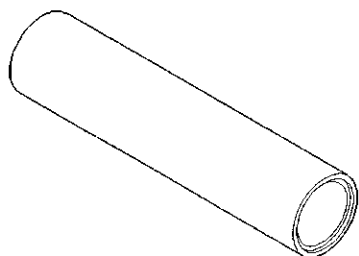
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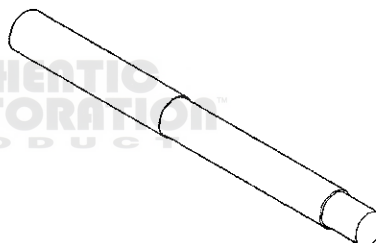
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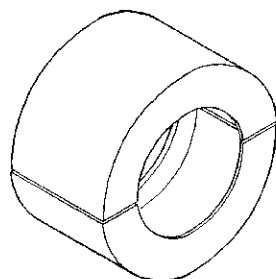
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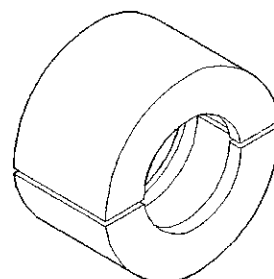
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Remover/Installer, Bushing—6456



Jaws, Bearing Cone (For Puller 6444)—6449

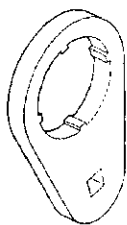


Jaws, 5th Gear (For Puller 6444)—6459

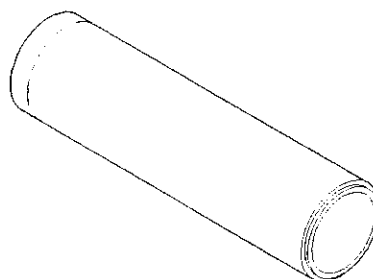


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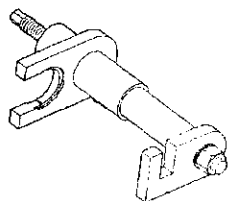
SPECIAL TOOLS (Continued)



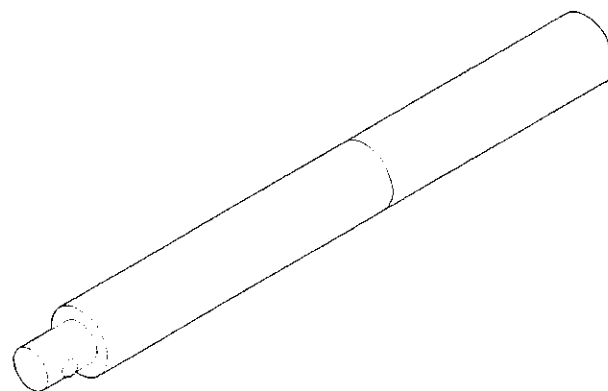
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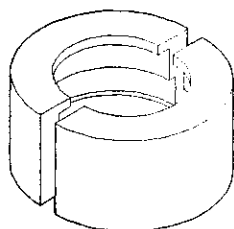
Installer—C-4040



Remover/Installer, Gear Shift Lever—6783



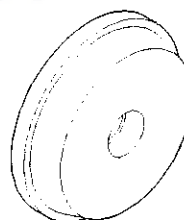
Handle Universal (Non-Threaded)—C-4171



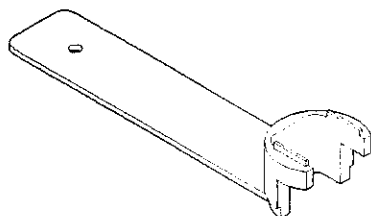
Jaws, Sprocket Remover (Use With 6444)—6820



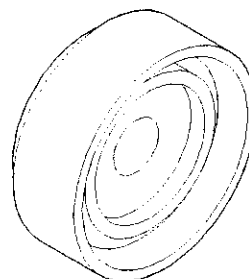
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Installer, Bearing Cup—C-4308



*Remover/Installer, NV4500 Shift Lever Stub
Shaft—6870*



Installer—C-4340

AUTOMATIC TRANSMISSION—42RE

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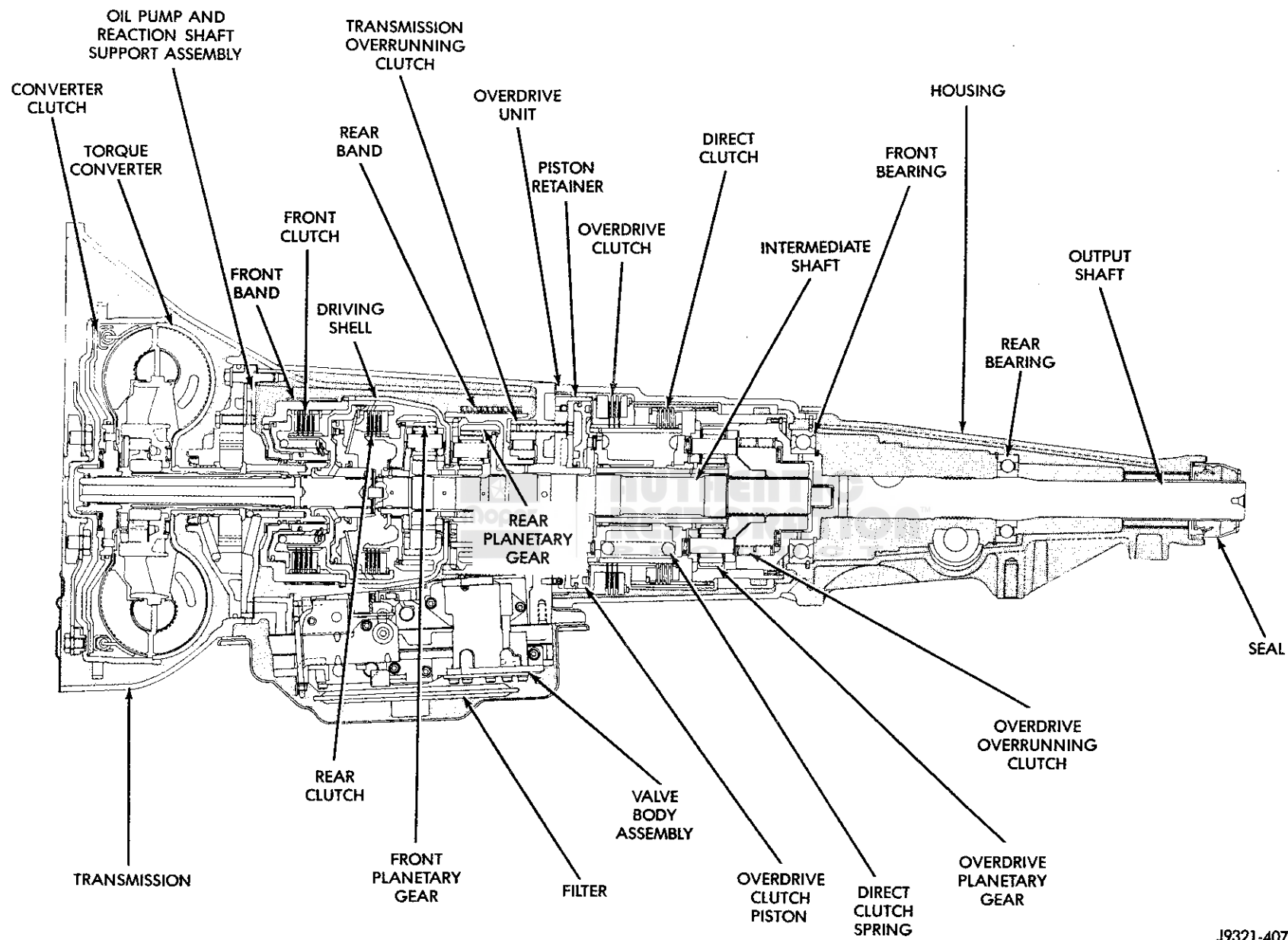
GENERAL INFORMATION**42RE TRANSMISSION**

The 42RE is a four speed fully automatic transmission (Fig. 1) with an electronic governor. First through third gear ranges are provided by the clutches, bands, overrunning clutch, and planetary gear sets in the transmission. Fourth gear range is provided by the overdrive unit that contains an overdrive clutch, direct clutch, planetary gear set, and overrunning clutch. The overdrive clutch is applied in fourth gear only. The direct clutch is applied in all ranges except fourth gear. The 42RE is equipped with a lock-up clutch in the torque converter. The

torque converter clutch is controlled by the Powertrain Control Module (PCM). The torque converter clutch is hydraulically applied and is released when fluid is vented from the hydraulic circuit by the torque converter control (TCC) solenoid on the valve body. The torque converter clutch engages in fourth gear, and in third gear when the O/D switch is OFF. Engagement occurs when the vehicle is cruising on a level plane after the vehicle has warmed up. The torque converter clutch disengages when the accelerator is applied. The torque converter clutch feature increases fuel economy and reduces the transmission fluid temperature. The 42RE transmission is cooled by an integral fluid cooler inside the radiator.



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Fig. 1 42RE Transmission

GENERAL INFORMATION (Continued)

TRANSMISSION IDENTIFICATION

Transmission identification numbers are stamped on the left side of the case just above the oil pan gasket surface (Fig. 2). Refer to this information when ordering replacement parts.

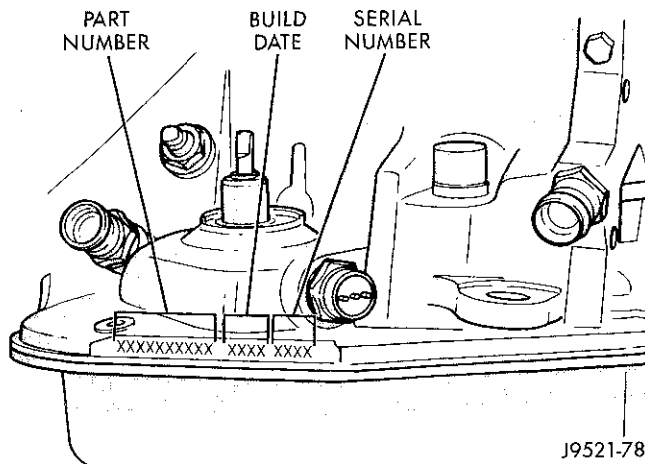


Fig. 2 Transmission Part And Serial Number Location

RECOMMENDED FLUID

Mopar ATF Plus, Type 7176 automatic transmission fluid is the recommended fluid for Chrysler automatic transmissions.

Dexron II fluid IS NOT recommended. Clutch chatter can result from the use of improper fluid. If Mopar ATF Plus is not available, Dexron II can be used as a supplement if the vehicle must be driven.

TORQUE CONVERTER—ELECTRONIC CLUTCH

The torque converter is a hydraulic device that couples the engine crankshaft to the transmission. The torque converter consists of an outer shell with an internal turbine, a stator, an overrunning clutch, an impeller, and an electronically applied converter clutch. Torque multiplication is created when the stator directs the hydraulic flow from the turbine to rotate the impeller in the direction the engine crankshaft is turning. The turbine transfers power to the planetary gear sets in the transmission. The transfer of power into the impeller assists torque multiplication. At low vehicle-speed, the overrunning clutch holds stator stationary (during torque multiplication) and allows the stator to freewheel at high vehicle speed. The converter clutch provides reduced engine speed and greater fuel economy when engaged. Clutch engagement also provides reduced transmission fluid temperatures. The converter clutch is engaged in fourth gear and in third gear when the overdrive switch is OFF. The torque converter hub drives the transmission oil (fluid) pump.

The torque converter is a sealed, welded unit that is not repairable and is serviced as an assembly.

CAUTION: The torque converter must be replaced if a transmission failure resulted in large amounts of metal or fiber contamination in the fluid. If the fluid is contaminated, flush the fluid cooler and lines.

TRANSMISSION GEAR RATIOS

Forward gear ratios are:

- 2.74:1 (first gear)
- 1.54:1 (second gear)
- 1.00:1 (third gear)
- 0.69:1 (fourth gear)
- 2.21 (reverse)

GEARSHIFT MECHANISM

The gear shift mechanism provides six shift positions which are:

- park (P)
- reverse (R)
- neutral (N)
- drive (D)
- manual second (2)
- manual low (1)

Manual low (1) range provides first gear only. Overrun braking is also provided in this range. Manual second (2) range provides first and second gear only.

Drive range provides first, second third and overdrive fourth gear ranges. The shift into overdrive fourth gear range occurs only after the transmission has completed the shift into D third gear range. No further movement of the shift mechanism is required to complete the 3-4 shift.

The fourth gear upshift occurs automatically when the overdrive selector switch is in the ON position.

DESCRIPTION AND OPERATION

ELECTRONIC GOVERNOR

Governor pressure is controlled electronically. Components used for governor pressure control include:

- Governor body
- Valve body transfer plate
- Governor pressure solenoid valve
- Governor pressure sensor
- Fluid temperature thermistor
- Throttle position sensor (TPS)
- Transmission speed sensor
- Powertrain control module (PCM)

GOVERNOR PRESSURE SOLENOID VALVE

The solenoid valve regulates the governor pressure needed for upshifts and downshifts. It is an electro-

DESCRIPTION AND OPERATION (Continued)

hydraulic device located in the governor body on the valve body transfer plate (Fig. 3).

The inlet side of the solenoid valve is exposed to normal transmission line pressure. The outlet side of the valve leads to the valve body governor circuit.

The solenoid valve regulates line pressure to produce governor pressure. The average current supplied to the solenoid controls governor pressure. One amp current produces zero kPa/psi governor pressure. Zero amps sets the maximum governor pressure.

The powertrain control module (PCM) supplies electrical power to the solenoid valve. Operating voltage is 12 volts (DC) and is provided through the battery terminal on the module.

The solenoid is polarity sensitive. The PCM energizes the solenoid by grounding it through the power ground terminal on the PCM.

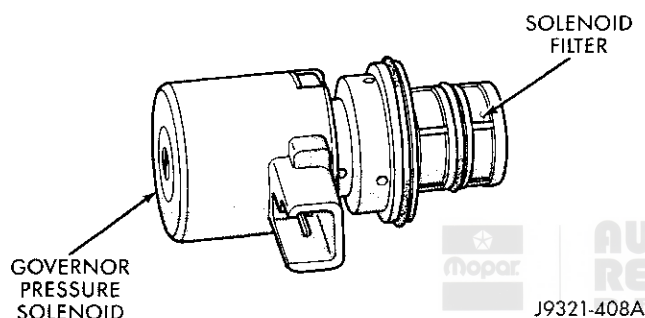


Fig. 3 Governor Pressure Solenoid Valve

GOVERNOR PRESSURE SENSOR

The governor pressure sensor measures output pressure of the governor pressure solenoid valve (Fig. 4).

The sensor output signal provides the necessary feedback to the PCM. This feedback is needed to adequately control governor pressure.

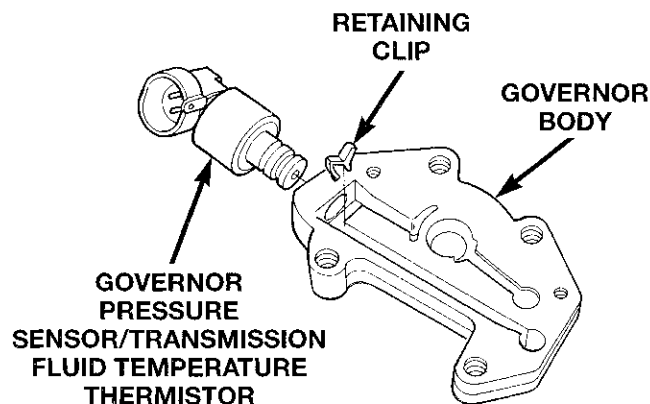


Fig. 4 Governor Pressure Sensor

GOVERNOR BODY AND TRANSFER PLATE

The transfer plate is designed to supply transmission line pressure to the governor pressure solenoid valve and to return governor pressure.

The governor pressure solenoid valve is mounted in the governor body. The body is bolted to the lower side of the transfer plate (Fig. 4). The transfer plate channels line pressure to the solenoid valve through the governor body. It also channels governor pressure from the solenoid valve to the governor circuit. It is the solenoid valve that develops the necessary governor pressure.

TRANSMISSION FLUID TEMPERATURE THERMISTOR

Transmission fluid temperature readings are supplied to the transmission control module by the thermistor (Fig. 5). The temperature readings are used to control engagement of the fourth gear overdrive clutch, the converter clutch, and governor pressure. Normal resistance value for the thermistor at room temperature is approximately 1000 ohms.

The PCM prevents engagement of the converter clutch and overdrive clutch, when fluid temperature is below approximately 10°C (50°F).

If fluid temperature exceeds 126°C (260°F), the PCM causes a 4-3 downshift and engage the converter clutch. Engagement is according to the third gear converter clutch engagement schedule.

The overdrive OFF lamp in the instrument panel illuminates when the shift back to third occurs. The transmission will not allow fourth gear operation until fluid temperature decreases to approximately 110°C (230°F).

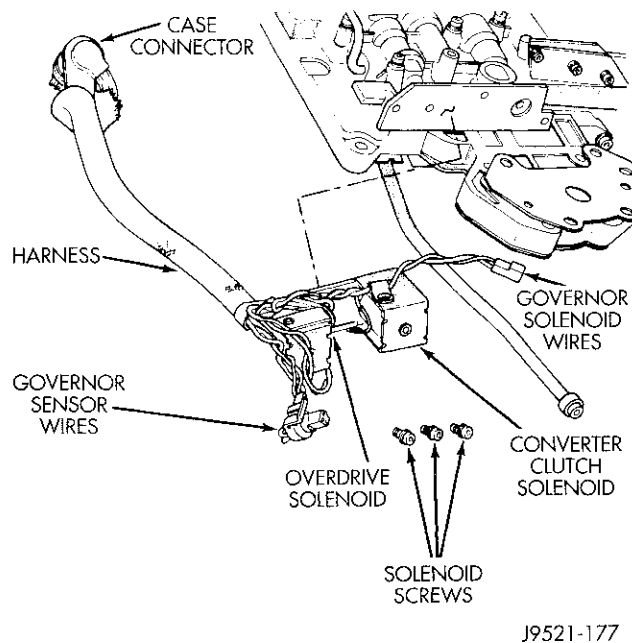
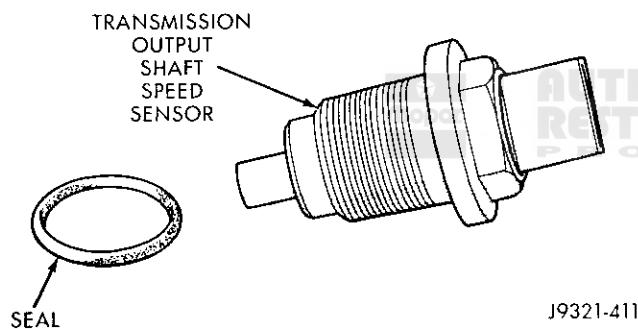
The thermistor is part of the pressure sensor and is immersed in transmission fluid at all times.

TRANSMISSION SPEED SENSOR

The speed sensor (Fig. 6) is located in the overdrive gear case. The sensor is positioned over the park gear and monitors transmission output shaft rotating speed. Speed sensor signals are triggered by the park gear lugs as they rotate past the sensor pickup face. Input signals from the sensor are sent to the transmission control module for processing. The vehicle speed sensor also serves as a backup for the transmission speed sensor. Signals from this sensor are shared with the powertrain control module.

THROTTLE POSITION SENSOR (TPS)

The TPS provides throttle position input signals to the PCM. This input signal is used to determine overdrive and converter clutch shift schedule and to select the proper governor curve.

DESCRIPTION AND OPERATION (Continued)**Fig. 5 Connector Location****Fig. 6 Transmission Speed Sensor****POWERTRAIN CONTROL MODULE (PCM)**

The PCM controls operation of the converter clutch, overdrive clutch, and governor pressure solenoid.

The control module determines transmission shift points based on input signals from the transmission thermistor, transmission output shaft speed sensor, crankshaft position sensor, vehicle speed sensor, and throttle position sensor.

Operating voltage is supplied through the battery terminal on the control module. The ignition voltage signal is supplied through a terminal on the ABS control module.

The DRB scan tool can be used to check operation of the control module and transmission electrical components. The diagnostic connector (for the scan tool) is located under the instrument panel near the steering column. The connector has a 6-way terminal and is blue in color.

GOVERNOR PRESSURE CURVES

There are four governor pressure curves programmed into the transmission control module. The different curves allow the control module to adjust governor pressure for varying conditions. One curve is used for operation when fluid temperature is at, or below, 1°C (30°F). A second curve is used when fluid temperature is at, or above, 10°C (50°F) during normal city or highway driving. A third curve is used during wide-open throttle operation. The fourth curve is used when driving with the transfer case in low range.

SHIFT VALVE OPERATION

The shift valves are moved by a combination of throttle and governor pressure. The governor pressure is generated by electrical components.

The conditions under which a shift to fourth will not occur when:

- Overdrive switch is Off
- Transmission fluid temperature is below 10° C (50° F) or above 121° C (250° F)
- Shift to third not yet completed
- Vehicle speed too low for 3-4 shift to occur

HYDRAULIC CONTROL SYSTEM

The hydraulic control system provides fully automatic operation. The system performs five basic functions which are: pressure supply, pressure regulation, flow control, clutch/band application, and lubrication.

PRESSURE REGULATION

The pressure regulator valve maintains line pressure. The amount of pressure developed is controlled by throttle pressure which is dependent on the degree of throttle opening. The regulator valve is located in the valve body.

The throttle valve determines line pressure and shift speed. Governor pressure increases in proportion to vehicle speed. The throttle valve controls upshift and downshift speeds by regulating pressure according to throttle position.

Shift Valve Flow Control

The manual valve is operated by the gearshift linkage and provides the operating range selected by the driver.

The 1-2 shift valve provides 1-2 or 2-1 shifts and the 2-3 shift valve provides 2-3 or 3-2 shifts.

The kickdown valve provides forced 3-2 or 3-1 downshifts depending on vehicle speed. Downshifts occur when the throttle is opened beyond downshift detent position. Detent is reached just before wide open throttle position.

The 2-3 valve throttle pressure plug provides 3-2 downshifts at varying throttle openings depending on vehicle speed.

DESCRIPTION AND OPERATION (Continued)

The 1-2 shift control valve transmits 1-2 shift pressure to the accumulator piston. This controls kickdown band capacity on 1-2 upshifts and 3-2 downshifts.

The 3-4 shift, quick fill, and timing valves plus the 3-4 accumulator, are only actuated when the overdrive solenoid is energized.

The solenoid contains a check ball that controls a vent port to the 3-4 valves. The check ball either diverts line pressure away from or directly to the 3-4 valves.

The limit valve determines maximum speed at which a 3-2 part throttle kickdown can be made. On transmissions without a limit valve, maximum speed for a 3-2 kickdown is at detent position.

The 2-3 shuttle valve has two functions. First is fast front band release and smooth engagement during lift-foot 2-3 upshifts. The second is to regulate front clutch and band application during 3-2 downshifts.

The 3-4 timing valve is moved by line pressure coming through the 3-4 shift valve. The timing valve holds the 2-3 shift valve in an upshift position. The purpose is to prevent the 2-3 valve from up or downshifting before the 3-4 valve.

The 3-4 accumulator is mounted on the overdrive housing and performs the same function as the 2-3 accumulator; it is used to smooth engagement during a 3-4 shift.

The switch valve directs fluid apply pressure to the converter clutch in one position and releases it in the opposite position. It also directs oil to the cooling and lube circuits. The switch valve regulates oil pressure to the torque converter by limiting maximum oil pressure to 130 psi.

OVERDRIVE OFF SWITCH

The overdrive OFF (control) switch is located in the instrument panel. The switch is a momentary contact device that signals the PCM to toggle current status of the overdrive function. At key-on, overdrive operation is allowed. Pressing the switch once causes the overdrive OFF mode to be entered and the overdrive OFF switch lamp to be illuminated. Pressing the switch a second time causes normal overdrive operation to be restored and the overdrive lamp to be turned off. The overdrive OFF mode defaults to ON after the ignition switch is cycled OFF and ON. The normal position for the control switch is the ON position. The switch must be in this position to energize the solenoid and allow a 3-4 upshift. The control switch indicator light illuminates only when the overdrive switch is turned to the OFF position, or when illuminated by the transmission control module.

3-4 SHIFT SEQUENCE

The overdrive clutch is applied in fourth gear only. The direct clutch is applied in all ranges except fourth gear. Fourth gear overdrive range is electronically controlled and hydraulically activated. Various sensor inputs are supplied to the powertrain control module to operate the overdrive solenoid on the valve body. The solenoid contains a check ball that opens and closes a vent port in the 3-4 shift valve feed passage. The overdrive solenoid (and check ball) are not energized in first, second, third, or reverse gear. The vent port remains open, diverting line pressure from the 2-3 shift valve away from the 3-4 shift valve. The overdrive control switch must be in the ON position to transmit overdrive status to the PCM. A 3-4 upshift occurs only when the overdrive solenoid is energized by the PCM. The PCM energizes the overdrive solenoid during the 3-4 upshift. This causes the solenoid check ball to close the vent port allowing line pressure from the 2-3 shift valve to act directly on the 3-4 upshift valve. Line pressure on the 3-4 shift valve overcomes valve spring pressure moving the valve to the upshift position. This action exposes the feed passages to the 3-4 timing valve, 3-4 quick fill valve, 3-4 accumulator, and ultimately to the overdrive piston. Line pressure through the timing valve moves the overdrive piston into contact with the overdrive clutch. The direct clutch is disengaged before the overdrive clutch is engaged. The boost valve provides increased fluid apply pressure to the overdrive clutch during 3-4 upshifts, and when accelerating in fourth gear. The 3-4 accumulator cushions overdrive clutch engagement to smooth 3-4 upshifts. The accumulator is charged at the same time as apply pressure acts against the overdrive piston.

CONVERTER CLUTCH ENGAGEMENT

Converter clutch engagement in third or fourth gear range is controlled by sensor inputs to the powertrain control module. Inputs that determine clutch engagement are: coolant temperature, engine rpm, vehicle speed, throttle position, and manifold vacuum. The torque converter clutch is engaged by the clutch solenoid on the valve body. The clutch can be engaged in third and fourth gear ranges depending on overdrive control switch position. If the overdrive control switch is in the normal ON position, the clutch will engage after the shift to fourth gear, and above approximately 72 km/h (45 mph). If the control switch is in the OFF position, the clutch will engage after the shift to third gear, at approximately 56 km/h (35 mph) at light throttle.

QUICK FILL VALVE

The 3-4 quick fill valve provides faster engagement of the overdrive clutch during 3-4 upshifts. The valve

DESCRIPTION AND OPERATION (Continued)

temporarily bypasses the clutch piston feed orifice at the start of a 3-4 upshift. This exposes a larger passage into the piston retainer resulting in a much faster clutch fill and apply sequence. The quick fill valve does not bypass the regular clutch feed orifice throughout the 3-4 upshift. Instead, once a predetermined pressure develops within the clutch, the valve closes the bypass. Clutch fill is then completed through the regular feed orifice.

CONVERTER DRAINBACK VALVE

The drainback valve is located in the transmission cooler outlet (pressure) line. The valve prevents fluid from draining from the converter into the cooler and lines when the vehicle is shut down for lengthy periods. Production valves have a hose nipple at one end, while the opposite end is threaded for a flare fitting. All valves have an arrow (or similar mark) to indicate direction of flow through the valve.

DIAGNOSIS AND TESTING

AUTOMATIC TRANSMISSION DIAGNOSIS

Automatic transmission problems can be a result of poor engine performance, incorrect fluid level, incorrect linkage or cable adjustment, band or hydraulic control pressure adjustments, hydraulic system malfunctions or electrical/mechanical component malfunctions. Begin diagnosis by checking the easily accessible items such as: fluid level and condition, linkage adjustments and electrical connections on 4-speed models. A road test will determine if further diagnosis is necessary.

PRELIMINARY DIAGNOSIS

Two basic procedures are required. One procedure for vehicles that are drivable and an alternate procedure for disabled vehicles (will not back up or move forward).

VEHICLE IS DRIVEABLE

- (1) Check for transmission control module fault codes using DRB scan tool.
- (2) Check fluid level and condition.
- (3) Adjust throttle and gearshift linkage if complaint was based on delayed, erratic, or harsh shifts.
- (4) Road test and note how transmission upshifts, downshifts, and engages.
- (5) Perform stall test if complaint is based on sluggish acceleration. Or, if abnormal throttle opening is needed to maintain normal speeds with a properly tuned engine.
- (6) Perform hydraulic pressure test if shift problems were noted during road test.
- (7) Perform air-pressure test to check clutch-band operation.

VEHICLE IS DISABLED

- (1) Check fluid level and condition.
- (2) Check for broken or disconnected gearshift or throttle linkage.
- (3) Check for cracked, leaking cooler lines, or loose or missing pressure-port plugs.
- (4) Raise and support vehicle on safety stands, start engine, shift transmission into gear, and note following:
 - (a) If propeller shaft turns but wheels do not, problem is with differential or axle shafts.
 - (b) If propeller shaft does not turn and transmission is noisy, stop engine. Remove oil pan, and check for debris. If pan is clear, remove transmission and check for damaged drive plate, converter, oil pump, or input shaft.
 - (c) If propeller shaft does not turn and transmission is not noisy, perform hydraulic-pressure test to determine if problem is hydraulic or mechanical.

PARK/NEUTRAL POSITION SWITCH

The center terminal of the park/neutral position switch is the starter-circuit terminal. It provides the ground for the starter solenoid circuit through the selector lever in PARK and NEUTRAL positions only. The outer terminals on the switch are for the backup lamp circuit.

SWITCH TEST

To test the switch, remove the wiring connector. Then test for continuity between the center terminal and the transmission case. Continuity should exist only when the transmission is in PARK or NEUTRAL.

Shift the transmission into REVERSE and test continuity at the switch outer terminals (Fig. 7). Continuity should exist only when the transmission is in REVERSE. Continuity should not exist between the outer terminals and the case.

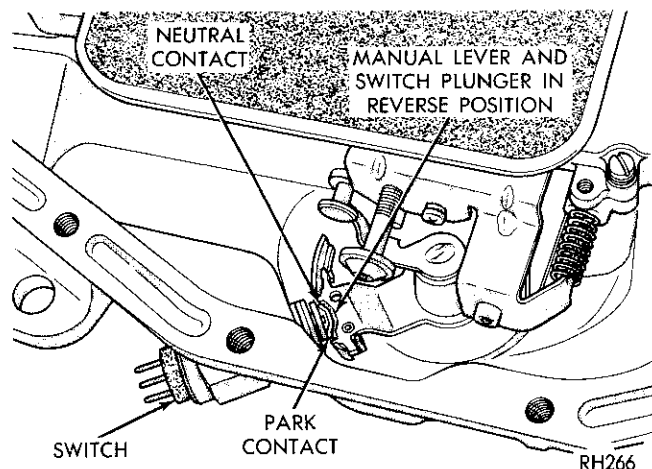
Check gearshift linkage adjustment before replacing a switch that tests bad.

CHECKING FLUID LEVEL AND CONDITION

Transmission fluid level and condition should be checked a minimum of six times per year under normal operation. If the vehicle is used for commercial operation, trailer towing, or similar high load operation, fluid level and condition should be checked weekly.

Fluid level is checked with the engine running at curb idle speed, brakes applied, transmission in Neutral, and the transmission fluid at normal operating temperature (hot).

- (1) Transmission fluid must be at normal operating temperature for accurate fluid level check. Drive vehicle if necessary to bring fluid temperature up to normal hot operating temperature of 82° C (180° F).

DIAGNOSIS AND TESTING (Continued)**Fig. 7 Park/Neutral Switch Terminals**

- (2) Position vehicle on level surface. This is extremely important for accurate fluid level check.
- (3) Start and run engine at curb idle speed.
- (4) Apply parking brakes.
- (5) Shift transmission momentarily into all gear ranges. Then shift transmission back to **Neutral**.
- (6) Clean top of filler tube and dipstick to keep dirt from entering tube.

CAUTION: Do not overfill the transmission. Overfilling may cause leakage out the pump vent which can be mistaken for a pump seal leak. Overfilling will also cause fluid aeration and foaming as the excess fluid is picked up and churned by the gear train. This will significantly reduce fluid life.

- (7) Remove dipstick and check **fluid level** as follows:

- (a) Dipstick has three indicator levels (Fig. 8) which are a MIN dot, an OK crosshatch area, and a MAX fill arrow.

- (b) Correct maximum level is to MAX arrow mark. Correct acceptable level is to OK mark in crosshatch area. Incorrect level is at or below MIN dot.

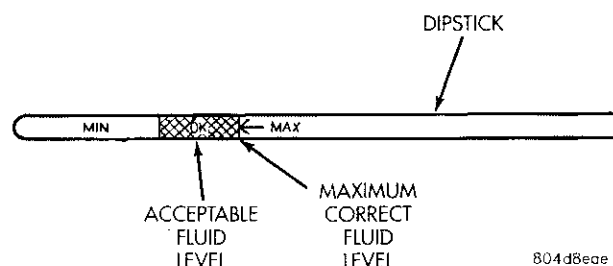
- (c) If fluid is low, add only enough Mopar ATF Plus to restore correct level. Do not overfill.

- (d) If transmission is overfilled, fluid can be removed with 1/8 to 3/16 in. diameter tubing and suction gun. Tubing will have to be adapted to nozzle of gun and be long enough to extend down fill tube and into transmission oil pan.

- (8) Check **fluid condition** as follows:

- (a) Fluid color should range from dark red to pink and be free of particles and sludge.

- (b) If fluid is orange, brown, or smells burned but shifts were OK, flow test and reverse flush cooler and lines. Then change fluid and filter and road test again to confirm proper operation.

**Fig. 8 Dipstick Fluid Level Marks**

(c) If fluid is black, dark brown, turned to sludge, contains extensive amount of metal or friction material particles, transmission will need overhaul. Main and auxiliary coolers will have to be flow tested and reverse flushed as well.

EFFECTS OF INCORRECT FLUID LEVEL

A low fluid level allows the pump to take in air along with the fluid. Air in the fluid will cause fluid pressures to be low and develop slower than normal. If the transmission is overfilled, the gears churn the fluid into foam. This aerates the fluid and causing the same conditions occurring with a low level. In either case, air bubbles cause fluid overheating, oxidation and varnish buildup which interferes with valve, clutch and servo operation. Foaming also causes fluid expansion which can result in fluid overflow from the transmission vent or fill tube. Fluid overflow can easily be mistaken for a leak if inspection is not careful.

CAUSES OF BURNT FLUID

Burnt, discolored fluid is a result of overheating which has two primary causes.

- (1) A result of restricted fluid flow through the main and/or auxiliary cooler. This condition is usually the result of a faulty or improperly installed drainback valve, a damaged main cooler, or severe restrictions in the coolers and lines caused by debris or kinked lines.

- (2) Heavy duty operation with a vehicle not properly equipped for this type of operation. Trailer towing or similar high load operation will overheat the transmission fluid if the vehicle is improperly equipped. Such vehicles should have an auxiliary transmission fluid cooler, a heavy duty cooling system, and the engine/axle ratio combination needed to handle heavy loads.

FLUID CONTAMINATION

Transmission fluid contamination is generally a result of:

- adding incorrect fluid
- failure to clean dipstick and fill tube when checking level

DIAGNOSIS AND TESTING (Continued)

- engine coolant entering the fluid
- internal failure that generates debris
- overheat that generates sludge (fluid breakdown)
- failure to reverse flush cooler and lines after repair
- failure to replace contaminated converter after repair

The use of non recommended fluids can result in transmission failure. The usual results are erratic shifts, slippage, abnormal wear and eventual failure due to fluid breakdown and sludge formation. Avoid this condition by using recommended fluids only.

The dipstick cap and fill tube should be wiped clean before checking fluid level. Dirt, grease and other foreign material on the cap and tube could fall into the tube if not removed beforehand. Take the time to wipe the cap and tube clean before withdrawing the dipstick.

Engine coolant in the transmission fluid is generally caused by a cooler malfunction. The only remedy is to replace the radiator as the cooler in the radiator is not a serviceable part. If coolant has circulated through the transmission for some time, an overhaul may also be necessary; especially if shift problems had developed.

The transmission cooler and lines should be reverse flushed whenever a malfunction generates sludge and/or debris. The torque converter should also be replaced at the same time.

Failure to flush the cooler and lines will result in recontamination. Flushing applies to auxiliary coolers as well. The torque converter should also be replaced whenever a failure generates sludge and debris. This is necessary because normal converter flushing procedures will not remove all contaminants.

OIL COOLER FLOW CHECK

After the new or repaired transmission has been installed and filled, the oil cooler flow should be checked using the following procedure:

(1) Disconnect the **From cooler** line at the transmission and place a collecting container under the disconnected line.

(2) Run the engine at curb idle speed, with the shift selector in neutral.

(3) If the fluid flow is intermittent or takes more than 20 seconds to collect one quart, the cooler should be replaced.

CAUTION: With the fluid set at the proper level, fluid collection should not exceed (1) quart or internal damage to the transmission may occur.

(4) If flow is found to be within acceptable limits, reconnect the cooler line. Then fill transaxle to the

proper level, using the approved type of automatic transmission fluid.

OVERDRIVE ELECTRICAL CONTROLS

The overdrive off switch, valve body solenoid, case connectors and related wiring can all be tested with a 12 volt test lamp or a volt/ohmmeter. Check continuity of each component when diagnosis indicates this is necessary. Refer to Group 8W, Wiring Diagrams for component locations and circuit information.

Switch and solenoid continuity should be checked whenever the transmission fails to shift into fourth gear range.

GEARSHIFT LINKAGE AND THROTTLE CABLE

GEARSHIFT LINKAGE

Gearshift linkage adjustment is important because it positions the valve body manual valve. Incorrect adjustment will cause creeping in Neutral, premature clutch wear, delayed engagement in any gear, or a no-start in Park or Neutral position.

Proper operation of the park/neutral position switch will provide a quick check of linkage adjustment.

THROTTLE VALVE CABLE ADJUSTMENT

Throttle valve cable adjustment is important to proper operation. This adjustment positions the throttle valve which controls shift speed, quality and part throttle downshift sensitivity.

If cable setting is too short, early shifts and slippage between shifts may occur. If the setting is too long, shifts may be delayed and part throttle downshifts may be very sensitive.

ROAD TESTING

Before road testing, be sure the fluid level and control cable adjustments have been checked and adjusted if necessary. Verify that diagnostic trouble codes have been resolved.

Observe engine performance during the road test. A poorly tuned engine will not allow accurate analysis of transmission operation.

Operate the transmission in all gear ranges. Check for shift variations and engine flare which indicates slippage. Note if shifts are harsh, spongy, delayed, early, or if part throttle downshifts are sensitive.

Slippage indicated by engine flare, usually means clutch, band or overrunning clutch problems. If the condition is advanced, an overhaul will be necessary to restore normal operation.

A slipping clutch or band can often be determined by comparing which internal units are applied in the various gear ranges. The Clutch and Band Application chart provides a basis for analyzing road test results.

DIAGNOSIS AND TESTING (Continued)

SHIFT LEVER POSITION	TRANSMISSION CLUTCHES AND BANDS					OVERDRIVE CLUTCHES		
	FRONT CLUTCH	FRONT BAND	REAR CLUTCH	REAR BAND	OVERRUN. CLUTCH	OVERDRIVE CLUTCH	DIRECT CLUTCH	OVERRUN. CLUTCH
Reverse	X			X			X	
Drive Range								
First			X		X		X	X
Second		X	X				X	X
Third	X		X				X	X
Fourth	X		X			X		
2-Range (Manual) Second)		X	X		X		X	X
1-Range (Manual Low)			X	X	X		X	X

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Clutch And Band Application**ANALYZING ROAD TEST**

Refer to the Clutch and Band Application chart and note which elements are in use in the various gear ranges.

Note that the rear clutch is applied in all forward ranges (D, 2, 1). The transmission overrunning clutch is applied in first gear (D, 2 and 1 ranges) only. The rear band is applied in 1 and R range only.

Note that the overdrive clutch is applied only in fourth gear and the overdrive direct clutch and overrunning clutch are applied in all ranges except fourth gear.

For example: If slippage occurs in first gear in D and 2 range but not in 1 range, the transmission overrunning clutch is faulty. Similarly, if slippage occurs in any two forward gears, the rear clutch is slipping.

Applying the same method of analysis, note that the front and rear clutches are applied simultaneously only in D range third and fourth gear. If the transmission slips in third gear, either the front clutch or the rear clutch is slipping.

If the transmission slips in fourth gear but not in third gear, the overdrive clutch is slipping. By selecting another gear which does not use these clutches, the slipping unit can be determined. For example, if the transmission also slips in Reverse, the front clutch is slipping. If the transmission does not slip in Reverse, the rear clutch is slipping.

If slippage occurs during the 3-4 shift or only in fourth gear, the overdrive clutch is slipping. Similarly, if the direct clutch were to fail, the transmis-

sion would lose both reverse gear and overrun braking in 2 position (manual second gear). If the transmission slips in any other two forward gears, the transmission rear clutch is probably slipping.

If the transmission will not shift to fourth gear, the control switch, overdrive solenoid or related wiring may also be the problem cause.

This process of elimination can be used to identify a slipping unit and check operation. Proper use of the Clutch and Band Application Chart is the key.

Although road test analysis will help determine the slipping unit, the actual cause of a malfunction usually cannot be determined until hydraulic and air pressure tests are performed. Practically any condition can be caused by leaking hydraulic circuits or sticking valves.

Unless a malfunction is obvious, such as no drive in D range first gear, do not disassemble the transmission. Perform the hydraulic and air pressure tests to help the probable cause.

HYDRAULIC PRESSURE TEST

Hydraulic test pressures range from a low of one psi (6.895 kPa) governor pressure, to 300 psi (2068 kPa) at the rear servo pressure port in reverse. Use 100 psi Gauge C-3292 to check pressure at the accumulator, front servo and governor. Use 300 psi Gauge C-3293-SP to check pressure at the rear servo and overdrive port.

DIAGNOSIS AND TESTING (Continued)

Pressure Test Port Locations

Pressure test ports locations are provided at the accumulator, front servo, and rear servo, governor passage, and overdrive clutch pressure passage (Fig. 9).

An accurate tachometer and two test gauges are required for the pressure test. Test Gauge C-3292 has a 100 psi range and is used at the accumulator, governor, and front servo pressure ports. Test Gauge C-3293-SP has a 300 psi range and is used at the rear servo port and overdrive test ports where pressures are higher. In cases where two test gauges are required, the 300 psi gauge can be used at any of the other test ports.

Line pressure is checked at the accumulator port on the right side of the case. The front servo pressure port is at the right side of the case just behind the filler tube opening.

The rear servo and governor pressure ports are at the right rear of the transmission case. The overdrive clutch pressure port is at the left rear of the case (Fig. 9).

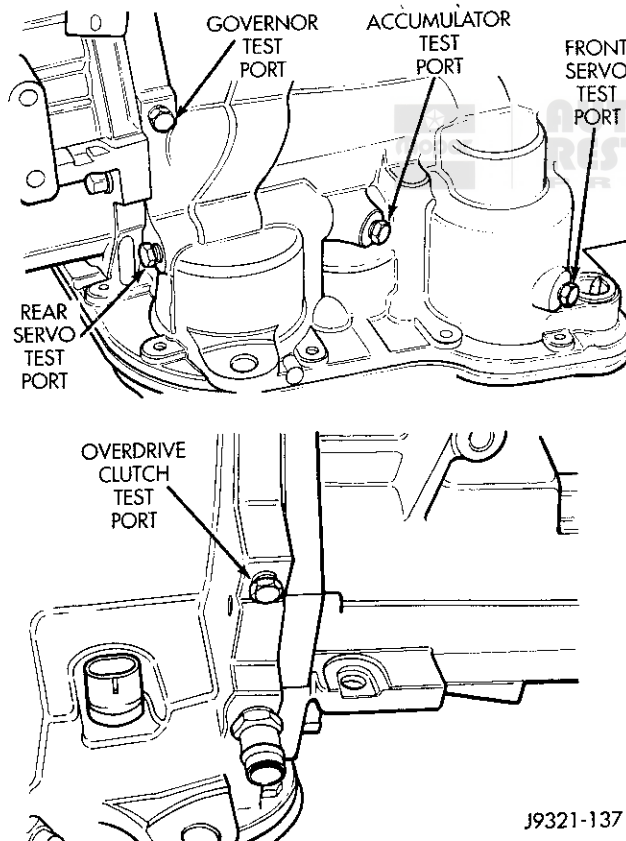


Fig. 9 Pressure Test Ports

PRESSURE TEST PROCEDURE

Connect a tachometer to the engine. Position the tachometer so it can be observed from under the vehicle. Raise the vehicle on a hoist that will allow the wheels to rotate freely.

Test One - Transmission In Manual Low

This test checks pump output, pressure regulation, and condition of the rear clutch and servo circuit. Test Gauges C-3292 and C-3293-SP are required for this test. Gauge C-3292 has a 100 psi range. Gauge C-3293-SP has a 300 psi range.

- (1) Connect 100 psi Gauge C-3292 to accumulator port.
- (2) Connect 300 psi Gauge C-3293-SP to rear servo port (Fig. 9).
- (3) Disconnect throttle and gearshift rods from manual and throttle levers.
- (4) Start and run engine at 1000 rpm.
- (5) Move shift lever (on manual lever shaft) all the way forward into manual low.
- (6) Move transmission throttle lever from full forward to full rearward position and note pressures on both gauges.
- (7) Line pressure at accumulator port should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (621-662 kPa) as lever is moved rearward.
- (8) Rear servo pressure should be same as line pressure within 3 psi (20.68 kPa).

Test Two - Transmission In Manual Second

This test checks pump output and pressure regulation. Use 100 psi Test Gauge C-3292 for this test.

- (1) Connect test gauge to accumulator pressure port (Fig. 9).
- (2) Start and run engine at 1000 rpm.
- (3) Move shift lever on valve body manual lever shaft, one detent rearward from full forward position. This is manual second.
- (4) Move transmission throttle lever from full forward to full rearward position and read pressure at both gauges.
- (5) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (621-662 kPa) as lever is moved rearward.

Test Three - Transmission In D Range

This test checks pressure regulation and condition of the clutch circuits. Use both pressure Test Gauges C-3292 and C-3293-SP for this test.

- (1) Connect test gauges to accumulator and front servo ports (Fig. 9). Use either test gauge at the two ports.
- (2) Start and run engine at 1600 rpm for this test.
- (3) Move selector lever to D range. This is two detents rearward from full forward position.
- (4) Read pressures on both gauges as transmission throttle lever is moved from full forward to full rearward position.

DIAGNOSIS AND TESTING (Continued)

(5) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase as lever is moved rearward.

(6) Front servo is pressurized only in D range and should be same as line pressure within 3 psi (21 kPa) up to downshift point.

Test Four - Transmission In Reverse

This test checks pump output, pressure regulation and the front clutch and rear servo circuits. Use 300 psi Test Gauge C-3293-SP for this test.

(1) Connect 300 psi gauge to rear servo port (Fig. 9).

(2) Start and run engine at 1600 rpm for test.

(3) Move valve body selector lever four detents rearward from the full forward position. This is Reverse range.

(4) Move throttle lever all way forward then all way rearward and note gauge readings.

(5) Pressure should be 145 - 175 psi (1000-1207 kPa) with lever forward and increase to 230 - 280 psi (1586-1931 kPa) as lever is moved rearward.

Test Five - Governor Pressure

This test checks governor operation by measuring governor pressure response to changes in engine speed. It is usually not necessary to check governor operation unless shift speeds are incorrect or if the transmission will not downshift.

(1) Connect 100 psi Test Gauge C-3292 to governor pressure port (Fig. 9).

(2) Move shift lever to D range.

(3) Start and run engine at curb idle speed and note pressure. At idle and with vehicle stopped, pressure should be zero to 1.5 psi maximum. If pressure exceeds this figure, governor valve or weights are sticking open.

(4) Slowly increase engine speed and observe speedometer and pressure test gauge. Governor pressure should increase in proportion to vehicle speed. Or approximately 1 psi for every 1 mph.

(5) Pressure rise should be smooth and drop back to 0 to 1.5 psi when wheels stop rotating.

(6) Compare results of pressure tests with analysis charts (Fig. 10).

Test Six - Overdrive Fourth Gear

This test checks line pressure at the overdrive clutch in fourth gear range. The test should be performed on the road or on a chassis dynamometer. Do not perform this test on a hoist. Use 300 psi Test Gauge C-3292 for this test.

(1) Remove tachometer; it is not needed for this test.

(2) Move 300 psi Gauge to overdrive clutch pressure test port. Then remove other gauge and reinstall test port plug.

(3) Lower vehicle.

(4) Turn on OD switch.

(5) Secure test gauge so it can be viewed from driver's seat.

(6) Start engine and shift into D range.

(7) Increase vehicle speed gradually until 3-4 shift occurs and note gauge pressure.

(8) Pressure should be 469-496 kPa (68-72 psi) with closed throttle and increase to 620-827 kPa (90-120 psi) at 1/2 to 3/4 throttle. Note that pressure can increase to around 896 kPa (130 psi) at full throttle.

(9) Return to shop or move vehicle off chassis dynamometer.

TEST CONDITION	INDICATION
Line pressure OK during any one test	Pump and regulator valve OK
Line Pressure OK in R but low in D, 2, 1	Leakage in rear clutch area (servo, clutch seals, governor support seal rings)
Pressure Low in D Fourth Gear Range	Overdrive clutch piston seal, or check ball problem
Pressure OK in 1, 2 but low in D3 and R	Leakage in front clutch area (servo, clutch seals, retainer bore, pump seal rings)
Pressure OK in 2 but low in R and 1	Leakage in rear servo
Front servo pressure low in 2	Leakage in servo; broken servo ring or cracked servo piston
Pressure low in all positions	Clogged filter, stuck regulator valve, worn or faulty pump, plugged fluid cooler
Governor pressure too high at idle speed, or governor pressure low at all mph figures	Faulty governor pressure solenoid, transmission control module, or governor pressure sensor
Lubrication/line pressure low at all throttle positions	Clogged fluid cooler or lines, seal rings leaking, output shaft plugged with debris, worn bushings in pump or clutch retainer

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Fig. 10 Pressure Test Analysis**CONVERTER STALL TEST**

Stall testing involves determining maximum engine speed obtainable at full throttle with the rear wheels locked and the transmission in D range. This test checks the holding ability of the converter overrunning and transmission clutches. When stall testing is completed, refer to the stall speed chart and diagnosis guides.

DIAGNOSIS AND TESTING (Continued)

WARNING: NEVER ALLOW ANYONE TO STAND DIRECTLY IN LINE WITH THE VEHICLE FRONT OR REAR DURING A STALL TEST. ALWAYS BLOCK THE WHEELS AND FULLY APPLY THE SERVICE AND PARKING BRAKES DURING THE TEST.

STALL TEST PROCEDURE

- (1) Connect tachometer to engine. Position tachometer so it can be viewed from driver's seat.
- (2) Check transmission fluid level. Add fluid if necessary.
- (3) Drive vehicle to bring transmission fluid up to normal operating temperature. Vehicle can be driven on road, or on chassis dynamometer, if available.
- (4) Block front wheels.
- (5) Fully apply service and parking brakes.
- (6) Open throttle completely and record maximum engine speed registered on tachometer. It takes 4-10 seconds to reach max rpm. **Once max rpm has been achieved, do not hold wide open throttle for more than 4-5 seconds.**

CAUTION: Stalling the converter causes a rapid increase in fluid temperature. To avoid fluid overheating, hold the engine at maximum rpm for no more than 5 seconds. If engine exceeds 2500 rpm during the test, release the accelerator pedal immediately; transmission clutch slippage is occurring.

- (7) If a second stall test is required, cool down fluid before proceeding. Shift into NEUTRAL and run engine at 1000 rpm for 20-30 seconds to cool fluid.
- (8) Refer to Stall Test Analysis.

STALL TEST ANALYSIS

Stall Speed Too High

If the stall speed exceeds 1800-2300 rpm by more than 200 rpm, transmission clutch slippage is indicated.

Stall Speed Low

Low stall speed with a properly tuned engine indicate a torque converter overrunning clutch problem. The condition should be confirmed by road testing before to converter replacement. A stall speed 250-350 rpm below normal indicates the converter overrunning clutch is slipping. The vehicle also exhibits poor acceleration but operates normally once highway cruise speeds are reached. Torque converter replacement will be necessary.

Stall Speed Normal But Acceleration Poor

If stall speeds are normal (1800-2300 rpm) but abnormal throttle opening is required for acceleration, or to maintain cruise speed, the converter over-

running clutch is seized. The torque converter will have to be replaced.

Converter Noise During Test

A whining noise caused by fluid flow is normal during a stall test. However, loud metallic noises indicate a damaged converter. To confirm that noise is originating from the converter, operate the vehicle at light throttle in DRIVE and NEUTRAL on a hoist and listen for noise coming from the converter housing.

AIR TESTING TRANSMISSION CLUTCH AND BAND OPERATION

Air-pressure testing can be used to check transmission front/rear clutch and band operation. The test can be conducted with the transmission either in the vehicle or on the work bench, as a final check, after overhaul.

Air-pressure testing requires that the oil pan and valve body be removed from the transmission. The servo and clutch apply passages are shown (Fig. 11).

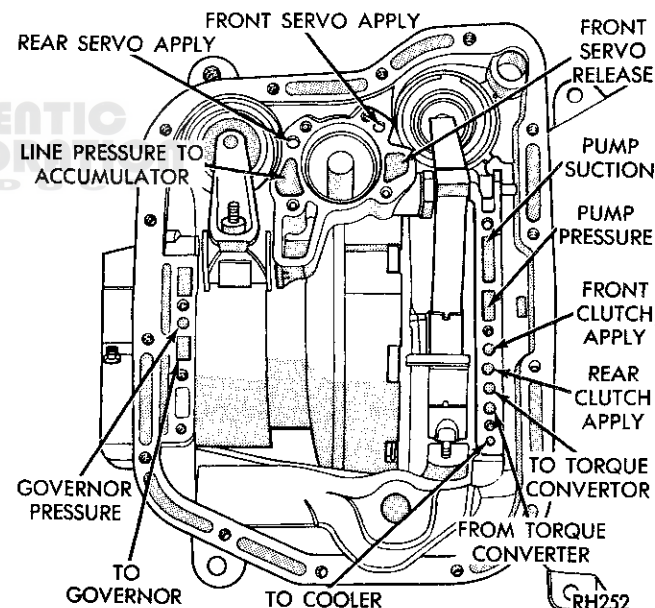


Fig. 11 Air Pressure Test Passages—Typical

Front Clutch Air Test

Place one or two fingers on the clutch housing and apply air pressure through front clutch apply passage. Piston movement can be felt and a soft thump heard as the clutch applies.

Rear Clutch Air Test

Place one or two fingers on the clutch housing and apply air pressure through rear clutch apply passage. Piston movement can be felt and a soft thump heard as the clutch applies.

DIAGNOSIS AND TESTING (Continued)**Front Servo Air Test**

Apply air pressure to the front servo apply passage. The servo rod should extend and cause the band to tighten around the drum. Spring pressure should release the servo when air pressure is removed.

Rear Servo Air Test

Apply air pressure to the rear servo apply passage. The servo rod should extend and cause the band to tighten around the drum. Spring pressure should release the servo when air pressure is removed.

CONVERTER HOUSING FLUID LEAK DIAGNOSIS

When diagnosing converter housing fluid leaks, two items must be established before repair.

- (1) Verify that a leak condition actually exists.
- (2) Determined the true source of the leak.

Some suspected converter housing fluid leaks may not be leaks at all. They may only be the result of residual fluid in the converter housing, or excess fluid spilled during factory fill or fill after repair. Converter housing leaks have several potential sources. Through careful observation, a leak source can be identified before removing the transmission for repair. Pump seal leaks tend to move along the drive hub and onto the rear of the converter. Pump O-ring or pump body leaks follow the same path as a seal leak (Fig. 12). Pump vent or pump attaching bolt leaks are generally deposited on the inside of the converter housing and not on the converter itself (Fig. 12). Pump seal or gasket leaks usually travel down the inside of the converter housing. Front band lever pin plug leaks are generally deposited on the housing and not on the converter.

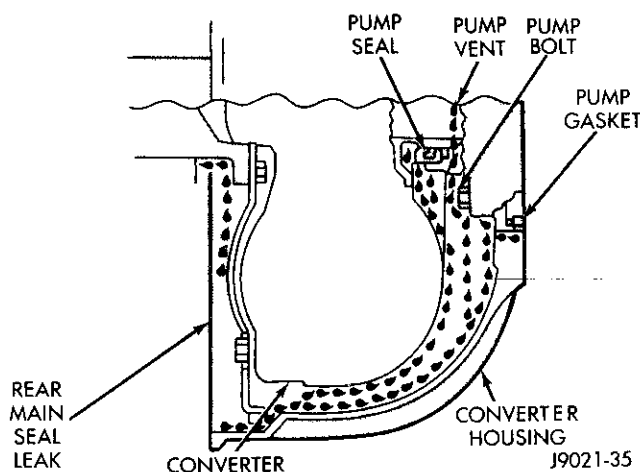


Fig. 12 Converter Housing Leak Paths

LEAK DIAGNOSIS PROCEDURE

- (1) Raise rear of vehicle and allow accumulated fluid to drain out of converter housing.
- (2) Check and adjust transmission fluid level.

(3) Raise vehicle. Remove converter housing dust cover and wipe as much fluid as possible from converter housing.

(4) Fabricate test probe (Fig. 13). Attach probe to converter housing with a dust shield bolt.

(5) Have a helper run engine at 2500 rpm (with transmission in Neutral) for two minutes; then stop engine.

(6) Inspect test probe and converter housing. If a leak is evident, note color of fluid. Transmission fluid is red. Engine oil ranges in color from brown to green, or to black when oil is dirty.

(7) Check probe **upper surface**. If upper surface is dry, converter and seal are OK. If probe upper surface is wet, converter and/or seal is leaking.

(8) Fluid leaking **under** the probe is coming from pump housing area. Leak could be from: pump seal and/or bushing, pump vent, kickdown lever shaft access plug, pump bolts, or porous spots in pump body or transmission case (Fig. 14).

(9) If porous spots in the transmission case or pump body are the suspected leak source, pressurize transmission as described in Leak Testing With Air Pressure.

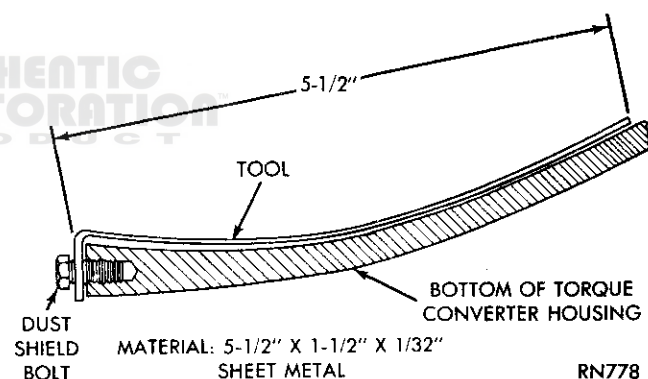


Fig. 13 Leak Test Probe

TORQUE CONVERTER LEAK POINTS

Possible sources of converter leaks are:

- (1) Leaks at the weld joint around the outside diameter weld (Fig. 14).
- (2) Leaks at the converter hub weld (Fig. 15).

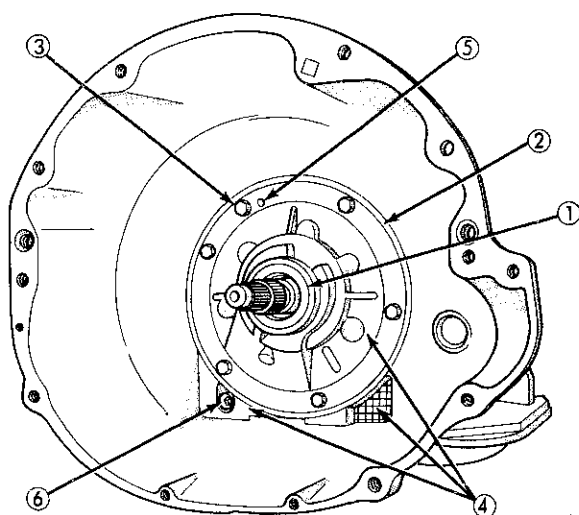
LEAK TESTING WITH AIR PRESSURE

This test involves closing off all openings and pressurizing the transmission to 8 psi with hand operated Air Pump Tool 7700.

A soapy water solution is applied to suspected leak points before and during the pressure test. Leaks will be indicated by the presence of air bubbles coming through the solution.

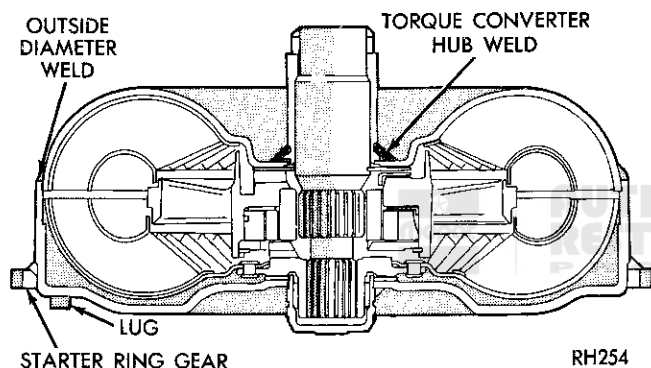
Some transmission openings such as the fill tube and front cooler line fitting can be closed off with a rubber plug or similar device. Plugs can be secured with wire or duct tape.

DIAGNOSIS AND TESTING (Continued)



RH253

Fig. 14 Pump Area Inspection Points



RH254

Fig. 15 Converter Leak Points—Typical

The transmission rear output shaft opening is closed off simply by leaving the transfer case bolted in place. However, if the transfer case has been removed, a shipping plug can be used to close off this opening.

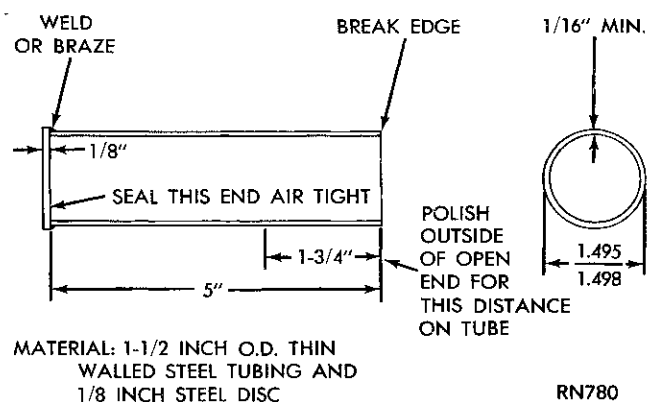
The torque converter hub opening in the pump and the pump vent require special tools to close them off.

The converter hub seal cup is made from thin wall tube and a 3.17 mm (1/8 in.) thick disc (Fig. 16).

A retaining strap is needed to secure the seal cup for testing. The strap can be made from 31.75 mm (1-1/4 in.) wide stock (Fig. 17). The strap attaching hole positions are approximate only. Measure hole position on the converter housing before drilling.

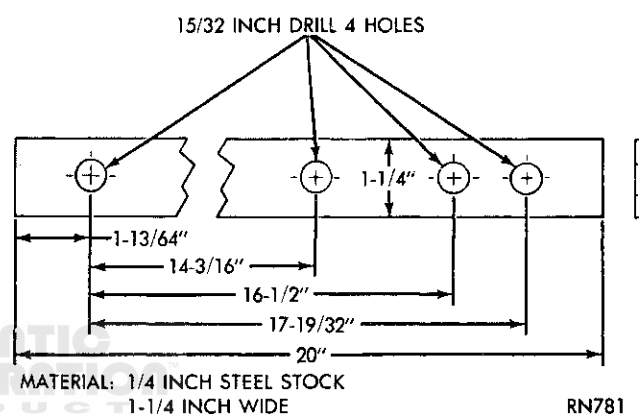
The pump vent tool is made from 6.35 mm (1/4 in.) rod and 4.76 mm (3/16 in.) plate (Fig. 18).

The fabricated tools can all be made from mild steel or aluminum stock.



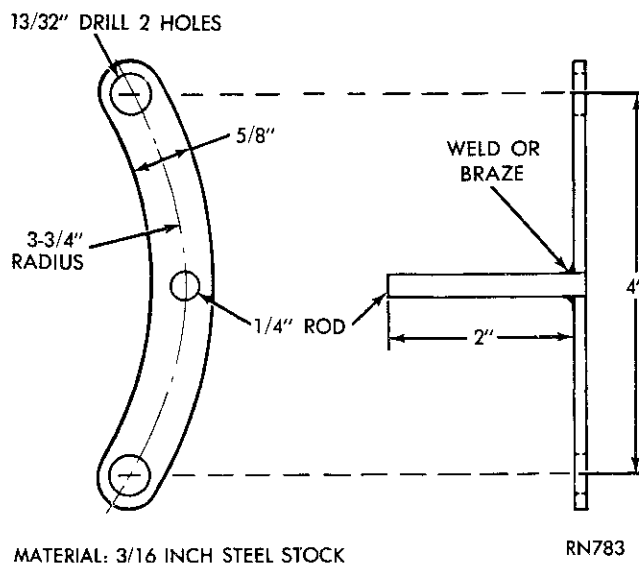
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Fig. 16 Converter Hub Seal Cup



RN781

Fig. 17 Seal Cup Retaining Strap



MATERIAL: 3/16 INCH STEEL STOCK

RN783

Fig. 18 Pump Vent Plug

DIAGNOSIS AND TESTING (Continued)**AIR PRESSURE LEAK TEST PROCEDURE**

(1) Install vent plug, converter hub seal cup and cup retaining strap (Fig. 19).

CAUTION: Be sure the surfaces of the hub seal cup are smooth and free of nicks, scratches, or burrs. Surface irregularities on the cup will damage the pump seal if not removed. Sand and/polish the cup with 400 grit sandpaper or crocus cloth to smooth the surface if necessary.

(2) Close off remaining transmission openings with rubber plugs, or stoppers or similar devices. **Do not close off rear cooler line fitting. Hand operated air pump will be attached to this fitting.**

(3) Attach Air Pump 7700 to rear cooler line fitting. Connect a length of copper tube to fitting. Then attach pump hose to tube with hose clamp (Fig. 20).

(4) Apply a thick soapy water solution to suspected leak areas.

CAUTION: The recommended test pressure is 8 psi. The maximum allowable test pressure is 10 psi. Do not exceed specified pressure.

- (5) Pressurize transmission to 8 psi. with air pump.
- (6) Observe suspected leak areas. Air bubbles appearing in soapy water solution indicate leak points.
- (7) Remove test tools and plugs after test completion and make necessary repairs as described in Leak Correction procedure.

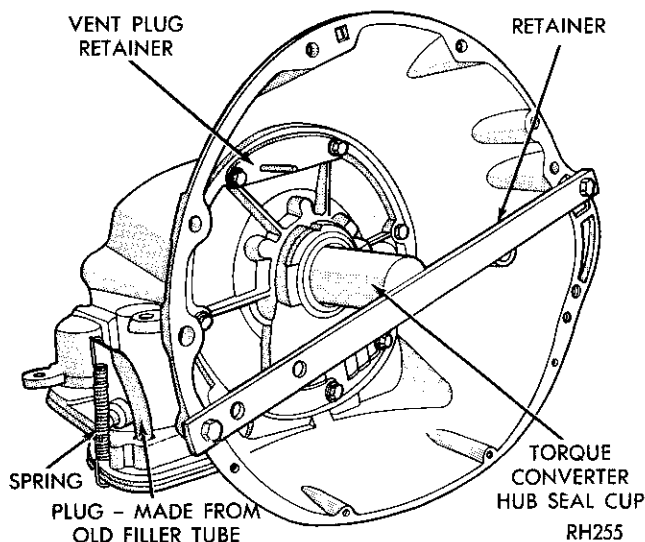
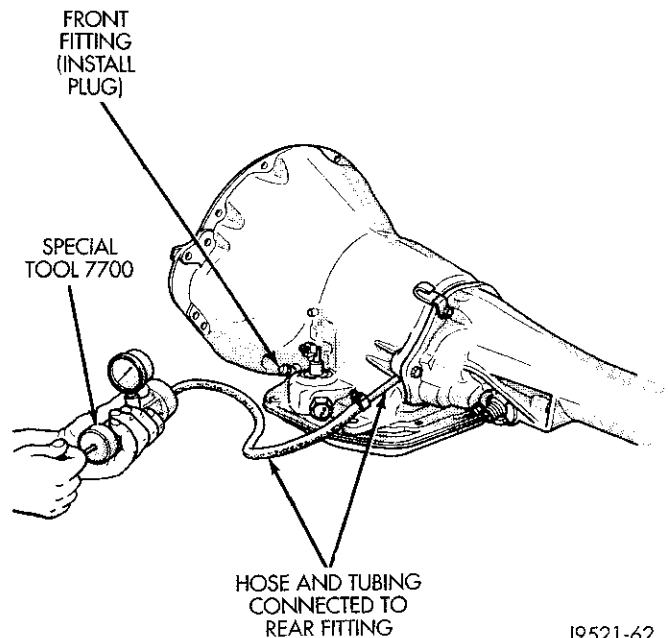


Fig. 19 Vent Plug And Hub Seal Cup Installation

CONVERTER HOUSING AREA LEAK CORRECTION

- (1) Remove converter.
- (2) Tighten front band adjusting screw until band is tight around front clutch retainer. This prevents front/rear clutches from coming out when oil pump is removed.



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Fig. 20 Pressurizing Transmission With Tool 7700

- (3) Remove oil pump and remove pump seal. Inspect pump housing drainback and vent holes for obstructions. Clear holes with solvent and wire.
- (4) Inspect pump bushing and converter hub. If bushing is scored, replace it. If converter hub is scored, either polish it with crocus cloth or replace converter if scoring is severe.
- (5) Install new pump seal, O-ring, gasket, bushing. Replace oil pump if cracked, porous or damaged in any way.
- (6) Loosen kickdown lever pin access plug three turns. Apply Loctite 592, or Permatex No. 2 to plug threads and tighten plug to 17 N·m (150 in. lbs.) torque.
- (7) Adjust front band.
- (8) Lubricate pump seal and converter hub with transmission fluid or petroleum jelly and install converter.
- (9) Install transmission and converter housing dust shield.
- (10) Lower vehicle.

DIAGNOSIS TABLES AND CHARTS—RE TRANSMISSION

The diagnosis charts provide additional reference when diagnosing a transmission fault. The charts provide general information on a variety of transmission, overdrive unit and converter clutch fault conditions.

The hydraulic flow charts in the Schematics and Diagrams section of this group, outline fluid flow and hydraulic circuitry. Circuit operation is provided for neutral, third, fourth and reverse gear ranges. Normal working pressures are also supplied for each of the gear ranges.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
HARSH ENGAGEMENT (FROM NEUTRAL TO DRIVE OR REVERSE)	<ol style="list-style-type: none"> 1. Fluid Level Low 2. Throttle Linkage Misadjusted 3. Mount and Driveline Bolts Loose 4. U-Joint Worn/Broken 5. Axle Backlash Incorrect 6. Hydraulic Pressure Incorrect 7. Band Misadjusted. 8. Valve Body Check Balls Missing. 9. Axle Pinion Flange Loose. 10. Clutch, band or planetary component Damaged. 11. Converter Clutch (if equipped) Faulty. 	<ol style="list-style-type: none"> 1. Add Fluid 2. Adjust linkage - setting may be too long. 3. Check engine mount, transmission mount, propeller shaft, rear spring to body bolts, rear control arms, crossmember and axle bolt torque. Tighten loose bolts and replace missing bolts. 4. Remove propeller shaft and replace U-Joint. 5. Check per Service Manual. Correct as needed. 6. Check pressure. Remove, overhaul or adjust valve body as needed. 7. Adjust rear band. 8. Inspect valve body for proper check ball installation. 9. Replace nut and check pinion threads before installing new nut. Replace pinion gear if threads are damaged. 10. Remove, disassemble and repair transmission as necessary. 11. Replace converter and flush cooler and line before installing new converter.
DELAYED ENGAGEMENT (FROM NEUTRAL TO DRIVE OR REVERSE)	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Filter Clogged. 3. Gearshift Linkage Misadjusted. 4. Torque Converter Drain Back (Oil drains from torque converter into transmission sump) 5. Rear Band Misadjusted. 6. Valve Body Filter Plugged. 7. Oil Pump Gears Worn/Damaged. 8. Governor Circuit and Solenoid Valve (RE Only) Electrical Fault. 	<ol style="list-style-type: none"> 1. Correct level and check for leaks. 2. Change filter. 3. Adjust linkage and repair linkage if worn or damaged. 4. If vehicle moves normally after 5 seconds after shifting into gear, no repair is necessary. If longer, inspect pump bushing for wear. Replace pump house. 5. Adjust band. 6. Replace fluid and filter. If oil pan and old fluid were full of clutch disc material and/or metal particles, overhaul will be necessary. 7. Remove transmission and replace oil pump. 8. Test with DRB and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	9. Hydraulic Pressure Incorrect. 10. Reaction Shaft Seal Rings Worn/Broken. 11. Rear Clutch/Input Shaft, Rear Clutch Seal Rings Damaged. 12. Governor Valve Stuck. 13. Regulator Valve Stuck. 14. Cooler Plugged.	9. Perform pressure test, remove transmission and repair as needed. 10. Remove transmission, remove oil pump and replace seal rings. 11. Remove and disassemble transmission and repair as necessary. 12. Remove and inspect governor components. Replace worn or damaged parts. 13. Clean. 14. Transfer case failure can plug cooler.
NO DRIVE RANGE (REVERSE OK)	1. Fluid Level Low. 2. Gearshift Linkage/Cable Loose/Misadjusted. 3. Rear Clutch Burnt. 4. Valve Body Malfunction. 5. Transmission Overrunning Clutch Broken. 6. Input Shaft Seal Rings Worn/Damaged. 7. Front Planetary Failed Broken.	1. Add fluid and check for leaks if drive is restored. 2. Repair or replace linkage components. 3. Remove and disassemble transmission and rear clutch and seals. Repair/replace worn or damaged parts as needed. 4. Remove and disassemble valve body. Replace assembly if any valves or bores are damaged. 5. Remove and disassemble transmission. Replace overrunning clutch. 6. Remove and disassemble transmission. Replace seal rings and any other worn or damaged parts. 7. Remove and repair.
NO DRIVE OR REVERSE (VEHICLE WILL NOT MOVE)	1. Fluid Level Low. 2. Gearshift Linkage/Cable Loose/Misadjusted. 3. U-Joint/Axle/Transfer Case Broken. 4. Filter Plugged.	1. Add fluid and check for leaks if drive is restored. 2. Inspect, adjust and reassemble linkage as needed. Replace worn/damaged parts. 3. Perform preliminary inspection procedure for vehicle that will not move. Refer to procedure in diagnosis section. 4. Remove and disassemble transmission. Repair or replace failed components as needed. Replace filter. If filter and fluid contained clutch material or metal particles, an overhaul may be necessary. Perform lube flow test. Flush oil. Replace cooler as necessary.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Oil Pump Damaged. 6. Valve Body Malfunctioned. 7. Transmission Internal Component Damaged. 8. Park Sprag not Releasing - Check Stall Speed, Worn/Damaged/Stuck. 9. Torque Converter Damage.	5. Perform pressure test to confirm low pressure. Replace pump body assembly if necessary. 6. Check press and inspect valve body. Replace valve body (as assembly) if any valve or bore is damaged. Clean and reassemble correctly if all parts are in good condition. 7. Remove and disassemble transmission. Repair or replace failed components as needed. 8. Remove, disassemble, repair. 9. Inspect and replace as required.
SHIFTS DELAYED OR ERRATIC (SHIFTS ALSO HARSH AT TIMES)	1. Fluid Level Low/High. 2. Fluid Filter Clogged. 3. Throttle Linkage Misadjusted. 4. Throttle Linkage Binding. 5. Gearshift Linkage/Cable Misadjusted. 6. Governor Valve Sticking. 7. Governor Seal Rings Worn/Damaged. 8. Clutch or Servo Failure. 9. Governor Circuit (RE Only) Electrical Fault. 10. Front Band Misadjusted. 11. Pump Suction Passage Leak.	1. Correct fluid level and check for leaks if low. 2. Replace filter. If filter and fluid contained clutch material or metal particles, an overhaul may be necessary. Perform lube flow test. 3. Adjust linkage as described in service section. 4. Check cable for binding. Check for return to closed throttle at transmission. 5. Adjust linkage/cable as described in service section. 6. Inspect, clean or repair. 7. Inspect/replace. 8. Remove valve body and air test clutch, and band servo operation. Disassemble and repair transmission as needed. 9. Test using DRB and repair as required. 10. Adjust band. 11. Check for excessive foam on dipstick after normal driving. Check for loose pump bolts, defective gasket. Replace pump assembly if needed.
NO REVERSE (D RANGES OK)	1. Gearshift Linkage/Cable Misadjusted/Damaged. 2. Park Sprag Sticking. 3. Rear Band Misadjusted/Worn.	1. Repair or replace linkage parts as needed. 2. Replace overdrive annulus gear. 3. Adjust band; replace.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Valve Body Malfunction. 5. Rear Servo Malfunction. 6. Direct Clutch in Overdrive Worn 7. Front Clutch Burnt.	4. Remove and service valve body. Replace valve body if any valves or valve bores are worn or damaged. 5. Remove and disassemble transmission. Replace worn/damaged servo parts as necessary. 6. Disassemble overdrive. Replace worn or damaged parts. 7. Remove and disassemble transmission. Replace worn, damaged clutch parts as required.
HAS FIRST/REVERSE ONLY (NO 1-2 OR 2-3 UPSHIFT)	1. Governor Valve, Shaft, Weights or Body Damaged/Stuck. 2. Valve Body Malfunction. 3. Front Servo/Kickdown Band Damaged/Burned.	1. Remove governor assembly and clean or repair as necessary. 2. Repair stuck 1-2 shift valve or governor plug. 3. Repair/replace.
MOVES IN 2ND OR 3RD GEAR, ABRUPTLY DOWNSHIFTS TO LOW	1. Valve Body Malfunction. 2. Governor Valve Sticking. 3. Governor Circuit (RE Only) Electrical Fault.	1. Remove, clean and inspect. Look for stuck 1-2 valve or governor plug. 2. Remove, clean and inspect. Replace faulty parts. 3. Test using DRB and repair as required.
NO LOW GEAR (MOVES IN 2ND OR 3RD GEAR ONLY)	1. Governor Valve Sticking. 2. Governor Circuit (RE Only) Electrical Fault. 3. Valve Body Malfunction. 4. Front Servo Piston Cocked in Bore. 5. Front Band Linkage Malfunction	1. Remove governor, clean, inspect and repair as required. 2. Test with DRB and repair as required. 3. Remove, clean and inspect. Look for sticking 1-2 shift valve, 2-3 shift valve, governor plug or broken springs. 4. Inspect servo and repair as required. 5. Inspect linkage and look for bind in linkage.
NO KICKDOWN OR NORMAL DOWNSHIFT	1. Throttle Linkage Misadjusted. 2. Accelerator Pedal Travel Restricted. 3. Governor/Valve Body Hydraulic Pressures Too High or Too Low Due to Sticking Governor, Valve Body Malfunction or Incorrect Hydraulic Control Pressure Adjustments. 4. Governor Circuit (RE Only) Electrical Fault.	1. Adjust linkage. 2. Verify floor mat is not under pedal, repair worn accelerator cable or bent brackets. 3. Perform hydraulic pressure tests to determine cause and repair as required. Correct valve body pressure adjustments as required. 4. Test with DRB and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Valve Body Malfunction. 6. TPS Malfunction. 7. PCM Malfunction. 8. Valve Body Malfunction.	5. Perform hydraulic pressure tests to determine cause and repair as required. Correct valve body pressure adjustments as required. 6. Replace sensor, check with DRB scan tool. 7. Check with DRB II and replace if required. 8. Repair sticking 1-2, 2-3 shift valves, governor plugs, 3-4 solenoid, 3-4 shift valve, 3-4 timing valve.
STUCK IN LOW GEAR (WILL NOT UPSHIFT)	1. Throttle Linkage Misadjusted/Stuck. 2. Gearshift Linkage Misadjusted. 3. Governor/Valve Body, Governor Valve Stuck Closed; Loose Output Shaft Support or Governor Housing Bolts, Leaking Seal Rings or Valve Body Problem (i.e., Stuck 1- 2 Shift Valve/Gov. Plug). 4. Governor Component (RE Only) Electrical Fault. 5. Front Band Out of Adjustment. 6. Clutch or Servo Malfunction.	1. Adjust linkage and repair linkage if worn or damaged. Check for binding cable or missing return spring. 2. Adjust linkage and repair linkage if worn or damaged. 3. Check line and governor pressures to determine cause. Correct as required. 4. Check operating pressures and test with DRB scan tool, repair faulty component. 5. Adjust Band. 6. Air pressure check operation of clutches and bands. Repair faulty component.
CREEPS IN NEUTRAL	1. Gearshift Linkage Misadjusted. 2. Rear Clutch Dragging/Warped. 3. Valve Body Malfunction.	1. Adjust linkage. 2. Disassemble and repair. 3. Perform hydraulic pressure test to determine cause and repair as required.
BUZZING NOISE	1. Fluid Level Low 2. Shift Cable Misassembled. 3. Valve Body Misassembled. 4. Pump Passages Leaking 5. Cooling System Cooler Plugged. 6. Overrunning Clutch Damaged.	1. Add fluid and check for leaks. 2. Route cable away from engine and bell housing. 3. Remove, disassemble, inspect valve body. Reassemble correctly if necessary. Replace assembly if valves or springs are damaged. Check for loose bolts or screws. 4. Check pump for porous casting, scores on mating surfaces and excess rotor clearance. Repair as required. Loose pump bolts. 5. Flow check cooler circuit. Repair as needed. 6. Replace clutch.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
SLIPS IN REVERSE ONLY	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Gearshift Linkage Misadjusted. 3. Rear Band Misadjusted. 4. Rear Band Worn. 5. Overdrive Direct Clutch Worn. 6. Hydraulic Pressure Too Low. 7. Rear Servo Leaking. 8. Band Linkage Binding. 	<ol style="list-style-type: none"> 1. Add fluid and check for leaks. 2. Adjust linkage. 3. Adjust band. 4. Replace as required. 5. Disassemble overdrive. Repair as needed. 6. Perform hydraulic pressure tests to determine cause. 7. Air pressure check clutch-servo operation and repair as required. 8. Inspect and repair as required.
SLIPS IN FORWARD DRIVE RANGES	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Fluid Foaming. 3. Throttle Linkage Misadjusted. 4. Gearshift Linkage Misadjusted. 5. Rear Clutch Worn. 6. Low Hydraulic Pressure Due to Worn Pump, Incorrect Control Pressure Adjustments, Valve Body Warpage or Malfunction, Sticking Governor, Leaking Seal Rings, Clutch Seals Leaking, Servo Leaks, Clogged Filter or Cooler Lines 7. Rear Clutch Malfunction, Leaking Seals or Worn Plates. 8. Overrunning Clutch Worn, Not Holding (Slips in 1 Only). 	<ol style="list-style-type: none"> 1. Add fluid and check for leaks. 2. Check for high oil level, bad pump gasket or seals, dirt between pump halves and loose pump bolts. Replace pump if necessary. 3. Adjust linkage. 4. Adjust linkage. 5. Inspect and replace as needed. 6. Perform hydraulic and air pressure tests to determine cause. 7. Air pressure check clutch-servo operation and repair as required. 8. Replace Clutch.
SLIPS IN LOW GEAR "D" ONLY, BUT NO IN 1 POSITION GROWLING, GRATING OR SCRAPING NOISES	<p>Overrunning Clutch Faulty.</p> <ol style="list-style-type: none"> 1. Drive Plate Broken. 2. Torque Converter Bolts Hitting Dust Shield. 3. Planetary Gear Set Broken/ Seized. 4. Overrunning Clutch Worn/Broken. 5. Oil Pump Components Scored/ Binding. 6. Output Shaft Bearing or Bushing Damaged. 7. Clutch Operation Faulty. 	<p>Replace overrunning clutch.</p> <ol style="list-style-type: none"> 1. Replace. 2. Dust shield bent. Replace or repair. 3. Check for debris in oil pan and repair as required. 4. Inspect and check for debris in oil pan. Repair as required. 5. Remove, inspect and repair as required. 6. Remove, inspect and repair as required. 7. Perform air pressure check and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	8. Front and Rear Bands Misadjusted.	8. Adjust bands.
DRAGS OR LOCKS UP	1. Fluid Level Low. 2. Clutch Dragging/Failed 3. Front or Rear Band Misadjusted. 4. Case Leaks Internally. 5. Servo Band or Linkage Malfunction. 6. Overrunning Clutch Worn. 7. Planetary Gears Broken. 8. Converter Clutch Dragging.	1. Check and adjust level. 2. Air pressure check clutch operation and repair as required. 3. Adjust bands. 4. Check for leakage between passages in case. 5. Air pressure check servo operation and repair as required. 6. Remove and inspect clutch. Repair as required. 7. Remove, inspect and repair as required (look for debris in oil pan). 8. Check for plugged cooler. Perform flow check. Inspect pump for excessive side clearance. Replace pump as required.
NO 4-3 DOWNSHIFT	1. Circuit Wiring and/or Connectors Shorted. 2. PCM Malfunction. 3. TPS Malfunction 4. Lockup Solenoid Not Venting. 5. Overdrive Solenoid Not Venting. 6. Valve Body Valve Sticking.	1. Test wiring and connectors with test lamp and volt/ohmmeter. Repair wiring as necessary. Replace connectors and/or harnesses as required. 2. Check PCM operation with DRB scan tool. Replace PCM only if faulty. 3. Check TPS with DRB scan tool at PCM. 4. Remove valve body and replace solenoid assembly if plugged or shorted. 5. Remove valve body and replace solenoid if plugged or shorted. 6. Repair stuck 3-4 shift valve or lockup timing valve.
NO 4-3 DOWNSHIFT WHEN CONTROL SWITCH IS TURNED OFF	1. Control Switch Open/Shorted. 2. Overdrive Solenoid Connector Shorted. 3. PCM Malfunction. 4. Valve Body Stuck Valves.	1. Test and replace switch if faulty. 2. Test solenoids and replace if seized or shorted. 3. Test with DRB scan tool. Replace PCM if faulty. 4. Repair stuck 3-4, lockup or lockup timing valve.
CLUNK NOISE FROM DRIVELINE ON CLOSED THROTTLE 4-3 DOWNSHIFT	1. Transmission Fluid Low. 2. Throttle Cable Misadjusted.	1. Add Fluid. 2. Adjust cable.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	3. Overdrive Clutch Select Spacer Wrong Spacer.	3. Replace overdrive piston thrust plate spacer.
3-4 UPSHIFT OCCURS IMMEDIATELY AFTER 2-3 SHIFT	1. Overdrive Solenoid Connector or Wiring Shorted. 2. TPS Malfunction. 3. PCM Malfunction. 4. Overdrive Solenoid Malfunction. 5. Valve Body Malfunction.	1. Test connector and wiring for loose connections, shorts or ground and repair as needed. 2. Test TPS and replace as necessary. Check with DRB scan tool. 3. Test PCM with DRB scan tool and replace controller if faulty. 4. Replace solenoid. 5. Remove, disassemble, clean and inspect valve body components. Make sure all valves and plugs slide freely in bores. Polish valves with crocus cloth if needed.
WHINE/NOISE RELATED TO ENGINE SPEED	1. Fluid Level Low. 2. Shift Cable Incorrect Routing.	1. Add fluid and check for leaks. 2. Check shift cable for correct routing. Should not touch engine or bell housing.
NO 3-4 UPSHIFT	1. Dash O/D Switch In OFF Position. 2. Overdrive Circuit Fuse Blown. 3. O/D Switch Wire Shorted/Open Cut. 4. Distance or Coolant Sensor Malfunction. 5. TPS Malfunction. 6. Neutral Switch to PCM Wire Shorted/Cut. 7. PCM Malfunction. 8. Overdrive Solenoid Shorted/Open. 9. Solenoid Feed Orifice in Valve Body Blocked. 10. Overdrive Clutch Failed.	1. Turn control switch to ON position. 2. Replace fuse. Determine why fuse failed and repair as necessary (i.e., shorts or grounds in circuit). 3. Check wires/connections with 12V test lamp and voltmeter. Repair damaged or loose wire/connection as necessary. 4. Test both sensors with test lamp or volt/ohmmeter and replace faulty sensor. 5. Check with DRB scan tool and replace if necessary. 6. Test switch as described in service section and replace if necessary. Engine no start. 7. Check with DRB scan tool and replace if necessary. 8. Replace solenoid if shorted or open and repair loose or damaged wires (DRB scan tool). 9. Remove, disassemble, and clean valve body thoroughly. Check feed orifice. 10. Disassemble overdrive and repair as needed.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	11. Hydraulic Pressure Low. 12. Valve Body Valve Stuck. 13. O/D Piston Incorrect Spacer. 14. Overdrive Piston Seal Failure. 15. O/D Check Valve/Orifice Failed.	11. Pressure test transmission to determine cause. 12. Repair stuck 3-4 shift valve, 3-4 timing valve. 13. Remove unit, check end play and install correct spacer. 14. Replace both seals. 15. Check for free movement and secure assembly (in piston retainer). Check ball bleed orifice.
SLIPS IN OVERDRIVE FOURTH GEAR	1. Fluid Level Low. 2. Overdrive Clutch Pack Worn. 3. Overdrive Piston Retainer Bleed Orifice Blown Out. 4. Overdrive Piston or Seal Malfunction. 5. 3-4 Shift Valve, Timing Valve or Accumulator Malfunction. 6. Overdrive Unit Thrust Bearing Failure. 7. O/D Check Valve/Bleed Orifice Failure.	1. Add fluid and check for leaks. 2. Remove overdrive unit and rebuild clutch pack. 3. Disassemble transmission, remove retainer and replace orifice. 4. Remove overdrive unit. Replace seals if worn. Replace piston if damaged. If piston retainer is damaged, remove and disassemble the transmission. 5. Remove and overhaul valve body. Replace accumulator seals. Make sure all valves operate freely in bores and do not bind or stick. Make sure valve body screws are correctly tightened and separator plates are properly positioned. 6. Disassemble overdrive unit and replace thrust bearing (NO. 1 thrust bearing is between overdrive piston and clutch hub; NO. 2 thrust bearing is between the planetary gear and the direct clutch spring plate; NO. 3 thrust bearing is between overrunning clutch hub and output shaft). 7. Check for function/secure orifice insert in O/D piston retainer.
DELAYED 3-4 UPSHIFT (SLOW TO ENGAGE)	1. Fluid Level Low. 2. Throttle Valve Cable Misadjusted. 3. Overdrive Clutch Pack Worn/Burnt. 4. TPS Faulty. 5. Overdrive Clutch Bleed Orifice Plugged.	1. Add fluid and check for leaks. 2. Adjust throttle valve cable. 3. Remove unit and rebuild clutch pack. 4. Test with DRB scan tool and replace TPS. 5. Disassemble transmission and replace orifice.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	6. Overdrive Solenoid or Wiring Shorted/Open. 7. Overdrive Excess Clearance 8. O/D Check Valve Missing or Stuck.	6. Test solenoid and check wiring for loose/corroded connections or shorts/grounds. Replace solenoid if faulty and repair wiring if necessary. 7. Remove unit. Measure end play and select proper spacer. 8. Check for presence of check valve. Repair or replace as required.
TORQUE CONVERTER LOCKS UP IN SECOND AND/OR THIRD GEAR	Lockup Solenoid, Relay or Wiring Shorted/Open.	Test solenoid, relay and wiring for continuity, shorts or grounds. Replace solenoid and relay if faulty. Repair wiring and connectors as necessary.
HARSH 1-2, 2-3, 3-4 OR 3-2 SHIFTS NO START IN PARK OR NEUTRAL	Lockup Solenoid Malfunction. 1. Gearshift Linkage/Cable Misadjusted. 2. Neutral Switch Wire Open/Cut. 3. Neutral Switch Faulty. 4. Neutral Switch Connect Faulty. 5. Valve Body Manual Lever Assembly Bent/Worn/Broken.	Remove valve body and replace solenoid assembly. 1. Adjust linkage/cable. 2. Check continuity with test lamp. Repair as required. 3. Refer to service section for test and replacement procedure. 4. Connectors spread open. Repair. 5. Inspect lever assembly and replace if damaged.
NO REVERSE (OR SLIPS IN REVERSE)	1. Direct Clutch Pack (front clutch) Worn. 2. Rear Band Misadjusted. 3. Front Clutch Malfunctioned/ Burned. 4. Overdrive Thrust Bearing Failure. 5. Direct Clutch Spring Collapsed/ Broken.	1. Disassemble unit and rebuild clutch pack. 2. Adjust band. 3. Air-pressure test clutch operation. Remove and rebuild if necessary. 4. Disassemble geartrain and replace bearings. 5. Remove and disassemble unit. Check clutch position and replace spring.
OIL LEAKS (ITEMS LISTED REPRESENT POSSIBLE LEAK POINTS AND SHOULD ALL BE CHECKED).	1. Speedometer Adapter Leaks. 2. Fluid Lines and Fittings Loose/Leaks/Damaged. 3. Fill Tube (where tube enters case) Leaks/Damaged. 4. Pressure Port Plug Loose Loose/Damaged. 5. Pan Gasket Leaks.	1. Replace both adapter seals. 2. Tighten fittings. If leaks persist, replace fittings and lines if necessary. 3. Replace O-ring seal. Inspect tube for cracks in fill tube. 4. Tighten to correct torque. Replace plug or reseal if leak persists. 5. Tighten pan screws (150 in. lbs.). If leaks persist, replace gasket.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	6. Valve Body Manual Lever Shaft Seal Leaks/Worn. 7. Rear Bearing Access Plate Leaks. 8. Gasket Damaged or Bolts are Loose. 9. Adapter/Extension Gasket Damaged Leaks/Damaged. 10. Neutral Switch Leaks/Damaged. 11. Converter Housing Area Leaks. 12. Pump Seal Leaks/Worn/Damaged. 13. Torque Converter Weld Leak/Cracked Hub. 14. Case Porosity Leaks.	6. Replace shaft seal. 7. Replace gasket. Tighten screws. 8. Replace bolts or gasket or tighten both. 9. Replace gasket. 10. Replace switch and gasket. 11. Check for leaks at seal caused by worn seal or burr on converter hub (cutting seal), worn bushing, missing oil return, oil in front pump housing or hole plugged. Check for leaks past O-ring seal on pump or past pump-to-case bolts; pump housing porous, oil coming out vent due to overfill or leak past front band shaft access plug. 12. Replace seal. 13. Replace converter. 14. Replace case.
NOISY OPERATION IN FOURTH GEAR ONLY	1. Overdrive Clutch Discs, Plates or Snap Rings Damaged. 2. Overdrive Piston or Planetary Thrust Bearing Damaged. 3. Output Shaft Bearings Scored/Damaged. 4. Planetary Gears Worn/Chipped. 5. Overdrive Unit Overrunning Clutch Rollers Worn/Scored.	1. Remove unit and rebuild clutch pack. 2. Remove and disassemble unit. Replace either thrust bearing if damaged. 3. Remove and disassemble unit. Replace either bearing if damaged. 4. Remove and overhaul overdrive unit. 5. Remove and overhaul overdrive unit.

SERVICE PROCEDURES**FLUID LEVEL CHECK**

Transmission fluid level should be checked monthly under normal operation. If the vehicle is used for trailer towing or similar heavy load hauling, check fluid level and condition weekly. Fluid level is checked with the engine running at curb idle speed, the transmission in NEUTRAL and the transmission fluid at normal operating temperature.

FLUID LEVEL CHECK PROCEDURE

(1) Transmission fluid must be at normal operating temperature for accurate fluid level check. Drive

vehicle if necessary to bring fluid temperature up to normal hot operating temperature of 82°C (180°F).

- (2) Position vehicle on level surface.
- (3) Start and run engine at curb idle speed.
- (4) Apply parking brakes.
- (5) Shift transmission momentarily into all gear ranges. Then shift transmission back to Neutral.
- (6) Clean top of filler tube and dipstick to keep dirt from entering tube.
- (7) Remove dipstick (Fig. 21) and check fluid level as follows:

(a) Correct maximum level is to MAX arrow mark. Correct acceptable level is to OK mark in crosshatch area.

(b) Incorrect level is at or below MIN line.

SERVICE PROCEDURES (Continued)

(c) If fluid is low, add only enough Mopar ATF Plus to restore correct level. Do not overfill.

CAUTION: Do not overfill the transmission. Overfilling may cause leakage out the pump vent which can be mistaken for a pump seal leak. Overfilling will also cause fluid aeration and foaming as the excess fluid is picked up and churned by the gear train. This will significantly reduce fluid life.

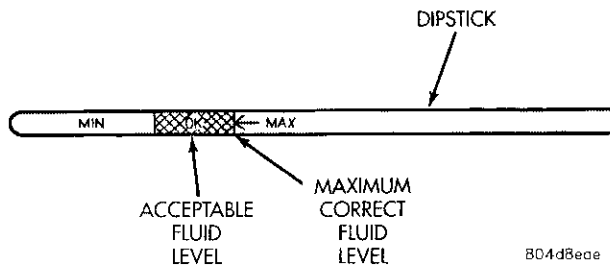


Fig. 21 Dipstick Fluid Level Marks—Typical

FLUID AND FILTER REPLACEMENT

Refer to the Maintenance Schedules in Group 0, Lubrication and Maintenance for proper service intervals. The service fluid fill after a filter change is approximately 3.8 liters (4.0 quarts).

PAN AND FILTER REMOVAL

- (1) Hoist and support vehicle on safety stands.
- (2) Place a large diameter shallow drain pan beneath the transmission pan.
- (3) Remove bolts holding front and sides of pan to transmission (Fig. 22).
- (4) Loosen bolts holding rear of pan to transmission.
- (5) Slowly separate front of pan away from transmission allowing the fluid to drain into drain pan.
- (6) Hold up pan and remove remaining bolt holding pan to transmission.
- (7) While holding pan level, lower pan away from transmission.
- (8) Pour remaining fluid in pan into drain pan.
- (9) Remove screws holding filter to valve body (Fig. 23).
- (10) Separate filter from valve body and pour fluid in filter into drain pan.
- (11) Dispose used trans fluid and filter properly.

INSPECTION AND CLEANING**INSPECTION**

Inspect bottom of pan and magnet for excessive amounts of metal or fiber contamination. A light coating of clutch or band material on the bottom of the pan does not indicate a problem unless accompanied by slipping condition or shift lag. If fluid and

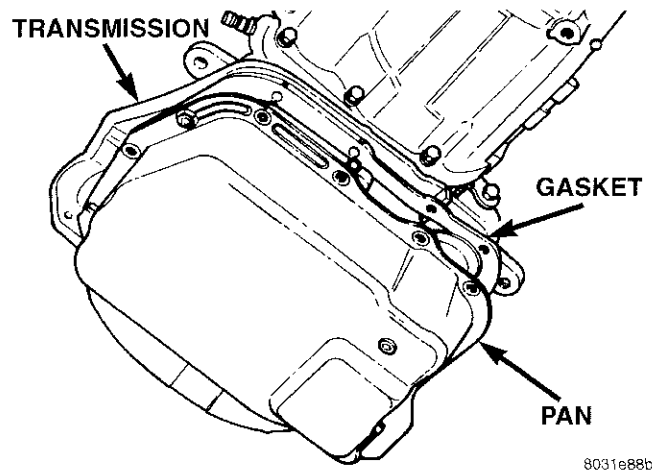


Fig. 22 Transmission Pan—Typical

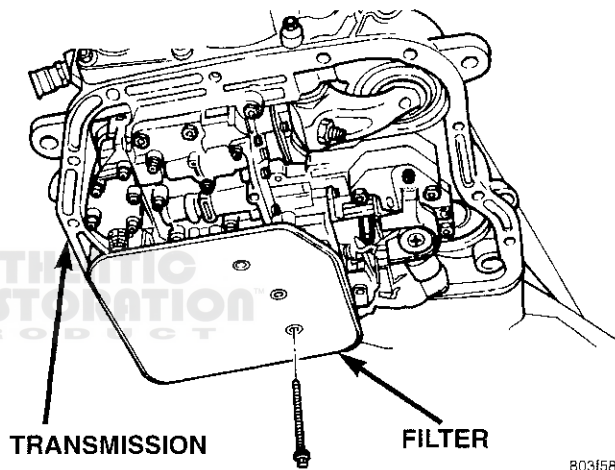


Fig. 23 Transmission Filter—Typical

pan are contaminated with excessive amounts or debris, refer to the diagnosis section of this group.

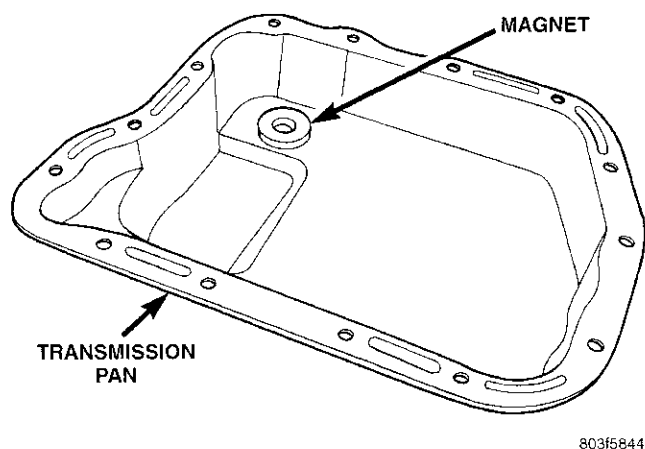
Check the adjustment of the front and rear bands, adjust if necessary. Refer to Adjustment section of this group for proper procedure.

CLEANING

- (1) Using a suitable solvent, clean pan and magnet (Fig. 24).
- (2) Using a suitable gasket scraper, clean gasket material from gasket surface of transmission case and the gasket flange around the pan.

FILTER AND PAN INSTALLATION

- (1) Place replacement filter in position on valve body.
- (2) Install screws to hold filter to valve body (Fig. 23). Tighten screws to 4 N·m (35 in. lbs.) torque.
- (3) Place new gasket in position on pan, and install pan on transmission.
- (4) Place pan in position on transmission.

SERVICE PROCEDURES (Continued)**Fig. 24 Pan and Magnet**

- (5) Install screws to hold pan to transmission (Fig. 22). Tighten bolts to 17 N·m (150 in. lbs.) torque.
- (6) Lower vehicle and fill transmission with Mopar ATF Plus, type 7176 fluid.

TRANSMISSION FILL PROCEDURE

To avoid overfilling transmission after a fluid change or overhaul, perform the following procedure:

- (1) Remove dipstick and insert clean funnel in transmission fill tube.
- (2) Add following initial quantity of Mopar ATF Plus to transmission:
 - (a) If only fluid and filter were changed, add **3 pints (1-1/2 quarts)** of ATF Plus to transmission.
 - (b) If transmission was completely overhauled, torque converter was replaced or drained, and cooler was flushed, add **12 pints (6 quarts)** of ATF Plus to transmission.
- (3) Apply parking brakes.
- (4) Start and run engine at normal curb idle speed.
- (5) Apply service brakes, shift transmission through all gear ranges then back to NEUTRAL, set parking brake, and leave engine running at curb idle speed.
- (6) Remove funnel, insert dipstick and check fluid level. If level is low, **add fluid to bring level to MIN mark on dipstick.**
- (7) Drive vehicle until transmission fluid is at normal operating temperature.
- (8) With the engine running at curb idle speed, the gear selector in NEUTRAL, and the parking brake applied, check the transmission fluid level.

CAUTION: Do not overfill transmission, fluid foaming and shifting problems can result.

- (9) Add fluid to bring level up to MAX arrow mark.

When fluid level is correct, shut engine off, release park brake, remove funnel, and install dipstick in fill tube.

CONVERTER DRAINBACK CHECK VALVE SERVICE

The converter drainback check valve is located in the cooler outlet (pressure) line near the radiator lower tank. The valve prevents fluid drainback when the vehicle is parked for lengthy periods. The valve check ball is spring loaded and has an opening pressure of approximately 2 psi.

The valve is serviced as an assembly; it is not repairable. Do not clean the valve if restricted, or contaminated by sludge, or debris. If the valve fails, or if a transmission malfunction occurs that generates sludge and/or clutch particles and metal shavings, the valve must be replaced.

The valve must be removed whenever the cooler and lines are reverse flushed. The valve can be flow tested when necessary. The procedure is exactly the same as for flow testing a cooler.

If the valve is restricted, installed backwards, or in the wrong line, it will cause an overheating condition and possible transmission failure.

CAUTION: The drainback valve is a one-way flow device. It must be properly oriented in terms of flow direction for the cooler to function properly. The valve must be installed in the pressure line. Otherwise flow will be blocked and would cause an overheating condition and eventual transmission failure.

ALUMINUM THREAD REPAIR

Damaged or worn threads in the aluminum transaxle case and valve body can be repaired by the use of Heli-Coils, or equivalent. This repair consists of drilling out the worn-out damaged threads. Then tap the hole with a special Heli-Coil tap, or equivalent, and installing a Heli-Coil insert, or equivalent, into the hole. This brings the hole back to its original thread size.

Heli-Coil, or equivalent, tools and inserts are readily available from most automotive parts suppliers.

FLUSHING COOLERS AND TUBES

When a transmission failure has contaminated the fluid, the oil cooler(s) must be flushed. The cooler bypass valve in the transmission must be replaced also. The torque converter must also be replaced with an exchange unit. This will insure that metal particles or sludged oil are not later transferred back into the reconditioned (or replaced) transmission.

There are two different procedures for flushing coolers and lines. The recommended procedure is to use Tool 6906 Cooler Flusher. The other procedure is to use a hand suction gun and mineral spirits.

SERVICE PROCEDURES (Continued)

WARNING: WEAR PROTECTIVE EYEWEAR THAT MEETS THE REQUIREMENTS OF OSHA AND ANSI Z87.1—1968. WEAR STANDARD INDUSTRIAL RUBBER GLOVES.

KEEP LIGHTED CIGARETTES, SPARKS, FLAMES, AND OTHER IGNITION SOURCES AWAY FROM THE AREA TO PREVENT THE IGNITION OF COMBUSTIBLE LIQUIDS AND GASES. KEEP A CLASS (B) FIRE EXTINGUISHER IN THE AREA WHERE THE FLUSHER WILL BE USED.

KEEP THE AREA WELL VENTILATED.

DO NOT LET FLUSHING SOLVENT COME IN CONTACT WITH YOUR EYES OR SKIN: IF EYE CONTAMINATION OCCURS, FLUSH EYES WITH WATER FOR 15 TO 20 SECONDS. REMOVE CONTAMINATED CLOTHING AND WASH AFFECTED SKIN WITH SOAP AND WATER. SEEK MEDICAL ATTENTION.

COOLER FLUSH USING TOOL 6906

(1) Remove cover plate filler plug on Tool 6906. Fill reservoir 1/2 to 3/4 full of fresh flushing solution. Flushing solvents are petroleum based solutions generally used to clean automatic transmission components. **DO NOT** use solvents containing acids, water, gasoline, or any other corrosive liquids.

(2) Reinstall filler plug on Tool 6906.

(3) Verify pump power switch is turned OFF. Connect red alligator clip to positive (+) battery post. Connect black (-) alligator clip to a good ground.

(4) Disconnect the cooler lines at the transmission.

NOTE: When flushing transmission cooler and lines, ALWAYS reverse flush.

(5) Connect the BLUE pressure line to the OUTLET (From) cooler line.

(6) Connect the CLEAR return line to the INLET (To) cooler line

(7) Turn pump ON for two to three minutes to flush cooler(s) and lines. Monitor pressure readings and clear return lines. Pressure readings should stabilize below 20 psi. for vehicles equipped with a single cooler and 30 psi. for vehicles equipped with dual coolers. If flow is intermittent or exceeds these pressures, replace cooler.

(8) Turn pump OFF.

(9) Disconnect CLEAR suction line from reservoir at cover plate. Disconnect CLEAR return line at cover plate, and place it in a drain pan.

(10) Turn pump ON for 30 seconds to purge flushing solution from cooler and lines. Turn pump OFF.

(11) Place CLEAR suction line into a one quart container of Mopar® type 7176 automatic transmission fluid.

(12) Turn pump ON until all transmission fluid is removed from the one quart container and lines. This

purges any residual cleaning solvent from the transmission cooler and lines. Turn pump OFF.

(13) Disconnect alligator clips from battery. Reconnect flusher lines to cover plate, and remove flushing adapters from cooler lines.

COOLER FLUSH USING SUCTION GUN AND MINERAL SPIRITS

(1) Disconnect the cooler lines at the transmission.

(2) Using a hand suction gun filled with mineral spirits, reverse flush the cooler. Force mineral spirits into the **From Cooler** line of the cooler and catch the exiting spirits from the **To Cooler** line. Observe for the presence of debris in the exiting fluid. Continue until fluid exiting is clear and free from debris.

(3) Using compressed air (under 40 psi.) in intermittent spurts, blow any remaining mineral spirits from the cooler, again in the reverse direction.

(4) Pump one (1) quart of automatic transmission fluid through the cooler before reconnecting.

(5) If at any stage of the cleaning process, the cooler does not freely pass fluid, the cooler must be replaced.

REMOVAL AND INSTALLATION**SPEEDOMETER SERVICE**

Rear axle gear ratio and tire size determine speedometer pinion requirements. If the pinion must be replaced, refer to the parts catalogue information for the correct part.

SPEEDOMETER ASSEMBLY REMOVAL

(1) Raise vehicle.

(2) Disconnect wires from vehicle speed sensor.

(3) Remove adapter clamp and screw (Fig. 25).

(4) Remove speed sensor and speedometer adapter as assembly.

(5) Remove speed sensor retaining screw and remove sensor from adapter.

(6) Remove speedometer pinion from adapter.

(7) Inspect sensor and adapter O-rings (Fig. 25). Remove and discard O-rings if worn or damaged.

(8) Inspect terminal pins in speed sensor. Clean pins with Mopar electrical spray cleaner if dirty or oxidized. Replace sensor if faulty, or pins are loose, severely corroded, or damaged.

SPEEDOMETER INSTALLATION AND INDEXING

(1) Thoroughly clean adapter flange and adapter mounting surface in housing. Surfaces must be clean for proper adapter alignment and speedometer operation.

(2) Install new O-rings on speed sensor and speedometer adapter if necessary (Fig. 25).

REMOVAL AND INSTALLATION (Continued)

(3) Lubricate sensor and adapter O-rings with transmission fluid.

(4) Install vehicle speed sensor in speedometer adapter. Tighten sensor attaching screw to 2-3 N·m (15-27 in. lbs.) torque.

(5) Install speedometer pinion in adapter.

(6) Count number of teeth on speedometer pinion. Do this before installing assembly in housing. Then lubricate pinion teeth with transmission fluid.

(7) Note index numbers on adapter body (Fig. 26). These numbers will correspond to number of teeth on pinion.

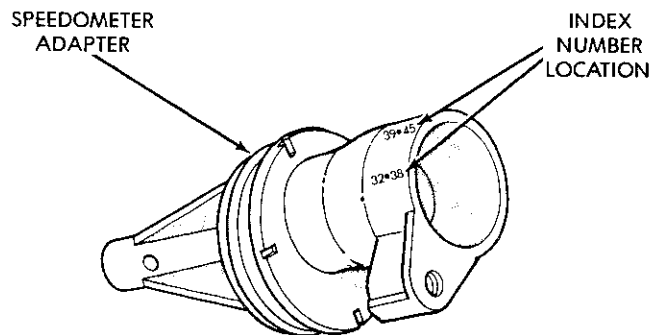
(8) Install speedometer assembly in housing.

(9) Rotate adapter until required range numbers are at 6 o'clock position. Be sure range index numbers correspond to number of teeth on pinion gear.

(10) Install speedometer adapter clamp and retaining screw. Tighten clamp screw to 10-12 N·m (90-110 in. lbs.) torque.

(11) Connect wires to vehicle speed sensor.

(12) Lower vehicle and top off transmission fluid level if necessary.



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Fig. 26 Index Numbers On Speedometer Pinion Adapter

(5) Install new seal on switch and install switch in case. Tighten switch to 34 N·m (25 ft. lbs.) torque.

(6) Test continuity of new switch with 12V test lamp.

(7) Connect switch wires and lower vehicle.

(8) Top off transmission fluid level.

PARK/NEUTRAL POSITION SWITCH

Switch Replacement

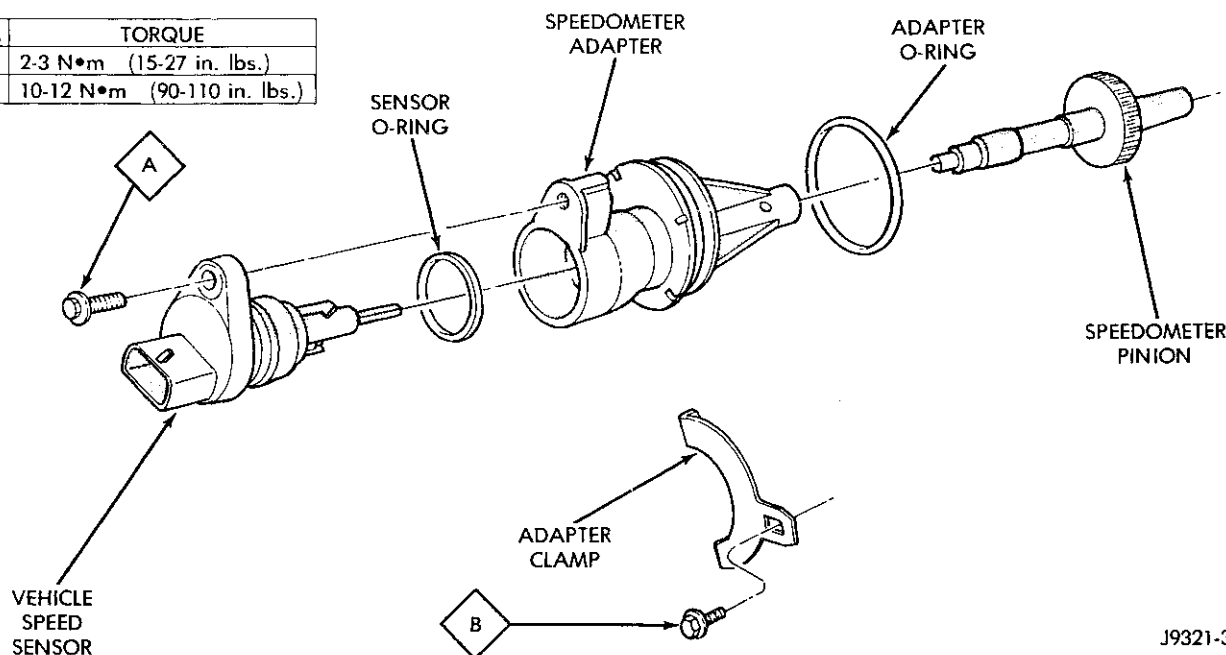
(1) Raise vehicle and position drain pan under switch.

(2) Disconnect switch wires.

(3) Remove switch from case.

(4) Move shift lever to Park and Neutral positions. Verify that switch operating lever fingers are centered in switch opening in case (Fig. 27).

ITEM	TORQUE
A	2-3 N·m (15-27 in. lbs.)
B	10-12 N·m (90-110 in. lbs.)



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Fig. 25 Speedometer Pinion Adapter Components

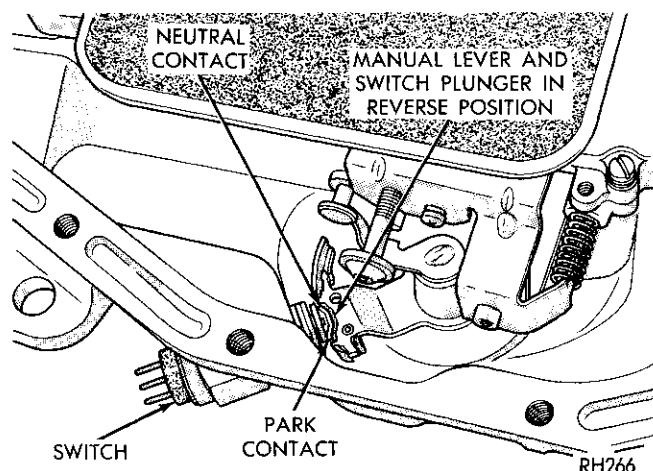
YOKE SEAL REPLACEMENT

REMOVAL

(1) Raise vehicle.

(2) Mark propeller shaft and axle yoke for alignment reference.

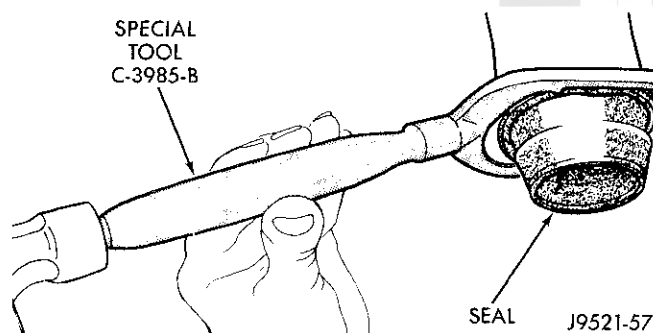
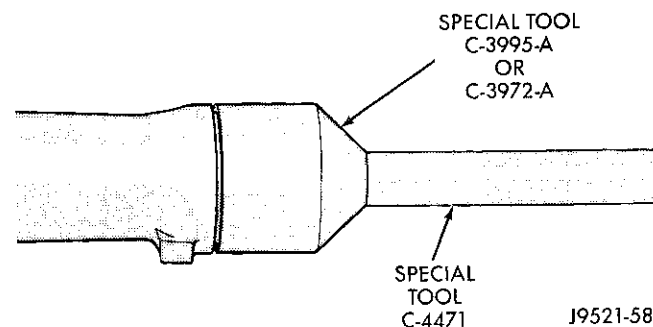
(3) Disconnect and remove propeller shaft.

REMOVAL AND INSTALLATION (Continued)**Fig. 27 Park/Neutral Position Switch**

(4) Remove old seal with Seal Remover C-3985-B (Fig. 28) from overdrive housing.

INSTALLATION

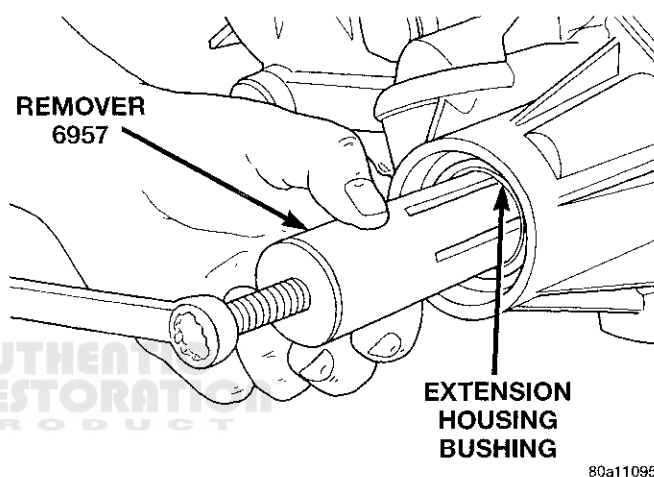
- (1) Place seal in position on overdrive housing.
- (2) Drive seal into overdrive housing with Seal Installer C-3995-A or C-3972 (Fig. 29).
- (3) Carefully guide propeller shaft slip yoke into housing and onto output shaft splines. Align marks made at removal and connect propeller shaft to rear axle pinion yoke.

**Fig. 28 Removing Overdrive Housing Yoke Seal****Fig. 29 Installing Overdrive Housing Yoke Seal****OVERDRIVE HOUSING BUSHING****REMOVAL**

- (1) Remove overdrive housing yoke seal.
- (2) Insert Special Tool # 6957 into overdrive housing. Tighten Tool to bushing and remove bushing (Fig. 30).

INSTALLATION

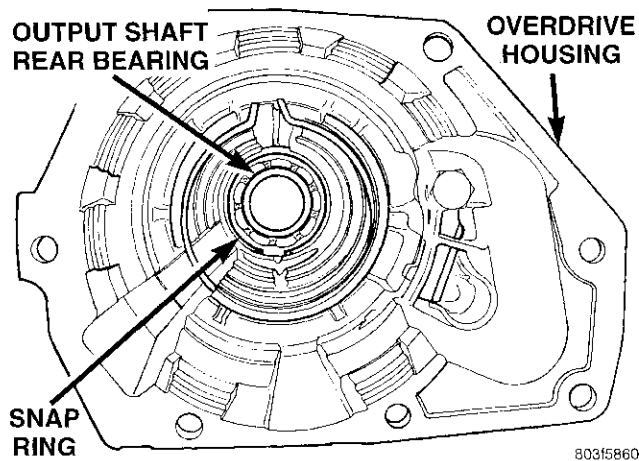
- (1) Align bushing oil hole with oil slot in overdrive housing.
- (2) Tap bushing into place with Special Tool # 6951 and Special Tool C-4171.
- (3) Install new oil seal in housing using Seal Installer C-3972-A.

**Fig. 30 Overdrive Housing Bushing Removal****OUTPUT SHAFT REAR BEARING****REMOVAL**

- (1) Remove overdrive unit from the vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove snap ring holding output shaft rear bearing into overdrive housing (Fig. 31).
- (4) Using a suitable driver inserted through the rear end of housing, drive bearing from housing.

INSTALLATION

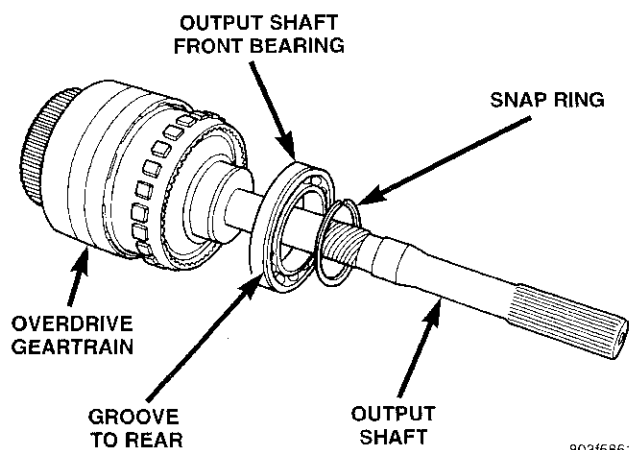
- (1) Place replacement bearing in position in housing.
- (2) Using a suitable driver, drive bearing into housing until the snap ring groove is visible.
- (3) Install snap ring to hold bearing into housing (Fig. 31).
- (4) Install overdrive geartrain into housing.
- (5) Install overdrive unit in vehicle.

REMOVAL AND INSTALLATION (Continued)**Fig. 31 Output Shaft Rear Bearing****OUTPUT SHAFT FRONT BEARING****REMOVAL**

- (1) Remove overdrive unit from the vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove snap ring holding output shaft front bearing to overdrive geartrain. (Fig. 32).
- (4) Pull bearing from output shaft.

INSTALLATION

- (1) Place replacement bearing in position on geartrain with locating retainer groove toward the rear.
- (2) Push bearing onto shaft until the snap ring groove is visible.
- (3) Install snap ring to hold bearing onto output shaft (Fig. 32).
- (4) Install overdrive geartrain into housing.
- (5) Install overdrive unit in vehicle.

**Fig. 32 Output Shaft Front Bearing****PARK LOCK****REMOVAL**

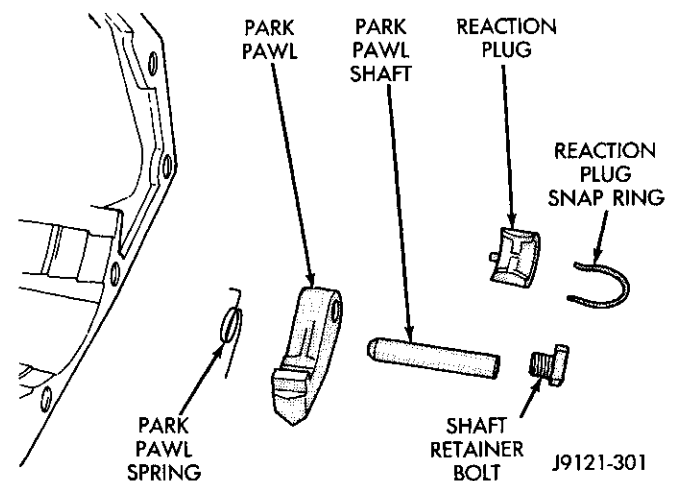
- (1) Remove overdrive unit from vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove bolt holding park pawl in overdrive housing.

CAUTION: Do not over stress snap ring during removal, snap ring distortion can result.

- (4) Remove snap ring holding reaction plug in overdrive housing.
- (5) Pull park pawl shaft from housing.
- (6) Separate park pawl, park pawl spring, and reaction plug from overdrive housing (Fig. 33).

INSTALLATION

- (1) Place park pawl, park pawl spring, and reaction plug in position in overdrive housing.
- (2) Insert park pawl shaft into housing through the park pawl, park pawl spring, and reaction plug (Fig. 33).
- (3) Install snap ring to hold reaction plug in overdrive housing.
- (4) Install bolt to hold park pawl in overdrive housing.
- (5) Install overdrive geartrain into housing.
- (6) Install overdrive unit in vehicle.

**Fig. 33 Park Lock**

REMOVAL AND INSTALLATION (Continued)**GOVERNOR SOLENOID AND PRESSURE SENSOR**

The governor is electronically controlled. It consists of a pressure sensor, a pressure solenoid, and the governor body (Fig. 34).

REMOVAL

- (1) Hoist and support vehicle on safety stands.
- (2) Remove transmission fluid pan and filter.
- (3) Disengage wire connectors from pressure sensor and solenoid (Fig. 34).
- (4) Remove screws holding pressure solenoid retainer to governor body.
- (5) Separate solenoid retainer from governor (Fig. 35).
- (6) Pull solenoid from governor body (Fig. 36).
- (7) Remove bolts holding governor body to valve body.
- (8) Separate governor body from valve body (Fig. 37).
- (9) Separate gasket from back of governor body.
- (10) Remove retainer holding pressure sensor to governor body.
- (11) Pull pressure sensor from governor body (Fig. 38).

INSTALLATION

Before installing the pressure sensor and solenoid in the governor body, replace O-ring seals, clean the gasket surfaces and replace gasket.

- (1) Lubricate O-ring on pressure sensor with transmission fluid.
- (2) Align pressure sensor to bore in governor body (Fig. 38).
- (3) Push pressure sensor into governor body.
- (4) Install retainer to hold pressure sensor to governor body.
- (5) Place gasket in position on back of governor body (Fig. 37).
- (6) Place governor body in position on valve body.
- (7) Install bolts to hold governor body to valve body.
- (8) Lubricate O-ring, on pressure solenoid, with transmission fluid.
- (9) Align pressure solenoid to bore in governor body (Fig. 36).
- (10) Push solenoid into governor body.
- (11) Place solenoid retainer in position on governor (Fig. 35).
- (12) Install screws to hold pressure solenoid retainer to governor body.
- (13) Engage wire connectors into pressure sensor and solenoid (Fig. 34).
- (14) Install transmission fluid pan and (new) filter.
- (15) Lower vehicle and road test to verify repair.

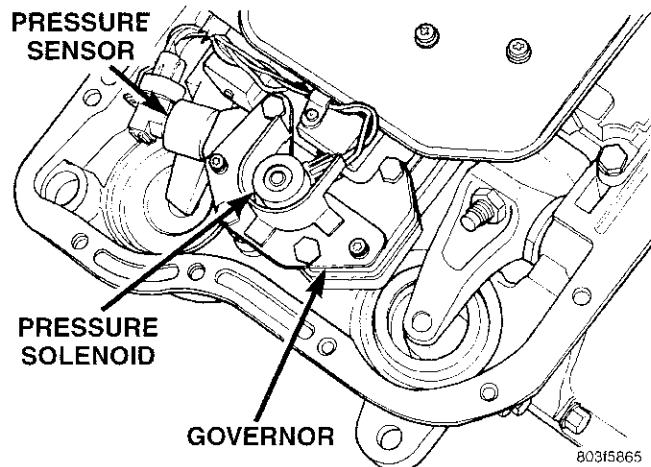


Fig. 34 Governor Solenoid And Pressure Sensor

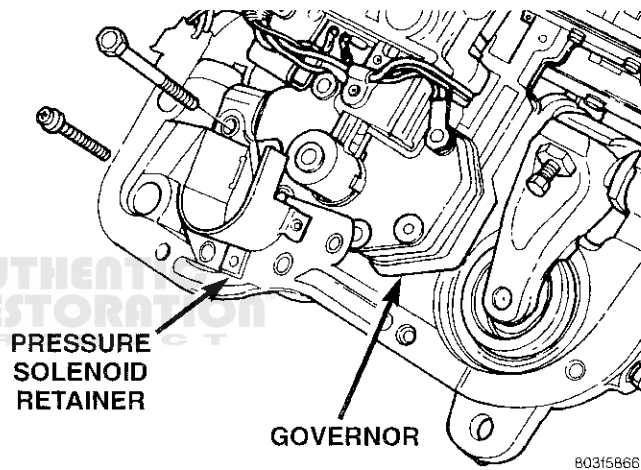


Fig. 35 Pressure Solenoid Retainer

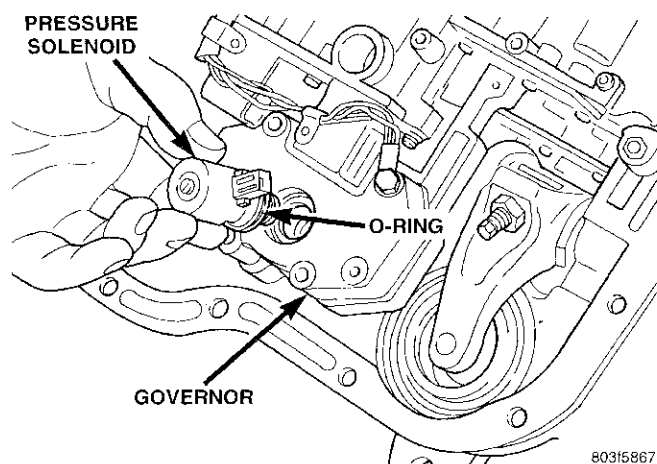
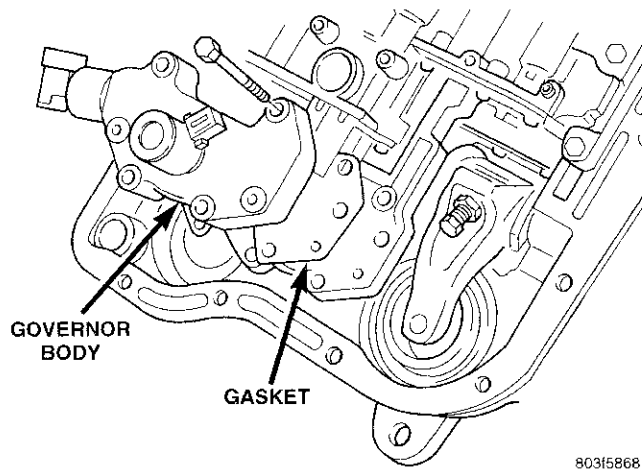
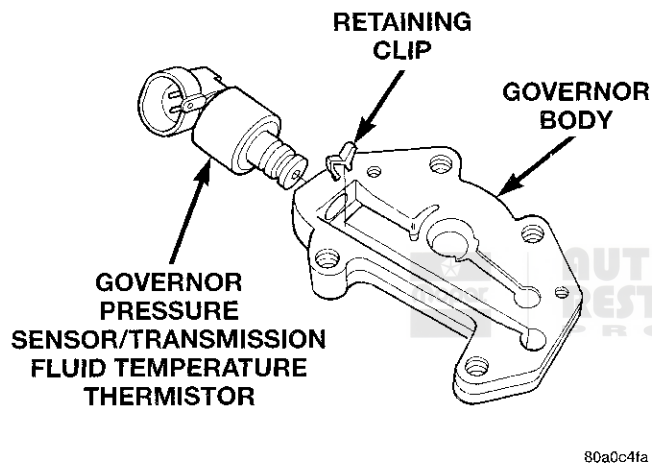


Fig. 36 Pressure Solenoid and O-ring

REMOVAL AND INSTALLATION (Continued)**Fig. 37 Governor Body and Gasket****Fig. 38 Pressure Sensor and Retainer****VALVE BODY**

The valve body can be removed for service without having to remove the entire transmission assembly.

The valve body can be disassembled for cleaning and inspection of the individual components. Refer to the procedures in the Disassemble and Assemble section.

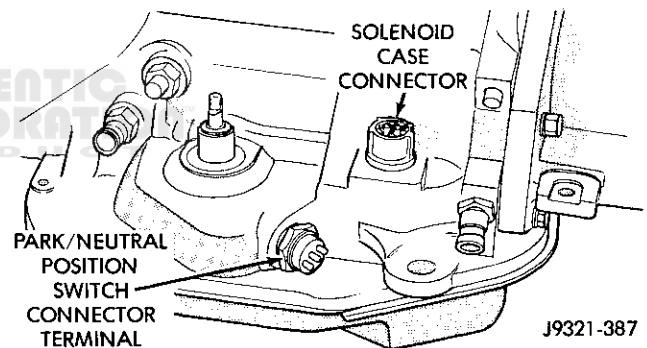
The only replaceable valve body components are:

- Manual lever
- Manual lever washer, seal, E-clip, and shaft seal
- Manual lever detent ball
- Throttle lever
- Fluid filter
- Pressure adjusting screw bracket
- Governor pressure solenoid
- Governor pressure sensor
- Converter clutch/overdrive solenoid assembly and harness (includes sump temperature thermistor)
- Governor housing gasket
- Solenoid case connector O-rings

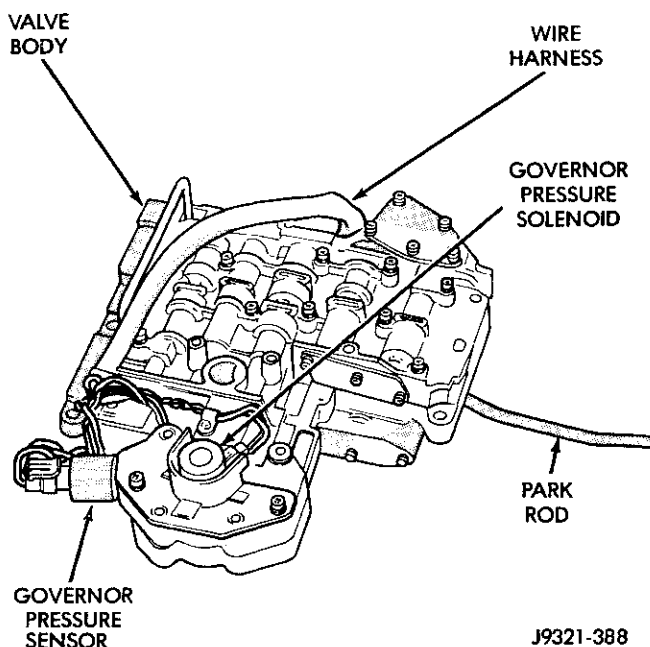
The remaining valve body components are serviced only as part of a complete valve body assembly.

REMOVAL

- (1) Shift transmission into NEUTRAL.
- (2) Raise vehicle.
- (3) Remove gearshift and throttle levers from shaft of valve body manual lever.
- (4) Disconnect wires at park/neutral position switch.
- (5) Disconnect wires at park/neutral position switch and solenoid case connector (Fig. 39).
- (6) Position drain pan under transmission oil pan.
- (7) Remove transmission oil pan and gasket.
- (8) Remove fluid filter from valve body.
- (9) Remove bolts attaching valve body to transmission case.
- (10) Lower valve body enough to remove accumulator piston and springs.
- (11) Work manual lever shaft and electrical connector out of transmission case. Then lower valve body, rotate it away from case, pull park rod out of sprag, and remove valve body (Fig. 40).

**Fig. 39 Transmission Case Connector****INSTALLATION**

- (1) Verify that park/neutral position switch has NOT been installed in case. Valve body cannot be installed if switch is in place.
- (2) Check condition of O-ring seals on valve body harness connector (Fig. 41). Replace seals on connector body if cut or worn.
- (3) Check condition of manual lever shaft seal in transmission case. Replace seal if lip is cut or worn. Install new seal with 15/16 deep well socket (Fig. 42).
- (4) Check condition of seals on accumulator piston (Fig. 43). Install new piston seals, if necessary.
- (5) Place valve body manual lever in low (1 position) so ball on park lock rod will be easier to install in sprag.
- (6) Lubricate shaft of manual lever with petroleum jelly. This will ease inserting shaft through seal in case.
- (7) Lubricate seal rings on valve body harness connector with Ru-Glyde or petroleum jelly.

REMOVAL AND INSTALLATION (Continued)**Fig. 40 Valve Body**

(8) Position valve body on case and work end of park lock rod into and through pawl sprag. Turn propeller shaft to align sprag and park lock teeth if necessary. The rod will click as it enters pawl. Move rod to check engagement.

CAUTION: It is possible for the park rod to displace into a cavity just above the pawl sprag during installation. Make sure the rod is actually engaged in the pawl and has not displaced into this cavity. If the rod enters the cavity during installation, it will become bent when the overdrive bolts are tightened. The rod will then have to be replaced because it is not repairable.

(9) Install accumulator springs and piston into case. Then swing valve body over piston and outer spring to hold it in place.

(10) Align accumulator piston and outer spring, manual lever shaft and electrical connector in case. Then seat valve body on case and install one or two bolts to hold valve body in place.

(11) Tighten valve body bolts alternately and evenly to 11 N·m (100 in. lbs.) torque.

(12) Install new fluid filter on valve body. Tighten filter screws to 4 N·m (35 in. lbs.) torque.

(13) Install and connect park/neutral position switch in case.

(14) Install throttle and gearshift levers on valve body manual lever shaft.

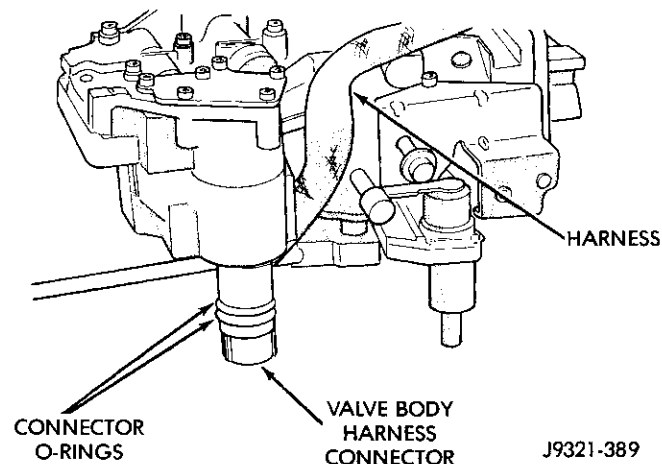
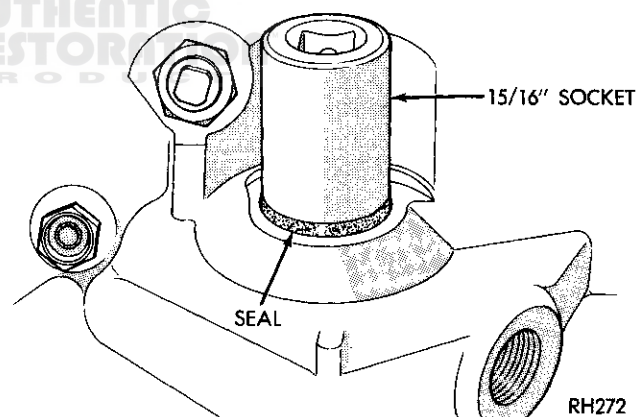
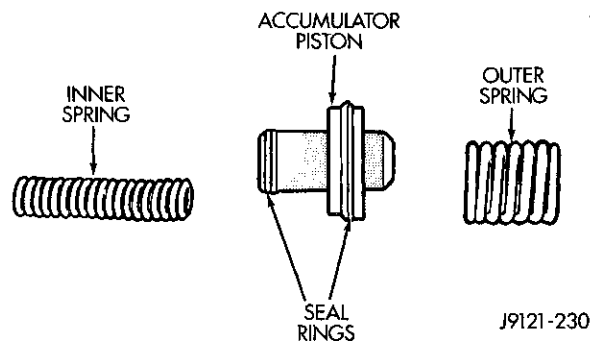
(15) Check and adjust front and rear bands if necessary.

(16) Connect valve body overdrive and converter clutch solenoid wires to case connector.

(17) Install oil pan and new gasket. Tighten pan bolts to 17 N·m (13 ft. lbs.) torque.

(18) Lower vehicle and fill transmission with Mopar ATF Plus, type 7176 fluid.

(19) Check and adjust gearshift and throttle valve cables, if necessary.

**Fig. 41 Valve Body Harness Connector O-Ring Seal****Fig. 42 Manual Lever Shaft Seal****Fig. 43 Accumulator Piston Components**

REMOVAL AND INSTALLATION (Continued)**TRANSMISSION COOLER LINE AND FITTINGS**

The transmission cooler lines are attached with quick connect fittings (Fig. 44).

COOLER LINE AND FITTING SERVICE

The cooler lines and fittings are NOT serviceable. Damaged fittings or cooler lines are to be replaced as assemblies.

Fittings swaged into cooler line hoses are serviced only as part of the entire cooler line.

DISCONNECTING COOLER LINES

(1) If fitting and cooler line are covered with dirt, mud, or grease, clean fitting and cooler line with Mopar spray type carburetor or brake cleaner.

(2) Disengage retainer on fitting and pull cooler line out of fitting.

(3) Cover open ends of cooler lines and fittings to prevent dirt entry.

(4) Inspect condition of fitting. Replace transmission fitting as an assembly if fitting body or retainer clip is damaged. Replace cooler line as assembly, if fitting swaged into cooler line hose, is damaged.

CONNECTING COOLER LINES

(1) If transmission or radiator fittings require replacement, apply Mopar Lock N' Seal, or Loctite 242 to fitting threads before installation.

(2) Wipe off cooler line and fitting with clean, dry cloth.

(3) Insert cooler line into fitting. Then push line inward until retainer secures line. A snap or click will be heard and felt through the line when the retainer seats behind the cooler line flange.

(4) **Pull outward on cooler lines to verify that they are properly secured.**

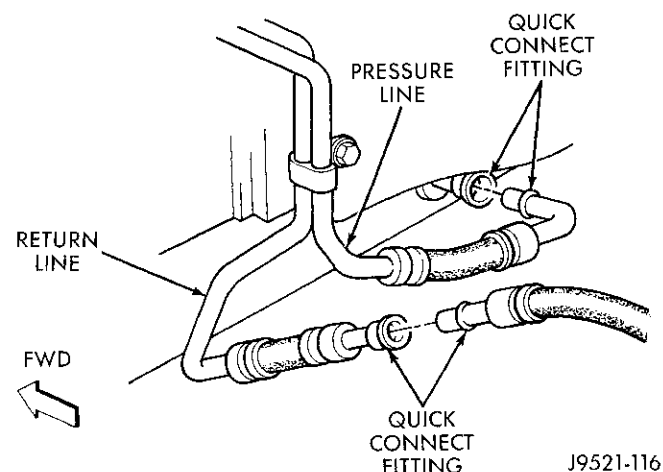


Fig. 44 Cooler Line Fitting

TRANSMISSION COOLER REPLACEMENT**MAIN COOLER REPLACEMENT**

The main transmission cooler is located in the radiator. The cooler is not a serviceable component. If the cooler is damaged, the radiator must be replaced.

AUXILIARY COOLER REPLACEMENT

(1) Remove grille, refer to Group 23, Body for proper procedures.

(2) Remove brackets holding cooler to radiator and radiator support (Fig. 45).

(3) Tag cooler hoses for installation reference (Fig. 45).

(4) Position drain pan under cooler lines.

(5) Loosen cooler connecting hose clamps and disconnect the hoses.

(6) Remove auxiliary cooler

(7) Connect cooler to hoses.

(8) Position cooler on radiator, or support and install brackets and fasteners.

(9) Tighten cooler hose clamps securely.

(10) Install grille.

(11) Check and adjust transmission fluid level.

OVERDRIVE UNIT**REMOVAL**

(1) Shift transmission into Park.

(2) Raise vehicle.

(3) Remove transmission oil pan, remove gasket, drain oil and reinstall pan.

(4) If overdrive unit had malfunctioned, or if fluid is contaminated, remove entire transmission. If diagnosis indicated overdrive clutch or governor problems only, remove overdrive unit only.

(5) Mark propeller shaft universal joint and axle pinion yoke for alignment reference at installation (Fig. 46).

(6) Disconnect and remove propeller shaft.

(7) Support transmission with transmission jack.

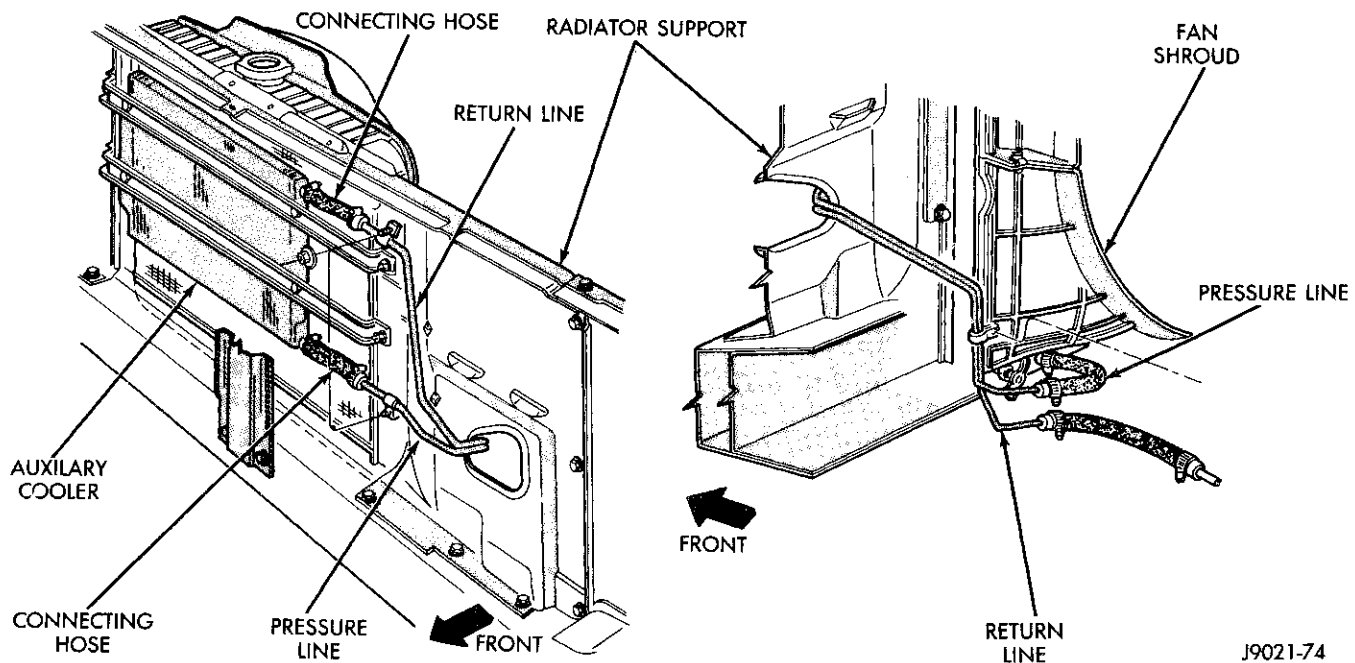
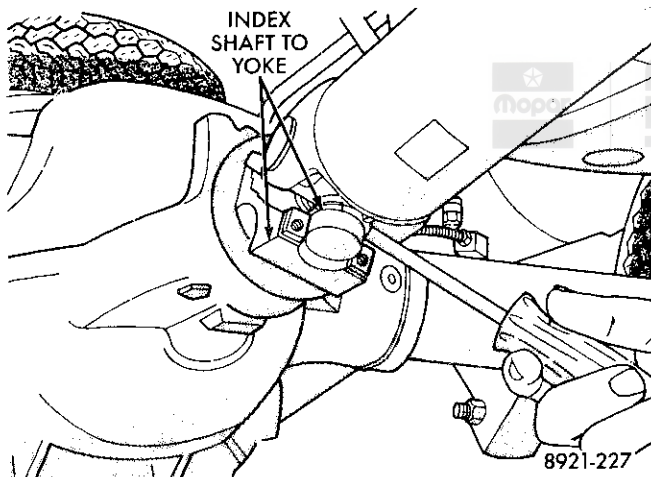
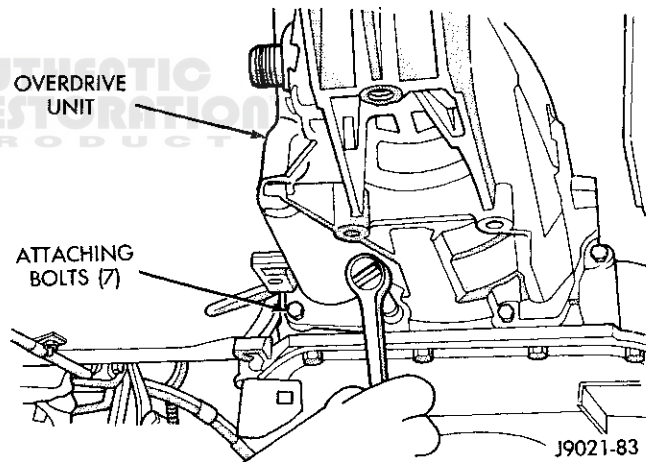
(8) Remove rear crossmember.

(9) Remove vehicle speed sensor and speedometer adapter.

(10) Remove bolts attaching overdrive unit to transmission (Fig. 47).

CAUTION: Support the overdrive unit with a jack before moving it rearward. This is necessary to prevent damaging the intermediate shaft. Do not allow the shaft to support the entire weight of the overdrive unit.

(11) Carefully work overdrive unit off intermediate shaft. Do not tilt compounder during removal. Keep it as level as possible.

REMOVAL AND INSTALLATION (Continued)**Fig. 45 Auxiliary Cooler Mounting****Fig. 46 Mark Propeller Shaft And Yoke For Alignment Reference****Fig. 47 Removing/Installing Overdrive Unit Attaching Bolts**

(a) If overdrive unit does not require service, immediately insert Alignment Tool 6227-2 in splines of planetary gear and overrunning clutch to prevent splines from rotating out of alignment. If misalignment occurs, overdrive unit will have to be disassembled in order to realign splines.

(b) If overdrive unit requires service, refer to Disassemble and Assemble section of this group for proper procedures.

(12) Remove and retain overdrive piston thrust bearing. Bearing may remain on piston or in clutch hub during removal.

(13) Position drain pan on workbench.

(14) Place overdrive unit over drain pan. Tilt unit to drain residual fluid from case.

(15) Examine fluid for clutch material or metal fragments. If fluid contains these items, overhaul will be necessary.

(16) If overdrive unit does not require any service, leave alignment tool in position. Tool will prevent accidental misalignment of planetary gear and overrunning clutch splines.

INSTALLATION

(1) Be sure overdrive unit Alignment Tool 6227-2 is fully seated before moving unit. If tool is not seated and gear splines rotate out of alignment, over-

REMOVAL AND INSTALLATION (Continued)

drive unit may have to be disassembled in order to realign splines.

(2) If overdrive piston retainer was not removed during service and original case gasket is no longer reusable, prepare new gasket by trimming it.

(3) Cut out old case gasket around piston retainer with razor knife (Fig. 48).

(4) Use old gasket as template and trim new gasket to fit.

(5) Position new gasket over piston retainer and on transmission case. Use petroleum jelly to hold gasket in place if necessary. **Do not use any type of sealer to secure gasket. Use petroleum jelly only.**

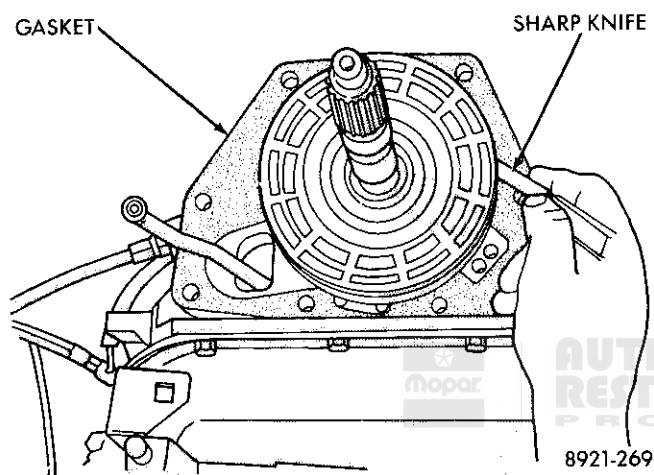


Fig. 48 Trimming Overdrive Case Gasket

(6) Install selective spacer on intermediate shaft, if removed. Spacer goes in groove just rearward of shaft rear splines (Fig. 49).

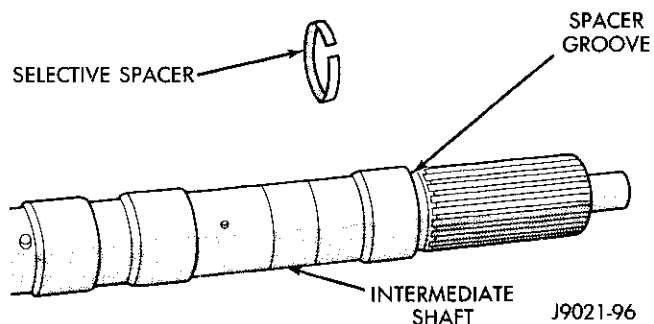


Fig. 49 Intermediate Shaft Selective Spacer Location

(7) Install overdrive piston in retainer (if removed). Lubricate piston seals with Mopar Door Ease, or Ru-Glyde to ease installation. Be sure piston locating lugs are aligned in piston retainer.

(8) Install thrust bearing in overdrive unit sliding hub. Use petroleum jelly to hold bearing in position.

CAUTION: Be sure the shoulder on the inside diameter of the bearing is facing forward.

(9) Verify that splines in overdrive planetary gear and overrunning clutch hub are aligned with Alignment Tool 6227-2. **Overdrive unit cannot be installed if splines are not aligned. If splines have rotated out of alignment, unit may have to be disassembled to realign splines.**

(10) Carefully slide Alignment Tool 6227-2 out of overdrive planetary gear and overrunning clutch splines.

(11) Raise overdrive unit and carefully slide it straight onto intermediate shaft. Insert park rod into park lock reaction plug at same time. **Avoid tilting overdrive during installation as this could cause planetary gear and overrunning clutch splines to rotate out of alignment. If this occurs, it will be necessary to remove and disassemble overdrive unit to realign splines.**

(12) Align slip-fit governor tubes and work overdrive unit forward on intermediate shaft until seated against transmission case.

(13) Install bolts attaching overdrive unit to transmission unit. Tighten bolts in diagonal pattern to 34 N·m (25 ft-lbs).

(14) Install crossmember.

(15) Install speed sensor and speedometer adapter. Be sure to index adapter.

(16) Connect speed sensor and overdrive wires.

(17) Align and install propeller shaft.

(18) If valve body was also removed, adjust bands, install valve body and install transmission oil pan and gasket.

TRANSMISSION/OVERDRIVE

The overdrive unit can be removed and serviced separately. It is not necessary to remove the entire transmission assembly to perform overdrive unit repairs.

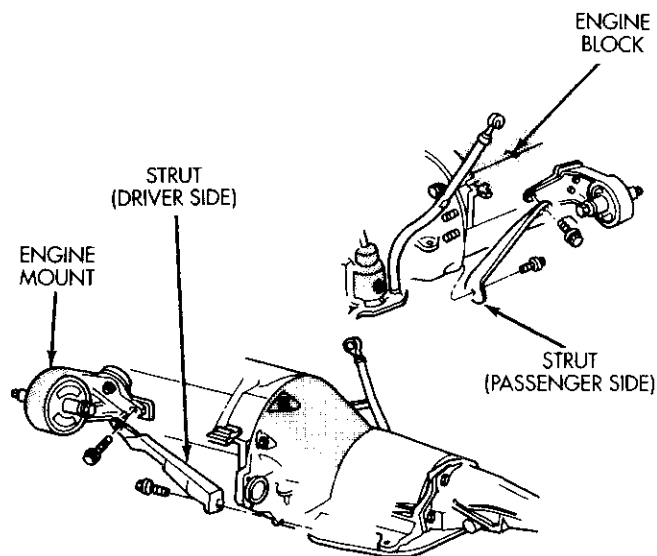
The entire transmission assembly must be removed in order to service the torque converter, driveplate, ring gear and oil pump. Refer to the transmission removal and installation procedures in this section.

If only the overdrive unit requires service, refer to the overdrive unit removal and installation procedures.

CAUTION: The transmission and torque converter must be removed as an assembly to avoid component damage. The converter drive plate, pump bushing, or oil seal can be damaged if the converter is left attached to the driveplate during removal. Be sure to remove the transmission and converter as an assembly.

REMOVAL AND INSTALLATION (Continued)**REMOVAL**

- (1) Disconnect battery negative cable.
- (2) Disconnect and lower or remove necessary exhaust components.
- (3) Remove engine-to-transmission struts, if equipped (Fig. 50).



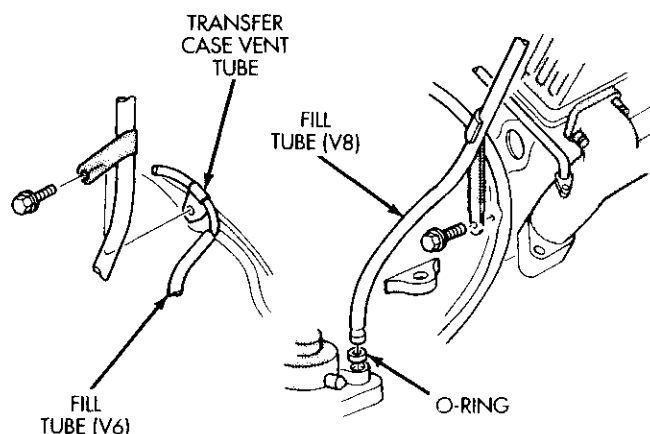
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Fig. 50 Transmission-To-Engine Strut Attachment

- (4) Disconnect fluid cooler lines at transmission.
- (5) Remove starter motor.
- (6) Disconnect and remove crankshaft position sensor. Retain sensor attaching bolts.

CAUTION: The crankshaft position sensor will be damaged if the transmission is removed (or installed) while the sensor is still bolted to the engine block. To avoid damage, be sure to remove the sensor before removing the transmission.

- (7) Remove torque converter access cover.
- (8) If transmission is being removed for overhaul, remove transmission oil pan, drain fluid and reinstall pan.
- (9) Remove fill tube bracket bolts and pull tube out of transmission. Retain fill tube O-ring (Fig. 50). On 4 x 4 models, it will also be necessary to remove bolt attaching transfer case vent tube to converter housing (Fig. 51).
- (10) Mark torque converter and drive plate for assembly alignment. Note that bolt holes in crankshaft flange, drive plate and torque converter all have one offset hole.
- (11) Rotate crankshaft in clockwise direction until converter bolts are accessible. Then remove bolts one



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Fig. 51 Fill Tube Attachment

at a time. Rotate crankshaft with socket wrench on dampener bolt.

- (12) Mark propeller shaft and axle yokes for assembly alignment. Then disconnect and remove propeller shaft. ON 4 x 4 models, remove both propeller shafts.

- (13) Disconnect wires from park/neutral position switch, transmission solenoid, and vehicle speed sensor.

- (14) Disconnect gearshift rod and torque shaft assembly from transmission.

- (15) Disconnect throttle valve cable from transmission bracket and throttle valve lever.

- (16) On 4 x 4 models, disconnect shift rod from transfer case shift lever. Or remove shift lever from transfer case and tie rod and lever to chassis component with wire.

- (17) Disconnect transmission fluid cooler lines at transmission fittings. Remove lines from retaining clips and tie lines to chassis with wire.

- (18) Support rear of engine with safety stand or jack.

- (19) Raise transmission slightly with service jack to relieve load on crossmember and supports.

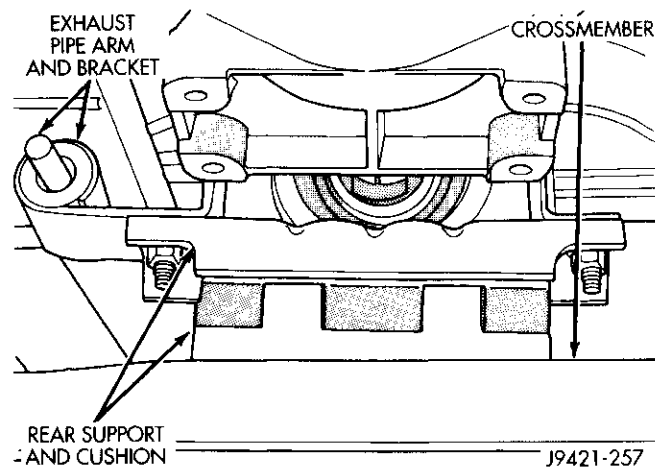
- (20) Remove bolts securing rear support and cushion to transmission and crossmember. Raise transmission slightly, slide exhaust hanger arm from bracket (Fig. 52) and (Fig. 53) and remove rear support.

- (21) Remove bolts attaching crossmember to frame and remove crossmember.

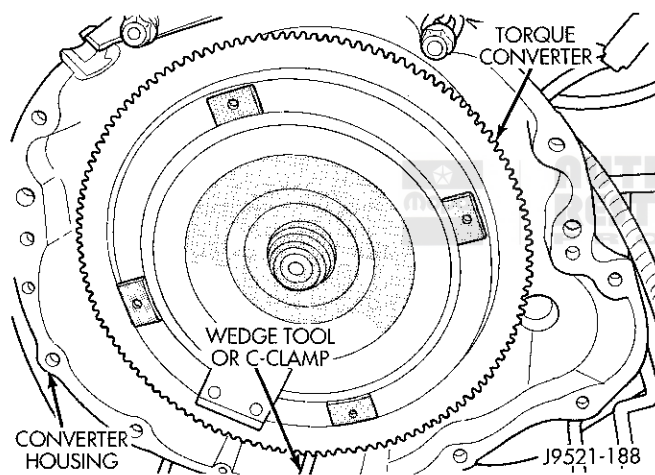
- (22) On 4 x 4 models, disconnect speed sensor wires and vent hose from transfer case. Then remove transfer case with transmission jack or aid of helper.

- (23) Remove all converter housing bolts.

- (24) Carefully work transmission and torque converter assembly rearward off engine block dowels.

REMOVAL AND INSTALLATION (Continued)**Fig. 52 Rear Support Cushion**

(25) Use wedge tool (Fig. 53), or C-clamp to hold torque converter in place during transmission removal.

**Fig. 53 Holding Converter In Place With Wedge Tool**

(26) Lower transmission and remove assembly from under the vehicle.

(27) To remove torque converter, remove C-clamp from edge of bell housing and carefully slide torque converter out of the transmission.

TRANSMISSION/OVERDRIVE INSTALLATION

(1) Check torque converter hub and hub drive notches for sharp edges burrs, scratches, or nicks. Polish the hub and notches with 320/400 grit paper and crocus cloth if necessary. The hub must be smooth to avoid damaging pump seal at installation.

(2) Lubricate converter drive hub and oil pump seal lip with transmission fluid.

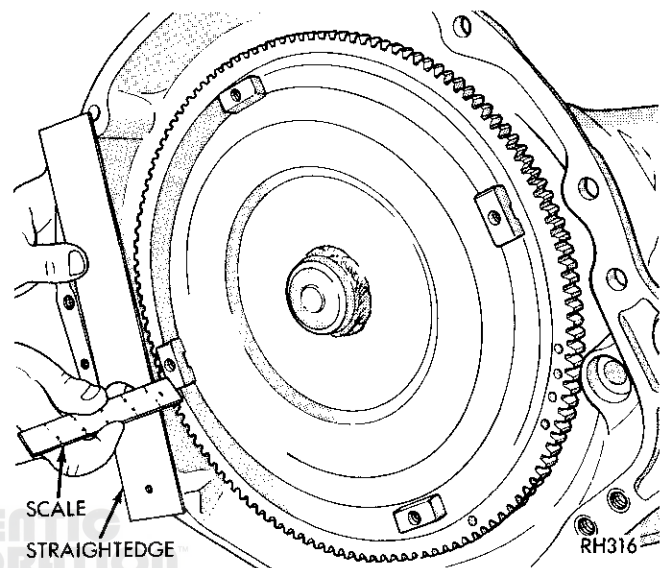
(3) Lubricate converter pilot hub with transmission fluid.

(4) Align and install converter in oil pump.

(5) Carefully insert converter in oil pump. Then rotate converter back and forth until fully seated in pump gears.

(6) Check converter seating with steel scale and straightedge (Fig. 54). Surface of converter lugs should be 1/2 in. to rear of straightedge when converter is fully seated.

(7) Temporarily secure converter with wedge tool or C-clamp.

**Fig. 54 Typical Method Of Checking Converter Seating**

(8) Position transmission on jack and secure it with chains.

(9) Check condition of converter driveplate. Replace the plate if cracked, distorted or damaged. **Also be sure transmission dowel pins are seated in engine block and protrude far enough to held transmission in alignment.**

(10) Raise transmission and align converter with drive plate and converter housing with engine block.

(11) Move transmission forward. Then raise, lower or tilt transmission to align converter housing with engine block dowels.

(12) Rotate converter so alignment marks scribed on converter are aligned with mark on driveplate.

(13) Carefully work transmission forward and over engine block dowels until converter hub is seated in crankshaft.

(14) Install bolts attaching converter housing to engine.

(15) Install rear support. Then lower transmission onto crossmember and install bolts attaching transmission mount to crossmember.

(16) Remove engine support fixture.

(17) Install crankshaft position sensor.

REMOVAL AND INSTALLATION (Continued)

(18) Install vehicle speed sensor and speedometer adapter.

(19) Install new plastic retainer grommet on any shift linkage rod or lever that was disconnected. Grommets should not be reused. Use pry tool to remove rod from grommet and cut away old grommet. Use pliers to snap new grommet into lever and to snap rod into grommet at assembly.

(20) Connect gearshift and throttle cable to transmission.

(21) Connect wires to park/neutral position switch, transmission solenoid(s) and oxygen sensor. Be sure transmission harnesses are properly routed.

CAUTION: It is essential that correct length bolts be used to attach the converter to the driveplate. Bolts that are too long will damage the clutch surface inside the converter. If new bolts are required, use the bolts specified in the parts catalog only.

(22) Install torque converter-to-driveplate bolts. On models with 10.75 in. converter, tighten bolts to 31 N·m (270 in. lbs.). On models with 12.2 in. converter, tighten bolts to 47 N·m (35 ft. lbs.).

(23) Install converter housing access cover.

(24) Install starter motor and cooler line bracket.

(25) Connect cooler lines to transmission.

(26) Install transmission fill tube. Install new seal on tube before installation.

(27) Install exhaust components.

(28) Align and connect propeller shaft.

(29) Adjust gearshift linkage and throttle valve cable if necessary.

(30) Lower vehicle.

(31) Fill transmission with Mopar ATF Plus, Type 7176 fluid.

TORQUE CONVERTER**REMOVAL**

(1) Remove transmission and torque converter from vehicle.

(2) Place a suitable drain pan under the converter housing end of the transmission.

CAUTION: Verify that transmission is secure on the lifting device or work surface, the center of gravity of the transmission will shift when the torque converter is removed creating an unstable condition.

The torque converter is a heavy unit. Use caution when separating the torque converter from the transmission.

(3) Pull the torque converter forward until the center hub clears the oil pump seal.

(4) Separate the torque converter from the transmission.

INSTALLATION

Check converter hub and drive notches for sharp edges, burrs, scratches, or nicks. Polish the hub and notches with 320/400 grit paper or crocus cloth if necessary. The hub must be smooth to avoid damaging the pump seal at installation.

(1) Lubricate converter hub and oil pump seal lip with transmission fluid.

(2) Place torque converter in position on transmission.

CAUTION: Do not damage oil pump seal or bushing while inserting torque converter into the front of the transmission.

(3) Align torque converter to oil pump seal opening.

(4) Insert torque converter hub into oil pump.

(5) While pushing torque converter inward, Rotate converter until converter is fully seated in the oil pump gears.

(6) Check converter seating with a scale and straightedge (Fig. 55). Surface of converter lugs should be 1/2 in. to rear of straightedge when converter is fully seated.

(7) If necessary, temporarily secure converter with C-clamp attached to the converter housing.

(8) Install the transmission in the vehicle.

(9) Fill the transmission with the recommended fluid.

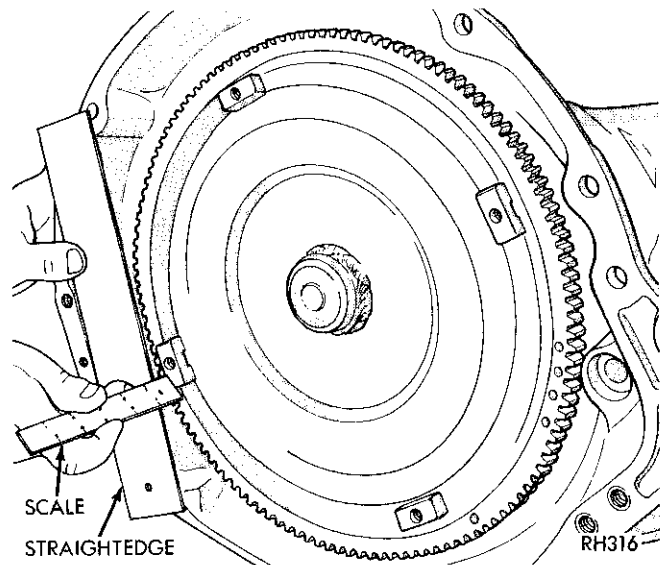


Fig. 55 Checking Torque Converter Seating
DISASSEMBLY AND ASSEMBLY

VALVE BODY

Remove the valve body from the transmission, refer to Removal and Installation procedures section in this group.

DISASSEMBLY AND ASSEMBLY (Continued)**VALVE BODY MAIN COMPONENT
DISASSEMBLE**

CAUTION: Do not clamp any valve body component in a vise. This practice can damage the component resulting in unsatisfactory operation after assembly and installation. Do not use pliers to remove any of the valves, plugs or springs and do not force any of the components out or into place. The valves and valve body housings will be damaged if force is used. Tag or mark the valve body springs for reference as they are removed. Do not allow them to become intermixed.

(1) Disconnect wires from governor pressure sensor and solenoid (Fig. 56).

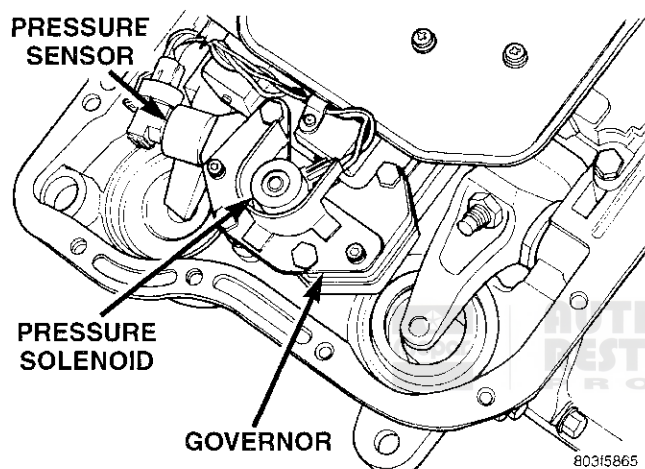


Fig. 56 Governor Pressure Solenoid And Sensor Wire Locations

(2) Remove screws attaching governor body and retainer plate to transfer plate (Fig. 57).

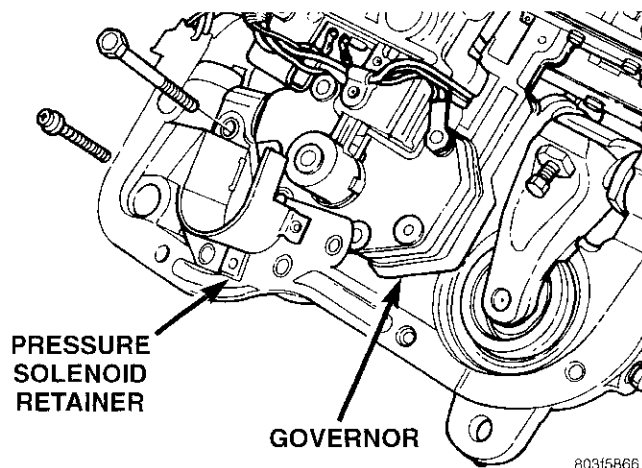


Fig. 57 Governor Body And Retainer Plate Attaching Screw

(3) Remove retainer plate, governor body and gasket from transfer plate (Fig. 58).

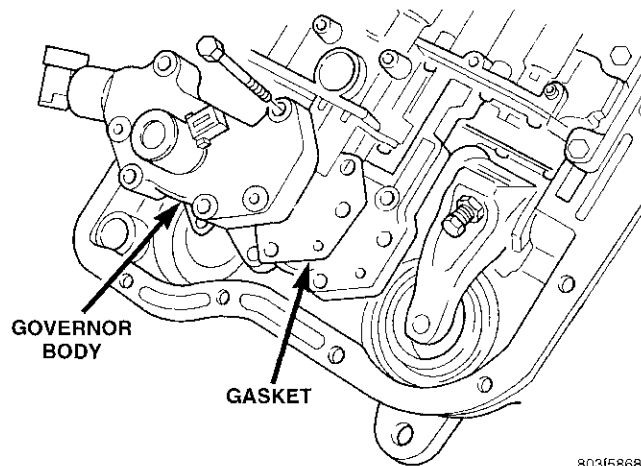


Fig. 58 Governor Body And Gasket

(4) Disconnect wires from governor pressure sensor, if not done previously.

(5) Remove governor pressure sensor from governor body. Sensor is retained in body with M-shaped spring clip (Fig. 59). Remove clip with small pointed tool and slide sensor out of body.

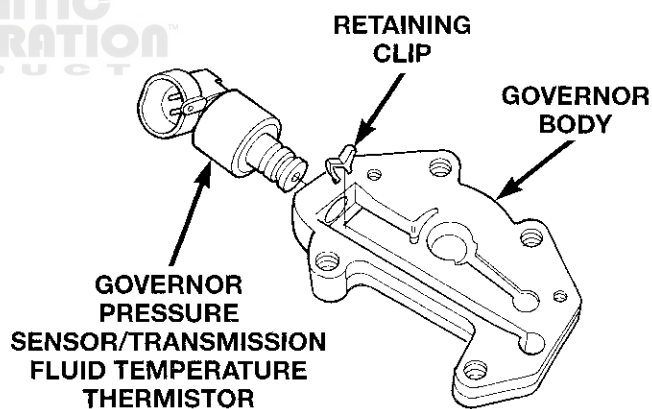
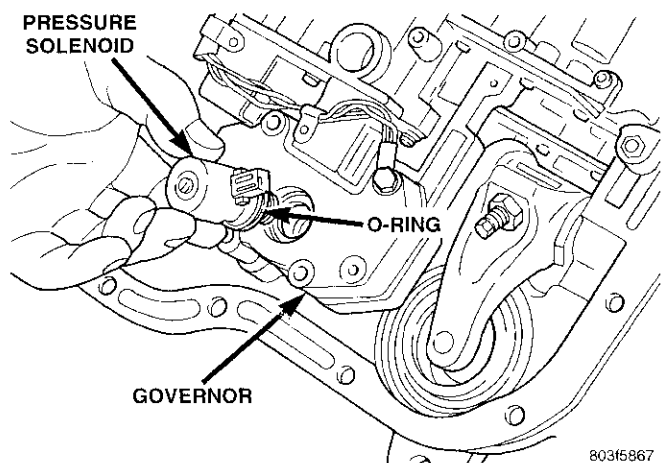
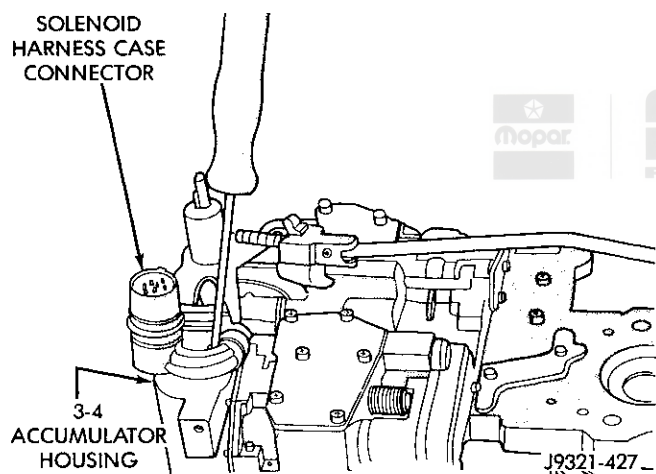


Fig. 59 Governor Pressure Sensor

(6) Remove governor pressure solenoid by pulling it straight out of bore in governor body (Fig. 60). Remove and discard solenoid O-rings if worn, cut, or torn.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 60 Governor Pressure Solenoid**

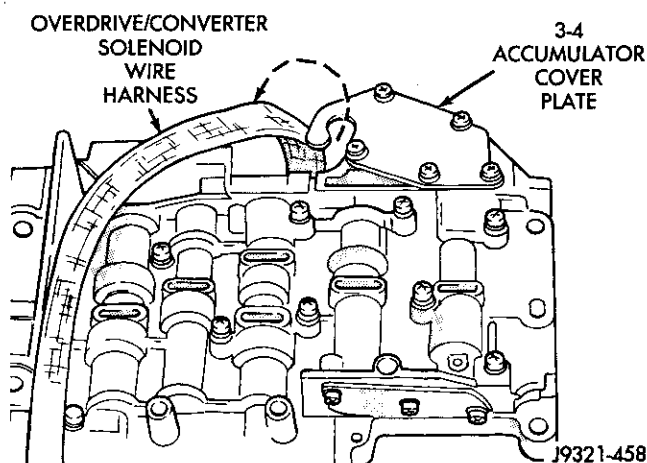
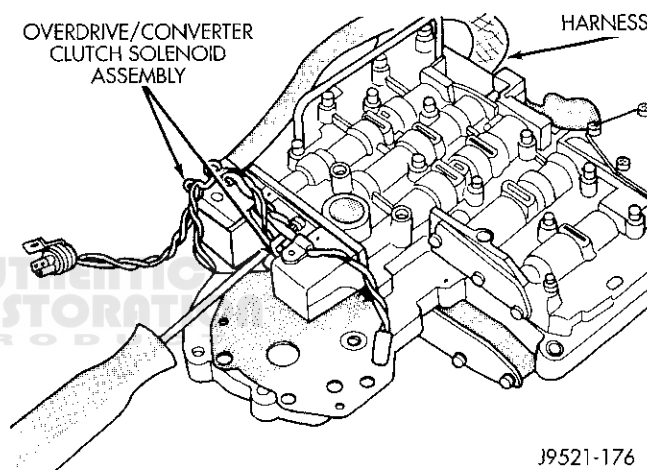
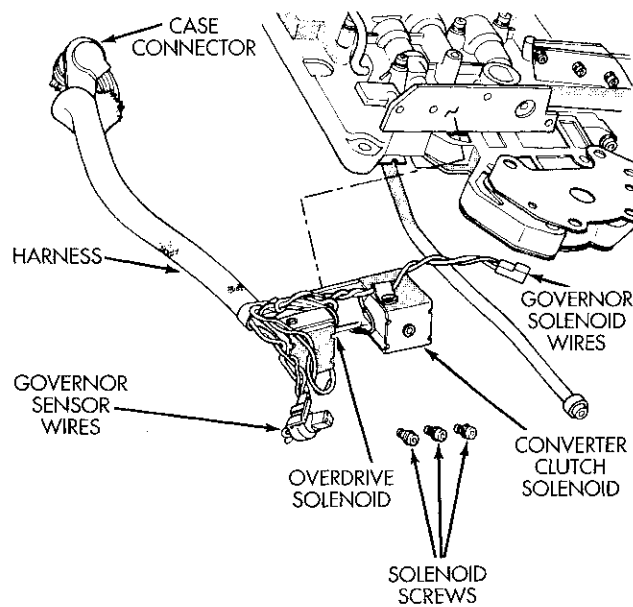
(7) Remove small shoulder bolt that secures solenoid harness case connector to 3-4 accumulator housing (Fig. 61). **Retain shoulder bolt. Either tape it to harness or thread it back into accumulator housing after connector removal.**

**Fig. 61 Solenoid Harness Case Connector Shoulder Bolt**

(8) Unhook overdrive/converter solenoid harness from 3-4 accumulator cover plate (Fig. 62).

(9) Turn valve body over and remove screws that attach overdrive/converter solenoid assembly to valve body (Fig. 63).

(10) Remove solenoid and harness assembly from valve body (Fig. 64).

**Fig. 62 Unhooking Solenoid Harness From Accumulator Cover Plate****Fig. 63 Solenoid Assembly Screws****Fig. 64 Solenoid Assembly**

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Remove boost valve cover (Fig. 65).

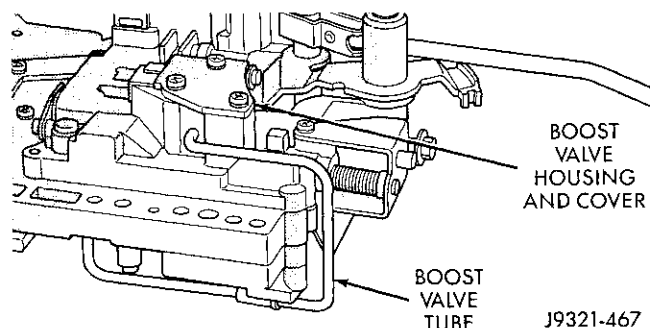


Fig. 65 Boost Valve Cover Location

(12) Remove boost valve retainer, valve spring and boost valve (Fig. 66).

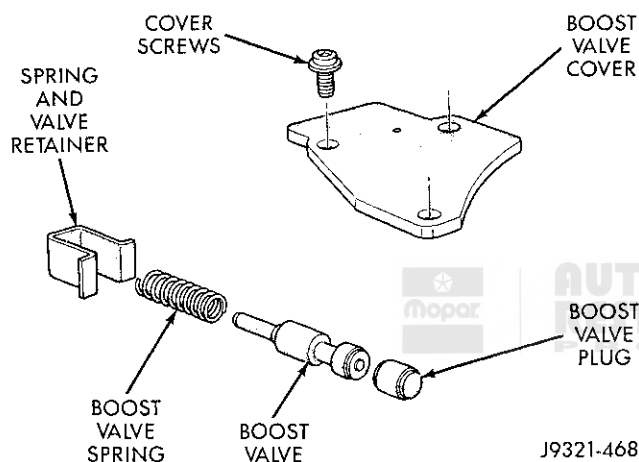


Fig. 66 Boost Valve Components

(13) Secure detent ball and spring with Retainer Tool 6583 (Fig. 67).

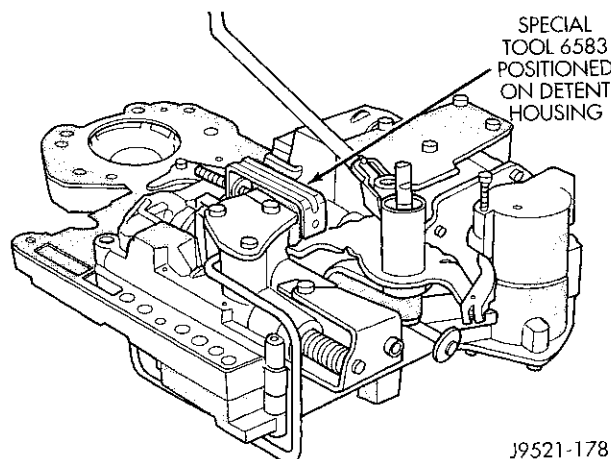


Fig. 67 Detent Ball And Spring

(14) Remove E-clip and washer that retains throttle lever shaft in manual lever (Fig. 68).

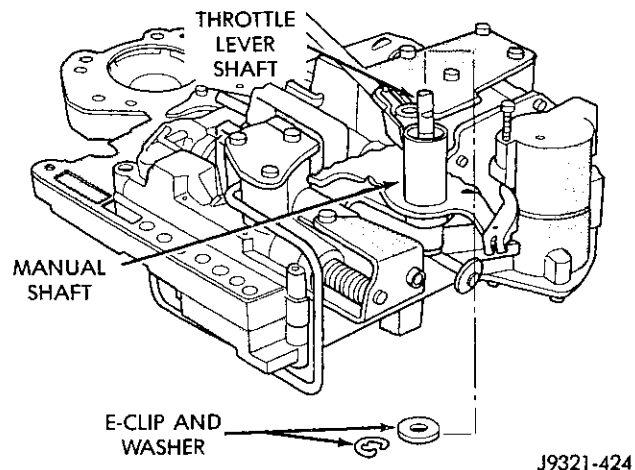


Fig. 68 Throttle Lever E-Clip And Washer

(15) Remove manual lever and throttle lever (Fig. 69). Rotate and lift manual lever off valve body and throttle lever shaft. Then slide throttle lever out of valve body.

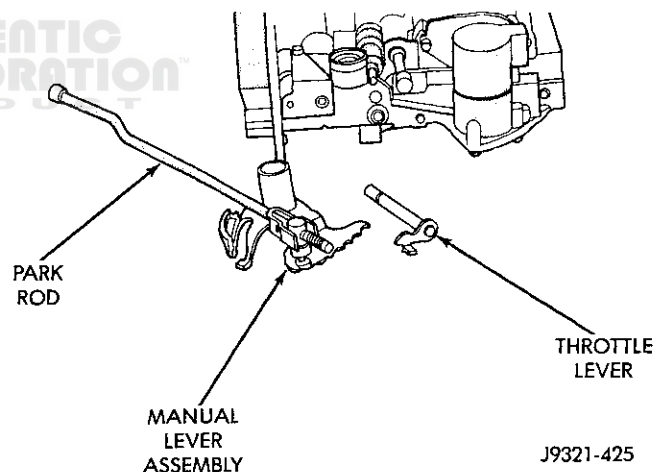


Fig. 69 Manual And Throttle Lever

DISASSEMBLY AND ASSEMBLY (Continued)

(16) Position pencil magnet next to detent housing to catch detent ball and spring. Then carefully remove Retainer Tool 6583 and remove detent ball and spring (Fig. 70).

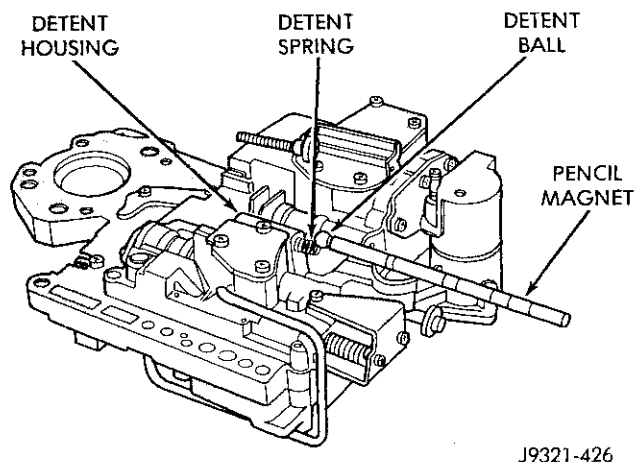


Fig. 70 Detent Ball And Spring

(17) Remove park rod E-clip and separate rod from manual lever (Fig. 71).

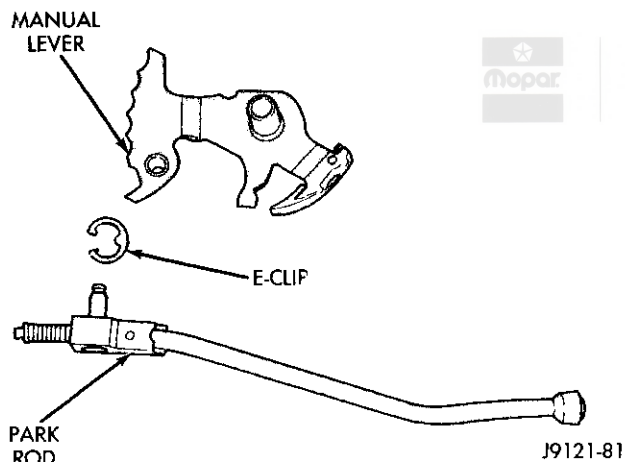


Fig. 71 Park Rod

(18) Remove screws attaching pressure adjusting screw bracket to valve body and transfer plate (Fig. 72). Hold bracket firmly against spring tension while removing last screw.

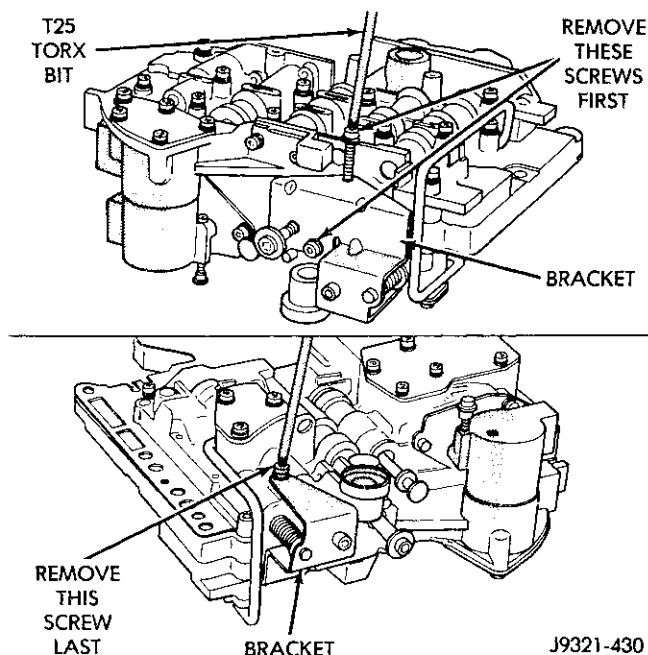


Fig. 72 Adjusting Screw Bracket Fastener

(19) Remove adjusting screw bracket, line pressure adjusting screw, pressure regulator valve spring and switch valve spring (Fig. 73). **Do not remove throttle pressure adjusting screw from bracket and do not disturb setting of either adjusting screw during removal.**

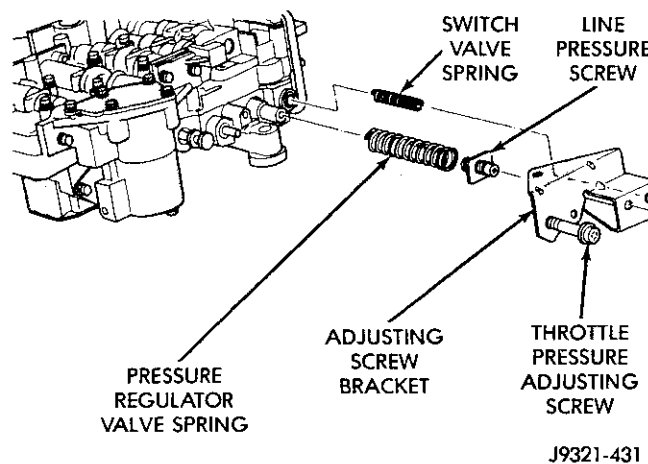


Fig. 73 Adjusting Screw Bracket And Spring

DISASSEMBLY AND ASSEMBLY (Continued)

(20) Loosen left-side 3-4 accumulator housing attaching screw about 2-3 threads. Then remove center and right-side housing attaching screws (Fig. 74).

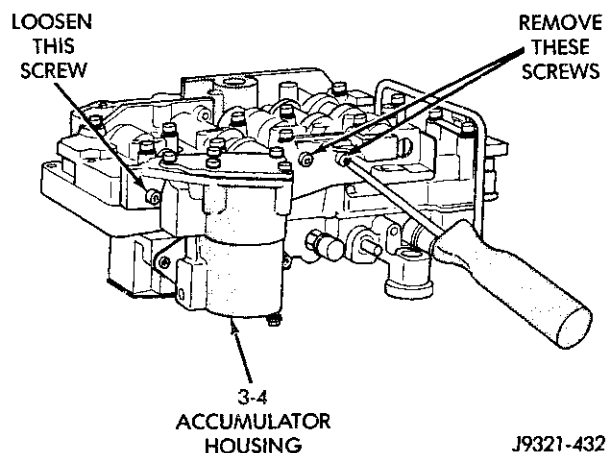


Fig. 74 Accumulator Housing Screw Locations

(21) Carefully rotate 3-4 accumulator housing upward and remove 3-4 shift valve spring and converter clutch valve plug and spring (Fig. 75).

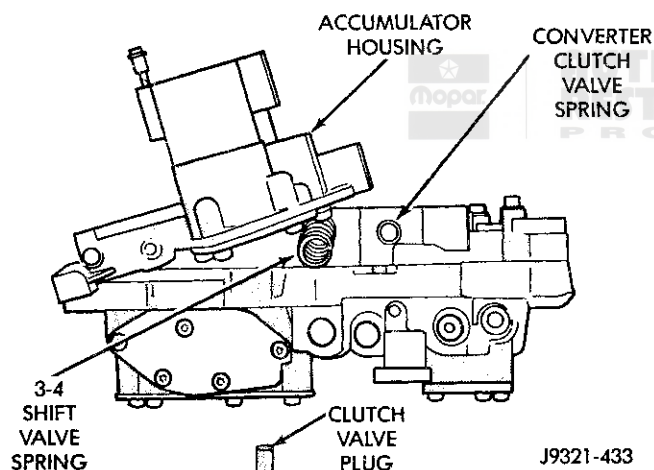


Fig. 75 3-4 Shift And Converter Clutch Valve Springs And Plug

(22) Remove left-side screw and remove 3-4 accumulator housing from valve body (Fig. 76).

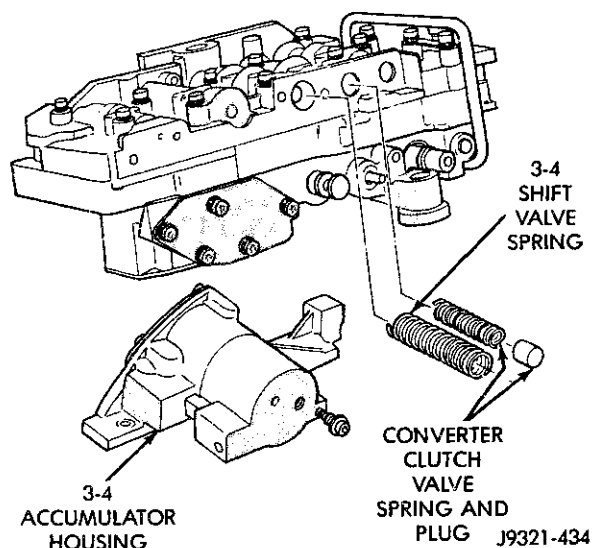


Fig. 76 Accumulator Housing, Valve Springs And Plug

(23) Remove pressure regulator valve spring from lower housing (Fig. 77).

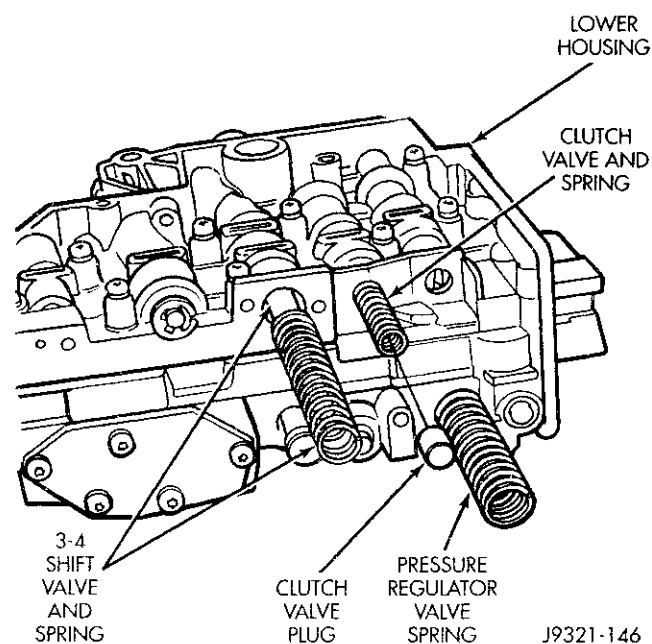


Fig. 77 Lower Housing Valve Spring Locations

DISASSEMBLY AND ASSEMBLY (Continued)

(24) Bend back tabs on boost valve tube brace (Fig. 78).

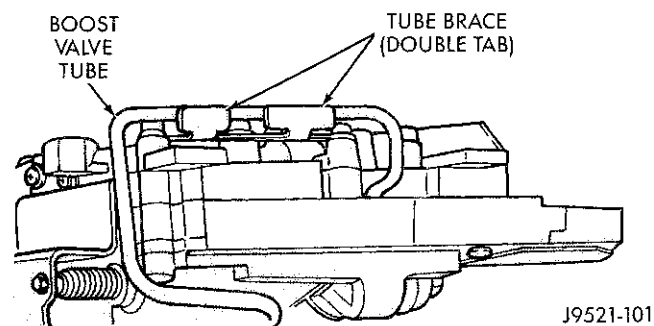


Fig. 78 Boost Valve Tube Brace

(25) Remove boost valve connecting tube (Fig. 79). Disengage tube from upper housing port first. Then rock opposite end of tube back and forth to work it out of lower housing.

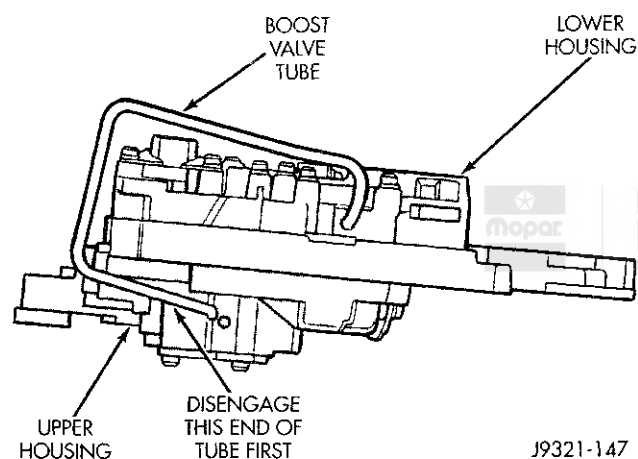


Fig. 79 Boost Valve Tube

CAUTION: Do not use tools to loosen or pry the connecting tube out of the valve body housings. Loosen and remove the tube by hand only.

(26) Turn valve body over so lower housing is facing upward (Fig. 80). In this position, the two check balls in upper housing will remain in place and not fall out when lower housing and separator plate are removed.

(27) Remove screws attaching valve body lower housing to upper housing and transfer plate (Fig. 80). **Note position of boost valve tube brace for assembly reference.**

(28) Remove lower housing and overdrive separator plate from transfer plate (Fig. 80).

(29) Remove transfer plate from upper housing (Fig. 81).

(30) Turn transfer plate over so upper housing separator plate is facing upward.

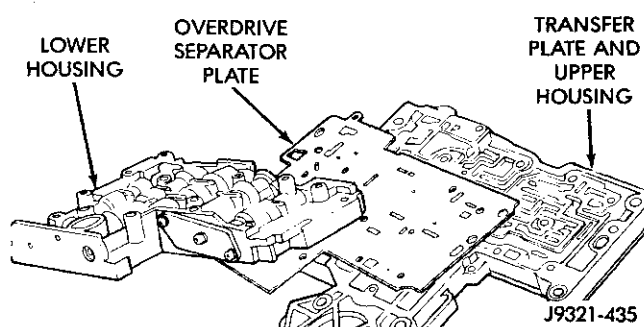


Fig. 80 Lower Housing

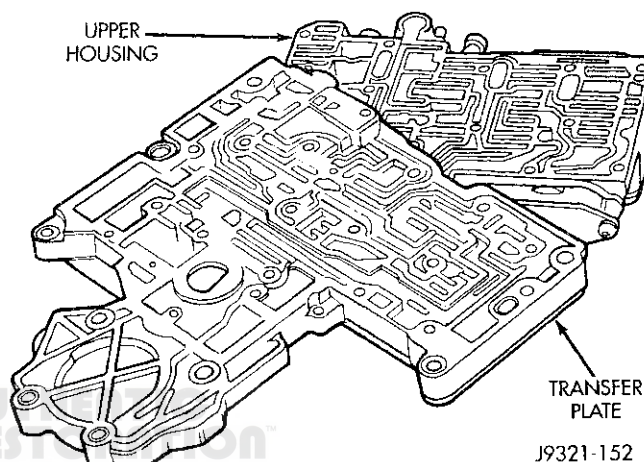


Fig. 81 Transfer Plate

(31) Remove brace plate from lower housing separator plate and transfer plate (Fig. 82).

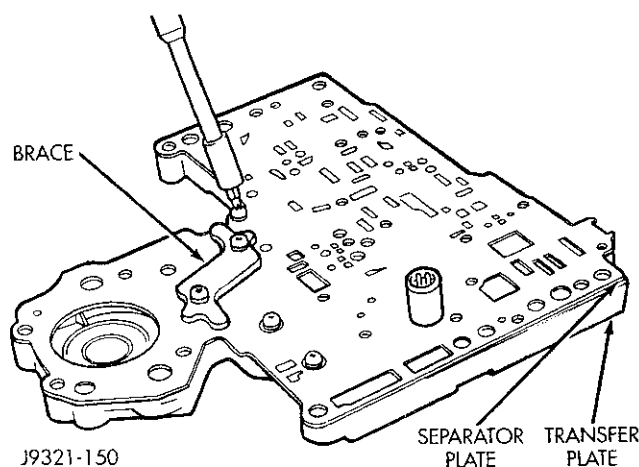


Fig. 82 Brace Plate

DISASSEMBLY AND ASSEMBLY (Continued)

(32) Remove upper housing separator plate from transfer plate (Fig. 83). Note position of filter in separator plate for assembly reference.

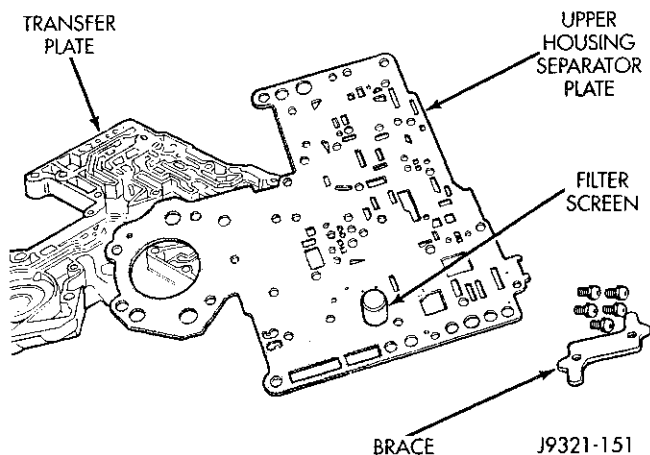


Fig. 83 Upper Housing Separator Plate

(33) Remove rear clutch and rear servo check balls from transfer plate. Note check ball location for assembly reference (Fig. 84).

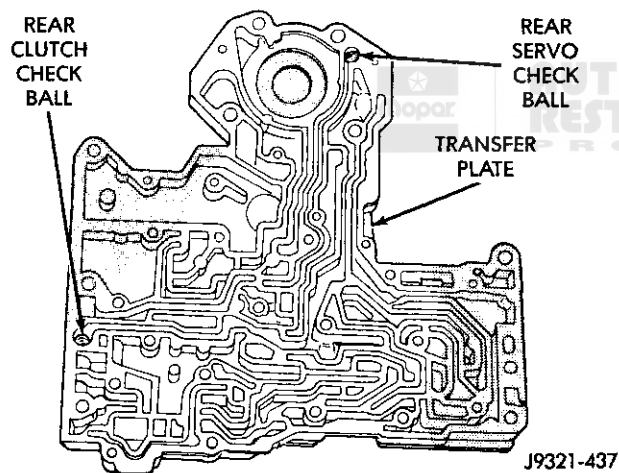


Fig. 84 Rear Clutch And Rear Servo Check Ball Locations

VALVE BODY UPPER HOUSING DISASSEMBLE

(1) Note location of check balls in valve body upper housing (Fig. 85). Then remove the one large diameter and the six smaller diameter check balls.

(2) Remove E-clip that secure shuttle valve secondary spring on valve stem (Fig. 86).

(3) Remove governor plug and shuttle valve covers (Fig. 87).

(4) Remove throttle plug, primary spring, shuttle valve, secondary spring, and spring guides (Fig. 87).

(5) Remove boost valve retainer, spring and valve if not previously removed.

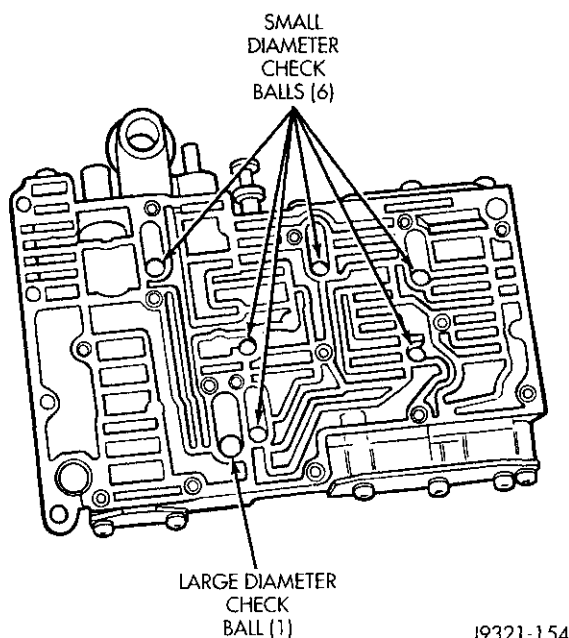


Fig. 85 Check Ball Locations In Upper Housing

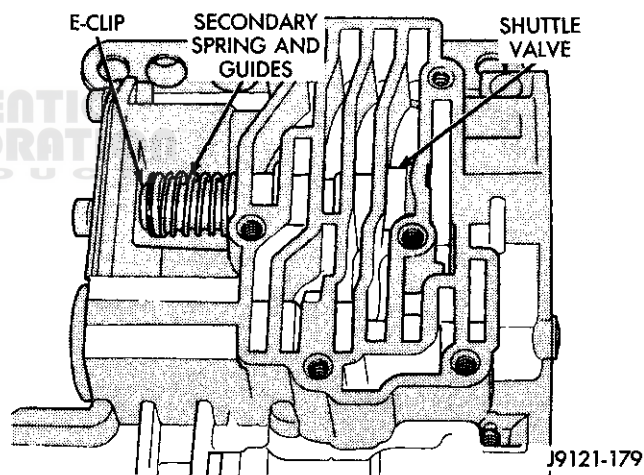
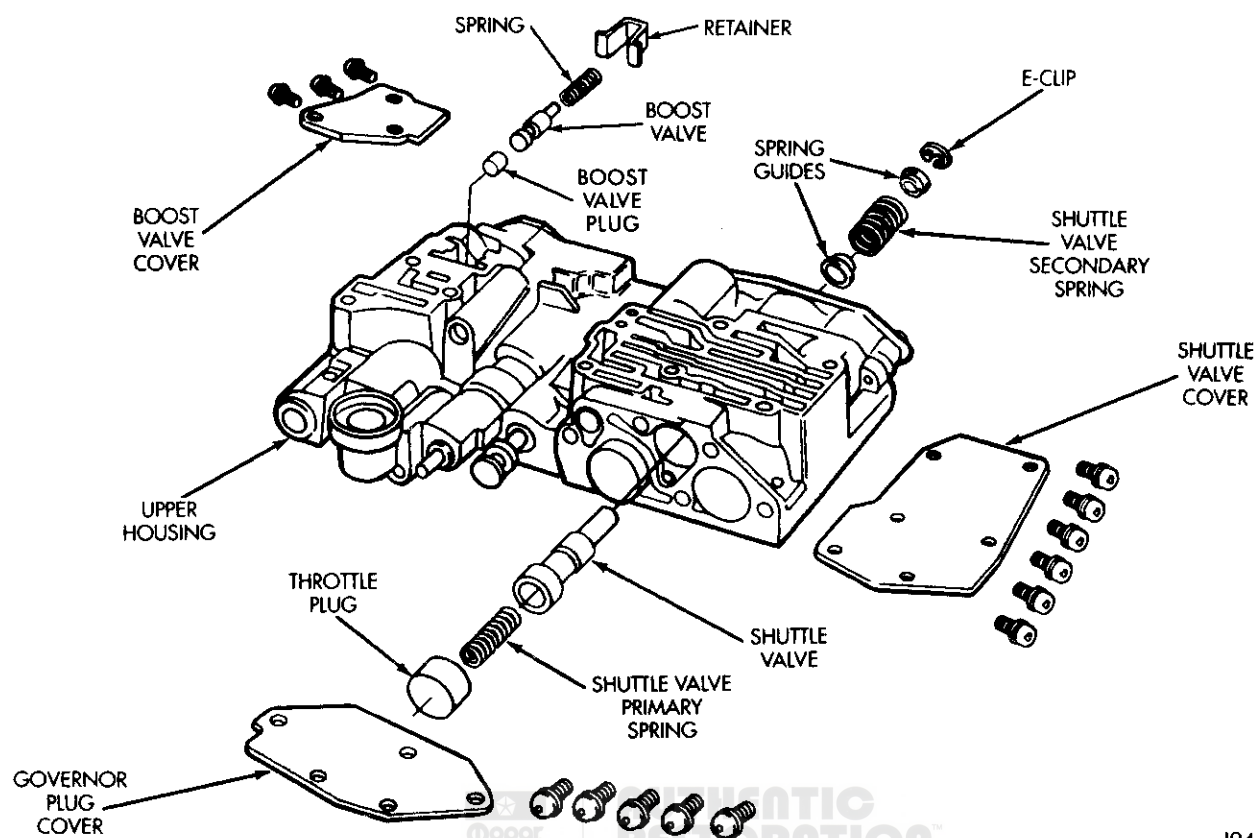


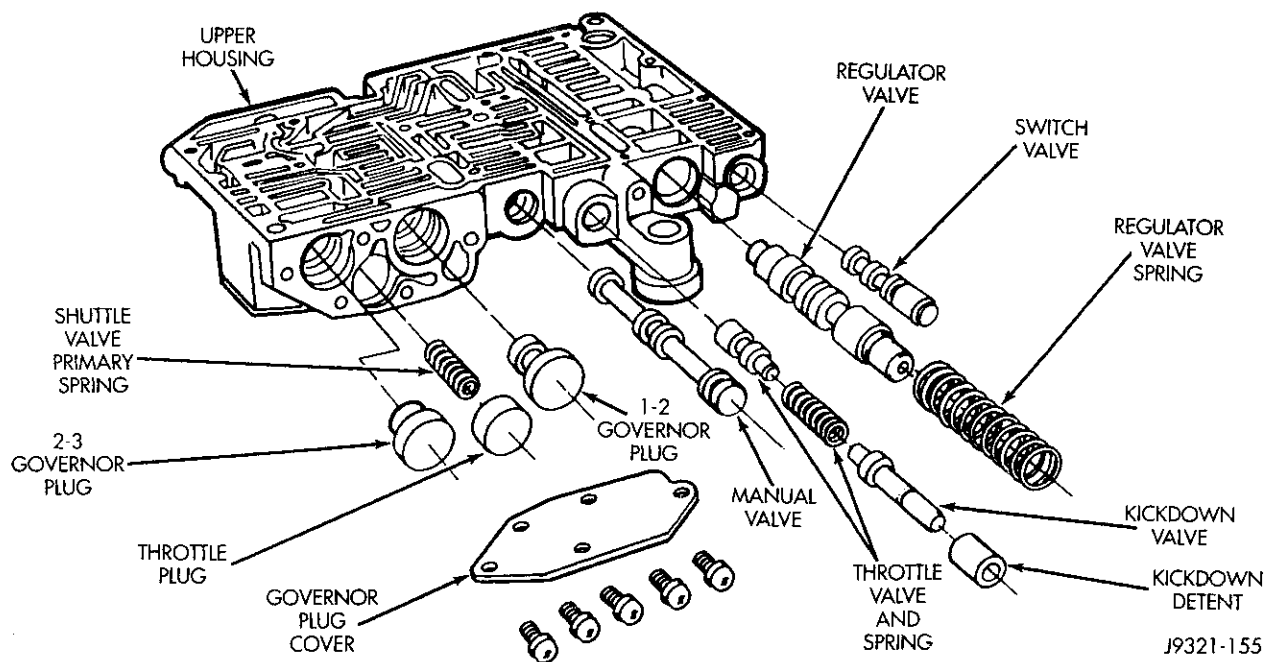
Fig. 86 Shuttle Valve E-Clip And Secondary Spring Location

(6) Turn upper housing over and remove switch valve, regulator valve and spring, and manual valve (Fig. 88).

(7) Remove kickdown detent, kickdown valve, and throttle valve and spring (Fig. 88).

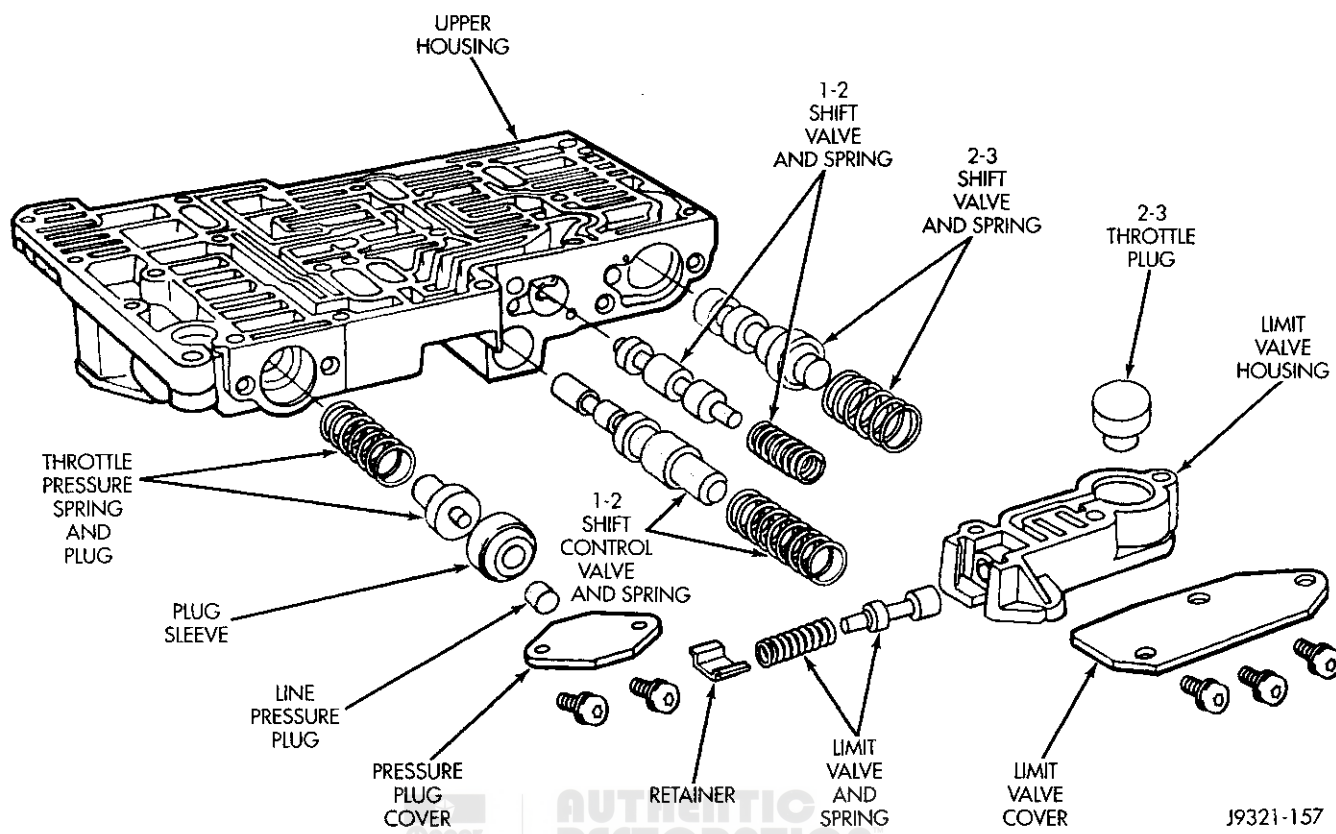
DISASSEMBLY AND ASSEMBLY (Continued)

J9421-217

Fig. 87 Shuttle And Boost Valve Components

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Fig. 88 Upper Housing Control Valve Locations

DISASSEMBLY AND ASSEMBLY (Continued)

J9321-157

Fig. 89 Upper Housing Shift Valve And Pressure Plug Locations

(8) Remove throttle plug and 1-2 and 2-3 governor plugs (Fig. 88). Also remove shuttle valve primary spring if not removed in prior step.

(9) Turn upper housing around and remove limit valve and shift valve covers (Fig. 89).

(10) Remove limit valve housing. Then remove retainer, spring, limit valve, and 2-3 throttle plug from limit valve housing (Fig. 89).

(11) Remove 1-2 shift control valve and spring (Fig. 89).

(12) Remove 1-2 shift valve and spring (Fig. 89).

(13) Remove 2-3 shift valve and spring from valve body (Fig. 89).

(14) Remove pressure plug cover (Fig. 89).

(15) Remove line pressure plug, sleeve, throttle pressure plug and spring (Fig. 89).

VALVE BODY LOWER HOUSING DISASSEMBLY

(1) Remove timing valve cover.

(2) Remove 3-4 timing valve and spring.

(3) Remove 3-4 quick fill valve, spring and plug.

(4) Remove 3-4 shift valve and spring.

(5) Remove converter clutch valve, spring and plug (Fig. 90).

(6) Remove converter clutch timing valve, retainer and valve spring.

3-4 ACCUMULATOR HOUSING DISASSEMBLY

(1) Remove end plate from housing.

(2) Remove piston spring.

(3) Remove piston. Remove and discard piston seals (Fig. 91).

VALVE BODY ASSEMBLE

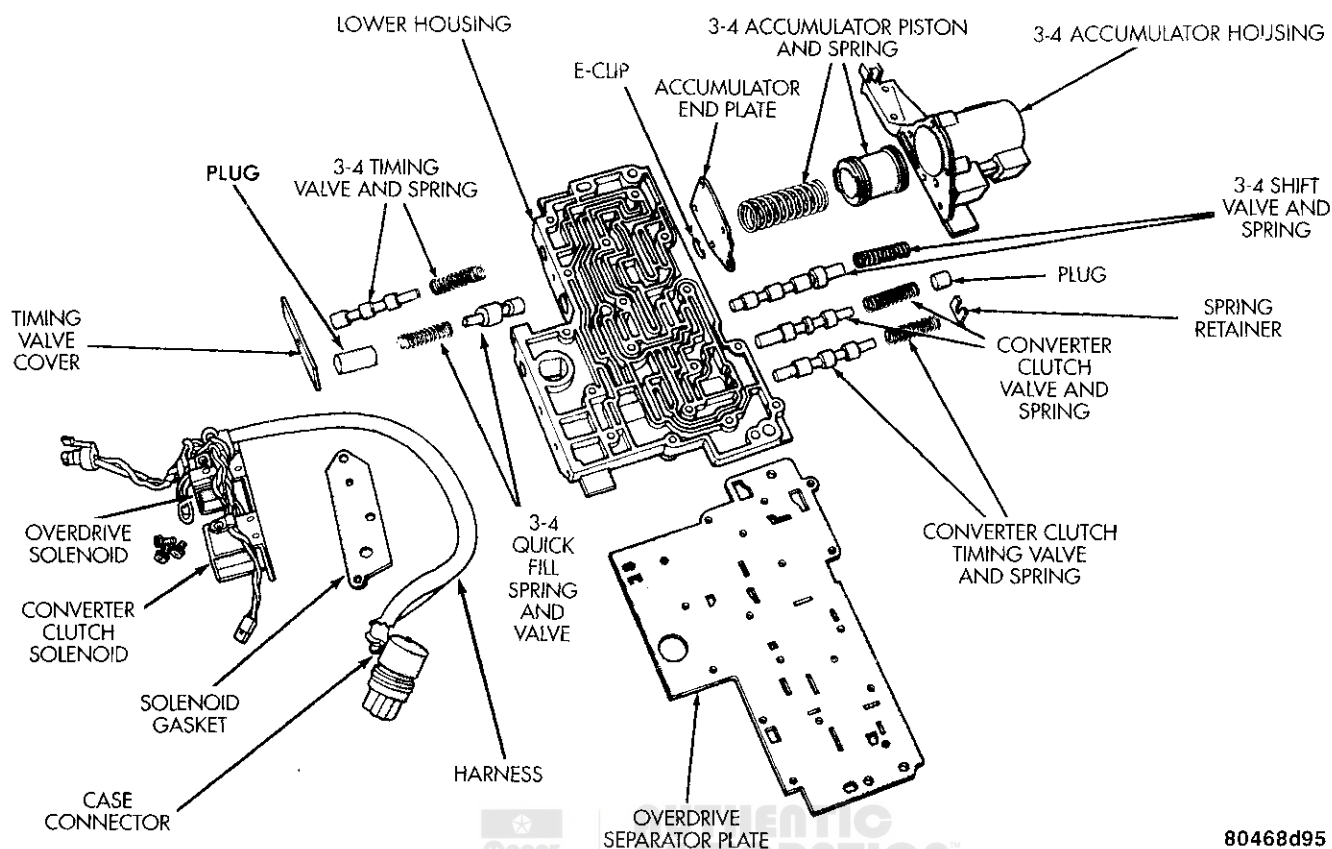
CAUTION: Do not force valves or plugs into place during reassembly. If the valve body bores, valves and plugs are free of distortion or burrs, the valve body components should all slide into place easily. In addition, do not overtighten the transfer plate and valve body screws during reassembly. Overtightening can distort the housings resulting in valve sticking, cross leakage and unsatisfactory operation. Tighten valve body screws to recommended torque only.

LOWER HOUSING ASSEMBLY

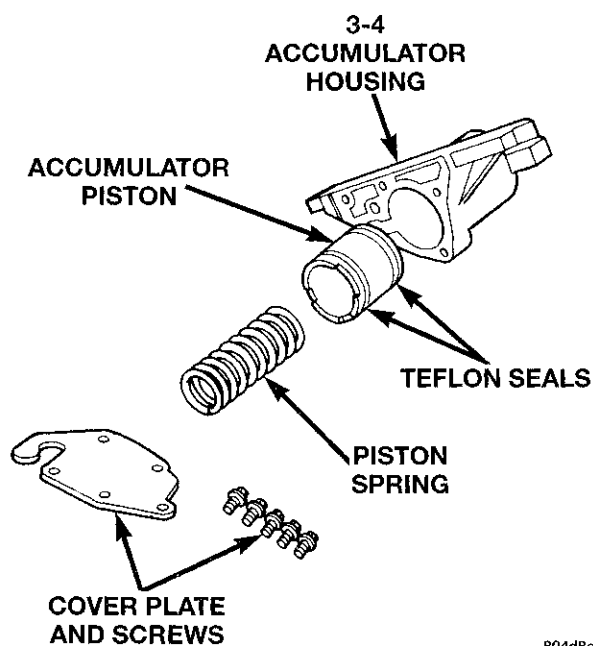
(1) Lubricate valves, springs, and the housing valve and plug bores with clean transmission fluid (Fig. 90).

(2) Install 3-4 timing valve spring and valve in lower housing.

(3) Install 3-4 quick fill valve in lower housing.

DISASSEMBLY AND ASSEMBLY (Continued)

80468d95

Fig. 90 Lower Housing Shift Valves And Springs

804d8eb9

Fig. 91 Accumulator Housing Components

(4) Install 3-4 quick fill valve spring and plug in housing.

(5) Install timing valve end plate. Tighten end plate screws to 4 N-m (35 in. lbs.) torque.

(6) Install 3-4 shift valve and spring.

(7) Install converter clutch valve, spring and plug.

(8) Install converter clutch timing valve and spring.

3-4 ACCUMULATOR ASSEMBLY

(1) Lubricate accumulator piston, seals and housing piston bore with clean transmission fluid (Fig. 91).

(2) Install new seal rings on accumulator piston.

(3) Install piston and spring in housing.

(4) Install end plate on housing.

DISASSEMBLY AND ASSEMBLY (Continued)**TRANSFER PLATE ASSEMBLY**

(1) Install rear clutch and rear servo check balls in transfer plate (Fig. 92).

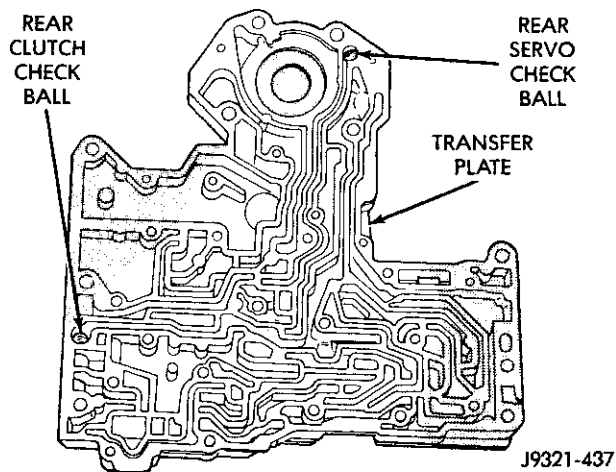


Fig. 92 Rear Clutch And Rear Servo Check Ball Locations

(2) Install filter screen in upper housing separator plate (Fig. 93).

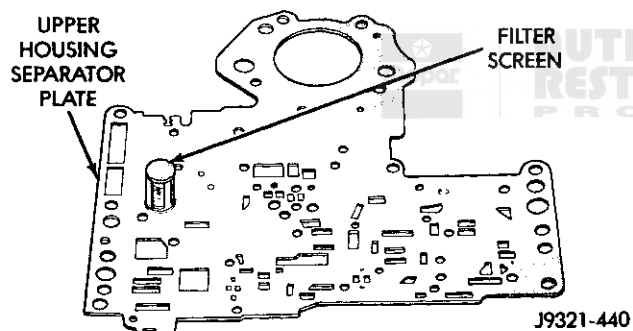


Fig. 93 Separator Plate Filter Screen Installation

(3) Align and position upper housing separator plate on transfer plate (Fig. 94).

(4) Install brace plate (Fig. 94). Tighten brace attaching screws to 4 N·m (35 in. lbs.) torque.

(5) Install remaining separator plate attaching screws. Tighten screws to 4 N·m (35 in. lbs.) torque.

ASSEMBLING UPPER AND LOWER HOUSINGS

(1) Position upper housing so internal passages and check ball seats are facing upward. Then install check balls in housing (Fig. 95). Seven check balls are used. The single large check ball is approximately 8.7 mm (11/32 in.) diameter. The remaining 6 check balls are approximately 6.3 mm (1/4 in.) in diameter.

(2) Position assembled transfer plate and upper housing separator plate on upper housing (Fig. 96). Be sure filter screen is seated in proper housing recess.

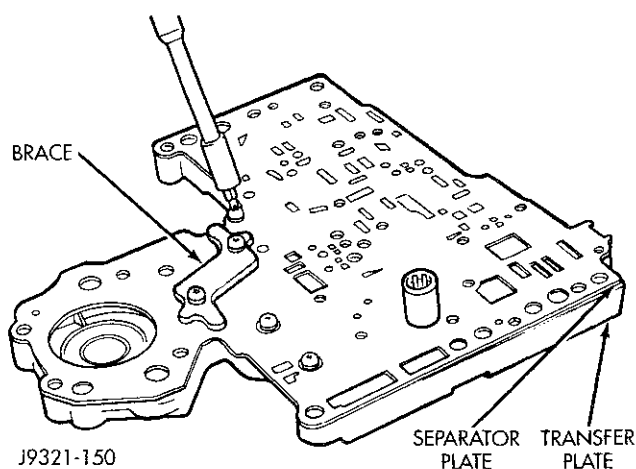


Fig. 94 Brace Plate

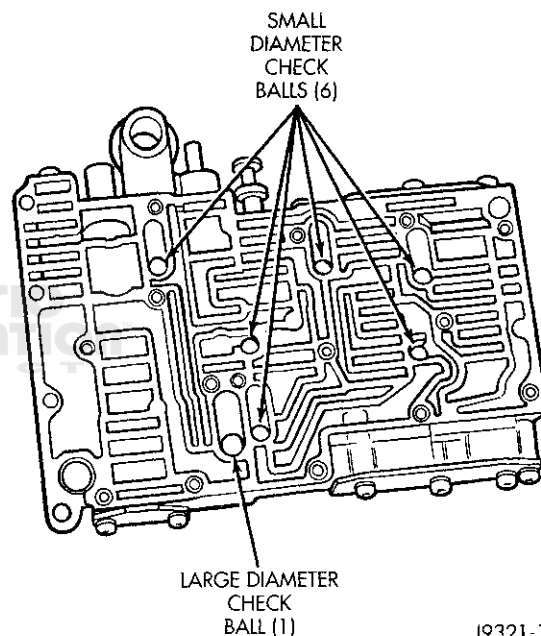


Fig. 95 Check Ball Locations In Upper Housing

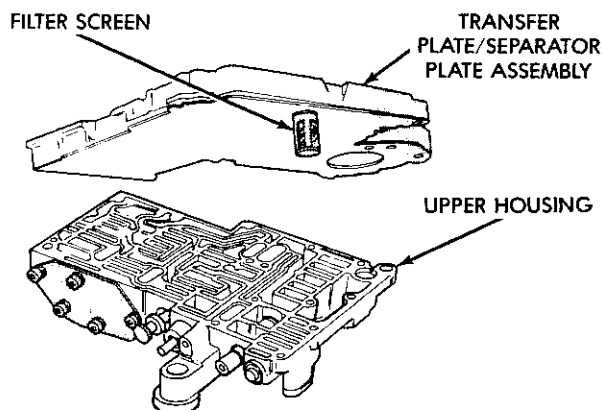
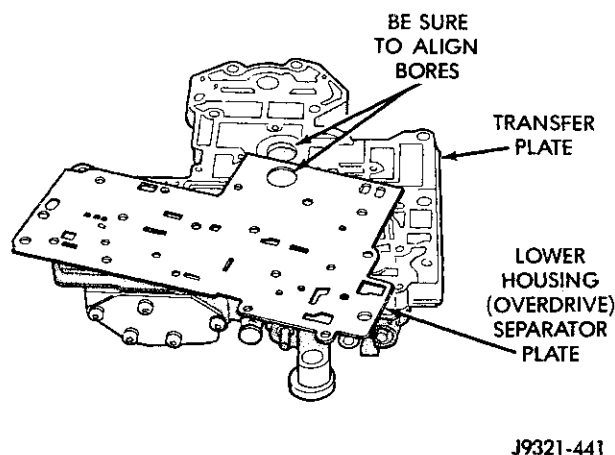


Fig. 96 Installing Transfer Plate On Upper Housing

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 97 Lower Housing Separator Plate**

(3) Position lower housing separator plate on transfer plate (Fig. 97).

(4) Install lower housing on assembled transfer plate and upper housing (Fig. 98).

(5) Install and start valve body screws by hand. Then tighten screws evenly to 4 N·m (35 in. lbs.) torque. Start at center and work out to sides when tightening screws (Fig. 98).

UPPER HOUSING VALVE AND PLUG INSTALLATION

Refer to (Fig. 99), (Fig. 100) and (Fig. 101) to perform the following steps.

(1) Lubricate valves, plugs, springs with clean transmission fluid.

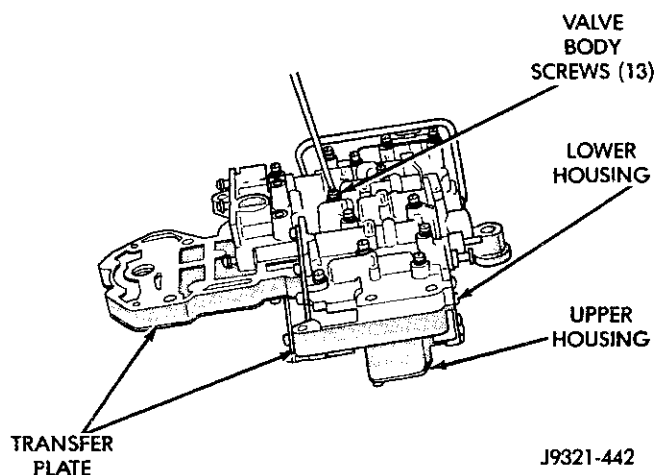
(2) Assemble regulator valve line pressure plug, sleeve, throttle plug and spring. Insert assembly in upper housing and install cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(3) Install 1-2 and 2-3 shift valves and springs.

(4) Install 1-2 shift control valve and spring.

(5) Install shift valve cover plate.

(6) Install shuttle valve as follows:

**Fig. 98 Installing Lower Housing On Transfer Plate And Upper Housing**

(a) Insert plastic guides in shuttle valve secondary spring and install spring on end of valve.

(b) Hold shuttle valve in place.

(c) Compress secondary spring and install E-clip in groove at end of shuttle valve.

(d) Verify that spring and E-clip are properly seated before proceeding.

(7) Install shuttle valve cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(8) Install 1-2 and 2-3 valve governor plugs in valve body.

(9) Install shuttle valve primary spring and throttle plug.

(10) Align and install governor plug cover. Tighten cover screws to 4 N·m (35 in. lbs.) torque.

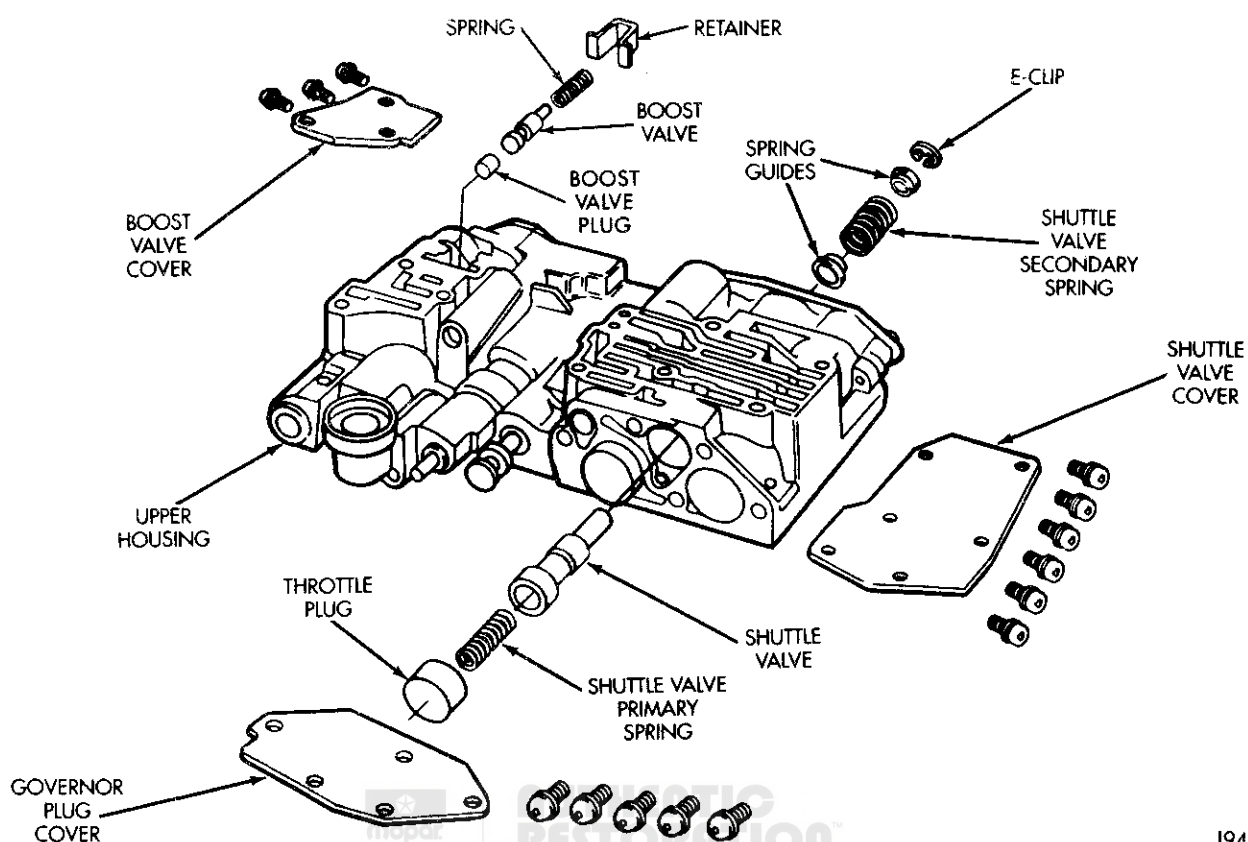
(11) Install manual valve.

(12) Install throttle valve and spring.

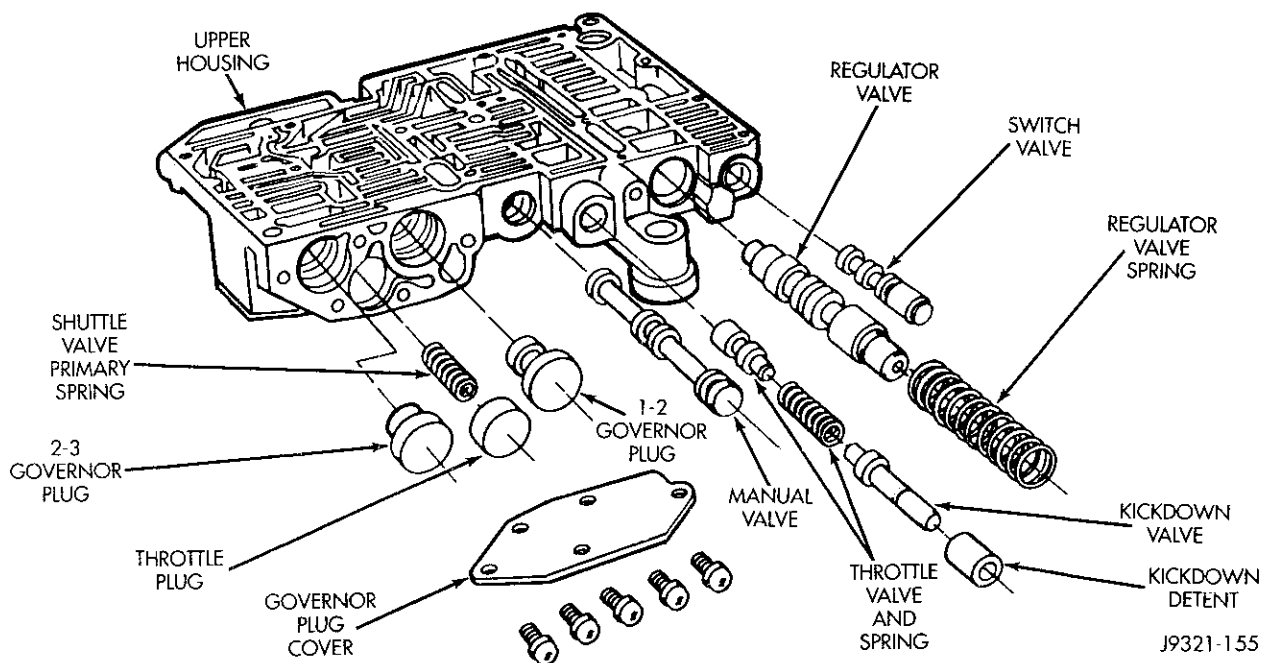
(13) Install kickdown valve and detent.

(14) Install pressure regulator valve.

(15) Install switch valve.

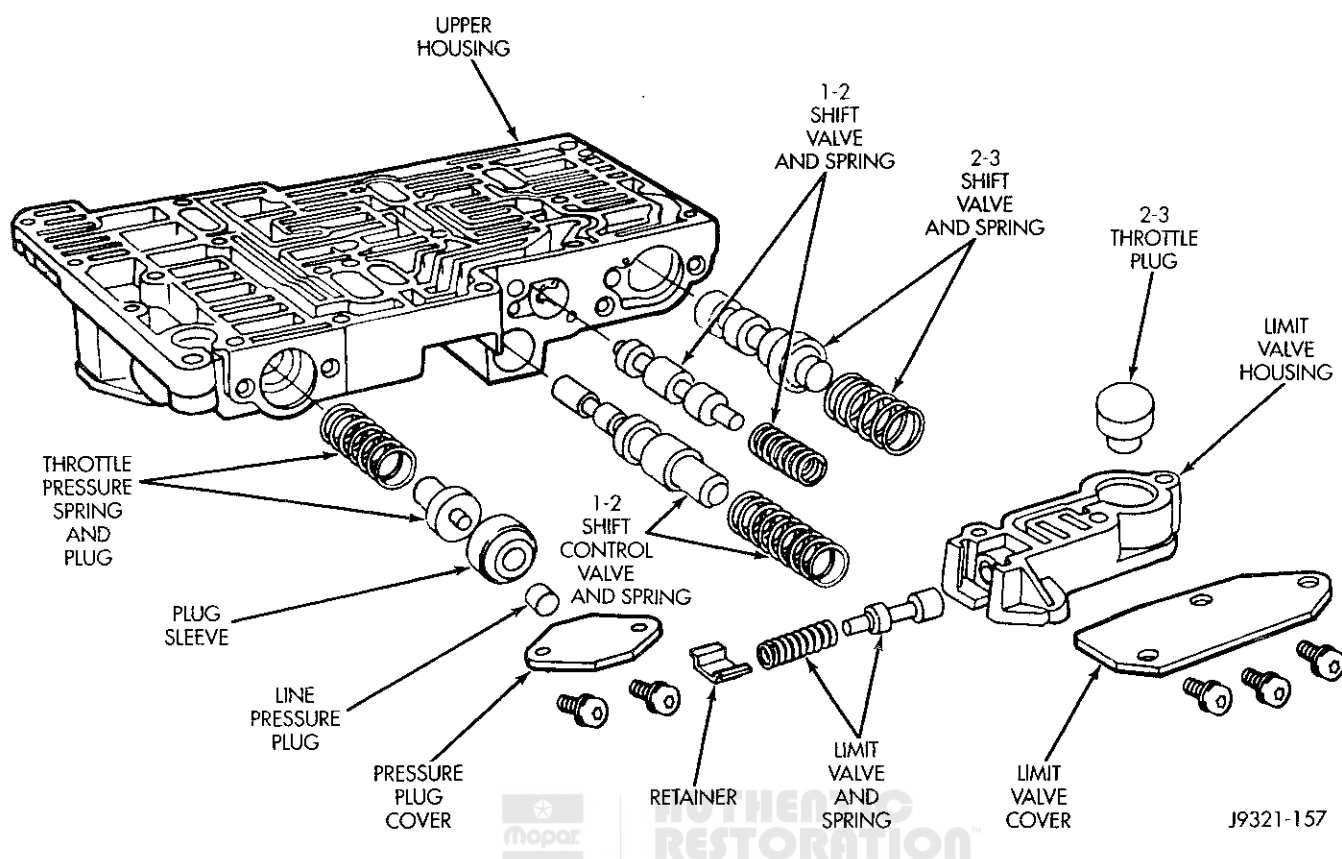
DISASSEMBLY AND ASSEMBLY (Continued)

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Fig. 99 Shuttle And Boost Valve Components

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Fig. 100 Upper Housing Control Valve Locations

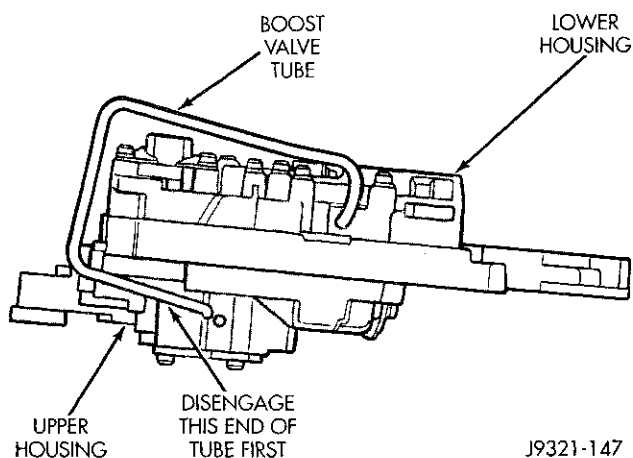
DISASSEMBLY AND ASSEMBLY (Continued)

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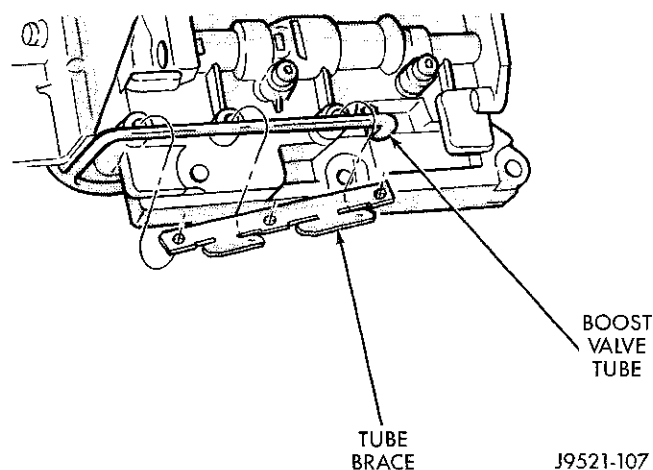
Fig. 101 Upper Housing Shift Valve And Pressure Plug Locations**BOOST VALVE TUBE AND BRACE INSTALLATION**

- (1) Position valve body assembly so lower housing is facing upward (Fig. 102).
- (2) Lubricate tube ends and housing ports with transmission fluid or petroleum jelly.
- (3) Start tube in lower housing port first. Then swing tube downward and work opposite end of tube into upper housing port (Fig. 102).

- (4) Insert and seat each end of tube in housings.
- (5) Slide tube brace under tube and into alignment with valve body screw holes (Fig. 103).
- (6) Install and finger tighten three screws that secure tube brace to valve body housings (Fig. 103).



J9321-147

Fig. 102 Boost Valve Tube

J9521-107

Fig. 103 Boost Valve Tube And Brace

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Bend tube brace tabs up and against tube to hold it in position (Fig. 104).

(8) **Tighten all valve body housing screws to 4 N·m (35 in. lbs.) torque after tube and brace are installed. Tighten screws in diagonal pattern starting at center and working outward.**

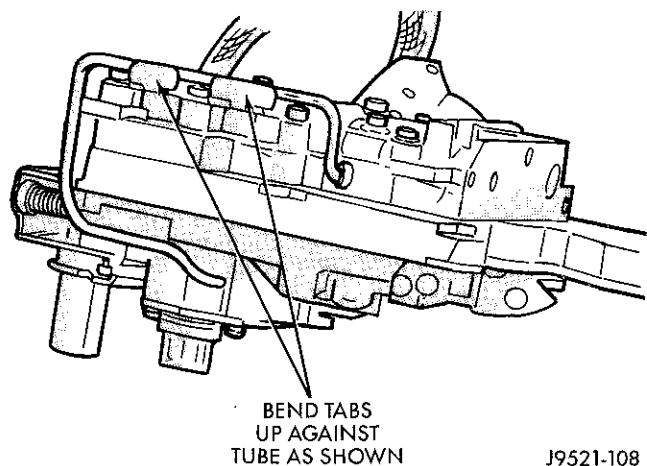


Fig. 104 Securing Boost Valve Tube With Brace Tabs

3-4 ACCUMULATOR INSTALLATION

(1) Position converter clutch valve and 3-4 shift valve springs in housing (Fig. 105).

(2) Loosely attach accumulator housing with right-side screw (Fig. 105). Install only one screw at this time as accumulator must be free to pivot upward for ease of installation.

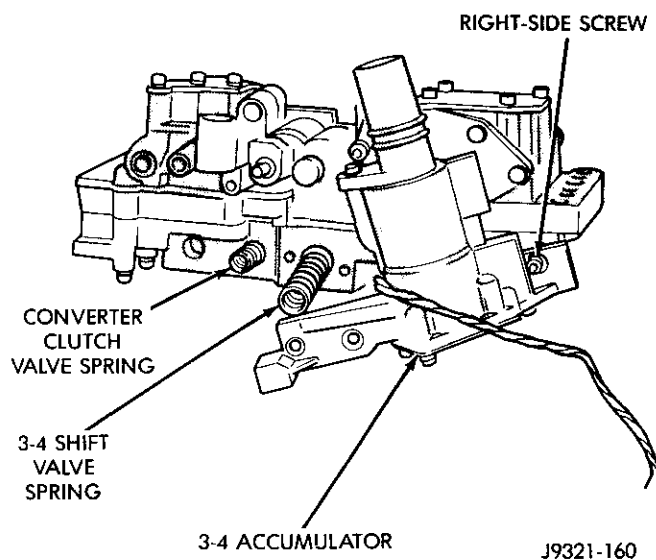


Fig. 105 Converter Clutch And 3-4 Shift Valve Springs

(3) Position plug on end of converter clutch valve spring. Then compress and hold springs and plug in place with fingers of one hand.

(4) Swing accumulator housing upward over valve springs and plug.

(5) Hold accumulator housing firmly in place and install remaining two attaching screws. Be sure springs and clutch valve plug are properly seated (Fig. 106).

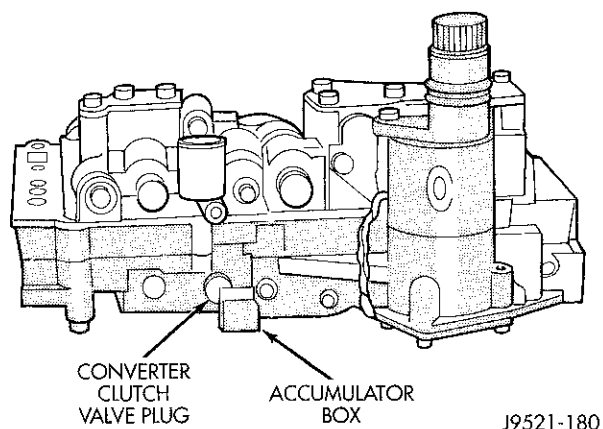


Fig. 106 Seating 3-4 Accumulator On Lower Housing

(6) Attach solenoid case connector to 3-4 accumulator with shoulder-type screw. Connector has small locating tang that fits in dimple at top of accumulator housing (Fig. 107). Seat tang in dimple before tightening connector screw.

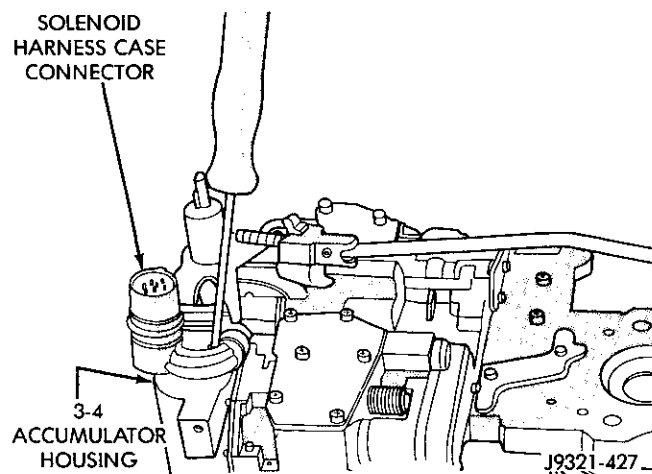


Fig. 107 Solenoid Harness Case Connector Shoulder Bolt

(7) Install solenoid assembly and gasket. Tighten solenoid attaching screws to 8 N·m (72 in. lbs.) torque.

(8) Verify that solenoid wire harness is properly routed (Fig. 108). **Solenoid harness must be clear of manual lever and park rod and not be**

DISASSEMBLY AND ASSEMBLY (Continued)

pinched between accumulator housing and cover.

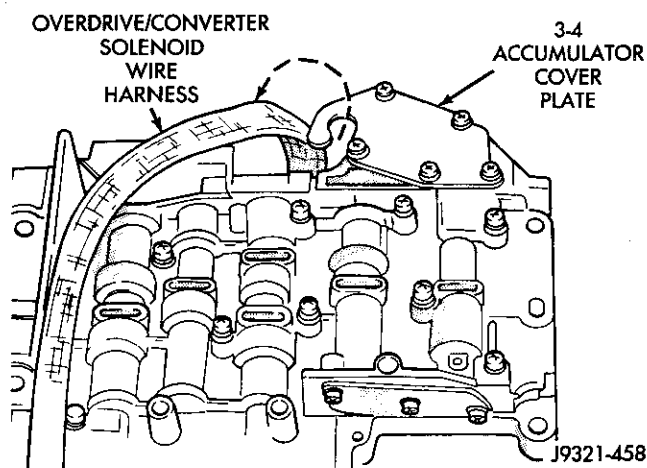


Fig. 108 Solenoid Harness Routing

VALVE BODY FINAL ASSEMBLY AND ADJUSTMENT

(1) Insert manual lever detent spring in upper housing.

(2) Position line pressure adjusting screw in adjusting screw bracket.

(3) Install spring on end of line pressure regulator valve.

(4) Install switch valve spring on tang at end of adjusting screw bracket.

(5) Position adjusting screw bracket on valve body. Align valve springs and press bracket into place. Install short, upper bracket screws first and long bottom screw last. Verify that valve springs and bracket are properly aligned. Then tighten all three bracket screws to 4 N·m (35 in. lbs.) torque.

(6) Install throttle lever in upper housing. Then install manual lever over throttle lever and start manual lever into housing.

(7) Position detent ball on end of spring. Then hold detent ball and spring in detent housing with Retainer Tool 6583 (Fig. 109).

(8) Align manual lever with detent ball and manual valve. Hold throttle lever upward. Then press down on manual lever until fully seated. Remove detent ball retainer tool after lever is seated.

(9) Then Install manual lever seal, washer and E-clip.

(10) Lubricate solenoid case connector O-rings and shaft of manual lever with light coat of petroleum jelly.

(11) Verify that throttle lever is aligned with end of kickdown valve stem and that manual lever arm is engaged in manual valve (Fig. 110).

(12) Install boost valve, valve spring, retainer and cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(13) Obtain new fluid filter for valve body but do not install filter at this time.

(14) If line pressure and/or throttle pressure adjustment screw settings were not disturbed, continue with overhaul or reassembly. However, if adjustment screw settings **were** moved or changed, readjust as described in Valve Body Control Pressure Adjustment procedure.

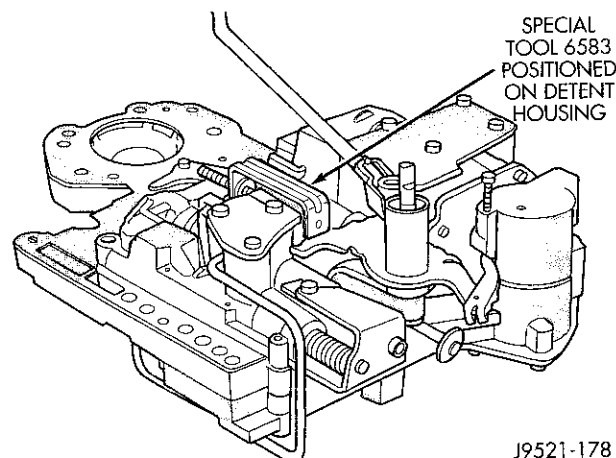


Fig. 109 Detent Ball Spring

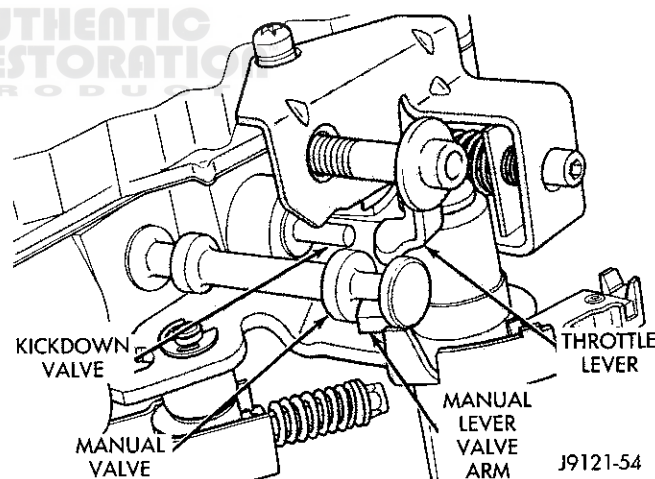


Fig. 110 Manual And Throttle Lever Alignment
GOVERNOR BODY, SENSOR AND SOLENOID INSTALLATION

CAUTION: Do not turn the small screw at the end of the governor pressure solenoid valve for any reason (Fig. 111). Turning the screw in either direction will ruin solenoid calibration and result in solenoid failure. In addition, the filter on the solenoid valve is **NOT** serviceable. Do not try to remove the filter as this will damage the solenoid valve housing.

DISASSEMBLY AND ASSEMBLY (Continued)

(1) Turn valve body assembly over so accumulator side of transfer plate is facing down.

(2) Install new O-rings on governor pressure solenoid and sensor (Fig. 111) and (Fig. 112).

(3) Lubricate solenoid and sensor O-rings with clean transmission fluid.

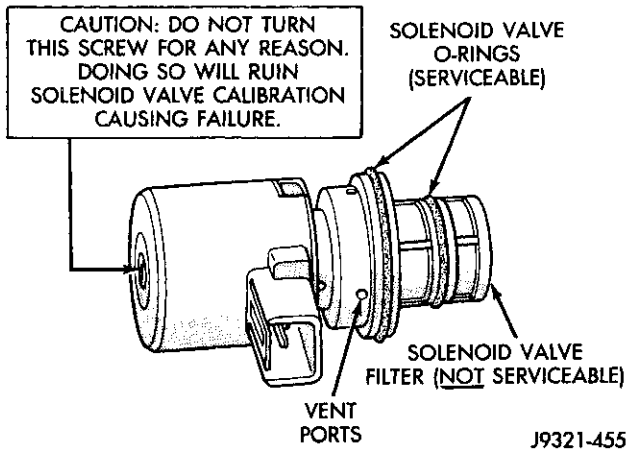


Fig. 111 Governor Pressure Solenoid

(4) Install governor pressure sensor in governor body. Then secure sensor with M-shaped retaining clip (Fig. 112).

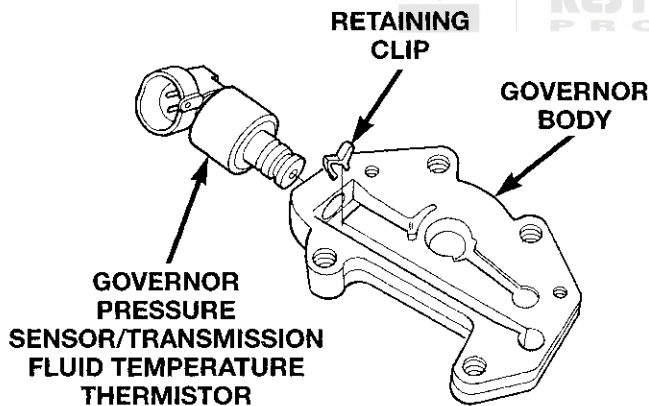


Fig. 112 Governor Pressure Sensor

(5) Install governor pressure solenoid in governor body (Fig. 113). Push solenoid in until it snaps into place in body.

(6) Position governor body gasket on transfer plate (Fig. 114).

