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MAINTENANCE SCHEDULES

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MAINTENANCE SCHEDULES FOR ALL MARKETS EXCEPT U.S., CANADA and MEXICO

DESCRIPTION — DIESEL ENGINES

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

There are two maintenance schedules that show the **required** service for your vehicle.

First is Schedule **"B"**. It is for vehicles that are operated under the conditions that are listed below and at the beginning of the schedule.

- Extensive engine idling.
- Driving in dusty conditions.
- More than 50% of your driving is at sustained high speeds during hot weather, above 32° C (90° F).
- Trailer towing.
- Taxi, police, or delivery service (commercial service).

NOTE: Most vehicles are operated under the conditions listed for Schedule ″B″.

Second is Schedule **"A"**. It is for vehicles that are not operated under any of the conditions listed under Schedule ″B″.

Use the schedule that best describes your driving conditions. Where time and mileage are listed, follow the interval that occurs first.

CAUTION: Failure to perform the required maintenance items may result in damage to the vehicle.

At Each Stop for Fuel

- Check the engine oil level about 5 minutes after a fully warmed engine is shut off. Checking the oil level while the vehicle is on level ground will improve the accuracy of the oil level reading. Add oil only when the level is at or below the ADD or MIN mark.
- Check the windshield washer solvent and add if required.

Once a Month

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

At Each Oil Change

- Change the engine oil filter.
- Inspect the exhaust system.
- Inspect the brake hoses.
- Check the manual transmission fluid level — if equipped.
- Check the coolant level, hoses, and clamps.
- Inspect engine accessory drive belts. Replace as necessary.
- Inspect for the presence of water in the fuel filter/water separator unit.
- Rotate the tires.

Schedule "B"

Follow schedule "B" if you usually operate your vehicle under one or more of the following conditions.

- Extensive engine idling.
- Driving in dusty conditions.
- More than 50% of your driving is at sustained high speeds during hot weather, above 32° C (90° F).
- Trailer towing.
- Taxi, police, or delivery service (commercial service).

MAINTENANCE SCHEDULES FOR ALL MARKETS EXCEPT U.S., CANADA and MEXICO (Continued)

Kilometers	10 000 km	20 000 km	30 000 km	40 000 km	50 000 km
Change the engine oil and engine oil filter.	X	X	X	X	X
Inspect the ball joints.	X	X	X	X	X
Inspect engine accessory drive belt.	X	X	X	X	
Replace engine accessory drive belt.					X
Inspect the engine air filter element. Replace as necessary.	X		X		X
Replace the engine air filter element.		X		X	
Replace the engine timing belt.					X
Inspect idler pulleys and timing belt tensioner‡.					X
Replace fuel filter/water separator unit.		X		X	
Inspect the brake linings.	X	X	X	X	X
Drain and refill the front and rear axle fluid.		X		X	
Drain and refill automatic transmission fluid and replace transmission main sump filter.					X

Kilometers	60 000 km	70 000 km	80 000 km	90 000 km	100 000 km
Change the engine oil and engine oil filter.	X	X	X	X	X
Inspect the ball joints.	X	X	X	X	X
Inspect engine accessory drive belt.	X	X	X	X	X
Replace engine accessory drive belt.					X
Inspect the engine air filter element. Replace as necessary.		X		X	
Replace the engine air filter element.	X		X		X
Inspect idler pulleys and timing belt tensioner‡.					X
Replace the engine timing belt.					X
Inspect the brake linings.	X	X	X	X	X
Drain and refill the front and rear axle fluid.	X		X		X
Replace the fuel filter/water separator unit.	X		X		X
Drain and refill the transfer case fluid.					X
Drain and refill the automatic transmission fluid and replace transmission main sump filter.					X

MAINTENANCE SCHEDULES FOR ALL MARKETS EXCEPT U.S., CANADA and MEXICO (Continued)

Kilometers	110 000 km	120 000 km	130 000 km	140 000 km	150 000 km	160 000 km
Change the engine oil and engine oil filter.	X	X	X	X	X	X
Inspect the ball joints.	X	X	X	X	X	X
Inspect the engine air filter element. Replace as necessary.	X		X		X	
Replace the engine air filter element.		X		X		X
Inspect engine accessory drive belt.	X	X	X	X		X
Replace engine accessory drive belt.					X	
Inspect the idler pulleys and timing belt tensioner‡.					X	
Replace the engine timing belt.					X	
Inspect the brake linings.	X	X	X	X	X	X
Drain and refill the front and rear axle fluid.		X		X		X
Replace the fuel filter/water separator unit.		X		X		X
Flush and replace the engine coolant.						X
Drain and refill automatic transmission fluid and replace transmission filter (s).					X	

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

‡ Replace if there is superficial wear, bearing clearance, or evident grease leak.

MAINTENANCE SCHEDULES FOR ALL MARKETS EXCEPT U.S., CANADA and MEXICO (Continued)

Schedule "A"

Kilometers	20 000 km	40 000 km	60 000 km	80 000 km	100 000 km
Change the engine oil and engine oil filter.	X	X	X	X	X
Inspect the ball joints.	X	X	X	X	X
Inspect the brake linings.		X		X	
Inspect the engine air filter element. Replace as necessary.	X		X		X
Replace the engine air filter element.		X		X	
Inspect the engine accessory drive belt.	X	X	X	X	X
Replace the engine accessory drive belt.					X
Replace the fuel filter/water separator unit.	X	X	X	X	X
Inspect idler pulleys, and timing belt tensioner‡.					X
Replace the engine timing belt.					X
Inspect the transfer case fluid.			X		

Kilometers	120 000 km	140 000 km	160 000 km	180 000 km
Change the engine oil and engine oil filter.	X	X	X	X
Inspect the ball joints.	X	X	X	X
Inspect the brake linings.	X		X	
Inspect the engine accessory drive belt.	X	X	X	X
Inspect the engine air filter element. Replace as necessary.		X		X
Replace the engine air filter element.	X		X	
Replace the fuel filter/water separator unit.	X	X	X	X
Flush and replace the engine coolant.			X	
Inspect the transfer case fluid.	X			
Drain and refill the transfer case fluid.				X
Drain and refill automatic transmission fluid and replace transmission filter (s).			X	

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

‡ Replace if there is superficial wear, bearing clearance, or evident grease leak.

WARNING: You can be badly injured working on or around a motor vehicle. Do only that service work for which you have the knowledge and the right equipment. If you have any doubt about your ability to perform a service job, take your vehicle to a competent mechanic.

COOLING - 2.5L/2.8L TURBO DIESEL

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COOLING - 2.5L/2.8L TURBO DIESEL

DESCRIPTION - COOLING SYSTEM

The cooling system regulates engine operating temperature. It allows the engine to reach normal operating temperature as quickly as possible, maintains normal operating temperature and prevents overheating.

The cooling system also provides a means of heating the passenger compartment. The cooling system is pressurized and uses a centrifugal water pump to circulate coolant throughout the system. A separate and remotely mounted, pressurized coolant tank using a pressure/vent cap is used.

COOLING SYSTEM COMPONENTS

The cooling system consists of:

- Charge Air Cooler
- Electric Cooling Fans
- A aluminum-core radiator with plastic side tanks
- A separate pressurized coolant tank
- A pressure/vent cap on the coolant tank
- Fan shroud
- Thermostat
- Coolant
- Low coolant warning lamp
- Coolant temperature gauge
- Water pump
- Hoses and hose clamps

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - COOLING SYSTEM FLOW CHECK

To determine whether coolant is flowing through the cooling system, use the following procedures:

(1) If engine is cold, idle engine until normal operating temperature is reached. Then feel the upper radiator hose. If it is hot, coolant is circulating.

WARNING: DO NOT REMOVE THE COOLING SYSTEM PRESSURE CAP WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.

(2) Remove pressure/vent cap when engine is cold, idle engine until thermostat opens, you should observe coolant flow while looking down in the coolant recovery pressure container. Once flow is detected install the pressure/vent cap.

DIAGNOSIS AND TESTING - COOLING SYSTEM AERATION

Low coolant level in a cross flow radiator will equalize in both tanks with engine off. With engine at running and at operating temperature, the high pressure inlet tank runs full and the low pressure outlet tank drops, resulting in cooling system aeration. Aeration will draw air into the water pump resulting in the following:

- High reading shown on the temperature gauge.
- Loss of coolant flow through the heater core.
- Corrosion in the cooling system.

- Water pump seal may run dry, increasing the risk of premature seal failure.
- Combustion gas leaks into the coolant can also cause aeration.

DIAGNOSIS AND TESTING - COOLING SYSTEM LEAK TEST

WARNING: THE WARNING WORDS "DO NOT OPEN HOT" ON THE RADIATOR PRESSURE CAP IS A SAFETY PRECAUTION. WHEN HOT, PRESSURE BUILDS UP IN COOLING SYSTEM. TO PREVENT SCALDING OR INJURY, THE RADIATOR CAP SHOULD NOT BE REMOVED WHILE THE SYSTEM IS HOT OR UNDER PRESSURE.

With engine not running, remove pressure/vent cap from the coolant recovery pressure container and wipe the filler neck sealing seat clean. The coolant level in the recovery pressure container should be full.

Attach the Cooling System Tester 7700 or equivalent to the radiator, as shown in (Fig. 1) and apply 104 kPa (15 psi) pressure. If the pressure drops more than 13.8 kPa (2 psi) in 2 minutes, inspect all points for external leaks.

All radiator and heater hoses should be shaken while at 104 kPa (15 psi), since some leaks occur only while driving due to engine movement.

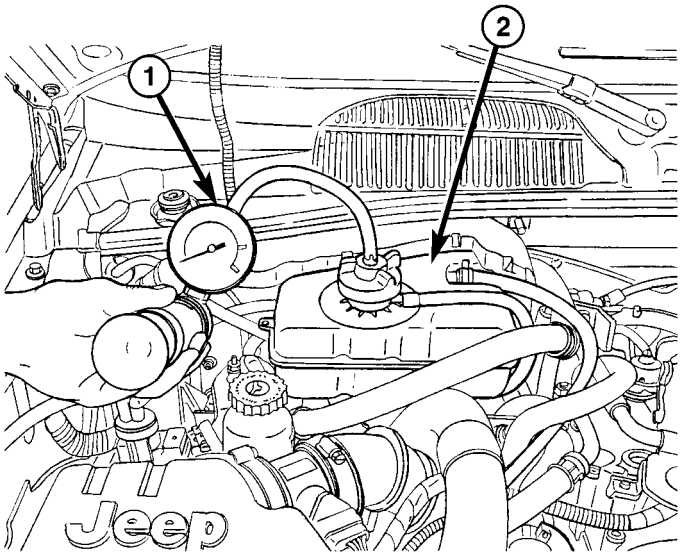

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Fig. 1 PRESSURE TESTING COOLING SYSTEM

1 - COOLANT PRESSURE TESTER
2 - COOLANT RECOVERY PRESSURE CONTAINER

If there are no external leaks, after the gauge dial shows a drop in pressure, detach the tester. Start engine and run until the thermostat opens, allowing the coolant to expand. Reattach the cooling system tester. If the needle on the dial fluctuates it indicates a combustion leak, usually a head gasket leak.

WARNING: WITH TOOL IN PLACE, PRESSURE WILL BUILD UP RAPIDLY. EXCESSIVE PRESSURE BUILT UP, BY CONTINUOUS ENGINE OPERATION, MUST BE RELEASED TO A SAFE PRESSURE POINT. NEVER PERMIT PRESSURE TO EXCEED 138 kPa (20 psi).

If the needle on the dial does not fluctuate, raise the engine rpm a few times. If an abnormal amount of coolant or steam emits from the tailpipe, it may indicate a coolant leak caused by a faulty head gasket, cracked engine block, or cracked cylinder head.

There may be internal leaks that can be determined by removing the oil dipstick. If water globules appear intermixed with the oil it will indicate an internal leak in the engine. If there is an internal leak, the engine must be disassembled for repair.

DIAGNOSIS AND TESTING - ON-BOARD DIAGNOSTICS (OBD)

COOLING SYSTEM RELATED DIAGNOSTICS

The Engine Control Module (ECM) has been programmed to monitor certain cooling system components. If the problem is sensed in a monitored circuit often enough to indicated an actual problem, a DTC is stored. The DTC will be stored in the ECM memory for eventual display to the service technician. (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION).

ACCESSING DIAGNOSTIC TROUBLE CODES

To read DTC's and to obtain cooling system data, (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION).

ERASING TROUBLE CODES

After the problem has been repaired, use the DRBIII® scan tool to erase a DTC. Refer to the appropriate Powertrain Diagnostic Procedures service information for operation of the DRBIII® scan tool.

DIAGNOSIS AND TESTING - COOLING SYSTEM

Establish what driving conditions caused the complaint. Abnormal loads on the cooling system such as the following may be the cause:

(1) PROLONGED IDLE, VERY HIGH AMBIENT TEMPERATURE, SLIGHT TAIL WIND AT IDLE, SLOW TRAFFIC, TRAFFIC JAMS, HIGH SPEED OR STEEP GRADES.

- Idle with A/C off when temperature gauge is at end of normal range.

(2) TRAILER TOWING:

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

(3) 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
- Brakes (possibly dragging)
- Changed parts (incorrect water pump)
- Reconditioned radiator or cooling system refilling (possibly under filled or air trapped in system).

NOTE: If investigation reveals none of the previous items as a cause for an engine overheating complaint, refer to following Cooling System Diagnosis charts.

These charts are to be used as a quick-reference only.

COOLING SYSTEM DIAGNOSIS-DIESEL ENGINE

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS LOW	1. Diesel engines, due to their inherent efficiency are slower to warm up than gasoline powered engines, and will operate at lower temperatures when the vehicle is unloaded.	1. The low gauge reading may be normal. Refer to thermostats in the manual text for information. See Thermostat Diagnosis-Diesel Engine.
	2. Is the temperature gauge connected to the temperature gauge coolant sensor on the engine?	2. Check, the engine temperature sensor connector in the engine compartment.
	3. Is the temperature gauge operating OK?	3. Check gauge operation. Repair as necessary.
	4. Coolant level low in cold ambient temperatures accompanied with poor heater performance.	4. Check coolant level in the coolant tank. Inspect system for leaks. Repair leaks as necessary. Refer to the Coolant section for WARNINGS and precautions before removing the pressure cap.
	5. Improper operation of internal heater doors or heater controls.	5. Inspect heater and repair as necessary. Refer to Heating and Air Conditioning for procedures.

COOLING - 2.5L/2.8L TURBO DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS HIGH. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM COOLING SYSTEM	1. Trailer is being towed, a steep hill is being climbed, vehicle is operated in slow moving traffic, or engine is being idled with very high ambient (outside) temperature and the air conditioning is on. Higher altitudes could aggravate these conditions.	1. This may be a temporary condition and repair is not necessary. Turn off the air conditioning and attempt to drive the vehicle without any of the previous conditions. Observe the temperature gauge. The gauge should return to the normal range. If the gauge does not return to normal range, determine the cause for the overheating and repair.
	2. Temperature gauge reading incorrectly.	2. Check gauge. Refer to I/P group.
	3. Coolant low in coolant tank and radiator.	3. Check for coolant leaks and repair as necessary.
	4. Pressure cap not installed tightly. If cap is loose, boiling point of coolant will be lowered.	4. Tighten cap.
	5. Poor seals at pressure/vent cap.	5. (a) Check condition of cap and cap seals. (b) Check condition of coolant tank filler neck. Make sure it does not leak pressure.
	6. Freeze point of antifreeze not correct. Mixture may be too rich.	6. Check antifreeze. Adjust antifreeze-to-water ratio as required.
	7. Coolant not flowing through system.	7. Check for coolant flow in coolant tank with engine warm and thermostat open. Coolant should be observed flowing through the tank. If flow is not observed, determine reason for lack of flow and repair as necessary.
	8. Radiator or A/C condenser fins are dirty or clogged.	8. Clean debris from radiator or A/C condenser
	9. Radiator core is corroded or plugged.	9. Have radiator re-cored or replaced.
	10. Aftermarket A/C installed without proper A/C condenser.	10. Install proper A/C condenser.
	11. Dragging Brakes.	11. Check and correct as necessary.
	12. Non-factory bug screen is being used reducing air flow.	12. Only a factory screen should be used.
	13. Thermostat partially or completely shut. This is more prevalent on high mileage vehicles.	13. Check thermostat and replace if necessary.
	14. Cylinder head gasket leaking.	14. Check cylinder head gasket for leaks.
	15. Heater core leaking.	15. Check heater core for leaks. Repair as necessary.

COOLING - 2.5L/2.8L TURBO DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READING IS INCONSISTENT (FLUCTUATES, CYCLES OR IS ERRATIC)	1. During cold weather operation, with the heater blower in the high position, the gauge reading may drop slightly. Fluctuation is also influenced by loads, outside temperature and extended idle time with diesel engines.	1. A normal condition. No correction is necessary.
	2. Temperature gauge or engine mounted gauge sensor defective or shorted. Also, corroded or loose wiring in this circuit.	2. Check operation of gauge and repair as necessary.
	3. Gauge reading rises when vehicle is brought to a stop after heavy use (engine still running).	3. A normal condition. No correction needed. Gauge should return to normal range after vehicle is driven.
	4. Gauge reading high after starting a warm-up (hot) engine.	4. A normal condition. No correction needed. Gauge should return to normal after a few minutes of engine operation.
	5. Coolant level low in the coolant tank (air will build up in the cooling system causing the thermostat to open late).	5. Check and correct coolant leaks.
	6. Cylinder head gasket leaking allowing exhaust gases to enter the cooling system causing the thermostat to open late.	6. (a) Check for cylinder head gasket leaks with a commercially available leak tester. (b) Check for coolant in engine oil. Inspect for white steam emitting from exhaust system. Repair as necessary.
	7. Water pump impeller loose on shaft.	7. Check water pump and replace as necessary.
	8. Loose accessory drive belt (water pump slipping).	8. Check and correct as necessary.
	9. Air leak on the suction side of the water pump allowing air to build up in the cooling system causing the thermostat to open late.	9. Locate leak and repair as necessary.
PRESSURE CAP IS BLOWING OFF STEAM AND/OR COOLANT. TEMPERATURE GAUGE READING MAY BE ABOVE NORMAL BUT NOT HIGH. COOLANT LEVEL MAY BE HIGH IN COOLANT TANK	1. Pressure relief valve in pressure/ vent cap is defective.	1. Check condition of pressure/ vent cap and cap seals.
	2. Head gasket leak or cracked cylinder head.	2. Repair as necessary.
COOLANT LOSS TO THE GROUND WITHOUT PRESSURE CAP BLOWOFF. GAUGE IS READING HIGH OR HOT	1. Coolant leaks in radiator, cooling system hoses, water pump, or engine.	1. Pressure test cooling system and repair as necessary.

COOLING - 2.5L/2.8L TURBO DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
HOSE OR HOSES COLLAPSE WHEN ENGINE IS COOLING	1. Vacuum created in cooling system on engine cool-down is not being relieved through pressure/vent cap.	1. Cap relief valve stuck. Replace if necessary.
NOISY FAN	1. Cooling fan blades loose. 2. Cooling fan blades striking a surrounding object. 3. Air obstructions at radiator or A/C condenser.	1. Replace cooling fan assembly. 2. Locate point of fan blade contact and repair as necessary. 3. Remove obstructions or clean debris from radiator or A/C condenser.
INADEQUATE AIR CONDITIONER PERFORMANCE (COOLING SYSTEM SUSPECTED)	1. Radiator and/or A/C condenser is restricted, obstructed or dirty (insects, leaves, etc.) 2. Engine is overheating (heat may be transferred from radiator to A/C condenser. High Under hood temperatures due to engine overheating may also transfer heat to A/C condenser). 3. The cooling system is equipped with air seals at the radiator and/or A/C condenser. If these seals are missing or damaged, not enough air flow will be pulled through the radiator and A/C condenser.	1. Remove restriction or clean debris from radiator or A/C condenser. 2. Correct overheating condition. 3. Check for missing or damaged air seals. Repair as necessary.
INADEQUATE HEATER PERFORMANCE. MAY BE ACCOMPANIED BY LOW GAUGE READING	1. Diesel engines, due to their inherent efficiency are slower to warm up than gasoline powered engines, and will operate at lower temperatures when the vehicle is unloaded. 2. Coolant level low. 3. Obstruction in heater hose fitting at engine. 4. Heater hose kinked. 5. Water pump is not pumping water to heater core. When the engine is fully warmed up, both heater hoses should be hot to the touch. If only one of the hoses is hot the water pump may not be operating correctly. The accessory drive belt may also be slipping causing poor water pump operation.	1. The lower gauge reading may be normal. 2. Pressure test cooling system. Repair leaks as necessary. 3. Remove heater hoses and check for obstructions. Repair as necessary. 4. Locate kinked area. Repair as necessary. 5. Refer to water pumps in this group. Repair as necessary. If a slipping belt is detected, refer to Engine Accessory Drive Belts in this group. Repair as necessary.

COOLING - 2.5L/2.8L TURBO DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
HEAT ODOR	1. Various heat shields are used at certain drive line components. One or more of these shields may be missing. 2. Is temperature gauge reading above the normal range? 3. Is the Cooling fan operating correctly? 4. Has undercoating been applied to any unnecessary components?	1. Locate missing shields. Repair or replace as necessary. 2. Refer to the previous Temperature Gauge Reads High in these Diagnostic Charts. Repair as necessary. 3. Refer to Cooling System Fan in this group for diagnosis. Repair as necessary. 4. Clean undercoating as necessary.
STEAM IS COMING FROM FRONT OF VEHICLE NEAR GRILL AREA WHEN WEATHER IS WET, ENGINE IS WARMED UP AND RUNNING, AND VEHICLE IS STATIONARY. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. During wet weather, moisture (snow, ice, or rain condensation) on the radiator will evaporate when the thermostat opens. This opening allows heated water into the radiator. When the moisture contacts the hot radiator, steam may be emitted. This usually occurs in cold weather with no fan or air flow to blow it away.	1. Occasional steam emitting from this area is normal. No repair is necessary.
COOLANT ODOR	1. Coolant color is not necessarily an indication of adequate corrosion or temperature protection. Do not rely on coolant color for determining condition of coolant.	1. Refer to Coolant in this group for antifreeze tests. Adjust antifreeze-to-water ratio as necessary.
COOLANT LEVEL CHANGES IN COOLANT TANK. TEMPERATURE GAUGE IS IN NORMAL RANGE	1. Level changes are to be expected as coolant volume fluctuates with engine temperature. If the level in the tank was between the HOT and COLD marks at normal engine operating temperature, the level should return to within that range after operation at elevated temperatures.	1. This a normal condition. No repair necessary.

STANDARD PROCEDURE - COOLING SYSTEM - REVERSE FLUSHING

CAUTION: The cooling system normally operates at 97-to-110 kPa (14-to -16 psi) pressure. Exceeding this pressure may damage the radiator or hoses.

Reverse flushing of the cooling system is the forcing of water through the cooling system. This is done using air pressure in the opposite direction of normal coolant flow. It is usually only necessary with very dirty systems with evidence of partial plugging.

CHEMICAL CLEANING

If visual inspection indicates the formation of sludge or scaly deposits, use a radiator cleaner (Mopar Radiator Kleen or equivalent) before flushing. This will soften scale and other deposits and aid the flushing operation.

CAUTION: Be sure instructions on the container are followed.

REVERSE FLUSHING RADIATOR

Disconnect the radiator hoses from the radiator fittings. Attach a section of radiator hose to the radiator bottom outlet fitting and insert the flushing gun. Connect a water supply hose and air supply hose to the flushing gun.

CAUTION: The cooling system normally operates at 97-to-110 kPa (14- to-16 psi) pressure. Exceeding this pressure may damage the radiator or hoses.

Allow the radiator to fill with water. When radiator is filled, apply air in short blasts allowing radiator to refill between blasts. Continue this reverse flushing until clean water flows out through rear of radiator cooling tube passages. For more information, refer to operating instructions supplied with flushing equipment. Have radiator cleaned more extensively by a radiator repair shop.

REVERSE FLUSHING ENGINE

Drain the cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE). Disconnect the radiator upper hose from the radiator and attach the flushing gun to the hose. Disconnect the radiator lower hose from the water pump. Attach a lead away hose to the water pump inlet fitting.

CAUTION: Be sure that the heater control valve is closed (heat off). This is done to prevent coolant flow with scale and other deposits from entering the heater core.

Connect the water supply hose and air supply hose to the flushing gun. Allow the engine to fill with water. When the engine is filled, apply air in short blasts, allowing the system to fill between air blasts. Continue until clean water flows through the lead away hose. For more information, refer to operating instructions supplied with flushing equipment.

Remove the lead away hose, flushing gun, water supply hose and air supply hose. Remove the thermostat housing (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - REMOVAL). Install the thermostat and housing with a replacement gasket (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - INSTALLATION). Connect the radiator hoses. Refill the cooling system with the correct antifreeze/water mixture (Refer to 7 - COOLING - STANDARD PROCEDURE).

CLEANING

Drain cooling system and refill with clean water. Refer to procedures in this section. Run engine with pressure/vent cap installed until upper radiator hose is hot. Stop engine and drain water from system. If water is dirty; fill, run, and drain system again, until water runs clear.

INSPECTION

After performing a cleaning/flush procedure, inspect all hoses, clamps and connections for deterioration and leaks. Inspect radiator and heater core for leaks.

SPECIFICATIONS

SPECIFICATIONS - COOLING SYSTEM CAPACITY

SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Cooling System With Auxiliary Heater	16.6 Liters (17.5 qts.)
Cooling System With Out Auxiliary Heater	13.8 Liters (14.6 qts.)

SPECIFICATIONS - TORQUE

2.5L/2.8L DIESEL - TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Accessory Drive Belt Idler Bolt	53	39	—
Accessory Drive Belt Tensioner Bolt	47.1	35	—
Cooling Fan Support Bolts	47.1	35	—
Thermostat Housing Bolts	27.5	21	—
Water Pump Housing Nuts	24.4	18	215

ACCESSORY DRIVE

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ACCESSORY DRIVE

SPECIFICATIONS - ACCESSORY BELT TENSION

ACCESSORY DRIVE BELT	GAUGE
2.5L/2.8L DIESEL ENGINE	
A/C Compressor/ Generator	Dynamic Tensioner
Power Steering Belt	Dynamic Tensioner

BELT TENSIONERS

DESCRIPTION

This engine is equipped with a spring loaded automatic belt tensioner (Fig. 1). This tensioner maintains constant belt tension at all times and requires no maintenance or adjustment.

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

OPERATION

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

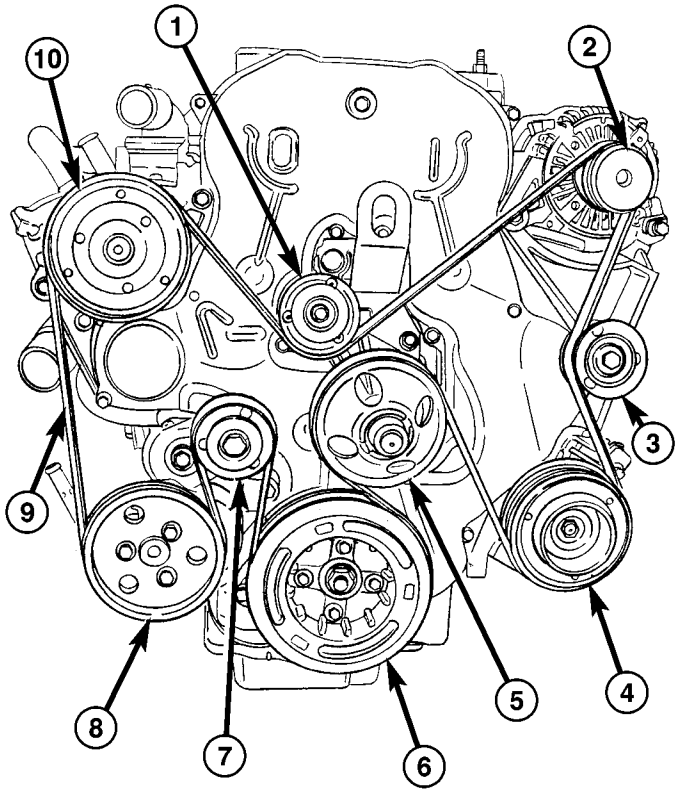

Fig. 1 ACCESSORY BELT ROUTING

1 - IDLER PULLEY
2 - GENERATOR
3 - IDLER PULLEY
4 - A/C COMPRESSOR
5 - COOLING FAN SUPPORT
6 - VIBRATION DAMPER
7 - BELT TENSIONER
8 - POWER STEERING PUMP
9 - ACCESSORY DRIVE BELT
10 - VISCOUS HEATER

BELT TENSIONERS (Continued)

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.

REMOVAL

(1) Disconnect negative battery cable.

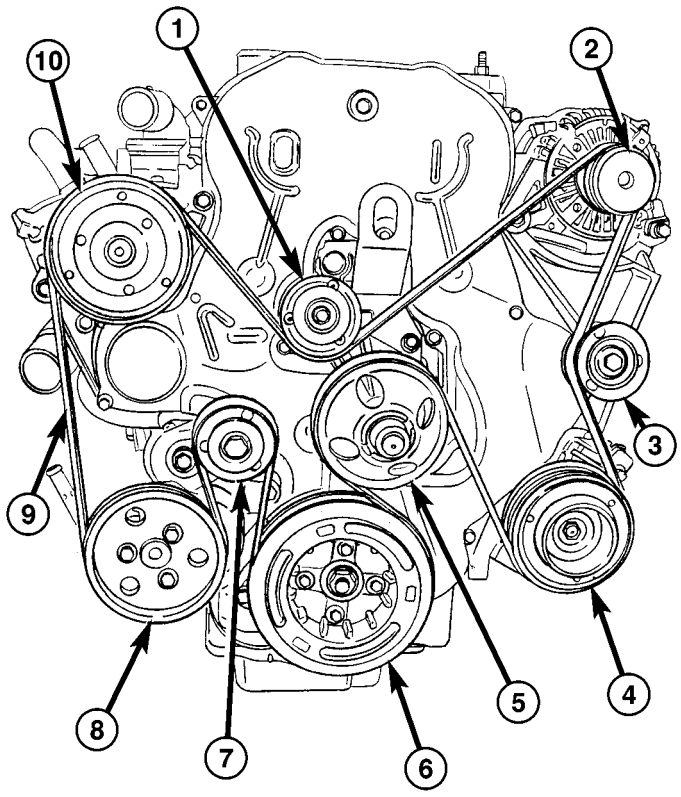

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Fig. 2 ACCESSORY BELT ROUTING

1 - IDLER PULLEY
2 - GENERATOR
3 - IDLER PULLEY
4 - A/C COMPRESSOR
5 - COOLING FAN SUPPORT
6 - VIBRATION DAMPER
7 - BELT TENSIONER
8 - POWER STEERING PUMP
9 - ACCESSORY DRIVE BELT
10 - VISCOUS HEATER

(2) Remove accessory drive belt (Fig. 2)(Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(3) Remove belt tensioner retaining bolt and remove tensioner from bracket (Fig. 3).

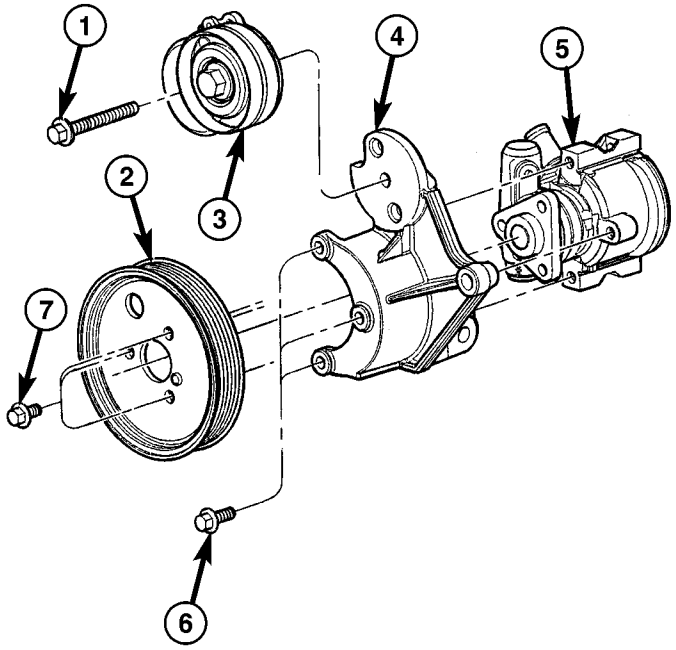

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Fig. 3 BELT TENSIONER ASSEMBLY

1 - ACCESSORY BELT TENSIONER RETAINING BOLT
2 - POWER STEERING PUMP PULLEY
3 - BELT TENSIONER
4 - BRACKET
5 - POWER STEERING PUMP
6 - POWER STEERING PUMP RETAINING BOLTS
7 - POWER STEERING PUMP PULLEY RETAINING BOLTS

INSTALLATION

(1) Install belt tensioner on bracket (Fig. 3). Torque retaining bolt to 47.1N·m.

(2) Install accessory drive belt (Fig. 2)(Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(3) Connect negative battery cable.

DRIVE BELT

DESCRIPTION

The accessory drive belt is a serpentine type belt (Fig. 4). Satisfactory performance of these belts depends on belt condition and proper belt tension.

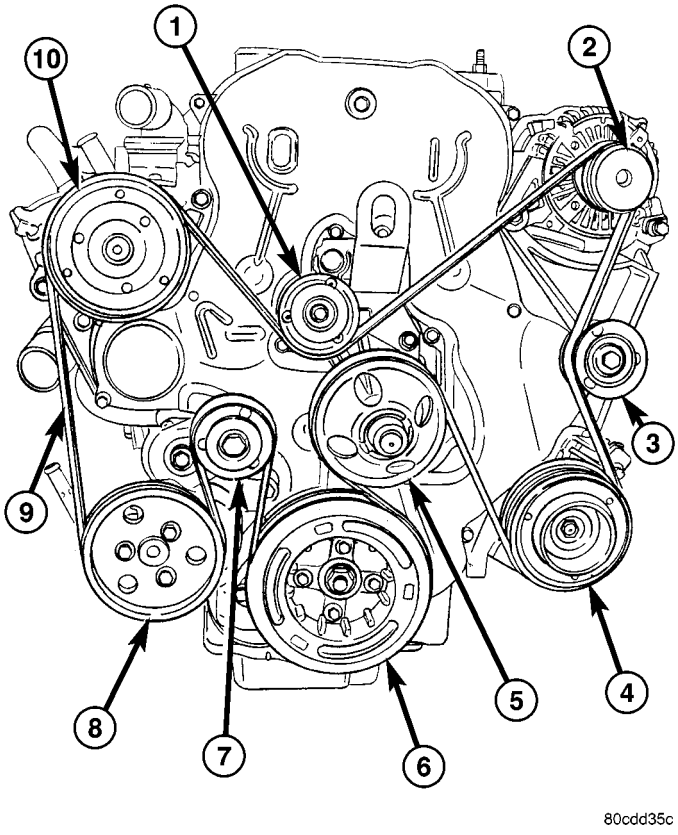

Fig. 4 ACCESSORY BELT ROUTING

1 - IDLER PULLEY
2 - GENERATOR
3 - IDLER PULLEY
4 - A/C COMPRESSOR
5 - COOLING FAN SUPPORT
6 - VIBRATION DAMPER
7 - BELT TENSIONER
8 - POWER STEERING PUMP
9 - ACCESSORY DRIVE BELT
10 - VISCOUS HEATER

OPERATION-ACCESSORY DRIVE BELT

The accessory drive belts form the link between the engine crankshaft and the engine driven accessories.

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. 5), 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. 5). 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.

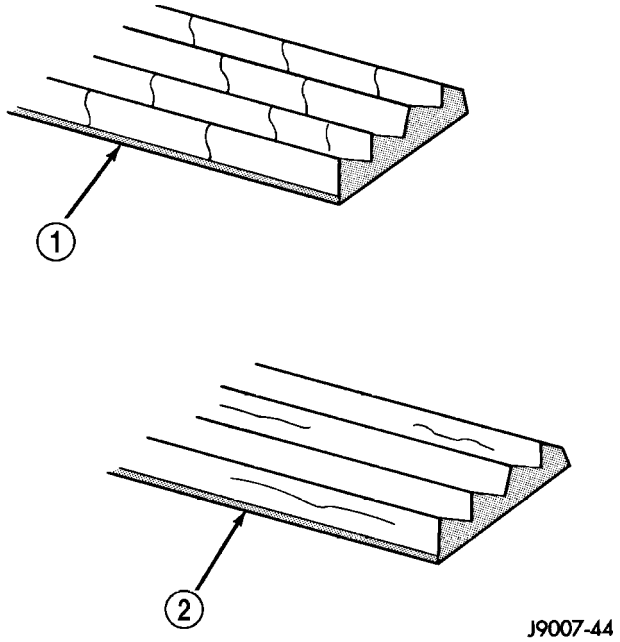

Fig. 5 BELT WEAR PATTERN

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

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 alignment, glazing, or excessive end play.

DRIVE BELT (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 BELT (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISE (Objectionable squeal, squeak, 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
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

NOTE: The belt routing schematics are published from the latest information available at the time of publication. If anything differs between these schematics and the Belt Routing Label, use the schematics on Belt Routing Label. This label is located in the engine compartment.

CAUTION: DO NOT LET TENSIONER ARM SNAP BACK TO THE FREEARM POSITION, SEVERE DAMAGE MAY OCCUR TO THE TENSIONER.

Belt tension is not adjustable. Belt adjustment is maintained by an automatic (spring loaded) belt tensioner.

(1) Disconnect negative battery cable.

(2) Rotate belt tensioner until it contacts its stop. Remove belt, then slowly rotate the tensioner into the freearm position.

INSTALLATION

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.

Belt tension is not adjustable. Belt adjustment is maintained by an automatic (spring load) belt tensioner.

(1) Check condition of all pulleys.

CAUTION: When installing the serpentine accessory drive belt, the belt MUST be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction.

DRIVE BELT (Continued)

(2) Install new belt. Route the belt around all pulleys except the idler pulley (Fig. 6). Rotate the tensioner arm until it contacts its stop position. Route the belt around the idler and slowly let the tensioner rotate into the belt. Make sure the belt is seated onto all pulleys (Fig. 6).

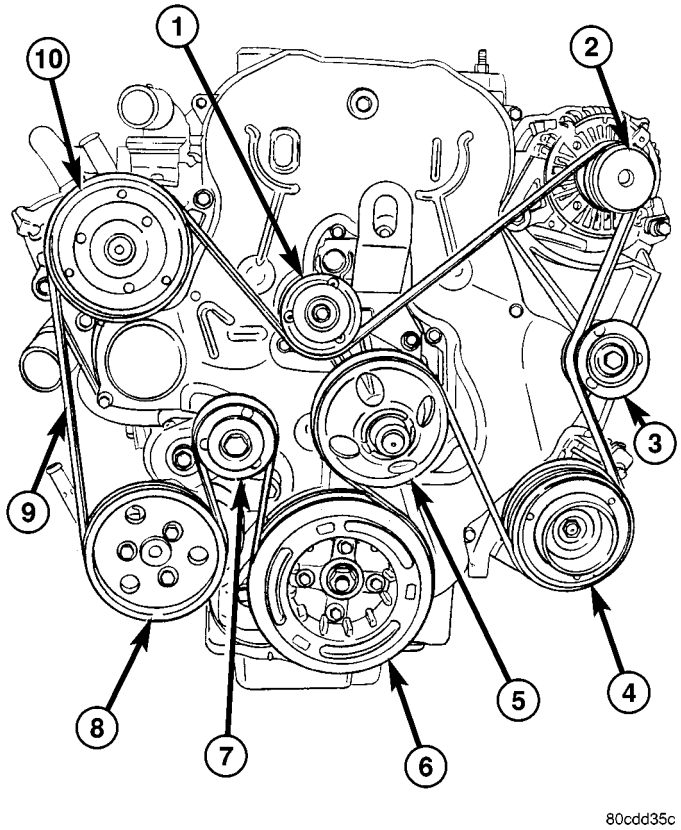

Fig. 6 ACCESSORY BELT ROUTING

1 - IDLER PULLEY
2 - GENERATOR
3 - IDLER PULLEY
4 - A/C COMPRESSOR
5 - COOLING FAN SUPPORT
6 - VIBRATION DAMPER
7 - BELT TENSIONER
8 - POWER STEERING PUMP
9 - ACCESSORY DRIVE BELT
10 - VISCOUS HEATER

IDLER PULLEYS

REMOVAL

CAUTION: The retaining bolts on the idler pulleys are left hand thread.

(1) Disconnect negative battery cable.
(2) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(3) Remove idler pulley retaining bolts and pulleys (Fig. 7) (Fig. 8).

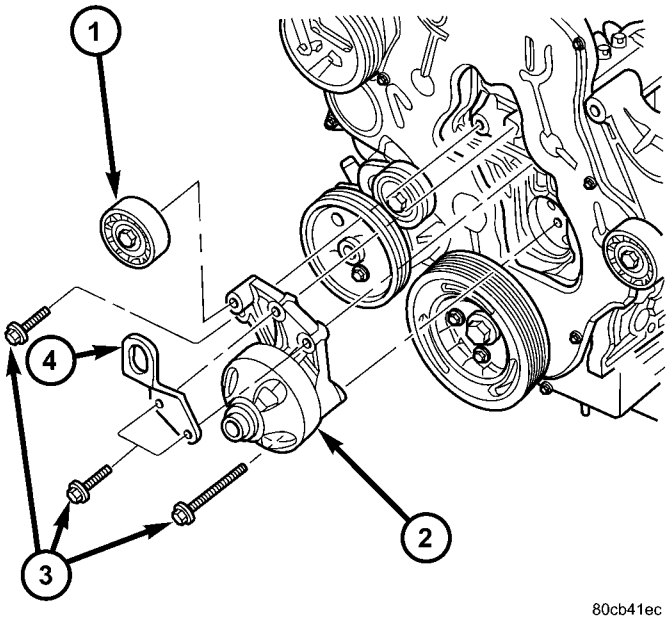

Fig. 7 COOLING FAN SUPPORT

1 - IDLER PULLEY
2 - COOLING FAN SUPPORT
3 - RETAINING BOLTS
4 - ENGINE LIFT HOOK

IDLER PULLEYS (Continued)

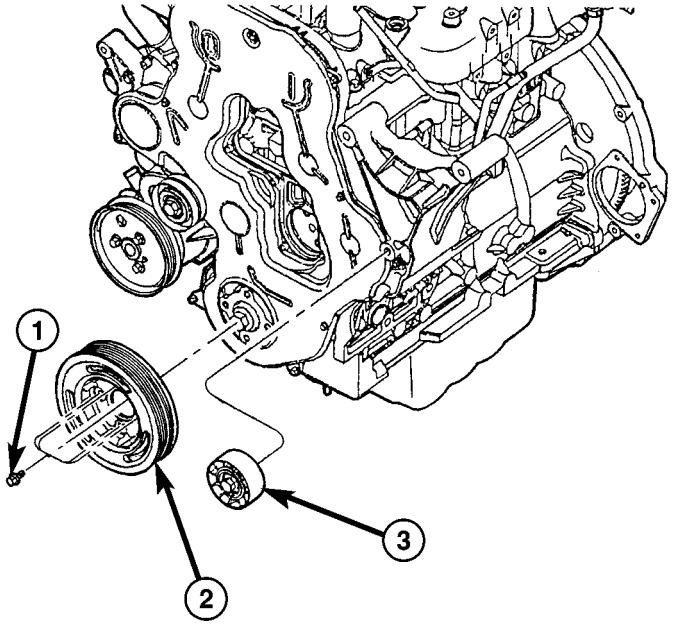

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Fig. 8 VIBRATION DAMPER AND IDLER PULLEY

1 - VIBRATION DAMPER/CRANKSHAFT PULLEY RETAINING BOLTS
2 - VIBRATION DAMPER/CRANKSHAFT PULLEY
3 - IDLER PULLEY

INSTALLATION

(1) Install idler pulleys and retaining bolts (Fig. 7) (Fig. 8). Torque bolts to 53N·m.

(2) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(3) Connect negative battery cable.

ENGINE

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COOLANT

STANDARD PROCEDURE

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 radiator 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 reserve/overflow tank. The coolant does not have to be removed from the tank unless the system is being refilled with a fresh mixture. Remove radiator cap and continue draining cooling system.

COOLANT (Continued)

STANDARD PROCEDURE - COOLING SYSTEM FILLING

Remove pressure/vent cap and fill system, using a 50/50 mix of Mopar® Antifreeze/Coolant, 5 Year/100,000 Mile Formula and distilled water.

Continue filling system until full. **Be careful not to spill coolant on drive belts or the generator.**

Fill coolant recovery pressure container to at least the MAX mark with 50/50 solution. It may be necessary to add coolant to the coolant recovery pressure container after three or four warm up/cool down cycles to maintain coolant level between the MAX and MIN mark. This will allow trapped air to be removed from the system.

STANDARD PROCEDURE - REFILLING COOLING SYSTEM

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

CAUTION: Failure to purge air from the cooling system can result in an overheating condition and severe engine damage.

(2) Fill system using a 50/50 mixture of ethyleneglycol antifreeze and low mineral content water, until coolant remains in the bottom of the coolant reserve/overflow. Install radiator cap.

(3) With heater control unit in the HEAT position, operate engine with radiator 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 reserve/overflow tank.

(5) Add coolant to reserve/overflow tank as necessary. **Only add coolant to the reserve/overflow tank when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.**

COOLANT RECOVERY PRESS CONTAINER

DESCRIPTION

This system works along with the radiator pressure cap. This is done by using thermal expansion and contraction of the coolant to keep the coolant free of trapped air. It provides:

- A volume for coolant expansion and contraction.
- A convenient and safe method for checking/adjusting coolant level at atmospheric pressure. This is done without removing the radiator pressure cap.
- Some reserve coolant to the radiator to cover minor leaks and evaporation or boiling losses.

As the engine cools, a vacuum is formed in the cooling system of both the radiator and engine. Coolant will then be drawn from the coolant tank and returned to a proper level in the radiator.

The coolant reservoir/overflow system has a radiator mounted pressurized cap, an overflow tube, and a plastic coolant reservoir/overflow tank, mounted to the right side of the cowl. It is mounted to the cowl with two nuts on top, and a slide bracket on the bottom.

OPERATION

The pressure chamber keeps the coolant free of trapped air, provides a volume for expansion and contraction, and provides a convenient and safe method for checking and adjusting coolant level at atmospheric pressure. It also provides some reserve coolant to cover minor leaks, evaporation or boiling losses. The overflow chamber allows coolant recovery in case of an overheat.

COOLING FAN

REMOVAL

REMOVAL - COOLING FAN

(1) (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL)

REMOVAL - COOLING FAN SUPPORT

(1) Disconnect negative battery cable.

(2) Remove fan drive viscous clutch and fan assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove cooling fan support from engine block (Fig. 1).

CLEANING

Clean the fan blades using a mild soap and water. Do not use an abrasive to clean the blades.

INSPECTION

WARNING: DO NOT ATTEMPT TO BEND OR STRAIGHTEN FAN BLADES IF FAN IS NOT WITHIN SPECIFICATIONS.

CAUTION: If fan blade assembly is replaced because of mechanical damage, water pump and fan drive viscous clutch should also be inspected. These components could have been damaged due to excessive vibration.

COOLING FAN (Continued)

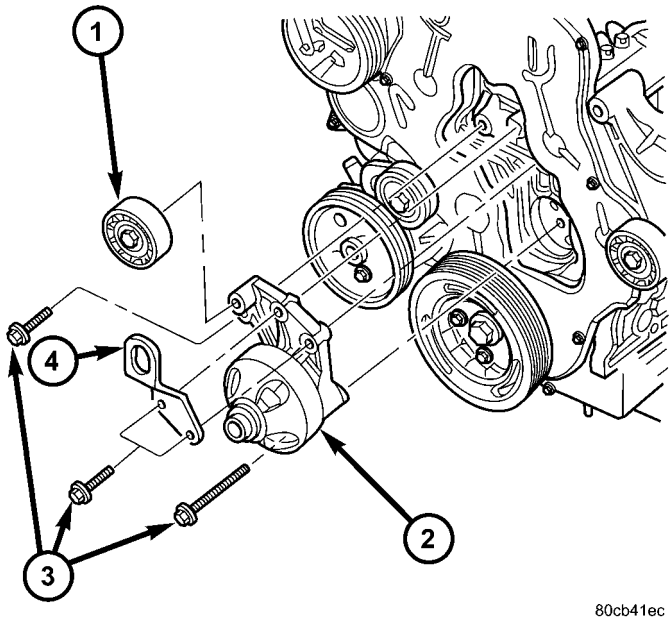

Fig. 1 COOLING FAN SUPPORT

1 - IDLER PULLEY
2 - COOLING FAN SUPPORT
3 - RETAINING BOLTS
4 - ENGINE LIFT HOOK

(1) Remove fan blade assembly from fan drive viscous clutch (four bolts).

(2) Lay fan on a flat surface with leading edge facing down. With tip of blade touching flat surface, replace fan if clearance between opposite blade and surface is greater than 2.0 mm (.090 inch). Rocking motion of opposite blades should not exceed 2.0 mm (.090 inch). Test all blades in this manner.

(3) Inspect fan assembly for cracks, bends, loose rivets or broken welds. Replace fan if any damage is found.

INSTALLATION

INSTALLATION - COOLING FAN

(1) (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION)

INSTALLATION - COOLING FAN SUPPORT

(1) Install cooling fan support to engine block (Fig. 1). Torque bolts to 47.1N·m.

(2) Install fan drive viscous clutch and fan assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(3) Connect negative battery cable.

COOLANT SYSTEM HOSES

REMOVAL

REMOVAL - UPPER RADIATOR HOSE

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

(2) Disconnect upper radiator hose from thermostat housing (Fig. 2).

(3) Disconnect upper radiator hose from radiator and remove from vehicle (Fig. 2).

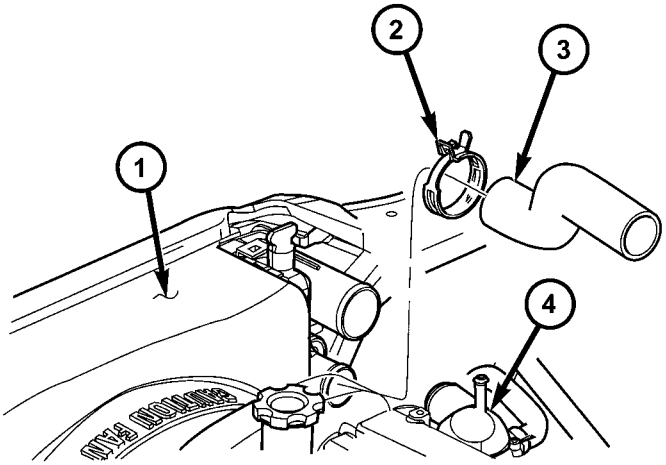

Fig. 2 UPPER RADIATOR HOSE

1 - FAN SHROUD
2 - HOSE CLAMP
3 - UPPER RADIATOR HOSE
4 - THERMOSTAT HOUSING

REMOVAL - HEATER CORE HOSES

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

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

(3) Disconnect heater core supply line at heater core and viscous heater (Fig. 3). Remove hose from vehicle.

(4) Disconnect heater core return line from heater core and EGR cooler (Fig. 3). Remove hose from vehicle.

COOLANT SYSTEM HOSES (Continued)

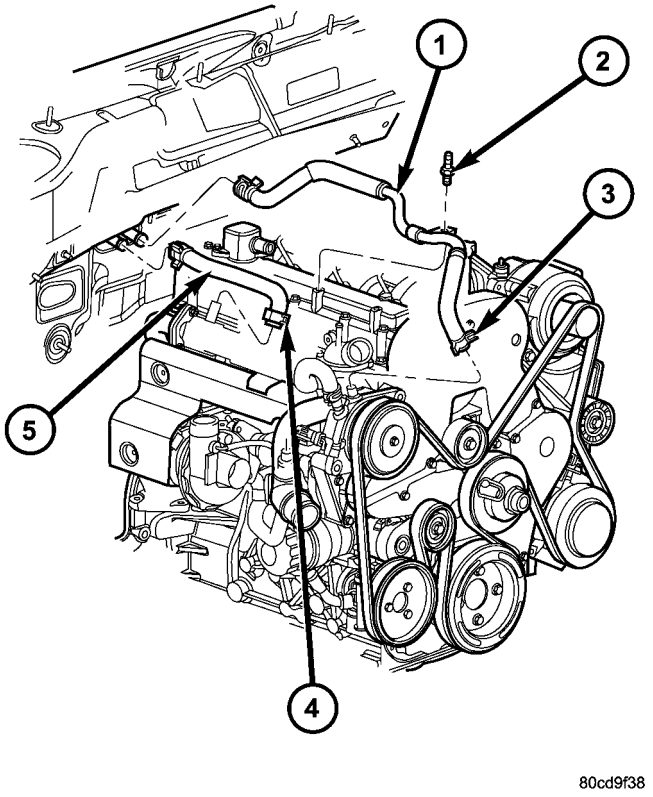

Fig. 3 HEATER CORE COOLANT HOSES

1 - HEATER CORE TO VISCOUS HEATER HOSE
2 - MOUNTING STUD
3 - HOSE CLAMP
4 - HOSE CLAMP
5 - HEATER CORE TO EGR COOLER HOSE

INSTALLATION

INSTALLATION - UPPER RADIATOR HOSE

(1) Install upper radiator hose on radiator and thermostat housing (Fig. 2).

(2) Reposition hose clamps in proper position.

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

INSTALLATION – HEATER CORE HOSES

(1) Connect heater core supply hose to heater core and viscous heater. Position hose clamps into proper position.

(2) Connect heater core return hose to heater core and EGR cooler. Position hose clamps into proper position.

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

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

ENGINE COOLANT TEMP SENSOR

DESCRIPTION

The engine coolant temperature sensor threads into a coolant passage in the cylinder head (Fig. 4). New sensors have sealant applied to the threads.

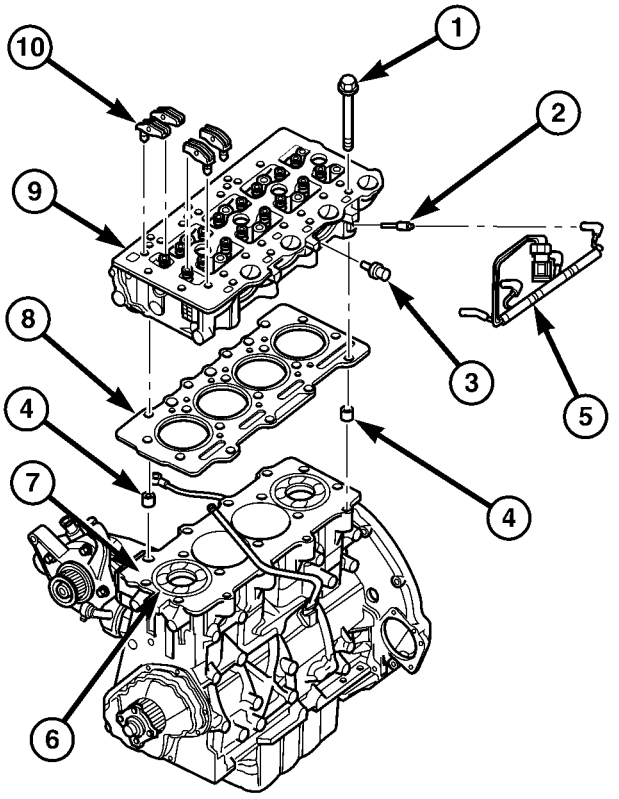

Fig. 4 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

OPERATION

The coolant temperature (ECT) sensor is a negative temperature coefficient (NTC) thermistor (resistance varies inversley with temperature). This means at cold tempertures its resistance is high so the voltage signal will be high. As coolant temperture increases, resistance decreases and the signal voltage will be low. This allows the sensor to provide an analog voltage signal to the ECM.

ENGINE COOLANT TEMP SENSOR (Continued)

REMOVAL

WARNING: DO NOT REMOVE OR LOOSEN THE COOLANT PRESSURE/VENT CAP, CYLINDER BLOCK DRAIN PLUGS, OR THE DRAINCOCK WHEN THE SYSTEM IS HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM THE COOLANT CAN OCCUR.

(1) Disconnect negative battery cable.
(2) Drain the cooling system. (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE)
(3) Disconnect coolant temperature sensor electrical connector (Fig. 5).
(4) Remove coolant temperature sensor from cylinder head (Fig. 5).

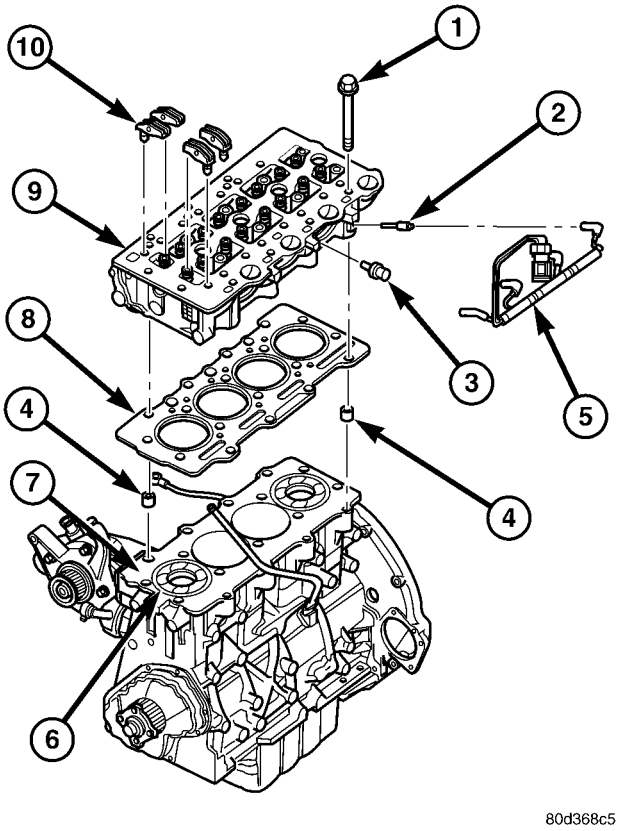

Fig. 5 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

INSTALLATION

(1) Install coolant temperature sensor in cylinder head (Fig. 5).
(2) Connect coolant temperature sensor electrical connector (Fig. 5).
(3) Refill cooling system. (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE)
(4) Connect negative battery cable.

ENGINE COOLANT THERMOSTAT

DESCRIPTION

A pellet-type thermostat controls the operating temperature of the engine by controlling the amount of coolant flow to the radiator (Fig. 6).

OPERATION

The thermostat starts to open at 80°C (176°F). Above this temperature, coolant is allowed to flow to the radiator. This provides quicker engine warmup and overall temperature control.

The same thermostat is used for winter and summer seasons. An engine should not be operated without a thermostat, except for servicing or testing. Operating without a thermostat causes other problems. These are: longer engine warmup time, unreliable warmup performance, increased exhaust emissions and crankcase condensation. This condensation can result in sludge formation.

REMOVAL

NOTE: The thermostat is not serviced separately. The thermostat and housing must be replaced as an assembly.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(3) Partially drain cooling system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Disconnect upper radiator hose and bypass hoses at thermostat housing.
(5) Remove thermostat housing retaining bolts, support bracket (2.8L) and housing from cylinder head, discard gasket (Fig. 7).

