GROUP TAB LOCATOR

LUBRICATION & MAINTENANCE

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LUBRICATION & MAINTENANCE

SPECIFICATIONS - FLUID CAPACITIES

DESCRIPTION	SPECIFICATION
FUEL TANK	20 U.S. Gallons (76 Liters)****
Engine Oil - with Filter - 2.7L Diesel	6.5L (6.9 qts.)
Engine Oil - with Filter - 4.0L	5.7 L (6.0 qts.)
Engine Oil - with Filter - 4.7L	5.7 L (6.0 qts.)
Cooling System - 2.7L Diesel	14.2L (15 qts.)***
Cooling System - 4.0L	14.1 L (15 qts.)***
Cooling System - 4.7L	13.7 L (14.5 qts.)***
AUTOMATIC TRANSMISSION	
Service Fill - 42RE	3.8 L (4.0 qts.)
Service Fill - 545RFE	2WD - 5.2 L (11 pts.) 4WD - 6.2 L (13 pts.)
Service Fill - W5J400	5.0 L (10.6 pts.)
O-haul Fill - 42RE	9.1-9.5 L (19-20 pts.)
O-haul Fill - 545RFE	13.33 L (28.0 pts.)
O-haul Fill - W5J400	7.7 L (16.3 pts)
Dry fill capacity 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 appropriate 21 - TRANSMISSION/ TRANSAXLE/AUTOMATIC/FLUID - STANDARD PROCEDURE).	
TRANSFER CASE	
NV242	1.35L (2.85 pts.)
NV247	1.6L (3.4 pts.)
FRONT AXLE ± 0.3 L (1 oz.)	
186 FBI (Model 30)	1.18 L (2.5 pts.)*
* With Vari-Lok add 0.07 L (2.5 oz.) of Friction Modifier.	

LUBRICATION & MAINTENANCE (Continued)

DESCRIPTION	SPECIFICATION
REAR AXLE ± 0.3 L (1 oz.)	
198 RBI (Model 35)	1.66 L (3.5 pts.)*
226 RBA (Model 44)	2.24 L (4.75 pts.)**
* With Trac-lok add 0.07 L (2.5 oz.) of Friction Modifier.	
** With Trac-lok or Vari-Lok, add 0.07 L (2.5 oz.) of Friction Modifier.	
*** Includes 0.9L (1.0 qts.) for coolant reservoir.	
****Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.	

INTERNATIONAL SYMBOLS

DESCRIPTION

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

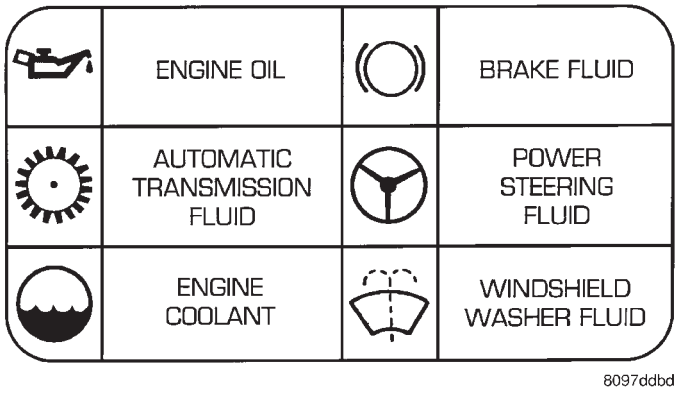

Fig. 1 INTERNATIONAL SYMBOLS

PARTS & LUBRICANT RECOMMENDATION

STANDARD PROCEDURE - PARTS & LUBRICANT RECOMMENDATIONS

Lubricating grease is rated for quality and usage by the NLGI. All approved products have the NLGI symbol (Fig. 2) 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 latter “L”. The letter following the usage letter indicates the quality of the lubricant. The following symbols indicate the highest quality.

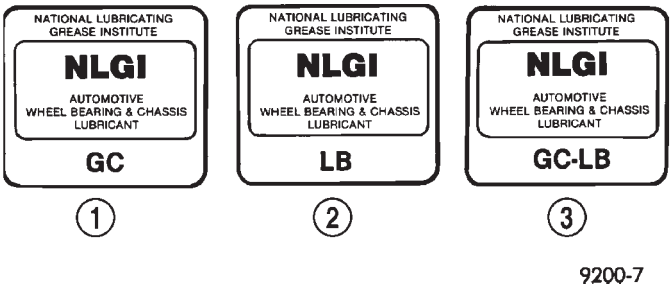

Fig. 2 NLGI Symbol

1 - WHEEL BEARINGS
2 - CHASSIS LUBRICATION
3 - CHASSIS AND WHEEL BEARINGS

When service is required, DaimlerChrysler Corporation recommends that only Mopar® brand parts, lubricants and chemicals be used. Mopar provides the best engineered products for servicing DaimlerChrysler Corporation vehicles.

FLUID TYPES

DESCRIPTION

DESCRIPTION - ENGINE COOLANT

ETHYLENE-GLYCOL MIXTURES

CAUTION: Richer antifreeze mixtures cannot be measured with normal field equipment and can cause problems associated with 100 percent ethylene-glycol.

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 antifreeze 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 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.

FLUID TYPES (Continued)

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 MIXTURES

It's 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 on a cooling system 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 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.

DESCRIPTION - HOAT COOLANT

WARNING: ANTIFREEZE IS AN ETHYLENE GLYCOL BASE COOLANT AND IS HARMFUL IF SWALLOWED OR INHALED. IF SWALLOWED, DRINK TWO GLASSES OF WATER AND INDUCE VOMITING. IF INHALED, MOVE TO FRESH AIR AREA. SEEK MEDICAL ATTENTION IMMEDIATELY. DO NOT STORE IN OPEN OR UNMARKED CONTAINERS. WASH SKIN AND CLOTHING THOROUGHLY AFTER COMING IN CONTACT WITH ETHYLENE GLYCOL. KEEP OUT OF REACH OF CHILDREN. DISPOSE OF GLYCOL BASE COOLANT PROPERLY, CONTACT YOUR DEALER OR GOVERNMENT AGENCY FOR LOCATION OF COLLECTION CENTER IN YOUR AREA. DO NOT OPEN A COOLING SYSTEM WHEN THE ENGINE IS AT OPERATING TEMPERATURE OR HOT UNDER PRESSURE, PERSONAL INJURY CAN RESULT. AVOID RADIATOR COOLING FAN WHEN ENGINE COMPARTMENT RELATED SERVICE IS PERFORMED, PERSONAL INJURY CAN RESULT.

CAUTION: Use of Propylene Glycol based coolants is not recommended, as they provide less freeze protection and less corrosion protection.

The cooling system is designed around the coolant. The coolant must accept heat from engine metal, in the cylinder head area near the exhaust valves and engine block. Then coolant carries the heat to the radiator where the tube/fin radiator can transfer the heat to the air.

The use of aluminum cylinder blocks, cylinder heads, and water pumps requires special corrosion protection. Mopar® Antifreeze/Coolant, 5 Year/100,000 Mile Formula (MS-9769), or the equivalent ethylene glycol base coolant with organic corrosion inhibitors (called HOAT, for Hybrid Organic Additive Technology) is recommended. This coolant offers the best engine cooling without corrosion when mixed with 50% Ethylene Glycol and 50% distilled water to obtain a freeze point of -37°C (-35°F). If it loses color or becomes contaminated, drain, flush, and replace with fresh properly mixed coolant solution.

CAUTION: Mopar® Antifreeze/Coolant, 5 Year/100,000 Mile Formula (MS-9769) may not be mixed with any other type of antifreeze. Mixing of coolants other than specified (non-HOAT or other HOAT), may result in engine damage that may not be covered under the new vehicle warranty, and decreased corrosion protection.

COOLANT PERFORMANCE

The required ethylene-glycol (antifreeze) and water mixture depends upon climate and vehicle operating conditions. The coolant performance of various mixtures follows:

Pure Water-Water can absorb more heat than a mixture of water and ethylene-glycol. This is for purpose of heat transfer only. Water also freezes at a higher temperature and allows corrosion.

100 percent Ethylene-Glycol-The corrosion inhibiting additives in ethylene-glycol need the presence of water to dissolve. Without water, additives form deposits in system. These act as insulation causing temperature to rise to as high as 149°C (300°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°C (-8°F).

50/50 Ethylene-Glycol and Water-Is the recommended mixture, it provides protection against freezing to -37°C (-34°F). The antifreeze concentration **must always** be a minimum of 44 percent, year-round in all climates. If percentage is lower, engine parts may be eroded by cavitation. Maximum protec-

FLUID TYPES (Continued)

tion against freezing is provided with a 68 percent antifreeze concentration, which prevents freezing down to -67.7°C (-90°F). A higher percentage will freeze at a warmer temperature. Also, a higher percentage of antifreeze can cause the engine to overheat because specific heat of antifreeze is lower than that of water.

CAUTION: Richer antifreeze mixtures cannot be measured with normal field equipment and can cause problems associated with 100 percent ethylene-glycol.

COOLANT SELECTION AND ADDITIVES

The use of aluminum cylinder blocks, cylinder heads and water pumps requires special corrosion protection. Only Mopar® Antifreeze/Coolant, 5 Year/100,000 Mile Formula (glycol base coolant with corrosion inhibitors called HOAT, for Hybrid Organic Additive Technology) is recommended. This coolant offers the best engine cooling without corrosion when mixed with 50% distilled water to obtain to obtain a freeze point of -37°C (-35°F). If it loses color or becomes contaminated, drain, flush, and replace with fresh properly mixed coolant solution.

CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

ENGINE OIL

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. CONTACT YOUR DEALER OR GOVERNMENT AGENCY FOR LOCATION OF COLLECTION CENTER IN YOUR AREA.

API SERVICE GRADE CERTIFIED

Use an engine oil that is API Service Grade Certified. MOPAR® provides engine oils that conform to this service grade.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. Use only engine oils with multiple viscosities such as 5W-30 or 10W-30. 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 particular temperature range and variation (Fig. 3).

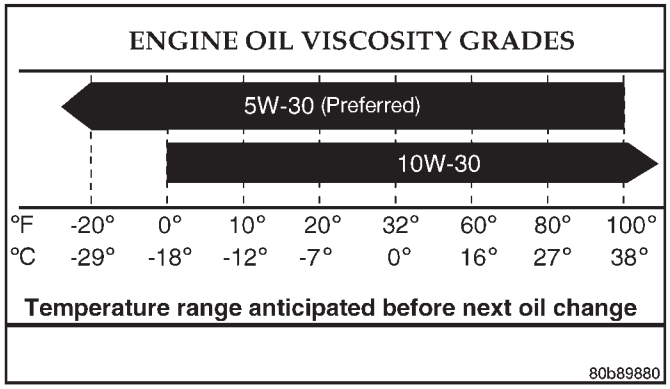

Fig. 3 Temperature/Engine Oil Viscosity - 4.7L

ENERGY CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. The designation of ENERGY CONSERVING is located on the label of an engine oil container.

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 API SYMBOL

FLUID TYPES (Continued)

DESCRIPTION - ENGINE OIL

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. CONTACT YOUR DEALER OR GOVERNMENT AGENCY FOR LOCATION OF COLLECTION CENTER IN YOUR AREA.

API SERVICE GRADE CERTIFIED

Use an engine oil that is API Service Grade Certified. MOPAR® provides engine oils that conform to this service grade.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. Use only engine oils with multiple viscosities such as 5W-30 or 10W-30. These oils 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 particular temperature range and variation (Fig. 5).

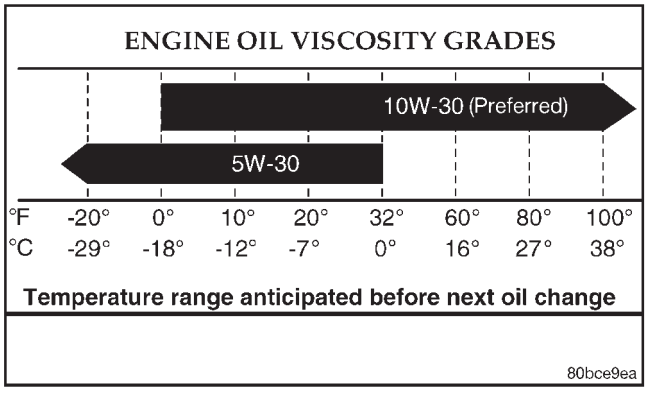

Fig. 5 Temperature/Engine Oil Viscosity - 4.0L

ENERGY CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. The designation of ENERGY CONSERVING is located on the label of an engine oil container.

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. 6).

Fig. 6 API Symbol

DESCRIPTION

A multi-purpose, hypoid gear lubricant which conforms to MIL-L-2105C and API GL 5 quality specifications should be used. Mopar Hypoid Gear Lubricant conforms to these specifications.

FRONT AXLE

- Lubricant is SAE 75W-140 SYNTHETIC.

REAR AXLE

- Lubricant is a thermally stable SAE 80W-90 gear lubricant.
- Lubricant for heavy-duty or trailer tow use is SAE 75W-140 SYNTHETIC.

NOTE: Trac-lok® and Vari-lok® equipped axles require a friction modifier be added to the lubricant.

DESCRIPTION - TRANSFER CASE - NV242

Recommended lubricant for the NV242 transfer case is Mopar® ATF+4, type 9602 Automatic Transmission Fluid.

DESCRIPTION - TRANSFER CASE - NV247

Mopar® Transfer Case Lubricant (P/N 05016796) is the only lubricant recommended for the NV247 transfer case.

DESCRIPTION - AUTOMATIC TRANSMISSION FLUID

NOTE: Refer to Service Procedures in this group for fluid level checking procedures.

Mopar® ATF +4, type 9602, Automatic Transmission Fluid is the recommended fluid for DaimlerChrysler automatic transmissions.

Dexron II fluid IS NOT recommended. Clutch chatter can result from the use of improper fluid.

Mopar® ATF +4, type 9602, Automatic Transmission Fluid when new is red in color. The ATF is dyed red so it can be identified from other fluids used in the vehicle such as engine oil or antifreeze. The red color is not permanent and is not an indicator of fluid

FLUID TYPES (Continued)

condition. As the vehicle is driven, the ATF will begin to look darker in color and may eventually become brown. **This is normal.** ATF+4 also has a unique odor that may change with age. Consequently, odor and color cannot be used to indicate the fluid condition or the need for a fluid change.

FLUID ADDITIVES

DaimlerChrysler strongly recommends against the addition of any fluids to the transmission, other than those automatic transmission fluids listed above. Exceptions to this policy are the use of special dyes to aid in detecting fluid leaks.

Various "special" additives and supplements exist that claim to improve shift feel and/or quality. These additives and others also claim to improve converter clutch operation and inhibit overheating, oxidation, varnish, and sludge. These claims have not been supported to the satisfaction of DaimlerChrysler and these additives **must not be used.** The use of transmission "sealers" should also be avoided, since they may adversely affect the integrity of transmission seals.

DESCRIPTION - AUTOMATIC TRANSMISSION FLUID - W5J400

NOTE: Refer to Service Procedures in this group for fluid level checking procedures.

Shell® 3403 Automatic Transmission Fluid is the recommended fluid for the W5J400 DaimlerChrysler automatic transmission.

Dexron II fluid IS NOT recommended. Clutch chatter can result from the use of improper fluid.

Shell® 3403 Automatic Transmission Fluid when new is red in color. The ATF is dyed red so it can be identified from other fluids used in the vehicle such as engine oil or antifreeze. The red color is not permanent and is not an indicator of fluid condition. As the vehicle is driven, the ATF will begin to look darker in color and may eventually become brown. **This is normal.**

FLUID ADDITIVES

DaimlerChrysler strongly recommends against the addition of any fluids to the transmission, other than those automatic transmission fluids listed above. Exceptions to this policy are the use of special dyes to aid in detecting fluid leaks.

Various "special" additives and supplements exist that claim to improve shift feel and/or quality. These additives and others also claim to improve converter clutch operation and inhibit overheating, oxidation, varnish, and sludge. These claims have not been supported to the satisfaction of DaimlerChrysler and these additives **must not be used.** The use of transmission "sealers" should also be avoided, since they may adversely affect the integrity of transmission seals.

DESCRIPTION - ENGINE OIL - DIESEL ENGINES

Use only Diesel Engine Oil meeting standard **MIL-2104C** or API Classification **CD or higher** or **CCML D4, D5**.

SAE VISCOSITY GRADE

CAUTION: Low viscosity oils must have the proper API quality or the CCMC G5 designation.

To assure of properly formulated engine oils, it is recommended that SAE Grade 10W-40 engine oils that meet Chrysler material standard MS-6395, be used. European Grade 10W-40 oils are also acceptable.

Oils of the SAE 5W-40 or 8W-80 grade number are preferred when minimum temperatures consistently fall below -12°C.

OPERATION - AUTOMATIC TRANSMISSION FLUID

The automatic transmission fluid is selected based upon several qualities. The fluid must provide a high level of protection for the internal components by providing a lubricating film between adjacent metal components. The fluid must also be thermally stable so that it can maintain a consistent viscosity through a large temperature range. If the viscosity stays constant through the temperature range of operation, transmission operation and shift feel will remain consistent. Transmission fluid must also be a good conductor of heat. The fluid must absorb heat from the internal transmission components and transfer that heat to the transmission case.

FLUID FILL/CHECK LOCATIONS

INSPECTION - FLUID FILL/CHECK LOCATIONS

The fluid fill/check locations and lubrication points are located in each applicable group.

MAINTENANCE SCHEDULES

DESCRIPTION

"Maintenance Schedule Information not included in this section, is located in the appropriate Owner's Manual."

LIFT POINTS

STANDARD PROCEDURE - HOISTING AND JACKING RECOMMENDATIONS

FLOOR JACK

When properly positioned, a floor jack can be used to lift a WJ vehicle (Fig. 7). Support the vehicle in the raised position with jack stands at the front and rear ends of the frame rails.

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

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

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. 7).

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.

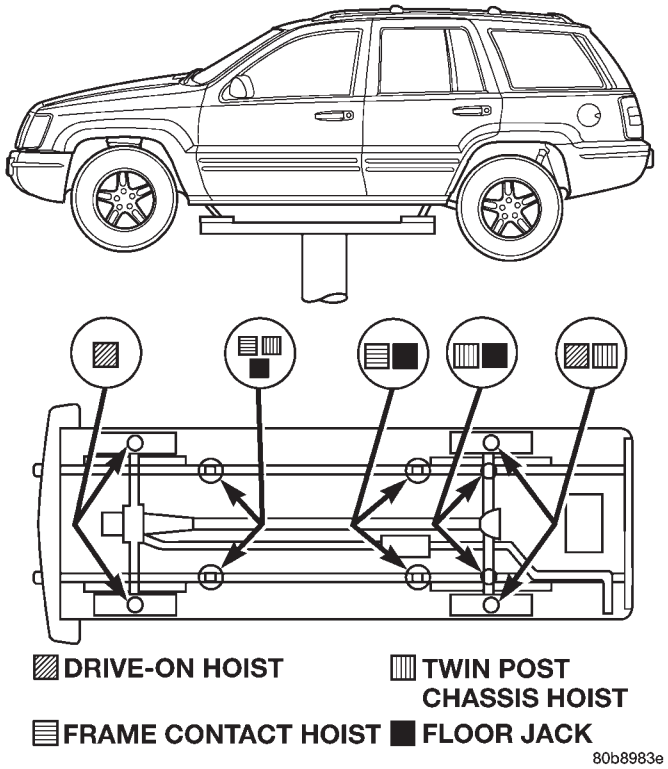

Fig. 7 Correct Vehicle Lifting Locations

JUMP STARTING

STANDARD PROCEDURE - JUMP STARTING

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.

JUMP STARTING (Continued)

(2) When using another vehicle as a booster source, park the booster vehicle within cable reach. Turn off all accessories, set the parking brake, place the automatic transmission in PARK or the manual transmission in NEUTRAL and turn the ignition OFF.

(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. 8).

(6) Start the engine in the vehicle which has the booster battery, let the engine idle a few minutes, then start the engine in the vehicle with the discharged battery.

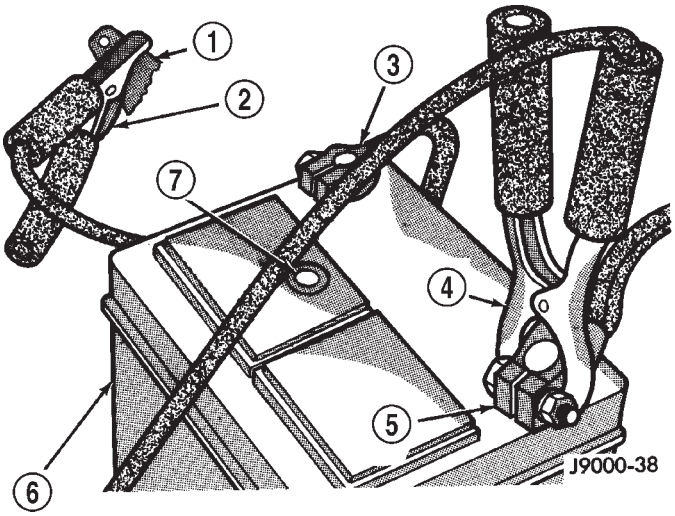

Fig. 8 Jumper Cable Clamp Connections

1 - ENGINE GROUND
2 - NEGATIVE JUMPER CABLE
3 - BATTERY NEGATIVE CABLE
4 - POSITIVE JUMPER CABLE
5 - BATTERY POSITIVE CABLE
6 - BATTERY
7 - TEST INDICATOR

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

(7) 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.

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.

EMERGENCY TOW HOOKS

DESCRIPTION

WARNING: REMAIN AT A SAFE DISTANCE FROM A VEHICLE THAT IS BEING TOWED VIA ITS TOW HOOKS. THE TOW STRAPS/CHAINS COULD BREAK AND CAUSE SERIOUS INJURY.

Some Jeep vehicles are equipped with front emergency tow hooks (Fig. 9). The tow hooks should be used for **EMERGENCY**purposes only.

CAUTION: DO NOT use emergency tow hooks for tow truck hook-up or highway towing.

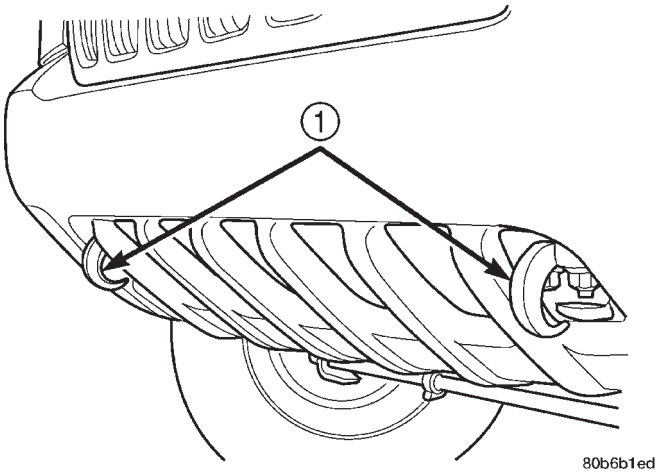

Fig. 9 Emergency Tow Hooks

1 - TOW HOOK

TOWING

STANDARD PROCEDURE - TOWING RECOMMENDATIONS

A vehicle equipped with SAE approved wheel lift-type towing equipment can be used to tow WJ vehicles. When towing a 4WD vehicle using a wheel-lift towing device, use tow dollies under the opposite end of the vehicle. A vehicle with flatbed device can also be used to transport a disabled vehicle (Fig. 10).

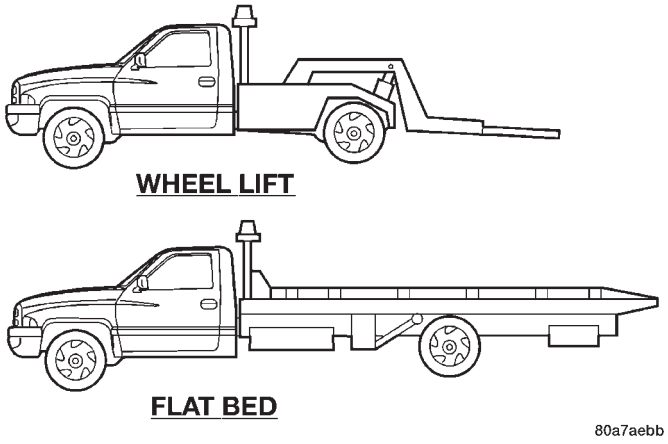

Fig. 10 Tow Vehicles With Approved Equipment

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.
- 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, or J-hooks to a bumper, steering linkage, drive shafts or a non-reinforced frame hole.
- Do not tow a heavily loaded vehicle. Use a flatbed device to transport a loaded vehicle.

TWO-WHEEL-DRIVE VEHICLE TOWING

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

WARNING: WHEN TOWING A DISABLED VEHICLE AND THE DRIVE WHEELS ARE SECURED IN A WHEEL LIFT OR TOW DOLLIES, ENSURE THE TRANSMISSION IS IN THE PARK POSITION (AUTOMATIC TRANSMISSION) OR A FORWARD DRIVE GEAR (MANUAL TRANSMISSION).

WARNING: ENSURE VEHICLE IS ON A LEVEL SURFACE OR THE WHEELS ARE BLOCKED TO PREVENT VEHICLE FROM ROLLING.

TWO WHEEL DRIVE TOWING-REAR END LIFTED

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

2WD vehicles can be towed with the front wheels on the surface for extended distances at speeds not exceeding 48 km/h (30 mph).

(1) Attach wheel lift device to rear wheels.
(2) Place the transmission in neutral.
(3) Raise vehicle to towing position.
(4) Attach safety chains. Route chains so not to interfere with tail pipe when vehicle is lifted.
(5) Turn the ignition switch to the OFF position to unlock the steering wheel.

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

(6) Secure steering wheel in straight ahead position with a clamp device designed for towing.
(7) Place transmission in park.

TWO WHEEL DRIVE TOWING-FRONT END LIFTED

CAUTION: Many vehicles are equipped with air dams, spoilers, and/or ground effect panels. To avoid component damage, a wheel-lift towing vehicle or a flat-bed hauling vehicle is recommended.

(1) Attach wheel lift device to rear wheels.
(2) Place the transmission in neutral.
(3) Raise the rear of the vehicle off the ground and install tow dollies under rear wheels.
(4) Attach wheel lift device to front wheels and raise vehicle to towing position.
(5) Attach the safety chains.

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

TOWING (Continued)

(6) Turn the ignition switch to the OFF position to unlock the steering wheel.
(7) Secure steering wheel in straight ahead position with a clamp device designed for towing.
(8) Place transmission in park.

FOUR-WHEEL-DRIVE VEHICLE TOWING

DaimlerChrysler Corporation recommends that a 4WD vehicle be transported on a flat-bed device. A Wheel-lift device can be used provided **the trailing wheels are off the ground and positioned in tow dollies.**

WARNING: WHEN TOWING A DISABLED VEHICLE AND THE DRIVE WHEELS ARE SECURED IN A WHEEL LIFT OR TOW DOLLIES, ENSURE THE TRANSMISSION IS IN THE PARK POSITION.

CAUTION: Many vehicles are equipped with air dams, spoilers, and/or ground effect panels. To avoid component damage, a wheel-lift towing vehicle or a flat-bed hauling vehicle is recommended.

FOUR WHEEL DRIVE TOWING—REAR END LIFTED

WARNING: ENSURE VEHICLE IS ON A LEVEL SURFACE OR THE WHEELS ARE BLOCKED TO PREVENT VEHICLE FROM ROLLING.

(1) Attach wheel lift device to front wheels.
(2) Place the transmission in neutral.
(3) Raise the front of the vehicle off the ground and install tow dollies under front wheels.
(4) Attach wheel lift device to rear wheels and raise vehicle to towing position.
(5) Attach safety chains. Route chains so not to interfere with tail pipe when vehicle is lifted.
(6) Turn the ignition switch to the OFF position to unlock the steering wheel.

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

(7) Secure steering wheel in straight ahead position with a clamp device designed for towing.
(8) Place transmission in park.

FOUR WHEEL DRIVE TOWING—FRONT END LIFTED

WARNING: ENSURE VEHICLE IS ON A LEVEL SURFACE OR THE WHEELS ARE BLOCKED TO PREVENT VEHICLE FROM ROLLING.

(1) Attach wheel lift device to rear wheels.
(2) Place the transmission in neutral.
(3) Raise the rear of the vehicle off the ground and install tow dollies under rear wheels.
(4) Attach wheel lift device to front wheels and raise vehicle to towing position.
(5) Attach the safety chains.

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

(6) Turn the ignition switch to the OFF position to unlock the steering wheel.
(7) Secure steering wheel in straight ahead position with a clamp device designed for towing.
(8) Place transmission in park.

COOLING - 2.7L DIESEL

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COOLING - 2.7L DIESEL

OPERATION—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 to circulate coolant throughout the system.

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - 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:

- 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.

TRAILER TOWING:

Consult Trailer Towing section of owners manual. Do not exceed limits.

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.

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 7 - COOLING - DIAGNOSIS AND TESTING)

DIAGNOSIS AND TESTING - COOLING SYSTEM

COOLING SYSTEM DIAGNOSIS—DIESEL ENGINE

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATUREGAUGE READS LOW	1. Vehicle is equipped with a heavy duty cooling system.	1. None. System operating normaly.
	2. Temperature gauge not connected	2. Connect gauge.
	3. Temperature gauge connected but not operating.	3. Check gauge. Refer (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - DIAGNOSIS AND TESTING)
	4. Coolant level low.	4. Fill cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE)
TEMPERATURE GAUGE READS HIGH. COOLANT MAY OR MAY NOT BE LEAKING FROM SYSTEM	1. Vehicle overloaded, high ambient (outside) temperatures with A/C turned on, stop and go driving or prolonged operation at idle speeds.	1. Temporary condition, repair not required. Notify customer of vehicle operation instructions located in Owners Manual.
	2. Temperature gauge not functioning correctly.	2. Check gauge. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - DIAGNOSIS AND TESTING)
	3. Air traped in cooling	3. Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE) and refill (Refer to 7 - COOLING - STANDARD PROCEDURE)
	4. Radiator cap faulty.	4. Replace radiator cap.
	5. Plugged A/C or radiator cooling fins.	5. Clean all debre away from A/C and radiator cooling fins.
	6. Coolant mixture incorrect.	6. Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE) refill with correct mixture (Refer to 7 - COOLING - STANDARD PROCEDURE).
	7. Thermostat stuck shut.	7. Replace thermostat.
	8. Bug screen or winter front being used.	8. Remove bug screen or winter front.
	9. Viscous fan drive not operating properly.	9. Check viscous fan (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - DIAGNOSIS AND TESTING)
	10. Cylinder head gasket leaking.	10. Check for leaking head gaskets (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).
	11. Heater core leaking.	11. Replace heater core.
	12. cooling system hoses leaking.	12. Tighten clamps or Replace hoses.
	13. Brakes dragging.	13. Check brakes. (Refer to 5 - BRAKES/HYDRAULIC/MECHANICAL - DIAGNOSIS AND TESTING)

COOLING - 2.7L DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READING INCONSISTENT (ERRATIC, CYCLES OR FLUCTUATES)	1. Heavy duty cooling system, extream cold ambient (outside) temperature or heater blower motor in high position.	1. None. System operating normaly.
	2. Temperature gauge or gauge sensor defective.	2. Check gauge. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - DIAGNOSIS AND TESTING)
	3. Temporary heavy usage or load.	3. None. Normal condition.
	4. Air traped in cooling system.	4. Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
	5. Water pump	5. Replace water pump.
	6. Air leak on suction side of water pump.	6. Check for leak. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING)
RADIATOR CAP LEAKING STEAM AND /OR COOLANT INTO RESERVOIR BOTTLE. (TEMPERATURE GAUGE MAY READ HIGH)	1. Radiator cap defective.	1. Replace radiator cap.
	2. Radiator neck surface damaged.	2. Replace radiator.
HOSE OR HOSES COLLAPSE WHEN ENGINE IS COOLING.	1. Vacuum created in cooling system on engine cool-down is not being relieved through coolant reservior/overflow system.	1. Replace radiator cap, check vent hose between radiator and reservoir bottle for blockage also check reservoir bottle vent for blockage.
NOISY FAN	1. Fan blade(s) loose, damaged.	1. Replace fan blade assembly.
	2. Thermal viscous fan drive.	2. None. Normal condition.
	3. Fan blades striking surrounding objects.	3. Locate contact point and repair as necessary.
	4. Thermal viscous fan drive bearing.	4. Replace viscous fan drive assembly.
	5. Obstructed air flow through radiator.	5. Remove obstruction.
INADEQUATE AIR CONDITIONER PERFORMANCE (COOLING SYSTEM SUSPECTED)	1. Radiator and/or A/C condenser air flow obstructed.	1. Remove obstruction and/or clean.
	2. Thermal viscous fan drive not working.	2. Check fan drive. (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - DIAGNOSIS AND TESTING)
	3. Air seals around radiator damaged or missing.	3. Inspect air seals, repair or replace as necessary.

COOLING - 2.7L DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
INADEQUATE HEATER PERFORMANCE. GUAGE MAY OR MAY NOT READ LOW.	1. Heavy duty cooling system, and cooler ambient temperatures.	1. None. Normal condition.
	2. Obstruction in heater hoses.	2. Remove hoses, remove obstruction.
	3. Water pump damaged.	3. Replace water pump.
HEAT ODOR	1. Damaged or missing drive line heat shields.	1. Repair or replace damaged or missing heat shields.
	2. Thermal viscous fan drive damaged.	2. Check thermal viscous fan drive. (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - DIAGNOSIS AND TESTING)

ACCESSORY DRIVE

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DRIVE BELTS

DIAGNOSIS AND TESTING - ACCESSORY DRIVE BELT

VISUAL DIAGNOSIS

When diagnosing serpentine accessory drive belts, small cracks that run across the ribbed surface of the belt from rib to rib (Fig. 1), are considered normal. These are not a reason to replace the belt. However, cracks running along a rib (not across) are **not** normal. Any belt with cracks running along a rib must be replaced (Fig. 1). Also replace the belt if it has excessive wear, frayed cords or severe glazing.

Refer to ACCESSORY DRIVE BELT DIAGNOSIS CHART for further belt diagnosis.

NOISE DIAGNOSIS

Noises generated by the accessory drive belt are most noticeable at idle. Before replacing a belt to resolve a noise condition, inspect all of the accessory drive pulleys for contamination, alignment, glazing, or excessive end play.

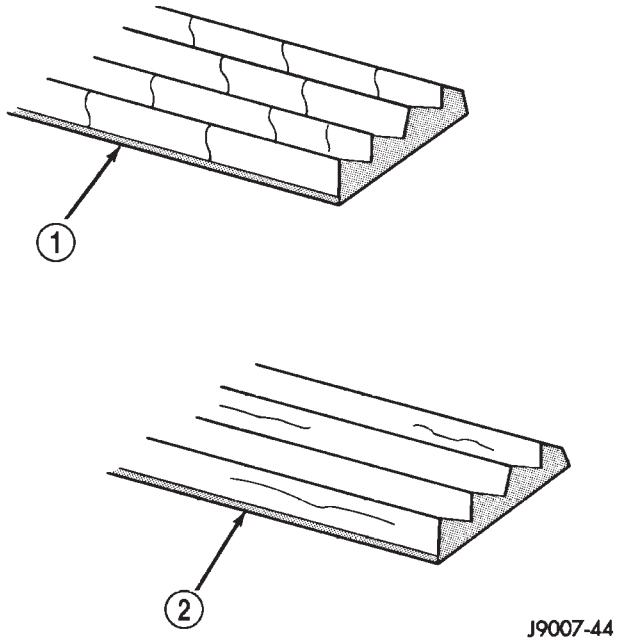

Fig. 1 Belt Wear Patterns

1 - NORMAL CRACKS BELT OK
2 - NOT NORMAL CRACKS REPLACE BELT

DRIVE BELTS (Continued)

ACCESSORY DRIVE BELT DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
RIB CHUNKING (One or more ribs has separated from belt body)	1. Foreign objects imbedded in pulley grooves.	1. Remove foreign objects from pulley grooves. Replace belt.
	2. Installation damage	2. Replace belt
RIB OR BELT WEAR	1. Pulley misaligned	1. Align pulley(s)
	2. Abrasive environment	2. Clean pulley(s). Replace belt if necessary
	3. Rusted pulley(s)	3. Clean rust from pulley(s)
	4. Sharp or jagged pulley groove tips	4. Replace pulley. Inspect belt.
	5. Belt rubber deteriorated	5. Replace belt
BELT SLIPS	1. Belt slipping because of insufficient tension	1. Inspect/Replace tensioner if necessary
	2. Belt or pulley exposed to substance that has reduced friction (belt dressing, oil, ethylene glycol)	2. Replace belt and clean pulleys
	3. Driven component bearing failure (seizure)	3. Replace faulty component or bearing
	4. Belt glazed or hardened from heat and excessive slippage	4. Replace belt.
LONGITUDAL BELT CRACKING	1. Belt has mistracked from pulley groove	1. Replace belt
	2. Pulley groove tip has worn away rubber to tensile member	2. Replace belt
″GROOVE JUMPING″ (Belt does not maintain correct position on pulley)	1. Incorrect belt tension	1. Inspect/Replace tensioner if necessary
	2. Pulley(s) not within design tolerance	2. Replace pulley(s)
	3. Foreign object(s) in grooves	3. Remove foreign objects from grooves
	4. Pulley misalignment	4. Align component
	5. Belt cordline is broken	5. Replace belt
BELT BROKEN (Note: Identify and correct problem before new belt is installed)	1. Incorrect belt tension	1. Replace Inspect/Replace tensioner if necessary
	2. Tensile member damaged during belt installation	2. Replace belt
	3. Severe misalignment	3. Align pulley(s)
	4. Bracket, pulley, or bearing failure	4. Replace defective component and belt

DRIVE BELTS (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISE (Objectional squeal, squeek, or rumble is heard or felt while drive belt is in operation)	1. Incorrect belt tension	1. Inspect/Replace tensioner if necessary
	2. Bearing noise	2. Locate and repair
	3. Belt misalignment	3. Align belt/pulley(s)
	4. Belt to pulley mismatch	4. Install correct belt
	5. Driven component induced vibration	5. Locate defective driven component and repair
	6. System resonent frequency induced vibration	6. Vary belt tension within specifications
TENSION SHEETING FABRIC FAILURE (Woven fabric on outside, circumference of belt has cracked or separated from body of belt)	1. Tension sheeting contacting stationary object	1. Correct rubbing condition
	2. Excessive heat causing woven fabric to age	2. Replace belt
	3. Tension sheeting splice has fractured	3. Replace belt
CORD EDGE FAILURE (Tensile member exposed at edges of belt or separated from belt body)	1. Incorrect belt tension	1. Inspect/Replace tensioner if necessary
	2. Belt contacting stationary object	2. Replace belt
	3. Pulley(s) out of tolerance	3. Replace pulley
	4. Insufficient adhesion between tensile member and rubber matrix	4. Replace belt

REMOVAL

CAUTION: Do not attempt to check belt tension with a belt tension gauge on vehicles equipped with an automatic belt tensioner.

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.

(1) A 3/8 inch square hole is provided in the automatic belt tensioner. 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 the accessory drive belt, the belt must be the correct length and routed correctly. If not, engine may overheat due to water pump rotating in wrong direction.

(1) Position drive belt over all pulleys **except** water pump pulley (Fig. 2).

(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.

DRIVE BELTS (Continued)

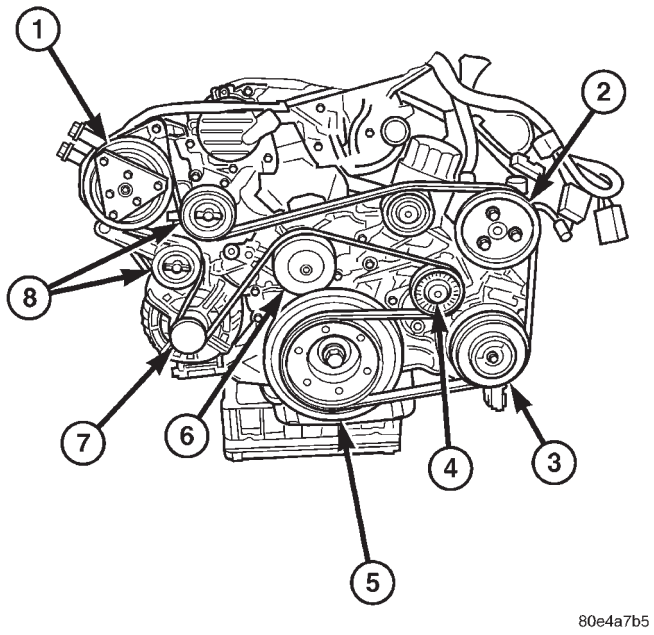

Fig. 2 ACCESSORY BELT ROUTING

1 - VISCOUS HEATER
2 - POWER STEERING PUMP
3 - AC COMPRESSOR
4 - AUTOMATIC BELT TENSIONER
5 - VIBRATION DAMPER/CRANKSHAFT PULLEY
6 - WATER PUMP PULLEY
7 - GENERATOR
8 - IDLER PULLEYS

BELT TENSIONERS

DESCRIPTION

CAUTION: Do not attempt to check belt tension with a belt tension gauge on vehicles equipped with an automatic belt tensioner.

Drive belts on all engines are equipped with a spring loaded automatic belt tensioner. This tensioner maintains constant belt tension at all times and requires no maintenance or adjustment.

OPERATION

WARNING: THE AUTOMATIC BELT TENSIONER ASSEMBLY IS SPRING LOADED. DO NOT ATTEMPT TO DISASSEMBLE THE TENSIONER ASSEMBLY.

The automatic belt tensioner maintains correct belt tension using a coiled spring within the tensioner housing. The spring applies pressure to the tensioner arm pressing the arm into the belt, tensioning the belt.

If a new belt is being installed, the arrow must be within approximately 3 mm (1/8 in.) of indexing mark. 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.

ENGINE

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COOLANT

DESCRIPTION

Coolant flows through the engine water jackets and cylinder heads absorbing heat produced by the engine during operation. The coolant carries heat to the radiator and heater core. Here it is transferred to ambient air passing through the radiator and heater core fins.

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 antifreeze 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 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. It's 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-

COOLANT (Continued)

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.

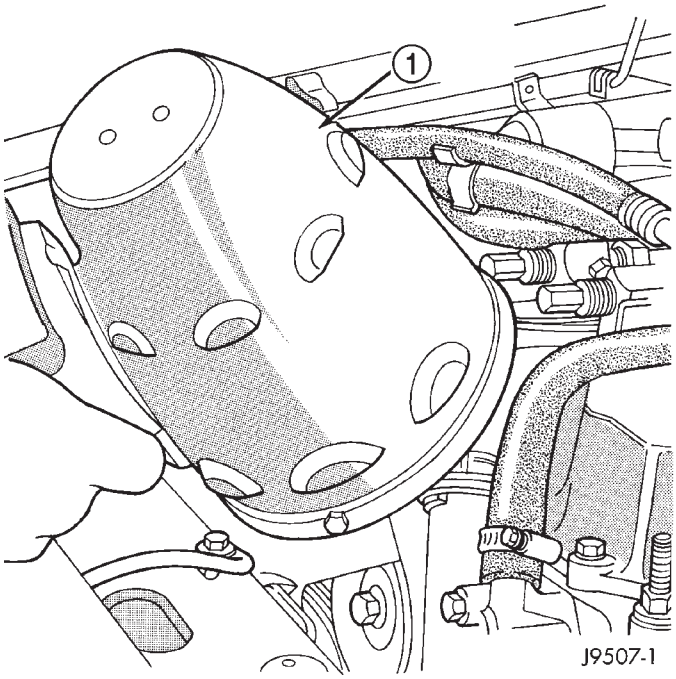

Fig. 1 Leak Detection Using Black Light—Typical
1 - TYPICAL BLACK LIGHT TOOL

DIAGNOSIS AND TESTING - COOLING SYSTEM LEAKS

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. 1).

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 coolant recovery pressure container cap and check coolant level. Push down on cap to disengage it from stop tabs. Wipe inside of container and examine lower inside sealing seat for nicks, cracks, paint, dirt and solder residue. Inspect radiator-to- pressure container hose for internal obstructions. Insert a wire through the hose to be sure it is not obstructed.

Inspect cams on outside of pressure container. If cams are damaged, seating of pressure cap valve and tester seal will be affected.

Attach pressure tester (7700 or an equivalent) to coolant pressure container (Fig. 2).

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 cannot 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

COOLANT (Continued)

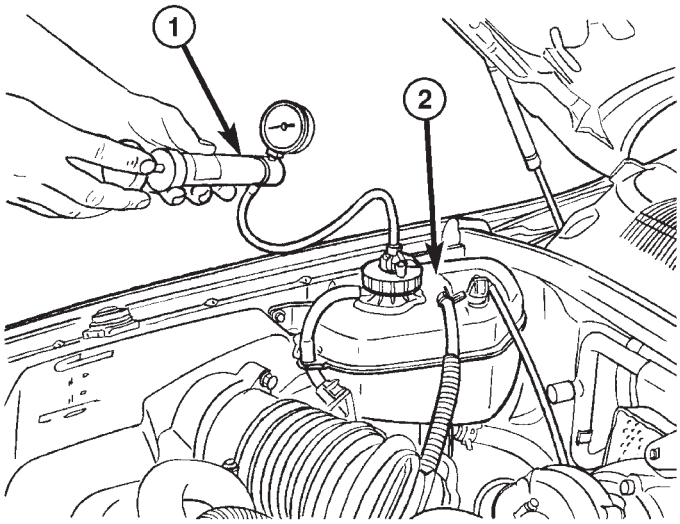

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Fig. 2 PRESSURE TESTING COOLING SYSTEM

1 - COOLANT PRESSURE TESTER
2 - COOLANT PRESSURE CONTAINER

leaks are not visible, inspect for internal leakage. Large radiator leak holes should be repaired by a reputable radiator repair shop.

INTERNAL LEAKAGE INSPECTION

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.

WARNING: WITH RADIATOR 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 coolant container until thermostat opens. Attach a Pressure Tester to container. 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 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 available 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 and suitably marked container for reuse.

WARNING: DO NOT REMOVE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN RADIATOR DRAIN WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

Drain sufficient coolant to allow thermostat removal.

Remove accessory drive belt.

Add coolant to pressure container 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 draincock immediately after test to eliminate boil over.

Start engine and accelerate rapidly three times, to approximately 3000 rpm 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.

STANDARD PROCEDURE

STANDARD PROCEDURE - ADDING ADDITIONAL COOLANT

The use of aluminum cylinder blocks, cylinder heads and water pumps requires special corrosion protection. Only Mopar® Antifreeze/Coolant, 5

COOLANT (Continued)

Year/100,000 Mile Formula (glycol base coolant with corrosion inhibitors called HOAT, for Hybrid Organic Additive Technology) is recommended. This coolant offers the best engine cooling without corrosion when mixed with 50% distilled water to obtain to obtain a freeze point of -37°C (-35°F). If it loses color or becomes contaminated, drain, flush, and replace with fresh properly mixed coolant solution.

CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

STANDARD PROCEDURE - DRAINING COOLING SYSTEM

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN THE RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

(1) DO NOT remove coolant recovery pressure container cap first. With engine cold, raise vehicle on a hoist and locate radiator draincock.

NOTE: Radiator draincock is located on the right/ lower side of radiator facing to rear of vehicle.

(2) Attach one end of a hose to the draincock. Put the other end into a clean container. Open draincock and drain coolant from radiator. This will empty the coolant recovery pressure container first. The coolant does not have to be removed from the container unless the system is being refilled with a fresh mixture. When container is empty, remove cap and continue draining cooling system.

To drain the engine of coolant, remove the cylinder block drain plug located on the side of cylinder block.

STANDARD PROCEDURE - REFILLING COOLING SYSTEM

(1) Tighten the radiator drain and the cylinder block drain plug(s) (if removed).

(2) Fill system using a 50/50 mixture of ethyleneglycol antifreeze and low mineral content water. Fill radiator to top and add sufficient coolant to the coolant recovery pressure container to raise level to FULL mark.

(3) With heater control unit in the HEAT position, operate engine with container cap in place.

(4) After engine has reached normal operating temperature, shut engine off and allow it to cool. When engine is cooling down, coolant will be drawn into the radiator from the pressure container.

(5) Add coolant to pressure container as necessary. **Only add coolant to the container when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.** To purge the cooling system of all air, this heat up/cool down cycle (adding coolant to cold engine) must be performed three times. Add necessary coolant to raise container level to the FULL mark after each cool down period.

COOLANT RECOVERY PRESSURE CONTAINER

DESCRIPTION

A pressurized, plastic coolant container is used with this cooling system (Fig. 3). The container is located at the right-rear side of the engine compartment and is mounted as the highest point of the cooling system.

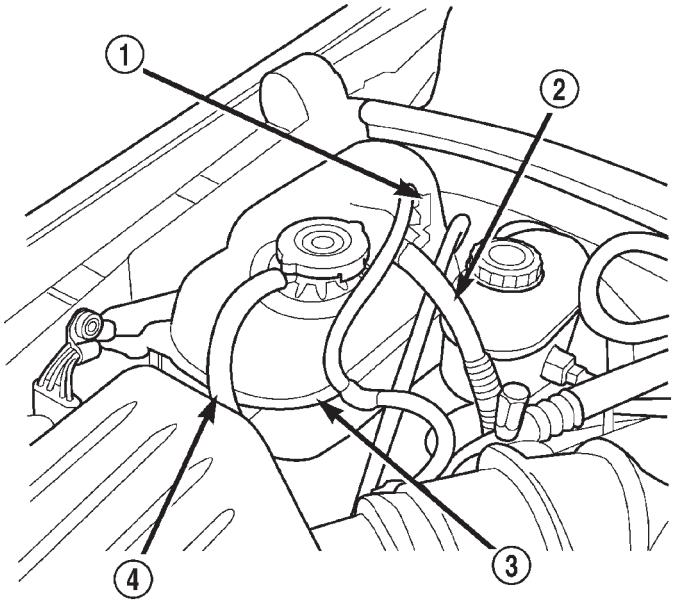

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Fig. 3 COOLANT RECOVERY PRESSURE CONTAINER

1 - LOW COOLANT LEVEL SENSOR
2 - COOLANT RECOVERY HOSE
3 - COOLANT RECOVERY PRESSURE CONTAINER
4 - OVERFLOW HOSE

OPERATION

The location of the container allows any air or vapor exceeding the pressure/vent cap rating to escape through the cap. Coolant flows through the container at all times during engine operation whether the engine is cold or at normal operating temperature. The coolant container is equipped with a pressure/vent cap. For more information (Refer to 7

COOLANT RECOVERY PRESSURE CONTAINER (Continued)

- COOLING/ENGINE/RADIATOR PRESSURE CAP - DESCRIPTION)

REMOVAL

WARNING: DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90C (194°F). OPEN CONTAINER SLOWLY AND RELEASE PRESSURE. STORE COOLANT IN PROPER CONTAINERS ONLY. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR. RISK OF INJURY TO SKIN AND EYES WITH HOT COOLANT WHICH SPLASHES OUT. RISK OF POISONING FROM SWALLOWING COOLANT.

NOTE: Turn container cap carefully as far as first detent, release pressure, then unscrew cap.

(1) Release cooling system pressure.
(2) Disconnect sensor electrical connector (Fig. 3).
(3) Remove radiator over flow hose (Fig. 3).
(4) Remove cooling system recovery hose (Fig. 3).
(5) Remove container retaining bolts.

INSTALLATION

(1) Position coolant container and install retaining bolts (Fig. 3).
(2) Properly route and install coolant recovery hose (Fig. 3).
(3) Properly route and install radiator overflow hose (Fig. 3).
(4) Connect sensor electrical connector (Fig. 3).
(5) Refill system with proper coolant mixture to proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(6) Start engine and inspect for leaks.

ENGINE COOLANT TEMP SENSOR

REMOVAL

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING WITH HOT COOLANT. RISK OF POISONING FROM SWALLOWING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90°C. OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN SUITABLE AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHES AND EYE WEAR.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Partailly drain coolant system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Unplug coolant temperature sensor electrical connector.

NOTE: Capture any residual coolant that may flow.

(5) Remove coolant temperature sensor (Fig. 4).

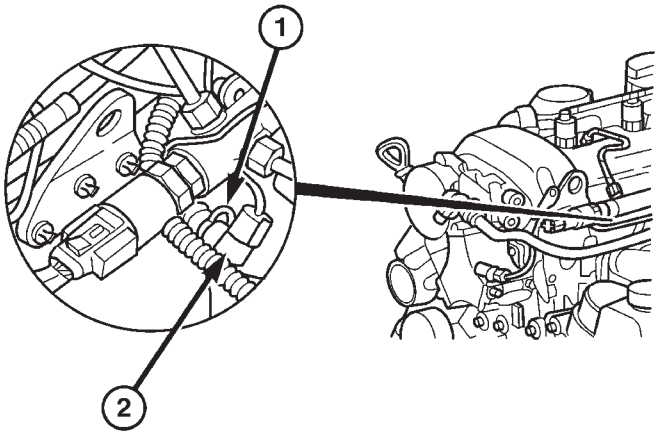

Fig. 4 ENGINE COOLANT TEMPERATURE SENSOR

1 - RETAINING CLAMP
2 - ENGINE COOLANT TEMPERATURE SENSOR

INSTALLATION

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING WITH HOT COOLANT. RISK OF POISONING FROM SWALLOWING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN SUITABLE AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHES AND EYE WEAR.

(1) Position and install coolant temperature sensor (Fig. 4).
(2) Connect coolant temperature sensor electrical connector (Fig. 4).
(3) Refill coolant system to proper level with proper mixture of coolant (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(5) Connect negative battery cable.

ENGINE COOLANT TEMP SENSOR (Continued)

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

ENGINE COOLANT THERMOSTAT

REMOVAL

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING WITH HOT COOLANT. RISK OF POISONING FROM SWALLOWING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN SUITABLE AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHES AND EYE WEAR.

NOTE: Inspect condition of all clamps and hoses, replace as necessary.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Drain engine coolant (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Remove bracket for fuel line.
(5) Remove coolant hoses and vent hose from thermostat housing.
(6) Remove thermostat housing (Fig. 5).
(7) Remove thermostat from housing.
(8) Clean all sealing surfaces.

INSTALLATION

(1) Clean all sealing surfaces.
(2) Position thermostat in housing and install thermostat housing (Fig. 5). Tighten bolts to 9N·m (80 lbs.in.).

NOTE: Inspect condition of all clamps and hoses, replace as necessary.

(3) Connect coolant hoses and vent hose (Fig. 5).
(4) Install bracket for fuel line (Fig. 5).
(5) Close coolant drain.
(6) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(7) Connect negative battery cable.

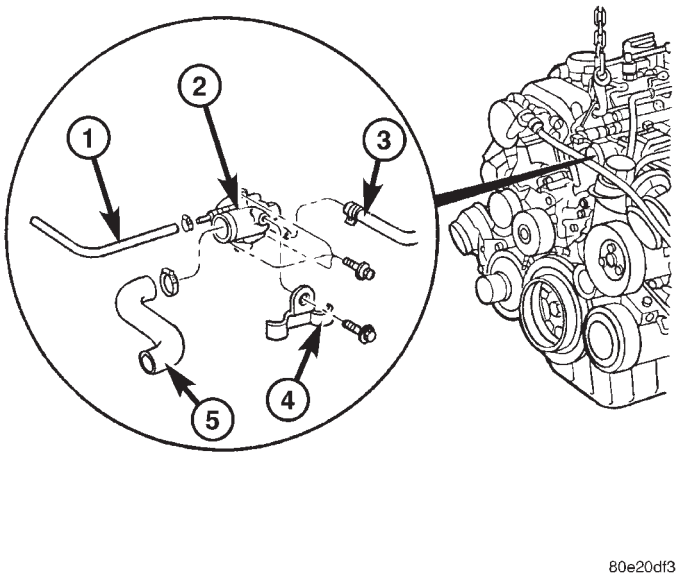

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Fig. 5 THERMOSTAT ASSEMBLY

1 - VENT HOSE
2 - THERMOSTAT HOUSING
3 - COOLANT HOSE
4 - FUEL LINE BRACKET
5 - UPPER RADIATOR HOSE

(8) Fill coolant system to proper level with appropriate coolant mixture (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(9) Start engine and inspect for leaks.

WATER PUMP

REMOVAL

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING WITH HOT COOLANT. RISK OF POISONING FROM SWALLOWING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN SUITABLE AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHES AND EYE WEAR.

(1) Disconnect negative battery cable.

WATER PUMP (Continued)

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Drain engine coolant (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(5) Disconnect coolant hoses at water pump.
(6) Remove idler pulley.
(7) Remove water pump and clean sealing surfaces (Fig. 6).

INSTALLATION

(1) Clean all sealing surfaces.
(2) Position and install waterpump (Fig. 6). Tighten M6 bolts to 14N·m (124 lbs. in.) and M8 bolts to 20N·m (177 lbs. in.).
(3) Install idler pulley. Tighten bolt to 35N·m (26 lbs. ft.).
(4) Install coolant hoses.
(5) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(6) Close coolant drain.
(7) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(8) Connect negative battery cable.
(9) Fill coolant system to proper level with the appropriate coolant mixture (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(10) Start engine and inspect for leaks.

RADIATOR FAN

DESCRIPTION

The hydraulic fan (Fig. 7) replaces both the electric fan and the engine driven mechanical fan. The hydraulic cooling fan is integral to the fan shroud and is located between the radiator and the engine.

The power steering pump supplies the hydraulic fluid and pressure to rotate the cooling fan blade, while the electrical portain of the fan is controlled by the electronic control module (ECM).

The hydraulic fan drive (motor) consists of the three major following components:

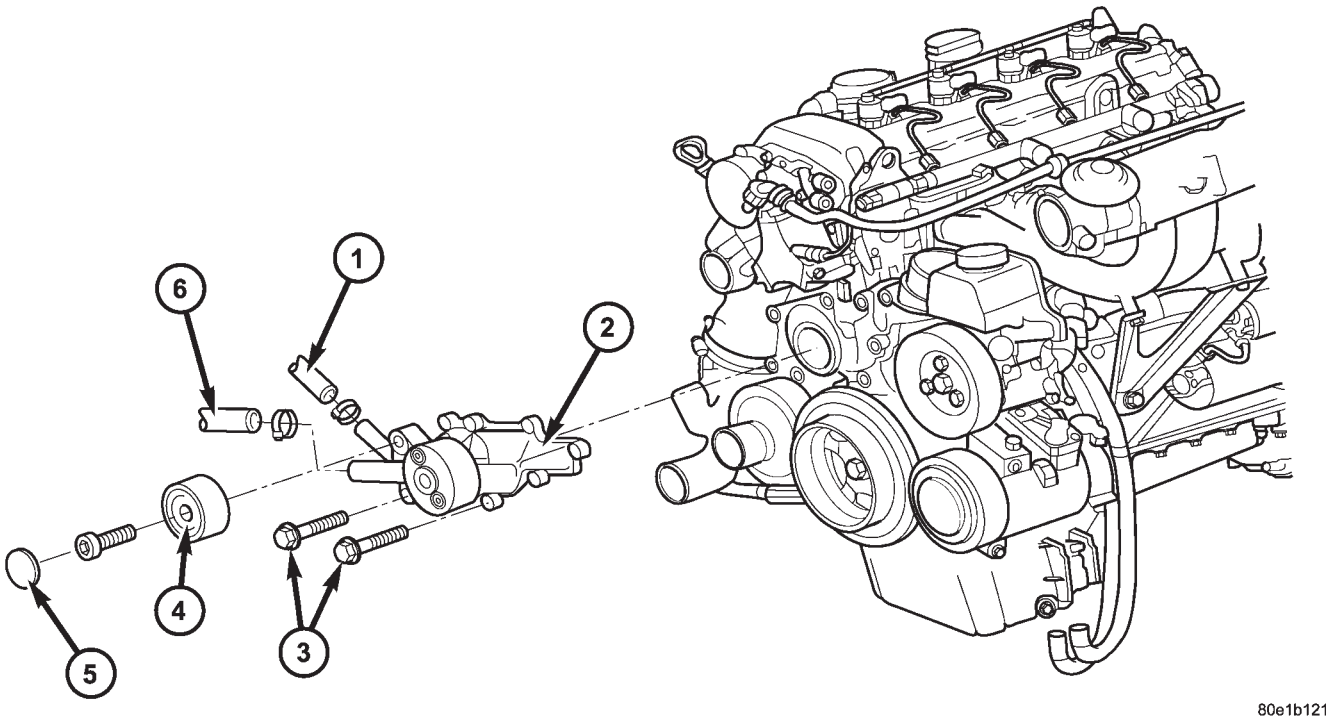

Fig. 6 WATER PUMP - TYPICAL

1 - COOLANT HOSE
2 - WATER PUMP
3 - WATER PUMP BOLTS
4 - IDLER PULLEY
5 - IDLER PULLEY CAP
6 - COOLANT HOSE

RADIATOR FAN (Continued)

- Steering flow control valve
- Fan control valve
- Two stage G-rotor hydraulic drive

The hydraulic fan and drive are not serviceable. Any failure of the fan blade, hydraulic fan drive or fan shroud requires replacement of the fan module. The fan blade and hydraulic fan drive are matched and balanced as a system and servicing either separately would disrupt this balance.

For hydraulic fluid routing information refer to (Fig. 8).

CAUTION: Do not attempt to service the hydraulic cooling fan or fan drive separately replace the cooling module as an assembly. Failure to do so may cause severe damage to the hydraulic cooling fan assembly.

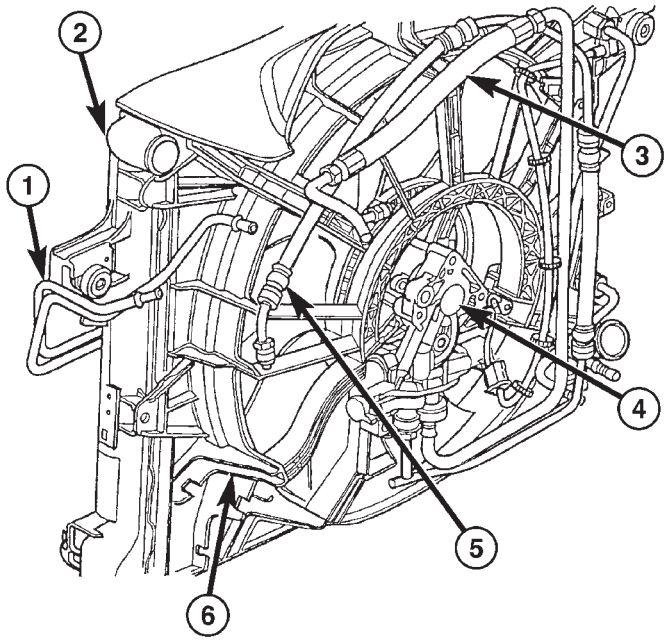

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Fig. 7 HYDRAULIC RADIATOR COOLING FAN AND FAN DRIVE

1 - POWER STEERING FLUID COOLER
2 - RADIATOR
3 - HIGH PRESSURE LINE FROM STEERING GEAR PUMP TO HYDRAULIC FAN MOTOR
4 - HYDRAULIC FAN MOTOR
5 - HIGH PRESSURE LINE FROM HYDRAULIC FAN MOTOR TO STEERING GEAR
6 - FAN SHROUD

OPERATION

The hydraulic radiator cooling fan replaces both the electric fan and the engine driven mechanical fan. The use of this hydraulic fan provides heavy trailer tow capability while at the same time reducing unnecessary power drain on both the engine and the vehicles electrical system.

HYDRAULIC FAN STRATEGY

The hydraulic radiator cooling fan is controlled by the Electronic Control Module (ECM). A PWM (Pulse Width Modulated) signal from the ECM controls the fan from 0 to 100% of the available fan speed. There are four inputs to the ECM that determine what speed percentage of fan is required by the vehicle. These inputs are:

- Engine Coolant Temperature
- Transmission Oil Temperature
- Battery Temperature
- A/C System Pressure

By monitoring these four parameters, the ECM can determine if cooling airflow is required. If airflow is required, the ECM will slowly ramp up (speed up) the fan speed until the operating parameter(s) are met for the driving condition. Once the temperature or pressure is reduced to within operating parameters, the fan will adjust or hold its speed to maintain the temperature / pressure requirements.

NOTE: If the ECM is not requesting fan on operation, the fan blade will spin between 100 and 500 RPM when the vehicle is at idle. This is due to a controlled minimum oil flow requirement through the fan drive motor.

ACTIVATING THE HYDRAULIC FAN WITH THE DRBIII®

Under the Engine Systems test heading, there is a subheading. “Hydraulic fan solenoid test”, that has the selections, on /off. Activating the fan with the DRBIII® will run the fan at 100% duty cycle, which will help troubleshoot any system problems, and also help with the deaeration procedure.

NOTE: Engine must be running to activate the fan with the DRBIII®.

RADIATOR COOLING FAN HYDRAULIC FLUID PATH

Hydraulic fluid is pumped from the power steering pump, though a high pressure delivery line, to the fan drive motor. As fluid is diverted through the G-rotors, rotational motion moves fluid from the high-pressure (inlet) side of the motor to the low-pressure (outlet) side. Fluid exiting the drive motor is divided into two paths. Path one continues through a high pressure delivery line to the steering gear, and path two sends fluid back to the power steering pump through a low pressure line. Fluid exits the steering gear under low pressure and travels through a low pressure line to the power steering fluid cooler before being returned back the power steering fluid reservoir (Fig. 7).

RADIATOR FAN (Continued)

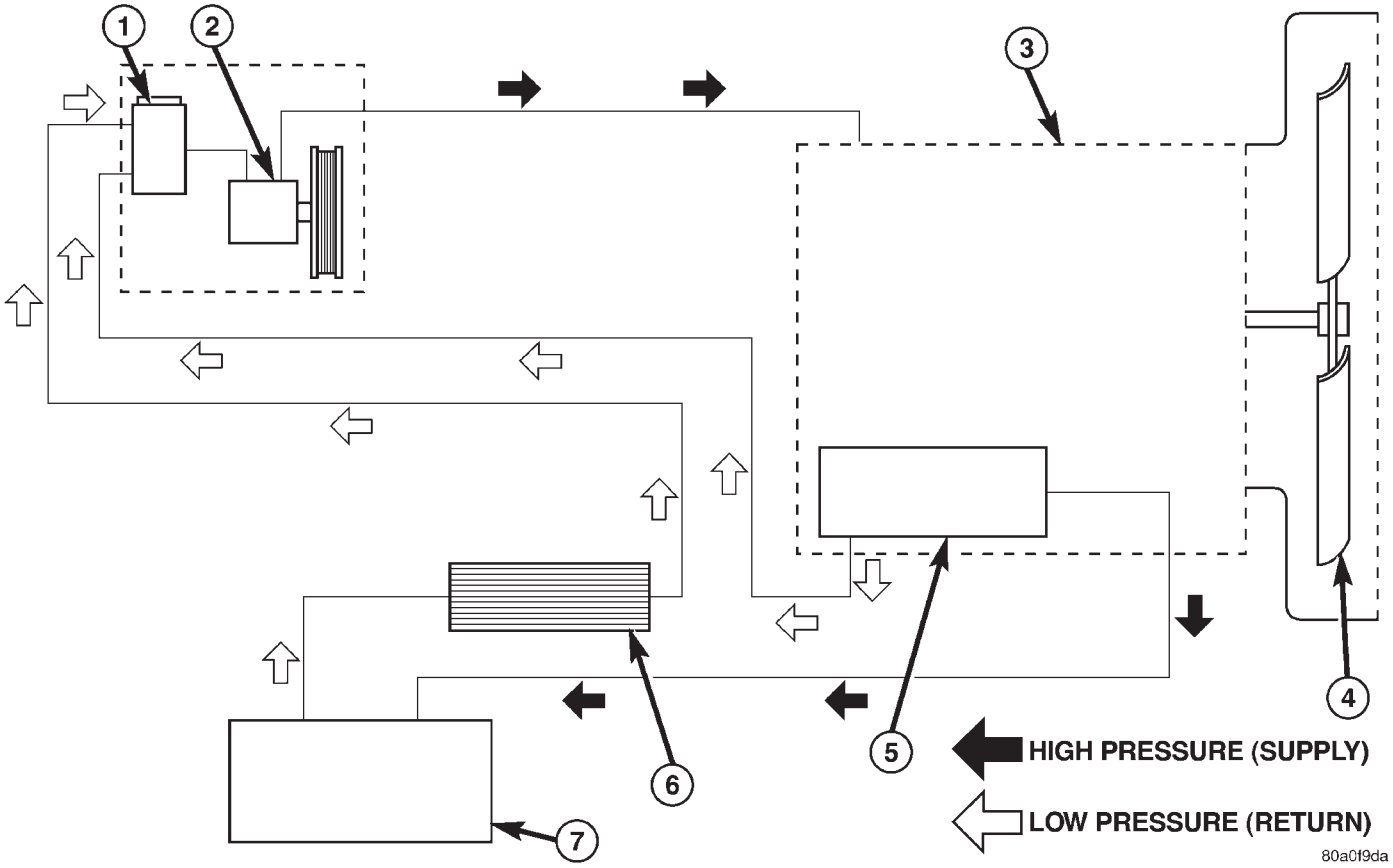

Fig. 8 HYDRAULIC FAN FLUID FLOW CIRCUIT

1 - POWER STEERING RESERVOIR
2 - POWER STEERING PUMP
3 - HYDRAULIC FAN DRIVE ASSEMBLY
4 - FAN BLADE
5 - HYDRAULIC FAN CONTROL SOLENOID
6 - POWER STEERING OIL COOLER
7 - STEERING GEAR

NOTE: There is a steering flow control valve located in the fan drive motor. Because of the design of the valve, steering assist can not be effected by the radiator cooling fan even during fan drive failure.

REMOVAL

(1) Raise vehicle on hoist.
(2) Drain cooling system.(Refer to 7 - COOLING - STANDARD PROCEDURE)

NOTE: The hydraulic fan drive is driven by the power steering pump. When removing lines or hoses from fan drive assembly use a drain pan to catch any power steering fluid that may exit the fan drive or the lines and hoses.

NOTE: When ever the high pressure line fittings are removed from the hydraulic fan drive the O-rings must be replaced.

(3) Disconnect two high pressure lines at hydraulic fan drive (Fig. 9). Remove and discard o-rings from line fittings.
(4) Disconnect low pressure return hose at hydraulic fan drive (Fig. 9).

NOTE: The lower mounting bolts can only be accessed from under vehicle.

(5) Remove two lower mounting bolts from the shroud (Fig. 11).
(6) Lower vehicle.
(7) Disconnect the electrical connector for the fan control solenoid.
(8) Disconnect the radiator upper hose at the radiator and position out of the way.
(9) Disconnect the power steering gear outlet hose and fluid return hose at the cooler (Fig. 10).
(10) Remove two upper mounting bolts from the shroud (Fig. 11).
(11) Remove the shroud and fan drive from vehicle.

RADIATOR FAN (Continued)

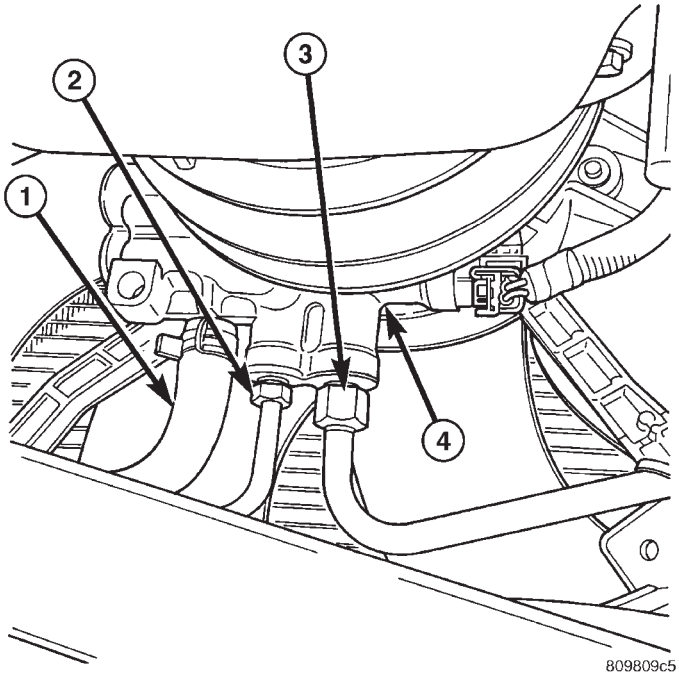

Fig. 9 HYDRAULIC LINES/HOSES AND ELECTRICAL CONNECTOR

1 - LOW PRESSURE RETURN HOSE
2 - HIGH PRESSURE LINE (OUTLET)
3 - HIGH PRESSURE LINE (INLET)
4 - HYDRAULIC FAN DRIVE

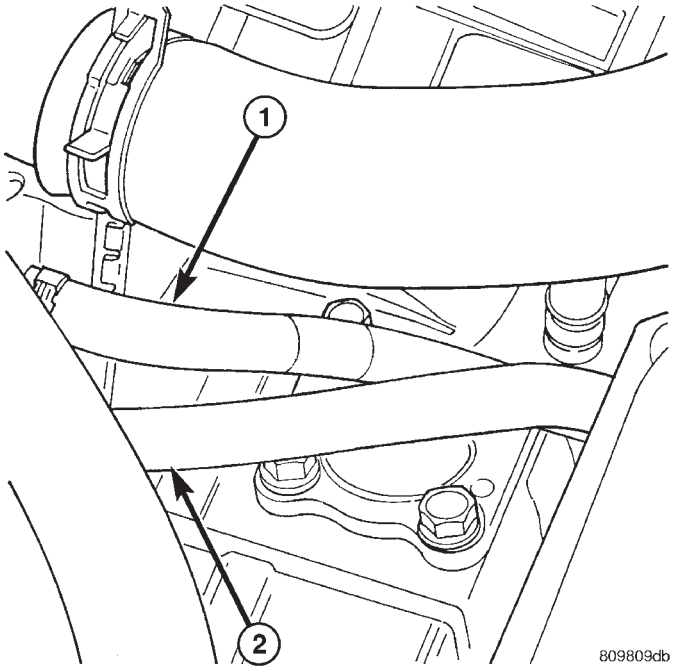

Fig. 10 POWER STEERING GEAR OUTLET AND RETURN HOSES

1 - POWER STEERING COOLER RETURN HOSE
2 - POWER STEERING COOLER SUPPLY HOSE

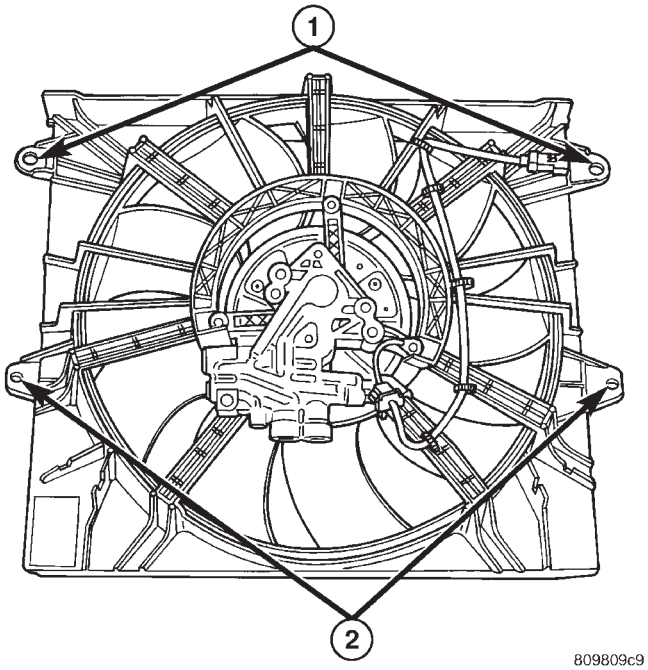

Fig. 11 FAN SHROUD MOUNTING BOLT LOCATIONS

1 - FAN SHROUD UPPER MOUNTING BOLT LOCATIONS
2 - FAN SHROUD LOWER MOUNTING BOLT LOCATIONS

INSTALLATION

CAUTION: There is an external ground wire connected to the hydraulic fan drive located at the electrical connector on the fan assembly. This ground MUST remain connected at all times. Failure to ensure ground before engine is operating can cause severe damage to the ECM.

(1) Position fan drive and shroud in vehicle.
(2) Install fan shroud upper mounting bolts. Do not tighten at this time.
(3) Install radiator upper hose onto radiator.
(4) Connect power steering cooler hoses.
(5) Raise vehicle on hoist.
(6) Install fan shroud lower mounting bolts. Tighten to 6 N·m (50 in. lbs.).

NOTE: When ever the high pressure line fittings are removed from the hydraulic fan drive the o-rings located on the fittings must be replaced.

(7) Lubricate the o-rings on the fittings with power steering fluid then connect inlet and outlet high pressure lines to fan drive (Fig. 12). Tighten inlet line to 49 N·m (36 ft. lbs.) tighten outlet line to 29 N·m (21.5 ft. lbs.).
(8) Connect low pressure return hose to fan drive (Fig. 12).
(9) Lower vehicle.

RADIATOR FAN (Continued)

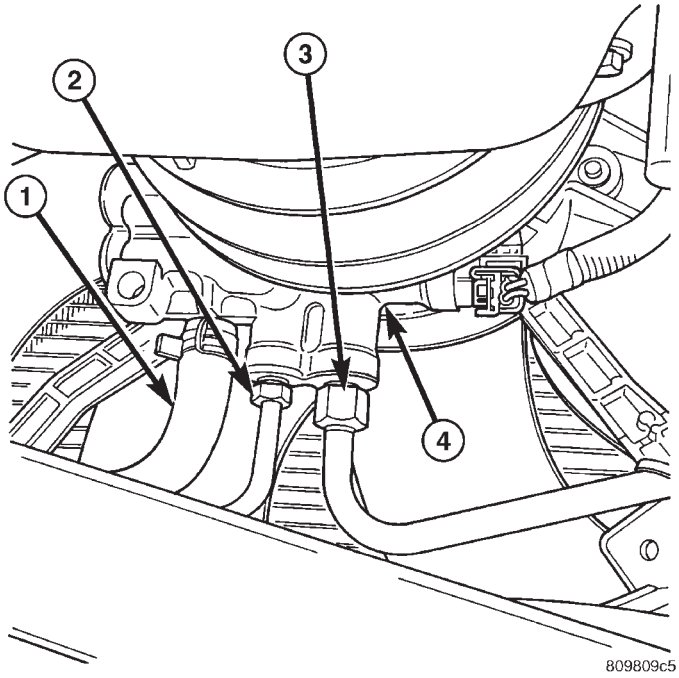

Fig. 12 HYDRAULIC LINES/HOSES AND ELECTRICAL CONNECTOR

1 - LOW PRESSURE RETURN HOSE
2 - HIGH PRESSURE LINE (OUTLET)
3 - HIGH PRESSURE LINE (INLET)
4 - HYDRAULIC FAN DRIVE

(10) Install radiator upper hose.

(11) Connect electrical connector for hydraulic fan control solenoid and assure ECM ground to fan assembly.

(12) Tighten fan shroud upper mounting bolts to 6 N·m (50 in. lbs.).

(13) Refill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

CAUTION: Do not run engine with power steering fluid below the full mark in the reservoir. Sever damage to the hydraulic cooling fan or the engine can occur.

(14) Refill power steering fluid reservoir and bleed air from steering system (Refer to 19 - STEERING/ PUMP - STANDARD PROCEDURE).

(15) Run engine and check for leaks.

RADIATOR PRESSURE CAP

DESCRIPTION

all vehicle are equipped with a pressure cap (Fig. 13). This cap releases pressure at some point within a range of 124-to-145 kPa (18-to-21 psi). The pressure relief point (in pounds) is engraved on top of the 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 contains a spring-loaded pressure relief valve. This valve opens when system pressure reaches the release range of 124-to-145 kPa (18-to-21 psi).

A rubber gasket seals the radiator filler neck. This is done to maintain vacuum during coolant cool-down and to prevent leakage when system is under pressure.

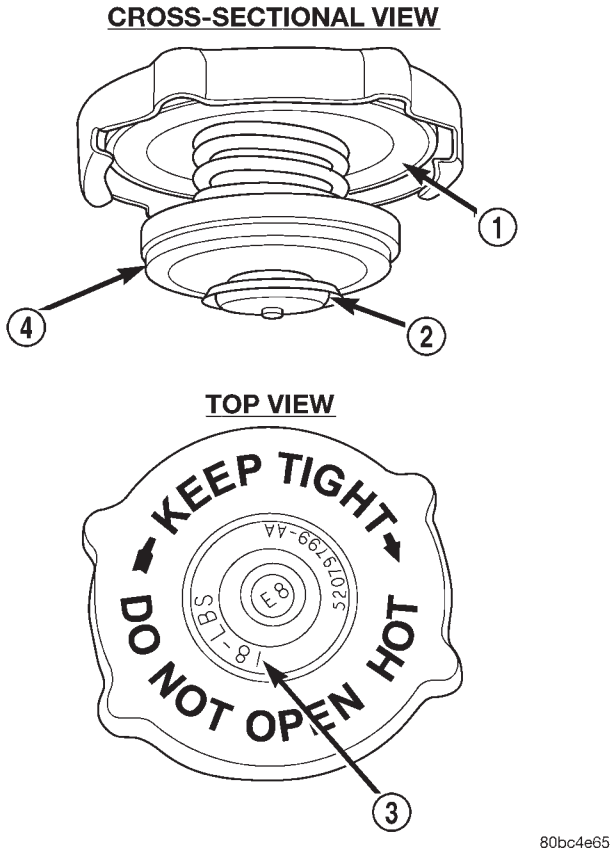

Fig. 13 Radiator Pressure Cap - Typical

1 - FILLER NECK SEAL
2 - VACUUM VENT VALVE
3 - PRESSURE RATING
4 - PRESSURE VALVE

RADIATOR PRESSURE CAP (Continued)

OPERATION

A vent valve in the center of the cap will remain shut as long as the cooling system is pressurized. As the coolant cools, it contracts and creates a vacuum in cooling system. This causes the vacuum valve to open and coolant in reserve/overflow tank to be drawn through connecting hose into radiator. If the vacuum valve is stuck shut, or overflow hose is kinked, radiator hoses will collapse on cool-down.

DIAGNOSIS AND TESTING - RADIATOR PRESSURE CAP

Remove cap from radiator. Be sure that sealing surfaces are clean. Moisten rubber gasket with water and install the cap on pressure tester (tool 7700 or an equivalent) (Fig. 14).

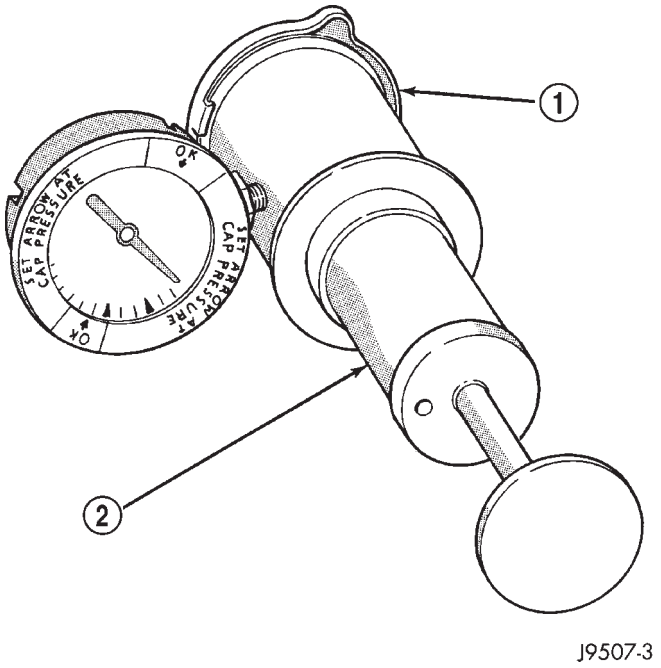

Fig. 14 Pressure Testing Radiator Pressure Cap—Typical

1 - PRESSURE CAP
2 - TYPICAL COOLING SYSTEM PRESSURE TESTER

Operate the tester pump and observe the gauge pointer at its highest point. The cap release pressure should be 124 to 145 kPa (18 to 21 psi). The cap is satisfactory when the pressure holds steady. It is also good if it holds pressure within the 124 to 145 kPa (18 to 21 psi) range for 30 seconds or more. If the pointer drops quickly, replace the cap.

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.

CLEANING

Clean the radiator pressure cap using a mild soap and water only.

INSPECTION

Visually inspect the pressure valve gasket on the cap. Replace cap if the gasket is swollen, torn or worn. Inspect the area around radiator filler neck for white deposits that indicate a leaking cap.

RADIATOR

DESCRIPTION

The radiator used with the 2.7L diesel is constructed of a horizontal down-flow aluminum core with plastic side tanks.

CAUTION: Plastic tanks, while stronger than brass, are subject to damage by impact, such as wrenches.

COOLING MODULE

The cooling module assembly includes the radiatorand hydraulic fan assembly. To replace either one of these components, the entire assembly must be removed from the vehicle and then disassembled. (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL)

DIAGNOSIS AND TESTING - RADIATOR FLOW TEST

There is coolant flow through the coolant recovery container before and after the thermostat opens. If engine is cold, idle engine until normal operating temperature is reached. Then feel the upper radiator hose. If the hose is hot, the thermostat is open and water is circulating through the cooling system.

CAUTION: Do not remove the vent valve to insert a temperature gauge thought the opening , coolant will spill out of the system and the engine will not be filled with coolant up to the heads. Major damage could happen if you run the engine in this condition.

RADIATOR (Continued)

REMOVAL

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN APPROVED AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR.

NOTE: Constant tension hose clamps are used on most vehicles. When removing or installing clamps use tools designed for servicing these types of clamps. A number or letter is stamped on the clamp. If replacement is required use only original equipment clamps with a matching letter or number.

NOTE: When removing the radiator, note the location of the rubber radiator-to-body air seals. These seals are used to prevent overheating and must remain in there original positions.

Do Not waste usable coolant. If solution is clean, drain into a clean container for reuse.

(1) Disconnect negative battery cable.

(2) Drain coolant from radiator (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

NOTE: When ever the high pressure line fittings are removed from the hydraulic fan drive the O-rings must be replaced.

(3) Disconnect both pressure lines at hydraulic fan drive (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(4) Disconnect low pressure return hose at hydraulic fan drive(Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(5) Disconnect fan electrical connector and set aside.

(6) Remove lower, upper radiator, and coolant pressure container hoses from radiator.

NOTE: The lower portion of the radiator is equipped with two alignment dowel pins that are seated in rubber grommets. These grommets are pressed into the lower cross member and must remain present to prevent radiator tank damage.

(7) Remove radiator retaining bolts, and carefully remove coolant module assembly from vehicle (Fig. 15).

(8) Separate coolant fan from radiator.

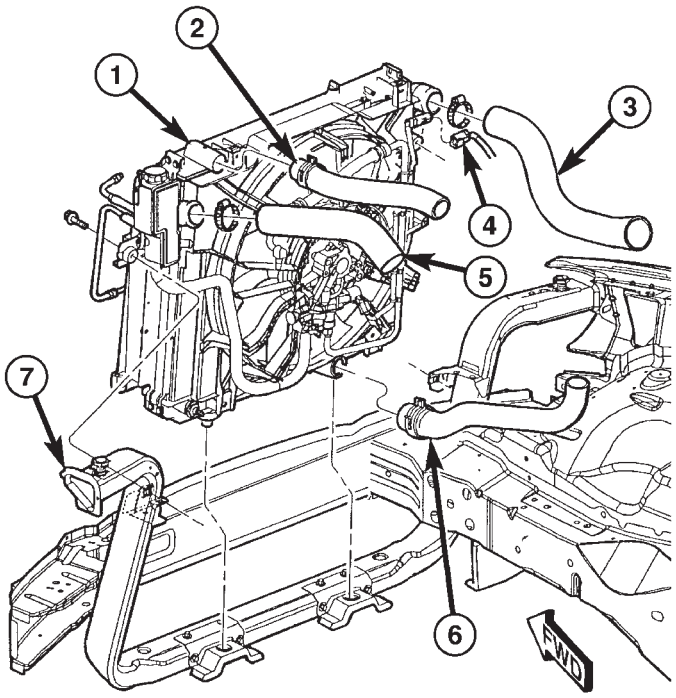

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Fig. 15 COOLING MODULE

1 - RADIATOR
2 - UPPER RADIATOR HOSE
3 - CHARGE AIR COOLER INLET HOSE
4 - COOLING FAN ELECTRICAL CONNECTOR
5 - CHARGE AIR COOLER OUTLET HOSE
6 - LOWER RADIATOR HOSE
7 - RADIATOR SUPPORT

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.

RADIATOR (Continued)

INSTALLATION

CAUTION: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEMS HOSES. USE ONLY THE TOOLS THAT ARE DESIGNED FOR THIS TYPE OF SERVICE. A NUMBER OR LETTER IS STAMPED ON THE CLAMP. IF REPLACEMENT IS REQUIRED, USE ONLY AN ORIGINAL EQUIPMENT CLAMP WITH THE MATCHING NUMBER OR LETTER.

NOTE: Care must be taken when installing the radiator not to damage the fins of the radiator or other ancillary components. Note the location and proper installation of the radiator to charge air cooler and radiator to body rubber air seals. These must be installed correctly to prevent engine over heating and provide proper A/C efficiency.

(1) Position the coolant module assembly.
(2) Carefully lower the radiator tank alignment dowels into the rubber grommets in the lower crossmember and secure coolant module.
(3) Connect upper, lower radiator and coolant pressure container hoses then secure.
(4) Connect coolant fan electrical connector and assure good ECM ground to fan assembly.

NOTE: When ever the pressure line fittings are installed at the hydraulic fan drive, the O-rings must be replaced.

(5) Connect low pressure return hose at hydraulic fan.
(6) Connect both high pressure hoses at hydraulic fan.

NOTE: Do Not waste usable coolant. If the solution is clean and the mixture is correct, reuse original coolant.

(7) Refill cooling system with correct mixture with the proper level (Refer to 7 - COOLING/ENGINE/ COOLANT - STANDARD PROCEDURE).
(8) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(9) Start engine and inspect for leaks.

ELECTRONIC CONTROL MODULES

TABLE OF CONTENTS

ENGINE CONTROL MODULE

DESCRIPTION

The ECM is located in the left side of engine compartment attached to the left inner fender behind the battery (Fig. 1).

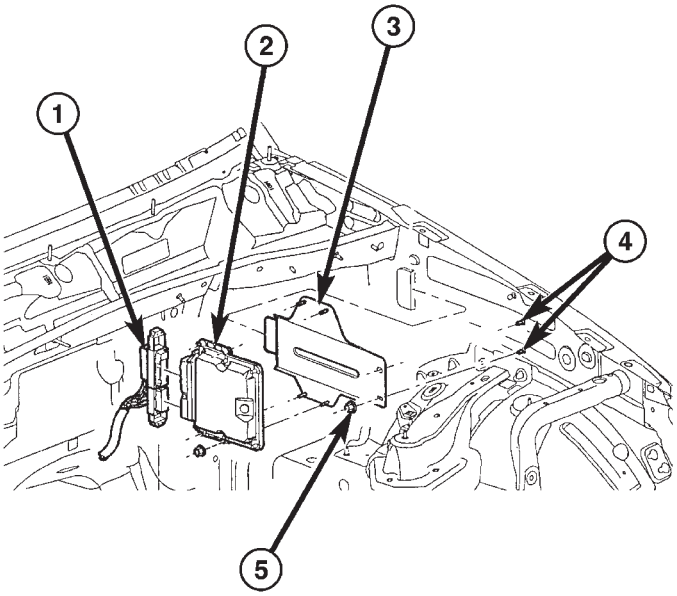

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Fig. 1 ENGINE CONTROL MODULE (ECM) REMOVAL/INSTALL

1 - ECM ELECTRICAL CONNECTORS
2 - ENGINE CONTROL MODULE (ECM)
3 - ECM MOUNTING BRACKET
4 - ECM MOUNTING BRACKET MOUNTING STUDS
5 - MOUNTING BRACKET RETAINING NUTS

OPERATION

The ECM has been programmed to monitor different circuits of the diesel fuel injection system. This monitoring is called on-board diagnostics. Certain criteria must be met for a diagnostic trouble code to be entered into the ECM memory. The criteria may be a range of: engine rpm, engine temperature, time or other input signals to the ECM. If all of the criteria for monitoring a system or circuit are met, and a problem is sensed, then a DTC will be stored in the ECM memory. It is possible that a DTC for a monitored circuit may not be entered into the ECM memory, even though a malfunction has occurred. This may happen when the monitoring criteria have not been met. The ECM compares input signal voltages from each input device with specifications (the established high and low limits of the input range) that are programmed into it for that device. If the input voltage is not within the specifications and other trouble code criteria are met, a DTC will be stored in the ECM memory.

ECM OPERATING MODES

As input signals to the ECM change, the ECM adjusts its response to the output devices. For example, the ECM must calculate a different fuel quantity and fuel timing for engine idle condition than it would for a wide open throttle condition. There are several different modes of operation that determine how the ECM responds to the various input signals.

Ignition Switch On (Engine Off)

When the ignition is turned on, the ECM activates the glow plug relay for a time period that is determined by engine coolant temperature, atmospheric temperature and battery voltage.

Engine Start-Up Mode

The ECM uses the engine temperature sensor and the crankshaft position sensor (engine speed) inputs to determine fuel injection quantity.

ENGINE CONTROL MODULE (Continued)

Normal Driving Modes

Engine idle, warm-up, acceleration, deceleration and wide open throttle modes are controlled based on all of the sensor inputs to the ECM. The ECM uses these sensor inputs to adjust fuel quantity and fuel injector timing.

Limp-In Mode

If there is a fault detected with the accelerator pedal position sensor, the ECM will set the engine speed at 1100 RPM.

Overspeed Detection Mode

If the ECM detects engine RPM that exceeds 5200 RPM, the ECM will set a DTC in memory and illuminate the MIL until the DTC is cleared.

After-Run Mode

The ECM transfers RAM information to ROM and performs an Input/Output state check.

MONITORED CIRCUITS

The ECM is able to monitor and identify most driveability related trouble conditions. Some circuits are directly monitored through ECM feedback circuitry. In addition, the ECM monitors the voltage state of some circuits and compares those states with expected values. Other systems are monitored indirectly when the ECM conducts a rationality test to identify problems. Although most subsytems of the engine control module are either directly or indirectly monitored, there may be occasions when diagnostic trouble codes are not immediately identified. For a trouble code to set, a specific set of conditions must occur and unless these conditions occur, a DTC will not set.

DIAGNOSTIC TROUBLE CODES

Each diagnostic trouble code (DTC) is diagnosed by following a specific procedure. The diagnostic test procedure contains step-by-step instruction for determining the cause of the DTC as well as no trouble code problems. Refer to the appropriate Diesel Powertrain Diagnostic Manual for more information.

HARD CODE

A DTC that comes back within one cycle of the ignition key is a hard code. This means that the problem is current every time the ECM/SKIM checks that circuit or function. Procedures in this manual verify if the DTC is a hard code at the beginning of each test. When the fault is not a hard code, an intermittent test must be performed. NOTE: If the DRBIII® displays faults for multiple components (i.e. ECT, VSS, IAT sensors) identify and check the shared circuits for possible problems before continuing (i.e. sensor grounds or 5-volt supply circuits). Refer to the appropriate schematic to identify shared circuits. Refer to the appropriate Diesel Powertrain Diagnostic Manual for more information.

INTERMITTENT CODE

A DTC that is not current every time the ECM/SKIM checks the circuit or function is an intermittent code. Most intermittent DTCs are caused by wiring or connector problems. Problems that come and go like this are the most difficult to diagnose; they must be looked for under specific conditions that cause them. **NOTE: Electromagnetic (radio) interference can cause an intermittent system malfunction.** This interference can interrupt communication between the ignition key transponder and the SKIM. The following checks may assist you in identifying a possible intermittent problem:

- Visually inspect the related wire harness connectors. Look for broken, bent, pushed out or corroded terminals.
- Visually inspect the related wire harness. Look for chafed, pierced or partially broken wire.
- Refer to hotlines or technical service bulletins that may apply. Refer to the appropriate Diesel Powertrain Diagnostic Manual for more information.

ECM DIAGNOSTIC TROUBLE CODES

IMPORTANT NOTE: Before replacing the ECM for a failed driver, control circuit or ground circuit, be sure to check the related component/circuit integrity for failures not detected due to a double fault in the circuit. Most ECM driver/control circuit failures are caused by internal failures to components (i.e. relays and solenoids) and shorted circuits (i.e. sensor pull-ups, drivers and ground circuits). These faults are difficult to detect when a double fault has occurred and only one DTC has set. If the DRBIII® displays faults for multiple components (i.e.VSS, ECT, Batt Temp, etc.) identify and check the shared circuits for possible problems before continuing (i.e. sensor grounds or 5-volt supply circuits). Refer to the appropriate wiring diagrams to identify shared circuits. Refer to the appropriate Diesel Powertrain Diagnostic Manual for more information.

ENGINE CONTROL MODULE (Continued)

STANDARD PROCEDURE - ECM/SKIM PROGRAMMING - DIESEL

NOTE: Before replacing the ECM for a failed driver, control circuit or ground circuit, be sure to check the related component/circuit integrity for failures not detected due to a double fault in the circuit. Most ECM driver/control circuit failures are caused by internal component failures (i.e. relay and solenoids) and shorted circuits (i.e. pull-ups, drivers and switched circuits). These failures are difficult to detect when a double fault has occurred and only one DTC has set.

ECM/SKIM PROGRAMMING

When a ECM and the SKIM are replaced at the same time perform the following steps in order:

(1) Program the new ECM

(2) Program the new SKIM

(3) Replace all ignition keys and program them to the new SKIM.

ECM/SKIM PROGRAMMING

When an ECM (Bosch) and the SKIM are replaced at the same time perform the following steps in order:

(1) Program the new SKIM

(2) Program the new ECM (Bosch)

PROGRAMMING THE ECM (Bosch)

(1) To program the VIN, connect the DRB III® and turn the ignition on.

(2) Select Engine from the main menu. The DRB III® will require the VIN to be entered before continuing.

(3) Select ENTER to update the VIN. The DRB III® will display the updated VIN.

(4) If the engine is equipped with air conditioning, the ECM A/C function must be enabled. Enable the ECM A/C function as follows:

- Using the DRB III® select ENGINE, MISCELLANEOUS, then ENABLE/DISABLE A/C
- Push 1 to enable A/C. DRB III® screen should display A/C Activated.

PROGRAMMING THE SKIM

(1) Turn the ignition switch on (transmission in park/neutral).

(2) Use the DRB III® and select THEFT ALARM, SKIM then MISCELLANEOUS.

(3) Select ECM REPLACED (DIESEL ENGINE).

(4) Program the vehicle four-digit PIN into SKIM.

(5) Select COUNTRY CODE and enter the correct country.

NOTE: Be sure to enter the correct country code. If the incorrect country code is programmed into SKIM, the SKIM must be replaced.

(6) Select YES to update VIN (the SKIM will learn the VIN from the PCM).

(7) Press ENTER to transfer the secret key (the PCM will send the secret key to the SKIM).

(8) Program ignition keys to SKIM.

NOTE: If the ECM and the SKIM are replaced at the same time, all vehicle keys will need to be replaced and programmed to the new SKIM.

PROGRAMMING IGNITION KEYS TO THE SKIM

(1) Turn the ignition switch on (transmission in park/neutral).

(2) Use the DRB III® and select THEFT ALARM, SKIM then MISCELLANEOUS.

(3) Select PROGRAM IGNITION KEY'S.

(4) Enter secured access mode by entering the vehicle four-digit PIN.

NOTE: A maximum of eight keys can be learned to each SKIM. Once a key is learned to a SKIM it (the key) cannot be transferred to another vehicle.

If ignition key programming is unsuccessful, the DRB III® will display one of the following messages:

Programming Not Attempted - The DRB III® attempts to read the programmed key status and there are no keys programmed into SKIM memory.

Programming Key Failed (Possible Used Key From Wrong Vehicle) - SKIM is unable to program key due to one of the following:

- faulty ignition key transponder
- ignition key is programmed to another vehicle.

8 Keys Already Learned, Programming Not Done - SKIM transponder ID memory is full.

(5) Obtain ignition keys to be programmed from customer (8 keys maximum).

(6) Using the DRB III®, erase all ignition keys by selecting MISCELLANEOUS and ERASE ALL CURRENT IGN. KEYS.

(7) Program all ignition keys.

Learned Key In Ignition - Ignition key transponder ID is currently programmed in SKIM memory.

REMOVAL

(1) Disconnect negative battery cable.

(2) Disconnect ECM electrical connectors (Fig. 2).

(3) Remove ECM bracket to inner fender retaining nuts (Fig. 2).

(4) Remove ECM and bracket assembly from vehicle (Fig. 2).

(5) Separate ECM from bracket.

ENGINE CONTROL MODULE (Continued)

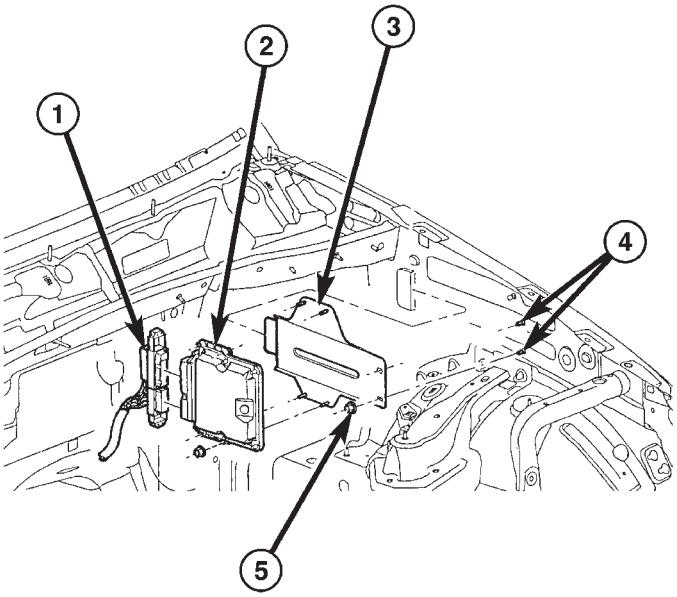

Fig. 2 ENGINE CONTROL MODULE (ECM) REMOVAL/INSTALL

1 - ECM ELECTRICAL CONNECTORS
2 - ENGINE CONTROL MODULE (ECM)
3 - ECM MOUNTING BRACKET
4 - ECM MOUNTING BRACKET MOUNTING STUDS
5 - MOUNTING BRACKET RETAINING NUTS

INSTALLATION

(1) Install ECM on bracket (Fig. 2).
(2) Position ECM and bracket assembly in vehicle (Fig. 2).
(3) Install ECM bracket to inner fender retaining nuts (Fig. 2).
(4) Connect ECM electrical connectors (Fig. 2).
(5) Connect negative battery cable.

TRANSMISSION CONTROL MODULE

DESCRIPTION

The electronic control system consists of various components providing inputs to the TCM. The TCM monitors transmission sensors, shifter assembly switches, and bus messages to determine transmission shift strategy. After shift strategies are determined, the TCM controls the actuation of transmission solenoids, which controls the routing of hydraulic fluid within the transmission, by moving a sequence of four valves to make a shift occur.

The W5J400 electronic transmission has a fully adaptive control system. The system performs its functions based on continuous real-time sensor feedback information. In addition the TCM receives information from the PCM/ECM (engine management) and ABS (chassis systems) controllers over the CAN C bus. The CAN C bus is a high-speed communication bus that allows real time control capability between various controllers. Most messages are sent every 20 milliseconds. This means critical information can be shared between the transmission, engine, and ABS controllers. The CAN C bus is a two wire bus with a CAN C Bus (+) circuit and a CAN C Bus (-) circuit. These circuits are twisted pairs in the harness to reduce the potential of radio and noise interference.

The transmission control system automatically adapts to changes in engine performance, vehicle speed, and transmission temperature variations to provide consistent shift quality. The control system ensures that clutch operation during up-shifting and downshifting is more responsive without increased harshness. The TCM activates the solenoid valves and moves valves in the valve body to achieve the necessary gear changes. The required pressure level is calculated from the load condition, engine speed. Vehicle speed (from ABS module) and transmission oil temperature, matched to the torque to be transmitted. Power for the transmission system is supplied through the shifter mechanism (no transmission control relay). The TCM (Fig. 3) is located in the center console, on the right side of the transmission tunnel.

OPERATION

The transmission control module (TCM) determines the current operating conditions of the vehicle and controls the shifting process for shift comfort and driving situations. It receives this operating data from sensors and broadcast messages from other modules.

The TCM uses inputs from several sensors that are directly hardwired to the controller and it uses several indirect inputs that are used to control shifts. This information is used to actuate the proper solenoids in the valve body to achieve the desired gear. The TCM continuously checks for electrical, mechanical, and some hydraulic problems. When the TCM detects a problem, it stores a Diagnostic Trouble Code (DTC).

The shift lever sensor assembly (SLSA) has sensors that are monitored by the TCM to calculate shift lever position. The reverse light switch, an integral part of the SLSA, controls the reverse light relay con-

TRANSMISSION CONTROL MODULE (Continued)

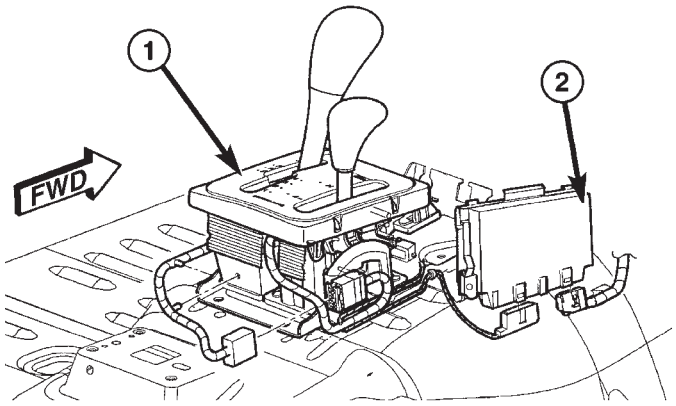

Fig. 3 Shifter Assembly and Transmission Control Module

1 - SHIFTER ASSEMBLY
2 - TRANSMISSION CONTROL MODULE

trol circuit. The Brake/Transmission Shift Interlock (BTSI) solenoid and the park lockout solenoid (also part of the SLSA) are controlled by the TCM.

The PCM and ABS broadcast messages over the controller area network (CAN C) bus for use by the TCM. The TCM uses this information, with other inputs, to determine the transmission operating conditions.

The TCM:

- determines the momentary operating conditions of the vehicle.
- controls all shift processes.
- considers shift comfort and the driving situation.

The TCM controls the solenoid valves for modulating shift pressures and gear changes. Relative to the torque being transmitted, the required pressures are calculated from load conditions, engine rpm, vehicle speed, and ATF temperature.

The following functions are contained in the TCM:

- Shift Program
- Downshift Safety
- Engine Management Intervention
- Torque Converter Lock-Up Clutch.
- Adaptation.

This transmission does not have a TCM relay. Power is supplied to the Shift module and the TCM directly from the ignition.

The TCM continuously checks for electrical problems, mechanical problems, and some hydraulic problems. When a problem is sensed, the TCM stores a diagnostic trouble code (DTC). Some of these codes cause the transmission to go into ″Limp-In″ or ″default″ mode. Some faults cause permanent Limp-In and others cause temporary Limp-In. The W5J400 defaults in the current gear position if a DTC is detected, then after a key cycle the transmission will go into Limp-in, which is mechanical 2nd gear. Some DTCs may allow the transmission to resume normal operation (recover) if the detected problem goes away. A permanent Limp-In DTC will recover when the key is cycled, but if the same DTC is detected for three key cycles the system will not recover and the DTC must be cleared from the TCM with the DRBIII® scan tool.

TCM SIGNALS

The TCM registers one part of the input signals by direct inputs, the other part by CAN C bus. In addition to the direct control of the actuators, the TCM sends various output signals by CAN C bus to other control modules.

Selector Lever Position

A series of 12 Hall-effect switches in the SLSA inform the TCM of the position of the selector lever.

The TCM monitors the SLSA for all shift lever positions through five position circuits. The SLSA provides a low-current 12-volt signal to the TCM. The TCM compares the on/off signals to programmed combinations to determine the exact position of the shift lever.

ATF Temperature Sensor

The ATF temperature sensor is a PTC thermistor. It measures the temperature of the transmission fluid and is an input signal for the TCM. The temperature of the ATF has an influence on the shift time and resulting shift quality. As the temperature rises, resistance rises. Therefore the probing voltage is decreasing. Because of its registration, the shifting process can be optimized in all temperature ranges.

The ATF temperature sensor is connected in series with the park/neutral contact. The temperature signal is transmitted to the TCM only when the reed contact of the park/neutral contact is closed because the TCM only reads ATF temperature while in a forward gear.

Starter Interlock

The TCM monitors a contact switch wired in series with the transmission temperature sensor to determine PARK and NEUTRAL positions. The contact switch is open in PARK and NEUTRAL. The TCM senses transmission temperature as high (switch supply voltage), confirming switch status as open. The TCM then broadcasts a message over CAN bus

to confirm switch status. The PCM receives this information and allows operation of the starter circuit.

N2 and N3 Speed Sensors

The N2 and N3 Input Speed Sensors are two Hall-effect speed sensors that are used by the TCM to calculate the transmissions input speed. Since the input speed cannot be measured directly, two of the drive elements are measured. Two input speed sensors were required because both drive elements are not active in all gears.

CAN C Bus Indirect Input Signals

A 2.5-volt bias (operating voltage) is present on the CAN C bus any time the ignition switch is in the RUN position. Both the TCM and the ABS apply this bias. On this vehicle, the CAN C bus is used for module data exchange only. The indirect inputs used on the W5J400 electronic control system are:

- Wheel Speed Sensors.
- Transfer Case Switch Status.
- Brake Switch.
- Engine RPM.
- Engine Temperature.
- Cruise Control Status.
- Gear Limit Request.
- Throttle Position - 0% at idle, 100% at WOT. If open, TCM assumes idle (0% throttle opening).
- Odometer Mileage
- Maximum Effective Torque.
- Engine in Limp-In Mode/Mileage Where DTC Was Set.
- Engine Torque Reduction Request.

BRAKE TRANSMISSION SHIFT INTERLOCK (BTSI)

The BTSI solenoid prevents shifting out of the PARK position until the ignition key is in the RUN position and the brake pedal is pressed. The TCM controls the ground while the ignition switch supplies power to the BTSI solenoid. The PCM monitors the brake switch and broadcasts brake switch status messages over the CAN C bus. If the park brake is depressed and there is power (Run/Start) to SLSA, the BTSI solenoid deactivates. The TCM monitors this for the SLSA because the SLSA does not communicate on the CAN C bus.

SHIFT SCHEDULES

The basic shift schedule includes up and downshifts for all five gears. The TCM adapts the shift program according to driving style, accelerator pedal position and deviation of vehicle speed. Influencing factors are:

- Road Conditions.
- Incline, Decline and Altitude.
- Trailer Operation, Loading.
- Engine Coolant Temperature.
- Cruise Control Operation.
- Sporty Driving Style.
- Low and High ATF Temperature.

Upshift To:	1-2	2-3	3-4	4-5
Activated By Solenoid:	1-2/4-5	2-3	3-4	1-2/4-5
Shift Point (at 35.2% of throttle)	17.8 km/h (11.6 mph)	32.1 km/h (19.95 mph)	67.5 km/h (41.94 mph)	73.8 km/h (45.86 mph)
Downshift From:	5-4	4-3	3-2	2-1
Activated By Solenoid:	1-2/4-5	3-4	2-3	1-2/4-5
Shift Point	55.7 km/h (34.61 mph)	40.5 km/h (25.17 mph)	24.4 km/h (15.16 mph)	15.1 km/h (9.38 mph)

DOWNSHIFT SAFETY

Selector lever downshifts are not performed if inadmissible high engine rpm is sensed.

ENGINE MANAGEMENT INTERVENTION

By briefly retarding the ignition timing during the shifting process, engine torque is reduced and therefore, shift quality is optimized.

ADAPTATION

To equalize tolerances and wear, an automatic adaptation takes place for:

- Shift Time.
- Clutch Filling Time.
- Clutch Filling Pressure.
- Torque Converter Lock-Up Control.

Adaptation data may be stored permanently and to some extent, can be diagnosed.

Driving Style Adaptation

The shift point is modified in steps based on the information from the inputs. The control module looks at inputs such as:

- vehicle acceleration and deceleration (calculated by the TCM).
- rate of change as well as the position of the throttle pedal (fuel injection information from the PCM).

TRANSMISSION CONTROL MODULE (Continued)

- lateral acceleration (calculated by the TCM).
- gear change frequency (how often the shift occurs).

Based on how aggressive the driver is, the TCM moves up the shift so that the present gear is held a little longer before the next upshift. If the driving style is still aggressive, the shift point is modified up to ten steps. If the driving returns to normal, then the shift point modification also returns to the base position.

This adaptation has no memory. The adaptation to driving style is nothing more than a shift point modification meant to assist an aggressive driver. The shift points are adjusted for the moment and return to base position as soon as the inputs are controlled in a more rational manner.

Shift Time Adaptation (Shift Overlap Adaptation, Working Pressure)

Shift time adaptation is the ability of the TCM to electronically alter the time it takes to go from one gear to another. Shift time is defined as the time it takes to disengage one shift member while another is being applied. Shift time adaptation is divided into four categories:

36. Accelerating upshift, which is an upshift under a load. For shift time adaptation for the 1-2 upshift to take place, the transmission must shift from 1st to 2nd in six different engine load ranges vs. transmission output speed ranges.

37. Decelerating upshift, which is an upshift under no load. This shift is a rolling upshift and is accomplished by letting the vehicle roll into the next gear.

38. Accelerating downshift, which is a downshift under load. This shift can be initiated by the throttle, with or without kickdown. The shift selector can also be used.

39. Decelerating downshift, which is accomplished by coasting down. As the speed of the vehicle decreases, the transmission downshifts.

Fill Pressure Adaptation (Apply Pressure Adaptation, Modulating Pressure)

Fill pressure adaptation is the ability of the TCM to modify the pressure used to engage a shift member. The value of this pressure determines how firm the shift will be.

- If too much pressure is used, the shift will be hard.
- If too little pressure is used, the transmission may slip.

The pressure adjustment is needed to compensate for the tolerances of the shift pressure solenoid valve. The amount the solenoid valve opens as well as how quickly the valve can move, has an effect on the pressure. The return spring for the shift member provides a resistance that must be overcome by the pressure in order for shift member to apply. These return springs have slightly different values. This also affects the application pressure and is compensated for by fill pressure adaptation.

Fill Time Adaptation (Engagement Time Adaptation)

Fill time is the time it takes to fill the piston cavity and take up any clearances for a friction element (clutch or brake). Fill time adaptation is the ability of the TCM to modify the time it takes to fill the shift member by applying a preload pressure.

CONTROLLER MODES OF OPERATION

Permanent Limp-In Mode

When the TCM determines there is a non-recoverable condition present that does not allow proper transmission operation, it places the transmission in permanent Limp-In Mode. When the condition occurs the TCM turns off all solenoids as well as the solenoid supply output circuit. If this occurs while the vehicle is moving, the transmission remains in the current gear position until the ignition is turned off or the shifter is placed in the ″P″ position. When the shifter has been placed in ″P,″ the transmission only allows 2nd gear operation. If this occurs while the vehicle is not moving, the transmission only allows operation in 2nd gear.

Temporary Limp-In Mode

This mode is the same as the permanent Limp-In Mode except if the condition is no longer present, the system resumes normal operation.

Under Voltage Limp-In Mode

When the TCM detects that system voltage has dropped below 8.5 volts, it disables voltage-dependant diagnostics and places the transmission in the temporary Limp-In Mode. When the TCM senses that the voltage has risen above 9.0 volts, normal transmission operation is resumed.

Hardware Error Mode

When the TCM detects a major internal error, the transmission is placed in the permanent Limp-In Mode and ceases all communication over the CAN bus. When the TCM has entered this mode normal transmission operation does not resume until all DTCs are cleared from the TCM.

Loss of Drive

If the TCM detects a situation that has resulted or may result in a catastrophic engine or transmission problem, the transmission is placed in the neutral position. Improper Ratio, Input Sensor Overspeed or Engine Overspeed DTCs cause the loss of drive.

Controlled Limp-in Mode

When a failure does not require the TCM to shut down the solenoid supply, but the failure is severe enough that the TCM places the transmission into a predefined gear, there are several shift performance concerns. For instance, if the transmission is slipping, the controller tries to place the transmission into 3rd gear and maintain 3rd gear for all forward drive conditions.

STANDARD PROCEDURE - TCM QUICK LEARN

The quick learn procedure requires the use of the DRBIII® scan tool.

This program allows the electronic transmission system to recalibrate itself. This will provide the proper baseline transmission operation. The quick learn procedure should be performed if any of the following procedures are performed:

- Transmission Assembly Replacement
- Transmission Control Module Replacement
- Solenoid Pack Replacement
- Clutch Plate and/or Seal Replacement
- Valve Body Replacement or Recondition

To perform the Quick Learn Procedure, the following conditions must be met:

- The brakes must be applied
- The engine speed must be above 500 rpm
- The throttle angle (TPS) must be less than 3 degrees
- The shift lever position must stay in PARK until prompted to shift to overdrive
- The shift lever position must stay in overdrive after the Shift to Overdrive prompt until the DRB® indicates the procedure is complete
- The calculated oil temperature must be above 60° and below 200°

ENGINE SYSTEMS

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CHARGING

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CHARGING

DESCRIPTION

The charging system used on diesel engines consists of:

- Bosch Generator / field internally controlled
- Ignition switch (Refer to Group 8D, Ignition System for information)
- Battery (Refer to Group 8A, Battery 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. The generator is driven by the engine through a serpentine belt and pulley arrangement.

All vehicles are equipped with On-Board Diagnostics (OBD). 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 Powertrain Diagnostic Manual for more information.

SPECIFICATIONS

TORQUE - DIESEL

DESCRIPTION	N-m	Ft. Lbs.	In. Lbs.
Generator Decoupler	110	81	-
Generator-to-Mounting Bracket Bolts (2)	40	30	-
B+ Generator Output Wire	9	-	75

GENERATOR

DESCRIPTION

The generator is belt-driven by the engine. It is serviced only as a complete assembly. If the generator fails for any reason, the entire assembly must be replaced. On certain generators, a decoupler is used. Refer to Generator Decoupler for additional information.

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 vehicles electrical system through the generator, battery, and ground terminals.

Noise emitting from the generator may be caused by:

- Worn, loose or defective bearings
- Loose or defective drive pulley
- Incorrect, worn or damaged drive belt
- Loose mounting bolts
- Misaligned drive pulley
- Defective stator or diode
- Damaged internal fins

REMOVAL

WARNING: DISCONNECT NEGATIVE BATTERY CABLE BEFORE REMOVING GENERATOR B+ OUTPUT WIRE FROM GENERATOR. FAILURE TO DO SO CAN RESULT IN PERSONAL INJURY OR DAMAGE TO VEHICLE ELECTRICAL SYSTEM.

(1) Disconnect negative battery cable.

(2) Remove accessory drive belt from generator pulley by relieving tension on belt tensioner. Refer to Cooling System for procedure.

(3) Remove turbo intercooler hose (Fig. 1).

(4) Loosen (but do not remove) mounting bolt for idler pulley (Fig. 1).

(5) The generator uses 4 horizontally mounted bolts (Fig. 2). Remove 2 upper generator mounting bolts.

(6) Raise vehicle.

(7) Lower oil pan splash shield at right frame rail by disconnecting 2 clips (Fig. 3).

(8) Remove bolt at air conditioning line support bracket (Fig. 4).

(9) Remove B+ output cable nut and cable at rear of generator.

(10) Disconnect generator field wire connector from rear of generator.

(11) Remove 2 lower generator mounting bolts (Fig. 2). Note lower bolts are slightly shorter than upper bolts.

(12) Lower generator for removal.

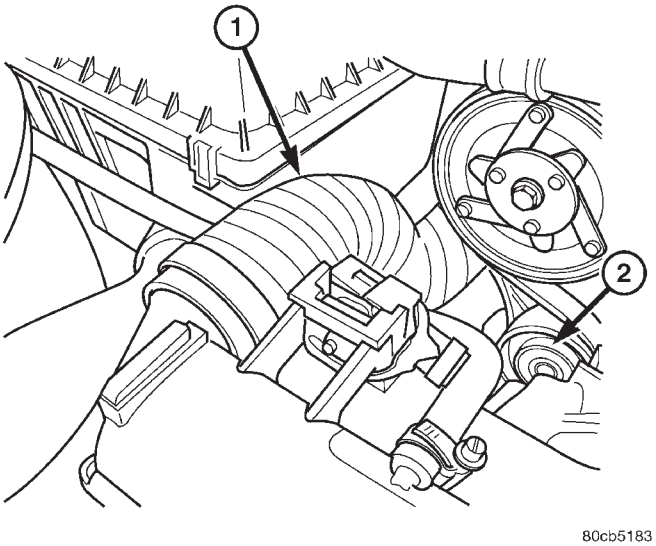

Fig. 1 TURBO INTERCOOLER HOSE

1 - INTERCOOLER HOSE
2 - IDLER PULLEY

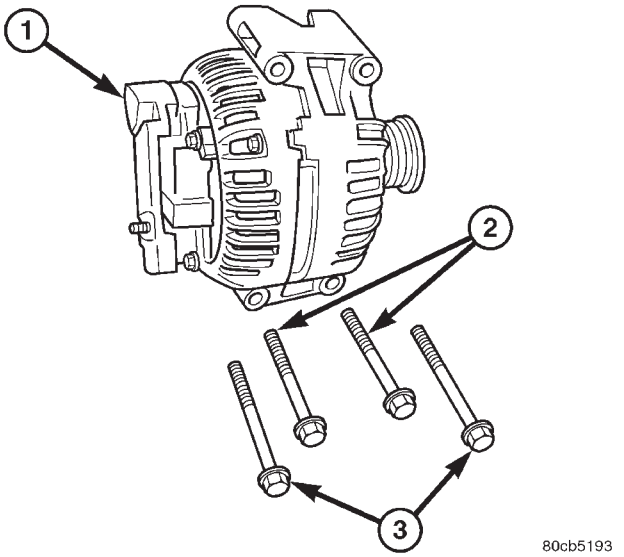

Fig. 2 GENERATOR - 2.7L DIESEL

1 - GENERATOR
2 - LOWER MOUNTING BOLTS
3- UPPER MOUNTING BOLTS

INSTALLATION

(1) Raise generator into position from bottom of vehicle.

GENERATOR (Continued)

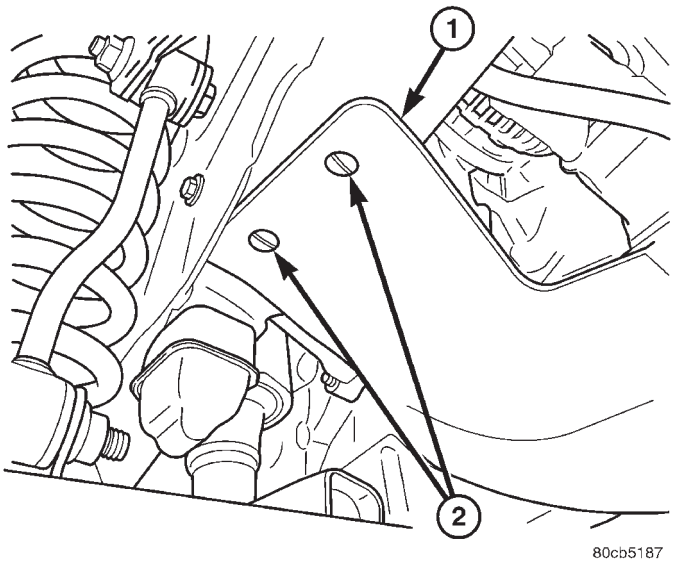

Fig. 3 OIL PAN SPLASH SHIELD

1 - OIL PAN SPLASH SHIELD
2 - SPLASH SHIELD CLIPS

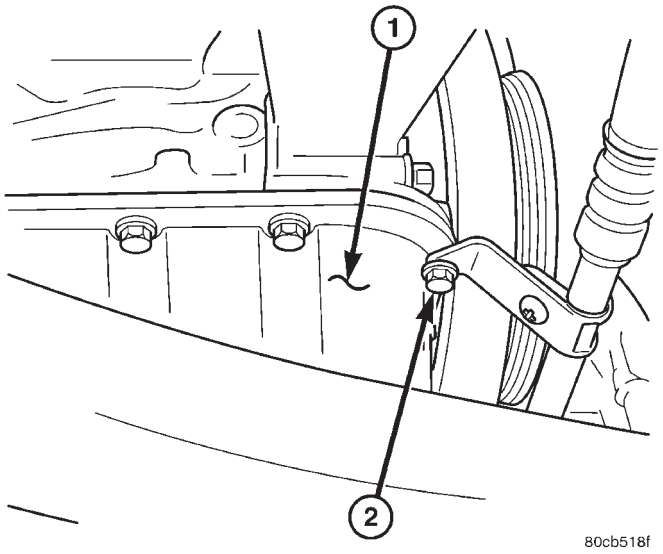

Fig. 4 AC LINE AT OIL PAN

1 - OIL PAN (RIGHT/FRONT)
2 - MOUNTING BOLT

(2) Install 2 lower generator mounting bolts finger tight (Fig. 2). Note lower bolts are slightly shorter than upper bolts.

(3) Connect generator field wire connector to rear of generator.

(4) Install B+ output cable nut and cable to rear of generator.

(5) Install bolt at air conditioning line support bracket (Fig. 4).

(6) Install oil pan splash shield. Press in 2 clips (Fig. 3).

(7) Lower vehicle.

(8) Install 2 upper generator mounting bolts. Tighten all 4 mounting bolts

(9) Tighten idler pulley bolt.

(10) Install turbo intercooler hose (Fig. 1).

(11) Install accessory drive belt by relieving tension on belt tensioner. Refer to Cooling System for procedure.

(12) Connect negative battery cable.

GENERATOR DECOUPLER PULLEY

DESCRIPTION

The generator decoupler is used only with certain engines. The decoupler is used in place of the standard generator drive pulley (Fig. 5).

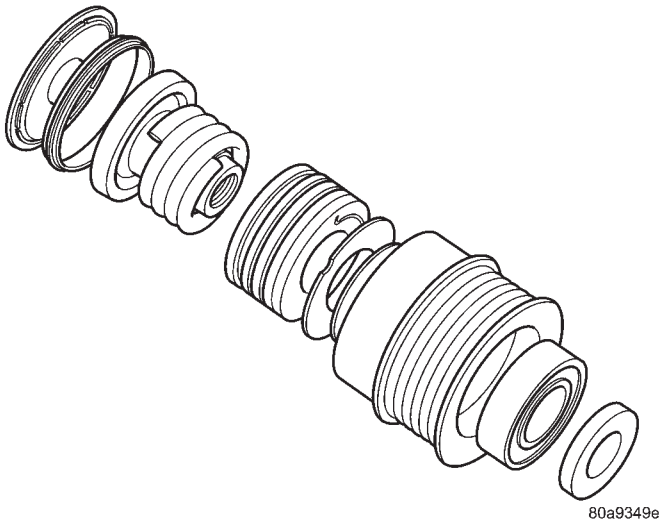

Fig. 5 GENERATOR DECOUPLER PULLEY (TYPICAL)

OPERATION

The generator decoupler is used only with certain engines. The decoupler (Fig. 5). is a one-way clutch designed to help reduce belt tension fluctuation, vibration, reduce fatigue loads, improve belt life, reduce hubloads on components, and reduce noise. Dry operation is used (no grease or lubricants). The decoupler is not temperature sensitive and also has a low sensitivity to electrical load. The decoupler is a non-serviceable item and is to be replaced as an assembly.

GENERATOR DECOUPLER PULLEY (Continued)

DIAGNOSIS AND TESTING - GENERATOR DECOUPLER

CONDITION	POSSIBLE CAUSES	CORRECTION
Does not drive generator (generator not charging)	Internal failure	Replace decoupler
Noise coming from decoupler	Internal failure	Replace decoupler

REMOVAL

The generator decoupler is used only with certain engines.

Two different type generator decoupler pulleys are used. One can be identified by the use of machined splines (Fig. 6). The other can be identified by a hex opening (Fig. 7) and will not use splines.

Different special tools are required to service each different decoupler. Refer to following procedure.

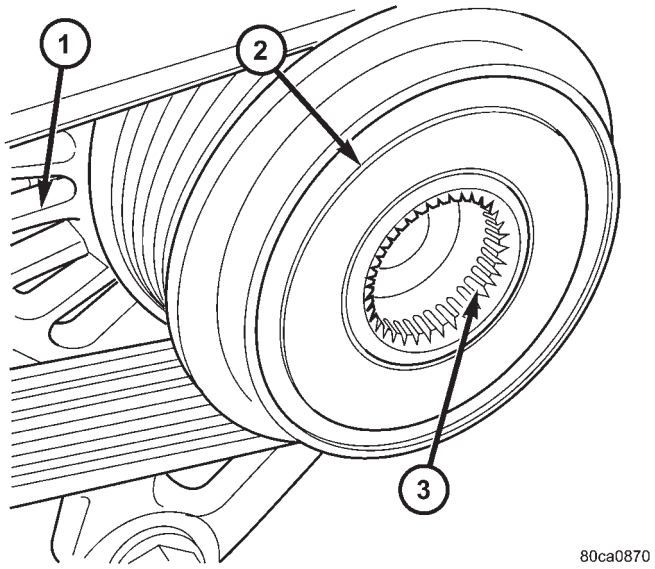

Fig. 6 GENERATOR DECOUPLER PULLEY (INA)

1 - GENERATOR
2 - DECOUPLER (INA)
3 - MACHINED SPLINES

INA Decoupler

(1) Disconnect negative battery cable.

(2) Remove generator and accessory drive belt. Refer to Generator Removal.

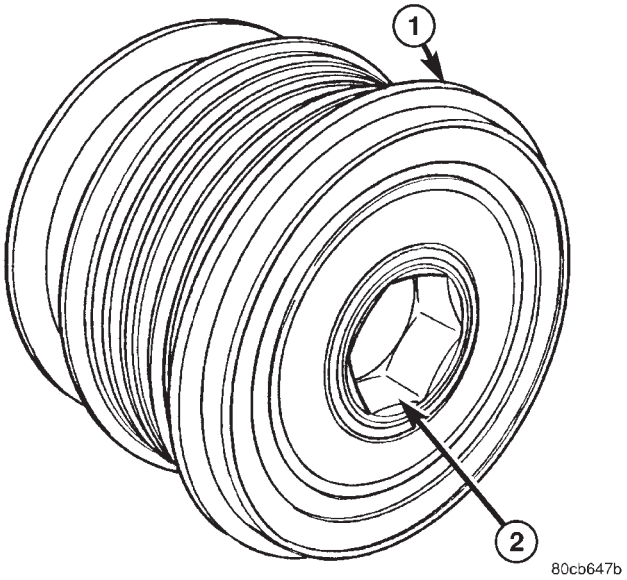

Fig. 7 GENERATOR DECOUPLER PULLEY (LITENS)

1 - DECOUPLER (LITENS)
2 - HEX OPENING

(3) Position Special Tool #8823 (VM.1048) into decoupler (Fig. 8).

(4) Determine if end of generator shaft is hex shaped (Fig. 9) or is splined (Fig. 10). If hex is used, insert a 10MM deep socket into tool #8823 (VM.1048) (Fig. 11). If splined, insert a 5/16” 6-point hex driver, or a 10MM 12-point triple square driver into tool #8823 (VM.1048) (Fig. 12).

(5) The generator shaft uses conventional right-hand threads to attach decoupler. To break decoupler loose from generator threads, rotate end of tool clockwise (Fig. 11) or, (Fig. 12).

(6) After breaking loose with tool, unthread decoupler by hand from generator.