(7) Install retainer plate on governor body and around solenoid (Fig. 115). Be sure solenoid connector is positioned in retainer cutout.

(8) Align screw holes in governor body and transfer plate. Then install and tighten governor body screws to 4 N·m (35 in. lbs.) torque.

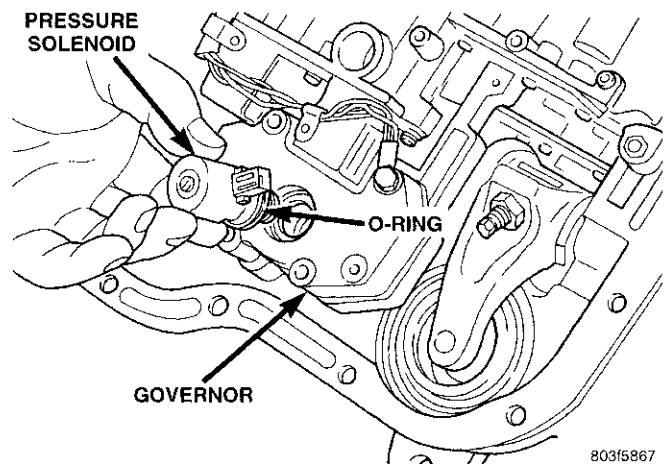


Fig. 113 Governor Pressure Solenoid

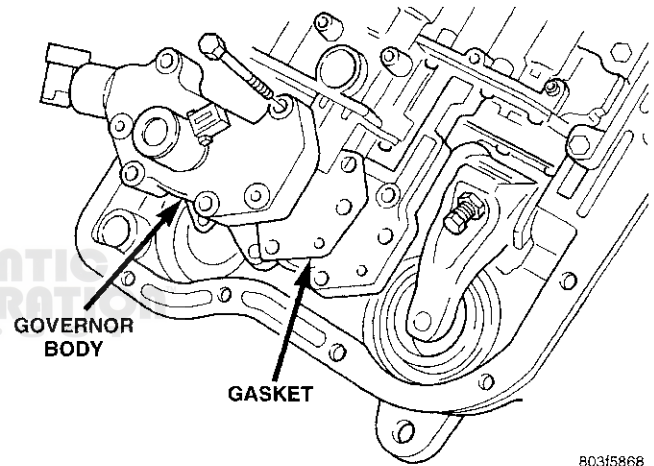


Fig. 114 Governor Body And Gasket

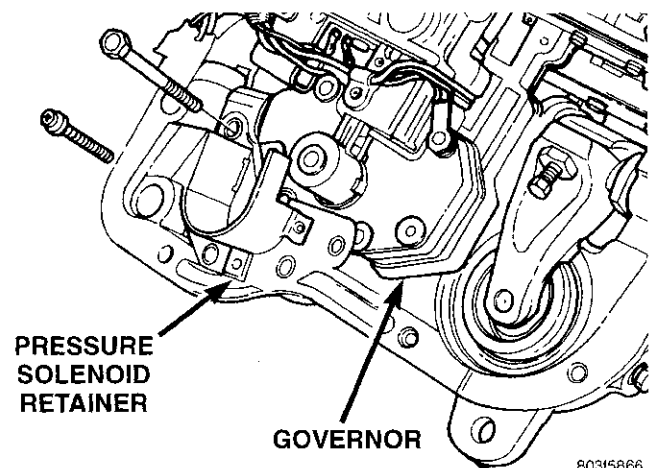


Fig. 115 Pressure Solenoid Retainer

(9) Connect harness wires to governor pressure solenoid and governor pressure sensor (Fig. 116).

DISASSEMBLY AND ASSEMBLY (Continued)

(10) Perform Line Pressure and Throttle Pressure adjustments, refer to adjustment section of this group for proper procedures.

(11) Install fluid filter and pan.

(12) Lower vehicle.

(13) Fill transmission with recommended fluid and road test vehicle to verify repair.

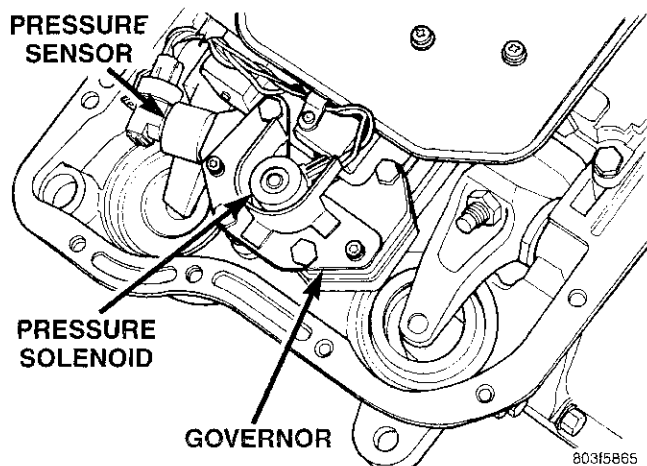


Fig. 116 Governor Pressure Sensor And Solenoid Connectors

TRANSMISSION**DISASSEMBLE**

- (1) Remove transmission from vehicle.
- (2) Remove overdrive unit.
- (3) Clean transmission exterior with steam gun or with solvent. Wear eye protection during cleaning operations.
- (4) Remove shift and throttle levers from valve body manual lever shaft.
- (5) Remove transmission speed sensor and O-ring seal from overdrive unit (Fig. 117).
- (6) Place transmission in upright position (Fig. 118).
- (7) Remove bolts attaching overdrive unit to transmission case (Fig. 118). An 11 mm socket is required. Note position of all wiring clips and bolts for installation reference.

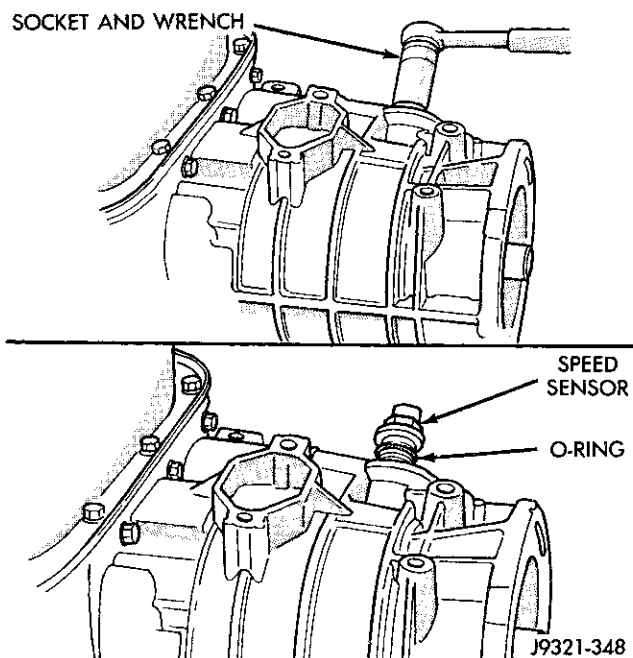


Fig. 117 Transmission Speed Sensor Removal/Installation

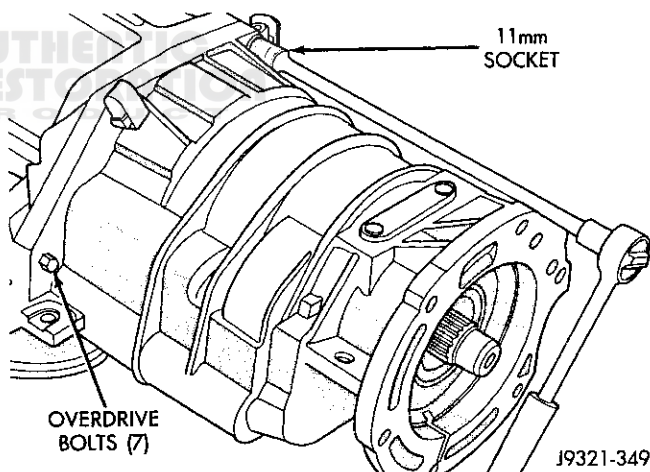


Fig. 118 Removing/Installing Overdrive Unit Attaching Bolts

DISASSEMBLY AND ASSEMBLY (Continued)

(8) Lift overdrive unit up and off transmission intermediate shaft (Fig. 119).

(a) If overdrive unit does not require service, insert Alignment Tool 6227-2 in overrunning clutch and planetary gear splines to maintain alignment (Fig. 120). **If clutch and gear splines rotate out of alignment, overdrive unit may have to be disassembled in order to realign splines.**

(b) If overdrive unit **does** requires service, refer to Overdrive Unit Overhaul section.

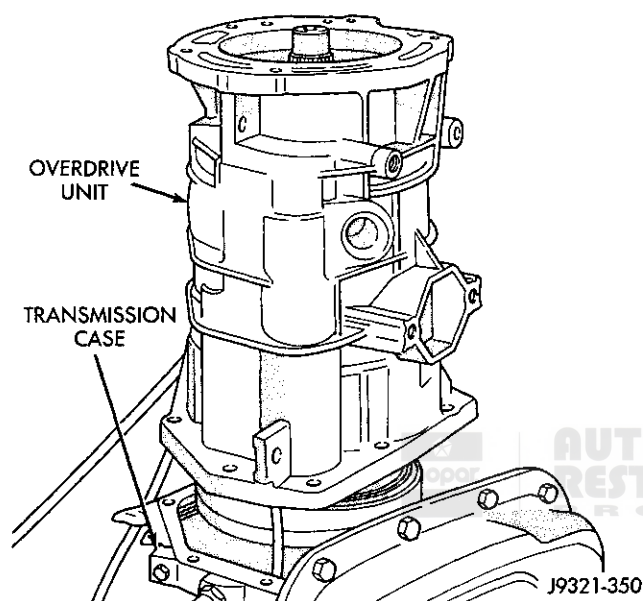


Fig. 119 Overdrive Unit Removal

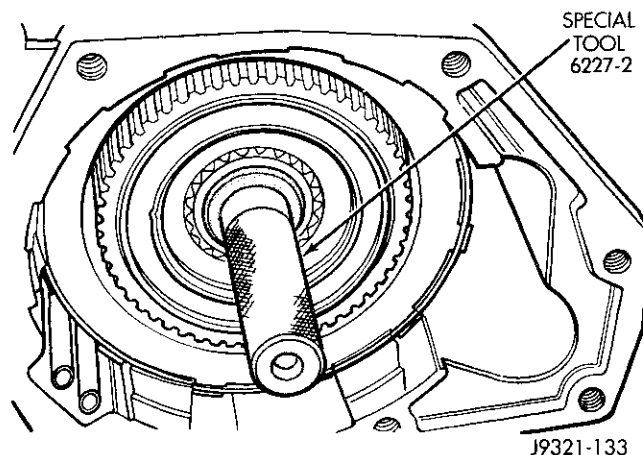


Fig. 120 Overdrive Spline Alignment Tool Installation

(9) Remove thrust bearing and thrust plate from overdrive piston (Fig. 121).

(10) Place transmission in horizontal position.

(11) Remove transmission oil pan and gasket.

(12) Remove oil filter from valve body (Fig. 122). Keep filter screws separate from other valve body

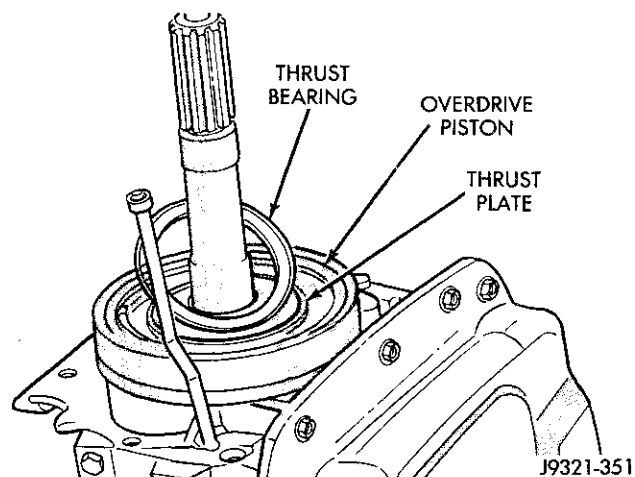


Fig. 121 Thrust Bearing And Plate Removal

screws. Filter screws are longer and should be kept with filter.

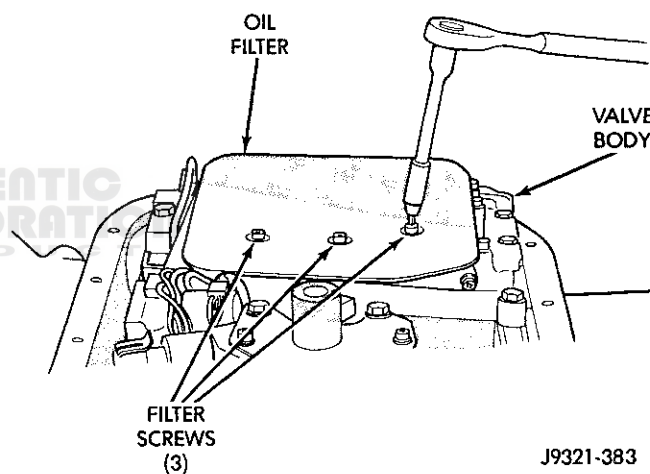


Fig. 122 Oil Filter Removal/Installation

(13) Remove overdrive piston from retainer (Fig. 123).

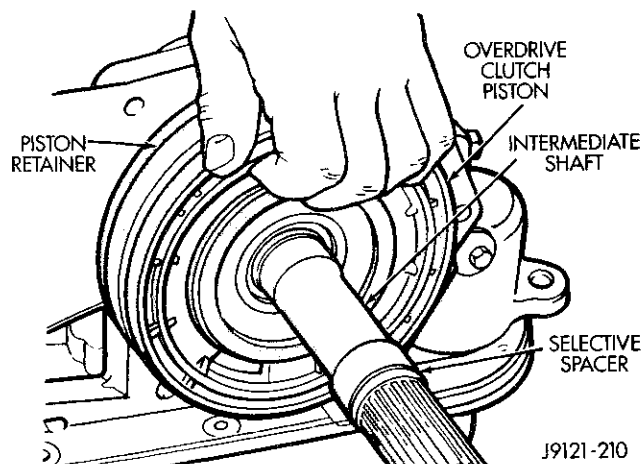


Fig. 123 Overdrive Piston Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(14) Remove pump oil seal with Special Tool C-3981-B (Fig. 124). Be sure to tighten tool threads completely into seal before using puller bolt to withdraw seal.

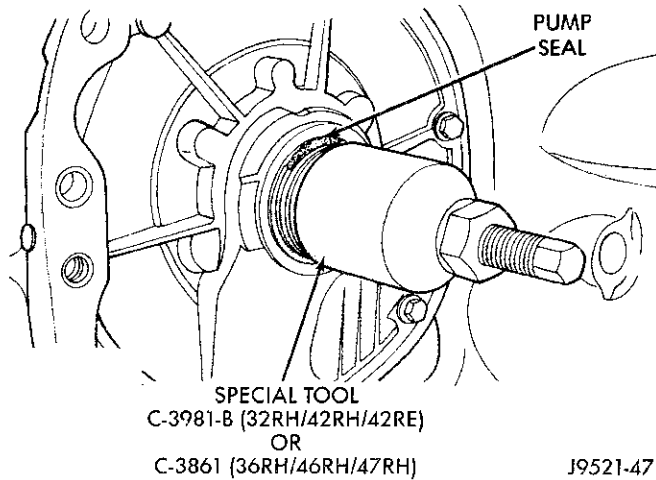


Fig. 124 Oil Pump Seal Removal

(15) Remove park/neutral position switch (Fig. 125).

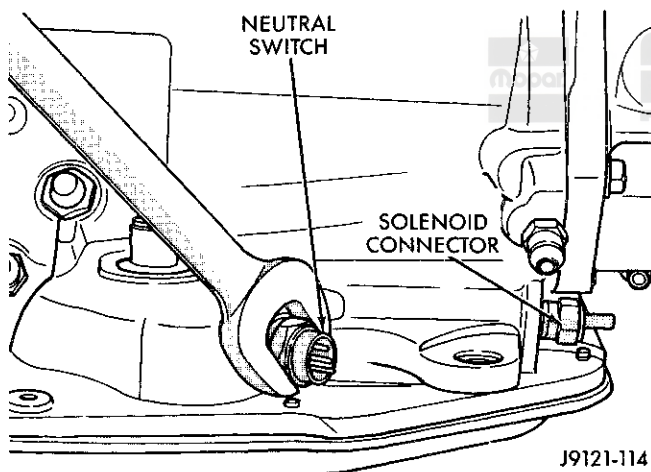


Fig. 125 Park/Neutral Position Switch Removal/Installation

(16) Remove hex head bolts attaching valve body to transmission case (Fig. 126). A total of 10 bolts are used. Note different bolt lengths for assembly reference.

(17) Remove valve body assembly. Push valve body harness connector out of case. Then work park rod and valve body out of case (Fig. 127). **Exercise care during removal as governor pressure solenoid and transducer can both be damaged by rough handling.**

(18) Remove accumulator piston and inner and outer springs (Fig. 128).

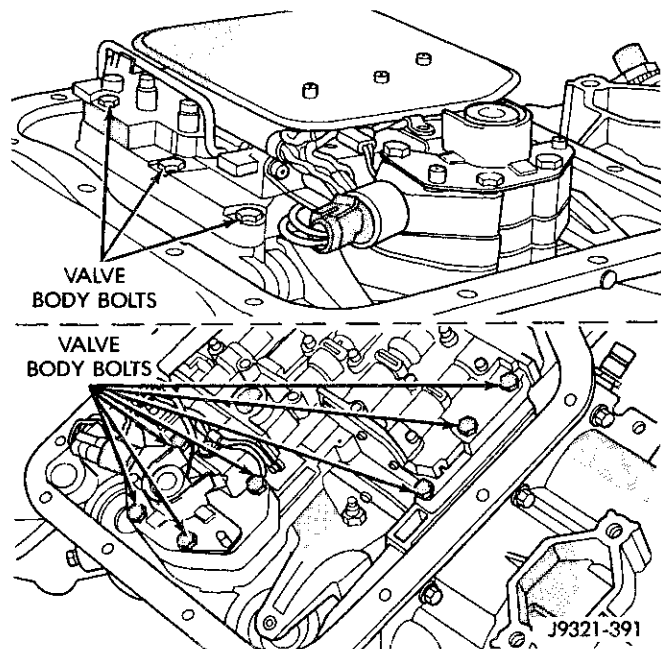


Fig. 126 Valve Body Bolt Locations

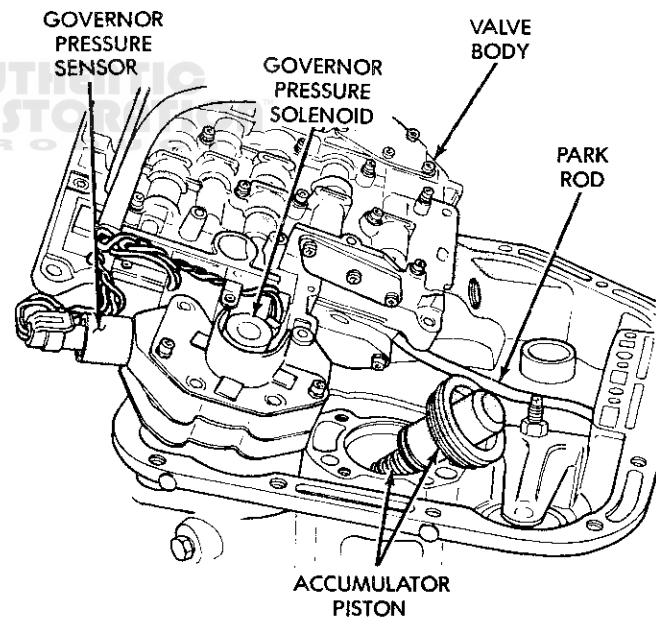
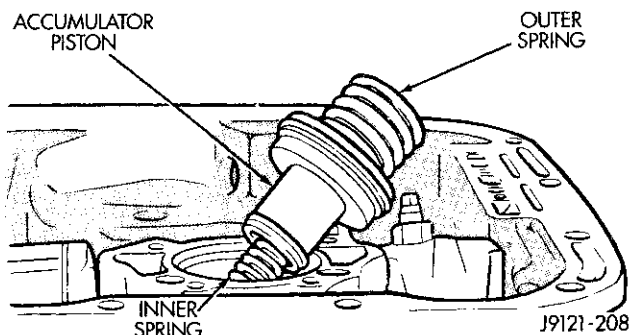


Fig. 127 Valve Body Removal

(19) Remove front band lever shaft access plug (Fig. 129). Plug is accessible through converter housing. Use 1/4 inch drive extension to remove plug as shown.

(20) Loosen front band adjusting screw locknut 4-5 turns. Then tighten band adjusting screw until band is tight around front clutch retainer. This prevents

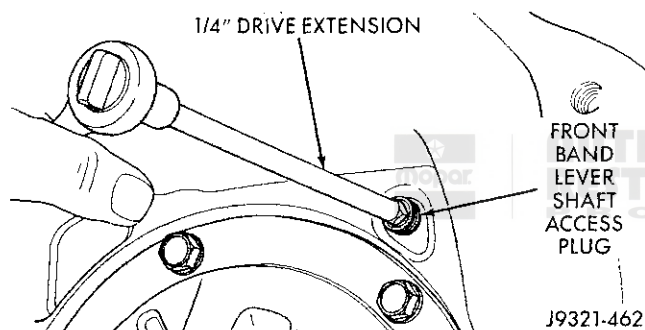
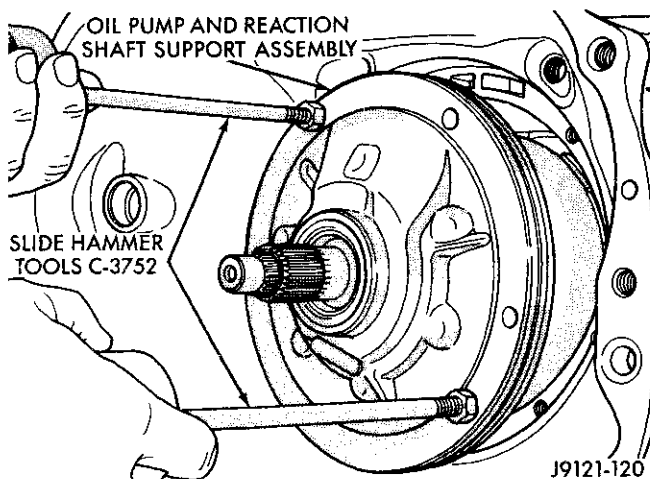
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 128 Accumulator Piston And Springs**

front/rear clutches from coming out with pump and possibly damaging clutch or pump components.

(21) Remove oil pump bolts.

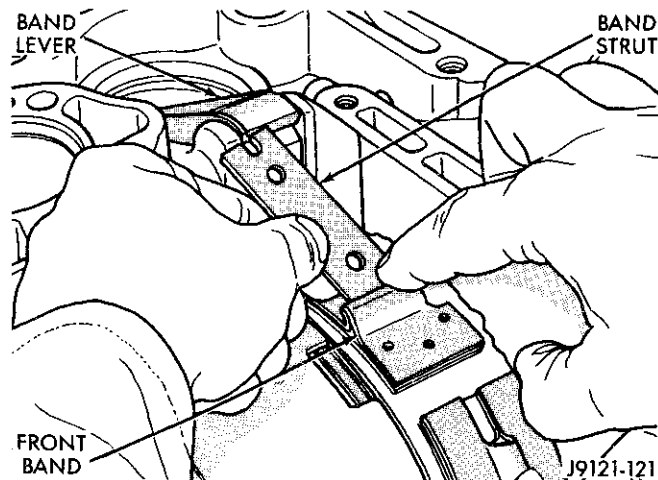
(22) Thread bolts of Slide Hammer Tools C-3752 into threaded holes in pump body flange (Fig. 130).

(23) Bump slide hammer weights outward to remove pump and reaction shaft support assembly from case (Fig. 130).

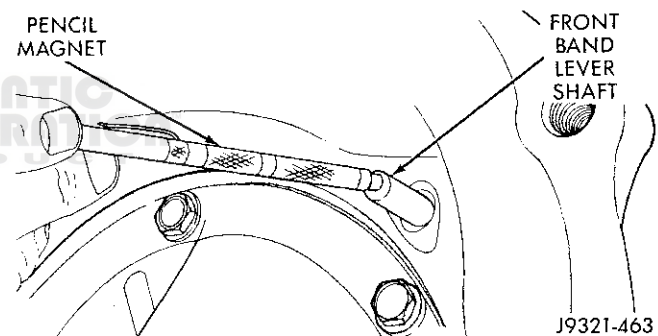
**Fig. 129 Removing/Installing Front Band Lever Shaft Access Plug****Fig. 130 Removing Oil Pump And Reaction Shaft Support Assembly**

(24) Loosen front band adjusting screw until band is completely loose.

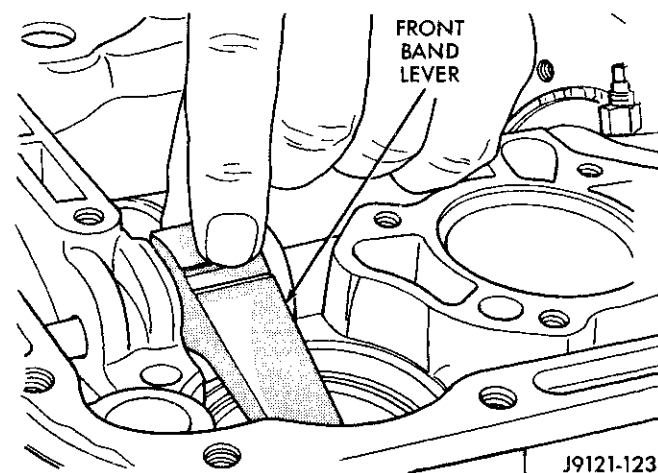
(25) Squeeze front band together and remove band strut (Fig. 131).

**Fig. 131 Removing/Installing Front Band Strut**

(26) Remove front band lever shaft with pencil magnet. Shaft is accessible from converter housing side of case (Fig. 132).

**Fig. 132 Removing Front Band Lever Shaft**

(27) Remove front band lever (Fig. 133).

**Fig. 133 Removing/Installing Front Band Lever**

DISASSEMBLY AND ASSEMBLY (Continued)

(28) Slide front band rearward and onto driving shell. Band will not be removed until after front/rear clutch removal.

(29) Remove front and rear clutch units as assembly. Grasp input shaft, hold clutch units together and remove them from case (Fig. 134).

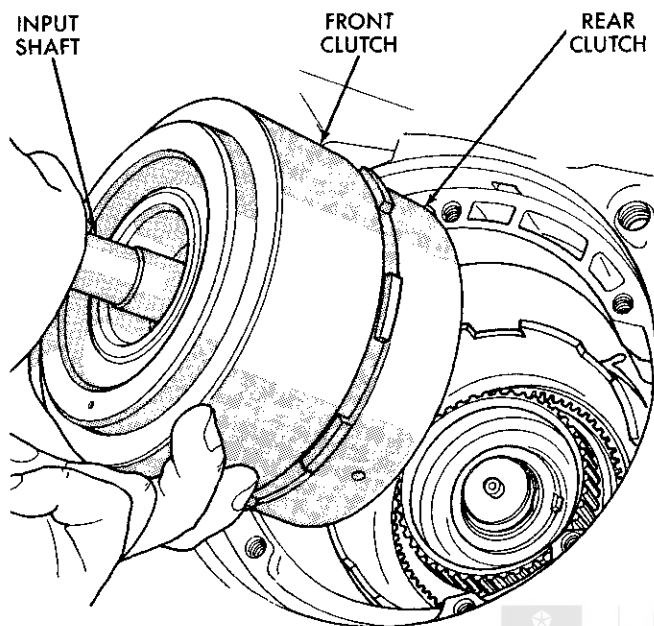


Fig. 134 Removing Front/Rear Clutch Assemblies

(30) Lift front clutch off rear clutch (Fig. 135). Set clutch units aside for overhaul.

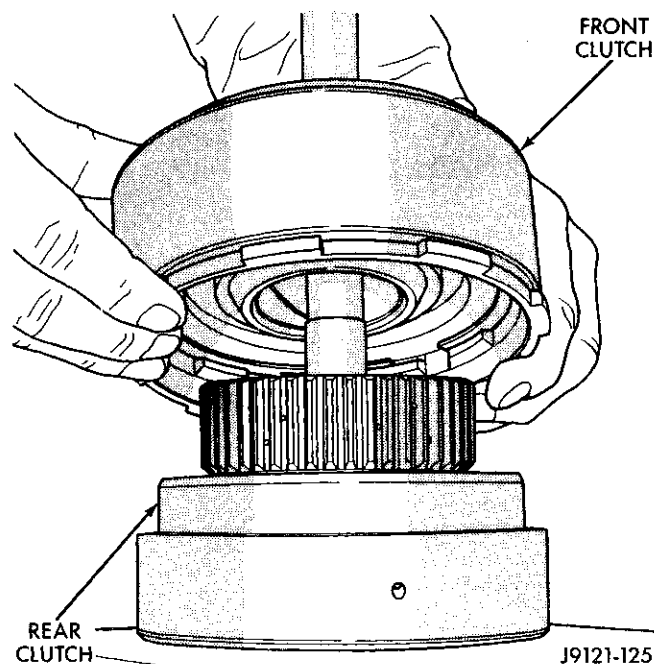


Fig. 135 Separating Front/Rear Clutch Assemblies

(31) Remove intermediate shaft thrust washer from front end of shaft or from rear clutch hub (Fig. 136).

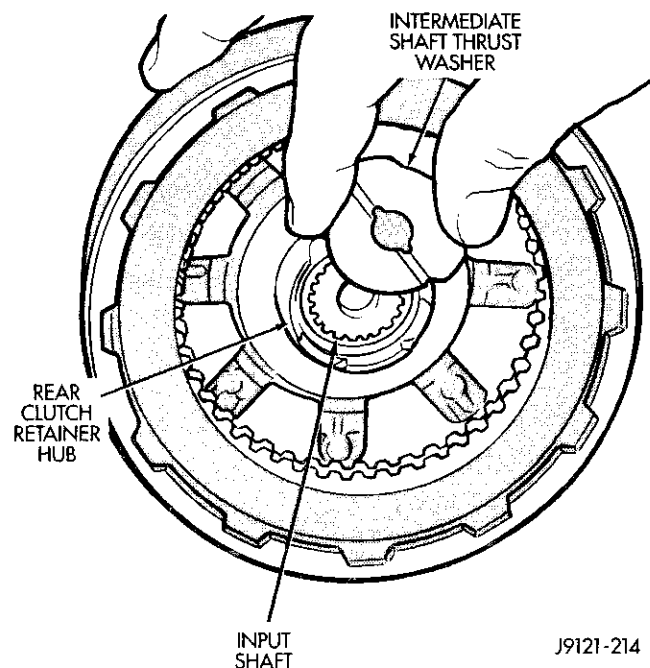


Fig. 136 Removing Intermediate Shaft Thrust Washer

(32) Remove output shaft thrust plate from intermediate shaft hub (Fig. 137).

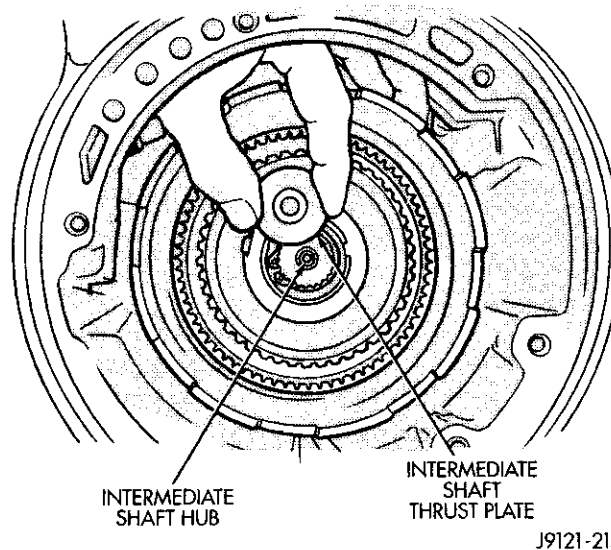


Fig. 137 Removing Intermediate Shaft Thrust Plate

DISASSEMBLY AND ASSEMBLY (Continued)

(33) Slide front band off driving shell (Fig. 138) and remove band from case.

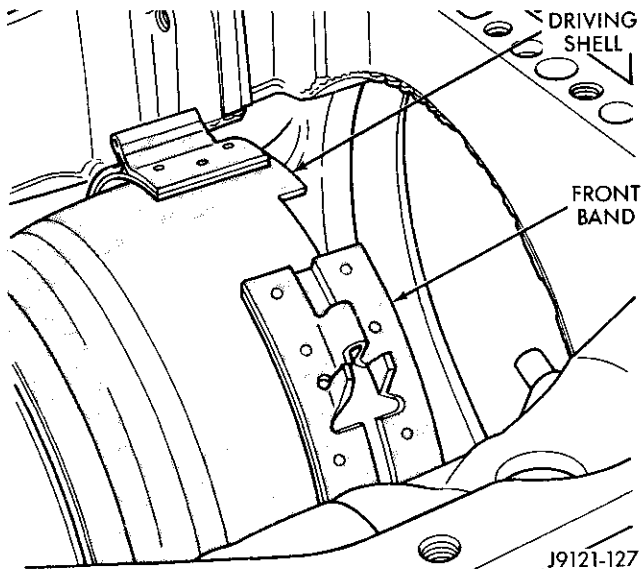


Fig. 138 Front Band Removal/Installation

(34) Remove planetary geartrain as assembly (Fig. 139). Support geartrain with both hands during removal. Do not allow machined surfaces on intermediate shaft or overdrive piston retainer to become nicked or scratched.

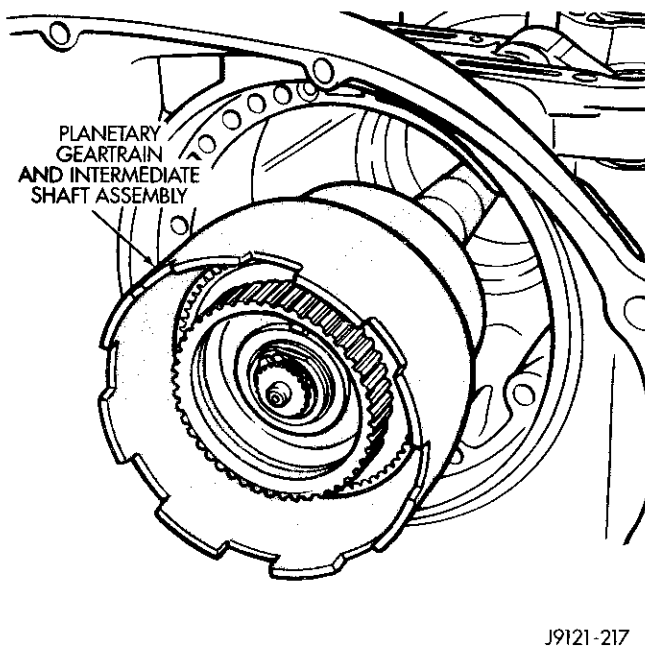


Fig. 139 Removing Planetary Geartrain And Intermediate Shaft Assembly

(35) Loosen rear band adjusting screw 4-5 turns.
(36) Remove low-reverse drum snap ring (Fig. 140).

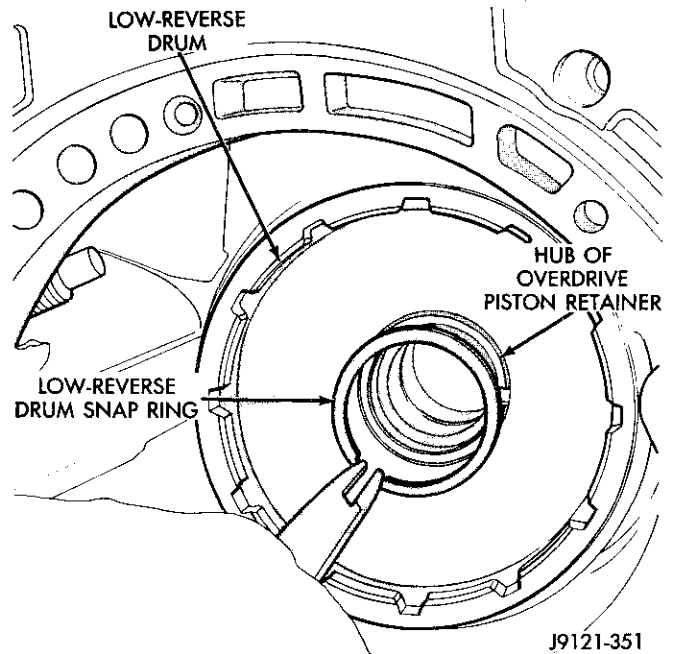


Fig. 140 Removing Low-Reverse Drum Snap Ring

(37) Remove bolts attaching overdrive piston retainer to rear of case (Fig. 141). Then remove piston retainer and gasket.

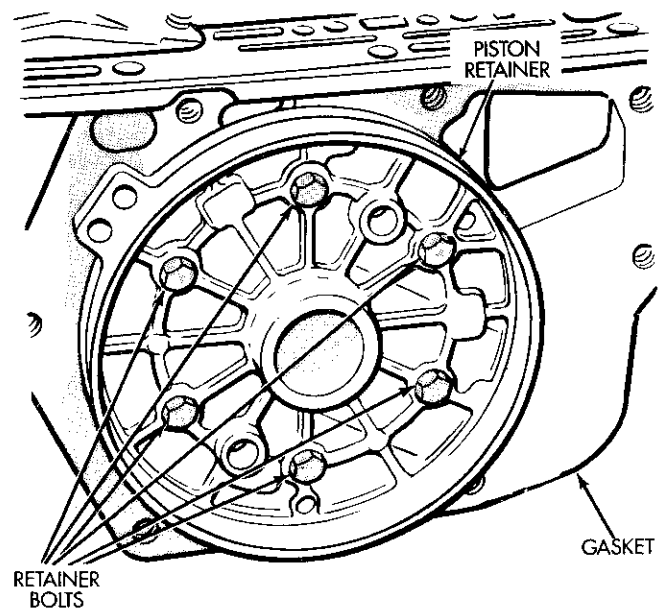


Fig. 141 Overdrive Piston Retainer Bolt Location

DISASSEMBLY AND ASSEMBLY (Continued)

(38) Remove rear band pivot and reaction pins (Fig. 142). Use parallel jaw snap ring pliers to remove pins. Insert and spread plier jaws in pin bore to grip pin. Then twist and pull pins to remove them.

(39) Remove rear band lever.

(40) Remove low-reverse drum and rear band as assembly. Turn drum clockwise and pull outward to remove it from overrunning clutch (Fig. 143).

(41) Remove bolts attaching overrunning clutch cam to case (Fig. 144).

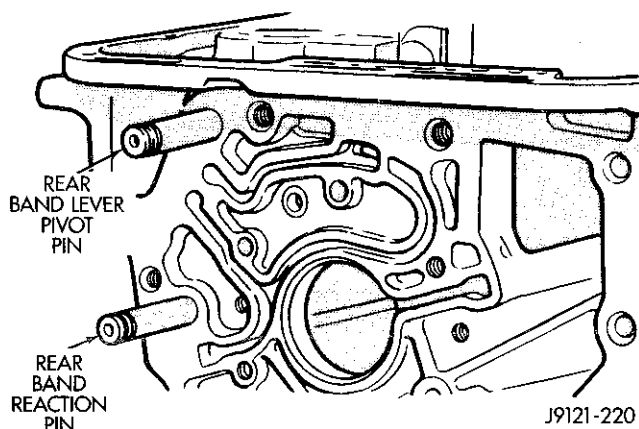


Fig. 142 Rear Band And Lever Pin Location

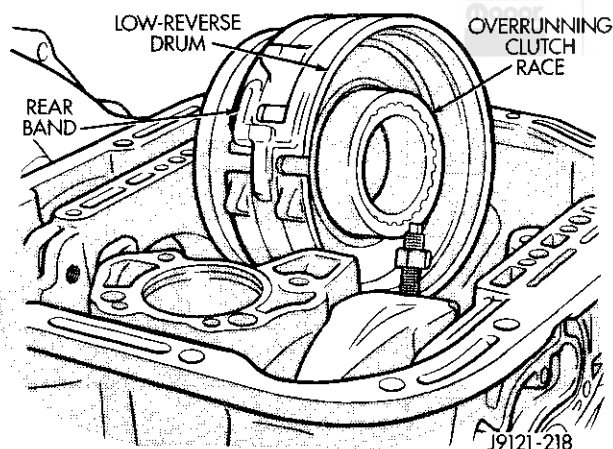


Fig. 143 Low-Reverse Drum And Rear Band Removal

(42) Remove overrunning clutch cam and roller clutch assembly as a unit (Fig. 145). Turn cam back and forth and tilt it inward to remove it from case.

(43) Compress front servo rod guide about 1/8 inch with Valve Spring Compressor C-3422-B (Fig. 146). A C-clamp and Special Tool C-4470 can also be used to compress rod guide.

(44) Remove front servo rod guide snap ring. Exercise caution when removing snap ring. Servo bore can be scratched or nicked if care is not exercised.

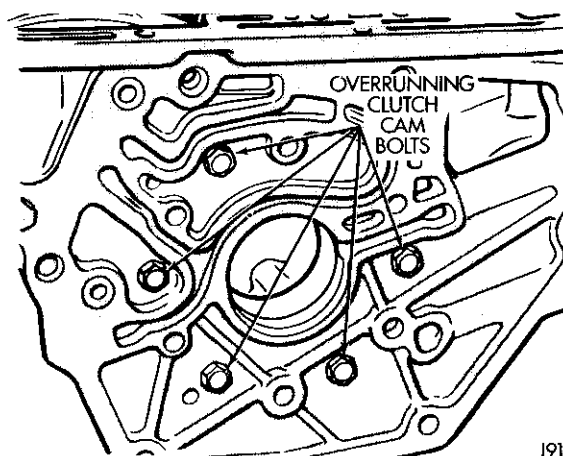


Fig. 144 Overrunning Clutch Cam Bolt Locations

(45) Remove compressor tools and remove front servo rod guide, spring and servo piston.

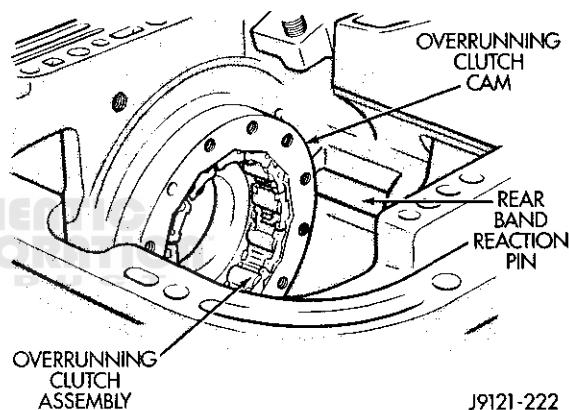


Fig. 145 Overrunning Clutch Assembly Removal

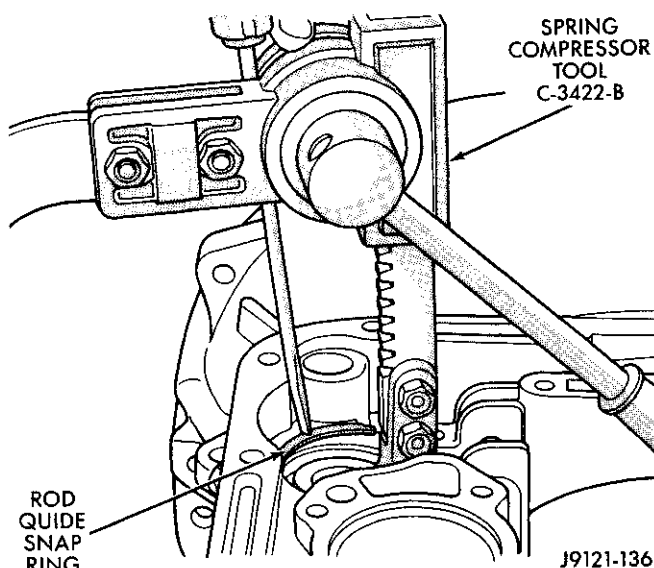


Fig. 146 Compressing Front Servo Rod Guide

DISASSEMBLY AND ASSEMBLY (Continued)

(46) Compress rear servo spring retainer about 1/16 inch with Valve Spring Compressor C-3422-B (Fig. 147). A C-clamp and Tool C-4470 or SP-5560 can also be used to compress spring retainer.

(47) Remove rear servo spring retainer snap ring. Then remove compressor tools and remove rear servo spring and piston.

(48) Inspect transmission and overdrive components. **If major components such as the overdrive unit, front clutch, or oil pump require service, refer to appropriate overhaul procedure.**

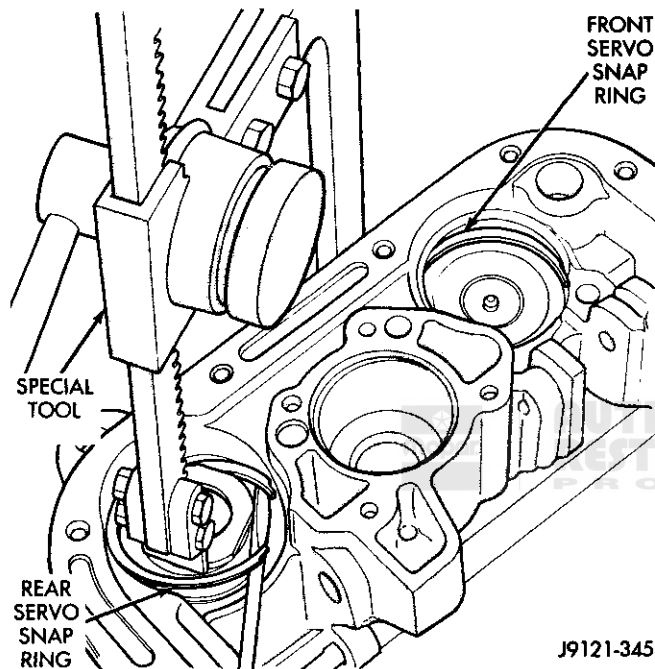


Fig. 147 Compressing Rear Servo Spring

TRANSMISSION ASSEMBLY PREPARATION

Do not allow dirt, grease, or foreign material to enter the case or transmission components during assembly. Keep the transmission case and components clean. Also make sure the tools and workbench area used for assembly operations are equally clean.

Shop towels used for wiping off tools and hands must be made from **lint free** material. Lint will stick to transmission parts and could interfere with valve operation, or even restrict fluid passages.

Lubricate the transmission components with Mopar transmission fluid during reassembly. Use Mopar Door Ease, or Ru-Glyde on seals and O-rings to ease installation.

Petroleum jelly can also be used to hold thrust washers, thrust plates and gaskets in position during assembly. However, **do not** use chassis grease, bearing grease, white grease, or similar lubricants on any transmission part. These types of lubricants can

eventually block or restrict fluid passages and interfere with valve operation. Use petroleum jelly only.

Do not force parts into place. The transmission components and subassemblies are easily installed by hand when properly aligned.

If a part seems extremely difficult to install, it is either misaligned or incorrectly assembled. Also verify that thrust washers, thrust plates and seal rings are correctly positioned before assembly. These parts can interfere with proper assembly if mis-positioned (or "left out" by accident).

The planetary geartrain, front/rear clutch assemblies and oil pump are all much easier to install when the transmission case is upright or as close to this position as possible. Either tilt the case upward with wood blocks, or cut a hole in the bench large enough for the output shaft. Then lower the shaft through the hole and support the transmission case directly on the bench.

TRANSMISSION ASSEMBLE

(1) Install rear servo piston, spring and retainer (Fig. 148). Install spring on top of servo piston and install retainer on top of spring.

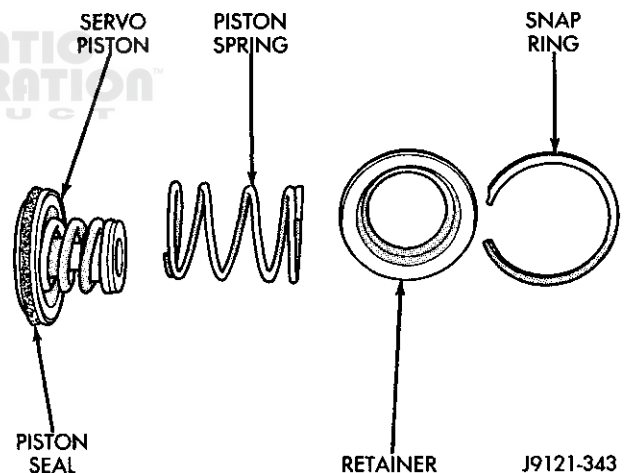


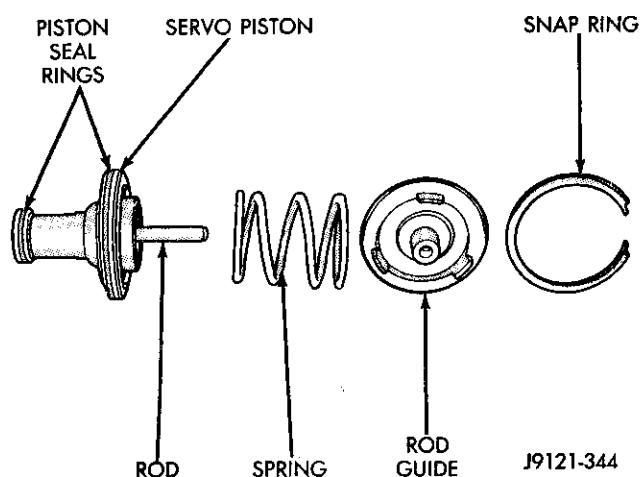
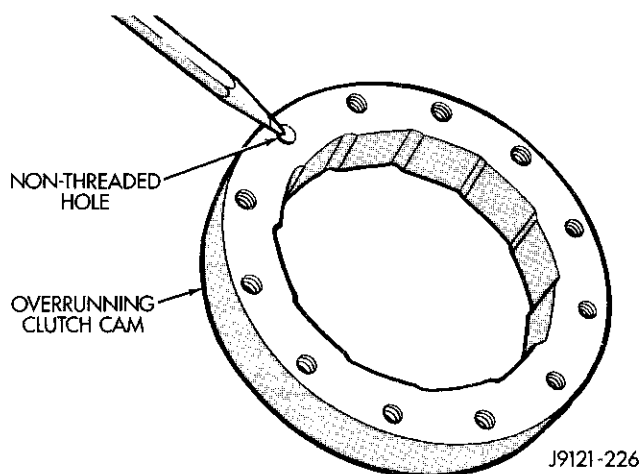
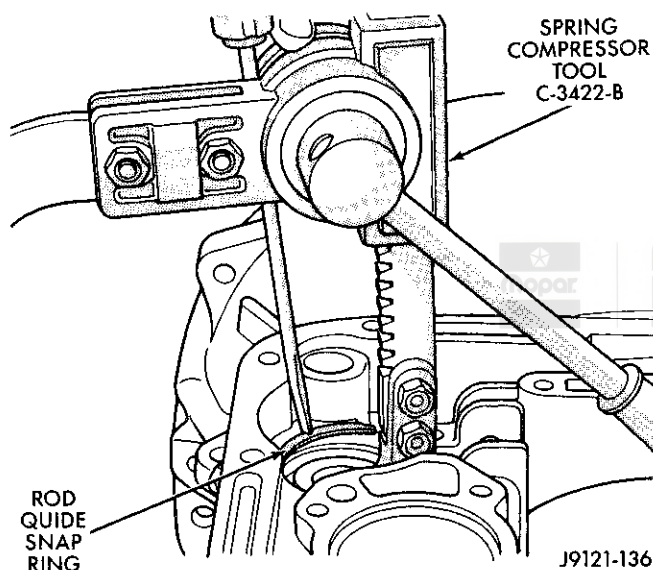
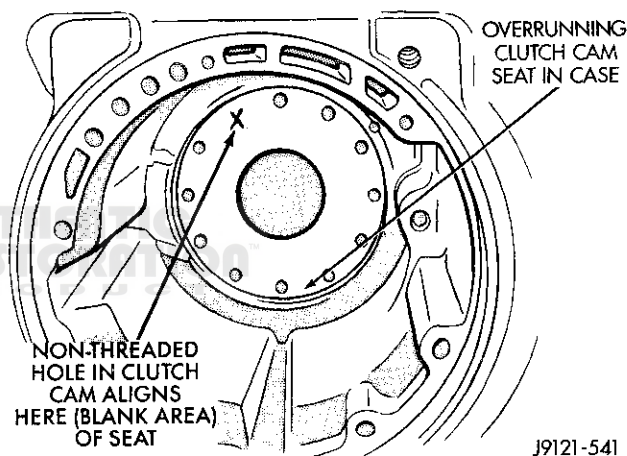
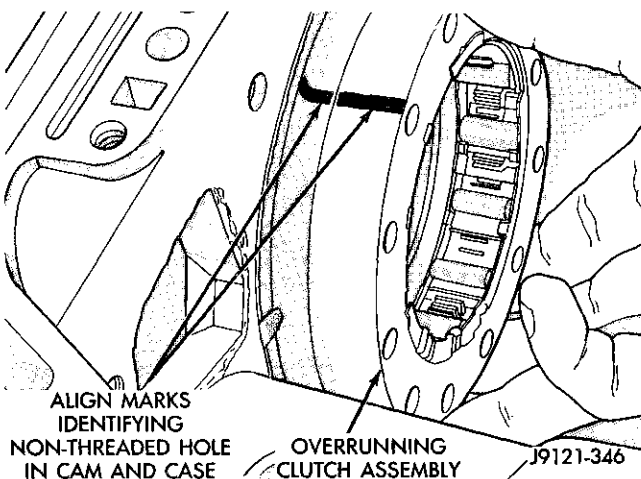
Fig. 148 Rear Servo Components

(2) Install front servo piston assembly, servo spring and rod guide (Fig. 149).

(3) Compress front/rear servo springs with Valve Spring Compressor C-3422-B and install each servo snap ring (Fig. 150).

(4) Examine bolt holes in overrunning clutch cam. Note that one hole is **not threaded** (Fig. 151). This hole must align with blank area in clutch cam bolt circle (Fig. 152). Mark hole location on clutch cam and blank area in case with grease pencil, paint stripe, or scribe mark for assembly reference.

(5) Mark location of non-threaded hole in clutch cam and blank area in bolt circle with grease pencil.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 149 Front Servo Components****Fig. 151 Location Of Non-Threaded Hole In Clutch Cam****Fig. 150 Compressing Front/Rear Servo Springs****Fig. 152 Location Of Blank Area In Clutch Cam Bolt Circle****Fig. 153 Overrunning Clutch Installation**

(6) Align and install overrunning clutch and cam in case (Fig. 153). **Be sure cam is correctly installed. Bolt holes in cam are slightly counter-sunk on one side. Be sure this side of cam faces rearward (toward piston retainer).**

(7) Verify that non-threaded hole in clutch cam is properly aligned. Check alignment by threading a bolt into each bolt hole. Adjust clutch cam position if necessary.

(8) Install and tighten overrunning clutch cam bolts to 17 N-m (13 ft. lbs.) torque. Note that clutch cam bolts are shorter than piston retainer bolts.

(9) Lubricate clutch cam rollers with transmission fluid.

DISASSEMBLY AND ASSEMBLY (Continued)

(10) Install rear band reaction pin (Fig. 154). Be sure pin is fully seated in case.

(11) Install rear band in case (Fig. 155). Be sure twin lugs on band are seated against reaction pin.

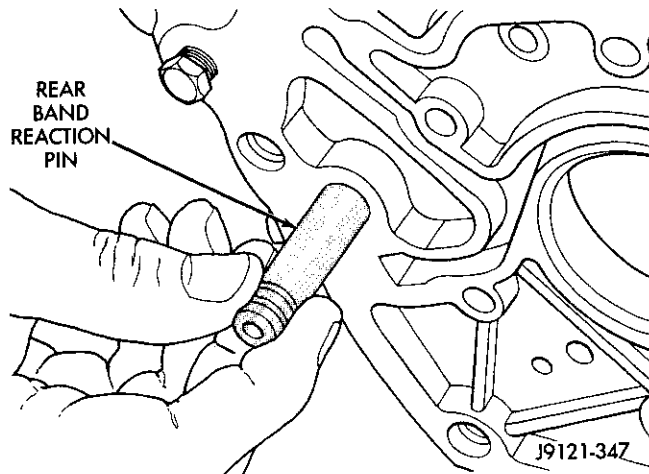


Fig. 154 Installing Rear Band Reaction Pin

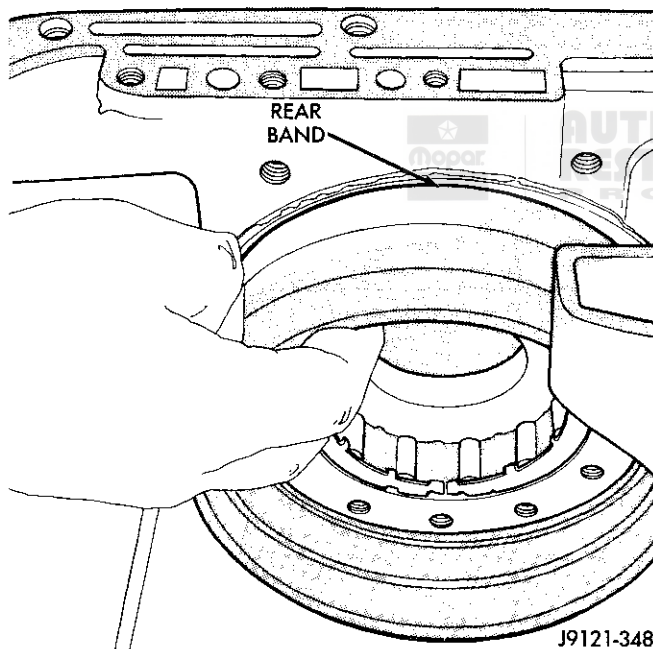


Fig. 155 Rear Band Installation

(12) Install low-reverse drum and check overrunning clutch operation as follows:

- (a) Lubricate overrunning clutch race (on drum hub) with transmission fluid.
- (b) Guide drum through rear band.
- (c) Tilt drum slightly and start race (on drum hub) into overrunning clutch rollers.

(d) Press drum rearward and turn it in clockwise direction until drum seats in overrunning clutch (Fig. 156).

(e) Turn drum back and forth. **Drum should rotate freely in clockwise direction and lock in counterclockwise direction (as viewed from front of case).**

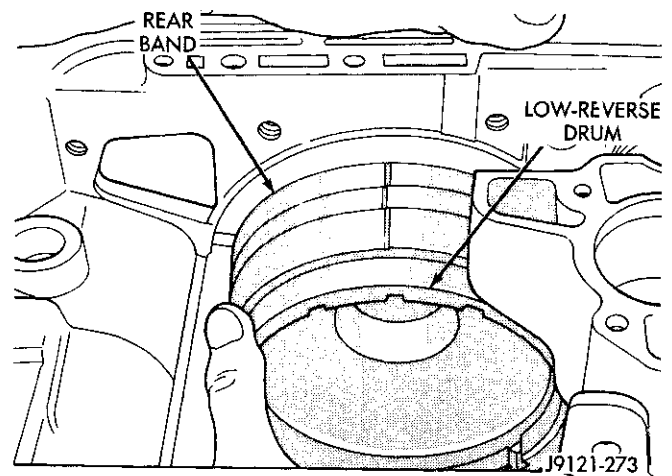


Fig. 156 Installing Low-Reverse Drum

(13) Install new gasket at rear of transmission case. Use petroleum jelly to hold gasket in place. Be sure to align governor feed holes in gasket with feed passages in case (Fig. 157). Also install gasket before overdrive piston retainer. Center hole in gasket is smaller than retainer and cannot be installed over retainer.

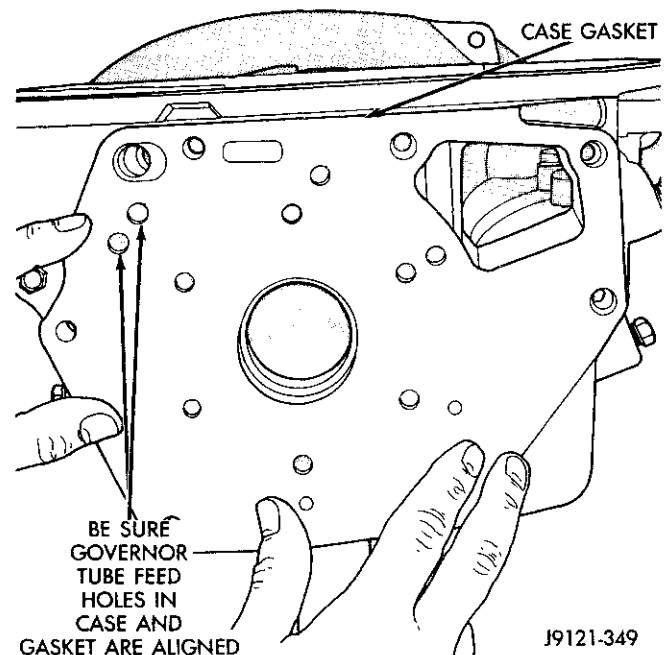


Fig. 157 Installing/Aligning Case Gasket

(14) Position overdrive piston retainer on transmission case and align bolt holes in retainer, gasket

DISASSEMBLY AND ASSEMBLY (Continued)

and case (Fig. 158). Then install and tighten retainer bolts to 17 N·m (13 ft. lbs.) torque.

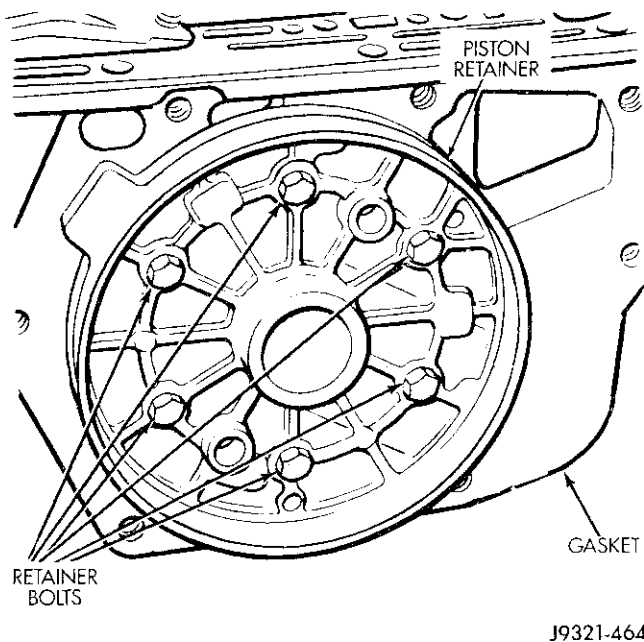


Fig. 158 Aligning Overdrive Piston Retainer

(15) Install snap ring that secures low-reverse drum to hub of piston retainer (Fig. 159).

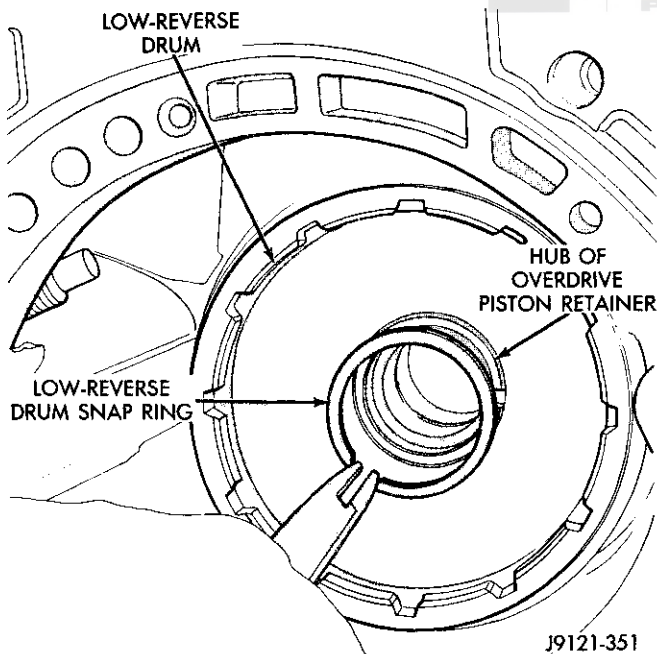


Fig. 159 Installing Low-Reverse Drum Retaining Snap Ring

(16) Install rear band lever and pivot pin (Fig. 160). Align lever with pin bores in case and push pivot pin into place.

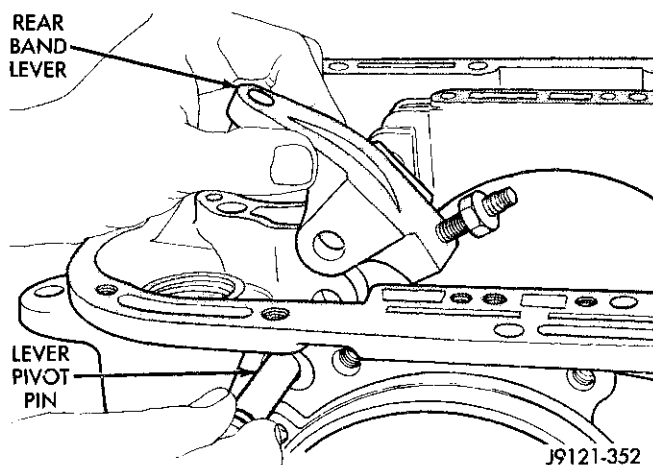


Fig. 160 Rear Band Lever And Pivot Pin Installation

(17) Install planetary geartrain assembly (Fig. 161).

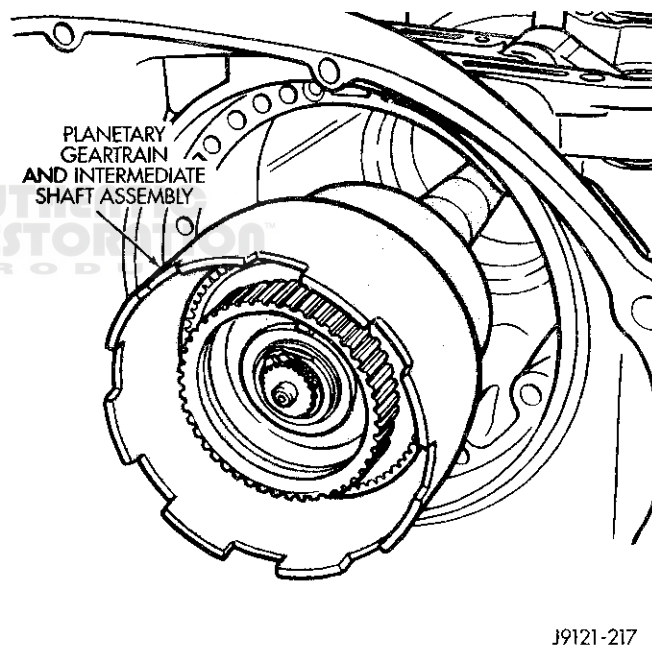


Fig. 161 Installing Planetary Geartrain

(18) Install thrust plate on intermediate shaft hub (Fig. 162). Use petroleum jelly to hold thrust plate in place.

(19) Check seal ring on rear clutch retainer hub and seal rings on input shaft (Fig. 163). Verify that diagonal-cut ends of teflon seal rings are properly joined and ends of metal ring are correctly hooked together. Also verify that shaft seal rings are installed in sequence shown.

(20) Check rear clutch thrust washer (Fig. 164). Use additional petroleum jelly to hold washer in place if necessary.

(21) Align clutch discs in front clutch and install front clutch on rear clutch (Fig. 165). Rotate front

DISASSEMBLY AND ASSEMBLY (Continued)

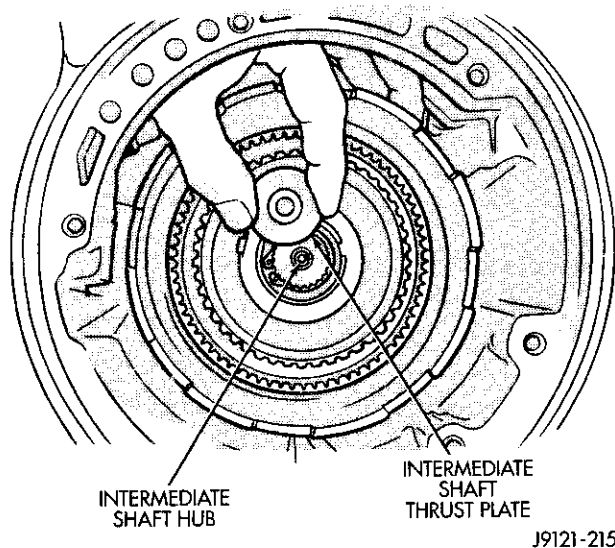


Fig. 162 Installing Intermediate Shaft Thrust Plate

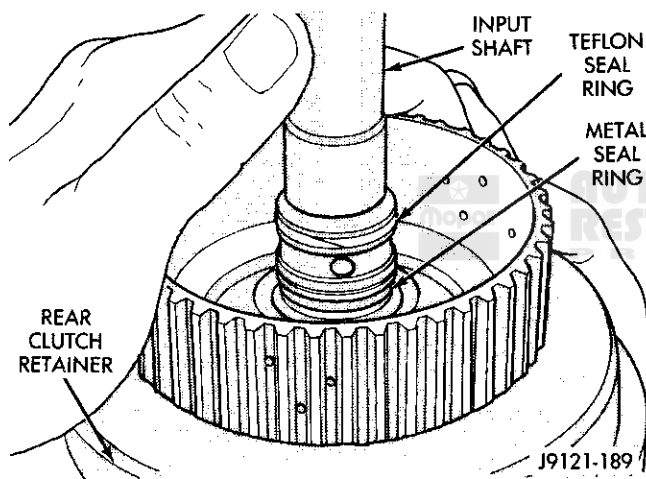


Fig. 163 Input Shaft Seal Ring Location

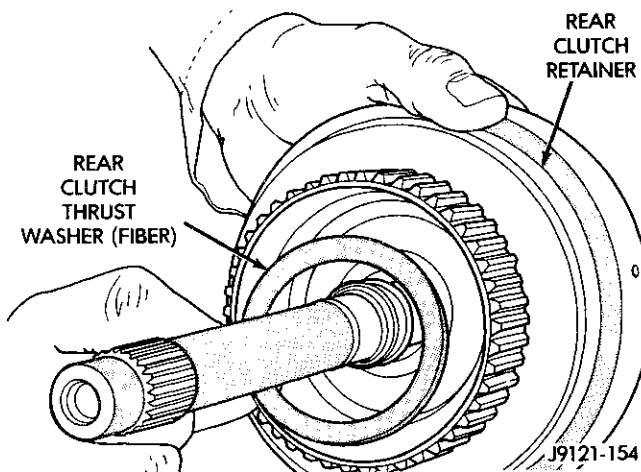


Fig. 164 Installing Rear Clutch Thrust Washer

clutch retainer back and forth until completely seated on rear clutch.

(22) Coat intermediate shaft thrust washer with petroleum jelly. Then install washer in rear clutch hub (Fig. 166). Use enough petroleum jelly to hold washer in place. **Be sure grooved side of washer faces rearward (toward output shaft) as shown.** Also note that washer only fits one way in clutch hub. Note thickness of this washer. It is a select fit part and is used to control transmission end play.

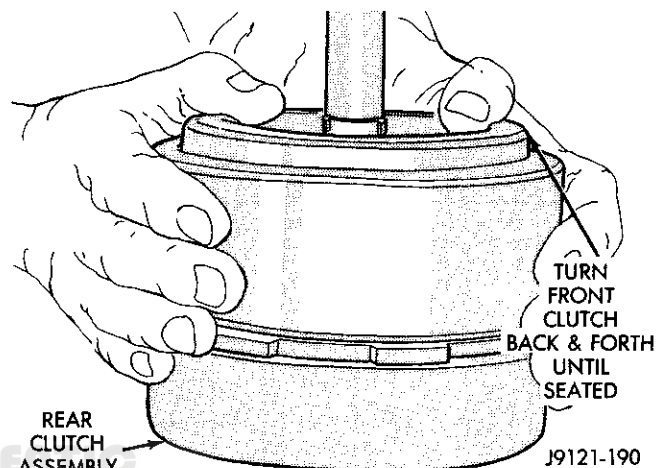


Fig. 165 Assembling Front And Rear Clutch Units

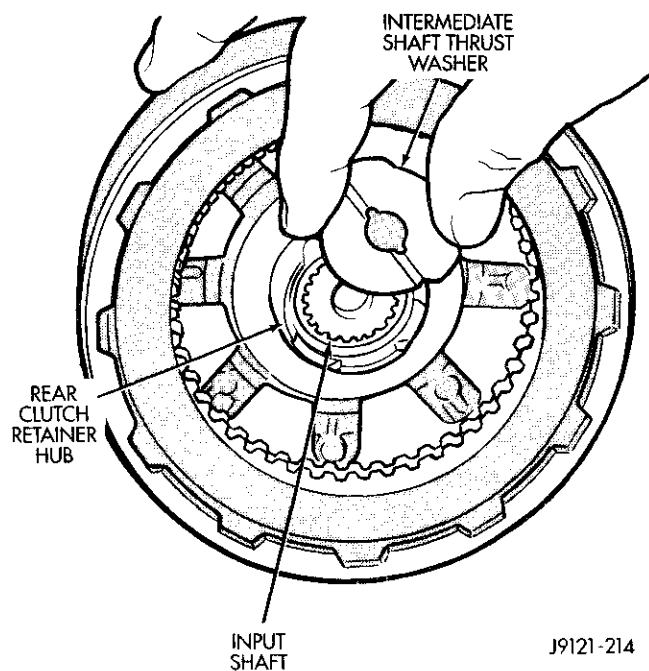


Fig. 166 Installing Intermediate Shaft Thrust Washer

(23) Align drive teeth on rear clutch discs with small screwdriver (Fig. 167). This makes installation on front planetary easier.

DISASSEMBLY AND ASSEMBLY (Continued)

(24) Raise front end of transmission upward as far as possible and support case with wood blocks. Front/rear clutch and oil pump assemblies are easier to install if transmission is as close to upright position as possible.

(25) Install front and rear clutch units as assembly (Fig. 168). Align rear clutch with front annulus gear and install assembly in driving shell. **Be sure output shaft thrust washer and thrust plate are not displaced during installation.**

(26) Carefully work assembled clutches back and forth to engage and seat rear clutch discs on front annulus gear. Also be sure front clutch drive lugs are fully engaged in slots of driving shell after installation.

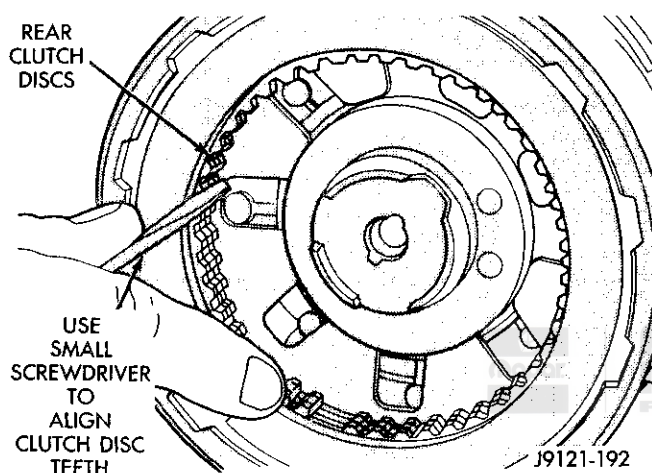


Fig. 167 Aligning Rear Clutch Disc Lugs

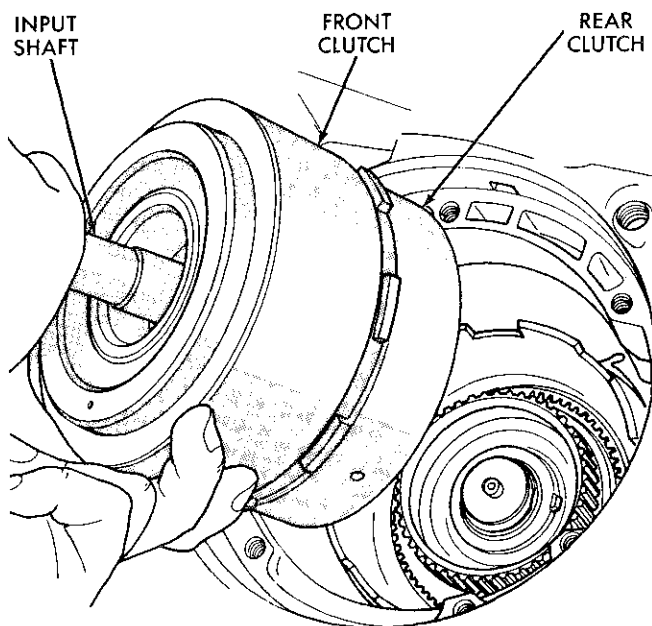


Fig. 168 Installing Front/Rear Clutch Assemblies

(27) Slide front band over front clutch retainer (Fig. 169).

(28) Insert front band lever pivot shaft part way into case (Fig. 169).

(29) Install front band lever, strut and adjusting screw (Fig. 170).

(30) Push front band lever shaft completely into place. Then tighten band adjusting screw until band just grips clutch retainer. Verify that front/rear clutches are still seated before continuing.

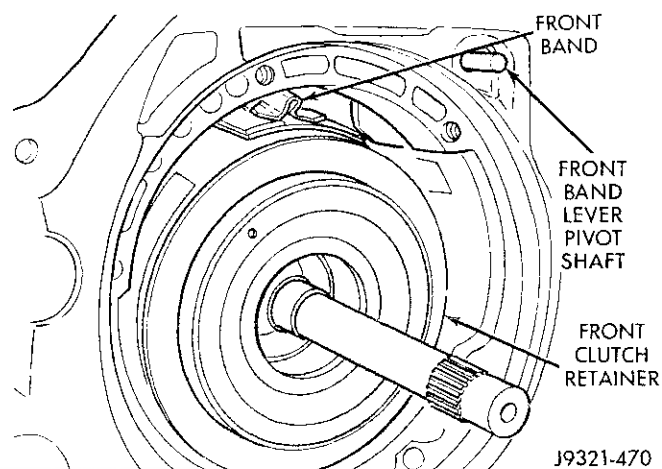


Fig. 169 Installing Front Band And Reaction Pin

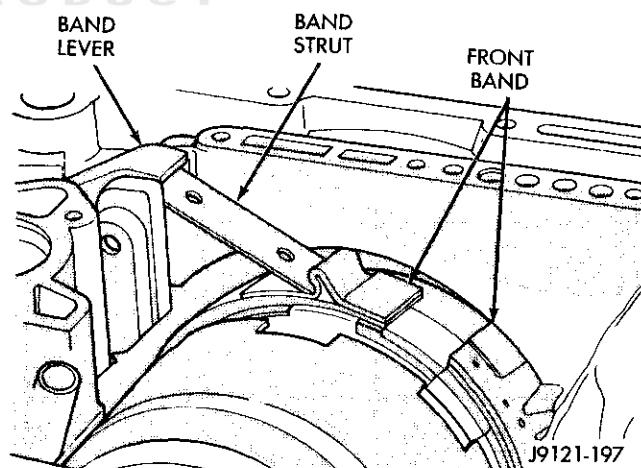


Fig. 170 Front Band Linkage Installation

(31) Coat band reaction pin access plug with sealer and install plug in converter housing.

(32) Check seal rings on reaction shaft support hub. Verify that seal rings are hooked together and that front clutch thrust washer is properly positioned (Fig. 171). Use extra petroleum jelly to hold thrust washer in place if necessary.

CAUTION: The thrust washer bore ID is chamfered on one side. Make sure this side of the washer is facing toward the front of the transmission.

DISASSEMBLY AND ASSEMBLY (Continued)

(33) Thread two Pilot Stud Tools C-3288-B into bolt holes in oil pump flange (Fig. 172).

(34) Align and install oil pump gasket (Fig. 172).

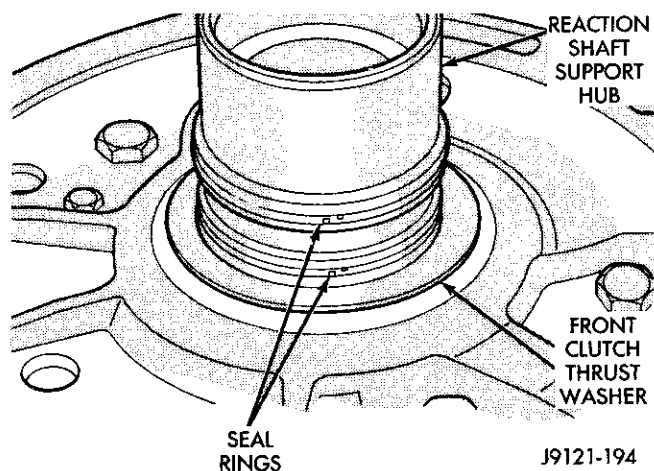


Fig. 171 Reaction Shaft Support Seal Rings And Front Clutch Thrust Washer

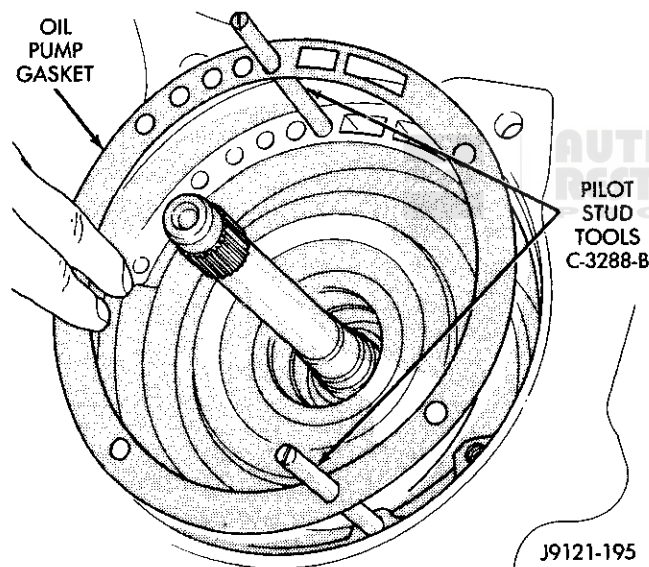


Fig. 172 Installing Pilot Studs And Oil Pump Gasket

(35) Lubricate oil pump body seal with Ru-Glyde, or petroleum jelly. Lubricate pump shaft seal lip with petroleum jelly.

(36) Install oil pump (Fig. 173). Align and position pump on pilot studs. Slide pump down studs and work it into front clutch hub and case by hand. Then install 2 or 3 pump bolts to hold pump in place.

(37) Remove pilot stud tools and install remaining oil pump bolts. Tighten bolts alternately in diagonal pattern to 20 N·m (15 ft. lbs.).

(38) Install new seals on overdrive piston. Then lubricate seals with Mopar Door Ease, or Ru-Glyde.

(39) Install overdrive piston in retainer. **Align locating lugs on piston in locating bores in**

retainer (Fig. 174). Use thin plastic strip or feeler gauge to help guide piston outer seal into retainer.

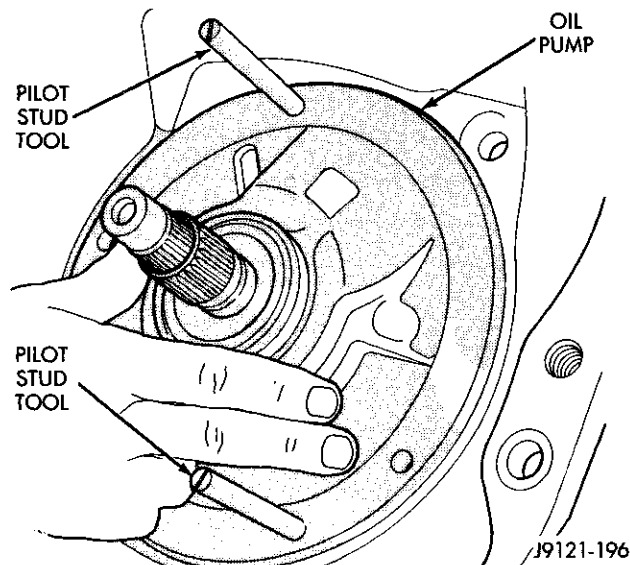


Fig. 173 Installing Oil Pump Assembly In Case

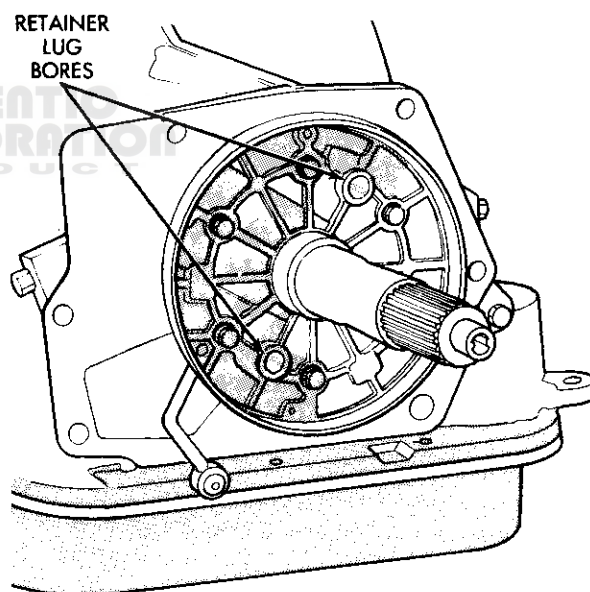


Fig. 174 Overdrive Piston Alignment

(40) Install spacer on intermediate shaft, if not previously installed.

DISASSEMBLY AND ASSEMBLY (Continued)

(41) Install overdrive piston thrust plate (Fig. 175). Use liberal quantity of petroleum jelly to hold thrust plate in position on piston.

(42) Install overdrive piston thrust bearing in direct clutch hub (Fig. 176). Use liberal quantity of petroleum jelly to hold thrust bearing in place. **Note that one side of bearing has dark coated surface. This surface faces overdrive piston. Also be sure raised shoulder on inside diameter of bearing faces forward as well.**

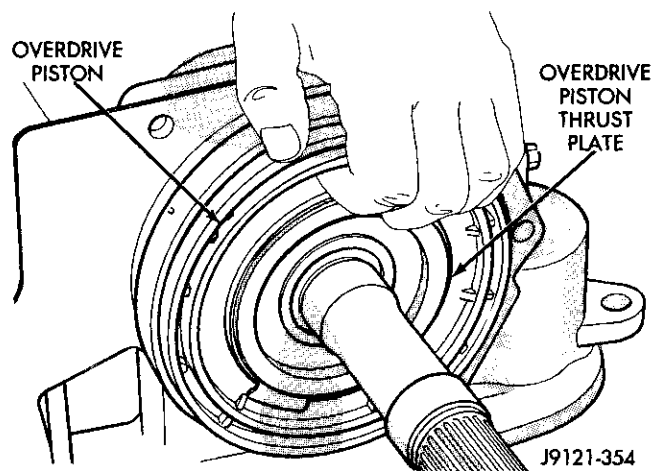


Fig. 175 Installing Overdrive Piston Thrust Plate

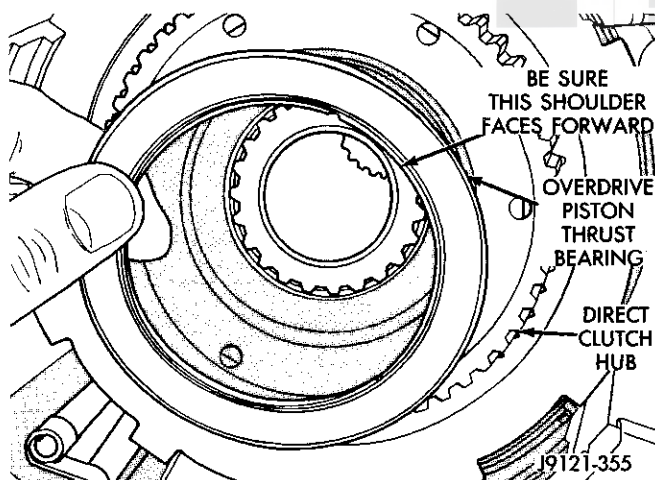


Fig. 176 Installing Overdrive Piston Thrust Bearing

(43) Apply small amount of petroleum jelly to pilot hub of intermediate shaft.

(44) Verify alignment of splines in overdrive unit planetary gear and overrunning clutch. Be sure Alignment Tool 6227-2 is still fully seated (Fig. 177). **If planetary gear and overrunning clutch splines become misaligned, overdrive unit cannot be fully installed on intermediate shaft. Overdrive unit may have to be disassembled in order to realign splines.**

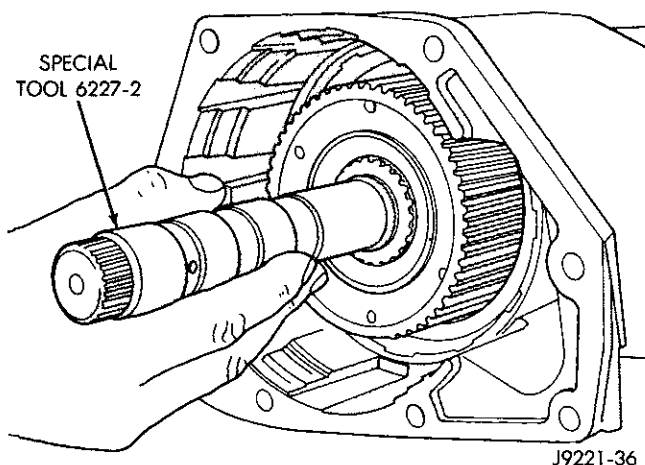


Fig. 177 Checking Alignment Of Overdrive Planetary Gear And Overrunning Clutch Splines

(45) Carefully withdraw alignment tool from overdrive unit.

(46) Lubricate intermediate shaft splines and bushing surfaces with transmission fluid or petroleum jelly.

(47) Install overdrive unit. Note that intermediate shaft is snug fit in overdrive planetary gear and overrunning clutch. If overdrive unit will not seat, gear and clutch splines are probably misaligned.

(48) Apply 1-2 drops of Mopar thread adhesive (or Loctite 242) to overdrive unit attaching bolts. Then install and tighten bolts to 34 N-m (25 ft. lbs.) torque. **Be sure wire harness clips are placed on appropriate overdrive bolts beforehand.**

(49) Measure and if necessary, correct input shaft end play as follows (Fig. 178):

(a) Be sure overdrive unit is installed on transmission. **End play cannot be properly checked with overdrive unit off transmission.**

(b) Attach dial indicator to converter housing.

(c) Position indicator plunger against input shaft and zero indicator.

(d) Move input shaft in and out and record reading. End play should be 0.56 - 2.31 mm (0.022 - 0.091 in.). Proceed to next step if end play is not within specified limits.

(e) Intermediate shaft thrust washer (in hub of rear clutch retainer) controls end play. Washer is a select fit part and can be changed to adjust end play. If end play turns out to be incorrect, remove oil pump, and clutches. Then install thinner/thicker thrust washer as necessary.

(50) Install accumulator piston and inner and outer springs (Fig. 179).

(51) Verify that park/neutral position switch has **not** been installed in case. Valve body can not be installed if switch is in position.

DISASSEMBLY AND ASSEMBLY (Continued)

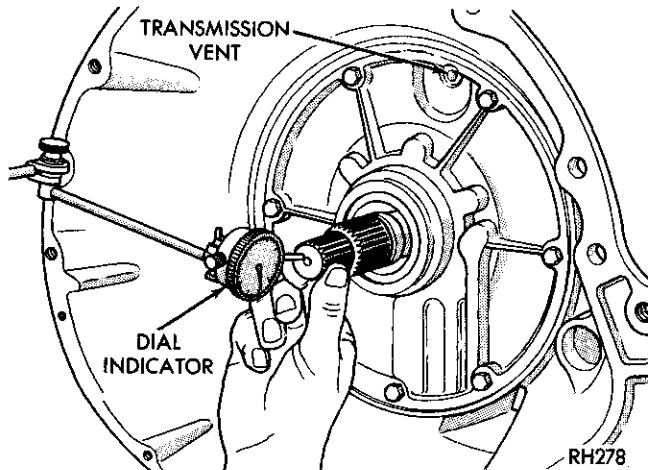


Fig. 178 Measuring Input Shaft End Play

(52) Verify that valve body solenoid harness is secured in 3-4 accumulator housing cover plate.

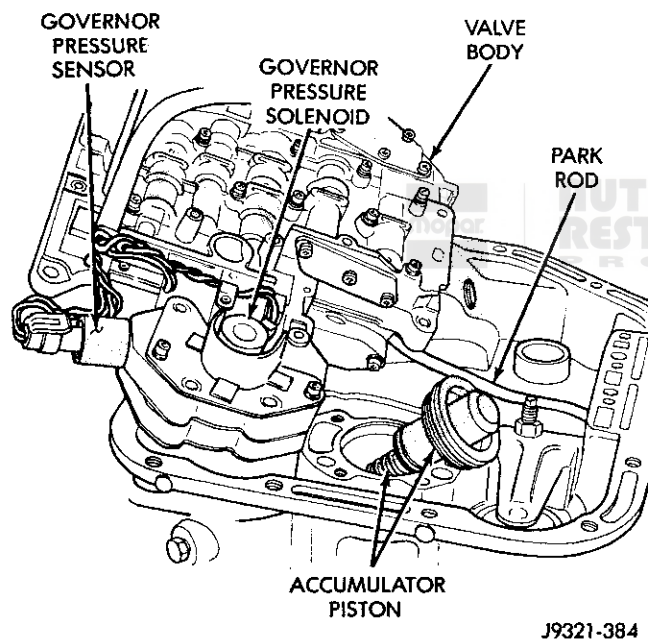


Fig. 179 Accumulator Piston And Springs

(53) Install valve body as follows:

(a) Align and carefully insert park rod into pawl. Rod will make click noise as it enters pawl. Move rod slightly to check engagement.

(b) Align and seat valve body on case. Be sure manual lever shaft and overdrive connector are fully seated in case. Also be sure valve body wiring is not pinched or kinked.

(c) Install and start all valve body attaching bolts by hand. Then tighten bolts evenly, in a diagonal pattern to 12 N·m (105 in. lbs.) torque. **Do not overtighten valve body bolts. This could**

result in distortion and cross leakage after installation..

CAUTION: It is possible for the park rod to displace into a cavity just above the pawl sprag during installation. Make sure the rod is actually engaged in the pawl and has not displaced into the cavity. If the rod enters the cavity during installation, it will become bent when the overdrive bolts are tightened. If this occurs, the rod will have to be removed and replaced.

(54) Install new filter on valve body. Tighten filter screws to 4 N·m (35 in. lbs.).

(55) Adjust front and rear bands as follows:

(a) Loosen band adjusting screw locknuts.

(b) Tighten each band adjusting screw to 5 N·m (72 in. lbs.) with torque wrench.

(c) **Back off front band adjusting screw 3-5/8 turns.**

(d) Back off rear band screw 4 turns.

(e) Tighten each adjusting screw locknut. Hold adjusting screws with wrench to prevent turning when tightening locknut.

(56) Install seal on park/neutral position switch (Fig. 180). Then install and tighten switch to 34 N·m (25 ft. lbs.).

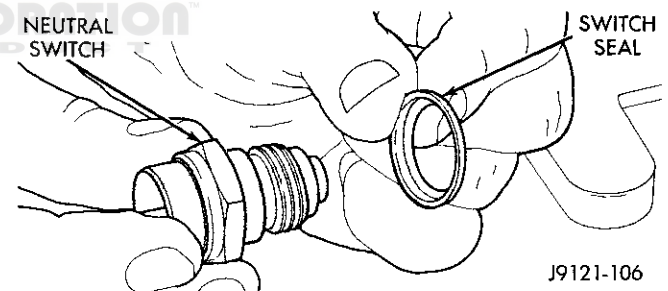


Fig. 180 Park/Neutral Position Switch Seal Position

(57) Install magnet in oil pan. Magnet goes on small protrusion at corner of pan.

(58) Position new oil pan gasket on case and install oil pan. Tighten pan bolts to 17 N·m (13 ft. lbs.).

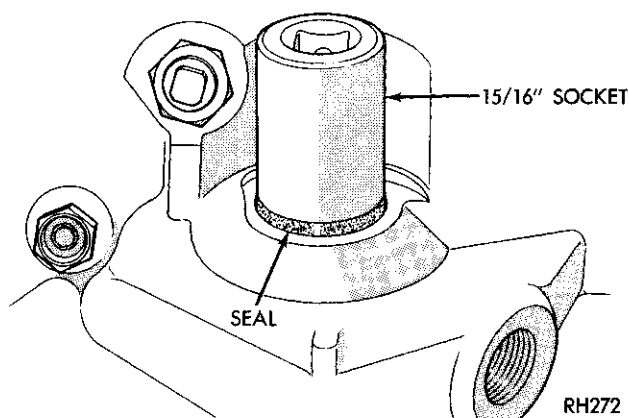
(59) Install new valve body manual shaft seal in case (Fig. 181). Lubricate seal lip and manual shaft with petroleum jelly. Start seal over shaft and into case. Seat seal with 15/16 inch, deep well socket.

(60) Install throttle valve and shift selector levers on valve body manual lever shaft.

(61) Cap or cover transmission openings (cooler line fittings, filler tube bore, etc.) to prevent dirt entry.

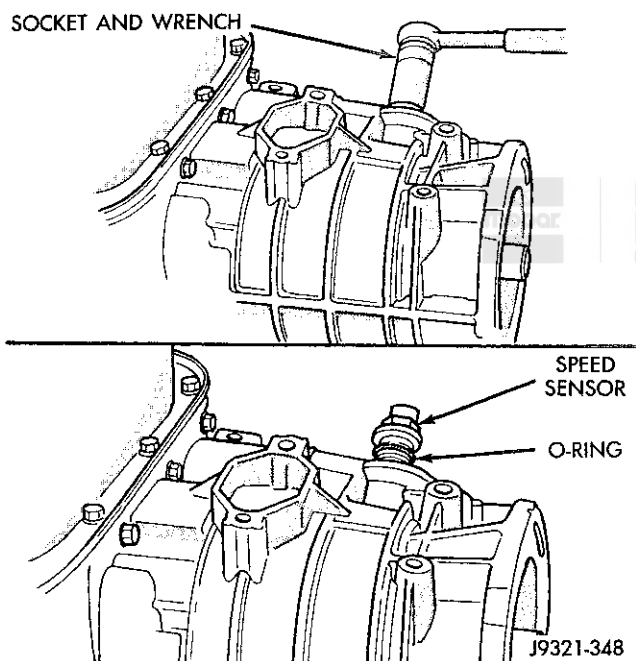
(62) Install torque converter. Use C-clamp or metal strap to hold converter in place for installation.

(63) Install transmission speed sensor in overdrive case (Fig. 182).

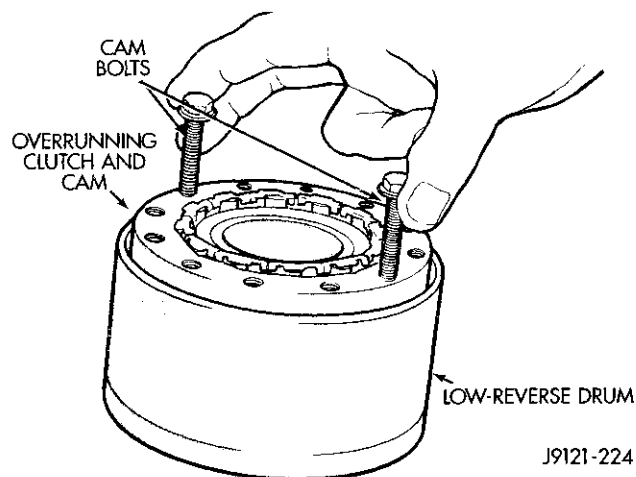
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 181 Installing Manual Lever Shaft Seal**

(64) Mount transmission on jack for installation in vehicle.

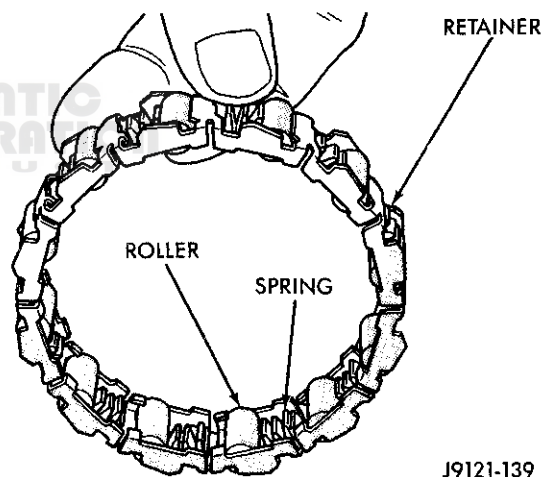
(65) Apply dielectric grease to terminal pins of solenoid case connector and neutral switch.

**Fig. 182 Transmission Speed Sensor****OVERRUNNING CLUTCH/LOW-REVERSE DRUM****DISASSEMBLE**

If the clutch assembly came out with the low-reverse drum, thread two clutch cam bolts into the cam. Then lift the cam out of the drum with the bolts (Fig. 183). Rotate the cam back and forth to ease removal if necessary. Remove the clutch roller and spring assembly from the race afterward.

**Fig. 183 Removing Overrunning Clutch From Low-Reverse Drum****OVERRUNNING CLUTCH/LOW-REVERSE DRUM, ASSEMBLE**

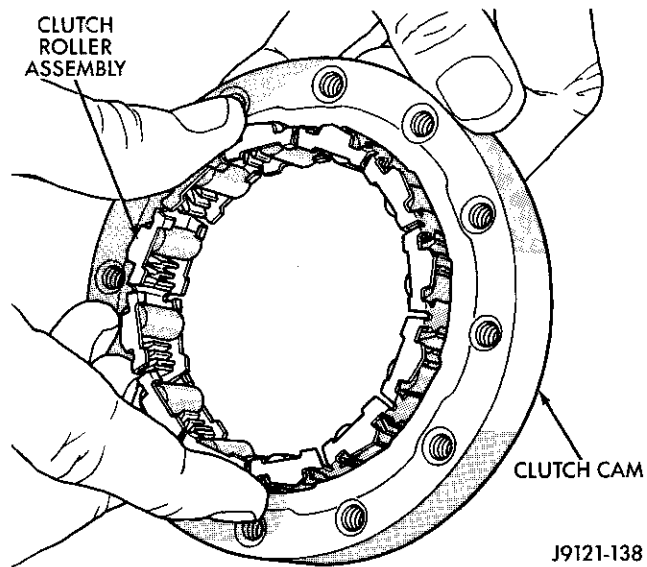
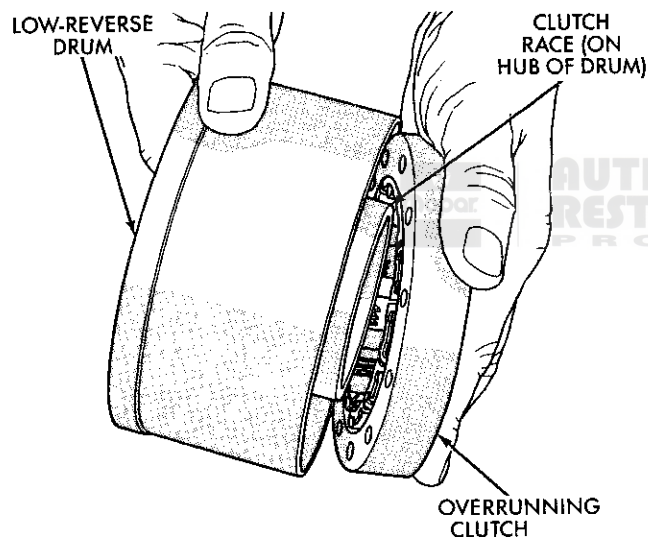
(1) Assemble clutch rollers and springs in retainer if necessary (Fig. 184).

**Fig. 184 Overrunning Clutch Rollers, Springs, Retainer**

(2) Install overrunning clutch roller, spring and retainer assembly in clutch cam (Fig. 185).

(3) Temporarily assemble and check overrunning clutch operation as follows:

- (a) Assemble cam and clutch.
- (b) Install clutch assembly on low-reverse drum with twisting motion (Fig. 186).
- (c) Install drum-clutch assembly in case and install clutch cam bolts.
- (d) Install rear support and support attaching bolts.
- (e) Check low-reverse drum rotation. **Drum should rotate freely in clockwise direction**

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 185 Assembling Overrunning Clutch And Cam**

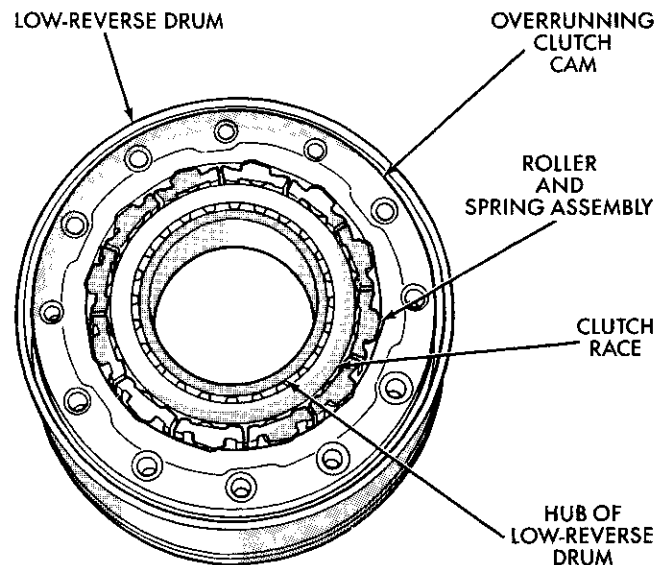
J9121-135

Fig. 186 Temporary Assembly Of Clutch And Drum To Check Operation

and lock when turned in counterclockwise direction (as viewed from front of case).

(4) Note component position for assembly reference. Bolt holes in clutch cam are countersunk on one side. Be sure this side of cam will face rearward when installed (Fig. 187).

(5) Remove rear support, overrunning clutch and low-reverse drum. Set components aside for final assembly. **If overrunning clutch will be installed before final assembly, install cam only as described in Transmission Assembly And Adjustment section. Clutch cam must be properly indexed in case to fit and operate properly.**



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Fig. 187 Assembled Overrunning Clutch**FRONT SERVO PISTON****DISASSEMBLE**

- (1) Remove seal ring from rod guide (Fig. 188).
- (2) Remove small snap ring from servo piston rod. Then remove piston rod, spring and washer from piston.
- (3) Remove and discard servo component O-ring and seal rings.

ASSEMBLE

Clean and inspect front servo components.

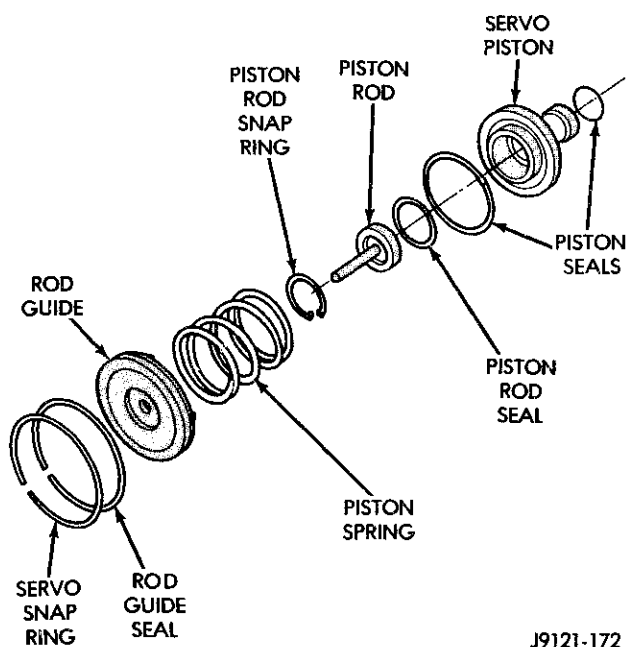
- (1) Lubricate new O-ring and seal rings with petroleum jelly and install them on piston, guide and rod.
- (2) Install rod in piston. Install spring and washer on rod. Compress spring and install snap ring (Fig. 188).
- (3) Set servo components aside for installation during transmission reassembly.

REAR SERVO PISTON**DISASSEMBLE**

- (1) Remove small snap ring and remove plug and spring from servo piston (Fig. 189).
- (2) Remove and discard servo piston seal ring.
- (3) Lubricate piston and guide seals with petroleum jelly. Lubricate other servo parts with Mopar ATF Plus transmission fluid.

ASSEMBLE

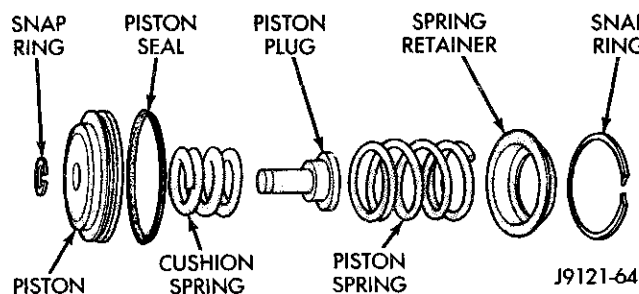
- (1) Install new seal ring on servo piston.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 188 Front Servo**

(2) Assemble piston, plug, spring and new snap ring.

(3) Lubricate piston seal lip with petroleum jelly.

(4) Set servo components aside for assembly installation.

**Fig. 189 Rear Servo Components****OIL PUMP AND REACTION SHAFT SUPPORT****DISASSEMBLE**

(1) Remove seal ring from housing and reaction shaft support (Fig. 190).

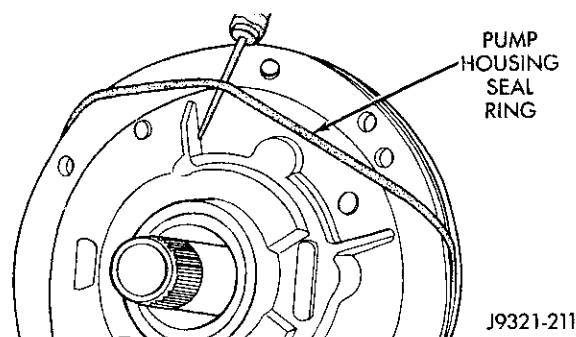
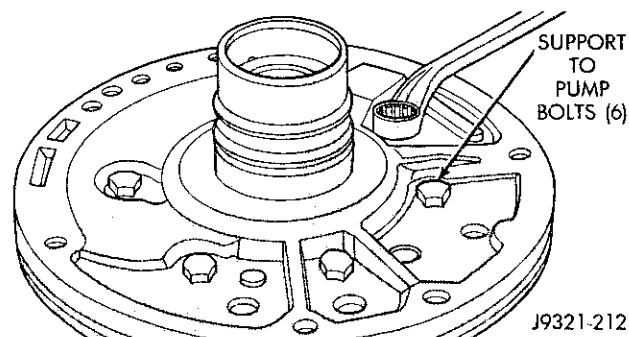
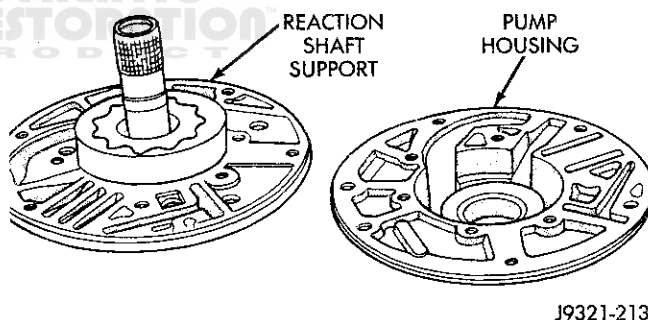
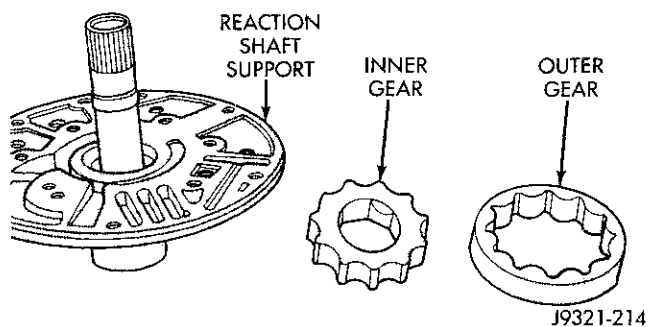
(2) Mark pump housing and support assembly for alignment reference.

(3) Loosen bolts that attach pump body to support (Fig. 191).

(4) Remove pump-to-support bolts and separate support from pump housing (Fig. 192).

(5) Remove inner and outer gears from reaction shaft support (Fig. 193).

(6) If pump seal was not removed during transmission disassembly, remove seal with punch and hammer.

**Fig. 190 Removing Pump Seal Ring****Fig. 191 Loosening Pump Support Bolts****Fig. 192 Separating Pump Housing From Reaction Shaft Support****Fig. 193 Pump Gear Removal**

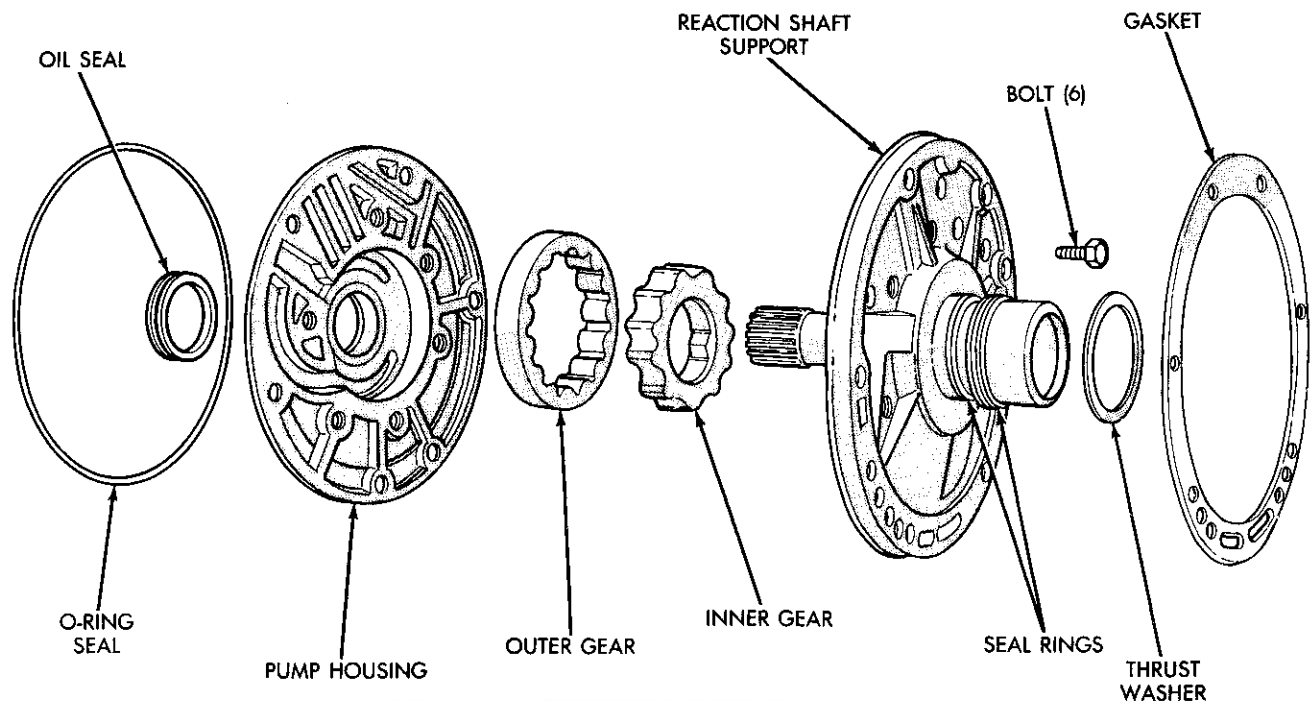


Fig. 194 Oil Pump And Reaction Shaft Support Components

(7) Remove front clutch thrust washer from support hub (Fig. 194).

OIL PUMP BUSHING REPLACEMENT

- (1) Remove pump bushing with Tool Handle C-4171 and Bushing Remover SP-3551 (Fig. 195).
- (2) Install new pump bushing with Tool Handle C-4171 and Bushing Installer SP-5117 (Fig. 195). Bushing should be flush with pump housing bore.
- (3) Stake new pump bushing in two places with blunt punch (Fig. 196). Remove burrs from stake points with knife blade afterward.

REACTION SHAFT SUPPORT BUSHING REMOVAL

- (1) Assemble Bushing Remover Tools SP-1191, 3633 and 5324 (Fig. 197). **Do not clamp any part of reaction shaft or support in vise.**
- (2) Hold Cup Tool SP-3633 firmly against reaction shaft and thread remover SP-5324 into bushing as far as possible by hand. Then thread remover tool 3-4 additional turns into bushing with a wrench.
- (3) Turn remover tool hex nut down against remover cup to pull bushing from shaft. Clean all chips from shaft after bushing removal.
- (4) Lightly grip old bushing in vise or with pliers and back remover tool out of bushing.

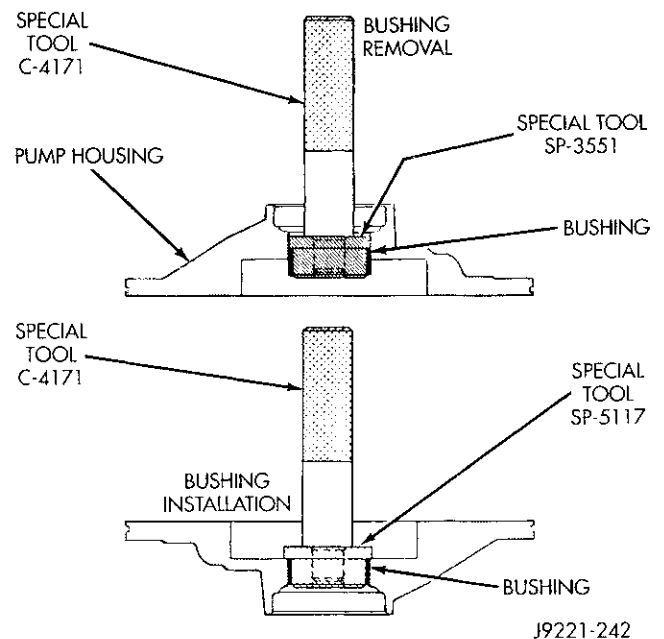
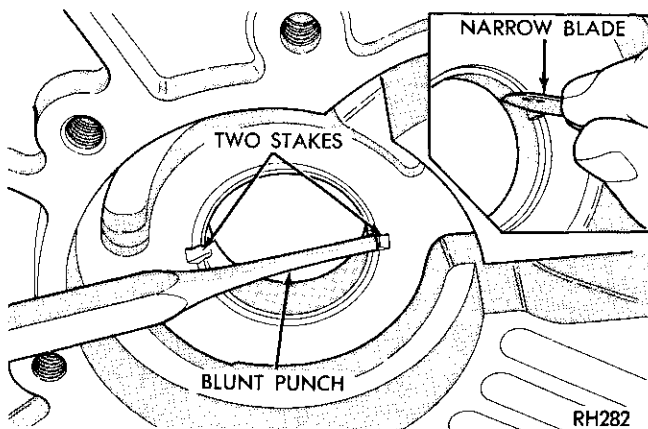


Fig. 195 Removing Oil Pump Bushing

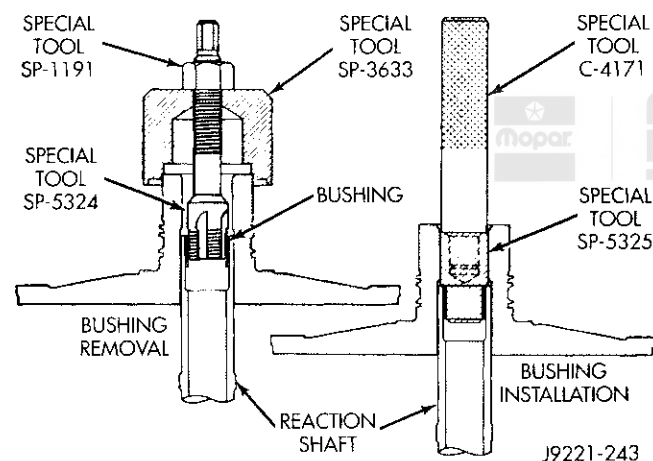
- (5) Assemble Bushing Installer Tools C-4171 and SP-5325 (Fig. 197).
- (6) Slide new bushing onto Installer Tool SP-5325.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 196 Staking Oil Pump Bushing**

(7) Position reaction shaft support upright on a clean smooth surface.

(8) Align bushing in bore. Then tap bushing into place until Bushing Installer SP-5325 bottoms.

(9) Clean reaction shaft support thoroughly after installing bushing.

**Fig. 197 Replacing Reaction Shaft Support Bushing**
OIL PUMP AND REACTION SHAFT SUPPORT ASSEMBLE

(1) Lubricate gear bore in pump housing with transmission fluid.

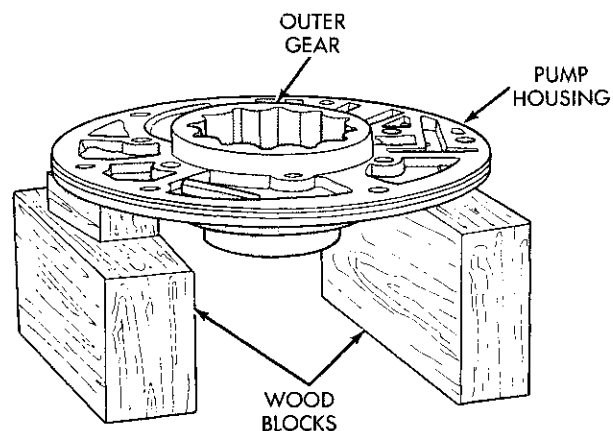
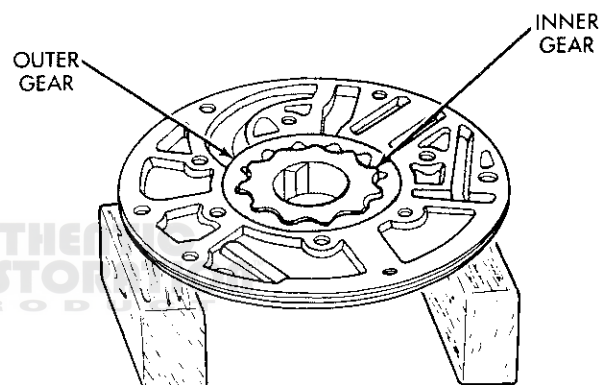
(2) Lubricate pump gears with transmission fluid.

(3) Support pump housing on wood blocks (Fig. 198).

(4) Install outer gear in pump housing (Fig. 198). Gear can be installed either way (it is not a one-way fit).

(5) Install pump inner gear (Fig. 199).

CAUTION: The pump inner gear is a one way fit. The bore on one side of the gear inside diameter (I.D.) is chamfered. Be sure the chamfered side faces forward (to front of pump).

**Fig. 198 Supporting Pump And Installing Outer Gear****Fig. 199 Pump Inner Gear Installation**

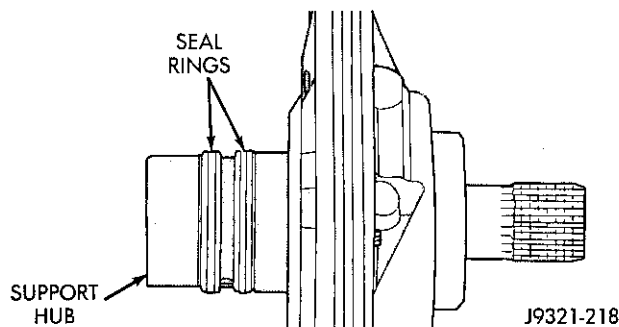
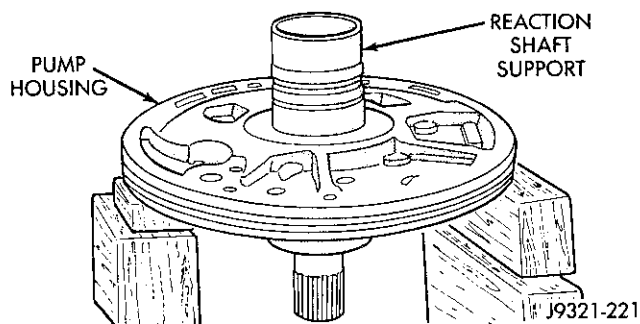
(6) Install new thrust washer on hub of reaction shaft support. Lubricate washer with transmission fluid or petroleum jelly.

(7) If reaction shaft seal rings are being replaced, install new seal rings on support hub (Fig. 200). Lubricate seal rings with transmission fluid or petroleum jelly after installation. Squeeze each ring until ring ends are securely hooked together.

CAUTION: The reaction shaft support seal rings will break if overspread, or twisted. If new rings are being installed, spread them only enough for installation. Also be very sure the ring ends are securely hooked together after installation. Otherwise, the rings will either prevent pump installation, or break during installation.

(8) Install reaction shaft support on pump housing (Fig. 201).

(9) Align reaction support on pump housing. Use alignment marks made at disassembly. Or, rotate

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 200 Hub Seal Ring Position****Fig. 201 Assembling Reaction Shaft Support And Pump Housing**

support until bolt holes in support and pump housing are all aligned (holes are offset for one-way fit).

(10) Install all bolts that attach support to pump housing. Then tighten bolts finger tight.

(11) Tighten support-to-pump bolts to required torque as follows:

(a) Reverse pump assembly and install it in transmission case. Position pump so bolts are facing out and are accessible.

(b) Secure pump assembly in case with 2 or 3 bolts, or with pilot studs.

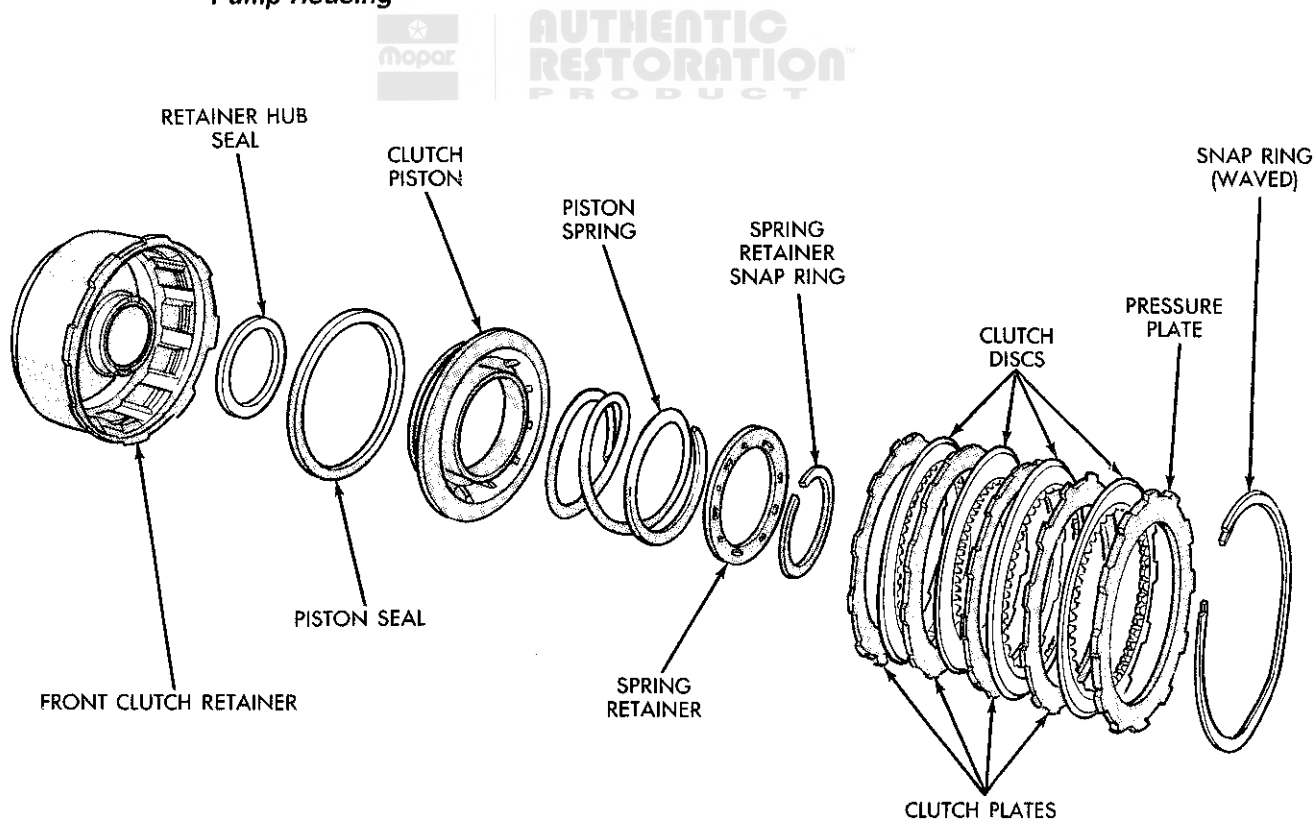
(c) Tighten support-to-pump bolts to 20 N·m (15 ft. lbs.).

(d) Remove pump assembly from transmission case.

(12) Install new oil seal in pump with Special Tool C-4193 and Tool Handle C-4171 (Fig. 202). Be sure seal lip faces inward.

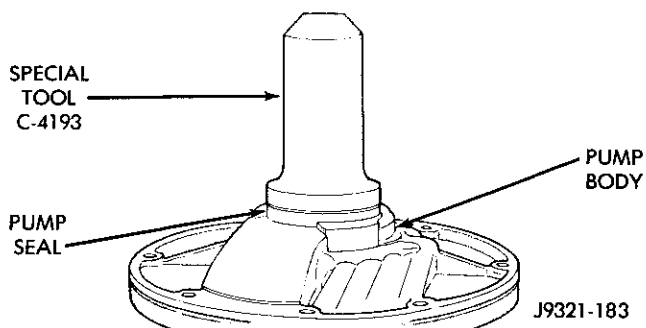
(13) Install new seal ring around pump housing. Be sure seal is properly seated in groove.

(14) Lubricate lip of pump oil seal and O-ring seal with transmission fluid.

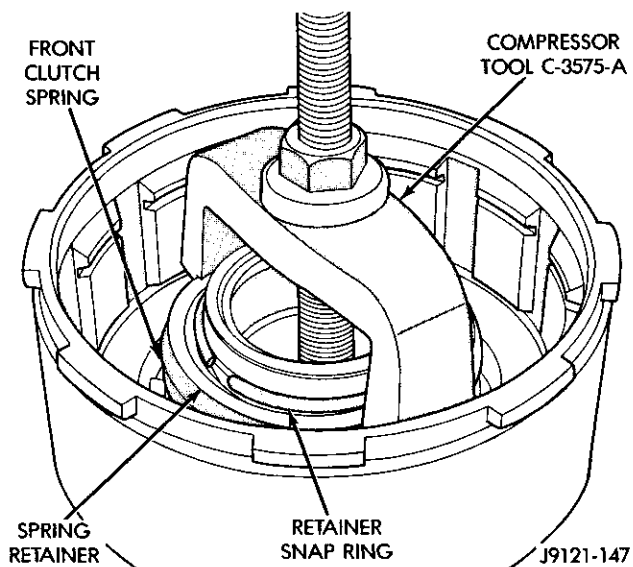


J9321-222

Fig. 203 Front Clutch Components

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 202 Pump Oil Seal Installation****FRONT CLUTCH****DISASSEMBLE**

- (1) Remove waved snap ring and remove pressure plate, clutch plates and clutch discs (Fig. 203).
- (2) Compress clutch piston spring with Compressor Tool C-3575-A (Fig. 204). Be sure legs of tool are seated squarely on spring retainer before compressing spring.
- (3) Remove retainer snap ring and remove compressor tool.
- (4) Remove spring retainer and clutch spring. Note position of retainer on spring for assembly reference.
- (5) Remove clutch piston from clutch retainer. Remove piston by rotating it up and out of retainer.
- (6) Remove seals from clutch piston and clutch retainer hub. Discard both seals as they are not reusable.

**Fig. 204 Compressing Front Clutch Piston Spring****ASSEMBLE**

- (1) Soak clutch discs in transmission fluid while assembling other clutch parts.
- (2) Install new seals on piston and in hub of retainer. Be sure lip of each seal faces interior of clutch retainer.

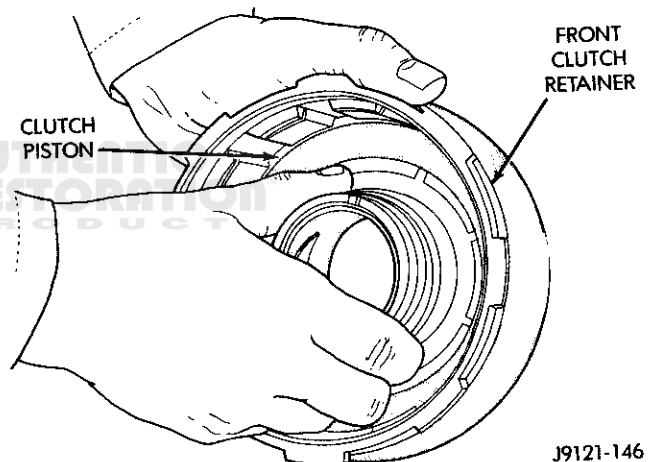
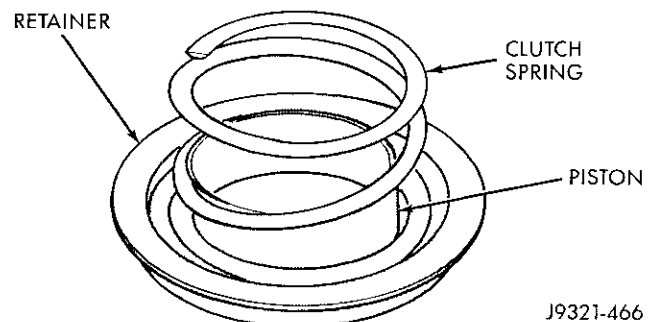
(3) Lubricate lips of piston and retainer seals with liberal quantity of Mopar Door Ease, or Ru-Glyde. Then lubricate retainer hub, bore and piston with light coat of transmission fluid.

(4) Install clutch piston in retainer (Fig. 205). Use twisting motion to seat piston in bottom of retainer. A thin strip of plastic (about 0.020" thick), can be used to guide seals into place if necessary.

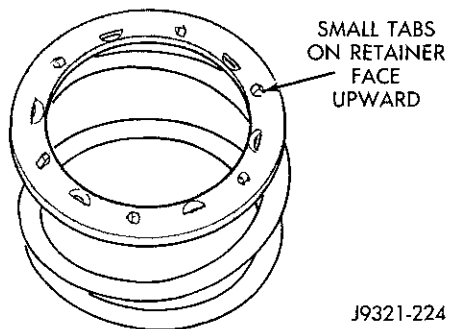
CAUTION: Never push the clutch piston straight in. This will fold the seals over causing leakage and clutch slip. In addition, never use any type of metal tool to help ease the piston seals into place. Metal tools will cut, shave, or score the seals.

(5) Position spring in clutch piston (Fig. 206).

(6) Position spring retainer on top of piston spring (Fig. 207). **Make sure retainer is properly installed. Small raised tabs should be facing upward. Semicircular lugs on underside of retainer are for positioning retainer in spring.**

**Fig. 205 Front Clutch Piston Installation****Fig. 206 Clutch Piston Spring Installation**

(7) Compress piston spring and retainer with Compressor Tool C-3575-A (Fig. 204). Then install new snap ring to secure spring retainer and spring.

DISASSEMBLY AND ASSEMBLY (Continued)

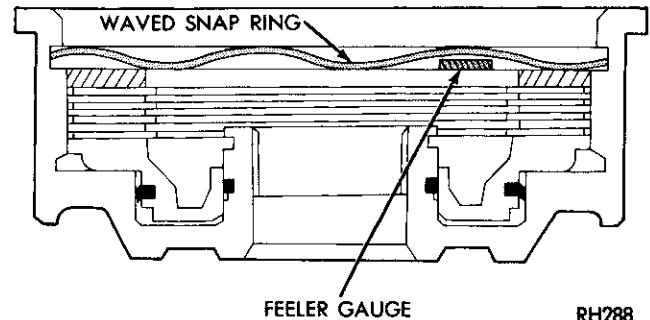
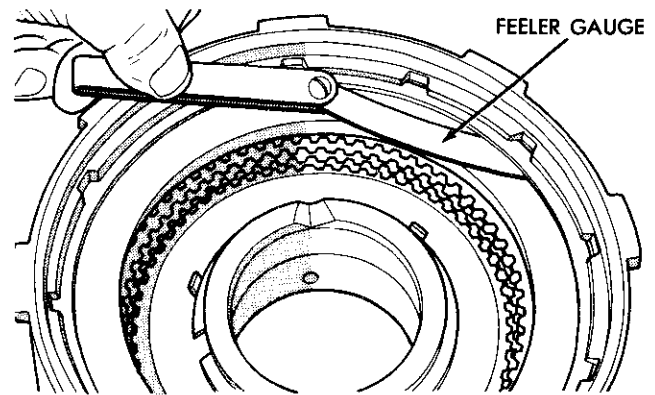
J9321-224

Fig. 207 Correct Spring Retainer Installed Position

(8) Install clutch plates and discs (Fig. 203). Install steel plate then disc until all plates and discs are installed. The front clutch uses 4 clutch discs.

(9) Install pressure plate and waved snap ring (Fig. 203).

(10) Check clutch plate clearance (Fig. 208). Clearance should be 1.70 to 3.40 mm (0.067 to 0.134 in.). If clearance is incorrect, clutch discs, plates pressure plates and snap ring may have to be changed.

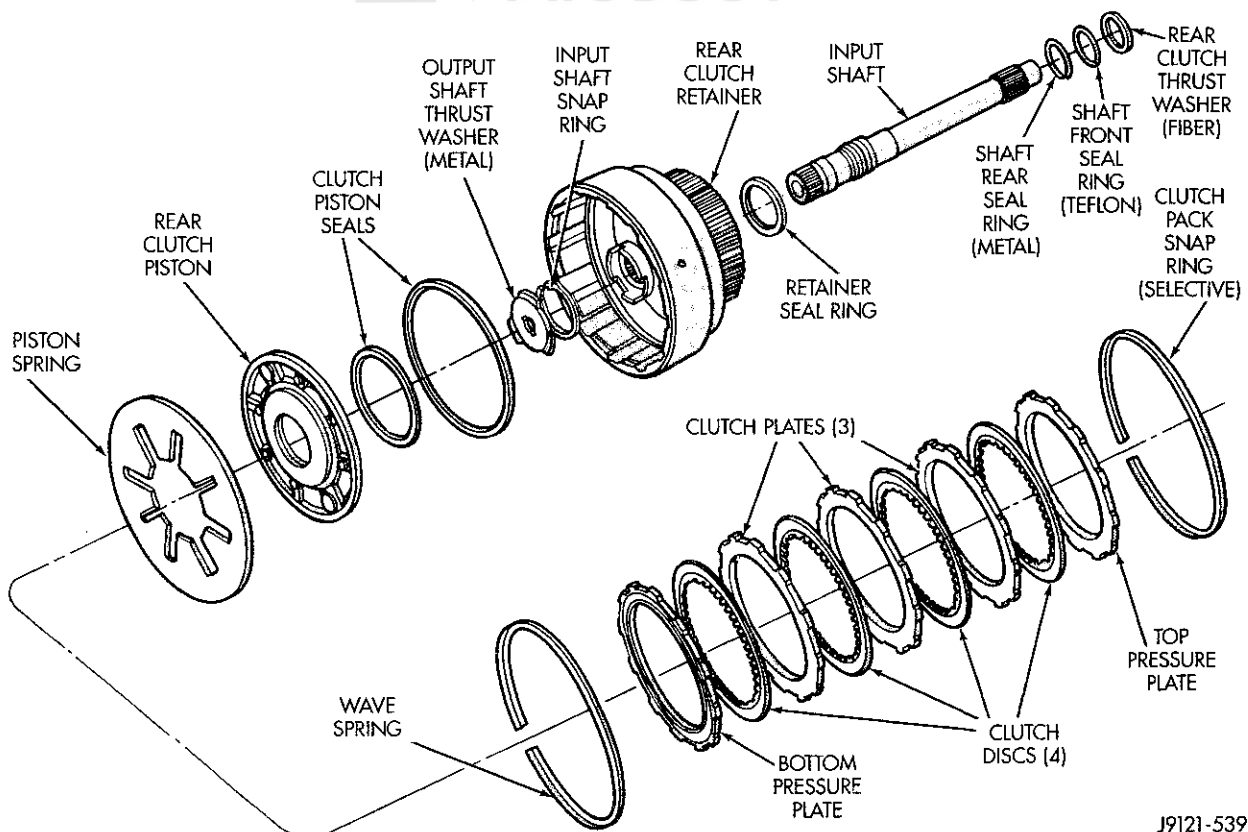


RH288

Fig. 208 Typical Method Of Measuring Front Clutch Pack Clearance**REAR CLUTCH****DISASSEMBLE**

(1) Remove fiber thrust washer from forward side of clutch retainer.

(2) Remove selective clutch pack snap ring (Fig. 209).



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Fig. 209 Rear Clutch Components

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Remove top pressure plate, clutch discs, steel plates, bottom pressure plate and wave spring (Fig. 209).

(4) Remove clutch piston with rotating motion.

(5) Remove and discard piston seals.

(6) Remove input shaft snap ring (Fig. 210).

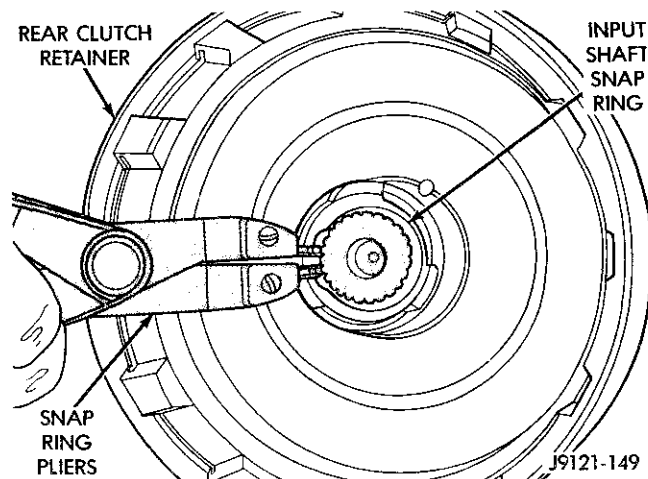


Fig. 210 Removing/Installing Input Shaft Snap Ring

(7) Press input shaft out of retainer with shop press and suitable size press tool (Fig. 211).

(8) Remove input shaft front/rear seal rings.

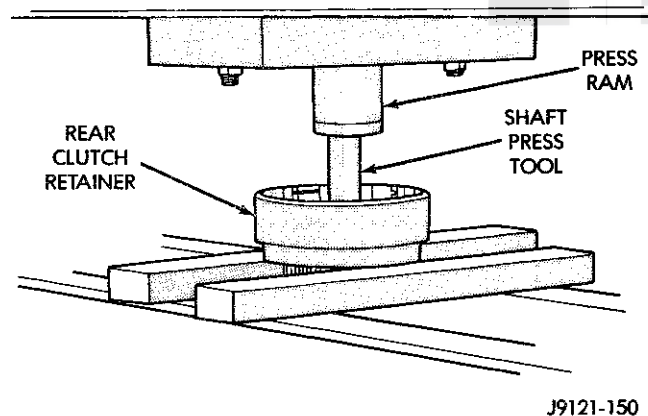


Fig. 211 Pressing Input Shaft Out Of Rear Clutch Retainer

ASSEMBLE

(1) Soak clutch discs in transmission fluid while assembling other clutch parts.

(2) Install new seal rings on clutch retainer hub and input shaft if necessary (Fig. 212).

(a) Be sure clutch hub seal ring is fully seated in groove and is not twisted.

(b) Note that input shaft front seal ring is teflon and rear seal ring is metal (Fig. 213). Be sure chamfered ends of teflon ring are properly joined and that ends of rear ring are securely hooked

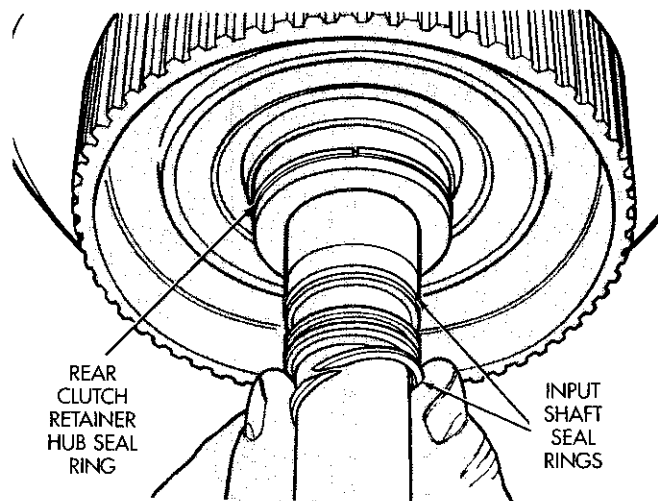


Fig. 212 Rear Clutch Retainer And Input Shaft Seal Ring Installation

together. Lubricate both rings with transmission fluid after installation.

(3) Lubricate splined end of input shaft and clutch retainer with transmission fluid. Then press input shaft into retainer (Fig. 214).

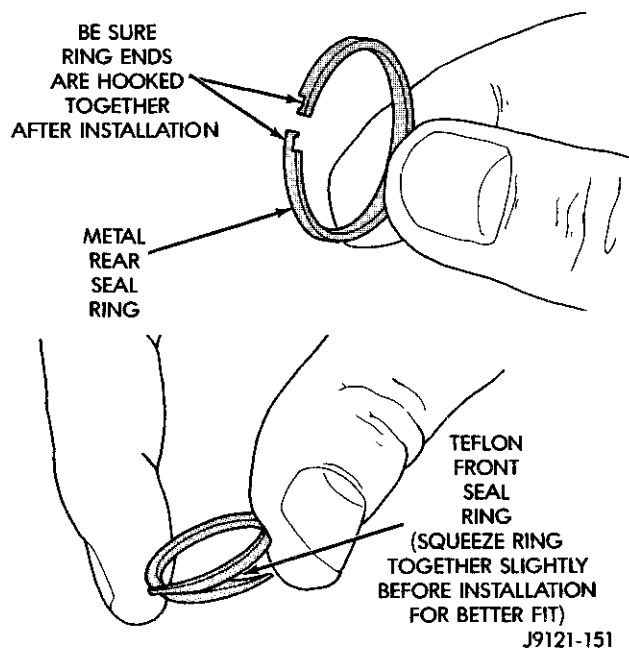


Fig. 213 Input Shaft Seal Ring Identification

(4) Install input shaft snap ring (Fig. 210).

(5) Install new seals on clutch piston. Be sure lip of each seal faces interior of clutch retainer.

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Lubricate lip of piston seals with generous quantity of Mopar Door Ease, or Ru-Glyde. Then lubricate retainer hub and bore with light coat of transmission fluid.

(7) Install clutch piston in retainer. Use twisting motion to seat piston in bottom of retainer. A thin strip of plastic (about 0.020" thick), can be used to guide seals into place if necessary.

CAUTION: Never push the clutch piston straight in. This will fold the seals over causing leakage and clutch slip. In addition, never use any type of metal tool to help ease the piston seals into place. Metal tools will cut, shave, or score the seals.

(8) Install piston spring in retainer and on top of piston (Fig. 215). Concave side of spring faces downward (toward piston).

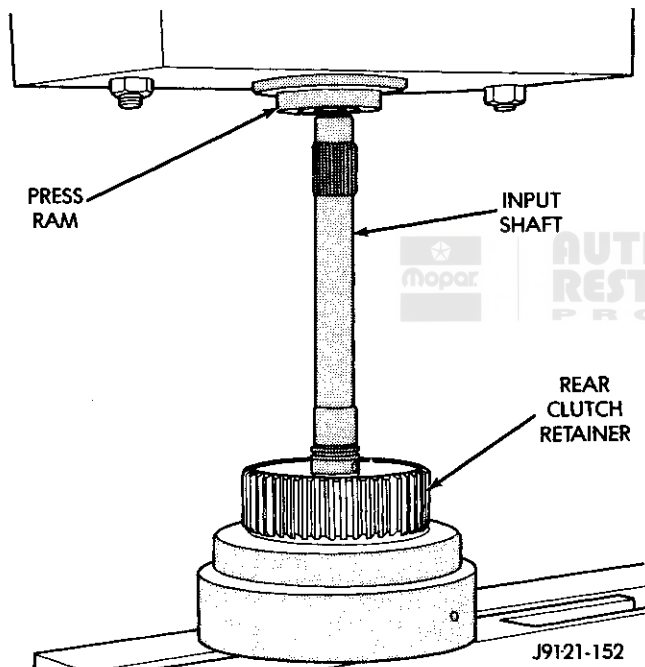


Fig. 214 Pressing Input Shaft Into Rear Clutch Retainer

(9) Install wave spring in retainer (Fig. 215). Be sure spring is completely seated in retainer groove.

(10) Install bottom pressure plate (Fig. 209). Ridged side of plate faces downward (toward piston) and flat side toward clutch pack.

(11) Install first clutch disc in retainer on top of bottom pressure plate. Then install a clutch plate followed by a clutch disc until entire clutch pack is installed (4 discs and 3 plates are required) (Fig. 209).

(12) Install top pressure plate.

(13) Install selective snap ring. Be sure snap ring is fully seated in retainer groove.

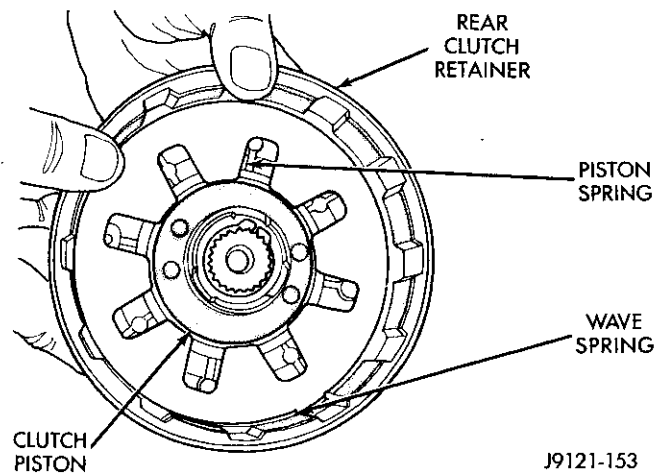


Fig. 215 Piston Spring/Wave Spring Position

(14) Measure clutch pack clearance (Fig. 216). Clearance should be 0.64 - 1.14 mm (0.025 - 0.045 in.). If clearance is incorrect, steel plates, discs, snap ring and pressure plates may have to be changed.

(15) Coat rear clutch fiber thrust washer with petroleum jelly and install washer over input shaft and into clutch retainer (Fig. 217). Use enough petroleum jelly to hold washer in place.

(16) Set rear clutch aside for installation during final assembly.

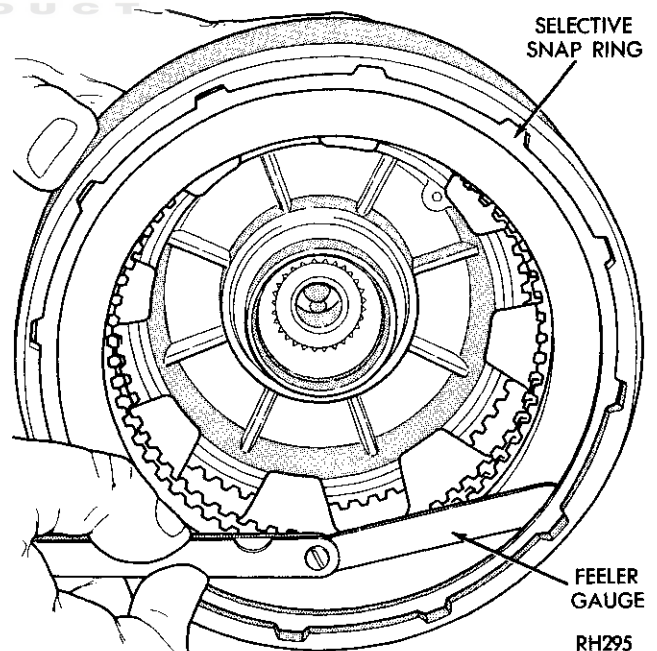
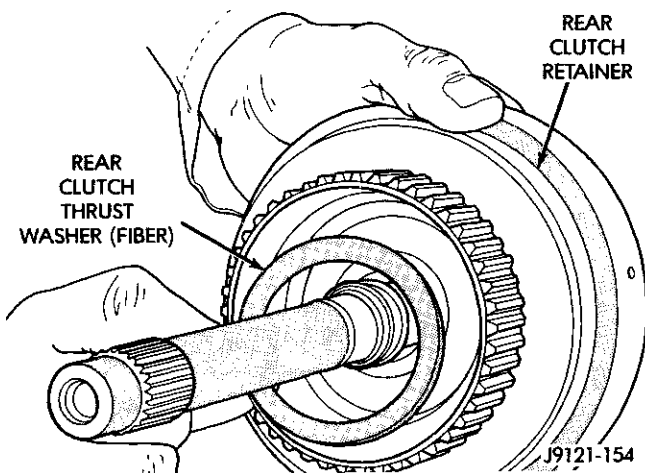


Fig. 216 Typical Method Of Checking Rear Clutch Pack Clearance

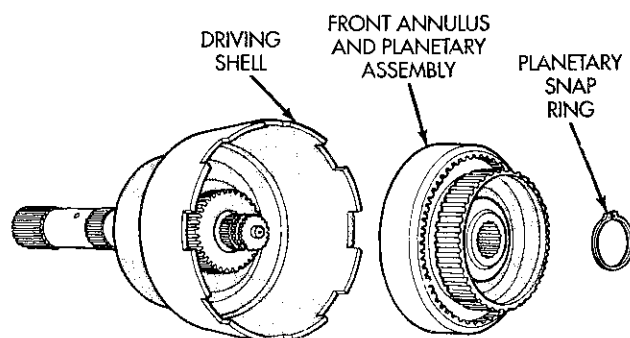
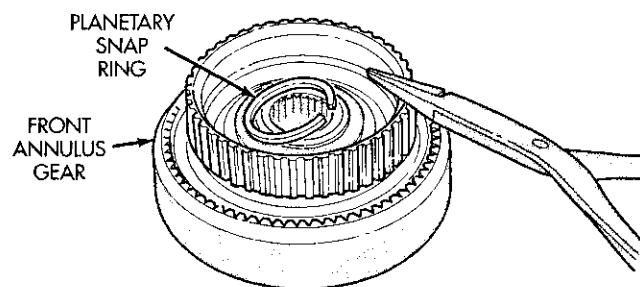
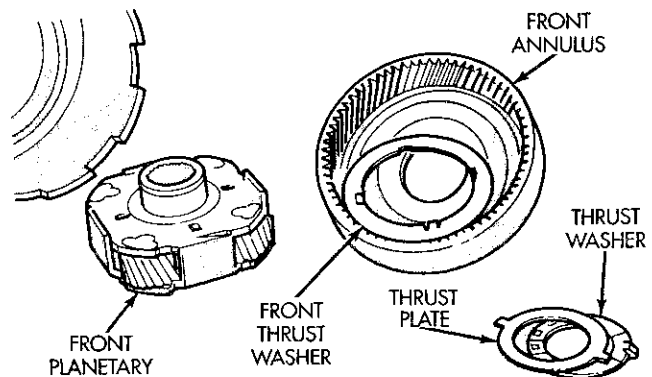
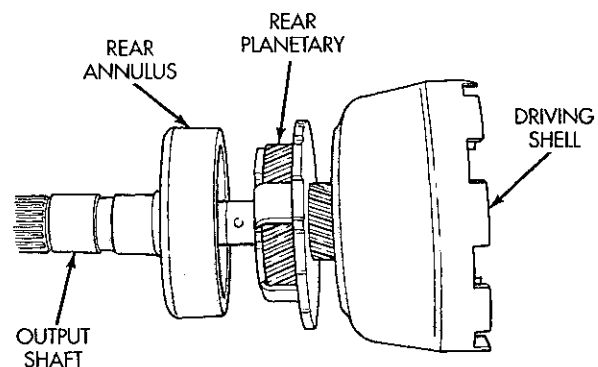
PLANETARY GEARTRAIN/OUTPUT SHAFT

DISASSEMBLE

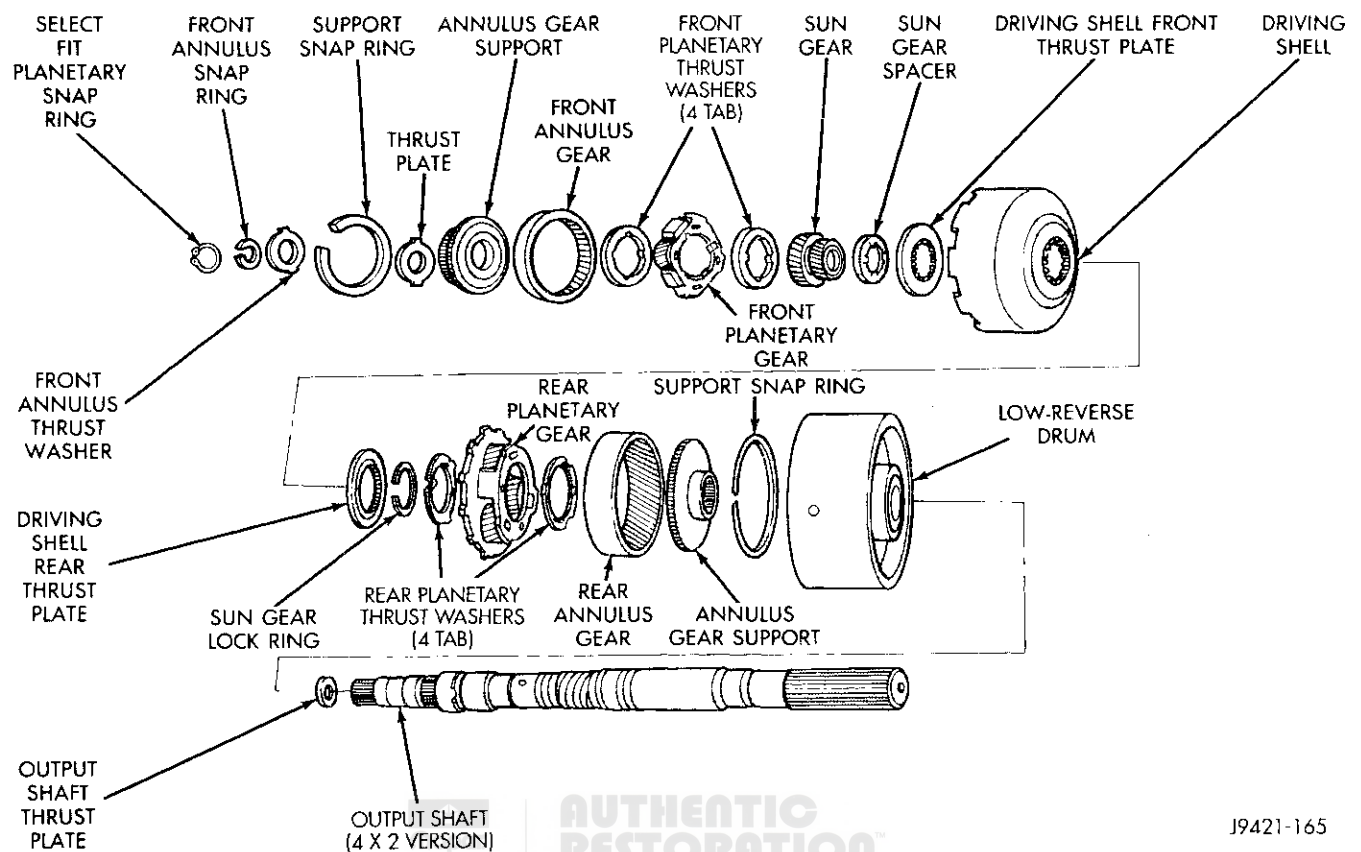
(1) Remove planetary snap ring (Fig. 218).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 217 Installing Rear Clutch Thrust Washer**

- (2) Remove front annulus and planetary assembly from driving shell (Fig. 218).
- (3) Remove snap ring that retains front planetary gear in annulus gear (Fig. 219).
- (4) Remove tabbed thrust washer and tabbed thrust plate from hub of front annulus (Fig. 220).
- (5) Separate front annulus and planetary gears (Fig. 220).
- (6) Remove front planetary gear front thrust washer from annulus gear hub.
- (7) Remove front planetary rear thrust washer from driving shell.
- (8) Separate and remove driving shell, rear planetary and rear annulus from output shaft (Fig. 221).
- (9) Remove tabbed thrust washers from rear planetary gear.
- (10) Remove snap ring that retains sun gear in driving shell. Then remove sun gear, spacer and thrust plates.

**Fig. 218 Front Annulus And Planetary Assembly Removal****Fig. 219 Front Planetary Snap Ring Removal****Fig. 220 Front Planetary And Annulus Gear Disassembly****Fig. 221 Removing Driving Shell, Rear Planetary And Rear Annulus****ASSEMBLE**

- (1) Lubricate output shaft and planetary components with transmission fluid. Use petroleum jelly to lubricate and hold thrust washers and plates in position.
- (2) Assemble rear annulus gear and support if disassembled. Be sure support snap ring is seated and that shoulder-side of support faces rearward (Fig. 223).

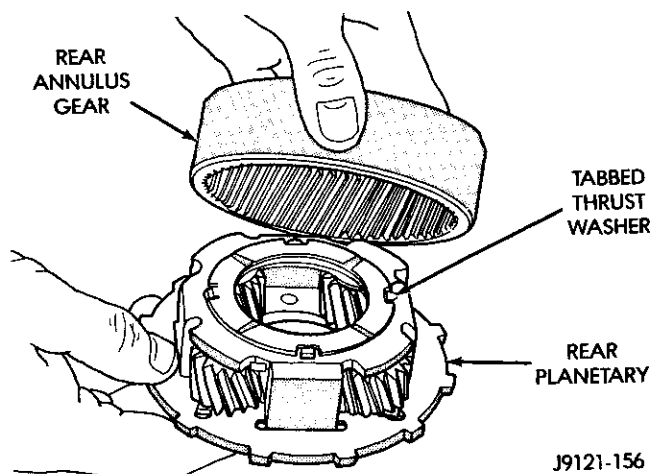
DISASSEMBLY AND ASSEMBLY (Continued)

J9421-165

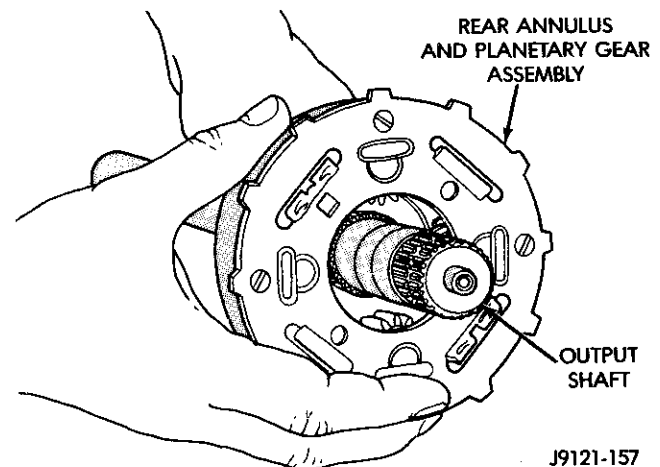
Fig. 222 Planetary Geartrain Components

(3) Install rear thrust washer on rear planetary gear (Fig. 222). Use enough petroleum jelly to hold washer in place. Also be sure all four washer tabs are properly engaged in gear slots.

(4) Install rear annulus over and onto rear planetary gear (Fig. 223).

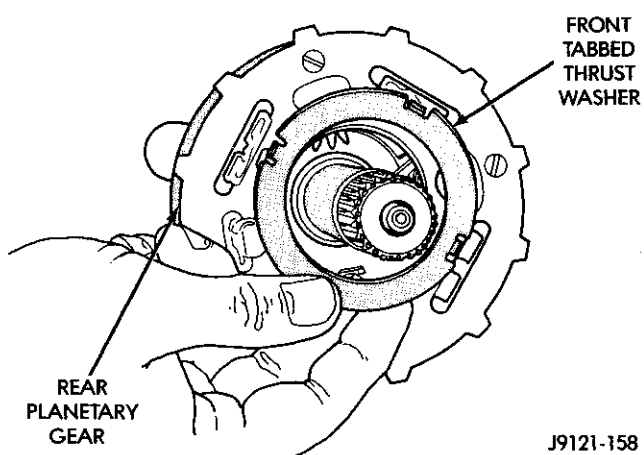
**Fig. 223 Assembling Rear Annulus And Planetary Gear**

(5) Install assembled rear planetary and annulus gear on output shaft (Fig. 224). Verify that assembly is fully seated on shaft.

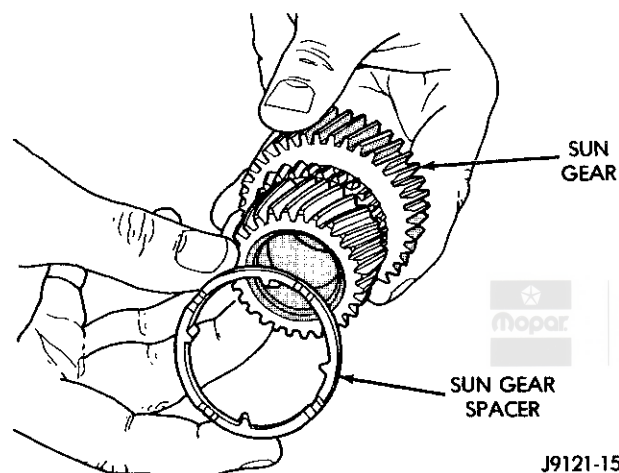
**Fig. 224 Installing Rear Annulus And Planetary On Output Shaft**

(6) Install front thrust washer on rear planetary gear (Fig. 225). Use enough petroleum jelly to hold washer on gear. Be sure all four washer tabs are seated in slots.

(7) Install spacer on sun gear (Fig. 226).

DISASSEMBLY AND ASSEMBLY (Continued)

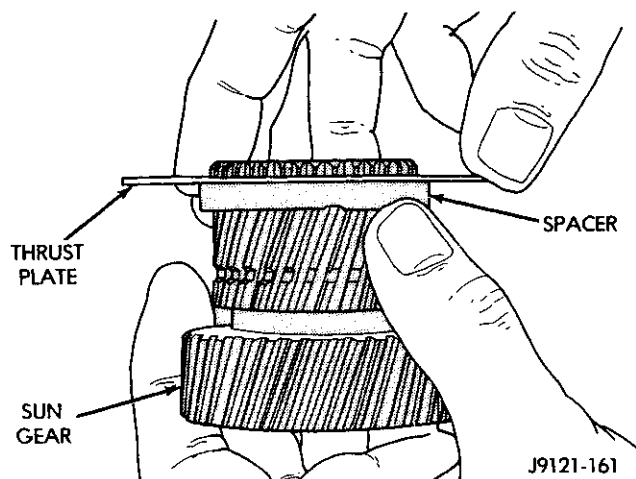
J9121-158

Fig. 225 Installing Rear Planetary Front Thrust Washer

J9121-159

Fig. 226 Installing Spacer On Sun Gear

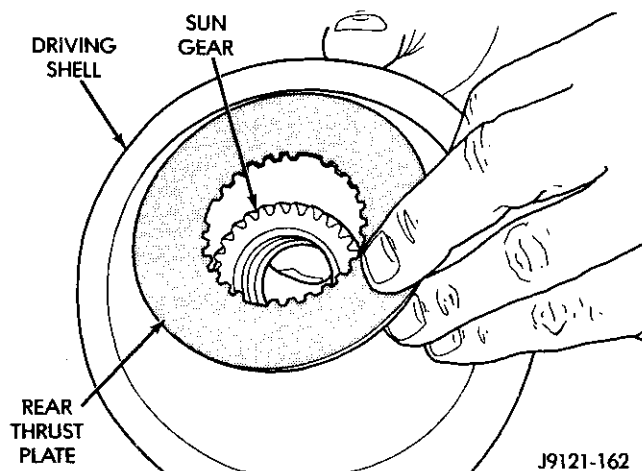
(8) Install thrust plate on sun gear (Fig. 227). Note that driving shell thrust plates are interchangeable. Use either plate on sun gear and at front/rear of shell.



J9121-161

Fig. 227 Installing Driving Shell Front Thrust Plate On Sun Gear

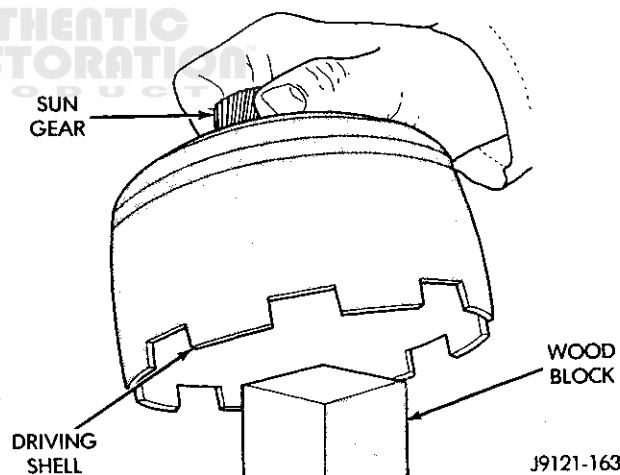
(9) Hold sun gear in place and install thrust plate over sun gear at rear of driving shell (Fig. 228).



J9121-162

Fig. 228 Installing Driving Shell Rear Thrust Plate

(10) Position wood block on bench and support sun gear on block (Fig. 229). This makes it easier to align and install sun gear lock ring. Keep wood block handy as it will also be used for geartrain end play check.



J9121-163

Fig. 229 Supporting Sun Gear On Wood Block

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Align rear thrust plate on driving shell and install sun gear lock ring. Be sure ring is fully seated in sun gear ring groove (Fig. 230).

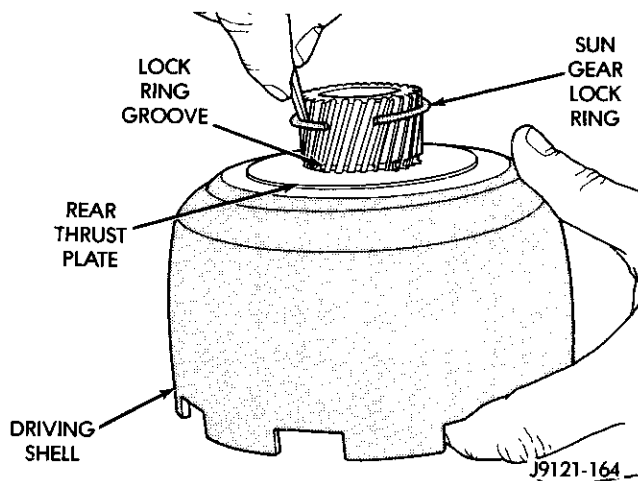


Fig. 230 Installing Sun Gear Lock Ring

(12) Install assembled driving shell and sun gear on output shaft (Fig. 231).

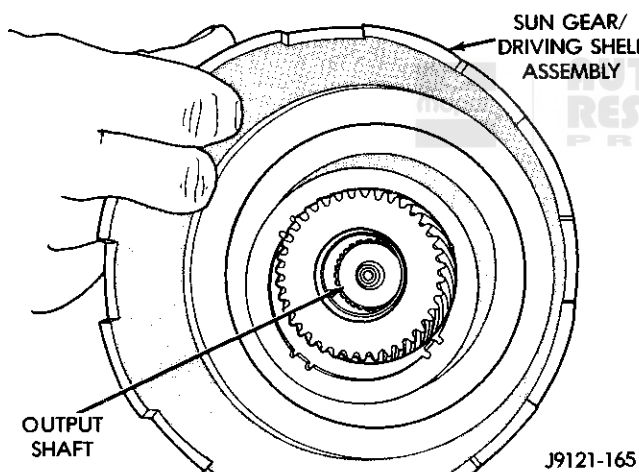


Fig. 231 Installing Assembled Sun Gear And Driving Shell On Output Shaft

(13) Install rear thrust washer on front planetary gear (Fig. 232). Use enough petroleum jelly to hold washer in place and be sure all four washer tabs are seated.

(14) Install front planetary gear on output shaft and in driving shell (Fig. 233).

(15) Install front thrust washer on front planetary gear. Use enough petroleum jelly to hold washer in place and be sure all four washer tabs are seated.

(16) Assemble front annulus gear and support, if necessary. Be sure support snap ring is seated.

(17) Install front annulus on front planetary (Fig. 233).

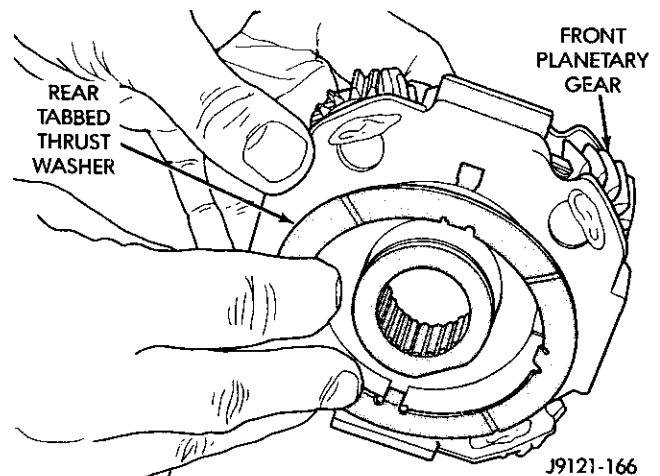


Fig. 232 Installing Rear Thrust Washer On Front Planetary Gear

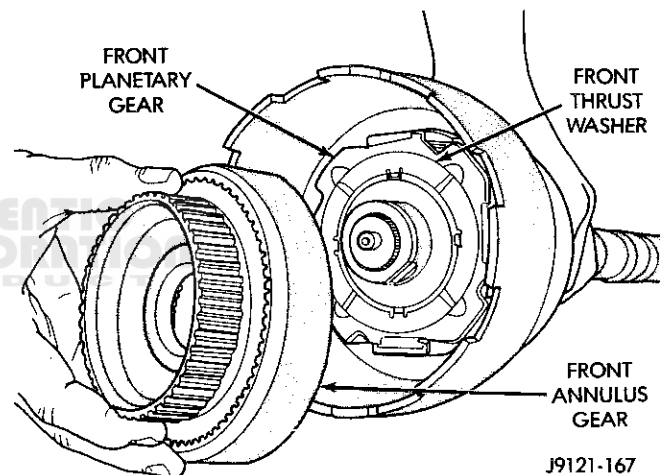


Fig. 233 Installing Front Planetary And Annulus Gears

(18) Position thrust plate on front annulus gear support (Fig. 234). Note that plate has two tabs on it. These tabs fit in notches of annulus hub.

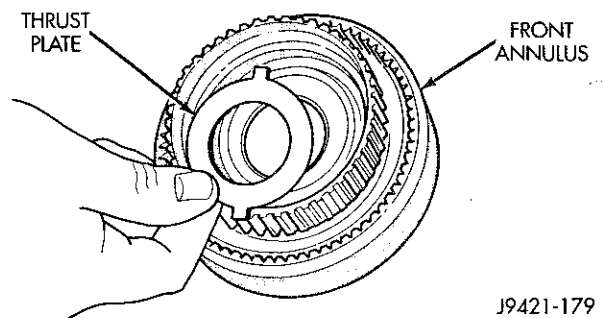


Fig. 234 Positioning Thrust Plate On Front Annulus Support

DISASSEMBLY AND ASSEMBLY (Continued)

(19) Install thrust washer in front annulus (Fig. 235). Align flat on washer with flat on planetary hub. Also be sure washer tab is facing up.

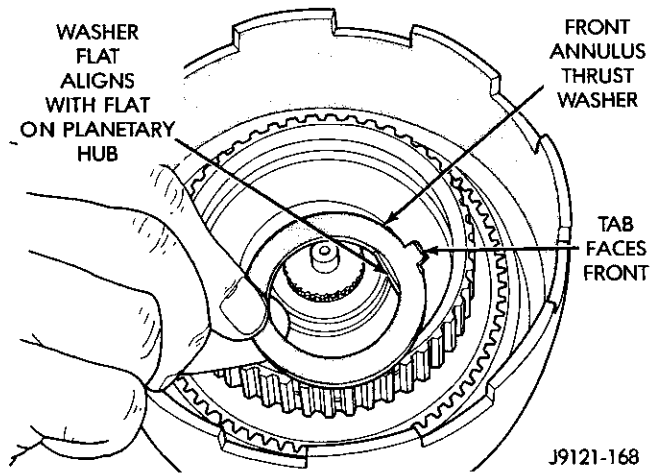


Fig. 235 Installing Front Annulus Thrust Washer

(20) Install front annulus snap ring (Fig. 236). Use snap ring pliers to avoid distorting ring during installation. Also be sure ring is fully seated.

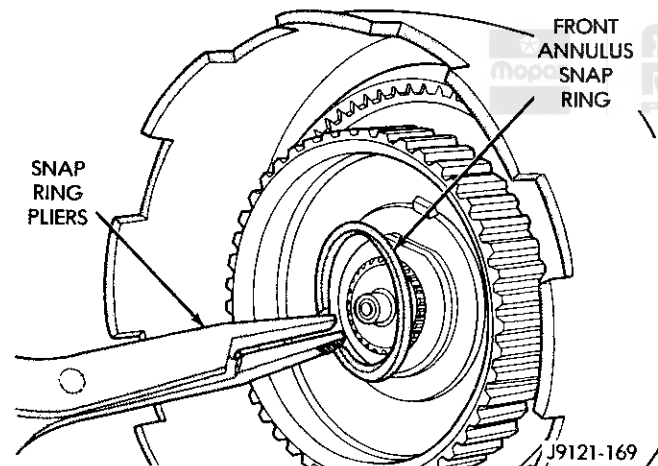


Fig. 236 Installing Front Annulus Snap Ring

(21) Install planetary selective snap ring with snap ring pliers (Fig. 237). Be sure ring is fully seated.

(22) Turn planetary geartrain assembly over so driving shell is facing workbench. Then support geartrain on wood block positioned under forward end of output shaft. This allows geartrain components to move forward for accurate end play check.

(23) Check planetary geartrain end play with feeler gauge (Fig. 238). Gauge goes between shoulder on output shaft and end of rear annulus support.

(24) Geartrain end play should be 0.12 to 1.22 mm (0.005 to 0.048 in.). If end play is incorrect, snap ring (or thrust washers) may have to be replaced. Snap

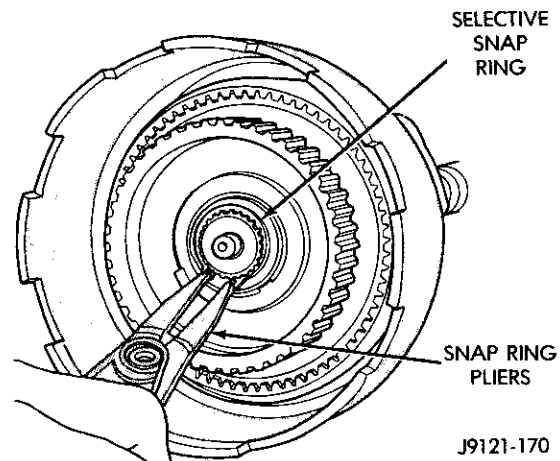


Fig. 237 Installing Planetary Selective Snap Ring

ring is available in three different thicknesses for adjustment purposes.

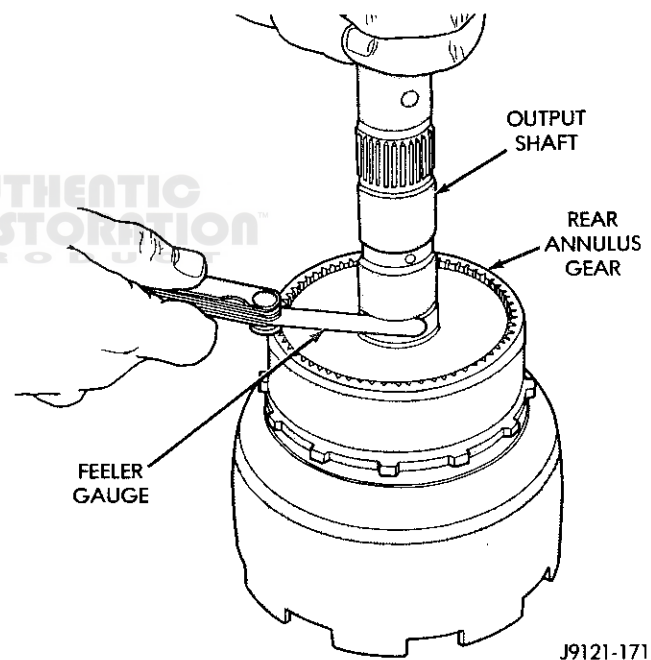


Fig. 238 Checking Planetary Geartrain End Play
OVERDRIVE UNIT

DISASSEMBLE**OVERDRIVE REMOVAL**

(1) Remove transmission speed sensor and O-ring seal from overdrive case (Fig. 239).

(2) Place transmission in upright position (Fig. 240).

(3) Remove bolts attaching overdrive unit to transmission case (Fig. 240). Note position of wire harness clips for installation reference.

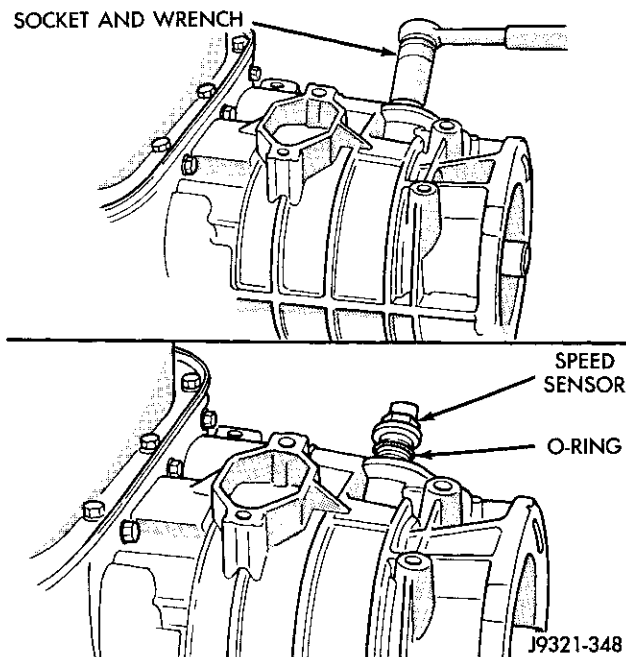
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 239 Transmission Speed Sensor Removal/Installation

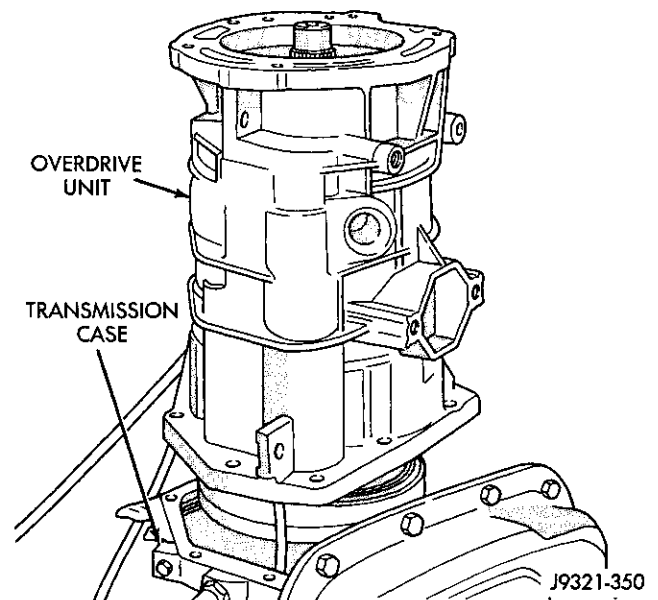


Fig. 241 Overdrive Unit Removal/Installation

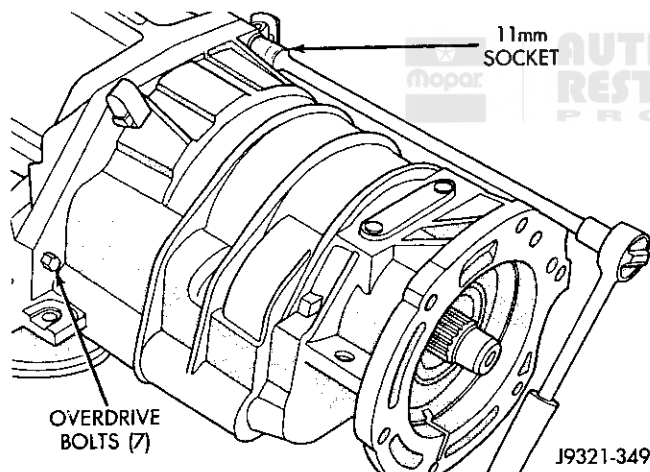


Fig. 240 Overdrive Unit Attaching Bolt Removal

(4) Lift overdrive unit up and off transmission case and intermediate shaft (Fig. 241).

(5) Remove overdrive piston thrust bearing (Fig. 242).

OVERDRIVE PISTON REMOVAL

(1) Remove overdrive piston thrust plate (Fig. 243). Retain thrust plate. It is a select fit part and may possibly be reused.

(2) Remove intermediate shaft spacer (Fig. 244). Retain spacer. It is a select fit part and may possibly be reused.

(3) Remove overdrive piston from retainer (Fig. 245).

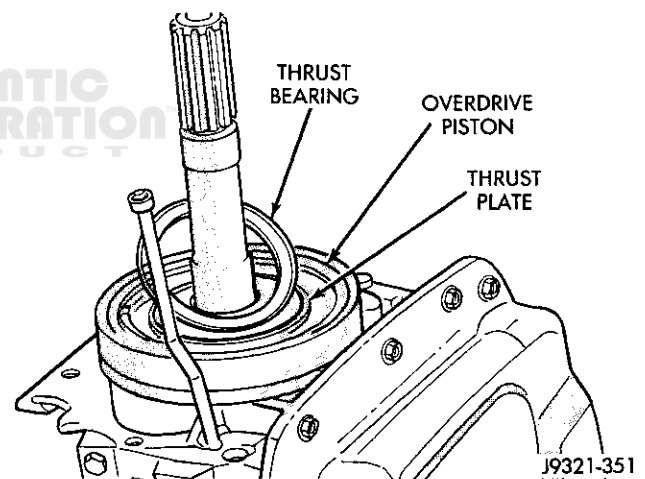


Fig. 242 Overdrive Piston Thrust Bearing Removal/Installation

OVERDRIVE CLUTCH PACK REMOVAL

(1) Remove overdrive clutch pack wire retaining ring (Fig. 246).

(2) Remove overdrive clutch pack (Fig. 247).

(3) Note position of clutch pack components for assembly reference (Fig. 248). Thick reaction plate goes to front as shown.

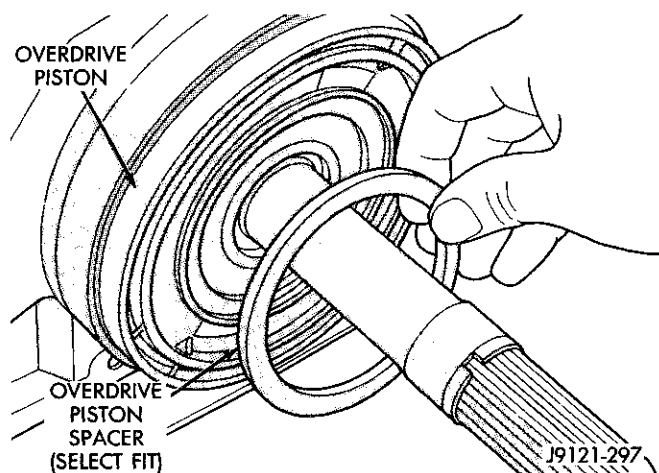
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 243 Overdrive Piston Thrust Plate Removal/Installation

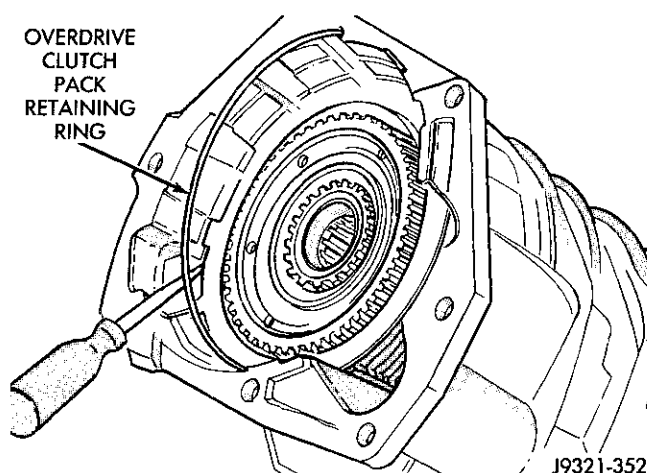


Fig. 246 Removing Overdrive Clutch Pack Retaining Ring

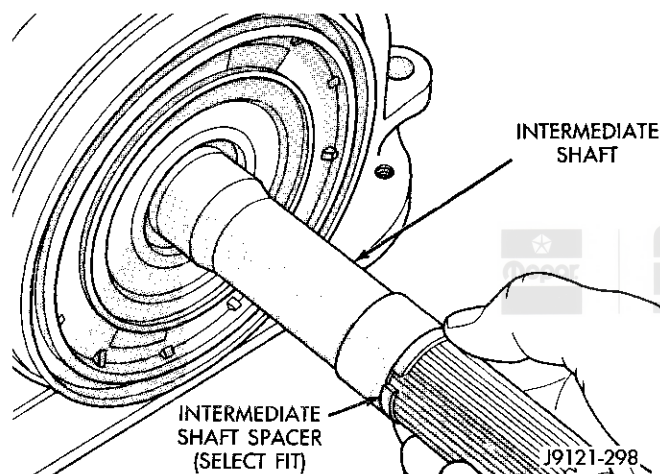


Fig. 244 Intermediate Shaft Spacer Location

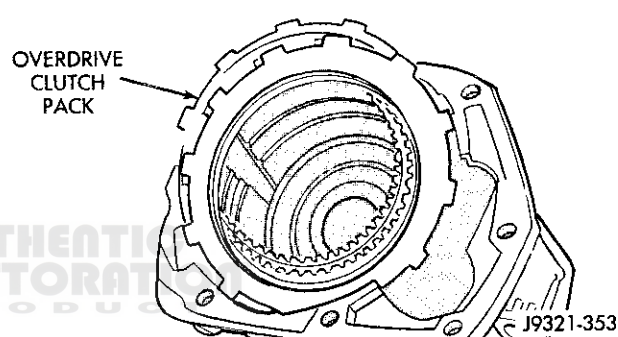


Fig. 247 Overdrive Clutch Pack Removal

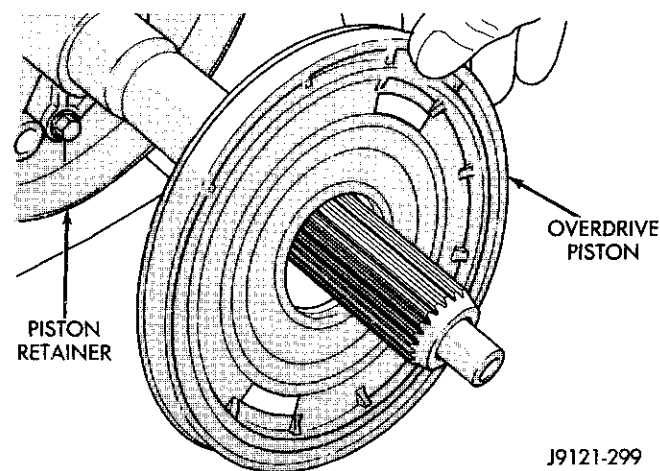


Fig. 245 Overdrive Piston Removal

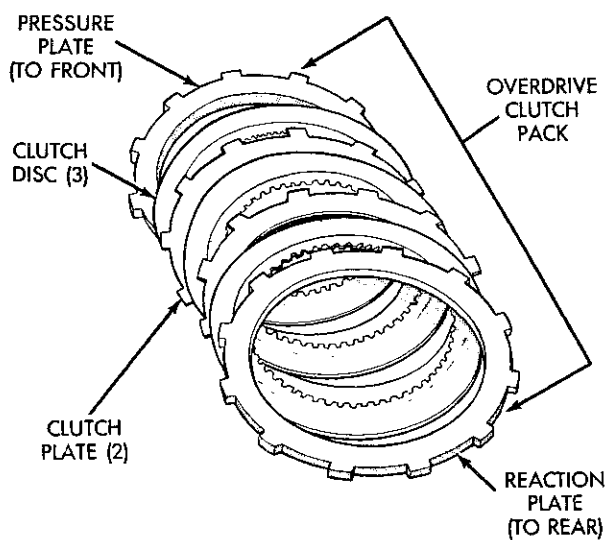


Fig. 248 Overdrive Clutch Component Position

DISASSEMBLY AND ASSEMBLY (Continued)**OVERDRIVE GEARTRAIN REMOVAL**

(1) Remove overdrive clutch wave spring (Fig. 249).

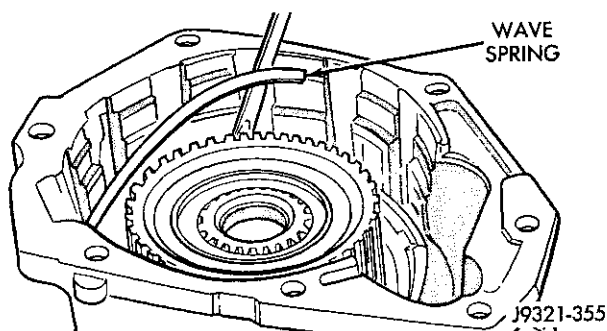


Fig. 249 Overdrive Clutch Wave Spring Removal/Installation

(2) Remove overdrive clutch reaction snap ring (Fig. 250). Note that snap ring is located in same groove as wave spring.

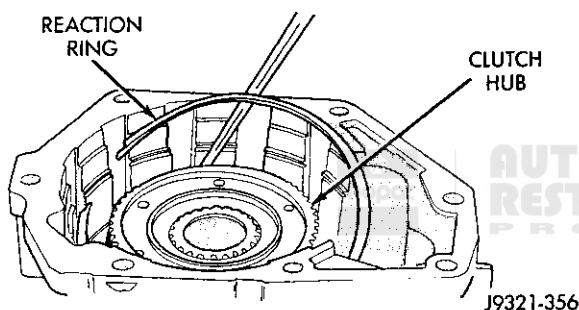


Fig. 250 Overdrive Clutch Reaction Snap Ring Removal/Installation

(3) Remove Torx head screws that attach access cover and gasket to overdrive case (Fig. 251). A T25 size Torx head bit is required.

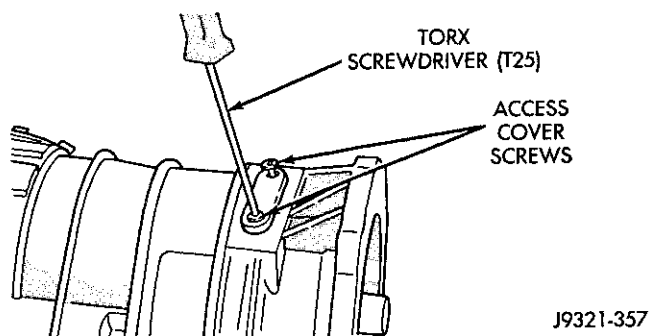


Fig. 251 Access Cover Screw Removal/Installation

(4) Remove access cover and gasket (Fig. 252).

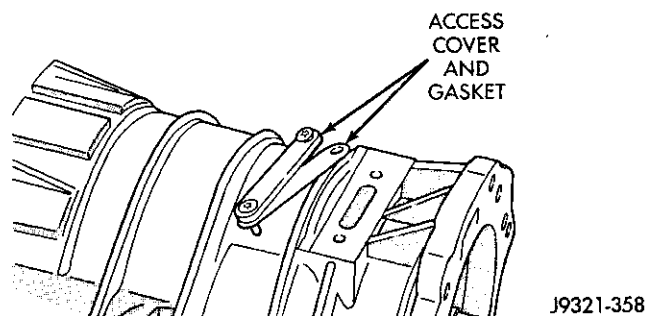


Fig. 252 Access Cover And Gasket Removal/Installation

(5) Expand output shaft bearing snap ring with expanding-type snap ring pliers. Then push output shaft forward to release shaft bearing from locating ring (Fig. 253).

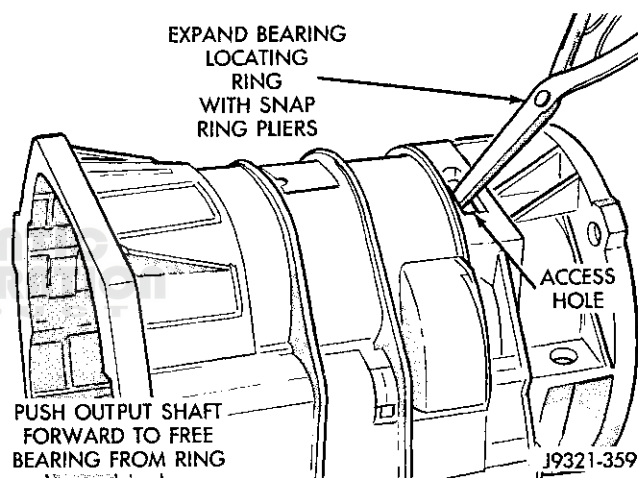


Fig. 253 Releasing Bearing From Locating Ring

(6) Lift gear case up and off geartrain assembly (Fig. 254).

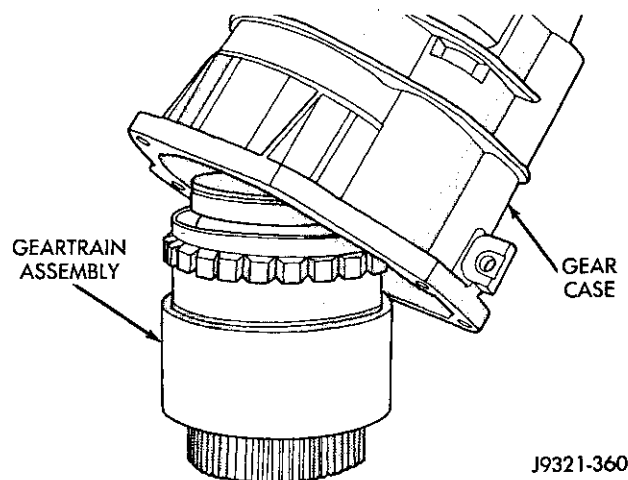


Fig. 254 Removing Gear Case From Geartrain Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Remove snap ring that retains rear bearing on output shaft (Fig. 255).

(8) Remove rear bearing from output shaft (Fig. 256).

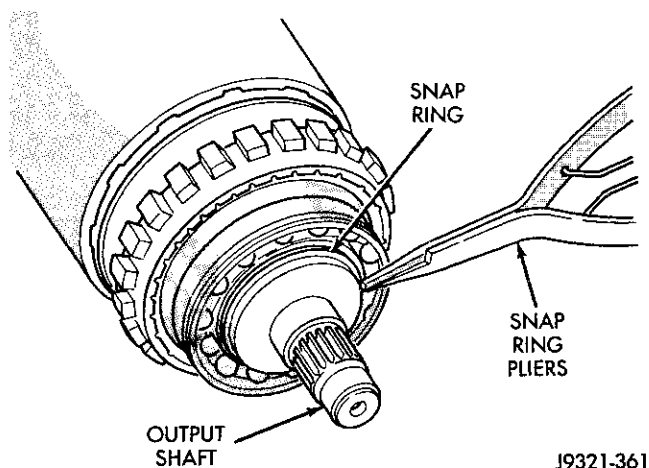


Fig. 255 Rear Bearing Snap Ring Removal/Installation

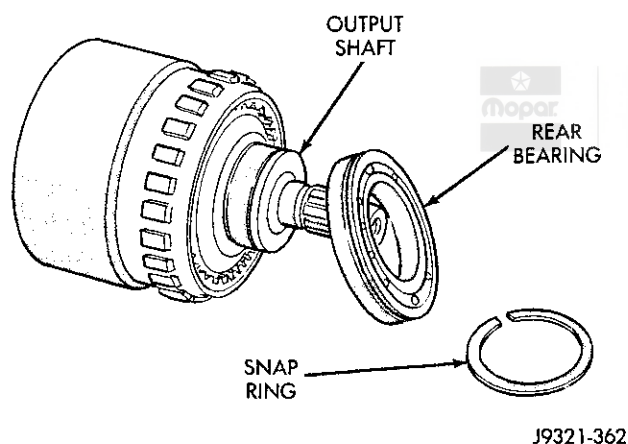


Fig. 256 Rear Bearing Removal

DIRECT CLUTCH, HUB AND SPRING REMOVAL

WARNING: THE NEXT STEP IN DISASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 830 POUNDS. USE SPRING COMPRESSOR TOOL 6227-1 AND A HYDRAULIC SHOP PRESS WITH A MINIMUM RAM TRAVEL OF 5-6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

(1) Mount geartrain assembly in shop press (Fig. 257).

(2) Position Compressor Tool 6227-1 on clutch hub (Fig. 257). Support output shaft flange with steel press plates as shown and center assembly under press ram.

(3) Use Special Tool C-3995-A (or similar size tool) at top of Tool 6227-1 to help distribute load and provide needed extra press length (Fig. 257).

(4) Apply press pressure slowly. Compress hub and spring far enough to expose clutch hub retaining ring and relieve spring pressure on clutch pack snap ring (Fig. 257).

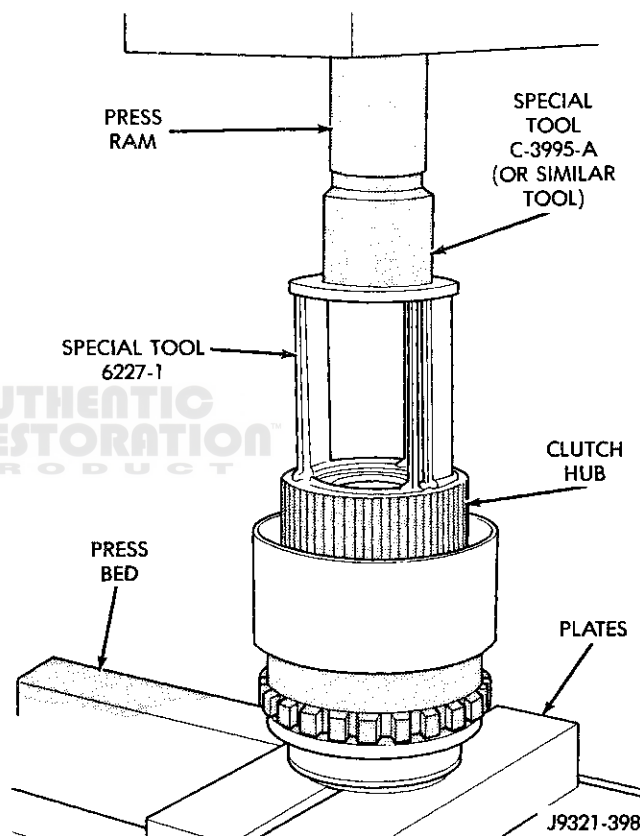


Fig. 257 Geartrain Mounted In Shop Press

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Remove direct clutch pack snap ring (Fig. 258).

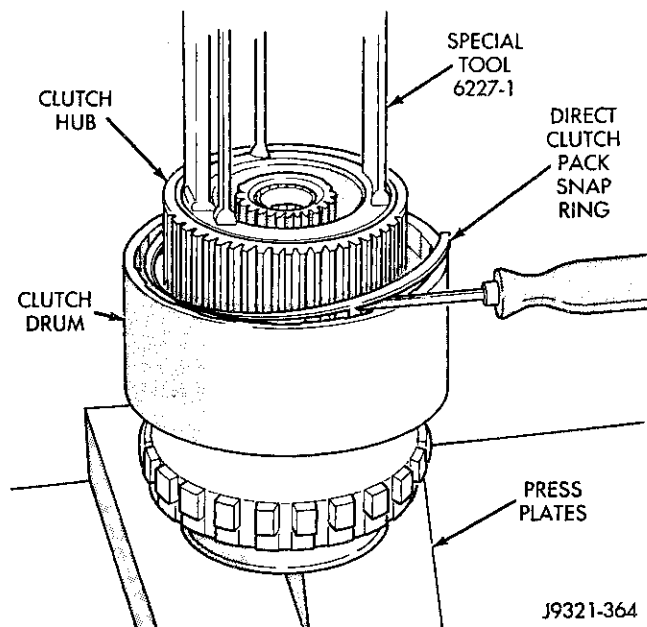


Fig. 258 Direct Clutch Pack Snap Ring Removal

(6) Remove direct clutch hub retaining ring (Fig. 259).

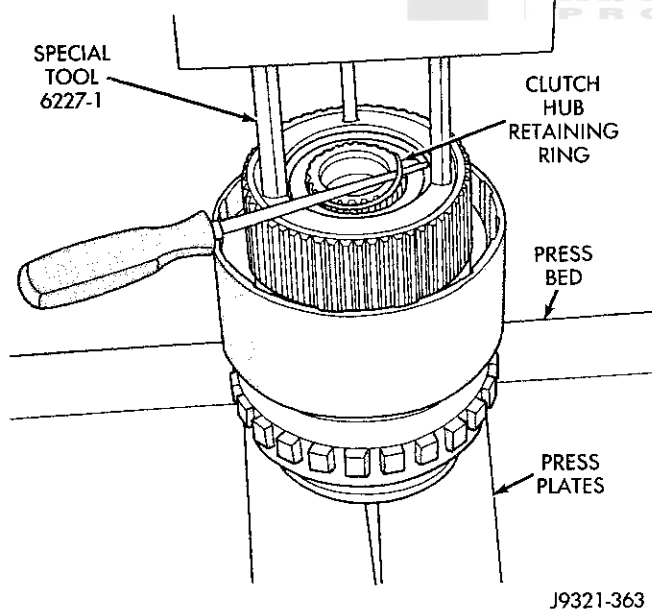


Fig. 259 Direct Clutch Hub Retaining Ring Removal

(7) Release press load **slowly and completely** (Fig. 260).

(8) Remove Special Tool 6227-1. Then remove clutch pack from hub (Fig. 260).

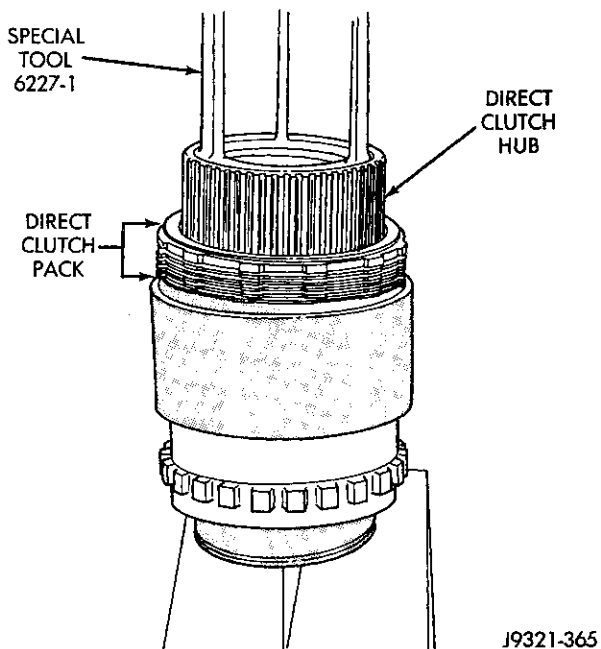


Fig. 260 Direct Clutch Pack Removal

Geartrain Disassembly

(1) Remove direct clutch hub and spring (Fig. 261).

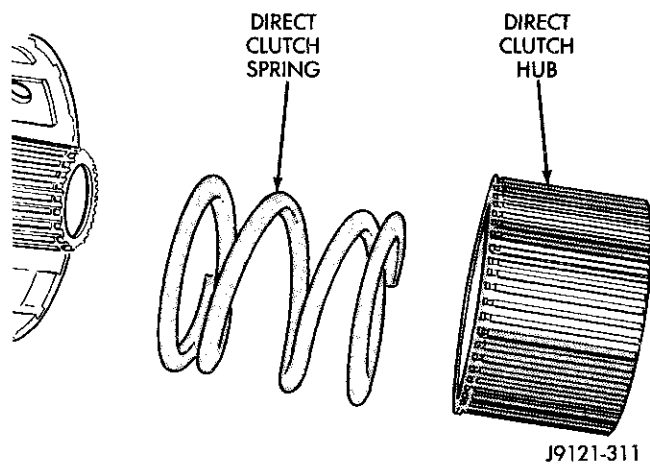


Fig. 261 Direct Clutch Hub And Spring Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(2) Remove sun gear and spring plate. Then remove planetary thrust bearing and planetary gear (Fig. 262).

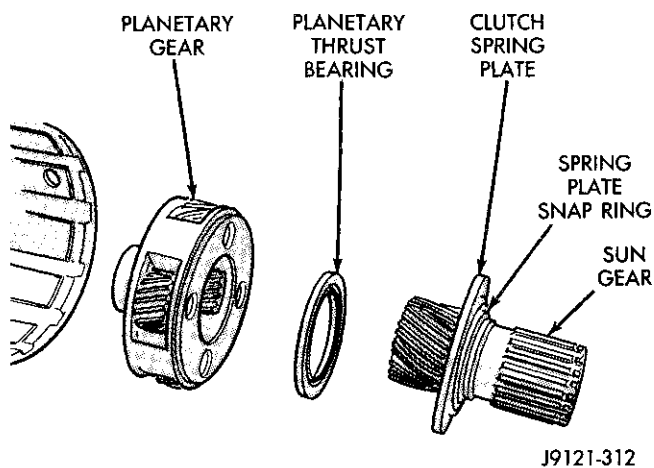


Fig. 262 Removing Sun Gear, Thrust Bearing And Planetary Gear

(3) Remove overrunning clutch assembly with expanding type snap ring pliers (Fig. 263). Insert pliers into clutch hub. Expand pliers to grip hub splines and remove clutch with counterclockwise, twisting motion.

(4) Remove thrust bearing from overrunning clutch hub (Fig. 264).

(5) Remove overrunning clutch from hub (Fig. 264).

(6) Mark position of annulus gear and direct clutch drum for assembly alignment reference (Fig. 265). Use small center punch or scribe to make alignment marks.

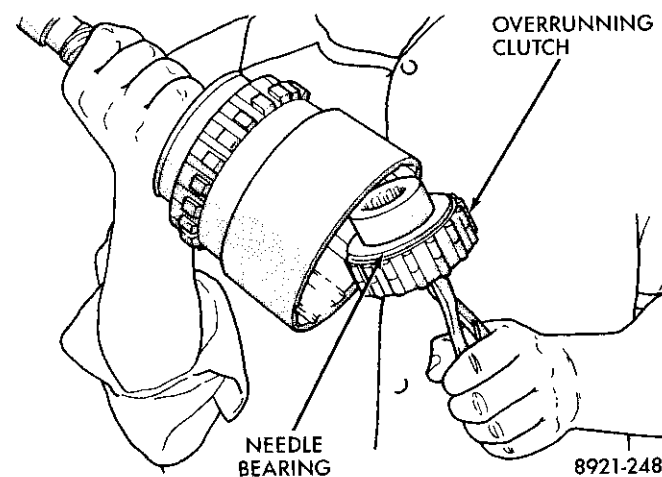


Fig. 263 Overrunning Clutch Assembly Removal/Installation

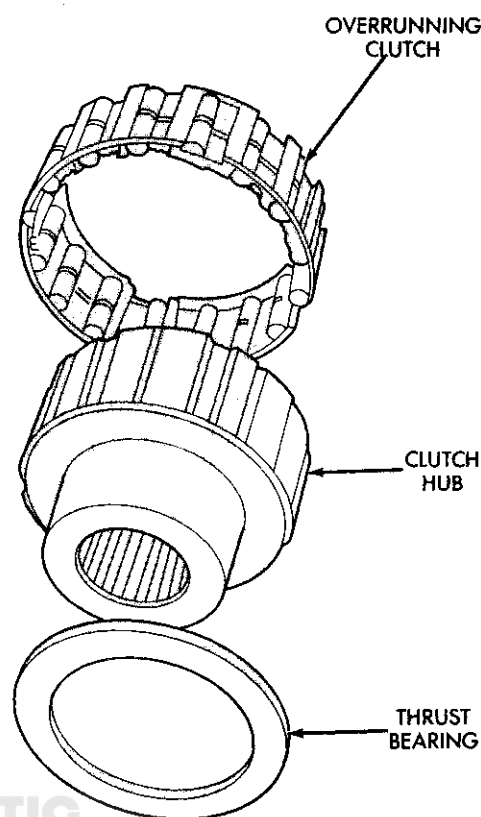


Fig. 264 Overrunning Clutch Components

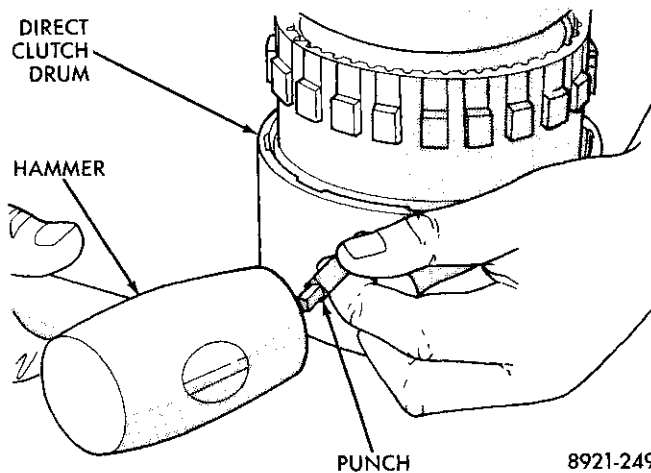
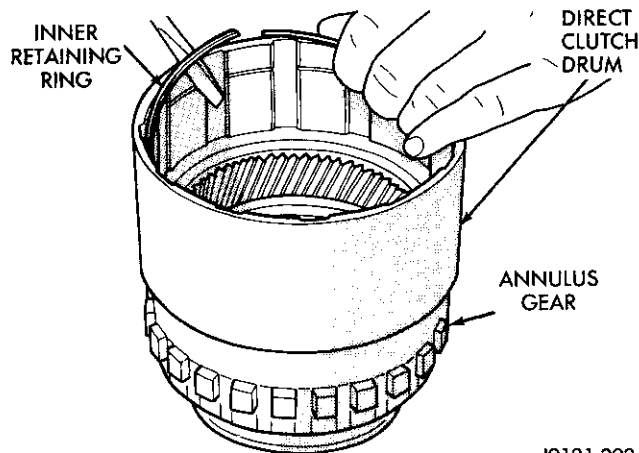


Fig. 265 Marking Direct Clutch Drum And Annulus Gear For Assembly Alignment

DISASSEMBLY AND ASSEMBLY (Continued)

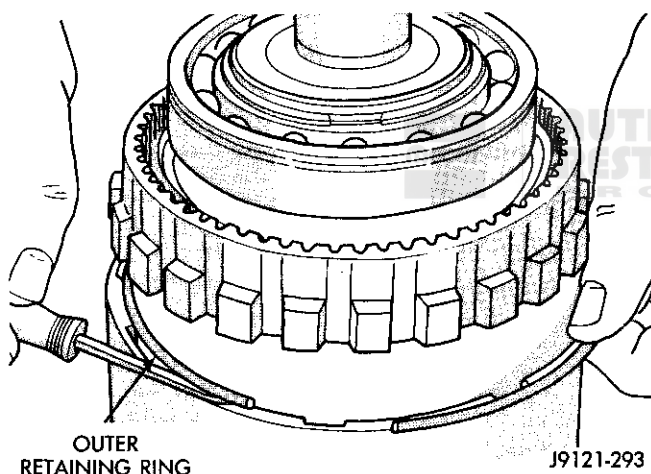
(7) Remove direct clutch drum rear retaining ring (Fig. 266).



J9121-292

Fig. 266 Clutch Drum Inner Retaining Ring Removal

(8) Remove direct clutch drum outer retaining ring (Fig. 267).



J9121-293

Fig. 267 Clutch Drum Outer Retaining Ring Removal

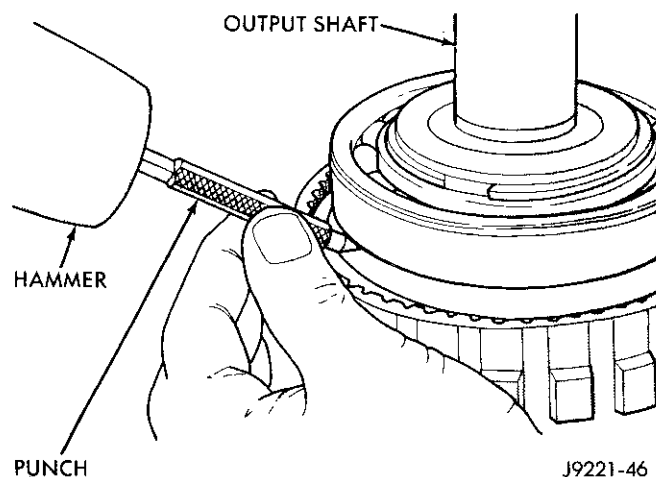
(9) Mark annulus gear and output shaft for assembly alignment reference (Fig. 268). Use punch or scriber to mark gear and shaft.

(10) Remove snap ring that secures annulus gear on output shaft (Fig. 269). Use two screwdrivers to unseat and work snap ring out of groove as shown.

(11) Remove annulus gear from output shaft (Fig. 270). Use rawhide or plastic mallet to tap gear off shaft.

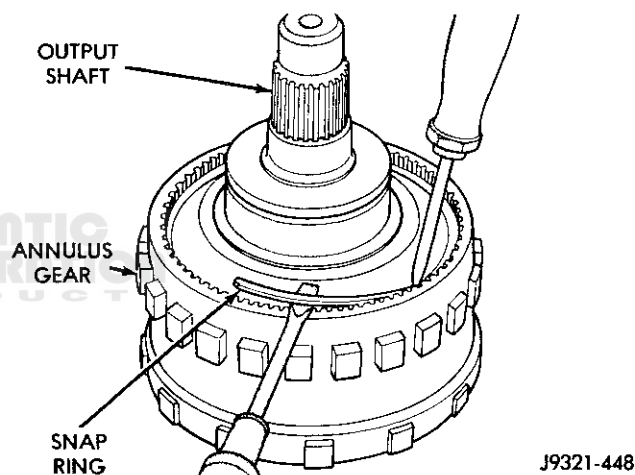
GEAR CASE AND PARK LOCK DISASSEMBLY

- (1) Remove locating ring from gear case.
- (2) Remove park pawl shaft retaining bolt and remove shaft, pawl and spring.
- (3) Remove reaction plug snap ring and remove reaction plug.



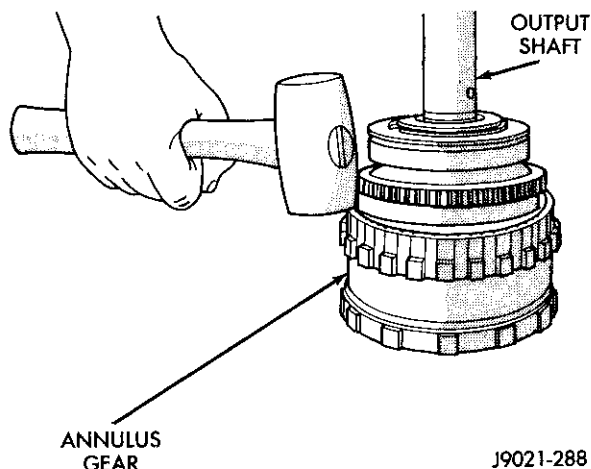
J9221-46

Fig. 268 Marking Annulus Gear And Output Shaft For Assembly Alignment



J9321-448

Fig. 269 Annulus Gear Snap Ring Removal



J9021-288

Fig. 270 Annulus Gear Removal

(4) Remove output shaft seal. Use punch or tool similar to Seal Remover C-3981.

DISASSEMBLY AND ASSEMBLY (Continued)**OVERDRIVE UNIT ASSEMBLY****GEARTRAIN AND DIRECT CLUTCH ASSEMBLY**

(1) Soak direct clutch and overdrive clutch discs in Mopar ATF Plus transmission fluid. Allow discs to soak for 10-20 minutes.

(2) Install new pilot bushing and clutch hub bushing in output shaft if necessary (Fig. 271). Lubricate bushings with petroleum jelly, or transmission fluid.

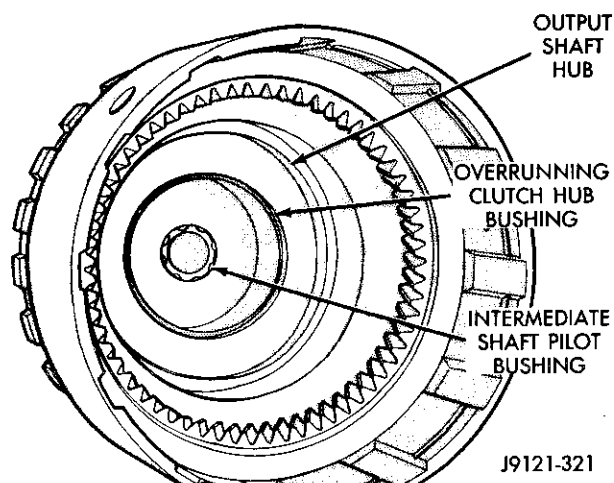


Fig. 271 Output Shaft Pilot Bushing

(3) Install annulus gear on output shaft, if removed. Then install annulus gear retaining snap ring (Fig. 272).

(4) Align and install clutch drum on annulus gear (Fig. 273). Be sure drum is engaged in annulus gear lugs.

(5) Install clutch drum outer retaining ring (Fig. 273).

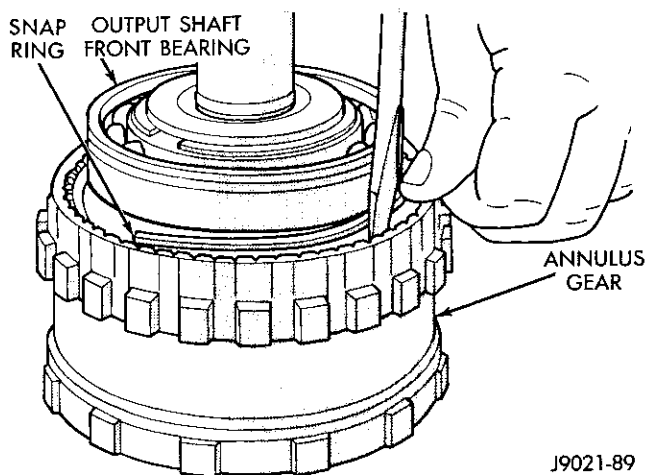


Fig. 272 Annulus Gear Installation

(6) Slide clutch drum forward and install inner retaining ring (Fig. 274).

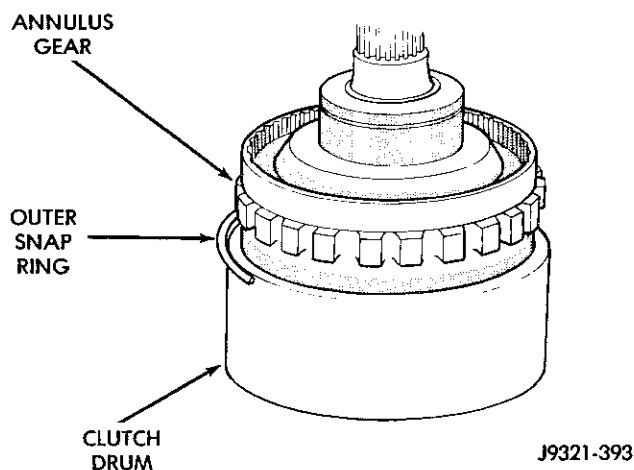


Fig. 273 Clutch Drum And Outer Retaining Ring Installation

(7) Install rear bearing and snap ring on output shaft (Fig. 275). Be sure locating ring groove in bearing is toward rear.

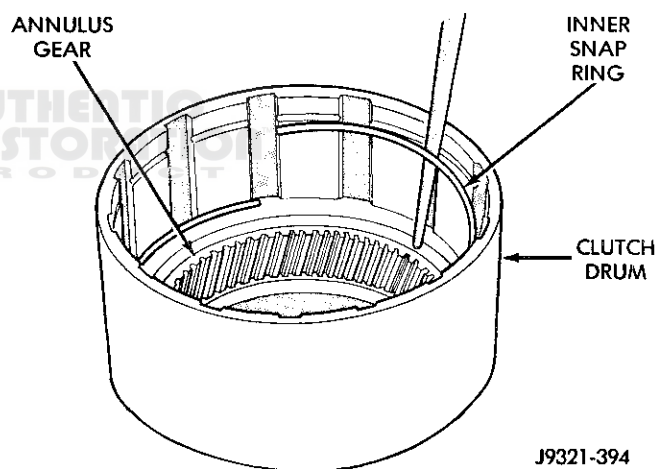


Fig. 274 Clutch Drum Inner Retaining Ring Installation

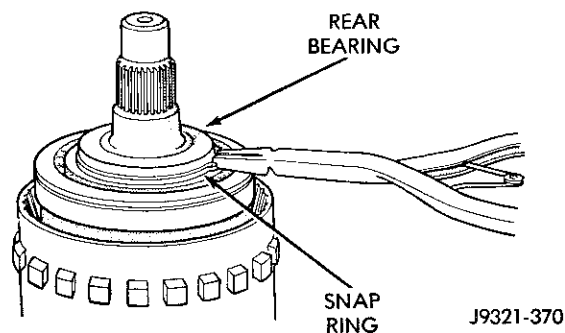


Fig. 275 Rear Bearing And Snap Ring Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(8) Install overrunning clutch on hub (Fig. 276). **Note that clutch only fits one way. Shoulder on clutch should seat in small recess at edge of hub.**

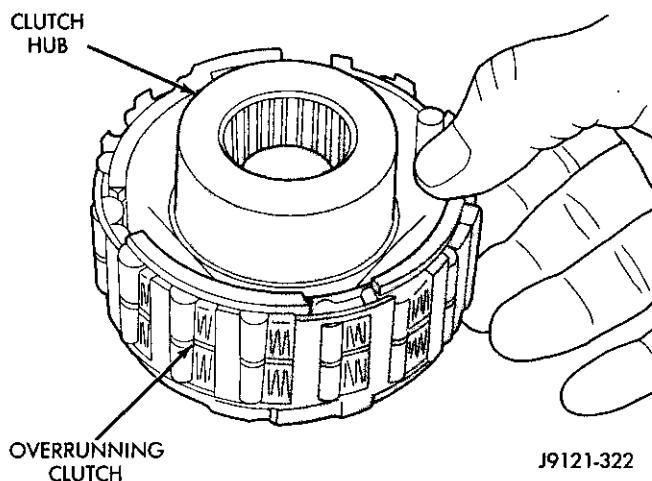


Fig. 276 Assembling Overrunning Clutch And Hub

(9) Install thrust bearing on overrunning clutch hub (Fig. 277). Use generous amount of petroleum jelly to hold bearing in place for installation. **Bearing fits one way only. Be sure bearing is seated squarely against hub. Reinstall bearing if it does not seat squarely.**

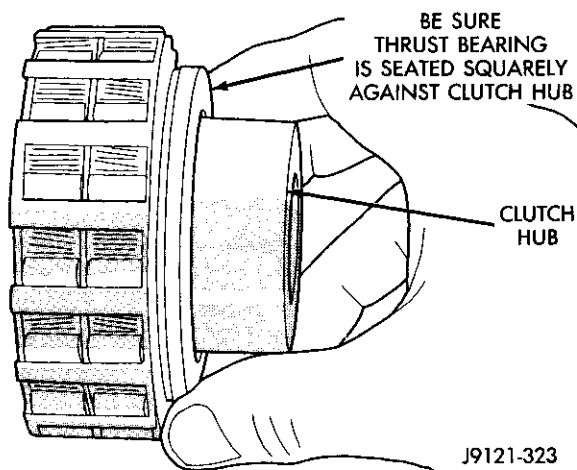


Fig. 277 Overrunning Clutch Thrust Bearing Installation

(10) Install overrunning clutch in output shaft (Fig. 278). Insert snap ring pliers in hub splines. Expand pliers to grip hub. Then install assembly with counterclockwise, twisting motion.

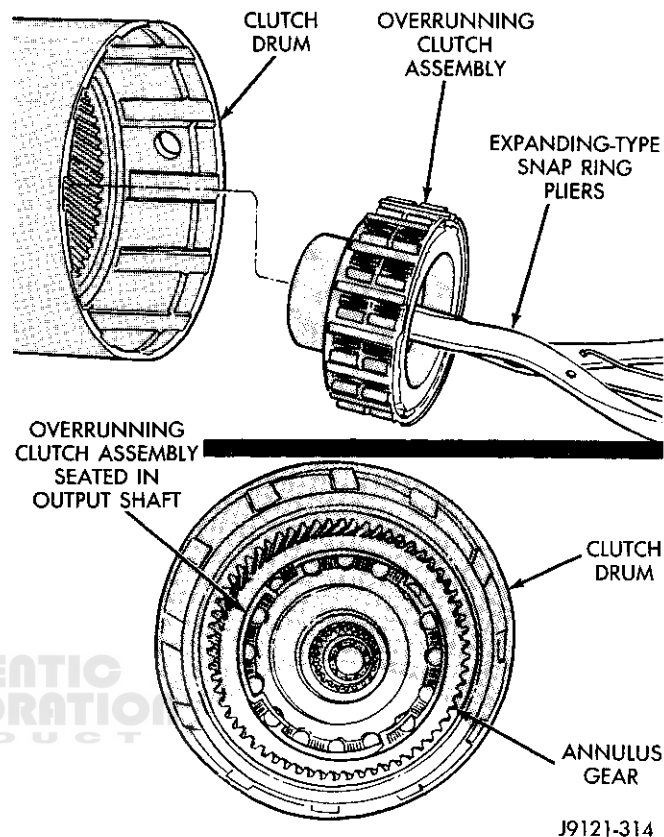


Fig. 278 Overrunning Clutch Installation

(11) Install planetary gear in annulus gear (Fig. 279). **Be sure planetary pinions are fully seated in annulus gear before proceeding.**

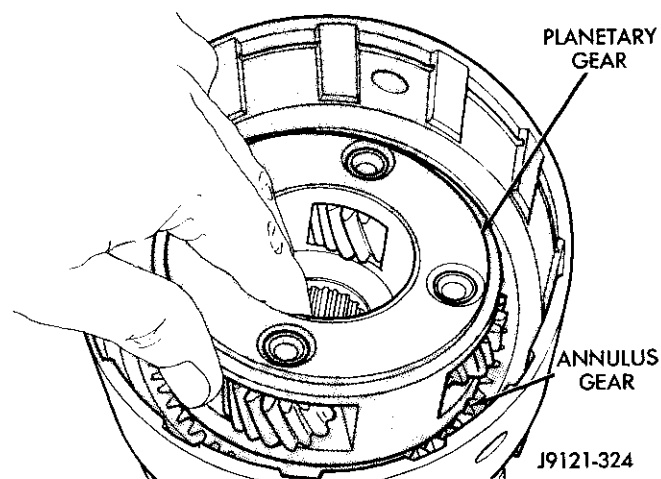


Fig. 279 Planetary Gear Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(12) Install direct clutch spring plate on sun gear. Shoulder side of plate should face outward and toward front. Then secure plate to sun gear with snap ring (Fig. 280).

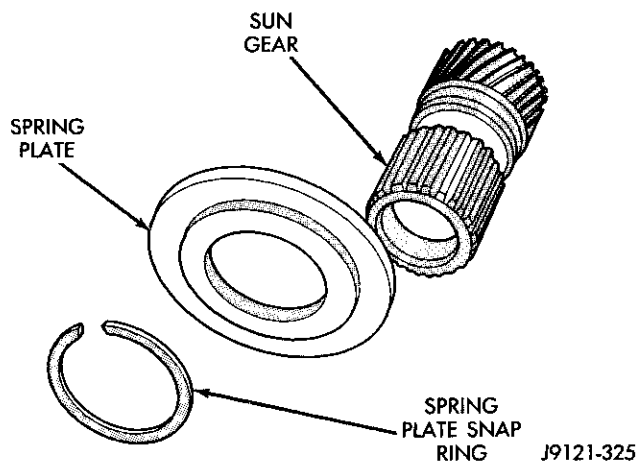


Fig. 280 Sun Gear And Spring Plate Assembly

(13) Coat planetary thrust bearing and bearing contact surface of spring plate with generous amount of petroleum jelly. This will help hold bearing in place during installation.

(14) Install planetary thrust bearing on sun gear (Fig. 281). Slide bearing onto gear and seat it against spring plate as shown. **Bearing fits one way only. If it does not seat squarely against spring plate, remove and reposition bearing.**

(15) Install assembled sun gear, spring plate and thrust bearing (Fig. 282). Be sure sun gear and thrust bearing are fully seated before proceeding.

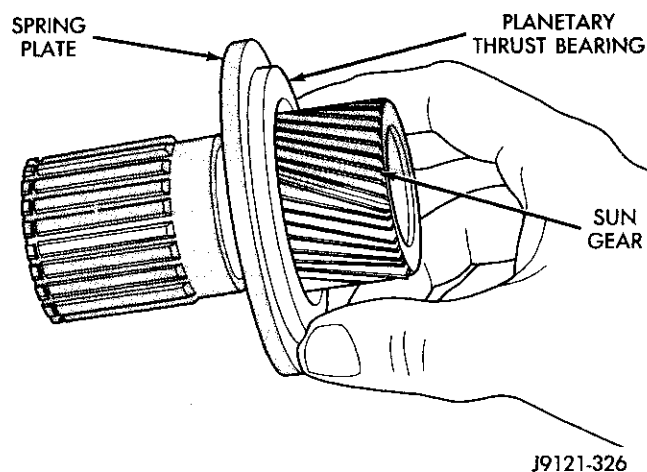


Fig. 281 Planetary Thrust Bearing Installation

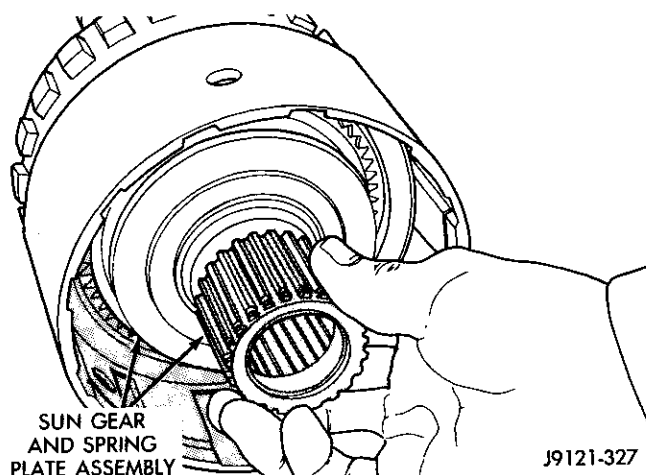


Fig. 282 Sun Gear Installation

(16) Mount assembled output shaft, annulus gear, and clutch drum in shop press. Direct clutch spring, hub and clutch pack are easier to install with assembly mounted in press.

(17) Align splines in hubs of planetary gear and overrunning clutch with Alignment tool 6227-2 (Fig. 283). Insert tool through sun gear and into splines of both hubs. Be sure alignment tool is fully seated before proceeding.

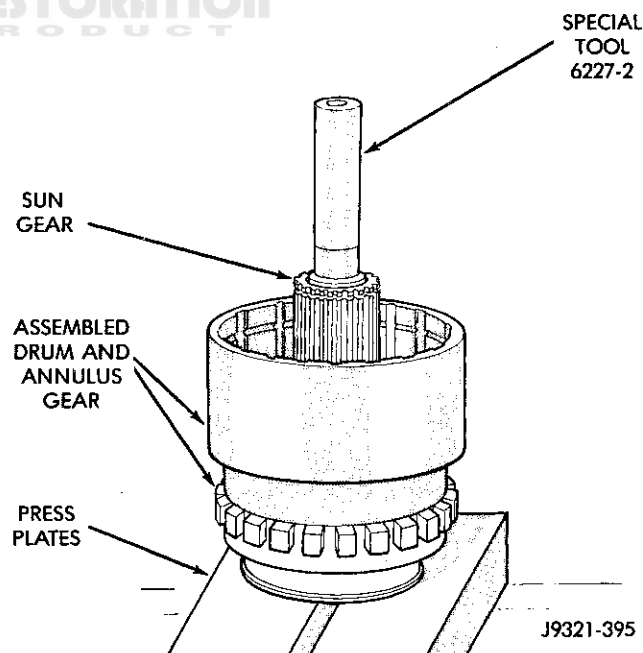


Fig. 283 Alignment Tool Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(18) Install direct clutch spring (Fig. 284). Be sure spring is properly seated on spring plate.

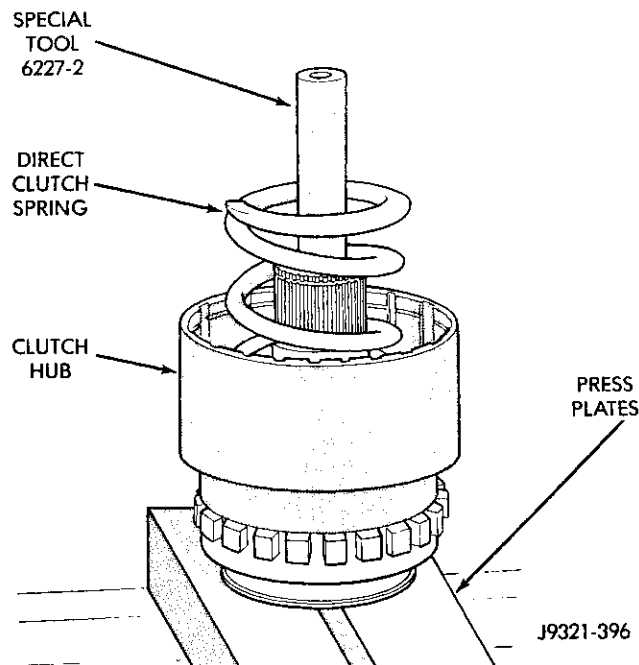


Fig. 284 Direct Clutch Spring Installation

(19) Assemble and install direct clutch pack on hub as follows:

- (a) Assemble clutch pack components (Fig. 285).
- (b) Install direct clutch reaction plate on clutch hub first. **Note that one side of reaction plate is counterbored. Be sure this side faces rearward. Splines at rear of hub are raised**

slightly. Counterbore in plate fits over raised splines. Plate should be flush with this end of hub (Fig. 286).

(c) Install first clutch disc followed by a steel plate until 6 discs and 5 plates have been installed.

(d) Install pressure plate. This is last clutch pack item to be installed. **Be sure plate is installed with shoulder side facing upward (Fig. 287).**

(20) Install clutch hub and clutch pack on direct clutch spring (Fig. 288). **Be sure hub is started on sun gear splines before proceeding.**

WARNING: THE NEXT STEP IN GEARTRAIN ASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH HUB AND SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 830 POUNDS. USE COMPRESSOR TOOL C-6227-1 AND A HYDRAULIC-TYPE SHOP PRESS WITH A MINIMUM RAM TRAVEL OF 6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

(21) Carefully **remove** Alignment Tool 6227-2 from clutch and hub splines. Withdraw tool slowly to avoid spline misalignment. Tool must be removed at this point to provide room for compressor tool movement.

(22) Position Compressor Tool 6227-1 on clutch hub (Fig. 289).

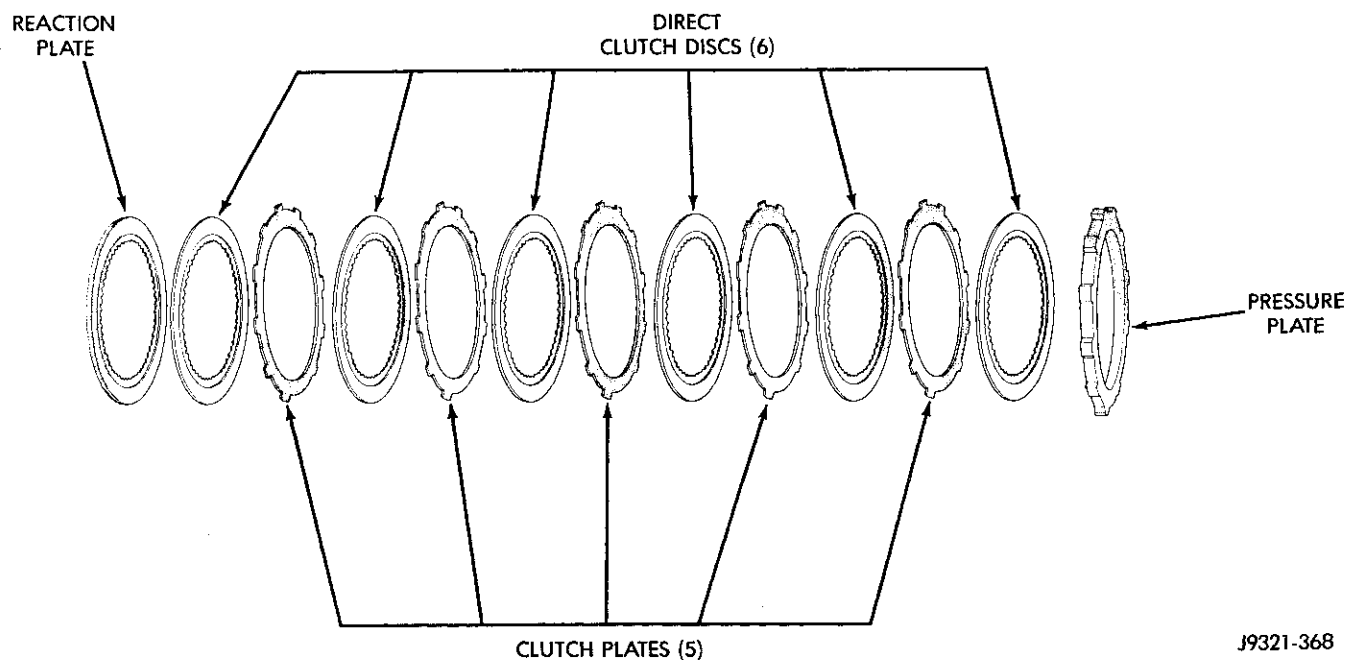
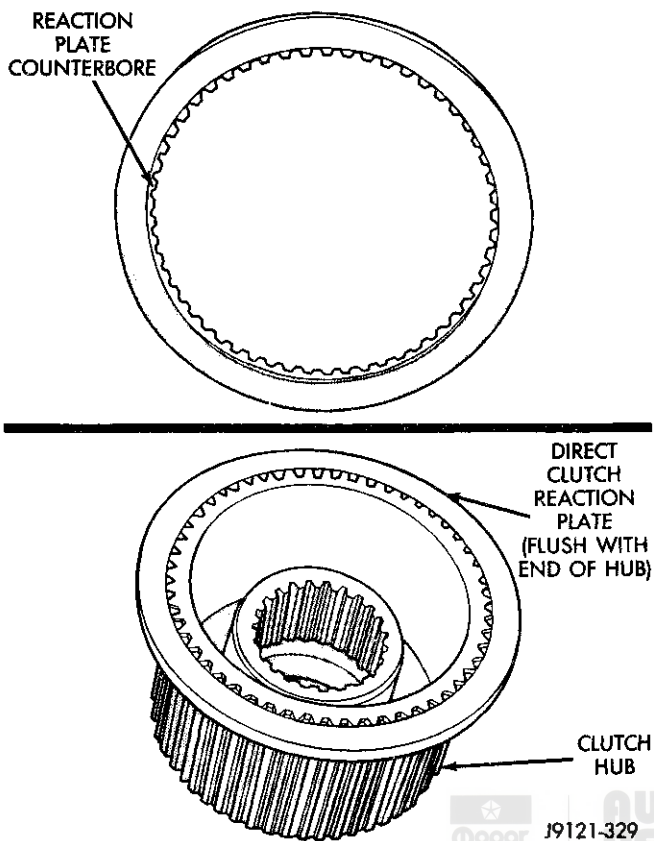
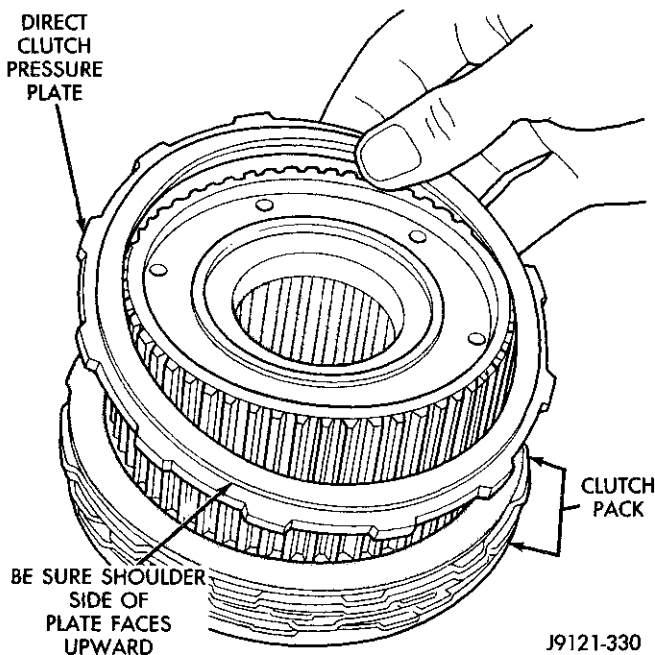
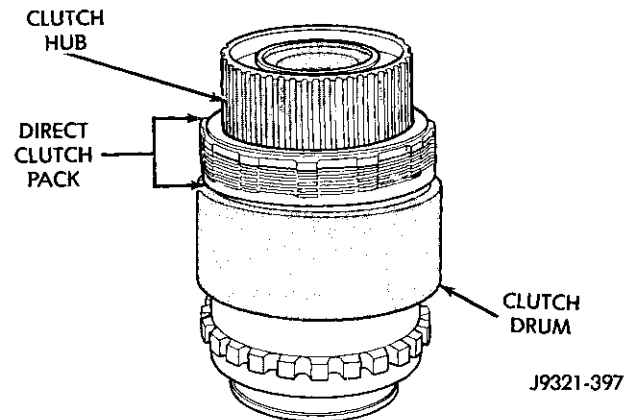
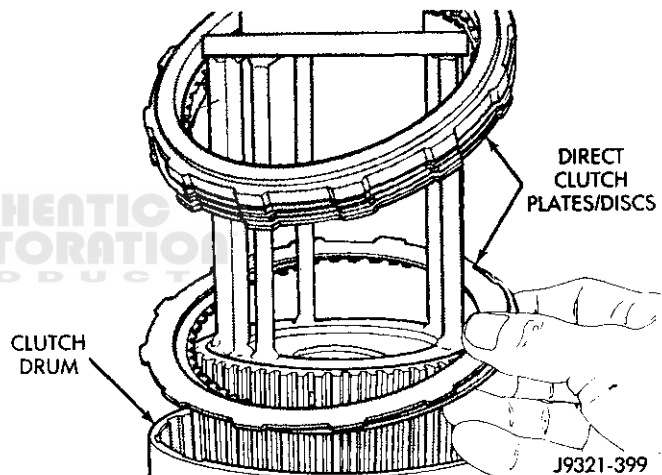


Fig. 285 Direct Clutch Pack Components

J9321-368

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 286 Correct Position Of Direct Clutch Reaction Plate****Fig. 287 Correct Position Of Direct Clutch Pressure Plate****Fig. 288 Direct Clutch Pack And Clutch Hub Installation****Fig. 289 Seating Clutch Pack In Drum**

(23) Position Tool C-3995-A or similar type tool on top of Tool 6227-1 (Fig. 290).

(24) Compress clutch hub and spring just enough to place tension on hub and hold it in place.

(25) Slide direct clutch pack upwards on hub (Fig. 289). Then set clutch pack on edge of clutch hub and compressor tool as shown.

(26) Slowly compress clutch hub and spring (Fig. 289). Compress spring and hub only enough to expose ring grooves for clutch pack snap ring and clutch hub retaining ring.

(27) Realign clutch pack on hub and seat clutch discs and plates in clutch drum (Fig. 289).

(28) Install direct clutch pack snap ring (Fig. 291). **Be very sure snap ring is fully seated in clutch drum ring groove.**

(29) Install clutch hub retaining ring (Fig. 292). **Be very sure retaining ring is fully seated in sun gear ring groove.**

DISASSEMBLY AND ASSEMBLY (Continued)

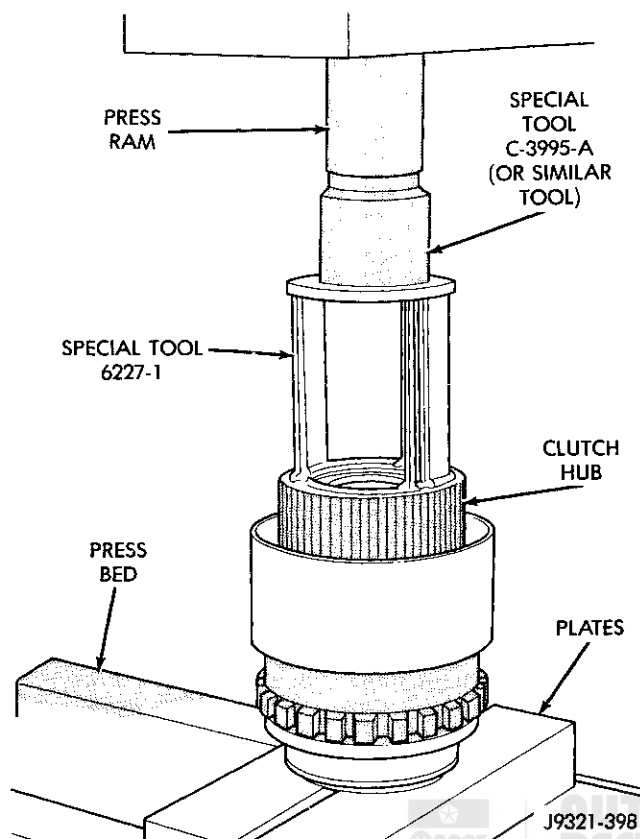


Fig. 290 Geartrain Mounted In Press

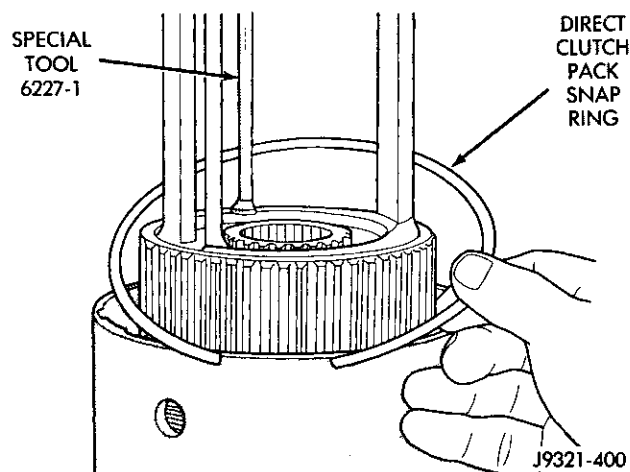


Fig. 291 Direct Clutch Pack Snap Ring Installation

(30) Slowly release press ram, remove compressor tools and remove geartrain assembly.

GEAR CASE ASSEMBLY AND INSTALLATION

(1) Position park pawl and spring in case and install park pawl shaft (Fig. 293). Verify that end of spring with 90° bend is hooked to pawl and straight end of spring is seated against case.

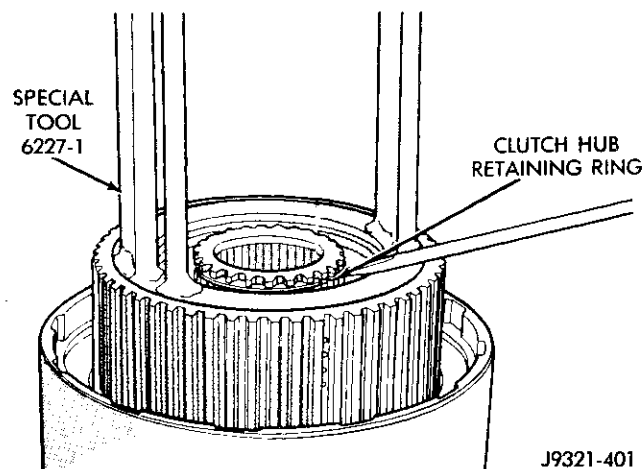


Fig. 292 Clutch Hub Retaining Ring Installation

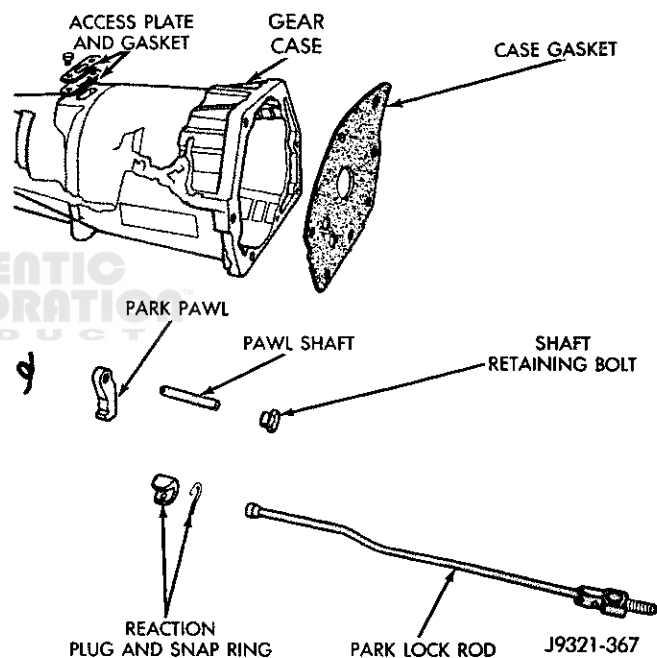


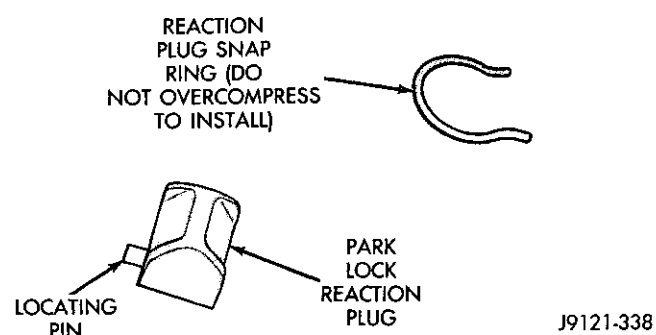
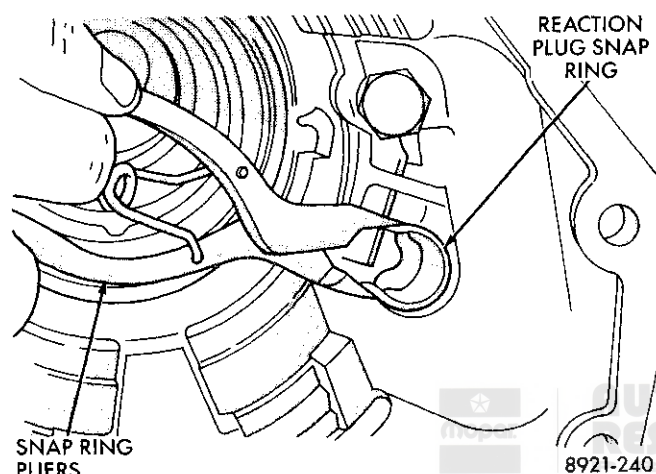
Fig. 293 Park Lock Components

(2) Install pawl shaft retaining bolt. Tighten bolt to 27 N·m (20 ft. lbs.) torque.

(3) Install park lock reaction plug. **Note that plug has locating pin at rear (Fig. 294). Be sure pin is seated in hole in case before installing snap ring.**

(4) Install reaction plug snap ring (Fig. 295). **Compress snap ring only enough for installation; do not distort it.**

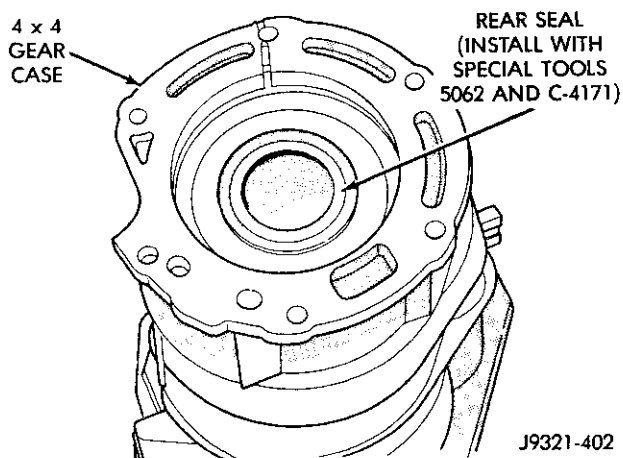
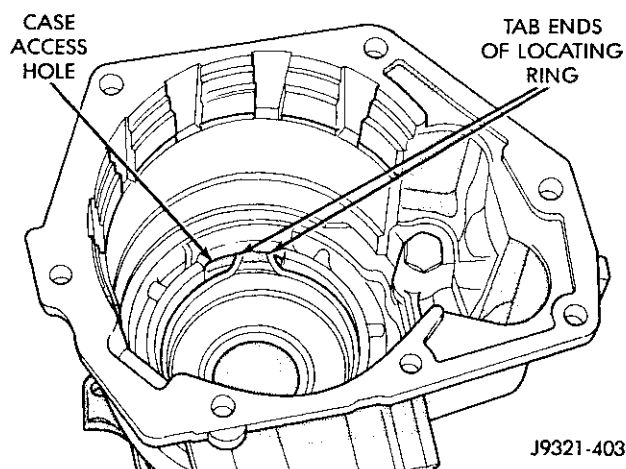
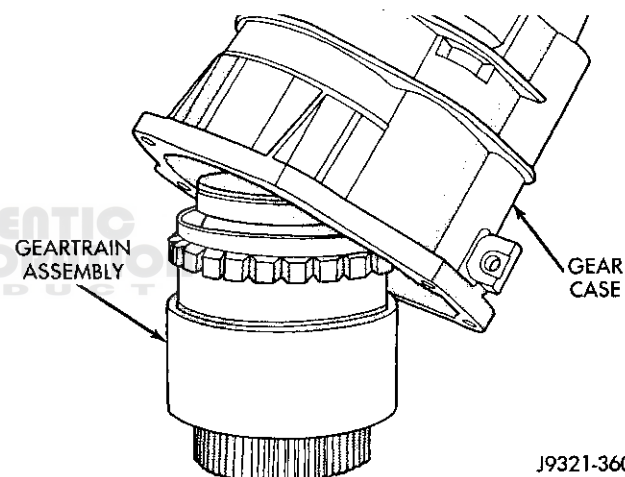
(5) Install new seal in gear case (Fig. 296). On 4x4 gear case, use Tool Handle C-4171 and Installer 5062 (or similar size tool) to seat seal in case. On 4 x 2 gear case, use same tool handle and suitable size installer to seat seal in case.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 294 Reaction Plug Locating Pin And Snap Ring****Fig. 295 Reaction Plug And Snap Ring Installation**

(6) Verify that tab ends of rear bearing locating ring extend into access hole in gear case (Fig. 297).