ENGINE COOLANT THERMOSTAT (Continued)

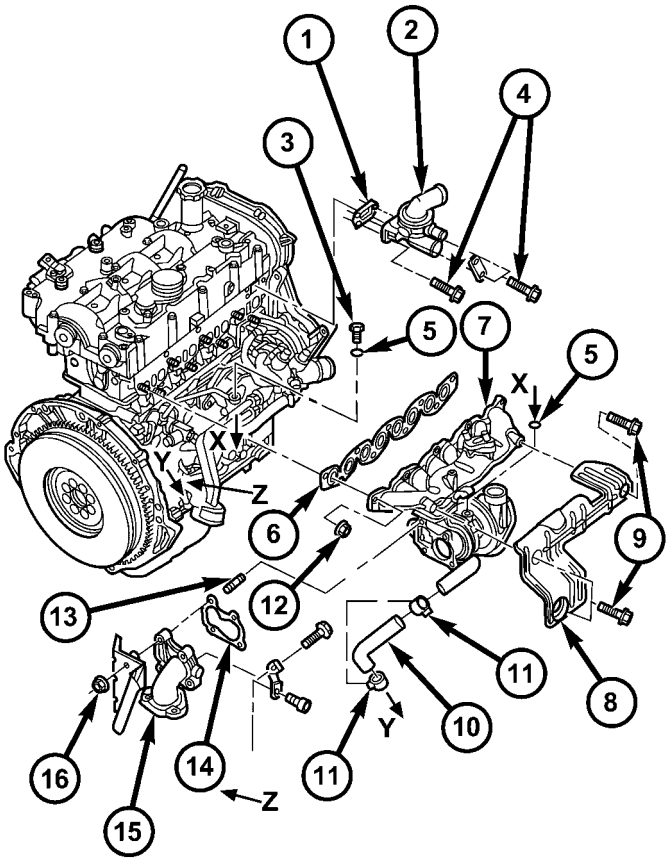

Fig. 6 THERMOSTAT HOUSING

1 - THERMOSTAT HOUSING GASKET
2 - THERMOSTAT HOUSING
3 - TURBOCHARGER OIL SUPPLY LINE BANJO BOLT
4 - THERMOSTAT HOUSING RETAINING BOLTS
5 - BRASS WASHER
6 - EXHAUST MANIFOLD GASKET
7 - EXHAUST MANIFOLD
8 - EXHAUST MANIFOLD HEATSHIELD
9 - EXHAUST MANIFOLD HEATSHIELD RETAINING BOLTS
10 - OIL RETURN HOSE
11 - HOSE CLAMPS
12 - EXHAUST MANIFOLD RETAINING NUTS
13 - TURBOCHARGER DOWNPIPE STUDS
14 - TURBOCHARGER DOWN PIPE GASKET
15 - TURBOCHARGER DOWNPIPE
16 - TURBOCHARGER DOWNPIPE RETAINING NUT

INSTALLATION

(1) Clean old gasket material from cylinder head and thermostat housing.

(2) Install thermostat housing with gasket and support bracket (2.8L) to cylinder head (Fig. 7). Torque bolts to 27.5N·m.

(3) Connect coolant bypass hose and upper radiator hose to thermostat housing.

(4) Refill cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

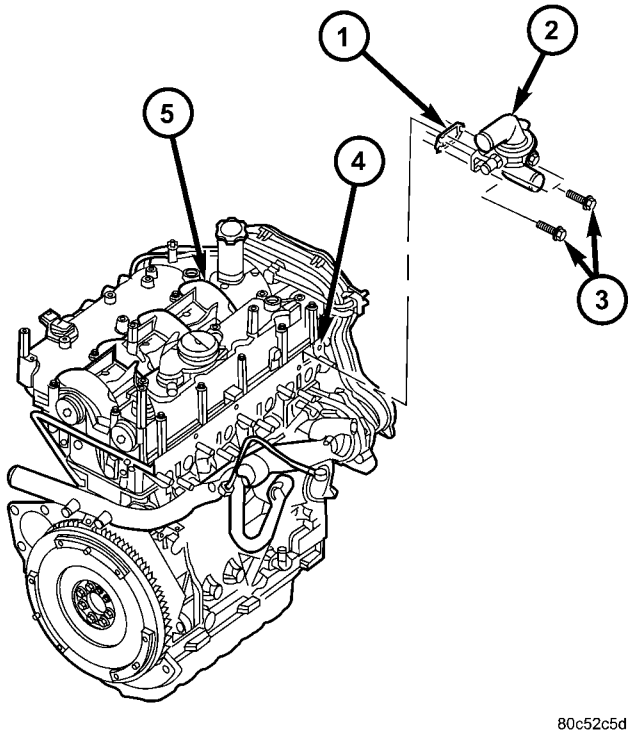

Fig. 7 THERMOSTAT HOUSING ASSEMBLY

1 - THERMOSTAT HOUSING GASKET
2 - THERMOSTAT HOUSING
3 - RETAINING BOLTS
4 - CYLINDER HEAD
5 - CYLINDER HEAD COVER/INTAKE MANIFOLD

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

(6) Connect negative battery cable.

FAN DRIVE VISCOUS CLUTCH

DESCRIPTION

CAUTION: If the viscous fan drive is replaced because of mechanical damage, the cooling fan blades should also be inspected. Inspect for fatigue cracks, loose blades, or loose rivets that could have resulted from excessive vibration. Replace fan blade assembly if any of these conditions are found. Also inspect water pump bearing and shaft assembly for any related damage due to a viscous fan drive malfunction.

The thermal viscous fan drive (Fig. 8) is a silicone-fluid-filled coupling used to connect the fan blades to the fan support bracket assembly. The coupling allows the fan to be driven in a normal manner. This is done at low engine speeds while limiting the top speed of the fan to a predetermined maximum level at higher engine speeds.

FAN DRIVE VISCOUS CLUTCH (Continued)

On the 2.5L Diesel engine, a viscous fan is standard.

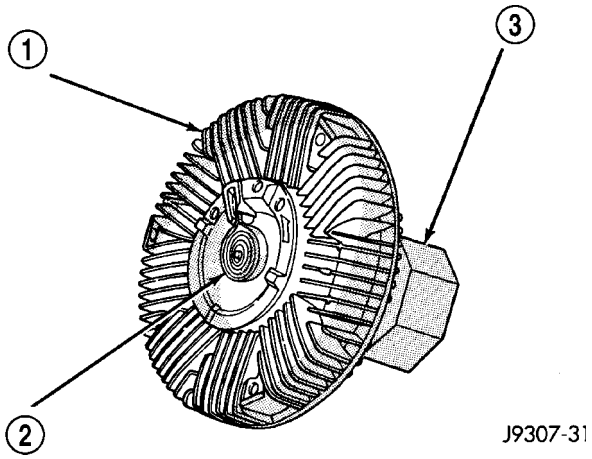

Fig. 8 Viscous Fan Drive - Typical

1 - VISCOUS FAN DRIVE
2 - THERMOSTATIC SPRING
3 - MOUNTING NUT TO WATER PUMP HUB

OPERATION

A thermostatic bimetallic spring coil is located on the front face of the viscous fan drive unit. This spring coil reacts to the temperature of the radiator discharge air. It engages the viscous fan drive for higher fan speed if the air temperature from the radiator rises above a certain point. Until additional engine cooling is necessary, **the fan will remain at a reduced rpm regardless of engine speed. Normally less than three hundred (300) rpm.**

Only when sufficient heat is present, will the viscous fan drive engage. This is when the air flowing through the radiator core causes a reaction to the bimetallic coil. It then increases fan speed to provide the necessary additional engine cooling.

Once the engine has cooled, the radiator discharge temperature will drop. The bimetallic coil again reacts and the fan speed is reduced to the previous disengaged speed.

DIAGNOSIS AND TESTING - FAN DRIVE VISCOUS CLUTCH

If the fan assembly free-wheels without drag (the fan blades will revolve more than five turns when spun by hand), replace the fan drive. This spin test must be performed when the engine is cool.

For the following test, the cooling system must be in good condition. It also will ensure against excessively high coolant temperature.

WARNING: BE SURE THAT THERE IS ADEQUATE FAN BLADE CLEARANCE BEFORE DRILLING.

(1) Drill a 3.18-mm (1/8-in) diameter hole in the top center of the fan shroud.

(2) Obtain a dial thermometer with an 8 inch stem (or equivalent). It should have a range of -18° to 105°C (0° to 220° F). Insert thermometer through the hole in the shroud. Be sure that there is adequate clearance from the fan blades.

(3) Connect a tachometer and an engine ignition timing light (timing light is to be used as a strobe light).

(4) Block the air flow through the radiator. Secure a sheet of plastic in front of the radiator (or air conditioner condenser). Use tape at the top to secure the plastic and be sure that the air flow is blocked.

(5) Be sure that the air conditioner (if equipped) is turned off.

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

(6) Start the engine and operate at 2400 rpm. Within ten minutes the air temperature (indicated on the dial thermometer) should be up to 93° C (200° F). Fan drive **engagement** should have started to occur at between 91° to 96° C (195° to 205° F). Engagement is distinguishable by a definite **increase** in fan flow noise (roaring). The timing light also will indicate an increase in the speed of the fan.

(7) When the air temperature reaches 93° C (200° F), remove the plastic sheet. Fan drive **disengagement** should have started to occur at between 62° to 85° C (145° to 185° F). A definite **decrease** of fan flow noise (roaring) should be noticed. If not, replace the defective viscous fan drive unit.

REMOVAL

(1) Disconnect negative battery cable.

NOTE: The thermal viscous fan drive/fan blade assembly is attached (threaded) to fan support.

(2) Remove fan blade/viscous fan drive assembly from water pump using special tool 6958 spanner wrench, by turning mounting nut counterclockwise as viewed from front (Fig. 9) (Fig. 10). Threads on viscous fan drive are **RIGHT HAND.**

(3) Do not attempt to remove fan/fan drive viscous clutch assembly from vehicle at this time.

(4) Do not unbolt fan blade assembly from fan drive viscous clutch at this time.

(5) Remove fan shroud to radiator bolts.

(6) Remove fan shroud and fan blade/fan drive viscous clutch assembly as a complete unit from vehicle.

FAN DRIVE VISCOUS CLUTCH (Continued)

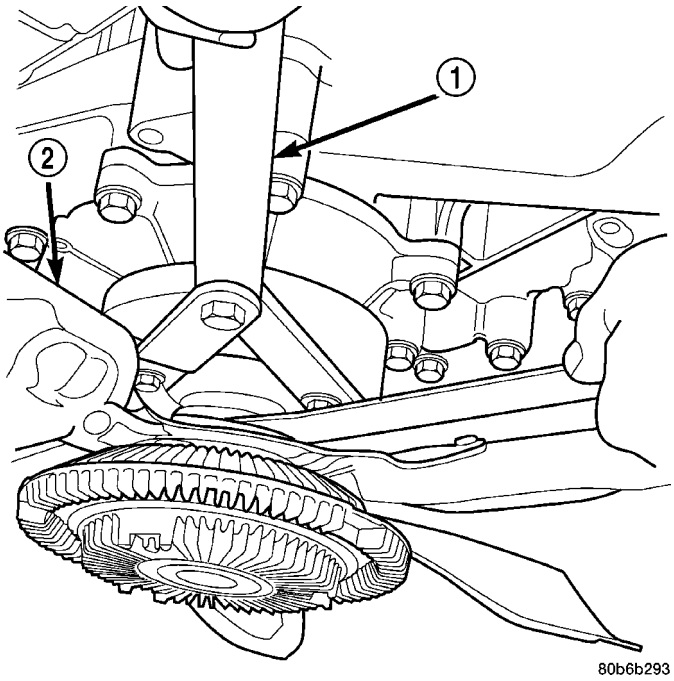

Fig. 9 FAN DRIVE VISCOUS CLUTCH - TYPICAL

1 - SPECIAL TOOL 6958 SPANNER WRENCH
2 - FAN

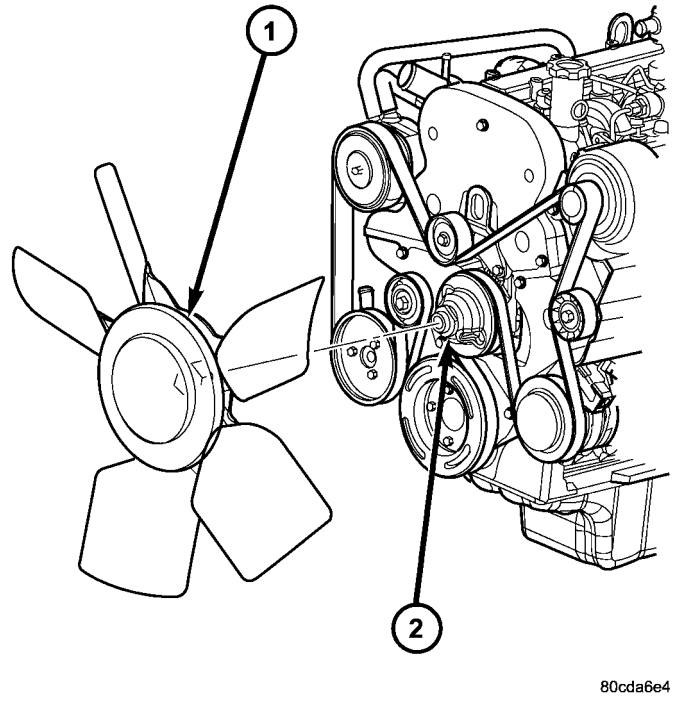

Fig. 10 COOLING FAN AND VISCOUS CLUTCH

1 - COOLING FAN AND FAN DRIVE VISCOUS CLUTCH ASSEMBLY
2 - FAN SUPPORT

(7) After removing fan blade/fan drive viscous clutch assembly, **do not** place viscous clutch in horizontal position. If stored horizontally, silicone fluid in the fan drive viscous clutch could drain into its bearing assembly and contaminate lubricant.

(8) Remove four bolts securing fan blade assembly to fan drive viscous clutch.

INSTALLATION

(1) Assemble fan blade to viscous fan drive. Tighten mounting bolts to 27 N·m (20 ft. lbs.) torque.

NOTE: The viscous fan and fan shroud must be installed as an assembly.

(2) Gently lay fan and viscous drive into fan shroud.

(3) Install the fan shroud to radiator mounting bolt. Torque bolts to 5.5N·m.

(4) Thread the fan and viscous drive onto the fan support and tighten nut using special tool 6958 spanner wrench.

(5) Connect negative battery cable.

RADIATOR

REMOVAL

(1) Disconnect negative battery cable.

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

(3) Remove engine oil fill cap.

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

(5) Remove air filter assembly from the engine bay.

(6) Recover and evacuate the refrigerant system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE) and (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(7) Disconnect high side refrigerant line from the upper radiator support bracket.

(8) Remove upper radiator support bracket retaining bolts and remove the support bracket.

(9) Remove high side refrigerant line retaining nut and remove the line from the condenser assembly. Position the line out of the way.

(10) Unbolt cooling fan from cooling fan support.

(11) Remove fan shroud retaining bolts and remove the fan and shroud as an assembly.

(12) Disconnect charge air cooler hoses from the charge air cooler.

(13) Disconnect engine coolant hoses from the radiator.

(14) Disconnect coolant reservoir hose from the radiator.

RADIATOR (Continued)

(15) Remove low side refrigerant line retaining nut and remove the line from the condenser assembly. Position the line out of the way.

(16) Remove condenser assembly retaining bolts and remove the condenser from the vehicle.

(17) Remove power steering cooler retaining bolts and unclip the air deflectors from both sides of the radiator (cooling module) assembly.

(18) Lift cooling module assembly out of the engine bay.

(19) Remove radiator retaining bolts and remove the cooling system module from vehicle.

(20) Separate charge air cooler from radiator.

INSTALLATION

(1) Install radiator on the charge air cooler and install retaining bolts.

(2) Install radiator (cooling module) assembly in the engine bay.

(3) Install power steering cooler retaining bolts and clip the air deflectors on both sides of the radiator (cooling module) assembly.

(4) Install condenser assembly and retaining bolts.

(5) Install low side refrigerant line and retaining nut.

(6) Connect coolant reservoir hose on the radiator.

(7) Connect engine coolant hoses on the radiator.

(8) Connect charge air cooler hoses on the charge air cooler.

(9) Install fan and fan shroud assembly and retaining bolts.

(10) Install cooling fan assembly to cooling fan support.

(11) Install high side refrigerant line and retaining nut.

(12) Install upper radiator support bracket and retaining bolts.

(13) Connect high side refrigerant line on the upper radiator support bracket.

(14) Evacuate and re-charge the refrigerant system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(15) Install air filter assembly in the engine bay.

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

(17) refill cooling system (Refer to 7 - COOLING/ ENGINE - STANDARD PROCEDURE).

(18) Connect negative battery cable.

WATER PUMP

DESCRIPTION

The water pump on the 2.5L/2.8L CRD diesel has a die cast aluminum housing. It bolts to a aluminum housing which attaches to the engine block.

OPERATION

The water pump is used to circulate coolant through the cooling system. The coolant is pumped through the engine block, cylinder head, heater core, EGR cooler, viscous heater, and radiator.

REMOVAL - WATER PUMP

(1) Disconnect negative battery cable.

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

(3) Remove timing belt inner and outer covers (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(4) Remove water pump retaining bolts and pump (Fig. 11).

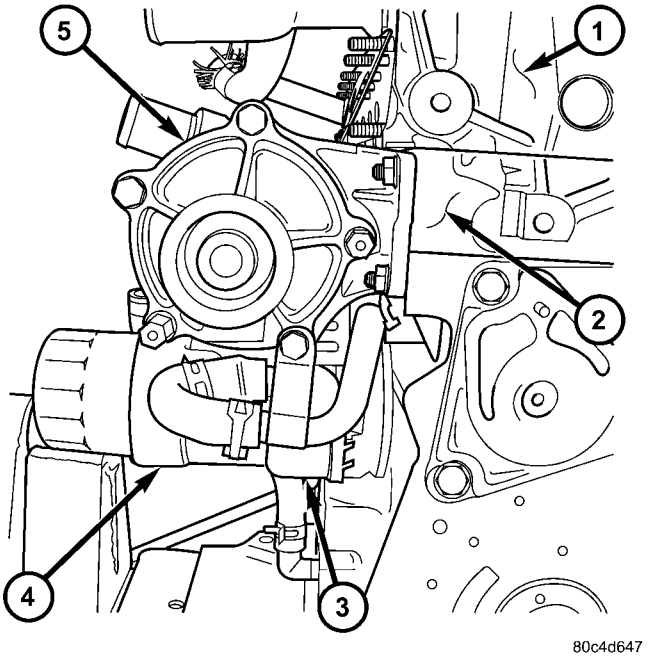

Fig. 11 WATER PUMP LOCATION

1 - CYLINDER HEAD
2 - ENGINE BLOCK
3 - OIL COOLER
4 - OIL FILTER HOUSING
5 - WATER PUMP

CLEANING

Clean gasket mating surfaces as necessary.

WATER PUMP (Continued)

INSTALLATION

(1) Clean mating surfaces of water pump housing and engine block as necessary.

(2) Place new o-ring in groove in water pump housing. Install water pump and retaining bolts. Torque bolts to 24.4N·m.

(3) Install both inner and outer timing belt covers (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(4) Refill cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

(5) Connect negative battery cable.

RADIATOR PRESSURE CAP

DESCRIPTION

The cooling system pressure cap is located on the coolant recovery pressure container. The cap construction includes; stainless steel swivel top, rubber seals, and retainer, main spring, and a spring loaded valve (Fig. 12).

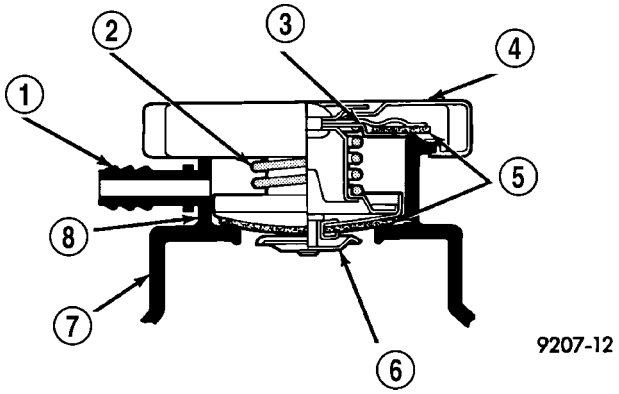

Fig. 12 Cooling System Pressure Cap Filler Neck

1 - OVERFLOW NIPPLE
2 - MAIN SPRING
3 - GASKET RETAINER
4 - STAINLESS-STEEL SWIVEL TOP
5 - RUBBER SEALS
6 - VENT VALVE
7 - PRESSURE BOTTLE
8 - FILLER NECK

OPERATION

The cooling system is equipped with a pressure cap that releases excessive pressure; maintaining a range of 97-124 kPa (14-18 psi).

The cooling system will operate at higher than atmospheric pressure. The higher pressure raises the coolant boiling point thus, allowing increased radiator cooling capacity.

There is also a vent valve in the center of the cap. This valve also opens when coolant is cooling and contracting, allowing the coolant to return to cooling system from coolant reserve system tank by vacuum through a connecting hose. **If valve is stuck shut, or the coolant recovery hose is pinched, the radiator hoses will be collapsed on cool down. Clean the vent valve (Fig. 12) and inspect coolant recovery hose routing, to ensure proper sealing when boiling point is reached.**

The gasket in the cap seals the filler neck, so that vacuum can be maintained, allowing coolant to be drawn back into the radiator from the reserve tank. **If the gasket is dirty or damaged, a vacuum may not be achieved, resulting is loss of coolant and eventual overheating due to low coolant level in radiator and engine.**

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - COOLING SYSTEM PRESSURE CAP

Dip the pressure cap in water. Clean any deposits off the vent valve or its seat and apply cap to end of the Pressure Cap Test Adaptor that is included with the Cooling System Tester 7700. Working the plunger, bring the pressure to 104 kPa (15 psi) on the gauge. If the pressure cap fails to hold pressure of at least 97 kPa (14 psi), replace the pressure cap.

CAUTION: The Cooling System Tester Tool is very sensitive to small air leaks that 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 the tool. Turn tool upside down and recheck pressure cap to confirm that cap is bad.

If the pressure cap tests properly while positioned on Cooling System Tester (Fig. 13), but will not hold pressure or vacuum when positioned on the filler neck. Inspect the filler neck and cap top gasket for irregularities that may prevent the cap from sealing properly.

DIAGNOSIS AND TESTING - PRESSURE RELIEF TEST

The pressure cap upper gasket (seal) pressure relief can be checked by removing the overflow hose at the radiator filler neck nipple (Fig. 14). Attach the Radiator Pressure Tool to the filler neck nipple and pump air into the radiator. Pressure cap upper gasket should relieve at 69-124 kPa (10-18 psi) and hold pressure at 55 kPa (8 psi) minimum.

RADIATOR PRESSURE CAP (Continued)

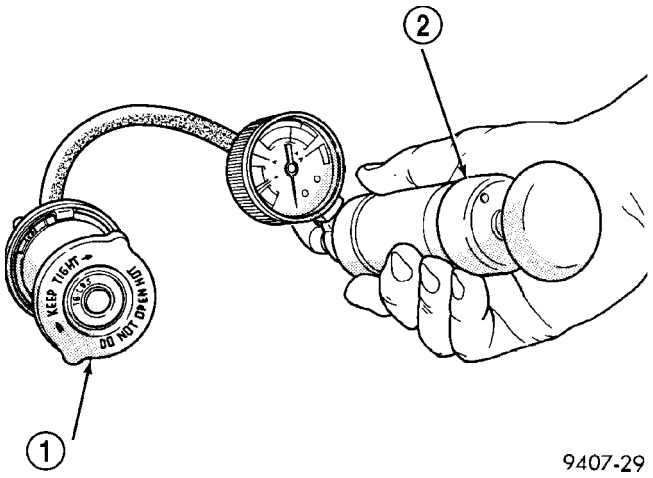

Fig. 13 Testing Cooling System Pressure Cap

1 - PRESSURE CAP
2 - PRESSURE TESTER

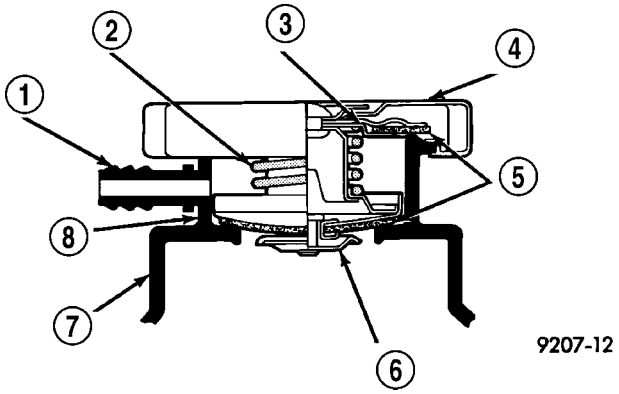

Fig. 14 Radiator Pressure Cap Filler Neck

1 - OVERFLOW NIPPLE
2 - MAIN SPRING
3 - GASKET RETAINER
4 - STAINLESS-STEEL SWIVEL TOP
5 - RUBBER SEALS
6 - VENT VALVE
7 - PRESSURE BOTTLE
8 - FILLER NECK

WARNING: THE WARNING WORDS "DO NOT OPEN HOT" ON THE RADIATOR PRESSURE CAP IS A SAFETY PRECAUTION. WHEN HOT, PRESSURE BUILDS UP IN COOLING SYSTEM. TO PREVENT SCALDING OR INJURY, THE RADIATOR CAP SHOULD NOT BE REMOVED WHILE THE SYSTEM IS HOT OR UNDER PRESSURE.

There is no need to remove the radiator cap at any time **except** for the following purposes:

(1) Check and adjust coolant freeze point.
(2) Refill system with new coolant.
(3) Conducting service procedures.
(4) Checking for vacuum leaks.

WARNING: IF VEHICLE HAS BEEN RUN RECENTLY, WAIT 15 MINUTES BEFORE REMOVING CAP. THEN PLACE A SHOP TOWEL OVER THE CAP AND WITHOUT PUSHING DOWN ROTATE COUNTERCLOCKWISE TO THE FIRST STOP. ALLOW FLUIDS TO ESCAPE THROUGH THE OVERFLOW TUBE AND WHEN THE SYSTEM STOPS PUSHING COOLANT AND STEAM INTO THE CRS TANK AND PRESSURE DROPS PUSH DOWN AND REMOVE THE CAP COMPLETELY. SQUEEZING THE RADIATOR INLET HOSE WITH A SHOP TOWEL (TO CHECK PRESSURE) BEFORE AND AFTER TURNING TO THE FIRST STOP IS RECOMMENDED.

CLEANING

Use only a mild soap to clean the pressure cap.

INSPECTION

Hold the cap in your hand, **top side up** (Fig. 14). The vent valve at the bottom of the cap should open. If the rubber gasket has swollen, preventing the valve from opening, replace the cap.

Hold the cleaned cap in your hand, **upside down.** If any light can be seen between vent valve and the rubber gasket, replace the cap. **Do not use a replacement cap that has a spring to hold the vent shut.**

A replacement cap must be of the type designed for coolant reserve systems. This design ensures coolant return to the radiator.

HOSE CLAMPS

DESCRIPTION - HOSE CLAMPS

The cooling system utilizes spring type hose clamps. If a spring type clamp replacement is necessary, replace with the original Mopar® equipment spring type clamp.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094) (Fig. 15). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

HOSE CLAMPS (Continued)

CAUTION: A number or letter is stamped into the tongue of constant tension clamps. If replacement is necessary, use only a original equipment clamp with matching number or letter (Fig. 15).

OPERATION - HOSE CLAMPS

The spring type hose clamp applies constant tension on a hose connection. To remove a spring type hose clamp, only use constant tension clamp pliers designed to compress the hose clamp.

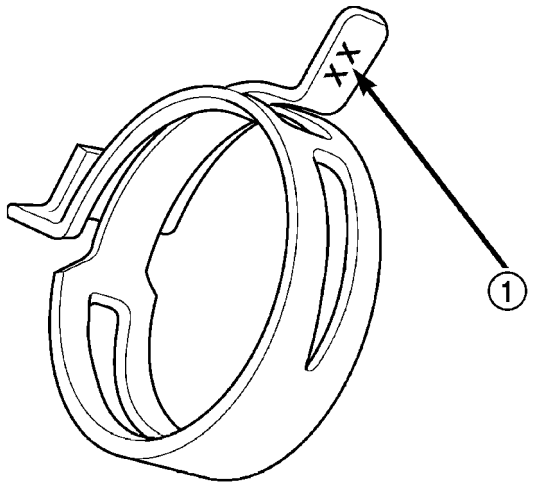

Fig. 15 Spring Clamp Size Location

1 - SPRING CLAMP SIZE LOCATION

ELECTRONIC CONTROL MODULES

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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).

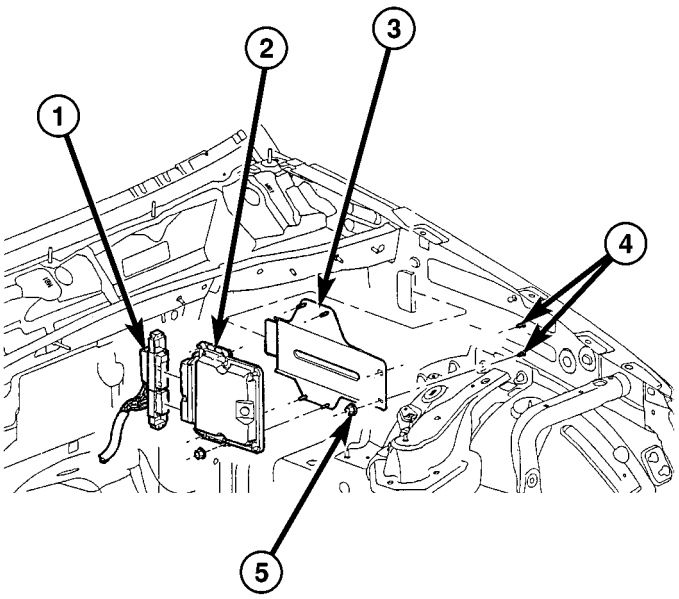

Fig. 1 ENGINE CONTROL MODULE (ECM) REMOVAL/INSTALL

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.

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

ENGINE CONTROL MODULE (Continued)

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, loose fitting 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.

STANDARD PROCEDURE - PCM/ECM/SKIM PROGRAMMING - DIESEL

NOTE: Before replacing the PCM/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 PCM/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.

ENGINE CONTROL MODULE (Continued)

PCM/SKIM PROGRAMMING

When a PCM (JTEC) and the SKIM are replaced at the same time perform the following steps in order:

(1) Program the new PCM (JTEC)
(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 PCM (JTEC)

The SKIS Secret Key is an ID code that is unique to each SKIM. This code is programmed and stored in the SKIM, PCM and transponder chip (ignition keys). When replacing the PCM it is necessary to program the secret key into the new PCM using the DRB III®. Perform the following steps to program the secret key into the PCM.

(1) Turn the ignition switch on (transmission in park/neutral).
(2) Use the DRB III® and select THEFT ALARM, SKIM then MISCELLANEOUS.
(3) Select PCM REPLACED (GAS ENGINE).
(4) Enter secured access mode by entering the vehicle four-digit PIN.
(5) Select ENTER to update PCM VIN.

NOTE: If three attempts are made to enter secure access mode using an incorrect PIN, secured access mode will be locked out for one hour. To exit this lockout mode, turn the ignition to the RUN position for one hour then enter the correct PIN. (Ensure all accessories are turned off. Also monitor the battery state and connect a battery charger if necessary).

(6) Press ENTER to transfer the secret key (the SKIM will send the secret key to the PCM).
(7) Press Page Back to get to the Select System menu and select ENGINE, JTEC (diesel only), MISCELLANEOUS, and SRI MEMORY CHECK.
(8) The DRB III® will ask, Is odometer reading between XX and XX? Select the YES or NO button on the DRB III®. If NO is selected, the DRB III® will read, Enter odometer Reading<From I.P. odometer>. Enter the odometer reading from the Instrument Panel and press ENTER.

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 PCM REPLACED (GAS 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 PCM 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.

ENGINE CONTROL MODULE (Continued)

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.

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.

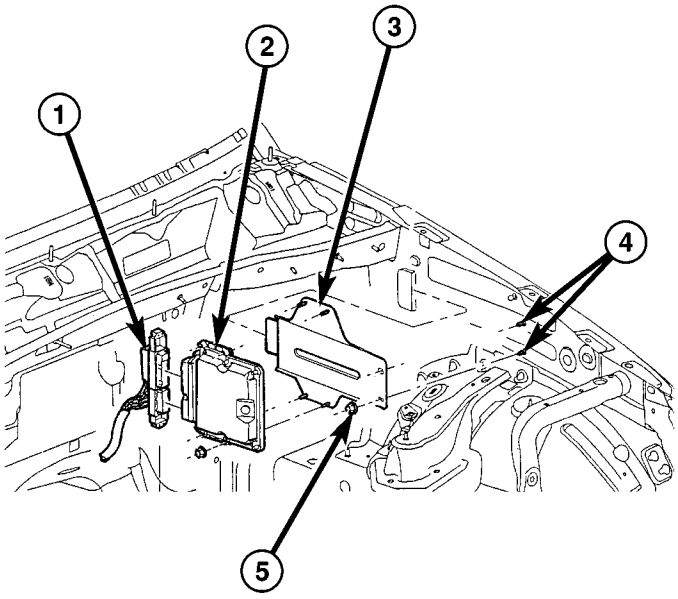

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Fig. 2 ENGINE CONTROL MODULE (ECM) REMOVAL/INSTALL

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

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BATTERY

DESCRIPTION

Vehicles equipped with a diesel engine utilize a spiral wound plate designed battery with recombination technology. This is a maintenance-free battery that is capable of delivering more power than a conventional battery. This additional power is required by a diesel engine during cold cranking.

Spiral plate technology takes the elements of traditional batteries - lead and sulfuric acid - to the next level. By tightly winding layers of spiral grids and acid-permeated vitreous separators into cells, the manufacturer has developed a battery with more power and service life than conventional batteries the same size. The spiral plate battery is completely, permanently sealed. Through gas recombination, hydrogen and oxygen within the battery are captured during normal charging and reunited to form the water within the electrolyte, eliminating the need to add distilled water. Therefore, these batteries have non-removable battery vent caps. Water **cannot** be added to this battery.

The acid inside an spiral plate battery is bound within the vitreous separators, ending the threat of acid leaks. This feature allows the battery to be installed in any position anywhere in the vehicle.

Spiral plate technology is the process by which the plates holding the active material in the battery are wound tightly in coils instead of hanging flat, like conventional batteries. This design has a lower internal resistance and also increases the active material surface area.

WARNING: NEVER EXCEED 14.4 VOLTS WHEN CHARGING A SPIRAL PLATE BATTERY. PERSONAL INJURY AND/OR BATTERY DAMAGE MAY RESULT.

Due to the maintanance-free design, distilled water cannot be added to this battery. Therefore, if more than 14.4 volts are used during the spiral plate battery charging process, water vapor can be exhausted through the pressure-sensitive battery vents and lost for good. This can permanently damage the spiral plate battery. Never exceed 14.4 volts when charging a spiral plate battery. Personal injury and/or battery damage may result.

Batteries are used to store electrical energy potential in a chemical form. When an electrical load is applied to the battery terminals, an electrochemical reaction occurs within the battery. This reaction causes the battery to discharge electrical current.

OPERATION

The battery is designed to store electrical energy in a chemical form. When an electrical load is applied to the terminals of the battery, an electrochemical reaction occurs. This reaction causes the battery to discharge electrical current from its terminals. As the battery discharges, a gradual chemical change takes place within each cell. The chemical changes within the battery are caused by the movement of excess or free electrons between the positive and negative plate groups. This movement of electrons produces a flow of electrical current through the load device attached to the battery terminals.

The battery is vented to release excess hydrogen gas that is created when the battery is being charged or discharged. However, even with these vents, hydrogen gas can collect in or around the battery. If hydrogen gas is exposed to flame or sparks, it may ignite. If the battery is equipped with removable cell caps, add distilled water whenever the electrolyte level is below the top of the plates. If the battery cell caps cannot be removed, the battery must be replaced if the electrolyte level becomes low.

BATTERY (Continued)

DIAGNOSIS AND TESTING - BATTERY

The battery must be completely charged and the terminals should be properly cleaned and inspected before diagnostic procedures are performed. Refer to Battery System Cleaning for the proper cleaning procedures, and Battery System Inspection for the proper battery inspection procedures. Refer to Standard Procedures for the proper battery charging procedures.

MICRO 420 BATTERY TESTER

The Micro 420 automotive battery tester is designed to help the dealership technicians diagnose the cause of a defective battery. Follow the instruction manual supplied with the tester to properly diagnose a vehicle. If the instruction manual is not available refer to the standard procedure in this section, which includes the directions for using the Micro 420 battery tester.

WARNING: IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING OR LOOSE POSTS, DO NOT TEST, ASSIST-BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

WARNING: EXPLOSIVE HYDROGEN GAS FORMS IN AND AROUND THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR THE BATTERY. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

WARNING: THE BATTERY CONTAINS SULFURIC ACID, WHICH IS POISONOUS AND CAUSTIC. AVOID CONTACT WITH THE SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL A PHYSICIAN IMMEDIATELY. KEEP OUT OF THE REACH OF CHILDREN.

A battery that will not accept a charge is faulty, and must be replaced. Further testing is not required. A fully-charged battery must be tested to determine its cranking capacity. A battery that is fully-charged, but does not pass the Micro 420 or load test, is faulty and must be replaced.

NOTE: Completely discharged batteries may take several hours to accept a charge. Refer to Standard Procedures for the proper battery charging procedures.

STANDARD PROCEDURE

STANDARD PROCEDURE - SPIRAL PLATE BATTERY CHARGING

Vehicles equipped with a diesel engine utilize a unique spiral plate battery. This battery has a maximum charging voltage that must not be exceeded in order to restore the battery to its full potential, failure to use the following spiral plate battery charging procedure could result in damage to the battery or personal injury.

Battery charging is the means by which the battery can be restored to its full voltage potential. A battery is fully-charged when:

- Micro 420 battery tester indicates battery is OK.
- Open-circuit voltage of the battery is 12.65 volts or above.
- Battery passes Load Test multiple times.

WARNING: IF THE BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS OR LOW ELECTROLYTE LEVEL, DO NOT TEST, ASSIST-BOOST, OR CHARGE. THE BATTERY MAY ARC INTERNALLY AND EXPLODE. PERSONAL INJURY AND/OR VEHICLE DAMAGE MAY RESULT.

CAUTION: Always disconnect and isolate the battery negative cable before charging a battery. Charge the battery directly at the battery terminals. Do not exceed 14.4 volts while charging a battery.

CAUTION: The battery should not be hot to the touch. If the battery feels hot to the touch, turn off the charger and let the battery cool before continuing the charging operation. Damage to the battery may result.

After the battery has been charged to 12.6 volts or greater, perform a load test to determine the battery cranking capacity. Refer to Battery Diagnosis and Testing for the proper battery test procedures. If the battery will endure a load test, return the battery to service. If the battery will not pass a load test, it is faulty and must be replaced.

Clean and inspect the battery hold downs, tray, terminals, posts, and top before completing battery service. Refer to Battery System Cleaning for the proper battery system cleaning procedures, and Battery System Inspection for the proper battery system inspection procedures.

BATTERY (Continued)

CHARGING A COMPLETELY DISCHARGED BATTERY – SPIRAL PLATE BATTERY

The following procedure should be used to recharge a completely discharged battery. Unless this procedure is properly followed, a good battery may be needlessly replaced.

(1) Measure the voltage at the battery posts with a voltmeter, accurate to 1/10 (0.10) volt (Fig. 1). Refer to Battery Removal and Installation for access instructions. If the reading is below ten volts, the battery charging current will be low. It could take several hours before the battery accepts a current greater than a few milliamperes. Such low current may not be detectable on the ammeters built into many battery chargers.

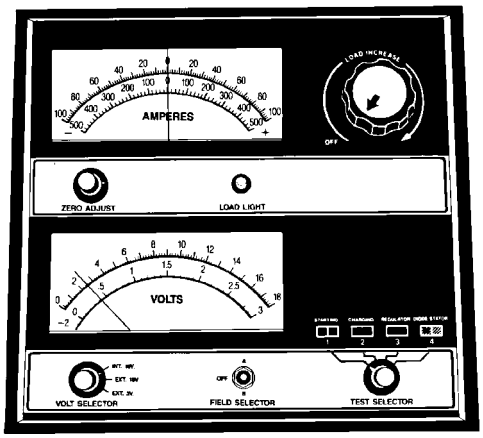

Fig. 1 Voltmeter Accurate to 1/10 Volt (Connected)

(2) Disconnect and isolate the battery negative cable. Connect the battery charger leads. Some battery chargers are equipped with polarity-sensing circuitry. This circuitry protects the battery charger and the battery from being damaged if they are improperly connected. If the battery state-of-charge is too low for the polarity-sensing circuitry to detect, the battery charger will not operate. This makes it appear that the battery will not accept charging current. See the instructions provided by the manufacturer of the battery charger for details on how to bypass the polarity-sensing circuitry.

(3) Battery chargers vary in the amount of voltage and current they provide. The amount of time required for a battery to accept measurable charging current at various voltages is shown in the Charge Rate Table. If the charging current is still not measurable at the end of the charging time, the battery is faulty and must be replaced. If the charging current is measurable during the charging time, the battery may be good and the charging should be completed in the normal manner.

SPIRAL-PLATE BATTERY CHARGE RATE TABLE	
Voltage	Minutes
14.4 volts maximum	up to 10 minutes
13.0 to 14 volts	up to 20 minutes
12.9 volts or less	up to 30 minutes

CHARGING TIME REQUIRED

The time required to charge a battery will vary, depending upon the following factors:

- **Battery Capacity** - A completely discharged heavy-duty battery requires twice the charging time of a small capacity battery.
- **Temperature** - A longer time will be needed to charge a battery at -18° C (0° F) than at 27° C (80° F). When a fast battery charger is connected to a cold battery, the current accepted by the battery will be very low at first. As the battery warms, it will accept a higher charging current rate (amperage).
- **Charger Capacity** - A battery charger that supplies only five amperes will require a longer charging time. A battery charger that supplies eight amperes will require a shorter charging time.
- **State-Of-Charge** - A completely discharged battery requires more charging time than a partially discharged battery. Electrolyte is nearly pure water in a completely discharged battery. At first, the charging current (amperage) will be low. As the battery charges, the specific gravity of the electrolyte will gradually rise.

The Battery Charging Time Table gives an indication of the time required to charge a typical battery at room temperature based upon the battery state-of-charge and the charger capacity.

SPIRAL-PLATE BATTERY CHARGING TIME TABLE		
Charging Amperage	5 Amps	8 Amps
Open Circuit Voltage	Hours Charging @ 21° C (70° F)	
12.25 to 12.49	6 hours	3 hours
12.00 to 12.24	10 hours	5 hours
10.00 to 11.99	14 hours	7 hours
Below 10.00	18 hours	9 hours

BATTERY (Continued)

STANDARD PROCEDURE - USING MICRO 420 BATTERY TESTER

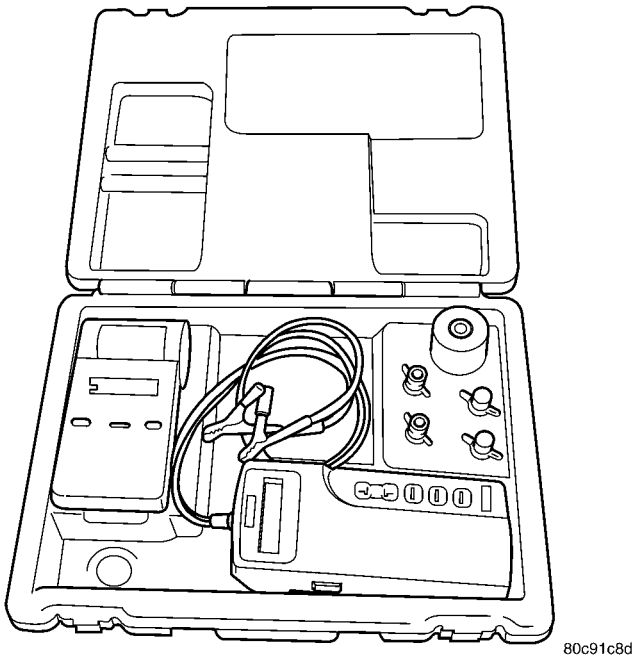

Fig. 2 MIDTRONICS TESTER

Always use the Micro 420 Instruction Manual that was supplied with the tester as a reference. If the Instruction Manual is not available the following procedure can be used:

WARNING: ALWAYS WEAR APPROPRIATE EYE PROTECTION AND USE EXTREME CAUTION WHEN WORKING WITH BATTERIES.

BATTERY TESTING

(1) If testing the battery OUT-OF-VEHICLE, clean the battery terminals with a wire brush before testing. If the battery is equipped with side post terminals, install and tighten the supplied lead terminal stud adapters. Do not use steel bolts. Failure to properly install the stud adapters, or using stud adapters that are dirty or worn-out may result in false test readings.

(2) If testing the battery IN-THE-VEHICLE, make certain all of the vehicle accessory loads are OFF, including the ignition. **The preferred test position is at the battery terminal**. If the battery is not accessible, you may test using both the positive and negative jumper posts. Select TESTING AT JUMPER POST when connecting to that location.

(3) Connect the tester (Fig. 2) to the battery or jumper posts, the red clamp to positive (+) and the black clamp to negative (–).

NOTE: Multiple batteries connected in parallel must have the ground cable disconnected to perform a battery test. Failure to disconnect may result in false battery test readings.

NOTE: When testing the battery in a PT Cruiser, always test at the battery terminals

(4) Using the ARROW key select **in** or **out** of vehicle testing and press ENTER to make a selection.

(5) If not selected, choose the Cold Cranking Amp (CCA) battery rating. Or select the appropriate battery rating for your area (see menu). The tester will then run its self programmed test of the battery and display the results. Refer to the test result table noted below.

CAUTION: If REPLACE BATTERY is the result of the test, this may mean a poor connection between the vehicle's cables and battery exists. After disconnecting the vehicle's battery cables from the battery, retest the battery using the OUT-OF-VEHICLE test before replacing.

(6) While viewing the battery test result, press the CODE button and the tester will prompt you for the last 4 digits of the VIN. Use the UP/DOWN arrow buttons to scroll to the correct character; then press ENTER to select and move to the next digit. Then press the ENTER button to view the SERVICE CODE. Pressing the CODE button a second time will return you to the test results.

BATTERY TEST RESULTS	
GOOD BATTERY	Return to service
GOOD - RECHARGE	Fully charge battery and return to service
CHARGE & RETEST	Fully charge battery and retest battery
REPLACE BATTERY	Replace the battery and retest complete system
BAD-CELL REPLACE	Replace the battery and retest complete system

NOTE: The SERVICE CODE is required on every warranty claim submitted for battery replacement.

IGNITION CONTROL

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CAMSHAFT POSITION SENSOR

DESCRIPTION

The camshaft position (CMP) sensor is mounted in the top of cylinder head cover/intake manifold at the rear of the engine (Fig. 1) (Fig. 2) The CMP sensor is a hall effect device.

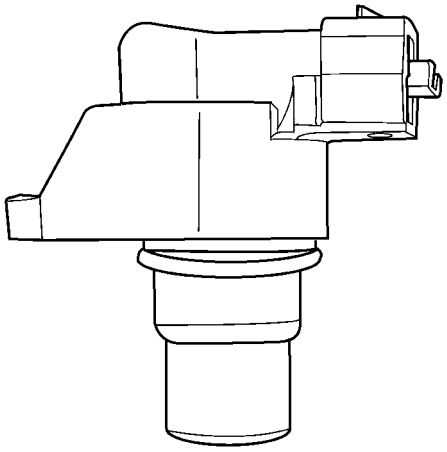

Fig. 1 CAMSHAFT POSITION SENSOR

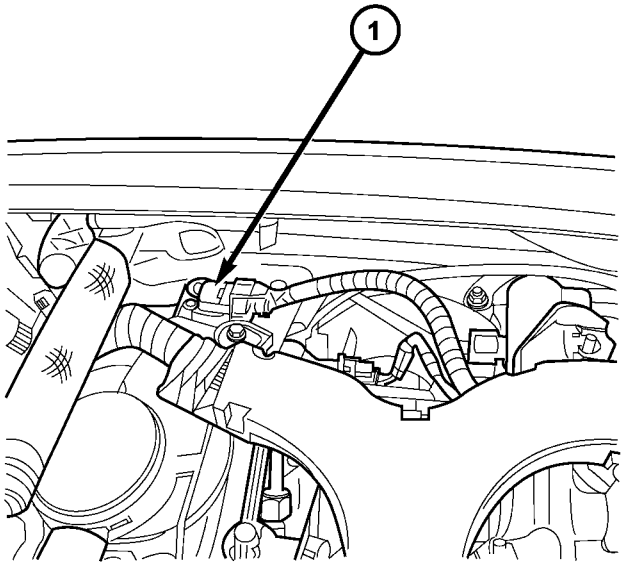

Fig. 2 CAMSHAFT POSITION (CMP) SENSOR

1 - CAMSHAFT POSITION (CMP) SENSOR

CAMSHAFT POSITION SENSOR (Continued)

OPERATION

The CMP sensor is a hall effect switch. A tooth made of a ferromagnetic material is attached to the camshaft. When this tooth passes the CMP sensor an electronic signal is created. This signal is then sent to the engine control module (ECM). This signal is used by the ECM to determine which cylinder has just entered its compression phase.

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(3) Disconnect CMP sensor electrical connector (Fig. 3).
(4) Remove CMP sensor retaining bolt and remove sensor from cylinder head cover/intake manifold (Fig. 3).

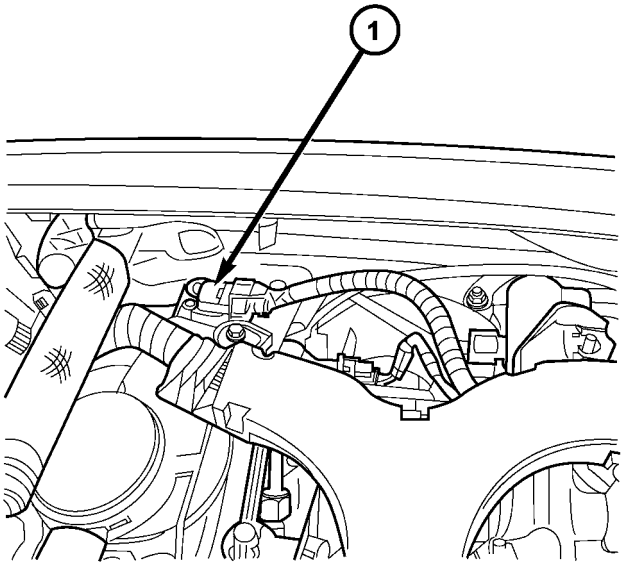

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Fig. 3 CAMSHAFT POSITION (CMP) SENSOR

1 - CAMSHAFT POSITION (CMP) SENSOR

INSTALLATION

(1) Lubricate O-ring on new CMP sensor and install in cylinder head cover/intake manifold (Fig. 3).
(2) Install retaining bolts. Torque to 10.8N·m.
(3) Connect sensor electrical connector.
(4) Install engine cover (Refer to 9 - ENGINE COVER - INSTALLATION).
(5) Connect negative battery cable.

GLOW PLUG

DESCRIPTION

Glow plugs are used to help start a cold or cool engine (Fig. 4). 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.

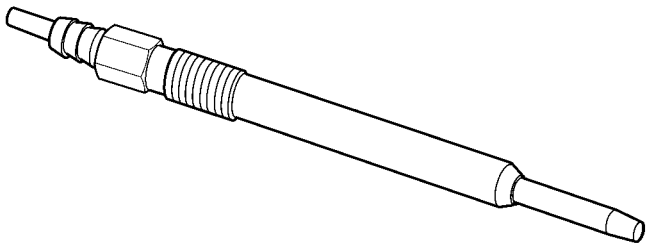

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Fig. 4 GLOW PLUG

OPERATION

Each glow plug will momentarily draw approximately 25 amps of electrical current during the initial key “ON” cycle. This is on a cold or cool engine. After heating the current draw will drop to approximately 9–12 amps per plug.

Total momentary cuurent draw for all four glow plugs is approximately 100 amps on a cold engine dropping to a total of approximately 40 amps after the plugs are heated.

Electrical operation of the glow plugs is controlled by two glow plug relays. Each glow plug relay controls two glow plugs. Refer to glow plug relays for more information.

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove generator (Refer to 8 - ELECTRICAL/ CHARGING/GENERATOR - REMOVAL).
(3) Disconnect glow plug electrical connectors (Fig. 6).

NOTE: The intake manifold inlet tube must be removed to remove the cylinder # 3 glow plug (Fig. 5).

GLOW PLUG (Continued)

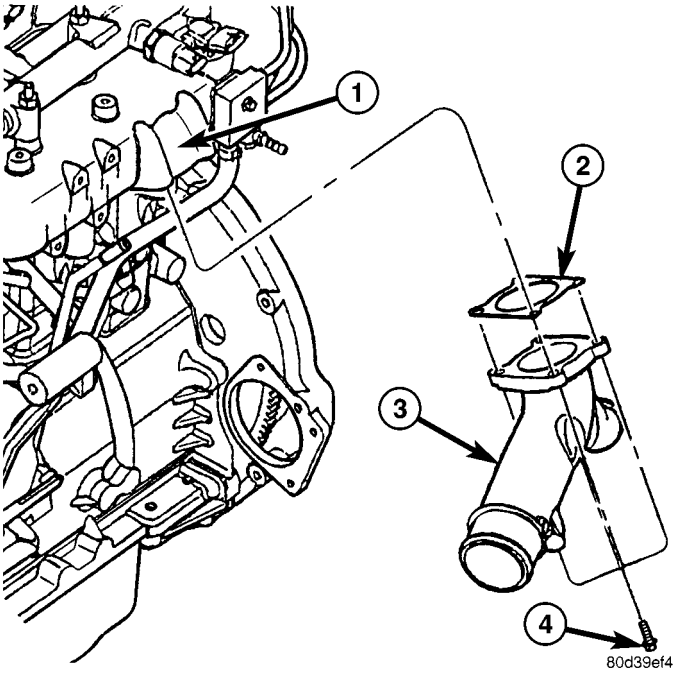

Fig. 5 INTAKE MANIFOLD AIR INLET TUBE

1 - CYLINDER HEAD COVER/INTAKE MANIFOLD
2 - AIR INLET TUBE GASKET
3 - INTAKE MANIFOLD AIR INLET TUBE
4 - RETAINING BOLTS

(4) Remove glow plugs from cylinder head (Fig. 6).

INSTALLATION

(1) Install glow plugs into cylinder head (Fig. 6).
(2) Connect glow plug electrical connectors (Fig. 6).
(3) Install intake manifold air inlet tube (Fig. 5).
(4) Install generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).
(5) Connect negative battery cable.

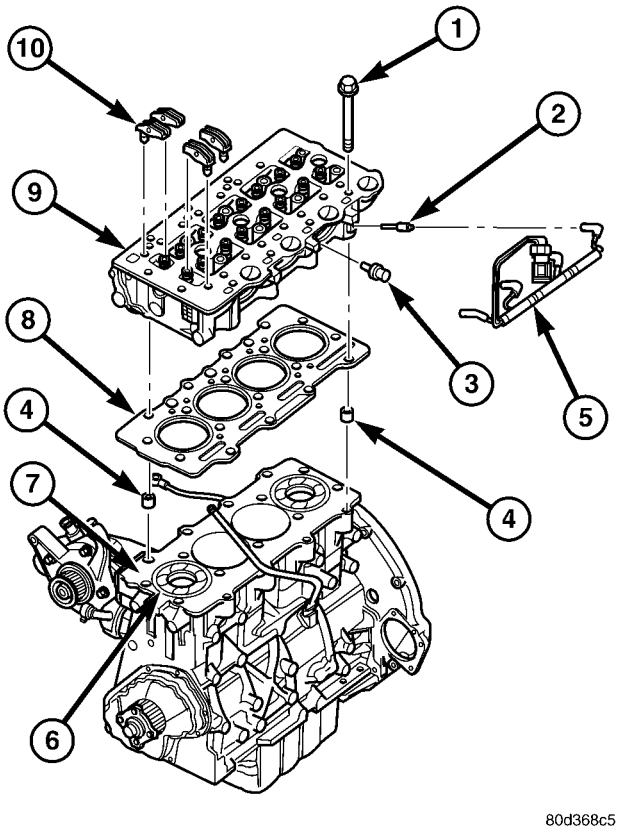

Fig. 6 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

GLOW PLUG RELAY

DESCRIPTION

There are two glow plug relays. These relays are located in the Power Distribution Center (PDC) in the engine compartment (Fig. 7).

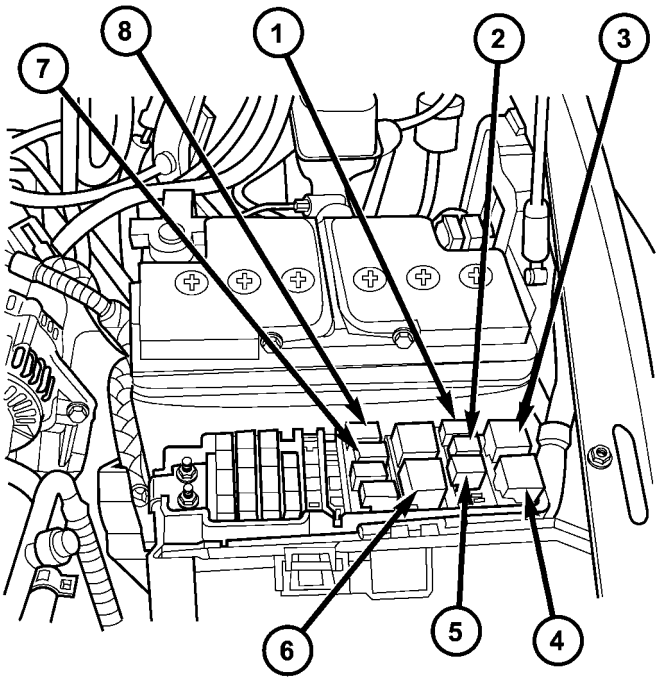

Fig. 7 GLOW PLUG RELAYS

1 - A/C COMPRESSOR CLUTCH RELAY
2 - VISCOUS HEATER RELAY
3 - ASD RELAY
4 - GLOW PLUG (3 + 4) RELAY #2
5 - CLUTCH SWITCH OVERRIDE RELAY
6 - GLOW PLUG (1 + 2) RELAY #1
7 - STARTER RELAY
8 - FUEL HEATER RELAY

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	10 SEC.	35 SEC.	200 SEC.
-10C	10 SEC.	23 SEC.	180 SEC.
+10C	1 SEC.	21 SEC.	160 SEC.
+30C	1 SEC.	20 SEC.	140 SEC.
+40C	1 SEC.	19 SEC.	70 SEC.
+70C	1 SEC.	16 SEC.	20 SEC.

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ENGINE - 2.5L/2.8L TURBO DIESEL

DESCRIPTION

DESCRIPTION - 2.5L/2.8L COMMON RAIL DIESEL ENGINE

The 2.5 Liter (2500cc) and 2.8L (2800cc) four-cylinder “common rail” direct injection engines are very simular in design and operability with a few differences. The 2.5L is the engine of choise from the manual transmission and the 2.8L for the automatic transmission. Both 4 cylinder “common rail” direct injection engines are an in-line overhead valve design. The engines utilize a cast iron cylinder block and an aluminum cylinder head with four valves per cylinder and dual overhead cam shafts. Both engins are turbocharged and intercooled. Differences include a longer crankshaft gear, larger cylinder bore and larger intake ducts in the cylinder head of the 2.8L. The 2.8L is also equipped with a EGR cooler. (Fig. 1).

DESCRIPTION	SPECIFICATION
Displacement	2.5L (2499 cc)
Displacement	2.8L (2900cc)
Bore - 2.5L	92.00 mm
Bore - 2.8L	94.00 mm
Stroke	94.00
Compression Ratio	17.5:1
Vacuum at Idle	700 mm/Hg (27.5 In/Hg)
Belt Tension	Automatic Belt Tensioner
Thermostat Opening	80°C ± 2°C
Generator Rating	Denso 12V-95A
Cooling System Capacity	13.8 Liters W/O Auxiliary Heater 16.6 Liters With Auxiliary Heater
Engine Oil Capacity	6.0L W/Filter Change
Timing System	Belt Driven DOHC Overhead Camshafts
Air Intake	Dry Filter With Turbocharger and Charge Air Cooler
Fuel Supply	Vane Pump Incorporated In Injection Pump
Fuel System	Direct Fuel Injection Common Rail System
Combustion Cycle	4 Stroke

DESCRIPTION	SPECIFICATION
Cylinder Compression Difference Between Cylinders	5 Bar
Cooling System	Water Cooling
Injection Pump	Rotary Pump and Electronically Managed
Lubrication	Pressure Lubricated By Rotary Pump
Minimum Oil Pressure (Warm)	0.7 Bar at Idle 2 Bar at 3800 rpm
Engine Rotation	Clockwise Viewed From Front Cover

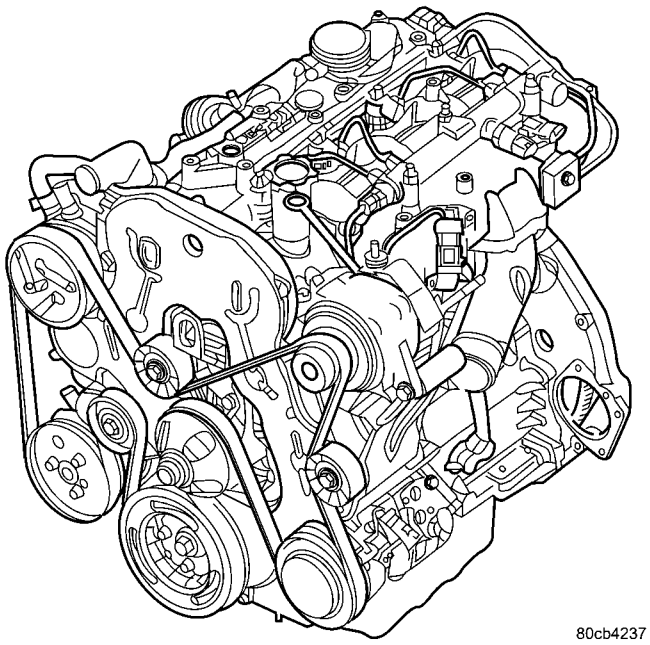


Fig. 1 2.5L/2.8L COMMON RAIL DIESEL ENGINE

DESCRIPTION - ENGINE COVER

The engine cover is made of plastic and used cosmetically to cover the top of the engine (Fig. 2).