GENERATOR DECOUPLER PULLEY (Continued)

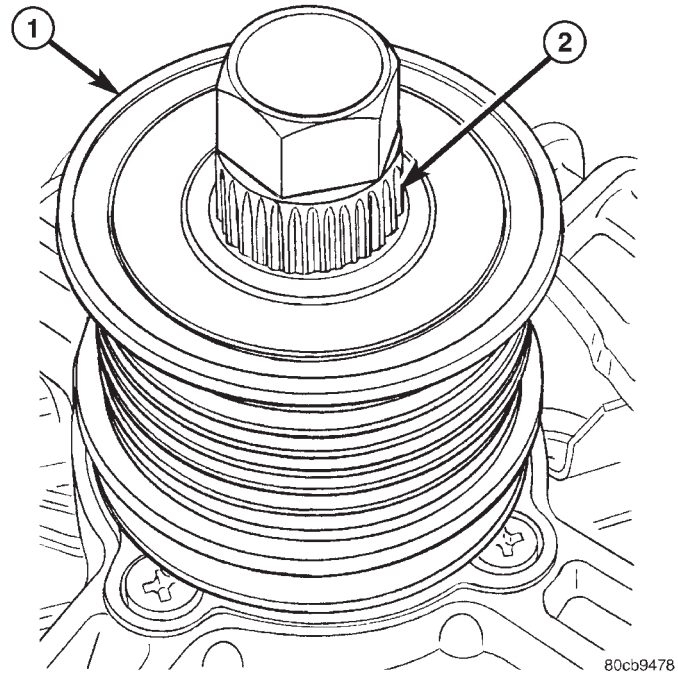

Fig. 8 #8823 (VM.1048) TOOL AND INA DECOUPLER

1 - INA DECOUPLER
2 - TOOL #8823 (VM.1048)

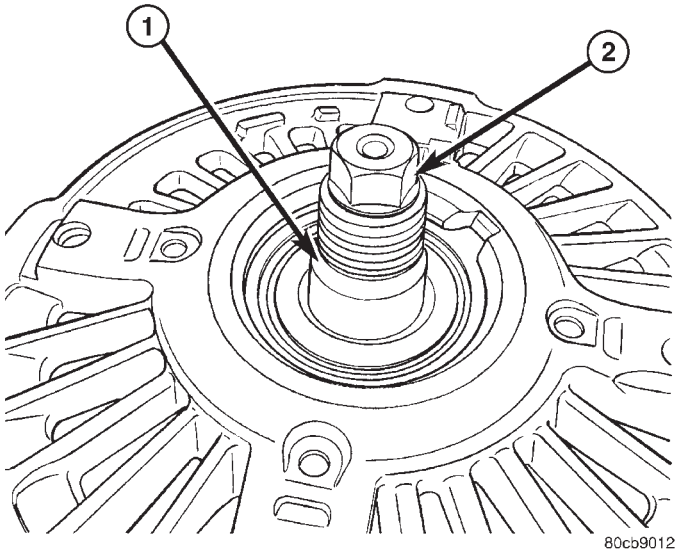

Fig. 9 END OF GENERATOR SHAFT (HEX)

1 - GENERATOR SHAFT
2 - HEX

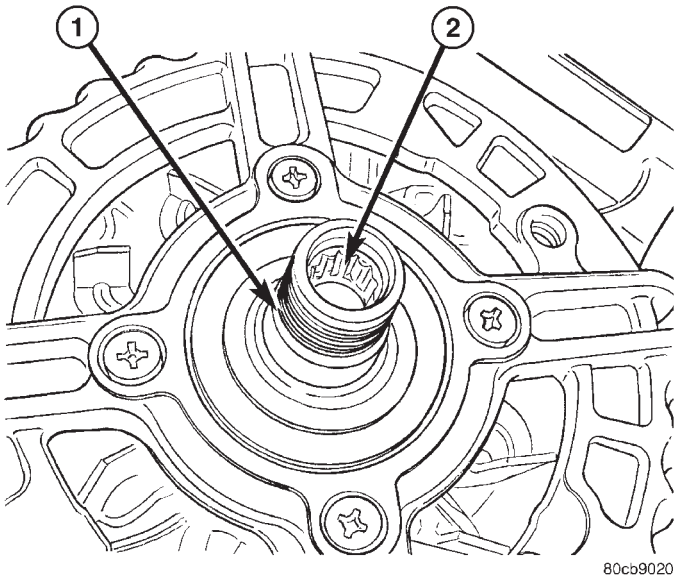

Fig. 10 END OF GENERATOR SHAFT (SPLINED)

1 - GENERATOR SHAFT
2 - SPLINES

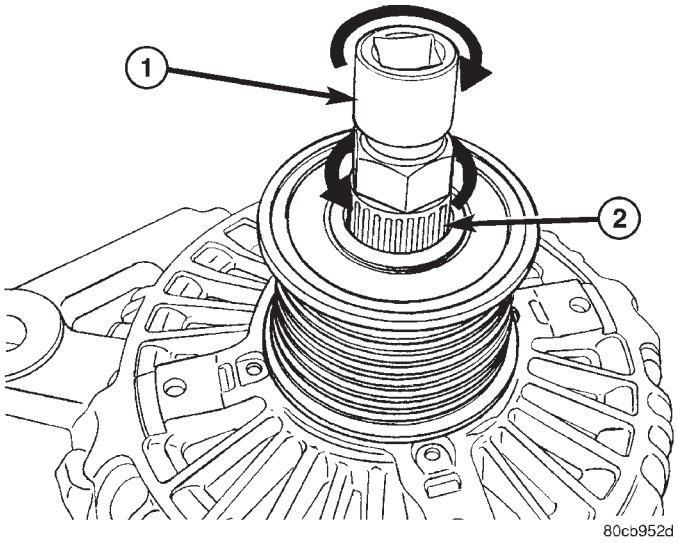

Fig. 11 DECOUPLER REMOVAL (INA-HEX)

1 - DEEP 10 MM SOCKET
2 - TOOL #8823 (VM.1048)

GENERATOR DECOUPLER PULLEY (Continued)

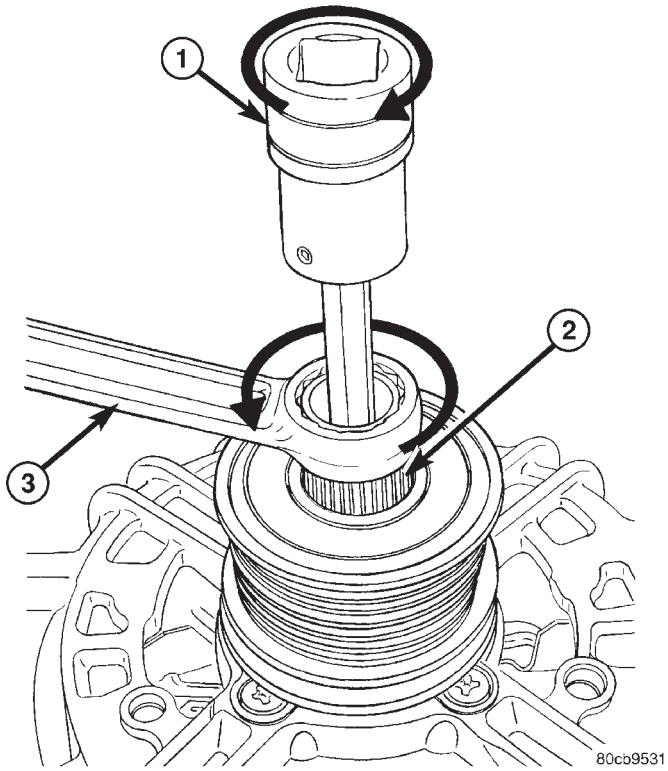

Fig. 12 DECOUPLER REMOVAL (INA-SPLINED)

1 - DRIVER
2 - TOOL #8823 (VM.1048)
3 - 17 MM WRENCH

Litens Decoupler

(1) Disconnect negative battery cable.

(2) Remove generator and accessory drive belt. Refer to Generator Removal.

(3) Position Special Tool #8433 (Fig. 13) into decoupler. Align to hex end of generator shaft.

(4) The generator shaft uses conventional right-hand threads to attach decoupler. To break decoupler loose from generator threads, rotate end of tool clockwise (Fig. 14).

(5) After breaking loose with tool, unthread decoupler by hand from generator.

INSTALLATION

INA Decoupler

(1) Thread decoupler pulley onto generator shaft by hand (right-hand threads).

(2) Position Special Tool #8823 (VM.1048) into decoupler (Fig. 8).

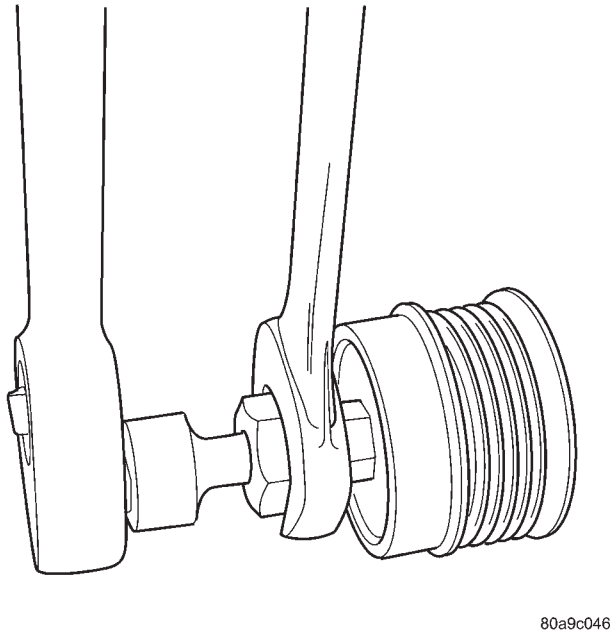

Fig. 13 # 8433 TOOL AND LITENS DECOUPLER

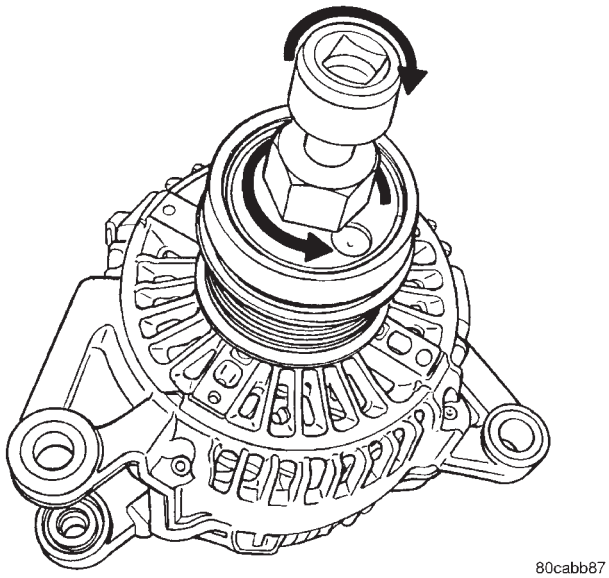

Fig. 14 DECOUPLER REMOVAL (LITENS)

(3) Determine if end of generator shaft is hex shaped (Fig. 9) or is splined (Fig. 10). If hex is used, insert a 10MM deep socket into tool #8823 (VM.1048) (Fig. 15). If splined, insert a 5/16” 6-point hex driver, or a 10MM 12-point triple square driver into tool #8823 (VM.1048) (Fig. 16).

GENERATOR DECOUPLER PULLEY (Continued)

(4) **Do not use an adjustable, ratcheting "click type" torque wrench. Most "click type" wrenches will only allow torque to be applied in a clockwise rotation. Use a dial-type or beam-type wrench.** Tighten in counter-clockwise rotation (Fig. 15) or, (Fig. 16). Refer to torque specifications.

(5) Install accessory drive belt, and generator. Refer to Generator Installation.

(6) Connect negative battery cable.

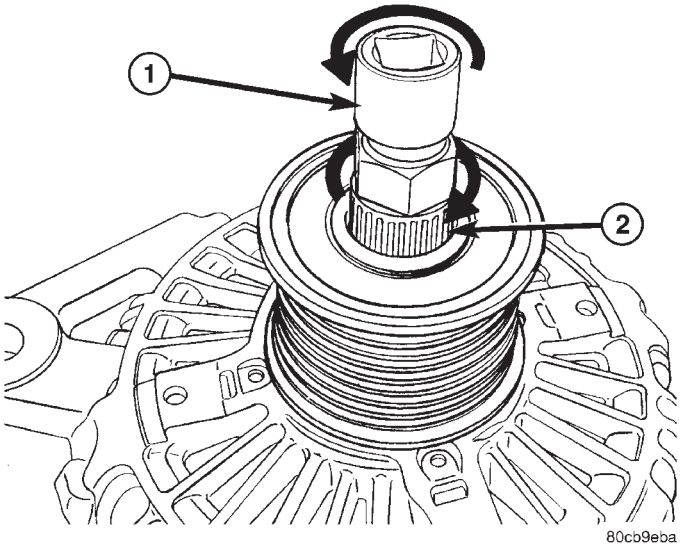

Fig. 15 DECOUPLER INSTALLATION (INA-HEX)

1 - 10MM DEEP SOCKET
2 - TOOL # 8823 (VM.1048)

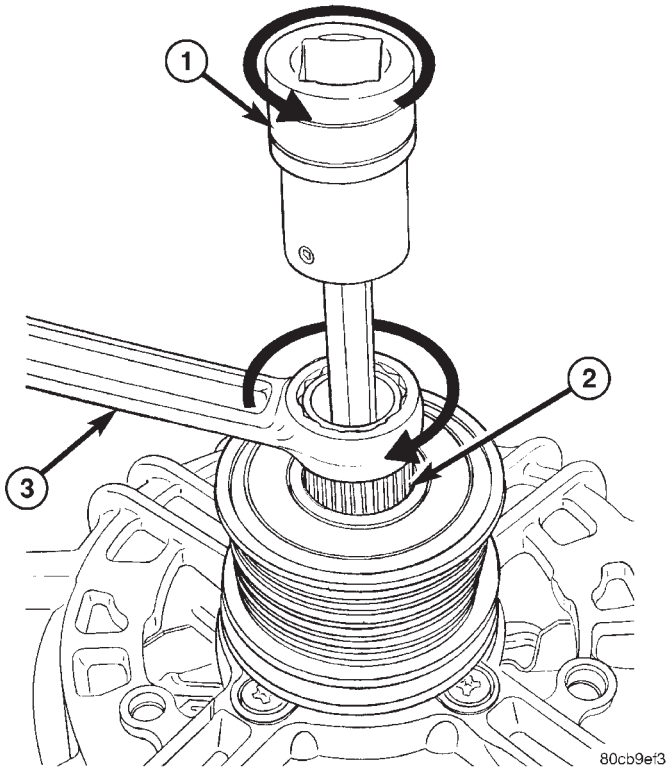

Fig. 16 DECOUPLER INSTALLATION (INA SPLINED)

1 - DRIVER
2 - TOOL # 8823 (VM.1048)

Litens Decoupler

(1) Thread decoupler pulley onto generator shaft by hand (right-hand threads).

(2) Position Special Tool 8433 (Fig. 13) into decoupler. Align tool to hex end of generator shaft.

(3) **Do not use an adjustable, ratcheting "click type" torque wrench. Most "click type" wrenches will only allow torque to be applied in a clockwise rotation. Use a dial-type or beam-type wrench.** Tighten in counter-clockwise rotation (Fig. 17). Refer to torque specifications.

(4) Install accessory drive belt, and generator. Refer to Generator Installation.

(5) Connect negative battery cable.

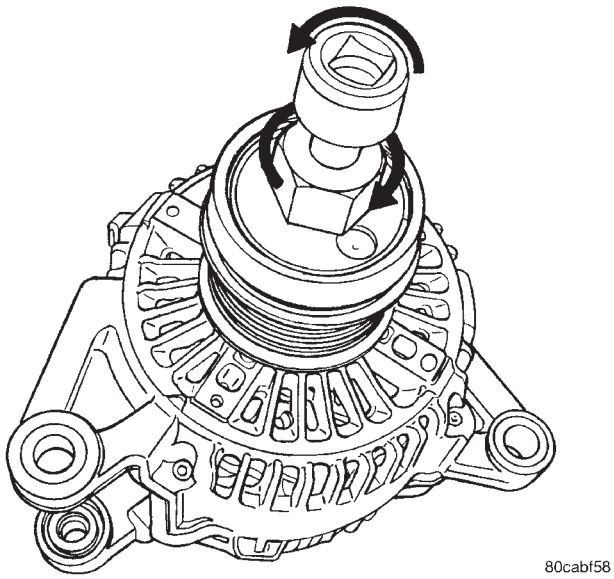

Fig. 17 DECOUPLER INSTALLATION (Litens)

STARTING

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STARTING

SPECIFICATIONS

STARTER MOTOR - DIESEL

Starter and Solenoid	
Engine Application	Diesel
Power Rating	2.2 Kilowatt
Voltage	12 Volts
Number of Fields	4
Number of Poles	4
Number of Brushes	4
Drive Type	Planetary Gear Reduction
Free Running Test Voltage	11.5 Volts
Free Running Test Maximum Amperage Draw	160 Amperes
Free Running Test Minimum Speed	5500 rpm
Solenoid Closing Maximum Voltage	7.8 Volts
*Cranking Amperage Draw test	350 Amperes
*Test at operating temperature. Cold engine, tight (new) engine, or heavy oil will increase starter amperage draw.	

STARTER MOTOR

REMOVAL - 2.7L DIESEL

(1) Disconnect and isolate negative battery cable.
(2) Raise and support vehicle.
(3) Remove battery cable mounting nut and cable eyelet at starter solenoid battery terminal.
(4) Remove 2 starter mounting bolts (Fig. 1).
(5) Partially lower starter to gain access to solenoid wire connector. Do not allow starter motor to hang from the wire harness.
(6) Disconnect solenoid wire at starter: slide red colored tab to unlock; push down on black colored tab while pulling connector from solenoid.
(7) Remove starter from vehicle.

INSTALLATION - 2.7L DIESEL

(1) Position starter motor to transmission.
(2) Install and tighten 2 mounting bolts. Refer to torque specifications.
(3) Connect solenoid wire to starter solenoid. Slide red colored tab to lock connector.
(4) Install battery cable and nut to solenoid stud. Refer to torque specifications.
(5) Lower vehicle.

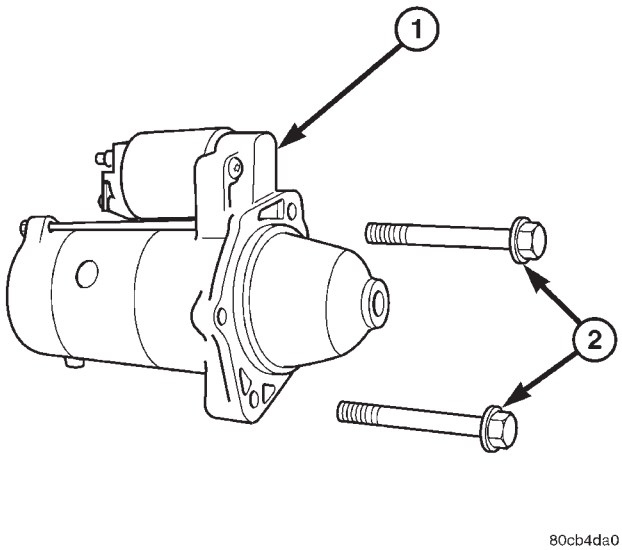

Fig. 1 STARTER MOTOR - 2.7L DIESEL

1 - STARTER MOTOR
2 - MOUNTING BOLTS (2)

(6) Connect negative battery cable.

IGNITION CONTROL

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GLOW PLUG

DESCRIPTION

Glow plugs are used to help start a cold or cool engine (Fig. 1). The glow plugs will heat up and glow to heat the combustion chamber of each cylinder. An individual glow plug is used for each cylinder. Each glow plug is threaded into the left side of the cylinder head below the cylinder head cover/intake manifold.

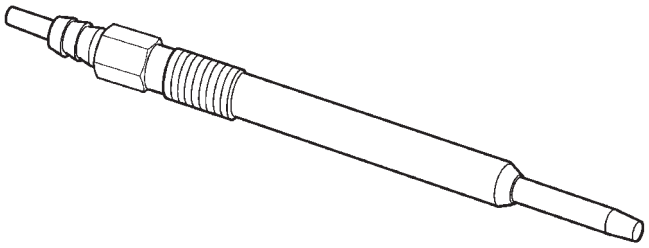

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Fig. 1 GLOW PLUG

OPERATION

The glow plugs are used to preheat the combustion chambers in order to achieve the ignition temperature required for the fuel-air mixture.

The glow plug consists of a housing with a female thread and an interference-fit rod. The heating element is integrated in the glow rod. It consists of a heating winding and a control winding connected in series.

When the glow plug system is switched “ON”, a current of about 30 ampere flows to each glow plug. The heating winding heats the glow plug. The control winding increases its resistance as the temperature rises and limits the current to approximately 15-25 ampere. The glow plug is protected this way from overloads.

REMOVAL

CAUTION: Engine temperature must be at least 90°C (194°F) before removing glow plugs. If cylinder head is already removed, warm cylinder head to 90°C (194°F) before removing glow plugs.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO SKIN AND EYES EXPOSED TO FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: Press in on fuel line locking tab to release fuel line. Pull back on locking tab to return to lock position.

(3) Remove fuel return flow line to high pressure pump.
(4) Disconnect glow plug electrical connector (Fig. 2).

WARNING: RISK OF INJURY TO SKIN AND EYES FROM HANDLING HOT OR GLOWING OBJECTS. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR.

(5) Remove glow plugs and clean glow plug bay (Fig. 2).

INSTALLATION

(1) Clean glow plug bay and install glow plug. Tighten glow plugs to 12N·m (106 lbs. in.).
(2) Connect glow plug electrical connector. (Fig. 2).

GLOW PLUG (Continued)

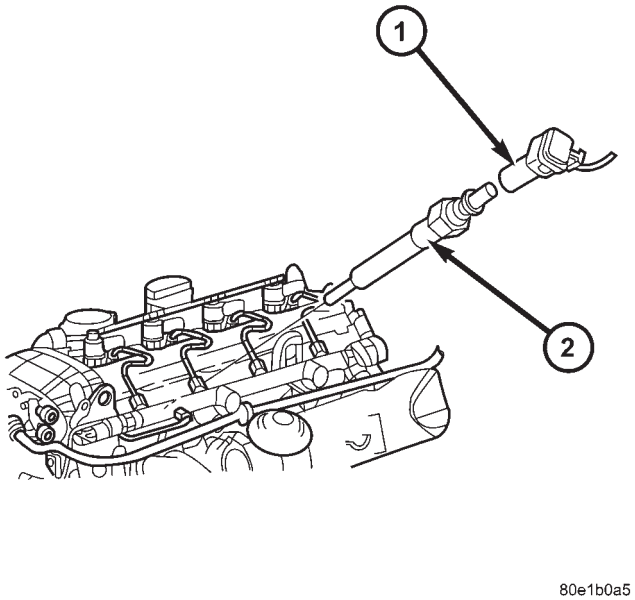

Fig. 2 GLOW PLUG LOCATION - TYPICAL

1 - GLOW PLUG ELECTRICAL CONNECTOR
2 - GLOW PLUG

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO SKIN AND EYES EXPOSED TO FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: Press in on fuel line locking tab to release fuel line. Pull back on locking tab to return to lock position.

(3) Install fuel return flow line to high pressure pump.
(4) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(5) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

GLOW PLUG RELAY

DESCRIPTION

There are two glow plug relays. These relays are located in the Power Distribution Center (PDC) in the engine compartment.

OPERATION

When the ignition (key) switch is place in the ON position, a signal is sent to the ECM relating current engine coolant temperature. This signal is sent from the engine coolant temperature sensor.

After receiving this signal, the ECM will determine if, when and for how long of a period the glow plug relays should be activated. This is done before, during and after the engine is started. Whenever the glow plug relays are activated, it will control the 12 volt 100 amp circuit for the operation of the four glow plugs. Each relay control two glow plugs.

The Glow Plug lamp is tied to this circuit. Lamp operation is also controlled by the ECM.

With a cold engine, the glow plug relays and glow plugs may be activated for a maximum time of 200 seconds. Refer to the following Glow Plug Control chart for a temperature/time comparison of the glow plug relay operation.

In this chart, Pre-Heat and Post-Heat times are mentioned. Pre-Heat is the amount of time the glow plug relay control circuit is activated when the ignition (key) is switched ON, without the engine running. Post-Heat is the amount of time the glow plug relay control circuit is activated after the engine is operated. The Glow Plug lamp will not be activated during the post-heat cycle.

Engine Coolant Temperature ″Key ON″	Wait-To Start Lamp ″ON″ (Seconds)	Pre-Heat Cycle (Glow Plugs On Seconds)	Post-Heat Cycle (Seconds)
-30C	20 SEC.	35 SEC.	200 SEC.
-10C	8 SEC.	23 SEC.	180 SEC.
+10C	6 SEC.	21 SEC.	160 SEC.
+30C	5 SEC.	20 SEC.	140 SEC.
+40C	4 SEC.	19 SEC.	70 SEC.
+70C	1 SEC.	16 SEC.	20 SEC.

DIAGNOSIS AND TESTING - GLOW PLUG RELAYS

Refer to the appropriate Diesel Powertrain Diagnosis Manual for information on diagnosing the glow plug relays.

ENGINE

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ENGINE - 2.7L DIESEL

DESCRIPTION

DESCRIPTION

This 2.7 Liter five-cylinder Common Rail Diesel Injection (CDI) engine is an in-line overhead valve diesel engine. This engine utilizes a cast iron cylinder block and an aluminum cylinder head. The engine is turbocharged and intercooled. This engine also has for valve per cylinder and dual overhead camshafts (Fig. 1).

DESCRIPTION	SPECIFICATION
Engine	2.7L CDI
Engine Description	5 Cylinder In-Line Engine With 4-Valve Technology
Fuel Injection System	Common Rail Diesel Injection (CDI)
Fuel	Diesel
Rated Output	125/4200 kW at RPM
Torque	400/1600-2400 Nm at RPM
Maximum Speed	4800 RPM
Compression Ratio	19:1
Bore/Stroke	88.0/88.4 mm
Eff. Displacement	2688 cm3

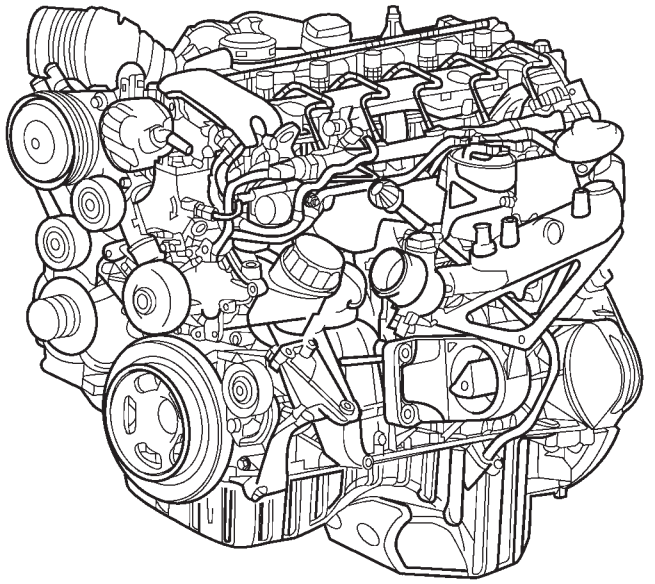


Fig. 1 2.7L DIESEL ENGINE

ENGINE - 2.7L DIESEL (Continued)

DESCRIPTION - ENGINE COVER

The engine cover is a black plastic cover used to cover the top of the engine (Fig. 2).

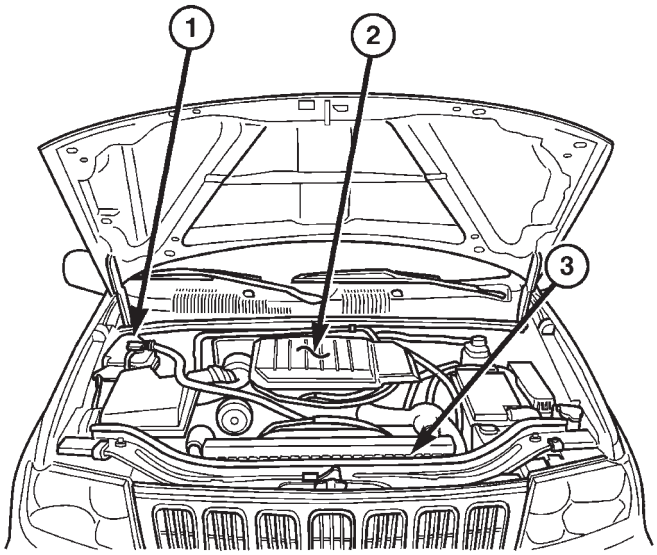


Fig. 2 ENGINE COMPARTMENT

1 - COOLANT PRESSURE CONTAINER
2 - ENGINE COVER
3 - RADIATOR

STANDARD PROCEDURE

STANDARD PROCEDURE - COMPRESSION TESTING ENGINE

(1) Warm up engine to operating temperature (approx. 80 °C).

(2) Shut off engine.

(3) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(4) Remove glow plugs (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/GLOW PLUG - REMOVAL).

(5) Crank engine several times with the starter to eliminate combustion residues in the cylinders.

(6) Insert compression tester adapter with check valve installed into glow plug hole of cylinder to be tested.

(7) Test compression pressure by cranking engine with starter for at least 8 revolutions.

(8) Carry out test procedure at the remaining cylinders in the same way.

(9) Compare pressure readings obtained with the specified pressures. If the pressure reading is below the minimum compression pressure or if the permissible difference between the individual cylinders is exceeded. Refer to cylinder leak down test.

(10) Remove compression tester and adapter from cylinder head.

(11) Install glow plugs (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/GLOW PLUG - INSTALLATION).

(12) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

INSPECTING

NOTE: If crankshaft rotates, install retaining lock for crankshaft/ring gear.

(1) Pressurize cylinder with compressed air and read off pressure loss at cylinder leak tester. If excessive pressure loss exists, determine cause. Refer to (DETERMINING PRESSURE LOSS OF CYLINDERS).

NOTE: If the retaining lock is installed, remove it, rotate engine and install lock once again.

(2) Carry out test of other cylinders in the firing order of engine.

STANDARD PROCEDURE - CHECKING OIL PRESSURE

(1) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(2) Remove oil galley plug together with seal at timing case cover.

(3) Screw oil pressure gauge adaptor fitting together with seal onto timing case cover.

(4) Connect oil pressure gauge to adaptor fitting.

(5) Check oil level, adjust with correct engine oil if necessary.

(6) Insert temperature of remote thermometer into oil level indicator tube.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

CAUTION: Ensure that fan and accessory drive belt DO NOT damage oil pressure gauge hose.

(7) Start engine and bring to operating temperature 90°C (194°F).

(8) Record engine oil pressure at idle.

(9) Raise engine speed to 3000 rpm and record oil pressure.

ENGINE - 2.7L DIESEL (Continued)

(10) At normal operating temperature the oil pressure must not drop below 3 bar (44 psi.). When engine speed is raised, oil pressure must rise with out delay and be no less than 3 bar (44 psi.) at 3000 rpm.

(11) If oil pressure is out of range, determine cause.

REMOVAL

REMOVAL - 2.7L DIESEL ENGINE

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING WITH HOT COOLANT. RISK OF POISONING FROM SWALLOWING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS COOLANT TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN SUITABLE AND APPROPRIATELY MARKED CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHES, AND EYE WEAR.

CAUTION: STORE OR DISCARD ALL FULIDS IN SUITABLE AND APPROPRIATELY MARKED CONTAINERS.

(1) Disconnect negative battery cable.

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(3) Drain cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

(4) Evacuate and recover air conditioning system (Refer to 24 - HEATING & AIR CONDITIONING/ PLUMBING - STANDARD PROCEDURE).

(5) Remove front grill and fascia assembly (Refer to 23 - BODY/EXTERIOR/GRILLE - REMOVAL).

(6) Remove headlamp assemblies (Refer to 23 - BODY/EXTERIOR/GRILLE FRAME - REMOVAL).

(7) Remove headlamp support.

(8) Remove upper radiator support.

(9) Remove upper radiator hose.

(10) Raise and suitably support vehicle.

(11) Disconnect supply and return lines at viscus fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(12) Disconnect lower radiator hose at radiator.

(13) Disconnect transmission cooler hoses at cooler.

(14) Disconnect fan electrical connector.

(15) Lower vehicle.

(16) Disconnect both power steering cooler hoses at cooler.

(17) Remove power steering resivior retaining bolts.

(18) Lift coolant module from vehicle (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).

(19) Remove air cleaner housing assembly.

(20) Remove air tube at turbocharger.

(21) Remove air conditioning lines from compressor.

(22) Remove junction block bracket from compressor.

(23) Remove turbocharger outlet to charge air cooler.

(24) Disconnect coolant resivior lines from engine.

(25) Disconnect signal line at turbocharger.

(26) Disconnect generator B+ at generator.

(27) Disconnect fuel supply and return lines at fuel filter (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL FILTER / WATER SEPARATOR - REMOVAL) .

(28) Remove battery (Refer to 8 - ELECTRICAL/ BATTERY SYSTEM/BATTERY - REMOVAL).

(29) Remove battery tray (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/TRAY - REMOVAL).

(30) Disconnect B+ wiring at power distribution center (PDC).

(31) Disconnect pedal position sensor electrical connectors.

(32) Disconnect 3 engine wiring harness connectors.

(33) Remove connector bracket from left sill plate.

(34) Remove exhaust flange retainer at turbocharger.

(35) Disconnect heater hoses.

(36) Raise and suitably support vehicle.

(37) Remove torque converter bolts.

(38) Remove starter (Refer to 8 - ELECTRICAL/ STARTING/STARTER MOTOR - REMOVAL).

(39) Remove transmission bell housing bolts from engine.

(40) Disconnect transmission electrical connectors.

(41) Lower vehicle.

(42) Suitably support transmission.

(43) Connect a suitable engine hoist.

(44) Raise engine approximately 76mm (3 in.).

(45) Remove left engine mount sill plate.

CAUTION: When removing engine care must be taken not to damage crankshaft sensor or other ancellary components.

(46) Remove engine from vehicle.

ENGINE - 2.7L DIESEL (Continued)

REMOVAL - ENGINE COVER

(1) Firmly grasp front of cover and lift straight up to release cover from mounting ball studs (Fig. 3).

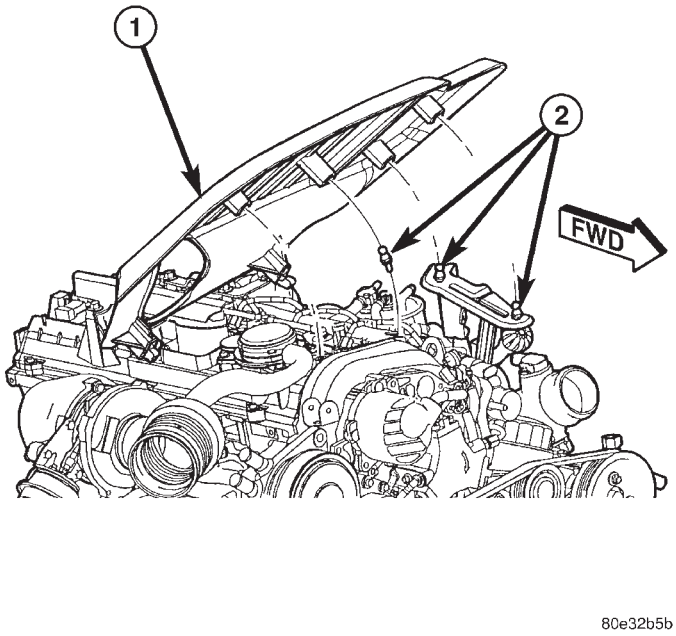


Fig. 3 ENGINE COVER FRONT MOUNTS

1 - ENGINE COVER
2 - MOUNTING BALL STUDS

(2) Pull cover out of rear mounts and remove from vehicle (Fig. 4).

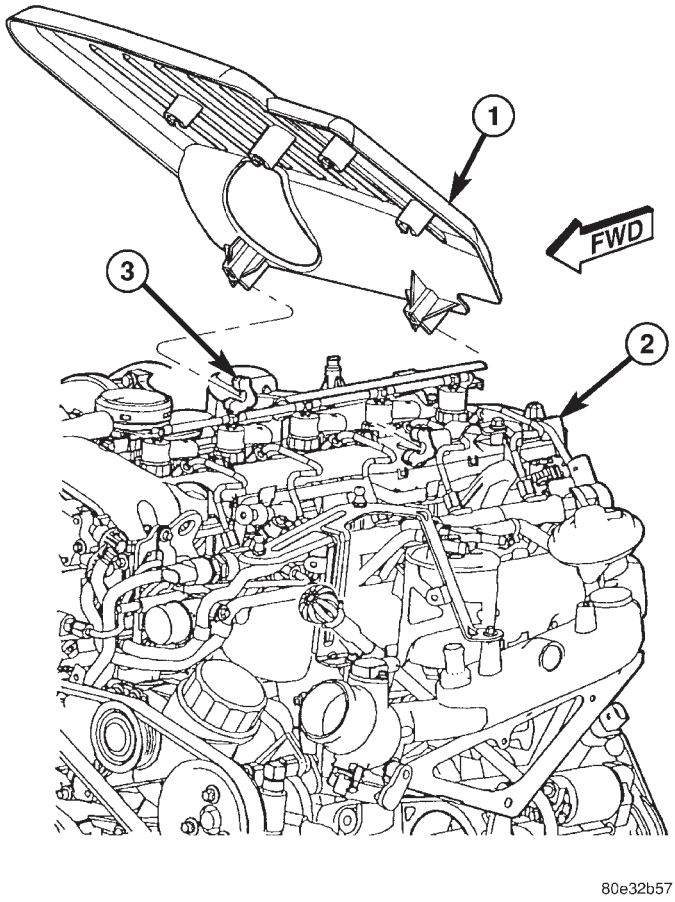


Fig. 4 ENGINE COVER REAR MOUNTS

1 - ENGINE COVER
2 - CYLINDER HEAD COVER
3 - REAR MOUNT

INSTALLATION

INSTALLATION - 2.7L DIESEL ENGINE

CAUTION: When installing engine, care must be taken not to damage crankshaft sensor or other ancillary components.

(1) Suitably support transmission.
(2) Position engine in bay area approximately 76MM (3 in.) above.
(3) Install left engine mount through bolt into sill plate, Do Not tighten.
(4) Lower engine until sill plate meets frame rail.
(5) Slide engine back toward transmission until engine meets bell housing.
(6) Raise and suitably support vehicle.
(7) Install and tighten transmission bell housing bolts
(8) Install and tighten transfer case bolts.
(9) Install starter (Refer to 8 - ELECTRICAL/ STARTING/STARTER MOTOR - INSTALLATION).
(10) Connect transmission and transfer case electrical connectors.
(11) Install and tighten torque converter bolts.
(12) Lower vehicle.
(13) Connect heater hoses.
(14) Connect exhaust flange retainer at turbocharger.
(15) Install connector bracket to left sill plate.
(16) Connect engine wiring harnesses.
(17) Connect pedal position sensor electrical harness connectors.
(18) Connect B+ wiring at power distribution center (PDC).
(19) Install battery tray.
(20) Install battery.
(21) Connect fuel supply and return lines.
(22) Connect generator B+ at generator.
(23) Connect signal line at turbocharger.
(24) Connect coolant pressure container lines.

(25) Install turbocharger outlet to charge air cooler.
(26) Install junction block bracket to compressor.
(27) Install air conditioning lines to compressor.
(28) Install air tube at turbocharger.
(29) Install air cleaner housing.
(30) Install coolant module (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).
(31) Position and install power steering reservoir.
(32) Connect both power steering cooler lines to cooler.
(33) Connect transmission cooler lines at cooler.
(34) Connect lower radiator hose to radiator.
(35) Connect supply and return lines at viscous fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).
(36) Install upper radiator hose.
(37) Install upper radiator support (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION)..
(38) Install headlamp support.
(39) Install headlamp assemblies.
(40) Install front grill and fascia assembly.
(41) Fill coolant system with proper mixture to proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(42) Fill engine oil to proper level. Refer to owners manual for specifications.
(43) Connect negative battery cable.
(44) Evacuate and recharge air conditioning (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE), (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(45) Bleed air from fuel injection system (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
(46) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(47) Start engine and inspect for leaks.
(48) Check transmission and transfer case oil levels. Refer to owners manual for specifications.

INSTALLATION - ENGINE COVER

(1) Align cover and push into rear mounts (Fig. 4).
(2) Push down front of cover slowly to align mounting ball studs (Fig. 3).
(3) Push down firmly on front of cover to lock cover in place.

ENGINE - 2.7L DIESEL (Continued)

SPECIFICATIONS - TORQUE SPECIFICATIONS

2.7L DIESEL

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Crankcase Ventilation			
Screw-Air Charge Distribution Pipe to Air Charge Distribution Panel	11	-	97
Cylinder Head			
8m-Bolt- Cylinder Head to Timing Case Cover	20	15	-
Bolt-Front Cover to Cylinder Head	14	-	124
12m-Bolt-Cylinder Head to Crankcase (3 stages, torque, torque angle, torque angle)	60, 90°, 90°	44	-
Crankcase, Timing Case Cover, End Cover			
Bolt-Crankshaft Bearing Cap to Crankcase (2 stages, torque, torque angle)	55, 90°	40	-
Bolt-End Cover to Crankcase	9	-	80
Bolt-Timing Case Cover to Crankcase	20	15	-
Plug-Coolant Drain to Crankcase	30	22	-
Oil Pan			
6m-Bolt-Oil Pan to Crankcase	9	-	80
8m-Bolt-Oil Pan to Crankcase	20	15	-
Bolt-Oil Pan to End Cover	9	-	80
Bolt-Oil Pan to Timing Case Cover	9	-	80
Bolt-Oil Pan to Transmission Bell Housing	40	30	-
Plug-Pil Pan to Oil Drain	47	35	-
Connecting Rod			
Bolt-Connecting Rod Cap to Connecting Rod (3 stage, 1&2 torque, 3 torque angle)	5,25,90°	-	44,221
Crankshaft			
Bolt-Crankshaft Bearing Cap (2 stage, 1 torque, 2 torque angle	55,90°	40.5	-
Flywheel, Driven Plate, Vibration Damper, Starter Ring Gear			
8.8m-Bolt-Central Bolt of Vibration Damper (2 stage, 1 torque, 2 torque angle)	200,90°	147.5	-
10.9m-Bolt-Central Bolt of Vibration Damper (2 stage, 1 torque, 2 torque angle)	325,90°	240	-
Bolt-Stretch Shank for Flywheel or 2 Mass Flywheel to Crankshaft (2 stage, 1 torque, 2 torque angle)	45,90°	33	
Turbo Charger			
Bolt-Oil Feed Line to Cylinder Head	9/22	-	80-194
Bolt-Oil Feed Line to Turbo Charger	30	22	-
Bolt-Turbo Charger Support	30	22	-
Bolt-Turbo Charger Support to Crankcase	20	-	177
Bolt-Oil Outlet Line to Turbo Charger	9	-	80

ENGINE - 2.7L DIESEL (Continued)

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Connection-Flange of Exhaust Manifold to Turbo Charger	30	22	-
Connection-Turbo Charger to Front Catalytic Converter	30	22	-
Charge Air Pipe/Charge Air Cooling			
Bolt-Charge Air Distribution Pipe	16	-	141
Bolt-Inlet Port Shut Off Positioning Motor to Air Charge Distribution Pipe	9	-	80
Bolt-Support to Charge Air Distribution Pipe	20	-	177
Bolt-Support to Engine Bracket	40	30	-
Clamp-Charge Air Pipes/Hoses	3	-	27
Belt Tensioning Device			
Bolt-Guide Pully to Coolant Pump	35	26	-
Bolt-Guide Pully to Timimg Case Cover	35	26	-
Bolt-V-Belt Tensioning Device to Tensioning Pully	36	26.5	-
Bolt-V-Belt Tensioning Device to Timing Case Cover	30	22	-
Exhaust Manifold			
Nut-Exhaust Manifold at Cylinder Head	30	22	-
Position Sensor			
Nut/Bolt-Camshaft Position Sensor to Cylinder Head Cover	11	-	97
Nut/Bolt-Crankshaft Position Sensor to Engine Block	8	-	70
Pre-Glow System			
Cylinder Head to Glow Plug	12	-	106
Starter			
Bolt-Starter to Crankcase	42	31	-
Nut-Connection of Circuit 30	14	-	124
Nut-Connection of Circuit 50	6	-	53
Alternator			
Bolt-Generator to Timing Case Cover	20	15	-
Bolt-Generator to Cooler Housing	6	-	53
Bolt-Cooler Housing of Generator to Crankcase	20	-	177
Nut-B+ Circuit to Generator	13-18	-	115-159
Nut-D+ Circuit to Generator	5	-	44
Nut-Collar to V-Belt Pully	80	59	-
Oil Pump			
Bolt-Oil Pump to Crankcase	18	-	133
Bolt-Oil Pipe to Crankshaft Bearing Cap	8	-	70
Oil Filter			
Screw Cap to Oil Filter	25	18.5	-
Oil Cooling System			

ENGINE - 2.7L DIESEL (Continued)

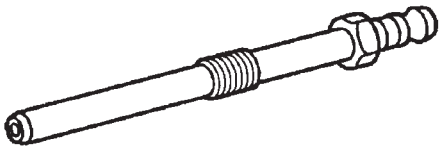
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Bolt-Oil-Water Heat Exchanger to Timing Cover Case	15	-	133
Oil Level Pressure			
Bolt-Dip Stick Guide Tube to Cylinder Head	14	-	123
Bolt-Oil Level Sensor to Oil Pan	14	-	123
Coolant Pre- Heater			
Coolant Pre-Heater in Engine Block	35	26	-
Engine Cooling General			
Bolt-Belt Pully to Coolant Pump	8-35	6 - 26	-
Bolt-Coolant Pump to Timing Case Cover 6m/8m	14/20	10 - 15	-
Bolt-Thremostat Housing to Cylinder Head	9	-	80
Coolant Drain Plug to Crankcase	30	22	-
Engine Suspension, Engine Mount, Engine Bracket			
Bolt-Engine Bracket to Crankcase (2 stage, torque, torque angle)	20/90°	15	-
Bolt-Engine Mount to Engine Bracket	55	40.5	-
Bolt-Front Engine Mount to Front Axle Carrier	35	26	-
Bolt-Rear Engine Cross Member to Body	40	30	-
Bolt-Rear Engine Mount to Rear Engine Cross Member	35	26	-
Bolt/Nut- Rear Engine Mount to Transmission	40	26	-
Bolt-Shrowd to Engine Bracket	10	-	88.5
Nut-Front Engine Mount to Engine Bracket	65	48	-
Nut-Engine Mount to Vehicle Frame	35	26	-
Fuel Filter			
Bolt-Clip to Fuel Filter	8	-	70
Bolt- Fuel Filter to Charge Air Distribution Pipe	14	-	124
Exhaust System			
Bolt- Catalytic Converter Bracket to Crankcase	20	-	177
Clamp-Connection Between Front Exhaust Pipe and Rear Exhaust System	55	41	-
Clip-Front Catalytic Converter to Engine Mount	20	-	177
Nut-Bracket to Tail Pipe	55	40.5	-
Nut-Exhaust Bracket to Threaded Plate of Center Exhaust Pipe	20	-	177
Support-Exhaust Bracket on Transmission	20	-	177
Refrigerant Compressor			
Bolt-Refrigerant Compressor to Timing Case Cover	20	-	177
Bolt-Refrigerant Compressor to Bracket	20	-	177
Bolt-Refrigerant Lines to Refrigerant Compressor	20	-	177
Timing Chain, Chain Tensioner			
Bolt-Camshaft Sprocket to Exhaust Camshaft	18	-	159
Bolt-Intermediate Gear of High Pressure Pump to Cylinder Head	40	29.5	-

ENGINE - 2.7L DIESEL (Continued)

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Timing Chain Tensioner to Timing Case Cover	80	59	-
Camshaft			
Bolt-Camshaft Bearing Cap to Cylinder Head	9	-	80
Bolt-Driver to Inlet Camshaft	50	37	-
Common Rail Diesel Injection			
Bolt-Bango Bolt of Leak Oil Line to Rail	20	-	177
Bolt-Bracket to High Pressure Pump	9	-	80
Bolt-High Pressure Pump to Cylinder Head	14	-	124
Bolt-Pre-delivery Pump to Top Cover of Cylinder Head	9	-	80
Bolt-Pressure Control Valve to Rail (2 stage, torque)	3/5	-	26/44
Bolt-Rail to Cylinder Head	14	-	124
Bolt-Shutoff Valve to Cylinder Head	8	-	70
Nut-Pressure Line to Rail/Injector (New,Reused)	22/25	16/18.5	-
Nut-Pressure Line to High Pressure Pump/Rail	22	16	-
Screw-Tensioning Claw to Injector (2 stage, 1 torque, 2 torque angle)	7/90°	-	62
Rail- Pressure Sensor to Rail	22	16	-
Pressure Pipe Connection to Injector	42	31	-
Threaded Rail to Rail	22	16	-
Fuel Cooling System			
Bolt-Fuel Cooler to Charge Air Distribution Pipe	14	-	124
Heater Booster, Heater Unit			
Bolt- Temperature Controlled Cut Out to Heater Booster control Module	12	-	106
Nut-Threaded Stud to Electronic Heater Booster	18	-	159

ENGINE - 2.7L DIESEL (Continued)

SPECIAL TOOLS



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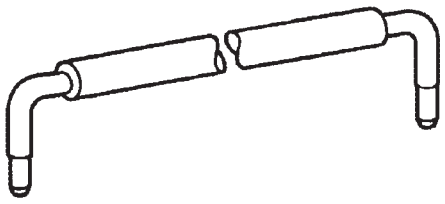
#8927 COMPRESSION TESTER ADAPTER



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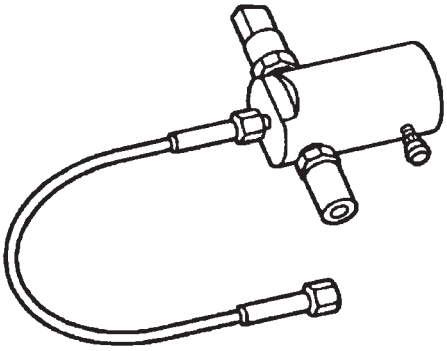
#8929 CAMSHAFT LOCKING PIN



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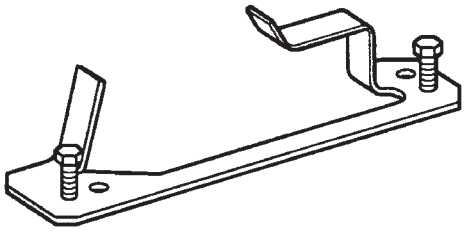
#8928 FUEL PRESSURE TESTER



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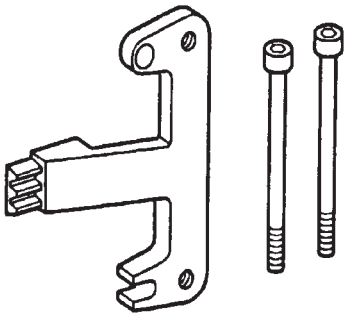
#8931 TIMING CHAIN RETAINER

ENGINE - 2.7L DIESEL (Continued)



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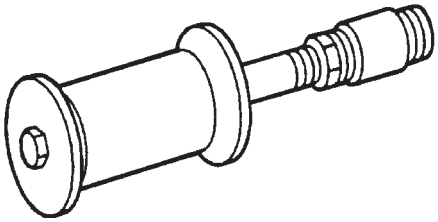
#8932 CRANKSHAFT LOCK



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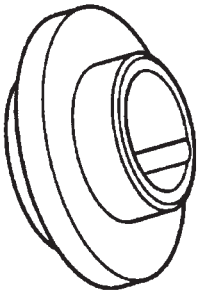
#8937 SLIDE HAMMER



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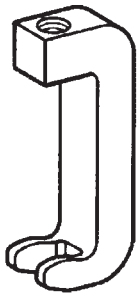
#8936 FRONT CRANKSHAFT SEAL INSTALLER



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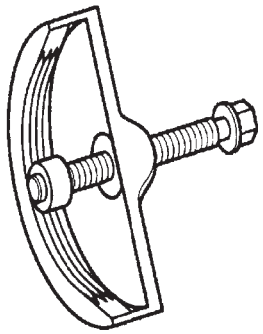
#8938 INJECTOR REMOVER

ENGINE - 2.7L DIESEL (Continued)



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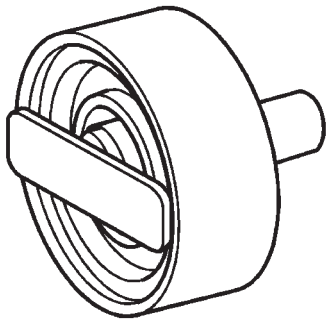
#8940 VIBRATION DAMPER REMOVER



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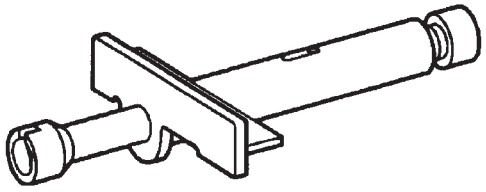
#8944 REAR MAIN SEAL INSTALLER



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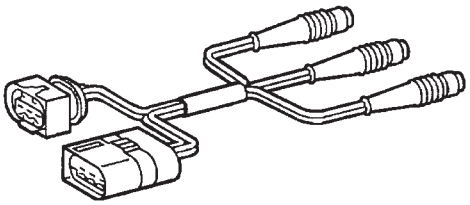
#8942 OIL JET INSTALLER



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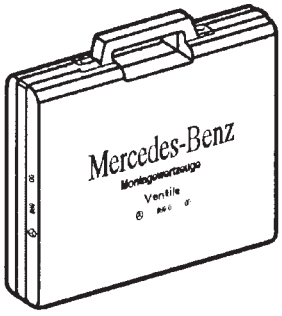
#8945 ADAPTER CABLE

ENGINE - 2.7L DIESEL (Continued)



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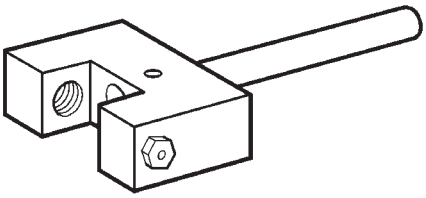
#8946 VALVE SERVICE TOOLS



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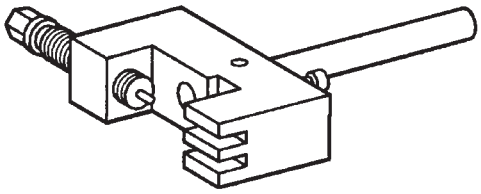
#8948 CHAIN SEPARATOR TOOL



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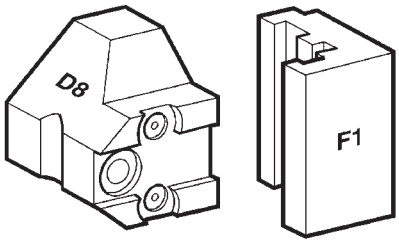
#8947 RIVET OPENER



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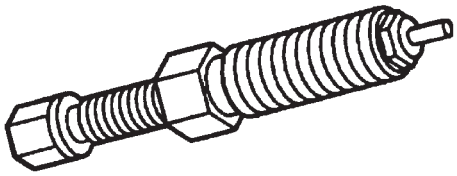
#8949 THRUST PIECE

ENGINE - 2.7L DIESEL (Continued)



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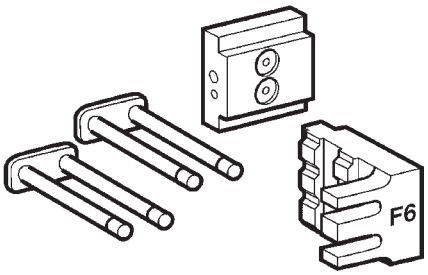
#8950 PRESSING SCREW



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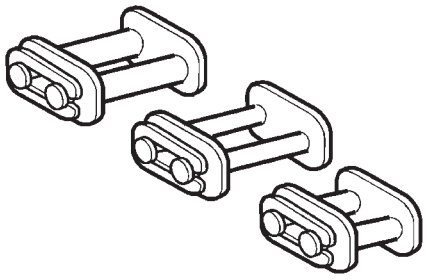
#8952 ASSEMBLY INSERTS



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#8951 ASSEMBLY LINKS

CYLINDER HEAD

STANDARD PROCEDURE

STANDARD PROCEDURE - CYLINDER HEAD BOLT INSPECTION

(1) Measure cylinder head bolts between points shown (Fig. 5).

Cylinder Head Bolts	Thread Diameter	12 M
	Length When New	102 mm
	Maximum Length	104 mm

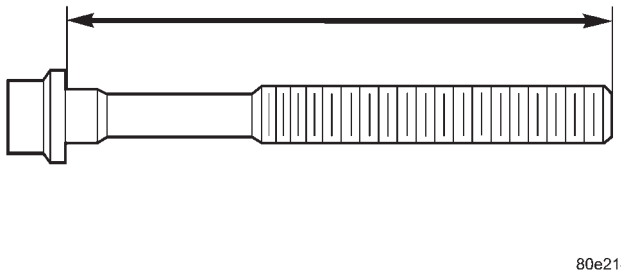

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Fig. 5 MEASURING CYLINDER HEAD BOLTS

(2) If the cylinder head bolt length is greater than the maximum allowable measurement, replace the cylinder head bolts.

STANDARD PROCEDURE - MEASURE CYLINDER HEAD SURFACE

NOTE: Only resurface cylinder head contact surface if porous or damaged. IT IS NOT necessary to rework minor variations in flatness in the longitudinal direction.

(1) Disconnect negative battery cable.
(2) Remove cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - REMOVAL).
(3) Remove valves.
(4) Inspect cylinder head contact surface for flatness, porous and damage.
(5) Using a straight edge, measure cylinder head and cylinder block flatness.
(6) Measure cylinder head height at point (1) indicated and retain reading (Fig. 6).

NOTE: The camshaft housing Must Not be machined. Basic bore of the camshaft bearings will be altered.

(7) Machine cylinder head contact surface, if necessary.
(8) Measure cylinder head height (1) at point indicated, record stock removal (Fig. 6) CYLINDER HEAD SPECIFICATIONS .
(9) Measure valve setback at points (2) indicated (Fig. 6) CYLINDER HEAD SPECIFICATIONS .

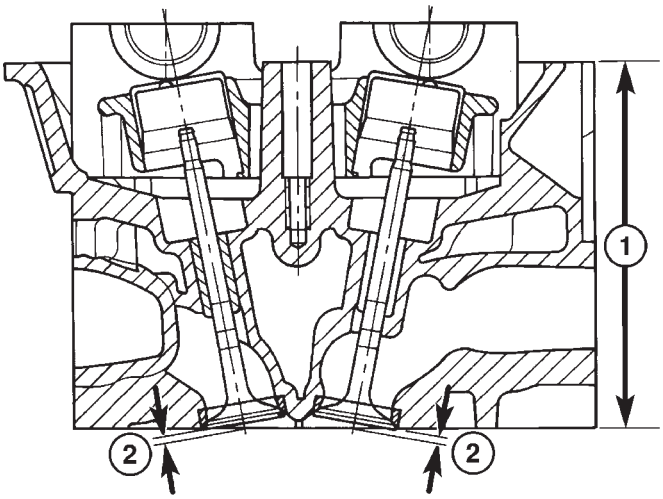

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Fig. 6 CYLINDER HEAD MEASURMENTS

NOTE: If measurement is less than dimension “2” no further correct valve clearance compensation is possible; replace valve seat ring or cylinder head if measurement is greater than specification.

CYLINDER HEAD SPECIFICATIONS

Description	Specification
Height of Cylinder Head (1), With Out Camshaft Housing	126.85mm to 127.15mm
Valve Set Back (2) With New Valves and New Valve Seat Rings	Exhaust Valve: 1.0mm - 1.4mm Intake Valve: 1.1mm - 1.5mm

CYLINDER HEAD (Continued)

REMOVAL

REMOVAL - CYLINDER HEAD

(1) Disconnect negative battery cable.
(2) Raise and support vehicle.

WARNING: RISK OF INJURY TO SKIN AND EYES FROM SCALDING COOLANT. DO NOT OPEN COOLING SYSTEM UNLESS TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN APPROVED CONTAINER ONLY. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR.

(3) Drain cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Lower vehicle.
(5) Remove engine cover. (Refer to 9 - ENGINE COVER- REMOVAL).
(6) Remove air cleaner housing.
(7) Remove air intake tube at turbocharger.
(8) Disconnect vacuum hose at turbocharger waste gate solenoid.
(9) Disconnect heater hoses and remove coolant pipe.

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING WHEN HANDLING FUEL.

(10) Remove fuel high pressure pipes and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ FUEL INJECTOR - REMOVAL).

NOTE: Refer to the appropriate injector servicing procedures for cleaning of the injectors and recesses.

(11) Clean injectors(Refer to 14 - FUEL SYSTEM/ FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE).
(12) Unbolt fuel air bleed at intake manifold and set aside.
(13) Disconnect fuel injector and glow plug wiring harness and set aside.
(14) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(15) Position piston of cylinder #1 to ignition TDC.
(16) Install retaining lock for crankshaft/starter ring gear.
(17) Remove timing chain tensioner(Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(18) Remove cylinder head front cover(Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
(19) Remove top guide rail (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(20) Remove camshafts(Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
(21) Remove idler gear (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(22) Remove pressure line at high pressure pump.
(23) Remove fuel return flow line between rail and high pressure pump.
(24) Remove high pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).
(25) Remove fuel return hose at fuel filter.
(26) Remove charge air distribution pipe (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - REMOVAL).
(27) Unbolt oil dip stick tube.
(28) Disconnect viscous heater and set aside.
(29) Disconnect precatalytic converter at turbocharger.
(30) Detach charge air pipe at turbocharger.
(31) Remove oil return flow line at turbocharger.
(32) Remove turbocharger support bracket.
(33) Remove upper timing case to cylinder head bolts.

NOTE: Loosen cylinder head bolts in the reverse order of the tightening sequence.

(34) Remove cylinder head bolts and inspect (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE).
(35) Remove cylinder head.

NOTE: Carefully clean all mating surfaces and bolt thread holes. Assure that no oil or grease is present during reassembly.

(36) Clean all mating surfaces and blow out bolt thread holes.

REMOVAL - CYLINDER HEAD FRONT COVER

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Partially drain cooling system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Disconnect viscous heater pipe and set aside.

CYLINDER HEAD (Continued)

(5) Disconnect cooling fan power steering hose at power steering pump and set aside.

(6) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(7) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TMNG BELT/CHAIN TENSIONER&PULLEY - REMOVAL).

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. SERVICE VEHICLE IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING WHEN HANDLING FUEL.

(8) Remove low pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).

(9) Remove vacuum pump (Refer to 9 - ENGINE/ENGINE BLOCK/INTERNAL VACUUM PUMP - REMOVAL).

(10) Remove bolts attaching front cover.

NOTE: Lower portion of front cover is sealed with RTV sealant. Carefully tug at front cover until it loosens from cylinder head.

(11) Raise locking pawl of top guide rail and remove cylinder head front cover (Fig. 7).

NOTE: Dowel pins are use as a guide during assembly and must remain in the proper position to assure a good sealing surface.

REMOVAL - CYLINDER HEAD GUIDE RAIL

(1) Disconnect negative battery cable.

CAUTION: Rotate engine at crankshaft only. DO NOT rotate the engine with the bolt of the camshaft sprocket. DO NOT rotate the engine back.

NOTE: Markings on the camshaft and camshaft bearing cap must be aligned.

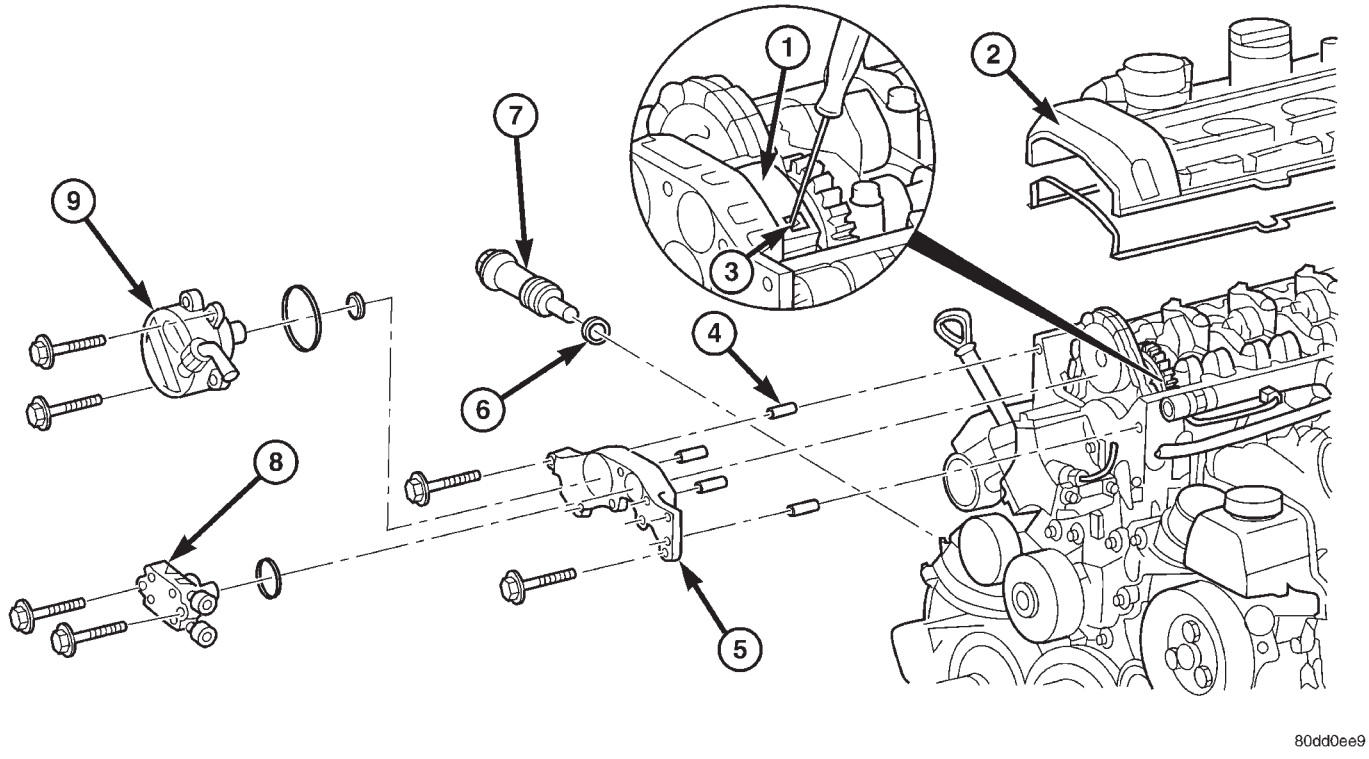

Fig. 7 CYLINDER HEAD FRONT COVER

1 - TOP GUIDE RAIL
2 - CYLINDER HEAD COVER
3 - LOCKING PAWL
4 - DOWEL PIN
5 - CYLINDER HEAD FRONT COVER
6 - SEAL
7 - TIMING CHAIN TENSIONER
8 - LOW PRESSURE PUMP
9 - VACUUM PUMP

CYLINDER HEAD (Continued)

(2) Position piston of number 1 cylinder to ignition TDC.
(3) Remove engine cover. (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(4) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(5) Carefully raise locking pawl of top slide rail and remove front cover at cylinder head (Fig. 7).
(6) Insert a locking pin through 1st camshaft bearing cap into the hole in the inlet camshaft sprocket.
(7) Counter hold the camshaft with an open end wrench to avoid damage and unbolt driver of inlet camshaft sprocket.
(8) Remove top guide rail.

INSTALLATION

INSTALLATION - CYLINDER HEAD

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. SERVICE VEHICLES IN WELL VENTILATED AREAS. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. WEAR PROTECTIVE CLOTHING.

NOTE: Thoroughly clean all mating surfaces with appropriate solvents and blow out bolt holes, to assure that no grease or oil is present during reassembly.

NOTE: If piston or connecting rods have been replaced, measure piston projection.

NOTE: Check facing cylinder head contact surface.

(1) Position the cylinder head and gasket properly on engine using the dowel pins as guide.

NOTE: Inspect all cylinder head bolts for defects and stretching before installation (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE).

CYLINDER HEAD BOLT TORQUE SEQUENCE

The M12 cylinder head bolts must be torqued in 3 stages.
(1) Install M12 cylinder head bolts finger tight.
(2) Torque bolts in numeric order starting with number 1 to 60 N·m (44 lbs.in.) (Fig. 8).
(3) Install M8 timing chain cover to cylinder head bolts (1A) (Fig. 8). Tighten to 20N·m (177 lbs.in.).
(4) Tighten M12 cylinder head bolts in numeric order starting with number 1 an additional 90° (Fig. 8).
(5) Tighten M12 cylinder head bolts in numeric order starting with number 1 an additional 90° (Fig. 8).

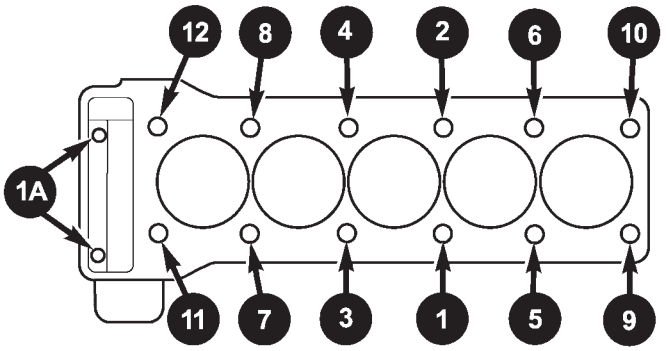

Fig. 8 CYLINDER HEAD BOLT TORQUE SEQUENCE

(2) Install turbocharger support bracket. Tighten bolts to 30N·m (22 lbs.ft.).
(3) Install oil return flow line at turbocharger.
(4) Attach charge air pipe at turbocharger.
(5) Reconnect the precatlytic converter to turbocharger. Tighten to 30N·m (22 lbs.ft.).
(6) Install viscous heater.
(7) Reconnect oil dip stick tube. Tighten to 14 N·m (124 lbs. in.).
(8) Install charge air distribution pipe (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - INSTALLATION).
(9) Install fuel return hose at fuel filter.
(10) Install high pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).
(11) Install fuel return flow line between rail and high pressure pump.
(12) Install pressure line at high pressure pump.
(13) Install idler gear (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).
(14) Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
(15) Install top guide rail (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).
(16) Install front cover at cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
(17) Install timing chain tensioner with new gasket. (Refer to 9 - ENGINE/VALVE TIMING/TIMING

CYLINDER HEAD (Continued)

BELT/CHAIN AND SPROCKETS - INSTALLATION) Tighten to 80N·m (59 lbs.ft.).

(18) Remove retaining lock for crankshaft/starter ring gear.

(19) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(20) Install and properly route fuel injector and glow plug wiring harness, making appropriate connections.

(21) Install fuel high pressure pipes and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ FUEL INJECTOR - INSTALLATION).

(22) Secure fuel air bleed at intake manifold.

(23) Connect vacuum hose at turbocharger waste gate solenoid.

(24) Install air intake tube at turbocharger (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - INSTALLATION).

(25) Install air cleaner housing.

(26) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

NOTE: DO NOT pressure test cooling system until engine has reached operating temperature.

(27) Refill cooling system with proper coolant mixture to proper level (Refer to 7 - COOLING/ENGINE/ COOLANT - STANDARD PROCEDURE).

(28) Connect negative battery cable.

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 CLOTHES.

(29) Start engine and inspect for leaks.

INSTALLATION - CYLINDER HEAD FRONT COVER

NOTE: Thoroughly clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.

NOTE: Dowel pins are used as a guide during assembly and must remain in the proper position to assure a good sealing surface.

(1) Apply sealant to lower portion and position cylinder head front cover.

(2) Raise locking pawl of top guide rail and guide front cover onto guide pins.

(3) Install bolts attaching front cover (Fig. 7) Tighten bolts to 14N·m (124 lbs. in.).

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. REMOVE SOURCES OF IGNITION FROM THE AREA. WEAR PROTECTIVE CLOTHING WHEN HANDLING FUEL. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS.

(4) Instal low pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).

(5) Install vacuum pump (Refer to 9 - ENGINE/ ENGINE BLOCK/INTERNAL VACUUM PUMP - INSTALLATION).

NOTE: Timing chain tensioner must be installed with a new gasket.

(6) Install timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(7) Connect power steering hose.

(8) Connect viscous heater pipe.

(9) Refill cooling system with proper mixture to proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

(10) Connect negative battery cable.

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 CLOTHES.

(11) Start the engine and inspect for leaks.

INSTALLATION - CYLINDER HEAD GUIDE RAIL

(1) Carefully position the top guide rail onto the guide pins.

(2) Counter hold the camshaft with an open end wrench and install driver of inlet camshaft sprocket. Tight bolt to 50N·m (37 lbs. ft.).

(3) Remove camshaft sprocket locking pin.

(4) Carefully raise locking pawl of top guide rail and install front cover at cylinder head (Fig. 7).

(5) Install timing chain tensioner with new gasket (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(6) Install engine cover (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(7) Reconnect negative battery cable.

CYLINDER HEAD (Continued)

WARNING: US 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 CLOTHES.

(8) Start engine and inspect for leaks.

CYLINDER HEAD COVER(S)

REMOVAL

(1) Disconnect negative battery cable.
(2) Detach hose from oil separator.
(3) Disconnect fuel injector and glow plug harness and set aside.
(4) Remove fuel high pressure pipes and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ FUEL INJECTOR - REMOVAL).
(5) Remove cylinder head cover retaining bolts and remove cover.

INSTALLATION

(1) Position cylinder head cover with new gasket and install bolts. Tighten bolts to 20 N·m (177 lbs. in.).
(2) Install and properly route fuel injector and glow plug wiring harness, making appropriate connections.
(3) Install injectors and high pressure pipes (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).
(4) Attach oil seperator hose.
(5) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

VALVE SPRINGS

REMOVAL

REMOVAL - VALVE SPRINGS

(1) Disconnect negative battery cable.
(2) Remove glow plugs (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/GLOW PLUG - REMOVAL).
(3) Remove injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(4) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(5) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(6) Remove front cover at cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
(7) Remove top guide rail (Refer to 9 - ENGINE/ CYLINDER HEAD - REMOVAL).
(8) Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).

NOTE: The timing chain must be held in up position so as not to jam during procedure.

(9) Position piston of cylinder to be processed to DTC by rotating the crankshaft clockwise.**DO NOT crank engine.DO NOT rotate engine backward.**
(10) Install crankshaft lock, special tool #8932.
(11) Seal injector hole with connection piece and retain with orginal tensioning claw.
(12) Connect cylinder leak tester with adaptors and pressurize the cylinder to 5 bar (73 psi.).

WARNING: Valve springs and retainers must be kept in order of the cylinder they were removed.

NOTE: Using tool, screw retaining fork into threaded edge of cylinder head and position thrust piece vertically at top of valve spring retainer.

(13) Compress valve spring.
(14) Remove valve keepers.
(15) Remove top valve spring retainer and valve spring.
(16) Remove valve stem seals.
(17) Remove bottom valve spring retainer.

NOTE: Inspect all cylinder head components for wear or damage.

(18) Repeat procedure for each cylinder as necessary.

REMOVAL - VALVES

(1) Remove cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - REMOVAL).
(2) Place insertion plate into the assembly board in direction of arrows on assembly board.
(3) Mount cylinder head onto assembly board with its front side pointing in direction of arrow on assembly board.
(4) Attach valve assembly tool to cylinder head.

VALVE SPRINGS (Continued)

WARNING: Suitably mark the valve and the position in the cylinder head before removal. Failure to do so will result in improperly seated valves and possible engine damage after reassembly.

NOTE: Using tool, screw retaining fork into threaded edge of cylinder head and position thrust piece vertically at top of valve spring retainer.

(5) Compress valve spring.
(6) Remove valve keepers.
(7) Remove top valve spring retainer and valve spring.
(8) Remove valve stem seals.
(9) Remove bottom valve spring retainer.
(10) Repeat steps 5 through 9 as necessary.
(11) Remove cylinder head from assembly board.

WARNING: Valves, springs and retainers must be kept in order of the cylinder they were removed.

(12) Remove valves.

INSTALLATION

INSTALLATION - VALVE SPRINGS

NOTE: Inspect all valve springs and retainers for wear or damage. Replace as necessary.

(1) Position piston of cylinder to be processed to TDC by rotating the crankshaft clockwise. **NO NOT crank engine or rotate engine counter clockwise.**
(2) Connect cylinder leak tester with adaptors and pressurize the cylinder to 5 bar (73 psi).
(3) Install lower valve spring retainer.
(4) Install valve stem seal.
(5) Install valve spring.
(6) Install valve spring retainer.

NOTE: Using tool, screw retaining fork into threaded edge of cylinder head and position thrust piece vertically at the top of each valve spring retainer.

NOTE: Ensure that the valve keepers are seated properly.

(7) Compress valve and install valve keepers.
(8) Repeat procedure for each cylinder as necessary.
(9) Remove special tooling from cylinder head.
(10) Position piston of #1 cylinder to ignition TDC.
(11) Install camshafts and check basic position (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
(12) Install top guide rail (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
(13) Install front cover at cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
(14) Install timing chain tensioner with new gasket (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION)
(15) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).
(16) Install glow plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/GLOW PLUG - INSTALLATION).

WARNING: SERVICE VEHICLES IN A WELL VENTILATED AREA AND AVOID IGNITION SORCES. RISK OF INJURY TO SKIN AND EYES FROM FUEL JET FLOWING OUT.

(17) Install injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).
(18) Reconnect negative battery cable.

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.

(19) Start the engine and inspect for leaks.

INSTALLATION - VALVES

WARNING: Valves must be kept in their original positions in cylinder head. Failure to do so will result in engine damage.

NOTE: Inspect all valves, springs and retainers for wear or damage. Replace as necessary.

(1) Install valves in their original position in the cylinder head.
(2) Mount cylinder head onto assembly board with its front side pointing in the direction of arrow on assembly board.
(3) Install lower valve spring retainer.
(4) Install valve stem seal.
(5) Install valve spring.
(6) Install valve spring retainer.

VALVE SPRINGS (Continued)

NOTE: Using tool, screw retaining fork into threaded edge of cylinder head and position thrust piece vertically at the top of each valve spring retainer.

NOTE: Ensure that the valve collets are seated properly.

(7) Compress valve and install valve keepers.
(8) Repeat steps 3 through 7 as necessary.
(9) Remove valve assembly from cylinder head.
(10) Remove cylinder head from assembly board.
(11) Install cylinder head on engine block (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
(12) Install glow plugs (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/GLOW PLUG - INSTALLATION).
(13) Connect negative battery cable.

WARNING: US EXTREME CAUTION WHEN THE ENGINE IS IN OPERATION. 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.

(14) Start engine and check for leaks.

CAMSHAFT(S)

STANDARD PROCEDURE - CHECKING CAMSHAFT POSITION

WARNING: NO FIRE, SPARKS, OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL AS WELL AS RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUEL ONLY INTO SUITABLE AND MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING WHEN HANDLING FUEL.

(1) Remove injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(2) Clean injectors and recesses(Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE).
(3) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

NOTE: Rotate engine at crankshaft only. DO NOT crank engine at the camshaft and DO NOT rotate the engine backward.

(4) Position piston of cylinder #1 to ignition TDC.
(5) Insert the locking pin through first camshaft bearing cap into the hole in the left inlet camshaft sprocket (Fig. 9).

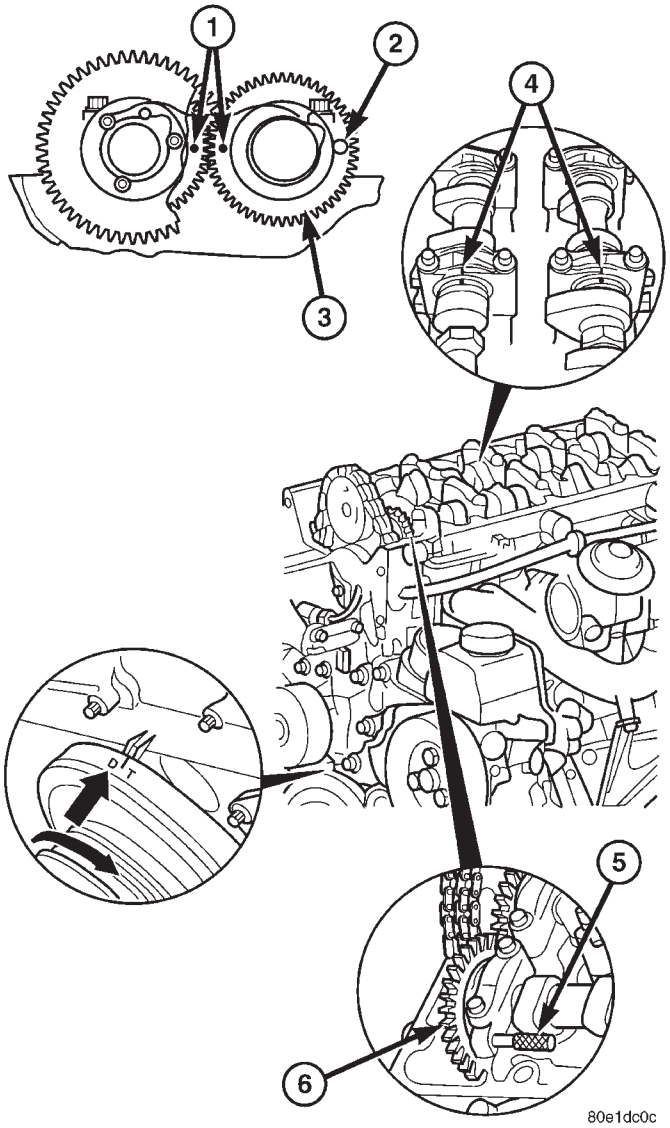

Fig. 9 CHECKING CAMSHAFT POSITION

1 - CAMSHAFT SPROCKET ALIGNMENT DOTS
2 - CAMSHAFT LOCK POSITION
3 - INTAKE CAMSHAFT SPROCKET
4 - CAMSHAFT AND BEARING CAP ALIGNMENT MARKS
5 - CAMSHAFT LOCKING PIN (SPECIAL TOOL #8929)
6 - INTAKE CAMSHAFT SPROCKET

NOTE: The two markings in the inlet camshaft sprockets must be positioned opposite and markings of camshaft and camshaft bearing cap must be aligned. If not, perform basic position of camshafts.

(6) Remove locking pin from camshaft bearing cap hole.

CAMSHAFT(S) (Continued)

(7) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(8) Install injectors (Refer to 14 - FUEL SYSTEM/ FUEL INJECTION/FUEL INJECTOR - INSTALLATION).

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 NO WEAR LOOSE CLOTHING.

(9) Start the engine and inspect for leaks.

REMOVAL

(1) Disconnect negative battery cable.

(2) Remove engine cover.(Refer to 9 - ENGINE - REMOVAL).

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. WEAR PROTECTIVE CLOTHING. STORE FUEL ONLY IN SUITABLE AND APPROPRIATELY MARKED CONTAINERS.

(3) Remove high pressure lines and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ FUEL INJECTOR - REMOVAL).

(4) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(5) Position piston of cylinder #1 to ignition TDC.

(6) Lock inlet camshaft (Fig. 10).

(7) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

NOTE: The lower portain of the cylinder head front cover is sealed with RTV sealant. Carefully tug front cover after bolt removal to loosen from cylinder head.

(8) Remove cylinder head front cover (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

(9) Remove top side rail (Refer to 9 - ENGINE/ CYLINDER HEAD - REMOVAL).

CAUTION: For all work in which the crankshaft should not rotate, secure camshaft gear to timing chain.

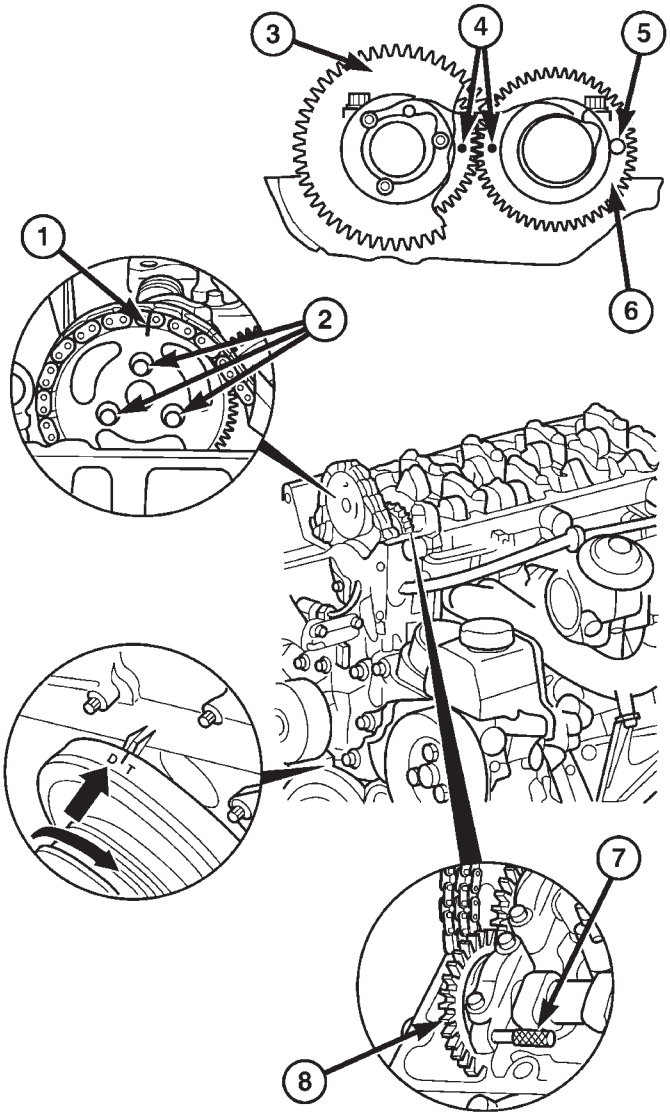

Fig. 10 CAMSHAFT ALIGNMENT

1 - EXHAUST CAMSHAFT SPROCKET AND CHAIN MARKING
2 - EXHAUST CAMSHAFT SPROCKET BOLTS
3 - EXHAUST CAMSHAFT SPROCKET
4 - CAMSHAFT ALIGNMENT DOTS
5 - INTAKE CAMSHAFT LOCK POSITION
6 - INTAKE CAMSHAFT SPROCKET
7 - INTAKE CAMSHAFT LOCK (SPECIAL TOOL #8929)
8 - INTAKE CAMSHAFT SPROCKET

CAMSHAFT(S) (Continued)

(10) Mark camshaft sprocket relative to timing chain.
(11) Unbolt camshaft sprocket from exhaust camshaft.

NOTE: Note the position of dowel pin for camshaft sprocket alignment during reassembly.

(12) Remove camshaft sprocket.

CAUTION: Camshaft bearing caps must remain in proper order and position.

(13) Mark and remove camshaft bearing caps.
(14) Remove the inlet and exhaust camshafts (Fig. 11).

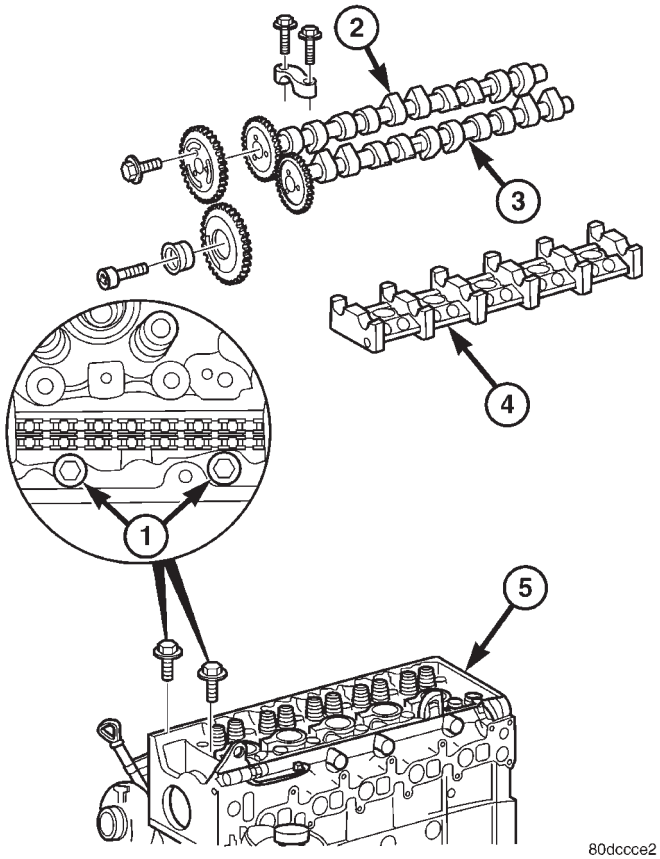

Fig. 11 CAMSHAFTS AND HOUSING ASSEMBLY

1 - CYLINDER HEAD BOLTS
2 - EXHAUST CAMSHAFT
3 - INTAKE CAMSHAFT
4 - CAMSHAFT HOUSING
5 - CYLINDER HEAD

INSTALLATION

CAUTION: The camshafts are sensitive to fracturing. Ensure they are installed free of stress.

CAUTION: Pay attention to assignment of camshafts. Camshaft code numbers are visible on the thrust collar of the axial bearing.

CAUTION: Oil bucket tappets and camshaft bearing points. Inspect ease of operation of bucket tappets.

(1) Install inlet and exhaust camshafts.

CAUTION: Install camshafts so that the two holes in camshaft sprockets are positioned opposite and the markings of the camshaft and camshaft bearing cap are aligned.

(2) Align inlet and exhaust camshafts at axial bearing (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - STANDARD PROCEDURE).
(3) Position piston of cylinder #1 to 30° TDC.

NOTE: Pay attention to markings on camshaft bearing caps.

(4) Install camshaft bearing caps in the proper order. Tighten bolts to 9N·m (80 lbs. in.).

CAUTION: Do not rotate engine counter clockwise.

(5) Position the piston of cylinder #1 to ignition TDC.

NOTE: Pay attention to markings on camshaft bearing caps.

(6) Install the bearing caps in reverse order at the same point. Tighten bearing cap bolts evenly in steps each of 1 turn.

NOTE: The piston of cylinder #1 must be positioned at ignition TDC when the inlet camshaft is locked.

(7) Insert locking pin through the first camshaft bearing cap into the whole in the camshaft sprocket.

NOTE: Do Not use old camshaft sprocket bolts.

(8) Fit camshaft sprocket with timing chain fitted on, onto exhaust camshaft paying attention to position of dowel pin. Tighten bolt to 18N·m (159 lbs.in.).
(9) Install timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

CAMSHAFT(S) (Continued)

(10) Inspect/Set basic position of camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - STANDARD PROCEDURE).

(11) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

NOTE: Refer to the appropriate injector servicing procedures for cleaning of injectors and recesses.

(12) Clean and install injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE), (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).

(13) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

(14) Reconnect negative battery cable.

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.

(15) Start engine and inspect for leaks.

ENGINE BLOCK

STANDARD PROCEDURE

STANDARD PROCEDURE - REPLACING ENGINE CORE AND OIL GALLERY PLUGS

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 12).

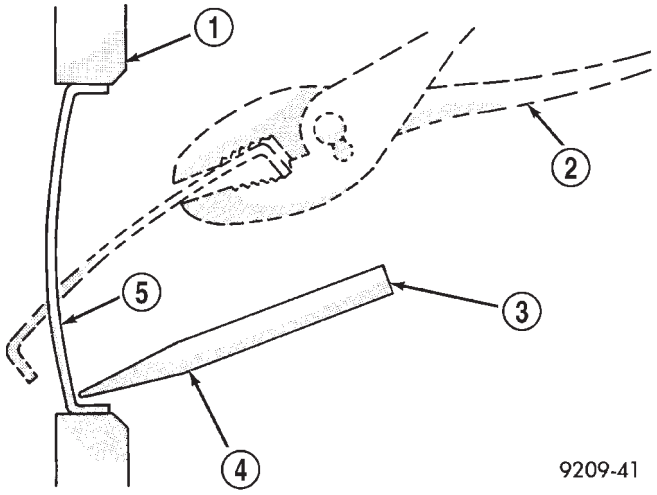

Fig. 12 Core Hole Plug Removal

1 - CYLINDER BLOCK
2 - REMOVE PLUG WITH PLIERS
3 - STRIKE HERE WITH HAMMER
4 - DRIFT PUNCH
5 - CUP PLUG

CAUTION: Do not drive cup plug into the casting as restricted cooling can result and cause serious engine problems.

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Mopar® Stud and Bearing Mount. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 in.) inside the lead-in chamfer.

It is not necessary to wait for curing of the sealant. The cooling system can be refilled and the vehicle placed in service immediately.

ENGINE BLOCK (Continued)

STANDARD PROCEDURE - MEASURING CYLINDER BORES

NOTE: This must be done with engine completely disassembled.

(1) Thoroughly clean all cylinder bores with appropriate cleaning solvent.

(2) Measure each cylinder at the three measuring points shown (Fig. 13).

(3) Using the three measurment point, measure cylinder in the longitudinal and in the transverse direction (Fig. 13).

(4) Use the measurment and table below to group cylinder bores:

Standard size	88.0 mm
Group code letter A	88.000-88.006 mm
Group code letter X	88.006-88.012 mm
Group code letter B	88.012-88.018 mm
Wear limit in longitudinal in transverse direction	0.020 mm
Permissible variation of cylinder shape (when new)	0.000-0.014 mm

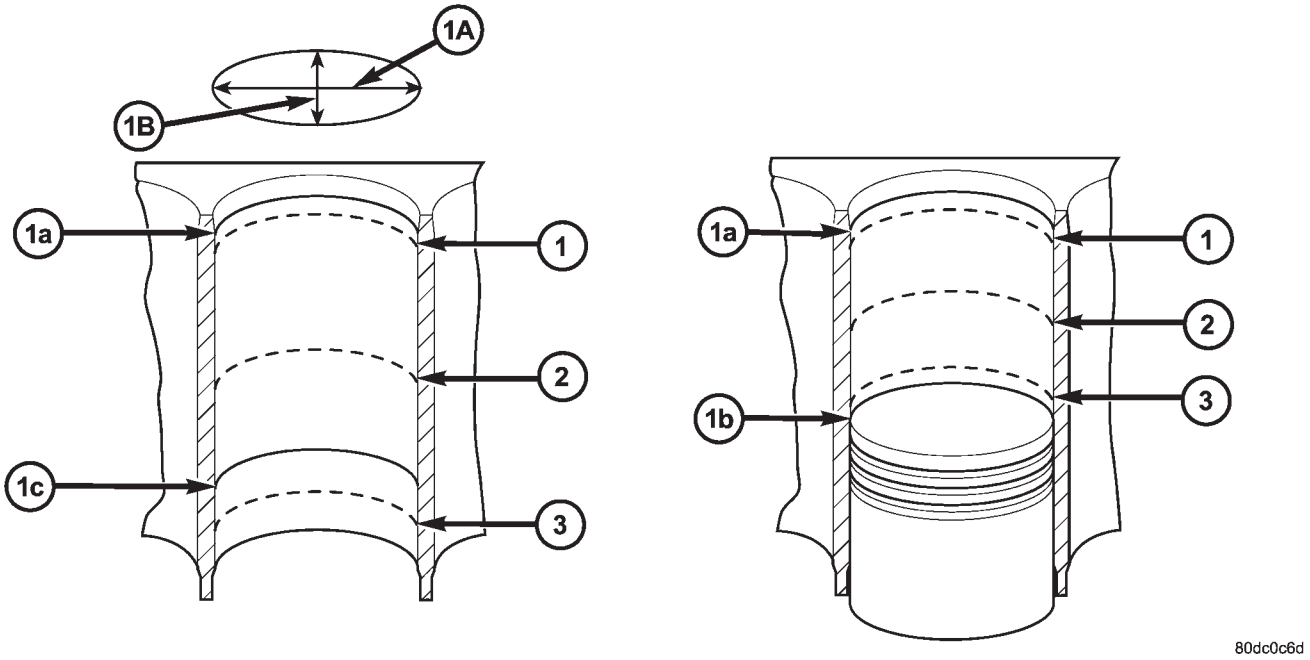

Fig. 13 MEASURING CYLINDER BORES

1 - MEASURING POINT OF CYLINDER BORE
2 - MEASURING POINT OF CYLINDER BORE
3 - MEASURING POINT OF CYLINDER BORE
1a - UPPER REVERSAL POINT OF #1 PISTON RING
1b - BOTTOM DEAD CENTER OF PISTON
1c - BOTTOM REVERSAL POINT OF OIL SCRAPER RING
1A - LONGITUDINAL DIRECTION
1B - TRANSVERSE PDIRECTION

CRANKSHAFT

STANDARD PROCEDURE - MEASURE CRANKSHAFT AND BLOCK JOURNALS

NOTE: After any bearing damage occurred, remove all debris which is present in the main oil gallery, connecting rod bores, and in the crankshaft and oil galleries. Include removal of the inserting steel ball of the main oil gallery before cleaning.

(1) Remove crankshaft (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT - REMOVAL).
(2) Clean all engine parts thoroughly.

CAUTION: After bearing has damage has occurred, replace connecting rods which have suffered overheating because of bearing damage. The connecting rod must not have any cross scores and notches.

(3) Inspect connecting rod. If damage is present, inspect crankshaft, replace as necessary.
(4) Inspect crankcase.
(5) Inspect standard size of crankshaft bearing shells.
(6) Inspect crankshaft bearing cap.
(7) Mount crankshaft radially.
(8) Inspect crankshaft bearing play.

NOTE: Radial mounting of the main bearings of standard size crankshaft is possible by assigning the color-coded bearing shells.

ASSIGN CRANKSHAFT BEARING SHELLS

The oil pan rail of the cylinder block is marked with chisel punches indicating what bearing shell are used.
(9) Assign crankshaft bearing shells.
(10) Mount crankshaft axially.
(11) Inspect crankshaft bearing play.

REMOVAL

(1) Remove engine (Refer to 9 - ENGINE - REMOVAL).
(2) Remove timing case cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL)
(3) Remove end cover.(Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - REMOVAL).
(4) Remove pistons (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - REMOVAL).

CAUTION: The crankshaft bearing caps are numbered consecutively, beginning with the first crankshaft bearing cap at the front of the engine. Attention must be paid to the way crankshaft bearing caps fit.

(5) Unbolt crankshaft bearing caps (Fig. 14).

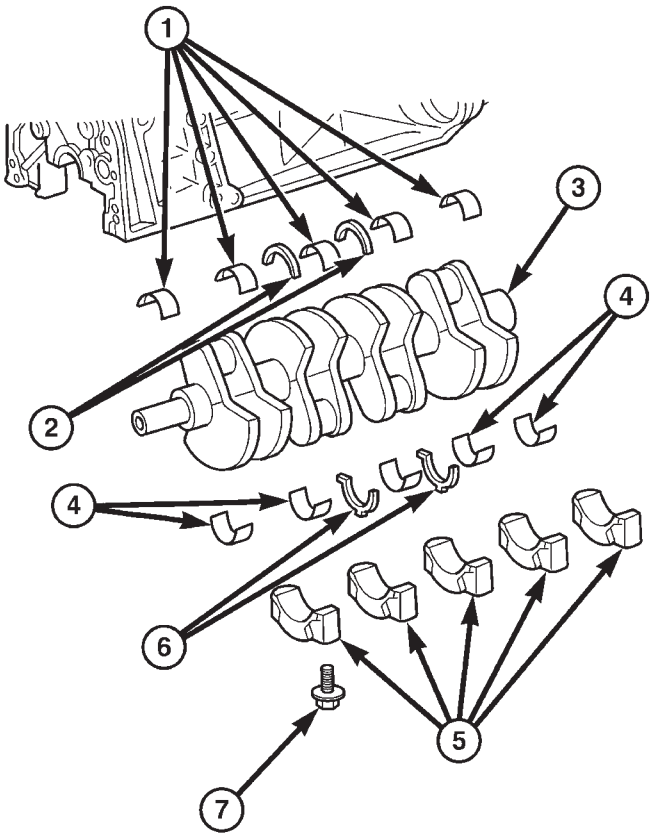

Fig. 14 CRANKSHAFT ASSEMBLY

1 - BEARING HALVES IN ENGINE BLOCK
2 - THRUST WASHERS IN ENGINE BLOCK
3 - CRANKSHAFT
4 - BEARING HALVES IN MAIN BEARING CAPS
5 - MAIN BEARING CAPS
6 - THRUST WASHERS IN MAIN BEARING CAPS
7 - MAIN BEARING BOLTS

(6) Inspect crankshaft bearing caps and bolts for wear and stretching.
(7) Remove crankshaft.

INSTALLATION

CAUTION: Oil the bearing shells before inserting crankshaft.

CRANKSHAFT (Continued)

CAUTION: Oil grooves in the thrust washers must point toward the thrust collars of the crankshaft.

CAUTION: Thrust washers in the bearing cap each have two retaining lugs as a anti-twist lock.

CAUTION: Oil thread and head contact surfaces of bolts that retain the crankshaft bearing caps; tighten bolts from inside to outside, beginning at the fit bearing. Rotate crankshaft to check clearance.

(1) Install crankshaft.

CAUTION: The crankshaft bearing caps are numbered consecutively, beginning with the first crankshaft bearing cap at the front of the engine. Attention must be paid to the way the crankshaft bearing caps fit.

(2) Install the crankshaft bearing caps.Tighten bolts in two stages. 55N·m (40.5 lbs ft), then 90°.
(3) Install the pistons (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - INSTALLATION).
(4) Install the end cover (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - INSTALLATION).
(5) Install the timing case cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
(6) Install the engine (Refer to 9 - ENGINE - INSTALLATION).
(7) Fill the crankcase with the correct engine oil, to the proper level. Refer to the owners manual for specifications.
(8) Fill the cooling system with the proper coolant, to the proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(9) Connect the negative battery cable.

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 CLOTHES.

(10) Start engine and inspect for leaks.

CRANKSHAFT OIL SEAL - REAR

REMOVAL

This must be done with the transmission removed from the vehicle.
(1) Disconnect the negative battery cable.
(2) Raise and support the vehicle.
(3) Drain the engine oil.

NOTE: Loosen all of the oil pan bolts to assure that the oil pan gasket is not damaged when removing the rear main oil seal and end cover assembly.

NOTE: Inspect the oil pan gasket for damage. If the oil pan gasket is damaged, remove the oil pan and replace the oil pan gasket.

(4) Loosen the oil pan bolts.
(5) Remove the flywheel.

CAUTION: Care must be taken when removing the rear main seal and adaptor assembly. Failure to do so will result in damage to the oil pan gasket.

(6) Remove the rear main seal/adaptor retaining bolts and carefully pry the adaptor from the crankcase at the adaptor shoulders (Fig. 15).

INSTALLATION

NOTE: Thoroughly clean all mating surfaces with the appropriate solvents to assure that no grease or oil is present during reassembly.

NOTE: Carefully position the rear main seal/adaptor evenly onto the assembly sleeve. The rear main oil seal lip MUST NOT roll over the edge of the tool.

(1) Position the rear main oil seal/adaptor with assembly sleeve onto the crankshaft so that the dowel sleeves fit into the guide holes (Fig. 15). Care must be taken so that the oil pan gasket is not damaged.
(2) Install the rear main seal/adaptor to crankcase bolts and tighten to 9·Nm (80 lbs.in) (Fig. 15).
(3) Tighten the M6 oil pan bolts to 9N·m (80 lbs in) and the M8 bolts to 20 N·m (15 lbs ft).
(4) Install the fly wheel and tighten bolts in two stages (Fig. 15). 45N·m (33 lbs. ft.) then 90°.
(5) Install the oil pan drain plug and tighten to 25N·m (18 lbs ft).
(6) Lower the vehicle.

CRANKSHAFT OIL SEAL - REAR (Continued)

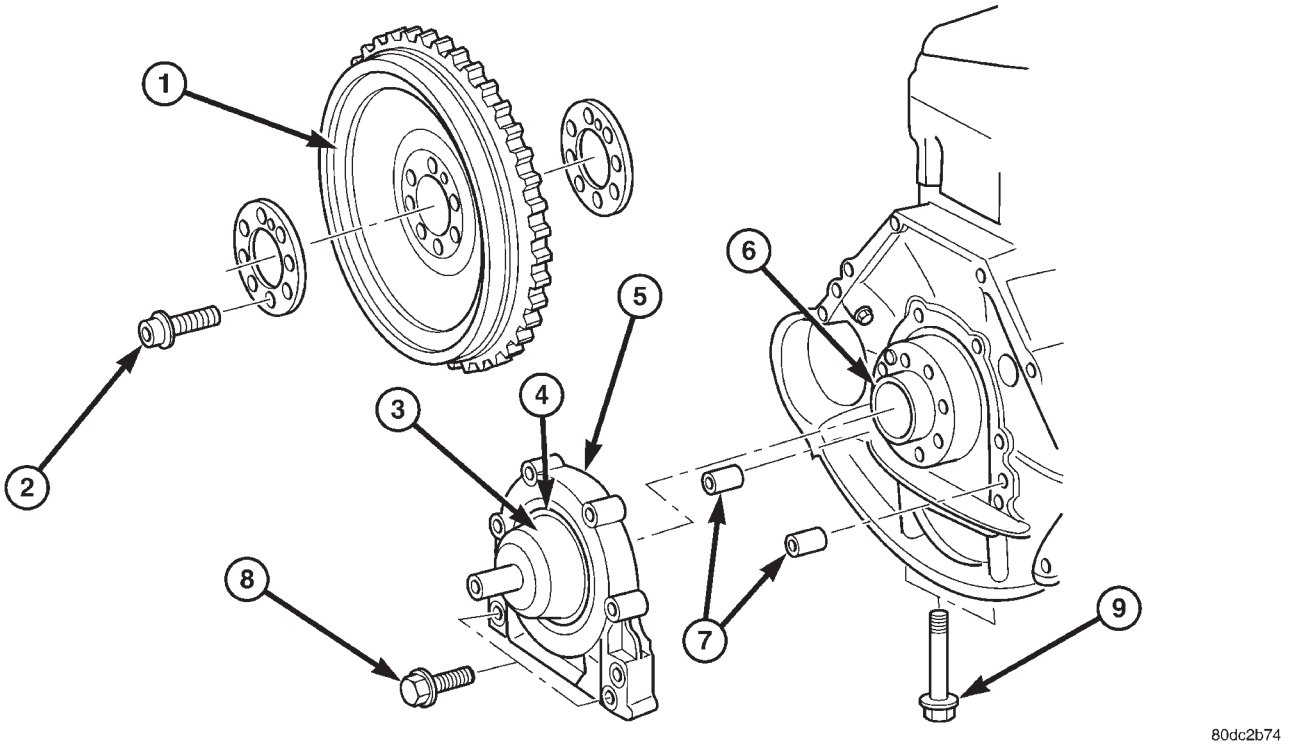

Fig. 15 REAR MAIN SEAL/ADAPTER

1 - FLYWHEEL
2 - FLYWHEEL BOLTS
3 - SPECIAL TOOL 8944
4 - REAR CRANKSHAFT OIL SEAL
5 - REAR CRANKSHAFT SEAL ADAPTER
6 - CRANKSHAFT
7 - ALIGNMENT DOWELS
8 - REAR CRANKSHAFT SEAL ADAPTER RETAINING BOLT
9 - OIL PAN TO REAR CRANKSHAFT SEAL ADAPTER RETAINING BOLT

(7) Fill the crankcase with the correct engine oil, to the proper level. Refer to owners manual for specifications.

(8) Connect the negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(9) Start the engine and inspect for leaks.

CRANKSHAFT OIL SEAL - FRONT

REMOVAL

(1) Disconnect the negative battery cable.

(2) Remove the accessory drive belt.

(3) Install the retaining lock for the crankshaft/ring gear.

NOTE: If the hub of the belt pulley/vibration damper is tight, use a puller to remove it. Do Not tilt the puller. The groves of the puller MUST mesh fully into the slots of the belt pulley.

NOTE: Inspect the running surface of the belt pulley for wear.

(4) Remove the belt pully/vibration damper.

CAUTION: Care must be taken to prevent severe damage to the crankshaft and mounting whole for the front crankshaft seal.

(5) Using a suitable prying tool, remove the front crankshaft seal from the timing cover (Fig. 16).

CRANKSHAFT OIL SEAL - FRONT (Continued)

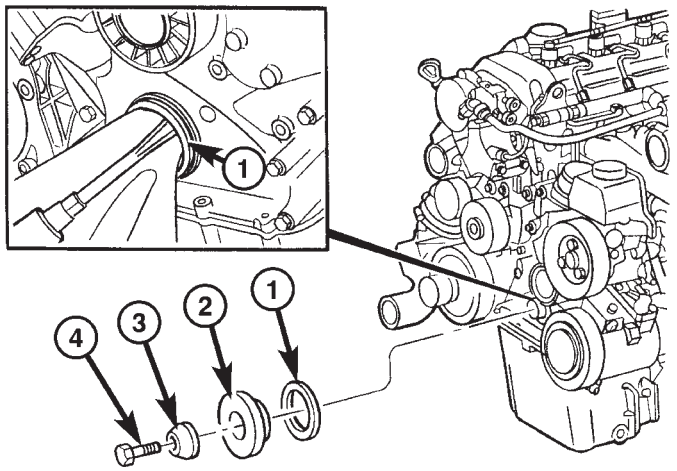

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Fig. 16 FRONT SEAL REMOVAL/INSTALLATION

1 - FRONT CRANKSHAFT OIL SEAL
2 - SEAL INSTALLER SPECIAL TOOL #8936
3 - WASHER
4 - RETAINING BOLT

INSTALLATION

NOTE: Thoroughly clean all mating surfaces with the appropriate solvents to assure that no grease or oil is present during reassembly.

NOTE: Carefully position the front crankshaft seal evenly onto the timing cover.

(1) Install the front crankshaft seal.
(2) Install the belt pulley/vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).
(3) Remove the retaining lock for the crankshaft/ ring gear.
(4) Install the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(5) Reconnect the negative battery cable.
(6) Fill the crankcase with the correct engine oil to the proper level.

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 CLOTHES.

(7) Start the engine and inspect for leaks.

FLYWHEEL

REMOVAL

(1) Remove transmission (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - W5J400 - REMOVAL).

NOTE: M6x90 bolts must be used with retaining lock to prevent damage to rear end cover.

(2) Install retaining lock for crankshaft/starter ring gear.

NOTE: Flywheel does not need balancing or should it be interchanged.

(3) Remove flywheel with both inner and outer washers (Fig. 17).

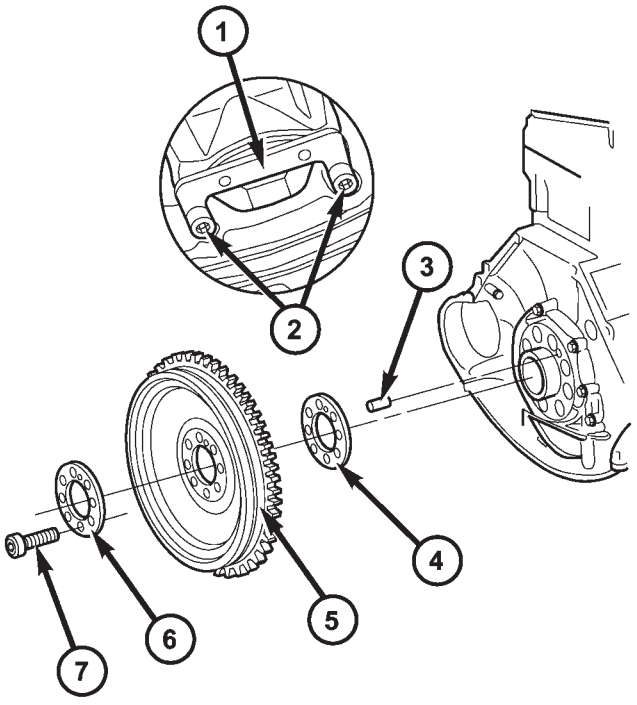

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Fig. 17 FLYWHEEL ASSEMBLY

1 - SPECIAL TOOL #8932 CRANKSHAFT LOCK
2 - RETAINING BOLTS
3 - ALIGNMENT PIN
4 - WASHER
5 - FLYWHEEL
6 - FLYWHEEL
7 - FLYWHEEL BOLT

FLYWHEEL (Continued)

INSTALLATION

NOTE: A flex rod torque wrench must not be used in order to avoid angle errors when tightening to degrees.

(1) Align flywheel and inner and outer washers with straight pin. Tighten bolts in two stages. 45N·m (33 lbs. ft.) then 90°.
(2) Remove the retaining lock from the crankshaft/ starter ring gear.
(3) Install clutch.
(4) Install transmission (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - W5J400 - INSTALLATION).
(5) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS IN OPERATION. 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 CLOTHES.

(6) Start the vehicle.

PISTON & CONNECTING ROD

DESCRIPTION

The pistons are of a free floating design. Oil jets in the engine block lubricate and cool the piston and pin assembly. The connecting rods have a pressed in place wrist pin bushing which is lubricated by the oil jets (Fig. 18).

STANDARD PROCEDURE

STANDARD PROCEDURE - CHECKING AND REPAIRING CONNECTING RODS

NOTE: Connecting rods with blue discoloration, cross scores or notches must be replaced. Compensate for different weights by milling off the balancing weight.

(1) Inspect connecting rod for discoloring, cross scores and notches.

NOTE: Connecting rod and bearing cap are marked in sets and attached with two sleeves.

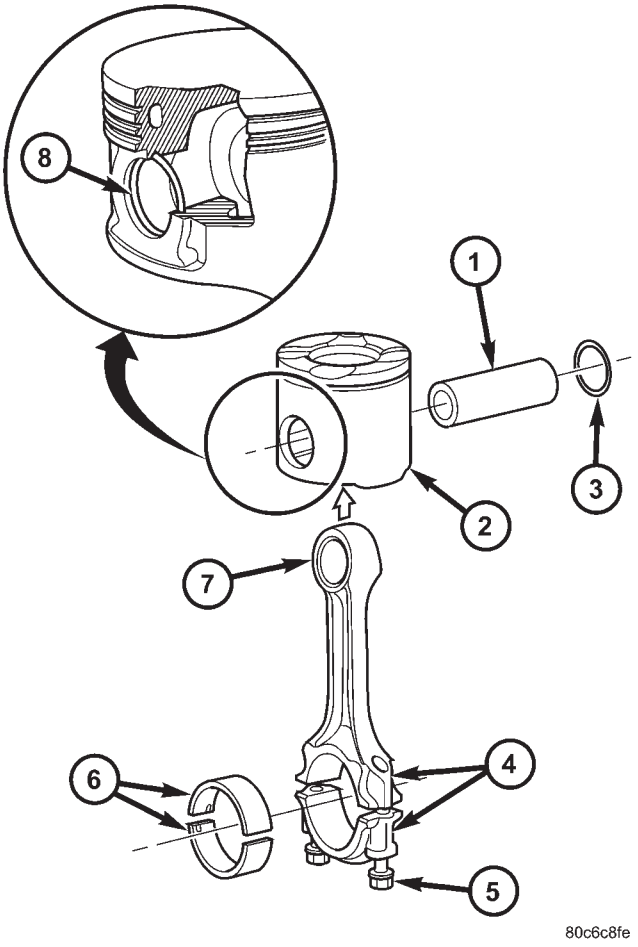

Fig. 18 PISTON AND CONNECTING ROD ASSEMBLY

1 - PISTON PIN
2 - PISTON
3 - SNAP RING
4 - CONNECTING ROD ALIGNMENT NUMBERS
5 - CONNECTING ROD BOLT
6 - CONNECTING ROD BEARING
7 - CONNECTING ROD
8 - SNAP RING

(2) Bolt connecting rod bearing cap to connecting rod. Tighten connecting rod bearing caps to initial specification (Refer to 9 - ENGINE/ENGINE BLOCK/ PISTON & CONNECTING ROD - INSTALLATION).

PISTON & CONNECTING ROD (Continued)

NOTE: If the maximum permissible diameter is exceeded, grind off contact surface of connecting rod bearing cap by a Maximum of 0.02mm.

(3) Using a dial indicator, measure connecting rod bearing basic bore, repair as necessary (Fig. 19).

NOTE: If excessive wear is present, press in new connecting rod bushings.

(4) Measure connecting rod bushing inner diameter (Fig. 19).
(5) Inspect wristpin bushing.
(6) Measure piston pin end play in connecting rod bushing.
(7) Measure peak to valley height of connecting rod bushing on inside.

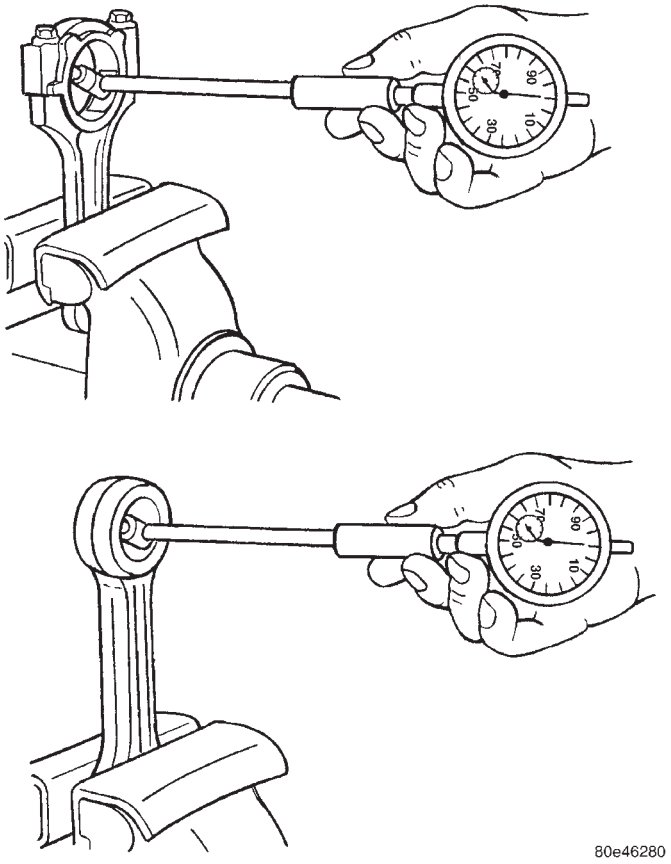

Fig. 19 MEASURING CONNECTING RODS

CONNECTING ROD SPECIFICATIONS

Distance between middle connecting rod bore to connecting rod bushing bore	148.970 mm to 149.030 mm
Width of connecting rod bearing bore at connecting rod bushing bore	21.940 mm to 22 mm
Connecting rod bearing shell basic bore	51.600 mm to 51.614 mm
Allowable out-of-roundness and taper of basic bore	.020 mm
Allowable twist of connecting rod bearing bore to connecting rod bushing bore over a length of 100 mm	.100 mm
Allowable variation of axial parallelism of connecting rod bearing bore to connecting rod bushing bore over a length of 100 mm	.045 mm
Allowable difference in weight of complete connecting rod of an engine	2g
Connecting rod inner bushing	30.018 to 30.024 mm
Connecting rod outer bushing	32.575 mm to 32.600 mm
Connecting rod basic bore	32.500 mm to 32.525 mm
Piston pin play in connecting rod	.018 mm to .024 mm
Peak-to-Valley height (Rz) of connecting rod bushing on inside	5
Connecting rod bolt thread	M8 x 1

PISTON & CONNECTING ROD (Continued)

STANDARD PROCEDURE - MEASURING PISTON PROTRUSION

After replacing the pistons/connecting rods or machining the engine block contact surface, it is then necessary to measure the piston protrusion.

Measure protrusion between piston crown and cylinder head contact surface without the head gasket installed. The measurment must be carried out in the direction of the piston pin in order to eliminate piston rock.

(1) Measure piston protrusion at the two measuring points (arrows) (Fig. 20).

Piston protrusion with new crankcase should be 0.38 - 0.62 mm.

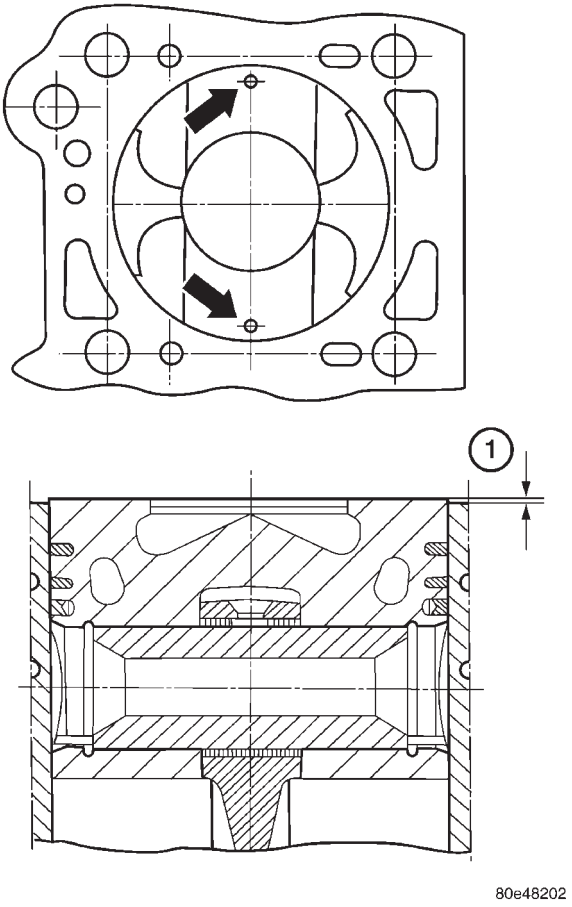

Fig. 20 MEASURING PISTON PROTRUSION

1 - PISTON PROTRUSION MEASUREMENT

REMOVAL

(1) Disconnect the negative battery cable.

(2) Remove the engine (Refer to 9 - ENGINE - REMOVAL).

(3) Remove the cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

(4) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(5) Push back on the chain tensioner and remove the oil pump chain from the oil pump.

(6) Remove the oil pump.

NOTE: Mark the connecting rod and connecting rod bearing cap to each other at the inlet side.

(7) Remove the connecting rod bearing cap.

NOTE: Do Not mix up the top and bottom connecting rod bearing shells.

(8) Mark the connecting rod bearing shell and the connecting rod bearing cap to each other.

NOTE: If the pistons are used, the direction of travel arrows and the marking of the pistons may no longer be visible because of carbon deposits. The carbon deposits on the pistons must be removed.

NOTE: If the arrows indicating the driving direction on the piston are no longer visible, they must be marked again.

(9) Remove the connecting rod together with the piston through the top of the engine.

NOTE: DO NOT mix up the top and bottom connecting rod bearing shells.

(10) Mark the connecting rod bearing shell and connecting rod to each other.

CAUTION: Care must be taken not to damage the piston.

PISTON & CONNECTING ROD (Continued)

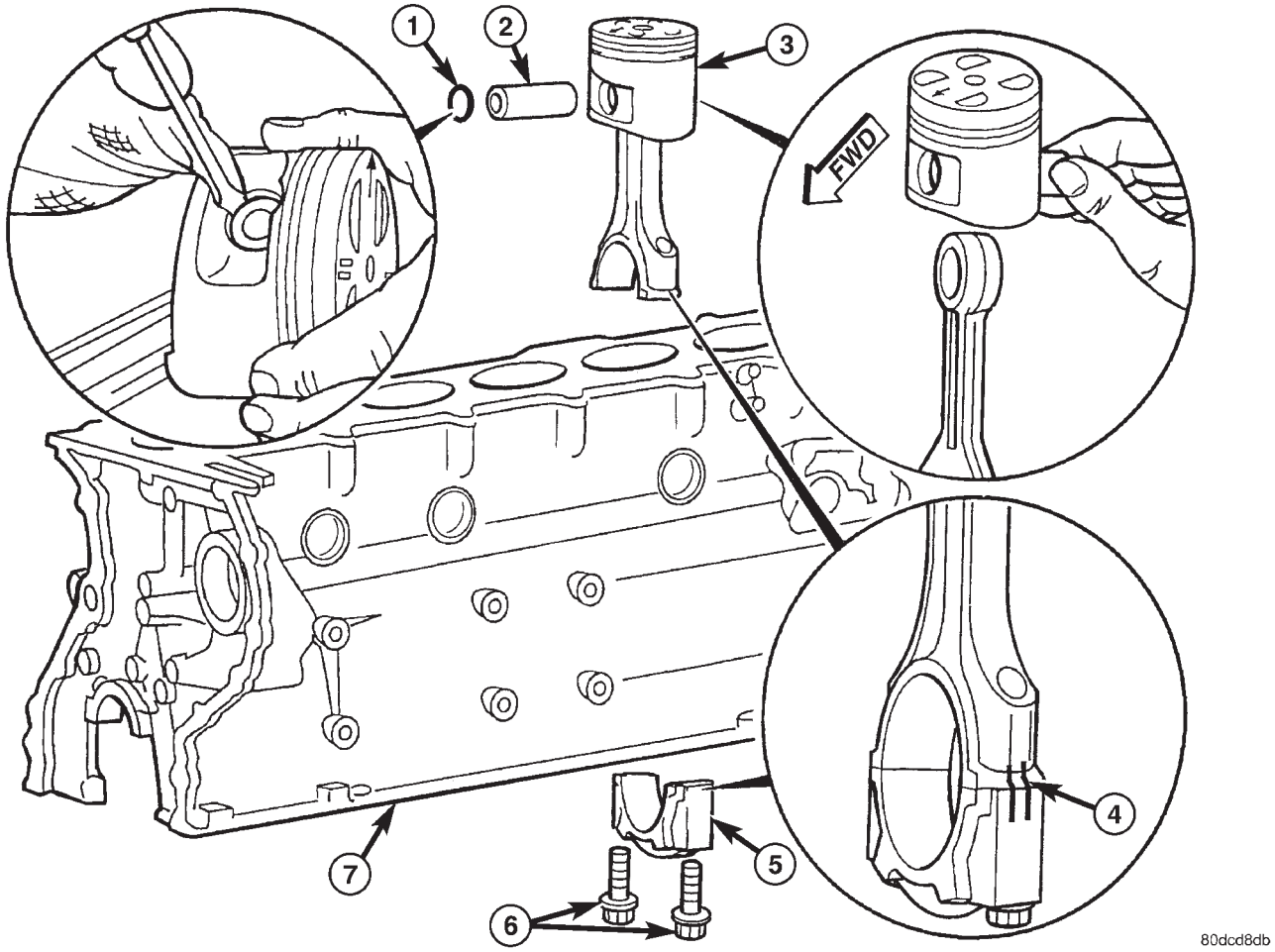

Fig. 21 PISTON AND CONNECTING ROD ASSEMBLY

1 - PISTON PIN CIRCLIP
2 - PISTON PIN
3 - PISTON ASSEMBLY
4 - CONNECTING ROD AND CAP ALIGNMENT MARKS
5 - CONNECTING ROD CAP
6 - CONNECTING ROD BOLTS
7 - ENGINE BLOCK

(11) Remove the piston pin circle clip. (Fig. 21).
(12) Press the piston pin out of the piston and connecting rod bushing. (Fig. 21).
(13) Inspect the connecting rod for wear and damage.

INSTALLATION

(1) Assign piston to the cylinder bore.
(2) Using the appropriate clean engine oil, oil piston pin and connecting rod bushing.

CAUTION: Assemble the piston and connecting rod so that the arrow is pointing in the direction of travel (in the opposite direction of power flow). The marking on the connecting rod is pointing toward the inlet side.

(3) Assemble piston and connecting rod (Fig. 22).
(4) Insert piston pin by hand (Fig. 22).

CAUTION: Care must be taken not to damage the piston.

(5) Insert circle clip of piston pin into groove on piston (Fig. 22).
(6) Using the appropriate clean engine oil, clean the cylinder bores, connecting rod bearing journals, connecting rod bearing shells and pistons.

CAUTION: Offset the piston ring gaps by 120°.

(7) Position a ring compressor over piston and rings. Tighten ring compressor (Fig. 23).**Ensure that ring position does not change during this operation.**

CAUTION: Rotate the crankshaft sufficiently so that the connecting rod does not touch the connecting rod journal when the piston is pushed onto the cylinder bore.

PISTON & CONNECTING ROD (Continued)

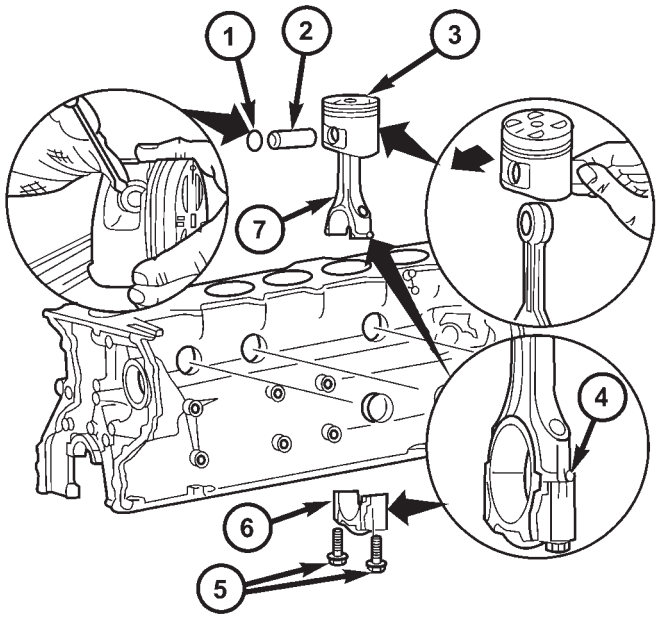

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Fig. 22 PISTON AND CONNECTING ROD ASSEMBLY

1 - CIRCLE CLIP
2 - PISTON PIN
3 - PISTON ASSEMBLY
4 - CONNECTING ROD ALIGNMENT MARKINGS
5 - CONNECTING ROD BOLTS
6 - CONNECTING ROD CAP
7 - CONNECTING ROD

(8) Install piston with arrow pointing in the direction of travel (in the opposite direction to power flow) (the marking on the connecting rod should be pointing toward the inlet side). (Fig. 23).

(9) Clean and inspect the connecting rod bolts.

CAUTION: Assure that the correct top and bottom connecting rod bearings shells are used in accordance with the markings.

CAUTION: The anti-twist locks of the connecting rod bearing shells must be located in the slots of the connecting rod bearing caps.

(10) Insert connecting rod bearing shell into connecting rod bearing cap.

CAUTION: The markings on the connecting rod and connecting rod cap must be lined up.

(11) Install connecting rod bearing cap. Tighten bolts in 3 stages, 5N·m (44 lbs in), 25N·m (221 lbs in), 90°.

(12) Rotate crankshaft fully and check the clearance.