(7) Support geartrain on Tool 6227-1 (Fig. 298). Be sure tool is securely seated in clutch hub.

(8) Install overdrive gear case on geartrain (Fig. 298).

**Fig. 296 Rear Seal Installation—4x4 Gear Case****Fig. 297 Correct Rear Bearing Locating Ring Position****Fig. 298 Overdrive Gear Case Installation**

(9) Expand front bearing locating ring with snap ring pliers (Fig. 299). Then slide case downward until locating ring locks in bearing groove and release snap ring.

(10) Install locating ring access cover and gasket in overdrive unit case (Fig. 300).

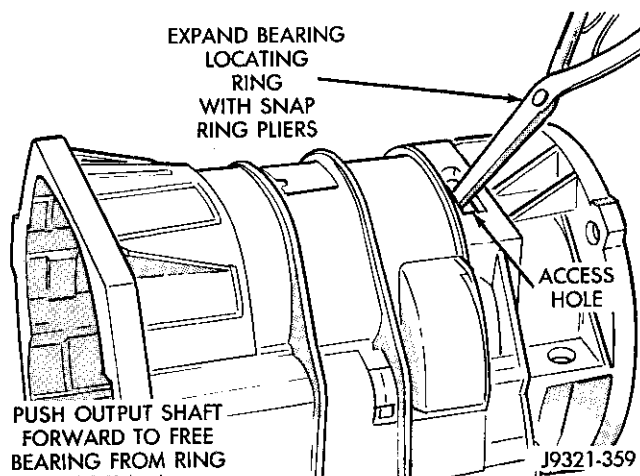
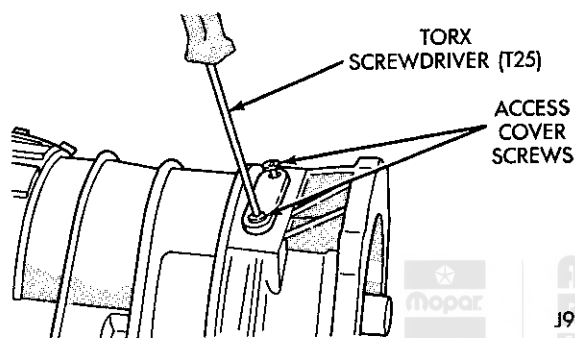
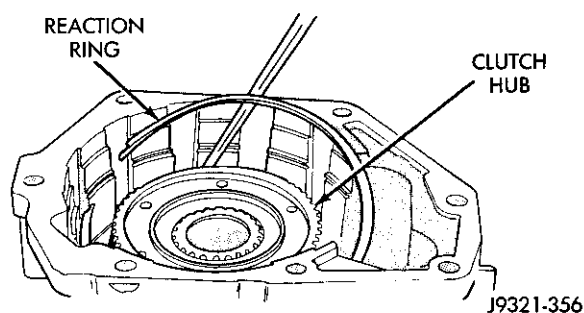
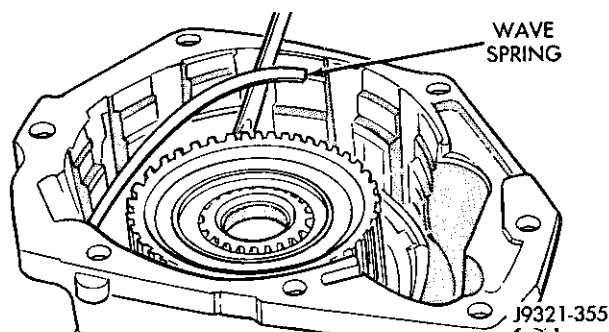
OVERDRIVE CLUTCH INSTALLATION

(1) Install overdrive clutch reaction ring first. Reaction ring is flat with notched ends (Fig. 301).

(2) Install wave spring on top of reaction ring (Fig. 302). **Reaction ring and wave ring both fit in same ring groove.** Use screwdriver to seat each ring securely in groove.

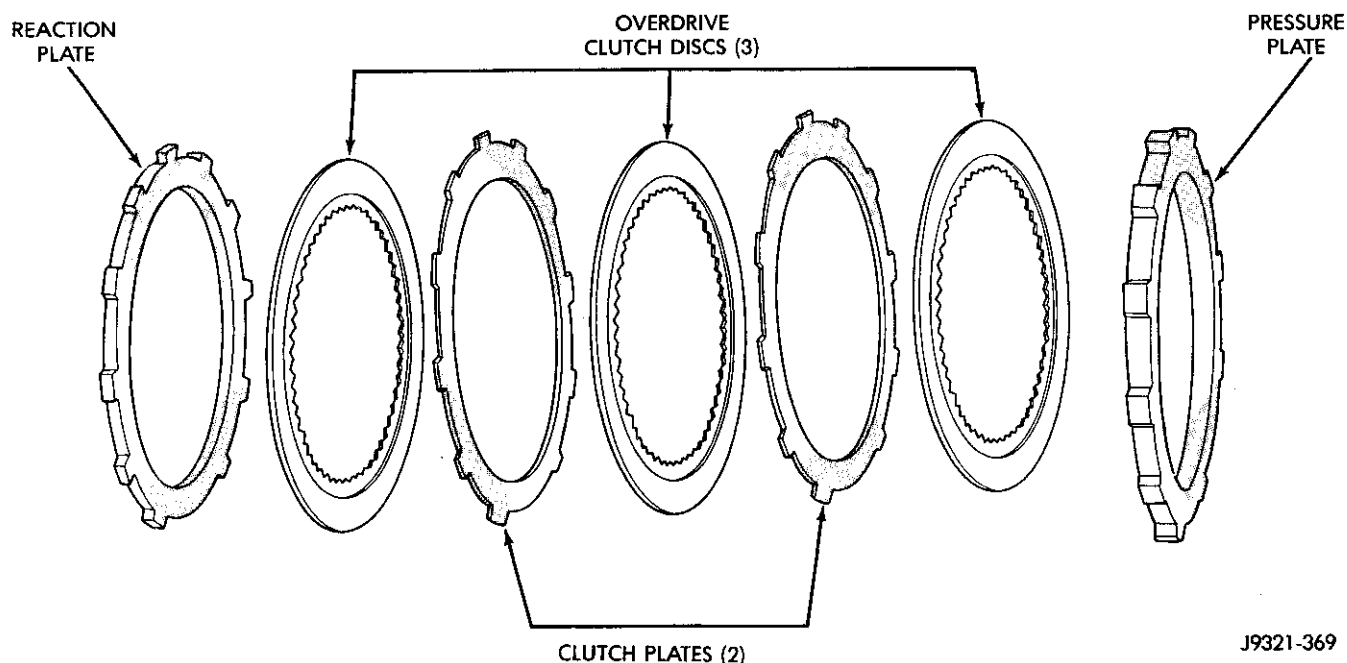
(3) Assemble overdrive clutch pack (Fig. 303).

(4) Install overdrive clutch reaction plate first. **Note that reaction plate is thinner than pressure plate.**

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 299 Seating Locating Ring In Rear Bearing****Fig. 300 Locating Ring Access Cover And Gasket Installation****Fig. 301 Overdrive Clutch Reaction Ring Installation****Fig. 302 Overdrive Clutch Wave Spring Installation**

(5) Install first clutch disc followed by first clutch plate. Then install remaining clutch discs and plates in same order.

(6) Verify clutch pack. 3 clutch discs, 2 steel plates, 1 reaction plate and 1 pressure plate are required.

**Fig. 303 Overdrive Clutch Components**

J9321-369

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Install clutch pack pressure plate. Note that pressure plate is thickest plate in clutch pack.

(8) Install clutch pack wire-type retaining ring (Fig. 304).

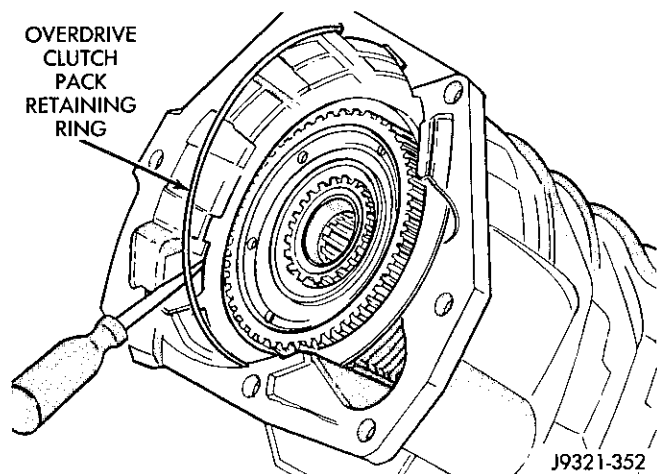


Fig. 304 Overdrive Clutch Pack Retaining Ring Installation

SHAFT END PLAY ADJUSTMENT

(1) Place overdrive unit in vertical position. Mount it on blocks, or in workbench with appropriate size mounting hole cut into it. Be sure unit is facing upward for access to direct clutch hub. Also be sure output shaft is not loaded and internal components are moved rearward for accurate measurement.

(2) Determine correct thickness **intermediate shaft spacer** as follows:

(a) Insert Special Tool 6312 through sun gear, planetary gear and into pilot bushing in output shaft. Be sure tool bottoms against planetary shoulder.

(b) Position Gauge Tool 6311 across face of overdrive case (Fig. 305). Then position Dial Caliper C-4962 over gauge tool.

(c) Extend sliding scale of dial caliper downward through gauge tool slot until scale contacts end of Gauge Alignment Tool 6312. Lock scale in place. Remove dial caliper tool and note distance measured (Fig. 305).

(d) Select proper thickness end play spacer from spacer chart based on distance measured (Fig. 306).

(e) Remove Gauge Alignment Tool 6312.

(3) Determine correct thickness **overdrive piston thrust plate** as follows:

(a) Position Gauge Tool 6311 across face of overdrive case. Then position Dial Caliper C-4962 over gauge tool (Fig. 307).

(b) Measure distance to clutch hub thrust bearing seat at four points 90° apart. Then average measurements by adding them and dividing by 4.

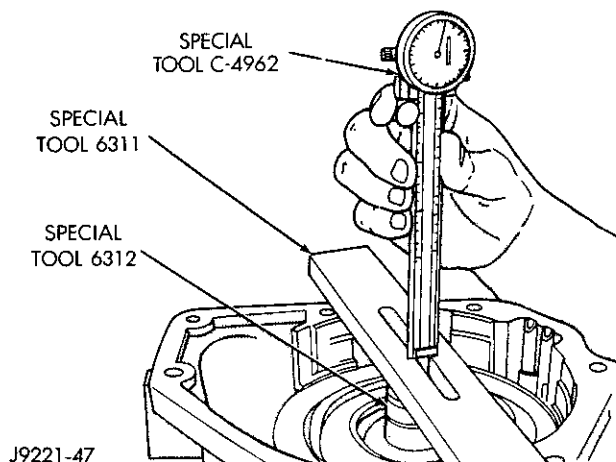


Fig. 305 Shaft End Play Measurement

End Play Measurement (Inches)	Spacer Thickness (Inches)
.7336 - .7505	.158 - .159
.7506 - .7675	.175 - .176
.7676 - .7855	.193 - .194
.7856 - .8011	.211 - .212

J9121-341

Fig. 306 Intermediate Shaft End Play Spacer Selection

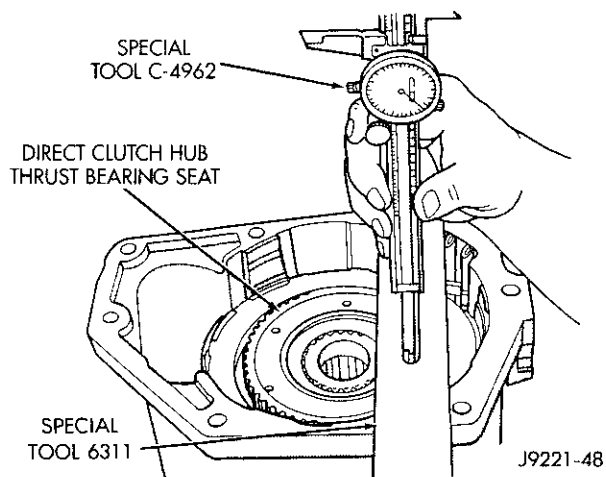


Fig. 307 Overdrive Piston Thrust Plate Measurement

(c) Select and install required thrust plate from information in thrust plate chart (Fig. 308).

(4) Leave Alignment Tool 6227-2 in place. Tool will keep planetary and clutch hub splines in alignment until overdrive unit is ready for installation on transmission.

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Transmission speed sensor can be installed at this time if desired. However, it is recommended that sensor not be installed until after overdrive unit is secured to transmission.

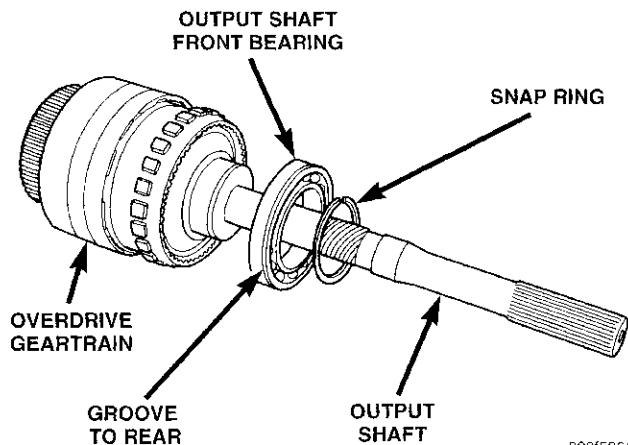
End Play Measurement (Inches)	Spacer Thickness (Inches)
1.7500 - 1.7649	.108 - .110
1.7650 - 1.7799	.123 - .125
1.7800 - 1.7949	.138 - .140
1.7950 - 1.8099	.153 - .155
1.8100 - 1.8249	.168 - .170
1.8250 - 1.8399	.183 - .185
1.8400 - 1.8549	.198 - .200
1.8550 - 1.8699	.213 - .215
1.8700 - 1.8849	.228 - .230
1.8850 - 1.8999	.243 - .245

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Fig. 308 Overdrive Piston Thrust Plate Selection
OVERDRIVE GEARTRAIN

DISASSEMBLE

- (1) Remove output shaft front bearing snap ring (Fig. 309).
- (2) Remove front bearing from output shaft (Fig. 309).



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Fig. 309 Removing Snap Ring And Front Bearing

WARNING: THE NEXT STEP IN GEARTRAIN DISASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 830 POUNDS. USE SPRING COMPRESSOR TOOL 6227-1 AND A HYDRAULIC SHOP PRESS WITH A MINIMUM RAM TRAVEL OF 5-6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS

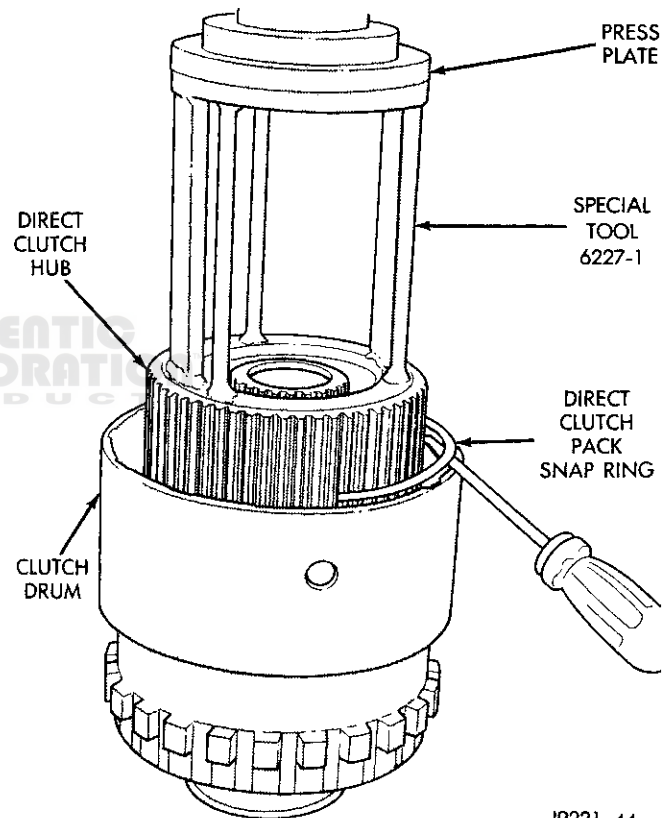
REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

- (3) Mount geartrain in shop press.

(4) Position Compressor Tool 6227-1 on clutch hub (Fig. 310). Support output shaft flange with steel press plates as shown and center assembly under press ram.

(5) Apply press pressure slowly. Compress hub and spring far enough to expose clutch hub retaining ring and relieve spring pressure on clutch pack snap ring (Fig. 310).

(6) Remove direct clutch pack snap ring first (Fig. 310).



J9221-44

Fig. 310 Removing Direct Clutch Pack Snap Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Remove direct clutch hub retaining ring (Fig. 311).

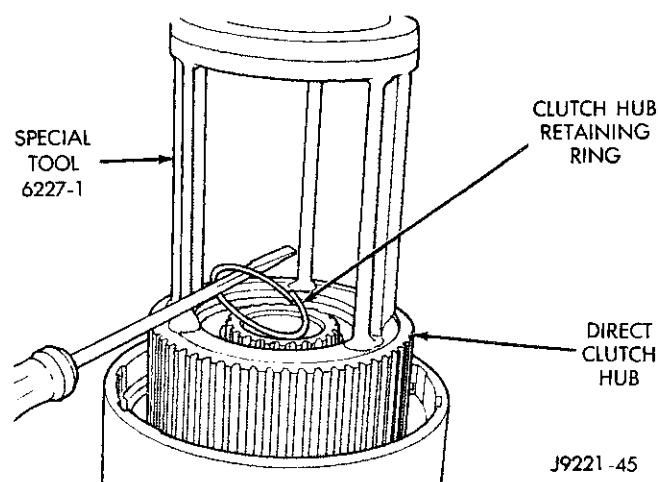


Fig. 311 Removing Direct Clutch Hub Retaining Ring

(8) Release press load on clutch spring **slowly and completely**. Remove press tools and geartrain.

(9) Remove direct clutch pack from hub (Fig. 312).

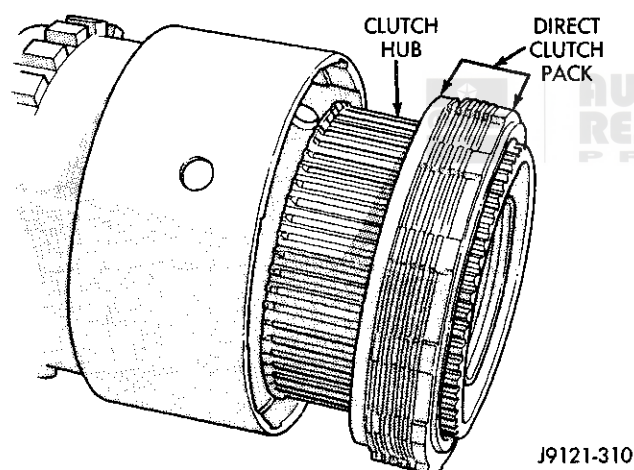


Fig. 312 Direct Clutch Pack Removal

(10) Remove direct clutch hub and spring (Fig. 313).

(11) Remove sun gear and spring plate, planetary thrust bearing and planetary gear (Fig. 314).

(12) Remove overrunning clutch assembly with expanding type snap ring plier (Fig. 315). Insert pliers into clutch hub. Expand pliers to grip hub splines and remove clutch with counterclockwise, twisting motion.

(13) Remove thrust bearing from overrunning clutch hub (Fig. 316).

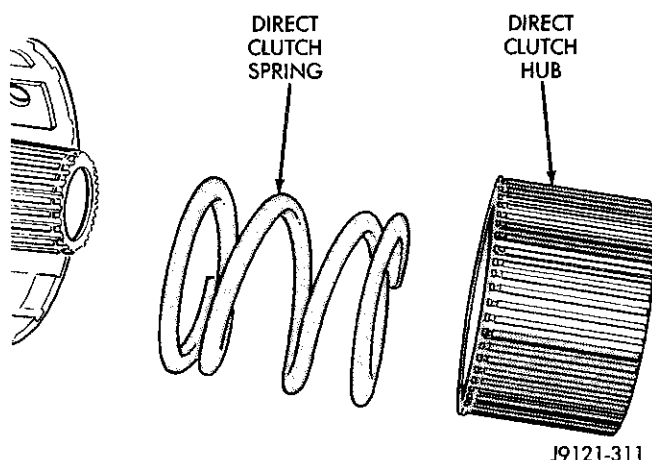


Fig. 313 Direct Clutch Hub And Spring Removal

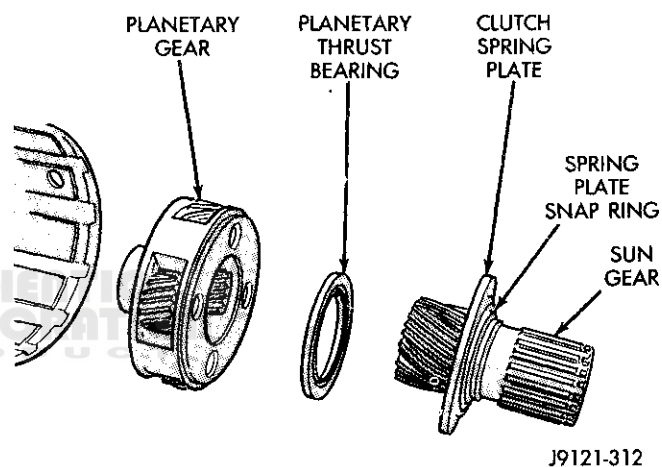


Fig. 314 Removing Sun Gear/Thrust Bearing/Planetary Gear

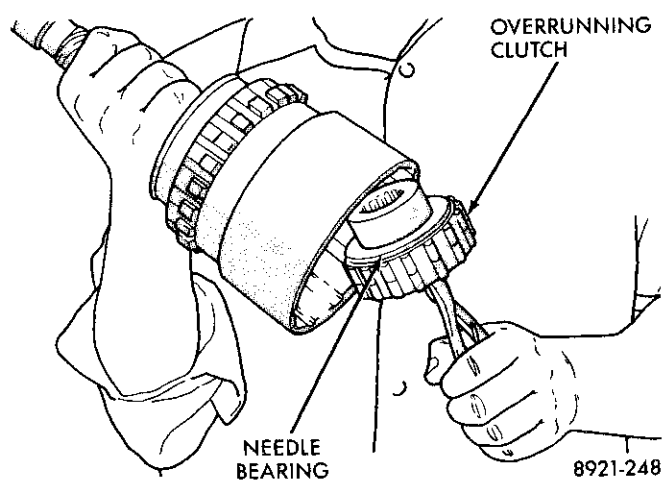


Fig. 315 Removing Overrunning Clutch Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

(14) Remove overrunning clutch from hub (Fig. 316).

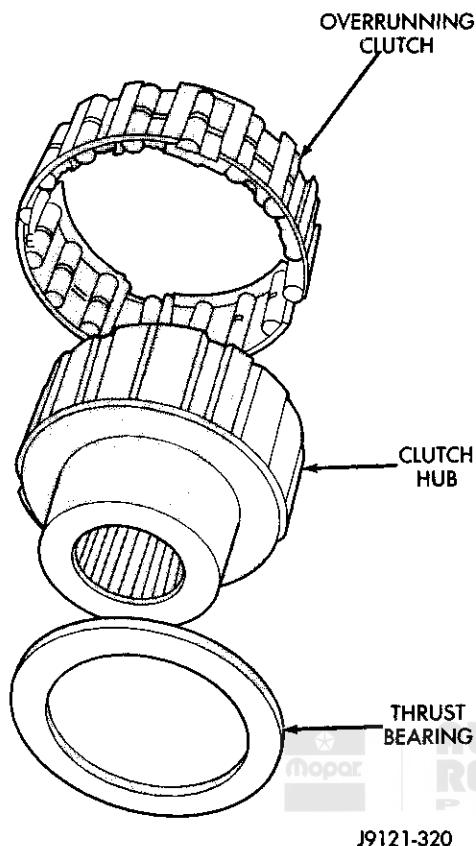


Fig. 316 Overrunning Clutch Components

(15) Mark position of annulus gear and direct clutch drum for assembly alignment reference (Fig. 317). Use small center punch or scribe to make alignment marks.

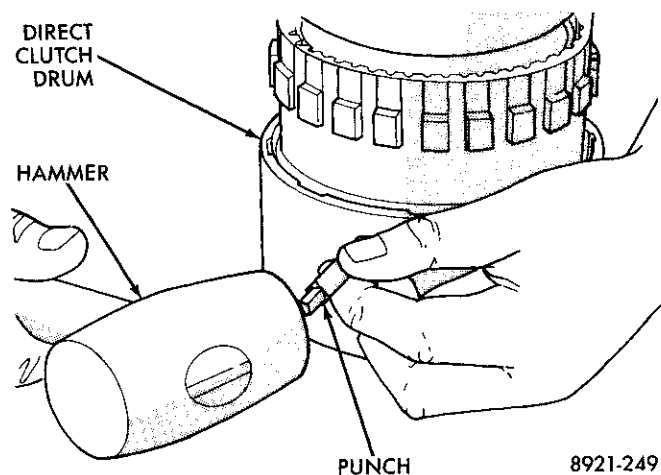


Fig. 317 Marking Direct Clutch Drum And Annulus Gear For Assembly Alignment

(16) Remove direct clutch drum rear retaining ring (Fig. 318).

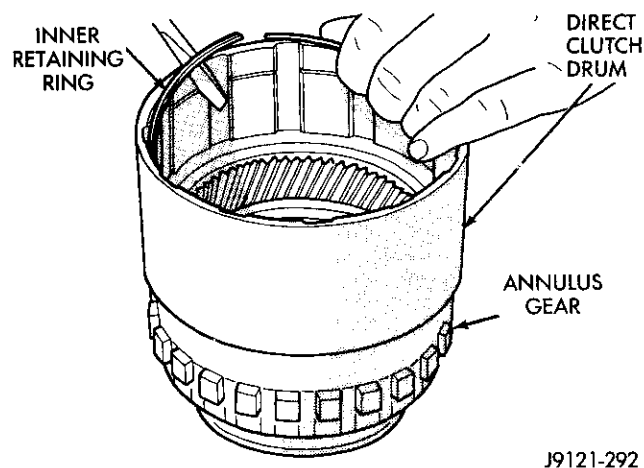


Fig. 318 Removing Clutch Drum Inner Retaining Ring

(17) Remove direct clutch drum outer retaining ring (Fig. 319).

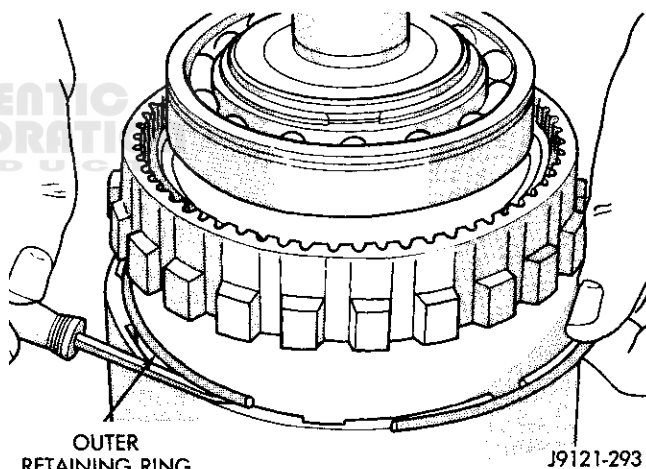


Fig. 319 Removing Clutch Drum Outer Retaining Ring

(18) Mark annulus gear and output shaft for assembly alignment reference (Fig. 320).

(19) Remove annulus gear from output shaft (Fig. 321). Use rawhide or plastic mallet to tap gear off shaft.

(20) Remove output shaft front bearing if not previously removed.

ASSEMBLE

(1) Soak direct clutch and overdrive clutch discs in Mopar ATF Plus before installation. Also lubricate geartrain components with ATF Plus during reassembly.

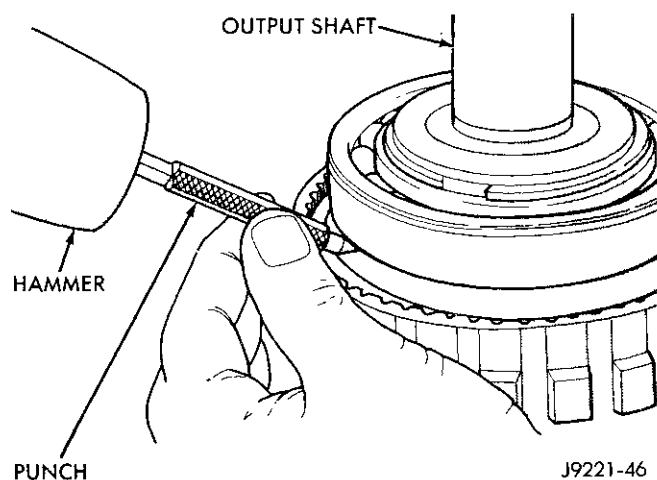
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 320 Marking Annulus Gear And Output Shaft For Assembly Alignment

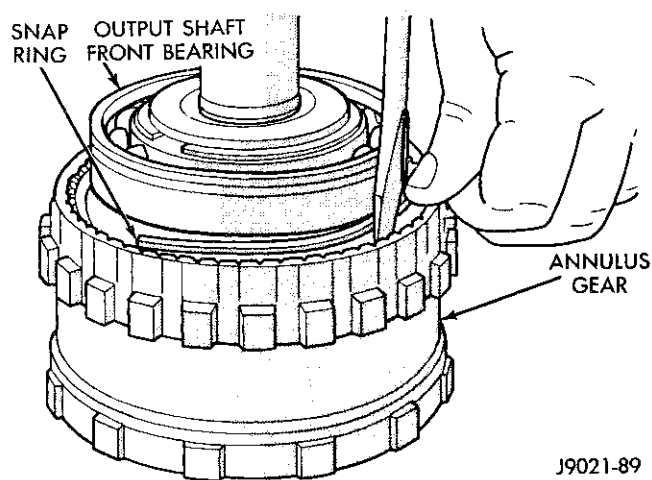


Fig. 322 Installing Annulus Gear And Snap Ring

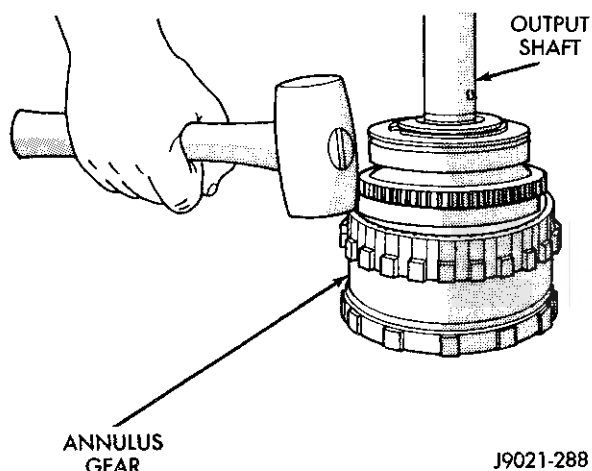


Fig. 321 Removing Annulus Gear

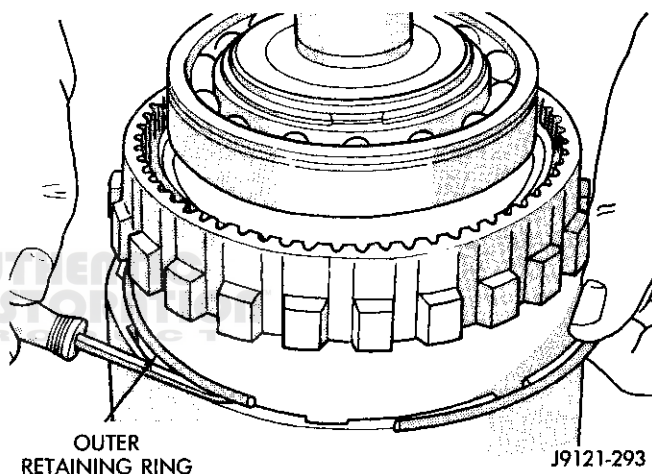


Fig. 323 Clutch Drum And Outer Retaining Ring Installation

(2) Install new pilot bushing and clutch hub bushing in output shaft if necessary (Fig. 322). Lubricate new (or old) bushings with petroleum jelly.

(3) Install front bearing and bearing snap ring on output shaft (Fig. 322).

(4) Align and install annulus gear on output shaft (Fig. 322).

(5) Install annulus snap ring (Fig. 322).

(6) Align and install clutch drum on annulus gear (Fig. 323). Be sure drum is engaged in annulus gear lugs.

(7) Install clutch drum outer retaining ring (Fig. 323).

(8) Slide clutch drum forward and install inner retaining ring (Fig. 324).

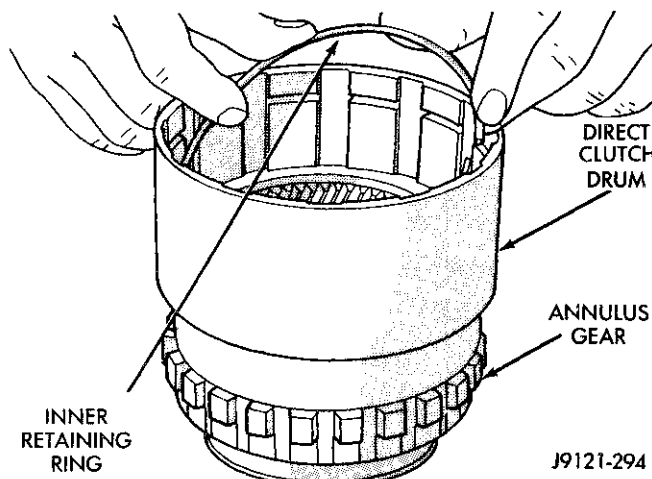


Fig. 324 Installing Clutch Drum Inner Retaining Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(9) Install overrunning clutch on hub (Fig. 325). **Clutch only fits one way. Shoulder on clutch should seat in small recess at edge of hub.**

(10) Install thrust bearing on overrunning clutch hub (Fig. 326). Use petroleum jelly to hold bearing in place during installation. **Bearing fits one way only. Be sure bearing is seated squarely against hub. Reposition bearing if it does not seat squarely.**

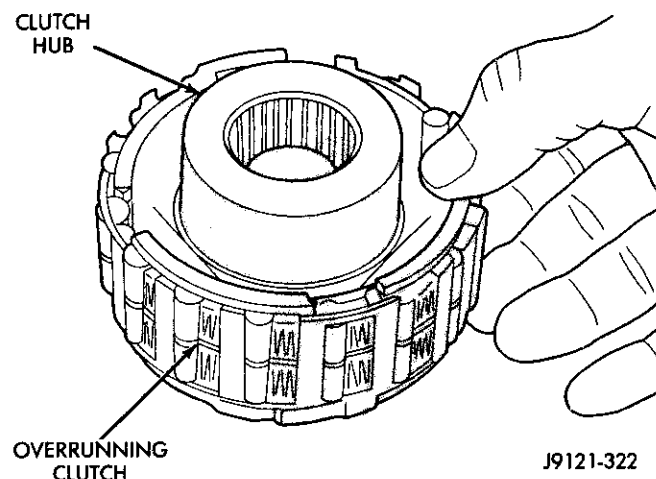


Fig. 325 Assembling Overrunning Clutch And Hub

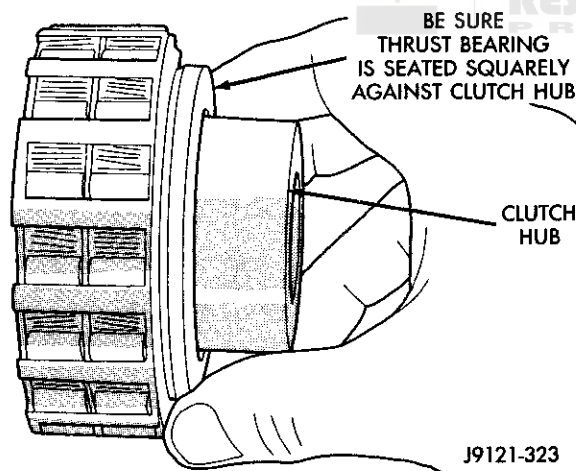


Fig. 326 Installing Overrunning Clutch Thrust Bearing

(11) Install overrunning clutch (Fig. 327). Insert snap ring pliers in hub splines. Expand pliers to grip hub. Then install assembly with counterclockwise, twisting motion.

(12) Install planetary gear in annulus gear (Fig. 328). **Be sure planetary pinions are fully seated in annulus gear before proceeding.**

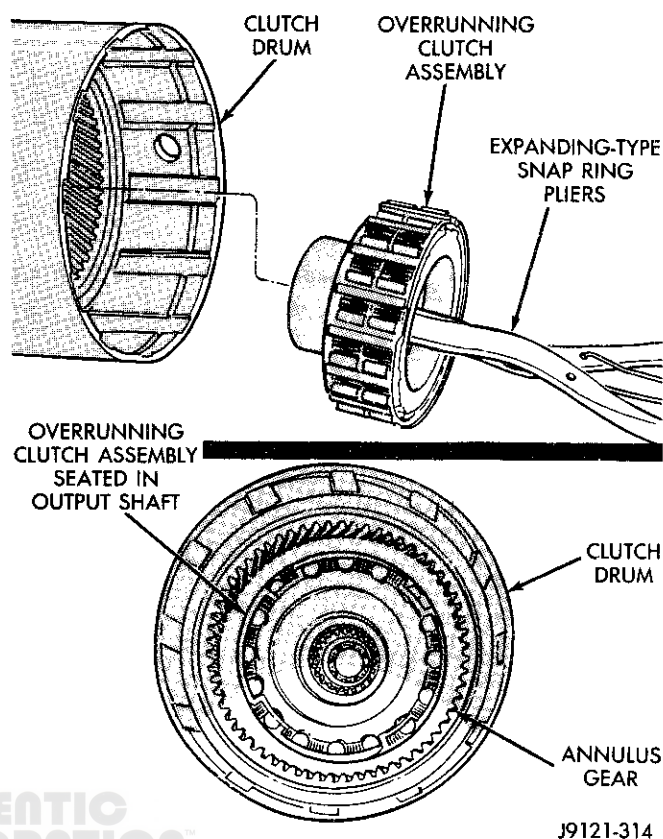


Fig. 327 Overrunning Clutch Installation

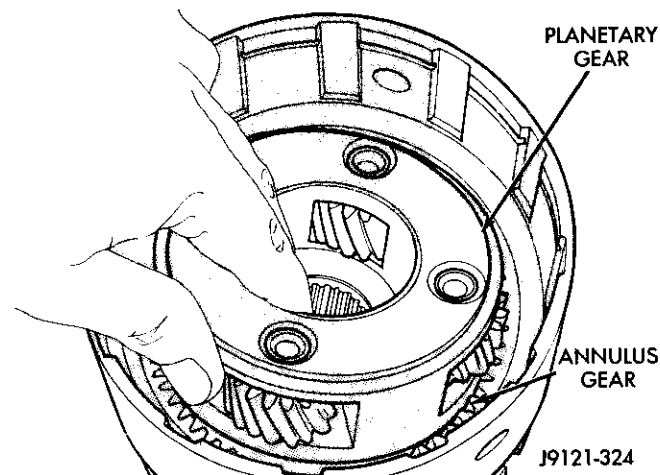


Fig. 328 Planetary Gear Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(13) Install direct clutch spring plate on sun gear. Then secure plate to sun gear with snap ring (Fig. 329). Shoulder side of plate should face outward and toward front.

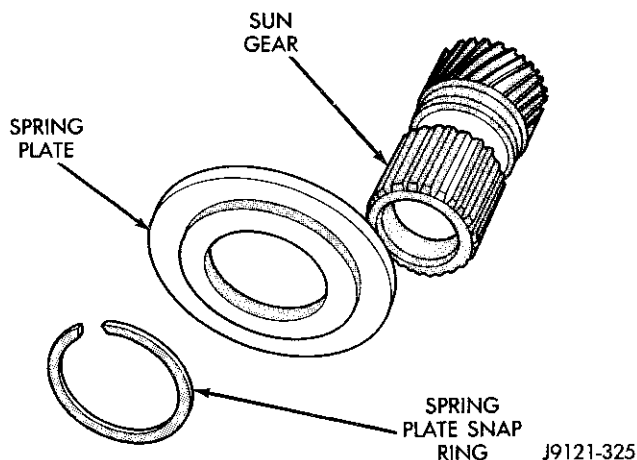


Fig. 329 Sun Gear And Spring Plate Assembly

(14) Coat planetary thrust bearing and bearing contact surface of spring plate with petroleum jelly. This will help hold bearing in place during installation.

(15) Install planetary thrust bearing on sun gear (Fig. 330). Slide bearing onto gear and seat it against spring plate as shown. **Bearing fits one way only. If it does not seat squarely against spring plate, remove and reposition bearing.**

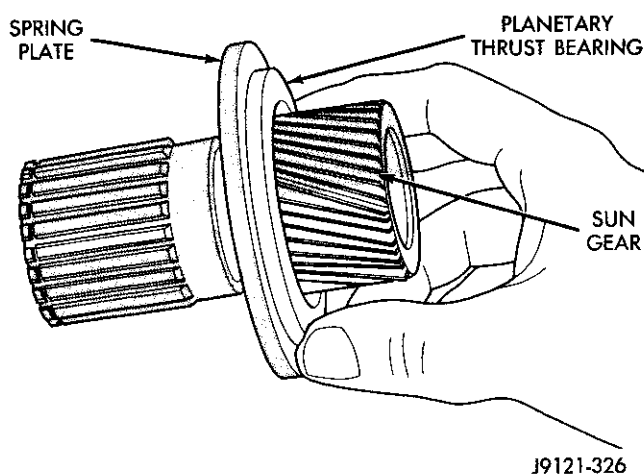


Fig. 330 Installing Planetary Thrust Bearing

(16) Install assembled sun gear, spring plate and thrust bearing (Fig. 331). Be sure sun gear and thrust bearing are fully seated before proceeding.

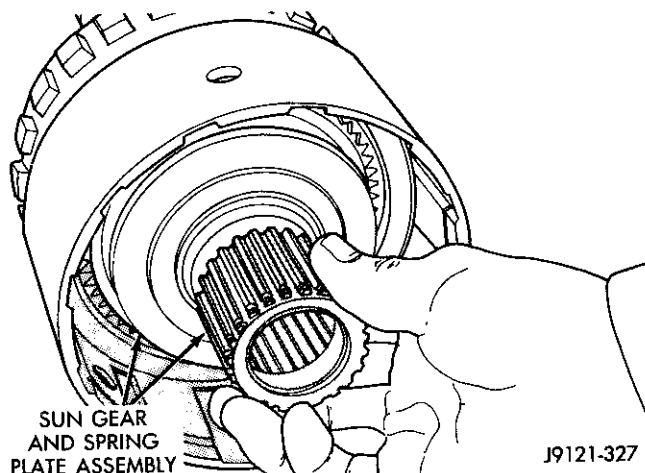


Fig. 331 Sun Gear Installation

(17) Align splines in hubs of planetary gear and overrunning clutch with Alignment Tool 6227-2 (Fig. 332). Insert tool through sun gear and into splines of both hubs. Be sure alignment tool is fully seated before proceeding.

(18) Install direct clutch spring. Be sure spring is properly seated on spring plate (Fig. 332).

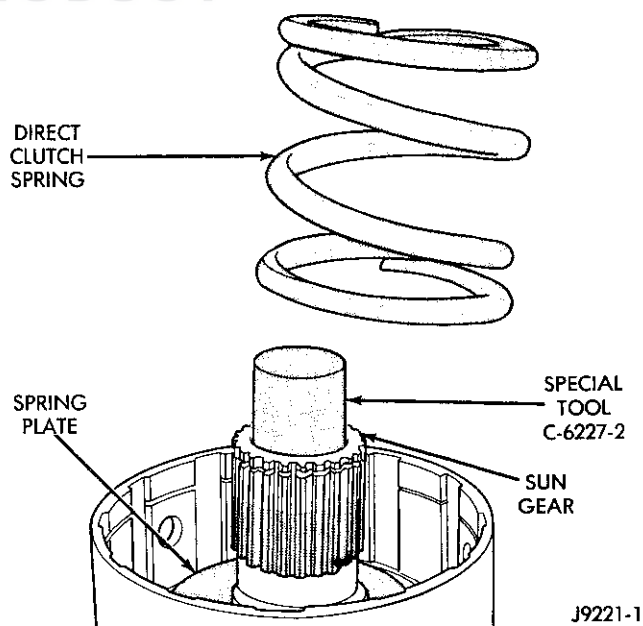


Fig. 332 Direct Clutch Spring Installation

DISASSEMBLY AND ASSEMBLY (Continued)

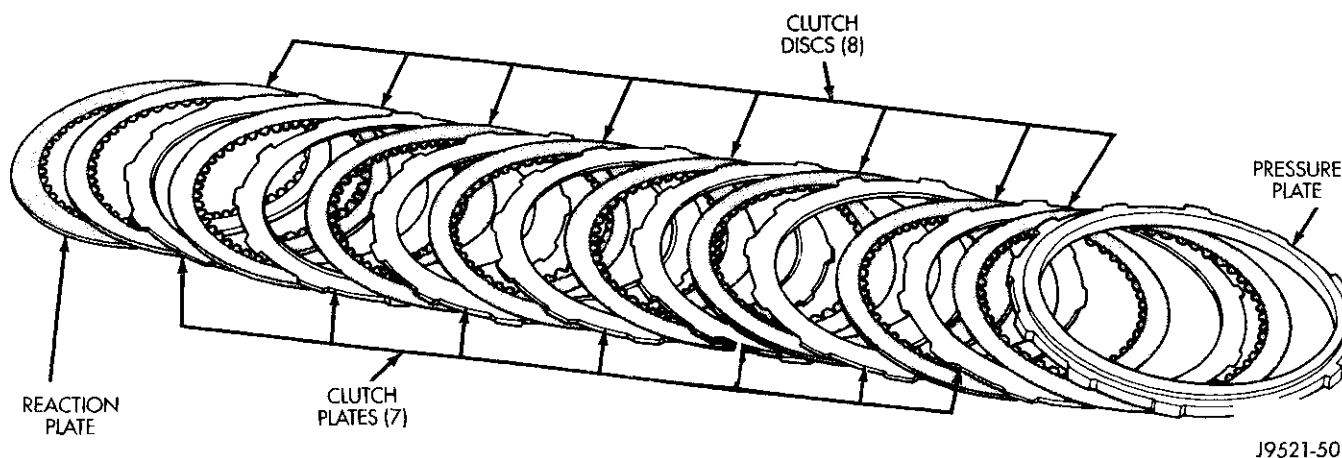


Fig. 333 Direct Clutch Pack Components

(19) Assemble direct clutch pack for installation on hub (Fig. 333).

(20) Install direct clutch reaction plate on clutch hub. **One side of reaction plate is counterbored. Be sure this side faces rearward. Splines at rear of hub are raised slightly and counterbore in plate fits over these splines. Plate should be flush with this end of hub (Fig. 334).**

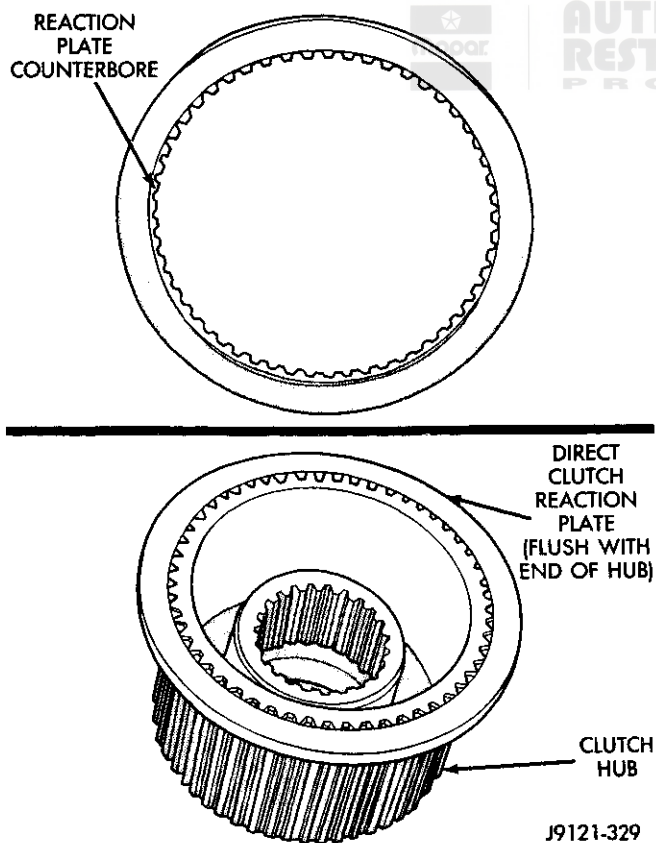


Fig. 334 Correct Position Of Direct Clutch Reaction Plate

(21) Install remainder of direct clutch components as follows:

(a) Install first clutch disc on reaction plate followed by a steel plate.

(b) Alternately install remaining clutch discs and steel plates until required number are installed (Fig. 333). The clutch requires 8 discs and 7 steel plates.

(c) Last clutch pack item installed is clutch pressure plate. Be sure plate is installed with shoulder side of plate facing upward (Fig. 335).

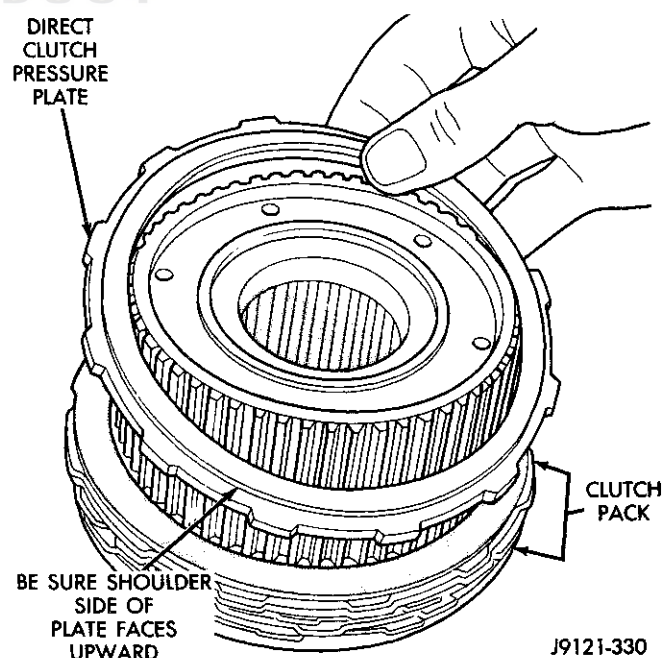


Fig. 335 Correct Position Of Direct Clutch Pressure Plate

DISASSEMBLY AND ASSEMBLY (Continued)

(22) Install clutch hub and clutch pack on direct clutch spring (Fig. 336).

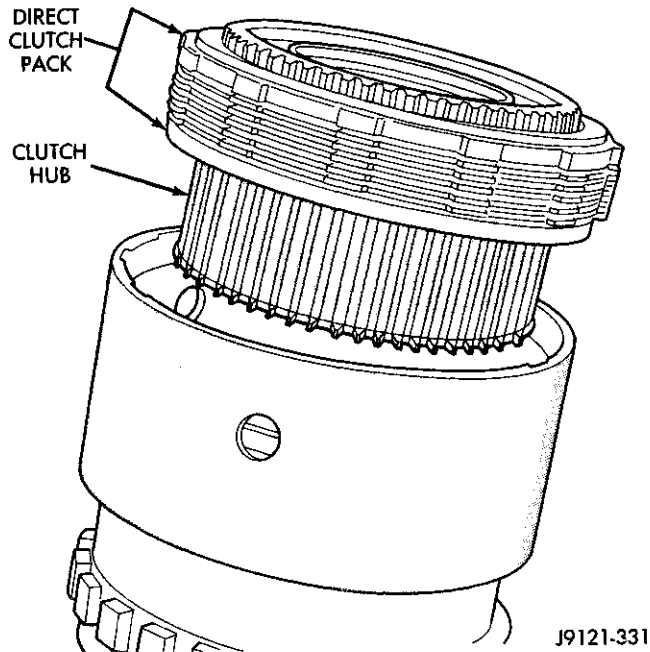


Fig. 336 Installing Assembled Direct Clutch Pack And Hub

(23) Mount geartrain assembly in shop press (Fig. 337).

WARNING: THE NEXT STEP IN GEARTRAIN ASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH HUB AND SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 800 POUNDS. USE SPRING COMPRESSOR TOOL C-6227-1 AND A HYDRAULIC-TYPE SHOP PRESS WITH A MINIMUM RAM TRAVEL OF 5-6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

(24) Position Compressor Tool 6227-2 on clutch hub (Fig. 337).

(25) Slide direct clutch pack upwards on hub (Fig. 337). Slide pack upward and set it partially on edge of hub and compressor tool as shown in (Fig. 337).

(26) Slowly compress clutch hub and spring (Fig. 338). Compress spring and hub only enough to expose ring grooves for clutch pack snap ring and clutch hub retaining ring.

(27) Realign clutch pack on hub and seat clutch discs and plates in clutch drum (Fig. 338).

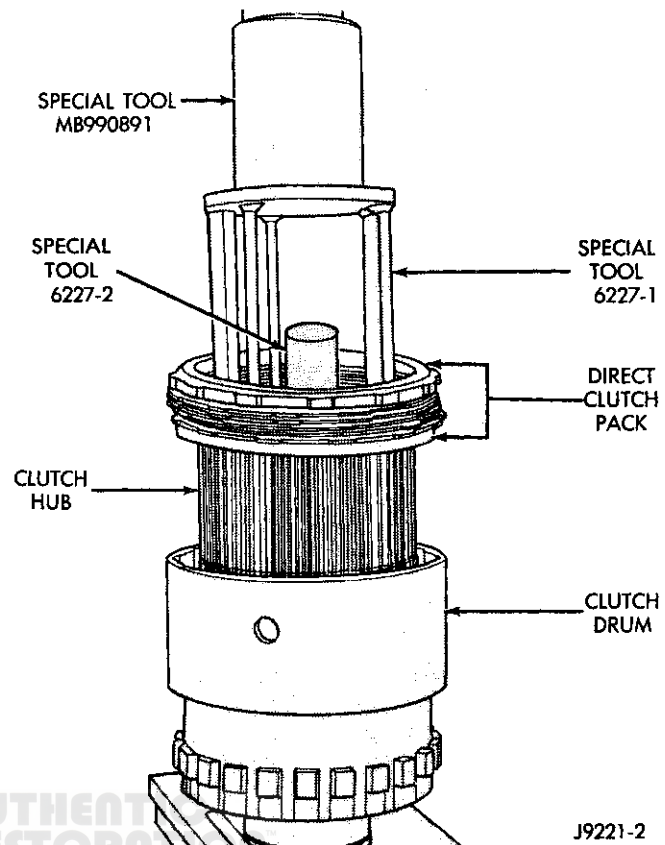


Fig. 337 Mounting Geartrain Assembly In Shop Press

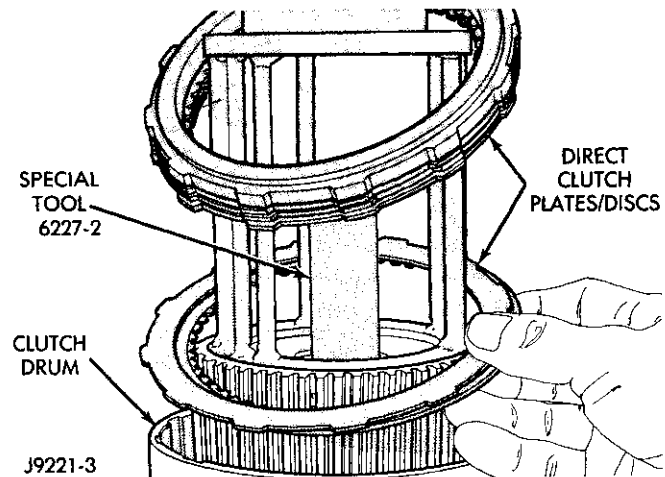


Fig. 338 Seating Clutch Pack In Drum

DISASSEMBLY AND ASSEMBLY (Continued)

(28) Install direct clutch pack snap ring (Fig. 339). Be very sure snap ring is fully seated in clutch drum ring groove.

(29) Install clutch hub retaining ring (Fig. 340). Be very sure retaining ring is fully seated in sun gear ring groove.

(30) Slowly release press ram, remove compressor tools and remove geartrain assembly.

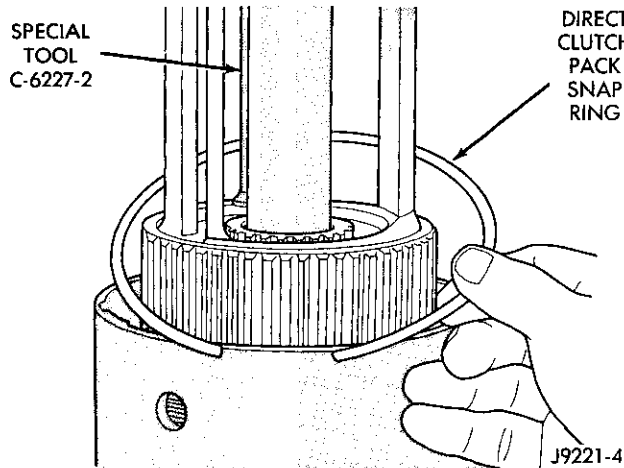


Fig. 339 Installing Direct Clutch Pack Snap Ring

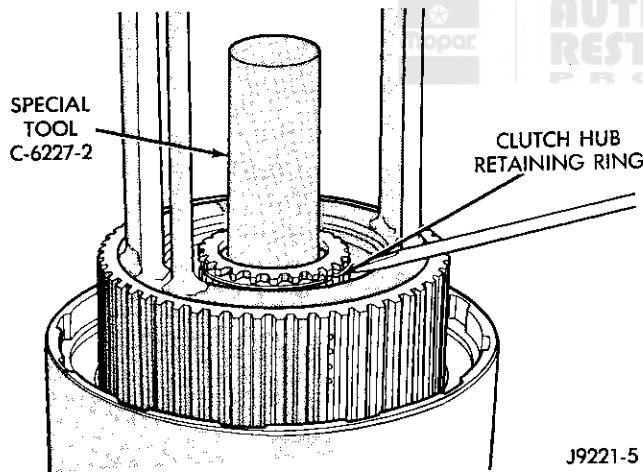


Fig. 340 Installing Clutch Hub Retaining Ring

CLEANING AND INSPECTION**VALVE BODY**

Clean the valve housings, valves, plugs, springs, and separator plates with a standard parts cleaning solution only. Do not use gasoline, kerosene, or any type of caustic solution.

Do not immerse any of the electrical components in cleaning solution. Clean the governor solenoid and sensor and the dual solenoid and harness assembly by wiping them off with dry shop towels only.

Dry all except the electrical parts with compressed air. Make sure all passages are clean and free from

obstructions. Do not use rags or shop towels to dry or wipe off valve body components. Lint from these materials can stick to valve body parts, interfere with valve operation, and clog filters and fluid passages.

Wipe the governor pressure sensor and solenoid valve with dry, lint free shop towels only. The O-rings on the sensor and solenoid valve are the only serviceable components. Be sure the vent ports in the solenoid valve are open and not blocked by dirt or debris. Replace the valve and/or sensor only when DRB scan tool diagnosis indicates this is necessary. Or, if either part has sustained physical damage (dented, deformed, broken, etc.).

CAUTION: Do not turn the small screw at the end of the solenoid valve for any reason. Turning the screw in either direction will ruin solenoid calibration and result in solenoid failure. In addition, the filter on the solenoid valve is NOT serviceable. Do not try to remove the filter as this will damage the valve housing.

Inspect the throttle and manual valve levers and shafts (Fig. 341). Do not attempt to straighten a bent shaft or correct a loose lever. Replace these components if worn, bent, loose or damaged in any way.

Inspect all of the valve body mating surfaces for scratches, nicks, burrs, or distortion. Use a straight-edge to check surface flatness. Minor scratches may be removed with crocus cloth using only very light pressure.

Minor distortion of a valve body mating surface may be corrected by smoothing the surface with a sheet of crocus cloth. Position the crocus cloth on a surface plate, sheet of plate glass or equally flat surface. If distortion is severe or any surfaces are heavily scored, the valve body will have to be replaced.

CAUTION: Many of the valves and plugs, such as the throttle valve, shuttle valve plug, 1-2 shift valve and 1-2 governor plug, are made of coated aluminum. Aluminum components are identified by the dark color of the special coating applied to the surface (or by testing with a magnet). Do not sand aluminum valves or plugs under any circumstances. This practice could damage the special coating causing the valves/plugs to stick and bind.

Inspect the valves and plugs for scratches, burrs, nicks, or scores. Minor surface scratches on steel valves and plugs can be removed with crocus cloth but **do not round off the edges of the valve or plug lands**. Maintaining sharpness of these edges is vitally important. The edges prevent foreign matter

CLEANING AND INSPECTION (Continued)

from lodging between the valves and plugs and the bore.

Inspect all the valve and plug bores in the valve body. Use a penlight to view the bore interiors. Replace the valve body if any bores are distorted or scored. Inspect all of the valve body springs. The springs must be free of distortion, warpage or broken coils.

Check the two separator plates for distortion or damage of any kind. Inspect the upper housing, lower housing, 3-4 accumulator housing, and transfer plate carefully. Be sure all fluid passages are clean and clear. Check condition of the upper housing and transfer plate check balls as well. The check balls and ball seats must not be worn or damaged.

Trial fit each valve and plug in its bore to check freedom of operation. When clean and dry, the valves and plugs should drop freely into the bores.

Valve body bores do not change dimensionally with use. If the valve body functioned correctly when new, it will continue to operate properly after cleaning and inspection. It should not be necessary to replace a

valve body assembly unless it is damaged in handling.

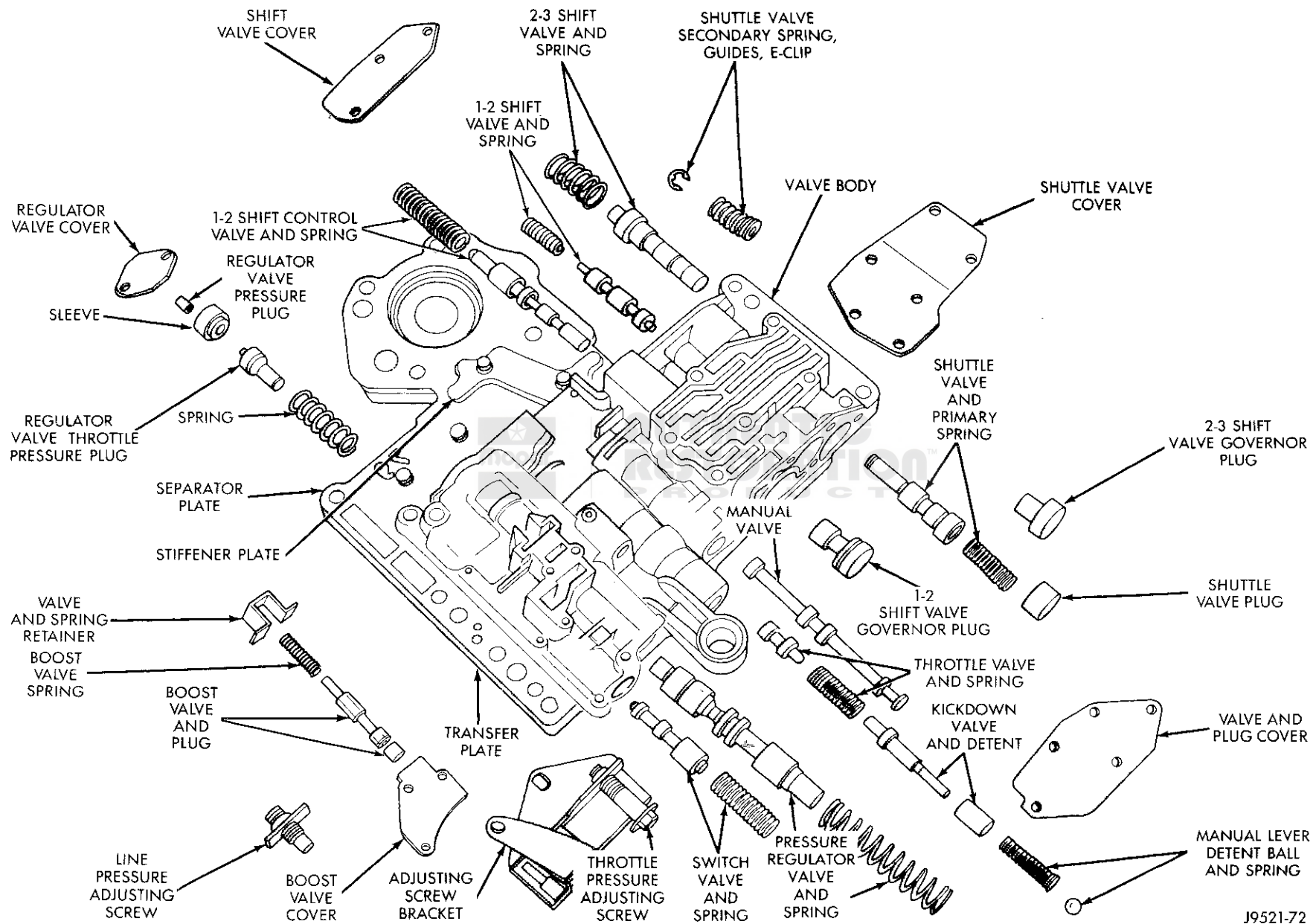
The only serviceable valve body components are listed below. The remaining valve body components are serviced only as part of a complete valve body assembly. Serviceable parts are:

- dual solenoid and harness assembly
- solenoid gasket
- solenoid case connector O-rings and shoulder bolt
- switch valve and spring
- pressure adjusting screw and bracket assembly
- throttle lever
- manual lever and shaft seal
- throttle lever shaft seal, washer, and E-clip
- fluid filter and screws
- detent ball and spring
- valve body screws
- governor pressure solenoid
- governor pressure sensor and retaining clip
- park lock rod and E-clip



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CLEANING AND INSPECTION (Continued)



J9521-72

Fig. 341 Upper Housing Valves, Plug, Springs And Brackets

CLEANING AND INSPECTION (Continued)**TRANSMISSION****GENERAL INFORMATION**

Inspect the transmission bushings during overhaul. Bushing condition is important as worn, scored bushings contribute to low pressures, clutch slip and accelerated wear of other components. However, do not replace bushings as a matter of course. Replace bushings only when they are actually worn, or scored.

Use recommended tools to replace bushings. The tools are sized and designed to remove, install, and seat bushings correctly. The bushing replacement tools are included in Bushing Tool Set C-3887-B.

Pre-sized service bushings are available for replacement purposes. Only the sun gear bushings are not serviced. Low cost of the sun gear assembly makes it easier to simply replace the gear and bushings as an assembly.

Heli-Coil inserts can be used to repair damaged, stripped or worn threads in aluminum parts. These inserts are available from most automotive parts suppliers. Stainless steel inserts are recommended.

The use of crocus cloth is permissible where necessary, providing it is used carefully. When used on shafts, or valves, use extreme care to avoid rounding off sharp edges. Sharp edges are vital as they prevent foreign matter from getting between the valve and valve bore.

Do not reuse oil seals, gaskets, seal rings, or O-rings during overhaul. Replace these parts as a matter of course. Also do not reuse snap rings or E-clips that are bent or distorted. Replace these parts as well.

Lubricate transmission parts with Mopar ATF Plus, Type 7176, transmission fluid during overhaul and assembly. Use petroleum jelly, Mopar Door Ease, or Ru-Glyde to prelubricate seals, O-rings, and thrust washers. Petroleum jelly can also be used to hold parts in place during reassembly.

TRANSMISSION CASE CLEANING AND INSPECTION

Clean the case in a solvent tank. Flush the case bores and fluid passages thoroughly with solvent. Dry the case and all fluid passages with compressed air. Be sure all solvent is removed from the case and that all fluid passages are clear.

NOTE: Do not use shop towels or rags to dry the case (or any other transmission component) unless they are made from lint-free materials. Lint will stick to case surfaces and transmission components and circulate throughout the transmission after assembly. A sufficient quantity of lint can block fluid passages and interfere with valve body operation.

Inspect the case for cracks, porous spots, worn bores, or damaged threads. Damaged threads can be repaired with Helicoil thread inserts. However, the case will have to be replaced if it exhibits any type of damage or wear.

Lubricate the front band adjusting screw threads with petroleum jelly and thread the screw part-way into the case. Be sure the screw turns freely.

OVERRUNNING CLUTCH/LOW-REVERSE DRUM/REAR SUPPORT

Clean the overrunning clutch assembly, clutch cam, low-reverse drum and rear support in solvent. Dry them with compressed air after cleaning.

Inspect condition of each clutch part after cleaning. Replace the overrunning clutch roller and spring assembly if any rollers or springs are worn or damaged, or if the roller cage is distorted, or damaged. Replace the cam if worn, cracked or damaged.

Replace the low-reverse drum if the clutch race, roller surface or inside diameter is scored, worn or damaged. **Do not remove the clutch race from the low-reverse drum under any circumstances. Replace the drum and race as an assembly if either component is damaged.**

Examine the rear support carefully for wear, cracks, scoring or other damage. Be sure the support hub is a snug fit in the case and drum. Replace the support if worn or damaged.

ACCUMULATOR

Inspect the accumulator piston and seal rings (Fig. 342). Replace the seal rings if worn or cut. Replace the piston if chipped or cracked.

Check condition of the accumulator inner and outer springs (Fig. 342). Replace the springs if the coils are cracked, distorted or collapsed.

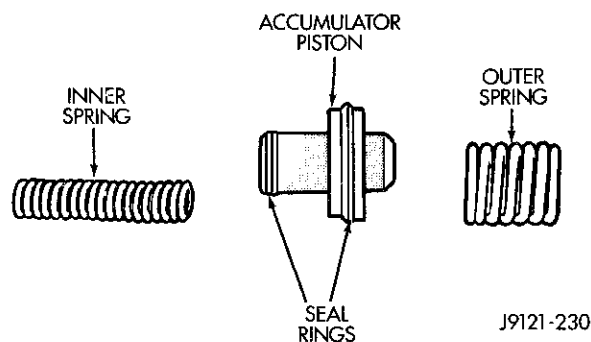


Fig. 342 Accumulator Components

FRONT SERVO

Clean the servo piston components with solvent and dry them with compressed air. Wipe the band clean with lint free shop towels.

CLEANING AND INSPECTION (Continued)

Replace the front band if distorted, lining is burned, flaking off, or worn to the point where the grooves in the lining material are no longer visible.

Inspect the servo components. Replace the springs if collapsed, distorted or broken. Replace the guide, rod and piston if cracked, bent, or worn. Discard the servo snap ring if distorted or warped.

Check the servo piston bore for wear. If the bore is severely scored, or damaged, it will be necessary to replace the case.

Replace any servo component if doubt exists about condition. Do not reuse suspect parts.

REAR SERVO

Remove and discard the servo piston seal ring (Fig. 343). Then clean the servo components with solvent and dry with compressed air. Replace either spring if collapsed, distorted or broken. Replace the plug and piston if cracked, bent, or worn. Discard the servo snap rings and use a new ones at assembly.

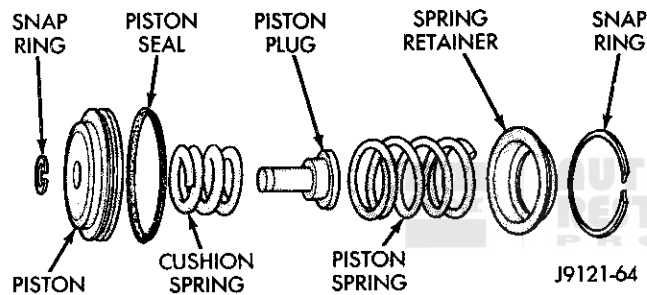


Fig. 343 Rear Servo Components

OIL PUMP AND REACTION SHAFT SUPPORT

Clean pump and support components with solvent and dry them with compressed air.

Check condition of the seal rings and thrust washer on the reaction shaft support. The seal rings do not need to be replaced unless cracked, broken, or severely worn.

Inspect the pump and support components. Replace the pump or support if the seal ring grooves or machined surfaces are worn, scored, pitted, or damaged. Replace the pump gears if pitted, worn chipped, or damaged.

Check the pump vent. The vent must be secure. Replace the pump body if the vent is cracked, broken, or loose.

Inspect the pump bushing. Then check the reaction shaft support bushing. Replace either bushing only if heavily worn, scored or damaged. It is not necessary to replace the bushings unless they are actually damaged.

Install the gears in the pump body and measure end clearance with a feeler gauge and straightedge (Fig. 344). Straightedge should be resting on pump body as shown:

- End clearance between outer gear and straight-edge should be 0.010 to 0.063 mm (0.0004 to 0.0025 in.).

- End clearance between inner gear and straight-edge should be 0.025 to 0.177 mm (0.001 to 0.007 in.).

Measure tip clearances with feeler gauge (Fig. 345):

- Clearance between inner gear tooth and outer gear should be 0.08 to 0.19 mm (0.0035 to 0.0075 in.).

- Clearance between outer gear and pump housing should also be 0.010 to 0.19 mm (0.0035 to 0.0075 in.).

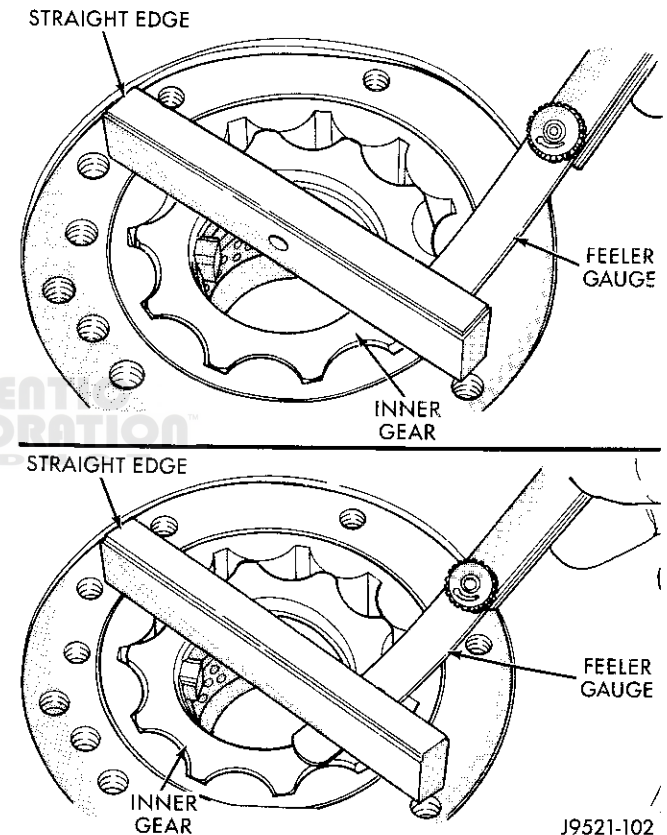
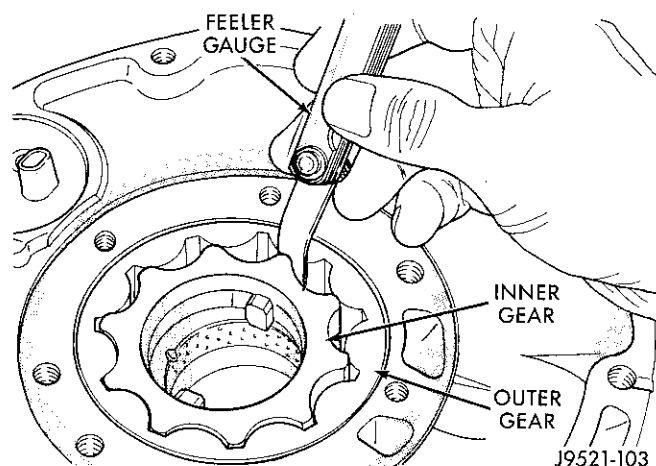


Fig. 344 Checking Pump Gear End Clearance

FRONT CLUTCH

Clean the front clutch components in solvent and dry them with compressed air only. Do not use rags or shop towels to dry any of the clutch parts. Lint from such materials will adhere to the component surfaces and could restrict or block fluid passages after assembly.

Replace the clutch discs if warped, worn, scored, burned or charred, or if the facing is flaking off. Replace the steel plates if heavily scored, warped, or broken. Be sure the driving lugs on the plates are in good condition. The lugs must not be bent, cracked or damaged in any way.

CLEANING AND INSPECTION (Continued)**Fig. 345 Checking Pump Gear Tip Clearance**

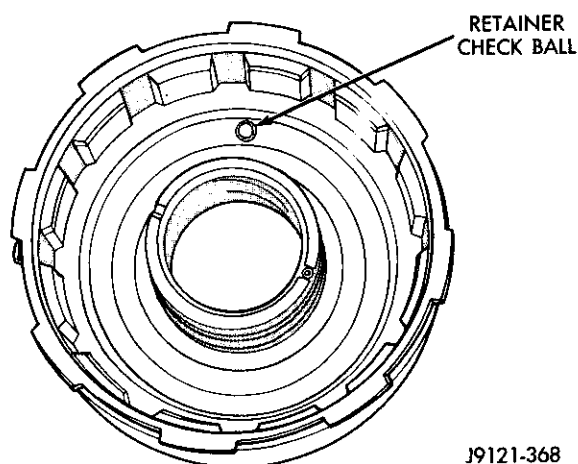
Replace the clutch spring and spring retainer if either is distorted, warped or broken.

Check the lug grooves in the clutch retainer. The steel plates should slide freely in the slots. Replace the retainer if the grooves are worn or damaged.

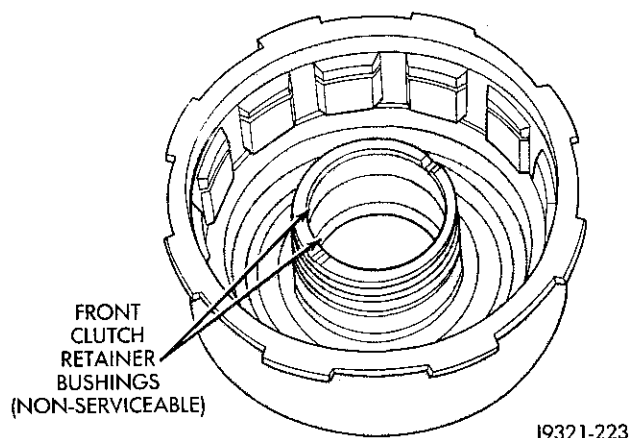
Check action of the check ball in the retainer (Fig. 346). The ball must move freely and not stick.

NOTE: Inspect the clutch retainer bushings carefully (Fig. 347). The retainer bushings are NOT serviceable. It will be necessary to replace the retainer if either bushing is scored, or worn.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

**Fig. 346 Front Clutch Piston Retainer Check Ball Location****REAR CLUTCH**

Clean the clutch components (Fig. 348) with solvent and dry them with compressed air. Do not use

**Fig. 347 Retainer Bushing Location/Inspection**

rags or shop towels to dry any of the clutch parts. Lint from such materials will adhere to component surfaces and could restrict or block fluid passages after assembly.

Replace the clutch discs if warped, worn, scored, burned/charred, the lugs are damaged, or if the facing is flaking off. Replace the top and bottom pressure plates if scored, warped, or cracked. Be sure the driving lugs on the pressure and clutch plates are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston spring and wave spring if either part is distorted, warped or broken.

Check the lug grooves in the clutch retainer. The clutch and pressure plates should slide freely in the slots. Replace the retainer if the grooves are worn or damaged. Also check action of the check balls in the retainer and piston. Each check ball must move freely and not stick.

Replace the retainer bushing if worn, scored, or doubt exists about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

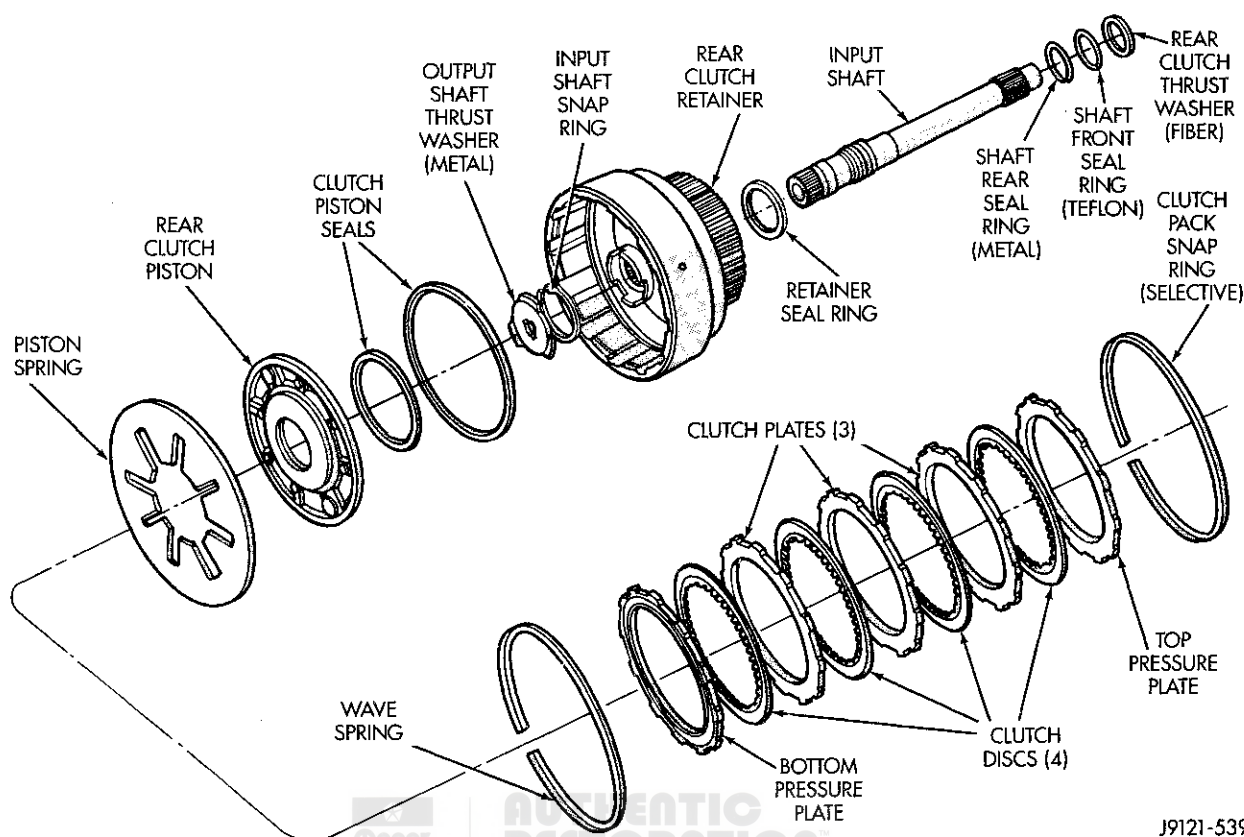
Check condition of the fiber thrust washer and metal output shaft thrust washer. Replace either washer if worn or damaged.

Check condition of the seal rings on the input shaft and clutch retainer hub. Replace the seal rings only if worn, distorted, or damaged. The input shaft front seal ring is teflon with chamfered ends. The rear ring is metal with interlocking ends.

Check the input shaft for wear, or damage. Replace the shaft if worn, scored or damaged in any way.

PLANETARY GEARTRAIN

Clean the planetary components in solvent and dry them with compressed air.

CLEANING AND INSPECTION (Continued)

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Fig. 348 Rear Clutch Components

Check sun gear and driving shell condition (Fig. 349). Replace the gear if damaged or if the bushings are scored or worn. The bushings are not serviceable. Replace the driving shell if worn, cracked or damaged.

Replace planetary gear sets if gears, pinion pins, or carrier are damaged in any way. Replace the annulus gears and supports if either component is worn or damaged.

Inspect the geartrain spacers, thrust plates, snap rings, and thrust washers (Fig. 349). Replace any of these parts that are worn, distorted or damaged. Do not attempt to reuse these parts.

The planetary gear thrust washers are different sizes. The large diameter washers go on the front planetary and the smaller washers go on the rear planetary. All the washers have four locating tabs on them. These tabs fit in the holes or slots provided in each planetary gear.

Inspect the output shaft carefully. Pay particular attention to the machined bushing/bearing surfaces on the shaft and the governor valve shaft bore at the shaft rear.

Replace the output shaft if the machined surfaces are scored, pitted, or damaged in any way. Also replace the shaft if the splines are damaged, or

exhibits cracks at any location (especially at the governor valve shaft bore).

The annulus gears can be removed from their supports if necessary. Just remove the snap rings and separate the two parts when replacement is necessary. In addition, the annulus gear bushings can be replaced if severely worn, or scored. However it is not necessary to replace the bushings if they only exhibit normal wear. Check bushing fit on the output shaft to be sure.

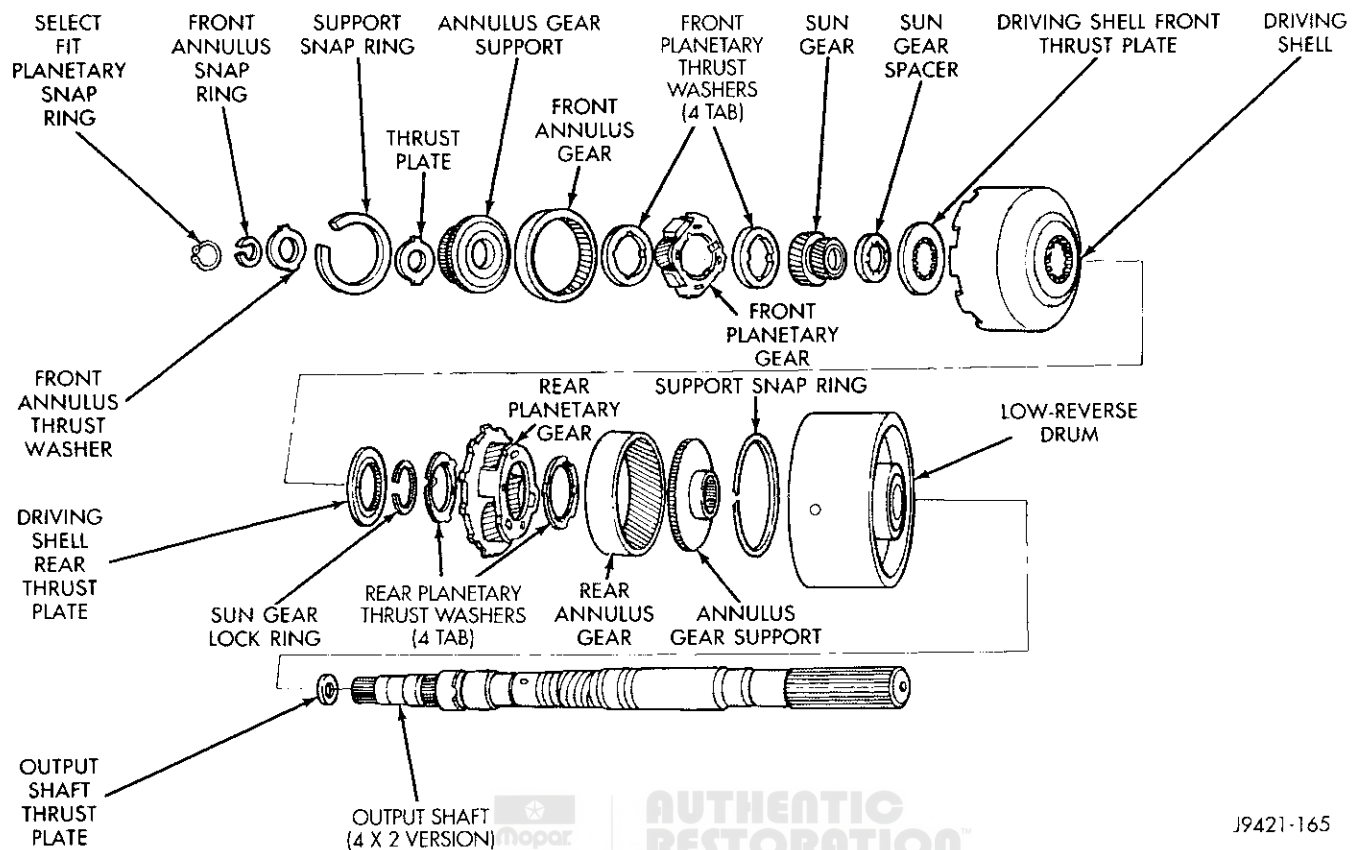
OVERDRIVE UNIT

Clean the geartrain and case components with solvent. Dry all parts except the bearings with compressed air. Allow bearings to air dry.

Do not use shop towels for wiping parts dry unless the towels are made from a lint-free material. A sufficient quantity of lint (from shop towels, cloths, rags, etc.) could plug the transmission filter and fluid passages.

Discard the old case gasket and seals. Do not attempt to salvage these parts. They are not reusable. Replace any of the overdrive unit snap rings if distorted or damaged.

Minor nicks or scratches on components can be smoothed with crocus cloth. However, do not attempt to reduce severe scoring on any components with

CLEANING AND INSPECTION (Continued)**Fig. 349 Planetary Geartrain Components**

abrasive materials. Replace severely scored components; do not try to salvage them.

Check condition of the park lock components and the overdrive case.

Replace the case if cracked, scored, or damaged. Replace the park lock pawl, plug, or spring if worn or damaged. Be sure the bullet at the end of the park lock rod is in good condition. Replace the rod if the bullet is worn or the rod itself is bent or distorted. Do not attempt to straighten the rod.

Check the bushings in the overdrive case. Replace the bushings if severely scored or worn. Also replace the case seal if loose, distorted, or damaged.

Examine the overdrive and direct clutch discs and plates. Replace the discs if the facing is worn, severely scored, or burned and flaking off. Replace the clutch plates if worn, heavily scored, or cracked. Check the lugs on the clutch plates for wear. The plates should slide freely in the drum. Replace the plates or drum if binding occurs.

Check condition of the annulus gear, direct clutch hub, clutch drum and clutch spring. Replace the gear, hub and drum if worn or damaged. Replace the spring if collapsed, distorted, or cracked.

Be sure the splines and lugs on the gear, drum and hub are in good condition. The clutch plates and discs should slide freely in these components.

Inspect the thrust bearings and spring plate. Replace the plate if worn or scored. Replace the bearings if rough, noisy, brinnelled, or worn.

Inspect the planetary gear assembly and the sun gear and bushings. If either the sun gear or the bushings are damaged, replace the gear and bushings as an assembly. The gear and bushings are not serviced separately.

The planetary carrier and pinions must be in good condition. Also be sure the pinion pins are secure and in good condition. Replace the carrier if worn or damaged.

Inspect the overrunning clutch and race. The race surface should be smooth and free of scores. Replace the overrunning clutch assembly or the race if either assembly is worn or damaged in any way.

Inspect the output shaft and governor components. Replace the shaft pilot bushing and inner bushing if damaged. Replace either shaft bearing if rough or noisy. Replace the bearing snap rings if distorted or cracked.

Check the machined surfaces on the output shaft. These surfaces should be clean and smooth. Very minor nicks or scratches can be smoothed with crocus cloth. Replace the shaft if worn, scored or damaged in any way.

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CLEANING AND INSPECTION (Continued)

Inspect the output shaft bushings. The small bushing is the intermediate shaft pilot bushing. The large bushing is the overrunning clutch hub bushing. Replace either bushing if scored, pitted, cracked, or worn.

The bushings can be removed with "blind hole puller tools" such as Snap-On set CG40CB for small bushings and set CG46 for large bushings. New bushings can be installed with tools from an all purpose installer kit such as the Snap-On A257 bushing driver set.

ADJUSTMENTS

TRANSMISSION THROTTLE VALVE CABLE ADJUSTMENT

The transmission throttle valve is operated by the valve body throttle lever. The throttle lever is actuated by a cable connected to the engine throttle body lever (Fig. 350). A lock button at the engine end of the cable provides for cable adjustment.

A correctly adjusted throttle valve cable, will cause the throttle lever on the transmission to move simultaneously with the throttle body lever from the idle position. Proper adjustment allows simultaneous movement without causing the transmission throttle lever to move ahead of, or lag behind the throttle body lever.

THROTTLE VALVE CABLE ADJUSTMENT CHECK

- (1) Turn ignition key to OFF position.
- (2) Remove air cleaner.
- (3) Verify that throttle body lever is at curb idle position. Then verify that transmission throttle lever (Fig. 350) is also at idle (full forward) position.
- (4) Slide cable off attachment stud on throttle body lever (Fig. 350).
- (5) Compare position of cable end to attachment stud on throttle body lever (Fig. 351):
 - (a) Cable end and attachment stud should be aligned (or centered on one another) to within 1 mm (0.039 in.) in either direction.
 - (b) If cable end and attachment stud are misaligned (off center), cable will have to be adjusted as described in following procedure.
- (6) Reconnect cable end to attachment stud. Then with aid of a helper, observe movement of transmission throttle lever and lever on throttle body.
 - (a) If both levers move simultaneously from idle to half-throttle and back to idle position, adjustment is correct.
 - (b) If transmission throttle lever moves ahead of, or lags behind throttle body lever, cable adjustment will be necessary. Or, if throttle body lever pre-

vents transmission lever from returning to closed position, cable adjustment will be necessary.

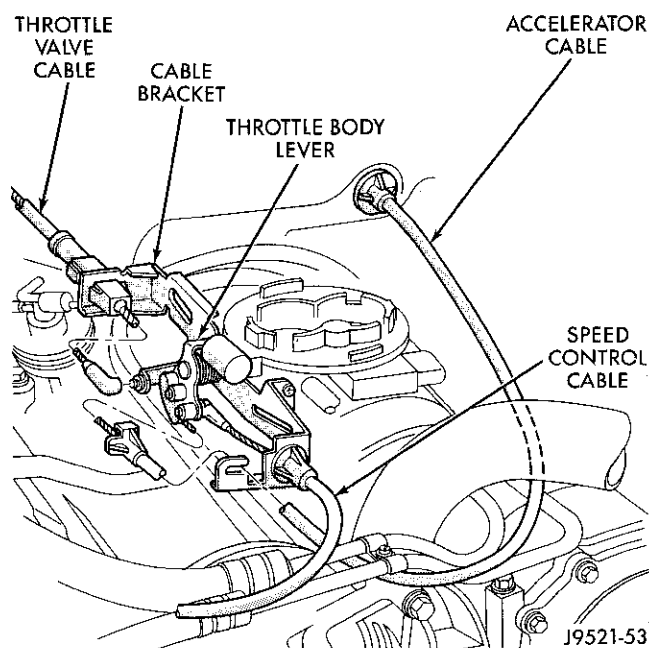


Fig. 350 Throttle Valve Cable Attachment —At Engine

THROTTLE VALVE CABLE ADJUSTMENT PROCEDURE

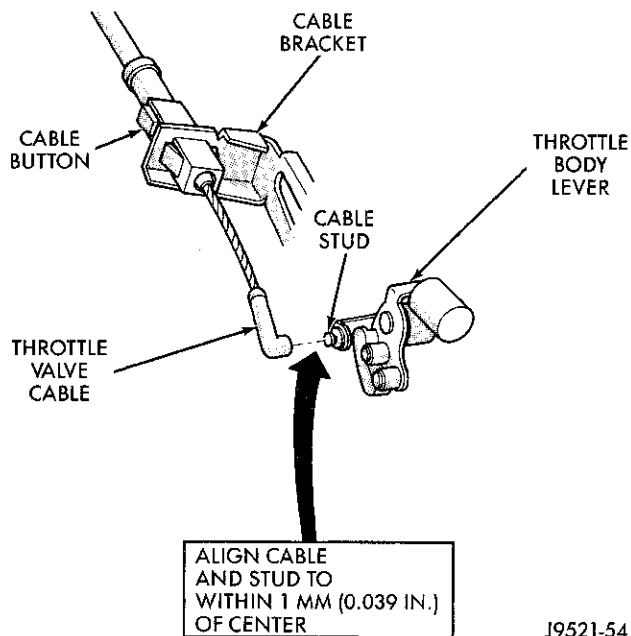
- (1) Turn ignition switch to OFF position and shift into Park.
- (2) Remove air cleaner.
- (3) Disconnect cable end from attachment stud on throttle body.
- (4) Verify that transmission throttle lever is in idle (full forward) position. Then be sure lever on throttle body is at curb idle position.
- (5) Press cable button inward to release cable (Fig. 351). Button only has to move about 2 mm (0.070 in.) to release cable in adjuster head.
- (6) Center cable end on attachment stud to within 1 mm (0.039 in.) and release cable button.
- (7) Check cable adjustment. Be sure transmission throttle lever and lever on throttle body move simultaneously and as described in cable adjustment checking procedure.

GEARSHIFT LINKAGE ADJUSTMENT

Check linkage adjustment by starting the engine in Park and Neutral. Adjustment is OK if the engine starts only in these positions.

Adjustment is incorrect if the engine starts in one but not both positions.

If the engine starts in any position other than Park or Neutral, or if the engine will not start at all, the park/neutral position switch is probably faulty.

ADJUSTMENTS (Continued)

J9521-54

Fig. 351 Throttle Valve Cable Adjustment**SHIFT LINKAGE ADJUSTMENT PROCEDURE**

Check condition of the shift linkage (Fig. 352) before adjustment. Do not attempt adjustment if any parts are worn, loose, or bent. Replace the linkage

grommets and bushing if the linkage exhibits excessive play. Replace the torque shaft, brackets, or shift rods if bent, or binding.

If either shift rod must be disconnected, replace the grommet securing the rod in the torque shaft arm. Disconnect the rods with a pry tool. Pry only where the grommet and rod attach and not on the rod itself. Then cut away the old grommet. Use pliers to snap the new grommet into the lever and to snap the rod into the grommet.

(1) Shift transmission into Park.

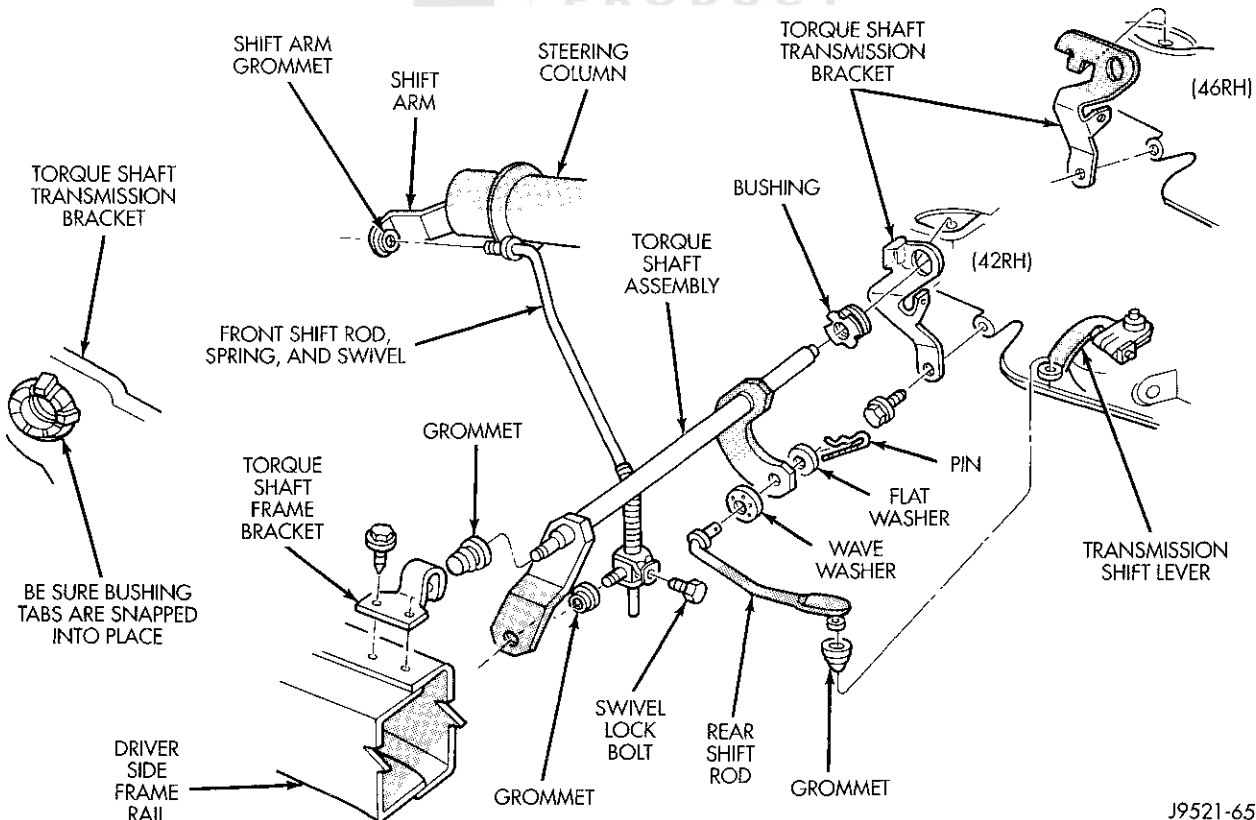
(2) Raise vehicle.

(3) Loosen lock bolt in front shift rod adjusting swivel (Fig. 353).

(4) Be sure front shift rod slides freely in swivel. Lube rod and swivel if necessary.

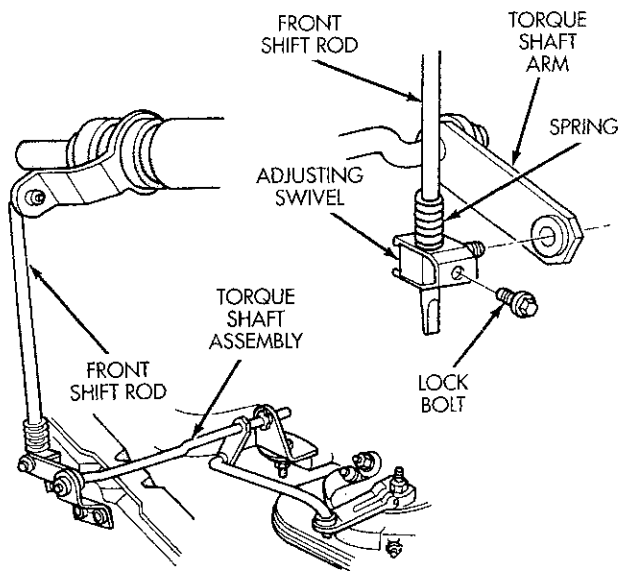
(5) Move transmission shift lever fully rearward into Park detent. Then center adjusting swivel in torque shaft grommet and tighten swivel lock bolt to 90 in. lbs. (10 N·m) torque.

(6) Lower vehicle and check shift linkage adjustment. Engine should only start in Park and Neutral position. **If engine starts in any position other than Park or Neutral, adjustment is incorrect or park/neutral position switch is faulty.**



J9521-65

Fig. 352 Column Shift Linkage

ADJUSTMENTS (Continued)

J9521-66

Fig. 353 Linkage Adjustment Components**FRONT BAND ADJUSTMENT**

The front (kickdown) band adjusting screw is located on the left side of the transmission case above the manual valve and throttle valve levers.

- (1) Raise vehicle.
- (2) Loosen band adjusting screw locknut (Fig. 354). Then back locknut off 3-5 turns. Be sure adjusting screw turns freely in case. Apply lubricant to screw threads if necessary.
- (3) Tighten band adjusting screw to 8 N·m (72 in. lbs.) torque with Inch Pound Torque Wrench C-3380-A, a 3-in. extension and 5/16 socket.

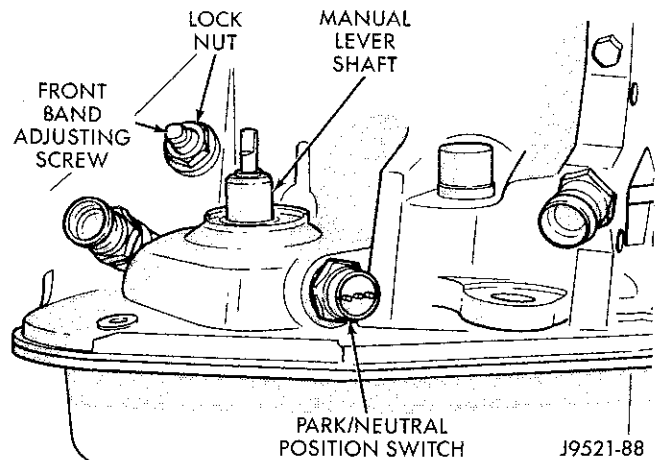
CAUTION: If Adapter C-3705 is needed to reach the adjusting screw (Fig. 355), tighten the screw to only 5 N·m (47-50 in. lbs.) torque.

- (4) Back off front band adjusting screw 2-7/8 turns.
- (5) Hold adjuster screw in position and tighten locknut to 41 N·m (30 ft. lbs.) torque.
- (6) Lower vehicle.

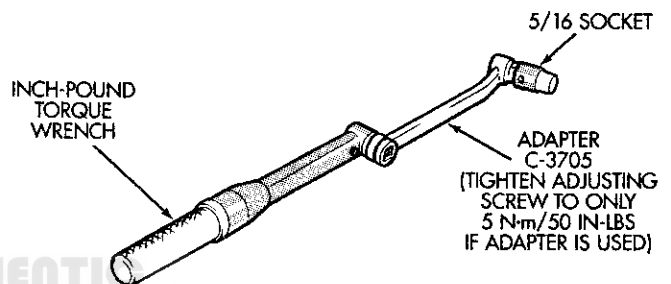
REAR BAND ADJUSTMENT

The transmission oil pan must be removed for access to the rear band adjusting screw.

- (1) Raise vehicle.
- (2) Remove transmission oil pan and drain fluid.
- (3) Loosen band adjusting screw locknut 5-6 turns. Be sure adjusting screw turns freely in lever.
- (4) Tighten adjusting screw to 8 N·m (72 in. lbs.) torque (Fig. 356).
- (5) Back off adjusting screw 2 turns.



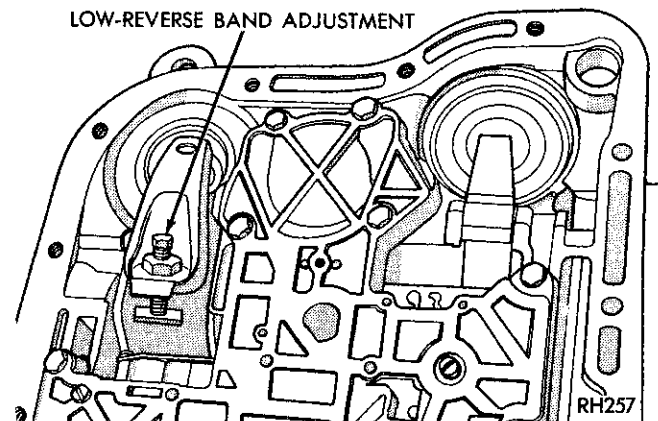
J9521-88

Fig. 354 Front Band Adjustment Screw Location

J9121-233

Fig. 355 Band Adjustment Adapter Tool

- (6) Hold adjusting screw in place and tighten locknut to 34 N·m (25 ft. lbs.) torque.
- (7) Position new gasket on oil pan and install pan on transmission. Tighten pan bolts to 17 N·m (13 ft. lbs.) torque.
- (8) Lower vehicle and refill transmission with Mopar ATF Plus, Type 7176 fluid.

**Fig. 356 Rear Band Adjustment Screw Location**

ADJUSTMENTS (Continued)**VALVE BODY****CONTROL PRESSURE ADJUSTMENTS**

There are two control pressure adjustments on the valve body;

- Line Pressure
- Throttle Pressure

Line and throttle pressures are interdependent because each affects shift quality and timing. As a result, both adjustments must be performed properly and in the correct sequence. Adjust line pressure first and throttle pressure last.

LINE PRESSURE ADJUSTMENT

Measure distance from the valve body to the inner edge of the adjusting screw with an accurate steel scale (Fig. 357).

Distance should be 33.4 mm (1-5/16 in.).

If adjustment is required, turn the adjusting screw in, or out, to obtain required distance setting.

NOTE: The 33.4 mm (1-5/16 in.) setting is an approximate setting. Manufacturing tolerances may make it necessary to vary from this dimension to obtain desired pressure.

One complete turn of the adjusting screw changes line pressure approximately 1-2/3 psi (9 kPa).

Turning the adjusting screw counterclockwise increases pressure while turning the screw clockwise decreases pressure.

THROTTLE PRESSURE ADJUSTMENT

Insert Gauge Tool C-3763 between the throttle lever cam and the kickdown valve stem (Fig. 358).

Push the gauge tool inward to compress the kickdown valve against the spring and bottom the throttle valve.

Maintain pressure against kickdown valve spring. Turn throttle lever stop screw until the screw head

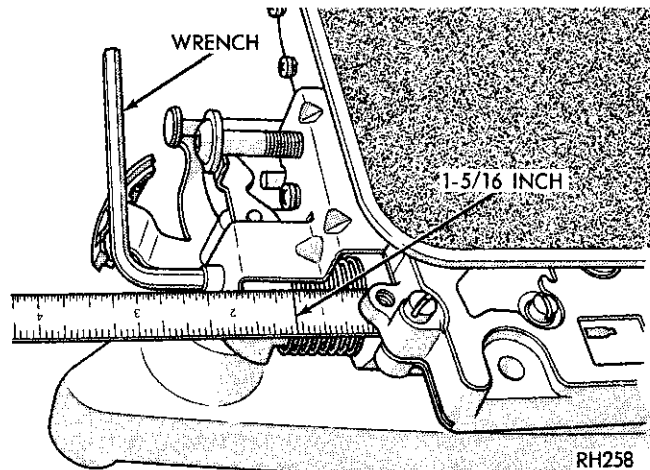


Fig. 357 Line Pressure Adjustment

touches throttle lever tang and the throttle lever cam touches gauge tool.

NOTE: The kickdown valve spring must be fully compressed and the kickdown valve completely bottomed to obtain correct adjustment.

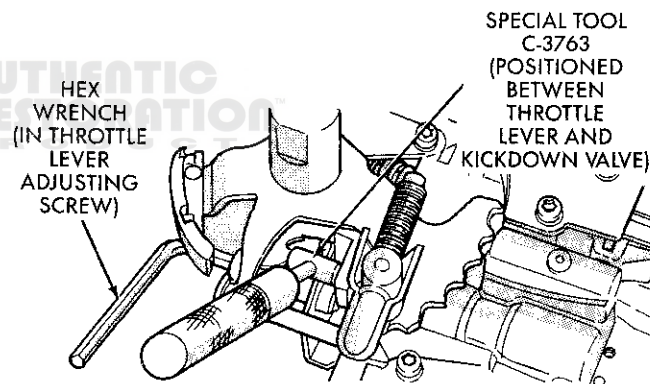
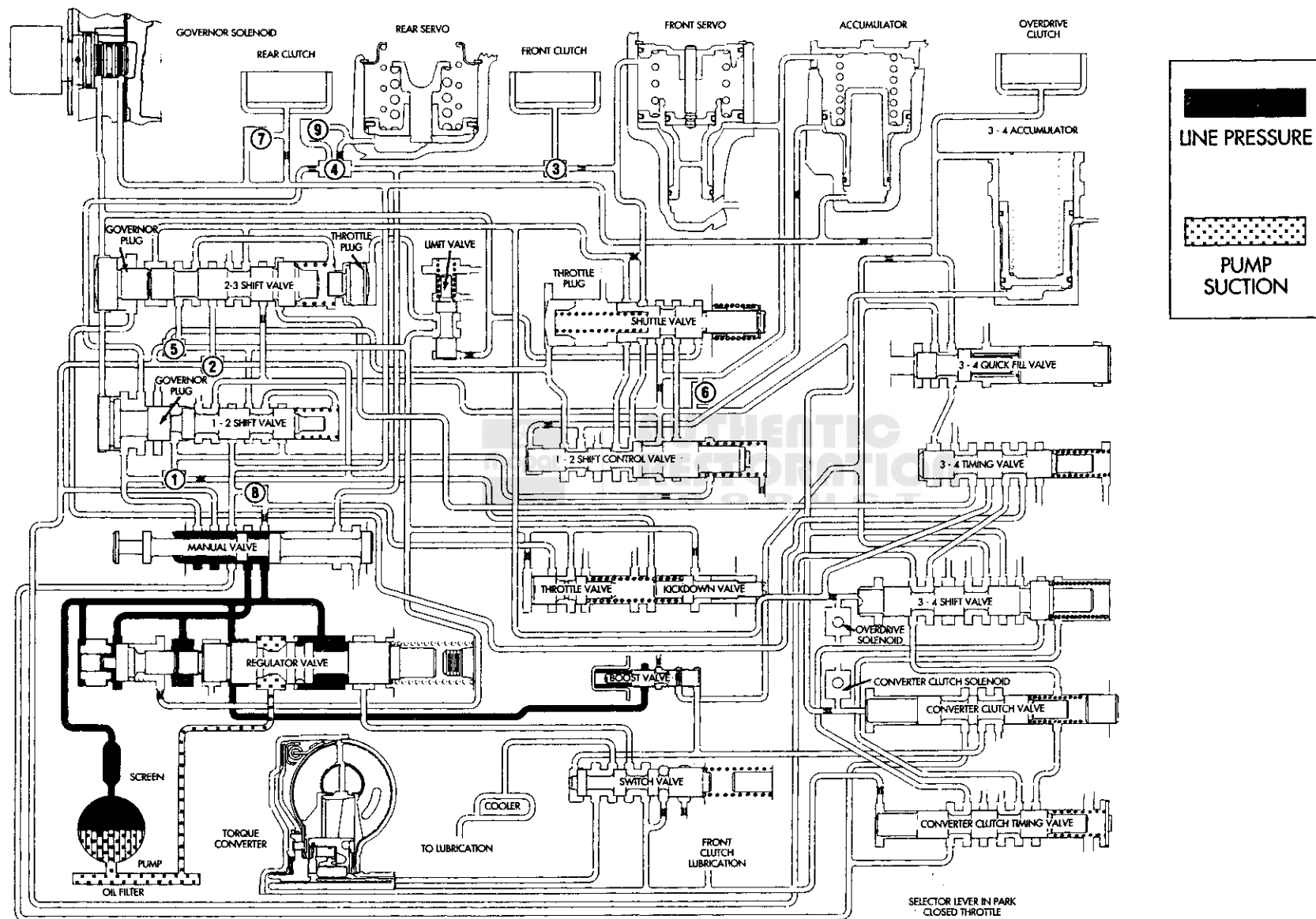


Fig. 358 Throttle Pressure Adjustment

SCHEMATICS AND DIAGRAMS**HYDRAULIC SCHEMATICS**

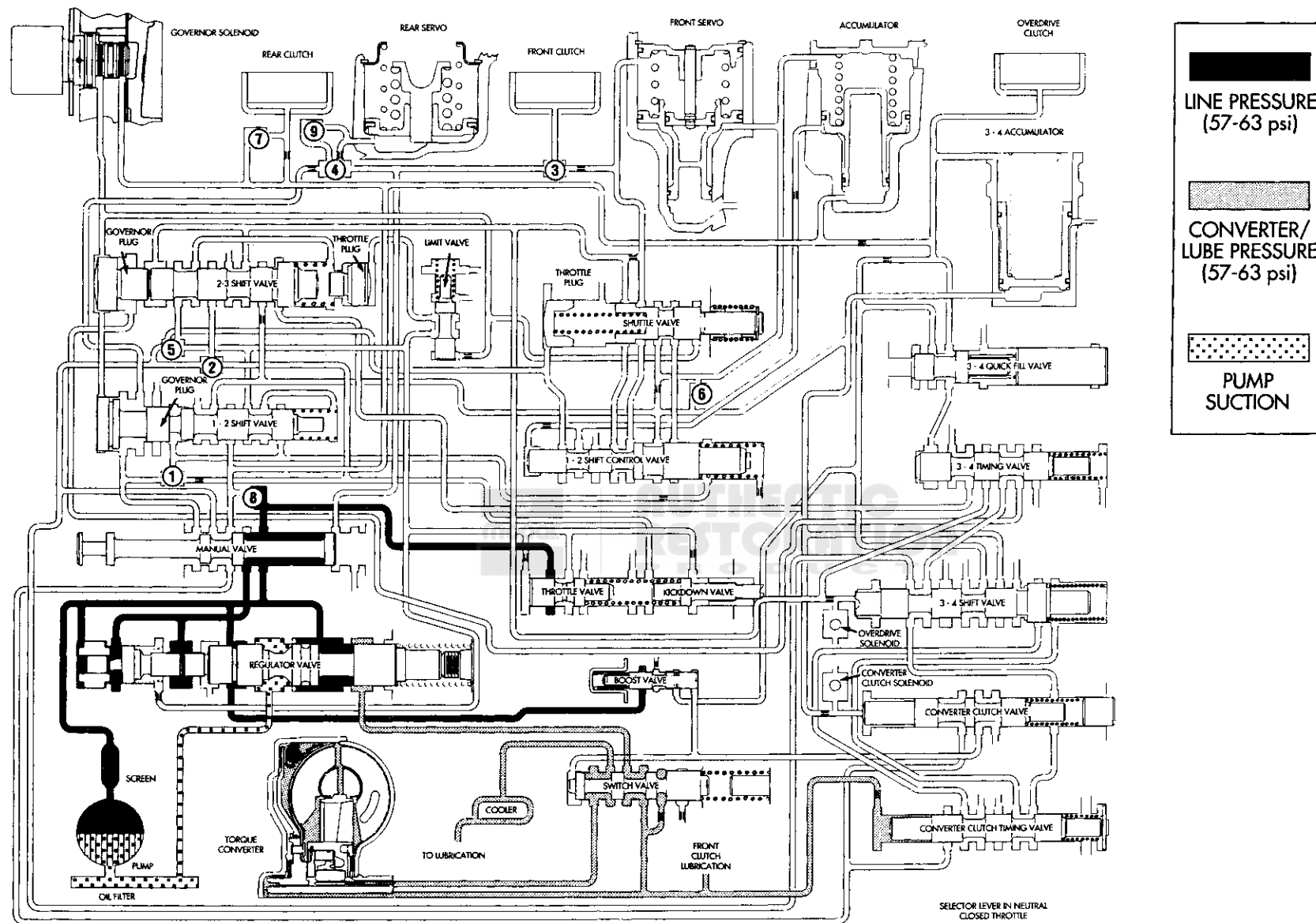
SCHEMATICS AND DIAGRAMS (Continued)



HYDRAULIC FLOW IN PARK

J9321-371

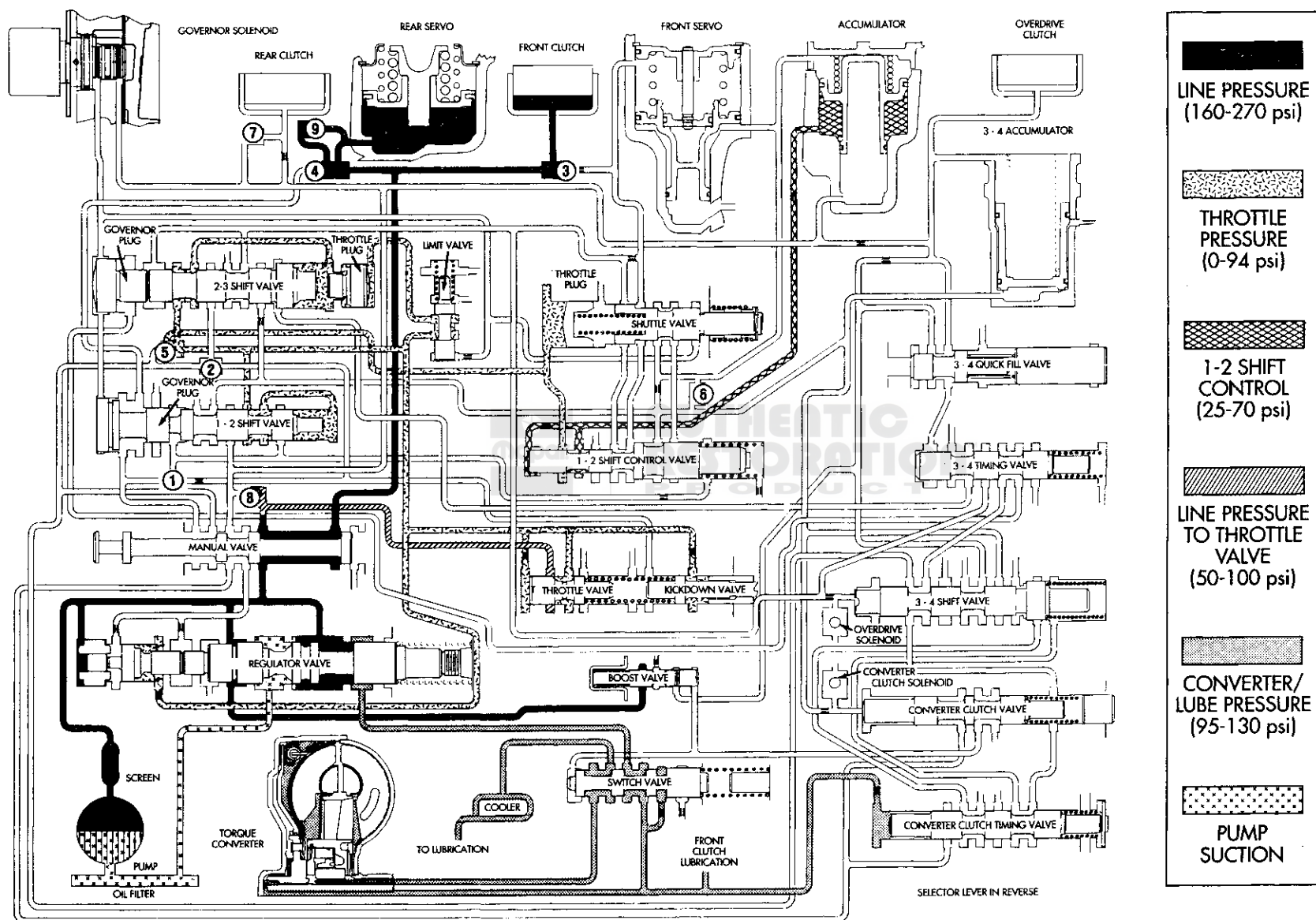
SCHEMATICS AND DIAGRAMS (Continued)



J9321-372

HYDRAULIC FLOW IN NEUTRAL

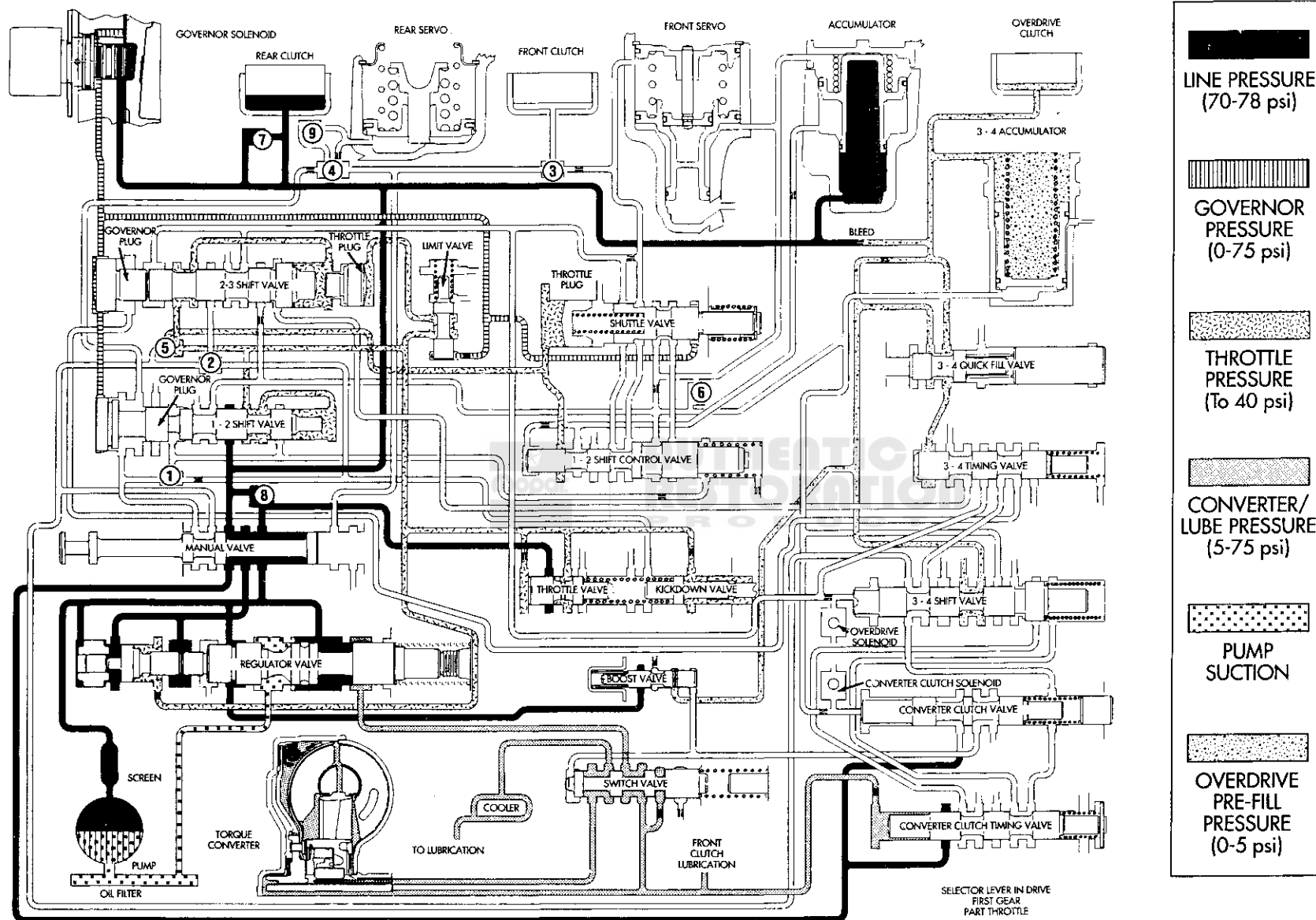
SCHEMATICS AND DIAGRAMS (Continued)



J9321-373

HYDRAULIC FLOW IN REVERSE

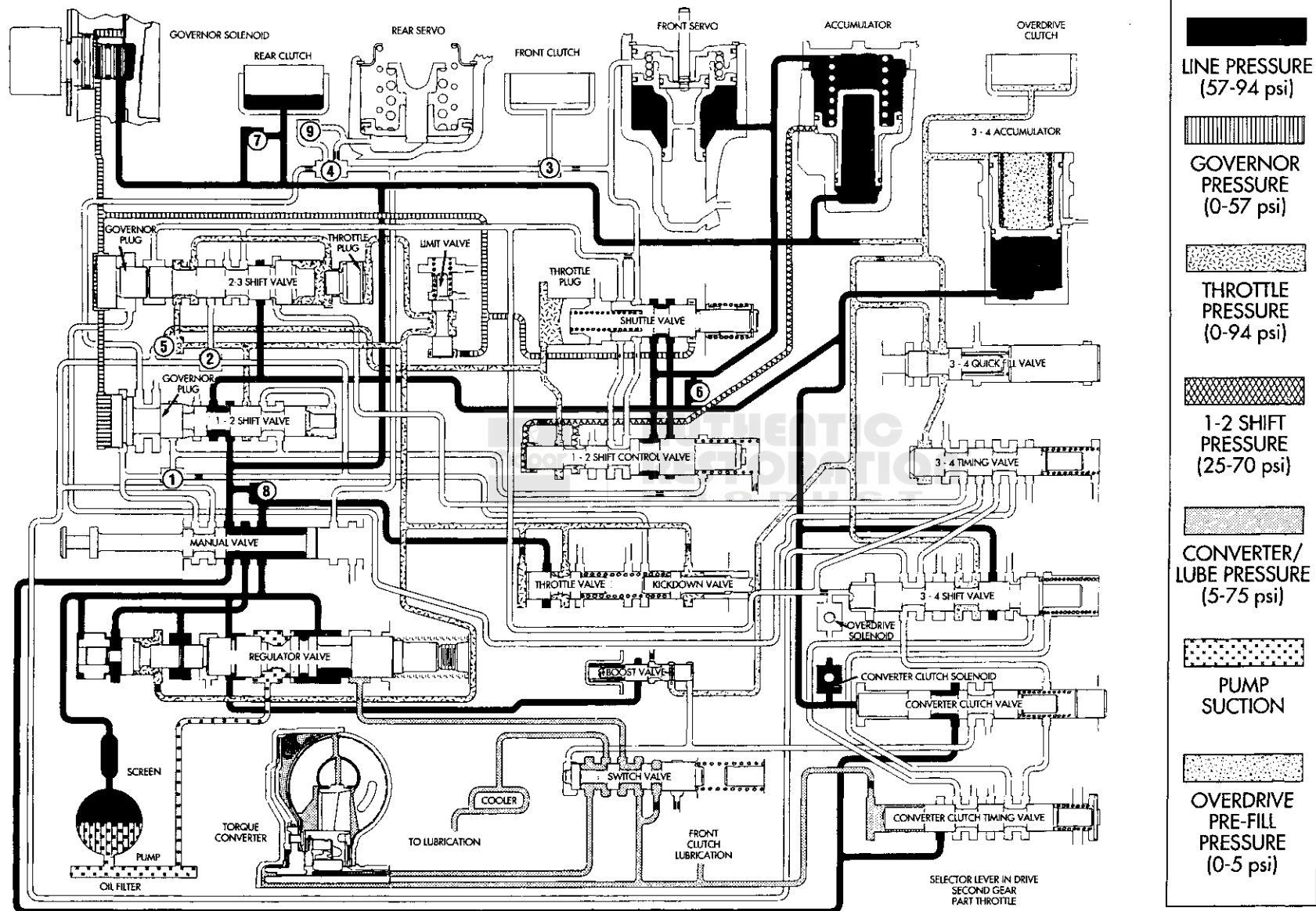
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J9321-374

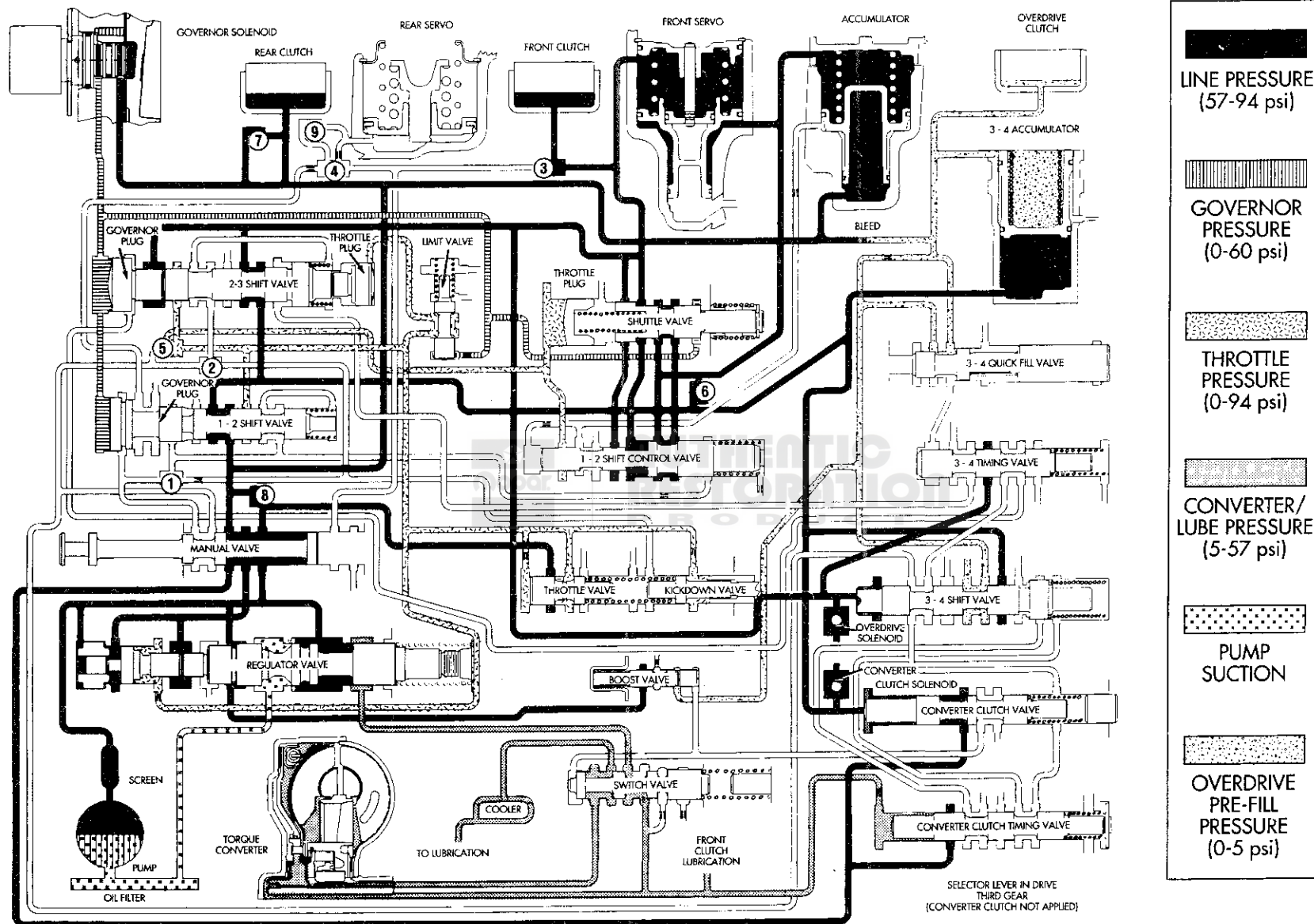
HYDRAULIC FLOW IN DRIVE FIRST GEAR

SCHEMATICS AND DIAGRAMS (Continued)



J9321-375

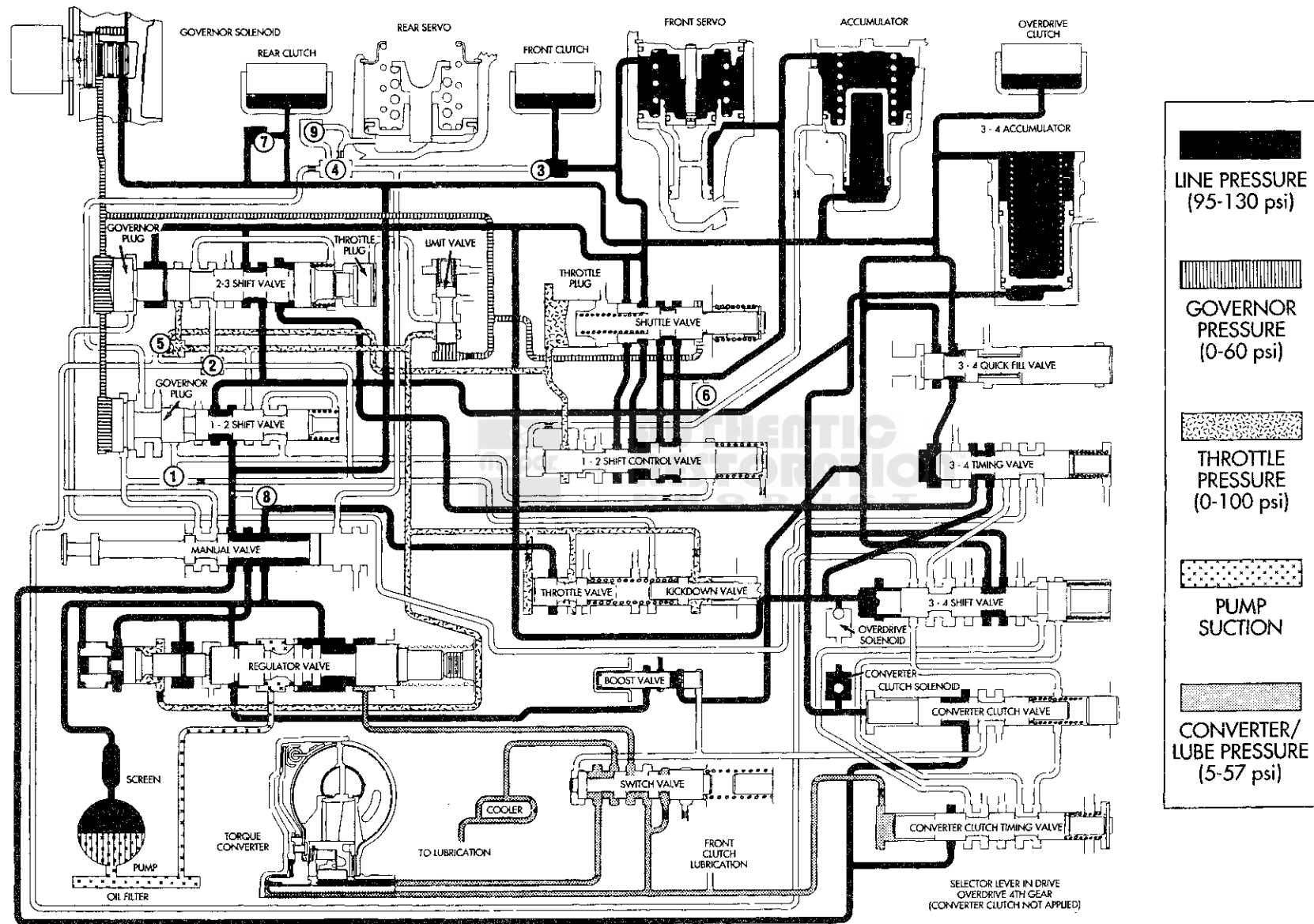
HYDRAULIC FLOW IN DRIVE SECOND GEAR



J9321-376

HYDRAULIC FLOW IN DRIVE THIRD GEAR

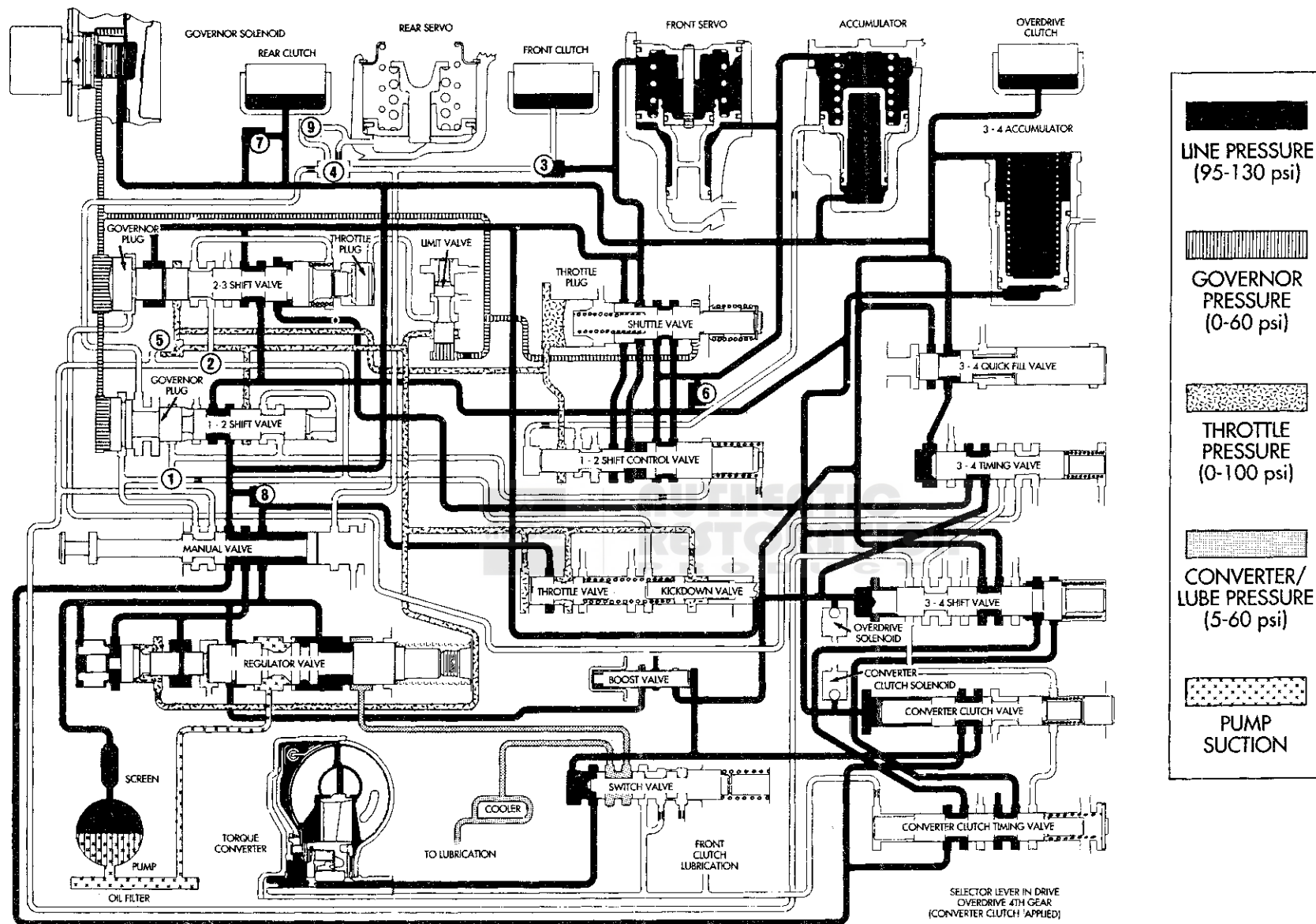
SCHEMATICS AND DIAGRAMS (Continued)



J9321-377

HYDRAULIC FLOW IN DRIVE FOURTH GEAR (CONVERTER CLUTCH NOT APPLIED)

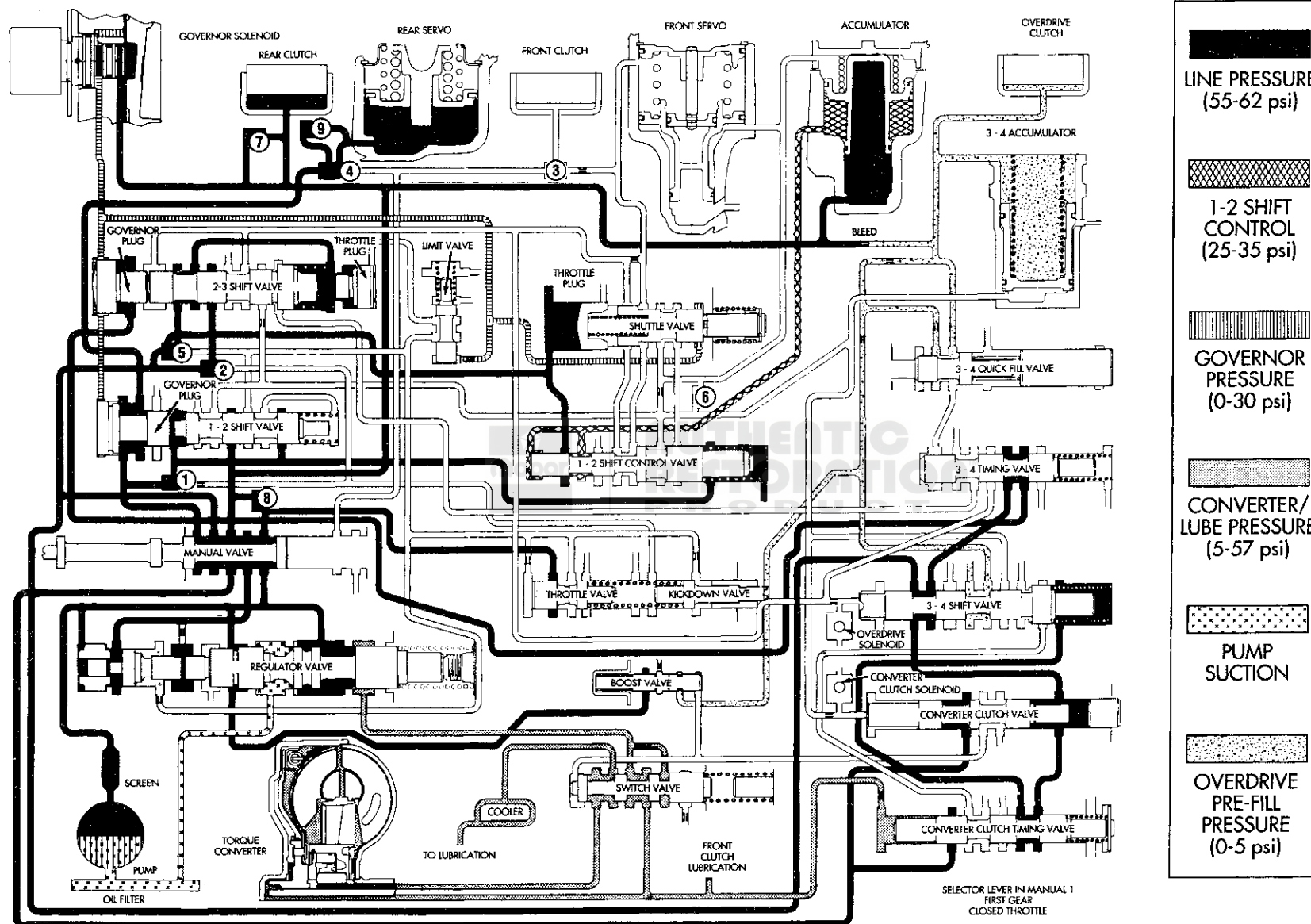
SCHEMATICS AND DIAGRAMS (Continued)



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HYDRAULIC FLOW IN DRIVE FOURTH GEAR (CONVERTER CLUTCH APPLIED)

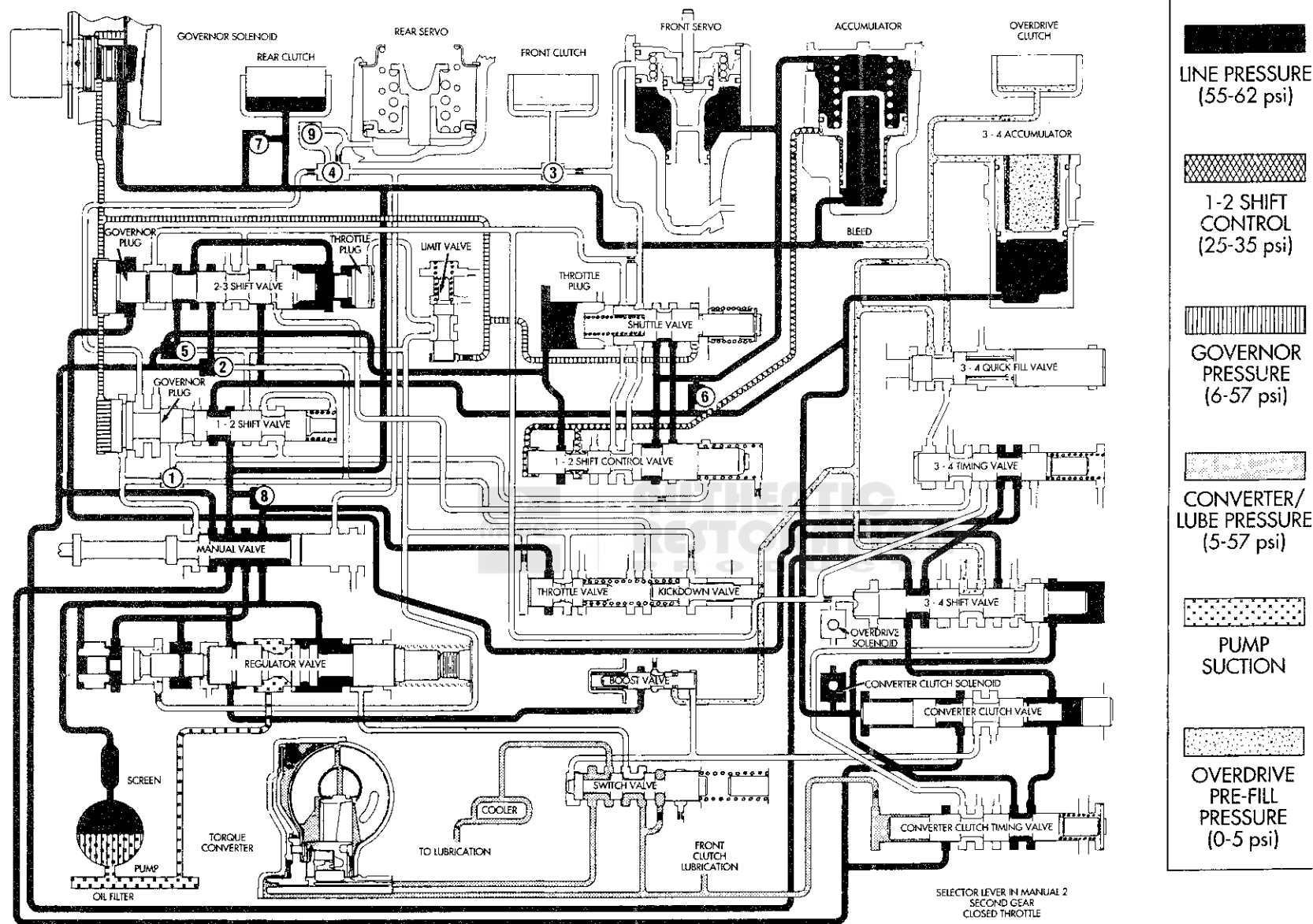
SCHEMATICS AND DIAGRAMS (Continued)



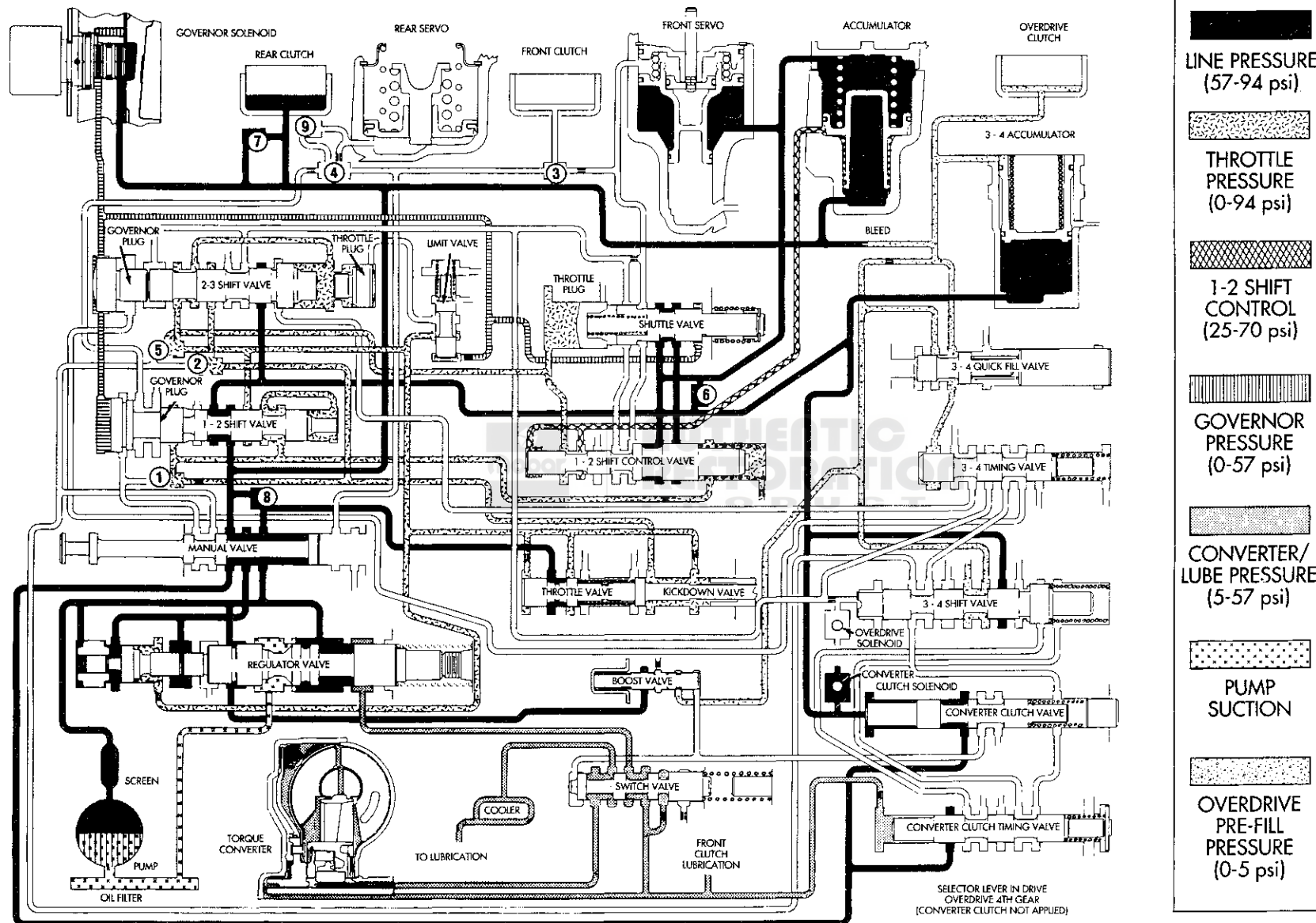
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HYDRAULIC FLOW IN MANUAL LOW (1)

SCHEMATICS AND DIAGRAMS (continued)




SCHEMATICS AND DIAGRAMS (Continued)



J9321-381

HYDRAULIC FLOW DURING FULL THROTTLE 3-2 DOWNSHIFT (PASSING GEAR)

SPECIFICATIONS**TRANSMISSION****GENERAL**

Component	Metric	Inch
Oil pump gear tip clearance	0.089-0.190 mm	0.004-0.008 in.
Planetary end play	0.127-1.22 mm	0.005-0.048 in.
Input shaft end play	0.56-2.31 mm	0.022-0.091 in.
Clutch pack clearance/ Front 4-disc.	1.70-3.40mm	0.067-0.134 in.
Clutch pack clearance/ Rear 4-disc.	0.81-1.40 mm	0.032-0.055 in.
Overdrive clutch disc usage	4 discs	
Direct clutch disc usage	8 discs	
Front clutch spring usage	1 spring	
Band adjustment from 72 in. lbs. Front band Rear band	 Back off 2-7/8 turns Back off 2 turns	
Recommended fluid	Mopar, ATF Plus type 7176	

TORQUE**DESCRIPTION****TORQUE**

Fitting, cooler line at trans.	18 N·m (13 ft. lbs.)
Bolt, torque convertor	31 N·m (23 ft. lbs.)
Bolt/nut, crossmember	68 N·m (50 ft. lbs.)
Bolt, driveplate to crankshaft . . .	75 N·m (55 ft. lbs.)
Plug, front band reaction	17 N·m (13 ft. lbs.)
Locknut, front band adj.	34 N·m (25 ft. lbs.)
Switch, park/neutral	34 N·m (25 ft. lbs.)
Bolt, fluid pan.	17 N·m (13 ft. lbs.)
Screws, fluid filter	4 N·m (35 in. lbs.)
Bolt, oil pump	20 N·m (15 ft. lbs.)
Bolt, overrunning clutch cam . . .	17 N·m (13 ft. lbs.)
Bolt, O/D to trans.	34 N·m (25 ft. lbs.)
Bolt, O/D piston retainer	17 N·m (13 ft. lbs.)
Plug, pressure test port	14 N·m (10 ft. lbs.)
Bolt, reaction shaft support	20 N·m (15 ft. lbs.)
Locknut, rear band	41 N·m (30 ft. lbs.)
Bolt, speedometer adapter	11 N·m (8 ft. lbs.)
Bolt, valve body to case	12 N·m (100 in. lbs.)
Sensor, trans speed	27 N·m (20 ft. lbs.)
Screw, solenoid wiring connector .	4 N·m (35 in. lbs.)
Screw, solenoid to transfer plate .	4 N·m (35 in. lbs.)

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SPECIFICATIONS (Continued)**THRUST WASHER/SPACER/SNAP RING DIMENSIONS**

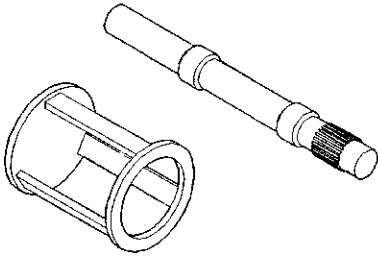
Component	Metric	Inch
Front clutch thrust washer (reaction shaft support hub)	1.55 mm	0.061 in.
Rear clutch thrust washer (clutch retainer)	1.55 mm	0.061 in.
Intermediate shaft thrust plate (shaft hub pilot)	1.5-1.6 mm	0.060-0.063 in.
Output shaft thrust washer (rear clutch hub)	Select fit to set end play	
Rear clutch pack snap ring	1.5 mm	0.060 in.
	1.95 mm	0.076 in.
	2.45 mm	0.098 in.
Planetary geartrain snap ring (at front of output shaft)	Select fit (three thicknesses available)	
Overdrive piston thrust plate	Thrust plate and spacer are select fit. Refer to size charts and selection procedures in Overdrive Unit D&A procedures	
Intermediate shaft spacer		

PRESSURE TEST

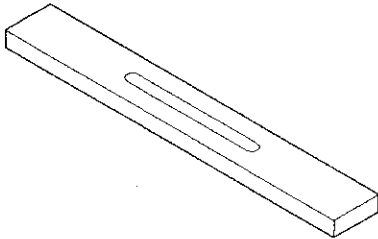
Overdrive clutch	Fourth gear only	Pressure should be 469-496 kPa (68-72 psi) with closed throttle and increase to 620-896 kPa (90-130 psi) at 1/2 to 3/4 throttle.
Line pressure (at accumulator)	Closed throttle	372-414 kPa (54-60 psi).
Front servo	Third gear only	No more than 21 kPa (3 psi) lower than line pressure.
Rear servo	1 range R range	No more than 21 kPa (3 psi) lower than line pressure. 1103 kPa (160 psi) at idle, builds to 1862 kPa (270 psi) at 1600 rpm.
Governor	D range closed throttle	Pressure should respond smoothly to changes in mph and return to 0-7 kPa (0-1.5 psi) when stopped with transmission in D, 1, 2. Pressure above 7 kPa (1.5 psi) at stand still will prevent transmission from downshifting.

SPECIAL TOOLS

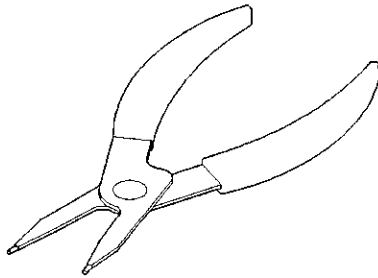
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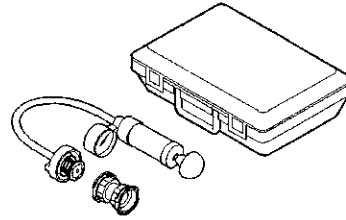
Spring Compressor and Alignment Shaft—6227



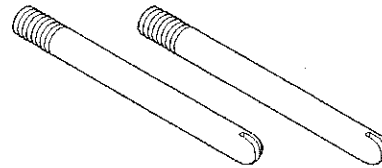
Gauge Bar—6311



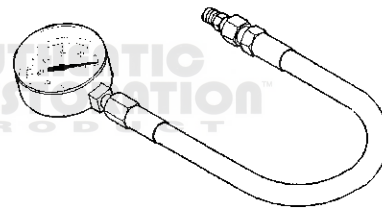
Snap-ring Plier—6823



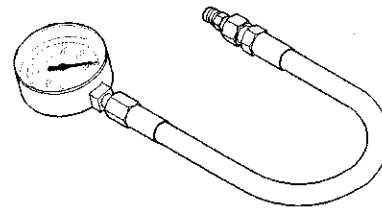
Pressure Tester—7700



Extension Housing Pilot—C-3288-B

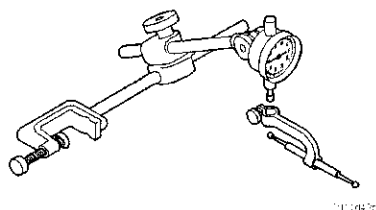


Pressure Gauge—C-3292

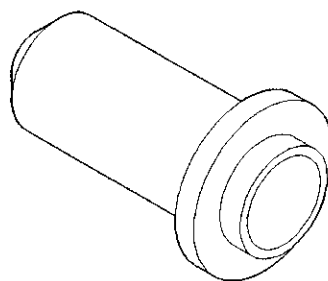


Pressure Gauge—C-3293SP

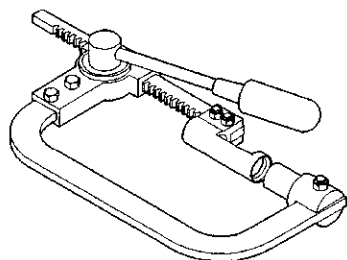
SPECIAL TOOLS (Continued)



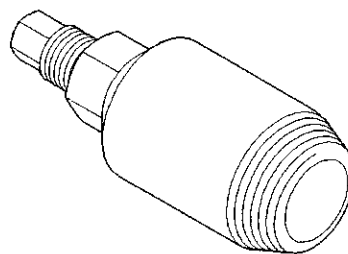
Dial Indicator—C-3339



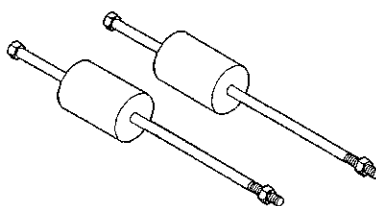
Seal Installer—C-3860-A



Spring Compressor—C-3422-B



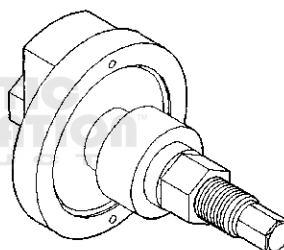
Seal Puller—C-3861



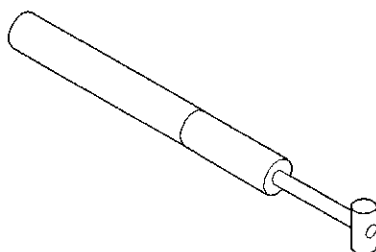
Puller, Slide Hammer—C-3752



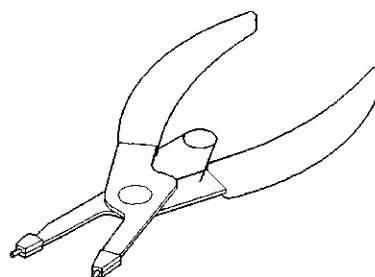
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Installer—C-3863-A

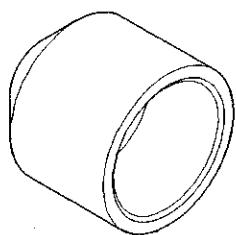


Gauge, Throttle Setting—C-3763

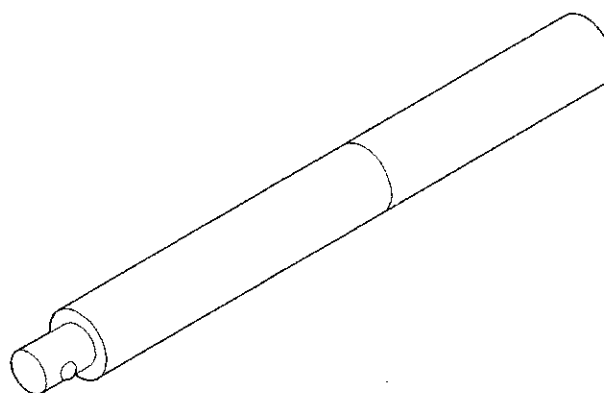


Snap-ring Plier—C-3915

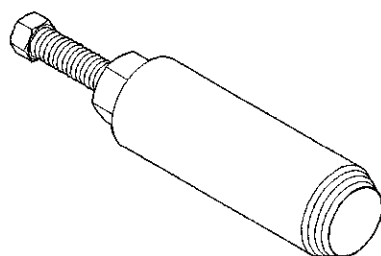
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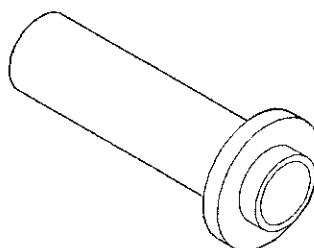
Seal Installer—C-3972-A



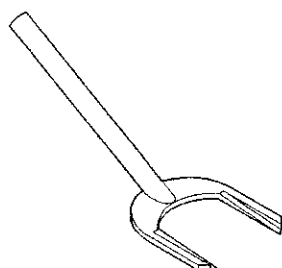
Universal Handle—C-4171



Seal Puller—C-3981-B



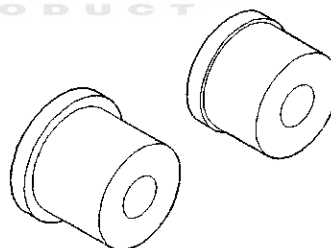
Seal Installer—C-4193-A



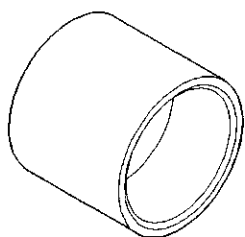
Seal Remover—C-3985-B



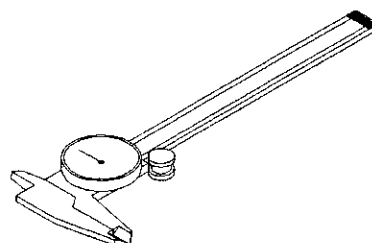
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Remover/Installer—C-4470

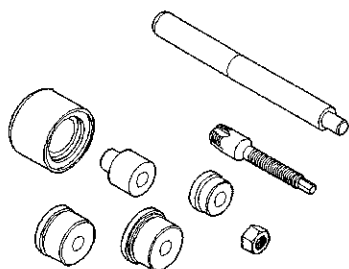


Installer—C-3995-A

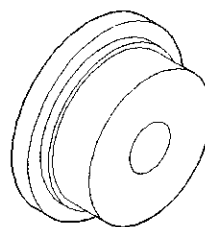


Dial Caliper—C-4962

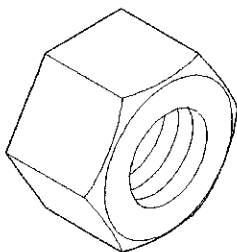
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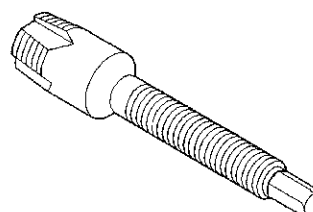
Bushing Remover/Installer Set—C-3887-B



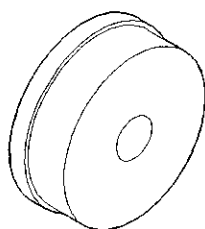
Installer, Oil Pump Bushing—SP-5118, From kit C-3887-B



Nut, Bushing Remover—SP-1191, From kit C-3887-B



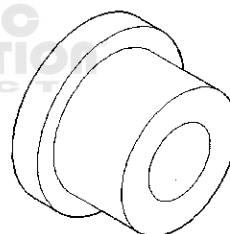
Remover, Reaction Shaft Bushing—SP-5301, From kit C-3887-B



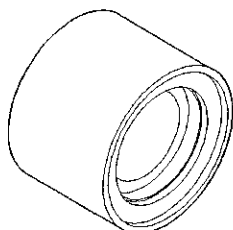
Remover, Front Clutch Bushing—SP-3629, From kit C-3887-B



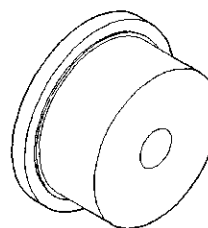
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Installer, Reaction Shaft Bushing—SP-5302, From kit C-3887-B



Cup, Bushing Remover—SP-3633, From kit C-3887-B



Installer, Front Clutch Bushing—SP-5511, From kit C-3887-B

AUTOMATIC TRANSMISSION—46/47RE

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GENERAL INFORMATION

46/47RE TRANSMISSION

The 46/47RE transmissions are four speed fully automatic transmissions with an electronic governor (Fig. 1) and (Fig. 2). First through third gear ranges are provided by the clutches, bands, overrunning clutch, and planetary gear sets in the transmission. Fourth gear range is provided by the overdrive unit that contains an overdrive clutch, direct clutch, planetary gear set, and overrunning clutch. The overdrive clutch is applied in fourth gear only. The direct clutch is applied in all ranges except fourth gear. The 46RE is equipped with a lock-up clutch in the torque converter. The torque converter clutch is controlled

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RE TRANSMISSION	377
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by the Powertrain Control Module (PCM). The torque converter clutch is hydraulically applied and is released when fluid is vented from the hydraulic circuit by the torque converter control (TCC) solenoid on the valve body. The torque converter clutch engages in fourth gear, and in third gear when the O/D switch is OFF. Engagement occurs when the vehicle is cruising on a level plane after the vehicle has warmed up. The torque converter clutch disengages when the vehicle begins to go uphill or the accelerator is applied. The torque converter clutch feature increases fuel economy and reduces the transmission fluid temperature. The 46RE transmission is cooled by an integral fluid cooler inside the radiator.



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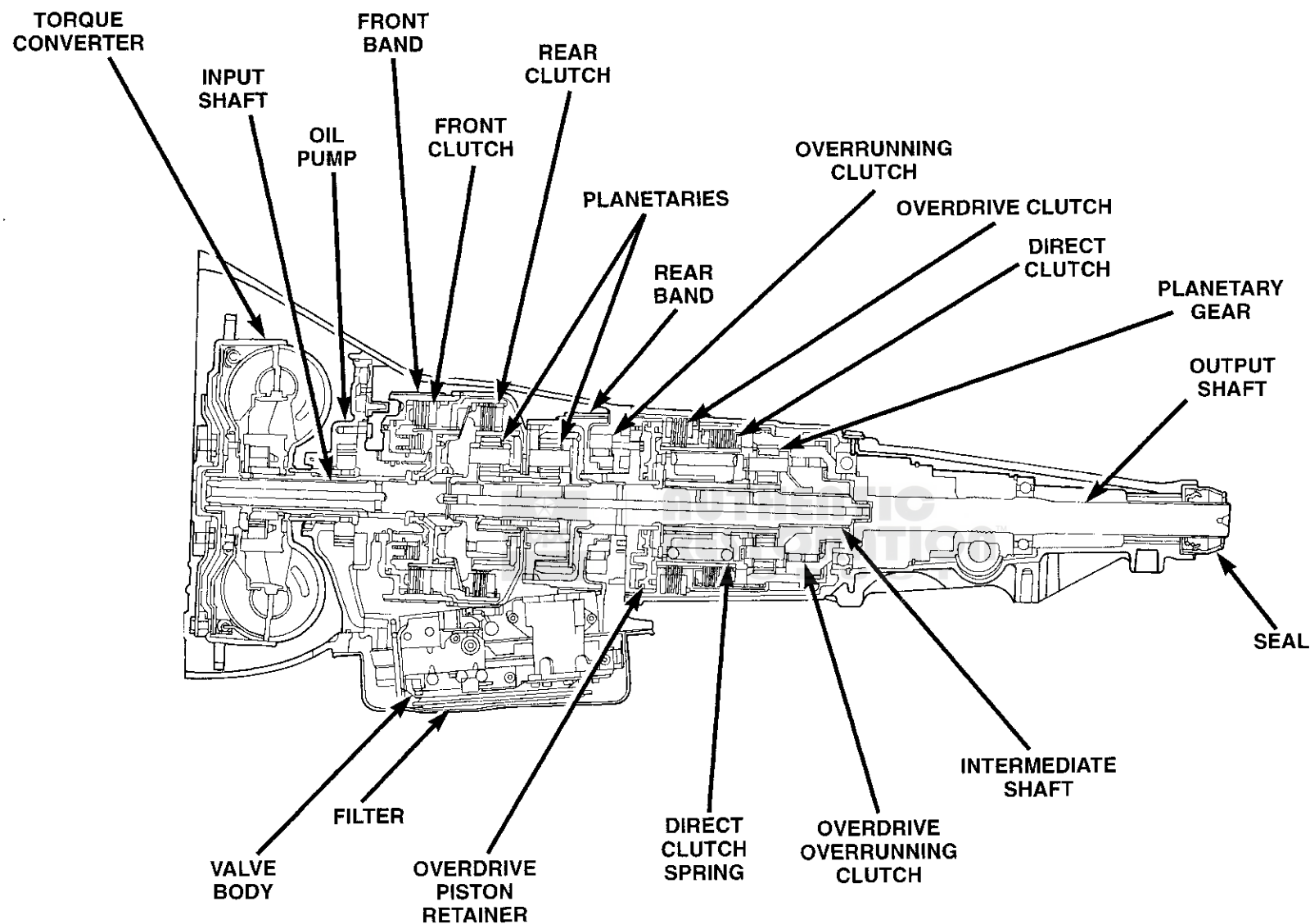
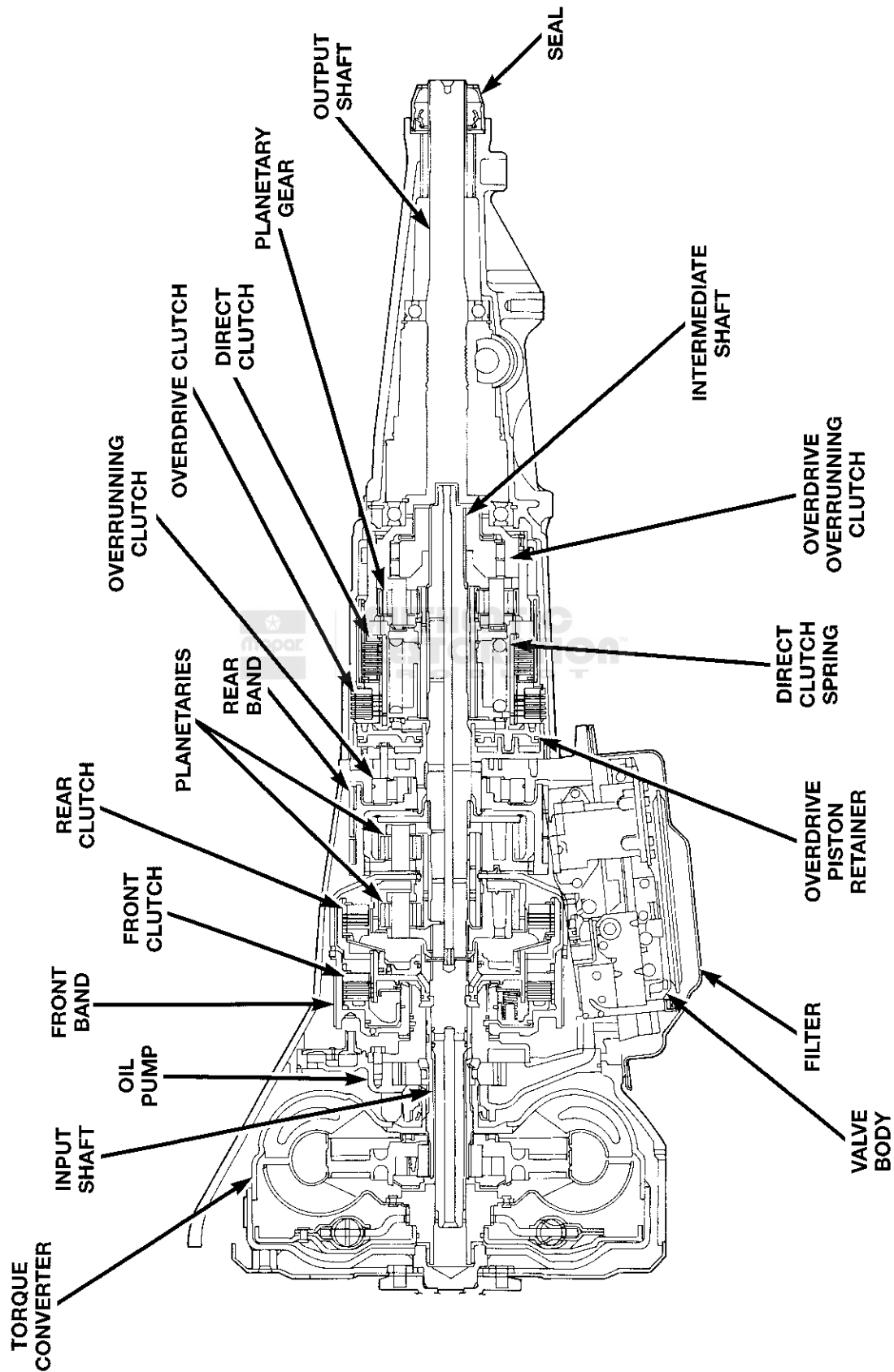


Fig. 1 46RE Transmission

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GENERAL INFORMATION (Continued)



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Fig. 2 47RE Transmission

TRANSMISSION IDENTIFICATION

Transmission identification numbers are stamped on the left side of the case just above the oil pan gasket surface (Fig. 3). Refer to this information when ordering replacement parts.

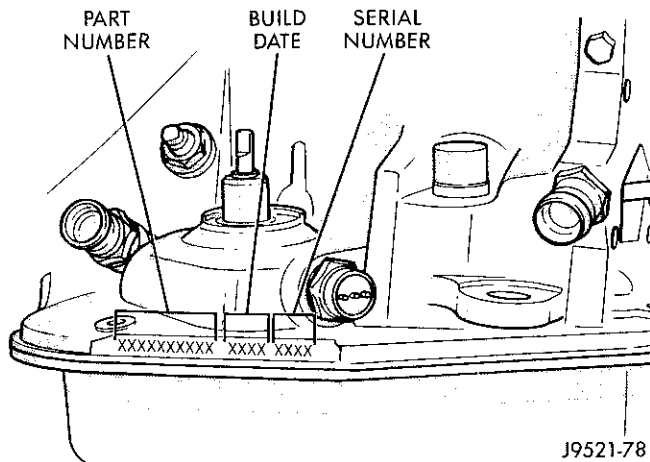


Fig. 3 Transmission Part And Serial Number Location

RECOMMENDED FLUID

Mopar ATF Plus, Type 7176 automatic transmission fluid is the recommended fluid for Chrysler automatic transmissions.

Dexron II fluid IS NOT recommended. Clutch chatter can result from the use of improper fluid. If Mopar ATF Plus is not available, Dexron II can be used as a supplement if the vehicle must be driven.

TORQUE CONVERTER—ELECTRONIC CLUTCH

The torque converter is a hydraulic device that couples the engine crankshaft to the transmission. The torque converter consists of an outer shell with an internal turbine, a stator, an overrunning clutch, an impeller, and an electronically applied converter clutch. Torque multiplication is created when the stator directs the hydraulic flow from the turbine to rotate the impeller in the direction the engine crankshaft is turning. The turbine transfers power to the planetary gear sets in the transmission. The transfer of power into the impeller assists torque multiplication. At low vehicle-speed, the overrunning clutch holds stator stationary (during torque multiplication) and allows the stator to freewheel at high vehicle speed. The converter clutch provides reduced engine speed and greater fuel economy when engaged. Clutch engagement also provides reduced transmission fluid temperatures. The converter clutch is engaged in fourth gear and in third gear when the overdrive switch is OFF. The torque converter hub drives the transmission oil (fluid) pump.

The torque converter is a sealed, welded unit that is not repairable and is serviced as an assembly.

CAUTION: The torque converter must be replaced if a transmission failure resulted in large amounts of metal or fiber contamination in the fluid. If the fluid is contaminated, flush the fluid cooler and lines.

46/47 RE GEAR RATIOS

46/47RE forward gear ratios are:

- 2.45:1 (first gear)
- 1.45:1 (second gear)
- 1.00:1 (third gear)
- 0.69:1 (fourth gear)
- 2.21 (reverse)

GEARSHIFT MECHANISM

The gear shift mechanism provides six shift positions which are:

- park (P)
- reverse (R)
- neutral (N)
- drive (D)
- manual second (2)
- manual low (1)

Manual low (1) range provides first gear only. Overrun braking is also provided in this range. Manual second (2) range provides first and second gear only.

Drive range provides first, second third and overdrive fourth gear ranges. The shift into overdrive fourth gear range occurs only after the transmission has completed the shift into D third gear range. No further movement of the shift mechanism is required to complete the 3-4 shift.

The fourth gear upshift occurs automatically when the overdrive selector switch is in the ON position.

DESCRIPTION AND OPERATION

ELECTRONIC GOVERNOR

Governor pressure is controlled electronically. Components used for governor pressure control include:

- Governor body
- Valve body transfer plate
- Governor pressure solenoid valve
- Governor pressure sensor
- Fluid temperature thermistor
- Throttle position sensor (TPS)
- Transmission speed sensor
- Powertrain control module (PCM)

GOVERNOR PRESSURE SOLENOID VALVE

The solenoid valve regulates the governor pressure needed for upshifts and downshifts. It is an electro-

DESCRIPTION AND OPERATION (Continued)

hydraulic device located in the governor body on the valve body transfer plate (Fig. 4).

The inlet side of the solenoid valve is exposed to normal transmission line pressure. The outlet side of the valve leads to the valve body governor circuit.

The solenoid valve regulates line pressure to produce governor pressure. The average current supplied to the solenoid controls governor pressure. One amp current produces zero kPa/psi governor pressure. Zero amps sets the maximum governor pressure.

The powertrain control module (PCM) supplies electrical power to the solenoid valve. Operating voltage is 12 volts (DC) and is provided through the battery terminal on the module.

The solenoid is polarity sensitive. The PCM energizes the solenoid by grounding it through the power ground terminal on the PCM.

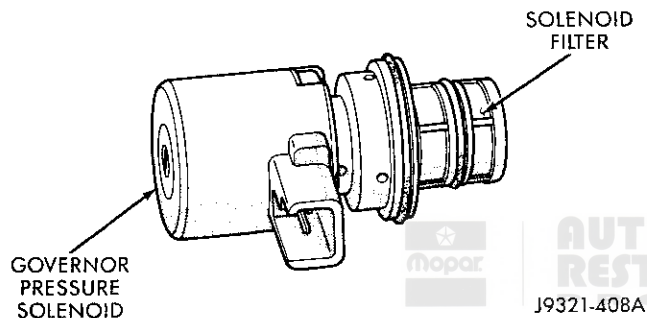


Fig. 4 Governor Pressure Solenoid Valve

GOVERNOR PRESSURE SENSOR

The governor pressure sensor measures output pressure of the governor pressure solenoid valve (Fig. 5).

The sensor output signal provides the necessary feedback to the PCM. This feedback is needed to adequately control governor pressure.

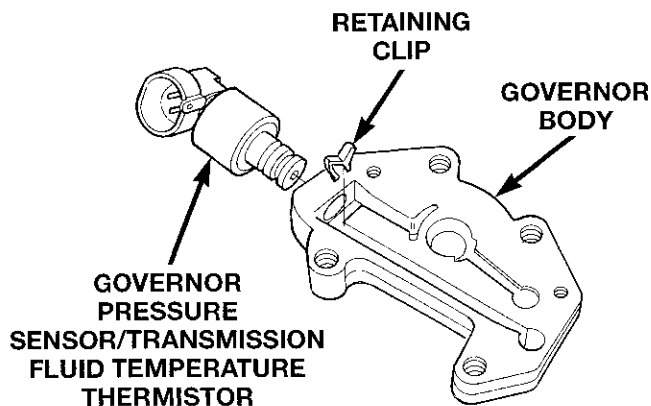


Fig. 5 Governor Pressure Sensor

GOVERNOR BODY AND TRANSFER PLATE

The transfer plate is designed to supply transmission line pressure to the governor pressure solenoid valve and to return governor pressure.

The governor pressure solenoid valve is mounted in the governor body. The body is bolted to the lower side of the transfer plate (Fig. 5). The transfer plate channels line pressure to the solenoid valve through the governor body. It also channels governor pressure from the solenoid valve to the governor circuit. It is the solenoid valve that develops the necessary governor pressure.

TRANSMISSION FLUID TEMPERATURE THERMISTOR

Transmission fluid temperature readings are supplied to the transmission control module by the thermistor (Fig. 6). The temperature readings are used to control engagement of the fourth gear overdrive clutch, the converter clutch, and governor pressure. Normal resistance value for the thermistor at room temperature is approximately 1000 ohms.

The PCM prevents engagement of the converter clutch and overdrive clutch, when fluid temperature is below approximately 10°C (50°F).

If fluid temperature exceeds 126°C (260°F), the PCM causes a 4-3 downshift and engage the converter clutch. Engagement is according to the third gear converter clutch engagement schedule.

The overdrive OFF lamp in the instrument panel illuminates when the shift back to third occurs. The transmission will not allow fourth gear operation until fluid temperature decreases to approximately 110°C (230°F).

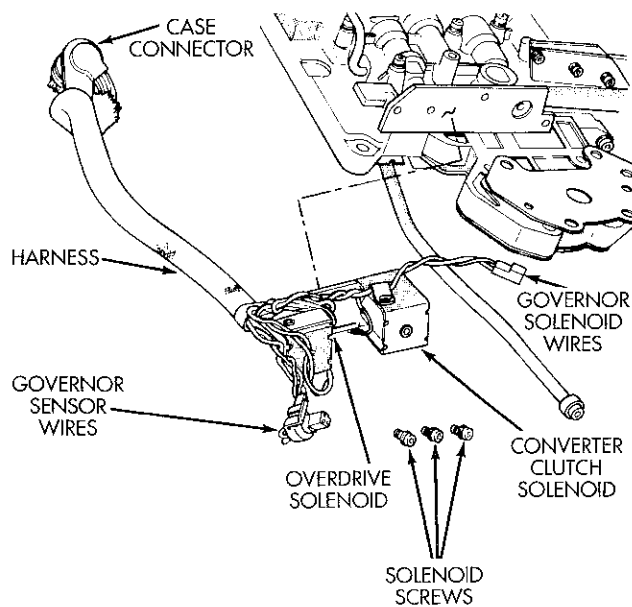
The thermistor is part of the pressure sensor and is immersed in transmission fluid at all times.

TRANSMISSION SPEED SENSOR

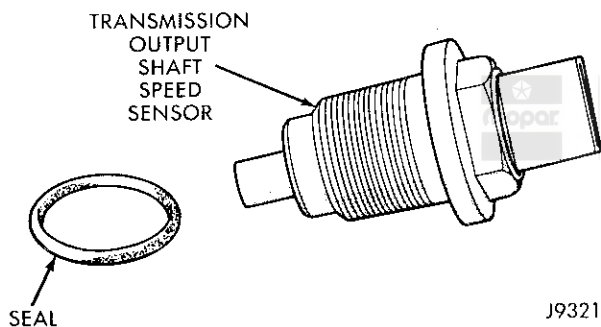
The speed sensor (Fig. 7) is located in the overdrive gear case. The sensor is positioned over the park gear and monitors transmission output shaft rotating speed. Speed sensor signals are triggered by the park gear lugs as they rotate past the sensor pickup face. Input signals from the sensor are sent to the transmission control module for processing. The vehicle speed sensor also serves as a backup for the transmission speed sensor. Signals from this sensor are shared with the powertrain control module.

THROTTLE POSITION SENSOR (TPS)

The TPS provides throttle position input signals to the PCM. This input signal is used to determine overdrive and converter clutch shift schedule and to select the proper governor curve.

DESCRIPTION AND OPERATION (Continued)

J9521-177

Fig. 6 Connector Location

J9321-411

Fig. 7 Transmission Speed Sensor**POWERTRAIN CONTROL MODULE (PCM)**

The PCM controls operation of the converter clutch, overdrive clutch, and governor pressure solenoid.

The control module determines transmission shift points based on input signals from the transmission thermistor, transmission output shaft speed sensor, crankshaft position sensor, vehicle speed sensor, and throttle position sensor.

Operating voltage is supplied through the battery terminal on the control module. The ignition voltage signal is supplied through a terminal on the ABS control module.

The DRB scan tool can be used to check operation of the control module and transmission electrical components. The diagnostic connector (for the scan tool) is located under the instrument panel near the steering column. The connector has a 6-way terminal and is blue in color.

GOVERNOR PRESSURE CURVES

There are four governor pressure curves programmed into the transmission control module. The different curves allow the control module to adjust governor pressure for varying conditions. One curve is used for operation when fluid temperature is at, or below, 1°C (30°F). A second curve is used when fluid temperature is at, or above, 10°C (50°F) during normal city or highway driving. A third curve is used during wide-open throttle operation. The fourth curve is used when driving with the transfer case in low range.

SHIFT VALVE OPERATION

The shift valves are moved by a combination of throttle and governor pressure. The governor pressure is generated by electrical components.

The conditions under which a shift to fourth will not occur when:

- Overdrive switch is Off
- Transmission fluid temperature is below 10° C (50° F) or above 121° C (250° F)
- Shift to third not yet completed
- Vehicle speed too low for 3-4 shift to occur

HYDRAULIC CONTROL SYSTEM

The hydraulic control system provides fully automatic operation. The system performs five basic functions which are: pressure supply, pressure regulation, flow control, clutch/band application, and lubrication.

PRESSURE REGULATION

The pressure regulator valve maintains line pressure. The amount of pressure developed is controlled by throttle pressure which is dependent on the degree of throttle opening. The regulator valve is located in the valve body.

The throttle valve determines line pressure and shift speed. Governor pressure increases in proportion to vehicle speed. The throttle valve controls upshift and downshift speeds by regulating pressure according to throttle position.

Shift Valve Flow Control

The manual valve is operated by the gearshift linkage and provides the operating range selected by the driver.

The 1-2 shift valve provides 1-2 or 2-1 shifts and the 2-3 shift valve provides 2-3 or 3-2 shifts.

The kickdown valve provides forced 3-2 or 3-1 downshifts depending on vehicle speed. Downshifts occur when the throttle is opened beyond downshift detent position. Detent is reached just before wide open throttle position.

The 2-3 valve throttle pressure plug provides 3-2 downshifts at varying throttle openings depending on vehicle speed.

DESCRIPTION AND OPERATION (Continued)

The 1-2 shift control valve transmits 1-2 shift pressure to the accumulator piston. This controls kickdown band capacity on 1-2 upshifts and 3-2 downshifts.

The 3-4 shift, quick fill, and timing valves plus the 3-4 accumulator, are only actuated when the overdrive solenoid is energized.

The solenoid contains a check ball that controls a vent port to the 3-4 valves. The check ball either diverts line pressure away from or directly to the 3-4 valves.

The limit valve determines maximum speed at which a 3-2 part throttle kickdown can be made. On transmissions without a limit valve, maximum speed for a 3-2 kickdown is at detent position.

The 2-3 shuttle valve has two functions. First is fast front band release and smooth engagement during lift-foot 2-3 upshifts. The second is to regulate front clutch and band application during 3-2 downshifts.

The 3-4 timing valve is moved by line pressure coming through the 3-4 shift valve. The timing valve holds the 2-3 shift valve in an upshift position. The purpose is to prevent the 2-3 valve from up or downshifting before the 3-4 valve.

The 3-4 accumulator is mounted on the overdrive housing and performs the same function as the 2-3 accumulator; it is used to smooth engagement during a 3-4 shift.

The switch valve directs fluid apply pressure to the converter clutch in one position and releases it in the opposite position. It also directs oil to the cooling and lube circuits. The switch valve regulates oil pressure to the torque converter by limiting maximum oil pressure to 130 psi.

OVERDRIVE OFF SWITCH

The overdrive OFF (control) switch is located in the instrument panel. The switch is a momentary contact device that signals the PCM to toggle current status of the overdrive function. At key-on, overdrive operation is allowed. Pressing the switch once causes the overdrive OFF mode to be entered and the overdrive OFF switch lamp to be illuminated. Pressing the switch a second time causes normal overdrive operation to be restored and the overdrive lamp to be turned off. The overdrive OFF mode defaults to ON after the ignition switch is cycled OFF and ON. The normal position for the control switch is the ON position. The switch must be in this position to energize the solenoid and allow a 3-4 upshift. The control switch indicator light illuminates only when the overdrive switch is turned to the OFF position, or when illuminated by the transmission control module.

3-4 SHIFT SEQUENCE

The overdrive clutch is applied in fourth gear only. The direct clutch is applied in all ranges except fourth gear. Fourth gear overdrive range is electronically controlled and hydraulically activated. Various sensor inputs are supplied to the powertrain control module to operate the overdrive solenoid on the valve body. The solenoid contains a check ball that opens and closes a vent port in the 3-4 shift valve feed passage. The overdrive solenoid (and check ball) are not energized in first, second, third, or reverse gear. The vent port remains open, diverting line pressure from the 2-3 shift valve away from the 3-4 shift valve. The overdrive control switch must be in the ON position to transmit overdrive status to the PCM. A 3-4 upshift occurs only when the overdrive solenoid is energized by the PCM. The PCM energizes the overdrive solenoid during the 3-4 upshift. This causes the solenoid check ball to close the vent port allowing line pressure from the 2-3 shift valve to act directly on the 3-4 upshift valve. Line pressure on the 3-4 shift valve overcomes valve spring pressure moving the valve to the upshift position. This action exposes the feed passages to the 3-4 timing valve, 3-4 quick fill valve, 3-4 accumulator, and ultimately to the overdrive piston. Line pressure through the timing valve moves the overdrive piston into contact with the overdrive clutch. The direct clutch is disengaged before the overdrive clutch is engaged. The boost valve provides increased fluid apply pressure to the overdrive clutch during 3-4 upshifts, and when accelerating in fourth gear. The 3-4 accumulator cushions overdrive clutch engagement to smooth 3-4 upshifts. The accumulator is charged at the same time as apply pressure acts against the overdrive piston.

CONVERTER CLUTCH ENGAGEMENT

Converter clutch engagement in third or fourth gear range is controlled by sensor inputs to the powertrain control module. Inputs that determine clutch engagement are: coolant temperature, engine rpm, vehicle speed, throttle position, and manifold vacuum. The torque converter clutch is engaged by the clutch solenoid on the valve body. The clutch can be engaged in third and fourth gear ranges depending on overdrive control switch position. If the overdrive control switch is in the normal ON position, the clutch will engage after the shift to fourth gear, and above approximately 72 km/h (45 mph). If the control switch is in the OFF position, the clutch will engage after the shift to third gear, at approximately 56 km/h (35 mph) at light throttle.

QUICK FILL VALVE

The 3-4 quick fill valve provides faster engagement of the overdrive clutch during 3-4 upshifts. The valve

DESCRIPTION AND OPERATION (Continued)

temporarily bypasses the clutch piston feed orifice at the start of a 3-4 upshift. This exposes a larger passage into the piston retainer resulting in a much faster clutch fill and apply sequence. The quick fill valve does not bypass the regular clutch feed orifice throughout the 3-4 upshift. Instead, once a predetermined pressure develops within the clutch, the valve closes the bypass. Clutch fill is then completed through the regular feed orifice.

CONVERTER DRAINBACK VALVE

The drainback valve is located in the transmission cooler outlet (pressure) line. The valve prevents fluid from draining from the converter into the cooler and lines when the vehicle is shut down for lengthy periods. Production valves have a hose nipple at one end, while the opposite end is threaded for a flare fitting. All valves have an arrow (or similar mark) to indicate direction of flow through the valve.

DIAGNOSIS AND TESTING**AUTOMATIC TRANSMISSION DIAGNOSIS**

Automatic transmission problems can be a result of poor engine performance, incorrect fluid level, incorrect linkage or cable adjustment, band or hydraulic control pressure adjustments, hydraulic system malfunctions or electrical/mechanical component malfunctions. Begin diagnosis by checking the easily accessible items such as: fluid level and condition, linkage adjustments and electrical connections on 4-speed models. A road test will determine if further diagnosis is necessary.

PRELIMINARY DIAGNOSIS

Two basic procedures are required. One procedure for vehicles that are drivable and an alternate procedure for disabled vehicles (will not back up or move forward).

VEHICLE IS DRIVEABLE

- (1) Check for transmission control module fault codes using DRB scan tool.
- (2) Check fluid level and condition.
- (3) Adjust throttle and gearshift linkage if complaint was based on delayed, erratic, or harsh shifts.
- (4) Road test and note how transmission upshifts, downshifts, and engages.
- (5) Perform stall test if complaint is based on sluggish acceleration. Or, if abnormal throttle opening is needed to maintain normal speeds with a properly tuned engine.
- (6) Perform hydraulic pressure test if shift problems were noted during road test.
- (7) Perform air-pressure test to check clutch-band operation.

VEHICLE IS DISABLED

- (1) Check fluid level and condition.
- (2) Check for broken or disconnected gearshift or throttle linkage.
- (3) Check for cracked, leaking cooler lines, or loose or missing pressure-port plugs.
- (4) Raise and support vehicle on safety stands, start engine, shift transmission into gear, and note following:
 - (a) If propeller shaft turns but wheels do not, problem is with differential or axle shafts.
 - (b) If propeller shaft does not turn and transmission is noisy, stop engine. Remove oil pan, and check for debris. If pan is clear, remove transmission and check for damaged drive plate, converter, oil pump, or input shaft.
 - (c) If propeller shaft does not turn and transmission is not noisy, perform hydraulic-pressure test to determine if problem is hydraulic or mechanical.

PARK/NEUTRAL POSITION SWITCH

The center terminal of the park/neutral position switch is the starter-circuit terminal. It provides the ground for the starter solenoid circuit through the selector lever in PARK and NEUTRAL positions only. The outer terminals on the switch are for the backup lamp circuit.

SWITCH TEST

To test the switch, remove the wiring connector. Then test for continuity between the center terminal and the transmission case. Continuity should exist only when the transmission is in PARK or NEUTRAL.

Shift the transmission into REVERSE and test continuity at the switch outer terminals (Fig. 8). Continuity should exist only when the transmission is in REVERSE. Continuity should not exist between the outer terminals and the case.

Check gearshift linkage adjustment before replacing a switch that tests bad.

CHECKING FLUID LEVEL AND CONDITION

Transmission fluid level and condition should be checked a minimum of six times per year under normal operation. If the vehicle is used for commercial operation, trailer towing, or similar high load operation, fluid level and condition should be checked weekly.

Fluid level is checked with the engine running at curb idle speed, brakes applied, transmission in Neutral, and the transmission fluid at normal operating temperature (hot).

- (1) Transmission fluid must be at normal operating temperature for accurate fluid level check. Drive vehicle if necessary to bring fluid temperature up to normal hot operating temperature of 82° C (180° F).

DIAGNOSIS AND TESTING (Continued)

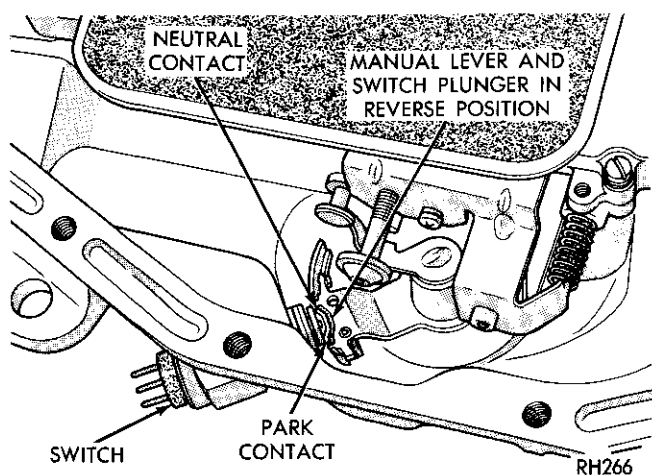


Fig. 8 Park/Neutral Switch Terminals

- (2) Position vehicle on level surface. This is extremely important for accurate fluid level check.
- (3) Start and run engine at curb idle speed.
- (4) Apply parking brakes.
- (5) Shift transmission momentarily into all gear ranges. Then shift transmission back to **Neutral**.
- (6) Clean top of filler tube and dipstick to keep dirt from entering tube.

CAUTION: Do not overfill the transmission. Overfilling may cause leakage out the pump vent which can be mistaken for a pump seal leak. Overfilling will also cause fluid aeration and foaming as the excess fluid is picked up and churned by the gear train. This will significantly reduce fluid life.

(7) Remove dipstick and check **fluid level** as follows:

(a) Dipstick has three indicator levels (Fig. 9) which are a MIN dot, an OK crosshatch area, and a MAX fill arrow.

(b) Correct maximum level is to MAX arrow mark. Correct acceptable level is to OK mark in crosshatch area. Incorrect level is at or below MIN dot.

(c) If fluid is low, add only enough Mopar ATF Plus to restore correct level. Do not overfill.

(d) If transmission is overfilled, fluid can be removed with 1/8 to 3/16 in. diameter tubing and suction gun. Tubing will have to be adapted to nozzle of gun and be long enough to extend down fill tube and into transmission oil pan.

(8) Check **fluid condition** as follows:

(a) Fluid color should range from dark red to pink and be free of particles and sludge.

(b) If fluid is orange, brown, or smells burned but shifts were OK, flow test and reverse flush cooler and lines. Then change fluid and filter and road test again to confirm proper operation.

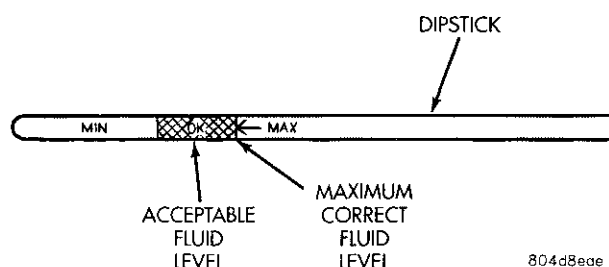


Fig. 9 Dipstick Fluid Level Marks

(c) If fluid is black, dark brown, turned to sludge, contains extensive amount of metal or friction material particles, transmission will need overhaul. Main and auxiliary coolers will have to be flow tested and reverse flushed as well.

EFFECTS OF INCORRECT FLUID LEVEL

A low fluid level allows the pump to take in air along with the fluid. Air in the fluid will cause fluid pressures to be low and develop slower than normal. If the transmission is overfilled, the gears churn the fluid into foam. This aerates the fluid and causing the same conditions occurring with a low level. In either case, air bubbles cause fluid overheating, oxidation and varnish buildup which interferes with valve, clutch and servo operation. Foaming also causes fluid expansion which can result in fluid overflow from the transmission vent or fill tube. Fluid overflow can easily be mistaken for a leak if inspection is not careful.

CAUSES OF BURNT FLUID

Burnt, discolored fluid is a result of overheating which has two primary causes.

(1) A result of restricted fluid flow through the main and/or auxiliary cooler. This condition is usually the result of a faulty or improperly installed drainback valve, a damaged main cooler, or severe restrictions in the coolers and lines caused by debris or kinked lines.

(2) Heavy duty operation with a vehicle not properly equipped for this type of operation. Trailer towing or similar high load operation will overheat the transmission fluid if the vehicle is improperly equipped. Such vehicles should have an auxiliary transmission fluid cooler, a heavy duty cooling system, and the engine/axle ratio combination needed to handle heavy loads.

FLUID CONTAMINATION

Transmission fluid contamination is generally a result of:

- adding incorrect fluid
- failure to clean dipstick and fill tube when checking level

DIAGNOSIS AND TESTING (Continued)

- engine coolant entering the fluid
- internal failure that generates debris
- overheat that generates sludge (fluid breakdown)
- failure to reverse flush cooler and lines after repair
- failure to replace contaminated converter after repair

The use of non recommended fluids can result in transmission failure. The usual results are erratic shifts, slippage, abnormal wear and eventual failure due to fluid breakdown and sludge formation. Avoid this condition by using recommended fluids only.

The dipstick cap and fill tube should be wiped clean before checking fluid level. Dirt, grease and other foreign material on the cap and tube could fall into the tube if not removed beforehand. Take the time to wipe the cap and tube clean before withdrawing the dipstick.

Engine coolant in the transmission fluid is generally caused by a cooler malfunction. The only remedy is to replace the radiator as the cooler in the radiator is not a serviceable part. If coolant has circulated through the transmission for some time, an overhaul may also be necessary; especially if shift problems had developed.

The transmission cooler and lines should be reverse flushed whenever a malfunction generates sludge and/or debris. The torque converter should also be replaced at the same time.

Failure to flush the cooler and lines will result in recontamination. Flushing applies to auxiliary coolers as well. The torque converter should also be replaced whenever a failure generates sludge and debris. This is necessary because normal converter flushing procedures will not remove all contaminants.

OIL COOLER FLOW CHECK

After the new or repaired transmission has been installed and filled, the oil cooler flow should be checked using the following procedure:

- (1) Disconnect the **From cooler** line at the transmission and place a collecting container under the disconnected line.
- (2) Run the engine at curb idle speed, with the shift selector in neutral.
- (3) If the fluid flow is intermittent or takes more than 20 seconds to collect one quart, the cooler should be replaced.

CAUTION: With the fluid set at the proper level, fluid collection should not exceed (1) quart or internal damage to the transmission may occur.

- (4) If flow is found to be within acceptable limits, reconnect the cooler line. Then fill transaxle to the

proper level, using the approved type of automatic transmission fluid.

OVERDRIVE ELECTRICAL CONTROLS

The overdrive off switch, valve body solenoid, case connectors and related wiring can all be tested with a 12 volt test lamp or a volt/ohmmeter. Check continuity of each component when diagnosis indicates this is necessary. Refer to Group 8W, Wiring Diagrams for component locations and circuit information.

Switch and solenoid continuity should be checked whenever the transmission fails to shift into fourth gear range.

GEARSHIFT LINKAGE AND THROTTLE CABLE**GEARSHIFT LINKAGE**

Gearshift linkage adjustment is important because it positions the valve body manual valve. Incorrect adjustment will cause creeping in Neutral, premature clutch wear, delayed engagement in any gear, or a no-start in Park or Neutral position.

Proper operation of the park/neutral position switch will provide a quick check of linkage adjustment.

THROTTLE VALVE CABLE ADJUSTMENT

Throttle valve cable adjustment is important to proper operation. This adjustment positions the throttle valve which controls shift speed, quality and part throttle downshift sensitivity.

If cable setting is too short, early shifts and slippage between shifts may occur. If the setting is too long, shifts may be delayed and part throttle downshifts may be very sensitive.

ROAD TESTING

Before road testing, be sure the fluid level and control cable adjustments have been checked and adjusted if necessary. Verify that diagnostic trouble codes have been resolved.

Observe engine performance during the road test. A poorly tuned engine will not allow accurate analysis of transmission operation.

Operate the transmission in all gear ranges. Check for shift variations and engine flare which indicates slippage. Note if shifts are harsh, spongy, delayed, early, or if part throttle downshifts are sensitive.

Slippage indicated by engine flare, usually means clutch, band or overrunning clutch problems. If the condition is advanced, an overhaul will be necessary to restore normal operation.

A slipping clutch or band can often be determined by comparing which internal units are applied in the various gear ranges. The Clutch and Band Applica-

DIAGNOSIS AND TESTING (Continued)

SHIFT LEVER POSITION	TRANSMISSION CLUTCHES AND BANDS					OVERDRIVE CLUTCHES		
	FRONT CLUTCH	FRONT BAND	REAR CLUTCH	REAR BAND	OVERRUN. CLUTCH	OVERDRIVE CLUTCH	DIRECT CLUTCH	OVERRUN. CLUTCH
Reverse	X			X			X	
Drive Range								
First			X		X		X	X
Second		X	X				X	X
Third	X		X				X	X
Fourth	X		X			X		
2-Range (Manual Second)		X	X		X		X	X
1-Range (Manual Low)			X	X	X		X	X

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Clutch And Band Application

tion chart provides a basis for analyzing road test results.

ANALYZING ROAD TEST

Refer to the Clutch and Band Application chart and note which elements are in use in the various gear ranges.

Note that the rear clutch is applied in all forward ranges (D, 2, 1). The transmission overrunning clutch is applied in first gear (D, 2 and 1 ranges) only. The rear band is applied in 1 and R range only.

Note that the overdrive clutch is applied only in fourth gear and the overdrive direct clutch and overrunning clutch are applied in all ranges except fourth gear.

For example: If slippage occurs in first gear in D and 2 range but not in 1 range, the transmission overrunning clutch is faulty. Similarly, if slippage occurs in any two forward gears, the rear clutch is slipping.

Applying the same method of analysis, note that the front and rear clutches are applied simultaneously only in D range third and fourth gear. If the transmission slips in third gear, either the front clutch or the rear clutch is slipping.

If the transmission slips in fourth gear but not in third gear, the overdrive clutch is slipping. By selecting another gear which does not use these clutches, the slipping unit can be determined. For example, if the transmission also slips in Reverse, the front clutch is slipping. If the transmission does not slip in Reverse, the rear clutch is slipping.

If slippage occurs during the 3-4 shift or only in fourth gear, the overdrive clutch is slipping. Similarly, if the direct clutch were to fail, the transmission would lose both reverse gear and overrun braking in 2 position (manual second gear). If the transmission slips in any other two forward gears, the transmission rear clutch is probably slipping.

If the transmission will not shift to fourth gear, the control switch, overdrive solenoid or related wiring may also be the problem cause.

This process of elimination can be used to identify a slipping unit and check operation. Proper use of the Clutch and Band Application Chart is the key.

Although road test analysis will help determine the slipping unit, the actual cause of a malfunction usually cannot be determined until hydraulic and air pressure tests are performed. Practically any condition can be caused by leaking hydraulic circuits or sticking valves.

Unless a malfunction is obvious, such as no drive in D range first gear, do not disassemble the transmission. Perform the hydraulic and air pressure tests to help the probable cause.

HYDRAULIC PRESSURE TEST

Hydraulic test pressures range from a low of one psi (6.895 kPa) governor pressure, to 300 psi (2068 kPa) at the rear servo pressure port in reverse. Use 100 psi Gauge C-3292 to check pressure at the accumulator, front servo and governor. Use 300 psi Gauge C-3293-SP to check pressure at the rear servo and overdrive port.

DIAGNOSIS AND TESTING (Continued)**Pressure Test Port Locations**

Pressure test ports locations are provided at the accumulator, front servo, and rear servo, governor passage, and overdrive clutch pressure passage (Fig. 10).

An accurate tachometer and two test gauges are required for the pressure test. Test Gauge C-3292 has a 100 psi range and is used at the accumulator, governor, and front servo pressure ports. Test Gauge C-3293-SP has a 300 psi range and is used at the rear servo port and overdrive test ports where pressures are higher. In cases where two test gauges are required, the 300 psi gauge can be used at any of the other test ports.

Line pressure is checked at the accumulator port on the right side of the case. The front servo pressure port is at the right side of the case just behind the filler tube opening.

The rear servo and governor pressure ports are at the right rear of the transmission case. The overdrive clutch pressure port is at the left rear of the case (Fig. 10).

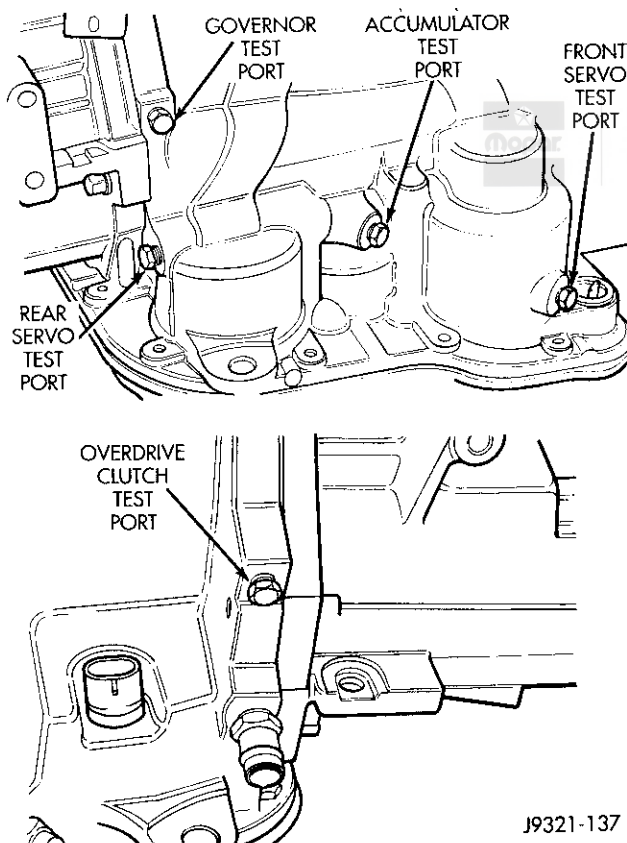


Fig. 10 Pressure Test Ports

PRESSURE TEST PROCEDURE

Connect a tachometer to the engine. Position the tachometer so it can be observed from under the vehicle. Raise the vehicle on a hoist that will allow the wheels to rotate freely.

Test One - Transmission In Manual Low

This test checks pump output, pressure regulation, and condition of the rear clutch and servo circuit. Test Gauges C-3292 and C-3293-SP are required for this test. Gauge C-3292 has a 100 psi range. Gauge C-3293-SP has a 300 psi range.

(1) Connect 100 psi Gauge C-3292 to accumulator port.

(2) Connect 300 psi Gauge C-3293-SP to rear servo port (Fig. 10).

(3) Disconnect throttle and gearshift rods from manual and throttle levers.

(4) Start and run engine at 1000 rpm.

(5) Move shift lever (on manual lever shaft) all the way forward into manual low.

(6) Move transmission throttle lever from full forward to full rearward position and note pressures on both gauges.

(7) Line pressure at accumulator port should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (621-662 kPa) as lever is moved rearward.

(8) Rear servo pressure should be same as line pressure within 3 psi (20.68 kPa).

Test Two - Transmission In Manual Second

This test checks pump output and pressure regulation. Use 100 psi Test Gauge C-3292 for this test.

(1) Connect test gauge to accumulator pressure port (Fig. 10).

(2) Start and run engine at 1000 rpm.

(3) Move shift lever on valve body manual lever shaft, one detent rearward from full forward position. This is manual second.

(4) Move transmission throttle lever from full forward to full rearward position and read pressure at both gauges.

(5) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase to 90-96 psi (621-662 kPa) as lever is moved rearward.

Test Three - Transmission In D Range

This test checks pressure regulation and condition of the clutch circuits. Use both pressure Test Gauges C-3292 and C-3293-SP for this test.

(1) Connect test gauges to accumulator and front servo ports (Fig. 10). Use either test gauge at the two ports.

(2) Start and run engine at 1600 rpm for this test.

(3) Move selector lever to D range. This is two detents rearward from full forward position.

(4) Read pressures on both gauges as transmission throttle lever is moved from full forward to full rearward position.

DIAGNOSIS AND TESTING (Continued)

(5) Line pressure should be 54-60 psi (372-414 kPa) with throttle lever forward and gradually increase as lever is moved rearward.

(6) Front servo is pressurized only in D range and should be same as line pressure within 3 psi (21 kPa) up to downshift point.

Test Four - Transmission In Reverse

This test checks pump output, pressure regulation and the front clutch and rear servo circuits. Use 300 psi Test Gauge C-3293-SP for this test.

(1) Connect 300 psi gauge to rear servo port (Fig. 10).

(2) Start and run engine at 1600 rpm for test.

(3) Move valve body selector lever four detents rearward from the full forward position. This is Reverse range.

(4) Move throttle lever all way forward then all way rearward and note gauge readings.

(5) Pressure should be 145 - 175 psi (1000-1207 kPa) with lever forward and increase to 230 - 280 psi (1586-1931 kPa) as lever is moved rearward.

Test Five - Governor Pressure

This test checks governor operation by measuring governor pressure response to changes in engine speed. It is usually not necessary to check governor operation unless shift speeds are incorrect or if the transmission will not downshift.

(1) Connect 100 psi Test Gauge C-3292 to governor pressure port (Fig. 10).

(2) Move shift lever to D range.

(3) Start and run engine at curb idle speed and note pressure. At idle and with vehicle stopped, pressure should be zero to 1.5 psi maximum. If pressure exceeds this figure, governor valve or weights are sticking open.

(4) Slowly increase engine speed and observe speedometer and pressure test gauge. Governor pressure should increase in proportion to vehicle speed. Or approximately 1 psi for every 1 mph.

(5) Pressure rise should be smooth and drop back to 0 to 1.5 psi when wheels stop rotating.

(6) Compare results of pressure tests with analysis charts (Fig. 11).

Test Six - Overdrive Fourth Gear

This test checks line pressure at the overdrive clutch in fourth gear range. The test should be performed on the road or on a chassis dynamometer. Do not perform this test on a hoist. Use 300 psi Test Gauge C-3292 for this test.

(1) Remove tachometer; it is not needed for this test.

(2) Move 300 psi Gauge to overdrive clutch pressure test port. Then remove other gauge and reinstall test port plug.

(3) Lower vehicle.

(4) Turn on OD switch.

(5) Secure test gauge so it can be viewed from driver's seat.

(6) Start engine and shift into D range.

(7) Increase vehicle speed gradually until 3-4 shift occurs and note gauge pressure.

(8) Pressure should be 469-496 kPa (68-72 psi) with closed throttle and increase to 620-827 kPa (90-120 psi) at 1/2 to 3/4 throttle. Note that pressure can increase to around 896 kPa (130 psi) at full throttle.

(9) Return to shop or move vehicle off chassis dynamometer.

TEST CONDITION	INDICATION
Line pressure OK during any one test	Pump and regulator valve OK
Line Pressure OK in R but low in D, 2, 1	Leakage in rear clutch area (servo, clutch seals, governor support seal rings)
Pressure Low in D Fourth Gear Range	Overdrive clutch piston seal, or check ball problem
Pressure OK in 1, 2 but low in D3 and R	Leakage in front clutch area (servo, clutch seals, retainer bore, pump seal rings)
Pressure OK in 2 but low in R and 1	Leakage in rear servo
Front servo pressure low in 2	Leakage in servo; broken servo ring or cracked servo piston
Pressure low in all positions	Clogged filter, stuck regulator valve, worn or faulty pump, plugged fluid cooler
Governor pressure too high at idle speed, or governor pressure low at all mph figures	Faulty governor pressure solenoid, transmission control module, or governor pressure sensor
Lubrication/line pressure low at all throttle positions	Clogged fluid cooler or lines, seal rings leaking, output shaft plugged with debris, worn bushings in pump or clutch retainer

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Fig. 11 Pressure Test Analysis

CONVERTER STALL TEST

Stall testing involves determining maximum engine speed obtainable at full throttle with the rear wheels locked and the transmission in D range. This test checks the holding ability of the converter overrunning and transmission clutches. When stall testing is completed, refer to the stall speed chart and diagnosis guides.

DIAGNOSIS AND TESTING (Continued)

WARNING: NEVER ALLOW ANYONE TO STAND DIRECTLY IN LINE WITH THE VEHICLE FRONT OR REAR DURING A STALL TEST. ALWAYS BLOCK THE WHEELS AND FULLY APPLY THE SERVICE AND PARKING BRAKES DURING THE TEST.

STALL TEST PROCEDURE

- (1) Connect tachometer to engine. Position tachometer so it can be viewed from driver's seat.
- (2) Check transmission fluid level. Add fluid if necessary.
- (3) Drive vehicle to bring transmission fluid up to normal operating temperature. Vehicle can be driven on road, or on chassis dynamometer, if available.
- (4) Block front wheels.
- (5) Fully apply service and parking brakes.
- (6) Open throttle completely and record maximum engine speed registered on tachometer. It takes 4-10 seconds to reach max rpm. **Once max rpm has been achieved, do not hold wide open throttle for more than 4-5 seconds.**

CAUTION: Stalling the converter causes a rapid increase in fluid temperature. To avoid fluid overheating, hold the engine at maximum rpm for no more than 5 seconds. If engine exceeds 2500 rpm during the test, release the accelerator pedal immediately; transmission clutch slippage is occurring.

- (7) If a second stall test is required, cool down fluid before proceeding. Shift into NEUTRAL and run engine at 1000 rpm for 20-30 seconds to cool fluid.
- (8) Refer to Stall Test Analysis.

STALL TEST ANALYSIS**Stall Speed Too High**

If the stall speed exceeds 1800-2300 rpm by more than 200 rpm, transmission clutch slippage is indicated.

Stall Speed Low

Low stall speed with a properly tuned engine indicate a torque converter overrunning clutch problem. The condition should be confirmed by road testing before to converter replacement. A stall speed 250-350 rpm below normal indicates the converter overrunning clutch is slipping. The vehicle also exhibits poor acceleration but operates normally once highway cruise speeds are reached. Torque converter replacement will be necessary.

Stall Speed Normal But Acceleration Poor

If stall speeds are normal (1800-2300 rpm) but abnormal throttle opening is required for acceleration, or to maintain cruise speed, the converter over-

running clutch is seized. The torque converter will have to be replaced.

Converter Noise During Test

A whining noise caused by fluid flow is normal during a stall test. However, loud metallic noises indicate a damaged converter. To confirm that noise is originating from the converter, operate the vehicle at light throttle in DRIVE and NEUTRAL on a hoist and listen for noise coming from the converter housing.

AIR TESTING TRANSMISSION CLUTCH AND BAND OPERATION

Air-pressure testing can be used to check transmission front/rear clutch and band operation. The test can be conducted with the transmission either in the vehicle or on the work bench, as a final check, after overhaul.

Air-pressure testing requires that the oil pan and valve body be removed from the transmission. The servo and clutch apply passages are shown (Fig. 12).

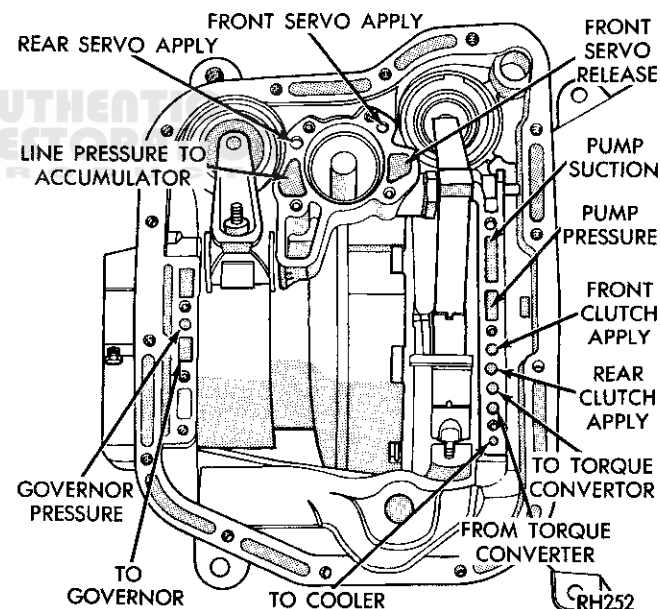


Fig. 12 Air Pressure Test Passages—Typical

Front Clutch Air Test

Place one or two fingers on the clutch housing and apply air pressure through front clutch apply passage. Piston movement can be felt and a soft thump heard as the clutch applies.

Rear Clutch Air Test

Place one or two fingers on the clutch housing and apply air pressure through rear clutch apply passage. Piston movement can be felt and a soft thump heard as the clutch applies.

DIAGNOSIS AND TESTING (Continued)

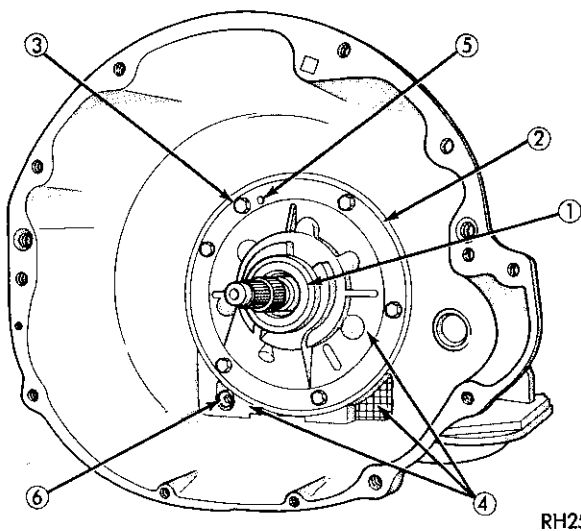


Fig. 15 Pump Area Inspection Points

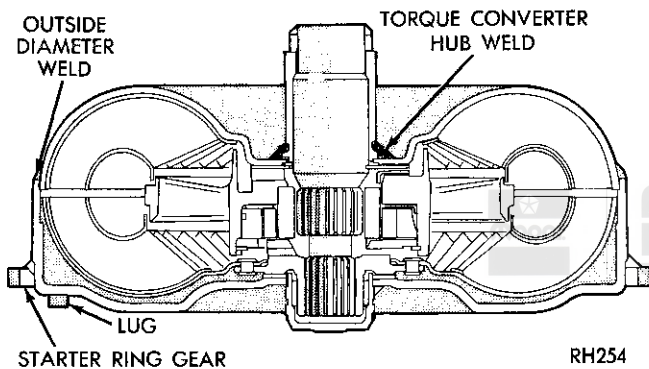


Fig. 16 Converter Leak Points—Typical

The transmission rear output shaft opening is closed off simply by leaving the transfer case bolted in place. However, if the transfer case has been removed, a shipping plug can be used to close off this opening.

The torque converter hub opening in the pump and the pump vent require special tools to close them off.

The converter hub seal cup is made from thin wall tube and a 3.17 mm (1/8 in.) thick disc (Fig. 17).

A retaining strap is needed to secure the seal cup for testing. The strap can be made from 31.75 mm (1-1/4 in.) wide stock (Fig. 18). The strap attaching hole positions are approximate only. Measure hole position on the converter housing before drilling.

The pump vent tool is made from 6.35 mm (1/4 in.) rod and 4.76 mm (3/16 in.) plate (Fig. 19).

The fabricated tools can all be made from mild steel or aluminum stock.

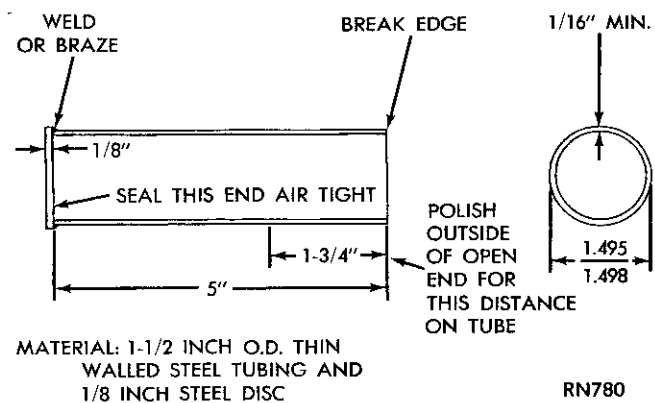


Fig. 17 Converter Hub Seal Cup

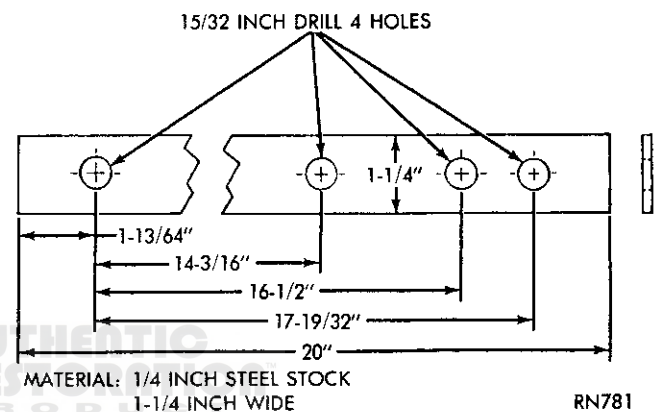


Fig. 18 Seal Cup Retaining Strap

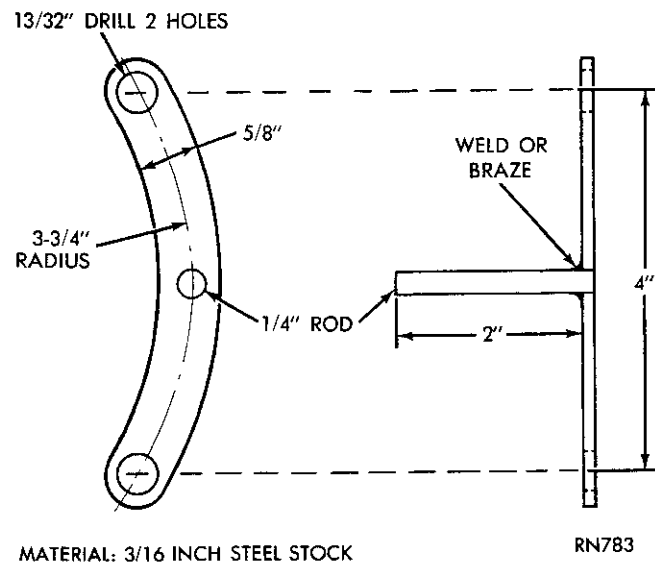


Fig. 19 Pump Vent Plug

DIAGNOSIS AND TESTING (Continued)

AIR PRESSURE LEAK TEST PROCEDURE

(1) Install vent plug, converter hub seal cup and cup retaining strap (Fig. 20).

CAUTION: Be sure the surfaces of the hub seal cup are smooth and free of nicks, scratches, or burrs. Surface irregularities on the cup will damage the pump seal if not removed. Sand and/polish the cup with 400 grit sandpaper or crocus cloth to smooth the surface if necessary.

(2) Close off remaining transmission openings with rubber plugs, or stoppers or similar devices. **Do not close off rear cooler line fitting. Hand operated air pump will be attached to this fitting.**

(3) Attach Air Pump 7700 to rear cooler line fitting. Connect a length of copper tube to fitting. Then attach pump hose to tube with hose clamp (Fig. 21).

(4) Apply a thick soapy water solution to suspected leak areas.

CAUTION: The recommended test pressure is 8 psi. The maximum allowable test pressure is 10 psi. Do not exceed specified pressure.

- (5) Pressurize transmission to 8 psi. with air pump.
- (6) Observe suspected leak areas. Air bubbles appearing in soapy water solution indicate leak points.
- (7) Remove test tools and plugs after test completion and make necessary repairs as described in Leak Correction procedure.

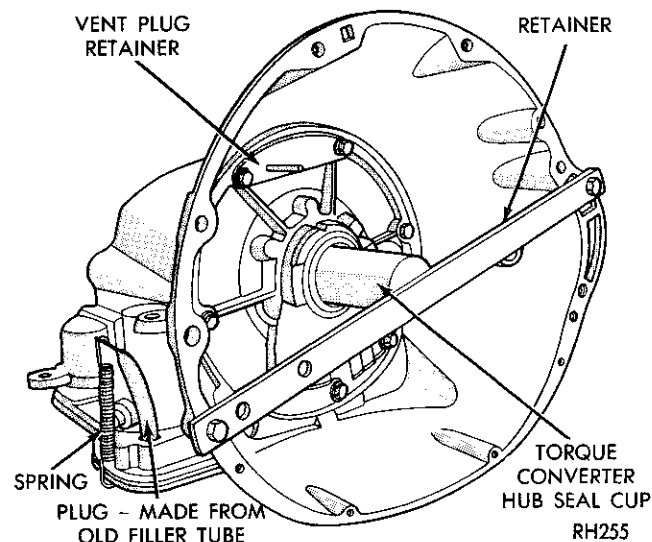
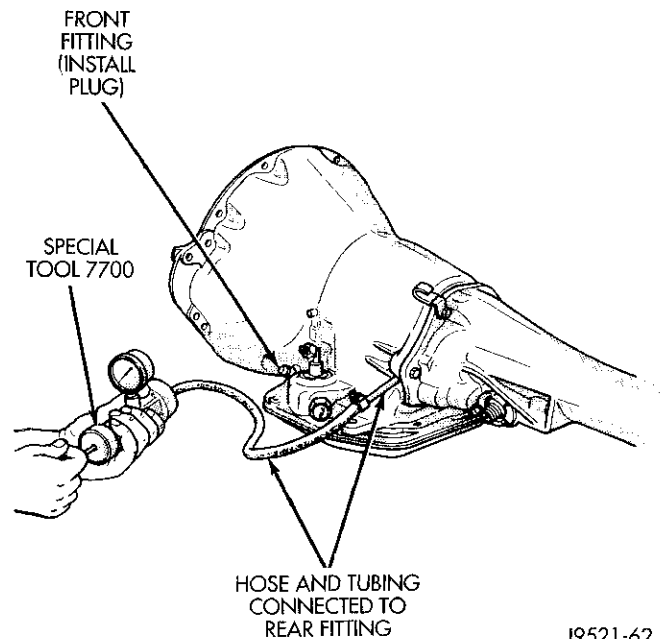


Fig. 20 Vent Plug And Hub Seal Cup Installation

CONVERTER HOUSING AREA LEAK CORRECTION

- (1) Remove converter.
- (2) Tighten front band adjusting screw until band is tight around front clutch retainer. This prevents front/rear clutches from coming out when oil pump is removed.



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Fig. 21 Pressurizing Transmission With Tool 7700

- (3) Remove oil pump and remove pump seal. Inspect pump housing drainback and vent holes for obstructions. Clear holes with solvent and wire.
- (4) Inspect pump bushing and converter hub. If bushing is scored, replace it. If converter hub is scored, either polish it with crocus cloth or replace converter if scoring is severe.
- (5) Install new pump seal, O-ring, gasket, bushing. Replace oil pump if cracked, porous or damaged in any way.
- (6) Loosen kickdown lever pin access plug three turns. Apply Loctite 592, or Permatex No. 2 to plug threads and tighten plug to 17 N·m (150 in. lbs.) torque.
- (7) Adjust front band.
- (8) Lubricate pump seal and converter hub with transmission fluid or petroleum jelly and install converter.
- (9) Install transmission and converter housing dust shield.
- (10) Lower vehicle.

DIAGNOSIS TABLES AND CHARTS—RE TRANSMISSION

The diagnosis charts provide additional reference when diagnosing a transmission fault. The charts provide general information on a variety of transmission, overdrive unit and converter clutch fault conditions.

The hydraulic flow charts in the Schematics and Diagrams section of this group, outline fluid flow and hydraulic circuitry. Circuit operation is provided for neutral, third, fourth and reverse gear ranges. Normal working pressures are also supplied for each of the gear ranges.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
HARSH ENGAGEMENT (FROM NEUTRAL TO DRIVE OR REVERSE)	<ol style="list-style-type: none"> 1. Fluid Level Low 2. Throttle Linkage Misadjusted 3. Mount and Driveline Bolts Loose 4. U-Joint Worn/Broken 5. Axle Backlash Incorrect 6. Hydraulic Pressure Incorrect 7. Band Misadjusted. 8. Valve Body Check Balls Missing. 9. Axle Pinion Flange Loose. 10. Clutch, band or planetary component Damaged. 11. Converter Clutch (if equipped) Faulty. 	<ol style="list-style-type: none"> 1. Add Fluid 2. Adjust linkage - setting may be too long. 3. Check engine mount, transmission mount, propeller shaft, rear spring to body bolts, rear control arms, crossmember and axle bolt torque. Tighten loose bolts and replace missing bolts. 4. Remove propeller shaft and replace U-Joint. 5. Check per Service Manual. Correct as needed. 6. Check pressure. Remove, overhaul or adjust valve body as needed. 7. Adjust rear band. 8. Inspect valve body for proper check ball installation. 9. Replace nut and check pinion threads before installing new nut. Replace pinion gear if threads are damaged. 10. Remove, disassemble and repair transmission as necessary. 11. Replace converter and flush cooler and line before installing new converter.
DELAYED ENGAGEMENT (FROM NEUTRAL TO DRIVE OR REVERSE)	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Filter Clogged. 3. Gearshift Linkage Misadjusted. 4. Torque Converter Drain Back (Oil drains from torque converter into transmission sump) 5. Rear Band Misadjusted. 6. Valve Body Filter Plugged. 7. Oil Pump Gears Worn/Damaged. 8. Governor Circuit and Solenoid Valve (RE Only) Electrical Fault. 	<ol style="list-style-type: none"> 1. Correct level and check for leaks. 2. Change filter. 3. Adjust linkage and repair linkage if worn or damaged. 4. If vehicle moves normally after 5 seconds after shifting into gear, no repair is necessary. If longer, inspect pump bushing for wear. Replace pump house. 5. Adjust band. 6. Replace fluid and filter. If oil pan and old fluid were full of clutch disc material and/or metal particles, overhaul will be necessary. 7. Remove transmission and replace oil pump. 8. Test with DRB and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	9. Hydraulic Pressure Incorrect. 10. Reaction Shaft Seal Rings Worn/Broken. 11. Rear Clutch/Input Shaft, Rear Clutch Seal Rings Damaged. 12. Governor Valve Stuck. 13. Regulator Valve Stuck. 14. Cooler Plugged.	9. Perform pressure test, remove transmission and repair as needed. 10. Remove transmission, remove oil pump and replace seal rings. 11. Remove and disassemble transmission and repair as necessary. 12. Remove and inspect governor components. Replace worn or damaged parts. 13. Clean. 14. Transfer case failure can plug cooler.
NO DRIVE RANGE (REVERSE OK)	1. Fluid Level Low. 2. Gearshift Linkage/Cable Loose/Misadjusted. 3. Rear Clutch Burnt. 4. Valve Body Malfunction. 5. Transmission Overrunning Clutch Broken. 6. Input Shaft Seal Rings Worn/Damaged. 7. Front Planetary Failed Broken.	1. Add fluid and check for leaks if drive is restored. 2. Repair or replace linkage components. 3. Remove and disassemble transmission and rear clutch and seals. Repair/replace worn or damaged parts as needed. 4. Remove and disassemble valve body. Replace assembly if any valves or bores are damaged. 5. Remove and disassemble transmission. Replace overrunning clutch. 6. Remove and disassemble transmission. Replace seal rings and any other worn or damaged parts. 7. Remove and repair.
NO DRIVE OR REVERSE (VEHICLE WILL NOT MOVE)	1. Fluid Level Low. 2. Gearshift Linkage/Cable Loose/Misadjusted. 3. U-Joint/Axle/Transfer Case Broken. 4. Filter Plugged.	1. Add fluid and check for leaks if drive is restored. 2. Inspect, adjust and reassemble linkage as needed. Replace worn/damaged parts. 3. Perform preliminary inspection procedure for vehicle that will not move. Refer to procedure in diagnosis section. 4. Remove and disassemble transmission. Repair or replace failed components as needed. Replace filter. If filter and fluid contained clutch material or metal particles, an overhaul may be necessary. Perform lube flow test. Flush oil. Replace cooler as necessary.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Oil Pump Damaged. 6. Valve Body Malfunctioned. 7. Transmission Internal Component Damaged. 8. Park Sprag not Releasing - Check Stall Speed, Worn/Damaged/Stuck. 9. Torque Converter Damage.	5. Perform pressure test to confirm low pressure. Replace pump body assembly if necessary. 6. Check press and inspect valve body. Replace valve body (as assembly) if any valve or bore is damaged. Clean and reassemble correctly if all parts are in good condition. 7. Remove and disassemble transmission. Repair or replace failed components as needed. 8. Remove, disassemble, repair. 9. Inspect and replace as required.
SHIFTS DELAYED OR ERRATIC (SHIFTS ALSO HARSH AT TIMES)	1. Fluid Level Low/High. 2. Fluid Filter Clogged. 3. Throttle Linkage Misadjusted. 4. Throttle Linkage Binding. 5. Gearshift Linkage/Cable Misadjusted. 6. Governor Valve Sticking. 7. Governor Seal Rings Worn/Damaged. 8. Clutch or Servo Failure. 9. Governor Circuit (RE Only) Electrical Fault. 10. Front Band Misadjusted. 11. Pump Suction Passage Leak.	1. Correct fluid level and check for leaks if low. 2. Replace filter. If filter and fluid contained clutch material or metal particles, an overhaul may be necessary. Perform lube flow test. 3. Adjust linkage as described in service section. 4. Check cable for binding. Check for return to closed throttle at transmission. 5. Adjust linkage/cable as described in service section. 6. Inspect, clean or repair. 7. Inspect/replace. 8. Remove valve body and air test clutch, and band servo operation. Disassemble and repair transmission as needed. 9. Test using DRB and repair as required. 10. Adjust band. 11. Check for excessive foam on dipstick after normal driving. Check for loose pump bolts, defective gasket. Replace pump assembly if needed.
NO REVERSE (D RANGES OK)	1. Gearshift Linkage/Cable Misadjusted/Damaged. 2. Park Sprag Sticking. 3. Rear Band Misadjusted/Worn.	1. Repair or replace linkage parts as needed. 2. Replace overdrive annulus gear. 3. Adjust band; replace.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Valve Body Malfunction. 5. Rear Servo Malfunction. 6. Direct Clutch in Overdrive Worn 7. Front Clutch Burnt.	4. Remove and service valve body. Replace valve body if any valves or valve bores are worn or damaged. 5. Remove and disassemble transmission. Replace worn/damaged servo parts as necessary. 6. Disassemble overdrive. Replace worn or damaged parts. 7. Remove and disassemble transmission. Replace worn, damaged clutch parts as required.
HAS FIRST/REVERSE ONLY (NO 1-2 OR 2-3 UPSHIFT)	1. Governor Valve, Shaft, Weights or Body Damaged/Stuck. 2. Valve Body Malfunction. 3. Front Servo/Kickdown Band Damaged/Burned.	1. Remove governor assembly and clean or repair as necessary. 2. Repair stuck 1-2 shift valve or governor plug. 3. Repair/replace.
MOVES IN 2ND OR 3RD GEAR, ABRUPTLY DOWNSHIFTS TO LOW	1. Valve Body Malfunction. 2. Governor Valve Sticking. 3. Governor Circuit (RE Only) Electrical Fault.	1. Remove, clean and inspect. Look for stuck 1-2 valve or governor plug. 2. Remove, clean and inspect. Replace faulty parts. 3. Test using DRB and repair as required.
NO LOW GEAR (MOVES IN 2ND OR 3RD GEAR ONLY)	1. Governor Valve Sticking. 2. Governor Circuit (RE Only) Electrical Fault. 3. Valve Body Malfunction. 4. Front Servo Piston Cocked in Bore. 5. Front Band Linkage Malfunction	1. Remove governor, clean, inspect and repair as required. 2. Test with DRB and repair as required. 3. Remove, clean and inspect. Look for sticking 1-2 shift valve, 2-3 shift valve, governor plug or broken springs. 4. Inspect servo and repair as required. 5. Inspect linkage and look for bind in linkage.
NO KICKDOWN OR NORMAL DOWNSHIFT	1. Throttle Linkage Misadjusted. 2. Accelerator Pedal Travel Restricted. 3. Governor/Valve Body Hydraulic Pressures Too High or Too Low Due to Sticking Governor, Valve Body Malfunction or Incorrect Hydraulic Control Pressure Adjustments. 4. Governor Circuit (RE Only) Electrical Fault.	1. Adjust linkage. 2. Verify floor mat is not under pedal, repair worn accelerator cable or bent brackets. 3. Perform hydraulic pressure tests to determine cause and repair as required. Correct valve body pressure adjustments as required. 4. Test with DRB and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Valve Body Malfunction. 6. TPS Malfunction. 7. PCM Malfunction. 8. Valve Body Malfunction.	5. Perform hydraulic pressure tests to determine cause and repair as required. Correct valve body pressure adjustments as required. 6. Replace sensor, check with DRB scan tool. 7. Check with DRB II and replace if required. 8. Repair sticking 1-2, 2-3 shift valves, governor plugs, 3-4 solenoid, 3-4 shift valve, 3-4 timing valve.
STUCK IN LOW GEAR (WILL NOT UPSHIFT)	1. Throttle Linkage Misadjusted/Stuck. 2. Gearshift Linkage Misadjusted. 3. Governor/Valve Body, Governor Valve Stuck Closed; Loose Output Shaft Support or Governor Housing Bolts, Leaking Seal Rings or Valve Body Problem (i.e., Stuck 1- 2 Shift Valve/Gov. Plug). 4. Governor Component (RE Only) Electrical Fault. 5. Front Band Out of Adjustment. 6. Clutch or Servo Malfunction.	1. Adjust linkage and repair linkage if worn or damaged. Check for binding cable or missing return spring. 2. Adjust linkage and repair linkage if worn or damaged. 3. Check line and governor pressures to determine cause. Correct as required. 4. Check operating pressures and test with DRB scan tool, repair faulty component. 5. Adjust Band. 6. Air pressure check operation of clutches and bands. Repair faulty component.
CREEPS IN NEUTRAL	1. Gearshift Linkage Misadjusted. 2. Rear Clutch Dragging/Warped. 3. Valve Body Malfunction.	1. Adjust linkage. 2. Disassemble and repair. 3. Perform hydraulic pressure test to determine cause and repair as required.
BUZZING NOISE	1. Fluid Level Low 2. Shift Cable Misassembled. 3. Valve Body Misassembled. 4. Pump Passages Leaking 5. Cooling System Cooler Plugged. 6. Overrunning Clutch Damaged.	1. Add fluid and check for leaks. 2. Route cable away from engine and bell housing. 3. Remove, disassemble, inspect valve body. Reassemble correctly if necessary. Replace assembly if valves or springs are damaged. Check for loose bolts or screws. 4. Check pump for porous casting, scores on mating surfaces and excess rotor clearance. Repair as required. Loose pump bolts. 5. Flow check cooler circuit. Repair as needed. 6. Replace clutch.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
SLIPS IN REVERSE ONLY	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Gearshift Linkage Misadjusted. 3. Rear Band Misadjusted. 4. Rear Band Worn. 5. Overdrive Direct Clutch Worn. 6. Hydraulic Pressure Too Low. 7. Rear Servo Leaking. 8. Band Linkage Binding. 	<ol style="list-style-type: none"> 1. Add fluid and check for leaks. 2. Adjust linkage. 3. Adjust band. 4. Replace as required. 5. Disassemble overdrive. Repair as needed. 6. Perform hydraulic pressure tests to determine cause. 7. Air pressure check clutch-servo operation and repair as required. 8. Inspect and repair as required.
SLIPS IN FORWARD DRIVE RANGES	<ol style="list-style-type: none"> 1. Fluid Level Low. 2. Fluid Foaming. 3. Throttle Linkage Misadjusted. 4. Gearshift Linkage Misadjusted. 5. Rear Clutch Worn. 6. Low Hydraulic Pressure Due to Worn Pump, Incorrect Control Pressure Adjustments, Valve Body Warpage or Malfunction, Sticking Governor, Leaking Seal Rings, Clutch Seals Leaking, Servo Leaks, Clogged Filter or Cooler Lines 7. Rear Clutch Malfunction, Leaking Seals or Worn Plates. 8. Overrunning Clutch Worn, Not Holding (Slips in 1 Only). 	<ol style="list-style-type: none"> 1. Add fluid and check for leaks. 2. Check for high oil level, bad pump gasket or seals, dirt between pump halves and loose pump bolts. Replace pump if necessary. 3. Adjust linkage. 4. Adjust linkage. 5. Inspect and replace as needed. 6. Perform hydraulic and air pressure tests to determine cause. 7. Air pressure check clutch-servo operation and repair as required. 8. Replace Clutch.
SLIPS IN LOW GEAR "D" ONLY, BUT NO IN 1 POSITION GROWLING, GRATING OR SCRAPING NOISES	<p>Overrunning Clutch Faulty.</p> <ol style="list-style-type: none"> 1. Drive Plate Broken. 2. Torque Converter Bolts Hitting Dust Shield. 3. Planetary Gear Set Broken/ Seized. 4. Overrunning Clutch Worn/Broken. 5. Oil Pump Components Scored/ Binding. 6. Output Shaft Bearing or Bushing Damaged. 7. Clutch Operation Faulty. 	<p>Replace overrunning clutch.</p> <ol style="list-style-type: none"> 1. Replace. 2. Dust shield bent. Replace or repair. 3. Check for debris in oil pan and repair as required. 4. Inspect and check for debris in oil pan. Repair as required. 5. Remove, inspect and repair as required. 6. Remove, inspect and repair as required. 7. Perform air pressure check and repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	8. Front and Rear Bands Misadjusted.	8. Adjust bands.
DRAGS OR LOCKS UP	1. Fluid Level Low. 2. Clutch Dragging/Failed 3. Front or Rear Band Misadjusted. 4. Case Leaks Internally. 5. Servo Band or Linkage Malfunction. 6. Overrunning Clutch Worn. 7. Planetary Gears Broken. 8. Converter Clutch Dragging.	1. Check and adjust level. 2. Air pressure check clutch operation and repair as required. 3. Adjust bands. 4. Check for leakage between passages in case. 5. Air pressure check servo operation and repair as required. 6. Remove and inspect clutch. Repair as required. 7. Remove, inspect and repair as required (look for debris in oil pan). 8. Check for plugged cooler. Perform flow check. Inspect pump for excessive side clearance. Replace pump as required.
NO 4-3 DOWNSHIFT	 1. Circuit Wiring and/or Connectors Shorted. 2. PCM Malfunction. 3. TPS Malfunction 4. Lockup Solenoid Not Venting. 5. Overdrive Solenoid Not Venting. 6. Valve Body Valve Sticking.	1. Test wiring and connectors with test lamp and volt/ohmmeter. Repair wiring as necessary. Replace connectors and/or harnesses as required. 2. Check PCM operation with DRB scan tool. Replace PCM only if faulty. 3. Check TPS with DRB scan tool at PCM. 4. Remove valve body and replace solenoid assembly if plugged or shorted. 5. Remove valve body and replace solenoid if plugged or shorted. 6. Repair stuck 3-4 shift valve or lockup timing valve.
NO 4-3 DOWNSHIFT WHEN CONTROL SWITCH IS TURNED OFF	1. Control Switch Open/Shorted. 2. Overdrive Solenoid Connector Shorted. 3. PCM Malfunction. 4. Valve Body Stuck Valves.	1. Test and replace switch if faulty. 2. Test solenoids and replace if seized or shorted. 3. Test with DRB scan tool. Replace PCM if faulty. 4. Repair stuck 3-4, lockup or lockup timing valve.
CLUNK NOISE FROM DRIVELINE ON CLOSED THROTTLE 4-3 DOWNSHIFT	1. Transmission Fluid Low. 2. Throttle Cable Misadjusted.	1. Add Fluid. 2. Adjust cable.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	3. Overdrive Clutch Select Spacer Wrong Spacer.	3. Replace overdrive piston thrust plate spacer.
3-4 UPSHIFT OCCURS IMMEDIATELY AFTER 2-3 SHIFT	1. Overdrive Solenoid Connector or Wiring Shorted. 2. TPS Malfunction. 3. PCM Malfunction. 4. Overdrive Solenoid Malfunction. 5. Valve Body Malfunction.	1. Test connector and wiring for loose connections, shorts or ground and repair as needed. 2. Test TPS and replace as necessary. Check with DRB scan tool. 3. Test PCM with DRB scan tool and replace controller if faulty. 4. Replace solenoid. 5. Remove, disassemble, clean and inspect valve body components. Make sure all valves and plugs slide freely in bores. Polish valves with crocus cloth if needed.
WHINE/NOISE RELATED TO ENGINE SPEED	1. Fluid Level Low. 2. Shift Cable Incorrect Routing.	1. Add fluid and check for leaks. 2. Check shift cable for correct routing. Should not touch engine or bell housing.
NO 3-4 UPSHIFT	1. Dash O/D Switch In OFF Position. 2. Overdrive Circuit Fuse Blown. 3. O/D Switch Wire Shorted/Open Cut. 4. Distance or Coolant Sensor Malfunction. 5. TPS Malfunction. 6. Neutral Switch to PCM Wire Shorted/Cut. 7. PCM Malfunction. 8. Overdrive Solenoid Shorted/Open. 9. Solenoid Feed Orifice in Valve Body Blocked. 10. Overdrive Clutch Failed.	1. Turn control switch to ON position. 2. Replace fuse. Determine why fuse failed and repair as necessary (i.e., shorts or grounds in circuit). 3. Check wires/connections with 12V test lamp and voltmeter. Repair damaged or loose wire/connection as necessary. 4. Test both sensors with test lamp or volt/ohmmeter and replace faulty sensor. 5. Check with DRB scan tool and replace if necessary. 6. Test switch as described in service section and replace if necessary. Engine no start. 7. Check with DRB scan tool and replace if necessary. 8. Replace solenoid if shorted or open and repair loose or damaged wires (DRB scan tool). 9. Remove, disassemble, and clean valve body thoroughly. Check feed orifice. 10. Disassemble overdrive and repair as needed.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	11. Hydraulic Pressure Low. 12. Valve Body Valve Stuck. 13. O/D Piston Incorrect Spacer. 14. Overdrive Piston Seal Failure. 15. O/D Check Valve/Orifice Failed.	11. Pressure test transmission to determine cause. 12. Repair stuck 3-4 shift valve, 3-4 timing valve. 13. Remove unit, check end play and install correct spacer. 14. Replace both seals. 15. Check for free movement and secure assembly (in piston retainer). Check ball bleed orifice.
SLIPS IN OVERDRIVE FOURTH GEAR	1. Fluid Level Low. 2. Overdrive Clutch Pack Worn. 3. Overdrive Piston Retainer Bleed Orifice Blown Out. 4. Overdrive Piston or Seal Malfunction. 5. 3-4 Shift Valve, Timing Valve or Accumulator Malfunction. 6. Overdrive Unit Thrust Bearing Failure. 7. O/D Check Valve/Bleed Orifice Failure.	1. Add fluid and check for leaks. 2. Remove overdrive unit and rebuild clutch pack. 3. Disassemble transmission, remove retainer and replace orifice. 4. Remove overdrive unit. Replace seals if worn. Replace piston if damaged. If piston retainer is damaged, remove and disassemble the transmission. 5. Remove and overhaul valve body. Replace accumulator seals. Make sure all valves operate freely in bores and do not bind or stick. Make sure valve body screws are correctly tightened and separator plates are properly positioned. 6. Disassemble overdrive unit and replace thrust bearing (NO. 1 thrust bearing is between overdrive piston and clutch hub; NO. 2 thrust bearing is between the planetary gear and the direct clutch spring plate; NO. 3 thrust bearing is between overrunning clutch hub and output shaft). 7. Check for function/secure orifice insert in O/D piston retainer.
DELAYED 3-4 UPSHIFT (SLOW TO ENGAGE)	1. Fluid Level Low. 2. Throttle Valve Cable Misadjusted. 3. Overdrive Clutch Pack Worn/Burnt. 4. TPS Faulty. 5. Overdrive Clutch Bleed Orifice Plugged.	1. Add fluid and check for leaks. 2. Adjust throttle valve cable. 3. Remove unit and rebuild clutch pack. 4. Test with DRB scan tool and replace TPS. 5. Disassemble transmission and replace orifice.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	6. Overdrive Solenoid or Wiring Shorted/Open. 7. Overdrive Excess Clearance 8. O/D Check Valve Missing or Stuck.	6. Test solenoid and check wiring for loose/corroded connections or shorts/grounds. Replace solenoid if faulty and repair wiring if necessary. 7. Remove unit. Measure end play and select proper spacer. 8. Check for presence of check valve. Repair or replace as required.
TORQUE CONVERTER LOCKS UP IN SECOND AND/OR THIRD GEAR HARSH 1-2, 2-3, 3-4 OR 3-2 SHIFTS NO START IN PARK OR NEUTRAL	Lockup Solenoid, Relay or Wiring Shorted/Open. Lockup Solenoid Malfunction. 1. Gearshift Linkage/Cable Misadjusted. 2. Neutral Switch Wire Open/Cut. 3. Neutral Switch Faulty. 4. Neutral Switch Connect Faulty. 5. Valve Body Manual Lever Assembly Bent/Worn/Broken.	Test solenoid, relay and wiring for continuity, shorts or grounds. Replace solenoid and relay if faulty. Repair wiring and connectors as necessary. Remove valve body and replace solenoid assembly. 1. Adjust linkage/cable. 2. Check continuity with test lamp. Repair as required. 3. Refer to service section for test and replacement procedure. 4. Connectors spread open. Repair. 5. Inspect lever assembly and replace if damaged.
NO REVERSE (OR SLIPS IN REVERSE)	1. Direct Clutch Pack (front clutch) Worn. 2. Rear Band Misadjusted. 3. Front Clutch Malfunctioned/ Burned. 4. Overdrive Thrust Bearing Failure. 5. Direct Clutch Spring Collapsed/ Broken.	1. Disassemble unit and rebuild clutch pack. 2. Adjust band. 3. Air-pressure test clutch operation. Remove and rebuild if necessary. 4. Disassemble geartrain and replace bearings. 5. Remove and disassemble unit. Check clutch position and replace spring.
OIL LEAKS (ITEMS LISTED REPRESENT POSSIBLE LEAK POINTS AND SHOULD ALL BE CHECKED).	1. Speedometer Adapter Leaks. 2. Fluid Lines and Fittings Loose/Leaks/Damaged. 3. Fill Tube (where tube enters case) Leaks/Damaged. 4. Pressure Port Plug Loose Loose/Damaged. 5. Pan Gasket Leaks.	1. Replace both adapter seals. 2. Tighten fittings. If leaks persist, replace fittings and lines if necessary. 3. Replace O-ring seal. Inspect tube for cracks in fill tube. 4. Tighten to correct torque. Replace plug or reseal if leak persists. 5. Tighten pan screws (150 in. lbs.). If leaks persist, replace gasket.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	6. Valve Body Manual Lever Shaft Seal Leaks/Worn. 7. Rear Bearing Access Plate Leaks. 8. Gasket Damaged or Bolts are Loose. 9. Adapter/Extension Gasket Damaged Leaks/Damaged. 10. Neutral Switch Leaks/Damaged. 11. Converter Housing Area Leaks. 12. Pump Seal Leaks/Worn/Damaged. 13. Torque Converter Weld Leak/Cracked Hub. 14. Case Porosity Leaks.	6. Replace shaft seal. 7. Replace gasket. Tighten screws. 8. Replace bolts or gasket or tighten both. 9. Replace gasket. 10. Replace switch and gasket. 11. Check for leaks at seal caused by worn seal or burr on converter hub (cutting seal), worn bushing, missing oil return, oil in front pump housing or hole plugged. Check for leaks past O-ring seal on pump or past pump-to-case bolts; pump housing porous, oil coming out vent due to overfill or leak past front band shaft access plug. 12. Replace seal. 13. Replace converter. 14. Replace case.
NOISY OPERATION IN FOURTH GEAR ONLY	1. Overdrive Clutch Discs, Plates or Snap Rings Damaged. 2. Overdrive Piston or Planetary Thrust Bearing Damaged. 3. Output Shaft Bearings Scored/Damaged. 4. Planetary Gears Worn/Chipped. 5. Overdrive Unit Overrunning Clutch Rollers Worn/Scored.	1. Remove unit and rebuild clutch pack. 2. Remove and disassemble unit. Replace either thrust bearing if damaged. 3. Remove and disassemble unit. Replace either bearing if damaged. 4. Remove and overhaul overdrive unit. 5. Remove and overhaul overdrive unit.

SERVICE PROCEDURES**FLUID LEVEL CHECK**

Transmission fluid level should be checked monthly under normal operation. If the vehicle is used for trailer towing or similar heavy load hauling, check fluid level and condition weekly. Fluid level is checked with the engine running at curb idle speed, the transmission in NEUTRAL and the transmission fluid at normal operating temperature.

FLUID LEVEL CHECK PROCEDURE

(1) Transmission fluid must be at normal operating temperature for accurate fluid level check. Drive

vehicle if necessary to bring fluid temperature up to normal hot operating temperature of 82°C (180°F).

(2) Position vehicle on level surface.

(3) Start and run engine at curb idle speed.

(4) Apply parking brakes.

(5) Shift transmission momentarily into all gear ranges. Then shift transmission back to Neutral.

(6) Clean top of filler tube and dipstick to keep dirt from entering tube.

(7) Remove dipstick (Fig. 22) and check fluid level as follows:

(a) Correct maximum level is to MAX arrow mark. Correct acceptable level is to OK mark in crosshatch area.

(b) Incorrect level is at or below MIN line.