REMOVAL

REMOVAL

(1) Disconnect negative battery cable.

(2) Disconnect under hood lamp from the hood assembly.

(3) With assistance from another person, remove the hood assembly from the vehicle.

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

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

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

(6) Remove air filter assembly from the engine bay.
(7) Recover refrigerant from A/C system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(8) Disconnect high side refrigerant line from the upper radiator support bracket.
(9) Remove upper radiator support bracket retaining bolts and remove the support bracket.
(10) Remove high side refrigerant line retaining nut and remove the line from the condenser assembly. Position the line out of the way.
(11) Remove cooling fan and fan drive viscous clutch assembly.
(12) Remove fan shroud retaining bolts and remove fan assembly and shroud together.
(13) Disconnect charge air cooler hoses from charge air cooler.
(14) Disconnect engine coolant hoses from engine assembly.
(15) Disconnect coolant reservoir hose from radiator.
(16) Remove low side refrigerant line retaining nut and remove line from the condenser assembly. Position the line out of the way.
(17) Remove condenser assembly retaining bolts and remove condenser from the vehicle.
(18) Remove power steering cooler retaining bolts and unclip air deflectors from both sides of the radiator (cooling module) assembly.
(19) Lift cooling module assembly out of the engine bay.
(20) Remove charge air cooler hose from the intake manifold.
(21) Remove high side refrigerant line from A/C compressor and remove high side line from the engine bay.
(22) Remove coolant reservoir retaining nuts and clips retaining electrical harness, position reservoir aside to allow access to remaining hoses.
(23) Disconnect remaining hoses from coolant reservoir and remove reservoir from the engine bay.
(24) Remove accessory drive belt from the engine (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(25) Accessing bolts through the pump pulley, remove power steering pump retaining bolts and position pump aside with lines still attached.
(26) Remove engine cover mounting bracket retaining bolts and remove the bracket from the top of the engine.
(27) Disconnect four large electrical connectors near the rear of the right front fenderwell.
(28) Disconnect heater core inlet and outlet hoses from the heater core.
(29) Remove generator from engine (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL). This will provide access to the wires beneath it.
(30) Remove low side refrigerant line retaining nuts from accumulator and compressor and remove from engine bay.
(31) Trace engine wiring and disconnect electrical connectors and tie straps one at a time untill all wiring is disconnected from the engine assembly. When all the engine electrical harness is disconnected fold the harness over the left front fenderwell.
(32) Remove coolant elbow retaining bolts from rear of the water pump.
(33) Disconnect coolant hoses leading from the coolant elbow and remove coolant elbow from engine.
(34) Remove oil cooler adapter.
(35) Raise and support the vehicle.
(36) Remove oil filter and adaptor assemby.
(37) Remove starter motor from engine (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL).
(38) Remove chassis ground wire above starter mounting location on the engine block.
(39) Remove exhaust inlet pipe retaining bolts and disconnect exhaust pipe from turbocharger.
(40) Remove transmission to engine retaining bolts.
(41) Lower vehicle.
(42) Connect a suitable lifting device to engine assembly.
(43) Remove right side engine mount from engine block.
(44) Disconnect crankshaft position sensor, located on the right rear of the engine.
(45) Disconnect oil pressure sensor, located between the engine block and the turbocharger. Make certain everything is disconnected from the engine assembly.
(46) Place a floor jack under the transmission to support the transmission.
(47) With engine and transmission supported by a lifting device carefully separate the engine from the transmission.
(48) Lift the engine assembly out of the engine bay.

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

REMOVAL - ENGINE COVER

(1) Remove oil fill cap and oil dipstick.

(2) Carefully lift engine engine cover from corners to remove from mounting bracket (Fig. 2).

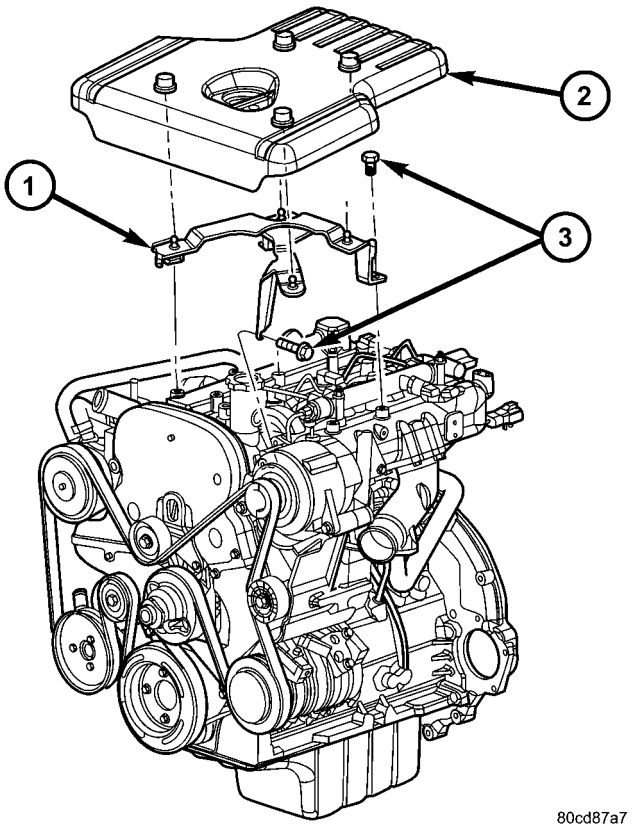


Fig. 2 ENGINE COVER REMOVAL/INSTALLATION

1 - ENGINE COVER BRACKET
2 - ENGINE COVER
3 - RETAINING BOLTS

INSTALLATION

INSTALLATION

(1) Install engine assembly in the engine bay.

(2) Line up the transmission input shaft with the corresponding hole in the clutch assembly (2.5L). Install the transmission assembly on the engine block mounted dowel pins (2.8L) if possible. If this proves to difficult removal of the transmission may be required.

(3) Connect oil pressure sensor, located between the engine block and the turbocharger.

(4) Connect crankshaft position sensor, located on the right rear of the engine.

(5) Install right side engine mount on the engine block.

(6) Disconnect lifting device from the engine assembly.

(7) Raise and support the vehicle.

(8) Install all transmission to engine retaining bolts.

(9) Install exhaust inlet pipe and retaining bolts.

(10) Install chassis ground wire above starter mounting location on the engine block.

(11) Install starter motor on the engine.

(12) Install oil filter and cooler assembly.

(13) Lower vehicle.

(14) Install oil cooler adapter.

(15) Install coolant elbow and retaining bolts and connect the hoses leading from it.

(16) Trace engine wiring and connect electrical connectors and tie straps one at a time until all wiring is connected on engine assembly.

(17) Install low side refrigerant line.

(18) Install generator on the engine (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).

(19) Connect heater core inlet and outlet hoses at heater core.

(20) Connect four large electrical connectors near rear of the right front fenderwell.

(21) Install engine cover mounting bracket and retaining bolts.

(22) Accessing bolts through the pump pulley, install the power steering pump and retaining bolts.

(23) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(24) Install coolant reservoir and connect hoses.

(25) Install coolant reservoir retaining nuts.

(26) Install high side refrigerant line on compressor.

(27) Install charge air cooler hose on intake manifold.

(28) Install cooling module assembly in the engine bay.

(29) Install power steering cooler and retaining bolts and clip the air deflectors on both sides of the radiator (cooling module) assembly.

(30) Install condenser assembly and retaining bolts.

(31) Install low side refrigerant line and retaining nut.

(32) Connect coolant reservoir hose on radiator.

(33) Connect engine coolant hoses on engine.

(34) Connect charge air cooler hoses on charge air cooler.

(35) Install fan shroud with cooling fan assembly inside the shroud and install the shroud retaining bolts.

(36) Connect cooling fan and fan drive viscous clutch assembly to fan support.

(37) Install high side refrigerant line and retaining nut.

(38) Install upper radiator support bracket and retaining bolts.
(39) Connect high side refrigerant line on the upper radiator support bracket.
(40) Charge refrigerant system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(41) Install air filter assembly.
(42) Install engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(43) Install engine oil fill cap.
(44) Fill cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).
(45) With assistance from another person, install hood assembly on the vehicle.
(46) Connect under hood lamp on the hood assembly.
(47) Connect negative battery cable.

INSTALLATION - ENGINE COVER

(1) Align engine cover with mounting bracket. Push down firmly on all four corners of engine cover to snap in place (Fig. 2).
(2) Install oil dipstick tube.
(3) Install oil fill cap.

SPECIFICATIONS

SPECIFICATIONS - 2.8L COMMON RAIL DIESEL ENGINE

ENGINE SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Type	R2816K3.05A
Number of Cylinders	4
Bore	94 mm
Stroke	94 mm
Displacement	2800cc
Injection Order	1-3-4-2
Compression Ratio	17.5:1 (± 0.5)
Maximum Power	105kW (140 HP) @ 4000 RPM
Peak Torque	320Nm (32.6 kgm) @ 2000 RPM
Cylinder Compression (Max. Difference Between Cylinders)	5 Bar
Minimum Oil Pressure (Warm)	0.7 Bar @ Idle 2 Bar @ 3800 RPM

DESCRIPTION	SPECIFICATION
CRANKSHAFT	
Front Journal Diameter	
Nominal	62.985-63.005 mm
-0.25	62.735-62.755 mm
Front Bearing Diameter	
Nominal	63.045-63.074 mm
-0.25	62.795-62.824 mm
Clearance Between Journal and Bearing	0.040-0.089 mm
Center Journal Diameter	
Nominal	63.005-63.020 mm
-0.25	62.755-62.770 mm
Center Bearing Diameter	
Nominal	63.005-63.020 mm
-0.25	62.755-62.770 mm
Clearance Between Journal and Bearing	0.008-0.051 mm
Rear Journal Diameter	
Nominal	89.980-90.000 mm
-0.25	89.730-99.750 mm
Rear Bearing Diameter	
Nominal	90.045-90.065 mm
-0.25	89.795-89.815 mm
Clearance Between Journal and Bearing	0.045-0.080 mm
Connecting Rod Journal	
Nominal	53.940-53.955 mm
-0.25	53.690-53.705 mm
Connecting Rod Bearing	
Nominal	53.977-54.016 mm
-0.25	53.727-53.766 mm
Clearance Between Journal and Bearing	0.022-0.076 mm
Crankshaft End Play	
End Play	0.080-0.280 mm
Adjustment	Thrust Washers
Thrust Washers Available	2.31-2.36 mm
	2.41-2.46 mm
	2.51-2.56 mm
Carrier with thrust washers installed	27.670-27.820 mm

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

DESCRIPTION	SPECIFICATION
MAIN BEARING CARRIERS	
Internal Diameter	
Front	67.025-67.050 mm
Center	66.670-66.690 mm
Rear	85.985-86.005 mm
LINERS	
Internal Diameter	93.997-94.015 mm
Protrusion	0.00-0.05 mm
Adjustment	Shims
Available Shims	0.15 mm
	0.17 mm
	0.20 mm
	0.23 mm
	0.25 mm
CYLINDER HEAD	
Minimum Thickness	94.95-95.05 mm
Gasket Thickness	1.32 mm ± 0.08, 0 notches
	1.42 mm ± 0.08, 1 notch
	1.52 mm ± 0.08, 2 notches
CONNECTING RODS	
Small End Bearing Internal Diameter	32.035-32.050 mm
Large End Internal Diameter	53.977-54.016 mm
PISTONS	
Skirt Diameter (measured at approximately 10 mm above the bottom of the skirt)	93.912-93.928 mm
Piston Clearance	0.010-0.022 mm
Top of Piston to Cylinder Head	0.69-0.83 mm
Piston Potrusion	0.49-0.60 Fit Gasket Number (1.32), 0 notches or holes
	0.61-0.70 Fit Gasket Number (1.42), 1 notch or hole
	0.71-0.83 Fit Gasket Number (1.52), 2 notches or holes

DESCRIPTION	SPECIFICATION
PISTON PINS	
Type	Full Floating
Pin Diameter	31.990-31.996 mm 32.000-32.004
Clearance	0.010-0.020 mm 0.004-0.012
PISTON RINGS	
Clearance in Groove	
Top	0.078-0.137 mm
Second	0.065-0.110 mm
Oil Control	0.035-0.080 mm
Fitted Gap	
Top	0.30-0.45 mm
Second	0.30-0.50 mm
Oil Control	0.25-0.50 mm
CAMSHAFT	
Journal Diameter–Front	29.960-29.980 mm
Bearing Clearance	0.03-0.08 mm
Journal Diameter–Center	39.250-39.270 mm
Bearing Clearance	0.03-0.08 mm
Journal Diameter–Rear	39.250-39.270 mm
Bearing Clearance	0.03-0.08 mm
HYDRAULIC LIFTER	
Outside Diameter	11.994 ± 0.006 mm
VALVES	
Intake Valve	
Opens	15.6° ± 2° A.T.D.C.
Closes	64.4° ± 2° A.B.D.C.
Exhaust Valve	
Opens	66° ± 2° B.B.D.C.
Closes	32° ± 2° A.T.D.C.
Face Angle	
Intake	45° 25'-55° 35'
Exhaust	45° 25'-45° 35'
Head Diameter	
Intake	32.30-32.50 mm
Exhaust	30.80-31.00 mm
Head Stand Down	
Intake	1.08-1.34 mm
Exhaust	0.99-1.25 mm
Stem Diameter	
Intake	5.952-5.970 mm
Exhaust	5.942-5.960 mm

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

DESCRIPTION	SPECIFICATION
Clearance in Guide	
Intake	0.030-0.060 mm
Exhaust	0.040-0.070 mm
VALVE GUIDE	
Inside Diameter	6.00-6.012 mm
Fitted Height	
Intake	14.5-15.0 mm
Exhaust	16.5-17.0 mm
VALVE SPRINGS	
Free Length	45.26 mm
Fitted Length	38.00 mm
Load at Fitted Length	182 ± 5-10% Kg
Load at Top of Lift	395 ± 5% Kg

DESCRIPTION	SPECIFICATION
Number of Coils	8
LUBRICATION	
Pressure Relief Valve Opens	6.50 bar
Pressure Relief Valve Spring-Free Length	51.5 mm
OIL PUMP	
Outer Rotor End Float	0.060-0.160 mm
Inner Rotor End Float	0.060-0.160 mm
Outer Rotor to Body Diameter Clearance	0.130-0.240 mm
Rotor Body to Drive Gear Clearance (pump not fitted)	0.90-1.50 mm

SPECIFICATIONS - TORQUE

2.5L/2.8L DIESEL TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Oil Pump Bolts	10.8	8	96
Vacuum Pump Bolts	10.8	8	96
Crankshaft Gear Bolts	10.8	8	96
Crankshaft Position Sensor Bolts	10.8	8	96
Flywheel Bolts - 2.5L	3 stages, 50N·m clockwise then 25N·m plus 90° cross sequence	37/18	—
Flywheel Bolts - 2.8L	3 stages, 50N·m clockwise then 25N·m plus 60° cross sequence	37/18	—
Cylinder Head Bolts - Refer to the Service Procedure			
Reluctor Wheel Bolts	14.6	11	130
Rear Main Bearing Support Bolts	27.5	21	240
Oil Cooler to Engine Block Bolt	47.1	35	—
Oil Cooler Mounting Stud	50	37	—
Water Pump Housing Nuts	24.4	18	212
Connecting Rod Bolts - Refer to the Service Procedure			
Balance Shaft Bolts	32.4	24	—
Oil Jet Bolts	10.8	8	96

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

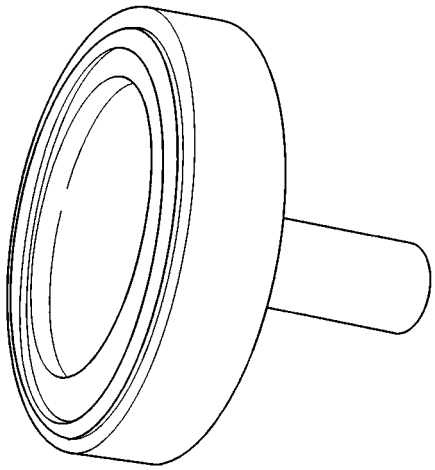
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Oil Pump Pick-up Tube	32.4	24	—
Oil Pan Bolts	11.8	8	96
Structural Support to Engine and Transmission Bolts	45.1	33	—
Crankshaft Hub Bolt	275	203	—
Crankshaft Pulley Bolts	32.4	24	—
Front Engine Cover Bolts	6	—	53
Transmission to Engine Bolts	83.4	62	—
Cylinder Head Cover / Intake Manifold Bolts	24.5	18	—
Camshaft Timing Access Bolts	24.5	18	—
Camshaft Access Plugs	80	59	—
Oil Separator Bolts	10.8	8	96
Camshaft Position Sensor Bolt	10.8	8	96
Boost Pressure / Intake Air Temp. Sensor Bolts	5.4	—	48
Accessory Drive Bracket Bolts	45.1	33	—
Accessory Drive Belt Idler Pulley Bolt	53	39	—
Vacuum Line Fitting Bolt	56.9	42	—
Fuel Pump Nuts	27.5	21	—
Fuel Line Fittings at Pump	27.5	21	—
Fuel Rail Retaining Bolts	24.5	18	217
Inner Timing Belt Cover Bolts			
8mm	10.8	8	96
10mm	45.1	33	—
Outer Timing Belt Cover Bolts			
3mm	6	—	54
8mm	10.8	8	96
Engine Mount Bracket to Cylinder Head Bolts	45.1	33	—
Structural Support to Engine and Transmission Bolts	45.1	33	
Intake Inlet Tube Bolts	10.1	8	89
Camshaft Sprocket Bolts	108	80	—
Camshaft Timing Access Bolts	24.5	18	212

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Timing Belt Idler Pulley Bolt	47.1	35	—
Timing Belt Tensioner Bolt	29.4	22	—
Fuel Injection Pump Gear Nut	88.3	65	—
Fuel Injection Pump Retaining Nuts	24.4	18	212
Engine Lift Hook Bolts	45.1	33	—
Thermostat Housing Bolts	24.5	18	—
Turbocharger Oil Supply Line Fitting	24.5	18	217
Turbocharger Oil Return Line Bolts	10.8	—	96
Exhaust Manifold Nuts	32.4	24	—
Exhaust Manifold Heat Shield	24.5	18	217
Exhaust Manifold Heatshield Bolts	27.5	21	—
EGR Valve Nuts	32.4	24	—
Coolant Pipe to EGR Valve Bolts	32.4	24	—
Turbocharger Downpipe Nuts	32.4	24	—
Turbocharger Bracket Bolts	47.1	35	—
Vibration Damper to Crankshaft Hub Bolts	27.5	21	—
Crankshaft Support Bolts	44.1	33	—
Turbocharger to Exhaust Manifold Nuts	32.4	24	—

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)

SPECIAL TOOLS



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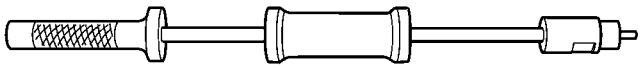
VM.1050 CRANKSHAFT REAR SEAL INSTALLER



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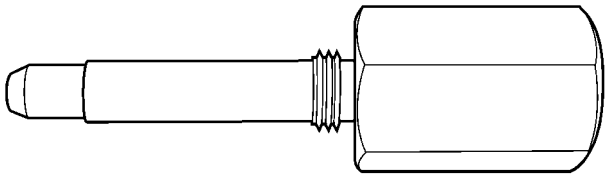
VM.1054 RELIEF VALVE REMOVER/CENTRAL CARRIER PIN REMOVER/INSTALLER



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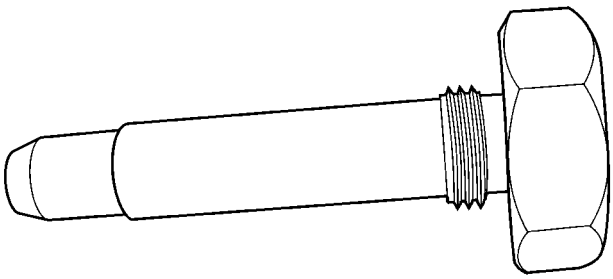
VM.1052 INTAKE CAMSHAFT ALIGNMENT PIN

80c13cec

VM.1055 CAMSHAFT/HIGH PRESSURE INJECTION PUMP GEAR HOLDER



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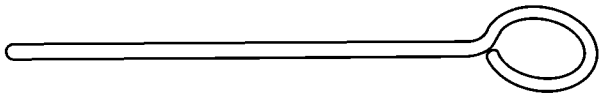
VM.1053 EXHAUST CAMSHAFT ALIGNMENT PIN



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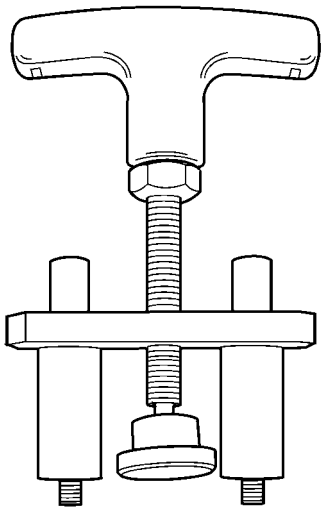
VM.1056 BALANCE SHAFT LOCKING PIN

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)



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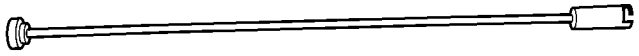
VM.1059 OIL PRESSURE RELIEF VALVE INSTALLER



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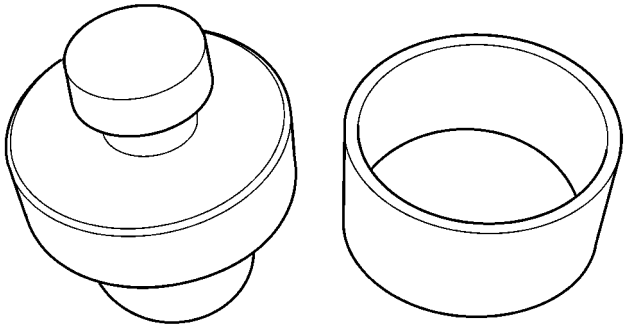
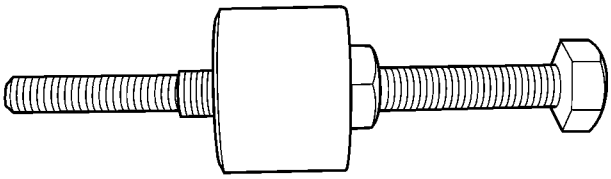
VM.1060 OIL JET REMOVER /INSTALLER



80c17810

VM.1061 FRONT COVER AND FRONT OIL SEAL INSTALLER



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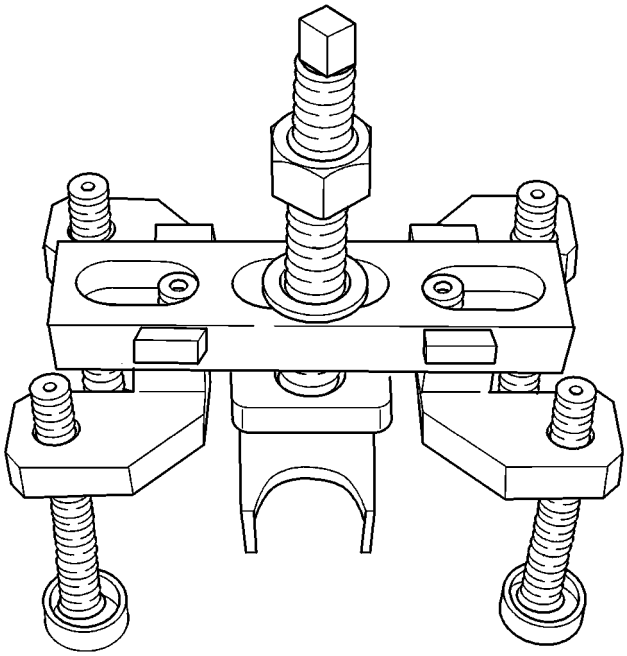
VM.1062 POWER STEERING PUMP INSTALLER



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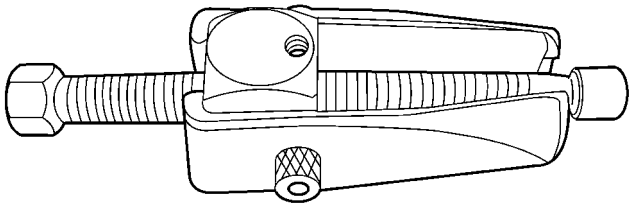
VM.1063 FUEL INJECTOR REMOVER

ENGINE - 2.5L/2.8L TURBO DIESEL (Continued)



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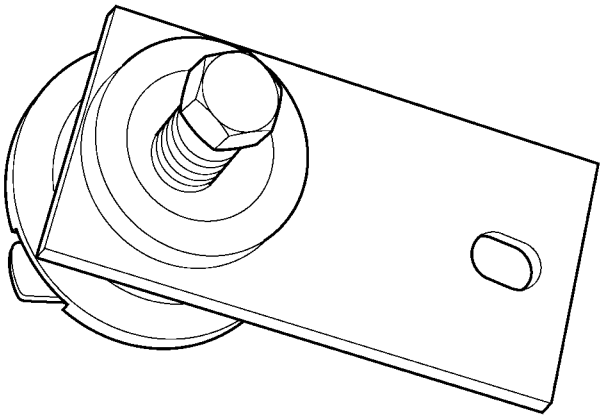
VM.1064 POWER STEERING PUMP GEAR REMOVER



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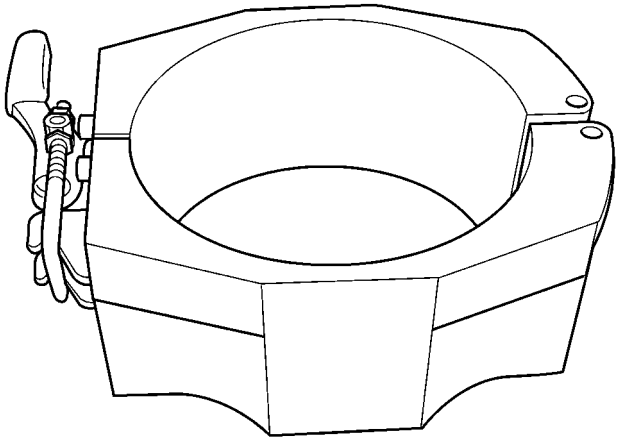
VM.1067 HIGH PRESSURE PUMP REMOVER



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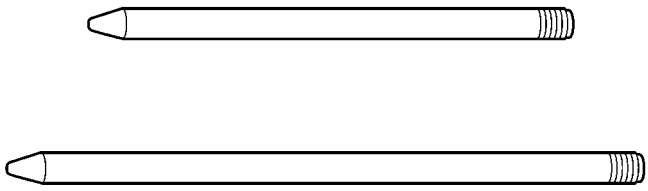
VM.1065 PISTON RING COMPRESSOR



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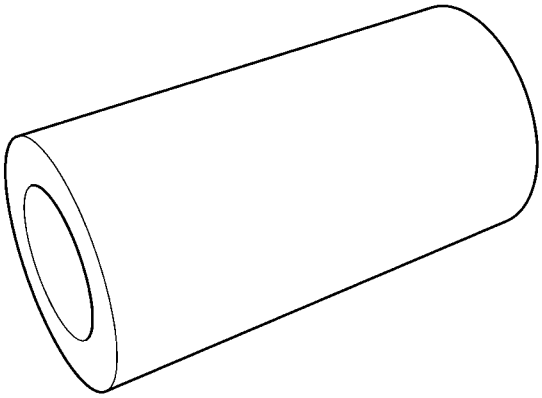
VM.1066 VALVE COVER ALIGNMENT PINS



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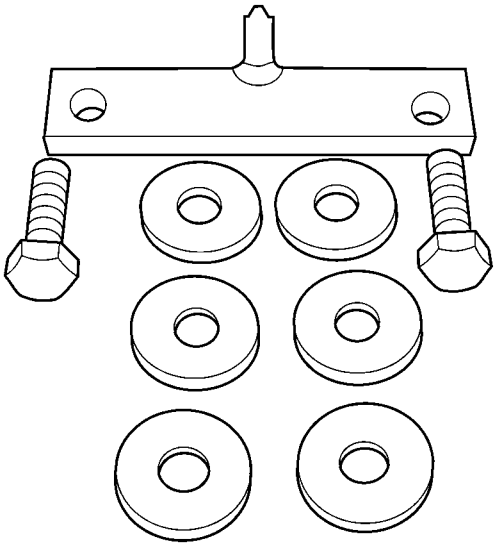
VM.1069 CRANKSHAFT REM/INSTALL SLEEVE



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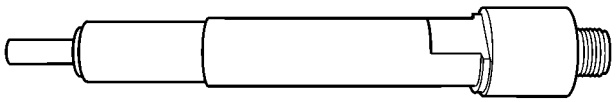
VM.1070 FLYWHEEL LOCKING TOOL



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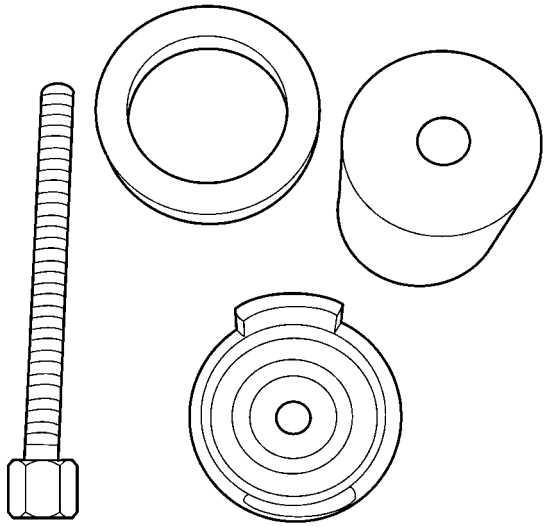
VM.1072 COMPRESSION TESTER ADAPTER



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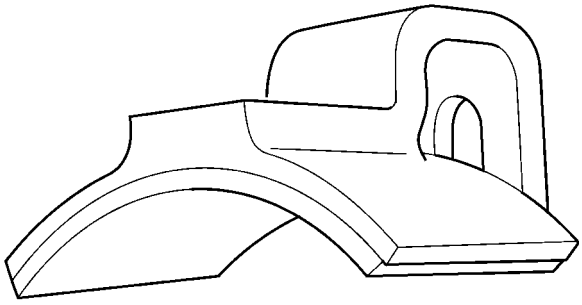
VM.1073 CRANKSHAFT FRONT BEARING REMOVER/INSTALLER



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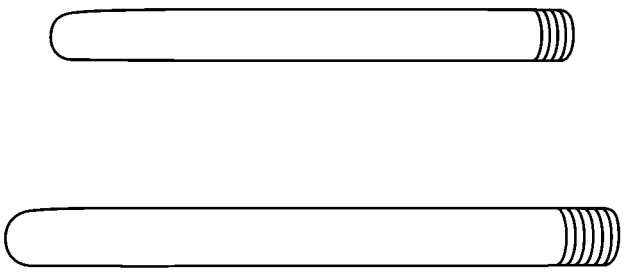
VM.1074 TIMING BELT RETAINER



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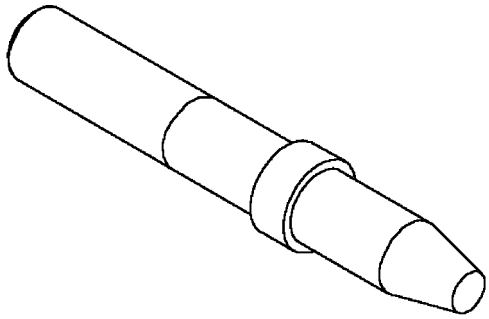
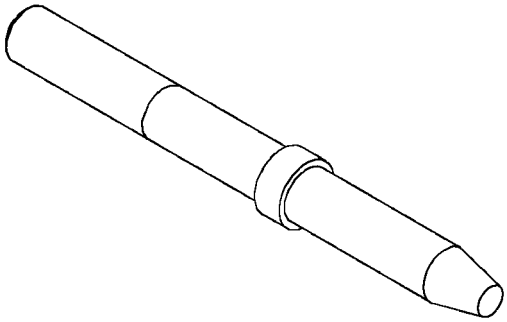
VM.1075 FLYWHEEL ALIGNMENT PINS



VM.8872 TDC LOCATING PIN



VM.8873 90 DEGREES AFTER TDC LOCATING PIN

CYLINDER HEAD

STANDARD PROCEDURE

STANDARD PROCEDURE - VALVE SERVICE

This procedure is done with the engine cylinder head removed from the block.

DISASSEMBLY

(1) Remove the engine cylinder head from the cylinder block. Refer to cylinder head removal and installation in this section.

(2) Use Valve Spring Compressor Tool and compress each valve spring.

(3) Remove the valve locks, retainers, and springs.

(4) Use a smooth stone or a jewelers file to remove any burrs on the top of the valve stem, especially around the groove for the locks.

(5) Remove the valves, and place them in a rack in the same order as removed.

VALVE CLEANING

(1) Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and head.

(2) Clean all grime and gasket material from the engine cylinder head machined gasket surface.

INSPECTION

(1) Inspect for cracks in the combustion chambers and valve ports.

(2) Inspect for cracks on the exhaust seat.

(3) Inspect for cracks in the gasket surface at each coolant passage.

(4) Inspect valves for burned, cracked or warped heads.

(5) Inspect for scuffed or bent valve stems.

(6) Replace valves displaying any damage.

(7) Check valve spring height (Fig. 3).

VALVE REFACING

(1) Use a valve refacing machine to reface the intake and exhaust valves to the specified angle.

(2) After refacing, a margin of at least 4.52-4.49 mm (.178-.177 inch) must remain (Fig. 4). If the margin is less than 4.49 mm (.177 inch), the valve must be replaced.

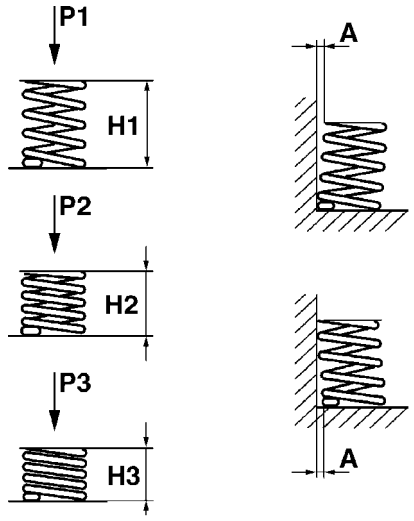


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Fig. 3 VALVE SPRING CHART

	LOAD Kg		HEIGHT mm	STATE
P1	0.00	H1	45.26	FREE LENGTH
P2	182-5 +10%	H2	38.00	VALVE CLOSED
P3	395±5%	H3	28.20	VALVE OPEN

VALVE SEAT REFACING

(1) Install a pilot of the correct size in the valve guide bore. Reface the valve seat to the specified angle with a good dressing stone. Remove only enough metal to provide a smooth finish.

(2) Use tapered stones to obtain the specified seat width when required.

VALVE STAND DOWN

Valve stand down is to maintain the adequate compression ratio.

(1) Invert cylinder head.

(2) Fit each valve to its respective valve guide.

(3) Using a straight edge and feeler gauge, check valve head stand down: Inlet valve head stand down 1.08 to 1.34 mm (.042 to .052 ins.) and exhaust valve stand down .99 to 1.25 mm (.035 to .049 ins.).

(4) If valve head stand down is not in accordance with above, discard original valves, check stand down with new valves and recut valve seat inserts to obtain correct stand down.

CYLINDER HEAD (Continued)

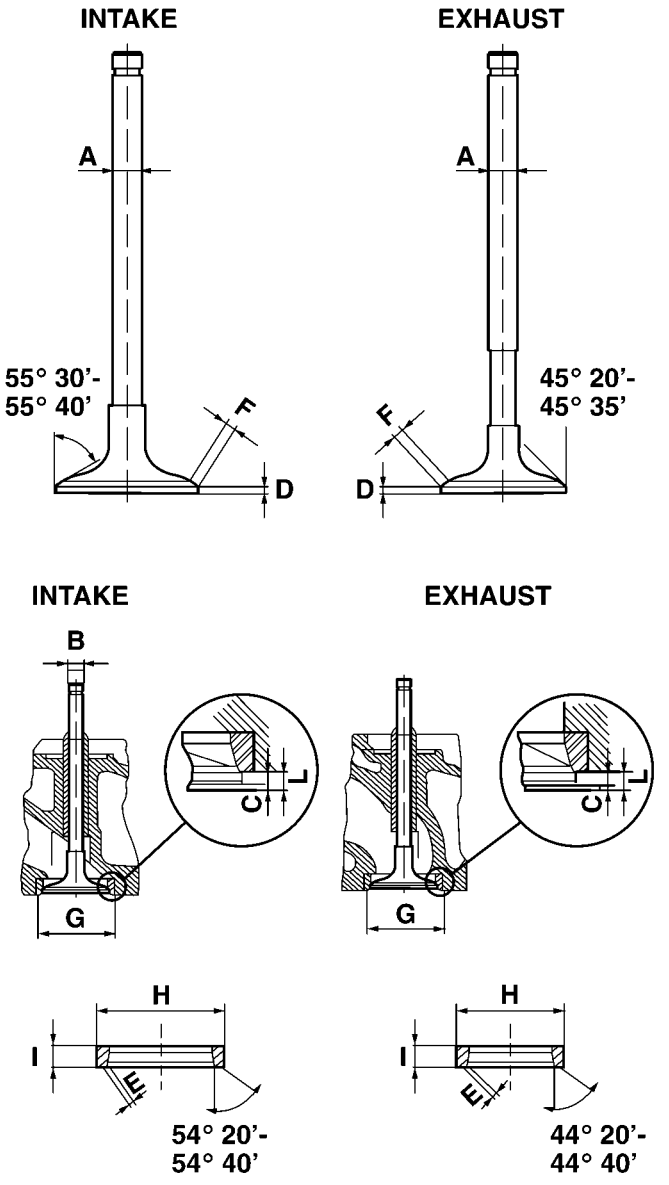

Fig. 4 VALVE SPECS.

MEASUREMENT	INTAKE	EXHAUST
A	7.940-7.960	7.922-7.940
B	8.00-8.015	8.000-8.015
C	1.08-1.34	0.990-1.250
		+0.07
D	2.2 ± 0.08	2.09
		−0.09
E	1.80-2.20	1.65-2.05
F	2.73-3.44	2.45-3.02
G	41.962-41.985	35.964-35.987
H	42.070-42.086	36.050-36.066
I	7.14-7.19	7.00-7.05
L	3.11-3.26	3.10-3.25

VALVE GUIDES

(1) Valve Guides height requirement.

(2) Measurement A (Fig. 5): 16.50 - 17.00 mm. Measurment B : 14.50 - 15.00 mm.

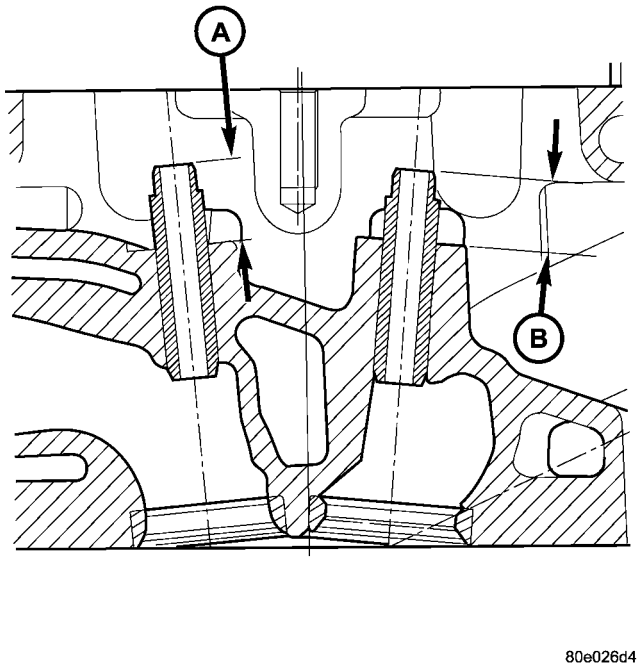

Fig. 5 VALVE GUIDE HEIGHT

VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

(1) Measure and record internal diameter of valve guides. Valve guide internal diameter is 8.0 to 8.015 mm (.3149 to .3155 ins.).

(2) Measure valve stems and record diameters. Intake valve stem diameter 7.94 to 7.96 mm (.3125 to .3133 in). Exhaust valve stem diameter 7.92 to 7.94 mm (.3118 to .31215 in).

(3) Subtract diameter of valve stem from internal diameter of its respective valve guide to obtain valve stem clearance in valve guide. Clearance of inlet valve stem in valve guide is .040 to .075 mm (.0015 to .0029 in). Clearance of exhaust valve stem in valve guide is .060 to .093 mm (.0023 to .0036 in).

(4) If valve stem clearance in valve guide exceeds tolerances, new valve guides must be installed.

CYLINDER HEAD (Continued)

STANDARD PROCEDURE - MEASURING PISTON PROTRUSION

(1) Use special tool VM.1010 with dial indicator special tool VM.1013 (Fig. 6).

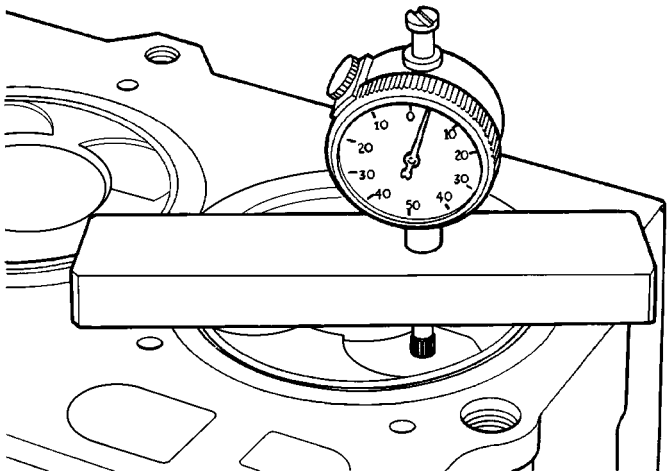

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Fig. 6 PISTON PROTRUSION

(2) Bring the piston of cylinder no. 1 exactly to top dead center.

(3) Zero the dial indicator on the cylinder block mating surface.

(4) Setup the dial indicator on the piston crown (above the center of the piston pin) 5mm (1/8 in.) from the edge of the piston and note the measurement.

(5) Repeat the procedure with the rest of the cylinders.

(6) Establish the thickness of the steel gasket by averaging the four piston potrusion readings.

Measure Dimension (mm)	0.49-0.60
Cylinder Head Gasket Thickness (mm)	1.32 No Holes or Notches
Piston Clearance (mm)	0.72-0.83
Measure Dimension (mm)	0.61-0.70
Cylinder Head Gasket Thickness (mm)	1.42 1 Hole or Notch
Piston Clearance (mm)	0.72-0.81
Measure Dimension (mm)	0.71-0.83
Cylinder Head Gasket Thickness (mm)	1.52 2 Holes or Notches
Piston Clearance (mm)	0.69-0.81

REMOVAL

(1) Disconnect negative battery cable.

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

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

(4) Remove radiator core support.

(5) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/ FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(6) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(7) Remove accessory drive belt tensioner and both idler pulleys, **Idler pulley bolts are L.H. thread-.**(Refer to 7 - COOLING/ACCESSORY DRIVE/BELT TENSIONERS - REMOVAL).

(8) Remove power steering pump pulley.

(9) Remove front engine lift bracket.

(10) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(11) Remove generator and support bracketing(Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).

(12) Remove viscous heater.

(13) Remove vibration damper.

(14) Remove throttle cable assembly and set aside.

(15) Disconnect main engine wiring harness connectors from right inner wheel housing.

(16) Disconnect main engine wiring harness ancillary components and set harness aside.

(17) Remove air cleaner housing.

(18) Disconnect EGR cooler assembly water inlet pipe.

(19) Remove EGR cooler from exhaust manifold (2.8L), Disconnect coolant pipe (2.5L).(Refer to 25 - EMISSIONS CONTROL/EXHAUST GAS RECIRCULATION/VALVE COOLER - REMOVAL).

(20) Remove exhaust manifold heat shield (Fig. 7).

(21) Remove turbocharger heat shield retaining bolt and position shield aside (Fig. 9).

(22) Remove turbocharger oil feed line from turbocharger (Fig. 9).

(23) Raise and support vehicle.

(24) Disconnect exhaust stabilizer bracket at lower exhaust manifold (Fig. 9).

(25) Disconnect exhaust system bracket at transmission crossmember.

(26) Lower the vehicle and remove the exhaust manifold retaining nuts.

(27) Slide the exhaust manifold and turbocharger off of exhaust manifold studs (Fig. 9).

(28) Remove coolant hoses at thermostat housing.

CYLINDER HEAD (Continued)

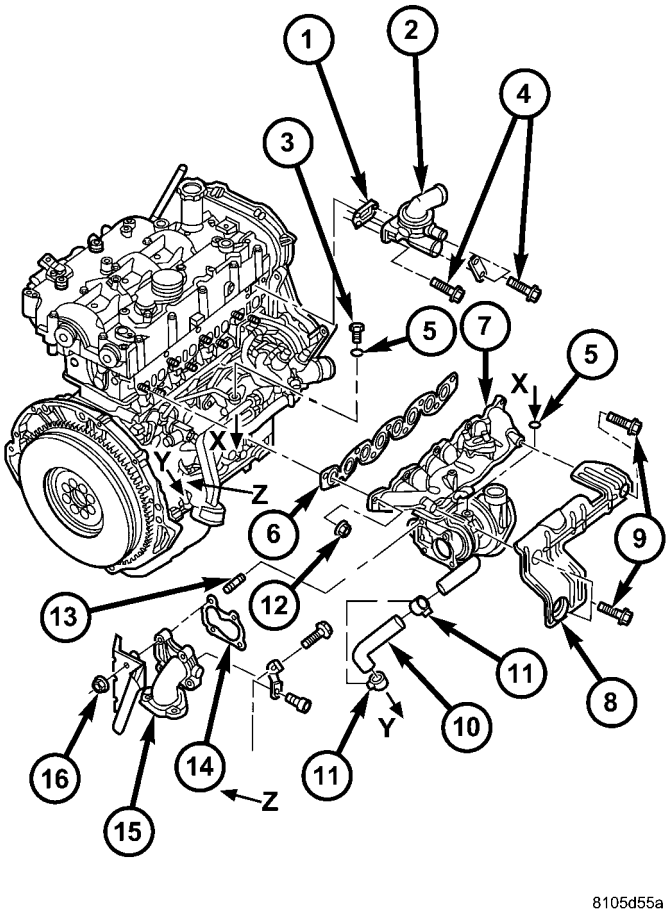

Fig. 7 THERMOSTAT HOUSING

1 - THERMOSTAT HOUSING GASKET
2 - THERMOSTAT HOUSING
3 - TURBOCHARGER OIL SUPPLY LINE BANJO BOLT
4 - THERMOSTAT HOUSING RETAINING BOLTS
5 - BRASS WASHER
6 - EXHAUST MANIFOLD GASKET
7 - EXHAUST MANIFOLD
8 - EXHAUST MANIFOLD HEATSHIELD
9 - EXHAUST MANIFOLD HEATSHIELD RETAINING BOLTS
10 - OIL RETURN HOSE
11 - HOSE CLAMPS
12 - EXHAUST MANIFOLD RETAINING NUTS
13 - TURBOCHARGER DOWNPIPE STUDS
14 - TURBOCHARGER DOWN PIPE GASKET
15 - TURBOCHARGER DOWNPIPE
16 - TURBOCHARGER DOWNPIPE RETAINING NUT

(29) Disconnect fuel return hose from fuel injectors and set aside (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).

(30) Remove fuel injector pressure lines (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).

(31) Disconnect fuel pump high pressure line at fuel rail (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).

(32) Disconnect oil dip stick tube from intake manifold.

(33) Disconnect brake booster line bracket from intake manifold and set aside.

(34) Remove fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).

CAUTION: Before removing the cylinder head cover/intake manifold or timing belt the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

(35) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(36) Remove timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(37) Using VM.1055, remove both camshaft gears (Fig. 8).

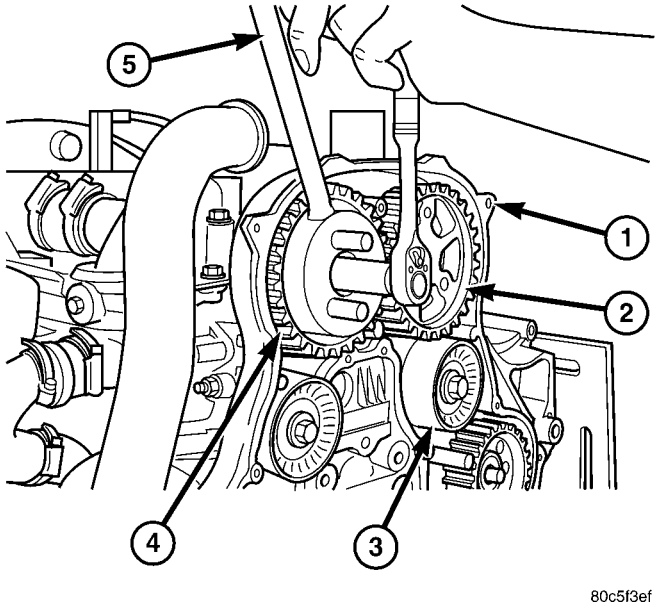

Fig. 8 CAMSHAFT GEAR REMOVAL/INSTALLATION

1 - TIMING BELT INNER COVER
2 - CAMSHAFT SPROCKET
3 - IDLER PULLEYS
4 - CAMSHAFT SPROCKET
5 - VM.1055

CYLINDER HEAD (Continued)

(38) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

(40) Remove rocker arm and lifter assemblies from cylinder head. **Be sure to keep in same order as removed.**

(41) Remove cylinder head cover/intake manifold gasket from cylinder head.

(42) Disconnect glow plug and engine coolant temperature electrical connectors.

(43) Remove turbocharger outlet to charge air cooler hose.

(44) Remove cylinder head bolts.

(45) Remove cylinder head assembly from engine block (Fig. 9).

CLEANING

Thoroughly clean the engine cylinder head and cylinder block mating surfaces. Clean the intake and exhaust manifold and engine cylinder head mating surfaces. Remove all gasket material and carbon.

Check to ensure that no coolant or foreign material has fallen into the tappet bore area.

Remove the carbon deposits from the combustion chambers and top of the pistons.

INSPECTION

Use a straightedge and feeler gauge to check the flatness of the engine cylinder head and block mating surfaces.

The minimum cylinder head thickness is 89.95mm (3.541 in.).

INSTALLATION

CAUTION: Piston protrusion must be measured to determine cylinder head gasket thickness if one or more cylinder liners have been replaced (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE).

NOTE: If cylinder liner(s) have not been removed, the same thickness head gasket that was removed can be used.

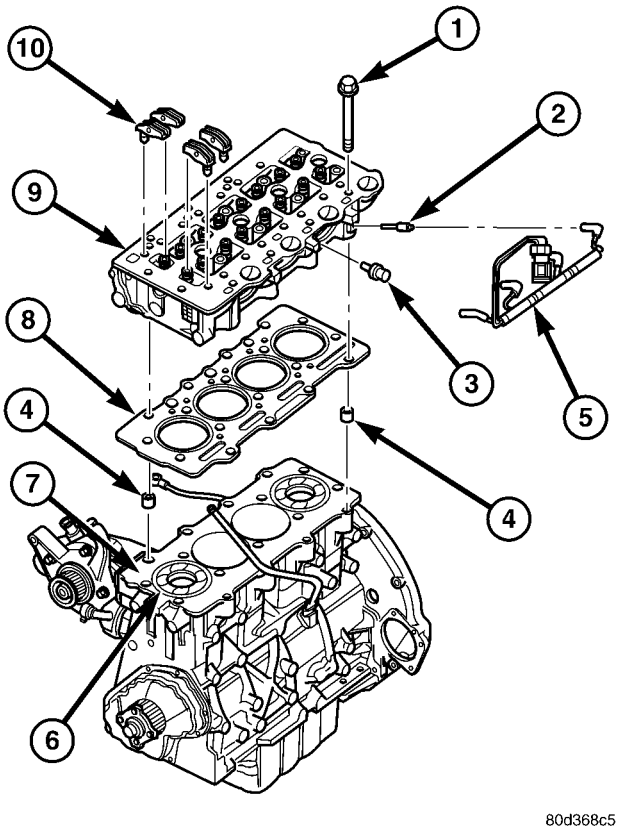

Fig. 9 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

(1) Clean and inspect gasket mating surfaces.
(2) Position correct head gasket on engine block.
(3) Place cylinder head on engine block.

CYLINDER HEAD (Continued)

CAUTION: New cylinder head bolts must be used.

(4) Tighten cylinder head bolts following procedure below.

Cylinder Head Bolt Torquing Procedure

(1) Lubricate cylinder head bolts with engine oil.

(2) Torque bolts to 30N·m in numerical starting with bolt #1 (Fig. 10).

(3) Tighten all bolts an additional 50°, starting with bolt #4 then 5-6-7-8-9-10-1-2-3-11-12-13-14-15-16-17-18 (Fig. 10).

(4) Finally tighten all bolts an additional 75° in numerical order starting with bolt #1 (Fig. 10).

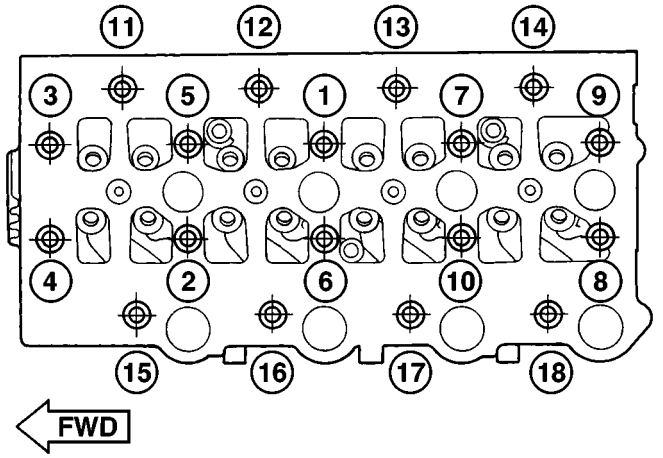

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Fig. 10 CYLINDER HEAD TORQUE SEQUENCE

(5) Slide exhaust manifold and turbocharger on exhaust manifold studs (Fig. 11).

(6) Install exhaust manifold retaining nuts. Torque nuts to 32.4N·m.

(7) Install exhaust manifold heat shield. Torque bolts to 27.5N·m.

(8) Install turbocharger outlet to charge air cooler pipe.

(9) Install upper radiator hose.

(10) Connect glow plug and coolant temperature sensor electrical connectors.

(11) Install new cylinder head cover/intake manifold gasket.

(12) Install rocker arm and lifter assemblies.**Be sure to put rocker arm and lifter assemblies in same location as removed.**

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

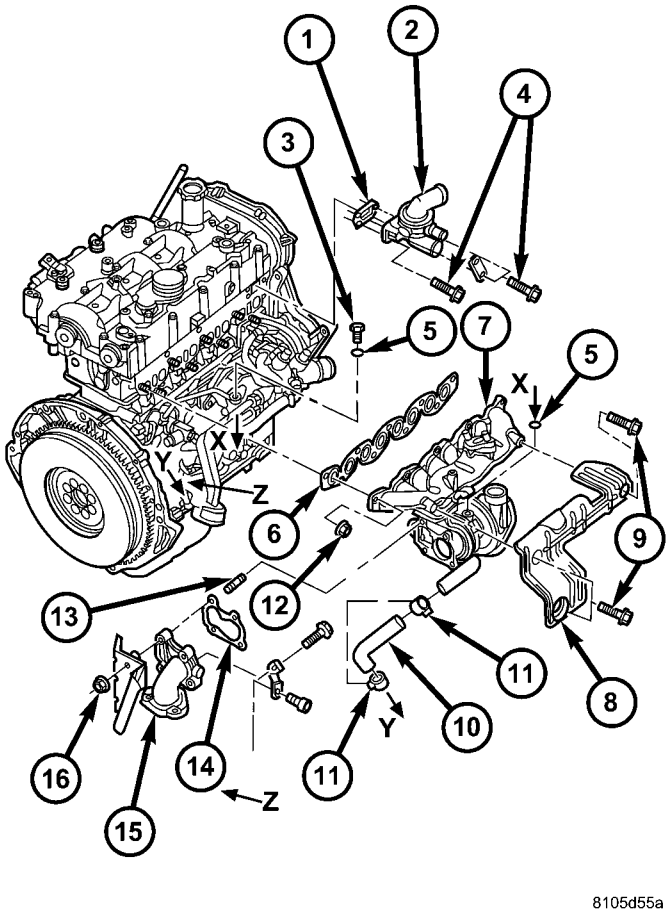

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Fig. 11 THERMOSTAT HOUSING

1 - THERMOSTAT HOUSING GASKET
2 - THERMOSTAT HOUSING
3 - TURBOCHARGER OIL SUPPLY LINE BANJO BOLT
4 - THERMOSTAT HOUSING RETAINING BOLTS
5 - BRASS WASHER
6 - EXHAUST MANIFOLD GASKET
7 - EXHAUST MANIFOLD
8 - EXHAUST MANIFOLD HEATSHIELD
9 - EXHAUST MANIFOLD HEATSHIELD RETAINING BOLTS
10 - OIL RETURN HOSE
11 - HOSE CLAMPS
12 - EXHAUST MANIFOLD RETAINING NUTS
13 - TURBOCHARGER DOWNPIPE STUDS
14 - TURBOCHARGER DOWN PIPE GASKET
15 - TURBOCHARGER DOWNPIPE
16 - TURBOCHARGER DOWNPIPE RETAINING NUT

(14) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(15) Using VM.1055, install both camshaft gears and tighten bolts finger tight.

(16) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

CYLINDER HEAD (Continued)

(17) Using VM.1055, torque cam gear retaining bolts to 108 N·m. (Fig. 12).

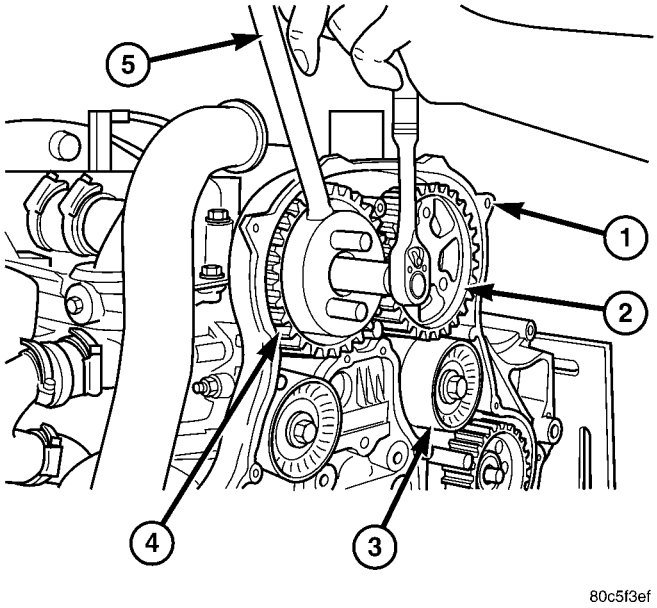

Fig. 12 CAMSHAFT GEAR REMOVAL/INSTALLATION

1 - TIMING BELT INNER COVER
2 - CAMSHAFT SPROCKET
3 - IDLER PULLEYS
4 - CAMSHAFT SPROCKET
5 - VM.1055

(18) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(19) **Remove crankshaft and both camshaft locking pins at this time** (Refer to 9 - ENGINE/ VALVE TIMING - STANDARD PROCEDURE) .