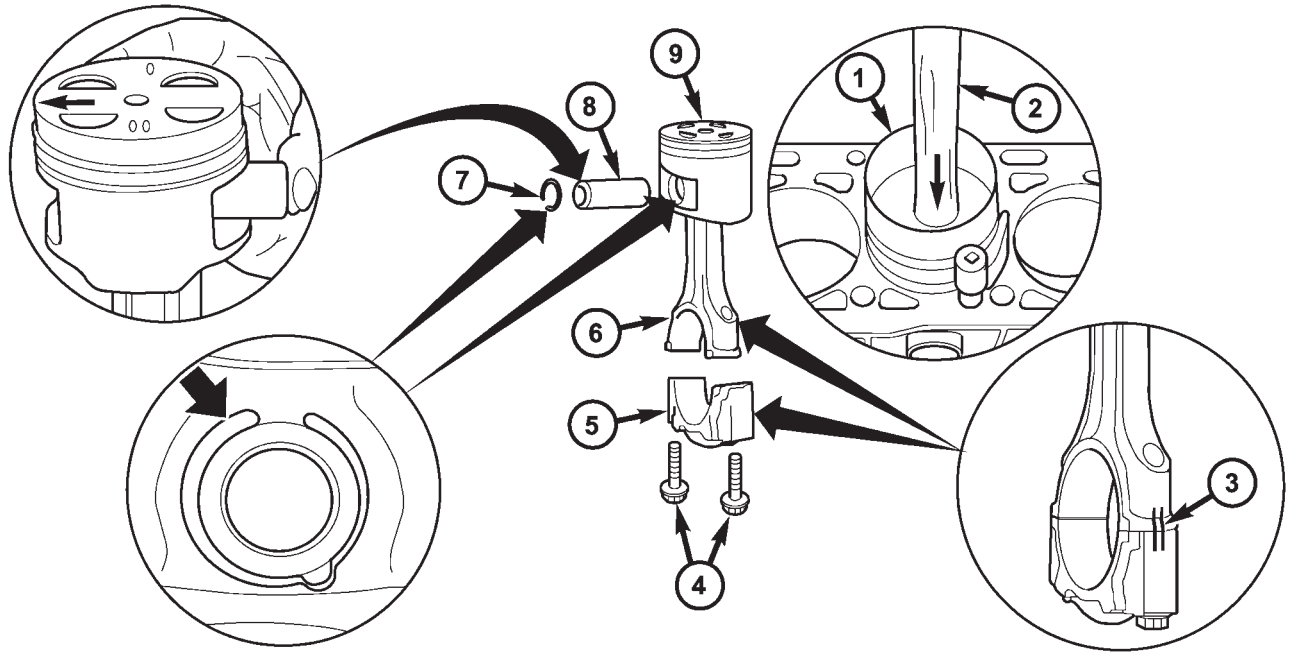

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Fig. 23 PISTON AND CONNECTING ROD INSTALLATION

1 - PISTON RING COMPRESSOR
2 - WOOD HAMMER HANDLE
3 - CONNECTING ROD ALIGNMENT MARKINGS
4 - CONNECTING ROD BOLTS
5 - CONNECTING ROD CAP
6 - CONNECTING ROD
7 - CIRCLE CLIP
8 - PISTON PIN
9 - PISTON ASSEMBLY

PISTON & CONNECTING ROD (Continued)

(13) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(14) Install engine oil pan and oil pan drain plug (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

CAUTION: Install a cylinder head gasket of standard thickness or a cylinder head gasket of repair thickness depending on piston projection.

(15) Measure piston projection (Refer to 9 - ENGINE/ENGINE BLOCK - STANDARD PROCEDURE).

(16) Install cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

(17) Install engine (Refer to 9 - ENGINE - INSTALLATION).

(18) Fill the crankcase with correct engine oil, to proper level. Refer to owners manual for specifications.

(19) Fill the cooing system with proper coolant, to the proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

(20) Connect negative battery cable.

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 CLOTHES.

(21) Start the engine and inspect for leaks.

PISTON RINGS

STANDARD PROCEDURE - PISTON RING FITTING

(1) Carefully clean the carbon from all ring grooves. Oil drain openings in the oil ring groove and pin boss must be clear. DO NOT remove metal from the grooves or lands. This will change ring-to-groove clearances and will damage the ring-to-land seating.

(2) Be sure the piston ring grooves are free of nicks and burrs.

(3) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 24). Rotate the ring in the groove. It must move freely around circumference of the groove.

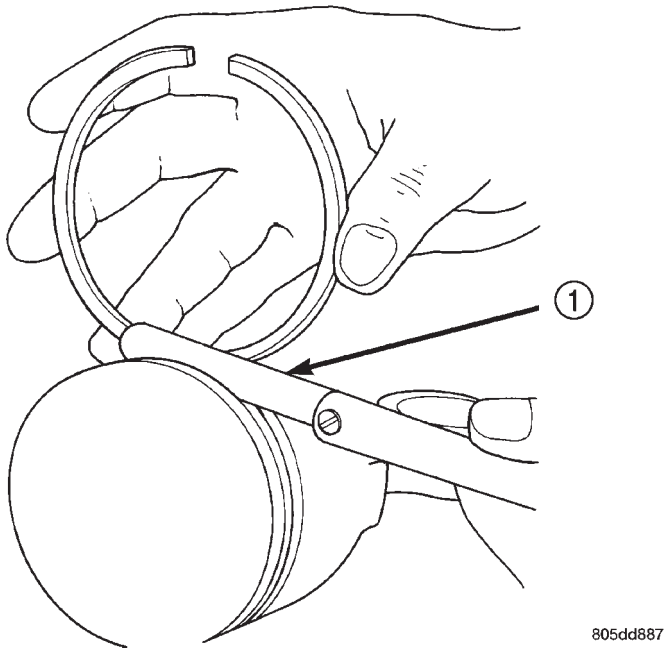

Fig. 24 Ring Side Clearance Measurement

1 - FEELER GAUGE

RING SIDE CLEARANCE CHART

ITEM	SPECIFICATION
Top Compression Ring	0.012 - 0.016 mm (0.0047 - 0.0063 in.)
Second Compression Ring	0.05 - 0.09 mm (0.0019 - 0.0035 in.)
Oil Control Ring	0.03 - 0.07 mm (0.0011 - 0.0027 in.)

PISTON RINGS (Continued)

(4) Place ring in the cylinder bore and push down with inverted piston to position near lower end of the ring travel. Measure ring gap with a feeler gauge fitting snugly between ring ends (Fig. 25).

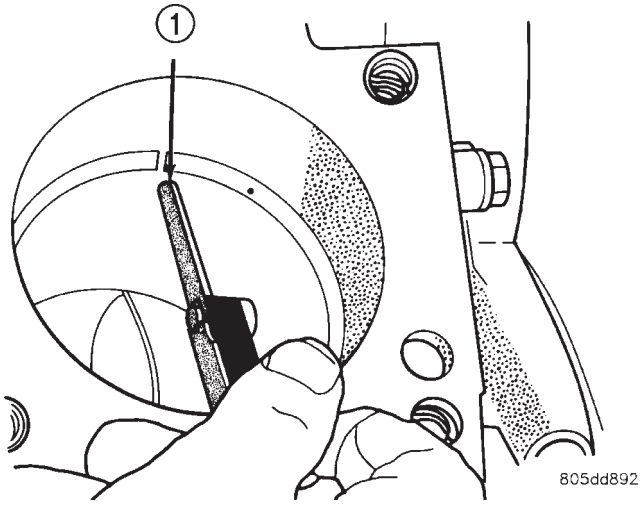

Fig. 25 Gap Measurement

1 - FEELER GAUGE

RING GAP MEASUREMENT CHART

ITEM	SPECIFICATION
Top Compression Ring	0.229 - 0.610 mm (0.0090 - 0.0240 in.)
Second Compression Ring	0.483 - 0.965 mm (0.0190 - 0.080 in.)
Oil Control Ring	0.254 - 1.500 mm (0.010 - 0.060 in.)

(5) The oil control rings are symmetrical, and can be installed with either side up. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(6) Using a ring expander, install compression rings with manufactures designation pointing toward piston crown (Fig. 26).

Ring Gap Orientation

- Position the gaps on the piston as shown (Fig. 27).
- Oil spacer - Gap on center line of piston skirt.
- Oil rails - gap 180° apart on centerline of piston pin bore.
- No. 2 Compression ring - Gap 120° from top oil rail gap.
- No. 1 Compression ring - Gap 120° from No. 2 compression ring gap.

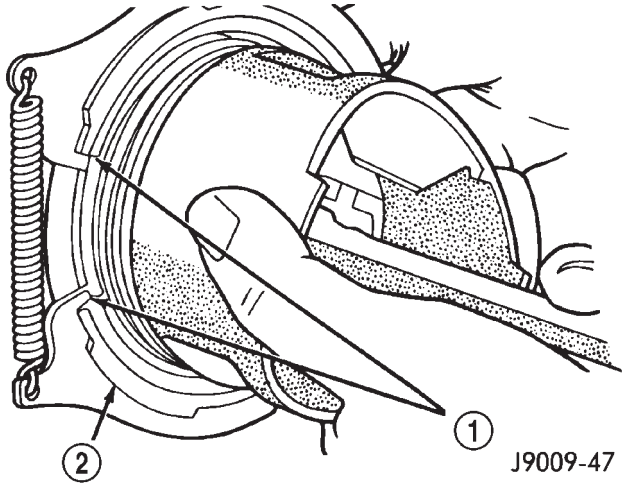

Fig. 26 Compression Ring Installation

1 - COMPRESSION RING
2 - RING EXPANDER RECOMMENDED

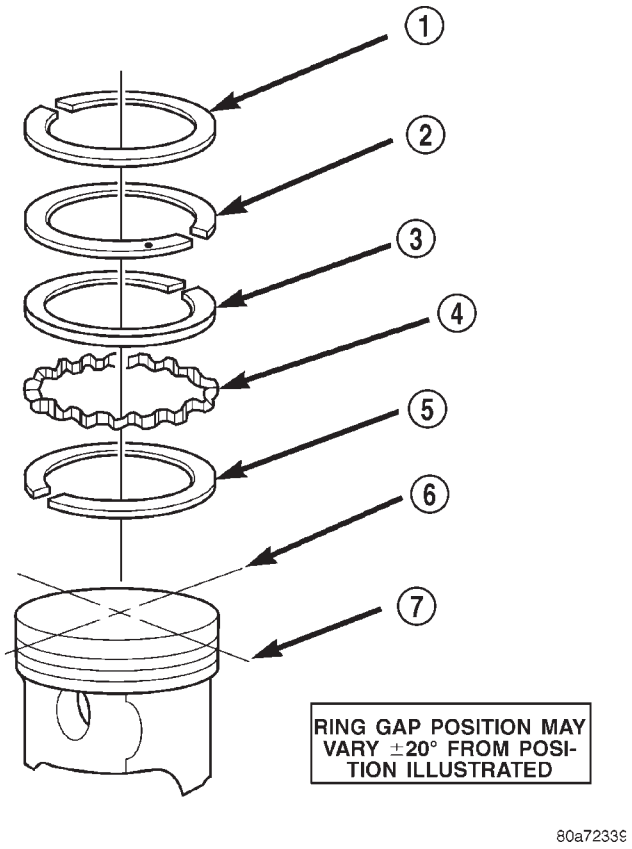

Fig. 27 Ring Gap Orientation

1 - TOP COMPRESSION RING
2 - BOTTOM COMPRESSION RING
3 - TOP OIL CONTROL RAIL
4 - OIL RAIL SPACER
5 - BOTTOM OIL CONTROL RAIL
6 - IMAGINARY LINE PARALLEL TO PISTON PIN
7 - IMAGINARY LINE THROUGH CENTER OF PISTON SKIRT

VIBRATION DAMPER

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(3) Install retaining lock for crankshaft/ring gear (Fig. 28).
(4) Remove crankshaft center bolt and washer (Fig. 28).

NOTE: If hub of belt pulley/vibration damper is tight, use puller to remove. DO NOT tilt puller when in use. Grooves of the puller must mesh fully into the slots of the belt pulley.

(5) Remove the belt pulley/vibration damper (Fig. 28).

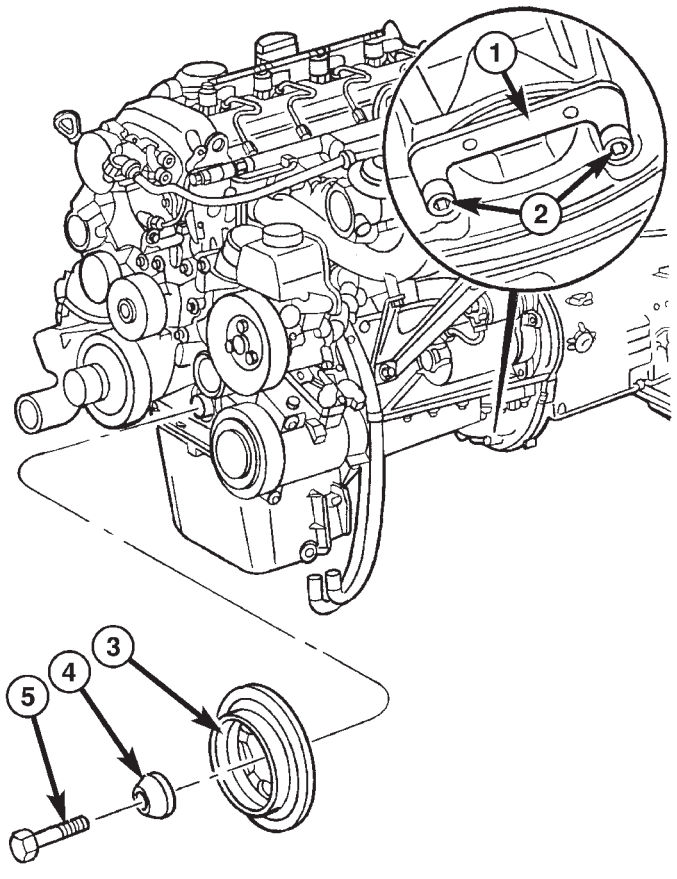

Fig. 28 VIBRATION DAMPER/CRANKSHAFT PULLEY

1 - SPECIAL TOOL #8932
2 - RETAINING BOLTS
3 - VIBRATION DAMPER/CRANKSHAFT PULLEY
4 - WASHER
5 - CRANKSHAFT BOLT

NOTE: If grooves can be felt in the belt pulley/vibration damper during inspection, the pulley/damper must be replaced.

(6) Inspect hub at belt pulley/vibration damper for wear grooves.
(7) Replace front crankshaft seal.

INSTALLATION

NOTE: Align parallel key, fix in place with grease. Turn to ensure the slot is aligned with parallel key in crankshaft.

NOTE: Front crankshaft seal must be replaced before installing the belt pulley/vibration damper.

(1) Position the belt pulley/vibration damper.
(2) Install crankshaft center bolt and washer. Tighten bolt in two stages. M8.8 bolt to 200N·m (148 lbs. ft.) then 90°, M10.9 bolt to 325N·m (240 lbs. ft.) then 90°.

NOTE: Inspect accessory drive belt for wear. Replace as necessary.

(3) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(4) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS IN OPERATION. 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.

(5) Start vehicle and inspect for leaks.

VACUUM PUMP

DESCRIPTION

The vacuum pump is operated by a slotted extension attached to the vacuum pump shaft. The vacuum pump shaft slotted extension fits into, and is driven by, the exhaust camshaft gear.

The vacuum pump is a constant displacement, vane-type pump. Vacuum is generated by vanes mounted in the pump rotor. The rotor is located in the pump housing and is pressed onto the pump shaft.

The vacuum pump rotating components are internally lubricated.

The vacuum pump is not serviceable and must be replaced as a unit. Do not disassemble or attempt to repair the pump.

VACUUM PUMP (Continued)

OPERATION

Vacuum pump output is transmitted to the Heater, Electronic, Vacuum, Air Conditioner (HEVAC) and speed control, systems through a supply hose. The hose is connected to an outlet port on the pump housing and uses an in-line check valve to retain system vacuum when vehicle is not running.

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 exhaust camshaft gear.

REMOVAL

(1) Disconnect negative battery cable.

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(3) Partailly drain coolant system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

(4) Disconnect viscous heater line and set aside.

(5) Disconnect cooling fan, power steering line and set aside.

(6) Remove vacuum line at vacuum pump.

NOTE: Observe position of driver on rear of pump.

(7) Remove vacuum pump and seals (Fig. 29).

(8) Clean all sealing surfaces.

INSTALLATION

(1) Clean all sealing surfaces.

(2) Position driver on rear of pump and install vacuum pump with new seals. Tighten bolts to 14N·m (124 lbs. in.).

(3) Install vacuum line to vacuum pump.

(4) Reconnect cooling fan , power steering hose.

(5) Reconnect viscous heater pipe.

(6) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).Tighten screws to 10 N·m (89 lbs. in.).

(7) Connect negative battery cable.

(8) Refill coolant system with correct mixture to proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

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 CLOTHES.

(9) Start the engine and inspect for leaks.

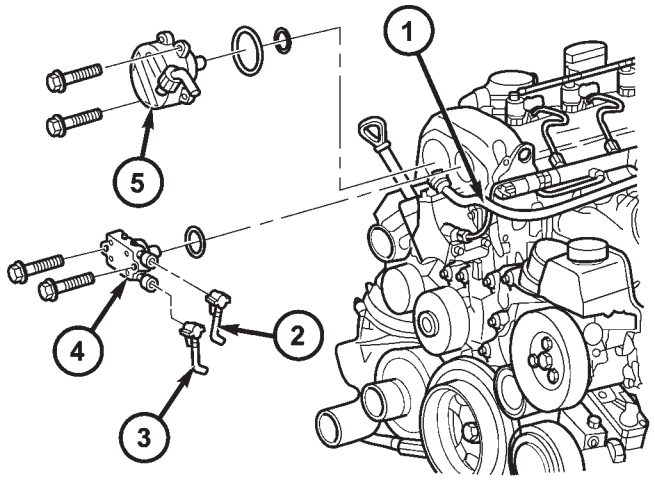

Fig. 29 VACUUM PUMP AND LOW PRESSURE FUEL PUMP ASSEMBLIES

1 - VACUUM LINE
2 - FUEL OUTLET LINE
3 - FUEL FEED LINE
4 - LOW PRESSURE FUEL PUMP
5 - VACUUM PUMP

OIL

REMOVAL - OIL SEPARATOR

(1) Disconnect breather hose.

(2) Remove the separator retaining bolts

(3) Twist to remove oil separator from cover.

INSTALLATION - OIL SEPARATOR

(1) Lubricate the oil separator o - ring with clean engine oil.

(2) Position separator above cover and apply downward pressure to seat.

(3) Install retaining bolts and tighten to 8N·m (70 lbs. in.).

(4) Connect breather hose.

OIL JET

DESCRIPTION

There are five oil jets installed in the engine block (Fig. 30). These oil jets are used to cool and lubricate the piston assemblies.

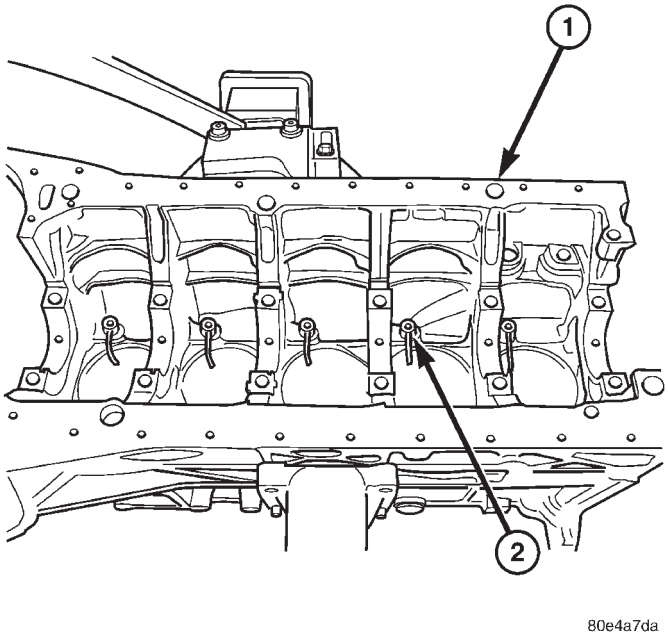

Fig. 30 OIL JET LOCATION

1 - ENGINE BLOCK
2 - OIL JET

REMOVAL

The engine must be removed from the vehicle and completely dissassembled to replace the oil jets.

(1) Remove engine from vehicle.
(2) Completely dissassemble engine.
(3) Using an extraction claw and a slide hammer, remove the oil jets from engine block.

INSTALLATION

(1) Install oil jet into special tool #8924.
(2) Align oil jet in location in engine block.
(3) Drive oil jets into block using special tool #8924 until oil jet is fully seated into engine block (Fig. 31).
(4) Reassemble engine.
(5) Install engine into vehicle.

OIL PAN

REMOVAL

(1) Disconnect negative battery cable.
(2) Raise and support vehicle.
(3) Drain engine oil.

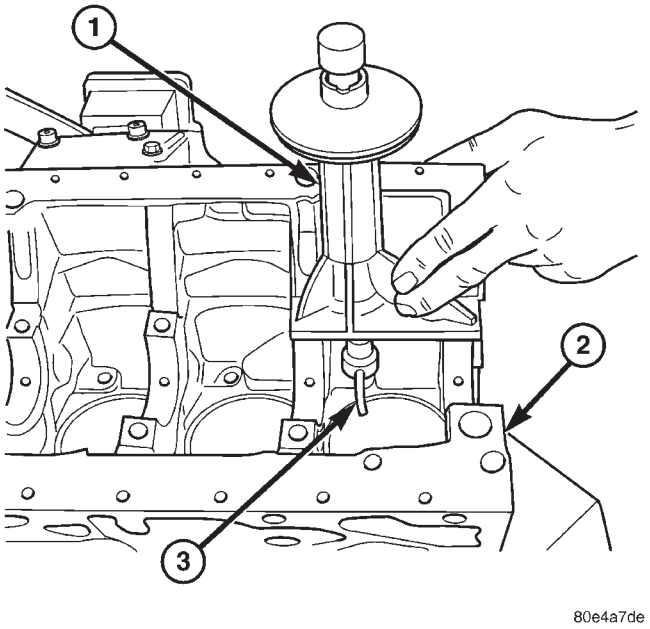

Fig. 31 OIL JET INSTALLATION

1 - OIL JET INSTALLER #8942
2 - ENGINE BLOCK
3 - OIL JET

(4) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

NOTE: Oil pan bolts are different diameters and lengths and must be installed in their proper position.

(5) Remove oil pan bolts, oil pan and gasket.

INSTALLATION

NOTE: Thoroughly clean all mating surfaces with the appropriate solvents to assure that no grease or oil is present during reassembly.

NOTE: Oil pan bolts are different diameters and lengths. They must be installed in the proper position.

(1) Install the oil pan. Tighten M6 bolts to 9N·m (80 lbs. in.) and M8 bolts to 20N·m (15 lbs. ft.).
(2) Refill crankcase with the proper engine oil to the proper level. Refer to owners manual for specification.
(3) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(4) Start the engine and inspect for leaks.

OIL PUMP

REMOVAL

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
(3) Unbolt oil pump from crankcase.
(4) Press chain tensioner off oil pump chain and remove oil pump (Fig. 32).

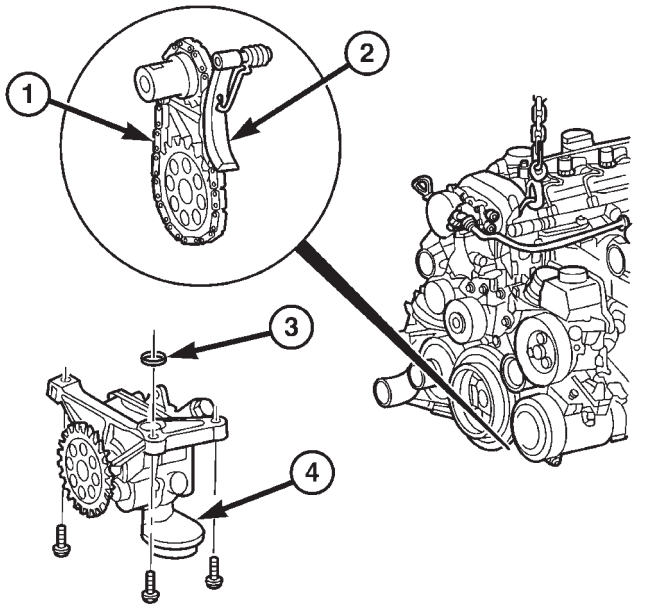

Fig. 32 OIL PUMP ASSEMBLY

1 - OIL PUMP CHAIN
2 - OIL PUMP CHAIN TENSIONER
3 - O-RING
4 - OIL PUMP

REMOVAL- OIL PUMP CHAIN

(1) Disconnect negative battery cable.
(2) Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
(3) Remove oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).
(4) Using special tool #8948, position and fit chain seperating tool and thrust spindle onto a link of the oil pump chain (Fig. 33).
(5) Screw the thrust pin in and seperate the oil pump chain link.
(6) Remove pressed - out oil pump chain pin from chain seperation tool.

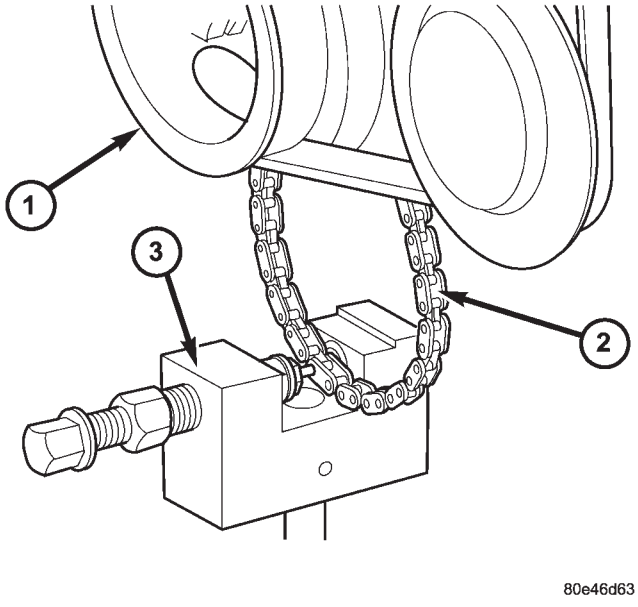

Fig. 33 OIL PUMP CHAIN LINK REMOVAL

1 - VIBRATION DAMPER/PULLEY
2 - OIL PUMP CHAIN
3 - SPECIAL TOOL #8948

CAUTION: IT IS ESSENTIAL that the installation procedure for the oil pump chain is followed exactly. Failure to do so will result in severe engine damage.

INSTALLATION

INSTALLATION

NOTE: Clean strainer of oil pump. If oil pump is dry, fill with appropriate engine oil.

(1) Position oil pump and install oil pump chain.
(2) Install oil pump and seal.Tighten bolts to 18N·m (159 lbs. in.).
(3) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
(4) Fill crankcase to proper level with correct engine oil. Refer to owners manual for specification.
(5) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

OIL PUMP (Continued)

INSTALLATION - OIL PUMP CHAIN

CAUTION: IT IS ESSENTIAL that the installation procedure is followed exactly. Failure to do so will result in severe engine damage.

(1) Connect old oil pump chain and new chain with temporary link, outer plate and locking element (Fig. 34).

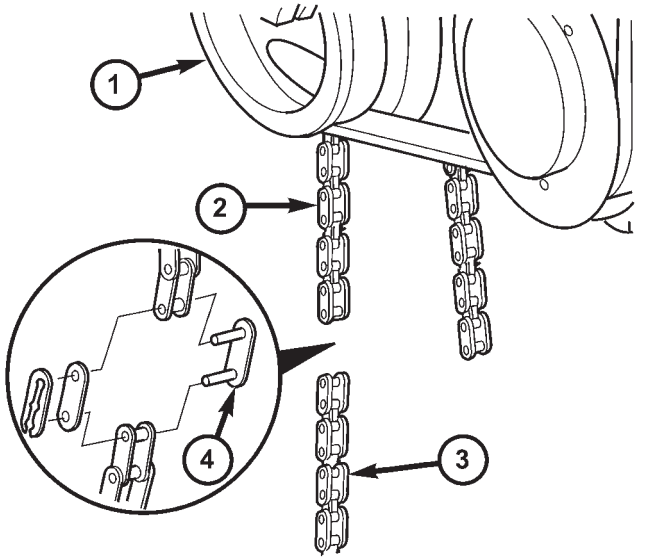

Fig. 34 INSTALLING OIL PUMP CHAIN TEMPORARY LINK

1 - VIBRATION DAMPER/CRANKSHAFT PULLEY
2 - OLD OIL PUMP CHAIN
3 - NEW OIL PUMP CHAIN
4 - TEMPORARY LINK

(2) Slowly rotate crankshaft in a clockwise direction until it is possible to connect the ends of the new and old oil pump chains.

(3) Remove assembly locking element, outer plate and assembly link (Fig. 35).

CAUTION: Insert new riveted link from the rear.

(4) Connect ends of new oil pump chain with new riveted link (Fig. 36).

NOTE: When assembling riveting tool, one piece is secured by a screw and the other can move loosely on the thrust spindle.

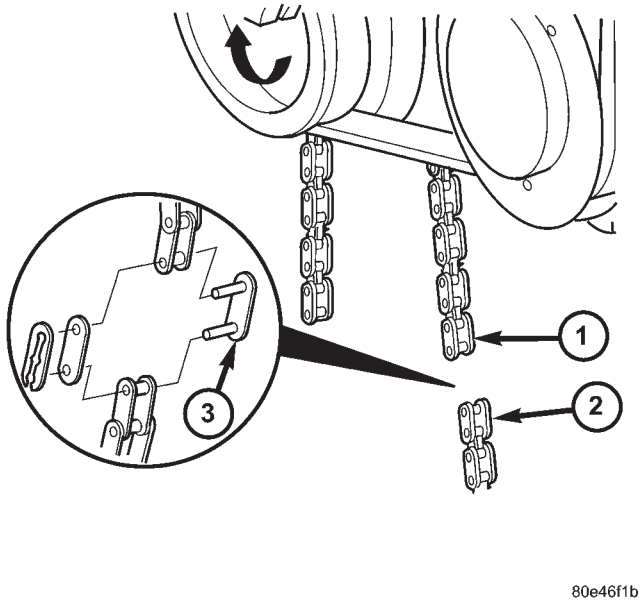

Fig. 35 REMOVING OIL PUMP CHAIN TEMPORARY LINK

1 - NEW OIL PUMP CHAIN
2 - OLD OIL PUMP CHAIN
3 - TEMPORARY LINK

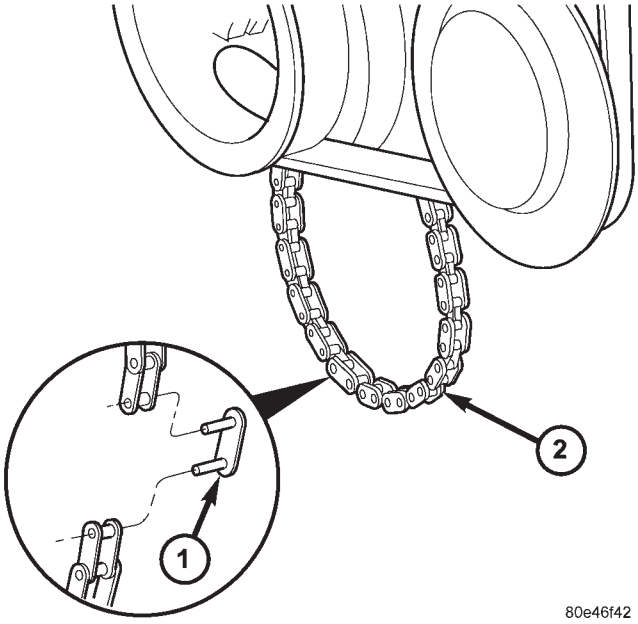

Fig. 36 INSTALLING NEW RIVETED LINK

1 - NEW RIVETED LINK
2 - OIL PUMP CHAIN

OIL PUMP (Continued)

(5) Assemble riveting tool by attaching inserts. (Fig. 37).

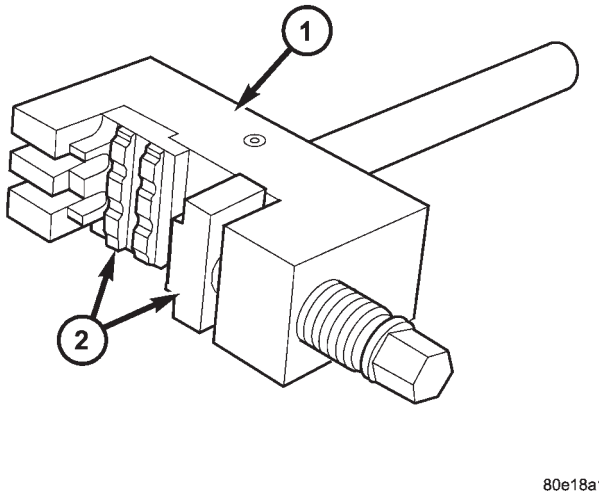

Fig. 37 INSTALLING ASSEMBLY INSERTS INTO RIVETING TOOL

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8952

NOTE: The outer plate will be held in place by a magnet.

(6) Place new outer plate into tool insert.

NOTE: Ensure that the riveted link and riveting tool are aligned.

(7) Position riveting tool over new link and press in new rivet as far as the tool stop.
(8) Remove riveting tool to change inserts.
(9) Install insert on riveting tool and secure with screw.
(10) Install insert on riveting tool (Fig. 38).

NOTE: The outer plate is held in place magnetically by riveting tool.

(11) Insert new outer plate into the moving assembly insert.
(12) Position riveting tool so that spacer webs of the guide are side by side.
(13) Ensure that riveted link and outer plate are aligned.

NOTE: When turning spindle of riveting tool, be sure that pins of riveted link are inserted into holes of outer plate.

(14) Screw in spindle of riveting tool until firm resistance is felt.
(15) Remove riveting tool.

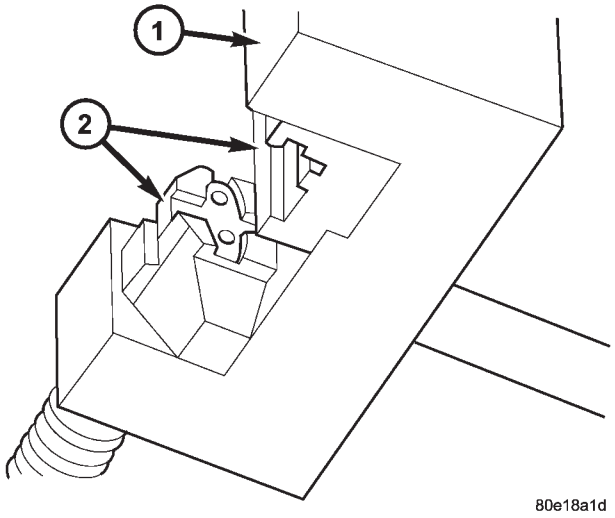

Fig. 38 INSTALLING RIVETING INSERTS INTO RIVETING TOOL

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8949

(16) Turn over tool moving assembly insert to the riveting profile.

NOTE: Rivet pins of the riveted link individually.

(17) Position riveting tool exactly over middle of pin (Fig. 39).

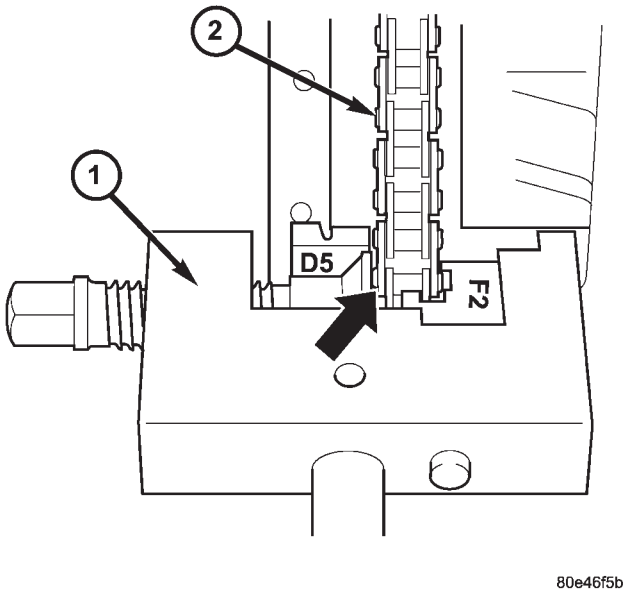

Fig. 39 RIVETING NEW LINK

1 - RIVETING TOOL
2 - OIL PUMP CHAIN

OIL PUMP (Continued)

(18) Tighten riveting tool spindle until it stops.
(19) Remove riveting tool, inspect riveting, rerivet if necessary (Fig. 40).
(20) Repeat procedure for both rivets.

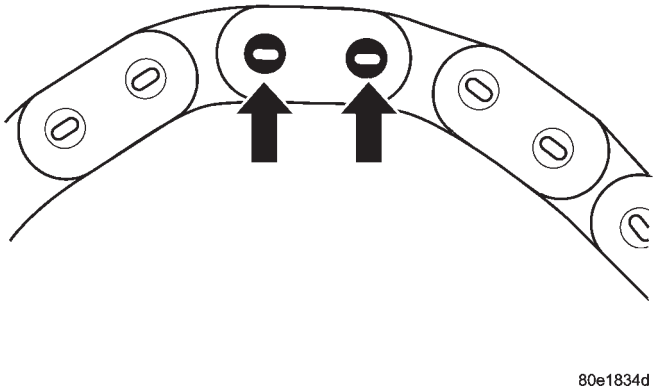

Fig. 40 RIVET INSPECTION

(21) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).
(22) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
(23) Refill engine with proper oil to the correct level.
(24) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELT OR FAN. DO NOT WEAR LOOSE CLOTHES.

(25) Start engine and inspect for leaks.

OIL COOLER & LINES

REMOVAL - OIL COOLER

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Unscrew oil filter housing cap.
(4) Raise and suitably support vehicle.

WARNING: DO NOT OPEN COOLING SYSTEM UNLESS TEMPERATURE IS BELOW 90°C (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN A MARKED AND SUITABLE CONTAINER. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR.

NOTE: Collect any residual fluids that may flow.

(5) Drain engine coolant.
(6) Remove fuel full-flow filter (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL FILTER / WATER SEPARATOR - REMOVAL).
(7) Remove coolant hose from exhaust heat exchanger.
(8) Remove bolts attaching exhaust heat exchanger to cylinder head.
(9) Remove air charge distribution pipe (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - REMOVAL).
(10) Remove coolant hose at oil-water heat exchanger.

NOTE: Collect any residual fluids that may flow.

(11) Remove automatic transmission fluid line at oil-water heat exchanger.
(12) Remove oil-water heat exchanger at timing case cover.

INSTALLATION - OIL COOLER

(1) Install oil cooler to timing case cover. Tighten bolts to 15 N·m (132 lbs. in.).
(2) Install transmission fluid lines to oil cooler.
(3) Install coolant hose to oil cooler.
(4) Install air charge distribution pipe (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - INSTALLATION).
(5) Install bolts attaching exhaust heat exchanger to cylinder head.
G
(6) Install coolant hose from exhaust heat exchanger.
(7) Install fuel full-flow filter (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL FILTER / WATER SEPARATOR - INSTALLATION).
(8) Close engine coolant drains.
(9) Install oil filter housing cap. Tighten to 25N·m (181 lbs. ft.).
(10) Install engine cover (Refer to 9 - ENGINE - INSTALLATION). Tighten screws to 10N·m (89 lbs. in.).
(11) Refill coolant system to proper level with properly mixed coolant (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(12) Check engine oil level, refill with proper engine oil as necessary. Refer to owners manual for specifications.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

OIL COOLER & LINES (Continued)

(13) Start engine and inspect for leaks.
(14) Inspect engine oil level 2 minutes after turning engine off. Refill as necessary.

INTAKE MANIFOLD

DESCRIPTION - INLET PORT SHUT OFF

A swirl and a charge air inlet port each are provided in the intake manifold for each cylinder (Fig. 41). The charge air ports can be closed by means of flaps. The flaps are connected to each other by linkage, which is operated by the inlet port shut off motor. The valves are held in position by means of spring force.

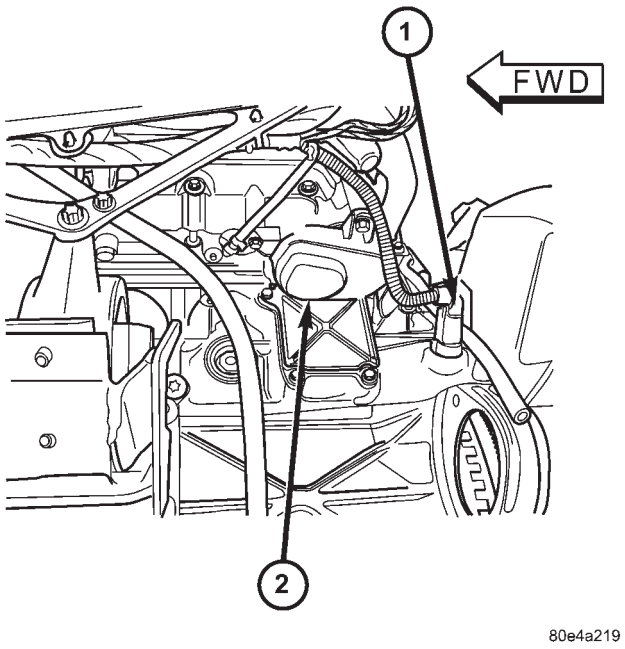

Fig. 41 SENSOR LOCATION

1 - CRANKSHAFT POSITION SENSOR
2 - SWIRL ACTUATOR

OPERATION - INLET PORT SHUT OFF

With lower engine speed and load range, all charge air ports are sealed off by way of flaps. The entire air flow flows in only through the swirl inlet ports. This results in a high air swirling which produces more effective mixing of fuel with air, enhancing combustion.

As engine speed and load rise, the charge inlet ports are continuously opened to obtain the best possible ratio between air swirling and air mass for each operating point. This optimizes engine power, exhaust characteristics, and reduces soot.

The position of the flaps in the charge air ports is determined by input received by the ECM (Engine Control Module). The inlet port shut off motor receives a PWM signal from the ECM for this purpose. A direct current motor pushes the adjusting lever into the correct position. If a fault or an open circuit occurs, the flaps are opened.

TIMING CHAIN COVER

REMOVAL

WARNING: DO NOT OPEN COOLING SYSTEM UNLESS TEMPERATURE IS BELOW 90°c (194°F). OPEN CAP SLOWLY TO RELEASE PRESSURE. STORE COOLANT IN APPROVED CONTAINER ONLY. RISK OF INJURY TO SKIN AND EYES FROM SCALDING COOLANT. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR.

(1) Disconnect negative battery cable.
(2) Drain coolant (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(3) Drain engine oil.
(4) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

NOTE: Inspect condition of hoses and clamps, replace as necessary.

(5) Detach coolant hoses on thermostat housing.
(6) Remove air intake hose.
(7) Remove air charge pipe together with air charge hose.
(8) Remove hydraulic cooling fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(9) Remove viscous heater hose and set aside.

WARNING: NO FIRE, OPEN FLAMES OR SMOKING. SERVICE VEHICLE IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY FROM SKIN AND EYE CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING WHEN HANDLING FUEL.

(10) Remove fuel high pressure lines and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(11) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

NOTE: Rotate engine on crankshaft. DO NOT crank the engine at the bolt of the camshaft sprocket.

NOTE: DO NOT crank engine back.

TIMING CHAIN COVER (Continued)

(12) Position piston of cylinder 1 to ignition TDC. **Markings on the camshaft bearing cap must be aligned.**

(13) Install retaining lock for crankshaft/starter ring gear.

(14) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL)

(15) Release rail on bracket.

(16) Remove coolant thermostat (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - REMOVAL).

(17) Remove cylinder head front cover (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

(18) Remove belt pulley of power steering pump.

NOTE: NO NOT open the air conditioning system.

(19) Unplug AC compressor electrical connector and unbolt AC compressor. Relocate in lower engine compartment **with out** opening the system.

(20) Detach the coolant hose to oil-water heat exchanger at crankcase.

(21) Detach and plug the transmission oil lines to oil-water heat exchanger.

(22) Detach coolant hoses on coolant pump.

(23) Remove water pump (Refer to 7 - COOLING/ENGINE/WATER PUMP - REMOVAL).

(24) Remove air charge pipe.

(25) Remove generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).

(26) Remove belt/pulley vibration damper.(Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

NOTE: Remove the bolts in area of timing case cover. Loosen all other oil pan bolts.

(27) Remove oil pan bolts.

(28) Remove M8 bolts of cylinder head on timing case cover.

(29) Remove timing case cover (Fig. 42).

(30) Remove remaining ancillary components attached to the timing case cover.

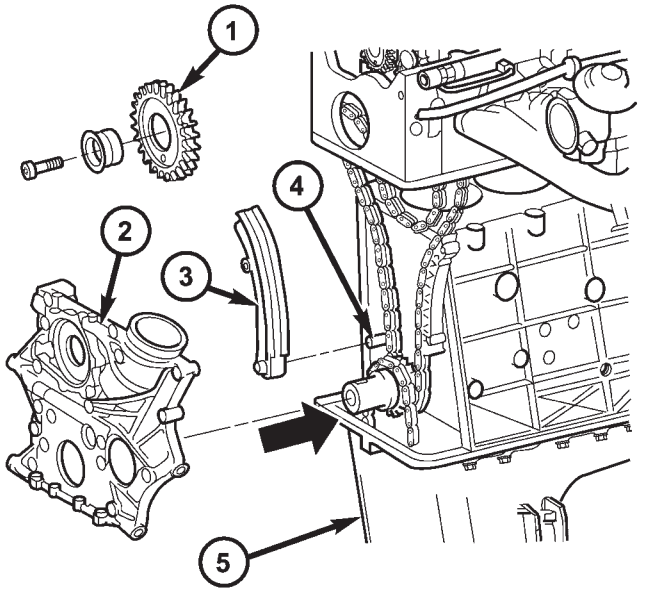

Fig. 42 TIMING CHAIN COVER

1 - INTERMEDIATE GEAR
2 - TIMING CHAIN COVER
3 - TENSIONING RAIL
4 - BEARING PIN
5 - OIL PAN

INSTALLATION

NOTE: Thoroughly clean all mating surfaces with the appropriate solvents to assure that no grease or oil is present during assembly.

(1) Inspect cylinder head gasket and oil pan gasket. If damaged, replace.

(2) Replace the front crankshaft seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - INSTALLATION).

(3) Install ancillary components to timing case cover.

(4) Position and install timing case cover. Tighten bolts to 20 N·m (177 lbs in).

(5) Install the M8 bolts of cylinder head on timing case cover. Tighten bolts to 20 N·m (177 lbs in).

(6) Position and install the oil pan. Tighten M6 bolts to 9 N·m (80 lbs in) and M8 bolts to 20 N·m (177 lbs in).

(7) Install belt /pulley vibration damper. Tighten M8.8 bolt in two stages, 200N·m (147 lbs ft.) then 90°, M10.9 bolt 325N·m (240 lbs ft) then 90°.

(8) Install generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).

(9) Install air charge pipe (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - INSTALLATION).

(10) Install water pump (Refer to 7 - COOLING/ENGINE/WATER PUMP - INSTALLATION).

(11) Connect coolant hoses to water pump.

(12) Connect the transmission oil lines to oil-water heat exchanger.

(13) Connect coolant hose to oil-water heat exchanger.

TIMING CHAIN COVER (Continued)

(14) Install the AC compressor and reconnect electrical connector.

(15) Install belt pulley onto power steering pump.

(16) Apply sealant to lower portain of, and install, front cover to cylinder block. Tighten bolts to 20N·m (177 lbs in) (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

(17) Install coolant thermostat (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - INSTALLATION).

(18) Install rail on bracket.

(19) Install timing chain tensioner with new seal (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(20) Install fuel high pressure lines and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ FUEL INJECTOR - INSTALLATION).

(21) Remove retaining lock for crankshaft/starter ring gear.

(22) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(23) Install hydraulic cooling fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(24) Install viscous heater.

(25) Install air charge pipe with air charge hose (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM - INSTALLATION).

(26) Install air intake hose.

(27) Fill coolant to the proper level, with the proper coolant (Refer to 7 - COOLING/ENGINE/ COOLANT - STANDARD PROCEDURE).

(28) Tighten the oil drain plug to 30N·m (265 lbs in).

(29) Fill the crankcase with the correct oil, to the proper level. Refer to owners manual for specifications.

(30) Connect the negative battery cable.

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 CLOTHES.

CAUTION: DO NOT pressure test cooling system until the engine reaches operating temperature.

(31) Start engine and inspect for leaks.

TIMING BELT/CHAIN AND SPROCKETS

REMOVAL

REMOVAL - BOTTOM GUIDE RAIL

(1) Disconnect negative battery cable.

(2) Remove cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - REMOVAL).

NOTE: Oil pan DOES NOT need to be removed. Remove bolts in the area of timing case cover then loosen the remaining bolts.

NOTE: Remove timing case cover carefully. Care must be taken not to damage oil pan gasket.

(3) Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(4) Remove guide rail from bearing pin (Fig. 43).

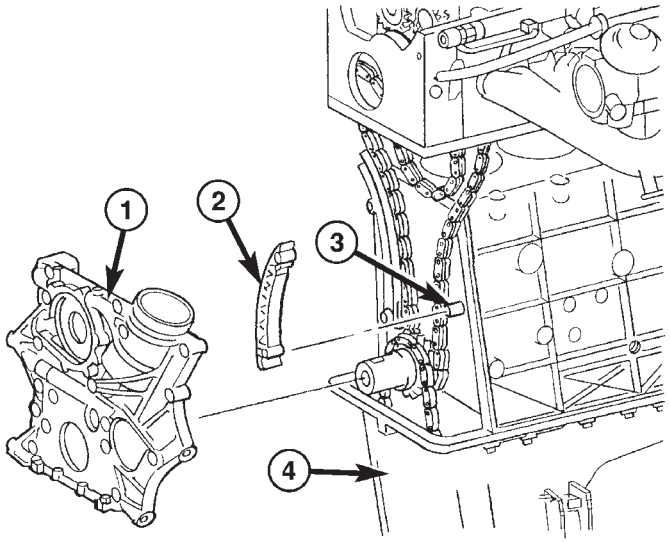

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Fig. 43 BOTTOM GUIDE RAIL

1 - TIMING CHAIN COVER
2 - BOTTOM SLIDE RAIL
3 - BEARING PIN
4 - OIL PAN

TIMING BELT/CHAIN AND SPROCKETS (Continued)

REMOVAL - INTERMEDIATE GEAR

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

WARNING: NO FIRE, FLAMES OR SMOKING. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(3) Remove fuel high pressure lines injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(4) Clean injectors and recesses (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE).
(5) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(6) Insert locking pin through first camshaft bearing cap into hole in inlet camshaft sprocket to lock inlet camshaft.
(7) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(8) Remove cylinder head front cover (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
(9) Remove top slide rail (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
(10) Remove high pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).
(11) Mark camshaft sprocket relative to timing chain.
(12) Unbolt camshaft sprocket from exhaust camshaft.

NOTE: Note position of dowel pin for camshaft sprocket alignment during reassembly.

(13) Secure camshaft sprocket to timing chain with tie strap.
(14) Remove camshaft sprocket.
(15) Remove intermediate gear and bushing (Fig. 44).

REMOVAL - TIMING CHAIN TENSIONING RAIL

(1) Disconnect negative battery cable.
(2) Remove cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

NOTE: Oil pan DOES NOT need to be removed. Remove bolts in the area of timing case cover then loosen the remaining bolts.

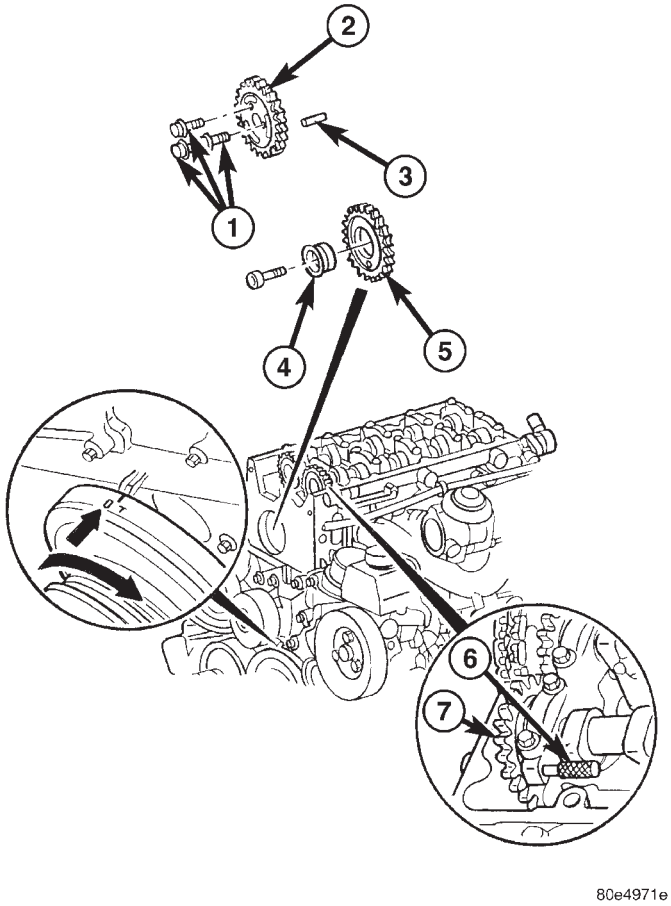

Fig. 44 HIGH RESSURE PUMP INTERMEDIATE GEAR

1 - CAMSHAFT SPROCKET BOLTS
2 - INTAKE CAMSHAFT
3 - DOWEL PIN
4 - INTERMEDIATE GEAR BUSHING
5 - INTERMEDIATE GEAR
6 - CAMSHAFT LOCKING PIN
7 - INTAKE CAMSHAFT SPROCKET

NOTE: Remove timing case cover carefully. Care must be taken not to damage oil pan gasket.

(3) Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(4) Remove tensioning rail from bearing pin (Fig. 45).

REMOVAL - TIMING CHAIN

(1) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(2) Remove vacuum pump (Refer to 9 - ENGINE/ENGINE BLOCK/INTERNAL VACUUM PUMP - REMOVAL).

TIMING BELT/CHAIN AND SPROCKETS (Continued)

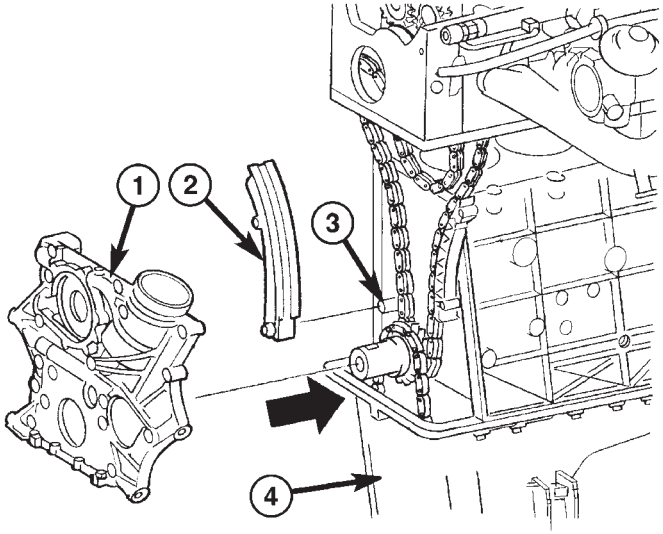

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Fig. 45 TIMING CHAIN TENSIONING RAIL

1 - TIMING CHAIN COVER
2 - TENSIONING RAIL
3 - BEARING PIN
4 - OIL PAN

(3) Remove low pressure fuel pump and drive (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/ FUEL INJECTION PUMP - REMOVAL).

(4) Remove guide rail in cylinder head (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(5) Remove timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

CAUTION: Cover timing case recess to prevent foreign material from entering engine.

(6) Secure timing chain to camshaft sprocket with tie straps (Fig. 46).

(7) Remove camshaft sprocket with timing chain attached, from camshaft.

NOTE: When fitting the thrust spindle, ensure that the thrust pin is positioned at the left timing chain pin of a chain link (Fig. 47).

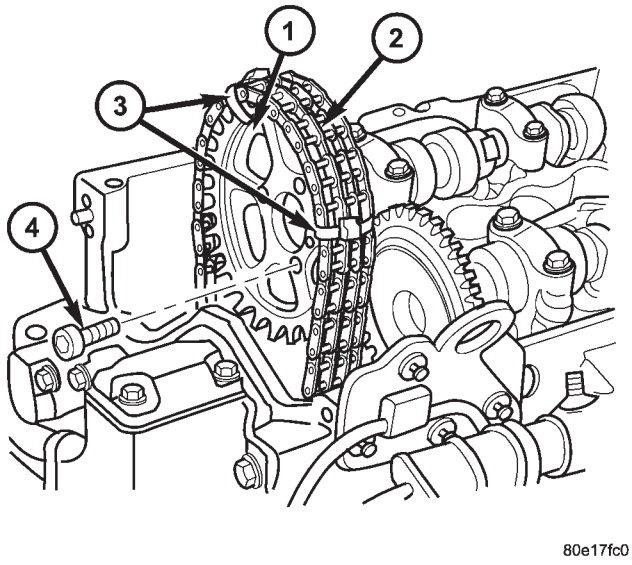

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Fig. 46 SECURING TIMING CHAIN TO SPROCKET

1 - CAMSHAFT SPROCKET
2 - TIMING CHAIN
3 - TIE STRAPS
4 - RETAINING BOLTS

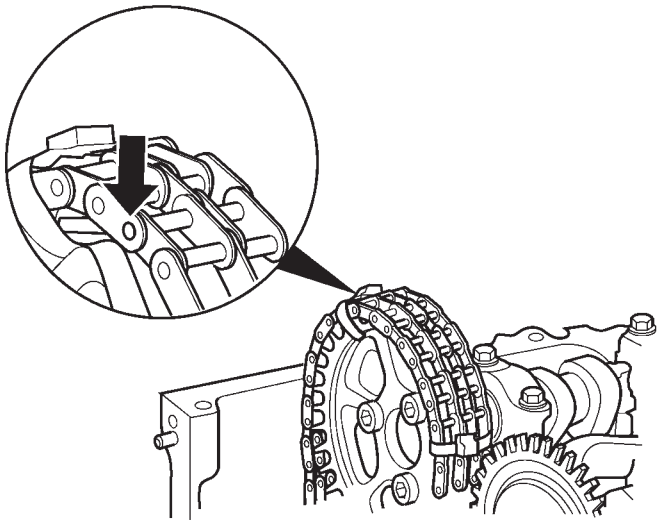

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Fig. 47 THRUST PIN POSITION

(8) Using special tool #8948, position timing chain separating tool at the timing chain of the camshaft sprocket (Fig. 48).

(9) Screw the thrust pin in and separate the timing chain.

(10) Unscrew the thrust spindle and remove the tool.

NOTE: DO NOT detach timing chain from camshaft sprocket.

TIMING BELT/CHAIN AND SPROCKETS (Continued)

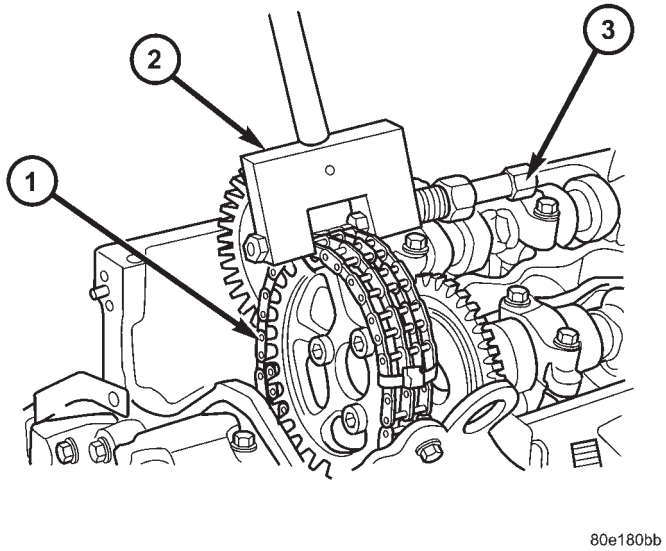

Fig. 48 SEPARATING TIMING CHAIN WITH SPECIAL TOOL #8948

1 - TIMING CHAIN
2 - SPECIAL TOOL #8948
3 - THRUST SPINDLE

(11) Install camshaft sprocket with timing chain, to camshaft.

(12) Remove pressed - out timing chain pin from chain separation tool.

(13) Attach special tool 8931, timing chain retainer, to cylinder head with bolts supplied (Fig. 49).

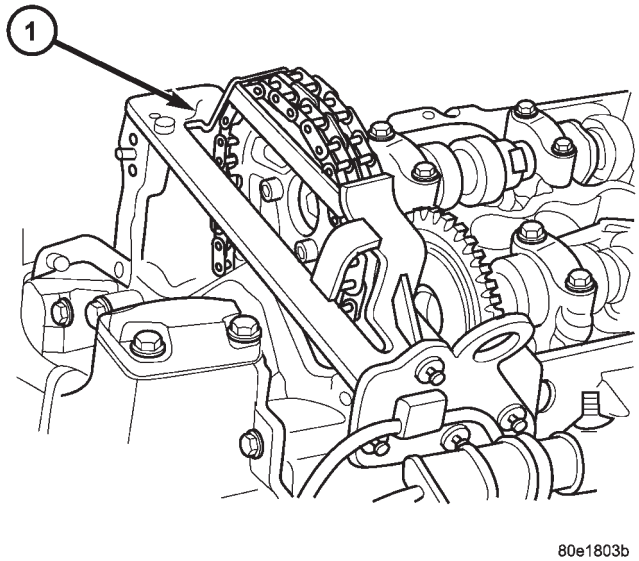

Fig. 49 SPECIAL TOOL # 8931

1 - SPECIAL TOOL #8931

(14) Remove timing chain to camshaft sprocket tie straps.

(15) Connect new timing chain and old timing chain with assembly link, assembly plate and locking element, and secure (Fig. 50) (Fig. 51).

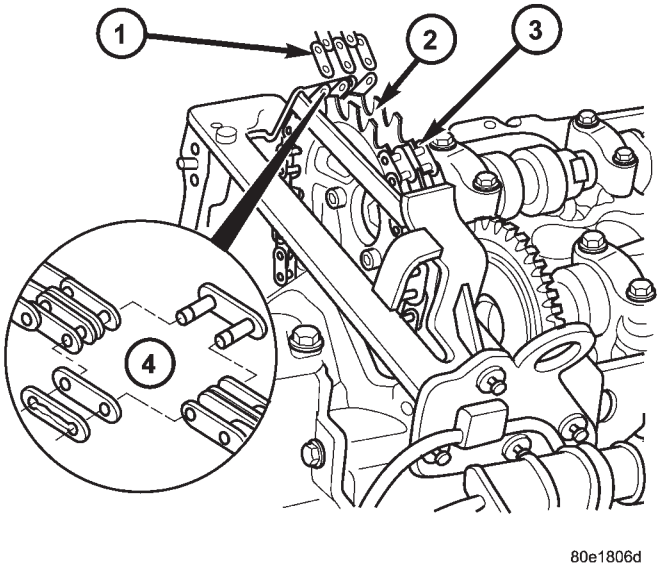

Fig. 50 INSTALLING TEMPORARY LINK

1 - NEW TIMING CHAIN
2 - CAMSHAFT SPROCKET
3 - OLD TIMING CHAIN
4 - TEMPORARY LINK

CAUTION: IT IS ESSENTIAL that the installation procedure for the timing chain is followed exactly. Failure to do so will result in severe engine damage.

INSTALLATION

INSTALLATION - BOTTOM GUIDE RAIL

NOTE: Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.

(1) Install slide rail on bearing pin.

(2) Install timing cover (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(3) Install oil pan bolts. Tighten M6 bolts to 9N·m (80 lbs.in.) and M8 bolts to 20N·m (15 lbs. ft.).

(4) Install cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - INSTALLATION).

(5) Reconnect negative battery cable.

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 CLOTHES.

(6) Start the engine and inspect for leaks.

TIMING BELT/CHAIN AND SPROCKETS (Continued)

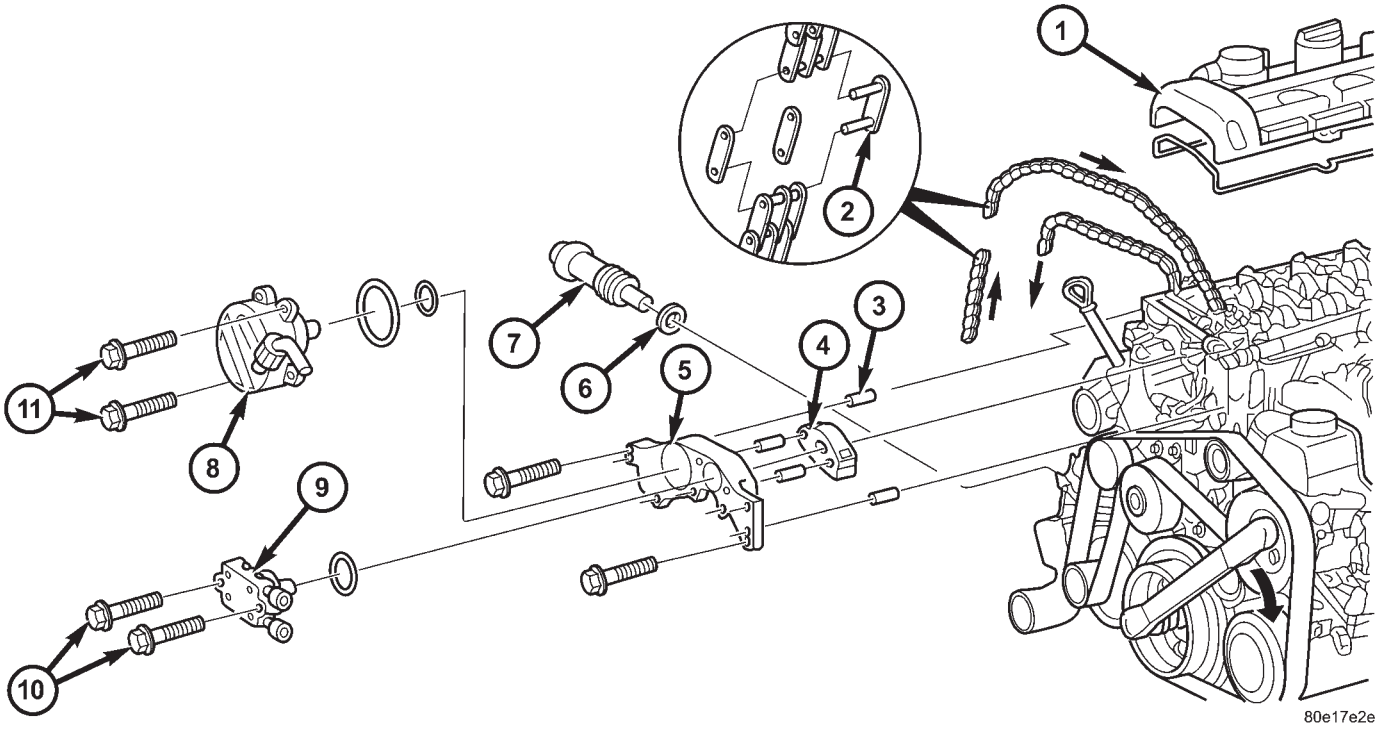

Fig. 51 TIMING CHAIN TEMPORARY LINK

1 - CYLINDER HEAD COVER
2 - TIMING CHAIN TEMPORARY LINK
3 - ALIGNMENT PINS
4 - TOP GUIDE RAIL
5 - CYLINDER HEAD FRONT COVER
6 - TIMING CHAIN TENSIONER SEAL
7 - TIMING CHAIN TENSIONER
8 - VACUUM PUMP
9 - LOW PRESSURE FUEL PUMP
10 - LOW PRESSURE PUMP MOUNTING BOLTS
11 - VACUUM PUMP MOUNTING BOLTS

INSTALLATION - INTERMEDIATE GEAR

NOTE: Refer to appropriate injector servicing procedures for cleaning of injectors and recesses.

(1) Install intermediate gear and bushing. Tighten bolt to 40N·m (30 lbs.ft.)

(2) Install camshaft sprocket, noting dowel pin alignment. Tighten bolt to 18 N·m (159 lbs. in.).

(3) Remove tie strap retaining timing chain to sprocket.

WARNING: NO FIRE, FLAMES OR SMOKING. SERVIVE VEHICLE IN WELL VENTILATED AREA. RISK OF INJURY FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. WEAR PROTECTIVE CLOTHING.

(4) Install high pressure pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).

(5) Install top slide rail (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(6) Install cylinder head front cover (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

(7) Install timing chain tensioner with new gasket (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

NOTE: Inspect basic position of camshaft and reset if necessary.

(8) Remove camshaft locking pin.

(9) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

WARNING: NO FIRE, FLAMES OR SMOKING. SERVIVE VEHICLE IN WELL VENTILATED AREA. RISK OF INJURY FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. WEAR PROTECTIVE CLOTHING.

(10) Install fuel high pressure lines and injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).

(11) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

TIMING BELT/CHAIN AND SPROCKETS (Continued)

(12) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(13) Start engine and inspect for leaks.

INSTALLATION - TIMING CHAIN TENSIONING RAIL

NOTE: Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.

(1) Install tensioning rail on bearing pin
(2) Install timing cover (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
(3) Install oil pan bolts. Tighten M6 bolts to 9N·m (80 lbs.in.) and M8 bolts to 20N·m (15 lbs. ft.).
(4) Install cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - INSTALLATION).
(5) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start the engine and inspect for leaks.

ADJUSTMENTS

INSTALLATION - TIMING CHAIN

CAUTION: IT IS ESSENTIAL that the installation procedure is followed exactly. Failure to do so will result in severe engine damage.

CAUTION: Cover timing case recesses to prevent foreign material from entering engine.

(1) Connect new timing chain and old timing chain with the assembly link, the assembly plate and the assembly locking element, and secure (Fig. 52).

NOTE: Always keep new timing chain meshed with camshaft sprocket.

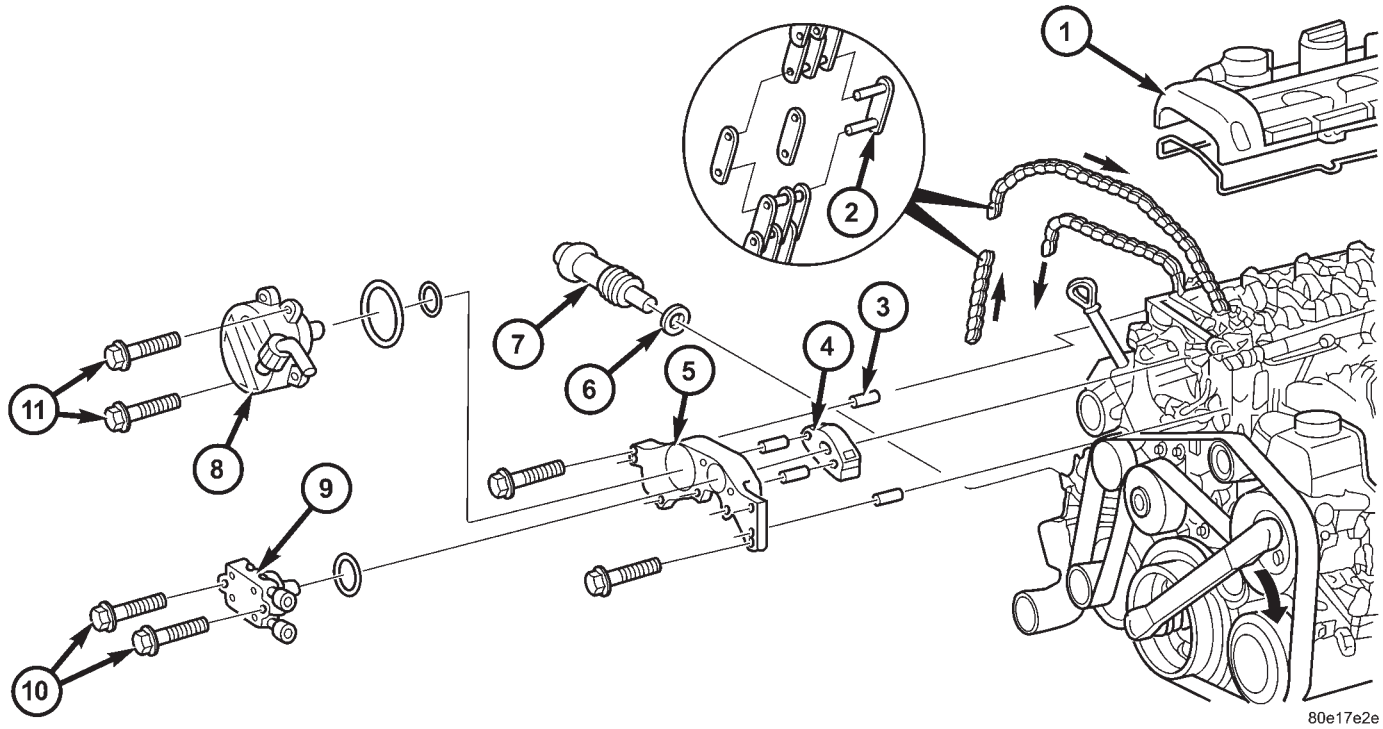

Fig. 52 TIMING CHAIN TEMPORARY LINK

1 - CYLINDER HEAD COVER
2 - TIMING CHAIN TEMPORARY LINK
3 - ALIGNMENT PINS
4 - TOP GUIDE RAIL
5 - CYLINDER HEAD FRONT COVER
6 - TIMING CHAIN TENSIONER SEAL
7 - TIMING CHAIN TENSIONER
8 - VACUUM PUMP
9 - LOW PRESSURE FUEL PUMP
10 - LOW PRESSURE PUMP MOUNTING BOLTS
11 - VACUUM PUMP MOUNTING BOLTS

TIMING BELT/CHAIN AND SPROCKETS (Continued)

NOTE: Rotate engine at crankshaft only. DO NOT crank engine and DO NOT rotate engine backward (Fig. 52).

NOTE: Draw out the end of old timing chain evenly as it becomes free, to the same extent that new timing chain is drawn in (Fig. 52).

(2) Draw in new timing chain by rotating the crankshaft slowly in direction of rotation of engine until the ends of the new timing chain meet and can be connected (Fig. 52).

NOTE: Assembly link is only an assembly aid and NOT designed for engine running.

(3) Remove assembly locking element, assembly outer plate and assembly link (Fig. 53).

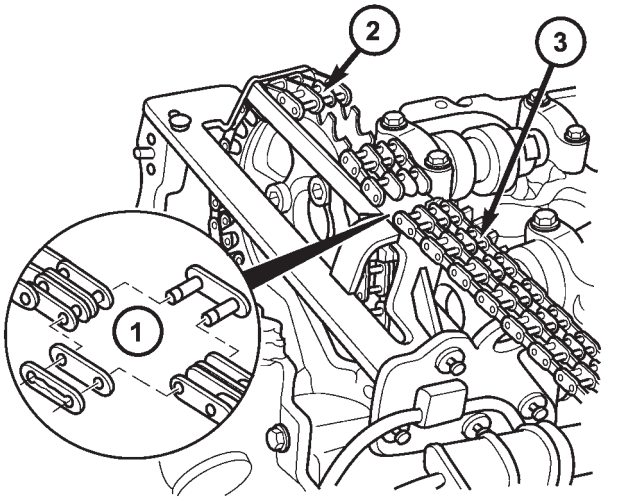

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Fig. 53 REMOVING TEMPORARY LINK

1 - TEMPORARY LINK
2 - NEW TIMING CHAIN
3 - OLD TIMING CHAIN

(4) Attach new timing chain to camshaft sprocket and retain.

(5) Insert new riveted link and new middle plate into ends of timing chain (Fig. 54).

(6) Take off retaining devise at cylinder head.

(7) Remove camshaft sprocket from camshaft with timing chain secured.

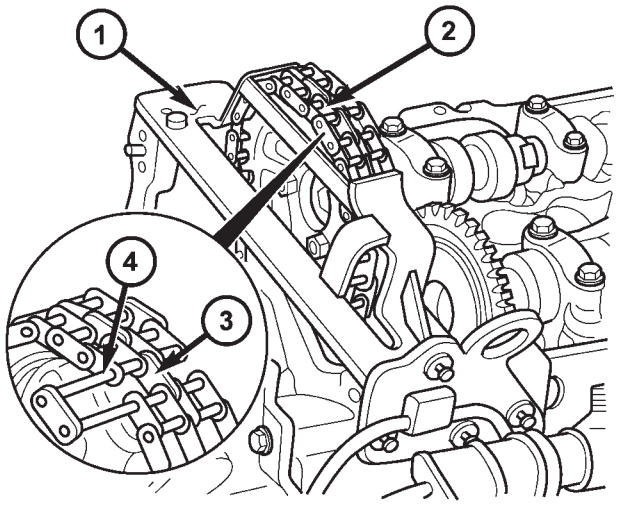

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Fig. 54 INSERT NEW RIVETED LINK

1 - SPECIAL TOOL #8931
2 - NEW TIMING CHAIN ENDS
3 - NEW MIDDLE PLATE
4 - NEW RIVETED LINK

NOTE: When assembling riveting tool, piece F5 is secured by a screw and D9 can move loosely on thrust spindle

(8) Assemble riveting tool by inserting pieces F5 and D9 (Fig. 55).

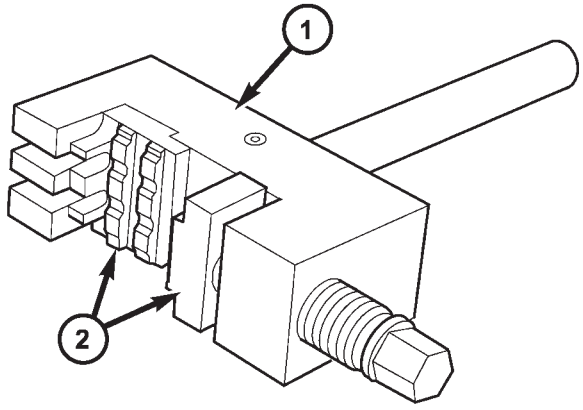

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Fig. 55 INSTALLING ASSEMBLY INSERTS INTO RIVETING TOOL

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8952

TIMING BELT/CHAIN AND SPROCKETS (Continued)

NOTE: Ensure that the riveted link and riveting tool are aligned.

(9) Press in new riveted link as far as the stop (Fig. 56).

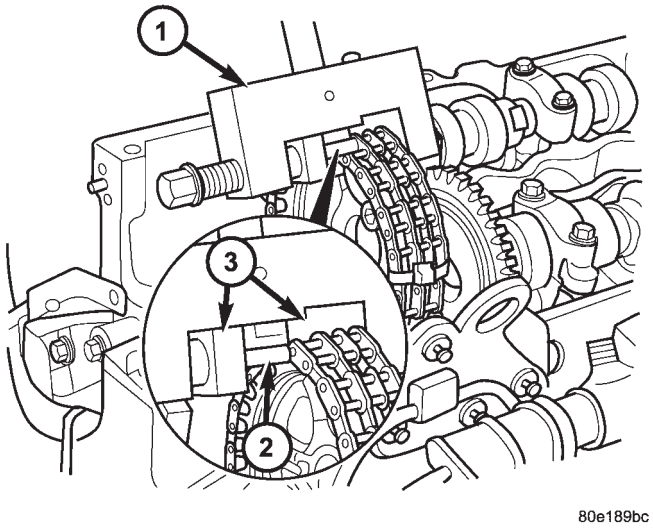

Fig. 56 PRESSING IN NEW RIVETED LINK

1 - SPECIAL TOOL #8947
2 - NEW RIVETED LINK
3 - SPECIAL TOOL #8952

(10) Remove riveting tool to change inserts.
(11) Install insert F1 on riveting tool and secure with screw (Fig. 57).
(12) Install insert D8 on riveting tool (Fig. 57).

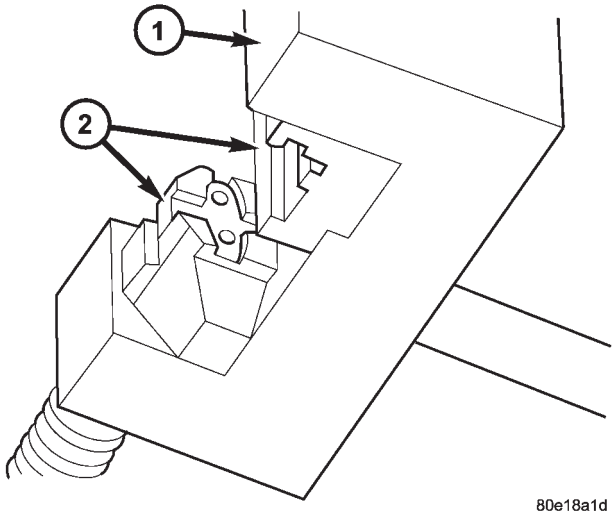

Fig. 57 INSTALLING RIVETING INSERTS INTO RIVETING TOOL

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8949

NOTE: The outer plate is held magnetically by riveting tool.

(13) Insert new outer plate into the moving assembly insert.
(14) Position riveting tool so that spacer webs of the guide are side by side.
(15) Ensure that riveted link and outer plate are aligned (Fig. 58).

NOTE: When turning spindle of riveting tool, be sure that pins of riveted link are inserted into holes of outer plate (Fig. 58).

(16) Screw in spindle of riveting tool until firm resistance is felt (Fig. 58).

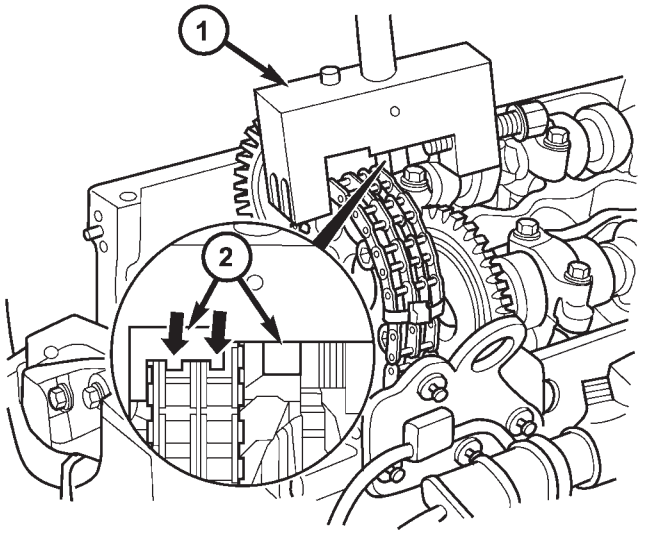

Fig. 58 INSTALLING LINK OUTER PLATE

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8949

TIMING BELT/CHAIN AND SPROCKETS (Continued)

(17) Remove riveting tool.

(18) Turn over moving assembly insert (D8) to the riveting profile.

(19) Position riveting tool exactly over middle of pin.

(20) Tighten riveting tool spindle to end of travel.

(21) Repeat procedure for both riveting pins (Fig. 59).

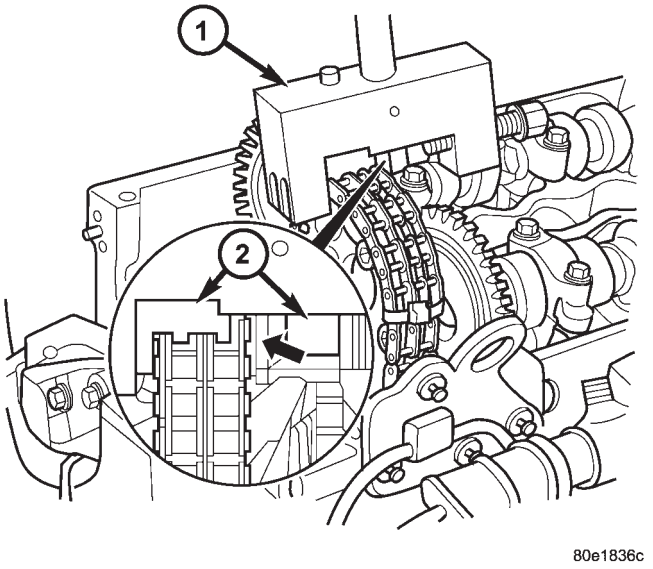

Fig. 59 RIVETING LINKS OF THE RIVETED LINK

1 - SPECIAL TOOL #8947
2 - SPECIAL TOOL #8949

(22) Inspect riveting, rerivet if required (Fig. 60).

(23) Install camshaft sprocket with timing chain retained onto camshaft. Tighten camshaft bolts to 18N·m (159 lbs.in.).

(24) Remove camshaft sprocket to timing chain tie straps.

(25) Install guide rail and tighten low pressure fuel pump drive to 50N·m (37 lbs. ft.).

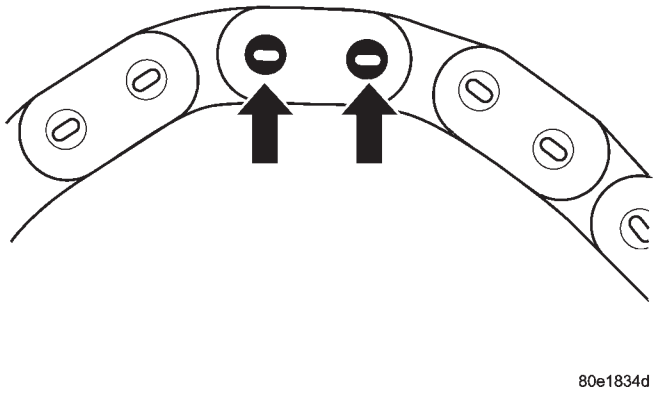

Fig. 60 RIVET INSPECTION

(26) Install low pressure fuel pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).

(27) Install timing chain tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(28) Install vacuum pump (Refer to 9 - ENGINE/ENGINE BLOCK/INTERNAL VACUUM PUMP - INSTALLATION).

(29) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(30) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

(31) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(32) Start engine and inspect for leaks.

TIMING CHAIN TENSIONER

REMOVAL

(1) Disconnect negative battery cable.

CAUTION: Rotate engine at crankshaft only. DO NOT rotate the engine with the bolt of the camshaft sprocket. DO NOT rotate the engine counter clockwise.

NOTE: Markings on the camshaft and camshaft bearing cap must be aligned.

(2) Position piston of number 1 cylinder to ignition TDC.
(3) Partially drain cooling system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Remove viscous heater.
(5) Remove intake air scoop.
(6) Remove accessory drive belt and idler pulley above generator (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(7) Remove timing chain tensioner (Fig. 61).

INSTALLATION

NOTE: Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.

(1) Install timing chain tensioner with new gasket. Tighten to 80N·m (59 lbs.ft.).
(2) Install viscous heater.
(3) Install idler pulley and accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(4) Install intake air scoop.
(5) Reconnect negative battery cable.

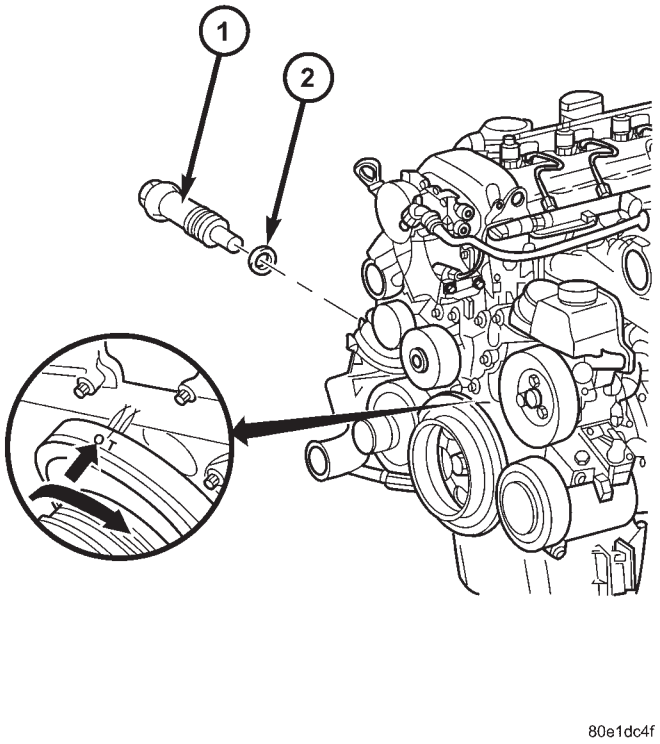

Fig. 61 TIMING CHAIN TENSIONER

1 - TIMING CHAIN TENSIONER
2 - TIMING CHAIN TENSIONER SEAL

(6) Refill coolant system with correct mixture to proper level (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(7) Start the engine and inspect for leaks.

EXHAUST SYSTEM AND TURBOCHARGER - 2.7L DIESEL

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EXHAUST SYSTEM AND TURBOCHARGER - 2.7L DIESEL

DESCRIPTION - 2.7L DIESEL

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.

The diesel engine exhaust system consists of an engine exhaust manifold, turbocharger, exhaust pipe, resonator, extension pipe (if needed), muffler and exhaust tailpipe.

The exhaust system must be properly aligned and secured to prevent stress, leakage and body contact. The exhaust components should be kept a minimum of 25.4 mm (1.0 in.) away from the body and frame. If the system contacts any body panel, it may amplify objectionable noises from the engine or body.

DIAGNOSIS AND TESTING - DIESEL ENGINE

EXHAUST SYSTEM DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
EXCESSIVE EXHAUST NOISE OR LEAKING EXHAUST GASES	1. Leaks at pipe joints.	1. Tighten/replace clamps/bolts at leaking joints.
	2. Rusted or expanded muffler.	2. Replace muffler. Inspect exhaust system.
	3. Broken or rusted exhaust pipe.	3. Replace exhaust pipe.
	4. Exhaust pipe leaking at manifold flange.	4. Tighten/replace flange attaching nuts/bolts.
	5. Exhaust manifold cracked or broken.	5. Replace exhaust manifold.
	6. Leak between exhaust manifold and cylinder head.	6. Tighten/replace exhaust manifold to cylinder head bolts.
	7. Turbocharger mounting flange cracked.	7. Remove turbocharger and inspect.
	8. Restriction in exhaust system.	8. Remove restriction, if possible. Replace restricted part if necessary.

TURBOCHARGER SYSTEM

DESCRIPTION

CAUTION: The turbocharger is a performance part and must not be tampered with. The wastegate bracket is an integral part of the turbocharger. Tampering with the wastegate components can reduce durability by increasing cylinder pressure and thermal loading due to incorrect inlet and exhaust manifold pressure. Poor fuel economy and failure to meet regulatory emissions laws may result. Increasing the turbocharger boost WILL NOT increase engine power.

The turbocharger used on this vehicle is of the variable turbine type (Fig. 1). These turbochargers use the entire exhaust energy to boost efficiency of the turbocharger and the engine.

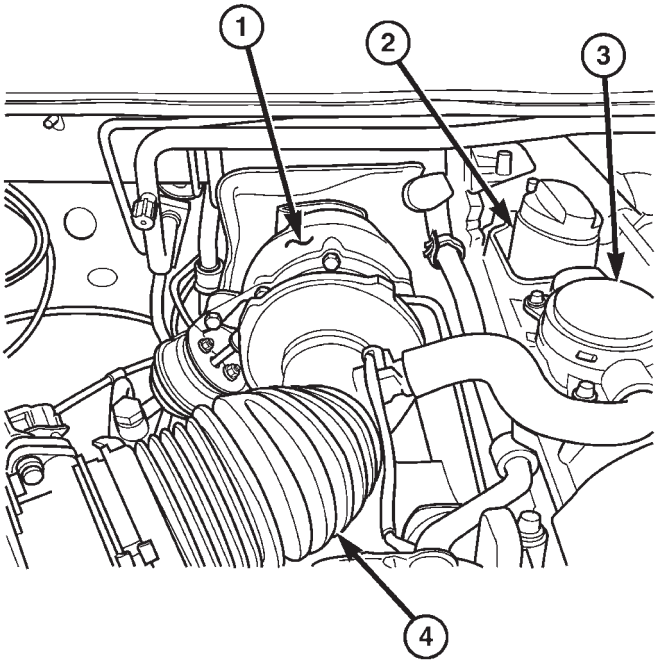

Fig. 1 TURBOCHARGER LOCATION

1 - TURBOCHARGER
2 - CYLINDER HEAD COVER
3 - OIL SEPARATOR
4 - AIR INLET TUBE
5 - WASTEGATE ACTUATOR

The advantages of a turbocharger with variable turbine geometry are:

- Higher charge pressure already in the lower and in upper engine speed ranges.
- Higher torque as a result of improved cylinder charge.
- Reduction in exhaust emissions as a result of an improvement in the air supply of the engine.
- Increased power output as a result of the higher charge pressure combined with a reduced exhaust backpressure and thus improved charge cycle.

OPERATION

The exhaust gases of the engine are directed through the exhaust manifold into the turbine housing onto the turbine wheel (Fig. 2). The flow energy of the exhaust gases cause the turbine wheel to rotate. Consequently, the compressor wheel, which is connected through the turbine shaft with the turbine wheel, is driven at the same speed. The fresh air inducted by the compressor wheel is compressed and passed to the engine (Fig. 2).

The charge pressure is controlled by varying the position of the guide vanes (Fig. 2). The guide stud of the control linkage of the boost pressure actuator turns the adjusting ring in the turbine housing (Fig. 2). As a result, all the guide vanes whose guide studs likewise mesh into the adjusting ring, are also turned (Fig. 2).

At low speeds, the flow cross-section is reduced by closing the guide vanes (Fig. 2). Consequently the speed at which the exhaust gas impacts on the turbine wheel is increased, as a result of which the speed of the turbocharger and thus the charge pressure rises.

At high engine speeds the guide vanes are increasingly opened and the flow cross-section is thus enlarged, as a result of which the speed of the turbocharger reduces and the charge pressure drops.

REMOVAL - TURBOCHARGER

WARNING: THE NORMAL OPERATING TEMPERATURE OF THE EXHAUST SYSTEM IS VERY HIGH. NEVER WORK AROUND OR ATTEMPT TO SERVICE ANY PART OF THE EXHAUST SYSTEM UNTIL IT IS COOL. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE TURBOCHARGER. THE TEMPERATURE OF THE TURBOCHARGER RISES TO A HIGH LEVEL AFTER A SHORT PERIOD OF ENGINE OPERATION TIME.

NOTE: THERE IS NO PROCEDURE FOR REPAIRING THE TURBOCHARGER. IF DAMAGE IS FOUND DURING INSPECTION, THE TURBOCHARGER MUST BE REPLACED.

(1) Disconnect negative battery cable.
(2) Disconnect oil separator hose from turbocharger air inlet hose.

TURBOCHARGER SYSTEM (Continued)

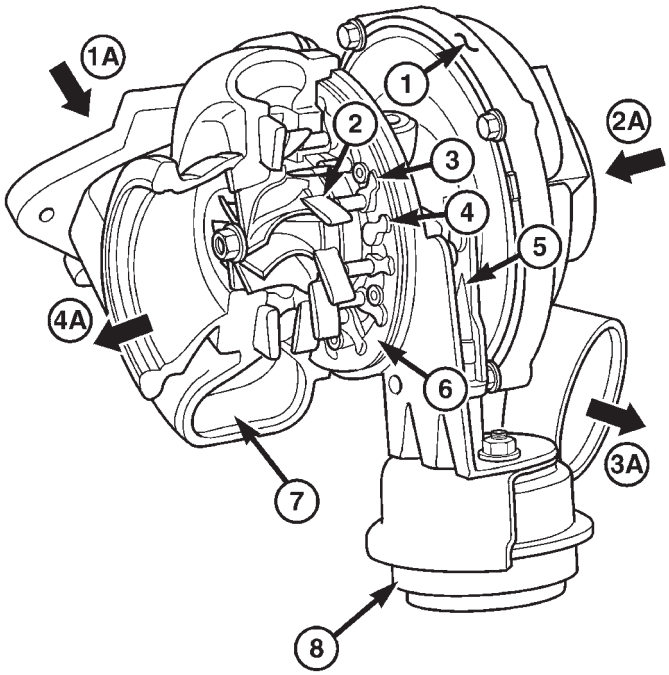

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Fig. 2 TURBOCHARGER COMPONENTS

1 - COMPRESSOR HOUSING
2 - GUIDE VANE
3 - GUIDE STUD OF GUIDE VANE
4 - GUIDE STUD OF CONTROL LINKAGE
5 - CONTROL LINKAGE
6 - ADJUSTING RING
7 - TURBINE HOUSING
8 - CHARGE PRESSURE CONTROL UNIT
1A - EXHAUST GASES TO TURBINE WHEEL
2A - TURBO INLET (FRESH AIR)
3A - TURBO OUTLET (COMPRESSED AIR)
4A - EXHAUST OUTLET

(3) Disconnect MAF inlet tube from turbocharger.
(4) Disconnect charge air inlet tube at turbocharger.
(5) Disconnect charge air inlet tube to turbocharger housing support bracket.
(6) Disconnect wastegate motor vacuum hose.
(7) Disconnect turbocharger to charge air lower support bracket.
(8) Disconnect turbocharger upper and lower oil lines and capture lost fluid.
(9) Remove the exhaust down pipe to turbocharger spring clamp and separate.
(10) Remove turbocharger from support bracket.

INSTALLATION

(1) Position and install the turbocharger on the lower support bracket.
(2) Position exhaust down pipe to turbocharger and secure with clamp.
(3) Reconnect turbocharger oil lines with new seals.
(4) Connect waste gate solenoid vacuum hose.
(5) Connect charge air inlet tube to turbocharger housing support bracket.
(6) Connect charger air inlet tube.
(7) Connect MAF intake tube.
(8) Connect oil separator tube to MAF intake tube.
(9) Connect negative battery cable.

WASTEGATE

REMOVAL - WASTE GATE SOLENOID

(1) Disconnect negative battery cable.
(2) Disconnect waste gate solenoid electrical connector.
(3) Disconnect engine vacuum harness from waste gate solenoid (Fig. 3).
(4) Remove waste gate solenoid from bracket (Fig. 3).

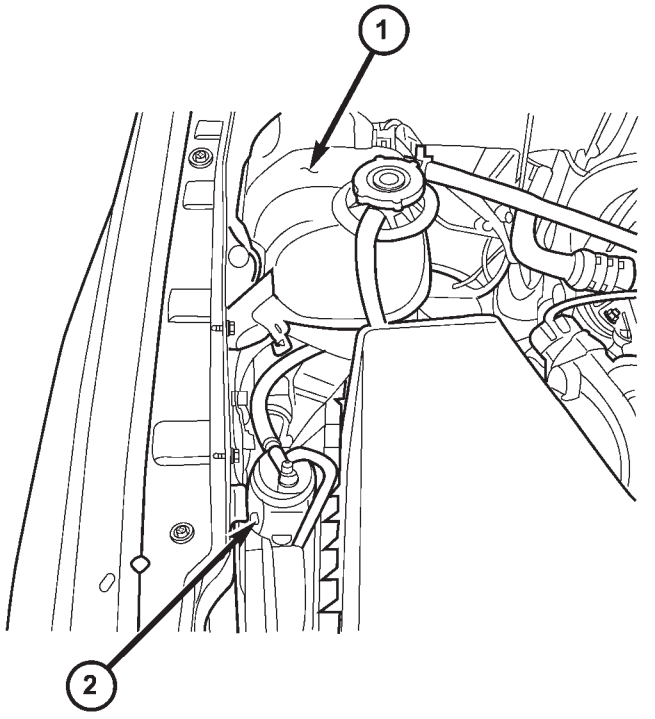

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Fig. 3 WASTEGATE SOLENOID LOCATION

1 - COOLANT PRESSURE CONTAINER
2 - WASTEGATE SOLENOID

WASTEGATE (Continued)

INSTALLATION

(1) Position and install waste gate solenoid onto bracket.
(2) Connect engine vacuum harness to waste gate solenoid
(3) Connect waste gate solenoid electrical connector.
(4) Connect negative battery cable.

CHARGE AIR COOLER AND PLUMBING

DESCRIPTION

The charge air system consists of the charge air cooler and charge air cooler piping.

The charge air cooler is a heat exchanger that uses air flow from vehicle motion 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.

OPERATION

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 located in front of the radiator. From the charge air cooler the air flows back into the intake manifold.

DIAGNOSIS AND TESTING - CHARGE AIR COOLER SYSTEM - LEAKS

Low turbocharger boost pressure and low engine preformance can be caused by leaks in the charge air cooler or it's plumbing. The following procedure outlines how to check for leaks in the charge air cooler system.

(1) Loosen clamp and remove turbocharger to air inlet duct rubber sleeve from turbocharger.
(2) Insert Special Tool 8442 Adapter into the rubber sleeve. Tighten existing clamp to 8 N·m (72 in.lbs.).

CAUTION: Do not apply more than 138 kpa (20 psi) air pressure to the charge air cooler system, sever damage to the charge air cooler system may occur.

(3) Connect regulated air supply to air fitting on Special Tool 8442 Adapter. Set air pressure to a Maximum of 138 kpa (20 psi).
(4) Using soapy water check the air inlet ducts, rubber sleeves, charge air cooler and intake manifold for leaks.

REMOVAL - CHARGE AIR COOLER

WARNING: IF THE ENGINE WAS JUST TURNED OFF, THE AIR INTAKE SYSTEM TUBES MAY BE HOT.

NOTE: Note the location of the rubber air charge cooler to A/C condenser and air charger cooler to radiator air seals. The seals are use to prevent overheating and improve charge air and A/C efficiency.

(1) Disconnect the battery negative cables.
(2) Remove cooling module (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).
(3) Remove the front grill.
(4) Mark the position of the radiator upper cross member and remove cross member.
(5) Unbolt the transmission auxiliary cooler and power steering cooler from the charge air cooler and set aside.
(6) Remove the boost tubes from the charge air cooler.
(7) Remove power steering reservoir retaining bolt, and set reservoir aside.
(8) Remove the charge air cooler bolts.

NOTE: Care must be taken not to damage the charge air cooler fins and the fins of other ancillary cooler components.

(9) Pivot the charge air cooler rearward and up to remove.

CLEANING

CAUTION: Do not use caustic cleaners to clean the charge air cooler. Damage to the charge air cooler will result.

NOTE: If internal debris cannot be removed from the cooler, the charge air cooler MUST be replaced.

(1) If the engine experiences a turbocharger failure or any other situation where oil or debris get into the charge air cooler, the charge air cooler must be cleaned internally.
(2) Position the charge air cooler so the inlet and outlet tubes are vertical.
(3) Flush the cooler internally with solvent in the direction opposite of normal air flow.
(4) Shake the cooler and lightly tap on the end tanks with a rubber mallet to dislodge trapped debris.
(5) Continue flushing until all debris or oil are removed.

CHARGE AIR COOLER AND PLUMBING (Continued)

(6) Rinse the cooler with hot soapy water to remove any remaining solvent.

(7) Rinse thoroughly with clean water and blow dry with compressed air.

INSPECTION

Visually inspect the charge air cooler for cracks, holes, or damage. Inspect the tubes, fins, and welds for tears, breaks, or other damage. Replace the charge air cooler if damage is found.

Pressure test the charge air cooler, using Charge Air Cooler Tester Kit.

INSTALLATION - CHARGE AIR COOLER

(1) Position the power steering reservoir along with charge air cooler. Install the bolts and tighten to 2 N·m (17 in. lbs.).

(2) Install cooling module (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION) (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(3) Install the transmission auxiliary cooler (if equipped) (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - INSTALLATION).

(4) Install the power steering cooler.

(5) Install the boost tubes to the charge air cooler. With the clamps in position, tighten the clamps to 11 N·m (95 in. lbs.)

(6) Align and install upper cross member.

(7) Install the front grill (Refer to 23 - BODY/EXTERIOR/GRILLE - INSTALLATION).

(8) Connect the battery negative cable.

(9) Start engine and check for leaks.

FUEL SYSTEM

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FUEL INJECTION

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CAMSHAFT POSITION SENSOR

DESCRIPTION

The camshaft position sensor is mounted on the cylinder head cover (Fig. 1). The sensor detects the camshaft position contactlessly (hall effect) by means of a segment at the camshaft. The electronic control module (ECM) detects TDC position of cylinder 1 by means of the signal supplied by the camshaft sensor. Injection timing is synchronized by means of the camshaft signal and the crankshaft signal.

OPERATION

The signal circuit of the camshaft sensor has a voltage of approximately 5V. If the segment machined into the exhaust camshaft sprocket is positioned opposite the camshaft sensor, the camshaft signal is approximately 0V. This 0V to 5V signal is used by the engine control module (ECM) for detecting ignition TDC of cylinder 1 as the engine rotates. If no signal is supplied by the camshaft position sensor, the vehicle will not start.

REMOVAL

(1) Disconnect negative battery cable.

CAMSHAFT POSITION SENSOR (Continued)

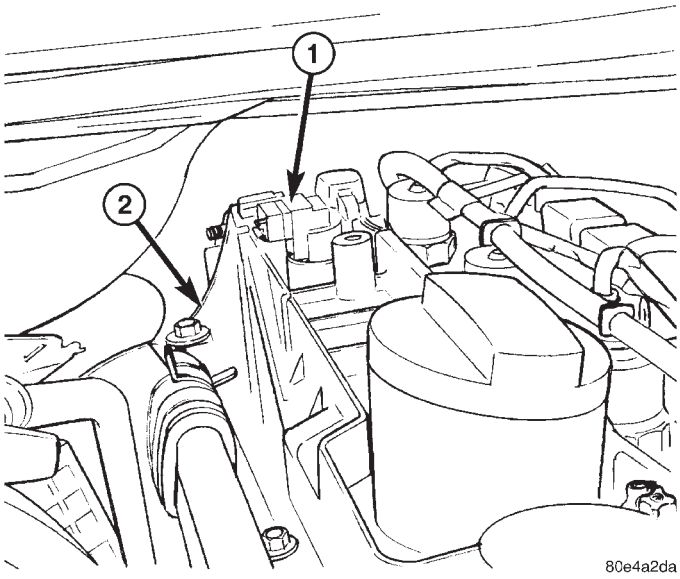

Fig. 1 CAMSHAFT POSITION SENSOR LOCATION

1 - CAMSHAFT POSITION (CMP) SENSOR
2 - CYLINDER HEAD COVER

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(3) Disconnect camshaft position sensor electrical connector.

(4) Remove retaining bolt and remove sensor.

INSTALLATION

(1) Install camshaft position sensor and tighten bolt.

(2) Reconnect electrical connector.

(3) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

(4) Reconnect negative battery cable.

CRANKSHAFT POSITION SENSOR

DESCRIPTION

The crankshaft position sensor is located at the left rear of the engine just above the starter motor (Fig. 2). This sensor is used to detect engine speed.

OPERATION

The crankshaft position and engine speed are detected contactlessly. The distance between the crankshaft position sensor and the teeth of the driven plate is fixed by the installation position.

When the crankshaft rotates, an alternating voltage is generated in the crankshaft position sensor by the teeth of the driven plate.

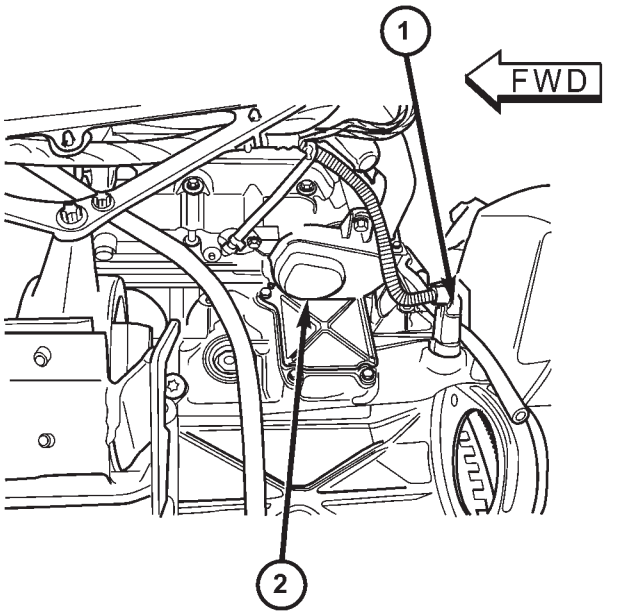

Fig. 2 SENSOR LOCATION

1 - CRANKSHAFT POSITION SENSOR
2 - SWIRL ACTUATOR

In this case, the front edge of a tooth generates a positive voltage pulse and the rear edge a negative voltage pulse. The distance from the positive to the negative voltage peak equals the length of a tooth.

The gap created by 2 missing teeth (arrow) has the effect that no voltage is generated in the crankshaft position sensor. This is analyzed in order to detect the TDC position of cylinder 1

FUEL PRESSURE SENSOR

DESCRIPTION

The rail sensor monitors and passes on the current rail pressure to the control module (Fig. 3). The non-constant system pressure influences the position of the sensor diaphragm which alters the sensors electrical resistance.

OPERATION

The rail pressure sensor measures the current rail pressure and supplies an appropriate voltage signal to the Engine Control Module (ECM). The pressure control valve is then actuated by the ECM through a control loop until the desired rail pressure is reached.

FUEL PRESSURE SENSOR (Continued)

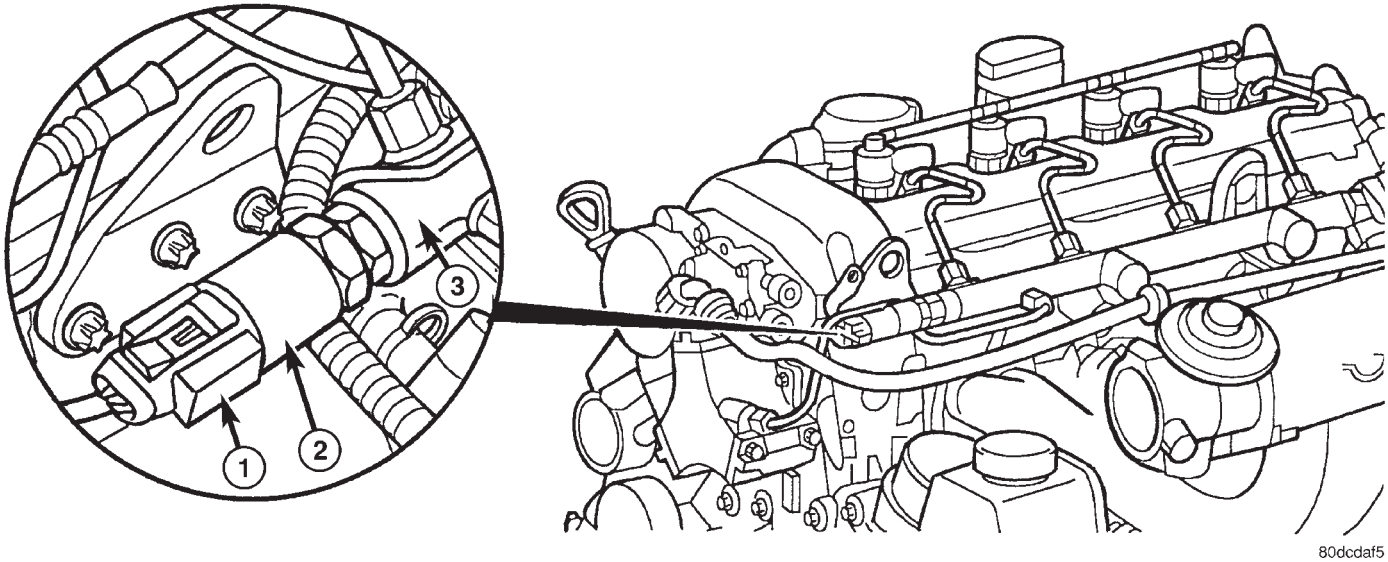

Fig. 3 FUEL PRESSURE SENSOR

1 - FUEL PRESSURE ELECTRICAL CONNECTOR
2 - FUEL PRESSURE SENSOR
3 - FUEL RAIL

REMOVAL

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: To avoid leakage problems, the rail pressure sensor should not be removed unless it is to be replaced.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Unplug electrical connector at rail pressure sensor (Fig. 3).
(4) Counterhold at the threaded connection of rail and remove rail pressure sensor.

INSTALLATION

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Coat sealing surface of fuel rail with lubricating varnish and replace seal.
(2) Counterhold at the threaded connection of the fuel rail and install the rail pressure sensor (Fig. 3). Tighten to 22N·m (194 lbs. in.).
(3) Connect rail sensor electrical connector (Fig. 3).
(4) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(5) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOU HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

FUEL INJECTOR

DESCRIPTION

FUEL INJECTOR

There are individual fuel injectors for all five cylinders. These fuel injectors are used to spray fuel into the combustion chamber (Fig. 4).

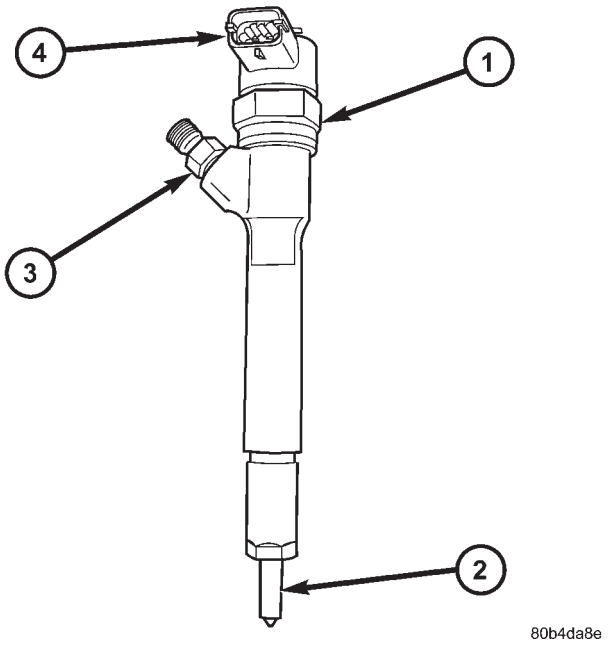

Fig. 4 FUEL INJECTOR

1 - FUEL INJECTOR
2 - NOZZLE
3 - FUEL INLET FITTING
4 - ELECTRICAL CONNECTION

OPERATION

The injector operation can be subdivided into four operating states with the engine running and the high-pressure pump generating pressure:

- Injector closed (with high pressure applied)
- Injector opens (start of injection)
- Injector opened fully
- Injector closes (end of injection)

Injector closed (with high pressure applied)

With the injector closed (at-rest state), the solenoid valve is not energized and is therefore closed. With the bleed orifice closed, the valve spring forces the armature's ball onto the bleed-orifice seat. The rail's high pressure build up in the valve control chamber, and the same pressure is also present in the nozzle's chamber volume. The rail pressure applied at the control plunger's end face, together with the force of the nozzle spring, maintain the nozzle in the closed position against the opening forces applied to its pressure stage (Fig. 5).

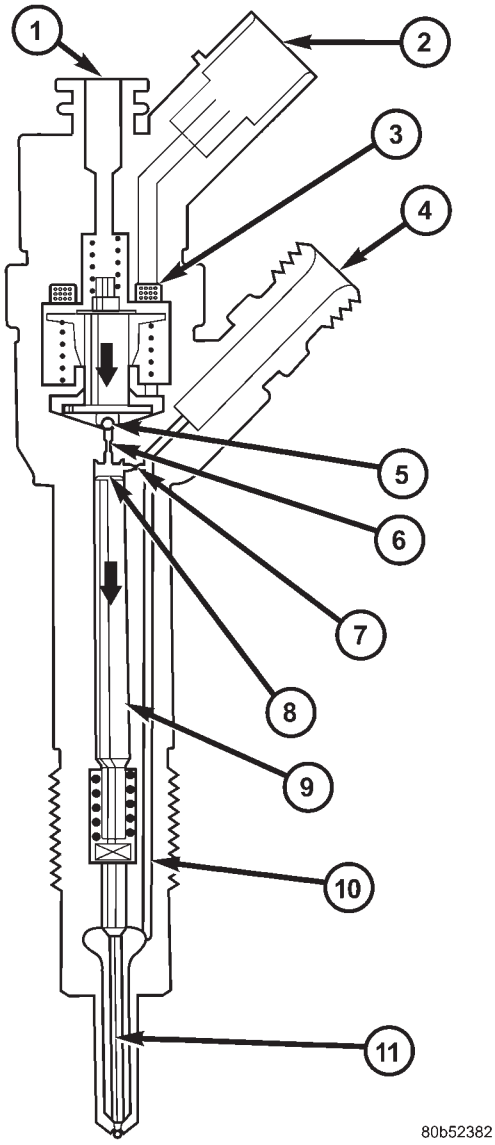

Fig. 5 INJECTOR COMPONENTS

1 - INJECTOR CLOSED (AT-REST STATUS)
2 - ELECTRICAL CONNECTION
3 - TRIGGERING ELEMENT (SOLENOID VALVE)
4 - FUEL INLET (HIGH PRESSURE) FROM THE RAIL
5 - VALVE BALL
6 - BLEED ORIFICE
7 - FEED ORIFICE
8 - VALVE CONTROL CHAMBER
9 - VALVE CONTROL PLUNGER
10 - FEED PASSAGE TO THE NOZZLE
11 - NOZZLE NEEDLE

Injector opens (start of injection)

The solenoid valve is energized with the pickup current which serves to ensure that it open quickly.

FUEL INJECTOR (Continued)

The force exerted by the triggered solenoid now exceeds that of the valve spring and the armature opens the bleed orifice. Almost immediately, the high-level pick-up current is reduced to the lower holding current required for the electromagnet. This is possible due to the magnetic circuit's air gap now being smaller. When the bleed orifice opens, fuel can flow from the valve control chamber into the cavity situated above it, and from there via the fuel return to the tank. The bleed orifice prevents complete pressure balance, and the pressure in the valve control chamber sinks as a result. This leads to the pressure in the valve-control chamber being lower than that in the nozzle's chamber volume which is still at the same pressure level as the rail. The reduced pressure in the valve-control chamber causes a reduction in the force exerted on the control plunger, the nozzle needle open as a result, and injection starts (Fig. 5).

Injector opens fully

The control plunger reaches its upper stop where it remains supported by a cushion of fuel which is generated by the flow of fuel between the bleed and feed orifices. The injector nozzle has now opened fully, and the fuel is injected into the combustion chamber at a pressure almost equal to that in the fuel rail (Fig. 5).

Injector closes (end of injection)

As soon as the solenoid valve is no longer triggered, the valve spring forces the armature downwards and the ball closes the bleed orifice. The armature is a 2–piece design. Here, although the armature plate is guided by a driver shoulder in its downward movement, it can "overspring" with the return spring so that it exerts no downwards-acting forces on the armature and the ball. The closing of the bleed orifice lead to pressure build up in the control chamber via the input from the feed orifice. This pressure is the same as that in the rail and exerts an increased force on the control plunger through its end face. This force, together with that of the spring, now exceeds the force exerted by the chamber volume and the nozzle needle closes. Injection ceases as soon as the nozzle needle comes up against its bottom stop again (Fig. 5).

STANDARD PROCEDURE - CLEANING FUEL INJECTORS

NOTE: Before cleaning the injector recesses, seal the injector holes in the injector recesses with the appropriate pin to prevent debris from falling into the recesses and entering the motor.

(1) Seal the injector holes inside the cylinder head recesses.

(2) Wipe out injector recesses with a non - woven cloth, then clean with a cylinder brush.

(3) Clean the bottom of the cylinder recess with a round brush.

(4) Blow out the recess and clean again with a non - woven cloth and cover over.

(5) Perform these steps for each injector recess.

NOTE: DO NOT clean the tip of the injector with a wire brush. Use a non - woven cloth.

(6) Clean injector body with a wire brush.

(7) Clean injector tips with a non -woven cloth.

(8) Grease injector body with anti seize lubricant.

NOTE: Always replace the seals that seal off the injectors at the cylinder head to the combustion chamber and replace the retaining screws.

REMOVAL

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: The engine must be lowered in the vehicle to remove the fourth and fifth cylinders fuel injectors.

(1) Disconnect negative battery cable.

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(3) **If the fourth or fifth injectors are being replaced the engine must be supported and the engine mount through bolts removed. Lower engine down in engine compartment until injectors can be removed.**

(4) Unplug injector electrical connectors.

NOTE: Counterhold injection lines with wrench socket at threaded connections of injectors.

(5) Remove injector high pressure lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - REMOVAL).

(6) Press in locking clamps and detach injector return lines.

(7) Remove tension claw at injectors.

FUEL INJECTOR (Continued)

NOTE: If injectors are tight, remove with extraction claw in place of tensioning claw. If extraction claw contacts cylinder head cover, remove cylinder head cover. If necessary, remove injectors with threaded adaptor and discard injector.

(8) Remove injectors (Fig. 6).

(9) Clean injectors and recesses (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE).

INSTALLATION

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Clean injectors and recesses (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - STANDARD PROCEDURE).

(2) Coat injector body with anti seize lubricant then install injectors with new seals.

(3) Install tensioning claws with new screws at injectors. Tighten screws in two stages, 7 N·m (62 lbs. in.) then 90°.

NOTE: If locking clamp has been pulled off at injector, the locking clamp must be replaced.

(4) Position fuel return line at injectors and secure locking clamps.

NOTE: Counterhold injection lines with wrench socket at threaded connections of injectors.

(5) Install high pressure injection lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - INSTALLATION).

(6) Reconnect injector electrical connectors.

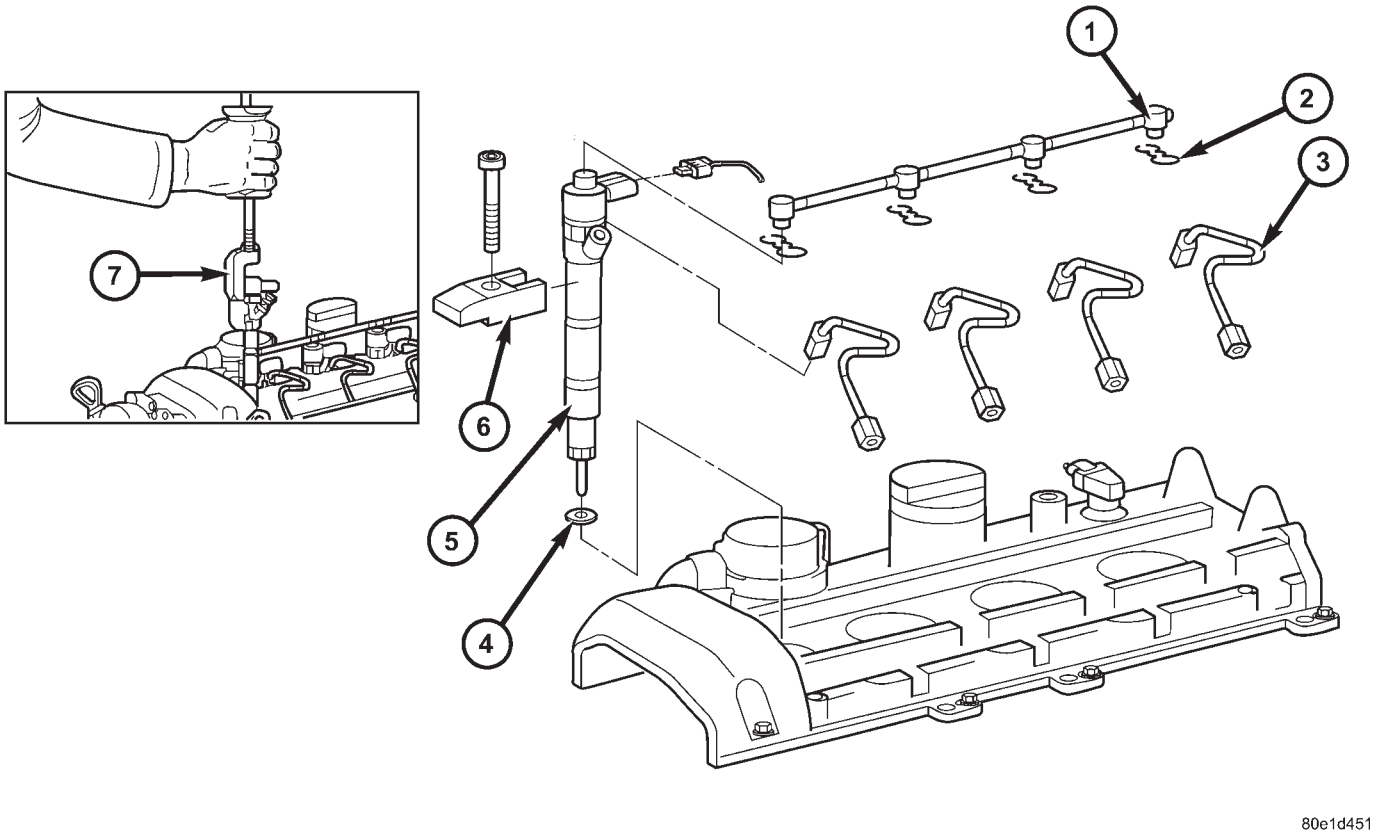

Fig. 6 FUEL INJECTOR REMOVAL/INSTALLATION

1 - INJECTOR RETURN LINES
2 - RETAINING CLIP
3 - INJECTOR HIGH PRESSURE LINE
4 - INJECTOR SEAL
5 - FUEL INJECTOR
6 - TENSIONING CLAW
7 - SPECIAL TOOLS #8938 AND #8937

FUEL INJECTOR (Continued)

(7) **If injectors four and five were replaced raise engine back in position and install engine mount through bolts.**

(8) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

(9) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(10) Start engine and inspect for leaks.

FUEL RAIL

DESCRIPTION

The fuel rail acts like a high pressure store. It is available to all injectors for drawing fuel which has been compressed by the injection pump. The rail pressure sensor, rail pressure solenoid, high pressure line, and the return flow line are attached to the fuel rail (Fig. 7).

OPERATION

The stored fuel volume inside the rail acts as a damper for pressure fluctuations which result because of pulsating supply and brief large extractions of fuel during injector firing. The rail primarily influences the atomization of fuel at the injector nozzle, and the accuracy of injected quantity during injection.

REMOVAL

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Disconnect negative battery cable.

(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

(3) Disconnect fuel rail pressure sensor and pressure control valve electrical connectors (Fig. 7).

(4)

CAUTION: When slackening and tightening fuel injection line union nuts, counter hold with wrench at threaded connection. ON NO ACCOUNT exceed the tightening torque at any time. Do NOT crimp or bend lines.

NOTE: After removing lines, seal connections and ensure cleanliness.

(5) Remove injector high pressure lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - REMOVAL) (Fig. 7).

(6) Remove pressure line of high pressure pump (Fig. 7).

NOTE: Note attention to the use of locking arm.

(7) Detach fuel return flow line to high pressure pump at rail (Fig. 7).

(8) Detach fuel return flow line to fuel filter at fuel filter (Fig. 7).

(9) Remove fuel rail (Fig. 7).

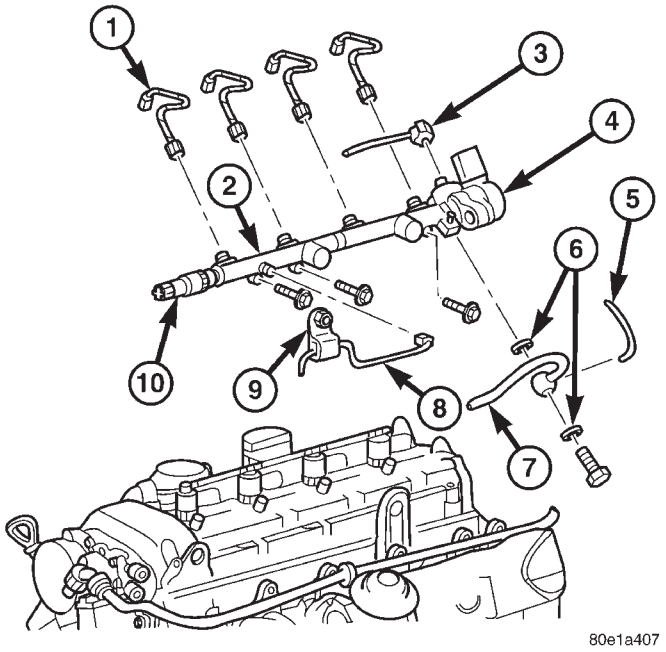

Fig. 7 FUEL PRESSURE SOLENOID

1 - INJECTION LINES
2 - FUEL RAIL
3 - FUEL RETURN LINE
4 - FUEL PRESSURE SOLENOID
5 - OIL LINE
6 - SEALS
7 - FUEL RETURN LINE AT COOLER
8 - HIGH PRESSURE FUEL LINE TO FUEL RAIL
9 - FUEL LINE BRACKET
10 - FUEL PRESSURE SENSOR

FUEL RAIL (Continued)

INSTALLATION

WARNING: NO FIRE, FLAMES OR SMOKING. RISK OF POISONING FROM INHALING OR SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Position and loosely install fuel return line from fuel filter, with new seals to rail (Fig. 7).
(2) Position fuel rail to cylinder head, feed in high pressure line with new seals (Fig. 7).
(3) Tighten fuel rail bolts to 14 N·m (124 lbs.in.) (Fig. 7).
(4) Tighten nut of pressure line to high pressure pump/rail to 22N·m (194 lbs.in.).
(5) Tighten banjo bolt of fuel return line to fuel rail to 20N·m (177 lbs.in.).

CAUTION: Inspect sealing cones at the lines. Replace as necessary. Ensure that all fuel pressure lines are exactly located in original position.

(6) Install injector lines (Fig. 7). Tighten nut of pressure line to rail/injector to 22N·m (194 lbs.in.).
(7) Reconnect fuel rail pressure sensor and pressure control valve electrical connectors (Fig. 7).
(8) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(9) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(10) Start engine and inspect for leaks.

MANIFOLD AIR FLOW (MAF) SENSOR

DESCRIPTION

The Mass Air Flow (MAF) Sensor is mounted inline in the air intake between the air filter and the turbocharger (Fig. 8).

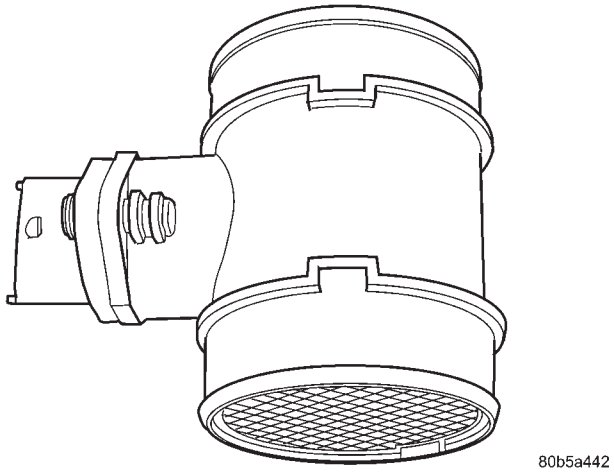

Fig. 8 MASS AIR FLOW (MAF) SENSOR

OPERATION

The ECM uses the mass air flow (MAF) sensor to measure air density. A signal voltage is provided to the MAF sensor that contains a ceramic element. As engine speed increases, air flow across the ceramic element increases. Changes in air flow and air density cause the temperature of the ceramic element to fluxuate. The ceramic element changes resistance respectively to changes in temperature. The change in resistance varies the signal voltage output to the ECM. The signal voltage is used by the ECM as a measure for the air mass supplied. The Diesel Power Relay supplies battery power the to MAF sensor, ground is provided by the ECM. The MAF sensor signal is provided by the ECM.

REMOVAL

(1) Disconnect negative battery cable.
(2) Disconnect mass air flow (MAF) sensor electrical connector (Fig. 9).
(3) Disconnect air inlet tube.
(4) Remove MAF to air cleaner housing retaining bolts and remove sensor (Fig. 9).

INSTALLATION

(1) Position mass air flow (MAF) sensor to air cleaner housing and tighten bolts (Fig. 9).
(2) Connect air inlet tube.
(3) Connect MAF sensor electrical connector (Fig. 9).
(4) Connect negative battery cable.