SERVICE PROCEDURES (Continued)

(c) If fluid is low, add only enough Mopar ATF Plus to restore correct level. Do not overfill.

CAUTION: Do not overfill the transmission. Overfilling may cause leakage out the pump vent which can be mistaken for a pump seal leak. Overfilling will also cause fluid aeration and foaming as the excess fluid is picked up and churned by the gear train. This will significantly reduce fluid life.

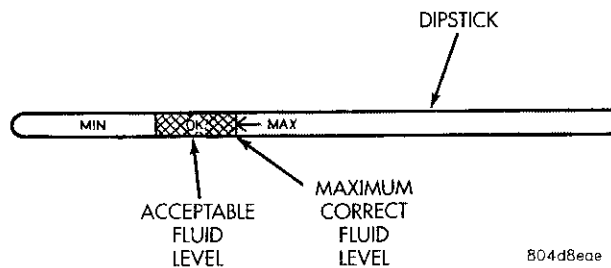


Fig. 22 Dipstick Fluid Level Marks—Typical

FLUID AND FILTER REPLACEMENT

Refer to the Maintenance Schedules in Group 0, Lubrication and Maintenance for proper service intervals. The service fluid fill after a filter change is approximately 3.8 liters (4.0 quarts).

PAN AND FILTER REMOVAL

- (1) Hoist and support vehicle on safety stands.
- (2) Place a large diameter shallow drain pan beneath the transmission pan.
- (3) Remove bolts holding front and sides of pan to transmission (Fig. 23).
- (4) Loosen bolts holding rear of pan to transmission.
- (5) Slowly separate front of pan away from transmission allowing the fluid to drain into drain pan.
- (6) Hold up pan and remove remaining bolt holding pan to transmission.
- (7) While holding pan level, lower pan away from transmission.
- (8) Pour remaining fluid in pan into drain pan.
- (9) Remove screws holding filter to valve body (Fig. 24).
- (10) Separate filter from valve body and pour fluid in filter into drain pan.
- (11) Dispose used trans fluid and filter properly.

INSPECTION AND CLEANING

INSPECTION

Inspect bottom of pan and magnet for excessive amounts of metal or fiber contamination. A light coating of clutch or band material on the bottom of the pan does not indicate a problem unless accompanied by slipping condition or shift lag. If fluid and

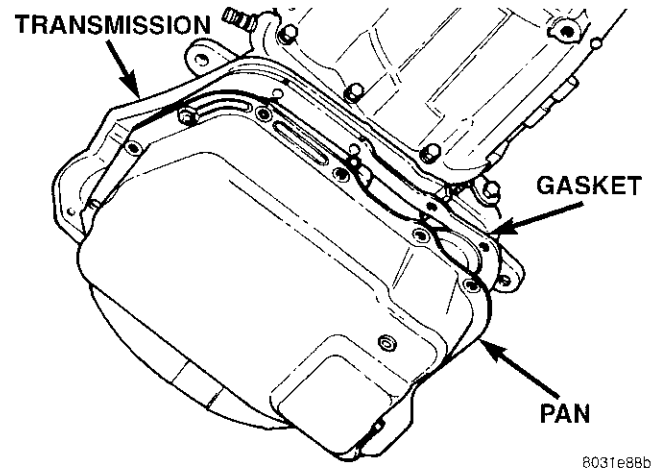


Fig. 23 Transmission Pan—Typical

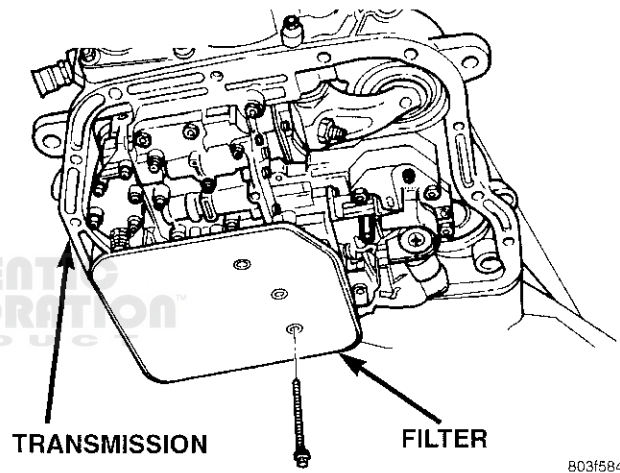


Fig. 24 Transmission Filter—Typical

pan are contaminated with excessive amounts or debris, refer to the diagnosis section of this group.

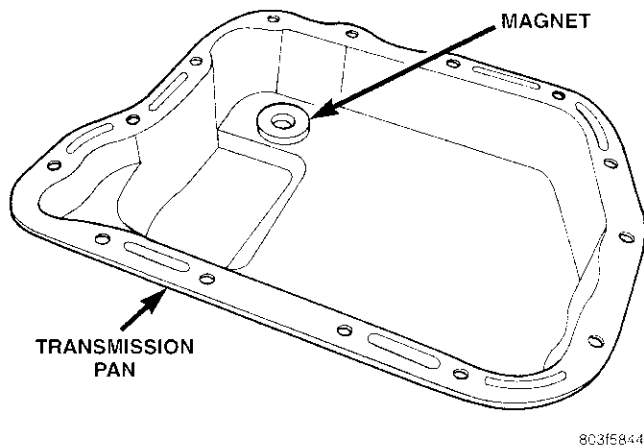
Check the adjustment of the front and rear bands, adjust if necessary. Refer to Adjustment section of this group for proper procedure.

CLEANING

- (1) Using a suitable solvent, clean pan and magnet (Fig. 25).
- (2) Using a suitable gasket scraper, clean gasket material from gasket surface of transmission case and the gasket flange around the pan.

FILTER AND PAN INSTALLATION

- (1) Place replacement filter in position on valve body.
- (2) Install screws to hold filter to valve body (Fig. 24). Tighten screws to 4 N·m (35 in. lbs.) torque.
- (3) Place new gasket in position on pan, and install pan on transmission.
- (4) Place pan in position on transmission.

SERVICE PROCEDURES (Continued)**Fig. 25 Pan and Magnet**

- (5) Install screws to hold pan to transmission (Fig. 23). Tighten bolts to 17 N·m (150 in. lbs.) torque.
- (6) Lower vehicle and fill transmission with Mopar ATF Plus, type 7176 fluid.

TRANSMISSION FILL PROCEDURE

To avoid overfilling transmission after a fluid change or overhaul, perform the following procedure:

- (1) Remove dipstick and insert clean funnel in transmission fill tube.
- (2) Add following initial quantity of Mopar ATF Plus to transmission:
 - (a) If only fluid and filter were changed, add **3 pints (1-1/2 quarts)** of ATF Plus to transmission.
 - (b) If transmission was completely overhauled, torque converter was replaced or drained, and cooler was flushed, add **12 pints (6 quarts)** of ATF Plus to transmission.
- (3) Apply parking brakes.
- (4) Start and run engine at normal curb idle speed.
- (5) Apply service brakes, shift transmission through all gear ranges then back to NEUTRAL, set parking brake, and leave engine running at curb idle speed.
- (6) Remove funnel, insert dipstick and check fluid level. If level is low, **add fluid to bring level to MIN mark on dipstick.**
- (7) Drive vehicle until transmission fluid is at normal operating temperature.
- (8) With the engine running at curb idle speed, the gear selector in NEUTRAL, and the parking brake applied, check the transmission fluid level.

CAUTION: Do not overfill transmission, fluid foaming and shifting problems can result.

- (9) Add fluid to bring level up to MAX arrow mark.

When fluid level is correct, shut engine off, release park brake, remove funnel, and install dipstick in fill tube.

CONVERTER DRAINBACK CHECK VALVE SERVICE

The converter drainback check valve is located in the cooler outlet (pressure) line near the radiator lower tank. The valve prevents fluid drainback when the vehicle is parked for lengthy periods. The valve check ball is spring loaded and has an opening pressure of approximately 2 psi.

The valve is serviced as an assembly; it is not repairable. Do not clean the valve if restricted, or contaminated by sludge, or debris. If the valve fails, or if a transmission malfunction occurs that generates sludge and/or clutch particles and metal shavings, the valve must be replaced.

The valve must be removed whenever the cooler and lines are reverse flushed. The valve can be flow tested when necessary. The procedure is exactly the same as for flow testing a cooler.

If the valve is restricted, installed backwards, or in the wrong line, it will cause an overheating condition and possible transmission failure.

CAUTION: The drainback valve is a one-way flow device. It must be properly oriented in terms of flow direction for the cooler to function properly. The valve must be installed in the pressure line. Otherwise flow will be blocked and would cause an overheating condition and eventual transmission failure.

ALUMINUM THREAD REPAIR

Damaged or worn threads in the aluminum transaxle case and valve body can be repaired by the use of Heli-Coils, or equivalent. This repair consists of drilling out the worn-out damaged threads. Then tap the hole with a special Heli-Coil tap, or equivalent, and installing a Heli-Coil insert, or equivalent, into the hole. This brings the hole back to its original thread size.

Heli-Coil, or equivalent, tools and inserts are readily available from most automotive parts suppliers.

FLUSHING COOLERS AND TUBES

When a transmission failure has contaminated the fluid, the oil cooler(s) must be flushed. The cooler bypass valve in the transmission must be replaced also. The torque converter must also be replaced with an exchange unit. This will insure that metal particles or sludged oil are not later transferred back into the reconditioned (or replaced) transmission.

There are two different procedures for flushing coolers and lines. The recommended procedure is to use Tool 6906 Cooler Flusher. The other procedure is to use a hand suction gun and mineral spirits.

SERVICE PROCEDURES (Continued)

WARNING: WEAR PROTECTIVE EYEWEAR THAT MEETS THE REQUIREMENTS OF OSHA AND ANSI Z87.1-1968. WEAR STANDARD INDUSTRIAL RUBBER GLOVES.

KEEP LIGHTED CIGARETTES, SPARKS, FLAMES, AND OTHER IGNITION SOURCES AWAY FROM THE AREA TO PREVENT THE IGNITION OF COMBUSTIBLE LIQUIDS AND GASES. KEEP A CLASS (B) FIRE EXTINGUISHER IN THE AREA WHERE THE FLUSHER WILL BE USED.

KEEP THE AREA WELL VENTILATED.

DO NOT LET FLUSHING SOLVENT COME IN CONTACT WITH YOUR EYES OR SKIN: IF EYE CONTAMINATION OCCURS, FLUSH EYES WITH WATER FOR 15 TO 20 SECONDS. REMOVE CONTAMINATED CLOTHING AND WASH AFFECTED SKIN WITH SOAP AND WATER. SEEK MEDICAL ATTENTION.

COOLER FLUSH USING TOOL 6906

(1) Remove cover plate filler plug on Tool 6906. Fill reservoir 1/2 to 3/4 full of fresh flushing solution. Flushing solvents are petroleum based solutions generally used to clean automatic transmission components. **DO NOT** use solvents containing acids, water, gasoline, or any other corrosive liquids.

(2) Reinstall filler plug on Tool 6906.

(3) Verify pump power switch is turned OFF. Connect red alligator clip to positive (+) battery post. Connect black (-) alligator clip to a good ground.

(4) Disconnect the cooler lines at the transmission.

NOTE: When flushing transmission cooler and lines, ALWAYS reverse flush.

(5) Connect the BLUE pressure line to the OUTLET (From) cooler line.

(6) Connect the CLEAR return line to the INLET (To) cooler line

(7) Turn pump ON for two to three minutes to flush cooler(s) and lines. Monitor pressure readings and clear return lines. Pressure readings should stabilize below 20 psi. for vehicles equipped with a single cooler and 30 psi. for vehicles equipped with dual coolers. If flow is intermittent or exceeds these pressures, replace cooler.

(8) Turn pump OFF.

(9) Disconnect CLEAR suction line from reservoir at cover plate. Disconnect CLEAR return line at cover plate, and place it in a drain pan.

(10) Turn pump ON for 30 seconds to purge flushing solution from cooler and lines. Turn pump OFF.

(11) Place CLEAR suction line into a one quart container of Mopar® type 7176 automatic transmission fluid.

(12) Turn pump ON until all transmission fluid is removed from the one quart container and lines. This

purges any residual cleaning solvent from the transmission cooler and lines. Turn pump OFF.

(13) Disconnect alligator clips from battery. Reconnect flusher lines to cover plate, and remove flushing adapters from cooler lines.

COOLER FLUSH USING SUCTION GUN AND MINERAL SPIRITS

(1) Disconnect the cooler lines at the transmission.

(2) Using a hand suction gun filled with mineral spirits, reverse flush the cooler. Force mineral spirits into the **From Cooler** line of the cooler and catch the exiting spirits from the **To Cooler** line. Observe for the presence of debris in the exiting fluid. Continue until fluid exiting is clear and free from debris.

(3) Using compressed air (under 40 psi.) in intermittent spurts, blow any remaining mineral spirits from the cooler, again in the reverse direction.

(4) Pump one (1) quart of automatic transmission fluid through the cooler before reconnecting.

(5) If at any stage of the cleaning process, the cooler does not freely pass fluid, the cooler must be replaced.

REMOVAL AND INSTALLATION**SPEEDOMETER SERVICE**

Rear axle gear ratio and tire size determine speedometer pinion requirements. If the pinion must be replaced, refer to the parts catalogue information for the correct part.

SPEEDOMETER ASSEMBLY REMOVAL

(1) Raise vehicle.

(2) Disconnect wires from vehicle speed sensor.

(3) Remove adapter clamp and screw (Fig. 26).

(4) Remove speed sensor and speedometer adapter as assembly.

(5) Remove speed sensor retaining screw and remove sensor from adapter.

(6) Remove speedometer pinion from adapter.

(7) Inspect sensor and adapter O-rings (Fig. 26). Remove and discard O-rings if worn or damaged.

(8) Inspect terminal pins in speed sensor. Clean pins with Mopar electrical spray cleaner if dirty or oxidized. Replace sensor if faulty, or pins are loose, severely corroded, or damaged.

SPEEDOMETER INSTALLATION AND INDEXING

(1) Thoroughly clean adapter flange and adapter mounting surface in housing. Surfaces must be clean for proper adapter alignment and speedometer operation.

(2) Install new O-rings on speed sensor and speedometer adapter if necessary (Fig. 26).

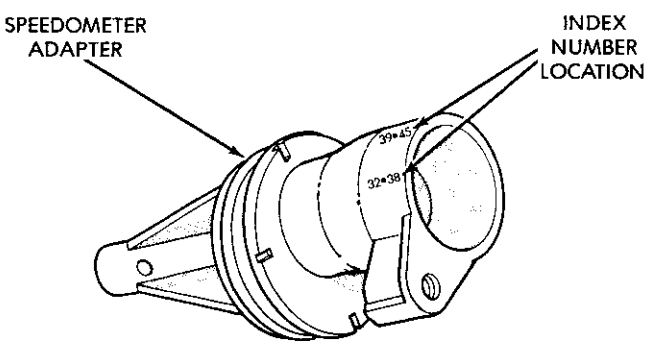
REMOVAL AND INSTALLATION (Continued)

- (3) Lubricate sensor and adapter O-rings with transmission fluid.
- (4) Install vehicle speed sensor in speedometer adapter. Tighten sensor attaching screw to 2-3 N·m (15-27 in. lbs.) torque.
- (5) Install speedometer pinion in adapter.
- (6) Count number of teeth on speedometer pinion. Do this before installing assembly in housing. Then lubricate pinion teeth with transmission fluid.
- (7) Note index numbers on adapter body (Fig. 27). These numbers will correspond to number of teeth on pinion.
- (8) Install speedometer assembly in housing.
- (9) Rotate adapter until required range numbers are at 6 o'clock position. Be sure range index numbers correspond to number of teeth on pinion gear.
- (10) Install speedometer adapter clamp and retaining screw. Tighten clamp screw to 10-12 N·m (90-110 in. lbs.) torque.
- (11) Connect wires to vehicle speed sensor.
- (12) Lower vehicle and top off transmission fluid level if necessary.

PARK/NEUTRAL POSITION SWITCH

Switch Replacement

- (1) Raise vehicle and position drain pan under switch.
- (2) Disconnect switch wires.
- (3) Remove switch from case.
- (4) Move shift lever to Park and Neutral positions. Verify that switch operating lever fingers are centered in switch opening in case (Fig. 28).



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Fig. 27 Index Numbers On Speedometer Pinion Adapter

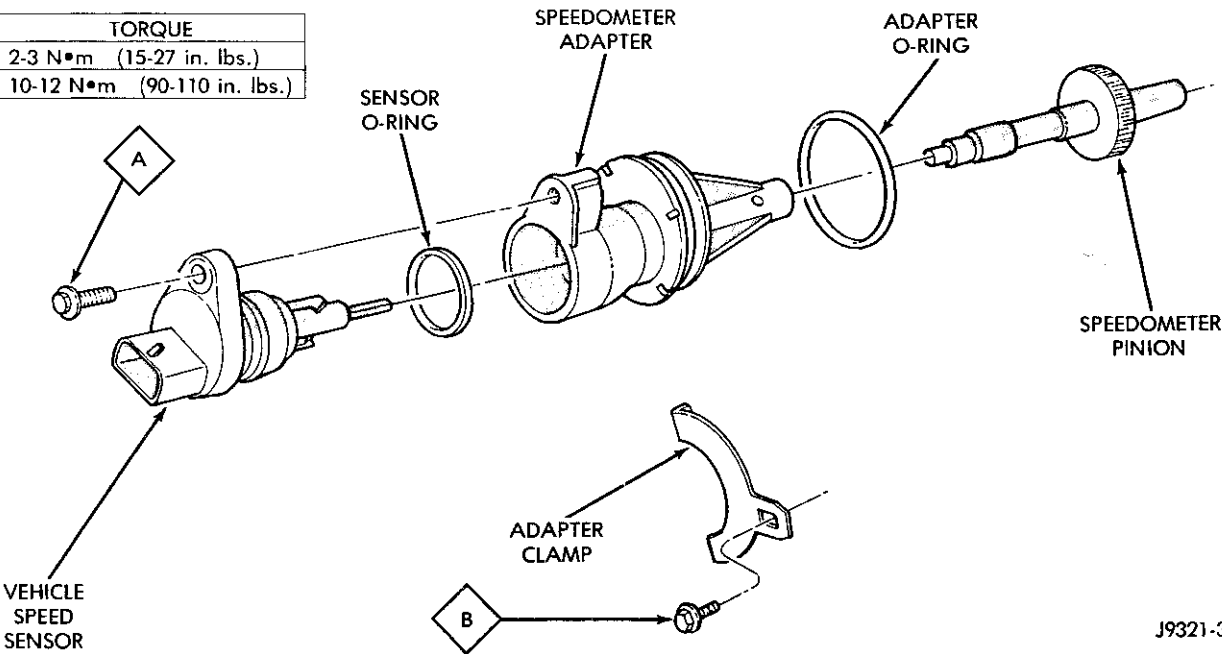
- (5) Install new seal on switch and install switch in case. Tighten switch to 34 N·m (25 ft. lbs.) torque.
- (6) Test continuity of new switch with 12V test lamp.
- (7) Connect switch wires and lower vehicle.
- (8) Top off transmission fluid level.

YOKE SEAL REPLACEMENT

REMOVAL

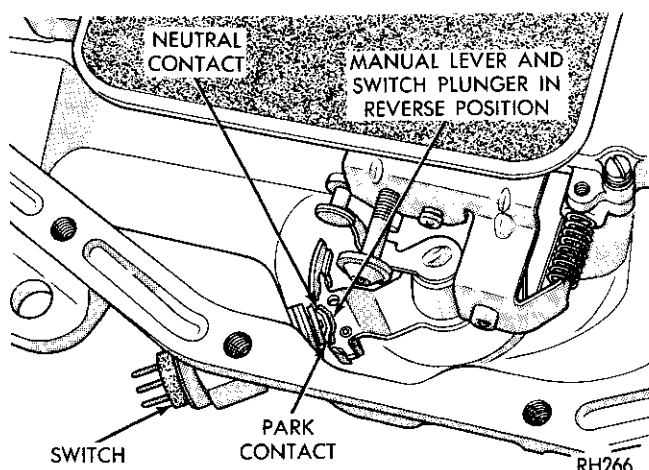
- (1) Raise vehicle.
- (2) Mark propeller shaft and axle yoke for alignment reference.
- (3) Disconnect and remove propeller shaft.

ITEM	TORQUE
A	2-3 N•m (15-27 in. lbs.)
B	10-12 N•m (90-110 in. lbs.)



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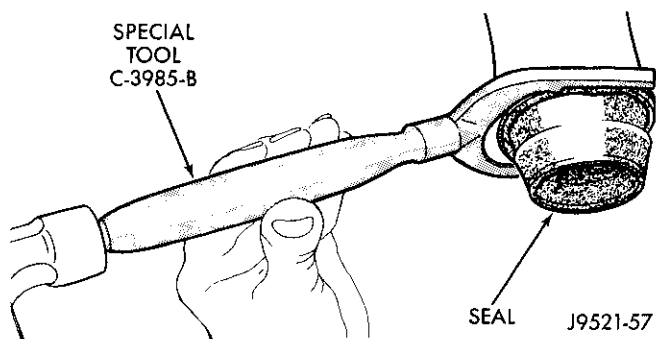
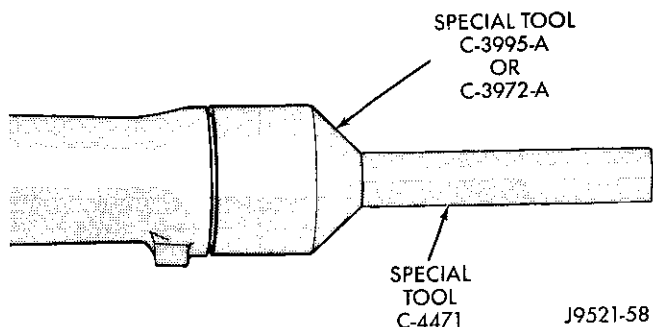
Fig. 26 Speedometer Pinion Adapter Components

REMOVAL AND INSTALLATION (Continued)**Fig. 28 Park/Neutral Position Switch**

(4) Remove old seal with Seal Remover C-3985-B (Fig. 29) from overdrive housing.

INSTALLATION

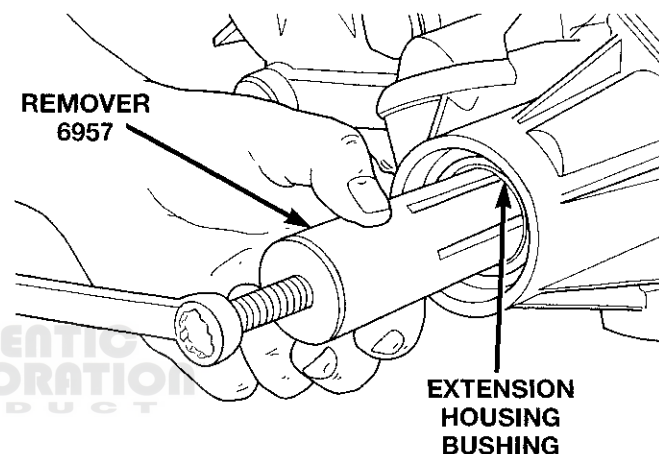
- (1) Place seal in position on overdrive housing.
- (2) Drive seal into overdrive housing with Seal Installer C-3995-A or C-3972 (Fig. 30).
- (3) Carefully guide propeller shaft slip yoke into housing and onto output shaft splines. Align marks made at removal and connect propeller shaft to rear axle pinion yoke.

**Fig. 29 Removing Overdrive Housing Yoke Seal****Fig. 30 Installing Overdrive Housing Yoke Seal****OVERDRIVE HOUSING BUSHING****REMOVAL**

- (1) Remove overdrive housing yoke seal.
- (2) Insert Special Tool # 6957 into overdrive housing. Tighten Tool to bushing and remove bushing (Fig. 31).

INSTALLATION

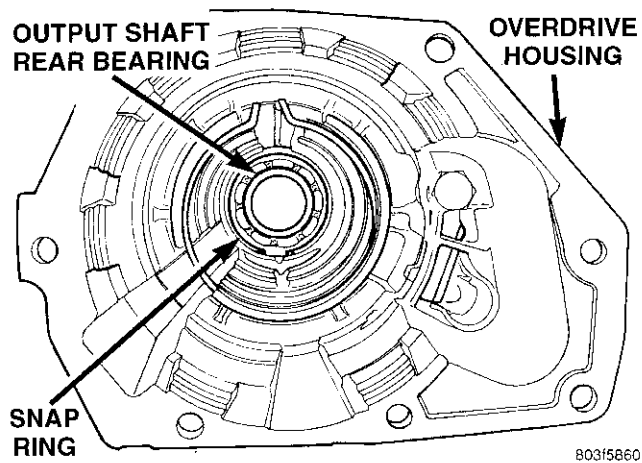
- (1) Align bushing oil hole with oil slot in overdrive housing.
- (2) Tap bushing into place with Special Tool # 6951 and Special Tool C-4171.
- (3) Install new oil seal in housing using Seal Installer C-3972-A.

**Fig. 31 Overdrive Housing Bushing Removal**
OUTPUT SHAFT REAR BEARING**REMOVAL**

- (1) Remove overdrive unit from the vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove snap ring holding output shaft rear bearing into overdrive housing (Fig. 32).
- (4) Using a suitable driver inserted through the rear end of housing, drive bearing from housing.

INSTALLATION

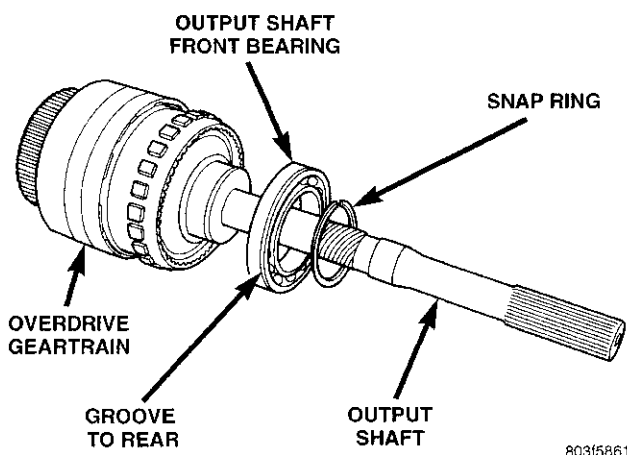
- (1) Place replacement bearing in position in housing.
- (2) Using a suitable driver, drive bearing into housing until the snap ring groove is visible.
- (3) Install snap ring to hold bearing into housing (Fig. 32).
- (4) Install overdrive geartrain into housing.
- (5) Install overdrive unit in vehicle.

REMOVAL AND INSTALLATION (Continued)**Fig. 32 Output Shaft Rear Bearing****OUTPUT SHAFT FRONT BEARING****REMOVAL**

- (1) Remove overdrive unit from the vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove snap ring holding output shaft front bearing to overdrive geartrain. (Fig. 33).
- (4) Pull bearing from output shaft.

INSTALLATION

- (1) Place replacement bearing in position on geartrain with locating retainer groove toward the rear.
- (2) Push bearing onto shaft until the snap ring groove is visible.
- (3) Install snap ring to hold bearing onto output shaft (Fig. 33).
- (4) Install overdrive geartrain into housing.
- (5) Install overdrive unit in vehicle.

**Fig. 33 Output Shaft Front Bearing****PARK LOCK****REMOVAL**

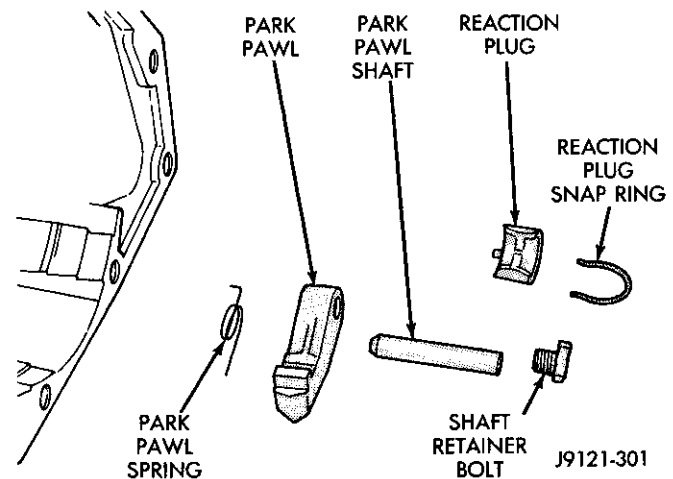
- (1) Remove overdrive unit from vehicle.
- (2) Remove overdrive geartrain from housing.
- (3) Remove bolt holding park pawl in overdrive housing.

CAUTION: Do not over stress snap ring during removal, snap ring distortion can result.

- (4) Remove snap ring holding reaction plug in overdrive housing.
- (5) Pull park pawl shaft from housing.
- (6) Separate park pawl, park pawl spring, and reaction plug from overdrive housing (Fig. 34).

INSTALLATION

- (1) Place park pawl, park pawl spring, and reaction plug in position in overdrive housing.
- (2) Insert park pawl shaft into housing through the park pawl, park pawl spring, and reaction plug (Fig. 34).
- (3) Install snap ring to hold reaction plug in overdrive housing.
- (4) Install bolt to hold park pawl in overdrive housing.
- (5) Install overdrive geartrain into housing.
- (6) Install overdrive unit in vehicle.

**Fig. 34 Park Lock**

REMOVAL AND INSTALLATION (Continued)

GOVERNOR SOLENOID AND PRESSURE SENSOR

The governor is electronically controlled. It consists of a pressure sensor, a pressure solenoid, and the governor body (Fig. 35).

REMOVAL

- (1) Hoist and support vehicle on safety stands.
- (2) Remove transmission fluid pan and filter.
- (3) Disengage wire connectors from pressure sensor and solenoid (Fig. 35).
- (4) Remove screws holding pressure solenoid retainer to governor body.
- (5) Separate solenoid retainer from governor (Fig. 36).
- (6) Pull solenoid from governor body (Fig. 37).
- (7) Remove bolts holding governor body to valve body.
- (8) Separate governor body from valve body (Fig. 38).
- (9) Separate gasket from back of governor body.
- (10) Remove retainer holding pressure sensor to governor body.
- (11) Pull pressure sensor from governor body (Fig. 39).

INSTALLATION

Before installing the pressure sensor and solenoid in the governor body, replace O-ring seals, clean the gasket surfaces and replace gasket.

- (1) Lubricate O-ring on pressure sensor with transmission fluid.
- (2) Align pressure sensor to bore in governor body (Fig. 39).
- (3) Push pressure sensor into governor body.
- (4) Install retainer to hold pressure sensor to governor body.
- (5) Place gasket in position on back of governor body (Fig. 38).
- (6) Place governor body in position on valve body.
- (7) Install bolts to hold governor body to valve body.
- (8) Lubricate O-ring, on pressure solenoid, with transmission fluid.
- (9) Align pressure solenoid to bore in governor body (Fig. 37).
- (10) Push solenoid into governor body.
- (11) Place solenoid retainer in position on governor (Fig. 36).
- (12) Install screws to hold pressure solenoid retainer to governor body.
- (13) Engage wire connectors into pressure sensor and solenoid (Fig. 35).
- (14) Install transmission fluid pan and (new) filter.
- (15) Lower vehicle and road test to verify repair.

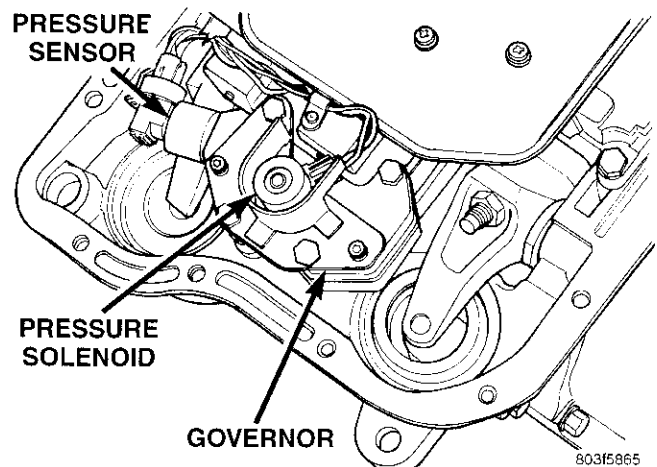


Fig. 35 Governor Solenoid And Pressure Sensor

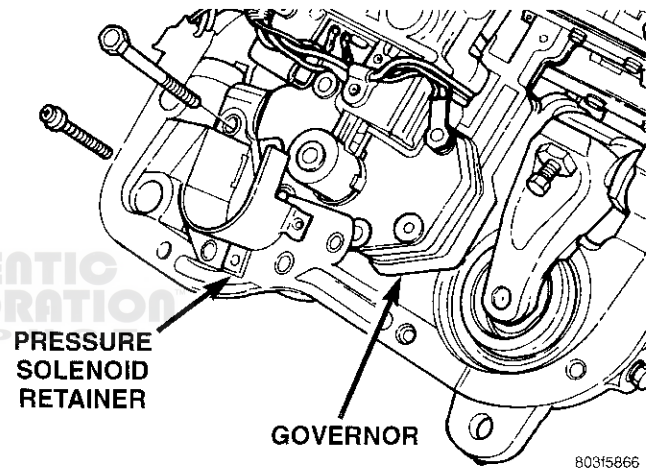


Fig. 36 Pressure Solenoid Retainer

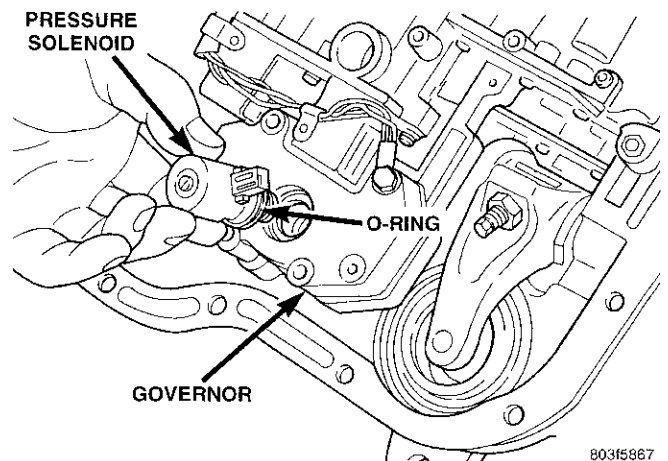
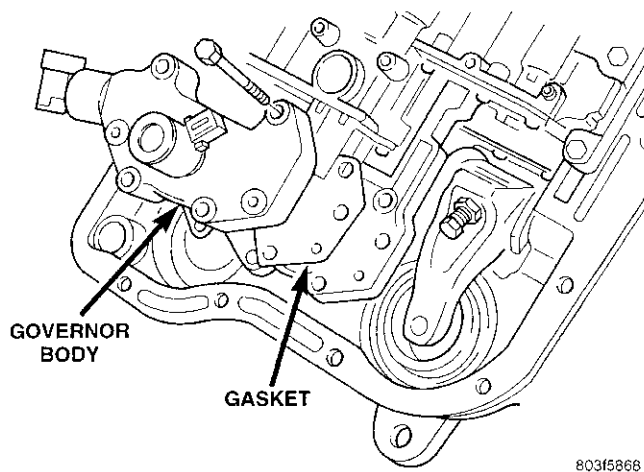
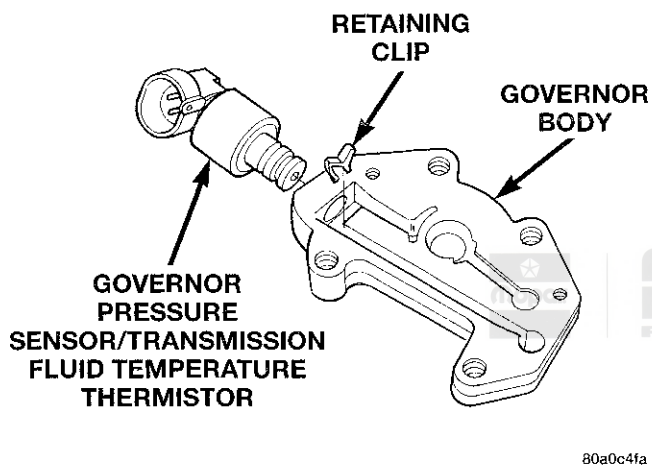


Fig. 37 Pressure Solenoid and O-ring

REMOVAL AND INSTALLATION (Continued)**Fig. 38 Governor Body and Gasket****Fig. 39 Pressure Sensor and Retainer****VALVE BODY**

The valve body can be removed for service without having to remove the entire transmission assembly.

The valve body can be disassembled for cleaning and inspection of the individual components. Refer to the procedures in the Disassemble and Assemble section.

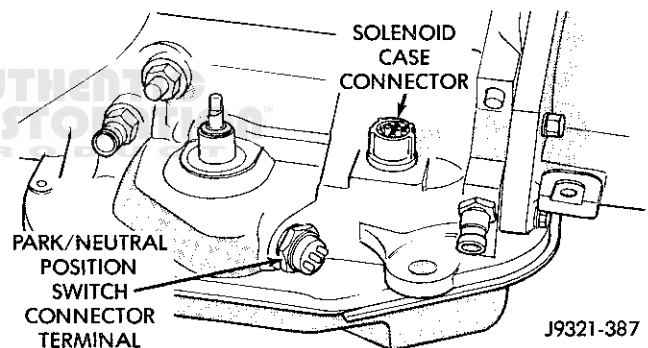
The only replaceable valve body components are:

- Manual lever
- Manual lever washer, seal, E-clip, and shaft seal
- Manual lever detent ball
- Throttle lever
- Fluid filter
- Pressure adjusting screw bracket
- Governor pressure solenoid
- Governor pressure sensor
- Converter clutch/overdrive solenoid assembly and harness (includes sump temperature thermistor)
 - Governor housing gasket
 - Solenoid case connector O-rings

The remaining valve body components are serviced only as part of a complete valve body assembly.

REMOVAL

- (1) Shift transmission into NEUTRAL.
- (2) Raise vehicle.
- (3) Remove gearshift and throttle levers from shaft of valve body manual lever.
- (4) Disconnect wires at park/neutral position switch.
- (5) Disconnect wires at park/neutral position switch and solenoid case connector (Fig. 40).
- (6) Position drain pan under transmission oil pan.
- (7) Remove transmission oil pan and gasket.
- (8) Remove fluid filter from valve body.
- (9) Remove bolts attaching valve body to transmission case.
- (10) Lower valve body enough to remove accumulator piston and springs.
- (11) Work manual lever shaft and electrical connector out of transmission case. Then lower valve body, rotate it away from case, pull park rod out of sprag, and remove valve body (Fig. 41).

**Fig. 40 Transmission Case Connector****INSTALLATION**

(1) Verify that park/neutral position switch has NOT been installed in case. Valve body cannot be installed if switch is in place.

(2) Check condition of O-ring seals on valve body harness connector (Fig. 42). Replace seals on connector body if cut or worn.

(3) Check condition of manual lever shaft seal in transmission case. Replace seal if lip is cut or worn. Install new seal with 15/16 deep well socket (Fig. 43).

(4) Check condition of seals on accumulator piston (Fig. 44). Install new piston seals, if necessary.

(5) Place valve body manual lever in low (1 position) so ball on park lock rod will be easier to install in sprag.

(6) Lubricate shaft of manual lever with petroleum jelly. This will ease inserting shaft through seal in case.

(7) Lubricate seal rings on valve body harness connector with Ru-Glyde or petroleum jelly.

REMOVAL AND INSTALLATION (Continued)

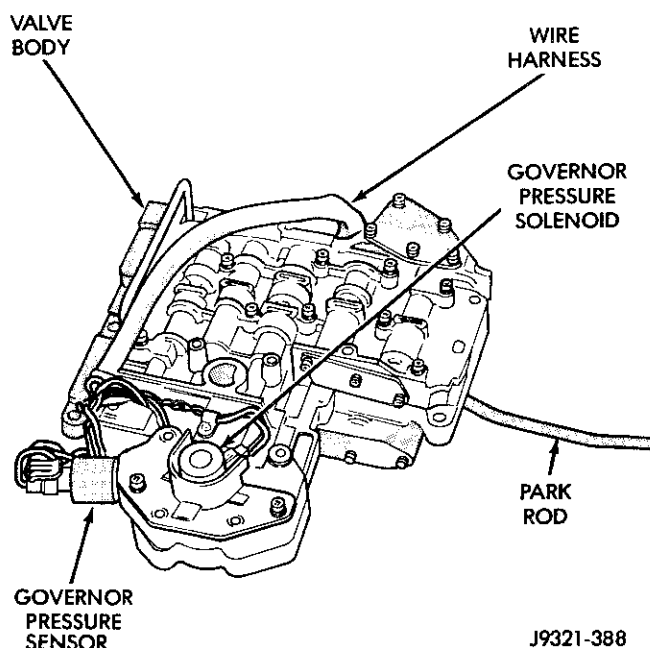


Fig. 41 Valve Body

(8) Position valve body on case and work end of park lock rod into and through pawl sprag. Turn propeller shaft to align sprag and park lock teeth if necessary. The rod will click as it enters pawl. Move rod to check engagement.

CAUTION: It is possible for the park rod to displace into a cavity just above the pawl sprag during installation. Make sure the rod is actually engaged in the pawl and has not displaced into this cavity. If the rod enters the cavity during installation, it will become bent when the overdrive bolts are tightened. The rod will then have to be replaced because it is not repairable.

(9) Install accumulator springs and piston into case. Then swing valve body over piston and outer spring to hold it in place.

(10) Align accumulator piston and outer spring, manual lever shaft and electrical connector in case. Then seat valve body on case and install one or two bolts to hold valve body in place.

(11) Tighten valve body bolts alternately and evenly to 11 N·m (100 in. lbs.) torque.

(12) Install new fluid filter on valve body. Tighten filter screws to 4 N·m (35 in. lbs.) torque.

(13) Install and connect park/neutral position switch in case.

(14) Install throttle and gearshift levers on valve body manual lever shaft.

(15) Check and adjust front and rear bands if necessary.

(16) Connect valve body overdrive and converter clutch solenoid wires to case connector.

(17) Install oil pan and new gasket. Tighten pan bolts to 17 N·m (13 ft. lbs.) torque.

(18) Lower vehicle and fill transmission with Mopar ATF Plus, type 7176 fluid.

(19) Check and adjust gearshift and throttle valve cables, if necessary.

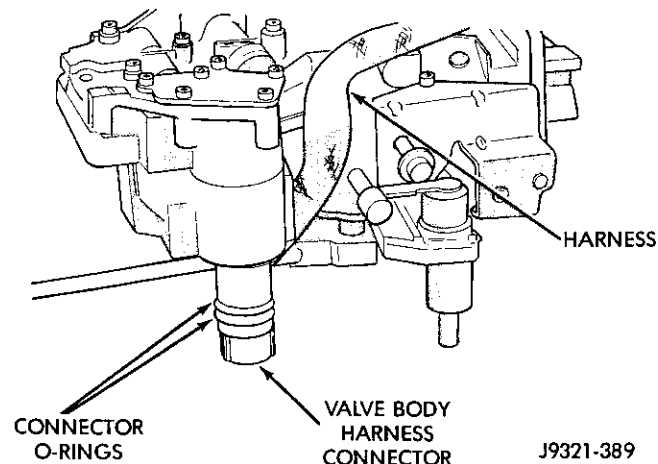


Fig. 42 Valve Body Harness Connector O-Ring Seal

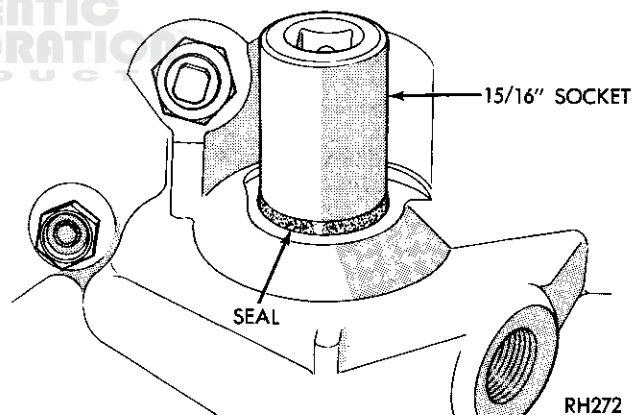


Fig. 43 Manual Lever Shaft Seal

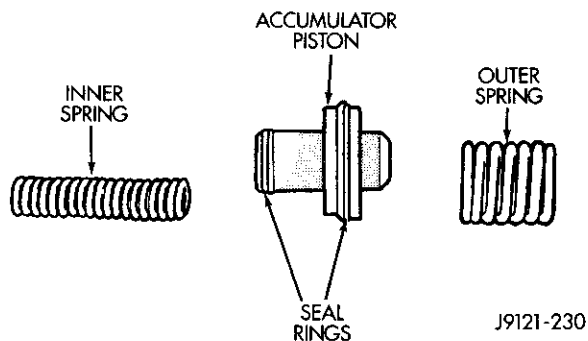


Fig. 44 Accumulator Piston Components

REMOVAL AND INSTALLATION (Continued)**TRANSMISSION COOLER LINE AND FITTINGS**

The transmission cooler lines are attached with quick connect fittings (Fig. 45).

COOLER LINE AND FITTING SERVICE

The cooler lines and fittings are NOT serviceable. Damaged fittings or cooler lines are to be replaced as assemblies.

Fittings swaged into cooler line hoses are serviced only as part of the entire cooler line.

DISCONNECTING COOLER LINES

- (1) If fitting and cooler line are covered with dirt, mud, or grease, clean fitting and cooler line with Mopar spray type carburetor or brake cleaner.
- (2) Disengage retainer on fitting and pull cooler line out of fitting.
- (3) Cover open ends of cooler lines and fittings to prevent dirt entry.
- (4) Inspect condition of fitting. Replace transmission fitting as an assembly if fitting body or retainer clip is damaged. Replace cooler line as assembly, if fitting swaged into cooler line hose, is damaged.

CONNECTING COOLER LINES

- (1) If transmission or radiator fittings require replacement, apply Mopar Lock N' Seal, or Loctite 242 to fitting threads before installation.
- (2) Wipe off cooler line and fitting with clean, dry cloth.
- (3) Insert cooler line into fitting. Then push line inward until retainer secures line. A snap or click will be heard and felt through the line when the retainer seats behind the cooler line flange.
- (4) **Pull outward on cooler lines to verify that they are properly secured.**

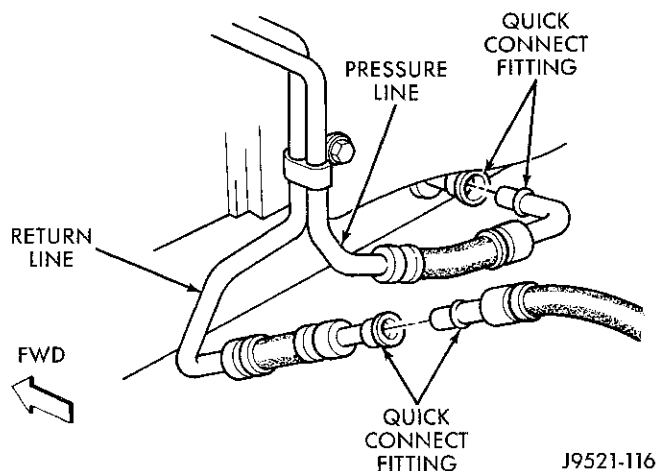


Fig. 45 Cooler Line Fitting

TRANSMISSION COOLER REPLACEMENT**MAIN COOLER REPLACEMENT**

The main transmission cooler is located in the radiator. The cooler is not a serviceable component. If the cooler is damaged, the radiator must be replaced.

AUXILIARY COOLER REPLACEMENT

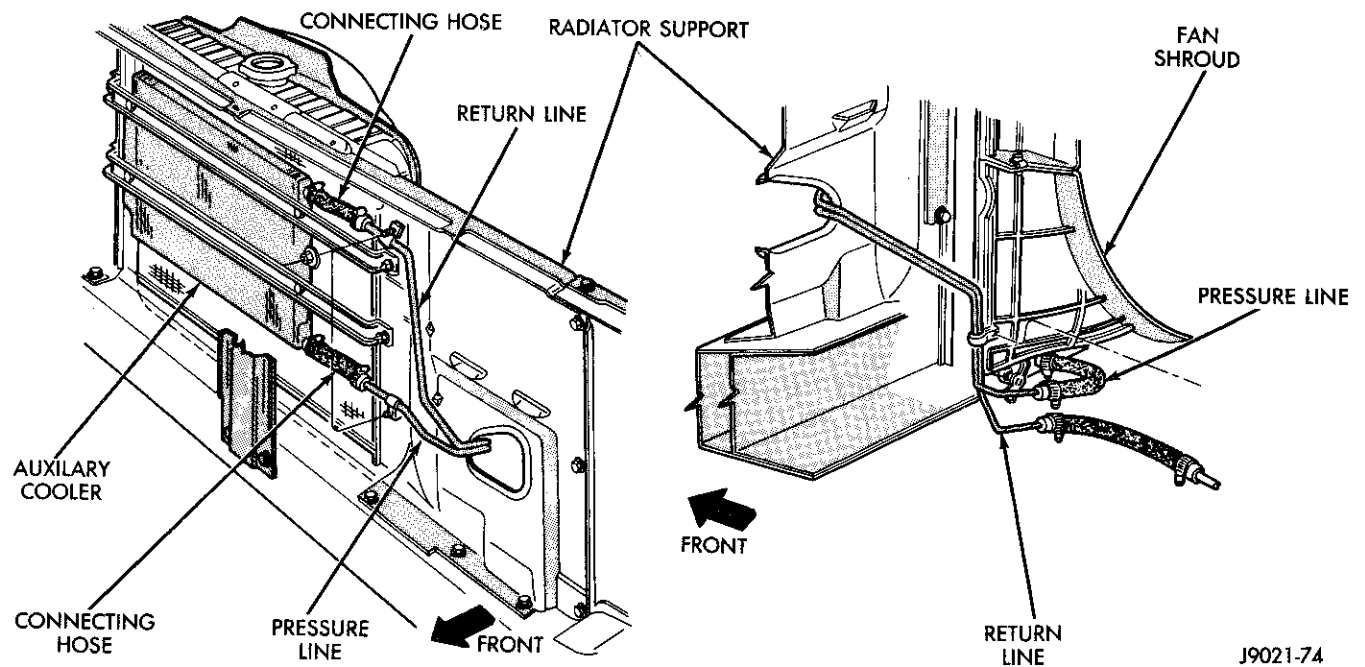
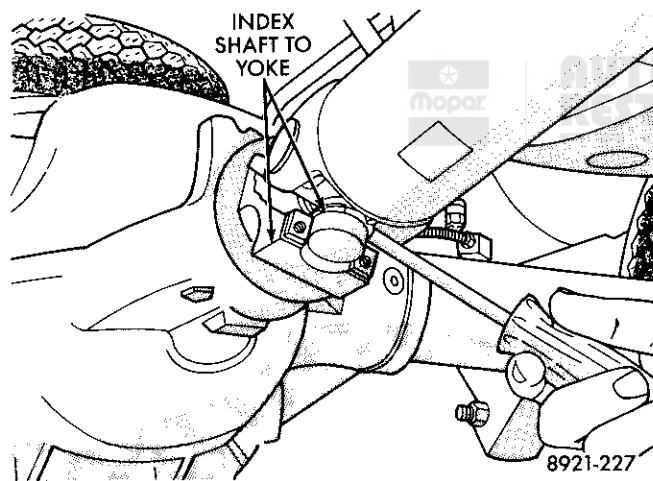
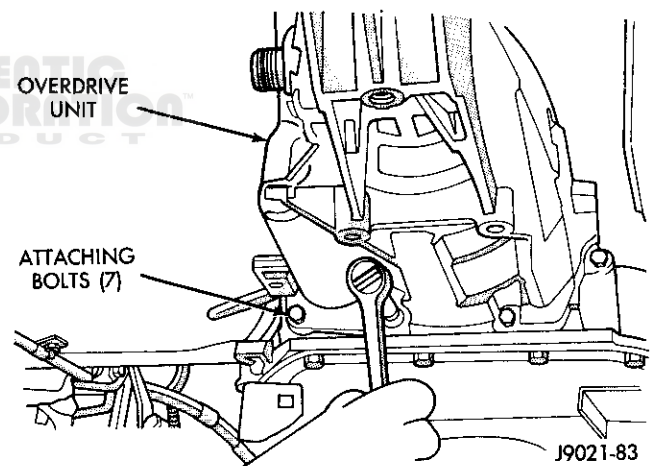
- (1) Remove grille, refer to Group 23, Body for proper procedures.
- (2) Remove brackets holding cooler to radiator and radiator support (Fig. 46).
- (3) Tag cooler hoses for installation reference (Fig. 46).
- (4) Position drain pan under cooler lines.
- (5) Loosen cooler connecting hose clamps and disconnect the hoses.
- (6) Remove auxiliary cooler
- (7) Connect cooler to hoses.
- (8) Position cooler on radiator, or support and install brackets and fasteners.
- (9) Tighten cooler hose clamps securely.
- (10) Install grille.
- (11) Check and adjust transmission fluid level.

OVERDRIVE UNIT**REMOVAL**

- (1) Shift transmission into Park.
- (2) Raise vehicle.
- (3) Remove transmission oil pan, remove gasket, drain oil and reinstall pan.
- (4) If overdrive unit had malfunctioned, or if fluid is contaminated, remove entire transmission. If diagnosis indicated overdrive clutch or governor problems only, remove overdrive unit only.
- (5) Mark propeller shaft universal joint and axle pinion yoke for alignment reference at installation (Fig. 47).
- (6) Disconnect and remove propeller shaft.
- (7) Support transmission with transmission jack.
- (8) Remove rear crossmember.
- (9) Remove vehicle speed sensor and speedometer adapter.
- (10) Remove bolts attaching overdrive unit to transmission (Fig. 48).

CAUTION: Support the overdrive unit with a jack before moving it rearward. This is necessary to prevent damaging the intermediate shaft. Do not allow the shaft to support the entire weight of the overdrive unit.

- (11) Carefully work overdrive unit off intermediate shaft. Do not tilt compounder during removal. Keep it as level as possible.

REMOVAL AND INSTALLATION (Continued)**Fig. 46 Auxiliary Cooler Mounting****Fig. 47 Mark Propeller Shaft And Yoke For Alignment Reference****Fig. 48 Removing/Installing Overdrive Unit Attaching Bolts**

(a) If overdrive unit does not require service, immediately insert Alignment Tool 6227-2 in splines of planetary gear and overrunning clutch to prevent splines from rotating out of alignment. If misalignment occurs, overdrive unit will have to be disassembled in order to realign splines.

(b) If overdrive unit requires service, refer to Disassemble and Assemble section of this group for proper procedures.

(12) Remove and retain overdrive piston thrust bearing. Bearing may remain on piston or in clutch hub during removal.

(13) Position drain pan on workbench.

(14) Place overdrive unit over drain pan. Tilt unit to drain residual fluid from case.

(15) Examine fluid for clutch material or metal fragments. If fluid contains these items, overhaul will be necessary.

(16) If overdrive unit does not require any service, leave alignment tool in position. Tool will prevent accidental misalignment of planetary gear and overrunning clutch splines.

INSTALLATION

(1) Be sure overdrive unit Alignment Tool 6227-2 is fully seated before moving unit. If tool is not seated and gear splines rotate out of alignment, over-

REMOVAL AND INSTALLATION (Continued)

drive unit may have to be disassembled in order to realign splines.

(2) If overdrive piston retainer was not removed during service and original case gasket is no longer reusable, prepare new gasket by trimming it.

(3) Cut out old case gasket around piston retainer with razor knife (Fig. 49).

(4) Use old gasket as template and trim new gasket to fit.

(5) Position new gasket over piston retainer and on transmission case. Use petroleum jelly to hold gasket in place if necessary. **Do not use any type of sealer to secure gasket. Use petroleum jelly only.**

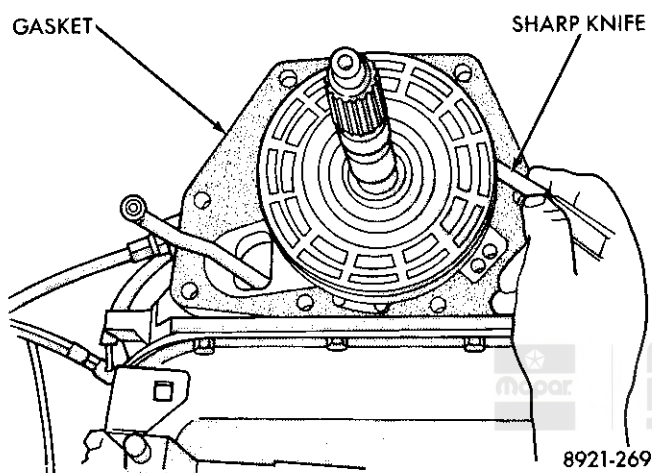


Fig. 49 Trimming Overdrive Case Gasket

(6) Install selective spacer on intermediate shaft, if removed. Spacer goes in groove just rearward of shaft rear splines (Fig. 50).

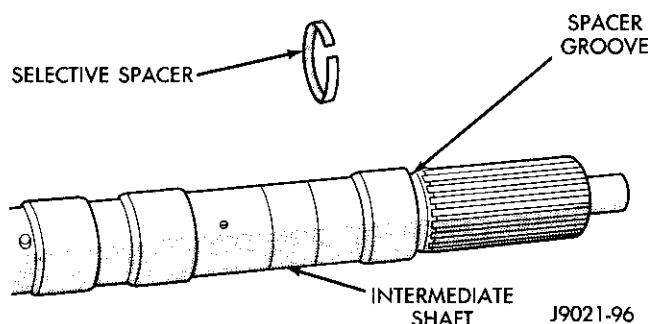


Fig. 50 Intermediate Shaft Selective Spacer Location

(7) Install overdrive piston in retainer (if removed). Lubricate piston seals with Mopar Door Ease, or Ru-Glyde to ease installation. Be sure piston locating lugs are aligned in piston retainer.

(8) Install thrust bearing in overdrive unit sliding hub. Use petroleum jelly to hold bearing in position.

CAUTION: Be sure the shoulder on the inside diameter of the bearing is facing forward.

(9) Verify that splines in overdrive planetary gear and overrunning clutch hub are aligned with Alignment Tool 6227-2. **Overdrive unit cannot be installed if splines are not aligned. If splines have rotated out of alignment, unit may have to be disassembled to realign splines.**

(10) Carefully slide Alignment Tool 6227-2 out of overdrive planetary gear and overrunning clutch splines.

(11) Raise overdrive unit and carefully slide it straight onto intermediate shaft. Insert park rod into park lock reaction plug at same time. **Avoid tilting overdrive during installation as this could cause planetary gear and overrunning clutch splines to rotate out of alignment. If this occurs, it will be necessary to remove and disassemble overdrive unit to realign splines.**

(12) Align slip-fit governor tubes and work overdrive unit forward on intermediate shaft until seated against transmission case.

(13) Install bolts attaching overdrive unit to transmission unit. Tighten bolts in diagonal pattern to 34 N·m (25 ft-lbs).

(14) Install crossmember.

(15) Install speed sensor and speedometer adapter. Be sure to index adapter.

(16) Connect speed sensor and overdrive wires.

(17) Align and install propeller shaft.

(18) If valve body was also removed, adjust bands, install valve body and install transmission oil pan and gasket.

TRANSMISSION/OVERDRIVE

The overdrive unit can be removed and serviced separately. It is not necessary to remove the entire transmission assembly to perform overdrive unit repairs.

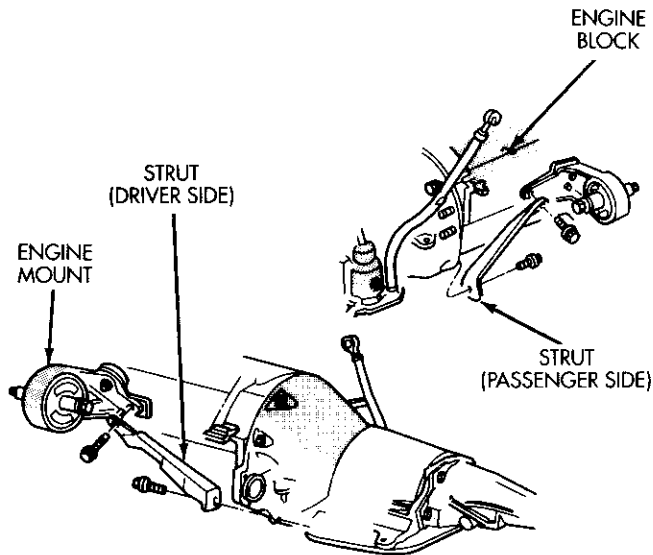
The entire transmission assembly must be removed in order to service the torque converter, driveplate, ring gear and oil pump. Refer to the transmission removal and installation procedures in this section.

If only the overdrive unit requires service, refer to the overdrive unit removal and installation procedures.

CAUTION: The transmission and torque converter must be removed as an assembly to avoid component damage. The converter drive plate, pump bushing, or oil seal can be damaged if the converter is left attached to the driveplate during removal. Be sure to remove the transmission and converter as an assembly.

REMOVAL AND INSTALLATION (Continued)**REMOVAL**

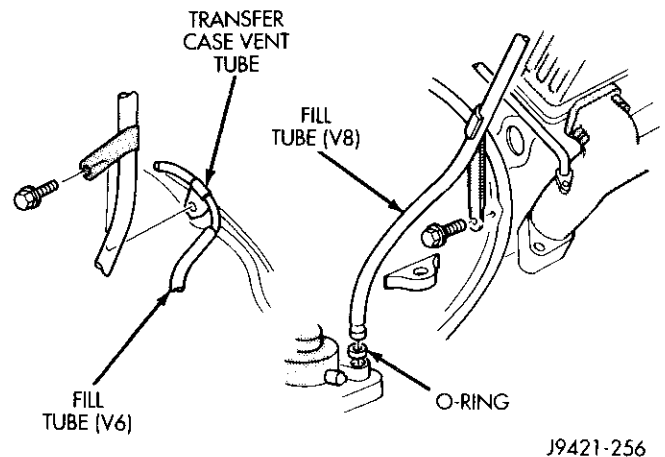
- (1) Disconnect battery negative cable.
- (2) Disconnect and lower or remove necessary exhaust components.
- (3) Remove engine-to-transmission struts, if equipped (Fig. 51).

**Fig. 51 Transmission-To-Engine Strut Attachment**

- (4) Disconnect fluid cooler lines at transmission.
- (5) Remove starter motor.
- (6) Disconnect and remove crankshaft position sensor. Retain sensor attaching bolts.

CAUTION: The crankshaft position sensor will be damaged if the transmission is removed (or installed) while the sensor is still bolted to the engine block. To avoid damage, be sure to remove the sensor before removing the transmission.

- (7) Remove torque converter access cover.
- (8) If transmission is being removed for overhaul, remove transmission oil pan, drain fluid and reinstall pan.
- (9) Remove fill tube bracket bolts and pull tube out of transmission. Retain fill tube O-ring (Fig. 51). On 4 x 4 models, it will also be necessary to remove bolt attaching transfer case vent tube to converter housing (Fig. 52).
- (10) Mark torque converter and drive plate for assembly alignment. Note that bolt holes in crankshaft flange, drive plate and torque converter all have one offset hole.
- (11) Rotate crankshaft in clockwise direction until converter bolts are accessible. Then remove bolts one

**Fig. 52 Fill Tube Attachment**

at a time. Rotate crankshaft with socket wrench on dampener bolt.

- (12) Mark propeller shaft and axle yokes for assembly alignment. Then disconnect and remove propeller shaft. ON 4 x 4 models, remove both propeller shafts.

- (13) Disconnect wires from park/neutral position switch, transmission solenoid, and vehicle speed sensor.

- (14) Disconnect gearshift rod and torque shaft assembly from transmission.

- (15) Disconnect throttle valve cable from transmission bracket and throttle valve lever.

- (16) On 4 x 4 models, disconnect shift rod from transfer case shift lever. Or remove shift lever from transfer case and tie rod and lever to chassis component with wire.

- (17) Disconnect transmission fluid cooler lines at transmission fittings. Remove lines from retaining clips and tie lines to chassis with wire.

- (18) Support rear of engine with safety stand or jack.

- (19) Raise transmission slightly with service jack to relieve load on crossmember and supports.

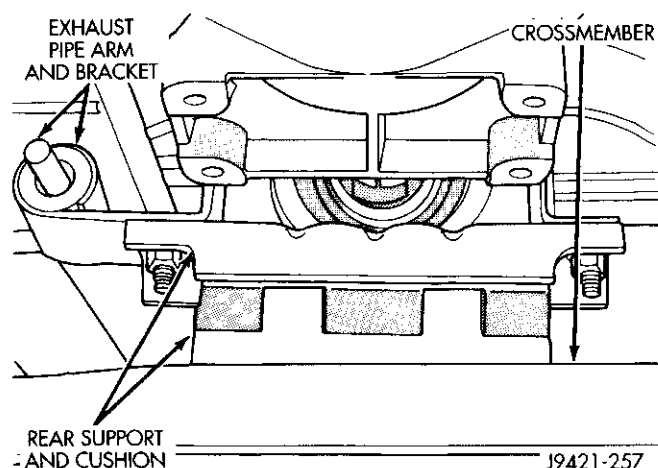
- (20) Remove bolts securing rear support and cushion to transmission and crossmember. Raise transmission slightly, slide exhaust hanger arm from bracket (Fig. 53) and (Fig. 54) and remove rear support.

- (21) Remove bolts attaching crossmember to frame and remove crossmember.

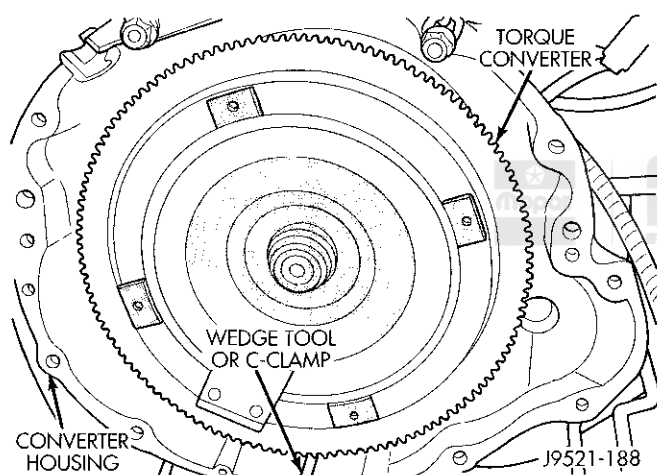
- (22) On 4 x 4 models, disconnect speed sensor wires and vent hose from transfer case. Then remove transfer case with transmission jack or aid of helper.

- (23) Remove all converter housing bolts.

- (24) Carefully work transmission and torque converter assembly rearward off engine block dowels.

REMOVAL AND INSTALLATION (Continued)**Fig. 53 Rear Support Cushion**

(25) Use wedge tool (Fig. 54), or C-clamp to hold torque converter in place during transmission removal.

**Fig. 54 Holding Converter In Place With Wedge Tool**

(26) Lower transmission and remove assembly from under the vehicle.

(27) To remove torque converter, remove C-clamp from edge of bell housing and carefully slide torque converter out of the transmission.

TRANSMISSION/OVERDRIVE INSTALLATION

(1) Check torque converter hub and hub drive notches for sharp edges burrs, scratches, or nicks. Polish the hub and notches with 320/400 grit paper and crocus cloth if necessary. The hub must be smooth to avoid damaging pump seal at installation.

(2) Lubricate converter drive hub and oil pump seal lip with transmission fluid.

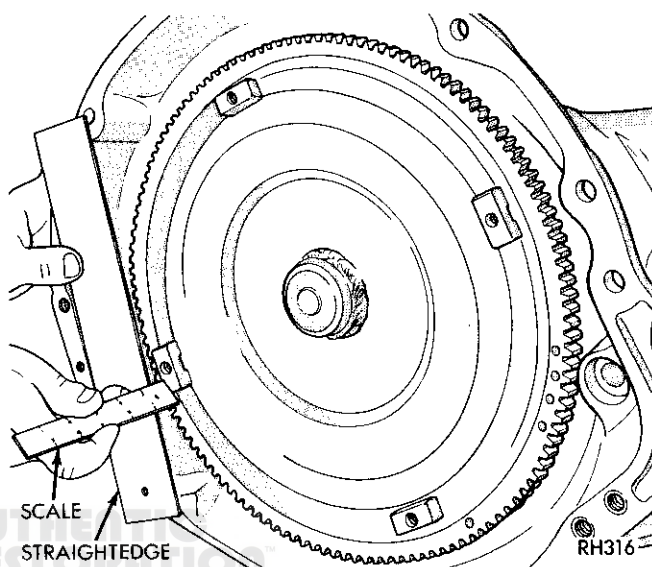
(3) Lubricate converter pilot hub with transmission fluid.

(4) Align and install converter in oil pump.

(5) Carefully insert converter in oil pump. Then rotate converter back and forth until fully seated in pump gears.

(6) Check converter seating with steel scale and straightedge (Fig. 55). Surface of converter lugs should be 1/2 in. to rear of straightedge when converter is fully seated.

(7) Temporarily secure converter with wedge tool or C-clamp.

**Fig. 55 Typical Method Of Checking Converter Seating**

(8) Position transmission on jack and secure it with chains.

(9) Check condition of converter driveplate. Replace the plate if cracked, distorted or damaged. **Also be sure transmission dowel pins are seated in engine block and protrude far enough to held transmission in alignment.**

(10) Raise transmission and align converter with drive plate and converter housing with engine block.

(11) Move transmission forward. Then raise, lower or tilt transmission to align converter housing with engine block dowels.

(12) Rotate converter so alignment marks scribed on converter are aligned with mark on driveplate.

(13) Carefully work transmission forward and over engine block dowels until converter hub is seated in crankshaft.

(14) Install bolts attaching converter housing to engine.

(15) Install rear support. Then lower transmission onto crossmember and install bolts attaching transmission mount to crossmember.

(16) Remove engine support fixture.

(17) Install crankshaft position sensor.

REMOVAL AND INSTALLATION (Continued)

(18) Install vehicle speed sensor and speedometer adapter.

(19) Install new plastic retainer grommet on any shift linkage rod or lever that was disconnected. Grommets should not be reused. Use pry tool to remove rod from grommet and cut away old grommet. Use pliers to snap new grommet into lever and to snap rod into grommet at assembly.

(20) Connect gearshift and throttle cable to transmission.

(21) Connect wires to park/neutral position switch, transmission solenoid(s) and oxygen sensor. Be sure transmission harnesses are properly routed.

CAUTION: It is essential that correct length bolts be used to attach the converter to the driveplate. Bolts that are too long will damage the clutch surface inside the converter. If new bolts are required, use the bolts specified in the parts catalog only.

(22) Install torque converter-to-driveplate bolts. On models with 10.75 in. converter, tighten bolts to 31 N·m (270 in. lbs.). On models with 12.2 in. converter, tighten bolts to 47 N·m (35 ft. lbs.).

(23) Install converter housing access cover.

(24) Install starter motor and cooler line bracket.

(25) Connect cooler lines to transmission.

(26) Install transmission fill tube. Install new seal on tube before installation.

(27) Install exhaust components.

(28) Align and connect propeller shaft.

(29) Adjust gearshift linkage and throttle valve cable if necessary.

(30) Lower vehicle.

(31) Fill transmission with Mopar ATF Plus, Type 7176 fluid.

TORQUE CONVERTER

REMOVAL

(1) Remove transmission and torque converter from vehicle.

(2) Place a suitable drain pan under the converter housing end of the transmission.

CAUTION: Verify that transmission is secure on the lifting device or work surface, the center of gravity of the transmission will shift when the torque converter is removed creating an unstable condition.

The torque converter is a heavy unit. Use caution when separating the torque converter from the transmission.

(3) Pull the torque converter forward until the center hub clears the oil pump seal.

(4) Separate the torque converter from the transmission.

INSTALLATION

Check converter hub and drive notches for sharp edges, burrs, scratches, or nicks. Polish the hub and notches with 320/400 grit paper or crocus cloth if necessary. The hub must be smooth to avoid damaging the pump seal at installation.

(1) Lubricate converter hub and oil pump seal lip with transmission fluid.

(2) Place torque converter in position on transmission.

CAUTION: Do not damage oil pump seal or bushing while inserting torque converter into the front of the transmission.

(3) Align torque converter to oil pump seal opening.

(4) Insert torque converter hub into oil pump.

(5) While pushing torque converter inward, Rotate converter until converter is fully seated in the oil pump gears.

(6) Check converter seating with a scale and straightedge (Fig. 56). Surface of converter lugs should be 1/2 in. to rear of straightedge when converter is fully seated.

(7) If necessary, temporarily secure converter with C-clamp attached to the converter housing.

(8) Install the transmission in the vehicle.

(9) Fill the transmission with the recommended fluid.

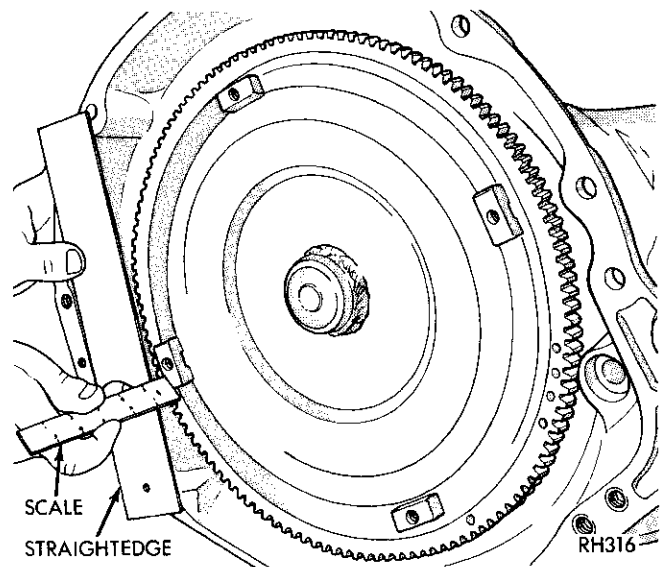


Fig. 56 Checking Torque Converter Seating
DISASSEMBLY AND ASSEMBLY

VALVE BODY

Remove the valve body from the transmission, refer to Removal and Installation procedures section in this group.

DISASSEMBLY AND ASSEMBLY (Continued)**VALVE BODY MAIN COMPONENT
DISASSEMBLE**

CAUTION: Do not clamp any valve body component in a vise. This practice can damage the component resulting in unsatisfactory operation after assembly and installation. Do not use pliers to remove any of the valves, plugs or springs and do not force any of the components out or into place. The valves and valve body housings will be damaged if force is used. Tag or mark the valve body springs for reference as they are removed. Do not allow them to become intermixed.

(1) Disconnect wires from governor pressure sensor and solenoid (Fig. 57).

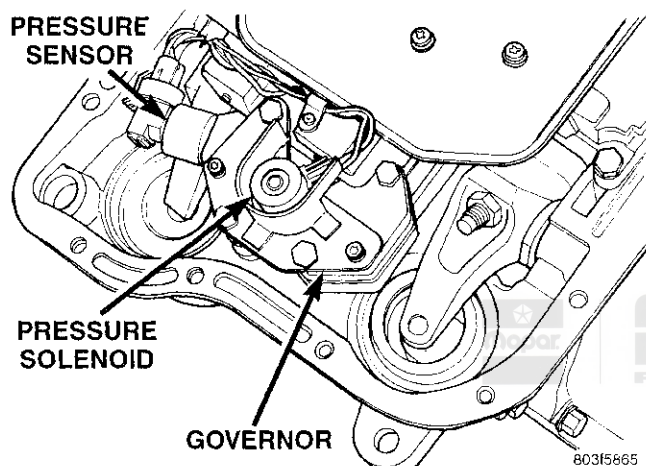


Fig. 57 Governor Pressure Solenoid And Sensor Wire Locations

(2) Remove screws attaching governor body and retainer plate to transfer plate (Fig. 58).

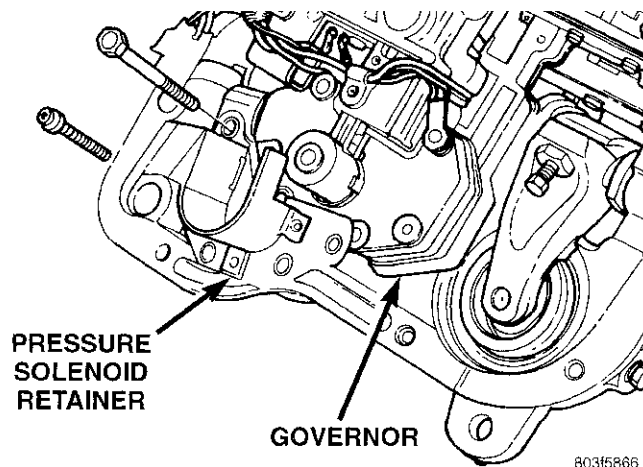


Fig. 58 Governor Body And Retainer Plate Attaching Screw

(3) Remove retainer plate, governor body and gasket from transfer plate (Fig. 59).

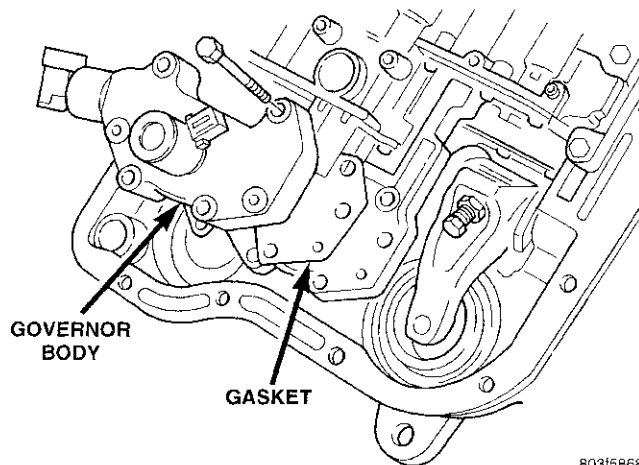


Fig. 59 Governor Body And Gasket

(4) Disconnect wires from governor pressure sensor, if not done previously.

(5) Remove governor pressure sensor from governor body. Sensor is retained in body with M-shaped spring clip (Fig. 60). Remove clip with small pointed tool and slide sensor out of body.

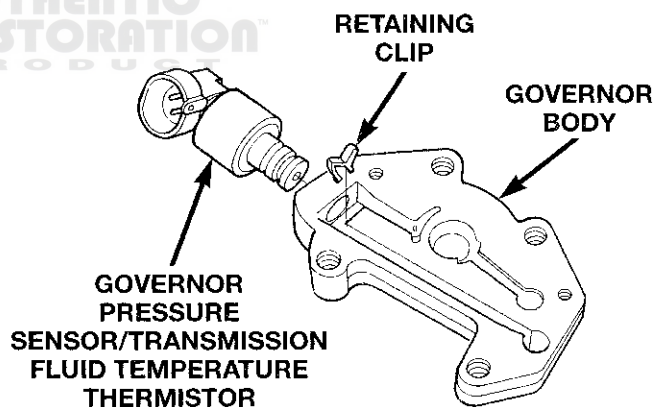
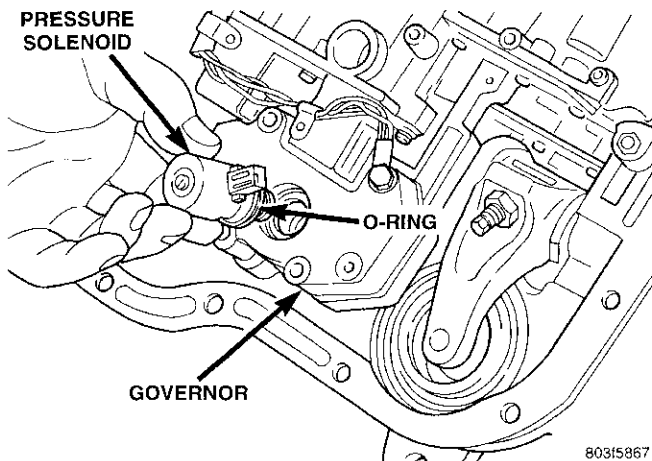
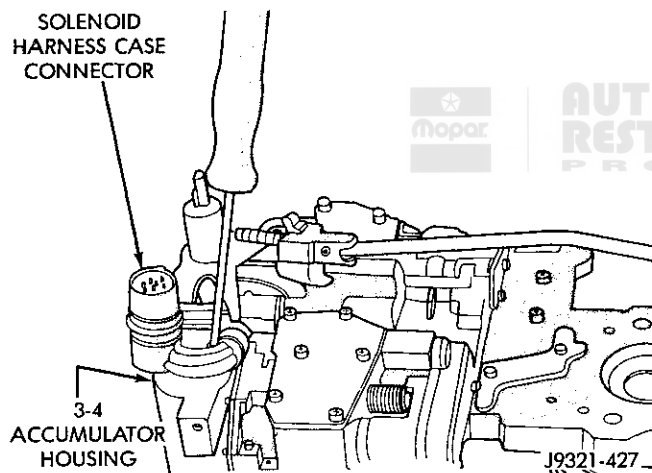


Fig. 60 Governor Pressure Sensor

(6) Remove governor pressure solenoid by pulling it straight out of bore in governor body (Fig. 61). Remove and discard solenoid O-rings if worn, cut, or torn.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 61 Governor Pressure Solenoid**

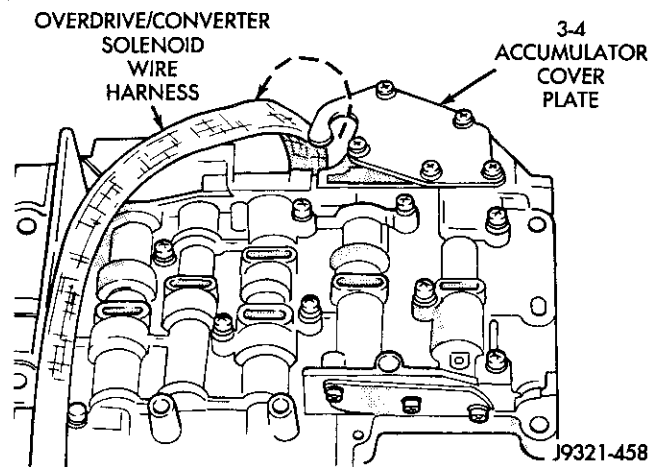
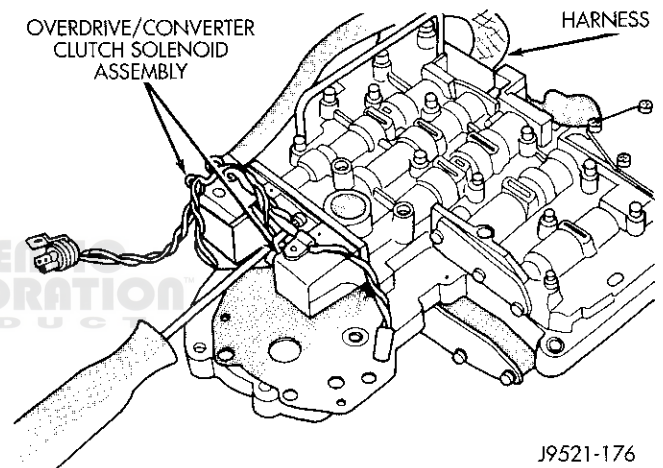
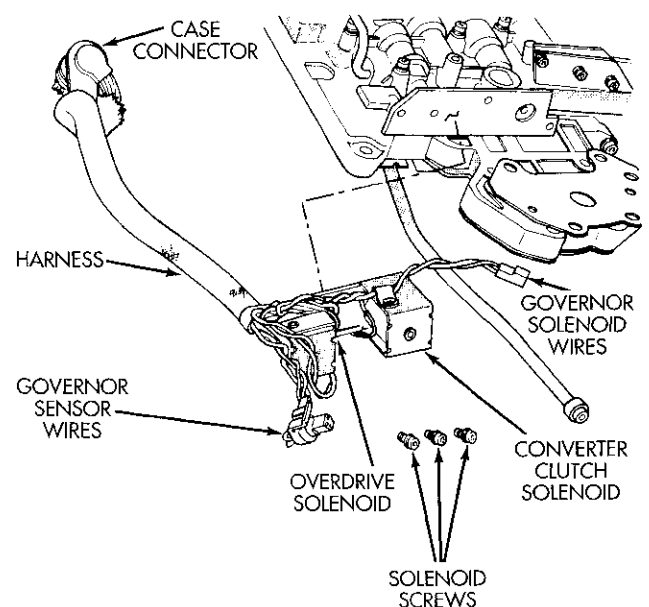
(7) Remove small shoulder bolt that secures solenoid harness case connector to 3-4 accumulator housing (Fig. 62). **Retain** shoulder bolt. **Either** tape it to harness or thread it back into accumulator housing after connector removal.

**Fig. 62 Solenoid Harness Case Connector Shoulder Bolt**

(8) Unhook overdrive/converter solenoid harness from 3-4 accumulator cover plate (Fig. 63).

(9) Turn valve body over and remove screws that attach overdrive/converter solenoid assembly to valve body (Fig. 64).

(10) Remove solenoid and harness assembly from valve body (Fig. 65).

**Fig. 63 Unhooking Solenoid Harness From Accumulator Cover Plate****Fig. 64 Solenoid Assembly Screws****Fig. 65 Solenoid Assembly**

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Remove boost valve cover (Fig. 66).

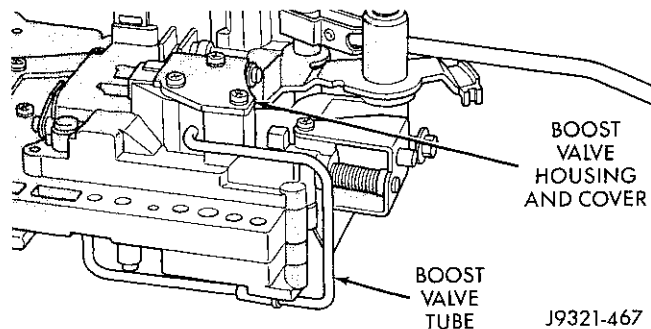


Fig. 66 Boost Valve Cover Location

(12) Remove boost valve retainer, valve spring and boost valve (Fig. 67).

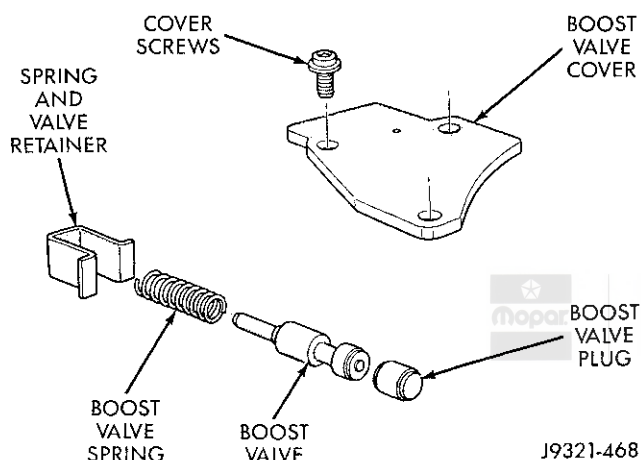


Fig. 67 Boost Valve Components

(13) Secure detent ball and spring with Retainer Tool 6583 (Fig. 68).

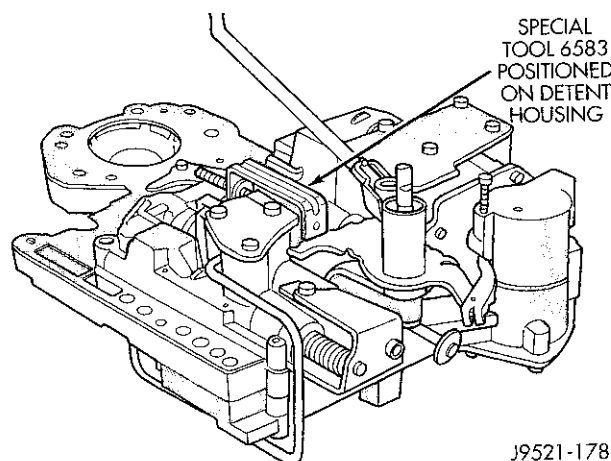


Fig. 68 Detent Ball And Spring

(14) Remove E-clip and washer that retains throttle lever shaft in manual lever (Fig. 69).

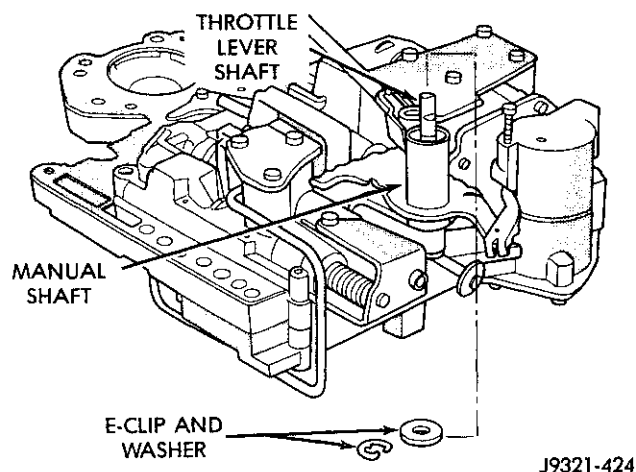


Fig. 69 Throttle Lever E-Clip And Washer

(15) Remove manual lever and throttle lever (Fig. 70). Rotate and lift manual lever off valve body and throttle lever shaft. Then slide throttle lever out of valve body.

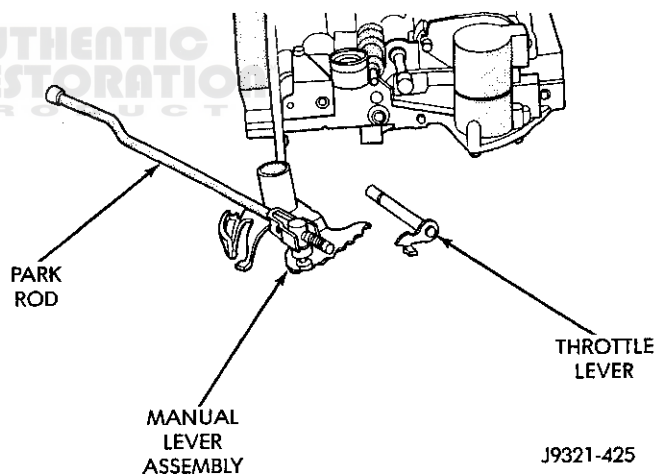


Fig. 70 Manual And Throttle Lever

DISASSEMBLY AND ASSEMBLY (Continued)

(16) Position pencil magnet next to detent housing to catch detent ball and spring. Then carefully remove Retainer Tool 6583 and remove detent ball and spring (Fig. 71).

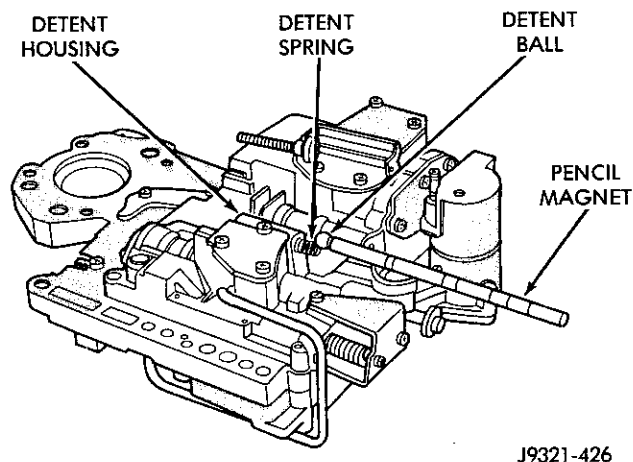


Fig. 71 Detent Ball And Spring

(17) Remove park rod E-clip and separate rod from manual lever (Fig. 72).

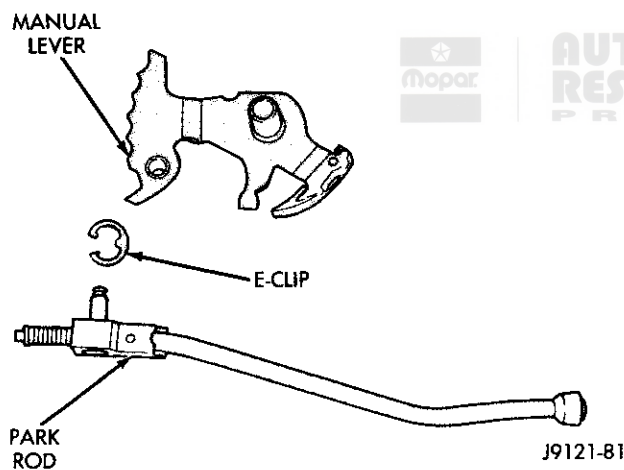


Fig. 72 Park Rod

(18) Remove screws attaching pressure adjusting screw bracket to valve body and transfer plate (Fig. 73). Hold bracket firmly against spring tension while removing last screw.

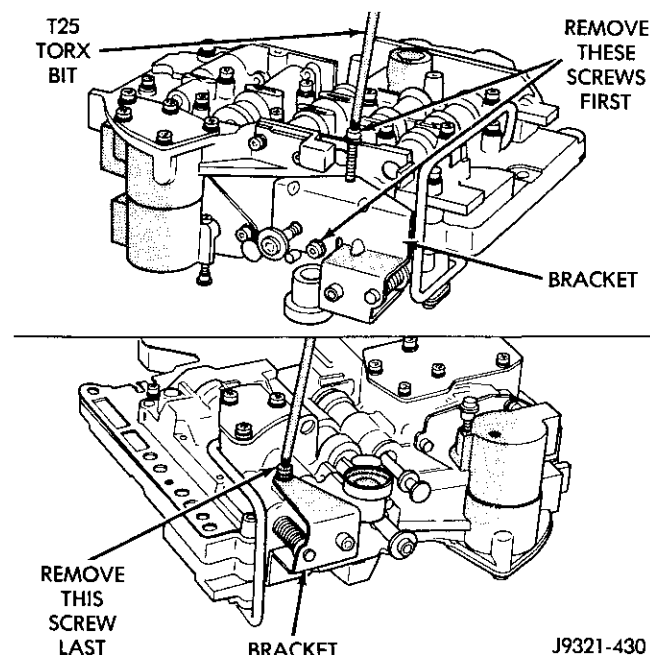


Fig. 73 Adjusting Screw Bracket Fastener

(19) Remove adjusting screw bracket, line pressure adjusting screw, pressure regulator valve spring and switch valve spring (Fig. 74). **Do not remove throttle pressure adjusting screw from bracket and do not disturb setting of either adjusting screw during removal.**

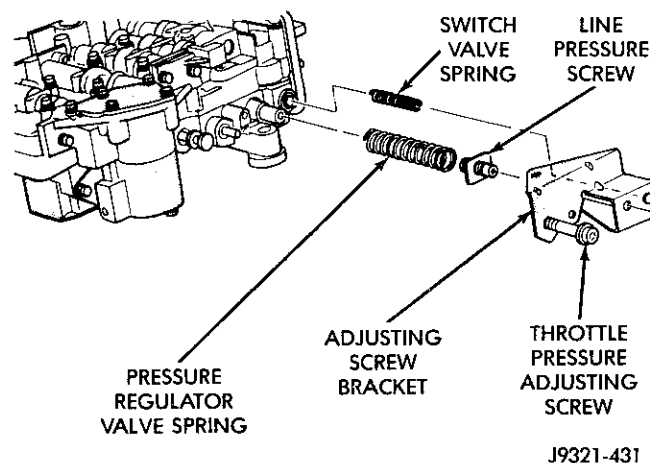


Fig. 74 Adjusting Screw Bracket And Spring

DISASSEMBLY AND ASSEMBLY (Continued)

(20) Loosen left-side 3-4 accumulator housing attaching screw about 2-3 threads. Then remove center and right-side housing attaching screws (Fig. 75).

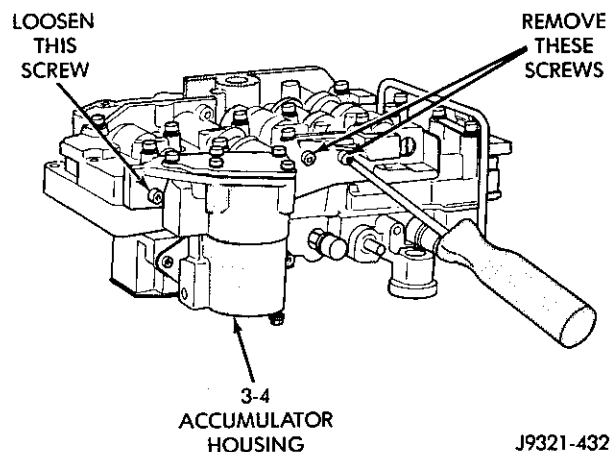


Fig. 75 Accumulator Housing Screw Locations

(21) Carefully rotate 3-4 accumulator housing upward and remove 3-4 shift valve spring and converter clutch valve plug and spring (Fig. 76).

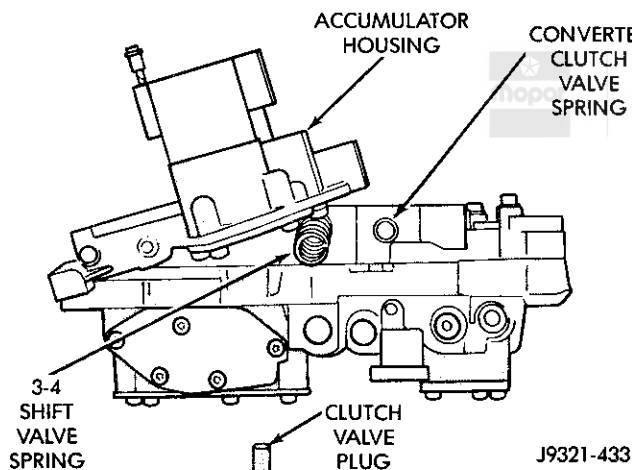


Fig. 76 3-4 Shift And Converter Clutch Valve Springs And Plug

(22) Remove left-side screw and remove 3-4 accumulator housing from valve body (Fig. 77).

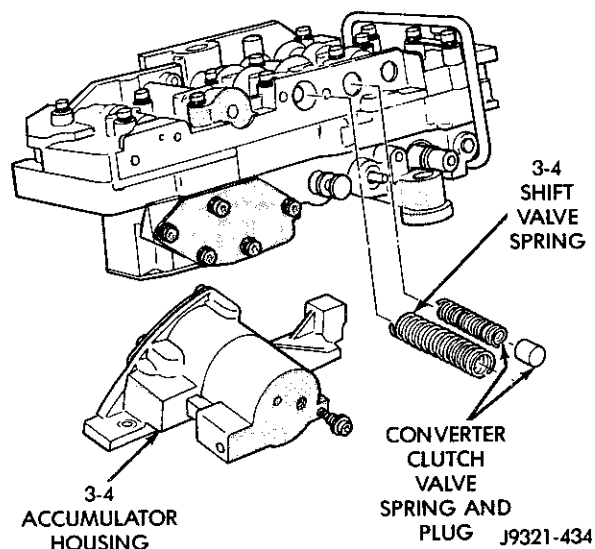


Fig. 77 Accumulator Housing, Valve Springs And Plug

(23) Remove pressure regulator valve spring from lower housing (Fig. 78).

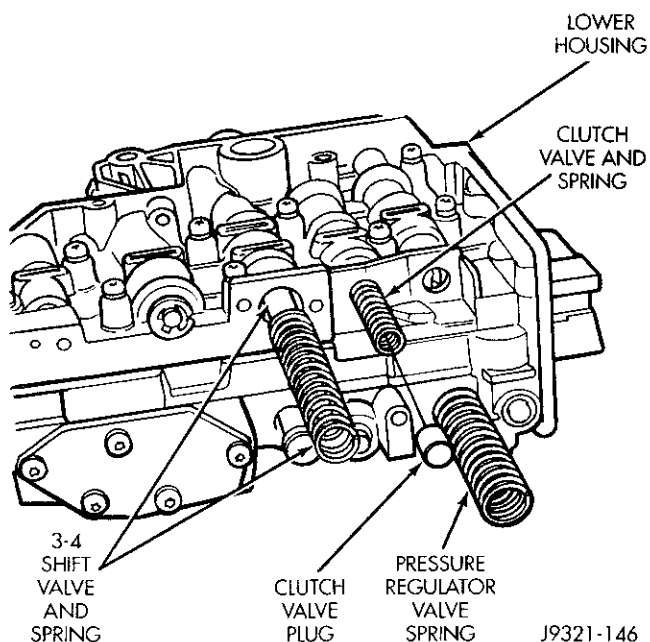


Fig. 78 Lower Housing Valve Spring Locations

DISASSEMBLY AND ASSEMBLY (Continued)

(24) Bend back tabs on boost valve tube brace (Fig. 79).

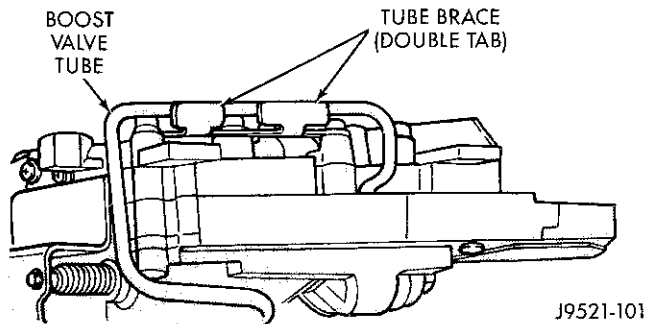


Fig. 79 Boost Valve Tube Brace

(25) Remove boost valve connecting tube (Fig. 80). Disengage tube from upper housing port first. Then rock opposite end of tube back and forth to work it out of lower housing.

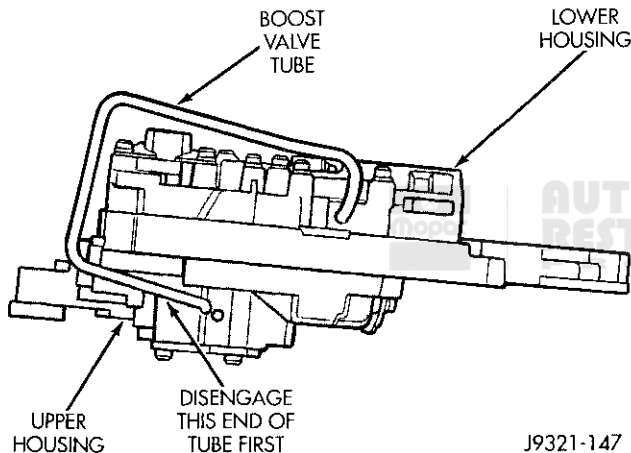


Fig. 80 Boost Valve Tube

CAUTION: Do not use tools to loosen or pry the connecting tube out of the valve body housings. Loosen and remove the tube by hand only.

(26) Turn valve body over so lower housing is facing upward (Fig. 81). In this position, the two check balls in upper housing will remain in place and not fall out when lower housing and separator plate are removed.

(27) Remove screws attaching valve body lower housing to upper housing and transfer plate (Fig. 81). **Note position of boost valve tube brace for assembly reference.**

(28) Remove lower housing and overdrive separator plate from transfer plate (Fig. 81).

(29) Remove transfer plate from upper housing (Fig. 82).

(30) Turn transfer plate over so upper housing separator plate is facing upward.

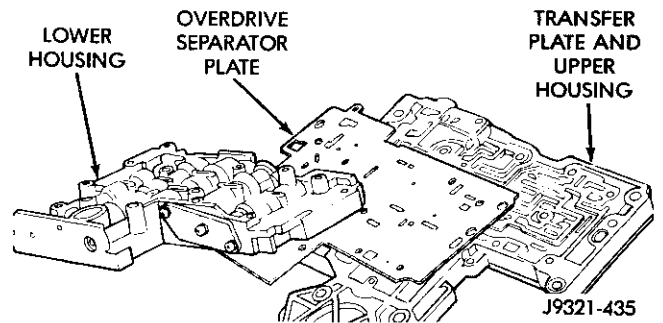


Fig. 81 Lower Housing

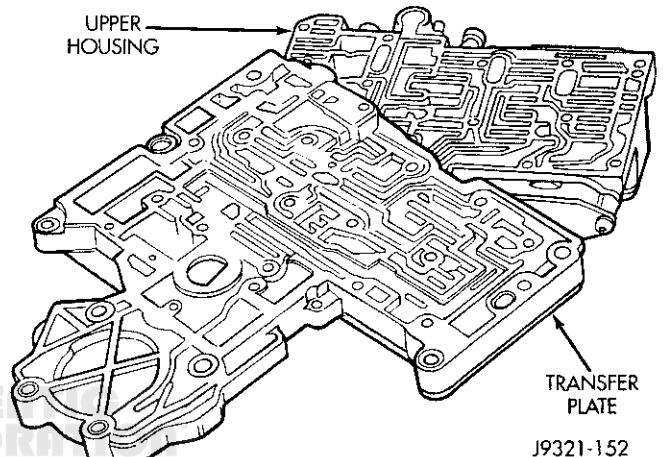


Fig. 82 Transfer Plate

(31) Remove brace plate from lower housing separator plate and transfer plate (Fig. 83).

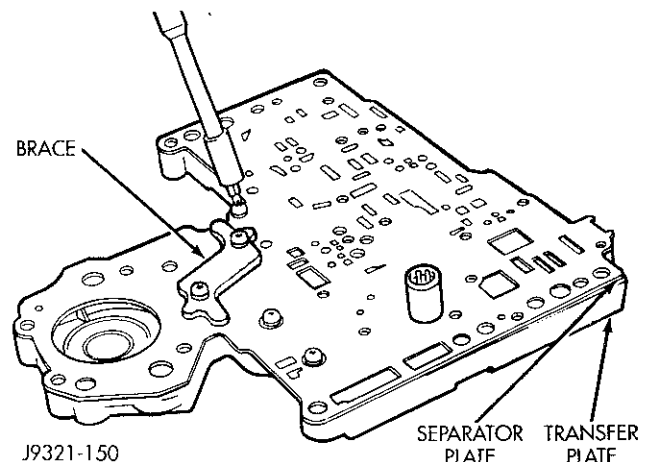


Fig. 83 Brace Plate

DISASSEMBLY AND ASSEMBLY (Continued)

(32) Remove upper housing separator plate from transfer plate (Fig. 84). Note position of filter in separator plate for assembly reference.

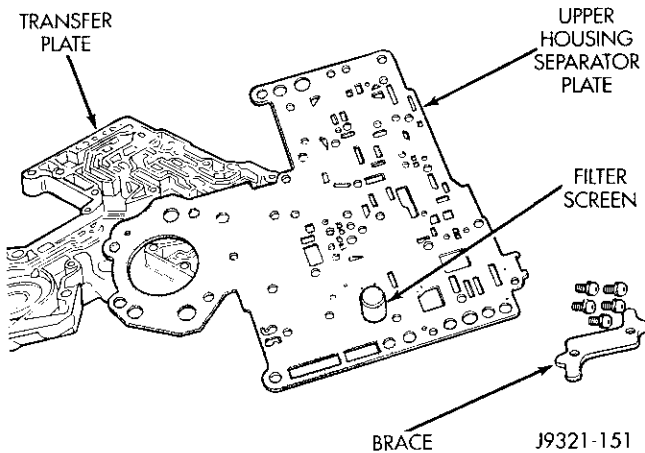


Fig. 84 Upper Housing Separator Plate

(33) Remove rear clutch and rear servo check balls from transfer plate. Note check ball location for assembly reference (Fig. 85).

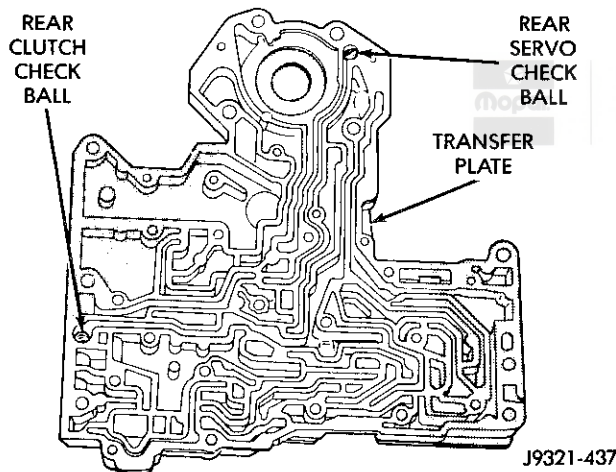


Fig. 85 Rear Clutch And Rear Servo Check Ball Locations

VALVE BODY UPPER HOUSING DISASSEMBLE

(1) Note location of check balls in valve body upper housing (Fig. 86). Then remove the one large diameter and the six smaller diameter check balls.

(2) Remove E-clip that secure shuttle valve secondary spring on valve stem (Fig. 87).

(3) Remove governor plug and shuttle valve covers (Fig. 88).

(4) Remove throttle plug, primary spring, shuttle valve, secondary spring, and spring guides (Fig. 88).

(5) Remove boost valve retainer, spring and valve if not previously removed.

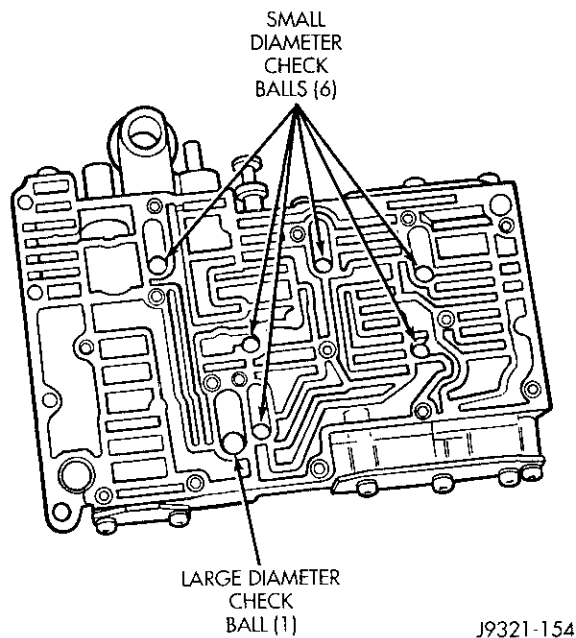


Fig. 86 Check Ball Locations In Upper Housing

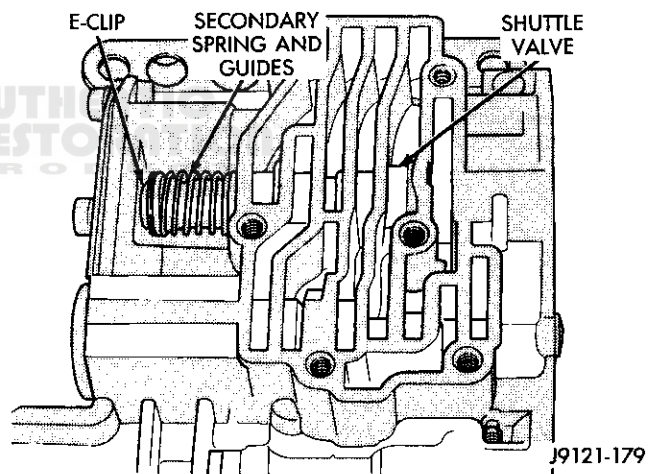


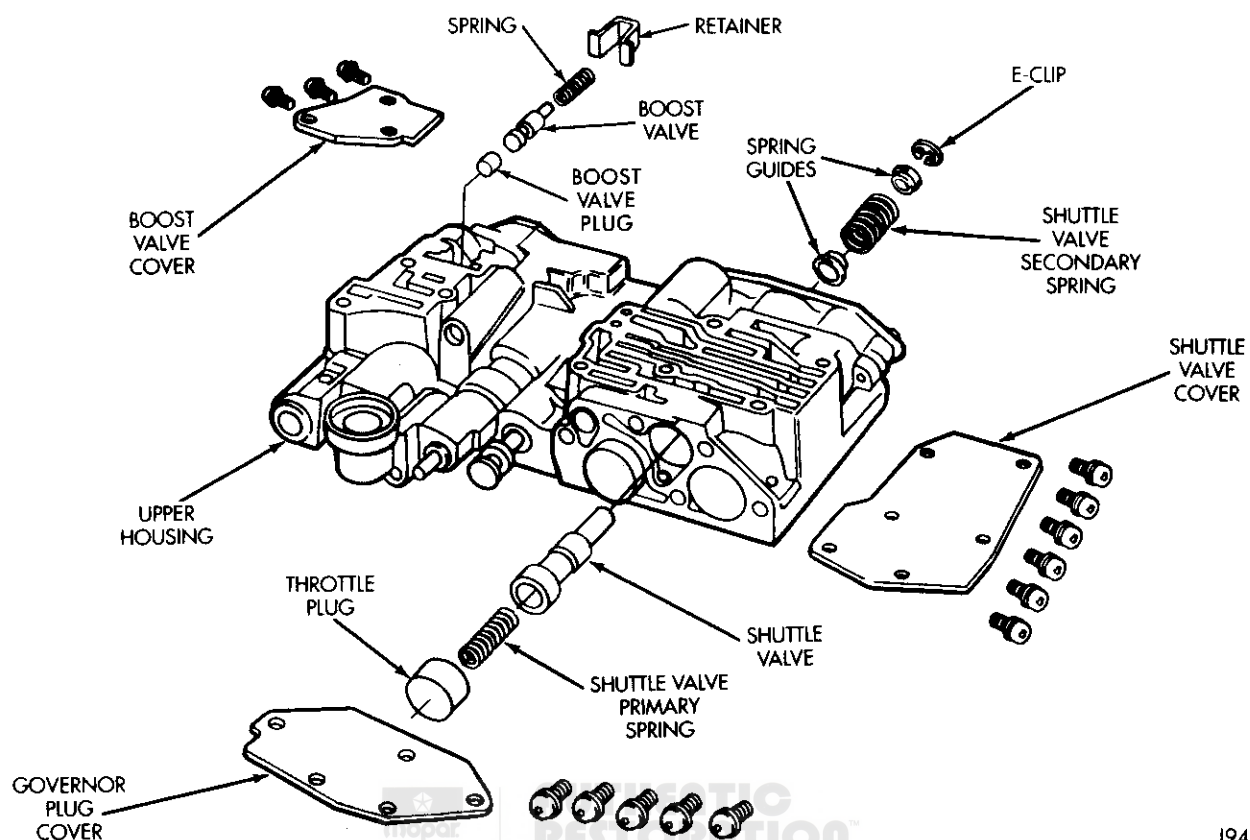
Fig. 87 Shuttle Valve E-Clip And Secondary Spring Location

(6) Turn upper housing over and remove switch valve, regulator valve and spring, and manual valve (Fig. 89).

(7) Remove kickdown detent, kickdown valve, and throttle valve and spring (Fig. 89).

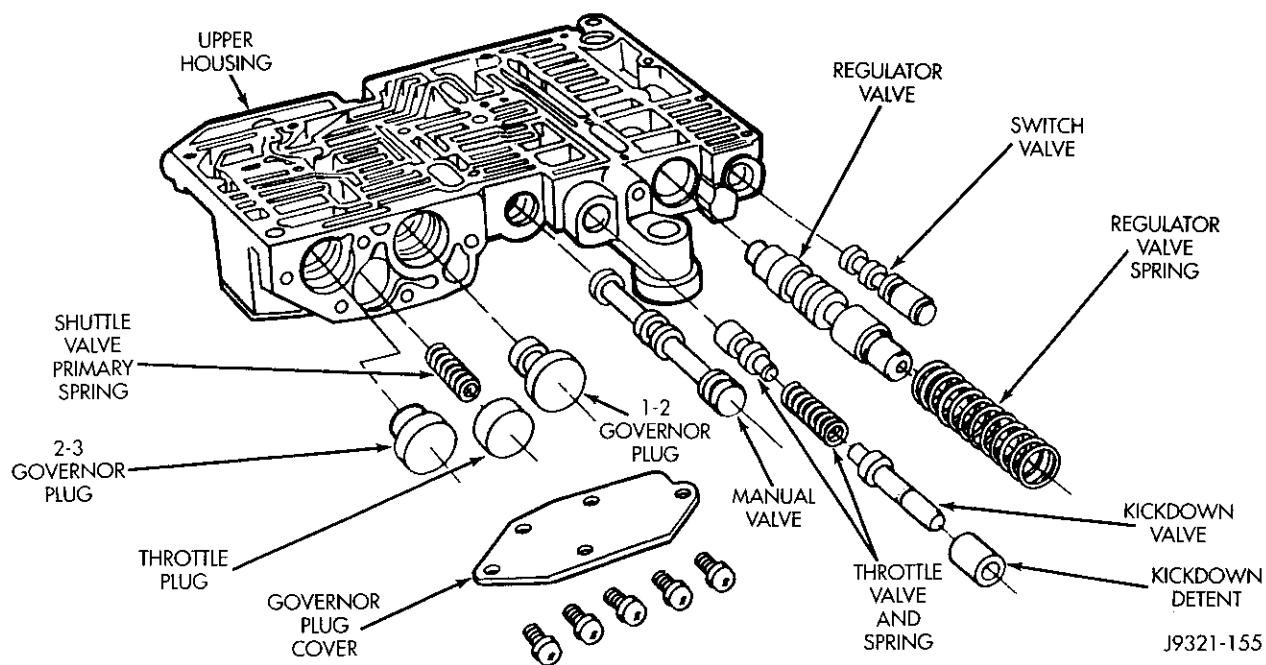
(8) Remove throttle plug and 1-2 and 2-3 governor plugs (Fig. 89). Also remove shuttle valve primary spring if not removed in prior step.

DISASSEMBLY AND ASSEMBLY (Continued)



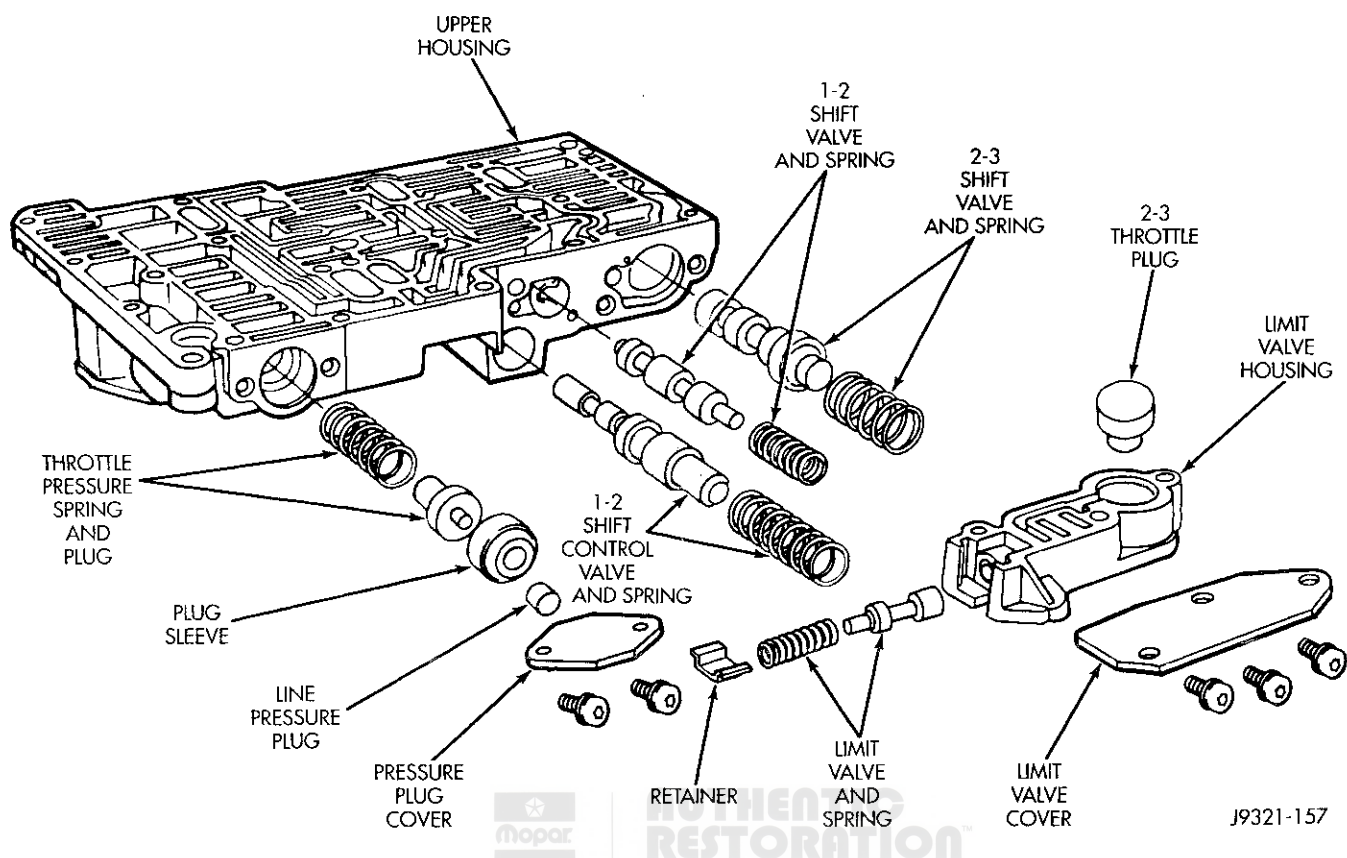
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Fig. 88 Shuttle And Boost Valve Components



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Fig. 89 Upper Housing Control Valve Locations

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 90 Upper Housing Shift Valve And Pressure Plug Locations**

(9) Turn upper housing around and remove limit valve and shift valve covers (Fig. 90).

(10) Remove limit valve housing. Then remove retainer, spring, limit valve, and 2-3 throttle plug from limit valve housing (Fig. 90).

(11) Remove 1-2 shift control valve and spring (Fig. 90).

(12) Remove 1-2 shift valve and spring (Fig. 90).

(13) Remove 2-3 shift valve and spring from valve body (Fig. 90).

(14) Remove pressure plug cover (Fig. 90).

(15) Remove line pressure plug, sleeve, throttle pressure plug and spring (Fig. 90).

VALVE BODY LOWER HOUSING DISASSEMBLY

(1) Remove timing valve cover.

(2) Remove 3-4 timing valve and spring.

(3) Remove 3-4 quick fill valve, spring and plug.

(4) Remove 3-4 shift valve and spring.

(5) Remove converter clutch valve, spring and plug (Fig. 91).

(6) Remove converter clutch timing valve, retainer and valve spring.

3-4 ACCUMULATOR HOUSING DISASSEMBLY

(1) Remove end plate from housing.

(2) Remove piston spring.

(3) Remove piston. Remove and discard piston seals (Fig. 92).

VALVE BODY ASSEMBLE

CAUTION: Do not force valves or plugs into place during reassembly. If the valve body bores, valves and plugs are free of distortion or burrs, the valve body components should all slide into place easily. In addition, do not overtighten the transfer plate and valve body screws during reassembly. Overtightening can distort the housings resulting in valve sticking, cross leakage and unsatisfactory operation. Tighten valve body screws to recommended torque only.

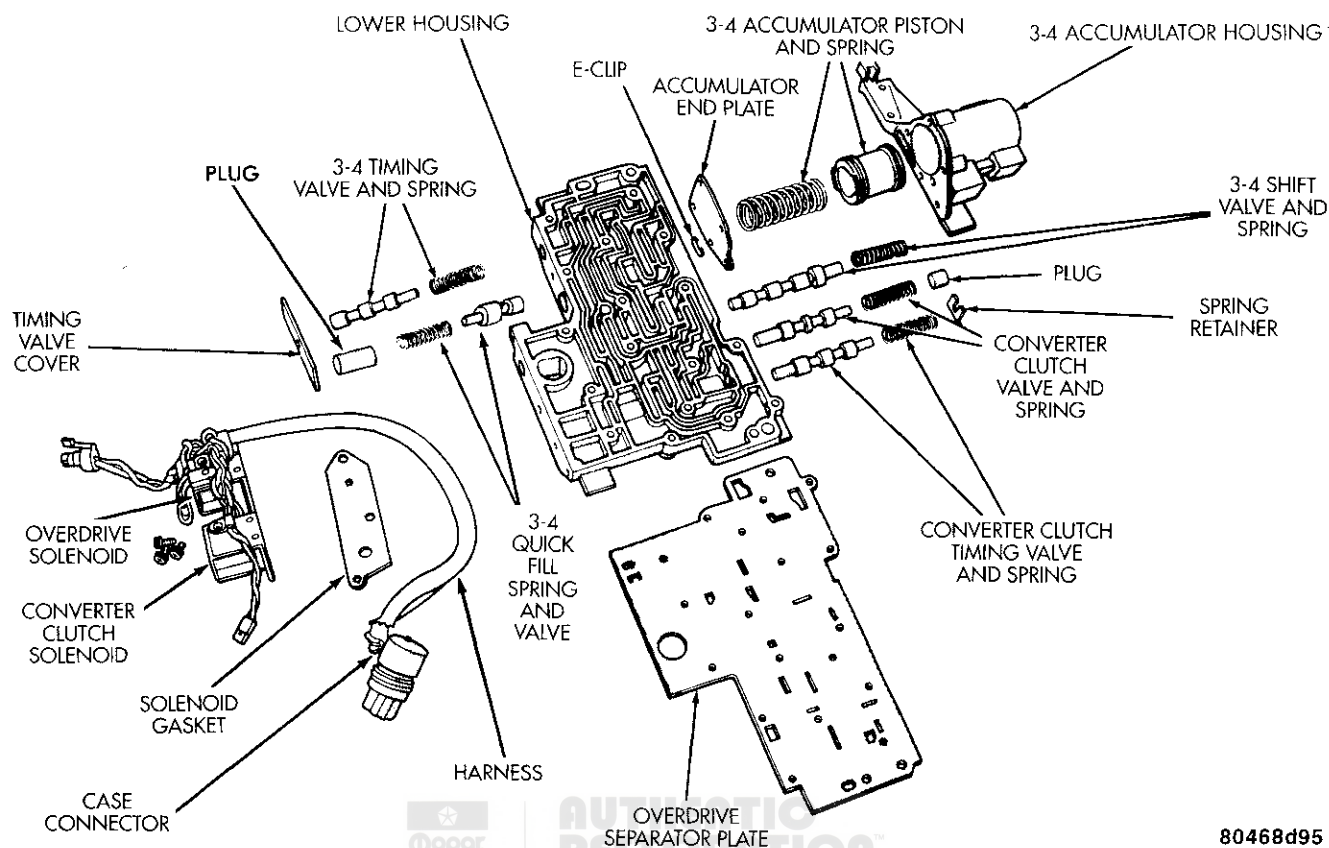
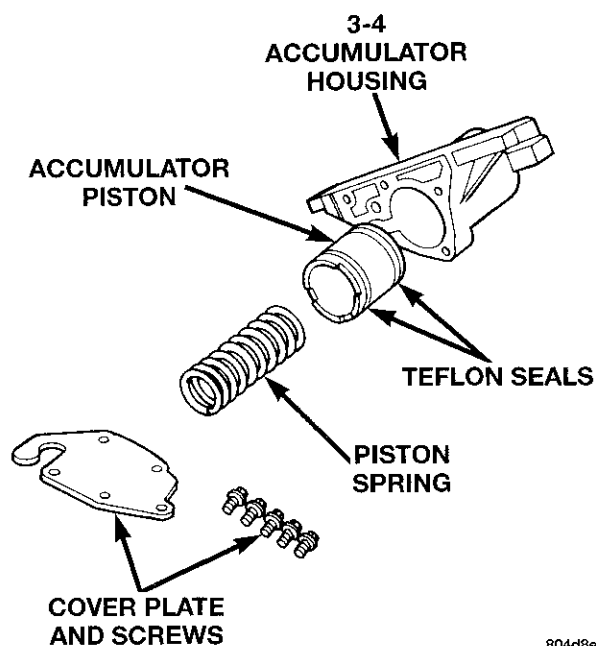
LOWER HOUSING ASSEMBLY

(1) Lubricate valves, springs, and the housing valve and plug bores with clean transmission fluid (Fig. 91).

(2) Install 3-4 timing valve spring and valve in lower housing.

(3) Install 3-4 quick fill valve in lower housing.

(4) Install 3-4 quick fill valve spring and plug in housing.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 91 Lower Housing Shift Valves And Springs****Fig. 92 Accumulator Housing Components**

- (7) Install converter clutch valve, spring and plug.
- (8) Install converter clutch timing valve and spring.

3-4 ACCUMULATOR ASSEMBLY

- (1) Lubricate accumulator piston, seals and housing piston bore with clean transmission fluid (Fig. 92).
- (2) Install new seal rings on accumulator piston.
- (3) Install piston and spring in housing.
- (4) Install end plate on housing.

- (5) Install timing valve end plate. Tighten end plate screws to 4 N·m (35 in. lbs.) torque.
- (6) Install 3-4 shift valve and spring.

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DISASSEMBLY AND ASSEMBLY (Continued)**TRANSFER PLATE ASSEMBLY**

(1) Install rear clutch and rear servo check balls in transfer plate (Fig. 93).

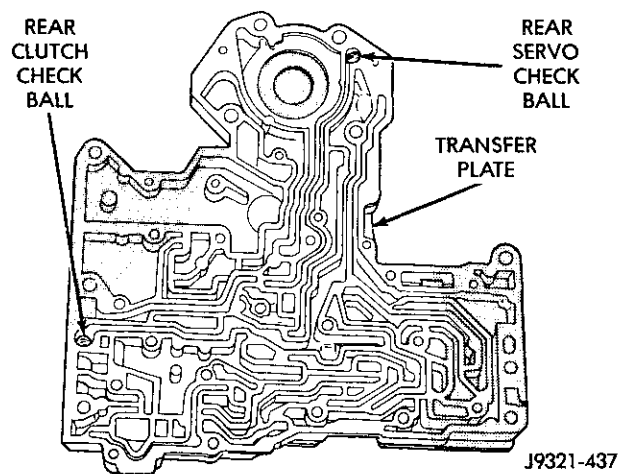


Fig. 93 Rear Clutch And Rear Servo Check Ball Locations

(2) Install filter screen in upper housing separator plate (Fig. 94).

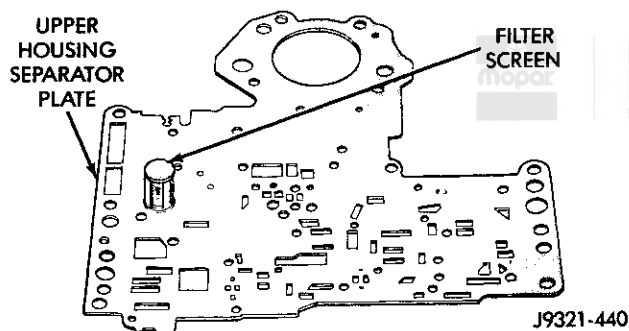


Fig. 94 Separator Plate Filter Screen Installation

(3) Align and position upper housing separator plate on transfer plate (Fig. 95).

(4) Install brace plate (Fig. 95). Tighten brace attaching screws to 4 N·m (35 in. lbs.) torque.

(5) Install remaining separator plate attaching screws. Tighten screws to 4 N·m (35 in. lbs.) torque.

ASSEMBLING UPPER AND LOWER HOUSINGS

(1) Position upper housing so internal passages and check ball seats are facing upward. Then install check balls in housing (Fig. 96). Seven check balls are used. The single large check ball is approximately 8.7 mm (11/32 in.) diameter. The remaining 6 check balls are approximately 6.3 mm (1/4 in.) in diameter.

(2) Position assembled transfer plate and upper housing separator plate on upper housing (Fig. 97). Be sure filter screen is seated in proper housing recess.

(3) Position lower housing separator plate on transfer plate (Fig. 98).

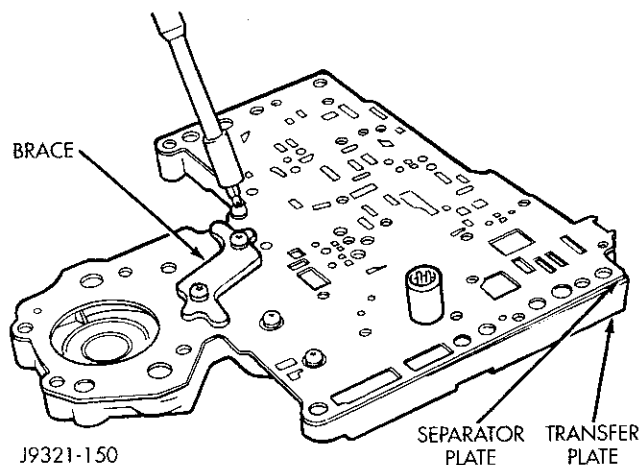


Fig. 95 Brace Plate

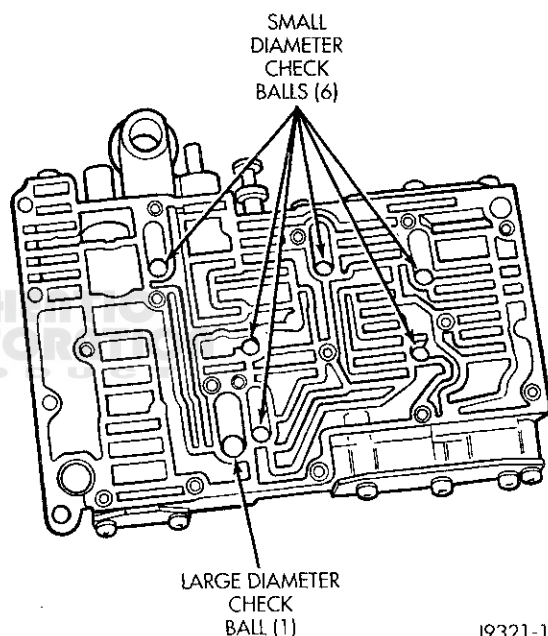


Fig. 96 Check Ball Locations In Upper Housing

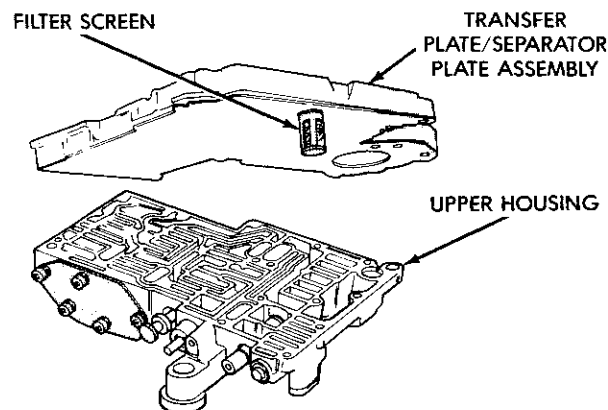
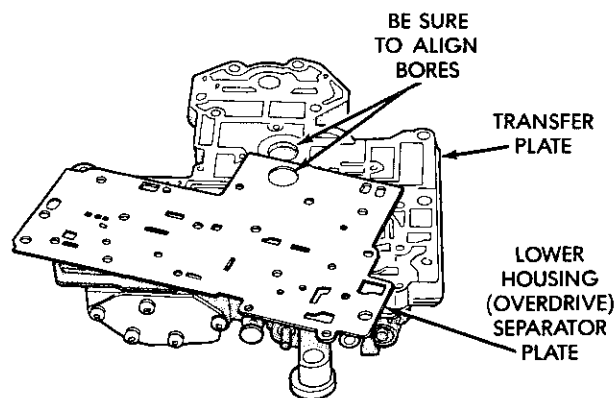


Fig. 97 Installing Transfer Plate On Upper Housing

DISASSEMBLY AND ASSEMBLY (Continued)

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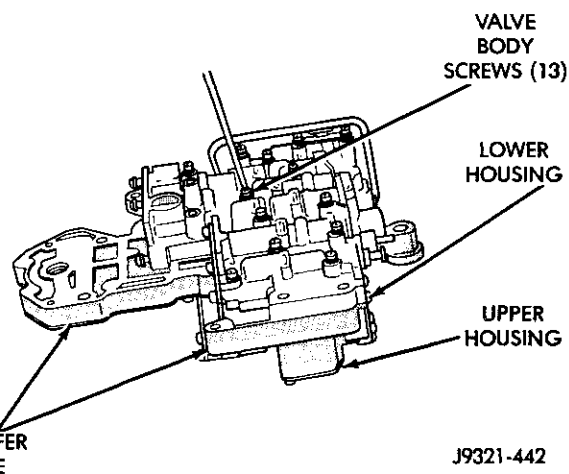
Fig. 98 Lower Housing Separator Plate

(4) Install lower housing on assembled transfer plate and upper housing (Fig. 99).

(5) Install and start valve body screws by hand. Then tighten screws evenly to 4 N·m (35 in. lbs.) torque. Start at center and work out to sides when tightening screws (Fig. 99).

UPPER HOUSING VALVE AND PLUG INSTALLATION

Refer to (Fig. 100), (Fig. 101) and (Fig. 102) to perform the following steps.



J9321-442

Fig. 99 Installing Lower Housing On Transfer Plate And Upper Housing

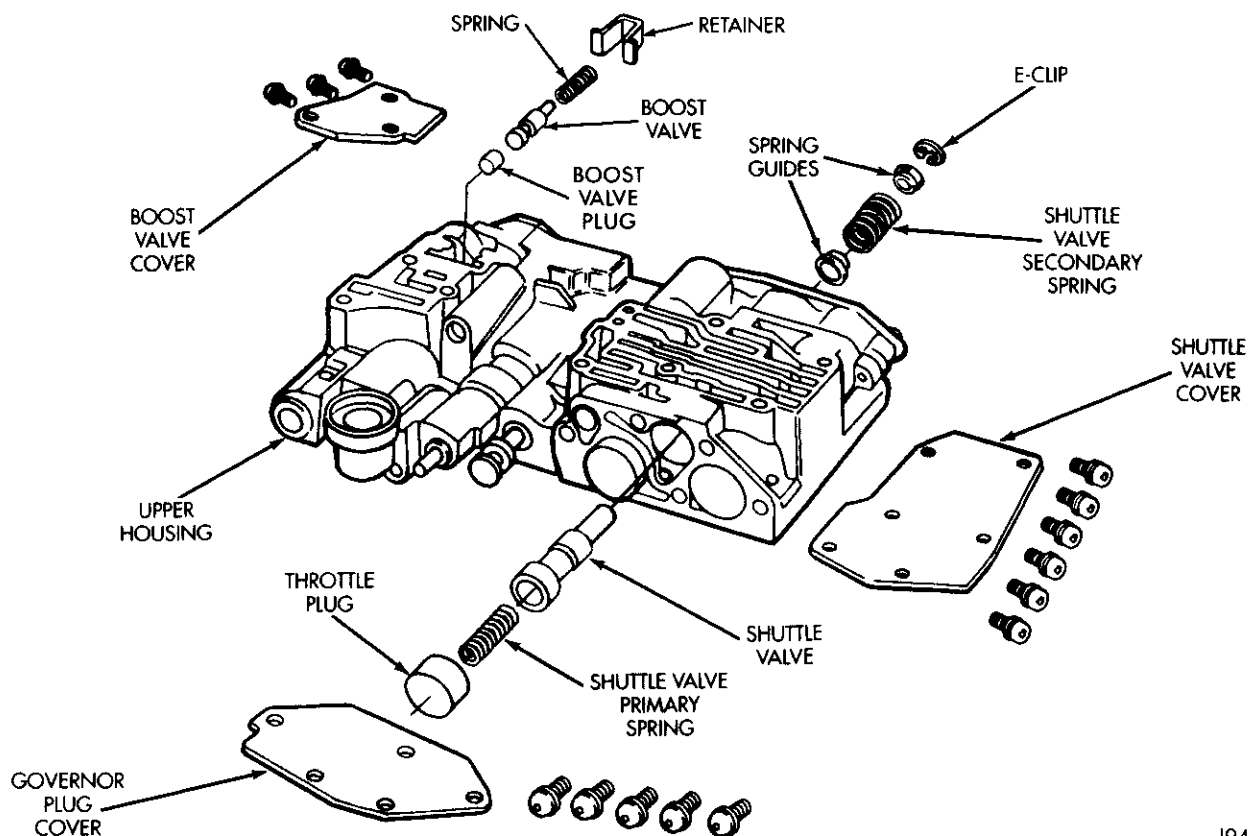
(1) Lubricate valves, plugs, springs with clean transmission fluid.

(2) Assemble regulator valve line pressure plug, sleeve, throttle plug and spring. Insert assembly in upper housing and install cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(3) Install 1-2 and 2-3 shift valves and springs.

(4) Install 1-2 shift control valve and spring.

(5) Install shift valve cover plate.



J9421-217

Fig. 100 Shuttle And Boost Valve Components

DISASSEMBLY AND ASSEMBLY (Continued)

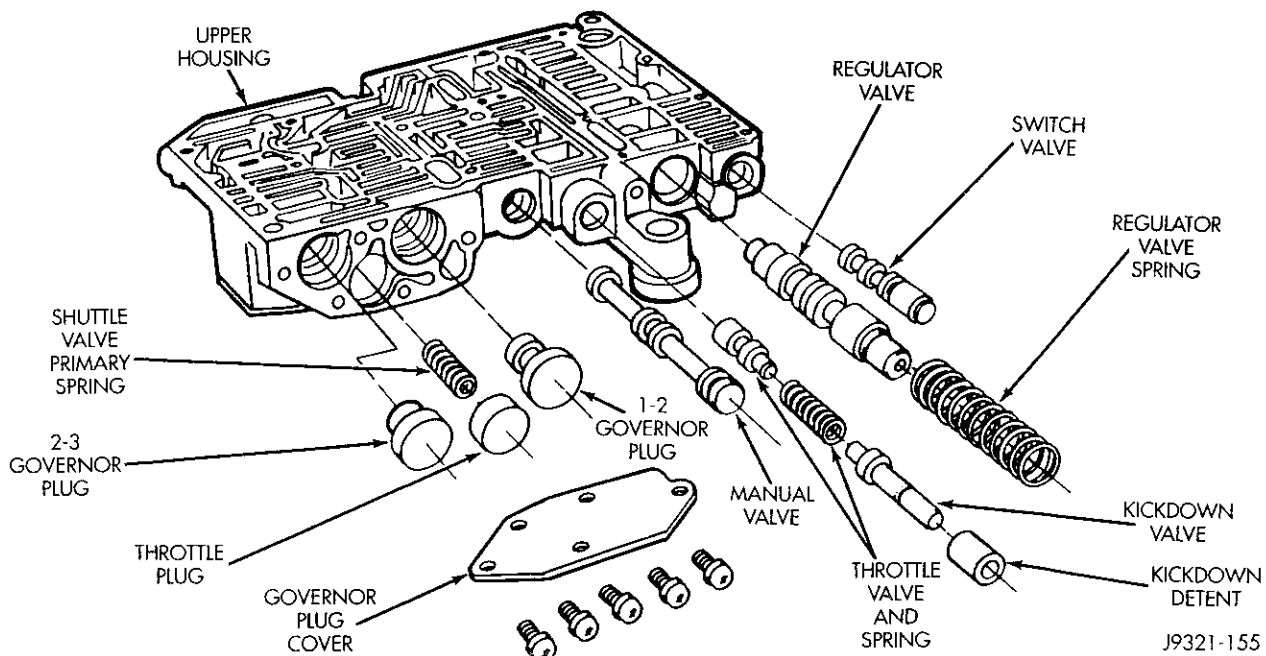


Fig. 101 Upper Housing Control Valve Locations

(6) Install shuttle valve as follows:

- (a) Insert plastic guides in shuttle valve secondary spring and install spring on end of valve.
- (b) Hold shuttle valve in place.

(c) Compress secondary spring and install E-clip in groove at end of shuttle valve.

- (d) Verify that spring and E-clip are properly seated before proceeding.

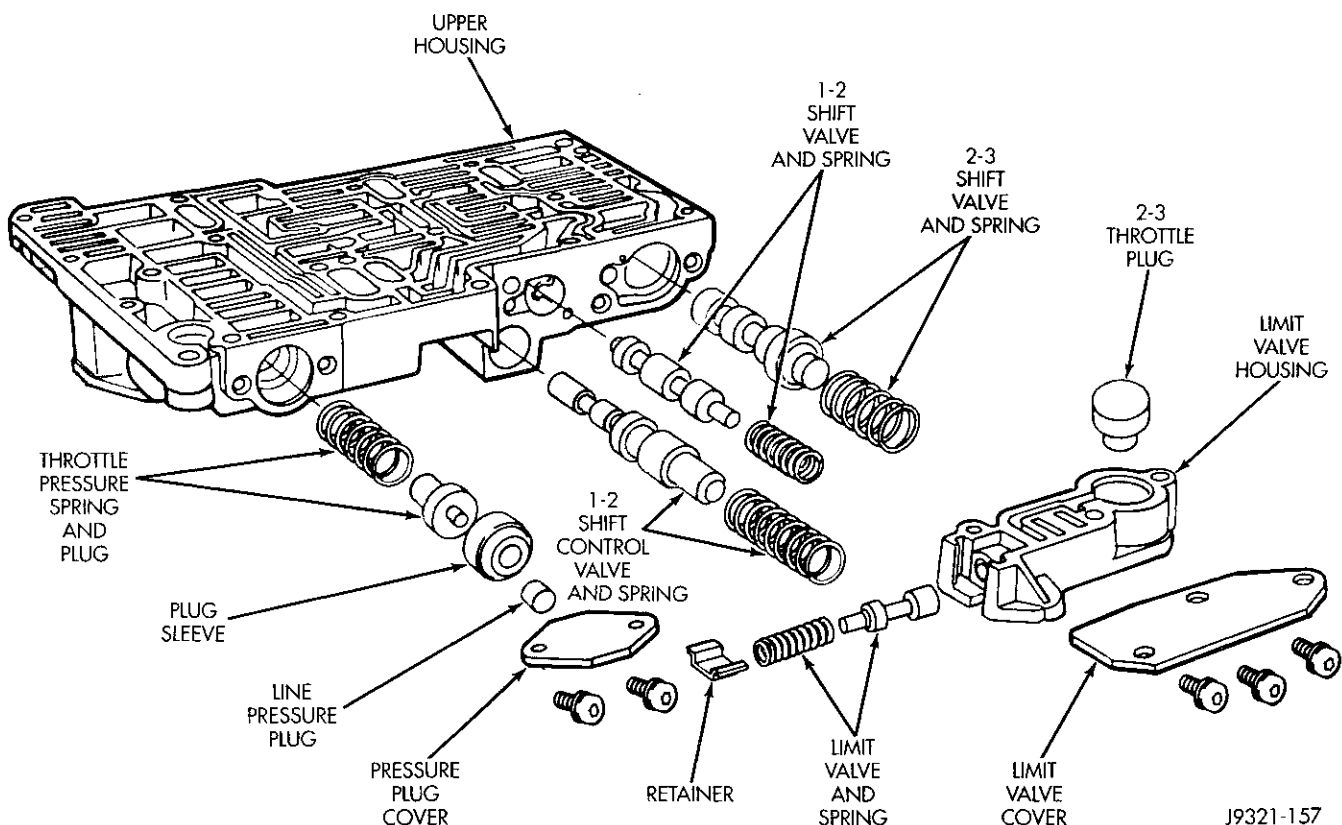


Fig. 102 Upper Housing Shift Valve And Pressure Plug Locations

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Install shuttle valve cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(8) Install 1-2 and 2-3 valve governor plugs in valve body.

(9) Install shuttle valve primary spring and throttle plug.

(10) Align and install governor plug cover. Tighten cover screws to 4 N·m (35 in. lbs.) torque.

(11) Install manual valve.

(12) Install throttle valve and spring.

(13) Install kickdown valve and detent.

(14) Install pressure regulator valve.

(15) Install switch valve.

BOOST VALVE TUBE AND BRACE INSTALLATION

(1) Position valve body assembly so lower housing is facing upward (Fig. 103).

(2) Lubricate tube ends and housing ports with transmission fluid or petroleum jelly.

(3) Start tube in lower housing port first. Then swing tube downward and work opposite end of tube into upper housing port (Fig. 103).

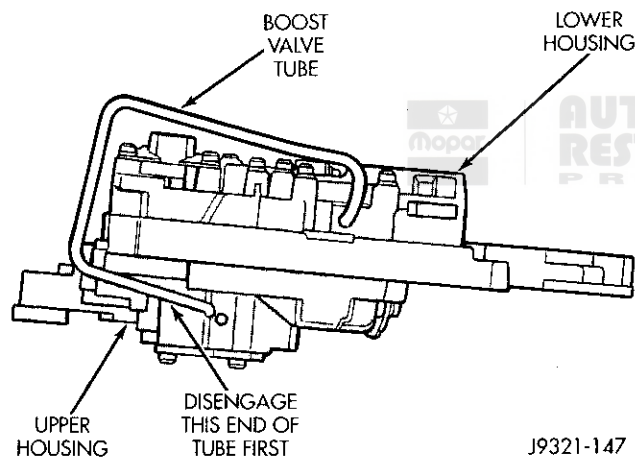


Fig. 103 Boost Valve Tube

(4) Insert and seat each end of tube in housings.

(5) Slide tube brace under tube and into alignment with valve body screw holes (Fig. 104).

(6) Install and finger tighten three screws that secure tube brace to valve body housings (Fig. 104).

(7) Bend tube brace tabs up and against tube to hold it in position (Fig. 105).

(8) **Tighten all valve body housing screws to 4 N·m (35 in. lbs.) torque after tube and brace are installed. Tighten screws in diagonal pattern starting at center and working outward.**

3-4 ACCUMULATOR INSTALLATION

(1) Position converter clutch valve and 3-4 shift valve springs in housing (Fig. 106).

(2) Loosely attach accumulator housing with right-side screw (Fig. 106). Install only one screw at this

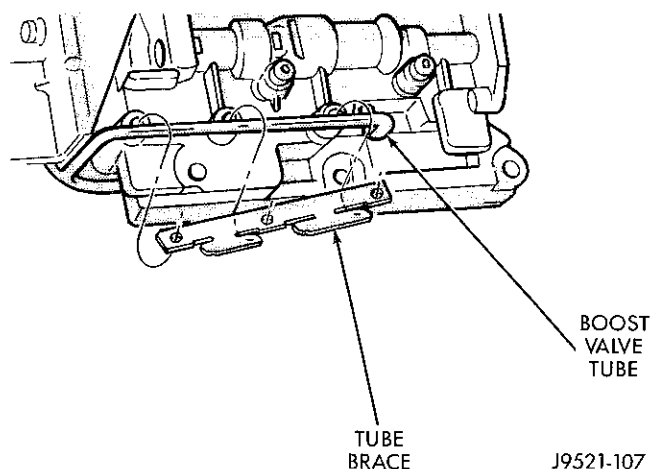


Fig. 104 Boost Valve Tube And Brace

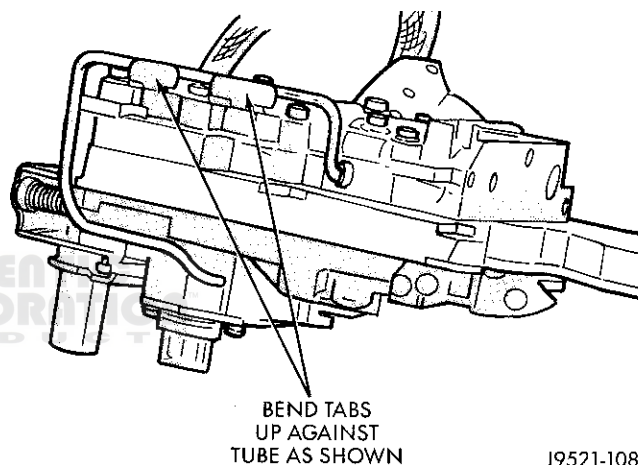


Fig. 105 Securing Boost Valve Tube With Brace Tabs

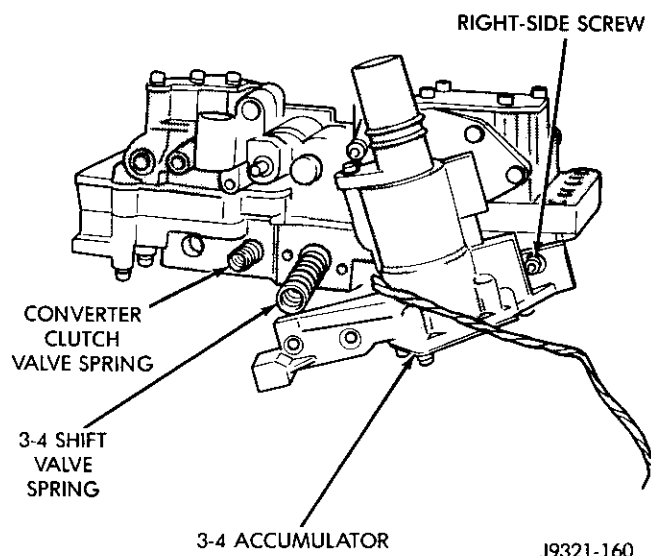


Fig. 106 Converter Clutch And 3-4 Shift Valve Springs

DISASSEMBLY AND ASSEMBLY (Continued)

time as accumulator must be free to pivot upward for ease of installation.

(3) Position plug on end of converter clutch valve spring. Then compress and hold springs and plug in place with fingers of one hand.

(4) Swing accumulator housing upward over valve springs and plug.

(5) Hold accumulator housing firmly in place and install remaining two attaching screws. Be sure springs and clutch valve plug are properly seated (Fig. 107).

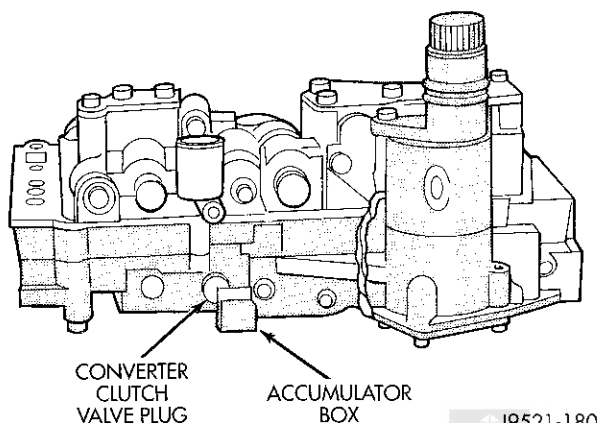


Fig. 107 Seating 3-4 Accumulator On Lower Housing

(6) Attach solenoid case connector to 3-4 accumulator with shoulder-type screw. Connector has small locating tang that fits in dimple at top of accumulator housing (Fig. 108). Seat tang in dimple before tightening connector screw.

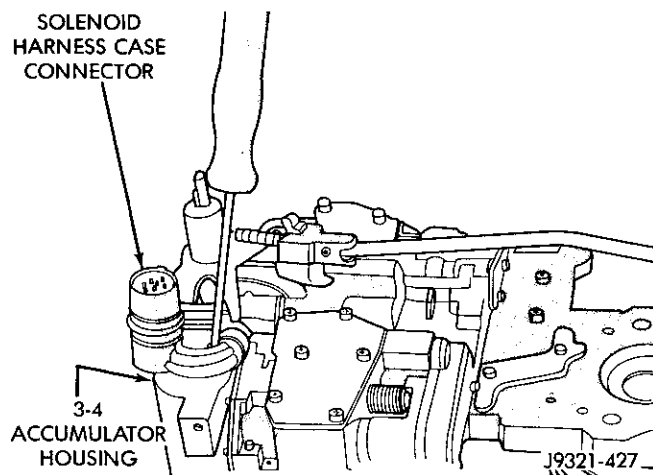


Fig. 108 Solenoid Harness Case Connector Shoulder Bolt

(7) Install solenoid assembly and gasket. Tighten solenoid attaching screws to 8 N·m (72 in. lbs.) torque.

(8) Verify that solenoid wire harness is properly routed (Fig. 109). **Solenoid harness must be clear of manual lever and park rod and not be pinched between accumulator housing and cover.**

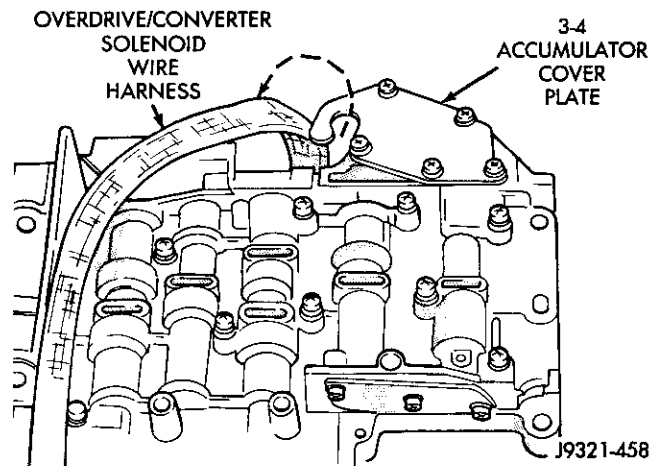


Fig. 109 Solenoid Harness Routing

VALVE BODY FINAL ASSEMBLY AND ADJUSTMENT

(1) Insert manual lever detent spring in upper housing.

(2) Position line pressure adjusting screw in adjusting screw bracket.

(3) Install spring on end of line pressure regulator valve.

(4) Install switch valve spring on tang at end of adjusting screw bracket.

(5) Position adjusting screw bracket on valve body. Align valve springs and press bracket into place. Install short, upper bracket screws first and long bottom screw last. Verify that valve springs and bracket are properly aligned. Then tighten all three bracket screws to 4 N·m (35 in. lbs.) torque.

(6) Install throttle lever in upper housing. Then install manual lever over throttle lever and start manual lever into housing.

(7) Position detent ball on end of spring. Then hold detent ball and spring in detent housing with Retainer Tool 6583 (Fig. 110).

(8) Align manual lever with detent ball and manual valve. Hold throttle lever upward. Then press down on manual lever until fully seated. Remove detent ball retainer tool after lever is seated.

(9) Then Install manual lever seal, washer and E-clip.

(10) Lubricate solenoid case connector O-rings and shaft of manual lever with light coat of petroleum jelly.

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Verify that throttle lever is aligned with end of kickdown valve stem and that manual lever arm is engaged in manual valve (Fig. 111).

(12) Install boost valve, valve spring, retainer and cover plate. Tighten cover plate screws to 4 N·m (35 in. lbs.) torque.

(13) Obtain new fluid filter for valve body but do not install filter at this time.

(14) If line pressure and/or throttle pressure adjustment screw settings were not disturbed, continue with overhaul or reassembly. However, if adjustment screw settings **were** moved or changed, readjust as described in Valve Body Control Pressure Adjustment procedure.

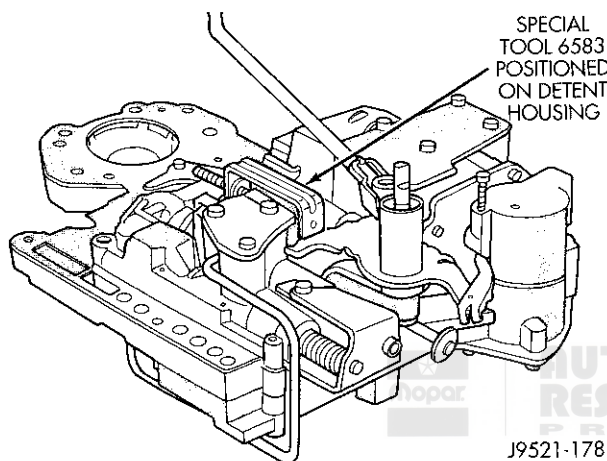


Fig. 110 Detent Ball Spring

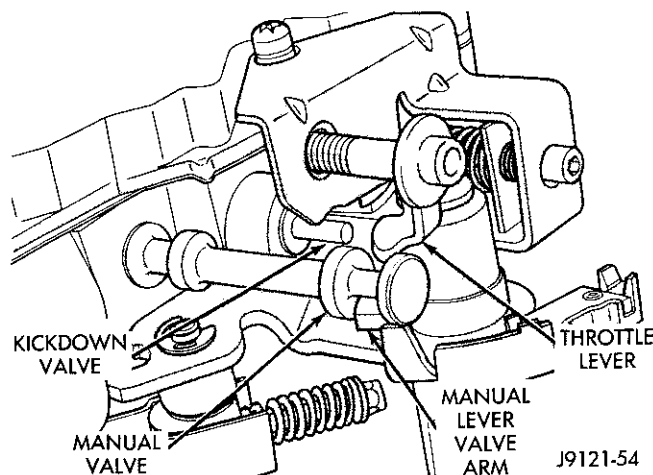


Fig. 111 Manual And Throttle Lever Alignment

GOVERNOR BODY, SENSOR AND SOLENOID INSTALLATION

CAUTION: Do not turn the small screw at the end of the governor pressure solenoid valve for any reason (Fig. 112). Turning the screw in either direction will ruin solenoid calibration and result in solenoid failure. In addition, the filter on the solenoid valve is

NOT serviceable. Do not try to remove the filter as this will damage the solenoid valve housing.

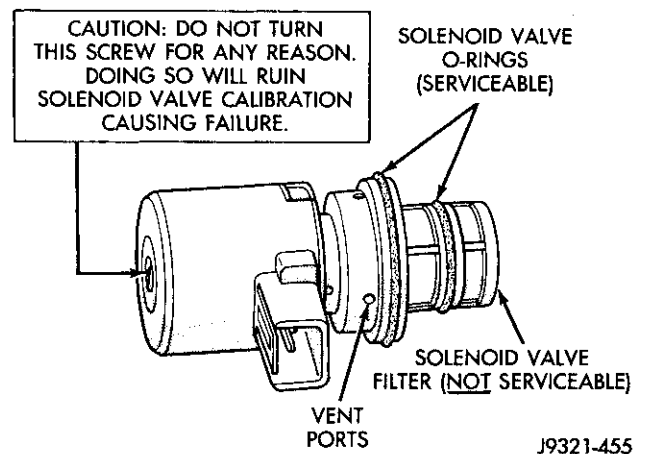


Fig. 112 Governor Pressure Solenoid

(1) Turn valve body assembly over so accumulator side of transfer plate is facing down.

(2) Install new O-rings on governor pressure solenoid and sensor (Fig. 112) and (Fig. 113).

(3) Lubricate solenoid and sensor O-rings with clean transmission fluid.

(4) Install governor pressure sensor in governor body. Then secure sensor with M-shaped retaining clip (Fig. 113).

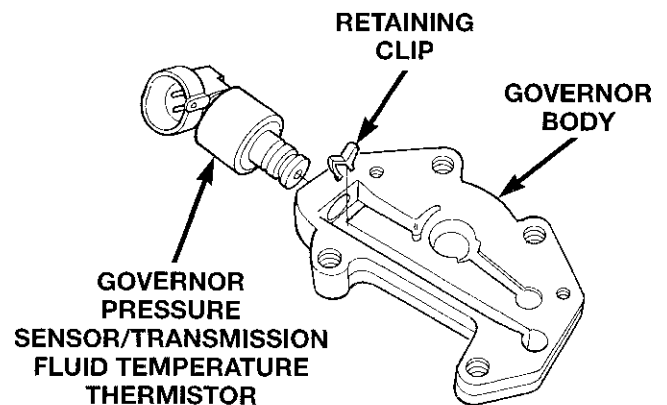


Fig. 113 Governor Pressure Sensor

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Install governor pressure solenoid in governor body (Fig. 114). Push solenoid in until it snaps into place in body.

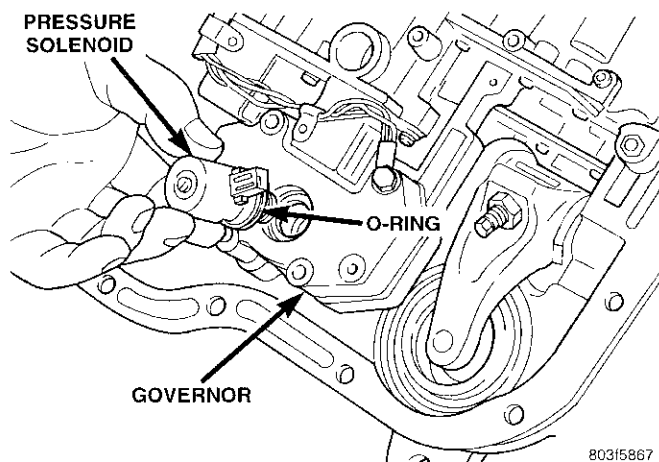


Fig. 114 Governor Pressure Solenoid

(6) Position governor body gasket on transfer plate (Fig. 115).

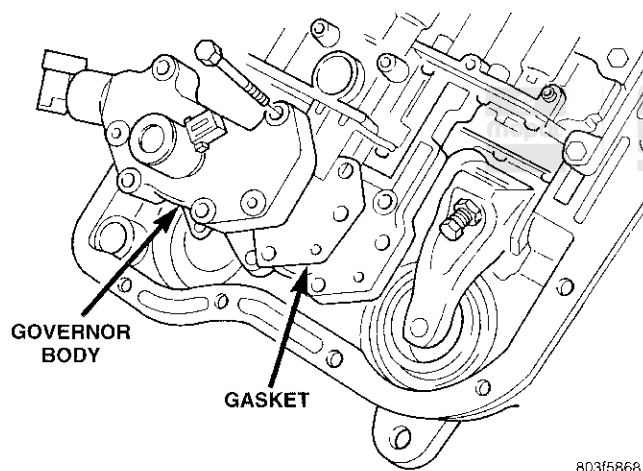


Fig. 115 Governor Body And Gasket

(7) Install retainer plate on governor body and around solenoid (Fig. 116). Be sure solenoid connector is positioned in retainer cutout.

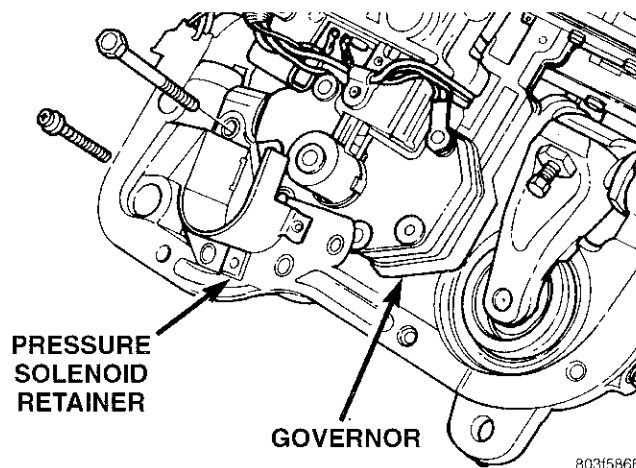


Fig. 116 Pressure Solenoid Retainer

(8) Align screw holes in governor body and transfer plate. Then install and tighten governor body screws to 4 N·m (35 in. lbs.) torque.

(9) Connect harness wires to governor pressure solenoid and governor pressure sensor (Fig. 117).

(10) Perform Line Pressure and Throttle Pressure adjustments, refer to adjustment section of this group for proper procedures.

(11) Install fluid filter and pan.

(12) Lower vehicle.

(13) Fill transmission with recommended fluid and road test vehicle to verify repair.

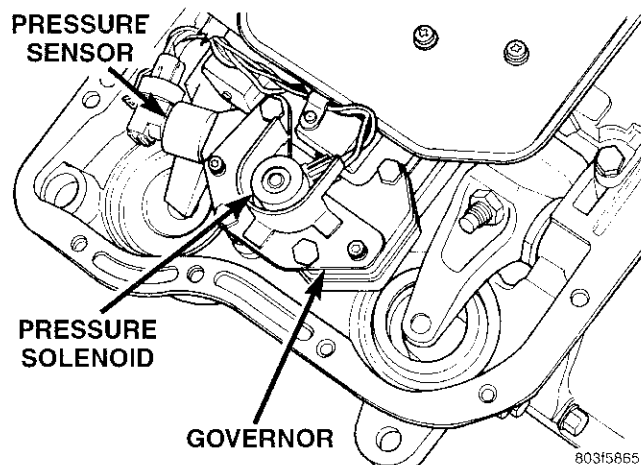
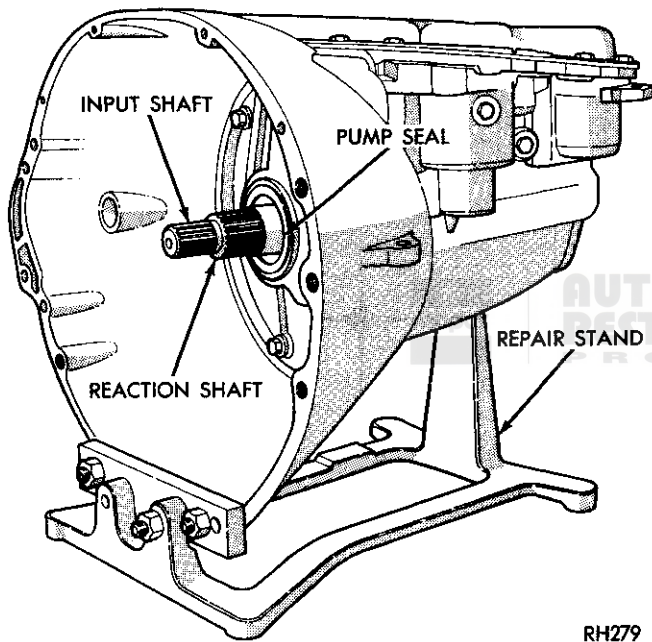


Fig. 117 Governor Pressure Sensor And Solenoid Connectors

DISASSEMBLY AND ASSEMBLY (Continued)**TRANSMISSION****DISASSEMBLE**

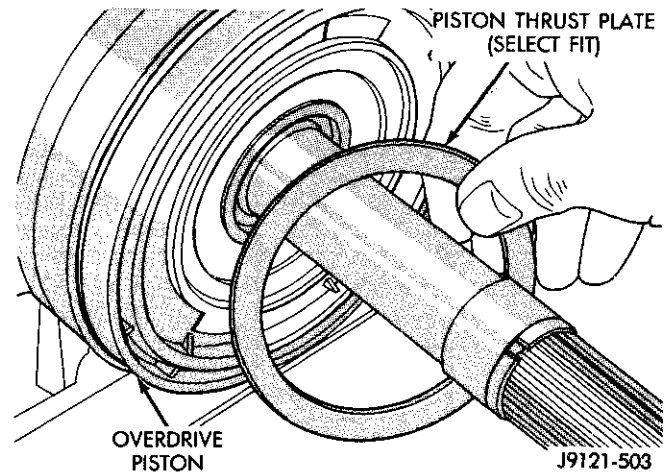
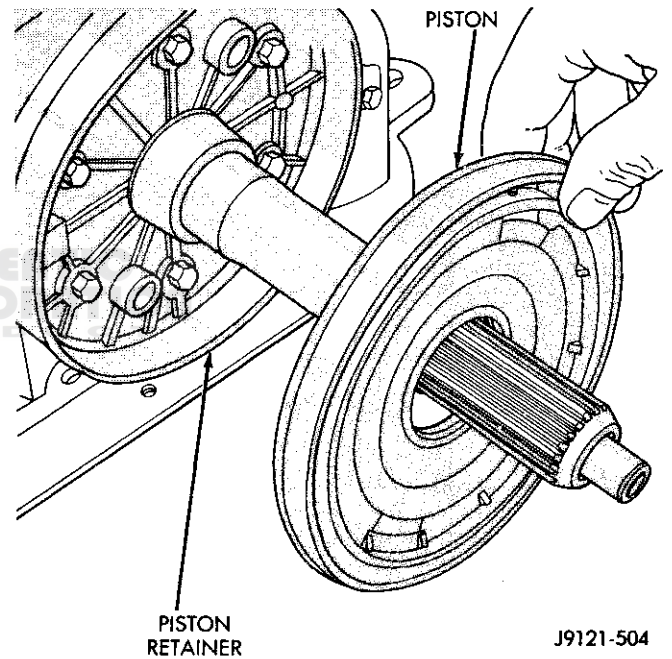
- (1) Drain fluid from transmission.
- (2) Remove transmission from vehicle.
- (3) Install a suitable tail shaft housing plug to avoid contaminating internal components with cleaning solvents.
- (4) Clean exterior of transmission with suitable solvent or pressure washer.
- (5) Remove torque converter from front of transmission.
- (6) Remove throttle and shift levers from valve body manual shaft and throttle lever shaft.
- (7) Mount transmission in repair stand C-3750-B or similar type stand (Fig. 118).

**Fig. 118 Repair Stand**

- (8) Remove overdrive unit from transmission case, refer to Removal and Installation section of this group for proper procedures.

- (9) Remove thrust plate from overdrive piston (Fig. 119).

- (10) Remove overdrive piston from retainer (Fig. 120).

**Fig. 119 Overdrive Piston Thrust Plate****Fig. 120 Overdrive Piston**

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Remove overdrive piston thrust bearing (Fig. 121).

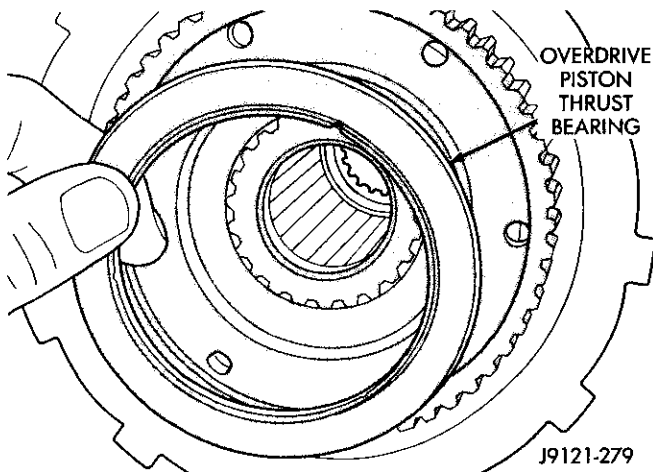


Fig. 121 Overdrive Piston Thrust Bearing

(12) Remove pump oil seal with Special Tool C-3861 (Fig. 122). Be sure to tighten tool threads completely into seal before using puller bolt to withdraw seal.

(13) Remove fluid pan and filter.

(14) Remove park/neutral position switch and seal (Fig. 122).

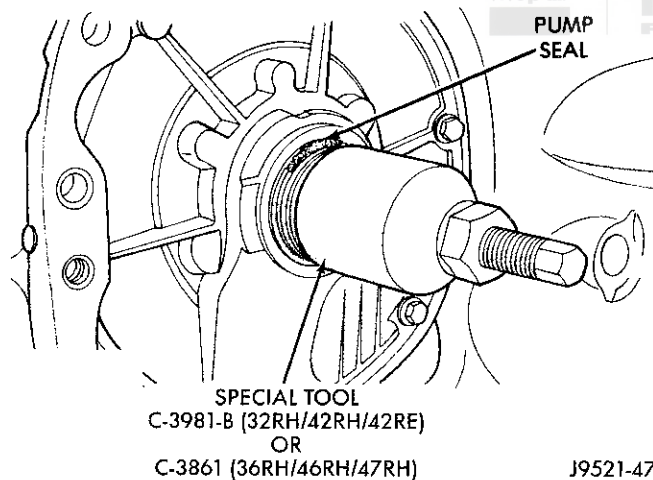


Fig. 122 Removing Pump Oil Seal

(15) Remove valve body and electronic governor.

(16) Remove accumulator outer spring, piston and inner spring (Fig. 123). Note position of piston and springs for assembly reference. Remove and discard piston seals if worn or cut.

(17) Remove front band lever pin access plug (Fig. 125). Use square end of 1/4 in. drive extension to remove plug as shown.

(18) Remove oil pump and reaction shaft support assembly as follows:

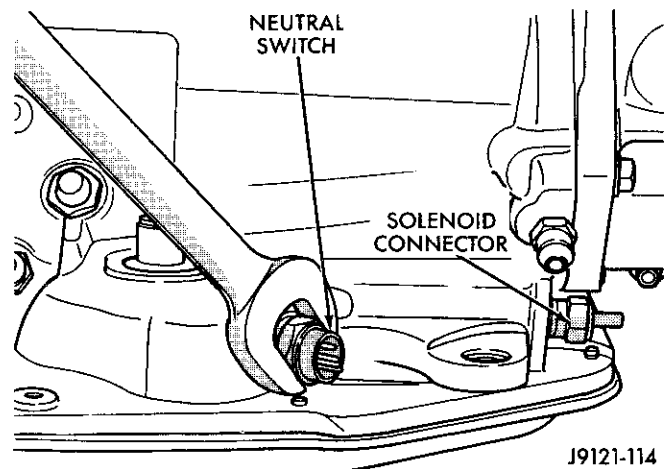


Fig. 123 Park/Neutral Position Switch

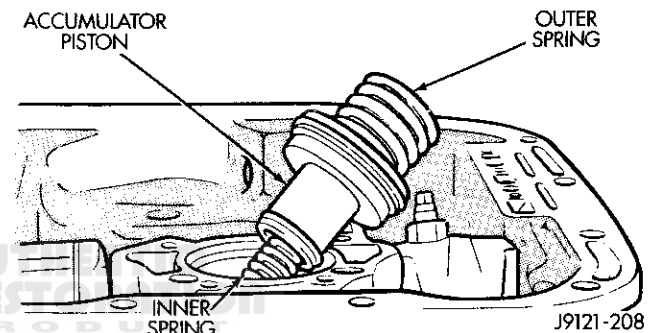


Fig. 124 Accumulator Component Removal

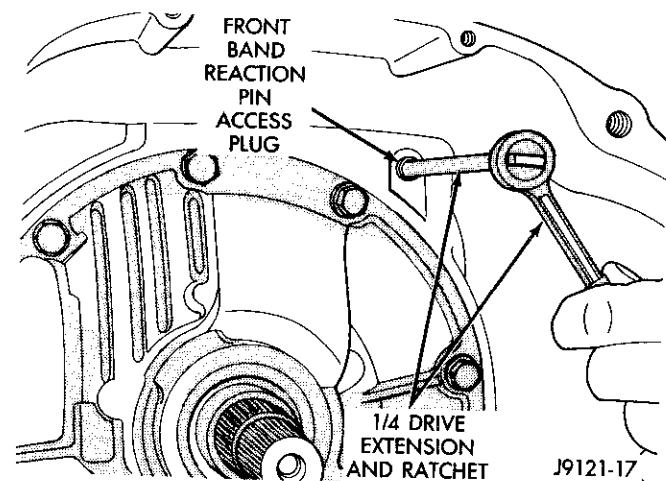


Fig. 125 Front Band Lever Pin Access Plug

(a) Tighten front band adjusting screw until band is tight around front clutch retainer (Fig. 126). This will prevent retainer from coming out with pump and possibly damaging clutch or pump components.

(b) Remove oil pump bolts.

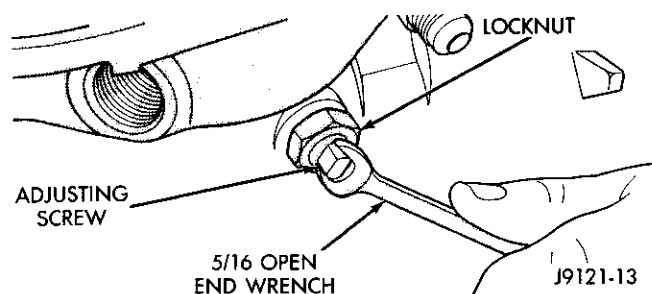
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 126 Tightening Front Band To Hold Front Clutch In Place

(c) Thread Slide Hammer Tools C-3752 into threaded holes in flange of oil pump housing (Fig. 127).

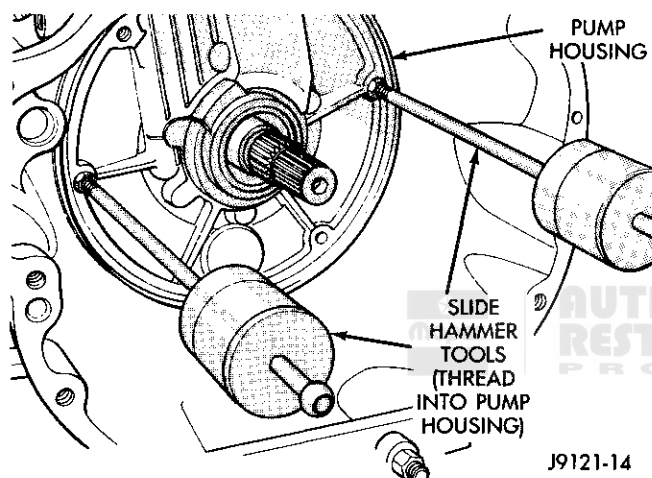


Fig. 127 Oil Pump Removal Tools

(d) Remove oil pump and reaction shaft support by bumping slide hammers outward alternately to pull pump from case (Fig. 128).

(19) Remove oil pump gasket (Fig. 129). Note gasket position in case for assembly reference.

(20) Loosen front band adjusting screw until band is completely loose.

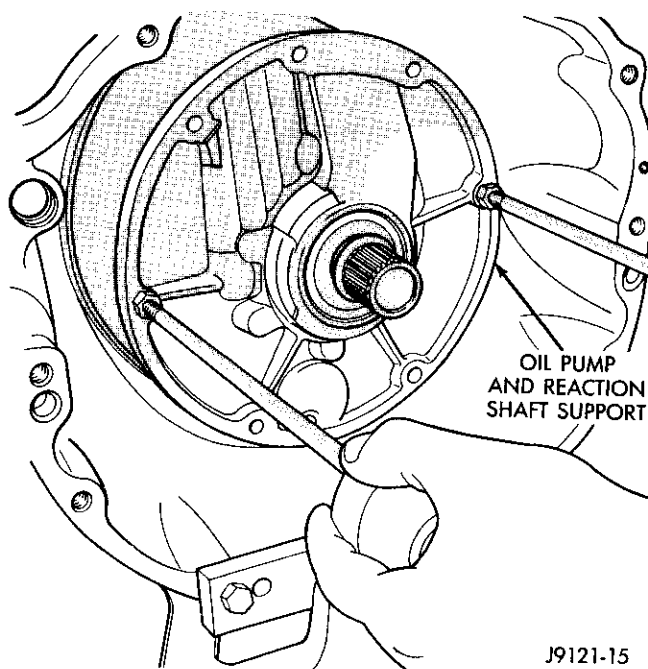


Fig. 128 Oil Pump Removal

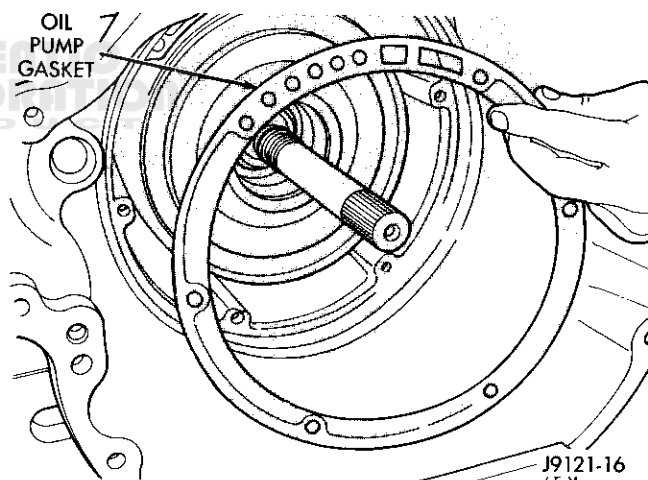


Fig. 129 Oil Pump Gasket

DISASSEMBLY AND ASSEMBLY (Continued)

(21) Remove front band strut and anchor (Fig. 130).

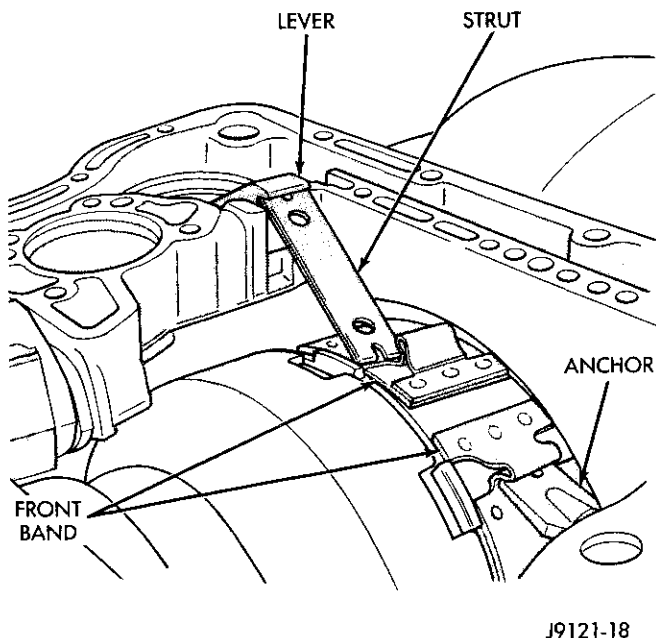


Fig. 130 Front Band Linkage

(22) Squeeze front band together slightly and slide band over front clutch retainer and out of case (Fig. 131).

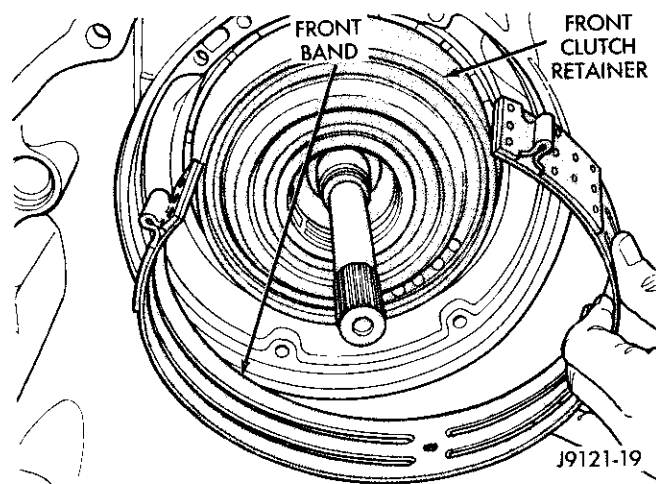


Fig. 131 Front Band

(23) Remove front and rear clutch assemblies as a unit (Fig. 132). Set assemblies aside for disassembly and inspection after removal.

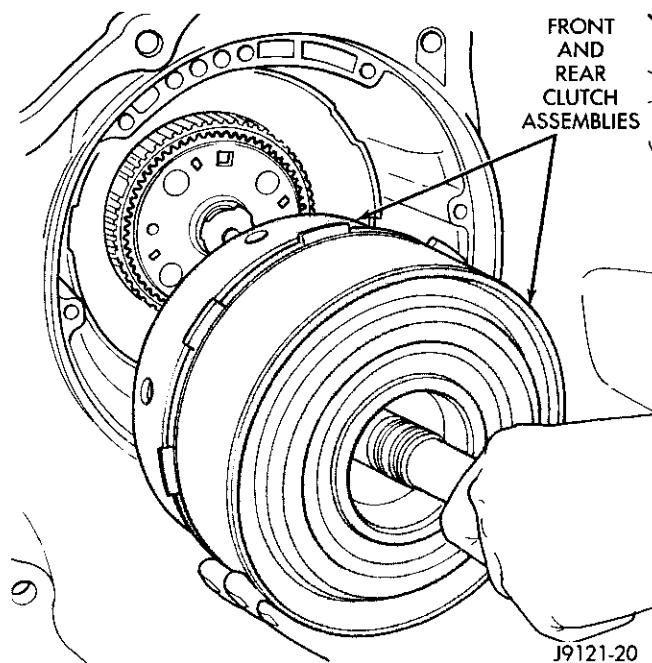


Fig. 132 Removing Front/Rear Clutch Assemblies

(24) Remove front band reaction pin and lever. Start pin through lever and out of case bore with drift or punch. Then use pencil magnet to withdraw pin completely (Fig. 133).

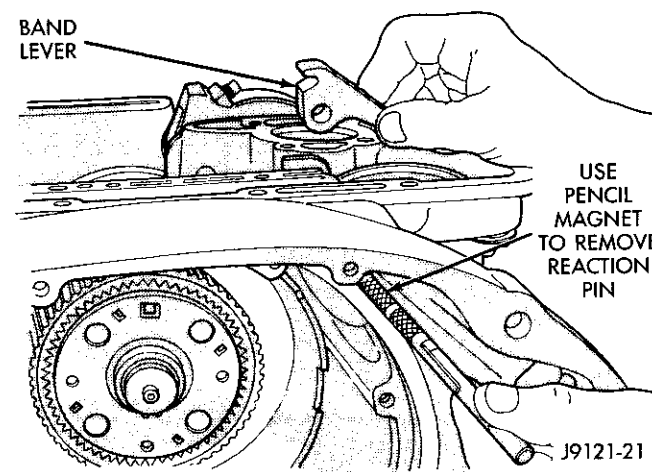


Fig. 133 Front Band Lever And Pin

DISASSEMBLY AND ASSEMBLY (Continued)

(25) Remove intermediate shaft thrust washer. Triangular shaped washer will either be on shaft pilot hub or in rear clutch retainer (Fig. 134).

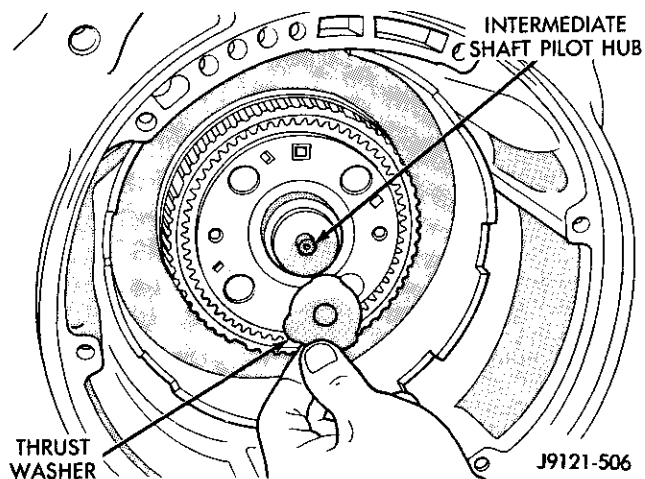


Fig. 134 Intermediate Shaft Thrust Washer

(26) Remove thrust plate from intermediate shaft hub (Fig. 135).

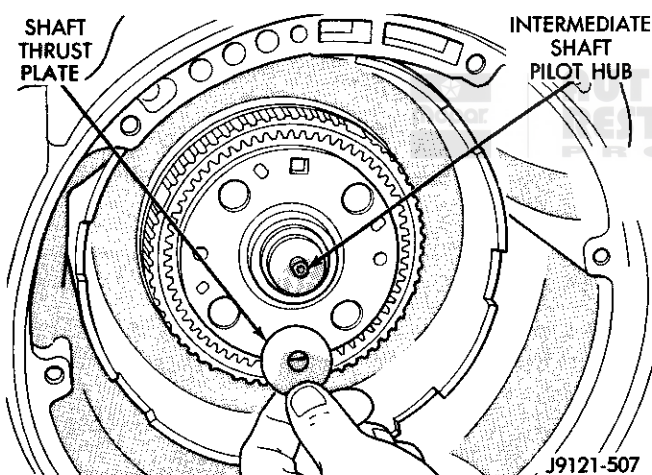


Fig. 135 Intermediate Shaft Thrust Plate

(27) Remove intermediate shaft-planetary geartrain assembly (Fig. 136). Set assembly aside for disassembly and inspection later in procedure.

(28) Loosen rear band locknut and loosen adjusting screw 3-4 turns.

(29) Remove snap ring that retains low-reverse drum on overdrive piston retainer hub (Fig. 137).

(30) Slide low-reverse drum and thrust washer off piston retainer hub and out of rear band (Fig. 138).

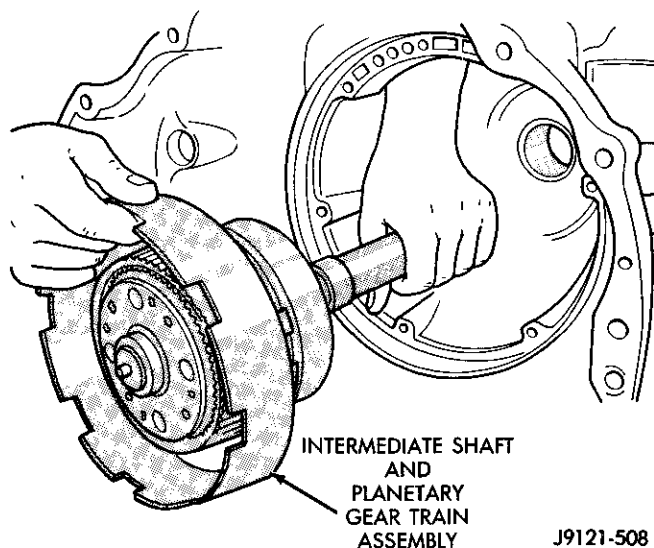


Fig. 136 Intermediate Shaft And Planetary Geartrain

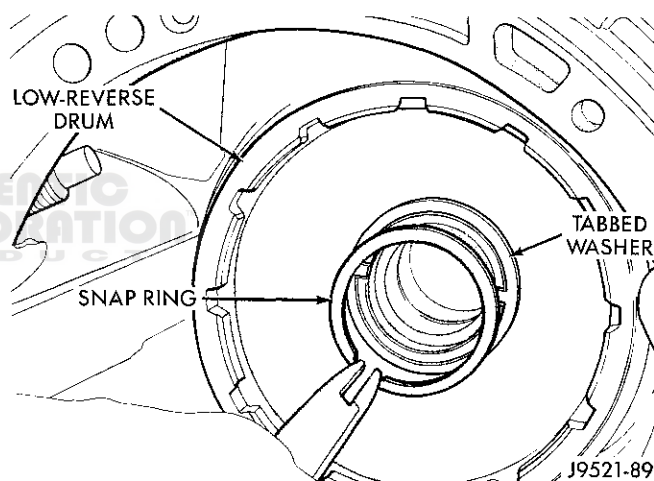


Fig. 137 Low-Reverse Drum Snap Ring

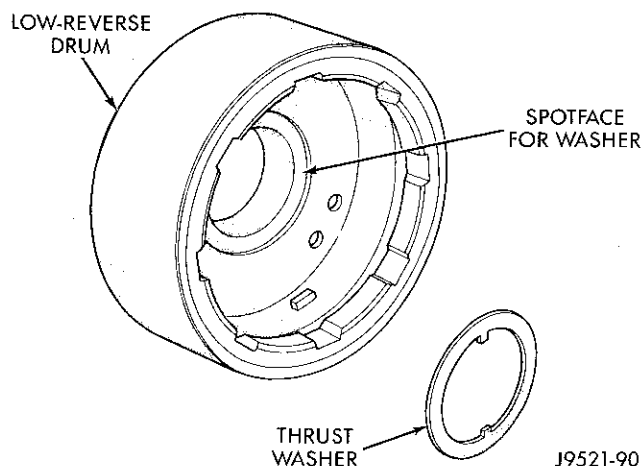
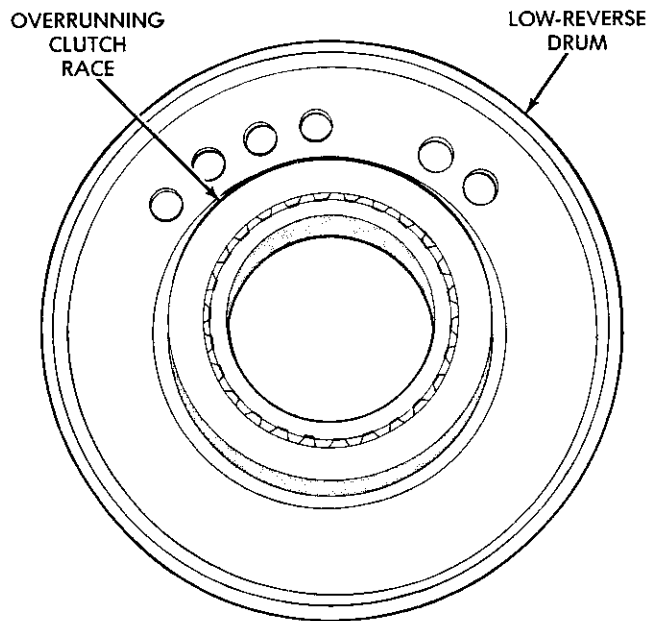


Fig. 138 Low-Reverse Drum And Thrust Washer

DISASSEMBLY AND ASSEMBLY (Continued)

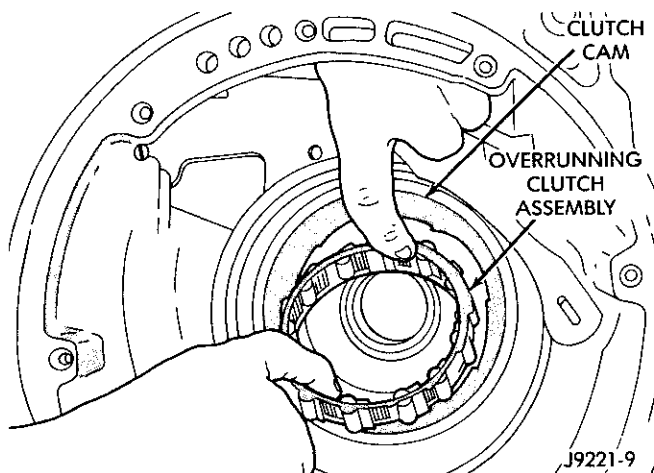
(31) Note that overrunning clutch race will remain on splines of low-reverse drum after removal (Fig. 139). **The race is a permanent press fit on the hub splines. Do not attempt to remove the race.**



J9221-8

Fig. 139 Overrunning Clutch Race Position On Low-Reverse Drum

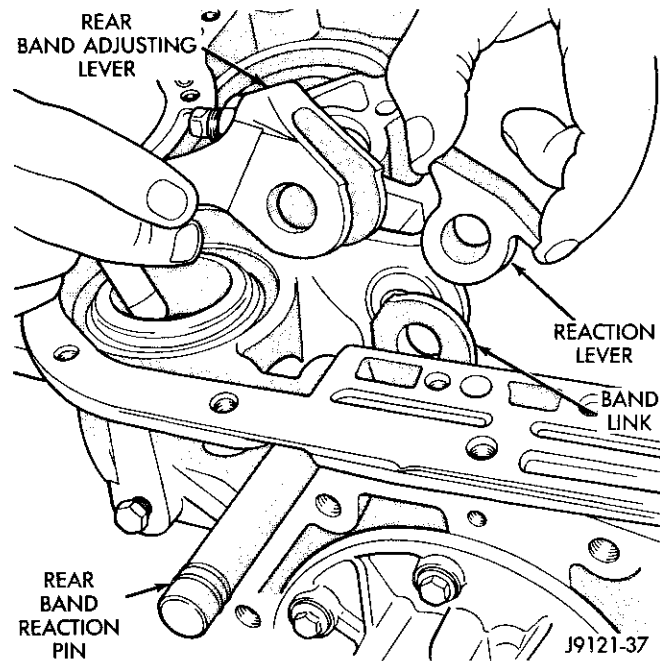
(32) Remove overrunning clutch assembly (Fig. 140). Assembly can be removed without displacing rollers and springs if care is exercised. Note position of rollers and springs for assembly reference.



J9221-9

Fig. 140 Overrunning Clutch

(33) Remove rear band adjusting lever, reaction lever and pin (Fig. 141).

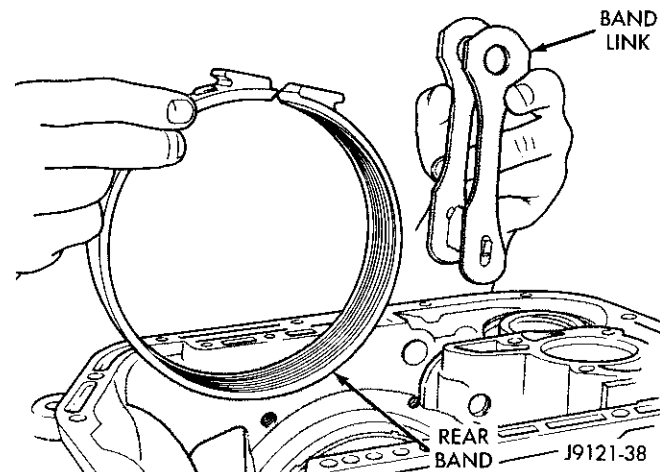


J9121-37

Fig. 141 Rear Band Levers And Pins

(34) Remove strut from rear band. Keep strut with levers and pin for cleaning, inspection and assembly reference.

(35) Remove rear band and link (Fig. 142).



J9121-38

Fig. 142 Rear Band And Link

DISASSEMBLY AND ASSEMBLY (Continued)

(36) Compress front servo rod guide with large C-clamp and Tool C-4470, or Compressor Tool C-3422-B (Fig. 143). Compress guide only enough to permit snap ring removal (about 1/8 in.).

(37) Remove servo piston snap ring (Fig. 143). Unseat one end of ring. Then carefully work removal tool around back of ring until free of ring groove. **Exercise caution when removing snap ring. Servo bore can be scratched or nicked if care is not exercised.**

(38) Remove tools and remove servo piston and spring.

(39) Compress rear servo piston with C-clamp and Tool C-4470, or Valve Spring Compressor C-3422-B (Fig. 144). Compress servo spring retainer only enough to permit snap ring removal.

(40) Remove servo piston snap ring (Fig. 144). Start one end of ring out of bore. Then carefully work removal tool around back of snap ring until free of ring groove. **Exercise caution when removing snap ring. Servo bore can be scratched or nicked if care is not exercised.**

(41) Remove tools and remove rear servo retainer, spring and piston assembly.

(42) Remove overdrive piston retainer bolts and remove retainer from case (Fig. 145).

(43) Remove gasket from rear of case after removing piston retainer.

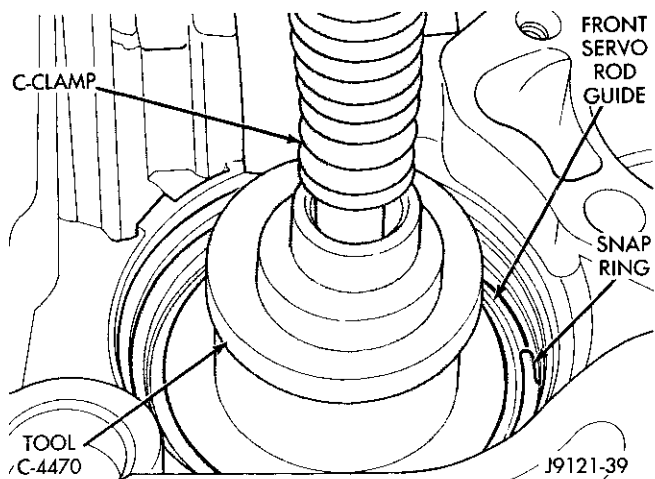


Fig. 143 Front Servo Retaining Snap Ring

TRANSMISSION ASSEMBLY

Do not allow dirt, grease, or foreign material to enter the case or transmission components during assembly. Keep the transmission case and components clean. Also make sure the tools and workbench area used for reassembly operations are equally clean.

Shop towels used for wiping off tools and your hands must be made from **lint free** materials. Lint

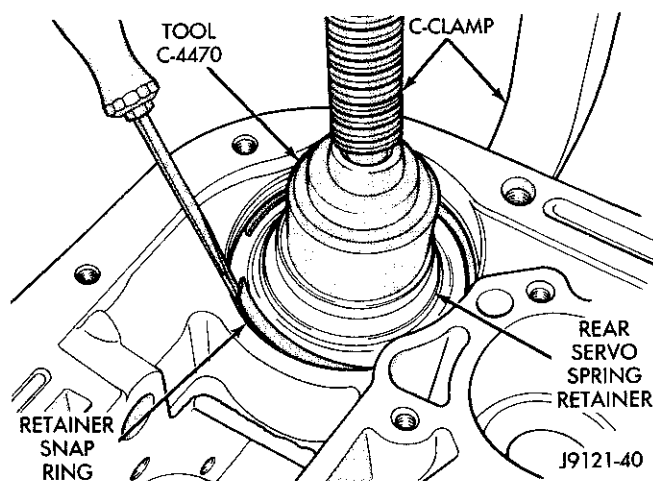


Fig. 144 Rear Servo Retaining Snap Ring

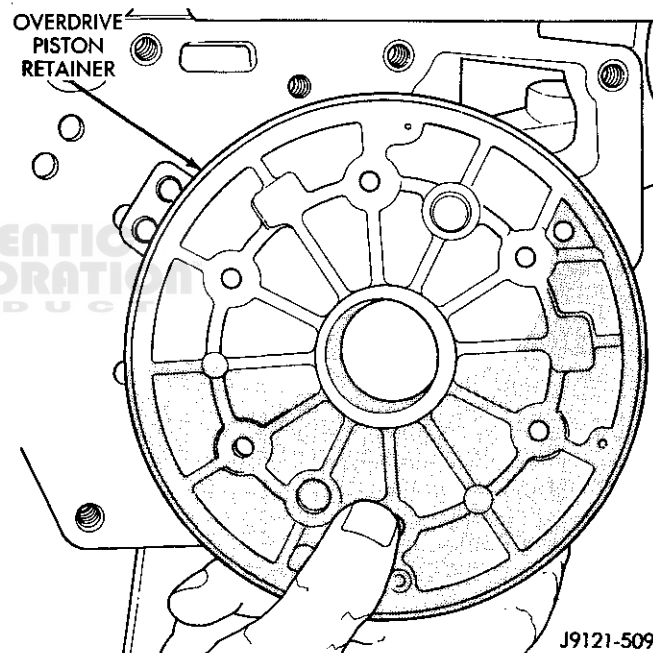


Fig. 145 Overdrive Piston Retainer

will stick to transmission parts and could interfere with valve operation or even restrict fluid passages.

Lubricate transmission clutch and gear components with Mopar ATF Plus during reassembly. Soak clutch discs in transmission fluid before installation.

Use Mopar Door Ease, or Ru-Glyde on piston seals and O-rings to ease installation. Petroleum jelly can also be used to lubricate and hold thrust washers and plates in position during assembly.

Do not use chassis grease, bearing grease, white grease, or similar lubricants on any part. These types of lubricants can eventually block or restrict fluid passages and valve operation. Use petroleum jelly only.

DISASSEMBLY AND ASSEMBLY (Continued)

Do not force parts into place. The transmission components and sub-assemblies are easily installed by hand when properly aligned. If a part seems difficult to install, it is either misaligned or incorrectly assembled. Verify that thrust washers, thrust plates and seal rings are correctly positioned. These parts will prevent proper assembly is mispositioned (or "left out" by accident).

The planetary geartrain, front/rear clutch assemblies and oil pump are all much easier to install when the transmission case is upright or as close to this position as possible. Either tilt the case upward with wood blocks, or cut a hole in the bench large enough for the intermediate shaft and rear support. Then lower the shaft and support into the hole and support the rear of the case directly on the bench.

FRONT/REAR SERVO INSTALLATION

(1) Lubricate rear servo piston seal with Mopar Door Ease or ATF Plus. Lubricate servo bore in case with ATF Plus.

(2) Install rear servo piston in case. Position piston at slight angle to bore and insert piston with twisting motion (Fig. 146).

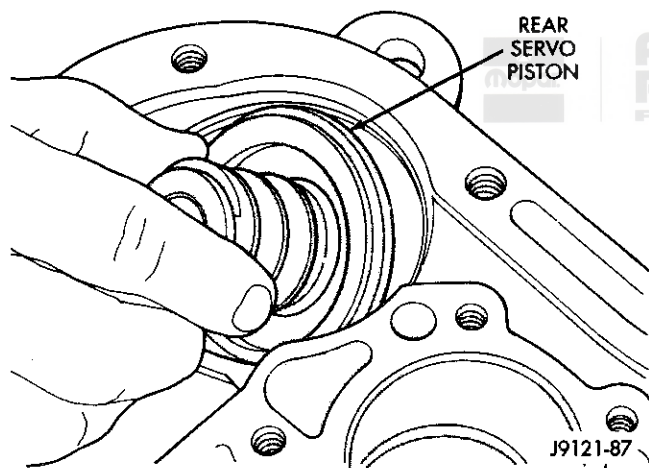


Fig. 146 Rear Servo Piston

(3) Install rear servo spring and retainer in case bore (Fig. 147). Be sure spring is seated on piston.

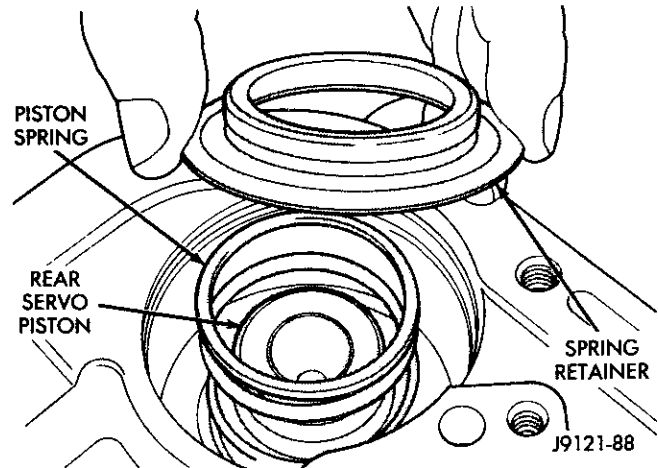


Fig. 147 Rear Servo Piston Spring And Retainer

(4) Compress rear servo piston with C-clamp or Valve Spring Compressor C-3422-B and install servo piston snap ring (Fig. 148).

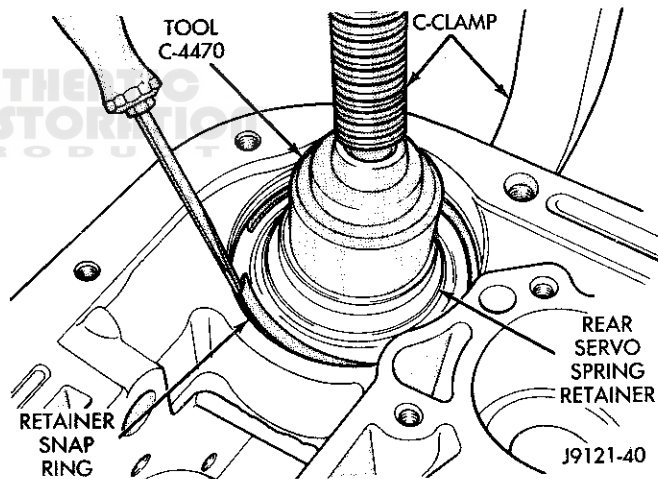


Fig. 148 Rear Servo Snap Ring

(5) Lubricate front servo piston components and servo bore in case with transmission fluid.

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Install front servo piston in bore. Carefully "run" small, suitable tool around piston ring to press it back into groove and ease installation (Fig. 149). Rotate piston into bore at same time. Rock piston slightly to ease piston ring past snap ring groove and into bore.

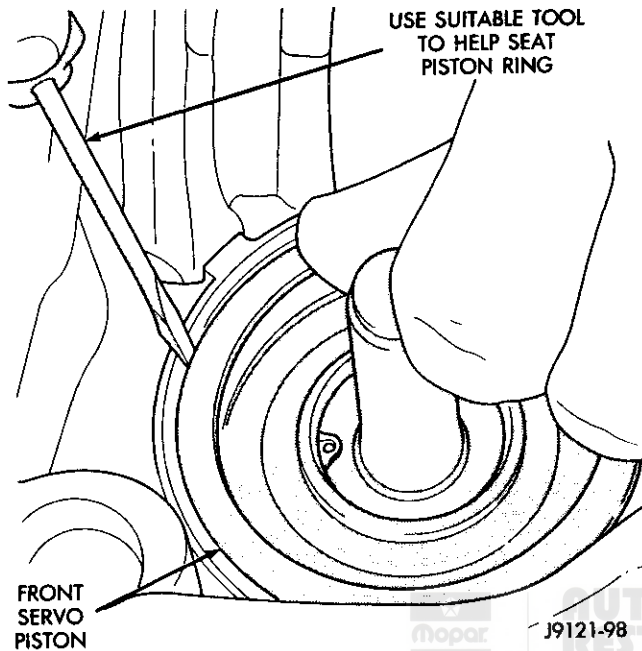


Fig. 149 Front Servo Piston

(7) Bottom front servo piston in bore and install servo spring.

(8) Install front servo piston rod guide as follows:

(a) Place Tool SP-5560 (or similar size tool) on guide and position C-clamp on tool and case (Fig. 150).

(b) Slowly compress rod guide while simultaneously easing seal ring into bore with suitable tool.

(9) Install rod guide snap ring (Fig. 150).

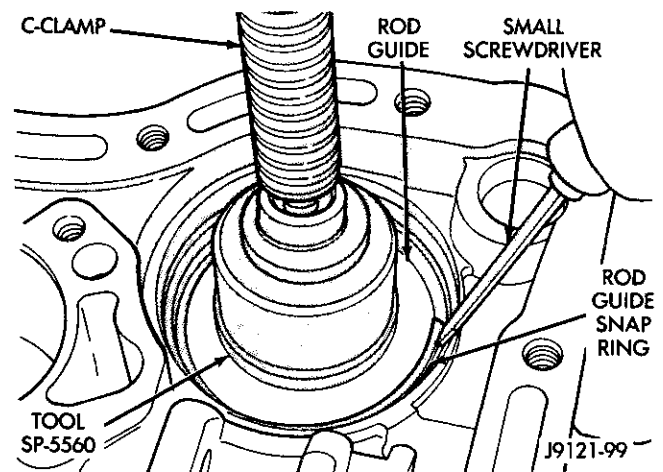


Fig. 150 Front Servo Rod Guide And Snap Ring

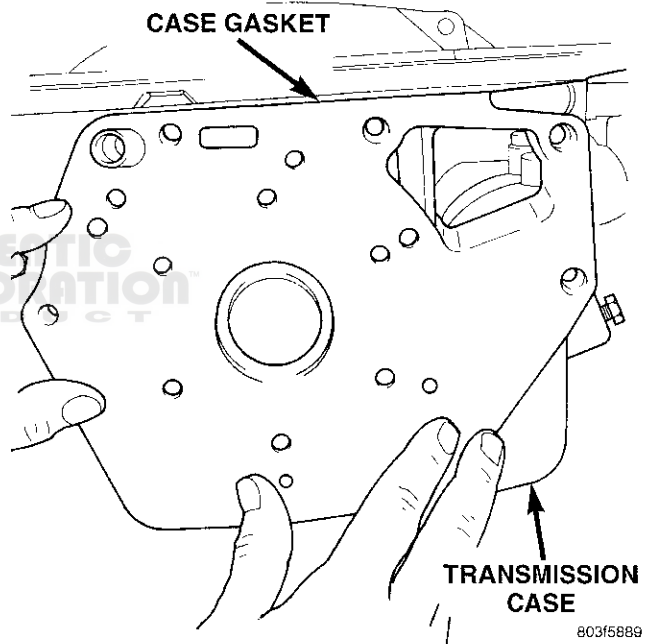


Fig. 151 Case Gasket

OVERRUNNING CLUTCH, REAR BAND, LOW-REVERSE DRUM, AND OVERDRIVE PISTON RETAINER INSTALLATION

(1) Install new gasket at rear of transmission case (Fig. 151). Use petroleum jelly to hold gasket in place.

DISASSEMBLY AND ASSEMBLY (Continued)

(2) Install overdrive piston retainer. Be sure governor tube bores in retainer are aligned with governor feed passages in gasket and case (Fig. 152). Install and tighten retainer bolts to 17 N·m (13 ft. lbs.) torque.

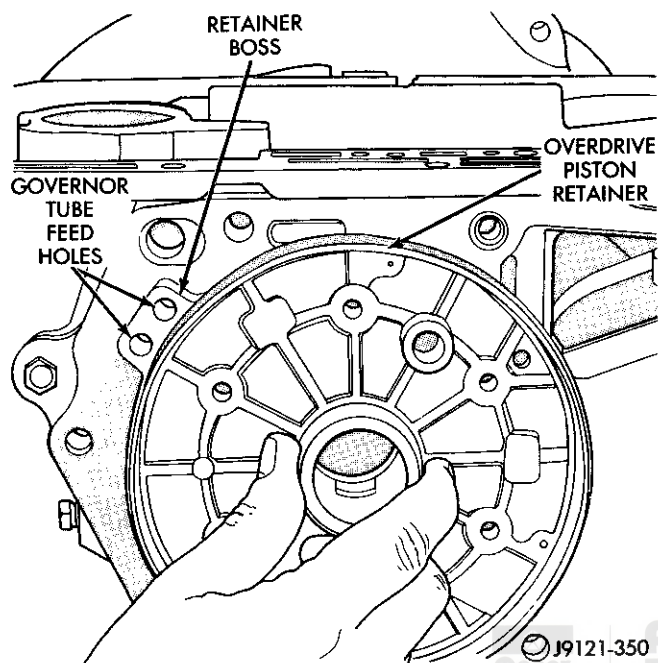


Fig. 152 Overdrive Piston Retainer

(3) Install overrunning clutch components if not yet installed. Refer to Overrunning Clutch Overhaul in this section for procedures if necessary.

(4) Position rear band and link in case (Fig. 153).

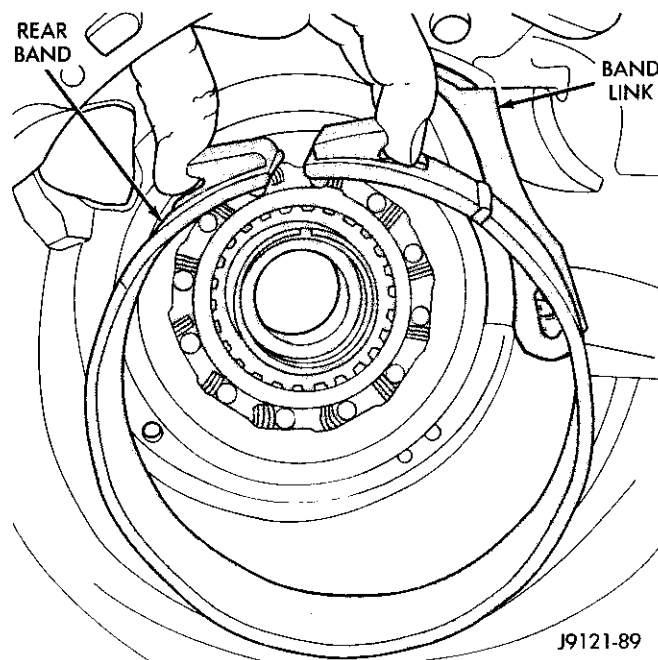


Fig. 153 Rear Band And Link

(5) Install low-reverse drum (Fig. 154). Slide drum through rear band, onto piston retainer hub and into engagement with overrunning clutch and race.

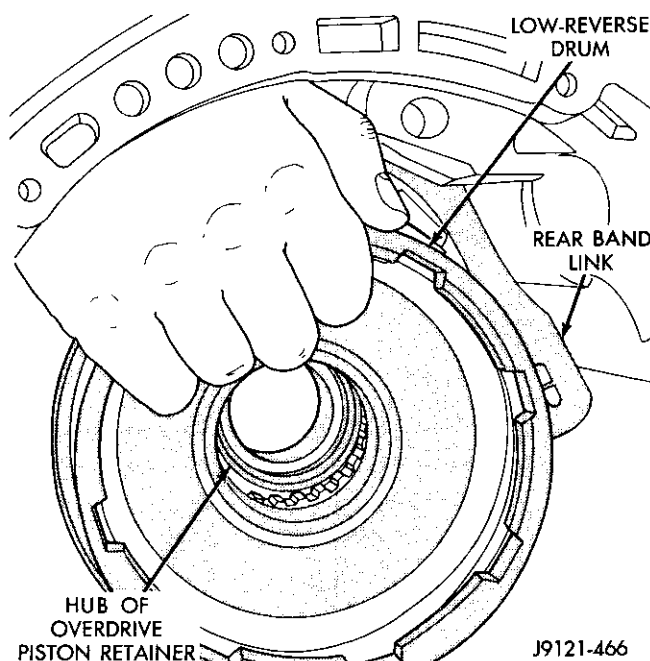


Fig. 154 Low-Reverse Drum

(6) Install thrust washer in low-reverse drum spot-face (Fig. 155). Use petroleum jelly to hold washer in place.

(7) Install snap ring that secures low-reverse drum to rear support hub (Fig. 155).

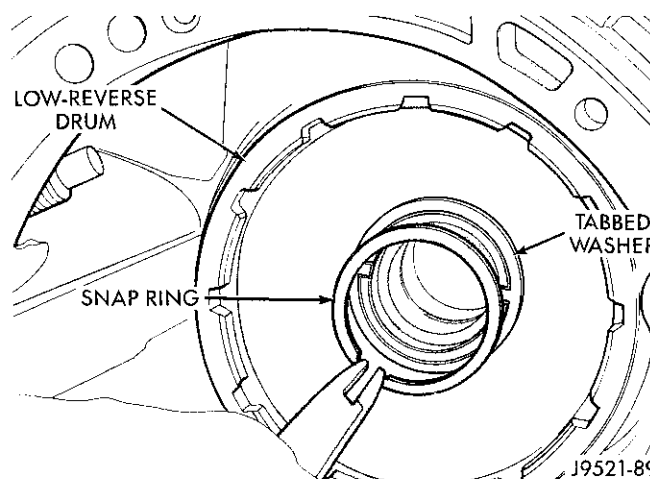


Fig. 155 Low-Reverse Drum Snap Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(8) Insert band reaction pin part way into case and band link (Fig. 156).

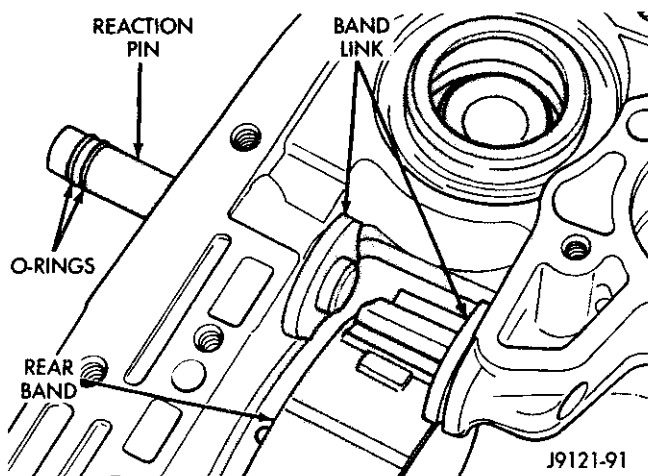


Fig. 156 Rear Band Reaction Pin

(9) Install rear band adjusting lever, reaction lever, and strut (Fig. 157). Be sure levers and strut are aligned and engaged before seating band reaction pin in case.

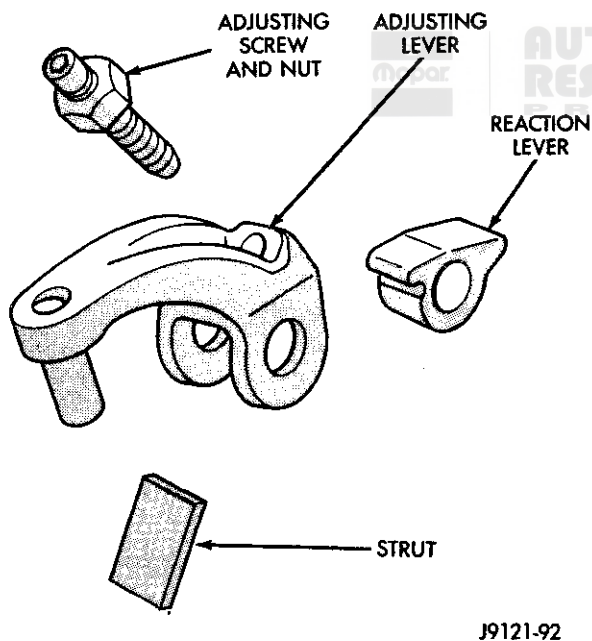


Fig. 157 Rear Band Levers And Strut
PLANETARY GEARTRAIN, FRONT/REAR CLUTCH, AND FRONT BAND INSTALLATION

(1) Install assembled intermediate shaft and planetary geartrain (Fig. 158). **Support shaft carefully during installation. Do not allow shaft bearing/bushing surfaces to become nicked or scratched.**

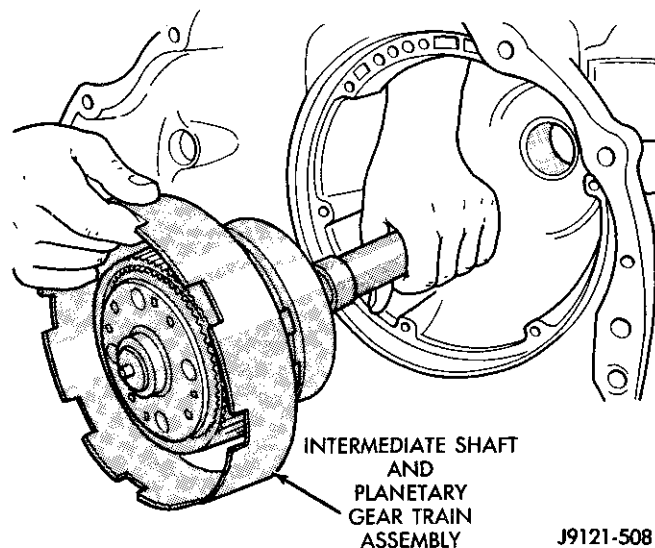


Fig. 158 Intermediate Shaft And Planetary Geartrain

(2) Lubricate intermediate shaft thrust plate with petroleum jelly and install plate on shaft pilot hub (Fig. 159).

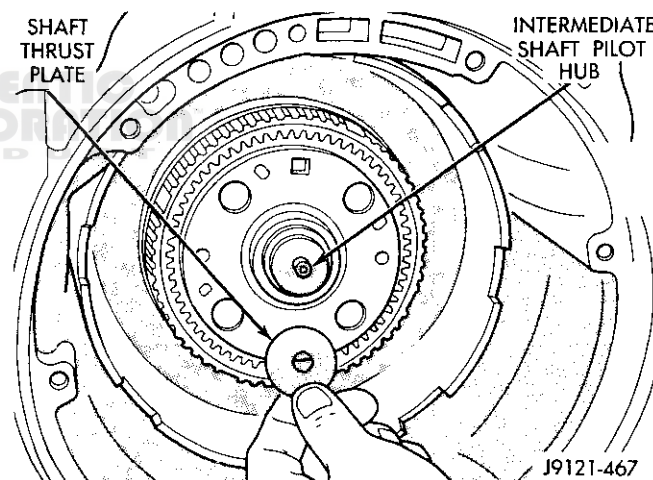
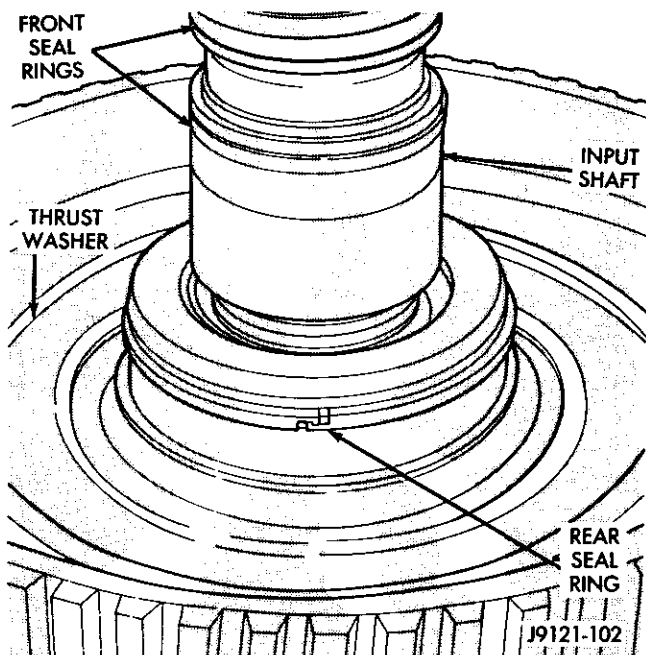
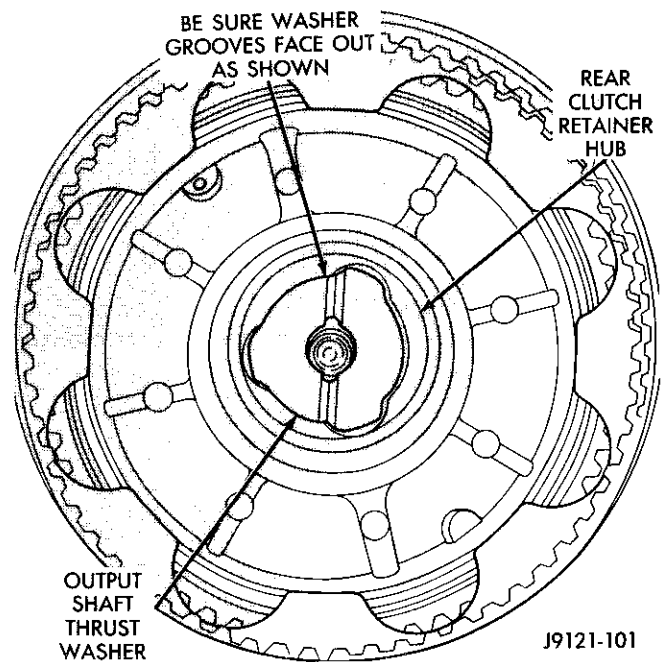
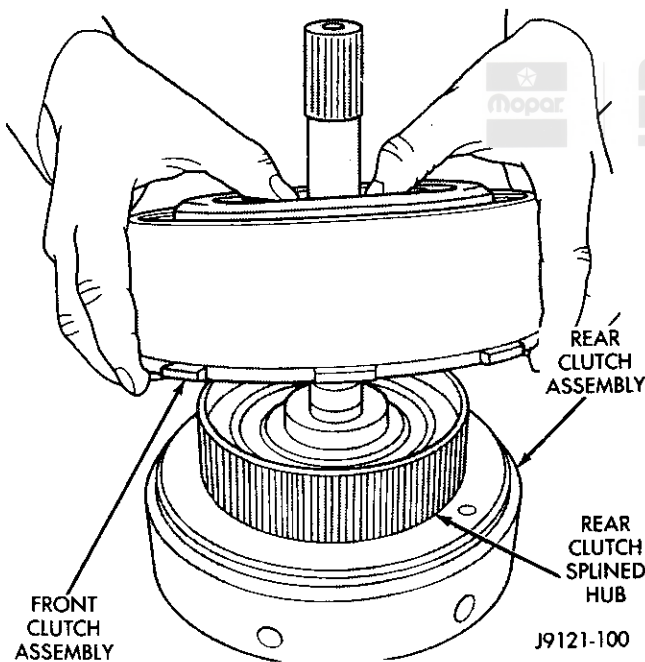


Fig. 159 Intermediate Shaft Thrust Plate

(3) Check input shaft front seal rings, fiber thrust washer and rear seal ring (Fig. 160). Be ends of rear seal ring are hooked together and diagonal cut ends of front seal rings are firmly seated against each other as shown. Lubricate seal rings with petroleum jelly after checking them.

(4) Assemble front and rear clutches (Fig. 161). Align lugs on front clutch discs. Mount front clutch on rear clutch. Turn front clutch retainer back and forth until front clutch discs are fully seated on rear clutch splined hub.

(5) Install intermediate shaft thrust washer in hub of rear clutch retainer (Fig. 162). Use petroleum jelly to hold washer in place. Position washer so grooves

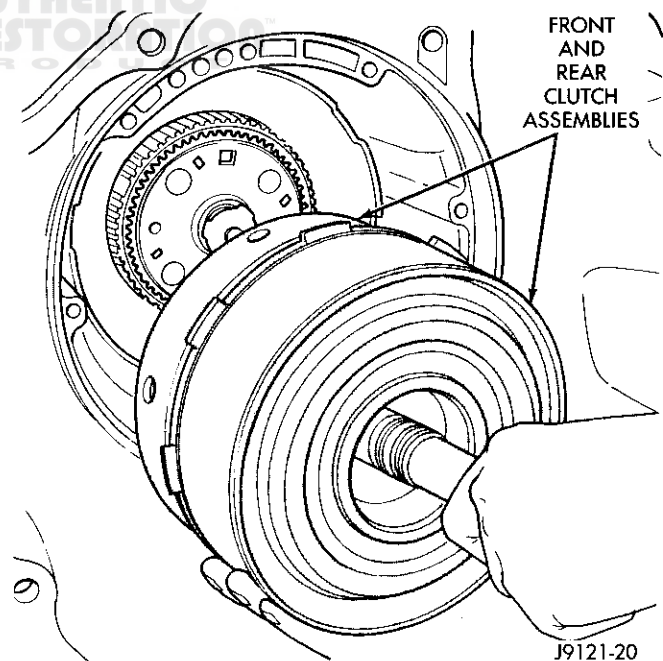
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 160 Input Shaft Seal Ring And Thrust Washer****Fig. 162 Intermediate Shaft Thrust Washer****Fig. 161 Assembling Front And Rear Clutches**

are facing outward. Washer only fits one way in clutch retainer hub.

(6) Place transmission case in upright position, or place blocks under front end of transmission repair stand to tilt case rearward. This makes it easier to install front/rear clutch assembly.

(7) Align discs in rear clutch. Then install and engage assembly in front planetary and driving shell

(Fig. 163). Turn clutch retainers back and forth until both clutches are seated.

**Fig. 163 Front/Rear Clutch Assemblies**

(8) Position front band lever in case and over servo rod guide. Then install front band lever pin in case and slide it through lever.

(9) Coat threads of front band pin access plug with sealer and install it in case. Tighten plug to 17 N·m (13 ft. lbs.) torque.

DISASSEMBLY AND ASSEMBLY (Continued)

(10) Slide front band over front clutch retainer and install front band strut and anchor (Fig. 164).

(11) Tighten front band adjusting screw until band is tight on clutch retainer. This will hold clutches in place while oil pump is being installed. **Verify that front/rear clutch assembly is still properly seated before tightening band.**

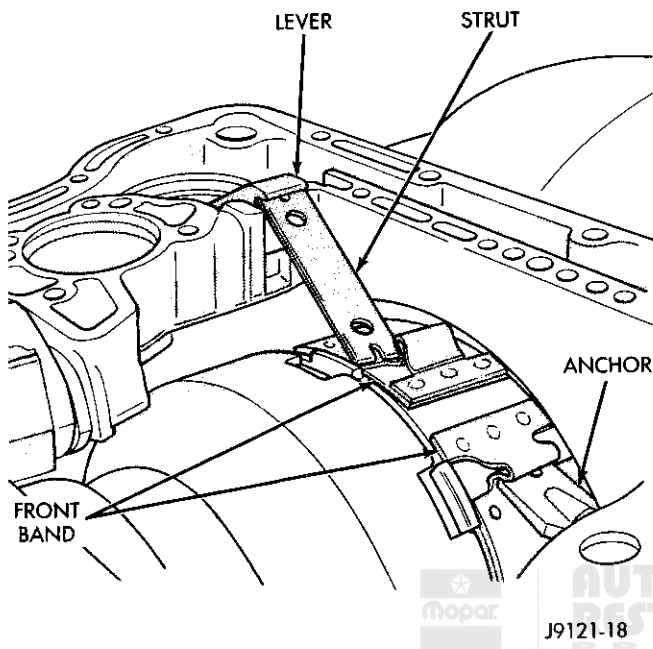


Fig. 164 Front Band And Linkage

OIL PUMP INSTALLATION

(1) Install oil pump Pilot Studs C-3288-B in case (Fig. 165).

(2) Install new oil pump gasket on pilot studs and seat it in case. Be sure gasket is properly aligned with fluid passages in case (Fig. 165).

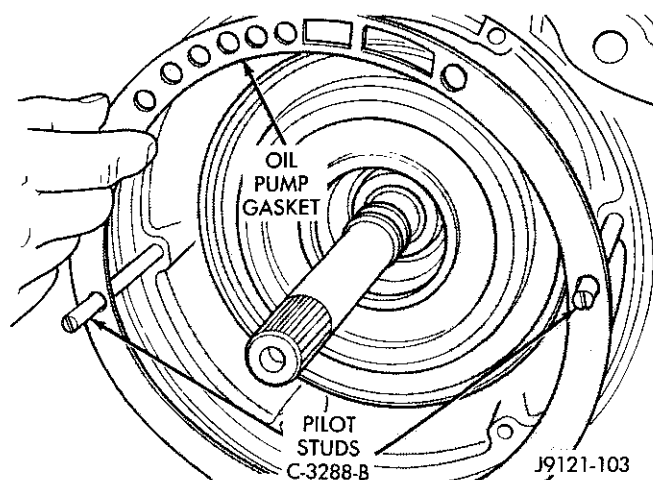


Fig. 165 Oil Pump Gasket And Pilot Studs

(3) Coat front clutch thrust washer with petroleum jelly to hold it in place. Then install washer over reaction shaft hub and seat it on pump (Fig. 166).

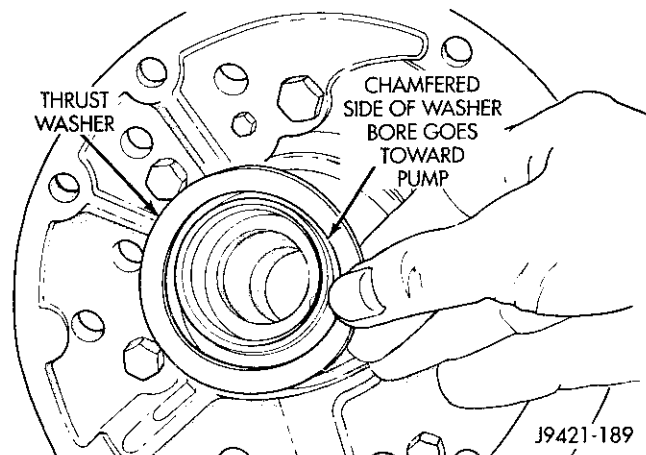


Fig. 166 Front Clutch Thrust Washer

CAUTION: The thrust washer bore (I.D.), is chamfered on one side. Make sure the chamfered side is installed so it faces the pump.

(4) Check seal rings on reaction shaft support. Be sure rings are hooked together correctly. Also be sure fiber thrust washer is in position (Fig. 167). Use extra petroleum jelly to hold washer in place if necessary.

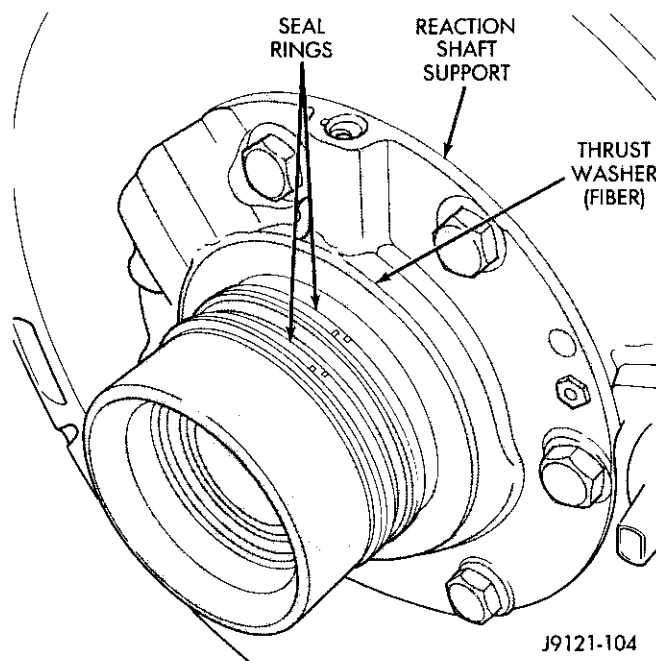


Fig. 167 Reaction Shaft Seal Ring And Thrust Washer

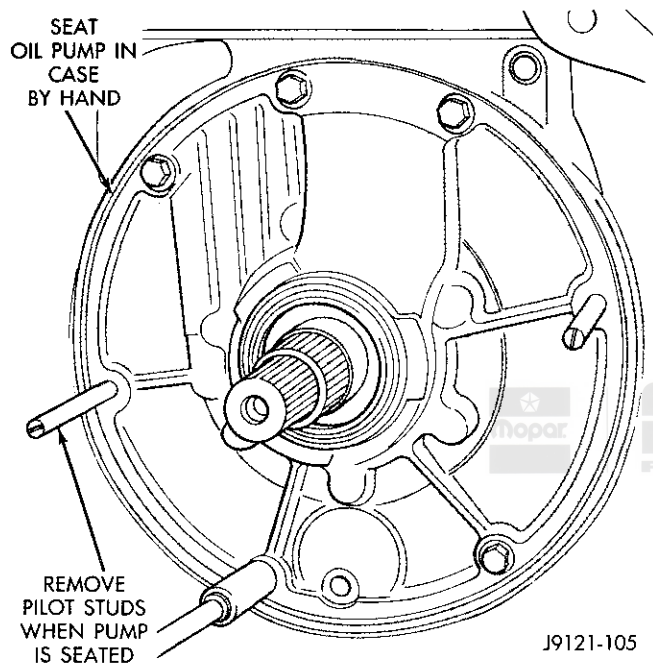
(5) Lubricate oil pump seals with petroleum Mopar ATF Plus.

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Mount oil pump on pilot studs and slide pump into case opening (Fig. 168). **Work pump into case by hand. Do not use a mallet or similar tools to seat pump.**

(7) Remove pilot studs and install oil pump bolts. Tighten pump bolts alternately and evenly to fully seat pump in case. Then final-tighten pump bolts to 20 N·m (15 ft. lbs.) torque.

(8) Verify correct installation. Rotate input and intermediate shafts and check for bind. If bind exists, components are either misassembled, or not seated. Disassemble and correct as necessary before proceeding.



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Fig. 168 Oil Pump**OVERDRIVE UNIT AND PISTON INSTALLATION**

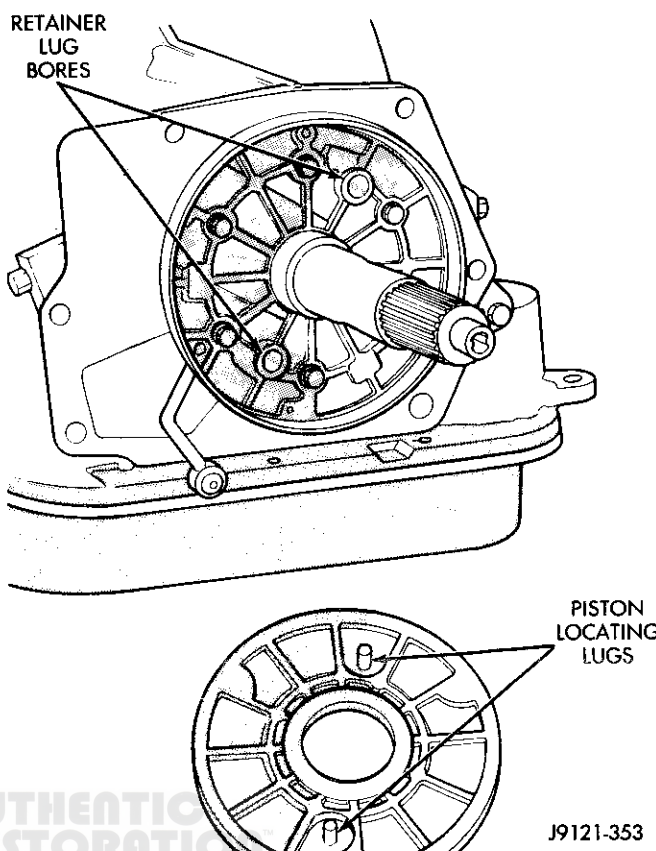
(1) Install new seals on overdrive piston. Then lubricate seals with Mopar Door Ease, or Ru-Glyde to ease installation.

(2) Install overdrive piston in retainer. **Align locating lugs on piston in locating bores in retainer** (Fig. 169). Use thin plastic strip or feeler gauge to help guide piston outer seal into retainer.

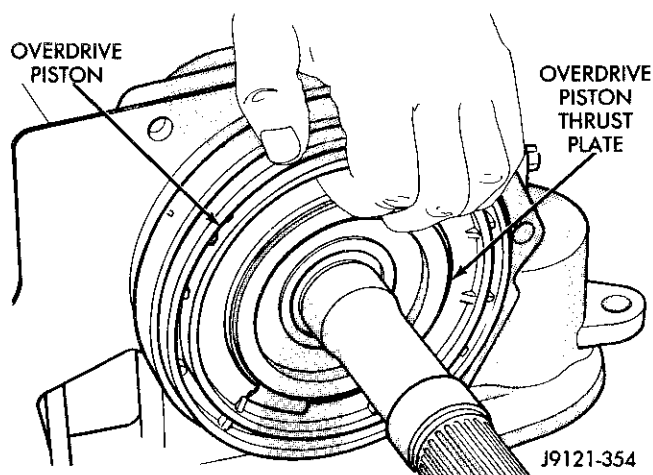
(3) Install spacer on intermediate shaft, if not previously installed.

(4) Install overdrive piston thrust plate (Fig. 170). Use liberal quantity of petroleum jelly to hold thrust plate in position on piston.

(5) Install overdrive piston thrust bearing in direct clutch hub (Fig. 171). Use liberal quantity of petroleum jelly to hold thrust bearing in place. **Note that one side of bearing has dark coated surface. This surface faces overdrive piston.** Also be



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Fig. 169 Overdrive Piston Alignment

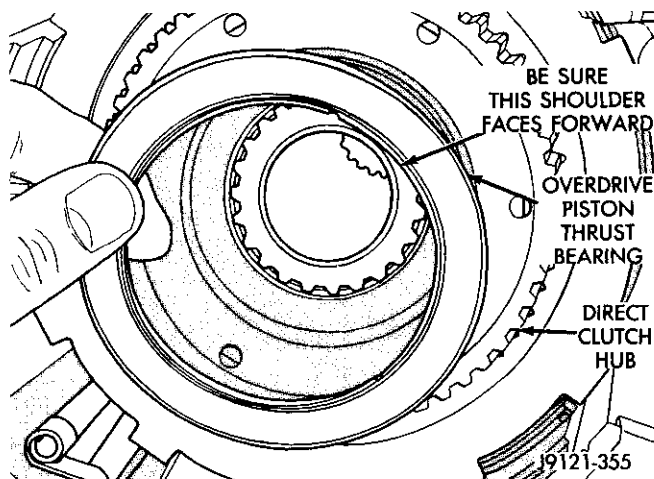
J9121-354

Fig. 170 Overdrive Piston Thrust Plate

sure raised shoulder on inside diameter of bearing faces forward as well.

(6) Apply small amount of petroleum jelly to pilot hub of intermediate shaft.

(7) Verify alignment of splines in overdrive unit planetary gear and overrunning clutch. Be sure Alignment Tool 6227-2 is fully seated (Fig. 172). **If planetary gear and overrunning clutch splines become misaligned, overdrive unit cannot be**

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 171 Overdrive Piston Thrust Bearing**

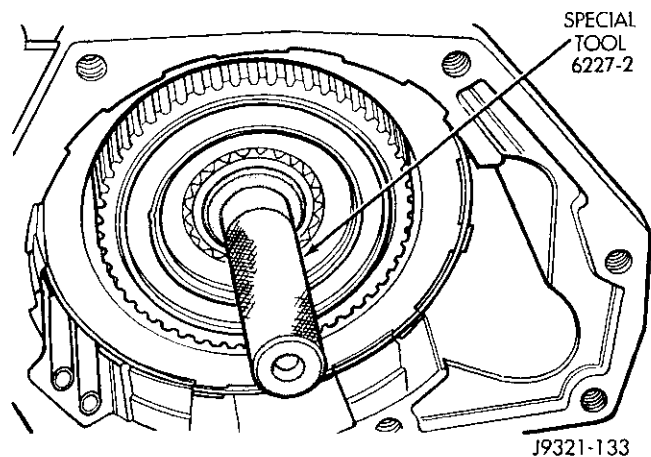
fully installed on intermediate shaft. Overdrive unit will have to be disassembled in order to realign splines.

(8) Carefully withdraw alignment tool from overdrive unit.

(9) Lubricate intermediate shaft splines and bushing surfaces with transmission fluid or petroleum jelly.

(10) Install overdrive unit. Be sure governor tubes are aligned with feed holes in piston retainer boss. Intermediate shaft is snug fit in overdrive planetary gear and overrunning clutch. If overdrive unit will not seat fully, rotate overdrive output shaft slightly to align splines and try again.

(11) Apply 1-2 drops of Mopar Lock N' Seal (or Loctite 242) to overdrive unit attaching bolts. Then install and tighten bolts to 34 N·m (25 ft. lbs.) torque.

**Fig. 172 Checking Alignment Of Overdrive Planetary Gear And Overrunning Clutch Splines****INPUT SHAFT END PLAY CHECK**

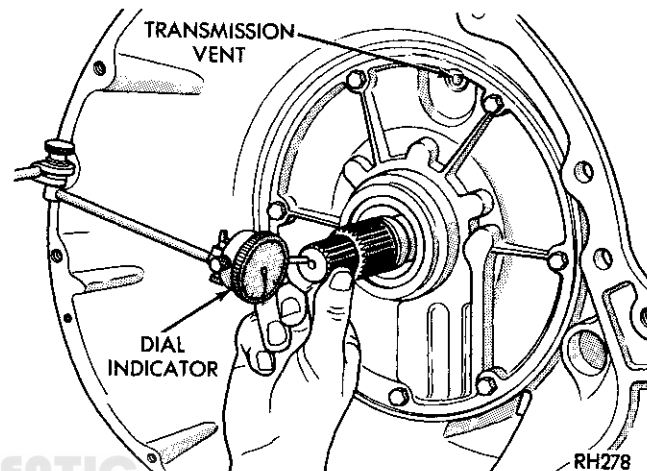
(1) Check input shaft end play as follows.

(2) Attach dial indicator to converter housing (Fig. 173). Position indicator plunger against input shaft and zero indicator.

(3) Move input shaft in and out and record reading.

(4) End play should be 0.86 - 2.13 mm (0.034 - 0.084 in.).

(5) If end play is incorrect, change intermediate shaft thrust washer. The thrust washer controls end play and is available in three thicknesses for adjustment purposes.

**Fig. 173 Checking Input Shaft End Play****BAND ADJUSTMENTS AND INSTALLATION OF ACCUMULATOR, VALVE BODY, OIL PAN, AND TORQUE CONVERTER**

(1) Install accumulator inner spring, piston and outer spring (Fig. 174).

(2) Verify that park/neutral position switch has **not** been installed in case. Valve body can not be installed if switch is in position.

(3) Install new valve body manual shaft seal in case (Fig. 175). Lubricate seal lip and manual shaft with petroleum jelly. Start seal over shaft and into case. Seat seal with 15/16 inch, deep well socket.

(4) Install valve body as follows:

(a) Start park rod into park pawl. If rod will not slide past park pawl, pawl is engaged in park gear. Rotate overdrive output shaft with suitable size 12 point socket; this will free pawl and allow rod to engage.

(b) Align and seat valve body on case. Be sure manual lever shaft and overdrive connector are fully seated in case.

(c) Install and start all valve body attaching bolts by hand. Then tighten bolts evenly, in a diagonal pattern to 12 N·m (105 in. lbs.) torque. **Do not overtighten valve body bolts. This could result in distortion and cross leakage after installation.**

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Install new filter on valve body. Tighten filter screws to 4 N·m (35 in. lbs.).

(6) Install seal on park/neutral position switch (Fig. 176). Then install and tighten switch to 34 N·m (25 ft. lbs.).

(7) Adjust front and rear bands as follows:

(a) Loosen locknut on each band adjusting screw 4-5 turns.

(b) Tighten both adjusting screws to 8 N·m (72 in. lbs.).

(c) Back off front band adjusting screw 2-7/8 turns.

(d) Back off rear band adjusting screw 2 turns.

(e) Hold each adjusting screw in position and tighten locknut to 34 N·m (25 ft. lbs.) torque.

(8) Install magnet in oil pan. Magnet seats on small protrusion at corner of pan.

(9) Position new oil pan gasket on case and install oil pan. Tighten pan bolts to 17 N·m (13 ft. lbs.).

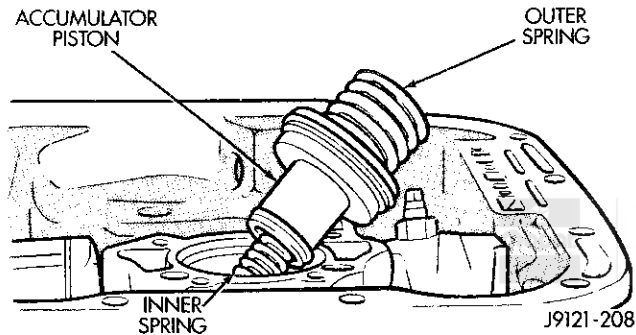


Fig. 174 Accumulator Piston And Springs

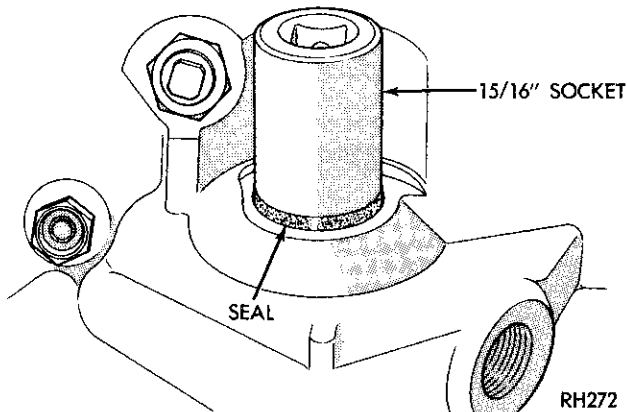


Fig. 175 Manual Lever Shaft Seal

(10) Install throttle valve and shift selector levers on valve body manual lever shaft.

(11) Cap or cover transmission openings (cooler line fittings, filler tube bore, etc.) to prevent dirt entry.

(12) Apply small quantity of dielectric grease to terminal pins of solenoid case connector and neutral switch.

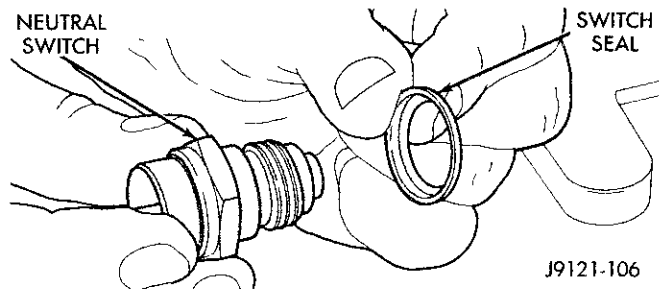


Fig. 176 Park/Neutral Position Switch Seal Position

CAUTION: If the condition of the transmission before the overhaul procedure caused excessive metallic or fiber contamination in the fluid, replace the torque converter. Fluid contamination and transmission failure can result.

(13) Install torque converter, refer to Removal and Installation section of this group for proper procedure. Use C-clamp or metal strap to hold converter in place for installation.

CAUTION: If the condition of the transmission before the overhaul procedure caused excessive metallic or fiber contamination in the fluid, reverse flush the cooler (s) and cooler lines before filling the overhauled transmission. Poor transmission performance and transmission failure can result.

(14) Install transmission in vehicle.

(15) Fill transmission with recommended fluid. Refer to Service Procedures section of this group.

(16) Road test vehicle to verify repair.

OVERDRIVE PISTON AND RETAINER SERVICE

Remove and discard the piston seals. Use a pencil or length of thin plastic to remove the old seals. Do not use metal tools as they can scratch, or score the seal grooves.

Clean the piston and retainer in solvent but do not use any type of caustic materials for cleaning. Such materials may etch the piston surfaces causing damage.

Inspect the piston and retainer carefully. Replace either part if cracked, porous or damaged in any way. Check condition of the locating lugs on the piston. Be sure the lugs are in good condition and are not worn, chipped or broken.

Inspect the check ball in the piston (Fig. 177). Be sure the ball is secure and is not partially dislodged, or loose. Replace the piston if doubt exists about piston or check ball condition.

Carefully work new piston seals into place by hand. Apply a liberal coating of Mopar Door Ease, or Ru-Glyde to the seals to ease installation. Then cover

DISASSEMBLY AND ASSEMBLY (Continued)

the piston with paper or clean plastic sheeting to keep it dust free for assembly installation.

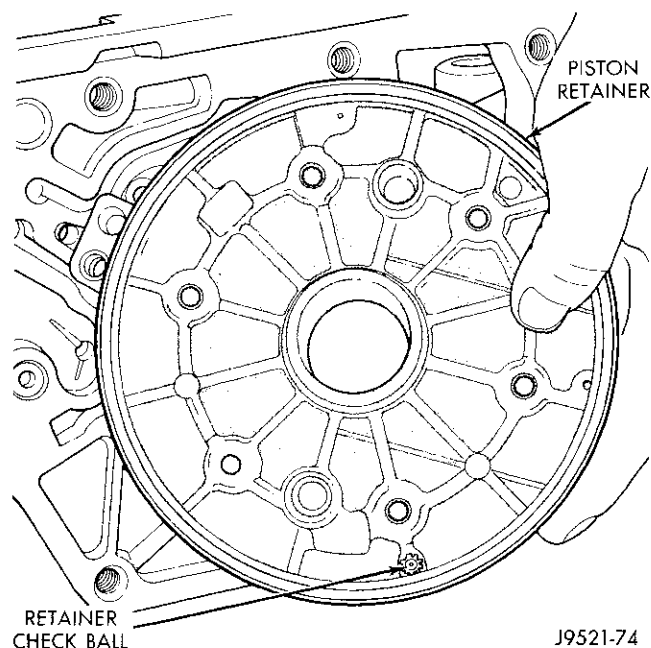


Fig. 177 Overdrive Piston

OVERRUNNING CLUTCH

Inspect condition of the clutch cam, cage-type retainer, rollers, springs and clutch race.

Replace the clutch cam if worn or damaged. Also check fit of the cam in the transmission case. If the cam is loose, the case may be worn, or cracked.

The clutch race is permanently pressed onto the low-reverse drum hub. If either the drum or race are worn or damaged, replace the drum and race as an assembly. Check fit of the race on the low-reverse drum hub splines. Replace the drum and race as an assembly if the race is loose on the hub splines.

Examine the overrunning clutch assembly carefully. Replace assembly if the rollers, springs, or cage-type retainer are worn, or damaged.

If the clutch cam requires replacement, install a new cam as described in the following procedure.

OVERRUNNING CLUTCH CAM REPLACEMENT

(1) Tap old cam out of case with pin punch. Insert punch through bolt holes at rear of case (Fig. 178). Alternate position of punch to avoid cocking cam during removal.

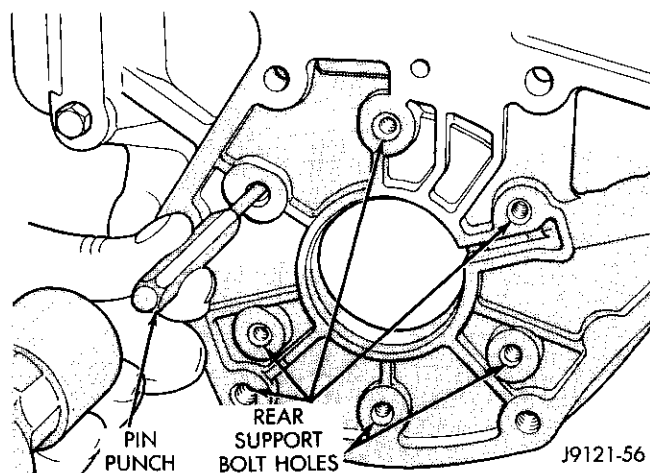


Fig. 178 Overrunning Clutch Cam

(2) Clean clutch cam bore and case. Be sure to remove all chips/shavings generated during cam removal.

(3) Temporarily install overdrive piston retainer in case. Use 3-4 bolts to secure retainer.

(4) Align and start new clutch cam and spring retainer in case. Be sure serrations on cam and in case are aligned (Fig. 179). Then tap cam into case just enough to hold it in place.