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

(21) Install brake booster line bracket to intake manifold.

(22) Install oil dip stick tube to intake manifold.

(23) Connect fuel pump high pressure line to fuel rail.

(24) Install fuel injector pressure lines.

(25) Connect fuel return hose to fuel injectors.

(26) Connect engine coolant hoses to thermostat housing.

(27) Raise vehicle.

(28) Reconnect exhaust system bracket at transmission crossmember.

(29) Connect exhaust stabilizer bracket to lower exhaust manifold (Fig. 11).

(30) Install turbocharger oil feed line to turbocharger.

(31) Lower vehicle.

(32) Install turbocharger heat shield.

(33) Install exhaust manifold heat shield.

(34) Install EGR cooler assembly and connect engine coolant hoses.

(35) Install air cleaner housing.

(36) Install main engine wiring harness and connect all ancillary electrical components.

(37) Install throttle cable assembly.

(38) Install viscous heater.

(39) Install vibration damper.

(40) Install generator (Refer to 8 - ELECTRICAL/ CHARGING/GENERATOR - INSTALLATION).

(41) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(42) Install front engine lift bracket.

(43) Install power steering pump pulley.

(44) Install accessory drive belt tensioner and both idler pulleys. **Idler pulley retaining bolts are L. H. Thread.**

(45) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(46) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(47) Install upper radiator core support.

(48) Refill cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

(49) Install engine cover and bracket (Refer to 9 - ENGINE COVER - INSTALLATION).

(50) Connect negative battery cable.

(51) Start engine and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).

CAMSHAFT OIL SEAL(S)

REMOVAL

(1) Disconnect negative battery cable.

(2) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/ FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(4) Remove fan support (Refer to 7 - COOLING/ ENGINE/RADIATOR FAN - REMOVAL).

(5) Remove vibration damper.

(6) Remove outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

CAMSHAFT OIL SEAL(S) (Continued)

WARNING: Before removing the timing belt the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

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

(8) Using VM.1055, remove both camshaft gears (Fig. 13).

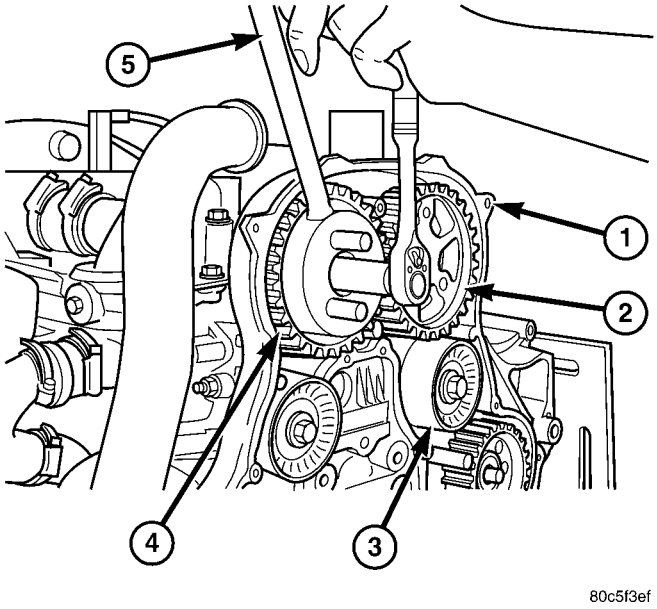

Fig. 13 CAMSHAFT GEAR REMOVAL/INSTALLATION

1 - TIMING BELT INNER COVER
2 - CAMSHAFT SPROCKET
3 - IDLER PULLEYS
4 - CAMSHAFT SPROCKET
5 - VM.1055

(9) Remove both camshaft oil seals.

INSTALLATION

(1) Install new camshaft oil seal using VM.1057.

(2) Install camshaft sprockets and tighten retaining bolts finger tight.

(3) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(4) Torque camshaft sprockets to 108 N·m using VM.1055 to hold sprockets (Fig. 13).

(5) Install outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(6) Install vibration damper.

(7) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(8) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(9) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(10) Connect negative battery cable.

CAMSHAFT(S)

DESCRIPTION

The camshafts are made of gray cast iron with eight machined lobes and four bearing journals (Fig. 14).

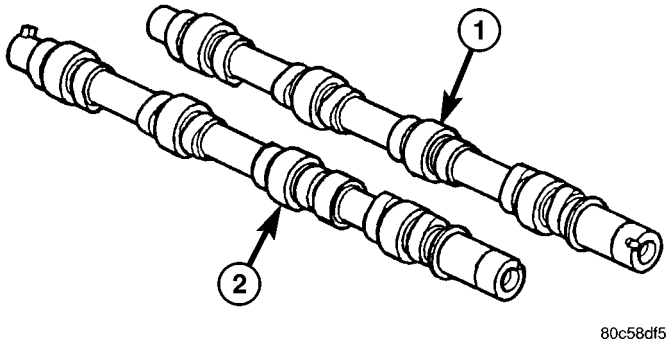

Fig. 14 CAMSHAFTS

1 - INTAKE CAMSHAFT
2 - EXHAUST CAMSHAFT

OPERATION

When the camshaft rotates the lobes actuate the hydraulic lifters and rocker arms, forcing downward on the rocker arms which opens the valves.

REMOVAL

(1) Disconnect negative battery cable.

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

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

(4) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(5) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(6) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(7) Remove vibration damper.

(8) Remove generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).

CAMSHAFT(S) (Continued)

CAUTION: Before removing the cylinder head cover/ intake manifold or timing belt the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

(9) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(10) Remove timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(11) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

(13) With cylinder head cover/intake manifold on work bench, remove plugs at rear of cylinder head cover/intake manifold.

(14) Remove camshaft oil seals (Fig. 15).

(15) Remove snapring and thrust washer from camshaft (Fig. 15).

(16) Slide camshaft through access hole at rear of cylinder head cover/intake manifold.

INSTALLATION

(1) Lubricate camshafts with Mopar® Engine Oil Supplement, or equivalent.

(2) Carefully install camshafts into access holes in rear of cylinder head cover/intake manifold.

(3) Install thrust washer, snapring, and camshaft oil seal (Fig. 15).

(4) Install access hole plugs and gaskets at rear of cylinder head cover/intake manifold. Torque plugs to 80N·m.

(5) Install cylinder head cover/intake manifold on engine block (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(6) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(7) Install timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

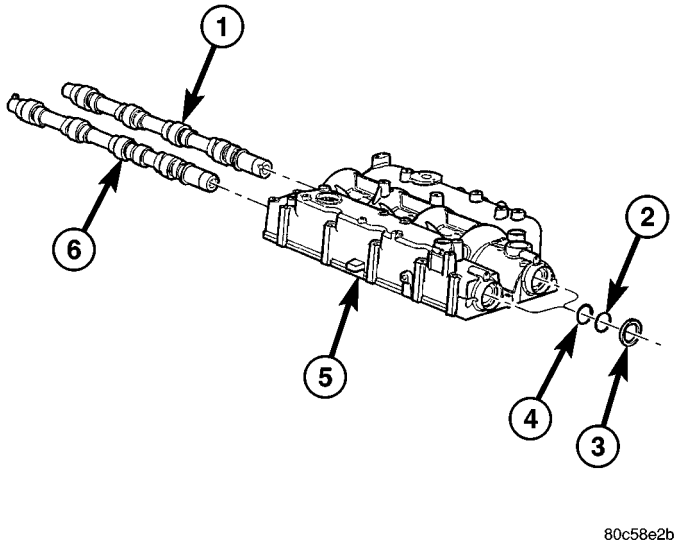

Fig. 15 CAMSHAFT ASSEMBLY

1 - INTAKE CAMSHAFT
2 - SNAPRING
3 - CAMSHAFT OIL SEAL
4 - THRUST WASHER
5 - CYLINDER HEAD COVER/INTAKE MANIFOLD
6 - EXHAUST MANIFOLD

(8) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(9) Install generator (Refer to 8 - ELECTRICAL/ CHARGING/GENERATOR - INSTALLATION).

(10) Install vibration damper.

(11) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(12) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(13) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(14) Refill cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).

(15) Connect negative battery cable.

CYLINDER HEAD COVER

DESCRIPTION

The cylinder head cover is made of cast aluminum and is also the intake manifold on this engine (Fig. 16).

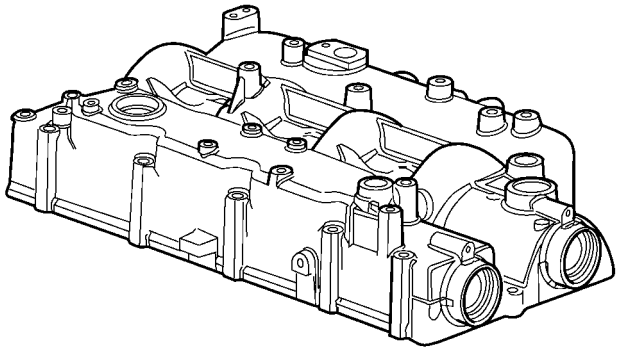

Fig. 16 CYLINDER HEAD COVER/INTAKE MANIFOLD

REMOVAL

CAUTION: Before removing the cylinder head cover/ intake manifold the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

(1) Disconnect negative battery cable.
(2) Remove engine cover and bracket (Refer to 9 - ENGINE - REMOVAL).
(3) Drain cooling system (Refer to 7 - COOLING/ ENGINE/COOLANT - STANDARD PROCEDURE).
(4) Remove cooling fan and fan drive viscous drive assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).
(5) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(6) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(7) Remove generator (Refer to 8 - ELECTRICAL/ CHARGING/GENERATOR - REMOVAL).

CAUTION: Before removing the cylinder head cover/ intake manifold or timing belt the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

(8) Rotate engine until 90° after TDC is reached. Install both camshaft locking pins and the crankshaft locking pin. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)
(9) Remove outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(10) Remove timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(11) Remove inner timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(12) Disconnect camshaft position sensor, boost pressure/intake air temperature sensor, EGR solenoid, and fuel pressure sensor electrical connectors.
(13) Disconnect vacuum lines at EGR solenoid.
(14) Position electrical harness out of way.
(15) Remove fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(16) Remove fuel rail (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL RAIL - REMOVAL).
(17) Remove oil dipstick tube retaining bolt at intake manifold inlet.
(18) Disconnect oil separator outlet hose at separator.
(19) Remove turbo inlet tube retaining bolt at intake manifold.
(20) Disconnect EGR tube at intake manifold inlet tube.
(21) Remove cylinder head cover/intake manifold retaining bolts (Fig. 17).
(22) Lift cylinder head cover/intake manifold from cylinder head (Fig. 17).

NOTE: When removing rocker arm and lifter assemblies, be sure to keep them in order as they were removed from the cylinder head. Always keep lifters in an upright position when removed from cylinder head.

(23) Remove rocker arm and lifter assemblies from cylinder head.
(24) Remove cylinder head cover/intake manifold gasket from cylinder head.

INSTALLATION

(1) Clean and inspect sealing surfaces.
(2) Install new gasket on cylinder head.

CYLINDER HEAD COVER (Continued)

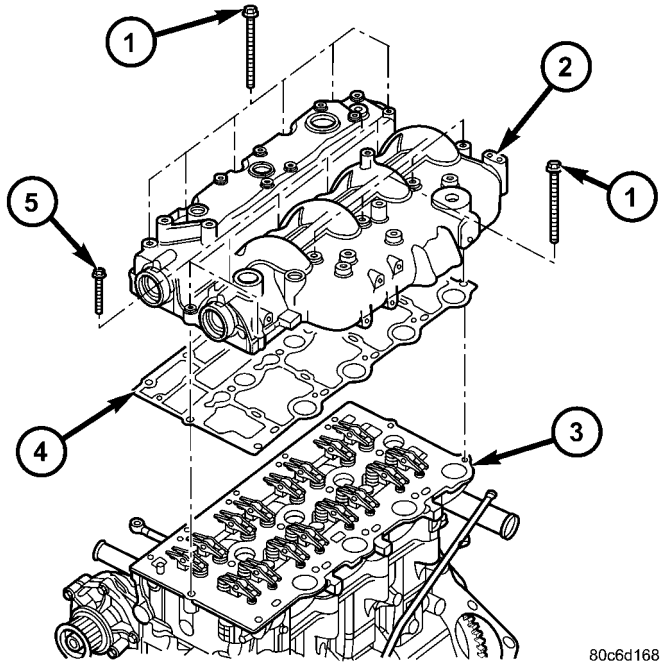

Fig. 17 CYLINDER HEAD COVER/INTAKE MANIFOLD ASSEMBLY

1 - CYLINDER HEAD COVER/INTAKE MANIFOLD BOLTS(LONG)
2 - CYLINDER HEAD COVER/INTAKE MANIFOLD
3 - CYLINDER HEAD
4 - CYLINDER HEAD COVER/INTAKE MANIFOLD GASKET
5 - CYLINDER HEAD COVER/INTAKE MANIFOLD BOLTS(SHORT)

(3) Install rocker arm and lifter assemblies in cylinder head. **Be sure to put rocker arm and lifter assemblies in same location as removed.**

(4) Install cylinder head cover/intake manifold alignment studs in cylinder head (Fig. 18).

(5) Install cylinder head cover/intake manifold over alignment stud.

NOTE: Be sure to lubricate cylinder head cover/intake manifold retaining bolts with engine oil before assembly. If new bolts are being installed, DO NOT lubricate before assembly.

(6) Install two cylinder head cover/intake manifold retaining bolts and tighten finger tight.

(7) Remove alignment studs and install remaining retaining bolts. Tighten retaining bolts finger tight.

(8) Torque cylinder head cover/intake manifold retaining bolts following procedure below.

CYLINDER HEAD COVER/INTAKE MANIFOLD TIGHTENING PROCEDURE

- Alternate between bolts #11 and #16 to seat cylinder head cover/intake manifold on cylinder head (Fig. 19). Torque bolts to 7 N·m.
- Torque all cylinder head cover/intake manifold retaining bolts to 25 N·m in numerical order starting with #1 and ending with #16 (Fig. 19).

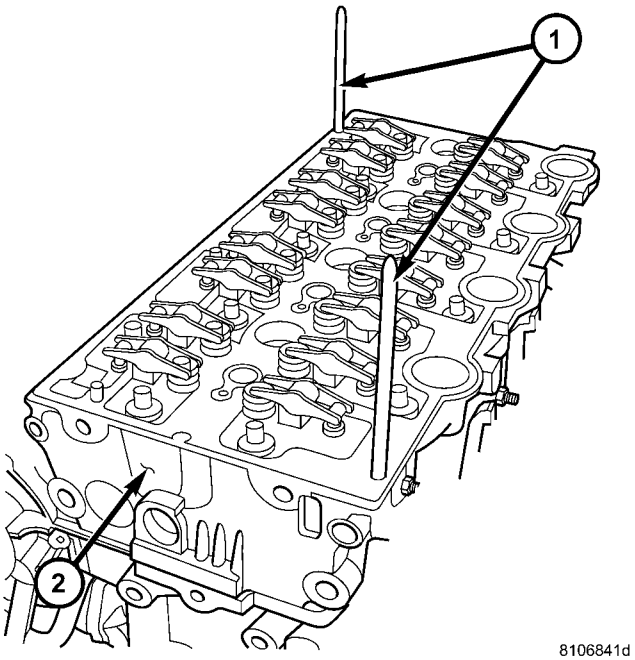

Fig. 18 CYLINDER HEAD COVER ALIGNMENT STUDS VM.1066

1 - CYLINDER HEAD COVER/INTAKE MANIFOLD STUDS VM.1066
2 - CYLINDER HEAD

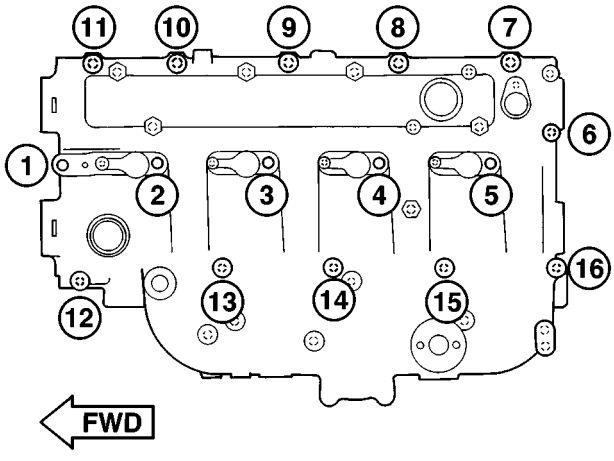

Fig. 19 CYLINDER HEAD COVER/INTAKE MANIFOLD TIGHTENING SEQUENCE

(9) Connect EGR tube at intake manifold inlet tube. Torque clamp to 10.8 N·m.

(10) Install turbo inlet tube retaining bolt at intake manifold. Torque bolt to 27.5 N·m.

CYLINDER HEAD COVER (Continued)

(11) Connect oil separator outlet hose at separator.
(12) Install oil dipstick tube retaining bolt at intake manifold inlet. Torque bolt to 10 N·m.
(13) Install power steering pump reservoir in bracket.
(14) Install fuel rail (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL RAIL - INSTALLATION).
(15) Install fuel injectors and fuel injector supply lines (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).
(16) Connect vacuum lines at EGR solenoid.
(17) Connect camshaft position sensor, boost pressure/intake air temperature sensor, EGR solenoid, and fuel pressure sensor electrical connectors.
(18) Install inner timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
(19) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).
(20) Install outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
(21) Remove crankshaft and both camshaft locking pins (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE).
(22) Install vibration damper.
(23) Install generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).
(24) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).
(25) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(26) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).
(27) Refill cooling system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(28) Install engine cover and bracket (Refer to 9 - ENGINE - INSTALLATION).
(29) Connect negative battery cable.

ROCKER ARMS

DESCRIPTION

The rocker arms are made of stamped steel (Fig. 20).

OPERATION

The rocker arms are used as a link between the camshaft and valves. As the camshaft rotates the lobes of the camshafts apply downward pressure on the rocker arms. This pressure is then transmitted to the valves which causes the valves to open.

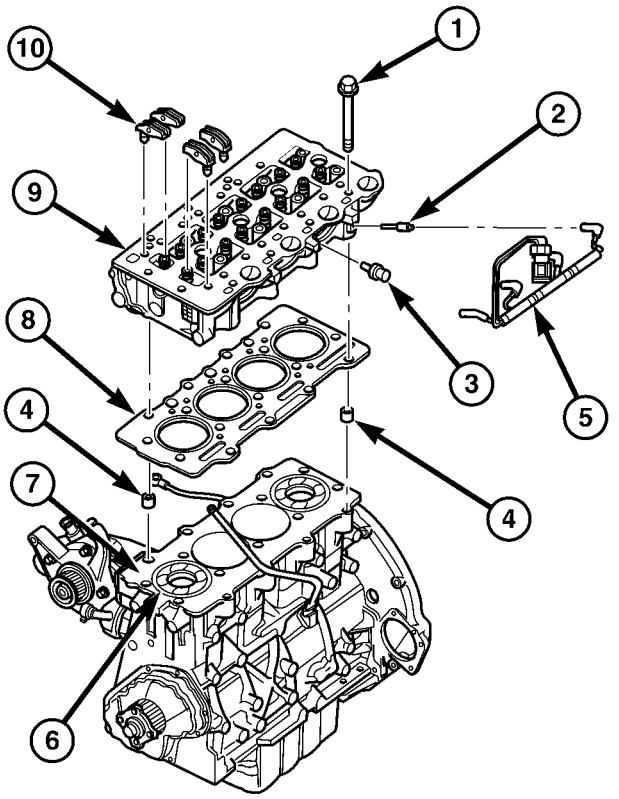

Fig. 20 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

REMOVAL

(1) Disconnect negative battery cable.
(2) Drain cooling system (Refer to 7 - COOLING/ENGINE/COOLANT - STANDARD PROCEDURE).
(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).
(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(6) Remove vibration damper.
(7) Remove outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(8) Remove timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

ROCKER ARMS (Continued)

(9) Remove inner timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

(11) Remove rocker arms from lifters (Fig. 21).

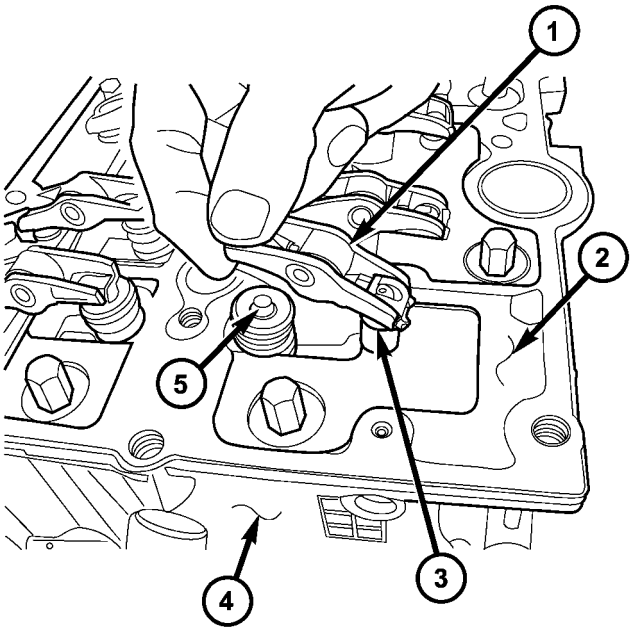

Fig. 21 ROCKER ARM ASSEMBLY

1 - ROCKER ARM ASSEMBLY
2 - CYLINDER HEAD COVER/INTAKE MANIFOLD
3 - HYDRAULIC LIFTER
4 - CYLINDER HEAD
5 - VALVE

INSTALLATION

(1) Clean and inspect gasket sealing surfaces.

(2) Install new gasket on cylinder head.

(3) Lubricate lifter ball end of lifter(s), valve(s), and rocker arm roller(s) with Mopar® Engine Oil Supplement or equivlalent.

(4) Connect rocker arm(s) to lifter and reposition on valve(s).

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

(6) Install inner timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(7) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(8) Install outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(9) Install vibration damper.

(10) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(11) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(12) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

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

(14) Connect negative battery cable.

HYDRAULIC LIFTERS

DESCRIPTION

Valve lash is controlled by hydraulic tappets located inside the cylinder head, in tappet bores below the camshafts (Fig. 22).

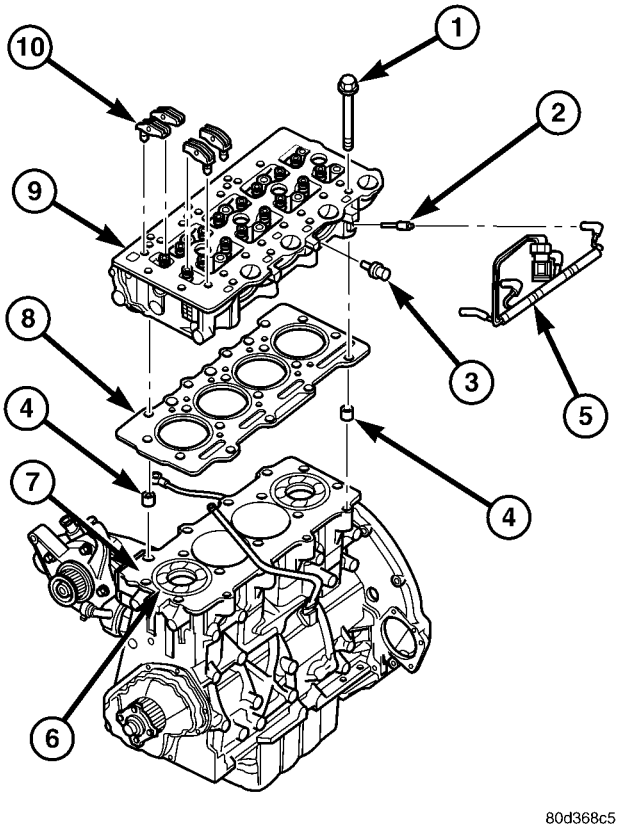

Fig. 22 CYLINDER HEAD ASSEMBLY

1 - CYLINDER HEAD BOLT
2 - GLOW PLUG
3 - COOLANT TEMPERATURE SENSOR
4 - CYLINDER HEAD ALIGNMENT DOWEL
5 - GLOW PLUG HARNESS
6 - CYLINDER LINER
7 - CYLINDER BLOCK
8 - CYLINDER HEAD GASKET
9 - CYLINDER HEAD
10 - ROCKER ARM ASSEMBLIES

HYDRAULIC LIFTERS (Continued)

REMOVAL

(1) (Refer to 9 - ENGINE/CYLINDER HEAD/ ROCKER ARM / ADJUSTER ASSY - REMOVAL)

INSPECTION

Clean each lifter assembly in cleaning solvent to remove all varnish and sludge deposits. Inspect for indications of scuffing on the side and base of each lifter body.

INSTALLATION

(1) (Refer to 9 - ENGINE/CYLINDER HEAD/ ROCKER ARM / ADJUSTER ASSY - INSTALLATION)

ENGINE BLOCK

DESCRIPTION

The 2.5L/2.8L CRD Diesel engine uses a cast iron engine block with wet cast iron cylinder liners (Fig. 23).

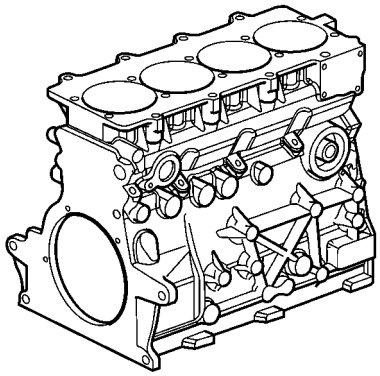

Fig. 23 ENGINE BLOCK

CRANKSHAFT

DESCRIPTION

The crankshaft for the 2.5L and the 2.8L is a forged steel type design with five main bearing journals. The crankshaft is located at the bottom of the engine block and is held in place with three main bearing supports (Fig. 24). There is a difference between crankshafts on the 2.5L and the 2.8L. The 2.5L has a smooth front surface, where as the 2.8L has a groove. The crankshafts ARE NOT interchangeable.

OPERATION

The crankshaft transfers force generated by combustion within the cylinder bores to the flywheel or flexplate.

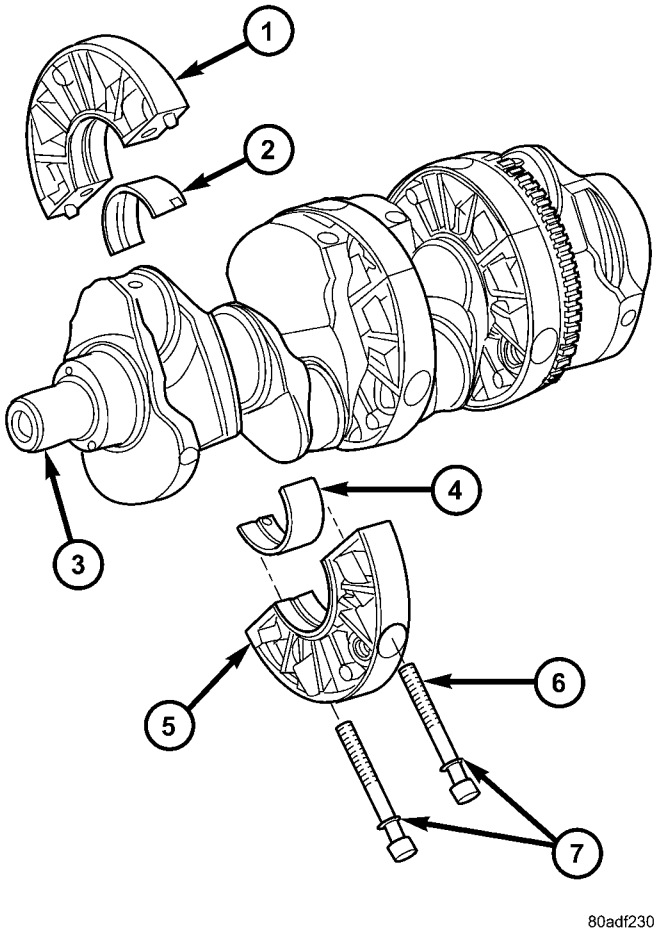

Fig. 24 CRANKSHAFT ASSEMBLY TYPICAL

1 - CRANKSHAFT SUPPORT HALVE
2 - MAIN BEARING HALVE
3 - CRANKSHAFT
4 - MAIN BEARING HALVE
5 - CRANKSHAFT SUPPORT HALVE
6 - MAIN BEARING SUPPORT BOLTS
7 - WASHERS

STANDARD PROCEDURE - CHECKING CRANKSHAFT END PLAY

(1) Mount a dial indicator to a stationary point at rear of engine. Locate the probe perpendicular against the flywheel (Fig. 25).

(2) Move the crankshaft all the way to the front of its travel.

(3) Zero the dial indicator.

(4) Move the crankshaft all the way to the rear and read dial indicator. For crankshaft end play clearances (Refer to 9 - ENGINE - SPECIFICATIONS) .

REMOVAL

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

(2) Mount engine on an engine stand.

CRANKSHAFT (Continued)

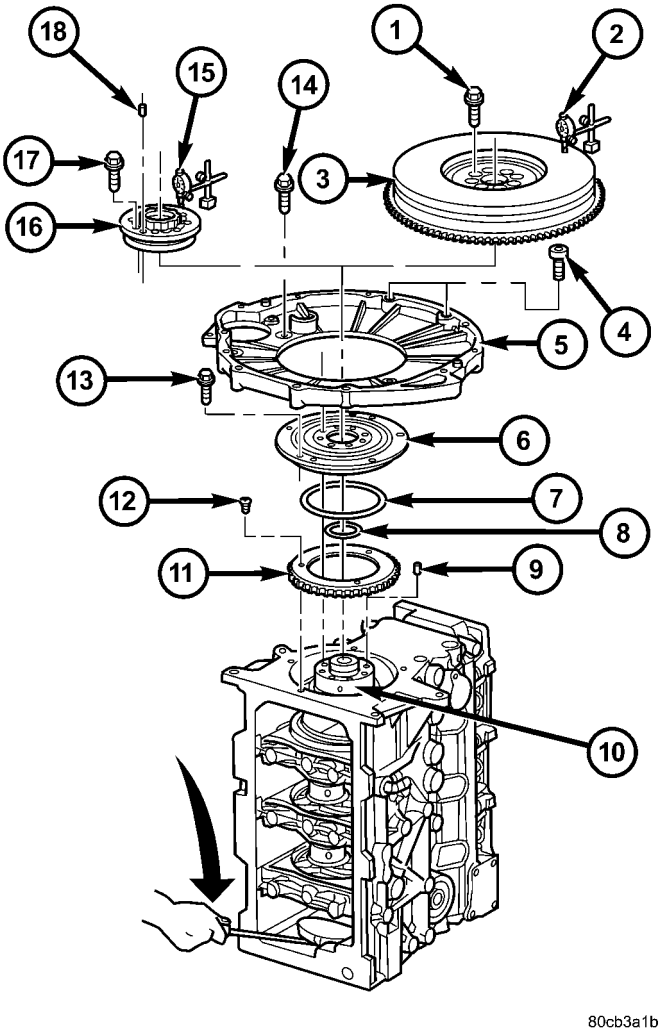

Fig. 25 CHECKING CRANKSHAFT ENDPLAY

1 - FLYWHEEL RETAINING BOLTS
2 - DIAL INDICATOR
3 - FLYWHEEL
4 - TRANSMISSION ADAPTER PLATE BOLT
5 - TRANSMISSION ADAPTER PLATE
6 - REAR MAIN BEARING SUPPORT
7 - O-RING
8 - O-RING
9 - ALIGNMENT DOWEL
10 - CRANKSHAFT
11 - RELUCTOR WHEEL
12 - RELUCTOR WHEEL RETAINING BOLTS
13 - REAR MAIN BEARING SUPPORT RETAINING BOLTS
14 - TRANSMISSION ADAPTER PLATE BOLT
15 - DIAL INDICATOR
16 - FLEXPLATE ADAPTER
17 - FLEXPLATE ADAPTER RETAINING BOLTS
18 - ALIGNMENT DOWEL

(3) Drain engine oil and remove oil filter.

(4) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(5) Remove timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(6) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

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

(9) Remove flywheel.

(10) Remove rear main bearing support/adapter plate retaining bolts and remove adapter plate (Fig. 26).

(11) Remove rear main bearing support by threading two retaining bolts in holes provided. Tighten bolts equally to push main bearing support out of block (Fig. 26).

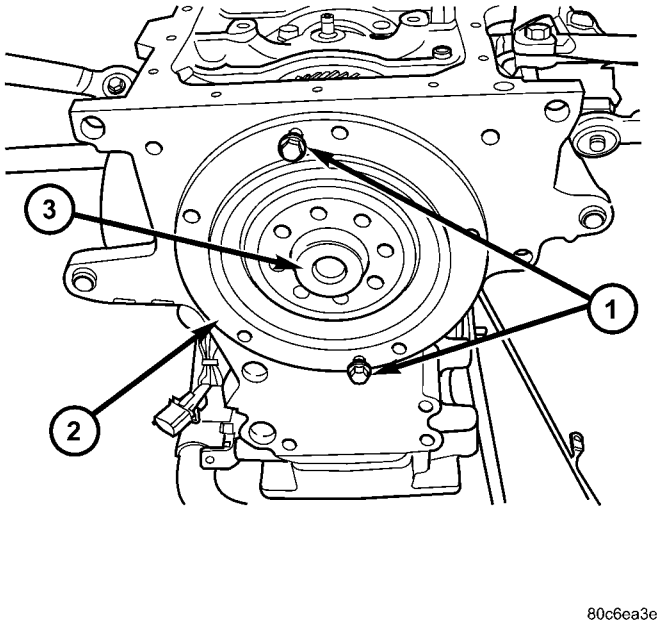

Fig. 26 REAR MAIN BEARING SUPPORT REMOVAL

1 - BOLTS
2 - REAR MAIN BEARING SUPPORT
3 - CRANKSHAFT

(12) Remove front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - REMOVAL).

(13) Remove crankshaft sprocket.

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

(15) Remove oil pump pickup tube (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

CRANKSHAFT (Continued)

(16) Remove balance shaft assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT - REMOVAL).

(17) Remove oil jets (Refer to 9 - ENGINE/LUBRICATION/OIL JET - REMOVAL).

(18) Remove piston and connecting rod assemblies (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - REMOVAL).

(19) Slide special tool VM.1069 on crankshaft (Fig. 27).

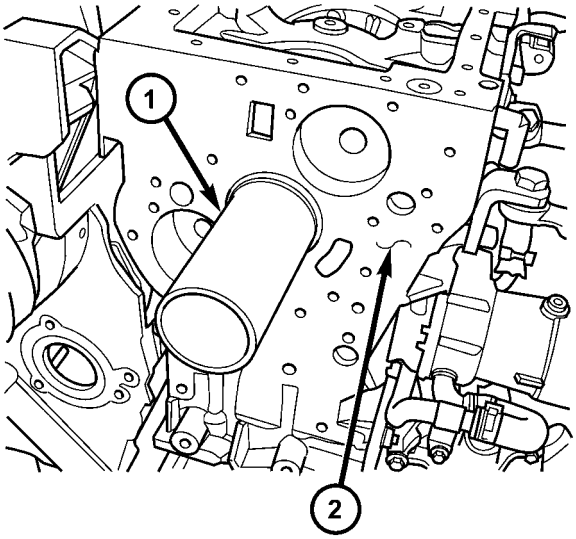

Fig. 27 CRANKSHAFT SLEEVE VM.1069

1 - CRANKSHAFT SLEEVE VM.1069
2 - ENGINE BLOCK

(20) Using special tool VM.1054, remove crankshaft support retainers and o-rings (Fig. 28).

(21) Slide crankshaft out rear of engine block.

INSTALLATION

(1) Install crankshaft in engine block. **Be sure to align oil holes in crankshaft supports and engine block.**

(2) Install crankshaft support retainers (Fig. 29).

(3) Remove special tool VM.1069 from crankshaft (Fig. 27).

(4) Install crankshaft sprocket.

(5) Install front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - INSTALLATION).

(6) Install rear main bearing support in engine block (Fig. 26). **Be sure to align oil hole in rear main bearing support with hole in block.**

(7) Install adapter plate and retaining bolts. Torque bolts to 27.5N·m.

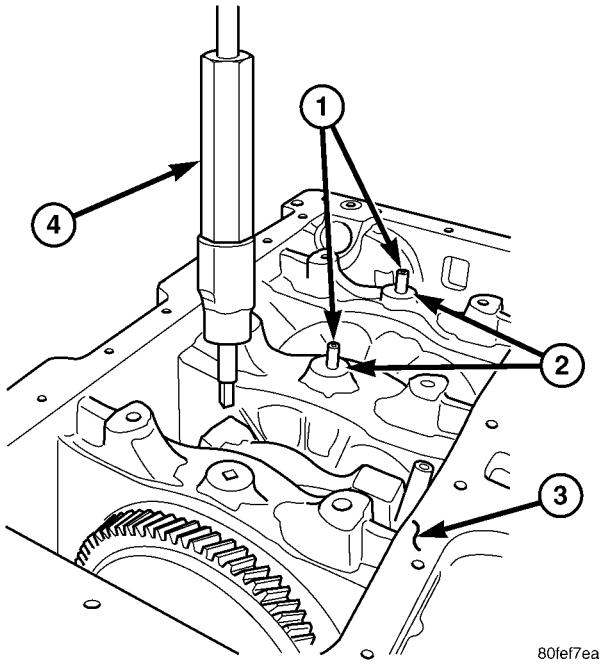

Fig. 28 CRANKSHAFT SUPPORT RETAINERS/ BALANCE SHAFT OIL FEED

1 - CRANKSHAFT SUPPORT RETAINERS/BALANCE SHAFT OIL FEED
2 - O-RINGS (3)
3 - ENGINE BLOCK
4 - CRANKSHAFT SUPPORT RETAINER/BALANCE SHAFT OIL FEED REMOVER - INSTALLER VM.1054

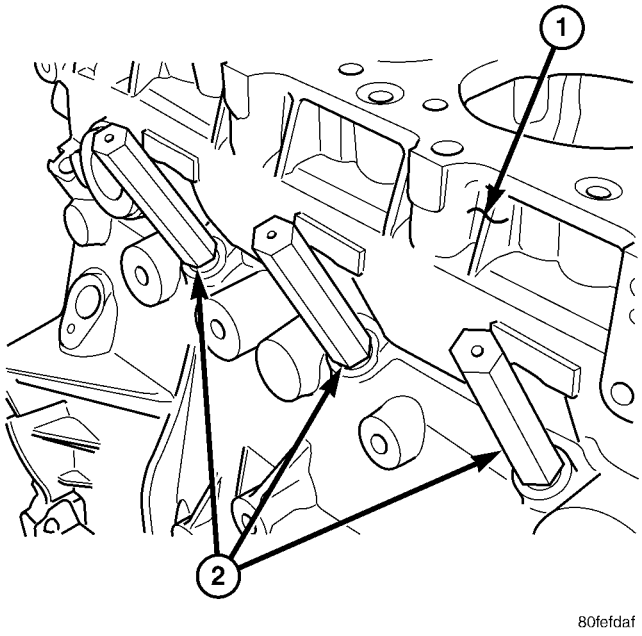

Fig. 29 CRANKSHAFT SUPPORT RETAINERS/ BALANCE SHAFT OIL FEED ALIGNMENT PINS

1 - ENGINE BLOCK
2 - ALIGNMENT PINS VM 1079

CRANKSHAFT (Continued)

(8) Install flywheel.

(9) Install piston and connecting rod assemblies (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - INSTALLATION).

(10) Install oil jets (Refer to 9 - ENGINE/LUBRICATION/OIL JET - INSTALLATION).

(11) Install balance shaft assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT - INSTALLATION).

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

(13) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

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

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

(16) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(17) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(18) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(19) Install engine in vehicle.

(20) Fill engine oil with proper oil to correct level.

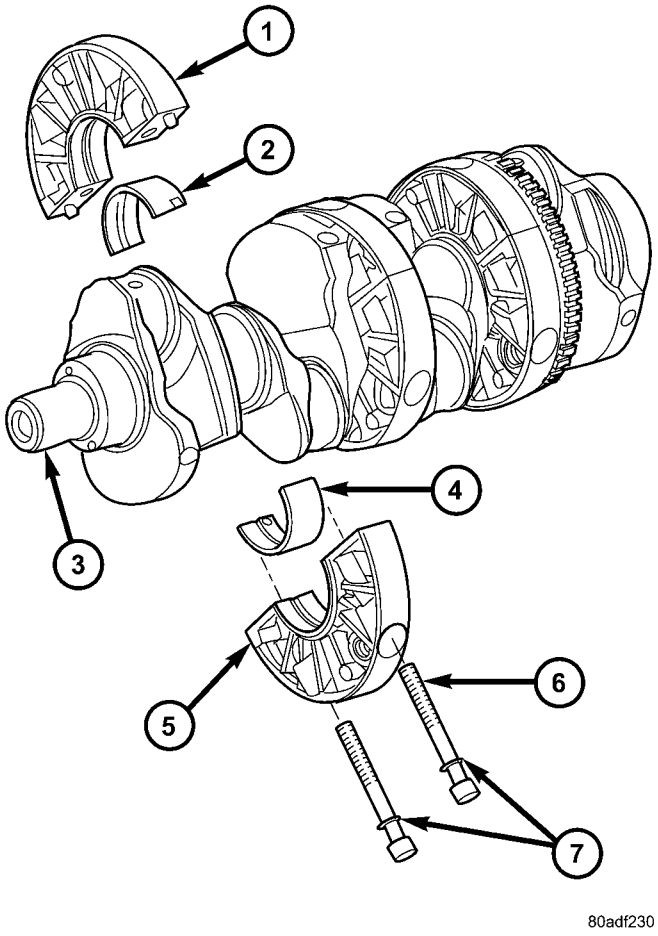

Fig. 30 CRANKSHAFT ASSEMBLY

1 - CRANKSHAFT SUPPORT HALVE
2 - MAIN BEARING HALVE
3 - CRANKSHAFT
4 - MAIN BEARING HALVE
5 - CRANKSHAFT SUPPORT HALVE
6 - MAIN BEARING SUPPORT BOLTS
7 - WASHERS

CRANKSHAFT MAIN BEARINGS

REMOVAL

The engine must be removed from vehicle and completely disassembled to replace the front main bearing.

CRANKSHAFT MAIN BEARINGS

NOTE: Identify the correct crankshaft by noting the smooth surface on the front of the 2.5L crankshaft and the groove on the front of the 2.8L crankshaft.

(1) With crankshaft assembly removed from engine.

(2) Remove crankshaft supports from crankshaft and remove bearing halves from supports (Fig. 30).

CRANKSHAFT MAIN BEARINGS (Continued)

CRANKSHAFT FRONT MAIN BEARING

(1) Using special tool VM.1073 push front main bearing out of front of engine block (Fig. 31).

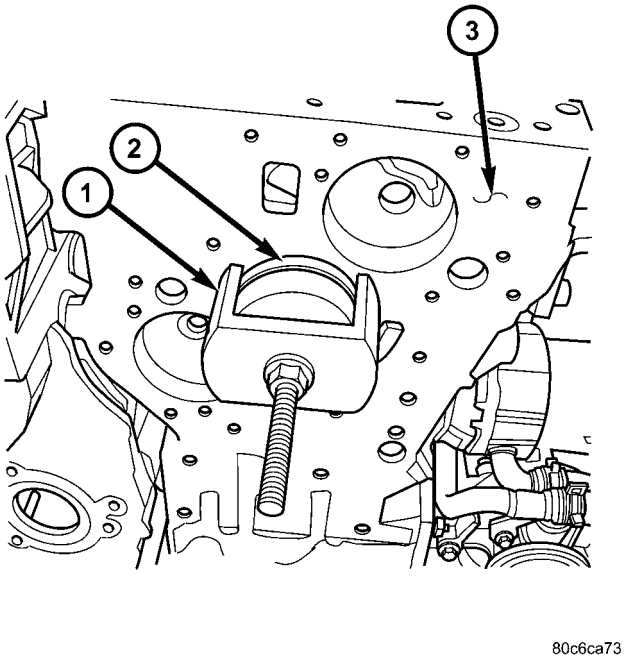

Fig. 31 FRONT MAIN BEARING REMOVAL

1 - VM.1073
2 - FRONT CRANKSHAFT MAIN BEARING
3 - ENGINE BLOCK

INSTALLATION

CRANKSHAFT MAIN BEARINGS

NOTE: Identify the correct crankshaft by noting the smooth surface on the front of the 2.5L crankshaft and the groove on the front of the 2.8L crankshaft.

(1) Install bearing halves in crankshaft supports.

(2) Lubricate crankshaft and main bearings with clean engine oil.

(3) Install crankshaft supports on crankshaft (Fig. 32). Torque bolts to 44.1N·m.

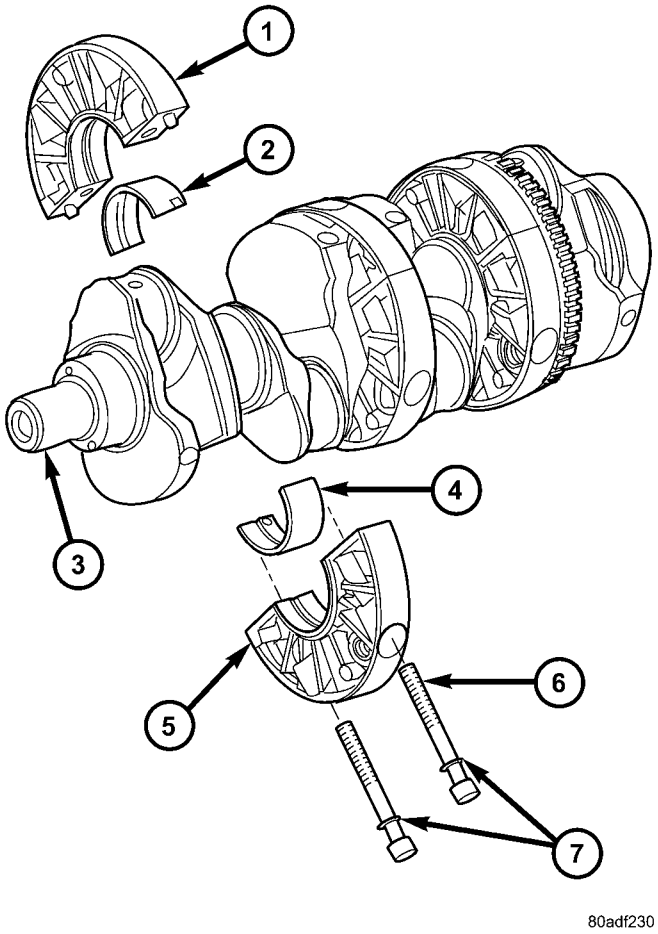

Fig. 32 CRANKSHAFT ASSEMBLY

1 - CRANKSHAFT SUPPORT HALVE
2 - MAIN BEARING HALVE
3 - CRANKSHAFT
4 - MAIN BEARING HALVE
5 - CRANKSHAFT SUPPORT HALVE
6 - MAIN BEARING SUPPORT BOLTS
7 - WASHERS

CRANKSHAFT MAIN BEARINGS (Continued)

FRONT CRANKSHAFT MAIN BEARING

(1) Using special tool VM.1073, push front crankshaft main bearing in engine block (Fig. 33).

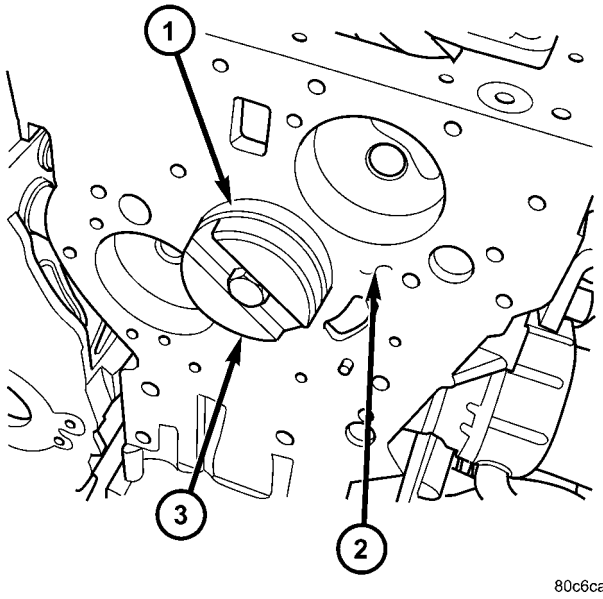

Fig. 33 FRONT MAIN BEARING INSTALLATION

1 - FRONT CRANKSHAFT MAIN BEARING
2 - ENGINE BLOCK
3 - SPECIAL TOOL VM.1073

(2) Be sure oil hole in bearing lines up with oil gallery in engine block (Fig. 34).

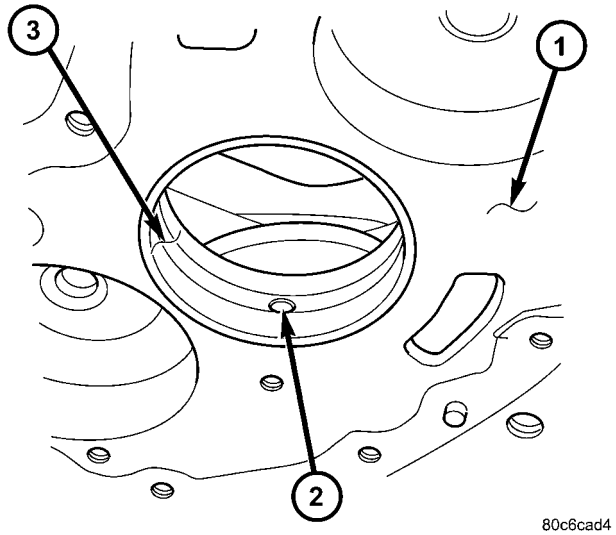

Fig. 34 FRONT MAIN BEARING ALIGNMENT

1 - ENGINE BLOCK
2 - OIL HOLE IN BEARING
3 - FRONT CRANKSHAFT MAIN BEARING

(3) Reassemble engine and install in vehicle.

CRANKSHAFT OIL SEAL - FRONT

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).
(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(4) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(5) Remove vibration damper/crankshaft pulley (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
(6) Remove outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(7) Remove timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(8) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

NOTE: Crankshaft hub retaining bolt has left hand thread.

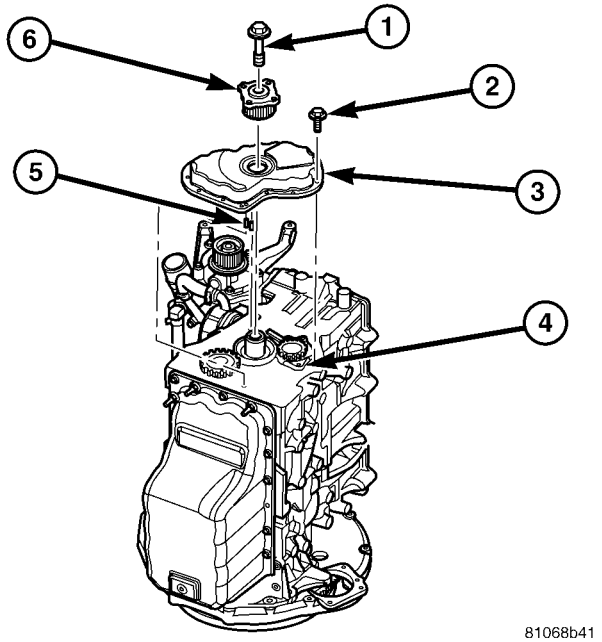

Fig. 35 FRONT ENGINE COVER

1 - CRANKSHAFT HUB RETAINING BOLT
2 - FRONT COVER RETAINING BOLTS
3 - FRONT COVER
4 - ENGINE BLOCK
5 - FRONT ENGINE COVER ALIGNMENT DOWEL
6 - CRANKSHAFT HUB

CRANKSHAFT OIL SEAL - FRONT (Continued)

(9) Remove crankshaft hub.

(10) Remove front engine cover (Fig. 35) (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - REMOVAL) .

(11) With cover on work bench, pry out old seal.

INSTALLATION

CAUTION: Do Not use a hammer to install the crankshaft oil seal.

NOTE: To prevent potential oil leaks, DO NOT touch the front crankshaft inner seal. Always handle the seal from the outer diameter.

(1) Clean engine block and front engine cover sealing surfaces.

(2) Install crankshaft oil seal on VM.1061 (Fig. 36).

(3) Place sleeve for VM.1061 on pressbench as shown (Fig. 36).

(4) Position VM.1061 and press in new seal into front engine cover (Fig. 36).

(5) Install front engine cover on engine (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - INSTALLATION).

(6) Install crankshaft hub and retaining bolt. Torque bolt to 304N·m.

(7) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(8) Install timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(9) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(10) Install vibration damper/crankshaft pulley (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

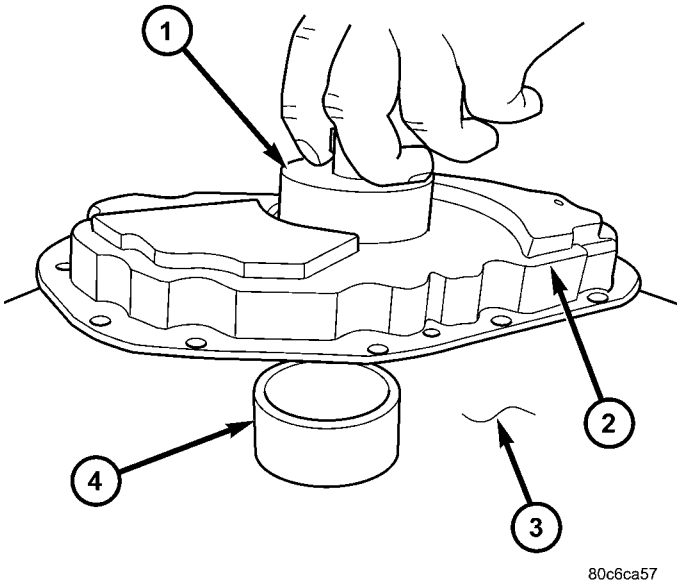

Fig. 36 VM.1061 PLACEMENT

1 - VM.1061
2 - FRONT ENGINE COVER
3 - PRESS BENCH
4 - SLEEVE FROM VM.1061

(11) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(12) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(13) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(14) Connect negative battery cable.

CRANKSHAFT OIL SEAL - REAR

REMOVAL

This must be done with either the engine or transmission removed from vehicle.

(1) Remove flywheel assembly.
(2) Pry out old crankshaft oil seal.

INSTALLATION

NOTE: To prevent potential oil leaks, DO NOT touch the rear crankshaft inner seal. Always handle the seal from the outer diameter.

(1) Using special tool VM.1050, install rear crankshaft oil seal in rear main bearing support (Fig. 37).

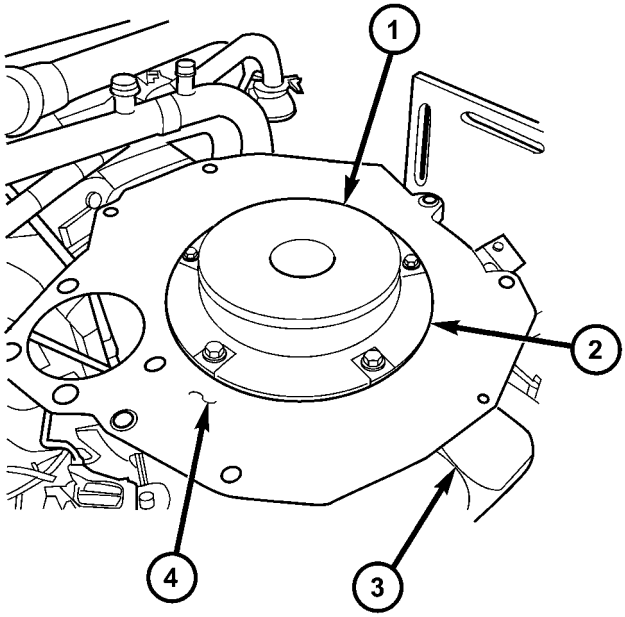

Fig. 37 REAR CRANKSHAFT OIL SEAL INSTALLATION USING VM.1050

1 - SPECIAL TOOL VM.1050
2 - REAR MAIN BEARING SUPPORT
3 - OIL PAN
4 - ENGINE TO TRANSMISSION ADAPTER PLATE

(2) Install engine or tranmission in vehicle.

CYLINDER LINERS

DESCRIPTION

The cylinder wall liner used on this engine is of the wet design. O-rings are used to seal the liner to the engine block.

REMOVAL

(1) Remove engine from vehicle.
(2) With engine completely disassembled, use special tool VM.1001 to remove liner assembly (Fig. 38).

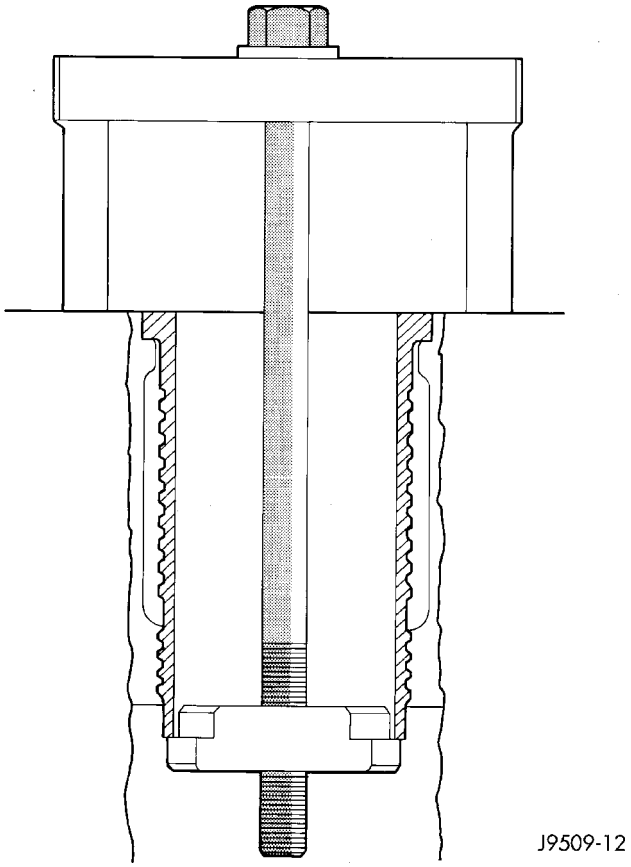

Fig. 38 CYLINDER LINER REMOVER

CYLINDER LINERS (Continued)

(3) Tighten bolt on VM.1001 to remove liner from block (Fig. 39).

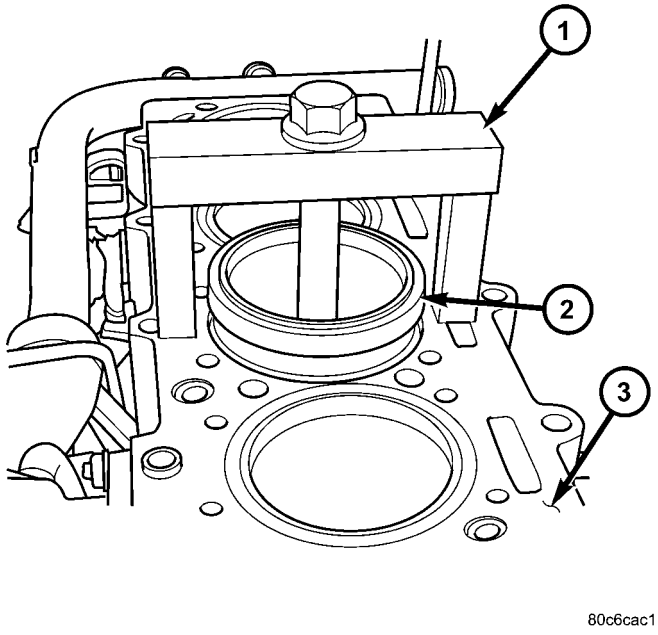

Fig. 39 CYLINDER LINER REMOVAL

1 - SPECIAL TOOL VM.1001
2 - CYLINDER LINER
3 - ENGINE BLOCK

(4) Remove shims from cylinder liner or cylinder block recess. Keep shims with each cylinder liner.