MANIFOLD AIR FLOW (MAF) SENSOR (Continued)

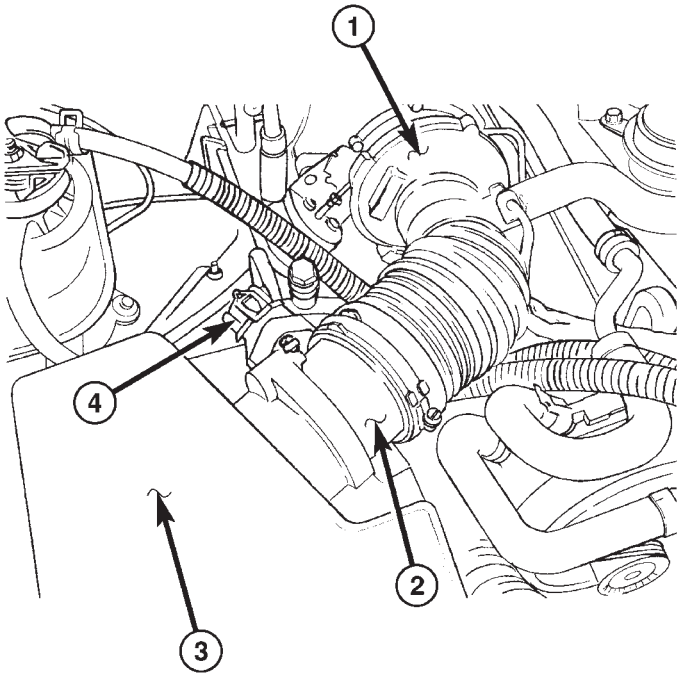

Fig. 9 MAF SENSOR LOCATION

1 - TURBOCHARGER
2 - MAF SENSOR
3 - AIR CLEANER HOUSING
4 - MAF SENSOR ELECTRICAL CONNECTOR

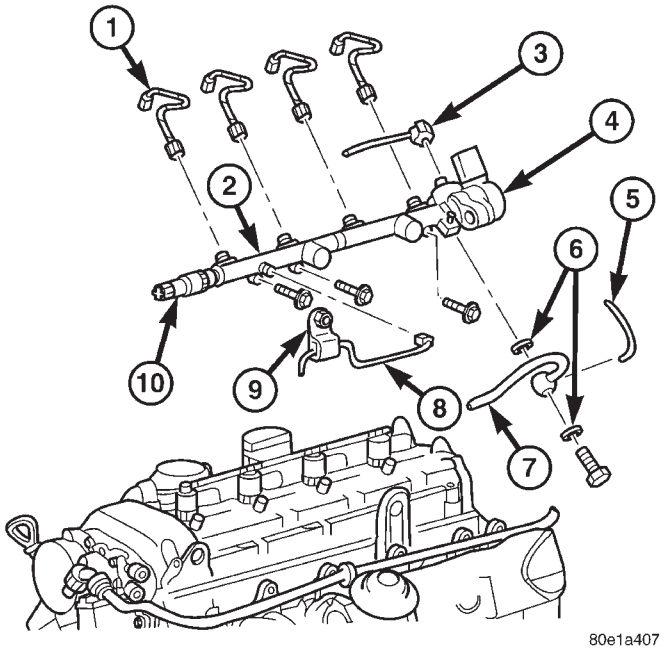

Fig. 10 FUEL PRESSURE SOLENOID

1 - INJECTION LINES
2 - FUEL RAIL
3 - FUEL RETURN LINE
4 - FUEL PRESSURE SOLENOID
5 - OIL LINE
6 - SEALS
7 - FUEL RETURN LINE AT COOLER
8 - HIGH PRESSURE FUEL LINE TO FUEL RAIL
9 - FUEL LINE BRACKET
10 - FUEL PRESSURE SENSOR

FUEL PRESSURE SOLENOID

DESCRIPTION

The fuel pressure solenoid is attached to the rear of the fuel rail. The solenoid controls and maintains the rail pressure constant along with a control current transmitted by the engine control module (ECM) (Fig. 10).

OPERATION

High pressure which is present in the fuel rail flows to the ball seat of the solenoid (Fig. 11). The specified pressure required by the system is built up in the rail by the fuel pressure solenoid building up a magnetic force which corresponds to this specific pressure by means of a control current from the electronic control module (ECM) (Fig. 11). This magnetic force equals a certain outlet cross section at the ball seat of the solenoid. The rail pressure is altered as a result of the quantity of fuel which flows off (Fig. 11). The current fuel pressure is signaled by the fuel pressure sensor to the engine control module (ECM). The controlled fuel flows back along the return fuel line, into the tank.

In a de-energized state, the fuel pressure solenoid is closed as the spring force presses the ball into the ball seat (Fig. 11). When driving, the fuel pressure solenoid is constantly open (Fig. 11). When engine is started, the fuel pressure solenoid is held closed by magnetic force (Fig. 11). When driving, the pressure of the fluid counteracts the magnetic force of the coil and the slight spring force (Fig. 11).

REMOVAL

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

FUEL PRESSURE SOLENOID (Continued)

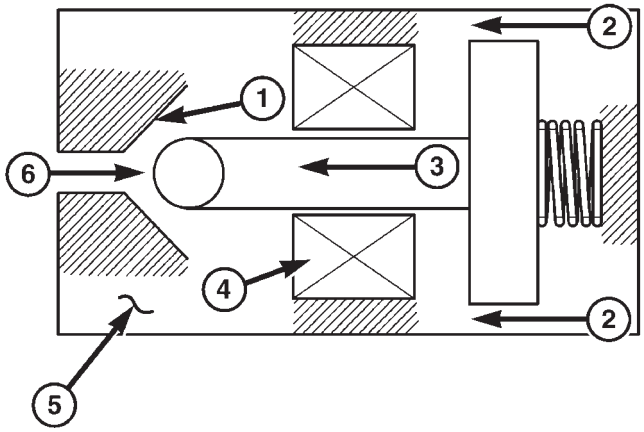

Fig. 11 FUEL PRESSURE SOLENOID OPERATION

1 - BALL SEAT
2 - SPRING FORCE
3 - MAGNETIC FORCE
4 - COIL
5 - FUEL PRESSURE SOLENOID
6 - HIGH PRESSURE FEED

(3) Remove fuel rail (Refer to 14 - FUEL SYSTEM/ FUEL INJECTION/FUEL INJECTOR - REMOVAL).

(4) Clamp fuel rail securely in vise with protective jaws.

NOTE: Once removed, the pressure solenoid must always be replaced.

(5) Remove fuel pressure solenoid retaining screws and remove solenoid (Fig. 12).

INSTALLATION - FUEL PRESSURE SOLENOID

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: Apply a thin film of special grease to the seals before installing. If the seals are damaged when being installed, an internal leak may occur which can not be recognized externally.

(1) Position fuel pressure solenoid to fuel rail and retain with screws. Tighten in two stages 3N·m (26 lbs. in.), then 5N·m (44 lbs. ft.).

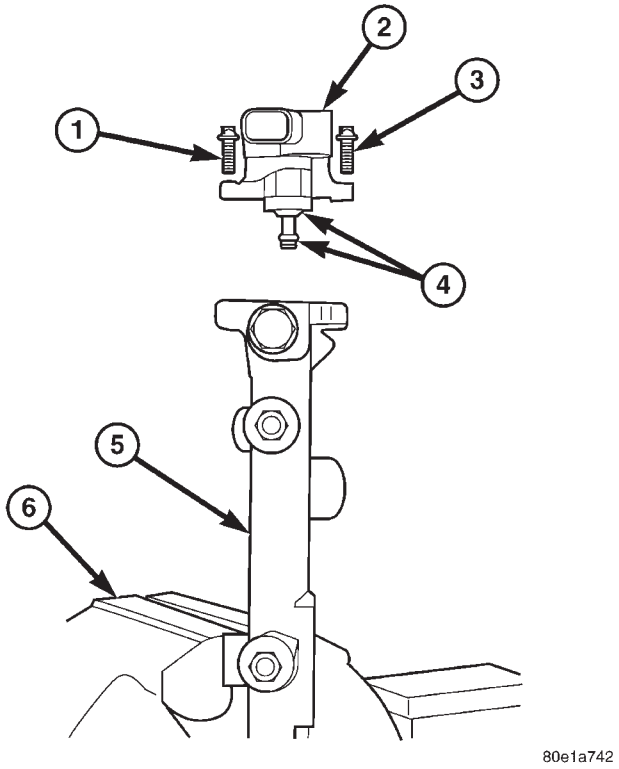

Fig. 12 FUEL PRESSURE SOLENOID ASSEMBLY

1 - RETAINING BOLT
2 - FUEL PRESSURE SOLENOID
3 - RETAINING BOLT
4 - O-RING LOCATION
5 - FUEL RAIL
6 - VISE

(2) Install fuel rail (Refer to 14 - FUEL SYSTEM/ FUEL INJECTION/FUEL INJECTOR - INSTALLATION).

(3) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

(4) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS, OR FAN. DO NOT WEAR LOOSE CLOTHES.

(5) Start engine and inspect for leaks.

BOOST PRESSURE SENSOR

DESCRIPTION

The boost pressure sensor is mounted to the top of the intake manifold just above the intake air inlet (Fig. 13). The sensor allows the ECM to monitor air pressure within the intake manifold.

BOOST PRESSURE SENSOR (Continued)

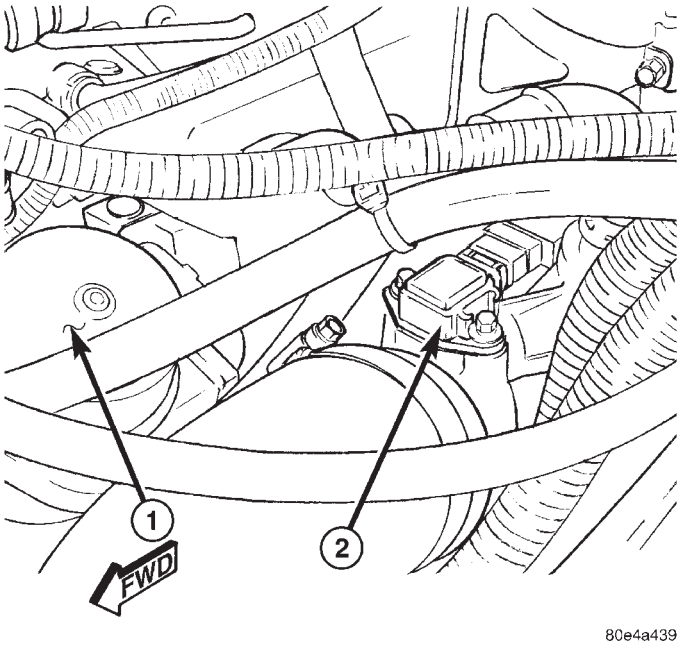

Fig. 13 BOOST PRESSURE SENSOR LOCATION

1 - OIL FILTER CAP
2 - BOOST PRESSURE SENSOR

OPERATION

When the intake manifold pressure is low (high vacuum) sensor voltage output is 0.25-1.8 volts at the ECM. When the intake manifold pressure is high due to turbo boost, sensor voltage output is 2.0-4.7 volts. The sensor receives a 5-volts reference from the ECM. Sensor ground is also provides by the ECM. The ECM uses boost pressure combined with intake air temerature to determine the volume of air entering the engine.

DIAGNOSIS AND TESTING - BOOST PRESSURE SENSOR

If the boost pressure sensor fails, the ECM records a DTC into memory and continues to operate the engine in one of the three limp-in modes. When the ECM is operating in this mode, a loss of power will be present, as if the turbocharger was not operating. The best method for diagnosing faults with the boost pressure sensor is with the DRB III® scan tool. Refer to the Diesel Powertrain Diagnostic Manual for more information.

Refer to On-Board Diagnostics in Emissions Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

INTAKE AIR TEMPERATURE SENSOR

DESCRIPTION

This sensor is also used to monitor the intake air temperature (Fig. 14).

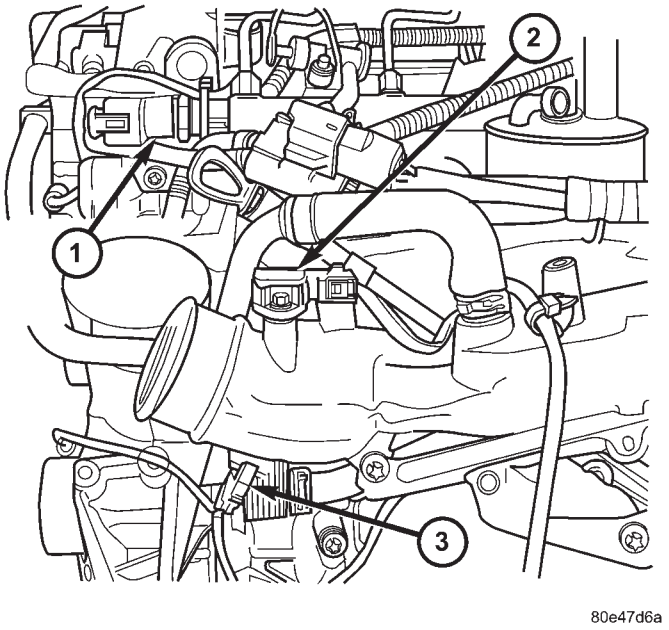

Fig. 14 SENSOR LOCATIONS

1 - FUEL PRESSURE SENSOR
2 - BOOST PRESSURE SENSOR
3 - INTAKE AIR TEMPERATURE SENSOR

OPERATION

The intake air temperature sensor is a negative temperature coefficient (NTC) thermistor (resistance varies inversly with temperature). This means at cold air temperature its resistance is high, sothe voltage signal will be high. As intake air temperature increases, sensor resistance decreases and the signal voltage will be low. This allows the sensor to provide an analog voltage signal (0.2-4.8 volts) to the ECM.

FUEL DELIVERY

TABLE OF CONTENTS

FUEL DELIVERY

STANDARD PROCEDURE - BLEEDING AIR FROM FUEL SYSTEM

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(2) Press locking ring at bleeder valve in direction of arrow and pull off seal.
(3) Press inlet connection into bleeder valve until it locks.
(4) Connect line between inlet connection and reservoir.
(5) Connect hand pump to vacuum side at reservoir.
(6) Operate hand pump until fuel flows through line free of bubbles.
(7) Press locking ring at bleeder valve in direction of arrow and detach inlet connection.
(8) Press seal into bleeder valve until it locks.
(9) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

FUEL FILTER / WATER SEPARATOR

DESCRIPTION

In order to assure trouble free operation with winter grade diesel fuel, a preheater valve is located with in the fuel filter. Depending on the temperature of the heated return flow fuel, fuel flows back through the preheating valve into the fuel filter to heat up or flows directly back into the fuel tank.

OPERATION

PRE - HEATING Up to 45°C (113°F), the thermo bimetal plate of the preheater, shuts off the return fuel flow port to the fuel tank. The fuel from the rail flows into the fuel filter to be warmed. If there is air in the system, a ball seals off a port and the air is directed to the fuel tank.

NON PRE - HEATING From above 45°C (113°F) the thermo bimetal plate of the preheater, shuts off the port to the fuel filter and fuel from the rail flows directly into the return flow line to the fuel tank.

REMOVAL

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

FUEL FILTER / WATER SEPARATOR (Continued)

(1) Disconnect negative battery cable.
(2) Insert a suitable hose into the fuel drain port in rear of filter, turn drain port counterclockwise and drain fuel into a suitable and appropriately marked container.
(3) Disconnect fuel feed and return lines at fuel filter and set aside.
(4) Disconnect fuel heater electrical connector at fuel filter.
(5) Remove fuel filter retaining bracket bolt and remove fuel filter.

INSTALLATION

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: Assure fuel filter drain port is closed.

(1) Connect fuel heater electrical connector.
(2) Position fuel filter in bracket and tighten retaining bolt.
(3) Connect fuel feed and return lines.
(4) Connect negative battery cable.
(5) Start engine and inspect for leaks.

FUEL PUMP

DESCRIPTION

DESCRIPTION - HIGH PRESSURE PUMP

The high pressure pump is a radial piston pump with three pistons arranged at an angle of 120°. The high pressure pump is driven at about 1.3 times the speed of the camshaft. The high pressure pump is mounted to the front of the cylinder head (Fig. 1).

DESCRIPTION - LOW PRESSURE PUMP

The low pressure pump (Fig. 2)supplies an adequate quantity of filtered fuel in all operating conditions from the fuel tank, at an adequate pressure, to the high pressure pump.

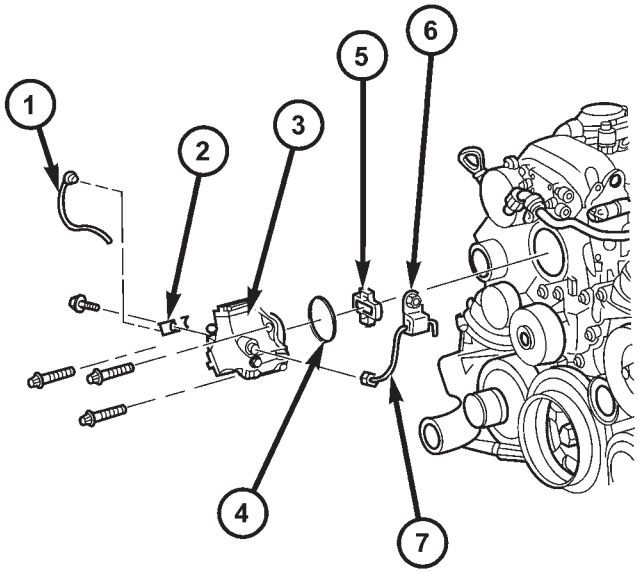

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Fig. 1 HIGH PRESSURE PUMP

1 - FUEL RETURN LINE
2 - FUEL LINE BRACKET
3 - HIGH PRESSURE PUMP
4 - O-RING
5 - PUMP DRIVE
6 - FUEL LINE BRACKET
7 - HIGH PRESSURE FUEL LINE FROM PUMP TO FUEL RAIL

OPERATION

OPERATION

LOW PRESSURE SIDE

The fuel supplied by the fuel delivery pump flows through the fuel feed to the throttle valve. Any air entrained by the fuel is directed through the restrictor to the return flow. The throttle valve opens against the force of the spring at a pressure of approx. 0.4 bar and the fuel is able to flow along a ring line to the individual pistons. The eccentric shaft with its eccentric plate moves the pistons up and down against the piston spring of the three pump elements. The leak fuel from the pistons flows along the return flow to the fuel tank. The fuel flowing out of the throttle valve, also flows off along the return flow.

FUEL PUMP (Continued)

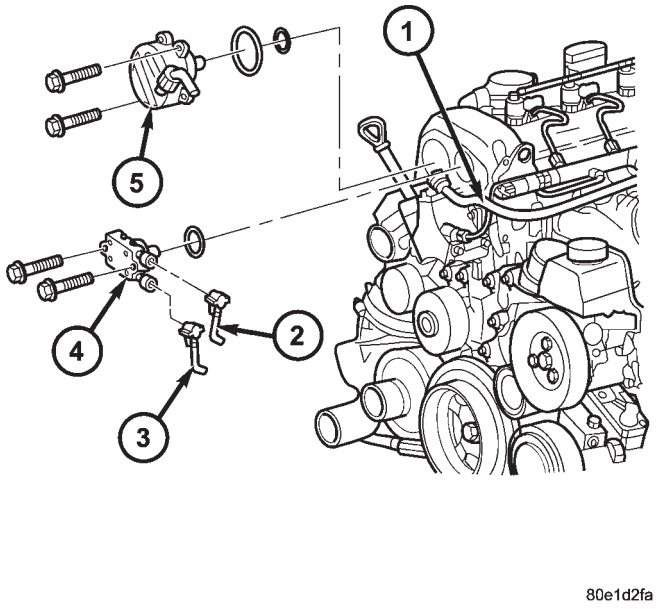

Fig. 2 VACUUM PUMP AND LOW PRESSURE FUEL PUMP ASSEMBLIES

1 - VACUUM LINE
2 - FUEL OUTLET LINE
3 - FUEL FEED LINE
4 - LOW PRESSURE FUEL PUMP
5 - VACUUM PUMP

HIGH PRESSURE SIDE

A. Filling the piston: The piston is moved down as a result of the piston spring. The fuel supplied by the fuel delivery pump flows along the ring passage, the valve disk and the valve spring into the cylinder. The ball valve prevents the fuel from being able to flow back from the high pressure passage.

B. Producting high pressure: The piston is moved up by the rising eccentric shaft and the fuel is thus compressed. The valve disk shuts off the delivery volume to the fuel feed. Once the fuel pressure in the cylinder rises beyond the pressure which exists in the high pressure circuit, the ball valve opens and the fuel is pumped into the high pressure circuit.

OPERATION - LOW PRESSURE PUMP

The low pressure pump draws fuel from tank through fuel filter and supplies the high pressure pump. Fuel pressure at starter speed is 0.4 to 1.5 bar (6 to 22 psi.). A fuel pressure of 2.0 to 2.5 bar (29 to 36 psi.) is reached at idle speed. Fuel pressure is limited to 3.5 bar ± .5 bar (51 psi. ± 7 psi) by the valve in the fuel delivery pump. This valve opens by overcoming a spring force and allows excessive fuel to flow to the intake side of the low pressure pump. This diverted fuel flows into the return flow pipe through the fuel cooler back to the tank. As a result of this circulation, the fuel always remains relatively cool.

REMOVAL

REMOVAL - HIGH PRESSURE PUMP

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(4) Partially drain coolant system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(5) Disconnect viscous heater hose at heater and bracket above idler pulley and set aside.
(6) Disconnect hydraulic fan power steering hose at steering pump and set aside.
(7) Remove bolt for fuel line retainer at lifting eye.

CAUTION: DO NOT slacken the threaded connection. Use a wrench to counterhold at the threaded connection when loosening and tightening the union nut. DO NOT EXCEED tightening torque.

CAUTION: DO NOT crimp or bend fuel line. Capture all fluids that flow out of connections.

(8) Unbolt pressure line at pressure pump.
(9) Detach fuel return flow line at high pressure pump.

NOTE: Detach high pressure pump driver and intermediate piece if pump is being replaced.

(10) Remove bolts attaching high pressure pump and remove pump (Fig. 3).

FUEL PUMP (Continued)

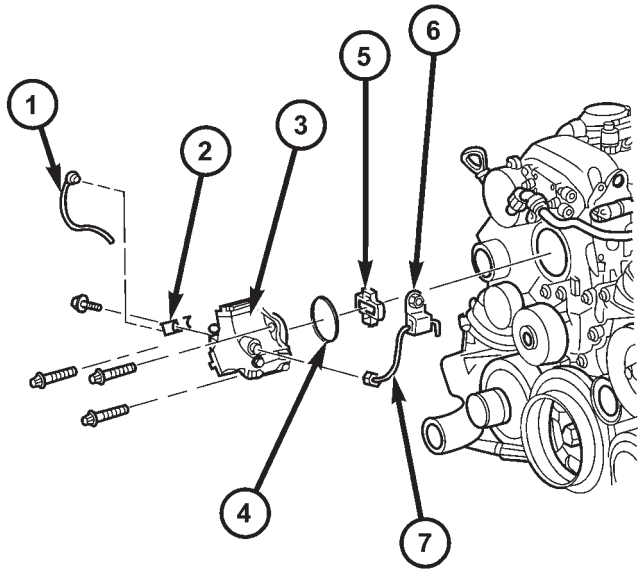

Fig. 3 HIGH PRESSURE PUMP

1 - FUEL RETURN LINE
2 - FUEL LINE BRACKET
3 - HIGH PRESSURE PUMP
4 - O-RING
5 - PUMP DRIVE
6 - FUEL LINE BRACKET
7 - HIGH PRESSURE FUEL LINE FROM PUMP TO FUEL RAIL

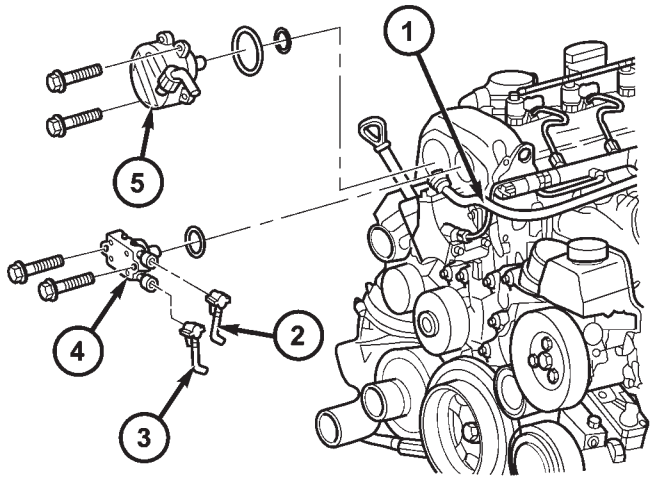

Fig. 4 VACUUM PUMP AND LOW PRESSURE FUEL PUMP ASSEMBLIES

1 - VACUUM LINE
2 - FUEL OUTLET LINE
3 - FUEL FEED LINE
4 - LOW PRESSURE FUEL PUMP
5 - VACUUM PUMP

REMOVAL - LOW PRESSURE PUMP

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Remove vacuum pump (Refer to 9 - ENGINE/ENGINE BLOCK/INTERNAL VACUUM PUMP - REMOVAL).
(4) Detach fuel lines at low pressure pump (Fig. 4).
(5) Remove low pressure pump (Fig. 4).

INSTALLATION

INSTALLATION - HIGH PRESSURE PUMP

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

CAUTION: Clean sealing surfaces with appropriate solvents and replace all seals.

NOTE: Inspect then attach high pressure pump driver and intermediate piece if pump is being replaced. If wear is present at driver, replace the intermediate gear.

FUEL PUMP (Continued)

(1) Position and secure the high pressure pump to cylinder head (Fig. 3). Tighten bolts to 14 N·m (124 lbs. in.).

CAUTION: NEVER slacken the thread connection. Use a wrench to counterhold at threaded connection when slackening and tightening torque in order to avoid also slackening the threaded connection the next time.

CAUTION: DO NOT crimp or bend fuel line. Inspect sealing cone at line; replace line if compression exists.

(2) Attach fuel flow return line (Fig. 3).
(3) Install bracket to high pressure pump (Fig. 3). Tighten nut to 9N·m (80 lbs. in.).

CAUTION: NEVER slacken the thread connection. Use a wrench to counterhold at threaded connection when slackening and tightening torque in order to avoid also slackening the threaded connection the next time.

CAUTION: DO NOT crimp or bend fuel line. Inspect sealing cone at line; replace line if compression exists.

(4) Attach high pressure fuel line to pump (Fig. 3). Tighten to 22N·m (194 lbs.in.).
(5) Connect hydraulic fan power steering hose and viscous heater hose, then secure in bracket above idler pulley.
(6) Install bolt for fuel line retainer at lifting eye.
(7) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(8) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(9) Connect negative battery cable.
(10) Refill coolant system with proper mixture to correct level.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOU HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(11) Start engine and inspect for leaks.

INSTALLATION - LOW PRESSURE PUMP

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

NOTE: Clean sealing surfaces, replace seal if necessary.

(1) Prime the low pressure pump with the appropriate fuel.
(2) Attach low pressure fuel pump to cylinder head front cover. Tighten bolt to 9N·m (80 lbs. in.).
(3) Attach fuel lines to low pressure pump.
(4) Install vacuum pump (Refer to 9 - ENGINE/ENGINE BLOCK/INTERNAL VACUUM PUMP - INSTALLATION).
(5) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(6) Reconnect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHING.

(7) Start engine and inspect for leaks.

FUEL LINES

REMOVAL - HIGH PRESSURE LINES

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).

CAUTION: Counterhold with wrench at threaded connections of injectors. DO NOT EXCEED the tightening torque in order to avoid also slackings the threaded connection.

FUEL LINES (Continued)

CAUTION: DO NOT crimp or bend lines.

NOTE: After removing injection lines, seal connections and ensure cleanliness.

(3) Unscrew union nuts of injection lines.
(4) Remove injection lines (Fig. 5).

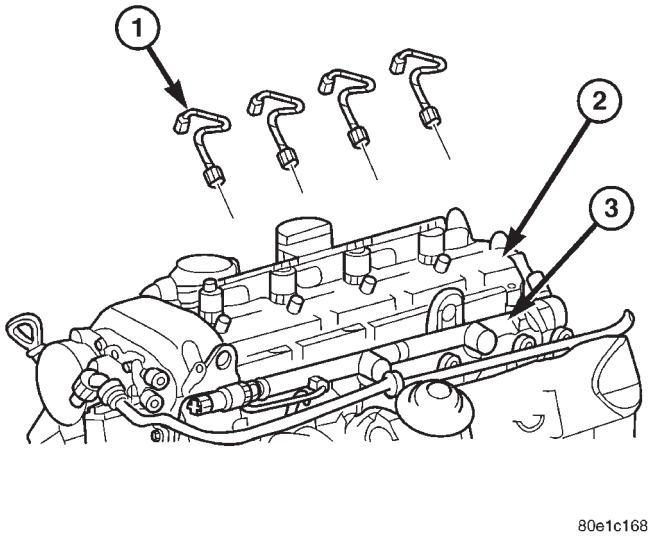

Fig. 5 HIGH PRESSURE LINES AT INJECTORS

1 - HIGH PRESSURE LINE
2 - CYLINDER HEAD COVER
3 - FUEL RAIL

INSTALLATION - HIGH PRESSURE LINES

WARNING: NO SPARKS, OPEN FLAMES OR SMOKING. RISK OF POISONING FROM INHALING AND SWALLOWING FUEL. RISK OF INJURY TO EYES AND SKIN FROM CONTACT WITH FUEL. POUR FUELS ONLY INTO SUITABLE AND APPROPRIATELY MARKED CONTAINERS. WEAR PROTECTIVE CLOTHING.

(1) Loosen the fuel rail mounting bolts to install lines free of stress.

CAUTION: Inspect sealing cone at lines. Replace if compression points exist. Ensure lines are exactly located.

(2) Position and install fuel lines (Fig. 5). Tighten to 22N·m (195 lbs. in.) using a wrench to counterhold at threaded connection.
(3) Tighten fuel rail to 14N·m (124 lbs. in.).
(4) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
(5) Connect negative battery cable.

WARNING: USE EXTREME CAUTION WHEN ENGINE IS OPERATING. DO NOT STAND IN DIRECT LINE WITH FAN. DO NOT PUT YOUR HANDS NEAR PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.

(6) Start engine and inspect for leaks.

STEERING - 2.7L - DIESEL

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PUMP

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PUMP

REMOVAL

(1) Open the hood and disconnect the negative battery cable.

(2) Remove the intercooler outlet hose from the vehicle.

(3) Remove the battery. Refer to the electrical section.

(4) Siphon and drain the fluid from the pump.

(5) Remove the accessory drive belt from the power steering pump pulley. Refer to Cooling System for the procedure.

(6) Install a allen wrench in the power steering pump center shaft to hold the pump in position. Remove the (3) power steering pump pulley retaining bolts (Fig. 1).

(7) Remove the power steering pump pulley from the pump.

(8) Remove the power steering fluid supply hose from the pump (Fig. 2).

(9) Remove the power steering fluid pressure line from the pump (Fig. 2).

(10) Remove the power steering pump to the mount and remove the pump from the vehicle.

PUMP (Continued)

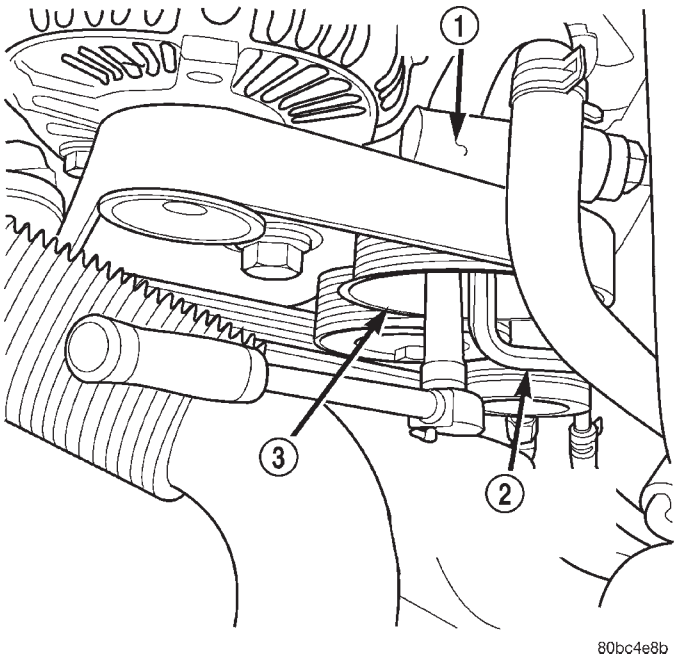

Fig. 1 Installing Power Steering Pump Pulley

1 - POWER STEERING PUMP
2 - ALLEN WRENCH HOLDING PUMP CENTER SHAFT
3 - POWER STEERING PUMP PULLEY

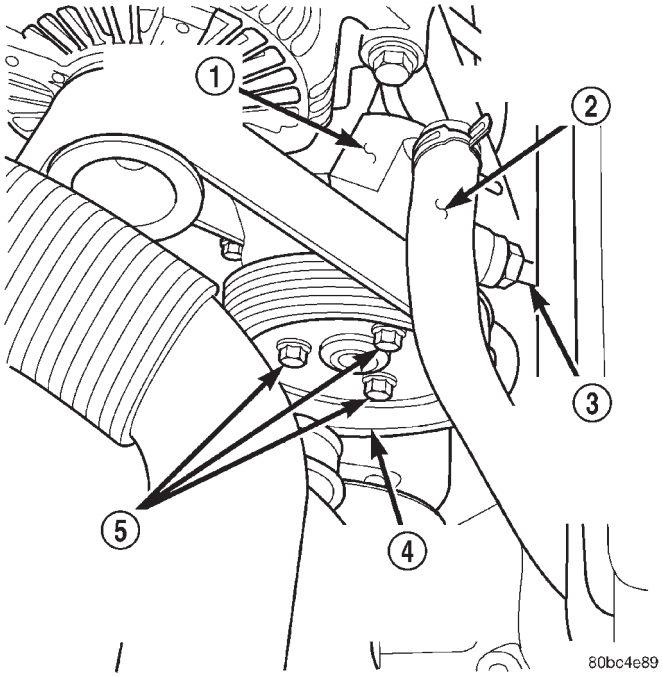

Fig. 2 Diesel Power Steering Pump Position & Orientation

1 - POWER STEERING PUMP
2 - POWER STEERING FLUID SUPPLY HOSE
3 - POWER STEERING FLUID PRESSURE LINE
4 - POWER STEERING PUMP PULLEY
5 - POWER STEERING PUMP PULLEY RETAINING BOLTS

INSTALLATION

CAUTION: Power steering system fluid may be contaminated with metal shavings, overheated or improper fluid. All fluid should be drained from the system. After any component replacement, system should be flushed and filled with Mopar Power Steering fluid, or equivalent.

(1) Position the pump to the pump mount and install the retaining bolts. Torque the bolts to 27 N·m (20 ft. lbs.).
(2) Install the power steering fluid pressure line on the pump. Torque the nut to 24 N·m (18 ft. lbs.). Be certain the sealing o-ring is lubricated and free of tears.
(3) Install the power steering fluid supply hose on the pump.
(4) Install the power steering pump pulley on the pump. Torque the retaining bolts to 27 N·m (20 ft. lbs.). Use the allen wrench to hold the pump from rotating.
(5) Install the accessory drive belt on the power steering pump pulley. Refer to Cooling System for the procedure.
(6) Install the battery.
(7) Install the intercooler outlet hose on the vehicle.
(8) Connect the negative battery cable.
(9) Fill the power steering fluid. Refer to - Power Steering Pump Initial Operation - in this group for the procedure.

RESERVOIR

REMOVAL

(1) Siphon and drain the fluid from the pump.
(2) Remove the intercooler outlet hose from the vehicle.
(3) Remove the front fascia. Refer to the body section.
(4) Remove the cooler hose to the reservoir.
(5) Remove the return hose at the reservoir from the pump.
(6) Remove the supply hose at the reservoir from the fan.

INSTALLATION

(1) Install the supply hose at the reservoir from the fan.
(2) Install the return hose at the reservoir from the pump.
(3) Install the cooler hose to the reservoir.
(4) Install the front fascia. Refer to the body section.

RESERVOIR (Continued)

(5) Install the intercooler outlet hose to the vehicle.

(6) Fill the reservoir and check the power steering system for leaks.

PULLEY

REMOVAL

(1) Open the hood and disconnect the negative battery cable.

(2) Remove the intercooler outlet hose from the vehicle.

(3) Remove the accessory drive belt from the power steering pump pulley. Refer to Cooling System for the procedure.

(4) Install a allen wrench in the power steering pump center shaft to hold the pump in position. Remove the (3) power steering pump pulley retaining bolts (Fig. 3).

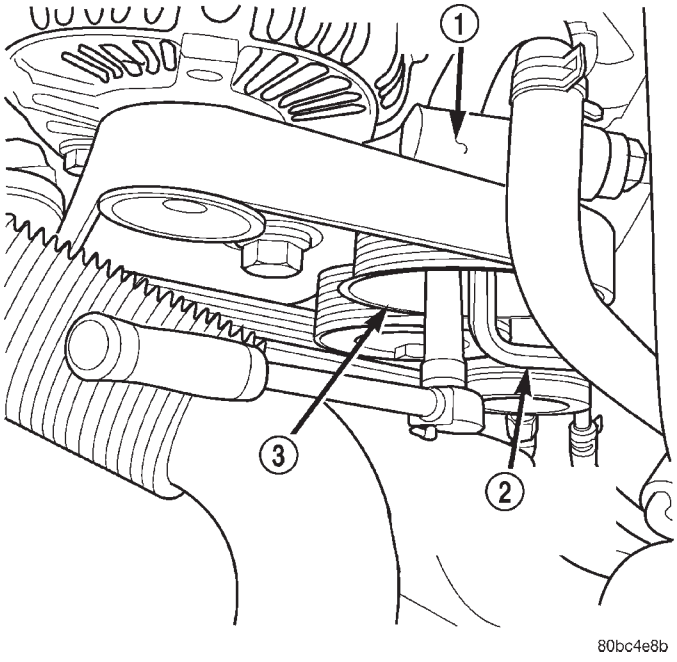

Fig. 3 Installing Power Steering Pump Pulley

1 - POWER STEERING PUMP
2 - ALLEN WRENCH HOLDING PUMP CENTER SHAFT
3 - POWER STEERING PUMP PULLEY

(5) Remove the power steering pulley.

INSTALLATION

(1) Install the power steering pump pulley on the pump. Torque the retaining bolts to 27 N·m (20 ft. lbs.). Use the allen wrench to hold the pump from rotating.

(2) Install the accessory drive belt on the power steering pump pulley. Refer to Cooling System for the procedure.

(3) Install the intercooler outlet hose on the vehicle.

(4) Connect the negative battery cable.

HOSES

REMOVAL

REMOVAL - PRESSURE HOSE - PUMP TO THE HYDRAULIC FAN MODULE

(1) Drain the power steering fluid from the reservoir.

(2) Raise and support the vehicle.

(3) Remove the metal skid plate.

(4) Disconnect the high pressure hose from the hydraulic fan motor.

(5) Lower the vehicle.

(6) Disconnect the high pressure hose from the power steering pump.

(7) Remove the hose from the clipped position on the fan shroud.

(8) Remove the hose from the vehicle.

REMOVAL - RETURN HOSE - RESERVOIR TO THE HYDRAULIC FAN MODULE

(1) Drain the power steering fluid from the reservoir.

(2) Remove the battery.

(3) Remove the front fascia. Refer to the body section.

(4) Remove the power steering reservoir. Refer to reservoir removal in this section.

(5) Disconnect the rubber return hose from the power steering reservoir.

(6) Raise and support the vehicle.

(7) Remove the metal skid plate.

(8) Disconnect the rubber return hose from the hydraulic fan motor.

(9) Remove the hose from the vehicle.

REMOVAL - PRESSURE HOSE - GEAR TO THE HYDRAULIC FAN MODULE

(1) Drain the power steering fluid from the reservoir.

(2) Remove the battery.

(3) Remove the battery tray.

(4) Remove the front fascia. Refer to the body section.

(5) Remove the power steering reservoir. Refer to reservoir removal in this section.

HOSES (Continued)

(6) Disconnect the high pressure hose from the power steering gear.
(7) Remove the hose from the clipped position on the fan shroud.
(8) Raise and support the vehicle.
(9) Remove the metal skid plate.
(10) Disconnect the high pressure hose from the hydraulic fan motor.
(11) Remove the hose from the vehicle.

REMOVAL - RETURN HOSE - RESERVOIR TO THE PUMP

(1) Drain the power steering fluid from the reservoir.
(2) Remove the battery.
(3) Disconnect the rubber hose from the power steering pump.
(4) Disconnect the rubber hose from the power steering reservoir.
(5) Remove the hose from the vehicle.

REMOVAL - 3/8" GEAR OUTLET HOSE

(1) Drain the power steering fluid from the reservoir.
(2) Remove the battery.
(3) Remove the battery tray.
(4) Remove the front fascia. Refer to the body section.
(5) Remove the power steering reservoir. Refer to reservoir removal in this section.
(6) Disconnect the rubber hose from the steering cooler inlet tube.
(7) Disconnect the metal tube from the power steering gear.
(8) Remove the hose from the vehicle.

REMOVAL - INLET COOLER HOSE

(1) Disconnect negative battery cable at battery.
(2) Drain the power steering fluid out of the reservoir.
(3) Remove the front fascia grille assembly,(Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT FASCIA - REMOVAL).
(4) Remove the grille opening reinforcement panel
(5) Place a drain pan under the cooler.
(6) Disconnect the lower hose at cooler.
(7) Disconnect the cooler hose at the gear.
(8) Remove the bracket holding the cooler hoses (Fig. 4).
(9) Remove the cooler hose from the vehicle.

REMOVAL - OUTLET COOLER HOSE

(1) Disconnect negative battery cable at battery.
(2) Drain the power steering fluid out of the reservoir.

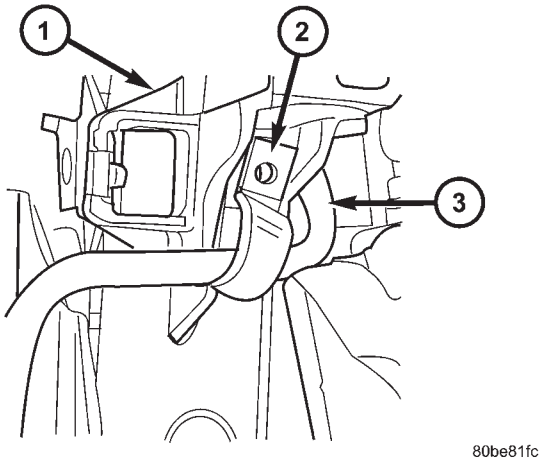

Fig. 4 COOLER HOSES MOUNTING BRACKET

1 - RADIATOR
2 - COOLER HOSES MOUNTING BRACKET
2 - COOLER HOSE

(3) Remove the front fascia grille assembly,(Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT FASCIA - REMOVAL).
(4) Remove the grille opening reinforcement panel
(5) Place a drain pan under the cooler.
(6) Disconnect the upper hose at cooler.
(7) Disconnect the cooler hose at the reservoir.
(8) Remove the bracket holding the cooler hoses (Fig. 4).
(9) Remove the cooler hose from the vehicle.

INSTALLATION

INSTALLATION - PRESSURE HOSE PUMP TO THE HYDRAULIC FAN MODULE

NOTE: Lubrication and a new o-ring must be used when reinstalling.

(1) Install the hose to the vehicle.
(2) Reconnect the high pressure hose to the power steering pump. Tighten the hose to 22.5 N·m (17 ft.lbs.).
(3) Install the hose to the clipped position on the fan shroud.
(4) Raise and support the vehicle.
(5) Reconnect the high pressure hose to the hydraulic fan motor. Tighten the hose to 22.5 N·m (17 ft.lbs.).
(6) Install the metal skid plate.
(7) Remove the support and lower the vehicle.
(8) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

HOSES (Continued)

INSTALLATION - RETURN HOSE - RESERVOIR TO THE HYDRAULIC FAN MODULE

(1) Install the hose to the vehicle.
(2) Reconnect the rubber return hose to the hydraulic fan motor. Tighten the hose.
(3) Install the metal skid plate.
(4) Reconnect the rubber return hose to the power steering reservoir. Tighten the hose clamp.
(5) Remove the support and lower the vehicle.
(6) Install the power steering reservoir. Refer to the reservoir installation in this section.
(7) Install the front fascia. Refer to the body section.
(8) Install the battery
(9) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

INSTALLATION - PRESSURE HOSE - GEAR TO HYDRAULIC FAN MODULE

NOTE: Lubrication and a new o-ring must be used when reinstalling.

(1) Install the hose to the vehicle.
(2) Reconnect the high pressure hose to the hydraulic fan motor. Tighten the hose to 22.5 N·m (17 ft.lbs.).
(3) Install the metal skid plate.
(4) Remove the support and lower the vehicle.
(5) Reconnect the high pressure hose to the power steering gear. Tighten the hose to 22.5 N·m (17 ft.lbs.).
(6) Install the hose to the clipped position on the fan shroud.
(7) Install the battery tray.
(8) Install the power steering reservoir. Refer to the reservoir installation in this section.
(9) Install the front fascia. Refer to the body section.
(10) Install the battery
(11) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

INSTALLATION - RETURN HOSE - RESERVOIR TO THE PUMP

(1) Install the hose to the vehicle.
(2) Reconnect the rubber hose to the power steering pump. Tighten the hose clamp.
(3) Reconnect the rubber hose to the power steering reservoir. Tighten the hose clamp.
(4) Install thebattery.
(5) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

INSTALLATION - 3/8″ GEAR OUTLET HOSE

NOTE: Lubrication and a new o-ring must be used when reinstalling.

(1) Install the hose to the vehicle.
(2) Reconnect the rubber hose to the steering cooler inlet tube. Tighten the hose clamp.
(3) Reconnect the metal tube to the power steering gear. Tighten the hose to 22.5 N·m (17 ft.lbs.).
(4) Install the battery tray.
(5) Install the power steering reservoir. Refer to the reservoir installation in this section.
(6) Install the front fascia. Refer to the body section.
(7) Install the battery
(8) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

INSTALLATION - INLET COOLER HOSE

(1) Install the cooler hose to the vehicle.
(2) Reconnect the cooler hose at the gear.
(3) Reconnect the lower hose at cooler. Tighten the hose to 22.5 N·m (17 ft.lbs.)
(4) Install the bracket holding the cooler hoses (Fig. 4).
(5) Install the grille opening reinforcement panel
(6) Install the front fascia grille assembly, (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT FASCIA - INSTALLATION).
(7) Reconnect negative battery cable at battery.
(8) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

INSTALLATION - OUTLET COOLER HOSE

(1) Install the cooler hose to the vehicle.
(2) Reconnect the cooler hose at the reservoir.
(3) Reconnect the upper hose at the cooler. Tighten the hose to 22.5 N·m (17 ft. lbs.)
(4) Install the bracket holding the cooler hoses (Fig. 4). Tighten the bracket to 22.5 N·m (17 ft. lbs.)
(5) Install the grille opening reinforcement panel
(6) Install the front fascia grille assembly, (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT FASCIA - INSTALLATION).
(7) Reconnect negative battery cable at battery.
(8) Refill the power steering fluid and bleed the system,(Refer to 19 - STEERING/PUMP - STANDARD PROCEDURE).

TRANSMISSION AND TRANSFER CASE

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AUTOMATIC TRANSMISSION - W5J400

DESCRIPTION

The W5J400 automatic transmission (Fig. 1) is an electronically controlled 5-speed transmission with a lock-up clutch in the torque converter. The ratios for the gear stages are obtained by 3 planetary gear sets. Fifth gear is designed as an overdrive with a high-speed ratio.

The gears are actuated electronically/hydraulically. The gears are shifted by means of an appropriate combination of three multi-disc holding clutches, three multi-disc driving clutches, and two freewheeling clutches.

Electronic transmission control enables precise adaptation of pressures to the respective operating conditions and to the engine output during the shift phase which results in a significant improvement in shift quality.

Furthermore, it offers the advantage of a flexible adaptation to various vehicle and engines.

Basically, the automatic transmission with electronic control offers the following advantages:

- Reduces fuel consumption.
- Improved shift comfort.
- More favourable step-up through the five gears.
- Increased service life and reliability.
- Lower maintenance costs.

TRANSMISSION IDENTIFICATION

The transmission name, W5J400, can be decoded to describe the transmission as follows:

- W = A transmission using a hydraulic torque converter.
- 5 = 5 forward gears.
- J = A transmission first used in a Jeep® vehicle.
- 400 = A 4X4 transmission.

The transmission can be generically identified visually by the presence of a round 13-way connector located near the front corner of the transmission oil pan, on the right side. Specific transmission information can be found stamped into a pad on the left side of the transmission, above the oil pan rail.

TRANSMISSION GEAR RATIOS

The gear ratios for the W5J400 automatic transmission are as follows:

1st Gear	3.59:1
2nd Gear	2.19:1
3rd Gear	1.41:1
4th Gear	1.00:1
5th Gear	0.83:1
Reverse	3.16:1
Reverse (In 4WD Low range)	1.93:1

TRANSMISSION HOUSING

The converter housing and transmission are made from a light alloy. These are bolted together and centered via the outer multi-disc carrier of multi-disc holding clutch, B1. A coated intermediate plate provides the sealing. The oil pump and the outer multi-disc carrier of the multi-disc holding clutch, B1, are bolted to the converter housing. The stator shaft is pressed into it and prevented from rotating by splines. The electrohydraulic unit is bolted to the transmission housing from underneath. A sheet metal steel oil pan forms the closure.

MECHANICAL SECTION

The mechanical section consists of a drive shaft, output shaft, a sun gear shaft, and three planetary

AUTOMATIC TRANSMISSION - W5J400 (Continued)

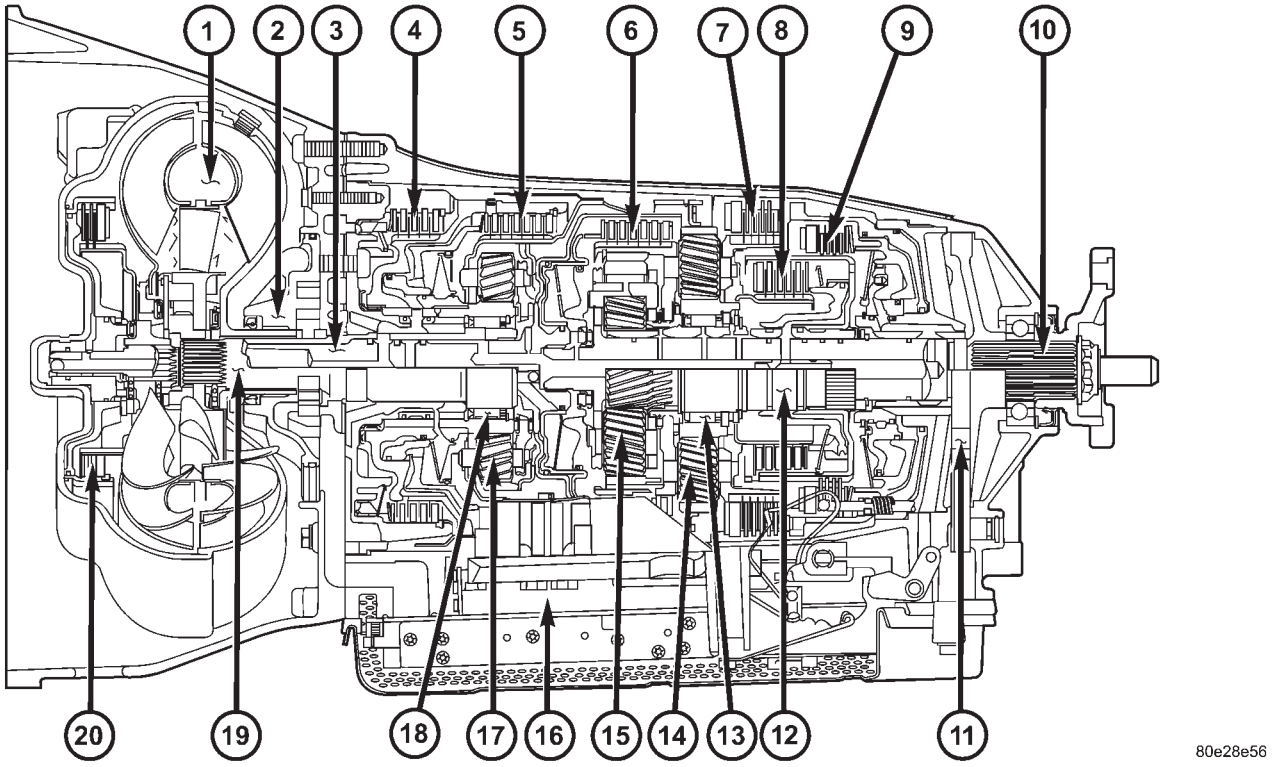

Fig. 1 W5J400 Automatic Transmission

1 - TORQUE CONVERTER
2 - OIL PUMP
3 - DRIVESHAFT
4 - MULTI-DISC HOLDING CLUTCH B1
5 - DRIVING CLUTCH K1
6 - DRIVING CLUTCH K2
7 - MULTI-DISC HOLDING CLUTCH B3
8 - DRIVING CLUTCH K3
9 - MULTI-DISC HOLDING CLUTCH B2
10 - OUTPUT SHAFT
11 - PARKING LOCK GEAR
12 - INTERMEDIATE SHAFT
13 - FREEWHEEL F2
14 - REAR PLANETARY GEAR SET
15 - CENTER PLANETARY GEAR SET
16 - ELECTROHYDRAULIC CONTROL UNIT
17 - FRONT PLANETARY GEAR SET
18 - FREEWHEEL F1
19 - STATOR SHAFT
20 - TORQUE CONVERTER LOCK-UP CLUTCH

gear sets which are coupled to each other. The planetary gear sets each have four planetary pinion gears. The oil pressure for the torque converter lock-up clutch and clutch K2 is supplied through bores in the drive shaft. The oil pressure to clutch K3 is transmitted through the output shaft. The lubricating oil is distributed through additional bores in both shafts. All the bearing points of the gear sets, as well as the freewheeling clutches and actuators, are supplied with lubricating oil. The parking lock gear is connected to the output shaft via splines.

Freewheeling clutches F1 and F2 are used to optimize the shifts. The front freewheel, F1, is supported on the extension of the stator shaft on the transmission side and, in the locking direction, connects the sun gear of the front planetary gear set to the transmission housing. In the locking direction, the rear freewheeling clutch, F2, connects the sun gear of the center planetary gear set to the sun gear of the rear planetary gear set.

ELECTROHYDRAULIC CONTROL UNIT

The electrohydraulic control unit comprises the shift plate made from light alloy for the hydraulic control and an electrical control unit. The electrical control unit comprises of a supporting body made of plastic, into which the electrical components are assembled. The supporting body is mounted on the shift plate and screwed to it.

Strip conductors inserted into the supporting body make the connection between the electrical components and a plug connector. The connection to the wiring harness on the vehicle and the transmission control module (TCM) is produced via this 13-pin plug connector with a bayonet lock.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

SHIFT GROUPS

The hydraulic control components (including actuators) which are responsible for the pressure distribution before, during, and after a gear change are described as a shift group. Each shift group contains a command valve, a holding pressure shift valve, a shift pressure shift valve, overlap regulating valve, and a solenoid.

The hydraulic system contains three shift groups: 1-2/4-5, 2-3, and 3-4. Each shift group can also be described as being in one of two possible states. The active shift group is described as being in the shift phase when it is actively engaging/disengaging a clutch combination. The 1-2/4-5 shift group control the B1 and K1 clutches. The 2-3 shift group controls the K2 and K3 clutches. The 3-4 shift group controls the K3 and B2 clutches.

OPERATION

The transmission control is divided into the electronic and hydraulic transmission control functions. While the electronic transmission control is responsible for gear selection and for matching the pressures to the torque to be transmitted, the transmission's power supply control occurs via hydraulic elements in the electrohydraulic control module. The oil supply to the hydraulic elements, such as the hydrodynamic torque converter, the shift elements and the hydraulic transmission control, is provided by way of an oil pump connected with the torque converter.

The Transmission Control Module (TCM) allows for the precise adaptation of pressures to the corresponding operating conditions and to the engine output during the gearshift phase, resulting in a noticeable improvement in shift quality. The engine speed limit can be reached in the individual gears at full throttle and kickdown. The shift range can be changed in the forward gears while driving, but the TCM employs a downshift safeguard to prevent over-revving the engine. The system offers the additional advantage of flexible adaptation to different vehicle and engine variants.

EMERGENCY RUNNING FUNCTION

In order to ensure a safe driving state and to prevent damage to the automatic transmission, the TCM control module switches to limp-home mode in the event of critical faults. A DTC assigned to the fault is stored in memory. All solenoid and regulating valves are thus de-energized.

The net effect is:

- The last engaged gear remains engaged.
- The modulating pressure and shift pressures rise to the maximum levels.
- The torque converter lockup clutch is deactivated.

In order to preserve the operability of the vehicle to some extent, the hydraulic control can be used to engage 2nd gear or reverse using the following procedure:

- Stop the vehicle.
- Switch off engine.
- Move selector lever to ″P″.
- Wait at least 10 seconds.
- Start engine.
- Move selector lever to D: 2nd gear.
- Move selector lever to R: Reverse gear.

The limp-home function remains active until the DTC is rectified or the stored DTC is erased with the DRB® tool. Sporadic faults can be reset via ignition OFF/ON.

CLUTCH APPLICATION

Refer to CLUTCH APPLICATION for which shift elements are applied in each gear position.

CLUTCH APPLICATION

GEAR	RATIO	B1	B2	B3	K1	K2	K3	F1	F2
1	3.59	X*	X				X*	X	X
2	2.19		X		X		X*		X
3	1.41		X		X	X			
4	1.00				X	X	X		
5	0.83	X				X	X	X*	
N	X						X		
R	3.16	X*		X			X	X	
R (4WD Low)	1.93			X	X		X		
* = The shift components required during coast.									

AUTOMATIC TRANSMISSION - W5J400 (Continued)

FIRST GEAR POWERFLOW

Torque from the torque converter is increased via the drive shaft (25) and all three planetary gearsets and transferred to the output shaft (26) (Fig. 2) and (Fig. 3).

Front Planetary Gear Set

The annulus gear (8) is driven by the drive shaft (25). The sun gear (21) is held against the housing by the locked freewheel F1 (20) during acceleration and via the engaged multiple-disc holding clutch B1 (4) during deceleration. The planetary pinion gears (17) turn on the fixed sun gear (21) and increase the torque from the annulus gear (8) to the planetary carrier (13). The planetary carrier (13) moves at a reduced speed in the running direction of the engine.

Rear Planetary Gear Set

The annulus gear (11) turns at a reduced speed due to the mechanical connection to the front planetary carrier (15). The sun gear (23) is held against the housing by the engaged multiple-disc holding clutch B2 (6), by the locked freewheel F2 (24) during acceleration and by the engaged multiple-disc clutch K3 (12) during deceleration. The planetary gears (19) turn on the fixed sun gear (23) and increase the torque from the annulus gear (11) to the planetary carrier (15). The planetary carrier (15) moves at a reduced speed in the running direction of the engine.

Center Planetary Gear Set

The annulus gear (10) is driven at the same speed as the rear planetary carrier (15) as a result of a mechanical connection. The sun gear (22) is held against the housing by the multiple-disc holding clutch B2 (6). The planetary pinion gears (18) turn on the fixed sun gear (22) and increase the torque from the annulus gear (10) to the planetary carrier (14). The output shaft (26) connected to the planetary carrier (14) turns at a reduced speed in the running direction of the engine.

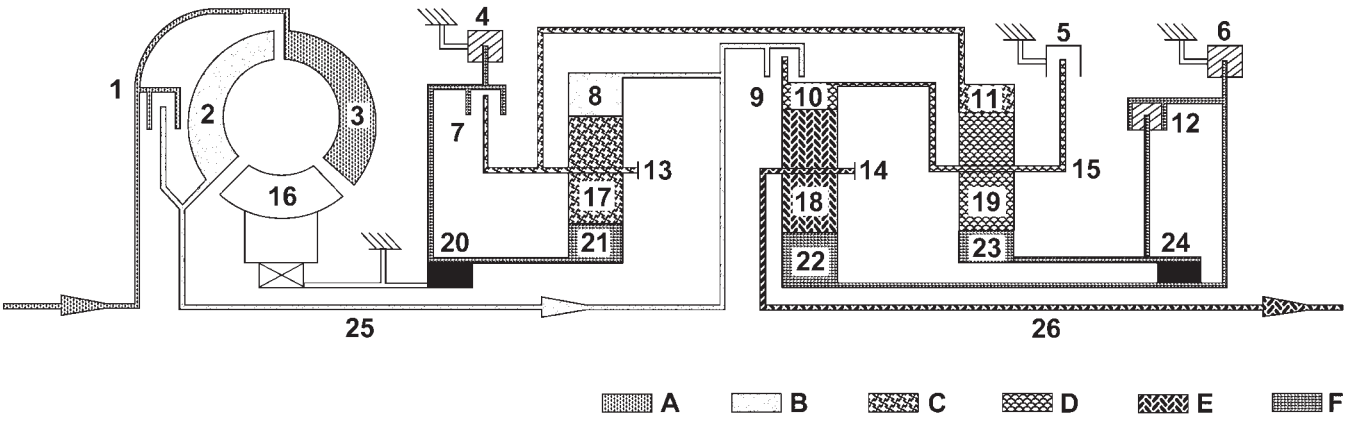

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Fig. 2 First Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

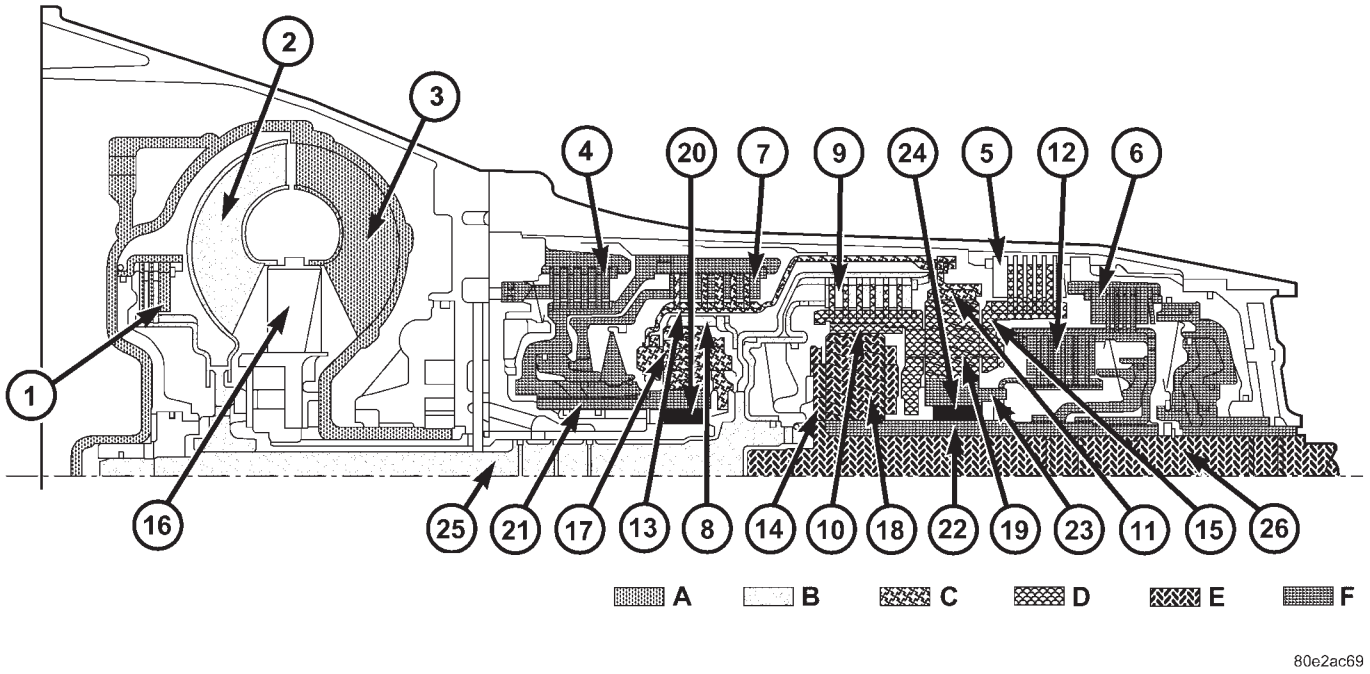

Fig. 3 First Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

SECOND GEAR POWERFLOW

Torque from the torque converter is increased via the drive shaft (25) and the center and rear planetary gearset and transferred to the output shaft (26) (Fig. 4) and (Fig. 5).

Front Planetary Gear Set

The planetary carrier (13) and sun gear (21) are connected via the engaged multiple-disc clutch K1 (7). The planetary gearset is therefore blocked and turns as a closed unit at the input speed due to the mechanical connection of the annulus gear (8) and drive shaft.

Rear Planetary Gear Set

The annulus gear (11) turns at the input speed as a result of the mechanical connection to the front planetary carrier (13). The sun gear (23) is held against the housing by the engaged multiple-disc holding clutch B2 (6), by the locked freewheel F2 (24) during acceleration and by the engaged multiple-disc clutch K3 (12) during deceleration. The planetary pinion gears (19) turn on the fixed sun gear (23) and increase the torque from the annulus gear (11) to the planetary carrier (15). The planetary carrier (15) moves at a reduced speed in the running direction of the engine.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

Center Planetary Gear Set

The annulus gear (10) is driven at the same speed as the rear planetary carrier (15) as a result of a mechanical connection. The sun gear (22) is held against the housing by the multiple-disc holding clutch B2 (6). The planetary pinion gears (18) turn on the fixed sun gear (22) and increase the torque from the annulus gear (10) to the planetary carrier (14). The output shaft (5) connected to the planetary carrier (14) turns at a reduced speed in the running direction of the engine.

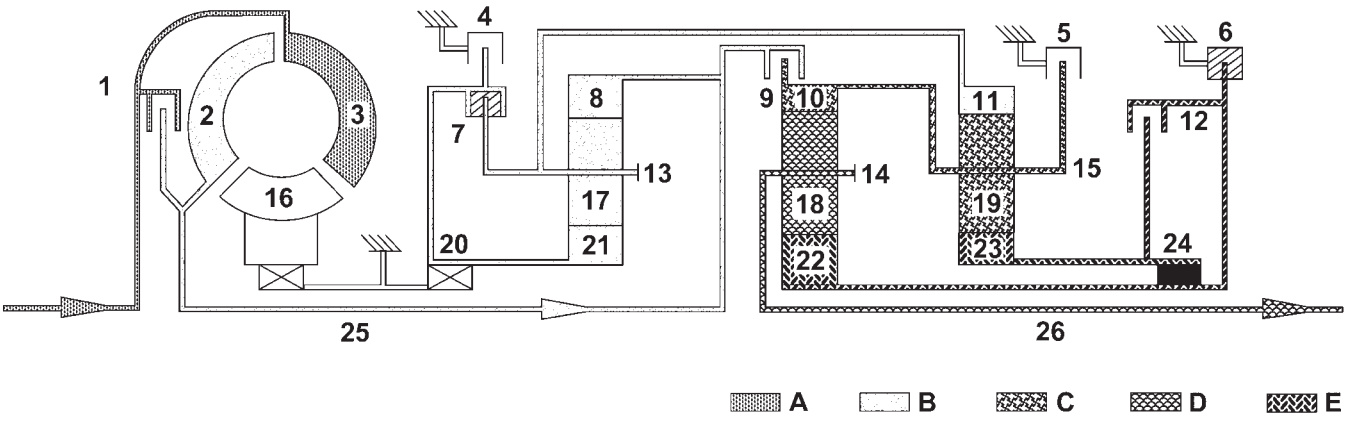

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Fig. 4 Second Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - FIXED PARTS

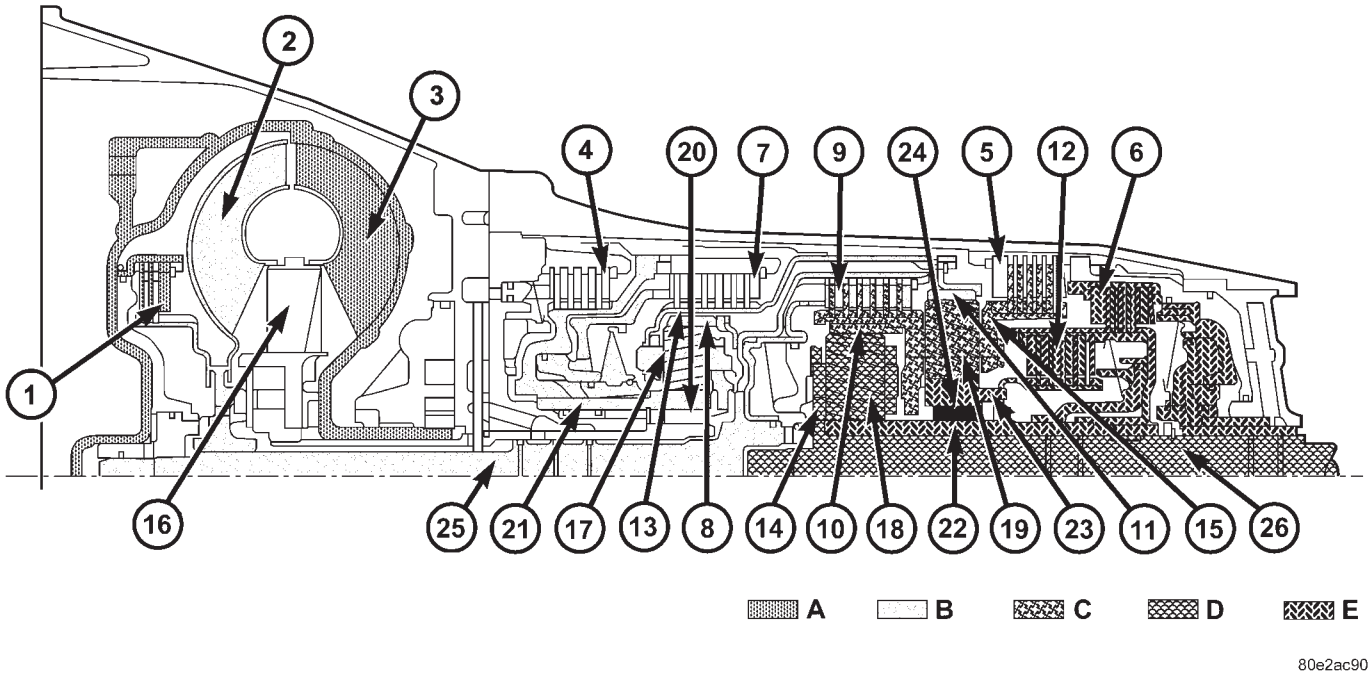

Fig. 5 Second Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - FIXED PARTS

THIRD GEAR POWERFLOW

Torque from the torque converter is increased via the drive shaft (25) and the center planetary gearset and transferred to the output shaft (26) (Fig. 6) and (Fig. 7).

Front Planetary Gear Set

The planetary carrier (13) and sun gear (21) are connected via the engaged multiple-disc clutch K1 (7). The planetary gearset is therefore locked and turns as a closed unit at the input speed due to the mechanical connection of the annulus gear (8) and drive shaft (25).

Rear Planetary Gear Set

The multiple-disc clutch K2 (9) is engaged and transfers the input speed of the drive shaft (25) to the planetary carrier (15) via the annulus gear (10). The annulus gear (11) turns in the same way as the planetary carrier (15) due to the mechanical connection with the locked front planetary gearset. This planetary gearset is therefore locked and turns as a closed unit.

Center Planetary Gear Set

The annulus gear (10) turns at the input speed as a result of the engaged multiple-disc clutch K2 (9). The sun gear (22) is held against the housing by the

AUTOMATIC TRANSMISSION - W5J400 (Continued)

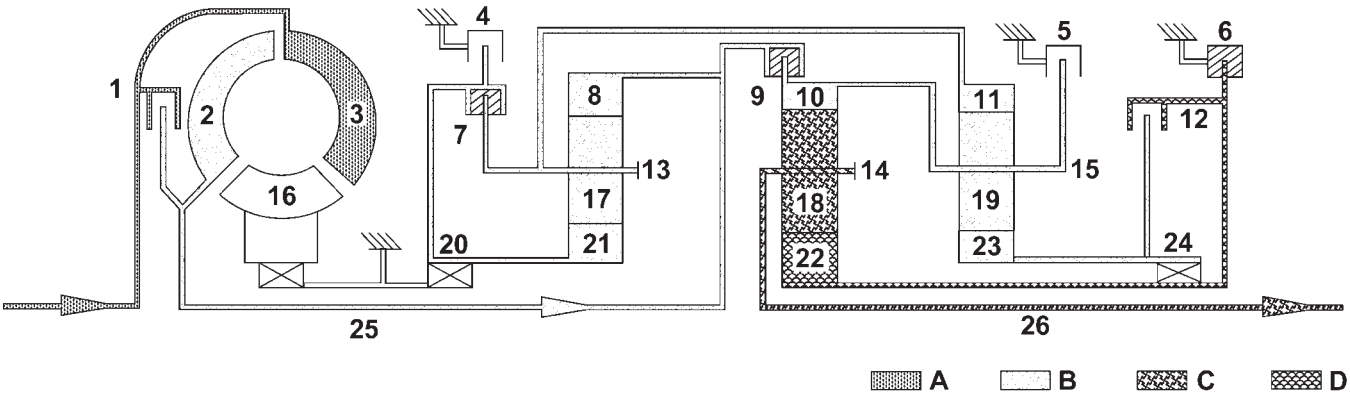

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Fig. 6 Third Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH	14 - CENTER PLANETARY CARRIER
2 - TORQUE CONVERTER TURBINE	15 - REAR PLANETARY CARRIER
3 - TORQUE CONVERTER IMPELLER	16 - TORQUE CONVERTER STATOR
4 - HOLDING CLUTCH B1	17 - FRONT PLANETARY PINION GEARS
5 - HOLDING CLUTCH B3	18 - CENTER PLANETARY PINION GEARS
6 - HOLDING CLUTCH B2	19 - REAR PLANETARY PINION GEARS
7 - DRIVING CLUTCH K1	20 - FREEWHEELING CLUTCH F1
8 - FRONT PLANETARY ANNULUS GEAR	21 - FRONT PLANETARY SUN GEAR
9 - DRIVING CLUTCH K2	22 - CENTER PLANETARY SUN GEAR
10 - CENTER PLANETARY ANNULUS GEAR	23 - REAR PLANETARY SUN GEAR
11 - REAR PLANETARY ANNULUS GEAR	24 - FREEWHEELING CLUTCH F2
12 - DRIVING CLUTCH K3	25 - DRIVE SHAFT
13 - FRONT PLANETARY CARRIER	26 - OUTPUT SHAFT
A - ENGINE SPEED	C - FIRST GEAR RATIO
B - TRANSMISSION INPUT SPEED	D - FIXED PARTS

multiple-disc holding clutch B2 (6). The planetary pinion gears (18) turn on the fixed sun gear (22) and increase the torque from the annulus gear (10) to the planetary carrier (14). The output shaft (26) connected to the planetary carrier (14) turns at a reduced speed in the running direction of the engine.

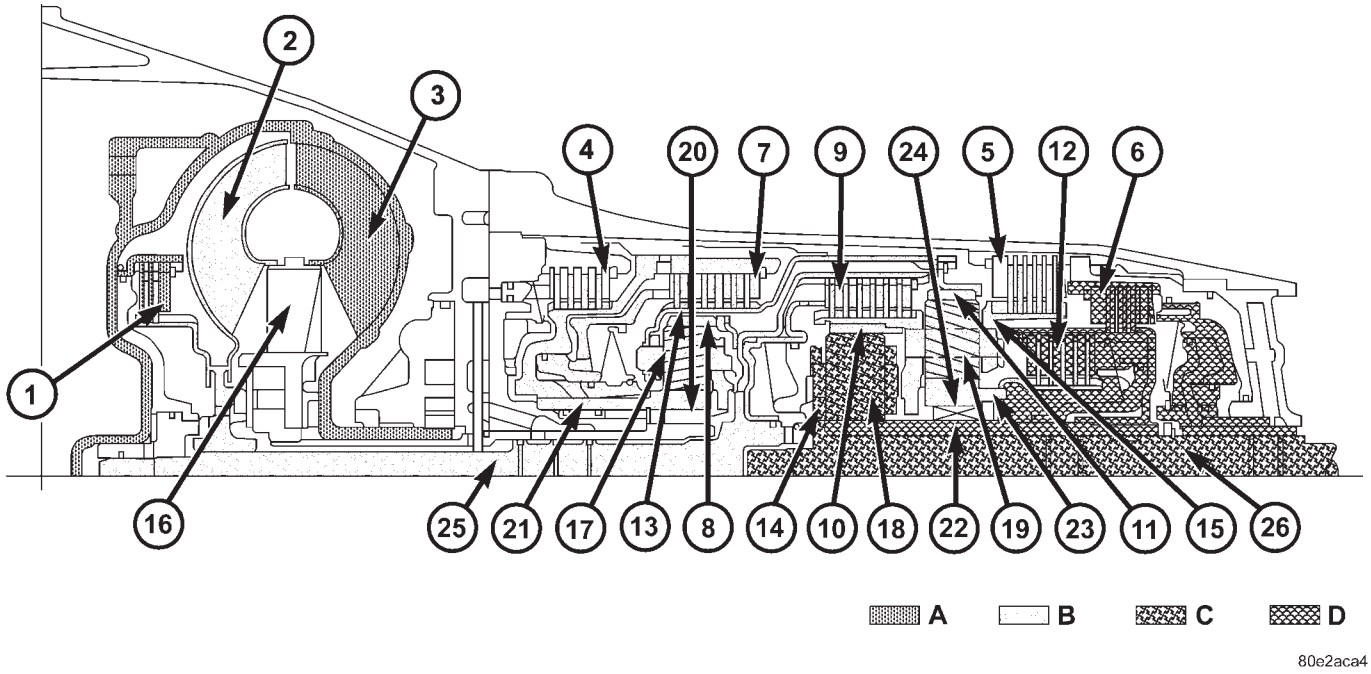

Fig. 7 Third Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
C - FIRST GEAR RATIO
D - FIXED PARTS

AUTOMATIC TRANSMISSION - W5J400 (Continued)

FOURTH GEAR POWERFLOW

Speed and torque are not converted by the direct gear ratio of the 4th gear. Power is transferred from the drive shaft (25) to the output shaft (26) via three locked planetary gearsets (Fig. 8) and (Fig. 9).

Front Planetary Gear Set

The planetary carrier (13) and sun gear (21) are connected via the engaged multiple-disc clutch K1 (7). The planetary gearset is therefore locked and turns as a closed unit at the input speed due to the mechanical connection of the annulus gear (8) and the drive shaft (25).

Rear Planetary Gear Set

The multiple-disc clutch K2 (9) is engaged and transfers the input speed of the drive shaft (25) to the planetary carrier (15) via the annulus gear (10). The annulus gear (11) turns in the same way as the planetary carrier (15) due to the mechanical connection with the locked front planetary gearset. The planetary gearset is therefore locked and turns as a closed unit.

Center Planetary Gear Set

The annulus gear (10) turns at the input speed as a result of the engaged multiple-disc clutch K2 (9). The multiple-disc clutch K3 (12) connects the sun gears (22) and (23) of the rear and center planetary gearset. The planetary gearset is locked by the same speeds of the annulus gear (10) and the sun gear (22) and it turns as a closed unit.

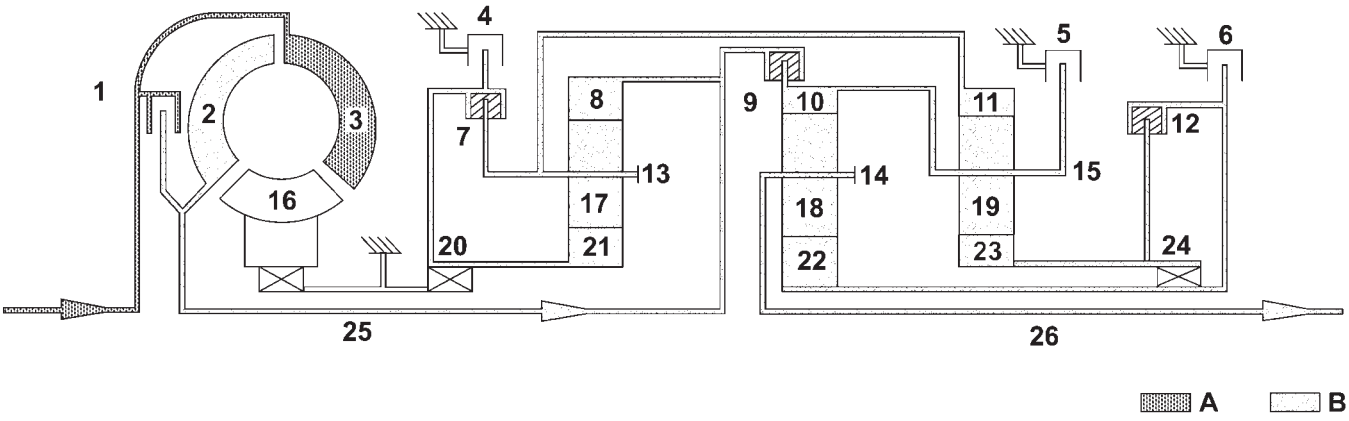

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Fig. 8 Fourth Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
B - TRANSMISSION INPUT SPEED

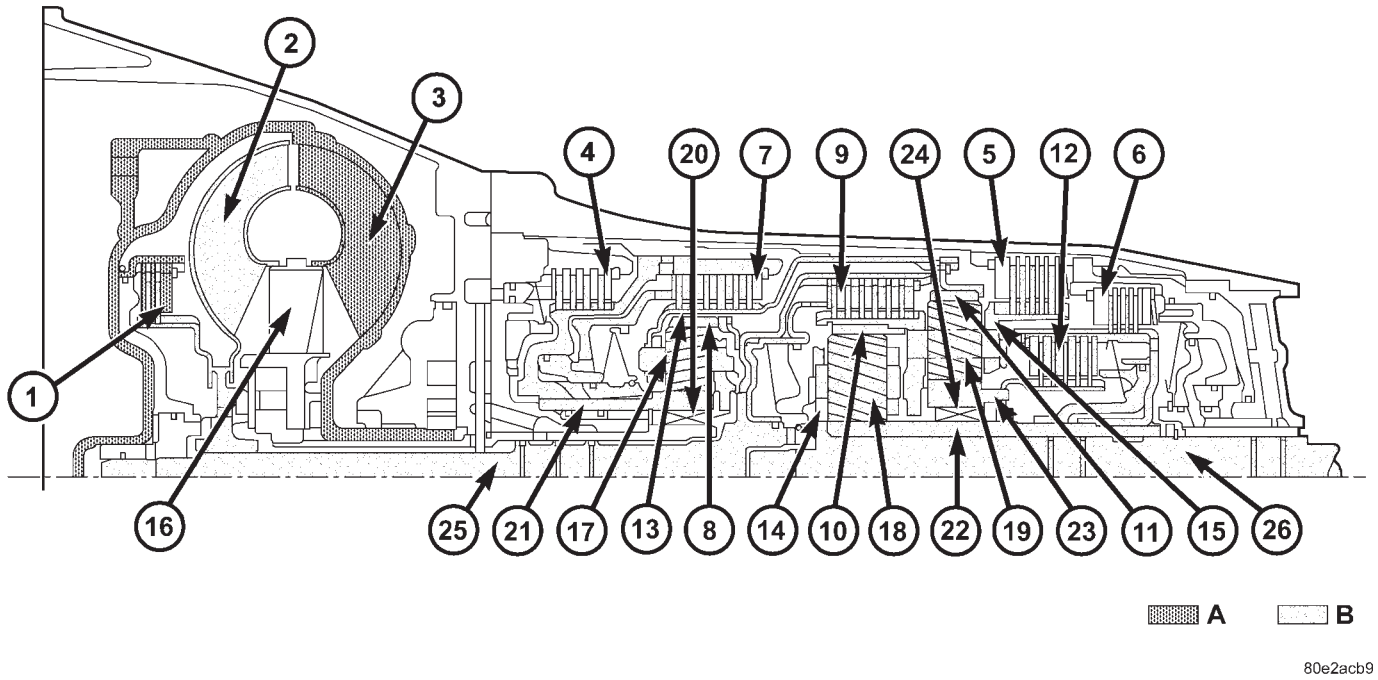

Fig. 9 Fourth Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
B - TRANSMISSION INPUT SPEED

AUTOMATIC TRANSMISSION - W5J400 (Continued)

FIFTH GEAR POWERFLOW

Torque from the torque converter is increased via the drive shaft (25) and all three planetary gearsets and transferred to the output shaft (26) (Fig. 10) and (Fig. 11).

Front Planetary Gear Set

The annulus gear (8) is driven by the drive shaft (25). The sun gear (21) is held against the housing by the locked freewheel F1 (20) during acceleration and via the engaged multiple-disc holding clutch B1 (4) during deceleration. The planetary pinion gears (17) turn on the fixed sun gear (21) and increase the torque from the annulus gear (8) to the planetary carrier (13). The planetary carrier (13) moves at a reduced speed in the running direction of the engine.

Rear Planetary Gear Set

The multiple-disc clutch K2 (9) is engaged and transfers the input speed of the drive shaft (25) to the planetary carrier (15) via the annulus gear (10). The annulus gear (11) turns at a reduced speed due to the mechanical connection with the front planetary carrier (13). The planetary pinion gears (19) turn between the annulus gear (11) and the sun gear (23). The sun gear (23) moves at an increased speed in the running direction of the engine.

Center Planetary Gear Set

The annulus gear (10) turns at the input speed as a result of the engaged multiple-disc clutch K2 (9). The multiple-disc clutch K3 (12) transfers an increased speed to the sun gear (22) due to the connection with the sun gear (23). The planetary pinion gears (18) turn between the annulus gear (10) and the sun gear (22). The speed of the planetary carrier (14) and the output shaft connected to the planetary carrier (5) lies between that of the annulus gear (10) and the sun gear (22). This provides a step-up ratio.

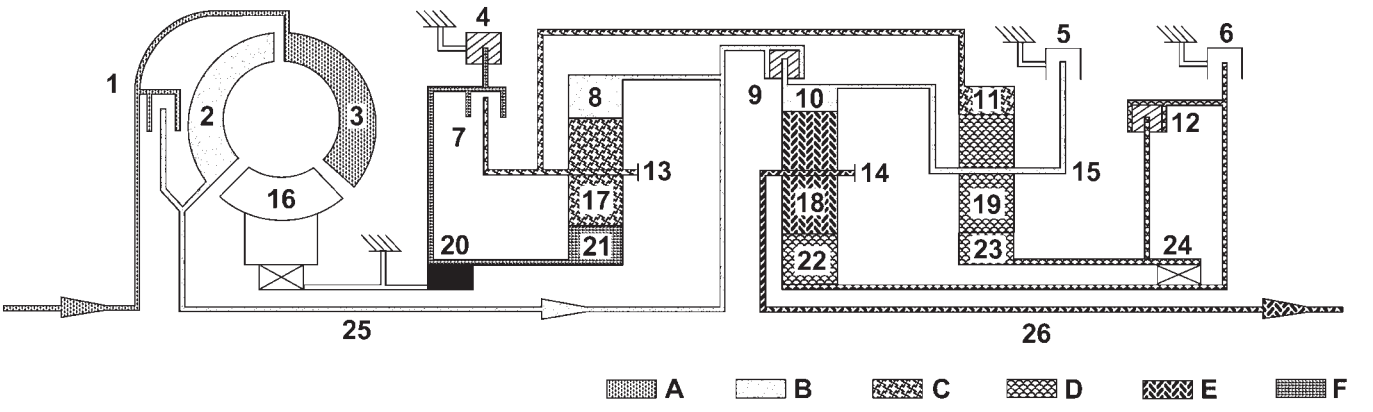

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Fig. 10 Fifth Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

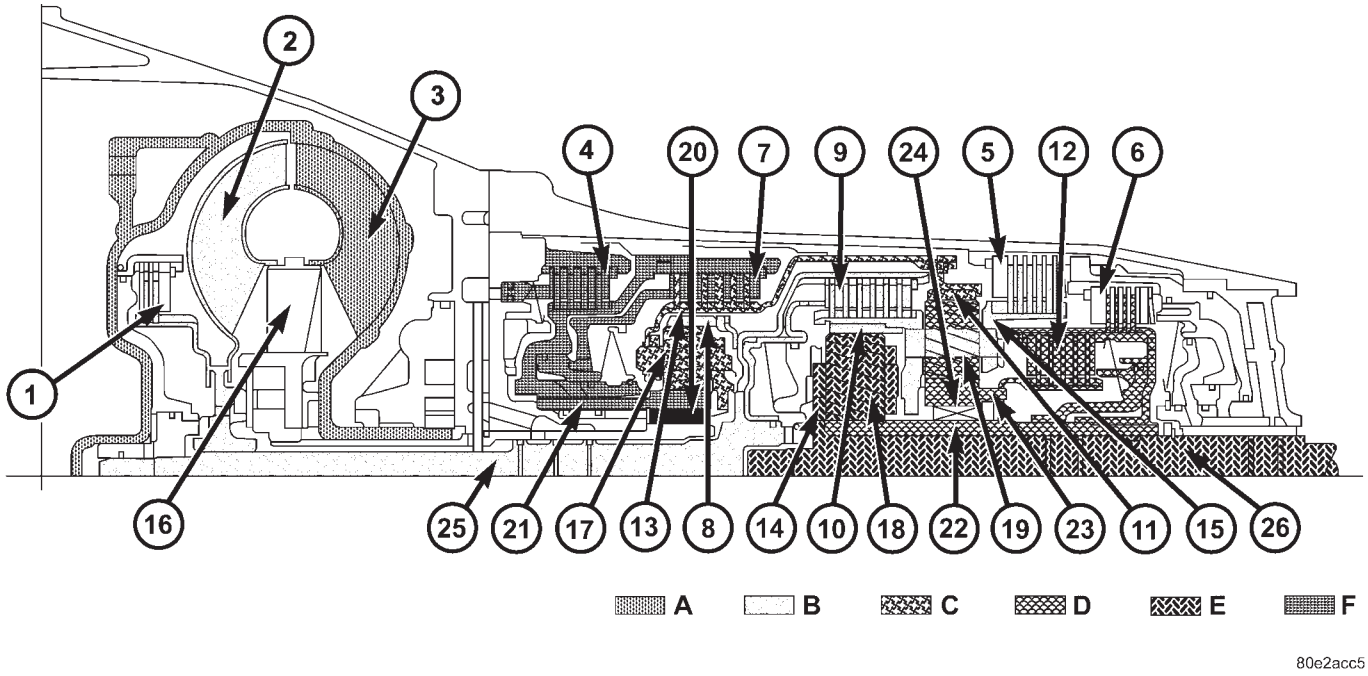

Fig. 11 Fifth Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

REVERSE GEAR POWERFLOW

Torque from the torque converter is increased via the drive shaft (25) and all three planetary gearsets and transferred with reversed direction of rotation to the output shaft (26) (Fig. 12) and (Fig. 13).

Front Planetary Gear Set

The annulus gear (8) is driven by the drive shaft (25). The sun gear (21) is held against the housing by the locked freewheel F1 (20) during acceleration and via the engaged multiple-disc holding clutch B1 (4) during deceleration. The planetary pinion gears (17) turn on the fixed sun gear (21) and increase the torque from the annulus gear (8) to the planetary carrier (13). The planetary carrier (13) moves at a reduced speed in the running direction of the engine.

Rear Planetary Gear Set

The planetary carrier (15) is held against the housing by the engaged multiple-disc holding clutch B3 (5). The annulus gear (11) turns at a reduced speed due to the mechanical connection to the front planetary carrier (13). The planetary gears (19) turn between the annulus gear (11) and the sun gear (23). The direction is reversed by the held planetary carrier (15) so that the sun gear (23) turns in the opposite direction to the running direction of the engine.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

Center Planetary Gear Set

The annulus gear (10) is held against the housing by the multiple-disc holding clutch B3 (5) via the mechanical connection to the planetary carrier (15). The sun gear (22) turns backwards due to the engaged multiple-disc clutch K3 (12). The planetary gears (18) turn on the fixed annulus gear (10) and increase the torque from the sun gear (22) to the planetary carrier (14). The output shaft (26) connected to the planetary carrier (14) turns at a reduced speed in the opposite direction to the running direction of the engine.

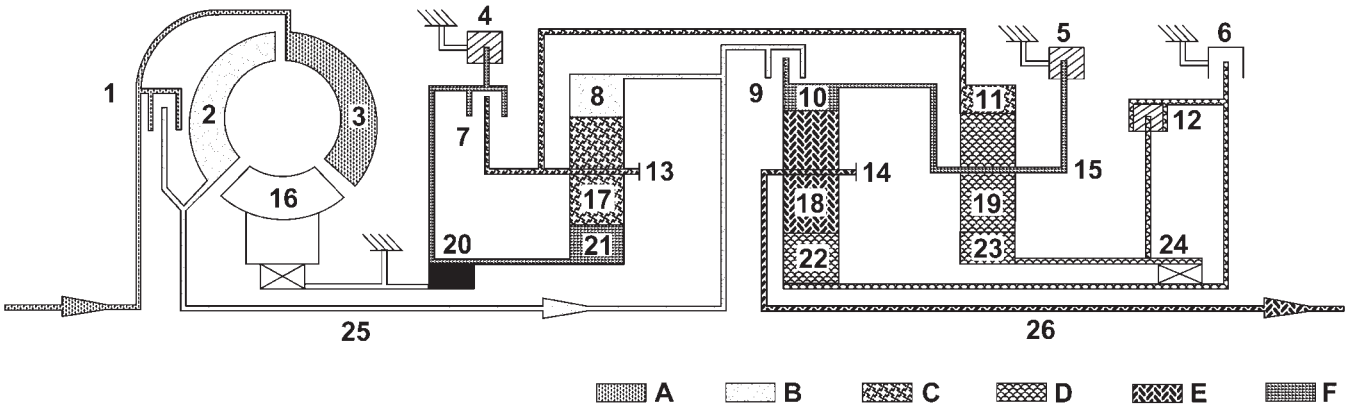

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Fig. 12 Reverse Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

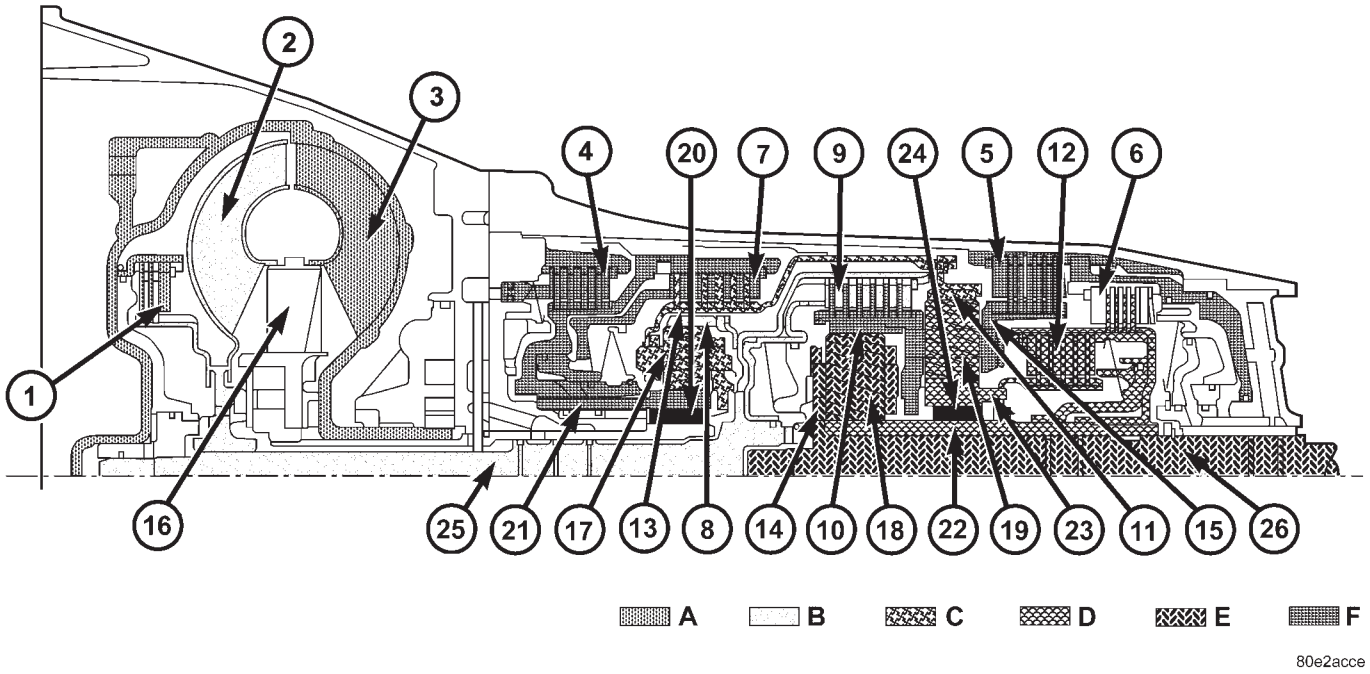

Fig. 13 Reverse Gear Powerflow

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - THIRD GEAR RATIO
F - FIXED PARTS

REVERSE GEAR POWERFLOW (4WD Low)

Torque from the torque converter is increased via the drive shaft (25) and all three planetary gearsets and transferred with reversed direction of rotation to the output shaft (26) (Fig. 14) and (Fig. 15).

Front Planetary Gear Set

The clutch K1 (7) is shifted. The planetary carrier (13) and sun gear (21) are connected to each other as a result. The annulus gear (8) is driven via the drive shaft (25). The planetary gear set is locked and turns as a unit.

Rear Planetary Gear Set

The planetary carrier (15) is held against the housing by the engaged multiple-disc holding clutch B3 (5). The annulus gear (11) turns at a reduced speed due to the mechanical connection to the front planetary carrier (13). The planetary pinion gears (19) turn between the annulus gear (11) and the sun gear (23). The direction is reversed by the held planetary carrier (15) so that the sun gear (23) turns in the opposite direction to the running direction of the engine.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

Center Planetary Gear Set

The annulus gear (10) is held against the housing by the multiple-disc holding clutch B3 (5) via the mechanical connection to the planetary carrier (15). The sun gear (22) turns backwards due to the engaged multiple-disc clutch K3 (12). The planetary gears (18) turn on the fixed annulus gear (10) and increase the torque from the sun gear (22) to the planetary carrier (14). The output shaft (26) connected to the planetary carrier (14) turns at a reduced speed in the opposite direction to the running direction of the engine.

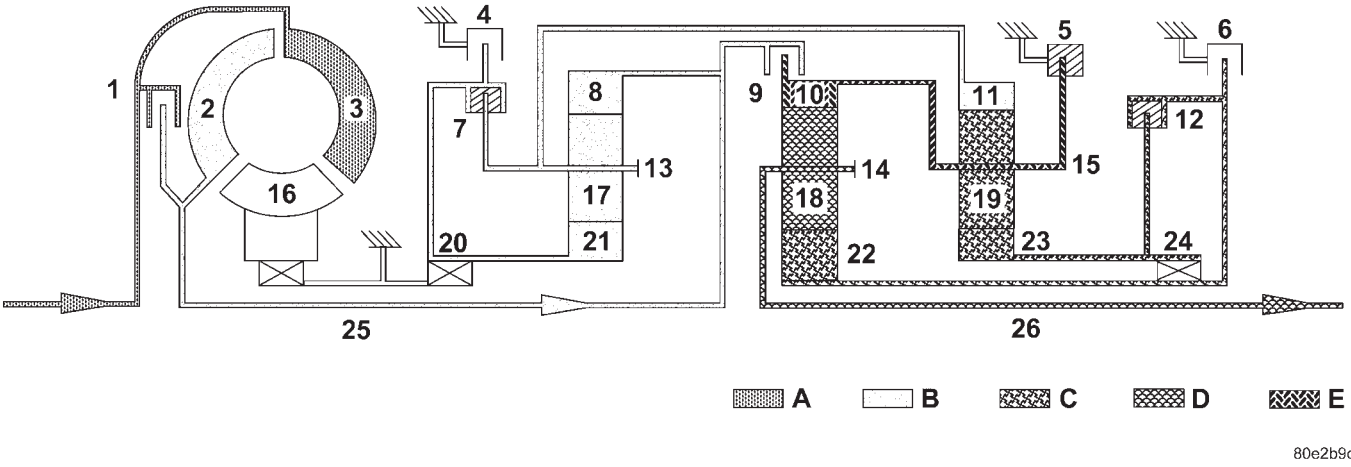

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Fig. 14 Reverse Gear Powerflow - 4WD Low

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - FIXED PARTS

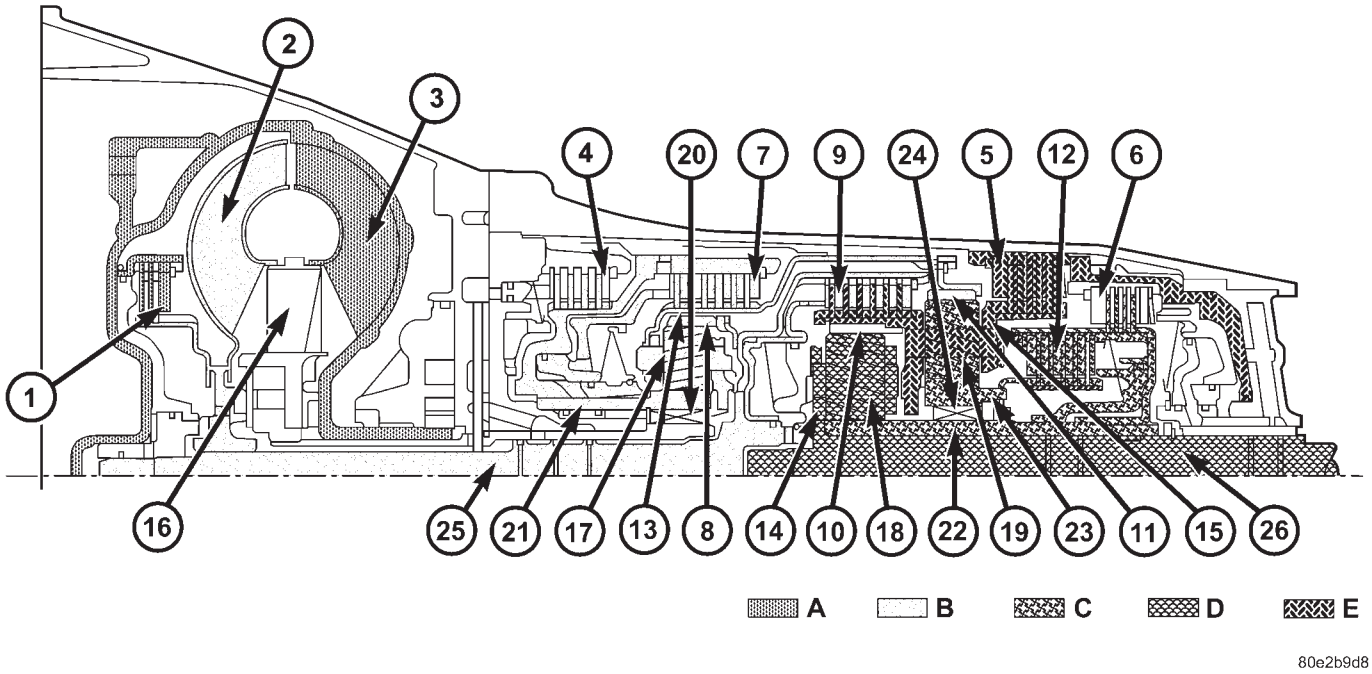


Fig. 15 Reverse Gear Powerflow - 4WD Low

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER TURBINE
3 - TORQUE CONVERTER IMPELLER
4 - HOLDING CLUTCH B1
5 - HOLDING CLUTCH B3
6 - HOLDING CLUTCH B2
7 - DRIVING CLUTCH K1
8 - FRONT PLANETARY ANNULUS GEAR
9 - DRIVING CLUTCH K2
10 - CENTER PLANETARY ANNULUS GEAR
11 - REAR PLANETARY ANNULUS GEAR
12 - DRIVING CLUTCH K3
13 - FRONT PLANETARY CARRIER
A - ENGINE SPEED
B - TRANSMISSION INPUT SPEED
C - FIRST GEAR RATIO
14 - CENTER PLANETARY CARRIER
15 - REAR PLANETARY CARRIER
16 - TORQUE CONVERTER STATOR
17 - FRONT PLANETARY PINION GEARS
18 - CENTER PLANETARY PINION GEARS
19 - REAR PLANETARY PINION GEARS
20 - FREEWHEELING CLUTCH F1
21 - FRONT PLANETARY SUN GEAR
22 - CENTER PLANETARY SUN GEAR
23 - REAR PLANETARY SUN GEAR
24 - FREEWHEELING CLUTCH F2
25 - DRIVE SHAFT
26 - OUTPUT SHAFT
D - SECOND GEAR RATIO
E - FIXED PARTS

SHIFT GROUPS/ SHIFT SEQUENCE

1-2 Shift - First Gear Engaged

The end face of the command valve (5) (Fig. 16) is kept unpressurized via the solenoid valve for 1-2 and 4-5 shift (1). Via the holding pressure shift valve (4), the working pressure (p-A) is present at the multiple-disc holding clutch B1 (7). Clutch K1 (6) is unpressurized.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

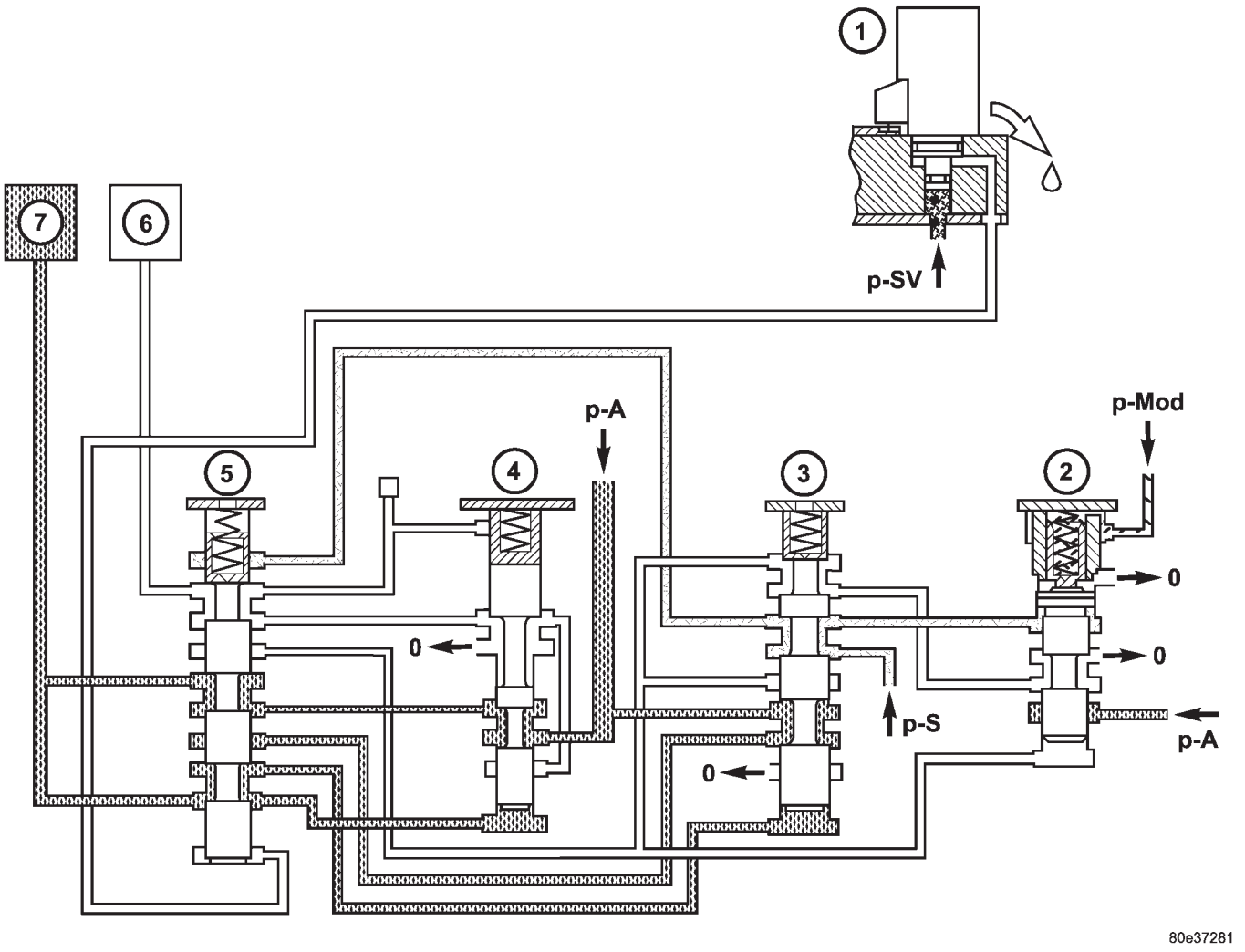


Fig. 16 First Gear Engaged

1 - 1-2/4-5 SHIFT SOLENOID
2 - 1-2/4-5 OVERLAP VALVE
3 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE
4 - 1-2/4-5 HOLDING PRESSURE SHIFT VALVE
5 - 1-2/4-5 COMMAND VALVE
6 - DRIVING CLUTCH K1
7 - HOLDING CLUTCH B1

Shift Phase

Via the 1-2 and 4-5 shift solenoid valve (1) (Fig. 17), the shift valve pressure (p-SV) is directed onto the end face of the command valve (5). The command valve is moved and the shift pressure (p-S) coming from the shift pressure shift valve (3) is directed via the command valve (5) onto clutch K1 (6). Simultaneously the clutch B1 (7) is subjected to overlap pressure by the overlap regulating valve (2).

The B1 (7) pressure acting on the end face of the shift pressure shift valve (3) is replaced by the working pressure (p-A). The rising shift pressure (p-S) at clutch K1 (6) acts on the annular face of the overlap regulating valve (2) and reduces the overlap pressure regulated by the overlap regulating valve (2). When a corresponding pressure level is reached at the holding pressure shift valve (4), this valve switches over.

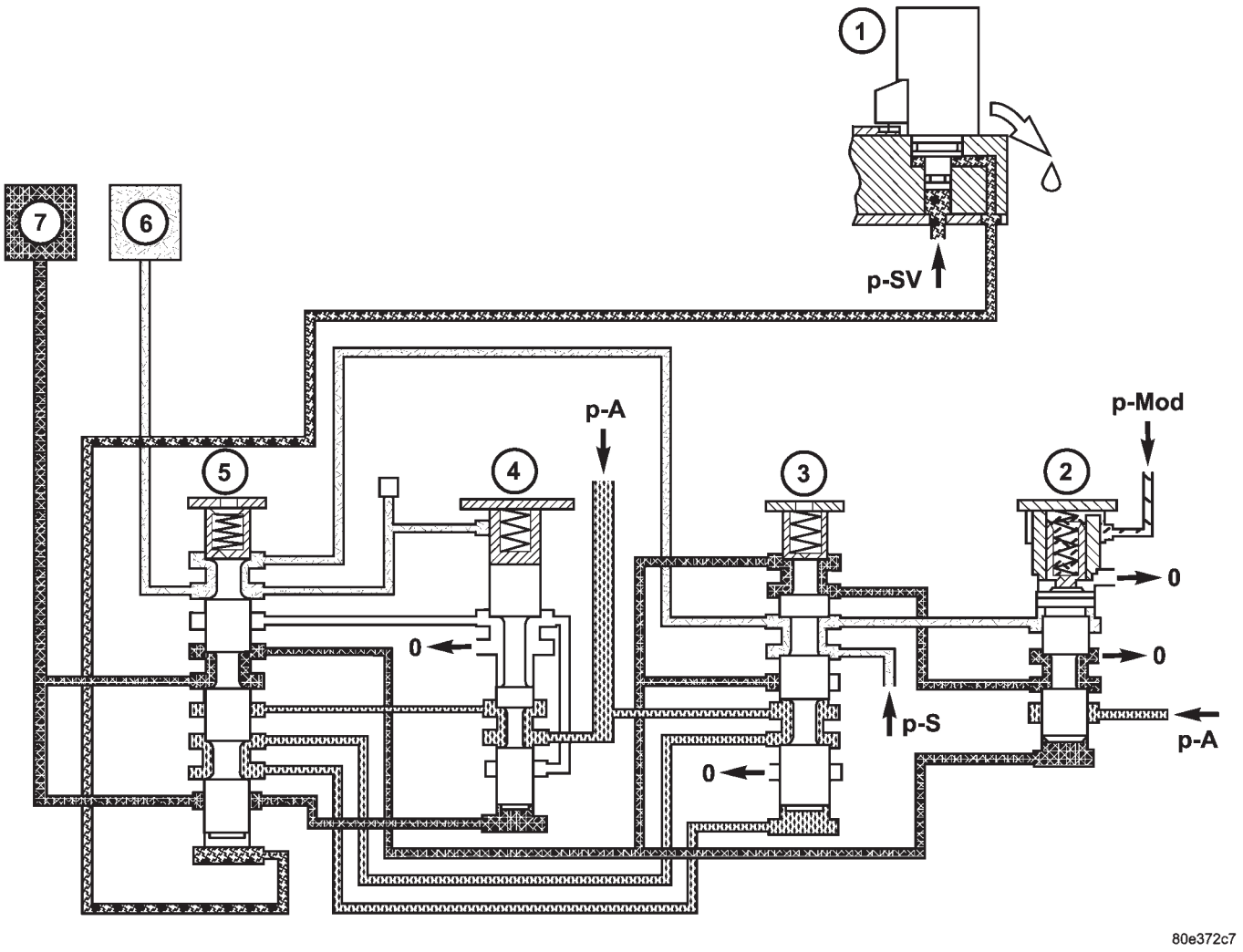


Fig. 17 Shift Phase

1 - 1-2/4-5 SHIFT SOLENOID
2 - 1-2/4-5 OVERLAP VALVE
3 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE
4 - 1-2/4-5 HOLDING PRESSURE SHIFT VALVE
5 - 1-2/4-5 COMMAND VALVE
6 - DRIVING CLUTCH K1
7 - HOLDING CLUTCH B1

Second Gear Engaged

After the gearchange is complete, the pressure on the end face of the command valve (5) (Fig. 18) is reduced via the 1-2 and 4-5 shift solenoid valve (1), and the command valve (5) is pushed back to its basic position. Via the holding pressure shift valve (4) the working pressure (p-A) now passes via the command valve (5) to clutch K1 (6). The multiple-disc holding clutch B1 (7) is deactivated (unpressurized). The spring of the shift pressure shift valve (3) pushes the valve back to its basic position.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

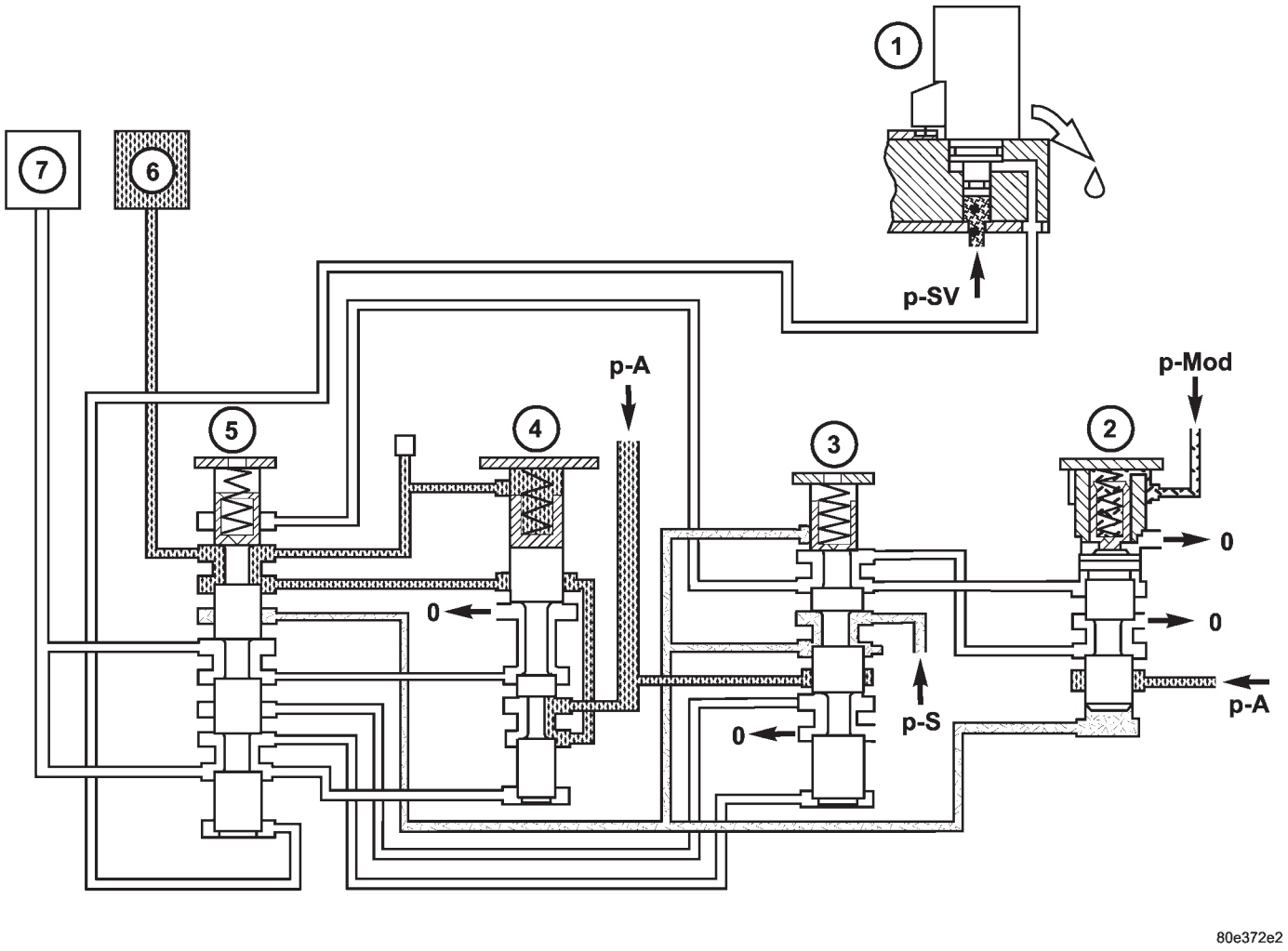


Fig. 18 Second Gear Engaged

1 - 1-2/4-5 SHIFT SOLENOID
2 - 1-2/4-5 OVERLAP VALVE
3 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE
4 - 1-2/4-5 HOLDING PRESSURE SHIFT VALVE
5 - 1-2/4-5 COMMAND VALVE
6 - DRIVING CLUTCH K1
7 - HOLDING CLUTCH B1

Gear Shift N to D (1st gear) - Engine Started

With the engine started (Fig. 19) and the gearshift lever in the NEUTRAL or PARK positions, holding clutch B1 (1) and driving clutch K3 (4) are applied and the various valves in the 1-2/4-5 shift group are positioned to apply pressure to the holding clutch B2.

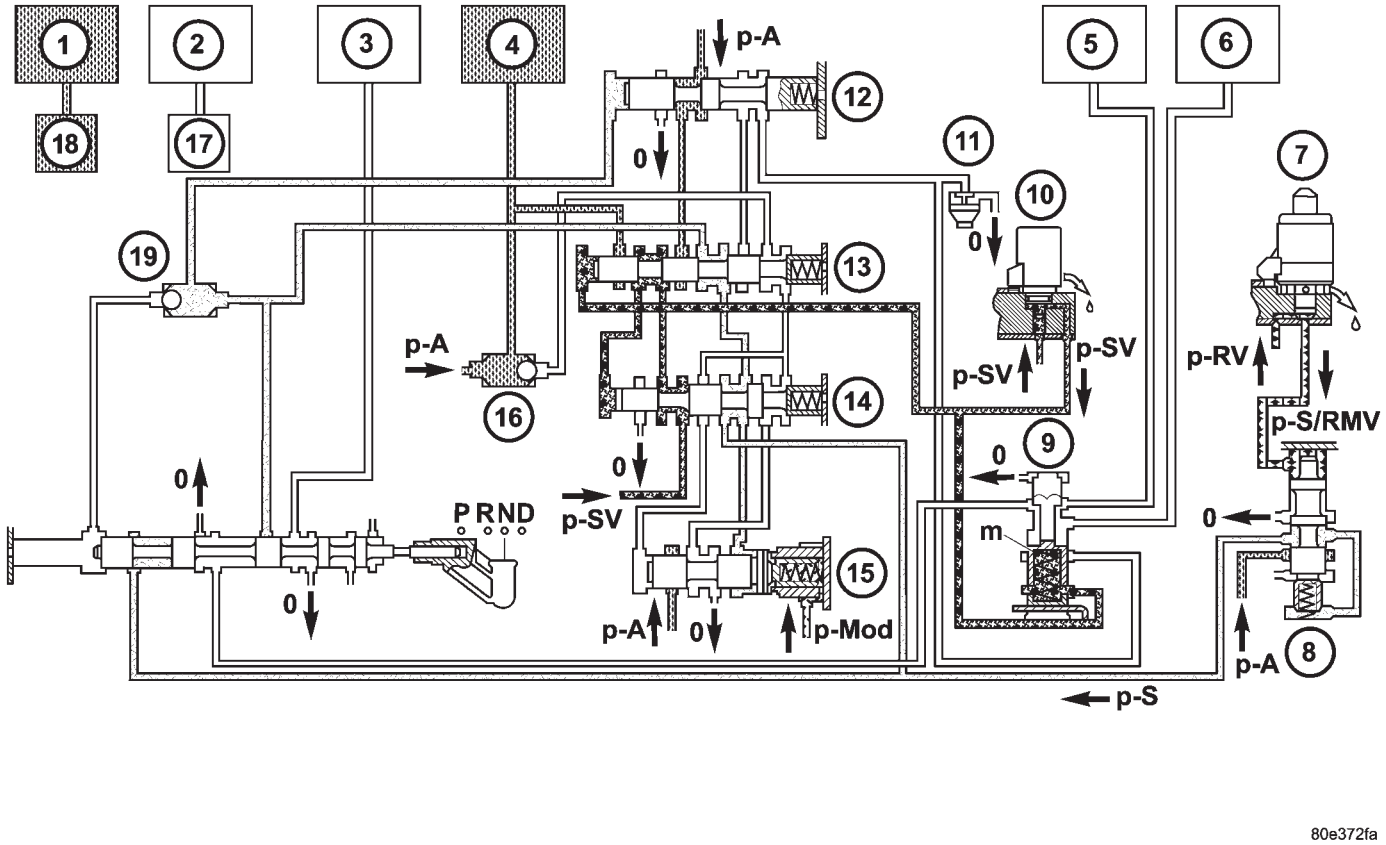


Fig. 19 Engine Started

1 - HOLDING CLUTCH B1
2 - DRIVING CLUTCH K1
3 - HOLDING CLUTCH B3
4 - DRIVING CLUTCH K3
5 - HOLDING CLUTCH B2 PISTON
6 - HOLDING CLUTCH B2 PISTON OPPOSING FACE
7 - SHIFT PRESSURE REGULATING SOLENOID
8 - SHIFT PRESSURE REGULATING VALVE
9 - SHIFT VALVE B2
10 - 3-4 SHIFT SOLENOID
11 - PRESSURE HOLDING VALVE
12 - 3-4 HOLDING PRESSURE SHIFT VALVE
13 - 3-4 COMMAND VALVE
14 - 3-4 SHIFT PRESSURE SHIFT VALVE
15 - 3-4 OVERLAP REGULATING VALVE
16 - BALL VALVE
17 - 1-2/4-5 COMMAND VALVE
18 - 1-2/4-5 COMMAND VALVE
19 - BALL VALVE

Activation Sequence

The selector valve (Fig. 20) opens the shift pressure (p-S) feed connection from the ball valve (19) with the shift valve B2 (9). With the shift valve B2 (9) in the upper position, shift pressure (p-S) travels behind the piston B2 (5) and simultaneously to the opposing face of the piston B2 (6). The multiple-disc holding clutch B2 begins to close.

The pressure on the opposing face of the piston B2 (6) ensures a soft activation of the multiple-disc holding clutch B2.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

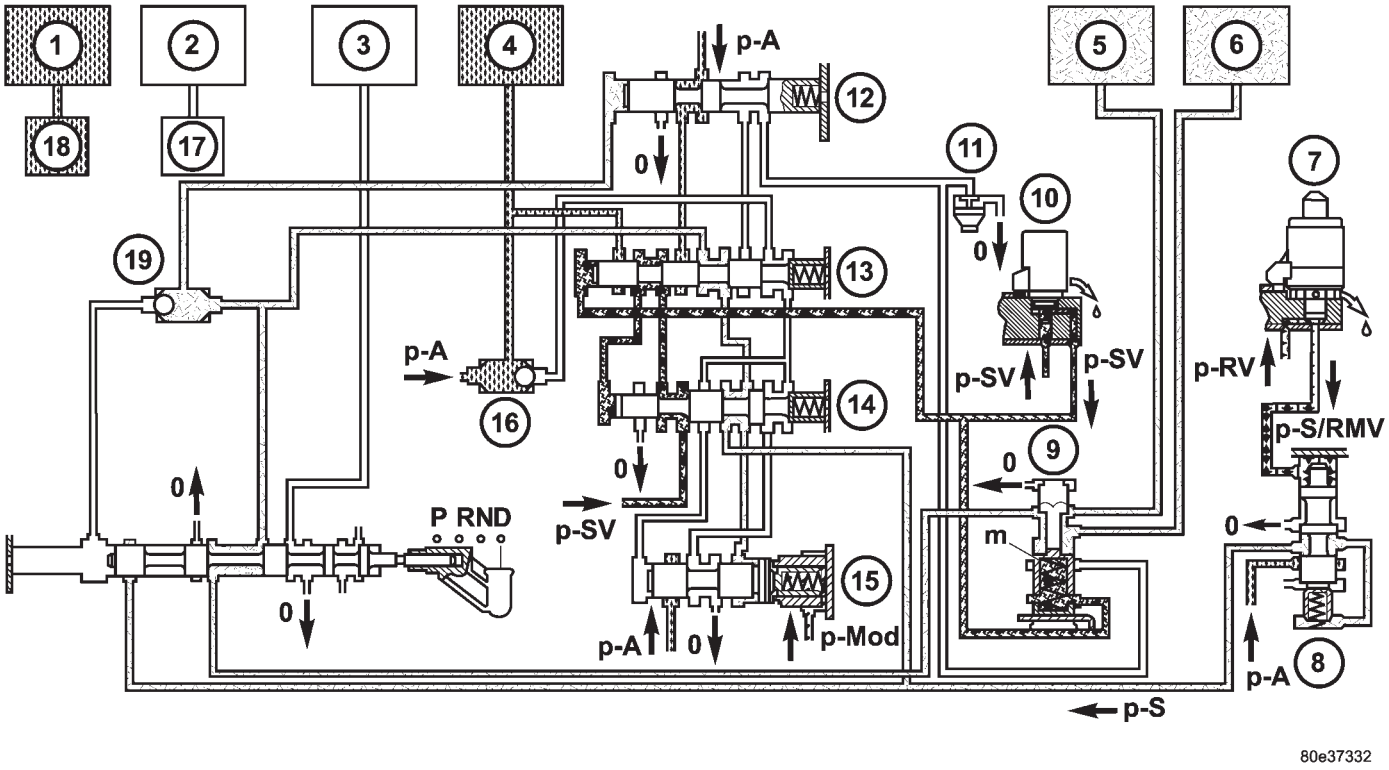


Fig. 20 Activation Sequence

1 - HOLDING CLUTCH B1
2 - DRIVING CLUTCH K1
3 - HOLDING CLUTCH B3
4 - DRIVING CLUTCH K3
5 - HOLDING CLUTCH B2 PISTON
6 - HOLDING CLUTCH B2 PISTON OPPOSING FACE
7 - SHIFT PRESSURE REGULATING SOLENOID
8 - SHIFT PRESSURE REGULATING VALVE
9 - SHIFT VALVE B2
10 - 3-4 SHIFT SOLENOID
11 - PRESSURE HOLDING VALVE
12 - 3-4 HOLDING PRESSURE SHIFT VALVE
13 - 3-4 COMMAND VALVE
14 - 3-4 SHIFT PRESSURE SHIFT VALVE
15 - 3-4 OVERLAP REGULATING VALVE
16 - BALL VALVE
17 - 1-2/4-5 COMMAND VALVE
18 - 1-2/4-5 COMMAND VALVE
19 - BALL VALVE

First Gear Engaged

The TCM control module monitors the activation sequence via the speed of the input shaft, which slows down as the frictional connection in the multiple-disc holding clutch increases. When the speed drops to the specified level, the TCM shuts off the power to the 3-4 shift solenoid valve (10) (Fig. 21). The spring chamber of the shift valve B2 (9) is depressurized and switches downwards. This connects the line to the opposing face of the piston B2 (6) with the pressure holding valve (11). The pressure on the opposing face of the piston B2 (6) drops to a residual pressure.

The working pressure (p-A) is formed and travels via the 2-3 holding pressure shift valve, the 2-3 command valve and the ball valve (16) to multi-plate clutch K3 (4) and via the 3-4 command valve (13) to the end face of the 3-4 shift pressure shift valve (14). The 3-4 shift pressure shift valve (14) is moved against the force of the spring towards the right. At the same time the 3-4 solenoid valve (10) is energized. This allows shift valve pressure (p-SV) to enter the spring chamber of the shift valve B2 (9) and to reach the end face of the 3-4 command valve (13). The shift valve B2 (9) is held in the upper position and the 3-4 command valve (13) switches towards the right. At the end face of the 3-4 shift pressure shift valve (14) the working pressure (p-A) is replaced by shift valve pressure (p-SV).

The 3-4 command valve (13) moves to the left. Working pressure (p-A) travels via the holding pres-

sure shift valve (12) and the 3-4 command valve (13) to the piston of multiple-disc holding clutch B2 (5).

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - AUTOMATIC TRANSMISSION

CAUTION: Before attempting any repair on a W5J400 automatic transmission, check for Diagnostic Trouble Codes with the DRB® scan tool.

Transmission malfunctions may be caused by these general conditions:

- Poor engine performance.
- Improper adjustments.
- Hydraulic malfunctions.
- Mechanical malfunctions.
- Electronic malfunctions.
- Transfer case performance.

Diagnosis of these problems should always begin by checking the easily accessible variables: fluid level and condition, gearshift cable adjustment. Then perform a road test to determine if the problem has been corrected or if more diagnosis is necessary.

DIAGNOSIS AND TESTING - PRELIMINARY

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).

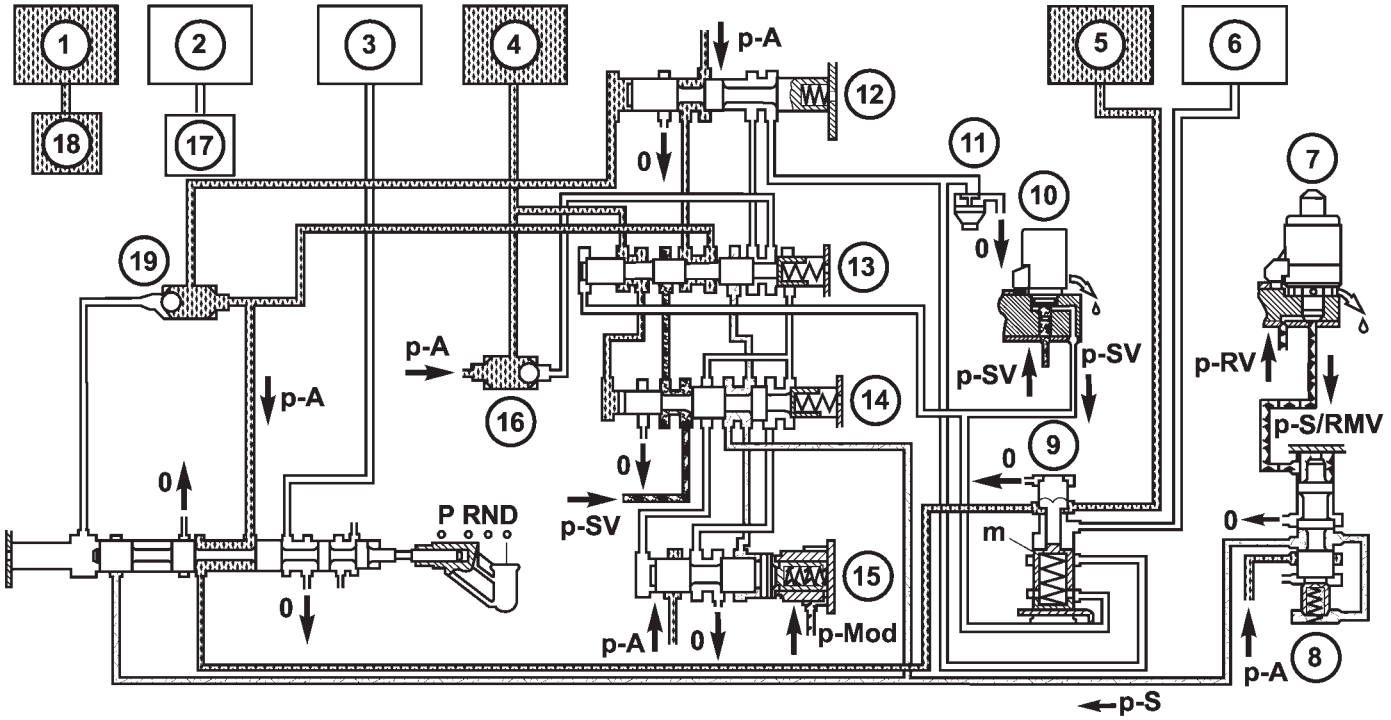


Fig. 21 First Gear Engaged

1 - HOLDING CLUTCH B1
2 - DRIVING CLUTCH K1
3 - HOLDING CLUTCH B3
4 - DRIVING CLUTCH K3
5 - HOLDING CLUTCH B2 PISTON
6 - HOLDING CLUTCH B2 PISTON OPPOSING FACE
7 - SHIFT PRESSURE REGULATING SOLENOID
8 - SHIFT PRESSURE REGULATING VALVE
9 - SHIFT VALVE B2
10 - 3-4 SHIFT SOLENOID
11 - PRESSURE HOLDING VALVE
12 - 3-4 HOLDING PRESSURE SHIFT VALVE
13 - 3-4 COMMAND VALVE
14 - 3-4 SHIFT PRESSURE SHIFT VALVE
15 - 3-4 OVERLAP REGULATING VALVE
16 - BALL VALVE
17 - 1-2/4-5 COMMAND VALVE
18 - 1-2/4-5 COMMAND VALVE
19 - BALL VALVE

AUTOMATIC TRANSMISSION - W5J400 (Continued)

VEHICLE IS DRIVABLE

(1) Check for transmission fault codes using DRB® scan tool.