(5) **Verify that cam is correctly positioned before proceeding any further. Narrow ends of cam ramps should be to left when cam is viewed from front end of case (Fig. 179).**

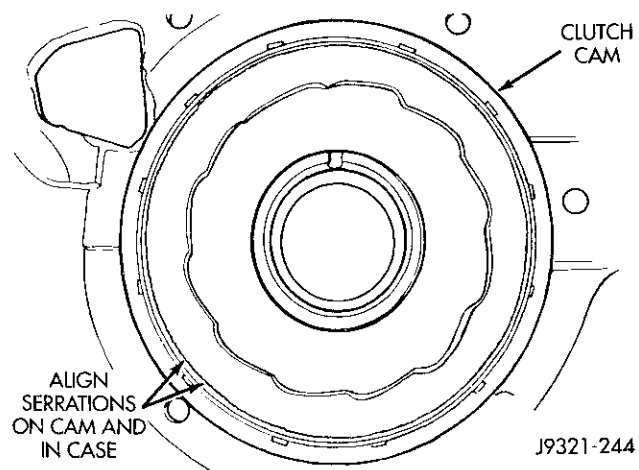


Fig. 179 Positioning Replacement Clutch Cam In Case

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Insert Adapter Tool SP-5124 into piston retainer (Fig. 180).

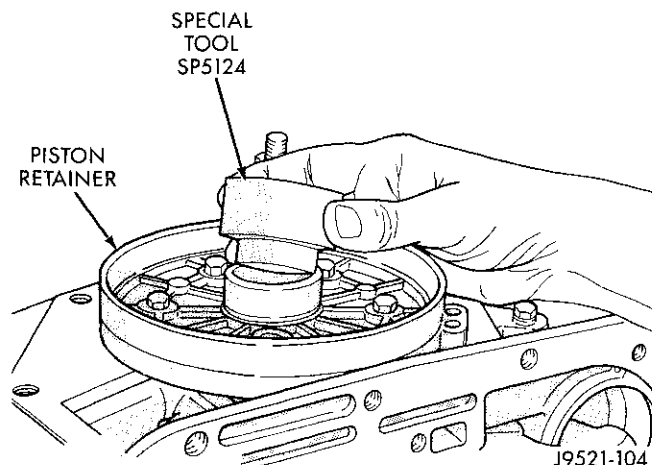


Fig. 180 Positioning Adapter Tool In Overdrive Piston Retainer

(7) Assemble Puller Bolt SP-3701 and Press Plate SP-3583-A (Fig. 181).

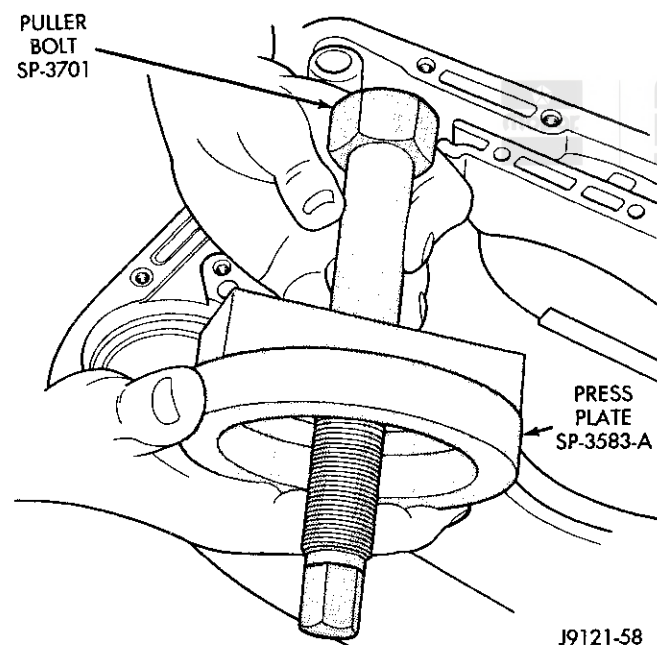


Fig. 181 Assembling Clutch Cam Puller Bolt And Press Plate

(8) Install assembled puller plate and bolt (Fig. 182). Insert bolt through cam, case and adapter tool. Be sure plate is seated squarely on cam.

(9) Hold puller plate and bolt in place and install puller nut SP-3701 on puller bolt (Fig. 183).

(10) Tighten puller nut to press clutch cam into case (Fig. 183). **Be sure cam is pressed into case evenly and does not become cocked.**

(11) Remove clutch cam installer tools.

(12) Stake case in 12 places around clutch cam to help secure cam in case. Use blunt punch or chisel to stake case.

(13) Remove piston retainer from case. Cover retainer with plastic sheeting, or paper to keep it dust free.

(14) Clean case and cam thoroughly. Be sure any chips/shavings generated during cam installation are removed from case.

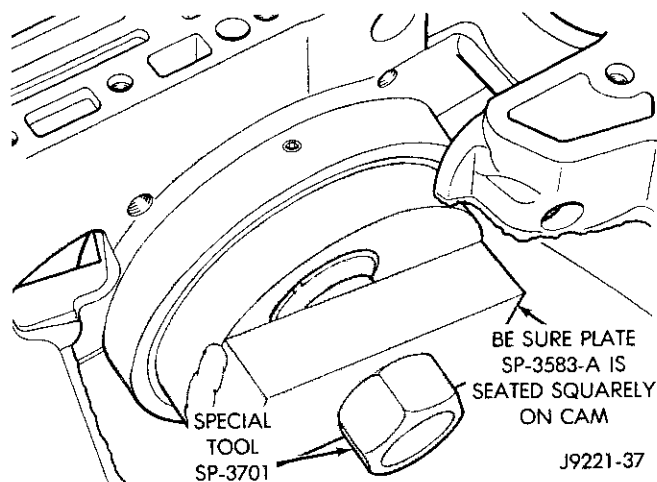


Fig. 182 Positioning Puller Plate On Clutch Cam

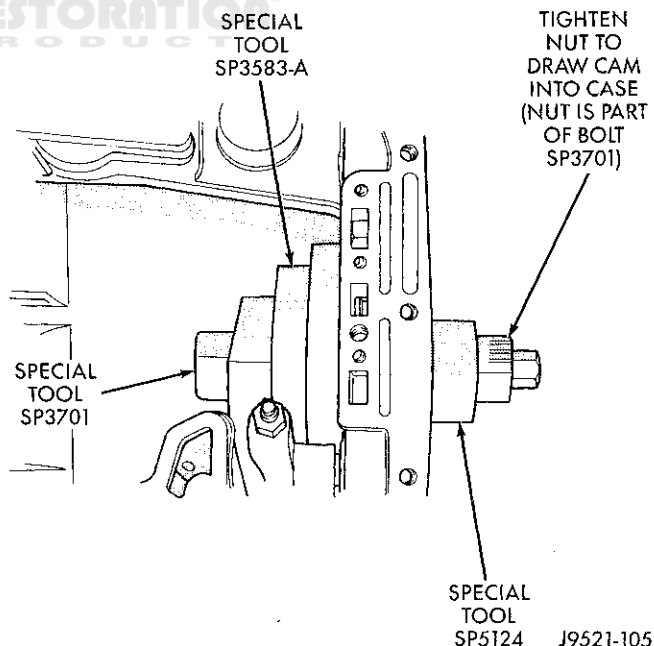


Fig. 183 Pressing Overrunning Clutch Cam Into Case

OVERRUNNING CLUTCH INSTALLATION

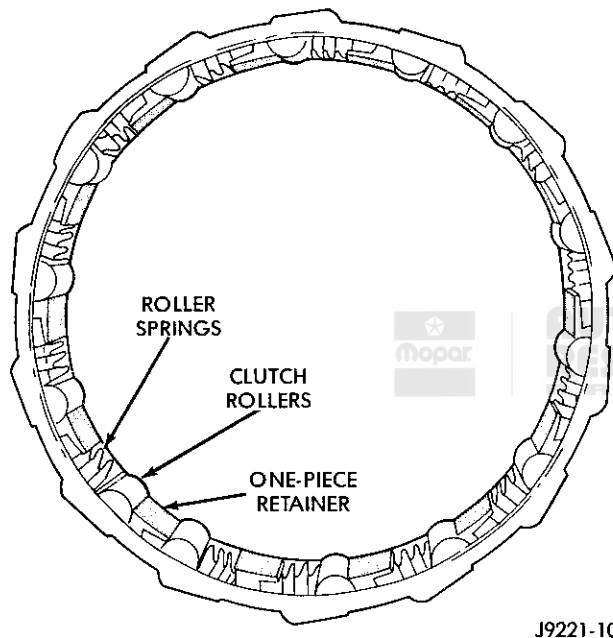
(1) Lubricate overdrive piston retainer hub, clutch race, clutch cam, and overrunning clutch rollers with transmission fluid.

DISASSEMBLY AND ASSEMBLY (Continued)

(2) If any overrunning clutch rollers or springs came out of retainer, reinstall them as follows: Install and seat spring in retainer first. Then insert roller between spring and retainer stop as shown (Fig. 184). Verify that each roller and spring are fully seated before proceeding.

(3) Install and seat clutch assembly in cam (Fig. 185). **The roller retainer is a one-way fit in the cam. The flanged side of the retainer should be facing outward. The retainer and rollers will slip easily into the cam when properly positioned.**

(4) Check overrunning clutch operation. Low-reverse drum should rotate freely in clockwise direction and lock in counterclockwise direction.



J9221-10

Fig. 184 Overrunning Clutch Roller And Spring Position In Retainer

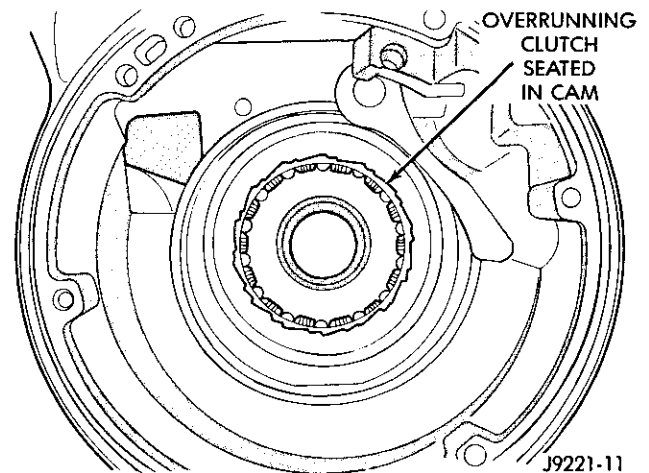
FRONT SERVO PISTON**DISASSEMBLE**

- (1) Remove seal ring from rod guide (Fig. 186).
- (2) Remove small snap ring from servo piston rod. Then remove piston rod, spring and washer from piston.
- (3) Remove and discard servo component O-ring and seal rings.

ASSEMBLE

Clean and inspect front servo components.

- (1) Lubricate new O-ring and seal rings with petroleum jelly and install them on piston, guide and rod.

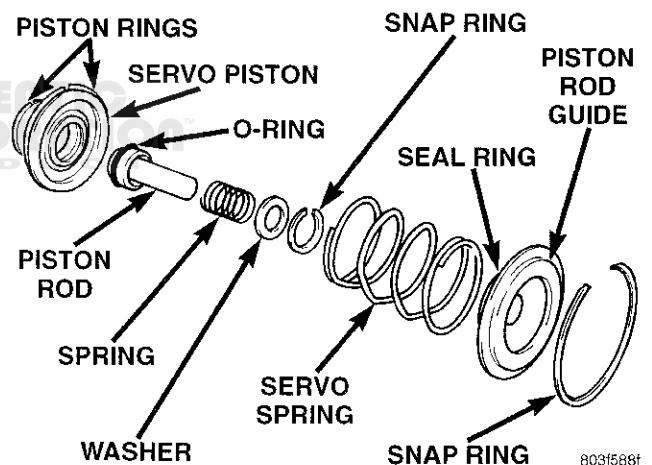


J9221-11

Fig. 185 Overrunning Clutch Seated In Cam

(2) Install rod in piston. Install spring and washer on rod. Compress spring and install snap ring (Fig. 186).

(3) Set servo components aside for installation during transmission reassembly.



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Fig. 186 Front Servo

REAR SERVO PISTON**DISASSEMBLE**

- (1) Remove small snap ring and remove plug and spring from servo piston (Fig. 187).
- (2) Remove and discard servo piston seal ring.
- (3) Lubricate piston and guide seals with petroleum jelly. Lubricate other servo parts with Mopar ATF Plus transmission fluid.

ASSEMBLE

- (1) Install new seal ring on servo piston.
- (2) Assemble piston, plug, spring and new snap ring.
- (3) Lubricate piston seal lip with petroleum jelly.

DISASSEMBLY AND ASSEMBLY (Continued)

(4) Set servo components aside for assembly installation.

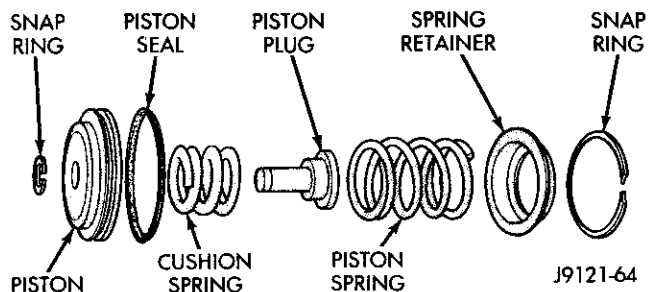


Fig. 187 Rear Servo Components

OIL PUMP AND REACTION SHAFT SUPPORT**DISASSEMBLE**

(1) Mark position of support in oil pump body for assembly alignment reference. Use scribe or paint to make alignment marks.

(2) Place pump body on two wood blocks.

(3) Remove reaction shaft support bolts and separate support from pump body (Fig. 188).

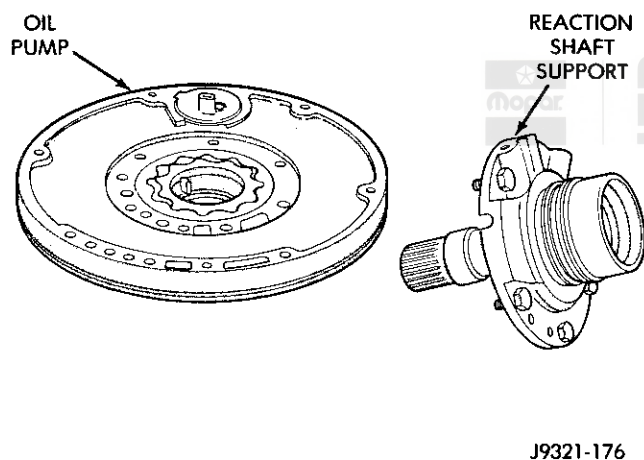


Fig. 188 Reaction Shaft Support

(4) Remove pump inner and outer gears (Fig. 189).
(5) Remove O-ring seal from pump body (Fig. 190). Discard seal after removal.

(6) Remove oil pump seal with Remover Tool C-3981. Discard seal after removal.

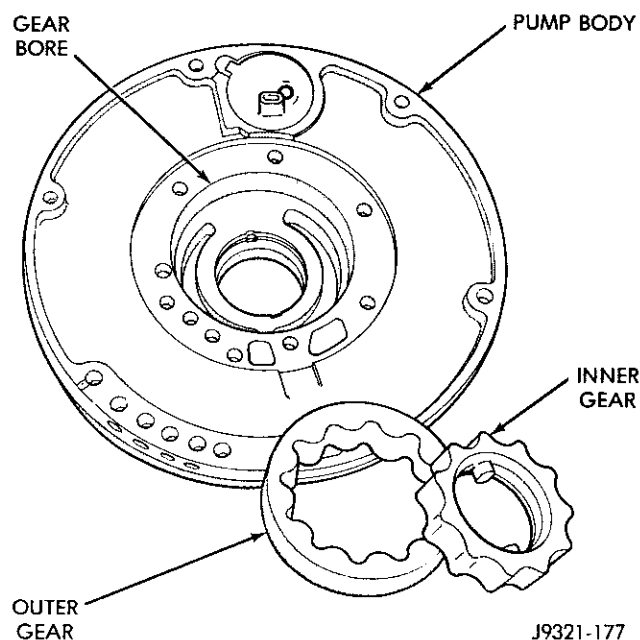


Fig. 189 Pump Gear

OIL PUMP BUSHING REMOVAL

(1) Position pump housing on clean, smooth surface with gear cavity facing down.

(2) Remove bushing with Tool Handle C-4171 and Bushing Remover SP-3550 (Fig. 191).

OIL PUMP BUSHING INSTALLATION

(1) Assemble Tool Handle C-4171 and Bushing Installer SP-5118.

(2) Place bushing on installer tool and start bushing into shaft.

(3) Tap bushing into place until Installer Tool SP-5118 bottoms in pump cavity. Keep tool and bushing square with bore. Do not allow bushing to become cocked during installation.

(4) Stake pump bushing in two places with blunt punch. Remove burrs from stake points with knife blade (Fig. 192).

REACTION SHAFT SUPPORT BUSHING REMOVAL

(1) Assemble Cup Tool SP-3633, Nut SP-1191 and Bushing Remover SP-5301 (Fig. 193).

(2) Hold cup tool firmly against reaction shaft. Thread remover tool into bushing as far as possible by hand.

(3) Using wrench, thread remover tool an additional 3-4 turns into bushing to firmly engage tool.

(4) Tighten tool hex nut against cup tool to pull bushing from shaft. Clean all chips from shaft and support after bushing removal.

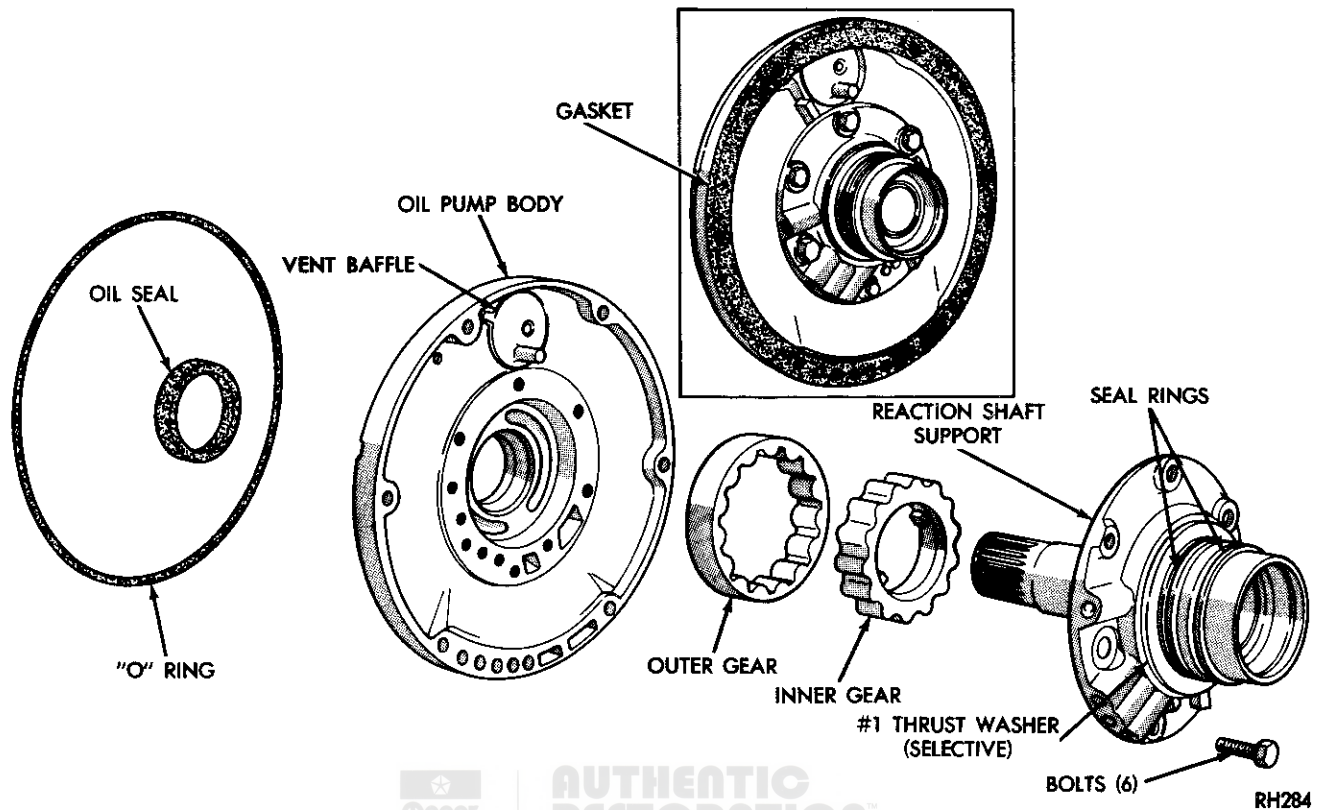


Fig. 190 Oil Pump And Reaction Shaft Components

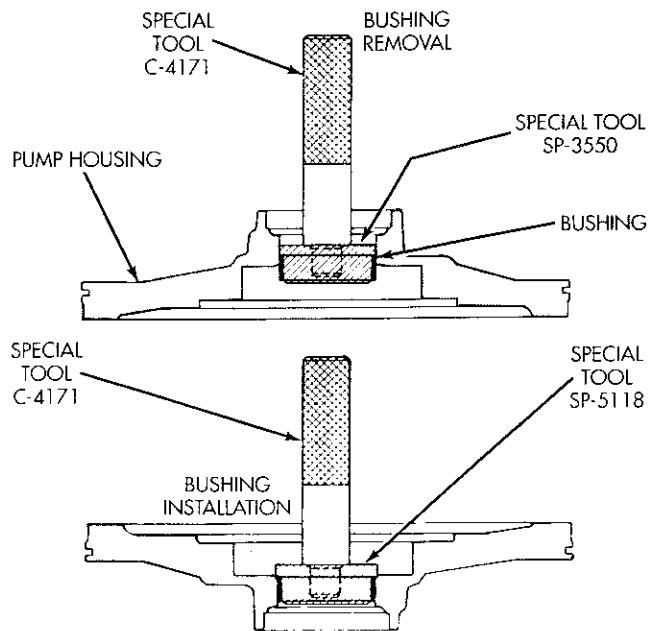


Fig. 191 Oil Pump Bushing

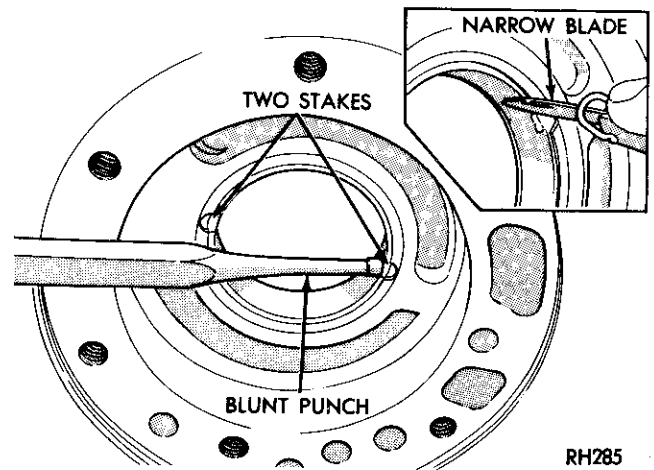


Fig. 192 Staking-Deburring Oil Pump Bushing

J9221-244

DISASSEMBLY AND ASSEMBLY (Continued)**REACTION SHAFT SUPPORT BUSHING INSTALLATION**

(1) Place reaction shaft support upright on a clean, smooth surface.

(2) Assemble Bushing Installer Tools C-4171 and SP-5302. Then slide new bushing onto installer tool (Fig. 193).

(3) Start bushing in shaft. Tap bushing into shaft until installer tool bottoms against support flange.

(4) Clean reaction shaft support thoroughly after bushing replacement (to remove any chips).

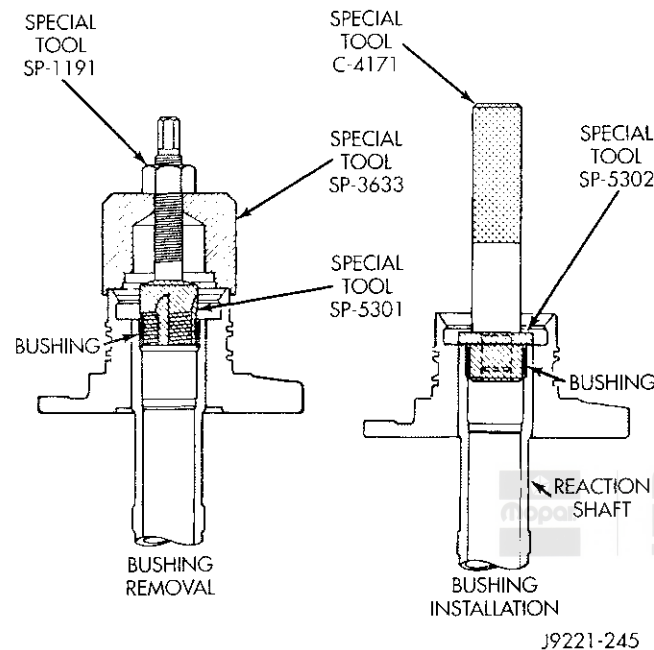


Fig. 193 Reaction Shaft Bushing

ASSEMBLE

(1) Lubricate pump gears with transmission fluid and install them in pump body.

(2) Install thrust washer on reaction shaft support hub. Lubricate washer with petroleum jelly or transmission fluid before installation.

(3) If reaction shaft seal rings are being replaced, install new seal rings on support hub. Lubricate seal rings with transmission fluid or petroleum jelly after installation. Squeeze each ring until ring ends are securely hooked together.

CAUTION: The reaction shaft support seal rings will break if overspread, or twisted. If new rings are being installed, spread them only enough for installation. Also be very sure the ring ends are securely hooked together after installation. Otherwise, the rings will either prevent pump installation, or break during installation.

(4) Align and install reaction shaft support on pump body.

(5) Install bolts attaching reaction shaft support to pump. Tighten bolts to 20 N·m (175 in. lbs.) torque.

(6) Install new pump seal with Installer Tool C-3860-A (Fig. 194). Use hammer or mallet to tap seal into place.

(7) Install new O-ring on pump body. Lubricate oil seal and O-ring with petroleum jelly.

(8) Cover pump assembly to prevent dust entry and set aside for assembly installation.

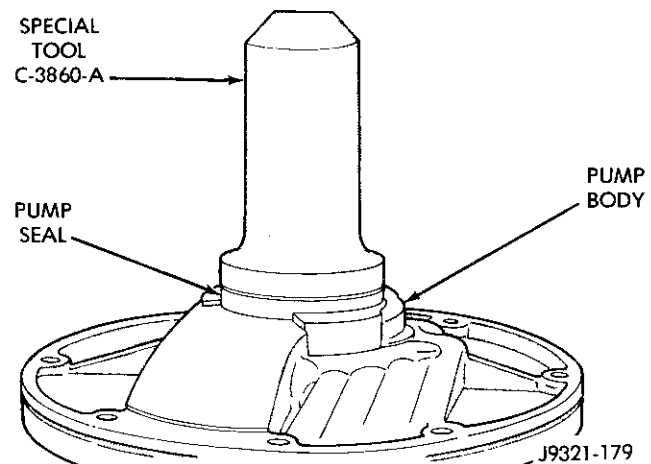


Fig. 194 Oil Pump Seal

FRONT CLUTCH

NOTE: Check number of plates and discs in clutch pack for assembly reference. Some models use an additional clutch disc and plate.

DISASSEMBLE

(1) Remove waved snap ring and remove reaction plate, clutch plates and clutch discs. **Note**

(2) Compress clutch piston retainer and piston springs with Compressor Tool C-3863-A (Fig. 195).

(3) Remove retainer snap ring and remove compressor tool.

(4) Remove clutch piston springs (Fig. 196).

(5) Remove clutch piston from retainer with a twisting motion.

(6) Remove and discard clutch piston inner and outer seals.

FRONT CLUTCH RETAINER BUSHING REMOVAL

(1) Assemble Tool Handle C-4171 and Bushing Remover SP-3629 (Fig. 197).

(2) Insert remover tool in bushing and drive bushing straight out of clutch retainer.

FRONT CLUTCH RETAINER BUSHING INSTALLATION

(1) Mount Bushing Installer SP-5511 on tool handle (Fig. 197).

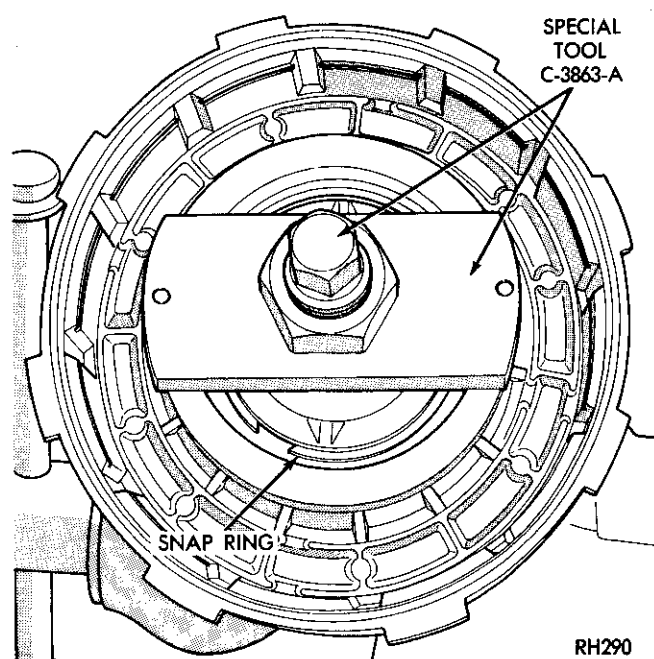
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 195 Removing Front Clutch Spring Retainer Snap Ring

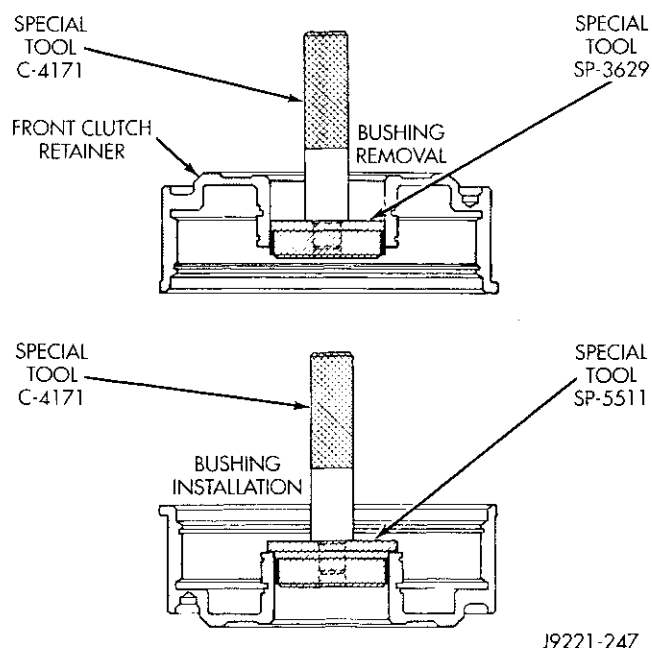


Fig. 197 Front Clutch Retainer Bushing Replacement Tools

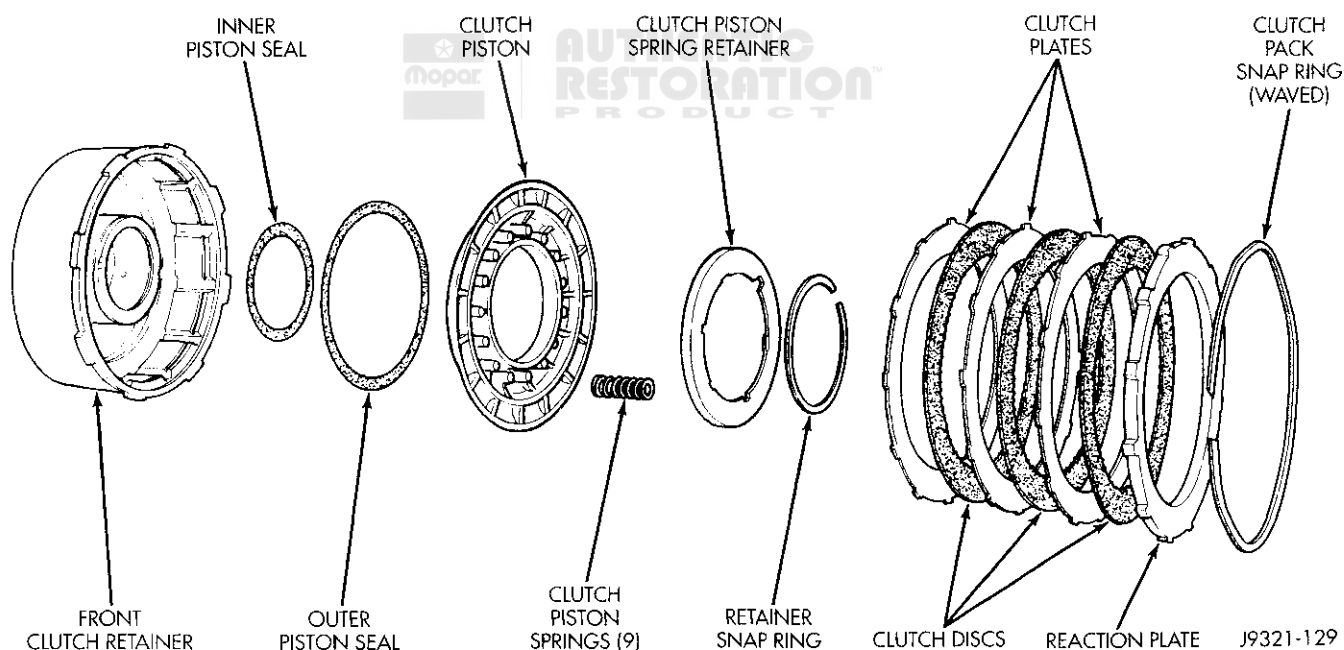


Fig. 196 Front Clutch Components

- (2) Slide new bushing onto installer tool and start bushing into retainer.
- (3) Tap new bushing into place until installer tool bottoms against clutch retainer.
- (4) Remove installer tools and clean retainer thoroughly.

ASSEMBLE

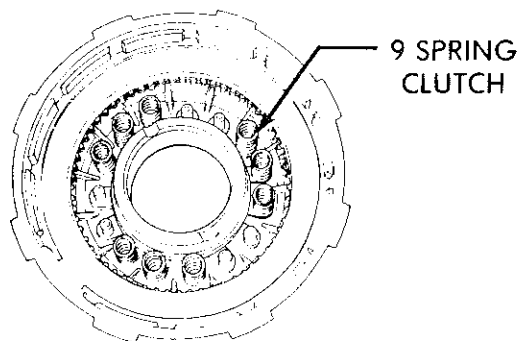
- (1) Soak clutch discs in transmission fluid.

- (2) Install new inner and outer seals on clutch piston. Be sure seal lips face interior of retainer.
- (3) Lubricate new inner and outer piston seals with Ru-Glyde, or Mopar Door Ease.
- (4) Install clutch piston in retainer. Use twisting motion to seat piston in bottom of retainer. A thin strip of plastic (about 0.015 - 0.020 in. thick), can be used to guide seals into place if necessary.

DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Never push the clutch piston straight in. This will fold the seals over causing leakage and clutch slip. In addition, never use any type of metal tool to help ease the piston seals into place. Metal tools will cut, shave, or score the seals.

(5) Install and position nine clutch piston springs (Fig. 198).



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Fig. 198 Front Clutch Spring Position

(6) Install spring retainer on top of piston springs.
(7) Compress spring retainer and piston springs with Tool C-3863-A.

(8) Install spring retainer snap ring and remove compressor tool.

(9) Install clutch plates and discs (Fig. 196). Three clutch discs, three steel plates and one reaction plate are required.

(10) Install reaction plate followed by waved snap ring.

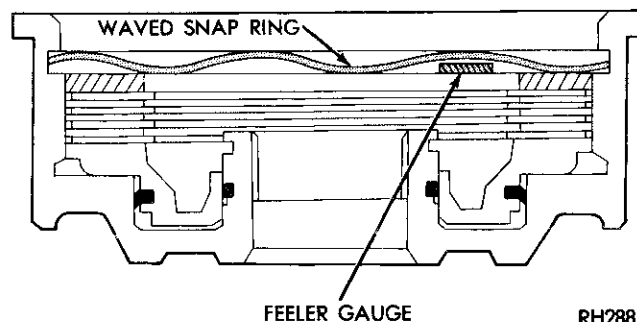
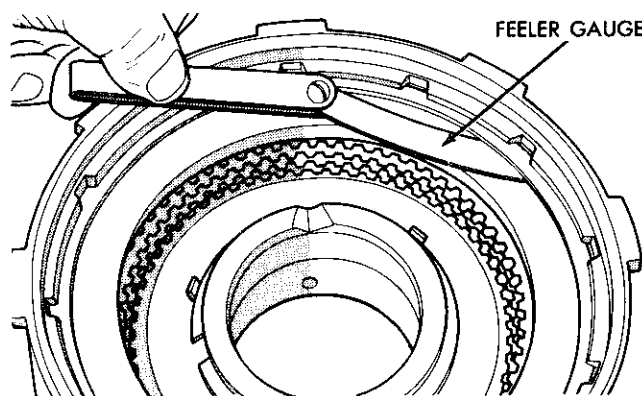
(11) Check clutch pack clearance with feeler gauge (Fig. 199). Clearance between waved spring and pressure plate should 1.78 - 3.28 mm (0.070 - 0.129 in.). If clearance is incorrect, clutch plates, clutch discs, snap ring, or pressure plate may have to be changed.

REAR CLUTCH

NOTE: Check number of plates and discs in clutch pack for assembly reference. Some models use an additional clutch disc and plate.

DISASSEMBLY

- (1) Remove clutch pack select fit snap ring.
- (2) Remove reaction plate and remove clutch plates and discs (Fig. 200).
- (3) Remove pressure plate, wave spring, spacer ring and piston spring from clutch retainer.
- (4) Remove clutch piston from piston retainer with a twisting motion.
- (5) Remove input shaft thrust washer, if washer remained in piston retainer hub during removal.



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Fig. 199 Typical Method Of Measuring Front Clutch Pack Clearance

(6) Remove seals from clutch piston. Discard seals after removal.

INPUT SHAFT REMOVAL

If the input shaft must be replaced, first remove the retaining ring that secures the shaft in the piston retainer hub. Then press the old shaft out of the retainer with a shop press.

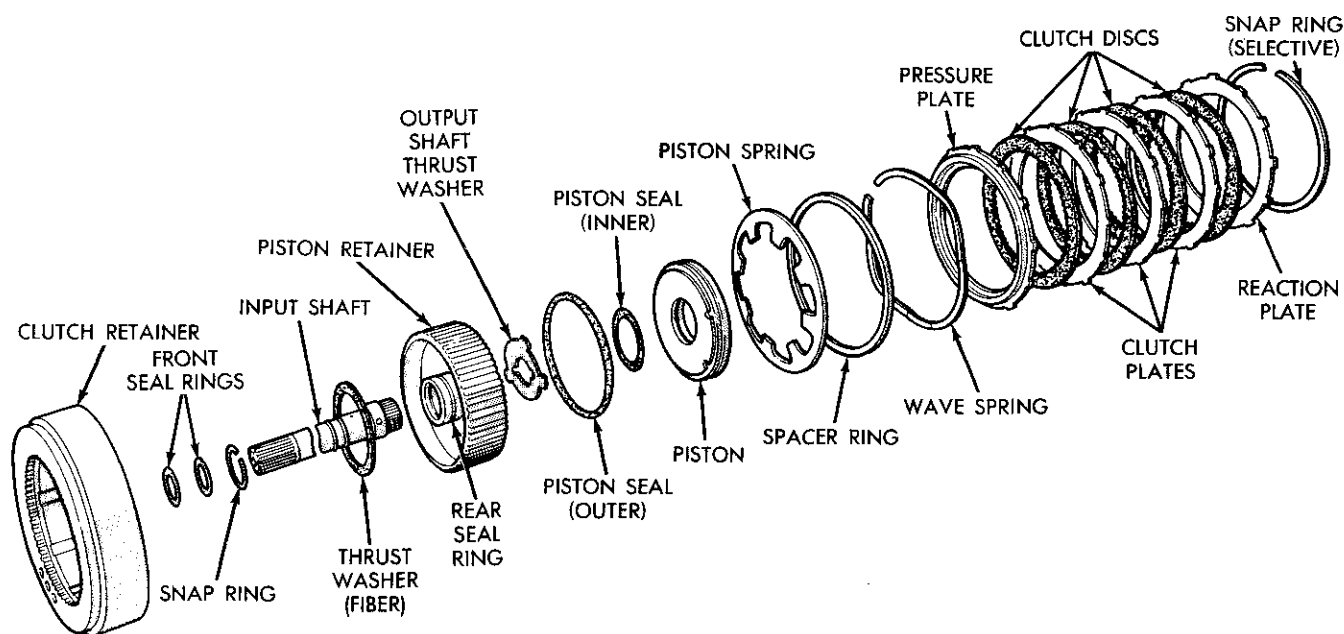
INPUT SHAFT INSTALLATION

Lubricate the splines of the new shaft with petroleum jelly or ATF Plus. Then align the shaft in the piston retainer and carefully press it into place. Do not allow the shaft to become cocked during installation. The retainer can be cracked if misalignment occurs.

Install the shaft retaining ring after pressing the shaft into place. Be sure the ring is fully seated before proceeding with clutch assembly.

ASSEMBLY

- (1) Soak clutch discs in transmission fluid before assembly.
- (2) Install new seals on clutch piston. Lubricate piston seals with Mopar Door Ease, or Ru-Glyde to ease installation. **Be sure seal lips face input shaft.**
- (3) Install clutch piston in retainer. Use twisting motion to seat piston in bottom of retainer. A thin

DISASSEMBLY AND ASSEMBLY (Continued)

J9121-66

Fig. 200 Rear Clutch Components

strip of plastic (about 0.020" thick), can be used to guide seals into place if necessary.

CAUTION: Never push the clutch piston straight in. This will fold the seals over causing leakage and clutch slip. In addition, never use any type of metal tool to help ease the piston seals into place. Metal tools will cut, shave, or score the seals.

(4) Assemble piston retainer and clutch retainer.

(5) Support clutch retainer with wood blocks, or insert input shaft through pre-drilled hole in workbench. Clutch pack components are easier to install if retainers are properly supported.

(6) Install piston spring in clutch retainer. Concave side of spring faces upward and away from clutch piston.

(7) Install spacer ring on top of piston spring.

(8) Install wave spring on top of spacer ring. Then seat wave spring in retainer groove. **If wave spring will not seat properly, spacer ring has probably shifted over and into wave spring groove in retainer. Use small screwdriver to realign spacer ring if necessary.**

(9) Install inner pressure plate in clutch retainer.

(10) Install first clutch disc followed by steel plate until all discs and plates are installed. 4 clutch discs and steel plates are required (Fig. 200).

(11) Install reaction plate on top of last clutch disc.

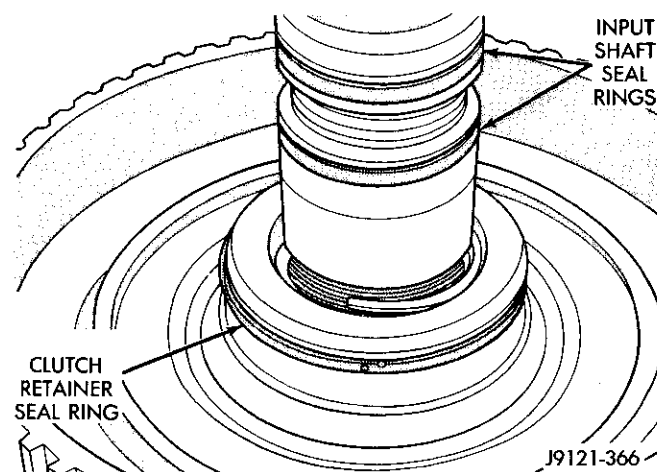
(12) Install selective snap ring to secure clutch pack in retainer.

(13) Install new seal rings on input shaft if necessary (Fig. 201). Be very sure ring ends are all securely hooked together before proceeding.

(14) Check clutch pack clearance with feeler gauge (Fig. 202). Clearance should be 0.63 to 1.14 mm (0.025 to 0.045 in.).

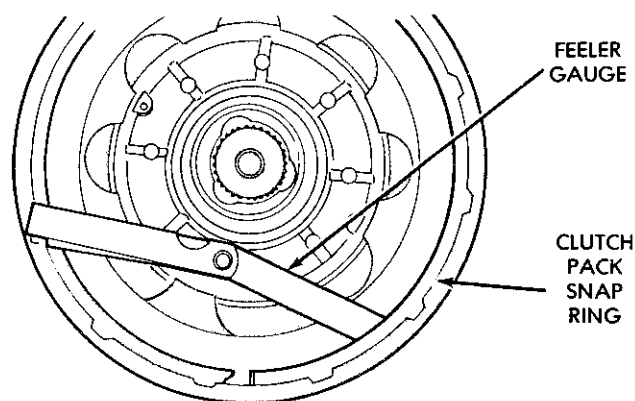
(15) If clutch pack clearance is incorrect, clutch pack snap ring, may have to be replaced.

(16) Install thrust washer on piston retainer hub (Fig. 200). Use petroleum jelly to hold thrust washer in place.



J9121-366

Fig. 201 Input Shaft Seal Ring Locations

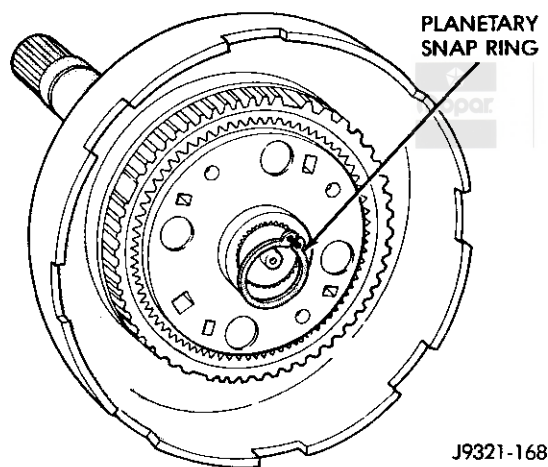
DISASSEMBLY AND ASSEMBLY (Continued)

J9321-167

Fig. 202 Measuring Rear Clutch Pack Clearance
PLANETARY GEARTRAIN

DISASSEMBLY

(1) Remove planetary snap ring from intermediate shaft (Fig. 203). Discard snap ring as it is not reusable.



J9321-168

Fig. 203 Removing Planetary Snap Ring

(2) Remove front planetary gear and front annulus gear as assembly (Fig. 204).

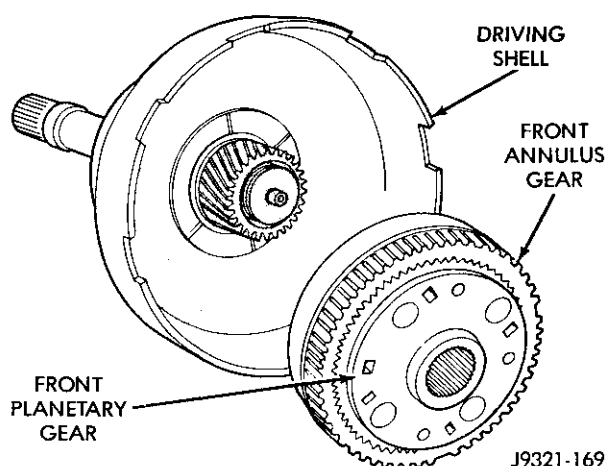
(3) Remove front planetary gear and thrust washer from front annulus gear (Fig. 205). Note thrust washer position for assembly reference.

(4) Remove tabbed thrust washer from driving shell (Fig. 206). Note washer position for assembly reference.

(5) Remove sun gear and driving shell as assembly (Fig. 207).

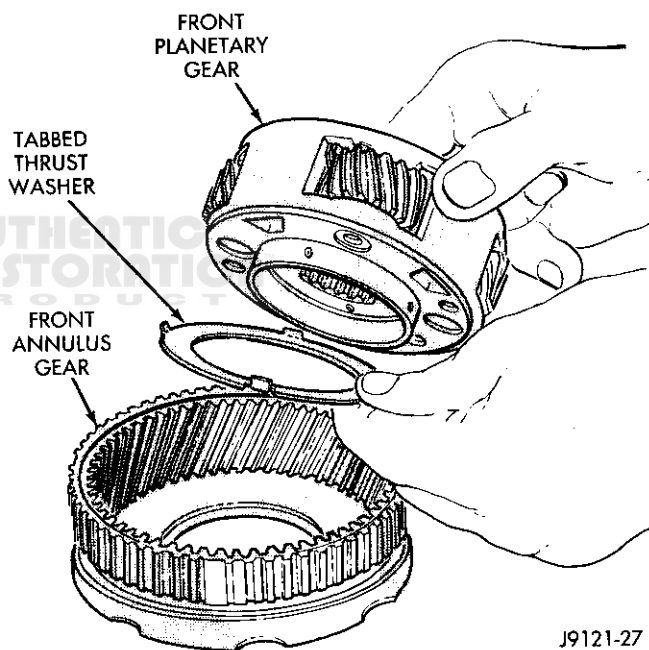
(6) Remove tabbed thrust washer from rear planetary gear (Fig. 208). Note washer position on gear for assembly reference.

(7) Remove rear planetary gear and rear annulus gear from intermediate shaft (Fig. 209).



J9321-169

Fig. 204 Removing Front Planetary And Annulus Gears



J9121-27

Fig. 205 Disassembling Front Planetary And Annulus Gears

(8) Remove thrust plate from rear annulus gear (Fig. 210).

ASSEMBLY

(1) Lubricate sun gear and planetary gears with transmission fluid during assembly. Use petroleum jelly to lubricate intermediate shaft bushing surfaces, thrust washers and thrust plates and to hold these parts in place during assembly.

(2) Install front snap ring on sun gear and install gear in driving shell. Then install thrust plate over sun gear and against rear side of driving shell (Fig. 211). Install rear snap ring to secure sun gear and thrust plate in driving shell.

DISASSEMBLY AND ASSEMBLY (Continued)

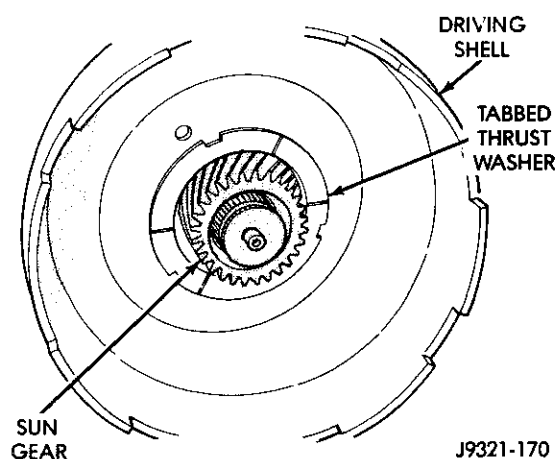


Fig. 206 Driving Shell Thrust Washer Removal

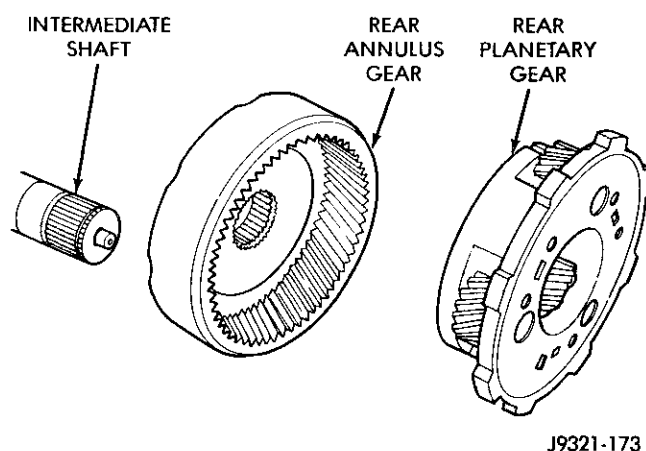


Fig. 209 Rear Planetary And Annulus Gear Removal

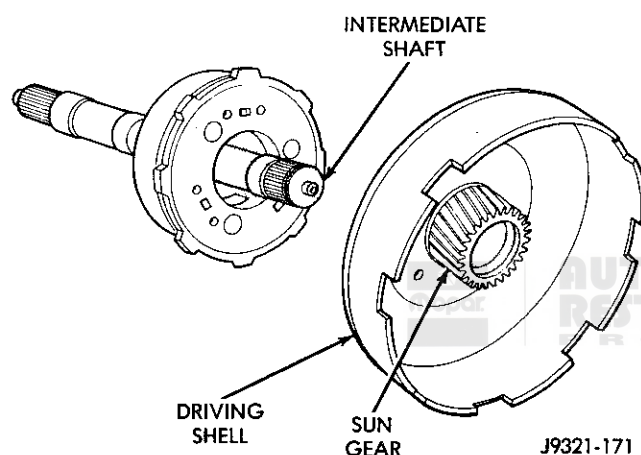


Fig. 207 Sun Gear And Driving Shell Removal

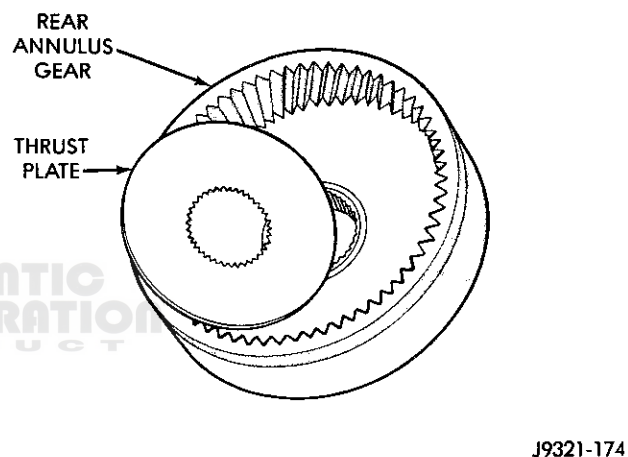


Fig. 210 Rear Annulus Thrust Plate Removal

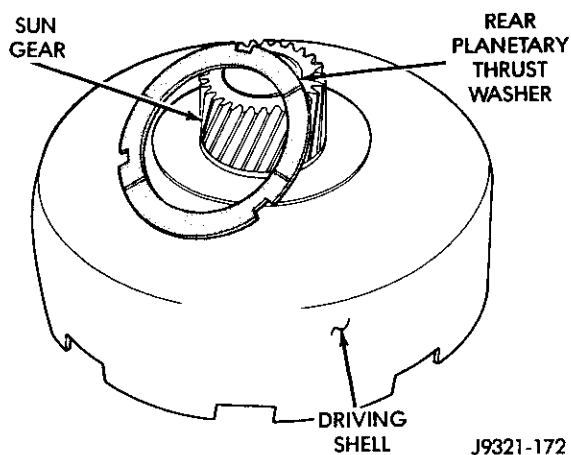


Fig. 208 Rear Planetary Thrust Washer Removal

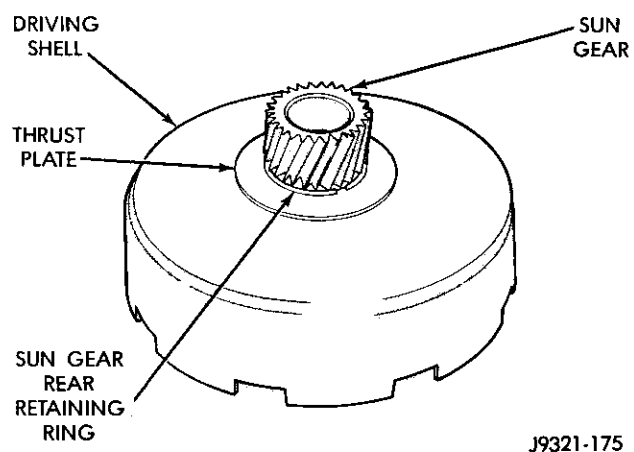


Fig. 211 Sun Gear Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Install rear annulus gear on intermediate shaft (Fig. 212).

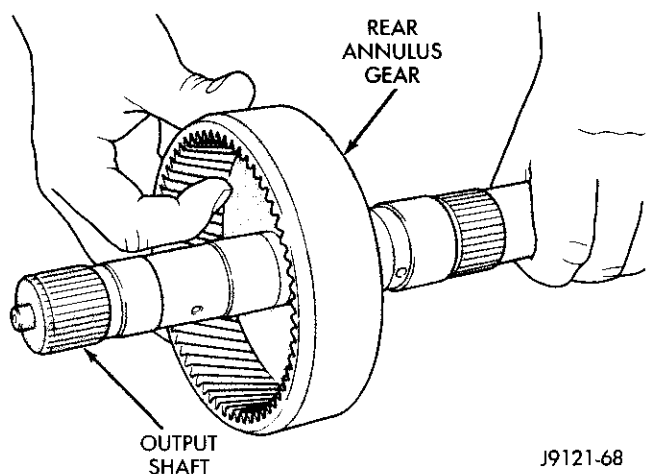


Fig. 212 Installing Rear Annulus Gear On Intermediate Shaft

(4) Install thrust plate in annulus gear (Fig. 213). Be sure plate is seated on shaft splines and against gear.

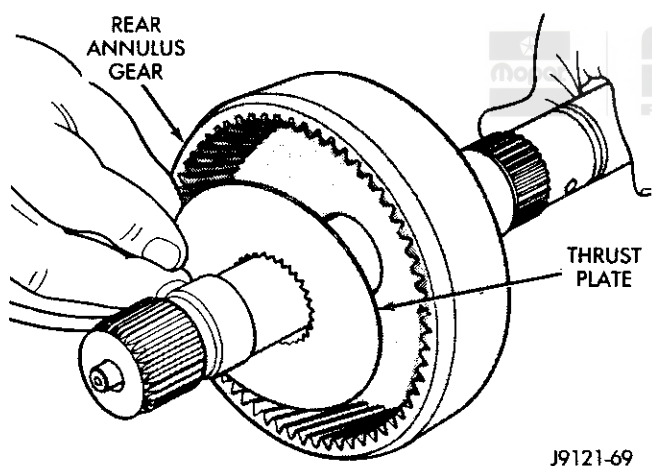


Fig. 213 Installing Rear Annulus Thrust Plate

(5) Install rear planetary gear in rear annulus gear (Fig. 214). Be sure planetary carrier is seated against annulus gear.

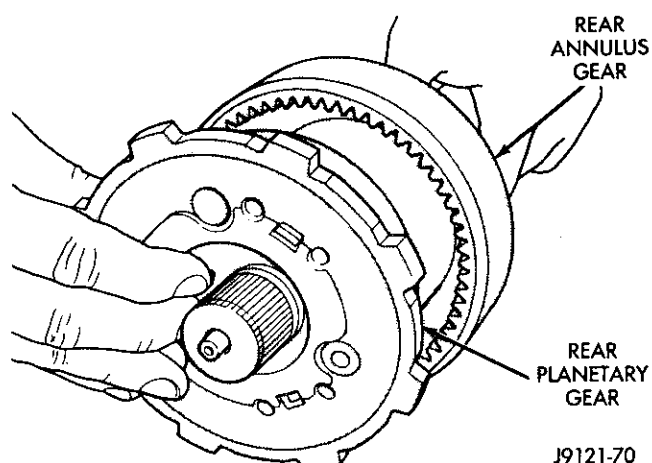


Fig. 214 Installing Rear Planetary Gear

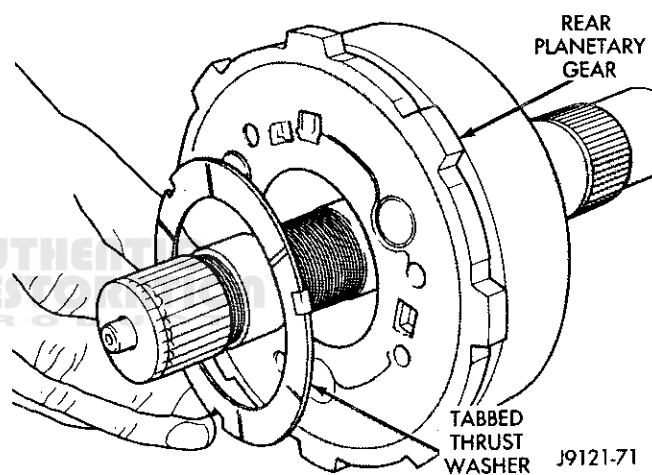


Fig. 215 Installing Rear Planetary Thrust Washer

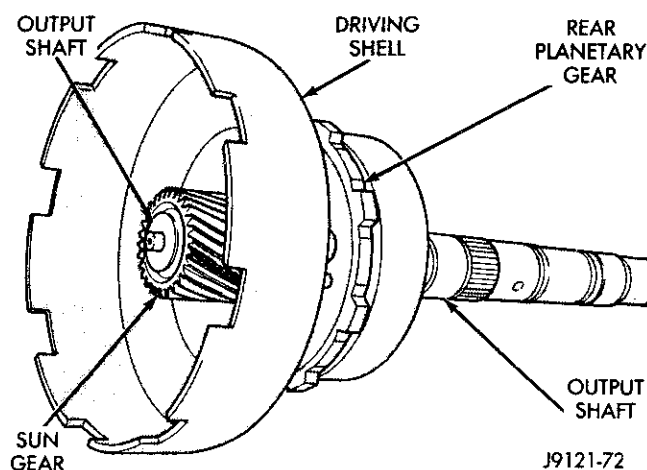


Fig. 216 Installing Sun Gear And Driving Shell

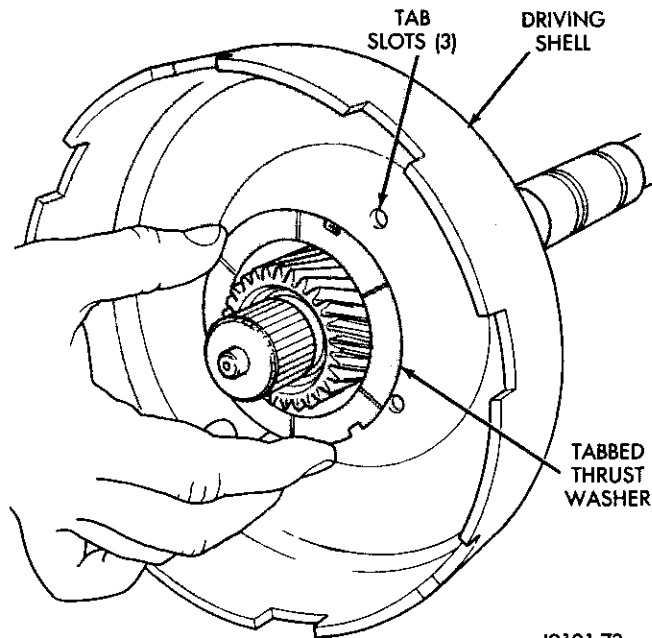
(6) Install tabbed thrust washer on front face of rear planetary gear (Fig. 215). Seat washer tabs in matching slots in face of gear carrier. Use extra petroleum jelly to hold washer in place if desired.

(7) Lubricate sun gear bushings with petroleum jelly or transmission fluid.

(8) Install sun gear and driving shell on intermediate shaft (Fig. 216). Seat shell against rear planetary gear. Verify that thrust washer on planetary gear was not displaced during installation.

DISASSEMBLY AND ASSEMBLY (Continued)

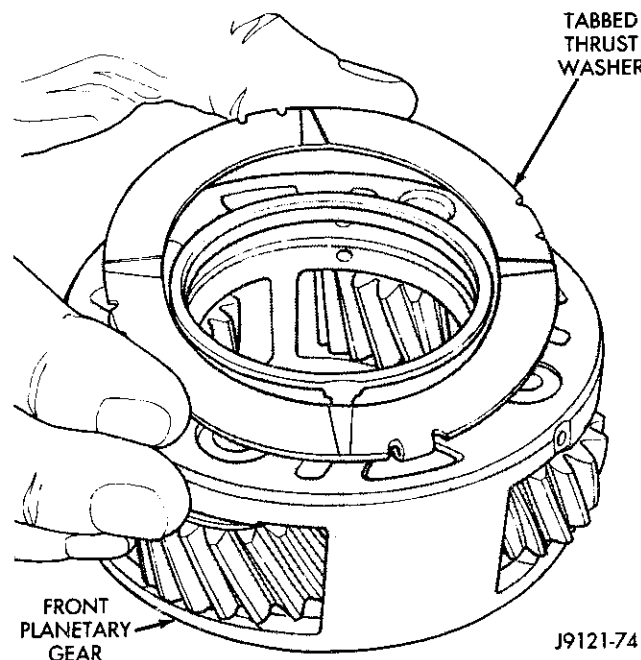
(9) Install tabbed thrust washer in driving shell (Fig. 217). Be sure washer tabs are seated in tab slots of driving shell. Use extra petroleum jelly to hold washer in place if desired.



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Fig. 217 Installing Driving Shell Thrust Washer

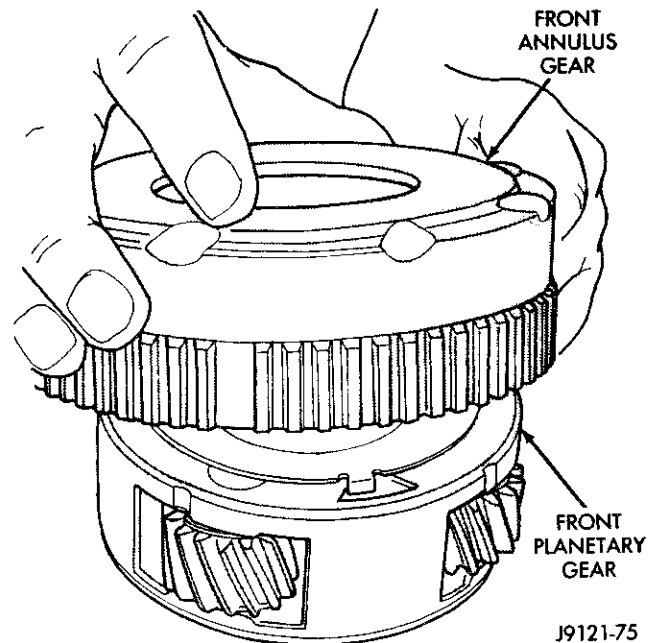
(10) Install tabbed thrust washer on front planetary gear (Fig. 218). Seat washer tabs in matching slots in face of gear carrier. Use extra petroleum jelly to hold washer in place if desired.



J9121-74

Fig. 218 Installing Thrust Washer On Front Planetary Gear

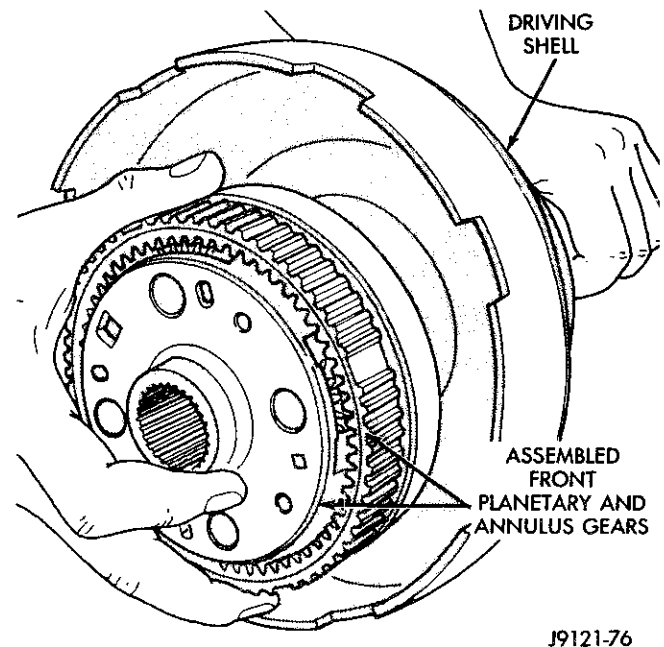
(11) Install front annulus gear over and onto front planetary gear (Fig. 219). Be sure gears are fully meshed and seated.



J9121-75

Fig. 219 Assembling Front Planetary And Annulus Gears

(12) Install front planetary and annulus gear assembly (Fig. 220). Hold gears together and slide them onto shaft. Be sure planetary pinions are seated on sun gear and that planetary carrier is seated on intermediate shaft.



J9121-76

Fig. 220 Installing Front Planetary And Annulus Gear Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

(13) Place geartrain in upright position. Rotate gears to be sure all components are seated and properly assembled. Snap ring groove at forward end of intermediate shaft will be completely exposed when components are assembled correctly.

(14) Install new planetary snap ring in groove at end of intermediate shaft (Fig. 221).

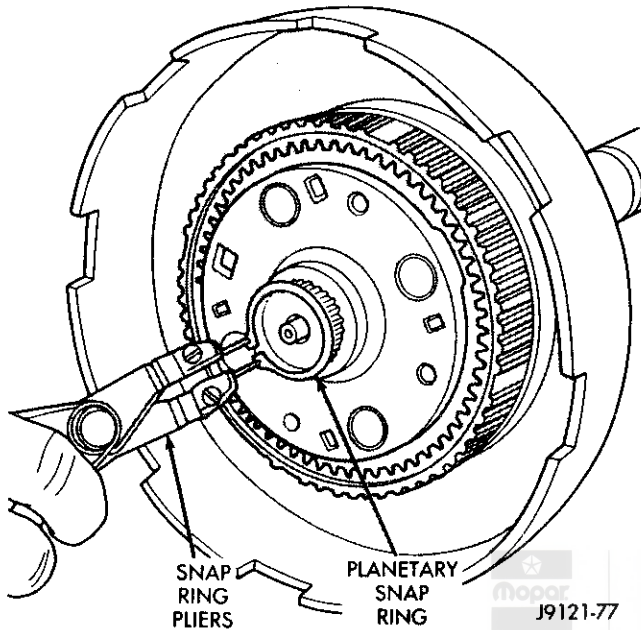


Fig. 221 Installing Planetary Snap Ring

(15) Turn planetary geartrain over. Position wood block under front end of intermediate shaft and support geartrain on shaft. Be sure all geartrain parts have moved forward against planetary snap ring. This is important for accurate end play check.

(16) Check planetary geartrain end play with feeler gauge (Fig. 222). Insert gauge between rear annulus gear and shoulder on intermediate shaft as shown. End play should be 0.15 to 1.22 mm (0.006 to 0.048 in.).

(17) If end play is incorrect, install thinner/thicker planetary snap ring as needed.

OVERDRIVE UNIT

NOTE: Check number of plates and discs in clutch pack for assembly reference. Some models use an additional clutch disc and plate.

DISASSEMBLE

(1) Remove overdrive piston thrust plate (Fig. 223). Retain thrust plate. It is a select fit part and can be reused.

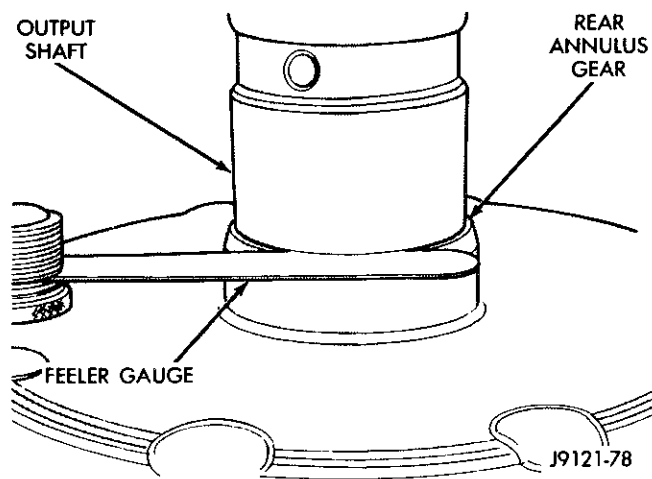


Fig. 222 Checking Planetary Geartrain End Play

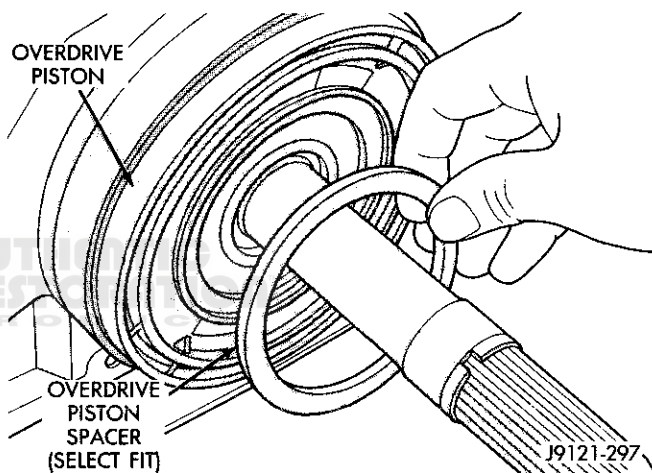


Fig. 223 Overdrive Piston Thrust Plate Removal/Installation

(2) Remove intermediate shaft spacer (Fig. 224). Retain spacer. It is a select fit part and can be reused.

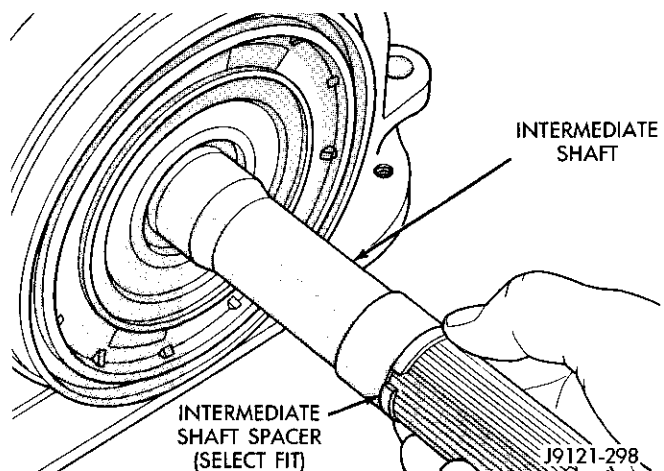


Fig. 224 Intermediate Shaft Spacer Location

DISASSEMBLY AND ASSEMBLY (Continued)

(3) Remove overdrive piston from retainer (Fig. 225).

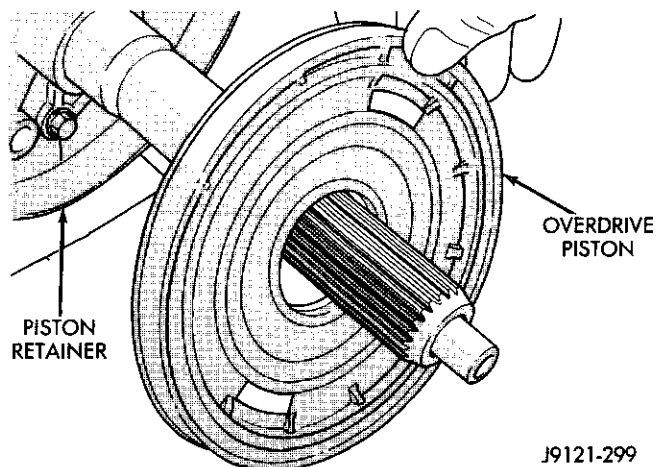


Fig. 225 Removing Overdrive Piston

(4) Remove overdrive piston thrust bearing from direct clutch hub (Fig. 226).

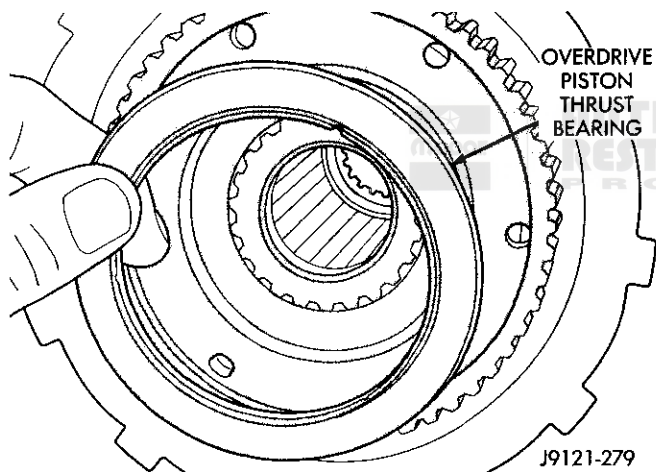


Fig. 226 Removing Overdrive Piston Thrust Bearing

(5) Remove overdrive clutch pack retaining ring (Fig. 227).

(6) Remove overdrive clutch pack (Fig. 228). Note that thickest plate is positioned at rear of clutch pack.

(7) Remove overdrive clutch wave spring (Fig. 229).

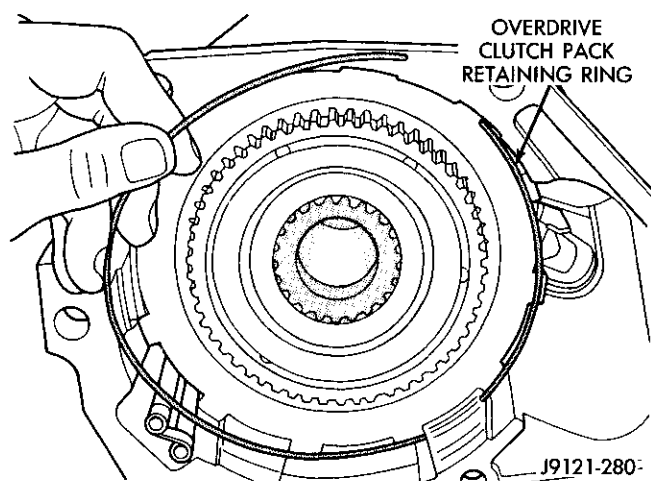


Fig. 227 Removing/Installing Overdrive Clutch Pack Retaining Ring

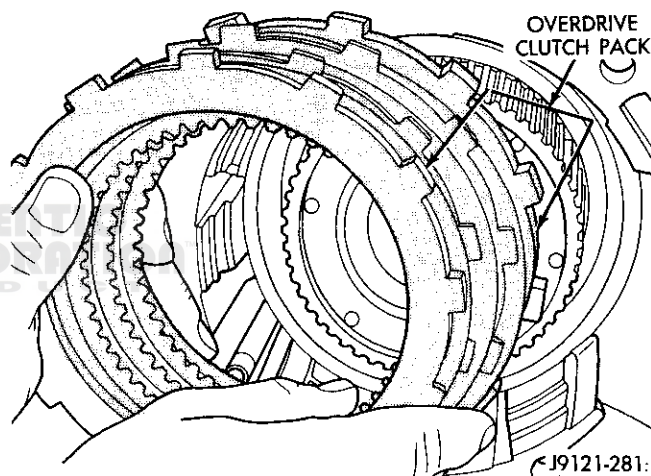


Fig. 228 Overdrive Clutch Pack Removal

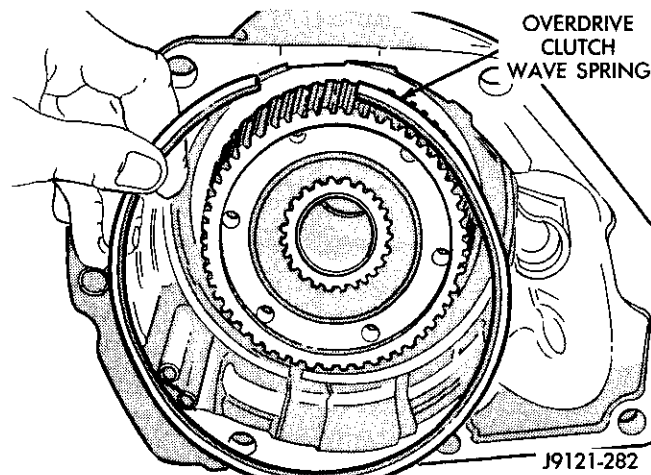


Fig. 229 Removing/Installing Overdrive Clutch Wave Spring

DISASSEMBLY AND ASSEMBLY (Continued)

(8) Remove overdrive clutch reaction snap ring (Fig. 230). Note that snap ring is located in same groove as wave spring.

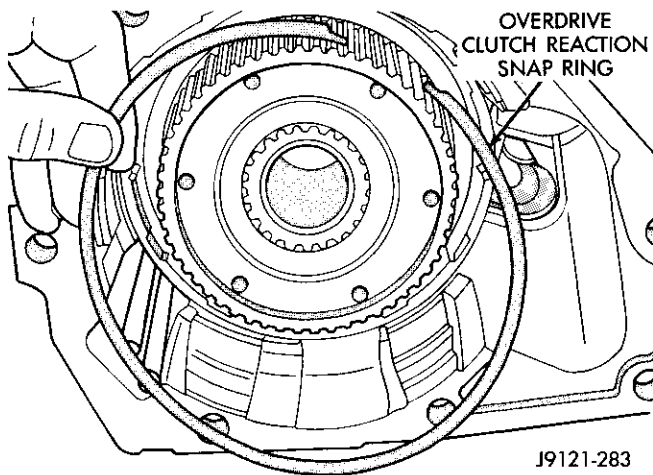


Fig. 230 Removing Overdrive Clutch Reaction Snap Ring

(9) Remove access cover and gasket from case (Fig. 231). Cover provides access to output shaft front bearing locating ring.

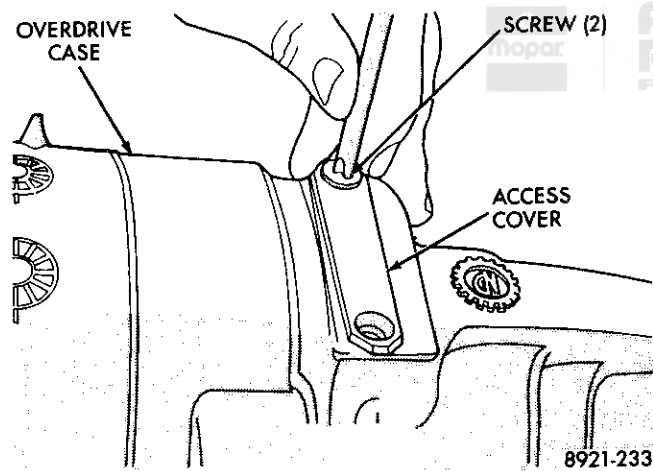


Fig. 231 Removing/Installing Locating Ring Access Cover

(10) Expand output shaft bearing snap ring with snap ring pliers. Then push output shaft forward to release shaft front bearing from locating ring (Fig. 232).

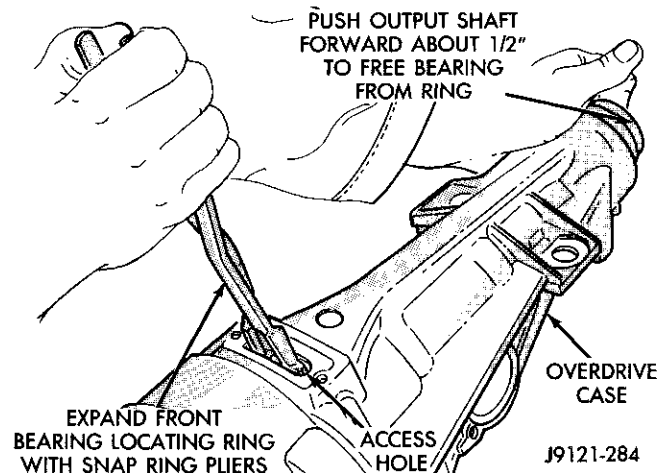


Fig. 232 Releasing Shaft Front Bearing From Locating Ring

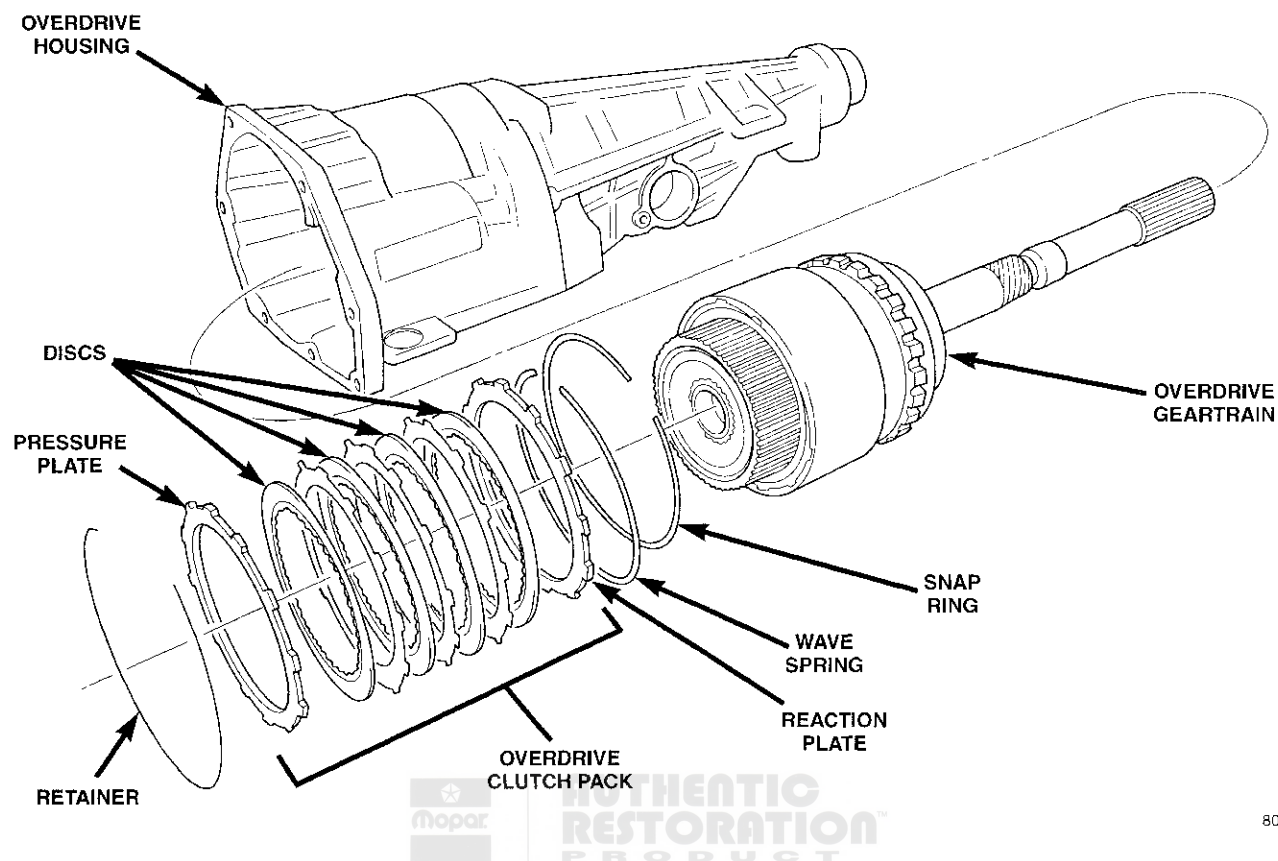
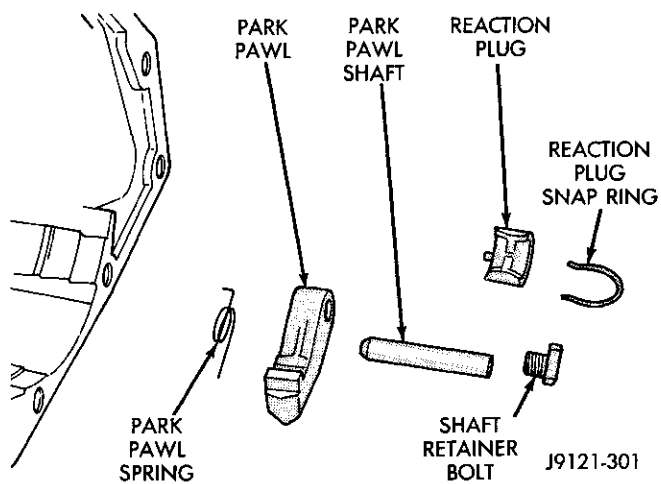
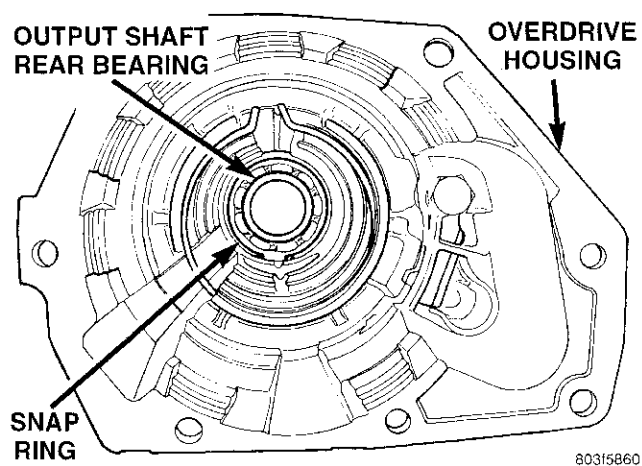
(11) Remove geartrain assembly from housing (Fig. 233). Set geartrain aside.

(12) Remove park pawl retaining bolt and reaction plug snap ring (Fig. 234). Compress snap ring only enough to remove it. Snap ring can be distorted if over compressed.

(13) Remove park pawl shaft, park pawl, pawl spring and reaction plug (Fig. 234).

(14) Remove output shaft rear bearing snap ring (Fig. 235). Remove snap ring with long jaw internal type snap ring pliers. Or, rotate snap ring until one end is adjacent to notch in case. Then unseat ring with extra long flat blade screwdriver.

(15) Remove rear bearing by tapping overdrive case on wood block to dislodge bearing.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 233 Removing Overdrive Geartrain****Fig. 234 Park Lock Component Removal****Fig. 235 Output Shaft Rear Bearing And Snap Ring Location**

DISASSEMBLY AND ASSEMBLY (Continued)**ASSEMBLE**

(1) Install front bearing and snap ring on output shaft (Fig. 236). **Be sure locating ring groove in bearing is toward rear of shaft. Otherwise, housing locating ring and bearing ring groove will not align. Remove and reposition bearing if necessary.**

(2) Install governor drive key in output shaft (Fig. 236). Use petroleum jelly to hold key in place if necessary.

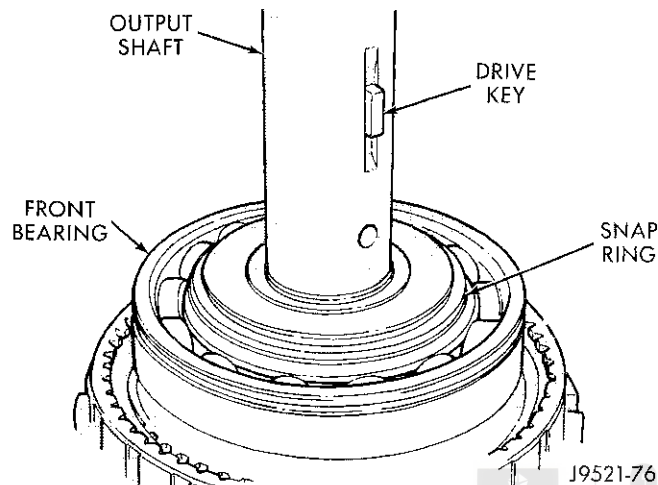


Fig. 236 Front Bearing—Typical

(3) Install output shaft rear bearing in case and install bearing snap ring. Be sure snap ring is fully seated.

(4) Position park pawl and spring in case and install park pawl shaft (Fig. 237). Verify that spring end is hooked to pawl and straight end of spring

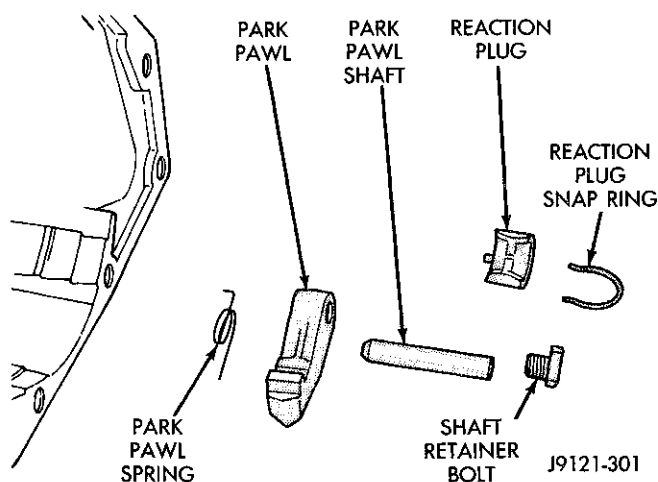


Fig. 237 Park Lock Components

(5) Install pawl shaft retaining bolt. Tighten bolt to 27 N·m (20 ft. lbs.) torque.

(6) Install park lock reaction plug. **Note that plug has locating pin at rear (Fig. 238).** Be sure pin

is seated in hole in case before installing snap ring.

(7) Install reaction plug snap ring (Fig. 239). **Compress snap ring only enough for installation; do not distort it.**

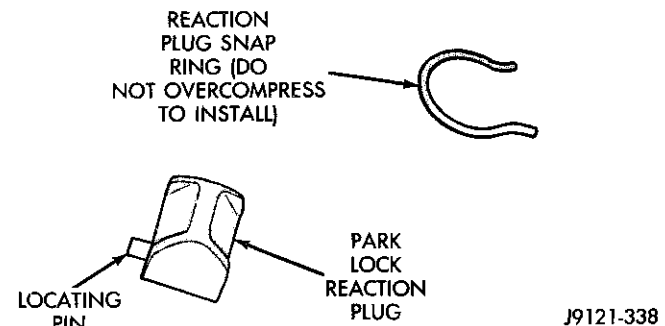


Fig. 238 Reaction Plug Locating Pin And Snap Ring

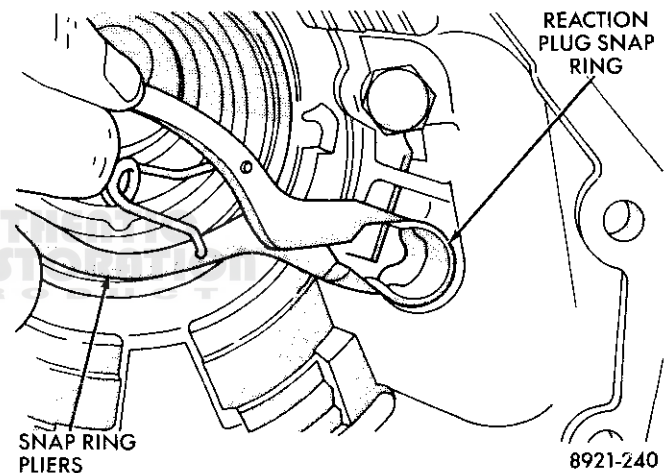


Fig. 239 Reaction Plug And Snap Ring Installation

(8) Install output shaft front bearing locating ring in case.

(9) Support geartrain on Tool 6227-1 (Fig. 240). Be sure tool is securely seated in clutch hub.

(10) Install overdrive unit case over geartrain (Fig. 240).

(11) Expand front bearing locating ring with snap ring pliers. Then slide case downward until locating ring locks in bearing groove and release snap ring.

(12) Install locating ring access plate and gasket in overdrive unit case (Fig. 241).

OVERDRIVE CLUTCH INSTALLATION AND ADJUSTMENT

(1) Verify overdrive clutch pack (Fig. 242). The overdrive clutch requires 4 clutch discs, 3 steel plates, 1 reaction plate and 1 pressure plate.

(2) Install clutch reaction ring first. Reaction ring is flat with notched ends (Fig. 243).

(3) Install wave spring on top of reaction ring. **Reaction ring and wave ring both fit in same**

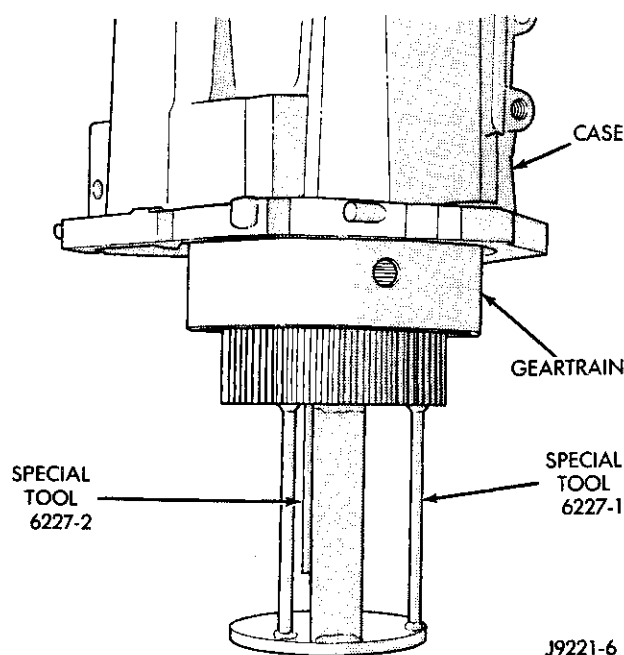


Fig. 240 Installing Overdrive Case On Geartrain

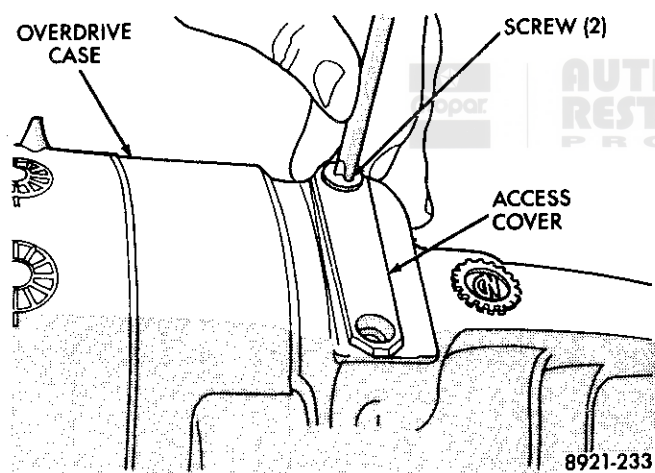


Fig. 241 Locating Ring Access Cover

ring groove. Use screwdriver to seat each ring securely in groove.

- (4) Install clutch pack reaction plate (Fig. 243).
- (5) Install first clutch disc followed by first clutch plate. Install remaining discs and plates in same order.
- (6) Install clutch pack pressure plate (Fig. 242).
- (7) Install clutch pack wire-type retaining ring (Fig. 243).
- (8) Place overdrive unit in vertical position and mount unit in vise or in workbench with appropriate size mounting hole cut into it. Be sure unit is facing upward for access to direct clutch hub.
- (9) Determine correct thickness **intermediate shaft spacer** as follows:

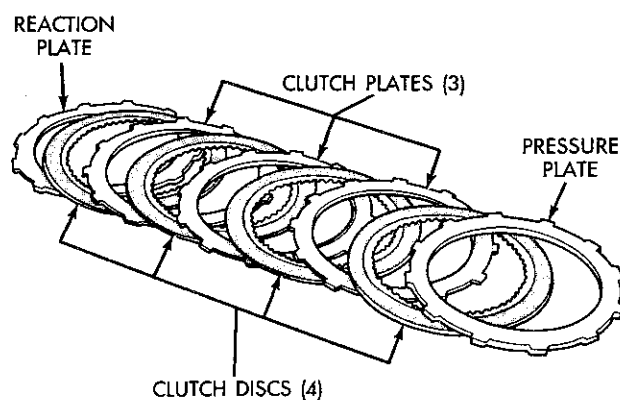


Fig. 242 Overdrive Clutch Pack Components

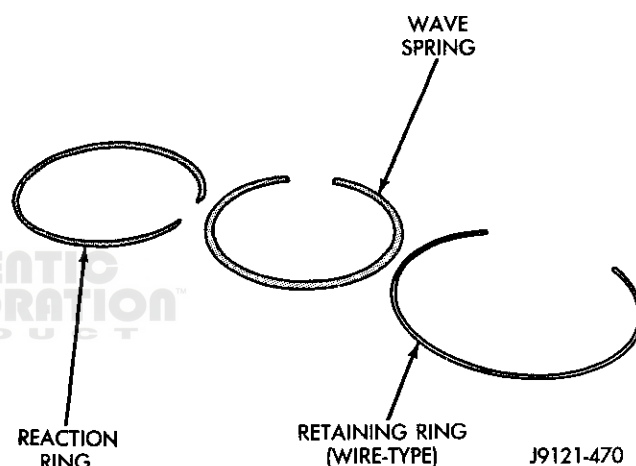


Fig. 243 Overdrive Clutch Ring Identification

(a) Insert Special Tool 6312 through sun gear, planetary gear and into pilot bushing in output shaft. Be sure tool bottoms against planetary shoulder.

(b) Position Gauge Tool 6311 across face of overdrive case (Fig. 244). Then position Dial Caliper C-4962 over gauge tool.

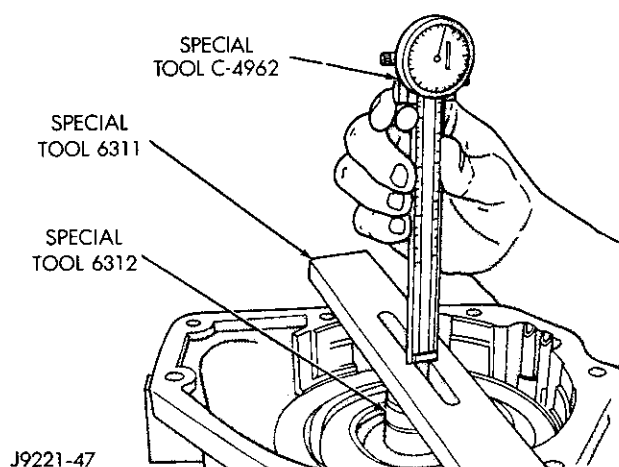
(c) Extend sliding scale of dial caliper downward through gauge tool slot until scale contacts end of Gauge Alignment Tool 6312. Lock scale in place. Remove dial caliper tool and note distance measured (Fig. 244).

(d) Select proper thickness end play spacer from spacer chart based on distance measured (Fig. 245).

(e) Remove Gauge Alignment Tool 6312.

(10) Determine correct thickness **overdrive piston thrust plate** as follows:

(a) Position Gauge Tool 6311 across face of overdrive case. Then position Dial Caliper C-4962 over gauge tool (Fig. 246).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 244 Shaft End Play Measurement**

End Play Measurement (Inches)	Spacer Thickness (Inches)
.7336 - .7505	.158 - .159
.7506 - .7675	.175 - .176
.7676 - .7855	.193 - .194
.7856 - .8011	.211 - .212

J9121-341

Fig. 245 Intermediate Shaft End Play Spacer Selection

(b) Measure distance to clutch hub thrust bearing seat at four points 90° apart. Then average measurements by adding them and dividing by 4.

(c) Select and install required thrust plate from information in thrust plate chart (Fig. 247).

(11) Leave Alignment Tool 6227-2 in place. Tool will keep planetary and clutch hub splines in alignment until overdrive unit is ready for installation on transmission.

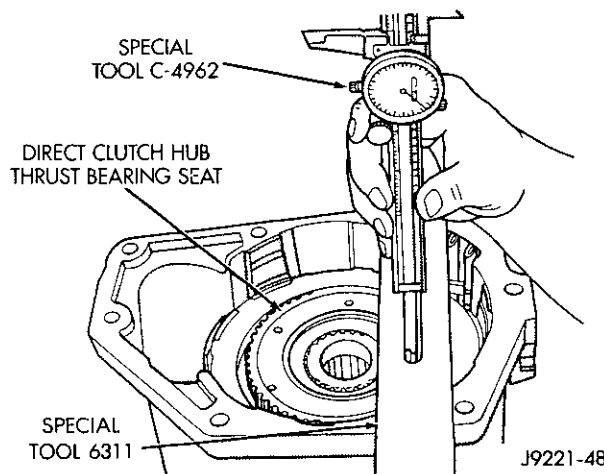
OVERDRIVE GEARTRAIN

NOTE: Check number of plates and discs in clutch pack for assembly reference. Some models use an additional clutch disc and plate.

DISASSEMBLE

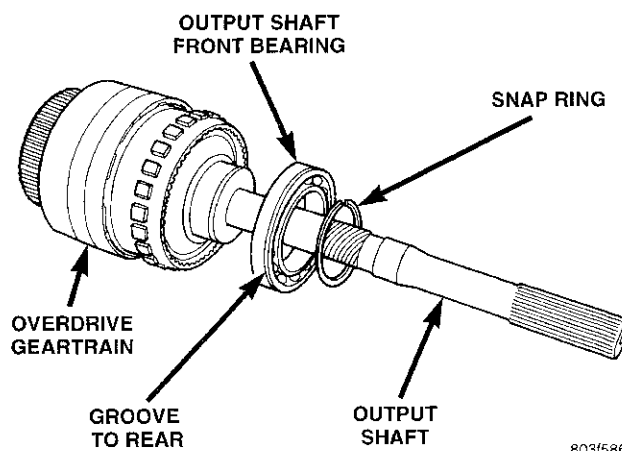
(1) Remove output shaft front bearing snap ring (Fig. 248).

(2) Remove front bearing from output shaft (Fig. 248).

**Fig. 246 Overdrive Piston Thrust Plate Measurement**

End Play Measurement (Inches)	Spacer Thickness (Inches)
1.7500 - 1.7649	.108 - .110
1.7650 - 1.7799	.123 - .125
1.7800 - 1.7949	.138 - .140
1.7950 - 1.8099	.153 - .155
1.8100 - 1.8249	.168 - .170
1.8250 - 1.8399	.183 - .185
1.8400 - 1.8549	.198 - .200
1.8550 - 1.8699	.213 - .215
1.8700 - 1.8849	.228 - .230
1.8850 - 1.8999	.243 - .245

J9121-342

Fig. 247 Overdrive Piston Thrust Plate Selection**Fig. 248 Removing Snap Ring And Front Bearing**

DISASSEMBLY AND ASSEMBLY (Continued)

WARNING: THE NEXT STEP IN GEARTRAIN DISASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 830 POUNDS. USE SPRING COMPRESSOR TOOL 6227-1 AND A HYDRAULIC SHOP PRESS WITH A MINIMUM RAM TRAVEL OF 5-6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

- (3) Mount geartrain in shop press.
- (4) Position Compressor Tool 6227-1 on clutch hub (Fig. 249). Support output shaft flange with steel press plates as shown and center assembly under press ram.
- (5) Apply press pressure slowly. Compress hub and spring far enough to expose clutch hub retaining ring and relieve spring pressure on clutch pack snap ring (Fig. 249).
- (6) Remove direct clutch pack snap ring first (Fig. 249).

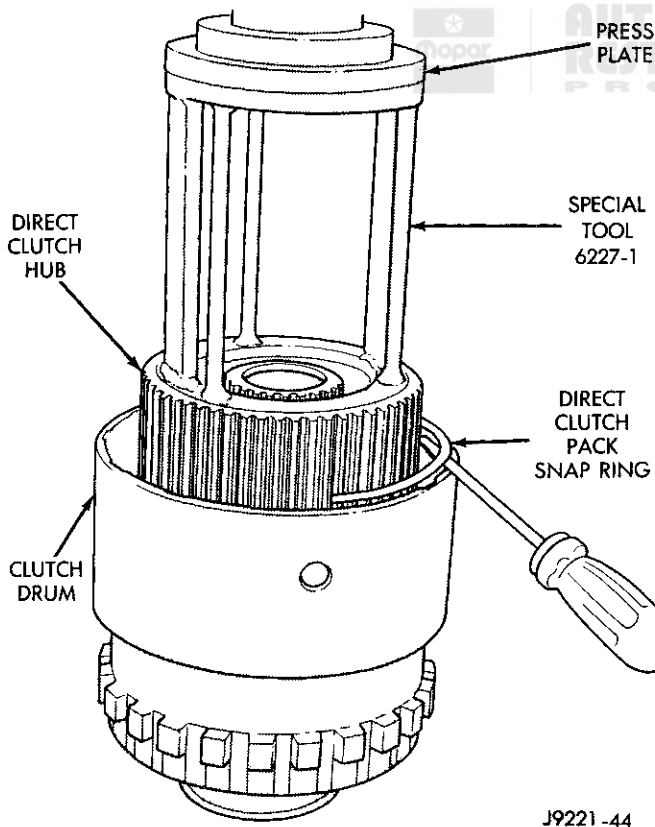


Fig. 249 Removing Direct Clutch Pack Snap Ring

- (7) Remove direct clutch hub retaining ring (Fig. 250).

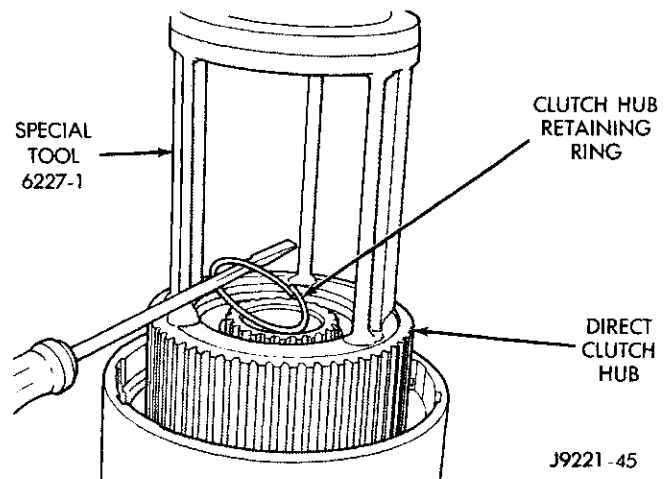


Fig. 250 Removing Direct Clutch Hub Retaining Ring

- (8) Release press load on clutch spring **slowly and completely**. Remove press tools and geartrain.
- (9) Remove direct clutch pack from hub (Fig. 251).

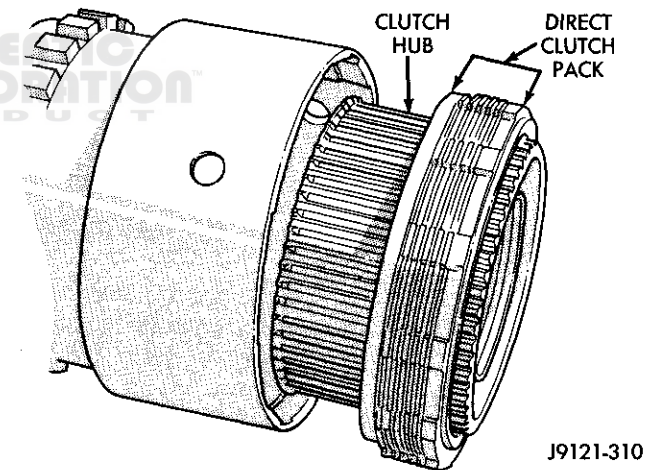
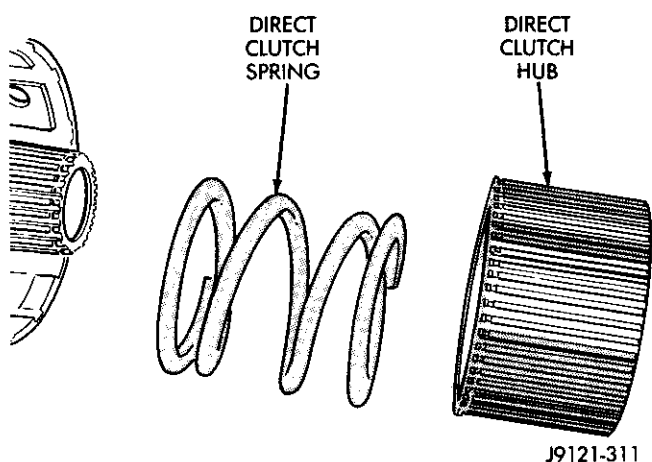
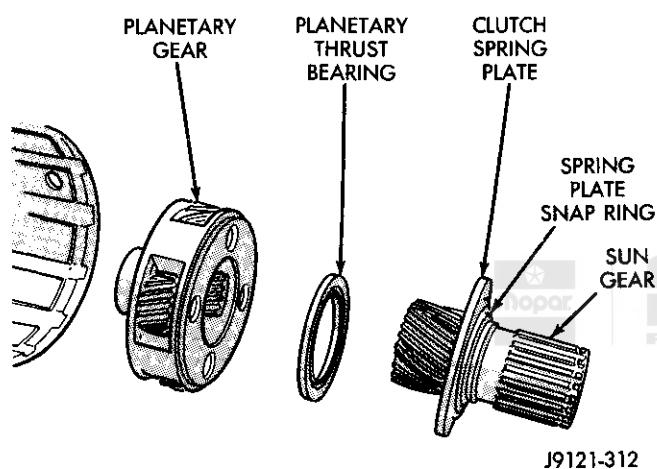
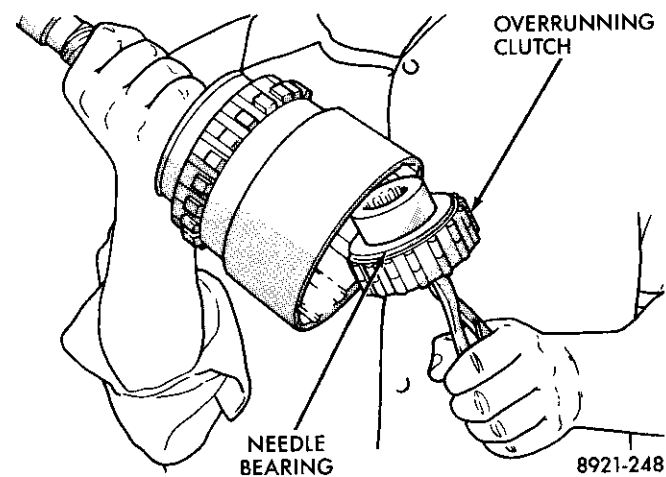
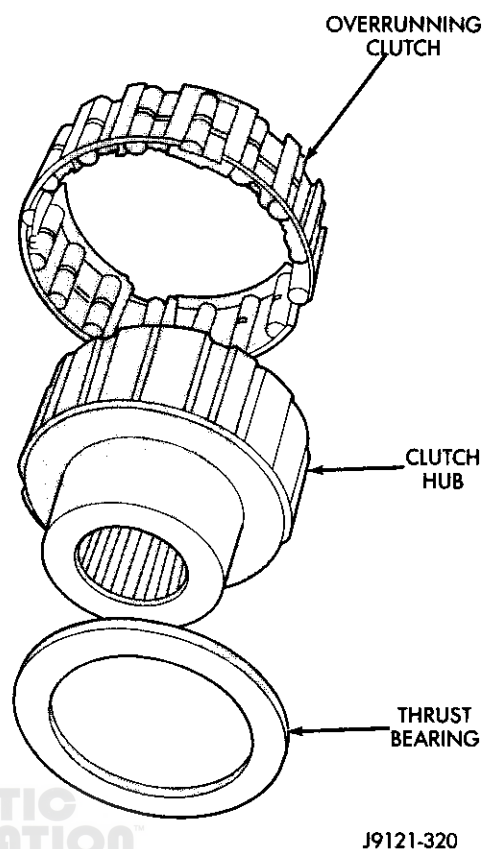
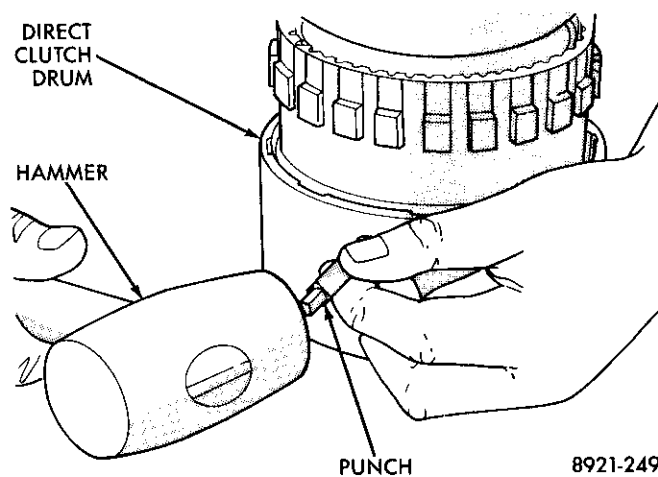


Fig. 251 Direct Clutch Pack Removal

- (10) Remove direct clutch hub and spring (Fig. 252).
- (11) Remove sun gear and spring plate, planetary thrust bearing and planetary gear (Fig. 253).
- (12) Remove overrunning clutch assembly with expanding type snap ring plier (Fig. 254). Insert pliers into clutch hub. Expand pliers to grip hub splines and remove clutch with counterclockwise, twisting motion.
- (13) Remove thrust bearing from overrunning clutch hub (Fig. 255).
- (14) Remove overrunning clutch from hub (Fig. 255).

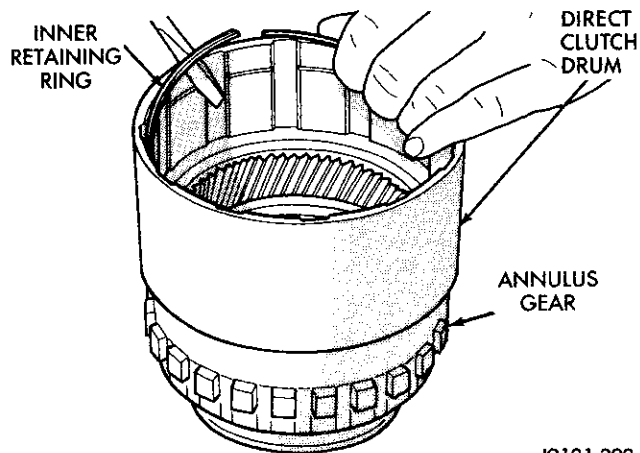
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 252 Direct Clutch Hub And Spring Removal****Fig. 253 Removing Sun Gear/Thrust Bearing/Planetary Gear****Fig. 254 Removing Overrunning Clutch Assembly****Fig. 255 Overrunning Clutch Components**

(15) Mark position of annulus gear and direct clutch drum for assembly alignment reference (Fig. 256). Use small center punch or scribe to make alignment marks.

**Fig. 256 Marking Direct Clutch Drum And Annulus Gear For Assembly Alignment**

DISASSEMBLY AND ASSEMBLY (Continued)

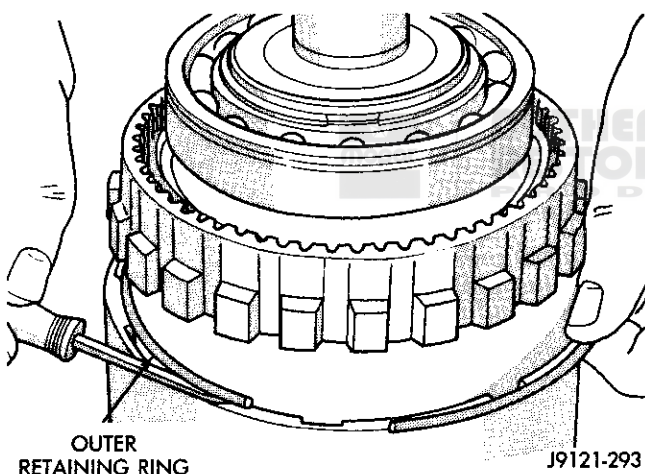
(16) Remove direct clutch drum rear retaining ring (Fig. 257).



J9121-292

Fig. 257 Removing Clutch Drum Inner Retaining Ring

(17) Remove direct clutch drum outer retaining ring (Fig. 258).



J9121-293

Fig. 258 Removing Clutch Drum Outer Retaining Ring

(18) Mark annulus gear and output shaft for assembly alignment reference (Fig. 259).

(19) Remove annulus gear from output shaft (Fig. 260). Use rawhide or plastic mallet to tap gear off shaft.

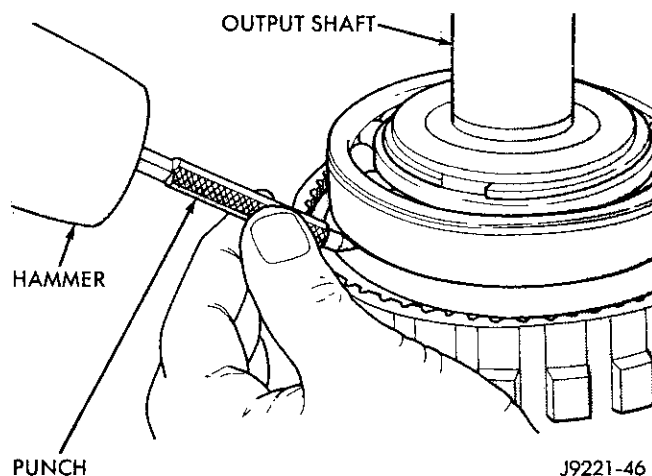
(20) Remove output shaft front bearing if not previously removed.

ASSEMBLE

(1) Soak direct clutch and overdrive clutch discs in Mopar ATF Plus before installation. Also lubricate geartrain components with ATF Plus during reassembly.

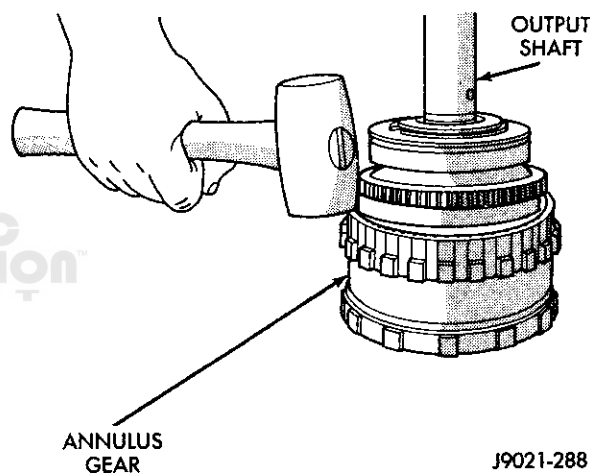
(2) Install new pilot bushing and clutch hub bushing in output shaft if necessary (Fig. 261). Lubricate new (or old) bushings with petroleum jelly.

(3) Install front bearing and bearing snap ring on output shaft (Fig. 261).



J9221-46

Fig. 259 Marking Annulus Gear And Output Shaft For Assembly Alignment

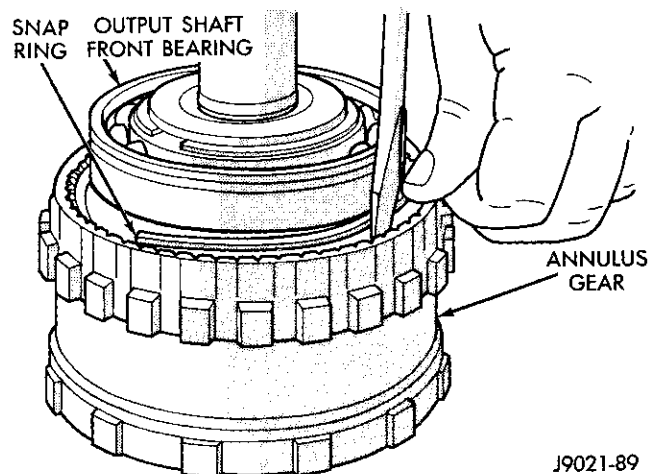


J9021-288

Fig. 260 Removing Annulus Gear

(4) Align and install annulus gear on output shaft (Fig. 261).

(5) Install annulus snap ring (Fig. 261).



J9021-89

Fig. 261 Installing Annulus Gear And Snap Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Align and install clutch drum on annulus gear (Fig. 262). Be sure drum is engaged in annulus gear lugs.

(7) Install clutch drum outer retaining ring (Fig. 262).

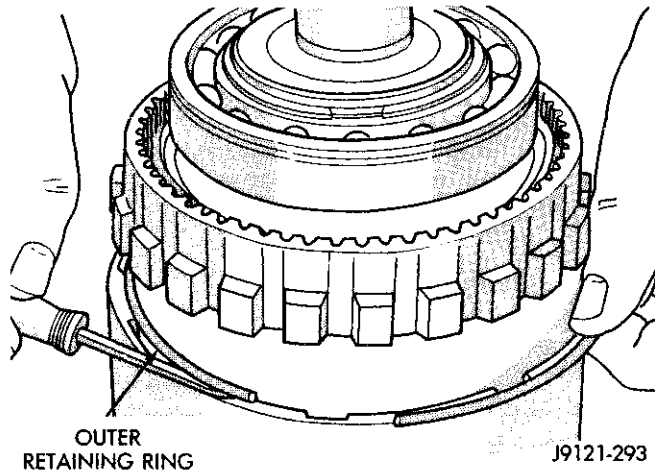


Fig. 262 Clutch Drum And Outer Retaining Ring Installation

(8) Slide clutch drum forward and install inner retaining ring (Fig. 263).

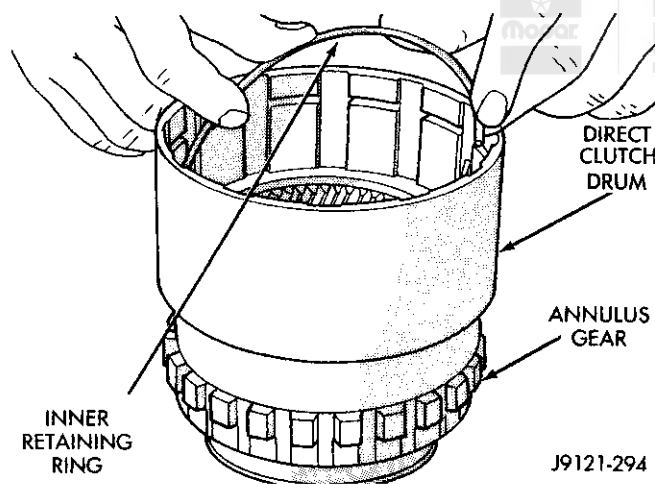


Fig. 263 Installing Clutch Drum Inner Retaining Ring

(9) Install overrunning clutch on hub (Fig. 264). **Clutch only fits one way. Shoulder on clutch should seat in small recess at edge of hub.**

(10) Install thrust bearing on overrunning clutch hub (Fig. 265). Use petroleum jelly to hold bearing in place during installation. **Bearing fits one way only. Be sure bearing is seated squarely against hub. Reposition bearing if it does not seat squarely.**

(11) Install overrunning clutch (Fig. 266). Insert snap ring pliers in hub splines. Expand pliers to grip hub. Then install assembly with counterclockwise, twisting motion.

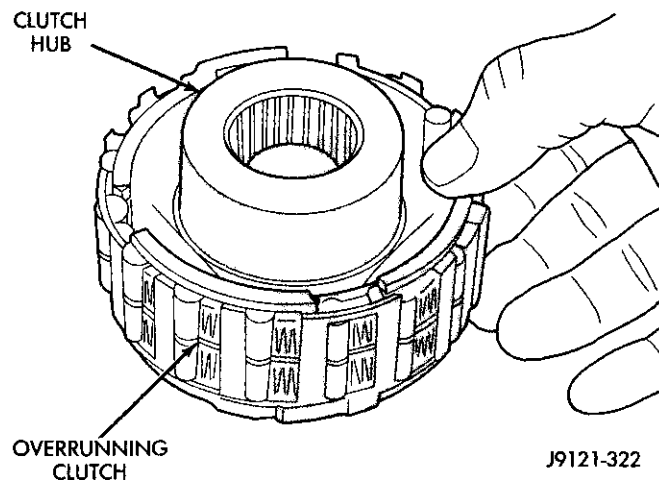


Fig. 264 Assembling Overrunning Clutch And Hub

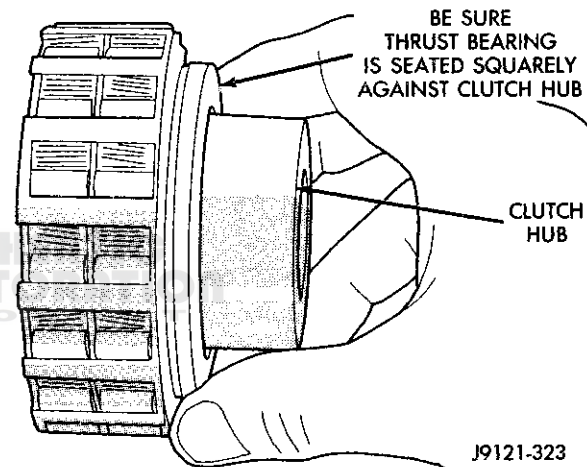


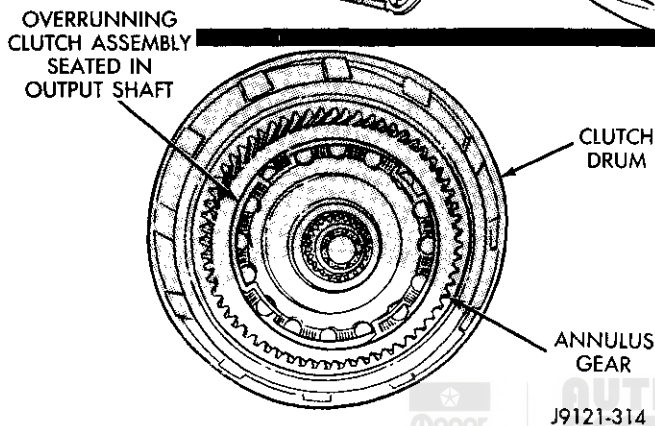
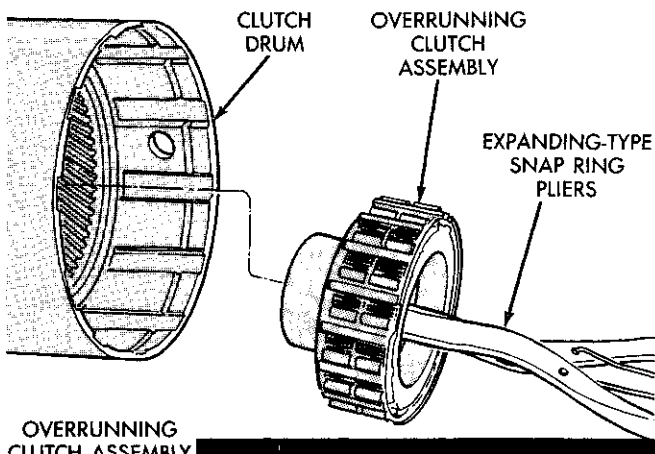
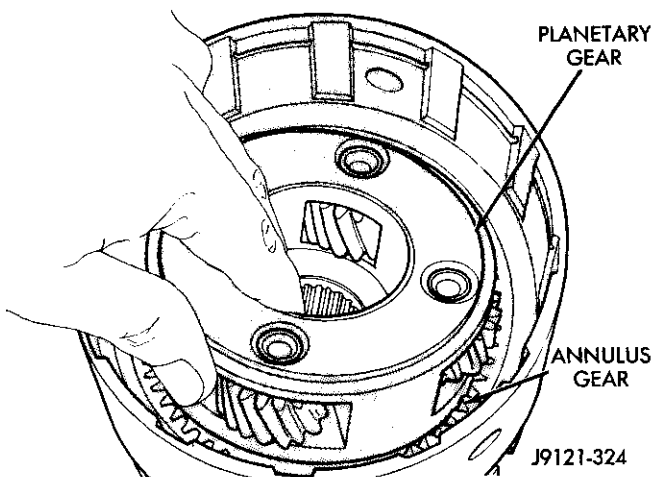
Fig. 265 Installing Overrunning Clutch Thrust Bearing

(12) Install planetary gear in annulus gear (Fig. 267). **Be sure planetary pinions are fully seated in annulus gear before proceeding.**

(13) Install direct clutch spring plate on sun gear. Then secure plate to sun gear with snap ring (Fig. 268). Shoulder side of plate should face outward and toward front.

(14) Coat planetary thrust bearing and bearing contact surface of spring plate with petroleum jelly. This will help hold bearing in place during installation.

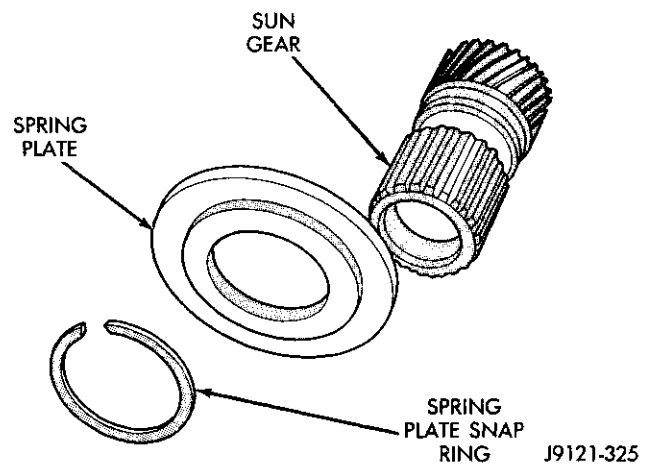
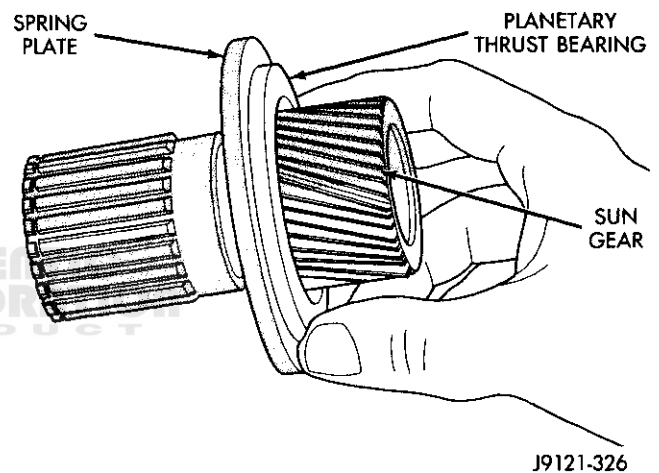
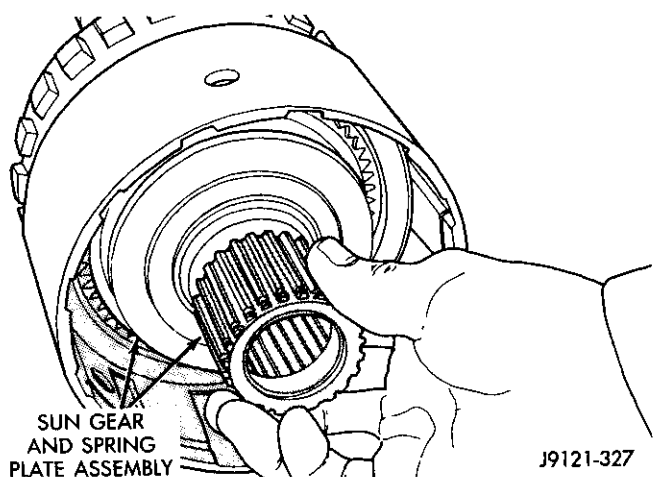
(15) Install planetary thrust bearing on sun gear (Fig. 269). Slide bearing onto gear and seat it against spring plate as shown. **Bearing fits one way only.**

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 266 Overrunning Clutch Installation****Fig. 267 Planetary Gear Installation**

If it does not seat squarely against spring plate, remove and reposition bearing.

(16) Install assembled sun gear, spring plate and thrust bearing (Fig. 270). Be sure sun gear and thrust bearing are fully seated before proceeding.

(17) Align splines in hubs of planetary gear and overrunning clutch with Alignment Tool 6227-2 (Fig. 271). Insert tool through sun gear and into splines of

**Fig. 268 Sun Gear And Spring Plate Assembly****Fig. 269 Installing Planetary Thrust Bearing****Fig. 270 Sun Gear Installation**

both hubs. Be sure alignment tool is fully seated before proceeding.

(18) Install direct clutch spring. Be sure spring is properly seated on spring plate (Fig. 271).

DISASSEMBLY AND ASSEMBLY (Continued)

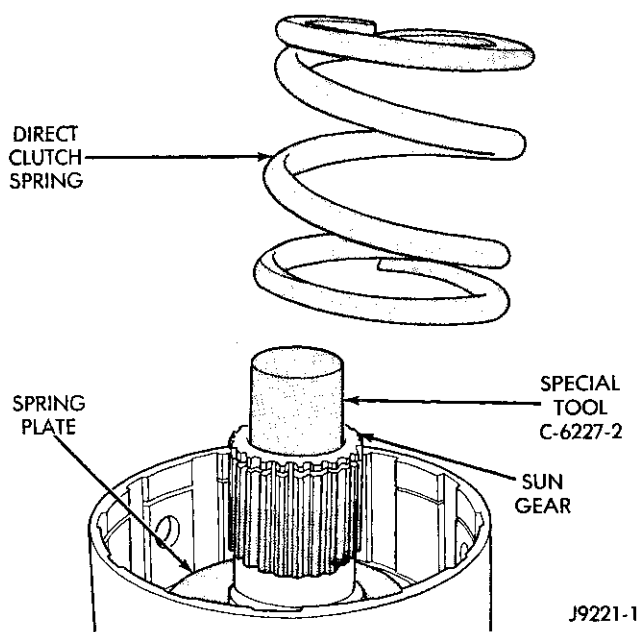


Fig. 271 Direct Clutch Spring Installation

(19) Assemble direct clutch pack for installation on hub (Fig. 272).

(20) Install direct clutch reaction plate on clutch hub. **One side of reaction plate is counterbored. Be sure this side faces rearward. Splines at rear of hub are raised slightly and counterbore in plate fits over these splines. Plate should be flush with this end of hub (Fig. 273).**

(21) Install remainder of direct clutch components as follows:

(a) Install first clutch disc on reaction plate followed by a steel plate.

(b) Alternately install remaining clutch discs and steel plates until required number are installed (Fig. 272). The clutch requires 8 discs and 7 steel plates.

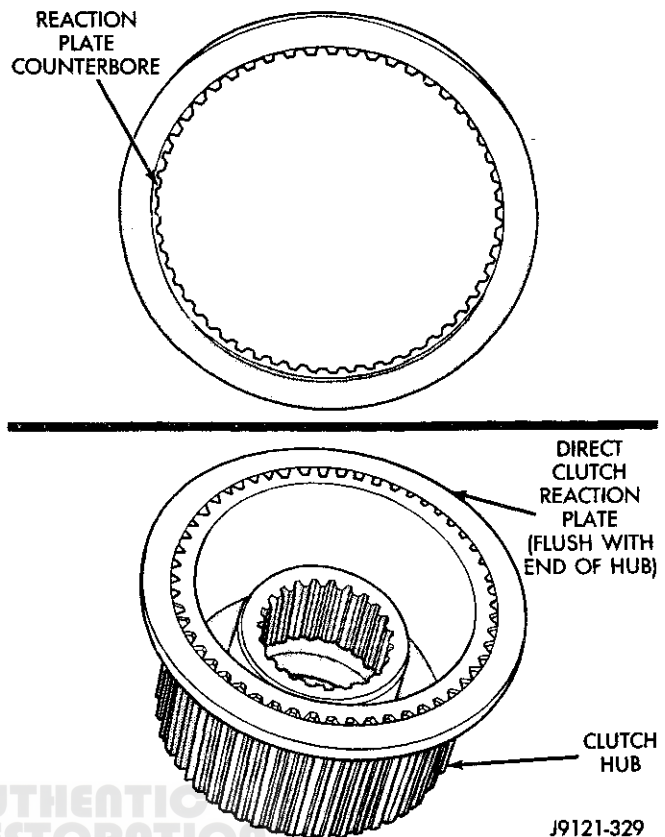


Fig. 273 Correct Position Of Direct Clutch Reaction Plate

(c) Last clutch pack item installed is clutch pressure plate. Be sure plate is installed with shoulder side of plate facing upward (Fig. 274).

(22) Install clutch hub and clutch pack on direct clutch spring (Fig. 275).

(23) Mount geartrain assembly in shop press (Fig. 276).

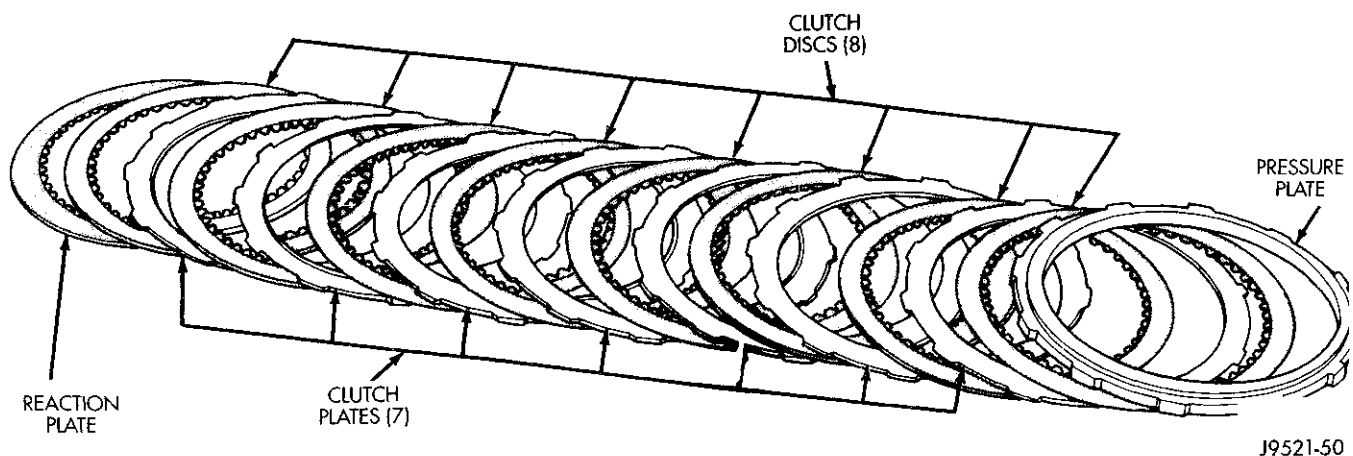


Fig. 272 Direct Clutch Pack Components

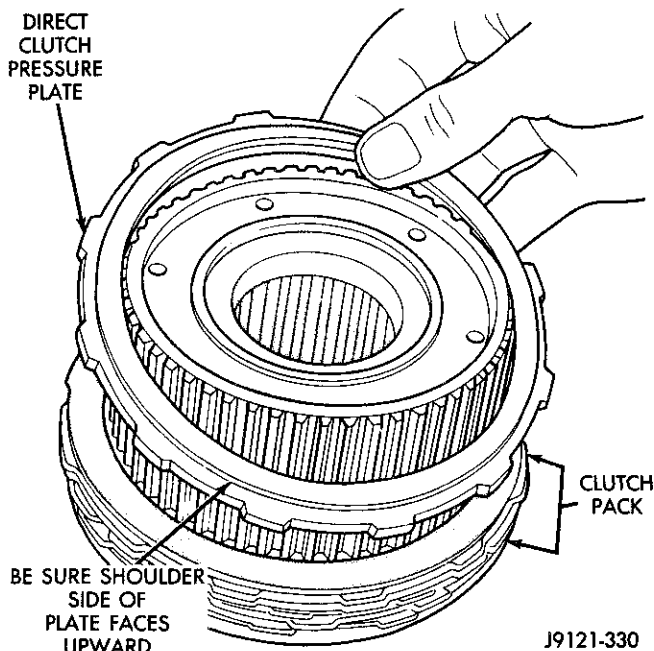
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 274 Correct Position Of Direct Clutch Pressure Plate

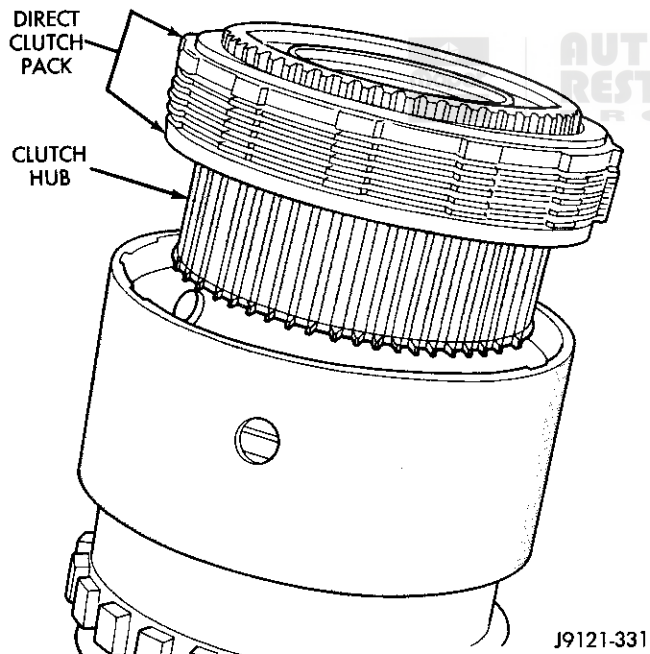


Fig. 275 Installing Assembled Direct Clutch Pack And Hub

WARNING: THE NEXT STEP IN GEARTRAIN ASSEMBLY INVOLVES COMPRESSING THE DIRECT CLUTCH HUB AND SPRING. IT IS EXTREMELY IMPORTANT THAT PROPER EQUIPMENT BE USED TO COMPRESS THE SPRING AS SPRING FORCE IS APPROXIMATELY 800 POUNDS. USE SPRING COMPRESSOR TOOL C-6227-1 AND A HYDRAULIC-TYPE SHOP PRESS WITH A MINIMUM RAM TRAVEL OF

5-6 INCHES. THE PRESS MUST ALSO HAVE A BED THAT CAN BE ADJUSTED UP OR DOWN AS REQUIRED. RELEASE CLUTCH SPRING TENSION SLOWLY AND COMPLETELY TO AVOID PERSONAL INJURY.

(24) Position Compressor Tool 6227-2 on clutch hub (Fig. 276).

(25) Slide direct clutch pack upwards on hub (Fig. 276). Slide pack upward and set it partially on edge of hub and compressor tool as shown in (Fig. 276).

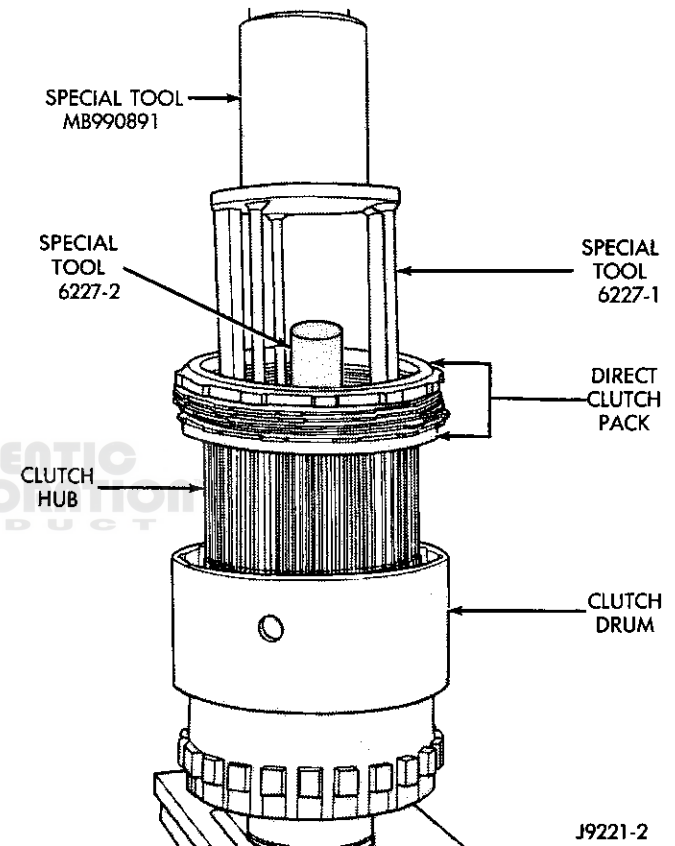


Fig. 276 Mounting Geartrain Assembly In Shop Press

(26) Slowly compress clutch hub and spring (Fig. 277). Compress spring and hub only enough to expose ring grooves for clutch pack snap ring and clutch hub retaining ring.

(27) Realign clutch pack on hub and seat clutch discs and plates in clutch drum (Fig. 277).

(28) Install direct clutch pack snap ring (Fig. 278). Be very sure snap ring is fully seated in clutch drum ring groove.

(29) Install clutch hub retaining ring (Fig. 279). Be very sure retaining ring is fully seated in sun gear ring groove.

(30) Slowly release press ram, remove compressor tools and remove geartrain assembly.

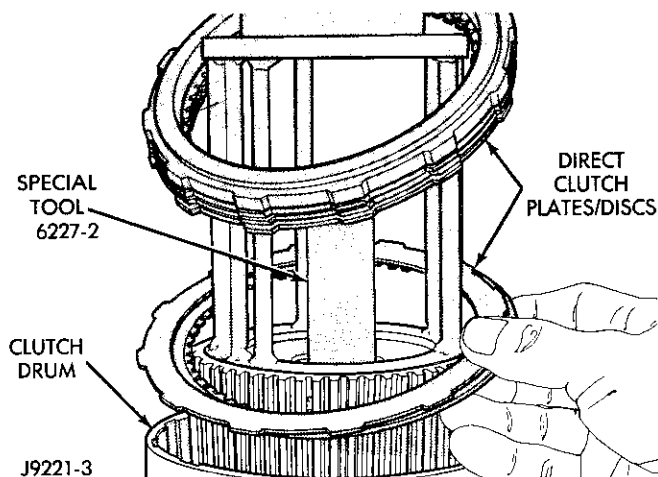


Fig. 277 Seating Clutch Pack In Drum

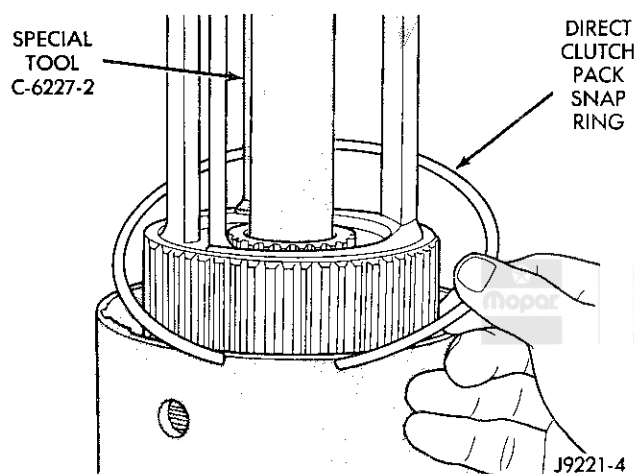


Fig. 278 Installing Direct Clutch Pack Snap Ring

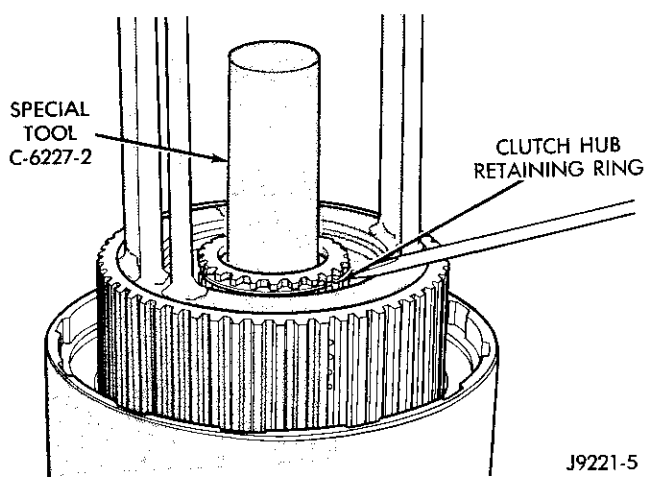


Fig. 279 Installing Clutch Hub Retaining Ring

CLEANING AND INSPECTION

VALVE BODY

Clean the valve housings, valves, plugs, springs, and separator plates with a standard parts cleaning solution only. Do not use gasoline, kerosene, or any type of caustic solution.

Do not immerse any of the electrical components in cleaning solution. Clean the governor solenoid and sensor and the dual solenoid and harness assembly by wiping them off with dry shop towels only.

Dry all except the electrical parts with compressed air. Make sure all passages are clean and free from obstructions. **Do not use rags or shop towels to dry or wipe off valve body components. Lint from these materials can stick to valve body parts, interfere with valve operation, and clog filters and fluid passages.**

Wipe the governor pressure sensor and solenoid valve with dry, lint free shop towels only. The O-rings on the sensor and solenoid valve are the only serviceable components. Be sure the vent ports in the solenoid valve are open and not blocked by dirt or debris. Replace the valve and/or sensor only when DRB scan tool diagnosis indicates this is necessary. Or, if either part has sustained physical damage (dented, deformed, broken, etc.).

CAUTION: Do not turn the small screw at the end of the solenoid valve for any reason. Turning the screw in either direction will ruin solenoid calibration and result in solenoid failure. In addition, the filter on the solenoid valve is **NOT** serviceable. Do not try to remove the filter as this will damage the valve housing.

Inspect the throttle and manual valve levers and shafts (Fig. 280). Do not attempt to straighten a bent shaft or correct a loose lever. Replace these components if worn, bent, loose or damaged in any way.

Inspect all of the valve body mating surfaces for scratches, nicks, burrs, or distortion. Use a straight-edge to check surface flatness. Minor scratches may be removed with crocus cloth using only very light pressure.

Minor distortion of a valve body mating surface may be corrected by smoothing the surface with a sheet of crocus cloth. Position the crocus cloth on a surface plate, sheet of plate glass or equally flat surface. If distortion is severe or any surfaces are heavily scored, the valve body will have to be replaced.

CLEANING AND INSPECTION (Continued)

CAUTION: Many of the valves and plugs, such as the throttle valve, shuttle valve plug, 1-2 shift valve and 1-2 governor plug, are made of coated aluminum. Aluminum components are identified by the dark color of the special coating applied to the surface (or by testing with a magnet). Do not sand aluminum valves or plugs under any circumstances. This practice could damage the special coating causing the valves/plugs to stick and bind.

Inspect the valves and plugs for scratches, burrs, nicks, or scores. Minor surface scratches on steel valves and plugs can be removed with crocus cloth but **do not round off the edges of the valve or plug lands**. Maintaining sharpness of these edges is vitally important. The edges prevent foreign matter from lodging between the valves and plugs and the bore.

Inspect all the valve and plug bores in the valve body. Use a penlight to view the bore interiors. Replace the valve body if any bores are distorted or scored. Inspect all of the valve body springs. The springs must be free of distortion, warpage or broken coils.

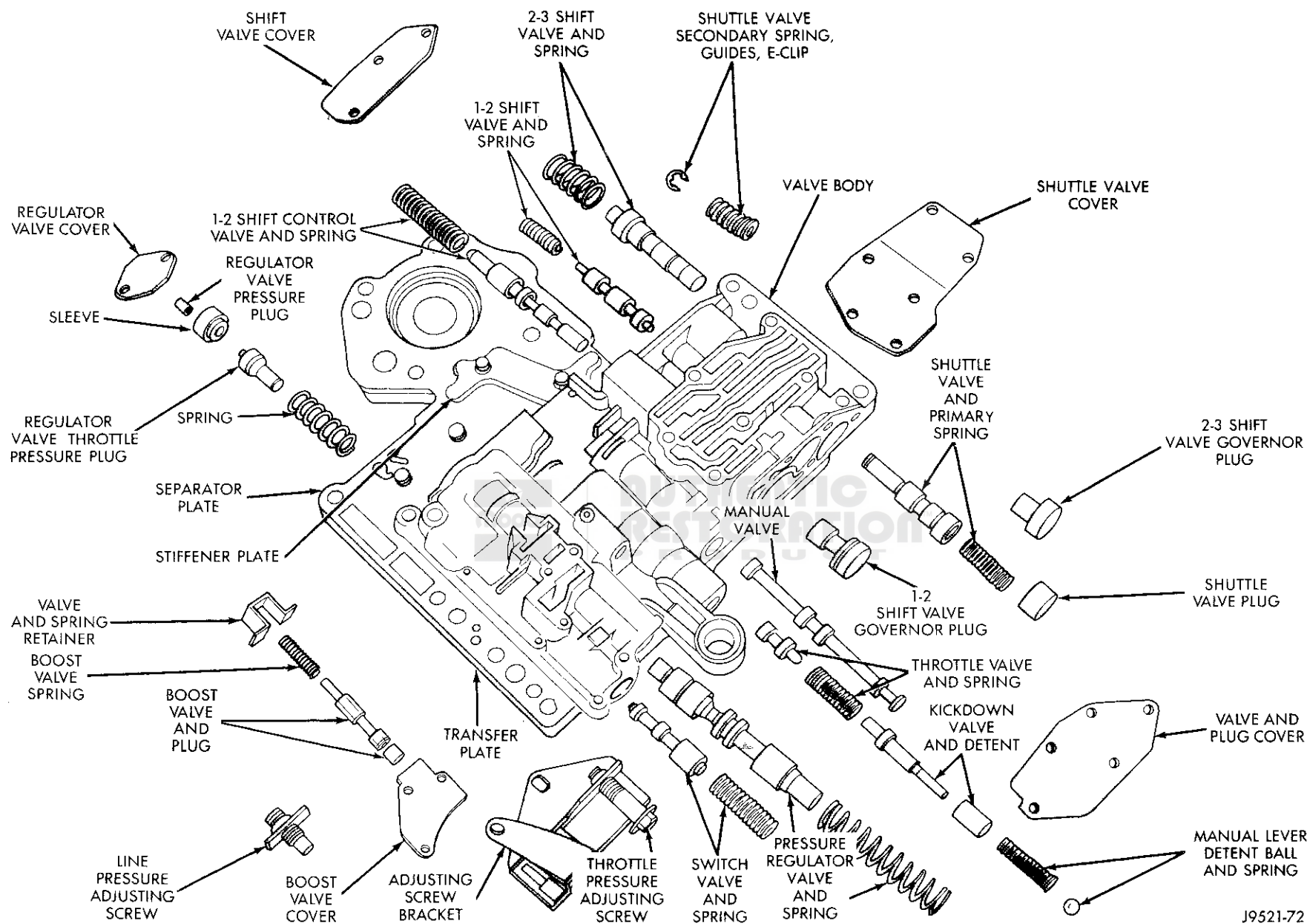
Check the two separator plates for distortion or damage of any kind. Inspect the upper housing, lower housing, 3-4 accumulator housing, and transfer plate carefully. Be sure all fluid passages are clean and clear. Check condition of the upper housing and transfer plate check balls as well. The check balls and ball seats must not be worn or damaged.

Trial fit each valve and plug in its bore to check freedom of operation. When clean and dry, the valves and plugs should drop freely into the bores.

Valve body bores do not change dimensionally with use. If the valve body functioned correctly when new, it will continue to operate properly after cleaning and inspection. It should not be necessary to replace a valve body assembly unless it is damaged in handling.

The only serviceable valve body components are listed below. The remaining valve body components are serviced only as part of a complete valve body assembly. Serviceable parts are:

- dual solenoid and harness assembly
- solenoid gasket
- solenoid case connector O-rings and shoulder bolt
- switch valve and spring
- pressure adjusting screw and bracket assembly
- throttle lever
- manual lever and shaft seal
- throttle lever shaft seal, washer, and E-clip
- fluid filter and screws
- detent ball and spring
- valve body screws
- governor pressure solenoid
- governor pressure sensor and retaining clip
- park lock rod and E-clip



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Fig. 280 Upper Housing Valves, Plug, Springs And Brackets

CLEANING AND INSPECTION (Continued)**TRANSMISSION****INSPECTION AFTER DISASSEMBLY**

Inspect all the transmission bushings during overhaul. Bushing condition is important as worn, scored bushings contribute to low pressures, clutch slip and accelerated wear of other components. Replace worn, or scored bushings, or if doubt exists about bushing condition.

Use recommended tools to replace bushings. The tools are sized and designed to remove, install and seat bushings correctly. The bushing replacement tools are included in Bushing Tool Sets C-3887-B, or C-3887-J.

Pre-sized service bushings are available for replacement purposes. Only the sun gear bushings are not serviced. Replace the gear as an assembly if the bushings are severely scored, or worn.

Heli-Coil inserts are recommended for repairing damaged, stripped or worn threads in aluminum parts. These inserts are available from most automotive jobbers. Stainless steel inserts are preferred.

The use of crocus cloth is permissible where necessary, providing it is used carefully. When used on valves, use extreme care to avoid rounding off sharp edges. Sharp edges are vital as they prevent foreign matter from getting between the valve and valve bore.

Do not reuse oil seals, gaskets, seal rings, or O-rings during overhaul. Replace these parts as a matter of course. Also do not reuse snap rings or E-clips that are bent or distorted. Replace these parts as well.

Lubricate transmission parts with Mopar ATF Plus, Type 7176 transmission fluid during assembly. Use Mopar Door Ease, or Ru-Glyde to lubricate piston seals and O-rings. Use petroleum jelly on thrust washers and to hold parts in place during reassembly.

TRANSMISSION CASE CLEANING AND INSPECTION

Clean the case in a solvent tank. Flush the case bores and fluid passages thoroughly with solvent. Dry the case and all fluid passages with compressed air. Be sure all solvent is removed from the case and that all fluid passages are clear.

NOTE: Do not use shop towels or rags to dry the case (or any other transmission component) unless they are made from lint-free materials. Lint will readily adhere to case surfaces and transmission components and will circulate throughout the transmission after assembly. A sufficient quantity of lint can block fluid passages and interfere with valve body operation.

Inspect the case for cracks, porous spots, worn servo bores, or damaged threads. Damaged threads can be repaired with Helicoil thread inserts. However, the case will have to be replaced if it exhibits damage or wear.

Lubricate the front band adjusting screw and locknut with petroleum jelly and thread it part way into the case. Be sure the screw turns freely and does not bind. Install the locknut on the screw after checking screw thread operation.

LOW-REVERSE DRUM AND REAR BAND

Clean the drum in solvent but just wipe the drum thrust washer and rear band clean with lint free shop towels.

Examine the double tabbed thrust washer for wear (Fig. 281). If the washer is worn, or damaged, check the spotface area of the drum for wear also.

Examine the band and friction material closely. Replace the band if bent, or distorted. Also replace the band if the friction material is burnt, cracked, or flaking away from the band. If the grooves in the band are no longer visible, the band lining is severely worn and should be replaced.

Check the band lever, adjusting screw, locknut, pivot pin, link and strut (Fig. 282). Replace any component exhibiting wear, or damage.

Remove and replace the O-rings on the band pivot pin (Fig. 282). Lubricate the new O-rings with transmission fluid after they are installed on the pin.

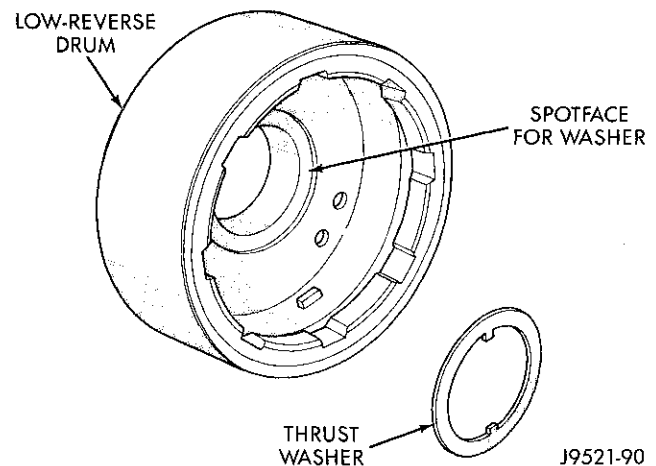
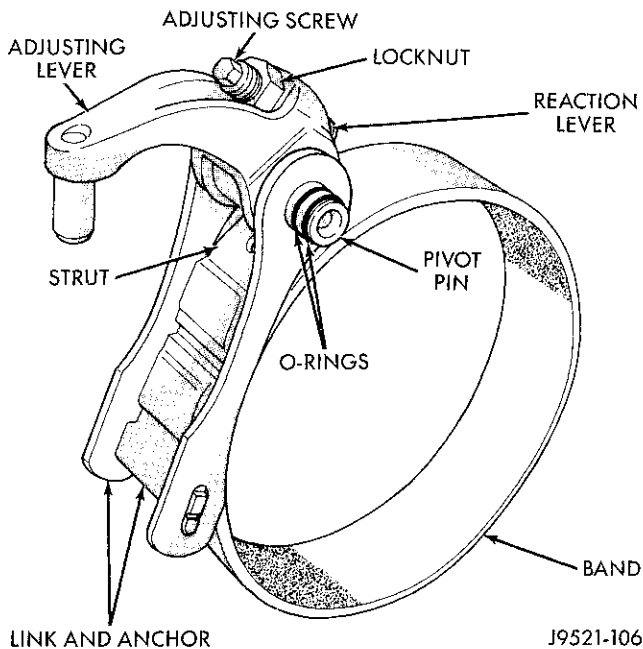
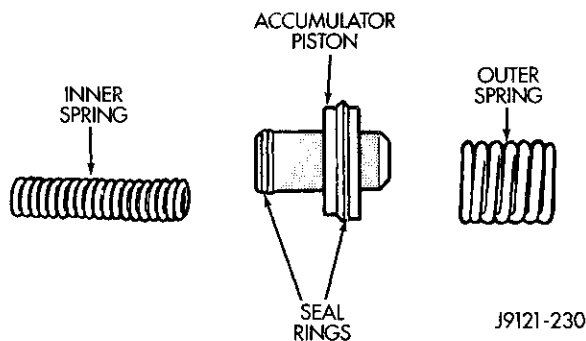


Fig. 281 Low Reverse Band And Thrust Washer

CLEANING AND INSPECTION (Continued)**Fig. 282 Rear Band And Linkage****ACCUMULATOR**

Inspect the accumulator piston and seal rings (Fig. 283). Replace the seal rings if worn or cut. Replace the piston if chipped or cracked.

Check condition of the accumulator inner and outer springs (Fig. 283). Replace the springs if the coils are cracked, distorted or collapsed.

**Fig. 283 Accumulator Components****FRONT SERVO**

Clean the servo piston components with solvent and dry them with compressed air. Wipe the band clean with lint free shop towels.

Replace the front band if distorted, lining is burned, flaking off, or worn to the point where the grooves in the lining material are no longer visible.

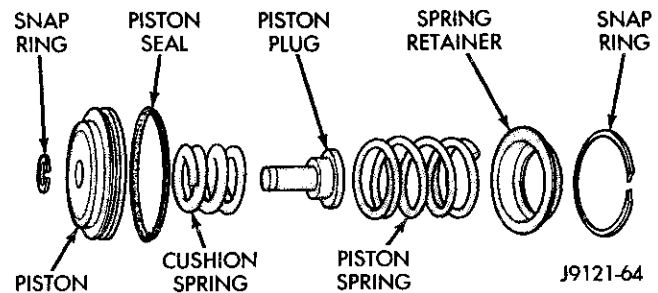
Inspect the servo components. Replace the springs if collapsed, distorted or broken. Replace the guide, rod and piston if cracked, bent, or worn. Discard the servo snap ring if distorted or warped.

Check the servo piston bore for wear. If the bore is severely scored, or damaged, it will be necessary to replace the case.

Replace any servo component if doubt exists about condition. Do not reuse suspect parts.

REAR SERVO

Remove and discard the servo piston seal ring (Fig. 284). Then clean the servo components with solvent and dry with compressed air. Replace either spring if collapsed, distorted or broken. Replace the plug and piston if cracked, bent, or worn. Discard the servo snap rings and use a new ones at assembly.

**Fig. 284 Rear Servo Components****OIL PUMP AND REACTION SHAFT SUPPORT**

Clean pump and support components with solvent and dry them with compressed air.

Check condition of the seal rings and thrust washer on the reaction shaft support. The seal rings do not need to be replaced unless cracked, broken, or severely worn.

Inspect the pump and support components. Replace the pump or support if the seal ring grooves or machined surfaces are worn, scored, pitted, or damaged. Replace the pump gears if pitted, worn chipped, or damaged.

Check the pump vent. The vent must be secure. Replace the pump body if the vent is cracked, broken, or loose.

Inspect the pump bushing. Then check the reaction shaft support bushing. Replace either bushing only if heavily worn, scored or damaged. It is not necessary to replace the bushings unless they are actually damaged.

Install the gears in the pump body and measure end clearance with a feeler gauge and straightedge (Fig. 285). Straightedge should be resting on pump body as shown:

- End clearance between outer gear and straightedge should be 0.010 to 0.063 mm (0.0004 to 0.0025 in.).
- End clearance between inner gear and straightedge should be 0.025 to 0.177 mm (0.001 to 0.007 in.).

CLEANING AND INSPECTION (Continued)

Measure tip clearances with feeler gauge (Fig. 286):

- Clearance between inner gear tooth and outer gear should be 0.08 to 0.19 mm (0.0035 to 0.0075 in.).
- Clearance between outer gear and pump housing should also be 0.010 to 0.19 mm (0.0035 to 0.0075 in.).

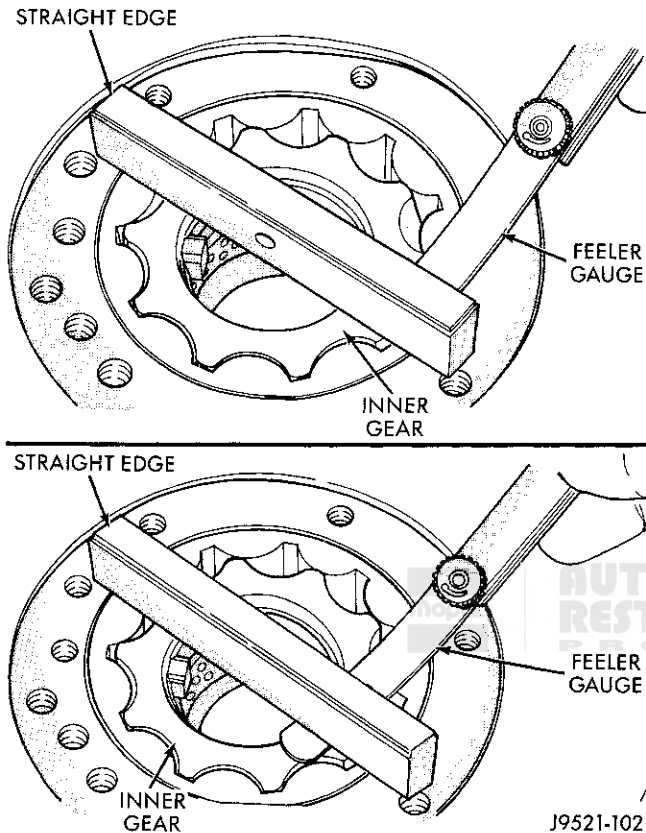


Fig. 285 Checking Pump Gear End Clearance

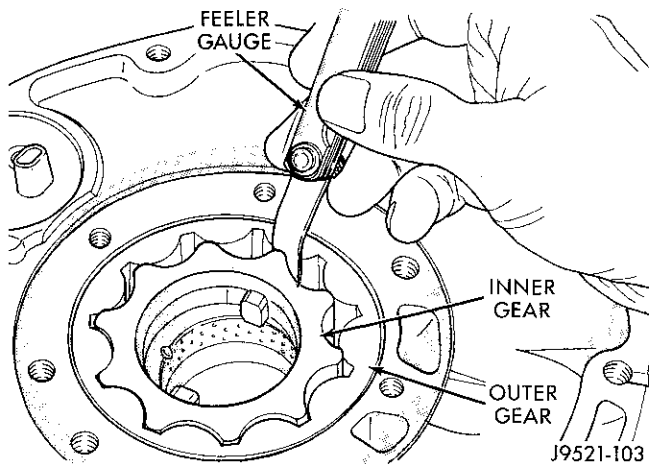


Fig. 286 Checking Pump Gear Tip Clearance

FRONT CLUTCH

Clean and inspect the front clutch components (Fig. 287). Replace the clutch discs if warped, worn, scored, burned or charred, the lugs are damaged, or if the facing is flaking off. Replace the steel plates and reaction plate if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plate are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston springs and spring retainer if either are distorted, warped or broken.

Check the lug grooves in the clutch piston retainer. The steel plates should slide freely in the slots. Replace the piston retainer if the grooves are worn or damaged. Also check action of the check ball in the piston retainer. The ball must move freely and not stick.

Replace the retainer bushing if worn, scored, or there is any doubt about bushing condition.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously scored.

Check the clutch piston check ball. The ball should be securely in place. Replace the piston if the ball is missing, or seized in place.

REAR CLUTCH

Clean the clutch components (Fig. 288) with solvent and dry them with compressed air.

Check condition of the input shaft seal rings. It is not necessary to remove or replace rings unless they are broken, cracked, or no longer securely hooked together.

Inspect the input shaft splines and machined surfaces. Very minor nicks or scratches can be smoothed off with crocus cloth. Replace the shaft if the splines are damaged, or any of the machined surfaces are severely scored.

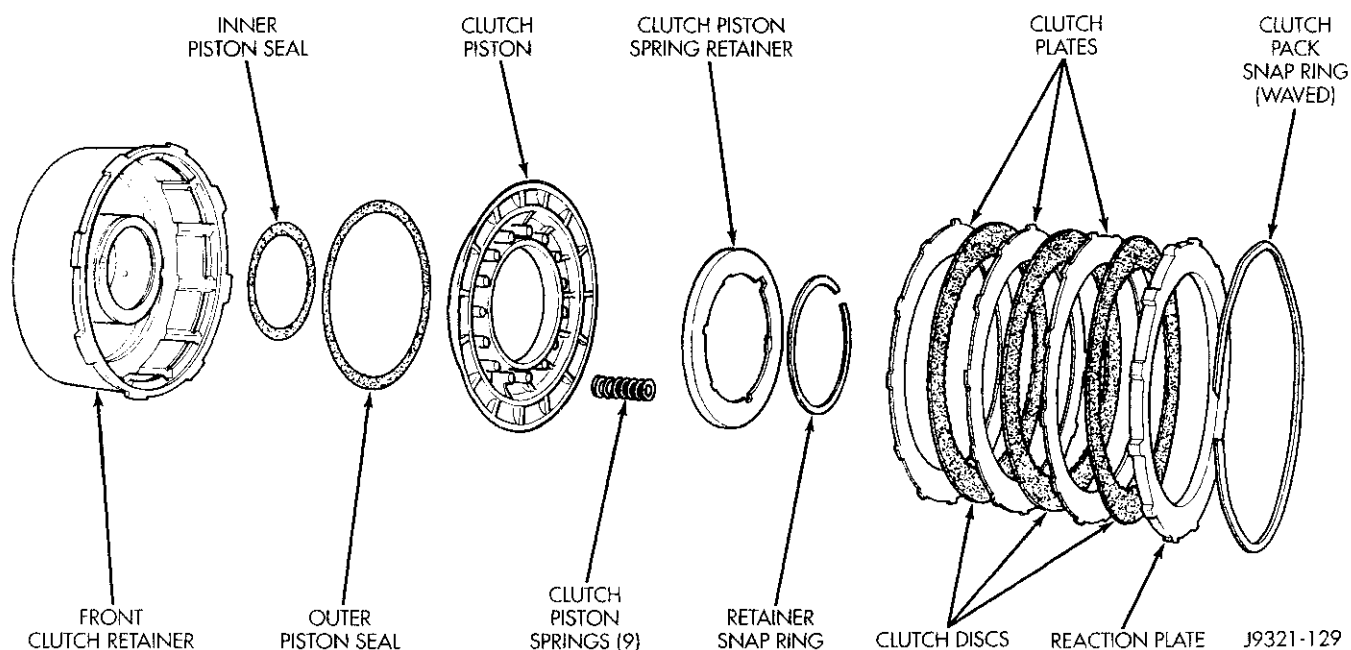
Replace the clutch discs if warped, worn, scored, burned/charred, the lugs are damaged, or if the facing is flaking off.

Replace the steel plates and the pressure plate if heavily scored, warped, or broken. Be sure the driving lugs on the discs and plates are also in good condition. The lugs must not be bent, cracked or damaged in any way.

Replace the piston spring and wave spring if either part is distorted, warped or broken.

Check the lug grooves in the clutch retainer. The steel plates should slide freely in the slots. Replace the retainer if the grooves are worn or damaged. Also check action of the retainer check ball. The ball must move freely and not stick.

Inspect the piston and retainer seal surfaces for nicks or scratches. Minor scratches can be removed

CLEANING AND INSPECTION (Continued)**Fig. 287 Front Clutch Components**

with crocus cloth. However, replace the piston and/or retainer if the seal surfaces are seriously damaged.

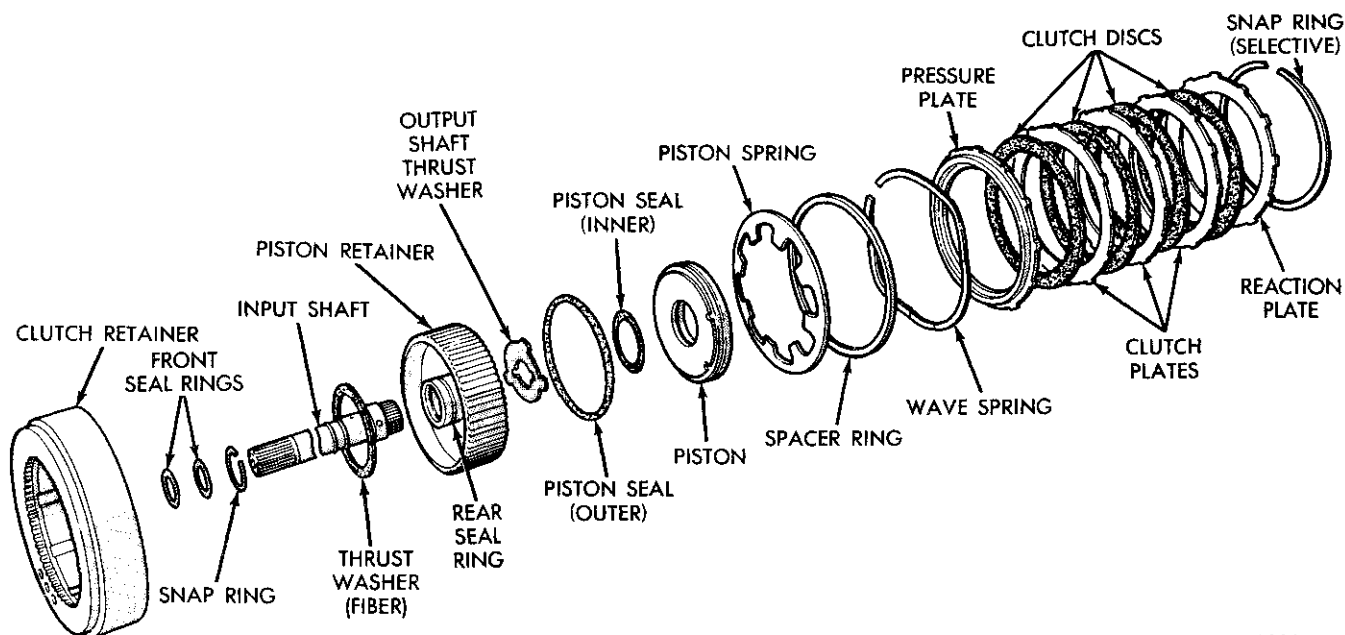
Check thrust washer condition. Washer thickness should be 1.55 to 1.60 mm (0.061 to 0.063 in.). Replace the washer if worn or damaged.

Check condition of the two seal rings on the input shaft and the single seal ring on the piston retainer hub. Replace the seal rings only if severely worn, cracked, or cannot be hooked together.

PLANETARY GEARTRAIN

Clean the intermediate shaft and planetary components (Fig. 289) in solvent and dry them with compressed air.

Inspect the planetary gear sets and annulus gears. The planetary pinions, shafts, washers, and retaining pins are serviceable. However, if a pinion carrier is

**Fig. 288 Rear Clutch Components**

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CLEANING AND INSPECTION (Continued)

damaged, the entire planetary gear set must be replaced as an assembly.

Replace the annulus gears if the teeth are chipped, broken, or worn, or the gear is cracked. Replace the planetary thrust plates and the tabbed thrust washers if cracked, scored or worn.

Inspect the machined surfaces of the intermediate shaft. Be sure the oil passages are open and clear. Replace the shaft if scored, pitted, or damaged.

Inspect the sun gear and driving shell (Fig. 289). If either component is worn or damaged, remove the sun gear rear retaining ring and separate the sun gear and thrust plate from the driving shell. Then replace the necessary component.

Replace the sun gear as an assembly if the gear teeth are chipped or worn. Also replace the gear as an assembly if the bushings are scored or worn. The sun gear bushings are not serviceable. Replace the thrust plate if worn, or severely scored. Replace the driving shell if distorted, cracked, or damaged in any way.

Replace all snap rings during geartrain assembly. Reusing snap rings is not recommended.

OVERDRIVE COMPONENT CLEANING AND INSPECTION

Clean the geartrain (Fig. 290) and case components (Fig. 291) with solvent. Dry all parts except the bearings with compressed air. Allow bearings to air dry.

Do not use shop towels for wiping parts dry unless the towels are made from a lint-free material. A sufficient quantity of lint (from shop towels, cloths, rags,

etc.) could plug the transmission filter and fluid passages.

Discard the old case gasket and seals. Do not attempt to salvage these parts. They are not reusable. Replace any of the overdrive unit snap rings if distorted or damaged.

Minor nicks or scratches on components can be smoothed with crocus cloth. However, do not attempt to reduce severe scoring on any components with abrasive materials. Replace severely scored components; do not try to salvage them.

Check condition of the park lock components and the overdrive case (Fig. 291).

Replace the case if cracked, scored, or damaged. Replace the park lock pawl, plug, or spring if worn or damaged. Be sure the bullet at the end of the park lock rod is in good condition. Replace the rod if the bullet is worn or the rod itself is bent or distorted. Do not attempt to straighten the rod.

Check the bushings in the overdrive case. Replace the bushings if severely scored or worn. Also replace the case seal if loose, distorted, or damaged.

Examine the overdrive and direct clutch discs and plates (Fig. 290). Replace the discs if the facing is worn, severely scored, or burned and flaking off. Replace the clutch plates if worn, heavily scored, or cracked. Check the lugs on the clutch plates for wear. The plates should slide freely in the drum. Replace the plates or drum if binding occurs.

Check condition of the annulus gear, direct clutch hub, clutch drum and clutch spring (Fig. 290).

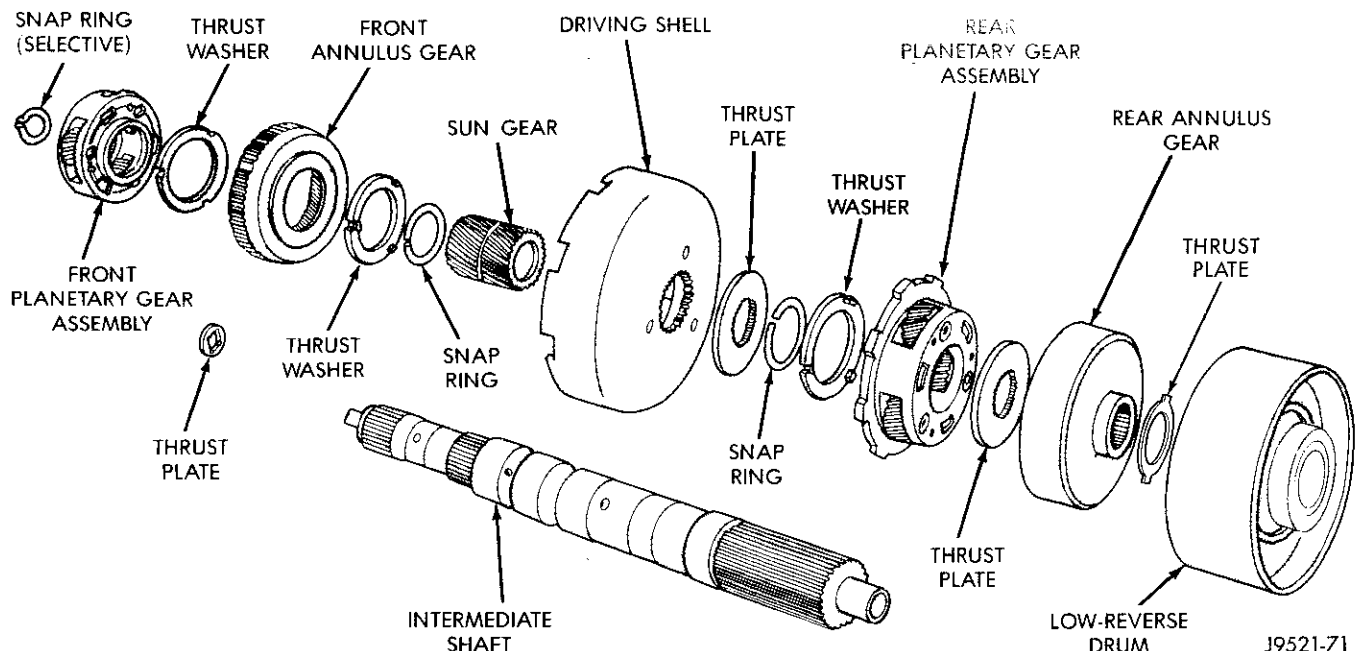
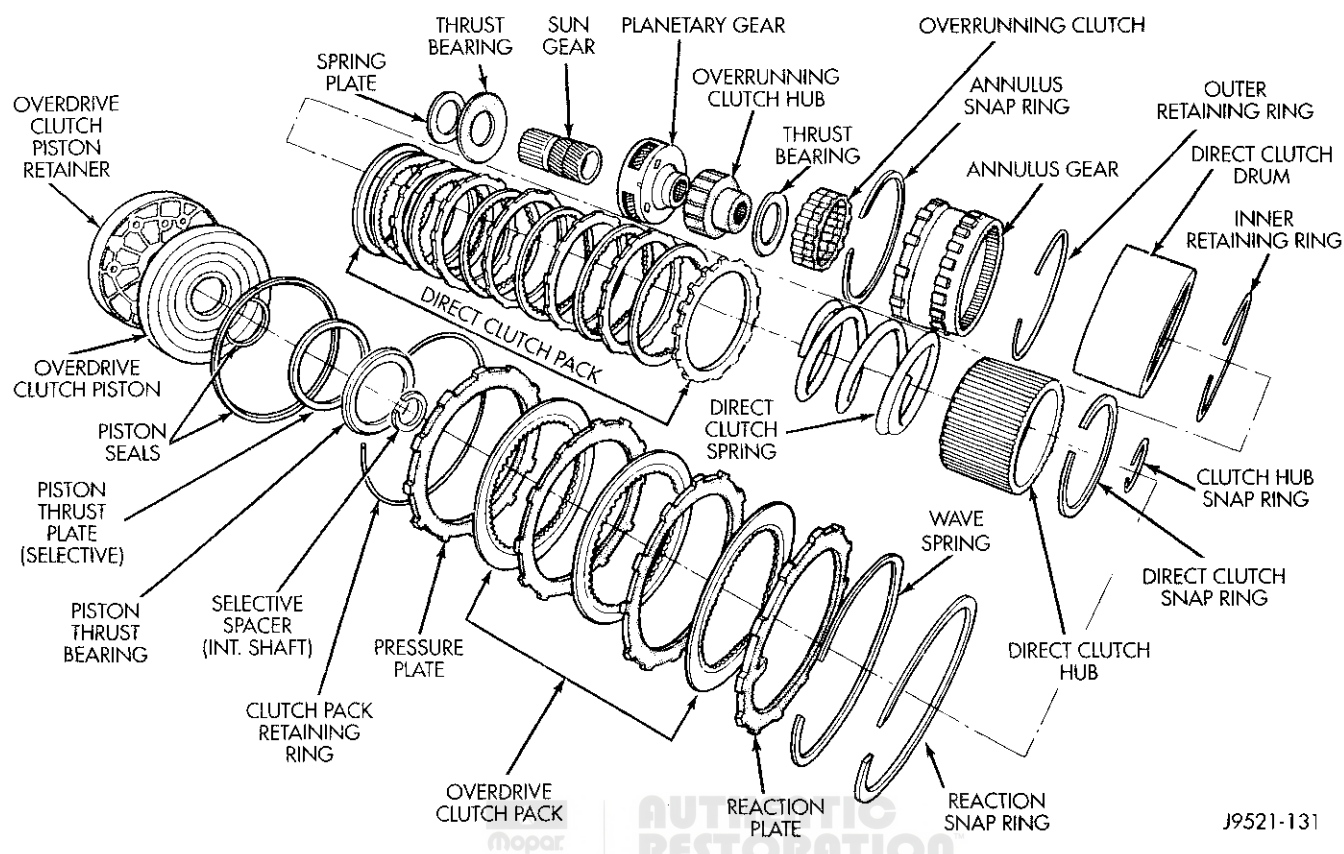


Fig. 289 Planetary Geartrain Components

CLEANING AND INSPECTION (Continued)**Fig. 290 Overdrive Geartrain Components**

Replace the gear, hub and drum if worn or damaged. Replace the spring if collapsed, distorted, or cracked.

Be sure the splines and lugs on the gear, drum and hub are in good condition. The clutch plates and discs should slide freely in these components.

Inspect the thrust bearings and spring plate (Fig. 290). Replace the plate if worn or scored. Replace the bearings if rough, noisy, brinnelled, or worn.

Inspect the planetary gear assembly and the sun gear and bushings (Fig. 290). If either the sun gear or the bushings are damaged, replace the gear and bushings as an assembly. The gear and bushings are not serviced separately.

The planetary carrier and pinions must be in good condition. Also be sure the pinion pins are secure and in good condition. Replace the carrier if worn or damaged.

Inspect the overrunning clutch and race. The race surface should be smooth and free of scores. Replace the overrunning clutch assembly or the race if either assembly is worn or damaged in any way.

Inspect the output shaft and governor components (Fig. 292). Replace the shaft pilot bushing and inner bushing if damaged. Replace either shaft bearing if rough or noisy. Replace the bearing snap rings if distorted or cracked.

Check the machined surfaces on the output shaft. These surfaces should be clean and smooth. Very minor nicks or scratches can be smoothed with crocus cloth. Replace the shaft if worn, scored or damaged in any way.

Inspect the output shaft bushings (Fig. 292). The small bushing is the intermediate shaft pilot bushing. The large bushing is the overrunning clutch hub bushing. Replace either bushing if scored, pitted, cracked, or worn.

The bushings can be removed with "blind hole puller tools" such as Snap-On set CG40CB for small bushings and set CG46 for large bushings. New bushings can be installed with tools from an all purpose installer kit such as the Snap-On A257 bushing driver set.

ADJUSTMENTS**TRANSMISSION THROTTLE VALVE CABLE ADJUSTMENT**

The transmission throttle valve is operated by the valve body throttle lever. The throttle lever is actuated by a cable connected to the engine throttle body lever (Fig. 293). A lock button at the engine end of the cable provides for cable adjustment.

ADJUSTMENTS (Continued)

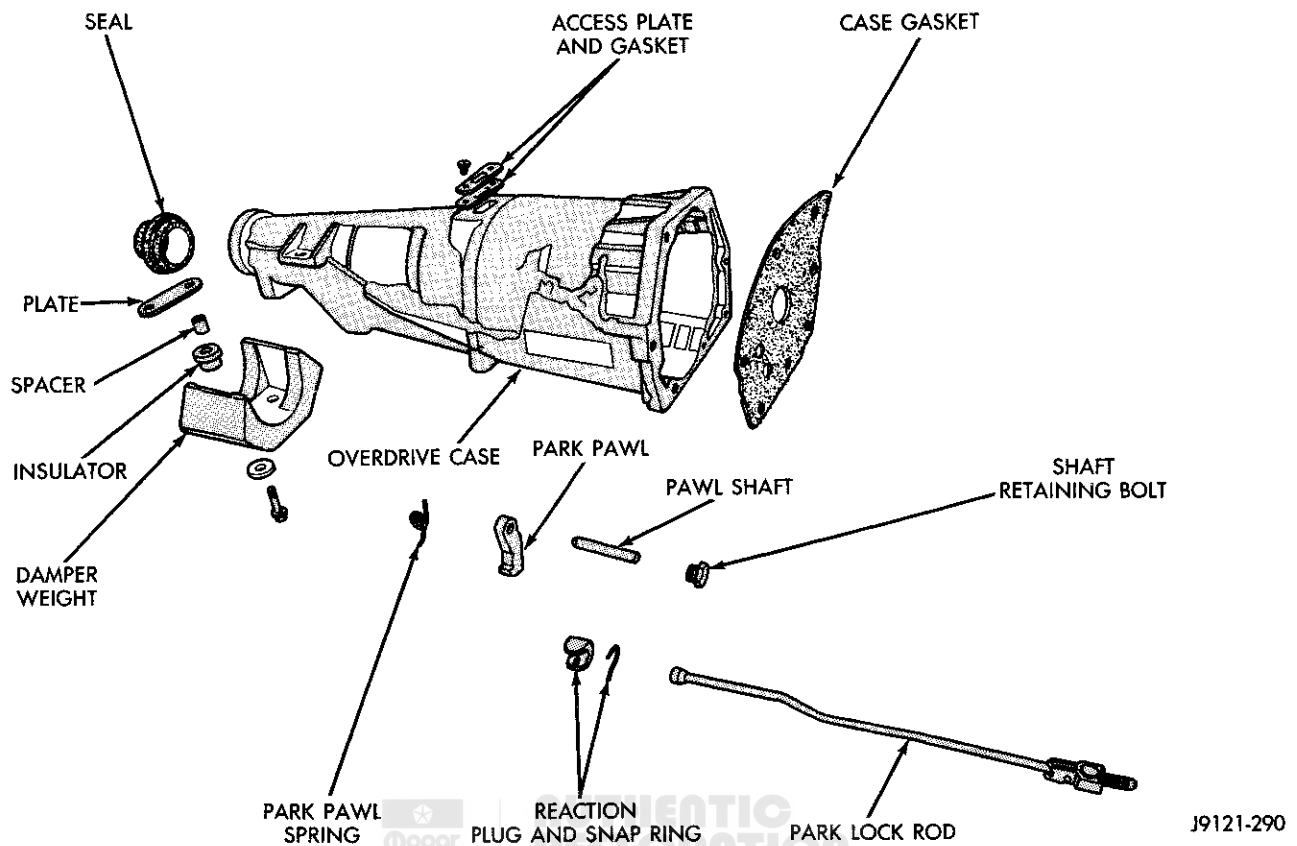


Fig. 291 Overdrive Case And Park Lock Components

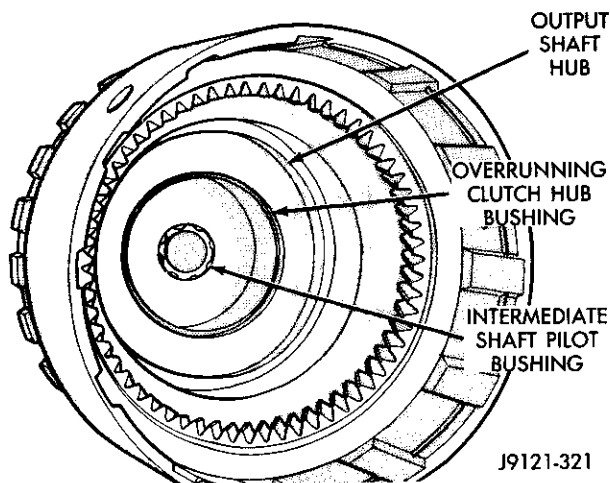


Fig. 292 Output Shaft Bushing Location

A correctly adjusted throttle valve cable, will cause the throttle lever on the transmission to move simultaneously with the throttle body lever from the idle position. Proper adjustment allows simultaneous movement without causing the transmission throttle lever to move ahead of, or lag behind the throttle body lever.

THROTTLE VALVE CABLE ADJUSTMENT CHECK

- (1) Turn ignition key to OFF position.
- (2) Remove air cleaner.
- (3) Verify that throttle body lever is at curb idle position. Then verify that transmission throttle lever (Fig. 293) is also at idle (full forward) position.
- (4) Slide cable off attachment stud on throttle body lever (Fig. 293).
- (5) Compare position of cable end to attachment stud on throttle body lever (Fig. 294):
 - (a) Cable end and attachment stud should be aligned (or centered on one another) to within 1 mm (0.039 in.) in either direction.
 - (b) If cable end and attachment stud are misaligned (off center), cable will have to be adjusted as described in following procedure.
- (6) Reconnect cable end to attachment stud. Then with aid of a helper, observe movement of transmission throttle lever and lever on throttle body.
 - (a) If both levers move simultaneously from idle to half-throttle and back to idle position, adjustment is correct.
 - (b) If transmission throttle lever moves ahead of, or lags behind throttle body lever, cable adjustment will be necessary. Or, if throttle body lever pre-

ADJUSTMENTS (Continued)

vents transmission lever from returning to closed position, cable adjustment will be necessary.

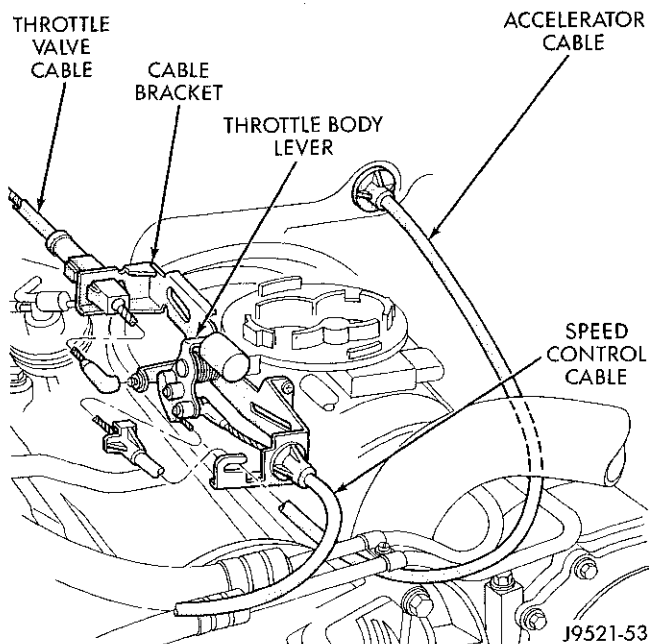


Fig. 293 Throttle Valve Cable Attachment — At Engine

THROTTLE VALVE CABLE ADJUSTMENT PROCEDURE

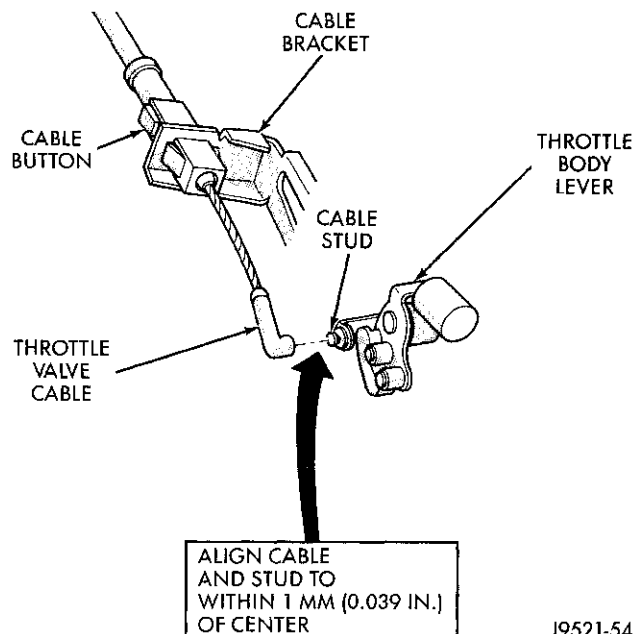
- (1) Turn ignition switch to OFF position and shift into Park.
- (2) Remove air cleaner.
- (3) Disconnect cable end from attachment stud on throttle body.
- (4) Verify that transmission throttle lever is in idle (full forward) position. Then be sure lever on throttle body is at curb idle position.
- (5) Press cable button inward to release cable (Fig. 294). Button only has to move about 2 mm (0.070 in.) to release cable in adjuster head.
- (6) Center cable end on attachment stud to within 1 mm (0.039 in.) and release cable button.
- (7) Check cable adjustment. Be sure transmission throttle lever and lever on throttle body move simultaneously and as described in cable adjustment checking procedure.

GEARSHIFT LINKAGE ADJUSTMENT

Check linkage adjustment by starting the engine in Park and Neutral. Adjustment is OK if the engine starts only in these positions.

Adjustment is incorrect if the engine starts in one but not both positions.

If the engine starts in any position other than Park or Neutral, or if the engine will not start at all, the park/neutral position switch is probably faulty.



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Fig. 294 Throttle Valve Cable Adjustment

SHIFT LINKAGE ADJUSTMENT PROCEDURE

Check condition of the shift linkage (Fig. 295) before adjustment. Do not attempt adjustment if any parts are worn, loose, or bent. Replace the linkage grommets and bushing if the linkage exhibits excessive play. Replace the torque shaft, brackets, or shift rods if bent, or binding.

If either shift rod must be disconnected, replace the grommet securing the rod in the torque shaft arm. Disconnect the rods with a pry tool. Pry only where the grommet and rod attach and not on the rod itself. Then cut away the old grommet. Use pliers to snap the new grommet into the lever and to snap the rod into the grommet.

- (1) Shift transmission into Park.
- (2) Raise vehicle.
- (3) Loosen lock bolt in front shift rod adjusting swivel (Fig. 296).
- (4) Be sure front shift rod slides freely in swivel. Lube rod and swivel if necessary.
- (5) Move transmission shift lever fully rearward into Park detent. Then center adjusting swivel in torque shaft grommet and tighten swivel lock bolt to 90 in. lbs. (10 N·m) torque.
- (6) Lower vehicle and check shift linkage adjustment. Engine should only start in Park and Neutral position. **If engine starts in any position other than Park or Neutral, adjustment is incorrect or park/neutral position switch is faulty.**

FRONT BAND ADJUSTMENT

The front (kickdown) band adjusting screw is located on the left side of the transmission case above the manual valve and throttle valve levers.

ADJUSTMENTS (Continued)

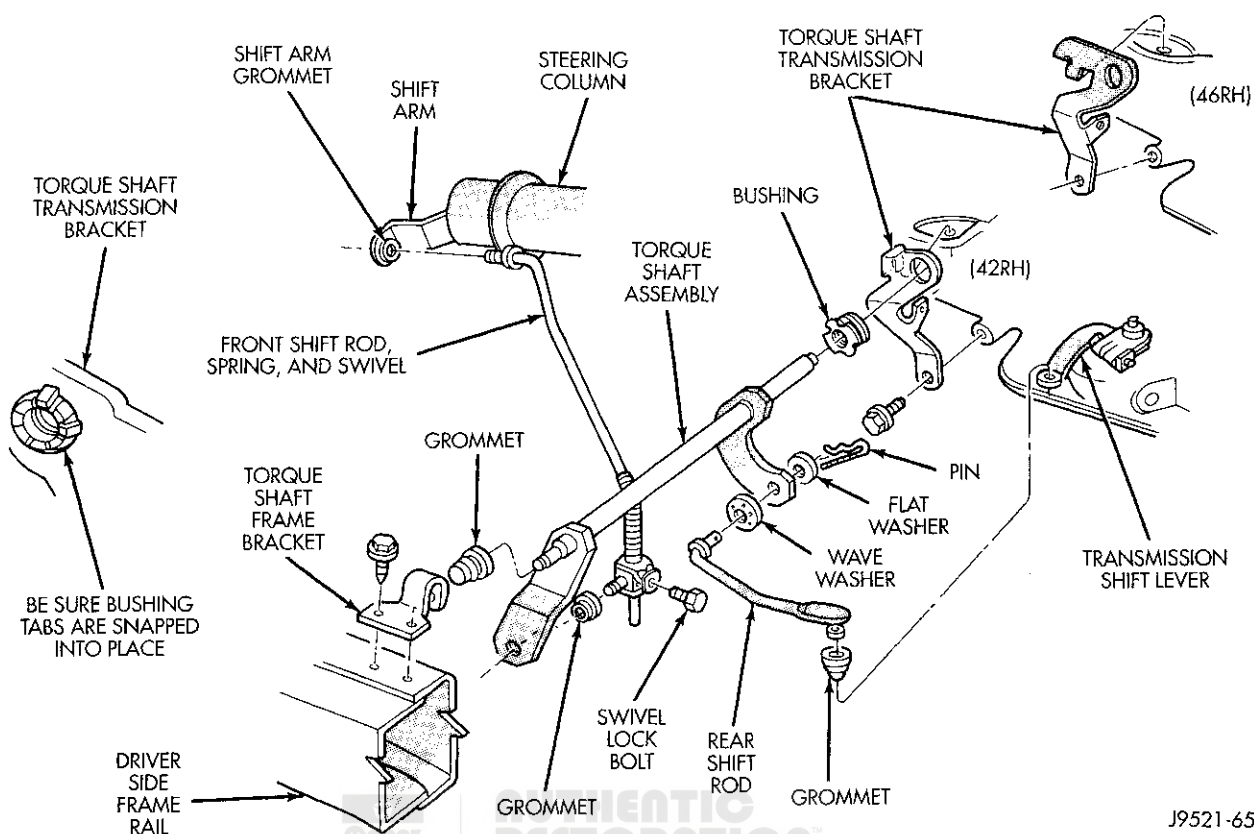


Fig. 295 Column Shift Linkage

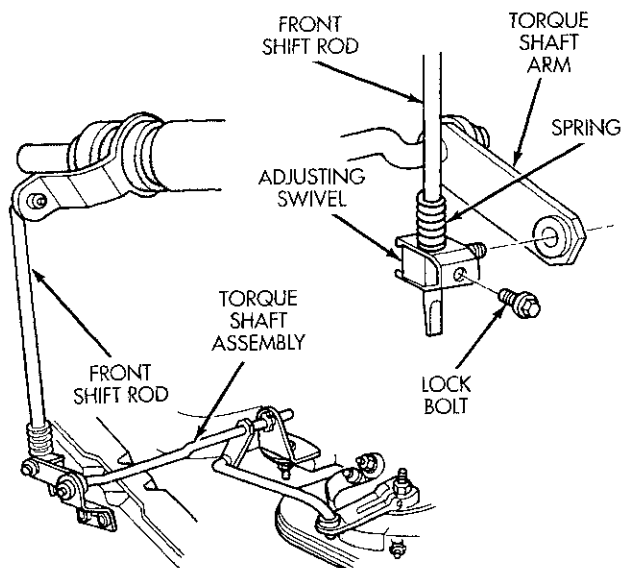


Fig. 296 Linkage Adjustment Components

- (1) Raise vehicle.
- (2) Loosen band adjusting screw locknut (Fig. 297). Then back locknut off 3-5 turns. Be sure adjusting

screw turns freely in case. Apply lubricant to screw threads if necessary.

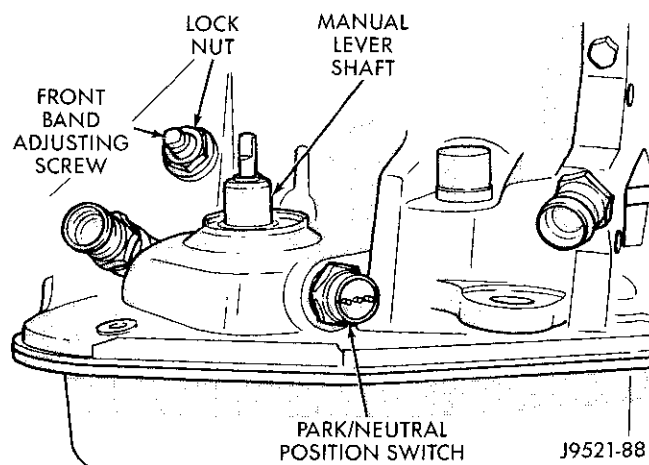


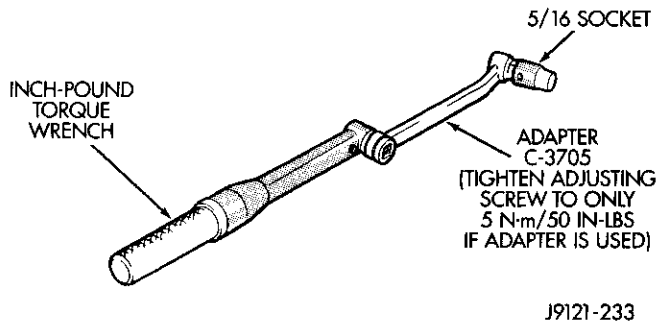
Fig. 297 Front Band Adjustment Screw Location

- (3) Tighten band adjusting screw to 8 N·m (72 in. lbs.) torque with Inch Pound Torque Wrench C-3380-A, a 3-in. extension and 5/16 socket.

CAUTION: If Adapter C-3705 is needed to reach the adjusting screw (Fig. 298), tighten the screw to only 5 N·m (47-50 in. lbs.) torque.

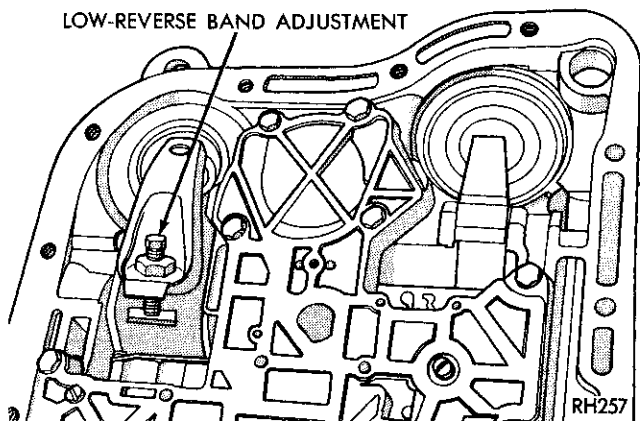
ADJUSTMENTS (Continued)

- (4) Back off front band adjusting screw 2-7/8 turns.
- (5) Hold adjuster screw in position and tighten locknut to 41 N·m (30 ft. lbs.) torque.
- (6) Lower vehicle.

**Fig. 298 Band Adjustment Adapter Tool****REAR BAND ADJUSTMENT**

The transmission oil pan must be removed for access to the rear band adjusting screw.

- (1) Raise vehicle.
- (2) Remove transmission oil pan and drain fluid.
- (3) Loosen band adjusting screw locknut 5-6 turns. Be sure adjusting screw turns freely in lever.
- (4) Tighten adjusting screw to 8 N·m (72 in. lbs.) torque (Fig. 299).
- (5) Back off adjusting screw 2 turns.
- (6) Hold adjusting screw in place and tighten locknut to 34 N·m (25 ft. lbs.) torque.
- (7) Position new gasket on oil pan and install pan on transmission. Tighten pan bolts to 17 N·m (13 ft. lbs.) torque.
- (8) Lower vehicle and refill transmission with Mopar ATF Plus, Type 7176 fluid.

**Fig. 299 Rear Band Adjustment Screw Location****VALVE BODY****CONTROL PRESSURE ADJUSTMENTS**

There are two control pressure adjustments on the valve body;

- Line Pressure
- Throttle Pressure

Line and throttle pressures are interdependent because each affects shift quality and timing. As a result, both adjustments must be performed properly and in the correct sequence. Adjust line pressure first and throttle pressure last.

LINE PRESSURE ADJUSTMENT

Measure distance from the valve body to the inner edge of the adjusting screw with an accurate steel scale (Fig. 300).

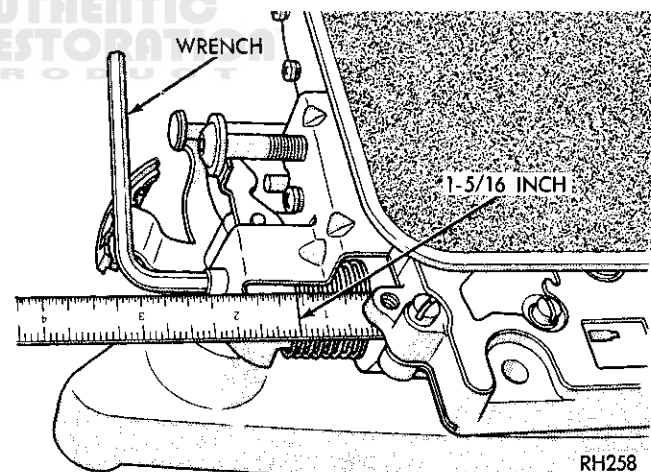
Distance should be 33.4 mm (1-5/16 in.).

If adjustment is required, turn the adjusting screw in, or out, to obtain required distance setting.

NOTE: The 33.4 mm (1-5/16 in.) setting is an approximate setting. Manufacturing tolerances may make it necessary to vary from this dimension to obtain desired pressure.

One complete turn of the adjusting screw changes line pressure approximately 1-2/3 psi (9 kPa).

Turning the adjusting screw counterclockwise increases pressure while turning the screw clockwise decreases pressure.

**Fig. 300 Line Pressure Adjustment****THROTTLE PRESSURE ADJUSTMENT**

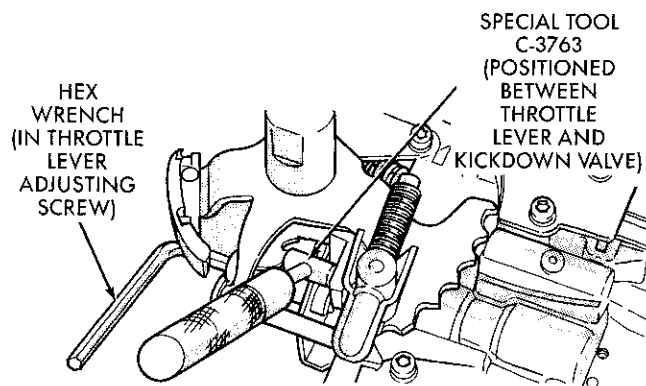
Insert Gauge Tool C-3763 between the throttle lever cam and the kickdown valve stem (Fig. 301).

Push the gauge tool inward to compress the kickdown valve against the spring and bottom the throttle valve.

Maintain pressure against kickdown valve spring. Turn throttle lever stop screw until the screw head touches throttle lever tang and the throttle lever cam touches gauge tool.

ADJUSTMENTS (Continued)

NOTE: The kickdown valve spring must be fully compressed and the kickdown valve completely bottomed to obtain correct adjustment.

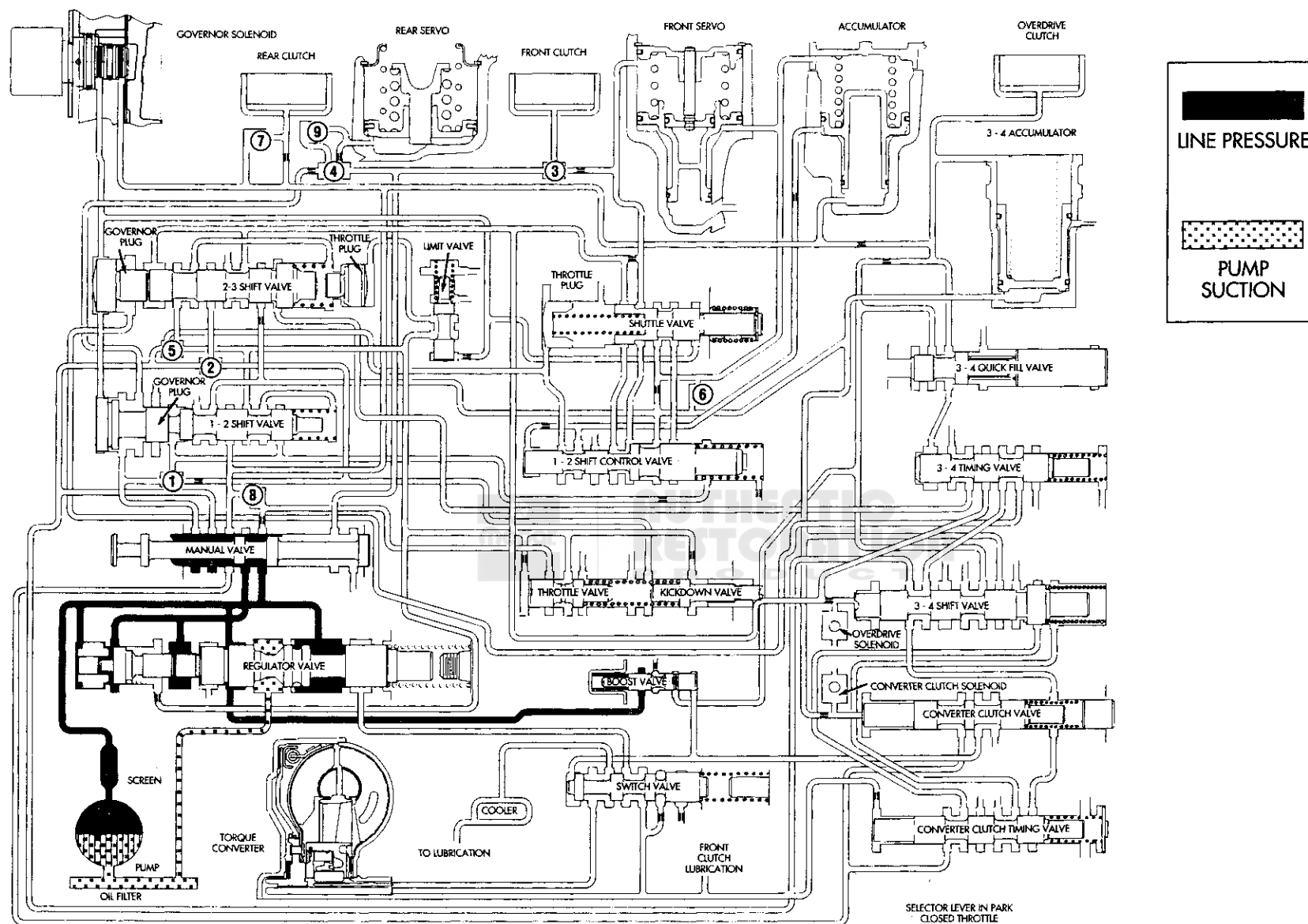
SCHEMATICS AND DIAGRAMS**HYDRAULIC SCHEMATICS**

J9521-109

Fig. 301 Throttle Pressure Adjustment



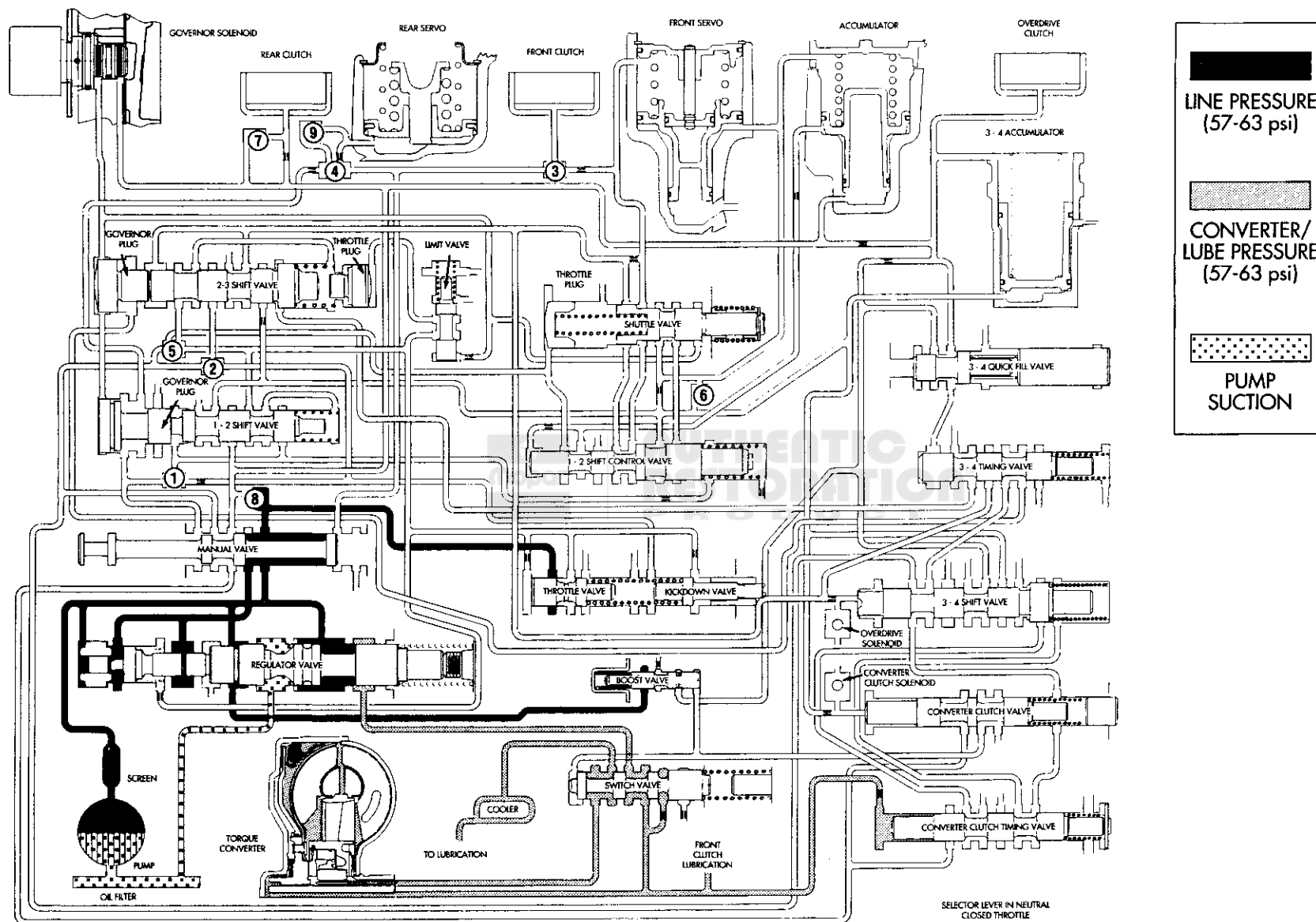
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HYDRAULIC FLOW IN PARK

J9321-371

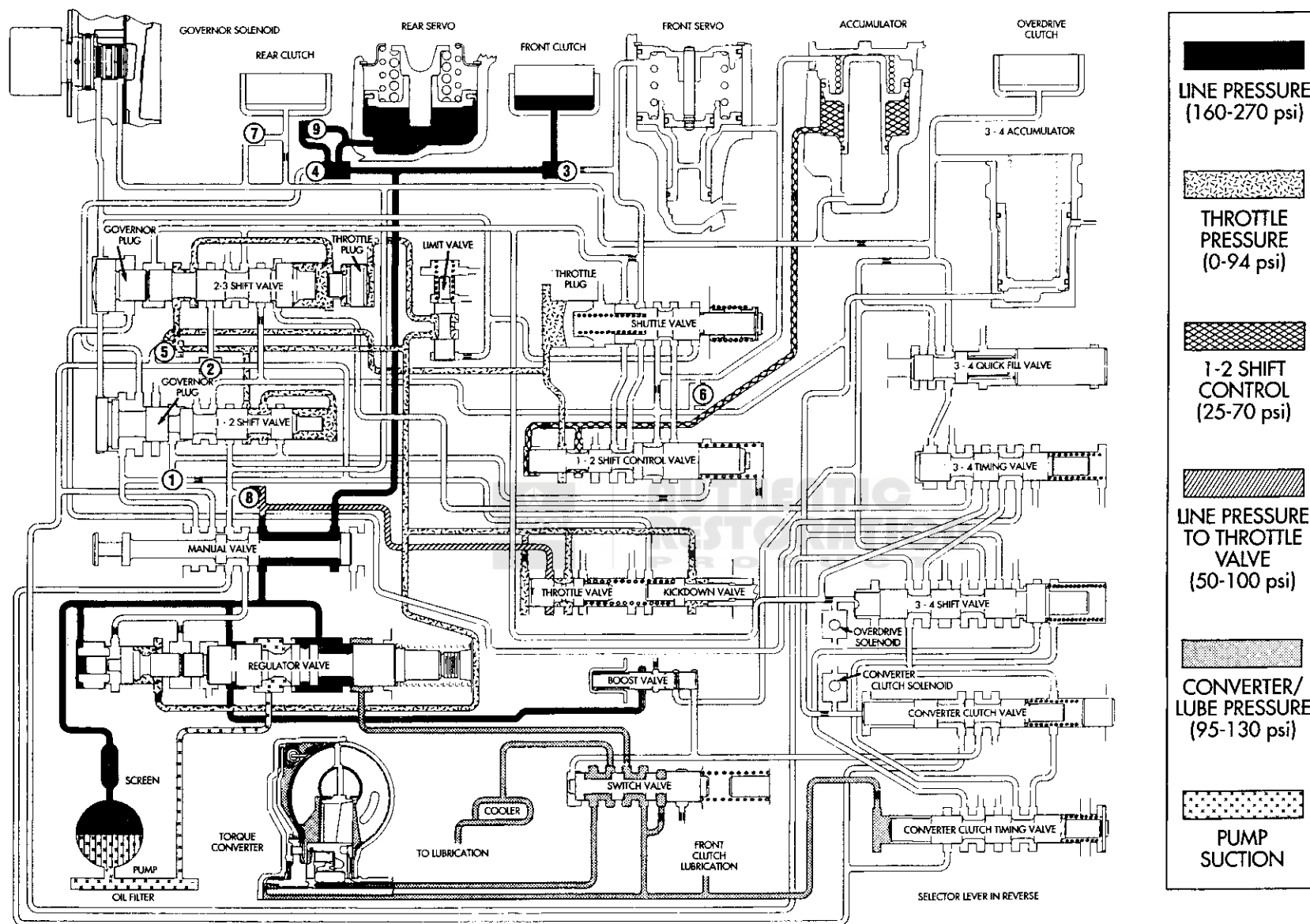
SCHEMATICS AND DIAGRAMS (Continued)



J9321-372

HYDRAULIC FLOW IN NEUTRAL

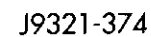
SCHEMATICS AND DIAGRAMS (Continued)



J9321-373

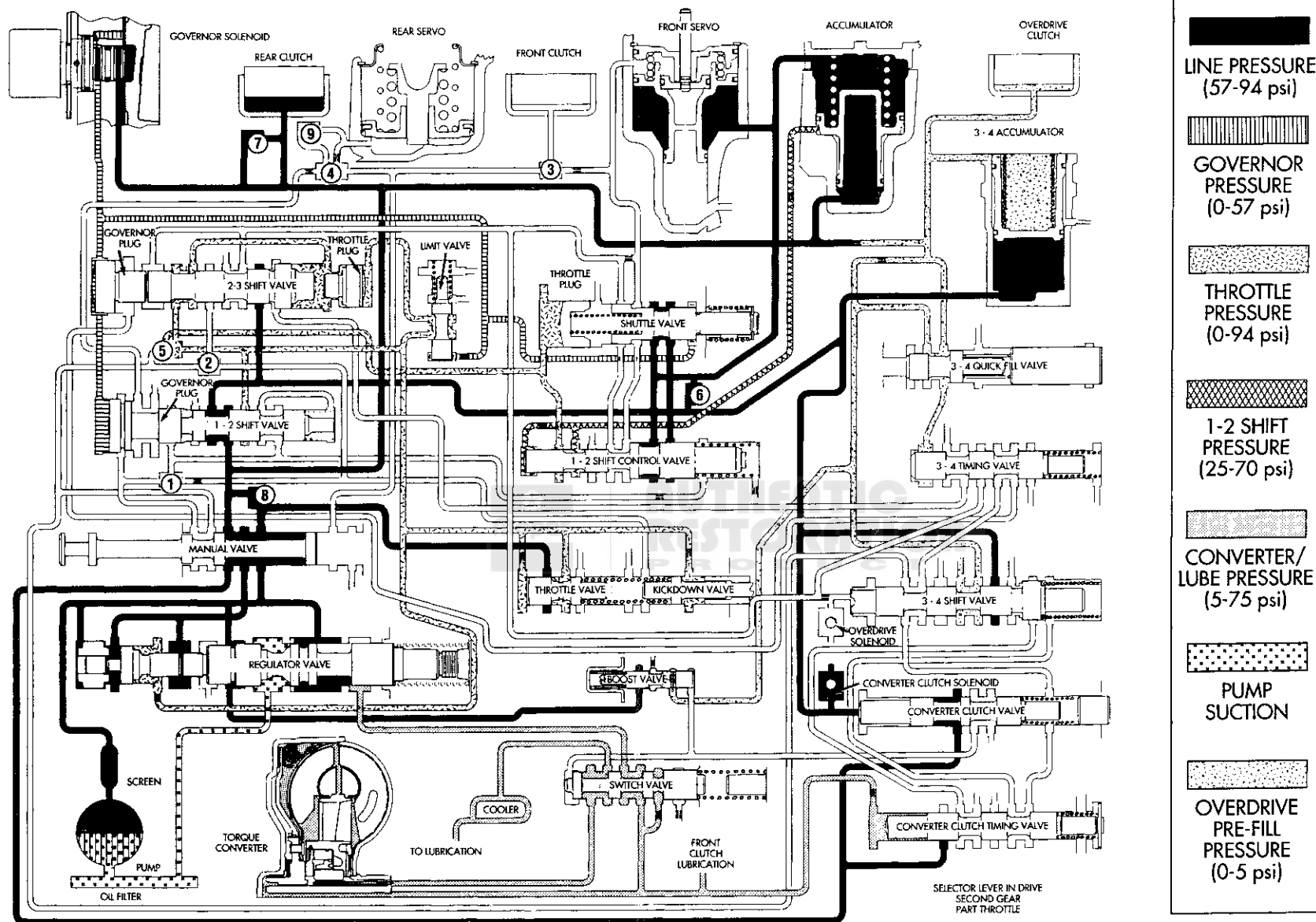
HYDRAULIC FLOW IN REVERSE

21 - 367



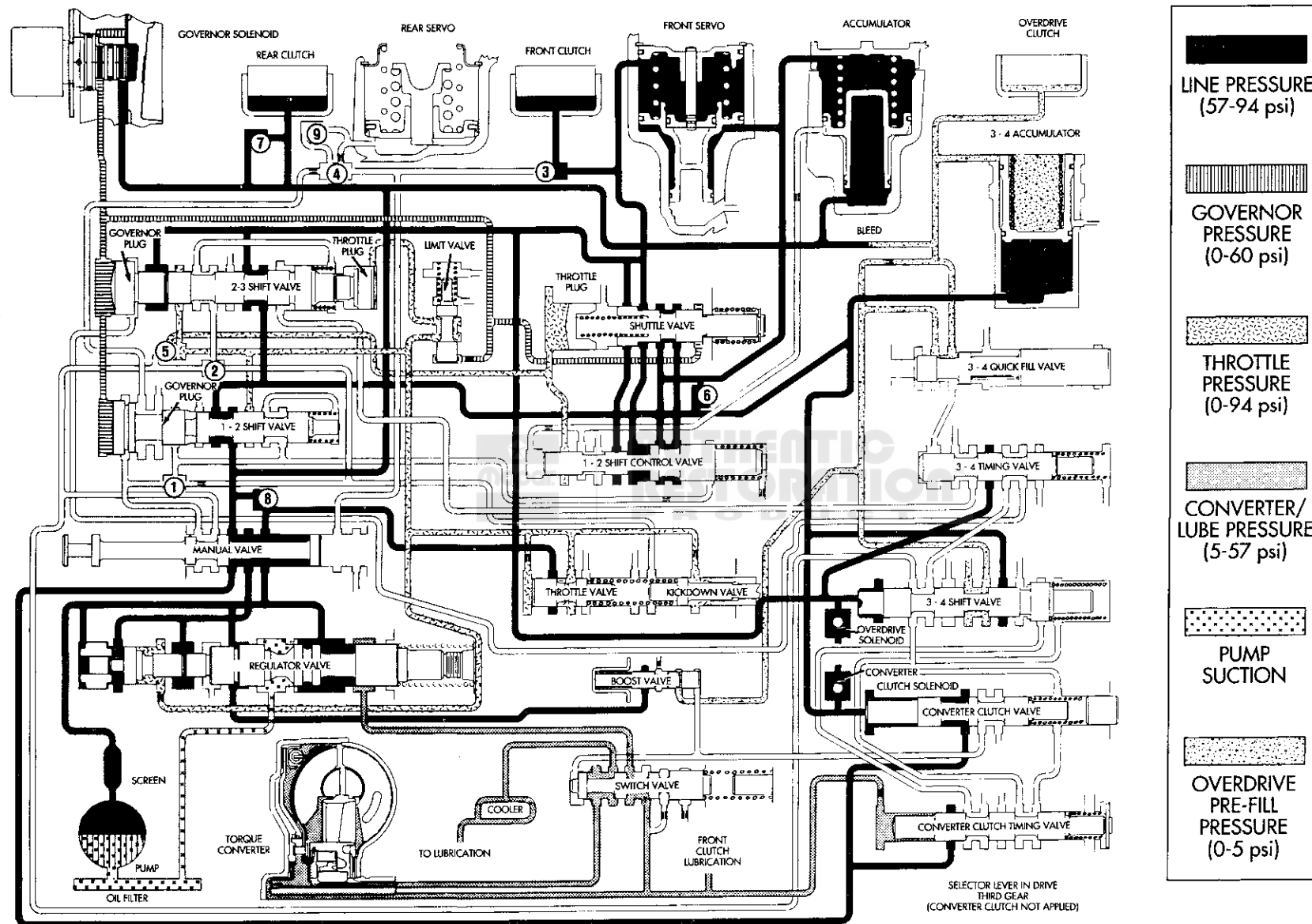
HYDRAULIC FLOW IN DRIVE FIRST GEAR

SCHEMATICS AND DIAGRAMS (Continued)



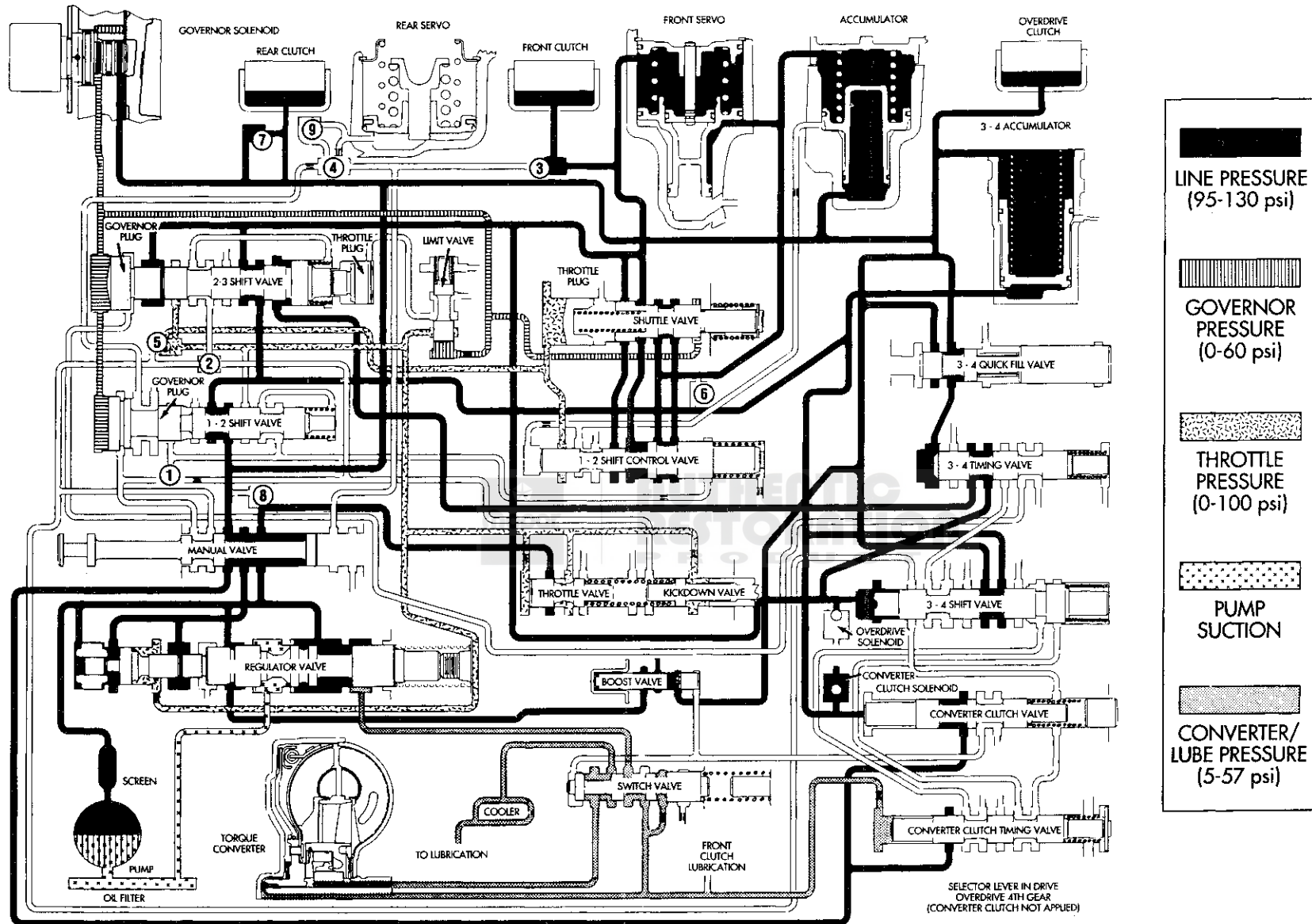
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SCHEMATICS AND DIAGRAMS (Continued)



J9321-376

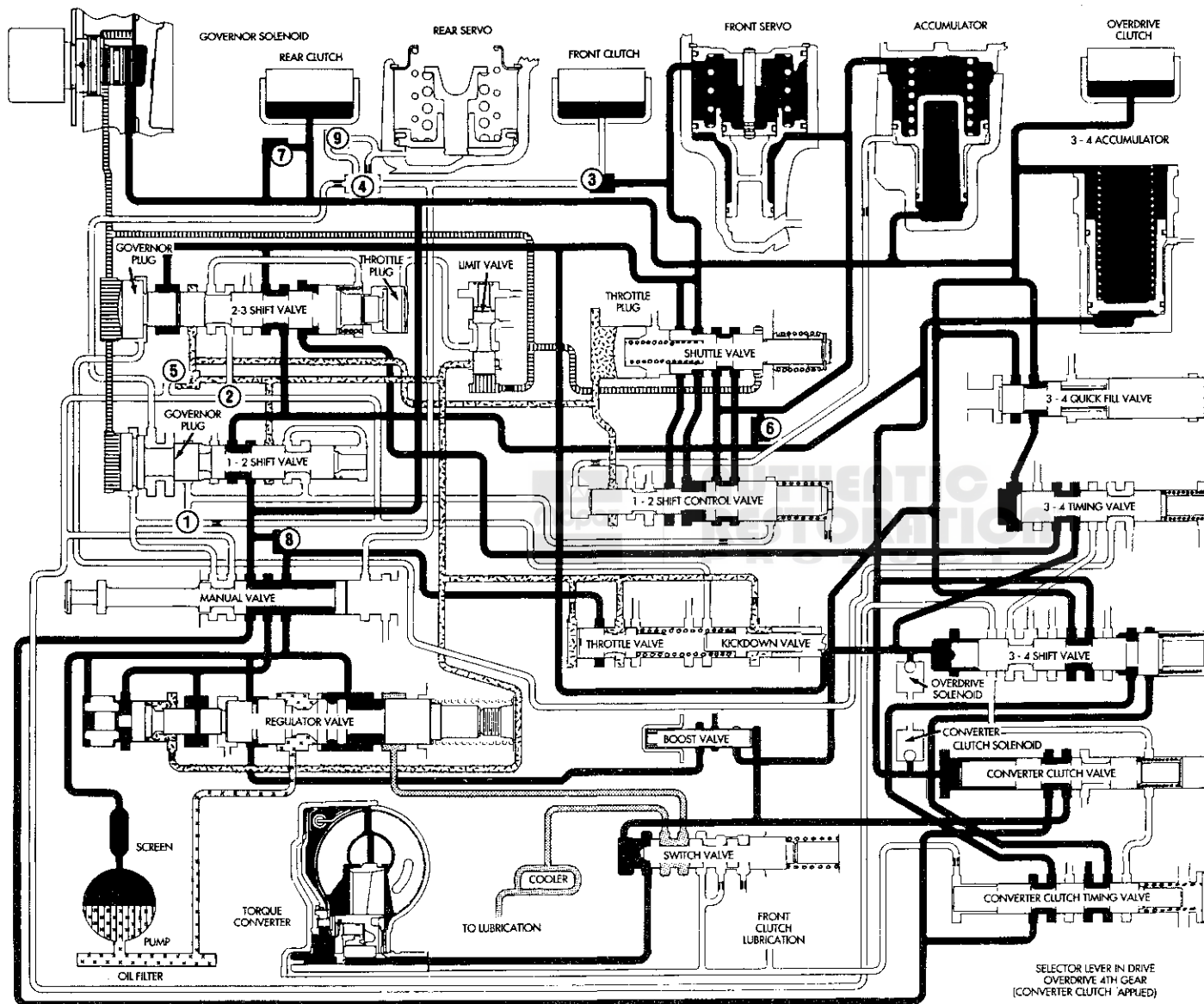
HYDRAULIC FLOW IN DRIVE THIRD GEAR



J9321-377

HYDRAULIC FLOW IN DRIVE FOURTH GEAR (CONVERTER CLUTCH NOT APPLIED)

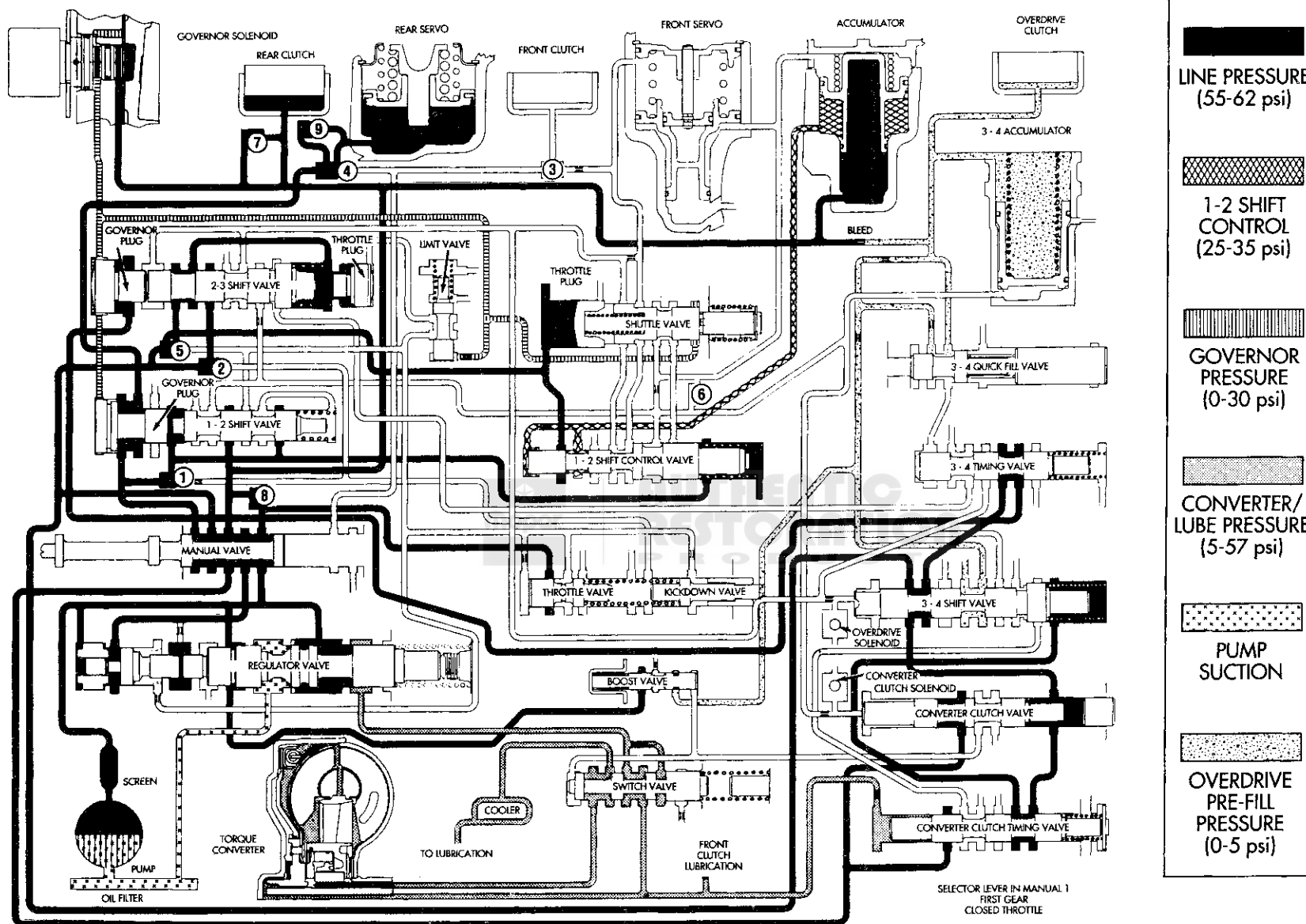
SCHEMATICS AND DIAGRAMS (Continued)



	LINE PRESSURE (95-130 psi)
	GOVERNOR PRESSURE (0-60 psi)
	THROTTLE PRESSURE (0-100 psi)
	CONVERTER/ LUBE PRESSURE (5-60 psi)
	PUMP SUCTION

HYDRAULIC FLOW IN DRIVE FOURTH GEAR (CONVERTER CLUTCH APPLIED)

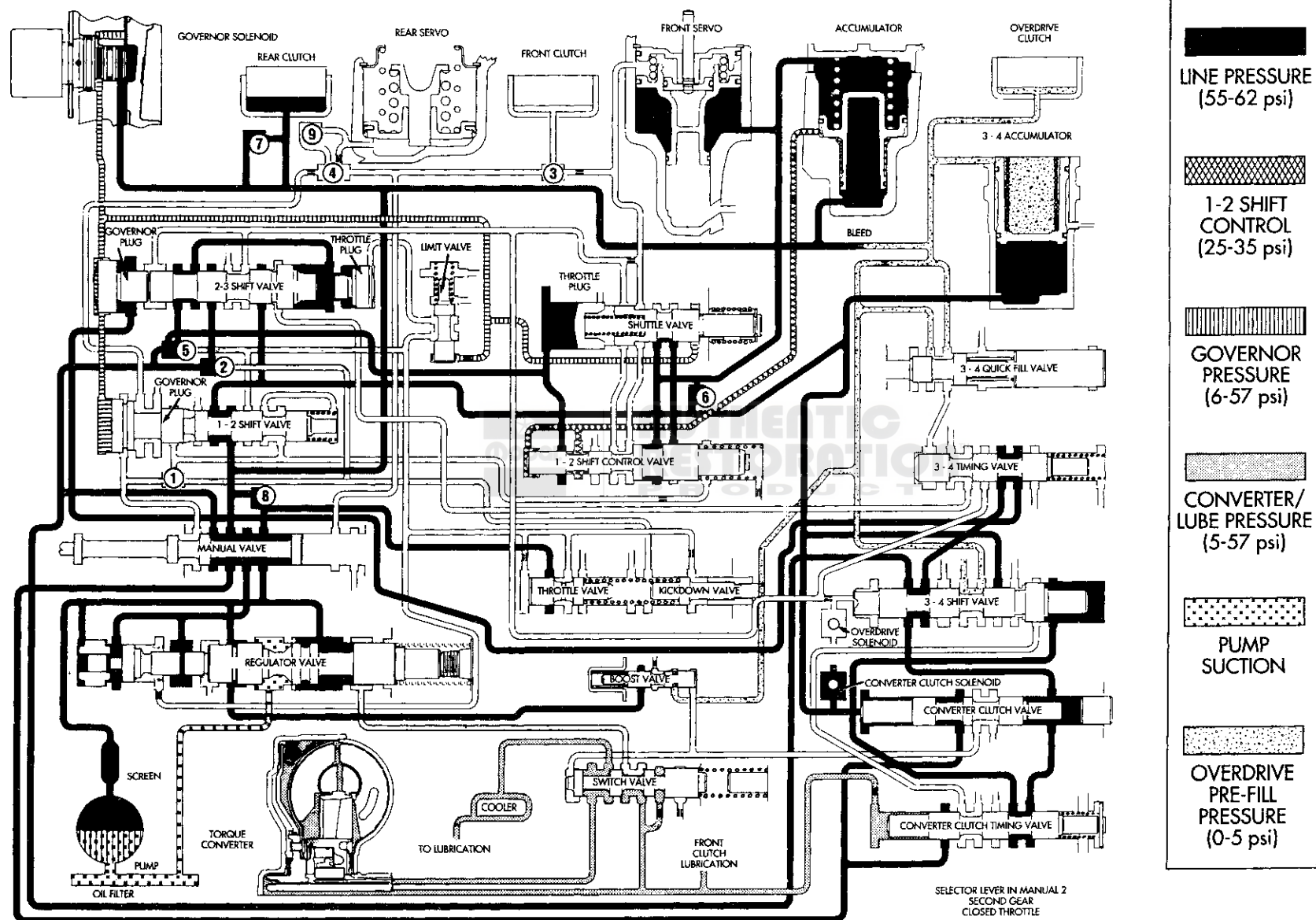
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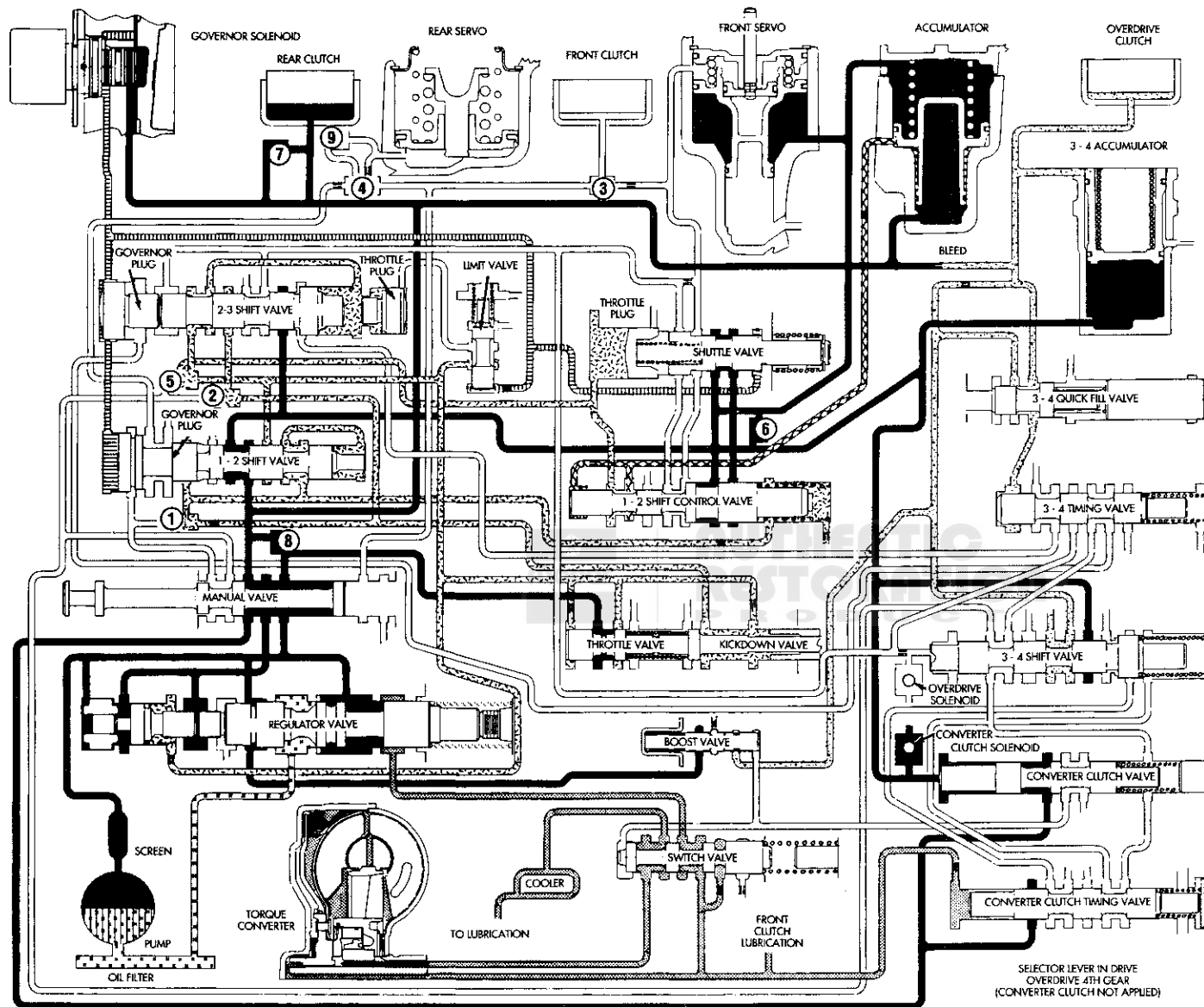
HYDRAULIC FLOW IN MANUAL LOW (1)

SCHEMATICS AND DIAGRAMS (Continued)



J9321-380

HYDRAULIC FLOW IN MANUAL SECOND (2)



LINE PRESSURE
 (57-94 psi)

THROTTLE PRESSURE
 (0-94 psi)

1-2 SHIFT CONTROL
 (25-70 psi)

GOVERNOR PRESSURE
 (0-57 psi)

CONVERTER/LUBE PRESSURE
 (5-57 psi)

PUMP SUCTION

OVERDRIVE PRE-FILL PRESSURE
 (0-5 psi)

SELECTOR LEVER IN DRIVE
 OVERDRIVE 4TH GEAR
 (CONVERTER CLUTCH NOT APPLIED)

J9321-381

HYDRAULIC FLOW DURING FULL THROTTLE 3-2 DOWNSHIFT (PASSING GEAR)

SPECIFICATIONS**RE TRANSMISSION****GENERAL**

Oil pump gear tip clearance	0.089-0.190 mm	0.004-0.008 in.
Planetary end play	0.150-1.22 mm	0.006-0.048 in.
Input shaft end play	0.86-2.13 mm	0.034-0.084 in.
Clutch pack clearance/ Front 3-disc.	1.78-3.28mm	0.070-0.129 in.
Clutch pack clearance/ Rear 4-disc.	0.64-1.14 mm	0.025-0.045 in.
Overdrive clutch disc usage	4 discs	
Direct clutch disc usage	8 discs	
Front clutch spring usage	9 spring	
Band adjustment from 72 in. lbs.		
Front band	Back off 2-7/8 turns	
Rear band	Back off 2 turns	
Recommended fluid	Mopar, ATF Plus	type 7176

TORQUE**DESCRIPTION****TORQUE**

Bolt, torque convertor 31 N·m (23 ft. lbs.)
 Bolt/nut, crossmember 68 N·m (50 ft. lbs.)
 Bolt, driveplate to crankshaft . . . 75 N·m (55 ft. lbs.)
 Plug, front band reaction 17 N·m (13 ft. lbs.)
 Locknut, front band adj. 34 N·m (25 ft. lbs.)
 Switch, park/neutral 34 N·m (25 ft. lbs.)
 Bolt, fluid pan. 17 N·m (13 ft. lbs.)
 Bolt, oil pump 20 N·m (15 ft. lbs.)
 Bolt, overrunning clutch cam . . . 17 N·m (13 ft. lbs.)
 Bolt, O/D to trans. 34 N·m (25 ft. lbs.)
 Bolt, O/D piston retainer 17 N·m (13 ft. lbs.)
 Plug, pressure test port 14 N·m (10 ft. lbs.)
 Bolt, reaction shaft support 20 N·m (15 ft. lbs.)
 Locknut, rear band 41 N·m (30 ft. lbs.)
 Bolt, speedometer adapter 11 N·m (8 ft. lbs.)
 Screw, fluid filter 4 N·m (35 in. lbs.)
 Bolt, valve body to case 12 N·m (100 in. lbs.)

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SPECIFICATIONS (Continued)**THRUST WASHER/SPACER/SNAP RING DIMENSIONS**

Front clutch thrust washer (reaction shaft support hub)	1.55 mm 2.15 mm	0.061 in. 0.084 in. 0.102 in.
Rear clutch thrust washer (clutch retainer)	1.55 mm	0.061 in.
Output shaft thrust plate (output shaft pilot hub)	1.5-1.6 mm	0.060-0.063 in.
Output shaft thrust washer (rear clutch hub)	1.3-1.4 mm 1.75-1.8 mm 2.1-2.2 mm	0.052-0.054 in. 0.068-0.070 in. 0.083-0.085 in.
Rear clutch pack snap ring	1.5-1.6 mm 1.9-1.95 mm	0.060-0.062 in. 0.074-0.076 in.
Planetary geartrain snap ring (at front of output shaft)	1.4-1.5 mm 1.6-1.7 mm	0.055-0.059 in. 0.062-0.066 in.

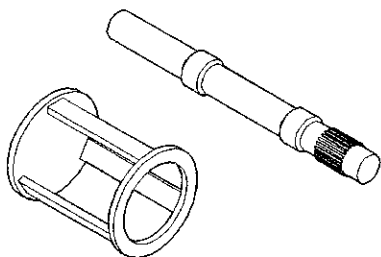
Overdrive piston thrust plate	Thrust plate and spacer are select fit components. Refer to size charts and
Intermediate shaft spacer	selection procedures in Overdrive Unit disassembly and assembly section.

PRESSURE TEST

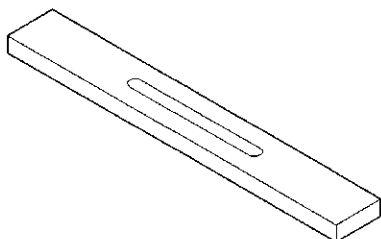
Overdrive clutch	Fourth gear only	Pressure should be 469-496 kPa (68-72 psi) with closed throttle and increase to 620-896 kPa (90-130 psi) at 1/2 to 3/4 throttle.
Line pressure (at accumulator)	Closed throttle	372-414 kPa (54-60 psi).
Front servo	Third gear only	No more than 21 kPa (3 psi) lower than line pressure.
Rear servo	1 range R range	No more than 21 kPa (3 psi) lower than line pressure. 1103 kPa (160 psi) at idle, builds to 1862 kPa (270 psi) at 1600 rpm.
Governor	D range closed throttle	Pressure should respond smoothly to changes in mph and return to 0-7 kPa (0-1.5 psi) when stopped with transmission in D, 1, 2. Pressure above 7 kPa (1.5 psi) at stand still will prevent transmission from downshifting.