INSPECTION

The cylinder walls should be checked for out-of-round and taper with a dial bore gauge. The cylinder bore out-of-round is 0.100 mm (.0039 in.) maximum and cylinder bore taper is 0.100 mm (.0039 in.) maximum. If the cylinder walls are badly scuffed or scored, new liners should be installed and honed, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B (Fig. 40). Top measurement should be 10 mm (3/8 in.) down and bottom measurement should be 10 mm (3/8 in.) up from the bottom bore.

INSTALLATION

(1) Carefully clean liner and engine block, and degrease the engine block where it comes into contact with the liners. Install the liners in the engine block as shown, rotating them back and forth by 45° in order to guarantee correct positioning (Fig. 41).

NOTE: All Measurements Must Be Taken On the High Pressure Pump Side.

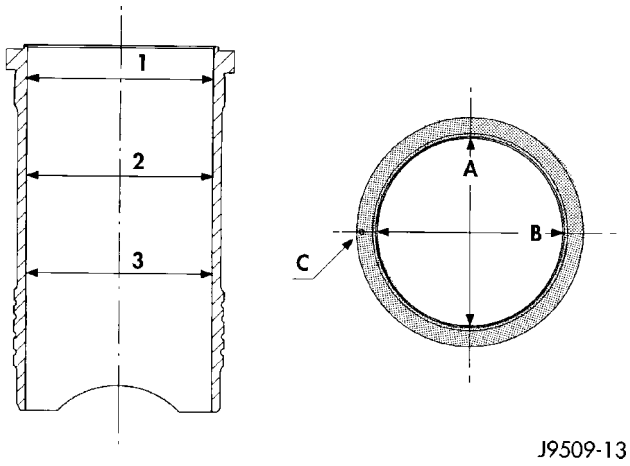

Fig. 40 LINER INSPECTION

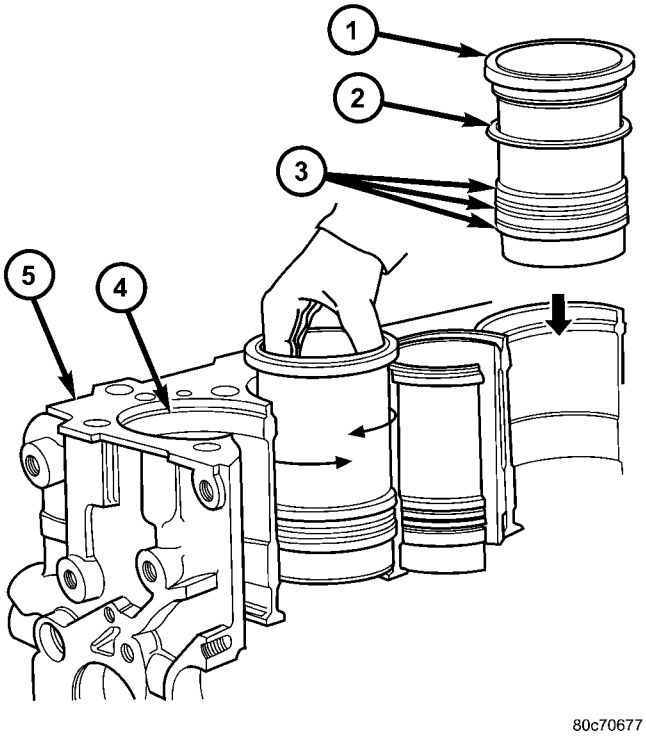

Fig. 41 LINER INSTALLATION

1 - CYLINDER LINER
2 - SHIMS
3 - O-RINGS
4 - BLOCK LEDGE
5 - ENGINE BLOCK

(2) Measure the liner recess relative to block deck with a dial indicator mounted on a special tool VM-1010 A.. Zero dial gauge on block deck.

(3) Move dial gauge to cylinder liner record reading on dial gauge.

(4) Remove liner and special tool.

(5) Then select the correct shim thickness to give proper protrusion (0.00 - 0.05 mm).

(6) Fit the shim and the O-rings onto the liner.

CYLINDER LINERS (Continued)

(7) Lubricate the lower liner location in the block.

(8) Fit the liners in the crankcase making sure that the shim is positioned correctly in the seat. Lock the liners in position using special tool (VM.1076) and bolts (Fig. 42).

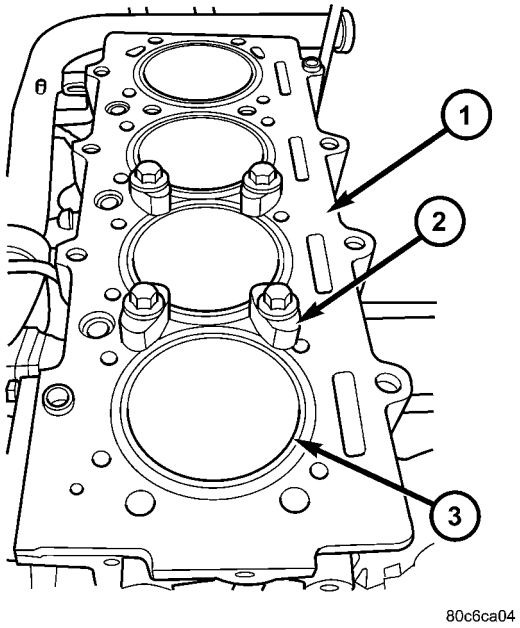

Fig. 42 LINER CLAMP LOCATION

1 - ENGINE BLOCK
2 - LINER RETAINER VM.1076
3 - CYLINDER LINER

(9) Recheck the liner protrusion. It should be 0.00 - 0.05 mm.

(10) Reassemble engine.

(11) Install engine in 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. 43).

STANDARD PROCEDURE - PISTON RING FITTING

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of cylinder bore (Fig. 44). Check gap with feeler gauge. Top compression ring gap .30 to .45mm (.0118 to .0177 in.). Second compression ring gap .30 to .45mm (.0118 to .0177 in.). Oil control ring gap .25 to .50mm (.0098 to .0196 in.).

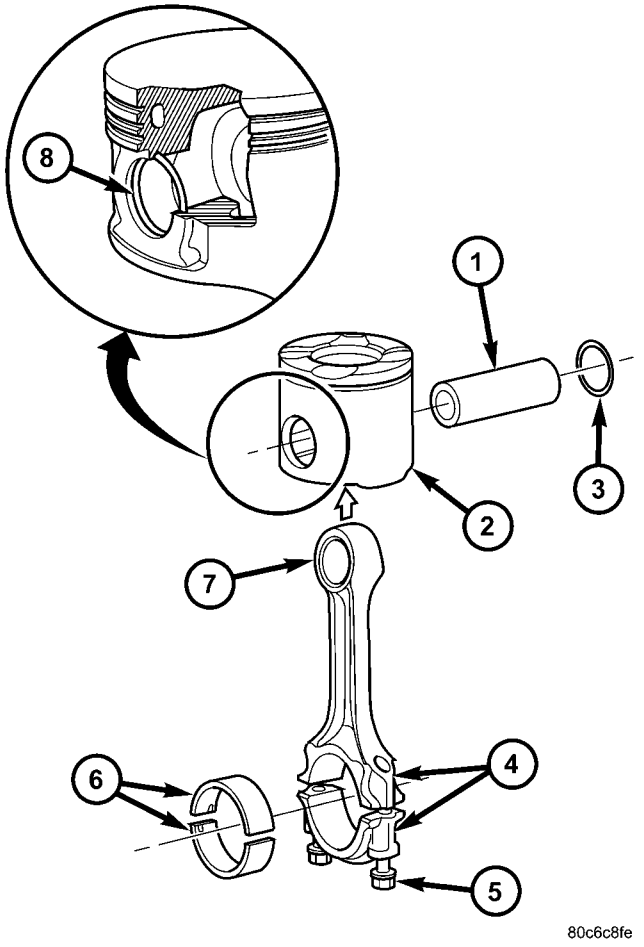

Fig. 43 PISTON AND CONNECTING ROD ASSEMBLY

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

(2) If ring gaps exceed dimension given, new rings or cylinder liners must be fitted. Keep piston rings in piston sets.

(3) Check piston ring to groove clearance (Fig. 45). Top compression ring gap .080 to .130mm (.0031 to .0051 in.). Second compression ring gap .070 to .110mm (.0027 to .0043 in.). Oil control ring gap .040 to .080mm (.0015 to .0031 in.).

REMOVAL

(1) Disconnect negative battery cable.

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

(3) Raise vehicle on hoist.

PISTON & CONNECTING ROD (Continued)

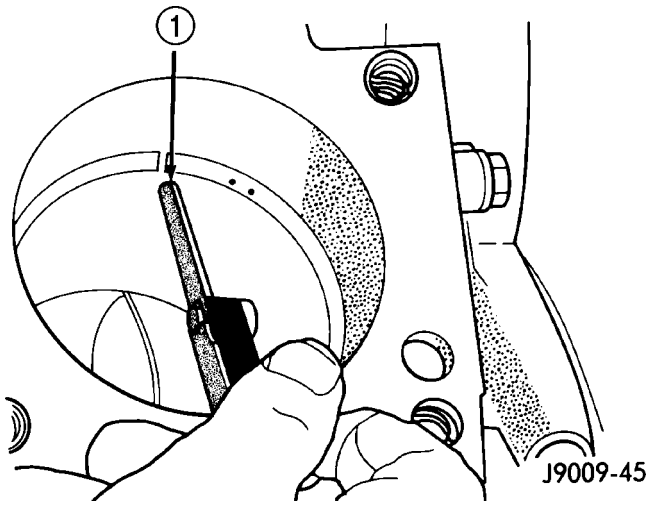

Fig. 44 RING END GAP MEASUREMENT

1 - FEELER GAUGE

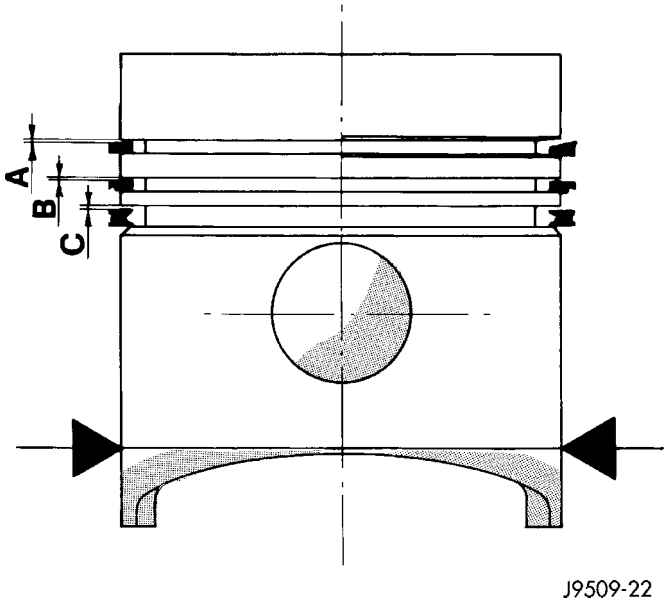

Fig. 45 PISTON RING TO GROOVE CLEARANCE

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

(5) Remove oil pump pickup tube.(Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL)

(6) Remove balance shaft assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT - REMOVAL).

(7) Remove top ridge of cylinder bores with a ridge reamer before removing pistons from cylinder block. **Be sure to keep top of pistons covered during this operation.**

(8) Piston and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.

NOTE: Be careful not to nick or scratch crankshaft journals

(9) After removal, install bearing cap on the mating rod and mark pistons with matching cylinder number when removed from engine block.

PISTON PIN - REMOVAL

(1) Secure connecting rods in a soft jawed vice.

(2) Remove 2 snap rings securing piston pin (Fig. 46).

(3) Push piston pin out of piston and connecting rod (Fig. 46).

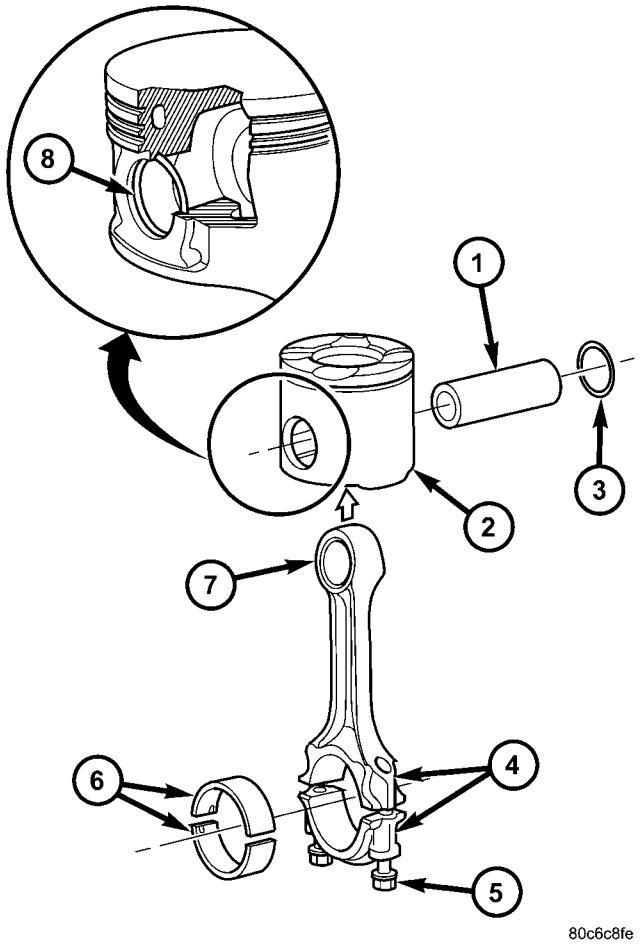

Fig. 46 PISTON AND CONNECTING ROD ASSEMBLY

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

PISTON RING - REMOVAL

(1) ID mark on face of top and second piston rings must point toward piston crown.

PISTON & CONNECTING ROD (Continued)

(2) Using a suitable ring expander, remove top and second piston rings (Fig. 47).

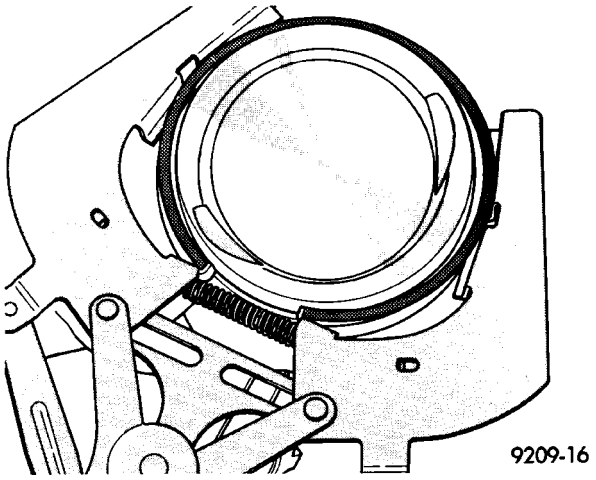

Fig. 47 PISTON RINGS - REMOVAL/INSTALLATION

(3) Remove upper oil ring side rail, lower oil ring side rail and then the oil expander from piston.

(4) Carefully clean carbon from piston crowns, skirts and ring grooves ensuring the 4 oil holes in the oil control ring groove are clear.

INSPECTION

PISTONS

(1) Piston Diameter: Size: 91.912-91.928mm (3.6185-3.6192 in.) Maximum wear limit .05mm (.0019 in.).

(2) Check piston pin bores in piston for roundness. Make 3 checks at 120° intervals. Maximum out of roundness .05mm (.0019in.).

(3) The piston diameter should be measured approximately 15 mm (.590 in.) up from the base.

(4) Skirt wear should not exceed 0.1 mm (.00039 in.).

(5) The clearance between the cylinder liner and piston should not exceed 0.065-0.083 mm (.0025-.0032 in.).

CONNECTING RODS

CAUTION: When assembling the connecting rod, be sure that the pawl on each of the connecting rod caps is facing the rear (fly wheel) side of the engine (Fig. 48).

(1) Assemble bearing shells and bearing caps to their respective connecting rods ensuring that the serrations on the cap and reference marks are aligned (Fig. 48).

(2) Tighten connecting cap bolts to 29 N·m (21 ft. lbs.) plus 60°.

(3) Without loosening connecting rod bolts, tighten all bolts to 88N·m.

(4) Check and record internal diameter of crank end of connecting rod.

CAUTION: When changing connecting rods, DO NOT use a stamp to mark the cylinder location. Identify the connecting rods and caps location using a paint marker. All four must have the same weight and the same number. Replacement connecting rods will only be supplied in sets of four (Fig. 48).

Connecting rods are supplied in sets of four since they all must be of the same weight category. Max allowable weight difference is 5 gr.

NOTE: Lightly heat the piston in oven. Insert piston pin in position and secure it with provided snap rings.

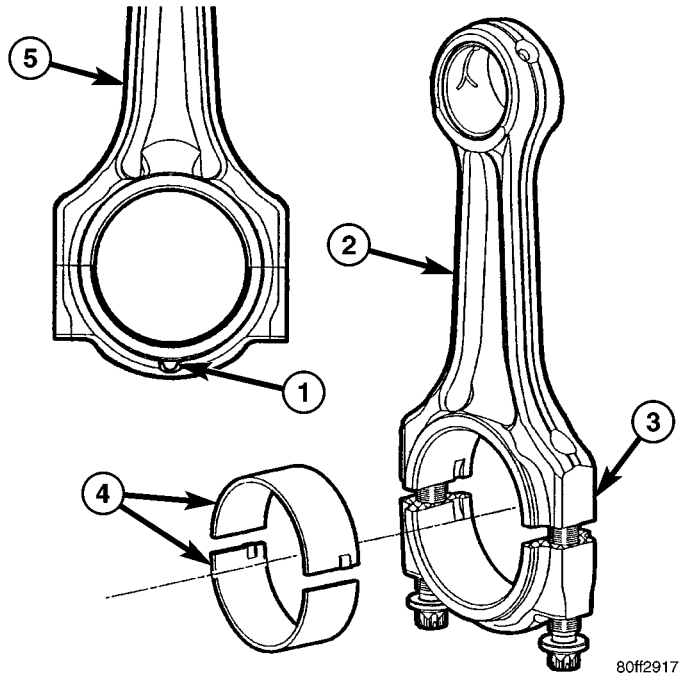

Fig. 48 CONNECTING ROD IDENTIFICATION

1 - CONNECTING ROD PAWL
2 - CONNECTING ROD
3 - PAINTED CYLINDER IDENTIFIER
4 - CONNECTING ROD BEARINGS
5 - CONNECTING ROD

After having coated threads with Molyguard, tighten con rod bolts to 29 N·m (21 ft. lbs.) plus 60°.

PISTON PINS

(1) Measure the diameter of piston pin in the center and both ends.

(2) Piston pin diameter is 31.992 to 31.996mm (1.259524 in to 1.259681 in.).

PISTON & CONNECTING ROD (Continued)

INSTALLATION

PISTON PIN INSTALLATION

(1) Secure connecting rod in soft jawed vice.
(2) Lubricate piston pin and piston with clean engine oil.
(3) Position piston on connecting rod (Fig. 49).

CAUTION: Ensure arrow on piston crown and the bearing cap numbers on the connecting rod are on the opposite side.

(4) Install piston pin (Fig. 49).
(5) Install clips in piston to retain piston pin (Fig. 49).

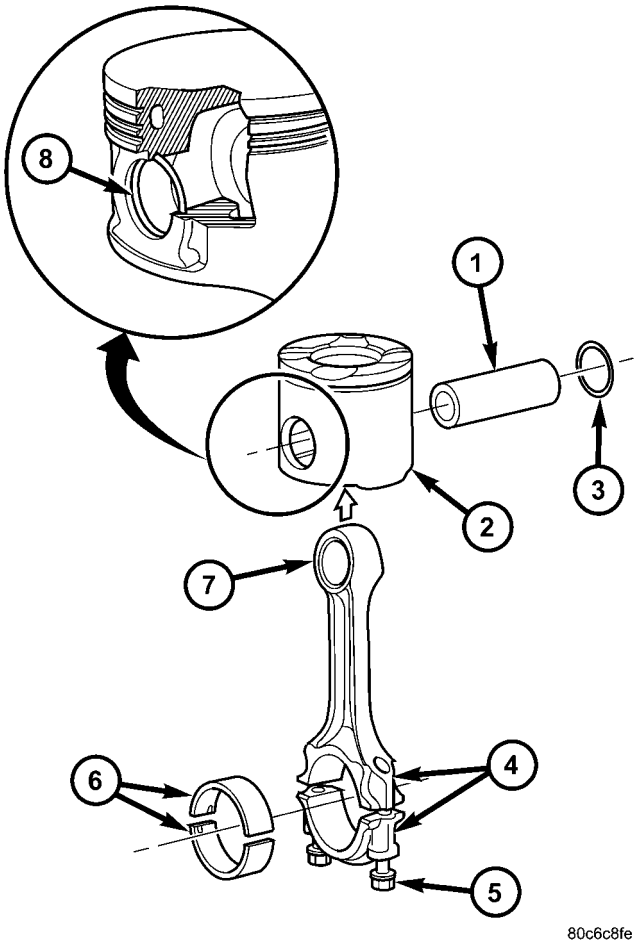

Fig. 49 PISTON AND CONNECTING ROD ASSEMBLY

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

(6) Remove connecting rod from vice.

PISTON RINGS - INSTALLATION

(1) Install rings on the pistons using a suitable ring expander (Fig. 50).

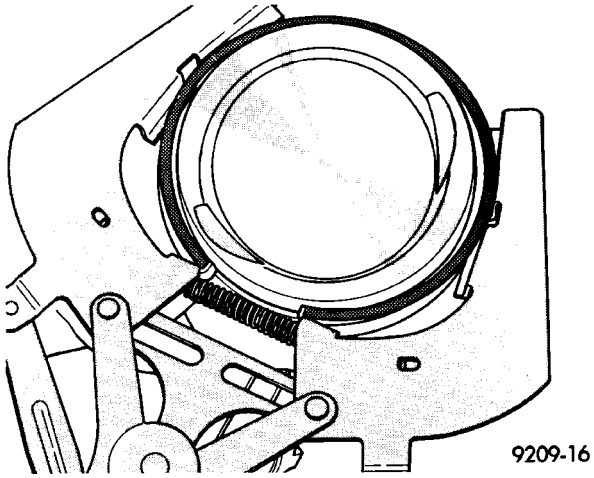

Fig. 50 PISTON RINGS-INSTALLATION

(2) Top compression ring is tapered and chromium plated. The second ring is of the scraper type and must be installed with scraping edge facing bottom of the piston. The third is an oil control ring. Ring gaps must be positioned, before inserting piston into the liners, as follows.
(3) Top ring gap must be positioned at the #3 position (looking at the piston crown from above) (Fig. 51).
(4) Second piston ring gap should be positioned at the #1 position (Fig. 51).
(5) Oil control ring gap should be positioned at the #2 position (Fig. 51).

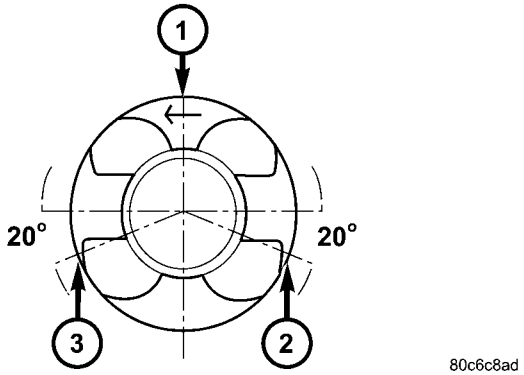

Fig. 51 PISTON RING GAP LOCATION

3 - TOP COMPRESSION RING GAP POSITION
1 - SECOND COMPRESSION RING GAP POSITION
2 - OIL CONTROL RING GAP POSITION

(6) When assembling pistons check that components are installed in the same position as before disassembly, determined by the numbers stamped on the crown of individual pistons. Engine cylinders are numbered starting from gear train end of the engine.

PISTON & CONNECTING ROD (Continued)

Face arrow on top of piston toward front of engine. Therefore, the numbers stamped on connecting rod big end should face toward the injection pump side of engine. To insert piston into cylinder use a ring compressor as shown in (Fig. 52).

INSTALLATION

(1) Before installing pistons, and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap (Fig. 51).

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted together.

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten (Fig. 52). **Ensure position of rings does not change during this operation**.

(4) Face arrow on piston towards front of engine.

NOTE: Be careful not to nick crankshaft journals.

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

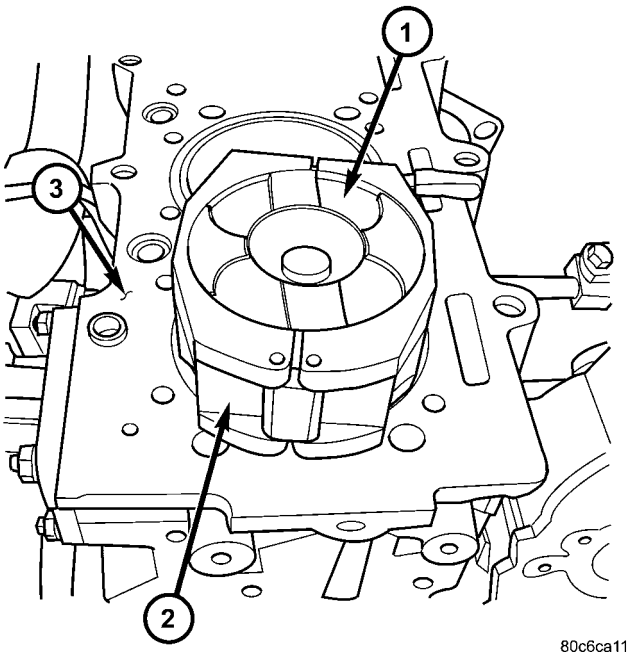

Fig. 52 PISTON INSTALLATION USING VM.1065

1 - PISTON
2 - VM.1065 PISTON RING COMPRESSOR
3 - ENGINE BLOCK

(6) Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

(7) Install connecting rod caps (Fig. 53). Install rod bolts and torque to 10N·m (88 lbs. in.). Torque bolts the next stage to 30N·m (22 ft.lb.) plus 60°. Then torque to 88N·m (65 ft.lb).

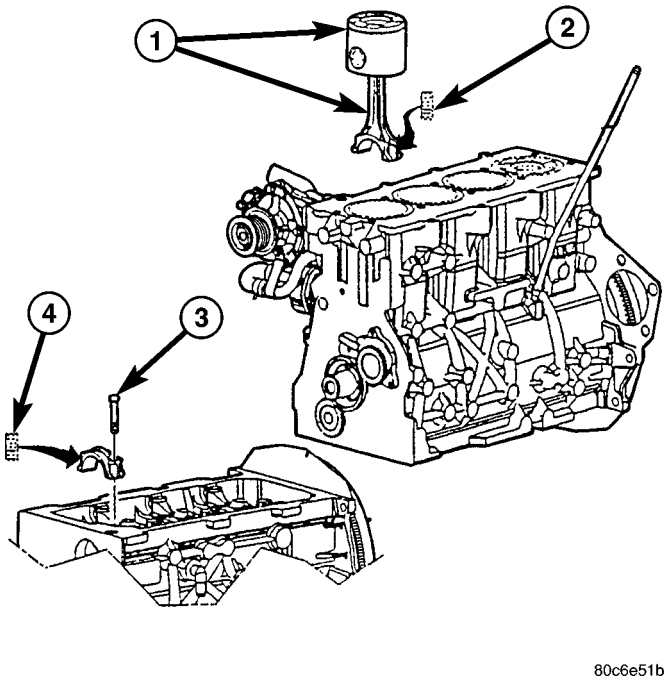

Fig. 53 PISTON AND CONNECTING ROD INSTALLATION

1 - PISTON AND CONNECTING ROD ASSEMBLY
2 - FOUR DIGIT NUMBER
3 - CONNECTING ROD BOLT
4 - FOUR DIGIT NUMBER

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

(9) Install balance shaft assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT - INSTALLATION).

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

(11) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(12) Connect negative battery cable.

VIBRATION DAMPER

REMOVAL

(1) Disconnect negative battery cable.

(2) Remove viscous cooling fan and shrowd (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

VIBRATION DAMPER (Continued)

(4) Remove vibration damper retaining bolts and damper (Fig. 54).

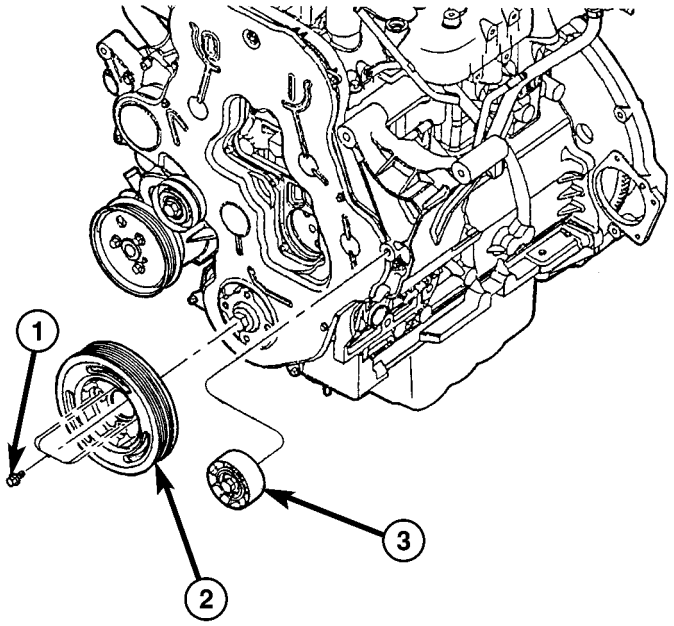

Fig. 54 VIBRATION DAMPER

1 - VIBRATION DAMPER/CRANKSHAFT PULLEY RETAINING BOLTS
2 - VIBRATION DAMPER/CRANKSHAFT PULLEY
3 - IDLER PULLEY

INSTALLATION

(1) Install vibration damper and retaining bolts. Torque bolts to 27.5N·m.

(2) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(3) Install viscous fan and fan shrowd (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(4) Connect negative battery cable.

INTERNAL VACUUM PUMP

DESCRIPTION

The diesel engine uses a internal vacuum pump. This vacuum pump is mounted in the front of the engine block under the engine front cover (Fig. 55). The vacuum pump is driven by a sprocket on the crankshaft.

REMOVAL

(1) Disconnect negative battery cable.

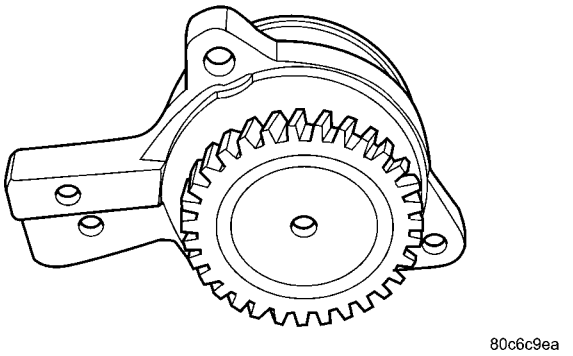

Fig. 55 VACUUM PUMP

(2) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(4) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(5) Remove vibration damper/crankshaft pulley (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(6) Remove outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

(8) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

NOTE: Crankshaft hub has LHD thread.

(9) Remove crankshaft hub.

(10) Remove front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - REMOVAL).

(11) Remove crankshaft sprocket (Fig. 56).

(12) Remove vacuum pump (Fig. 56).

INSTALLATION

NOTE: Verify the 3 blades on the vacuum pump are in place and correctly assembled. The tapered edge should be on the outer side. Make sure the pump rotates before installation.

(1) Lubricate vacuum pump components and install in engine block (Fig. 57). Torque bolts to 10.8N·m.

(2) Install crankshaft sprocket. Torque bolts to 10.8N·m.

INTERNAL VACUUM PUMP (Continued)

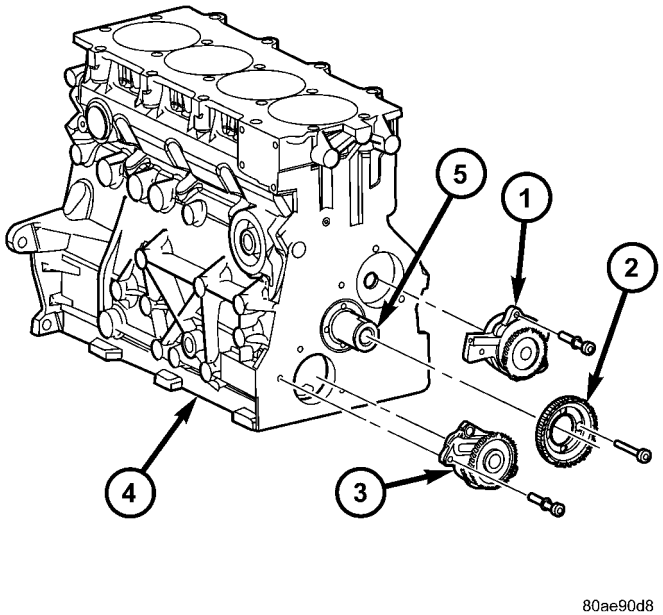

Fig. 56 OIL PUMP AND VACUUM PUMP

1 - VACUUM PUMP
2 - CRANKSHAFT SPROCKET
3 - OIL PUMP
4 - ENGINE BLOCK
5 - CRANKSHAFT

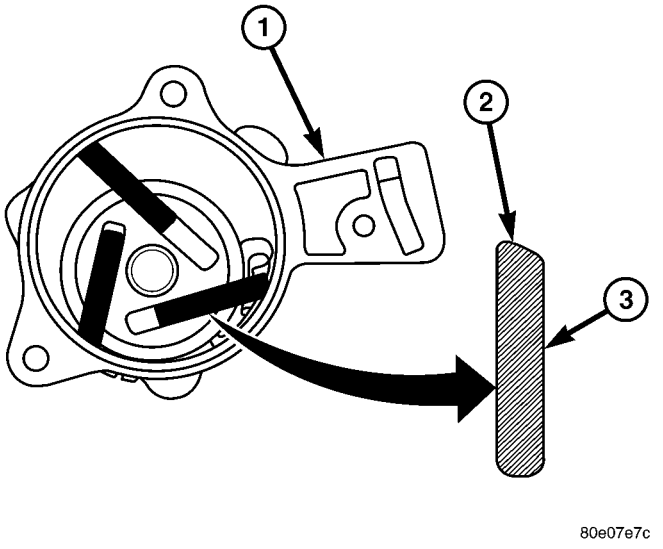

Fig. 57 VACUUM PUMP COMPONENTS

1 - VACUUM PUMP BODY
2 - VACUUM PUMP BLADE TAPERED EDGE
3 - VACUUM PUMP BLADE

(3) Install front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - INSTALLATION).

(4) Install front crankshaft hub. Torque bolt to 304N·m.

(5) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

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

(7) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(8) Install vibration damper/crankshaft pulley (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(9) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(10) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(11) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(12) Connect negative battery cable.

ENGINE COVER - FRONT

DESCRIPTION

The front engine cover on this engine is a stamped steel cover which covers the oil pump and vacuum pump.

REMOVAL

(1) Disconnect negative battery cable.

(2) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(4) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(5) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(6) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

ENGINE COVER - FRONT (Continued)

CAUTION: Before removing the cylinder head cover/ intake manifold or timing belt the engine must put at 90° after TDC. Failure to do so could result in valve and/or piston damage during reassembly. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

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

(8) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

NOTE: Crankshaft hub has left hand thread.

(9) Remove crankshaft hub.

(10) Remove front engine cover (Fig. 58).

INSTALLATION

(1) Clean engine block and front engine cover sealing surfaces.

(2) Apply a continous 3mm bead of Silicone Sealer to cover, install within 10 minutes. Torque bolts to 11.8N·m. (Fig. 58).

(3) Install crankshaft hub. Torque bolt to 304N·m.

(4) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(5) Install timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(6) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION)

(7) Install vibration damper (Refer to 9 - ENGINE/ ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(8) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(9) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

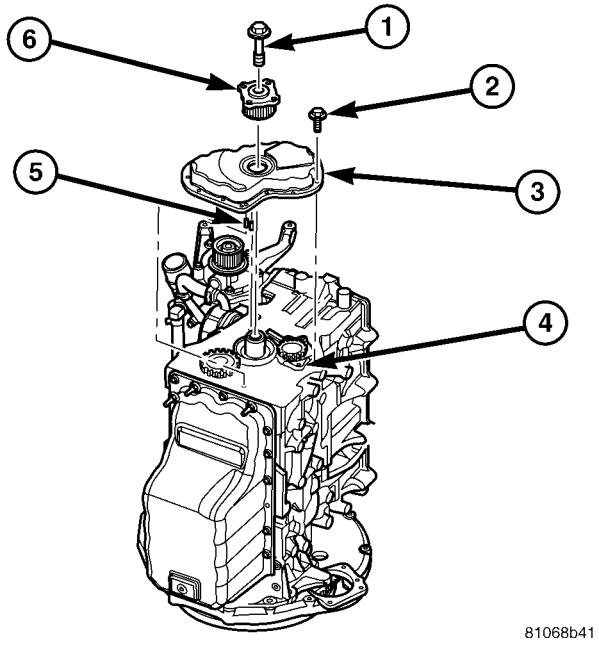

Fig. 58 FRONT ENGINE COVER

1 - CRANKSHAFT HUB RETAINING BOLT
2 - FRONT COVER RETAINING BOLTS
3 - FRONT COVER
4 - ENGINE BLOCK
5 - FRONT ENGINE COVER ALIGNMENT DOWEL
6 - CRANKSHAFT HUB

(10) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(11) Connect negative battery cable.

OIL

DESCRIPTION

Refer to the appropriate owner manual for oil specifications.

OIL FILTER ADAPTER

DESCRIPTION

An oil filter adapter is used on this vehicle to relocate the oil filter for easier access when servicing (Fig. 59).

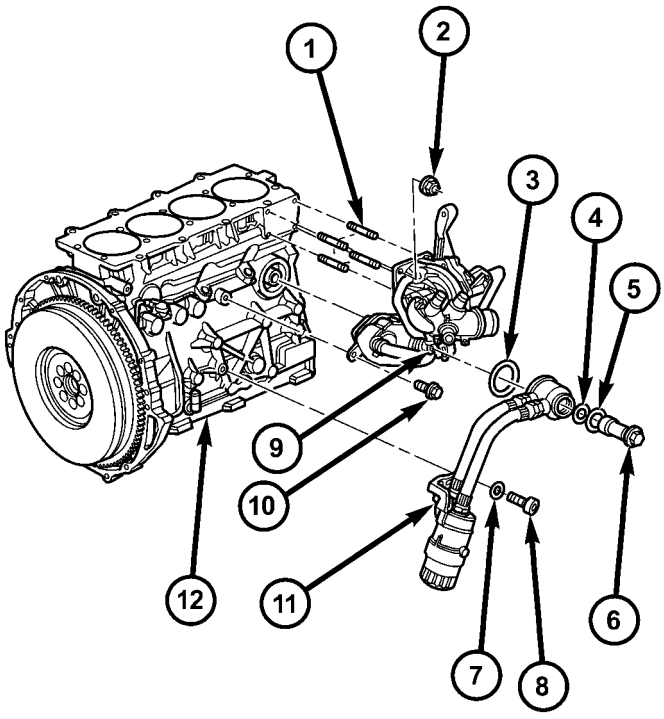

Fig. 59 OIL FILTER ADAPTER

1 - WATER PUMP HOUSING STUDS
2 - WATER PUMP HOUSING RETAINING NUTS
3 - O-RING
4 - O-RING
5 - O-RING
6 - OIL FILTER ADAPTER TO OIL COOLER RETAINING BOLT
7 - LOCK WASHER
8 - OIL FILTER ADAPTER TO ENGINE BLOCK RETAINING BOLT
9 - OIL COOLER ASSEMBLY
10 - OIL COOLER TO ENGINE BLOCK RETAINING BOLT
11 - OIL FILTER ADAPTER ASSEMBLY
12 - ENGINE BLOCK

OIL PAN

REMOVAL

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

NOTE: When installing engine support fixture, care must be taken not to damage the hood ajar switch mounted to the right inner fender.

(3) Install engine support fixture, special tool #8534.
(4) Raise vehicle on hoist.
(5) Remove both front wheel and tire assemblies.
(6) Remove front skid plate (if equipped).
(7) Drain engine oil.
(8) Remove front axle assembly (Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - REMOVAL).
(9) Loosen both engine mount through bolts.
(10) Lower vehicle.
(11) Raise engine using support fixture, special tool #8534, until the viscous fan almost touches the fan shroud.
(12) Raise vehicle on hoist.
(13) Support the front cradle assembly with a suitable lifting devise.
(14) Mark the front cradle to under body position to assure proper alignment during assembly.
(15) Remove both inner rail cradle alignment bolts in the front wheel housing.
(16) Loosen both power steering gear retaining bolts, leave the retaining nuts on the bolts.
(17) Loosen both front cradle mounting bolts.
(18) Loosen both rear cradle mounting bolts.
(19) Remove all oil pan retaining bolts and lower oil pan (Fig. 60).
(20) Lower front cradle using the suitable lifting devise until enough clearance is obtained to remove the oil pan.

INSTALLATION

(1) Clean oil pan and sealing surfaces. Inspect oil pan and engine block.
(2) Install oil pan, gasket, and retaining bolts (Fig. 60).
(3) Torque oil pan bolts to 11.8N·m (104 lbs.in.)..
(4) Raise the front cradle using a suitable lifting devise and align the cradle with the underbody marks made during the removal procedure.
(5) Torque the cradle mounting bolts to 122 N·m (90 lbs. ft.).
(6) Torque the inner rail mounting bolts to 47 N·m (35 lbs. ft.).

OIL PAN (Continued)

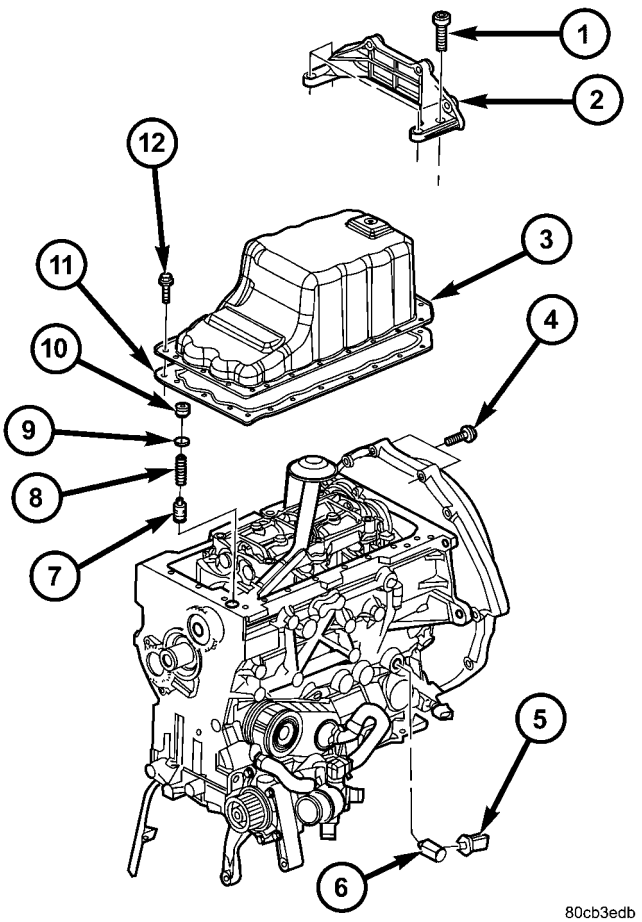

Fig. 60 OIL PAN AND PRESSURE RELIEF VALVE

1 - STRUCTURAL SUPPORT TO ENGINE BLOCK RETAINING BOLT
2 - STRUCTURAL SUPPORT
3 - OIL PAN
4 - STRUCTURAL SUPPORT TO TRANSMISSION ADAPTER PLATE RETAINING BOLT
5 - OIL PRESSURE SWITCH
6 - OIL PRESSURE SWITCH ADAPTER
7 - OIL PRESSURE RELIEF VALVE PLUNGER
8 - OIL PRESSURE RELIEF VALVE SPRING
9 - O-RING
10 - OIL PRESSURE RELIEF VALVE CAP
11 - OIL PAN GASKET
12 - OIL PAN RETAINING BOLTS

(7) Torque the steering gear mounting bolts to 162N·m (120 lbs. ft.).

(8) Remove the cradle support devise and lower the vehicle.

(9) Lower the engine using support fixture, special tool #8534, until the engine mount through bolts are seated in the cradle.

(10) Raise the vehicle.

(11) Torque engine mount through bolts to 88N·m (65 lbs. ft.).

(12) Install front axle assembly(Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - INSTALLATION).

(13) Install front axle skid plate (if equipped)(Refer to 13 - FRAME & BUMPERS/FRAME/FRONT SKID PLATE - INSTALLATION).

(14) Install both front wheel and tire assemblies-(Refer to 22 - TIRES/WHEELS/WHEELS - STANDARD PROCEDURE) tighten to 115–155 N·m (85–115 lbs. ft.).

NOTE: When removing engine support fixture, care must be taken not to damage the hood ajar switch mounted to the right inner fender well (if equipped).

(15) Lower the vehicle and remove the engine support fixture.

(16) Refill engine to proper level with the correct viscosity engine oil.

(17) Connect negative battery cable.

(18) Start engine and inspect for leaks.

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

(20) Perform complete front wheel alignment (Refer to 2 - SUSPENSION/WHEEL ALIGNMENT - STANDARD PROCEDURE).

OIL PRESSURE RELIEF VALVE

DESCRIPTION

The oil pressure relief valve mounts in the front of the engine block and is used to control oil flow through the engines lubrication system (Fig. 61).

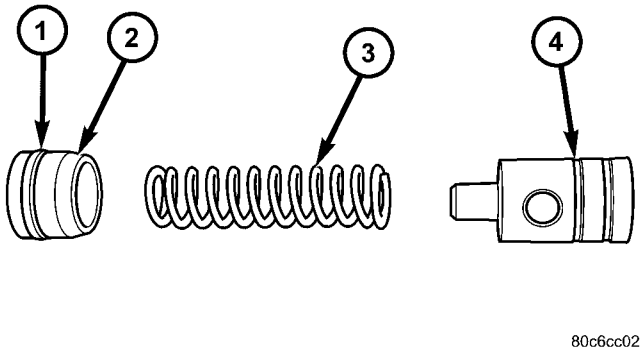

Fig. 61 OIL PRESSURE RELIEF VALVE

1 - O-RING
2 - OIL PRESSURE RELIEF VALVE CAP
3 - OIL PRESSURE RELIEF VALVE SPRING
4 - OIL PRESSURE RELIEF VALVE PLUNGER

OIL PRESSURE RELIEF VALVE (Continued)

REMOVAL

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

(2) Using special tool VM.1054, remove oil pressure relief valve from engine block (Fig. 62).

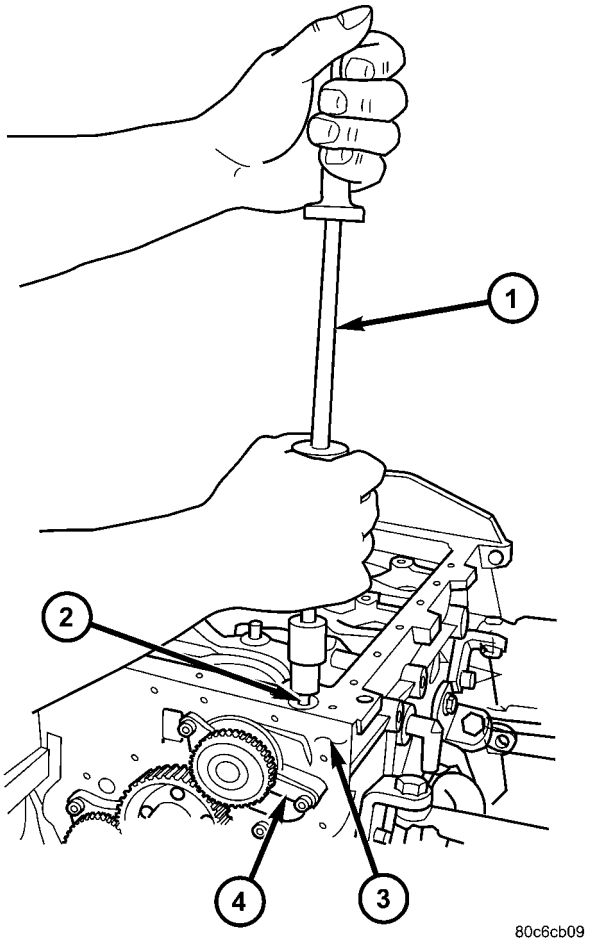

Fig. 62 OIL PRESSURE RELIEF VALVE REMOVAL

1 - VM.1054
2 - OIL PRESSURE RELIEF VALVE
3 - ENGINE BLOCK
4 - OIL PUMP

INSTALLATION

(1) Thoroughly clean all components and relief valve pocket in cylinder block.

(2) Lubricate all oil pressure relief valve components with engine oil.

(3) Install oil pressure relief valve plunger, spring, and cap.

(4) Using special tool VM.1059, push oil pressure relief valve cap in untill flush with engine block (Fig. 63).

(5) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

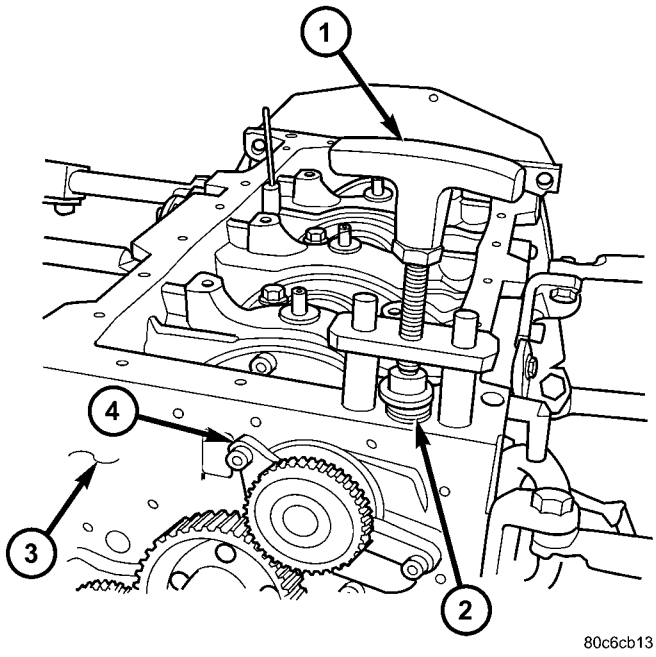

Fig. 63 OIL PRESSURE RELIEF VALVE INSTALLATION

1 - VM.1059
2 - OIL PRESSURE RELIEF VALVE
3 - ENGINE BLOCK
4 - OIL PUMP

OIL PRESSURE SENSOR/ SWITCH

DESCRIPTION

The oil pressure switch is located on the right side of the engine block. The switch screws into the engines main oil gallery.

OPERATION

The oil pressure sensor uses three circuits. They are:

- A signal circuit to the ECM.
- A sensor ground circuit through the ECM.
- A 5 volt reference circuit from the ECM.

The oil pressure sensor returns a voltage signal back to the ECM relating oil pressure. Ground for the sensor is supplied by the ECM.

OIL PUMP

REMOVAL

REMOVAL - OIL PUMP PICKUP TUBE

(1) Disconnect negative battery cable.

(2) Raise vehicle on hoist.

OIL PUMP (Continued)

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

(4) Remove oil pump pickup tube retaining bolt and pull pickup tube from engine block (Fig. 64)

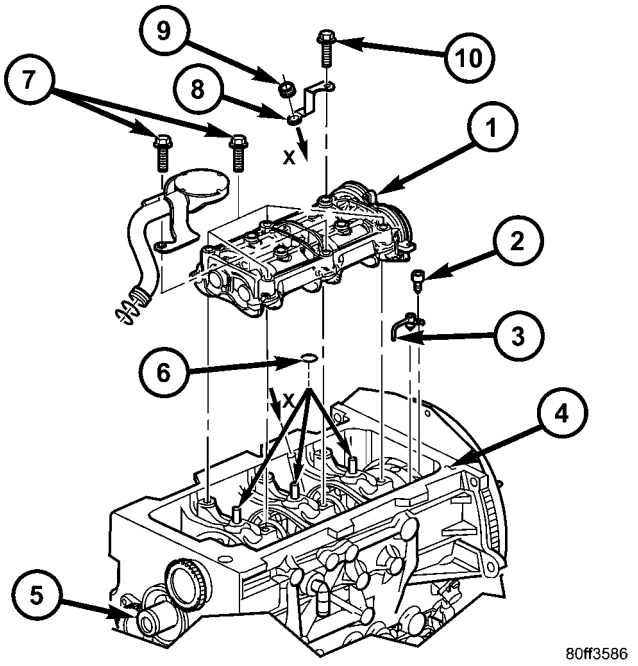

Fig. 64 OIL PUMP PICKUP TUBE ASSEMBLY

1 - BALANCE SHAFT
2 - OIL JET RETAINING BOLT
3 - OIL JET
4 - ENGINE BLOCK
5 - CRANKSHAFT
6 - O- RING(S)
7 - BALANCE SHAFT RETAINING BOLTS
8 - OIL DIPSTICK TUBE RETAINER
9 - RUBBER BUSHING
10 - RETAINING BOLT

REMOVAL - OIL PUMP

(1) Disconnect negative battery cable.

(2) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(3) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(4) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(5) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(6) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

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

(8) Remove timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(9) Remove front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - REMOVAL).

(10) Remove crankshaft sprocket (Fig. 65).

(11) Remove oil pump retaining bolts and remove pump from engine block (Fig. 65).

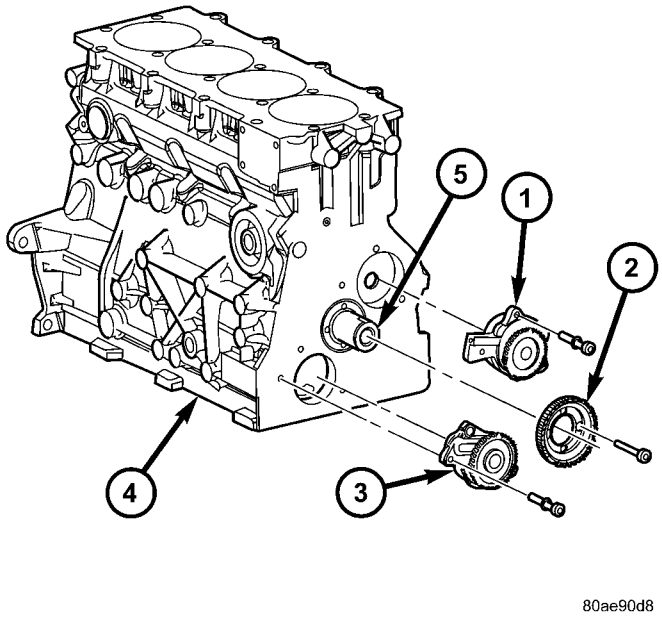

Fig. 65 OIL PUMP AND VACUUM PUMP

1 - VACUUM PUMP
2 - CRANKSHAFT SPROCKET
3 - OIL PUMP
4 - ENGINE BLOCK
5 - CRANKSHAFT

INSTALLATION

INSTALLATION - OIL PUMP PICKUP TUBE

(1) Lubricate o-ring on oil pump pickup tube with engine oil.

(2) Install pickup tube in engine block and install retaining bolt. Torque bolt to 32.4N·m. (Fig. 64).

(3) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(4) Refill engine oil to proper level.

(5) Connect negative battery cable.

INSTALLATION - OIL PUMP

(1) Lubricate oil pump rotor with engine oil.

(2) Install oil pump in bore in engine block.

OIL PUMP (Continued)

(3) Install oil pump retaining bolts. Torque bolts to 10.8N·m.

(4) Install crankshaft sprocket. Torque bolts to 10.8N·m.

(5) Install front engine cover (Refer to 9 - ENGINE/ENGINE BLOCK/ENGINE COVER - INSTALLATION).

(6) Install timing belt inner cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(7) Install timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(8) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(9) Install vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(10) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(11) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(12) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(13) Connect negative battery cable.

OIL JET

DESCRIPTION

There are four oil jets installed in the engine block. These oil jets are used to cool and lubricate the piston assemblies (Fig. 66).

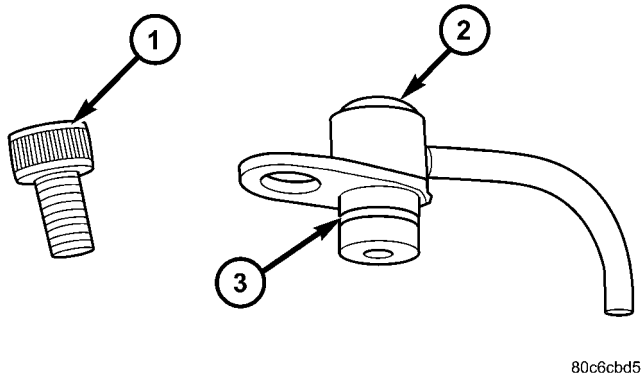

Fig. 66 OIL JET ASSEMBLY

1 - RETAINING BOLT
2 - OIL JET
3 - O-RING

REMOVAL

CAUTION: Use caution when removing and installing oil jets. Damage to oil jet nozzle could cause severe engine damage.

NOTE: Remove oil jets before removing piston, crankshaft liners.

(1) Disconnect negative battery cable.

(2) Raise vehicle on hoist.

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

(4) Using special tool VM.1060 to hold oil jet. Remove oil jet retaining bolt and remove oil jet from engine block (Fig. 67).

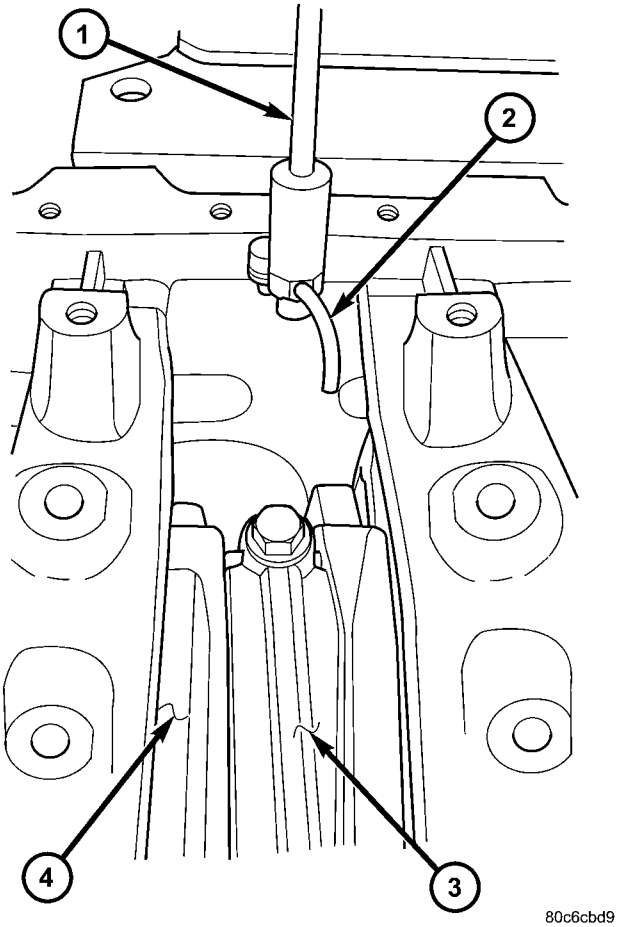

Fig. 67 OIL JET REMOVAL/INSTALLATION

1 - SPECIAL TOOL VM.1060
2 - OIL JET
3 - CONNECTING ROD
4 - CRANKSHAFT

OIL JET (Continued)

INSTALLATION

CAUTION: Use caution when removing and installaing oil jets. Damage to oil jet nozzle could cause severe engine damage.

NOTE: Carefully install the oil jets After assembling the engine liners, crankshaft and pistons.

(1) Lubricate o-ring on oil jet.
(2) Using special tool VM.1060, install oil jet in engine block (Fig. 67).
(3) Install oil jet retaining bolt. Torque bolt to 10.8N·m.
(4) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
(5) Refill engine oil to proper level.
(6) Connect negative battery cable.