(2) Check fluid level and condition.

(3) Adjust gearshift cable if complaint was based on delayed, erratic, or harsh shifts.

(4) Road test and note how transmission upshifts, downshifts, and engages.

VEHICLE IS DISABLED

(1) Check fluid level and condition.

(2) Check for broken or disconnected gearshift cable.

(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 driveplate, 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.

DIAGNOSIS AND TESTING - ROAD TESTING

Before road testing, be sure the fluid level and control cable adjustments have been checked and adjusted if necessary. Verify that all 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, overrunning clutch, or line pressure problems.

A slipping clutch can often be determined by comparing which internal units are applied in the various gear ranges. The Clutch Application chart CLUTCH APPLICATION provides a basis for analyzing road test results.

CLUTCH APPLICATION

GEAR	RATIO	B1	B2	B3	K1	K2	K3	F1	F2
1	3.59	X*	X				X*	X	X
2	2.19		X		X		X*		X
3	1.41		X		X	X			
4	1.00				X	X	X		
5	0.83	X				X	X	X*	
N	X						X		
R	3.16	X*		X			X	X	
R (4WD Low)	1.93			X	X		X		
* = The shift components required during coast.									

DIAGNOSIS AND TESTING - AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSES	CORRECTION
MAXIMUM SPEED 30 km/h	1. Speed Control 30 Actuated.	1. Instruct Customer.
ENGINE DIES WHEN TRANSMISSION IS SHIFTED INTO GEAR, ALSO NOISES IN N AND/OR P	1. PWM Valve Blocked.	1. Replace Valve.
	2. Torque Converter Lock Up Control Valve Locked.	2. Enable Movement of Valve, Remove Particle.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LEVER IN ″P″ POSITION BLOCKED (BRAKE ACTIVATED)	1. No Vacuum Brake Booster After Long Immobilization, Brake Pedal Not Fully Applied/Hard Pedal.	1. Check Vacuum/ Tightness of Brake Booster.
	2. No Stoplamp Switch Signal (no DTC IN ECM).	2. Check Contact to Stoplamp Switch. Replace Switch if Necessary.
GRUMBLING, DRONING, JERKING WHEN TCC IS ENGAGED	1. Slip Speed TCC to Low.	1. Switch Off Torque Converter Lock Up Using DRB®. If Complaint Is Not Reproduced Afterwards, Replace PWM Valve, Set Adaption Values to Zero.
HOWLING, HUMMING ABOVE 4000 RPM IN EACH GEAR	1. Oil Filter Blocked.	1. Replace Oil Filter.
	2. Oil Pump.	2. Replace Oil Pump.
WHINING, SINGING	1. Gear Set Noises in 1st, 2nd, 5th Gear.	1. Replace transmission..
	2. Intermediate Bearing Of The Drive Shaft At 0 km/h, Only When Cold.	2. Replace Intermediate Bearing of the Drive Shaft.
″CLACK″ NOISE FROM CENTER SHIFT AREA WHEN STOPPING OR STARTING	1. Park Lock Solenoid.	1. Replace Shifter Assembly.
CRACKING NOISE WHEN LOAD CYCLE	1. Stick - Slip Between Joint Flange and Collar Nut.	1. Install Zinc Coated Collar Nut Together With Washer.
CHATTERING IN CENTER CONSOLE SHIFT WHILE ACCELERATING	1. Bushing Shift Shaft Has Too Much Clearance.	1. Replace Shifter Lever and Cover Plate.
HARD 2-3 UPSHIFT WHEN STEPPING OFF THE ACCELERATOR PEDAL	1. Response Characteristic Control Loop.	1. Install K2 Disc Spring.
UPSHIFT 2-3, 3-4 SLIPPING	1. Spring of Regulating Valve Pressure control Valve Broken.	1. Replace spring.
HARD 2-1 DOWNSHIFT WHEN COMING TO A STOP	1. Transmission (2-1 downshift) Not Adapted.	1. Readapt Transmission.
	2. TCM Software Data.	2. Flash TCM.
	3. Free Wheeling Clutch F1 Defective.	Replace Free Wheeling Clutch F1.
HARD 3-2 DOWNSHIFT WHEN DECELERATION EVEN AFTER READAPTION	1. K3 Idles.	1. Install TCM And/Or Electrohydraulic Control Unit.
NO RESP. DELAYED UPSHIFT, NO DTC	1. Different Tire Sizes Are Mounted On The Front Axle.	1. Mount Uniform Tire Sizes On The Front Axle.
NO UPSHIFT 3-4, 4-5 AFTER FAST OFF (ACCELERATOR)	1. Upshift Prevention To Realize Dynamical Drivestyle.	1. Instruct Customer.
NO UPSHIFT OF 1ST GEAR BELOW 5000 RPM	1. Gear Recognition Switch.	1. Replace Gear Recognition Switch.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
NO UPSHIFT INTO 5TH GEAR WHEN FULL THROTTLE OR KICK DOWN ACTIVATION	1. The Upshift 4-5 At Full Throttle or Kick Down Never Occurs Until Reaching Cut Off Speed. Under These Conditions, The High Powered Vehicle Will Never Shift Into 5th Gear Below 250 km/h.	1. Instruct Customer.
NO KICK DOWN SHIFTING	1. Accelerator Pedal Value < 95%.	1. Check Engine Control. Adjust As Necessary.
Engine Turns Up While 2-3 Upshift and/or Hard 3-2 Downshift	1. Oil Level Too Low.	1. Check Oil At 80°C. Add if Necessary.
	2. Oil Filter Not Installed.	2. Install Oil Filter.
	3. Free Wheeling Clutch F2 Defective.	3. Replace Free Wheeling Clutch F2, Hollow Shaft, and Rear Sun Gear/Inner Disc Carrier K3.
GRABBING 2-3 COASTING UPSHIFT AND/OR BRAKE DOWNSHIFT	1. Oil Level Too Low.	1. Check Oil At 80°C. Add if Necessary.
	2. Oil Filter Not Installed.	2. Install Oil Filter.
	3. Control shift or Command Valve Blocked.	3. Check Each Slide Valve For Base Position and Ease Of Movement, Remove Particle.
	4. K3 Disc Burnt, Hot Spots or Rubbed Down.	4. Replace Inner and Outer Disc Carrier K3 And Control Valve.
DELAYED ENGAGEMENT, NO TRANSFER OF POWER IN R AND/OR D, ALSO AT TIMES	1. Oil Level Too Low.	1. Check Oil At 80°C. Add if Necessary.
	2. Recognition Switch - Selector Lever Position.	2. Replace Recognition Switch Only When Intermediate Position or Fault is Indicated.
	3. Oil Filter Not Installed.	3. Install Oil Filter.
	4. AEV, Delayed Pressure Build Up On Piston B2/B3.	4. Install New Shifting Procedure (TCM, electrohydraulic control unit or repair set).
	5. Wrong Combination TCM/ Electrohydraulic Control Unit.	5. Check Combination TCM/Electrohydraulic Control Unit. Replace TCM Resp. Electrohydraulic Control Unit, if necessary.
NO UPSHIFT OF 1ST GEAR AT TIMES	1. Connector Ballast Unit. Output Speed Sensor Loose, Incorrectly Contacted.	1. Check Connectors, Replace Output Speed sensor If Necessary.
	2. Output Speed Sensor Defective	2. Replace Output Speed Sensor.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LEAKAGE AT THE AREA OF THE ELECTRICAL PLUG TO THE CONDUCTOR PLATE	1. Deformation O-Rings.	1. Replace O-Rings.
	2. Deformation Adapter.	2.Replace Adaptor.
	3. The Conductor Plate Is Not Fitted Surface To Surface On The Valve Body In One Corner, The Plug Is Not Centered In The Socket And The O-ring Will Not Seal.	3. Remove Nose Of Conductor Plate.
	4. Contacting At The Conductor Plate Leaky. Oil In Harness, Sometimes In The Control Module.	4. Replace Conductor Plate.
LEAKAGE AT THE AREA OF BELL HOUSING/ TORQUE CONVERTER	1. Bolts (Torx M6) Outer Disc Carrier B1.	1. Clean Thread and Install the Bolts Using Sealer.
OIL LEAKS	1. 6 Lower Bolts (TorxM8) Converter Housing.	1. Clean Thread and Install the Bolts Using Sealer.
	2. Oil Drain Plug Converter Loose Resp. No Seal Ring Installed.	2. Install Drain Plug Correctly.
	3. Weld Seam Of Torque Converter Leaky.	3. Replace Torque Converter.
	4. Radial Sealing Ring Oil Pump Defective.	4. Replace Sealing Ring.
	5. O-Ring Oil Pump Defective Or Not Installed.	5. Install O-Ring.
	6. Bushing Of Oil Pump Loose, caused By Missing Fit Bolt At Transmission/Engine Flange.	6. Install Fit Bolt If Necessary.

STANDARD PROCEDURE - ALUMINUM THREAD REPAIR

Damaged or worn threads in the aluminum transmission 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.

REMOVAL

(1) Disconnect the negative battery cable.

(2) Raise and support the vehicle.

(3) Remove any necessary skid plates (Refer to 13 - FRAME & BUMPERS/FRAME/TRANSFER CASE SKID PLATE - REMOVAL).

(4) Mark propeller shaft and axle yokes for assembly alignment.

(5) Remove the rear propeller shaft.

(6) Remove the front propeller shaft.

(7) Disconnect and lower or remove any necessary exhaust components.

(8) Remove the starter motor.

(9) Remove the torque converter access plug from the diesel engine adapter.

(10) Rotate crankshaft in clockwise direction until converter bolts are accessible. Then remove bolts one at a time. Rotate crankshaft with socket wrench on dampener bolt.

(11) Disconnect gearshift cable from transmission manual valve lever.

(12) Remove bolt (3) (Fig. 22) and screw (1) holding the heat shield (2) to the transmission.

(13) Disconnect 13-pin plug connector (1) (Fig. 23). Turn bayonet lock of guide bushing (2) anti-clockwise.

(14) Drain transmission oil by unscrewing oil drain plug (8).

(15) Disconnect transfer case shift cable from the transfer case shift lever.

(16) Remove the clip securing the transfer case shift cable into the cable support bracket.

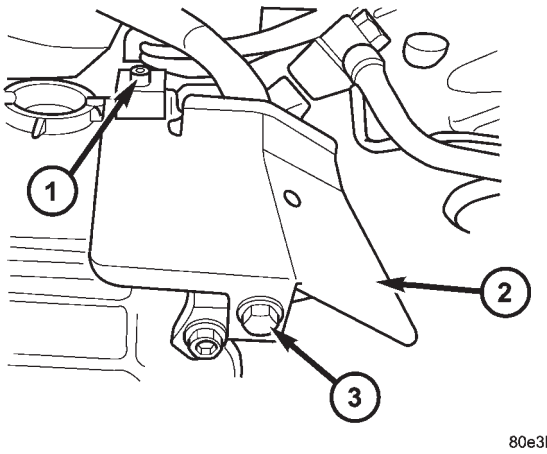


Fig. 22 Remove Heat Shield

1 - SCREW
2 - HEAT SHIELD
3 - BOLT

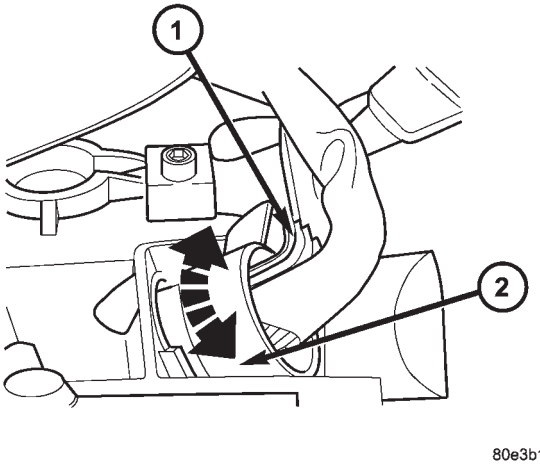


Fig. 23 Remove Wiring Connector Plug

1 - PLUG CONNECTOR
2 - GUIDE BUSHING

(17) Disconnect transmission fluid cooler lines at transmission fittings and clips.

(18) Disconnect the transmission vent hose from the transmission.

(19) Support rear of engine with safety stand or jack.

(20) Raise transmission slightly with service jack to relieve load on crossmember and supports.

(21) Remove bolts securing rear support and cushion to transmission and crossmember.

(22) Remove bolts attaching crossmember to frame and remove crossmember.

(23) Remove transfer case.

(24) Remove all remaining converter housing bolts.

(25) Carefully work transmission and torque converter assembly rearward off engine block dowels.

(26) Hold torque converter in place during transmission removal.

(27) Lower transmission and remove assembly from under the vehicle.

(28) To remove torque converter, carefully slide torque converter out of the transmission.

DISASSEMBLY

(1) Remove the torque converter (1) (Fig. 24).

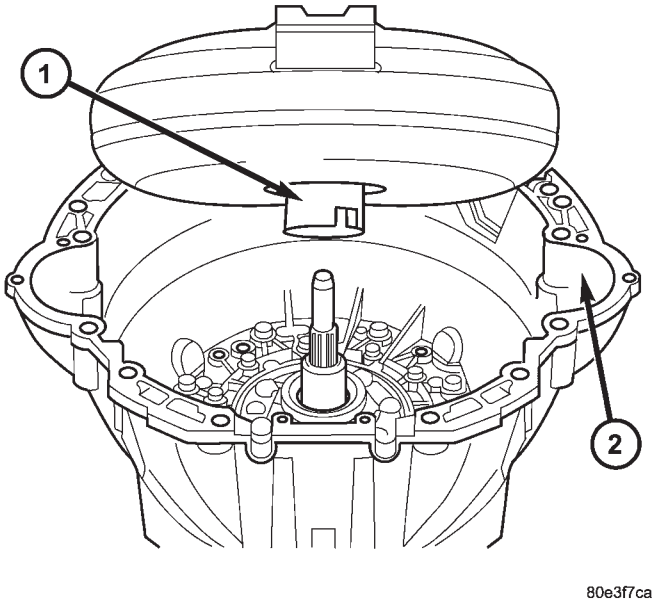


Fig. 24 Remove Torque Converter

1 - TORQUE CONVERTER
2 - CONVERTER HOUSING

(2) Loosen guide bushing (12) (Fig. 25) and remove from transmission housing.

(3) Detach oil pan (5) (Fig. 25).

(4) Remove oil filter (4) (Fig. 25).

(5) Unscrew Torx socket bolts (3) and remove electrohydraulic unit (2).

(6) Remove the bolts holding the transfer case adapter housing onto the transmission case.

(7) Remove the transfer case adapter housing from the transmission case.

(8) Remove the bolt holding the output shaft extension to the output shaft.

(9) Remove the output shaft extension from the output shaft.

(10) Remove the transmission rear oil seal.

(11) Remove the transmission rear output shaft shim.

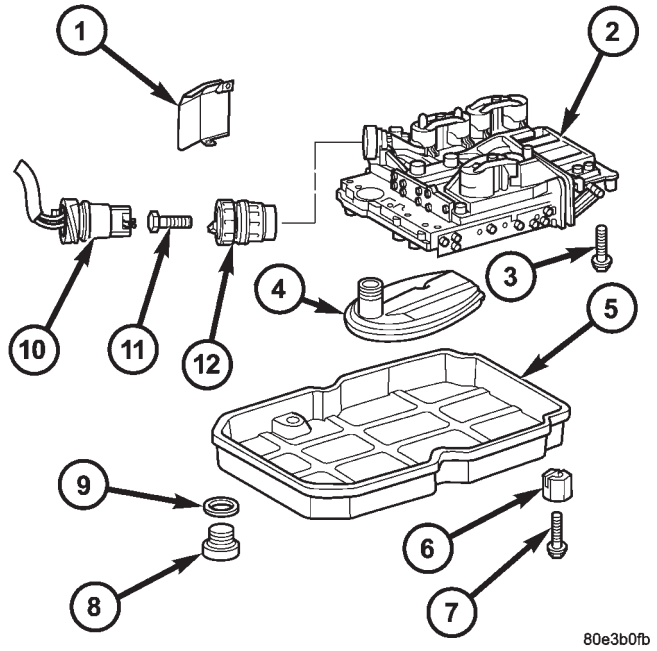


Fig. 25 Remove Electrohydraulic Unit

1 - HEAT SHIELD
2 - ELECTROHYDRAULIC UNIT
3 - BOLT
4 - OIL FILTER
5 - OIL PAN
6 - CLAMPING ELEMENT
7 - BOLT
8 - DRAIN PLUG
9 - DRAIN PLUG GASKET
10 - 13-PIN PLUG CONNECTOR
11 - BOLT
12 - GUIDE BUSHING

(12) Remove the transmission rear output shaft bearing retaining ring (1) (Fig. 26).

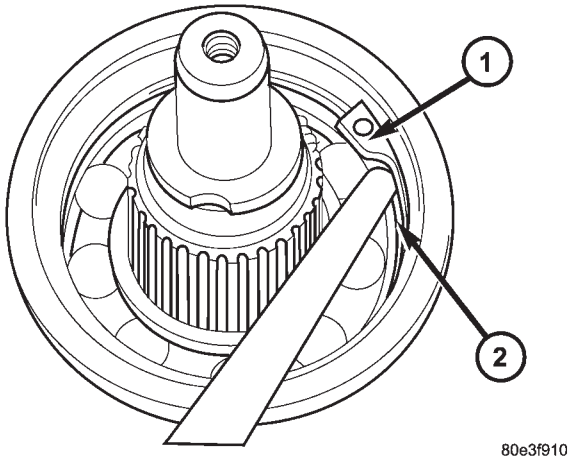


Fig. 26 Remove Rear Output Shaft Retaining Ring - Typical

1 - RETAINING RING
2 - OUTPUT SHAFT BEARING

AUTOMATIC TRANSMISSION - W5J400 (Continued)

(13) Assemble Puller, Size 5, 8903 (Fig. 27) and Bearing Puller Adapter 8904 onto the output shaft and output shaft bearing.

(14) Remove the output shaft bearing (Fig. 28).

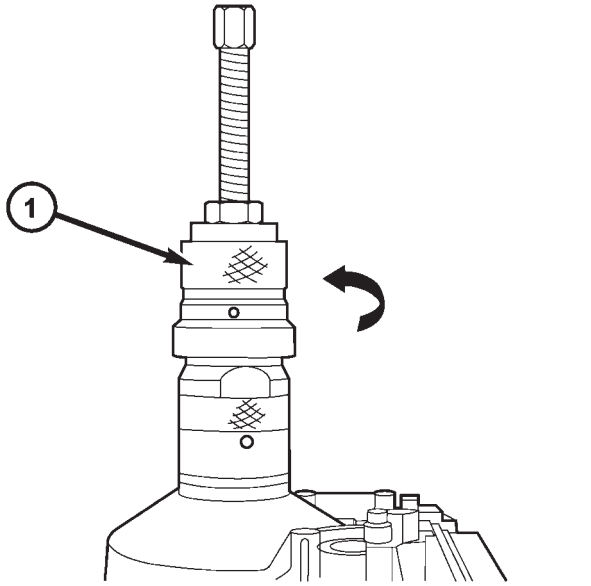


Fig. 27 Assemble Special Tool To Remove Output Shaft Rear Bearing

1 - PULLER, SIZE 5, 8903 AND BEARING PULLER ADAPTER 8904

(15) Remove the output shaft end-play shim from the output shaft.

(16) Remove the bolts holding the transmission housing to the converter housing from inside the converter housing.

(17) Stand the transmission upright on the converter housing. Be sure to use suitable spacers between the bench surface and the converter housing since the input shaft protrudes past the front surface of the housing.

(18) Remove the remaining bolts holding the transmission housing to the converter housing.

(19) Remove the transmission housing from the converter housing.

(20) Remove output shaft with center and rear gear set and clutch K3 (3) (Fig. 29).

(21) Remove thrust needle bearing (4) and thrust washer (5) (Fig. 29).

(22) Remove drive shaft with clutch K2 and front gear set (6).

(23) Remove clutch K1 (1).

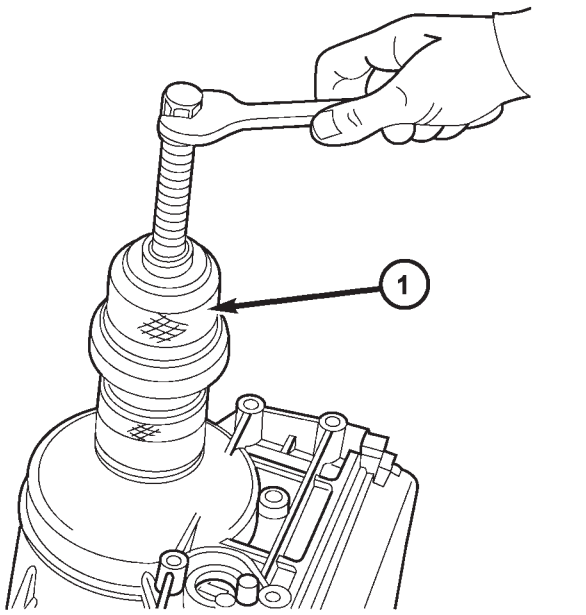


Fig. 28 Remove Output Shaft Rear Bearing

1 - PULLER, SIZE 5, 8903 AND BEARING PULLER ADAPTER 8904

(24) Unscrew Torx socket bolts (4) (Fig. 30) and remove oil pump (6). Screw two opposed bolts into the oil pump housing and press the oil pump out of the converter housing by applying light blows with a plastic hammer.

(25) Unscrew Torx socket bolts (1) (Fig. 30) and remove multiple-disc brake B1 (5) from converter housing. Screw two opposed bolts into the multiple-disc brake B1 (5) and separate from the converter housing by applying light blows with a plastic hammer.

(26) Detach intermediate plate (3) (Fig. 30) from converter housing (2).

(27) Remove multiple-disc pack B3 (2) (Fig. 31) and spring washer (3) by removing snap-ring (1) in transmission housing. To facilitate removal of the snap-ring (1), compress the multiple-disc pack B3 (2).

(28) Unscrew Torx socket bolts (7) (Fig. 31).

(29) Remove multiple-disc brake B2 (4) (Fig. 31) from transmission housing. The externally toothed disc carrier for multiple-disc holding clutch B2 is also the piston for multiple-disc holding clutch B3.

(30) Remove parking lock gear (5) (Fig. 31).

AUTOMATIC TRANSMISSION - W5J400 (Continued)

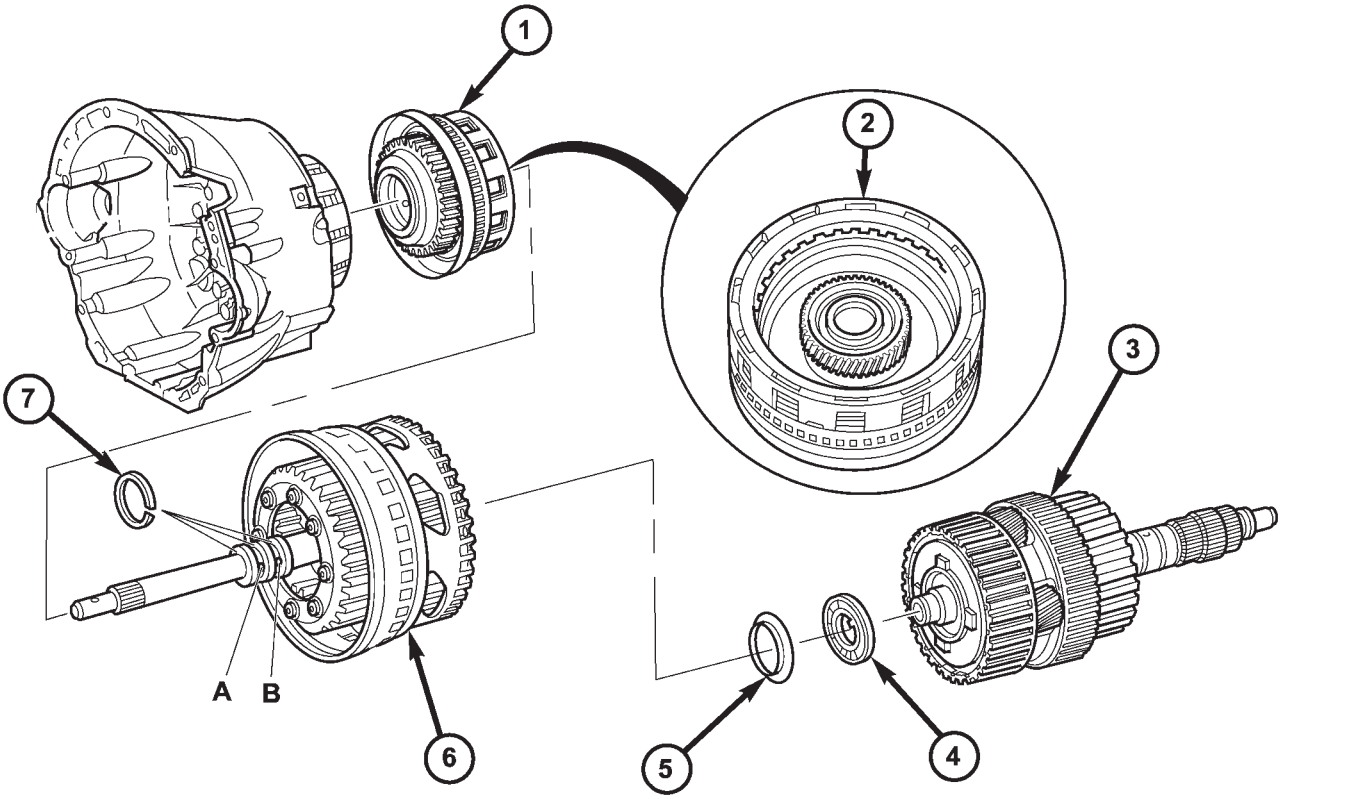


Fig. 29 Remove K1, K2, and K3 Clutches

1 - DRIVING CLUTCH K1
2 - SUN GEAR OF FRONT PLANETARY GEAR SET
3 - DRIVING CLUTCH K3, OUTPUT SHAFT , AND CENTER AND REAR PLANETARY GEAR SETS
4 - THRUST NEEDLE BEARING
5 - THRUST WASHER
6 - FRONT PLANETARY GEAR SET, DRIVING CLUTCH K2, AND DRIVE SHAFT
7 - TEFLON RINGS

AUTOMATIC TRANSMISSION - W5J400 (Continued)

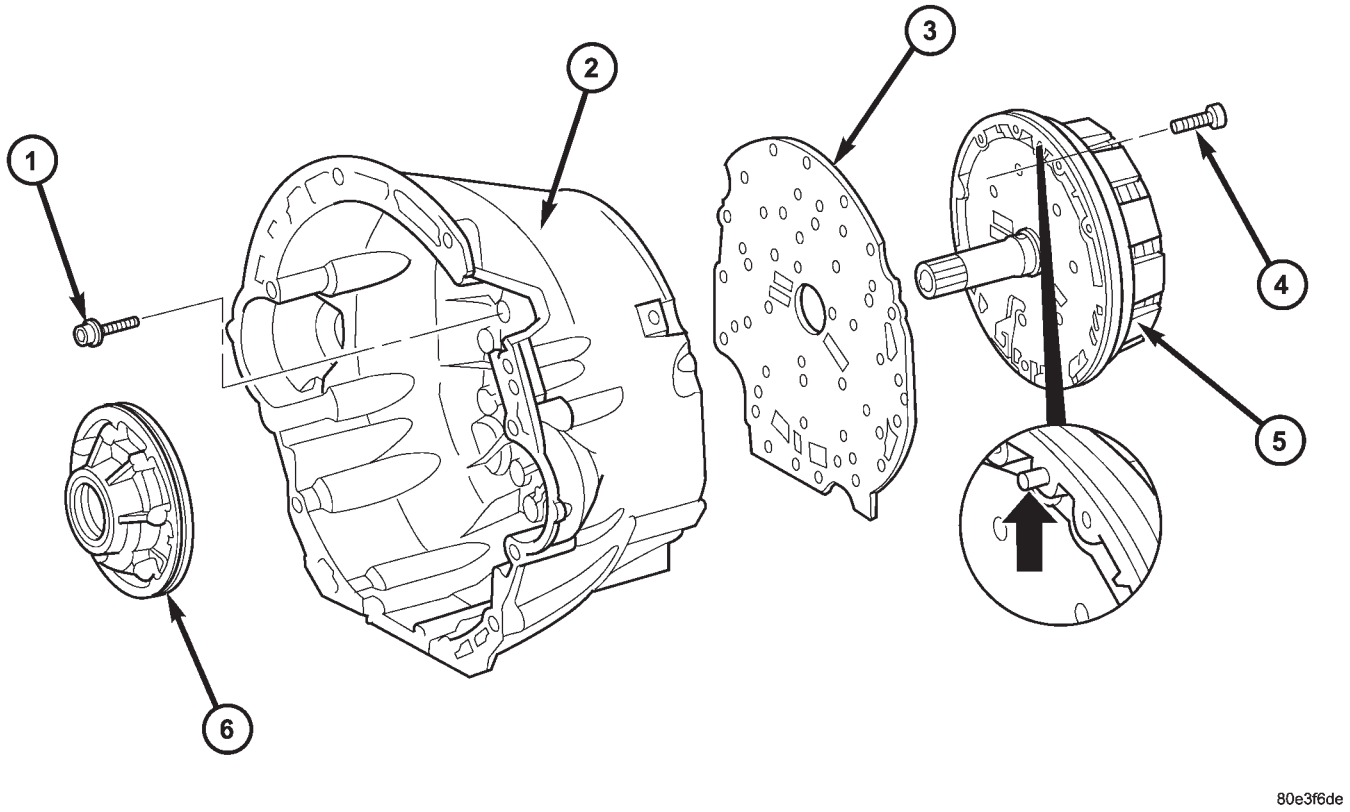


Fig. 30 Remove Holding Clutch B1 and Oil Pump

1 - BOLTS - M6X32
2 - CONVERTER HOUSING
3 - INTERMEDIATE PLATE
4 - BOLTS - M8X35
5 - HOLDING CLUTCH B1
6 - OIL PUMP

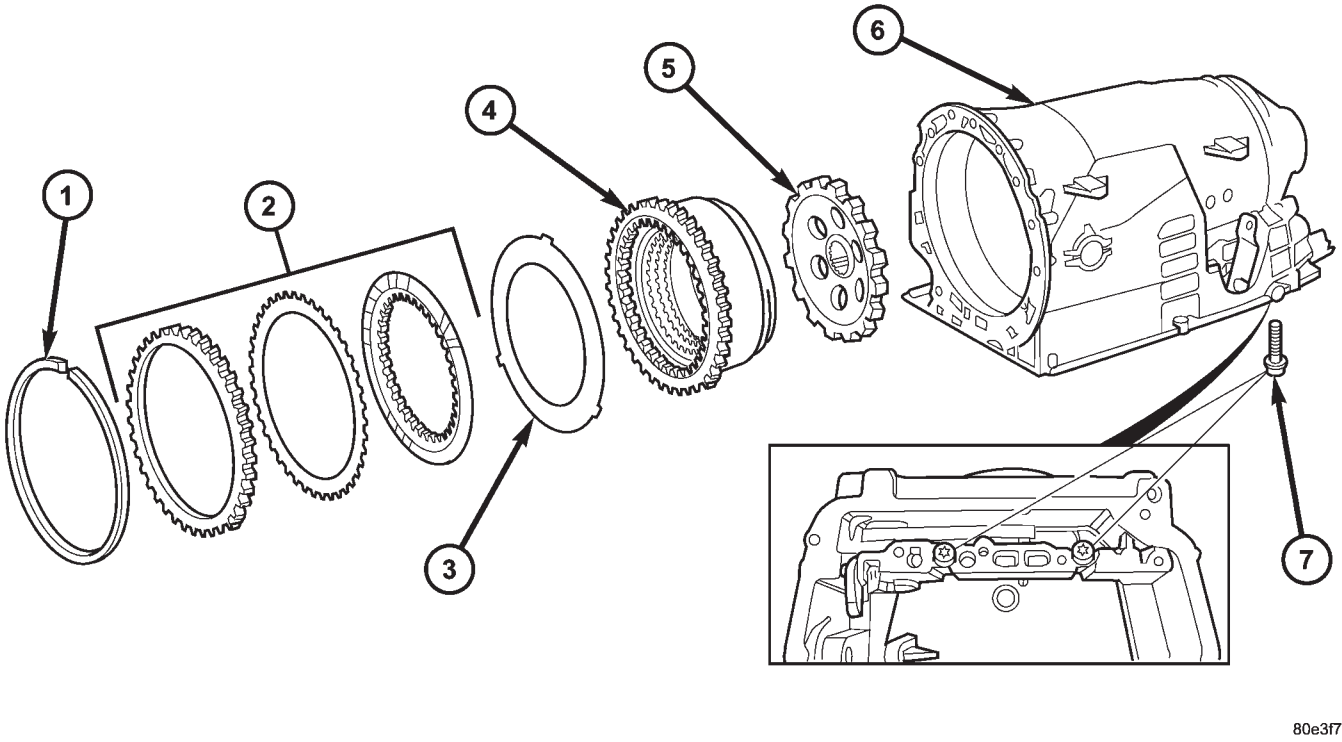


Fig. 31 Remove B2, B3, and Parking Gear

1 - SNAP-RING
2 - HOLDING CLUTCH B3 DISCS
3 - SPRING WASHER
4 - HOLDING CLUTCH B2
5 - PARK GEAR
6 - TRANSMISSION HOUSING
7 - BOLTS - M8X60

ASSEMBLY

(1) Insert parking lock gear (5) (Fig. 32).

(2) Install multiple-disc holding clutch B2 (4) in transmission housing (6) (Fig. 32).

(3) Screw in Torx socket bolts (7). Tighten the bolts to 16 N·m.

NOTE: During the measurement the snap ring (7) (Fig. 33) must contact the upper bearing surface of the groove in the outer multiple-disc carrier (8).

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

(4) Insert and measure spring washer (4) (Fig. 33) and multiple-disc pack B3 (2, 6).

(a) Put multiple-discs for multiple-disc brake B3 together in the sequence shown in the illustration and insert individually.

(b) Using a feeler gauge, determine the play ″L″ at three points between the snap ring (7) and outer multiple-disc (1). B3 clutch clearance should be 1.0-1.4 mm. Adjust the clearance as necessary.

(c) Adjust with snap-ring (7), if necessary. Snap rings are available in thicknesses of 3.2, 3.5, 3.8, 4.1 4.4 and 4.7 mm..

(5) Place intermediate plate (3) on converter housing (2) and align.

NOTE: The intermediate panel can generally be used several times. The panel must not be coated with sealant

(6) Check that the K1 clutch feed hole (Fig. 34) in the inner hub of clutch B1 is free before installing clutch B1.

(7) Install the holding clutch B1 (5) (Fig. 35) onto the converter housing and intermediate plate. Installed position of clutch B1 in relation to converter housing is specified by a plain dowel pin in clutch B1 (arrow).

(8) Install the bolts to hold clutch B1 (5) (Fig. 35) to the converter housing.

(9) Securely tighten multiple-disc brake B1 (5) on converter housing (2) to 10 N·m.

(10) Install new seals on the oil pump (Fig. 36).

(11) Install oil pump (6) and securely tighten. Tighten the oil pump bolts to 20 N·m.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

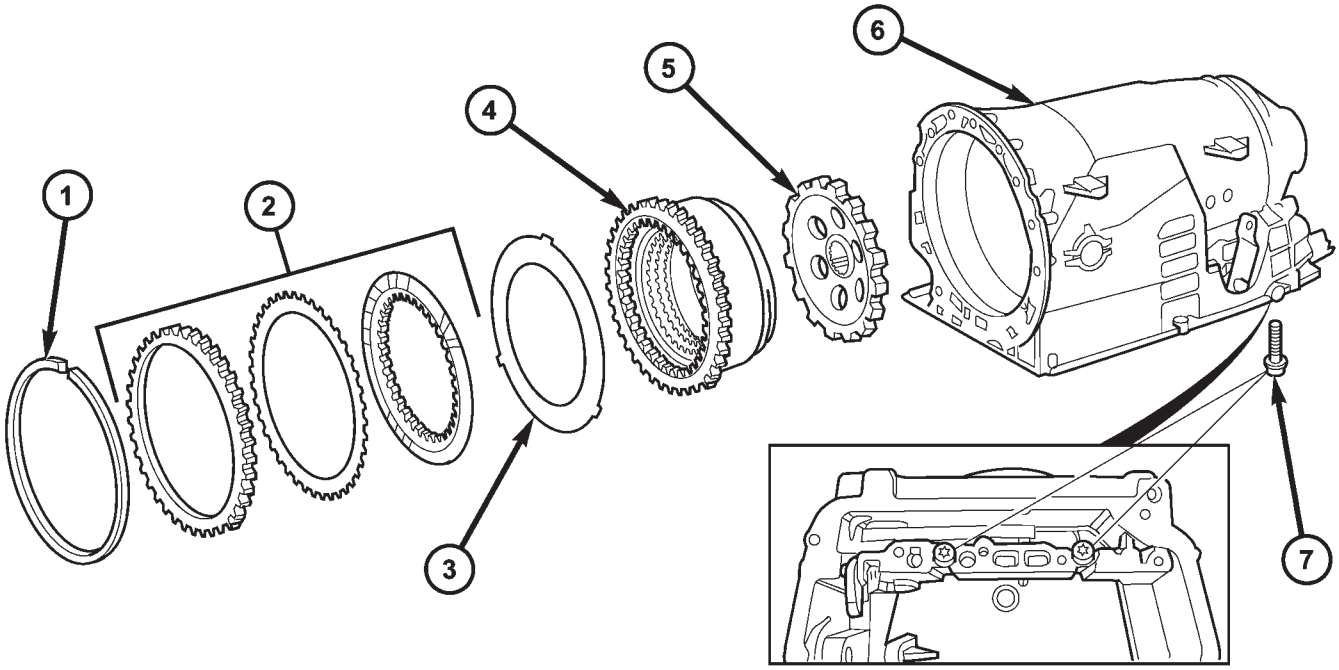


Fig. 32 Install B2, B3, and Parking Gear

1 - SNAP-RING
2 - HOLDING CLUTCH B3 DISCS
3 - SPRING WASHER
4 - HOLDING CLUTCH B2
5 - PARK GEAR
6 - TRANSMISSION HOUSING
7 - BOLTS - M8X60

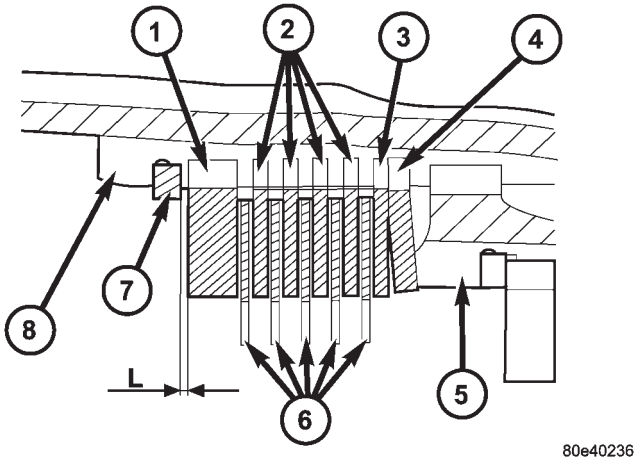


Fig. 33 Measure B3 Clutch Clearance

1 - OUTER DISC - 6.5 MM
2 - OUTER DISCS - 1.8 MM
3 - OUTER DISCS - 1.8 MM
4 - SPRING WASHER
5 - PISTON
6 - FRICTION DISCS
7 - SNAP-RING
8 - B3 DISC CARRIER

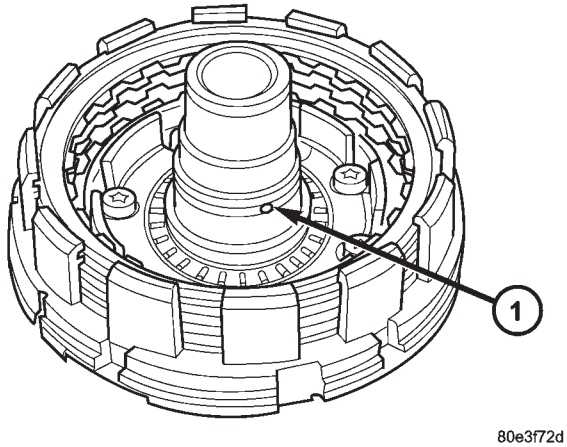


Fig. 34 Check K1 Feed Hole

1 - K1 CLUTCH FEED HOLE

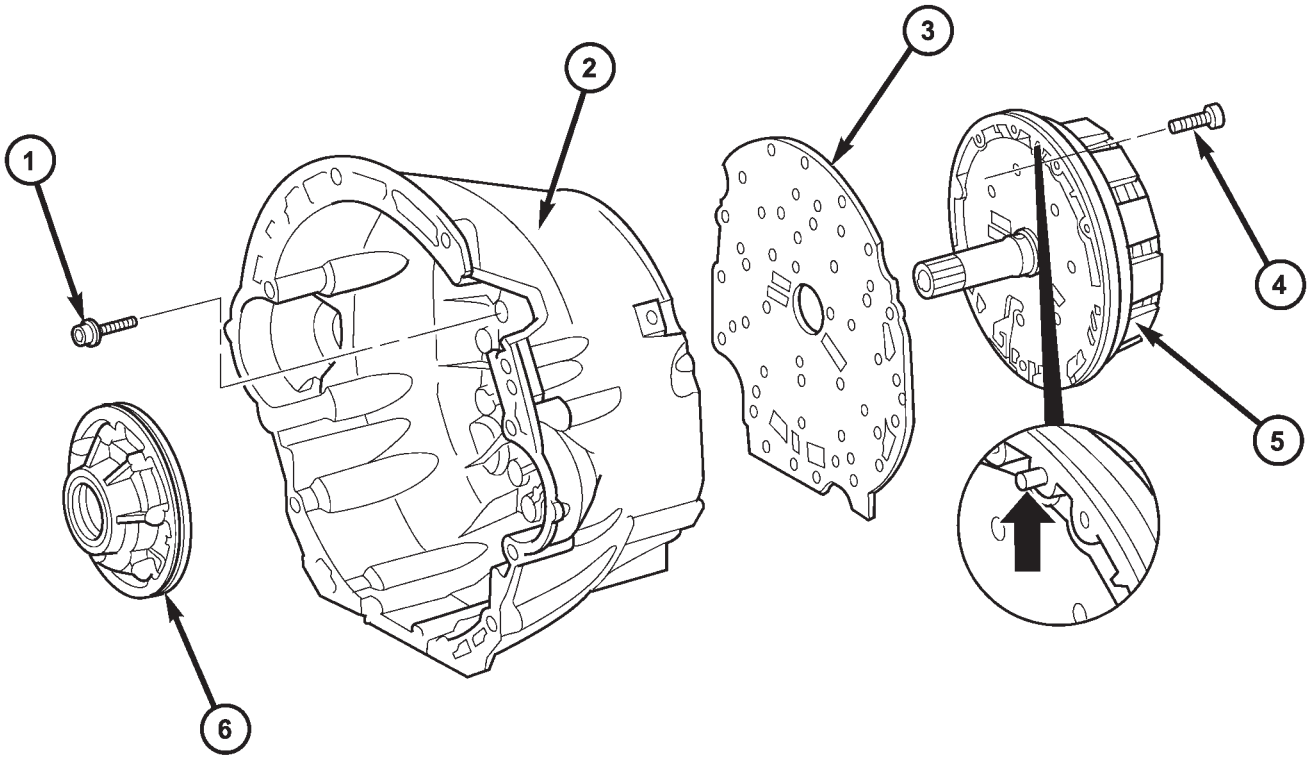


Fig. 35 Install Holding Clutch B1 and Oil Pump

1 - BOLTS - M6X32
2 - CONVERTER HOUSING
3 - INTERMEDIATE PLATE
4 - BOLTS - M8X35
5 - HOLDING CLUTCH B1
6 - OIL PUMP

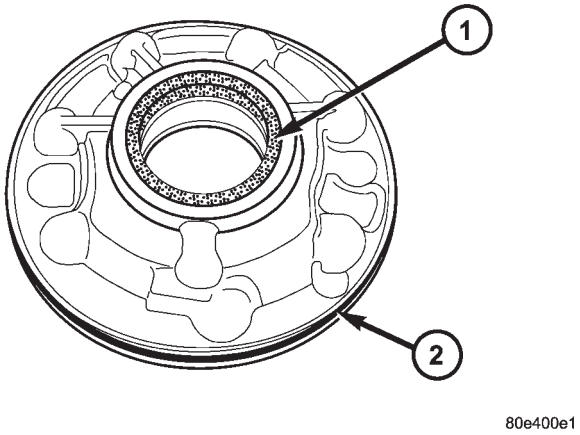


Fig. 36 Install New Oil Pump Seals

1 - INNER OIL SEAL
2 - OUTER OIL SEAL

(12) Using grease, insert Teflon rings (7) (Fig. 37) in the groove so that the joint remains together

(13) Mount clutch K1 (1) (Fig. 37).

(14) Install drive shaft with clutch K2 (6) and front gear set (1) (Fig. 37).

(15) Install front washer (5) and thrust needle bearing (4) (Fig. 37).

(16) Install output shaft with center and rear gear set and clutch K3 (3) (Fig. 37).

(17) Using grease, install both Teflon rings in the groove at the rear of the output shaft so that the joint stays together.

(18) Mount transmission housing on converter housing.

(19) Screw in Torx socket bolts through the transmission housing into the converter housing. Tighten the bolts to 20 N·m.

(20) Measure end play between park pawl gear and grooved ball bearing.

(a) Place Parallel Rest 8906 (1) on transmission housing. Using the depth gauge, measure from the parallel rest (1) to the parking lock gear (2) (Fig. 38).

AUTOMATIC TRANSMISSION - W5J400 (Continued)

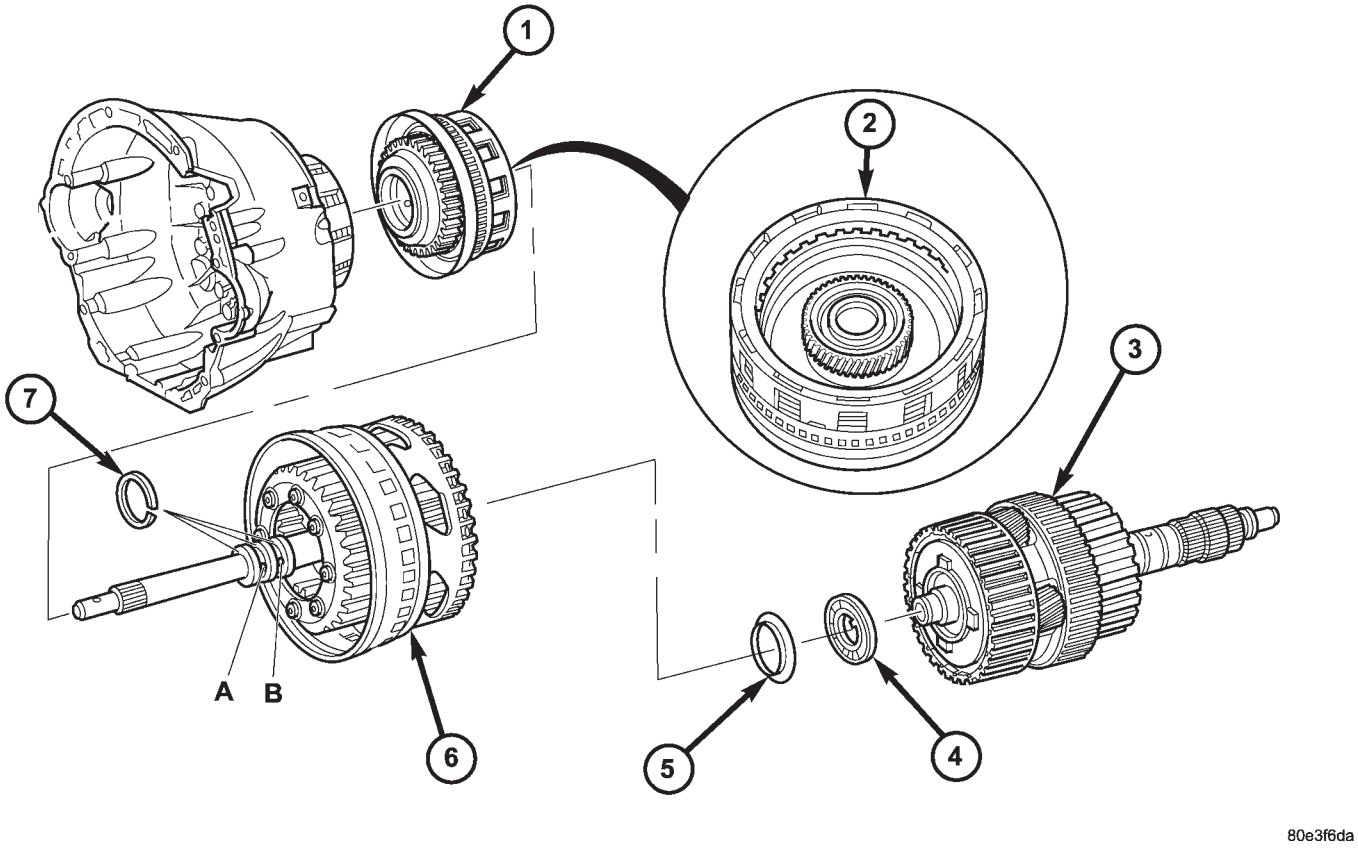


Fig. 37 Install K1, K2, and K3 Clutches

1 - DRIVING CLUTCH K1
2 - SUN GEAR OF FRONT PLANETARY GEAR SET
3 - DRIVING CLUTCH K3, OUTPUT SHAFT , AND CENTER AND REAR PLANETARY GEAR SETS
4 - THRUST NEEDLE BEARING
5 - THRUST WASHER
6 - FRONT PLANETARY GEAR SET, DRIVING CLUTCH K2, AND DRIVE SHAFT
7 - TEFLON RINGS

(b) Using the depth gauge, measure from the Parallel Rest 8906 (1) to the contact surface of the output shaft bearing (2) in the transmission housing (Fig. 39).

(c) Subtract the first figure from the second figure to determine the current end-play of the transmission. Select a shim such that the end-play will be 0.3-0.5 mm. Shims are available in thicknesses of 0.2, 0.3, 0.4 and 0.5 mm.

(d) Install the selected shim.

(21) Screw in Torx socket bolts through the converter housing into the transmission housing. Tighten the bolts to 20 N·m.

(22) Install output shaft bearing in rear transmission housing.

(a) Using a suitable alignment tool, press the output shaft bearing into the transmission housing. The closed side of the plastic cage must point towards the parking lock gear.

(b) Install the retaining ring (Fig. 40). Ensure that the retaining ring is seated correctly in the groove.

(c) Check that there is no play between the bearing and the retaining ring using feeler gauge.

(d) There must be no play between the retaining ring and the bearing. If the ring cannot be installed, a thinner ring must be used. If there is play between the ring and the bearing, a thicker ring must be installed. Retaining rings are available in thicknesses of 2.0, 2.1 and 2.2 mm.

(23) Install the rear output shaft shim onto the output shaft.

(24) Install a new transmission rear seal into the transmission case with Drift Punch 8902.

(25) Install the output shaft extension onto the output shaft.

(26) Install the bolt to hold the output shaft extension to the output shaft. Torque the bolt to 120 N·m (88 ft.lbs.).

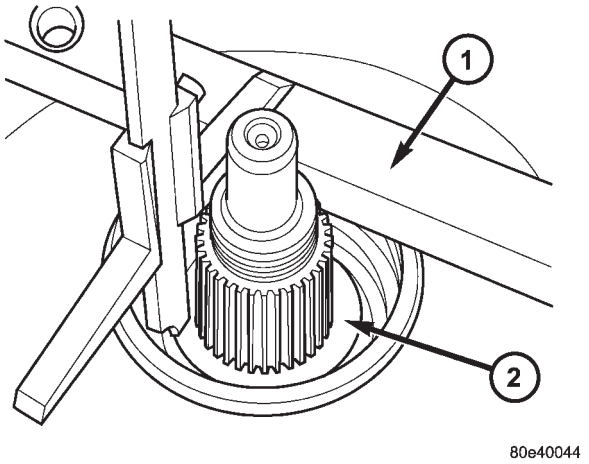


Fig. 38 Measure From Transmission Housing to Park Gear

1 - PARALLEL REST 8906
2 - PARK GEAR

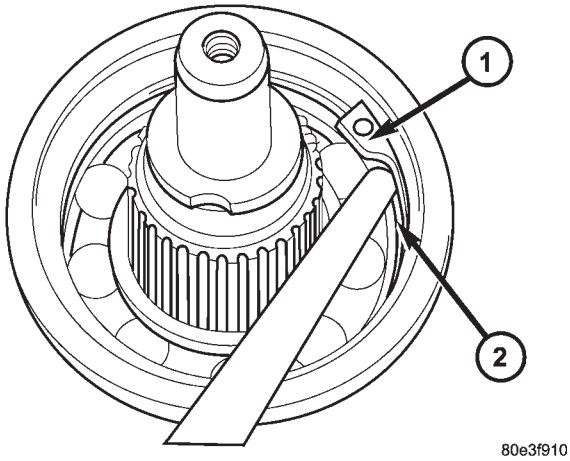


Fig. 40 Install Rear Output Shaft Retaining Ring - Typical

1 - RETAINING RING
2 - OUTPUT SHAFT BEARING

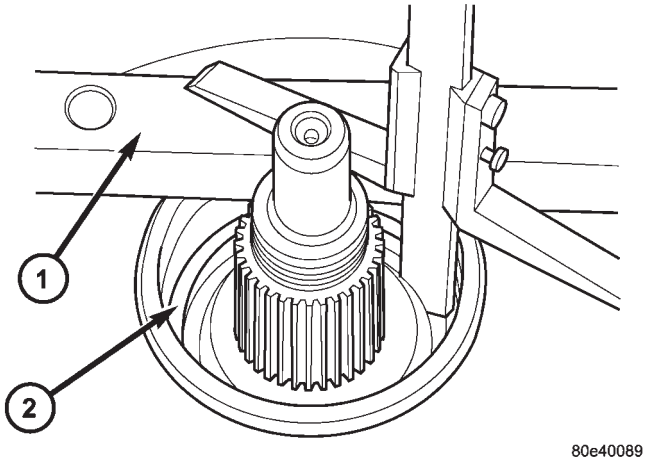


Fig. 39 Measure From Transmission Housing To Rear Bearing Contact Surface

1 - PARALLEL REST 8906
2 - OUTPUT SHAFT BEARING CONTACT SURFACE

(27) Install the transfer case adapter housing onto the transmission case.

(28) Install the bolts to hold the transfer case adapter housing onto the transmission case. Torque the bolt to 20 N·m (177 in.lbs.).

(29) Install electrohydraulic unit (2). Tighten the bolts to 8 N·m.

(30) Install oil filter (4) (Fig. 41).

(31) Install oil pan (5) (Fig. 41). Tighten the bolts to 8 N·m.

(32) Install guide bushing (12) (Fig. 41).

(33) Install the torque converter (Fig. 42).

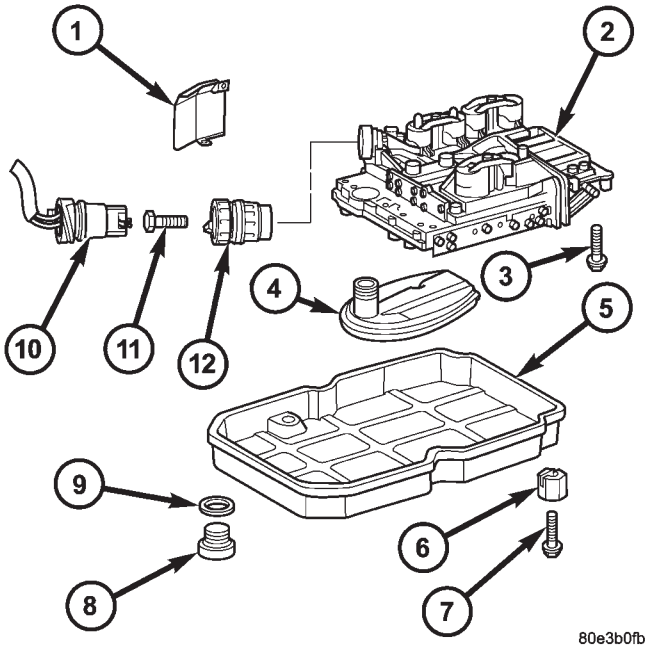


Fig. 41 Install Electrohydraulic Unit

1 - HEAT SHIELD
2 - ELECTROHYDRAULIC UNIT
3 - BOLT
4 - OIL FILTER
5 - OIL PAN
6 - CLAMPING ELEMENT
7 - BOLT
8 - DRAIN PLUG
9 - DRAIN PLUG GASKET
10 - 13-PIN PLUG CONNECTOR
11 - BOLT
12 - GUIDE BUSHING

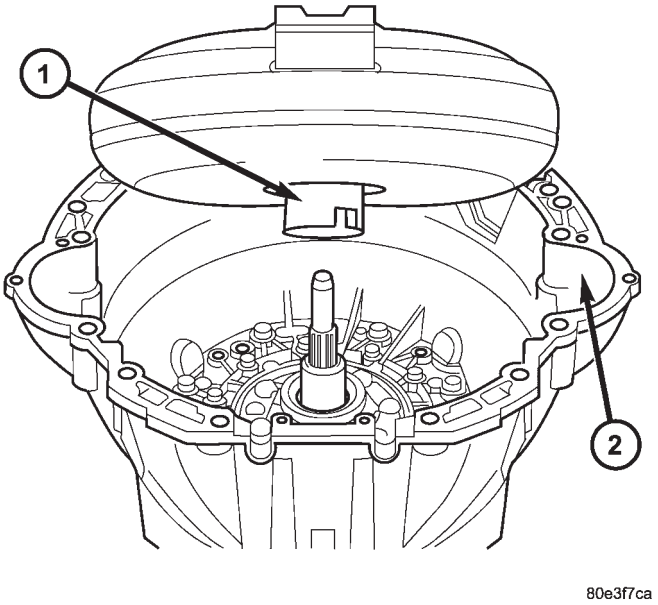


Fig. 42 Install Torque Converter

1 - TORQUE CONVERTER
2 - CONVERTER HOUSING

INSTALLATION

(1) Check torque converter hub and hub drive flats for sharp edges burrs, scratches, or nicks. Polish the hub and flats with 320/400 grit paper and crocus cloth if necessary. The hub must be smooth to avoid damaging pump seal at installation.

(2) If a replacement transmission is being installed, transfer any components necessary, such as the manual shift lever and shift cable bracket, from the original transmission onto the replacement transmission.

(3) Lubricate oil pump seal lip with transmission fluid.

(4) Place torque converter in position on transmission.

CAUTION: Do not damage oil pump seal or converter hub while inserting torque converter into the front of the transmission.

(5) Align torque converter to oil pump seal opening.

(6) Insert torque converter hub into oil pump.

(7) While pushing torque converter inward, rotate converter until converter is fully seated in the oil pump gears.

(8) Check converter seating with a scale and straightedge (Fig. 43). Surface of converter lugs should be at least 19 mm (3/4 in.) to rear of straightedge when converter is fully seated.

(9) If necessary, temporarily secure converter with C-clamp attached to the converter housing.

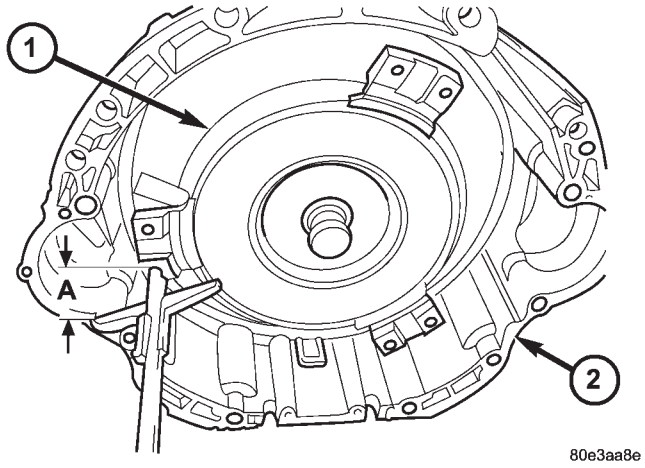


Fig. 43 Torque Converter Installation Depth

1 - TORQUE CONVERTER
2 - TRANSMISSION HOUSING

(10) 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 hold transmission in alignment.**

(11) Apply a light coating of Mopar® High Temp Grease to the torque converter hub pocket in the rear pocket of the engine's crankshaft.

(12) Raise transmission and align the torque converter with the drive plate and the transmission converter housing with the engine block.

(13) Move transmission forward. Then raise, lower, or tilt transmission to align the converter housing with the engine block dowels.

(14) Carefully work transmission forward and over engine block dowels until converter hub is seated in crankshaft. Verify that no wires, or the transmission vent hose, have become trapped between the engine block and the transmission.

(15) Install two bolts to attach the transmission to the engine.

(16) Install remaining torque converter housing to engine bolts. Tighten to 39 N·m (29 ft.lbs.).

(17) Install rear transmission crossmember. Tighten crossmember to frame bolts to 68 N·m (50 ft.lbs.).

(18) Install rear support to transmission. Tighten bolts to 47 N·m (35 ft.lbs.).

(19) Lower transmission onto crossmember and install bolts attaching transmission mount to crossmember. Tighten clevis bracket to crossmember bolts to 47 N·m (39 ft.lbs.). Tighten the clevis bracket to rear support bolt to 68 N·m (50 ft.lbs.).

(20) Remove engine support fixture.

(21) Connect gearshift cable to transmission.

(22) Check O-ring on plug connector (1) (Fig. 44), and replace if necessary.

(23) Install the plug connector (1) into the guide bushing (2). Turn bayonet lock of guide bushing (2) clockwise to connect plug connector (1).

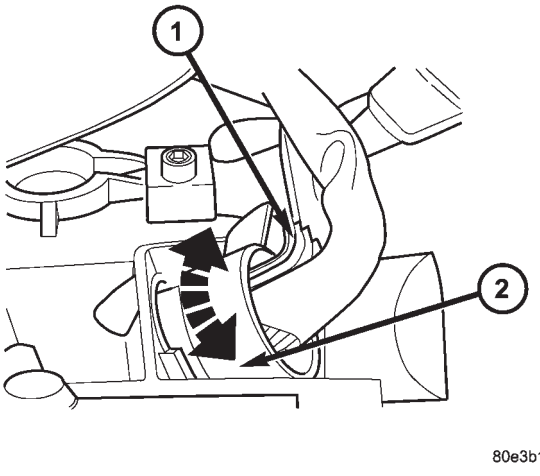


Fig. 44 Install Wiring Connector Plug

1 - PLUG CONNECTOR
2 - GUIDE BUSHING

(24) Position the heat shield (2) (Fig. 45) onto the transmission housing and install the screw (1) and bolt (3) to hold the shield in place.

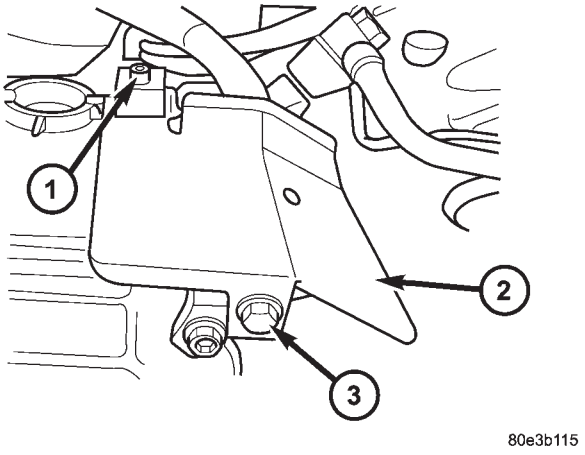


Fig. 45 Install Heat Shield

1 - SCREW
2 - HEAT SHIELD
3 - BOLT

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.

(25) Install all torque converter-to-driveplate bolts by hand.

(26) Verify that the torque converter is pulled flush to the driveplate. Tighten bolts to 42 N·m (30.5 ft. lbs.).

(27) Install the torque converter bolt access plug into the engine adapter.

(28) Install starter motor.

(29) Connect cooler lines to transmission.

(30) Install transmission fill tube.

(31) Install exhaust components.

(32) Install transfer case. Tighten transfer case nuts to 35 N·m (26 ft.lbs.).

(33) Install the transfer case shift cable to the cable support bracket and the transfer case shift lever.

(34) Align and connect propeller shafts.

(35) Adjust gearshift cable if necessary.

(36) Lower vehicle.

(37) Connect negative battery cable.

(38) Fill transmission with Shell® 3403 Automatic Transmission fluid (Refer to 21 - TRANSMISSION/ AUTOMATIC - W5J400/FLUID - STANDARD PROCEDURE).

(39) Verify proper operation.

AUTOMATIC TRANSMISSION - W5J400 (Continued)

SPECIFICATIONS - W5J400 AUTOMATIC TRANSMISSION

GEAR RATIOS

1ST	3.59:1
2ND	2.19:1
3RD	1.41:1
4TH	1.00:1
5TH	0.83:1
REVERSE	3.16:1
REVERSE (4WD Low)	1.93:1

SPECIFICATIONS

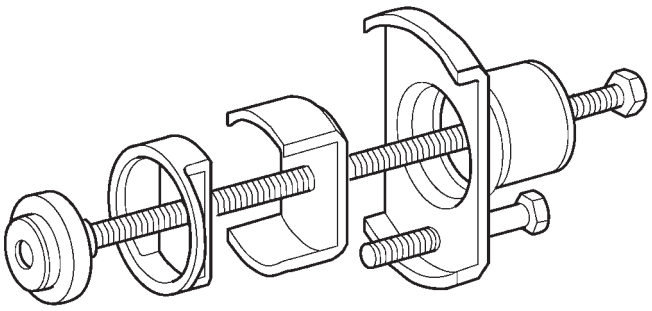
COMPONENT		METRIC (mm)
Output Shaft End-play		0.3-0.5
Output Shaft End-play Snap-rings		0.2, 0.3, 0.4, and 0.5
Rear Planetary Gear Set End-play		0.15-0.6
Rear Planetary Gear Set Snap-rings		3.0, 3.4, and 3.7
B1 Clutch Clearance	2 Disc	2.3-2.7
	3 Disc	2.7-3.1
	4 Disc	3.0-3.4
B1 Clutch Snap-rings		2.6, 2.9, 3.2, 3.5, 3.8, and 4.1
B2 Clutch Clearance	4 Disc	1.9-2.3
	5 Disc	2.0-2.4
B2 Clutch Snap-rings		2.9, 3.2, 3.5, 3.8, and 4.1
B3 Clutch Clearance		1.0-1.4
B3 Clutch Snap-rings		3.2, 3.5, 4.1, 4.4, and 4.7
K1 Clutch Clearance	3 Disc	2.7-3.1
	4 Disc	3.0-3.4
	5 Disc	3.3-3.7
	6 Disc	3.6-4.0
K1 Clutch Snap-rings		2.6, 2.9, 3.2, 3.5, 3.8, and 4.1
K2 Clutch Clearance	3 Disc	2.3-2.7
	4 Disc	2.4-2.8
	5 Disc	2.5-2.9
	6 Disc	2.7-3.1
K2 Clutch Snap-rings		2.3, 2.6, 2.9, 3.2, 3.5, and 3.8
K3 Clutch Clearance	3 Disc	2.3-2.7
	4 Disc	2.4-2.8
	5 Disc	2.5-2.9
K3 Clutch Snap-rings		2.0, 2.3, 2.6, 2.9, 3.2, and 3.5

TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Bolt, B2 Clutch Carrier	16	12.5	-
Bolt, B1 Carrier to Converter Housing	10	7.5	-
Bolt, Output Shaft Extension	120	88	-
Bolt, Transfer Case Adapter Housing	20	-	177
Bolt, Electrohydraulic Unit	8	-	70
Bolt, Transmission Housing to Converter Housing	20	15	-
Bolts, Oil Pan	8	-	70
Screws, Valve Body/Housing Side Cover	4	-	35
Bolt, Shift Plate	8	-	70
Bolt, Solenoid Leaf Spring	8	-	70
Plug, Oil Pan Drain	20	15	-
Nut, Shifter Mechanism to Floor Pan	7	-	65
Screw, Gearshift Cable Adjustment	7	-	65

AUTOMATIC TRANSMISSION - W5J400 (Continued)

SPECIAL TOOLS - W5J400 AUTOMATIC TRANSMISSION



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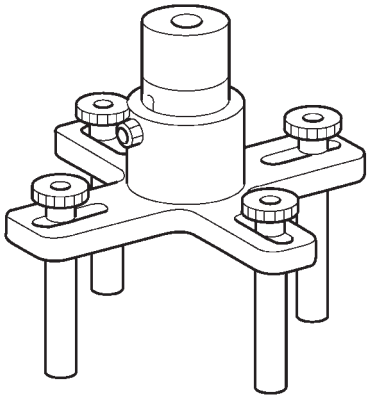
Compressor, Multi-use Spring - 8900



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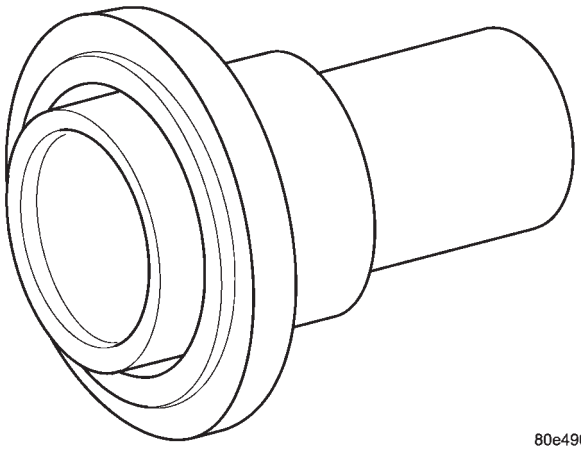
Tool, Pressing - 8901



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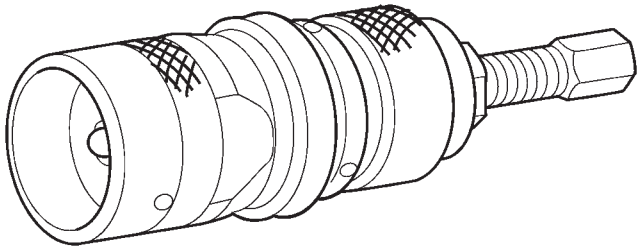
Punch, Drift - 8902



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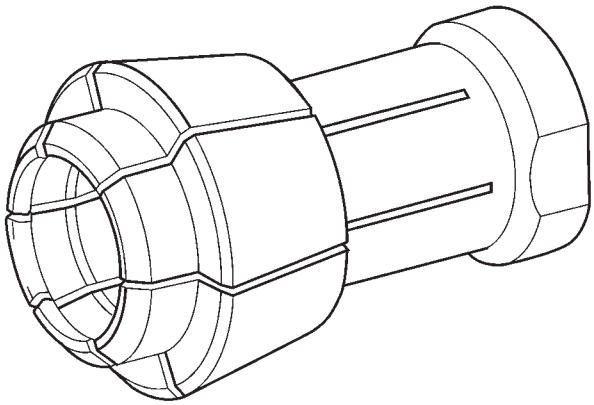
Puller, Size 5 - 8903



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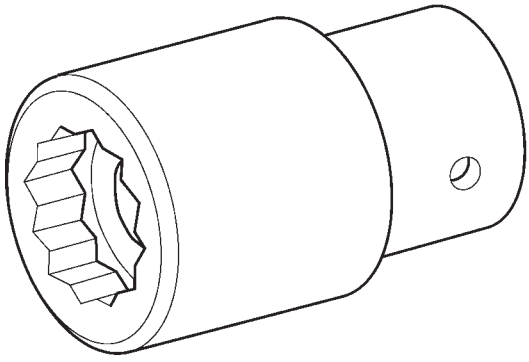
Adapter, Bearing Puller - 8904



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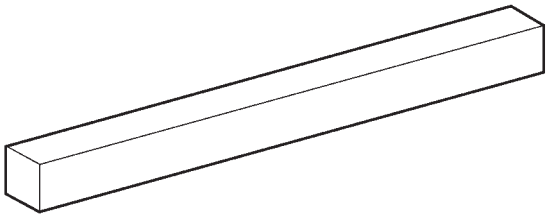
Socket - 8905

AUTOMATIC TRANSMISSION - W5J400 (Continued)



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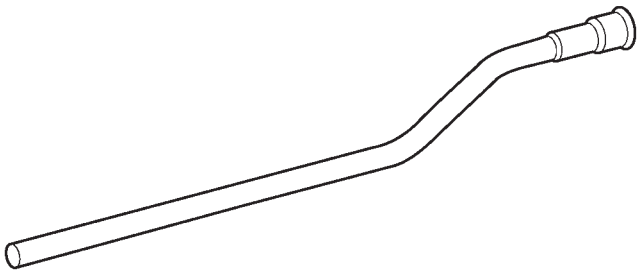
Parallel Rest - 8906



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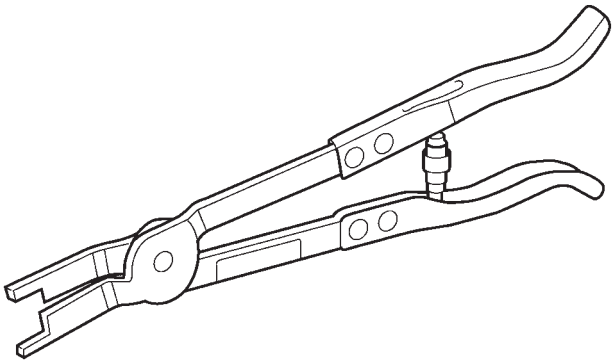
Tube, Filler - 8909



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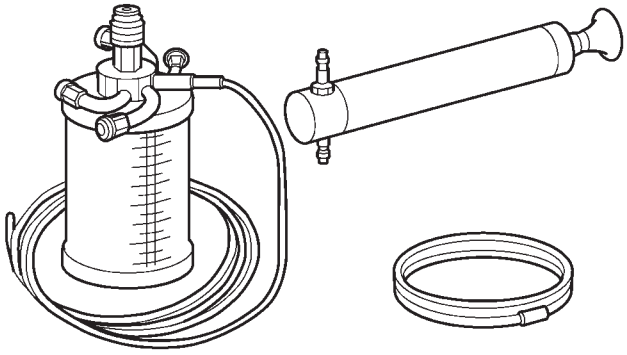
Pliers - 8907



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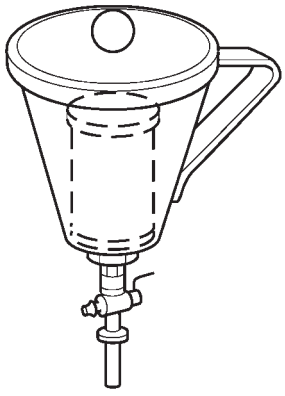
Pump - 8910



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Funnel - 8908

BRAKE TRANSMISSION SHIFT INTERLOCK MECHANISM

DESCRIPTION

The Brake Transmission Shifter/Ignition Interlock (BTSI), is a cable and solenoid operated system. It interconnects the automatic transmission floor mounted shifter to the steering column ignition switch (Fig. 46).

OPERATION

The system locks the shifter into the PARK position. The interlock system is engaged whenever the ignition switch is in the LOCK or ACCESSORY position. An additional electrically activated feature will prevent shifting out of the PARK position unless the brake pedal is depressed approximately one-half an inch. A magnetic holding device in the shifter assembly is energized when the ignition is in the RUN position. When the key is in the RUN position and the brake pedal is depressed, the shifter is unlocked and will move into any gear position. The interlock system also prevents the ignition switch from being turned to the LOCK or ACCESSORY position, unless the shifter is fully locked into the PARK position.

DIAGNOSIS AND TESTING - BRAKE TRANSMISSION SHIFT INTERLOCK

SYSTEM VERIFICATION

(1) Verify that the key can only be removed in the PARK position

(2) When the shift lever is in PARK And the shift handle pushbutton is in the “OUT” position, the ignition key cylinder should rotate freely from OFF to LOCK. When the shifter is in any other gear or neutral position, the ignition key cylinder should not rotate to the LOCK position.

(3) Shifting out of PARK should not be possible when the ignition key cylinder is in the OFF position.

(4) Shifting out of PARK should not be possible while applying normal pushbutton force and ignition key cylinder is in the RUN or START positions unless the foot brake pedal is depressed approximately 1/2 inch (12mm).

(5) Shifting out of PARK should not be possible when the ignition key cylinder is in the ACCESSORY or LOCK positions.

(6) Shifting between any gears, NEUTRAL or into PARK may be done without depressing foot brake pedal with ignition switch in RUN or START positions.

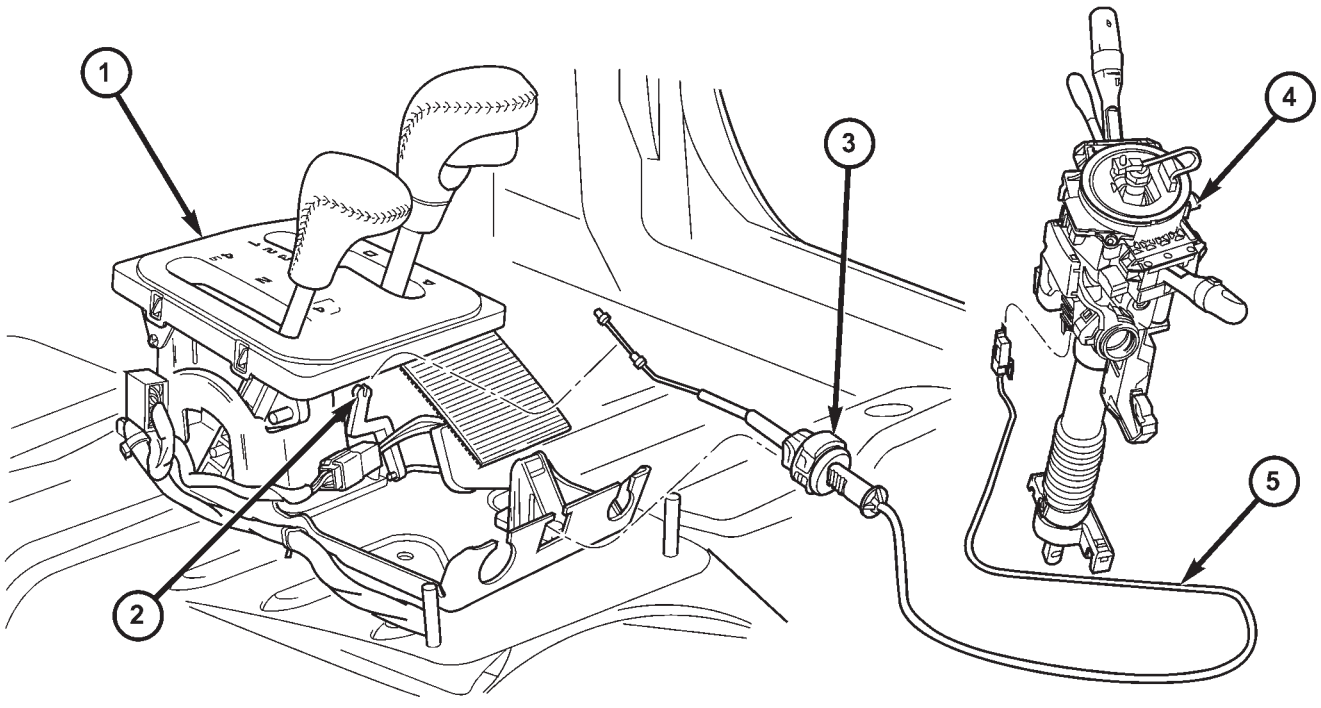

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Fig. 46 Ignition Interlock Cable

1 - SHIFT MECHANISM
2 - SHIFTER BTSI LEVER
3 - ADJUSTMENT CLIP
4 - STEERING COLUMN ASSEMBLY
5 - INTERLOCK CABLE

BRAKE TRANSMISSION SHIFT INTERLOCK MECHANISM (Continued)

DIAGNOSTIC CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
KEY WILL NOT ROTATE TO THE OFF/LOCK POSITION.	1. Misadjusted Park Lock cable.	1. Adjust Park Lock cable. (Refer to 21 - TRANSMISSION AND TRANSFER CASE/AUTOMATIC TRANSMISSION/BRAKE TRANSMISSION SHIFT INTERLOCK SYSTEM - ADJUSTMENTS)
	2. Misadjusted gearshift cable.	2. Adjust gearshift cable. (Refer to 21 - TRANSMISSION AND TRANSFER CASE/AUTOMATIC TRANSMISSION/GEAR SHIFT CABLE - ADJUSTMENTS)
	3. Burrs on ignition key.	3. Remove burrs and cycle key several times to verify operation.
	4. Binding or broken components.	4. Inspect system components and repair/replace components as necessary.
VEHICLE WILL NOT START UNLESS SHIFTER IS HELD FORWARD OF THE PARK POSITION.	1. Misadjusted gearshift cable.	1. Adjsut gearshift cable. (Refer to 21 - TRANSMISSION AND TRANSFER CASE/AUTOMATIC TRANSMISSION/GEAR SHIFT CABLE - ADJUSTMENTS)

ADJUSTMENTS - BRAKE TRANSMISSION SHIFT INTERLOCK

The park interlock cable is part of the brake/shift lever interlock system. Correct cable adjustment is important to proper interlock operation. The gear shift and park lock cables must both be correctly adjusted in order to shift out of PARK.

ADJUSTMENT PROCEDURE

(1) Remove floor console coin tray for access to the brake transmission shift interlock cable. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - REMOVAL)

(2) Shift the transmission into the PARK position.

(3) Turn ignition switch to LOCK position. **Be sure ignition key cylinder is in the LOCK position. Cable will not adjust correctly in any other position.**

(4) Pull cable lock button up to release cable (Fig. 47).

(5) Ensure that the cable is free to self-adjust by pushing cable rearward and releasing.

(6) Push lock button down until it snaps in place.

BTSI FUNCTION CHECK

(1) Verify removal of ignition key allowed in PARK position only.

(2) When the shift lever is in PARK, and the shift handle push-button is in the out position, the ignition key cylinder should rotate freely from off to lock. When the shifter is in any other position, the ignition key should not rotate from off to lock.

(3) Shifting out of PARK should be possible when the ignition key cylinder is in the off position.

BRAKE TRANSMISSION SHIFT INTERLOCK MECHANISM (Continued)

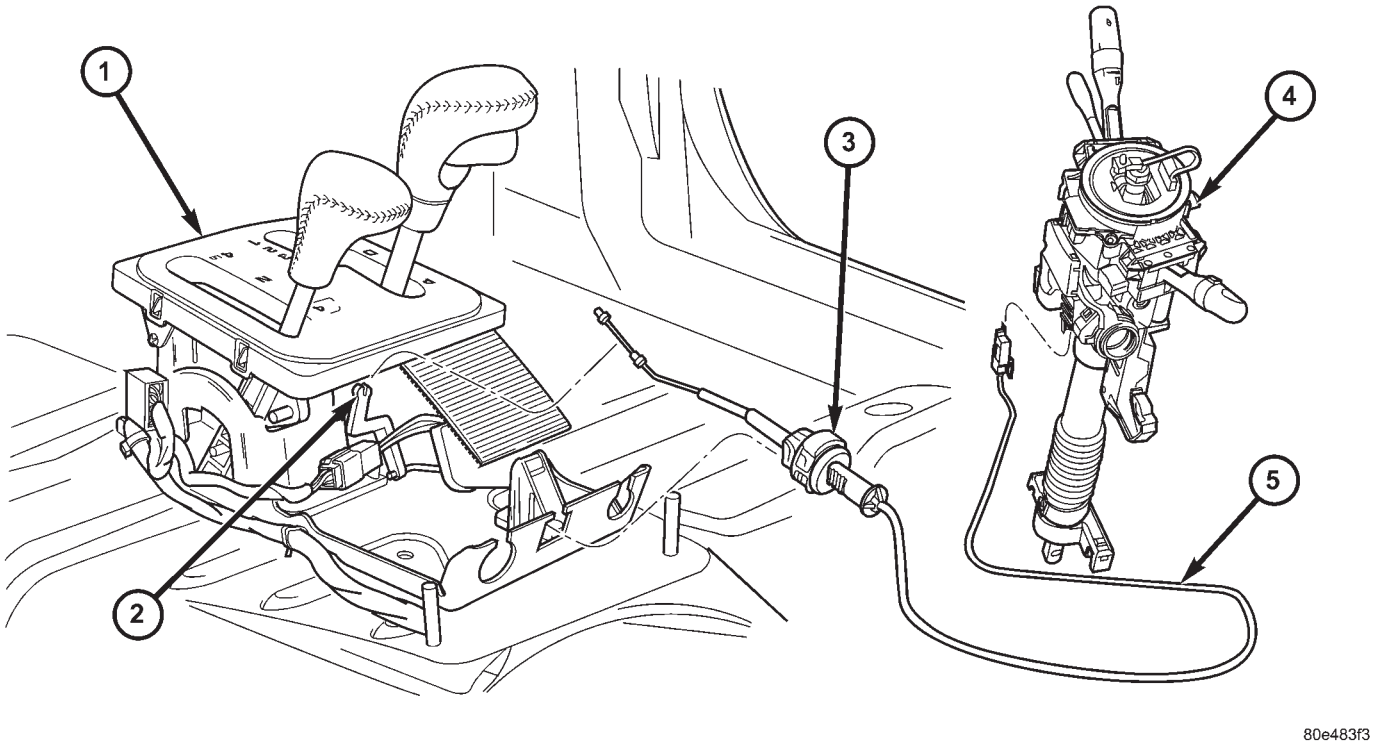

Fig. 47 Ignition Interlock Cable

1 - SHIFT MECHANISM
2 - SHIFTER BTSI LEVER
3 - ADJUSTMENT CLIP
4 - STEERING COLUMN ASSEMBLY
5 - INTERLOCK CABLE

(4) Shifting out of PARK should not be possible while applying normal push-button force, and ignition key cylinder is in the run or start positions, unless the foot brake pedal is depressed approximately 1/2 inch (12mm).

(5) Shifting out of PARK should not be possible when the ignition key cylinder is in the accessory or lock position.

(6) Shifting between any gear and NEUTRAL, or PARK, may be done without depressing foot brake with ignition switch in run or start positions.

(7) The floor shifter lever and gate positions should be in alignment with all transmission detent positions.

(8) Engine starts must be possible with shifter lever in PARK or NEUTRAL gate positions only. Engine starts must not be possible in any other gate positions other than PARK or NEUTRAL.

(9) With shifter lever handle push-button not depressed and lever detent in:

- PARK position- apply forward force on center of handle and remove pressure. Engine start must be possible.
- PARK position- apply rearward force on center of handle and remove pressure. Engine start must be possible.
- NEUTRAL position- engine start must be possible.
- NEUTRAL position, engine running and brakes applied- Apply forward force on center of shift handle. Transmission should not be able to shift into REVERSE detent.

DRIVING CLUTCHES

DESCRIPTION

Three multi-plate driving clutches (Fig. 48), the front, middle and rear multi-plate clutches K1, K2 and K3, are located in the planetary gear sets in the transmission housing.

A multi-plate driving clutch consists of a number of internally toothed discs (4) on an internally toothed disc carrier and externally toothed discs (3) on an externally toothed disc carrier.

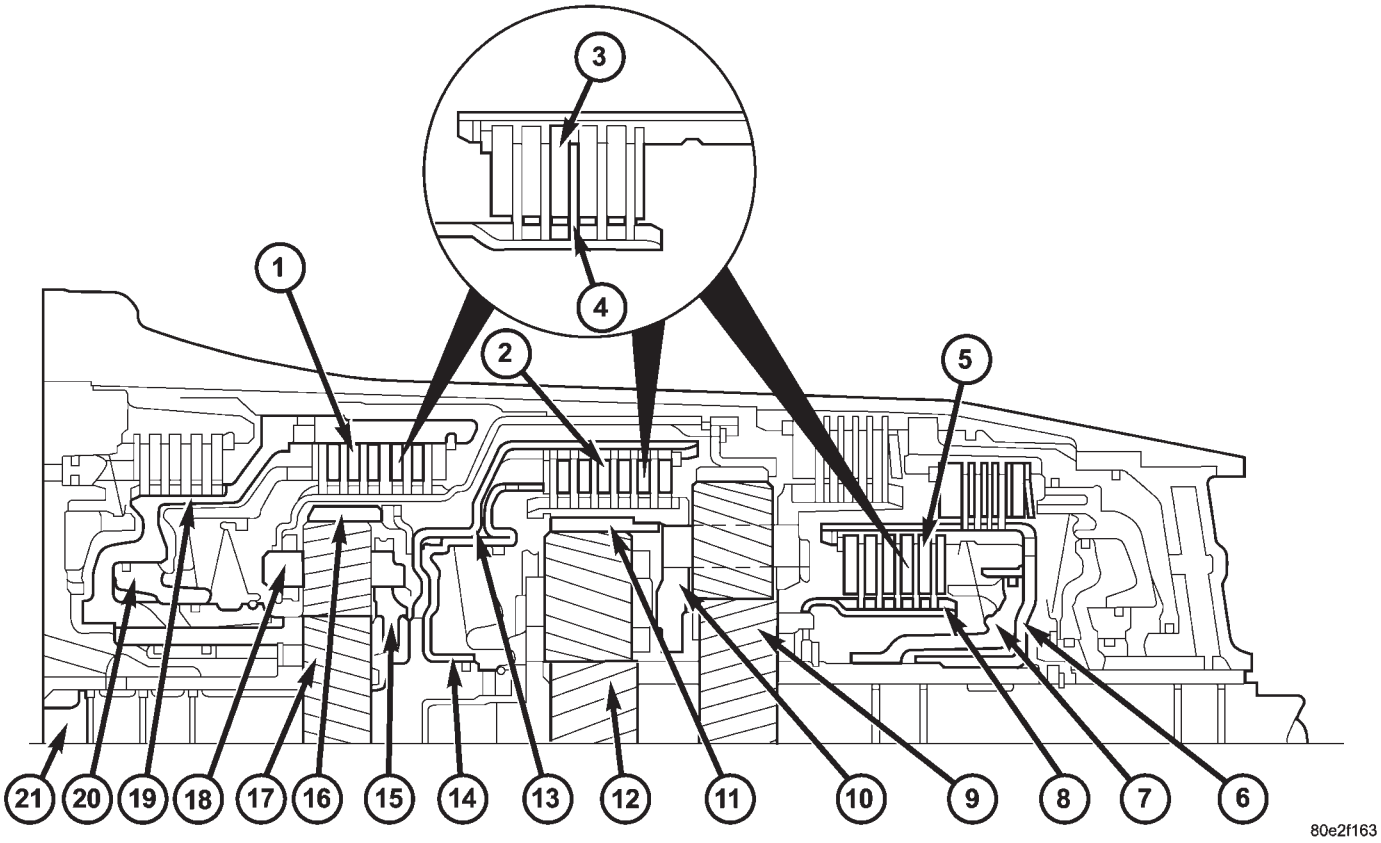

Fig. 48 Driving Clutches

1 - K1 CLUTCH
2 - K2 CLUTCH
3 - EXTERNALLY TOOTHED DISC
4 - INTERNALLY TOOTHED DISC
5 - K3 CLUTCH
6 - K3 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
7 - K3 CLUTCH PISTON
8 - K3 CLUTCH INTERNALLY TOOTHED DISC CARRIER
9 - REAR PLANETARY GEARSET SUN GEAR
10 - CENTER PLANETARY GEARSET PLANETARY CARRIER
11 - CENTER PLANETARY GEARSET ANNULUS GEAR
12 - CENTER PLANETARY GEARSET SUN GEAR
13 - K2 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
14 - K2 CLUTCH PISTON
15 - FRONT PLANETARY GEARSET PLANETARY CARRIER
16 - FRONT PLANETARY GEARSET ANNULUS GEAR
17 - FRONT PLANETARY GEARSET SUN GEAR
18 - K1 CLUTCH INTERNALLY TOOTHED DISC CARRIER
19 - K1 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
20 - K1 CLUTCH PISTON
21 - DRIVE SHAFT

DRIVING CLUTCHES (Continued)

OPERATION

The driving clutches (Fig. 49) produce a non-positive locking connection between two elements of a planetary gear set or between one element from each of two planetary gear sets in order to transmit the drive torque.

If the piston (20) on multi-plate clutch K1 (1) is subjected to oil pressure, it presses the internal and external discs of the disc set together. The sun gear (17) is locked with the planetary carrier (15) via the externally toothed disc carrier (19) and the internally toothed disc carrier (18). The front planetary gear set is thus locked and turns as a closed unit.

If the multi-plate clutch K2 (2) is actuated via the piston (14), the piston compresses the disc set. The annulus gear (16) of the front planetary gear set is locked with the annulus gear (11) of the center planetary gear set via the externally toothed disc carrier (13) and the center planetary carrier (10) on which the internally toothed discs are seated. Annulus gear (16) and annulus gear (11) turn at the same speed as the input shaft (21)

If the multi-plate clutch K3 (5) is actuated via the piston (7), the piston compresses the disc set. The sun gear (12) of the center planetary gear set is locked with the sun gear (9) of the rear planetary gear set via the externally toothed disc carrier (6) and the internally toothed disc carrier (8). Sun gear (12) and sun gear (9) turn at the same speed.

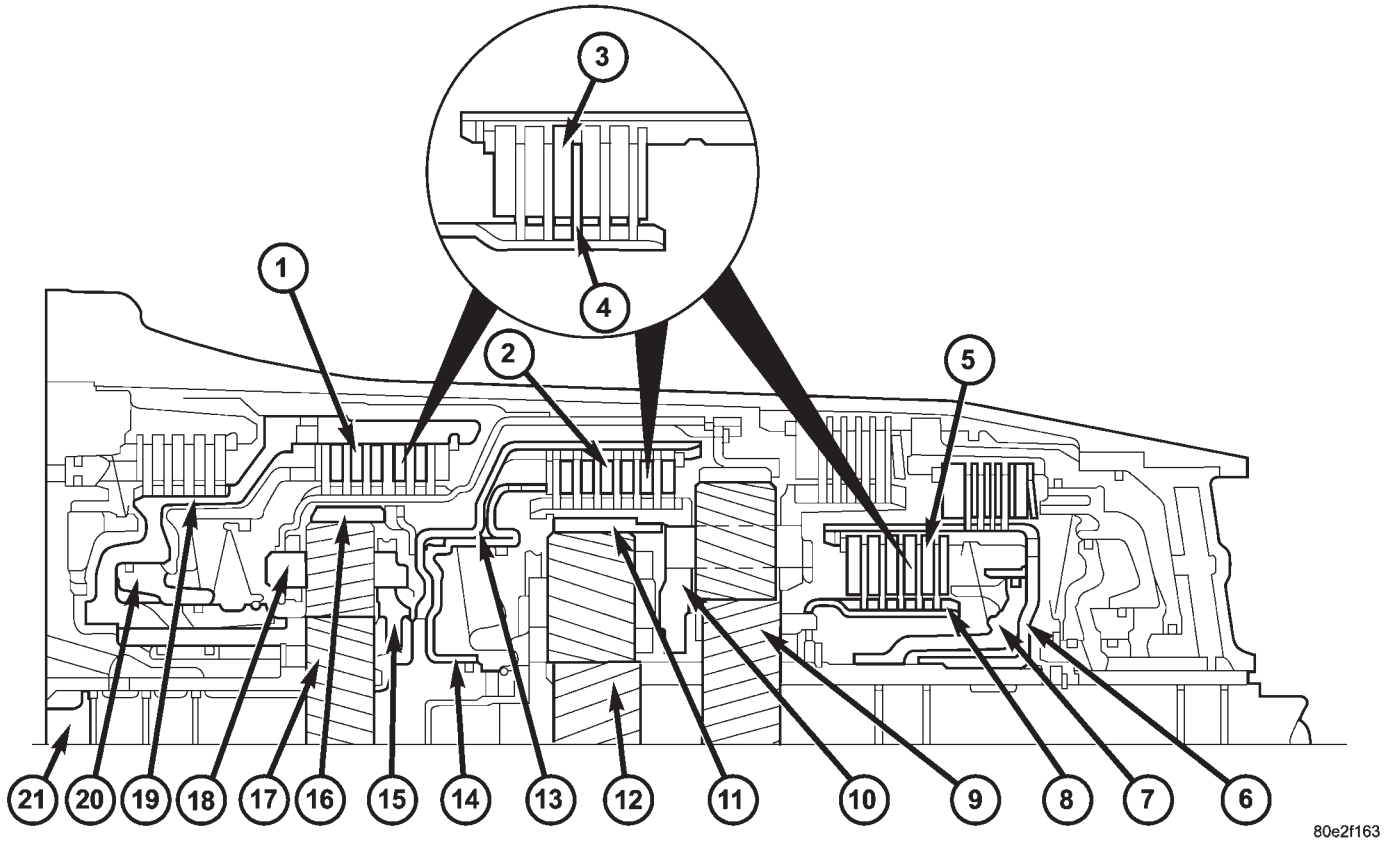

Fig. 49 Driving Clutches

1 - K1 CLUTCH
2 - K2 CLUTCH
3 - EXTERNALLY TOOTHED DISC
4 - INTERNALLY TOOTHED DISC
5 - K3 CLUTCH
6 - K3 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
7 - K3 CLUTCH PISTON
8 - K3 CLUTCH INTERNALLY TOOTHED DISC CARRIER
9 - REAR PLANETARY GEARSET SUN GEAR
10 - CENTER PLANETARY GEARSET PLANETARY CARRIER
11 - CENTER PLANETARY GEARSET ANNULUS GEAR
12 - CENTER PLANETARY GEARSET SUN GEAR
13 - K2 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
14 - K2 CLUTCH PISTON
15 - FRONT PLANETARY GEARSET PLANETARY CARRIER
16 - FRONT PLANETARY GEARSET ANNULUS GEAR
17 - FRONT PLANETARY GEARSET SUN GEAR
18 - K1 CLUTCH INTERNALLY TOOTHED DISC CARRIER
19 - K1 CLUTCH EXTERNALLY TOOTHED DISC CARRIER
20 - K1 CLUTCH PISTON
21 - DRIVE SHAFT

DRIVING CLUTCH K1

DISASSEMBLY

(1) Remove snap-ring (11) (Fig. 50) from outer multiple-disc carrier (6).

(2) Take multiple-disc pack (12) out of outer multiple-disc carrier (6).

(3) Place Multi-use Spring Compressor 8900 on the spring plate (8) and compress the spring until the snap-ring (10) is exposed.

(4) Remove snap-ring (10) (Fig. 50).

(5) Take out disc spring (7) and remove piston (6) by carefully blowing compressed air into the bore (A).

(6) Remove snap-ring (3) and take out front freewheeling clutch F1 (2).

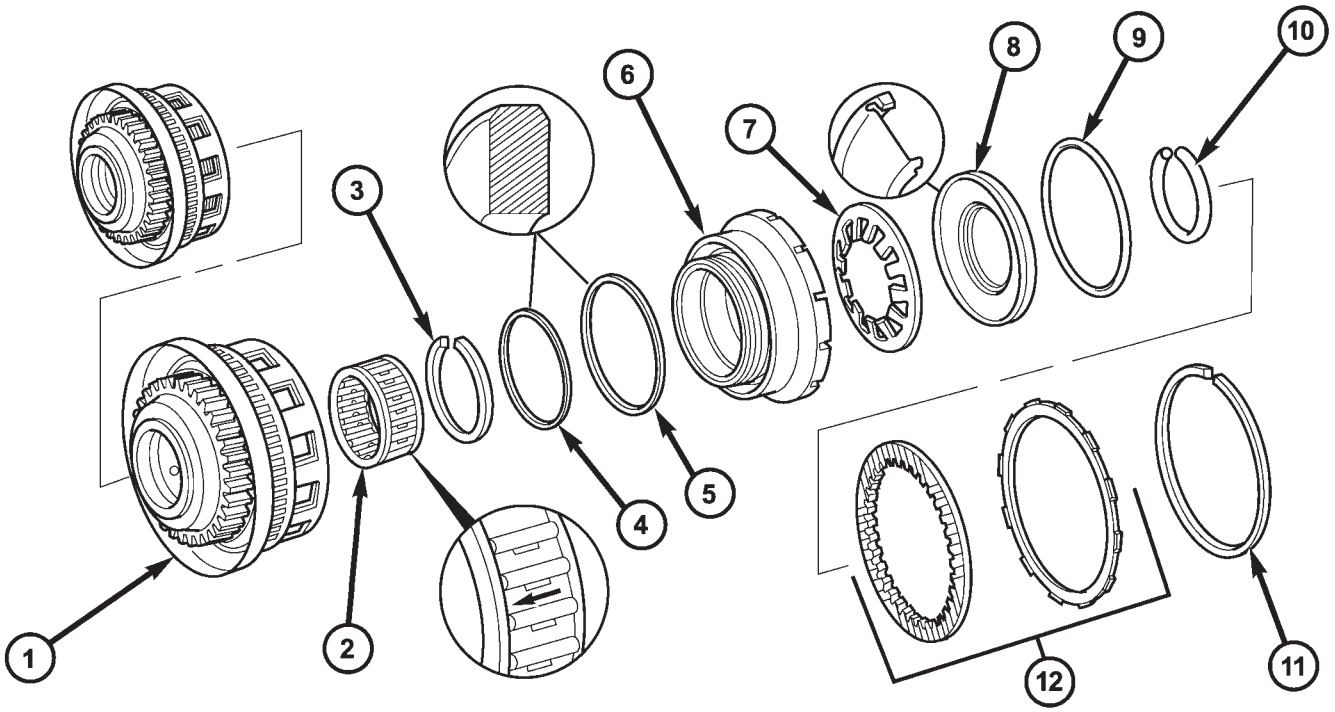

Fig. 50 Driving Clutch K1 Components

1 - K1 OUTER DISC CARRIER
2 - FREEWHEELING CLUTCH F1
3 - SNAP-RING
4 - OUTER DISC CARRIER SEALING RING
5 - PISTON SEALING RING
6 - PISTON
7 - DISC SPRING
8 - SPRING PLATE
9 - SPRING PLATE SEALING RING
10 - SNAP-RING
11 - SNAP-RING
12 - MULTIPLE DISC PACK

DRIVING CLUTCH K1 (Continued)

ASSEMBLY

(1) Install piston (6) (Fig. 51) in the outer multiple-disc carrier (1). Check sealing rings (4 and 5), replace if necessary. The rounded off edges of the sealing rings must point outwards.

(2) Insert disc spring (7) (Fig. 51). Insert disc spring with the curvature towards the piston.

(3) Insert spring plate (8). Insert spring plate with the curvature towards the sun gear. Check sealing ring (9), replace if necessary.

(4) Place Multi-use Spring Compressor 8900 on spring plate (8) and compress the spring until the groove of the snap-ring is exposed.

(5) Insert snap-ring (10) (Fig. 51). After installing, check snap-ring for correct seat

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

(6) Insert multiple-disc pack (12) in the outer multiple-disc carrier.

(7) Insert snap-ring (11).

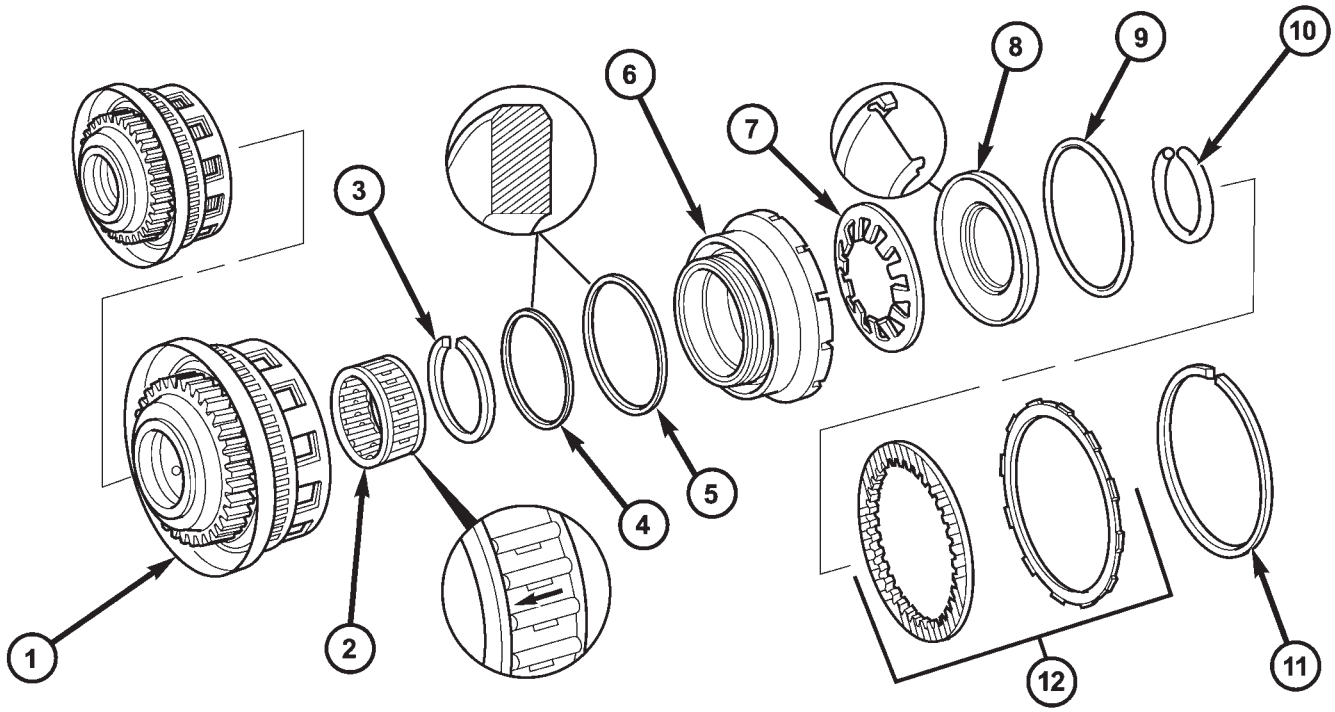

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Fig. 51 Driving Clutch K1 Components

1 - K1 OUTER DISC CARRIER
2 - FREEWHEELING CLUTCH F1
3 - SNAP-RING
4 - OUTER DISC CARRIER SEALING RING
5 - PISTON SEALING RING
6 - PISTON
7 - DISC SPRING
8 - SPRING PLATE
9 - SPRING PLATE SEALING RING
10 - SNAP-RING
11 - SNAP-RING
12 - MULTIPLE DISC PACK

DRIVING CLUTCH K1 (Continued)

(8) Measure the K1 clutch pack clearance.

(a) Mount Pressing Tool 8901 (1) (Fig. 52) on outer multiple disc.

(b) Using a lever press, compress pressing tool as far as the stop (then the marking ring is still visible, see small arrow).

(c) Using a feeler gauge, determine the play ″L″ (Fig. 53) at three points between the snap-ring (5) and outer multiple-disc (3).

(d) During the measurement the snap-ring (5) must contact the upper bearing surface of the groove in the outer multiple-disc carrier.

(e) The correct clutch clearance is 2.7-3.1 mm for three friction disc versions, 3.0-3.4 mm for four disc versions, 3.3-3.7 mm for five disc versions, and 3.6-4.0 mm for six disc versions.

(f) Adjust with snap-ring (5), if necessary. Snap-rings are available in thicknesses of 2.6, 2.9, 3.2, 3.5 3.8 and 4.1 mm.

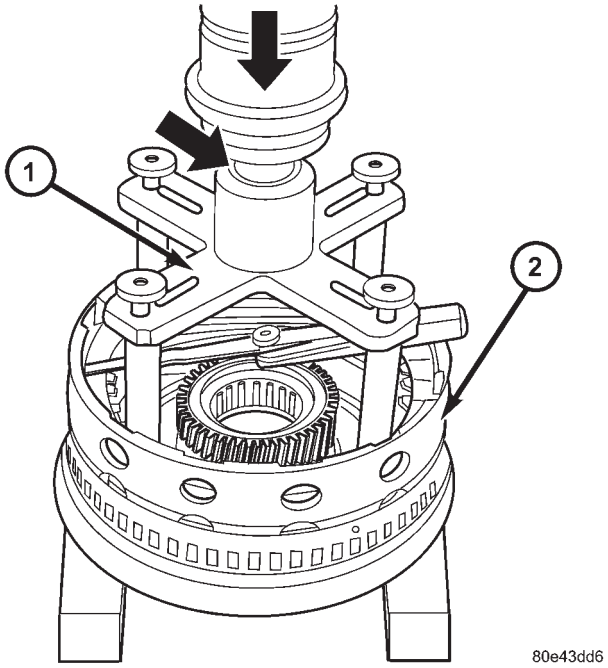


Fig. 52 Measure K1 Clutch Clearance

1 - PRESSING TOOL 8901
2 - K1 OUTER DISC CARRIER

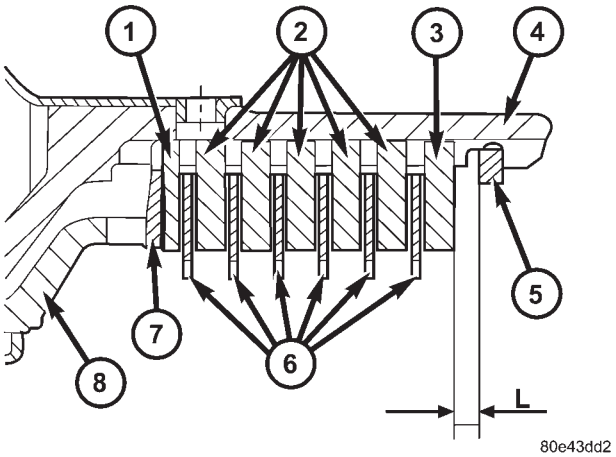


Fig. 53 Driving Clutch K1 Stack-up

1 - OUTER MULTIPLE DISC - 1.8MM
2 - OUTER MULTIPLE DISC - 2.8MM
3 - OUTER MULTIPLE DISC - 4.0MM
4 - K1 OUTER DISC CARRIER
5 - SNAP-RING
6 - FRICTION DISCS
7 - DISC SPRING
8 - PISTON

(9) Insert front freewheeling clutch F1 (2) and fit snap-ring (3). The freewheeling clutch F1 (2) must be installed in the direction of the arrow.

DRIVING CLUTCH K2

DISASSEMBLY

(1) Remove snap-ring (15) from the K1 inner multiple-disc carrier with integrated front gear set (1) and take off hollow gear (14).

(2) Remove drive shaft with clutch K2 (3) (Fig. 54).

(3) Remove needle thrust bearing (2).

(4) Remove snap-ring (13) (Fig. 54) from K2 outer multiple-disc carrier.

(5) Take out multiple-disc pack (12).

(6) Take out disk spring (11) (Fig. 54).

DRIVING CLUTCH K2 (Continued)

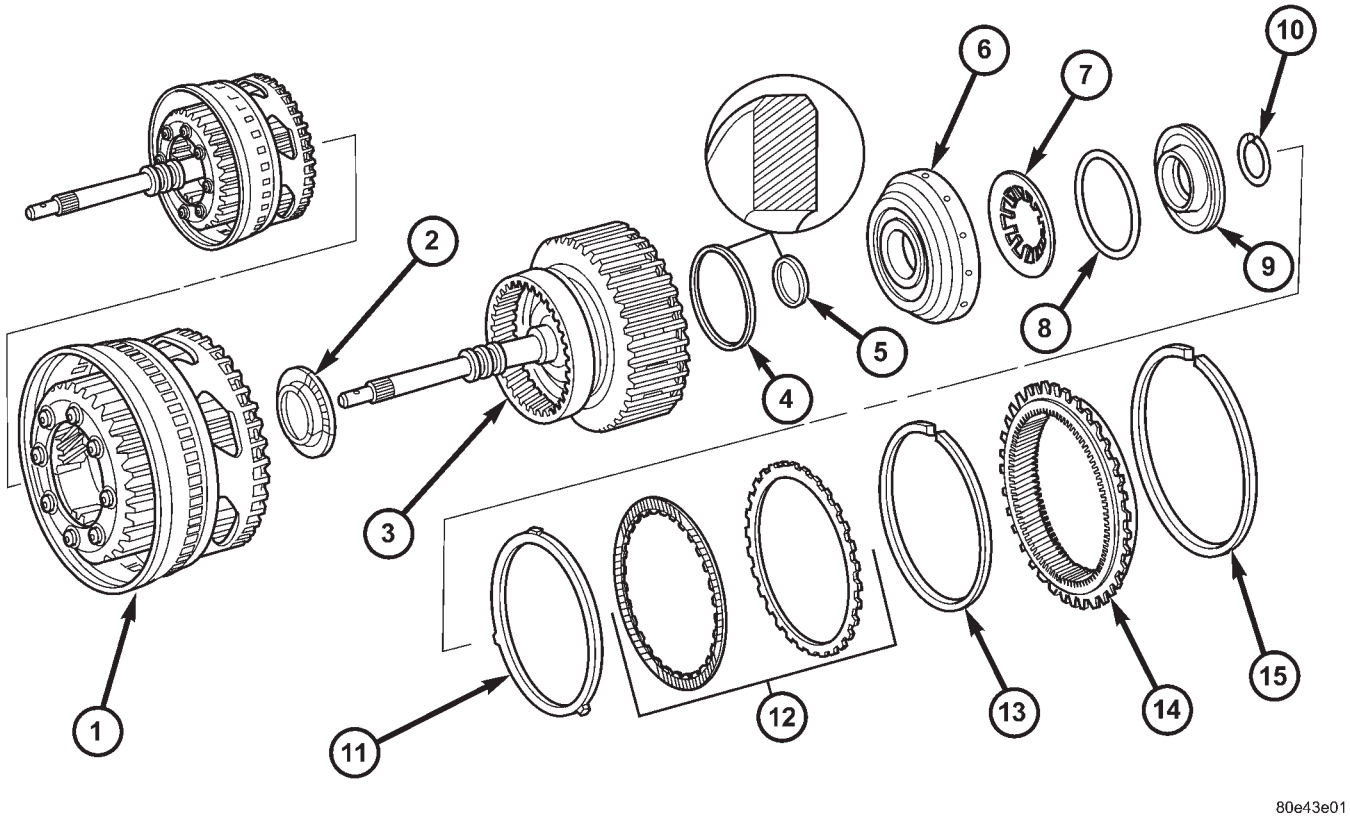


Fig. 54 Driving Clutch K2 Components

1 - K1 INNER DISC CARRIER WITH INTEGRATED FRONT GEAR SET	9 - SPRING RETAINER
2 - THRUST BEARING	10 - SNAP-RING
3 - INPUT SHAFT AND K2 CLUTCH	11 - DISC SPRING
4 - PISTON OUTER SEAL RING	12 - MULTIPLE DISC PACK
5 - PISTON INNER SEAL RING	13 - SNAP-RING
6 - PISTON	14 - HOLLOW GEAR
7 - DISC SPRING	15 - SNAP-RING
8 - SPRING RETAINER SEAL	

(7) Fit Multi-use Spring Compressor 8900 (Fig. 55) onto spring retainer (9) and press until snap-ring (10) is released.

(8) Remove snap-ring (10) (Fig. 54).

(9) Take out disc spring (7) and pull piston (6) out of outer multiple-disc carrier.

DRIVING CLUTCH K2 (Continued)

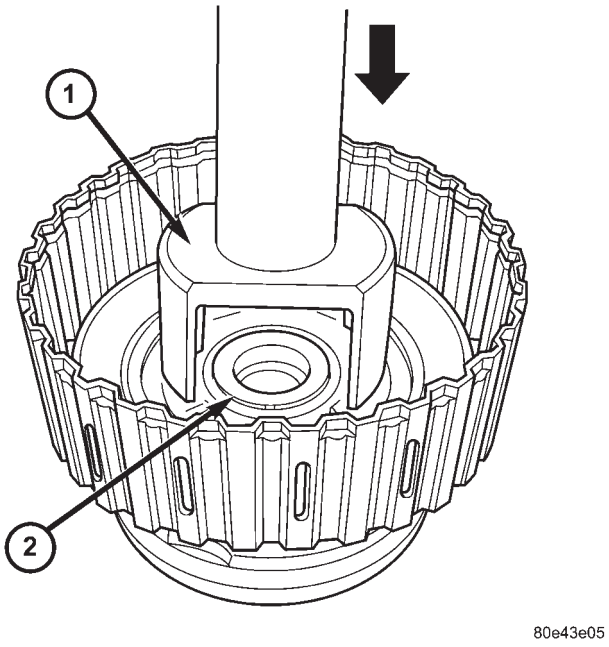


Fig. 55 Compress K2 Clutch Spring

1 - MULTI-USE SPRING COMPRESSOR 8900
2 - SNAP-RING

ASSEMBLY

(1) Install piston (6) (Fig. 56) in outer multiple-disc carrier. Inspect seals (4 and 5), replace if necessary. The rounded edges of the seals must point to the outside.

(2) Insert disk spring (7) and spring retainer (9). Insert disk spring (7) with curved side pointing toward spring retainer (9). Inspect seal 8 (Fig. 56), replace if necessary.

(3) Place Multi-use Spring Compressor 8900 (Fig. 57) on spring plate (9) and press until the groove of the snap-ring is exposed.

(4) Insert snap-ring (10).

(5) Insert disk spring (11).

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

(6) Insert multiple-disk set (12) into outer multiple-disk carrier.

(7) Fit snap-ring (13).

(8) Measure K2 clutch clearance.

(a) Mount Pressing Tool 8901 (1) (Fig. 58) on outer multiple disc.

(b) Using a lever press, compress pressing tool as far as the stop (then the marking ring is still visible, see small arrow).

(c) Using a feeler gauge, determine the play ″L″ (Fig. 59) at three points between the snap-ring (6) and outer multiple-disc (4).

(d) During the measurement the snap-ring (6) must contact the upper bearing surface of the groove in the outer multiple-disc carrier.

(e) The correct clutch clearance is 2.3-2.7 mm for three friction disc versions, 2.4-2.8 mm for four disc versions, 2.5-2.9 mm for five disc versions, and 2.7-3.1 mm for six disc versions.

(f) Adjust with snap-ring (6), if necessary. Snap-rings are available in thicknesses of 2.3, 2.6, 2.9, 3.2, 3.5 and 3.8 mm.

DRIVING CLUTCH K2 (Continued)

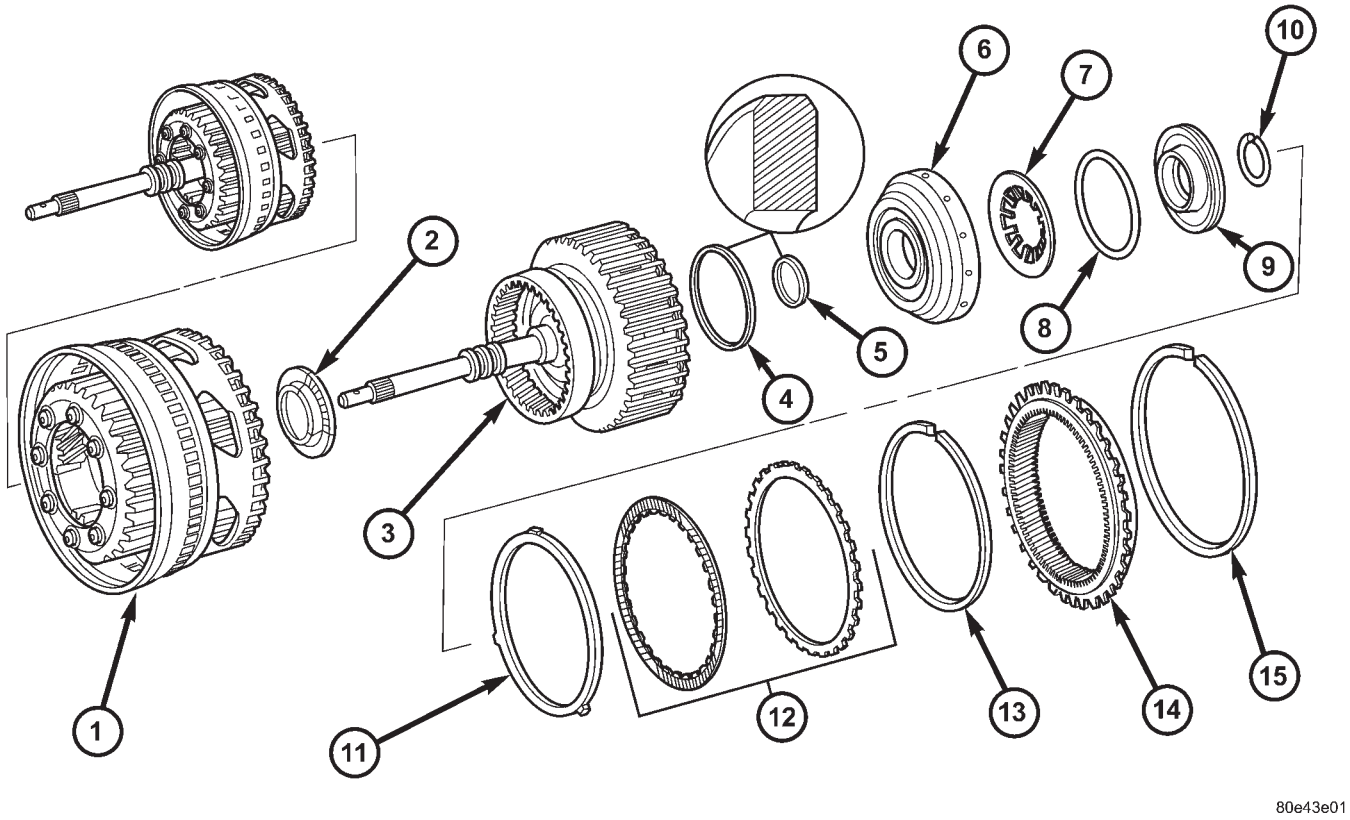


Fig. 56 Driving Clutch K2 Components

1 - K1 INNER DISC CARRIER WITH INTEGRATED FRONT GEAR SET	9 - SPRING RETAINER
2 - THRUST BEARING	10 - SNAP-RING
3 - INPUT SHAFT AND K2 CLUTCH	11 - DISC SPRING
4 - PISTON OUTER SEAL RING	12 - MULTIPLE DISC PACK
5 - PISTON INNER SEAL RING	13 - SNAP-RING
6 - PISTON	14 - HOLLOW GEAR
7 - DISC SPRING	15 - SNAP-RING
8 - SPRING RETAINER SEAL	

(9) Insert axial needle bearing (2) into K1 inner multiple-disk carrier. Insert axial needle bearing (2) with a little grease to prevent it slipping.

(10) Install drive shaft in K1 inner multiple-disc carrier with integrated front gear set (3).

DRIVING CLUTCH K2 (Continued)

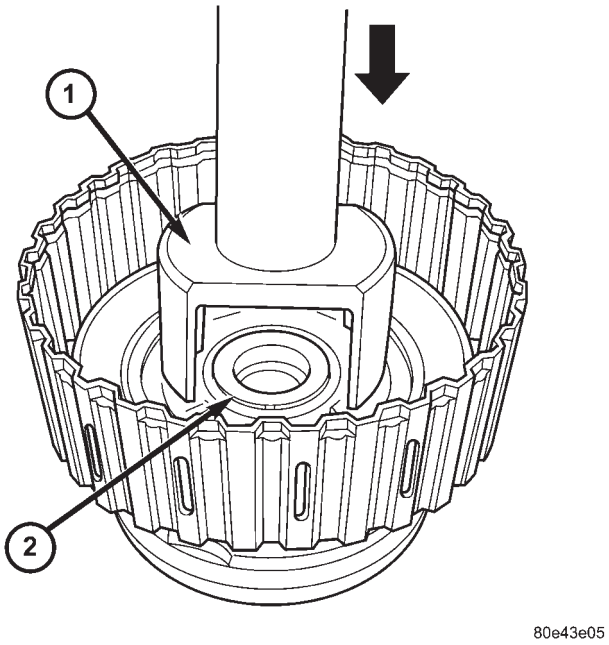


Fig. 57 Compress K2 Clutch Spring

1 - MULTI-USE SPRING COMPRESSOR 8900
2 - SNAP-RING

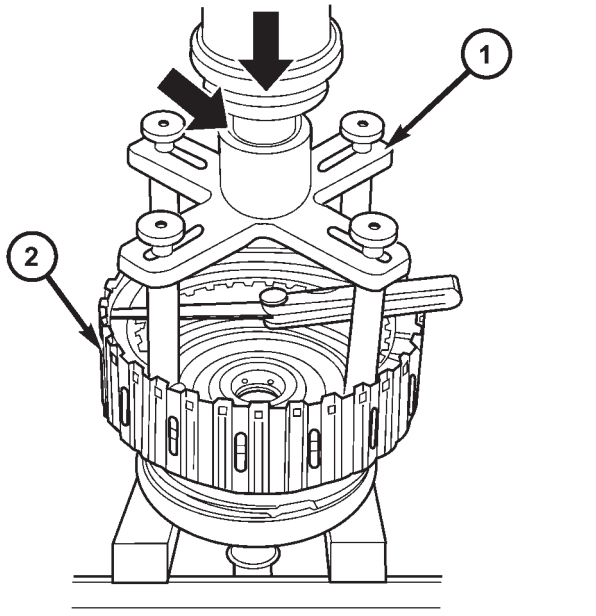


Fig. 58 Measure K2 Clutch Clearance

1 - PRESSING TOOL 8901
2 - K1 INNER DISC CARRIER

(11) Fit internally-geared wheel (14). Pay attention to installation position.

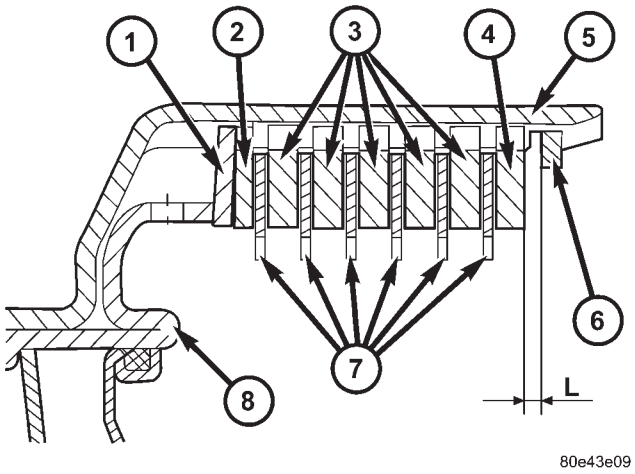


Fig. 59 Driving Clutch K2 Stack-up

1 - DISC SPRING
2 - OUTER MULTIPLE DISC - 1.8 MM
3 - OUTER MULTIPLE DISC - 2.8 MM
4 - OUTER MULTIPLE DISC - 4.0 MM
5 - K2 OUTER DISC CARRIER
6 - SNAP-RING
7 - FRICTION DISCS
8 - PISTON

DRIVING CLUTCH K3

DISASSEMBLY

(1) Remove snap-ring (1) (Fig. 60) from outer multiple-disc carrier.

(2) Remove multiple-disc pack (2) and disk spring (3) from outer multiple-disc carrier.

(3) Place Multi-use Spring Compressor 8900 (9) (Fig. 60) on disc spring (5) and compress the spring until the snap-ring (4) is exposed.

(4) Remove snap-ring (4).

(5) Remove spring plate (5) and piston (6) from outer multiple-disc carrier.

ASSEMBLY

(1) Install piston (6) in the outer multiple-disc carrier (8). Check sealing ring (7), replace if necessary. The rounded off edges of the sealing ring must point outwards.

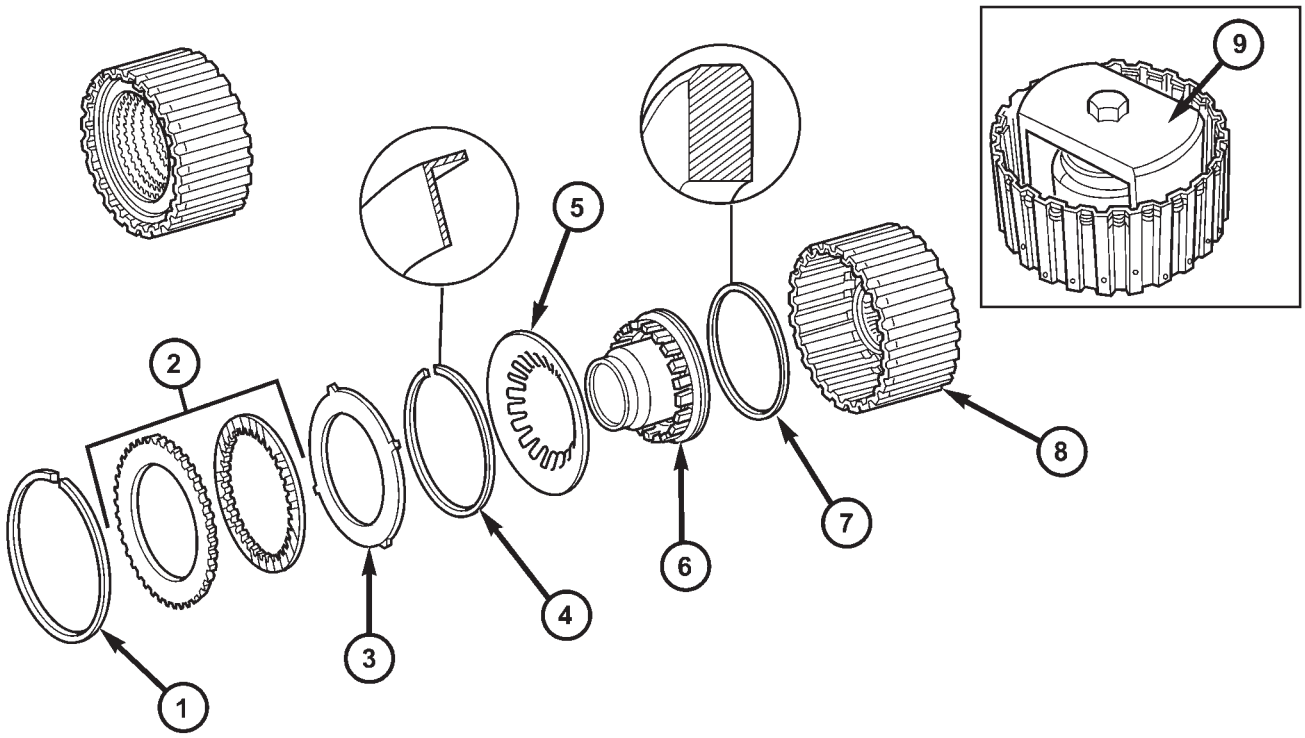
(2) Insert disc spring (5). Insert disc spring with the curvature towards the piston.

(3) Mount the Multi-use Spring Compressor 8900 (9) on the spring plate and clamp until the snap-ring groove is exposed.

(4) Insert snap-ring (4). The collar of the snap-ring must point towards the multiple-disc pack.