SPECIAL TOOLS

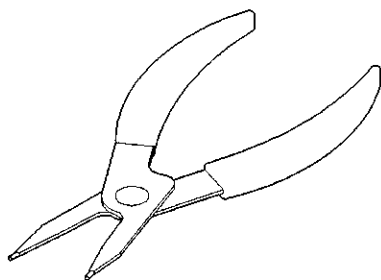
RE TRANSMISSION



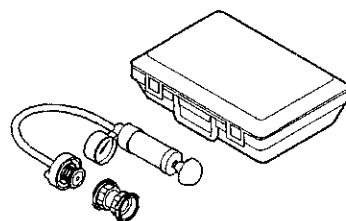
Spring Compressor and Alignment Shaft—6227



Gauge Bar—6311

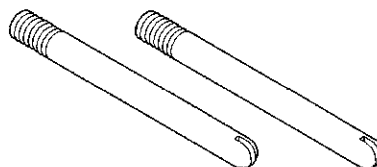


Snap-ring Plier—6823

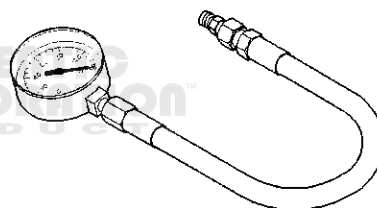


7700-c017c9c4

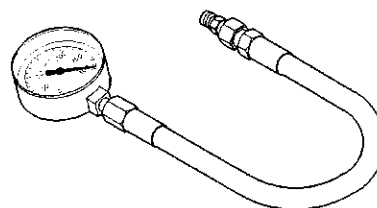
Pressure Tester—7700



Extension Housing Pilot—C-3288-B

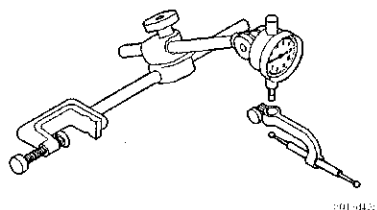


Pressure Gauge—C-3292

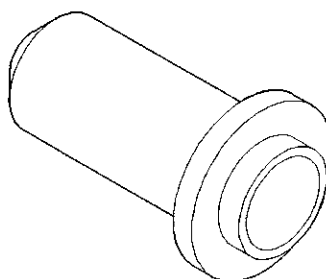


Pressure Gauge—C-3293SP

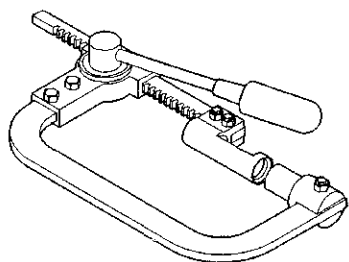
SPECIAL TOOLS (Continued)



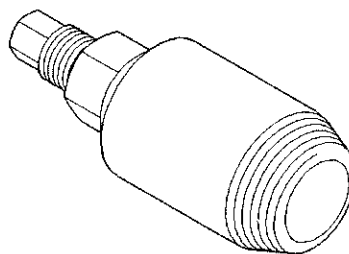
Dial Indicator—C-3339



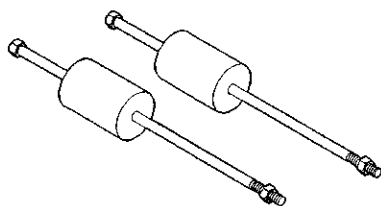
Seal Installer—C-3860-A



Spring Compressor—C-3422-B



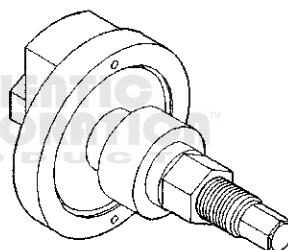
Seal Puller—C-3861



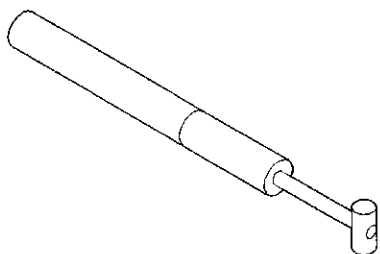
Puller, Slide Hammer—C-3752



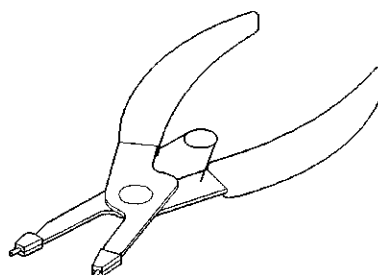
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Installer—C-3863-A

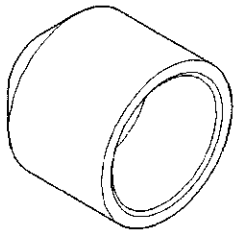


Gauge, Throttle Setting—C-3763

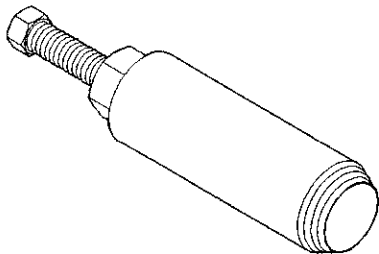


Snap-ring Plier—C-3915

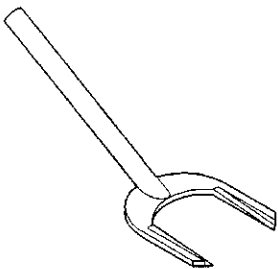
SPECIAL TOOLS (Continued)



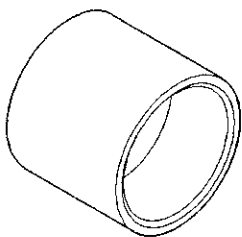
Seal Installer—C-3972-A



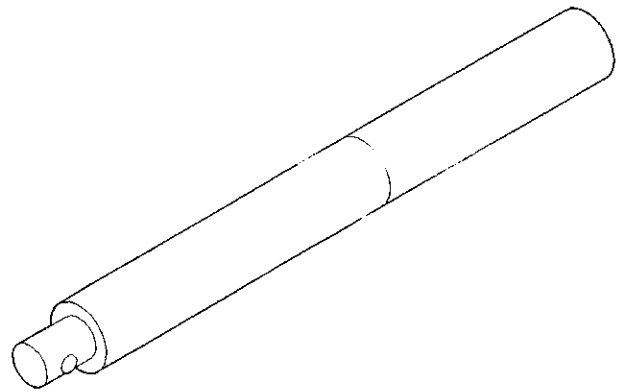
Seal Puller—C-3981-B



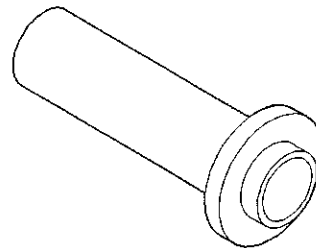
Seal Remover—C-3985-B



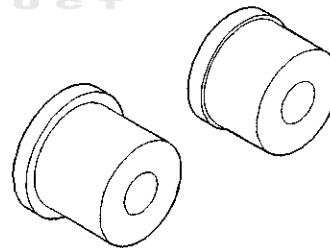
Installer—C-3995-A



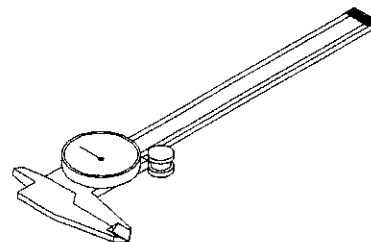
Universal Handle—C-4171



Seal Installer—C-4193-A



Remover/Installer—C-4470

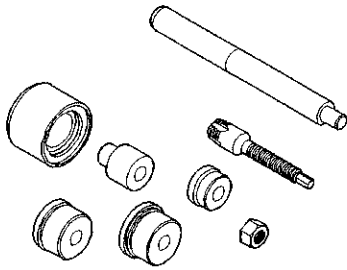


Dial Caliper—C-4962

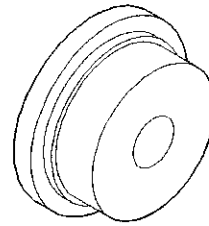


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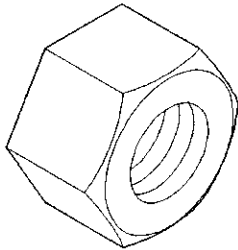
SPECIAL TOOLS (Continued)



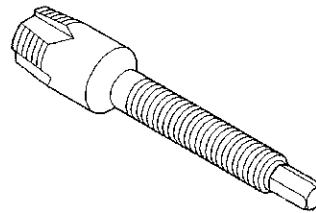
Bushing Remover/Installer Set—C-3887-B



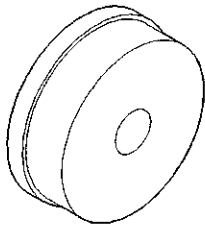
Installer, Oil Pump Bushing—SP-5118, From kit C-3887-B



Nut, Bushing Remover—SP-1191, From kit C-3887-B



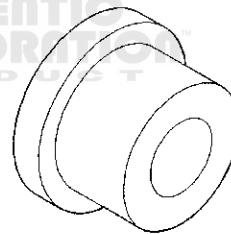
Remover, Reaction Shaft Bushing—SP-5301, From kit C-3887-B



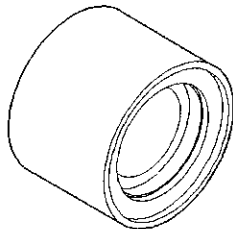
Remover, Front Clutch Bushing—SP-3629, From kit C-3887-B



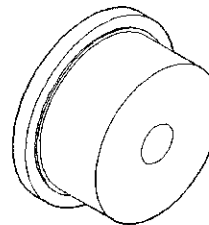
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Installer, Reaction Shaft Bushing—SP-5302, From kit C-3887-B



Cup, Bushing Remover—SP-3633, From kit C-3887-B



Installer, Front Clutch Bushing—SP-5511, From kit C-3887-B

NV231 HD/NV241/NV241 HD TRANSFER CASE

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GENERAL INFORMATION

GENERAL DESCRIPTION

The NV231 HD, NV241, and NV241 HD are all part-time transfer cases with a low-range gear system. They provide three operating ranges plus a Neutral position. The low range position provides a gear reduction ratio of 2.72:1 for increased low speed torque capability. Operating ranges are: 2-high, 4-high and 4-low.

The gear cases, retainer and extension are all of aluminum. Drive sprockets and an interconnecting drive chain are used to transmit engine torque to the front/rear propeller shafts. The mainshaft, input gear and front output shaft are supported by ball and needle bearings.

The synchro mechanism consists of a brass stop ring, synchro hub with 3 struts and 2 retaining springs and the sliding clutch (Fig. 1). The synchro components allow the transfer case to be shifted between 2H and 4H ranges while the vehicle is in motion. However, the vehicle must be stopped in order to shift into 4L range.

TRANSFER CASE APPLICATION

The NV231 HD is used in 1500 models only. The NV241 is used in 2500 models and the NV241 HD is used in 2500 and 3500 models with a V10 or diesel engine.

OPERATING RANGES

Transfer case operating ranges are:

- 2WD (2-wheel drive)
- 4x4 (4-wheel drive)
- 4 Lo (4-wheel drive low range)

The 2WD range is for use on any road surface at any time.

The 4x4 and 4 Lo ranges are for off road use only. They are not for use on hard surface roads. The only exception being when the road surface is covered by ice and snow.

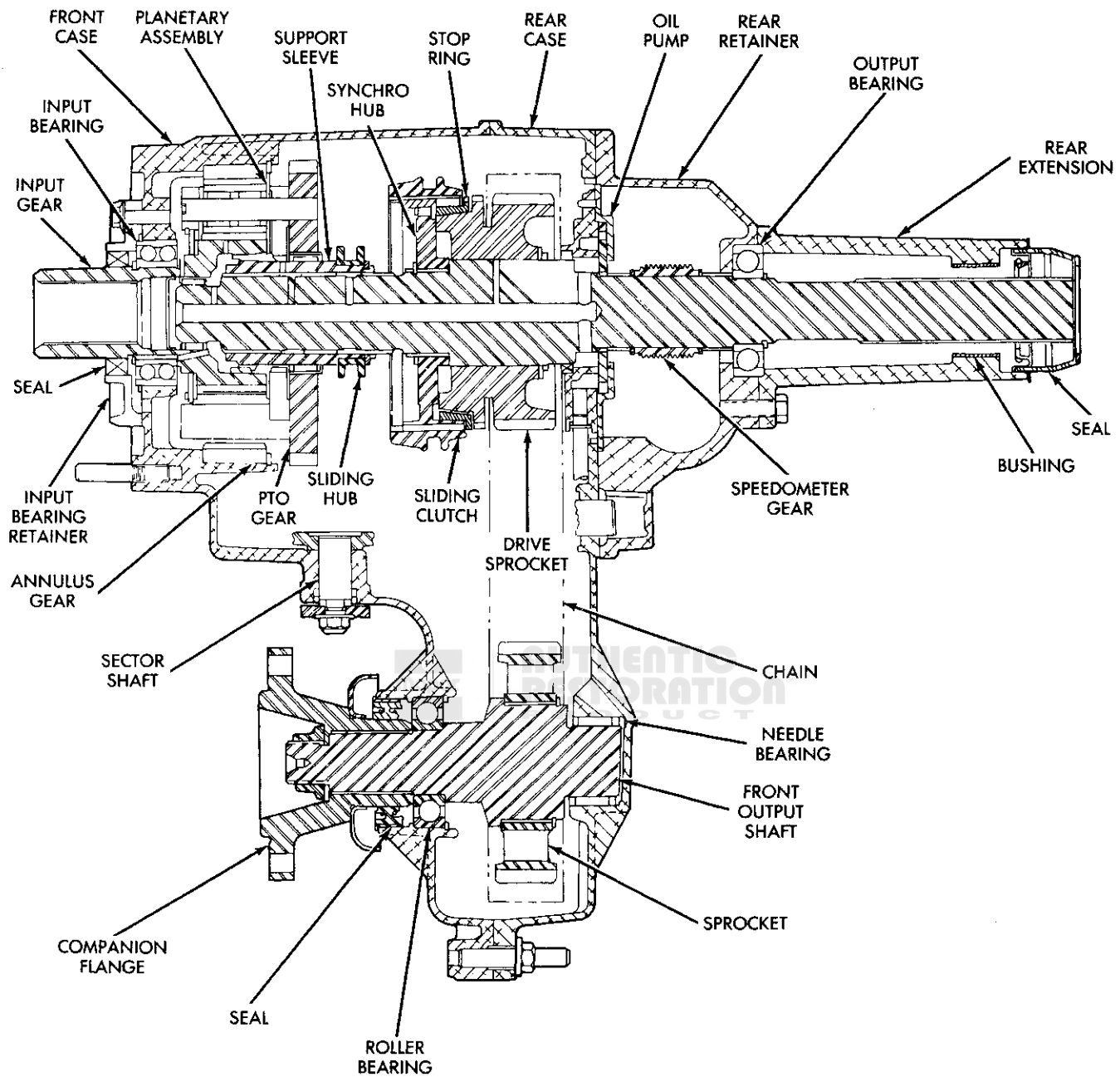
The low range reduction gear system is operative in 4 Lo range only. This range is for extra pulling power in off road situations. Low range reduction ratio is 2.72:1.

A front axle disconnect system is used to achieve two-wheel drive mode. The axle disconnect vacuum motor is actuated by a vacuum switch on the transfer case. The switch is operated by the transfer case range rod.

TRANSFER CASE SERVICE

Overhaul procedures for the NV231 HD and both versions of the NV241 transfer case are virtually the same. The only major difference between them is the PTO gear used in the NV241 HD model.

Although overhaul procedures are the same for all three transfer cases, internal parts are different and must not be interchanged.

GENERAL INFORMATION (Continued)

J9421-230

Fig. 1 NV231/NV241 Transfer Case (NV241 HD Version Shown)

GENERAL INFORMATION (Continued)**PTO CAPABILITY**

The NV241 HD transfer case has power take-off capability. A PTO gear permanently attached to the planetary carrier, and a removable PTO cover are provided for this purpose.

TRANSFER CASE IDENTIFICATION

An identification tag (Fig. 2) is attached to the rear case of every NV241 transfer case. The tag provides the transfer case model number, assembly number, serial number, and low range ratio.

The transfer case serial number also represents the date of build. For example, a serial number of 7-10-96 would represent July 10, 1996.

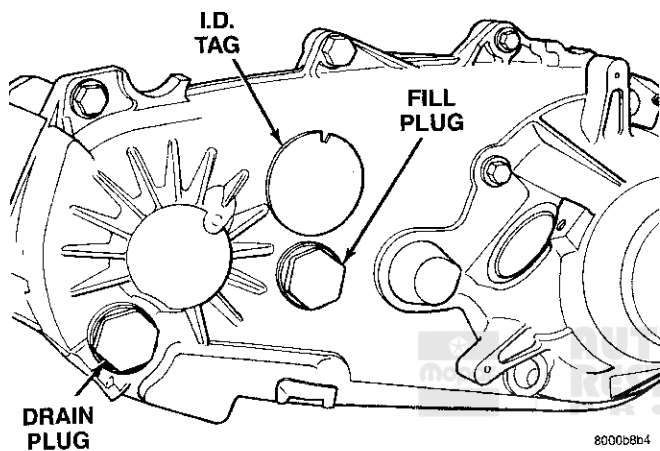


Fig. 2 Transfer Case Identification Tag

RECOMMENDED LUBRICANT AND CAPACITY

Recommended lubricant for all three transfer case models is Mopar Dexron II, or ATF Plus. Use this fluid for topping off the level, refilling after service, or normal fluid changes.

Do not use anti-friction additives or similar products in the NV231/NV241 transfer cases. Use recommended lubricant only.

Approximate lubricant refill capacities are 3.1 liters (6.5 pints) for the NV241 HD and 1.5 to 2 liters (3 to 3.6 pints) for the NV231 HD.

TRANSFER CASE SHIFT MECHANISM

The transfer case is operated by an adjustable floor mounted shift linkage. The transfer case shift lever is directly attached to the shift sector. The sector operates the range and mode forks within the transfer case.

Shift pattern is basically a straight-line pattern with a neutral detent. Lever range positions are imprinted in the shift knob.

DIAGNOSIS AND TESTING**SERVICE DIAGNOSIS**

Before attempting to repair a suspected transfer case malfunction, check all other driveline components beforehand.

The actual cause of a problem may be related to such items as: front hubs, axles, propeller shafts, wheels and tires, transmission, or clutch instead. If all other driveline components are in good condition and operating properly, refer to the Service Diagnosis chart for further information.

SERVICE PROCEDURES**CHECKING FLUID LEVEL**

Correct fluid level for the NV231 HD, NV241, or NV241 HD transfer case is to the bottom edge of the fill plug hole.

NOTE: A correct method of checking fluid level is important. An accurate check requires that the transfer case be level.

If fluid level is checked with the vehicle parked on the shop floor, be sure the floor area used is level. If fluid level is checked with the vehicle raised, use either a swivel arm or drive-on type hoist to be sure the vehicle is level.

FLUID DRAIN/REFILL

- (1) Raise vehicle.
- (2) Position drain pan under transfer case.
- (3) Remove drain and fill plugs and drain lubricant completely.
- (4) Install drain plug. Tighten plug to 41-54 N·m (30-40 ft. lbs.).
- (5) Remove drain pan.
- (6) Fill transfer case to bottom edge of fill plug opening with Mopar Dexron II.
- (7) Install and tighten fill plug to 41-54 N·m (30-40 ft. lbs.).
- (8) Lower vehicle.

IN-VEHICLE SERVICE

The front shaft companion flange, rear extension seal, output bearing, front shaft seal, and speedometer drive gear can all be serviced with the transfer case in the vehicle.

The rear extension, rear retainer, and companion flange, can all be removed for access while the transfer case is mounted in the vehicle. Removal/installation procedures are described in the transfer case disassembly/assembly procedures.

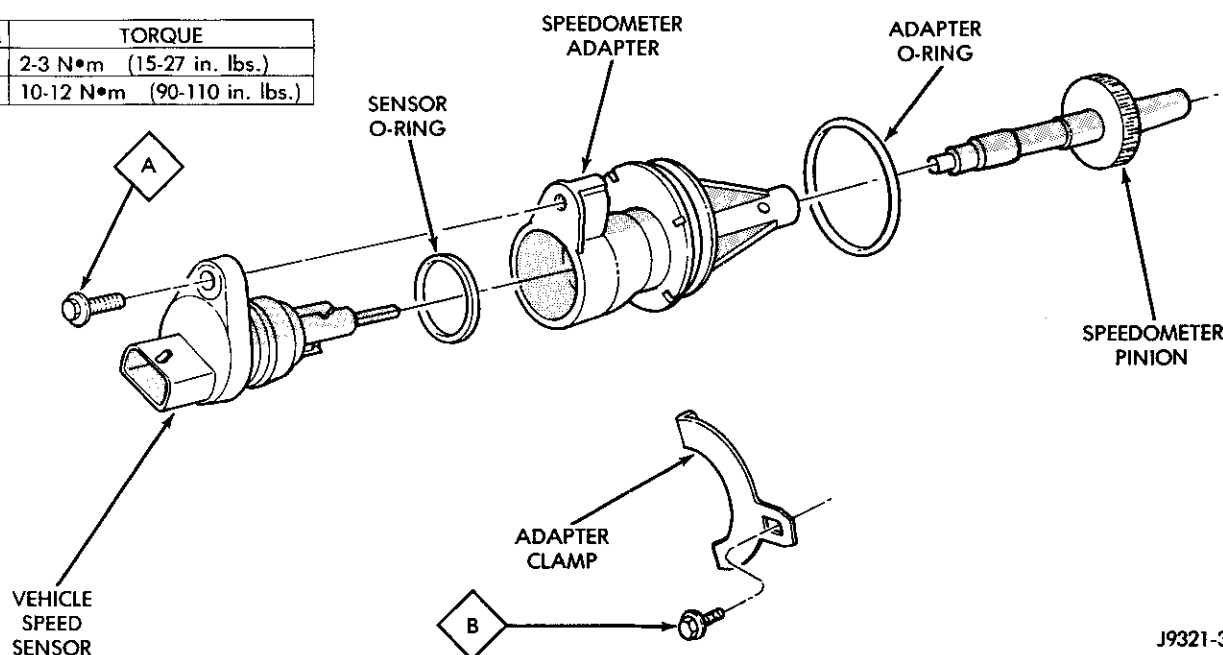
SERVICE PROCEDURES (Continued)

Condition	Possible Cause	Correction
TRANSFER CASE DIFFICULT TO SHIFT OR WILL NOT SHIFT INTO DESIRED RANGE	(1) Vehicle speed too great to permit shifting. (2) If vehicle was operated for extended period in 4H mode on dry paved surface, driveline torque load may cause difficulty. (3) Transfer case external shift linkage binding. (4) Insufficient or incorrect lubricant. (5) Internal components binding, worn or damaged.	(1) Stop vehicle and shift into desired range. Or reduce speed to 3-4 km/h (2-3 mph) before attempting to shift. (2) Stop vehicle, shift transmission to Neutral, shift transfer case to 2H mode and operate vehicle in 2H on dry paved surfaces. (3) Lubricate, repair or replace linkage bushings or tighten loose components as necessary. (4) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. (5) Disassemble unit and replace worn or damaged components as necessary.
TRANSFER CASE NOISY IN ALL DRIVE MODES	(1) Insufficient or incorrect lubricant.	(1) Drain and refill to edge of fill hole with DEXRON II® or MOPAR-MERCON® Automatic Transmission Fluid. Check for leaks and repair if necessary. Note: If unit is still noisy after drain and refill, disassembly and inspection may be required to locate source of noise.
NOISY IN – OR JUMPS OUT OF – FOUR WHEEL DRIVE LOW RANGE	(1) Transfer case not completely engaged in 4L position. (2) Shift linkage out of adjustment. (3) Shift linkage loose or binding. (4) Range fork damaged, inserts worn, or fork is binding on shift rail. (5) Low range gear worn or damaged.	(1) Stop vehicle, shift transfer case to Neutral, then shift back into 4L position. (2) Adjust linkage. (3) Tighten, lubricate or repair linkage as necessary. (4) Disassemble unit and repair as necessary. (5) Disassemble and repair as necessary.
LUBRICANT LEAKING FROM OUTPUT SHAFT SEALS OR FROM VENT	(1) Transfer case overfilled. (2) Vent closed or restricted. (3) Output shaft seals damaged or installed incorrectly.	(1) Drain to correct level. (2) Clear or replace vent if necessary. (3) Replace seals. Be sure seal lip faces interior of case when installed. Also be sure yoke seal surfaces are not scored or nicked. Remove scores and nicks with fine sandpaper or replace yoke(s) if necessary.
ABNORMAL TIRE WEAR	(1) Extended operation on dry hard surface (paved) roads in 4H range.	(1) Operate in 2H on hard surface (paved) roads.

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SERVICE PROCEDURES (Continued)

ITEM	TORQUE
A	2-3 N•m (15-27 in. lbs.)
B	10-12 N•m (90-110 in. lbs.)



J9321-385

Fig. 3 Speedometer Components**SPEEDOMETER SERVICE****REMOVAL**

- (1) Raise vehicle.
- (2) Disconnect wires from vehicle speed sensor.
- (3) Remove adapter clamp and screw (Fig. 3).
- (4) Remove speed sensor and speedometer adapter as assembly.
- (5) Remove speed sensor retaining screw and remove sensor from adapter.
- (6) Remove speedometer pinion from adapter.
- (7) Inspect sensor and adapter O-rings. Remove and discard O-rings if worn or damaged.
- (8) Inspect terminal pins in speed sensor. Clean pins with Mopar electrical spray cleaner if dirty or oxidized. Replace sensor if faulty, or pins are loose, severely corroded, or damaged.

SPEEDOMETER INSTALLATION AND INDEXING

- (1) Thoroughly clean adapter flange and adapter mounting surface in housing. Surfaces must be clean for proper adapter alignment and speedometer operation.
- (2) Install new O-rings on speed sensor and speedometer adapter if necessary.
- (3) Lubricate sensor and adapter O-rings with transmission fluid.
- (4) Install vehicle speed sensor in speedometer adapter. Tighten sensor attaching screw to 2-3 N•m (15-27 in. lbs.) torque.
- (5) Install speedometer pinion in adapter.

- (6) Count number of teeth on speedometer pinion. Do this before installing assembly in housing. Then lubricate pinion teeth with transmission fluid.

- (7) Note index numbers on adapter body (Fig. 4). These numbers will correspond to number of teeth on pinion.

- (8) Install speedometer assembly in housing.

- (9) Rotate adapter until required range numbers are at 6 o'clock position. Be sure range index numbers correspond to number of teeth on pinion gear.

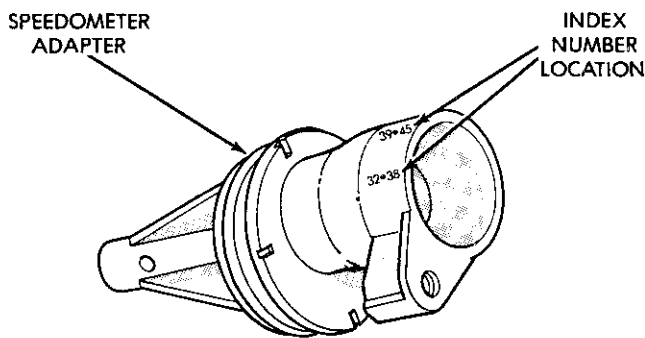
- (10) Install speedometer adapter clamp and retaining screw. Tighten clamp screw to 10-12 N•m (90-110 in. lbs.) torque.

- (11) Connect wires to vehicle speed sensor.

- (12) Lower vehicle.

REMOVAL AND INSTALLATION**TRANSFER CASE****REMOVAL**

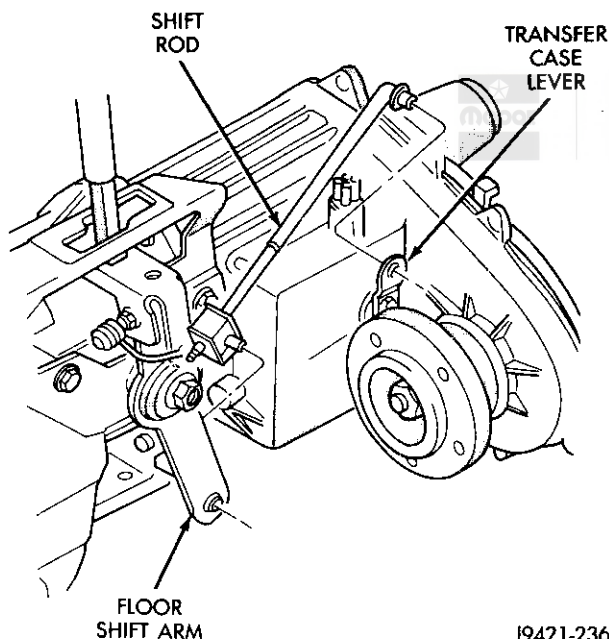
- (1) Raise vehicle.
- (2) Position drain oil container under transfer case.
- (3) Remove transfer case drain plug and drain lubricant into container.
- (4) Disconnect wires at vehicle speed sensor.
- (5) Disconnect vent hose and vacuum harness at transfer case switch.
- (6) Remove skid plate if equipped.

REMOVAL AND INSTALLATION (Continued)

J9321-386

Fig. 4 Location Of Index Numbers On Speedometer Adapter

(7) Disconnect shift rod from grommet in transfer case shift lever, or from floor shift arm whichever provides easy access (Fig. 5). Use channel lock style pliers to press rod out of lever grommet.



J9421-236

Fig. 5 Shift Rod Attachment

- (8) Support transmission with jack stand.
- (9) Remove rear crossmember.
- (10) Mark front and rear propeller shafts for assembly reference.
- (11) Remove front and rear propeller shafts.
- (12) Support transfer case with suitable jack. Secure transfer case to jack with safety chains.
- (13) Remove nuts attaching transfer case to transmission.

(14) Move transfer case assembly rearward until free of transmission output shaft.

(15) Lower jack and move transfer case from under vehicle.

(16) Remove all gasket material from rear of transmission overdrive, or extension housing.

INSTALLATION

(1) Apply Mopar Perfect Seal, silicone sealer, or Permatex No. 2 to both sides of transfer case-to-transmission gasket. Then position gasket on transmission.

(2) Align and seat transfer case on transmission. Be sure transfer case input gear splines are aligned with transmission output shaft. Align splines by rotating transfer case rear output shaft yoke if necessary. **Do not install any transfer case attaching nuts until the transfer case is completely seated against the transmission.**

(3) Install and tighten transfer case attaching nuts. If case has 5/16 in. studs, tighten nuts to 30-41 N·m (22-30 ft.lbs.). If case has 3/8 studs, tighten nuts to 41-47 N·m (30-35 ft. lbs.).

(4) Install rear crossmember.

(5) Remove jack stand from under transmission.

(6) Align and connect propeller shafts.

(7) Connect speed sensor wires, vacuum harness and vent hose.

(8) Connect shift rod to transfer case lever or floor shift arm. Use channel lock style pliers to press rod back into lever grommet.

(9) Adjust shift linkage if necessary. Refer to adjustment procedure in this section.

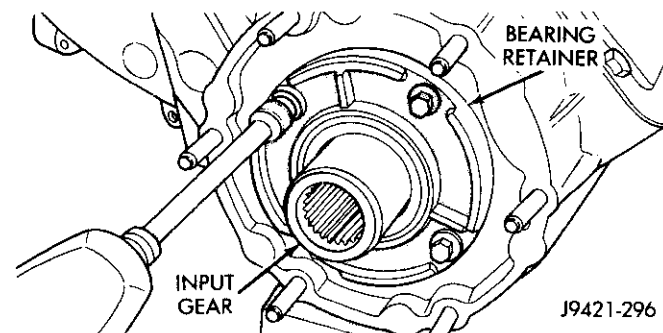
(10) Fill transfer case with recommended transmission fluid and install fill plug.

(11) Install skid plate if equipped.

(12) Lower vehicle

INPUT GEAR AND PLANETARY**REMOVAL**

(1) Remove input bearing retainer bolts (Fig. 6). A 10 mm socket is required.

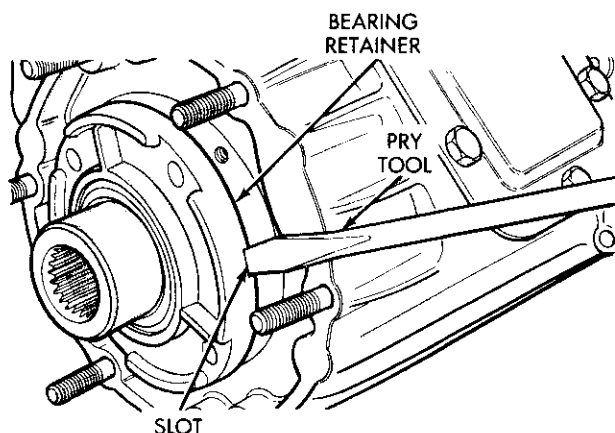


J9421-296

Fig. 6 Removing Input Bearing Retainer Bolts

REMOVAL AND INSTALLATION (Continued)

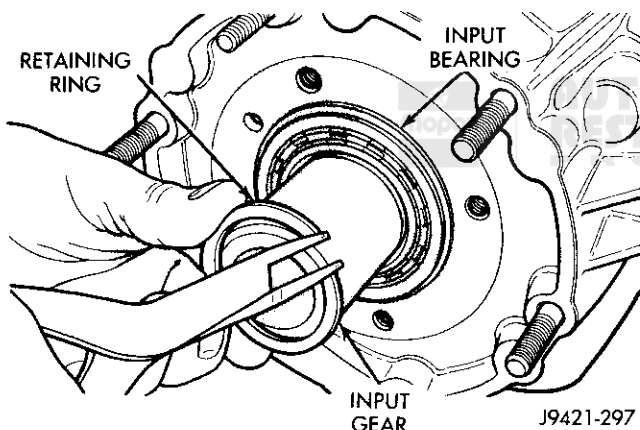
(2) Loosen bearing retainer with pry tool. Insert tool in retainer slot as shown (Fig. 7). Then remove retainer.



J9421-298

Fig. 7 Loosening/Removing Input Bearing Retainer

(3) Remove input gear retaining ring with heavy duty parallel jaw snap ring pliers (Fig. 8).



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Fig. 8 Removing Input Gear Retaining Ring

(4) Tap input gear out of bearing with plastic mallet (Fig. 9).

(5) Remove input gear and planetary/PTO gear as assembly (Fig. 10).

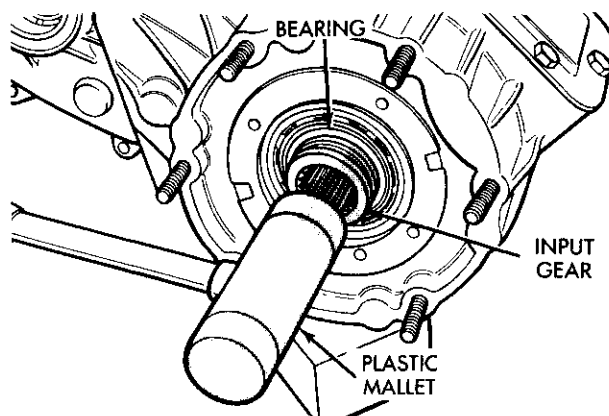
PLANETARY AND INPUT GEAR ASSEMBLY AND INSTALLATION

(1) Lubricate planetary components with transmission fluid.

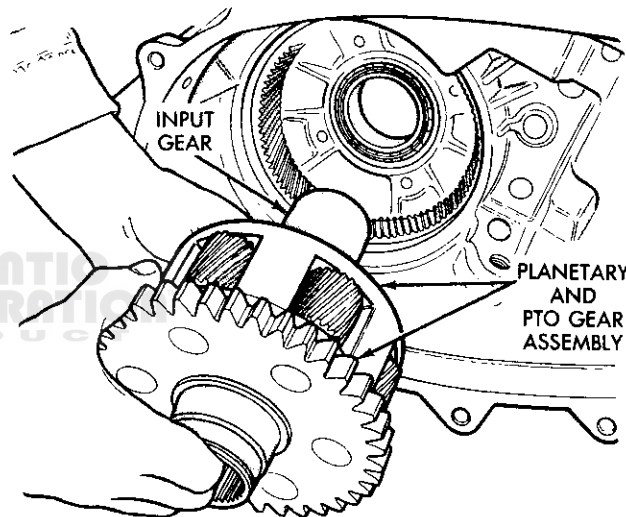
(2) Install new needle bearing in planetary carrier (Fig. 11). Use Handle C-4171 and Installer 5062 to install bearing.

(3) Install first thrust washer in carrier (Fig. 12). Lube washer with petroleum jelly before installation.

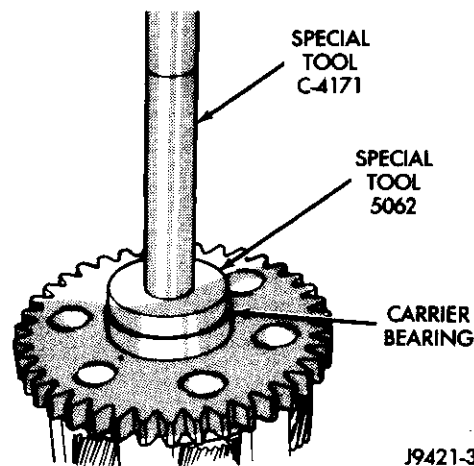
(4) Support carrier with wood blocks under PTO gear (Fig. 13).



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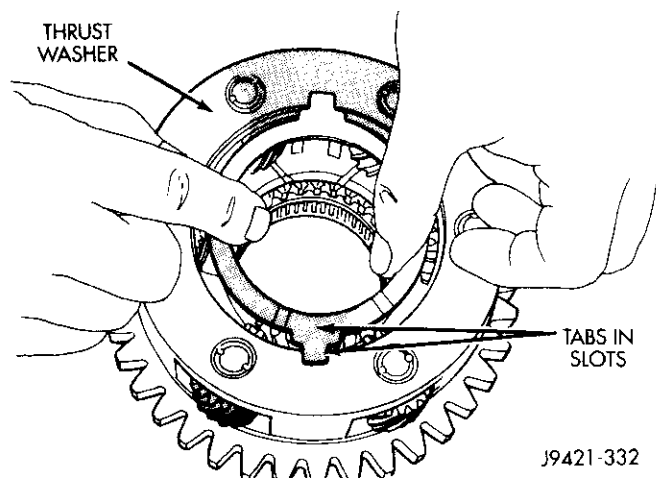
Fig. 9 Removing Input Gear Retaining Ring

J9421-300

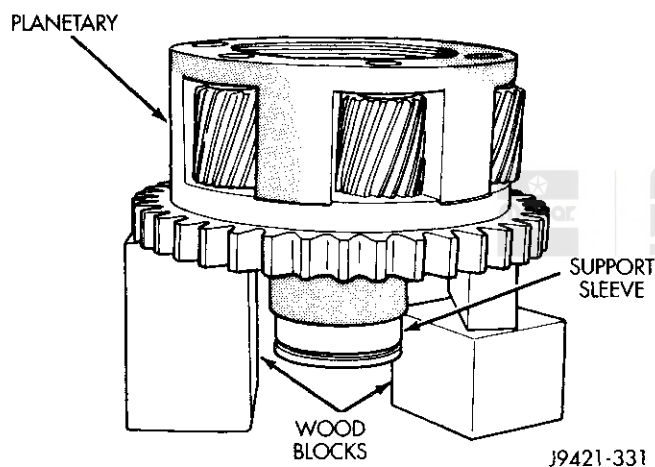
Fig. 10 Input Gear And Planetary Assembly Removal

J9421-329

Fig. 11 Planetary Carrier Needle Bearing Installation

REMOVAL AND INSTALLATION (Continued)**Fig. 12 Thrust Washer Installation**

(5) Install support sleeve in planetary carrier. Be sure sleeve is seated.

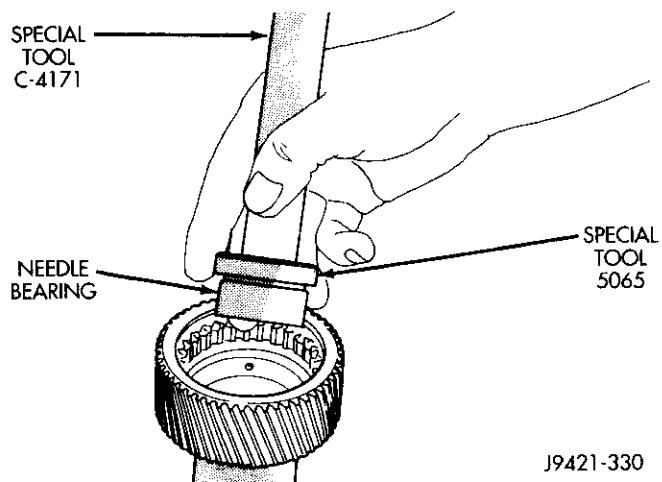
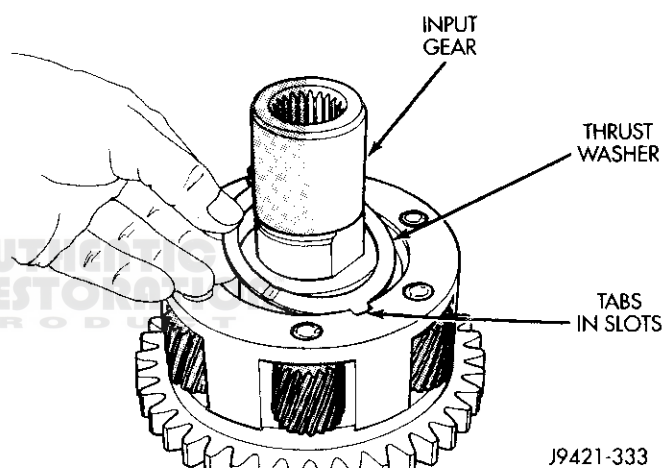
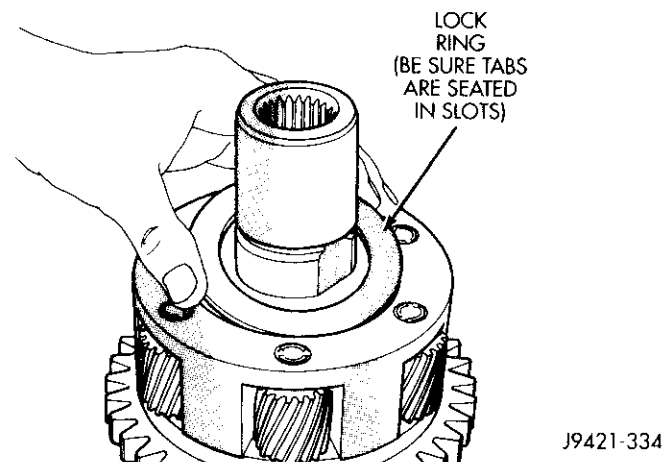
**Fig. 13 Support Sleeve Installation**

(6) Install new needle bearing in input gear if necessary (Fig. 14). Use Handle C-4171 and Installer 5065 to install bearing flush with upper edge of bearing bore. Note that bearing has built-in cup plug. Do not damage plug during installation.

(7) Install input gear in planetary carrier (Fig. 15).

(8) Install second thrust washer in planetary carrier. Be sure washer tabs are seated in carrier slots.

(9) Install lock ring (Fig. 16).

**Fig. 14 Installing Needle Bearing In Input Gear****Fig. 15 Input Gear And Thrust Washer Installation****Fig. 16 Lock Ring Installation**

REMOVAL AND INSTALLATION (Continued)

(10) Install retaining ring (Fig. 17).

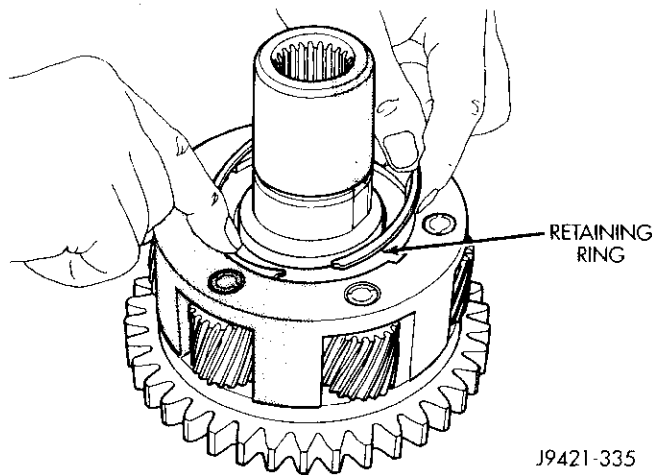


Fig. 17 Retaining Ring Installation

(11) Lubricate planetary pinions and annulus gear with transmission fluid.

(12) Install planetary/input gear assembly in case (Fig. 18).

(13) Start planetary pinions in low range annulus gear. Then tap carrier (or PTO gear on HD models), with hammer handle to seat planetary pinions in annulus gear.

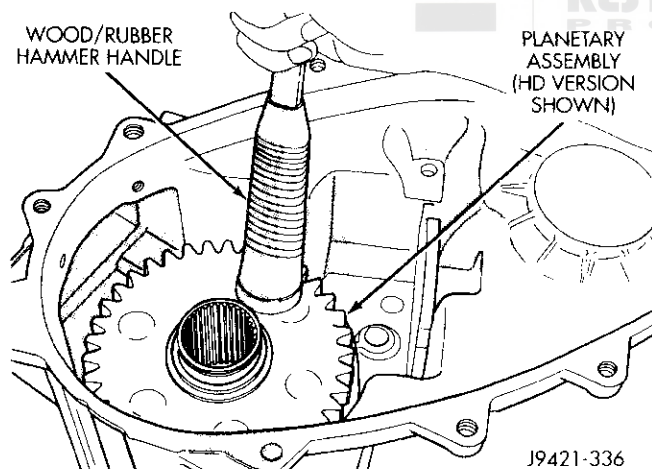


Fig. 18 Planetary/Input Gear Assembly Installation

(14) Install retaining ring on input gear (Fig. 19).

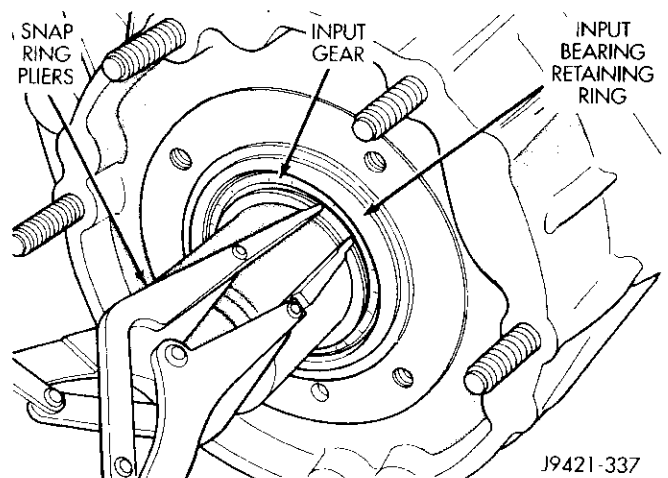


Fig. 19 Installing Input Gear Retaining Ring

(2) Shift transfer case into neutral.

(3) Remove companion flange nut (Fig. 20). A 1-1/8 in. socket is required. **Discard nut after removal. It is not reusable.**

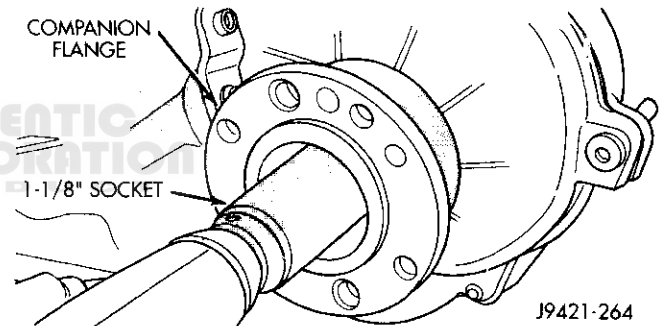


Fig. 20 Removing Companion Flange Nut

(4) Tap companion flange off front shaft with plastic mallet (Fig. 21).

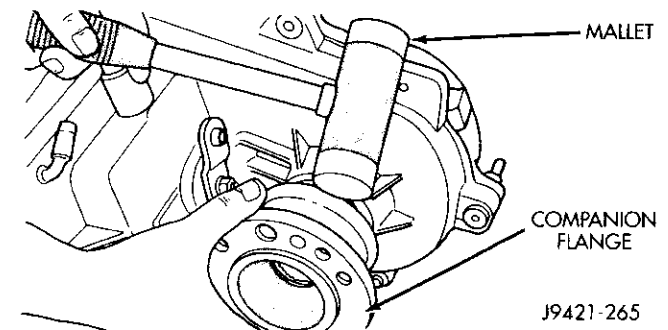


Fig. 21 Companion Flange Removal

DISASSEMBLY AND ASSEMBLY**TRANSFER CASE****REAR EXTENSION, RETAINER AND REAR CASE**

(1) If transfer case was not drained during removal, remove drain plug and drain fluid into pan positioned next to workbench.

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Remove companion flange rubber seal from front output shaft (Fig. 22).

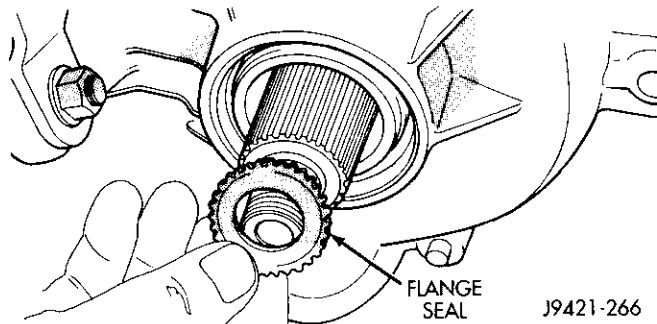


Fig. 22 Companion Flange Seal Removal

(6) Remove vacuum/indicator switch with 1-1/16 in. deep socket (Fig. 23).

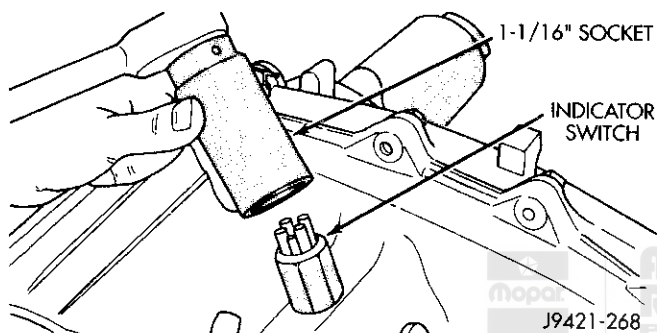


Fig. 23 Vacuum/Indicator Switch Removal

(7) Remove nut and washer that retain shift lever to sector shaft. Then remove shift lever from shaft (Fig. 24).

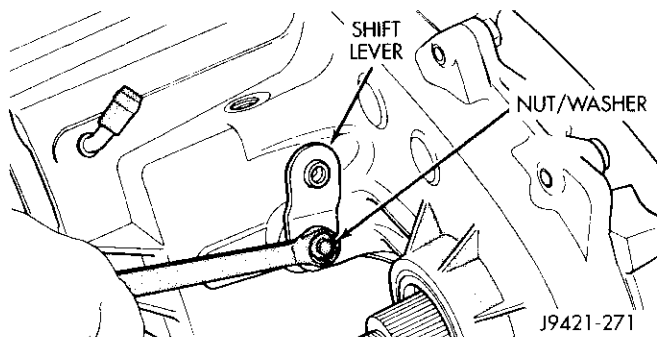


Fig. 24 Shift Lever Removal

(8) Loosen poppet plunger screw (Fig. 25).

(9) Remove poppet plunger screw and spring (Fig. 26). Note that screw has O-ring seal. Remove and discard seal this seal.

(10) Remove poppet plunger with magnet (Fig. 27).

(11) Remove rear extension bolts (Fig. 28). A 13 or 15 mm socket is required for removal.

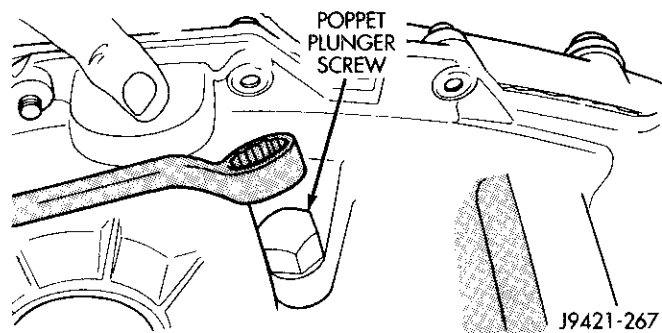


Fig. 25 Loosening Poppet Plunger Screw

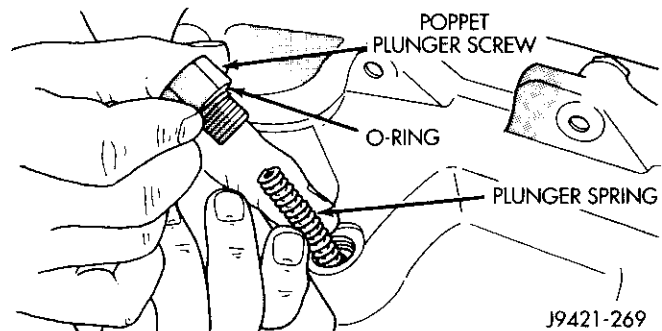


Fig. 26 Poppet Plunger Screw And Spring Removal

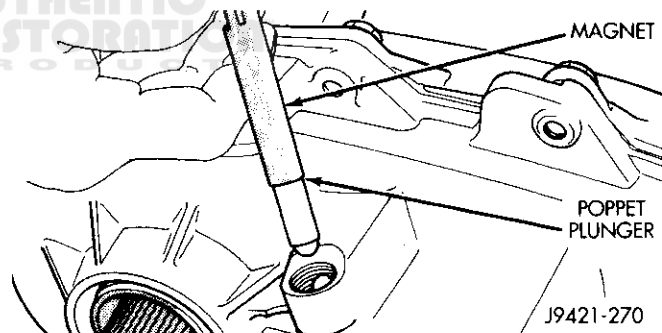


Fig. 27 Poppet Plunger Removal

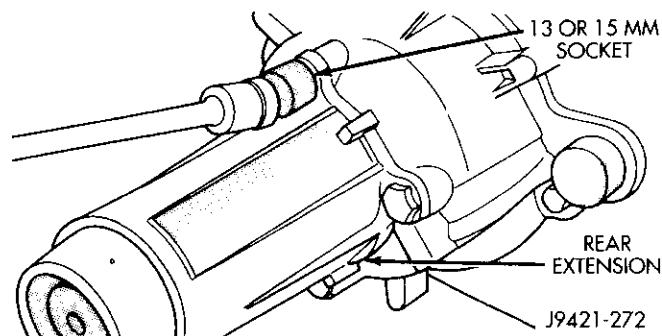


Fig. 28 Rear Extension Bolt Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(12) Remove rear extension (Fig. 29). Tap extension once or twice with a plastic mallet to break sealer bead and loosen it. Seal at rear of extension is serviceable. If seal is damaged, it can be removed with small chisel and punch.

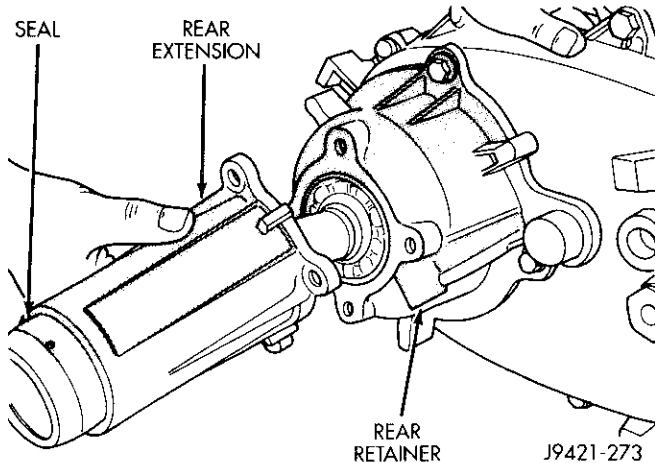


Fig. 29 Rear Extension Removal

(13) Remove output bearing retaining ring with heavy duty snap ring pliers (Fig. 30).

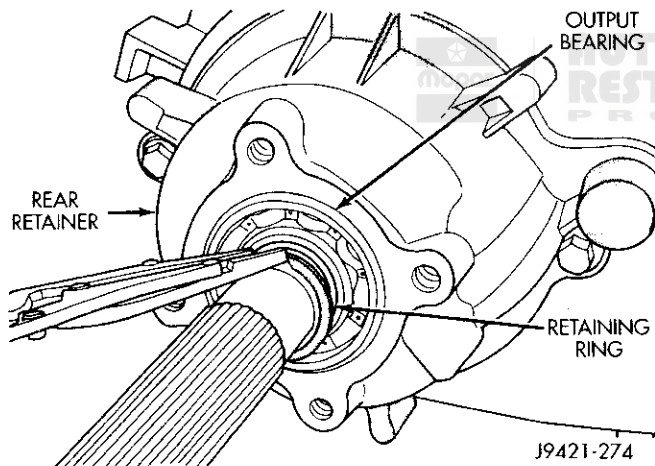


Fig. 30 Removing Output Bearing Retaining Ring

(14) Remove rear extension bolts (Fig. 31). A 13 or 15 mm socket is required.

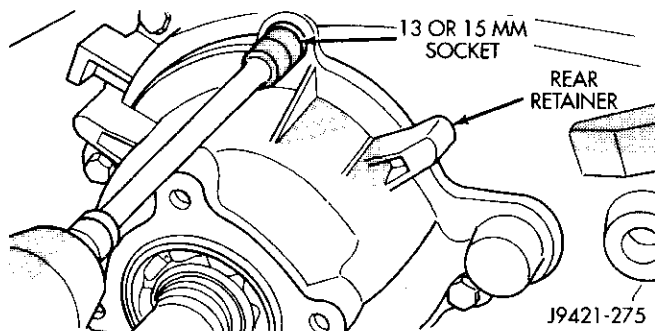


Fig. 31 Removing Rear Extension Bolts

(15) Loosen rear retainer with pry bar placed under flange (Fig. 32).

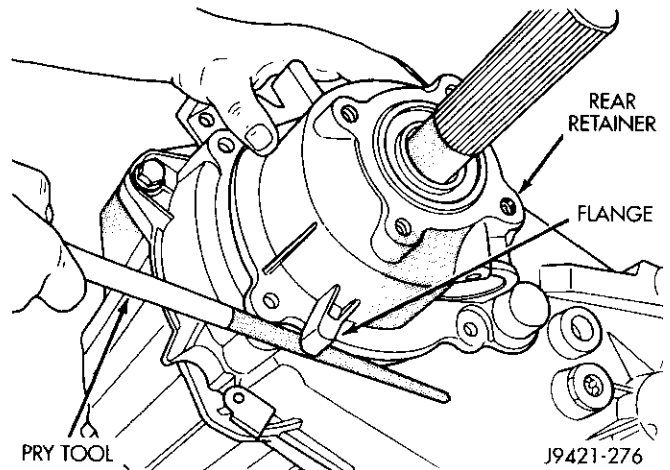


Fig. 32 Loosening Rear Retainer

(16) Remove rear retainer and output bearing as assembly (Fig. 33).

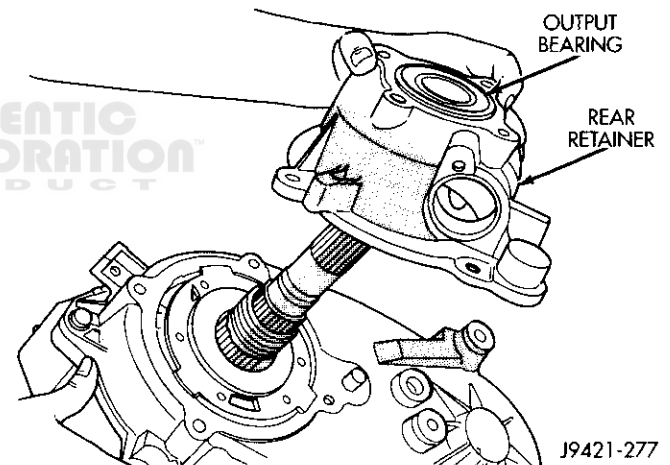


Fig. 33 Rear Retainer Removal

(17) Remove speedometer gear-rear retaining ring (Fig. 34). Then remove speedometer gear and front retaining ring (Fig. 35) and (Fig. 36).

(18) Note position of bolts that attach rear case to front case (Fig. 37). Some bolts/studs at ends of case require flat washers. Mark position of these bolts with paint or scribe.

(19) Remove rear case-to-front case bolts. A 15 mm socket is required.

(20) Loosen rear case with pry tool to break sealer bead. Insert tool in slot at each end of case (Fig. 38).

(21) Unseat rear case from alignment dowels (Fig. 39).

DISASSEMBLY AND ASSEMBLY (Continued)

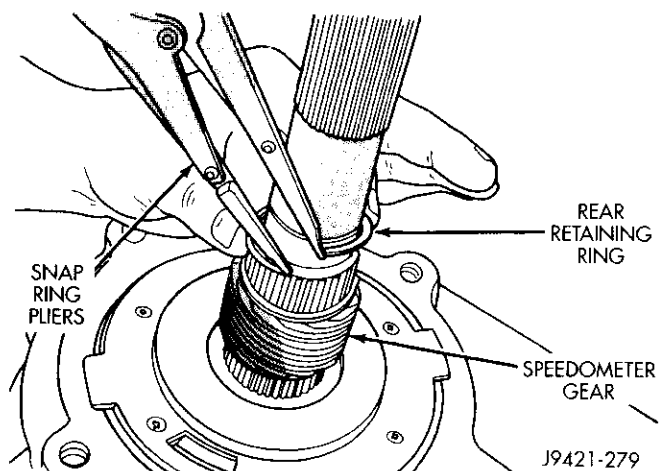


Fig. 34 Removing Speedometer Gear Rear Retaining Ring

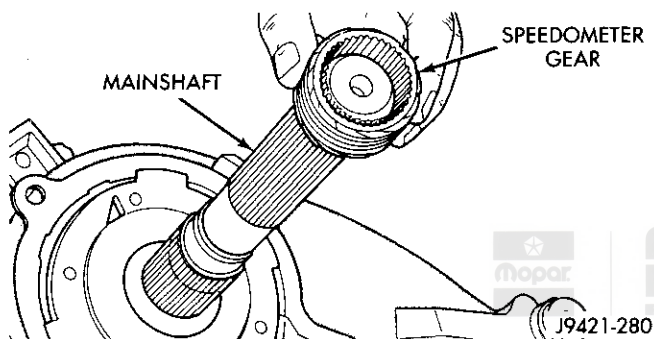


Fig. 35 Removing Speedometer Gear

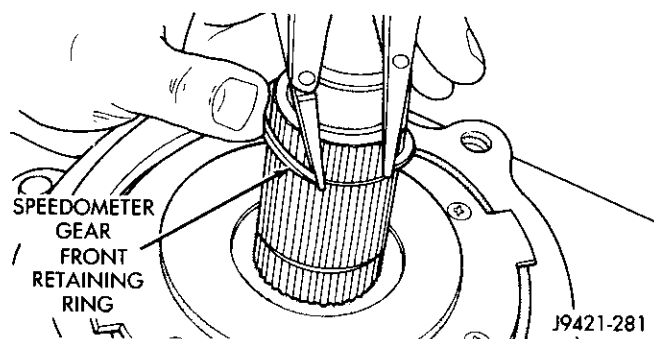


Fig. 36 Removing Speedometer Gear Rear Retaining Ring

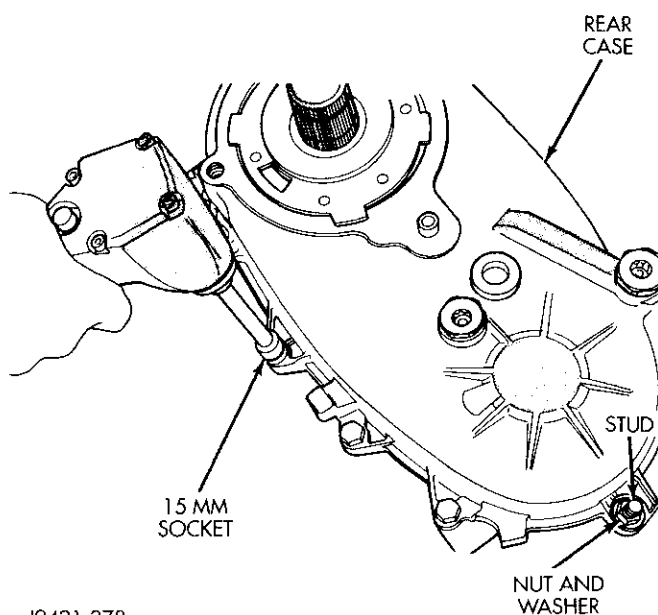


Fig. 37 Removing Case Attaching Bolts

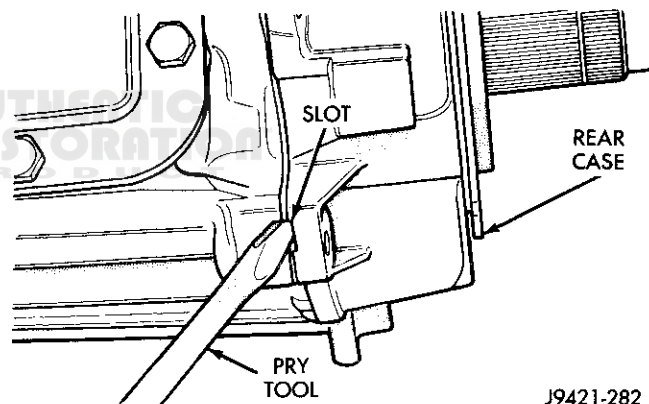


Fig. 38 Loosening Rear Case (Breaking Sealer Bead)

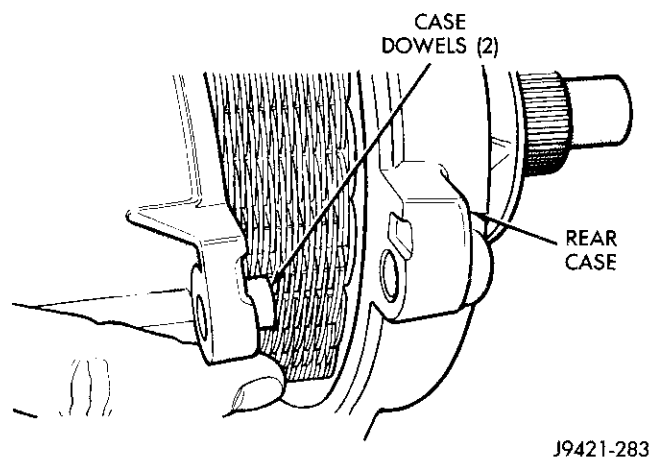


Fig. 39 Removing Rear Case From Alignment Dowels

DISASSEMBLY AND ASSEMBLY (Continued)

(22) Remove rear case from front case (Fig. 40).

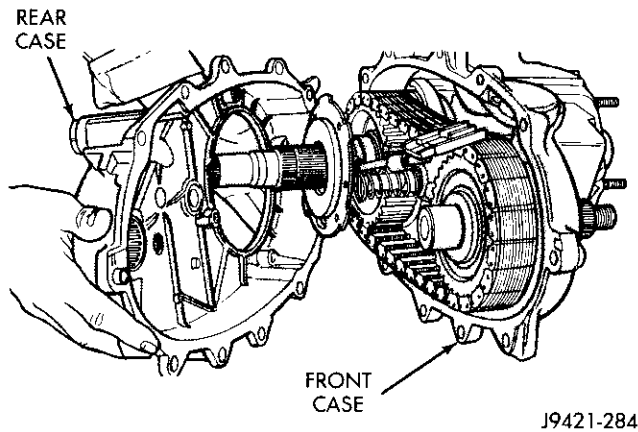


Fig. 40 Rear Case Removal

(23) Remove oil pump, pickup tube and filter as assembly (Fig. 41). **The oil pump can be disassembled for cleaning and inspection. However, the pump parts are not serviced separately. If any pump component is worn, or damaged, the pump must be replaced as an assembly.**

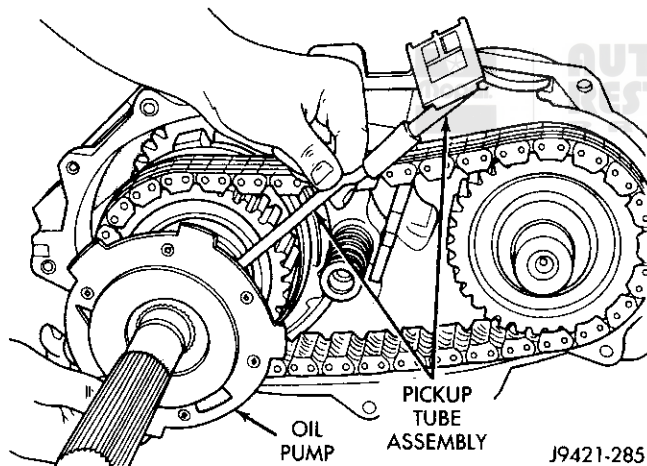


Fig. 41 Oil Pump And Pickup Tube Removal

FRONT CASE ASSEMBLY

(1) Start front shaft output bearing in case (Fig. 42). Then seat bearing with Tool Handle C-4171 and Installer Tool 5062, C-4210, or 7828. Use installer that is best fit in bearing.

(2) Install front output bearing retaining ring (Fig. 43).

(3) Install new front output seal in front case with Installer Tool 6888 and Tool Handle C-4171 as follows:

(a) Place new seal on tool. **Garter spring on seal goes toward interior of case.**

(b) Start seal in bore with light taps from hammer (Fig. 44). Once seal is started, continue tap-

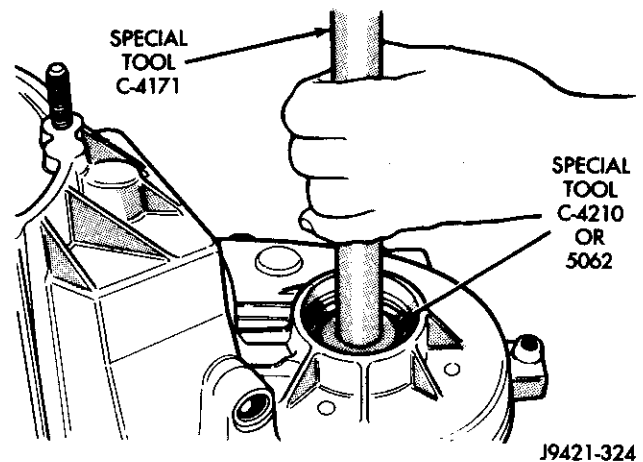


Fig. 42 Front Output Bearing Installation

ping seal into bore until installer tool bottoms against case.

(c) Remove installer and verify that seal is recessed the proper amount. Seal should be 2.03 to 2.5 mm (0.080 to 0.100 in.) **below** top edge of seal bore in front case (Fig. 64). This is correct final seal position.

CAUTION: Be sure the front output seal is seated below the top edge of the case bore as shown. The seal could loosen, or become cocked if not seated to recommended depth.

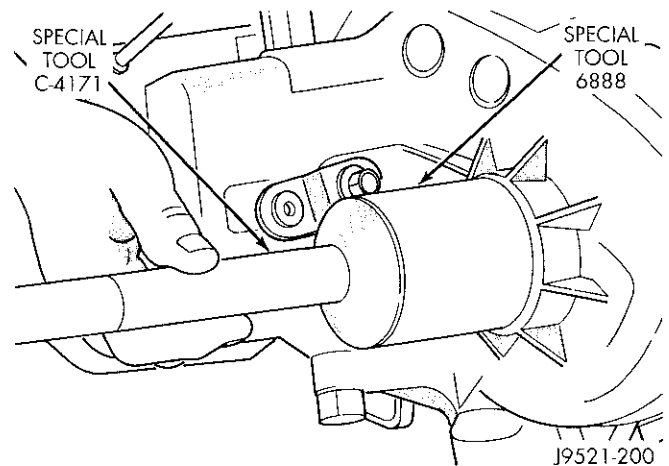


Fig. 43 Front Output Seal Installation

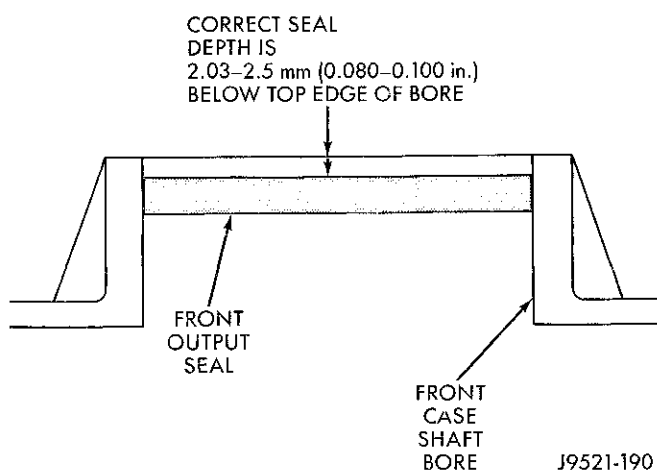
DISASSEMBLY AND ASSEMBLY (Continued)

Fig. 44 Checking Front Output Seal Installation Depth

(4) Install input bearing in case. Seat bearing with Handle C-4171 and Installer Tool 7828 (Fig. 45).

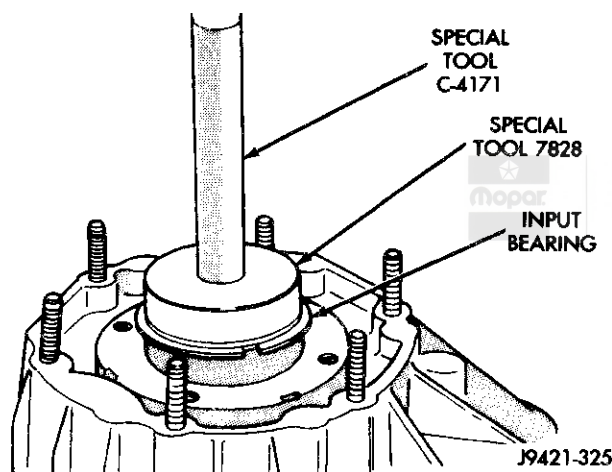


Fig. 45 Input Bearing Installation

(5) Install new sector shaft O-ring and O-ring retainer in sector shaft bore (Fig. 46). Lubricate O-ring with transmission fluid or petroleum jelly after installation.

(6) Install new oil seals in input bearing retainer and oil pump with Handle C-4171 and Installer C-4210, or 7828 (Fig. 47).

(7) Lubricate sector shaft with transmission fluid and install shift sector in case (Fig. 48). Position slot in sector so it will be aligned with shift fork pin when shift forks are installed.

(8) Install shift lever on sector shaft (Fig. 49).

(9) Install washer and nut on sector shaft to secure shift lever. Apply 1-2 drops Mopar Lock N' Seal, or Loctite 242 to nut threads before installation. Then tighten nut to 27-34 N·m (20-25 ft. lbs.) torque.

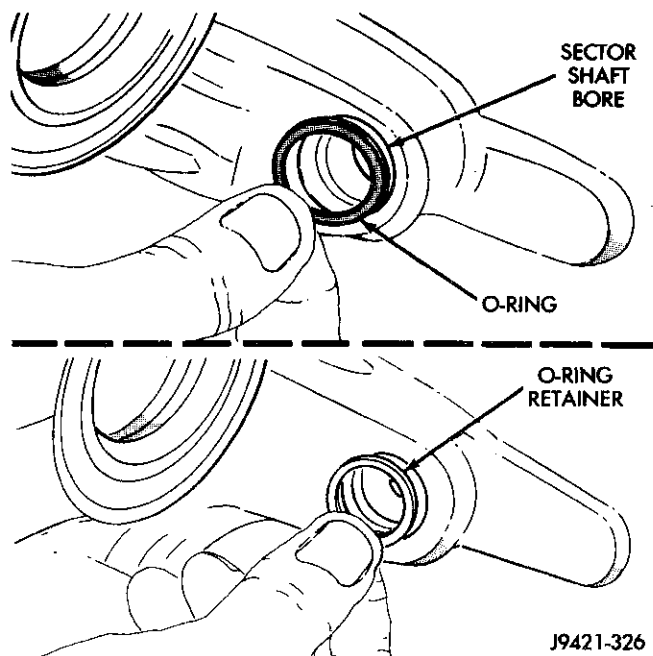


Fig. 46 Sector Shaft O-Ring And Retainer Installation

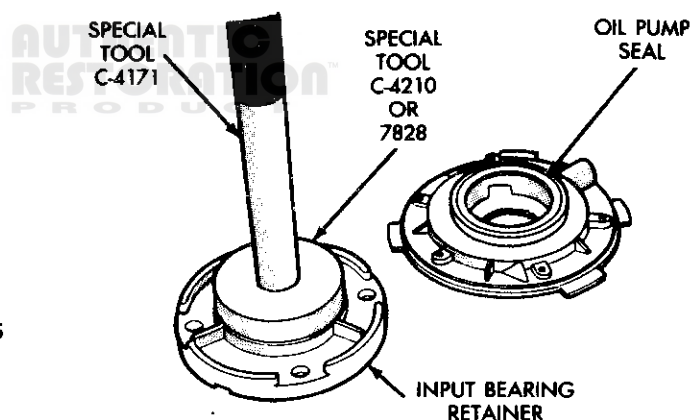


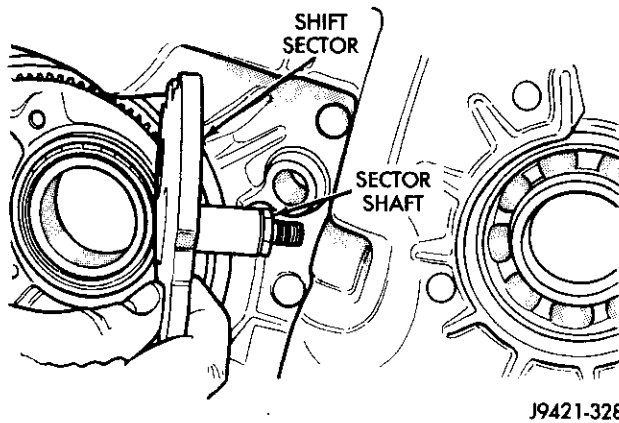
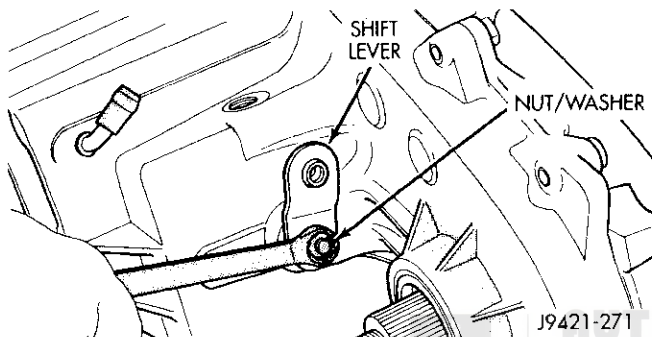
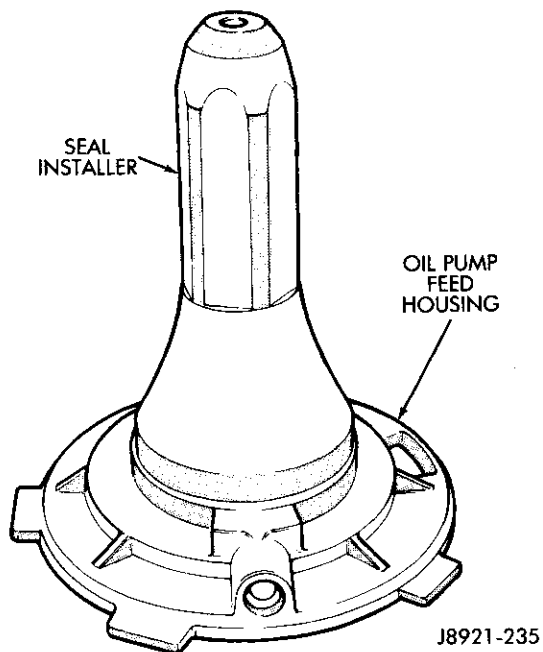
Fig. 47 Retainer And Pump Oil Seal Installation
REAR CASE, OIL PUMP AND SPEEDOMETER GEAR INSTALLATION

Lubricate the oil pump components with Dexron II before installation. Prime the oil pickup tube by pouring a little oil into the tube before installation.

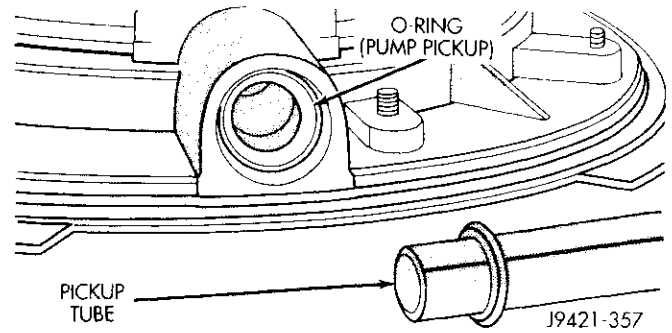
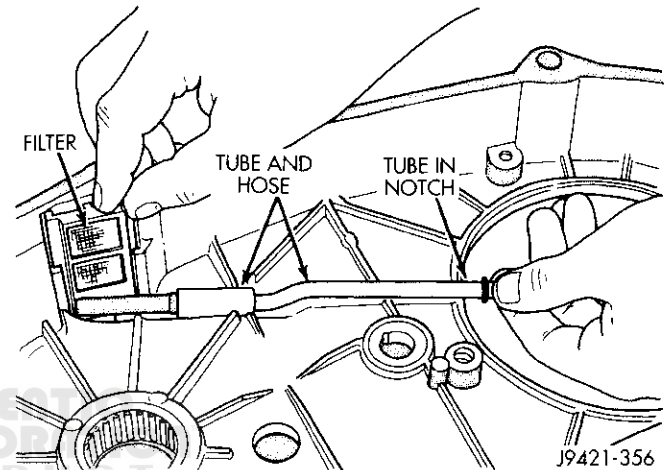
(1) If new seal has not been installed in oil pump yet, install new seal with suitable size installer tool such as Tool C-4210 (Fig. 50).

(2) Install new O-ring in pickup tube inlet of oil pump (Fig. 51).

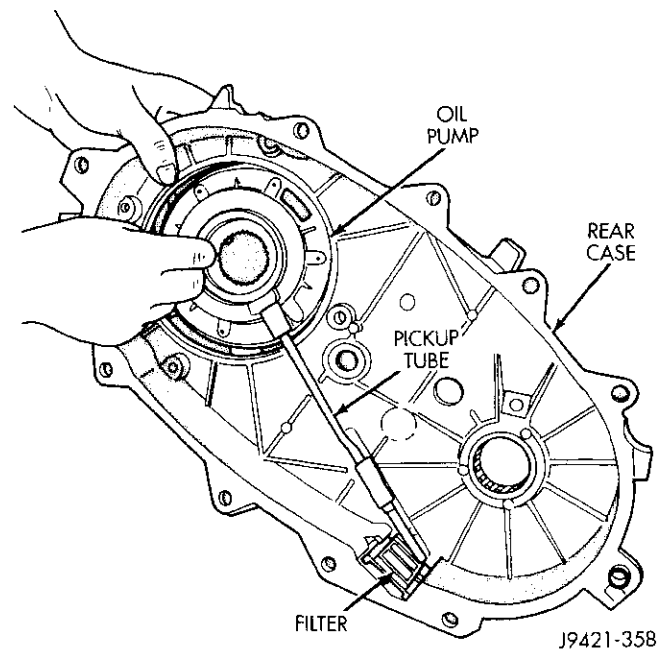
(3) Lubricate oil pump thoroughly with transmission fluid.

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 48 Shift Sector Installation****Fig. 49 Shift Lever Installation****Fig. 50 Oil Pump Seal Installation**

(4) Position oil pickup tube and filter in rear case. Be sure pickup filter is seated in case pocket and that pickup tube is aligned in case notches (Fig. 52). Be sure hose that connects tube to filter is securely positioned.

**Fig. 51 Pickup Tube O-Ring Installation****Fig. 52 Oil Pickup Tube And Filter Position In Rear Case**

(5) Insert oil pickup tube in oil pump and position pump in rear case (Fig. 53).

**Fig. 53 Positioning Oil Pump In Rear Case**

DISASSEMBLY AND ASSEMBLY (Continued)

(6) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive/sealant to mating surface of front case. Keep sealer bead width to maximum of 3/16 inch. **Do not use excessive amount of sealer as excess will be displaced into case interior.**

(7) Align oil pump with mainshaft and align shift rail with bore in rear case. Then install rear case and oil pump assembly (Fig. 54). **Be sure oil pump and pickup tube remain in position during case installation.**

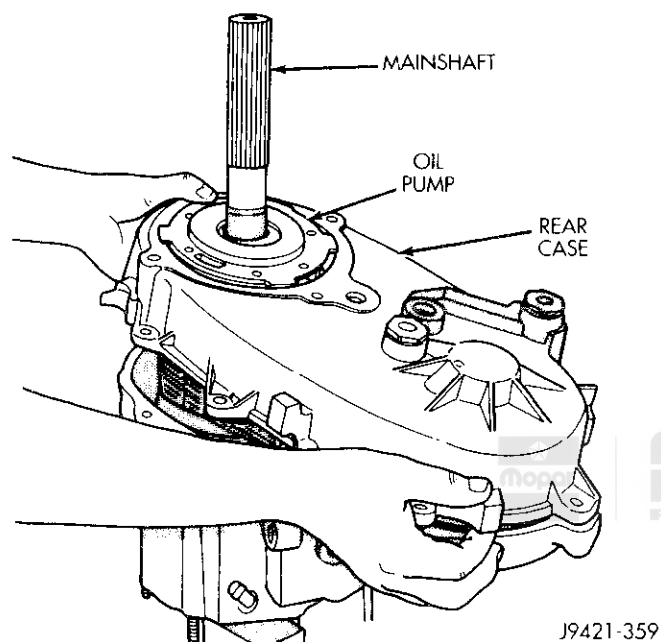


Fig. 54 Rear Case And Oil Pump Installation

(8) Install 4-5 rear case-to front case bolts to hold rear case in position. Tighten bolts snug but not to specified torque at this time.

CAUTION: Verify that shift rail (Fig. 55), and case alignment dowels are seated before installing any bolts. Case could be cracked if shaft rail or dowels are misaligned.

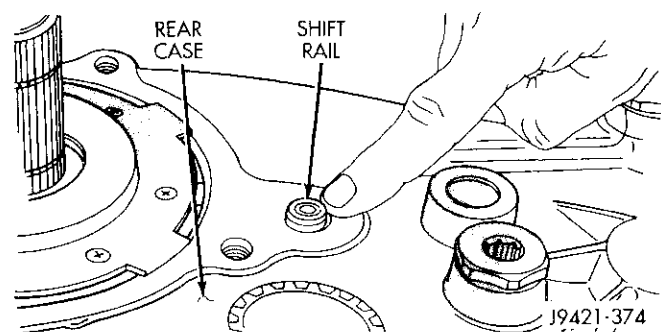


Fig. 55 Shift Rail Seated In Rear Case Bore

(9) Verify that oil pump is aligned and seated on rear case. Reposition pump if necessary.

(10) Install oil pump retaining ring on mainshaft (Fig. 56). Then install speedometer gear (Fig. 57), and speedometer gear retaining ring (Fig. 58).

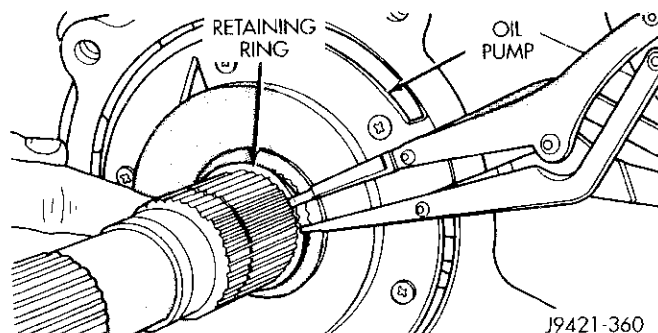


Fig. 56 Oil Pump Retaining Ring Installation

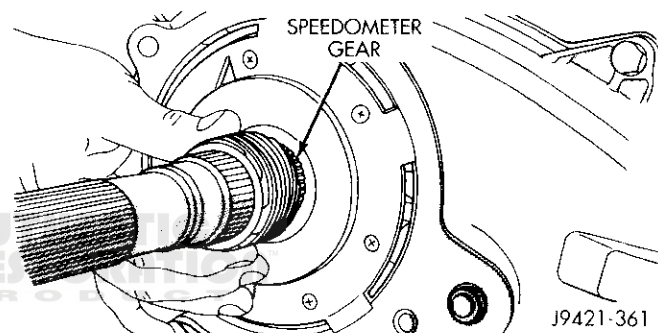


Fig. 57 Speedometer Gear Installation

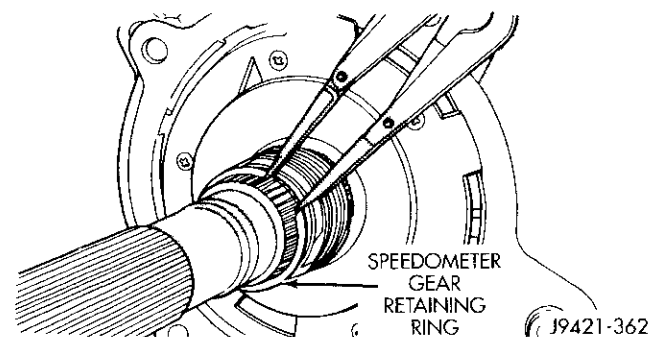
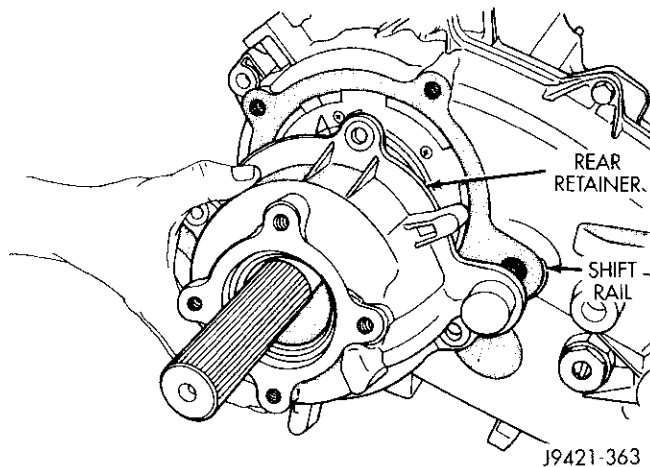


Fig. 58 Speedometer Gear Retaining Ring Installation

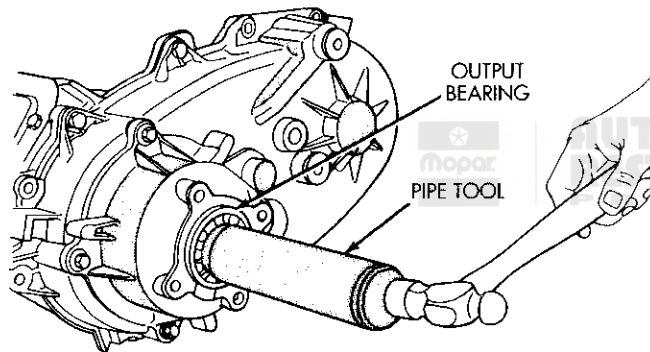
REAR RETAINER AND EXTENSION INSTALLATION

(1) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive/sealant to mating surface of rear retainer. Keep sealer bead width to maximum of 3/16 inch. **Do not use excessive amount of sealer as excess could be displaced into oil pump.**

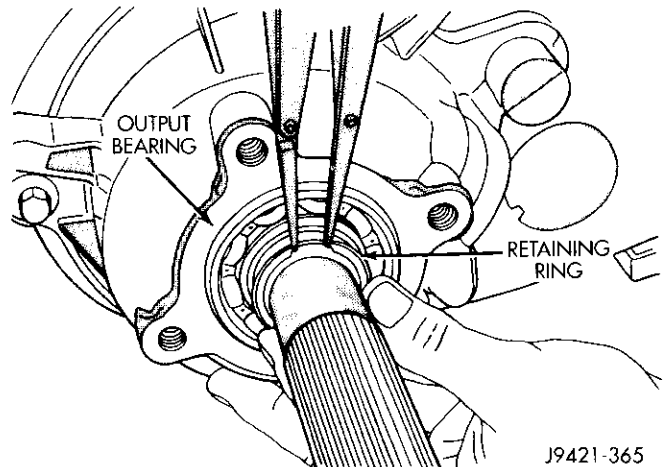
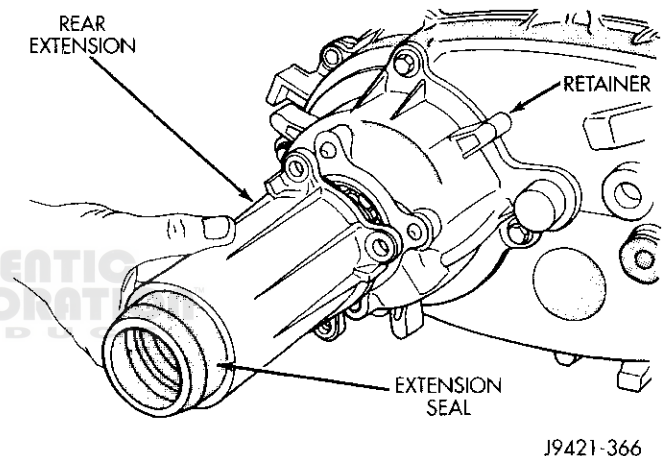
(2) Align and install rear retainer on rear case (Fig. 59).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 59 Rear Retainer Installation**

- (3) Apply Mopar silicone sealer to threads of rear retainer bolts. Then install retainer bolts finger tight.
- (4) Install output bearing on mainshaft and seat it in rear retainer with suitable size pipe tool (Fig. 60).

**Fig. 60 Output Bearing Installation**

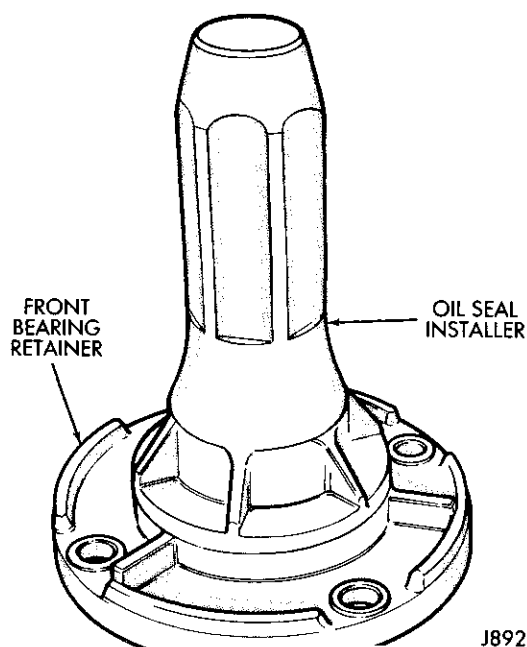
- (5) Install output bearing retaining ring (Fig. 61).
- (6) Tighten rear retainer bolts to 27-34 N·m (20-25 ft. lbs.) torque.
- (7) Install new seal in rear extension with suitable size installer tool.
- (8) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive/sealant to mating surface of rear extension. Keep sealer bead width to maximum of 3/16 inch. **Do not use excessive amount of sealer as excess could be displaced into output bearing.**
- (9) Align and install rear extension on retainer (Fig. 62).
- (10) Apply Mopar silicone sealer to threads of rear extension bolts. Then install and tighten bolts to 27-34 N·m (20-25 ft. lbs.) torque.
- (11) Apply Mopar silicone adhesive/sealer to mating surface of PTO cover and to cover bolt shanks

**Fig. 61 Output Bearing Retaining Ring Installation****Fig. 62 Rear Extension Installation**

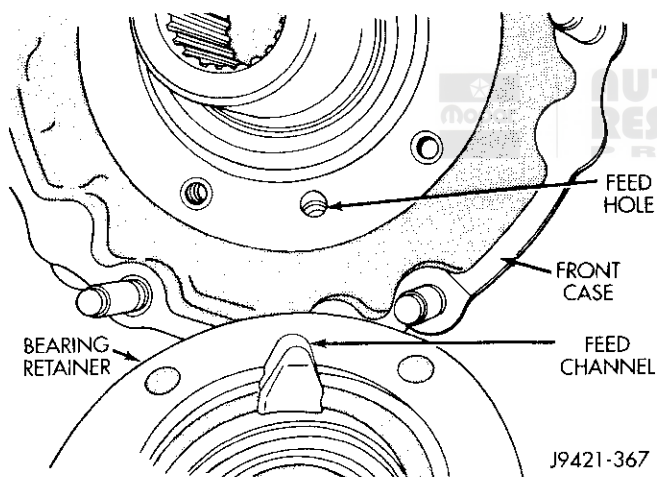
and underside of bolt heads. Then install and tighten bolts to 27-34 N·m (20-25 ft. lbs.) torque.

INPUT RETAINER, DETENT, AND COMPANION FLANGE INSTALLATION

- (1) Install new seal in input bearing retainer with Tools C-4171 and C-4210 (Fig. 63).
- (2) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive/sealant to mating surface of input retainer. Keep sealer bead width to maximum of 3/16 inch. **Do not use excessive amount of sealer as excess could be displaced into oil channel and feed hole in case..**
- (3) Align oil channel in retainer with oil feed hole in front case (Fig. 64).
- (4) Install retainer on input gear shaft and front case (Fig. 65).
- (5) Apply Mopar silicone sealer to threads of input retainer bolts. Then install and tighten bolts to 27-34 N·m (20-25 ft. lbs.) torque.
- (6) Install poppet plunger and spring (Fig. 66).

DISASSEMBLY AND ASSEMBLY (Continued)

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Fig. 63 Input Bearing Retainer Seal Installation

J9421-367

Fig. 64 Aligning Retainer Oil Channel and Case Feed Holes

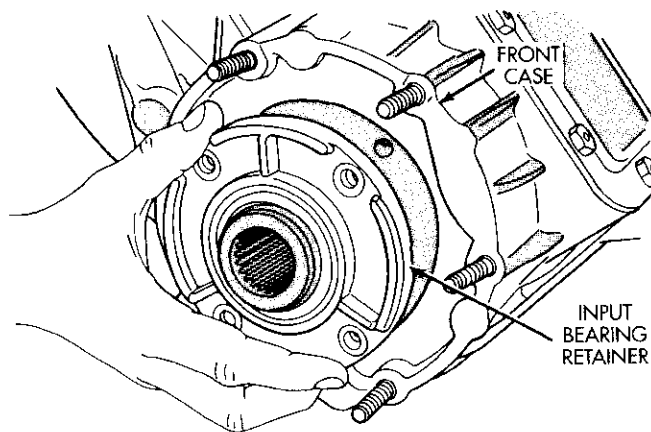
(7) Install new O-ring on poppet screw and install screw in front case (Fig. 67). Tighten screw to 16-24 N·m (12-18 ft. lbs.)

(8) Check stud at end of case halves (Fig. 68). If stud was loosened or came out during disassembly, apply Loctite 242 to stud threads and reseal stud in case.

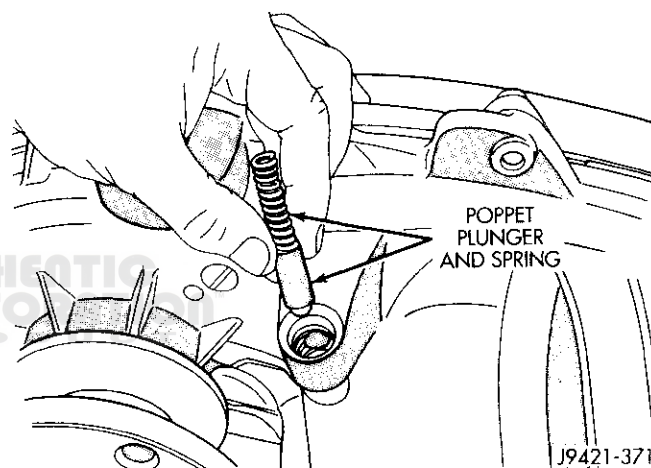
(9) Apply Loctite 242 to remainder of rear case-to-front case bolt threads and install bolts. Be sure lock washers are used on studs/bolts at case ends. Tighten bolts, or stud nuts as follows:

- flange head bolts to 47-61 N·m (35-45 ft. lbs.)
- all other bolts/nuts to 27-34 N·m (20-25 ft. lbs.)

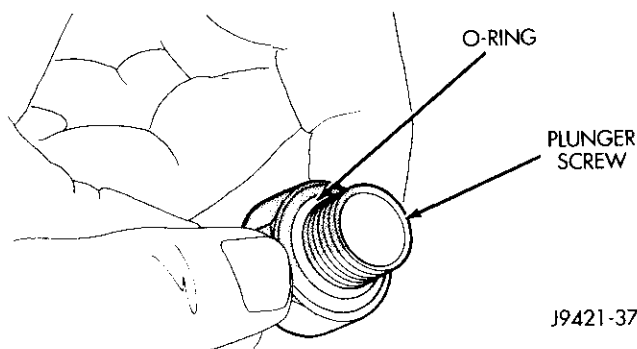
(10) Install companion flange seal on front shaft (Fig. 69).



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Fig. 65 Input Bearing Retainer Installation

J9421-371

Fig. 66 Poppet Plunger And Spring Installation

J9421-372

Fig. 67 O-Ring Installation On Poppet Plunger Screw

(11) Install companion flange on front shaft (Fig. 70). Then install and tighten flange nut to 176-271 N·m (130-200 ft. lbs.) torque.

(12) Install indicator switch. Tighten switch to 20-34 N·m (15-25 ft. lbs.) torque. Install new O-ring on switch beforehand if necessary.

(13) Install drain plug. Tighten plug to 41-54 N·m (30-40 ft. lbs.) torque.

DISASSEMBLY AND ASSEMBLY (Continued)

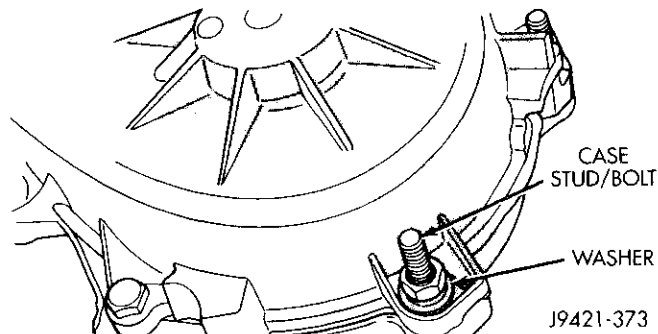


Fig. 68 Washer Installation On Case Stud And Dowel Bolts

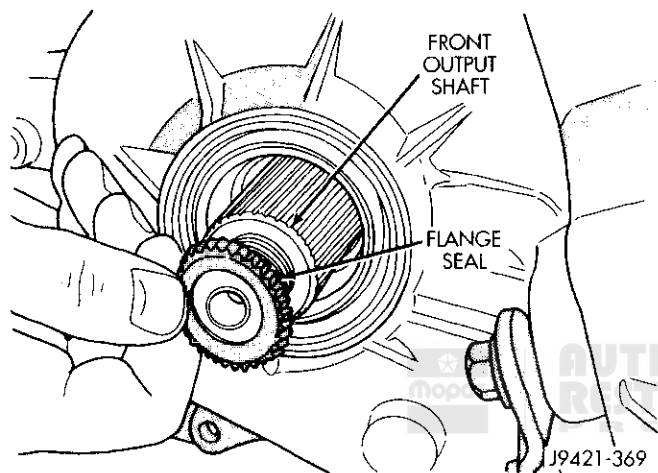


Fig. 69 Installing Flange Seal On Front Shaft

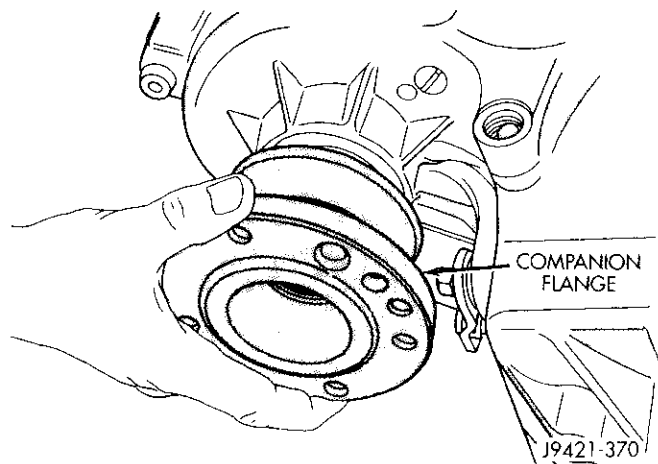


Fig. 70 Installing Companion Flange On Front Shaft GEARTRAIN AND SHIFT COMPONENT

DISASSEMBLY

- (1) Remove shift rail cup and spring (Fig. 71).
- (2) Remove front sprocket retaining ring (Fig. 72).
- (3) Pull mainshaft, front sprocket and chain outward about 25.4 mm (1-inch) simultaneously (Fig. 73).

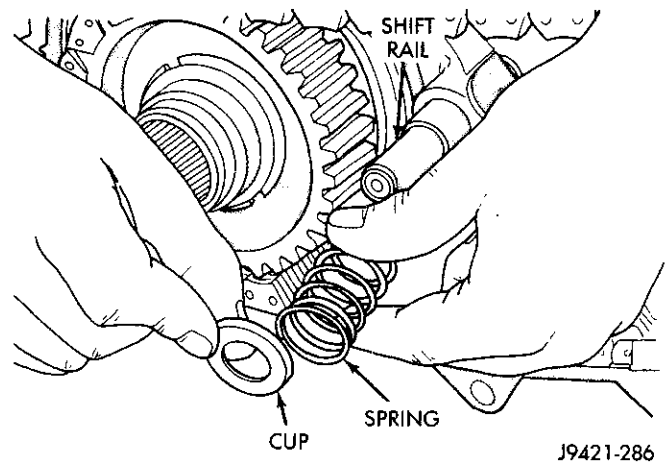


Fig. 71 Shift Rail Cup And Spring Removal

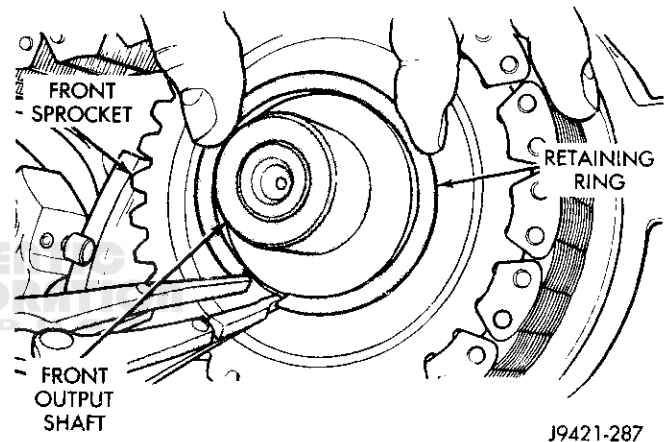


Fig. 72 Removing Front Sprocket Retaining Ring

- (4) Remove chain from mainshaft drive sprocket and remove front sprocket and chain as assembly.

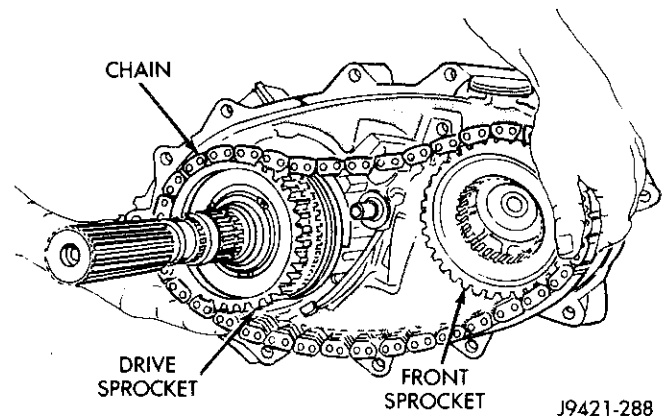
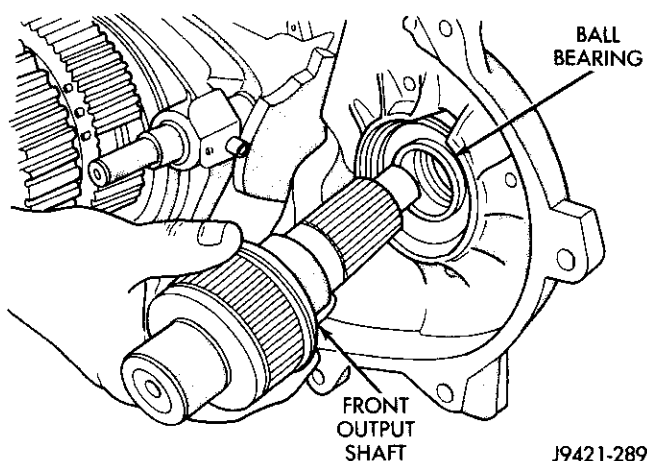
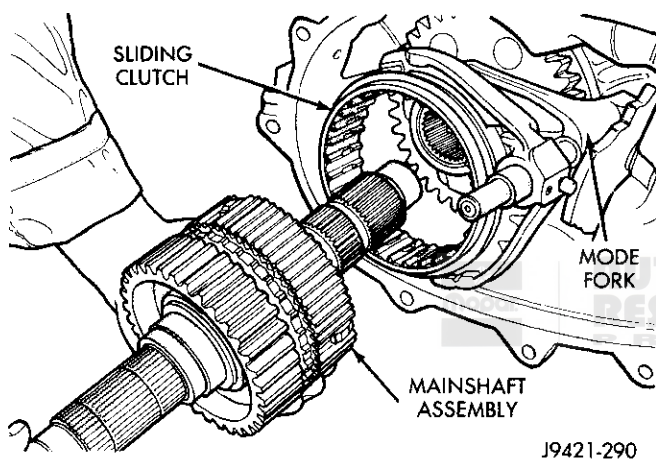
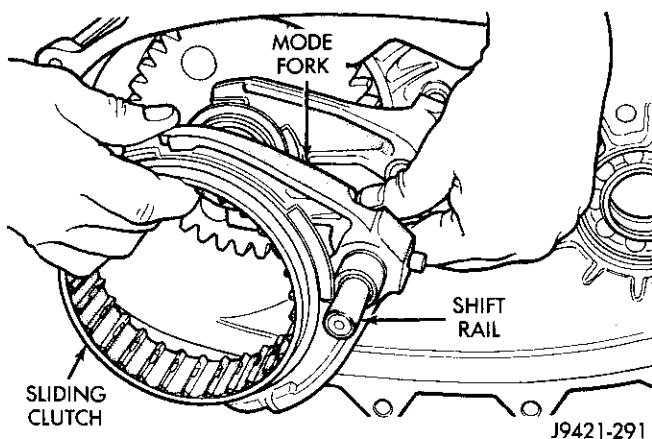


Fig. 73 Removing Drive Chain And Front Sprocket

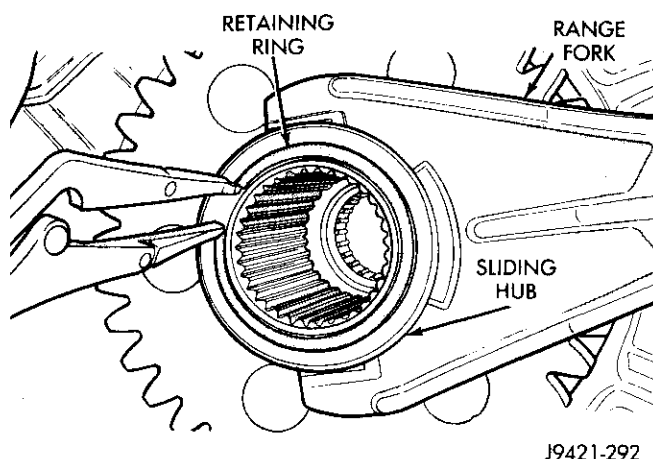
- (5) Remove front output shaft from bearing in case (Fig. 74).
- (6) Pull mainshaft assembly out of input gear, sliding clutch and case (Fig. 75).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 74 Front Output Shaft Removal****Fig. 75 Mainshaft Assembly Removal**

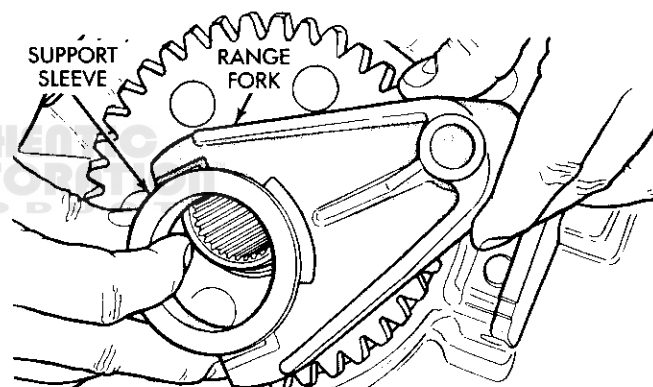
(7) Remove mode fork, sliding clutch and shift rail as assembly (Fig. 76). Note which way clutch fits in fork (long side of clutch goes to front).

**Fig. 76 Mode Fork, Shift Rail And Sliding Clutch Removal**

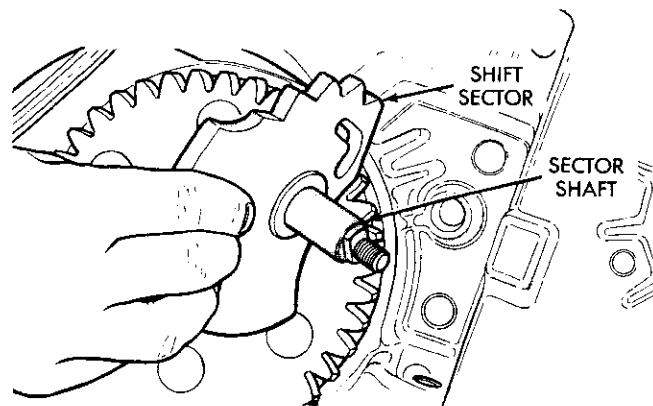
(8) Remove range fork retaining ring (Fig. 77).

**Fig. 77 Range Fork Retaining Ring Removal**

(9) Remove range fork and support sleeve as assembly (Fig. 78).

**Fig. 78 Range Fork And Support Sleeve Removal**

(10) Remove shift sector (Fig. 79).

**Fig. 79 Shift Sector Removal**

DISASSEMBLY AND ASSEMBLY (Continued)

(11) Remove shift sector shaft nylon retainer and O-ring from shaft bore in front case (Fig. 80).

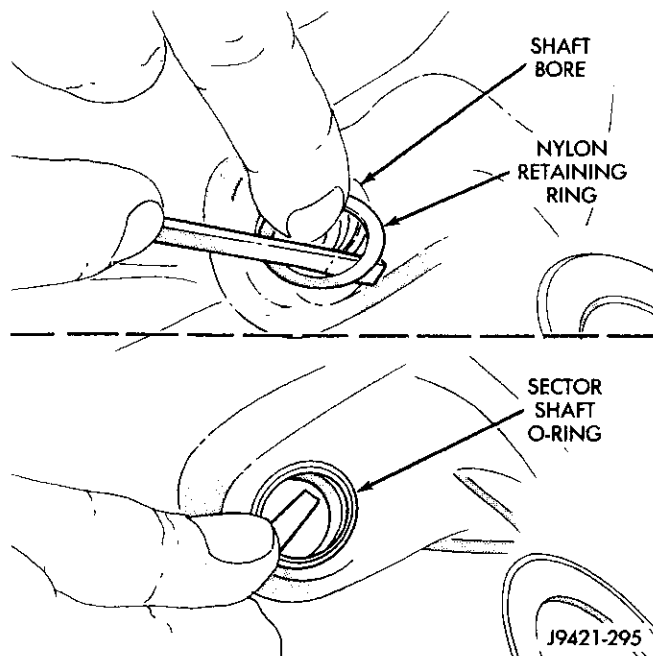


Fig. 80 Removing Sector Shaft O-Ring And Retainer

MAINSHAFT/SHIFT FORK ASSEMBLY AND INSTALLATION

(1) Support front case on wood blocks so case interior is facing up. Place blocks between mounting studs on forward surface of case. Be sure blocks will not interfere with input gear installation.

(2) Lubricate mainshaft components with Dexron II transmission fluid.

(3) Install drive sprocket on mainshaft (Fig. 81).

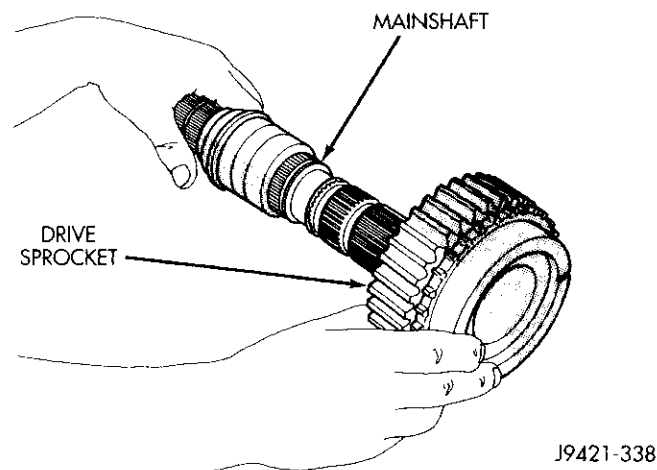


Fig. 81 Drive Sprocket Installation

(4) Install brass stop ring on drive sprocket (Fig. 82).

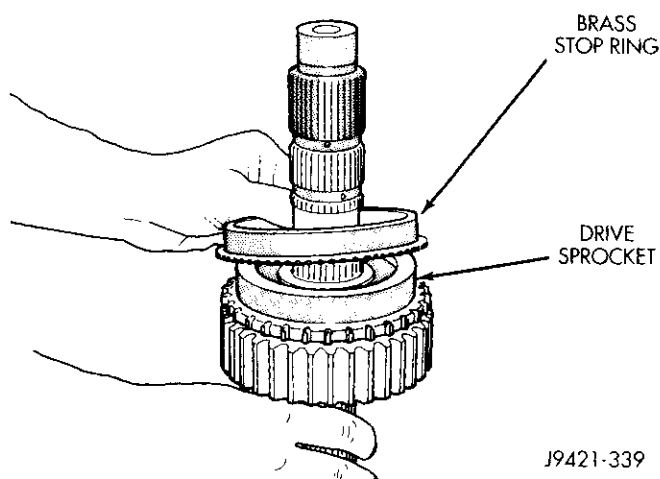


Fig. 82 Synchro Stop Ring Installation

(5) Install 3 synchro struts and 2 springs in hub as follows:

(a) Insert first strut in hub (Fig. 83). Strut shoulders rest (and slide) on sides hub slot as shown.

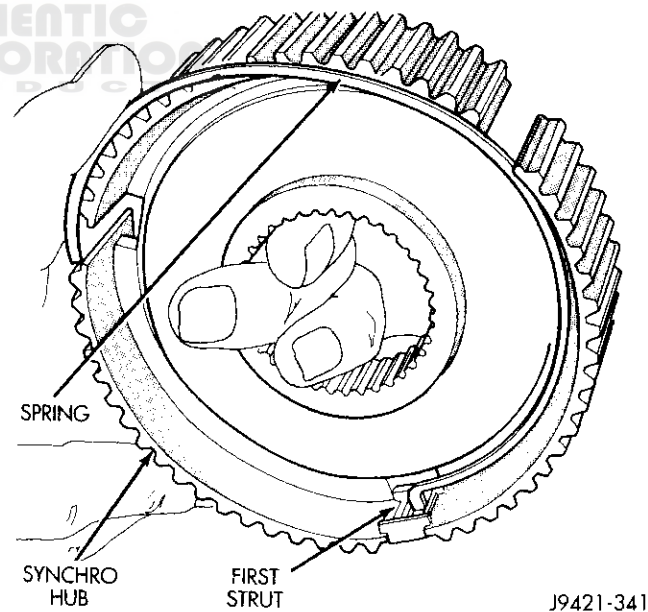


Fig. 83 Installing First Synchro Strut And Spring

DISASSEMBLY AND ASSEMBLY (Continued)

(b) Insert hooked end of first spring in center of strut to secure it. Then work spring into hub (Fig. 84).

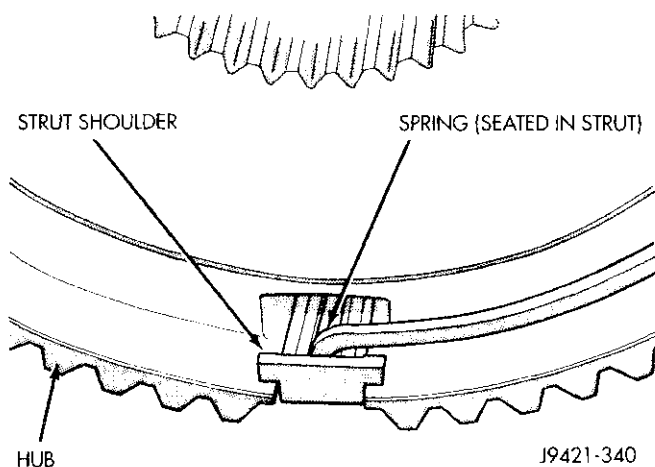


Fig. 84 Synchro Spring Installation

(c) Press spring inward and insert last two struts in hub slots. Be sure spring is positioned under struts to properly secure them (Fig. 85).

(d) Turn hub over and install remaining spring in hub. Position hooked end of second spring 180° away from first spring end.

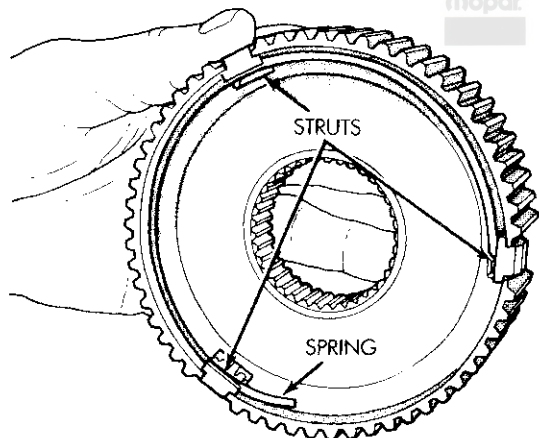


Fig. 85 Correct Position Of Struts And Springs

(6) Install assembled synchro hub on mainshaft (Fig. 86). Hub has shoulder on one side which goes toward sprocket (rear of shaft). Flat side of hub faces front of shaft.

(7) Install synchro hub retaining ring (Fig. 87). Be sure ring is fully seated before proceeding.

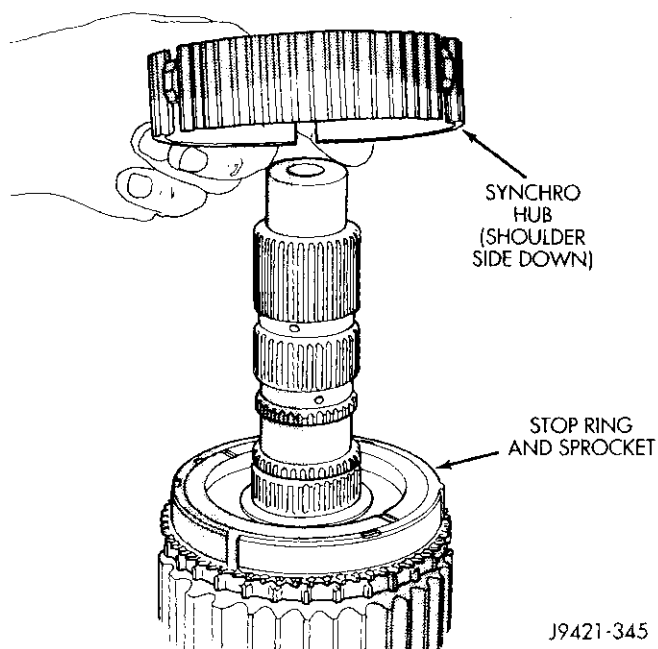


Fig. 86 Synchro Hub Installation

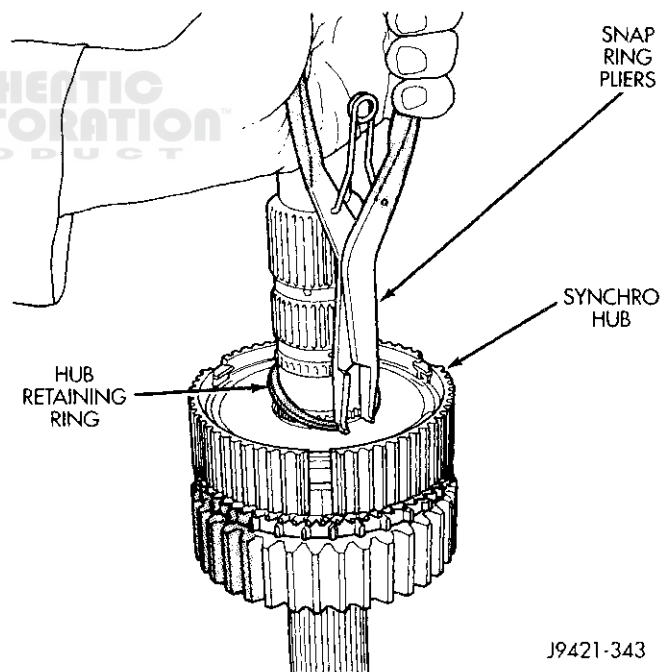


Fig. 87 Synchro Hub Retaining Ring Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(8) Install sliding clutch (sleeve) on synchro hub (Fig. 88).

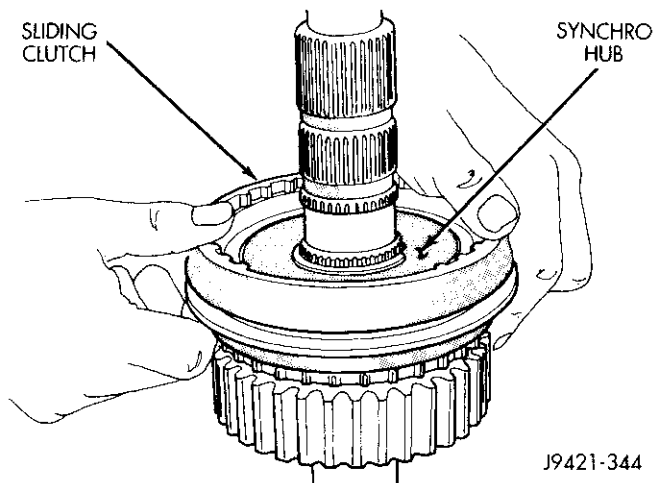


Fig. 88 Sliding Clutch Installation

CAUTION: The sliding clutch must be correctly positioned to ensure proper shifting. Position the clutch on the hub so a clutch spline is centered over each strut as shown (Fig. 89). If the clutch is installed so a gap

between splines is aligned with one or more struts, gear clash will result.

(9) Assemble range fork and synchro clutch and hub (Fig. 90). Then install fork and hub in case. Seat hub on support sleeve and seat range fork pin in shift sector slot (Fig. 91).

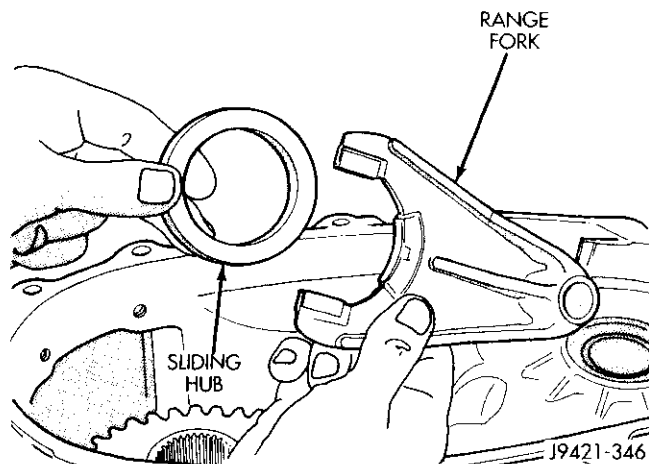


Fig. 90 Assembling Range Fork And Sliding Hub

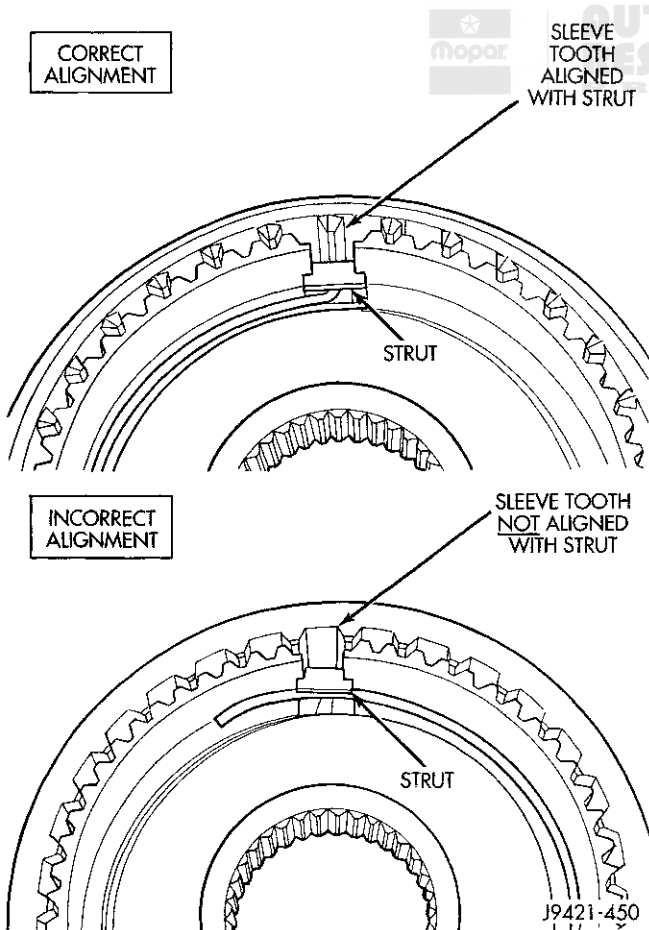


Fig. 89 Correct Alignment Of Struts And Sliding Clutch

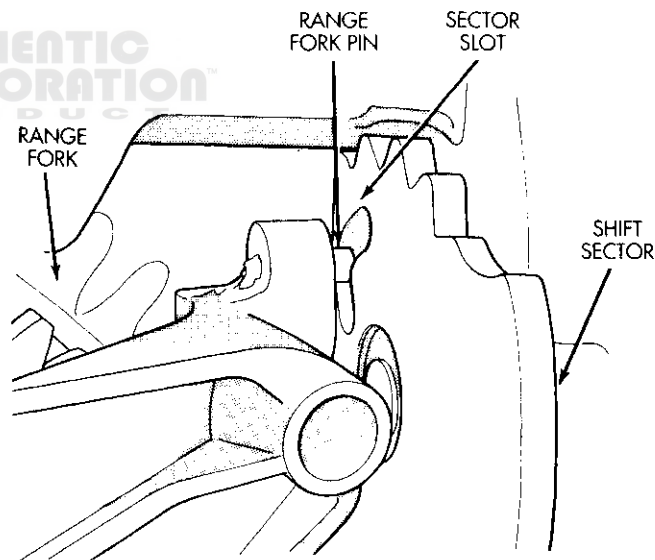


Fig. 91 Seating Range Fork And Hub

DISASSEMBLY AND ASSEMBLY (Continued)

(10) Install sliding hub and retaining ring (Fig. 92). Be sure ring is fully seated before proceeding.

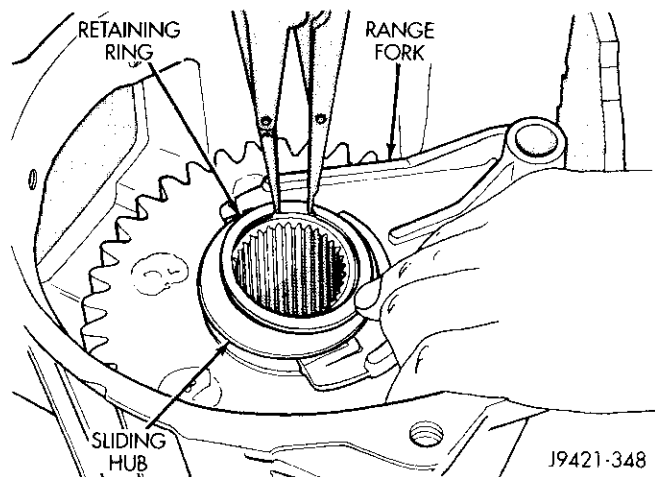


Fig. 92 Sliding Hub Retaining Ring Installation

(11) Install mode fork and shift rail in sliding clutch (Fig. 93).

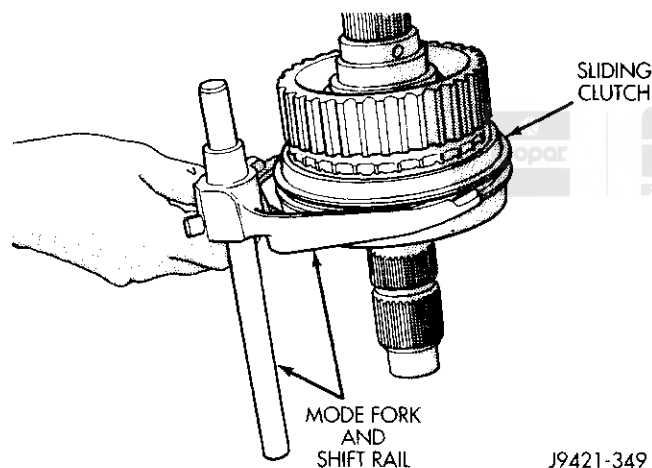


Fig. 93 Assembling Mode Fork and Mainshaft

(12) Install mainshaft/mode fork assembly (Fig. 94). Guide mainshaft through hub and into input gear and shift rail through range fork and into case bore.

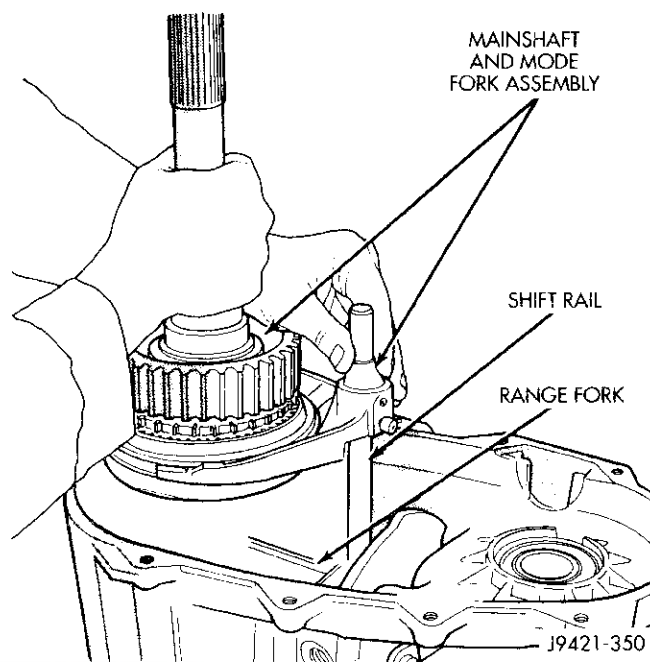


Fig. 94 Installing Mainshaft And Mode Fork Assembly
FRONT OUTPUT SHAFT, DRIVE CHAIN AND SPROCKET INSTALLATION

(1) Install front output shaft in bearing (Fig. 95).

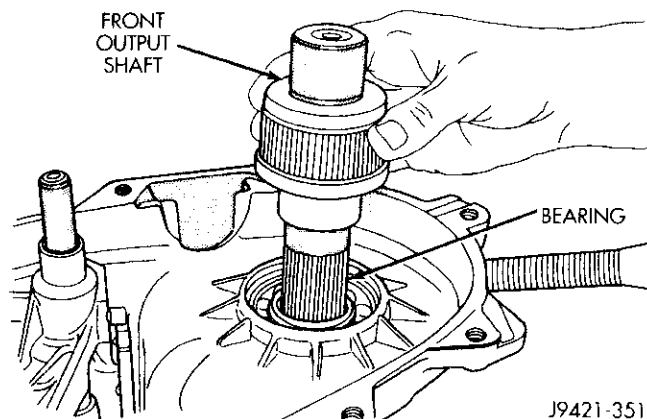
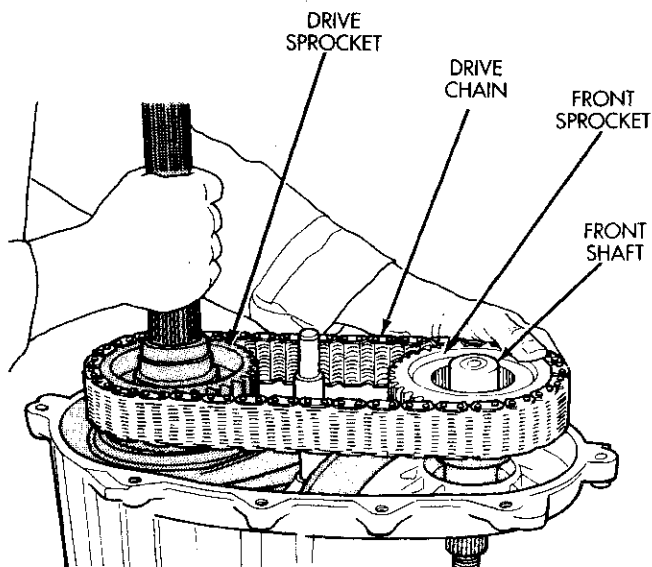


Fig. 95 Front Output Shaft Installation

DISASSEMBLY AND ASSEMBLY (Continued)

- (2) Insert front sprocket in drive chain (Fig. 96).
- (3) Install drive chain around mainshaft sprocket (Fig. 96). Then position front sprocket over front shaft.
- (4) Raise mainshaft about 2.54 cm (one inch) and seat front sprocket on front output shaft.

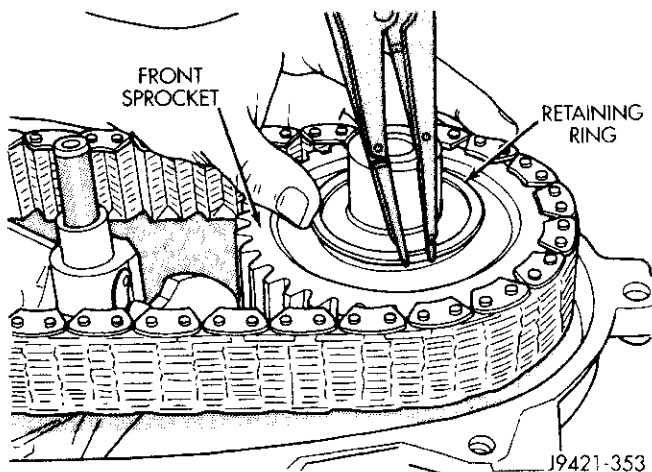


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Fig. 96 Drive Chain And Front Sprocket Installation

- (5) If mainshaft and sliding clutch were unseated during chain installation, align and reseat mainshaft in input gear and hub. Then reseat synchro hub in sliding clutch. Press synchro struts inward to ease clutch back onto hub.

- (6) Install front sprocket retaining ring (Fig. 97).

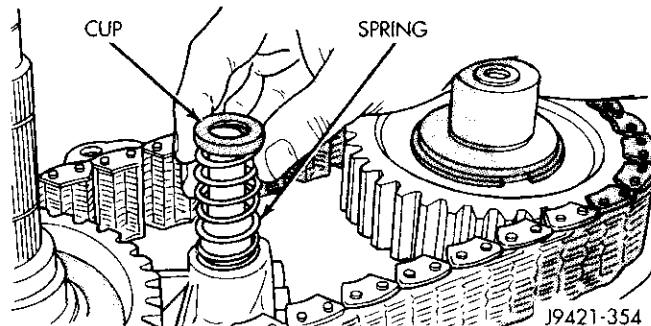


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Fig. 97 Front Sprocket Retaining Ring Installation

- (7) Realign sliding clutch on synchro hub if necessary. Press synchro struts inward to ease realignment. Be sure mainshaft is fully seated before proceeding.

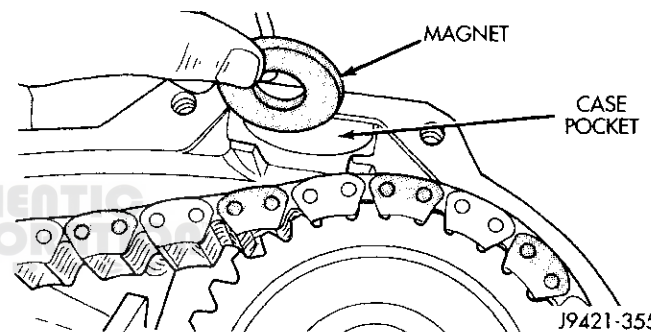
- (8) Install spring and cup on shift rail (Fig. 98).



J9421-354

Fig. 98 Shift Rail Spring And Cup Installation

- (9) Insert magnet in front case pocket (Fig. 99).



J9421-355

Fig. 99 Case Magnet Installation

DISASSEMBLY AND ASSEMBLY (Continued)**PLANETARY AND INPUT GEAR****DISASSEMBLY**

The only removable parts in the planetary assembly are the snap rings, needle bearing, thrust washers, lock ring, input gear, and support sleeve. **The planetary carrier, PTO gear, planetary pinions, and remaining planetary components are fixed parts and are serviced as an assembly.**

(1) Position planetary assembly so PTO gear is on bench (Fig. 100).

(2) Remove retaining ring that secures input gear and lock ring in planetary assembly.

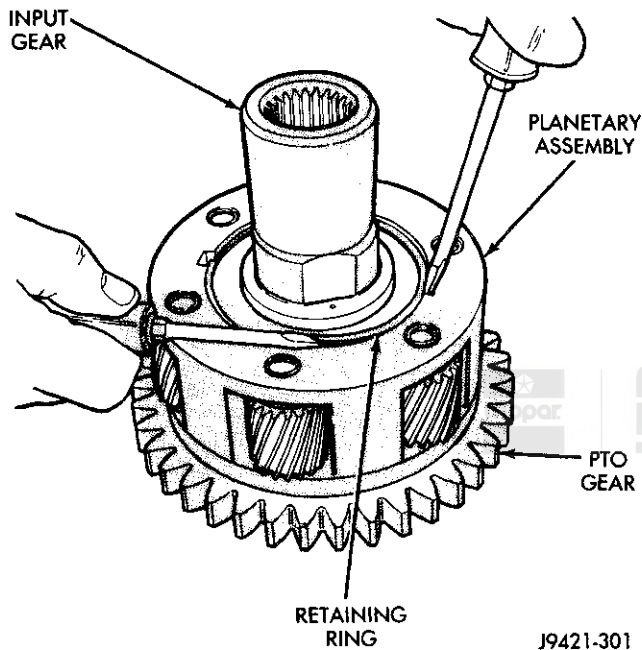


Fig. 100 Removing Lock Ring/Input Gear Retaining Ring

(3) Remove lock ring and front thrust washer from carrier (Fig. 101). Note that lock ring and thrust washer are both tabbed.

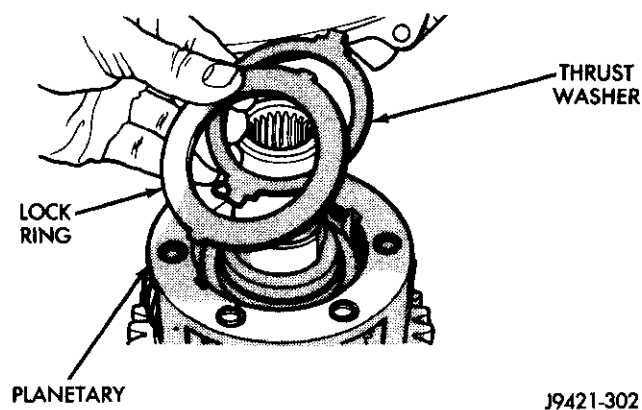


Fig. 101 Planetary Lock Ring And Front Thrust Washer Removal

(4) Remove input gear from planetary carrier (Fig. 102). Lift gear straight up and out of carrier.

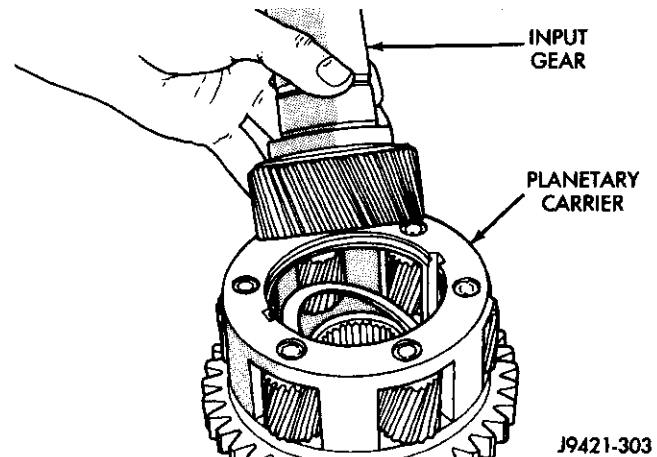


Fig. 102 Removing Input Gear From Planetary Carrier

(5) Remove support sleeve from carrier (Fig. 103).

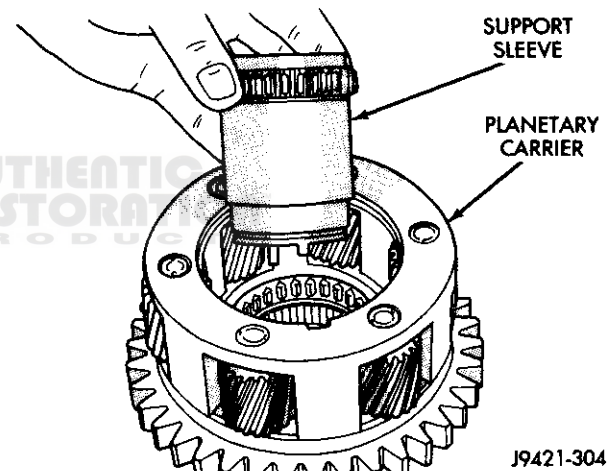


Fig. 103 Support Sleeve Removal

(6) Remove rear thrust washer (Fig. 104).

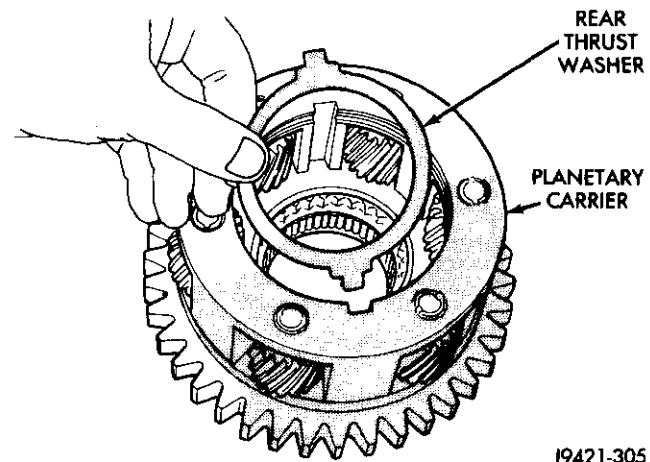


Fig. 104 Rear Thrust Washer Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(7) Inspect carrier needle bearing. If bearing is worn, rough, or damaged in any way, remove it with a brass punch and hammer (Fig. 105).

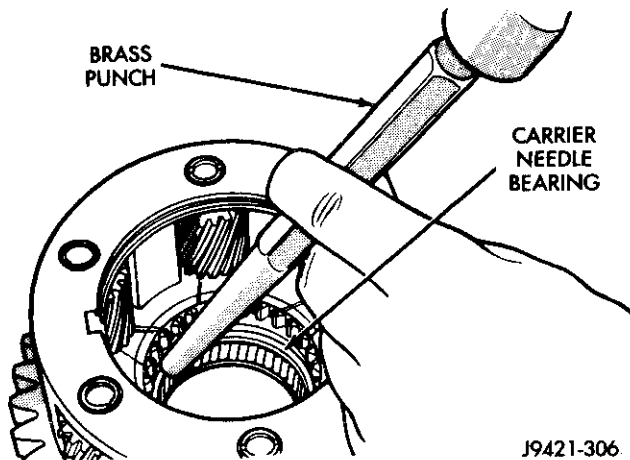


Fig. 105 Carrier Needle Bearing Removal

(8) Inspect needle bearing in input gear. Leave bearing in place if condition is good. However, if bearing is rough, distorted, noisy, or brinnelled, remove it with Puller Tool MD998346 as follows:

(a) Turn puller tool bolt until jaws retract enough to fit into bearing (Fig. 106).

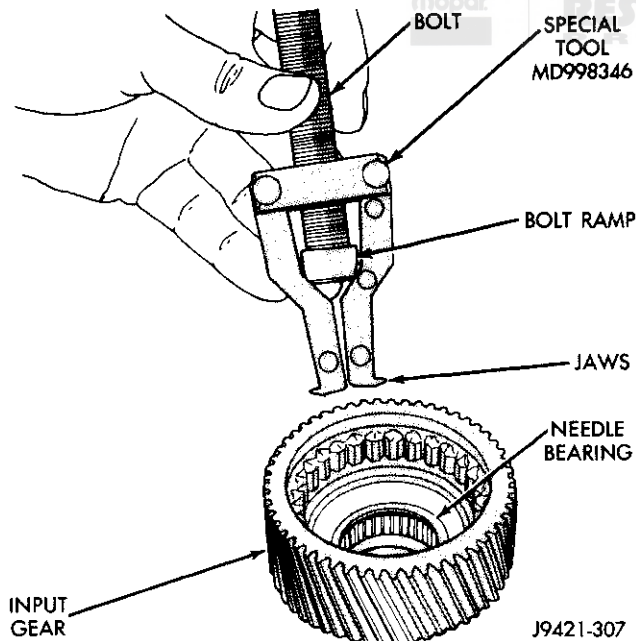


Fig. 106 Puller Jaws In Retracted Position

(b) Insert puller bolt and jaws into bearing (Fig. 107). Then turn puller bolt clockwise so ramp on bolt will spread jaws forcing them under bearing.

(c) Install puller bridge on puller bolt. Then install flat washer and nut on puller bolt (Fig. 108).

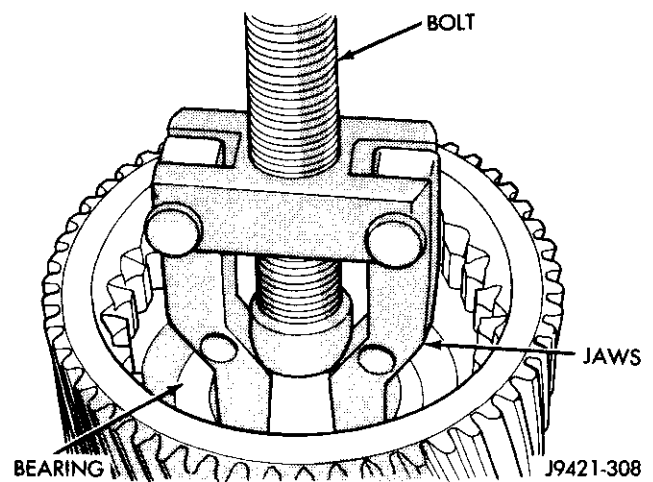


Fig. 107 Puller Bolt And Jaws Seated Under Needle Bearing

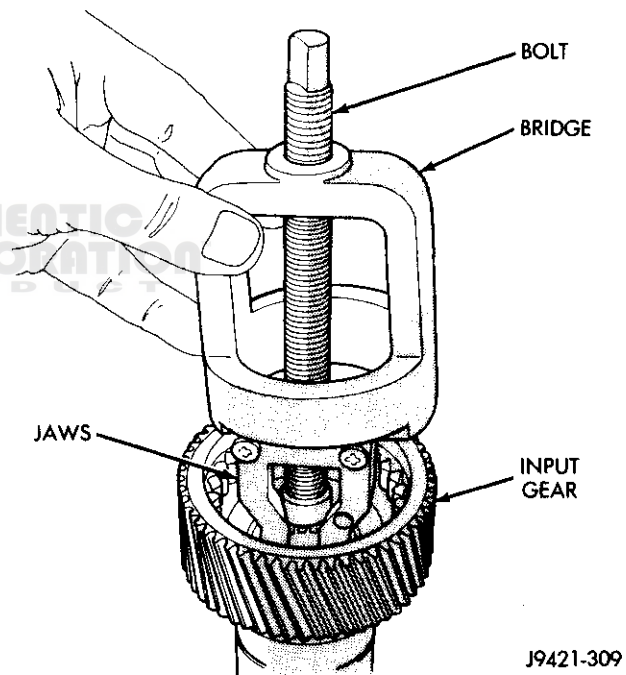


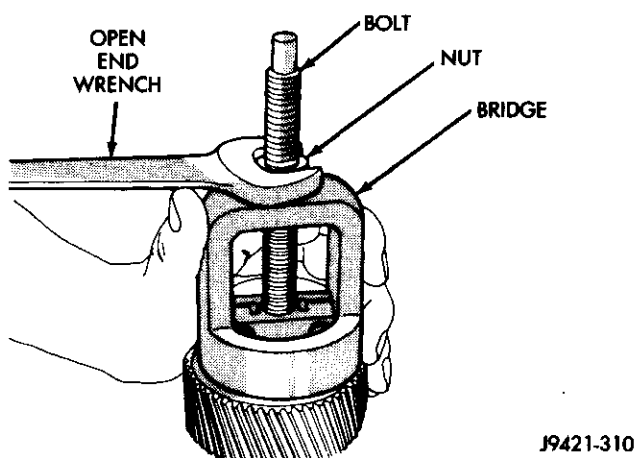
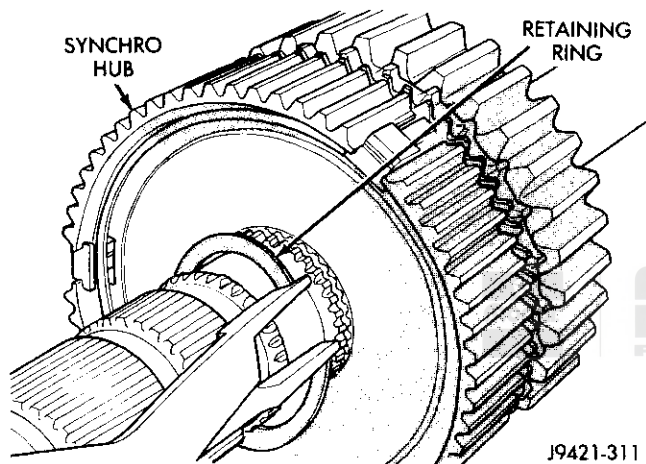
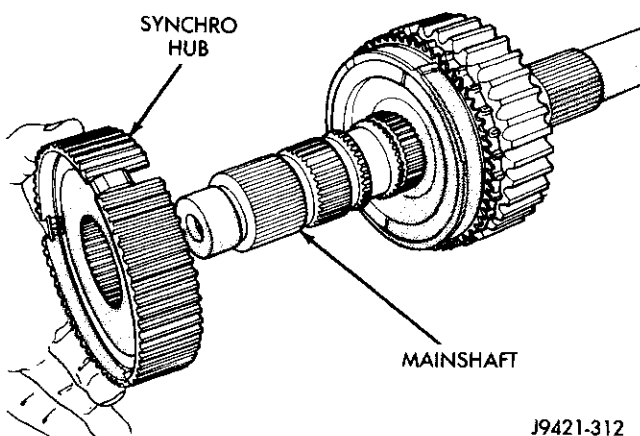
Fig. 108 Installing Puller Bridge

(d) Hold puller bridge from turning by hand or with pliers. Then tighten nut on puller bolt in clockwise direction to draw bearing out of input gear (Fig. 109).

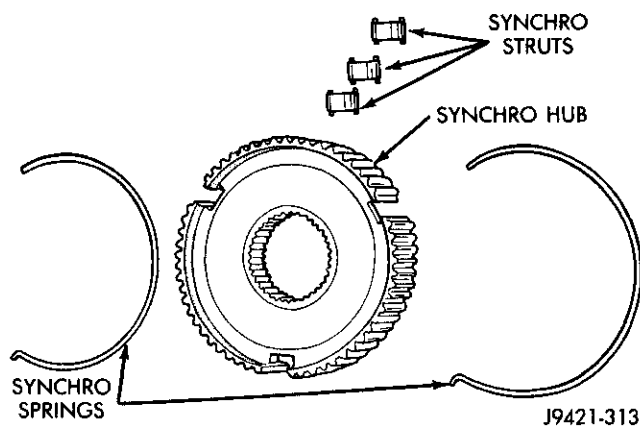
MAINSHAFT**DISASSEMBLY**

(1) Remove retaining ring that secures synchro hub on mainshaft (Fig. 110). Use standard (instead of parallel jaw) snap ring pliers to remove this retaining ring.

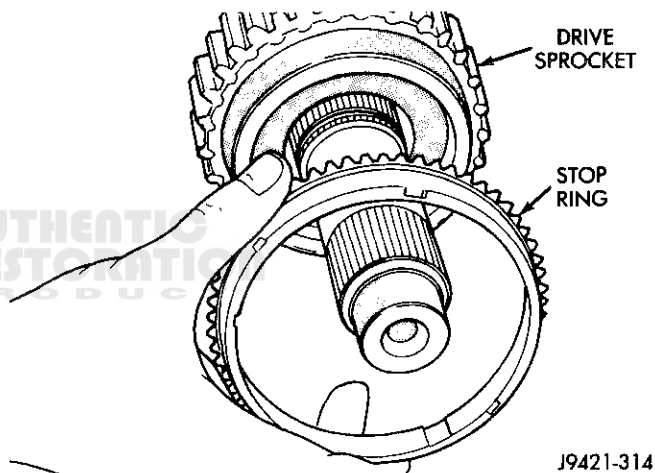
(2) Remove synchro hub (Fig. 111).

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 109 Removing Needle Bearing****Fig. 110 Synchro Hub Retaining Ring Removal****Fig. 111 Synchro Hub Removal**

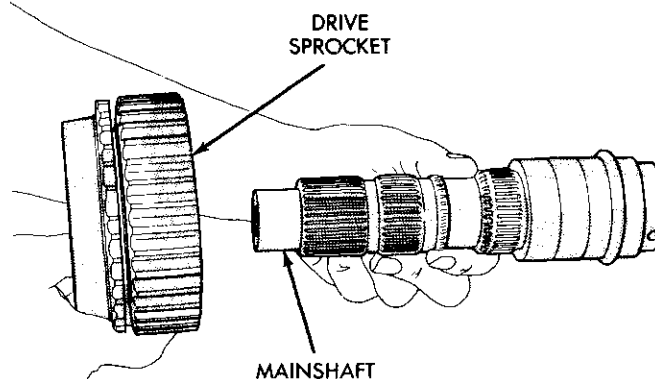
(3) Inspect synchro hub struts and springs. If struts appear worn, remove struts and springs from hub. Note position of springs for installation reference (Fig. 112).

**Fig. 112 Synchro Strut And Spring Removal**

(4) Remove brass stop ring (Fig. 113). Discard stop ring if worn, cracked, or any teeth are missing.

**Fig. 113 Synchro Stop Ring Removal**

(5) Remove drive sprocket (Fig. 114). Note that sprocket does not have needle bearings like prior transfer case models.

**Fig. 114 Drive Sprocket Removal**

DISASSEMBLY AND ASSEMBLY (Continued)**FRONT/REAR CASE BEARING AND SEAL****REMOVAL**

(1) Remove front output shaft oil seal with pry tool (Fig. 115).

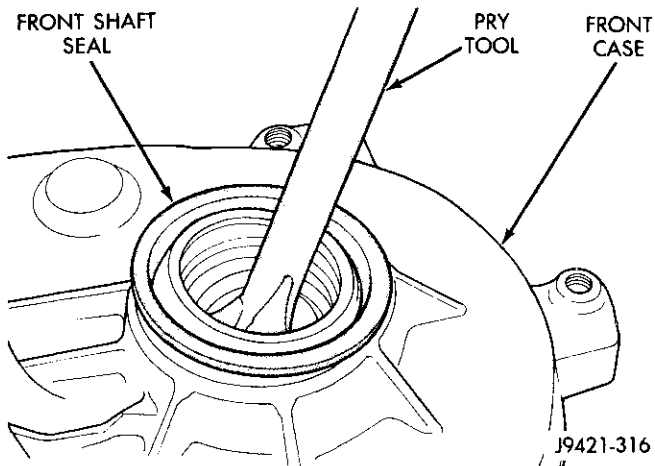


Fig. 115 Front Output Shaft Seal Removal

(2) Inspect front output bearing condition. If bearing is in good condition, do not remove it from case. But if bearing is rough, noisy, or exhibits wear, remove it as follows:

(a) Remove front output bearing retaining ring (Fig. 116).

(b) Knock bearing out of case with brass punch, plastic mallet or suitable size remover tool.

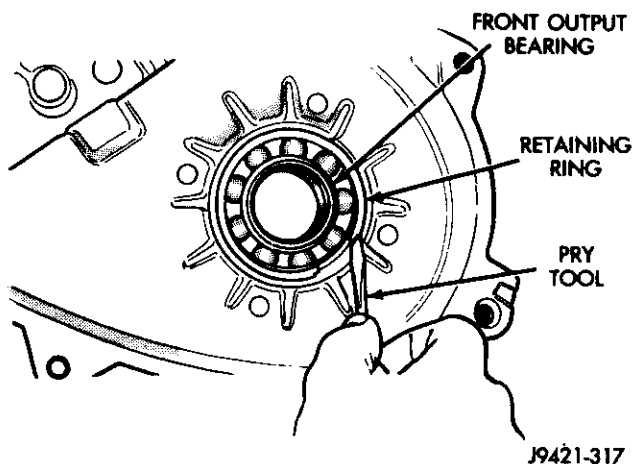


Fig. 116 Front Output Bearing Retaining Ring Removal

(3) Inspect condition of input bearing. Leave bearing in front case if condition is good. However, if bearing is rough, noisy, worn, or bearing locating ring or ring groove is damaged, remove bearing with Driver Handle C-4171 and Tool 7828 (Fig. 117).

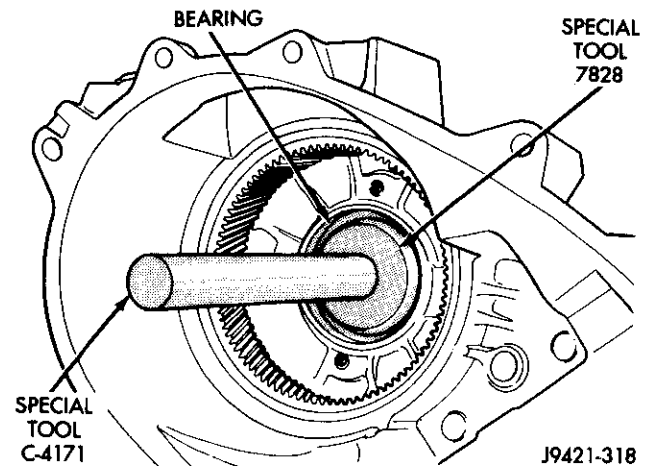


Fig. 117 Input Bearing Removal

(4) Inspect mainshaft output bearing. Replace bearing only if noisy, rough, or damaged in any way. If bearing is still in rear retainer, remove bearing from retainer.

(5) Inspect front output shaft needle bearing in rear case (Fig. 118). Leave bearing in place if in good condition. However, if bearing is damaged in any way, it will have to be replaced.

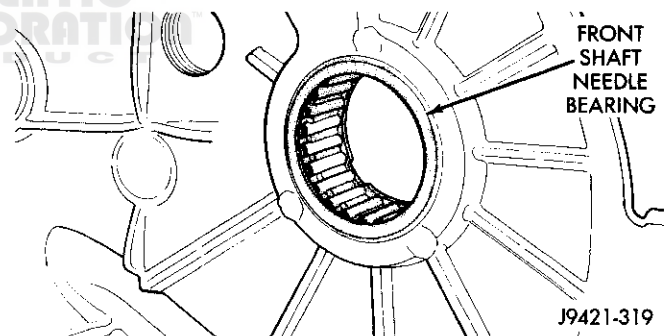
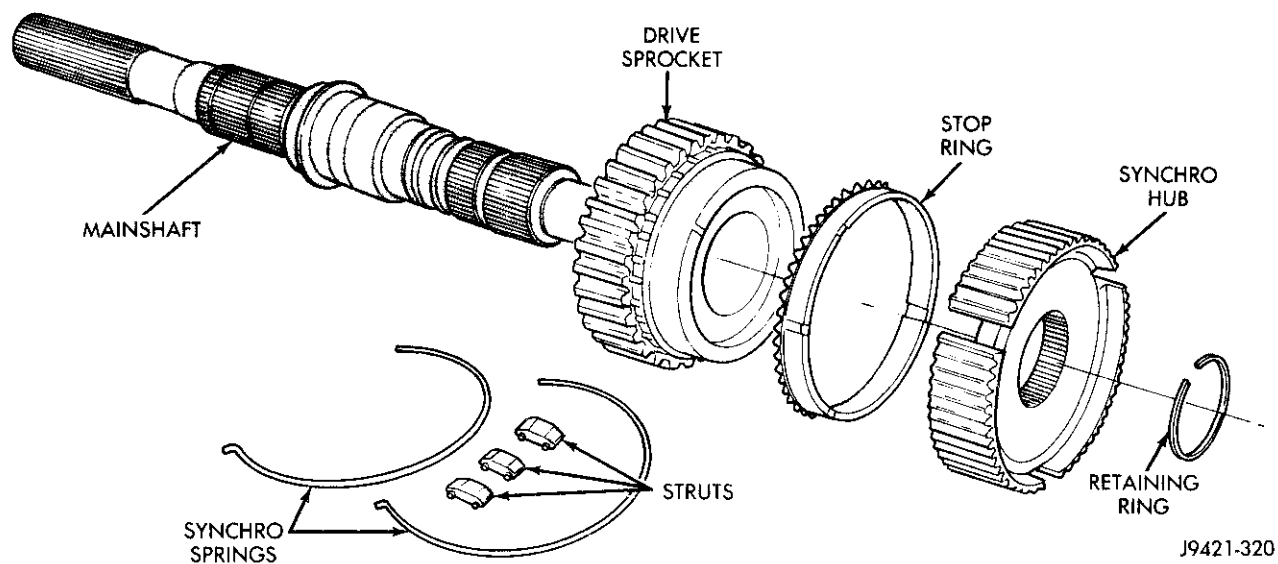


Fig. 118 Front Output Shaft Needle Bearing Location

CAUTION: If bearing replacement is necessary and the bearing is fully bottomed in the case bore, bearing removal will prove quite difficult. Blind hole puller tools like those found in Snap On Tool Sets CG40B, CG46, and CG2545AB will be required for bearing removal.

CLEANING AND INSPECTION**TRANSFER CASE CLEANING AND INSPECTION**

Wash all parts thoroughly in clean solvent. Be sure all old lubricant, sealant, metal particles, dirt and foreign material are removed from the surfaces of every part.

CLEANING AND INSPECTION (Continued)**Fig. 119 Mainshaft Components**

Apply compressed air to each oil feed port and channel in both case halves to remove any foreign material or cleaning solvent residue.

The oil pump can be disassembled for cleaning and inspection if desired. However, the pump parts are not serviced separately. If any pump component is worn, or damaged, the pump must be replaced as an assembly.

Inspect the spline teeth on the synchro hub (Fig. 119). If evidence of chipping or excessive wear is apparent, replace the hub. The hooked end of each synchro spring should be inserted in one of the struts. In addition, the springs should not interfere with the polished gear cone or inside diameters of the hub.

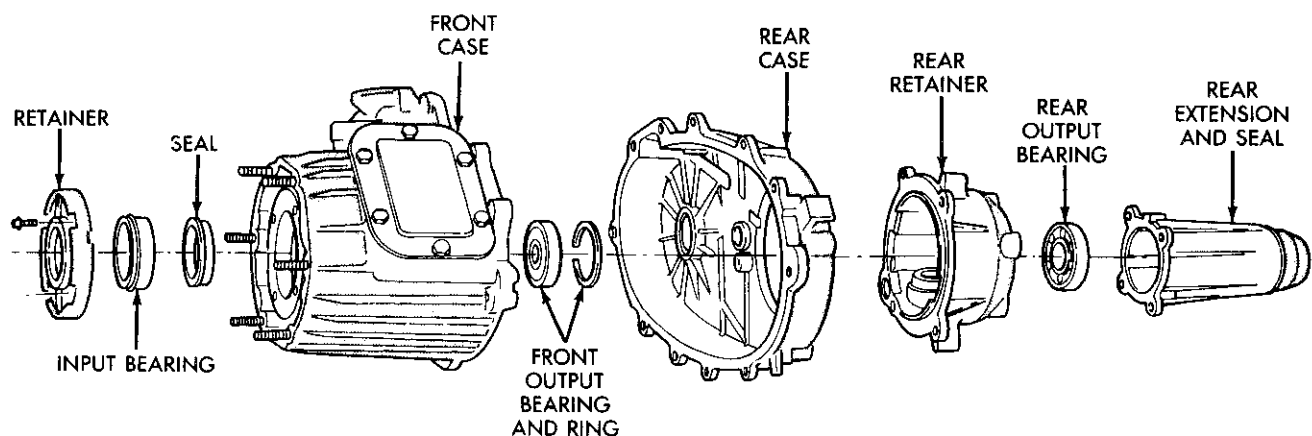
Inspect the stop ring for cracks and wear. Replace the ring if necessary or if doubt exists over condition. Check a replacement synchro ring for proper fit on

the cone with a minimum of wobble. Also check the synchronizer struts for wear or damage.

Inspect all gear teeth and splines for wear or damage. Also check splines for burrs, or nicks. Remove minor nicks and scratches with an oil stone. Replace any part with damaged splines.

It is recommended that all retaining (snap) rings be replaced during overhaul. Most of the retaining rings can be distorted during removal and should not be reused.

Inspect the two case halves (Fig. 120), for cracks, porosity, damaged mating surfaces, stripped bolt threads, or distortion. Replace either case half if necessary. However, stripped threads can be repaired with Heli-Coil stainless steel thread inserts. The case vent tube can be resecured with Loctite 680 if necessary.

**Fig. 120 Case Components And Bearings**

CLEANING AND INSPECTION (Continued)

Inspect the annulus gear. Be sure the gear teeth are in good condition. Replace the front case and annulus as an assembly if the gear is damaged.

Check condition of the shift fork pads (Fig. 121). The pads should be replaced if cracked, worn, or loose (won't stay on fork).

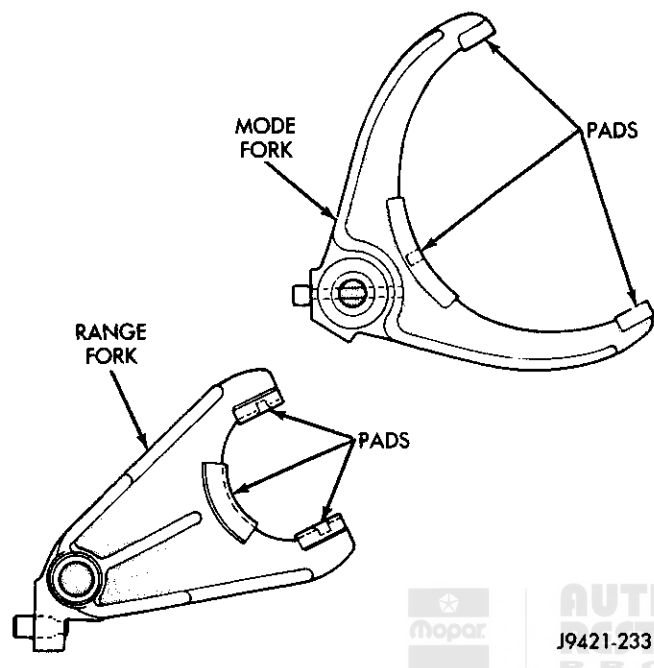


Fig. 121 Shift Fork Pads

The shift forks, clutch and sleeve should all be checked for wear, cracks, or any type of damage (Fig. 122). The shift sector shaft and detents should be inspected for wear. The mode fork and shift rail are a one-piece unit. If either part is damaged, replace the fork and rail as an assembly. Replace the shift rail cup and spring if they exhibit wear.

Inspect the planetary thrust washers (Fig. 123) carefully for wear or damage. Replace both washers if necessary.

The planetary carrier cannot be disassembled. It must be serviced as an assembly if damaged. Check condition of the pinion teeth and PTO gear teeth on heavy duty models. If pinion tooth wear is evident, it will also be necessary to check condition of the annulus gear teeth.

A PTO gear is only used on heavy duty versions of the NV241. The standard model is not equipped for PTO capability.

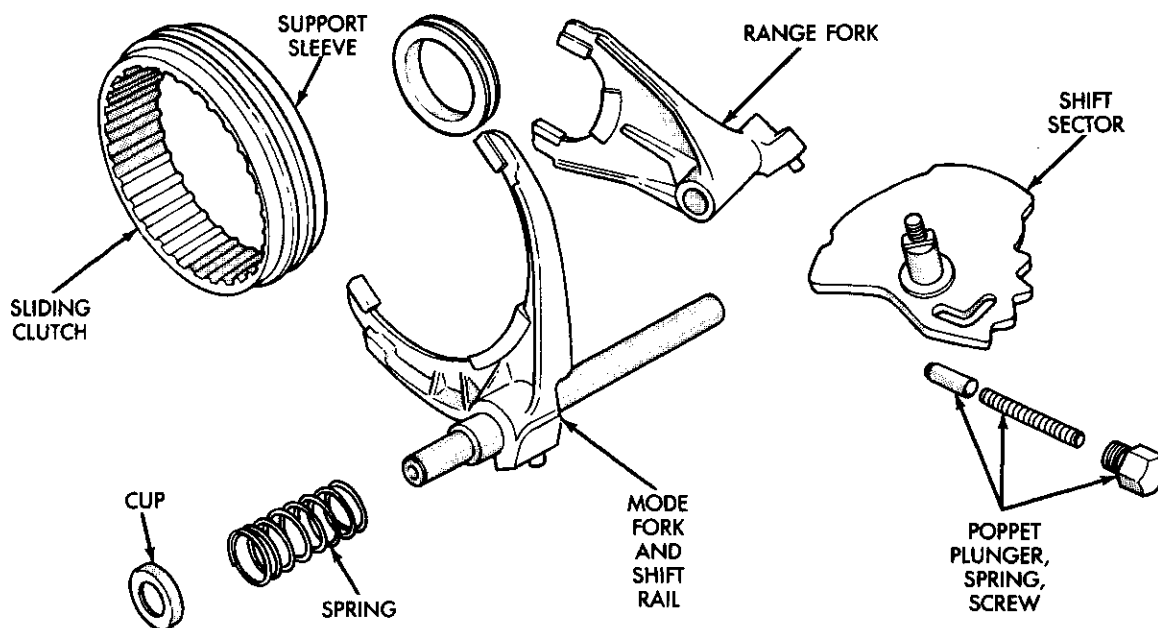
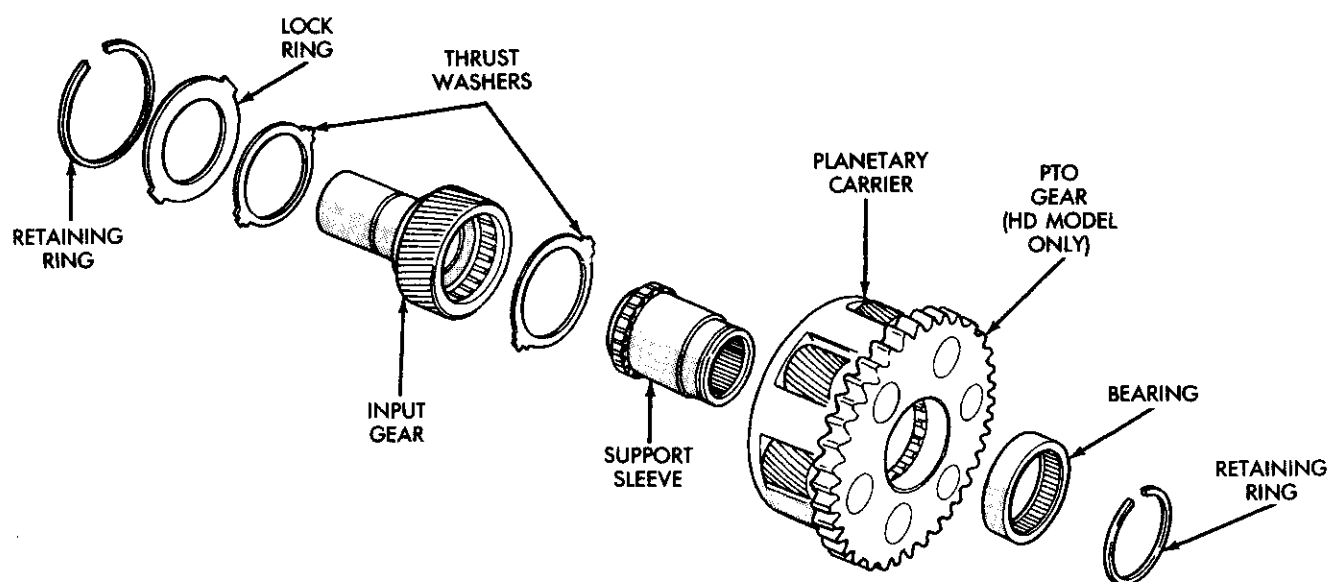


Fig. 122 Shift Fork Components



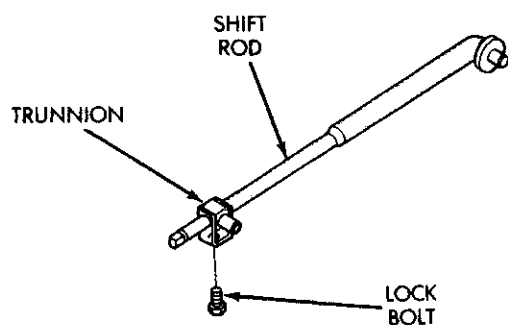
J9421-322

Fig. 123 Planetary And Input Gear Components

ADJUSTMENTS

SHIFT LINKAGE ADJUSTMENT

- (1) Move shift lever into 2H position.
- (2) Raise vehicle.
- (3) Loosen shift rod lock bolt at trunnion (Fig. 124).

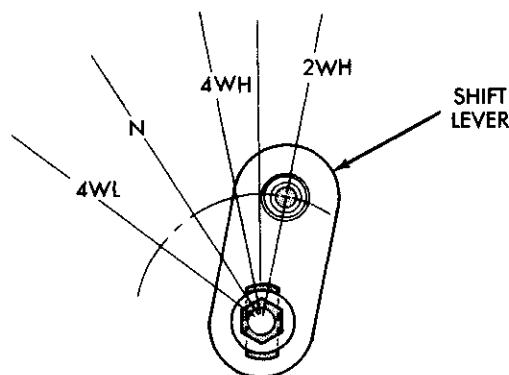


J9421-235

Fig. 124 Shift Rod Lock Bolt Location

- (4) Check shift rod fit in trunnion. Be sure rod does not bind in trunnion.

- (5) Verify that transfer case shift lever is in 2H position (Fig. 125).



J9421-231

Fig. 125 Shift Lever Range Positions

- (6) Tighten shift rod lock bolt to 10 N·m (90 in. lbs.) torque.
- (7) Lower vehicle.
- (8) Check shift linkage operation. Be sure transfer case shifts into and operates properly in all ranges.

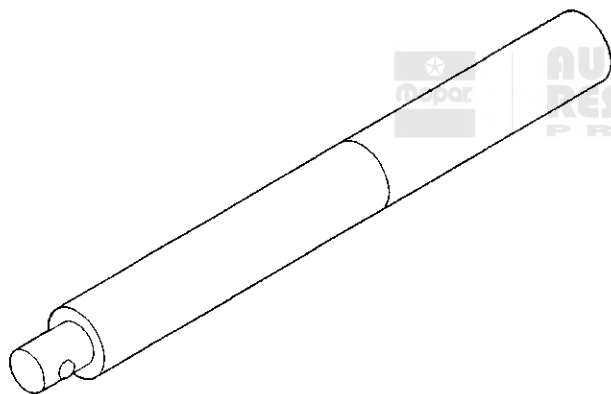
SPECIFICATIONS

TORQUE

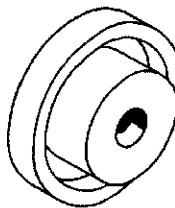
DESCRIPTION	TORQUE
Plug, Detent	16-24 N·m (12-18 ft. lbs.)
Bolt, Diff. Case	17-27 N·m (15-24 ft. lbs.)
Plug, Drain/Fill	40-45 N·m (30-40 ft. lbs.)
Bolt, Extension Housing . .	35-46 N·m (26-34 ft. lbs.)
Bolt, Front Brg. Retainer. .	16-27 N·m (12-20 ft. lbs.)
Bolt, Case Half	35-46 N·m (26-34 ft. lbs.)
Nut, Front Yoke	122-176 N·m (90-130 ft. lbs.)
Screw, Oil Pump	1.2-1.8 N·m (12-15 in. lbs.)
Nut, Range Lever	27-34 N·m (20-25 ft. lbs.)
Bolt, Rear Retainer	35-46 N·m (26-34 ft. lbs.)
Nuts, Mounting	35-47 N·m (26-35 ft. lbs.)
Bolts, U-Joint	19 N·m (17 ft. lbs.)
Vacuum Switch	20-34 N·m (15-25 ft. lbs.)

SPECIAL TOOLS

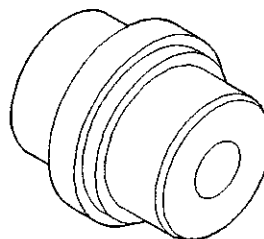
NV231HD, NV241, NV241HD



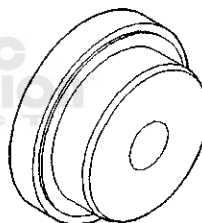
C-4171 Handle Universal (Non Threaded)



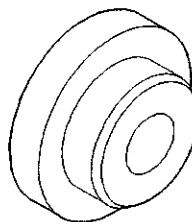
C-4210 Installer, Seal



5061 Installer, Bearing

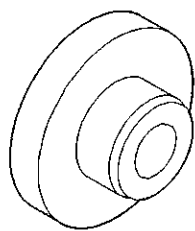


5062 Installer, Bearing

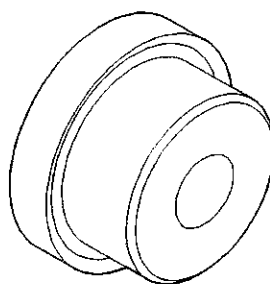


5063 Installer, Bearing

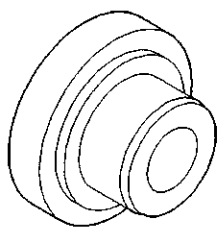
SPECIAL TOOLS (Continued)



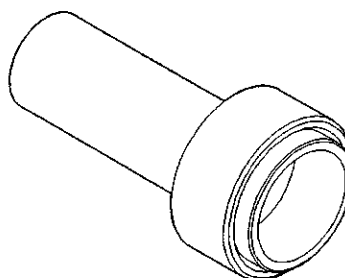
5064 Installer, Bearing



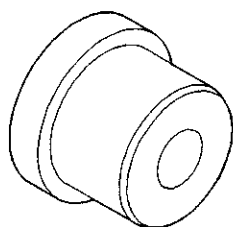
7828-A Installer, Input Gear Bearing



5065 Installer, Bearing



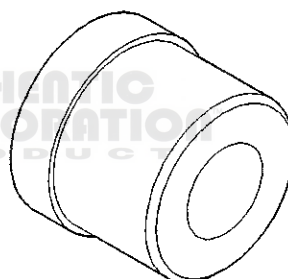
7888 Installer, Pump Housing Seal



5066 Installer, Bushing



**AUTHENTIC
RESTORATION
PRODUCT**



7889-A Remover, Rear Output Shaft Bushing

NV021 PTO ADAPTER

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GENERAL INFORMATION

GENERAL INFORMATION

The NV 021 PTO adapter provides power take-off capability for BR models with an automatic transmission. The adapter is available as an option on 2-wheel drive 2500 and 3500 models.

The NV 021 adapter is similar in appearance and mounting to a small transfer case (Fig. 1). A 4-wheel drive automatic transmission is used to simplify adapter mounting. The adapter has mounting studs in the front case for attachment to the overdrive unit gear case.

Basic components consist of the front case and rear extension, mainshaft, input gear, PTO gear, shift sector, and shift fork, shift rail and sleeve.

The mainshaft is supported in by a needle bearing in the input gear hub and by a ball bearing in the rear extension. The input gear is supported by a

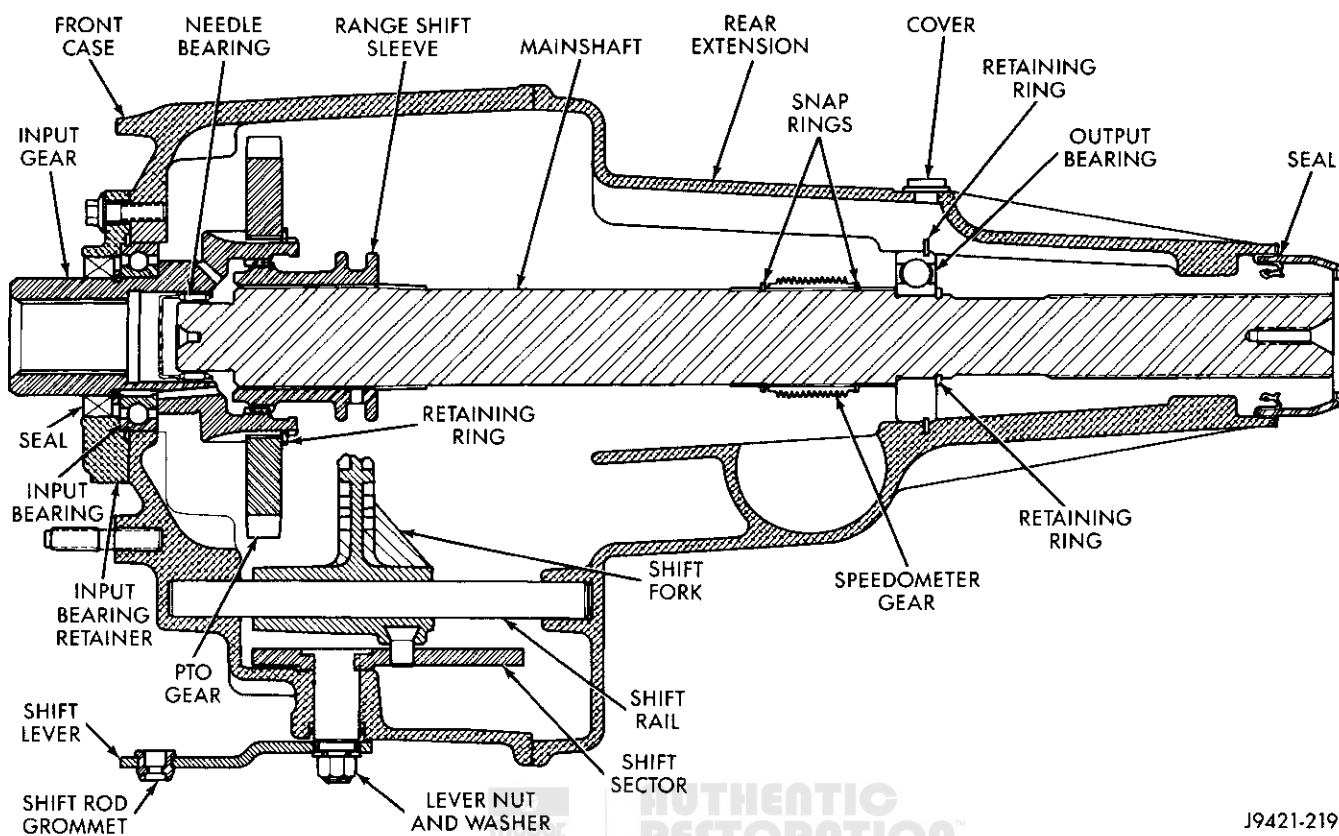
roller bearing in the front case. The PTO gear is splined to the input gear and is retained by a snap ring.

The input bearing is secured in the front case by a retainer. The output bearing is secured by a retaining ring on the mainshaft and by a second retaining ring in the rear extension.

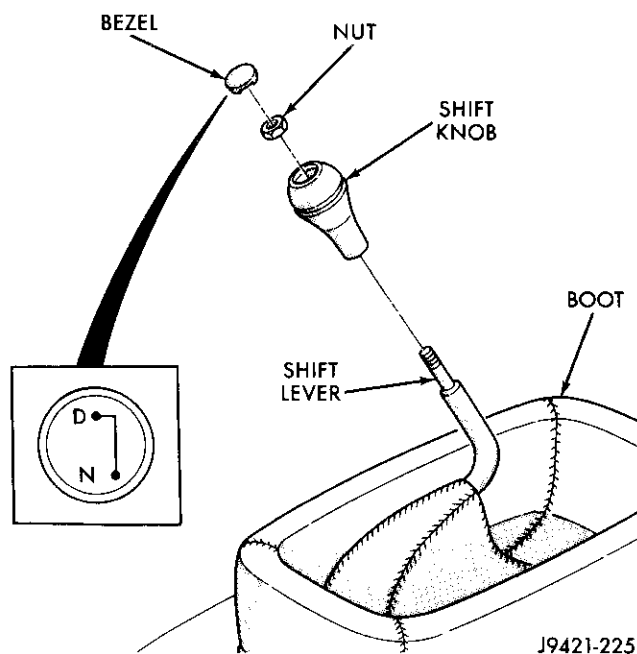
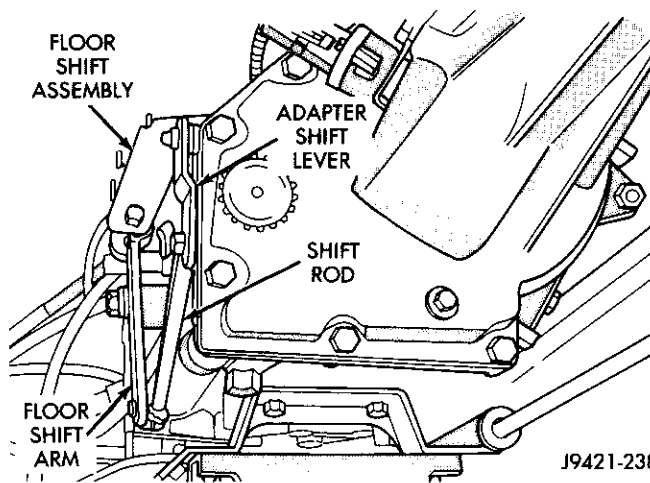
The speedometer drive gear is located at the rear of the mainshaft. The gear is secured on the shaft with two snap rings.

SHIFT LEVER AND LINKAGE

A floor mounted shift lever assembly (Fig. 2), is used for selecting desired operating range. The lever is attached to the adapter shift lever by a single shift rod (Fig. 3). The floor linkage assembly is the same as used on 4-wheel drive models with a transfer case.

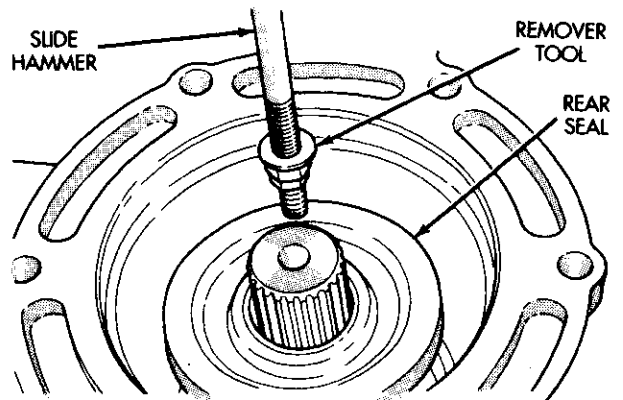
GENERAL INFORMATION (Continued)

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Fig. 1 NV 021 PTO Adapter**Fig. 2 Adapter Shift Lever And Shift Pattern****Fig. 3 Floor Shift Linkage**

GENERAL INFORMATION (Continued)

The adapter shift lever is attached directly to the shift sector shaft. Sector position is controlled by a detent poppet, spring and screw (Fig. 4). The poppet, under pressure from the spring, maintains sector detent position.



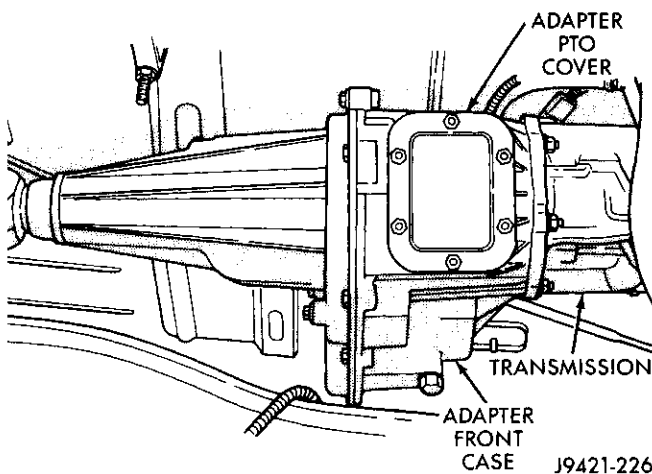
J9421-200

Fig. 4 Shift Sector Detent Controls

PTO ACCESSORY EQUIPMENT

Power take-off accessories such as pumps, gear drives, and towing equipment, are operated by a drive gear on the PTO adapter mainshaft.

The drive gear is accessible by removing the PTO access cover on the front case (Fig. 5). The auxiliary equipment to be operated is bolted directly to the adapter once the cover has been removed.



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Fig. 5 PTO Access Cover Location

RECOMMENDED LUBRICANT AND FILL LEVEL

Recommended lubricant for the NV 021 is Mopar Dexron II, or ATF Plus transmission fluid.

Approximate fluid capacity is 2.17 liters (4.6 pints). The adapter fill and drain plugs are located in the rear extension (Fig. 6).

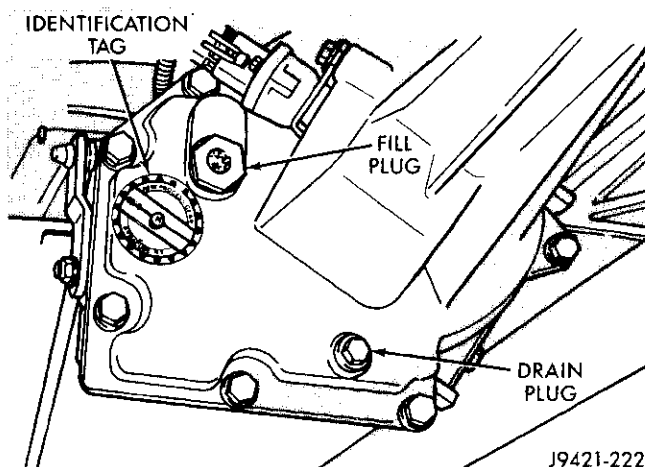


Fig. 6 Drain And Fill Plug Locations

The correct fill level is to the **bottom** edge of the fill plug hole.

ADAPTER IDENTIFICATION

A round, identification tag (Fig. 7) is attached to the rear extension. The tag provides the adapter model number, assembly number, serial number, and ratio.

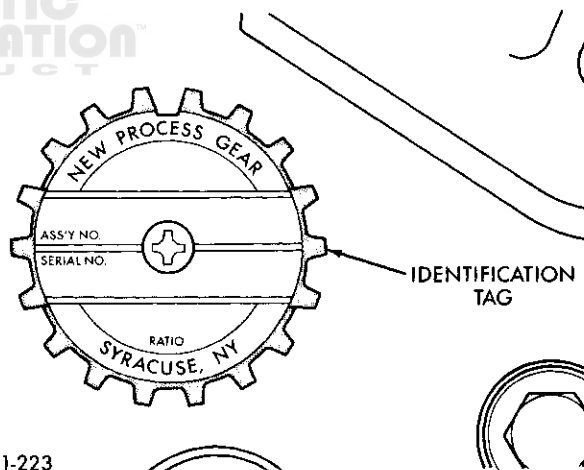


Fig. 7 Adapter I.D. Tag

The adapter serial number also represents the date of build. For example, a serial number of 9-10-93 would represent September 10, 1996.

DESCRIPTION AND OPERATION

PTO ADAPTER OPERATING RANGES AND SHIFTING

The NV 021 is a dual range unit. Operating ranges consist of drive (D) and neutral (N).

D range is used for normal driving and for PTO accessory operation while the vehicle is in motion.

DESCRIPTION AND OPERATION (Continued)

N range is used for PTO accessory operation when the vehicle is stopped.

N range is also used for breakdown towing with the front end raised. In this situation, the transmission must be shifted into Park and the PTO adapter into N range.

Operating/Shifting The PTO Adapter

To operate a PTO accessory while the vehicle is in motion:

- shift adapter into D range before engine start
- start engine
- shift transmission into D range and drive vehicle
- operate PTO accessory

To operate a PTO accessory while the vehicle is stopped:

- leave engine running
- shift transmission and adapter both into Neutral
- shift transmission back to Drive
- operate PTO accessory

To shift the adapter out of N and back to D range:

- leave engine running
- apply service brakes
- shift transmission into Reverse
- shift transmission back to Neutral and immediately shift adapter into D

To shift the adapter from D range into N:

- stop vehicle
- leave engine running
- shift transmission to Neutral
- shift adapter to N
- shift transmission back to D range
- operate accessory

DIAGNOSIS AND TESTING**ADAPTER SERVICE DIAGNOSIS**

The PTO adapter should not be removed until diagnosis indicates a fault has actually occurred. Verify that the other driveline components (transmission, axle), are operating correctly before removing the adapter.

Begin diagnosis by checking fluid level and shift linkage adjustment. Have a helper observe linkage operation if necessary.

If auxiliary power take-off equipment is attached to the adapter, be sure the device is properly attached and in mesh with the PTO gear. Loose, misaligned, or incompatible auxiliary equipment will result in noise and unsatisfactory operation.

The following diagnosis information provides a listing of probable causes of an adapter malfunction. Use the lists as a guideline during diagnosis.

Inoperative

If the adapter will not drive a PTO accessory, the most probable causes are:

- PTO accessory not compatible with adapter (no gear mesh)
- PTO accessory loose, or misaligned
- PTO accessory damaged/inoperative
- adapter shift lever or shift rod disconnected
- transmission not in drive range

Noisy Operation

The most probable causes of noise are:

- low lubricant level
- PTO accessory loose, misaligned, or not compatible
- misadjusted shift rod
- engine/transmission mounts loose/damaged
- loose linkage or adapter assembly bolts
- output bearing snap ring not seated in bearing groove
- damaged input/output bearing
- worn/damaged shift fork, sleeve, or input gear
- loose/missing poppet, spring, or screw
- PTO gear teeth damaged

Hard Shifting

The most probable causes of a hard shift condition are:

- incorrect shift technique
- transmission and adapter shaft speeds not matched
- PTO accessory misaligned, or loose
- low lubricant level (leak or underfilled)
- shift rod loose or misadjusted
- shift lever nut loose or missing
- engine/transmission mounts loose/damaged
- adapter shift fork or sleeve damaged

Fluid Leaks

Fluid leaks from the adapter will generally be from the vent, front/rear seal, front case-to-rear case joint, poppet plunger screw, or adapter-to-transmission joint.

A leak at the front end of the adapter may not always be from the input bearing retainer seal. Check front leaks carefully as the actual leak source may be the transmission.

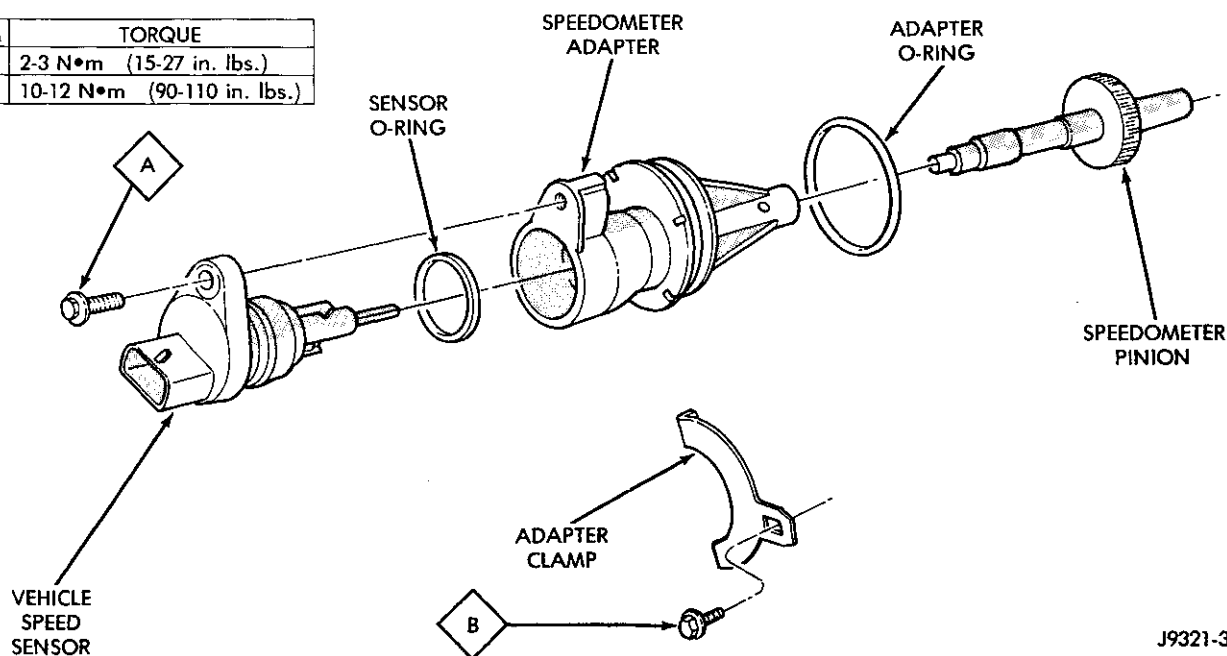
SERVICE PROCEDURES**PTO ADAPTER SERVICE**

The adapter can be removed and disassembled for service when necessary. Removal/installation and overhaul procedures are provided in this section.

Gaskets are not used in the PTO adapter. All mating surfaces are to be coated with Mopar Gasket Maker, Mopar Silicone Adhesive Sealer, or Loctite 518.

SERVICE PROCEDURES (Continued)

ITEM	TORQUE
A	2-3 N•m (15-27 in. lbs.)
B	10-12 N•m (90-110 in. lbs.)

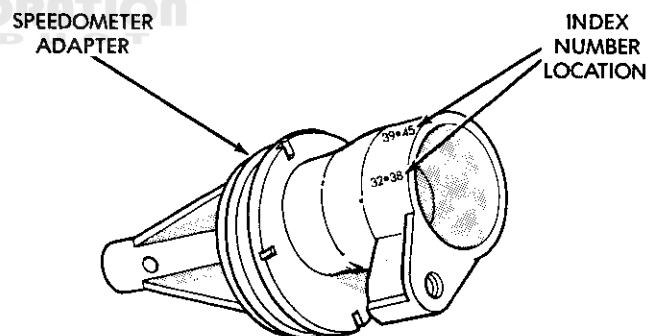


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Fig. 8 Speedometer Components**SPEEDOMETER SERVICE**

- (1) Raise vehicle.
- (2) Disconnect wires from vehicle speed sensor.
- (3) Remove adapter clamp and screw (Fig. 8).
- (4) Remove speed sensor and speedometer adapter as assembly.
- (5) Remove speed sensor retaining screw and remove sensor from adapter.
- (6) Remove speedometer pinion from adapter.
- (7) Inspect sensor and adapter O-rings. Remove and discard O-rings if worn or damaged.
- (8) Inspect terminal pins in speed sensor. Clean pins with Mopar electrical spray cleaner if dirty or oxidized. Replace sensor if faulty, or pins are loose, severely corroded, or damaged.

- (7) Note index numbers on adapter body (Fig. 9). These numbers will correspond to number of teeth on pinion.



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Fig. 9 Location Of Index Numbers On Speedometer Adapter**Speedometer Installation And Indexing**

- (1) Thoroughly clean adapter flange and adapter mounting surface in housing. Surfaces must be clean for proper adapter alignment and speedometer operation.
- (2) Install new O-rings on speed sensor and speedometer adapter if necessary.
- (3) Lubricate sensor and adapter O-rings with transmission fluid.
- (4) Install vehicle speed sensor in speedometer adapter. Tighten sensor attaching screw to 2-3 N•m (15-27 in. lbs.) torque.
- (5) Install speedometer pinion in adapter.
- (6) Count number of teeth on speedometer pinion. Do this before installing assembly in housing. Then lubricate pinion teeth with transmission fluid.

- (8) Install speedometer assembly in housing.
- (9) Rotate adapter until required range numbers are at 6 O'clock position. Be sure range index numbers correspond to number of teeth on pinion gear.
- (10) Install speedometer adapter clamp and retaining screw. Tighten clamp screw to 10-12 N•m (90-110 in. lbs.) torque.
- (11) Connect wires to vehicle speed sensor.
- (12) Lower vehicle.

REMOVAL AND INSTALLATION

ADAPTER

REMOVAL

- (1) Raise vehicle.
- (2) If adapter is to be removed for disassembly and overhaul, remove drain plug and drain lubricant from adapter.
- (3) Disconnect vehicle speed sensor wires at sensor (Fig. 10).

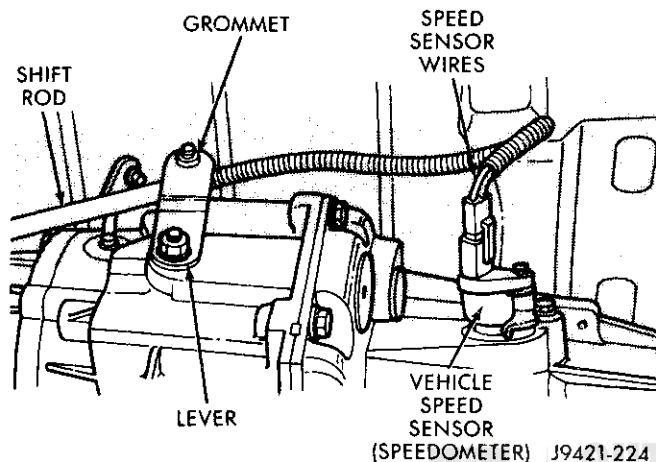


Fig. 10 Shift Rod And Speed Sensor Wire Attachment

- (4) Disconnect shift rod from grommet in adapter shift lever. Use channel lock-style pliers to press rod out of grommet.

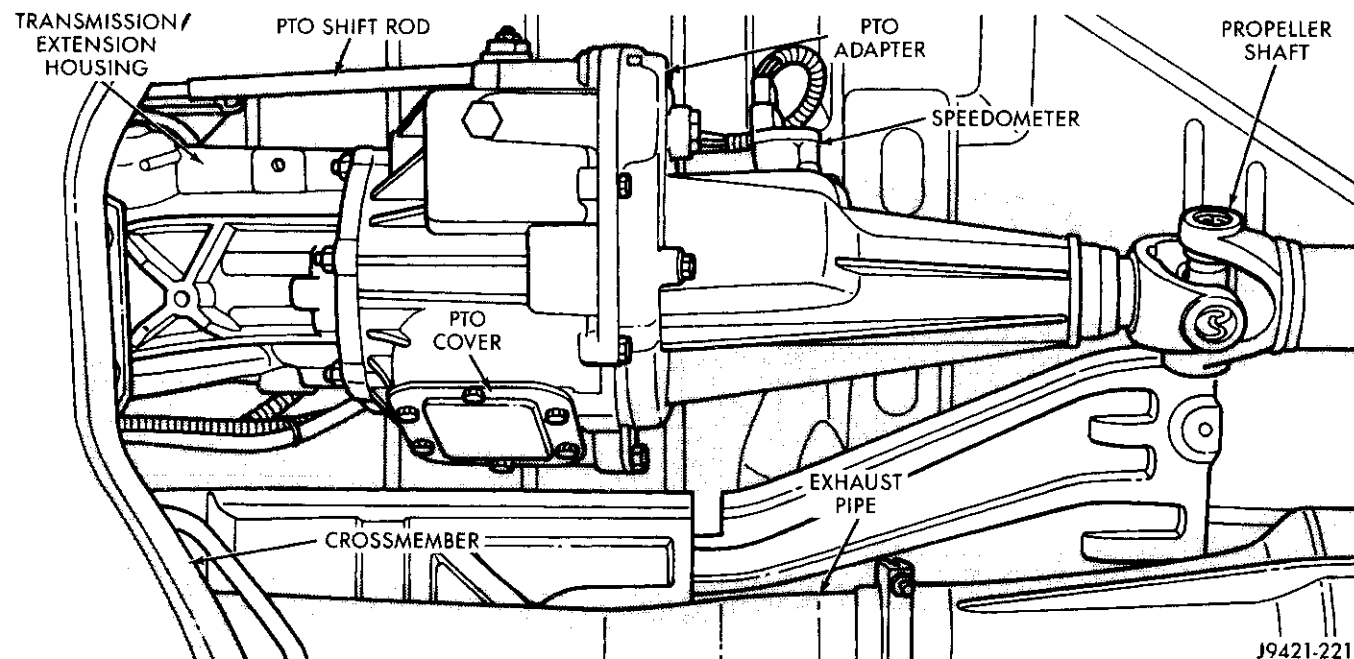


Fig. 11 PTO Adapter Mounting

- (5) Mark propeller shaft yoke for alignment reference. Then disconnect and remove propeller shaft.

- (6) Remove nuts securing adapter mounting studs to transmission extension (Fig. 11).

- (7) Slide adapter studs out of transmission extension and remove adapter from vehicle.

- (8) If a gasket is used between adapter and transmission, retain gasket if in good condition.

INSTALLATION

- (1) If adapter was overhauled, fill adapter to bottom edge of fill plug hole with Mopar Dexron II, or ATF Plus transmission fluid. Tighten fill plug to 41–54 N·m (30–40 ft. lbs.) torque.

- (2) Clean mounting surfaces of adapter and transmission extension with solvent.

- (3) Apply 2–3 drops of Mopar Lock N' Seal, or Loctite 242 to adapter mounting nuts.

- (4) Install gasket on adapter (if equipped). Apply thin bead of sealer to transmission extension and to gasket, if used.

- (5) Install adapter on transmission and install adapter mounting nuts. If adapter has 5/16 studs, tighten nuts to 30–41 N·m (22–30 ft. lbs.). If adapter has 3/8 studs, tighten nuts to 41–47 N·m (30–35 ft. lbs.).

- (6) Lubricate propeller shaft slip yoke with transmission fluid or petroleum jelly.

- (7) Align and install propeller shaft. Tighten shaft clamp bolts to 19 N·m (170 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

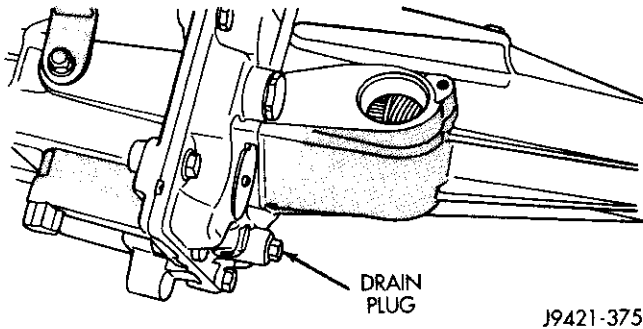
- (8) Connect shift rod to adapter shift lever. Be sure rod is fully seated in plastic grommet.
- (9) Adjust shift rod if necessary.
- (10) Lower vehicle.

DISASSEMBLY AND ASSEMBLY

ADAPTER OVERHAUL

DISASSEMBLY

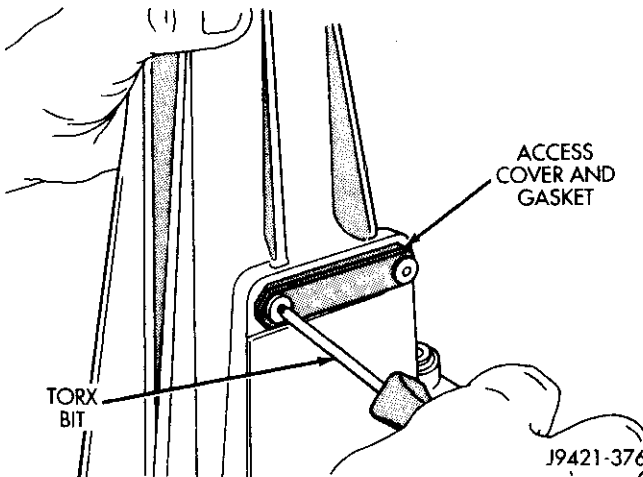
- (1) If adapter was not drained during removal, remove drain bolt at bottom of front housing and drain lubricant into drain pan (Fig. 12).



J9421-375

Fig. 12 Drain Bolt Location

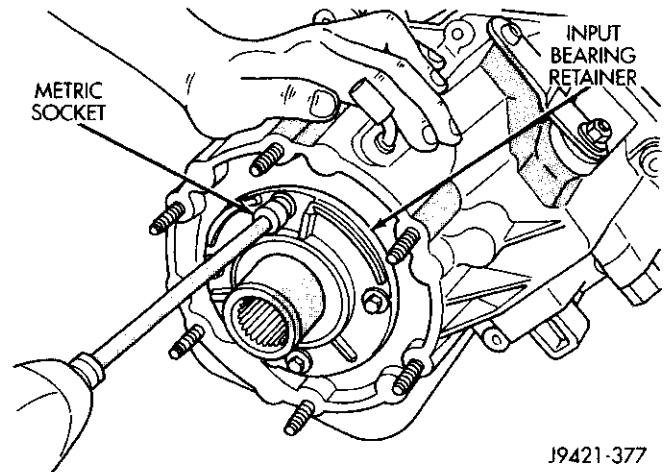
- (2) Remove mainshaft bearing retaining ring access cover and gasket (Fig. 13). Cover must be removed from extension for access to retaining ring. A torx head bit is required to remove cover screws.



J9421-376

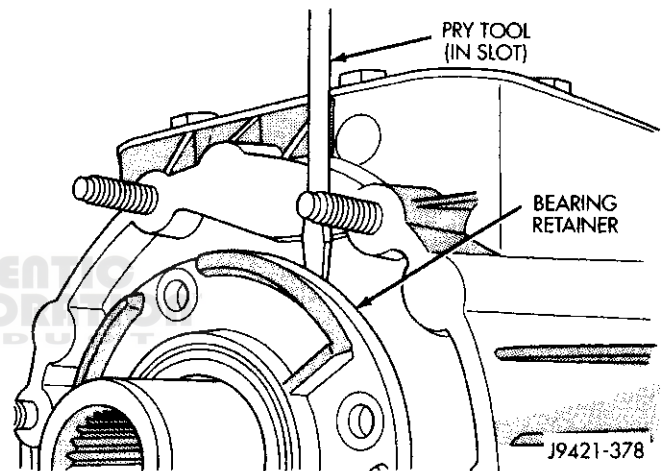
Fig. 13 Retaining Ring Access Cover Removal

- (3) Remove input bearing retainer bolts (Fig. 14).
- (4) Remove input bearing retainer as follows: Insert pry tool in retainer slot (Fig. 15). Then pry retainer outward to break sealer bead and remove retainer (Fig. 16).



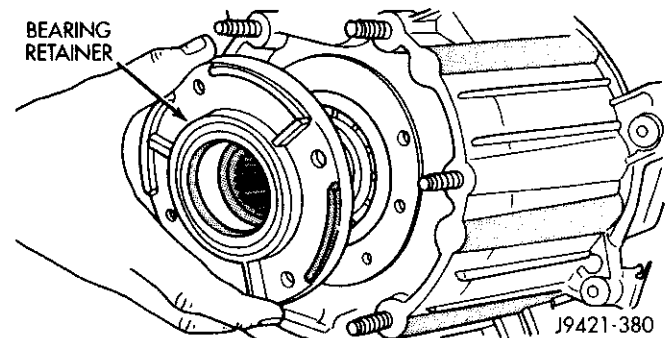
J9421-377

Fig. 14 Removing Input Bearing Retainer Bolts



J9421-378

Fig. 15 Loosening Bearing Retainer (Breaking Sealer Bead)



J9421-380

Fig. 16 Input Bearing Retainer Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Remove input gear retaining ring (Fig. 17).

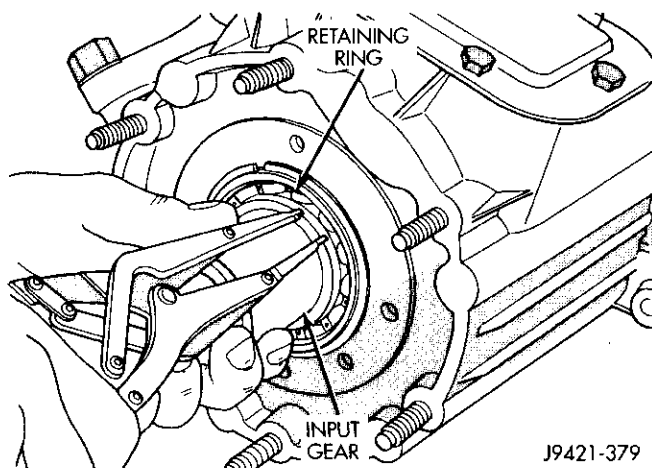


Fig. 17 Input Gear Retaining Ring Removal

(6) Support adapter on 3-4 small wood blocks (Fig. 18). Position blocks under transmission mounting surface of front case and between studs.

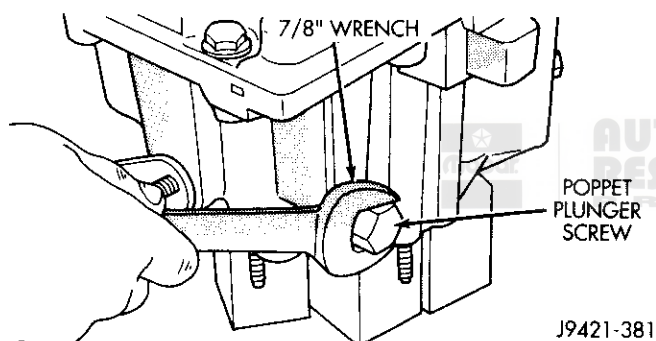


Fig. 18 Poppet Screw Removal

(7) Remove poppet plunger screw.

(8) Remove spring and poppet plunger (Fig. 19).

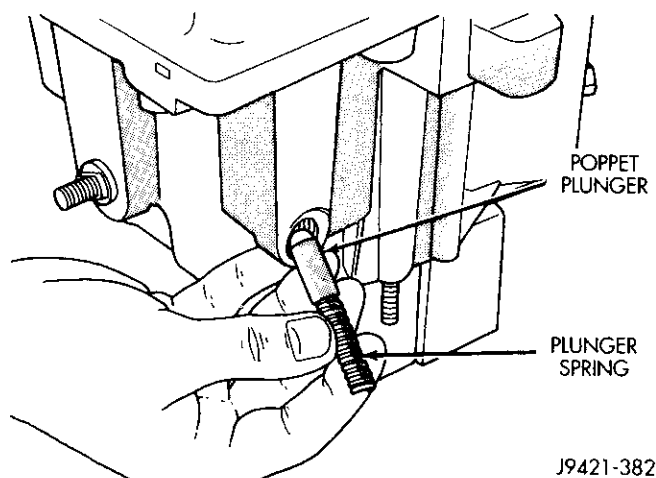


Fig. 19 Poppet And Spring Removal

(9) Loosen nut and washer that attach shift lever to sector shaft (Fig. 20). Then remove, nut, washer and lever from sector shaft (Fig. 21).

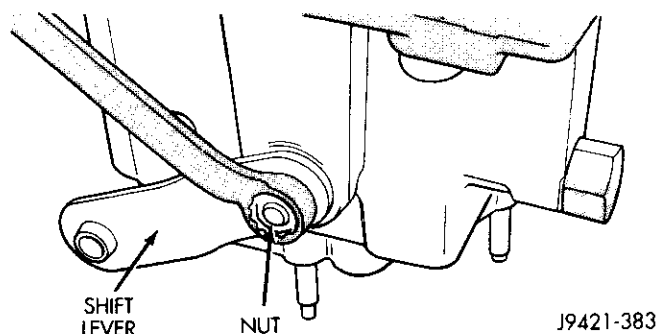


Fig. 20 Loosening Shift Lever Nut

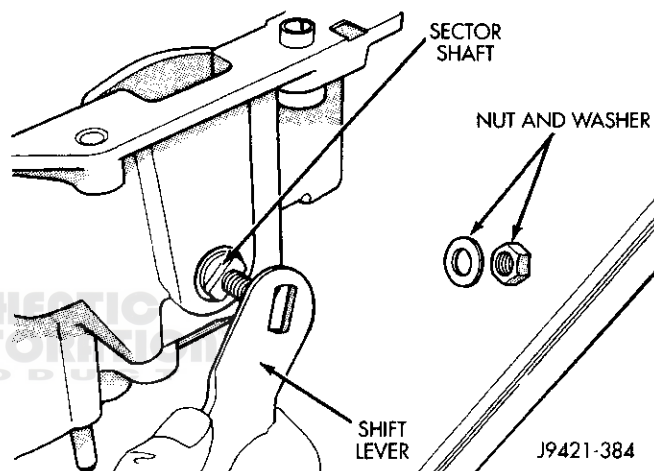


Fig. 21 Shift Lever, Nut And Washer Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(10) Remove bolts attaching front case to rear extension (Fig. 22). **Two attaching bolts require a flat washer (Fig. 23). Note position of these bolts for assembly reference. Mark bolt position with scribe or with paint stripe.**

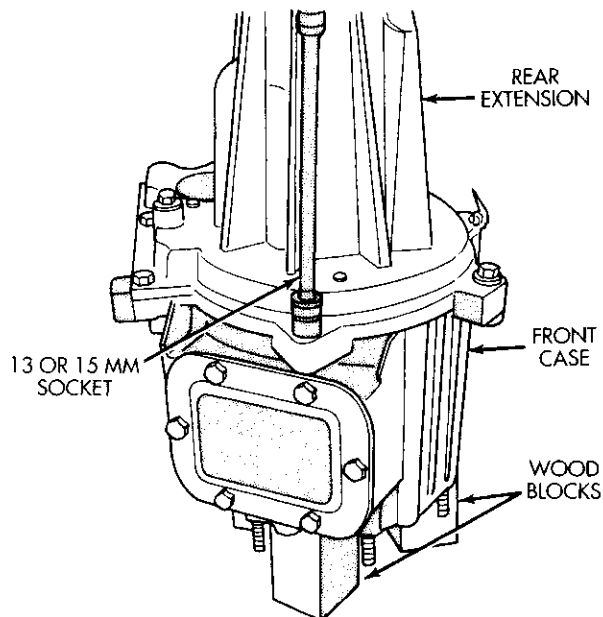


Fig. 22 Removing Rear Extension Attaching Bolts

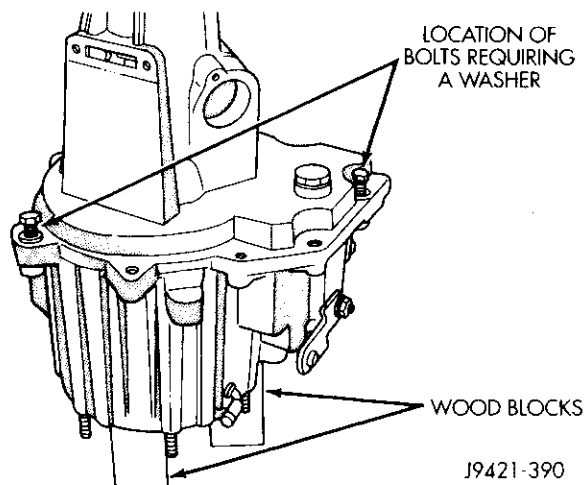


Fig. 23 Location Of Rear Extension Bolts Requiring Washers

(11) Pry extension away from front case with flat blade screwdriver. Position screwdriver in slots provided at each end of case and extension (Fig. 24).

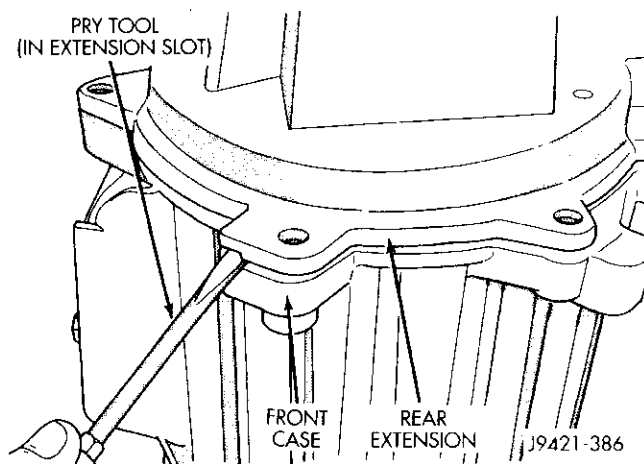


Fig. 24 Loosening Rear Extension (Breaking Sealer Bead)

(12) Remove rear extension as follows:

(a) Spread mainshaft bearing retaining ring with snap ring pliers (Fig. 25).

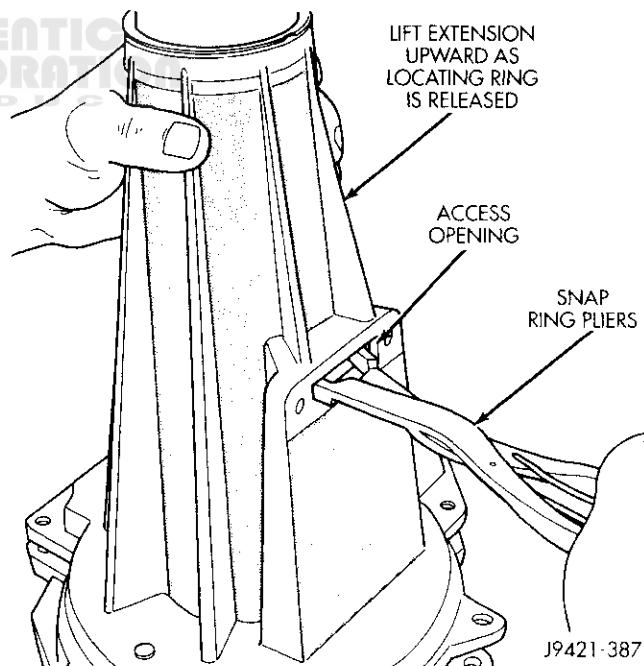


Fig. 25 Releasing Mainshaft Bearing Retaining Ring

DISASSEMBLY AND ASSEMBLY (Continued)

(b) Lift extension up and off mainshaft and front case (Fig. 26).

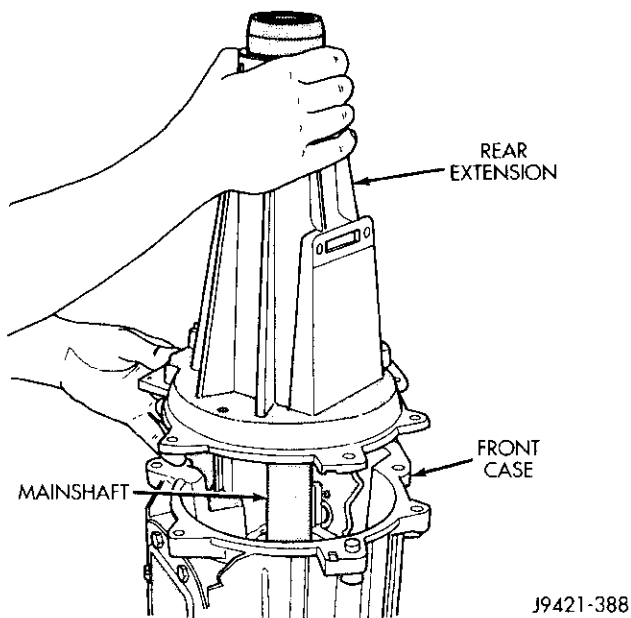


Fig. 26 Removing Rear Extension

(13) Remove mainshaft by lifting it straight up and out of input gear and shift sleeve (Fig. 27).

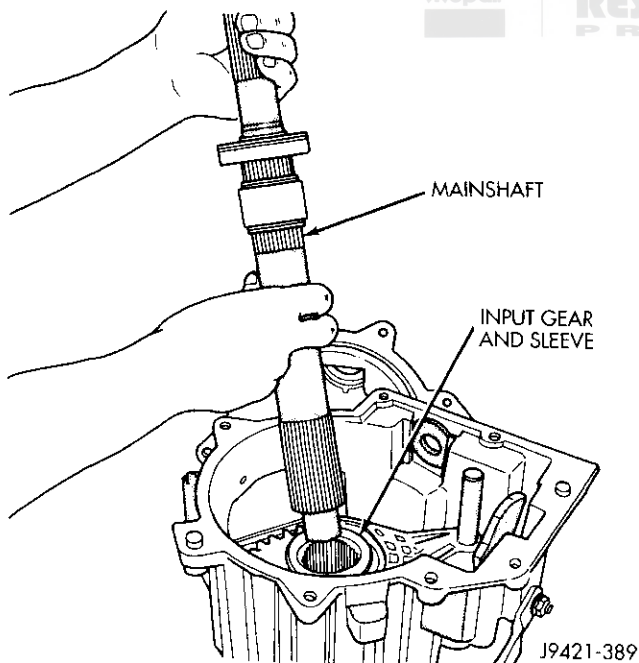


Fig. 27 Mainshaft Removal

(14) Remove rear output bearing retaining ring from mainshaft (Fig. 28).

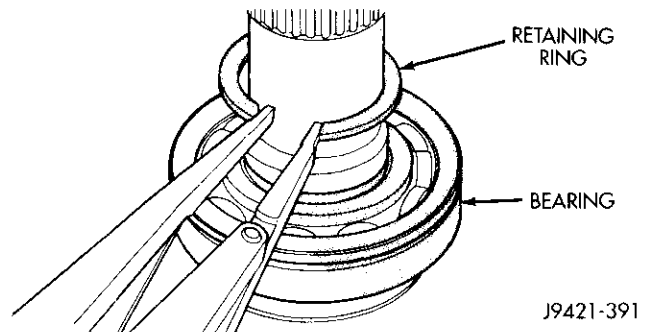


Fig. 28 Output Bearing Snap Ring Removal

(15) Remove output bearing from mainshaft. **Note position of snap ring groove in bearing for installation reference (Fig. 29).**

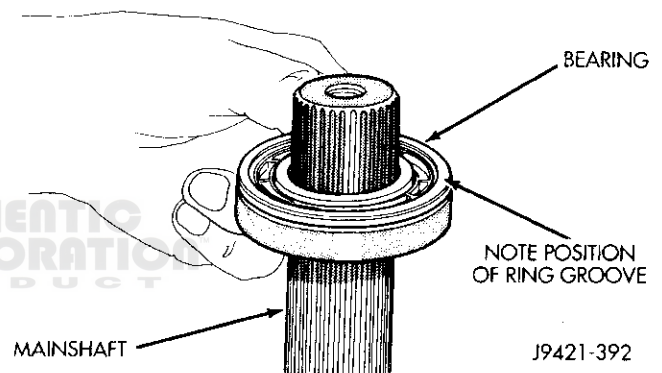


Fig. 29 Mainshaft Output Bearing Removal

(16) Remove speedometer gear rear retaining ring (Fig. 30).

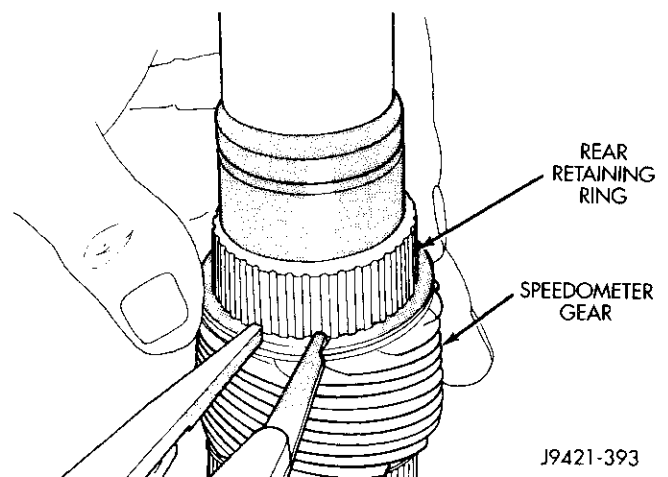


Fig. 30 Speedometer Gear Rear Snap Ring Removal

DISASSEMBLY AND ASSEMBLY (Continued)

(17) Remove speedometer gear from mainshaft (Fig. 31).

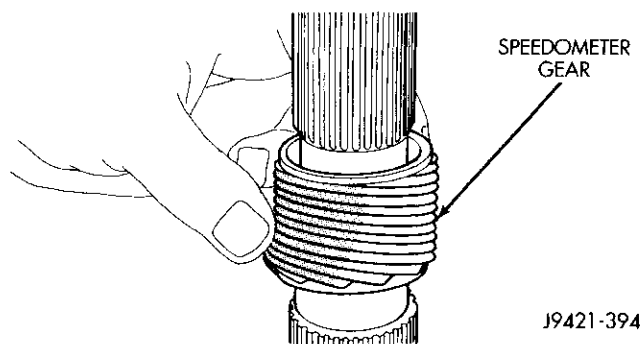


Fig. 31 Speedometer Gear Removal

(18) Remove speedometer gear front snap ring from mainshaft (Fig. 32).

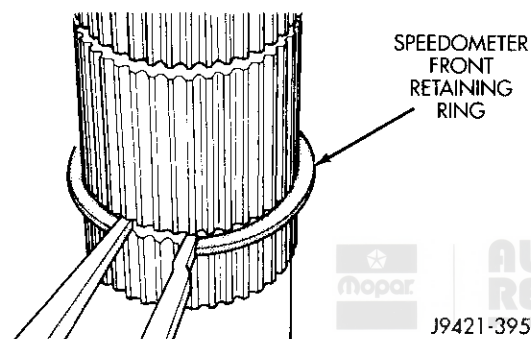


Fig. 32 Speedometer Gear Front Snap Ring Removal

(19) Remove shift rail by pulling it up and out of fork and case (Fig. 33).

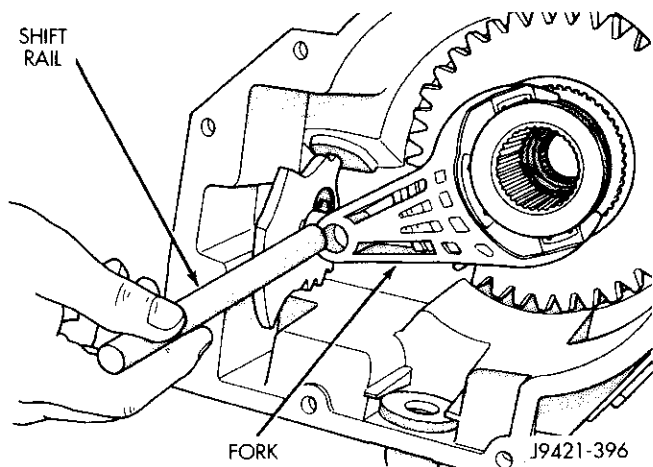


Fig. 33 Shift Rail Removal

(20) Remove shift fork and shift sleeve as assembly (Fig. 34).

(21) Separate shift fork and sleeve (Fig. 35). Note position of sleeve for installation reference.

(22) Roll case on side and off wood blocks.

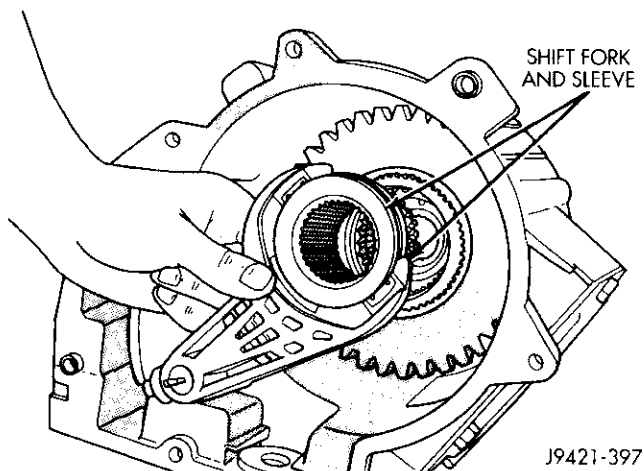


Fig. 34 Shift Fork And Sleeve Removal

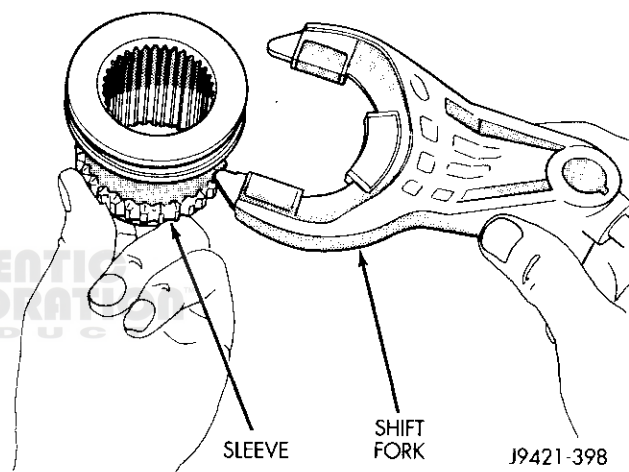


Fig. 35 Separating Shift Fork And Sleeve

(23) Tap input gear out of bearing with plastic mallet (Fig. 36).

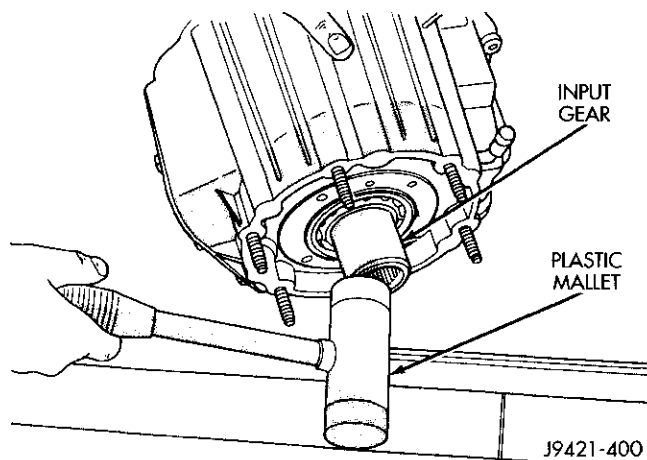


Fig. 36 Starting Input Gear Out of Bearing

DISASSEMBLY AND ASSEMBLY (Continued)

(24) Remove PTO and input gear assembly (Fig. 37). Lift assembly up and out of input bearing and case.

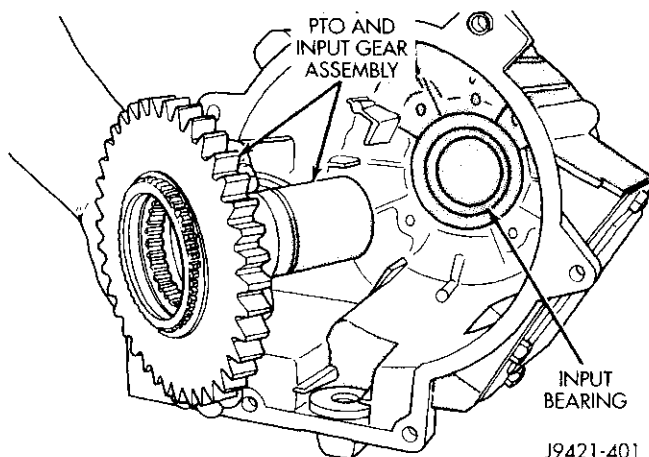


Fig. 37 Removing PTO/Input Gear Assembly

(25) Remove retaining ring that secures PTO gear on input gear (Fig. 38). Then slide PTO gear off input gear (Fig. 39).

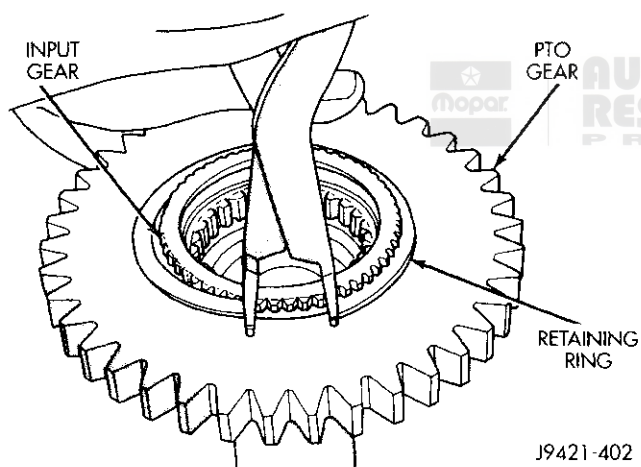


Fig. 38 Removing PTO Gear Retaining Ring

(26) Remove sector shaft O-ring retainer (Fig. 40), and O-ring (Fig. 41).

(27) Remove input bearing from front case with Driver Handle C-4171 and Tool C-4210 or 7828, whichever fits best (Fig. 42). **Bearing can only be removed from case interior because of bearing locating ring.**

(28) Inspect condition of needle bearing in input gear. If bearing is rough/noisy, worn, or brinnelled, remove bearing as follows:

(a) Turn bolt of Puller MD998346 to retract puller jaws. Then position puller jaws under bearing (Fig. 43).

(b) Tighten puller bolt to expand puller jaws and secure them under bearing.

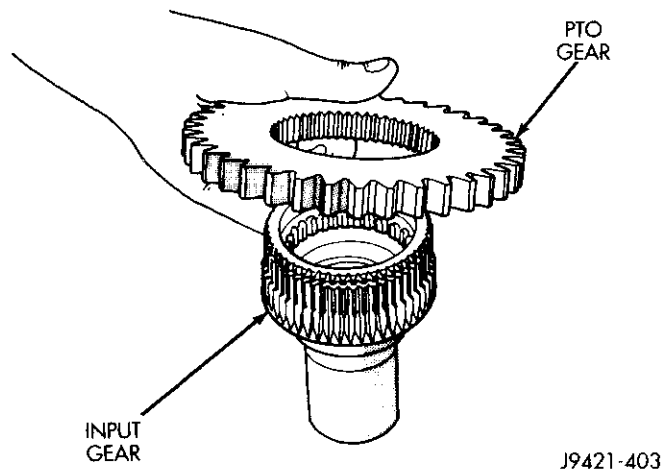


Fig. 39 Removing PTO Gear From Input Gear

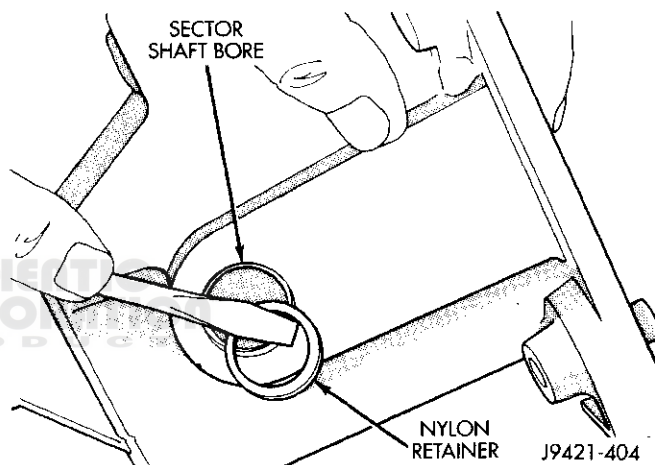


Fig. 40 Removing Shift Sector O-Ring Retainer

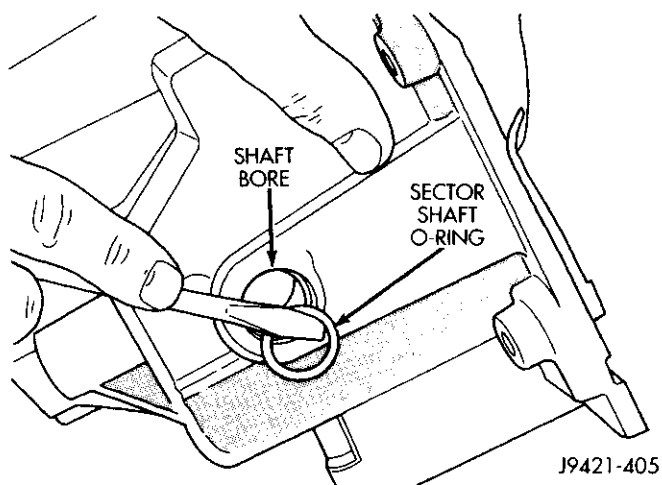
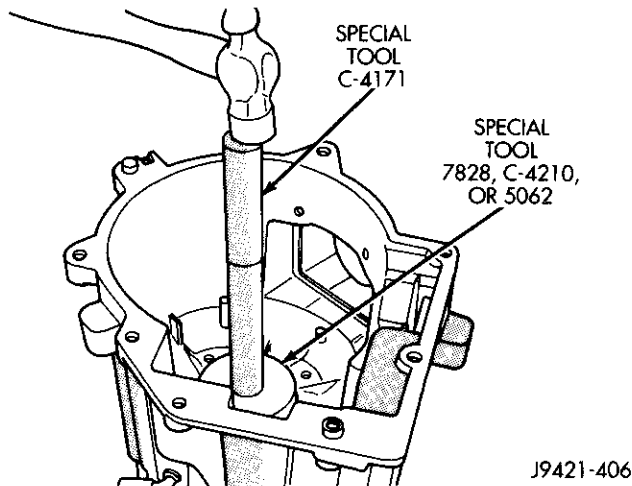
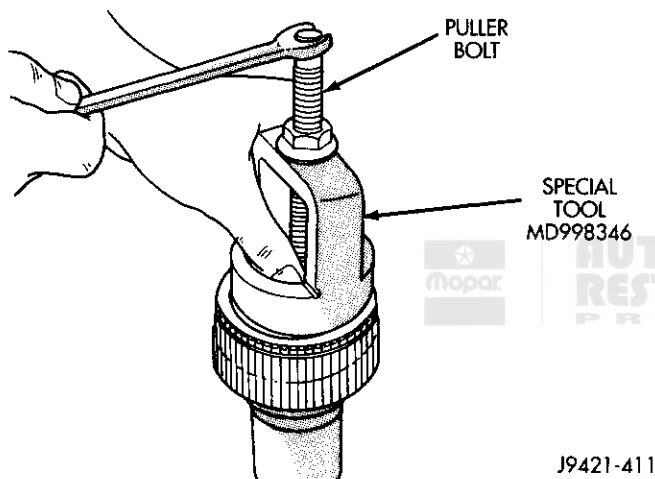
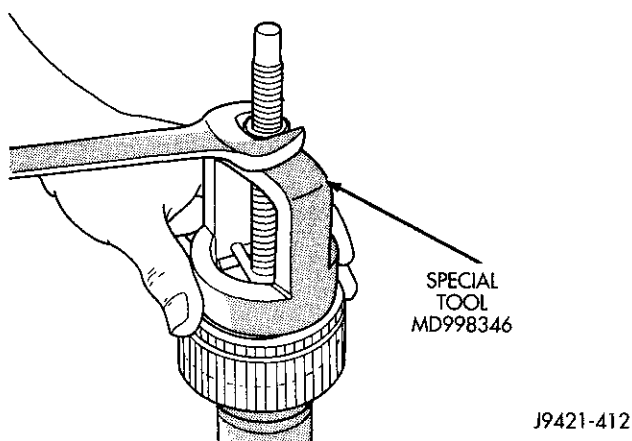
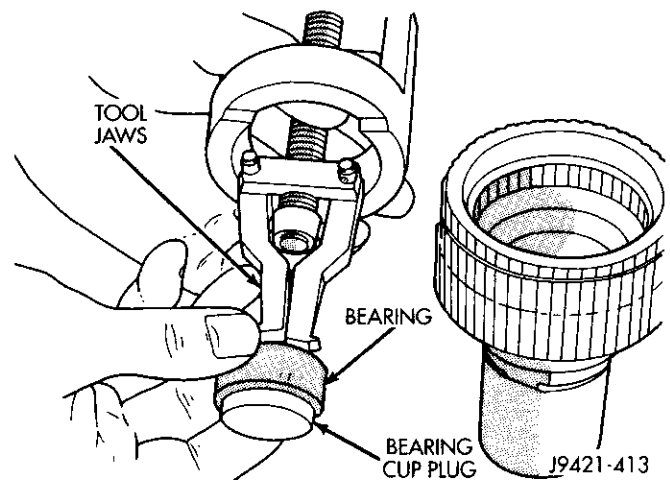


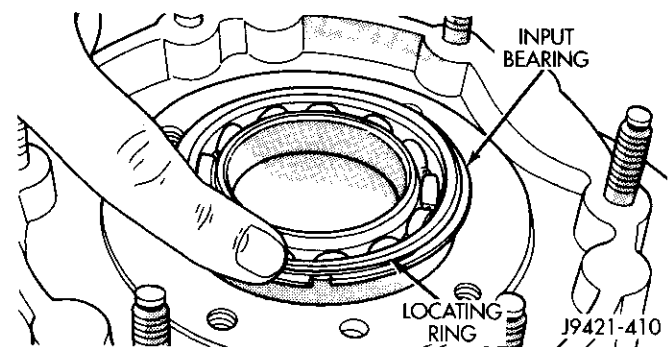
Fig. 41 Removing Shift Sector O-Ring

(c) Grip puller bridge and turn puller nut clockwise to draw bearing out of gear (Fig. 44). **Note that bearing has built in cup plug (Fig. 45).**

DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 42 Input Bearing Removal****Fig. 43 Tightening Puller Bolt To Seat Jaws Under Bearing****Fig. 44 Tightening Puller Nut To Pull Bearing From Gear****Fig. 45 Bearing Removed From Gear****ASSEMBLY**

Lubricate the adapter components with Mopar Dexron II, or ATF Plus during assembly operations. In addition, since gaskets are not used in the adapter, sealing surfaces are to be coated with Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive/sealer. Therefore, it is important that all sealing surfaces be clean and free of grease and oil before applying sealers.

(1) Start input bearing in front case bore. Verify that locating ring is installed on bearing (Fig. 46). Note that bearing can only be installed from case exterior because of the ring which controls depth of installation.

**Fig. 46 Input Bearing Locating Ring Position**

DISASSEMBLY AND ASSEMBLY (Continued)

(2) Seat input bearing in case (Fig. 47). Use driver Handle C-4171 and Installer C-4210, 5062, or 7828 to install bearing. Seat bearing until locating ring is flush against case.

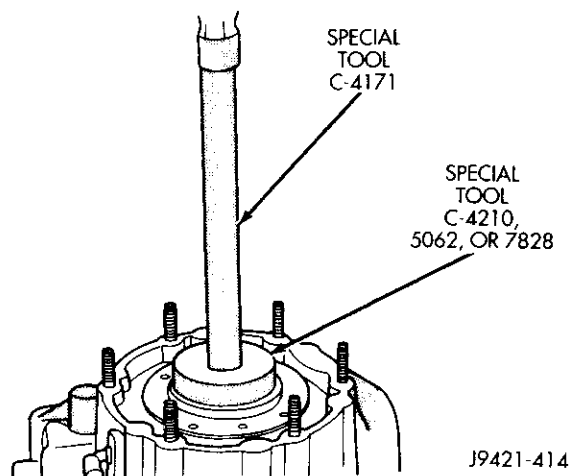


Fig. 47 Input Bearing Installation

(3) Install new needle bearing in input gear with Driver Handle C-4171 and Installer 5065 (Fig. 48).

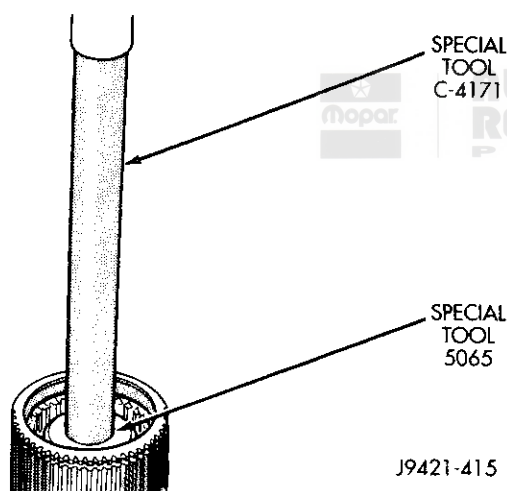


Fig. 48 Installing Needle Bearing In Input Gear

(4) Install new sector shaft O-ring (Fig. 49), and O-ring retainer (Fig. 50) in sector shaft bore.

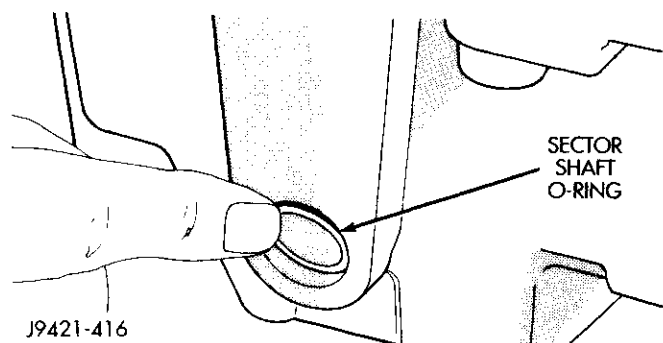


Fig. 49 Sector Shaft O-Ring Installation

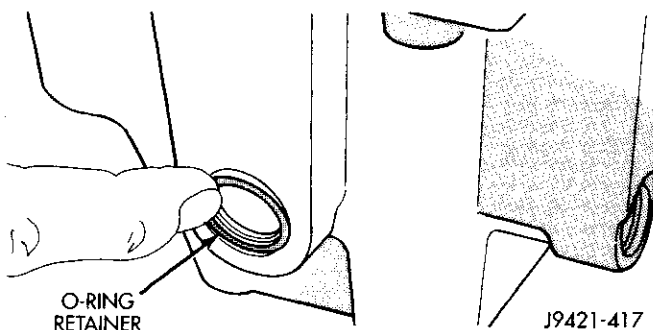


Fig. 50 Sector Shaft O-Ring Retainer Installation

(5) Install shift sector in front case (Fig. 51).

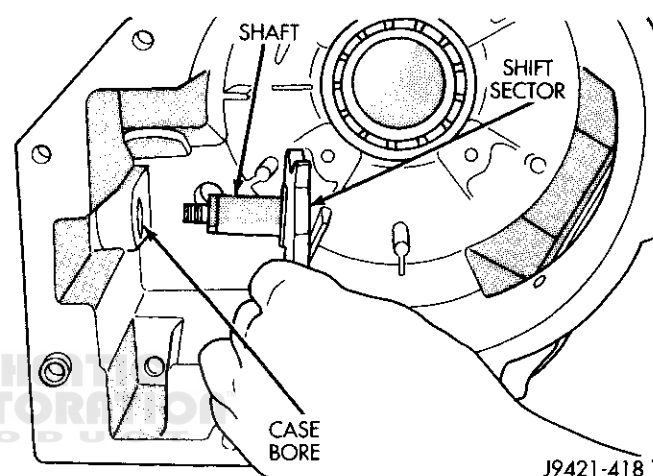


Fig. 51 Shift Sector Installation

(6) Support front case on 3-4 small wood blocks so interior of case is facing up. Position blocks between studs on front case.

(7) Install PTO gear on input gear (Fig. 52).

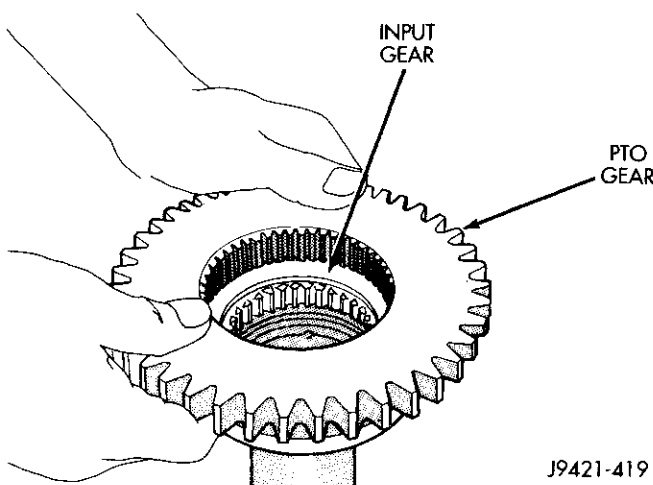


Fig. 52 Assembling Input And PTO Gears

DISASSEMBLY AND ASSEMBLY (Continued)

- (8) Install PTO gear retaining ring (Fig. 53).

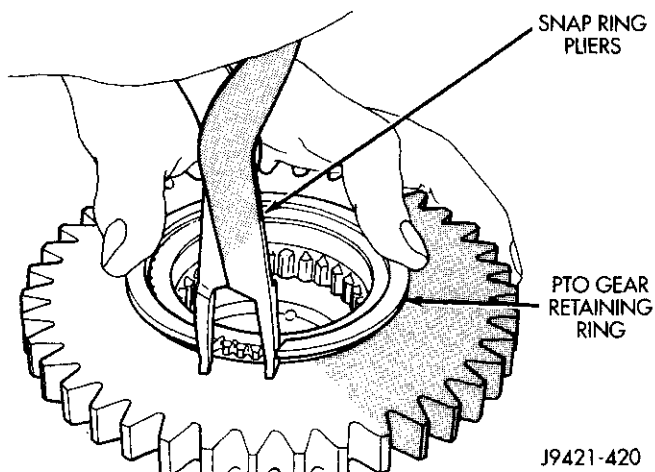


Fig. 53 Installing PTO Gear Retaining Ring

- (9) Install input/PTO gear assembly in case (Fig. 54).

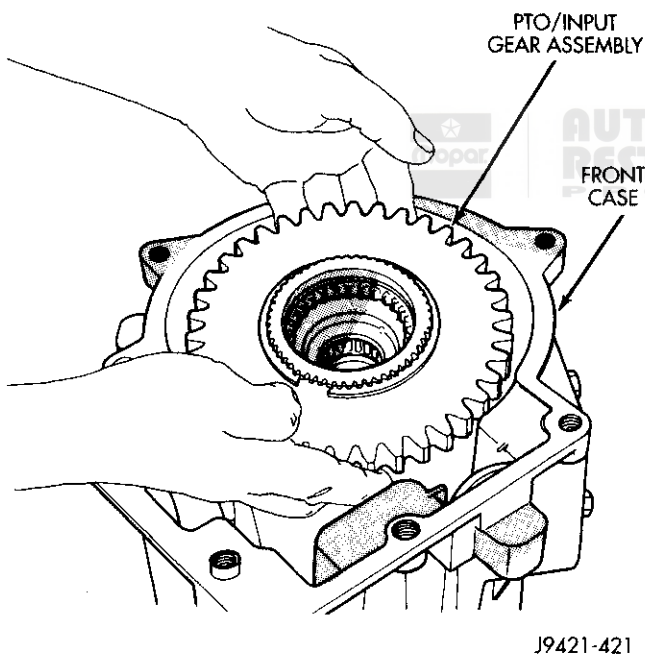


Fig. 54 Installing Input/PTO Gear Assembly In Case

- (10) Tap PTO gear with wood hammer handle until snap ring groove in input gear is accessible.

- (11) Remove front case from wood blocks and position case so input gear is accessible.

- (12) Install retaining ring on input gear (Fig. 55). **Be sure ring is fully seated in gear groove.**

- (13) Remount front case on wood blocks.

- (14) Assemble shift fork and sleeve (Fig. 56). Then install fork and sleeve (Fig. 57). Be sure sleeve is seated in input gear.