INTAKE MANIFOLD

DESCRIPTION

(Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - DESCRIPTION)

REMOVAL

(1) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)

INSTALLATION

(1) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION)

EXHAUST MANIFOLD

REMOVAL

(1) (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL)

INSTALLATION

(1) (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSTALLATION)

VALVE TIMING

STANDARD PROCEDURE - LOCKING ENGINE 90 DEGREES AFTER TDC

(1) Disconnect negative battery cable.
(2) Rotate engine by hand until special tool VM.8873 can be install in engine to transmission adapter plate on right side of engine, looking at the engine from the flywheel. This will lock the engine at 90° after TDC.
(3) Remove engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(4) Remove EGR valve and EGR cooler to exhaust manifold retaining nuts.
(5) Reposition EGR valve assembly out of way.
(6) Remove plug in cylinder head cover/intake manifold and insert VM.1053 to lock exhaust camshaft in position.
(7) Remove generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).
(8) Remove plug in cylinder head cover/intake manifold and insert VM.1052 to lock intake camshaft in position.
(9) At this point the timing belt can be removed for service.
(10) After engine service is completed and timing belt reinstalled, remove both camshaft locking pins from cylinder head cover/intake manifold.
(11) Install both camshaft access plugs.
(12) Remove 90° after TDC engine locking pin.
(13) Install generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).
(14) Install engine cover (Refer to 9 - ENGINE COVER - INSTALLATION).
(15) Connect negative battery cable.

BALANCE SHAFT

DESCRIPTION

The 2.5L and 2.8L Common Rail Diesel engine is equipped with two nodular cast iron balance shafts in a cast aluminum carrier. The balance shaft assembly is mounted to the engine block (Fig. 68).

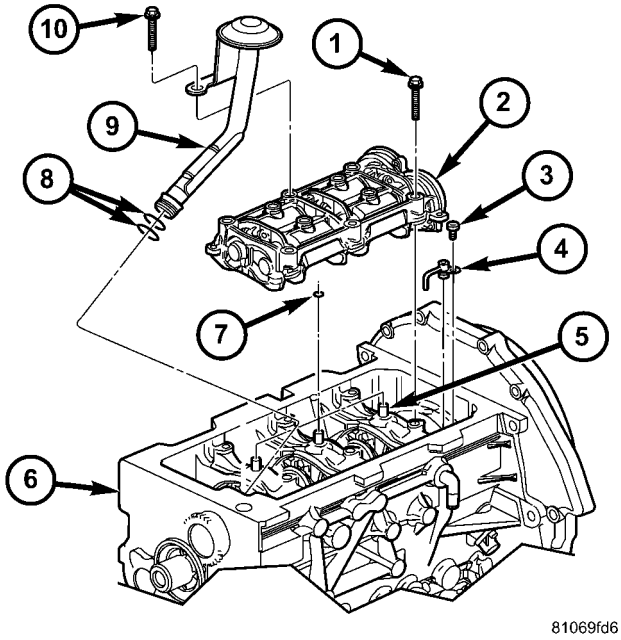

Fig. 68 OIL PICK-UP TUBE AND BALANCE SHAFT ASSEMBLY

1 - BALANCE SHAFT RETAINING BOLTS
2 - BALANCE SHAFT ASSEMBLY
3 - OIL JET RETAINING BOLT
4 - OIL JET
5 - CENTRAL CARRIER PINS
6 - ENGINE BLOCK
7 - CENTRAL CARRIER PIN O-RINGS
8 - OIL PUMP PICK UP TUBE O-RINGS
9 - OIL PUMP PICK-UP TUBE
10 - OIL PICK UP TUBE RETAINING BOLT

OPERATION

The balance shaft is driven by the crankshaft. The balance shafts are connected by heelical gears. The dual-counter rotating shafts decrease second order vertical shaking forces caused by component movement.

REMOVAL

(1) Disconnect negative battery cable.
(2) Raise vehicle on hoist.
(3) Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
(4) Remove oil pump pickup tube (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).
(5) Remove balance shaft assembly (Fig. 69).

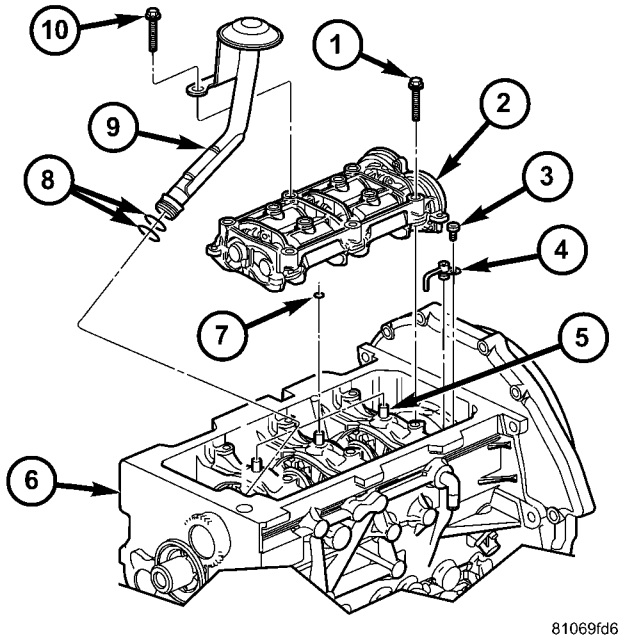

Fig. 69 OIL PICK-UP TUBE AND BALANCE SHAFT ASSEMBLY

1 - BALANCE SHAFT RETAINING BOLTS
2 - BALANCE SHAFT ASSEMBLY
3 - OIL JET RETAINING BOLT
4 - OIL JET
5 - CENTRAL CARRIER PINS
6 - ENGINE BLOCK
7 - CENTRAL CARRIER PIN O-RINGS
8 - OIL PUMP PICK UP TUBE O-RINGS
9 - OIL PUMP PICK-UP TUBE
10 - OIL PICK UP TUBE RETAINING BOLT

INSTALLATION

(1) Before installation of the balance shaft assembly, the # 1 cylinder must be brought to TDC. Using special tool VM.8872, roll engine over by hand until tool can be inserted into engine to transmission adpater plate locking flywheel from turning. Once the # 1 cylinder is brought to TDC, the balance shaft assembly can be installed (Fig. 70).

BALANCE SHAFT (Continued)

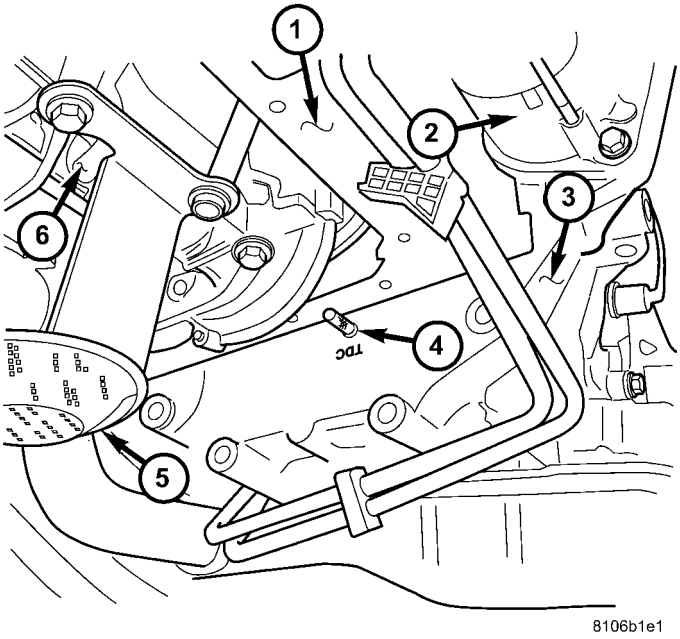

Fig. 70 TDC ALIGNMENT

1 - ENGINE BLOCK
2 - STARTER
3 - STRUCTURAL SUPPORT
4 - TDC ALIGNMENT PIN
5 - ENGINE OIL PICK UP TUBE
6 - BALANCE SHAFT ASSEMBLY

(2) With balance shaft assembly on work bench. Insert special tool VM.1056 into balance shaft assembly (Fig. 71). This will ensure proper balance shaft and crankshaft timing after assembly.

(3) Install balance shaft assembly and retaining bolts. Torque bolts to 32.4N·m.

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

(5) Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(6) Refill engine oil to proper level.

(7) Connect negative battery cable.

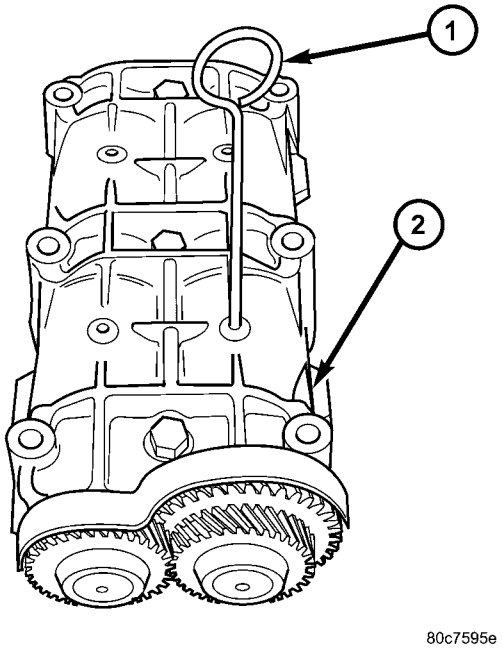

Fig. 71 BALANCE SHAFT ALIGNMENT PIN VM.1056

1 - VM.1056
2 - BALANCE SHAFT ASSEMBLY

TIMING BELT / CHAIN COVER(S)

REMOVAL

REMOVAL - TIMING BELT INNER COVER

(1) Disconnect negative battery cable.

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

(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(6) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

TIMING BELT / CHAIN COVER(S) (Continued)

(7) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(8) Remove timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(9) Remove timing belt idler pulleys (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT IDLER PULLEY - REMOVAL).

(10) Using special tool VM.1055, remove camshaft sprockets (Fig. 72).

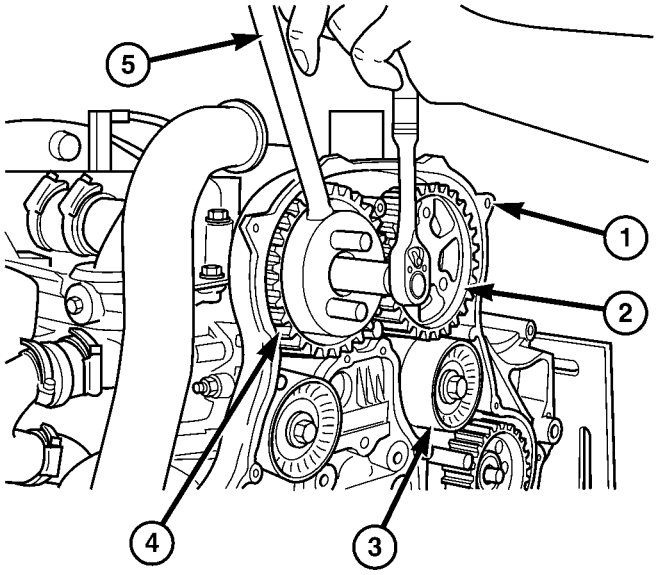

Fig. 72 CAMSHAFT SPROCKET REMOVAL/ INSTALLATION

1 - TIMING BELT INNER COVER
2 - CAMSHAFT SPROCKET
3 - IDLER PULLEYS
4 - CAMSHAFT SPROCKET
5 - VM.1055

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

(12) Remove injection pump sprocket (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).

(13) Remove timing belt inner cover retaining bolts and remove cover (Fig. 73).

REMOVAL - TIMING BELT OUTER COVER

(1) Disconnect negative battery cable.

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

(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/ FAN DRIVE VISCOUS CLUTCH - REMOVAL).

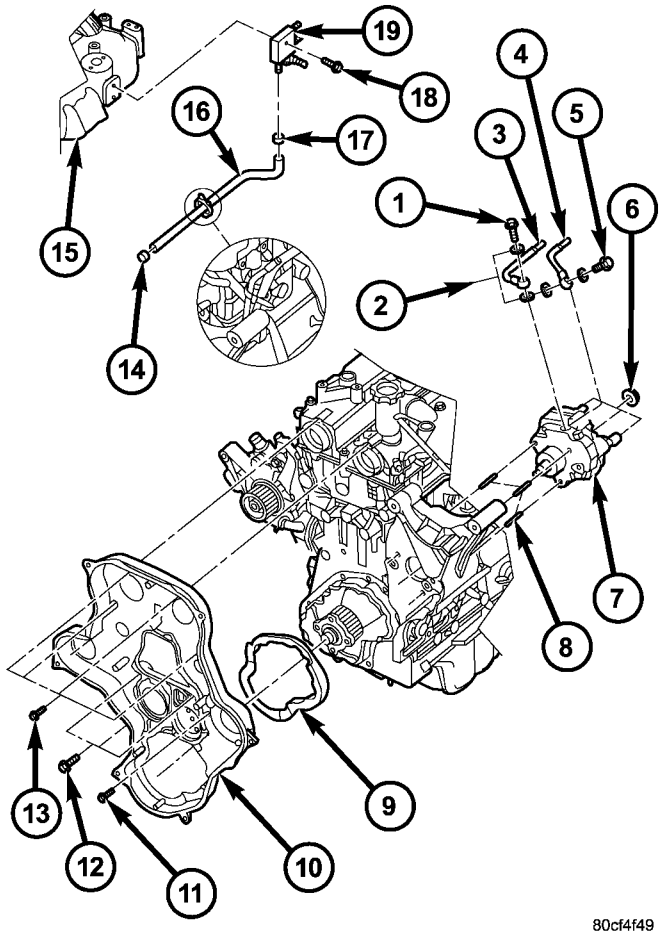

Fig. 73 TIMING BELT COVER - INNER

1 - BANJO FITTING
2 - BRASS WASHERS
3 - FUEL INLET LINE
4 - FUEL OUTLET LINE
5 - BANJO FITTING
6 - INJECTION PUMP RETAINING NUT
7 - INJECTION PUMP
8 - MOUNTING STUDS
9 - INNER TIMING COVER SEAL
10 - INNER TIMING COVER
11 - RETAINING BOLT
12 - RETAINING BOLT
13 - RETAINING BOLT
14 - HOSE CLAMP
15 - CYLINDER HEAD COVER/INTAKE MANIFOLD
16 - FUEL RETURN LINE TO INJECTION PUMP
17 - HOSE CLAMP
18 - FUEL RETURN JUNCTION BLOCK RETAINING BOLT
19 - FUEL RETURN JUNCTION BLOCK

(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(6) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(7) Remove timing belt outer cover retaining bolts and remove cover (Fig. 74).

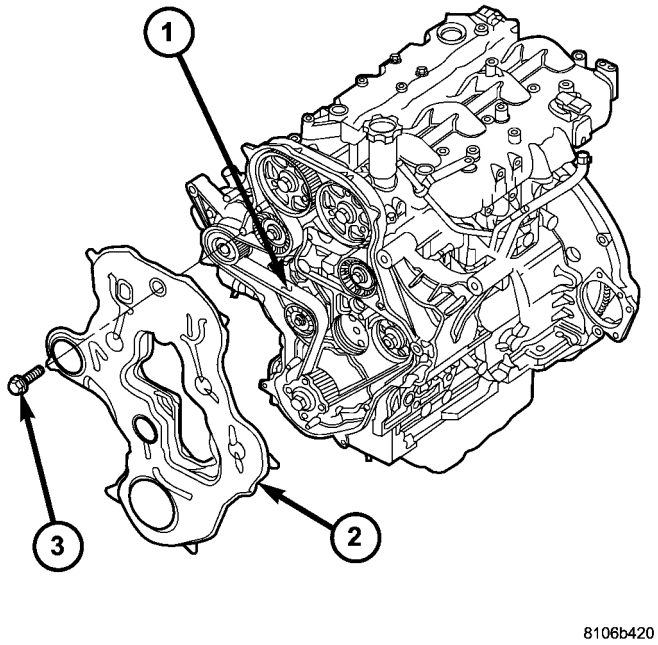

Fig. 74 TIMING BELT OUTER COVER

1 - TIMING BELT
2 - TIMING BELT OUTER COVER
3 - TIMING BELT OUTER COVER RETAINING BOLTS

INSTALLATION

INSTALLATION - TIMING BELT INNER COVER

(1) Install timing belt inner cover to engine front cover seal.

(2) Install timing belt inner cover to cylinder head cover gaskets.

(3) Install timing belt inner cover and retaining bolts. Torque 10mm bolts to 47.1N·m and 8mm bolts to 10.8N·m.

(4) Install injection pump sprocket (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).

(5) Install camshaft sprockets. Torque bolts to 108N·m.

(6) Install timing belt idler pulleys (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT IDLER PULLEY - INSTALLATION).

(7) Install timing belt and tensioner (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(8) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(9) Install vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(10) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(11) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(12) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

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

(14) Connect negative battery cable.

INSTALLATION - TIMING BELT OUTER COVER

(1) Install timing belt outer cover seal and cover. Torque 3mm bolts to 10.8N·m and 8mm bolts to 10.8N·m.

(2) Install vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(3) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(4) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(5) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

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

(7) Connect negative battery cable.

TIMING BELT IDLER PULLEY

REMOVAL

(1) Disconnect negative battery cable.

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

(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(6) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(7) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(8) Remove timing belt (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

TIMING BELT IDLER PULLEY (Continued)

NOTE: Idler pulley retaining bolts are left hand thread.

(9) Remove timing belt idler pulleys (Fig. 75).

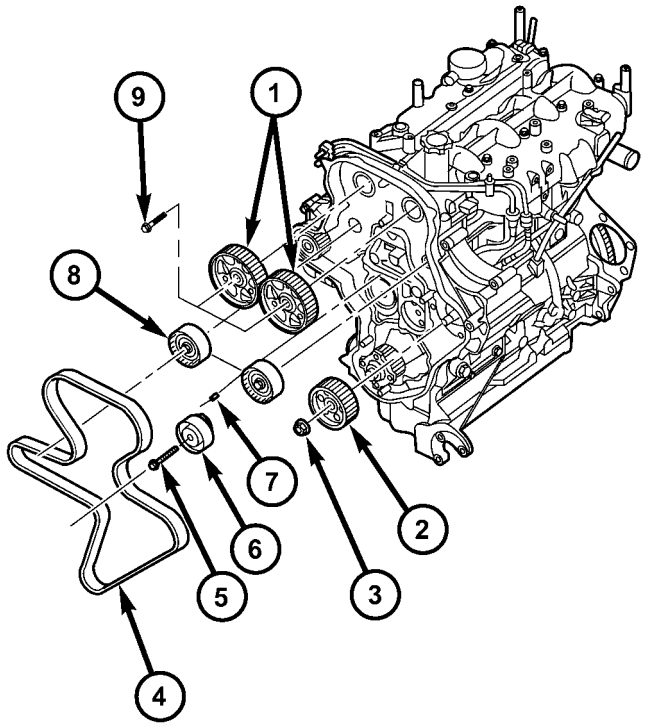

Fig. 75 TIMING BELT AND SPROCKETS

1 -CAMSHAFT SPROCKETS
2 - INJECTION PUMP SPROCKET
3 - INJECTION PUMP SPROCKET RETAINING NUT
4 - TIMING BELT
5 - TIMING BELT TENSIONER RETAINING BOLT
6 - TIMING BELT TENSIONER
7 - TENSIONER ALIGNMENT PIN
8 - IDLER PULLEY
9 - CAMSHAFT SPROCKET RETAINING BOLT

INSTALLATION

(1) Install timing belt idler pulleys. Torque bolts to 47.1N·m.

(2) Install timing belt (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

(3) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(4) Install vibration damper (Refer to 9 - ENGINE/ ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(5) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(6) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(7) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION) .

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

(9) Connect negative battery cable.

TIMING BELT/CHAIN AND SPROCKET(S)

REMOVAL

CAUTION: BEFORE REMOVING THE TIMING BELT, THE ENGINE MUST BE PLACED AT 90° AFTER TDC. FAILURE TO DO SO MAY RESULT IN VALVE AND/OR PISTON DAMAGE DURING ASSEMBLY. (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE)

(1) Disconnect negative battery cable.

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

(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/ FAN DRIVE VISCOUS CLUTCH - REMOVAL).

(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(6) Bring piston #1 to TDC, turn crankshaft until notch on the crankshaft hub is at the 12 o'clock position.

(7) Looking at the engine from the belt side, rotate the crankshaft 90° clockwise.

(8) Install the 90° alignment pin into the crankcase threaded hole on the right side of the engine to lock the crankcase (make sure the crankshaft does not rotate).

(9) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(10) Paint mark the crankshaft hub and the oil pump cover (this will be useful during the timing check).

(11) Remove the alternator.

(12) Remove the intake and exhaust camshaft plugs from the camshaft cover, to introduce the camshaft timing pins (if the engine is timed correctly, the pins can be installed).

TIMING BELT/CHAIN AND SPROCKET(S) (Continued)

(13) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(14) Loosen timing belt tensioner and remove timing belt (Fig. 76).

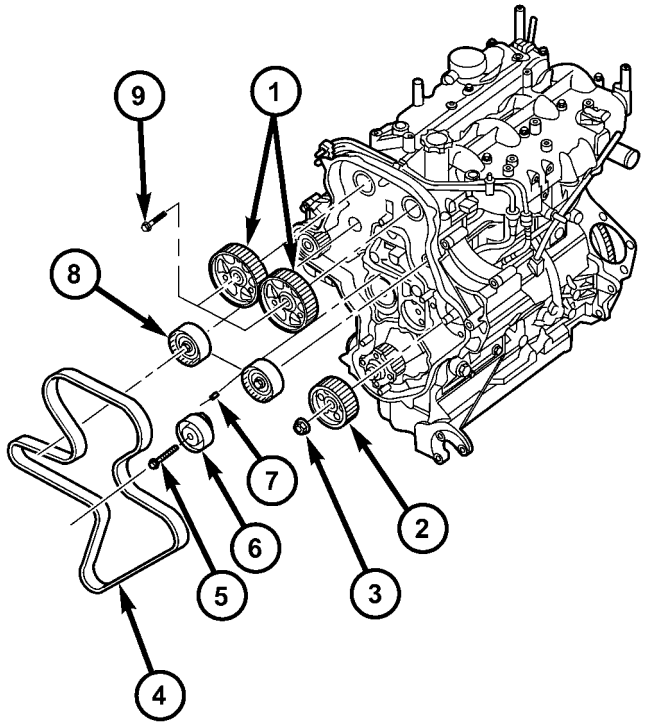

Fig. 76 TIMING BELT AND SPROCKETS

1 -CAMSHAFT SPROCKETS
2 - INJECTION PUMP SPROCKET
3 - INJECTION PUMP SPROCKET RETAINING NUT
4 - TIMING BELT
5 - TIMING BELT TENSIONER RETAINING BOLT
6 - TIMING BELT TENSIONER
7 - TENSIONER ALIGNMENT PIN
8 - IDLER PULLEY
9 - CAMSHAFT SPROCKET RETAINING BOLT

(15) Remove the intake and exhaust camshaft alignment pins.

(16) Loosen camshaft gears using special tool VM 1055 to retain the gears when removing bolts.

(17) Use camshaft bolt to rotate the intake camshafts until the intake alignment hole lines up with the hole on the camshaft cover. Install alignment pin VM 1052 and tighten with a wrench (repeat the operation for the exhaust camshaft alignment using alignment pin VM 1053).

INSTALLATION

(1) With both camshaft alignment pins still installed and the engine locked at 90° after TDC, verify that the camshaft gears are loose.

(2) Align timing mark on high pressure injection pump gear with timing mark on cover (Fig. 77).

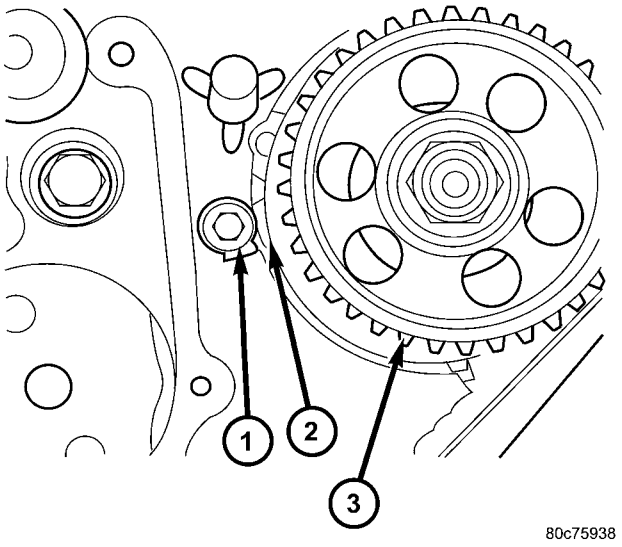

Fig. 77 INJECTION PUMP GEAR TIMING MARKS

1 - TIMING MARK ON COVER
2 - TIMING MARK ON INJECTION PUMP SPROCKET
3 - INJECTION PUMP SPROCKET

NOTE: DO NOT remove the timing belt from the package until it's ready to be installed. DO NOT expose timing belt to oil, grease or water contamination. DO NOT crimp belt at a sharp angle. DO NOT clean belt, pulleys or tensioner with solvent. Check that pulleys and bearings are not seized or damage before installing belt.

(3) Install timing belt on crankshaft hub and fix it with special tool VM 1074, then around high pressure injection pump, idler pulley, intake camshaft gear, exhaust camshaft gear, idler pulley, and water pump gear.

(4) Adjust the timing belt tensioner (turn it clockwise), lining up the center notch with the aluminum cover dowel pin. Tighten the retaining bolt to 28N·m.(Refer to 9 - ENGINE/VALVE TIMING/TMNG BELT/CHAIN TENSIONER&PULLEY - ADJUSTMENTS).

NOTE: To uniform the belt tension, with special tool VM 1055, slightly turn the intake camshaft pulley counterclockwise.

TIMING BELT/CHAIN AND SPROCKET(S) (Continued)

(5) Tighten the camshaft gear bolts to 60N·m while holding the gears with special tool VM 1055.
(6) Remove intake and exhaust alignment pins.
(7) Torque camshaft gear bolts to 108N·m while holding gears with special tool VM 1055 (Refer to 9 - ENGINE/VALVE TIMING - STANDARD PROCEDURE).
(8) Remove engine locking pin from engine block.
(9) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

WARNING: IF CAMSHAFT COVER WAS REMOVED WAIT 30 MINUTES BEFORE ROTATING CRANKSHAFT.

(10) Rotate the engine clockwise 2 revolutions (looking at engine from the belt side).
(11) Carefully line up the crankshaft hub painted mark with the oil pump cover mark.
(12) Check that the intake and exhaust camshaft alignment pins can be installed.

WARNING: IF THE CAMSHAFT ALIGNMENT PINS CAN NOT BE INSTALLED AT THIS TIME, REPEAT THE PROCEDURE FROM THE BEGINNING.

(13) Install the camshaft plugs.
(14) Install vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).
(15) Install the alternator.
(16) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).
(17) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(18) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).
(19) Install engine cover (Refer to 9 - ENGINE COVER - INSTALLATION).
(20) Connect negative battery cable.

TIMING BELT/CHAIN TENSIONER & PULLEY

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(3) Remove cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).
(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(5) Remove cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(6) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
(7) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(8) Loosen and remove timing belt tensioner (Fig. 78).

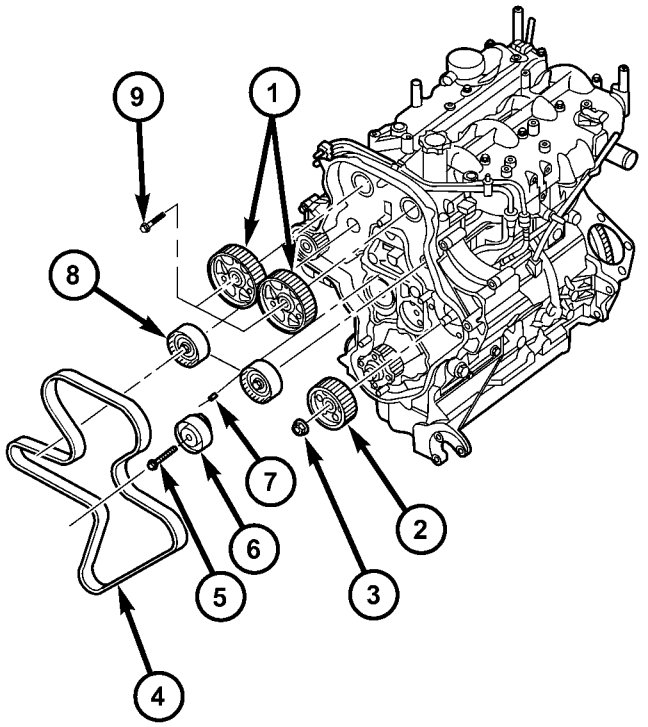

Fig. 78 TIMING BELT AND SPROCKETS

1 -CAMSHAFT SPROCKETS
2 - INJECTION PUMP SPROCKET
3 - INJECTION PUMP SPROCKET RETAINING NUT
4 - TIMING BELT
5 - TIMING BELT TENSIONER RETAINING BOLT
6 - TIMING BELT TENSIONER
7 - TENSIONER ALIGNMENT PIN
8 - IDLER PULLEY
9 - CAMSHAFT SPROCKET RETAINING BOLT

TIMING BELT/CHAIN TENSIONER & PULLEY (Continued)

INSTALLATION

NOTE: DO NOT remove the timing belt from the package until it's ready to be installed. DO NOT expose timing belt to oil, grease or water contamination. DO NOT crimp belt at a sharp angle. DO NOT clean belt, pulleys or tensioner with solvent. Check that pulleys and bearings are not seized or damage before installing belt.

(1) Install timing belt tensioner and retaining bolt.
(2) Adjust timing belt tensioner (Refer to 9 - ENGINE/VALVE TIMING/TMNG BELT/CHAIN TENSIONER&PULLEY - ADJUSTMENTS).
(3) Install timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
(4) Install vibration damper (Refer to 9 - ENGINE/ ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).
(5) Install cooling fan support (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).
(6) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(7) Install cooling fan and fan drive viscous clutch assembly (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

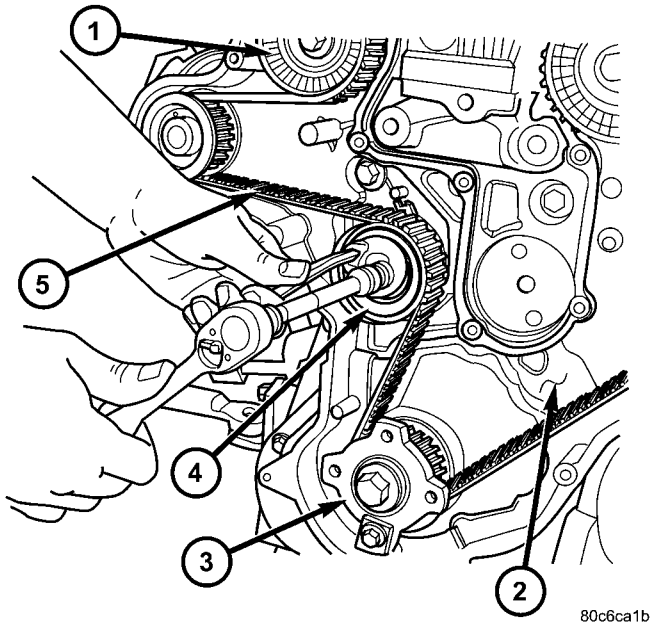

Fig. 79 TIMING BELT TENSIONER ADJUSTMENT

1 - TIMING BELT IDLER PULLEY
2 - ENGINE FRONT COVER
3 - CRANKSHAFT HUB
4 - TIMING BELT TENSIONER
5 - TIMING BELT

(8) Install engine cover (Refer to 9 - ENGINE COVER - INSTALLATION).
(9) Connect negative battery cable.

ADJUSTMENTS

ADJUSTMENT - TIMING BELT TENSIONER

(1) With timing belt outer cover removed and timing belt installed.
(2) Loosen timing belt tensioner (Fig. 79).
(3) Align timing belt tensioner alignment pointer as shown and torque timing belt tensioner retaining bolt to 34.7N·m. (Fig. 80).

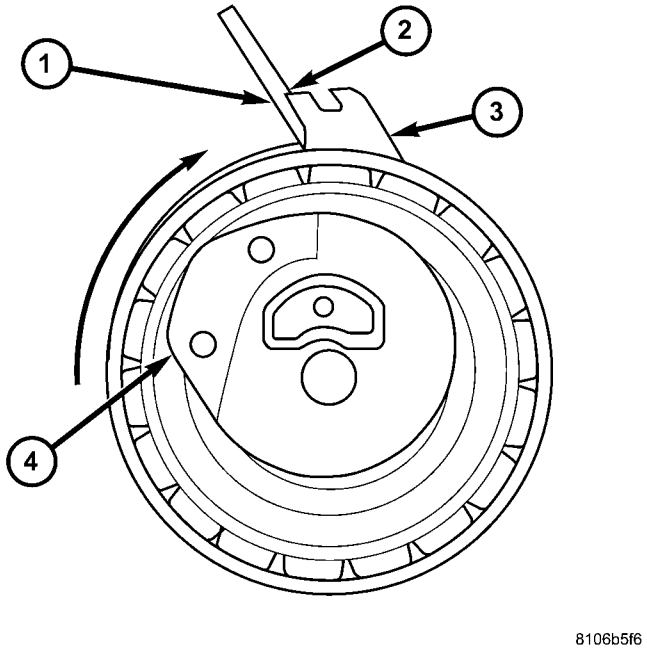

Fig. 80 TIMING BELT TENSIONER ALIGNMENT

1 - TENSIONER SPRING
2 - 1MM ALIGNMENT POINTER OVERLAP
3 - TENSIONER ALIGNMENT POINTER
4 - TENSIONER ASSEMBLY

(4) Rotate engine 2 complete revolution and then recheck tensioner alignment. Readjust tensioner alignment as necessary.

EXHAUST SYSTEM AND TURBOCHARGER

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EXHAUST SYSTEM AND TURBOCHARGER

DESCRIPTION

The basic exhaust system consists of an engine exhaust manifold, turbocharger, exhaust down pipe, exhaust pipe, exhaust heat shield(s), muffler and exhaust tailpipe

The exhaust system uses a single muffler.

The exhaust system must be properly aligned to prevent stress, leakage and body contact. If the system contacts any body panel, it will transfer objectionable noises originating from the engine to the body.

When inspecting an exhaust system, critically inspect for cracked or loose joints, stripped screw or bolt threads, corrosion damage and worn, cracked or broken hangers. Replace all components that are badly corroded or damaged. DO NOT attempt to repair.

When replacement is required, use original equipment parts (or equivalent). This will assure proper alignment and provide acceptable exhaust noise levels.

CAUTION: Avoid application of rust prevention compounds or undercoating materials to exhaust system floor pan exhaust heat shields. Light overspray near the edges is permitted. Application of coating will result in excessive floor pan temperatures and objectionable fumes.

EXHAUST SYSTEM AND TURBOCHARGER (Continued)

SPECIFICATIONS - TORQUE

2.5L/2.8L DIESEL - TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Exhaust Manifold Nuts	36	28	—
Exhaust Manifold Heat Shield Bolts	27.5	21	—
Turbocharger Bracket Bolts	47.1	35	—
Turbocharger Downpipe Nuts	32.4	24	—
Turbocharger Oil Supply Line Fitting	24.5	18	215
Turbocharger Oil Return Line bolts	10.8	—	96
Turbocharger to Exhaust Manifold Nuts	32.4	24	—

EXHAUST PIPE

REMOVAL

(1) Raise vehicle on hoist.
(2) Remove exhaust pipe to muffler and tail pipe assembly retaining nuts.
(3) Remove exhaust pipe to turbocharger downpipe retaining bolts (Fig. 1).
(4) Using a suitable pry bar, remove exhaust pipe from rubber exhaust hangers (Fig. 2).
(5) Lower exhaust pipe from vehicle.

INSTALLATION

(1) Install exhaust pipe in vehicle and attach rubber exhaust hangers to exhaust pipe (Fig. 2).
(2) Using a new gasket, connect exhaust pipe to turbocharger downpipe (Fig. 1). Torque bolts to 32.4N·m.
(3) Install exhaust pipe to muffler and tailpipe assembly retaining nuts. Torque nuts to 32.4N·m.
(4) Lower vehicle from hoist.

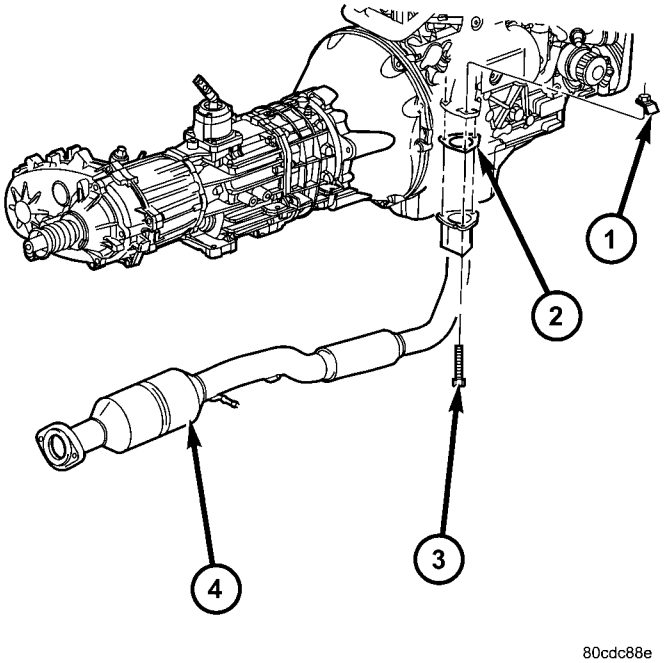

Fig. 1 EXHAUST PIPE REMOVAL/INSTALLATION

1 - RETAINING NUTS
2 - EXHAUST PIPE TO TURBO DOWNPIPE GASKET
3 - EXHAUST PIPE RETAINING BOLT
4 - EXHAUST PIPE

MUFFLER

REMOVAL

(1) Raise vehicle on hoist.
(2) Remove exhaust pipe to muffler and tailpipe assembly retaining nuts (Fig. 3).
(3) Using a suitable pry bar, pry muffler and tailpipe assembly out of exhaust hanger (Fig. 3).
(4) Remove muffler and tailpipe assembly from vehicle.

MUFFLER (Continued)

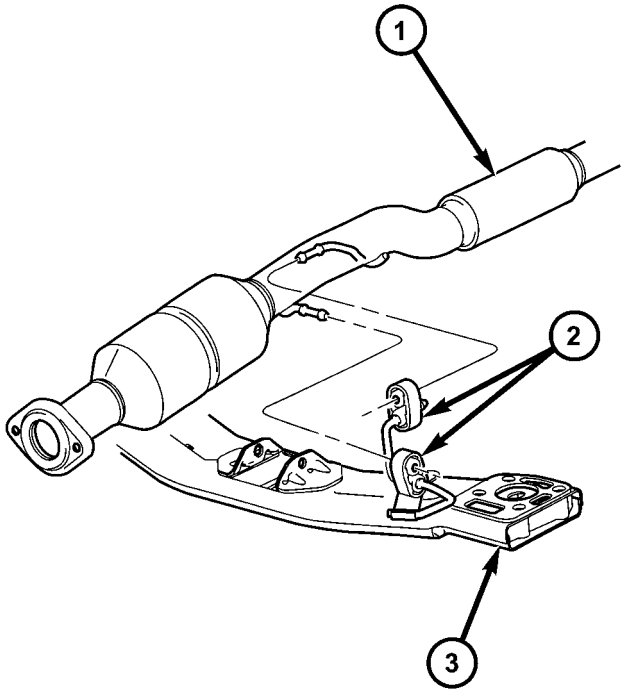

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Fig. 2 EXHAUST PIPE HANGERS

1 - EXHAUST PIPE
2 - RUBBER EXHAUST HANGERS
3 - TRANSMISSION CROSSMEMBER

INSTALLATION

(1) Install muffler and tailpipe assembly in vehicle and attach to exhaust hangers (Fig. 3).

(2) Install muffler and tailpipe assembly to exhaust pipe retaining nuts. Torque nuts to 32.4N·m.

(3) Lower vehicle from hoist.

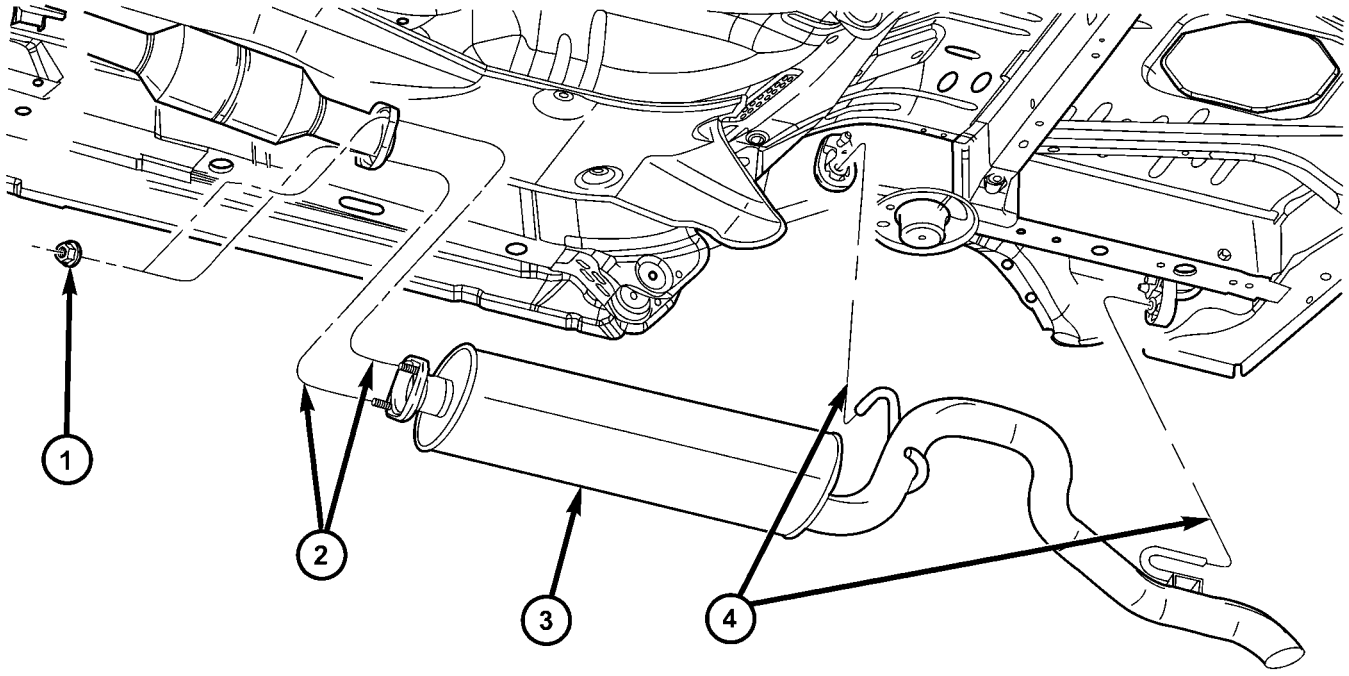

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Fig. 3 MUFFLER AND TAILPIPE ASSEMBLY

1 - RETAINING NUT
2 - ATTACHING STUD LOCATION
3 - MUFFLER AND TAILPIPE ASSEMBLY
4 - MUFFLER AND TAILPIPE HANGER LOCATIONS

HEAT SHIELDS

DESCRIPTION

Heat shields are needed to protect both the vehicle and the environment from the high temperatures developed by the catalytic converter. The catalytic converter releases additional heat into the exhaust system. Under severe operating conditions, the temperature increases in the area of the converter. Such conditions can exist when the engine misfires or otherwise does not operate at peak efficiency (Fig. 4).

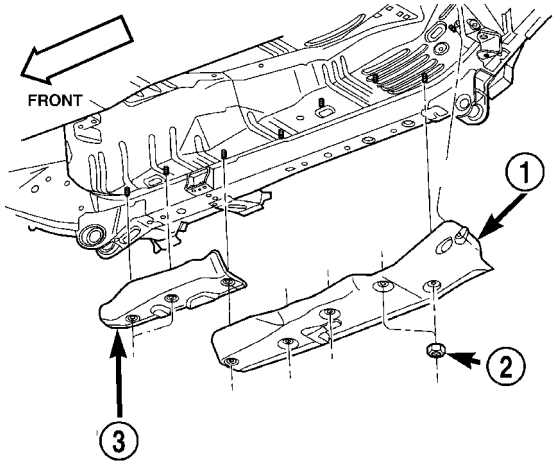

Fig. 4 Front and Rear Floor Pan Heat Shields Typical

1 - REAR FLOOR PAN HEAT SHIELD
2 - HEAT SHIELD RETAINING NUTS
3 - FRONT FLOOR PAN HEAT SHIELD

CHARGE AIR COOLER AND PLUMBING

REMOVAL

REMOVAL - CAC INLET HOSE

(1) Open and support hood of vehicle.
(2) Loosen hose clamps at both ends of charge air cooler (CAC) inlet hose (Fig. 5).
(3) Remove CAC inlet hose from turbocharger and CAC.

REMOVAL - CAC OUTLET HOSE

(1) Raise and support hood on vehicle.
(2) Loosen hose clamps at both ends of charge air cooler (CAC) outlet hose (Fig. 6).
(3) Remove hose from CAC and intake manifold inlet (Fig. 6).

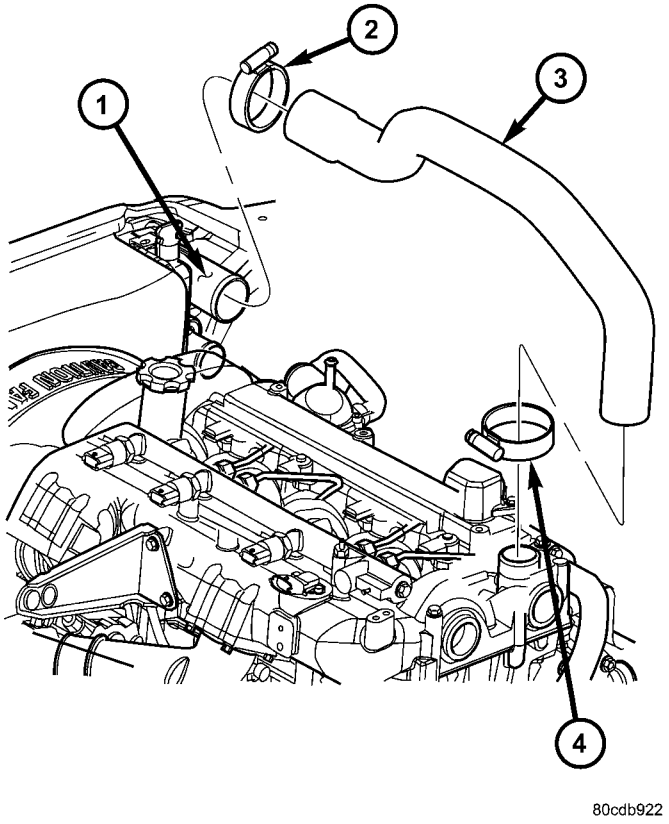

Fig. 5 CHARGE AIR COOLER INLET HOSE

1 - CHARGE AIR COOLER
2 - HOSE CLAMP
3 - CHARGE AIR COOLER INLET HOSE
4 - HOSE CLAMP

INSTALLATION

INSTALLATION - CAC INLET HOSE

(1) Install charge air cooler (CAC) inlet hose on turbocharger and CAC (Fig. 5).
(2) Tighten hose clamps (Fig. 5).
(3) Close hood.

INSTALLATION - CAC OUTLET HOSE

(1) Install charge air cooler (CAC) outlet hose on CAC and intake manifold inlet.
(2) Tighten both hose clamp on CAC outlet hose (Fig. 6).

CHARGE AIR COOLER AND PLUMBING (Continued)

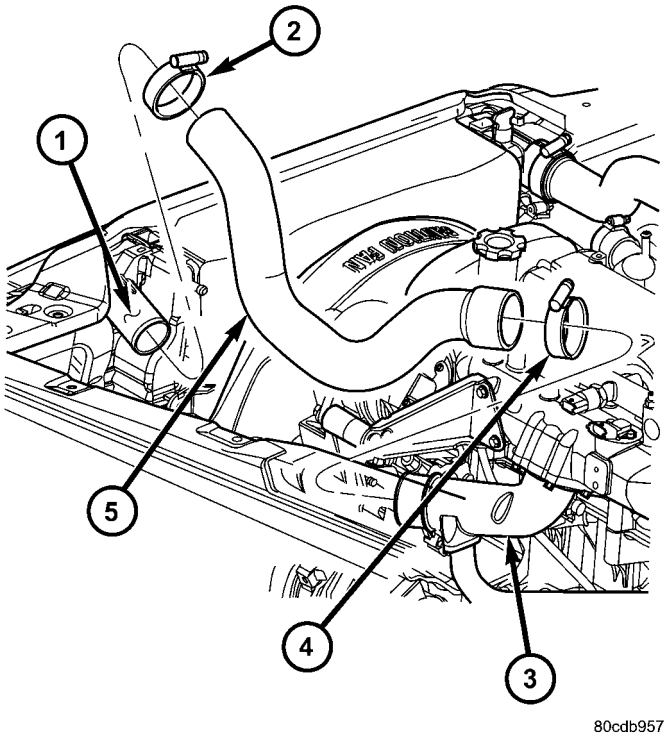

Fig. 6 CHARGE AIR COOLER OUTLET HOSE

1 - CHARGE AIR COOLER
2 - HOSE CLAMP
3 - INTAKE MANIFOLD INLET
4 - HOSE CLAMP
5 - CHARGE AIR COOLER OUTLET HOSE

(3) Close hood.

TURBOCHARGER

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 is an exhaust-driven supercharger which increases the pressure and density of the air entering the engine. With the increase of air entering the engine, more fuel can be injected into the cylinders, which creates more power during combustion.

The turbocharger assembly consists of four (4) major component systems (Fig. 7) (Fig. 8):

- Turbine section
- Compressor section
- Bearing housing
- Wastegate

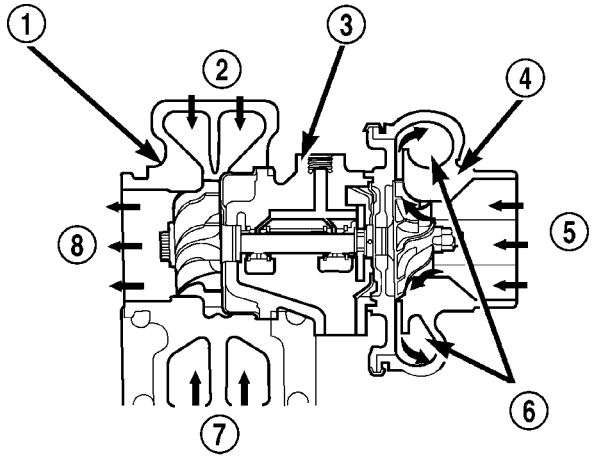

Fig. 7 Turbocharger Operation

1 - TURBINE SECTION
2 - EXHAUST GAS
3 - BEARING HOUSING
4 - COMPRESSOR SECTION
5 - INLET AIR
6 - COMPRESSED AIR TO ENGINE
7 - EXHAUST GAS
8 - EXHAUST GAS TO EXHAUST PIPE

OPERATION

Exhaust gas pressure and energy drive the turbine, which in turn drives a centrifugal compressor that compresses the inlet air, and forces the air into the engine through the charge air cooler and plumbing. Since heat is a by-product of this compression, the air must pass through a charge air cooler to cool the incoming air and maintain power and efficiency.

Increasing air flow to the engine provides:

- Improved engine performance
- Lower exhaust smoke density
- Improved operating economy
- Altitude compensation
- Noise reduction.

TURBOCHARGER (Continued)

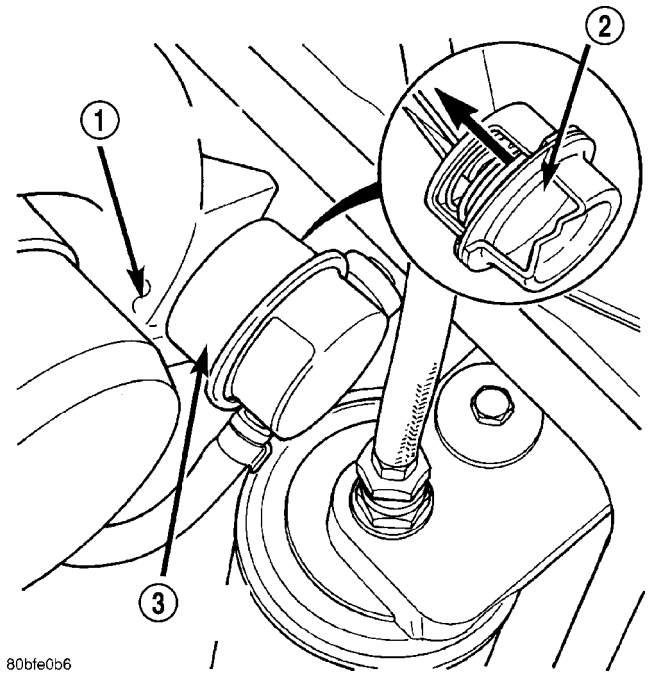

Fig. 8 Turbocharger Wastegate Actuator

1 - TURBOCHARGER
2 - DIAPHRAGM
3 - WASTE GATE ACTUATOR

The turbocharger also uses a wastegate (Fig. 9), which regulates intake manifold air pressure and prevents over boosting at high engine speeds. When the wastegate valve is closed, all of the exhaust gases flow through the turbine wheel. As the intake manifold pressure increases, the wastegate actuator opens the valve, diverting some of the exhaust gases away from the turbine wheel. This limits turbine shaft speed and air output from the impeller.

The turbocharger is lubricated by engine oil that is pressurized, cooled, and filtered. The oil is delivered to the turbocharger by a supply line that is tapped into the block. The oil travels into the bearing housing, where it lubricates the shaft and bearings (Fig. 10). A return pipe at the bottom of the bearing housing, routes the engine oil back to the crankcase.

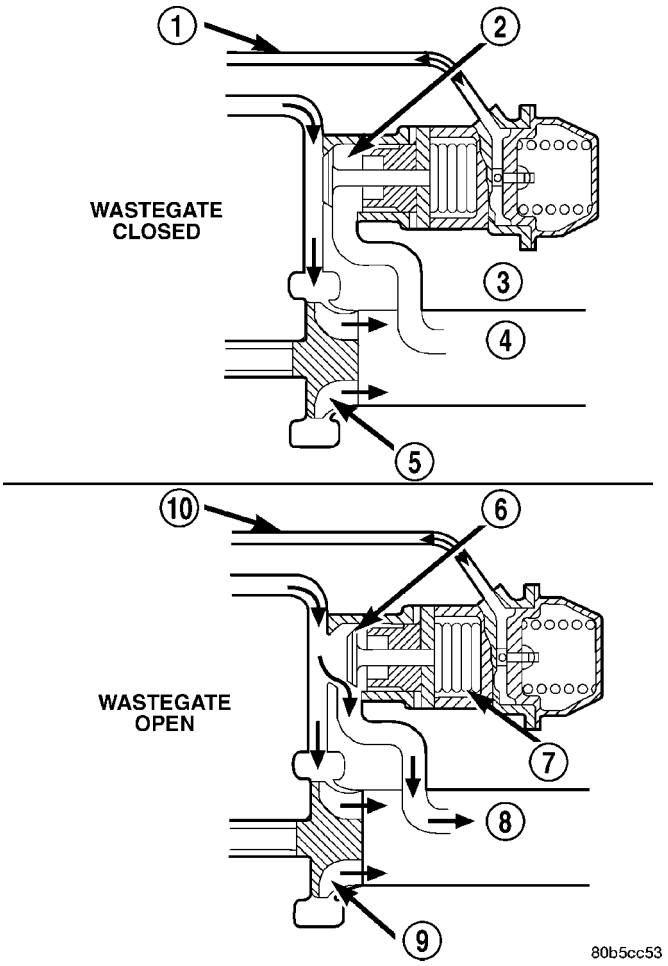

Fig. 9 Wastegate Operation

1 - SIGNAL LINE
2 - EXHAUST BYPASS VALVE
3 - WASTEGATE
4 - EXHAUST
5 - TURBINE
6 - EXHAUST BYPASS VALVE
7 - WASTEGATE
8 - EXHAUST
9 - TURBINE
10 - SIGNAL LINE

TURBOCHARGER (Continued)

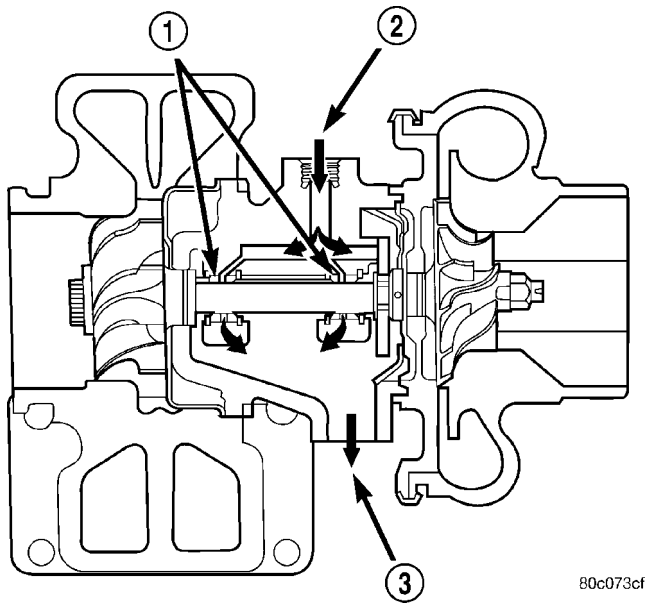

Fig. 10 Turbocharger Oil Supply and Drain

1 - BEARINGS
2 - OIL SUPPLY (FROM ENGINE BLOCK)
3 - OIL RETURN (TO OIL PAN)

The most common turbocharger failure is bearing failure related to repeated hot shutdowns with inadequate “cool-down” periods. A sudden engine shut down after prolonged operation will result in the transfer of heat from the turbine section of the turbocharger to the bearing housing. This causes the oil to overheat and break down, which causes bearing and shaft damage the next time the vehicle is started.

Letting the engine idle after extended operation allows the turbine housing to cool to normal operating temperature. The following chart should be used as a guide in determining the amount of engine idle time required to sufficiently cool down the turbocharger before shut down, depending upon the type of driving and the amount of cargo.

TURBOCHARGER ″COOL DOWN″ CHART			
Driving Condition	**Load**	**Turbo-charger Tempera-ture**	**Idle Time (in minutes) Before Shut Down**
Stop & Go	Empty	Cool	Less than 1
Stop & Go	Medium	Warm	1
Highway Speeds	Medium	Warm	2
City Traffic	Max. GCWR	Warm	3
Highway Speeds	Max. GCWR	Warm	4
Uphill Grade	Max. GCWR	Hot	5

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Remove air cleaner assembly (Fig. 11).
(4) Remove air inlet hose from turbocharger (Fig. 11).
(5) Remove charge air cooler inlet hose from tubocharger and reposition out of way.
(6) Drain cooling system.
(7) Remove coolant recovery pressure container (Refer to 7 - COOLING/ENGINE/COOLANT RECOVERY PRESS CONTAINER - REMOVAL).
(8) Disconnect both EGR cooler coolant hoses at cooler (Fig. 12).
(9) Remove EGR valve to exhaust manifold retaining nuts (Fig. 12).
(10) Remove EGR cooler to exhaust manifold retaining bolt (Fig. 12).