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

DRIVING CLUTCH K3 (Continued)



80e43e11

Fig. 60 Driving Clutch K3 Components

1 - SNAP-RING
2 - MULTIPLE DISC PACK
3 - DISC SPRING
4 - SNAP-RING
5 - SPRING PLATE
6 - PISTON
7 - SEALING RING
8 - OUTER DISC CARRIER
9 - MULTI-USE SPRING COMPRESSOR 8900

(5) Install disk spring (3) and multiple-disc pack (2) in outer multiple-disc carrier (8).

(6) Insert snap-ring (1).

(7) Measure the K3 clutch clearance.

(a) Mount Pressing Tool 8901 (1) (Fig. 61) on outer multiple disc.

(b) Using a lever press, compress pressing tool as far as the stop (then the marking ring is still visible, see small arrow).

(c) Using a feeler gauge, determine the play ″L″ (Fig. 62) at three points between the snap-ring (8) and outer multiple-disc (2).

(d) During the measurement the snap-ring (8) must contact the upper bearing surface of the groove in the outer multiple-disc carrier.

(e) The correct clutch clearance is 2.3-2.7 mm for three friction disc versions, 2.4-2.8 mm for four disc versions, and 2.5-2.9 mm for five disc versions.

(f) Adjust with snap-ring (8), if necessary. Snap-rings are available in thicknesses of 2.0, 2.3, 2.6, 2.9, 3.2 and 3.5 mm.

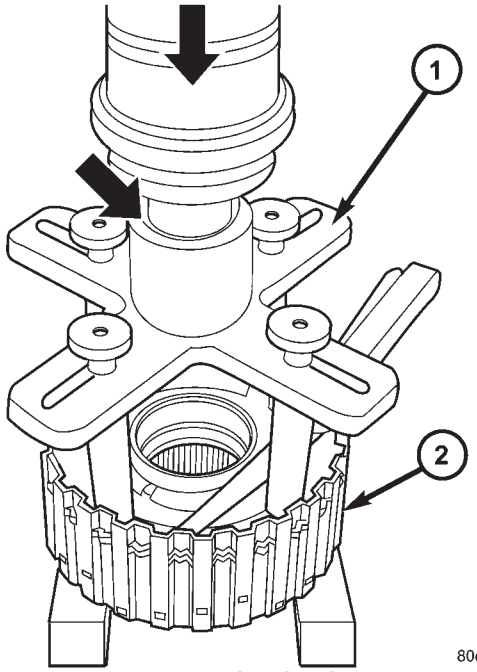


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Fig. 61 Measure K3 Clutch Clearance

1 - PRESSING TOOL 8901
2 - OUTER DISC CARRIER

DRIVING CLUTCH K3 (Continued)

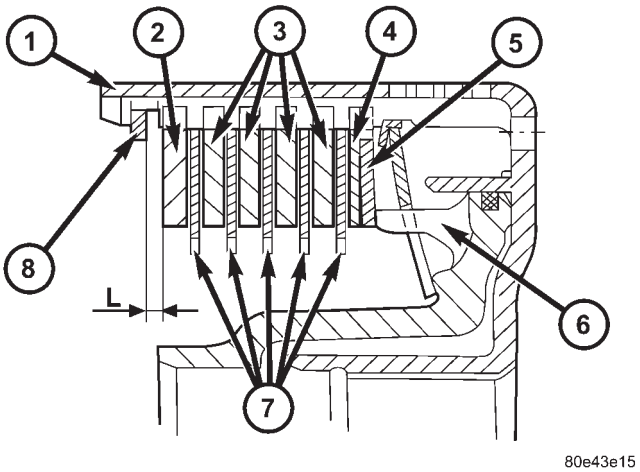

Fig. 62 Driving Clutch K3 Stack-up

1 - OUTER DISC CARRIER
2 - OUTER MULTIPLE DISC - 4.0 MM
3 - OUTER MULTIPLE DISC - 2.8 MM
4 - OUTER MULTIPLE DISC - 1.8 MM
5 - DISC SPRING
6 - PISTON
7 - FRICTION DISCS - 2.1 MM
8 - SNAP-RING

ELECTROHYDRAULIC UNIT

DESCRIPTION

The electrohydraulic control unit comprises the shift plate made from light alloy for the hydraulic control and an electrical control unit. The electrical control unit comprises of a supporting body made of plastic, into which the electrical components are assembled. The supporting body is mounted on the shift plate and screwed to it.

Strip conductors inserted into the supporting body make the connection between the electrical components and a plug connector. The connection to the wiring harness on the vehicle and the transmission control module (TCM) is produced via this 13-pin plug connector with a bayonet lock.

ELECTRICAL CONTROL UNIT

The electric valve control unit (7) (Fig. 63) consists of a plastic shell which houses the RPM sensors (1,12), regulating solenoid valves (3, 4), solenoid valves (5, 6, 10), the TCC solenoid valve (11), the park/neutral contact (9), and the transmission oil temperature sensor (8). Conductor tracks integrated into the shell connect the electric components to a plug connection (2). This 13-pin plug connection (2) establishes the connection to the vehicle-side cable harness and to the transmission control module (TCM). With the exception of the solenoid valves, all other electric components are fixed to the conductor tracks.

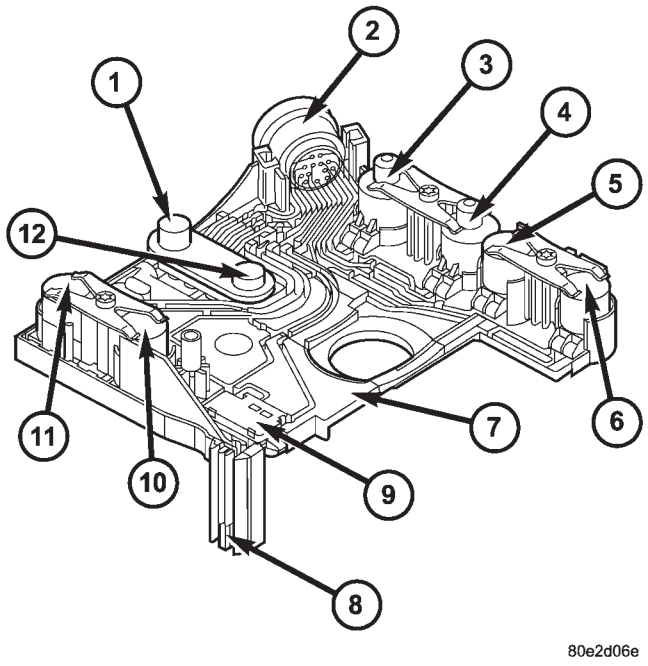

Fig. 63 Electrical Control Unit

1 - N3 SPEED SENSOR
2 - PLUG CONNECTOR
3 - MODULATING PRESSURE REGULATING SOLENOID
4 - SHIFT PRESSURE REGULATING SOLENOID
5 - 1-2/4-5 SHIFT SOLENOID
6 - 3-4 SHIFT SOLENOID
7 - ELECTRICAL CONTROL UNIT
8 - TRANSMISSION TEMPERATURE SENSOR
9 - STARTER INTERLOCK CONTACT
10 - 2-3 SHIFT SOLENOID
11 - TORQUE CONVERTER LOCK-UP SOLENOID
12 - N2 SPEED SENSOR

HYDRAULIC CONTROL UNIT

Working Pressure (Operating Pressure) (p-A)

The working pressure provides the pressure supply to the hydraulic control and the transmission shift elements. It is the highest hydraulic pressure in the entire hydraulic system. The working pressure is regulated at the working pressure regulating valve in relation to the load and gear. All other pressures required for the transmission control are derived from the working pressure.

Lubrication Pressure (p-Sm)

At the working pressure regulating valve surplus oil is diverted to the lubrication pressure regulating valve, from where it is used in regulated amounts to lubricate and cool the mechanical transmission components and the torque converter. Furthermore, the lubrication pressure (p-Sm) is also used to limit the pressure in the torque converter.

ELECTROHYDRAULIC UNIT (Continued)

Shift Pressure (p-S)

The shift pressure is determined by the shift pressure regulating solenoid valve and the shift pressure regulating valve. The shift pressure:

- Regulates the pressure in the activating shift element during the shift phase.
- Determines together with the modulating pressure the pressure reduction at the deactivating shift element as regulated by the overlap regulating valve.
- Initializes 2nd gear in limp-home mode.

Modulating Pressure (p-Mod)

The modulating pressure influences the size of the working pressure and determines together with the shift pressure the pressure regulated at the overlap regulating valve. The modulating pressure is regulated at the modulating pressure regulating solenoid valve, which is under regulating valve pressure. The modulating pressure is variable and relative to the engine load.

Regulating Valve Pressure (p-RV)

The regulating valve pressure is regulated at the regulating valve pressure regulating valve in relation to the working pressure (p-A) up to a maximum pressure of 8 bar. It supplies the modulating pressure regulating solenoid valve, the shift pressure regulating solenoid valve and the shift valve pressure regulating valve.

Shift Valve Pressure (p-SV)

The shift valve pressure (p-SV) is derived from the regulating valve pressure (p-RV), is regulated at the shift valve pressure regulating valve and is then present at the:

- 1-2 and 4-5 shift solenoid valve.
- 3-4 shift solenoid valve.
- 2-3 shift solenoid valve.
- Torque converter lockup solenoid valve.
- 3-4 and 2-3 shift pressure shift valve.

The shift valve pressure (p-SV) controls the command valves via the upshift/downshift solenoid valves.

Overlap Pressure (p-Ü)

The overlap pressure controls the shift component pressure reduction during a shift phase. The pressure in a shift element as it disengages is controlled during the shift phase depending on engine load (modulating pressure) and the pressure in the shift element as it engages. The adjusted pressure is inversely proportional to the transmission capability of the shift element being engaged (controlled overlap).

Working Pressure Regulating Valve (Operating Pressure)

The working pressure regulating valve (Fig. 64) is located in the valve housing of the shift plate. It regulates the primary pressure of the hydraulic system.

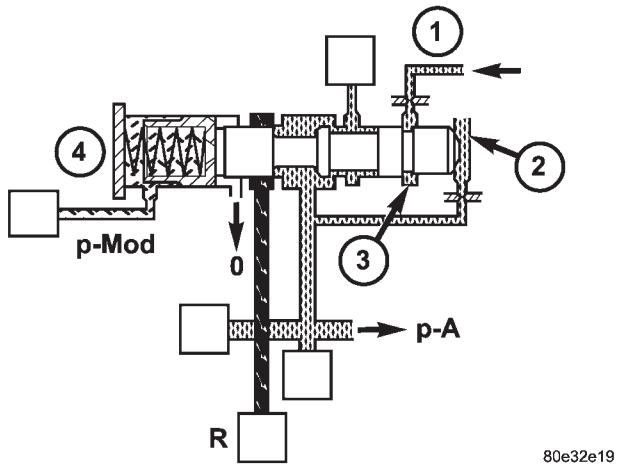

Fig. 64 Working Pressure Regulating Valve

1 - PRESSURE FROM K1/K2
2 - END FACE
3 - ANNULAR SURFACE
4 - WORKING PRESSURE REGULATING VALVE

ELECTROHYDRAULIC UNIT (Continued)

Torque Converter Lockup Clutch Regulating Valve

The torque converter lock-up clutch regulating valve (Fig. 65) is located in the valve housing of the electrohydraulic control module. The valve is responsible for the hydraulic control of the torque converter lockup clutch and distribution of the lubricating oil.

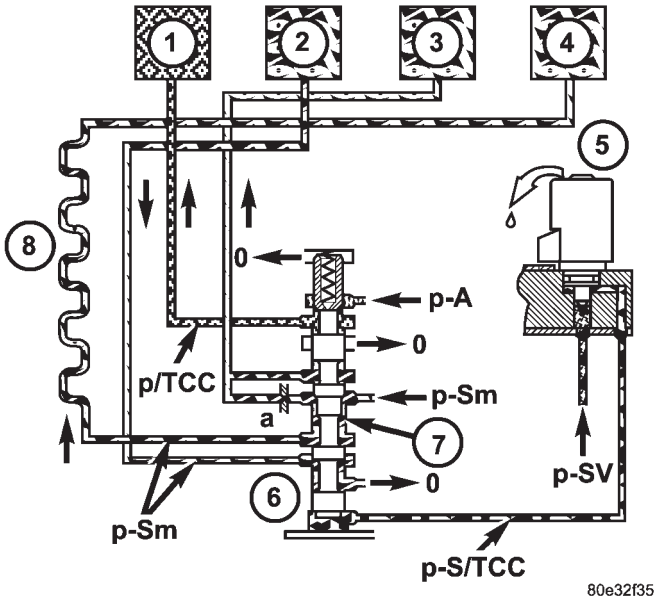

Fig. 65 Torque Converter Lockup Clutch Regulating Valve

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER OUTPUT
3 - TORQUE CONVERTER INPUT
4 - TORQUE CONVERTER LUBRICATION POINTS
5 - TORQUE CONVERTER LOCK-UP SOLENOID
6 - TORQUE CONVERTER LOCK-UP CLUTCH REGULATING VALVE
7 - ANNULAR PASSAGE THROTTLE
8 - OIL COOLER

Overlap Regulating Valve

Each shift group is assigned one overlap regulating valve (Fig. 66). The 1-2 / 4-5 overlap regulating valve is installed in the shift valve housing; the 2-3 and 3-4 overlap regulating valves are installed in the valve housing. The overlap regulating valve regulates the pressure reduction during a shift phase.

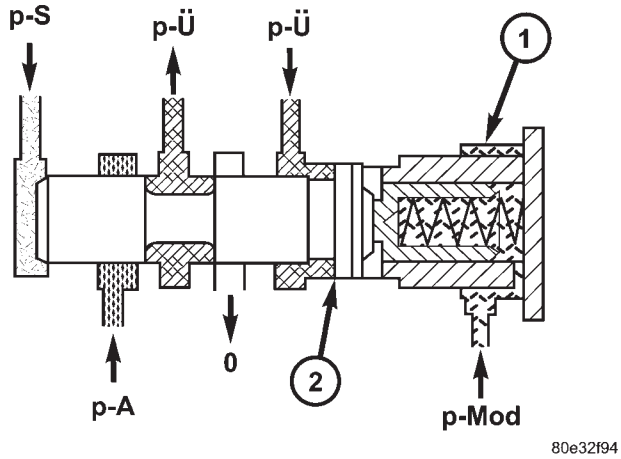

Fig. 66 Overlap Regulating Valve

1 - OVERLAP REGULATING VALVE
2 - ANNULAR SURFACE ON OVERLAP REGULATING VALVE

Command Valve

Each shift group possesses one command valve (Fig. 67). The 1-2 / 4-5 and 2-3 command valves are installed in the shift valve housing; the 3-4 command valve is installed in the valve housing. The command valve switches the shift group from the stationary phase to the shift phase and back again.

Holding Pressure Shift Valve

Each shift group possesses one holding pressure shift valve (Fig. 68). The 1-2 / 4-5 and 2-3 holding pressure shift valves are installed in the shift valve housing; the 3-4 holding pressure shift valve is installed in the valve housing. The holding pressure shift valve allocates the working pressure to one actuator of a shift group.

ELECTROHYDRAULIC UNIT (Continued)

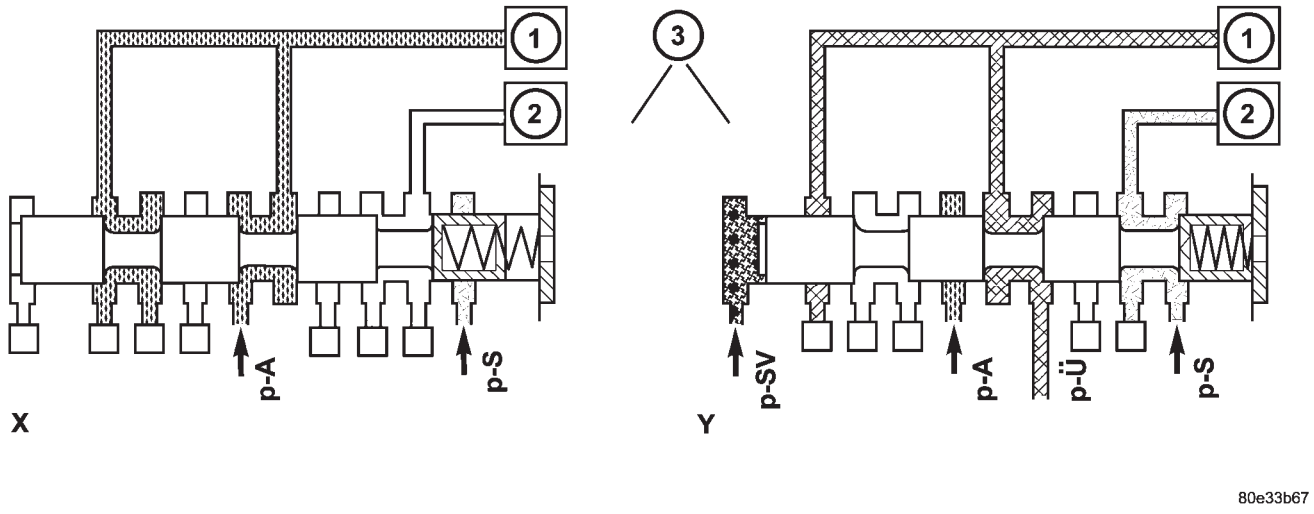

Fig. 67 Command Valve

1 - HOLDING CLUTCH B1
2 - DRIVING CLUTCH K1
3 - 1-2/4-5 COMMAND VALVE

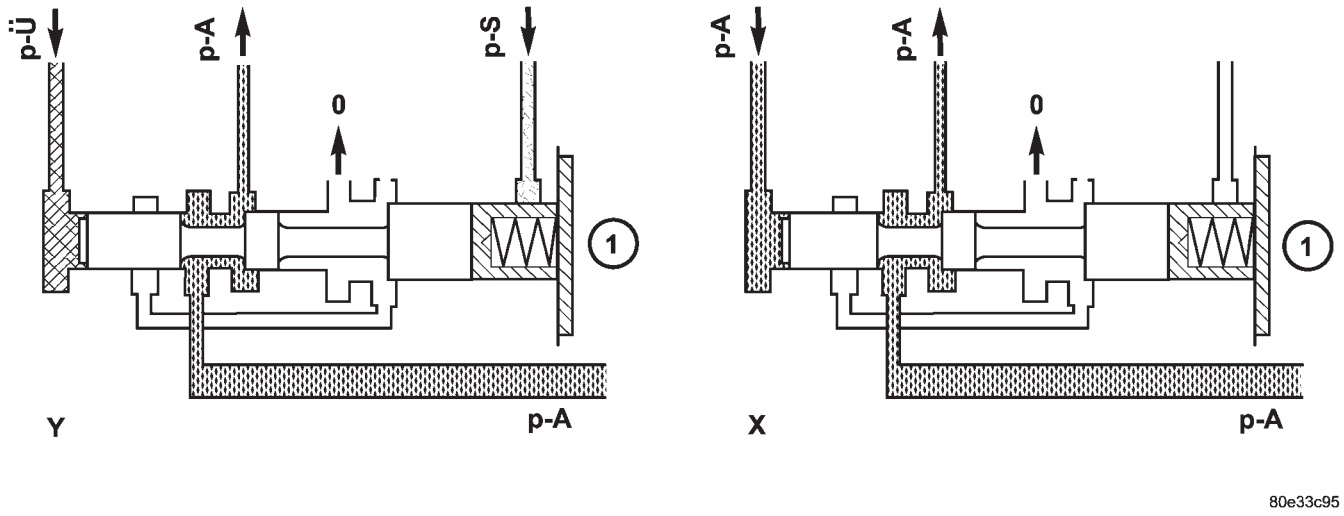

Fig. 68 Holding Pressure Shift Valve

1 - HOLDING PRESSURE SHIFT VALVE

Shift Pressure Shift Valve

Each shift group possesses one shift pressure shift valve (Fig. 69). The 1-2 / 4-5 and 2-3 shift pressure shift valves are installed in the shift valve housing; the 3-4 shift pressure shift valve is installed in the valve housing. It assigns the shift pressure (p-S) to the activating actuator and the overlap pressure (p-Ü) regulated by the overlap regulating valve to the deactivating actuator.

Lubrication Pressure Regulating Valve

The lubrication pressure regulating valve (Fig. 70) is located in the valve housing of the electrohydraulic control module. The valve controls the fluid to lubricate and cool the mechanical part of the transmission, and limits the pressure in the torque converter.

ELECTROHYDRAULIC UNIT (Continued)

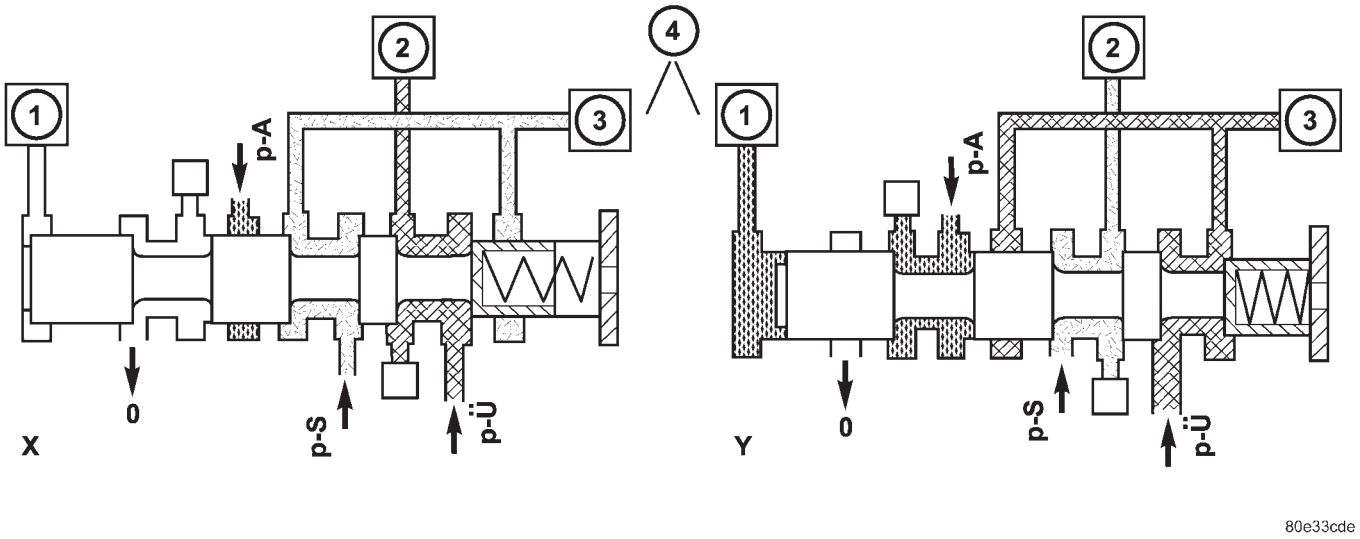

Fig. 69 Shift Pressure Shift Valve

1 - 1-2/4-5 COMMAND VALVE
2 - DRIVING CLUTCH K1
3 - HOLDING CLUTCH B1
4 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE

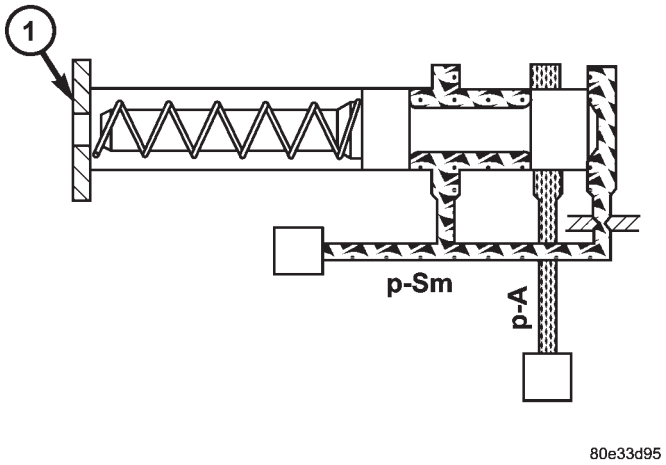

Fig. 70 Lubrication Pressure Regulating Valve

1 - LUBRICATION PRESSURE REGULATING VALVE

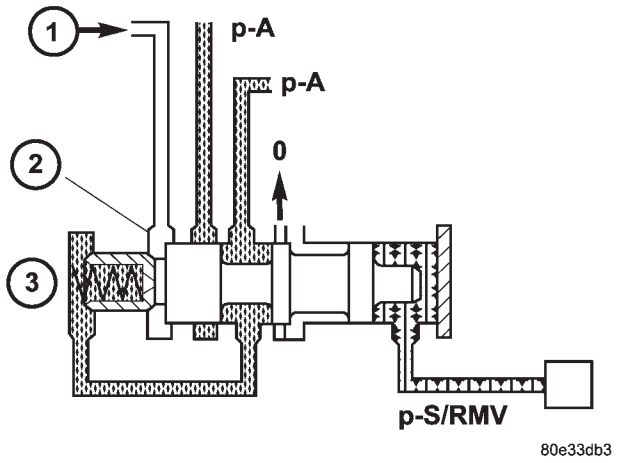

Fig. 71 Shift Pressure Regulating Valve

1 - PRESSURE FROM CLUTCH K2
2 - ANNULAR SURFACE
3 - SHIFT PRESSURE REGULATING VALVE

Shift Pressure Regulating Valve

The shift pressure regulating valve (Fig. 71) is located in the valve housing of the shift plate. It regulates the shift pressure (p-S).

ELECTROHYDRAULIC UNIT (Continued)

Regulating Valve Pressure Regulating Valve

The regulating valve pressure regulating valve (Fig. 72) is located in the valve housing of the electrohydraulic control module. It regulates the regulating valve pressure (p-RV).

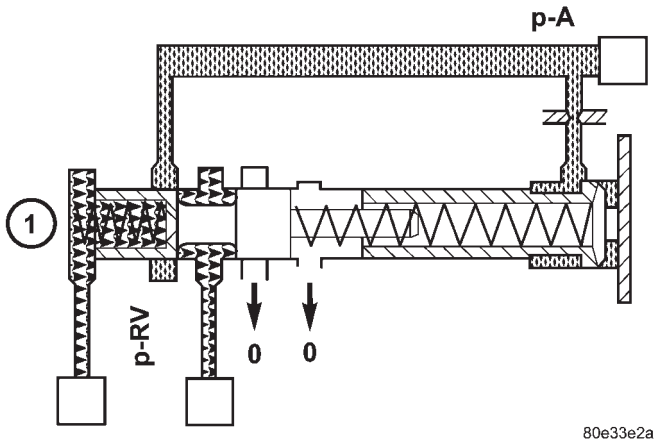

Fig. 72 Regulating Valve Pressure Regulating Valve

1 - REGULATING VALVE PRESSURE REGULATING VALVE

Shift Valve Pressure Regulating Valve

The shift valve pressure regulating valve (Fig. 73) is located in the valve housing of the electrohydraulic control module. It regulates the shift valve pressure (p-SV).

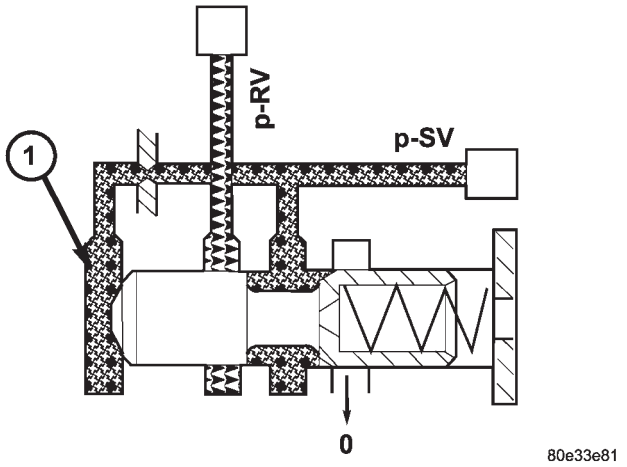

Fig. 73 Shift Valve Pressure Regulating Valve

1 - SHIFT VALVE PRESSURE REGULATING VALVE

OPERATION

ELECTRICAL CONTROL UNIT

Signals from the transmission control module (TCM) are converted into hydraulic functions in the electric valve control unit (7) (Fig. 74). The RPM sensors (1, 12), starter interlock contact (9), and transmission oil temperature sensor (8) of the electric valve control unit (7) supply the TCM with input signals. The solenoid valves are controlled by the TCM and trigger the hydraulic functions.

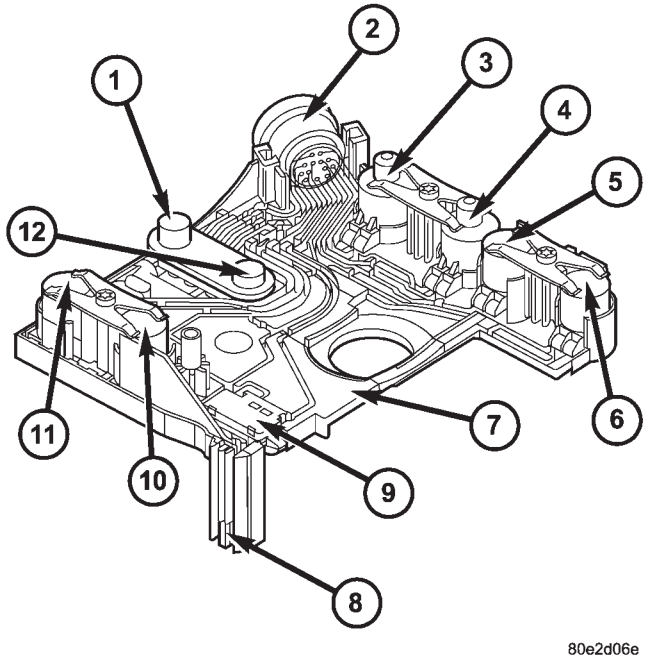

Fig. 74 Electrical Control Unit

1 - N3 SPEED SENSOR
2 - PLUG CONNECTOR
3 - MODULATING PRESSURE REGULATING SOLENOID
4 - SHIFT PRESSURE REGULATING SOLENOID
5 - 1-2/4-5 SHIFT SOLENOID
6 - 3-4 SHIFT SOLENOID
7 - ELECTRICAL CONTROL UNIT
8 - TRANSMISSION TEMPERATURE SENSOR
9 - STARTER INTERLOCK CONTACT
10 - 2-3 SHIFT SOLENOID
11 - TORQUE CONVERTER LOCK-UP SOLENOID
12 - N2 SPEED SENSOR

ELECTROHYDRAULIC UNIT (Continued)

HYDRAULIC CONTROL UNIT

Working Pressure Regulating Valve (Operating Pressure)

The working pressure (p-A) is regulated at the working pressure regulating valve (22) (Fig. 75) in relation to load (modulating pressure) and gear (K1 or K2 pressure). The spring in the working pressure regulating valve sets a minimum pressure level (basic pressure).

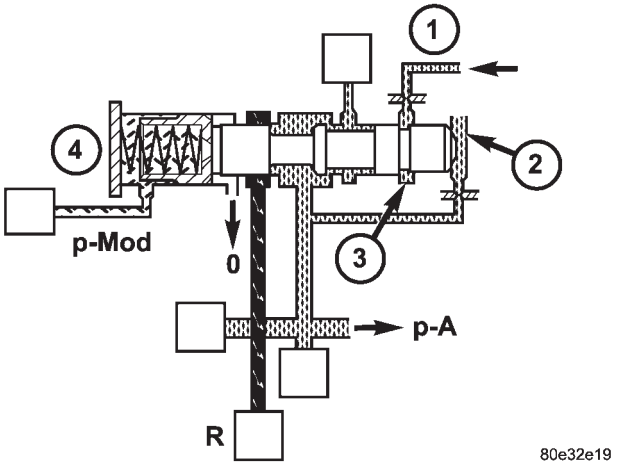

Fig. 75 Working Pressure Regulating Valve

1 - PRESSURE FROM K1/K2
2 - END FACE
3 - ANNULAR SURFACE
4 - WORKING PRESSURE REGULATING VALVE

Torque Converter Lockup Clutch Regulating Valve

The torque converter lockup clutch regulating valve (6) (Fig. 76) regulates the torque converter lock-up clutch working pressure in relation to the torque converter clutch control pressure. According to the size of the working pressure, the torque converter lockup clutch is either Engaged, Disengaged, or Slipping. When the regulating valve (6) is in the lower position, lubricating oil flows through the torque converter and oil cooler (8) into the transmission (torque converter lockup clutch unpressurized). In its regulating position (slipping, torque converter lockup clutch pressurized), a reduced volume of lubricating oil flows through the annular passage (7) bypassing the torque converter and passing direct through the oil cooler into the transmission. The rest of the lubricating oil is directed via the throttle ″a″ into the torque converter in order to cool the torque converter lockup clutch.

Overlap Regulating Valve

During the shift phase the pressure (Fig. 77) in the deactivating shift actuator is regulated in relation to the engine load (modulating pressure) and the pressure in the activating actuator. The regulated pressure is inversely proportional to the transfer capacity of the activating shift actuator (regulated overlap).

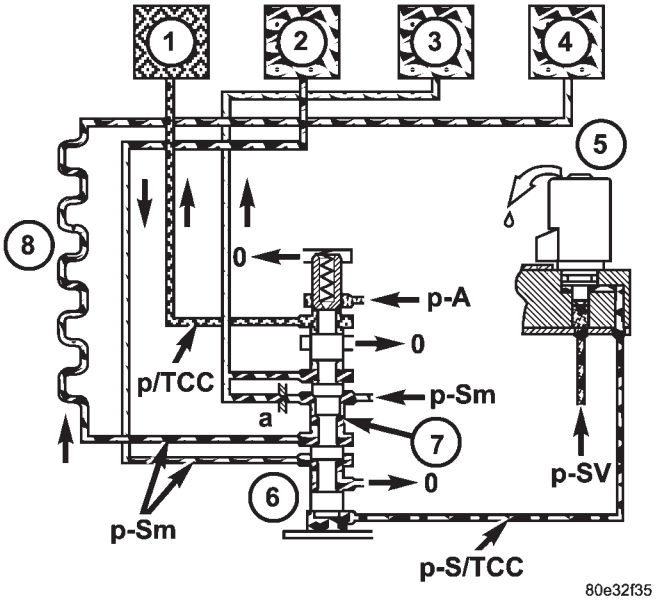

Fig. 76 Torque Converter Lockup Clutch Regulating Valve

1 - TORQUE CONVERTER LOCK-UP CLUTCH
2 - TORQUE CONVERTER OUTPUT
3 - TORQUE CONVERTER INPUT
4 - TORQUE CONVERTER LUBRICATION POINTS
5 - TORQUE CONVERTER LOCK-UP SOLENOID
6 - TORQUE CONVERTER LOCK-UP CLUTCH REGULATING VALVE
7 - ANNULAR PASSAGE THROTTLE
8 - OIL COOLER

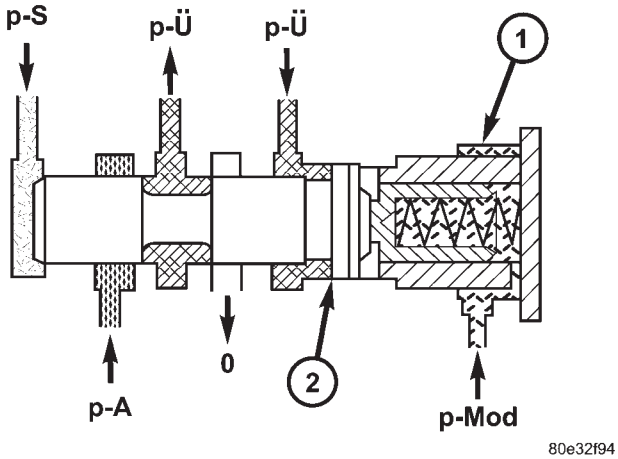

Fig. 77 Overlap Regulating Valve

1 - OVERLAP REGULATING VALVE
2 - ANNULAR SURFACE ON OVERLAP REGULATING VALVE

ELECTROHYDRAULIC UNIT (Continued)

Command Valve

When the end face is unpressurized (stationary phase), the working pressure is directed to the actuated shift element. If the end face of the command valve (Fig. 78) is subjected to the shift valve pressure (p-SV) (shift phase), then the shift pressure is switched to the activating element and the overlap pressure is switched to the deactivating element.

Shift Valve Holding Pressure

The holding pressure shift valve (Fig. 79) is actuated by the pressures present at the end face in the actuators and a spring. It assigns the working pressure to the actuator with the higher pressure (taking into account the spring force and the effective surface area). The other element of the shift group is then unpressurized. The valve switches over only during the shift phase and only at a certain pressure ratio between the overlap pressure (p-Ü) and the shift pressure (p-S).

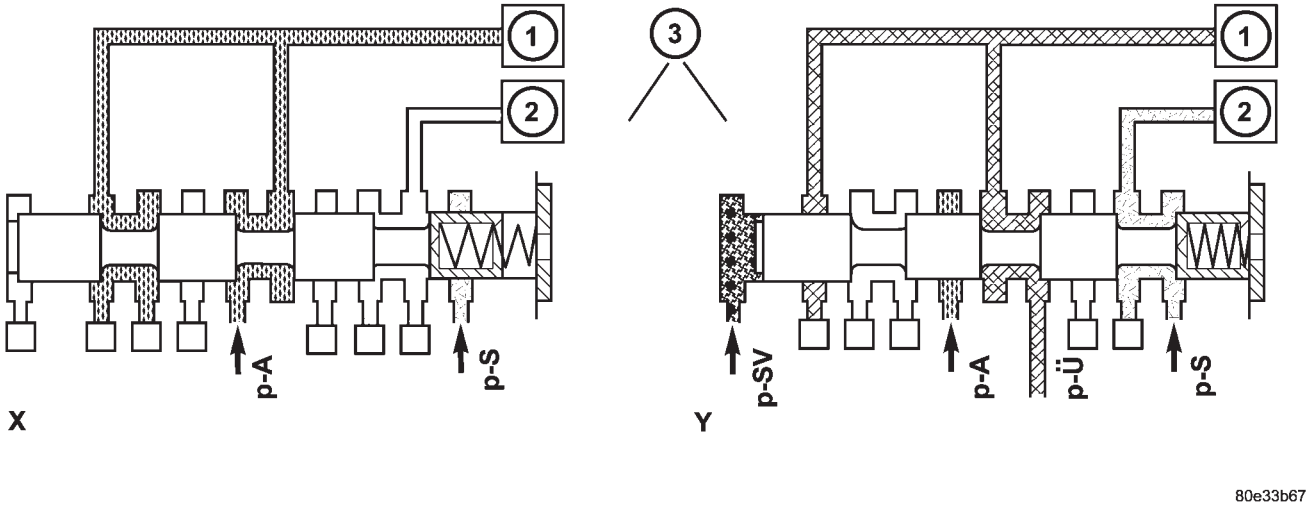

Fig. 78 Command Valve

1 - HOLDING CLUTCH B1
2 - DRIVING CLUTCH K1
3 - 1-2/4-5 COMMAND VALVE

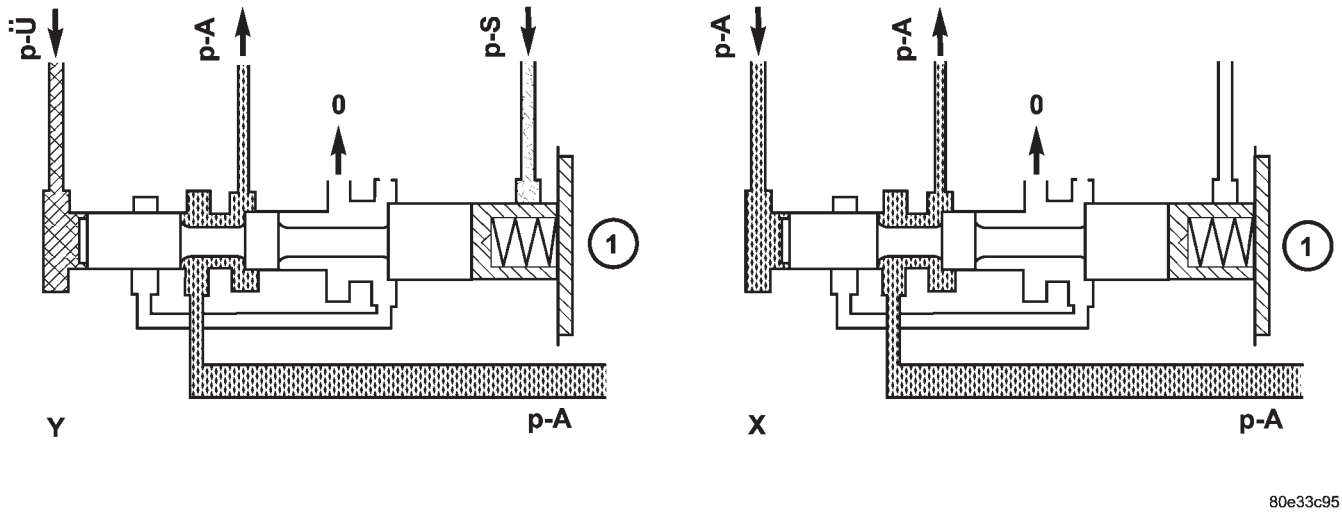

Fig. 79 Shift Valve Holding Pressure

1 - HOLDING PRESSURE SHIFT VALVE

ELECTROHYDRAULIC UNIT (Continued)

Shift Pressure Shift Valve

When the multiple-disc brake B1 (3) is activated, the working pressure (pa) is applied to the end face of the 1-2 / 4-5 shift pressure shift valve (4) (Fig. 80) via the command valve (1). Its shift state is maintained during the shift phase by substituting the shift element pressure acting on its end face (and which is variable during the shift phase) with a corresponding constant pressure. When the multi-plate clutch K1 (2) is activated, the end face of the shift valve is unpressurized during the stationary and shift phases, so the shift state is maintained during the shift phase in this case too.

Lubrication Pressure Regulating Valve

At the working pressure regulating valve surplus oil is diverted to the lubrication pressure regulating valve (1) (Fig. 81), from where the lubrication pressure (p-Sm) is used in regulated amounts to supply the transmission lubrication system including the torque converter.

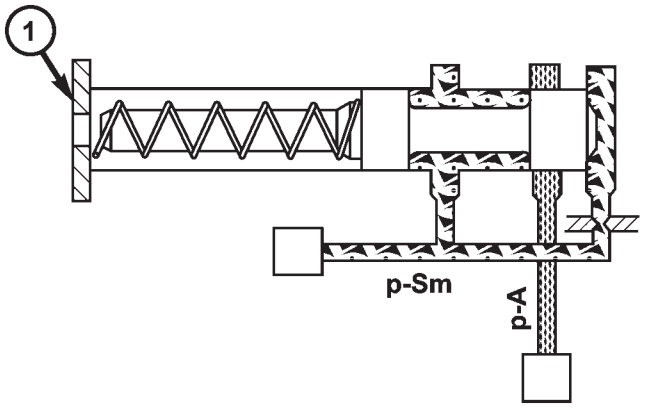

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Fig. 81 Lubrication Pressure Regulating Valve

1 - LUBRICATION PRESSURE REGULATING VALVE

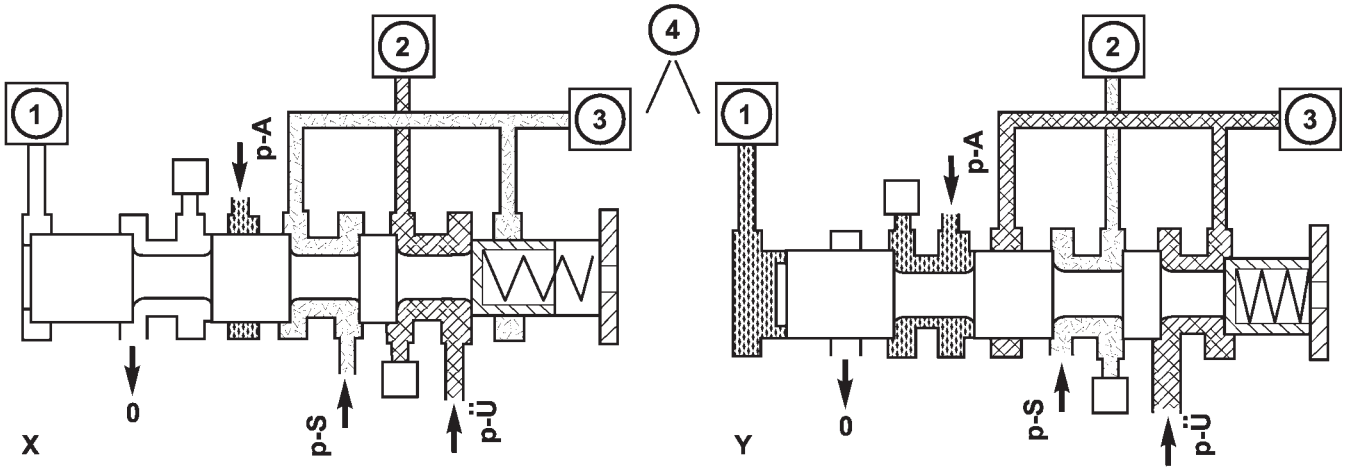

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Fig. 80 Shift Pressure Shift Valve

1 - 1-2/4-5 COMMAND VALVE
2 - DRIVING CLUTCH K1
3 - HOLDING CLUTCH B1
4 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE

ELECTROHYDRAULIC UNIT (Continued)

Shift Pressure Regulating Valve

The shift pressure is determined by the shift pressure regulating solenoid valve and the shift pressure regulating valve (3) (Fig. 82). In addition, pressure from the clutch K2 (1) is also present at the annular surface (2) of the shift pressure regulating valve (3). This reduces the shift pressure in 2nd gear.

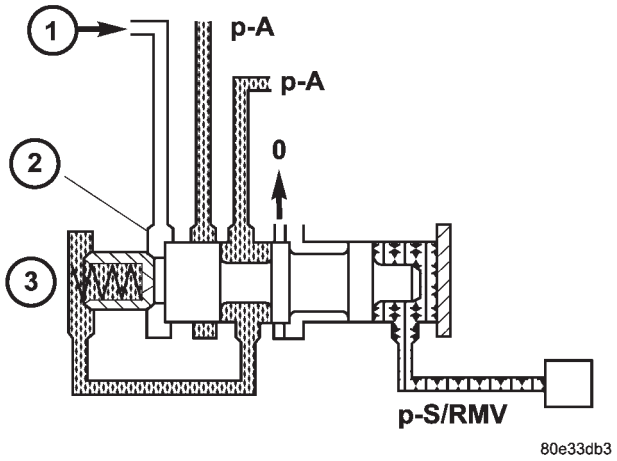

Fig. 82 Shift Pressure Regulating Valve

1 - PRESSURE FROM CLUTCH K2
2 - ANNULAR SURFACE
3 - SHIFT PRESSURE REGULATING VALVE

Regulating Valve Pressure Regulating Valve

The regulating valve pressure (p-RV) is set at the regulating valve pressure regulating valve (1) (Fig. 83) in relation to the working pressure (p-A) as far as the maximum pressure.

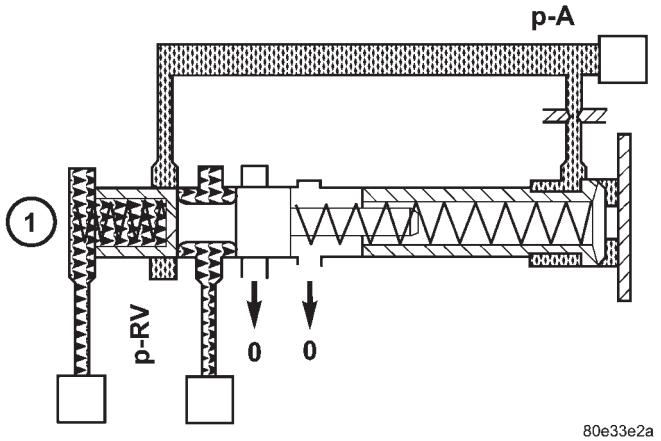

Fig. 83 Regulating Valve Pressure Regulating Valve

1 - REGULATING VALVE PRESSURE REGULATING VALVE

Shift Valve Pressure Regulating Valve

The non-constant regulating valve pressure (p-RV) is regulated to a constant shift valve pressure (p-SV) at the shift valve pressure regulating valve (1) (Fig. 84) and is used to supply the 1-2 and 4-5 / 3-4 / 2-3 solenoid valves and the torque converter lockup clutch PWM solenoid valve.

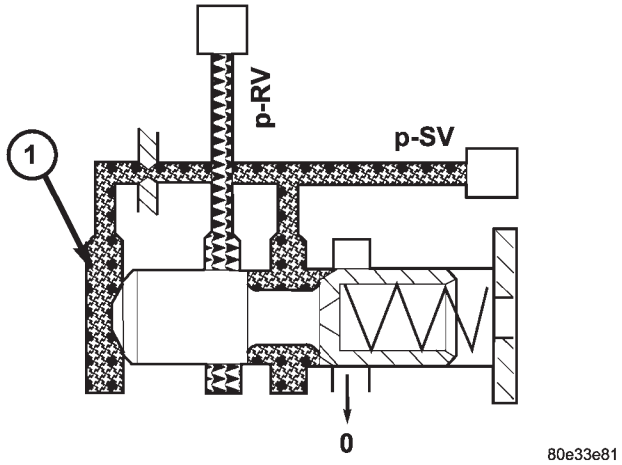

Fig. 84 Shift Valve Pressure Regulating Valve

1 - SHIFT VALVE PRESSURE REGULATING VALVE

REMOVAL

(1) Move selector lever to position ″P″.
(2) Raise vehicle.
(3) Remove bolt (3) (Fig. 85) and screw (1) holding the heat shield (2) to the transmission.
(4) Loosen guide bushing (2) (Fig. 85) and remove from transmission housing.

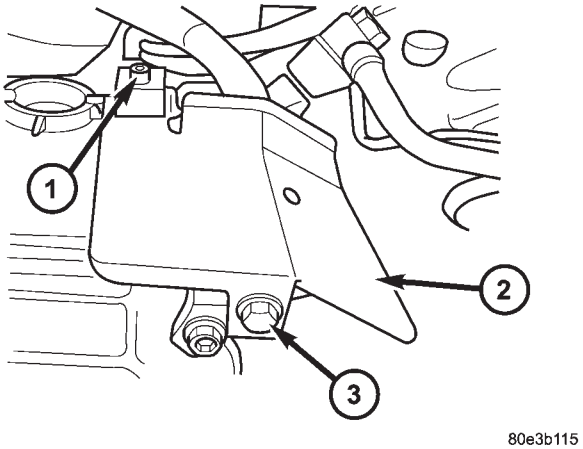

Fig. 85 Remove Heat Shield

1 - SCREW
2 - HEAT SHIELD
3 - BOLT

ELECTROHYDRAULIC UNIT (Continued)

(5) Disconnect 13-pin plug connector (1) (Fig. 86). Turn bayonet lock of guide bushing (2) anti-clockwise.

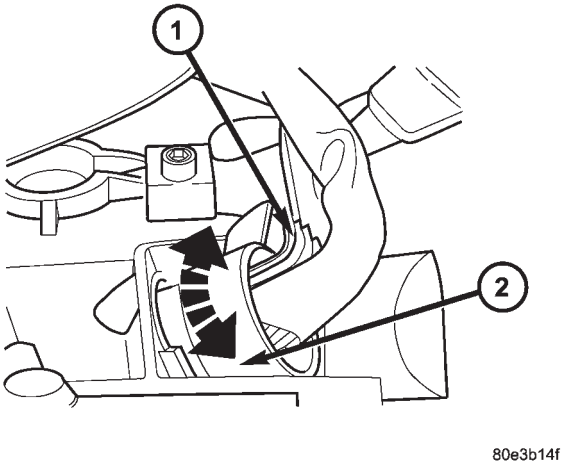

Fig. 86 Remove Wiring Connector Plug

1 - PLUG CONNECTOR
2 - GUIDE BUSHING

(6) Drain transmission oil by unscrewing oil drain plug (8) (Fig. 87).

NOTE: If the transmission fluid is burnt or contains abraded particles, the oil cooler lines and oil cooler must be flushed out.

(7) Detach oil pan (5).
(8) Remove oil filter (4).
(9) Unscrew Torx socket bolts (3) and remove electrohydraulic control module (2).

DISASSEMBLY

(1) Remove electrohydraulic unit from the vehicle.
(2) Remove solenoid caps (1, 2) (Fig. 88).
(3) Unscrew Torx socket bolts (3, 4) (Fig. 88).

NOTE: Pay attention to the different lengths of the Torx socket bolts.

(4) Remove leaf springs (5).
(5) Withdraw solenoid valves (6 - 11) from shift plate (13).

NOTE: Check O-rings on solenoid valves for damage and replace if necessary.

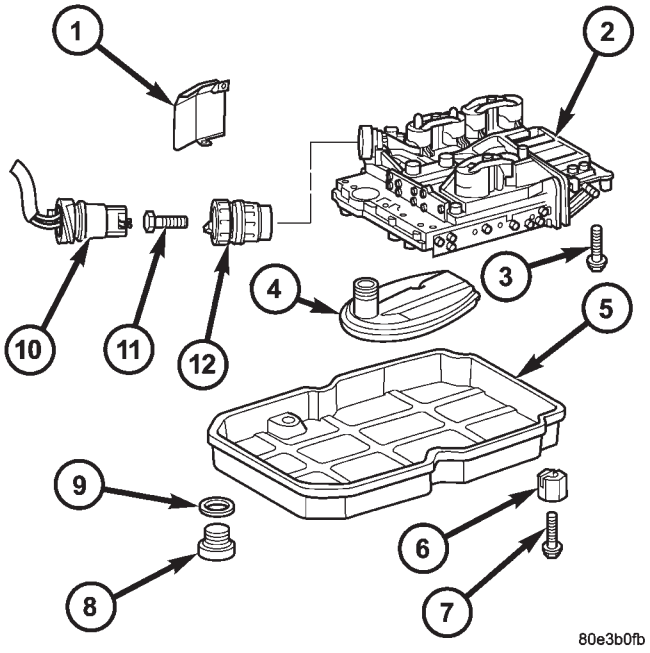

Fig. 87 Remove Electrohydraulic Unit

1 - HEAT SHIELD
2 - ELECTROHYDRAULIC UNIT
3 - BOLT
4 - OIL FILTER
5 - OIL PAN
6 - CLAMPING ELEMENT
7 - BOLT
8 - DRAIN PLUG
9 - DRAIN PLUG GASKET
10 - 13-PIN PLUG CONNECTOR
11 - BOLT
12 - GUIDE BUSHING

(6) Bend away retaining lug on stiffening rib on transmission oil temperature sensor.
(7) Remove electrohydraulic control module (12) from the shift plate (13).
(8) Note the locations of the major shift valve group components for assembly reference (Fig. 89).

NOTE: Pay great attention to cleanliness for all work on the shift plate. Fluffy cloths must not be used. Leather cloths are particularly good. After dismantling, all parts must be washed and blown out with compressed-air, noting that parts may be blown away.

ELECTROHYDRAULIC UNIT (Continued)

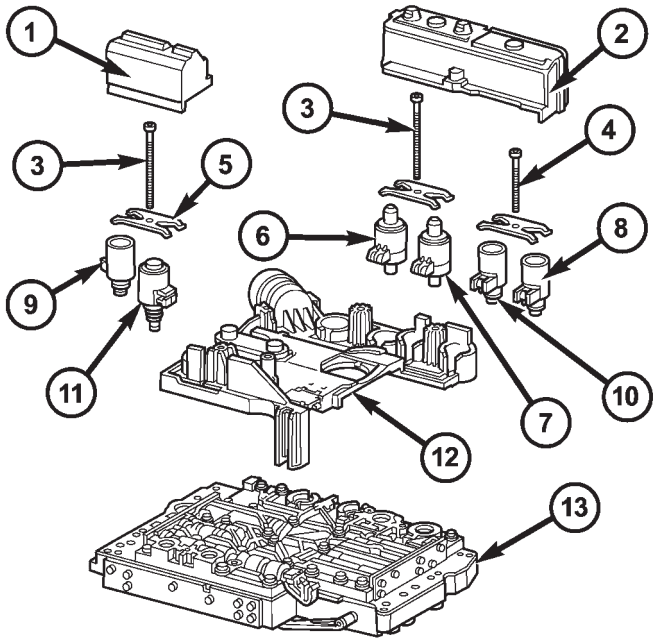

Fig. 88 Electrical Unit Components

1 - SOLENOID CAP
2 - SOLENOID CAP
3 - BOLT - M6X32
4 - BOLT - M6X30
5 - LEAF SPRING
6 - MODULATING PRESSURE REGULATING SOLENOID VALVE
7 - SHIFT PRESSURE REGULATING SOLENOID
8 - 3-4 SHIFT SOLENOID
9 - TORQUE CONVERTER LOCK-UP SOLENOID
10 - 1-2/4-5 SHIFT SOLENOID
11 - 2-3 SHIFT SOLENOID
12 - ELECTRICHYDRAULIC CONTROL MODULE
13 - SHIFT PLATE

(9) Unbolt leaf spring (5) (Fig. 90).

(10) Unscrew Torx bolts (1) (Fig. 90).

(11) Remove valve housing (2) from valve body (4) (Fig. 90).

(12) Remove the strainers for the modulating pressure and shift pressure control solenoid valves (Fig. 91) from the valve housing.

(13) Remove the strainer (1) (Fig. 92) in the inlet to torque converter lock-up control solenoid valve.

(14) Remove sealing plate (3).

NOTE: A total of 12 valve balls are located in the valve body, four made from plastic (4) and eight from steel (1, 3).

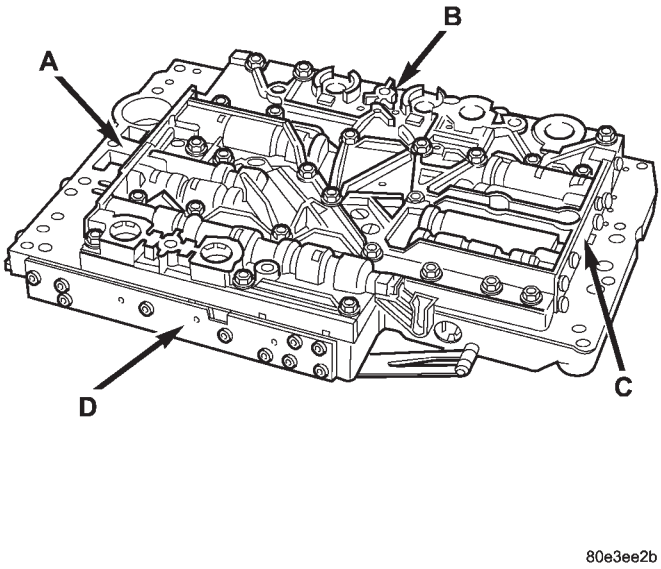

Fig. 89 Shift Valve Group Locations

A - OPERATING AND LUBRICATING PRESSURE REGULATING VALVES AND 2-3 OVERLAP VALVE

B - 1-2/4-5 SHIFT GROUP AND SHIFT, SHIFT VALVE, AND REGULATING VALVE PRESSURE REGULATING VALVES

C - 3-4 SHIFT GROUP

D - 2-3 SHIFT GROUP, TCC LOCK-UP AND B2 REGULATING VALVES

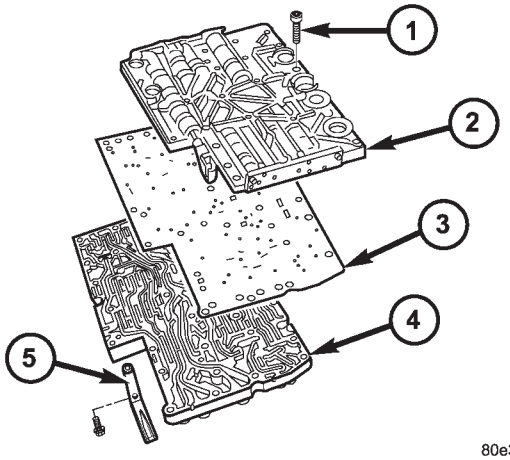

Fig. 90 Shift Plate Components

1 - BOLTS - 29
2 - VALVE HOUSING
3 - SEALING PLATE
4 - VALVE BODY
5 - LEAF SPRING

ELECTROHYDRAULIC UNIT (Continued)

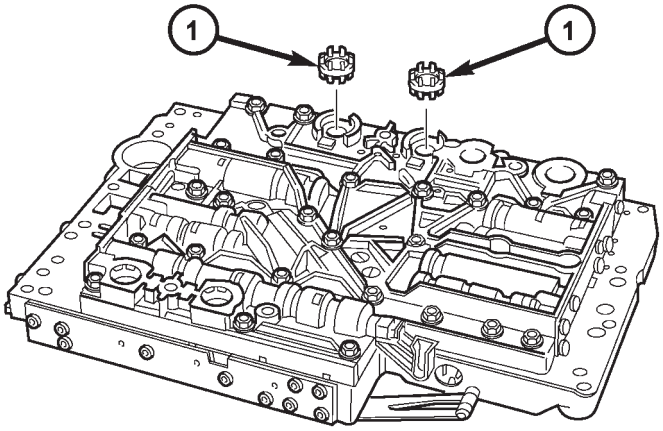

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Fig. 91 Solenoid Valve Strainer Locations

1 - SOLENOID VALVE STRAINERS

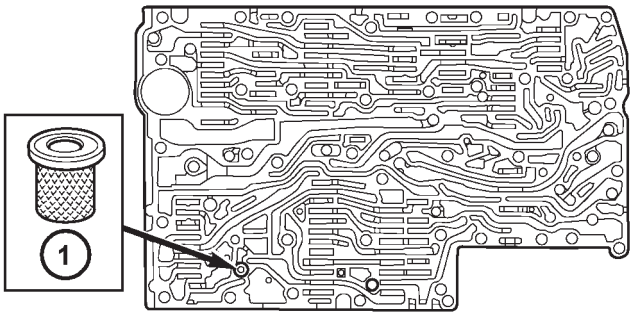

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Fig. 92 Converter Lock-up Solenoid Valve Strainer Location

1 - CONVERTER LOCK-UP SOLENOID STRAINER

(15) Note the location of all check balls (1, 3, 4) (Fig. 93) and the central strainer (2) for re-installation. Remove all check balls (1, 3, 4) and the central strainer (2).

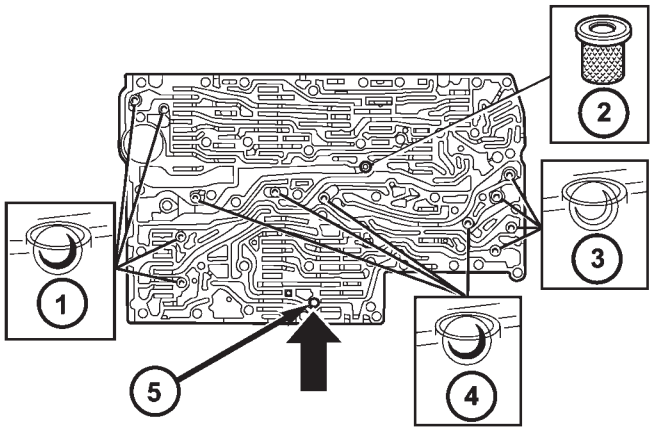

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Fig. 93 Check Balls and Strainer Location

1 - STEEL CHECK BALLS
2 - CENTRAL STRAINER
3 - STEEL CHECK BALLS
4 - PLASTIC CHECK BALLS
5 - PLAIN DOWEL PIN

(16) Remove the screws holding the side covers to the valve body and valve housing.

(17) Remove all valves and springs from the valve body (1) (Fig. 94). Check all valves for ease of movement and shavings.

NOTE: The sleeves and pistons of the overlap regulating valves must not be mixed up.

ELECTROHYDRAULIC UNIT (Continued)

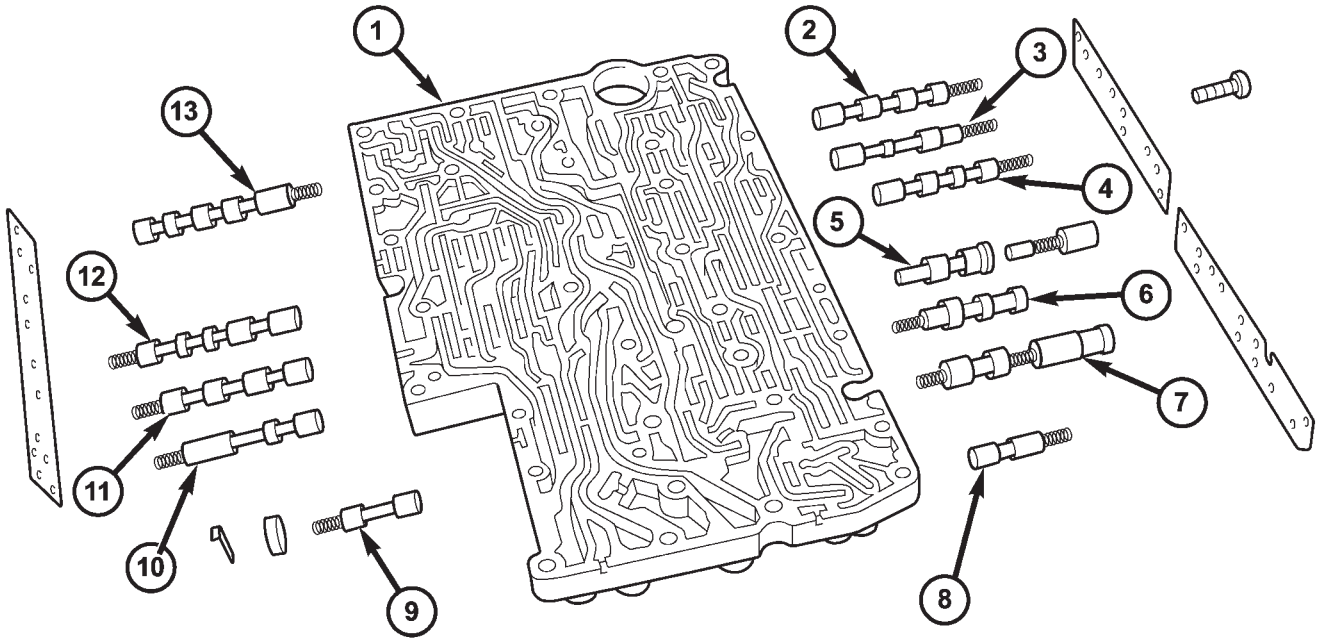

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Fig. 94 Valve Body Components

1 - VALVE BODY
2 - 1-2/4-5 COMMAND VALVE
3 - 1-2/4-5 HOLDING PRESSURE SHIFT VALVE
4 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE
5 - 1-2/4-5 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
6 - SHIFT PRESSURE REGULATING VALVE
7 - REGULATING VALVE PRESSURE REGULATING VALVE
8 - SHIFT VALVE PRESSURE REGULATING VALVE
9 - B2 SHIFT VALVE
10 - 2-3 HOLDING PRESSURE SHIFT VALVE
11 - 2-3 COMMAND VALVE
12 - 2-3 SHIFT PRESSURE SHIFT VALVE
13 - TCC LOCK-UP REGULATING VALVE

(18) Remove all valves and springs from the valve housing (2) (Fig. 95). Check all valves for ease of movement and shavings.

(19) Remove the pressure supply valve (1) (Fig. 96) from the valve body.

ASSEMBLY

NOTE: Pay great attention to cleanliness for all work on the shift plate. Fluffy cloths must not be used. Leather cloths are particularly good. After dismantling, all parts must be washed and blown out with compressed-air, noting that parts may be blown away.

(1) Install the pressure supply valve (1) (Fig. 97) into the valve body.

ELECTROHYDRAULIC UNIT (Continued)

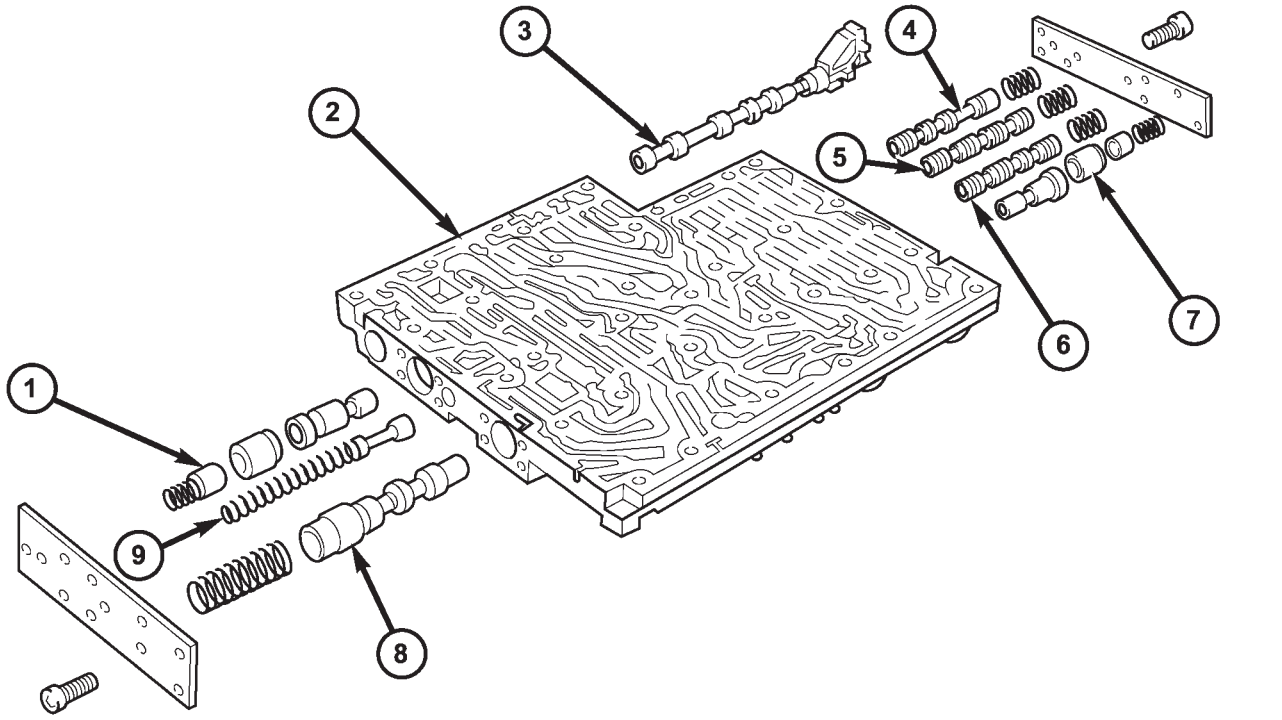

Fig. 95 Valve Housing Components

1 - 2-3 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
2 - VALVE HOUSING
3 - SELECTOR VALVE
4 - 3-4 HOLDING PRESSURE SHIFT VALVE
5 - 3-4 COMMAND VALVE
6 - 3-4 SHIFT PRESSURE SHIFT VALVE
7 - 3-4 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
8 - OPERATING PRESSURE REGULATING VALVE
9 - LUBRICATING PRESSURE REGULATING VALVE

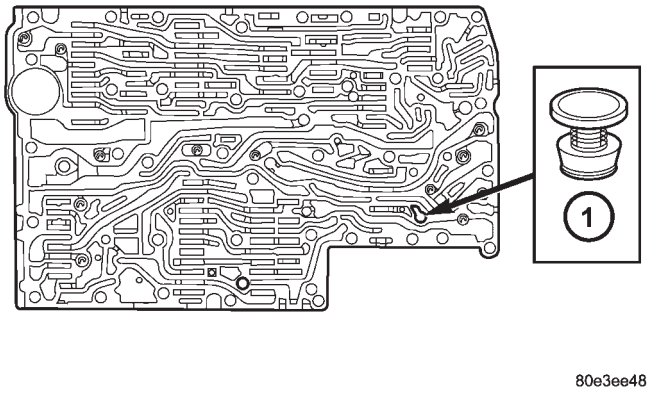

Fig. 96 Pressure Feed Valve Location

1 - PRESSURE FEED VALVE

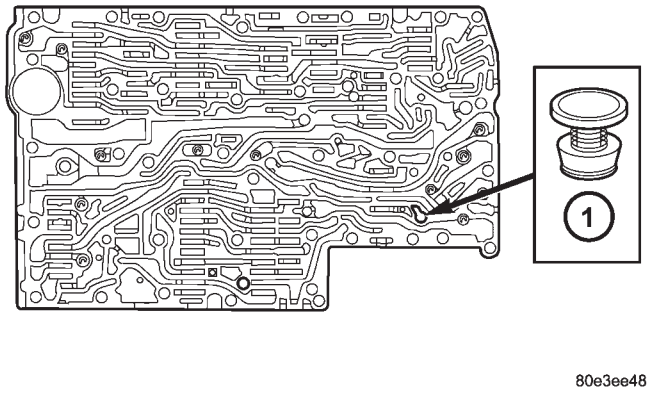

Fig. 97 Pressure Feed Valve Location

1 - PRESSURE FEED VALVE

ELECTROHYDRAULIC UNIT (Continued)

(2) Install all valves and springs from the valve body (1) (Fig. 98). Check all valves for ease of movement and shavings.

NOTE: The sleeves and pistons of the overlap regulating valves must not be mixed up.

(3) Install all valves and springs into the valve housing (2) (Fig. 99). Check all valves for ease of movement and shavings.

(4) Install the screws to hold the side covers to the valve body and valve housing. Tighten the screws to 4 N·m.

NOTE: A total of 12 valve balls are located in the valve body, four made from plastic (4) and eight from steel (1, 3).

(5) Install all check balls (1, 3, 4) (Fig. 100) and the central strainer (2).

(6) Install the strainer (1) (Fig. 101) in the inlet to torque converter lock-up control solenoid valve.

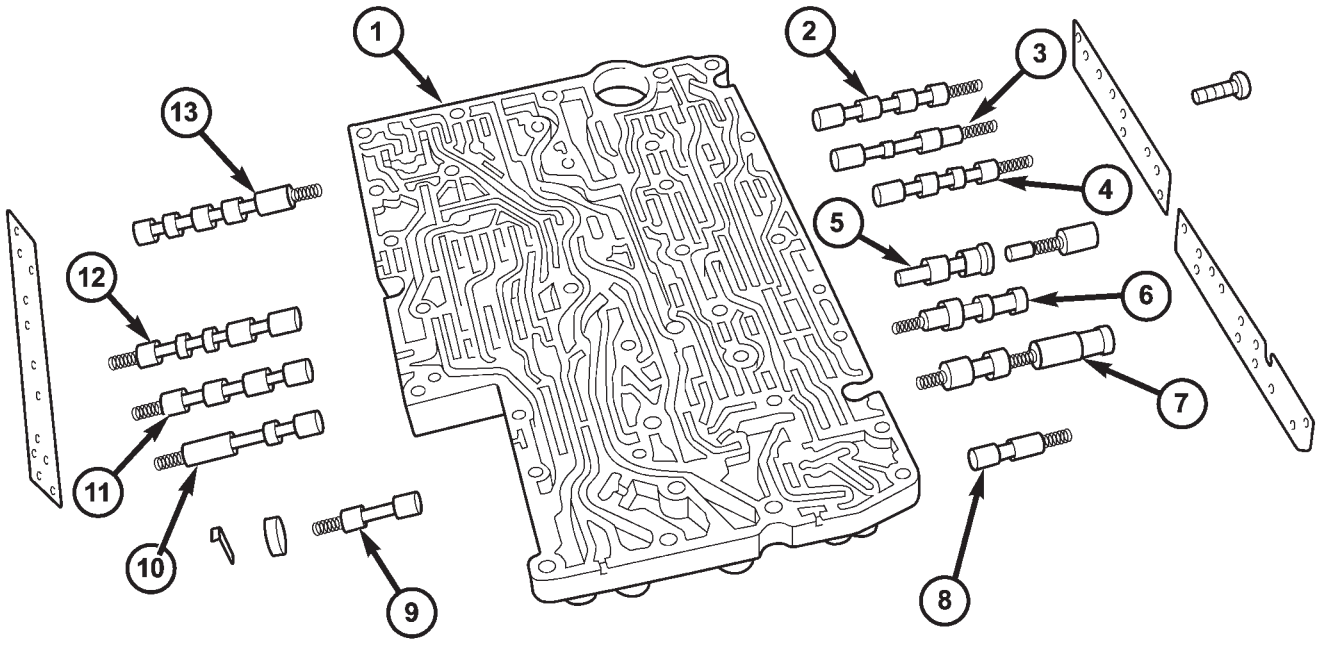

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Fig. 98 Valve Body Components

1 - VALVE BODY
2 - 1-2/4-5 COMMAND VALVE
3 - 1-2/4-5 HOLDING PRESSURE SHIFT VALVE
4 - 1-2/4-5 SHIFT PRESSURE SHIFT VALVE
5 - 1-2/4-5 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
6 - SHIFT PRESSURE REGULATING VALVE
7 - REGULATING VALVE PRESSURE REGULATING VALVE
8 - SHIFT VALVE PRESSURE REGULATING VALVE
9 - B2 SHIFT VALVE
10 - 2-3 HOLDING PRESSURE SHIFT VALVE
11 - 2-3 COMMAND VALVE
12 - 2-3 SHIFT PRESSURE SHIFT VALVE
13 - TCC LOCK-UP REGULATING VALVE

ELECTROHYDRAULIC UNIT (Continued)

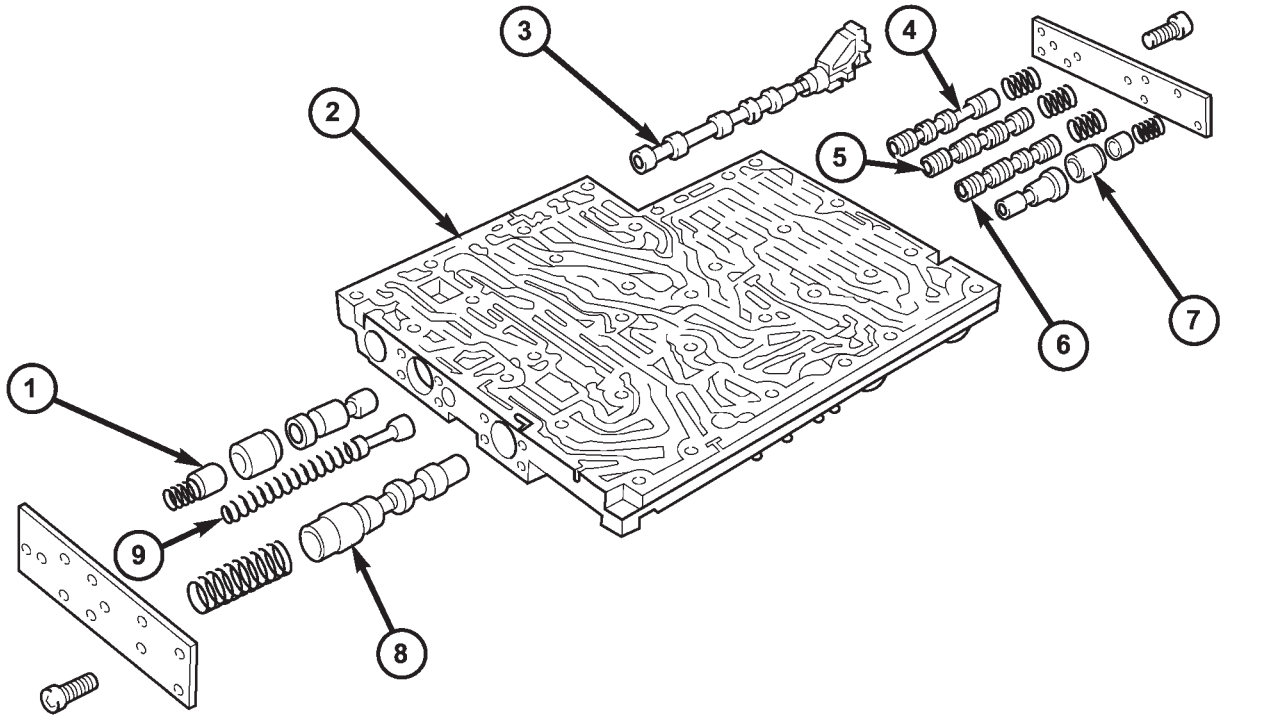

Fig. 99 Valve Housing Components

1 - 2-3 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
2 - VALVE HOUSING
3 - SELECTOR VALVE
4 - 3-4 HOLDING PRESSURE SHIFT VALVE
5 - 3-4 COMMAND VALVE
6 - 3-4 SHIFT PRESSURE SHIFT VALVE
7 - 3-4 OVERLAP REGULATING VALVE, SLEEVE, AND PISTON
8 - OPERATING PRESSURE REGULATING VALVE
9 - LUBRICATING PRESSURE REGULATING VALVE

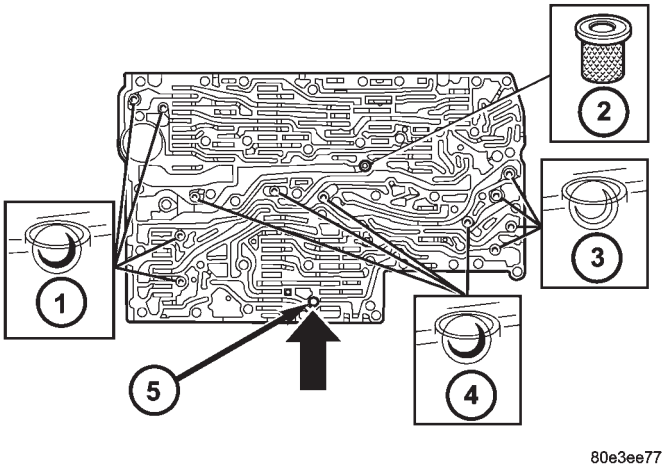

Fig. 100 Check Balls and Strainer Location

1 - STEEL CHECK BALLS
2 - CENTRAL STRAINER
3 - STEEL CHECK BALLS
4 - PLASTIC CHECK BALLS
5 - PLAIN DOWEL PIN

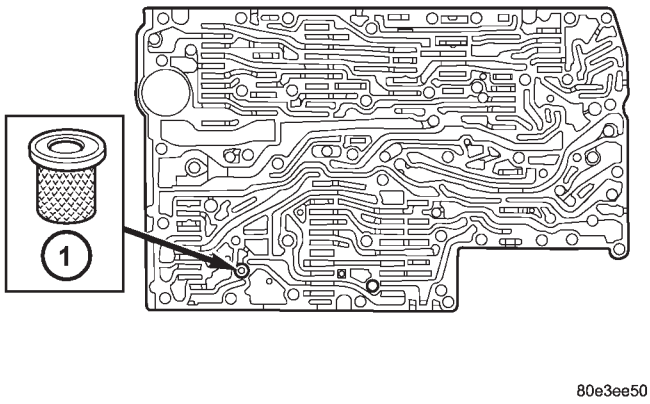

Fig. 101 Converter Lock-up Solenoid Valve Strainer Location

1 - CONVERTER LOCK-UP SOLENOID STRAINER

(7) Position the sealing plate (3) onto the valve body (4) (Fig. 102).

ELECTROHYDRAULIC UNIT (Continued)

(8) Install the valve housing (2) onto the valve body (4) and sealing plate (3).

(9) Install the shift plate Torx bolts (1) (Fig. 102). Tighten the bolts to 8 N·m.

(10) Install leaf spring (5) (Fig. 102).

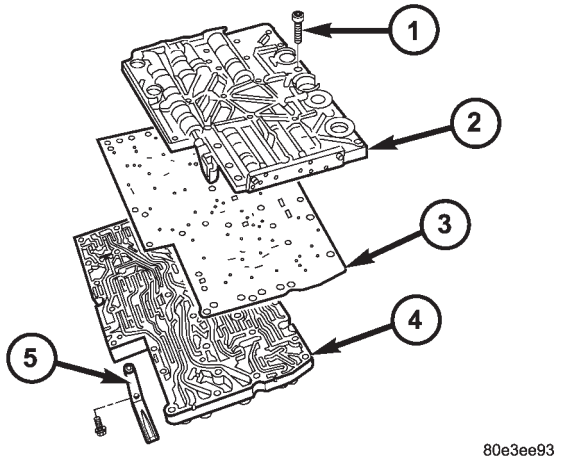

Fig. 102 Shift Plate Components

1 - BOLTS - 29
2 - VALVE HOUSING
3 - SEALING PLATE
4 - VALVE BODY
5 - LEAF SPRING

(11) Install the strainers for the modulating pressure and shift pressure control solenoid valves (Fig. 103) into the valve housing.

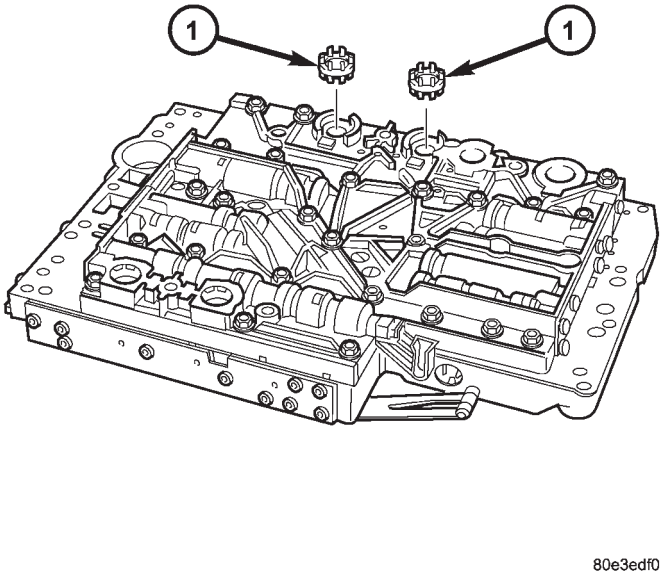

Fig. 103 Solenoid Valve Strainer Locations

1 - SOLENOID VALVE STRAINERS

(12) Install the electrohydraulic control module (12) onto the shift plate (13) (Fig. 104).

(13) Bend the retaining lug on stiffening rib on transmission oil temperature sensor to retain the electrohydraulic control module.

(14) Install the solenoid valves (6 - 11) into shift plate (13).

NOTE: Check O-rings on solenoid valves for damage and replace if necessary.

(15) Install the leaf springs (5).

(16) Install the Torx socket bolts (3, 4) (Fig. 104). Tighten the bolts to 8 N·m.

NOTE: Pay attention to the different lengths of the Torx socket bolts.

(17) Install the solenoid caps (1, 2).

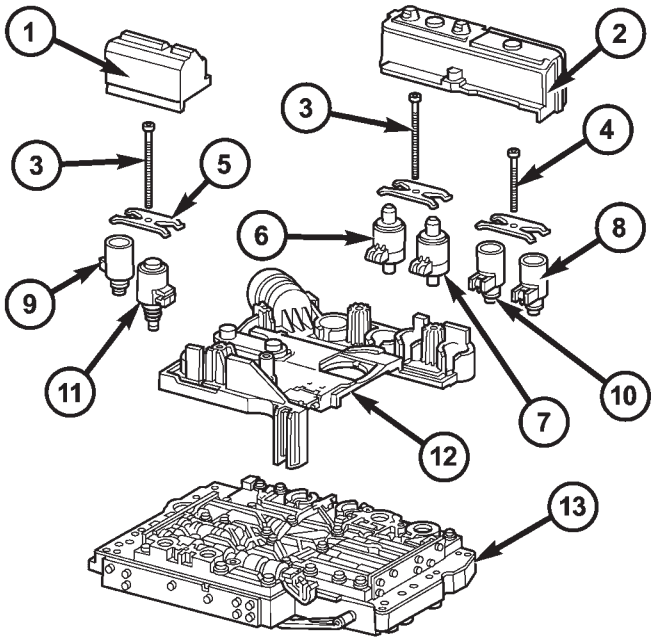

Fig. 104 Electrical Unit Components

1 - SOLENOID CAP
2 - SOLENOID CAP
3 - BOLT - M6X32
4 - BOLT - M6X30
5 - LEAF SPRING
6 - MODULATING PRESSURE REGULATING SOLENOID VALVE
7 - SHIFT PRESSURE REGULATING SOLENOID
8 - 3-4 SHIFT SOLENOID
9 - TORQUE CONVERTER LOCK-UP SOLENOID
10 - 1-2/4-5 SHIFT SOLENOID
11 - 2-3 SHIFT SOLENOID
12 - ELECTRICHYDRAULIC CONTROL MODULE
13 - SHIFT PLATE

(18) Install the electrohydraulic unit into the vehicle.

ELECTROHYDRAULIC UNIT (Continued)

INSTALLATION

(1) Position the electrohydraulic unit in the transmission housing.

(2) Insert selector valve (1) (Fig. 105) in driver of detent plate (2). When installing the electrohydraulic control module in the transmission housing, the plastic part of the selector valve (1) must engage in the driver of the detent plate (2).

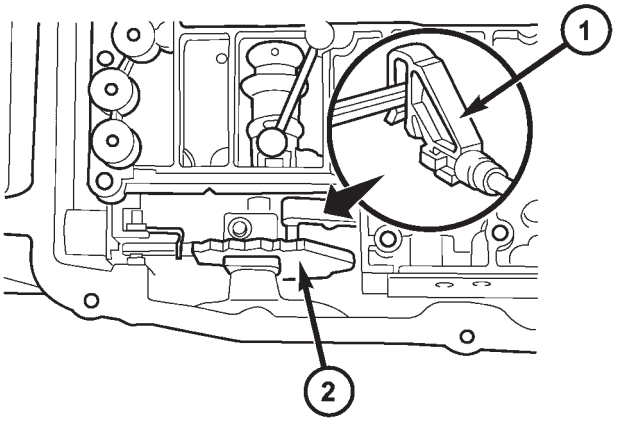

Fig. 105 Connect The Selector Valve To The Detent Plate

1 - SELECTOR VALVE
2 - DETENT PLATE

(3) Install the Torx socket bolts (3) (Fig. 106) and torque to 8 N·m.

(4) Install a new oil filter (4) (Fig. 106).

(5) Install oil pan (5) (Fig. 106).

(6) Install the oil drain plug (8) (Fig. 106) with a new drain plug gasket (9). Torque the drain plug to 20 N·m.

(7) Install the guide bushing (2) (Fig. 106) into the transmission housing and install the bolt to hold the guide bushing in place.

(8) Check O-ring on plug connector (1) (Fig. 107), and replace if necessary.

(9) Install the plug connector (1) into the guide bushing (2). Turn bayonet lock of guide bushing (2) clockwise to connect plug connector (1).

(10) Position the heat shield (2) (Fig. 108) onto the transmission housing and install the screw (1) and bolt (3) to hold the shield in place.

(11) Check oil level in automatic transmission, or add oil.

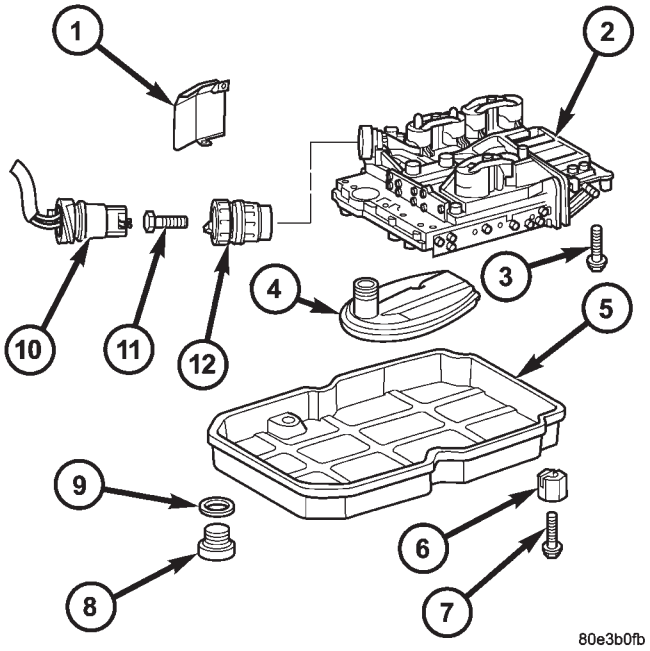

Fig. 106 Remove Electrohydraulic Unit

1 - HEAT SHIELD
2 - ELECTROHYDRAULIC UNIT
3 - BOLT
4 - OIL FILTER
5 - OIL PAN
6 - CLAMPING ELEMENT
7 - BOLT
8 - DRAIN PLUG
9 - DRAIN PLUG GASKET
10 - 13-PIN PLUG CONNECTOR
11 - BOLT
12 - GUIDE BUSHING

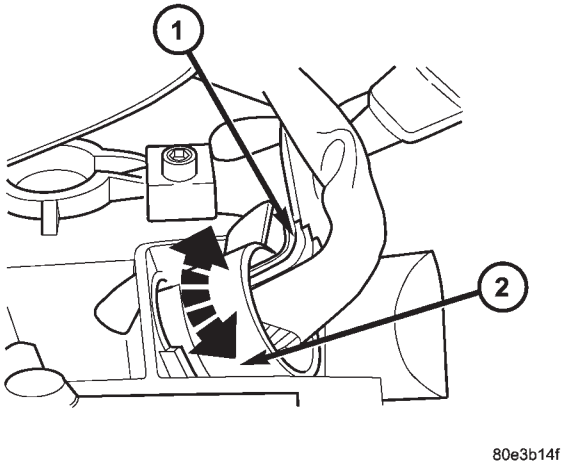

Fig. 107 Install Wiring Connector Plug

1 - PLUG CONNECTOR
2 - GUIDE BUSHING

ELECTROHYDRAULIC UNIT (Continued)

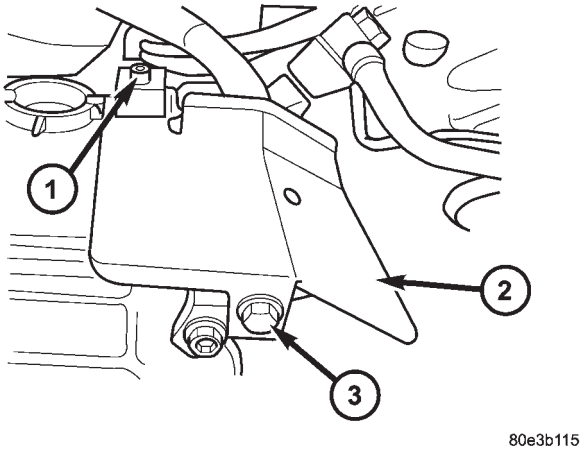

Fig. 108 Install Heat Shield

1 - SCREW
2 - HEAT SHIELD
3 - BOLT

FLUID AND FILTER

DESCRIPTION

The oil level control (Fig. 109) is located on the electrohydraulic unit and consists of the float (5) which is integrated into the electrohydraulic unit. The float is positioned to plug the opening between the oil gallery and gearset chamber so that the rotating gearsets do not splash about in oil as the oil level rises. The oil level control reduces power loss and prevents oil from being thrown out of the transmission housing at high oil temperatures.

OPERATION

With low oil levels (Fig. 110), the lubricating oil which flows constantly out of the gearset, flows back to oil gallery (2) though the opening (6). If the oil level rises, the oil presses the float (5) against the housing opening (6). The float (5) therefore separates the oil gallery (2) from the gearset chamber (1). The lubricating oil which continues to flow out of the gearsets is thrown against the housing wall, incorporated by the rotating parts and flows back into the oil gallery (2) through the upper opening (arrow).

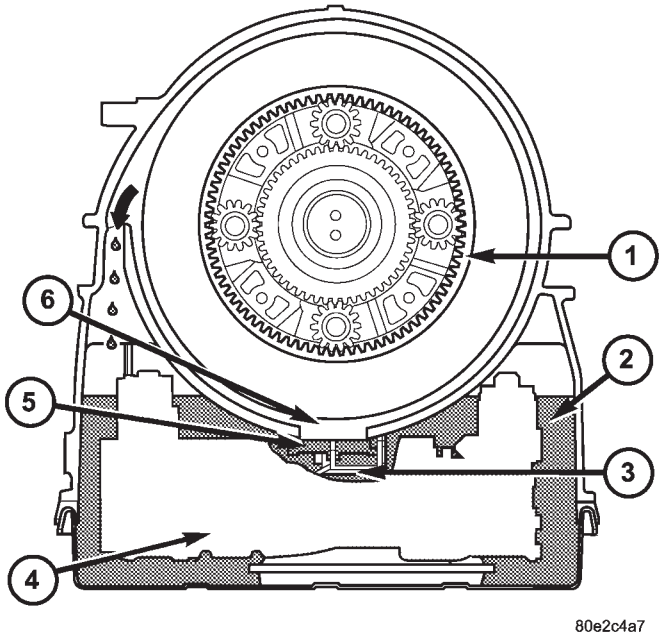

Fig. 109 Fluid Level Control

1 - GEARSET CHAMBER
2 - OIL GALLERY
3 - SHELL OF ELECTROHYDRAULIC UNIT
4 - ELECTROHYDRAULIC UNIT
5 - FLOAT
6 - OPENING

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - 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 and clutch 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.

FLUID AND FILTER (Continued)

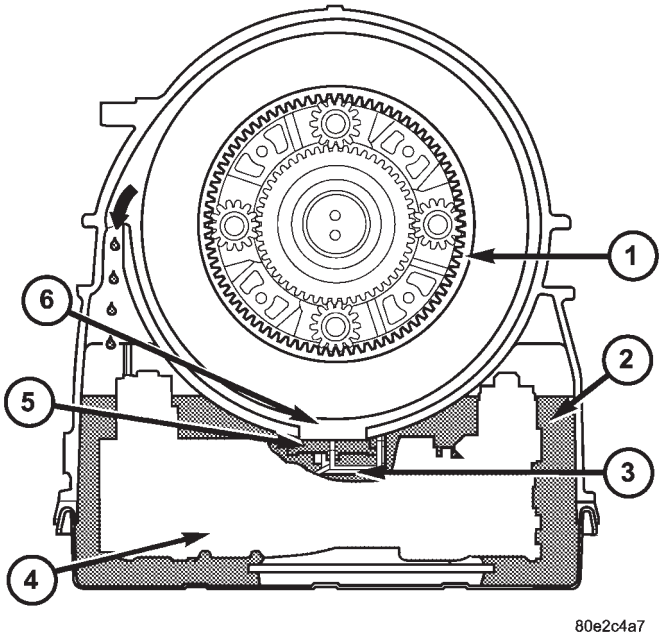

Fig. 110 Fluid Level Control

1 - GEARSET CHAMBER
2 - OIL GALLERY
3 - SHELL OF ELECTROHYDRAULIC UNIT
4 - ELECTROHYDRAULIC UNIT
5 - FLOAT
6 - OPENING

DIAGNOSIS AND TESTING - CAUSES OF BURNT FLUID

Burnt, discolored fluid is a result of overheating which has three primary causes.

(1) Internal clutch slippage, usually caused by low line pressure, inadequate clutch apply pressure, or clutch seal failure.

(2) 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.

(3) 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.

DIAGNOSIS AND TESTING - FLUID CONTAMINATION

Transmission fluid contamination is generally a result of:

- adding incorrect fluid
- failure to clean dipstick and fill tube when checking level
- 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, an overhaul is necessary.

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.

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FLUID AND FILTER (Continued)

STANDARD PROCEDURE

STANDARD PROCEDURE - CHECK OIL LEVEL

(1) Verify that the vehicle is parked on a level surface.

(2) Remove locking pin (1) (Fig. 111). Remove the plate of the locking pin with a suitable tool and press out the pin remaining in the cap downwards.

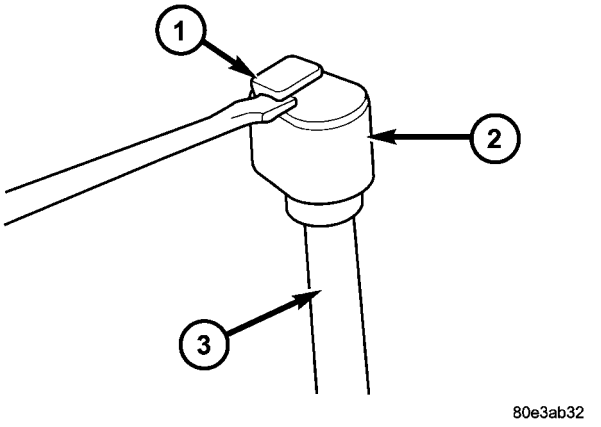

Fig. 111 Remove Dipstick Tube Cap Lock

1 - LOCKING PIN
2 - TUBE CAP
3 - DIPSTICK TUBE

(3) Remove cap (2).

WARNING: Risk of accident from vehicle starting off by itself when engine running. Risk of injury from contusions and burns if you insert your hands into the engine when it is started or when it is running. Secure vehicle to prevent it from moving off by itself. Wear properly fastened and close-fitting work clothes. Do not touch hot or rotating parts.

(4) Actuate the service brake. Start engine and let it run at idle speed in selector lever position ″P″.

(5) Shift through the transmission modes several times with the vehicle stationary and the engine idling

(6) Warm up the transmission, wait at least 2 minutes and check the oil level with the engine running. Push the Oil Dipstick 8863 in up to the stop and pull out again, read off oil level, repeat if necessary.

(7) Check transmission oil temperature.

NOTE: The true transmission oil temperature can only be read by a scan tool in REVERSE or any forward gear position. (Refer to 21 - AUTOMATIC TRANSMISSION-W5J400/TRANSMISSION TEMPERATURE SENSOR/PARK-NEUTRAL SWITCH - OPERATION)

(8) The transmission Oil Dipstick 8863 has indicator marks every 10mm. Determine the height of the oil level on the dipstick and using the height, the transmission temperature, and the Transmission Fluid Graph (Fig. 112), determine if the transmission oil level is correct.

(9) Add additional oil if necessary. Use Funnel 8908 to add oil.

(10) If the oil level is above the correct height, use Pump 8910 to remove the excess oil

(11) Re-check oil level as necessary.

(12) Once the oil level is correct, install a new dipstick tube cap (2) (Fig. 113) and lock pin (1).

STANDARD PROCEDURE - TRANSMISSION FILL

To avoid overfilling transmission after a fluid change or overhaul, perform the following procedure:

(1) Verify that the vehicle is parked on a level surface.

(2) Remove locking pin (1) (Fig. 114). Remove the plate of the locking pin with a suitable tool and press out the pin remaining in the cap downwards.

(3) Remove cap (2).

(4) Insert clean Funnel 8908 in transmission fill tube.

(5) Add following initial quantity of Shell® 3403 to transmission:

(a) If only fluid and filter were changed, add **5.0 L (10.6 pts.)** of transmission fluid to transmission.

(b) If transmission was completely overhauled, torque converter was replaced or drained, and cooler was flushed, add **7.7 L (16.3 pts.)** of transmission fluid to transmission.

(6) Check the transmission fluid (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - W5J400/FLUID - STANDARD PROCEDURE) and adjust as required.

FLUID AND FILTER (Continued)

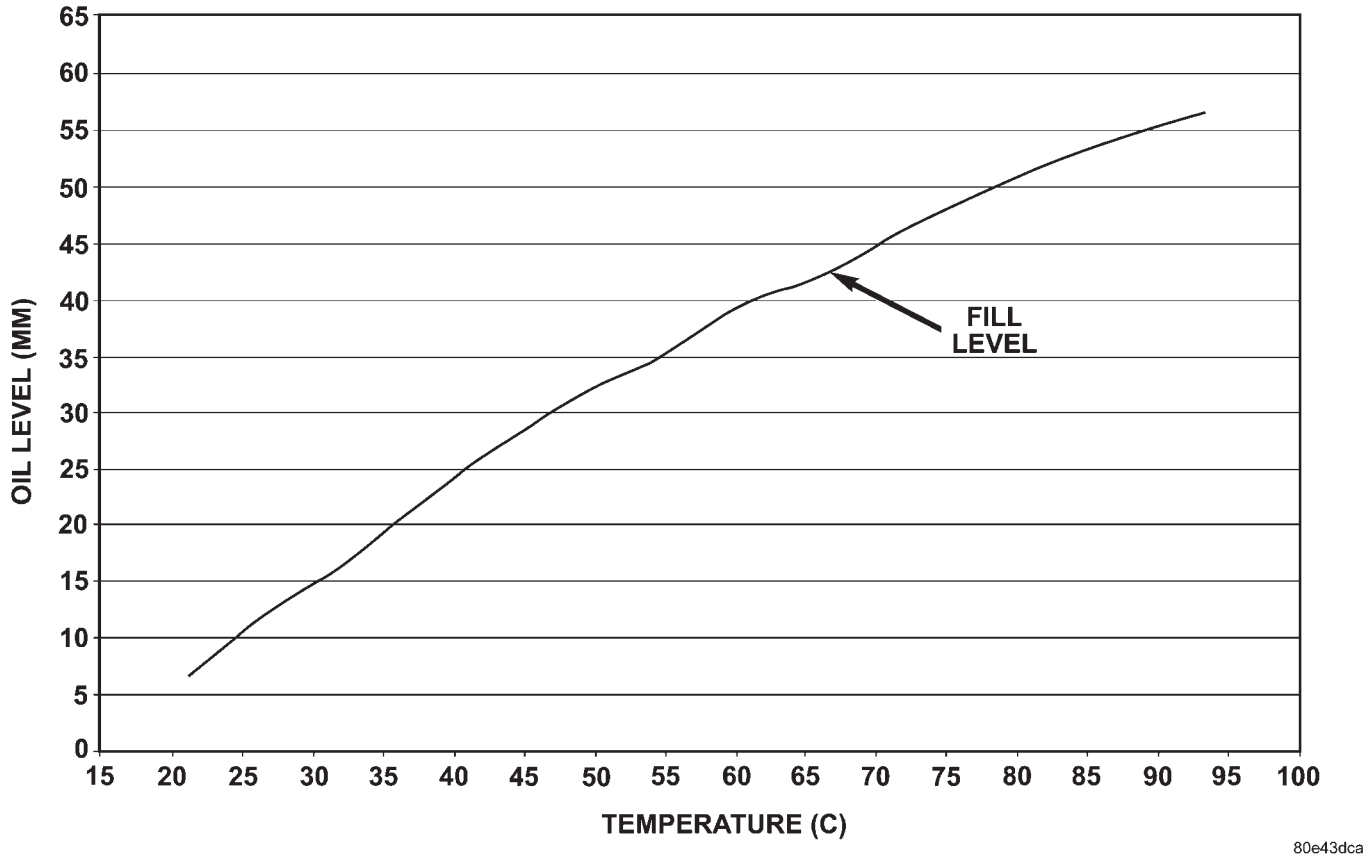

Fig. 112 W5J400 Fill Level Chart

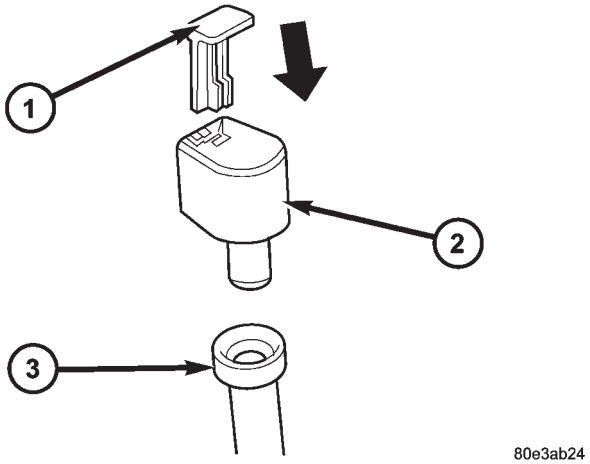

Fig. 113 Dipstick Tube Cap Components

1 - LOCKING PIN
2 - TUBE CAP
3 - DIPSTICK TUBE

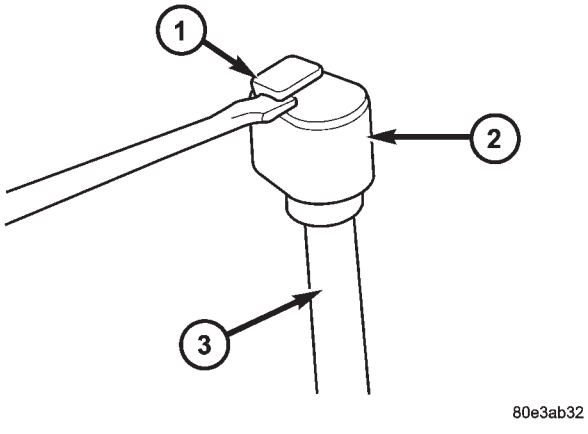

Fig. 114 Remove Dipstick Tube Cap Lock

1 - LOCKING PIN
2 - TUBE CAP
3 - DIPSTICK TUBE

FREEWHEELING CLUTCH

DESCRIPTION

Freewheeling clutches (Fig. 115) are installed in the front planetary gear set between the sun gear and the stator shaft, and in the rear planetary gear set between the sun gear and the intermediate shaft.

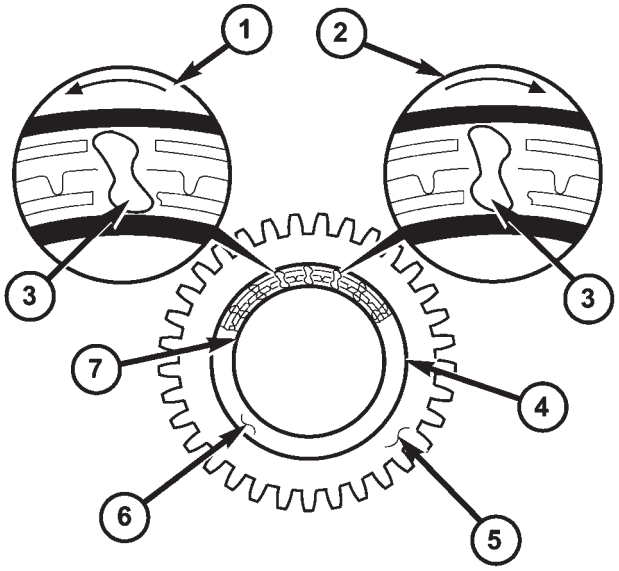

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Fig. 115 Freewheeling Clutch

1 - ROTATION DIRECTION ″A″
2 - ROTATION DIRECTION ″B″
3 - LOCKING ELEMENTS
4 - OUTER RACE
5 - FRONT OR REAR SUN GEAR
6 - LOCKING ELEMENT CAGE
7 - INNER RACE

The freewheel consists of an outer race (4), an inner race (7), a number of locking elements (3) and a cage (6) for these locking elements.

OPERATION

The freewheeling clutch (Fig. 116) optimizes individual gearshifts. They lock individual elements of a planetary gear set together or against the transmission housing in one direction of rotation to allow the torque to be transmitted.

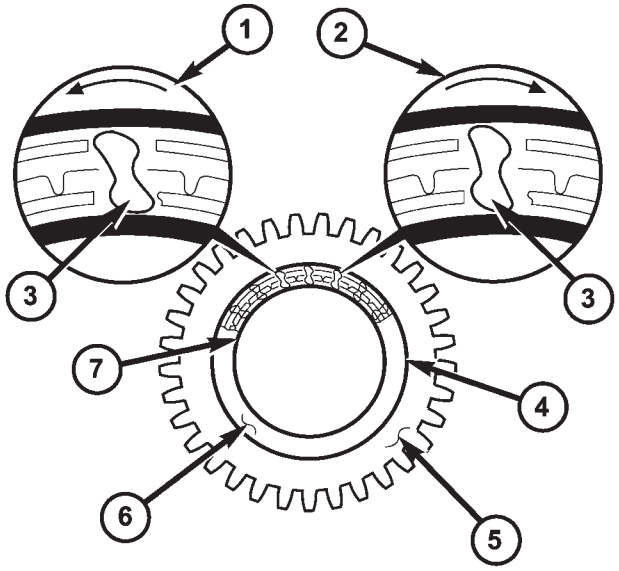

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Fig. 116 Freewheeling Clutch

1 - ROTATION DIRECTION ″A″
2 - ROTATION DIRECTION ″B″
3 - LOCKING ELEMENTS
4 - OUTER RACE
5 - FRONT OR REAR SUN GEAR
6 - LOCKING ELEMENT CAGE
7 - INNER RACE

If the inner race (7) of the freewheeling clutch is locked and the outer race (4) turns in direction ″A″ (1), the locking elements (3) adopt a diagonal position on account of their special contours, allowing the freewheel function. The outer race (4) slides over the locking elements (3) with negligible friction. If the rotation of the outer race (4) changes to direction ″B″ (2), the locking elements (3) stand up and lock the outer and inner races (4, 7) together.

FREEWHEELING CLUTCH (Continued)

DISASSEMBLY

(1) Remove retaining ring (5) (Fig. 117) from hollow shaft (1).

(2) Remove rear sun gear (4) with the K3 internally toothed disk carrier and rear freewheeling clutch F2 (3).

(3) Remove snap-ring (2) (Fig. 117) for freewheel.

(4) Press freewheeling clutch out of sun gear.

(5) Check O-rings (6), replace if necessary.

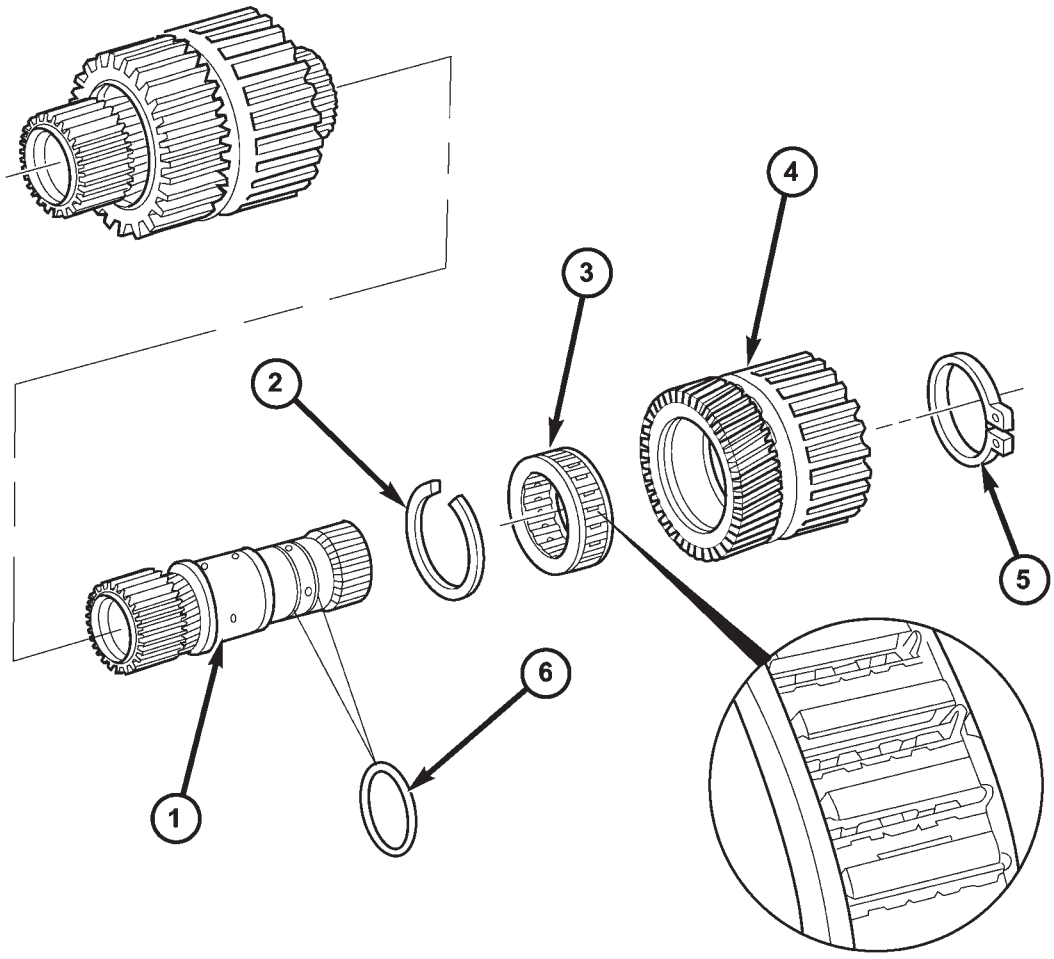

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Fig. 117 Freewheeling Clutch F2

1 - HOLLOW SHAFT
2 - SNAP-RING
3 - FREEWHEELING CLUTCH F2
4 - K3 INNER DISC CARRIER AND REAR PLANETARY SUN GEAR
5 - RETAINING RING
6 - O-RINGS

FREEWHEELING CLUTCH (Continued)

(6) Check the anti-friction bearing (Fig. 118) in the rear planetary sun gear for damage. Replace as necessary.

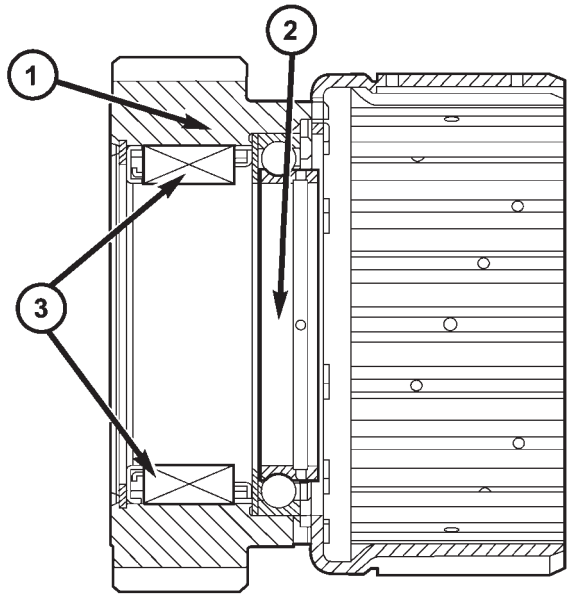

Fig. 118 Freewheeling Clutch F2 Anti-Friction Bearing

1 - K3 INNER DISC CARRIER AND REAR PLANETARY SUN GEAR
2 - ANTI-FRICTION BEARING
3 - FREEWHEELING CLUTCH F2

ASSEMBLY

(1) Press freewheeling clutch F2 (3) (Fig. 119) into sun gear (4).

(2) Install snap-ring (2) for freewheeling clutch.

(3) Check O-rings (6) (Fig. 119) on hollow shaft, replace if necessary.

(4) Install rear sun gear (4) with K3 internally toothed disc carrier and rear freewheeling clutch (3) onto the hollow shaft.

(5) Install retaining ring (5) onto hollow shaft (1).

FREEWHEELING CLUTCH (Continued)

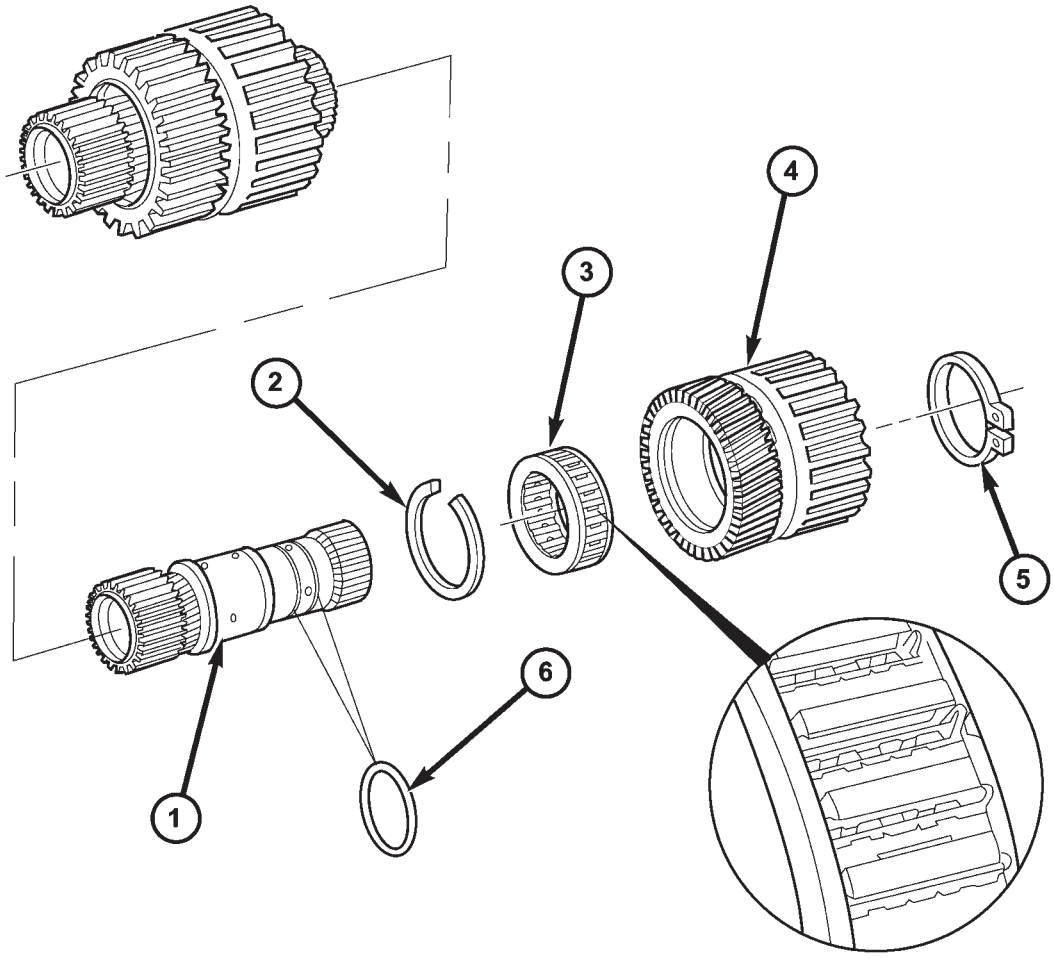

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Fig. 119 Freewheeling Clutch F2

1 - HOLLOW SHAFT	4 - K3 INNER DISC CARRIER AND REAR PLANETARY SUN GEAR
2 - SNAP-RING	5 - RETAINING RING
3 - FREEWHEELING CLUTCH F2	6 - O-RINGS

GEARSHIFT CABLE

DIAGNOSIS AND TESTING - GEARSHIFT CABLE

(1) The floor shifter lever and gate positions should be in alignment with all transmission PARK, NEUTRAL, and gear detent positions.

(2) Engine starts must be possible with floor shift lever in PARK or NEUTRAL gate positions only. Engine starts must not be possible in any other gear position.

(3) With floor shift lever handle push-button not depressed and lever in:

(a) PARK position - Apply forward force on center of handle and remove pressure. Engine starts must be possible.

(b) PARK position - Apply rearward force on center of handle and remove pressure. Engine starts must be possible.

(c) NEUTRAL position - Normal position. Engine starts must be possible.

(d) NEUTRAL position - Engine running and brakes applied, apply forward force on center of shift handle. Transmission shall not be able to shift from NEUTRAL to REVERSE.

GEARSHIFT CABLE (Continued)

REMOVAL

(1) Shift transmission into PARK.
(2) Raise vehicle.
(3) Remove the shift cable eyelet from the transmission manual shift lever.
(4) Remove shift cable from the cable support bracket.
(5) Lower vehicle.
(6) Remove necessary console parts for access to shift lever assembly and shift cable. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - REMOVAL)
(7) Disconnect cable at shift lever and shifter assembly bracket (Fig. 120).
(8) Remove the nuts holding the shift cable seal plate to the floor pan (Fig. 121).
(9) Pull cable through floor panel opening.

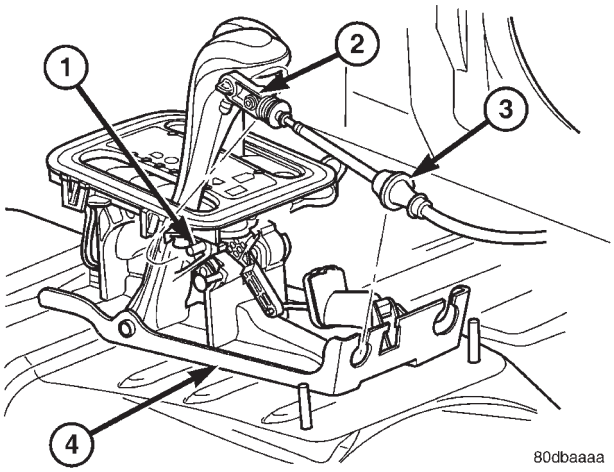


Fig. 120 Transmission Shift Cable at Shifter - Typical

1 - SHIFT LEVER PIN
2 - ADJUSTMENT SCREW
3 - SHIFT CABLE
4 - SHIFTER ASSEMBLY BRACKET

(10) Remove shift cable from vehicle.

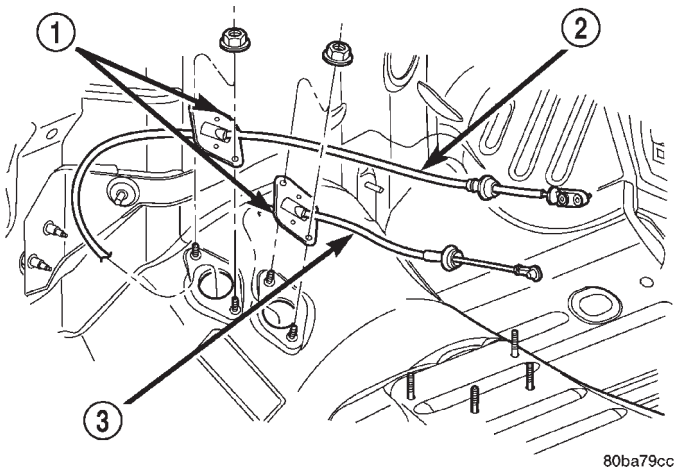


Fig. 121 Shift Cables at Floor Pan

1 - SEAL PLATES
2 - TRANSMISSION SHIFT CABLE
3 - TRANSFER CASE SHIFT CABLE

INSTALLATION

(1) Route cable through hole in floor pan.
(2) Install seal plate to studs in floor pan.
(3) Install nuts to hold seal plate to floor pan. Tighten nuts to 7 N·m (65 in.lbs.).
(4) Install the shift cable to the shifter assembly bracket. Push cable into the bracket until secure.
(5) Place the floor shifter lever in PARK position.
(6) Loosen the adjustment screw on the shift cable.
(7) Snap the shift cable onto the shift lever pin.
(8) Raise the vehicle.
(9) Install the shift cable to the shift cable support bracket.
(10) Shift the transmission into PARK. PARK is the rearmost detent position on the transmission manual shift lever.
(11) Snap the shift cable onto the transmission manual shift lever.
(12) Lower vehicle.

GEARSHIFT CABLE (Continued)

(13) Verify that the shift lever is in the PARK position.

(14) Push and hold forward on the shifter handle with at least 10-15 N·m of force to take up any movement of the shifter and gearshift cable adjuster.

(15) Tighten the adjustment screw to 7 N·m (65 in.lbs.).

(16) Verify correct shifter operation.

(17) Install any console parts removed for access to shift lever assembly and shift cable. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - INSTALLATION)

ADJUSTMENTS - GEARSHIFT CABLE

Check adjustment by starting the engine in PARK and NEUTRAL. Adjustment is CORRECT 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 contact may be faulty.

(1) Shift transmission into PARK.

(2) Remove floor console as necessary for access to the shift cable adjustment. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - REMOVAL)

(3) Loosen the shift cable adjustment screw (Fig. 122).

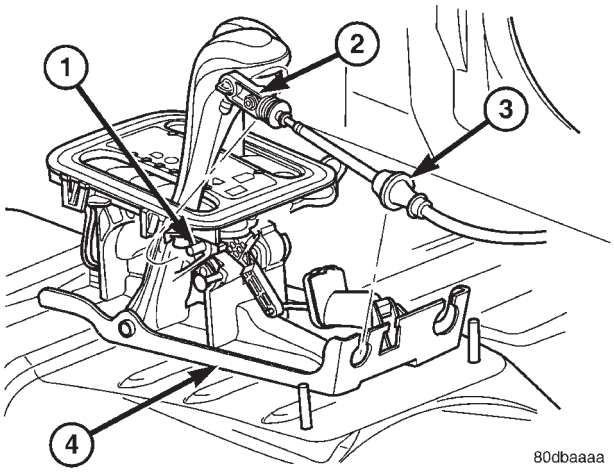


Fig. 122 Shift Cable at the Shifter - Typical

1 - SHIFT LEVER PIN
2 - ADJUSTMENT SCREW
3 - SHIFT CABLE
4 - SHIFTER ASSEMBLY BRACKET

(4) Raise vehicle.

(5) Unsnap cable eyelet from transmission shift lever.

(6) Verify transmission shift lever is in PARK detent by moving lever fully rearward. Last rearward detent is PARK position.

(7) Verify positive engagement of transmission park lock by attempting to rotate propeller shaft. Shaft will not rotate when park lock is engaged.

(8) Snap cable eyelet onto transmission shift lever.

(9) Lower vehicle

(10) Push and hold forward on the shifter handle with at least 10-15 N·m of force to take up any movement of the shifter and gearshift cable adjuster.

(11) Tighten the shift cable adjustment screw to 7 N·m (65 in.lbs.).

(12) Verify correct operation.

(13) Install any floor console components removed for access. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - INSTALLATION)

HOLDING CLUTCHES

DESCRIPTION

Three multiple-disc holding clutches (Fig. 123), the front, middle and rear multiple disc clutches B1, B3 and B2, are located in the planetary gear sets in the transmission housing.

A multiple-disc holding clutch consists of a number of internally toothed discs (10) on an internally toothed disc carrier and externally toothed discs (9) on an externally toothed disc carrier, which is rigidly connected to the transmission housing.

OPERATION

The holding clutches (Fig. 124) connect the annulus gear, sun gear, or planetary carrier of a planetary gear set against the transmission housing in order to transmit the drive torque.

If the piston (16) on multiple-disc holding clutch B1 (1) is subjected to oil pressure, it presses the internal (3) and external discs (2) of the disc set together. The internally toothed disc carrier (15) locks the sun gear (14) against the housing. The planetary pinion gears (13) turn on the sun gear (14).

If the multiple-disc holding clutch B2 (5) is actuated via the piston (7), the piston compresses the disc set. The internally toothed disc carrier (8) locks the sun gear (12) against the housing. The planetary pinion gears (11) turn on the sun gear (12).

If the multiple-disc holding clutch B3 (4) is actuated via the piston (6), the planetary carrier (9) and the annulus gear (10) are locked. When the multiple-disc brake B3 (4) is actuated, the direction of rotation is reversed.