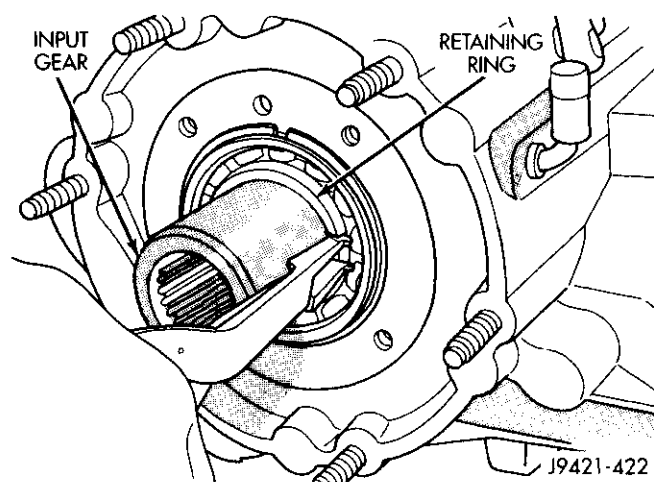


Fig. 55 Installing Input Gear Retaining Snap Ring

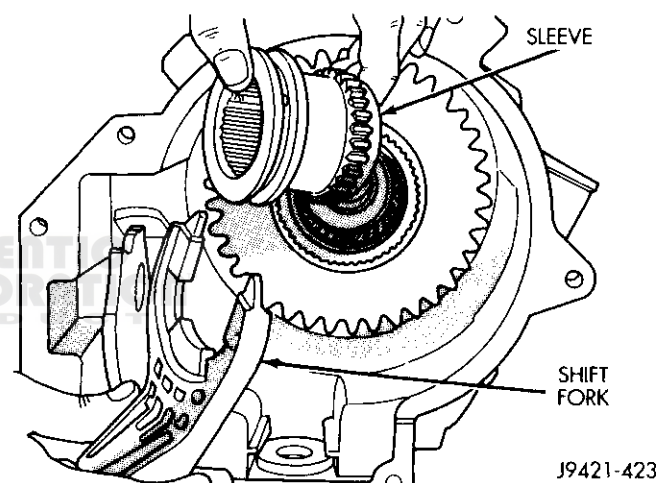


Fig. 56 Assembling Shift Fork And Sleeve

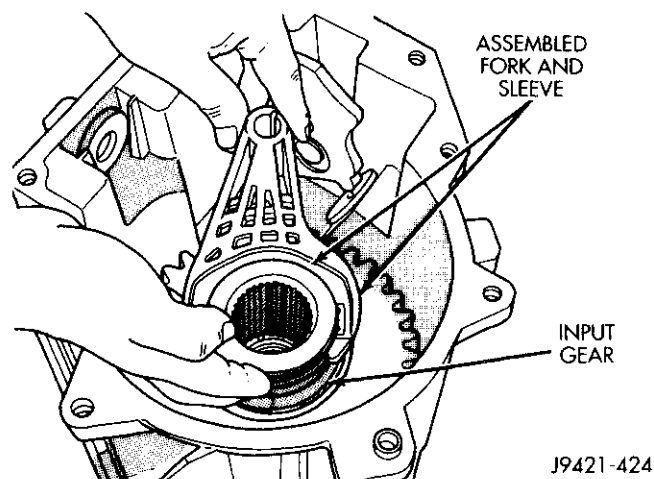


Fig. 57 Shift Fork And Sleeve Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(15) Align and install shift fork pin in sector slot (Fig. 58).

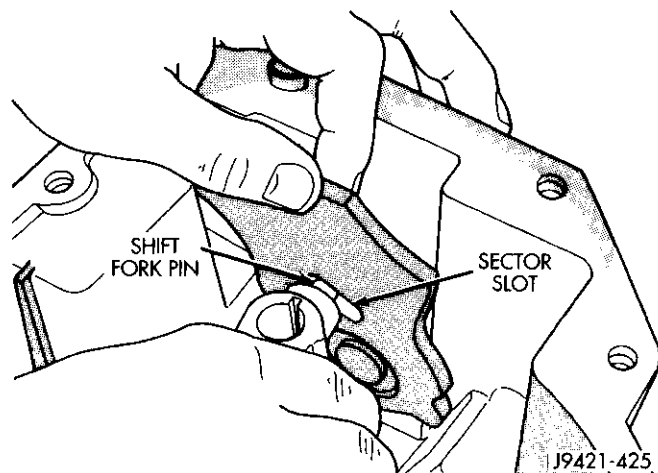


Fig. 58 Inserting Shift Fork Pin in Sector Slot

(16) Align shift sleeve in input gear and align shift fork with shift rail bore in case.

(17) Install shift rail through fork and into case bore (Fig. 59).

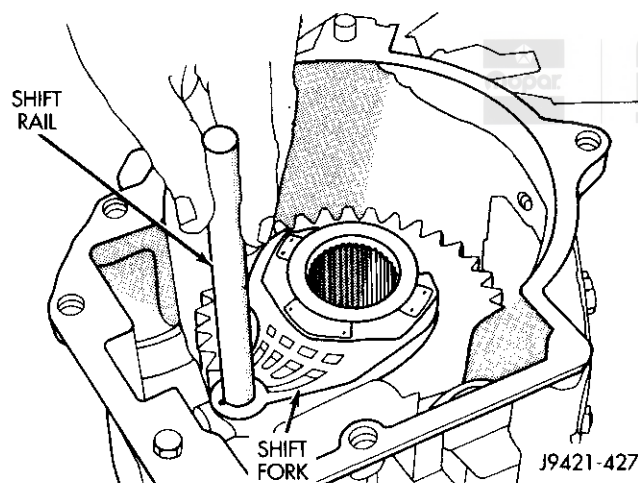


Fig. 59 Shift Rail Installation

(18) Install shift lever on sector shaft (Fig. 60). Then install lever washer and nut on sector shaft (Fig. 61). Apply Loctite 242 to nut before installation and tighten nut to 27-34 N·m (20-25 ft. lbs.) torque.

(19) Install magnet in case pocket.

(20) Install mainshaft (Fig. 62). Guide shaft through sleeve and into input gear bearing.

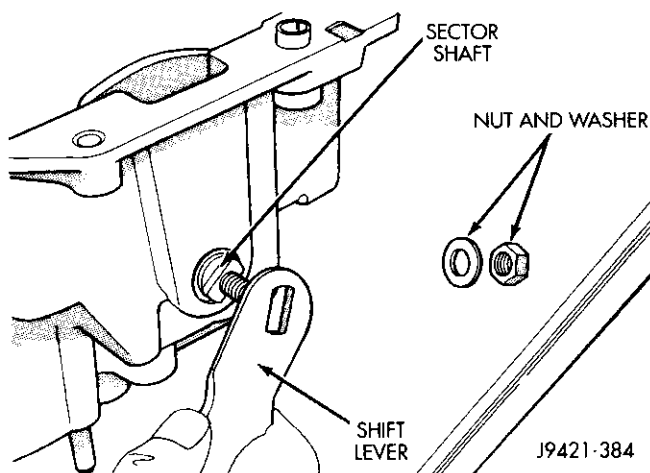


Fig. 60 Shift Lever Installation

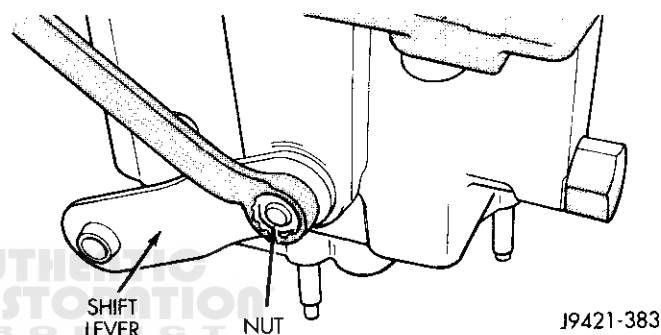


Fig. 61 Installing/Tightening Shift Lever Nut And Washer

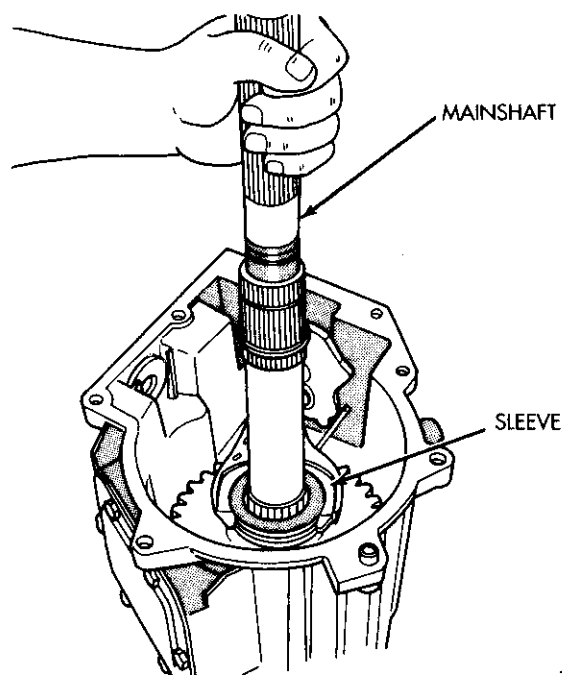


Fig. 62 Mainshaft Installation

DISASSEMBLY AND ASSEMBLY (Continued)

(21) Install first speedometer snap ring on shaft (Fig. 63), followed by speedometer gear (Fig. 64). Then install second snap ring to secure gear on shaft (Fig. 65).

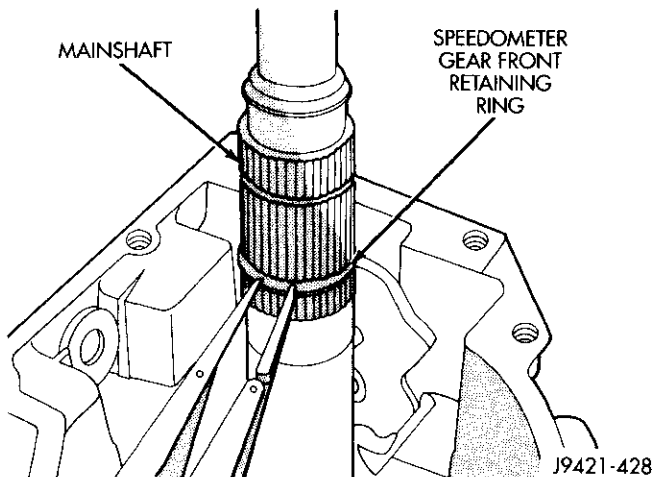


Fig. 63 Speedometer Front Ring installation

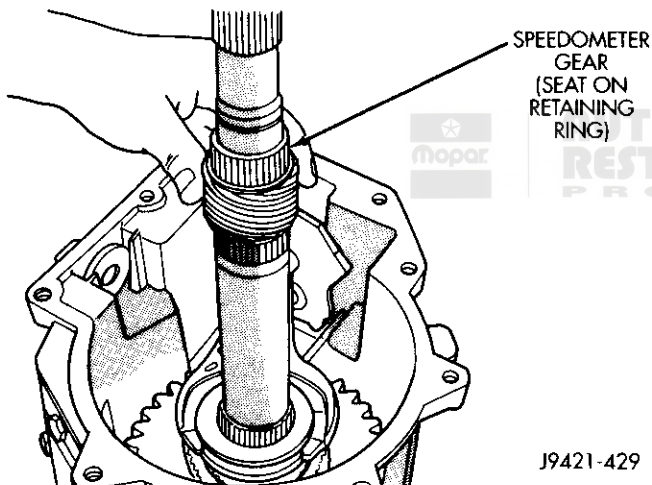


Fig. 64 Speedometer Gear installation

(22) Install output bearing on mainshaft (Fig. 66). Be sure groove in outer race of bearing is toward rear of shaft. If bearing is reversed, retaining ring (in extension) will not align bearing.

(23) Install output bearing retaining ring (Fig. 67). Use parallel jaw pliers to install ring.

(24) Install new seal in rear extension if necessary. Use suitable size installer tool and be sure seal is fully seated.

(25) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive sealer to mating surface of front case and rear extension. Sealer beads should be no more than 1/8 to 3/16 in. wide.

(26) Align and install rear extension on front case (Fig. 68).

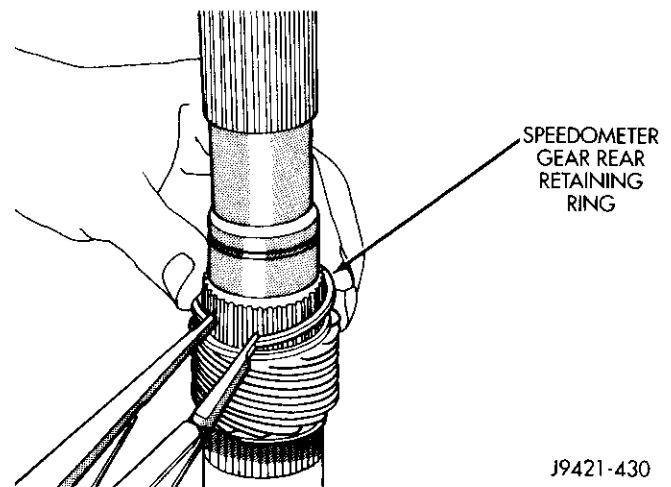


Fig. 65 Speedometer Front Ring installation

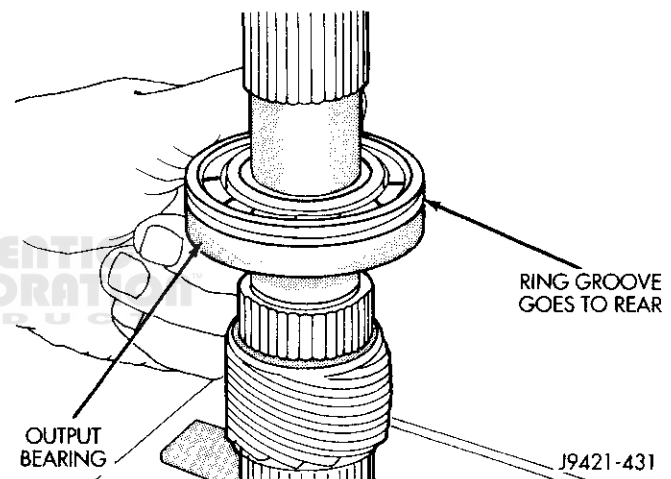


Fig. 66 Output Bearing Installation

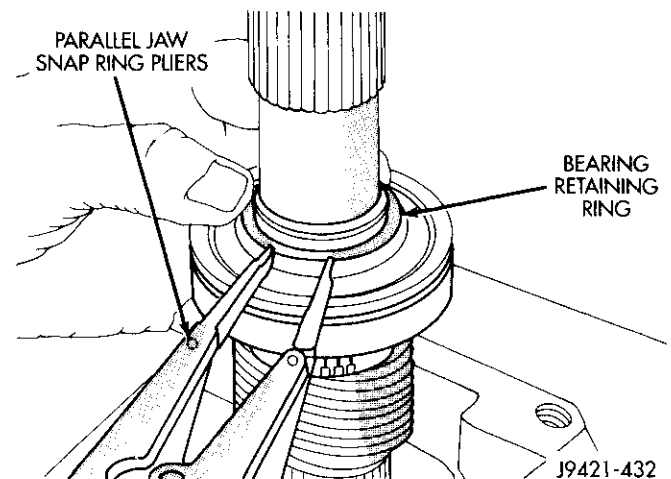
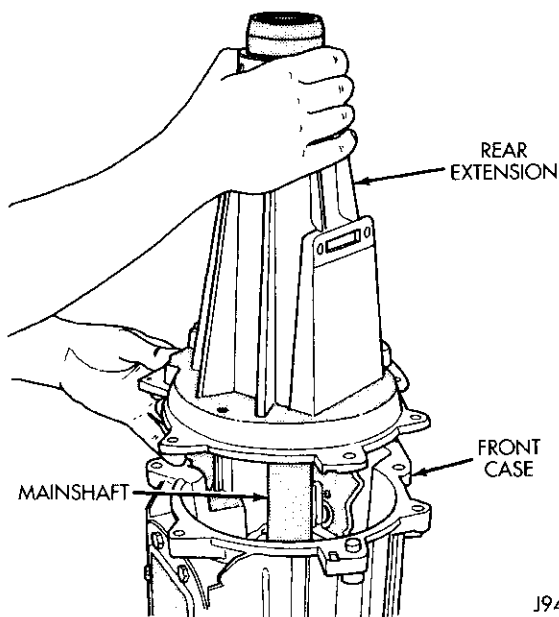


Fig. 67 Output Bearing Retaining Ring Installation

(27) Install one or two extension-to-front case bolts to hold assembly together. Be sure dowels are aligned in extension before hand tightening bolts.

DISASSEMBLY AND ASSEMBLY (Continued)



J9421-388

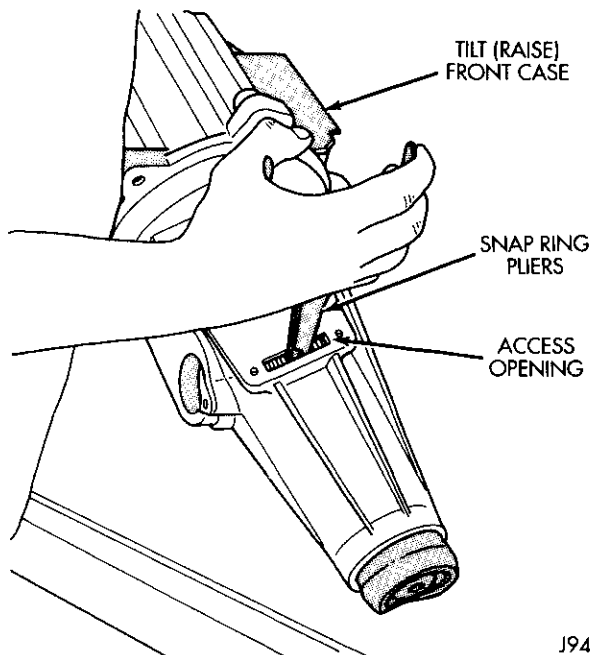
Fig. 68 Installing Rear Extension On Front Case

(28) Remove adapter assembly from wood blocks and place assembly in horizontal position on workbench.

(29) Seat output bearing retaining ring as follows:

(a) Reach in access cover opening in rear extension with snap ring pliers (Fig. 69).

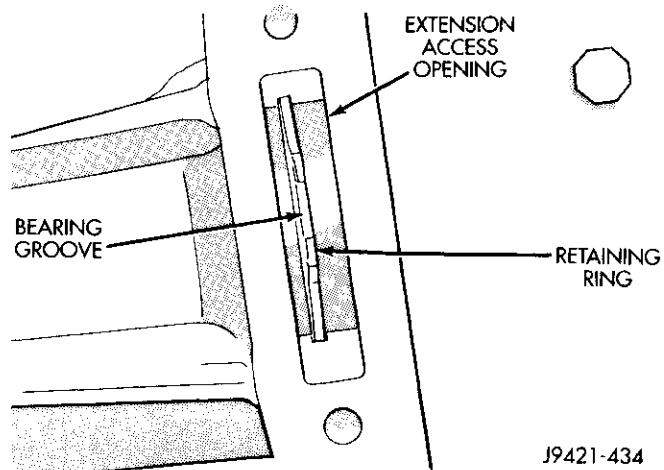
(b) Spread retaining ring with snap ring pliers and seat it in groove of output bearing. **If retaining ring is not aligned with bearing groove, tilt front case upward so mainshaft will move rearward for alignment.**



J9421-433

Fig. 69 Seating Output Bearing Retaining Ring

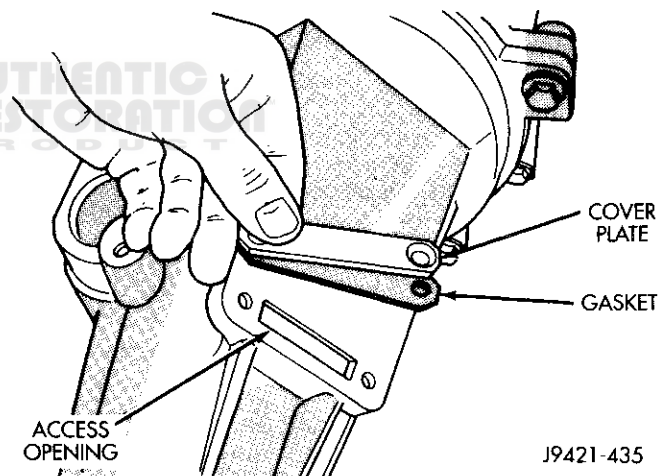
(c) Verify that retaining ring is fully seated in ring groove before proceeding (Fig. 70).



J9421-434

Fig. 70 Correct Seating Of Retaining Ring

(30) Install access cover and gasket in rear extension (Fig. 71). Then install and tighten torx screws to 8–11 N·m (75–95 in. lbs.) (Fig. 72).



J9421-435

Fig. 71 Access Cover And Gasket Installation

(31) Install new seal in input bearing retainer with Handle C-4171 and Installer 7828, C-4974, or similar size installer tool (Fig. 73).

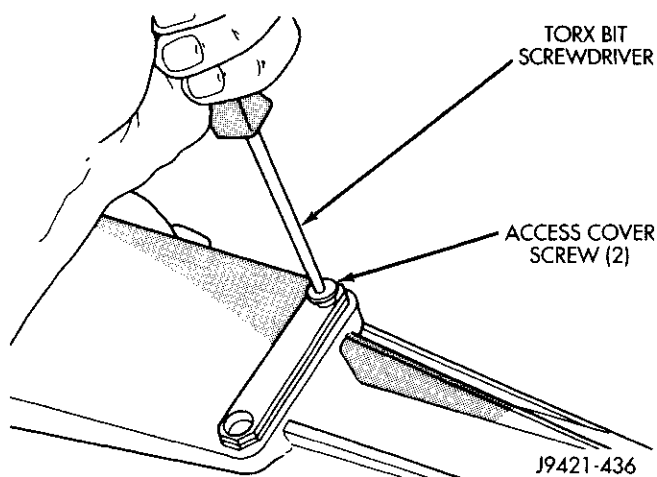
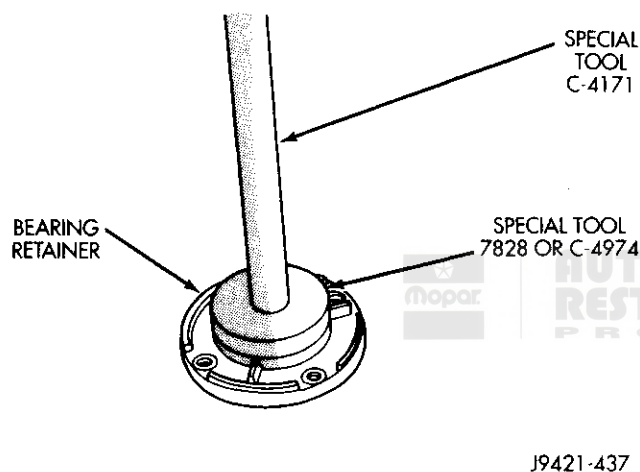
(32) Install input bearing retainer as follows:

(a) Note position of oil channel in retainer and oil feed hole in front case (Fig. 74). Be sure retainer is installed so channel is aligned with feed hole.

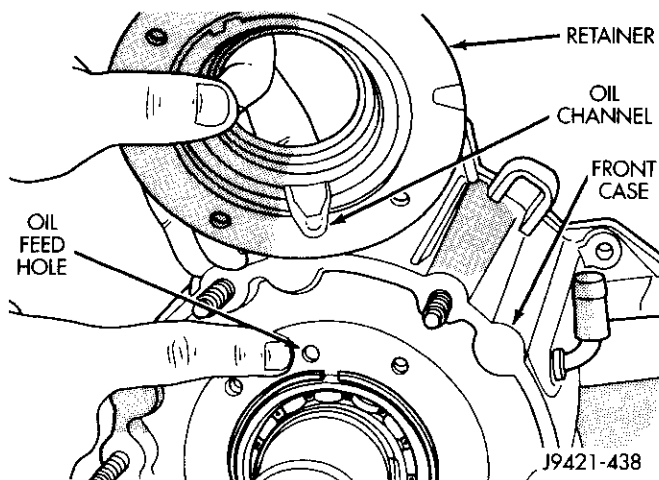
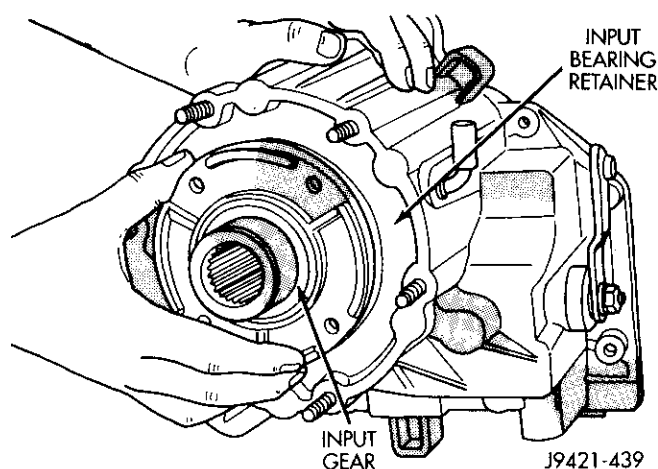
(b) Apply bead of Mopar Gasket Maker, Loctite 518, or Mopar silicone adhesive sealer to seal surface of retainer. Sealer bead should be no more than 1/8 to 3/16 in. wide.

(c) Apply transmission fluid to input gear hub.

(d) Align retainer channel with feed hole in case and install retainer (Fig. 75).

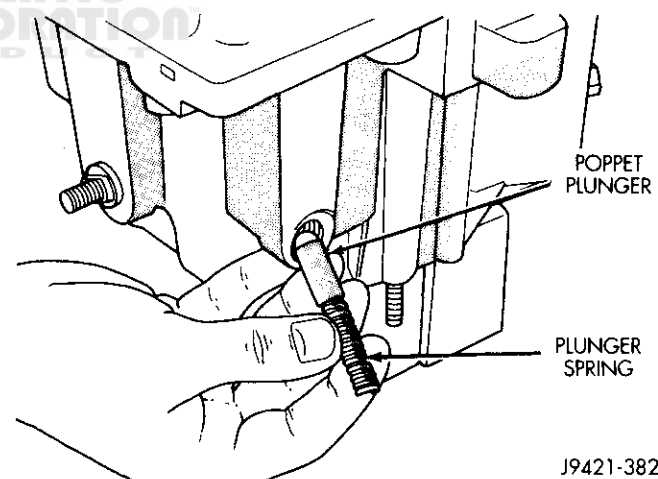
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 72 Installing Access Cover Screws****Fig. 73 Installing Input Bearing Retainer Seal**

(e) Apply sealer to retainer bolts. Then install and tighten bolts to 16–24 N·m (12–18 ft. lbs.) torque.

**Fig. 74 Retainer Oil Channel And Case Oil Feed Hole Locations****Fig. 75 Input Bearing Retainer Installation**

CAUTION: If a silicone sealer is used, do not use any more sealer than recommended. Excessive amounts of sealer will be displaced into the area between the retainer and case. This could result in partial or full blockage of the bearing oil feed hole in the front case.

(33) Install poppet plunger and spring in front case detent bore (Fig. 76).

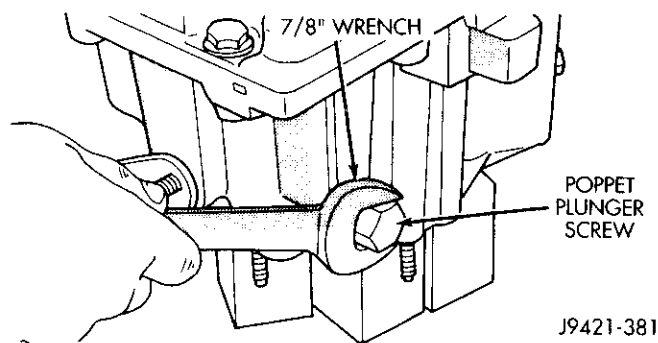
**Fig. 76 Poppet Plunger And Spring Installation**

(34) Install new O-ring on poppet plunger screw. Then install screw in front case (Fig. 77). Tighten screw to 16–24 N·m (12–18 ft. lbs.) torque.

(35) Install indicator switch in front case. Tighten switch to 20–34 N·m (15–25 ft. lbs.) torque.

(36) Install and tighten drain plug to 41–54 N·m (30–40 ft. lbs.) torque.

(37) Fill adapter with 2.1 liters (4.6 pints) liters of Mopar Dexron II, or ATF Plus transmission fluid and install fill plug. Tighten fill plug to 41–54 N·m (30–40 ft. lbs.) torque.

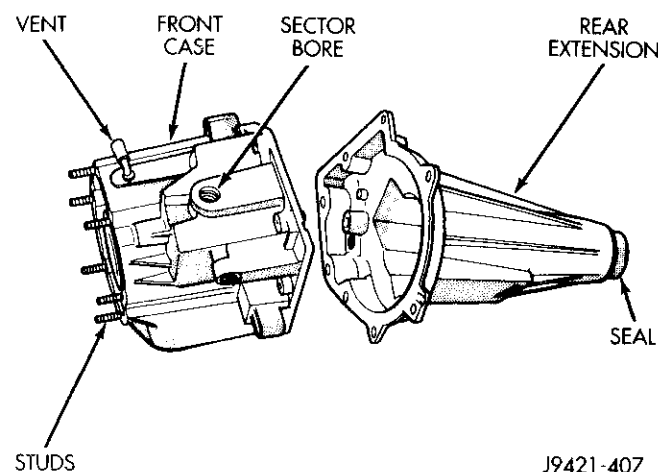
DISASSEMBLY AND ASSEMBLY (Continued)**Fig. 77 Poppet Plunger Screw Installation**

(38) Apply Mopar silicone adhesive/sealer to PTO cover mating surface and to threads of cover bolts. Then install cover and tighten bolts to 27–34 N·m (20–25 ft. lbs.) torque.

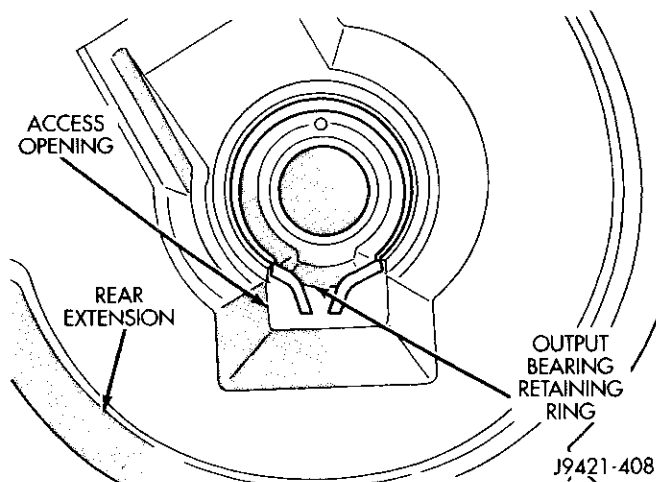
CLEANING AND INSPECTION**ADAPTER**

Clean the adapter components with solvent. Dry all the parts (except bearings) with compressed air. Allow bearings to air dry, or wipe them dry with clean shop towels.

Inspect the front case and rear extension (Fig. 78), for cracks, damaged threads, or scored mating surfaces. Minor scratches and nicks can be smoothed off with emery cloth. Damaged threads can be repaired with Heli-Coil, stainless steel thread inserts.

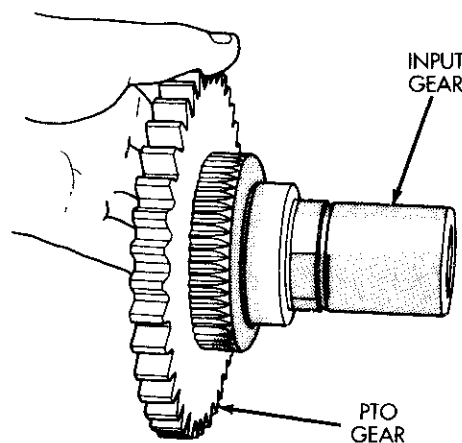
**Fig. 78 Front Case And Extension**

Be sure the front case sector bore, vent tube, and mounting studs are in good condition. Replace the extension oil seal if it is cut, or torn. Also check the retaining ring in the extension interior (Fig. 79). This ring secures the mainshaft output bearing to the extension.

**Fig. 79 Bearing Retaining Ring Location In Extension**

The extension has a bushing at the rear. If the bushing is worn, remove the seal. Then remove the bushing by cutting and collapsing it with a cape chisel. A new bushing can be installed with any suitable size installer tool similar to 5065 or 5062.

Slide the PTO gear onto the input gear and check fit (Fig. 80). Replace either gear if any gear teeth, or splines are damaged. Also check the bearing/seal surface of the input gear. Small scratches on this surface can be smoothed with 320/400 grit emery cloth if necessary.



J9421-409

Fig. 80 Input And PTO Gears

The various snap rings used in the adapter should be replaced during overhaul. This is recommended as some of the snap rings can be distorted during removal. A distorted snap ring will not seat properly.

Inspect the bearings carefully. Rotate them by hand and check for noise or roughness. Replace any bearing exhibiting roughness, noise, or visible surface damage of the rollers or bearing balls.

CLEANING AND INSPECTION (Continued)

Check the splines and gear teeth on the PTO gear, mainshaft, and shift sleeve. Replace any component exhibiting damage.

Install new O-rings on the poppet screw and in the sector shaft bore. Do not reuse the original O-rings.

Check condition of the plastic inserts on the shift fork. Be sure the inserts are not worn through, or otherwise damaged. Replace the fork if worn, or damaged in any way.

ADJUSTMENTS**SHIFT LINKAGE**

- (1) Place adapter floor shift lever in D position.
- (2) Raise vehicle.
- (3) Loosen locknut on shift rod.
- (4) Verify that adapter shift lever is in D position.
- (5) Tighten shift rod locknut and lower vehicle.

SPECIFICATIONS**NV 021 ADAPTER****TORQUE**

Description	Torque
Access Cover Screws	8-11 N•m (75-95 in. lbs.)
Adapter Mounting Nuts:	
With 5/16 stud	30-41 N•m (22-30 ft. lbs.)
With 3/8 stud	41-47 N•m (30-35 ft. lbs.)
Adapter Shift Lever Nut	27-34 N•m (20-25 ft. lbs.)
Fill/Drain Plugs	41-54 N•m (30-40 ft. lbs.)
Front Case-To-Rear	
Extension Bolts	27-34 N•m (20-25 ft. lbs.)
Indicator Switch	20-34 N•m (15-25 ft. lbs.)
Input Bearing Retainer Bolts	16-24 N•m (12-18 ft. lbs.)
Poppet Plunger Screw	16-24 N•m (12-18 ft. lbs.)
Propeller Shaft Clamp Bolts	19 N•m (170 in. lbs.)

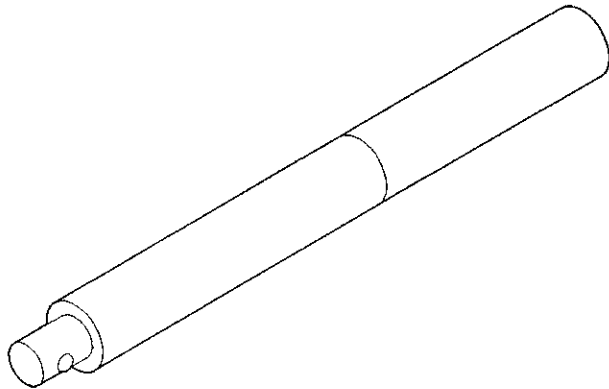
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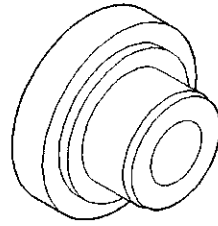
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SPECIAL TOOLS

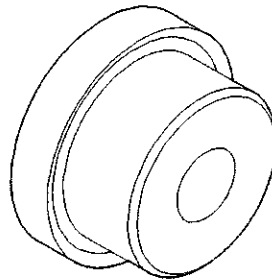
NV 021 ADAPTER



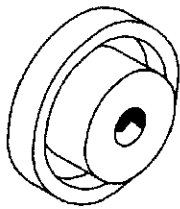
Handle C-4171



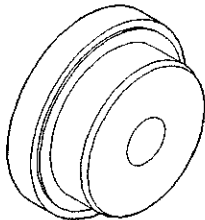
Driver 5065



Driver 7828



Driver C-4210



Driver 5062



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TIRES AND WHEELS

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TIRES

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DESCRIPTION AND OPERATION

TIRE INFORMATION

Tires are designed and engineered for each specific vehicle. They provide the best overall performance for normal operation. The ride and handling characteristics match the vehicle's requirements. With proper care they will give excellent reliability, traction, skid resistance, and tread life.

Driving habits have more effect on tire life than any other factor. Careful drivers will obtain, in most cases, much greater mileage than severe use or careless drivers. A few of the driving habits which will shorten the life of any tire are:

- Rapid acceleration
- Severe application of brakes
- High-speed driving
- Taking turns at excessive speeds
- Striking curbs and other obstacles

Radial ply tires are more prone to irregular tread wear. It is important to follow the tire rotation interval shown in the section on Tire Rotation. This will help to achieve a greater tread-life potential.

TIRE IDENTIFICATION

Tire type, size, aspect ratio and speed rating are encoded in the letters and numbers imprinted on the side wall of the tire. Refer to the chart to decipher the tire identification code (Fig. 1).

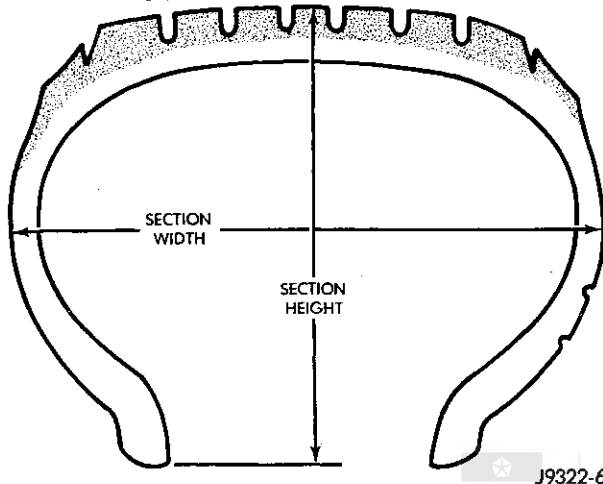
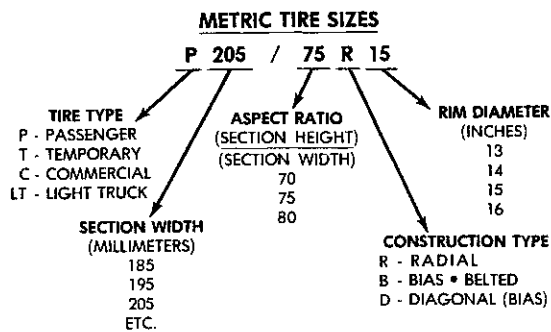
Performance tires will have a speed rating letter after the aspect ratio number. The speed rating is not always printed on the tire sidewall. The letter **S** indicates that the tire is speed rated up to 112 mph.

- **Q** up to 100 mph
- **T** up to 118 mph
- **U** up to 124 mph
- **H** up to 130 mph
- **V** up to 149 mph
- **Z** more than 149 mph (consult the tire manufacturer for the specific speed rating)

An All Season type tire will have either **M + S**, **M & S** or **M—S** (indicating mud and snow traction) imprinted on the side wall.

TIRE CHAINS

Tire snow chains may be used on **certain** models. Refer to Owner's Manual for more information.

DESCRIPTION AND OPERATION (Continued)**Fig. 1 Tire Identification****RADIAL-PLY TIRES**

Radial-ply tires improve handling, tread life, ride quality and decrease rolling resistance.

Radial-ply tires must always be used in sets of four and under no circumstances should they be used on the front only. They may be mixed with temporary spare tires when necessary. A maximum speed of 50 MPH is recommended while a temporary spare is in use.

Radial-ply tires have the same load-carrying capacity as other types of tires of the same size. They also use the same recommended inflation pressures.

The use of oversized tires, either in the front or rear of the vehicle, can cause vehicle drive train failure. This could also cause inaccurate wheel speed signals when the vehicle is equipped with Anti-Lock Brakes.

It is recommended that tires from different manufacturers NOT be mixed. The proper tire pressure should be maintained on all four tires. For proper tire pressure refer to the Tire Inflation Pressure Chart provided with the vehicle.

SPARE TIRE (TEMPORARY)

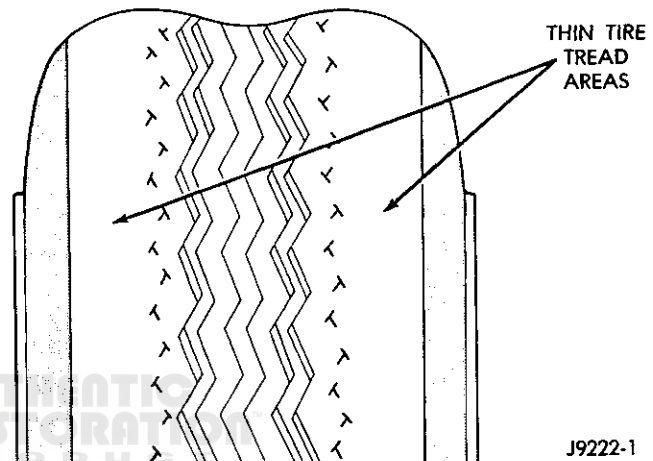
The temporary spare tire is designed for emergency use only. The original tire should be repaired and reinstalled at the first opportunity, or a new tire

purchased. Do not exceed speeds of 50 MPH. Refer to Owner's Manual for complete details.

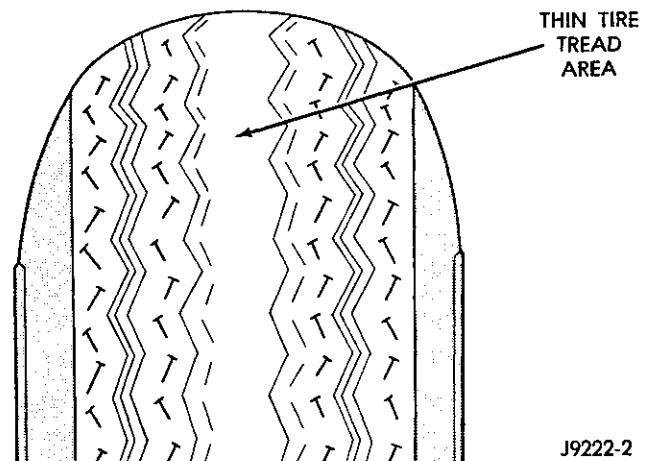
TIRE INFLATION PRESSURES

CAUTION: Models 2500 and 3500 now use a high pressure snap-in tire valve. Do not substitute with other tire valves. The Tire and Rim industry designations are TR413 for low pressure and 600HP for high pressure.

Under inflation (Fig. 2) causes rapid shoulder wear and tire flexing.

**Fig. 2 Under Inflation Wear**

Over inflation (Fig. 3) causes rapid center wear and loss of the tire's ability to cushion shocks.

**Fig. 3 Over Inflation Wear**

Improper inflation can cause;

- Uneven wear patterns
- Reduced tread life
- Reduced fuel economy
- Unsatisfactory ride
- Cause the vehicle to drift

DESCRIPTION AND OPERATION (Continued)

Refer to the Tire Inflation Pressure brochure for information regarding proper tire inflation. This information is provided with the Owner's Manual.

This pressure has been carefully selected to provide for safe vehicle operation. Tire pressure should be checked **cold** once a month. Tire pressure decreases when the outside temperature drops.

Inflation pressures specified on the placards are always **cold inflation pressure**. Cold inflation pressure is obtained after the vehicle has not been operated for at least 3 hours. Tire inflation pressures may increase from 2 to 6 pounds per square inch (psi) during operation. **Do not** reduce this normal pressure build-up.

Vehicles loaded to the maximum capacity should not be driven at continuous speeds above 75 mph (120 km/h).

WARNING: OVER OR UNDER INFLATED TIRES CAN AFFECT VEHICLE HANDLING AND MAY RESULT IN LOSS OF VEHICLE CONTROL.

TIRE PRESSURE FOR HIGH—SPEED OPERATION

Chrysler Corporation advocates driving at safe speeds within posted speed limits. Where speed limits allow the vehicle to be driven at high speeds, correct tire inflation pressure is very important. For speeds up to and including 75 mph (120 km/h), tires must be inflated to the pressures shown on the tire placard. For speeds in excess of 75 mph (120 km/h), tires must be inflated to the maximum pressure specified on the tire sidewall.

Vehicles loaded to the maximum capacity should not be driven at continuous speeds above 75 mph (120 km/h).

WARNING: OVER OR UNDER INFLATED TIRES CAN AFFECT VEHICLE HANDLING. THE TIRE CAN FAIL SUDDENLY, RESULTING IN LOSS OF VEHICLE CONTROL.

For emergency vehicles that are driven at speeds over 90 mph (144 km/h), special high-speed tires must be used. Consult tire manufacturer for correct inflation pressure recommendations.

REPLACEMENT TIRES

The original equipment tires provide a proper balance of many characteristics such as:

- Ride
- Noise
- Handling
- Durability
- Tread life
- Traction
- Rolling resistance

- Speed capability

It is recommended that tires equivalent to the original equipment tires be used when replacement is needed.

Failure to use equivalent replacement tires may adversely affect the safety and handling of the vehicle.

The use of oversize tires not listed in the specification charts may cause interference with vehicle components. Under extremes of suspension and steering travel, interference with vehicle components may cause tire damage.

WARNING: FAILURE TO EQUIP THE VEHICLE WITH TIRES HAVING ADEQUATE SPEED CAPABILITY CAN RESULT IN SUDDEN TIRE FAILURE.

DIAGNOSIS AND TESTING

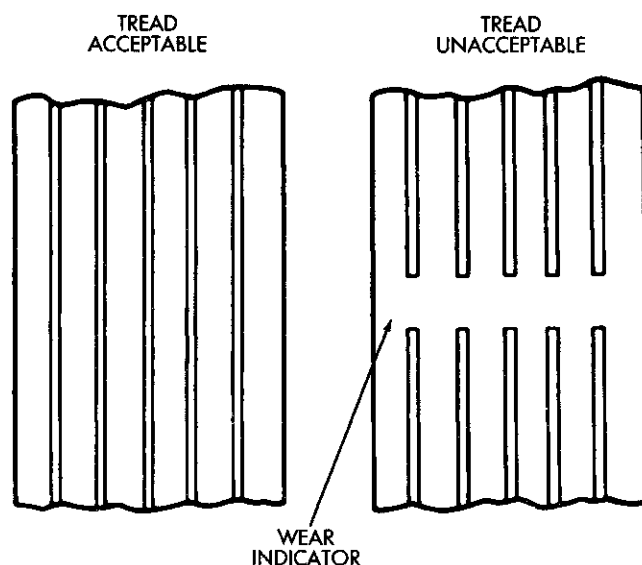
PRESSURE GAUGES

A high-quality air-pressure gauge is recommended to check tire pressure. After checking with the gauge, replace valve caps and finger tighten.

TREAD WEAR INDICATORS

Tread wear indicators are molded into the bottom of the tread grooves. When tread depth is 1.6 mm (1/16 in.), the tread wear indicators will appear as a 13 mm (1/2 in.) band.

Tire replacement is necessary when indicators appear in two or more grooves or if localized balding occurs (Fig. 4).



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Fig. 4 Tread Wear Indicators

DIAGNOSIS AND TESTING (Continued)**TIRE WEAR PATTERNS**

Under inflation results in faster wear on shoulders of tire. Over inflation causes faster wear at center of tread.

Excessive camber causes the tire to run at an angle to the road. One side of tread is worn more than the other.

Excessive toe-in or toe-out causes wear on the tread edges of the tire, from dragging of tire. There is a feathered effect across the tread (Fig. 5).

TIRE NOISE OR VIBRATION

Radial-ply tires are sensitive to force impulses caused by improper mounting, vibration, wheel defects, or possibly tire imbalance.

To find out if tires are causing the noise or vibration, drive the vehicle over a smooth road at varying speeds. Note the effect of acceleration and deceleration on noise level. Differential and exhaust noises will change in intensity as speed varies, while tire noise will usually remain constant.

LEAD CORRECTION CHART

Use the following chart to correct vehicle leading or drifting problems.

SERVICE PROCEDURES**ROTATION**

Tires on the front and rear axles operate at different loads and perform different steering, driving, and braking functions. For these reasons, the tires wear at unequal rates. They may also develop irregular wear patterns. These effects can be reduced by rotating the tires according to the maintenance schedule

in the Owners Manual. This will improve tread life, traction and maintain a smooth quiet ride.

The recommended method of tire rotation is (Fig. 6). Other methods can be used, but may not provide the same tire longevity benefits.

Dual wheel vehicles require a different tire rotation pattern. Refer to (Fig. 7) for the proper tire rotation with dual wheels.

MATCH MOUNTING



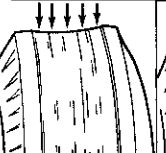

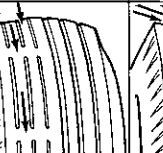
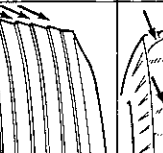

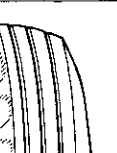
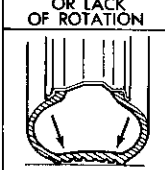
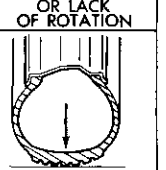
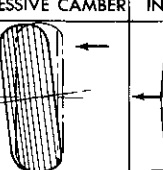
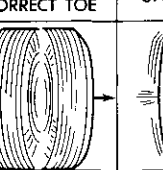
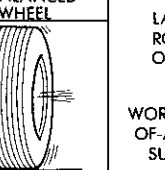
Wheels and tires are match mounted at the factory. This means that the high spot of the tire is matched to the low spot on the wheel rim. Each are marked with a bright colored temporary label on the outboard surface for alignment. The wheel is also marked permanently on the inside of the rim in the tire well. This permanent mark may be a paint dot, a permanent label or a stamped impression such as an X. An optional location mark is a small spherical indentation on the vertical face of the outboard flange on some non styled base steel wheels. The tire must be removed to locate the permanent mark on the inside of the wheel.

Before dismounting a tire from its wheel, a reference mark should be placed on the tire at the valve stem location. This reference will ensure that it is remounted in the original position on the wheel.

(1) Measure the total indicator runout on the center of the tire tread rib. Record the indicator reading. Mark the tire to indicate the high spot. Place a mark on the tire at the valve stem location (Fig. 8).

(2) Break down the tire and remount it 180 degrees on the rim (Fig. 9).

(3) Measure the total indicator runout again. Mark the tire to indicate the high spot.

CONDITION	RAPID WEAR AT SHOULDERS	RAPID WEAR AT CENTER	CRACKED TREADS	WEAR ON ONE SIDE	FEATHERED EDGE	BALD SPOTS	SCALLOPED WEAR
EFFECT	 						
CAUSE	UNDER-INFLATION OR LACK OF ROTATION 	OVER-INFLATION OR LACK OF ROTATION 	UNDER-INFLATION OR EXCESSIVE SPEED*	EXCESSIVE CAMBER 	INCORRECT TOE 	UNBALANCED WHEEL 	LACK OF ROTATION OF TIRES OR WORN OR OUT-OF-ALIGNMENT SUSPENSION.
CORRECTION	ADJUST PRESSURE TO SPECIFICATIONS WHEN TIRES ARE COOL ROTATE TIRES			ADJUST CAMBER TO SPECIFICATIONS	ADJUST TOE-IN TO SPECIFICATIONS	DYNAMIC OR STATIC BALANCE WHEELS	

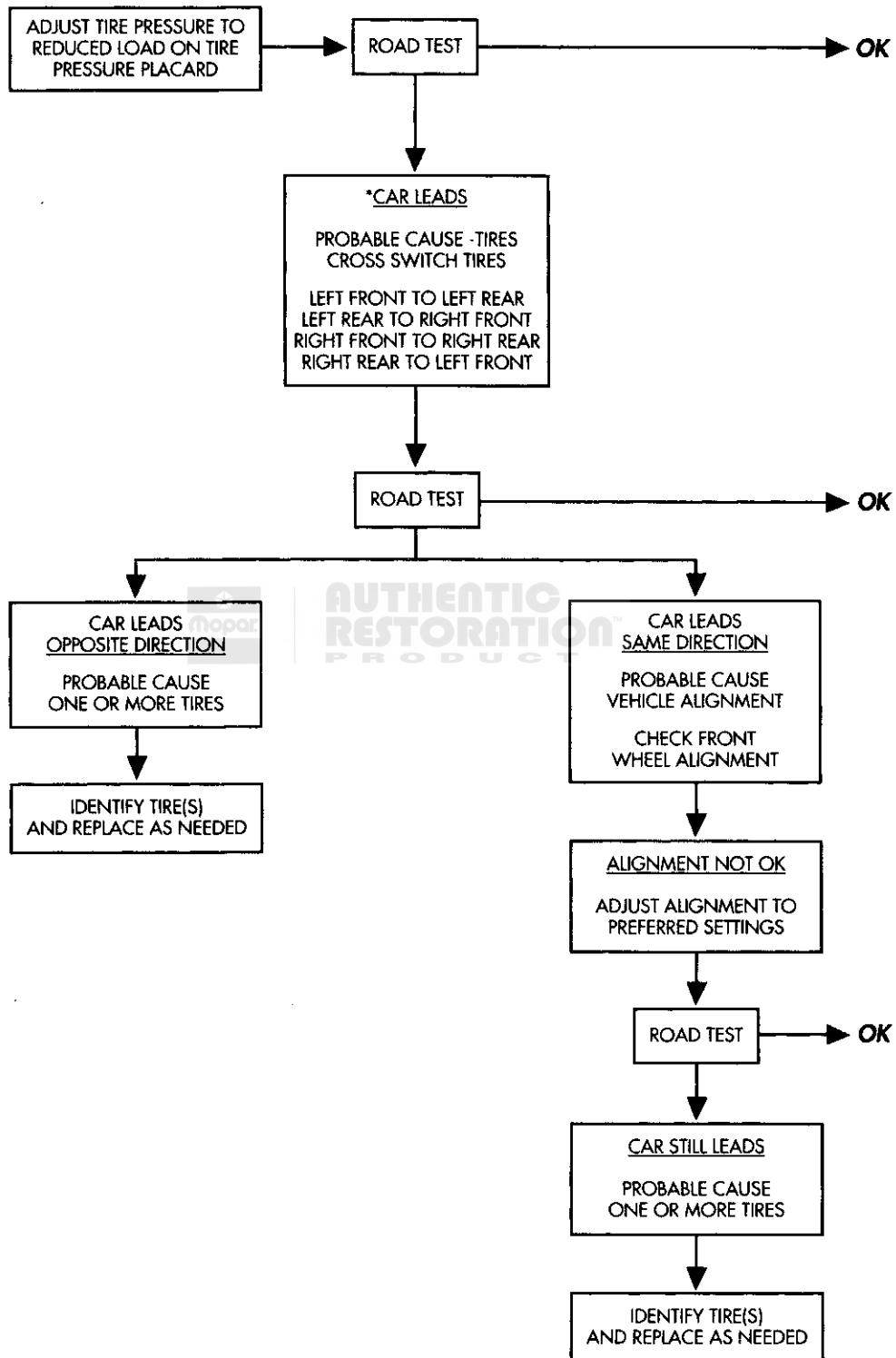
*HAVE TIRE INSPECTED FOR FURTHER USE.

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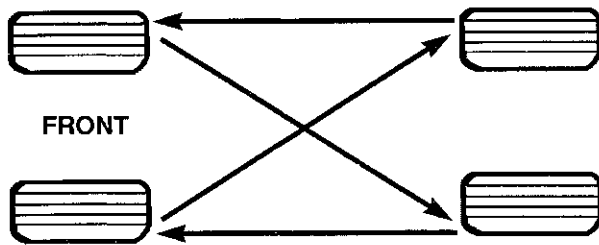
Fig. 5 Tire Wear Patterns

SERVICE PROCEDURES (Continued)

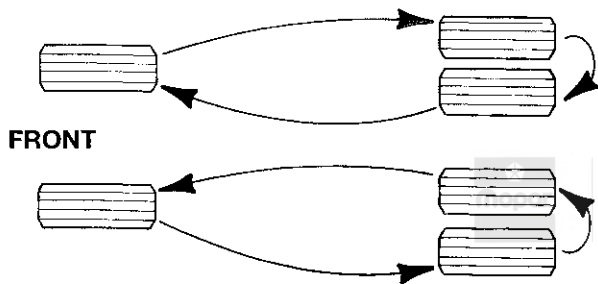
LEAD CORRECTION CHART



*NOTE: VERIFY THAT LEAD IS NOT RELATED TO STEERING WHEEL NOT CENTERED

SERVICE PROCEDURES (Continued)

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Fig. 6 Tire Rotation Pattern

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Fig. 7 Dual Wheel Tire Rotation Pattern

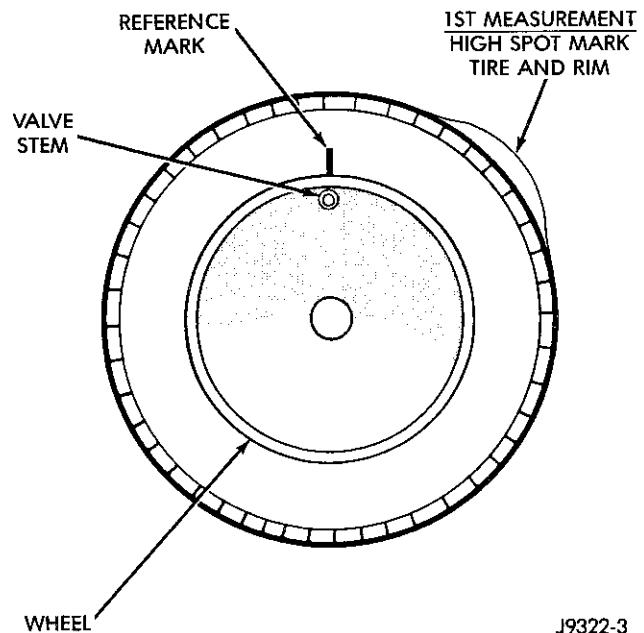
(4) If runout is still excessive, the following procedures must be done.

- If the high spot is within 101.6 mm (4.0 in.) of the first spot and is still excessive, replace the tire.
- If the high spot is within 101.6 mm (4.0 in.) of the first spot on the wheel, the wheel may be out of specifications. Refer to Wheel and Tire Runout.
- If the high spot is NOT within 101.6 mm (4.0 in.) of either high spot, draw an arrow on the tread from second high spot to first. Break down the tire and remount it 90 degrees on rim in that direction (Fig. 10). This procedure will normally reduce the runout to an acceptable amount.

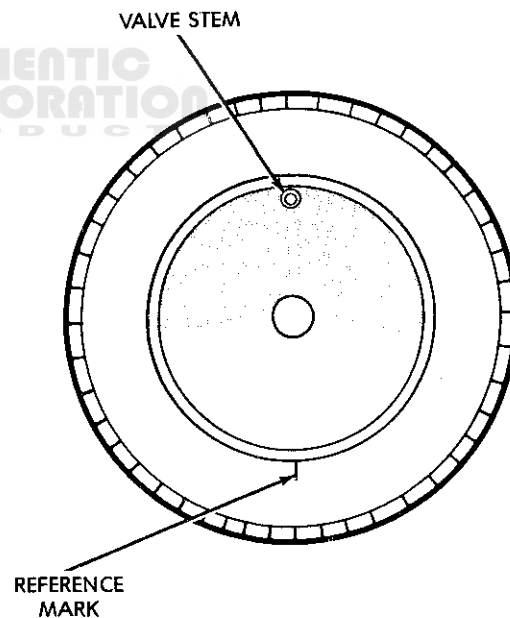
REPAIRING LEAKS

For proper repairing, a radial tire must be removed from the wheel. Repairs should only be made if the defect, or puncture, is in the tread area (Fig. 11). The tire should be replaced if the puncture is located in the sidewall.

Deflate tire completely before dismounting tire from the wheel. Use lubrication such as a mild soap



J9322-3

Fig. 8 First Measurement On Tire

J9322-4

Fig. 9 Remount Tire 180 Degrees

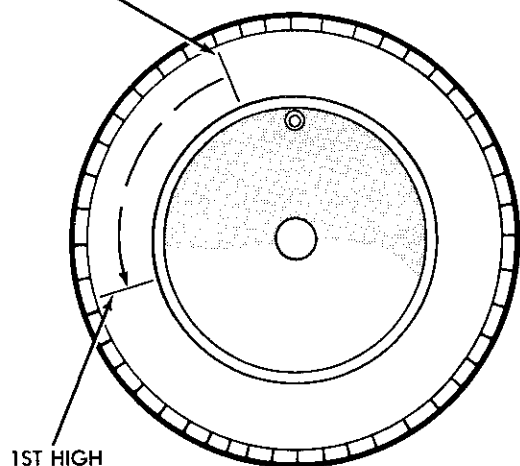
solution when dismounting or mounting tire. Use tools free of burrs or sharp edges which could damage the tire or wheel rim.

Before mounting tire on wheel, make sure all rust is removed from the rim bead and repaint if necessary.

Install wheel on vehicle, and tighten to proper torque specification.

SERVICE PROCEDURES (Continued)

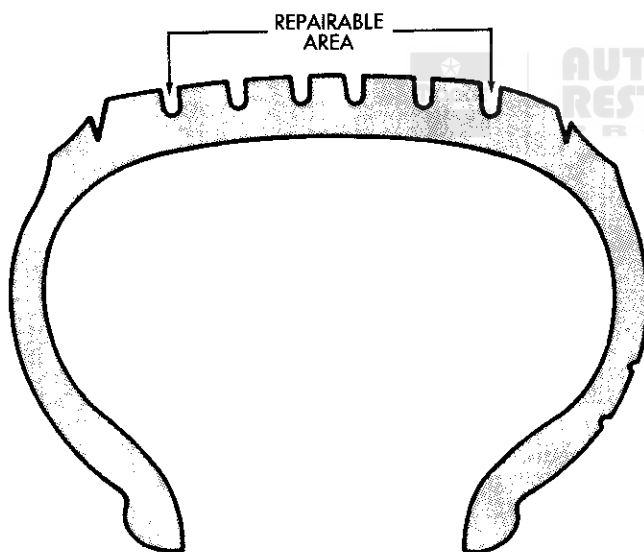
2ND HIGH SPOT
ON TIRE



1ST HIGH
SPOT ON
TIRE

J9322-5

Fig. 10 Remount Tire 90 Degrees In Direction of Arrow



J8922-6

Fig. 11 Tire Repair Area

CLEANING AND INSPECTION**CLEANING OF TIRES**

Remove protective coating on tires before delivery of vehicle. The coating could cause deterioration of tires.

Remove protective coating by:

- Applying warm water
- Letting it soak one minute
- Scrubbing the coating away with a soft bristle brush.
- Steam cleaning may also be used for cleaning.
- DO NOT use gasoline or wire brush for cleaning.
- DO NOT use mineral oil or an oil-based solvent.

WHEELS

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DESCRIPTION AND OPERATION

WHEELS INFORMATION

Original equipment wheels are designed for the specified Maximum Vehicle Capacity.

All models use steel or cast aluminum drop center wheels. The safety rim wheel (Fig. 1) has raised sections between the rim flanges and the rim well.

Initial inflation of the tire forces the bead over these raised sections. In case of tire failure, the raised sections hold the tire in position on the wheel until the vehicle can be brought to a safe stop.

Cast aluminum wheels require special balance weights and alignment equipment.

Ram Truck Models equipped with dual rear wheels have eight-stud hole rear wheels. The wheels have a flat mounting surface (Fig 2). The slots in the wheel must be aligned to provide access to the valve stem (Fig. 3).

DIAGNOSIS AND TESTING

WHEEL INSPECTION

Wheels must be replaced if they:

- Have excessive run out
- Are bent or dented
- Leak air
- Have damaged bolt holes

Wheel repairs employing hammering, heating, welding or repairing leaks are not allowed.

Original equipment replacement wheels should be used. When obtaining replacement wheels, they should be equivalent in load carrying capacity. The physical dimensions (diameter, width, offset, and bolt circle) of the wheel should be the same as the original wheel.

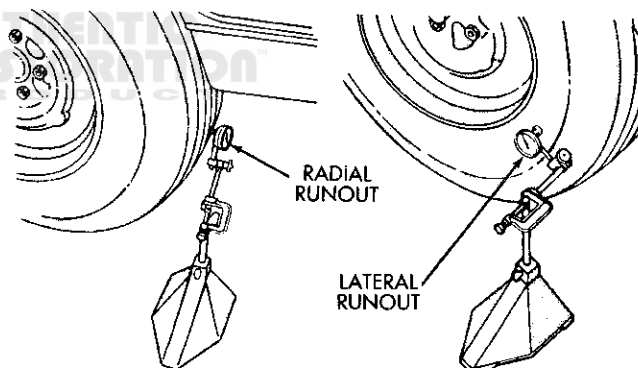
WARNING: FAILURE TO USE EQUIVALENT REPLACEMENT WHEELS MAY ADVERSELY AFFECT THE SAFETY AND HANDLING OF THE VEHICLE. REPLACEMENT WITH USED WHEELS IS NOT REC-

COMMENDED. THE SERVICE HISTORY OF THE RIM MAY HAVE INCLUDED SEVERE TREATMENT OR VERY HIGH MILEAGE. THE RIM COULD FAIL WITHOUT WARNING.

TIRE AND WHEEL RUNOUT

Radial runout is the difference between the high and low points on the tire or wheel (Fig. 1).

Lateral runout is the **wobble** of the tire or wheel.



J9022-4

Fig. 1 Checking Tire Runout

Radial runout of more than 1.5 mm (.060 inch) measured at the center line of the tread may cause the vehicle to shake.

Lateral runout of more than 2.0 mm (.080 inch) measured near the shoulder of the tire may cause the vehicle to shake.

Sometimes radial runout can be reduced. Relocate the wheel and tire assembly on the mounting studs (See Method 1). If this does not reduce runout to an acceptable level, the tire can be rotated on the wheel. (See Method 2).

DIAGNOSIS AND TESTING (Continued)

METHOD 1 (RELOCATE WHEEL ON HUB)

Check accuracy of the wheel mounting surface; adjust wheel bearings.

Drive vehicle a short distance to eliminate tire flat spotting from a parked position.

Make sure all wheel nuts are properly torqued.

Relocate wheel on the mounting, two studs over from the original position.

Re-tighten wheel nuts until all are properly torqued, to eliminate brake distortion.

Check radial runout. If still excessive, mark tire sidewall, wheel, and stud at point of maximum runout and proceed to Method 2.

METHOD 2 (RELOCATE TIRE ON WHEEL)

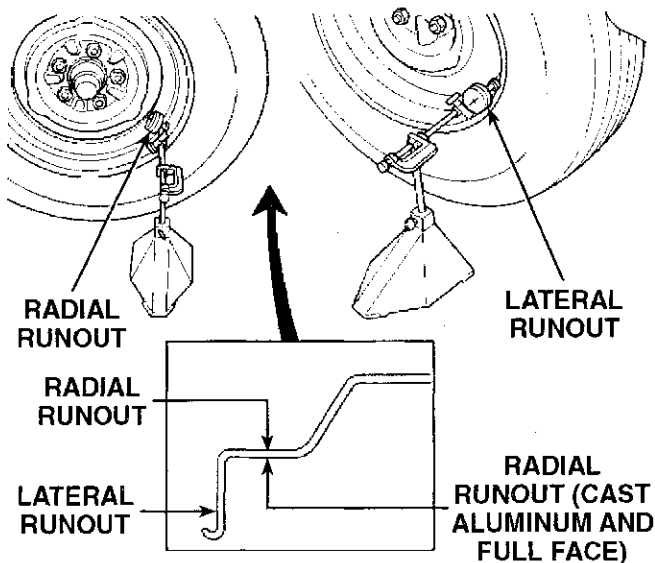
Rotating tire on wheel is particularly effective when there is runout in both tire and wheel.

Remove tire from wheel and re-mount wheel on hub in former position.

Check wheel radial runout (Fig. 2).

NOTE: If the vehicle is equipped with aluminum or full faced wheels the tire must be removed to check radial runout.

- **STEEL WHEELS:** Radial runout 0.040 in., Lateral runout 0.045 in.
- **ALUMINUM WHEELS:** Radial runout 0.030 in., Lateral runout 0.035 in.



800d1a12

Fig. 2 Checking Wheel Runout

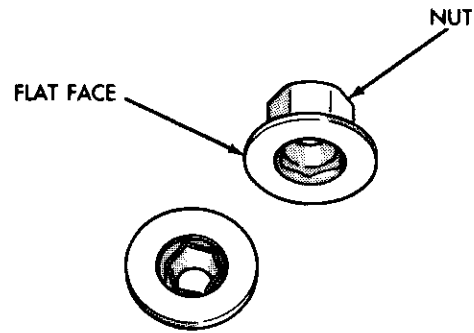
If point of greatest runout is near original chalk mark, remount tire 180 degrees. Recheck runout.

SERVICE PROCEDURES

WHEEL INSTALLATION

The wheel studs and nuts are designed for specific applications. Do not use replacement parts of lesser quality or a substitute design.

The 3500 use a two piece flat face nut (Fig. 3).



J9422-2

Fig. 3 Two Piece Lug Nut

All aluminum and some steel wheels have wheel stud nuts which feature an enlarged nose. This enlarged nose is necessary to ensure proper retention of the aluminum wheels.

CAUTION: Models equipped with chrome plated wheels are not supplied with chrome plated lug nuts. Under no circumstances are chrome plated lug nuts to be used, use only the factory specified lug nuts.

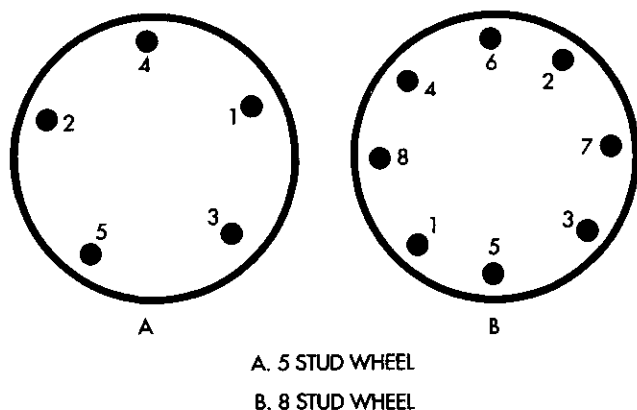
Before installing the wheel, be sure to remove any build up of corrosion on the wheel mounting surfaces. Ensure wheels are installed with good metal-to-metal contact. Improper installation could cause loosening of wheel nuts. This could affect the safety and handling of your vehicle.

To install the 5 stud wheel, first position it properly on the mounting surface. All wheel nuts should then be tightened just snug. Gradually tighten them in sequence to specified torque (Fig. 4). **Never use oil or grease on studs or nuts.**

DUAL REAR WHEEL INSTALLATION

Dual rear wheels use a special heavy duty lug nut wrench. It is recommended to remove and install dual rear wheels only when the proper wrench is available. The wrench is also use to remove wheel center caps for more information refer to Owner's Manual.

The tires on both wheels must be completely raised off the ground when tightening the lug nuts. This

SERVICE PROCEDURES (Continued)

J9122-7

Fig. 4 Lug Nut Tightening Pattern

will ensure correct wheel centering and maximum wheel clamping.

A two piece flat face lug nut with right-hand threads is used for retaining the wheels on the hubs (Fig. 3).

CAUTION: Models equipped with chrome plated wheels are not supplied with chrome plated lug nuts. Under no circumstances are chrome plated lug nuts to be used, use only the factory specified lug nuts.

The dual rear wheel lug nuts should be tightened according to the following procedure:

- Tighten the wheel lug nuts in the numbered sequential pattern until they are snug tight. Then tighten lug nut to specified torque following same number sequence (Fig. 4).

- Tighten lug nuts in same numbered sequence a second time to the specified torque. This will ensure that the wheels are thoroughly mated.

- Check lug nut specified torque after 100 miles (160 kilometers). Also after 500 miles (800 kilometers) of vehicle operation.

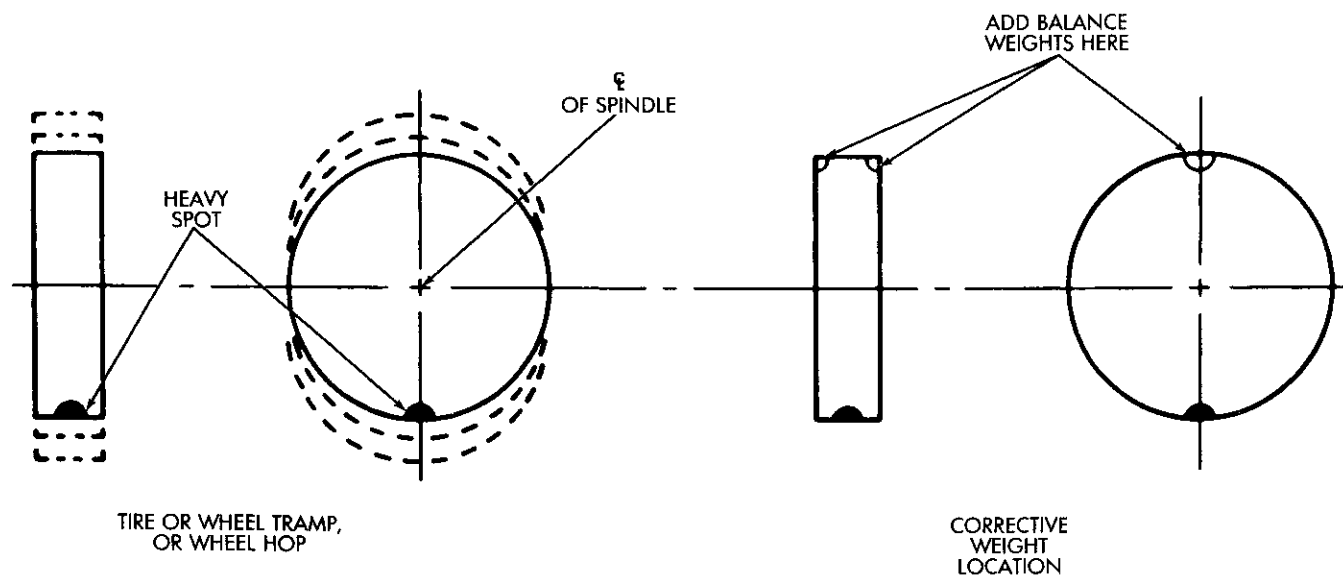
NOTE: Wheel lug nuts should be tightened to specified torque at every maintenance interval thereafter.

TIRE AND WHEEL BALANCE

It is recommended that a two plane dynamic balancer be used when a wheel and tire assembly require balancing. Static should be used only when a two plane balancer is not available.

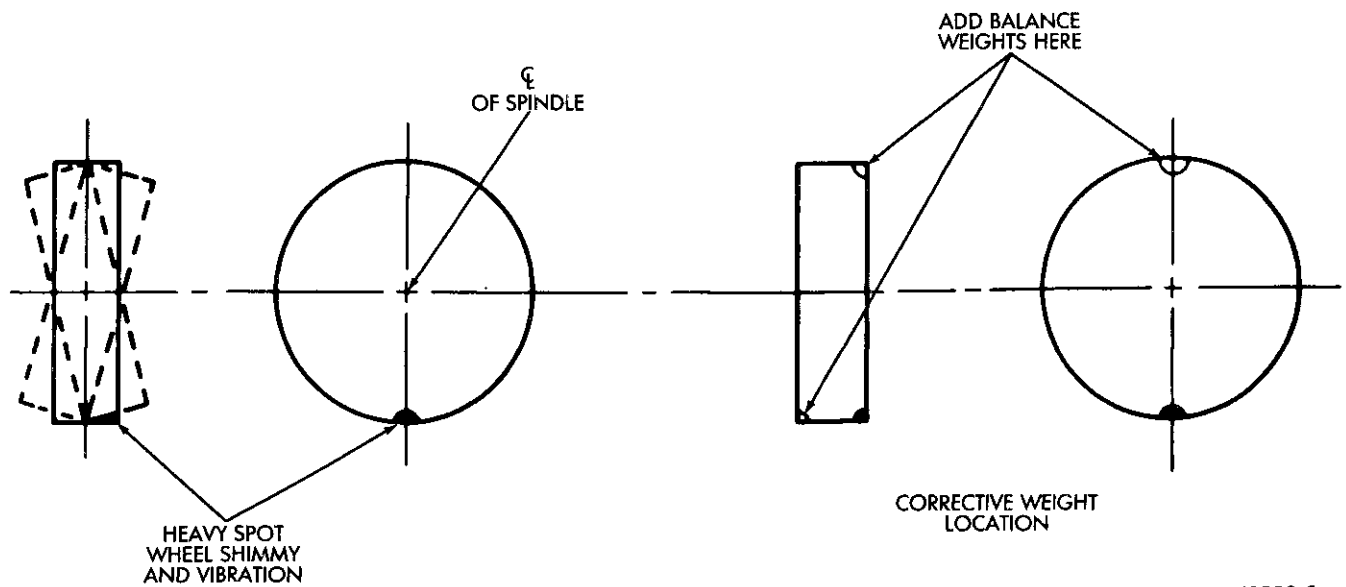
For static imbalance, find location of heavy spot causing imbalance. Counter balance wheel directly opposite the heavy spot. Determine weight required to counterbalance the area of imbalance. Place half of this weight on the **inner** rim flange and the other half on the **outer** rim flange (Fig. 5) and (Fig. 6). Off-vehicle balancing is necessary.

Wheel balancing can be accomplished with either on or off vehicle equipment. When using on-vehicle balancing equipment, remove the opposite wheel/tire.



J8922-8

Fig. 5 Static Unbalance & Balance



J8922-9

*Fig. 6 Dynamic Unbalance & Balance***SPECIFICATIONS****TORQUE SPECIFICATIONS****DESCRIPTION****TORQUE**

BR1500 (5 Stud Wheel)	130 N·m (95 ft. lbs.)
BR2500 (8 Stud Wheel)	180 N·m (135 ft. lbs.)
BR3500 (8 Stud Dual Wheel)	195 N·m (145 ft. lbs.)

BODY

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GENERAL SERVICE INFORMATION

GENERAL INFORMATION

SAFETY PRECAUTIONS AND WARNINGS

WARNING: EYE PROTECTION SHOULD BE USED WHEN SERVICING GLASS COMPONENTS. PERSONAL INJURY CAN RESULT.

USE A BREATHING FILTER WHEN SPRAYING PAINT OR SOLVENTS IN A CONFINED AREA. PERSONAL INJURY CAN RESULT.

AVOID PROLONGED SKIN CONTACT WITH PETROLEUM OR ALCOHOL BASED CLEANING SOLVENTS. PERSONAL INJURY CAN RESULT.

DO NOT GO UNDER A HOISTED VEHICLE THAT IS NOT PROPERLY SUPPORTED ON SAFETY STANDS. PERSONAL INJURY CAN RESULT.

CAUTION: When holes must be drilled or punched in an inner body panel, verify depth of space to the outer body panel, electrical wiring, or other components. Damage to vehicle can result.

Do not weld exterior panels unless combustible material on the interior of vehicle is removed from the repair area. Fire or hazardous condition can result.

Always have a fire extinguisher ready for use when welding.

Disconnect the negative (-) cable clamp from the battery when servicing electrical components that are live when the ignition is OFF. Damage to electrical system can result.

Do not use abrasive chemicals or compounds on painted surfaces. Damage to finish can result.

Do not use harsh alkaline based cleaning solvents on painted or upholstered surfaces. Damage to finish or color can result.

Do not hammer or pound on plastic trim panel when servicing interior trim, plastic panel can break.

Chrysler Corporation uses many different types of push-in fasteners to secure the interior and exterior trim to the body. Most of these fasteners can be

reused to assemble the trim during various repair procedures. At times a push-in fastener cannot be removed without damaging the fastener or the component it is holding. If it is not possible to remove a fastener without damaging a component or body, cut or brake the fastener and use a new one when installing the component. Never pry or pound on a plastic or press-board trim component. Using a suitable fork-type prying device, pry the fastener from the retaining hole behind the component being removed. When installing, verify fastener alignment with the retaining hole, by hand, push directly on or over the fastener until it seats. Apply a low force pull to the panel to verify that it is secure.

When it is necessary to remove components to service another, it should not be necessary to apply excessive force or bend a component to remove it. Before damaging a trim component, verify hidden fasteners or captured edges holding the component in place.

FRAME COATINGS INFORMATION

CAUTION: Depending on the vehicle build location, there are two different coatings applied to BR frames:

VEHICLE BUILD LOCATION	11th POSITION VIN CHARACTER	FRAME COATING
St. Louis North	J	E-Coat
Dodge City	S	Wax Coat
Saltillo Mexico	G	Wax Coat
Lago Alberto Mexico	M	Wax Coat

Replacement fasteners and torque values for frame attached components may vary depending on frame coatings. Ensure the replacement fastener is designed for the specific frame coating. Refer to the Torque Specifications Chart at the end of each group to determine the correct torque value.

PAINT

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GENERAL INFORMATION

PAINT CODE

Exterior vehicle body colors are identified on the Body Code plate. The plate is located on the floor pan under the passenger seat. Refer to the Introduction section at the front of this manual for body code plate description. The paint code is also identified on the Vehicle Safety Certification Label which is located on the drivers door shut face. The color names provided in the Paint and Trim Code Description chart are the color names used on most repair product containers.

BASE COAT/CLEAR COAT FINISH

On most vehicles a two part paint application (base coat/clear coat) is used. Color paint that is applied to primer is called base coat. The clear coat protects the base coat from ultra violet light and provides a durable high gloss finish.

WET SANDING, BUFFING AND POLISHING

Minor acid etching, orange peel or smudging in clear coat or single stage finishes can be reduced with light wet sanding, hand buffing and polishing. **If the finish has been wet sanded in the past, it can not be repeated. Wet sanding operation should be performed by a trained automotive paint technician.**

CAUTION: Do not remove clear coat finish, if equipped. Base coat paint must retain clear coat for durability.

PAINTED SURFACE TOUCH-UP

When a painted metal surface has been scratched or chipped, it should be touched-up as soon as possible to avoid corrosion. For best results, use Mopar® Scratch Filler/Primer, Touch-Up Paints and Clear Top Coat. Refer to Introduction group of this manual for Body Code Plate information.

TOUCH-UP PROCEDURE

(1) Scrape loose paint and corrosion from inside scratch or chip.

(2) Clean affected area with Mopar® Tar/Road Oil Remover and allow to dry.

(3) Fill the inside of the scratch or chip with a coat of filler/primer. Do not overlap primer onto good surface finish. The applicator brush should be wet enough to puddle fill the defect without running. Do not stroke brush applicator on body surface. Allow the filler/ primer to dry hard.

(4) Cover the filler/primer with color touch-up paint. Do not overlap touch-up color onto the original color coat around the scratch or chip. Butt the new color to the original color if possible. Do not stroke applicator brush on body surface. Allow touch-up paint to dry hard.

(5) On vehicles without clear coat, the touch-up color can be lightly (600 grit) wet sanded and polished with rubbing compound.

(6) On vehicles with clear coat, Apply clear top coat to touch- up paint with the same technique as described in Step 4. Allow clear top coat to dry hard. If desired, Step 5 can be performed on clear top coat.

SPECIFICATIONS**AFTERMARKET REPAIR PRODUCTS****1996 EXTERIOR PAINT CODES AND SUPPLIER STOCK NUMBERS**

COLOR NAME	CHRY CODE*	PPG	BASF	DuPONT	S-W ACME M-S	AKZO/NOBEL SIKKENS
Claret Red Pearl Coat	GM4	4052	18232	B8821	37296	CHA88:GM4
Claret Red Pearl Coat	RMM	5012	25052	B9569	50738	CHA95:RMM
Flame Red Pearl Coat	PR4	4679	23043	B9326	46916	CHA93:PR4
Light Driftwood Satin Glow	MFA	4569	22110	B9263	46579	CHA92:MFA
Light Driftwood Satin Glow	RFK	5011	25053	B9570	50736	CHA95:RFK
Spruce Pearl Coat	SPS	47844	26102	B9673	52175	CHA96:SPS
Spruce Pearl Coat	SPM	47550	26087	B9633	51531	CHA96:SPM
Aqua Pearl Coat	LQE	4446	22115	B9233	45859	CHA92:LQE
Aqua Pearl Coat	PQK	4786	24076	B9458	48783	CHA94:PQK
Moss Green Pearl Coat	RJN	47383	25036	B9533	50277	CHA95:RJN
Moss Green Pearl Coat	SJG	47492	26080	B9619	51527	CHA96:SJG
Light Kiwi Pearl Coat	SF4	47491	26076	B9628	51528	CHA96:SF4
Light Kiwi Pearl Coat	SF5	47450	26077	B9629	51529	CHA96:SF5
Brilliant Blue Pearl Coat	PCH	4784	24073	B9452	48538	CHA94:PCH
Black Clear Coat	DX8	9700	15214	99	34858 90-5950	CHA85:DX8
Stone White Clear Coat	SW1	83542	26089	B9622	51539	CHA96:SW1

*Herberts Standox and Spies Hecker use the Chrysler paint code as listed on the Body Code Plate and the Vehicle Safety Certification label.

SPECIFICATIONS (Continued)**1996 INTERIOR PAINT CODES AND SUPPLIER STOCK NUMBERS**

INTERIOR COLOR	CHRY. CODE	PPG	BASF	DuPONT	S-W ACME M-S
Medium Quartz	D5	34618/2-1346	19133 SEMI	C8904	40075
Blue Spruce	P8	18888/2-1578	25067	C9508	50511
Medium Driftwood	F6	27468/21502	23061	C9301	47481



**AUTHENTIC
RESTORATION™**
PRODUCT

STATIONARY GLASS

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DESCRIPTION AND OPERATION

SAFETY PRECAUTIONS

WARNING: DO NOT OPERATE THE VEHICLE WITHIN 24 HOURS OF WINDSHIELD INSTALLATION. IT TAKES AT LEAST 24 HOURS FOR URETHANE ADHESIVE TO CURE. IF IT IS NOT CURED, THE WINDSHIELD MAY NOT PERFORM PROPERLY IN AN ACCIDENT.

URETHANE ADHESIVES ARE APPLIED AS A SYSTEM. USE GLASS CLEANER, GLASS PREP SOLVENT, GLASS PRIMER, AND PINCHWELD (FENCE) PRIMER PROVIDED BY THE ADHESIVE MANUFACTURER. IF NOT, STRUCTURAL INTEGRITY COULD BE COMPROMISED.

BE SURE TO REFER TO THE URETHANE MANUFACTURER'S DIRECTIONS FOR CURING TIME SPECIFICATIONS, AND DO NOT USE ADHESIVE AFTER ITS EXPIRATION DATE.

VAPORS THAT ARE EMITTED FROM THE URETHANE ADHESIVE OR PRIMER COULD CAUSE PERSONAL INJURY, USE THEM IN A WELL VENTILATED AREA.

SKIN CONTACT WITH URETHANE ADHESIVE SHOULD BE AVOIDED, OR PERSONAL INJURY MAY RESULT.

ALWAYS WEAR EYE AND HAND PROTECTION WHEN WORKING WITH GLASS.

CAUTION: Protect all painted or trimmed surfaces from coming in contact with urethane or primers.

Be careful not to damage painted surfaces when removing moldings or cutting urethane around windshield.

It is difficult to salvage a windshield during the removal operation. The windshield is part of the structural support for the roof. The urethane bonding used to secure the windshield to the fence is difficult to cut or clean from any surface. If the moldings are set in urethane, it would also be unlikely they could be salvaged. Before removing the windshield, check

the availability of the windshield and moldings from the parts supplier.

REMOVAL AND INSTALLATION

WINDSHIELD

REMOVAL

It is difficult to salvage a windshield during the removal operation. The windshield is part of the structural support for the roof. The urethane bonding used to secure the glass to the fence is difficult to cut or clean from any surface. Since the molding is set in urethane, it is unlikely it would be salvaged. Before removing the glass, check the availability of the glass and molding from the parts supplier.

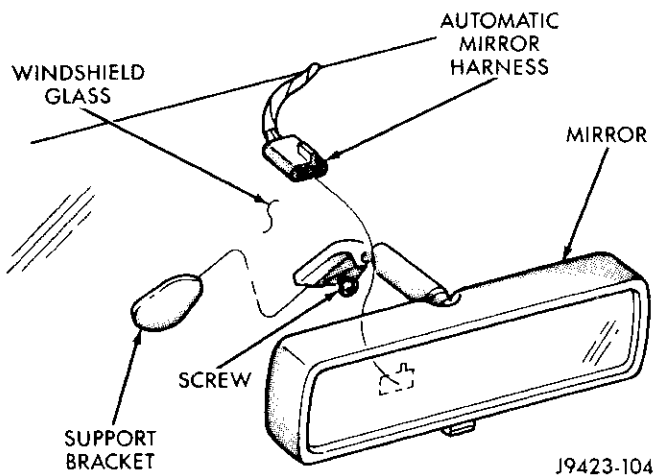
- (1) Remove inside rear view mirror (Fig. 1).
- (2) Remove cowl cover. Refer to Cowl Cover Removal paragraph in this group.
- (3) With doors open, remove windshield molding (Fig. 2). Pull outward on molding beginning at the bottom of A-pillars using pliers.
- (4) Cut urethane bonding from around windshield using a suitable sharp cold knife (C-4849). A pneumatic cutting device can be used but is not recommended (Fig. 3).
- (5) Separate windshield from vehicle.

INSTALLATION

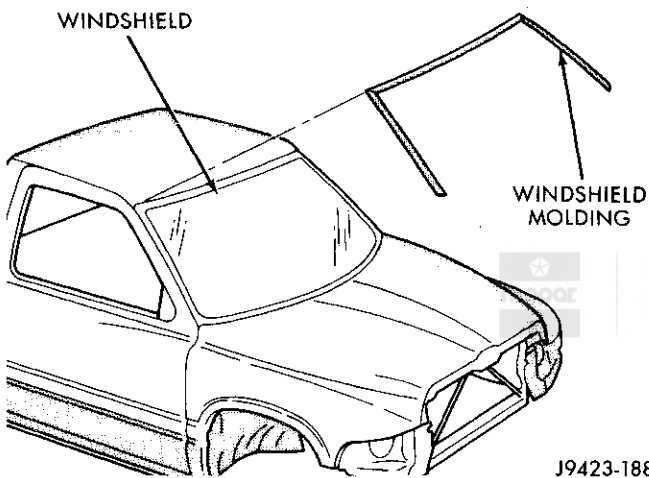
WARNING: Allow the urethane at least 24 hours to cure before returning the vehicle to use.

CAUTION: Roll down the left and right front door glass and open the rear glass slider (if available) before installing windshield to avoid pressurizing the passenger compartment if a door is slammed before urethane is cured. Water leaks can result.

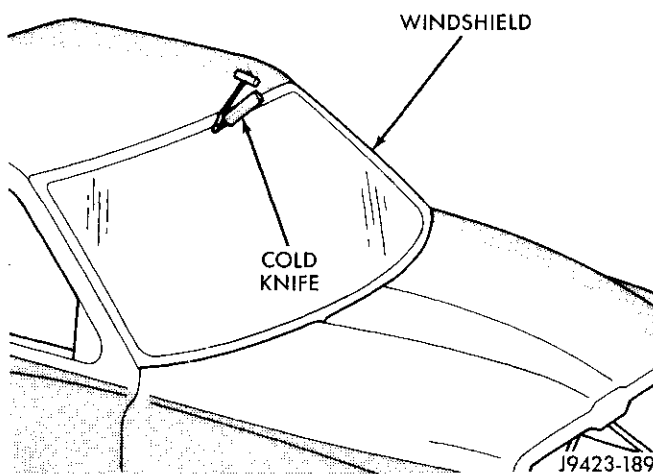
The windshield fence should be cleaned of most of its old urethane bonding material. A small amount of old urethane, approximately 1-2 mm in height, should remain on the fence. Do not grind off or com-

REMOVAL AND INSTALLATION (Continued)

J9423-104

Fig. 1 Rear View Mirror

J9423-188

Fig. 2 Windshield Moldings

J9423-189

Fig. 3 Cut Urethane Around Windshield

pletely remove all old urethane from the fence, the paint finish and bonding strength will be adversely affected. Support spacers should be cleaned and prop-

erly installed on weld studs or repair screws at bottom of windshield opening.

(1) Place replacement windshield into windshield opening and position glass in the center of the opening against the support spacers. Mark the glass at the support spacers with a grease pencil or pieces of masking tape and ink pen to use as a reference for installation. Remove replacement windshield from windshield opening (Fig. 4).

(2) Position the windshield inside up on a suitable work surface with two padded, wood 10 cm by 10 cm by 50 cm (4 in. by 4 in. by 20 in.) blocks, placed parallel 75 cm (2.5 ft.) apart (Fig. 5).

(3) Clean inside of windshield with MOPAR Glass Cleaner and lint-free cloth.

(4) Apply clear glass primer 25 mm (1 in.) wide around perimeter of windshield and wipe with a new clean and dry lint-free cloth.

(5) Apply the molding to the windshield:

- Press the upper corners of the molding onto the windshield.

- Press the header section onto the windshield.

- Press the A-Pillar sections onto the windshield.

(6) Apply black-out primer onto the glass using the windshield molding as a guide. The primer should be 15 mm (5/8 in.) wide on the top and sides of the glass and 25 mm (1 in.) on the bottom of windshield. Allow at least three minutes drying time.

(7) Position one 5 mm (3/16 in.) soft spacer (p/n 55028214) at the bottom of the windshield fence (Fig. 6).

(8) Apply a 13mm (1/2 in.) high and 10mm (3/8 in.) wide bead of urethane around the perimeter of windshield. At the bottom, apply the bead 7 mm (1/4 in.) inboard from the glass edge. On the three sides where the molding is on the glass, follow the edge of molding. The urethane bead should be shaped in a triangular cross-section, this can be achieved by notching the tip of the applicator (Fig. 7).

(9) With the aid of a helper, position the windshield over the windshield opening. Align the reference marks at the bottom of the windshield to the support spacers.

(10) Slowly lower windshield glass to the fence opening guiding the lower corners into proper position. Beginning at the bottom and continuing to the top, push glass onto fence along the A-Pillars. Push windshield inward to the fence at the bottom corners (Fig. 8).

(11) Clean excess urethane from exterior with MOPAR Super Clean or equivalent.

(12) Apply 150 mm (6 in.) lengths of 50 mm (2 in.) masking tape spaced 250 mm (10 in.) apart to hold molding in place until urethane cures.

(13) Install cowl cover and wipers.

(14) Install inside rear view mirror.

REMOVAL AND INSTALLATION (Continued)

(15) After urethane has cured, remove tape strips and water test windshield to verify repair.

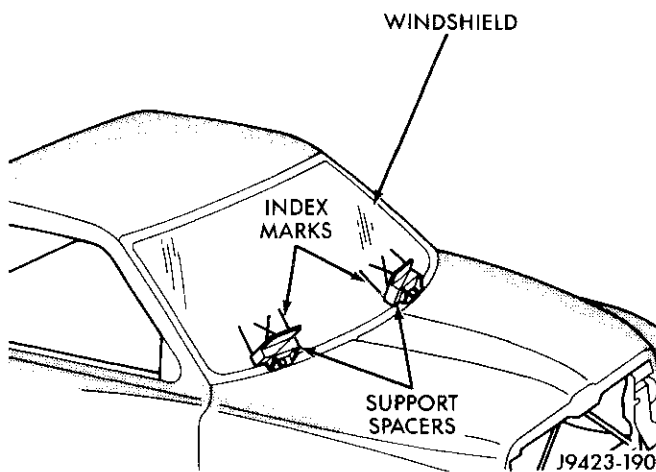
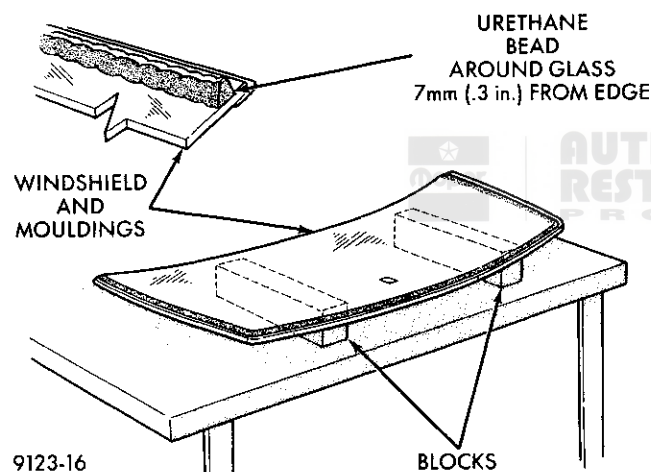


Fig. 4 Center Windshield and Mark at Support Spacers



**Fig. 5 Work Surface Set up and Molding Installation
BACKLITE—CONVENTIONAL CAB**

REMOVAL

It is difficult to salvage the backlite during the removal operation. The backlite is part of the structural support for the roof. The urethane bonding used to secure the glass to the fence is difficult to cut or clean from any surface. Since the molding is set in urethane, it is unlikely it would be salvaged. Before removing the backlite, check the availability from the parts supplier.

The backlite is attached to the window frame with urethane adhesive. The urethane adhesive is applied cold and seals the surface area between the window opening and the glass. The primer adheres the urethane adhesive to the backlite.

- (1) Roll down door glass.
- (2) Remove quarter trim panels.

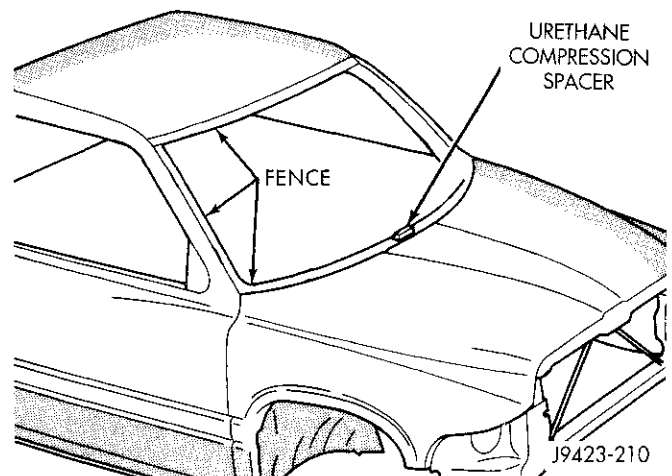


Fig. 6 Position Urethane Compression Spacer

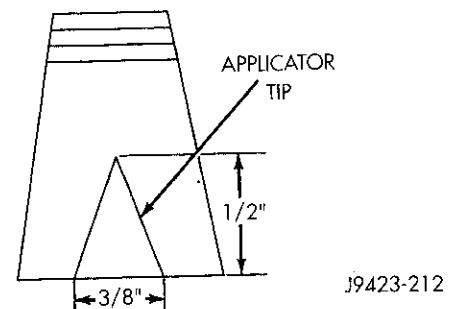


Fig. 7 Applicator Tip

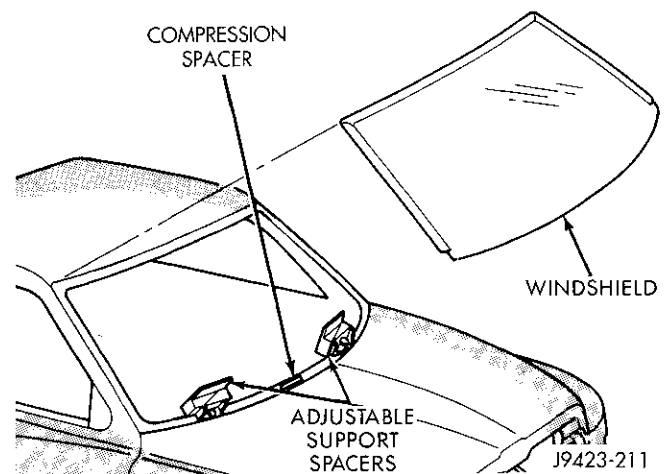
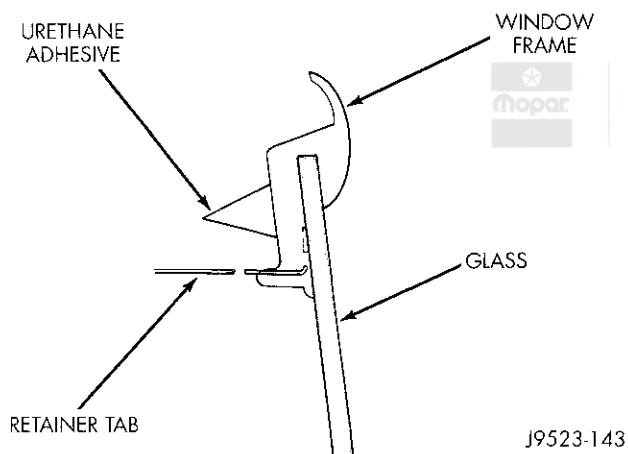


Fig. 8 Lower Windshield Into Position

- (3) Remove headliner.
- (4) Remove rear closure panel trim.
- (5) Bend rear window retaining tabs inward against glass.
- (6) Using a suitable pneumatic knife from inside the vehicle, cut urethane holding rear glass frame to opening fence.
- (7) Separate glass from vehicle.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

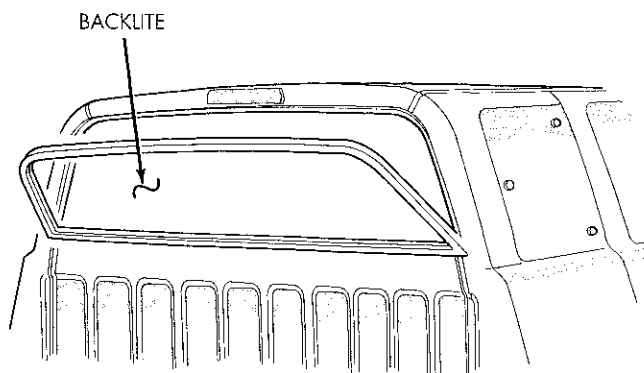
- (1) Clean urethane adhesive from around rear glass opening fence.
- (2) Apply black-out primer to outer edge of replacement rear glass frame.
- (3) Apply black-out primer to rear glass opening fence.
- (4) Apply a 13 mm (0.5 in.) bead of urethane around the perimeter of the window frame bonding surface (Fig. 9).
- (5) Set glass on lower fence and move glass forward into opening (Fig. 10).
- (6) Firmly push glass against rear window glass opening fence.
- (7) Bend tabs around edges of rear window opening fence to retain glass.
- (8) Clean excess urethane from exterior with MOPAR, Super Clean or equivalent.
- (9) Allow urethane to cure at least 24 hours (full cure is 72 hours).
- (10) Water test to verify repair before returning vehicle to service.
- (11) Install interior trim.



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Fig. 9 Urethane Adhesive Application**BACKLITE—CLUB CAB****REMOVAL**

- (1) Remove quarter trim panels.
- (2) Separate the weatherstrip seal lip from the window opening fence at one corner with a thin wood



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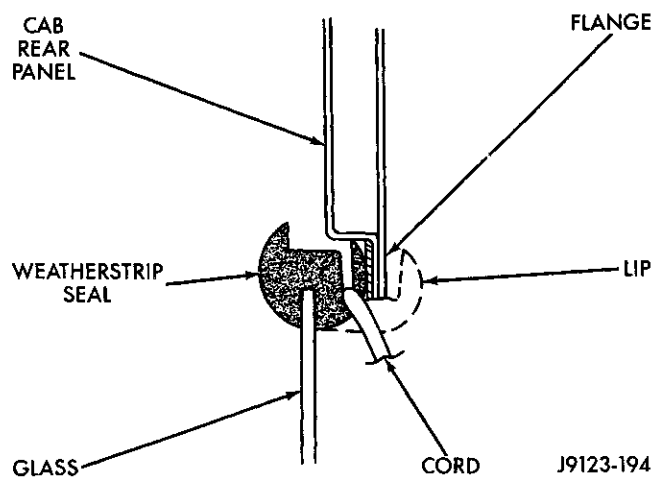
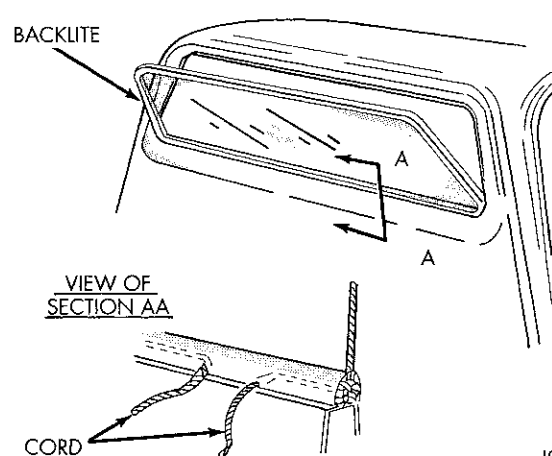
Fig. 10 Backlite Installation

or plastic pry tool. Carefully push the window glass out of the windowing opening.

- (3) Remove the weatherstrip seal from the glass.

INSTALLATION

- (1) Install the weatherstrip seal on the backlite. (Fig. 11).
- (2) Apply mastic or equivalent to window opening at roof joint upper corners.
- (3) Install the backlite (or frame) and the weatherstrip seal in the window opening with a length of cord (Fig. 11) according to the following instructions:
 - Moisten a length of 6 mm (0.25 in) diameter cord with a soap and water solution.
 - Ensure that the cord is long enough to go all the way around the perimeter of the weatherstrip seal.
 - Insert the cord into the window opening flange channel in the weatherstrip seal (Fig. 11).
 - Position the backlite and the weatherstrip seal in the window opening with the free ends of the cord inside the vehicle. The cords must be positioned at the bottom center of the window opening.
 - Pull evenly and simultaneously on each end of the cord (Fig. 12) to pull the weatherstrip seal channel lip over the window opening flange. (Both cords must reach the lower corners at the same time to ensure a proper seal.)
 - Push around perimeter to seat bottom of glass.
- (4) Test the window for water leaks.
- (5) Clean the vehicle, as necessary.
- (6) Install quarter trim panels.

REMOVAL AND INSTALLATION (Continued)**Fig. 11 Backlite Installation****Fig. 12 Installation Cord**

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SEATS

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REMOVAL AND INSTALLATION

BENCH SEAT TRACK

REMOVAL

- (1) Remove seat from vehicle.
- (2) Remove bolts attaching seat track to seat cushion frame (Fig. 1).
- (3) Remove inboard seat belt buckles.
- (4) Separate seat track from seat cushion frame.

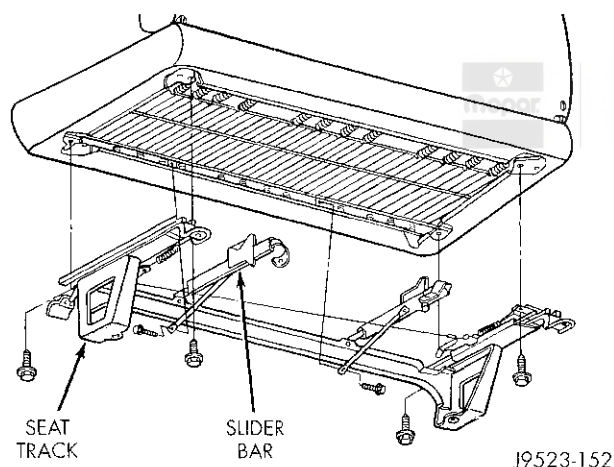


Fig. 1 Seat Track Removal

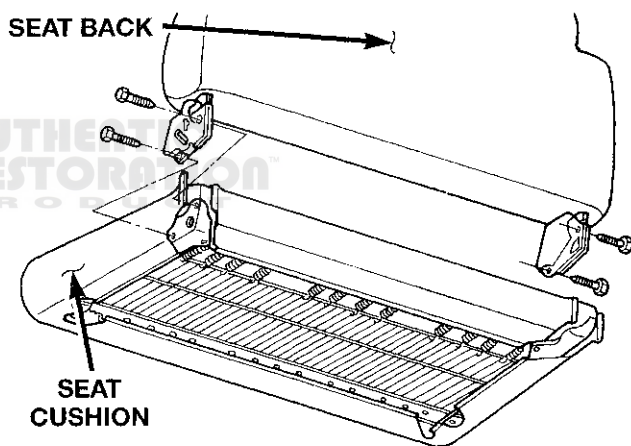
INSTALLATION

- (1) Position seat track on seat cushion frame.
- (2) Ensure seat track and slider bar are aligned.
- (3) Install rear seat track bolts. Tighten seat track bolts to 25 N·m (18 ft.lbs.) torque.
- (4) Install inboard seat belt buckles. Tighten bolts to 40 N·m (20 ft.lbs.) torque.
- (5) Pull seat release and move track rearward.
- (6) Install front seat track bolts. Tighten seat track bolts to 25 N·m (18 ft.lbs.) torque.
- (7) Align slider bars and install bolts. Tighten slider bar bolts to 8.5 N·m (6 ft.lbs.) torque.
- (8) Install seat.

BENCH SEAT BACK

REMOVAL

- (1) Move seat to the full forward position.
- (2) Release J-Strap and peel back side of cover (corner flap) (Fig. 3).
- (3) Remove bolts attaching seat back to seat cushion and separate seat back from seat cushion (Fig. 2).



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Fig. 2 Seat Back Removal/Installation

INSTALLATION

- (1) Align seat cushion with seat back.
- (2) Install bolts through seat back latch into seat cushion frame. Tighten bolts to 25 N·m (18 ft.lbs.) torque.
- (3) Pull side of cover (corner flap) facing rear of the cushion over and secure J-Strap (Fig. 3).
- (4) Plastic cover on side cover (corner flap) at rear of cushion must be over the pin on the inertia latches.

BENCH SEAT BACK COVER

REMOVAL

- (1) Remove seat back from vehicle.
- (2) Disengage J-Straps from base of seat back.
- (3) Remove hogrings, if equipped.
- (4) With seat back in a normal vertical position, roll cover upwards and remove.

REMOVAL AND INSTALLATION (Continued)

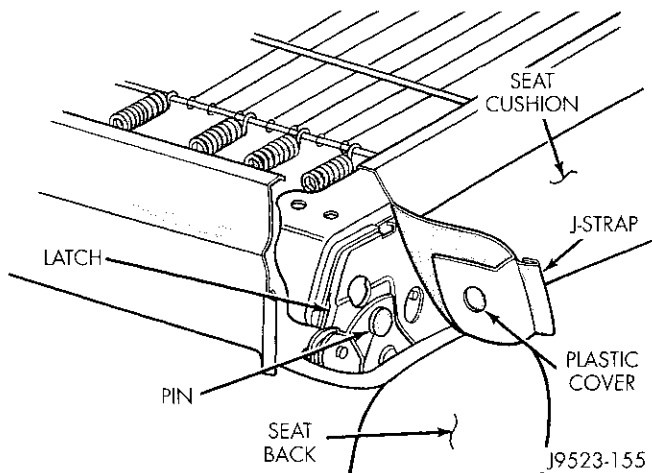


Fig. 3 J-Strap Corner Removal/Installation

INSTALLATION

- (1) With seat back in a normal vertical position, roll cover downwards over seat back.
- (2) Install hogrings, if equipped.
- (3) Secure J-Straps at base of seat back.
- (4) Install seat back.

BENCH SEAT CUSHION COVER

REMOVAL

- (1) Remove seat from vehicle.
- (2) Remove seat back.
- (3) Position seat cushion on a suitable work surface with frame side up.
- (4) Remove seat track.
- (5) Remove left and right side J-Straps.
- (6) Remove rear J-Strap.
- (7) Remove front J-Strap.
- (8) Roll trim cover off of front and rear corners and separate from foam cushion.

INSTALLATION

- (1) Position cushion cover on cushion and roll cover over front and rear corners.
- (2) Secure front J-Strap (Fig. 4).
- (3) Secure rear J-Strap.
- (4) Secure left and right side J-Straps.
- (5) Verify stitching lines are straight, correct as necessary.
- (6) Install seat track.
- (7) Install seat back.
- (8) Install seat.

SPLIT BENCH SEAT TRACK

REMOVAL

- (1) Disconnect power seat switch connector, if equipped.
- (2) Remove seat from vehicle.

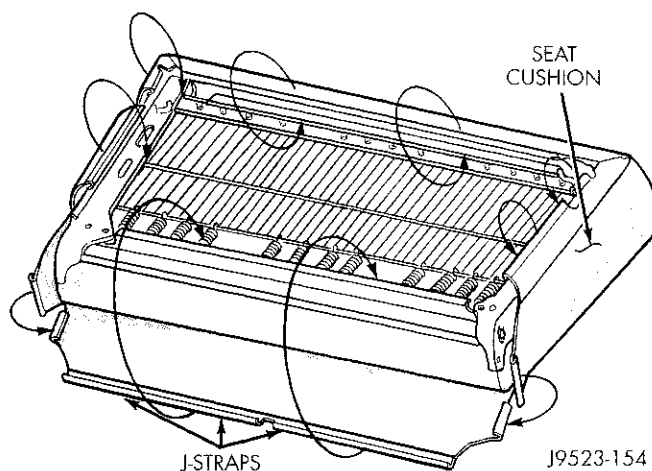


Fig. 4 J-Strap Installation

- (3) Remove bolts attaching seat track to seat frame (Fig. 5) and (Fig. 6).

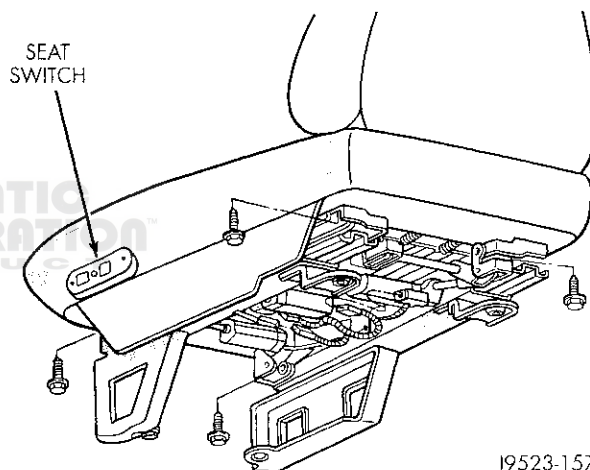


Fig. 5 Power Seat Track Removal/Installation

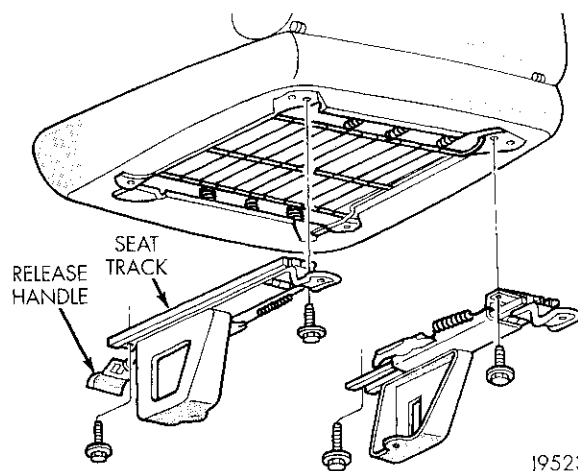


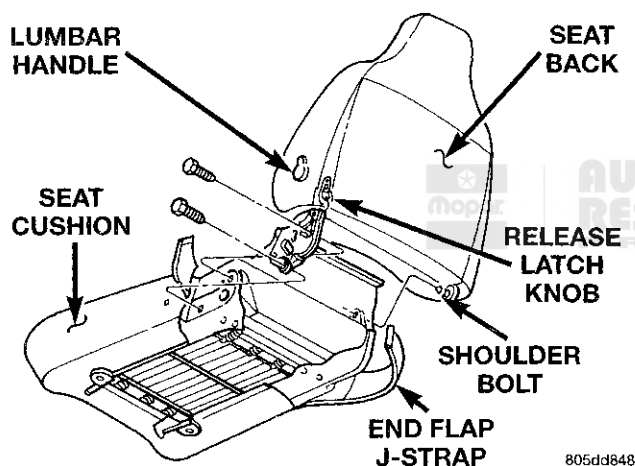
Fig. 6 Seat Track Removal/Installation

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

- (1) Install bolts attaching seat track to seat frame.
- (2) Install seat.
- (3) Connect power seat switch connector, if equipped.
- (4) Power adjuster on power seat must be cycled in all 6 functions to ensure the adjuster is working properly.

SPLIT BENCH SEAT BACK**REMOVAL**

- (1) Disconnect power seat switch connector, if equipped.
- (2) Remove center seat/console armrest.
- (3) Disconnect rear end flap J-Straps and peel back rear J-Strap.
- (4) Remove bolts attaching seat back to seat cushion frame.
- (5) Separate seat back from seat cushion (Fig. 7).

**Fig. 7 Seat Back Removal****INSTALLATION**

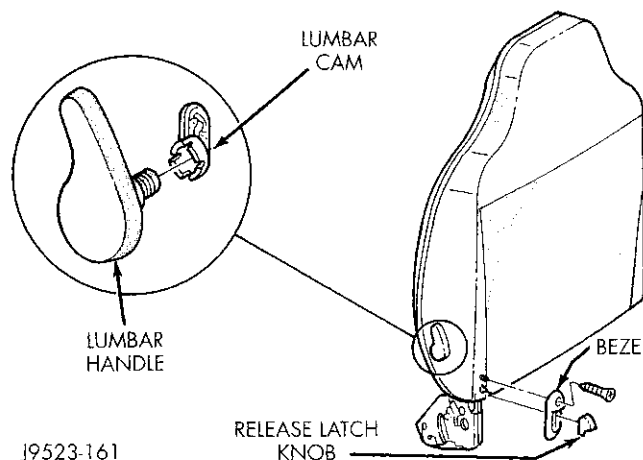
- (1) Align seat cushion with seat back and install shoulder bolt through seat back into seat cushion frame on inboard side. Tighten bolt to 49 N·m (36 ft.lbs.) torque.
- (2) Install bolts through seat back latch into seat cushion frame. Tighten bolts to 25 N·m (18 ft.lbs.) torque.
- (3) Connect rear end flap J-Straps and pull rear J-Strap up and secure to frame.
- (4) Install seat in vehicle.
- (5) Connect power seat switch connector, if equipped.

SPLIT BENCH SEAT BACK COVER**REMOVAL**

- (1) Using a trim stick or equivalent tool, pry off lumbar handle, if equipped (Fig. 8). (Damage to lum-

bar handle may occur during removal, verify availability of replacement handle before removing.)

- (2) Remove Latch release knob (Fig. 8).
- (3) Disengage J-Straps from base of seat back.
- (4) Remove hogrings, if equipped.
- (5) With seat back in a normal vertical position, roll cover upwards and remove.

**Fig. 8 Lumbar Handle Removal****INSTALLATION**

- (1) With seat back in a normal vertical position, roll cover downwards over seat back.
- (2) Install hogrings, if equipped.
- (3) Engage J-Straps at base of seat back.
- (4) Align lumbar handle with lumbar cam and tap on with rubber mallet until seated.
- (5) Install Latch release knob.
- (6) Install seat back on seat cushion.
- (7) Install seat.

SPLIT BENCH SEAT CUSHION COVER**REMOVAL**

- (1) Remove seat from vehicle.
- (2) Remove center seat/console armrest.
- (3) Remove seat tracks.
- (4) Remove seatback.
- (5) Position seat cushion on a suitable work surface with frame side up.
- (6) Remove rear J-Strap.
- (7) Remove Left and right J-Straps.
- (8) Remove front J-Strap.
- (9) Roll cushion cover off of foam cushion.

INSTALLATION

- (1) Position cushion cover on cushion and roll cover over front and rear corners. Verify stitching lines are straight, correct as necessary.
- (2) Pull front J-Strap up, align cover to foam notches and secure front J-Strap to frame (Fig. 9).

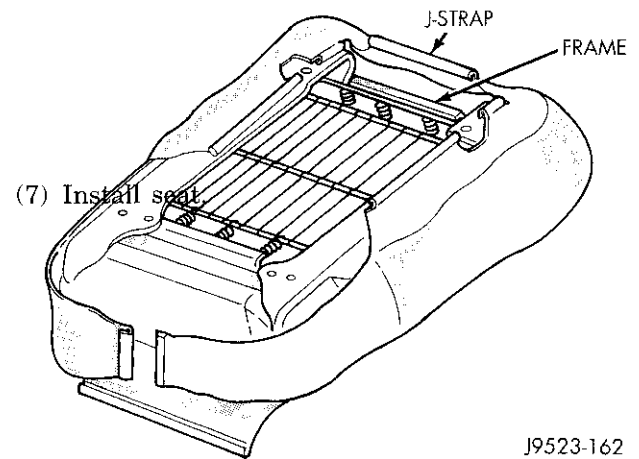
REMOVAL AND INSTALLATION (Continued)

(3) Pull the left J-Strap up and secure to frame.
Verify cover is straight.

(4) Pull the right side J-Strap up and secure to frame.

(5) Install seatback.

(6) Install seat tracks.



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Fig. 9 J-Strap Installation

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BODY COMPONENTS

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GENERAL INFORMATION**INTERIOR TRIM PANELS**

CAUTION: Do not attempt to remove interior trim panels/mouldings without first removing the necessary adjacent panels.

To avoid damaging the panels, ensure that all the screws and clips are removed before attempting to remove an interior trim panel/moulding. **Trim panels are somewhat flexible but can be damaged if handled improperly.**

DIAGNOSIS AND TESTING**WATER LEAKS**

Water leaks can be caused by poor sealing, improper body component alignment, body seam porosity, missing plugs, or blocked drain holes. Centrifugal and gravitational force can cause water to drip from a location away from the actual leak point, making leak detection difficult. All body sealing points should be water tight in normal wet driving conditions. Water flowing downward from the front of the vehicle should not enter the passenger or luggage compartment. Moving sealing surfaces will not always seal water tight under all conditions. At times, side glass or door seals will allow water to enter the passenger compartment during high pressure washing or hard driving rain (severe) conditions. Over compensating on door or glass adjustments to stop a water leak that occurs under severe conditions, can cause premature seal wear and excessive closing or latching effort. After completing a repair, water test vehicle to verify leak has stopped before returning vehicle to use.

VISUAL INSPECTION BEFORE WATER LEAK TESTS

Verify that floor and body plugs are in place, body drains are clear and body components are properly aligned and sealed. If component alignment or sealing is necessary, refer to the appropriate section of this group for proper procedures.

WATER LEAK TESTS

WARNING: DO NOT USE ELECTRIC SHOP LIGHTS OR TOOLS IN WATER TEST AREA, PERSONAL INJURY CAN RESULT.

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When the conditions causing a water leak have been determined, simulate the conditions as closely as possible.

- If a leak occurs with the vehicle parked in a steady light rain, flood the leak area with an open ended garden hose.

- If a leak occurs while driving at highway speeds in a steady rain, test the leak area with a reasonable velocity stream or fan spray of water. Direct the spray in the direction comparable to actual conditions.

- If a leak occurs when the vehicle is parked on an incline, hoist the end or side of the vehicle to simulate this condition. This method can be used when the leak occurs when the vehicle accelerates, stops or turns. If the leak occurs on acceleration, hoist the front of the vehicle. If the leak occurs when braking, hoist the back of the vehicle. If the leak occurs on left turns, hoist the left side of the vehicle. If the leak occurs on right turns, hoist the right side of the vehicle. For hoisting recommendations refer to Group 0, Lubrication and Maintenance, General Information section.

WATER LEAK DETECTION

To detect a water leak point of entry, do a water test and watch for water tracks or droplets forming on the inside of the vehicle. If necessary, remove interior trim covers or panels to gain visual access to the leak area. If the hose cannot be positioned without being held, have someone help do the water test.

Some water leaks must be tested for a considerable length of time to become apparent. When a leak appears, find the highest point of the water track or drop. The highest point usually will show the point of entry. After leak point has been found, repair the leak and water test to verify that leak has stopped.

Locating the entry point of water that is leaking into a cavity between panels can be difficult. The trapped water splashes or runs from the cavity it is dammed up in, often at a distance from the entry point. Most water leaks of this type become apparent after accelerating, stopping, turning, or when on an incline.

MIRROR INSPECTION METHOD

When a leak point area is visually obstructed, use a suitable mirror to gain visual access. A mirror can also be used to deflect light to a limited access area to assist in locating a leak point.

DIAGNOSIS AND TESTING (Continued)

BRIGHT LIGHT LEAK TEST METHOD

Some water leaks in the luggage compartment can be detected without water testing. Position the vehicle in a brightly light area. From inside the darkened luggage compartment inspect around seals and body seams. If necessary, have a helper direct a drop light over the suspected leak areas around the luggage compartment. If light is visible through a normally sealed location, water could enter through the opening.

PRESSURIZED LEAK TEST METHOD

When a water leak into the passenger compartment can not be detected by water testing, pressurize the passenger compartment and soap test exterior of the vehicle. To pressurize the passenger compartment, close all doors and windows, start engine, and set heater control to high blower in HEAT position. If engine can not be started, connect a charger to the battery to assure adequate voltage to the blower. With interior pressurized, apply dish detergent solution to suspected leak area on the exterior of the vehicle. Apply detergent solution with spray device or soft bristle brush. If soap bubbles occur at a body seam, joint, seal or gasket the leak entry point could be at that location.

WIND NOISE

Wind noise is the result of most air leaks. Air leaks can be caused by poor sealing, improper body component alignment, body seam porosity, or missing plugs in the engine compartment or door hinge pillar areas. All body sealing points should be air tight in normal driving conditions. Moving sealing surfaces will not always seal air tight under all conditions. At times, side glass or door seals will allow wind noise to be noticed in the passenger compartment during high cross-winds. Over compensating on door or glass adjustments to stop wind noise that occurs under severe conditions, can cause premature seal wear and excessive closing or latching effort. After a repair procedure has been performed, test vehicle to verify noise has stopped before returning vehicle to use.

Wind noise can also be caused by improperly fitted exterior moldings or body ornamentation. Loose moldings can flutter, creating a buzzing or chattering noise. An open cavity or protruding edge can create whistling or howling noise. Inspect the exterior of the vehicle to verify that these conditions do not exist.

VISUAL INSPECTION BEFORE TESTS

Verify that floor and body plugs are in place and body components are aligned and sealed. If component alignment or sealing is necessary, refer to the appropriate section of this group for proper procedures.

ROAD TESTING WIND NOISE

(1) Drive the vehicle to verify the general location of the wind noise.

(2) Apply 50 mm (2 in.) masking tape in 150 mm (6 in.) lengths along weatherstrips, weld seams or moldings. After each length is applied drive vehicle. If noise goes away after a piece of tape is applied, remove tape, locate and repair defect.

POSSIBLE CAUSE OF WIND NOISE

- Moldings standing away from body surface can catch wind and whistle.
- Gaps in sealed areas behind overhanging body flanges can cause wind rushing sounds.
- Misaligned movable components.
- Missing or improperly installed plugs in pillars.
- Weld burn through holes.

SERVICE PROCEDURES

BODY LUBRICATION

All mechanisms and linkages should be lubricated when necessary. This will maintain ease of operation and provide protection against rust and excessive wear. The weatherstrip seals should be lubricated to prolong their life as well as to improve door sealing.

All applicable exterior and interior vehicle operating mechanisms should be:

- Inspected.
- Cleaned.
- Pivot/sliding contact areas on the mechanisms should then be lubricated.

(1) When necessary, lubricate the operating mechanisms with the specified lubricants.

(2) Apply silicone lubricant to a cloth and wipe it on door seals to avoid over-spray that can soil passenger clothing.

(3) Before applying lubricant, the component should be wiped clean. After lubrication, any excess lubricant should be removed.

(4) The hood latch, latch release mechanism, latch striker and safety latch should be lubricated periodically.

(5) The door lock cylinders should be lubricated 2 times each year (preferably autumn and spring):

- Spray a small amount of lock cylinder lubricant directly into the lock cylinder.
- Apply a small amount to the key and insert it into the lock cylinder.
- Rotate it to the locked position and then back to the unlocked position several times.
- Remove the key. Wipe the lubricant from it with a clean cloth to avoid soiling of clothing.

REMOVAL AND INSTALLATION

GRILLE

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove bolt holding bottom of grille to frame.
- (4) Remove bolts holding sides of grille to frame.
- (5) Remove nuts holding grille to hood (Fig. 1).
- (6) Separate grille from vehicle.

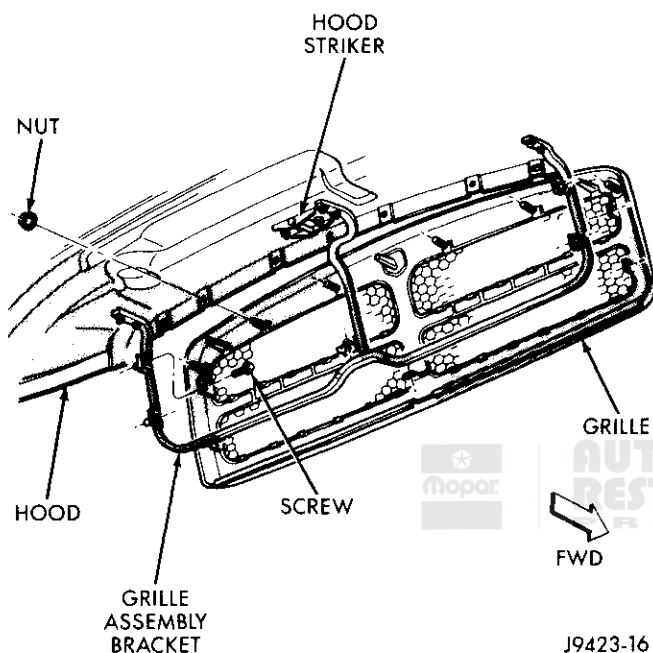


Fig. 1 Grille

INSTALLATION

Reverse the preceding operation.

GRILLE FRAME

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove bolts holding guide loop for hood safety catch release rod to grille frame.
- (4) Remove grille.
- (5) Remove screws holding grille frame to hood (Fig. 2).
- (6) Separate grille frame from vehicle.

INSTALLATION

Reverse the preceding operation.

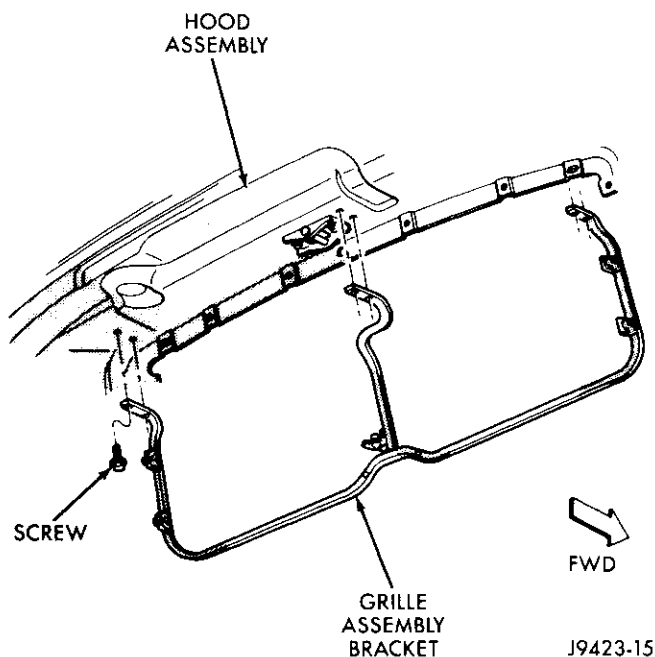


Fig. 2 Grille Mounting Frame

GRILLE SEALS

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove push-in fasteners holding seals to bottom of grille (Fig. 3).
- (4) Separate seals from grille.

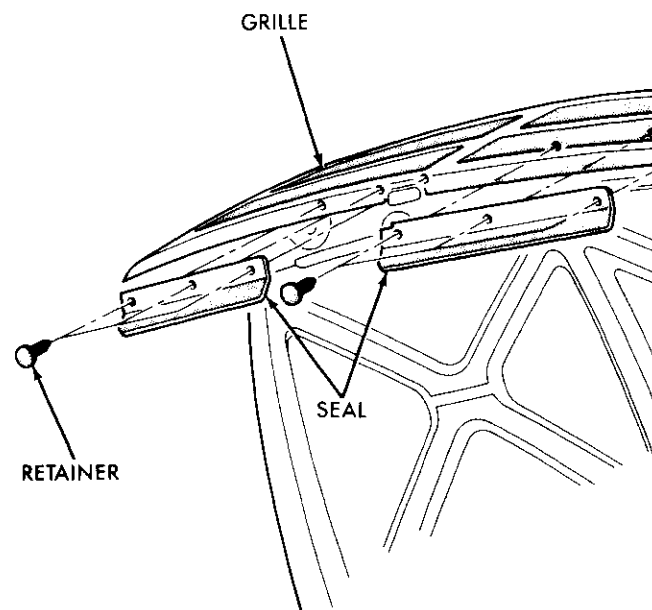


Fig. 3 Grille Seals

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

Reverse the preceding operation.

HOOD**REMOVAL**

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Disconnect the under hood lamp wire connector.
- (4) Mark all bolt and hinge attachment locations with a grease pencil or other suitable device to provide reference marks for installation.
- (5) Remove the top hood to hinge attaching bolts and loosen the bottom bolts until they can be removed by hand (Fig. 4).
- (6) With assistance of a helper at the opposite side of the vehicle to support the hood, remove the bottom hood to hinge attaching bolts. Separate the hood from the vehicle.

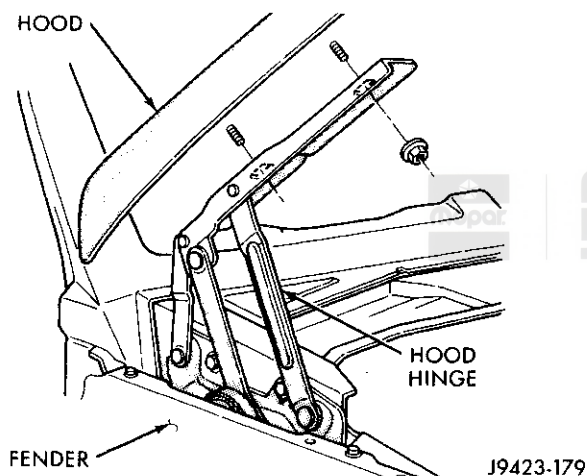


Fig. 4 Hood

INSTALLATION

Align all marks and secure bolts. The hood should be aligned to 5 mm (0.2 in.) gap to the front fenders and flush across the top surfaces along fenders.

Reverse the preceding operation.

HOOD SILENCER**REMOVAL**

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove push-in fasteners holding silencer to hood (Fig. 5).
- (4) Separate hood silencer from vehicle.

INSTALLATION

Reverse the preceding operation.

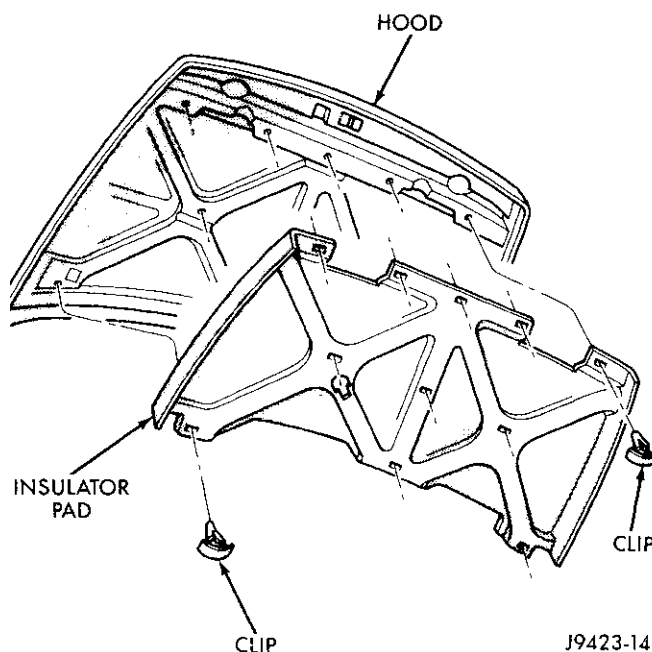


Fig. 5 Hood Silencer

HOOD HINGE**REMOVAL**

- (1) Support hood on the side that requires hinge replacement.
- (2) Mark all bolt and hinge attachment locations with a grease pencil or other suitable device to provide reference marks for installation. When installing hood hinge, align all marks and secure bolts. The hood should be aligned to 5 mm (0.2 in.) gap to the front fenders and flush across the top surfaces along fenders. Shims can be added or removed under hood hinge to achieve proper hood height.
- (3) Remove hood to hinge attaching bolts (Fig. 6).
- (4) Remove hood hinge to cowl panel attaching bolts and separate hinge from vehicle.

INSTALLATION

Reverse the preceding operation. If necessary, paint new hinge before installation.

HOOD SAFETY CATCH**REMOVAL**

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove bolts holding hood safety catch to hood (Fig. 7).
- (4) Separate safety catch from vehicle.

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)

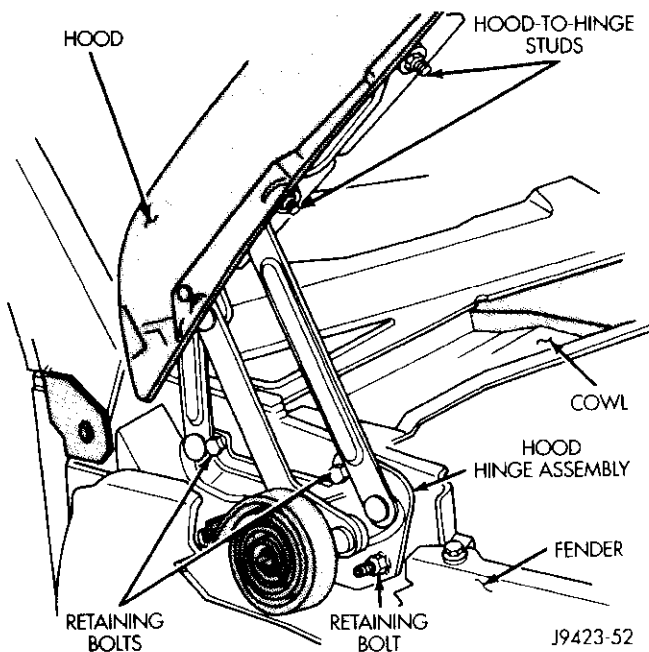


Fig. 6 Hood Hinge

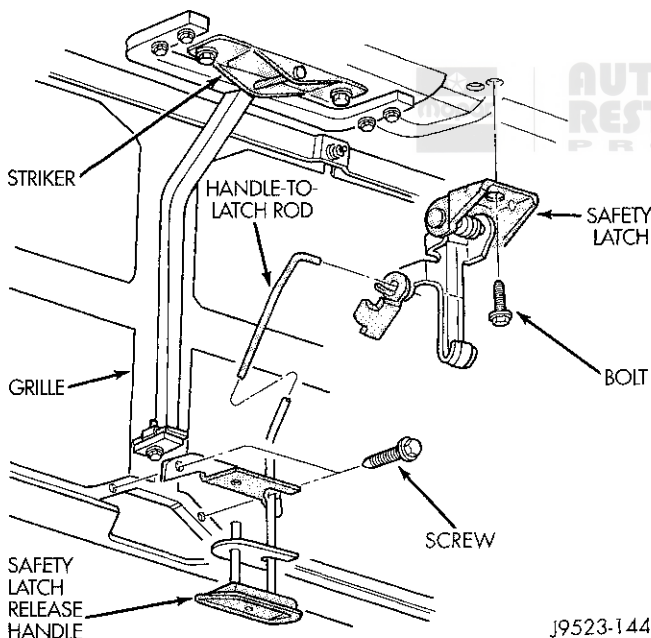


Fig. 7 Hood Safety Catch and Latch Striker

HOOD LATCH STRIKER

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove bolts holding hood latch striker to hood (Fig. 7).
- (4) Separate hood latch striker from vehicle.

INSTALLATION

Reverse the preceding operation.

HOOD LATCH

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove bolts holding hood latch to radiator closure panel crossmember (Fig. 8).
- (4) Separate hood latch from crossmember.
- (5) Disconnect release cable from hood latch.

INSTALLATION

Reverse the preceding operation.

HOOD RELEASE CABLE

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove hood latch.
- (4) Disconnect release cable from hood latch.
- (5) Detach the release cable from the retainer clips in the engine compartment.
- (6) Separate the release cable grommet from the dash panel hole.
- (7) From the inside of the vehicle, remove the screws attaching the hood release handle to the bottom of the instrument panel.
- (8) Pull/route the hood release cable through the dash panel hole and remove it via the inside of the vehicle.

INSTALLATION

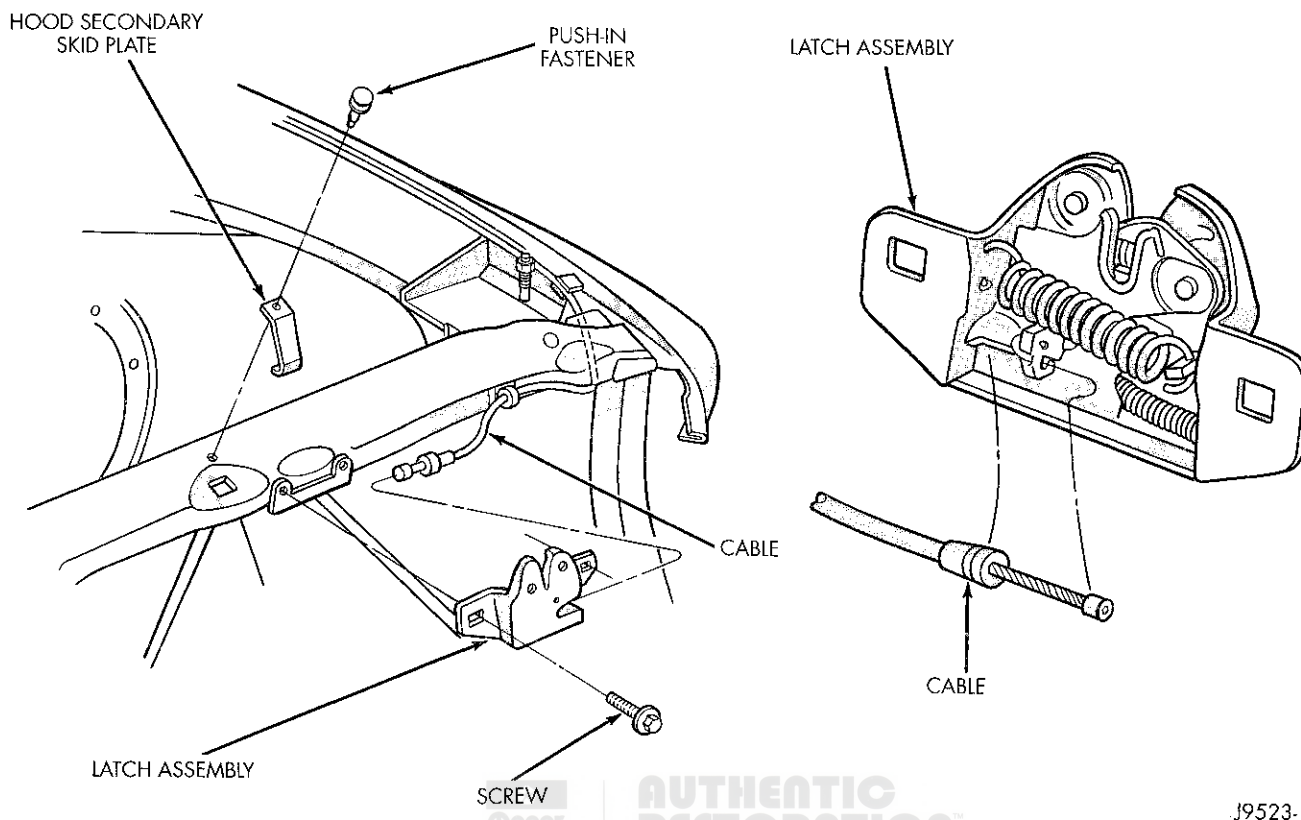
NOTE: If replacement hood latch is also being installed, ensure that it is thoroughly lubricated.

- (1) From inside the vehicle, pull/route the hood release cable through the dash panel hole and into the engine compartment.
- (2) Install the hood release handle.
- (3) Install the cable grommet in the dash panel hole.
- (4) Attach the release cable to the retainer clips in the engine compartment.
- (5) Attach release cable to hood latch.
- (6) Install hood latch.
- (7) Test the hood latch release cable for proper operation.

COWL COVER

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.

REMOVAL AND INSTALLATION (Continued)**Fig. 8 Hood Latch**

(3) Remove wiper arms, refer to Group 8K, Windshield Wipers and Washers.

(4) Disconnect windshield washer tubing from coupling near left hood hinge.

(5) Remove retainers holding cowl cover to cowl box (Fig. 9).

(6) Pull cowl seal from pinch flange a front of cowl.

(7) Separate cowl cover from vehicle.

INSTALLATION

Reverse the preceding operation.

FRONT WHEELHOUSE LINER**REMOVAL**

(1) Hoist and support vehicle on safety stands.

(2) Remove front wheel.

(3) Remove plastic rivets holding wheelhouse liner to fender at the edge of wheel opening.

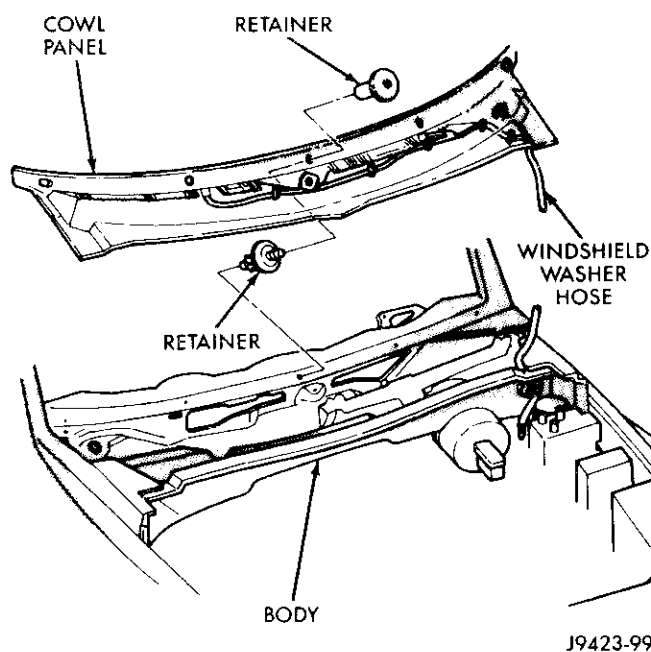
(4) Remove plastic rivets holding liner to the wheelhouse (Fig. 10).

(5) Remove plastic rivets holding liner to front bumper fascia.

(6) Separate front wheelhouse liner from vehicle.

INSTALLATION

Reverse the preceding operation.

**Fig. 9 Cowl Cover**

REMOVAL AND INSTALLATION (Continued)

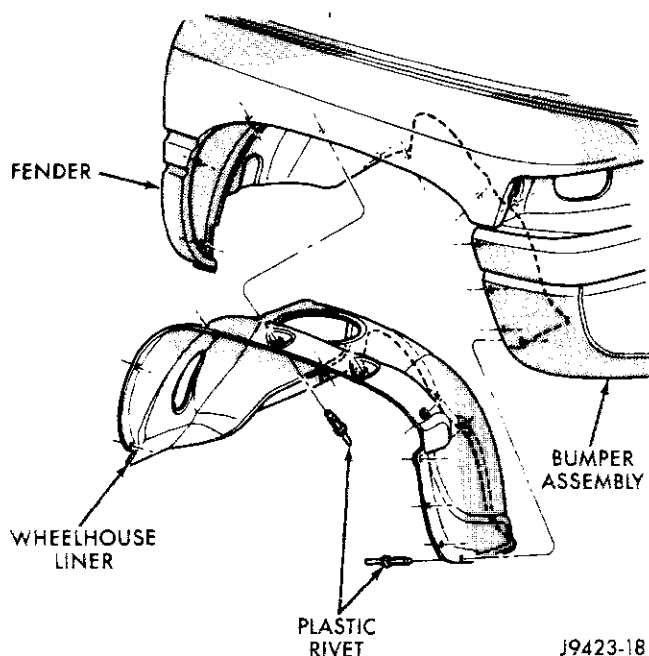


Fig. 10 Front Wheelhouse Liner

LEFT FRONT FENDER

REMOVAL

- (1) Release primary hood latch.
- (2) Release hood safety catch and open hood.
- (3) Remove front bumper, refer to Group 13, Bumpers and Frame for procedures.
- (4) Remove air cleaner from wheelhouse (DIESEL ONLY).
- (5) Remove coolant overflow bottle (V-10 ONLY).
- (6) Remove battery and tray, refer to Group 8B, Battery/Starter/Generator Service for procedures.
- (7) Remove screws holding power distribution center to left wheelhouse (Fig. 11).
- (8) Disengage wire harness tie-downs from wheelhouse.
- (9) Disconnect wiring harness to headlamp connector.
- (10) Disconnect wiring harness to airbag sensor and remove airbag sensor from wheelhouse.
- (11) Remove bolts holding anti-lock brake controller to wheelhouse (Fig. 11), if equipped. Refer to Group 5, Brakes for procedures.
- (12) Disengage windshield washer tubing tie-downs from wheelhouse (Fig. 11).
- (13) Remove bolts holding front fender to cowl reinforcement (Fig. 12).
- (14) Remove bolts holding front fender to radiator closure panel (Fig. 13).
- (15) Remove bolts holding bottom of front fender to rocker panel lower flange (Fig. 14).
- (16) Open left door.

(17) Remove bolt holding front fender to hinge pillar mounting bracket (Fig. 14).

(18) Remove bolts holding top of fender to radiator closure panel (Fig. 14).

(19) Separate left front fender from vehicle.

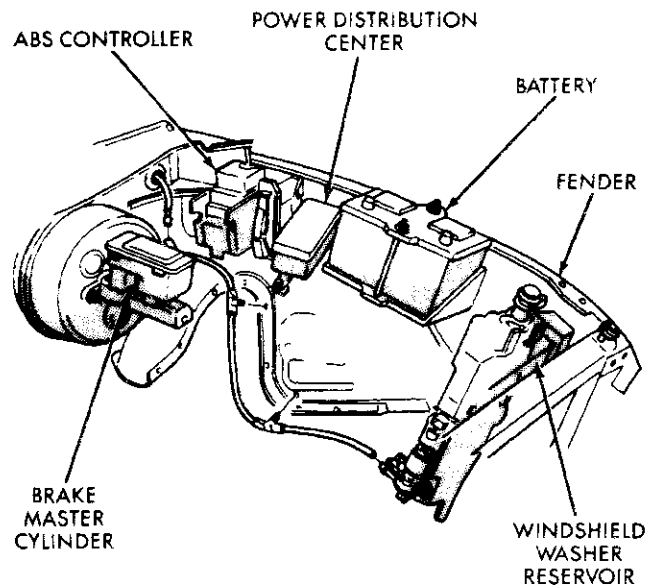
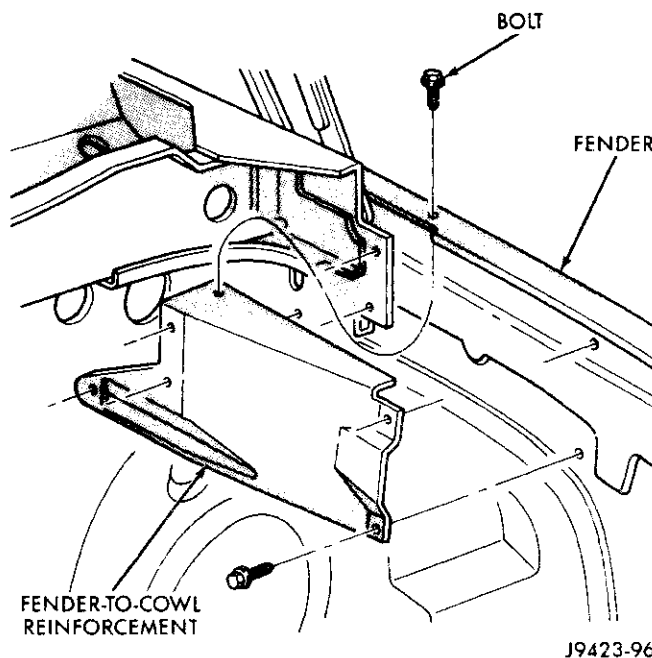
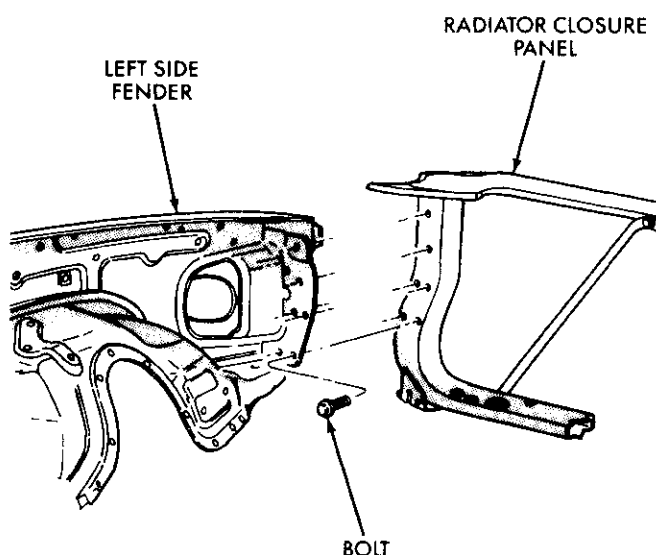


Fig. 11 Left Front Fender Access Components

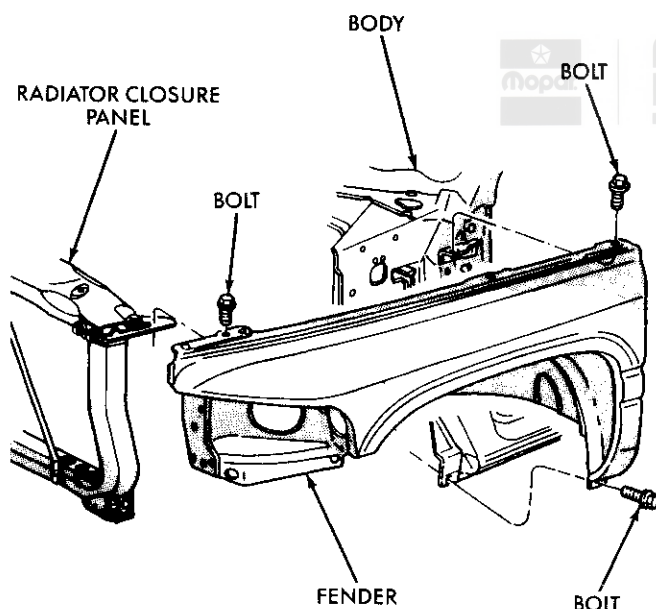


**Fig. 12 Fender to Cowl Reinforcement—Typical
INSTALLATION**

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)

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Fig. 13 Left Fender to Radiator Closure Panel Fasteners

J9423-170

Fig. 14 Left Front Fender**RIGHT FRONT FENDER****REMOVAL**

(1) Remove front bumper, refer to Group 13, Bumpers and Frame for procedures.

(2) Remove auxiliary battery and tray on right side, if equipped. Refer to Group 8B, Battery/Starter/Generator Service for procedures.

(3) Disengage wire harness tie-downs from wheelhouse.

(4) Disconnect wiring harness to headlamp connector.

(5) Disconnect wiring harness to airbag sensor and remove airbag sensor from wheelhouse.

(6) Remove front wheelhouse liner (Fig. 10).

(7) Disengage air conditioning tubing from inner fender clips.

(8) Remove bolts holding front fender to cowl reinforcement (Fig. 12).

(9) Remove bolts holding front fender to radiator closure panel (Fig. 15).

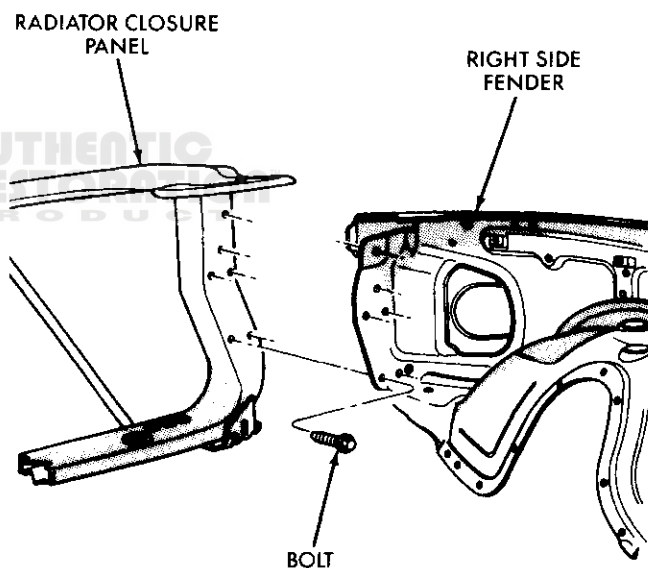
(10) Remove bolts holding bottom of front fender to rocker panel lower flange (Fig. 16).

(11) Open right door.

(12) Remove bolt holding front fender to hinge pillar mounting bracket (Fig. 16).

(13) Remove bolts holding top of fender to radiator closure panel (Fig. 16).

(14) Separate right front fender from vehicle.



J9423-95

Fig. 15 Right Fender to Radiator Closure Panel Fasteners**INSTALLATION**

Reverse the preceding operation.

EXTERIOR NAMEPLATES**REMOVAL**

(1) Insert a plastic trim stick or a hard wood wedge behind the emblem to separate the adhesive backing from the body (Fig. 17) and (Fig. 18).

(2) Clean adhesive residue from body with MOPAR Super Clean solvent or equivalent.

REMOVAL AND INSTALLATION (Continued)

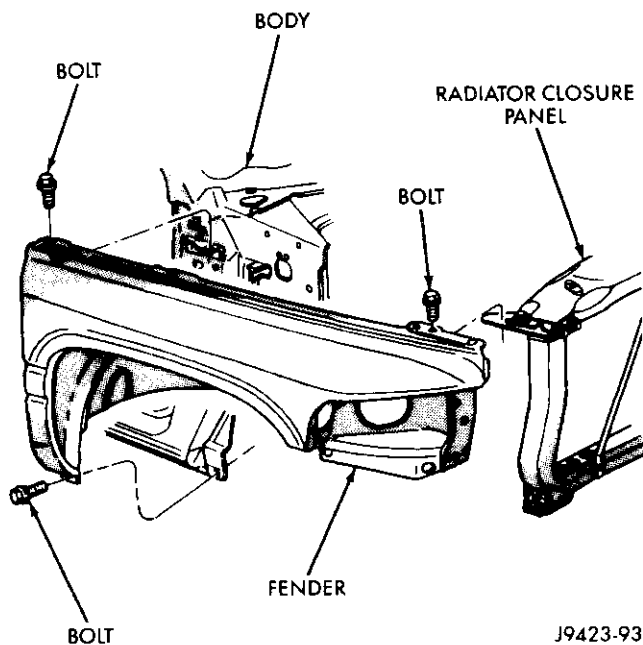
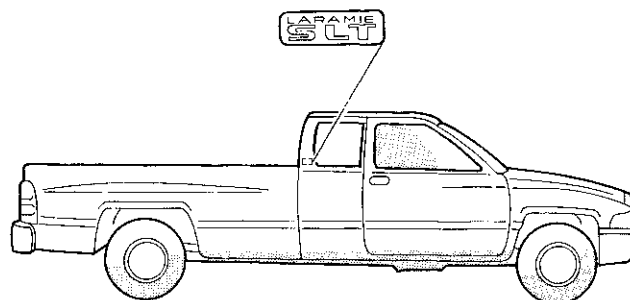


Fig. 16 Right Front Fender

INSTALLATION

When a new emblem is being installed, steps 1, 2 and 3 installation procedure are not required.



J9523-126

Fig. 18 Exterior Nameplates—Club Cab

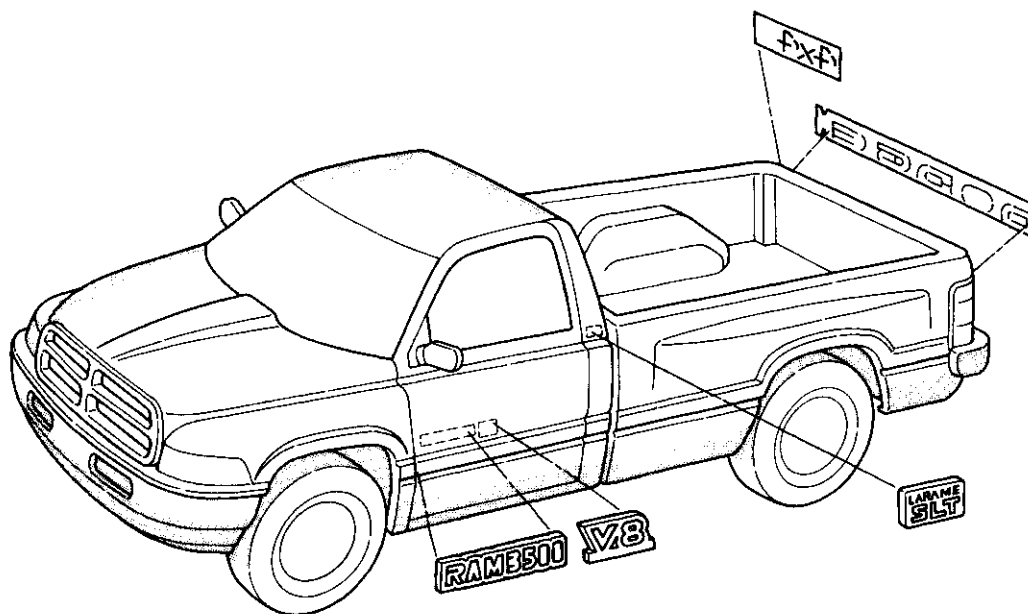
(1) If The original emblem is to be reused, peel old adhesive tape from back of emblem.

(2) Clean adhesive residue from emblem with Mopar Super Clean solvent or equivalent.

(3) Cover the back of emblem with two sided adhesive tape. Trim tape to fit emblem. Tape can be acquired from automotive paint retailer.

(4) Remove protective cover from adhesive tape on back of emblem.

(5) Position emblem properly on body.



J9423-182

Fig. 17 Exterior Nameplates

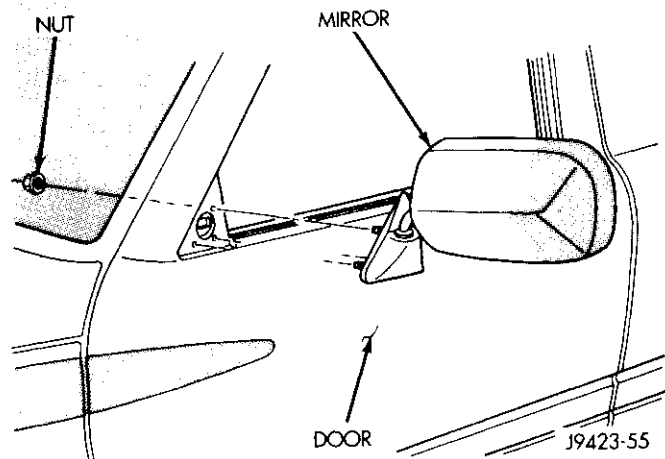
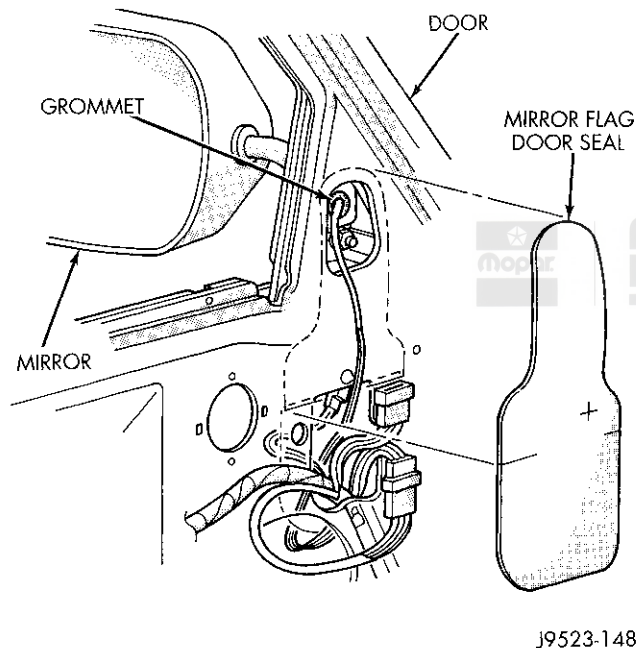
REMOVAL AND INSTALLATION (Continued)

(6) Press emblem firmly to body with palm of hand.

(7) If temperature is below 21°C (70°F) warm emblem with a heat lamp or gun to assure adhesion. Do not exceed 65°C (150°F) when heating emblem.

SIDE VIEW MIRROR**REMOVAL**

- (1) Remove door trim panel.
- (2) Remove mirror flag door seal (Fig. 19).
- (3) Disengage power mirror wire connector from door harness, if equipped.
- (4) Remove nuts holding side view mirror to door frame (Fig. 20).
- (5) Separate harness grommet from door frame, if equipped.
- (6) Separate side view mirror from vehicle.

**Fig. 20 Side View Mirror****Fig. 19 Mirror Flag Door Seal****INSTALLATION**

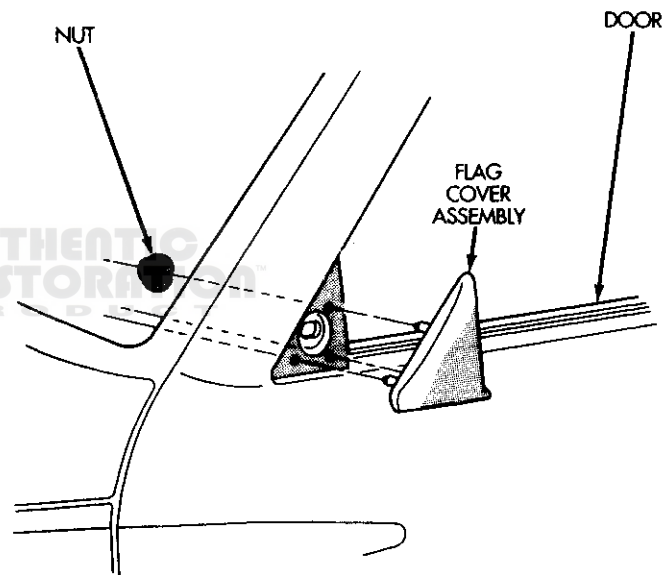
Reverse the preceding operation.

MIRROR FLAG COVER**REMOVAL**

- (1) Remove door trim panel.
- (2) Remove flag door seal.
- (3) Remove nuts holding door flag cover to door frame (Fig. 21).
- (4) Separate flag cover from vehicle.

INSTALLATION

Reverse the preceding operation.

**Fig. 21 Mirror Flag Cover****LOW MOUNTED SIDE VIEW MIRROR****REMOVAL**

- (1) Remove bolts holding lower support legs to outer door panel.
- (2) Remove bolts holding upper support arms to outer door panel (Fig. 22).
- (3) Separate mirror from vehicle.

INSTALLATION

Place insulation washers between support frame and painted door panel and reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)

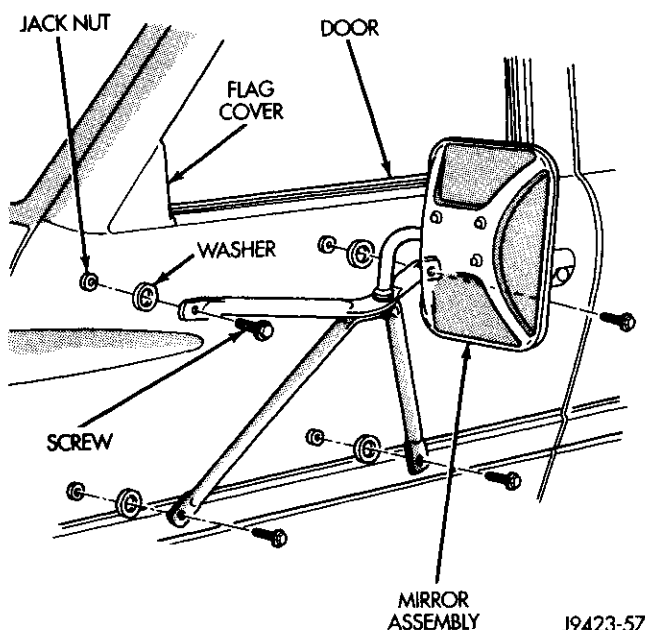


Fig. 22 Low Mounted Side View Mirror

FRONT DOOR TRIM PANEL

REMOVAL

- (1) Release door latch and open door.
- (2) Roll window down.
- (3) Remove window crank (Fig. 23), if equipped.
- (4) Remove screws holding door trim panel to door from inside arm rest pull cup (Fig. 24).
- (5) Disengage clips holding power window/lock switch panel to door trim panel (Fig. 25). Disengage wire connectors from switch panel, if equipped.
- (6) Remove screw holding door trim to outside mirror frame.
- (7) Using a trim panel removal tool, disengage clips holding door trim to door around perimeter of trim panel.
- (8) Disengage power mirror wire connector, if equipped.
- (9) While holding bottom of trim panel away from door, simultaneously lift upward and forward.
- (10) Separate door trim panel from inner belt weatherstrip.
- (11) Disengage power outside mirror wire connector from control switch.
- (12) Separate door trim panel from vehicle.

INSTALLATION

Reverse the preceding operation.

FRONT DOOR WATER DAM

REMOVAL

- (1) Remove door trim panel.

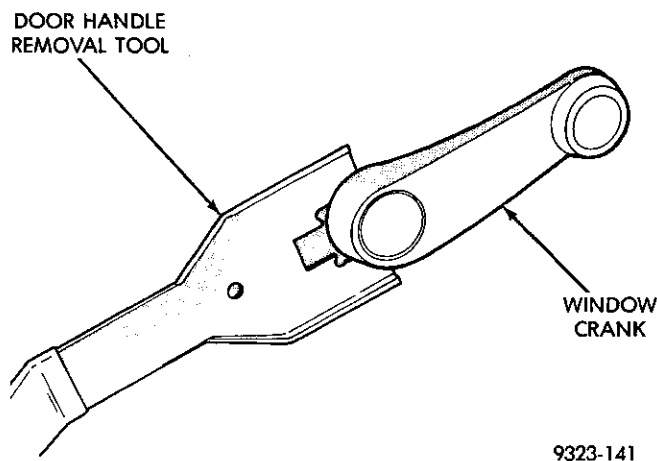


Fig. 23 Window Crank—Typical

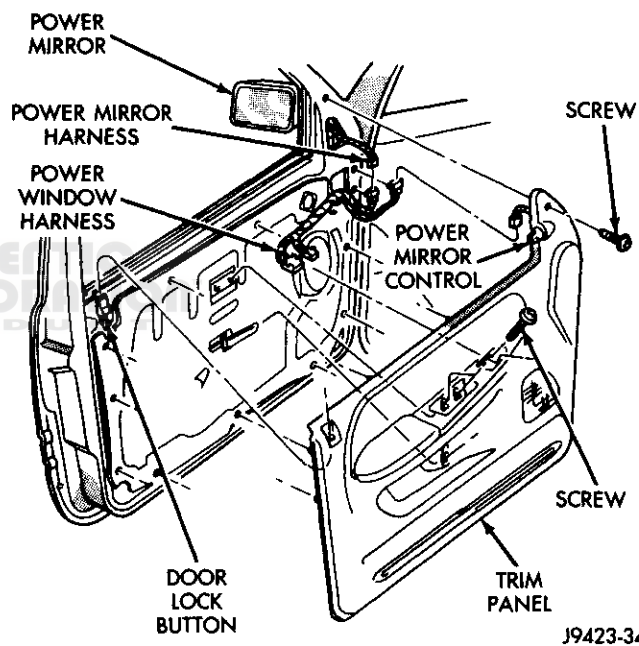


Fig. 24 Door Trim Panel

- (2) Peel water dam away from adhesive around perimeter of inner door panel (Fig. 26).

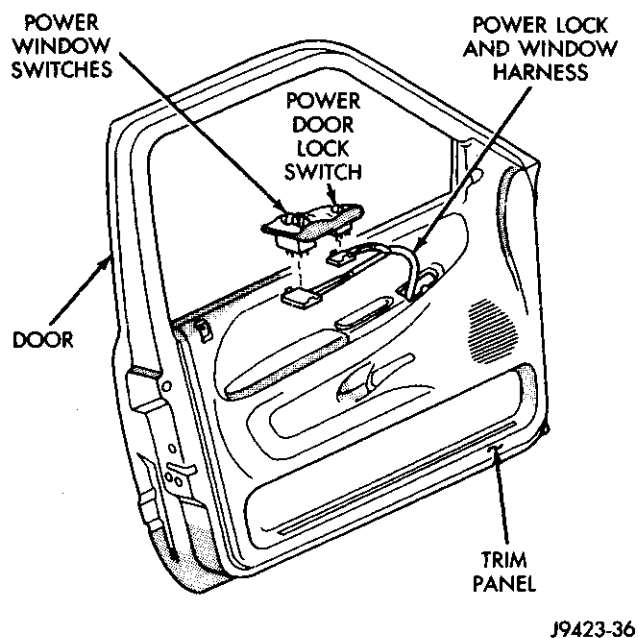
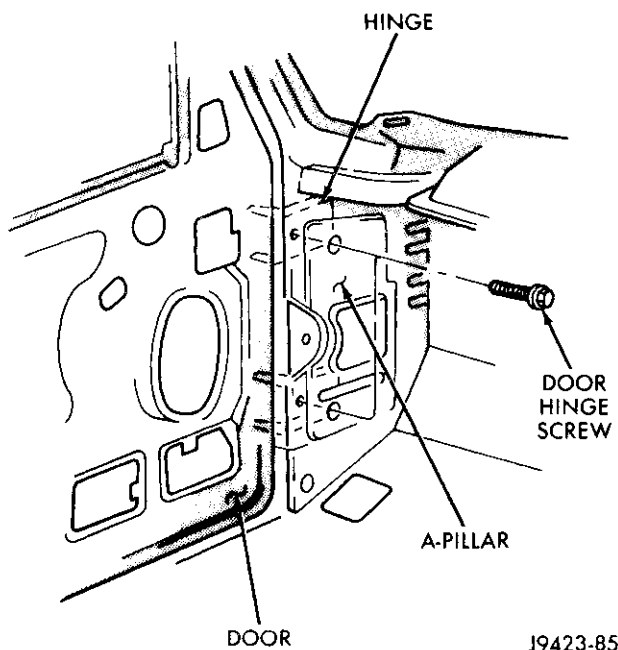
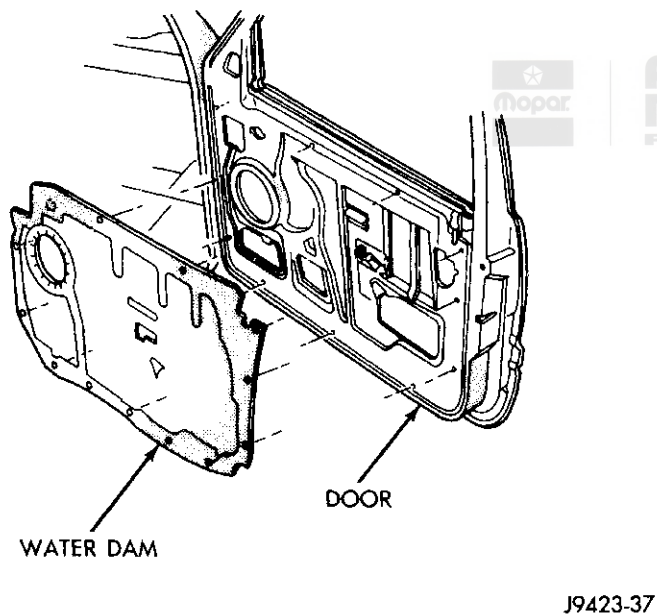
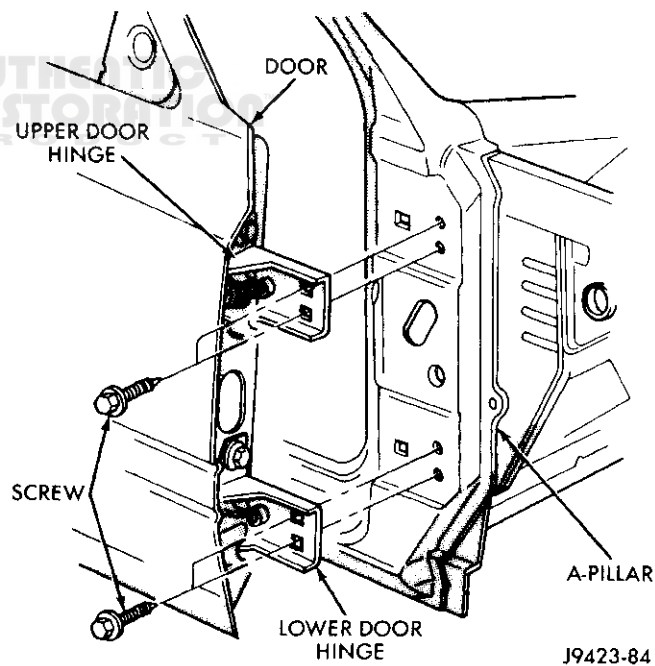
INSTALLATION

Reverse the preceding operation.

FRONT DOOR

REMOVAL

- (1) Release door latch and open door.
- (2) Remove cowl trim panel.
- (3) Disengage door wire harness connector of instrument panel harness and push door harness through access hole in pillar.
- (4) Remove hidden bolts holding door hinge to hinge pillar from behind cowl panel (Fig. 27).

REMOVAL AND INSTALLATION (Continued)**Fig. 25 Power Window/Lock Switch Panel****Fig. 27 Door Hinge Hidden Bolt****Fig. 26 Door Water Dam****Fig. 28 Door**

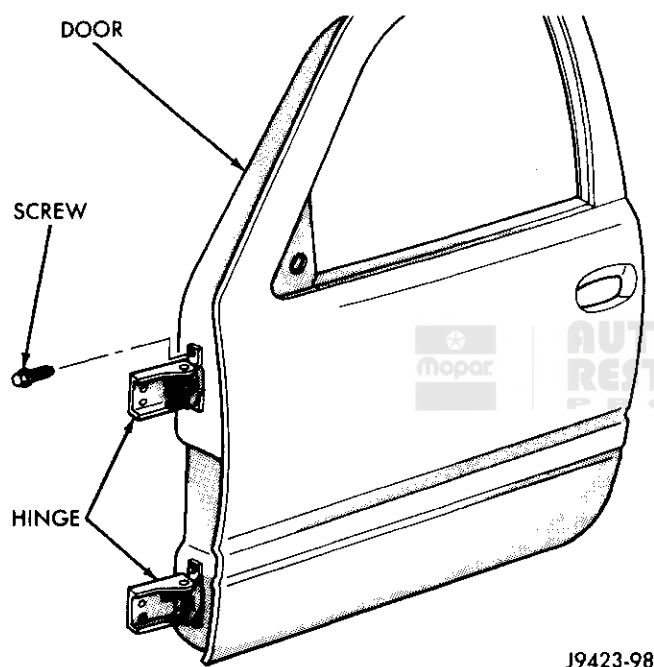
- (5) Using a suitable marker, mark the outline of the door hinges on the hinge pillar to aid installation.
- (6) Support door on a suitable lifting device.
- (7) Remove bolts holding lower door hinge to hinge pillar (Fig. 28).
- (8) While holding the door steady on lift, remove bolts holding upper door hinge to hinge pillar.
- (9) Separate door from vehicle.

INSTALLATION

Reverse the preceding operation. Align door to achieve equal spacing on all sides and flush across the gaps.

REMOVAL AND INSTALLATION (Continued)**FRONT DOOR HINGE****REMOVAL**

- (1) Release door latch and open door.
- (2) Remove cowl trim panel.
- (3) Remove hidden bolt holding door hinge to hinge pillar (Fig. 27).
- (4) Support door on a suitable lifting device.
- (5) Using a suitable marker, mark the outline of the door hinge on the hinge pillar to aid installation.
- (6) Remove bolts holding door hinge to hinge pillar (Fig. 28).
- (7) Remove bolts holding door hinge to door end frame (Fig. 29).
- (8) Separate door hinge from vehicle.



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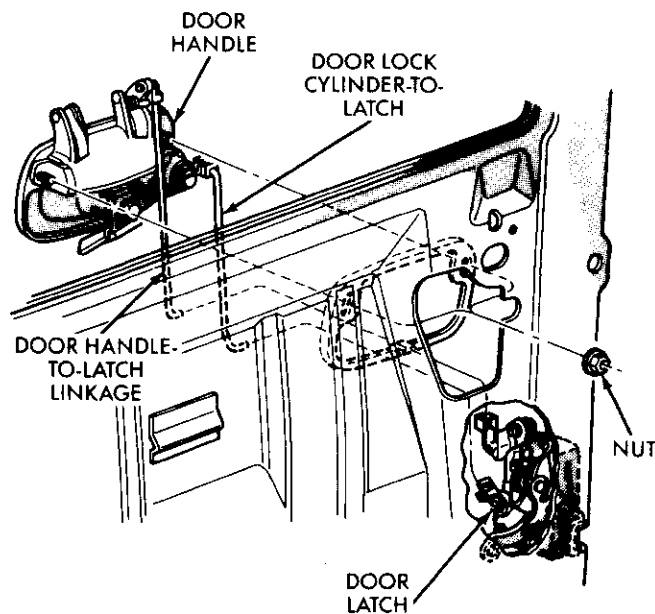
Fig. 29 Door Hinge**INSTALLATION**

Reverse the preceding operation. If necessary, paint replacement door hinge before installation.

FRONT DOOR OUTSIDE HANDLE**REMOVAL**

- (1) Remove door trim panel.
- (2) Remove water dam as necessary to gain access to door handle.
- (3) Roll glass up.
- (4) Remove fastener access plug from door end panel.
- (5) Disengage clips holding latch and lock rods to door latch.
- (6) Separate latch and lock rods from door latch.
- (7) Remove nuts holding outside door handle retaining bracket to door handle (Fig. 30).

- (8) Separate retaining bracket from door.
- (9) Separate outside door handle from vehicle.



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Fig. 30 Outside Door Handle**INSTALLATION**

Reverse the preceding operation.

FRONT DOOR LOCK CYLINDER**REMOVAL**

- (1) Remove outside door handle.
- (2) Remove clip holding lock cylinder to outside door handle (Fig. 31).
- (3) Pull door lock from door handle.

INSTALLATION

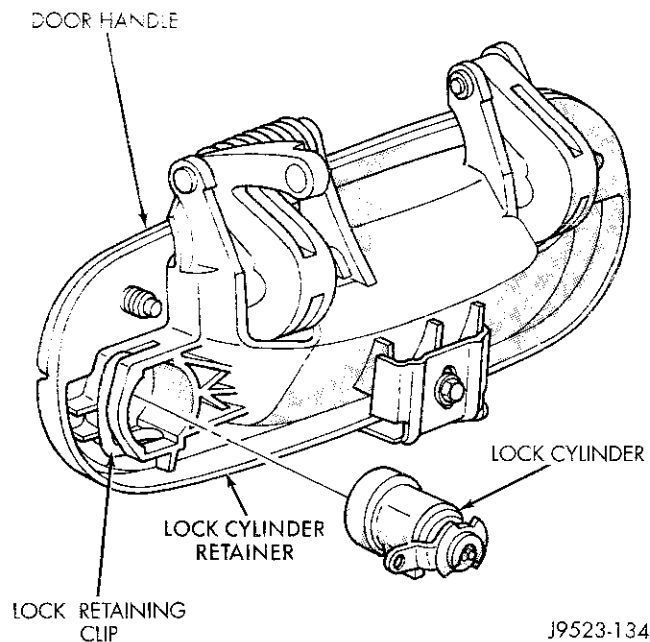
Reverse the preceding operation.

FRONT DOOR LATCH**REMOVAL**

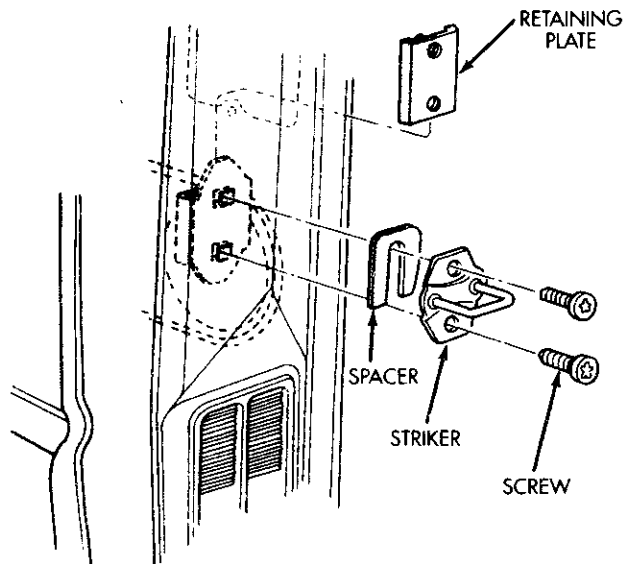
- (1) Remove door trim panel.
- (2) Remove water dam.
- (3) Disengage clips holding lock and latch rods to door latch.
- (4) Remove screws holding door latch to door end panel (Fig. 32).
- (5) Separate door latch/lock from vehicle.

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 31 Door Lock Cylinder****INSTALLATION**

Reverse the preceding operation.

**Fig. 33 Front Door Latch Striker****FRONT DOOR INSIDE HANDLE ACTUATOR****REMOVAL**

- (1) Raise the window to the closed position.
- (2) Remove the door trim panel and water dam.
- (3) Remove the screws attaching the actuator to the door.

INSTALLATION

- (1) Install the screws attaching the actuator to the door.
- (2) Test handle for proper operation.
- (3) Install the door water dam and trim panel.

FRONT DOOR INNER BELT WEATHERSTRIP**REMOVAL**

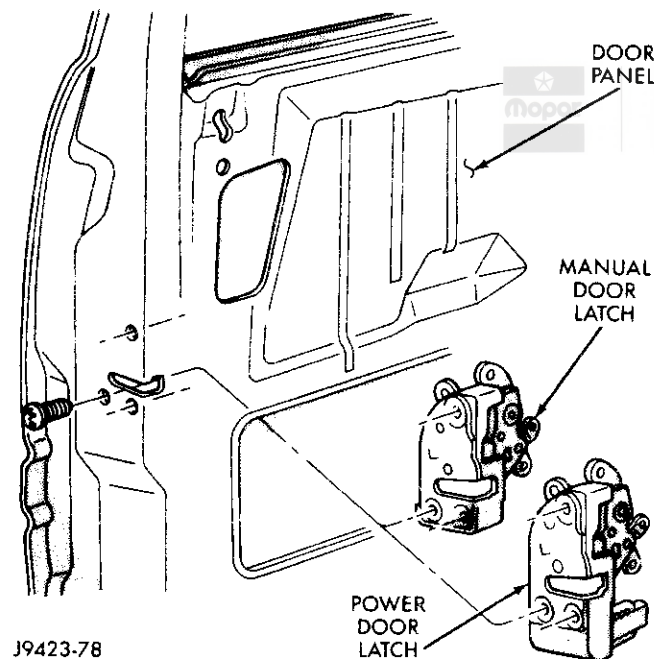
- (1) Remove door trim panel.
- (2) Lift inner door belt weatherstrip upward (Fig. 34).
- (3) Separate inner door belt weatherstrip from door.

INSTALLATION

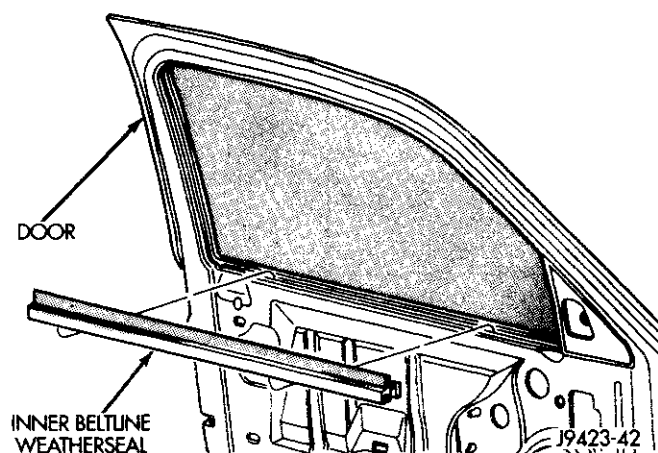
Reverse the preceding operation.

FRONT DOOR OUTER BELT WEATHERSTRIP**REMOVAL**

- (1) Roll door glass down.
- (2) Remove mirror.

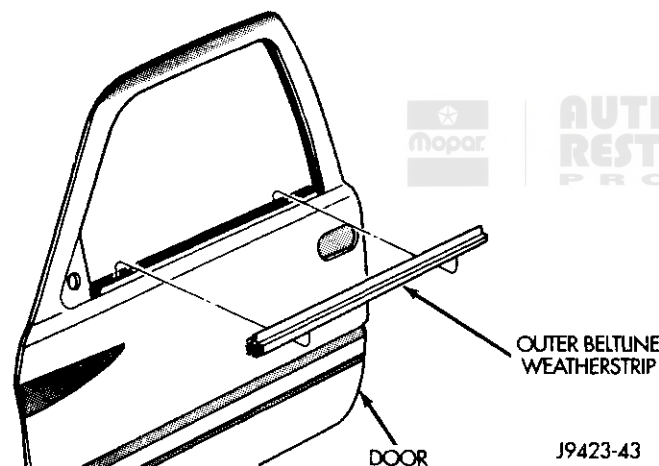
**Fig. 32 Door Latch/Lock****FRONT DOOR LATCH STRIKER****REMOVAL**

- (1) Release door latch and open door.
- (2) Mark outline of striker base on door jamb to aid installation.
- (3) Remove screws holding striker to door jamb (Fig. 33).
- (4) Separate striker from vehicle.

REMOVAL AND INSTALLATION (Continued)**Fig. 34 Inner Door Belt Weatherstrip**

(3) Using a hook tool inserted into the end of the belt weatherstrip, lift upward.

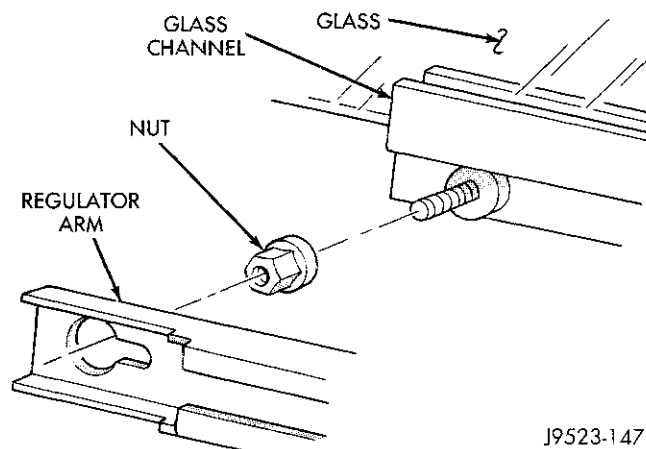
(4) Separate outer door belt weatherstrip from vehicle (Fig. 35).

**Fig. 35 Outer Door Belt Weatherstrip****INSTALLATION**

Reverse the preceding operation.

FRONT DOOR GLASS**REMOVAL**

- (1) Remove door trim panel.
- (2) Remove weather shield as necessary to gain access to door glass lift plate.
- (3) Remove inner door belt weatherstrip.
- (4) Align door glass lift plate to access holes in inner door panel.
- (5) Loosen bolts holding front lower run channel to inner door panel.
- (6) Remove nuts holding door glass to lift plate (Fig. 36).
- (7) Separate glass from lift plate.

**Fig. 36 Door Glass**

(8) Lift glass upward and out of opening at top of door.

INSTALLATION

Reverse the preceding operation.

FRONT DOOR WINDOW REGULATOR**REMOVAL**

- (1) Remove door trim panel.
- (2) Remove water dam.
- (3) Remove nuts holding door glass to window regulator.
- (4) Remove glass from door or move glass to full up position.
- (5) Disengage power window motor wire connector from door harness, if equipped.
- (6) Remove bolts holding window regulator to inner door panel.
- (7) Separate window regulator from door panel (Fig. 37).
- (8) Extract window regulator through access hole in inner door panel.

INSTALLATION

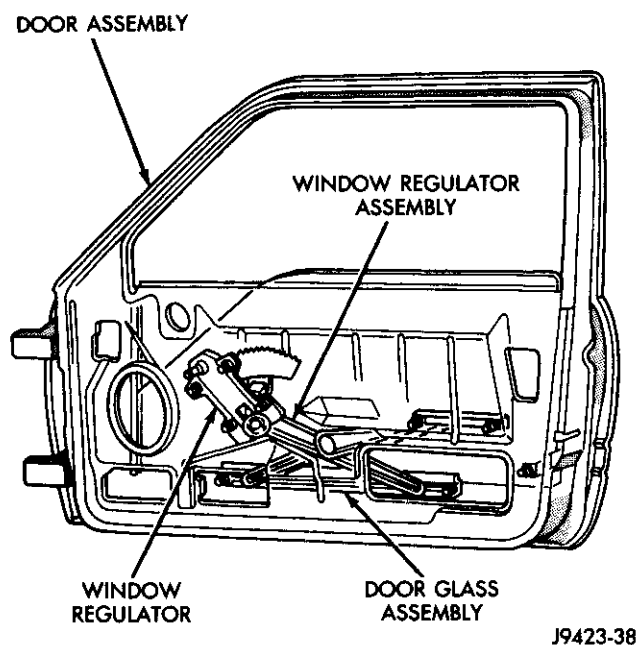
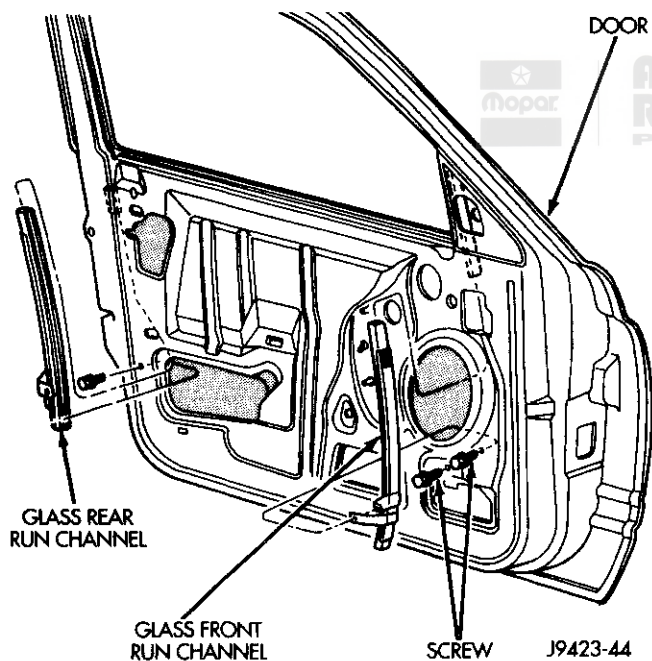
Reverse the preceding operation.

FRONT DOOR GLASS RUN LOWER CHANNELS**REMOVAL**

- (1) Remove door trim panel and weather shield.
- (2) Roll door glass up.
- (3) Remove bolts holding run channel to inner door panel (Fig. 38).
- (4) Slide channel downward to disengage it from the upper glass frame.
- (5) Separate door glass run channel from door.

INSTALLATION

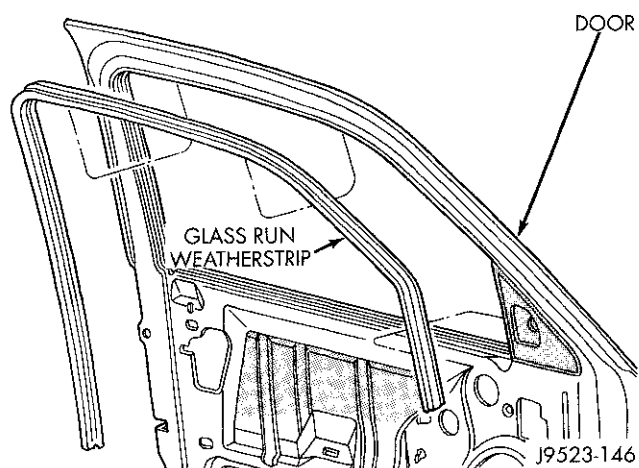
Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 37 Door Glass Window Regulator****Fig. 38 Door Glass Run Lower Channels**
FRONT DOOR GLASS RUN WEATHERSTRIP**REMOVAL**

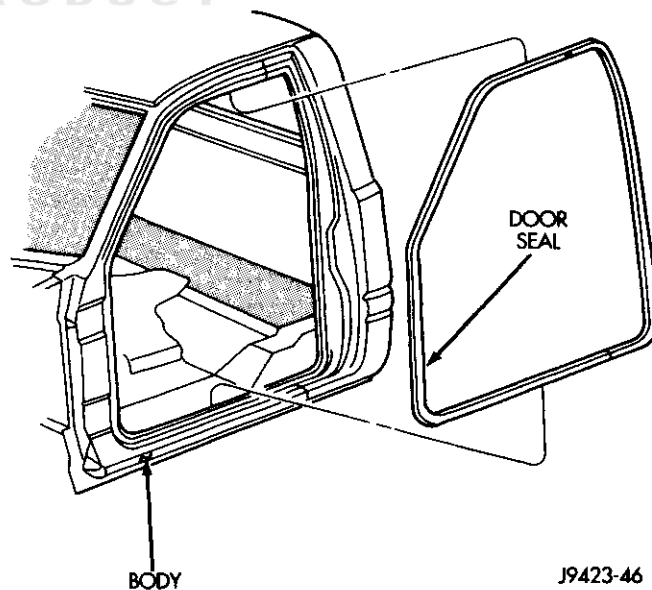
- (1) Remove door trim panel.
- (2) Remove inner door belt weatherstrip.
- (3) Pull door glass run weatherstrip from channel around window opening (Fig. 39).

INSTALLATION

Reverse the preceding operation.

**Fig. 39 Door Glass Run Weatherstrip**
FRONT DOOR SEAL**REMOVAL**

- (1) Remove A-pillar molding.
- (2) Remove cowl panel and sill cover.
- (3) Remove quarter panel.
- (4) Pull weatherstrip from pinch flange around door opening (Fig. 40).

**Fig. 40 Door Seal****INSTALLATION**

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**FRONT DOOR SECONDARY SEAL****REMOVAL**

(1) Warm the seal and body metal to approximately 38°C (100°F) using a suitable heat lamp or heat gun.

(2) Pull seal from painted surface (Fig. 41).

INSTALLATION

(1) Remove adhesive tape residue from painted surface of vehicle.

(2) If seal is to be reused, remove tape residue from seal. Clean back of seal with MOPAR, Super Kleen solvent or equivalent. Wipe seal dry with lint free cloth. Apply new body side moulding (two sided adhesive) tape to back of seal.

(3) Clean body surface with MOPAR, Super Kleen solvent or equivalent. Wipe surface dry with lint free cloth.

(4) Remove protective cover from tape on back of seal and apply seal to body.

(5) Heat body and seal, see step one. Firmly press seal to body surface to assure adhesion.

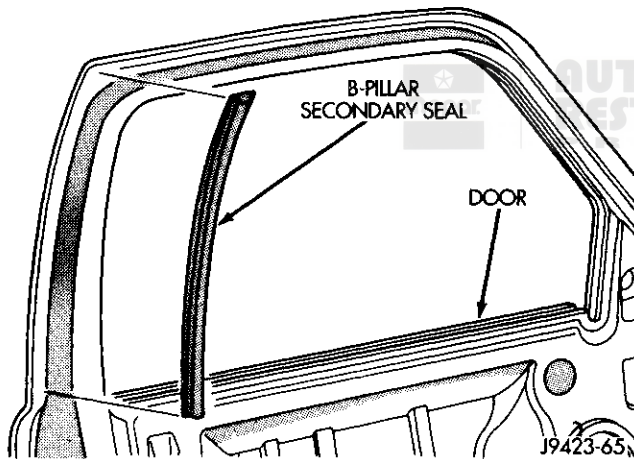


Fig. 41 Front Door Secondary Seal

ROOF RAIL WEATHERSTRIP AND RETAINER**REMOVAL**

(1) Release door latch and open door.

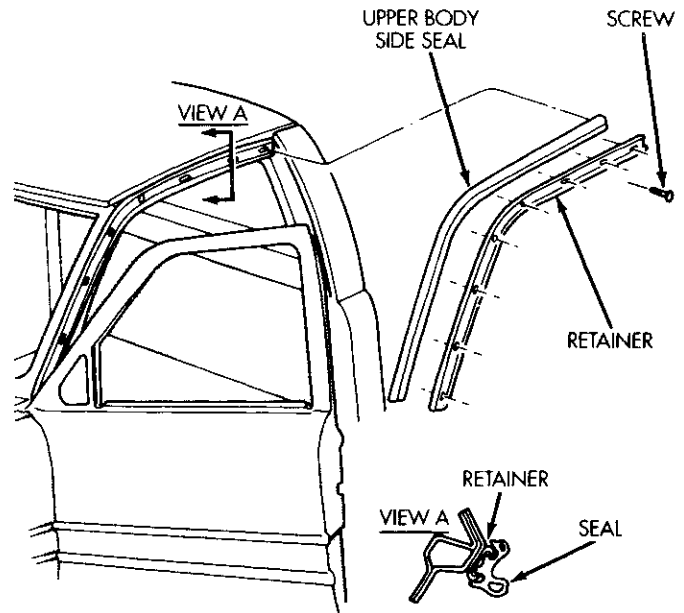
(2) Starting from rearward end of weatherstrip, pull weatherstrip from retainer.

(3) Remove screws holding retainer to roof rail (Fig. 42).

(4) Separate retainer from vehicle.

INSTALLATION

Reverse the preceding operation.



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Fig. 42 Roof Rail Weatherstrip and Retainer

ROOF JOINT MOLDING**REMOVAL**

(1) Warm the roof joint molding and roof panel to approximately 38°C (100°F) using a suitable heat lamp or heat gun.

(2) Pull molding from roof joint (Fig. 43).

INSTALLATION

(1) Remove adhesive tape residue from roof joint.

(2) If molding is to be reused, remove tape residue from back of molding. Clean molding with MOPAR, Super Kleen solvent or equivalent. Wipe molding dry with lint free cloth. Apply new body side molding (two sided adhesive) tape to back of molding.

(3) Clean roof joint with MOPAR, Super Kleen solvent or equivalent. Wipe dry with lint free cloth.

(4) Remove protective cover from tape on back of molding and apply molding to roof joint.

(5) Heat roof and molding, see step one. Firmly press molding into roof joint to assure adhesion.

QUARTER VENT WINDOW—CLUB CAB**REMOVAL**

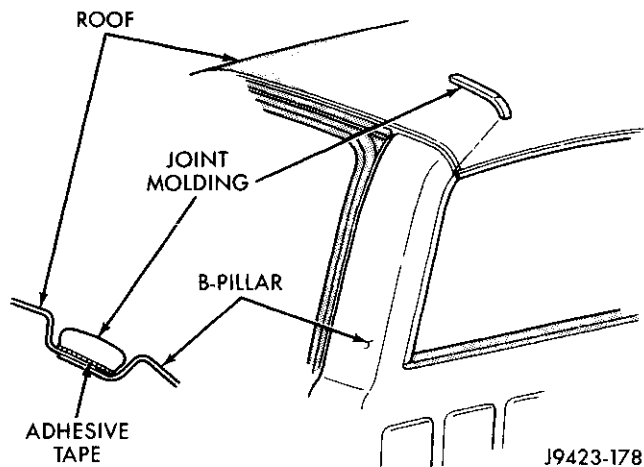
(1) Remove quarter trim panel.

(2) Remove the latch retaining screws from the cab rear side panel (Fig. 44).

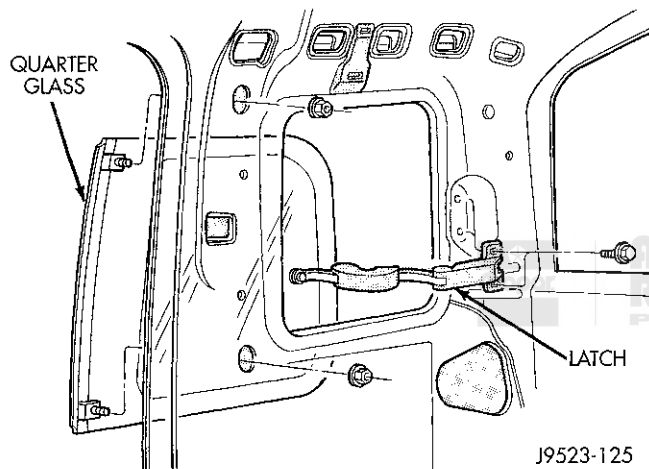
(3) Remove the frame/hinge retaining nuts from the B-pillar.

(4) Remove the window glass from the cab.

(5) If necessary, remove the latch from the glass.

REMOVAL AND INSTALLATION (Continued)

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Fig. 43 Roof Joint Molding

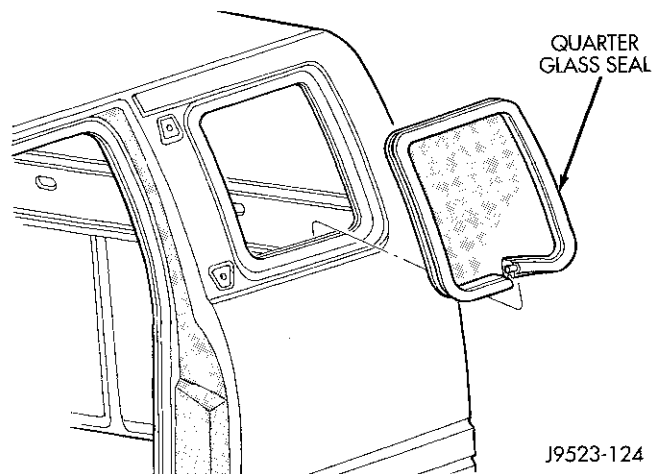
J9523-125

Fig. 44 Vent Window Removal/Installation**INSTALLATION**

- (1) If removed, install the latch to the glass. Tighten the screw with 6 N·m (60 in. lbs.) torque.
- (2) Center the window glass at the opening, insert the hinge studs in the B-pillar holes, and install the retaining nuts. Tighten the nuts with 11 N·m (95 in. lbs.) torque.
- (3) Attach the latch to the rear side panel with the screws. Tighten the screws with the latch in the lock position and pushing rearward on the latch. Tighten the screws with 11 N·m (95 in. lbs.) torque.
- (4) Test the vent window for water leaks.
- (5) Install quarter trim panel.

QUARTER VENT WINDOW WEATHERSTRIP**REMOVAL**

- (1) Remove the window. If necessary, refer to the removal procedure.
- (2) Pull the seal away from the flange around the perimeter of the window opening (Fig. 45).



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Fig. 45 Weatherstrip Seal Removal/Installation

- (3) Clean the flange as necessary.

INSTALLATION

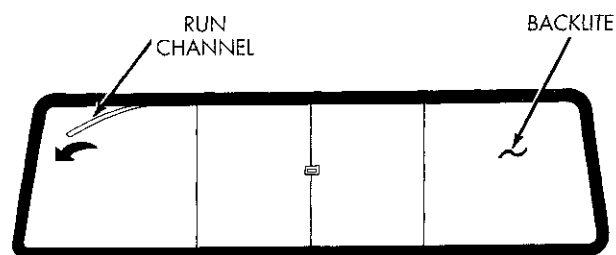
- (1) Center and butt the seal ends together at the bottom, centerline of the opening.
- (2) Mate the seal with the bottom flange.
- (3) Mate the seal with the front, vertical flange.
- (4) Move upward and mate the seal with the top flange.
- (5) Mate the seal with the rear, vertical flange.

SLIDING BACKLITE—CONVENTIONAL CAB

If complete removal of the sliding rear window is required, refer to the rear window removal/installation procedures for conventional cab vehicles.

SLIDING VENT GLASS—CONVENTIONAL CAB**REMOVAL**

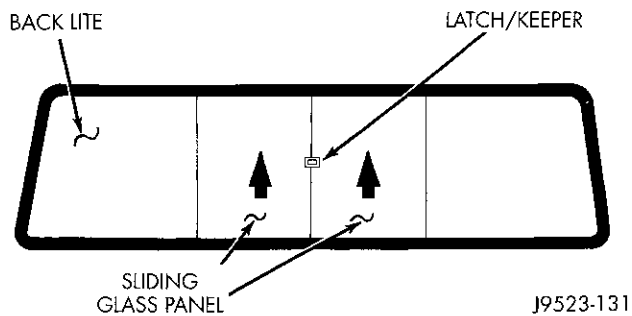
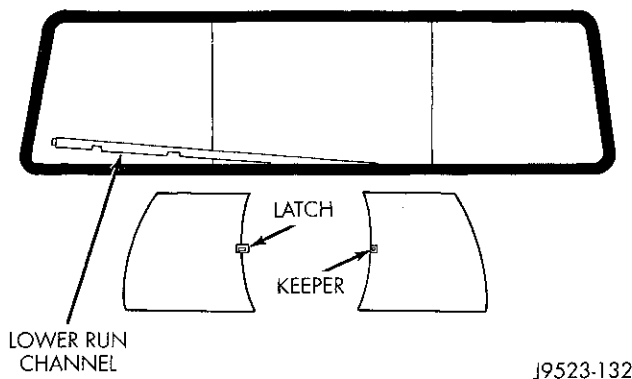
- (1) Slide the upper left and upper right run channels out of window frame (Fig. 46).
- (2) Slide left and right glass panels upward, remove and separate latch and keeper (Fig. 47).
- (3) If necessary, remove lower glass channel and replace (Fig. 48).



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Fig. 46 Run Channel Removal**INSTALLATION**

- (1) If necessary, install lower run channel.

REMOVAL AND INSTALLATION (Continued)**Fig. 47 Glass Panel Removal****Fig. 48 Lower Run Channel Removal**

(2) Position left and right glass panels at window opening and lower into the lower run channel. The glass panels must be in the closed position (Fig. 49).

(3) Slide the upper left and upper right run channels into the window frame.

(4) Verify window and latch/keeper operation.

LATCH AND KEEPER—CONVENTIONAL CAB**REMOVAL**

- (1) Disengage latch and keeper.
- (2) Remove latch/keeper screws.
- (3) Separate Latch/keeper from glass panel.

INSTALLATION

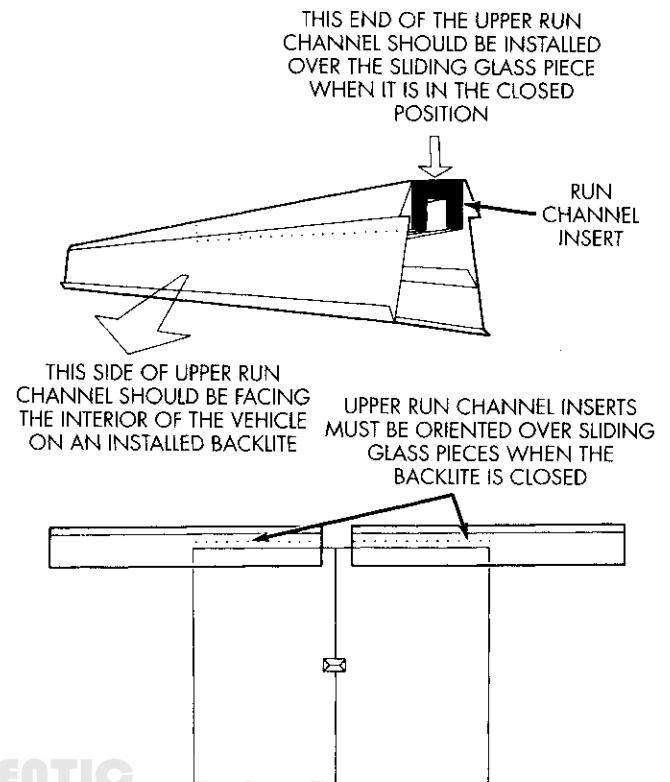
- (1) Position Latch/keeper on glass panel.
- (2) Install screws. Tighten the screws with 1.5 N·m (15 in. lbs.) torque.
- (3) Engage latch and keeper to verify operation.

SLIDING BACKLITE—CLUB CAB

To remove the sliding rear window in a club cab, refer to the rear window removal/installation procedures for club cab vehicles.

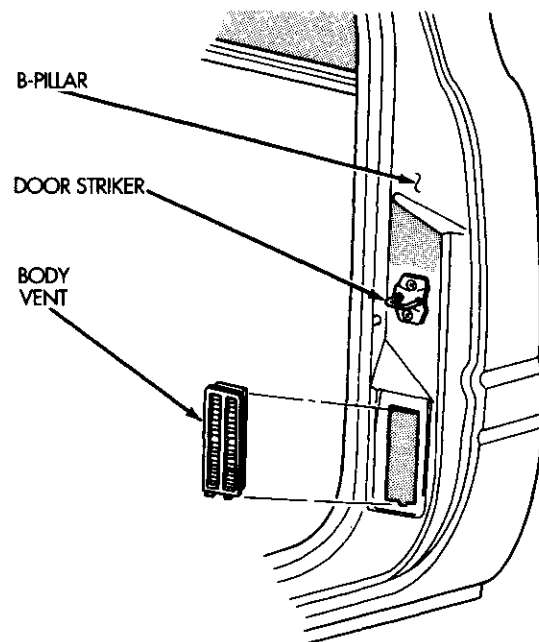
BODY VENT**REMOVAL**

- (1) Release door latch and open door.

**Fig. 49 Glass Panel Installation**

(2) Pull outward at top of vent to disengage clips holding vent to door jamb (Fig. 50).

(3) Separate vent from vehicle.

**Fig. 50 Body Vent**

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REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

Reverse the preceding operation.

TAPE STRIPE**REMOVAL**

(1) If the panel that is being serviced is not going to be refinished, apply a length of masking tape parallel to the edge of the original tape stripe to aid installation.

(2) Warm the panel to approximately 38°C (100°F) using a suitable heat lamp or heat gun.

(3) Peel tape stripe (Fig. 51) from body panel using an even pressure pull.

(4) Remove adhesive residue from body panel using a suitable adhesive removing solvent.

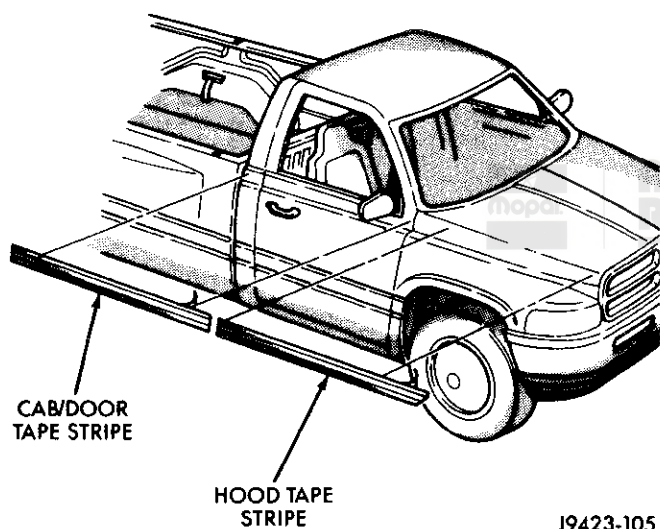


Fig. 51 Tape Stripe Overlay

INSTALLATION

The painted surface of the body panel to be covered by a tape stripe overlay must be smooth and completely cured before overlay can be applied. If painted surface is not smooth, wet sand with 600 grit wet/dry sand paper until surface is smooth. Ripples and feather edging will read through overlay if surface is not properly prepared.

Installation equipment:

- Pail filled with mild dish soap solution.
- Lint free applicator cloth or sponge.
- Body putty applicator squeegee.
- Heat gun or sun lamp.
- Razor knife.

(1) Spread replacement tape stripe overlay across a smooth flat work surface, finish side down.

(2) Peel paper backing away from overlay exposing adhesive back of overlay.

(3) Apply soap solution liberally to adhesive back of overlay.

(4) Apply soap solution liberally to body panel surface.

(5) Place overlay into position on body panel. Smooth out wrinkles by pulling lightly on edges of overlay until it lays flat on painted surface.

(6) Push air pockets from under overlay to the perimeter of the panel from the center of the overlay out.

(7) Squeegee soap solution and air bubbles from behind overlay from the center of the panel out using a body putty applicator squeegee (Fig. 52).

CAUTION: Do not cut into painted surface of body panel when trimming overlay to size.

(8) Trim overlay to size using a razor knife. Leave at least 13 mm (0.5 in.) for edges of doors and openings.

CAUTION: Do not overheat overlay when performing step 12.

(9) Apply heat to overlay to evaporate residual moisture from edges of overlay and to allow overlay to be stretched into concave surfaces.

(10) Edge turn overlay around doors or fenders.

(11) Install exterior trim if necessary.

(12) Small air or water bubbles under overlay can be pierced with a pin and smoothed out.

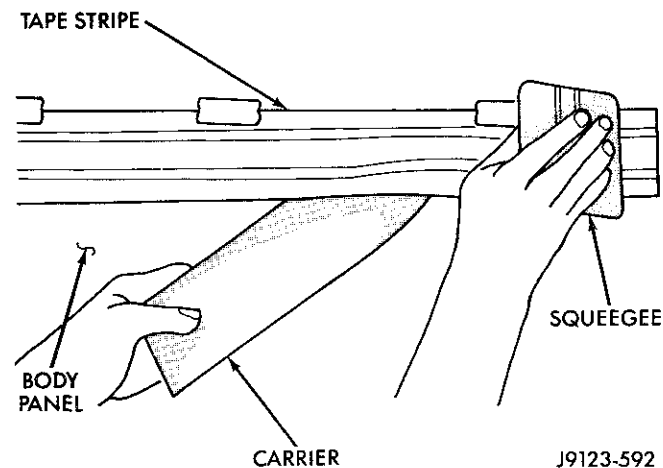


Fig. 52 Tape Stripe Application

BODY SIDE MOLDINGS**REMOVAL**

(1) Warm the effected stick-on molding and body metal to approximately 38°C (100°F) using a suitable heat lamp or heat gun.

REMOVAL AND INSTALLATION (Continued)

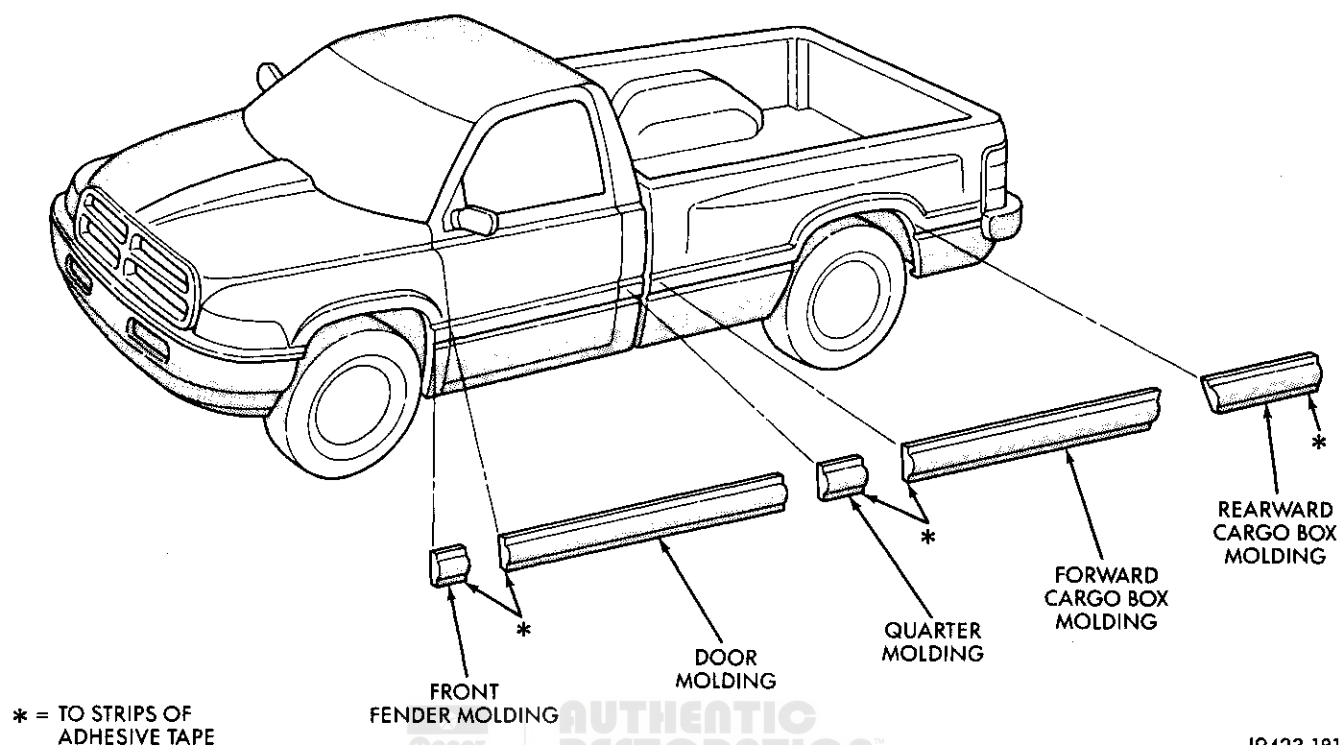


Fig. 53 Body Side Moldings

(2) Pull stick-on molding from painted surface (Fig. 53) and (Fig. 54).

INSTALLATION

(1) Remove adhesive tape residue from painted surface of vehicle.

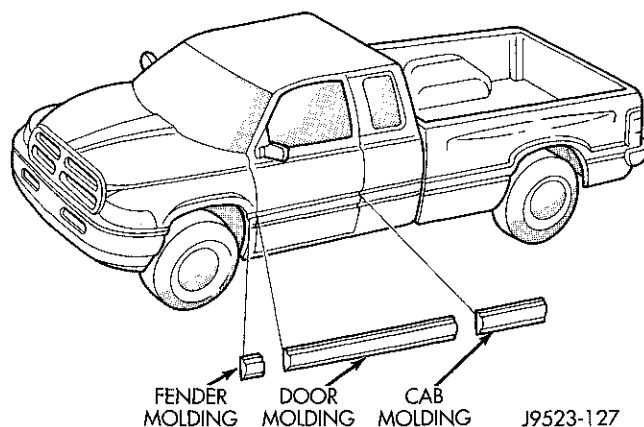
(2) If molding is to be reused, remove tape residue from molding. Clean back of molding with MOPAR, Super Kleen solvent or equivalent. Wipe molding dry with lint free cloth. Apply new body side molding (two sided adhesive) tape to back of molding.

(3) Clean body surface with MOPAR Super Kleen solvent or equivalent. Wipe surface dry with lint free cloth.

(4) Apply a length of masking tape on the body, parallel to the top edge of the molding to use as a guide, if necessary.

(5) Remove protective cover from tape on back of molding. Apply molding to body below the masking tape guide.

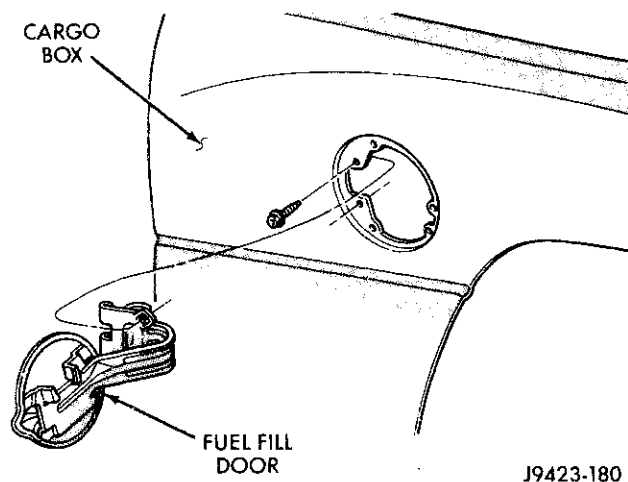
(6) Remove masking tape guide and heat body and molding, see step one. Firmly press molding to body surface to assure adhesion.

Fig. 54 Body Side Moldings—Club Cab
FUEL FILL DOOR**REMOVAL**

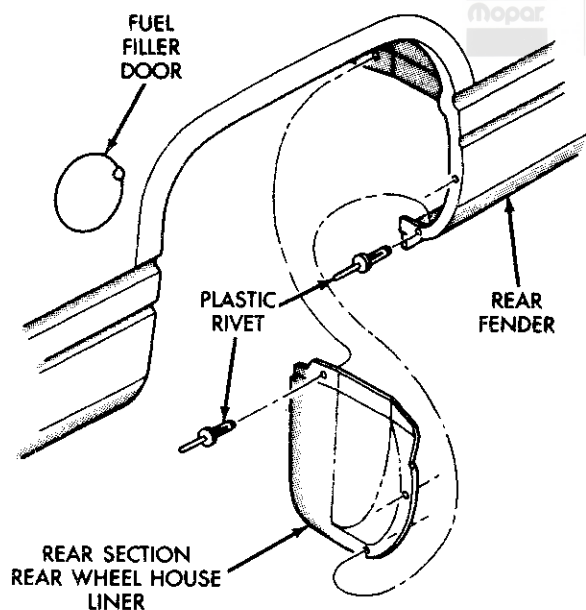
- (1) Open fuel fill door.
- (2) Remove bolts holding fuel fill door to cargo box quarter panel (Fig. 55).
- (3) Separate fuel fill door from vehicle.

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)*Fig. 55 Fuel Fill Door***REAR SPLASH SHIELDS****REMOVAL**

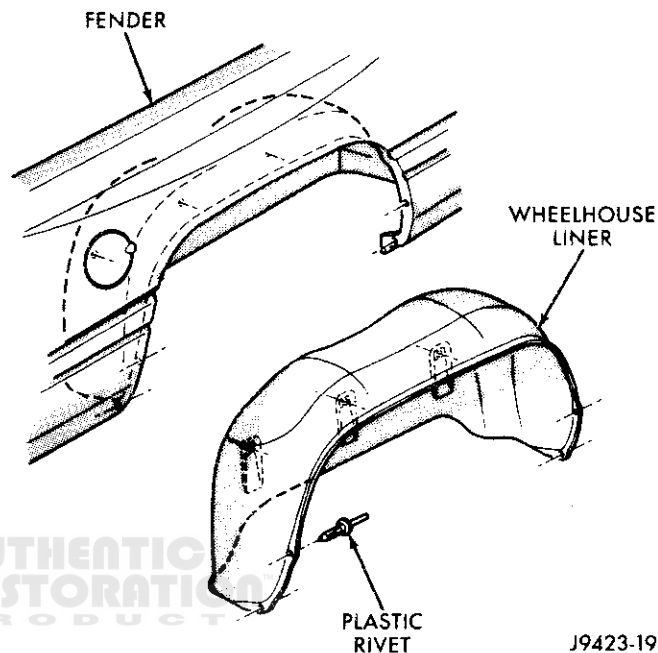
- (1) Remove plastic rivets holding rear splash shield to rear wheel opening lip (Fig. 56).
- (2) Remove plastic rivets holding rear splash shield to rear wheelhouse.
- (3) Separate splash shield from vehicle.

*Fig. 56 Rear Splash Shields***INSTALLATION**

- (1) Position splash shield in wheelhouse opening.
- (2) Install plastic rivets holding rear splash shield to rear wheelhouse.
- (3) Install plastic rivets holding rear splash shield to rear wheel opening lip.

REAR WHEELHOUSE LINER**REMOVAL**

- (1) Remove plastic rivets holding rear wheelhouse liner to rear wheel opening lip (Fig. 57).
- (2) Remove plastic rivets holding rear wheelhouse liner to rear wheelhouse.
- (3) Separate rear wheelhouse liner from vehicle.

*Fig. 57 Rear Wheelhouse Liner***INSTALLATION**

- (1) Position rear wheelhouse liner in wheelhouse opening.
- (2) Install plastic rivets holding rear wheelhouse liner to rear wheelhouse.
- (3) Install plastic rivets holding rear wheelhouse liner to rear wheel opening lip.

REAR FENDER (DUAL REAR WHEELS)**REMOVAL**

- (1) Open fuel fill door, left side only.
- (2) Remove screws holding fuel fill neck to rear fender opening.
- (3) Remove tail lamp, refer to Group 8L, Lamps for proper procedures.
- (4) Remove nuts holding rear fender to cargo box side panel through tail lamp opening.
- (5) Remove clearance lamps, refer to Group 8L, Lamps for proper procedures.
- (6) Remove sockets from clearance lamps.
- (7) Remove bolts holding bottom of fender to cargo box forward of rear wheel.
- (8) Remove bolts holding bottom of fender to cargo box rearward of rear wheel.

REMOVAL AND INSTALLATION (Continued)

(9) Remove rear wheelhouse splash shields and liner.

(10) Remove nuts holding front of rear fender to cargo box from behind side panel forward of wheelhouse.

(11) Remove screws holding access panel to top of wheelhouse.

(12) Remove nuts holding rear fender to cargo box through access hole in to of wheelhouse.

(13) Separate rear fender from cargo box side panel.

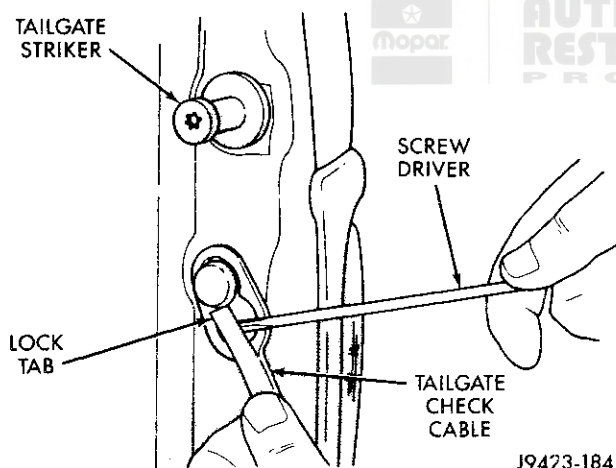
INSTALLATION

Reverse the preceding operation.

TAILGATE CHECK CABLE

REMOVAL

- (1) Release tailgate latch and open tailgate.
- (2) Pry lock tab outward to clear stud head on cargo box (Fig. 58).
- (3) Push cable end forward until stud head is in clearance hole portion of cable end.
- (4) Separate cable end from stud.
- (5) Remove screw holding cable to tailgate.
- (6) Separate check cable from tailgate.



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Fig. 58 Tailgate Check Cable

INSTALLATION

Reverse the preceding operation.

TAILGATE

REMOVAL

- (1) Release tailgate latch and open tailgate.
- (2) Disconnect tailgate marker light harness, if equipped.
- (3) Close tailgate until the notch in the right hand collar aligns with the pivot pin.
- (4) Slip tailgate hinge collar from hinge pins.

(5) Slide tailgate to the right and separate left hand collar from the pivot pin.

(6) Separate tailgate from vehicle.

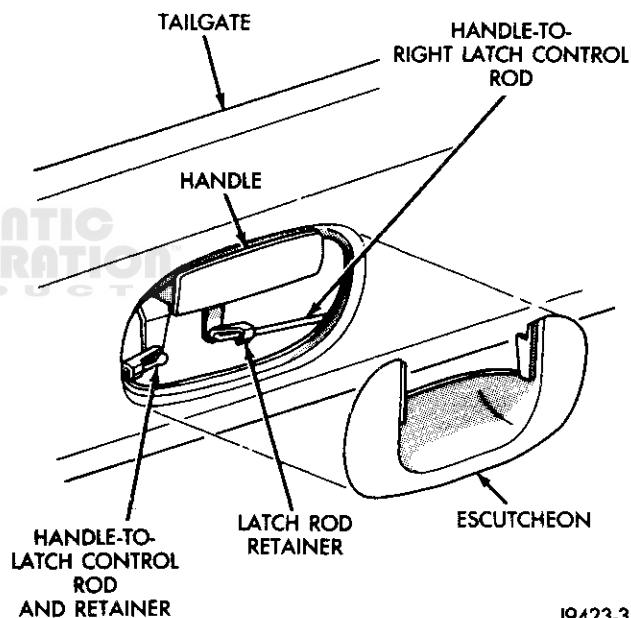
INSTALLATION

Reverse the preceding operation.

TAILGATE HANDLE ESCUTCHEON

REMOVAL

- (1) Lift and hold tailgate latch release handle.
- (2) Using a trim stick (C-4755), pry bottom of escutcheon outward to disengage clips.
- (3) Rotate escutcheon upward to disengage clip above release handle.
- (4) Lift escutcheon upward from behind release handle.
- (5) Separate escutcheon from vehicle (Fig. 59).



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Fig. 59 Tailgate Handle Escutcheon

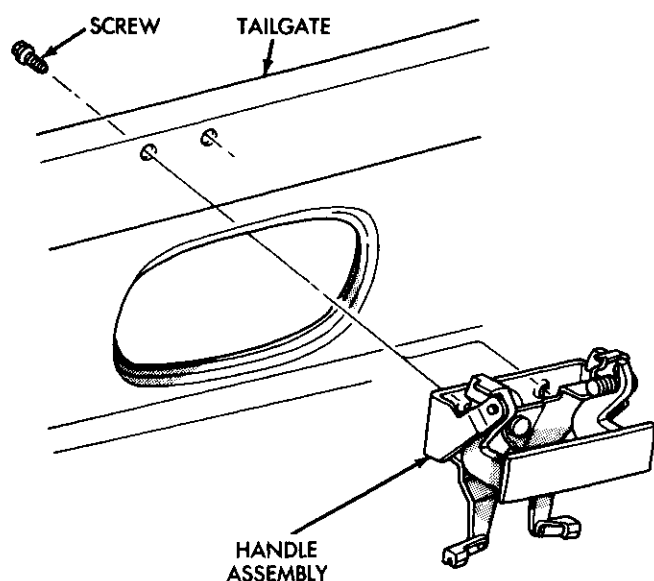
INSTALLATION

Reverse the preceding operation.

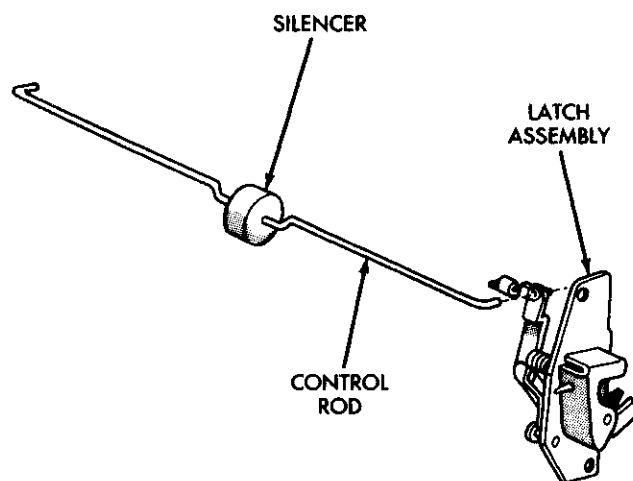
TAILGATE LATCH HANDLE

REMOVAL

- (1) Remove tailgate latch handle escutcheon.
- (2) Disengage clips holding linkage rods to latch handle.
- (3) Separate linkage rods from handle.
- (4) Remove screws holding latch handle to tailgate (Fig. 60).
- (5) Separate latch handle from vehicle.

REMOVAL AND INSTALLATION (Continued)

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Fig. 60 Tailgate Latch Handle

J9423-33

Fig. 61 Tailgate Latch**INSTALLATION**

Reverse the preceding operation.

TAILGATE LATCH**REMOVAL**

- (1) Remove tailgate latch handle escutcheon.
- (2) Release tailgate latch and open tailgate.
- (3) Disengage linkage rod from latch handle (Fig. 61).
- (4) Remove screws holding latch to tailgate.
- (5) Separate latch from tailgate.
- (6) Pull latch and linkage rod from tailgate.

INSTALLATION

Reverse the preceding operation.

TAILGATE LATCH STRIKER**REMOVAL**

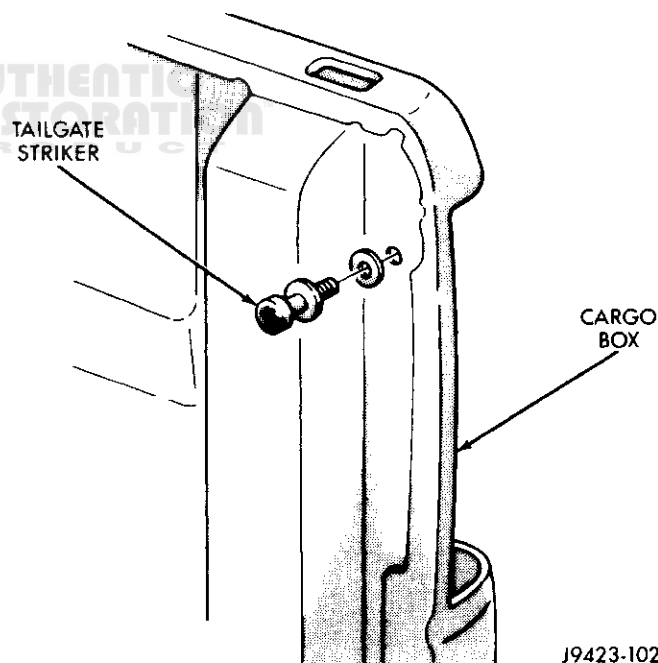
- (1) Release tailgate latch and open tailgate.
- (2) Mark outline of striker on cargo box jamb to aid installation.
- (3) Using a Torx drive wrench, remove striker from cargo box (Fig. 62).

INSTALLATION

Reverse the preceding operation.

TAILGATE SLAM BUMPER**REMOVAL**

- (1) Release tailgate latch and open tailgate.



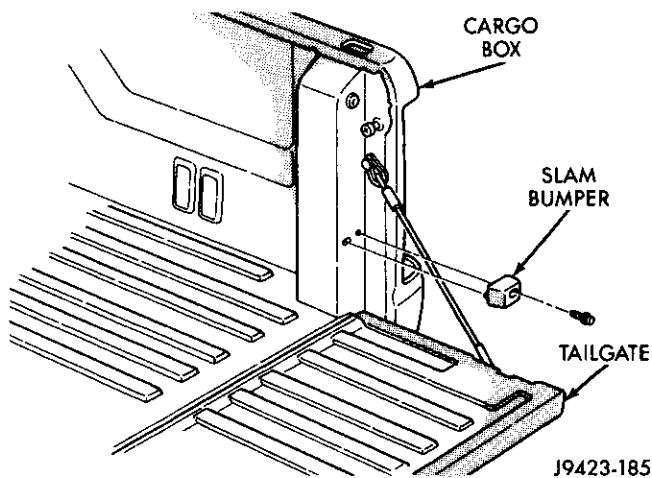
J9423-102

Fig. 62 Tailgate Latch

- (2) Remove screw holding slam bumper to cargo box (Fig. 63).
- (3) Separate slam bumper from vehicle.

INSTALLATION

- (1) Position slam bumper on vehicle.
- (2) Install screw holding slam bumper to cargo box.
- (3) Close tailgate and verify operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 63 Tailgate Slam Bumper****TAILGATE DECALS****REMOVAL**

- (1) Warm the panel to approximately 38°C (100°F) using a suitable heat lamp or heat gun.
- (2) Peel tape stripe from body panel using an even pressure pull.
- (3) Remove adhesive residue from body panel using a suitable adhesive removing solvent.

INSTALLATION

- (1) Clean painted body surface with Mopar Super Clean solvent or equivalent and a lint free cloth.
- (2) Remove protective cover from back side of decal.
- (3) Position decal properly on body.
- (4) Press decal firmly to body with palm of hand.
- (5) If temperature is below 21°C (70°F) warm decal with a heat lamp or gun to assure adhesion. Do not exceed 65°C (150°F) when heating emblem.

TAILGATE APPLIQUE**REMOVAL**

- (1) Warm the tailgate applique and tailgate metal to approximately 38°C (100°F) using a suitable heat lamp or heat gun.
- (2) Pull applique from tailgate (Fig. 64).

INSTALLATION

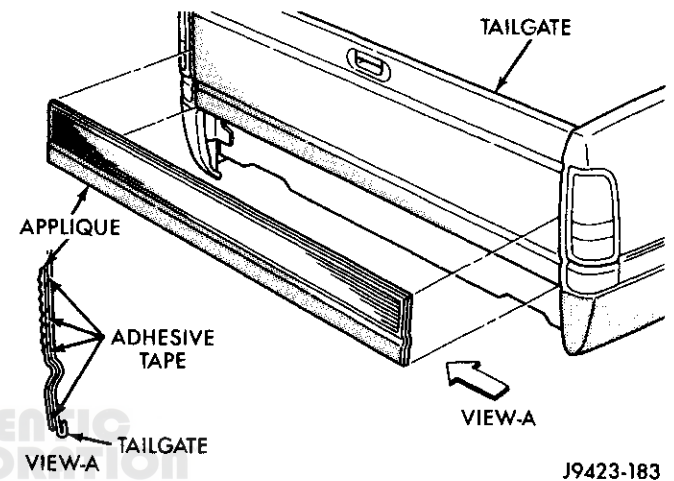
- (1) Remove adhesive tape residue from painted surface of tailgate.
- (2) If applique is to be reused, remove tape residue from applique. Clean back of applique with MOPAR, Super Kleen solvent or equivalent. Wipe molding dry with lint free cloth. Apply new body side molding (two sided adhesive) tape to back of applique.

(3) Clean tailgate surface with MOPAR, Super Kleen solvent or equivalent. Wipe surface dry with lint free cloth.

(4) Apply a length of masking tape on the body, parallel to the top edge of the applique to use as a guide, if necessary.

(5) Remove protective cover from tape on back of applique. Apply applique to body below the masking tape guide.

(6) Remove masking tape guide and heat tailgate and applique, see step one. Firmly press applique to tailgate to assure adhesion.

**Fig. 64 Tailgate Applique****CARGO BOX****REMOVAL**

- (1) Open fuel fill door.
- (2) Remove screws holding fuel fill neck adaptor to cargo box side wall.
- (3) Separate fuel fill neck from cargo box.
- (4) Disengage tail lamp wire connector from main body harness at left rear frame rail.
- (5) Remove bolts holding cargo box to frame rails (Fig. 65).
- (6) Using a suitable lifting device, separate cargo box from vehicle.

INSTALLATION

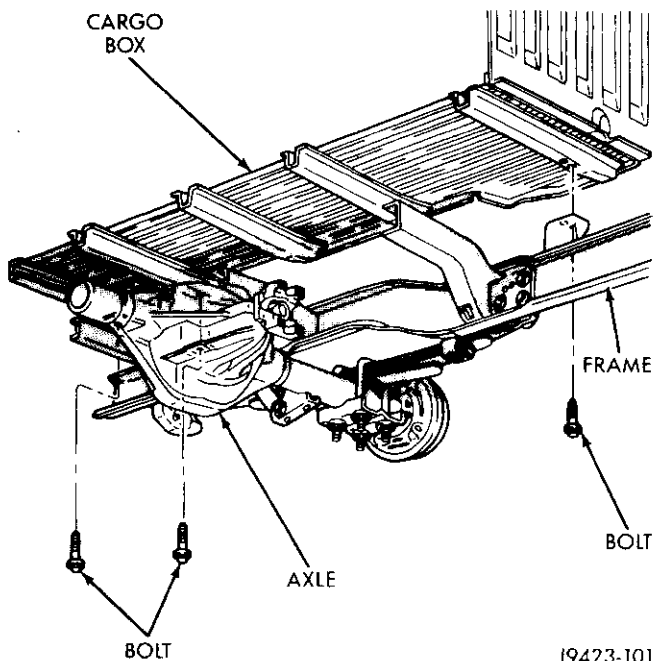
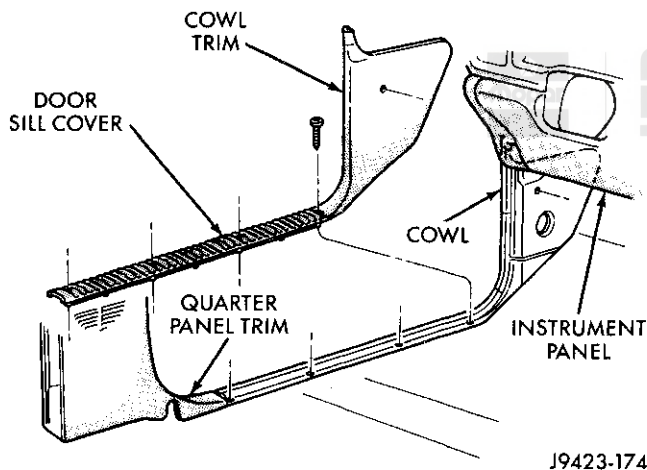
Reverse the preceding operation.

COWL AND DOOR SILL COVER**REMOVAL**

- (1) Remove screw holding cowl trim to cowl.
- (2) Remove screws holding door sill cover to floor at door sill (Fig. 66).
- (3) Separate door sill and cowl trim from vehicle.

INSTALLATION

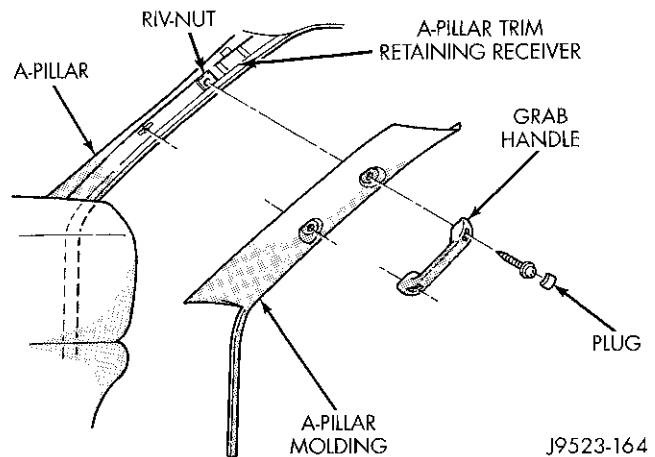
Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 65 Cargo Box****Fig. 66 Cowl and Door Sill Cover****A-PILLAR GRAB HANDLE****REMOVAL**

- (1) Using a small flat blade screw driver, Pry trim plugs from A-pillar grab handle.
- (2) Remove screws holding grab handle to A-pillar (Fig. 67).
- (3) Separate A-pillar grab handle from vehicle.

INSTALLATION

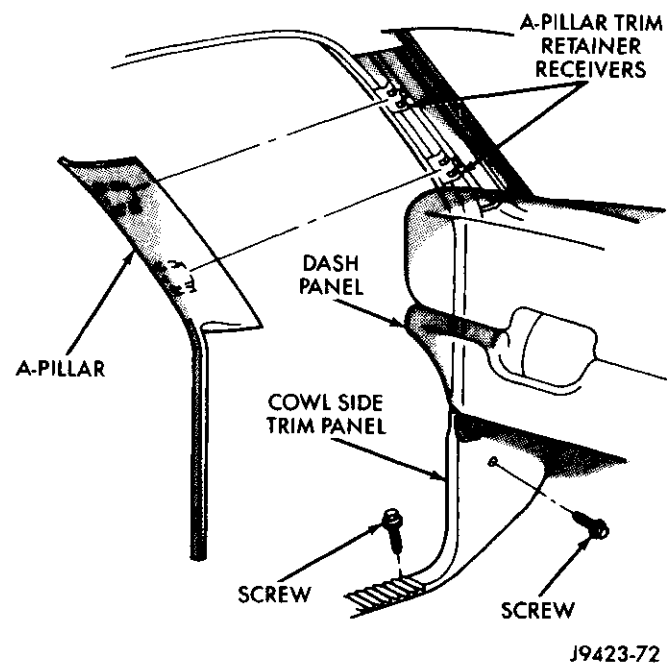
Reverse the preceding operation.

**Fig. 67 A-pillar Grab Handle (4X4)****A-PILLAR MOLDING**

NOTE: Damage to trim molding may occur during removal. verify availability of replacement molding before removing.

REMOVAL

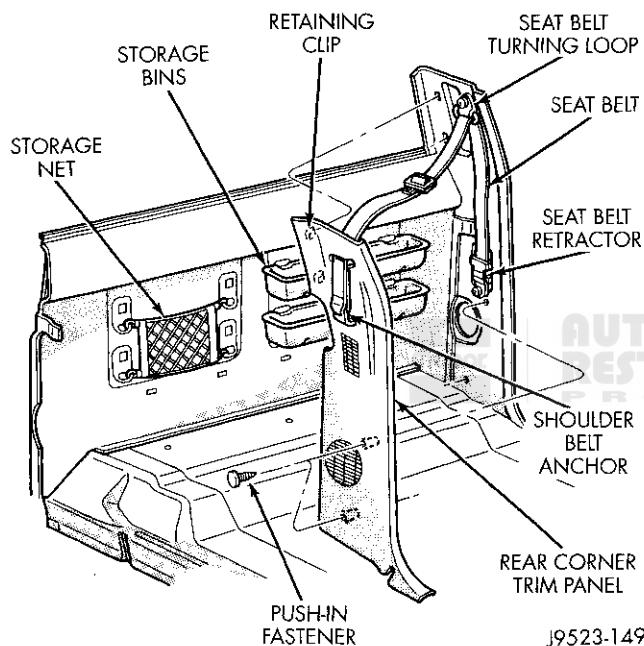
- (1) Remove A-pillar grab handle, if equipped.
- (2) Disengage clips holding A-pillar molding to A-pillar (Fig. 68).
- (3) Separate A-pillar molding from vehicle.

**Fig. 68 A-pillar Molding****INSTALLATION**

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**QUARTER TRIM PANEL****REMOVAL**

- (1) Remove rear floor stowage tray.
- (2) Remove door sill cover as necessary to clear quarter trim.
- (3) Remove bolt holding seat belt anchor to floor.
- (4) Remove push-in fasteners holding quarter trim panel to lower quarter panel (Fig. 69).
- (5) Disengage clips holding quarter trim panel to upper quarter panel.
- (6) Separate quarter trim panel from quarter panel.
- (7) Pull seat belt webbing through opening in quarter trim panel.

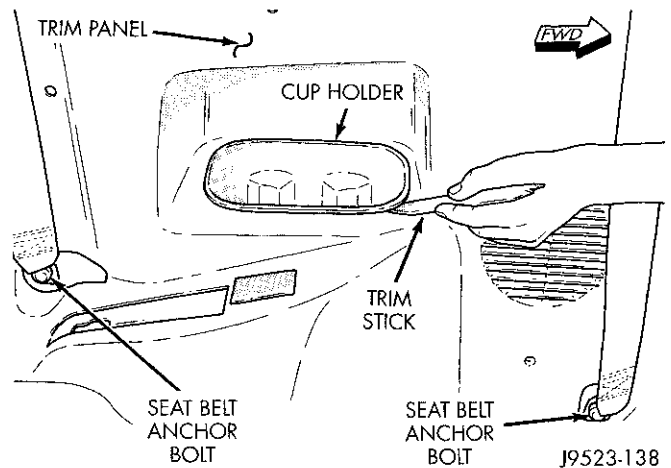
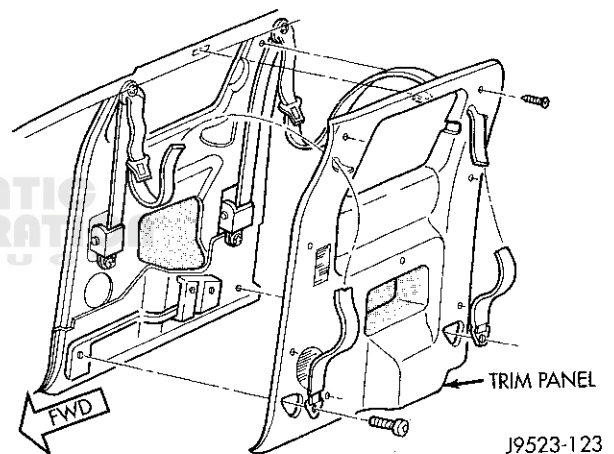
**Fig. 69 Quarter Trim Panel****INSTALLATION**

Reverse the preceding operation.

QUARTER TRIM PANEL—CLUB CAB**REMOVAL**

- (1) Remove rear seat. Refer to the removal procedure in this section, if necessary.
- (2) Remove door sill cover as necessary to clear quarter trim.
- (3) Using a trim stick or small flat blade screwdriver, remove cup holder (Fig. 70).
- (4) Remove lower seat belt anchor bolts (Fig. 71).
- (5) Remove screws holding club cab quarter trim panel to quarter panel (Fig. 71).
- (6) Separate club cab quarter trim panel from quarter panel.

- (7) Pull seat belt webbing through opening in quarter trim panel and remove panel from vehicle.

**Fig. 70 Cup Holder Removal****Fig. 71 Quarter Trim Panel—Club Cab****INSTALLATION**

- (1) Position trim panel in vehicle and pull seat belt webbing through opening in quarter trim panel.
- (2) Position trim panel at quarter panel and install trim panel screws.
- (3) Install lower seat belt anchor bolts.
- (4) Install cup holder.
- (5) Install door sill cover as necessary.
- (6) Install rear seat. Refer to the installation procedure in this section, if necessary.

REAR CLOSURE PANEL TRIM**REMOVAL**

- (1) Remove quarter trim panels.
- (2) Remove rear floor stowage tray.
- (3) Remove stowage bins.
- (4) Remove stowage net.
- (5) Remove screws holding bottom of rear closure panel trim to floor (Fig. 72).

REMOVAL AND INSTALLATION (Continued)

(6) Remove screws holding rear closure panel trim to rear cab wall.

(7) Disengage clips holding top of rear closure panel trim to rear cab wall.

(8) Remove push-in fastener in top center of rear closure trim panel.

(9) Separate rear closure panel trim from vehicle.

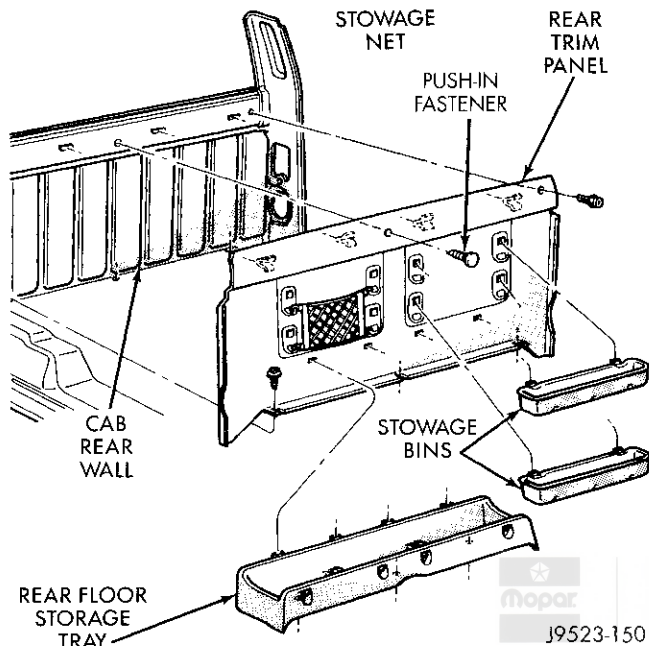


Fig. 72 Rear Closure Panel Trim

INSTALLATION

Reverse the preceding operation.

SEAT BELT RETRACTOR—CONVENTIONAL CAB

NOTE: Inspect the shoulder belt, retractor and buckle. Replace the belt or buckle that is either cut, frayed, torn or damaged. Replace the belt if the retractor is inoperative.

REMOVAL

- (1) Remove bolt holding seat belt lower anchor to floor at base of quarter trim panel.
- (2) Remove quarter trim panel.
- (3) Remove bolt holding seat belt turning loop to B-pillar (Fig. 73).
- (4) Separate turning loop from B-pillar.
- (5) Disengage body harness wire connector from seat belt retractor.
- (6) Remove bolt holding seat belt retractor to quarter panel.
- (7) Separate seat belt retractor from vehicle.

INSTALLATION

Reverse the preceding operation.

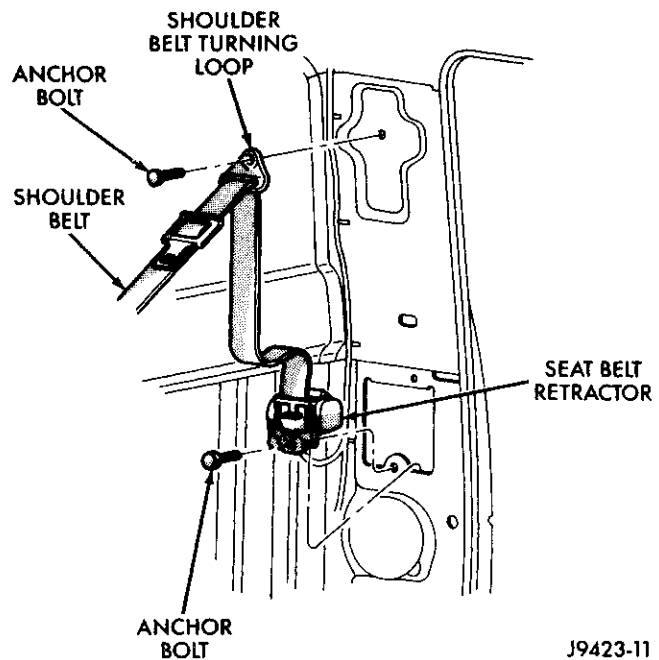


Fig. 73 Seat Belt Retractor

SEAT BELT RETRACTORS—CLUB CAB

NOTE: Inspect the shoulder belt, retractor and buckle. Replace the belt or buckle that is either cut, frayed, torn or damaged. Replace the belt if the retractor is inoperative.

REMOVAL

- (1) Remove seat belt lower anchor bolts.
- (2) Remove club cab quarter trim panel. If necessary, refer to the removal procedure in this group.
- (3) Remove turning loop anchor bolts (Fig. 74).
- (4) Disengage body harness wire connector from seat belt retractor.
- (5) Remove seat belt retractor anchor bolts.
- (6) Separate seat belt retractors from vehicle.

INSTALLATION

Reverse the preceding operation.

SEAT BELT BUCKLE**REMOVAL**

- (1) Move seat to the forward position.
- (2) Hinge seat backs forward.
- (3) Remove bolt holding seat belt buckle to seat frame.
- (4) Separate seat belt buckle from vehicle.

INSTALLATION

Reverse the preceding operation. Install the seat belt buckle anchor nuts. Tighten to 40 N·m (30 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

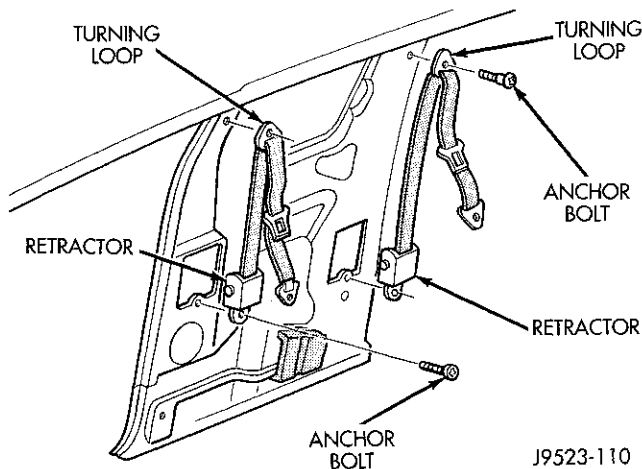


Fig. 74 Seat Belt Retractors—Club Cab

REAR SEAT BELT BUCKLE

REMOVAL

(1) Turn release handle on underside of rear seat to disengage seat cushion and move seat to the stowed position.

Access to rear seat belt buckle nuts can be obtained through an opening between the rear seat back and the floor.

(2) Remove seat belt buckle anchor nuts (Fig. 75).

(3) Separate seat belt buckle from vehicle.

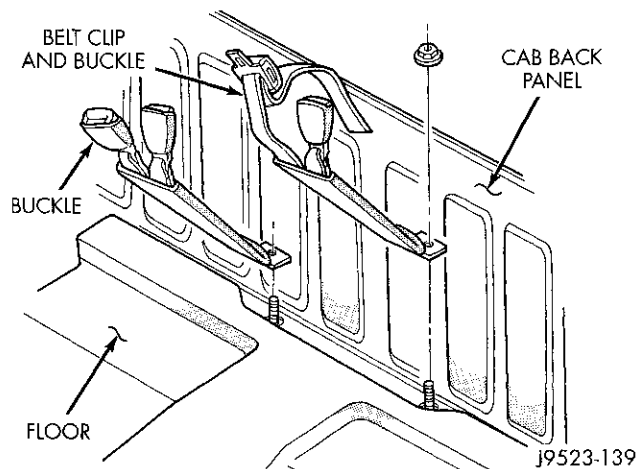


Fig. 75 Rear Seat Belt Buckle Removal

INSTALLATION

(1) Position the seat belt buckle on the anchoring studs.