TURBOCHARGER (Continued)

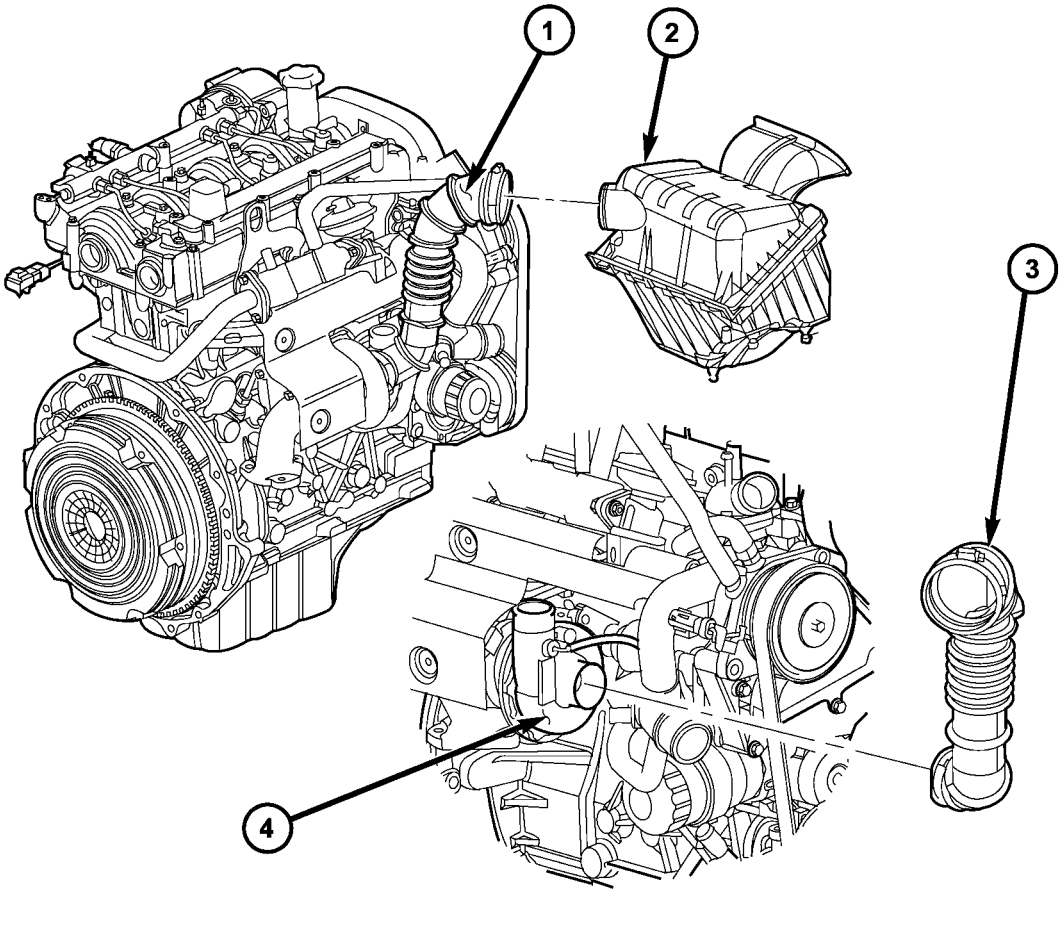

Fig. 11 TURBOCHARGER INLET HOSE FROM AIR CLEANER

1 - TURBOCHARGER INLET HOSE
2 - AIR CLEANER HOUSING
3 - TURBOCHARGER INLET HOSE
4 - TURBOCHARGER

(11) Reposition EGR cooler out of way.

(12) Remove exhaust manifold heat shield retaining bolts and remove heat shield (Fig. 13).

(13) Disconnect turbocharger oil supply line at turbocharger (Fig. 13).

(14) Raise vehicle on hoist.

(15) Disconnect exhaust pipe at turbocharger down pipe.

(16) Disconnect turbocharger oil return line at turbocharger (Fig. 13).

(17) Lower vehicle.

(18) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(19) Remove viscous heater (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/ELECTRIC COOLANT PUMP - REMOVAL).

(20) Remove the thermostat housing (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - REMOVAL).

(21) Remove exhaust manifold retaining nuts and remove exhaust manifold and turbocharger assembly from vehicle (Fig. 13).

(22) Remove turbocharger to exhaust manifold retaining nuts and separate turbocharger from exhaust manifold (Fig. 14).

CLEANING

All old gaskets should be inspected for any tears or signs of prior leakage. If any gaskets show such indications, they should be replaced with new gaskets. All gasket mating surfaces must be cleaned of old gasket material to produce a smooth and dirt free sealing surface for the new gasket.

TURBOCHARGER (Continued)

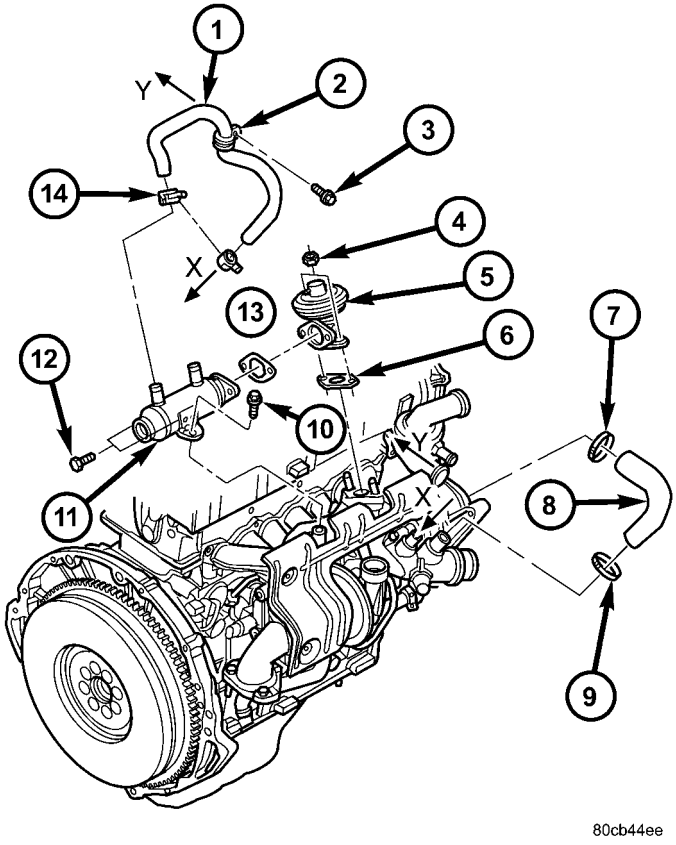

Fig. 12 EGR VALVE, COOLER, AND COMPONENTS

1 - COOLANT HOSE
2 - HOSE RETAINER
3 - RETAINING BOLT
4 - EGR VALVE RETAINING NUTS
5 - EGR VALVE
6 - EGR VALVE GASKET
7 - HOSE CLAMP
8 - COOLANT HOSE
9 - HOSE CLAMP
10 - EGR COOLER TO EXHAUST MANIFOLD RETAINING BOLT (2.8L)
11 - EGR COOLER (2.8L)
12 - EGR COOLER TO EGR VALVE RETAINING BOLTS (2.8L)
13 - EGR COOLER TO EGR VALVE GASKET (2.8L)
14 - HOSE CLAMP

INSTALLATION

(1) Connect turbocharger to exhaust manifold with new gasket (Fig. 14). Torque retaining nuts to 32.4N·m.

NOTE: After Tightening The Exhaust Manifold To Specification Using a Diagonal-Cross Pattern, Retrace The Pattern Checking The Correct Torque Value Again.

(2) Install exhaust manifold and turbocharger assembly with new gasket in position on studs in cylinder head (Fig. 13). Install retaining nuts and torque to 36N·m.

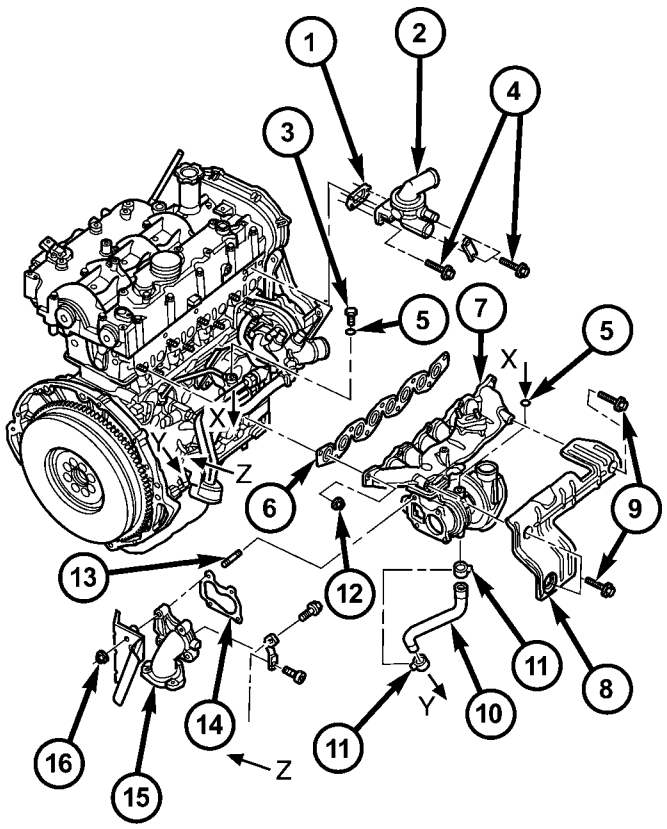

Fig. 13 EXHAUST MANIFOLD AND COMPONENTS

1 - THERMOSTAT HOUSING GASKET
2 - THERMOSTAT HOUSING
3 - TURBOCHARGER OIL SUPPLY LINE BANJO BOLT
4 - THERMOSTAT HOUSING RETAINING BOLTS
5 - BRASS WASHER
6 - EXHAUST MANIFOLD GASKET
7 - EXHAUST MANIFOLD
8 - EXHAUST MANIFOLD HEAT SHIELD
9 - EXHAUST MANIFOLD HEAT SHIELD RETAINING BOLTS
10 - OIL RETURN HOSE
11 - HOSE CLAMPS
12 - EXHAUST MANIFOLD RETAINING NUTS
13 - TURBOCHARGER DOWN PIPE STUDS
14 - TURBOCHARGER DOWN PIPE GASKET
15 - TURBOCHARGER DOWN PIPE
16 - TURBOCHARGER DOWN PIPE RETAINING NUT

(3) Install thermostat housing (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - INSTALLATION).

(4) Install viscous heater (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/ELECTRIC COOLANT PUMP - INSTALLATION).

(5) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(6) Raise vehicle on hoist.

TURBOCHARGER (Continued)

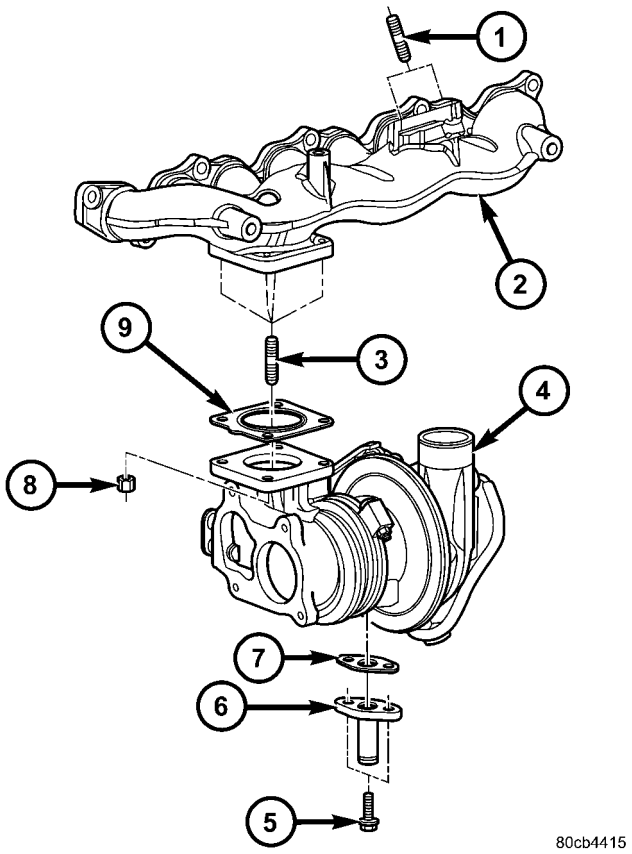

Fig. 14 EXHAUST MANIFOLD AND TURBOCHARGER ASSEMBLY

1 - EGR VALVE MOUNTING STUDS
2 - EXHAUST MANIFOLD
3 - TURBOCHARGER TO EXHAUST MANFOLD MOUNTING STUDS
4 - TURBOCHARGER ASSEMBLY
5 - TURBOCHARGER OIL RETURN FITTING ATTACHING BOLT
6 - TURBOCHARGER OIL RETURN FITTING
7 - OIL RETURN FITTING GASKET
8 - RETAINING NUT
9 - TURBOCHARGER TO EXHAUST MANIFOLD GASKET

(7) Connect turbocharger oil return line at turbocharger (Fig. 13).

(8) Connect exhaust pipe at turbocharger downpipe.

(9) Lower vehicle from hoist.

(10) Connect oil supply line at turbocharger (Fig. 13). Torque banjo fitting to 24.5N·m.

(11) Install exhaust manifold heat shield (Fig. 13). Torque retaining bolts to 27.5N·m.

(12) Reposition EGR cooler and or EGR valve assembly on exhaust manifold (Fig. 12). Torque retaining nuts and bolt to 32.4N·m.

(13) Connect EGR pipe to EGR valve. Tighten bolts to 32.4N·m.

(14) Connect EGR cooler coolant hoses at cooler (2.8L) (Fig. 12).

(15) Install coolant recovery pressure container (Refer to 7 - COOLING/ENGINE/COOLANT RECOVERY PRESS CONTAINER - INSTALLATION).

(16) Refill cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).

(17) Connect charge air cooler inlet hose at turbocharger.

(18) Install air cleaner assembly (Fig. 11).

(19) Connect air inlet hose to turbocharger (Fig. 11).

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

(21) Connect negative battery cable.

FUEL SYSTEM

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FUEL SYSTEM - 2.5L/2.8L TURBO DIESEL

DESCRIPTION - DIESEL FUEL DELIVERY SYSTEM

The fuel system on the 2.5L / 2.8L Common Rail Diesel Engine uses a fuel injection pump and an Electronic Control Module (ECM).

The fuel delivery system consists of the:

- Accelerator pedal
- Air cleaner housing/element
- Fuel filter/water separator
- Fuel heater
- Fuel heater relay
- Fuel injection pump
- Fuel injectors
- Fuel tank
- Fuel tank filler/vent tube assembly
- Fuel tank filler tube cap
- Fuel tank module containing the rollover valve and a fuel gauge sending unit (fuel level sensor).
- Fuel tubes/lines/hoses
- High-pressure fuel injector lines
- Low-pressure fuel supply lines
- Low-pressure fuel return line
- Overflow valve
- Quick-connect fittings
- Water draining

WARNING - HIGH FUEL SYSTEM PRESSURE

WARNING: HIGH-PRESSURE FUEL LINES DELIVER FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE INJECTORS. THIS MAYBE AS HIGH AS 1600BAR (23,200PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH-PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT HIGH-PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - AIR IN FUEL SYSTEM

Air will enter the fuel system whenever fuel supply lines, separator filters, injection pump, high-pressure lines or injectors are removed or disconnected. Air trapped in the fuel system can result in hard starting, a rough running engine, engine misfire, low power, excessive smoke and fuel knock.

Inspect the fuel system from the fuel tank to the injectors for loose connections (Refer to 14 - FUEL SYSTEM - WARNING). Leaking fuel is an indicator of loose connections or defective seals. Air can also enter the fuel system between the fuel tank and the fuel/lift pump. Inspect the fuel tank and fuel lines for damage that might allow air into the system.

With the DRBIII® connected to the vehicle, select Engine and the select Sensor Display. Page down to view Fuel Pressure Set Point and Actual Fuel Pressure. Start the engine and observe the Fuel Pressure Set Point and the Actual Fuel Pressure. If the Actual Fuel Pressure Oscillates above and below the Fuel Pressure Set Point in a regular cycle, inspect the fuel system for air intrusion.

If the Actual Fuel Pressure gradually drops below the Fuel Pressure Set Point then spikes well above the Fuel Pressure Set Point, replace the fuel pressure solenoid (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL PRESSURE SOLENOID - REMOVAL).

FUEL SYSTEM - 2.5L/2.8L TURBO DIESEL (Continued)

DIAGNOSIS AND TESTING - FUEL SUPPLY RESTRICTIONS

LOW-PRESSURE LINES

Fuel supply line restrictions or a defective fuel/lift pump can cause starting problems and prevent engine from accelerating. The starting problems include; low power and/or white fog like exhaust.

Test all fuel supply lines for restrictions or blockage, including the fuel filter. Flush or replace as necessary.

HIGH-PRESSURE LINES

CAUTION: High pressure lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. High pressure lines must be replaced at each disassembly. Use only recommended lines when replacement of high-pressure fuel line is necessary.

Restricted (kinked or bent) high-pressure lines can cause starting problems, poor engine performance, engine mis-fire and white smoke from exhaust (Refer to 14 - FUEL SYSTEM - WARNING).

STANDARD PROCEDURE

STANDARD PROCEDURE - PRIMING FUEL SYSTEM

NOTE: DO NOT force or pull up hard on the plunger when priming the fuel system. Damage to the plunger or fuel filter/water separate will result.

The fuel system must be primed if the fuel system has been serviced. This is done using the fuel primer plunger located at the top of the fuel filter/water separator.

(1) With service completed on the fuel system.

(2) Unscrew fuel system primer plunger by unscrewing it counterlockwise (Fig. 1).

(3) Pull primer up out of bore until it stops (Fig. 1).

(4) Pump primer plunger up and down until air bubbles cannot be seen in fuel filter cap at the bottom of the fuel filter/water separator (Fig. 1).

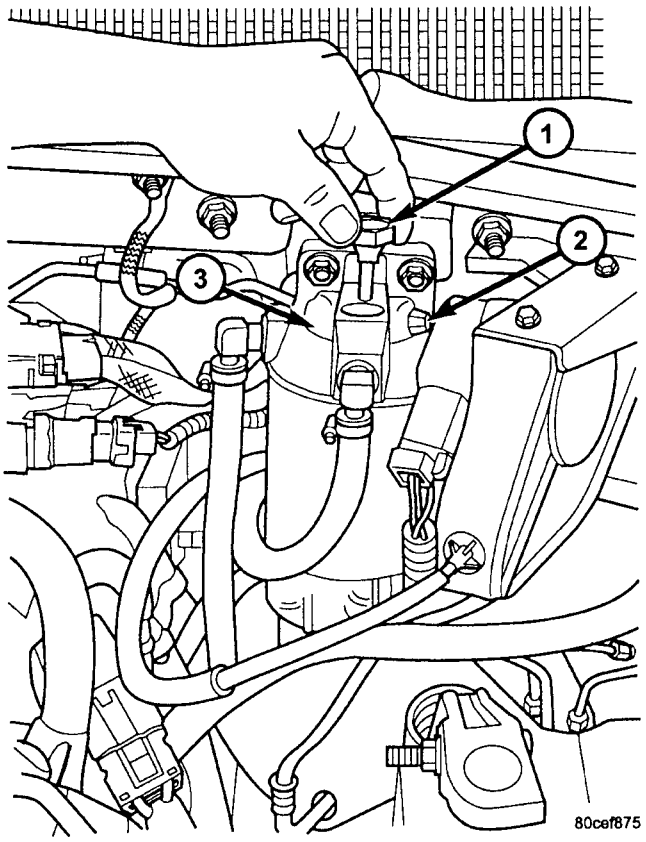

Fig. 1 FUEL FILTER PRIMING PLUNGER

1 - FUEL FILTER PRIMING PLUNGER
2 - AIR BLEED
3 - FUEL FILTER / WATER SEPARATOR

STANDARD PROCEDURES - CLEANING FUEL SYSTEM COMPONENTS

CAUTION: Cleanliness cannot be overemphasized when handling or replacing diesel fuel system components. This especially includes the fuel injectors, high-pressure fuel lines, fuel rail, and fuel injection pump. Very tight tolerances are used with these parts. Dirt contamination could cause rapid part wear and possible plugging of fuel injector nozzle tip holes. This in turn could lead to possible engine misfire. Always wash/clean any fuel system component thoroughly before disassembly and then air dry. DO NOT wire brush injector nozzles when cleaning. Cap or cover any open part after disassembly. Before assembly, examine each part for dirt, grease or other contaminants and clean if necessary. When installing new parts, lubricate them with clean engine oil or clean diesel fuel only.

FUEL SYSTEM - 2.5L/2.8L TURBO DIESEL (Continued)

SPECIFICATIONS - TORQUE

2.5L / 2.8L DIESEL - TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Crankshaft Position Sensor Bolt	10.8	8	96
Boost Pressure / Intake Air Temperature Sensor Bolts	5.4	—	48
High Pressure Injection Pump Nuts	24.4	18	—
Fuel Line Fittings at Pump	27.5	21	—
High Pressure Injection Pump Sprocket Nut	88.3	65	—
Fuel Injector Retaining Bolts	32.4	24	—
High Pressure Fuel Lines	22	17	194
Fuel Rail Bolts	24.5	18	—

FUEL DELIVERY

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FUEL FILTER / WATER SEPARATOR

DESCRIPTION

The fuel filter/water separator assembly is located in the left rear corner of the engine compartment (Fig. 1).

OPERATION

The fuel filter/water separator protects the fuel injection pump by removing water and contaminants from the fuel. The construction of the filter/separator allows fuel to pass through it, but helps prevent moisture (water) from doing so. Moisture collects at the bottom of the canister.

Refer to the maintenance schedules for the recommended fuel filter replacement intervals.

For draining of water from canister, refer to Fuel Filter/Water Separator Removal/Installation section.

A Water-In-Fuel (WIF) sensor is part of the fuel filter cap. Refer to Water-In-Fuel Sensor Description/ Operation.

The fuel heater is also part of the fuel filter cap. Refer to Fuel Heater Description/Operation.

REMOVAL

(1) Disconnect negative battery cable.

(2) Drain fuel filter/water separator assembly by loosening drain at bottom of fuel filter cap.

(3) Remove two fuel lines from the water separator (Fig. 2). Loosen retaining clamps and slide the hose from barbed fittings (Fig. 2).

(4) Remove fuel water separator retaining nuts and carefully slide separator off its mounting studs (Fig. 3). Use care not to spill excess fuel or damage electrical connections, located on the bottom of the assembly.

(5) Disconnect electrical connectors located on the bottom of the separator assembly.

(6) Remove fuel water separator from the engine bay.

FUEL FILTER / WATER SEPARATOR (Continued)

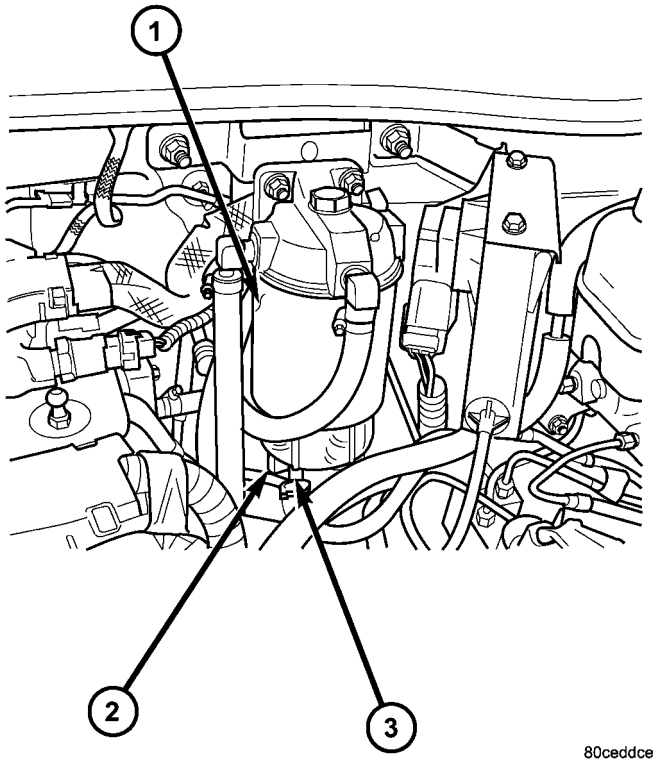

Fig. 1 FUEL FILTER / WATER SEPARATOR

1 - FUEL FILTER / WATER SEPARATOR ASSEMBLY
2 - WATER-IN-FUEL SENSOR
3 - FUEL HEATER

INSTALLATION

(1) Position fuel water separator in the engine bay and connect the electrical connectors located on the bottom of the separator assembly.

(2) Install fuel water separator on its mounting studs and install the retaining nuts (Fig. 3).

(3) Install two fuel lines on the water separator (Fig. 2).

(4) Prime fuel system using the fuel priming plunger (Refer to 14 - FUEL SYSTEM - STANDARD PROCEDURE).

(5) Connect negative battery cable.

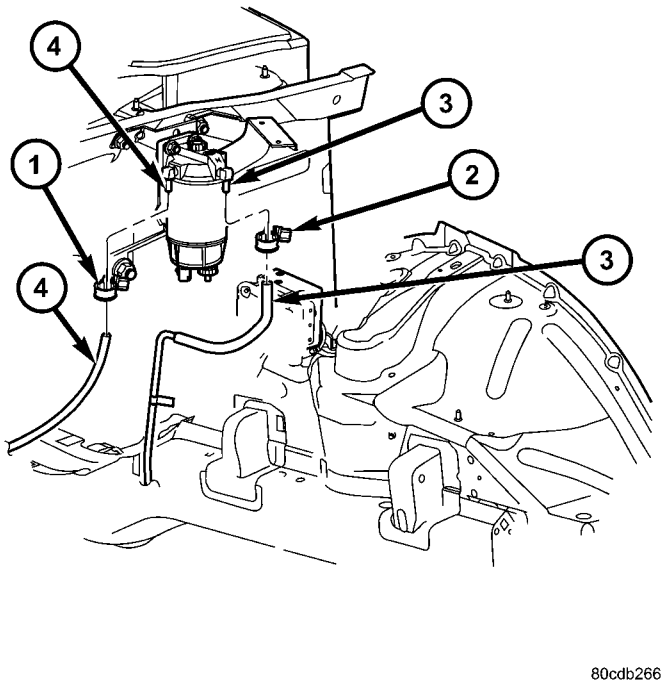

Fig. 2 FUEL FILTER/WATER SEPARATOR FUEL LINES

1 - HOSE CLAMP
2 - HOSE CLAMP
3 - FUEL INLET LINE TO FUEL FILTER/WATER SEPARATOR
4 - FUEL OUTLET LINE TO INJECTION PUMP

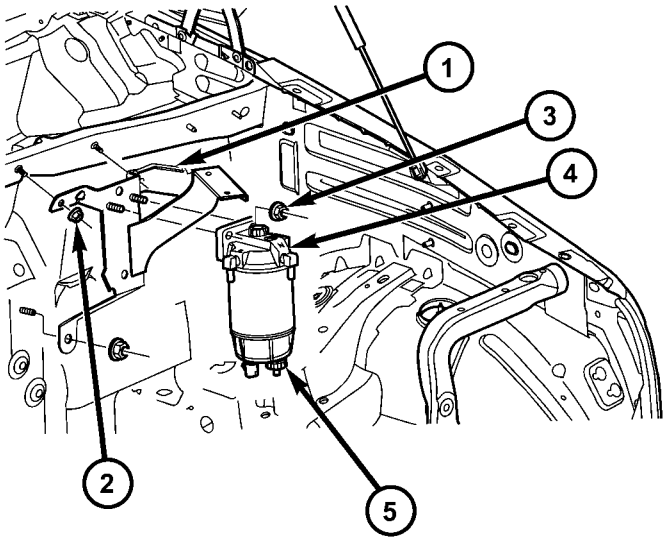

Fig. 3 FUEL FILTER/WATER SEPARATOR REMOVAL AND INSTALLATION

1 - FUEL FILTER/WATER SEPARATOR BRACKET
2 - BRACKET RETAINING NUTS
3 - FUEL FILTER/WATER SEPARATOR RETAINING NUTS
4 - FUEL FILTER/WATER SEPARATOR
5 - WATER DRAIN

WATER IN FUEL SENSOR

DESCRIPTION

The WIF sensor is located in the bowl assembly of the fuel filter/water separator (Fig. 4).

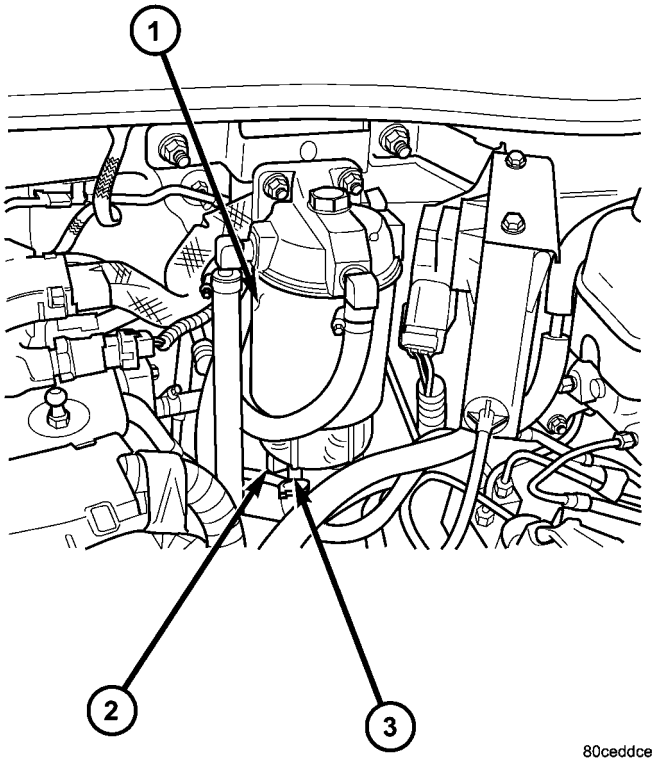

Fig. 4 FUEL FILTER / WATER SEPARATOR

1 - FUEL FILTER / WATER SEPARATOR ASSEMBLY
2 - WATER-IN-FUEL SENSOR
3 - FUEL HEATER

OPERATION

The sensor sends an input to the Engine Control Module (ECM) when it senses water in the fuel filter/water separator. As the water level in the filter/separator increases, the resistance across the WIF sensor decreases. This decrease in resistance is sent as a signal to the ECM and compared to a high water standard value. Once the value reaches 30 to 40 kilohms, the ECM will activate the water-in-fuel warning lamp. This all takes place when the ignition key is initially put in the ON position.

REMOVAL

(1) Disconnect negative battery cable.

(2) Drain fuel filter/water separator assembly by loosening drain at bottom of fuel filter cap.

(3) Disconnect WIF sensor electrical connector (Fig. 4).

(4) Unscrew WIF sensor from fuel filter cap at bottom fuel filter/water separator assembly.

INSTALLATION

(1) Install WIF sensor into fuel filter cap hand tight.

(2) Connect WIF sensor electrical connector (Fig. 4).

(3) Prime fuel system using fuel priming plunger (Refer to 14 - FUEL SYSTEM - STANDARD PROCEDURE)

(4) Connect negative battery cable.

FUEL RAIL

DESCRIPTION

WARNING: HIGH - PRESSURE FUEL LINE DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH - PRESSURE LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

The fuel rail is mounted to the cylinder head cover/intake manifold (Refer to 14 - FUEL SYSTEM - WARNING) (Fig. 5).

OPERATION

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

The fuel rail stores the fuel for the injectors at high pressure. At the same time, the pressure oscillations which are generated due to the high-pressure pump delivery and the injection of fuel are dampened by the rail volume.

The fuel rail is common to all cylinders, hence it's name “common rail”. Even when large quantities of

FUEL RAIL (Continued)

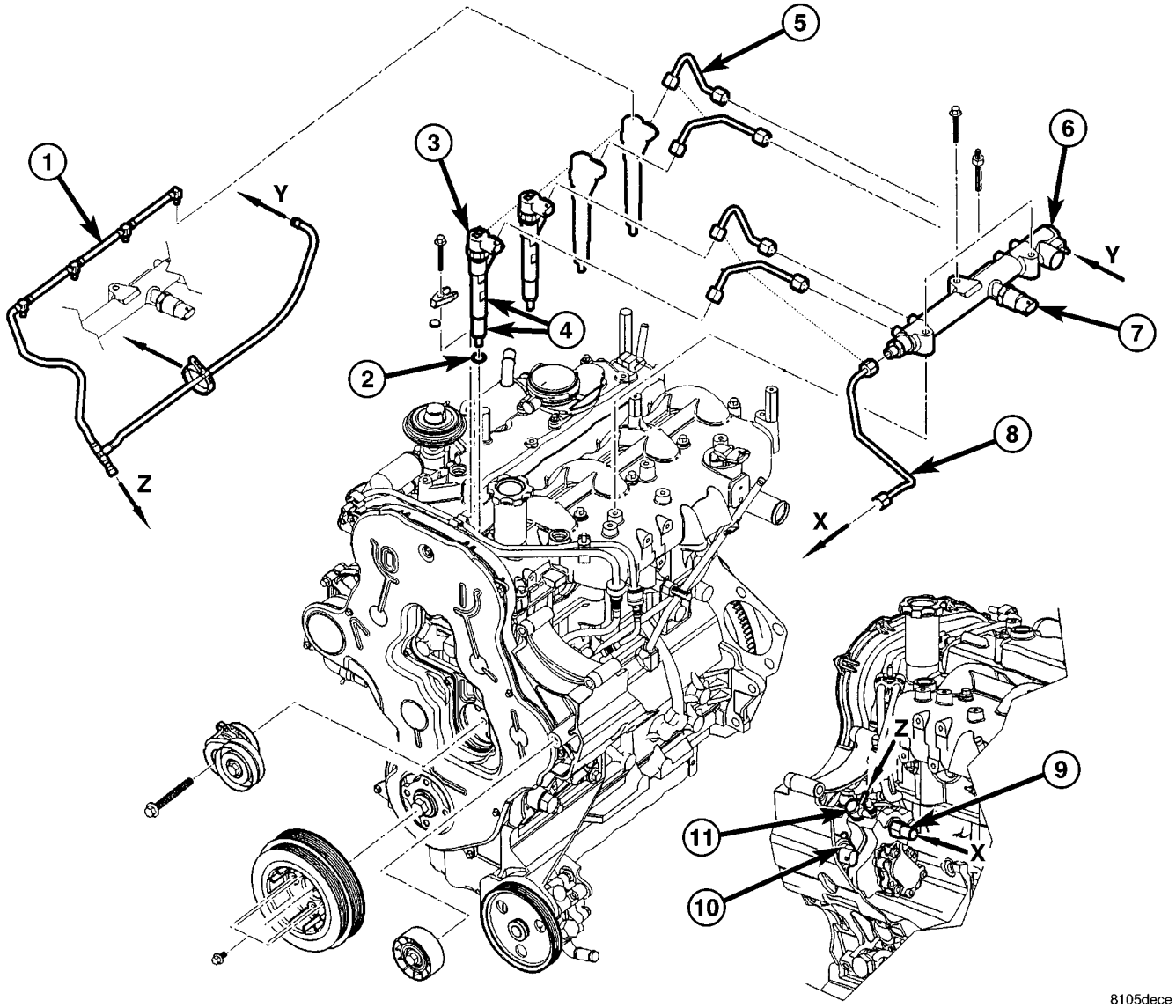

Fig. 5 FUEL SYSTEM COMPONENTS

1 - FUEL INJECTOR RETURN LINE
2 - WASHER
3 - FUEL INJECTOR
4 - INJECTOR ASSEMBLY LUBRACATION POINT
5 - HIGH PRESSURE FUEL LINE
6 - FUEL RAIL
7 - FUEL RAIL PRESSURE SENSOR
8 - HIGH PRESSURE FUEL RAIL SUPPLY LINE
9 - INJECTION PUMP HIGH PRESSURE OUTLET
10 - FUEL PRESSURE SOLENOID
11 - FUEL PRESSURE RETURN INLET

fuel are extracted, the fuel rail maintains a constant inner pressure. This ensures that the injection pressure remains constant from the moment the injector opens.

REMOVAL

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(1) Disconnect negative battery cable.

(2) Remove engine cover and bracket assembly (Refer to 9 - ENGINE COVER - REMOVAL).

(3) Disconnect fuel pressure sensor electrical connector (Fig. 6).

FUEL RAIL (Continued)

(4) Disconnect fuel rail return line at fuel rail (Fig. 6).

(5) Disconnect fuel high pressure line from injection pump to fuel rail at fuel rail.

(6) Disconnect fuel high pressure line from fuel rail to fuel injector at fuel rail (Fig. 6).

(7) Remove fuel rail retaining bolts and remove rail from cylinder head cover/intake manifold (Fig. 6).

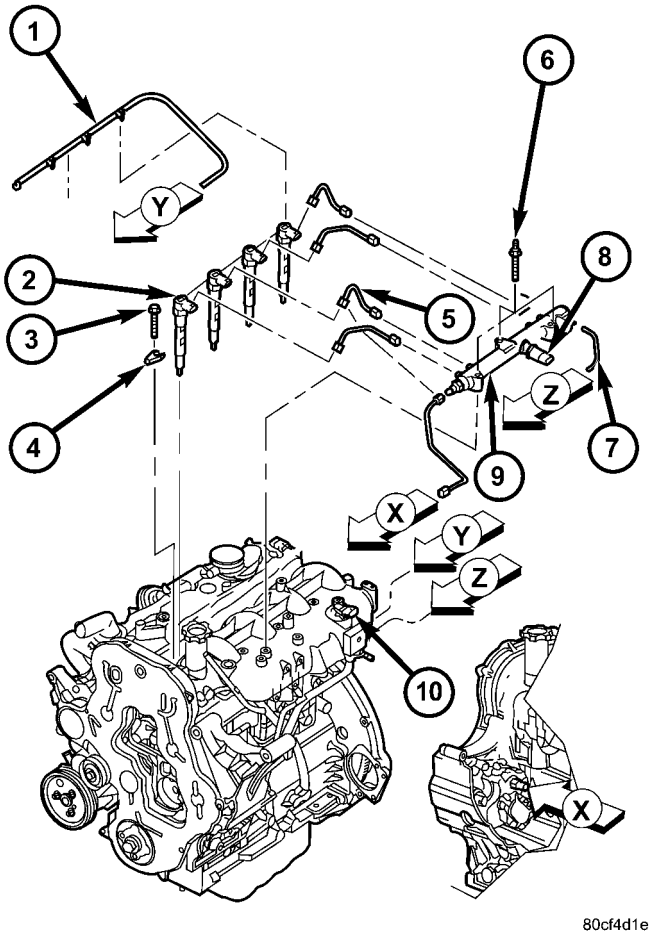

Fig. 6 FUEL SYSTEM COMPONENTS

1 - FUEL INJECTOR RETURN LINE
2 - FUEL INJECTOR
3 - RETAINING BOLT
4 - INJECTOR RETAINER
5 - HIGH PRESSURE FUEL LINE
6 - FUEL RAIL RETAINING BOLT
7 - FUEL RAIL RETURN LINE
8 - FUEL PRESSURE SENSOR
9 - FUEL RAIL
10 - BOOST PRESSURE/INTAKE AIR TEMPERATURE SENSOR

INSTALLATION

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(1) Install fuel rail on cylinder head cover/intake manifold (Fig. 6). Torque retaining bolts to 27.5N·m. (Refer to 14 - FUEL SYSTEM - WARNING)

(2) Connect injector high pressure fuel lines at fuel rail (Fig. 6).

(3) Connect fuel rail high pressure fuel line at fuel rail.

(4) Connect fuel rail fuel return line at fuel rail (Fig. 6).

(5) Connect fuel pressure sensor electrical connector (Fig. 6).

(6) Install engine cover and bracket assembly (Refer to 9 - ENGINE COVER - INSTALLATION).

(7) Connect negative battery cable.

FUEL LINES

DESCRIPTION

DESCRIPTION

All fuel lines up to the fuel injection pump are considered low-pressure. This includes the fuel lines from the fuel tank to the fuel injection pump. The fuel return lines and the fuel drain lines are also considered low-pressure lines. High-pressure lines are used between the fuel injection pump and the fuel injectors (Refer to 14 - FUEL SYSTEM - WARNING). Also refer to High-Pressure Fuel Lines Description/Operation (Refer to 14 - FUEL SYSTEM/ FUEL DELIVERY/FUEL LINES - OPERATION).

FUEL LINES (Continued)

DESCRIPTION - HIGH PRESSURE FUEL LINES

NOTE: High Pressure Fuel Lines Must Be Replaced At Each Disassembly.

(Refer to 14 - FUEL SYSTEM - WARNING). The high-pressure fuel lines are used between the fuel injection pump and the fuel injector rail, and between the fuel injection rail and fuel injectors. All other fuel lines are considered low-pressure lines

OPERATION - HIGH PRESSURE FUEL LINES

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

NOTE: High Pressure Fuel Lines To Injectors Must Be Replaced At Each Disassembly.

CAUTION: The high-pressure fuel lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. If lines are ever kinked or bent, they must be replaced. Use only the recommended lines when replacement of high-pressure fuel line is necessary.

High-pressure fuel lines deliver fuel under extremely high pressure from the high pressure pump to the fuel injectors (Refer to 14 - FUEL SYSTEM - WARNING). The lines expand and contract from the high-pressure fuel pulses generated during the injection process. All high-pressure fuel lines are of the same length and inside diameter. Correct high-pressure fuel line usage and installation is critical to smooth engine operation.

DIAGNOSIS AND TESTING - HIGH PRESSURE FUEL LINES

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

High-pressure fuel line leaks can cause starting problems and poor engine performance.

Start the engine. Carefully move the cardboard over the high-pressure fuel lines and check for fuel spray onto the cardboard (Fig. 7). If a high-pressure line connection is leaking, Replace damaged, restricted or leaking high-pressure fuel lines with the correct replacement line.

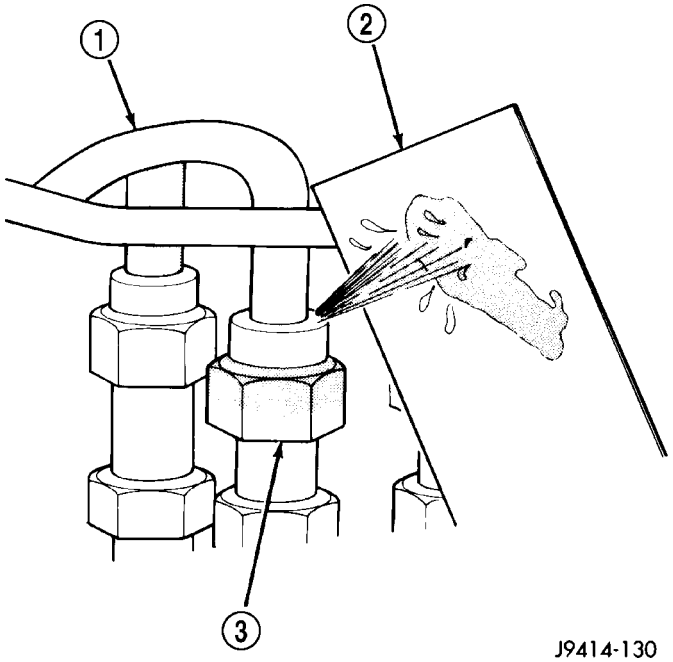

Fig. 7 Typical Test for Leaks with Cardboard

1 - HIGH-PRESSURE LINE
2 - CARDBOARD
3 - FITTING

CAUTION: The high-pressure fuel lines cannot contact each other or other components. Do not attempt to weld high-pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high-pressure fuel line is necessary.

FUEL INJECTION PUMP

DESCRIPTION

A radial-piston pump is used as the high pressure pump for fuel pressure generation (Refer to 14 - FUEL SYSTEM - WARNING) (Fig. 8).

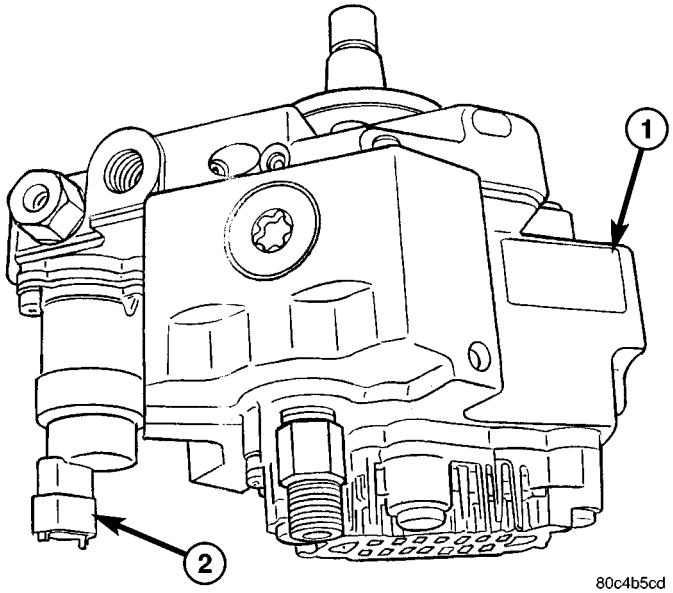

Fig. 8 FUEL INJECTION PUMP

1 - FUEL INJECTION PUMP
2 - INJECTION PUMP PRESSURE SOLENOID

REMOVAL

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(1) Disconnect negative battery cable.
(2) Remove engine cover and bracket(Refer to 9 - ENGINE - REMOVAL).
(3) Evacuate A/C system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(4) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(5) Remove cooling fan and fan shroud.
(6) Remove charge air cooler outlet hose to intake manifold.
(7) Remove fan support assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(8) Remove timing belt outer cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
(9) Using special tool VM.1055, remove high pressure injection pump sprocket retaining nut (Fig. 9).

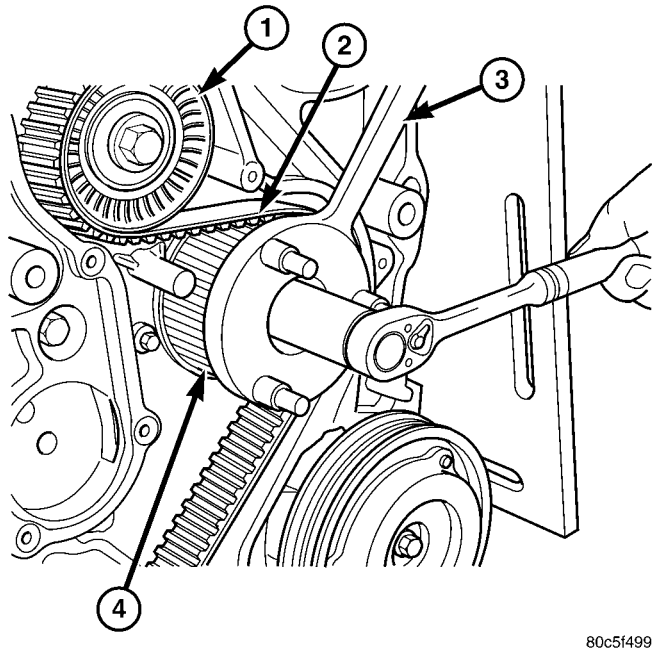

Fig. 9 INJECTION PUMP SPROCKET RETAINING NUT REMOVAL/INSTALLATION

1 - IDLER PULLEY
2 - TIMING BELT
3 - VM.1055
4 - INJECTION PUMP SPROCKET

NOTE: The use of special tool VM.1067 will allow you to remove the high pressure injection pump without removing the timing belt from the engine. This will allow you to remove and install the high pressure injection pump without altering injection pump timing.

(10) Install feet from VM.1067 in injection pump sprocket as shown (Fig. 10).
(11) Install inner flange of special tool VM.1067 on injection pump sprocket as shown (Fig. 11). Secure flange to feet in injection pump sprocket with allen bolts supplied with tool.
(12) Screw the high pressure injection pump sprocket holding plate assembly into flange of VM.1067 (Fig. 12) Using left hand threaded bolt supplied, secure holding plate assembly to timing belt inner cover.
(13) Disconnect A/C lines at compressor.

FUEL INJECTION PUMP (Continued)

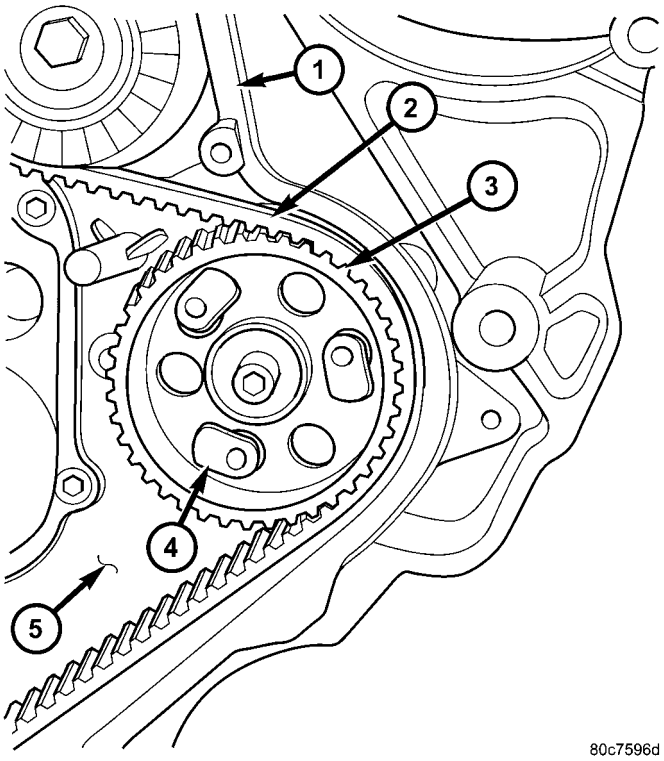

Fig. 10 VM.1067 FEET INSTALLATION

1 - OUTER TIMING BELT SEALING SURFACE
2 - TIMING BELT
3 - TIMING BELT SPROCKET
4 - FEET FOR SPECIAL TOOL VM.1067
5 - INNER TIMING BELT COVER

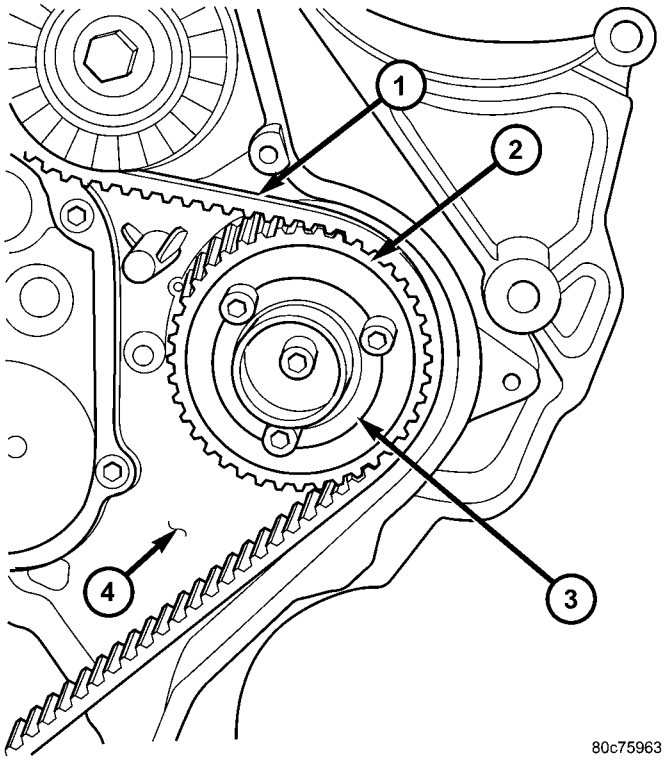

Fig. 11 VM.1067 INSTALLATION

1 - TIMING BELT
2 - INJECTION PUMP SPROCKET
3 - FLANGE OF VM.1067
4 - INNER TIMING BELT COVER

(14) Remove intake inlet tube at intake manifold.

(15) Remove high pressure injection pump to fuel rail high pressure line.

(16) Disconnect high pressure injection pump fuel pressure solenoid electrical connector.

(17) Disconnect fuel supply and return lines at high pressure injection pump (Fig. 13).

(18) Remove alternator to intake manifold bracket.

(19) Remove vacuum line bracket from intake manifold.

(20) Remove high pressure injection pump retaining nuts and remove pump (Fig. 13).

INSTALLATION

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

NOTE: If Engine Timing Is Of Concern,(Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION) or (Refer to 9 - ENGINE/VALVE TIMING/TMNG BELT/CHAIN TENSIONER&PULLEY - ADJUSTMENTS).

(1) Loosen bolt in center of injection pump holding plate and slide high pressure injection pump through the accessory bracket into the injection pump sprocket.

(2) Install high pressure high pressure injection pump retaining nuts (Fig. 13). Torque nuts to 27.5N·m.

(3) Unscrew injection pump holding plate (part of VM.1067) from inner timing belt cover and remove (Fig. 12).

(4) Install high pressure injection pump sprocket retaining nut to hold sprocket in place.

(5) Remove flange and feet (both part of VM.1067) from high pressure injection pump sprocket (Fig. 10) (Fig. 11).

FUEL INJECTION PUMP (Continued)

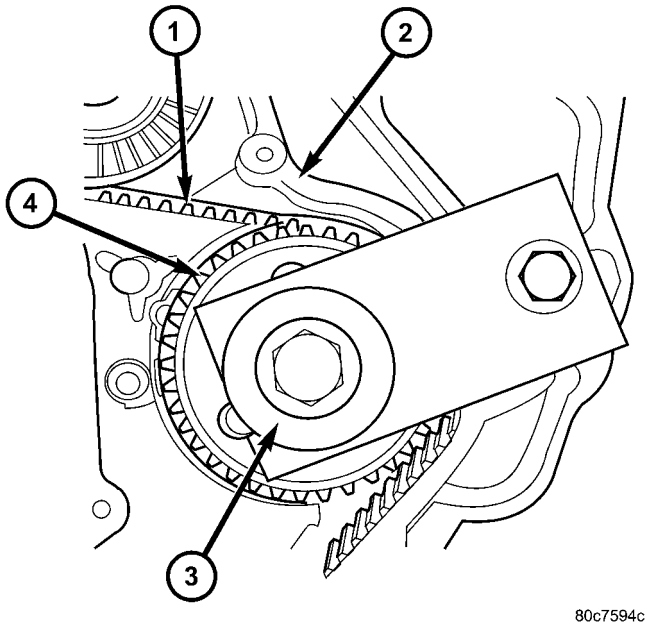

Fig. 12 INJECTION PUMP/GEAR REMOVAL USING VM.1067

1 - TIMING BELT
2 - INNER TIMING BELT COVER
3 - INJECTION PUMP SPROCKET HOLDING PLATE ASSEMBLY PART OF VM.1067
4 - INJECTION PUMP SPROCKET

(6) Using special tool VM.1055 (Fig. 9), torque high pressure injection pump sprocket retaining nut to 88.3N·m.

(7) Connect fuel pressure solenoid electrical connector.

(8) Connect fuel supply and return lines at high pressure injection pump (Fig. 13). (Refer to 14 - FUEL SYSTEM - WARNING).

(9) Install outer timing belt cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(10) Install fan support assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(11) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(12) Install cooling fan and shroud assembly.

(13) Install charge air cooler outlet hose.

(14) Install engine cover and bracket (Refer to 9 - ENGINE - INSTALLATION).

(15) Connect negative battery cable.

(16) Evacuate and recharge A/C system (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

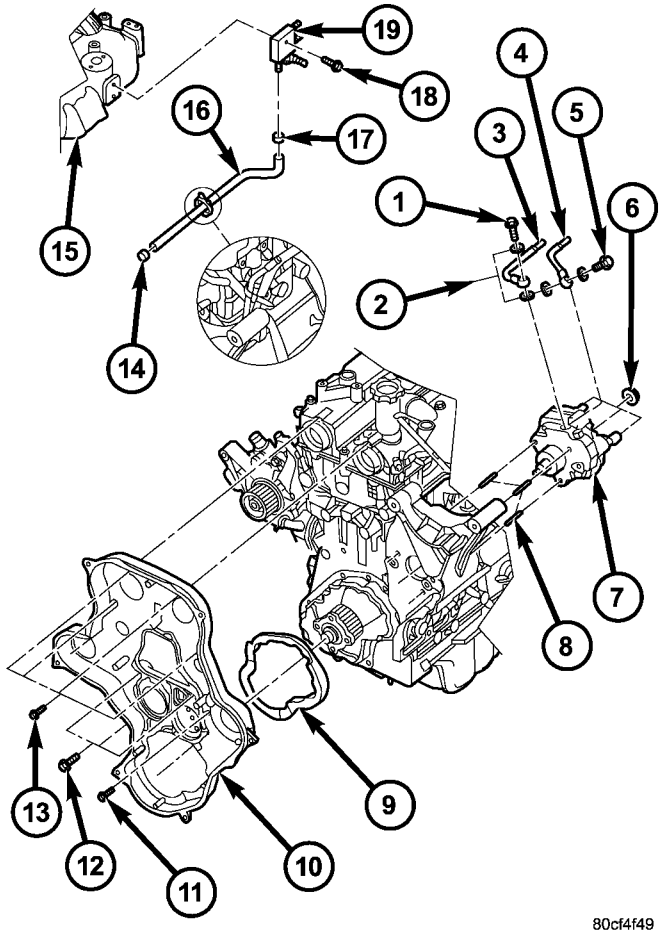

Fig. 13 FUEL INJECTION PUMP REMOVAL/ INSTALLATION

1 - BANJO FITTING
2 - BRASS WASHERS
3 - FUEL INLET LINE
4 - FUEL OUTLET LINE
5 - BANJO FITTING
6 - INJECTION PUMP RETAINING NUT
7 - INJECTION PUMP
8 - MOUNTING STUDS
9 - INNER TIMING COVER SEAL
10 - INNER TIMING COVER
11 - RETAINING BOLT
12 - RETAINING BOLT
13 - RETAINING BOLT
14 - HOSE CLAMP
15 - CYLINDER HEAD COVER/INTAKE MANIFOLD
16 - FUEL RETURN LINE TO INJECTION PUMP
17 - HOSE CLAMP
18 - FUEL RETURN JUNCTION BLOCK RETAINING BOLT
19 - FUEL RETURN JUNCTION BLOCK

FUEL TANK MODULE

DESCRIPTION

The fuel pump module assembly is located in the fuel tank. The assembly is divided into 2–sections, upper and lower. The lower section is locked to the bottom of the fuel tank. The complete assembly contains the following components:

- A separate fuel pick-up, or inlet filter
- A lockring to retain upper section of pump module to tank
- A rollover valve
- A soft gasket between tank flange and module
- A fuel gauge sending unit (fuel level sensor)
- Two fuel line connections (supply and return)

The fuel gauge sending unit may be serviced separately.

REMOVAL

Fuel tank removal is not required for fuel tank module removal. Access is from rear cargo area.

(1) Disconnect negative battery cable.

(2) Four cargo holdown clamps are located inside the vehicle on the floor of the rear cargo area. Remove the 2 rearward mounted clamps by drilling out the clamp rivets.

(3) Fold carpeting forward to gain access to fuel tank module access plate (Fig. 14).

(4) Remove 4 fuel pump module access plate nuts (Fig. 14).

(5) While applying heat with a heat gun, carefully pry up the fuel tank module access plate. **Take care not to bend plate.**

(6) Thoroughly clean area around top of tank module to prevent contaminants from entering fuel tank or lines.

(7) Disconnect fuel supply and return lines at fuel tank module by pressing 2 buttons at sides of fittings.

(8) Disconnect fuel tank module electrical connector.

(9) Remove module lockring using a brass drift and a hammer (counter-clockwise).

(10) Carefully lift upper section of fuel tank module from fuel tank exposing connections (Fig. 15)**(lift upper section from tank slowly until rubber gasket can be retained. If not, the gasket will fall into fuel tank.)**

(11) Disconnect electrical connector at bottom of upper tank module section (Fig. 15).

(12) Disconnect both fuel lines at bottom of upper tank module section (Fig. 15).

(13) Remove upper section of fuel tank module.