HOLDING CLUTCHES (Continued)

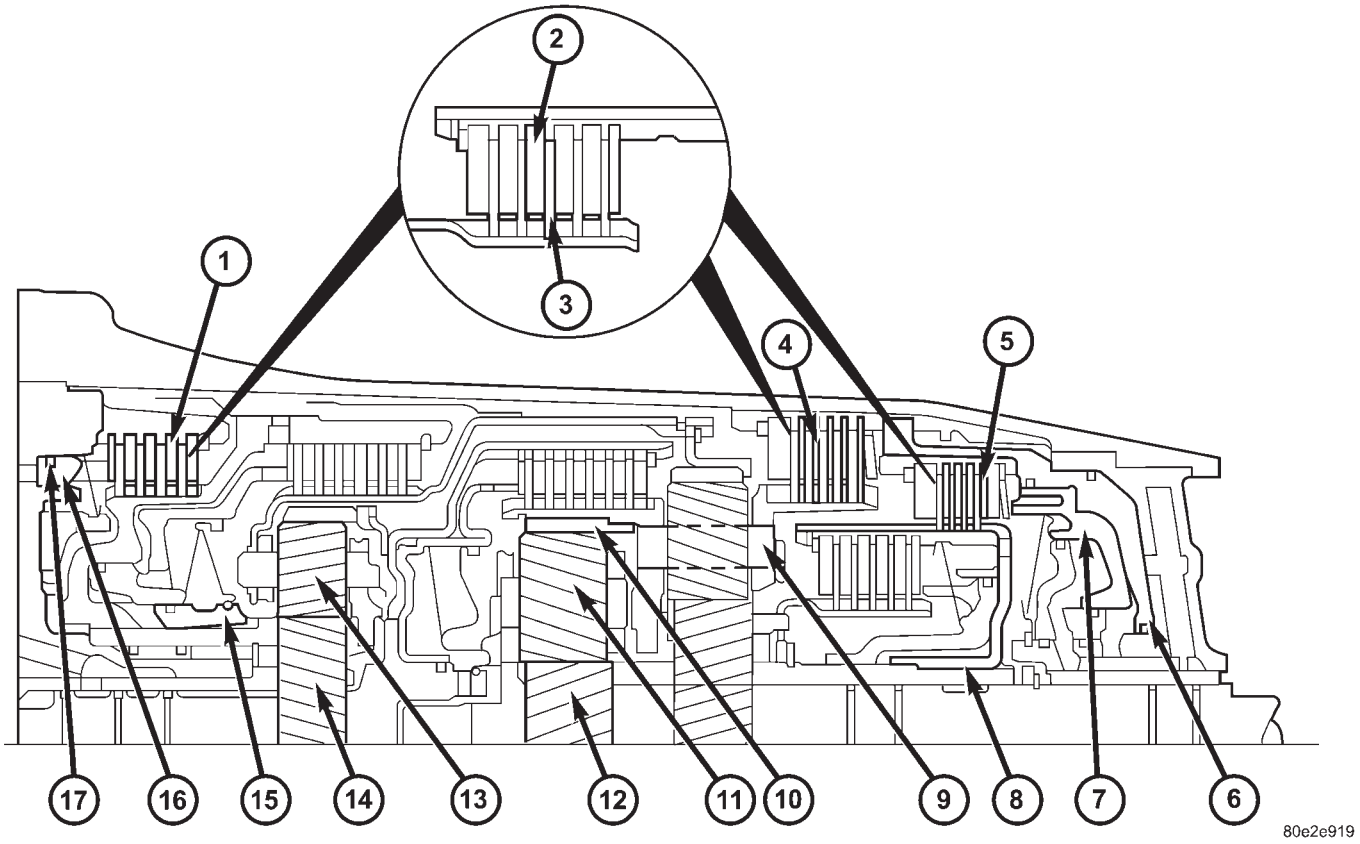


Fig. 123 Holding Clutches

1 - B1 CLUTCH
2 - EXTERNALLY TOOTHED DISC
3 - INTERNALLY TOOTHED DISC
4 - B3 CLUTCH
5 - B2 CLUTCH
6 - B3 CLUTCH PISTON
7 - B2 CLUTCH PISTON
8 - B2 CLUTCH INTERNALLY TOOTHED DISC CARRIER
9 - REAR PLANETARY GEARSET PLANETARY CARRIER
10 - CENTER PLANETARY GEARSET ANNULUS GEAR
11 - CENTER PLANETARY GEARSET PINION GEARS
12 - CENTER PLANETARY GEARSET SUN GEAR
13 - FRONT PLANETARY GEARSET PINION GEARS
14 - FRONT PLANETARY GEARSET SUN GEAR
15 - B1 CLUTCH INTERNALLY TOOTHED DISC CARRIER
16 - B1 CLUTCH PISTON
17 - B1 CLUTCH EXTERNALLY TOOTHED DISC CARRIER

HOLDING CLUTCHES (Continued)

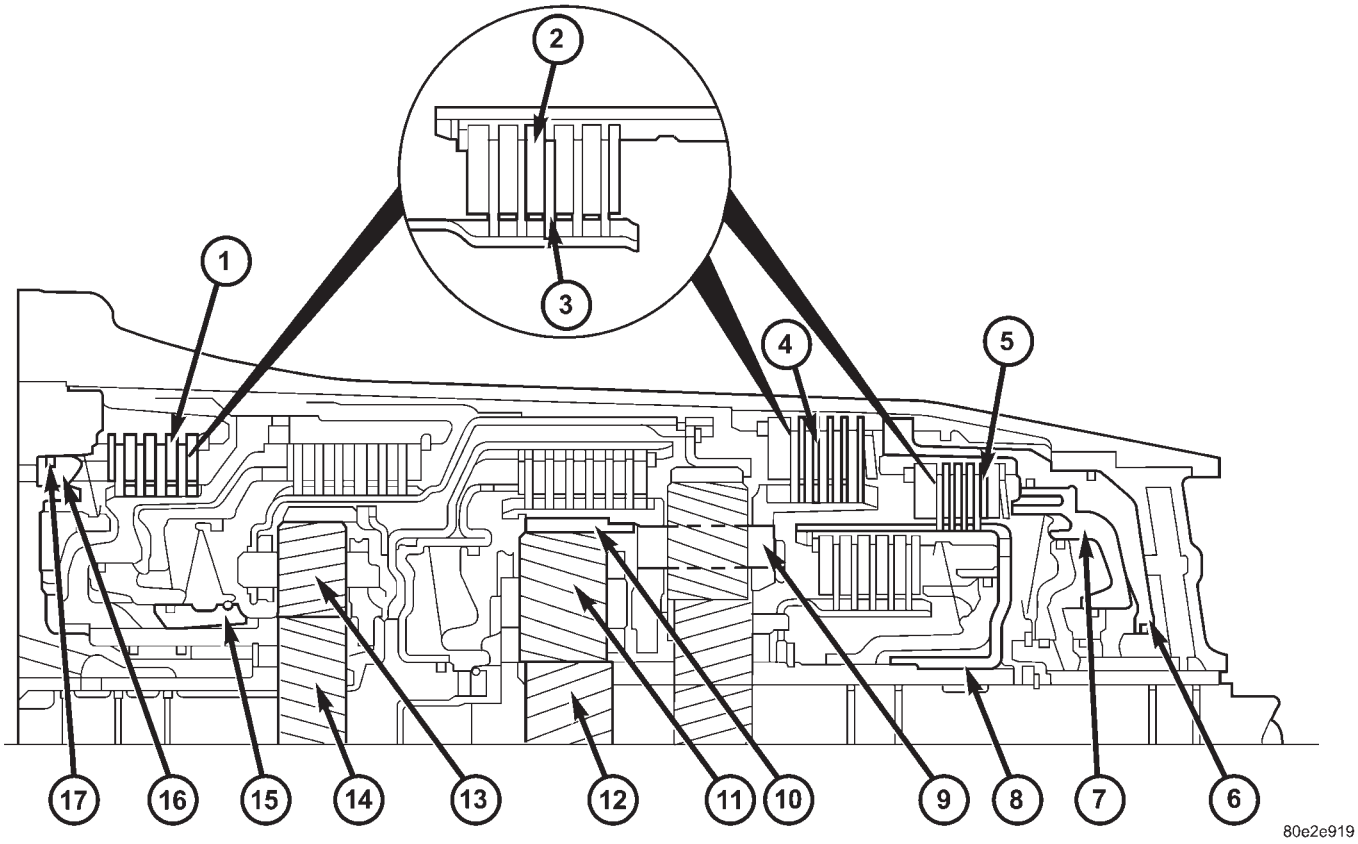


Fig. 124 Holding Clutches

1 - B1 CLUTCH
2 - EXTERNALLY TOOTHED DISC
3 - INTERNALLY TOOTHED DISC
4 - B3 CLUTCH
5 - B2 CLUTCH
6 - B3 CLUTCH PISTON
7 - B2 CLUTCH PISTON
8 - B2 CLUTCH INTERNALLY TOOTHED DISC CARRIER
9 - REAR PLANETARY GEARSET PLANETARY CARRIER
10 - CENTER PLANETARY GEARSET ANNULUS GEAR
11 - CENTER PLANETARY GEARSET PINION GEARS
12 - CENTER PLANETARY GEARSET SUN GEAR
13 - FRONT PLANETARY GEARSET PINION GEARS
14 - FRONT PLANETARY GEARSET SUN GEAR
15 - B1 CLUTCH INTERNALLY TOOTHED DISC CARRIER
16 - B1 CLUTCH PISTON
17 - B1 CLUTCH EXTERNALLY TOOTHED DISC CARRIER

HOLDING CLUTCH B1

DISASSEMBLY

(1) Remove snap-ring (7) (Fig. 125).

(2) Remove multiple-disc pack (6) and disc spring (5) from outer multiple-disc carrier.

(3) Place the Multi-use Spring Compressor 8900 (8) (Fig. 125) on disc spring (3) and compress the spring until the snap-ring (4) is exposed.

(4) Remove snap-ring (4).

(5) Remove piston (2) from the outer multiple-disc carrier by carefully blowing compressed air into the bore (A).

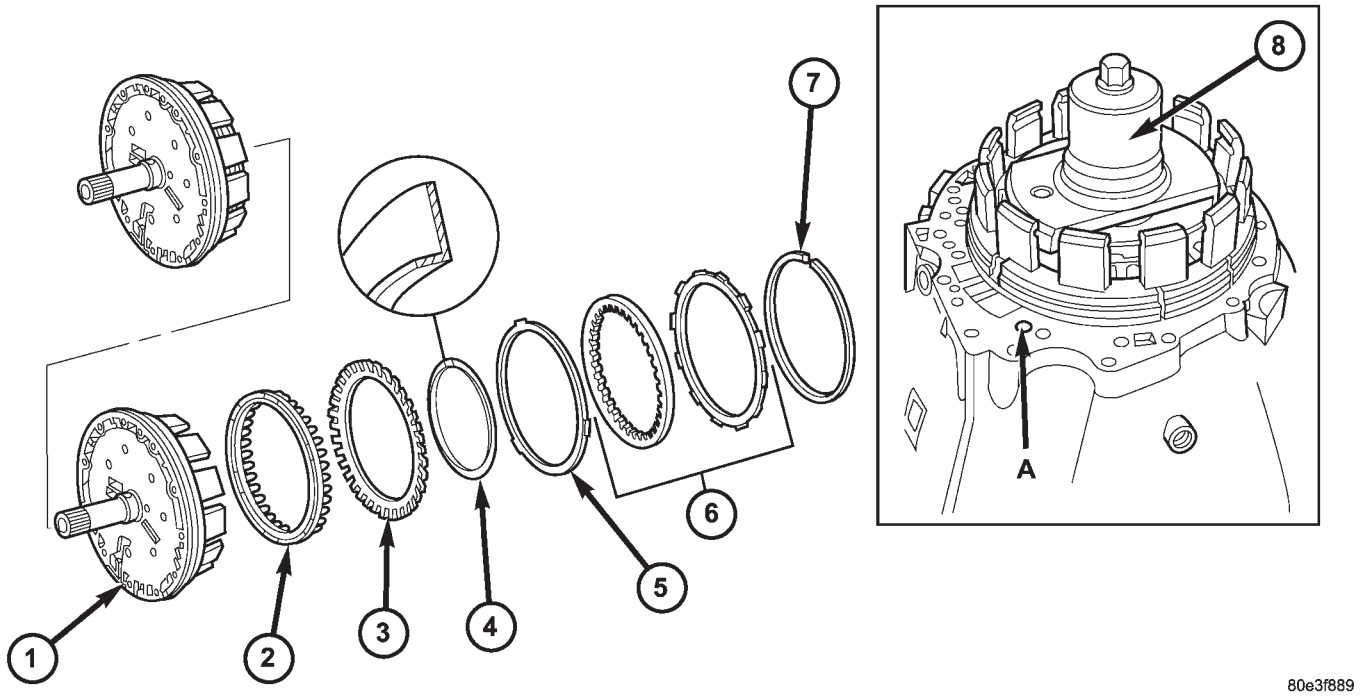


Fig. 125 Holding Clutch B1

1 - HOLDING CLUTCH B1 OUTER CARRIER
2 - PISTON
3 - DISC SPRING
4 - SNAP-RING
5 - DISC SPRING
6 - MULTIPLE DISC PACK
7 - SNAP-RING
8 - MULTI-USE SPRING COMPRESSOR 8900

HOLDING CLUTCH B1 (Continued)

ASSEMBLY

(1) Install piston (2) (Fig. 126) in outer multiple-disc carrier (1). Press in piston using the disc spring (3) and Multi-use Spring Compressor 8900 (8). Place compressor (8) on disc spring (3) and compress until the groove of the snap-ring is exposed

NOTE: Check vulcanized gasket, replace if necessary.

(2) Insert snap-ring (4) (Fig. 126).

NOTE: The collar of the snap-ring must point towards the multiple-disc pack. After installing, check snap-ring for correct seat.

(3) Insert disc spring (5) and multiple-disc pack (6) in the outer multiple-disc carrier.

(4) Insert snap-ring (7).

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

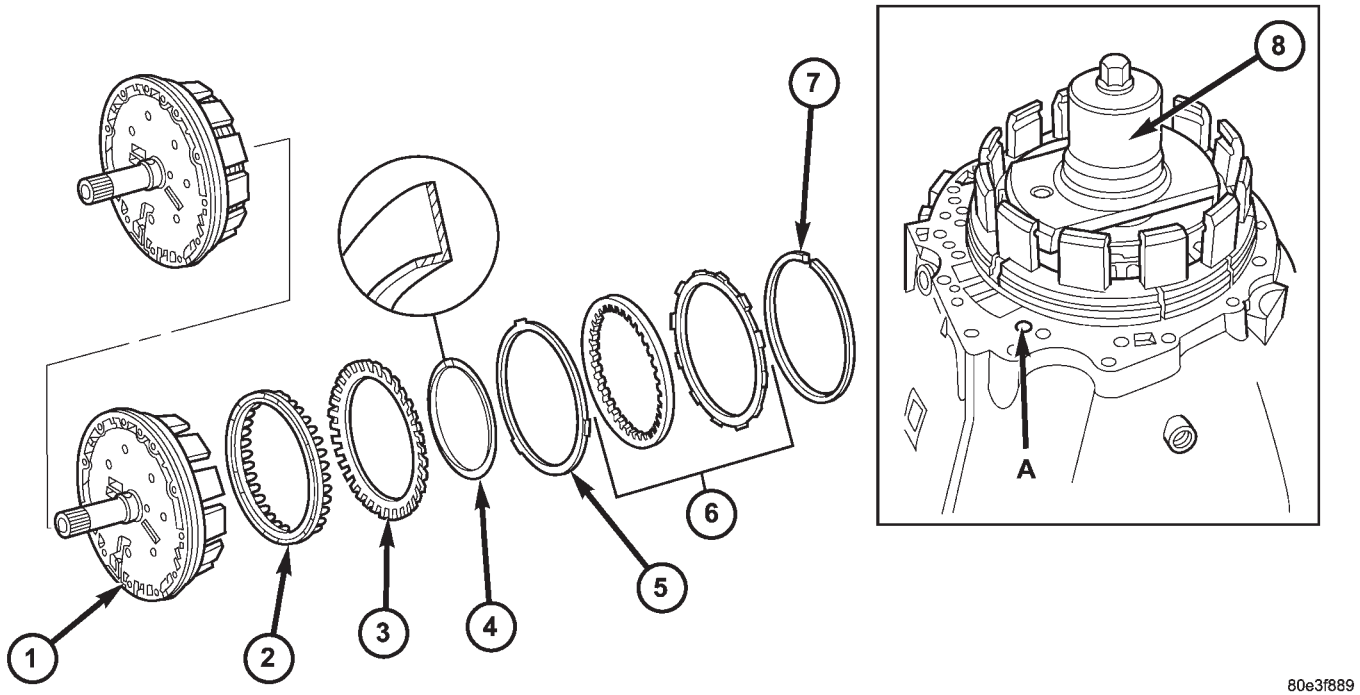


Fig. 126 Holding Clutch B1

1 - HOLDING CLUTCH B1 OUTER CARRIER
2 - PISTON
3 - DISC SPRING
4 - SNAP-RING
5 - DISC SPRING
6 - MULTIPLE DISC PACK
7 - SNAP-RING
8 - MULTI-USE SPRING COMPRESSOR 8900

HOLDING CLUTCH B1 (Continued)

(5) Measure B1 clutch clearance.

(a) Mount Pressing Tool 8901 (1) (Fig. 127) on outer multiple disc.

(b) Using a lever press (Fig. 127), compress pressing tool as far as the stop (then the marking ring is still visible, see small arrow).

(c) Using a feeler gauge, determine the play ″L″ (Fig. 128) at three points between the snap-ring (6) and outer multiple-disc (4). During the measurement, the snap-ring (6) must contact the upper bearing surface of the groove in the outer multiple-disc carrier (5). The correct clearance is 2.3-2.7 mm for 2 friction disc versions, 2.7-3.1 mm for 3 disc versions, and 3.0-3.4 mm for 4 disc versions.

(d) Adjust with snap-ring (6), if necessary. Snap-rings are available in thicknesses of 2.6, 2.9, 3.2, 3.5, 3.8 and 4.1 mm.

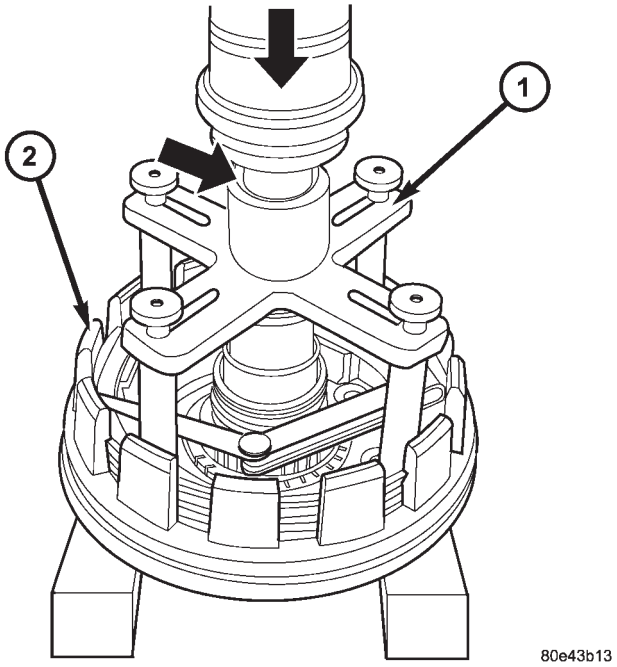


Fig. 127 Measure B1 Clutch Clearance

1 - PRESSING TOOL 8901
2 - B1 CLUTCH OUTER CARRIER

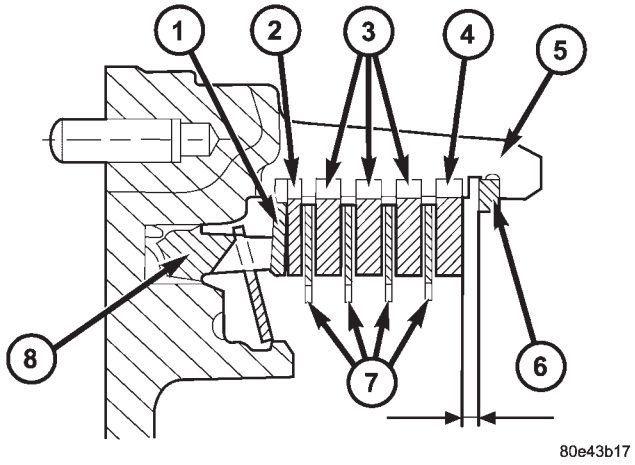


Fig. 128 B1 Clutch Stack-up

1 - DISC SPRING
2 - OUTER MULTIPLE DISC - 1.8 mm
3 - OUTER MULTIPLE DISC - 2.8 mm
4 - OUTER MULTIPLE DISC - 4.0 mm
5 - B1 OUTER CARRIER
6 - SNAP-RING
7 - FRICTION DISCS
8 - PISTON

HOLDING CLUTCH B2

DISASSEMBLY

(1) Remove snap ring (1) (Fig. 129).

(2) Take multiple-disc pack B2 (2) and disc spring (3) out of the outer multiple-disc carrier B2 (8). The outer multiple-disc carrier for the multi-disc holding clutch B2 is the piston for the multiple-disc holding clutch B3 at the same time.

(3) Place the Multi-use Spring Compressor 8900 on the spring disc (14) and compress the spring until the groove for the snap-ring is exposed.

(4) Remove snap-ring (16) (Fig. 129).

(5) Remove spring plate (15) and disc spring (14).

HOLDING CLUTCH B2 (Continued)

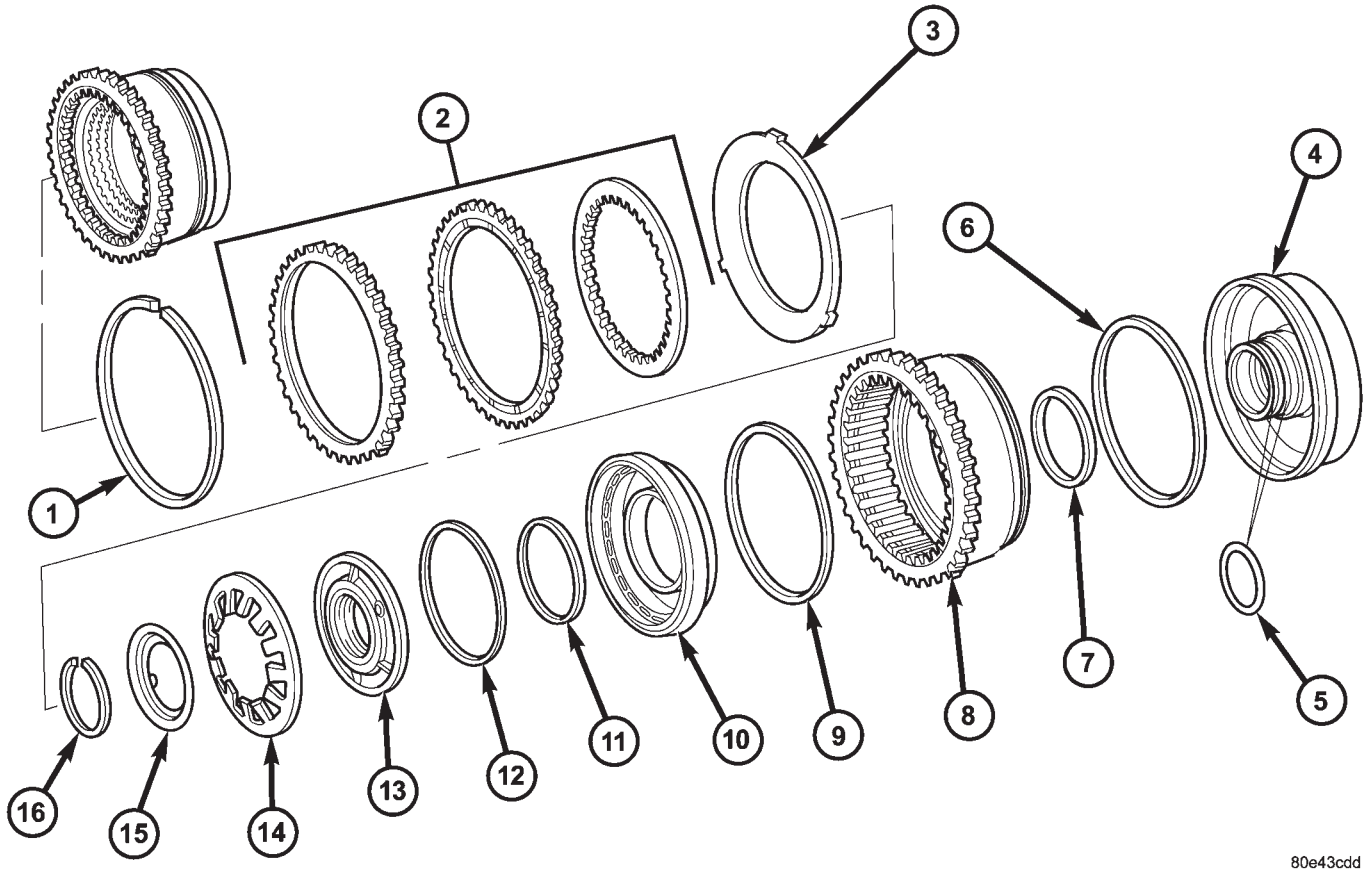


Fig. 129 Holding Clutch B2

1 - SNAP-RING
2 - MULTIPLE DISC PACK
3 - DISC SPRING
4 - B2 AND B3 PISTON GUIDE
5 - O-RING
6 - B3 PISTON SEALING RING
7 - B3 PISTON SEALING RING
8 - B3 PISTON/B2 OUTER DISC CARRIER
9 - B3 PISTON SEALING RING
10 - B2 PISTON
11 - PISTON GUIDE SEALING RING
12 - PISTON GUIDE SEALING RING
13 - PISTON GUIDE RING
14 - PISTON BACK PRESSURE DISC SPRING
15 - SPRING PLATE
16 - SNAP-RING

HOLDING CLUTCH B2 (Continued)

(6) Separate piston guide ring (13) and the B2 piston (10) from the B3 piston (8) by blowing compressed air into the bore (**D**) (Fig. 130).

(7) Press piston guide ring (13) out of the B2 piston (10).

(8) Separate piston guide (4) from the B3 piston (8) by blowing compressed air into the bore (**A**) (Fig. 130).

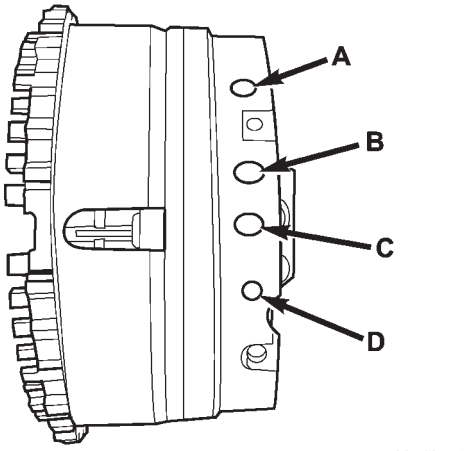


Fig. 130 B2 Clutch Oil Supply Locations

A - B3 PISTON
B - B2 PISTON GUIDE RING SIDE
C - K3 CLUTCH FEED
D - B2 PISTON SHIFT SIDE

ASSEMBLY

(1) Assemble piston guide (4) (Fig. 131) and B3 piston (8) in the correct position.

(2) Check all sealing rings (Fig. 132), replace if necessary. The rounded off edges on the sealing rings (6), (3) and (2) must point outwards. The rounded off edges on the sealing ring (4) must point inwards.

(3) Insert B2 piston (10) (Fig. 131) in B3 piston (8).

(4) Insert piston guide ring (2) (Fig. 133). The valve (1) in the piston guide ring must be on top.

(5) Insert disc spring (14) (Fig. 131) and spring plate (15). Insert disc spring with the curvature towards the spring plate

(6) Place Multi-use Spring Compressor 8900 on the disc spring (14) and compress the spring until the groove for the snap-ring is exposed.

(7) Insert snap-ring (16).

NOTE: Pay attention to sequence of discs. Place new friction multiple-discs in ATF fluid for one hour before installing.

(8) Insert disc spring (3) and multiple-disc pack (2) in the B2 outer multiple-disc carrier.

(9) Insert snap-ring (1).

NOTE: During the measurement the snap-ring (8) must contact the upper bearing surface of the groove in the outer multiple-disc carrier.

(10) Measure the B2 clutch pack clearance.

(a) Mount Pressing Tool 8901 (1) (Fig. 134) on outer multiple disc.

(b) Using a lever press, compress the pressing tool as far as the stop (then the marking ring is still visible, see small arrow).

(c) Using a feeler gauge, determine the play ″L″ (Fig. 135) at three points between the snap-ring (8) and outer multiple-disc (7).

(d) The correct clutch clearance is 1.9-2.3 mm for the four friction disc versions and 2.0-2.4 mm for the five disc versions.

(e) Adjust with snap-ring (8), if necessary. Snap-rings are available in thicknesses of 2.9, 3.2, 3.5, 3.8 and 4.1 mm.

HOLDING CLUTCH B2 (Continued)

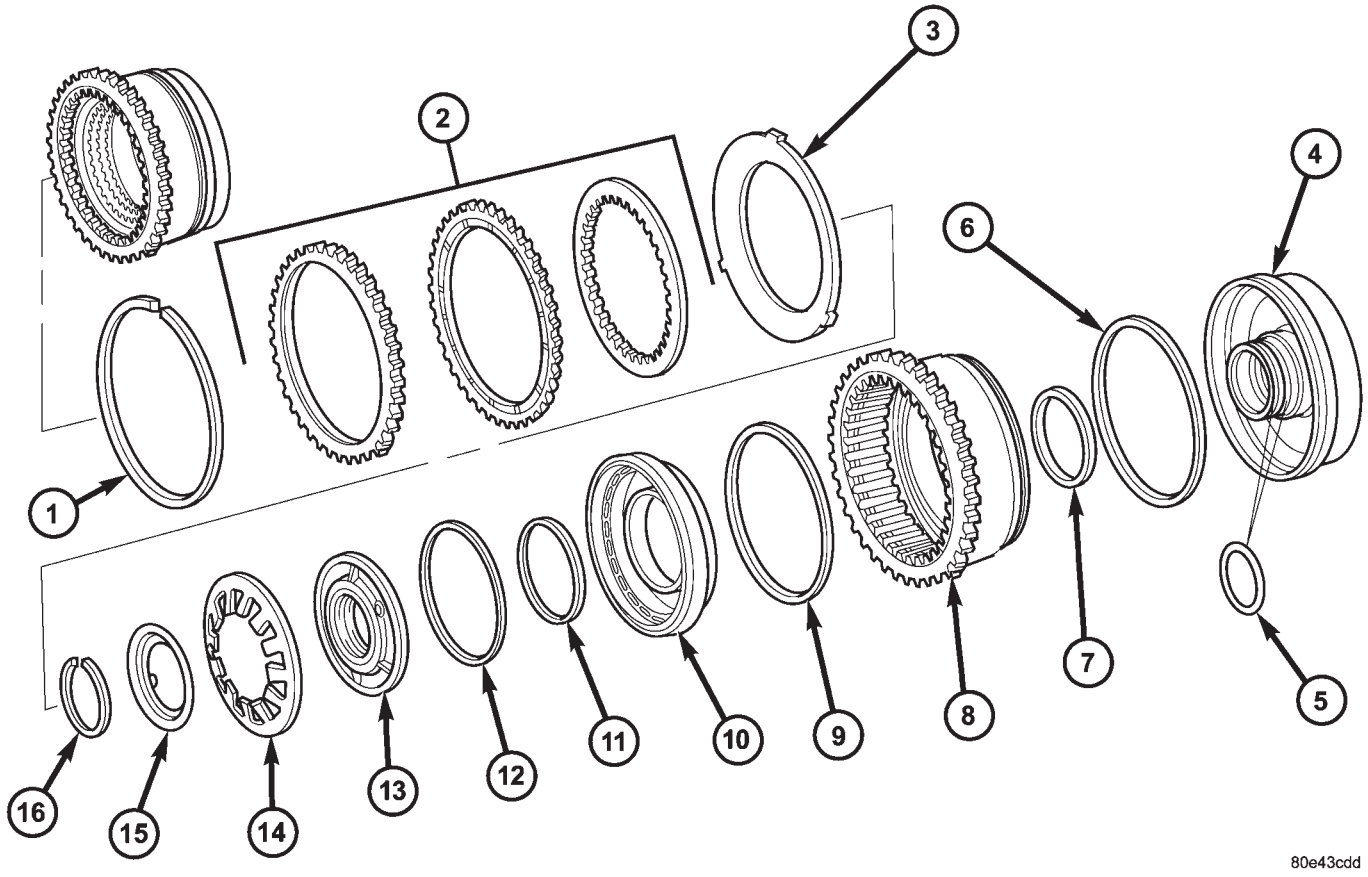


Fig. 131 Holding Clutch B2

1 - SNAP-RING
2 - MULTIPLE DISC PACK
3 - DISC SPRING
4 - B2 AND B3 PISTON GUIDE
5 - O-RING
6 - B3 PISTON SEALING RING
7 - B3 PISTON SEALING RING
8 - B3 PISTON/B2 OUTER DISC CARRIER
9 - B3 PISTON SEALING RING
10 - B2 PISTON
11 - PISTON GUIDE SEALING RING
12 - PISTON GUIDE SEALING RING
13 - PISTON GUIDE RING
14 - PISTON BACK PRESSURE DISC SPRING
15 - SPRING PLATE
16 - SNAP-RING

HOLDING CLUTCH B2 (Continued)

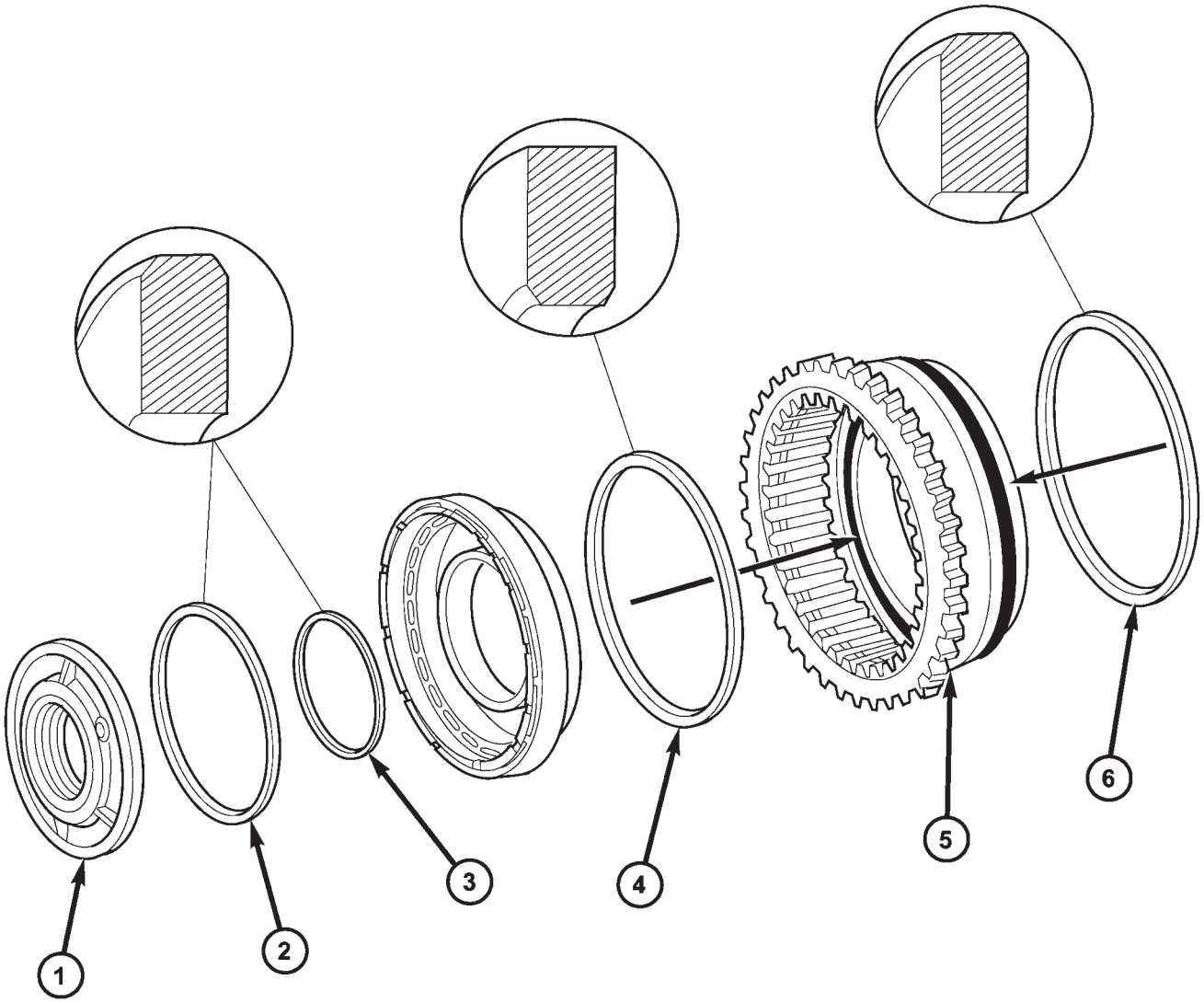


Fig. 132 Holding Clutch B2/B3 Seals

1 - PISTON GUIDE RING	4 - B3 PISTON SEALING RING
2 - PISTON GUIDE RING SEALING RING	5 - B3 PISTON/B2 OUTER DISC CARRIER
3 - PISTON GUIDE RING SEALING RING	6 - B3 PISTON SEALING RING

HOLDING CLUTCH B2 (Continued)

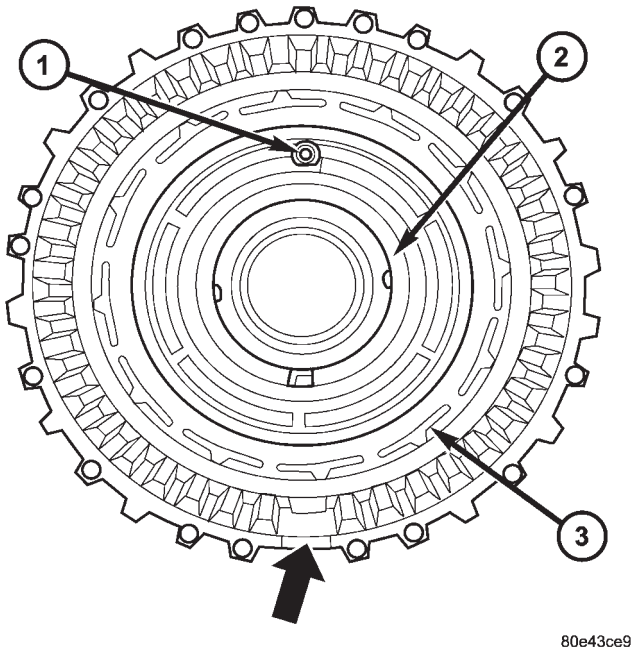


Fig. 133 B2 Piston and Piston Guide Ring

1 - VALVE
2 - PISTON GUIDE RING
3 - B2 PISTON

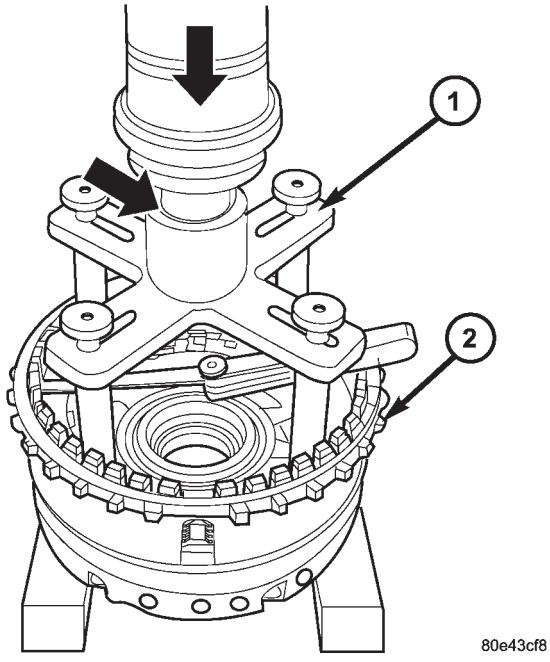


Fig. 134 Measure B2 Clutch Clearance

1 - PRESSING TOOL 8901
2 - B3 PISTON/B2 OUTER DISC CARRIER

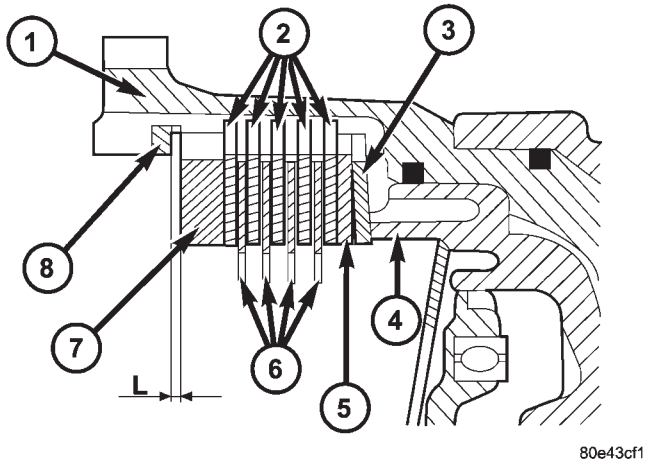


Fig. 135 B2 Clutch Stack-up

1 - B2 OUTER DISC CARRIER
2 - FRICTION DISCS
3 - DISC SPRING
4 - B2 PISTON
5 - OUTER MULTIPLE DISC - 1.8 MM
6 - OUTER MULTIPLE DISC - 1.8 MM
7 - OUTER MULTIPLE DISC - 6.5 MM
8 - SNAP-RING

INPUT SPEED SENSORS

DESCRIPTION

The input speed sensors (6, 8) (Fig. 136) are fixed to the shell of the control unit via contact blades. The speed sensors are pressed against the transmission housing (2) by a spring (7) which is held against the valve housing of the shift plate (5). This ensures a defined distance between the speed sensors and the exciter ring (4).

OPERATION

Signals from the input speed sensors (6, 8) (Fig. 137) are recorded in the transmission control module (TCM) together with the wheel and engine speeds and other information and are processed into an input signal for electronic control.

Input speed sensor N2 (6) records the speed of the front sun gear via the externally toothed disc carrier of the multiple-disc clutch K1 (10) and input speed sensor N3 (8) records the speed of the front planet carrier via the internally toothed disc carrier of multiple-disc clutch K1 (3).

INPUT SPEED SENSORS (Continued)

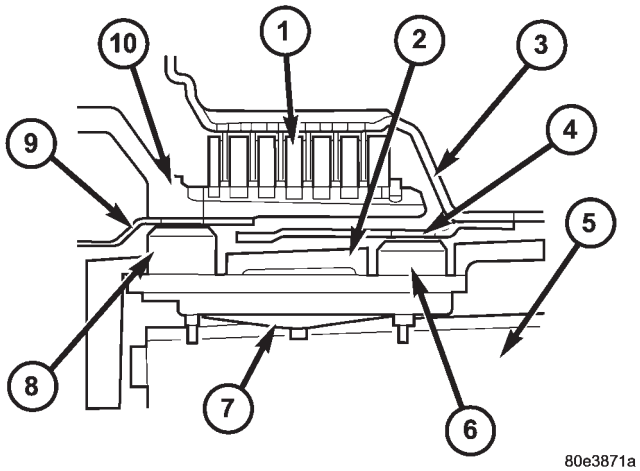


Fig. 136 Speed Sensors

1 - DRIVING CLUTCH K1
2 - TRANSMISSION HOUSING
3 - DRIVING CLUTCH K1 INTERNALLY TOOTHED DISC
4 - EXCITER RING
5 - VALVE HOUSING OF SHIFT PLATE
6 - N2 INPUT SPEED SENSOR
7 - SPRING
8 - N3 INPUT SPEED SENSOR
9 - EXCITER RING
10 - DRIVING CLUTCH K1 EXTERNALLY TOOTHED DISC

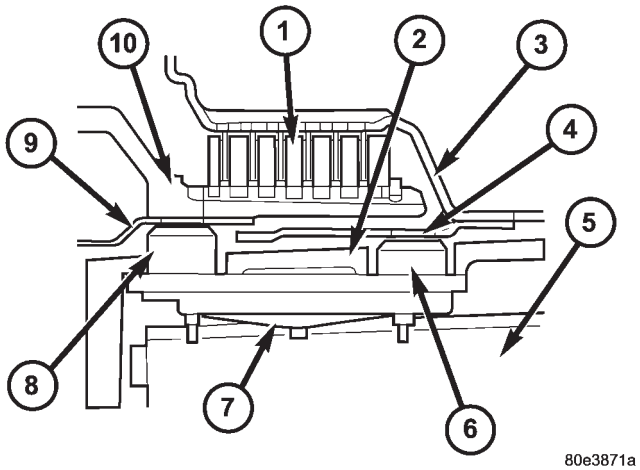


Fig. 137 Input Speed Sensors

1 - DRIVING CLUTCH K1
2 - TRANSMISSION HOUSING
3 - DRIVING CLUTCH K1 INTERNALLY TOOTHED DISC
4 - EXCITER RING
5 - VALVE HOUSING OF SHIFT PLATE
6 - N2 INPUT SPEED SENSOR
7 - SPRING
8 - N3 INPUT SPEED SENSOR
9 - EXCITER RING
10 - DRIVING CLUTCH K1 EXTERNALLY TOOTHED DISC

OIL PUMP

DESCRIPTION

The oil pump (Fig. 138) (crescent-type pump) is installed in the torque converter casing behind the torque converter and is driven by the drive flange of the torque converter. The pump creates the oil pressure required for the hydraulic procedures.

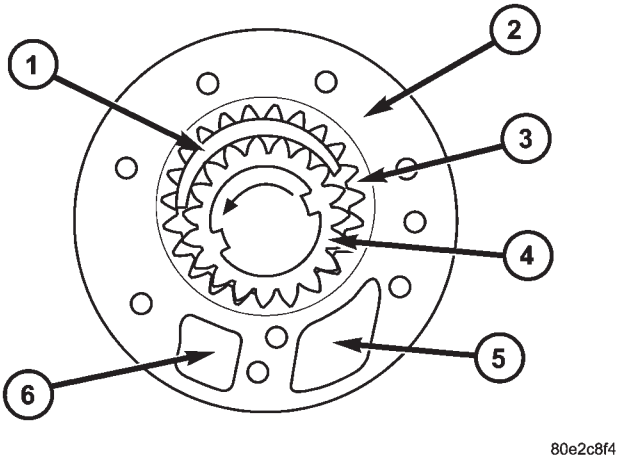


Fig. 138 Oil Pump

1 - CRESCENT
2 - OIL PUMP
3 - EXTERNAL GEAR
4 - INTERNAL GEAR
5 - INLET CHAMBER
6 - PRESSURE CHAMBER

OPERATION

When the engine is running, the oil (Fig. 139) is pumped through the inlet chamber (5) along the upper and lower side of the crescent to the pressure chamber (6) of the housing. The meshing of the teeth prevents oil flowing from the delivery side to the intake side. An external gear (3), eccentrically mounted in the pump housing, is located on the internal gear (4) which is connected to the drive flange. The crescent (1) drives the external wheel.

OIL PUMP (Continued)

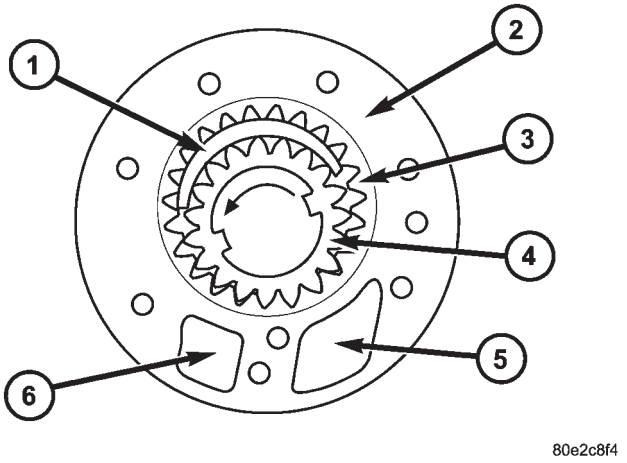


Fig. 139 Oil Pump

1 - CRESCENT
2 - OIL PUMP
3 - EXTERNAL GEAR
4 - INTERNAL GEAR
5 - INLET CHAMBER
6 - PRESSURE CHAMBER

DISASSEMBLY

(1) Remove pump gears (1 and 2) (Fig. 140) from pump housing.

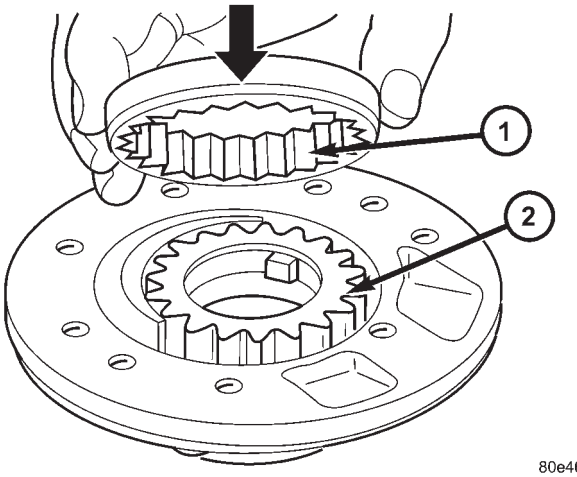


Fig. 140 Oil Pump Gears

1 - OUTER PUMP ROTOR
2 - INNER PUMP ROTOR

(2) Remove the inner oil pump seal (1) (Fig. 141).
(3) Replace the outer oil pump O-ring (2) (Fig. 141).

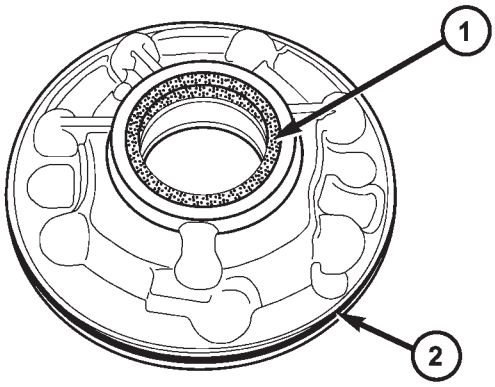


Fig. 141 Remove Oil Pump Seals

1 - INNER OIL SEAL
2 - OUTER OIL SEAL

ASSEMBLY

(1) Install new inner oil pump seal (1) (Fig. 142).
(2) Replace O-ring (2) (Fig. 142).

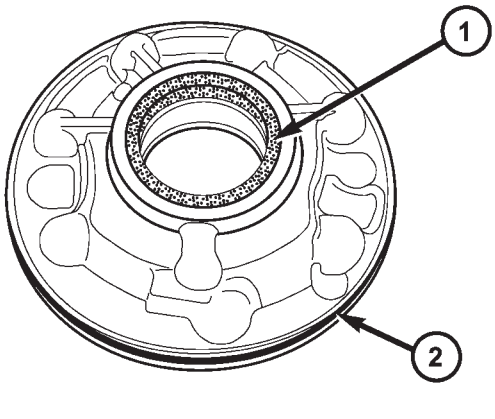


Fig. 142 Install New Oil Pump Seals

1 - INNER OIL SEAL
2 - OUTER OIL SEAL

OIL PUMP (Continued)

(3) Lubricate pump gears and place in the pump housing. Insert pump gear (1) (Fig. 143) so that the chamfer (arrow) points towards the pump housing.

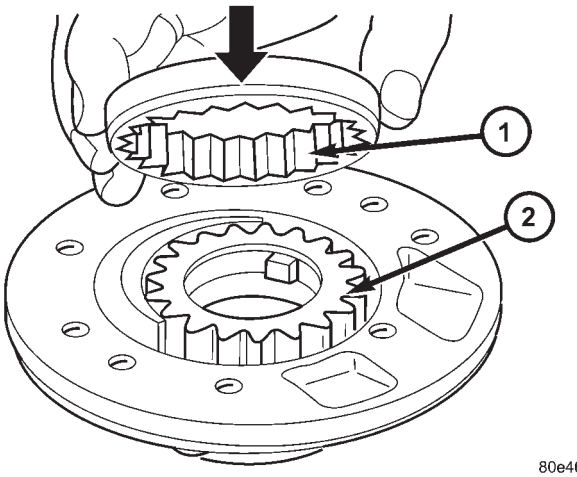


Fig. 143 Oil Pump Gears

1 - OUTER PUMP ROTOR
2 - INNER PUMP ROTOR

PARK LOCK CABLE

REMOVAL

(1) Place the shifter in the PARK position.
(2) Lower the steering column cover.
(3) With the ignition switch in the "RUN" position depress the park lock cable locking tab, located on top of the cable connector at the steering column and pull the park lock cable straight out.
(4) Remove the park lock cable from steering column (Fig. 144).
(5) Remove the floor console and related trim. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - REMOVAL)
(6) Disconnect the park lock cable from the shift BTSI lever and remove the cable from the shifter assembly bracket.
(7) Release the park lock cable from any remaining clips.
(8) Remove park lock cable from the vehicle.

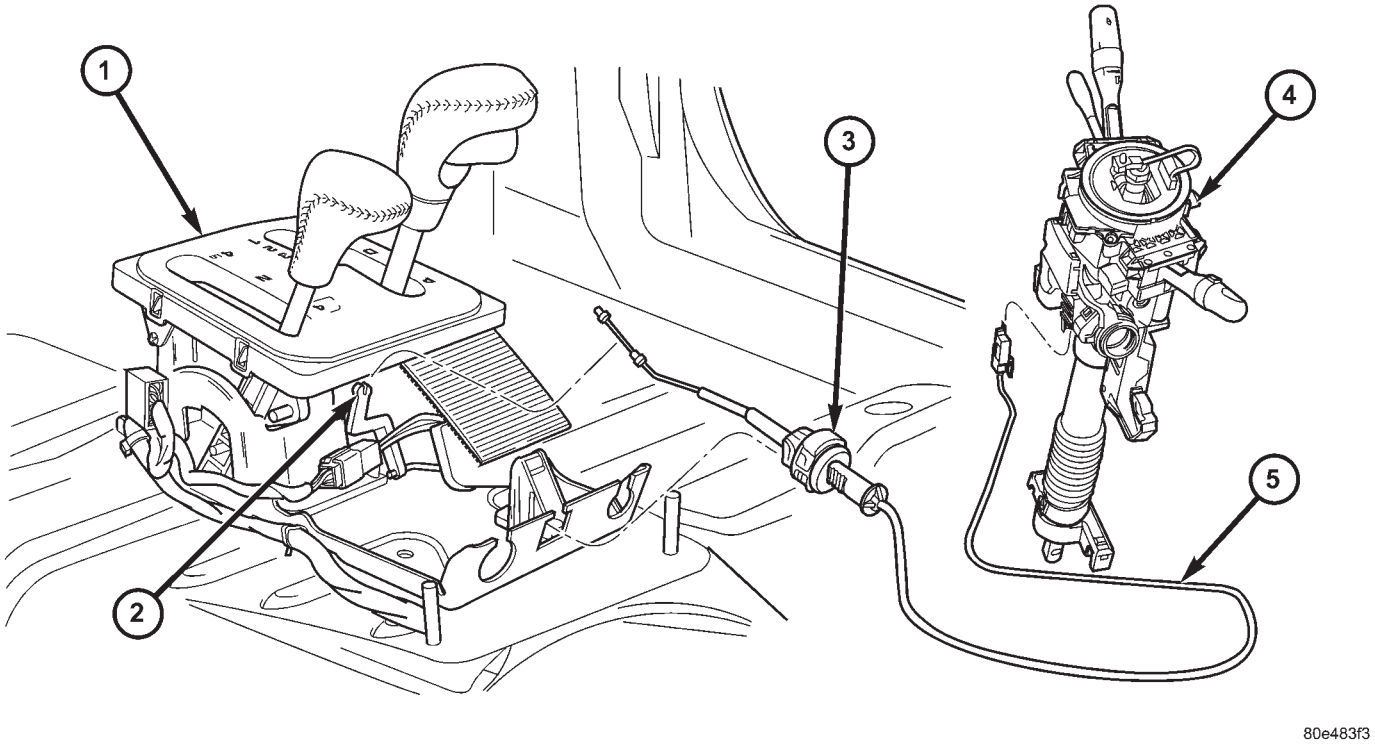


Fig. 144 Ignition Interlock Cable

1 - SHIFT MECHANISM
2 - SHIFTER BTSI LEVER
3 - ADJUSTMENT CLIP
4 - STEERING COLUMN ASSEMBLY
5 - INTERLOCK CABLE

PARK LOCK CABLE (Continued)

INSTALLATION

NOTE: The gearshift cable must be secured into position and properly adjusted before the installation of the Park Lock Cable.

(1) Verify that the shifter is in the PARK position.
(2) Push the park lock cable straight into the square mounting hole in the steering column until cable snaps in place.
(3) Route park lock cable to the shifter mechanism.
(4) Install the park lock cable end fitting into shifter BTSI lever.
(5) Pull rearward on the cable housing to snap park lock cable adjuster ears into floor shifter bracket.
(6) Place the ignition key cylinder in the ACCESSORY position.
(7) Push the cable adjuster lock clamp downward to lock it.
(8) Test the park lock cable operation.
(9) Install the floor console and related trim. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - INSTALLATION)

PISTONS

DESCRIPTION

There are several sizes and types of pistons used in an automatic transmission. Some pistons are used to apply clutches. They all have in common the fact that they are round or circular in shape, located within a smooth walled cylinder, which is closed at one end and converts fluid pressure into mechanical movement. The fluid pressure exerted on the piston is contained within the system through the use of piston rings or seals.

OPERATION

The principal which makes this operation possible is known as Pascal's Law. Pascal's Law can be stated as: "Pressure on a confined fluid is transmitted equally in all directions and acts with equal force on equal areas."

PRESSURE

Pressure (Fig. 145) is nothing more than force (lbs.) divided by area (in or ft.), or force per unit area. Given a 100 lb. block and an area of 100 sq. in. on the floor, the pressure exerted by the block is: 100 lbs. 100 in or 1 pound per square inch, or PSI as it is commonly referred to.

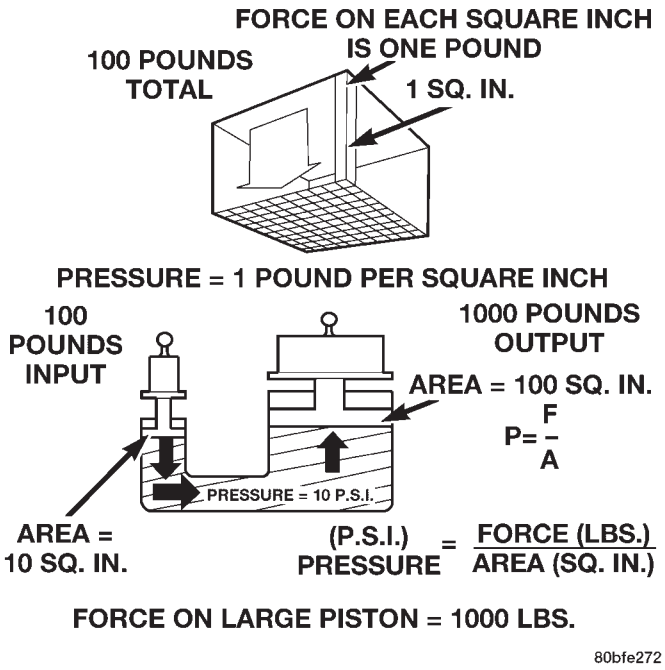


Fig. 145 Force and Pressure Relationship

PRESSURE ON A CONFINED FLUID

Pressure is exerted on a confined fluid (Fig. 146) by applying a force to some given area in contact with the fluid. A good example of this is a cylinder filled with fluid and equipped with a piston that is closely fitted to the cylinder wall. If a force is applied to the piston, pressure will be developed in the fluid. Of course, no pressure will be created if the fluid is not confined. It will simply "leak" past the piston. There must be a resistance to flow in order to create pressure. Piston sealing is extremely important in hydraulic operation. Several kinds of seals are used to accomplish this within a transmission. These include but are not limited to O-rings, D-rings, lip seals, sealing rings, or extremely close tolerances between the piston and the cylinder wall. The force exerted is downward (gravity), however, the principle remains the same no matter which direction is taken. The pressure created in the fluid is equal to the force applied, divided by the piston area. If the force is 100 lbs., and the piston area is 10 sq. in., then the pressure created equals 10 PSI. Another interpretation of Pascal's Law is that regardless of container shape or size, the pressure will be maintained throughout, as long as the fluid is confined. In other words, the pressure in the fluid is the same everywhere within the container.

PISTONS (Continued)

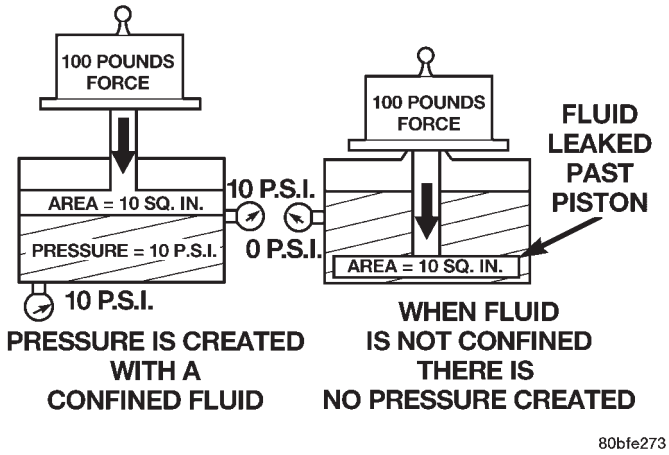


Fig. 146 Pressure on a Confined Fluid

FORCE MULTIPLICATION

Using the 10 PSI example used in the illustration (Fig. 147), a force of 1000 lbs. can be moved with a force of only 100 lbs. The secret of force multiplication in hydraulic systems is the total fluid contact area employed. The illustration, (Fig. 147), shows an area that is ten times larger than the original area. The pressure created with the smaller 100 lb. input is 10 PSI. The concept “pressure is the same everywhere” means that the pressure underneath the larger piston is also 10 PSI. Pressure is equal to the force applied divided by the contact area. Therefore, by means of simple algebra, the output force may be found. This concept is extremely important, as it is also used in the design and operation of all shift valves and limiting valves in the valve body, as well as the pistons, of the transmission, which activate the clutches and bands. It is nothing more than using a difference of area to create a difference in pressure to move an object.

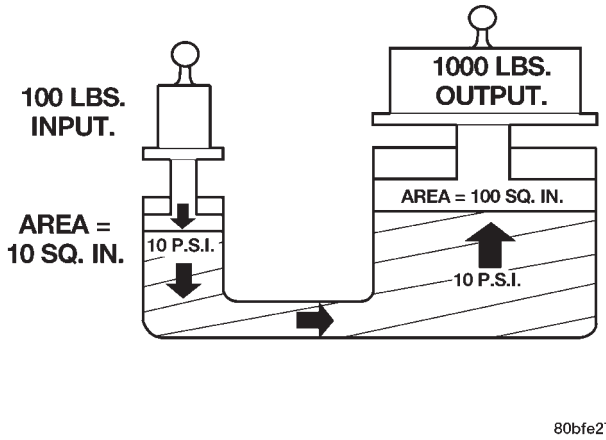


Fig. 147 Force Multiplication

PISTON TRAVEL

The relationship between hydraulic lever and a mechanical lever is the same. With a mechanical lever it’s a weight-to-distance output rather than a pressure-to-area output. Using the same forces and areas as in the previous example, the smaller piston (Fig. 148) has to move ten times the distance required to move the larger piston one inch. Therefore, for every inch the larger piston moves, the smaller piston moves ten inches. This principle is true in other instances also. A common garage floor jack is a good example. To raise a car weighing 2000 lbs., an effort of only 100 lbs. may be required. For every inch the car moves upward, the input piston at the jack handle must move 20 inches downward.

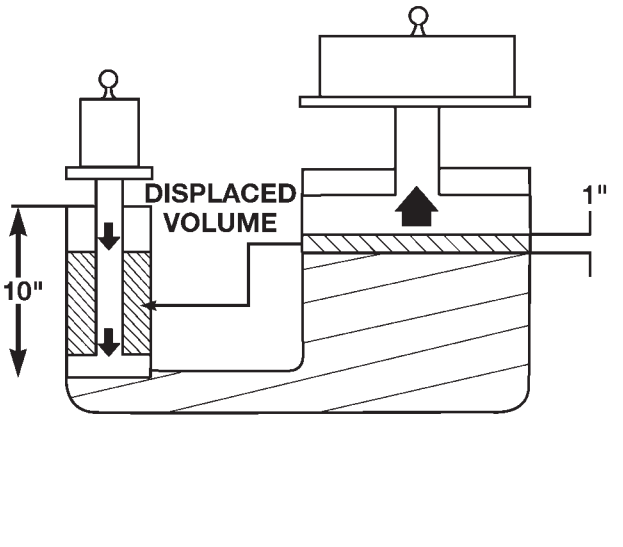


Fig. 148 Piston Travel

PLANETARY GEARTRAIN

DESCRIPTION

Three planetary gear sets (Fig. 149) are used to produce the different gear ratios. These are located in the mechanical part of the transmission as the front, middle and rear planetary gear sets.

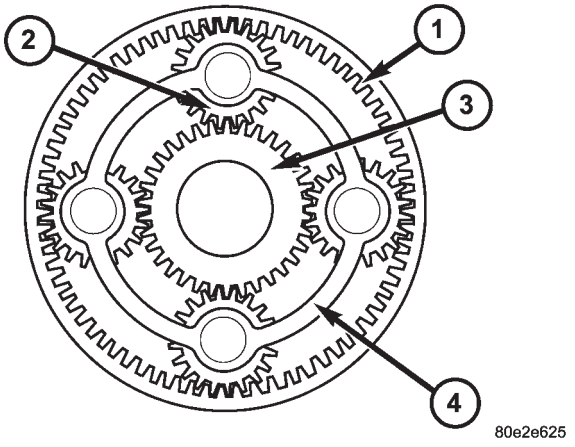


Fig. 149 Planetary Geartrain

1 - ANNULUS GEAR
2 - PLANETARY PINION GEARS
3 - SUN GEAR
4 - PLANETARY CARRIER

OPERATION

The annulus gear (1) (Fig. 150) and sun gear (3) elements of a planetary gear system are alternately driven and braked by the actuating elements of the multi-plate clutch and multiple-disc brake. The planetary pinion gears (2) can turn on the internal gearing of the annulus gear (1) and on the external gearing of the sun gear (3). This allows for a variety of gear ratios and the reversal of the rotation direction without the need for moving gear wheels or shift collars. When two components of the planetary gear set are locked together, the planetary gear set is locked and turns as a closed unit.

The torque and engine speed are converted according to the lever ratios and the ratio of the number of teeth on the driven gears to that on the drive gears, and is referred to as the gear ratio. The overall ratio of a number of planetary gear sets connected in series is obtained by multiplying the partial ratios.

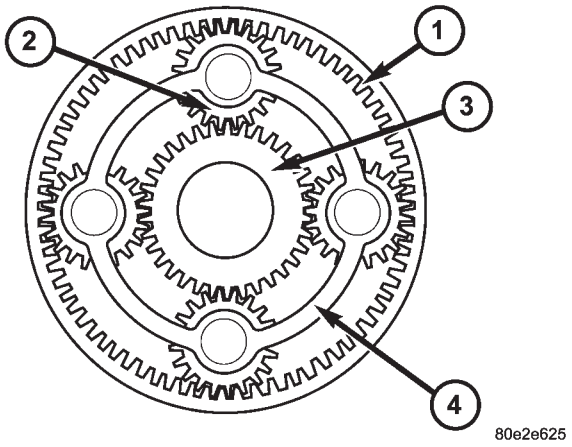


Fig. 150 Planetary Geartrain

1 - ANNULUS GEAR
2 - PLANETARY PINION GEARS
3 - SUN GEAR
4 - PLANETARY CARRIER

DISASSEMBLY

(1) Remove upper two visible Teflon rings (1) (Fig. 151) from output shaft.

(2) Remove retaining ring (11), shim (10), thrust needle bearing (9) and thrust washer (8) from output shaft.

(3) Remove clutch K3 (7).

(4) Remove rear tubular shaft/freewheeling clutch F2 (6) (Fig. 151) from output shaft.

(5) Remove rear gear set (5) with integrated tubular shaft of center gear set from output shaft.

(6) Remove thrust washer (4).

ASSEMBLY

(1) Mount thrust washer (4) (Fig. 152) with the collar pointing towards the planet carrier.

(2) Mount rear gear set (5) with integrated tubular shaft of the center gear set on output shaft.

(3) Using grease, install lower three Teflon rings (1) (Fig. 152) in the groove so that the joint stays together

(4) Put rear tubular shaft/freewheeling clutch F2 (6) onto output shaft.

(5) Install clutch K3 (7).

(6) Mount retaining ring, shim, thrust needle bearing and thrust washer (8 - 11) (Fig. 152).

(7) Using grease, insert the upper two Teflon rings (1) in the groove so that the joint remains together.

PLANETARY GEARTRAIN (Continued)

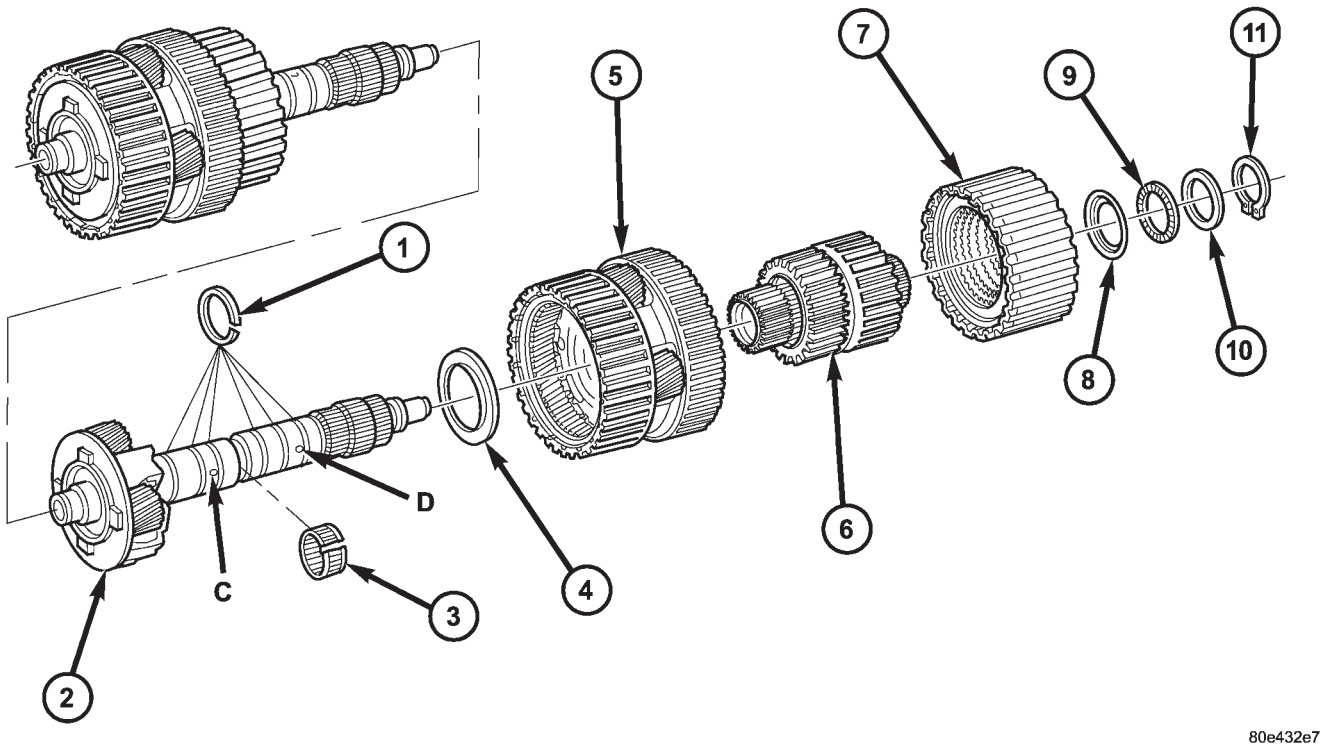


Fig. 151 Output Shaft with Center and Rear Planetary Geartrain

1 - TEFLON RINGS
2 - OUTPUT SHAFT WITH CENTER PLANETARY CARRIER
3 - NEEDLE BEARING
4 - THRUST WASHER
5 - REAR PLANETARY GEAR SET
6 - REAR HOLLOW SHAFT/FREEWHEELING CLUTCH F2
7 - DRIVING CLUTCH K3
8 - THRUST WASHER
9 - AXIAL NEEDLE BEARING
10 - SHIM
11 - RETAINING RING

PLANETARY GEARTRAIN (Continued)

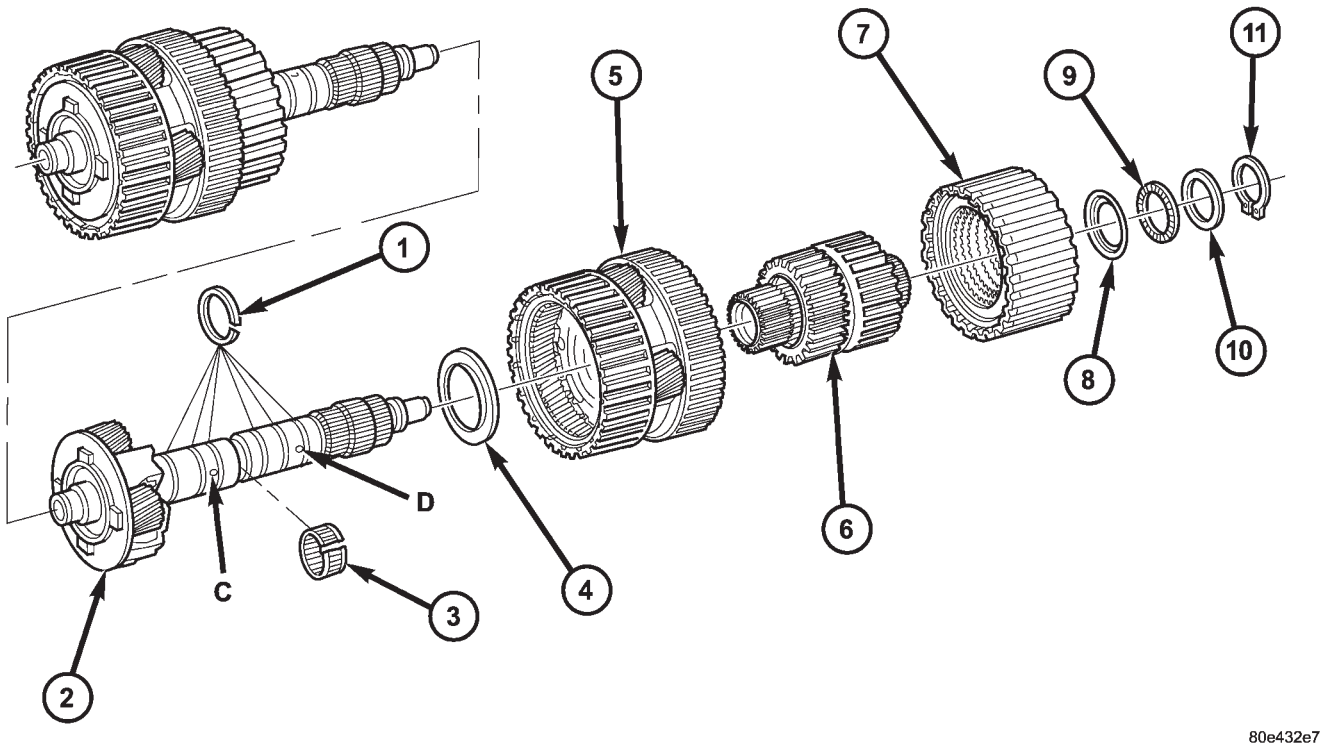


Fig. 152 Output Shaft with Center and Rear Planetary Geartrain

1 - TEFLON RINGS
2 - OUTPUT SHAFT WITH CENTER PLANETARY CARRIER
3 - NEEDLE BEARING
4 - THRUST WASHER
5 - REAR PLANETARY GEAR SET
6 - REAR HOLLOW SHAFT/FREEWHEELING CLUTCH F2
7 - DRIVING CLUTCH K3
8 - THRUST WASHER
9 - AXIAL NEEDLE BEARING
10 - SHIM
11 - RETAINING RING

PLANETARY GEARTRAIN (Continued)

(8) Inspect axial play (Fig. 153) between shim (10) and retaining ring (11). Check axial play ″S″ between shim (10) and retaining ring (1) using a feeler gauge. Clearance should be 0.15-0.6 mm. Shims are available in thicknesses of 3.0, 3.4, and 3.7 mm. Adjust as necessary

NOTE: During the test, apply a contact force by hand to K3 in the direction of the arrow.

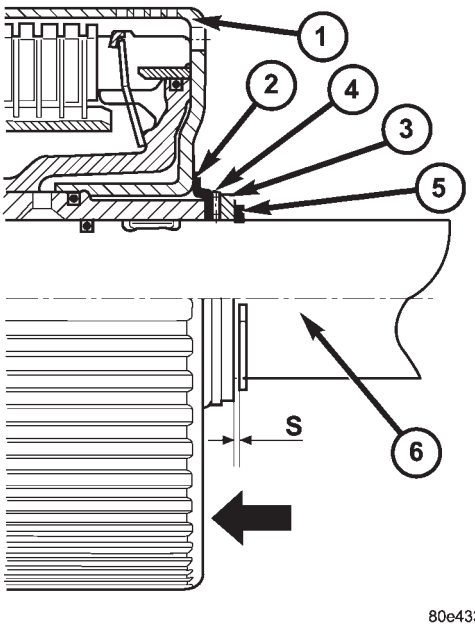


Fig. 153 Check Center and Rear Planetary End-Play

1 - DRIVING CLUTCH K3
2 - THRUST WASHER
3 - SHIM
4 - AXIAL NEEDLE BEARING
5 - RETAINING RING
6 - OUTPUT SHAFT WITH CENTER PLANETARY CARRIER

SHIFT MECHANISM

DESCRIPTION

The gear shift mechanism provides eight shift positions which are:

- Park (P)
- Reverse (R)
- Neutral (N)
- Drive (D)
- Manual fourth (4)
- Manual third (3)
- Manual second (2)
- Manual low (1)

The Selector Lever Sensor Assembly (SLSA) is a microprocessor-equipped module that detects transmission shift lever position and reports that position to the TCM. The SLSA contains a Hall-effect sensor array that is connected to the microprocessor. The microprocessor controls a set of circuits that are connected to the TCM. The TCM applies a sensing voltage to these circuits, and the SLSA grounds these circuits in a programmed pattern indicating shift lever position.

The reverse light switch, an integral part of the SLSA, controls the reverse light relay control circuit. The Brake/Transmission Shift Interlock (BTSI) solenoid and the park lockout solenoid (also part of the SLSA) are controlled by the TCM.

OPERATION

The transmission control module (TCM) monitors the shift lever and sensor assembly (SLSA) for all shift lever positions through five position circuits. The SLSA provides a low-current 12-volt signal to the TCM. The TCM compares the on/off signals to programmed combinations to determine the exact position of the shift lever.

Each circuit can be either HI or LO, depending on the shift lever position. The TCM can decode this information and determine the position of the shift lever. Each shift lever position has a certain combination of HI and LO circuits that are called a Grey Code.

This transmission does not have an internal range sensor. The requested gear must be communicated to the TCM by the shifter module. There are 12 Hall-effect sensors. Five circuits send a grey code (PRNDL Code) to the transmission controller to accomplish this. The grey code is a valid signal that reports the status of each Hall-effect sensor for each switch position to determine gear position and gear shift movement (fore and aft direction). If this grey code is incorrect, a DTC is set. The shifter sense circuits communicate the position of the shift lever to the TCM. Each circuit is terminated at the shifter.

The SLSA grey code can be viewed with the DRB® scan tool and compared to the Grey Code table SLSA Grey Code Table to verify proper operation.

SHIFT MECHANISM (Continued)

SLSA GREY CODE TABLE

	C1	C2	C3	C4	C5
PARK	H	H	H	L	L
T1	L	H	H	L	H
REVERSE	L	H	H	H	L
T2	L	L	H	H	H
NEUTRAL	H	L	H	H	L
T3	H	L	L	H	H
D	L	L	H	L	L
4	L	L	L	H	L
3	L	H	L	L	L
2	H	L	L	L	L
1	H	H	L	H	L

PARK LOCKOUT SOLENOID

The SLSA contains a park lockout solenoid. The park lockout solenoid is energized by the TCM whenever the shift position is not PARK and vehicle speed is above 10 kph (6 mph).

REMOVAL

(1) Remove any necessary console parts for access to shift lever assembly and shifter cables. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - REMOVAL)

(2) Shift transmission into PARK.

(3) Disconnect the transmission shift cable at shift lever and shifter assembly bracket (Fig. 154).

(4) Disconnect the park lock cable from the shifter BTSI lever and the shifter assembly bracket. (Fig. 155)

(5) Disconnect the transfer case shift cable from the transfer case shift lever pin (Fig. 156), if equipped.

(6) Remove the clip holding the transfer case shift cable to the shifter assembly bracket, if equipped.

(7) Remove the transfer case shift cable from the shifter assembly bracket, if equipped.

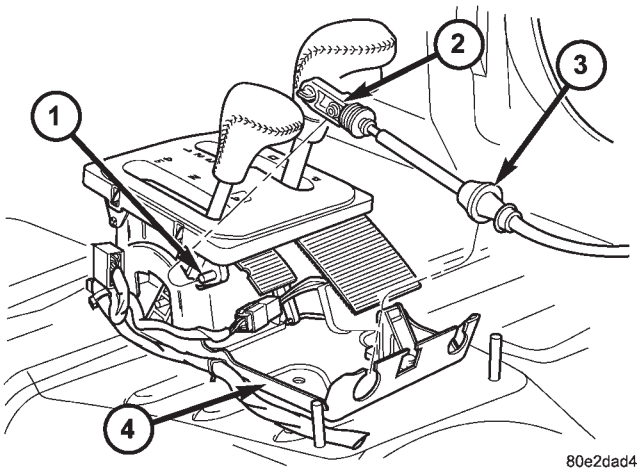


Fig. 154 Transmission Shift Cable

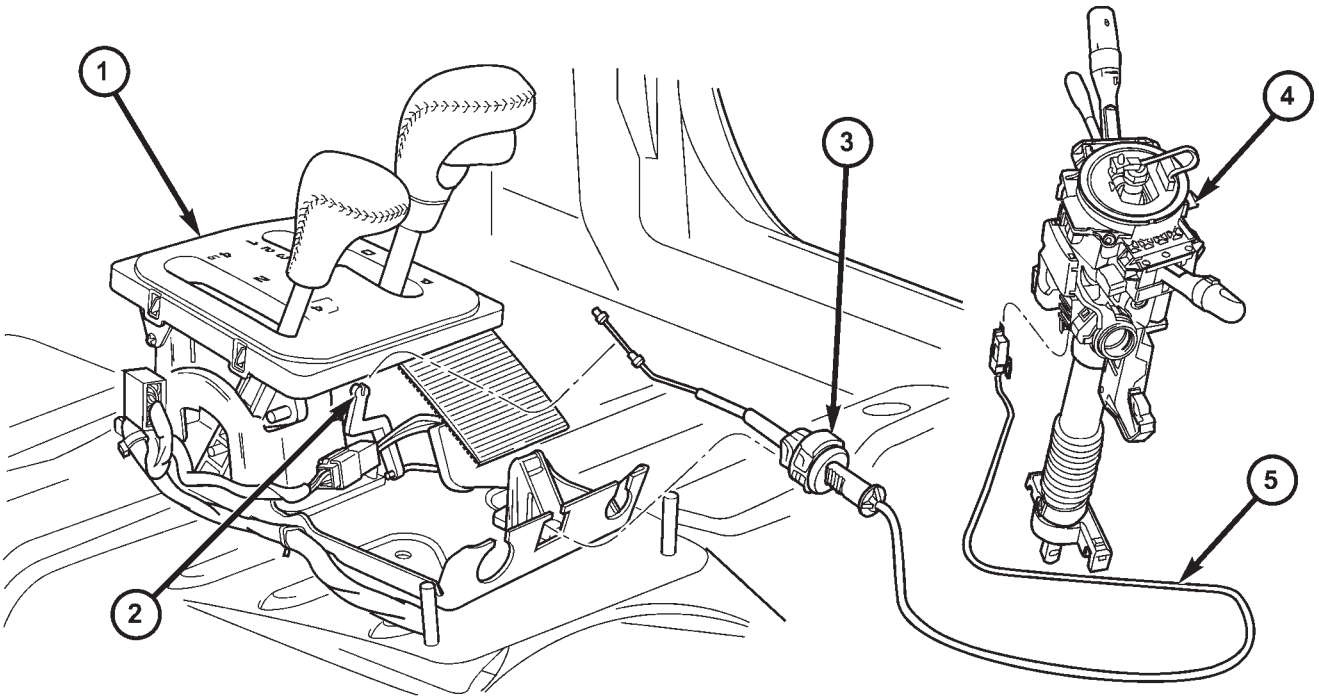
1 - SHIFT LEVER PIN
2 - ADJUSTMENT SCREW
3 - SHIFT CABLE
4 - SHIFTER ASSEMBLY BRACKET

(8) Disengage all wiring connectors from the shifter assembly.

(9) Remove all nuts holding the shifter assembly to the floor pan (Fig. 157).

(10) Remove the shifter assembly from the vehicle.

SHIFT MECHANISM (Continued)



80e483f3

Fig. 155 Ignition Interlock Cable

1 - SHIFT MECHANISM
2 - SHIFTER BTSI LEVER
3 - ADJUSTMENT CLIP
4 - STEERING COLUMN ASSEMBLY
5 - INTERLOCK CABLE

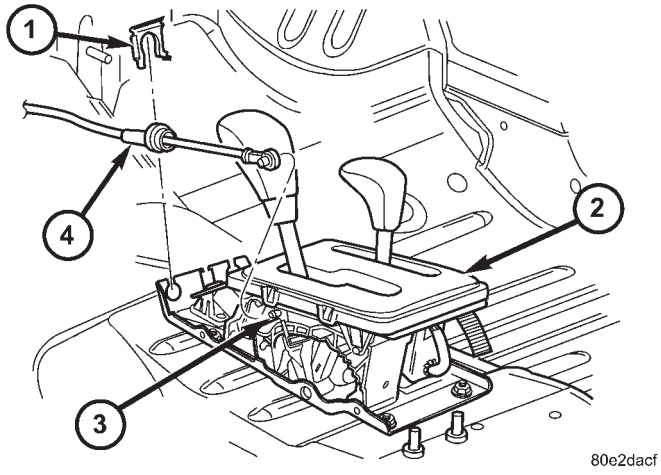


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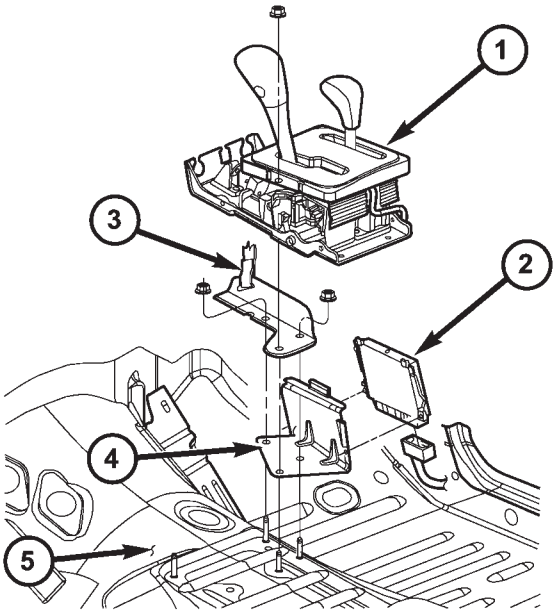
Fig. 156 Transfer Case Shift Cable

1 - CLIP
2 - SHIFTER
3 - TRANSFER CASE SHIFT LEVER PIN
4 - TRANSFER CASE SHIFT CABLE



80e2dad2

Fig. 157 Shifter Assembly

1 - SHIFTER ASSEMBLY
2 - TRANSMISSION CONTROL MODULE
3 - STRAP
4 - BRACKET
5 - FLOOR PAN

SHIFT MECHANISM (Continued)

INSTALLATION

(1) Install shifter assembly onto the shifter assembly studs on the floor pan.

(2) Install the nuts to hold the shifter assembly onto the floor pan. Tighten nuts to 28 N·m (250 in.lbs.).

(3) Place the floor shifter lever in PARK position.

(4) Loosen the adjustment screw on the shift cable.

(5) Verify that the park lock cable adjustment tab is pulled upward to the unlocked position.

(6) Install wiring harness to the shifter assembly bracket. Engage any wire connectors removed from the shifter assembly.

(7) Install the transfer case shift cable to the shifter assembly bracket. Install clip to hold cable to the bracket.

(8) Snap the transfer case shift cable, if equipped, onto the transfer case shift lever pin.

(9) Install the park lock cable into the shifter assembly bracket and into the shifter BTSI lever.(Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC/SHIFT INTERLOCK MECHANISM - ADJUSTMENTS)

(10) Install the shift cable to the shifter assembly bracket. Push cable into the bracket until secure.

(11) Snap the shift cable onto the shift lever pin.

(12) Verify that the shift lever is in the PARK position.

(13) Tighten the adjustment screw to 7 N·m (65 in.lbs.).

(14) Place the key in the accessory position.

(15) Push downward on the park lock cable adjustment tab to lock the adjustment.

(16) Verify correct shifter, park lock, and BTSI operation.

(17) Install any console parts removed for access to shift lever assembly and shift cables. (Refer to 23 - BODY/INTERIOR/FLOOR CONSOLE - INSTALLATION)

SOLENOID

DESCRIPTION

The typical electrical solenoid used in automotive applications is a linear actuator. It is a device that produces motion in a straight line. This straight line motion can be either forward or backward in direction, and short or long distance.

A solenoid is an electromechanical device that uses a magnetic force to perform work. It consists of a coil of wire, wrapped around a magnetic core made from steel or iron, and a spring loaded, movable plunger, which performs the work, or straight line motion.

The solenoids used in transmission applications are attached to valves which can be classified as **normally open** or **normally closed**. The **normally open** solenoid valve is defined as a valve which allows hydraulic flow when no current or voltage is applied to the solenoid. The **normally closed** solenoid valve is defined as a valve which does not allow hydraulic flow when no current or voltage is applied to the solenoid. These valves perform hydraulic control functions for the transmission and must therefore be durable and tolerant of dirt particles. For these reasons, the valves have hardened steel poppets and ball valves. The solenoids operate the valves directly, which means that the solenoids must have very high outputs to close the valves against the sizable flow areas and line pressures found in current transmissions. Fast response time is also necessary to ensure accurate control of the transmission.

The strength of the magnetic field is the primary force that determines the speed of operation in a particular solenoid design. A stronger magnetic field will cause the plunger to move at a greater speed than a weaker one. There are basically two ways to increase the force of the magnetic field:

1. Increase the amount of current applied to the coil or
2. Increase the number of turns of wire in the coil.

The most common practice is to increase the number of turns by using thin wire that can completely fill the available space within the solenoid housing. The strength of the spring and the length of the plunger also contribute to the response speed possible by a particular solenoid design.

A solenoid can also be described by the method by which it is controlled. Some of the possibilities include variable force, pulse-width modulated, constant ON, or duty cycle. The variable force and pulse-width modulated versions utilize similar methods to control the current flow through the solenoid to position the solenoid plunger at a desired position somewhere between full ON and full OFF. The constant ON and duty cycled versions control the voltage across the solenoid to allow either full flow or no flow through the solenoid's valve.

SOLENOID (Continued)

UPSHIFT/DOWNSHIFT SOLENOID VALVES

The solenoid valves for upshifts and downshifts (Fig. 158) are located in the shell of the electric control unit and pressed against the shift plate with a spring.

The solenoid valves (1) initiate the upshift and downshift procedures in the shift plate.

The solenoid valves (1) are sealed off from the valve housing of the shift plate (5) by two O-rings (4, 6). The contact springs (8) at the solenoid valve engage in a slot in the conductor tracks (7). The force of the contact spring (8) ensures safe contacts.

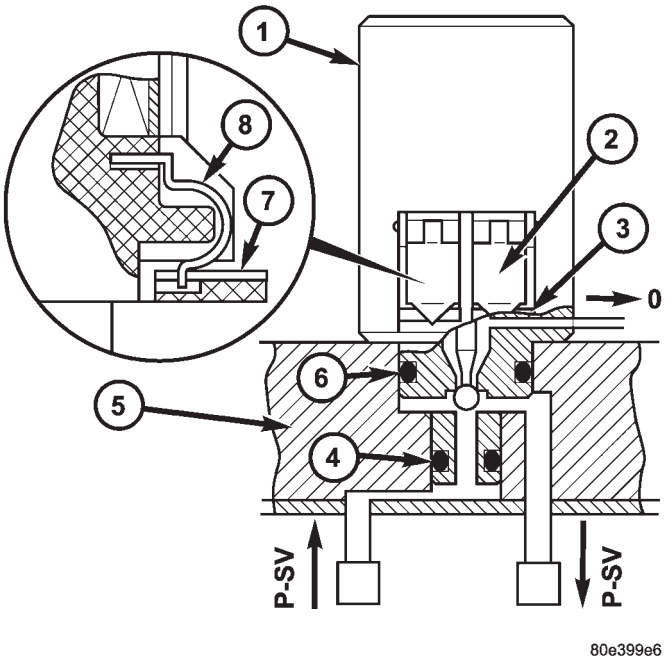


Fig. 158 Upshift/Downshift Solenoid Valves

1 - UPSHIFT/DOWNSHIFT SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - O-RING
5 - VALVE HOUSING OF SHIFT PLATE
6 - O-RING
7 - CONDUCTOR TRACK
8 - CONTACT SPRING

MODULATING PRESSURE CONTROL SOLENOID VALVE

The modulating pressure control solenoid valve (Fig. 159) is located in the shell of the electric valve control unit and pressed against the shift plate by a spring.

Its purpose is control the modulating pressure depending on the continuously changing operating conditions, such as load and gear change.

The modulating pressure regulating solenoid valve (1) has an interference fit and is sealed off to the valve body of the shift plate (4) by a seal (arrow). The contact springs (2) at the solenoid valve engage in a slot in the conductor tracks (3). The force of the contact springs (2) ensures secure contacts.

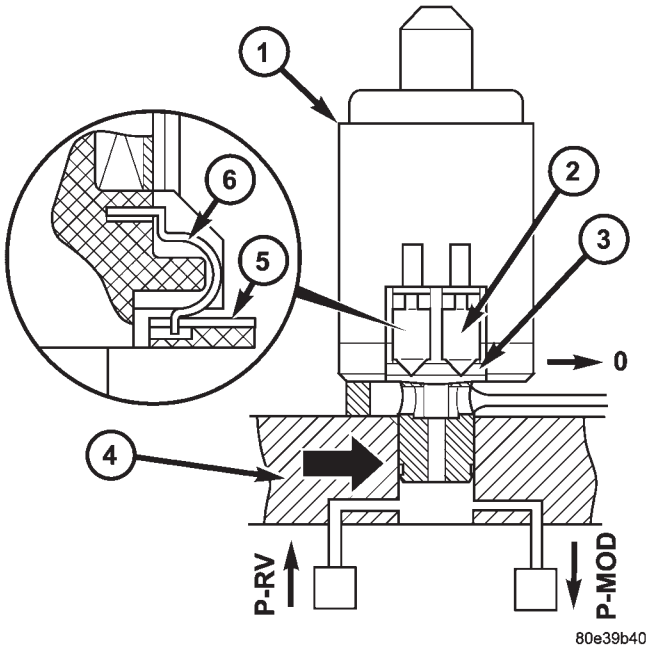


Fig. 159 Modulating Pressure Control Solenoid Valve

1 - MODULATING PRESSURE CONTROL SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING SHIFT PLATE
5 - CONDUCTOR TRACK
6 - CONTACT SPRING

SOLENOID (Continued)

TORQUE CONVERTER LOCKUP CLUTCH PWM SOLENOID VALVE

The torque converter lockup clutch PWM solenoid valve (1) (Fig. 160) is located in the shell of the electric valve control unit and pressed against the shift plate by a spring.

The PWM solenoid valve (1) for the torque converter lockup controls the pressure for the torque converter lockup clutch.

The torque converter lockup PWM solenoid valve (1) is sealed off to the valve body of the shift plate (4) by an O-ring (5) and a seal (arrow). The contact springs (2) at the solenoid valve engage in a slot in the conductor tracks (3). The force of the contact springs (2) ensures secure contacts.

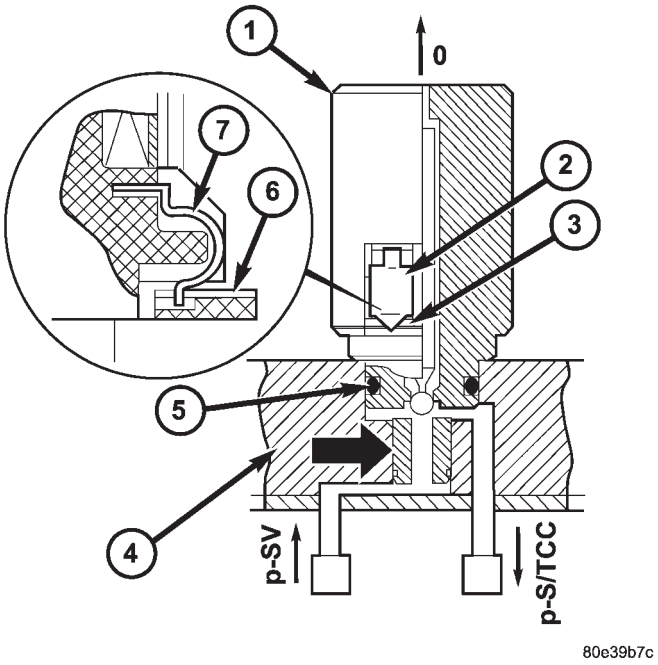


Fig. 160 Torque Converter Lockup Clutch PWM Solenoid Valve

1 - TORQUE CONVERTER LOCKUP CLUTCH PWM SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING OF SHIFT PLATE
5 - O-RING
6 - CONDUCTOR TRACK
7 - CONTACT SPRING

SHIFT PRESSURE CONTROL SOLENOID VALVE

The shift pressure control solenoid valve (1) (Fig. 161) is located in the shell of the electric valve control unit and pressed against the shift plate by a spring.

Its purpose is to control the shift pressure depending on the continuously changing operating conditions, such as load and gear change.

The shift pressure regulating solenoid valve (1) has an interference fit and is sealed off to the valve body of the shift plate (4) by a seal (arrow). The contact springs (2) at the solenoid valve engage in a slot in the conductor tracks (3). The force of the contact springs (2) ensures secure contacts

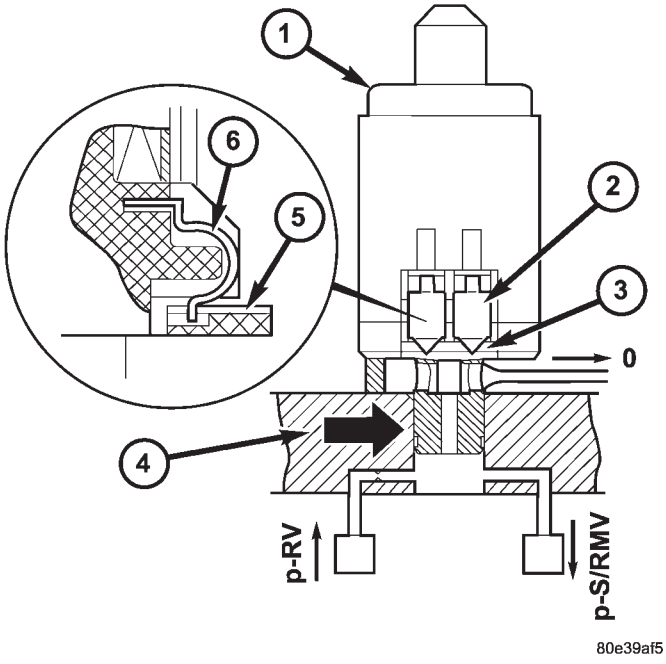


Fig. 161 Shift Pressure Control Solenoid Valve

1 - SHIFT PRESSURE CONTROL SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING SHIFT PLATE
5 - CONDUCTOR TRACK
6 - CONTACT SPRING

OPERATION

When an electrical current is applied to the solenoid coil, a magnetic field is created which produces an attraction to the plunger, causing the plunger to move and work against the spring pressure and the load applied by the fluid the valve is controlling. The plunger is normally directly attached to the valve which it is to operate. When the current is removed from the coil, the attraction is removed and the plunger will return to its original position due to spring pressure.

SOLENOID (Continued)

The plunger is made of a conductive material and accomplishes this movement by providing a path for the magnetic field to flow. By keeping the air gap between the plunger and the coil to the minimum necessary to allow free movement of the plunger, the magnetic field is maximized.

UPSHIFT/DOWNSHIFT SOLENOID VALVES

If a solenoid valve (Fig. 162) is actuated by the TCM, it opens and guides the control pressure (p-SV) to the assigned command valve. The solenoid valve remains actuated and therefore open until the shifting process is complete. The shift pressure (p-SV) to the command valve is reduced to zero as soon as the power supply to the solenoid valve is interrupted.

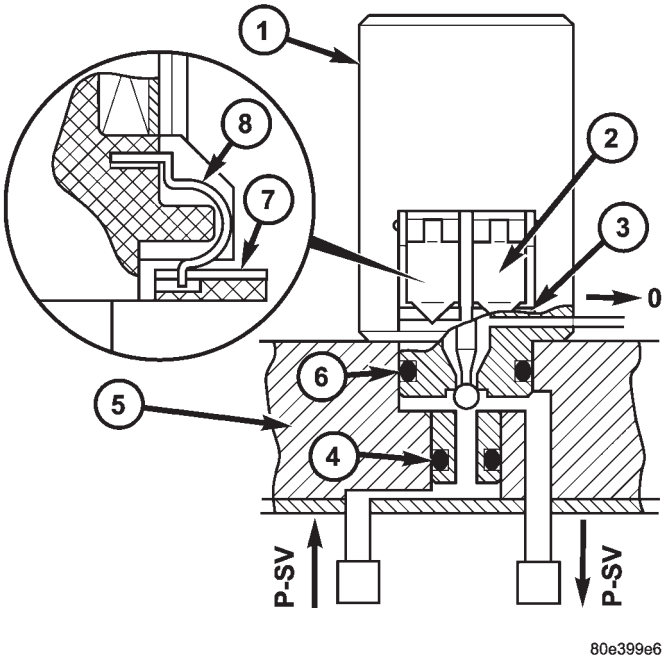


Fig. 162 Upshift/Downshift Solenoid Valves

1 - UPSHIFT/DOWNSHIFT SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - O-RING
5 - VALVE HOUSING OF SHIFT PLATE
6 - O-RING
7 - CONDUCTOR TRACK
8 - CONTACT SPRING

MODULATING PRESSURE CONTROL SOLENOID VALVE

The modulating pressure regulating solenoid valve (1) (Fig. 163)assigns a proportional pressure to the current which is controlled by the TCM according to the load.

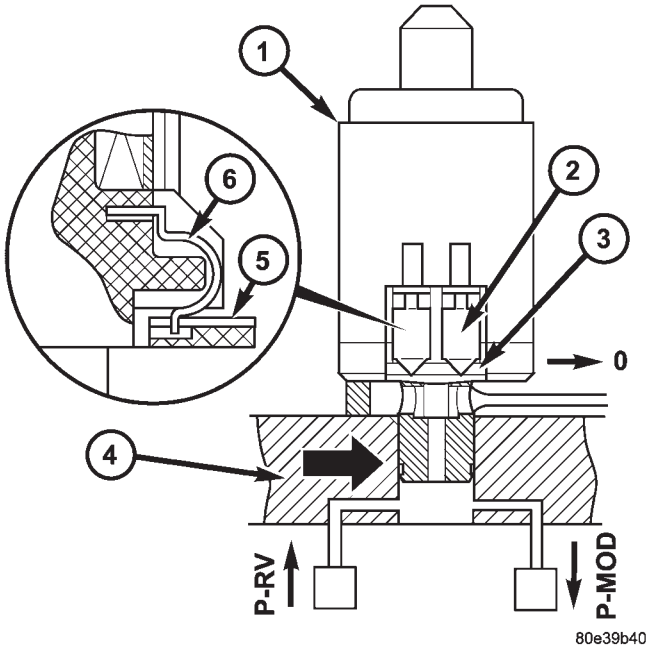


Fig. 163 Modulating Pressure Control Solenoid Valve

1 - MODULATING PRESSURE CONTROL SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING SHIFT PLATE
5 - CONDUCTOR TRACK
6 - CONTACT SPRING

SOLENOID (Continued)

TORQUE CONVERTER LOCKUP CLUTCH PWM SOLENOID VALVE

The torque converter lockup PWM solenoid (1) (Fig. 164) valve converts pulse-wave-modulated current controlled by the TCM into the appropriate hydraulic control pressure (p-S/TCC).

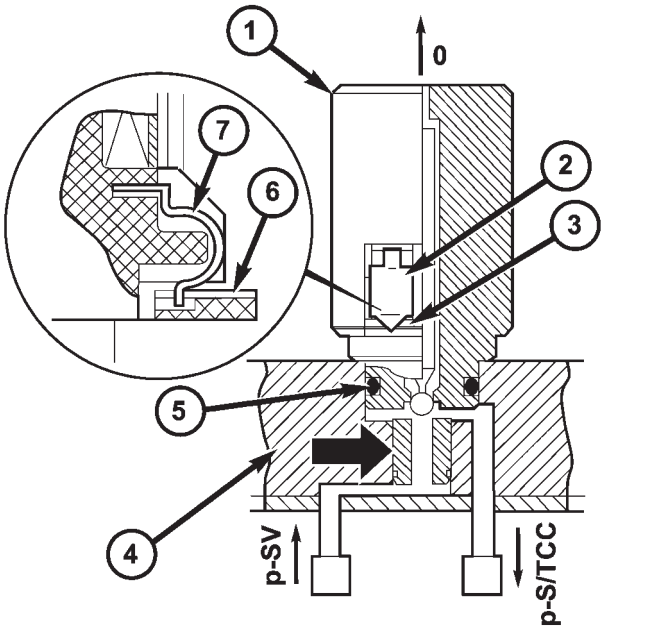


Fig. 164 Torque Converter Lockup Clutch PWM Solenoid Valve

1 - TORQUE CONVERTER LOCKUP CLUTCH PWM SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING OF SHIFT PLATE
5 - O-RING
6 - CONDUCTOR TRACK
7 - CONTACT SPRING

SHIFT PRESSURE CONTROL SOLENOID VALVE

The shift pressure regulating solenoid valve (1) (Fig. 165) assigns a proportional pressure to the current which is controlled by the TCM according to the load.

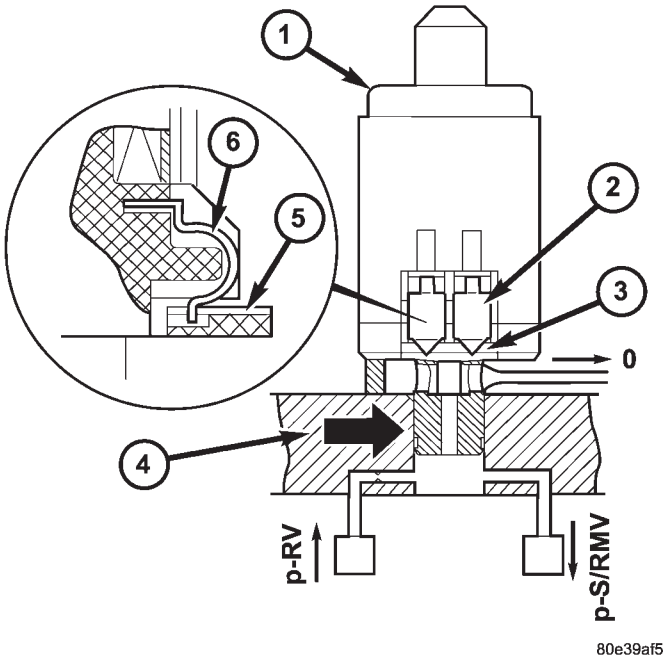


Fig. 165 Shift Pressure Control Solenoid Valve

1 - SHIFT PRESSURE CONTROL SOLENOID VALVE
2 - CONTACT SPRING
3 - CONDUCTOR TRACK
4 - VALVE HOUSING SHIFT PLATE
5 - CONDUCTOR TRACK
6 - CONTACT SPRING

TEMPERATURE SENSOR/ PARK-NEUTRAL CONTACT

DESCRIPTION

DESCRIPTION - PARK/NEUTRAL CONTACT

The park/neutral contact (4) (Fig. 166) is located in the shell of the electric control unit and is fixed to the conductor tracks.

Its purpose is to recognize selector valve and selector lever positions ″P″ and ″N″. The park/neutral contact consists of:

- the plunger (2).
- the permanent magnet (3).
- the dry-reed contact (4).

TEMPERATURE SENSOR/PARK-NEUTRAL CONTACT (Continued)

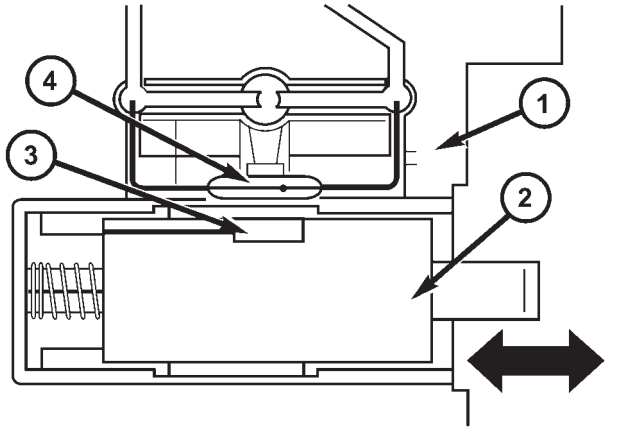


Fig. 166 Park/Neutral Contact

1 - SHELL OF ELECTRIC CONTROL MODULE
2 - PLUNGER
3 - PERMANENT MAGNET
4 - DRY-REED CONTACT

DESCRIPTION

The transmission oil temperature sensor (1) (Fig. 167) is located in the shell of the electric valve control unit and is fixed to the conductor tracks.

Its purpose is to measure the temperature of the transmission oil and pass the temperature to the TCM as an input signal. It is a temperature-dependent resistor (PTC).

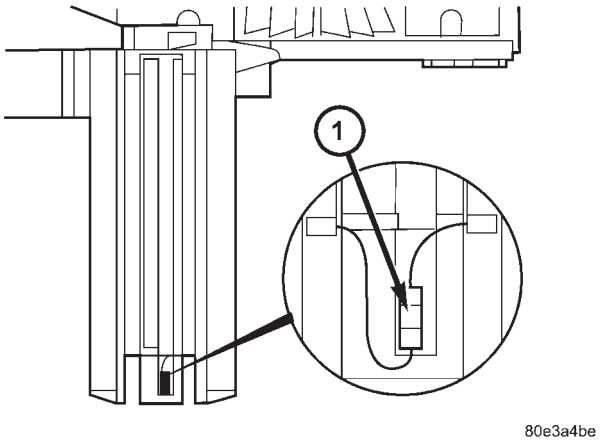


Fig. 167 Transmission Temperature Sensor

1 - TRANSMISSION TEMPERATURE SENSOR

OPERATION

OPERATION

In selector lever positions ″P″ and ″N″ the park/neutral contact (4) (Fig. 168) is actuated by a cam track which is located on the detent plate. The permanent magnet (3) is moved away from the dry-reed contact (4). The dry-reed contact (4) is opened. The TCM receives an electric signal. The circuit to the starter in the selector lever positions ″P″ and ″N″ is closed.

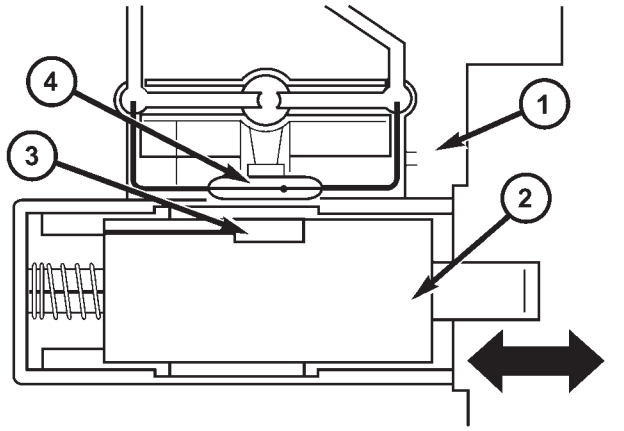


Fig. 168 Park/Neutral Contact

1 - SHELL OF ELECTRIC CONTROL MODULE
2 - PLUNGER
3 - PERMANENT MAGNET
4 - DRY-REED CONTACT

OPERATION

The temperature of the transmission oil has a considerable effect on the shifting time and therefore the shift quality. By measuring the oil temperature, shift operations can be optimized in all temperature ranges. The transmission oil temperature sensor (1) (Fig. 169) is switched in series with the park/neutral contact. The temperature signal is transferred to the TCM only when the dry-reed contact of the park/neutral contact is closed in a forward gear position.

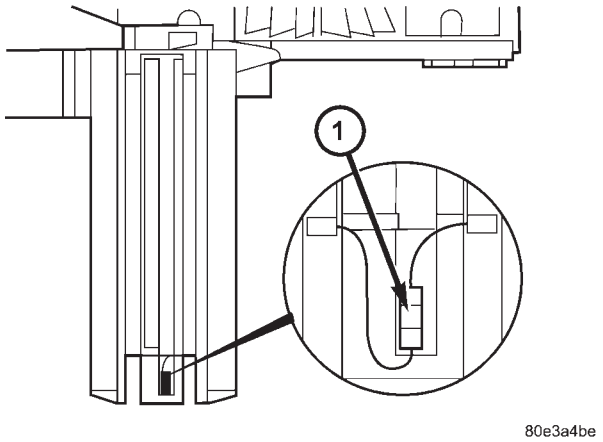


Fig. 169 Transmission Temperature Sensor

1 - TRANSMISSION TEMPERATURE SENSOR

TEMPERATURE SENSOR/PARK-NEUTRAL CONTACT (Continued)

Refer to the Transmission Temperature Sensor Specifications table (Fig. 170) for the relationship between transmission temperature, sensor voltage, and sensor resistance.

TRANSMISSION TEMP SENSOR SPECIFICATIONS
TEMPERATURE/VOLTAGE/RESISTANCE CHART

TEMPERATURE (C)	TEMPERATURE (F)	VOLTAGE	RESISTANCE
-50	-58	0.73	506.0
-45	-49	0.77	534.0
-40	-40	0.80	564.0
-35	-31	0.84	593.0
-30	-22	0.88	624.0
-25	-13	0.91	654.0
-20	-4	0.95	686.0
-15	5	0.98	718.0
-10	14	1.02	750.0
-5	23	1.05	783.0
0	32	1.09	817.0
5	41	1.12	851.0
10	50	1.16	886.0
15	59	1.19	921.0
20	68	1.23	957.0
25	77	1.26	994.0
30	86	1.30	1032.0
35	95	1.33	1070.0
40	104	1.37	1109.0
45	113	1.40	1149.0
50	122	1.44	1189.0
55	131	1.48	1231.0
60	140	1.51	1273.0
65	149	1.55	1316.0
70	158	1.58	1360.0
75	167	1.62	1405.0
80	176	1.65	1450.0
85	185	1.69	1497.0
90	194	1.72	1545.0
95	203	1.76	1594.0
100	212	1.79	1644.0
105	221	1.83	1695.0
110	230	1.86	1747.0
115	239	1.90	1800.0
120	248	1.93	1855.0
125	257	1.97	1911.0
130	266	2.00	1968.0
135	275	2.04	2027.0
140	284	2.08	2087.0
145	293	2.11	2148.0
150	302	2.15	2211.0
155	311	2.18	2276.0
160	320	2.22	2342.0
165	329	2.25	2410.0
170	338	2.29	2479.0
175	347	2.32	2551.0

80e3afbe

Fig. 170 Transmission Temperature Sensor Specifications

TORQUE CONVERTER

DESCRIPTION

The torque converter (Fig. 171) 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. The converter clutch provides reduced engine speed and greater fuel economy when engaged. Clutch engagement also provides reduced transmission fluid temperatures. The converter clutch engages in third gear. 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.

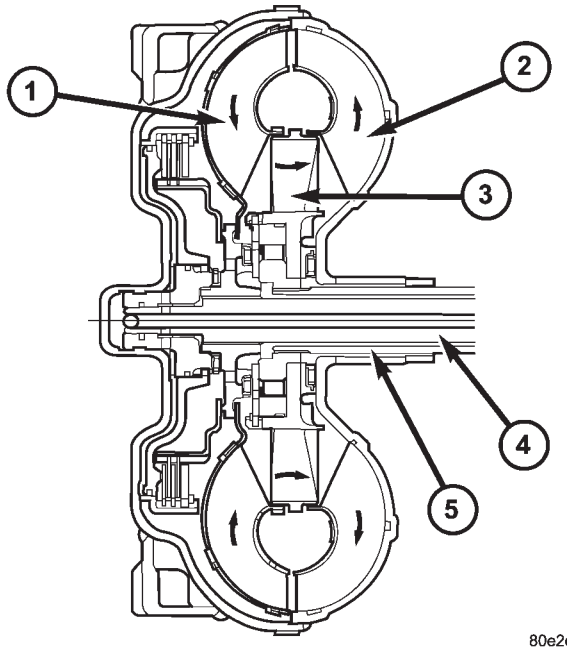


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Fig. 171 Torque Converter

1 - TURBINE
2 - IMPELLER
3 - STATOR
4 - INPUT SHAFT
5 - STATOR SHAFT

TORQUE CONVERTER (Continued)

IMPELLER

The impeller (Fig. 172) is an integral part of the converter housing. The impeller consists of curved blades placed radially along the inside of the housing on the transmission side of the converter. As the converter housing is rotated by the engine, so is the impeller, because they are one and the same and are the driving members of the system.

TURBINE

The turbine (Fig. 173) is the output, or driven, member of the converter. The turbine is mounted within the housing opposite the impeller, but is not attached to the housing. The input shaft is inserted through the center of the impeller and splined into the turbine. The design of the turbine is similar to the impeller, except the blades of the turbine are curved in the opposite direction.

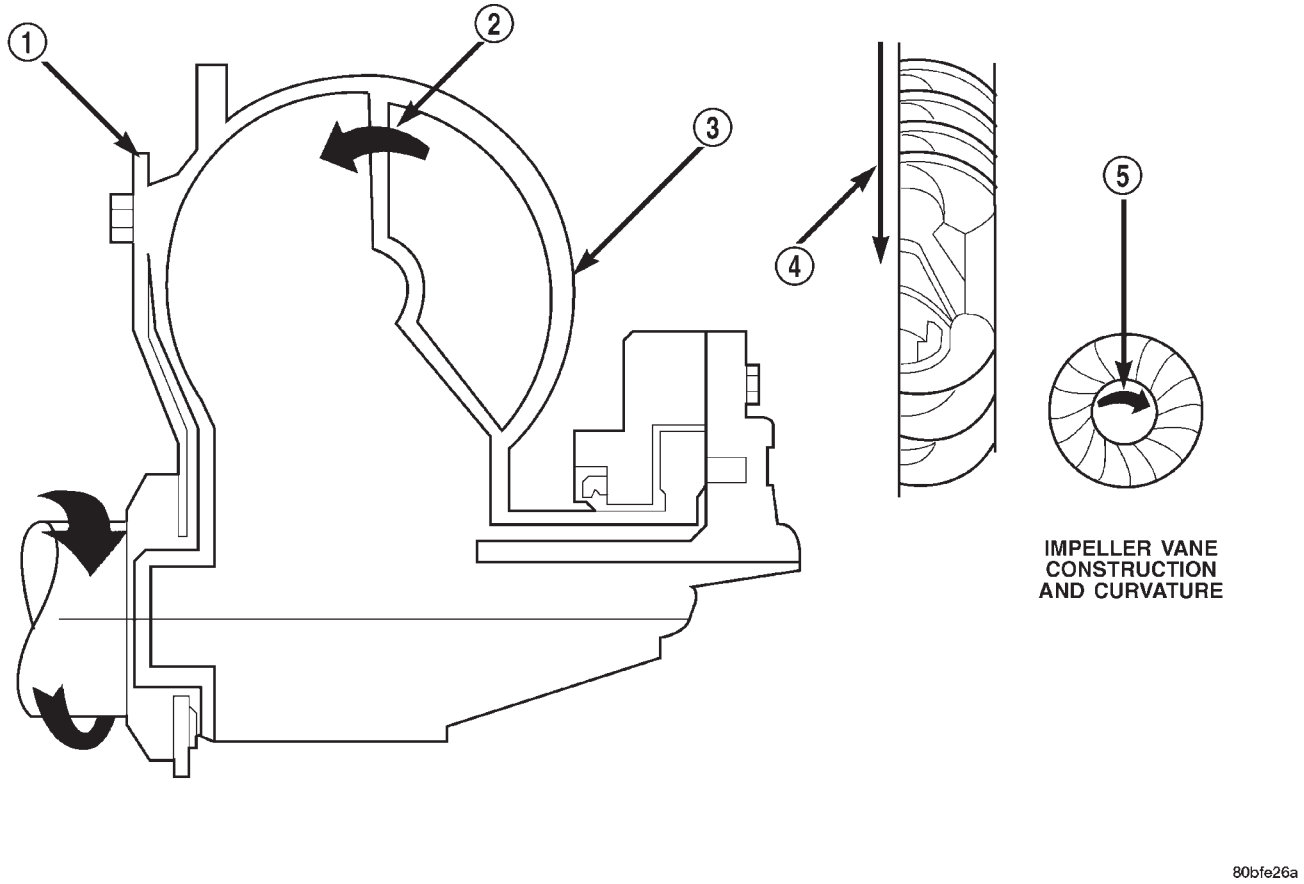


Fig. 172 Impeller

1 - ENGINE FLEXPLATE
2 - OIL FLOW FROM IMPELLER SECTION INTO TURBINE SECTION
3 - IMPELLER VANES AND COVER ARE INTEGRAL
4 - ENGINE ROTATION
5 - ENGINE ROTATION

TORQUE CONVERTER (Continued)

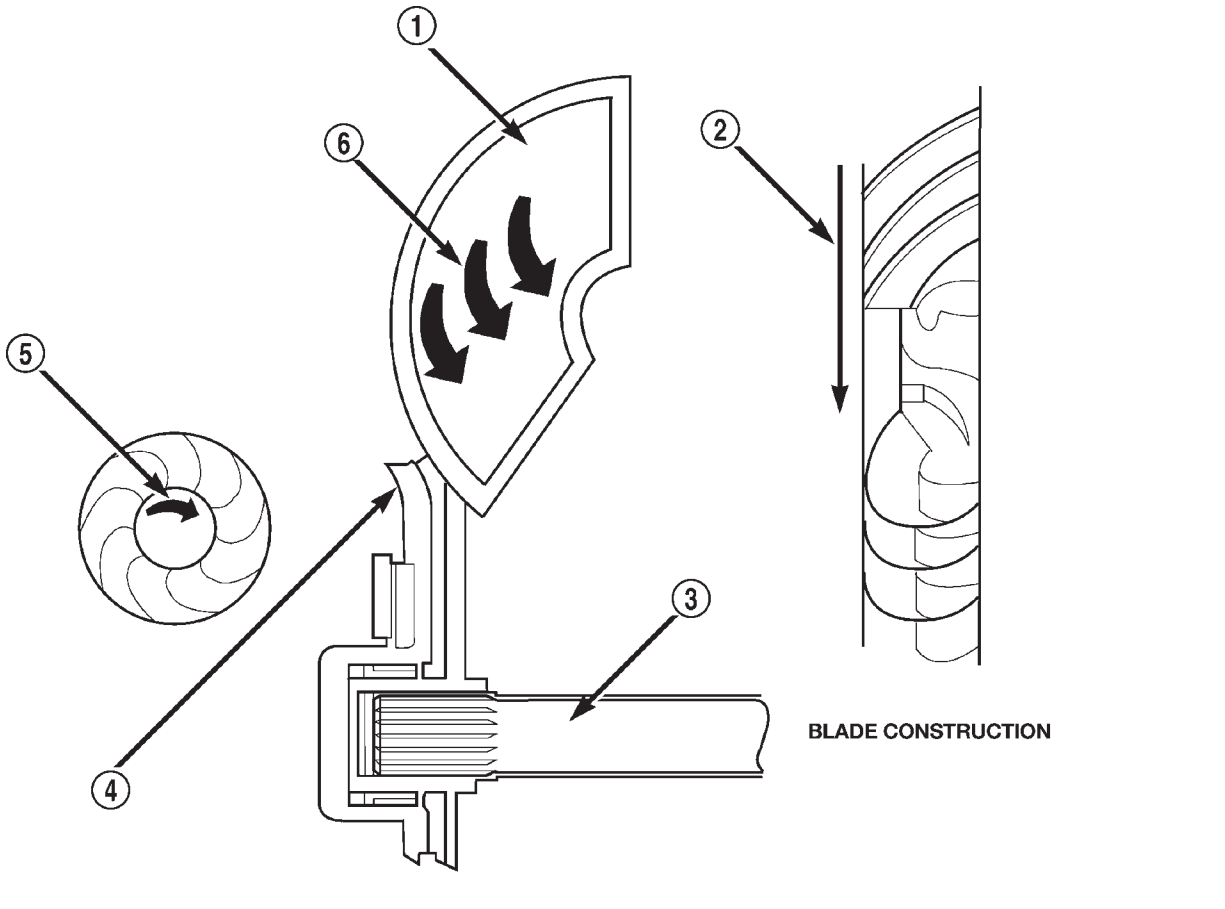


Fig. 173 Turbine

1 - TURBINE VANE
2 - ENGINE ROTATION
3 - INPUT SHAFT
4 - PORTION OF TORQUE CONVERTER COVER
5 - ENGINE ROTATION
6 - OIL FLOW WITHIN TURBINE SECTION

STATOR

The stator assembly (Fig. 174) is mounted on a stationary shaft which is an integral part of the oil pump. The stator is located between the impeller and turbine within the torque converter case (Fig. 175). The stator contains a freewheeling clutch, which allows the stator to rotate only in a clockwise direction. When the stator is locked against the freewheeling clutch, the torque multiplication feature of the torque converter is operational.

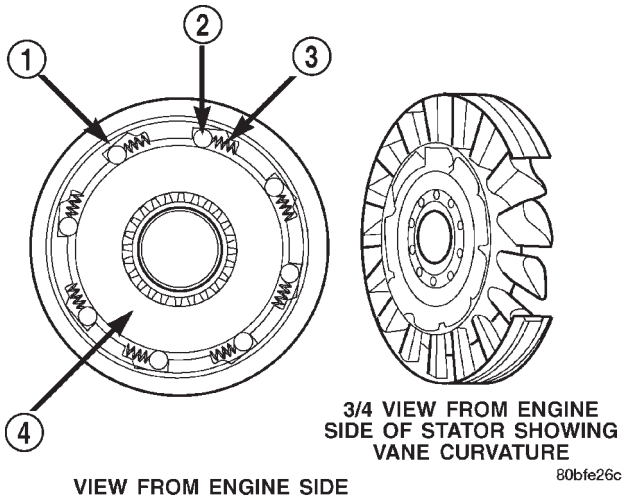


Fig. 174 Stator Components

1 - CAM (OUTER RACE)
2 - ROLLER
3 - SPRING
4 - INNER RACE

TORQUE CONVERTER (Continued)

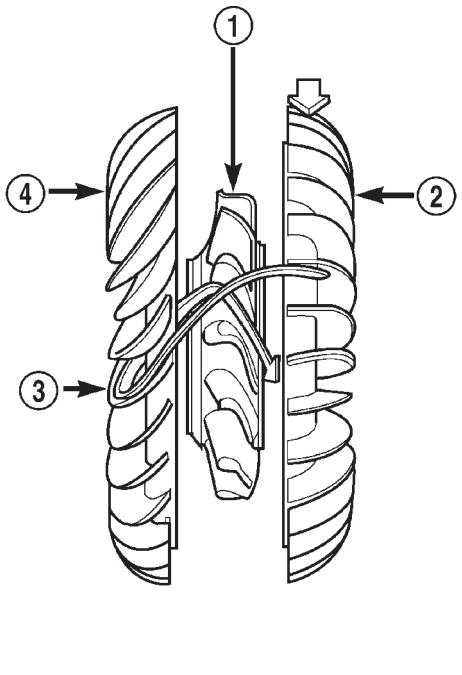


Fig. 175 Stator Location

1 - STATOR
2 - IMPELLER
3 - FLUID FLOW
4 - TURBINE

TORQUE CONVERTER CLUTCH (TCC)

The TCC (Fig. 176) was installed to improve the efficiency of the torque converter that is lost to the slippage of the fluid coupling. Although the fluid coupling provides smooth, shock-free power transfer, it is natural for all fluid couplings to slip. If the impeller and turbine were mechanically locked together, a zero slippage condition could be obtained. A hydraulic piston with friction material was added to the turbine assembly to provide this mechanical lock-up.

In order to reduce heat build-up in the transmission and buffer the powertrain against torsional vibrations, the TCM can duty cycle the torque converter lock-up solenoid to achieve a smooth application of the torque converter clutch. This function, referred to as Electronically Modulated Converter Clutch (EMCC) can occur at various times depending on the following variables:

- Shift lever position
- Current gear range
- Transmission fluid temperature
- Engine coolant temperature
- Input speed
- Throttle angle
- Engine speed

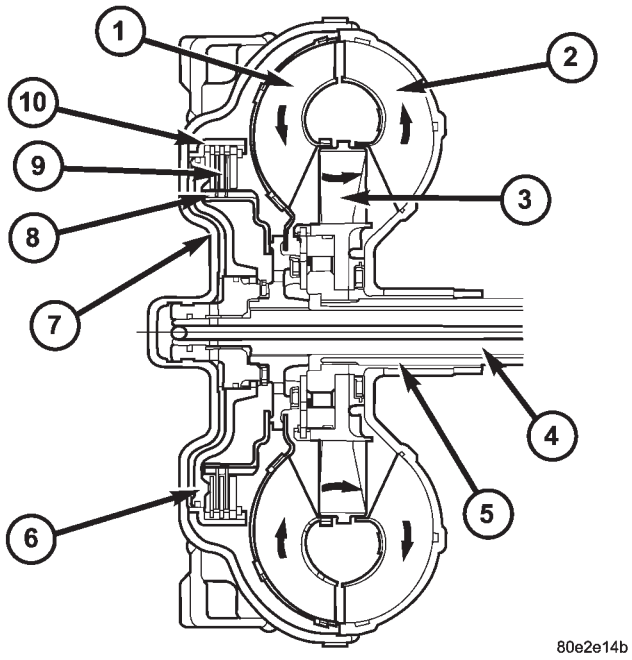


Fig. 176 Torque Converter Lock-up Clutch

1 - TURBINE
2 - IMPELLER
3 - STATOR
4 - INPUT SHAFT
5 - STATOR SHAFT
6 - PISTON
7 - COVER SHELL
8 - INTERNALLY TOOTHED DISC CARRIER
9 - CLUTCH PLATE SET
10 - EXTERNALLY TOOTHED DISC CARRIER

OPERATION

The converter impeller (driving member), which is integral to the converter housing and bolted to the engine drive plate, rotates at engine speed. The converter turbine (driven member), which reacts from fluid pressure generated by the impeller, rotates and turns the transmission input shaft.

TURBINE

As the fluid that was put into motion by the impeller blades strikes the blades of the turbine, some of the energy and rotational force is transferred into the turbine and the input shaft. This causes both of them (turbine and input shaft) to rotate in a clockwise direction following the impeller. As the fluid is leaving the trailing edges of the turbine's blades it continues in a “hindering” direction back toward the impeller. If the fluid is not redirected before it strikes the impeller, it will strike the impeller in such a direction that it would tend to slow it down.

TORQUE CONVERTER (Continued)

STATOR

Torque multiplication is achieved by locking the stator's over-running clutch to its shaft (Fig. 177). Under stall conditions (the turbine is stationary), the oil leaving the turbine blades strikes the face of the stator blades and tries to rotate them in a counter-clockwise direction. When this happens the over-running clutch of the stator locks and holds the stator from rotating. With the stator locked, the oil strikes the stator blades and is redirected into a "helping" direction before it enters the impeller. This circulation of oil from impeller to turbine, turbine to stator, and stator to impeller, can produce a maximum torque multiplication of about 2.0:1. As the turbine begins to match the speed of the impeller, the fluid that was hitting the stator in such as way as to cause it to lock-up is no longer doing so. In this condition of operation, the stator begins to free wheel and the converter acts as a fluid coupling.

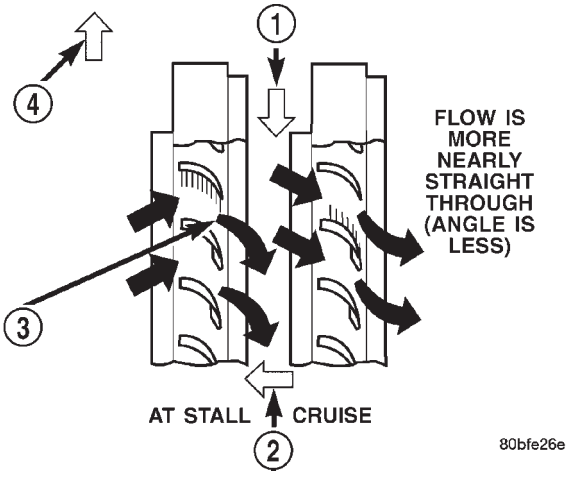


Fig. 177 Stator Operation

1 - DIRECTION STATOR WILL FREE WHEEL DUE TO OIL PUSHING ON BACKSIDE OF VANES
2 - FRONT OF ENGINE
3 - INCREASED ANGLE AS OIL STRIKES VANES
4 - DIRECTION STATOR IS LOCKED UP DUE TO OIL PUSHING AGAINST STATOR VANES

TORQUE CONVERTER CLUTCH (TCC)

In a standard torque converter, the impeller and turbine are rotating at about the same speed and the stator is freewheeling, providing no torque multiplication. By applying the turbine's piston and friction material (Fig. 178) to the front cover, a total converter engagement can be obtained. The result of this engagement is a direct 1:1 mechanical link between the engine and the transmission.