(2) Install the seat belt buckle anchor nuts. Tighten to 40 N·m (30 ft. lbs.) torque.

(3) Turn release handle to disengage seat from stowed position and push seat cushion downward to lock into place.

BENCH SEAT

REMOVAL

- (1) Move seat track to forward position.
- (2) Hinge seat backs forward.
- (3) Remove nuts holding rear of seat tracks to floor (Fig. 76).
- (4) Move seat track to rearward position.
- (5) Remove bolts holding front of seat tracks to floor.
- (6) Separate seat from vehicle.

INSTALLATION

Seat adjustment latch must be engaged prior to seat installation. Verify inboard and outboard seat latch operation.

Reverse the removal procedure.

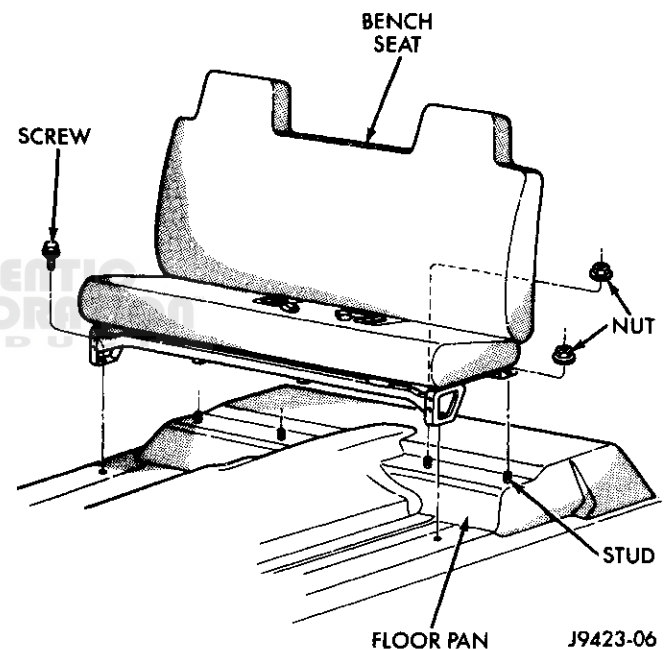


Fig. 76 Bench Seat

SPLIT BENCH SEAT

REMOVAL

- (1) Move seat track to forward position.
- (2) Hinge seat back forward.
- (3) Disengage power seat wire connector from body harness, if equipped (Fig. 77).
- (4) Remove nuts holding outboard and inboard tracks to floor (Fig. 77).
- (5) Move seat track to forward position.
- (6) Remove bolt holding inboard seat track to bottom of center occupant seat.
- (7) Remove bolts holding front of seat tracks to floor.
- (8) Lift center occupant seat upward to clear rear attachment stud.

REMOVAL AND INSTALLATION (Continued)

- (9) Separate seat from vehicle.

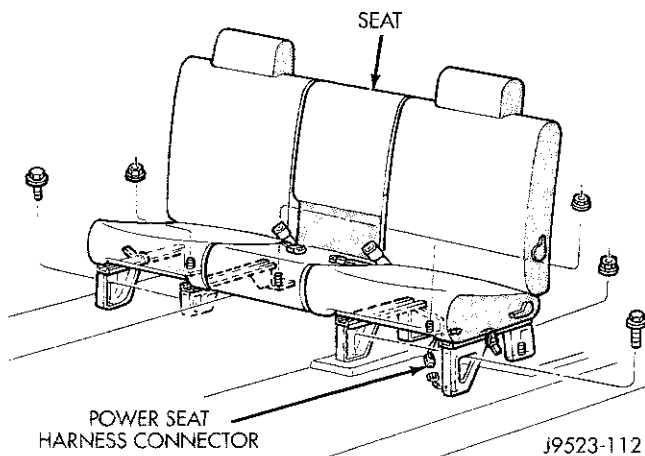


Fig. 77 Split Bench Seat

INSTALLATION

- (1) Position seat in vehicle.
- (2) Install bolts holding front of seat tracks to floor. Tighten the bolts with 28 N·m (250 in-lbs) torque.
- (3) Install bolt holding inboard seat track to bottom of center occupant seat. Tighten the bolt with 28 N·m (250 in-lbs) torque.
- (4) Install nuts holding outboard and inboard tracks to floor. Tighten the nuts with 40 N·m (30 ft. lbs.) torque.
- (5) Connect power seat wire connector to body harness, if equipped.

CENTER SEAT/CONSOLE**REMOVAL**

- (1) Remove bolts on driver and passenger seat inboard seat tracks.
- (2) Separate center section.

INSTALLATION

- (1) Position and align center section on driver and passenger seat inboard seat tracks.
- (2) Install bolts. Tighten to 19.5 N·m (14 ft. lbs.) torque.

CONSOLE LID**REMOVAL**

- (1) Open console lid.
- (2) Using a small flat blade screwdriver, disengage locking tabs located under the console lid trim bezel.
- (3) Separate bezel from lid.
- (4) Move driver and passenger seat to full forward position.
- (5) Using a small drift and hammer, tap out console lid hinge pin.

- (6) Separate lid from console.

INSTALLATION

- (1) Align console lid with console. Verify lid tension spring is in position.
- (2) Install hinge pin.
- (3) Position trim bezel on lid and snap into place.

REAR SEAT—CLUB CAB**REMOVAL**

- (1) Move front seat track to full forward position.
- (2) Turn release handle on underside of rear seat (Fig. 78) to disengage seat cushion and move seat to the stowed position (Fig. 79).
- (3) Remove side support bracket screws and lift seat to disengage from cab (Fig. 80).

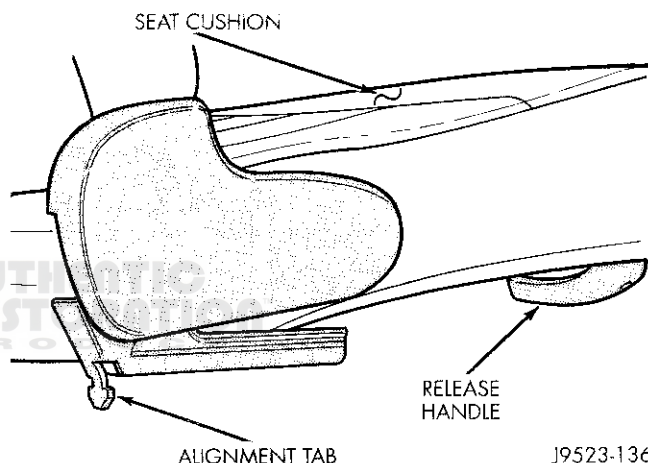


Fig. 78 Rear Seat Release Handle

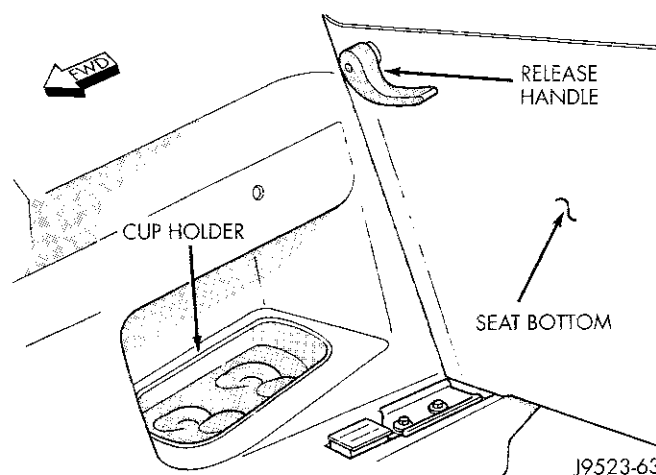


Fig. 79 Rear Seat Stowed

INSTALLATION

- (1) Position seat in vehicle.
- (2) Align seatback hooks with loops on cab rear panel (Fig. 80).

REMOVAL AND INSTALLATION (Continued)

(3) Align side support alignment tabs, and lower seat into place.

(4) Install side support bracket screws. Tighten the screws to 28 N·m (250 in-lbs) torque.

(5) Turn release handle to disengage seat from stowed position and push seat cushion downward to lock into place.

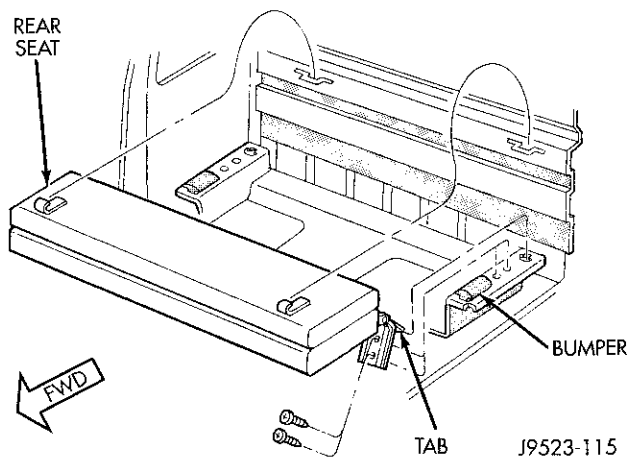


Fig. 80 Rear Seat Removal/Installation

FLOOR SHIFT BOOT—MANUAL TRANSMISSION

REMOVAL

- (1) Pull edge of floor shift boot upward to expose fasteners (Fig. 81).
- (2) Remove screws holding floor shift boot to floor.
- (3) Remove gear shift knob.
- (4) Separate gear shift boot from floor.
- (5) Lift floor shift boot off shifter.

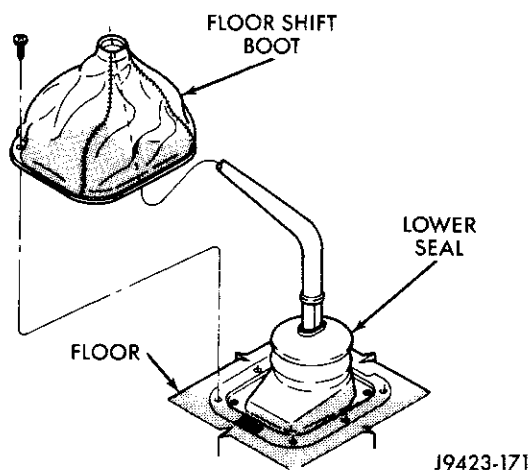


Fig. 81 Floor Shift Boot—Manual Transmission

INSTALLATION

Reverse the preceding operation.

4WD FLOOR SHIFT BOOT— MANUAL TRANSMISSION

REMOVAL

- (1) Pull edge of floor shift boot upward to expose fasteners (Fig. 82).
- (2) Remove screws holding floor shift boot to floor.
- (3) Remove gear shift knob.
- (4) Separate gear shift boot from floor.
- (5) Lift floor shift boot off shifter.

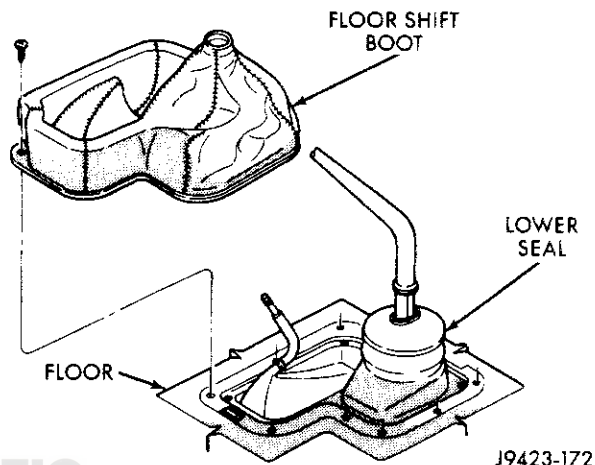


Fig. 82 4WD Floor Shift Boot—Manual Transmission

INSTALLATION

Reverse the preceding operation.

4WD FLOOR SHIFT BOOT— AUTOMATIC TRANSMISSION

REMOVAL

- (1) Pull edge of floor shift boot upward to expose fasteners (Fig. 83).
- (2) Remove screws holding floor shift boot to floor.
- (3) Remove gear shift knob.
- (4) Separate gear shift boot from floor.
- (5) Lift floor shift boot off shifter.

INSTALLATION

Reverse the preceding operation.

REAR FLOOR STOWAGE TRAY

REMOVAL

- (1) Move seat tracks to forward position.
- (2) Remove screws holding rear floor stowage tray to floor (Fig. 84).
- (3) Disengage hooks on stowage tray from slots in rear closure panel trim.
- (4) Separate rear floor stowage tray from vehicle.

INSTALLATION

Reverse the preceding operation.

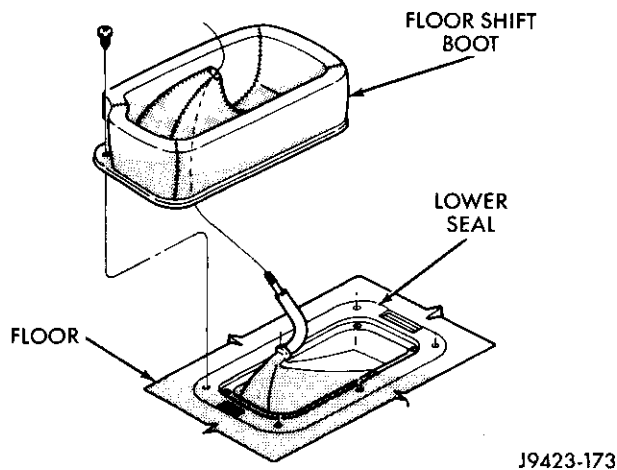
REMOVAL AND INSTALLATION (Continued)

Fig. 83 4WD Floor Shift Boot— Automatic Transmission

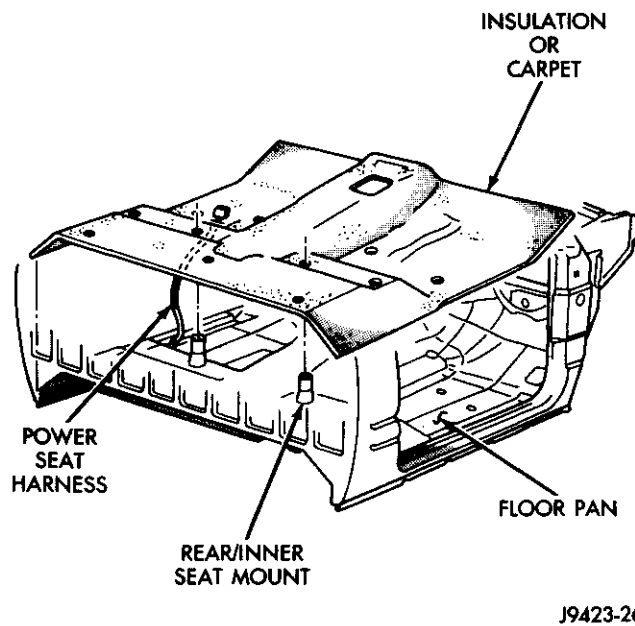


Fig. 85 Floor Carpet or Mat

FLOOR CARPET OR MAT—CLUB CAB**REMOVAL**

- (1) Remove front and rear seats.
- (2) Remove door sill and cowl trim covers.
- (3) Remove floor shift boot, if equipped.
- (4) Remove emergency jack tool kit.
- (5) Remove rear seat belt buckles.
- (6) Remove quarter trim panels.
- (7) Fold carpet or mat toward center of cab.
- (8) Remove carpet or mat through door opening.

INSTALLATION

Reverse the preceding operation.

REARVIEW MIRROR**REMOVAL**

- (1) Loosen the mirror base setscrew (Fig. 86).
- (2) Slide the mirror base upward and off the bracket.

INSTALLATION

- (1) Position the mirror base at the bracket and slide it downward onto the support bracket.
- (2) Tighten the setscrew securely.

REARVIEW MIRROR SUPPORT BRACKET**INSTALLATION**

- (1) Mark the position for the mirror bracket on the outside of the windshield glass with a wax pencil.

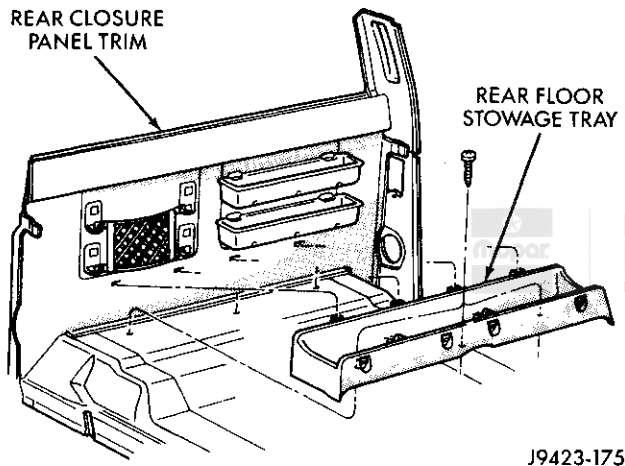


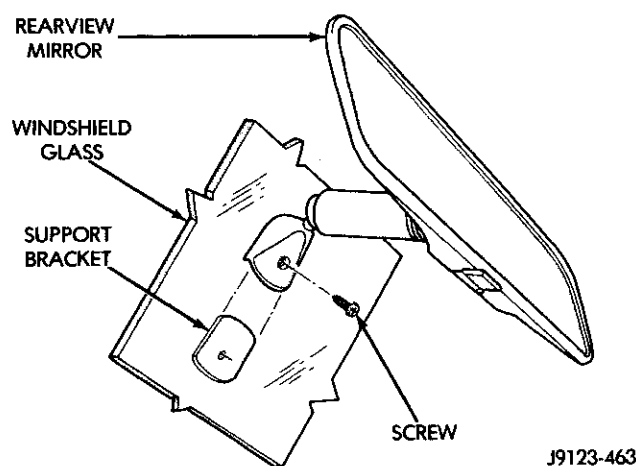
Fig. 84 Rear Floor Stowage Tray

FLOOR CARPET OR MAT**REMOVAL**

- (1) Remove seat.
- (2) Remove door sill and cowl trim covers.
- (3) Remove bolts holding lower seat belt anchors to floor.
- (4) Remove floor shift boot, if equipped.
- (5) Remove rear stowage tray.
- (6) Remove quarter trim panels.
- (7) Remove rear closure panel trim.
- (8) Fold carpet or mat toward center of cab.
- (9) Remove carpet or mat through door opening (Fig. 85).

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 86 Rearview Mirror**

(2) Clean the bracket contact area on the glass. Use a mild powdered cleanser on a cloth saturated with isopropyl (rubbing) alcohol. Final clean the glass with a paper dampened with alcohol.

(3) Sand the surface on the support bracket with fine grit sandpaper. Wipe the bracket surface clean with a paper towel.

(4) Apply accelerator to the surface on the bracket according to the following instructions:

- Crush the vial to saturate the felt applicator.
- Remove the paper sleeve.
- Apply accelerator to the contact surface on the bracket.
- Allow the accelerator to dry for five minutes.
- Do not touch the bracket contact surface after the accelerator has been applied.

(5) Apply adhesive accelerator to the bracket contact surface on the windshield glass. Allow the accelerator to dry for one minute. Do not touch the glass contact surface after the accelerator has been applied.

(6) Install the bracket according to the following instructions:

- Apply one drop of adhesive at the center of the bracket contact surface on the windshield glass.
- Apply an even coat of adhesive to the contact surface on the bracket.
- Align the bracket with the marked position on the windshield glass.
- Press and hold the bracket in place for at least one minute.

NOTE: Verify that the mirror support bracket is correctly aligned because the adhesive will cure rapidly.

(7) Allow the adhesive to cure for 8-10 minutes. Remove any excess adhesive with an alcohol-dampened cloth.

(8) Allow the adhesive to cure for an additional 8-10 minutes before installing the mirror.

SUN VISOR**REMOVAL**

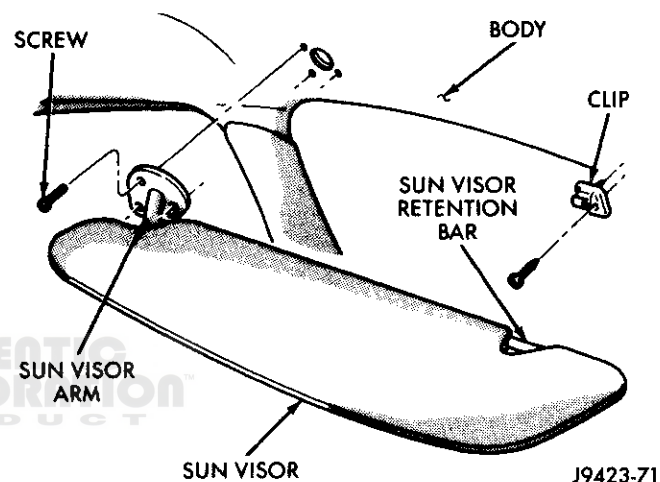
(1) Remove screws holding sun visor to roof header (Fig. 87).

(2) If equipped, disengage lighted vanity mirror connector.

(3) Separate sun visor from roof.

(4) Remove screw holding sun visor hook to roof header.

(5) Separate sun visor hook from roof.

**Fig. 87 Sun Visor****INSTALLATION**

Reverse the preceding operation.

HEADLINER**REMOVAL**

(1) Remove sun visors and visor hooks (Fig. 88).

(2) Remove overhead assist handle.

(3) Remove coat hook.

(4) Remove overhead console, if equipped. Refer to Group 8C, Overhead Console for removal procedure.

(5) Remove A-pillar moldings.

(6) Remove quarter trim panels.

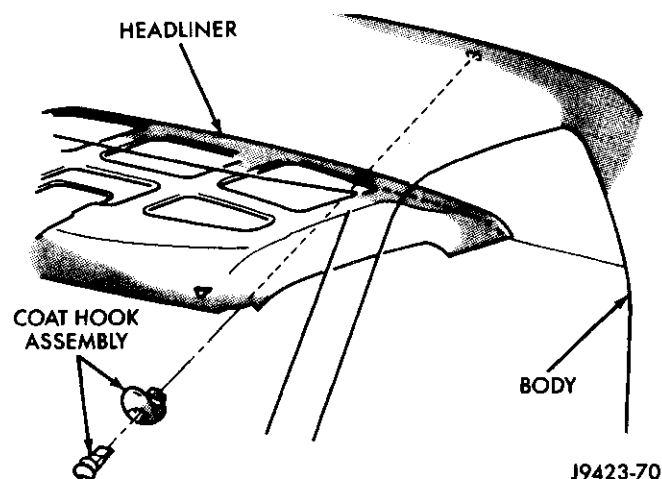
(7) Remove dome lamp. Refer to Group 8L, Lamps for removal procedure.

(8) Separate headliner from roof panel.

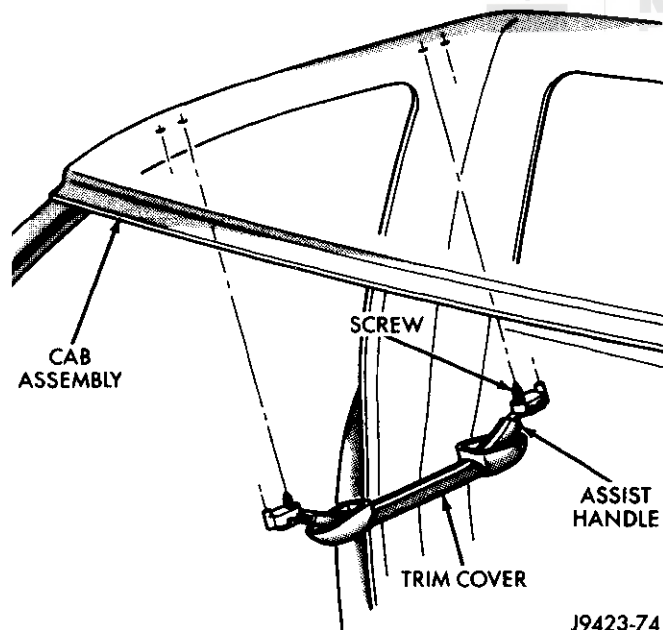
(9) Extract headliner through door opening.

INSTALLATION

Reverse the preceding operation.

REMOVAL AND INSTALLATION (Continued)**Fig. 88 Headliner****OVERHEAD ASSIST HANDLE****REMOVAL**

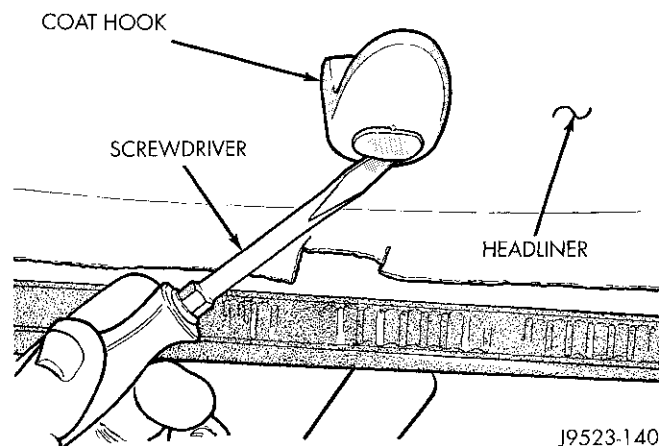
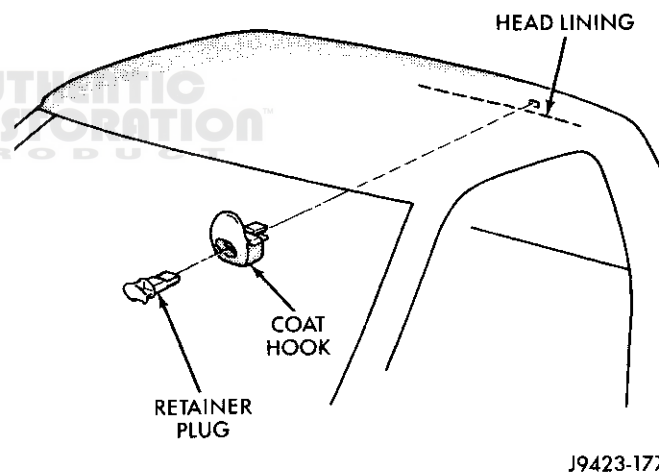
- (1) Disengage tabs holding assist handle end covers to assist handle.
- (2) Remove screws holding overhead assist handle to roof rail (Fig. 89).
- (3) Separate overhead assist handle from vehicle.

**Fig. 89 Overhead Assist Handle****INSTALLATION**

Reverse the preceding operation.

COAT HOOK**REMOVAL**

- (1) Pry retainer plug from center of coat hook (Fig. 90) and (Fig. 91).
- (2) Pull coat hook out of rear header panel.

**Fig. 90 Coat Hook Removal****Fig. 91 Coat Hook****INSTALLATION**

Reverse the preceding operation.

ADJUSTMENTS**HOOD**

- (1) Loosen the hinge arm-to-hood panel bolts at each side of the vehicle.
- (2) Loosen the hood latch screws.
- (3) Close the hood. Adjust the fore/aft position.
- (4) Raise the hood. Tighten the hinge arm-to-hood panel bolts.
- (5) Tighten the latch screws.
- (6) Lower the hood. Inspect clearance between the hood and the cowl cover.

ADJUSTMENTS (Continued)

HOOD LATCH STRIKER

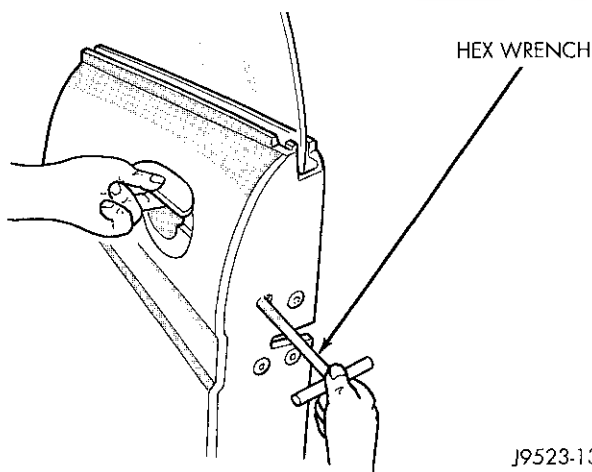
- (1) Open the hood.
- (2) Loosen the latch striker screws.
- (3) Slowly close the hood and observe the latching operation.
- (4) As necessary, re-adjust the striker position. Tighten the screws.

HOOD LATCH

- (1) Open the hood.
- (2) Loosen the hood latch screws.
- (3) Move the latch to the correct location and lightly tighten the screws.
- (4) Close the hood slowly and observe the latching operation.
- (5) As necessary, re-adjust the latch position and tighten the screws.

FRONT DOOR LATCH

- (1) Insert a hex-wrench through the elongated hole in the door end frame near the latch striker opening (Fig. 92).
- (2) Loosen torx head screw on the side of the latch linkage.
- (3) Lift upward on outside door handle and release it.
- (4) Tighten torx head screw on latch.
- (5) Verify latch operation.



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Fig. 92 Door Latch Adjustment

FRONT DOOR FORE/AFT

Fore/aft (lateral) door adjustment is done by loosening the hinge to cowl screws one hinge at a time. Then move the door to the correct position.

- (1) Support the door with a padded floor jack.
- (2) Loosen the hinge to cowl screws, if necessary, refer to the front door hinge removal/installation procedure for hinge fastener location. Move the door to the correct fore/aft position.
- (3) Tighten the hinge to cowl screws.
- (4) Remove the floor jack from the door.

FRONT DOOR IN/OUT

In/out door adjustment is done by loosening the hinge to door fasteners. Then move the door to the correct position.

- (1) Support the door with a padded floor jack.
- (2) Loosen the applicable hinge to door fasteners. Move the door to the correct in/out position.
- (3) If necessary, loosen the other hinge to door fasteners and move the door to the correct in/out position.
- (4) Tighten the hinge to door fasteners.
- (5) Remove the floor jack from the door.

FRONT DOOR UP/DOWN

Up/down door adjustment is done by loosening the hinge to cowl fasteners at both hinges. Then move the door to the correct position.

- (1) Support the door with a padded floor jack.
- (2) Loosen hinge to cowl fasteners at both hinges. Move the door to the correct up/down position.
- (3) Tighten the hinge to cowl fasteners.
- (4) Remove the floor jack from the door.

SPECIFICATIONS

TORQUE SPECIFICATIONS

WAX COATED FRAME

DESCRIPTION	TORQUE
Cab mounting bolt . . . . .	.81 N·m (60 ft. lbs.)
Cargo box bolt. . . . .	.27 N·m (20 ft. lbs.)

E-COATED FRAME

DESCRIPTION	TORQUE
Cab mounting bolt81 N·m (60 ft. lbs.)
Cargo box bolt.27 N·m (20 ft. lbs.)

HEATING AND AIR CONDITIONING

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GENERAL INFORMATION

HEATER AND AIR CONDITIONER

All vehicles are equipped with a common heater-A/C housing assembly (Fig. 1). The system combines air conditioning, heating, and ventilating capabilities in a single unit housing mounted under the instrument panel. On heater-only systems, the evaporator

coil is omitted and replaced with an air restrictor plate.

Outside fresh air enters the vehicle through the cowl top opening at the base of the windshield, and passes through a plenum chamber to the heater-A/C system blower housing (Fig. 2). Air flow velocity can then be adjusted with the blower motor speed selector switch on the heater-A/C control panel. The air

GENERAL INFORMATION (Continued)

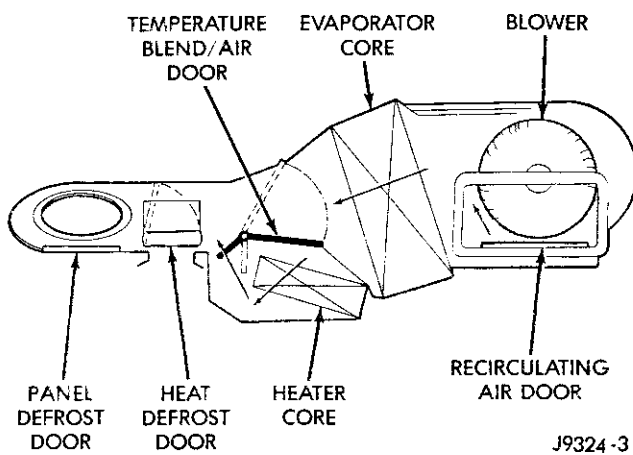


Fig. 1 Common Blend-Air Heater-Air Conditioner System

intake openings must be kept free of snow, ice, leaves, and other obstructions for the heater-A/C system to receive a sufficient volume of outside air.

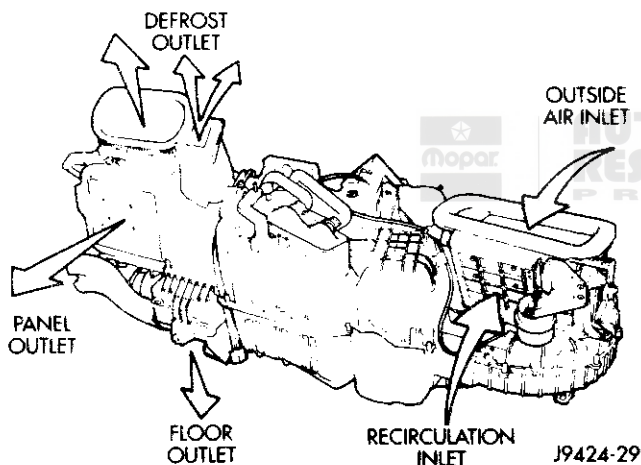


Fig. 2 Heater-A/C System Air Flow (Front View)

The heater and optional air conditioner are blend-air type systems. In a blend-air system, a blend-air door controls the amount of unconditioned air (or cooled air from the evaporator on models with air conditioning) is allowed to flow through, or around, the heater core. A temperature control knob on the heater-A/C control panel determines the discharge air temperature by moving a cable, which operates the blend-air door. This allows an almost immediate manual control of the system's output air temperature.

The mode control knob on the heater-A/C control panel is used to direct the conditioned air to the selected system outlets. The mode control knob switches engine vacuum to control the mode doors, which are operated by vacuum actuator motors.

On air conditioned vehicles, the outside air intake can be shut off by selecting the recirculation mode with the mode control knob. This will open a vacuum actuated recirculating air door and recirculate the air that is already inside the vehicle.

The optional air conditioner for all models is designed for the use of non-CFC, R-134a refrigerant. The air conditioning system has an evaporator to cool and dehumidify the incoming fresh or recirculated air prior to blending it with the heated air. This system uses a fixed orifice tube in the condenser outlet line to meter refrigerant flow to the evaporator coil. To maintain minimum evaporator temperature, a fixed pressure setting switch on the accumulator cycles the compressor clutch.

HEATER AND AIR CONDITIONER CONTROLS

Both the heater and heater-A/C systems use a combination of mechanical, electrical, and vacuum controls. These controls provide the vehicle operator with a number of setting options to help control the climate and comfort within the vehicle. Refer to the Owner's Manual for more information on the suggested operation and use of these controls.

The heater-A/C control panel is located to the right of the instrument cluster on the instrument panel (Fig. 3). The control panel contains a temperature control knob, a mode control knob, a blower motor switch knob, and the Message Center. For more information on the Message Center, refer to Group 8E - Instrument Panel Systems.

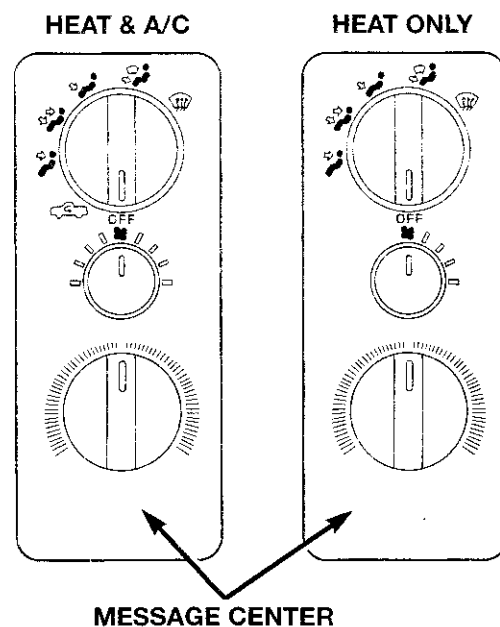


Fig. 3 Heater-Air Conditioner Control Panels

GENERAL INFORMATION (Continued)**SERVICE WARNINGS AND PRECAUTIONS****WARNING:**

- THE AIR CONDITIONING SYSTEM CONTAINS REFRIGERANT UNDER HIGH PRESSURE. SEVERE PERSONAL INJURY MAY RESULT FROM IMPROPER SERVICE PROCEDURES. REPAIRS SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.

- AVOID BREATHING THE REFRIGERANT AND REFRIGERANT OIL VAPOR OR MIST. EXPOSURE MAY IRRITATE EYES, NOSE, AND/OR THROAT. WEAR EYE PROTECTION WHEN SERVICING THE AIR CONDITIONING REFRIGERANT SYSTEM. SERIOUS EYE INJURY CAN RESULT FROM DIRECT CONTACT WITH THE REFRIGERANT. IF EYE CONTACT IS MADE, SEEK MEDICAL ATTENTION IMMEDIATELY.

- DO NOT EXPOSE THE REFRIGERANT TO OPEN FLAME. POISONOUS GAS IS CREATED WHEN REFRIGERANT IS BURNED. AN ELECTRONIC LEAK DETECTOR IS RECOMMENDED.

- IF ACCIDENTAL SYSTEM DISCHARGE OCCURS, VENTILATE THE WORK AREA BEFORE RESUMING SERVICE. LARGE AMOUNTS OF REFRIGERANT RELEASED IN A CLOSED WORK AREA WILL DISPLACE THE OXYGEN AND CAUSE SUFFOCATION.

- THE EVAPORATION RATE OF R-134a REFRIGERANT AT AVERAGE TEMPERATURE AND ALTITUDE IS EXTREMELY HIGH. AS A RESULT, ANYTHING THAT COMES IN CONTACT WITH THE REFRIGERANT WILL FREEZE. ALWAYS PROTECT THE SKIN OR DELICATE OBJECTS FROM DIRECT CONTACT WITH THE REFRIGERANT.

- THE R-134a SERVICE EQUIPMENT OR THE VEHICLE REFRIGERANT SYSTEM SHOULD NOT BE PRESSURE TESTED OR LEAK TESTED WITH COMPRESSED AIR. SOME MIXTURES OF AIR AND R-134a HAVE BEEN SHOWN TO BE COMBUSTIBLE AT ELEVATED PRESSURES. THESE MIXTURES ARE POTENTIALLY DANGEROUS, AND MAY RESULT IN FIRE OR EXPLOSION CAUSING INJURY OR PROPERTY DAMAGE.

CAUTION:

- Liquid refrigerant is corrosive to metal surfaces. Follow the operating instructions supplied with equipment being used.

- Never add R-12 to a refrigerant system designed to use R-134a. Damage to the system will result.

- R-12 refrigerant oil must not be mixed with the R-134a refrigerant oil. They are not compatible.

- Do not use R-12 equipment or parts on the R-134a system. Damage to the system will result.

- Do not over-charge the refrigerant system. This will cause excessive compressor head pressure and can cause noise and system failure.

In addition to the warnings and cautions listed above, the following precautions must also be observed whenever servicing the air conditioning system:

- Recover the refrigerant before opening any fitting or connection. Open the fittings with caution even after the system has been discharged. Never open or loosen a connection before recovering the refrigerant.

- The refrigerant system must always be evacuated before charging.

- Do not open the refrigerant system or uncap a replacement component until you are ready to service the system. This will prevent contamination in the system.

- Before disconnecting a component, clean the outside of the fittings thoroughly to prevent contamination from entering the refrigerant system.

- Immediately after disconnecting a component from the refrigerant system, seal the open fittings with a cap or plug.

- Before connecting an open refrigerant fitting, always install a new seal or gasket. Coat the fitting and seal with clean refrigerant oil before connecting.

- Do not remove the sealing caps from a replacement component until ready to install it.

- When installing a refrigerant line, avoid sharp bends. Position the lines away from the exhaust, or any sharp edges which may chafe the line.

- Tighten fittings only to the specified torque. The aluminum fittings used in the refrigerant system will not tolerate over-tightening.

- When disconnecting a fitting, use a wrench on both halves of the fitting. This will prevent twisting of the refrigerant lines or tubes.

- Refrigerant oil will absorb moisture from the atmosphere, if left uncapped. Do not open a container of oil until you are ready to use it. Install the cap immediately after using. Store the oil only in a clean moisture-free container.

- Keep service tools and the work area clean. Contamination of the refrigerant system through careless work habits must be avoided.

COOLING SYSTEM REQUIREMENTS

To maintain the performance level of the heating-air conditioning system, the engine cooling system must be properly maintained.

The use of a bug screen is not recommended. Any obstructions in front of the radiator or condenser will reduce the performance of the air conditioning and engine cooling systems.

GENERAL INFORMATION (Continued)**COOLANT PRECAUTIONS****WARNING:**

- **ANTIFREEZE IS AN ETHYLENE GLYCOL BASED COOLANT AND IS HARMFUL IF SWALLOWED OR INHALED. IF SWALLOWED, DRINK TWO GLASSES OF WATER AND INDUCE VOMITING. IF INHALED, MOVE TO A FRESH AIR AREA. SEEK MEDICAL ATTENTION IMMEDIATELY.**

- **WASH THE SKIN AND CLOTHING THOROUGHLY AFTER COMING IN CONTACT WITH ETHYLENE GLYCOL.**

- **KEEP OUT OF THE REACH OF CHILDREN AND PETS.**

- **DO NOT OPEN A COOLING SYSTEM WHEN THE ENGINE IS AT OPERATING TEMPERATURE. PERSONAL INJURY MAY RESULT.**

- **DO NOT STORE ENGINE COOLANT IN OPEN OR UNMARKED CONTAINERS.**

- **HOT ENGINE COOLANT CAN CAUSE SEVERE BURNS. DO NOT OPEN THE RADIATOR DRAIN COCK WHEN THE COOLING SYSTEM IS HOT AND PRESSURIZED. ALLOW THE COOLANT TO DECREASE TO ROOM TEMPERATURE BEFORE STARTING REPAIR OPERATIONS.**

The engine cooling system is designed to develop internal pressures of 97 to 124 kPa (14 to 18 psi). Allow the vehicle 15 minutes to cool down, or until a safe temperature and pressure are attained, before opening the cooling system. Refer to Group 7 - Cooling System for more information.

REFRIGERANT HOSES/TUBES PRECAUTIONS

Kinks or sharp bends in the refrigerant tubing or hoses will reduce the capacity of the entire system. High pressures are produced in the system when it is operating. Extreme care must be exercised to make sure that all connections are pressure tight.

A good rule for the flexible hose refrigerant lines is to keep the radius of all bends at least ten times the diameter of the hose. Sharp bends will reduce the flow of refrigerant. The flexible hose lines should be routed so they are at least 80 mm (3 inches) from the exhaust manifold. It is a good practice to inspect all flexible hose lines at least once a year to make sure they are in good condition and properly routed.

There are two types of refrigerant fittings:

- All fittings with O-rings need to be coated with refrigerant oil before installation. Use only O-rings approved for use with R-134a refrigerant. Failure to do so may result in a leak.

- Unified plumbing connections with aluminum gaskets cannot be serviced with O-rings. The gaskets are not reusable and new gaskets do not require lubrication before installing.

Using the proper wrenches when making a connection is very important. Improper wrenches or improper use of the wrenches can damage the fittings. Always use two wrenches when loosening or tightening tube fittings. Use one wrench to hold the stationary part while loosening or tightening with the other wrench.

The refrigerant must be recovered completely before opening any fitting or connection. Open the fittings with caution, even after the refrigerant has been recovered. If any pressure is noticed as a fitting is loosened, tighten the fitting and recover the system again.

Do not discharge refrigerant into the atmosphere. Use an R-134a refrigerant recovery/recycling device that meets SAE Standard J2210.

The refrigerant system will remain chemically stable as long as pure, moisture-free R-134a refrigerant oil is used. Dirt, moisture, or air can upset this chemical stability. Operational troubles or serious damage can occur if foreign material is present in the refrigerant system.

When it is necessary to open the refrigerant system, have everything needed to service the system ready. The system should not be left open any longer than necessary. Cap or plug all lines and fittings as soon as they are opened to prevent the entrance of dirt and moisture. All lines and components in parts stock should be capped or sealed until they are ready to be used.

All tools, including the refrigerant recycling equipment, the manifold gauge set, and test hoses should be kept clean and dry. All tools and equipment must be designed for R-134a refrigerant.

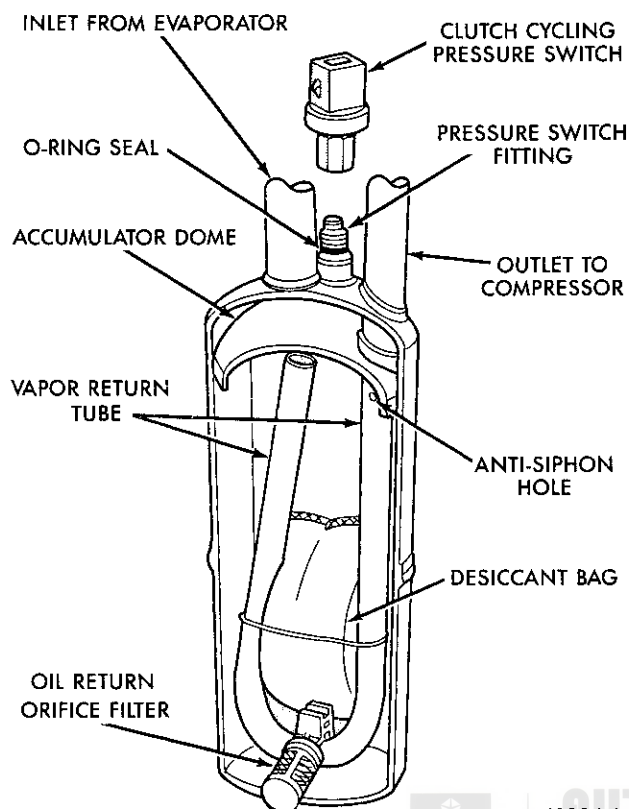
DESCRIPTION AND OPERATION**ACCUMULATOR**

The accumulator is mounted in the engine compartment between the evaporator coil outlet tube and the compressor inlet. Refrigerant enters the accumulator canister as a low pressure vapor through the inlet tube. Any liquid, oil-laden refrigerant falls to the bottom of the canister, which acts as a separator. A desiccant bag is mounted inside the accumulator canister to absorb any moisture which may be in the refrigerant system (Fig. 4).

BLOWER MOTOR

The blower motor and blower wheel are located in the right end of the heater-A/C housing, below the glove box. It can be removed from the passenger compartment side of the housing.

The blower motor will only operate when the ignition switch is in the On position, and the heater-A/C mode control switch is in any position, except Off.

DESCRIPTION AND OPERATION (Continued)**Fig. 4 Accumulator**

J9324-6

The blower motor speed is controlled by the blower motor switch and resistor. The blower motor circuit is protected by a fuse in the fuseblock module.

The blower motor cannot be repaired and, if faulty, must be replaced.

BLOWER MOTOR RESISTOR

The blower motor resistor contains several resistor wires. The blower motor receives ignition switched battery feed from a fuse in the fuseblock module. The blower motor speed is controlled by changing the resistance in the blower motor ground path through the blower motor switch and the blower motor resistor wires.

With the blower motor switch in the lowest speed position, the ground path for the motor is applied through all of the resistor wires. Each higher speed selected with the blower motor switch applies the blower motor ground path through fewer of the resistor wires, increasing the blower motor speed. When the blower motor switch is in the highest speed position, the blower motor resistor is bypassed and the ground circuit is applied directly to the blower motor.

The blower motor resistor cannot be repaired and, if faulty, must be replaced.

BLOWER MOTOR SWITCH

The heater, or heater-A/C blower motor is controlled by a rotary switch, mounted in the heater-A/C control panel. The switch allows the selection of four blower motor speeds and an Off position, but will only operate with the ignition switch in the On position, and the heater-A/C mode control switch in any position except Off.

The blower motor switch is connected in series with the blower motor ground circuit through the heater-A/C mode control switch. The blower motor switch directs this ground path to the blower motor through the blower motor resistor wires, or directly to the blower motor, as required to achieve the selected blower motor speed.

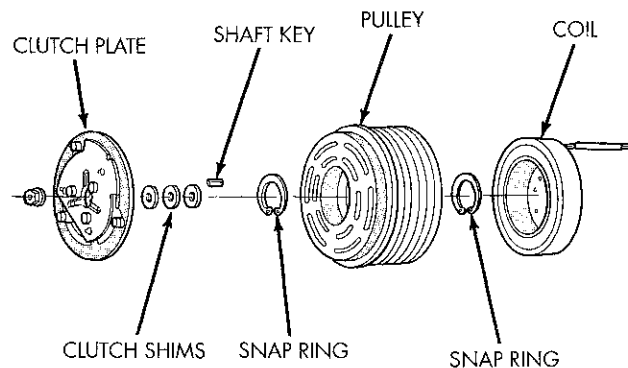
The blower motor switch cannot be repaired and, if faulty, must be replaced. The switch is serviced only as a part of the heater or heater-A/C control assembly. The switch knob is available for service.

COMPRESSOR

The air conditioning system uses a Sanden SD7H15 fixed displacement compressor on all models. A label identifying the use of R-134a refrigerant is located on the compressor. The purpose of the compressor is to compress the low-pressure refrigerant vapor from the evaporator into a high-pressure, high-temperature vapor. The compressor is serviced only as an assembly.

COMPRESSOR CLUTCH

The compressor clutch assembly consists of a stationary electromagnetic coil, a hub bearing and pulley assembly, and a clutch plate (Fig. 5). The electromagnetic coil and pulley are retained on the compressor with snap rings. The clutch plate is mounted on the compressor shaft and secured with a nut.



J9524-33

Fig. 5 Compressor Clutch

These components provide the means to engage and disengage the compressor from the engine ser-

DESCRIPTION AND OPERATION (Continued)

pentine accessory drive belt. When the clutch coil is energized, it magnetically draws the clutch into contact with the pulley and drives the compressor shaft. When the coil is not energized, the pulley free-wheels on the clutch hub bearing, which is part of the pulley. The compressor clutch and coil are the only serviced parts on the compressor.

The compressor clutch is controlled by several components: the heater-A/C mode control switch, the low/high pressure cut-off switch, the fin sensing cycling clutch switch, the compressor clutch relay, and the Powertrain Control Module (PCM). The PCM may delay compressor clutch engagement for up to 30 seconds. Refer to Group 14 - Fuel System for more information on the PCM controls.

COMPRESSOR CLUTCH RELAY

The compressor clutch relay is a International Standards Organization (ISO) micro-relay. The terminal designations and functions are the same as a conventional ISO relay. However, the micro-relay terminal orientation (footprint) is different, current capacity is lower, and the relay case dimensions are smaller than on the conventional ISO relay.

The compressor clutch relay is a electro-mechanical device that switches current to the compressor clutch coil when the Powertrain Control Module (PCM) grounds the coil side of the relay. The PCM responds to inputs from the heater-A/C mode control switch, the low pressure cycling clutch switch, and the high pressure cut-off switches.

The compressor clutch relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location.

CONDENSER

The condenser is located in front of the engine cooling radiator. It is a heat exchanger that allows the high-pressure refrigerant gas to give up its heat to the air passing over the condenser fins. This causes the refrigerant gas to condense into a high-pressure liquid refrigerant. The condenser is serviced only as an assembly.

EVAPORATOR COIL

The evaporator coil is located in the A/C housing, under the instrument panel. Refrigerant enters the evaporator as a low-temperature, low-pressure liquid. As air passes over the fins of the evaporator, the humidity in the air condenses on the fins, and the heat from the air is absorbed by the refrigerant. Heat absorption causes the refrigerant to become a low-pressure gas before it leaves the evaporator.

The evaporator coil cannot be repaired and, if faulty, it must be replaced.

FIXED ORIFICE TUBE

The fixed orifice tube is located in the outlet line of the condenser. The inlet and outlet ends of the tube have a screen to filter the refrigerant. O-rings on the tube body prevent the refrigerant from by-passing the fixed orifice. The fixed orifice tube is used to meter the flow of liquid refrigerant into the evaporator coil. The fixed orifice tube cannot be repaired and, if faulty, must be replaced.

HIGH PRESSURE CUT-OFF SWITCH

The high pressure cut-off switch is located on the discharge line near the compressor. When the discharge line pressure rises above 3100-3375 kPa (450-490 psi) the switch interrupts power to the compressor clutch. This switch prevents compressor operation when the discharge line pressure approaches high levels. The switch will cut-in when the pressure drops to 1860-2275 kPa (270-330 psi). The switch is a factory-calibrated unit. The high pressure cut-off switch cannot be adjusted or repaired and, if faulty, must be replaced.

HIGH PRESSURE RELIEF VALVE

The high pressure relief valve is located on the compressor manifold. The valve is used to prevent excessive system pressure. The valve vents the system when a pressure of 3445 to 4135 kPa (500 to 600 psi), and above, is reached. This prevents damage to the compressor and other system components due to condenser air flow being restricted or an over-charge of refrigerant. The valve closes with a minimum pressure of 2756 kPa (400 psi).

The high pressure relief valve vents only enough refrigerant to reduce system pressure, and then re-seats itself. The majority of the refrigerant is conserved in the system. If the valve vents refrigerant, it does not mean the valve is faulty. The valve is part of the compressor assembly and must not be removed or otherwise disturbed.

LOW PRESSURE CYCLING CLUTCH SWITCH

The low pressure cycling clutch switch is mounted on top of the accumulator. The switch is connected in series with the A/C request signal circuit, between the heater-A/C mode control switch and the Powertrain Control Module (PCM). The switch contacts open and close causing the PCM to turn the compressor clutch on and off. This regulates the system pressure and controls evaporator temperature. Controlling evaporator temperature prevents condensate water on the evaporator fins from freezing and obstructing air conditioning system air flow.

The switch contacts are normally open when the suction pressure is approximately 172 kPa (25 psi) or lower. The switch will close when the suction pres-

DESCRIPTION AND OPERATION (Continued)

sure rises to approximately 296 kPa (43 psi) or above. Lower ambient temperatures, below approximately -1°C (30°F) during cold weather will also open the switch contacts. This is due to the pressure/temperature relationship of the refrigerant in the system.

The low pressure cycling clutch switch is a factory-calibrated unit. It cannot be adjusted or otherwise repaired. If faulty, the switch must be replaced.

REFRIGERANT

The R-134a refrigerant used in this air conditioning system is a non-toxic, non-flammable, clear, and colorless liquefied gas. R-134a refrigerant is not compatible with R-12 refrigerant in an air conditioning system. Even a small amount of R-12, added to a R-134a refrigerant system, will cause compressor failure, refrigerant oil sludge, or poor air conditioning system performance.

The refrigerant system service ports have been designed to ensure that the system is not accidentally filled with the wrong refrigerant (R-12).

REFRIGERANT LINE COUPLERS

Spring locking couplers are used to connect refrigerant lines and other components to the refrigerant system. The coupling is held together by a garter spring inside a circular cage. When the coupling halves are connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage prevent the flared end of the female fitting from pulling out of the cage. O-rings are used to seal the coupling. These O-rings are compatible with R-134a refrigerant and must be replaced with O-rings made of the same material.

REFRIGERANT LINES

The refrigerant lines are used to carry the refrigerant between the various air conditioning system components. A barrier hose design is used for the air conditioning system on this vehicle. The ends of the refrigerant hoses are made from lightweight aluminum, and use braze-less fittings. The refrigerant lines and hoses cannot be repaired and, if faulty, must be replaced.

REFRIGERANT OIL

The oil used in the SD7H15 compressor is a polyalkylene glycol, synthetic (SP-20 PAG), wax-free refrigerant oil. Use only refrigerant oil of the same type to service the system. Refrigerant oil will absorb any moisture it comes in contact with, even moisture in the air. The oil container should be kept tightly capped until it is ready to be used. Then, cap the oil immediately after using, to prevent contamination.

REFRIGERANT SYSTEM SERVICE EQUIPMENT

WARNING: EYE PROTECTION MUST BE WORN WHEN SERVICING AN AIR CONDITIONING REFRIGERANT SYSTEM. TURN OFF (ROTATE CLOCKWISE) ALL VALVES ON THE EQUIPMENT BEING USED, BEFORE PROCEEDING WITH THIS OPERATION. FAILURE TO OBSERVE THESE WARNINGS MAY RESULT IN PERSONAL INJURY.

When servicing the air conditioning system, a refrigerant charging station and a recovery/recycling device for R-134a must be used. This device must meet SAE Standard J2210. Contact an automotive service equipment supplier for refrigerant charging and recycling/recovering equipment. Refer to the operating instructions provided with the equipment for proper operation.

A manifold gauge set may be needed with some charging and/or recovery/recycling devices (Fig. 6). The service hoses on the gauge set being used should have manual (turn wheel), or automatic, back-flow valves at the service port connector ends. This will prevent refrigerant from being released into the atmosphere.

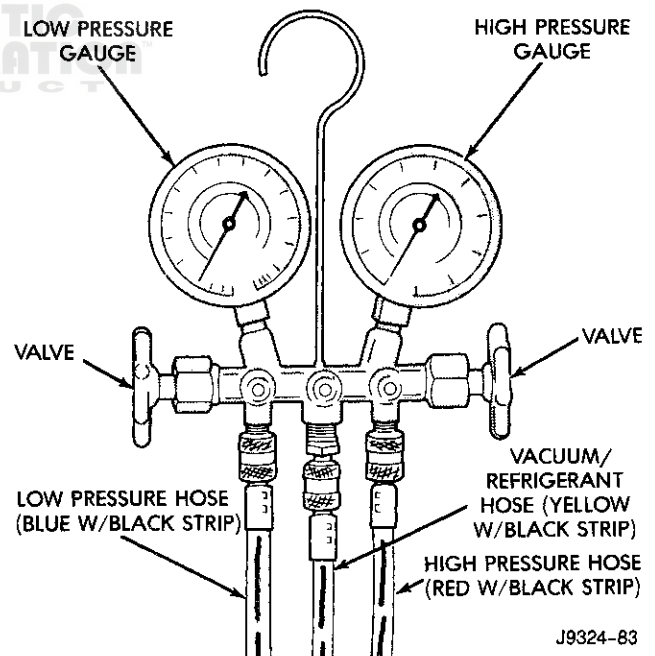


Fig. 6 Manifold Gauge Set

MANIFOLD GAUGE SET CONNECTIONS

CAUTION: Do not use an R-12 manifold gauge set on an R-134a system. The refrigerants are not compatible and system damage will result.

DESCRIPTION AND OPERATION (Continued)**LOW PRESSURE GAUGE HOSE**

The low pressure hose (Blue with Black stripe) attaches to the suction service port. This port is located at the right front of the engine compartment in the suction line.

HIGH PRESSURE GAUGE HOSE

The high pressure hose (Red with Black stripe) attaches to the discharge service port. This port is located on the discharge line between the compressor and the condenser.

RECOVERY/RECYCLING/EVACUATION/CHARGING HOSE

The center manifold hose (Yellow, or White, with Black stripe) is used to recover, evacuate, and charge the refrigerant system. When the low or high pressure valves on the manifold gauge set are opened, the refrigerant in the system will escape through this hose.

REFRIGERANT SYSTEM SERVICE PORTS

The service ports are used to charge, recover/recycle, evacuate, and test the air conditioning refrigerant system. Unique service port coupler sizes are used on the R-134a system, to ensure that the system is not accidentally contaminated by the use of the wrong refrigerant (R-12), or refrigerant service equipment.

The high pressure service port is located on the compressor manifold or plumbing. The low pressure service port is located on the suction line. After servicing the refrigerant system, always re-install the service port caps.

DIAGNOSIS AND TESTING**A/C PERFORMANCE**

The air conditioning system is designed to provide the passenger compartment with low temperature and low humidity air. The evaporator, located in the heater-A/C housing behind the instrument panel, is cooled to temperatures near the freezing point. As warm damp air passes over the fins in the evaporator, the air is cooled and the moisture is removed as it condenses on the fins. During periods of high heat and humidity, an air conditioning system will be more effective in the Recirc mode. With the mode control knob set in the Recirc position, only air from the passenger compartment passes through the evaporator. As the passenger compartment air dehumidifies, the air conditioning system performance levels improve.

Humidity has an important bearing on the temperature of the air delivered to the vehicle's interior. It is important to understand the effect that humidity

has on the performance of the air conditioning system. When humidity is high, the evaporator has to perform a double duty. It must lower the air temperature, and it must lower the temperature of the moisture in the air that condenses on the evaporator's fins. Condensing the moisture in the air transfers heat energy into the evaporator fins and tubing. This reduces the amount of heat the evaporator can absorb from the air. High humidity greatly reduces the evaporator's ability to lower the temperature of the air.

However, evaporator capacity used to reduce the amount of moisture in the air is not wasted. Wringing some of the moisture out of the air entering the vehicle adds to the comfort of the passengers. Although, an owner may expect too much from their air conditioning system on humid days. A performance test is the best way to determine whether the system is performing up to standard. This test also provides valuable clues as to the possible cause of trouble with the air conditioning system.

Review the Service Warnings and Precautions in the front of this group before performing this procedure. The air temperature in the test room and in the vehicle must be a minimum of 21°C (70°F) for this test.

(1) Connect a tachometer and a manifold gauge set.

(2) Set the heater-A/C mode control switch in the Panel and Recirc positions, the temperature control knob in the full cool position, and the blower motor switch in the full counterclockwise position.

(3) Start the engine and hold the idle at 1,000 rpm with the compressor clutch engaged.

(4) The engine should be at operating temperature. The doors and windows must be open.

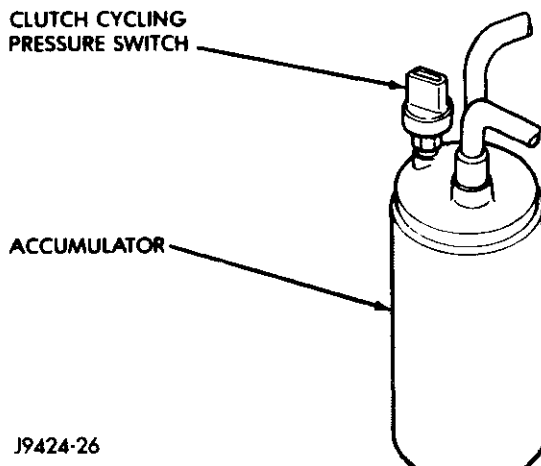
(5) Insert a thermometer in the left center A/C (panel) outlet. Operate the engine for five minutes.

(6) The compressor clutch may cycle, depending upon the ambient temperature and humidity. If the clutch cycles, remove the low pressure cycling clutch switch connector from the switch located on the accumulator (Fig. 7). Place a jumper wire across the terminals of the low pressure cycling clutch switch connector.

(7) With the compressor clutch engaged, record the discharge air temperature, the compressor discharge pressure, and the evaporator inlet pressure.

(8) Compare the discharge air temperature to the Performance Temperature and Pressure chart. If the discharge air temperature is high, see Refrigerant System Leaks and Refrigerant System Charge in this group.

(9) Compare the compressor discharge and suction (evaporator inlet) pressures to the Performance Temperature and Pressure chart. If the compressor dis-

DIAGNOSIS AND TESTING (Continued)

J9424-26

Fig. 7 Low Pressure Cycling Clutch Switch

charge pressure or suction pressure is not normal, see the Pressure Diagnosis chart.

HEATER PERFORMANCE**PREPARATIONS**

Review the Service Warnings and Precautions in the front of this group before performing the following procedures.

Check the radiator coolant level, serpentine drive belt tension, and engine vacuum line connections. Also check the radiator air flow and the radiator fan operation. Start the engine and allow it to warm up to normal operating temperature.

WARNING: DO NOT REMOVE THE RADIATOR CAP WHEN THE ENGINE IS AT OPERATING TEMPERATURE, PERSONAL INJURY MAY RESULT.

If the vehicle has been operated recently, wait 15 minutes or longer before removing the radiator cap. Place a rag over the cap and turn it to the first safety stop. Allow any pressure to escape through the overflow tube. When the system stabilizes, remove the cap completely.

MAXIMUM HEATER OUTPUT

Engine coolant is delivered to the heater core through two heater hoses. With the engine idling at normal operating temperature, set the temperature control knob in the full heat position, the mode control knob in the Floor position, and the blower motor switch knob in the full clockwise position. Using a test thermometer, check the air temperature coming from the floor outlets, refer to the Temperature Reference Chart.

If the floor outlet air temperature is low, refer to Group 7 -Cooling System for the coolant temperature specifications. Both of the heater hoses should be hot to the touch. The coolant return hose should be slightly cooler than the supply hose. If the coolant return hose is much cooler than the supply hose, locate and repair the engine coolant flow obstruction in the heater system.

OBSTRUCTED COOLANT FLOW

Possible locations or causes of obstructed coolant flow:

Ambient Temperature	21°C (70°F)	27°C (80°F)	32°C (90°F)	38°C (100°F)	43°C (110°F)
Air Temperature at Center Panel Outlet	-3 to 3°C (27-38°F)	1 to 7°C (33-44°F)	3 to 9°C (37-48°F)	6 to 13°C (43-55°F)	10 to 18°C (50-64°F)
Evaporator Inlet Pressure at Charge Port	172-241 kPa (25-35 psi)	221-276 kPa (32-40 psi)	255-310 kPa (37-45 psi)	269-345 kPa (39-50 psi)	310-379 kPa (45-55 psi)
Compressor Discharge Pressure	1102-1378 kPa (160-200 psi)	1309-1516 kPa (190-220 psi)	1378-1654 kPa (200-240 psi)	1516-1791 kPa (220-260 psi)	1723-2067 kPa (250-300 psi)

J9424-24

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LOW AND HIGH SIDE PRESSURE LOW	1. Refrigerant system low.	1. Recover refrigerant, evacuate, leak test and charge system.
LOW SIDE PRESSURE HIGH AND HIGH SIDE PRESSURE LOW	1. Internal compressor leak. 2. Compressor head gasket leaking. 3. Drive belt slipping.	1. Replace the compressor. 2. Replace the compressor. 3. Replace the drive belt.
LOW AND HIGH SIDE PRESSURE HIGH	1. Condenser fins blocked. 2. Air in system. 3. System overcharged.	1. Clean condenser fins. 2. Recover refrigerant, evacuate, leak test and charge system. 3. Recover refrigerant and charge system.
LOW SIDE PRESSURE LOW AND HIGH SIDE PRESSURE HIGH	1. Fixed orifice tube restricted. 2. Accumulator restricted. 3. Condenser restricted.	1. Recover refrigerant, replace orifice tube, evacuate and charge system. 2. Recover refrigerant, replace accumulator, evacuate and charge system. 3. Recover refrigerant, replace condenser, evacuate and charge system.
LOW AND HIGH SIDE PRESSURE NORMAL COOLING POOR	1. Excessive oil in system. 2. Blend-air door not sealed.	1. Recover refrigerant, restore oil to proper level, evacuate and charge system. 2. Adjust blend-air door cable.



**AUTHENTIC
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PRODUCT

J9524-7

Pressure Diagnosis

AMBIENT TEMPERATURE		MINIMUM HEATER SYSTEM AIR OUTLET TEMPERATURE	
°C	°F	°C	°F
15.5	60	62.2	144
21.1	70	63.8	147
26.6	80	65.5	150
32.2	90	67.2	153

J9124-11

Temperature Reference Chart

- Pinched or kinked heater hoses.
- Improper heater hose routing.
- Plugged heater hoses or supply and return ports at the cooling system connections (refer to Group 7 - Cooling System).
- A plugged heater core.

If proper coolant flow through the heater system is verified, and outlet air temperature is still low, a mechanical problem may exist.

MECHANICAL PROBLEMS

Possible locations or causes of insufficient heat:

- An obstructed cowl air intake.
- Obstructed heater system outlets.
- A blend-air door not functioning properly.

TEMPERATURE CONTROL

If the heater discharge air temperature cannot be adjusted with the temperature control knob on the heater-A/C control panel, the following could require service:

- The temperature control cable (not connected or not routed properly).
- Improper engine coolant temperature.

HEATER-A/C CONTROLS

Satisfactory heater and air conditioner performance depends upon proper operation, and adjustment, of all operating controls and refrigeration system components. For circuit descriptions and dia-

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
INSUFFICIENT HEAT	<ol style="list-style-type: none"> 1. Mode door not operating properly. 2. Blend-air door not operating properly. 3. Restricted water flow. 4. Insufficient coolant temperature. 	<ol style="list-style-type: none"> 1. Repair mode door cable/motor and adjust. Repair binding or misaligned door. 2. Repair door or cable/motor and adjust. Repair binding or misaligned door. 3. Repair kink in heater hose. Repair water valve if equipped. Repair plugged heater core. 4. Repair coolant system.
TOO MUCH HEAT	<ol style="list-style-type: none"> 1. Blend-air door not operating properly. 	<ol style="list-style-type: none"> 1. Repair door or cable/motor and adjust. Repair binding or misaligned door.

J9524-4

Heater Diagnosis

grams, refer to 8W-42 -Air Conditioning/Heater in Group 8W - Wiring Diagrams. These inspections, tests, and adjustments should be used to locate the cause of a malfunction.

Operation must be tested as described in the following sequence:

(1) Inspect the condition, routing, and installation of the temperature control cable. See Removal and Installation in this group for more information.

(2) Inspect and adjust the serpentine drive belt. Refer to Group 7 -Cooling System for the procedures.

(3) Start the engine and adjust the engine speed to 1,300 rpm.

(4) On vehicles with air conditioning, move the temperature control knob to the extreme left (Cool) position, and set the mode control switch in the Bi-Level position. The outside (recirculation) air door should be open to outside air. If not OK, see the Vacuum System tests in this group.

(5) Open the vehicle windows. Test the blower motor operation in all speeds. If not OK, see the diagnosis for the blower motor components in this group. Leave the blower motor switch in the High speed position.

(6) On vehicles with air conditioning, the compressor should be running, and the air conditioning system in operation. If not OK, see the diagnosis for the refrigerant system. If the refrigerant system is OK, see the diagnosis for the compressor clutch components and circuits in this group.

(7) Check the mode control switch operation. The heater and air conditioner system should respond as described in the owner's manual to each mode selected. Reduce the engine speed to normal idle. The vacuum will be high at low idle, and the vacuum actuators should respond quickly. If not OK, see the Vacuum System tests in this group.

(8) If the vacuum tests and the electrical component and circuit tests reveal no problems, disassem-

ble the heater-A/C housing and air distribution duct to inspect for mechanical misalignment or binding of doors.

VACUUM SYSTEM

Vacuum control is used to operate the mode doors in the heater and heater-A/C housings. Testing of the heater and heater-A/C mode control switch operation will determine if the vacuum, electrical, and mechanical controls are functioning. However, it is possible that a vacuum control system that operates perfectly at engine idle (high engine vacuum) may not function properly at high engine speeds or loads (low engine vacuum). This can be caused by leaks in the vacuum system, or a faulty vacuum check valve.

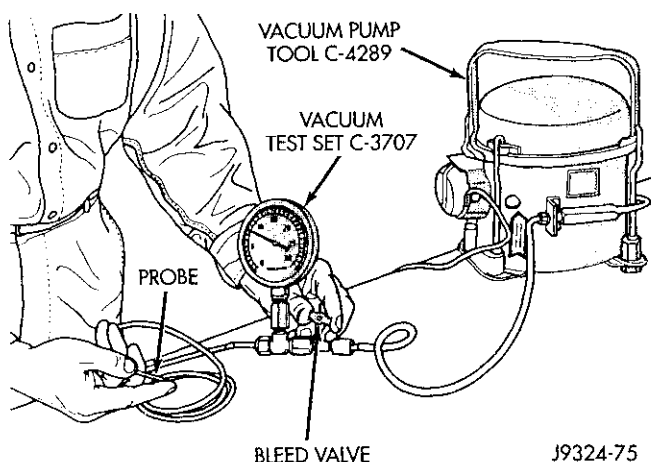
A vacuum system test will help to identify the source of poor vacuum system performance, or vacuum system leaks. Before starting this test, stop the engine and make certain that the problem isn't a disconnected vacuum source tube at the engine intake manifold or the vacuum reservoir.

Use an adjustable vacuum test set (Special Tool C-3707) and a suitable vacuum pump to test the heater-A/C vacuum control system. With a finger placed over the end of the vacuum test hose probe (Fig. 8), adjust the bleed valve on the test set gauge to obtain a vacuum of exactly 27 kPa (8 in. Hg.). Release and block the end of the probe several times to verify that the vacuum reading returns to the exact 27 kPa (8 in. Hg.) setting. Otherwise, a false reading will be obtained during testing.

ONE-WAY CHECK VALVE

(1) Disconnect the heater-A/C vacuum supply (black) tube in the engine compartment. This tube passes through an opening in the dash panel.

(2) Remove the one-way vacuum check valve. The valve is located on the (black) vacuum supply hose at the intake manifold.

DIAGNOSIS AND TESTING (Continued)

J9324-75

Fig. 8 Adjust Vacuum Test Bleed Valve

(3) Connect the test set vacuum supply hose to the heater side of the valve. When connected to this side of the check valve, no vacuum should pass and the test set gauge should return to the 27 kPa (8 in. Hg.) setting. If OK, go to step Step 4. If not OK, replace the faulty valve.

(4) Connect the test set vacuum supply hose to the engine vacuum side of the valve. When connected to this side of the check valve, vacuum should flow through the valve without restriction. If not OK, replace the faulty valve.

HEATER-A/C CONTROLS

(1) Connect the test set vacuum probe to the heater-A/C vacuum supply (black) hose in the engine compartment. Position the test set gauge so that it can be viewed from the passenger compartment.

(2) Place the heater-A/C mode control selector in each mode, one at a time, and pause after each selection. The test set gauge should return to the 27 kPa (8 in. Hg.) setting shortly after each selection is made. If not OK, a component or vacuum line in the selected mode's circuit has a vacuum leak. See the procedure in Locating Vacuum Leaks.

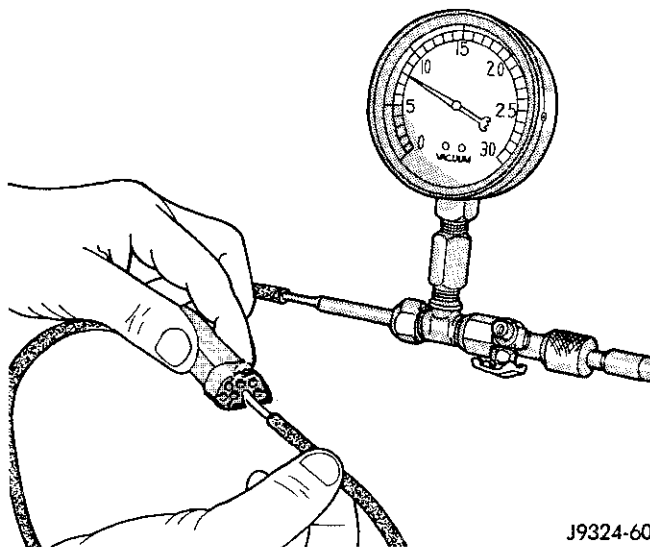
CAUTION: Do not use lubricant on the switch ports or in the holes in the plug, as lubricant will ruin the vacuum valve in the switch. A drop of clean water in the connector plug holes will help the connector slide onto the switch ports.

LOCATING VACUUM LEAKS

(1) Disconnect the vacuum connector from the back of the heater-A/C mode control switch on the control panel.

(2) Connect the test set vacuum hose probe to each port in the vacuum harness connector, one at a time, and pause after each connection (Fig. 9). The test set gauge should return to the 27 kPa (8 in. Hg.) setting

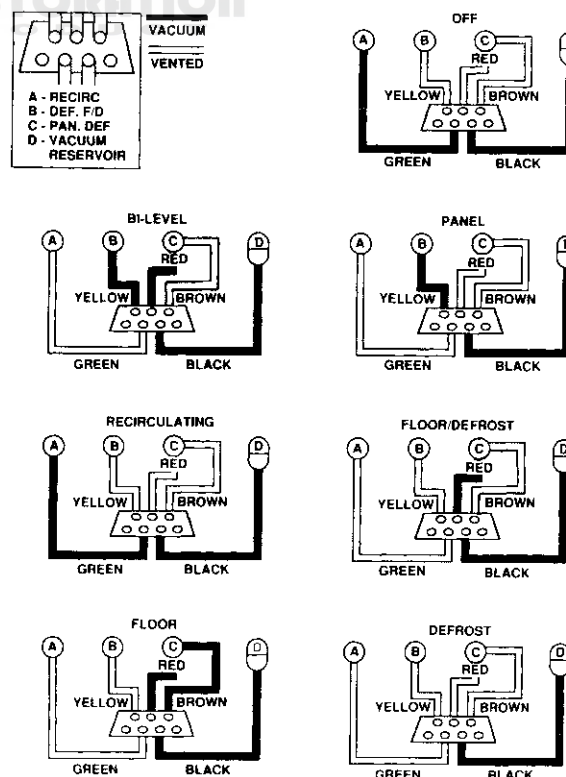
shortly after each connection is made. If OK, replace the faulty mode control switch. If not OK, go to step Step 3.



J9324-60

Fig. 9 Vacuum Circuit Test

(3) Determine the vacuum line color of the vacuum circuit that is leaking. To determine the vacuum line colors, refer to the Vacuum Circuits chart (Fig. 10).



J9424-27

Fig. 10 Vacuum Circuits

DIAGNOSIS AND TESTING (Continued)

(4) Disconnect and plug the vacuum line from the component (fitting, actuator, valve, switch, or reservoir) on the other end of the leaking circuit. Instrument panel disassembly or removal may be necessary to gain access to some components.

(5) Connect the test set hose or probe to the open end of the leaking circuit. The test set gauge should return to the 27 kPa (8 in. Hg.) setting shortly after each connection is made. If OK, replace the faulty disconnected component. If not OK, go to Step 6.

(6) To locate a leak in a vacuum line, leave one end of the line plugged and connect the test set hose or probe to the other end. Run your fingers slowly along the line while watching the test set gauge. The vacuum reading will fluctuate when your fingers contact the source of the leak. To repair the vacuum line, cut out the leaking section of the line. Then, insert the loose ends of the line into a suitable length of 3mm (1/8-inch) inside diameter rubber hose.

BLOWER MOTOR

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams. Possible causes of an inoperative blower motor include:

- Faulty fuse
- Faulty blower motor ground circuit wiring or connectors
- Faulty blower motor resistor
- Faulty blower motor switch
- Faulty heater-A/C mode control switch
- Faulty blower motor feed circuit wiring or connectors
- Faulty blower motor.

Possible causes of the blower motor not operating in all speeds include:

- Faulty fuse
- Faulty blower motor switch
- Faulty blower motor resistor
- Faulty blower motor circuit wiring or connectors.

VIBRATION

Possible causes of blower motor vibration include:

- Improper blower motor mounting
- Improper blower wheel mounting
- Blower wheel out of balance or bent
- Blower motor faulty.

NOISE

To verify that the blower is the source of the noise, disconnect the blower motor connector and operate the heater-A/C system. If the noise goes away, possible causes include:

- Foreign material in the heater-A/C housing
- Improper blower motor mounting
- Improper blower wheel mounting
- Blower motor faulty.

BLOWER MOTOR RESISTOR

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams.

To test the blower motor resistor, unplug the resistor connector. Each blower motor switch input terminal on the resistor must have continuity to the resistor output terminal, which is connected to the circuit going to the blower motor. If the blower motor resistor continuity does not check OK, replace the faulty resistor.

BLOWER MOTOR SWITCH

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams. The blower motor switch is only serviced as a part of the heater or heater-A/C control assembly.

(1) Turn the ignition switch to the Off position. Remove the heater-A/C control from the instrument panel. Check for continuity between the ground circuit cavity of the control connector and a good ground. There should be continuity. If OK, go to Step 2. If not OK, repair the open circuit to ground as required.

(2) With the heater-A/C control disconnected, place the mode control knob in any position except the Off position. Check for continuity between the ground terminal and each of the blower motor driver terminals of the control as you move the blower switch to each of the four speed positions. There should be continuity at each driver terminal in only one speed position. If OK, test and repair the blower driver circuits between the control connector and the blower motor resistor as required. If not OK, replace the faulty heater-A/C control.

COMPRESSOR

When investigating an air conditioning related noise, you must first know the conditions under which the noise occurs. These conditions include: weather, vehicle speed, in gear or neutral, engine temperature, and any other special condition.

Noises that develop during air conditioning operation can often be misleading. For example: What sounds like a failed front bearing or connecting rod, may be caused by loose bolts, nuts, mounting brackets, or a loose clutch assembly. Verify serpentine drive belt tension. Improper belt tension can cause a misleading noise when the compressor is engaged. The noise may not occur when the compressor is disengaged.

Drive belts are speed sensitive. At different engine speeds and depending upon belt tension, belts can develop noises that are mistaken for a compressor noise.

DIAGNOSIS AND TESTING (Continued)

(1) Select a quiet area for testing. Duplicate the complaint conditions as much as possible. Switch the compressor on and off several times to clearly identify the compressor noise. Listen to the compressor clutch while engaged and disengaged.

(2) To duplicate a high-ambient temperature condition (high head pressure), restrict the air flow through the condenser. Install a manifold gauge set to make sure that the discharge pressure does not exceed 2070 kPa (300 psi).

(3) Tighten all compressor mounting bolts, the clutch mounting nut, the clutch coil mounting screws and the serpentine drive belt to the correct specifications.

(4) Check the refrigerant hoses for rubbing or interference, which can cause unusual noises.

(5) Check the refrigerant system charge. See Charging Refrigerant System in this group.

(6) Check the compressor noise as in Step 1.

(7) If the noise still exists, loosen the compressor mounting bolts and tighten again. Repeat Step 1.

(8) If the noise continues, replace the compressor and repeat Step 1.

COMPRESSOR CLUTCH COIL

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams. The battery must be fully-charged before performing the following tests. Refer to Group 8A - Battery for more information.

(1) Connect an ammeter (0-10 ampere scale) in series with the clutch coil terminal. Use a voltmeter (0-20 volt scale) with clip-type leads for measuring the voltage across the battery and the compressor clutch coil.

(2) With the heater-A/C mode control switch in any A/C mode, and the blower motor switch in the lowest speed position, start the engine and run it at normal idle.

(3) The compressor clutch coil voltage should read within two volts of the battery voltage. If there is voltage at the clutch coil, but the reading is not within two volts of the battery voltage, test the clutch coil feed circuit for excessive voltage drop and repair as required. If there is no voltage reading at the clutch coil, refer to the Powertrain Diagnostic Procedures manual for testing of the compressor clutch circuit. The following components must be checked and repaired as required before you can complete testing of the clutch coil:

- Fuses in the fuseblock module and the power distribution center
- Heater-A/C mode control switch
- Compressor clutch relay
- High pressure cut-off switch
- Low pressure cycling clutch switch

- Powertrain control module.

(4) The compressor clutch coil is acceptable if the current draw measured at the clutch coil is 2.0 to 3.9 amperes with electrical system voltage at 11.5 to 12.5 volts. This should only be checked with the work area temperature at 21°C (70°F). If system voltage is more than 12.5 volts, add electrical loads by turning on electrical accessories until the system voltage drops below 12.5 volts.

(a) If the clutch coil current reading is 4 amperes or more, the coil is shorted and should be replaced.

(b) If the clutch coil current reading is zero, the coil is open and should be replaced.

COMPRESSOR CLUTCH RELAY

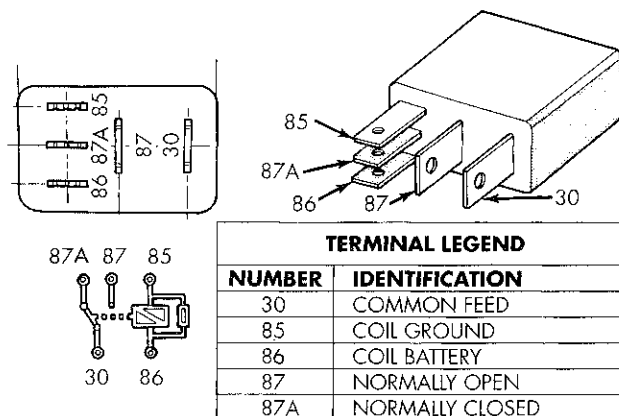
For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams.

The compressor clutch relay is located in the Power Distribution Center (PDC). Refer to the PDC label for relay identification and location. Remove the relay from the PDC to perform the following tests:

(1) A relay in the de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 2. If not OK, replace the faulty relay.

(2) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 3. If not OK, replace the faulty relay.

(3) Connect a battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, see the Circuit Test in this group. If not OK, replace the faulty relay.



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Compressor Clutch Relay**CIRCUIT TEST**

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams.

DIAGNOSIS AND TESTING (Continued)

(1) The relay common feed terminal cavity (30) is connected to fused battery feed. There should be battery voltage at this cavity at all times. If OK, go to Step 2. If not OK, repair the open circuit to the PDC as required.

(2) The relay normally closed terminal (87A) is not used in this application. Go to Step 3.

(3) The relay normally open terminal cavity (87) is connected to the compressor clutch coil. There should be continuity between this cavity and the A/C compressor clutch relay output circuit cavity of the compressor clutch coil connector. If OK, go to Step 4. If not OK, repair the open circuit as required.

(4) The coil battery terminal cavity (86) is connected to fused ignition switch output. There should be battery voltage at this cavity with the ignition switch in the On position. If OK, go to Step 5. If not OK, repair the open circuit to the fuseblock module as required.

(5) The coil ground terminal cavity (85) is switched to ground through the Powertrain Control Module (PCM). There should be continuity between this cavity and the A/C compressor clutch relay control circuit cavity of the PCM connector C (gray) at all times. If not OK, repair the open circuit as required.

HIGH PRESSURE CUT-OFF SWITCH

For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams.

(1) Verify that the refrigerant system is properly charged.

(2) Unplug the high pressure switch connector and test for continuity between the switch terminals. There should be continuity. If OK, refer to the wiring diagrams and repair the circuits as required. If not OK, replace the faulty switch.

LOW PRESSURE CYCLING CLUTCH SWITCH

Verify that the refrigerant system has the correct refrigerant charge. For circuit descriptions and diagrams, refer to 8W-42 - Air Conditioning/Heater in Group 8W - Wiring Diagrams.

(1) Unplug the low pressure cycling clutch switch connector from the switch on the accumulator, and install a jumper wire between the two connector cavities.

(2) Connect a manifold gauge set to the service ports.

(3) Place the heater-A/C mode control switch in any A/C position and start the engine.

(4) Check the continuity between the two terminals of the low pressure switch. There should be continuity with a suction pressure reading of 296 kPa (43 psi) or above, and no continuity with a suction pressure reading of 172 kPa (25 psi) or below. If OK,

test and repair the clutch control circuit as required. If not OK, replace the faulty switch.

REFRIGERANT SYSTEM LEAKS

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE LEAK TESTING THE SYSTEM.

If the air conditioning system is not cooling properly, determine if the refrigerant system is fully-charged. See A/C Performance in this group. If the refrigerant system is low or empty, a leak at a line, fitting, or component seal is likely. Fittings, lines, or components that appear to be oily indicate a possible refrigerant leak. To detect a leak in the refrigerant system, perform one of the following procedures:

SYSTEM EMPTY

(1) Evacuate the refrigerant system. See Refrigerant System Evacuate in this group.

(2) Connect and dispense 0.283 kPa (0.6 lbs. or 10 oz.) of R-134a refrigerant into the evacuated refrigerant system. See Refrigerant System Charge in this group.

(3) Position the vehicle in a wind-free work area. This will aid in detecting small leaks.

(4) With the engine not running, use an electronic R-134a leak detector and search for leaks. Move the leak detector probe slowly along the bottom side of all lines and fittings, because R-134a is heavier than air.

(5) To inspect the evaporator coil for leaks, insert the leak detector probe into the center panel outlet. Set the blower motor switch to the lowest speed (A/C) position, and the mode control switch in the Recirc mode.

SYSTEM LOW

(1) Position the vehicle in a wind-free work area. This will aid in detecting small leaks.

(2) Bring the refrigerant system up to operating temperature and pressure. This is done by allowing the engine to run with the air conditioning system on for five minutes.

(3) With the engine not running, use an electronic R-134a leak detector and search for leaks. Move the leak detector probe slowly along the bottom side of all lines and fittings, because R-134a is heavier than air.

(4) To inspect the evaporator coil for leaks, insert the leak detector probe into the center panel outlet. Set the blower motor switch to the lowest speed (A/C) position, and the mode control switch in the Recirc mode.

SERVICE PROCEDURES

REFRIGERANT RECOVERY

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE RECOVERING REFRIGERANT.

R-134a refrigerant is a hydrofluorocarbon (HFC) that does not contain chlorine. A R-134a refrigerant recovery/recycling station that meets SAE Standard J2210 must be used to recover the refrigerant. Refer to the operating instructions provided with the equipment for proper operation.

REFRIGERANT SYSTEM EVACUATE

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE EVACUATING THE SYSTEM.

If the refrigerant system has been open to the atmosphere, it must be evacuated before the system can be charged. Moisture and air mixed with the refrigerant will raise the compressor head pressure above acceptable operating levels. This will reduce the performance of the air conditioner and damage the compressor. Evacuating will boil the moisture out of the refrigerant system at near room temperature. To evacuate the refrigerant system, use the following procedure:

(1) Connect a suitable charging station and manifold gauge set to the vehicle.

(2) Open the low and high side valves and start the vacuum pump. When the suction gauge reads 88 kPa (26 in. Hg.) vacuum or greater, close all of the valves and turn off the vacuum pump. If the system fails to reach the specified vacuum, the system has a leak that must be corrected. If the system maintains the specified vacuum for five minutes, restart the vacuum pump. Then open the suction and discharge valves and evacuate an additional ten minutes.

(3) Close all of the valves. Turn off and disconnect the vacuum pump.

(4) The refrigerant system is now ready to be charged with refrigerant.

REFRIGERANT SYSTEM CHARGE

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE CHARGING THE REFRIGERANT SYSTEM.

After the system has been tested for leaks and evacuated, a refrigerant charge can be injected into the system. See Refrigerant Charge Capacity for the proper amount of the refrigerant charge. Charge the

system using a recovery/recycling/charging station approved for R-134a refrigerant. This device must meet SAE Standard J2210. Refer to the instructions provided with the equipment for proper operation.

REFRIGERANT CHARGE CAPACITY

The R-134a system charge capacity is 0.9 kg (32 ozs.).

REFRIGERANT OIL LEVEL

When an air conditioning system is assembled at the factory, all components (except the compressor) are refrigerant oil free. After the system has been charged and operated, the oil in the compressor is dispersed through the refrigerant system. The accumulator, evaporator, condenser, and compressor will retain a significant amount of oil.

It is important to have the correct amount of oil in the refrigerant system. This will ensure proper lubrication of the compressor. Too little oil will result in damage to the compressor. Too much oil will reduce the cooling capacity of the system.

It will not be necessary to check oil level in the compressor or to add oil, unless there has been an oil loss. This may be due to a rupture or leak from a refrigerant line, a compressor shaft seal, an evaporator, or a condenser. If a rupture occurs, add 1 ounce of oil to the system after the repair has been made. Oil loss at a leak point will be evident by the presence of a wet, shiny surface around the leak.

Refrigerant oil must be added when a accumulator, evaporator, or condenser are replaced. Refer to the Refrigerant Oil Capacities chart (Fig. 11). When a compressor is replaced, the oil must be drained from the old compressor and measured. Drain all the oil from the new compressor, then fill the new compressor with the same amount of oil that was drained out of the old compressor.

Component	ml	oz
A/C System	230	7.75
Accumulator	120	4
Condenser	30	1
Evaporator Coil	60	2
Compressor	(see Oil Level Check)	

J9524-6

Fig. 11 Refrigerant Oil Capacities

REMOVAL AND INSTALLATION

REFRIGERANT LINE COUPLERS

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE PERFORMING THE FOLLOWING OPERATION.

REMOVAL

(1) Recover the refrigerant from the refrigerant system as described in this group.

(2) Remove the secondary clip from the coupling. Fit the appropriate spring lock coupling tool from the A/C Tool Kit (Special Tool 6125) (Fig. 12).

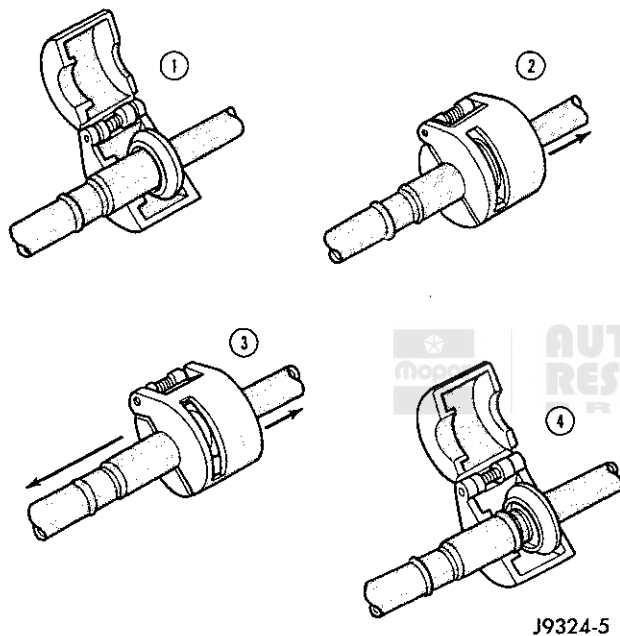


Fig. 12 Spring Lock Coupling Disconnect

(3) Close the tool and push it into the open side of the cage to expand the garter spring and release the female fitting.

NOTE: The garter spring may not release if the tool is cocked while pushing it into the cage opening.

(4) After the garter spring is expanded, pull the fittings apart within the tool.

(5) Remove the tool from the disconnected coupling.

(6) Separate the two ends of the coupling.

INSTALLATION

(1) Check to ensure that the garter spring is in the cage of the male fitting. If the garter spring is missing, install a new spring by pushing it into the cage opening. If the garter spring is damaged, remove it

from the cage with a small wire hook (DO NOT use a screwdriver) and install a new garter spring.

(2) Clean any dirt or foreign material from both halves of the coupling.

(3) Install new O-rings on the male fitting.

CAUTION: Use only the specified O-rings as they are made of a special material for the R-134a system. The use of any other O-ring may allow the connection to leak intermittently during vehicle operation.

(4) Lubricate the male fitting and O-ring, and the inside of the female fitting with clean R-134a (SP20 PAG) refrigerant oil.

(5) Fit the female fitting to the male fitting and push together until the garter spring snaps over the flared end of the female fitting.

(6) Ensure the coupling is fully engaged by pulling back on the lines on either side of the coupling.

(7) Install the secondary clip on the coupling.

COMPRESSOR

The compressor may be removed and repositioned without disconnecting the refrigerant lines or discharging the refrigerant system. Discharging is not necessary if servicing the compressor clutch or clutch coil, the engine, the cylinder head, or the generator.

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE PERFORMING THE FOLLOWING OPERATION.

REMOVAL

(1) Disconnect and isolate the battery negative cable.

(2) Loosen and remove the serpentine drive belt. Refer to Group 7 - Cooling System for the procedures.

(3) Disconnect the compressor clutch coil wiring.

(4) Recover the refrigerant from the refrigerant system as described in this group.

(5) Remove the refrigerant lines from the compressor. Install plugs in, or tape over, all of the open refrigerant fittings.

(6) Remove the compressor mounting bolts, and lift the compressor from the mounting bracket.

INSTALLATION

NOTE: If a replacement compressor is being installed, be certain to check the oil level. See Refrigerant Oil Level in this group.

(1) If the compressor mounting bracket was removed, install the bracket to the engine. Tighten the mounting bolts to 27 N·m (20 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

(2) Install the compressor on the mounting bracket. Tighten the bolts to 27 N·m (20 ft. lbs.).

(3) Remove the tape or plugs from all of the refrigerant fittings, and install the refrigerant lines on the compressor.

(4) Install the serpentine drive belt. Refer to Group 7 - Cooling System for the procedures.

(5) Connect the compressor clutch coil wiring.

(6) Connect the battery negative cable.

(7) Evacuate and charge the refrigerant system as described in this group.

COMPRESSOR CLUTCH

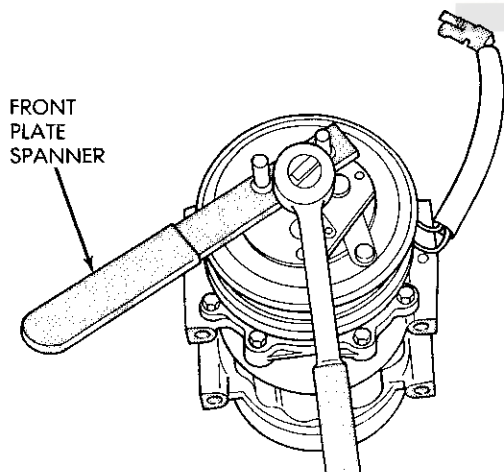
The refrigerant system can remain fully-charged during compressor clutch, pulley, or coil replacement. The compressor clutch can be serviced in the vehicle.

REMOVAL

(1) Disconnect and isolate the battery negative cable.

(2) On models with the diesel engine option, remove the compressor as described in this group. Do not remove the refrigerant lines or fittings.

(3) Insert the two pins of the spanner wrench (Special Tool 6462 in Kit 6460) into the holes of the clutch plate. Hold the clutch plate stationary and remove the hex nut (Fig. 13).



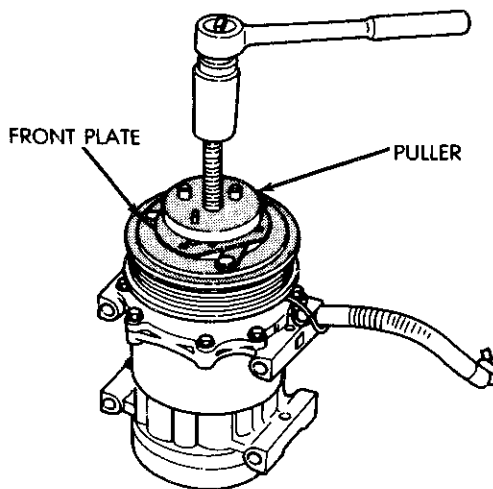
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Fig. 13 Compressor Shaft Nut Remove/Install

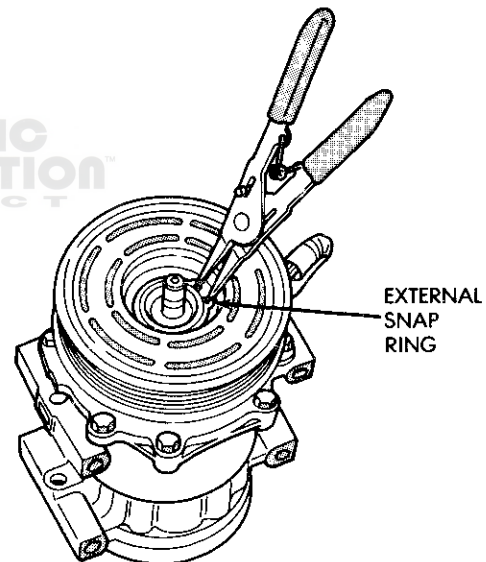
(4) Remove the clutch plate. On models with the diesel engine option, a puller (Special Tool 6461 in Kit 6460) is used to remove the clutch plate (Fig. 14). This compressor also uses a shaft key which must be removed.

(5) Remove the external front housing snap ring with snap ring pliers (Fig. 15).

(6) Install the lip of the rotor puller (Special Tool C-6141-1 in Kit 6460) into the snap ring groove exposed in the previous step, and install the shaft protector (Special Tool C-6141-2 in Kit 6460) (Fig. 16).



J8924-18

Fig. 14 Clutch Puller - Diesel Models

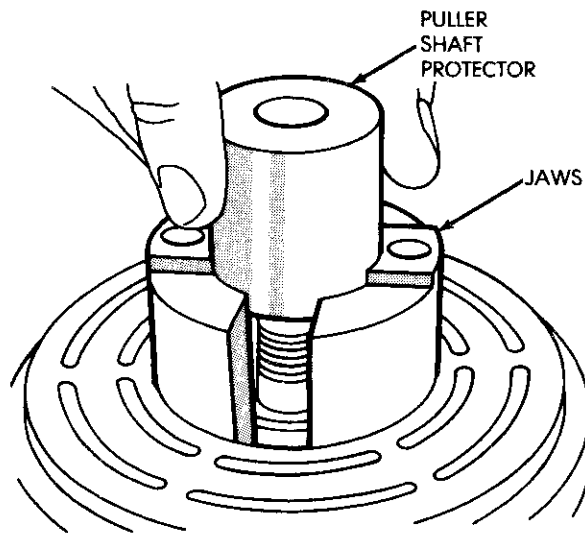
J8924-20

Fig. 15 External Snap Ring Remove

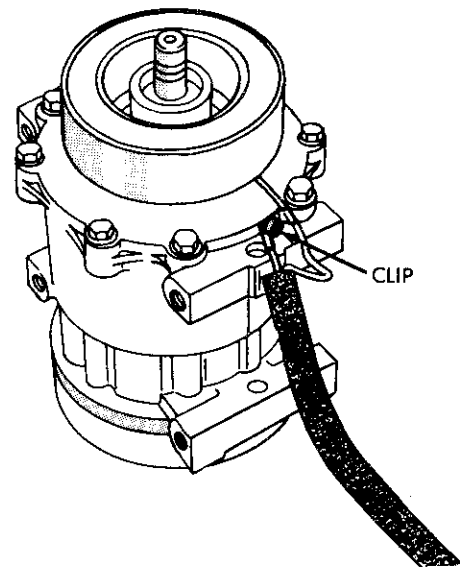
(7) Install the puller through-bolts (Special Tool C-6461 in Kit 6460) through the puller flange and into the jaws of the rotor puller and tighten (Fig. 17). Turn the puller center bolt clockwise until the rotor pulley is free.

(8) Remove the screw and retainer from the clutch coil lead wire on the compressor front housing (Fig. 18).

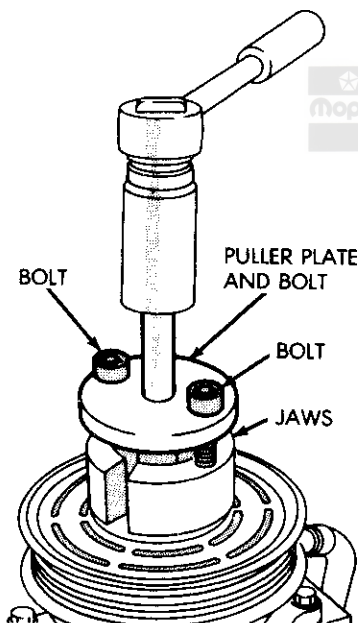
(9) Remove the snap ring from the compressor hub and remove the clutch field coil (Fig. 19).

REMOVAL AND INSTALLATION (Continued)

J8924-21

Fig. 16 Shaft Protector and Puller

J8924-23

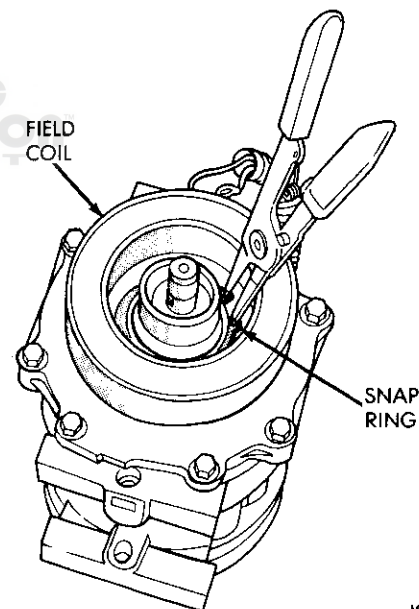
Fig. 18 Clutch Coil Lead Wire

J8924-22

Fig. 17 Install Puller Plate**INSTALLATION**

- (1) Install the clutch field coil and snap ring.
- (2) Install the clutch coil wire lead retaining clip on the compressor front housing and tighten the retaining screw.
- (3) Align the rotor assembly squarely on the front compressor housing hub.
- (4) Thread the handle (Special Tool 6464 in Kit 6460) into the driver (Special Tool 6143 in Kit 6460) (Fig. 20).

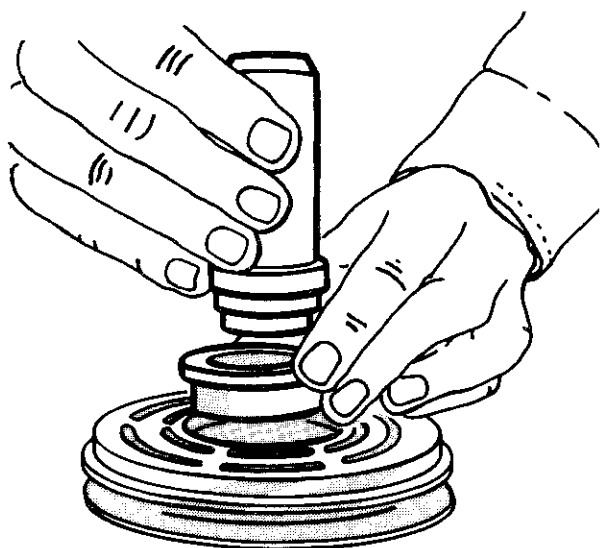
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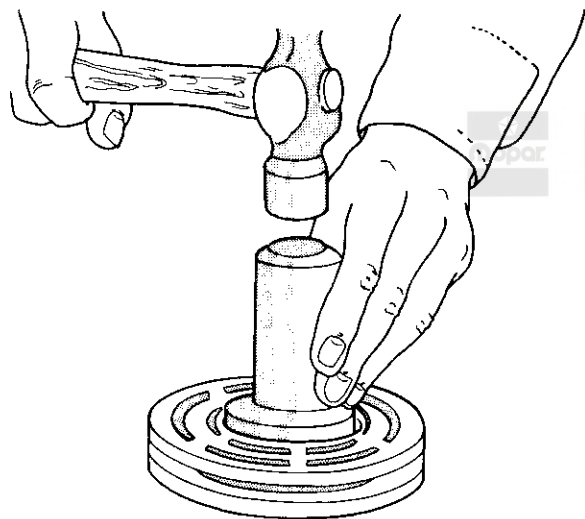
J8924-24

Fig. 19 Clutch Field Coil Snap Ring Remove

- (5) Place the driver tool assembly into the bearing cavity on the rotor. Make certain the outer edge of the tool rests firmly on the rotor bearing inner race (Fig. 21).
- (6) Tap the end of the driver while guiding the rotor to prevent binding. Tap until the rotor bottoms against the compressor front housing hub. Listen for a distinct change of sound during the tapping process, to indicate the bottoming of the rotor.
- (7) Install the external front housing snap ring.

REMOVAL AND INSTALLATION (Continued)

J8924-25

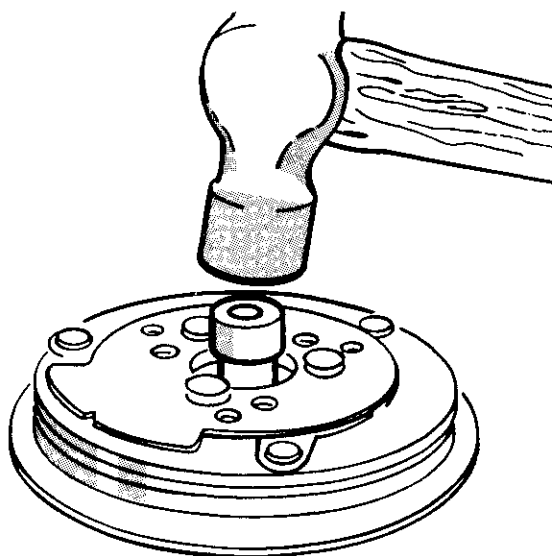
Fig. 20 Rotor Installer Set

J8924-26

Fig. 21 Rotor Install

(8) Check that the original clutch shims are in place on the compressor shaft and install the clutch plate. On models with the diesel engine option, install the shaft key. On all models, use the shaft protector (Special Tool 6141-2 in Kit 6460) to install the clutch plate on the compressor shaft (Fig. 22). Tap the clutch plate over the compressor shaft until it has bottomed against the clutch shims. Listen for a distinct change of sound during the tapping process, to indicate the bottoming of the clutch plate.

(9) Replace the compressor shaft hex nut. Tighten the hex nut to 14.4 N·m (10.5 ft. lbs.).



J8924-27

Fig. 22 Clutch Plate Install

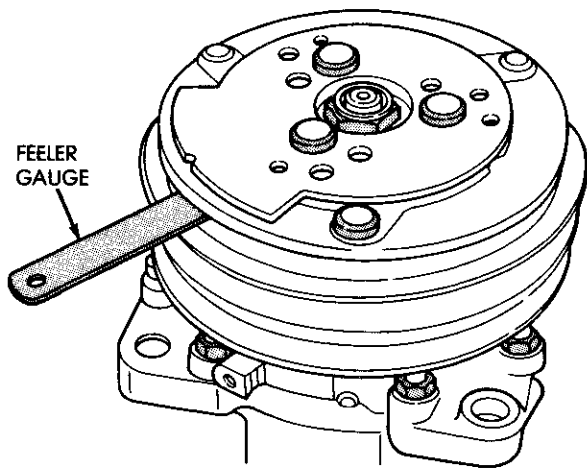
(10) Check the clutch air gap with a feeler gauge (Fig. 23). If the air gap does not meet the specification, add or subtract shims as required. The specification is 0.41-0.79 mm (0.016-0.031 inch). If the air gap is not consistent around the circumference of the clutch, lightly pry up at the minimum variations. Lightly tap down at the points of maximum variation.

NOTE: The air gap is determined by the spacer shims. When installing an original, or a new clutch assembly, try the original shims first. When installing a new clutch onto a compressor that previously did not have a clutch, use 0.040, 0.020, and 0.005 shims from the clutch hardware package that is provided with the new clutch.

(11) Reverse the remaining removal procedures to complete the installation.

CLUTCH BREAK-IN

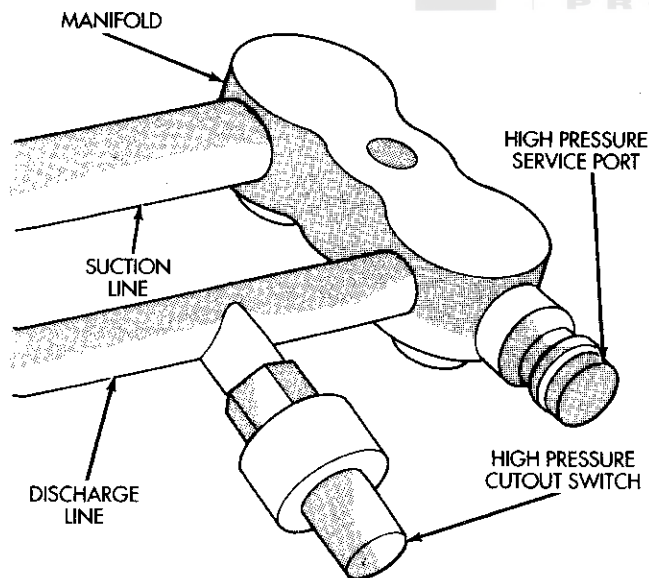
After a new compressor clutch has been installed, cycle the compressor clutch approximately 20 times (5 seconds on, then 5 seconds off). During this procedure, set the heater-A/C control to the A/C (Recirc) mode, the blower motor switch in the highest speed position, and the engine speed at 1500 -2000 rpm. This procedure (burnishing) will seat the opposing friction surfaces and provide a higher compressor clutch torque capability.

REMOVAL AND INSTALLATION (Continued)

J8924-28

Fig. 23 Check Clutch Air Gap**HIGH PRESSURE CUT-OFF SWITCH****REMOVAL**

- (1) Disconnect and isolate the battery negative cable.
- (2) Unplug the wiring connector from the switch (Fig. 24).



J9424-32

Fig. 24 High Pressure Cut-Off Switch

- (3) Unscrew the switch from the discharge line fitting.

INSTALLATION

- (1) Install and tighten the switch.
- (2) Plug the wiring connector into the switch.

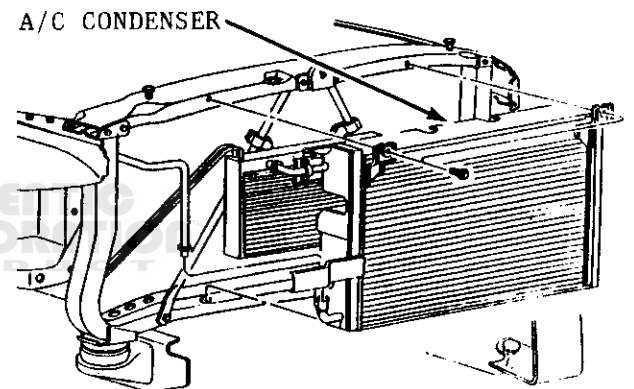
- (3) Connect the battery negative cable.

CONDENSER

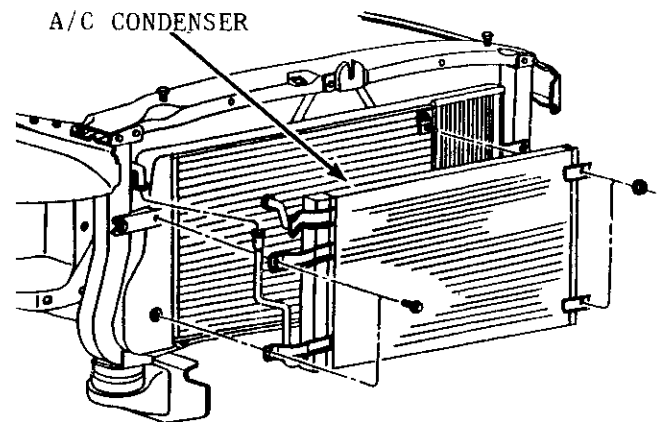
WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE PERFORMING THE FOLLOWING OPERATION.

REMOVAL

- (1) Disconnect and isolate the battery negative cable.
- (2) Recover the refrigerant from the refrigerant system as described in this group.
- (3) Disconnect the refrigerant lines from the condenser. Install plugs in, or tape over, all of the open refrigerant fittings.
- (4) Remove the mounting screws from the condenser (Fig. 25) or (Fig. 26).



J9424-35

Fig. 25 Condenser Mounting - Gasoline Engine

J9424-36

Fig. 26 Condenser Mounting - Diesel Engine

- (5) Carefully remove the condenser from the vehicle.

REMOVAL AND INSTALLATION (Continued)**INSTALLATION**

- (1) Carefully position the condenser in the vehicle.
- (2) Install and tighten the condenser mounting screws to 11 N·m (95 in. lbs.).
- (3) Evacuate the refrigerant system as described in this group.
- (4) Add 1 ounce of refrigerant oil to the refrigerant system if the condenser was replaced.
- (5) Charge the refrigerant system as described in this group.
- (6) Connect the battery negative cable.

FIXED ORIFICE TUBE

WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE PERFORMING THE FOLLOWING OPERATION.

REMOVAL

- (1) Disconnect and isolate the battery negative cable.
- (2) Recover the refrigerant from the refrigerant system as described in this group.
- (3) Disconnect the refrigerant line coupler at the condenser outlet line.
- (4) Remove the fixed orifice tube using a needle nose pliers. Note the orientation of the fixed orifice tube for correct reinstallation.

INSTALLATION

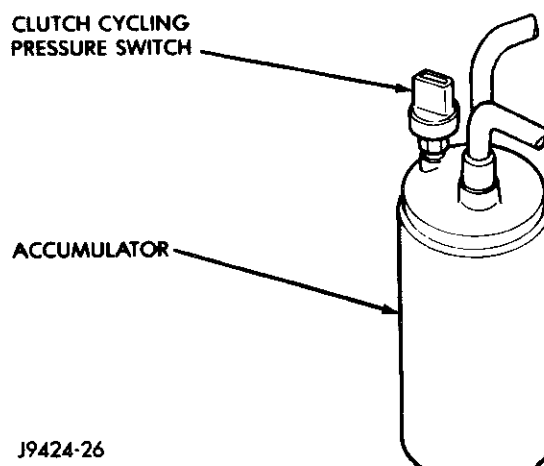
- (1) Install the fixed orifice tube in the condenser outlet line.
- (2) Connect the condenser refrigerant line.
- (3) Evacuate and charge the refrigerant system as described in this group.
- (4) Connect the battery negative cable.

ACCUMULATOR

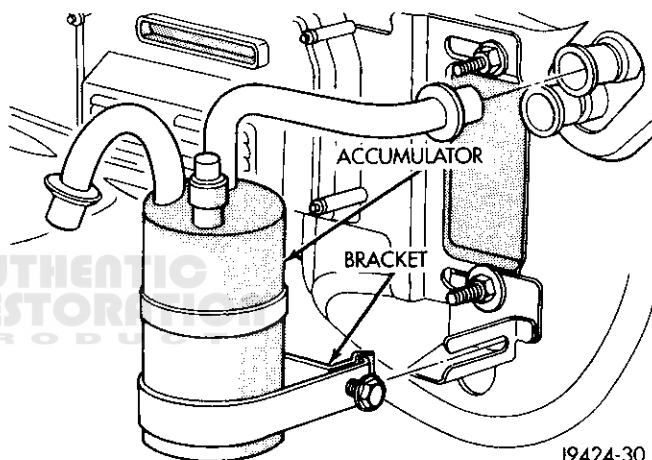
WARNING: REVIEW THE WARNINGS AND CAUTIONS IN THE FRONT OF THIS GROUP BEFORE PERFORMING THE FOLLOWING OPERATION.

REMOVAL

- (1) Disconnect and isolate the battery negative cable.
- (2) Recover the refrigerant from the refrigerant system as described in this group.
- (3) Disconnect the refrigerant lines from the compressor and the evaporator. Install plugs in, or tape over, all of the open refrigerant fittings.
- (4) Unplug the wire harness from the low pressure cycling clutch switch (Fig. 27).
- (5) Loosen the support bracket screw (Fig. 28).
- (6) Remove the accumulator.



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Fig. 27 Low Pressure Cycling Clutch Switch

J9424-30

Fig. 28 Accumulator and Bracket**INSTALLATION**

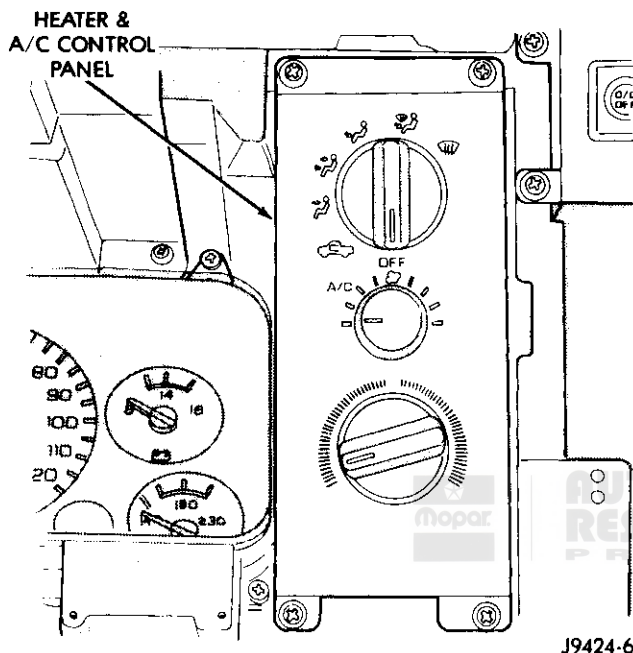
- (1) Install the accumulator in the support bracket.
- (2) Tighten the support bracket screw.
- (3) Plug the wire harness into the low pressure cycling clutch switch.
- (4) Remove the plugs or tape from the refrigerant line fittings. Connect the refrigerant lines to the compressor and the evaporator.
- (5) Evacuate and charge the refrigerant system as described in this group.
- (6) Connect the battery negative cable.

LOW PRESSURE CYCLING CLUTCH SWITCH

- (1) Disconnect and isolate the battery negative cable.
- (2) Unplug the wire harness connector from the switch.
- (3) Unscrew the switch from the fitting on the accumulator.
- (4) Reverse the removal procedures to install.

REMOVAL AND INSTALLATION (Continued)**HEATER-A/C CONTROL****REMOVAL**

- (1) Disconnect and isolate the battery negative cable.
- (2) Remove the instrument cluster bezel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (3) Remove the four screws securing the heater-A/C control to the instrument panel (Fig. 29).

**Fig. 29 Heater-A/C Control Remove/Install**

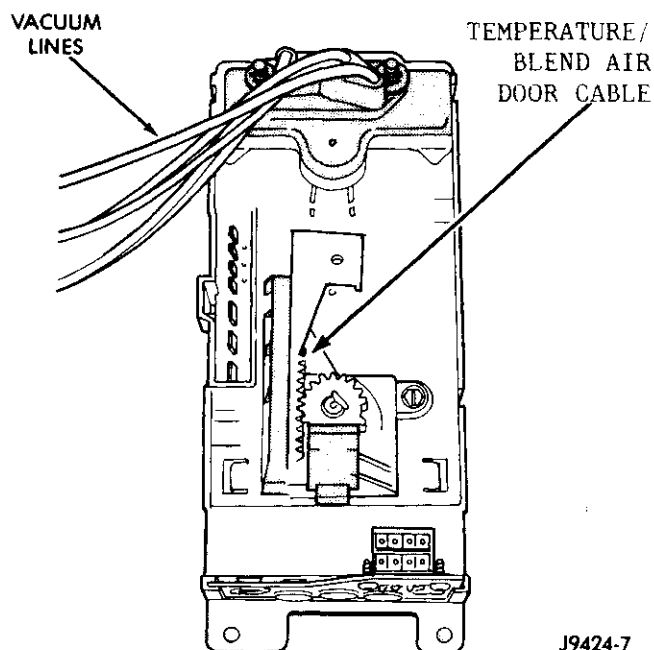
- (4) Disconnect the vacuum and electrical connectors from the back of the heater-A/C control (Fig. 30).
- (5) Release the temperature control cable housing retainer flag and disconnect the cable core from the back of the heater-A/C control.

INSTALLATION

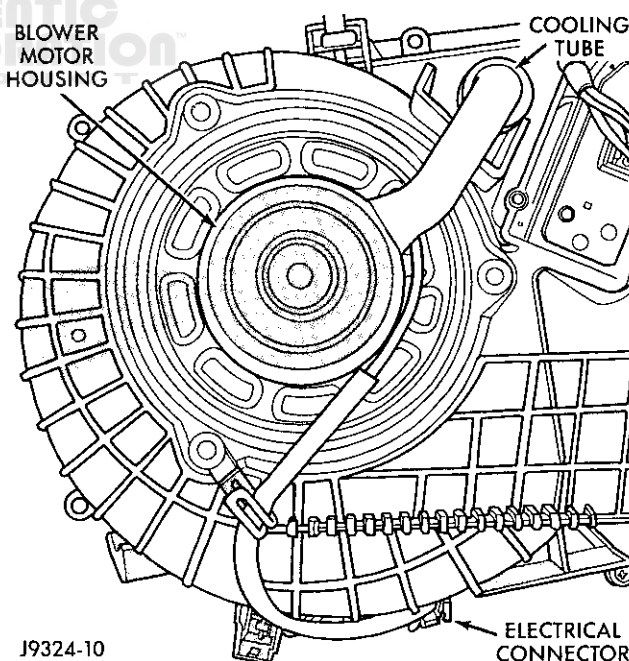
- (1) Connect the temperature control cable to the back of the heater-A/C control.
- (2) Connect the vacuum and electrical connectors to the heater-A/C control.
- (3) Install the heater-A/C control to the instrument panel with four screws.
- (4) Install the instrument cluster bezel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (5) Connect the battery negative cable.

BLOWER MOTOR**REMOVAL**

- (1) Disconnect and isolate the battery negative cable.

**Fig. 30 Vacuum Connector**

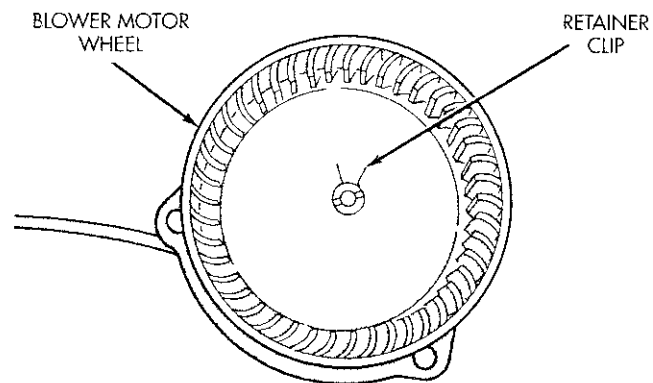
- (2) Disconnect the blower motor cooling tube (Fig. 31).

**Fig. 31 Blower Motor**

- (3) Remove the blower motor wiring from the retainer. Unplug the wiring connector.
- (4) Remove the blower motor and wheel assembly mounting screws.
- (5) Remove the blower motor and wheel.

REMOVAL AND INSTALLATION (Continued)

(6) Remove the blower motor wheel retainer clip and remove the wheel from the blower motor shaft (Fig. 32).



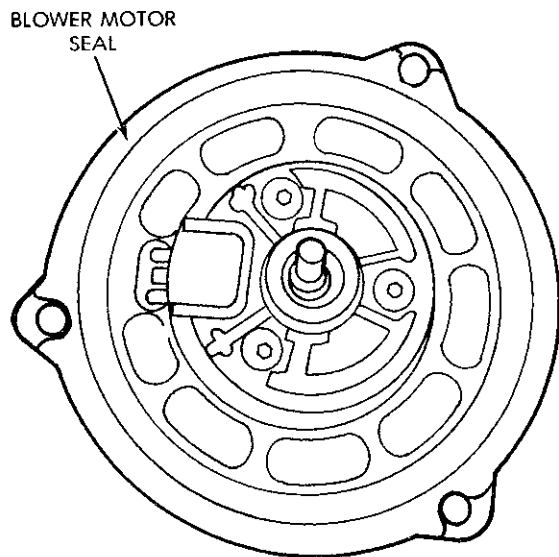
J9324-92

Fig. 32 Blower Motor Wheel**INSTALLATION**

(1) Press the blower motor wheel onto the blower motor shaft. Be sure the flat on the blower motor shaft lines up with the flat inside the wheel.

(2) Install the retainer clip. The ears of the retainer clip must be over the flat surface on the motor shaft.

(3) Be certain that the blower motor seal is installed on the blower motor housing (Fig. 33).



J9324-33

Fig. 33 Blower Motor Seal

(4) Install the blower motor.
(5) Install and tighten the blower motor mounting screws.

(6) Connect the wiring connector and install the wiring into the retainer.

(7) Connect the blower motor cooling tube.

(8) Connect the battery negative cable.

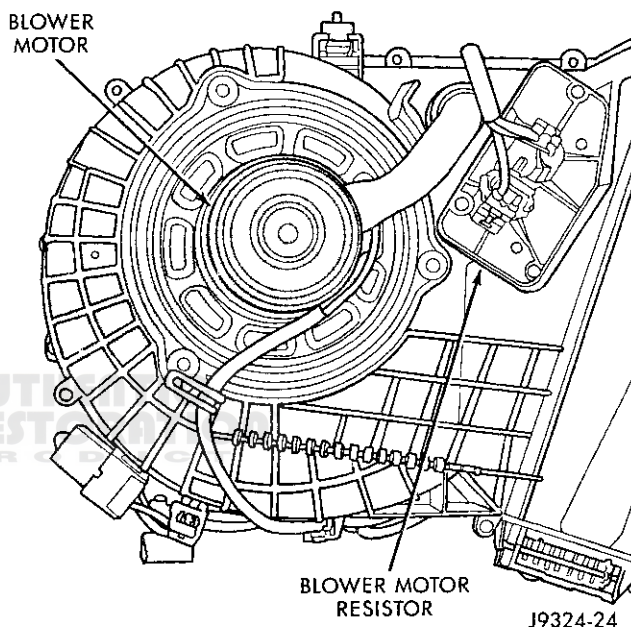
BLOWER MOTOR RESISTOR**REMOVAL**

(1) Disconnect and isolate the battery negative cable.

(2) Unplug the blower motor resistor connector.

(3) Remove the resistor retaining screws.

(4) Remove the blower motor resistor (Fig. 34).



J9324-24

Fig. 34 Blower Motor Resistor**INSTALLATION**

(1) Install the blower motor resistor. Install and tighten the screws.

(2) Connect the resistor connector.

(3) Connect the battery negative cable.

DEFROSTER DUCT**REMOVAL**

(1) Remove the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.

(2) Remove the defroster duct retaining screws.

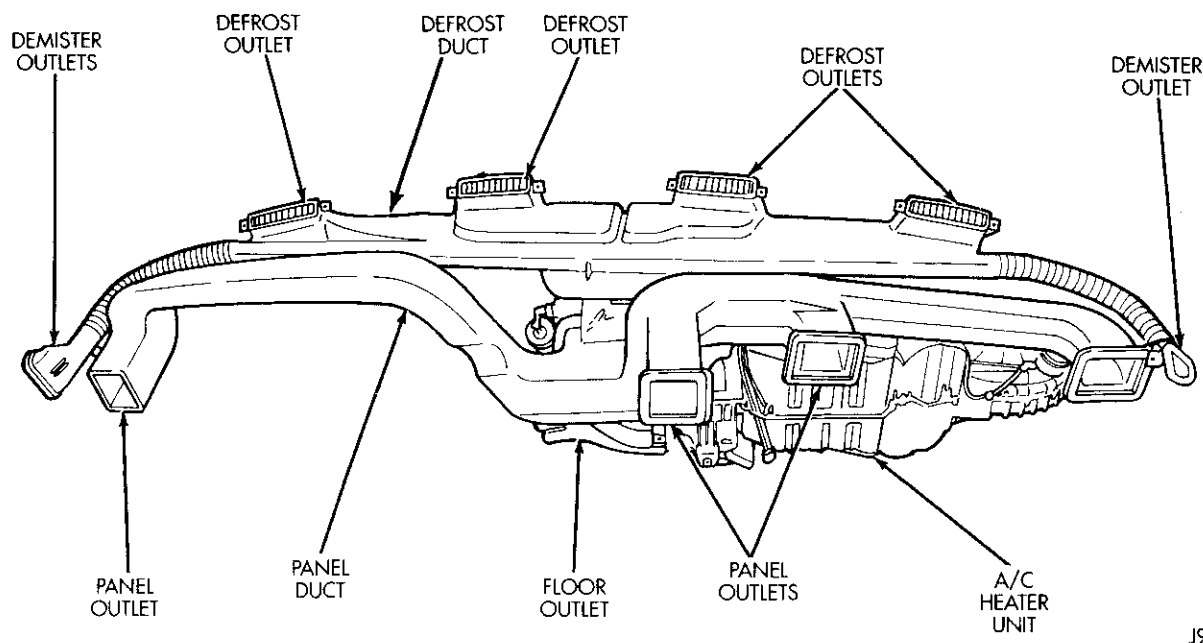
(3) Remove the defroster duct (Fig. 35).

INSTALLATION

(1) Install the defroster duct.

(2) Install and tighten the defroster duct retaining screws.

(3) Install the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.

REMOVAL AND INSTALLATION (Continued)

J9424-31

Fig. 35 Defroster Duct**PANEL/DEFROST DOOR****REMOVAL**

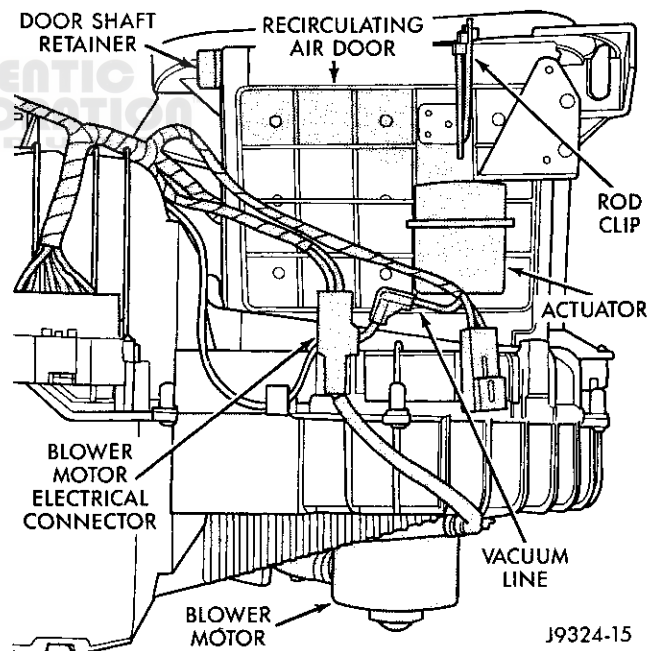
- (1) Remove the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (2) Remove the defroster duct as described in this group.
- (3) Disconnect the actuating rod.
- (4) Pry the panel/defrost door shaft retainer from the shaft.
- (5) Remove the door through the top opening.

INSTALLATION

- (1) Install the panel/defrost door through the top opening and position in place.
- (2) Press the door shaft retainer onto the shaft.
- (3) Connect the rod and rod clip to the door lever.
- (4) Install the defroster duct as described in this group.
- (5) Install the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.

RECIRCULATING AIR DOOR ACTUATOR**REMOVAL**

- (1) Remove the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (2) Disconnect the vacuum line from the actuator (Fig. 36).
- (3) Disconnect the actuating rod clip.
- (4) Remove the actuator retaining screws.
- (5) Remove the actuator.



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Fig. 36 Recirculating Air Door Actuator**INSTALLATION**

- (1) Position the actuator on the heater-A/C housing. Install and tighten the screws.
- (2) Connect the rod and rod clip to the door lever.
- (3) Connect the actuator vacuum line.
- (4) Install the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.

REMOVAL AND INSTALLATION (Continued)**TEMPERATURE CONTROL CABLE****REMOVAL**

(1) Lower the steering column and roll down the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.

(2) Disconnect the cable from the top of the heater-A/C housing (Fig. 37).

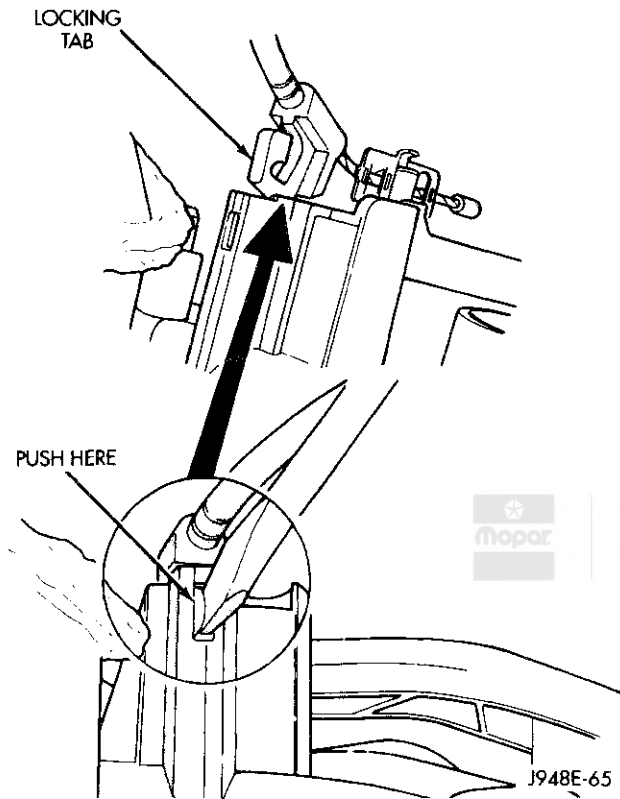


Fig. 37 Temperature Control Cable (Heater-A/C Housing End)

(3) Remove the heater-A/C control as described in this group and disconnect the temperature control cable (Fig. 38).

INSTALLATION

- (1) Connect the cable to the heater-A/C control.
- (2) Install the heater-A/C control as described in this group.
- (3) Connect the cable to the top of the heater-A/C housing.
- (4) Install the instrument panel and raise the steering column. Refer to Group 8E - Instrument Panel Systems for the procedures.

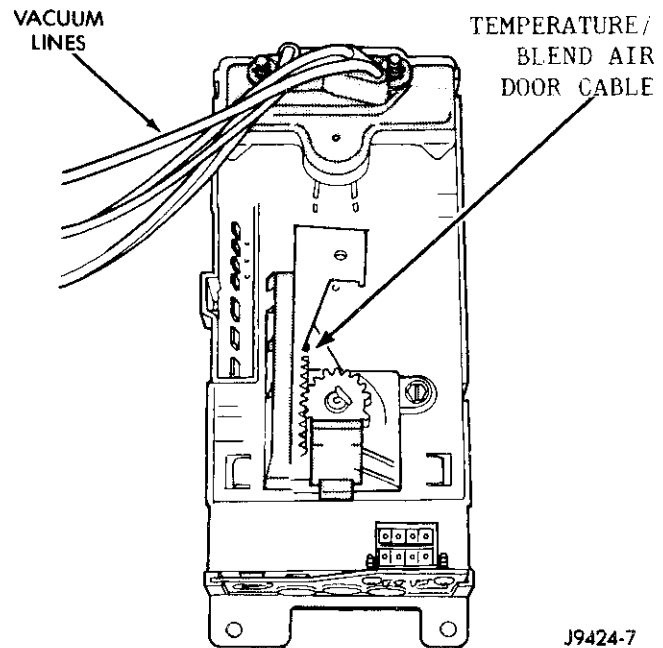


Fig. 38 Temperature Control Cable (Heater-A/C Control End)

HEATER-A/C HOUSING**REMOVAL**

- (1) Disconnect and isolate the battery negative cable.
- (2) Recover the refrigerant from the refrigerant system as described in this group.
- (3) Disconnect the refrigerant lines from the evaporator tubes (Fig. 39). Install plugs in, or tape over, all of the open refrigerant fittings.

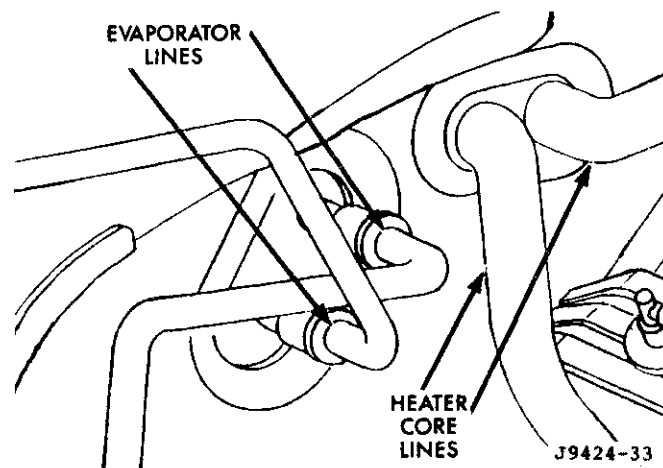
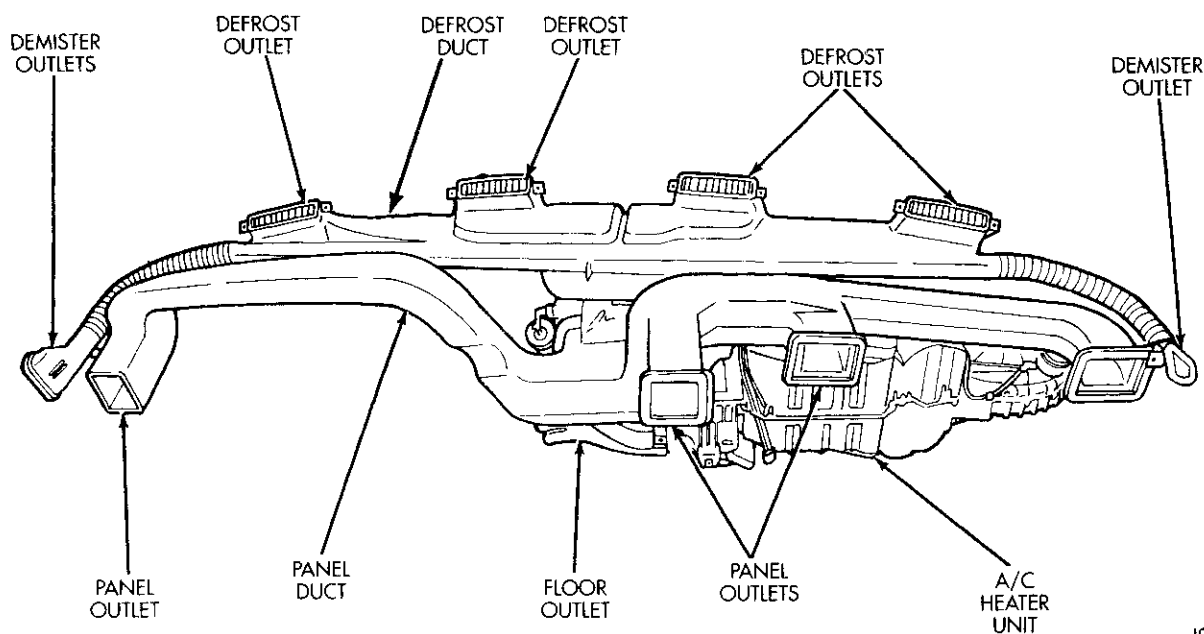


Fig. 39 Evaporator and Heater Core Lines

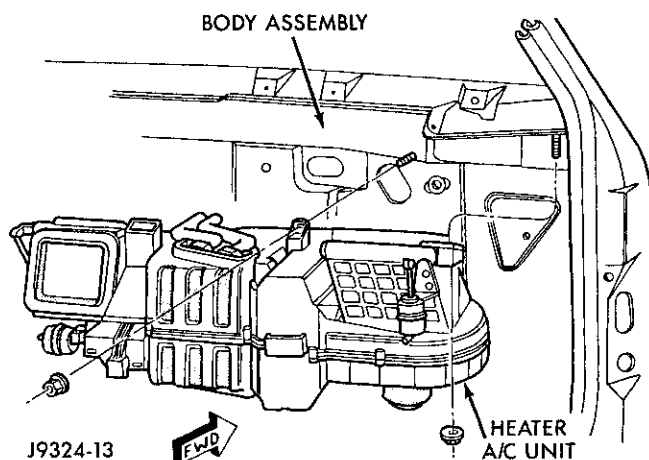
- (4) Drain the cooling system. Refer to Group 7 - Cooling System for the procedures.
- (5) Disconnect the heater hoses from the heater core tubes.

REMOVAL AND INSTALLATION (Continued)

J9424-31

Fig. 40 Defroster Duct

- (6) Remove the coolant reserve/overflow bottle.
- (7) Remove the Powertrain Control Module (PCM) and set aside. Do not unplug the PCM connectors.
- (8) Remove the heater-A/C housing mounting nuts from the studs on the engine compartment side of the dash panel.
- (9) Remove the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (10) Remove the defroster duct (Fig. 40).
- (11) Unplug the heater-A/C housing electrical connections.
- (12) Remove the heater-A/C housing mounting nuts from the studs on the passenger compartment side of the dash panel (Fig. 41).



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Fig. 41 Heater-A/C Housing

- (13) Remove the heater-A/C housing from the vehicle.

INSTALLATION

- (1) Position the heater-A/C housing to the dash panel. Be sure the drain tube is positioned in the dash panel drain hole.
- (2) Install the mounting nuts to the studs on the passenger compartment side of the dash panel. Tighten the nuts to 4.5 N·m (40 in. lbs.).
- (3) Install the mounting nuts to the studs on the engine compartment side of the dash panel. Tighten the nuts to 7 N·m (60 in. lbs.).
- (4) Connect the heater hoses to the heater core tubes.
- (5) Unplug or remove the tape from the refrigerant fittings, and connect the refrigerant lines to the evaporator tubes.
- (6) Install the coolant reserve/overflow bottle.
- (7) Install the PCM.
- (8) Install the defroster duct.
- (9) Connect the rear floor heat duct to the center heat duct adaptor.
- (10) Connect the heater-A/C housing electrical connectors.
- (11) Install the instrument panel. Refer to Group 8E - Instrument Panel Systems for the procedures.
- (12) Fill the cooling system. Refer to Group 7 - Cooling System for the procedures.
- (13) Evacuate and charge the refrigerant system as described in this group.
- (14) Connect the battery negative cable.

REMOVAL AND INSTALLATION (Continued)

(15) Start the vehicle and check for proper operation of the heating and air conditioning systems.

EVAPORATOR COIL**REMOVAL**

(1) Remove the heater-A/C housing as described in this group.

(2) Turn the heater-A/C housing upside down.

(3) Remove the retaining screws holding the two housing halves together. Remove the center heat duct adaptor and remove the screw.

(4) Carefully turn the heater-A/C housing over. Remove the top half of the housing (Fig. 42).

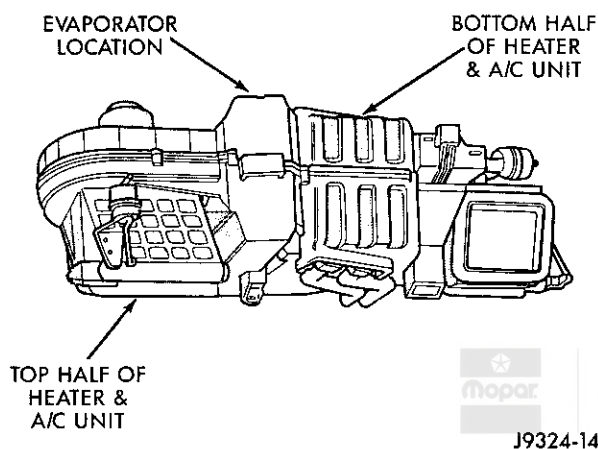


Fig. 42 Evaporator in Heater-A/C Housing (Upside Down)

(5) Remove the evaporator from the housing.

INSTALLATION

(1) Position the evaporator in the bottom half of the heater-A/C housing.

(2) Position the top half of the heater-A/C housing over the bottom half. Carefully turn the housing over. Install and tighten the retaining screws.

(3) Snap on the center heat duct adaptor.

(4) Install the heater-A/C housing as described in this group.

NOTE: If the evaporator was replaced, add 2 ounces of SP20 PAG refrigerant oil to the refrigerant system.

HEAT/DEFROST DOOR ACTUATOR**REMOVAL**

(1) Remove the heater-A/C housing from the vehicle as described in this group.

(2) Turn the heater-A/C housing upside down.

(3) Disconnect the vacuum line from the actuator (Fig. 43).

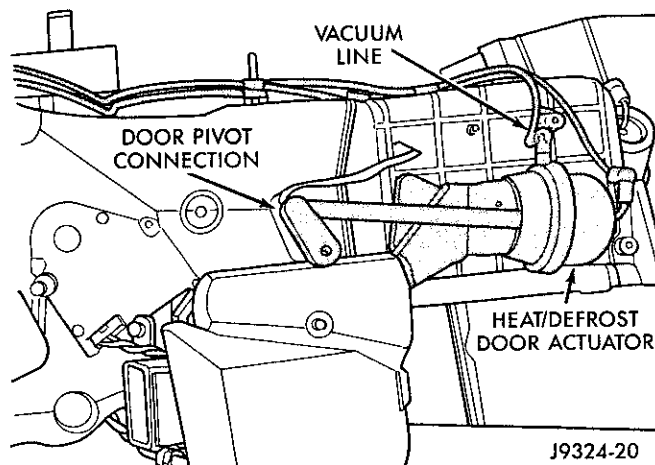


Fig. 43 Heat/Defrost Door Actuator

(4) Separate the door pivot connection from the door pivot pin.

(5) Remove the retaining screws.

(6) Remove the heat/defrost door actuator.

INSTALLATION

(1) Install the heat/defrost door actuator.

(2) Install and tighten the retaining screws.

(3) Press the door pivot connection onto the door pivot pin.

(4) Connect the vacuum line.

(5) Install the heater-A/C housing into the vehicle.

HEAT/DEFROST DOOR**REMOVAL**

(1) Remove the heater-A/C housing as described in this group.

(2) Turn the heater-A/C housing upside down.

(3) Separate the actuator door pivot connection from the door pivot pin.

(4) Disconnect the vacuum line from the actuator.

(5) Remove the retaining screws holding the two halves of the heater-A/C housing together. Remove the center heat duct adaptor and remove the screw.

(6) Remove the bottom half of the heater-A/C housing.

(7) Remove the heat/defrost door.

INSTALLATION

(1) Position the door pivot pin in the pivot hole.

(2) Press the actuator door pivot connection onto the door pivot pin.

(3) Position the top half of the heater-A/C housing onto the bottom. Be certain the door pivot pins align with the pivot holes.

(4) Carefully turn the heater-A/C housing over. Install and tighten the screws.

(5) Snap on the center heat duct adaptor.

(6) Connect the vacuum line to the actuator.

REMOVAL AND INSTALLATION (Continued)

- (7) Install the heater-A/C housing.

HEATER CORE**REMOVAL**

- (1) Remove the heater-A/C housing as described in this group.
- (2) Remove the heater core retaining screws.
- (3) Pull the heater core straight out of the housing (Fig. 44).

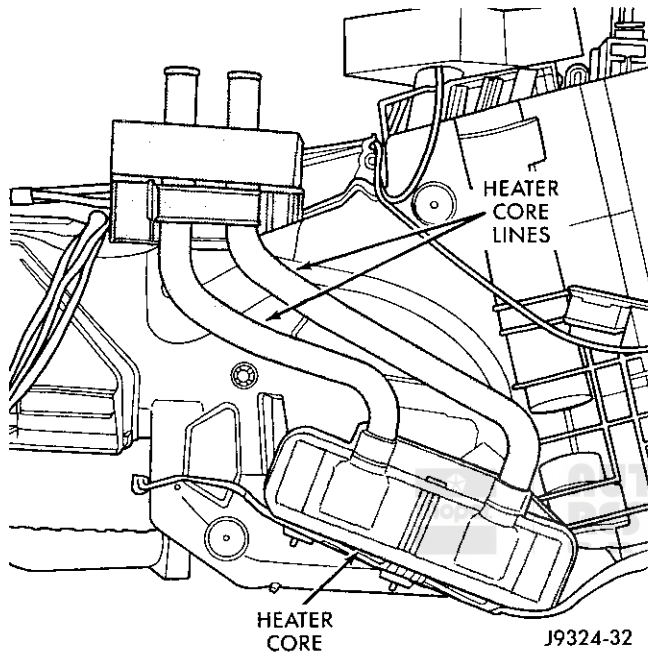


Fig. 44 Heater Core

INSTALLATION

- (1) Install the heater core into the housing.
- (2) Position the clips over the heater core tubes. Install and tighten the screws.
- (3) Install the heater-A/C housing as described in this group.

PANEL/DEFROST DOOR ACTUATOR**REMOVAL**

- (1) Remove the heater-A/C housing as described in this group.
- (2) Disconnect the vacuum line from the actuator (Fig. 45).
- (3) Separate the actuator door pivot connection from the door pivot pin.
- (4) Remove the retaining screws.
- (5) Remove the panel/defrost door actuator.

INSTALLATION

- (1) Install the panel/defrost door actuator.
- (2) Install and tighten the retaining screws.

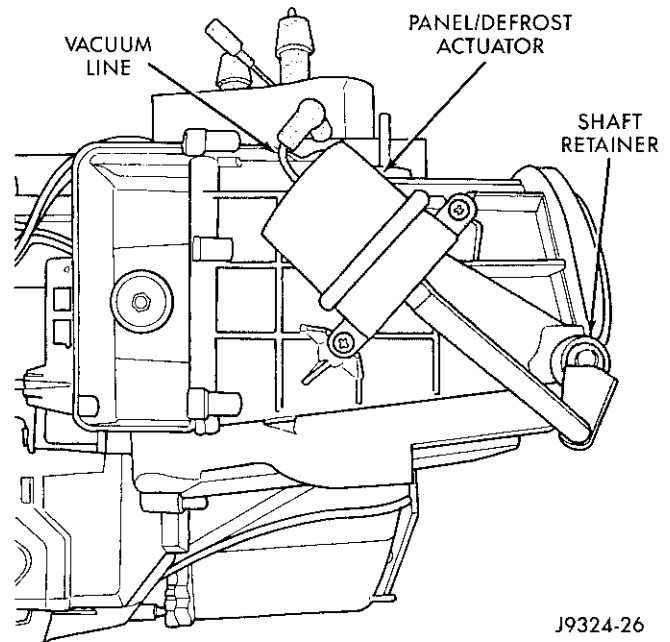


Fig. 45 Panel/Defrost Door Actuator

- (3) Press the actuator door pivot connection onto the door pivot pin.
- (4) Connect the vacuum line to the actuator.
- (5) Install the heater-A/C housing as described in this group.

RECIRCULATING AIR DOOR**REMOVAL**

- (1) Remove the heater-A/C housing as described in this group.
- (2) Disconnect the actuator rod clip.
- (3) Pry the recirculating air door shaft retainer from the shaft.
- (4) Remove the recirculating air door through the top opening.

INSTALLATION

- (1) Install the recirculating air door through the top opening and position in place.
- (2) Press the recirculating air door shaft retainer onto the shaft.
- (3) Connect the rod and rod clip to the door lever.
- (4) Install the heater-A/C housing as described in this group.

TEMPERATURE CONTROL DOOR**REMOVAL**

- (1) Remove the heater-A/C housing as described in this group.
- (2) Turn the heater-A/C housing upside down.

REMOVAL AND INSTALLATION (Continued)

(3) Remove the screws holding the two housing halves together. Remove the center heat duct adaptor and remove the screw.

(4) Remove the bottom half of the heater-A/C housing.

(5) Remove the temperature control door (Fig. 46).

INSTALLATION

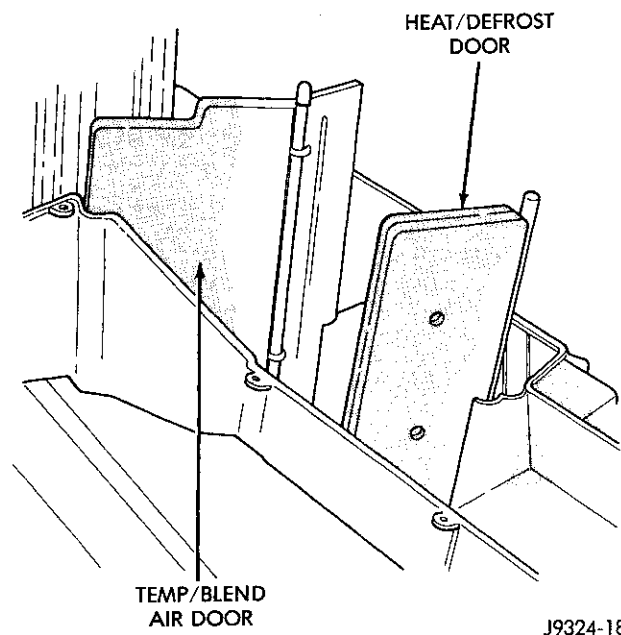
(1) Install the temperature control door.

(2) Position the top half of the heater-A/C housing onto the bottom half. Be sure the door pivot pins align with the pivot holes.

(3) Carefully turn the heater-A/C housing over. Install and tighten the screws.

(4) Snap on the center heat duct adaptor.

(5) Install the heater-A/C housing as described in this group.



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Fig. 46 Temperature Control (Blend Air) Door



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EMISSION CONTROL SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Throughout this group, references are made to particular vehicle models by alphabetical designation or by the particular vehicle nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section at the beginning of this manual.

All vehicles are equipped with either a 3.9L (V-6) engine, a 5.2L (V-8) engine, two different 5.9L (V-8) engines, two different 8.0L (V-10) engines, or a 5.9L Cummins in-line 6 cylinder diesel engine.

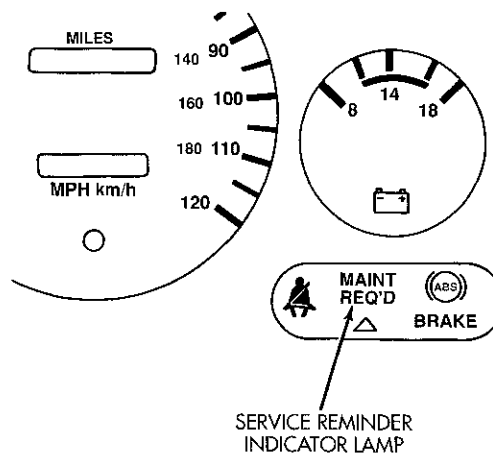
- The 3.9L (V-6) and 5.2L (V-8) engines will be referred to in this group as: LDC (Light Duty Emission Cycle) engines.
- The 5.9L (V-8) gas powered engine will be referred to as either: LDC (Light Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The 8.0L (V-10) engine will be referred to as either: MDC (Medium Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The diesel engine will be referred to as: HDC (Heavy Duty Emission Cycle) engine.

Either of the HDC gas powered engines can be easily identified by the use of an engine mounted air injection pump. The 3.9L/5.2L/5.9L LDC gas engines or the diesel engine will not use an air injection pump.

Maintenance requirements for LDC and HDC emission systems differ because of different load and operating conditions.

SERVICE REMINDER INDICATOR (SRI) LAMP

The service reminder indicator (SRI) lamp is used with 5.9L HDC V-8 and 8.0L HDC V-10 gas powered engines only. It is not used with LDC, MDC or diesel engines. The lamp is displayed on the instrument panel as the MAINT REQ'D lamp (Fig. 1).



J9514-13

Fig. 1 SRI Lamp Location

The SRI system is incorporated into the powertrain control module (PCM). The PCM records the vehicles mileage and stores it into memory. At that time, the

GENERAL INFORMATION (Continued)

PCM checks for certain mileage trip points. When the current mileage matches one of the trip points, the SRI lamp is activated.

Certain parts are to be replaced, or certain maintenance must be performed at either an indicated mileage or when the SRI lamp remains on when the key is in the ON position. After performing the part replacement or required maintenance, the SRI lamp must be reset to turn the lamp off.

For required part replacement or maintenance schedules in time or mileage intervals, refer to either Group 0, Lubrication and Maintenance in this manual, or the vehicle Owners Manual.

Failure to perform the part replacement or required maintenance and only reset the SRI lamp may be a violation of federal law. Only after performing the part replacement or required maintenance, should the SRI lamp be reset.



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ON-BOARD DIAGNOSTICS

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GENERAL INFORMATION

SYSTEM DESCRIPTION

The Powertrain Control Module (PCM) monitors many different circuits in the fuel injection, ignition, emission and engine systems. If the PCM senses a problem with a monitored circuit often enough to indicate an actual problem, it stores a Diagnostic Trouble Code (DTC) in the PCM's memory. If the code applies to a non-emissions related component or system, and the problem is repaired or ceases to exist, the PCM cancels the code after 40 warm-up cycles. Diagnostic trouble codes that affect vehicle emissions illuminate the Malfunction Indicator (check engine) Lamp. Refer to Malfunction Indicator Lamp in this section.

Certain criteria must be met before the PCM stores a DTC in memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the PCM.

The PCM might not store a DTC for a monitored circuit even though a malfunction has occurred. This may happen because one of the DTC criteria for the circuit has not been met. **For example**, assume the diagnostic trouble code criteria requires the PCM to monitor the circuit only when the engine operates between 750 and 2000 RPM. Suppose the sensor's output circuit shorts to ground when engine operates above 2400 RPM (resulting in 0 volt input to the PCM). Because the condition happens at an engine speed above the maximum threshold (2000 rpm), the PCM will not store a DTC.

There are several operating conditions for which the PCM monitors and sets DTC's. Refer to Monitored Systems, Components, and Non-Monitored Circuits in this section.

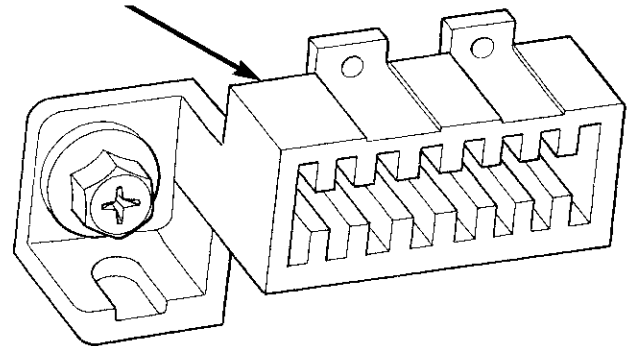
NOTE: Various diagnostic procedures may actually cause a diagnostic monitor to set a DTC. For instance, pulling a spark plug wire to perform a spark test may set the misfire code. When a repair

is completed and verified, connect the DRB scan tool to the 16-way data link connector (Fig. 1) to erase all DTC's and extinguish the MIL.

The data link connector is located at the lower edge of the instrument panel near the steering column.

Technicians can display stored DTC's by two different methods. Refer to Diagnostic Trouble Codes in this section. For DTC information, refer to charts in this section.

16-WAY DATA
LINK CONNECTOR



805dd852

Fig. 1 16-Way Data Link (Diagnostic) Connector
DESCRIPTION AND OPERATION

MALFUNCTION INDICATOR LAMP (MIL)

As a functional test, the MIL (check engine) illuminates at key-on before engine cranking. Whenever the Powertrain Control Module (PCM) sets a Diagnostic Trouble Code (DTC) that affects vehicle emissions, it illuminates the MIL. If a problem is detected, the PCM sends a message to the instrument cluster to illuminate the lamp. The PCM illuminates the MIL only for DTC's that affect vehicle emissions. There are some monitors that may take

DESCRIPTION AND OPERATION (Continued)

two consecutive trips, with a detected fault, before the MIL is illuminated. The MIL stays on continuously when the PCM has entered a Limp-In mode or identified a failed emission component. Refer to the Diagnostic Trouble Code charts in this group for emission related codes.

Also, the MIL either flashes or illuminates continuously when the PCM detects active engine misfire. Refer to Misfire Monitoring in this section.

Additionally, the PCM may reset (turn off) the MIL when one of the following occur:

- PCM does not detect the malfunction for 3 consecutive trips (except misfire and Fuel system Monitors).
- PCM does not detect a malfunction while performing three successive engine misfire or fuel system tests. The PCM performs these tests while the engine is operating within ± 375 RPM of and within 10 % of the load of the operating condition at which the malfunction was first detected.

STATE DISPLAY TEST MODE

The switch inputs to the Powertrain Control Module (PCM) have two recognized states; HIGH and LOW. For this reason, the PCM cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the State Display screen shows the change from HIGH to LOW or LOW to HIGH, assume the entire switch circuit to the PCM functions properly. Connect the DRB scan tool to the data link connector and access the state display screen. Then access either State Display Inputs and Outputs or State Display Sensors.

CIRCUIT ACTUATION TEST MODE

The Circuit Actuation Test Mode checks for proper operation of output circuits or devices the Powertrain Control Module (PCM) may not internally recognize. The PCM attempts to activate these outputs and allow an observer to verify proper operation. Most of the tests provide an audible or visual indication of device operation (click of relay contacts, fuel spray, etc.). Except for intermittent conditions, if a device functions properly during testing, assume the device, its associated wiring, and driver circuit work correctly. Connect the DRB scan tool to the data link connector and access the Actuators screen.

DIAGNOSTIC TROUBLE CODES

A Diagnostic Trouble Code (DTC) indicates the PCM has recognized an abnormal condition in the system.

The technician can display DTC's in two ways. The first way is to cycle the ignition switch and count the number of times the malfunction indicator (Check Engine) lamp on the instrument panel flashes on and off. The DRB scan tool provides the second method of displaying DTC's. Diagnostic trouble codes are the results of a system or circuit failure, but do not directly identify the failed component or components.

NOTE: For a list of DTC's, refer to the charts in this section.

OBTAINING DIAGNOSTIC TROUBLE CODES**USING DRB SCAN TOOL**

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST ON AN OPERATING ENGINE.

(1) Connect DRB scan tool to the data link (diagnostic) connector located in the passengers compartment, below the center of instrument cluster on the drivers side.

(2) Turn the ignition switch on, access Read Fault Screen. Record all the DTC's shown on the DRB scan tool. Observe the malfunction indicator (check engine) lamp on the instrument panel. The lamp should light for 2 seconds then go out (bulb check).

(3) To erase DTC's, use the Erase Trouble Code data screen on the DRB scan tool.

USING THE MALFUNCTION INDICATOR LAMP (MIL)

(1) Cycle the ignition key On - Off - On - Off - On within 5 seconds.

(2) Count the number of times the MIL (check engine lamp) on the instrument panel flashes on and off. The number of flashes represents the trouble code. There is a slight pause between the flashes representing the first and second digits of the code. Longer pauses separate individual two digit trouble codes.

DESCRIPTION AND OPERATION (Continued)**DIAGNOSTIC TROUBLE CODE DESCRIPTIONS**

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
11	P1391**	9D	Intermittent Loss of CMP or CKP	Intermittent loss of either camshaft or crankshaft position sensor
	or	28	No Crank Reference Signal at PCM	No crank reference signal detected during engine cranking.
	or P1398**	BA	Misfire Adaptive Numerator at Limit	CKP sensor target windows have too much variation
12*			Battery Disconnect	Direct battery input to PCM was disconnected within the last 50 Key-on cycles.
13**	P1297	27	No Change in MAP From Start to Run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading from start-up.
14**	P0107	24	MAP Sensor Voltage Too Low	MAP sensor input below minimum acceptable voltage.
	or P0108	25	MAP Sensor Voltage Too High	MAP sensor input above maximum acceptable voltage.
	or P1296	87	No 5 Volts To MAP Sensor	5 Volt output to MAP sensor open
15**	P0500	23	No Vehicle Speed Sensor Signal	No vehicle speed sensor signal detected during road load conditions.
	or P0720	A6	Low Output Spd Sensr RPM, Above 15 MPH	Output Speed Sensor Circuit
17**	P0125	80	Closed Loop Temp Not Reached	Engine does not reach 50°F within 5 minutes with a vehicle speed signal.
17	or	21	Engine Is Cold Too Long	Engine did not reach operating temperature within acceptable limits.
21**	P0131	9B	Upstream O2s Voltage Shorted to Ground	Tested after key off and at start to run.
	or P0132	3E	Left O2 Sensor Shorted to Voltage	Left oxygen sensor input voltage maintained above the normal operating range.
	or P0133	66	Upstream O2 Sensor Slow Response	Upstream oxygen sensor response slower than minimum required switching frequency or value does not go above .65 volts. (3.9/5.2/5.9L LD only)
	or			

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	P0133	66	Left Upstream O2 Sensor Slow Switching	Upstream oxygen sensor response slower than minimum required switching frequency or value does not go above .65 volts. (5.9L HD/8.0L only)
	or P0135	67	Upstream O2 Sensor Heater Failure	Upstream oxygen sensor heating element circuit malfunction. (3.9/5.2/5.9L LD only)
	or P0135	67	Left Upstream O2 Sensor Heater Failure	Left Upstream oxygen sensor heating element circuit malfunction.(5.9L HD/8.0L only)
	or P0137	9C	Downstream O2s Voltage Shorted to Ground	Tested after key off and at start to run.
	or P0138	7E	Downstream O2 Sensor Shorted to Voltage	Downstream oxygen sensor input voltage maintained above the normal operating range.
	or P0139	68	Downstream O2 Unable to Switch Rich/Lean	Neither rich or lean condition detected from the downstream oxygen sensor.
	or P0141	69	Downstream O2 Sensor Heater Failure	Downstream oxygen sensor heating element circuit malfunction.
	or P0143	90	Post-Catalyst O2 Sen Shorted to Ground	Tested after key off and at start to run. (8.0L only)
	or P0144	93	Post-Catalyst O2 Sen Shorted to Voltage	Post catalyst oxygen sensor input voltage maintained above the normal operating range. (8.0L only)
	or P0145	9F	Post Catalyst O2S Sensor Slow Response	Post catalyst oxygen sensor response slower than minimum required switching frequency or value does not go above .65 volts. (8.0L only)
	or P0147	BD	Post-Catalyst O2S Heater Failure	Post catalyst oxygen sensor heating element circuit malfunction. (8.0L only)
	or P0151	B5	Right Bank UPSTRM O2S Shorted to Ground	Tested after key off. (8.0L only)
	or P0153	7A	Right Upstream O2 Sensor Slow Response	Right upstream catalyst oxygen sensor response slower than minimum required switching frequency or value does not go above .65 volts. (8.0L only)
	or			

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	P0155 or P0157 or P0158 or P0159 or P0161	7C B6 7F 7B 7D	Right Upstream O2 Sensor Heater Failure Right Bank DWNSTR O2S Shorted to Ground Right Downstream O2S Shorted To Voltage Right Downstream O2 Sensor Slow Response Right Downstream O2S Heater Failure	Right upstream catalyst oxygen sensor heating element circuit malfunction. (8.0L only) Tested after key off. (8.0L only) Right downstream catalyst oxygen sensor input voltage maintained above the normal operating range. (8.0L only) Right downstream catalyst oxygen sensor response slower than minimum required switching frequency or value does not go above .65 volts. (8.0L only) Right downstream catalyst oxygen sensor heating element circuit malfunction. (8.0L only)
22**	P0117 or P0118	1E 1F	ECT Sensor Voltage Too Low ECT Sensor Voltage Too High	Engine coolant temperature sensor input below minimum acceptable voltage. Engine coolant temperature sensor input above maximum acceptable voltage.
23**	P0112 or P0113	39 3A	Intake Air Temp Sensor Voltage Low Intake Air Temp Sensor Voltage High	Intake air temperature sensor input below the maximum acceptable voltage. Intake air temperature sensor input above the minimum acceptable voltage.
24**	P0121 or P0122 or P0123	84 1A 1B	TPS Voltage Does Not Agree With MAP Throttle Position Sensor Voltage Low Throttle Position Sensor Voltage High	TPS signal does not correlate to MAP sensor Throttle position sensor input below the minimum acceptable voltage Throttle position sensor input above the maximum acceptable voltage.
25**	P0505 or P1294	19 8A	Idle Air Control Motor Circuits Target Idle Not Reached	A shorted or open condition detected in one or more of the idle air control motor circuits. Actual idle speed does not equal target idle speed.
27**	P0201 or P0202	15 14	Injector #1 Control Circuit Injector #2 Control Circuit	Injector #1 output driver does not respond properly to the control signal. Injector #2 output driver does not respond properly to the control signal.

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	or P0203	13	Injector #3 Control Circuit	Injector #3 output driver does not respond properly to the control signal.
	or P0204	3D	Injector #4 Control Circuit	Injector #4 output driver does not respond properly to the control signal.
	or P0205	45	Injector #5 Control Circuit	Injector #5 output driver does not respond properly to the control signal.
	or P0206	46	Injector #6 Control Circuit	Injector #6 output driver does not respond properly to the control signal.
	or P0207	4F	Injector #7 Control Circuit	Injector #7 output driver does not respond properly to the control signal. (Except 3.9L)
	or P0208	50	Injector #8 Control Circuit	Injector #8 output driver does not respond properly to the control signal. (Except 3.9L)
	or		Injector #9 Control Circuit	Injector #9 output driver does not respond properly to the control signal. (8.0L only)
	or		Injector #10 Control Circuit	Injector #10 output driver does not respond properly to the control signal. (8.0L only)
	or			
31*	P0441	71	Evap Purge Flow Monitor Failure	Insufficient or excessive vapor flow detected during evaporative emission system operation.
	or P0443	12	EVAP Purge Solenoid Circuit	An open or shorted condition detected in the duty cycle purge solenoid circuit.
32**	P0403	11	EGR Solenoid Circuit	An open or shorted condition detected in the EGR transducer solenoid circuit. (5.9L HD only)
33*		10	A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.
34*		0F	Speed Control Solenoid Circuits	An open or shorted condition detected in the Speed Control vacuum or vent solenoid circuits.
	or	57	Speed Control Switch Always Low	MUX speed control switch below specified volts.
37**	P0711	A4	Trans Temp Sensr, No Temp Rise After Start	Transmission temperature sensor
	or			

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	P0712 or P0713 or P0740 or P0743 or P1899	4A 4B 94 0C 72	Trans Temp Sensor Voltage too Low Trans Temp Sensor Voltage too High Torq Conv Clu, No RPM Drop At Lockup Torque Converter Clutch Solenoid CKT P/N switch Stuck In Park Or In Gear	Transmission temperature sensor Transmission temperature sensor Relationship between engine speed and vehicle speed indicates no torque converter clutch engagement. An open or shorted condition detected in the torque converter part throttle unlock solenoid control circuit. Park/Neutral Switch Performance
41***		0B	Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
42*	or or or or or or	65 0A 2C 95 96 97	Fuel Pump Relay Control Circuit Auto Shutdown Relay Control Circuit No ASD Relay Output Voltage at PCM Fuel Level Sending Unit Volts Too Low Fuel Level Sending Unit Volts Too High Fuel Level Unit No Change Over Miles	An open or shorted condition detected in the fuel pump relay control circuit. An open or shorted condition detected in the auto shutdown relay circuit. An Open condition Detected In The ASD Relay Output Circuit. Open circuit between BCM and fuel gauge sending unit. Circuit shorted to voltage between BCM and fuel gauge sending unit. No movement of fuel level sender detected.
43**	P0300 or P0301 or P0302 or P0303 or P0304 or P0305 or P0306	6A 6B 6C 6D 6E AE AF	Multiple Cylinder Misfire Cylinder #1 Misfire Cylinder #2 Misfire Cylinder #3 Misfire Cylinder #4 Misfire Cylinder #5 Misfire Cylinder #6 Misfire	Misfire detected in multiple cylinders. Misfire detected in cylinder #1. Misfire detected in cylinder #2. Misfire detected in cylinder #3. Misfire detected in cylinder #4. Misfire detected in cylinder #5. Misfire detected in cylinder #6.

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	or P0307	B0	Cylinder #7 Misfire	Misfire detected in cylinder #7. (Except 3.9L)
	or P0308	B1	Cylinder #8 Misfire	Misfire detected in cylinder #8. (Except 3.9L)
	or P0309		Cylinder #9 Misfire	Misfire detected in cylinder #9. (8.0L only)
	or P0310		Cylinder #10 Misfire	Misfire detected in cylinder #10. (8.0L only)
	or P0351	2B	Ignition Coil #1 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
44**	P1492	9A	Battery Temp Sensor Voltage Too High	Battery temperature sensor input voltage above an acceptable range.
	or P1493	99	Battery Temp Sensor Voltage Too Low	Battery temperature sensor input voltage below an acceptable range.
45**	P0748	AB	Governor Pressure Solenoid Control Circuit	Governor pressure solenoid circuit
	or P0753	32	Trans 3-4 Solenoid Circuit	Overdrive Solenoid Circuit
	or P1756	8D	Gov Press Not Equal To Target @ 15-20 PSI	Governor mid-pressure malfunction
	or P1763	A8	Governor Pressure Sensr Volts Too Hi	Governor pressure sensor volts above specified volts.
	or P1764	A7	Governor Pressure Sensr Volts Too Lo	Governor pressure sensor volts below specified volts.
	or P1765	AD	Trans 12 Volt Supply Relay Cntrl Circuit	Transmission relay circuit
	or P0783	A5	3-4 Shift Sol, No RPM Drop @ 3-4 Shift	3-4 Shift Malfunction
	or P1757	8E	Gov Pres Above 3 PSI In Gear With 0 MPH	Governor low pressure malfunction
	or P1762	A9	Gov Press Sen Offset Volts Too Lo Or Hi	Governor pressure sensor
	or	BC	O/D Switch Pressed (LO) More than 5 Min	Overdrive switch low
46***		06	Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.

DESCRIPTION AND OPERATION (Continued)

MIL CODE	GENERIC SCAN TOOL CODE	HEX CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
47***		05	Charging System Voltage Too Low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of generator output circuit.
51**	P0171 or P0174 or P0175	77 79 78	Fuel System Lean Right Bank Fuel System Lean Right Bank Fuel System Rich	A lean air/fuel mixture has been indicated by an abnormally rich correction factor. A lean air/fuel mixture has been indicated by an abnormally rich correction factor at the right bank. (8.0L only) A rich air/fuel mixture has been indicated by an abnormally lean correction factor at the right bank. (8.0L only).
52**	P0172	76	Fuel System Rich	A rich air/fuel mixture has been indicated by an abnormally lean correction factor.
53**	P0601	02	Internal Controller Failure	PCM Internal fault condition detected.
54**	P0340	01	No Cam Signal at PCM	No camshaft signal detected during engine cranking.
55*				Completion of fault code display on Check Engine lamp.
63**	P1698	31	PCM Failure EEPROM Write Denied	Unsuccessful attempt to write to an EEPROM location by the PCM.
64**	P0420	70	Catalytic Converter Efficiency Failure	Catalyst efficiency below required level.
71**	P1496	B9	Auxiliary 5 Volt Supply Output Too Low	5 volt output from regulator does not meet minimum requirement.
72**	P0420 or P0432	70 B4	Catalytic Converter Efficiency Failure Right Bank Catalyst Efficiency Failure	Catalyst efficiency below required level. Catalyst efficiency below required level. (8.0L only)

* Check Engine Lamp (MIL) will not illuminate if this Diagnostic Trouble Code was recorded. Cycle Ignition key as described in manual and observe code flashed by Check Engine lamp.

** Check Engine Lamp (MIL) will illuminate during engine operation if this Diagnostic Trouble Code was recorded.

*** Generator Lamp illuminated

MONITORED SYSTEMS

There are new electronic circuit monitors that check fuel, emission, engine and ignition performance. These monitors use information from various sensor circuits to indicate the overall operation of the fuel, engine, ignition and emission systems and thus the emissions performance of the vehicle.

The fuel, engine, ignition and emission systems monitors do not indicate a specific component problem. They do indicate that there is an implied problem within one of the systems and that a specific problem must be diagnosed.

If any of these monitors detect a problem affecting vehicle emissions, the Malfunction Indicator (Check

DESCRIPTION AND OPERATION (Continued)

Engine) Lamp will be illuminated. These monitors generate Diagnostic Trouble Codes that can be displayed with the check engine lamp or a scan tool.

The following is a list of the system monitors:

- Misfire Monitor
- Fuel System Monitor
- Oxygen Sensor Monitor
- Oxygen Sensor Heater Monitor
- Catalyst Monitor

All these system monitors require two consecutive trips with the malfunction present to set a fault.

Following is a description of each system monitor, and its DTC.

Refer to the appropriate Powertrain Diagnostics Procedures manual for diagnostic procedures.

DTC 21—OXYGEN SENSOR (O2S) MONITOR

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most important element of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 Air Fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx) from the exhaust.

The O2S is also the main sensing element for the Catalyst and Fuel Monitors.

The O2S can fail in any or all of the following manners:

- slow response rate
- reduced output voltage
- dynamic shift
- shorted or open circuits

Response rate is the time required for the sensor to switch from lean to rich once it is exposed to a richer than optimum A/F mixture or vice versa. As the sensor starts malfunctioning, it could take longer to detect the changes in the oxygen content of the exhaust gas.

The output voltage of the O2S ranges from 0 to 1 volt. A good sensor can easily generate any output voltage in this range as it is exposed to different concentrations of oxygen. To detect a shift in the A/F mixture (lean or rich), the output voltage has to change beyond a threshold value. A malfunctioning sensor could have difficulty changing beyond the threshold value.

DTC 21—OXYGEN SENSOR HEATER MONITOR

If there is an oxygen sensor (O2S) shorted to voltage DTC, as well as a O2S heater DTC, the O2S

fault **MUST** be repaired first. After the O2S fault is repaired, verify that the heater circuit is operating correctly.

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most important element of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 Air Fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx) from the exhaust.

The voltage readings taken from the O2S sensor are very temperature sensitive. The readings are not accurate below 300°C. Heating of the O2S sensor is done to allow the engine controller to shift to closed loop control as soon as possible. The heating element used to heat the O2S sensor must be tested to ensure that it is heating the sensor properly.

The O2S sensor circuit is monitored for a drop in voltage. The sensor output is used to test the heater by isolating the effect of the heater element on the O2S sensor output voltage from the other effects.

DTC 43—MISFIRE MONITOR

Excessive engine misfire results in increased catalyst temperature and causes an increase in HC emissions. Severe misfires could cause catalyst damage. To prevent catalytic converter damage, the PCM monitors engine misfire.

The Powertrain Control Module (PCM) monitors for misfire during most engine operating conditions (positive torque) by looking at changes in the crankshaft speed. If a misfire occurs the speed of the crankshaft will vary more than normal.

DTC 51/52—FUEL SYSTEM MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide. The catalyst works best when the Air Fuel (A/F) ratio is at or near the optimum of 14.7 to 1.

The PCM is programmed to maintain the optimum air/fuel ratio of 14.7 to 1. This is done by making short term corrections in the fuel injector pulse width based on the O2S sensor output. The programmed memory acts as a self calibration tool that the engine controller uses to compensate for variations in engine specifications, sensor tolerances and engine fatigue over the life span of the engine. By monitoring the actual fuel-air ratio with the O2S sensor (short term) and multiplying that with the program long-term

DESCRIPTION AND OPERATION (Continued)

(adaptive) memory and comparing that to the limit, it can be determined whether it will pass an emissions test. If a malfunction occurs such that the PCM cannot maintain the optimum A/F ratio, then the MIL will be illuminated.

DTC 64—CATALYST MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide.

Normal vehicle miles or engine misfire can cause a catalyst to decay. A meltdown of the ceramic core can cause a reduction of the exhaust passage. This can increase vehicle emissions and deteriorate engine performance, driveability and fuel economy.

The catalyst monitor uses dual oxygen sensors (O₂S's) to monitor the efficiency of the converter. The dual O₂S's sensor strategy is based on the fact that as a catalyst deteriorates, its oxygen storage capacity and its efficiency are both reduced. By monitoring the oxygen storage capacity of a catalyst, its efficiency can be indirectly calculated. The upstream O₂S is used to detect the amount of oxygen in the exhaust gas before the gas enters the catalytic converter. The PCM calculates the A/F mixture from the output of the O₂S. A low voltage indicates high oxygen content (lean mixture). A high voltage indicates a low content of oxygen (rich mixture).

When the upstream O₂S detects a lean condition, there is an abundance of oxygen in the exhaust gas. A functioning converter would store this oxygen so it can use it for the oxidation of HC and CO. As the converter absorbs the oxygen, there will be a lack of oxygen downstream of the converter. The output of the downstream O₂S will indicate limited activity in this condition.

As the converter loses the ability to store oxygen, the condition can be detected from the behavior of the downstream O₂S. When the efficiency drops, no chemical reaction takes place. This means the concentration of oxygen will be the same downstream as upstream. The output voltage of the downstream O₂S copies the voltage of the upstream sensor. The only difference is a time lag (seen by the PCM) between the switching of the O₂S's.

To monitor the system, the number of lean-to-rich switches of upstream and downstream O₂S's is counted. The ratio of downstream switches to upstream switches is used to determine whether the catalyst is operating properly. An effective catalyst will have fewer downstream switches than it has upstream switches i.e., a ratio closer to zero. For a totally ineffective catalyst, this ratio will be one-to-one, indicating that no oxidation occurs in the device.

The system must be monitored so that when catalyst efficiency deteriorates and exhaust emissions

increase to over the legal limit, the MIL (check engine lamp) will be illuminated.

TRIP DEFINITION

For a system monitor to erase or turn off a MIL illumination for open/short diagnostics, the PCM must first recognize that the engine has operated for 2 minutes with no failures after 3 sequential key on.

All system monitors, component rationality and functionality monitors have their own trip counters. Once the appropriate conditions have been met, the monitor will be run. If the monitor fails, the MIL will be illuminated. If conditions can be repeated at 3 separate key on times with no malfunctions, the MIL will be turned off.

Anytime the MIL is illuminated, a DTC is stored. The DTC can self erase only when the MIL has been extinguished. Once the MIL is extinguished, the PCM must pass the diagnostic test for the most recent DTC for 40 warm-up cycles (80 warm-up cycles for the Fuel System Monitor and the Misfire Monitor). A warm-up cycle can best be described by the following:

- The engine must be running
- A rise of 40°F in engine temperature must occur from the time when the engine was started
- Engine coolant temperature must reach at least 160°F

Once the above conditions occur, the PCM is considered to have passed a warm-up cycle. Due to the conditions required to extinguish the MIL and erase the DTC, it is most important that after a repair has been made, all DTC's be erased and the repair verified.

COMPONENT MONITORS

There are several components that will affect vehicle emissions if they malfunction. If one of these components malfunctions the Malfunction Indicator Lamp (Check Engine) will illuminate.

Some of the component monitors are checking for proper operation of the part. Electrically operated components now have input (rationality) and output (functionality) checks. Previously, a component like the Throttle Position sensor (TPS) was checked by the PCM for an open or shorted circuit. If one of these conditions occurred, a DTC was set. Now there is a check to ensure that the component is working. This is done by watching for a TPS indication of a greater or lesser throttle opening than MAP and engine rpm indicate. In the case of the TPS, if engine vacuum is high and engine rpm is 1600 or greater and the TPS indicates a large throttle opening, a DTC will be set. The same applies to low vacuum and 1600 rpm.

DESCRIPTION AND OPERATION (Continued)

Any component that has an associated limp in will set a fault after 1 trip with the malfunction present.

Refer to the Diagnostic Trouble Codes Description Charts in this section and the appropriate Powertrain Diagnostic Procedure Manual for diagnostic procedures.

NON-MONITORED CIRCUITS

The PCM does not monitor the following circuits, systems and conditions that could have malfunctions causing driveability problems. The PCM might not store diagnostic trouble codes for these conditions. However, problems with these systems may cause the PCM to store diagnostic trouble codes for other systems or components. For example, a fuel pressure problem will not register a fault directly, but could cause a rich/lean condition or misfire. This could cause the PCM to store an oxygen sensor or misfire diagnostic trouble code

FUEL PRESSURE

The fuel pressure regulator controls fuel system pressure. The PCM cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing the PCM to store an oxygen sensor or fuel system diagnostic trouble code.

SECONDARY IGNITION CIRCUIT

The PCM cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

CYLINDER COMPRESSION

The PCM cannot detect uneven, low, or high engine cylinder compression.

EXHAUST SYSTEM

The PCM cannot detect a plugged, restricted or leaking exhaust system, although it may set a fuel system fault.

FUEL INJECTOR MECHANICAL MALFUNCTIONS

The PCM cannot determine if a fuel injector is clogged, the needle is sticking or if the wrong injector is installed. However, these could result in a rich or lean condition causing the PCM to store a diagnostic trouble code for either misfire, an oxygen sensor, or the fuel system.

EXCESSIVE OIL CONSUMPTION

Although the PCM monitors engine exhaust oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

THROTTLE BODY AIR FLOW

The PCM cannot detect a clogged or restricted air cleaner inlet or filter element.

VACUUM ASSIST

The PCM cannot detect leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices. However, these could cause the PCM to store a MAP sensor diagnostic trouble code and cause a high idle condition.

PCM SYSTEM GROUND

The PCM cannot determine a poor system ground. However, one or more diagnostic trouble codes may be generated as a result of this condition. The module should be mounted to the body at all times, also during diagnostic.

PCM CONNECTOR ENGAGEMENT

The PCM may not be able to determine spread or damaged connector pins. However, it might store diagnostic trouble codes as a result of spread connector pins.

HIGH AND LOW LIMITS

The PCM compares input signal voltages from each input device with established high and low limits for the device. If the input voltage is not within limits and other criteria are met, the PCM stores a diagnostic trouble code in memory. Other diagnostic trouble code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before verifying a diagnostic trouble code condition.

LOAD VALUE

ENGINE	IDLE/NEUTRAL	2500 RPM/ NEUTRAL
All Engines	2% to 8% of Maximum Load	9% to 17% of Maximum Load

EVAPORATIVE EMISSION CONTROLS

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DESCRIPTION AND OPERATION

EVAPORATION (EVAP) CONTROL SYSTEM

The function of the EVAP control system is to prevent the emissions of gasoline vapors from the fuel tank into the atmosphere. When fuel evaporates in the fuel tank, the vapors pass through vent hoses or tubes to a carbon filled EVAP canister. They are temporarily held in the canister until they can be drawn into the intake manifold when the engine is running.

All 3.9L/5.2L/5.9L/8.0L gasoline powered engines use a duty cycle purge system. The PCM controls vapor flow by operating the duty cycle EVAP purge solenoid. Refer to Duty Cycle Solenoid for additional information.

The EVAP canister is used with all 3.9L/5.2L/5.9L/8.0L gasoline powered engines for the storage of fuel vapors from the fuel tank.

NOTE: The hoses used in this system are specially manufactured. If replacement becomes necessary, it is important to use only fuel resistant hose.

PRESSURE RELIEF/ROLLOVER VALVE

These vehicles are equipped with a combination pressure relief and rollover valve. This dual function valve will relieve fuel tank pressure and also prevent fuel flow through the fuel tank vent hoses in the event of an accidental vehicle rollover.

Tank pressure is relieved through a calibrated orifice, in the valve, to the canister. Refer to the Fuel Tank section of Group 14, Fuel Systems for removal and installation procedures.

EVAP CANISTER

A maintenance free, EVAP canister is used with all 3.9L/5.2L/5.9L/8.0L gasoline powered engines. The canister is mounted to the left frame rail below left side of vehicle (Fig. 1). The EVAP canister is filled with granules of an activated carbon mixture. Fuel vapors entering the EVAP canister are absorbed by the charcoal granules.

Fuel tank pressure vents into the EVAP canister. Fuel vapors are temporarily held in the canister until they can be drawn into the intake manifold. The duty cycle EVAP canister purge solenoid allows the EVAP canister to be purged at predetermined times and at certain engine operating conditions.

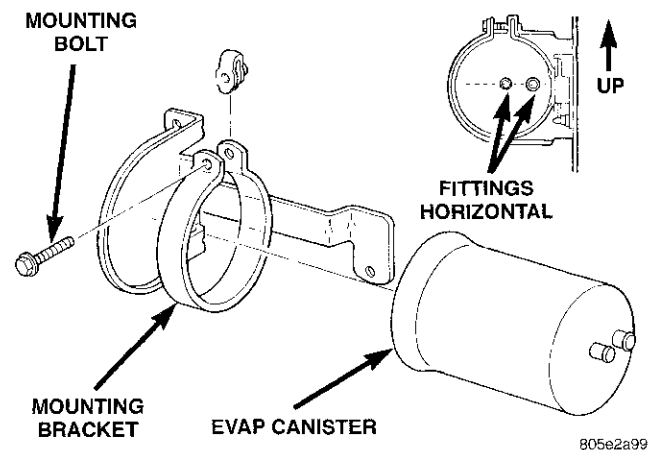


Fig. 1 EVAP Canister

DESCRIPTION AND OPERATION (Continued)**DUTY CYCLE EVAP CANISTER PURGE SOLENOID**

All 3.9L/5.2L/5.9L/8.0L gasoline powered engines use a duty cycle EVAP canister purge solenoid. The solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold start warm-up period and the hot start time delay, the PCM does not energize the solenoid. When de-energized, no vapors are purged. The PCM de-energizes the solenoid during open loop operation.

The engine enters closed loop operation after it reaches a specified temperature and the time delay ends. During closed loop operation, the PCM energizes and de-energizes the solenoid 5 or 10 times per second, depending upon operating conditions. The PCM varies the vapor flow rate by changing solenoid pulse width. Pulse width is the amount of time the solenoid energizes. The PCM adjusts solenoid pulse width based on engine operating condition.

The solenoid attaches to a bracket mounted to the intake manifold (Fig. 2) or (Fig. 3).

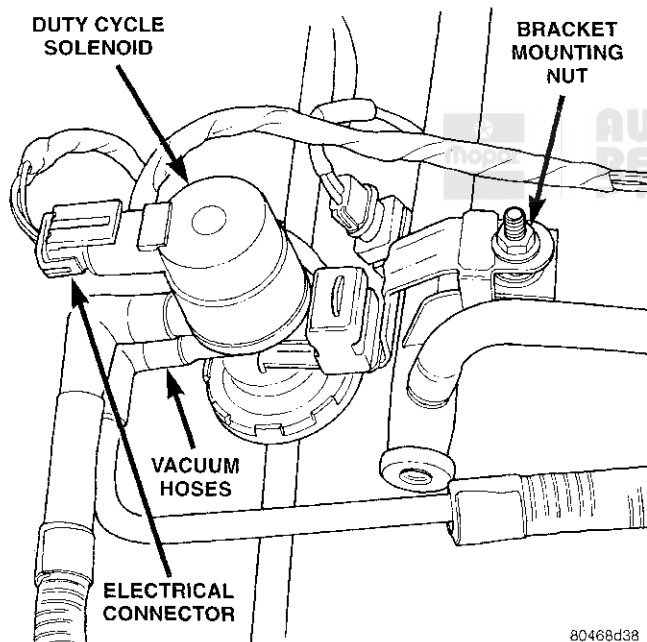


Fig. 2 EVAP Purge Solenoid—3.9L/5.2L/5.9L Engines

FUEL TANK FILLER TUBE CAP

The loss of any fuel or vapor out of filler neck is prevented by the use of a pressure-vacuum fuel tank filler tube cap. Relief valves inside cap will release only under significant pressure of 6.58 to 8.44 kPa (1.95 to 2.5 psi). The vacuum release for all fuel filler tube caps is between .97 and 2.0 kPa (.14 and .29 psi). This cap must be replaced by a similar unit if replacement is necessary. This is in order for the system to remain effective.

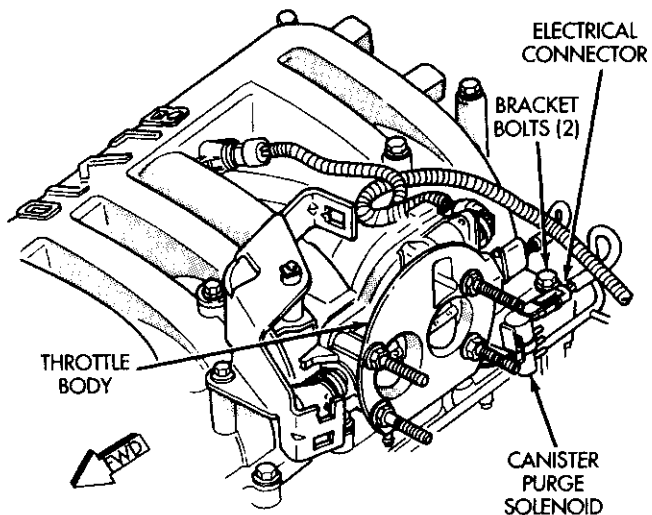


Fig. 3 EVAP Purge Solenoid—8.0L V-10 Engine

CAUTION: Remove fuel tank filler tube cap before servicing any fuel system component. This is done to help relieve tank pressure.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

All 3.9L V-6 and 5.2L/5.9L V-8 gas powered engines are equipped with a closed crankcase ventilation system and a positive crankcase ventilation (PCV) valve. The 8.0L V-10 engine is not equipped with a PCV valve. Refer to Crankcase Ventilation System—8.0L V-10 Engine for information.

This system consists of a crankcase PCV valve mounted on the cylinder head (valve) cover with a hose extending from the valve to the intake manifold.

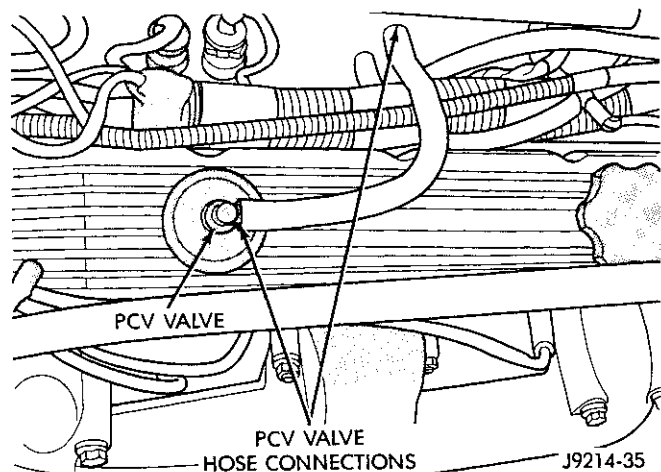


Fig. 4 PCV Valve/Hose—Typical

DESCRIPTION AND OPERATION (Continued)

A closed engine crankcase breather/filter, with a hose connecting it to the air cleaner housing, provides the source of air for system.

The PCV system operates by engine intake manifold vacuum (Fig. 5). Filtered air is routed into the crankcase through the air cleaner hose and crankcase breather/filter. The metered air, along with crankcase vapors, are drawn through the PCV valve and into a passage in the intake manifold. The PCV system manages crankcase pressure and meters blow by gases to the intake system, reducing engine sludge formation.

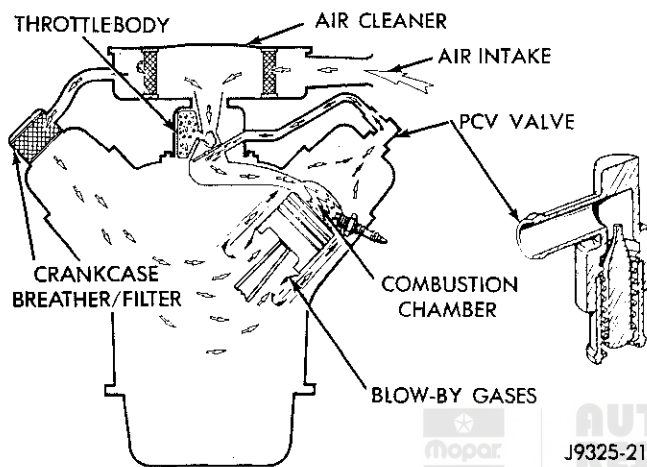


Fig. 5 Typical Closed Crankcase Ventilation System

The PCV valve contains a spring loaded plunger. This plunger meters the amount of crankcase vapors routed into the combustion chamber based on intake manifold vacuum.

When the engine is not operating or during an engine pop-back, the spring forces the plunger back against the seat. This will prevent vapors from flowing through the valve.

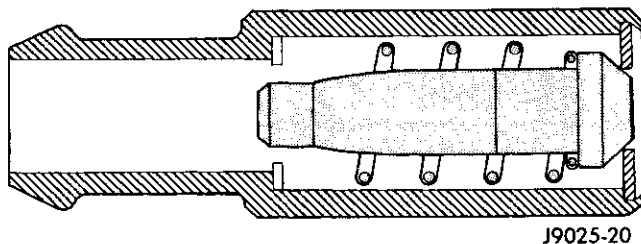


Fig. 6 Engine Off or Engine Pop-Back—No Vapor Flow

During periods of high manifold vacuum, such as idle or cruising speeds, vacuum is sufficient to completely compress spring. It will then pull the plunger to the top of the valve (Fig. 7). In this position there is minimal vapor flow through the valve.

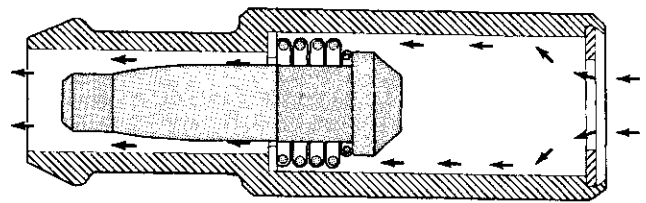


Fig. 7 High Intake Manifold Vacuum—Minimal Vapor Flow

During periods of moderate manifold vacuum, the plunger is only pulled part way back from inlet. This results in maximum vapor flow through the valve (Fig. 8).

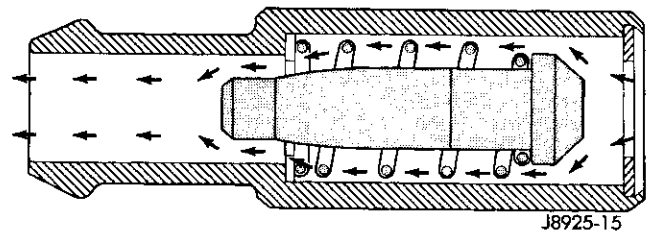


Fig. 8 Moderate Intake Manifold Vacuum—Maximum Vapor Flow

CRANKCASE VENTILATION SYSTEM—8.0L V-10 ENGINE

The 8.0L V-10 engine is equipped with a Crankcase Ventilation (CCV) system. The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve (PCV valve).

A molded vacuum tube connects manifold vacuum to the top of the right cylinder head (valve) cover. The vacuum tube connects to a fixed orifice fitting (Fig. 9) of a calibrated size 2.6 mm (0.10 inches). It meters the amount of crankcase vapors drawn out of the engine. **The fixed orifice fitting is grey in color.** A similar fitting (but does not contain a fixed orifice) is used on the left cylinder head (valve) cover. This fitting is black in color. Do not interchange these two fittings.

When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum draws the vapor/air mixture through the fixed orifice and into the intake manifold. The vapors are then consumed during engine combustion.

CRANKCASE BREATHER/FILTER—3.9L/5.2L/5.9L GAS POWERED ENGINES

The crankcase breather/filter (Fig. 10) is used on gas powered engines only (except 8.0L V-10). It is located on the cylinder head (valve) cover. The filter may be cleaned by washing in kerosene or similar solvent. Filter must then be thoroughly drained.

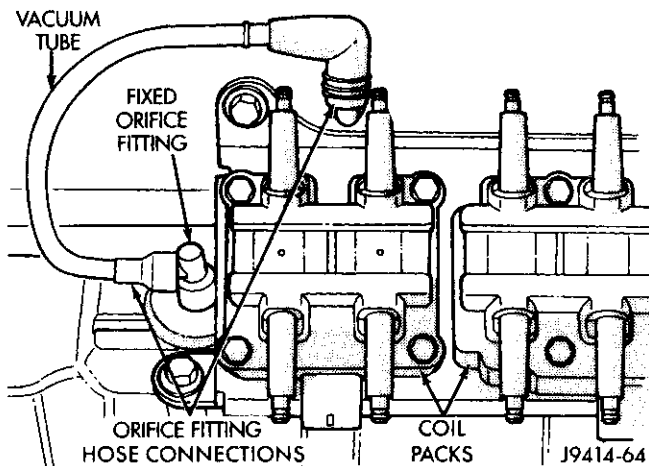
DESCRIPTION AND OPERATION (Continued)

Fig. 9 Fixed Orifice Fitting—8.0L V-10 Engine—Typical

More frequent service may be necessary for vehicles operated extensively on short run, stop and go or extended engine idle service, or extreme dust conditions.

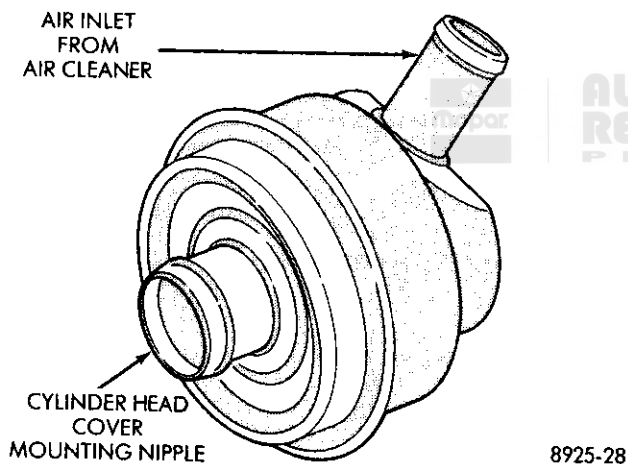


Fig. 10 Crankcase Breather/Filter—Gas Powered Engines (Except 8.0L V-10)

VEHICLE EMISSION CONTROL INFORMATION (VECI) LABEL

Vehicles equipped with 3.9L V-6 or 5.2L/5.9L V-8 LDC-gas powered engines have a VECI label.

The label combines both emission control information and vacuum hose routing. This label is located in the engine compartment in front of the radiator (Fig. 11) and contains the following:

- Engine family and displacement
- Evaporative family
- Emission control system schematic
- Certification application
- Engine timing specifications (if adjustable)
- Idle speeds (if adjustable)
- Spark plug and gap

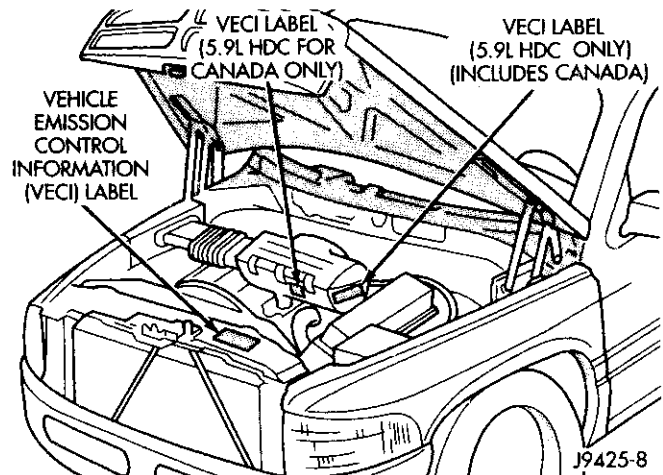


Fig. 11 VECI Label Location

The 5.9L HDC-gas powered engine will have two labels. One of the labels is located in front of the radiator in the engine compartment (Fig. 11) and will contain vacuum hose routing only. The other is attached to the drivers side of the engine air cleaner housing (Fig. 11) and will contain the following:

- Engine family and displacement
- Evaporative family
- Certification application
- Engine timing specifications (if adjustable)
- Idle speeds (if adjustable)
- Spark plug and gap

The label for the 8.0L V-10 HDC-gas powered engine is also located in the engine compartment. It is attached to a riveted metal plate located to the right side of the generator (Fig. 12).

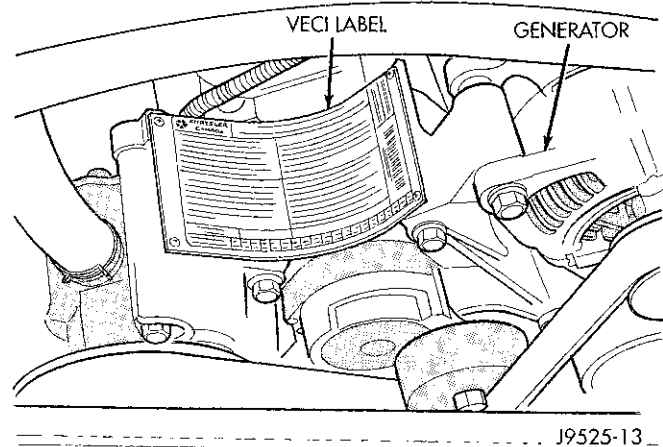


Fig. 12 VECI Label Location—8.0L V-10 Engine

There are unique labels for vehicles built for sale in the country of Canada and for both Light Duty Cycle (LDC) and Heavy Duty Cycle (HDC) engines. Canadian labels are written in both the English and

DESCRIPTION AND OPERATION (Continued)

French languages. For all Canadian vehicles, the label is split into two different labels.

The VECI labels are permanently attached and cannot be removed without defacing information and destroying label.

DIAGNOSIS AND TESTING

PCV VALVE TEST

(1) With engine idling, remove the PCV valve from cylinder head (valve) cover. If the valve is not plugged, a hissing noise will be heard as air passes through the valve. Also, a strong vacuum should be felt at the valve inlet (Fig. 13).

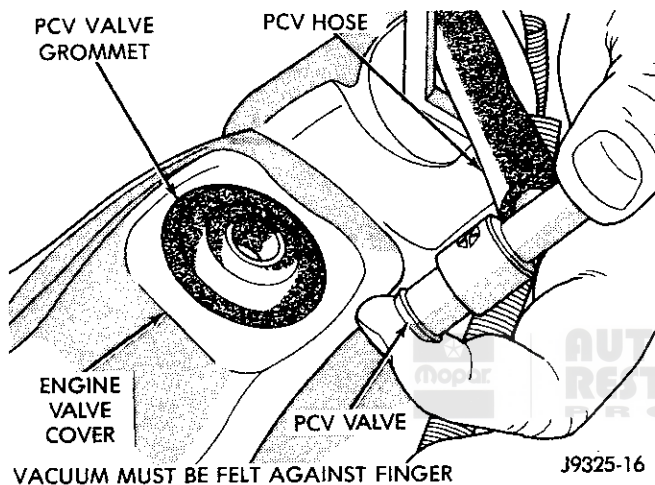


Fig. 13 Check Vacuum at PCV Valve—Typical

(2) Install the PCV valve. Remove the crankcase breather/filter. Hold a piece of stiff paper, such as a parts tag, loosely over the opening of crankcase breather/filter at the cylinder head (valve) cover (Fig. 14).

(3) The paper should be drawn against the opening in the cylinder head (valve) cover with noticeable force. This will be after allowing approximately one minute for crankcase pressure to reduce.

(4) Turn engine off and remove PCV valve from cylinder head (valve) cover. The valve should rattle when shaken (Fig. 15).

(5) Replace the PCV valve and retest the system if it does not operate as described in the preceding tests. **Do not attempt to clean the old PCV valve.**

(6) If the paper is not held against the opening in cylinder head (valve) cover after new valve is installed, the PCV valve hose may be restricted and must be replaced. The passage in the intake manifold must also be checked and cleaned.

(7) To clean the intake manifold fitting, turn a 1/4 inch drill (by hand) through the fitting to dislodge any solid particles. Blow out the fitting with shop air.

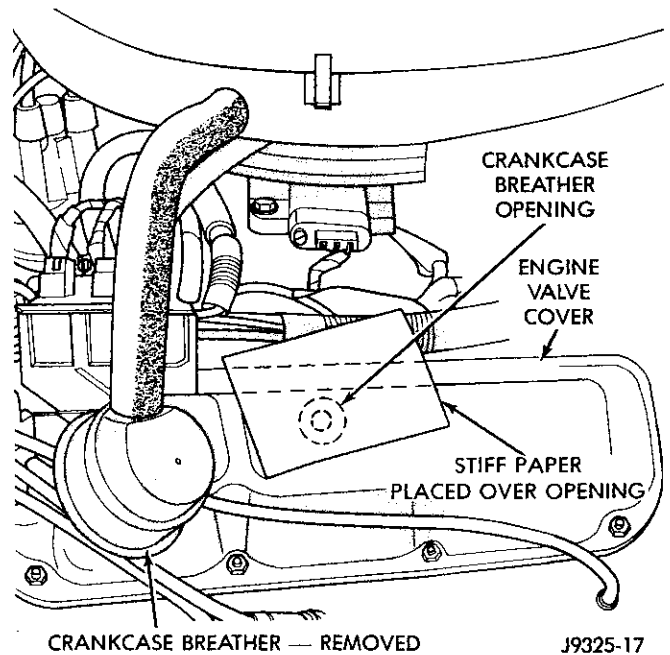


Fig. 14 Check Vacuum at Crankcase Breather Opening—Typical

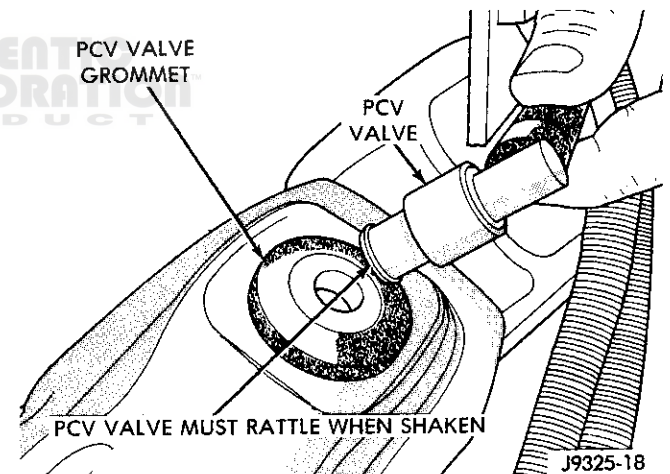


Fig. 15 Shake PCV Valve—Typical

If necessary, use a smaller drill to avoid removing any metal from the fitting.

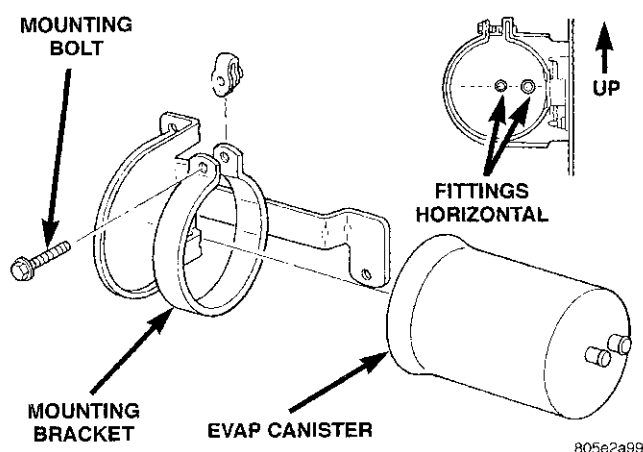
VACUUM SCHEMATICS

A vacuum schematic for emission related items can be found on the VECI label. Refer to Vehicle Emission Control Information (VECI) Label in this group for label location.

REMOVAL AND INSTALLATION

EVAPORATIVE (EVAP) CANISTER

The EVAP canister is mounted to the left frame rail near left door (Fig. 16).

REMOVAL AND INSTALLATION (Continued)**Fig. 16 EVAP Canister****REMOVAL**

(1) Remove fuel tubes/lines at EVAP canister. Note location of tubes/lines before removal for easier installation.

(2) Remove mounting bolt at canister mounting strap.

(3) Remove canister from mounting bracket.

INSTALLATION

(1) Place canister to mounting bracket. Rotate canister until fittings are in a horizontal position as shown in (Fig. 16).

(2) Install canister strap bolt and tighten to 10 N·m (95 in. lbs.) torque.

(3) Install fuel tubes/lines to canister.

EVAP CANISTER PURGE SOLENOID—3.9L/5.2L/5.9L ENGINES**REMOVAL**

(1) Remove air cleaner housing.

(2) Disconnect electrical wiring connector at solenoid (Fig. 17).

(3) Disconnect vacuum harness at solenoid (Fig. 17).

(4) Remove solenoid and its support bracket from intake manifold.

(5) Remove EVAP canister purge solenoid from engine.

INSTALLATION

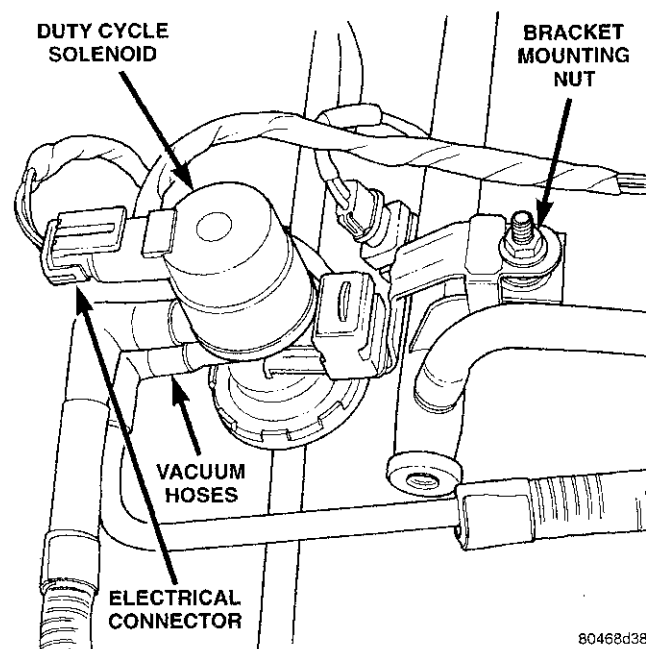
(1) Install EVAP canister purge solenoid and its mounting bracket to intake manifold.

(2) Connect vacuum harness and wiring connector.

(3) Install air cleaner housing.

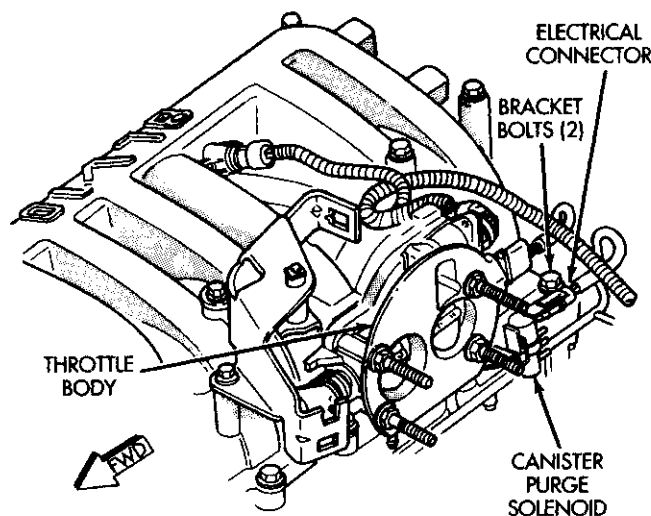
EVAP CANISTER PURGE SOLENOID—8.0L ENGINE

The solenoid is located at the rear of the throttle body (Fig. 18).

**Fig. 17 Duty Cycle EVAP Canister Purge Solenoid—3.9L/5.2L/5.9L Engines****REMOVAL**

(1) Remove the air cleaner cover.

(2) Remove the 4 air cleaner housing mounting nuts and remove housing from throttle body.

**Fig. 18 Duty Cycle EVAP Canister Purge Solenoid—8.0L Engine**

(3) Disconnect vacuum harness at solenoid.

(4) Disconnect wiring connector at solenoid.

REMOVAL AND INSTALLATION (Continued)

(5) Lift solenoid and rubber grommet from mounting bracket.

INSTALLATION

- (1) Install solenoid to mounting bracket.
- (2) Install wiring connector to solenoid.
- (3) Install vacuum harness to solenoid.
- (4) Install air cleaner housing to throttle body.
- (5) Install 4 air cleaner housing mounting nuts. Tighten nuts to 11 N·m (96 in. lbs.) torque.
- (6) Install air cleaner housing cover.

FUEL TANK FILLER TUBE CAP

If replacement of the fuel tank filler tube cap is necessary, it must be replaced with an identical cap to be sure of correct system operation.

CAUTION: Remove the fuel tank filler tube cap to relieve fuel tank pressure. The cap must be removed prior to disconnecting any fuel system component or before draining the fuel tank.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	Torque
EVAP Canister Mounting Bolt . . .	10 N·m (95 in. lbs.)



**AUTHENTIC
RESTORATION™
PRODUCT**

AIR INJECTION SYSTEM-HDC GAS ENGINES

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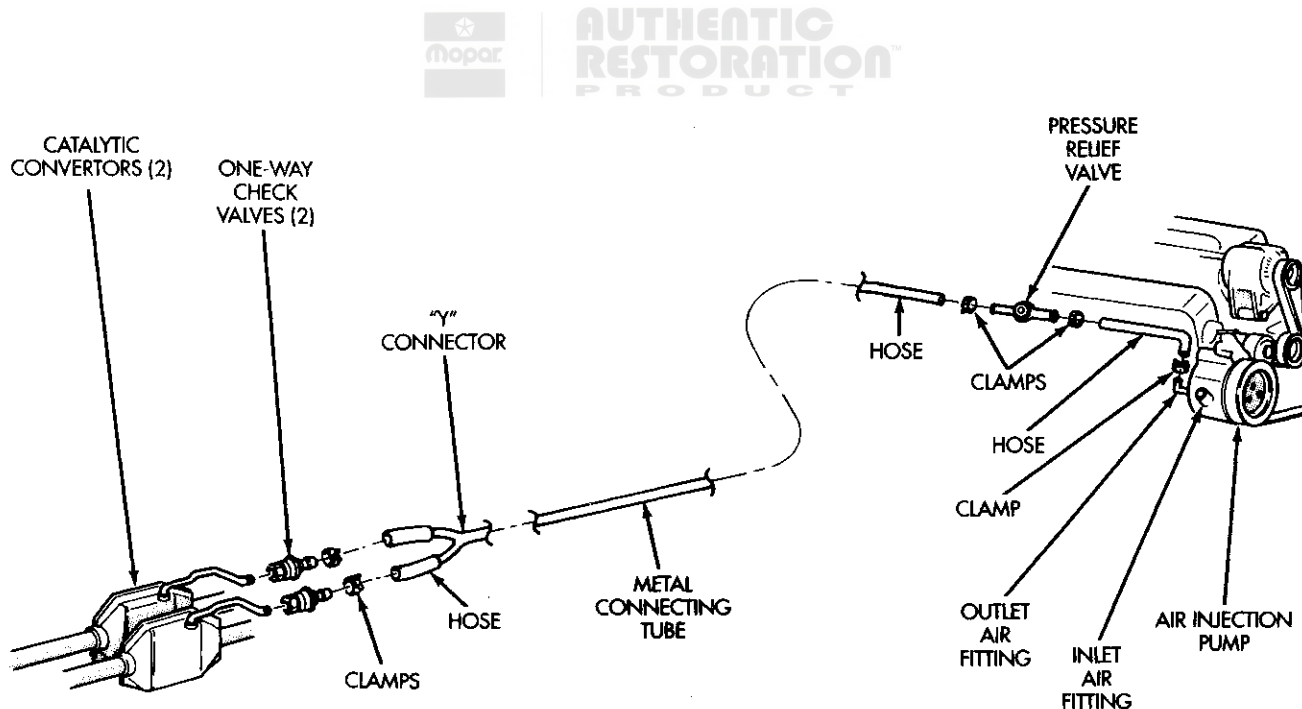
GENERAL INFORMATION

GENERAL INFORMATION

The air injection system (Fig. 1), (Fig. 2) or (Fig. 3) is used on 5.9L V-8 and 8.0L V-10 heavy duty cycle (HDC) gas powered engines only. The air injection system consists of:

- A belt-driven air injection (AIR) pump

- An air pressure relief valve
- Rubber connecting air injection hoses with clamps
- Metal connecting air tubes
- Two one-way check valves
- An injection pump air filter (8.0L V-10 engine only)



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Fig. 1 Air Injection System Components—Typical

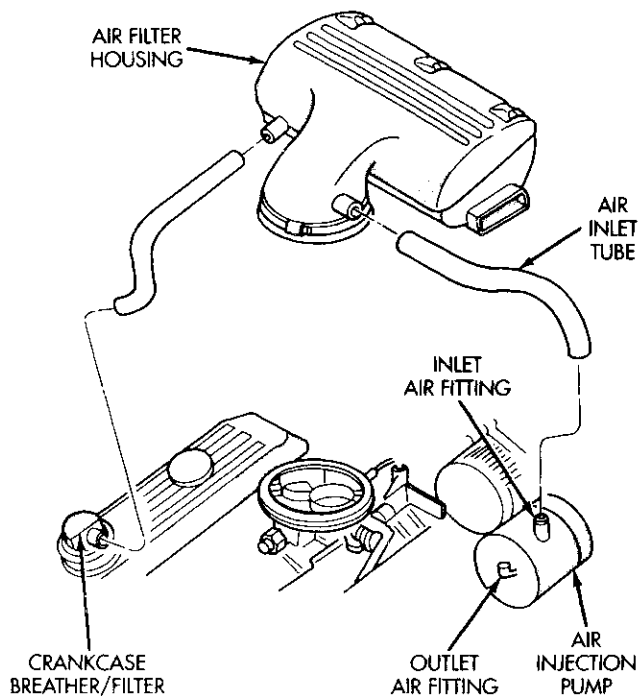


Fig. 2 Air Inlet for Air Pump—5.9L HDC Engine

DESCRIPTION AND OPERATION

AIR INJECTION SYSTEM OPERATION

The air injection system adds a controlled amount of air to the exhaust gases aiding oxidation of hydrocarbons and carbon monoxide in the exhaust stream. The system does not interfere with the ability of the EGR system (if used) to control nitrous oxide (NOx) emissions.

5.9L HDC ENGINE: Air is drawn into the pump through a rubber tube that is connected to a fitting on the air cleaner housing (Fig. 2).

8.0L V-10 ENGINE: Air is drawn into the pump through a rubber tube that is connected to a fitting on the air injection pump filter housing (Fig. 3). Air is drawn into the filter housing from the front of the vehicle with rubber tube. This tube is used as a silencer to help prevent air intake noise at the opening to the pump filter housing. An air filter is located within the air pump filter housing (Fig. 3).

Air is then compressed by the air injector pump. It is expelled from the pump and routed into a rubber tube where it reaches the air pressure relief valve (Fig. 1). Pressure relief holes in the relief valve will prevent excess downstream pressure. If excess downstream pressure occurs at the relief valve, it will be vented into the atmosphere.

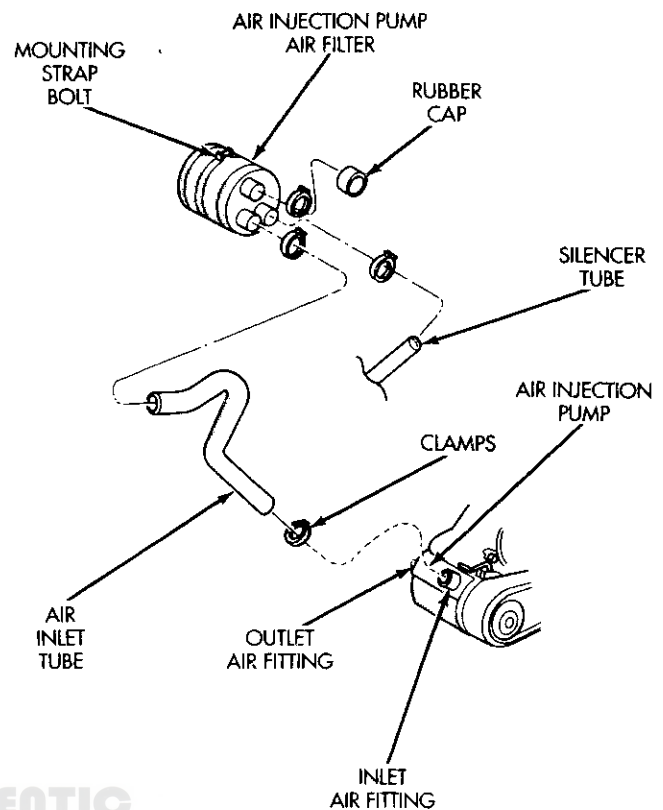


Fig. 3 Air Inlet and Air Pump Air Filter—8.0L V-10 Engine

Air is then routed (Fig. 1) from the relief valve, through a tube, down to a "Y" connector, through the two one-way check valves and injected at both of the catalytic converters (referred to as downstream).

The two one-way check valves (Fig. 1) protect the hoses, air pump and injection tubes from hot exhaust gases backing up into the system. Air is allowed to flow through these valves in one direction only (towards the catalytic converters).

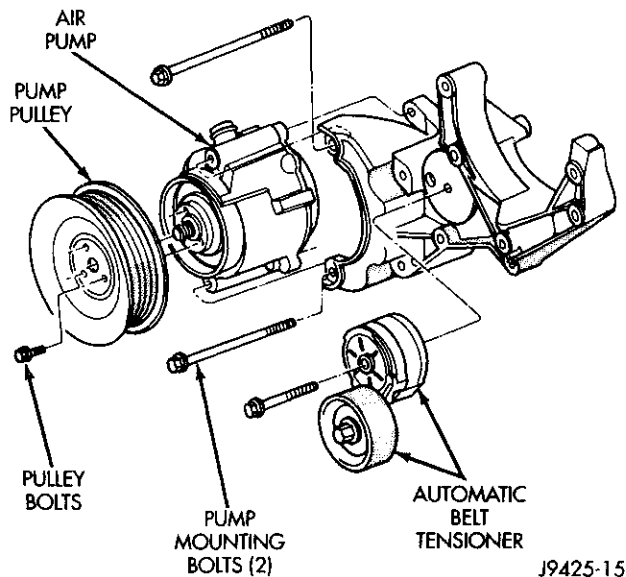
Downstream air flow assists the oxidation process in the catalyst, but does not interfere with EGR operation (if EGR system is used).

AIR INJECTION PUMP

The air pump is mounted on the front of the engine and driven by a belt connected to the crankshaft pulley (Fig. 4).

The air injection system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases. To determine if excessive noise is fault of air injection system, disconnect drive belt and operate engine.

CAUTION: Do not attempt to lubricate the air injection pump. Oil in the pump will cause rapid deterioration and failure.

DESCRIPTION AND OPERATION (Continued)**Fig. 4 Air Injection Pump Mounting—Typical**

Refer to the Air Pump Diagnosis chart for additional information.

ONE-WAY CHECK VALVE

A check valve (Fig. 1) is located on each of the air injection downstream tubes.

Each check valve has a one-way diaphragm which prevents hot exhaust gases from backing up into the hose and pump. The check valve will protect the system if the air injection pump belt fails, an air hose ruptures or exhaust system pressure becomes abnormally high.

DIAGNOSIS AND TESTING**TESTING ONE-WAY CHECK VALVE**

The one-way check valves are not repairable. To determine condition of valve, remove the rubber air tube from the inlet side of each check valve. Start the engine. If exhaust gas is escaping through the inlet side of check valve, it must be replaced.

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE BELT NOISE	<ol style="list-style-type: none"> 1. Loose belt or defective auto. belt tensioner. 2. Seized pump. 	<ol style="list-style-type: none"> 1. Refer to Group 7, Cooling. 2. Replace pump.
EXCESSIVE PUMP NOISE CHIRPING	<ol style="list-style-type: none"> 1. Insufficient break-in. 	<ol style="list-style-type: none"> 1. Recheck for noise after 1600 km. (1,000 miles) of operation.
EXCESSIVE PUMP NOISE CHIRPING, RUMBLING, OR KNOCKING	<ol style="list-style-type: none"> 1. Leak in hose. 2. Loose hose. 3. Hose touching other engine parts. 4. Relief valve inoperative. 5. Check valve inoperative. 6. Pump mounting fasteners loose. 7. Pump failure. 	<ol style="list-style-type: none"> 1. Locate source of leak using soap solution and correct. 2. Reassemble and replace or tighten hose clamp. 3. Adjust hose position. 4. Replace relief valve. 5. Replace check valve. 6. Tighten mounting screws as specified. 7. Replace pump.
NO AIR SUPPLY (ACCELERATE ENGINE TO 1500 RPM AND OBSERVE AIR FLOW FROM HOSES). IF THE FLOW INCREASES AS THE RPM'S INCREASE, THE PUMP IS FUNCTIONING NORMALLY. IF NOT, CHECK POSSIBLE CAUSE.	<ol style="list-style-type: none"> 1. Loose drive belt. 2. Leaks in supply hose. 3. Leak at fitting(s). 4. Check valve inoperative. 5. Plugged inlet air filter (8.0L). 	<ol style="list-style-type: none"> 1. Refer to Group 7, Cooling. 2. Locate leak and repair or replace as required. 3. Tighten or replace clamps. 4. Replace check valve. 5. Replace filter.

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REMOVAL AND INSTALLATION

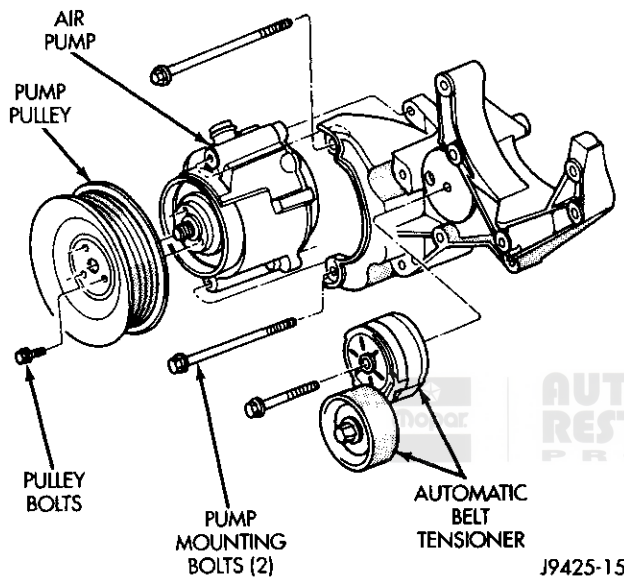
AIR INJECTION PUMP

REMOVAL

The air injection pump does not have any internal serviceable parts.

(1) Disconnect both of the hoses (tubes) at the air injection pump.

(2) Loosen, but do not remove at this time, the three air pump pulley mounting bolts (Fig. 5).



J9425-15

Fig. 5 Air Injection Pump—Typical

(3) Relax the automatic belt tensioner and remove the engine accessory drive belt. Refer to Group 7, Cooling System. See Belt Removal/Installation.

(4) Remove the three air pump pulley bolts and remove pulley from pump.

(5) Remove the two air pump mounting bolts (Fig. 5) and remove pump from mounting bracket.

INSTALLATION

(1) Position air injection pump to mounting bracket.

(2) Install two pump mounting bolts to mounting bracket. Tighten bolts to 40 N·m (30 ft. lbs.) torque.

(3) Install pump pulley and three mounting bolts. Tighten bolts finger tight.

(4) Relax tension from automatic belt tensioner and install drive belt. Refer to Group 7, Cooling System. See Belt Removal/Installation.

(5) Tighten pump pulley bolts to 11 N·m (105 in. lbs.) torque.

(6) Install hoses and hose clamps at pump.

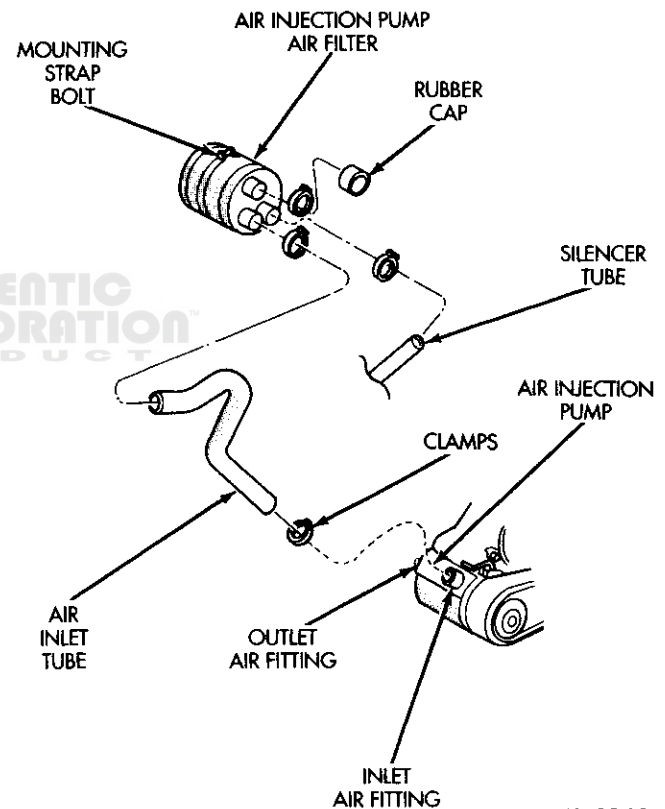
AIR INJECTION PUMP AIR FILTER—8.0L V-10 ENGINE

The air filter for the air injection pump is located in the air pump filter housing. The housing is located in the right-front side of the engine compartment. Do not attempt to clean or replace the filter within the housing. Replace the entire air injection pump filter/filter housing assembly.

For required maintenance schedules on the air pump filter (listed in time or mileage intervals), refer to Group 0, Lubrication and Maintenance. Also refer to the vehicle Owners Manual.

REMOVAL

(1) Remove the silencer tube at the housing (Fig. 6).



J9425-19

Fig. 6 Air Injection Pump Air Filter—8.0L V-10 Engine

(2) Remove the air inlet tube at the housing (Fig. 6).

(3) Remove the rubber cap (Fig. 6).

(4) Remove the mounting bracket strap bolt.

(5) Note the position of the tube fittings before removing filter assembly from bracket. Gently bend the strap and remove filter assembly.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) Install the filter assembly to the mounting bracket.
- (2) Install and tighten strap bolt.
- (3) Install rubber tubes and cap at filter.

ONE-WAY CHECK VALVE

REMOVAL

- (1) Remove the hose clamp at inlet side of valve.
- (2) Remove hose from valve.
- (3) Remove valve from catalyst tube (unscrew). **To prevent damage to catalyst tube, a backup wrench must be used on the tube.**

INSTALLATION

- (1) Install valve to catalyst tube. Tighten to 33 N·m (25 ft. lbs.) torque.

- (2) Install hose and hose clamp to valve.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Torque
Air Pump Mounting Bolts.	40 N·m (30 ft. lbs.)
Air Pump Pulley Mounting Bolts	11 N·m (105 in. lbs.)
One Way Check Valve to Catalyst Tube	33 N·m (25 ft. lbs.)



EXHAUST GAS RECIRCULATION (EGR) SYSTEM-5.9L HDC GAS ENGINE

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GENERAL INFORMATION

EXHAUST GAS RECIRCULATION (EGR) SYSTEMS

An EGR system is used with certain 5.9L HDC V-8 engines only. The system is not used with 3.9L/5.2L/5.9L LDC engines or the 8.0L V-10 engine.

The EGR system reduces oxides of nitrogen (NO_x) in the engine exhaust and helps prevent spark knock. This is accomplished by allowing a predetermined amount of hot exhaust gas to recirculate and dilute the incoming fuel/air mixture. This dilution reduces peak flame temperature during combustion.

A malfunctioning EGR system can cause engine spark knock, sags or hesitation, rough idle, engine stalling and poor driveability.

DESCRIPTION AND OPERATION

EGR SYSTEM OPERATION

The system consists of:

- An EGR valve assembly (Fig. 1) or (Fig. 2) mounted to the intake manifold.
- An EGR valve control containing a combination back-pressure transducer and an electric vacuum solenoid (Fig. 1) or (Fig. 2).
- The powertrain control module (PCM) to control the electric solenoid portion of the valve control.
- An EGR tube (Fig. 3) connecting a passage in the intake manifold (near the EGR valve) to the rear of the right exhaust manifold.
- Hoses to connect the various components.

When the PCM removes the ground signal to the electric solenoid portion of the valve control, EGR system operation starts to occur. The PCM will monitor and determine when to supply and remove this ground signal depending on certain engine temperatures, throttle positions and other engine operating conditions.

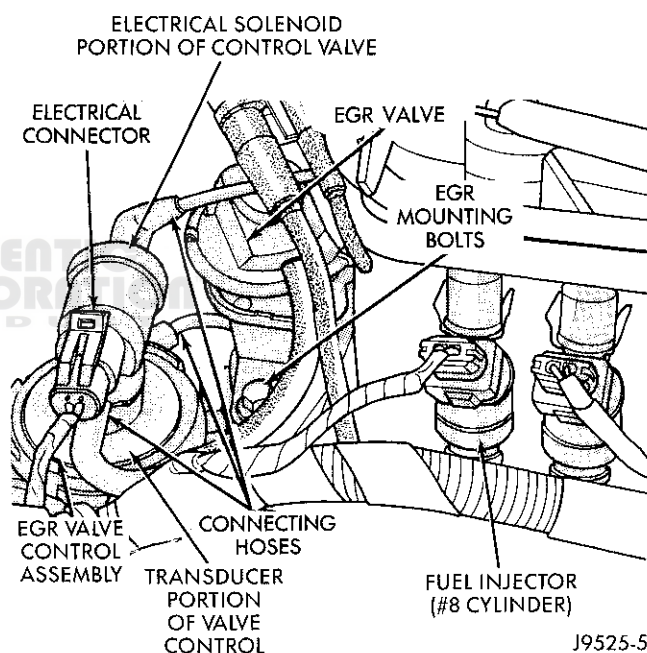


Fig. 1 EGR System Component Location—5.9L HDC Engine

If the electrical connector to the EGR valve control is disconnected, or the electrical signal is lost, the EGR valve will operate at all times. This may result in; poor engine performance, rough idle speed and reduced driveability during certain operating conditions.

The EGR valve control also contains an internal pressure-type transducer (Fig. 2). This transducer portion of the valve control is operated by exhaust back-pressure from the EGR valve. Exhaust is delivered to the EGR valve through the metal EGR tube (Fig. 3). This connects it to the rear of the right

DESCRIPTION AND OPERATION (Continued)

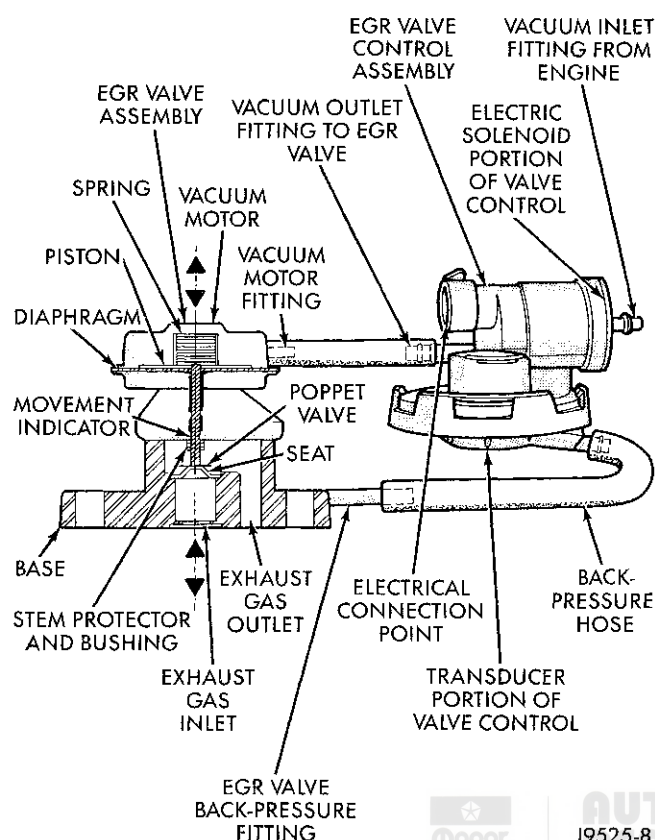


Fig. 2 EGR Valve and EGR Valve Control—Typical

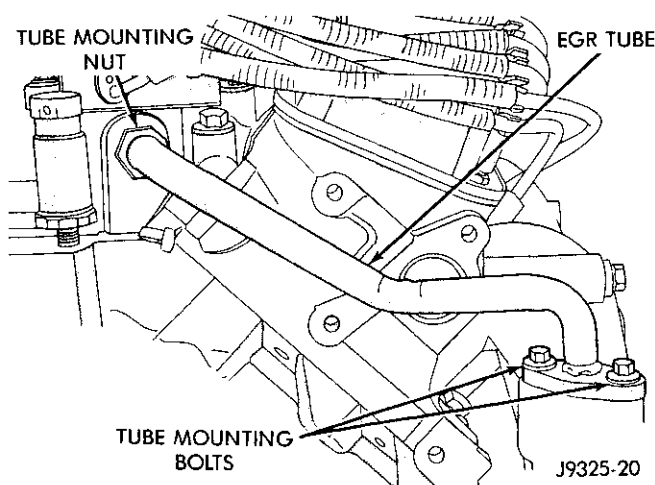


Fig. 3 EGR Tube—5.9L HDC Engine

exhaust manifold. A rubber hose connects the back-pressure fitting on the EGR valve to the back-pressure fitting on the valve control (Fig. 2).

When the ground signal is removed from the electric portion of the valve control (solenoid is not energized), and exhaust gas back-pressure entering the EGR valve inlet is high enough, back-pressure is supplied to the valve control. It then holds the bleed valve in the transducer closed. This allows engine

vacuum to flow through the EGR valve control to activate and operate the EGR valve for exhaust gas recirculation. If back-pressure is not strong enough to close the bleed valve in the transducer, the valve control will bleed off engine vacuum preventing EGR valve operation.

The transducer measures and uses this exhaust back-pressure signal from the EGR valve to regulate and provide the correct amount of exhaust gas recirculation under all conditions.

Exhaust gas recirculation will begin in this order when:

- The powertrain control module (PCM) determines that EGR system operation is necessary.
- The electrical portion of the EGR valve control is not energized (grounded) by the PCM.
- Exhaust back-pressure entering the transducer in the EGR valve control is strong enough to close its bleed valve.
- Engine vacuum is passed through the EGR valve control to the EGR valve.
- The inlet seat (poppet valve) at the bottom of the EGR valve opens to dilute and recirculate exhaust gas back into the intake manifold.

DIAGNOSIS AND TESTING

EGR GAS FLOW TEST

Use the following test procedure to determine if exhaust gas is flowing through the EGR valve. It can also be used to determine if the EGR tube is plugged, or the system passages in the intake or exhaust manifolds are plugged.

This is not to be used as a complete test of the EGR system.

The engine must be started, running and warmed to operating temperature for this test.

(1) All engines are equipped with two fittings located on the EGR valve (Fig. 4). The upper fitting (located on the vacuum motor) supplies engine vacuum to a diaphragm within the EGR valve for valve operation. The lower fitting (located on the base of the EGR valve) is used to supply exhaust back-pressure to the EGR valve control.

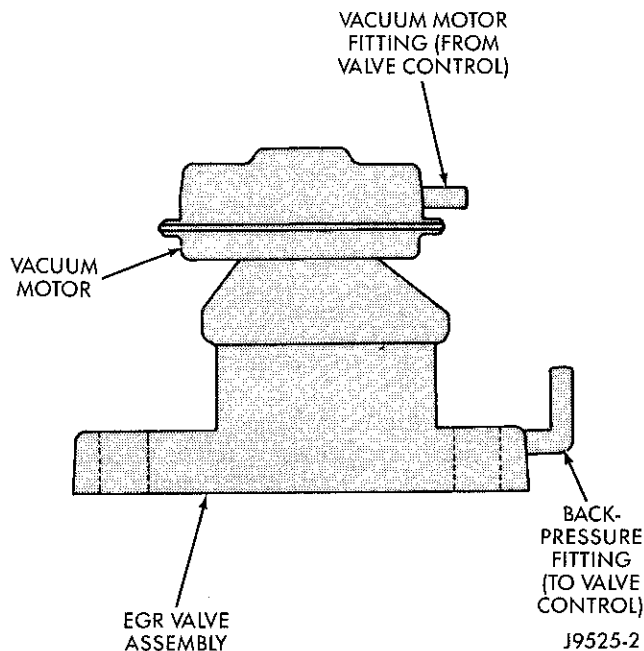
(2) Disconnect the rubber hose at the vacuum motor fitting (Fig. 4) on the top of the EGR valve vacuum motor.

(3) Connect a hand-held vacuum pump to this fitting.

(4) Start the engine.

(5) Slowly apply 5 inches of vacuum to the fitting on the EGR valve motor.

(6) While applying vacuum, and with the engine running at idle speed, the idle speed should drop or the engine may even stall. This is indicating that

DIAGNOSIS AND TESTING (Continued)**Fig. 4 Typical EGR Valve**

exhaust gas is flowing through the EGR tube between the intake and exhaust manifolds.

(7) If the engine speed did not change, the EGR valve may be defective, the EGR tube may be plugged with carbon, or the passages in the intake and exhaust manifolds may be plugged with carbon.

(a) Remove EGR valve from engine. Refer to EGR Valve Removal in this group.

(b) Apply vacuum to the vacuum motor fitting and observe the stem on the EGR valve. If the stem is moving, it can be assumed that the EGR valve is functioning correctly. The problem is in either a plugged EGR tube or plugged passages at the intake or exhaust manifolds. Refer to step (c). If the stem will not move, replace the EGR valve. Note: The EGR valve, valve control and attaching hoses are serviced as one unit. Refer to EGR Valve Removal/Installation in this group.

(c) Remove the EGR tube between the intake and exhaust manifolds. Check and clean the EGR tube and its related openings on the manifolds. Refer to EGR Tube in this group for procedures.

(8) Do not attempt to clean the EGR valve. If the valve shows evidence of heavy carbon build-up near the base, replace it.

EGR SYSTEM TEST

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE TESTING THE EGR SYSTEM.

(1) Warm up the engine and bring to operating temperature before performing the proceeding tests.

(2) Check the condition of all EGR system hoses and tubes for leaks, cracks, kinks and hardening of rubber hoses. Repair and correct these conditions before performing any tests.

(3) Be sure the hoses at both the EGR valve and EGR valve control are connected to the proper fittings.

(4) Be sure the electrical connector is firmly connected at the valve control.

(5) To check EGR system operation, connect the DRB scan tool to the 16-way data link connector. The data link connector is located on the lower edge of the instrument panel near the steering column. Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool when diagnosing the EGR system.

(6) After checking the system with the DRB scan tool, proceed to the following EGR Valve Leakage and EGR Valve Control Tests and repair as necessary.

EGR VALVE LEAKAGE TEST

This is not to be used as a complete test of the EGR system.

If the engine will not idle, dies out on idle, or idle is rough or slow, the poppet valve (Fig. 2) at the base of the EGR valve may be leaking in the closed position. The diaphragm (Fig. 2) within the EGR valve may also be ruptured.

(1) The engine should be off for the following test.

(2) Disconnect the rubber hose from the fitting (Fig. 2) at the top (vacuum motor) side of the EGR valve.

(a) Connect a hand-held vacuum pump to this fitting.

(b) Apply 15 inches of vacuum to the pump.

(c) Observe the gauge reading on the pump.

(d) If vacuum falls off, the diaphragm in the EGR valve has ruptured.

(e) Replace the EGR valve. Note: The EGR valve, valve control and attaching hoses are serviced as one unit. Refer to EGR Valve Removal/Installation in this group.

(f) Proceed to the next step.

(3) A small metal fitting (back-pressure fitting) is located at the base of the EGR valve (Fig. 2). A rubber back-pressure hose connects it to the back-pressure fitting on the EGR valve control. Disconnect this rubber hose at the EGR valve fitting.

(4) Remove the air cleaner housing from the throttle body.

(5) Using compressed air, and using an air nozzle with a rubber tip, apply approximately 50 psi of regulated shop air to the metal back-pressure fitting on the EGR valve.

DIAGNOSIS AND TESTING (Continued)

(6) By hand, open the throttle to the wide open position. Air **should not be heard** emitting from the intake manifold while applying air pressure at the back-pressure fitting.

(7) If air **can be heard** emitting from the intake manifold, the poppet valve (Fig. 2) is leaking at the bottom of the EGR valve. Replace the EGR valve. Note: The EGR valve, valve control and attaching hoses are serviced as one unit. Refer to EGR Valve Removal/Installation in this group. Do not attempt clean the old EGR valve.

EGR VALVE CONTROL TEST**TESTING ELECTRICAL SOLENOID PORTION OF VALVE CONTROL**

This is not to be used as a complete test of the EGR system.

Electrical operation of the valve control should be checked with the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool. Replace solenoid if necessary.

TESTING VACUUM TRANSDUCER PORTION OF VALVE CONTROL

The first part of this test will determine if the transducer diaphragm at the back-pressure side of the valve control has ruptured or is leaking. The second part of the test will determine if engine vacuum (full-manifold) is flowing from the inlet to the outlet side of the valve control. This is not to be used as a complete test of the EGR system.

(1) Electrical operation of the valve control should first be checked with the DRB scan tool before proceeding with the vacuum test. Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.

(2) Disconnect the rubber back-pressure hose from the fitting at the bottom of EGR valve control (Fig. 2).

(3) Connect a hand-held vacuum pump to this fitting.

(4) Apply 10 inches of vacuum to this fitting.

(5) If vacuum falls off, the valve control diaphragm is leaking.

(6) Replace the EGR valve control. Proceed to next step for further testing.

(7) Remove the rubber hose at the vacuum **inlet** fitting (Fig. 2) on the EGR valve control.

(8) Connect a vacuum gauge to this disconnected hose.

(9) Start the engine and bring to operating temperature. Hold engine speed at approximately 1500 rpm.

(10) Check for steady engine vacuum (full-manifold) at this hose.

(11) If engine vacuum (full-manifold) is not present, check vacuum line to engine and repair as necessary before proceeding to next step.

(12) Reconnect the rubber hose to the vacuum **inlet** fitting (Fig. 2) on the EGR valve control.

(13) Disconnect the rubber hose at the vacuum **outlet** fitting (Fig. 2) on the EGR valve control.

(14) Connect a vacuum gauge to this fitting.

(15) Disconnect the electrical connector (Fig. 1) at the valve control. This will simulate an open circuit (no ground from the PCM) at the valve control.

(16) Start the engine and bring to operating temperature.

(17) Hold the engine speed to approximately 2000 rpm while checking for engine vacuum (full-manifold) at this fitting. **To allow full manifold vacuum to flow through the valve control, exhaust back-pressure must be present at valve control. It must be high enough to hold the bleed valve in the transducer portion of the valve control closed.** Have a helper momentarily (a second or two) hold a rag over the tailpipe opening to build some exhaust back-pressure while observing the vacuum gauge. Heavy gloves should be worn. **Do not cover the tailpipe opening for an extended period of time as damage to components or overheating may result.**

(18) As temporary back-pressure is built, full manifold vacuum should be observed at the vacuum control outlet fitting. Without back-pressure, and engine at approximately 2000 rpm, the gauge reading will be low. This low reading is normal. At idle speed, the gauge reading will be erratic. This is also normal.

(19) If full manifold vacuum is not present at the outlet fitting, but was present at the inlet fitting, replace the valve control. Note: The EGR valve, valve control and attaching hoses are serviced as one unit. Refer to EGR Valve Removal/Installation in this group.

REMOVAL AND INSTALLATION**EGR VALVE****REMOVAL**

The EGR valve, valve control and hoses are serviced as one unit.

(1) Remove air cleaner assembly.

(2) Disconnect vacuum hoses at EGR valve and EGR valve control. Note position of hoses for easier installation.

(3) Remove two EGR valve mounting bolts (Fig. 5).

(4) Remove EGR valve and gasket.

(5) Discard old EGR gasket.

(6) Clean intake manifold mating surface and check for cracks.

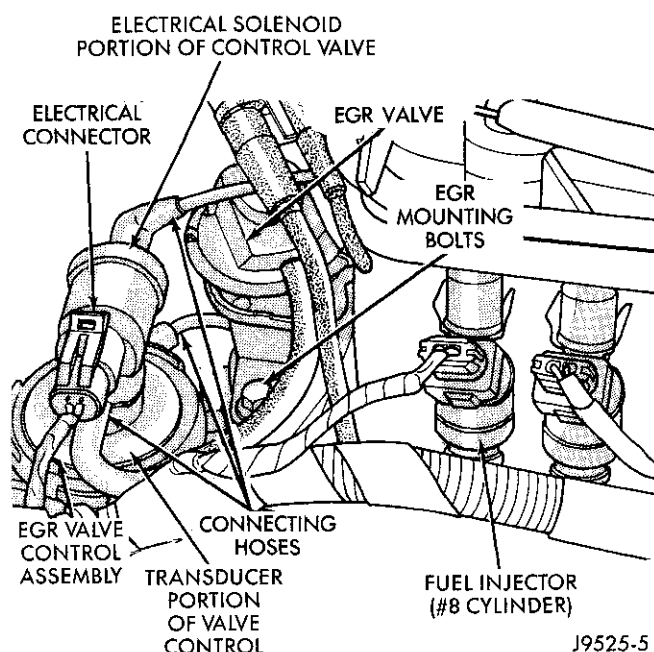
REMOVAL AND INSTALLATION (Continued)

Fig. 5 EGR Valve and Mounting Bolts—5.9L HDC Engine

INSTALLATION

- (1) Place new EGR gasket on intake manifold.
- (2) Install EGR valve. Tighten mounting bolts to 23 N·m (200 in. lbs.) torque.
- (3) Connect vacuum hoses.
- (4) Install air cleaner assembly.

EGR VALVE CONTROL (EGR SOLENOID)

The EGR valve, the EGR valve control and the hoses are serviced as one unit. Refer to EGR Valve Removal/Installation for procedures.

EGR TUBE**REMOVAL**

- (1) Remove air cleaner housing.
- (2) Remove the spark plug cable loom and plug cables from valve cover mounting stud at rear of right valve cover. Position spark plug cables to top of valve cover.
- (3) Disconnect two vacuum hoses at exhaust gas recirculation (EGR) valve.
- (4) Remove 2 EGR valve mounting bolts (Fig. 5) and remove EGR valve. Discard old gasket.
- (5) Disconnect electrical connector at engine oil pressure sending unit.
- (6) To prevent damage to oil pressure sending unit, a special tool, such as number C-4597 must be used (Fig. 6). Remove sending unit from engine.
- (7) Loosen EGR tube mounting nut at intake manifold (Fig. 7).

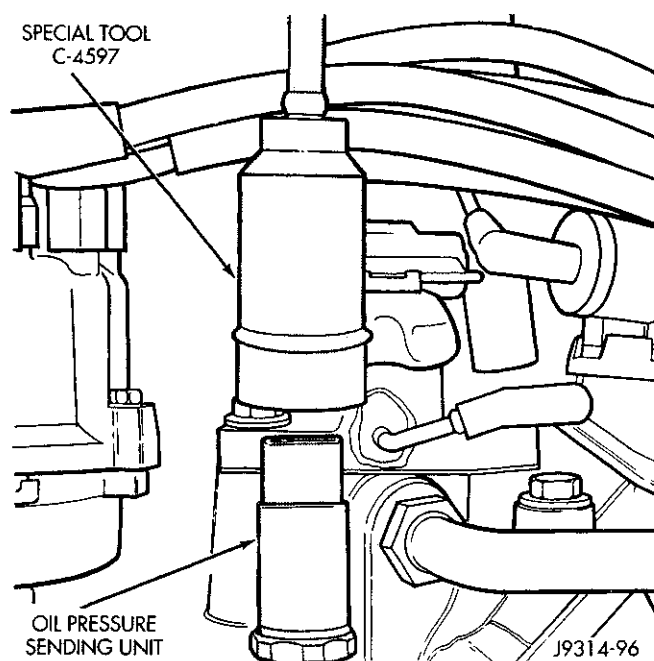


Fig. 6 Oil Pressure Sending Unit—3.9L/5.2L/5.9L Engines

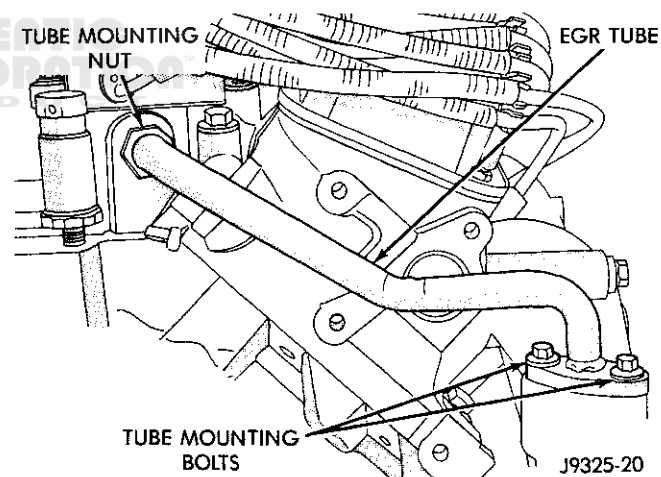


Fig. 7 EGR Tube—5.9L HDC Engine

- (8) Remove EGR tube mounting bolts at exhaust manifold (Fig. 7) and remove EGR tube.

INSTALLATION

- (1) Clean the EGR tube and exhaust manifold (at EGR tube mounting point) of any old gasket material.
- (2) Install a new gasket to exhaust manifold end of EGR tube.
- (3) Install EGR tube to both manifolds. Tighten mounting nut at intake manifold. Tighten two mounting bolts at exhaust manifold to 23 N·m (204 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

- (4) Coat the threads of the oil pressure sending unit with thread sealant. Do not allow any of the thread sealant to get into the sending unit opening or the opening at the engine. Install sending unit to engine and tighten to 14 N·m (130 in. lbs.) torque. Install electrical connector to sending unit.
- (5) Clean the intake manifold and EGR valve of any old gasket material.
- (6) Install a new EGR valve gasket to intake manifold.
- (7) Install EGR valve to intake manifold. Tighten two mounting bolts to 23 N·m (200 in. lbs.) torque.
- (8) Install vacuum lines to EGR valve.
- (9) Install spark plug cable loom and plug cables to valve cover mounting stud.

- (10) Install air cleaner housing.

SPECIFICATIONS

TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
EGR Valve Mounting Bolts . . .	23 N·m (204 in. lbs.)
EGR Tube Bolts at Exhaust	
Manifold	23 N·m (204 in. lbs.)



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