The clutch can be engaged in second, third, fourth, and fifth gear ranges.

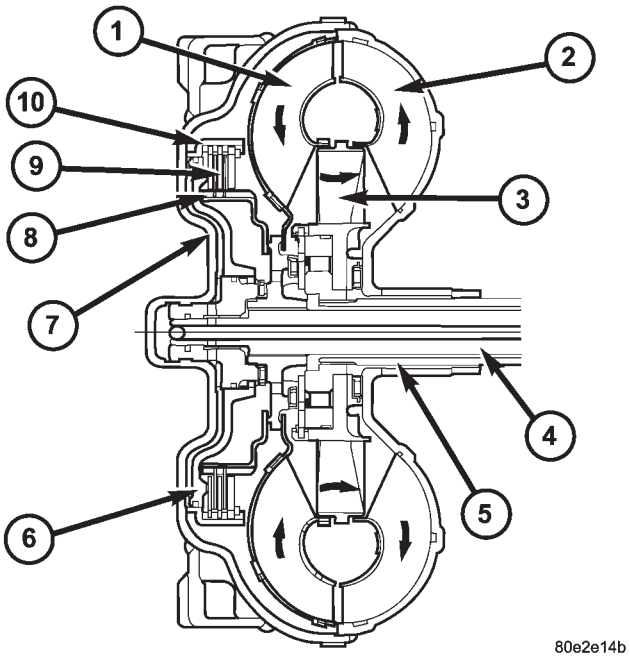


Fig. 178 Torque Converter Lock-up Clutch

1 - TURBINE
2 - IMPELLER
3 - STATOR
4 - INPUT SHAFT
5 - STATOR SHAFT
6 - PISTON
7 - COVER SHELL
8 - INTERNALLY TOOTHED DISC CARRIER
9 - CLUTCH PLATE SET
10 - EXTERNALLY TOOTHED DISC CARRIER

The TCM controls the torque converter by way of internal logic software. The programming of the software provides the TCM with control over the torque converter solenoid. There are four output logic states that can be applied as follows:

- No EMCC
- Partial EMCC
- Full EMCC
- Gradual-to-no EMCC

NO EMCC

Under No EMCC conditions, the TCC Solenoid is OFF. There are several conditions that can result in NO EMCC operations. No EMCC can be initiated due to a fault in the transmission or because the TCM does not see the need for EMCC under current driving conditions.

TORQUE CONVERTER (Continued)

PARTIAL EMCC

Partial EMCC operation modulates the TCC Solenoid (duty cycle) to obtain partial torque converter clutch application. Partial EMCC operation is maintained until Full EMCC is called for and actuated. During Partial EMCC some slip does occur. Partial EMCC will usually occur at low speeds, low load and light throttle situations.

FULL EMCC

During Full EMCC operation, the TCM increases the TCC Solenoid duty cycle to full ON after Partial EMCC control brings the engine speed within the desired slip range of transmission input speed relative to engine rpm.

GRADUAL-TO-NO EMCC

This operation is to soften the change from Full or Partial EMCC to No EMCC. This is done at mid-throttle by decreasing the TCC Solenoid duty cycle.

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 flats for sharp edges, burrs, scratches, or nicks. Polish the hub and flats 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 oil pump seal lip with transmission fluid.

(2) Place torque converter in position on transmission.

CAUTION: Do not damage oil pump seal or converter hub 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. 179). Surface of converter lugs should be at least 19 mm (3/4 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.

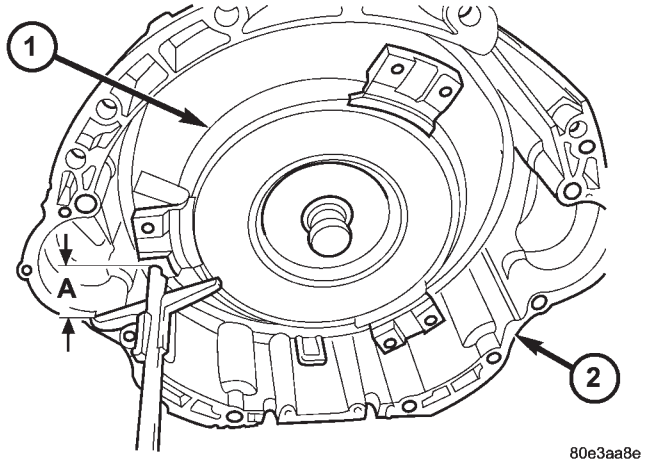


Fig. 179 Torque Converter Installation Depth

1 - TORQUE CONVERTER
2 - TRANSMISSION HOUSING

TRANSFER CASE - NV247

REMOVAL

(1) Open the hood and disconnect the negative battery cable.

(2) Remove the (2) upper fan shroud retaining bolts.

(3) Raise the vehicle on a hoist.

(4) Remove the (2) lower fan shroud retaining bolts.

CAUTION: Mark the position of the driveshaft in relation to its companion flange prior to disassembly. Driveshaft must be reinstalled in the same position it was in prior to disassembly.

(5) Remove the front driveshaft retaining bolts (Fig. 180) and remove the driveshaft from the transfer case companion flange. Support the driveshaft with mechanics wire.

TRANSFER CASE - NV247 (Continued)

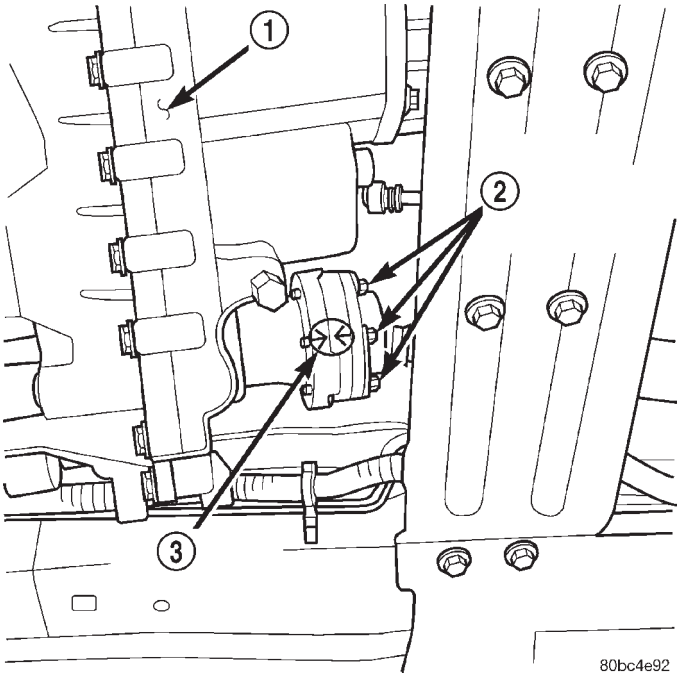


Fig. 180 Front Driveshaft Retaining Bolts

1 - TRANSFER CASE
2 - FRONT DRIVESHAFT RETAINING BOLTS
3 - REFERENCE MARK

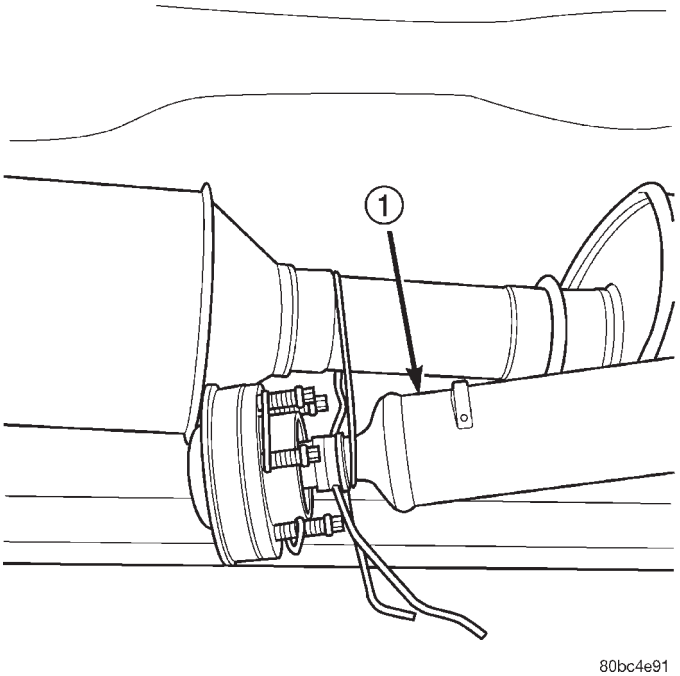


Fig. 181 Rear Driveshaft - Supported

1 - REAR DRIVESHAFT

(6) Remove the rear driveshaft retaining bolts and remove the driveshaft from the transfer case companion flange. Support the driveshaft with mechanics wire (Fig. 181).

(7) Disconnect the transfer case shift cable from the shifter arm (Fig. 182).

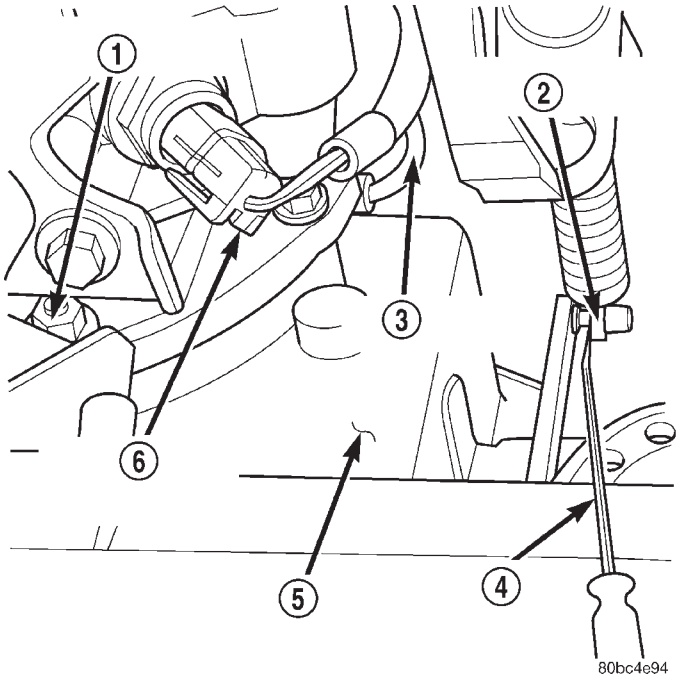


Fig. 182 Transfer Case Position and Orientation

1 - TRANSFER CASE RETAINING NUTS
2 - TRANSFER CASE SHIFTER CABLE
3 - TRANSFER CASE VENT HOSE
4 - FLAT BLADED TOOL
5 - TRANSFER CASE
6 - TRANSMISSION ELECTRICAL CONNECTOR

(8) Disconnect the vent tube from the transfer case (Fig. 182).

(9) Remove the transmission oil pan and drain the transmission fluid. Reinstall the transmission oil pan.

(10) Position a jack under the transmission support crossmember and support the transmission and transfer case assembly.

(11) Remove the (8) transmission support crossmember retaining bolts (Fig. 183).

(12) Position a transmission jack under the transfer case.

(13) Lower the transmission assembly enough to gain access and remove the transfer case to transmission retaining nuts.

(14) Remove the transfer case from the vehicle.

DISASSEMBLY

Position transfer case on shallow drain pan. Remove drain plug and drain lubricant remaining in case.

TRANSFER CASE - NV247 (Continued)

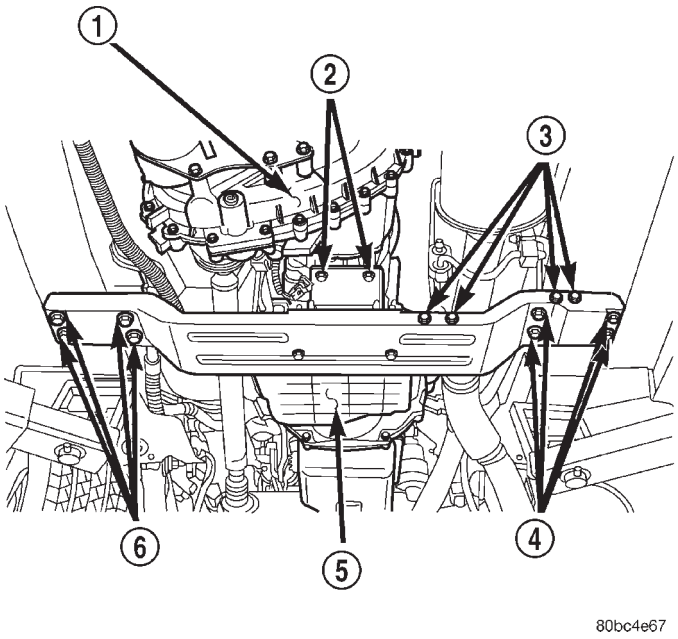


Fig. 183 Transmission Support Crossmember Position and Orientation

1 - TRANSFER CASE
2 - TRANSMISSION MOUNT RETAINING BOLTS (2 OF 4)
3 - EXHAUST SYSTEM SUPPORT BRACKET RETAINING BOLTS
4 - CROSSMEMBER RETAINING BOLTS
5 - TRANSMISSION
6 - CROSSMEMBER RETAINING BOLTS

REAR CASE AND OIL PUMP

(1) Remove the bolts (Fig. 184) holding the transfer case damper to the transfer case.

(2) Remove the damper (Fig. 185) from the transfer case.

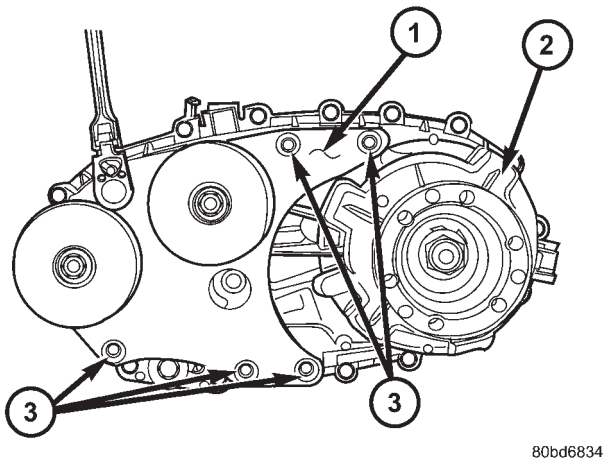


Fig. 184 Remove Damper Bolts

1 - DAMPER
2 - TRANSFER CASE
3 - BOLTS

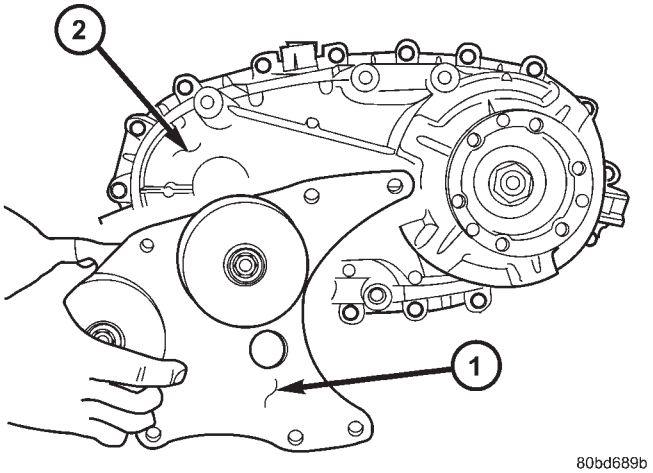


Fig. 185 Remove Damper

1 - DAMPER
2 - TRANSFER CASE

(3) Install two bolts (Fig. 186) partially into the rear propellor shaft companion flange, 180° from each other.

(4) Install the rectangular end of the Flange Holder C-3281 over the bolts to hold the companion flange stationary and remove the nut holding the companion flange to the rear output shaft.

(5) Use Remover C-452 (Fig. 187) to remove the rear companion flange.

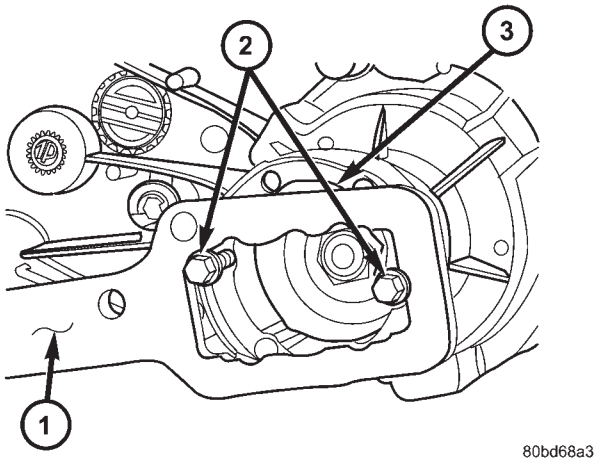


Fig. 186 Hold Companion Flange

1 - HOLDER C-3281
2 - BOLTS
3 - COMPANION FLANGE

(6) Support transfer case so rear case is facing upward.

(7) Remove bolts holding front case to rear case. The case alignment bolt require flat washers (Fig. 188).

TRANSFER CASE - NV247 (Continued)

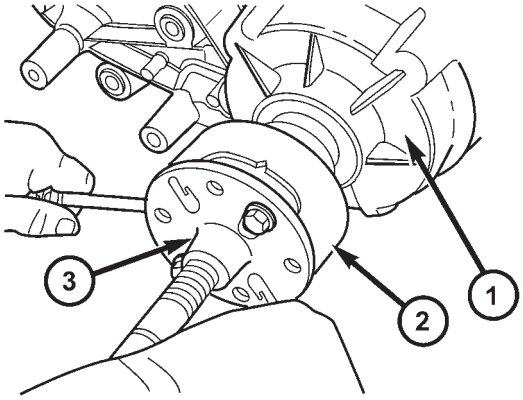


Fig. 187 Remove Companion Flange

1 - TRANSFER CASE
2 - COMPANION FLANGE
3 - REMOVER C-452

(8) Loosen rear case with flat blade screwdriver to break sealer bead. Insert screwdriver blade only into notches provided at each end of case (Fig. 189).

(9) Remove rear case.

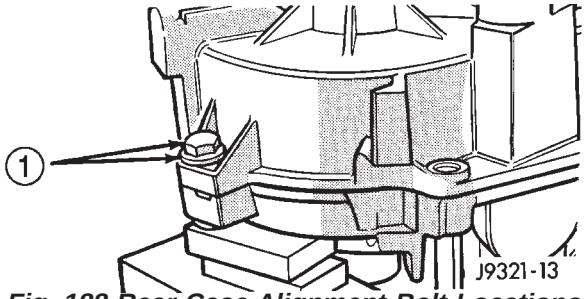


Fig. 188 Rear Case Alignment Bolt Locations

1 - ALIGNMENT BOLT AND WASHER (AT EACH END OF CASE)

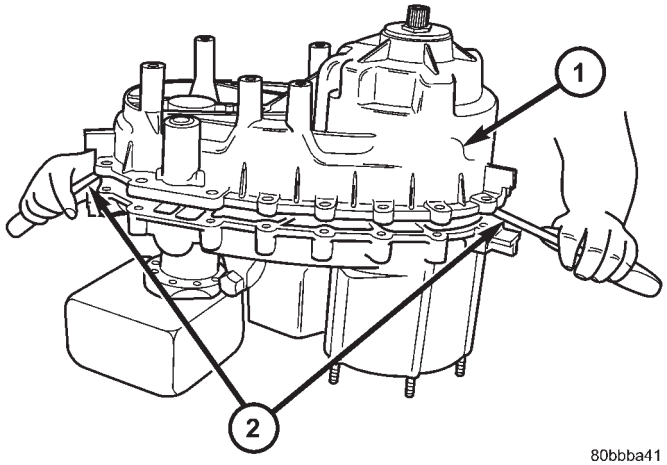


Fig. 189 Rear Case Removal

1 - REAR TRANSFER CASE HALF
2 - SCREWDRIVER SLOTS

(10) Remove the screws holding the transfer case chain snubber (Fig. 190) to the rear transfer case half.

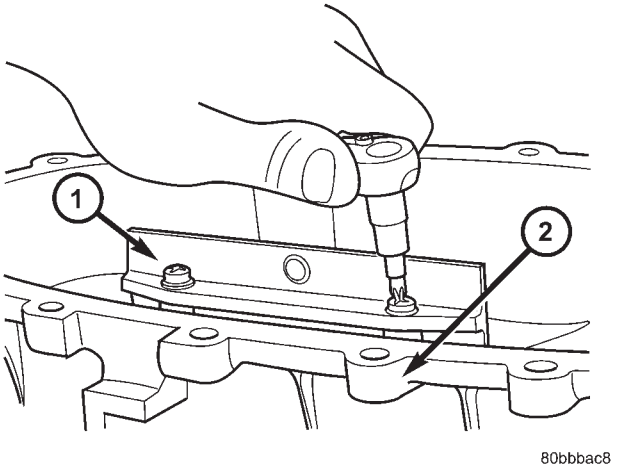


Fig. 190 Remove Transfer Case Chain Snubber

1 - TRANSFER CASE CHAIN SNUBBER
2 - REAR CASE HALF

(11) Remove the oil pump retaining snap-ring (Fig. 191).

(12) Disengage oil pickup tube from oil pump (Fig. 192).

(13) Remove oil pump assembly (Fig. 193).

(14) Remove pick-up tube o-ring from oil pump (Fig. 194), if necessary. Do not disassemble the oil pump, it is not serviceable.

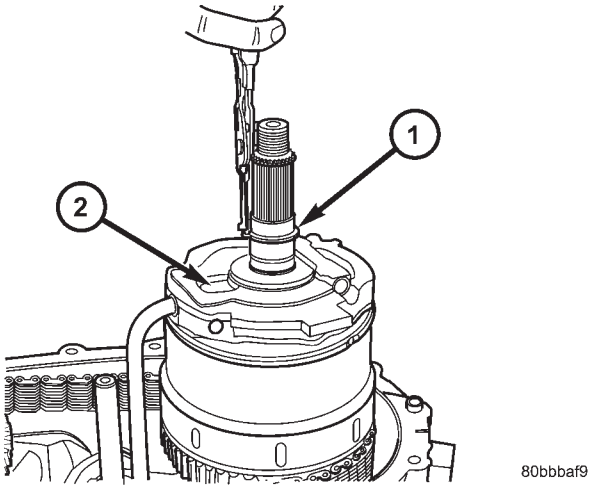


Fig. 191 Remove Oil Pump Snap-ring

1 - OIL PUMP SNAP-RING
2 - OIL PUMP

TRANSFER CASE - NV247 (Continued)

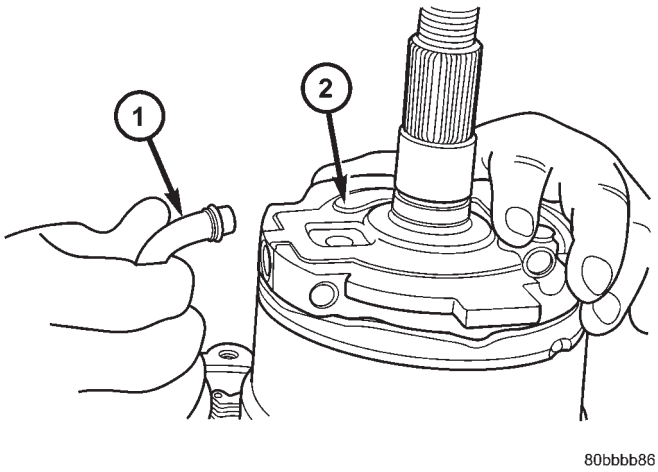


Fig. 192 Disengage Oil Pump Tube From Oil Pump

1 - OIL PUMP PICKUP TUBE
2 - OIL PUMP

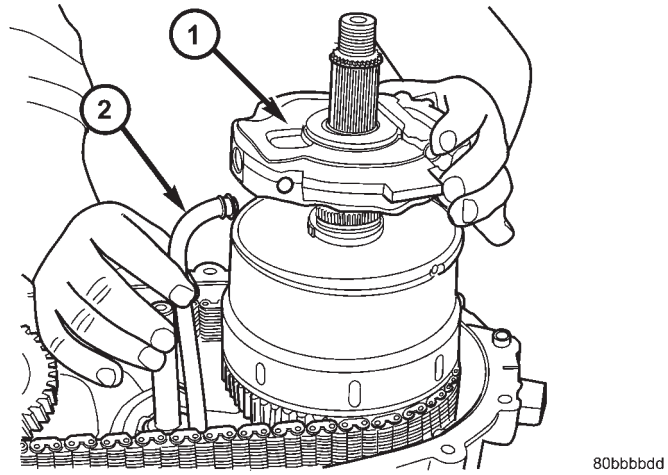


Fig. 193 Remove Oil Pump

1 - OIL PUMP
2 - OIL PUMP PICKUP TUBE

COMPANION FLANGE AND RANGE LEVER

(1) Remove front companion flange nut as follows:
(a) Move range lever to 4L position.
(b) Remove nut with socket and impact wrench.

(2) Remove companion flange. If flange is difficult to remove by hand, remove it with bearing splitter, or with standard two jaw puller. Be sure puller tool is positioned on flange and not on slinger as slinger will be damaged.

(3) Remove seal washer from front output shaft. Discard washer as it should not be reused.

(4) Remove nut and washer that attach range lever to sector shaft. Then move sector to neutral position and remove range lever from shaft.

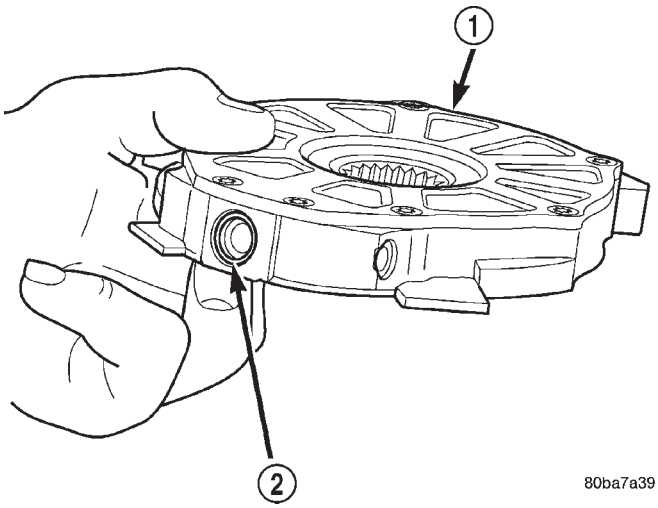


Fig. 194 Pick-up Tube O-ring Location

1 - OIL PUMP
2 - O-RING

NOTE: Note position of range lever so it can be re-installed correctly.

PROGRESSIVE COUPLING

(1) Remove progressive coupling locating snap-ring (Fig. 195) and progressive coupling thrust washer (Fig. 196) from the mainshaft.

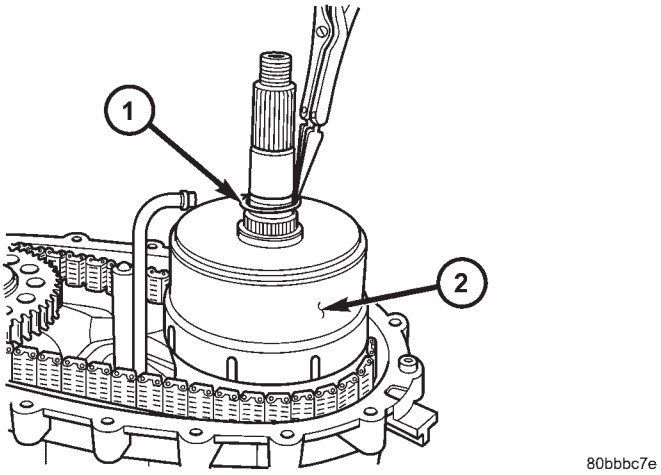


Fig. 195 Remove Progressive Coupler Snap-ring

1 - PROGRESSIVE COUPLING SNAP-RING
2 - PROGRESSIVE COUPLING

TRANSFER CASE - NV247 (Continued)

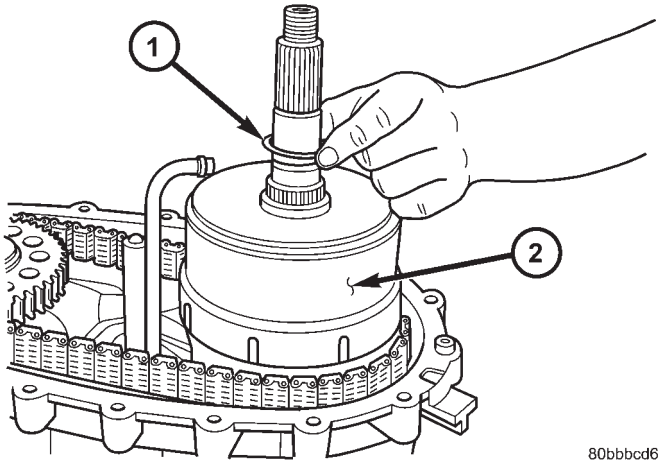


Fig. 196 Remove Progressive Coupler Thrust Washer

1 - PROGRESSIVE COUPLING THRUST WASHER
2 - PROGRESSIVE COUPLING

(2) Remove progressive coupling from mainshaft (Fig. 197).

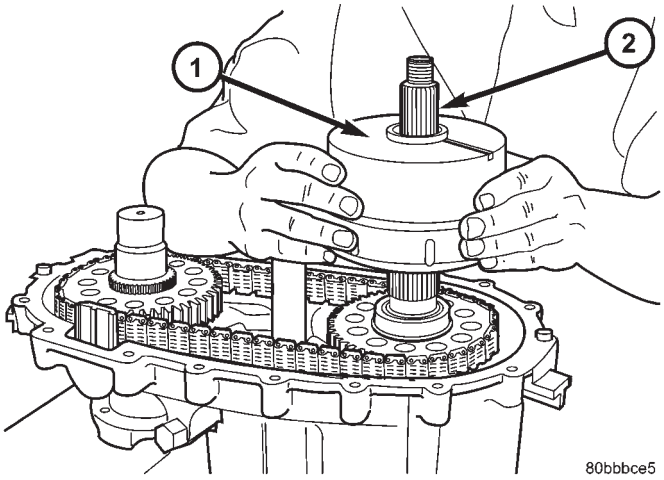


Fig. 197 Remove Progressive Coupler

1 - PROGRESSIVE COUPLING
2 - MAINSHAFT

FRONT OUTPUT SHAFT AND DRIVE CHAIN

(1) Remove rear output shaft drive gear snap-ring (Fig. 198).

(2) Disengage drive gear (Fig. 199). Pry gear upward and off mainshaft as shown.

(3) Remove front output shaft, drive chain and drive gear as assembly (Fig. 199).

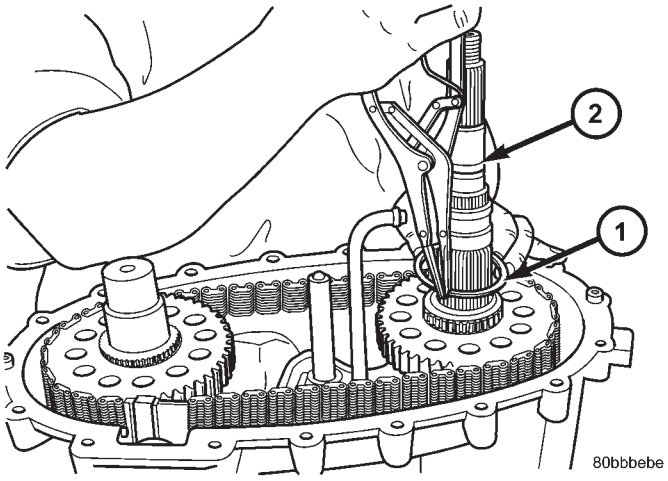


Fig. 198 Remove Output Shaft Drive Gear Snap-ring

1 - REAR OUTPUT SHAFT DRIVE GEAR SNAP-RING
2 - REAR OUTPUT SHAFT

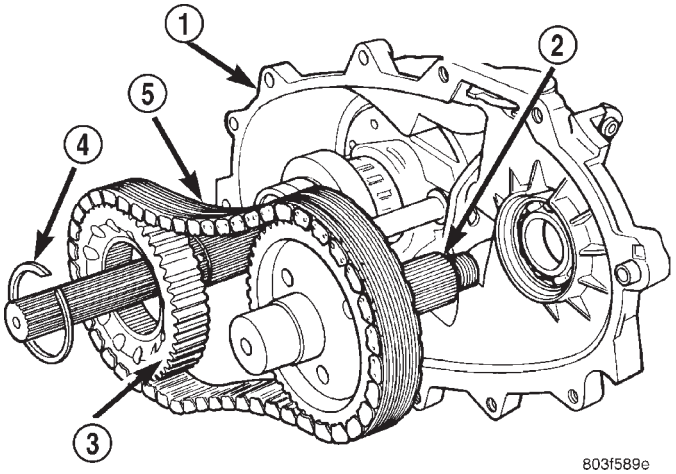


Fig. 199 Front Output Shaft, Drive Gear And Chain Removal

1 - REAR HOUSING
2 - OUTPUT SHAFT AND SPROCKET
3 - MAINSHAFT SPROCKET
4 - SNAP-RING
5 - DRIVE CHAIN

TRANSFER CASE - NV247 (Continued)

(4) Remove front output shaft drive gear snap-ring. (Fig. 200)

(5) Remove output shaft drive gear from front output shaft. (Fig. 201)

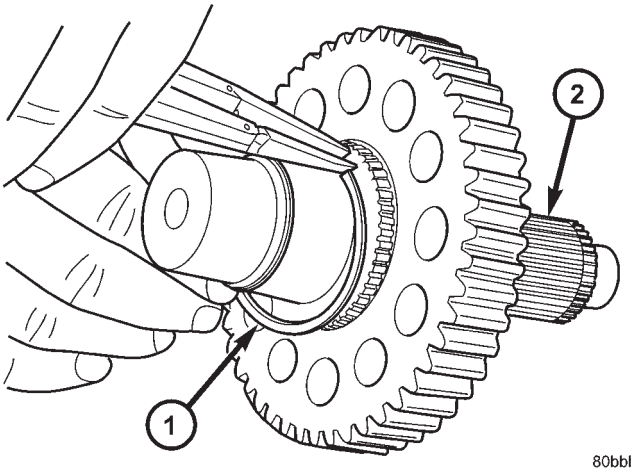


Fig. 200 Remove Front Output Shaft Drive Gear Snap-ring

1 - FRONT OUTPUT SHAFT DRIVE GEAR SNAP-RING
2 - FRONT OUTPUT SHAFT

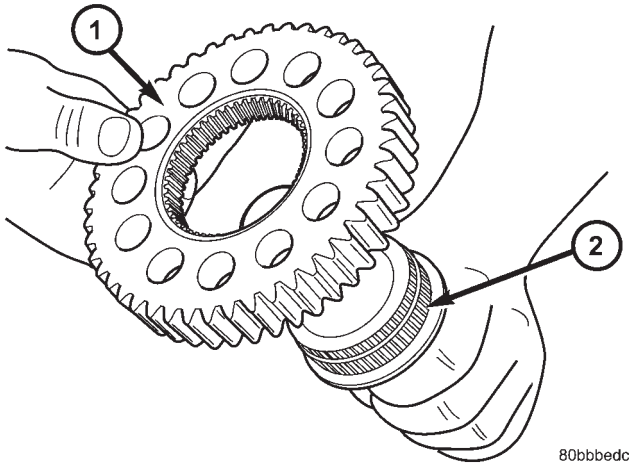


Fig. 201 Remove Front Output Shaft Drive Gear

1 - FRONT OUTPUT SHAFT DRIVE GEAR
2 - FRONT OUTPUT SHAFT

(6) Remove the oil pump pickup tube from the front case half. (Fig. 202)

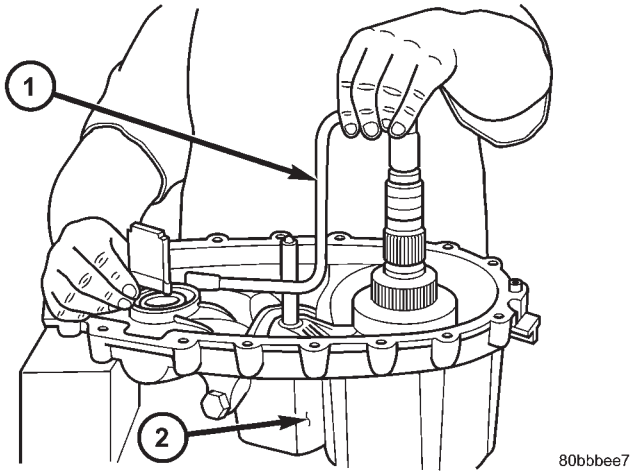


Fig. 202 Remove Oil Pump Pickup Tube

1 - OIL PUMP PICKUP TUBE
2 - FRONT CASE HALF

SHIFT FORKS AND MAINSHAFT

(1) Remove detent plug, O-ring, detent spring and detent plunger (Fig. 203).

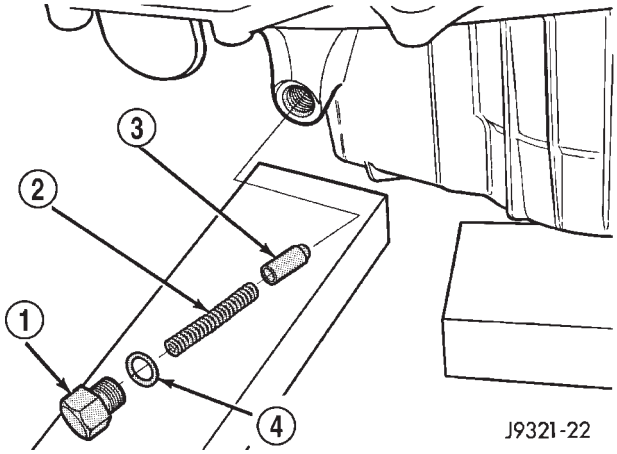


Fig. 203 Detent Plug, Spring And Plunger Removal

1 - DETENT PLUG
2 - DETENT SPRING
3 - DETENT PLUNGER
4 - PLUG O-RING

TRANSFER CASE - NV247 (Continued)

(2) Remove shift rail from shift fork and transfer case housing.
(3) Rotate range shift fork until it disengages from shift sector.
(4) Remove mainshaft and shift fork from input gear pilot bearing.

NOTE: Loose needle bearings are used to support the drive sprocket hub on the mainshaft. Do not lift mainshaft by drive sprocket hub or needle bearings will become dislodged.

(5) Wrap rag around mainshaft underneath drive sprocket hub and remove drive sprocket hub from mainshaft. Be sure to retrieve all the drive sprocket hub needle bearings.
(6) Remove snap ring holding clutch sleeve onto mainshaft.
(7) Remove range clutch sleeve, blockout spring, locking clutch, and locking clutch spring from mainshaft (Fig. 204).

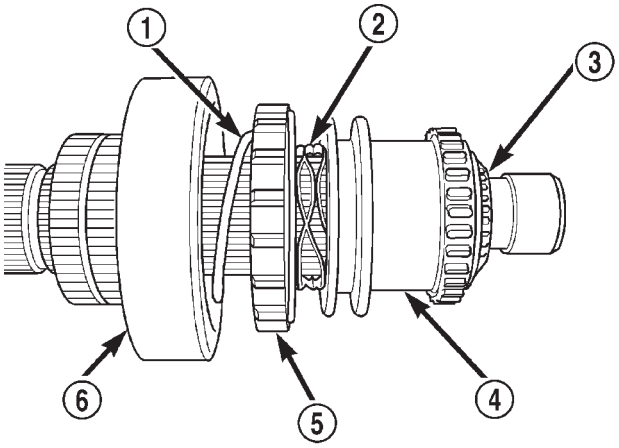


Fig. 204 Range Clutch Sleeve, Blockout Spring, Locking Clutch and Spring

1 - LOCKING CLUTCH SPRING
2 - BLOCKOUT SPRING
3 - SNAP-RING
4 - RANGE CLUTCH SLEEVE
5 - LOCKING CLUTCH
6 - DRIVE SPROCKET HUB

(8) Remove shift sector. Rotate and tilt sector as needed to remove it.
(9) Remove shift sector bushing and O-ring (Fig. 205).

INPUT GEAR/LOW RANGE ASSEMBLY

(1) Turn front case on side so that the input shaft is facing upward.
(2) Remove the input shaft seal with a suitable screw mounted in a slide hammer.

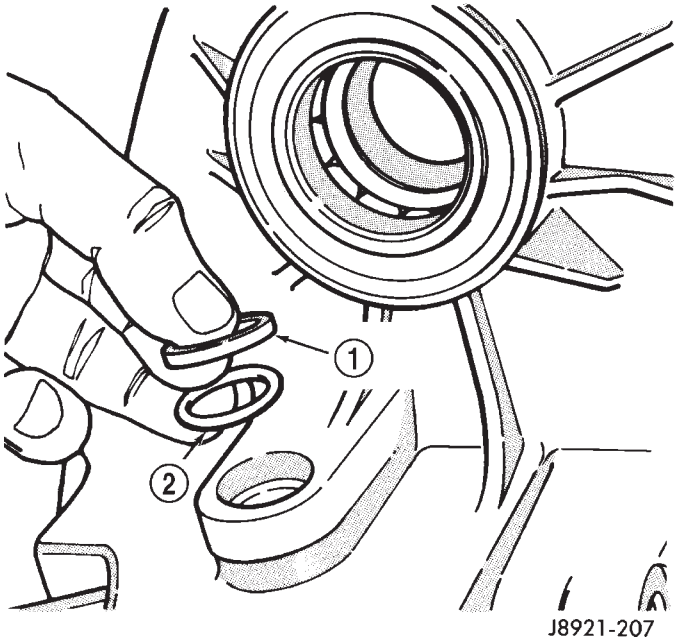


Fig. 205 Sector Bushing And O-Ring Removal

1 - SHIFT SECTOR BUSHING
2 - O-RING

(3) Remove snap-ring that retains input gear shaft in front bearing.
(4) Remove input and low range gear assembly (Fig. 206).

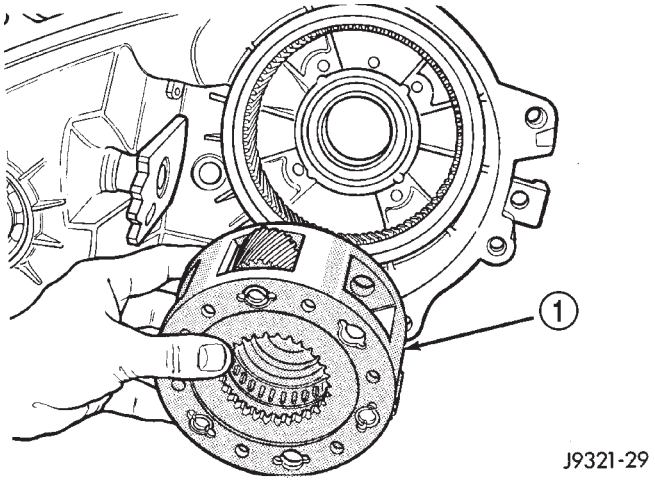


Fig. 206 Input And Low Range Gear Assembly Removal

1 - INPUT AND LOW RANGE GEAR ASSEMBLY

TRANSFER CASE - NV247 (Continued)

INPUT AND LOW RANGE GEAR

(1) Remove snap-ring that retains input gear in low range gear (Fig. 207).
(2) Remove retainer (Fig. 208).
(3) Remove front tabbed thrust washer (Fig. 209).
(4) Remove input gear (Fig. 210).
(5) Remove rear tabbed thrust washer from low range gear (Fig. 211).

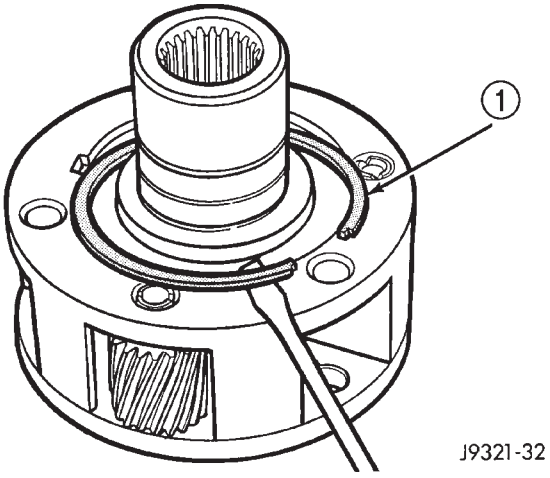


Fig. 207 Input Gear Snap-Ring Removal

1 - INPUT GEAR SNAP-RING

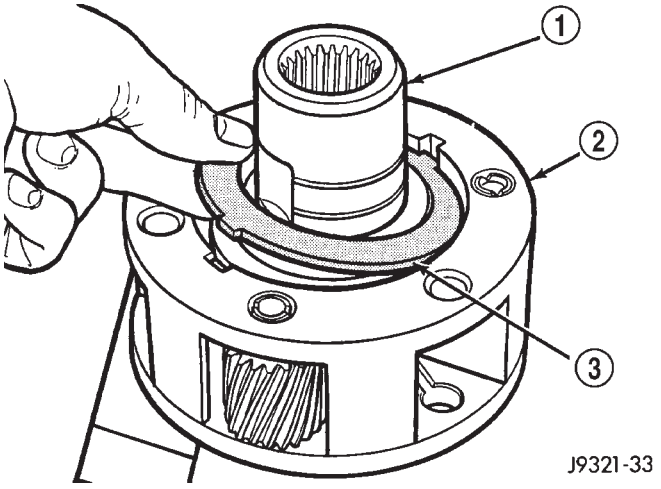


Fig. 208 Input Gear Retainer

1 - INPUT GEAR
2 - LOW RANGE GEAR
3 - RETAINER

INSPECTION

MAINSHAFT

Examine the mainshaft components carefully for evidence of wear or damage.

Replace the thrust washers if worn or damaged.

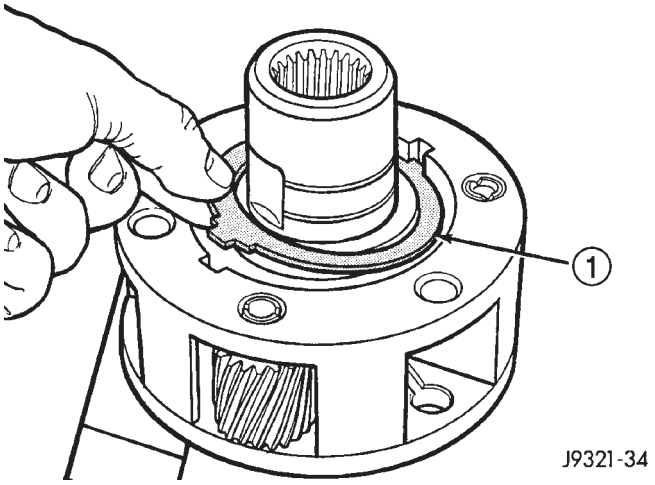


Fig. 209 Front Tabbed Thrust Washer

1 - FRONT TABBED THRUST WASHER

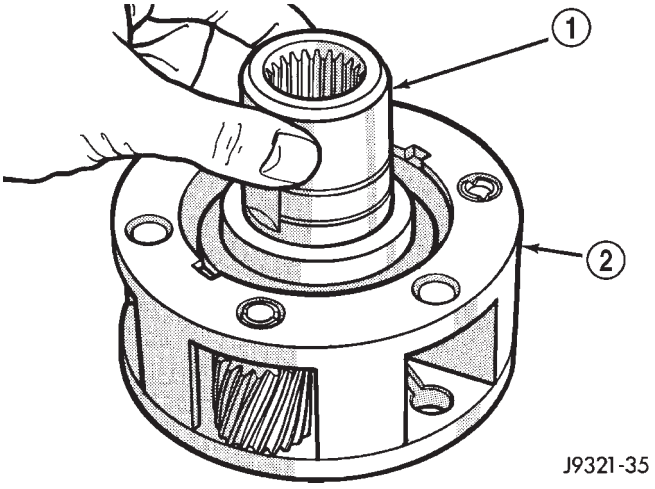


Fig. 210 Input Gear Removal

1 - INPUT GEAR
2 - LOW RANGE GEAR

Replace the mainshaft and sprocket gears if the teeth or gear bores are worn or damaged.

Replace the mainshaft bearings if worn, flat spotted, brinelled, or damaged in any way.

Replace the mainshaft if it is bent, exhibits wear or damage to the bearing surfaces, splines or gear teeth.

INPUT AND LOW RANGE GEARS

Inspect the low range gear pinions and pinion pins. Replace the low range gear if any of the pins or pinions are worn or damaged.

Inspect the thrust washers, retainer, and snap-ring. Replace the snap-ring if bent, or distorted. Replace the thrust washers and retainer if worn, cracked or damaged in any way.

TRANSFER CASE - NV247 (Continued)

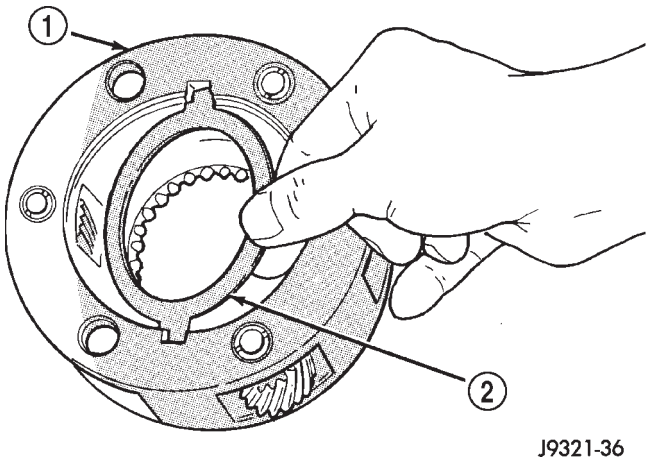


Fig. 211 Rear Tabbed Thrust Washer Removal

1 - LOW RANGE GEAR
2 - REAR TABBED THRUST WASHER

Examine the input gear carefully. Be sure the gear teeth and bearing surfaces are in good condition. Replace the gear if wear or damage is evident.

Check the input gear pilot bearing. Rotate the bearing and check for roughness or noise. Also check bearing position in the bore. The bearing should be recessed approximately 2.5 mm (0.100 in.) below the top edge of the bore. The bearing should not be seated at the bottom of the bore. Replace the bearing if worn, or roughness is evident. Replace both the gear and bearing if the bearing is a loose fit in the bore.

GEAR CASE AND RETAINERS

Examine both case halves carefully. Replace any case half if wear, cracks, or other damage is evident.

Check condition of the low range annulus gear and the shift rail bushing in the front case (Fig. 212). The low range annulus gear is not a serviceable part. Replace the gear and case as an assembly if the gear is loose, worn, or damaged. The shift rail bushing is a serviceable part and can be replaced if necessary.

Examine the sealing surfaces of both case halves. Small burrs, or scratches on these surfaces can be reduced with crocus cloth or a fine tooth file.

Examine condition of the shift rail bushing in the front case. If the bushing is worn or damaged, it can be removed with a blind hole type puller. A replacement bushing can be installed with a suitable size driver. Recess the bushing slightly below the edge of the bore but do not seat it all the into the case.

GEARTRAIN

Inspect the mainshaft splines, gear teeth and bearing surfaces carefully for evidence of wear, or damage. Replace the shaft if necessary. do not attempt to salvage it if damaged.

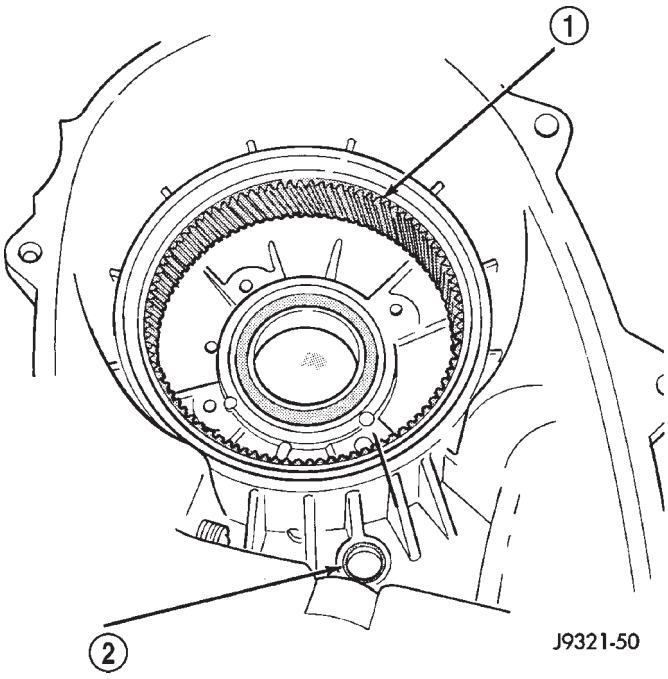


Fig. 212 Low Range Annulus Gear Location

1 - LOW RANGE ANNULUS GEAR
2 - SHIFT RAIL BUSHING

The shift rail and range fork are an assembly. Replace both parts if either is damaged. However, the nylon pads in the fork can be replaced if worn, or cracked.

Inspect the transfer case snap-rings closely. Do not attempt to salvage a distorted snap-ring by straightening or reshaping it. Replace any snap-ring that is distorted, or worn.

Inspect the low range gear, input gear and the gear thrust washers retainer, and snap-ring. The low range gear is serviced as an assembly only. Replace the gear if the case or pinions are damaged.

During inspection, also make sure the seal surface of the input gear is in good condition. Minor nicks on this surface can be reduced with crocus cloth. However, replace the gear if the seal surface is severely scored or worn.

OIL PUMP AND PROGRESSIVE COUPLING

The oil pump and progressive coupling are not serviceable components. Replace the coupling as an assembly if it is damaged. Replace the oil pump as an assembly if the gear teeth are worn, or if the pump has become damaged.

BEARINGS AND SEALS

The transfer case seals should be replaced during overhaul. Use new seals in the front and rear cases. Also replace the yoke seal washer and the detent plug O-ring.

TRANSFER CASE - NV247 (Continued)

Check condition of each transfer case bearing. Replace any bearing exhibiting signs of roughness, wear, or damage.

ASSEMBLY

Lubricate transfer case components with Mopar® Transfer Case Lubricant or petroleum jelly (where indicated) during assembly.

CAUTION: The bearing bores in various transfer case components contain oil feed holes. Make sure replacement bearings do not block the holes.

BEARINGS AND SEALS

(1) Remove front output shaft seal from front case with pry tool (Fig. 213).

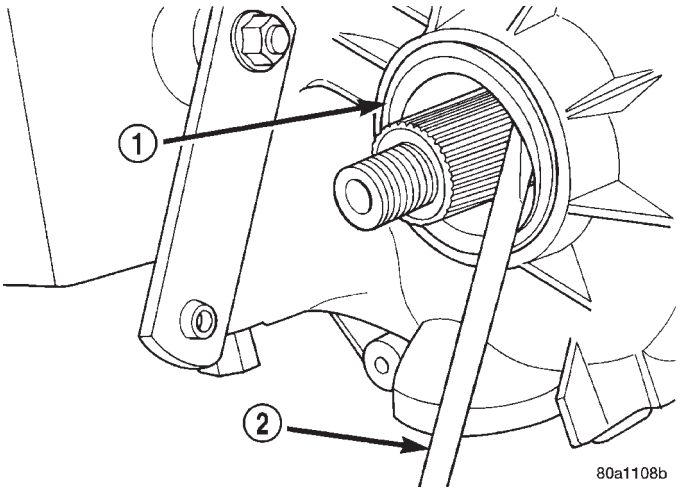


Fig. 213 Remove Front Output Shaft Seal - Typical

1 - OUTPUT SHAFT SEAL
2 - PRYBAR

(2) Remove snap-ring that retains front output shaft bearing in front case (Fig. 214).

(3) Using tool 6953, remove bearing from front case (Fig. 215).

(4) Using tool 6953, install new bearing.

(5) Install snap-ring to hold bearing into case.

(6) Install new front output seal in front case with Installer Tool 6952-A 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. 216). Once seal is started, continue tapping seal into bore until installer tool bottoms against case.

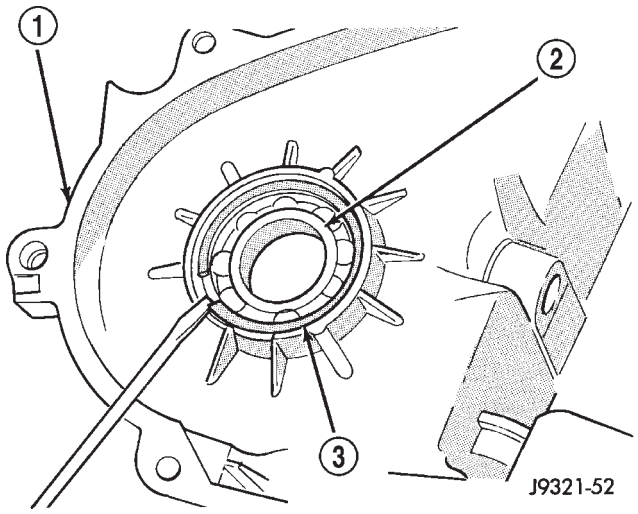


Fig. 214 Output Shaft Front Bearing Snap-Ring Removal

1 - FRONT CASE
2 - OUTPUT SHAFT FRONT BEARING
3 - BEARING SNAP-RING

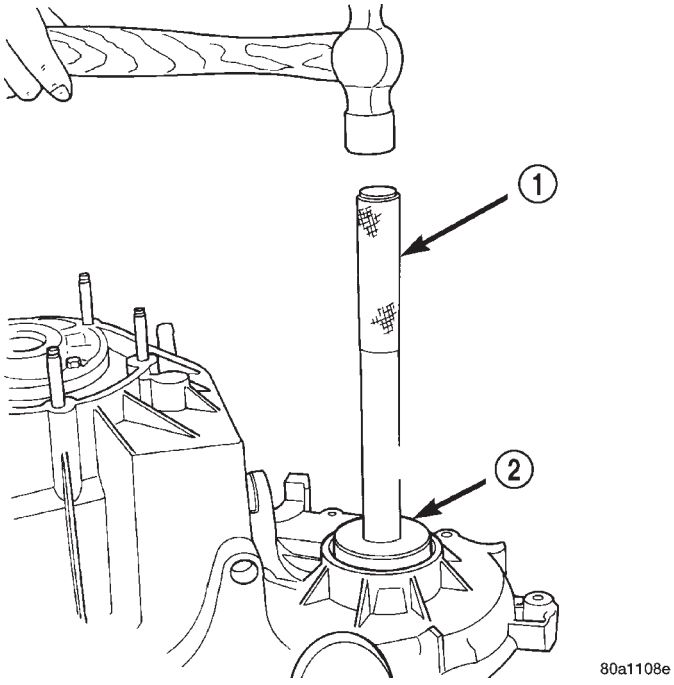


Fig. 215 Remove Output Shaft Front Bearing

1 - HANDLE C-4171
2 - REMOVER/INSTALLER 6953

TRANSFER CASE - NV247 (Continued)

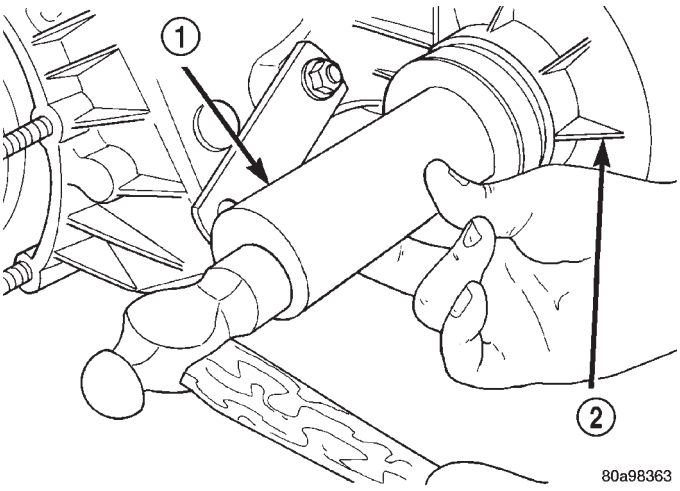


Fig. 216 Front Output Seal Installation

1 - INSTALLER 6952-A
2 - TRANSFER CASE

(7) Remove the output shaft rear bearing with the screw and jaws from Remover L-4454 and Cup 8148 (Fig. 217).

(8) Install new bearing with Tool Handle C-4171 and Installer 5066 (Fig. 218). **The bearing bore is chamfered at the top. Install the bearing so it is flush with the lower edge of this chamfer (Fig. 219).**

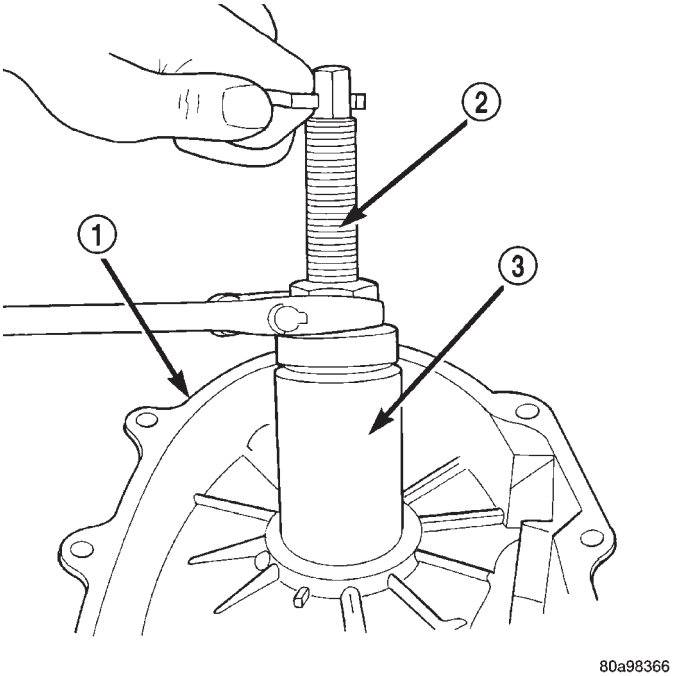


Fig. 217 Output Shaft Rear Bearing Removal

1 - REAR CASE
2 - SPECIAL TOOL L-4454-1 AND L-4454-3
3 - SPECIAL TOOL 8148

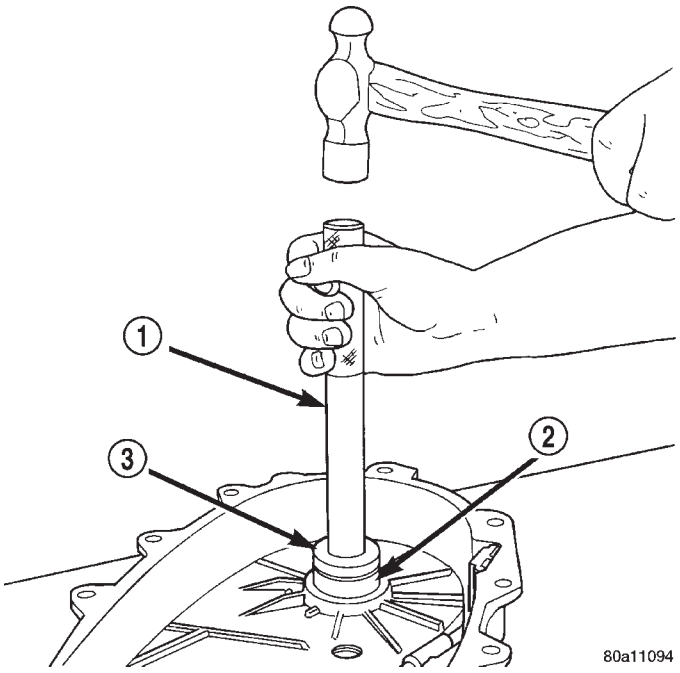


Fig. 218 Output Shaft Rear Bearing Installation

1 - HANDLE C-4171
2 - OUTPUT SHAFT INNER BEARING
3 - INSTALLER 5066

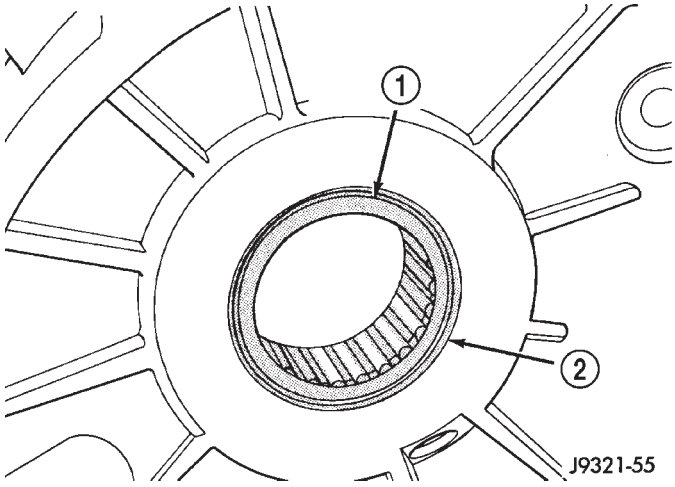


Fig. 219 Output Shaft Rear Bearing Installation Depth

1 - BEARING (SEATED) AT LOWER EDGE OF CHAMFER
2 - CHAMFER

(9) Using Remover C-4210 and Handle C-4171, drive input shaft bearing from inside the annulus gear opening in the case. (Fig. 220).

(10) Install locating ring on new bearing.

(11) Position case so forward end is facing upward.

TRANSFER CASE - NV247 (Continued)

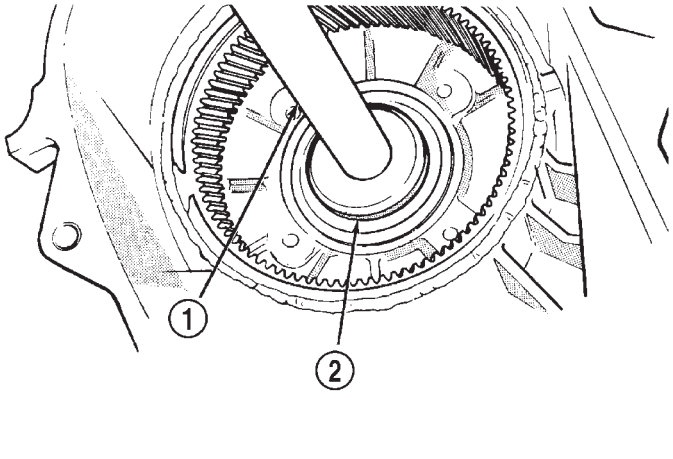


Fig. 220 Input Shaft Bearing Removal

1 - SPECIAL TOOL C-4171
2 - SPECIAL TOOL C-4210

(12) Using Remover C-4210 and Handle C-4171, drive input shaft bearing into case. The bearing locating ring must be fully seated against case surface.

(13) Remove input gear pilot bearing by inserting a suitably sized drift into the splined end of the input gear and driving the bearing out with the drift and a hammer (Fig. 221).

(14) Install new pilot bearing with Installer 8128 and Handle C-4171 (Fig. 222).

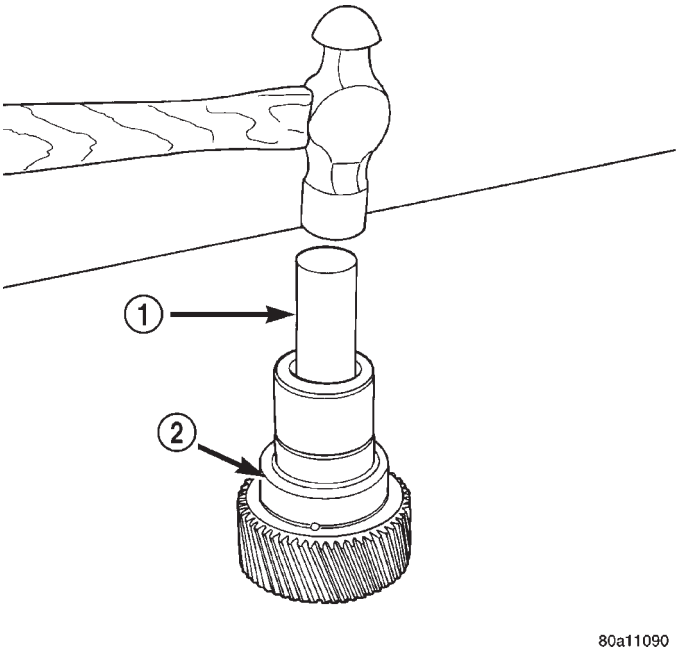


Fig. 221 Remove Input Gear Pilot Bearing

1 - DRIFT
2 - INPUT GEAR

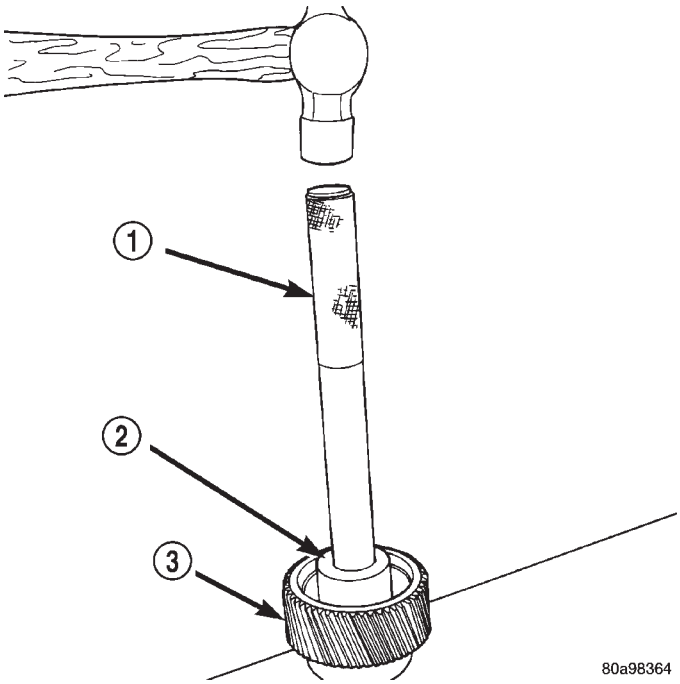


Fig. 222 Install Input Gear Pilot Bearing

1 - HANDLE C-4171
2 - INSTALLER 8128
3 - INPUT GEAR

INPUT AND LOW RANGE GEAR

(1) Lubricate gears and thrust washers (Fig. 223) with transfer case lubricant.

(2) Install first thrust washer in low range gear (Fig. 223). Be sure washer tabs are properly aligned in gear notches.

(3) Install input gear in low range gear. Be sure input gear is fully seated.

(4) Install remaining thrust washer in low range gear and on top of input gear. Be sure washer tabs are properly aligned in gear notches.

(5) Install retainer on input gear and install snap-ring.

(6) Align and install low range/input gear assembly in front case (Fig. 224). Be sure low range gear pinions are engaged in annulus gear and that input gear shaft is fully seated in front bearing.

(7) Install snap-ring to hold input/low range gear into front bearing.

(8) Install a new input shaft seal with Installer C-3995-A and Universal Handle C-4171.

TRANSFER CASE - NV247 (Continued)

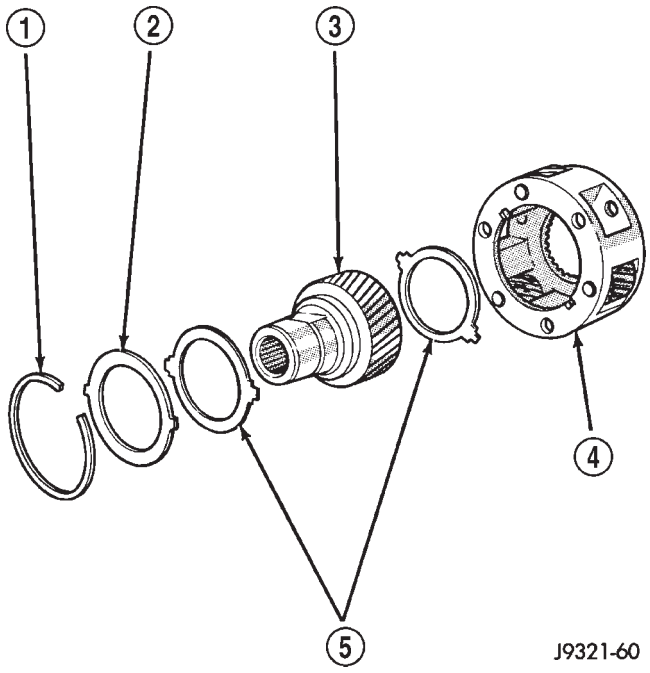


Fig. 223 Input/Low Range Gear Components

1 - SNAP-RING
2 - RETAINER PLATE
3 - INPUT GEAR
4 - LOW RANGE GEAR
5 - THRUST WASHERS

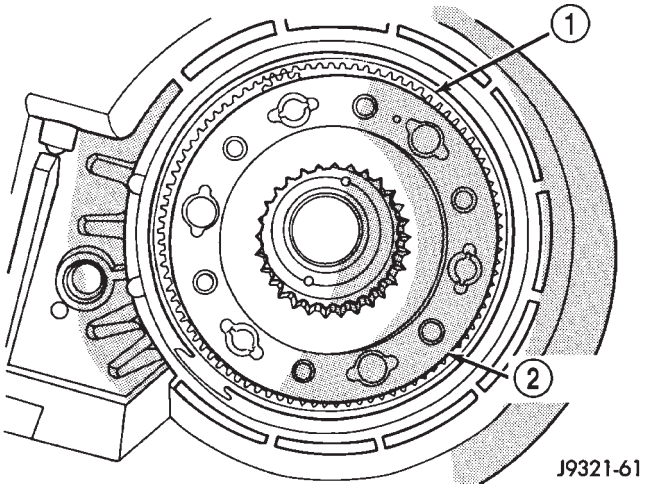


Fig. 224 Input/Low Range Gear Installation

1 - ANNULUS GEAR
2 - INPUT/LOW RANGE GEAR

SHIFT FORKS AND MAINSHAFT

(1) Install new sector shaft O-ring and bushing (Fig. 225).

(2) Install shift sector.

(3) Install locking clutch spring, locking clutch, blockout spring, and range clutch sleeve, to mainshaft as shown in (Fig. 226). Install snap ring.

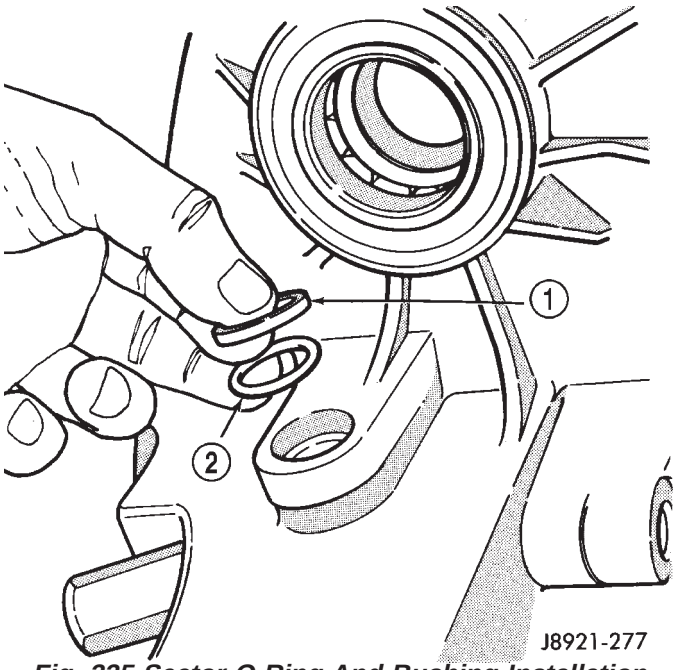


Fig. 225 Sector O-Ring And Bushing Installation

1 - SECTOR BUSHING
2 - O-RING

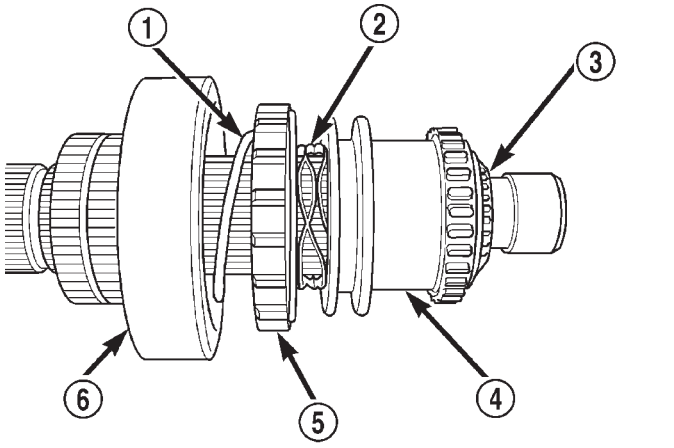


Fig. 226 Range Clutch Sleeve, Blockout Spring, Locking Clutch and Spring

1 - LOCKING CLUTCH SPRING
2 - BLOCKOUT SPRING
3 - SNAP-RING
4 - RANGE CLUTCH SLEEVE
5 - LOCKING CLUTCH
6 - DRIVE SPROCKET HUB

(4) Install drive sprocket hub to mainshaft and manually load the needle bearings.

(5) Install new pads on range fork, if necessary.

(6) Install range shift fork to range clutch sleeve. Install mainshaft/range shift fork assembly into transfer case and input planetary assembly. Rotate fork until it engages with slot in shift sector.

TRANSFER CASE - NV247 (Continued)

(7) Install shift rail to shift range fork and transfer case housing.
(8) Rotate shift sector to NEUTRAL position.
(9) Install new O-ring on detent plug (Fig. 227).
(10) Lubricate detent plunger with transfer case lubricant or light coat of petroleum jelly.
(11) Install detent plunger, spring and plug (Fig. 227).
(12) Verify that plunger is properly engaged in sector.

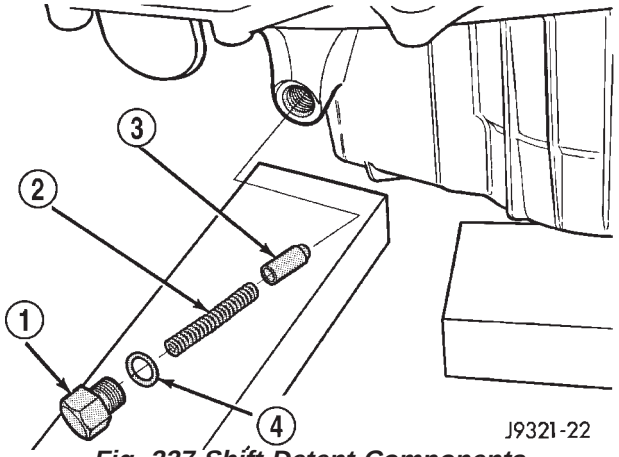


Fig. 227 Shift Detent Components

1 - DETENT PLUG
2 - DETENT SPRING
3 - DETENT PLUNGER
4 - PLUG O-RING

FRONT OUTPUT SHAFT AND DRIVE CHAIN

(1) Install the front output shaft drive gear (Fig. 228) onto the front output shaft.
(2) Install the front output shaft drive gear snap-ring (Fig. 229) onto the output shaft.

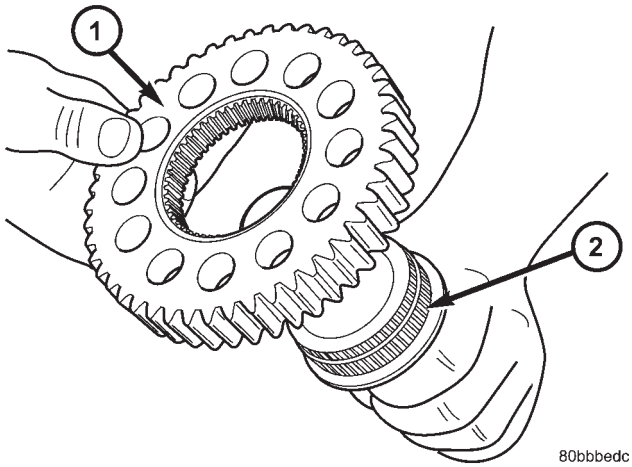


Fig. 228 Install Front Output Shaft Drive Gear

1 - FRONT OUTPUT SHAFT DRIVE GEAR
2 - FRONT OUTPUT SHAFT

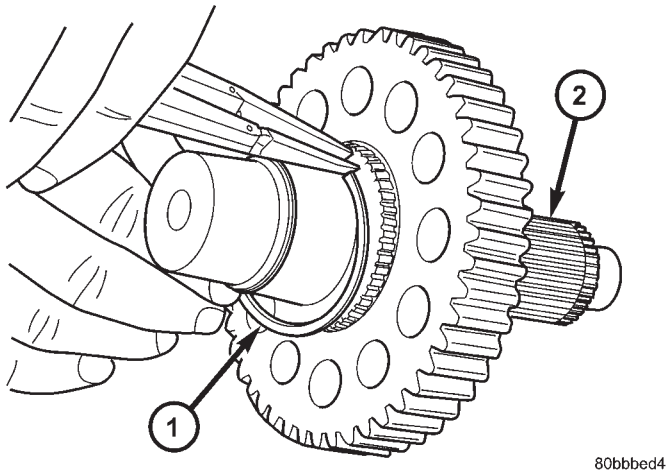


Fig. 229 Install Front Output Shaft Drive Gear Snap-ring

1 - FRONT OUTPUT SHAFT DRIVE GEAR SNAP-RING
2 - FRONT OUTPUT SHAFT

(3) Install the oil pump pickup tube (Fig. 230) into the front transfer case half.

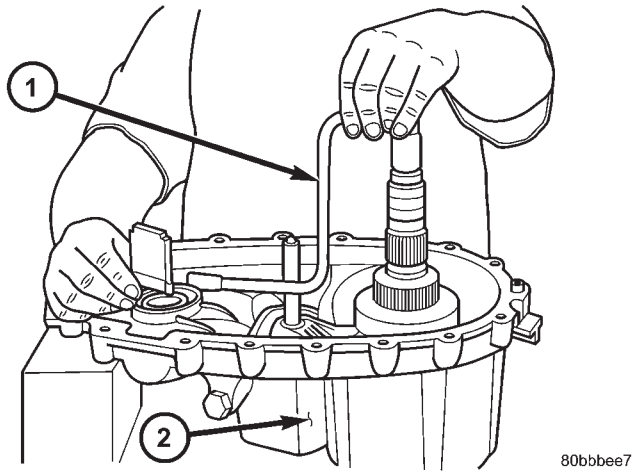


Fig. 230 Install Oil Pump Pickup Tube

1 - OIL PUMP PICKUP TUBE
2 - FRONT CASE HALF

(4) Lubricate front output shaft assembly, drive chain and drive gear with transfer case lubricant.
(5) Assemble drive chain, drive gear and front output shaft (Fig. 231).
(6) Start drive gear on mainshaft.
(7) Guide front output shaft into bearing and drive gear onto mainshaft drive gear (Fig. 231).
(8) Install drive gear snap-ring (Fig. 232).

TRANSFER CASE - NV247 (Continued)

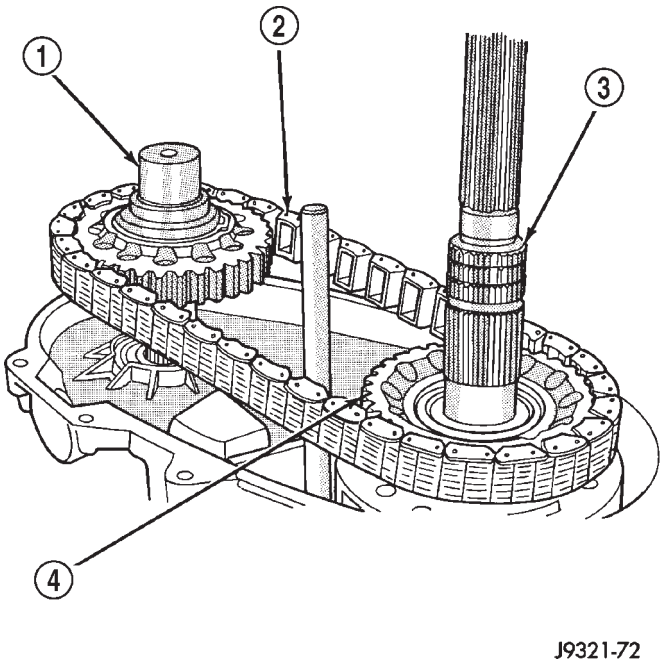


Fig. 231 Installing Drive Chain, Front Output Shaft And Drive Gear

1 - FRONT OUTPUT SHAFT
2 - DRIVE CHAIN
3 - MAINSHAFT
4 - DRIVE GEAR

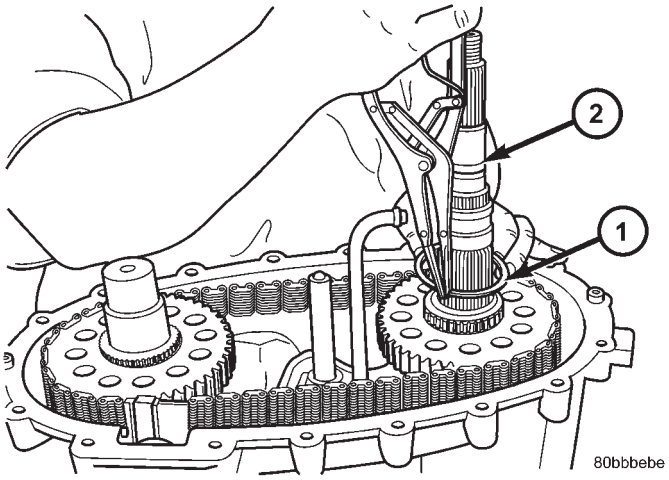


Fig. 232 Install Output Shaft Drive Gear Snap-ring

1 - REAR OUTPUT SHAFT DRIVE GEAR SNAP-RING
2 - REAR OUTPUT SHAFT

PROGRESSIVE COUPLING

(1) Install progressive coupling (Fig. 233).

(2) Install the progressive coupling thrust washer (Fig. 234) over the output shaft and against the coupling.

(3) Install the progressive coupling snap-ring (Fig. 235) onto the output shaft.

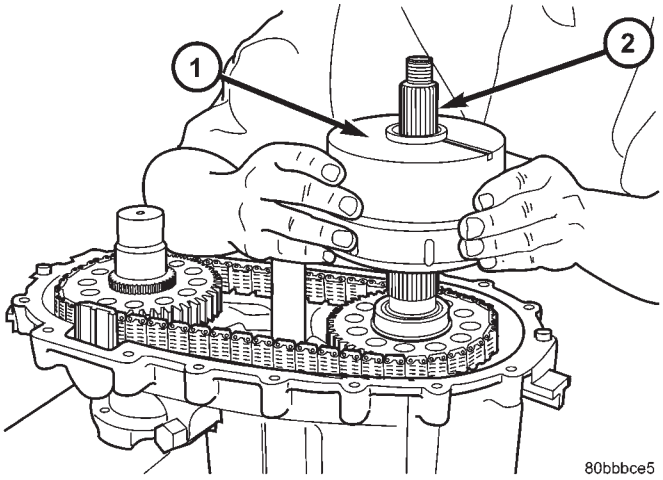


Fig. 233 Install Progressive Coupler

1 - PROGRESSIVE COUPLING
2 - MAINSHAFT

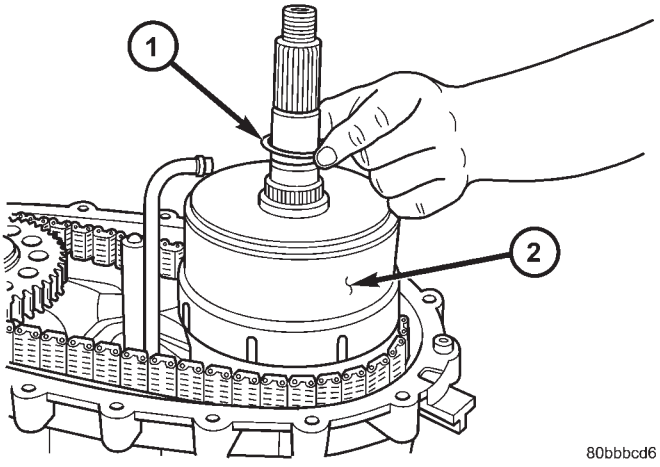


Fig. 234 Install Progressive Coupler Thrust Washer

1 - PROGRESSIVE COUPLING THRUST WASHER
2 - PROGRESSIVE COUPLING

TRANSFER CASE - NV247 (Continued)

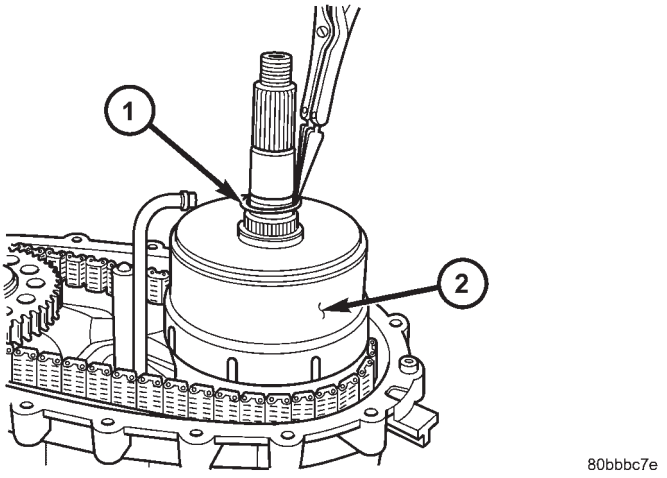


Fig. 235 Install Progressive Coupler Snap-ring

1 - PROGRESSIVE COUPLING SNAP-RING
2 - PROGRESSIVE COUPLING

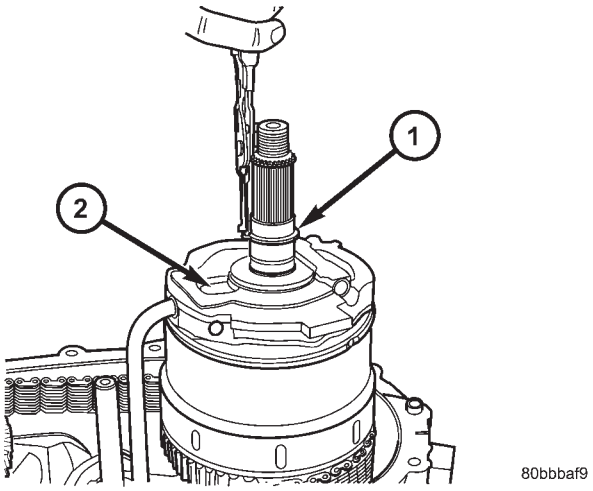


Fig. 237 Install Oil Pump Snap-ring

1 - OIL PUMP SNAP-RING
2 - OIL PUMP

OIL PUMP

(1) Install new O-ring on flanged end of oil pickup tube.
(2) Install oil pump (Fig. 236).
(3) Install oil pump retaining snap-ring (Fig. 237).
(4) Insert oil pickup tube in pump (Fig. 238).

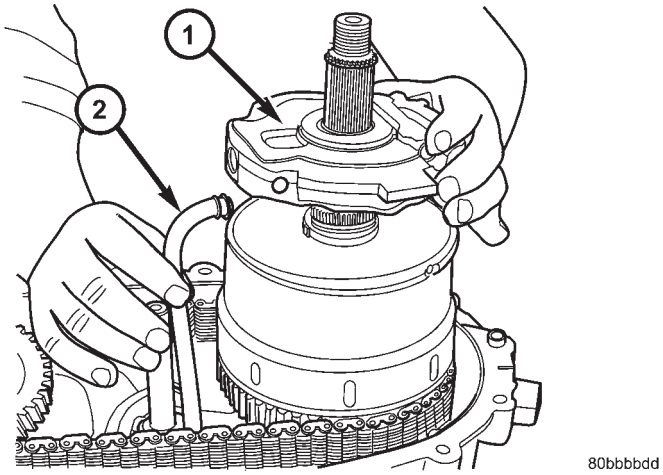


Fig. 236 Install Oil Pump

1 - OIL PUMP
2 - OIL PUMP PICKUP TUBE

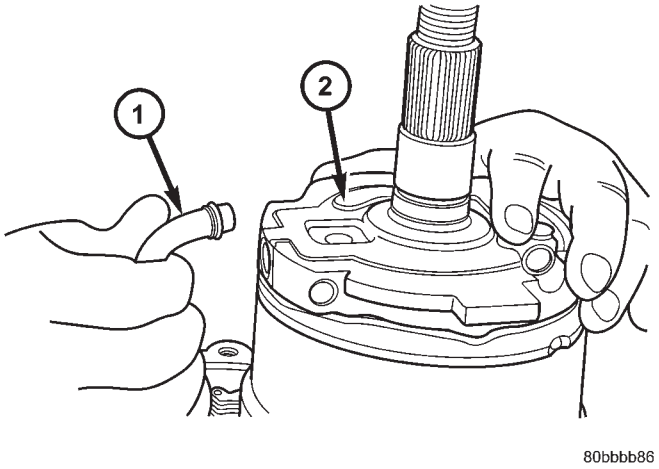


Fig. 238 Engage Oil Pump Tube to Oil Pump

1 - OIL PUMP PICKUP TUBE
2 - OIL PUMP

REAR CASE

(1) Install magnet in front case pocket (Fig. 239).
(2) Clean sealing flanges of front case and rear case with a wax and grease remover.
(3) Apply 3 mm (1/8 in.) wide bead of Mopar® gasket maker or silicone adhesive sealer to mounting flange of front case. Work sealer bead around bolt holes as shown (Fig. 240).
(4) Align and install rear case on front case.
(5) Install case attaching bolts. Alignment bolts at each end of case are only ones requiring washers (Fig. 241).
(6) Tighten case bolts to 27-34 N·m (20-25 ft. lbs.) torque.

TRANSFER CASE - NV247 (Continued)

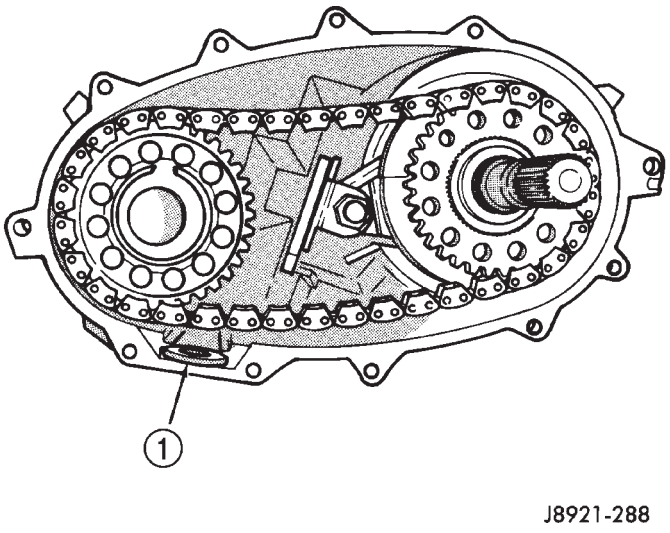


Fig. 239 Installing Case Magnet

1 - MAGNET

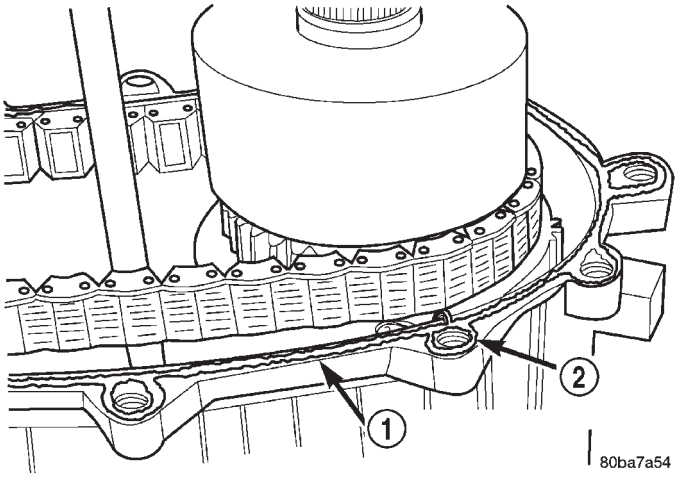


Fig. 240 Applying Sealer To Front Case Flange

1 - FRONT CASE FLANGE
2 - SEALER BEAD

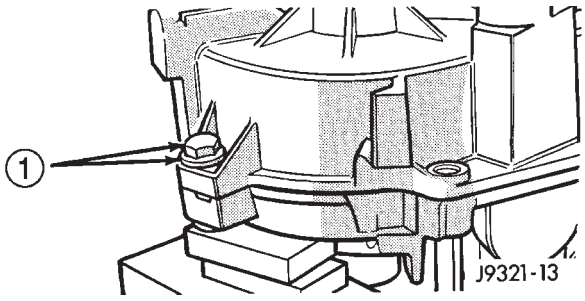


Fig. 241 Alignment Bolt

1 - ALIGNMENT BOLT AND WASHER (AT EACH END OF CASE)

COMPANION FLANGE AND RANGE LEVER

(1) Install range lever, washer and locknut on sector shaft (Fig. 242). Tighten locknut to 27-34 N·m (20-25 ft. lbs.) torque.

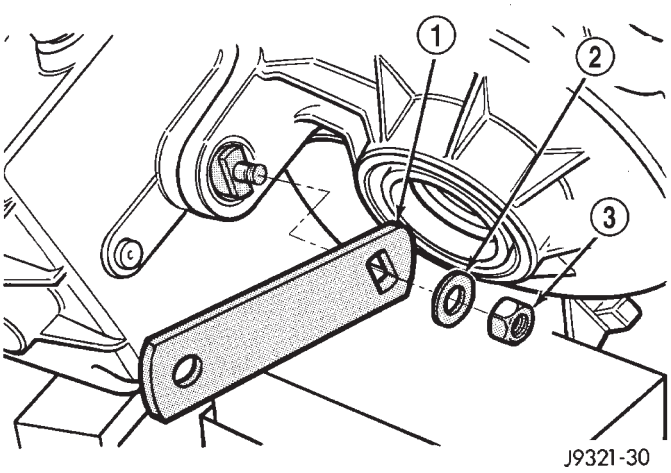


Fig. 242 Range Lever Installation - Typical

1 - RANGE LEVER
2 - WASHER
3 - LOCKNUT

(2) Install new seal washer on front output shaft (Fig. 243).

(3) Lubricate flange hub with transfer case lubricant and install flange on front shaft.

(4) Install new seal washer on front shaft.

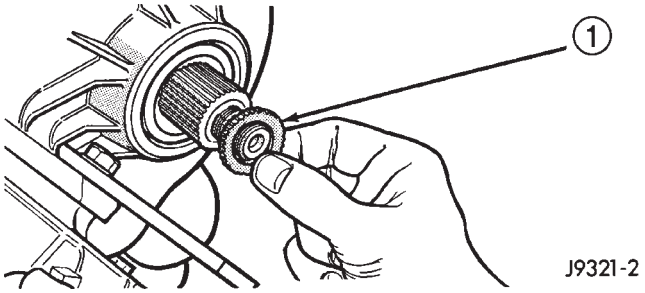


Fig. 243 Flange Seal Washer Installation

1 - YOKE SEAL WASHER

(5) Install companion flange and new nut on front output shaft.

(6) Tighten flange nut to 122-176 N·m (90-130 ft. lbs.) torque. Use Tool C-3281 (Fig. 244), or similar tool to hold flange while tightening flange nut.

(7) Install companion flange and new nut on rear output shaft.

(8) Tighten flange nut to 122-176 N·m (90-130 ft. lbs.) torque. Use Tool C-3281, or similar tool to hold flange while tightening flange nut.

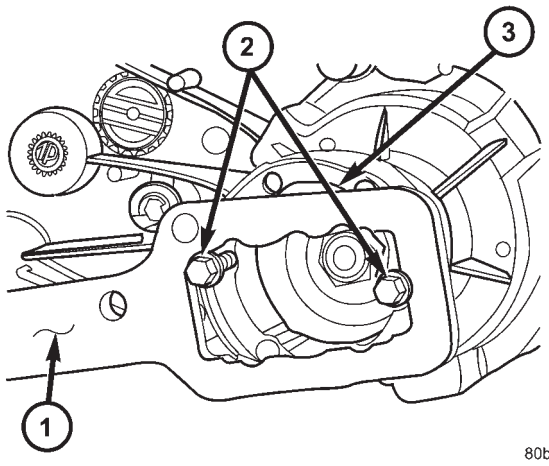


Fig. 244 Hold Companion Flange

1 - HOLDER C-3281
2 - BOLTS
3 - COMPANION FLANGE

FINAL ASSEMBLY

(1) Position transfer case damper onto the transfer case.

(2) Install the damper bolts (Fig. 245). Tighten bolts to 41-54 N·m (30-40 ft. lbs.) torque.

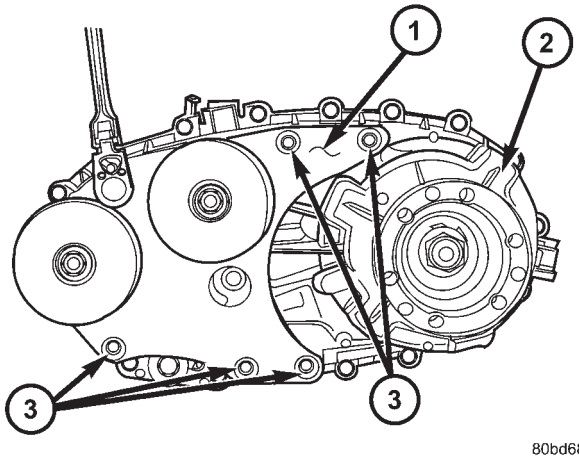


Fig. 245 Install Damper Bolts

1 - DAMPER
2 - TRANSFER CASE
3 - BOLTS

(3) Install drain plug. Tighten plug to 41-54 N·m (30-40 ft. lbs.) torque.

(4) Level transfer case and fill it with Mopar® Transfer Case Lubricant. Correct fill level is to bottom edge of fill plug hole.

(5) Install and tighten fill plug to 41-54 N·m (30-40 ft. lbs.) torque.

INSTALLATION

NOTE: If a replacement transfer case is being installed, be certain the counter weight is installed on the transfer case housing prior to installation.

(1) Install the transfer case on the transmission. Torque the transfer case retaining nuts to 75 N·m (55 ft. lbs.).

(2) Install the vent tube on the transfer case.

(3) Connect the transfer case shift cable on the shifter arm.

(4) Using the jack, raise the transmission assembly into position and install the (8) transmission support crossmember retaining bolts (Fig. 246). Torque the bolts to 41 N·m (30 ft. lbs.).

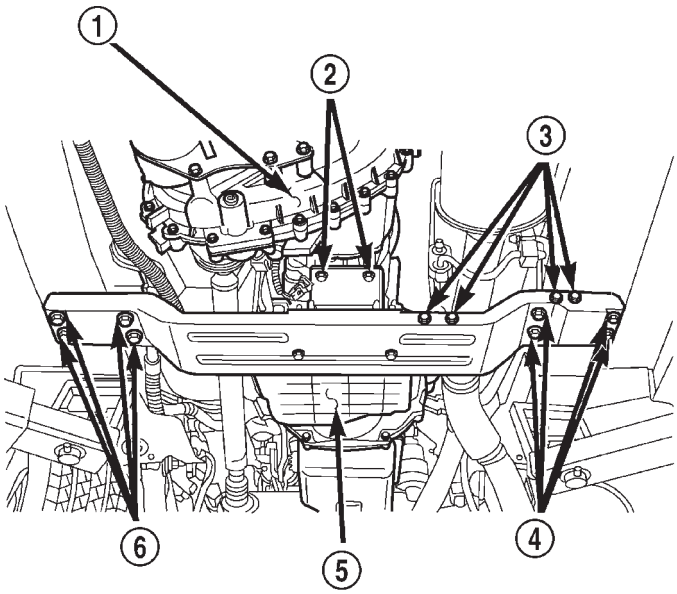


Fig. 246 Transmission Support Crossmember Position and Orientation

1 - TRANSFER CASE
2 - TRANSMISSION MOUNT RETAINING BOLTS (2 OF 4)
3 - EXHAUST SYSTEM SUPPORT BRACKET RETAINING BOLTS
4 - CROSSMEMBER RETAINING BOLTS
5 - TRANSMISSION
6 - CROSSMEMBER RETAINING BOLTS

TRANSFER CASE - NV247 (Continued)

(5) Install the rear driveshaft. Torque the bolts to 32 N·m (24 ft. lbs.). Be certain to install the driveshaft in the same position as before removal.

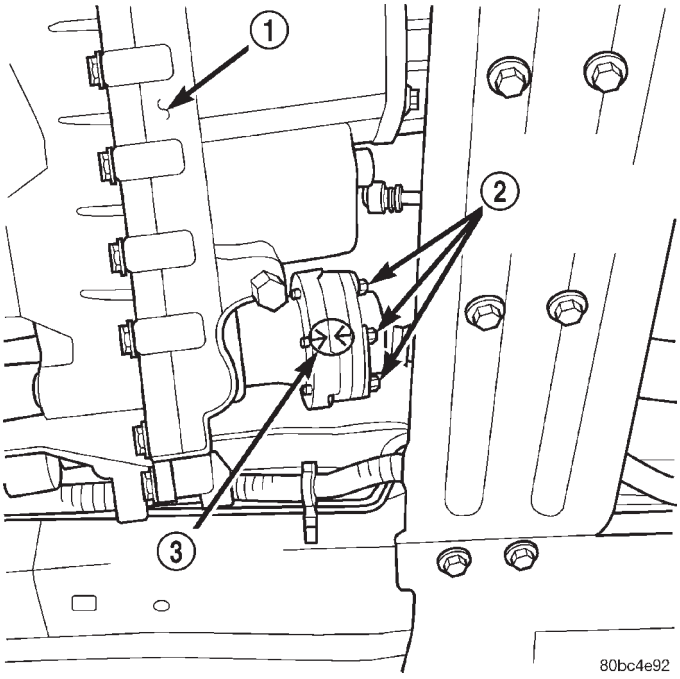


Fig. 247 Front Driveshaft Retaining Bolts

1 - TRANSFER CASE
2 - FRONT DRIVESHAFT RETAINING BOLTS
3 - REFERENCE MARK

(6) Install the front driveshaft. Torque the bolts to 32 N·m (24 ft. lbs.) (Fig. 247). Be certain to install the driveshaft in the same position as before removal.

(7) Install the (2) lower fan shroud retaining bolts. Torque the bolts to 15 N·m (132 in. lbs.).

(8) Lower the vehicle on the hoist.

(9) Install the (2) upper fan shroud retaining bolts. Torque the bolts to 15 N·m (132 in. lbs.).

(10) Fill the transmission fluid to specification.

(11) Connect the negative battery cable.

SPECIFICATIONS

TRANSFER CASE - NV247

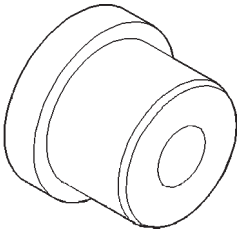
TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Bolt, crossmember	41-47	30.2-34.7	-
Plug, Detent	16-24	11.8-17.7	-
Plugs, drain/fill	41-54	30.2-39.8	-
Bolts, case half	27-34	19.9-25	-
Nut, companion flange	122-176	90-130	-
Lock-nut, shift	27-34	19.9-25	-
Nuts, T-case mount stud	33-41	24.3-30.2	-

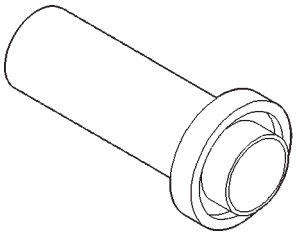
TRANSFER CASE - NV247 (Continued)

SPECIAL TOOLS

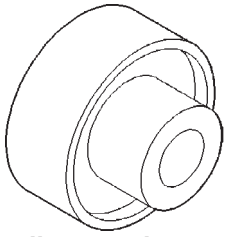
TRANSFER CASE - NV247



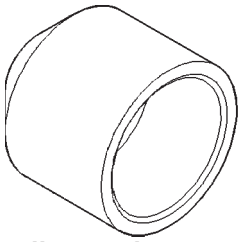
Installer, Bearing - 5066



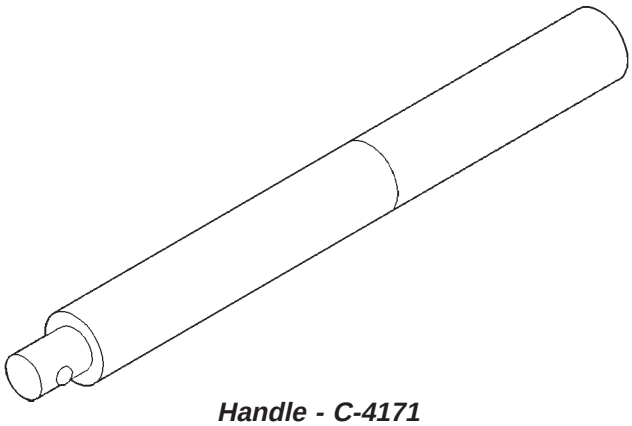
Installer, Seal - 6952-A



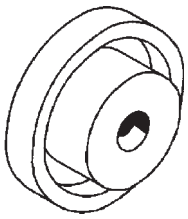
Installer, Bearing - 6953



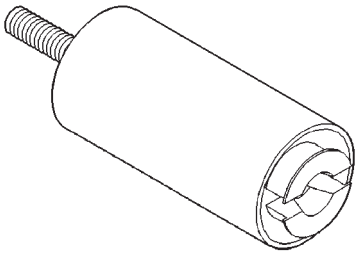
Installer, Seal - C-3995-A



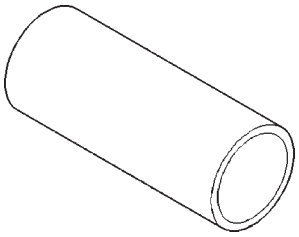
Handle - C-4171



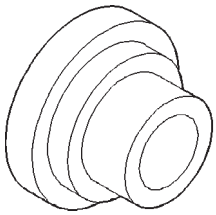
Remover, Bearing - C-4210



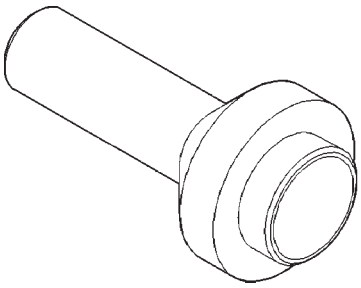
Remover, Bearing - L-4454



Cup, Installer - 8148



Installer, Bearing - 8128



Installer, Seal - 7884

EMISSIONS CONTROL - 2.7L DIESEL

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EMISSIONS CONTROL - 2.7L DIESEL

DESCRIPTION

The 2.7L diesel Engine Control Module (ECM) controls many different circuits in the fuel injection and engine systems. If the ECM senses a problem with a monitored circuit that indicates an actual problem, a Diagnostic Trouble Code (DTC) will be stored in the ECM's memory, and eventually may illuminate the MIL (Malfunction Indicator Lamp) constantly while the key is on. If the problem is repaired, or is intermittent, the ECM will erase the DTC after 40 warm-up cycles without the the fault detected. A warm-up cycle consists of starting the vehicle when the engine is cold, then the engine is warmed up to a certain temperature, and finally, the engine temperature falls to a normal operating temperature, then the key is turned off.

Certain criteria must be met for a DTC to be entered into ECM memory. The criteria may be a specific range of engine rpm, engine or fuel temperature and/or input voltage to the ECM. A DTC indicates that the ECM has identified an abnormal signal in a circuit or the system.

There are several operating conditions that the ECM does not monitor and set a DTC for. Refer to the following Monitored Circuits and Non–Monitored Circuits in this section.

ECM MONITORED SYSTEMS

The ECM can detect certain problems in the electrical system.

Open or Shorted Circuit – The ECM will not distinguish between an open or a short to ground, however the ECM can determine if there is excessive current on a circuit, such as a short to voltage or a decrease in component resistance.

Output Device Current Flow – The ECM senses whether the output devices are electrically connected.

If there is a problem with the circuit, the ECM senses whether the circuit is open, shorted to ground (–), or shorted to (+) voltage.

Fuel Pressure: Fuel pressure is controlled by the fuel injection pump and fuel pressure solenoid. The ECM uses a fuel pressure sensor to determine if a fuel pressure problem exists.

Fuel Injector Malfunctions: The ECM can determine if a fuel injector has an electrical problem. The fuel injectors on the diesel engine are **controlled** by the ECM.

ECM NON–MONITORED SYSTEMS

The ECM does not monitor the following circuits, systems or conditions that could have malfunctions that result in driveability problems. A DTC will not be displayed for these conditions.

Cylinder Compression: The ECM cannot detect uneven, low, or high engine cylinder compression.

Exhaust System: The ECM cannot detect a plugged, restricted or leaking exhaust system.

Vacuum Assist: Leaks or restrictions in the vacuum circuits of the Exhaust Gas Recirculation System (EGR) are not monitored by the ECM.

ECM System Ground: The ECM cannot determine a poor system ground. However, a DTC may be generated as a result of this condition.

ECM/PCM Connector Engagement: The ECM cannot determine spread or damaged connector pins. However, a DTC may be generated as a result of this condition.

HIGH AND LOW LIMITS

The ECM compares input signals from each input device. It has high and low limits that are programmed into it for that device. If the inputs are not within specifications and other DTC criteria are met, a DTC will be stored in memory. Other DTC criteria might include engine rpm limits or input voltages from other sensors or switches. The other inputs might have to be sensed by the ECM when it senses a high or low input voltage from the control system device in question.

EXHAUST GAS RECIRCULATION

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EXHAUST GAS RECIRCULATION

DESCRIPTION

The EGR system reduces oxides of nitrogen (NOx) in the engine exhaust. This is accomplished by allowing a predetermined amount of hot exhaust gas to recirculate and dilute the incoming fuel/air mixture.

A malfunctioning EGR system can cause engine stumble, sags, or hesitation, rough idle, engine stalling and poor driveability.

OPERATION

The system consists of:

- An EGR valve assembly, located toward the rear of the engine on the intake manfiold.
- An EGR solenoid, located in the left rear of engine compartment near EGR valve. The EGR solenoid controls the “on time” of the EGR valve.
- The ECM operates the EGR solenoid. The ECM is located inside the vehicle under the instrument panel.
- The vacuum pump supplies vacuum for the EGR solenoid and the EGR valve. This pump also supplies vacuum for operation of the power brake booster and the heating and air conditioning system. The pump is located in the front of the engine block and is driven by the exhaust camshaft.
- Vacuum lines and hoses connect the various components.

When the ECM supplies a variable ground signal to the EGR solenoid, EGR system operation begins. The ECM will monitor and determine when to supply and remove this variable ground signal. This will depend on inputs from the engine coolant temperature, throttle position and engine speed sensors.

When the variable ground signal is supplied to the EGR solenoid, vacuum from the vacuum pump will be allowed to pass through the EGR solenoid and on to the EGR valve with a connecting hose.

Exhaust gas recirculation will begin in this order when:

- The ECM determines that EGR system operation is necessary.
- The engine is running to operate the vacuum pump.
- A variable ground signal is supplied to the EGR solenoid.
- Variable vacuum passes through the EGR solenoid 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.

The EGR system will be shut down by the ECM after 60 seconds of continuous engine idling to improve idle quality.

VALVE

DESCRIPTION

The egr valve is mounted to the intake manifold at the left rear corner of the engine (Fig. 1).

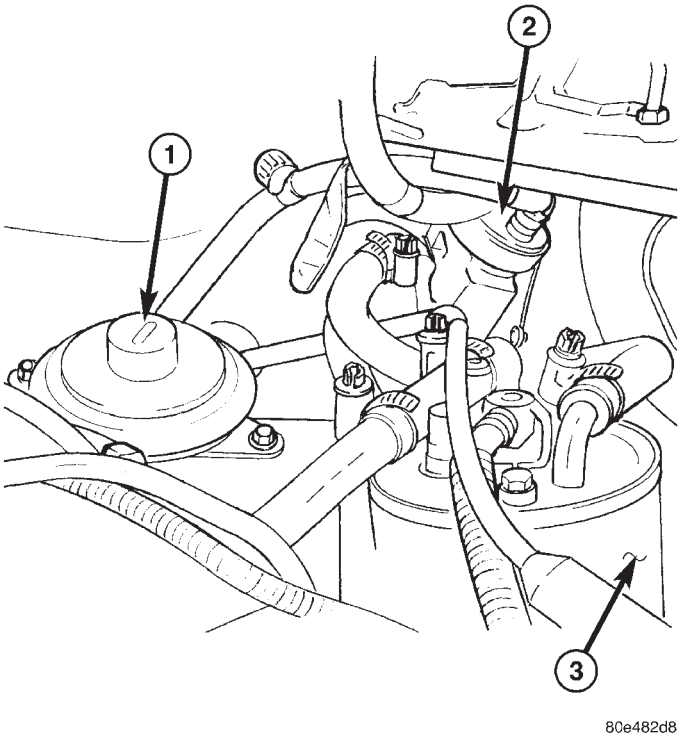

Fig. 1 EGR COMPONENTS

1 - EGR VALVE
2 - EGR SOLENOID
3 - FUEL FILTER

OPERATION

The engines use Exhaust Gas Recirculation (EGR) systems. The EGR system reduces oxides of nitrogen (NOx) in engine exhaust and helps prevent detonation (engine knock). Under normal operating conditions, engine cylinder temperature can reach more than 3000°F. Formation of NOx increases proportionally with combustion temperature. To reduce the emission of these oxides, the cylinder temperature must be lowered. The system allows a predetermined amount of hot exhaust gas to recirculate and dilute the incoming air/fuel mixture. The diluted air/fuel mixture reduces peak flame temperature during combustion.

REMOVAL

(1) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(2) Disconnect EGR valve vacuum line (Fig. 2).
(3) Remove EGR valve retaining bolts and EGR valve (Fig. 2).

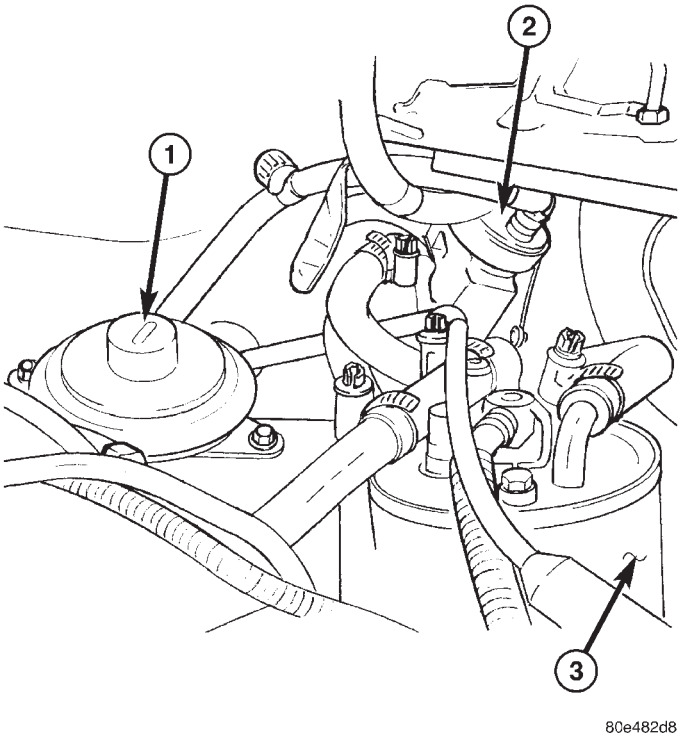

Fig. 2 EGR COMPONENTS

1 - EGR VALVE
2 - EGR SOLENOID
3 - FUEL FILTER

INSTALLATION

(1) Clean EGR valve sealing surfaces.
(2) Lubricate o-ring and install egr valve in intake manifold. Tighten EGR valve retaining bolts (Fig. 2).
(3) Connect vacuum line (Fig. 2).
(4) Install engine cover (Refer to 9 - ENGINE - INSTALLATION).

SOLENOID

DESCRIPTION

The EGR solenoid is mounted in the left-rear of the engine compartment (Fig. 3). The EGR solenoid serves two different functions. One is to control vacuum bleed-off of the EGR valve. The other is to control the “on time” of the EGR valve.

REMOVAL

(1) Disconnect negative battery cable.
(2) Disconnect EGR solenoid electrical connector.
(3) Disconnect EGR solenoid from engine vacuum harness (Fig. 3).
(4) Remove EGR solenoid from bracket (Fig. 3).

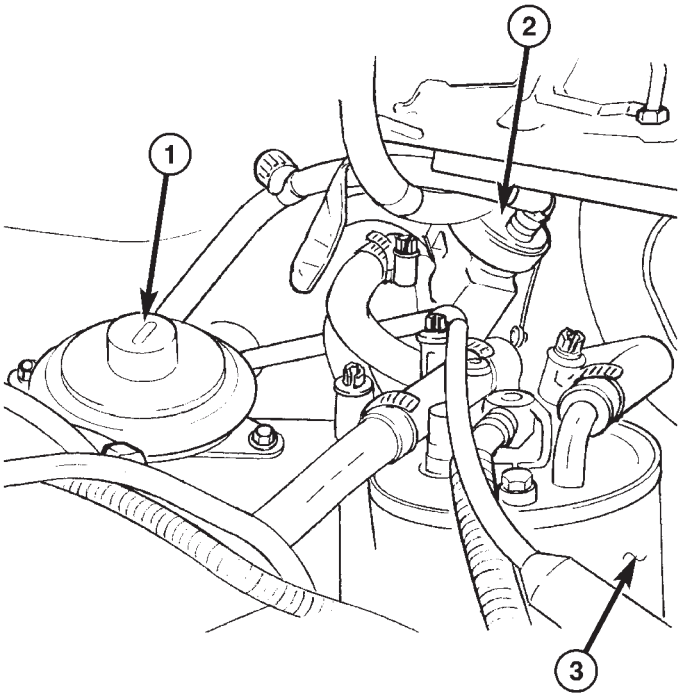

Fig. 3 EGR COMPONENTS

1 - EGR VALVE
2 - EGR SOLENOID
3 - FUEL FILTER

INSTALLATION

(1) Position and install EGR solenoid onto bracket.
(2) Connect engine vacuum harness to EGR solenoid.
(3) Connect EGR solenoid electrical connector.
(4) Connect negative battery cable.

ON-BOARD DIAGNOSTICS

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ON-BOARD DIAGNOSTICS

DESCRIPTION - DIAGNOSTIC TROUBLE CODES

On the following pages, a list of DTC's is provided for the 2.7L diesel engine. A DTC indicates that the ECM has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but most likely will not identify the failed component directly. Refer to the appropriate diagnostic manual for more information on diagnosis of trouble codes.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored DTC can be displayed through the use of the DRB III® scan tool. The DRB III® connects to the data link connector. The data link connector is located under the instrument panel near bottom of the steering column (Fig. 1).

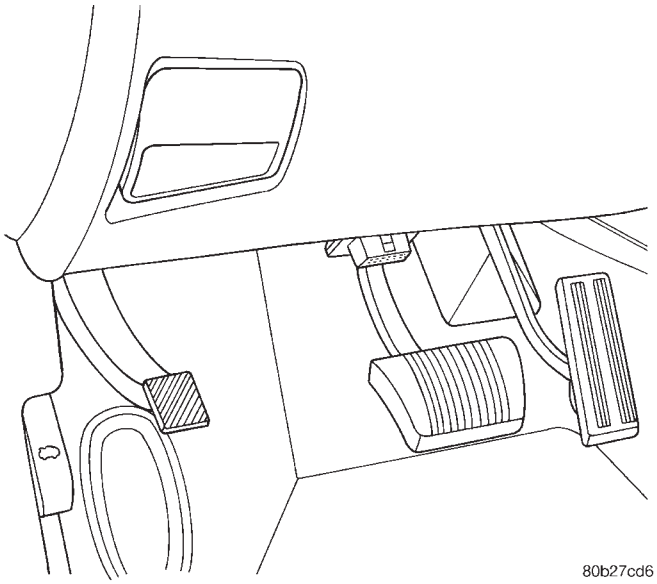

Fig. 1 Data Link Connector - Typical

ERASING TROUBLE CODES

After the problem has been repaired, use the DRB III® scan tool to erase a DTC.

ON-BOARD DIAGNOSTICS (Continued)

ENGINE CONTROL MODULE (ECM) - DRBIII® CODES

Generic Scan Tool Code	DRB III® Scan Tool Display
P0070	Ambient Air Temperature Circuit Signal Voltage Too High Ambient Air Temperature Circuit Signal Voltage Too Low
P0100	Mass Air Flow Sensor Signal Voltage Too High Mass Air Flow Sensor Signal Voltage Too Low Mass Air Flow Sensor Supply Voltage Out of Range
P0105	Barometric Pressure Circuit Signal Voltage To High Barometric Pressure Circuit Signal Voltage To Low
P0110	Charge Air Temperature Sensor Circuit Signal Too High Charge Air Temperature Sensor Circuit Signal Too Low
P0115	Engine Coolant Temperature Sensor Circuit Voltage To Low Engine Coolant Temperature Sensor Circuit Voltage To High
P0190	Fuel Pressure Sensor Signal Voltage Too High Fuel Pressure Sensor Signal Voltage Too Low Fuel Pressure Sensor Signal Voltage Out of Range
P0201	Injector 1 Over Current Low Side Injector 1 Over Current High Side Injector 1 Load Drop Injector 1 SL Error
P0202	Injector 2 Over Current Low Side Injector 2 Over Current High Side Injector 2 Load Drop Injector 2 SL Error
P0203	Injector 3 Over Current Low Side Injector 3 Over Current High Side Injector 3 Load Drop Injector 3 SL Error
P0204	Injector 4 Over Current Low Side Injector 4 Over Current High Side Injector 4 Load Drop Injector 4 SL Error
P0205	Injector 5 Over Current Low Side Injector 5 Over Current High Side Injector 5 Load Drop Injector 5 SL Error

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P0235	Boost Pressure Sensor Plausibility Boost Pressure Sensor Signal Voltage Too Low Boost Pressure Sensor Signal Voltage Too High Boost Pressure Sensor Signal Voltage Too High Or Low
P0243	Boost Pressure EVM Short Circuit Boost Pressure EVM Open Circuit Boost Pressure EVM Positive Governor Deviation Boost Pressure EVM Negative Governor Deviation
P0335	Engine Speed Sensor
P0340	CMP Signal Frequency Too High IAT Failure IAT Dynamically Implausible CMP Signal Static Defect
P0380	Glow Plug Relay 1 Open Circuit Glow Plug Relay 1 Short Circuit
P0382	Glow Plug Relay 2 Open Circuit Glow Plug Relay 2 Short Circuit
P0403	EGR EVM Open Load EGR EVM Short Circuit EGR EVM Negative Governor Deviation
P0460	Fuel Level Sensor Signal Too Low Fuel Level Sensor Signal Too High
P0500 test	Vehicle Speed Sensor Frequency Too High Vehicle Speed Sensor Plausibility Vehicle Speed Sensor Signal Voltage Too High
P0514	Battery Temperature Sensor Signal Too High Battery Temperature Sensor Signal Too Low
P0520	Oil Pressure Sensor Signal Too High Oil Pressure Sensor Signal Too Low Oil Pressure Sensor Supply Out of Range
P0530	A/C Pressure Transducer Out of Range A/C Pressure Transducer Signal Voltage Too High A/C Pressure Transducer Signal Voltage Too Low
P0560	Battery Voltage Signal Too High Battery Voltage Signal Too Low

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P0579	Speed Control Switch Signal Too High Speed Control Switch Signal Too Low Speed Control Switch Plausibility Error
P0606	ECM Recovery Flag ECM Redundant Monitoring ECM Gate Array Monitoring
P0615	Starter Relay Circuit Short Circuit
P0620	Generator Battery Voltage Too Low Generator Battery Voltage Too High Generator Short Circuit Generator Open Load Generator High Current Generator High Battery Voltage Difference Generator Low Battery Voltage Difference
P0641	ECM Sensor Supply Too High ECM Sensor Supply Too Low
P0645	A/C Compressor Relay Control Open Load A/C Compressor Relay Control Short Circuit
P0651	ECM Sensor Supply Too Low ECM Sensor Supply Too High
P0685	ECM (ASD) Relay Control Circuit Shuts Off Too Early ECM (ASD) Relay Control Circuit Shuts Off Too Late
P700	EGS Transmission Faults Shift Solenoid A Electrical Shift Solenoid B Electrical Shift Solenoid C Electrical Torque Converter Clutch Electrical Pressure Control Solenoid Electrical Pressure Control Solenoid B Electrical Transmission Control System Electrical
P702	Input Turbine Speed Circuit Malfunction Selector Lever: Code Invalid or CAN Message Distorted or Position Implausible CAN: Right and Left Rear Wheel Speed Implausible or Inconsistent ABS - Node or ABS Information Distorted Transmission Fault CAN: T - Case Information Implausible or Information Distorted Torque Converter Lock - Up - Clutch Gear Recognition Negative

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P0703	Brake Switch Signal Plausibility Brake Switch Signal Plausibility After Initialization
P0836	4 Wheel Drive Switch Signal Too Low 4 Wheel Drive Switch Signal Too High 4 Wheel Drive Switch Plausibility Error 2 4 Wheel Drive Switch Plausibility Error 1
P0850	Park/Neutral Switch Signal Plausibility
P1130	Fuel Pressure Plausibility, Minimum Pressure at Eng Speed Too Low Fuel Pressure Plausibility, Maximum Exceeded Fuel Pressure Plausibility, Regulator Sticks Fuel Pressure Plausibility, Leakage
P1131	Fuel Pressure Actuator Open Load Fuel Pressure Actuator Short Circuit Fuel Pressure Actuator Power Stage Error
P1205	Injector Classification Checksum Error Injector Classification Invalid Injector Class
P1235	EGS Fuel Quantity Demand, Parity Error EGS Fuel Quantity Demand, Toggle Bit EGS Fuel Quantity Demand, Demand Not Plausible
P1242	CAN BUS Message Missing From EGS CAN BUS Mute CAB BUS
P1270	Swirl Actuator Short Circuit Swirl Actuator Open Load Swirl Actuator Diagnosis Ground Switching
P1499	Hydraulic Fan Solenoid Short Circuit Hydraulic Fan Solenoid Open Load
P1511	Battery Sense 1 Too High Battery Sense 1 Too Low
P1512	Battery Sense 2 Too High Battery Sense 2 Too Low
P1536	Generator Excitation Current Too High
P1601	Injector Boost Capacitor Voltage 1 Too High Injector Boost Capacitor Voltage 1 Too Low
P1605	Ignition Signal Plausibility After Initalization
P1606	After Run Test Failure, Zero Fuel Quantity After Run Test Failure, Injector Power Stage

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P1608	A to D Monitoring, RAM Test Failure A to D Monitoring, Ground Connection to PPS Failure A to D Monitoring, Test Voltage Failure
P1610	5 Voltage Supply Too High 5 Voltage Supply Too Low
P1643	Cabin Heater Relay Short Circuit Cabin Heater Relay Load Open
P1651	J1850: IFR Error J1850: Status Error
P1652	J1850 BUS Short to Plus J1850 BUS Short to Ground J1850 BUS Transmit Buffer Full J1850 BUS Arbitration Error J1850 BUS Internal SPI Transmission Error J1850 BUS Receive Dead/PV Test J1850 BUS Not Permitted Reset
P1680	EEPROM Fault Checksum EEPROM Fault Checksum Error EEPROM Fault Communication Error EEPROM Fault Different Variation Number EEPROM Fault Code Work Incorrect or Missing EEPROM Fault VIN Write Error
P1685	SKIM Write Access to Secret Key in EEPROM Bad SKIM Read Access to Secret Key in EEPROM RAM Mirror Bad SKIM Timed Out During Communication SKIM Received Invalid Key Code
P2120	Acc. Pedal Position Sensor Supply Out of Range Acc. Pedal Position Sensor Plausibility With Brake Switch Acc. Pedal Position Sensor Signal Too High
P2125	Accel Pedal Sensor Signal to High Accel Pedal Sensor Supply Out of Range Accel Pedal Sensor (PGS) Plausibility w/ PWG

SERVICE MANUAL COMMENTS

What features do you find most useful? _____

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What errors have you found? Please include page number. _____

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