(14) Using an approved gas holding tank, drain fuel tank through tank module opening. **If only**

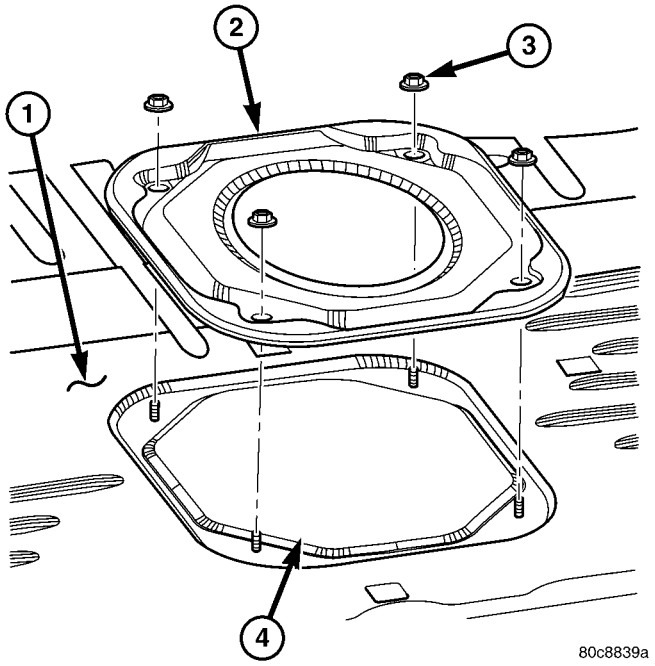

Fig. 14 ACCESS PLATE

1 - FLOORPAN AT REAR
2 - FUEL PUMP MODULE ACCESS PLATE
3 - NUTS (4)
4 - OPENING TO PUMP MODULE

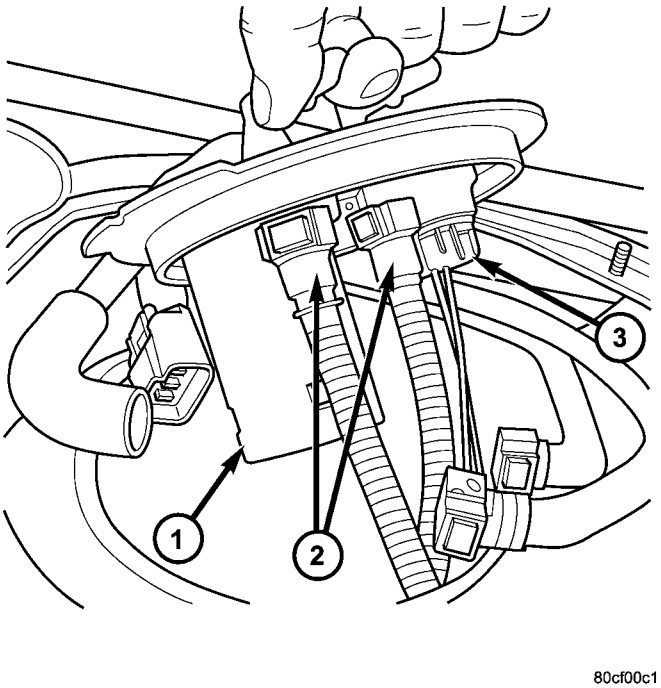

Fig. 15 FUEL TANK MODULE

1 - FUEL TANK CHECK (CONTROL) VALVE
2 - QUICK-CONNECT FITTINGS
3 - ELECTRICAL CONNECTOR

FUEL TANK MODULE (Continued)

upper section of tank module is being serviced, draining fuel tank is not necessary. If any other fuel tank component is being serviced, the tank must be completely drained.

(15) To remove lower section of tank module:

(a) Using finger pressure, push on elastic release tab while sliding lock tab upward (Fig. 16).

(b) The sides of lower tank module are equipped with tension springs (Fig. 16). These springs hold module to bottom of the fuel tank in 2 formed guides (Fig. 17). Release module assembly from these 2 guides by sliding toward right side of fuel tank.

(c) Lift assembly fom fuel tank.

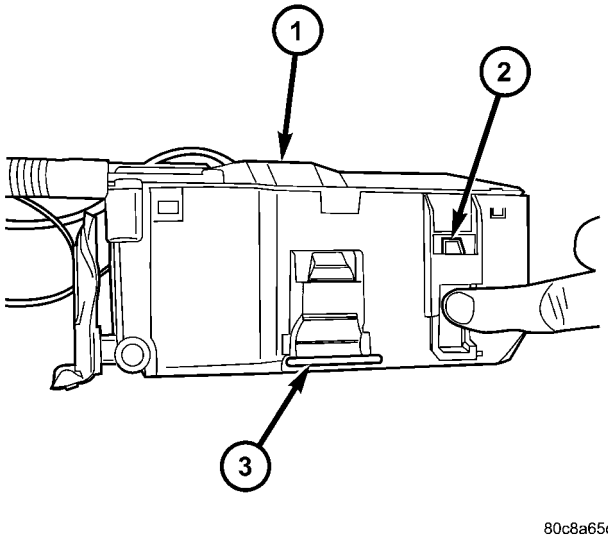

Fig. 16 LOWER SECTION - FUEL PUMP MODULE

1 - LOWER SECTION - FUEL PUMP MODULE
2 - RELEASE LOCK AND TAB
3 - TENSION SPRINGS

INSTALLATION

CAUTION: Whenever fuel tank module is serviced, pump module gasket must be replaced.

(1) Position lower section of fuel pump module assembly into fuel tank.

(2) The bottom of fuel tank has 2 formed guides. Lock module assembly into these 2 guides by sliding toward left side of fuel tank.

(3) Push down on plastic tab to lock module to fuel tank guides.

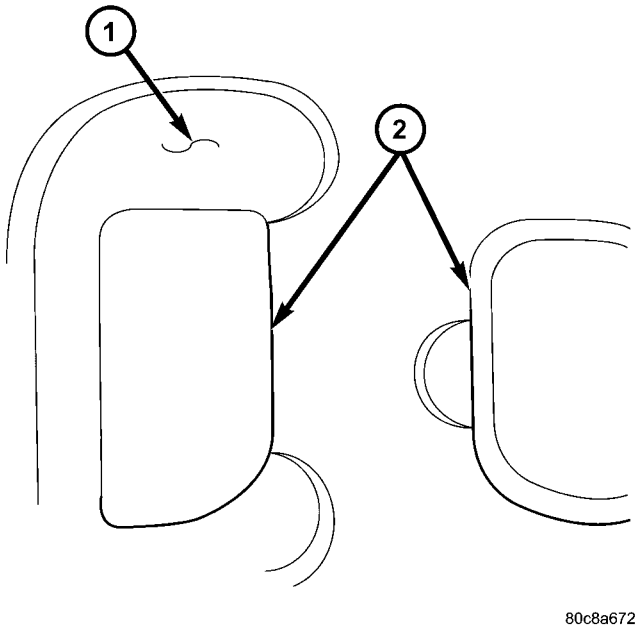

Fig. 17 FUEL TANK MODULE GUIDES (IN FUEL TANK)

1 - FUEL TANK (INSIDE/LOWER)
2 - FUEL TANK MODULE GUIDES

(4) Connect fuel supply and return lines to bottom of upper tank module section.

(5) Connect electrical connector to bottom of upper tank module section.

(6) Position tank module into fuel tank. Notch on module must be facing rear of tank.

(7) Position lock ring to module. Tap lockring using a brass drift and hammer (clockwise) until rotated up to built-on stops.

(8) Attach (snap on) 2 fuel filter fuel lines to top of fuel pump module.

(9) Fill fuel tank with fuel.

(10) Start engine and check for fuel leaks.

(11) Apply silicone sealant to bottom of fuel pump module metal access plate.

(12) Install fuel pump module metal access plate and 4 nuts. Tighten nuts to 3 N·m (26 in. lbs.) torque.

(13) Position carpet and install 2 new cargo clamp rivets into each cargo holdown clamp.

FUEL LEVEL SENDING UNIT / SENSOR

DESCRIPTION

The fuel gauge sending unit (fuel level sensor) is attached to the side of the lower fuel tank module. The sending unit consists of a float, an arm, and a variable resistor track (card).

OPERATION

For Fuel Gauge Operation: A constant current source of approximately 32 milliamps is supplied to the resistor track on the fuel gauge sending unit. This is fed directly from the Engine Control Module (ECM). **NOTE: For diagnostic purposes, this 12V power source can only be verified with the circuit opened (fuel tank module electrical connector unplugged). With the connectors plugged, output voltages will vary from about 0.6 volts at FULL, to about 8.6 volts at EMPTY (about 8.6 volts at EMPTY for Jeep models, and about 7.0 volts at EMPTY for Dodge Truck models).** The resistor track is used to vary the voltage (resistance) depending on fuel tank float level. As fuel level increases, the float and arm move up, which decreases voltage. As fuel level decreases, the float and arm move down, which increases voltage. The varied voltage signal is returned back to the ECM through the sensor return circuit.

Both of the electrical circuits between the fuel gauge sending unit and the ECM are hard-wired (not multi-plexed). After the voltage signal is sent from the resistor track, and back to the ECM, the ECM will interpret the resistance (voltage) data and send a message across the multi-plex bus circuits to the instrument panel cluster. Here it is translated into the appropriate fuel gauge level reading. Refer to Instrument Panel for additional information.

DIAGNOSIS AND TESTING - FUEL LEVEL SENDING UNIT

The fuel level sending unit contains a variable resistor (track). As the float moves up or down, electrical resistance will change. Refer to Instrument Panel and Gauges for Fuel Gauge testing. To test the gauge sending unit only, it must be removed from vehicle. The unit is a separate part of the lower fuel tank module section. Refer to Fuel Tank Module Removal/Installation for procedures (remove only the upper section of the fuel pump module). Measure the resistance across the sending unit terminals. With float in up position, resistance should be 20 ohms (+/- 5%). With float in down position, resistance should be 270 ohms (+/- 5%).

REMOVAL

The fuel level sending unit (fuel level sensor) and float assembly is located on the side of the lower section of the fuel tank module. The lower section of the fuel tank module is located within the fuel tank.

(1) Remove lower section of fuel tank module from fuel tank (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TANK MODULE - REMOVAL).

(2) To remove sending unit from tank module, lift on plastic locking tab (Fig. 18) while sliding sending unit upwards.

(3) Disconnect electrical connector from bottom of upper section of fuel tank module. Separate necessary sending unit wiring.

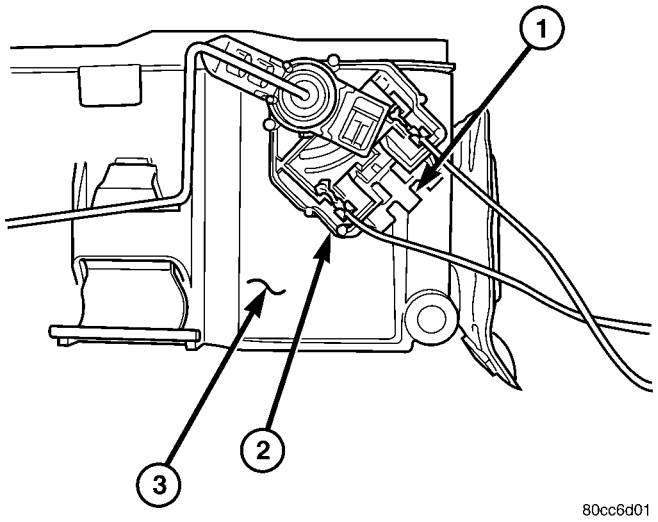

Fig. 18 FUEL LEVEL SENDING UNIT

1 - LIFT TAB HERE FOR REMOVAL
2 - FUEL LEVEL SENDING UNIT
3 - LOWER SECTION OF PUMP MODULE

INSTALLATION

(1) Connect necessary wiring into electrical connectors.

(2) Position sending unit to tank module. Slide and snap into place.

(3) Install lower section of fuel tank module. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TANK MODULE - INSTALLATION)

FUEL HEATER

DESCRIPTION

The fuel heater is used to prevent diesel fuel from waxing and plugging the fuel filter during cold weather operation. The fuel heater is located in the fuel filter cap of the fuel filter/water separator assembly (Fig. 19).

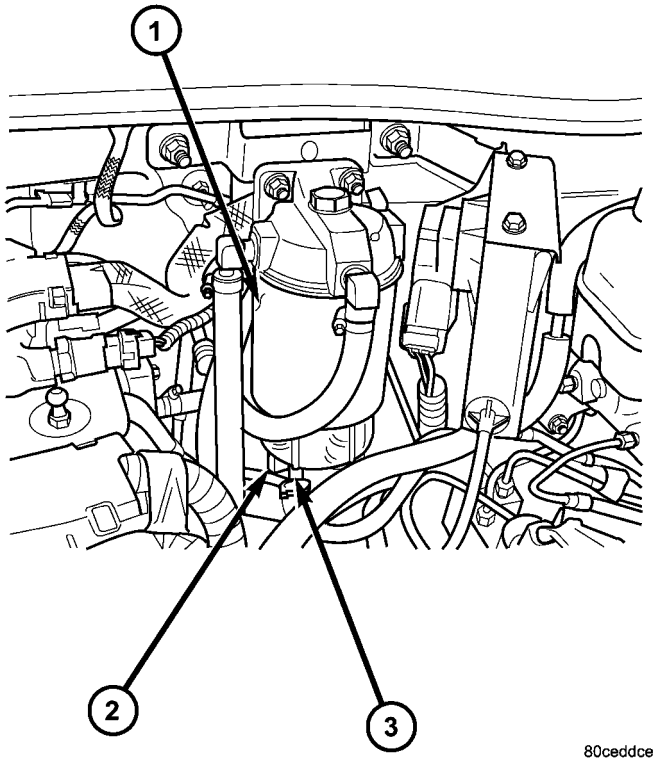

Fig. 19 FUEL FILTER / WATER SEPARATOR

1 - FUEL FILTER / WATER SEPARATOR ASSEMBLY
2 - WATER-IN-FUEL SENSOR
3 - FUEL HEATER

OPERATION

The element inside the heater assembly is made of a Positive Temperature Coefficient (PTC) material, and has power applied to it by the fuel heater relay anytime the ignition key is in the “on” position. PTC material has a high resistance to current flow when its temperature is high, which means that it will not generate heat when the temperature is above a certain value. When the temperature is below 7°C (45° F), the resistance of the PTC element is lowered, and allows current to flow through the fuel heater element warming the fuel. When the temperature is above 29°C (85° F), the PTC element’s resistance rises, and current flow through the heater element stops.

Voltage to operate the fuel heater is supplied from the ignition (key) switch and through the fuel heater relay. Refer to the following Fuel Heater Relay for additional information. **The fuel heater and fuel heater relay are not controlled by the Engine Control Module (ECM).**

REMOVAL

(1) Disconnect negative battery cable.
(2) Disconnect fuel heater and WIF sensor electrical connectors.
(3) Drain fuel filter/water separator assembly into a suitable container by loosening drain at bottom of fuel filter cap.
(4) Remove fuel filter cap from bottom of filter assembly.
(5) Remove fuel heater retaining screws and remove heater assembly from fuel filter cap (Fig. 20).

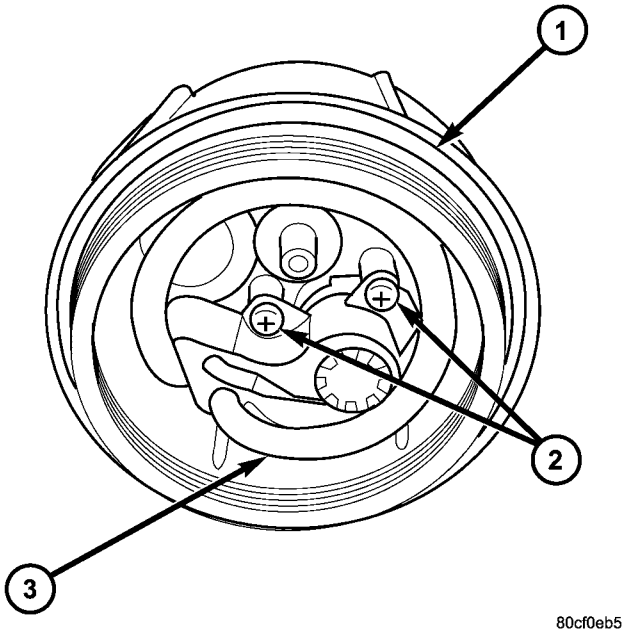

Fig. 20 FUEL HEATER ASSEMBLY

1 - FUEL FILTER CAP ASSEMBLY
2 - FUEL HEATER RETAINING SCREWS
3 - FUEL HEATER ASSEMBLY

INSTALLATION

(1) Install fuel heater assembly in fuel filter cap. Tighten retaining screws.
(2) Install fuel filter cap on fuel filter assembly.
(3) Connect fuel heater and WIF sensor electrical connectors.
(4) Prime fuel system using the fuel priming plunger. (Refer to 14 - FUEL SYSTEM - STANDARD PROCEDURE)
(5) Connect negative battery cable.

FUEL PRESSURE SOLENOID

DESCRIPTION

The fuel pressure solenoid is attached to the rear of the injection pump (Refer to 14 - FUEL SYSTEM - WARNING) (Fig. 21).

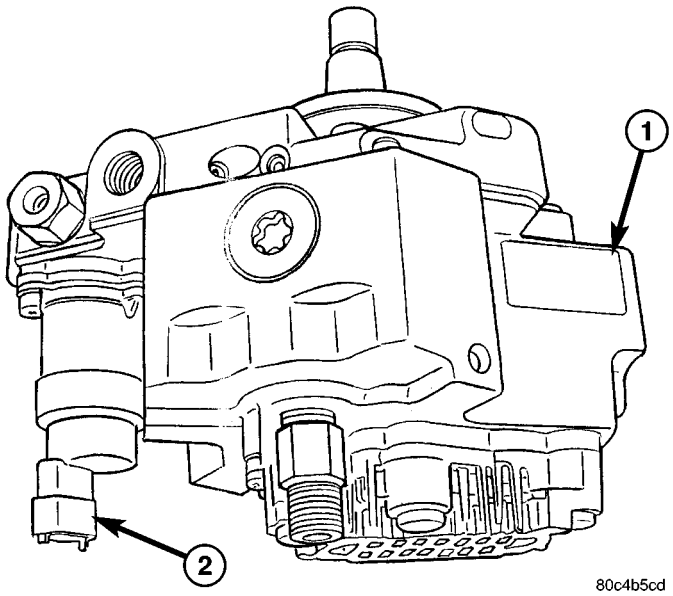

Fig. 21 FUEL INJECTION PUMP

1 - FUEL INJECTION PUMP
2 - INJECTION PUMP PRESSURE SOLENOID

OPERATION

The fuel pressure solenoid sets the correct pressure in the fuel rail as a function of engine loading and maintains it at the proper level. If the rail pressure is excessive, the solenoid opens and a portion of the fuel returns from the fuel rail to the fuel tank via a return line. If the rail pressure is too low, the solenoid closes and seals off the high-pressure stage from the low-pressure stage (Refer to 14 - FUEL SYSTEM - WARNING).

FUEL INJECTION

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CRANKSHAFT POSITION SENSOR

DESCRIPTION

The crankshaft position sensor is mounted in the right rear of the engine block below the turbocharger (Fig. 1). This sensor is used to detect engine speed.

OPERATION

The crankshaft position sensor is a magnetic pickup type sensor that generates an A/C signal. The sensor contains a permanent magnet and a coil of wire. The sensor generates an A/C signal each time a notch in the reluctor wheel on the crankshaft passes across the permanent magnet. The ECM calculates engine speed based on the frequency of the A/C signal.

REMOVAL

(1) Disconnect negative battery cable.

(2) Raise vehicle on houst.

(3) Remove exhaust pipe to turbocharger down pipe retaining bolts and lower exhaust pipe from turbocharger downpipe.

(4) Disconnect crankshaft position sensor electrical connector.

(5) Remove crankshaft position sensor retaining bolt and remove sensor from engine block (Fig. 2).

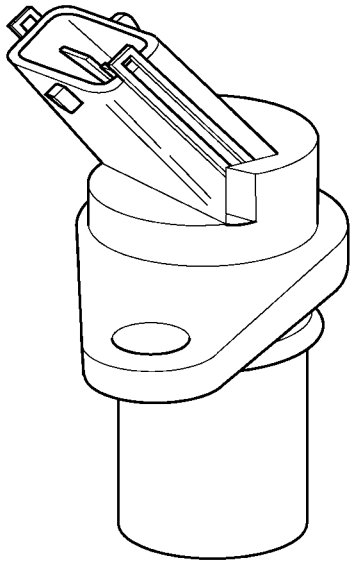

Fig. 1 CRANKSHAFT POSITION SENSOR

INSTALLATION

(1) Lubricate o-ring on crankshaft position sensor and install sensor in engine block (Fig. 2).

(2) Install crankshaft position sensor retaining bolt (Fig. 2). Torque bolt to 10.8N·m.

(3) Connect crankshaft position sensor electrical connection.

CRANKSHAFT POSITION SENSOR (Continued)

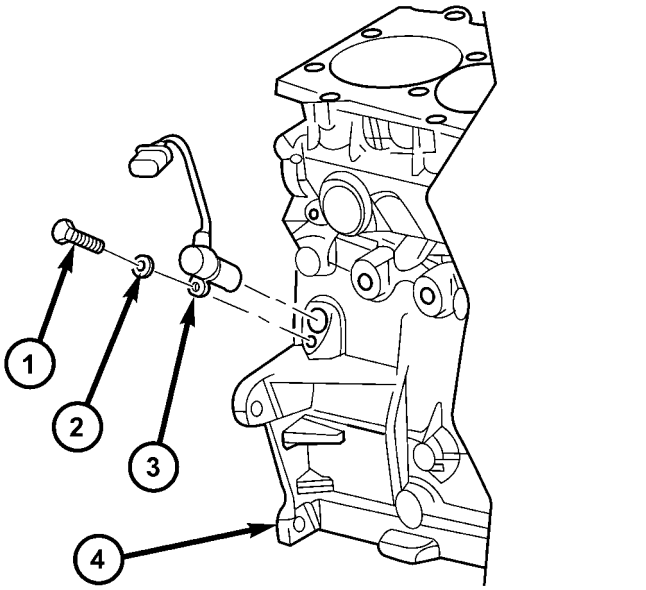

Fig. 2 CRANKSHAFT POSITION (CKP) SENSOR REMOVAL/INSTALL

1 - RETAINING BOLT
2 - WASHER
3 - CRANKSHAFT POSITION (CKP) SENSOR
4 - ENGINE BLOCK

(4) Connect exhaust pipe to turbocharger downpipe. Torque bolts to 32.4N·m.
(5) Lower vehicle from hoist.
(6) Connect negative battery cable.

ACCELERATOR PEDAL POSITION SENSOR

DESCRIPTION

The Accelerator Pedal Position Sensor is a variable resistor that provides the ECM with an input signal (voltage) (Fig. 3). The signal represents throttle blade position. As the position of the accelerator pedal changes, the resistance of the sensor changes (Fig. 4).

REMOVAL

(1) Disconnect negative battery cable.
(2) Disconnect accelerator pedal position sensor electrical connector (Fig. 5).
(3) Remove accelerator pedal position sensor assembly mounting bolts (Fig. 5).
(4) Open accelerator pedal position sensor assembly and disconnect accelerator cable (Fig. 6).
(5) Remove accelerator pedal position sensor assembly.

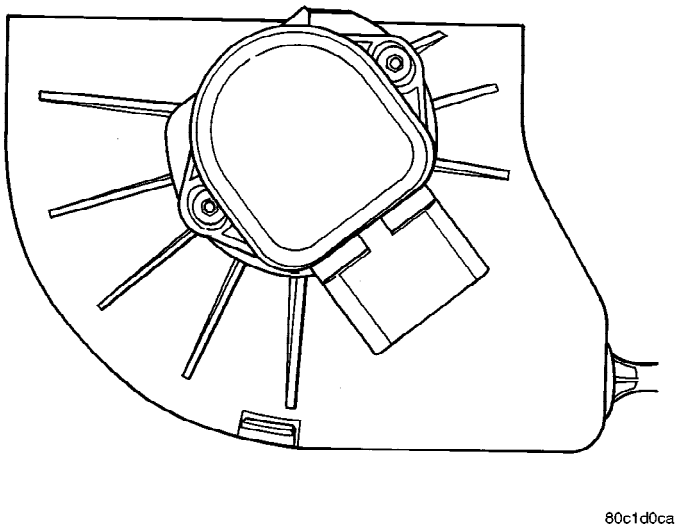

Fig. 3 ACCELERATOR PEDAL POSITION SENSOR ASSEMBLY

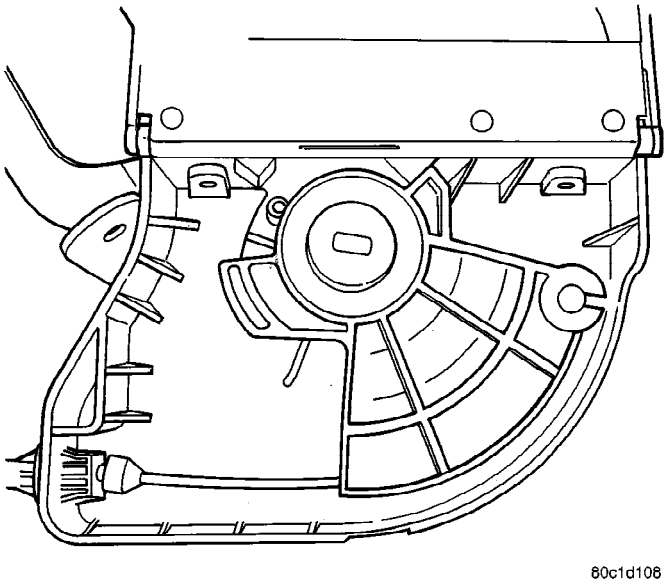

Fig. 4 ACCELERATOR PEDAL POSITION SENSOR ASSEMBLY OPEN

INSTALLATION

(1) Connect accelerator cable to accelerator pedal position sensor assembly and close cover.
(2) Attach accelerator pedal position sensor assembly to mounting bracket.
(3) Connect sensor electrical connector.
(4) Connect negative battery cable

ACCELERATOR PEDAL POSITION SENSOR (Continued)

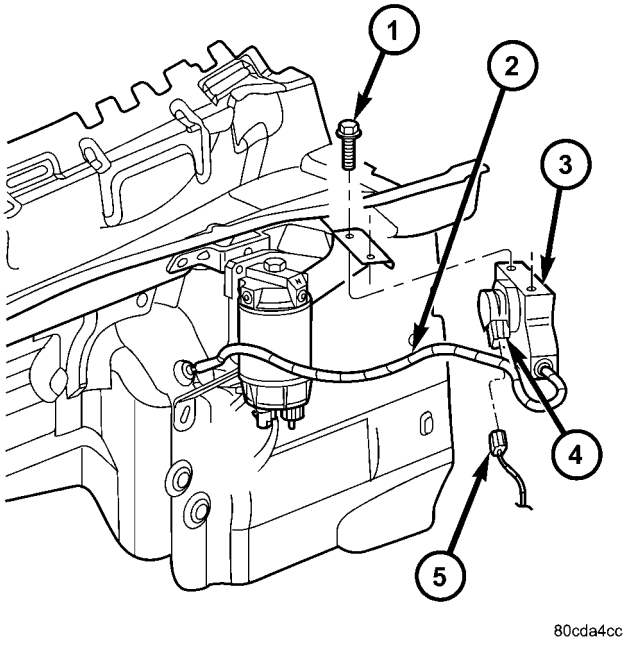

Fig. 5 ACCELERATOR PEDAL POSITION SENSOR

1 - RETAINING BOLTS
2 - ACCELERATOR CABLE
3 - ACCELERATOR PEDAL POSITION SENSOR BRACKET
4 - ACCELERATOR PEDAL POSITION SENSOR
5 - ACCELERATOR PEDAL POSITION SENSOR ELECTRICAL SENSOR

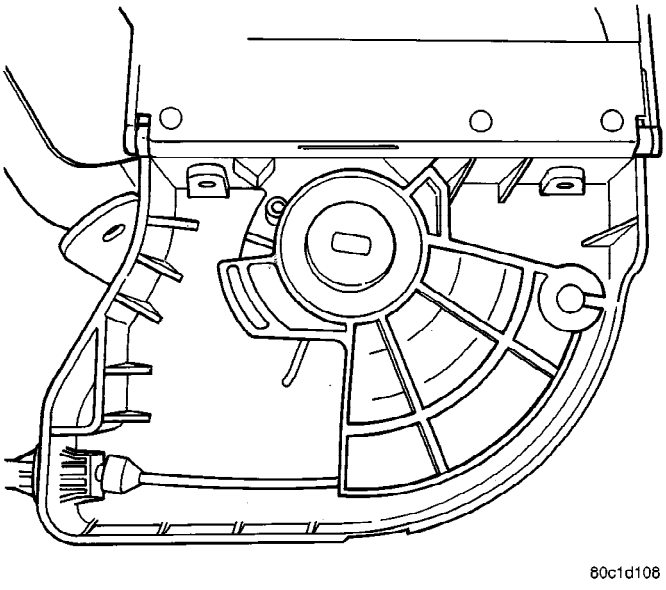

Fig. 6 ACCELERATOR PEDAL POSITION SENSOR ASSEMBLY OPEN

BOOST PRESSURE SENSOR

DESCRIPTION

The boost pressure/ intake air temperature sensor is mounted to the top of the intake manifold. The sensor allows the ECM to monitor air pressure within the intake manifold. This sensor is also used to monitor the intake air temperature (Fig. 7).

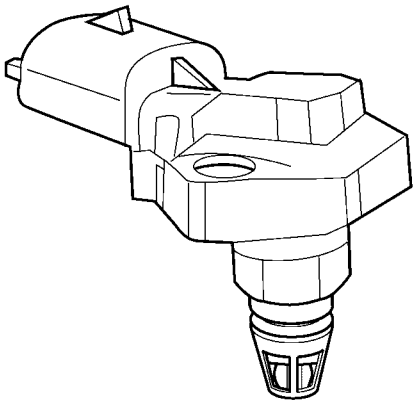

Fig. 7 BOOST PRESSURE SENSOR / INTAKE AIR TEMPERATURE SENSOR

OPERATION

When the intake manifold pressure is low 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/INTAKE AIR TEMPERATURE 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.

BOOST PRESSURE SENSOR (Continued)

Refer to On-Board Diagnostics in Emissions Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove engine cover and bracket assembly (Refer to 9 - ENGINE COVER - REMOVAL).
(3) Disconnect sensor electrical connector (Fig. 8).
(4) Remove retaining bolts and remove sensor from cylinder head cover/intake manifold (Fig. 8).

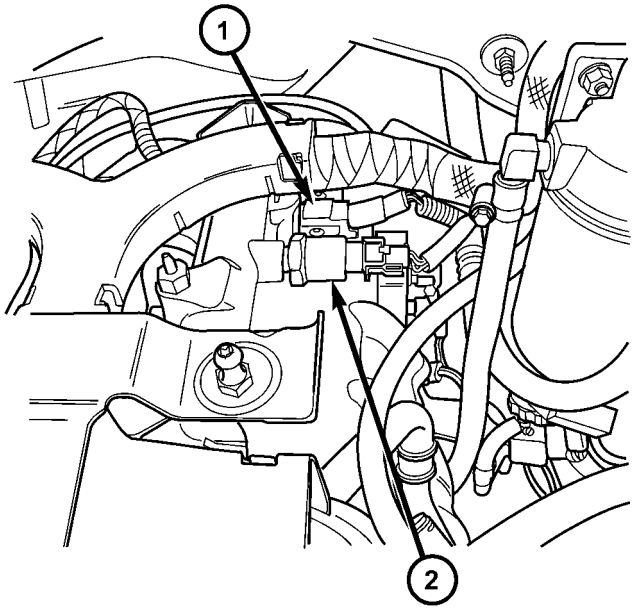

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Fig. 8 SENSOR LOCATIONS

1 - BOOST PRESSURE/INTAKE AIR TEMPERATURE SENSOR
2 - FUEL PRESSURE SENSOR

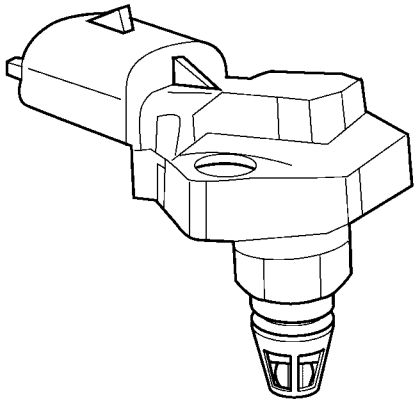
INSTALLATION

(1) Install sensor and retaining bolts into cylinder head cover/intake manifold (Fig. 8). Torque to 5.4 N·m.
(2) Connect sensor electrical connector (Fig. 8).
(3) Install engine cover and bracket assembly (Refer to 9 - ENGINE COVER - INSTALLATION).
(4) Connect negative battery cable.

INTAKE AIR TEMPERATURE SENSOR

DESCRIPTION

The boost pressure/ intake air temperature sensor is mounted to the top of the intake manifold. The sensor allows the ECM to monitor air pressure within the intake manifold. This sensor is also used to monitor the intake air temperature (Fig. 9).



8100a221

Fig. 9 BOOST PRESSURE SENSOR / 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.

REMOVAL

(1) (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/BOOST PRESSURE SENSOR - REMOVAL)

INSTALLATION

(1) (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/BOOST PRESSURE SENSOR - INSTALLATION)

FUEL INJECTOR

DESCRIPTION

FUEL INJECTOR

WARNING: HIGH - PRESSURE FUEL LINE DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH - PRESSURE LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(Refer to 14 - FUEL SYSTEM - WARNING) There are individual fuel injectors for all four cylinders. These fuel injectors are used to spray fuel into the combustion chamber (Fig. 10).

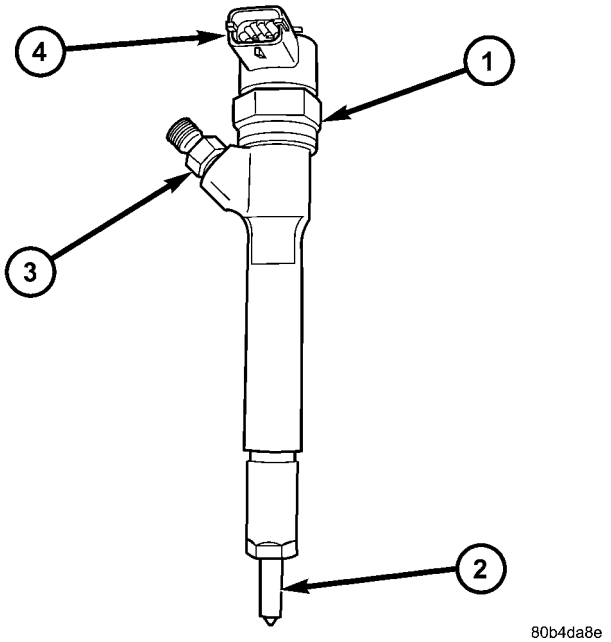


Fig. 10 FUEL INJECTOR

1 - FUEL INJECTOR
2 - NOZZLE
3 - FUEL INLET FITTING
4 - ELECTRICAL CONNECTION

OPERATION

(Refer to 14 - FUEL SYSTEM - WARNING) 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)

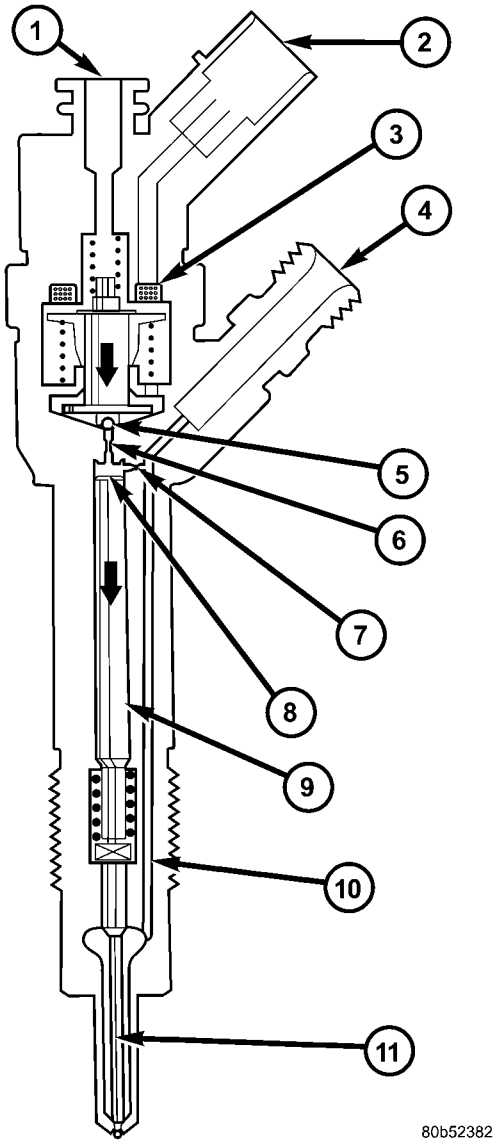


Fig. 11 INJECTOR COMPONENTS

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 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

FUEL INJECTOR (Continued)

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. 11).

Injector opens (start of injection)

The solenoid valve is energized with the pickup current which serves to ensure that it open quickly. 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 opens as a result, and injection starts (Fig. 11).

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. 11).

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. 11).

REMOVAL

WARNING: HIGH - PRESSURE FUEL LINE DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH - PRESSURE LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE - REMOVAL).
(3) Disconnect injector electrical connector.
(4) Remove fuel return line from injector (Fig. 12).
(5) Remove fuel injector high pressure line (Refer to 14 - FUEL SYSTEM - WARNING) (Fig. 12).
(6) Remove fuel injector retainer and retaining bolt (Fig. 12).

NOTE: DO NOT use a wire brush to clean the fuel injector or nozzle. Possible restriction of the injector needle may result.

(7) Remove fuel injector from cylinder head (Fig. 12).

INSTALLATION

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

NOTE: DO NOT use a brush to clean around the injector nozzle. DO NOT lubricate area around injector nozzle. The injector may become restricted with debris.

FUEL INJECTOR (Continued)

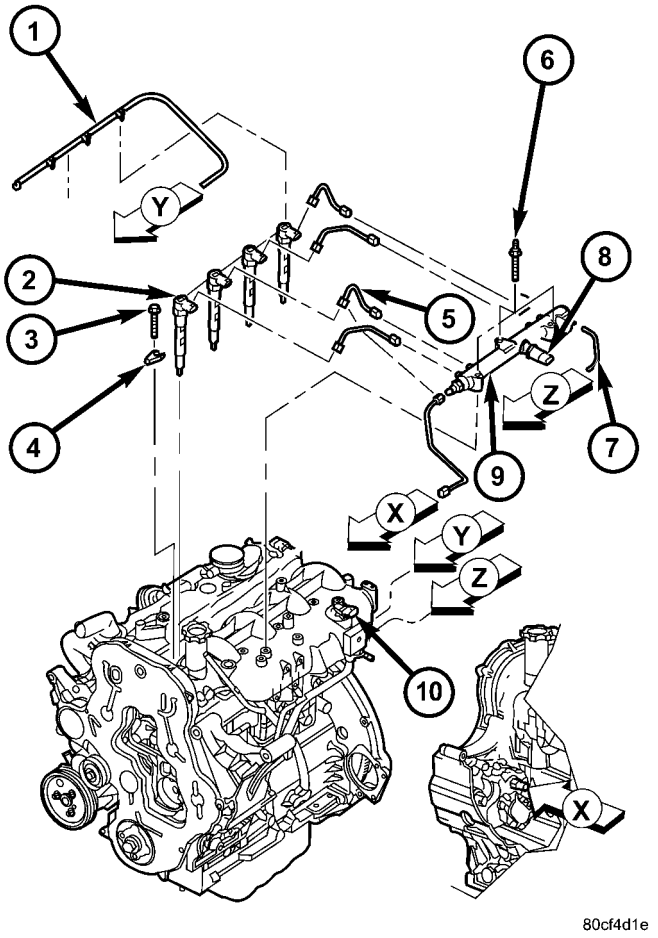


Fig. 12 FUEL SYSTEM COMPONENTS

1 - FUEL INJECTOR RETURN LINE
2 - FUEL INJECTOR
3 - RETAINING BOLT
4 - INJECTOR RETAINER
5 - HIGH PRESSURE FUEL LINE
6 - FUEL RAIL RETAINING BOLT
7 - FUEL RAIL RETURN LINE
8 - FUEL PRESSURE SENSOR
9 - FUEL RAIL
10 - BOOST PRESSURE/INTAKE AIR TEMPERATURE SENSOR

NOTE: Be sure the copper washer is installed on end of injector before installing in cylinder head.

(1) Apply antiseize compound to injector body.
(2) Install fuel injector in cylinder head.
(3) Install fuel injector high pressure line (Refer to 14 - FUEL SYSTEM - WARNING) (Fig. 12).
(4) Install fuel injector retainer and bolt (Fig. 12). Torque bolt to 32.4 N·m.
(5) Install fuel return line to injector (Fig. 12).
(6) Connect fuel injector electrical connector.
(7) Install engine cover and bracket assembly (Refer to 9 - ENGINE COVER - INSTALLATION).
(8) Connect negative battery cable.

FUEL PRESSURE SENSOR

DESCRIPTION

WARNING: HIGH - PRESSURE FUEL LINE DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH - PRESSURE LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

The fuel rail pressure sensor screws into the fuel rail at the top of the engine (Fig. 13).

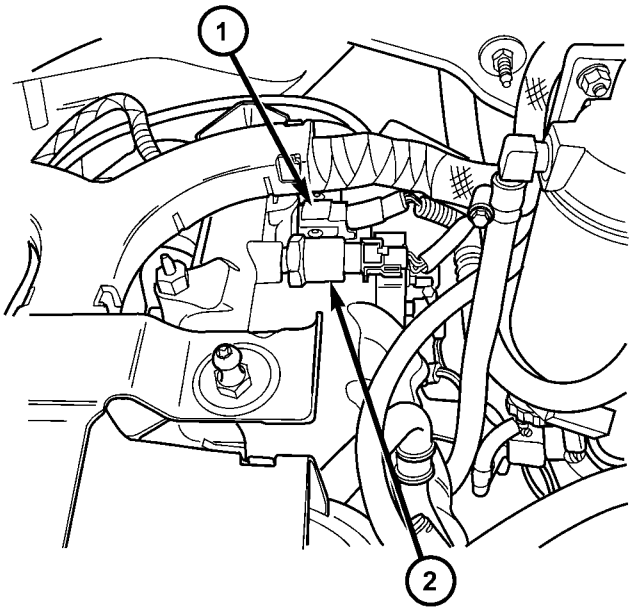


Fig. 13 SENSOR LOCATIONS

1 - BOOST PRESSURE/INTAKE AIR TEMPERATURE SENSOR
2 - FUEL PRESSURE SENSOR

FUEL PRESSURE SENSOR (Continued)

OPERATION

WARNING: AVOID ALL CONTACT WITH FUEL SPRAY. THE INJECTION PUMP SUPPLIES HIGH-PRESSURE FUEL TO EACH INDIVIDUAL INJECTOR THROUGH HIGH-PRESSURE LINES. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN AND CAUSE PERSONAL INJURY. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

The fuel flows to the fuel pressure sensor through an opening in the rail, the end of which is sealed off by the sensor diaphram. Pressurized fuel reaches the sensor's diaphram through a blind hole. The sensor element (semiconductor device) for converting the pressure to an electric signal is mounted on this diaphram. The signal generated by the sensor is sent to the ECM.

REMOVAL

(1) Disconnect negative battery cable.
(2) Remove engine cover (Refer to 9 - ENGINE COVER - REMOVAL).
(3) Disconnect fuel pressure sensor electrical connector (Fig. 13).
(4) Remove fuel pressure sensor from fuel rail (Fig. 13).

INSTALLATION

WARNING: HIGH - PRESSURE LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 1600BAR (23,200 PSI.). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH - PRESSURE FUEL LEAKS. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE SKIN CAUSING PERSONAL INJURY OR DEATH. INSPECT FOR HIGH — PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING WHEN SERVICING FUEL SYSTEM.

(1) Install fuel pressure sensor in fuel rail (Fig. 13).
(2) Connect fuel pressure sensor electrical connector (Fig. 13).
(3) Install engine cover (Refer to 9 - ENGINE COVER - INSTALLATION).
(4) Connect negative battery cable.

AUTOMATIC TRANSMISSION - 545RFE

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AUTOMATIC TRANSMISSION - 545RFE

DESCRIPTION

The 545RFE automatic transmission is a sophisticated, multi-range, electronically controlled transmission which combines optimized gear ratios for responsive performance, state of the art efficiency features and low NVH. Other features include driver adaptive shifting and three planetary gear sets to provide wide ratio capability with precise ratio steps for optimum driveability. The three planetary gear sets also make available a unique alternate second gear ratio. The primary 2nd gear ratio fits between 1st and 3rd gears for normal through-gear accelerations. The alternate second gear ratio (2prime) allows smoother 4-2 kickdowns at high speeds to provide 2nd gear passing performance over a wider highway cruising range. An additional overdrive ratio (0.67:1) is also provided for greater fuel economy and less NVH at highway speeds.

The hydraulic portion of the transmission consists of the transmission fluid, fluid passages, hydraulic valves, and various line pressure control components.

The primary mechanical components of the transmission consist of the following:

- Three multiple disc input clutches
- Three multiple disc holding clutches
- Five hydraulic accumulators
- Three planetary gear sets
- Dual Stage Hydraulic oil pump
- Valve body
- Solenoid pack

The TCM is the “heart” or “brain” of the electronic control system and relies on information from various direct and indirect inputs (sensors, switches, etc.) to determine driver demand and vehicle operating conditions. With this information, the TCM can calculate and perform timely and quality shifts through various output or control devices (solenoid pack, transmission control relay, etc.).

TRANSMISSION IDENTIFICATION

Transmission identification numbers are stamped on the left side of the case just above the oil pan sealing surface (Fig. 1). Refer to this information when ordering replacement parts. A label is attached to the transmission case above the stamped numbers. The label gives additional information which may also be necessary for identification purposes.

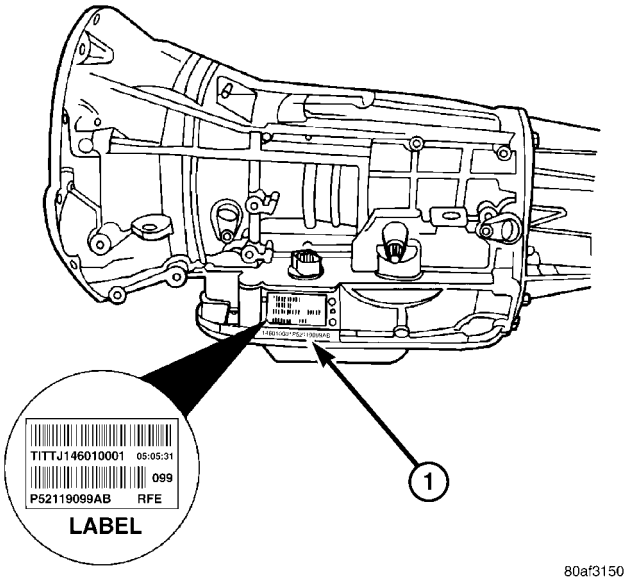


Fig. 1 Transmission Part And Serial Number Location

1 - IDENTIFICATION NUMBERS (STAMPED)

GEAR RATIOS

The 545RFE gear ratios are:

1st	3.00:1
2nd	1.67:1
2nd Prime	1.50:1
3rd	1.00:1
4th	0.75:1
5th	0.67:1
Reverse	3.00:1

OPERATION

The 545RFE offers full electronic control of all automatic up and downshifts, and features real-time adaptive closed-loop shift and pressure control. Electronic shift and torque converter clutch controls help protect the transmission from damage due to high temperatures, which can occur under severe operating conditions. By altering shift schedules, line pressure, and converter clutch control, these controls reduce heat generation and increase transmission cooling.

To help reduce efficiency-robbing parasitic losses, the transmission includes a dual-stage transmission fluid pump with electronic output pressure control. Under most driving conditions, pump output pressure greatly exceeds that which is needed to keep the clutches applied. The 545RFE pump-pressure control system monitors input torque and adjusts the pump pressure accordingly. The primary stage of the pump works continuously; the second stage is bypassed when demand is low. The control system also monitors input and output speed and, if incipient clutch slip is observed, the pressure control solenoid duty cycle is varied, increasing pressure in proportion to demand.

A high-travel torque converter damper assembly allows earlier torque converter clutch engagement to reduce slippage. Needle-type thrust bearings reduce internal friction. The 545RFE is packaged in a one-piece die-cast aluminum case. To reduce NVH, the case has high lateral, vertical and torsional stiffness. It is also designed to maximize the benefit of the structural dust cover that connects the bottom of the bell housing to the engine bedplate, enhancing overall power train stiffness. Dual filters protect the pump and other components. A pump return filter is added to the customary main sump filter. Independent lubrication and cooler circuits assure ample pressure for normal transmission operation even if the cooler is obstructed or the fluid cannot flow due to extremely low temperatures.

The hydraulic control system design (without electronic assist) provides the transmission with PARK, REVERSE, NEUTRAL, SECOND, and THIRD gears, based solely on driver shift lever selection. This design allows the vehicle to be driven (in “limp-in” mode) in the event of a electronic control system failure, or a situation that the Transmission Control Module (TCM) recognizes as potentially damaging to the transmission.

The TCM also performs certain self-diagnostic functions and provides comprehensive information (sensor data, DTC's, etc.) which is helpful in proper diagnosis and repair. This information can be viewed with the DRB scan tool.

AUTOMATIC TRANSMISSION - 545RFE (Continued)

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - AUTOMATIC TRANSMISSION

CAUTION: Before attempting any repair on a 545RFE 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

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. If the problem persists after the preliminary tests and corrections are completed, hydraulic pressure checks should be performed.

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 presure problems.

A slipping clutch can often be determined by comparing which internal units are applied in the various gear ranges. The Clutch Application chart provides a basis for analyzing road test results.

CLUTCH APPLICATION CHART

SLP	UD	OD	R	2C	4C	L/R	OVERRUNNING
P-PARK						ON	
R–REVERSE			ON			ON	
N-NEUTRAL						ON	
D-OVERDRIVE FIRST	ON					ON*	ON
SECOND	ON			ON			
SECOND PRIME	ON				ON		
THIRD	ON	ON					
FOURTH		ON			ON		
FIFTH		ON		ON			
LIMP-IN	ON	ON					
2-FIRST	ON					ON*	ON
SECOND	ON			ON			
LIMP-IN	ON			ON			
1-LOW	ON					ON	ON

*L/R clutch is on only with the output shaft speed below 150 rpm.

DIAGNOSIS AND TESTING - HYDRAULIC PRESSURE TEST

An accurate tachometer and pressure test gauges are required. Test Gauge C-3293-SP has a 300 psi range and is used at all locations where pressures exceed 100 psi.

Pressure Test Port Locations

Only two pressure ports are supplied on the transmission case. The torque converter clutch apply and release ports are located on the right side of the transmission case (Fig. 2).

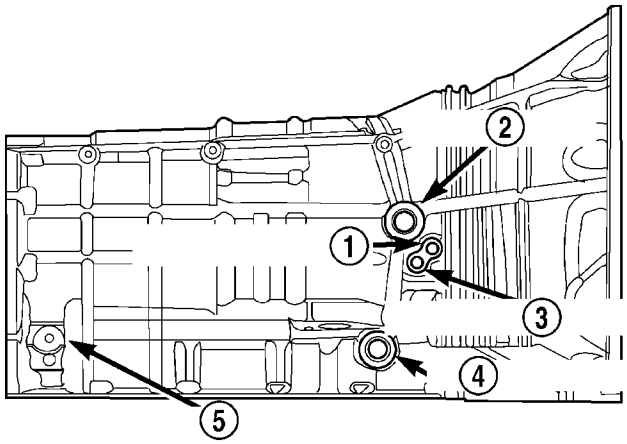


Fig. 2 Torque Converter Pressure Locations

1 - TCC RELEASE
2 - TO COOLER
3 - TCC APPLY
4 - FROM COOLER
5 - LINE PRESSURE SENSOR

To determine the line pressure, there are two available methods. The DRB® scan tool can be used to read line pressure from the line pressure sensor. The second method is to install Line Pressure Adapter 8259 (Fig. 4) into the transmission case and then install the pressure gauge and the original sensor into the adapter. This will allow a comparison of the DRB® readings and the gauge reading to determe the accuracy of the line pressure sensor. The DRB® line pressure reading should match the gauge reading within ±10 psi.

In order to access any other pressure tap locations, the transmission oil pan must be removed, the pressure port plugs removed and Valve Body Pressure Tap Adapter 8258-A (Fig. 5) installed. The extensions supplied with Adapter 8258-A will allow the installation of pressure gauges to the valve body. Refer to (Fig. 3) for correct pressure tap location identification.

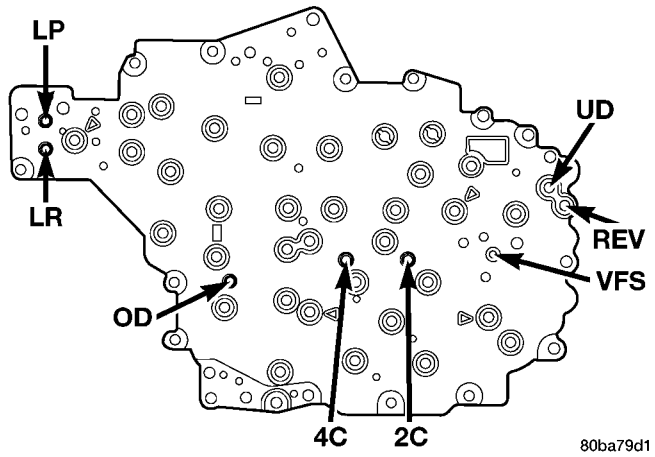


Fig. 3 Pressure Tap Locations

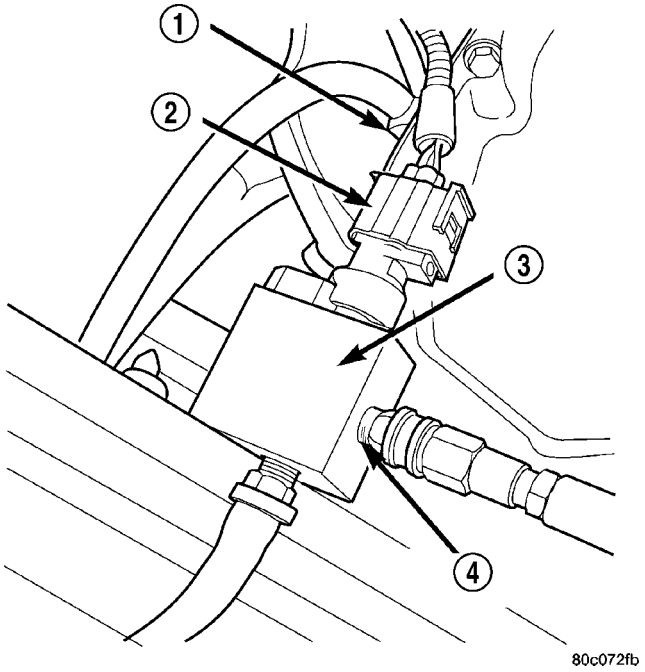


Fig. 4 Line Pressure Adapter 8259

1 - LINE PRESSURE SENSOR PORT
2 - LINE PRESSURE SENSOR
3 - TOOL 8259
4 - PRESSURE TAP

AUTOMATIC TRANSMISSION - 545RFE (Continued)

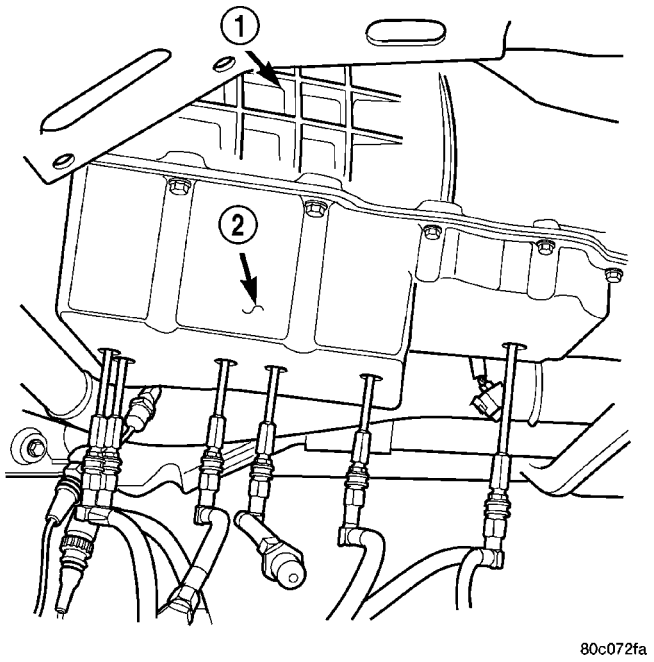


Fig. 5 Valve Body Pressure Tap Adapter 8258-A

1 - 545RFE TRANSMISSION
2 - TOOL 8258-A

TEST PROCEDURE

All pressure readings should be taken with the transmission fluid level full, transmission oil at the normal operating temperature, and the engine at 1500 rpm. Check the transmission for proper operation in each gear position that is in question or if a specific element is in question, check the pressure readings in at least two gear positions that employ that element. Refer to the Hydraulic Schematics at the rear of this section to determine the correct pressures for each element in a given gear position.

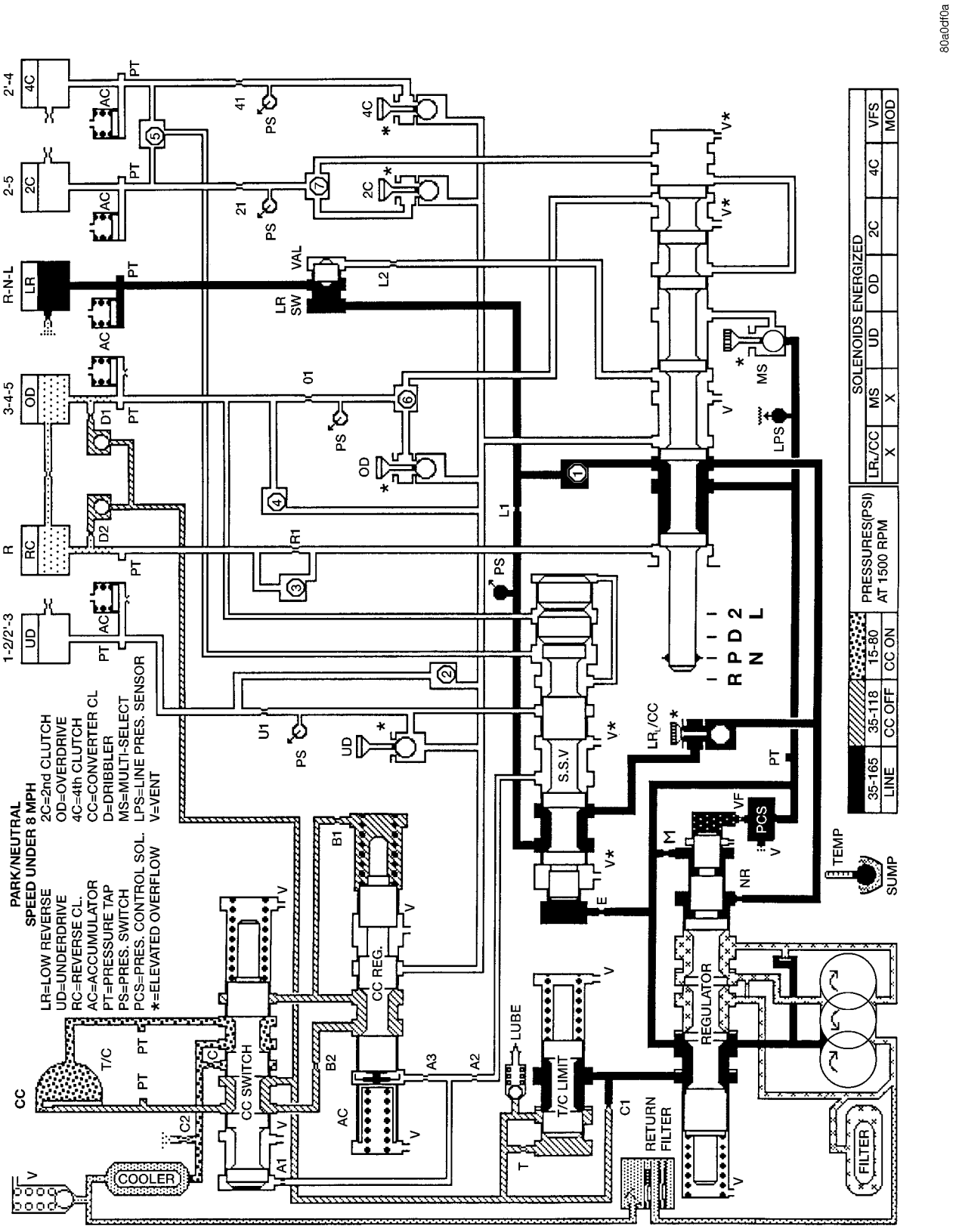
NOTE: The 545RFE utilizes closed loop control of pump line pressure. The pressure readings may therefore vary greatly but should always follow line pressure.

Some common pressures that can be measured to evaluate pump and clutch performance are the upshift/downshift pressures and the garage shift pressures. The upshift/downshift pressure for all shifts except the 4-5 shift is 120 psi. The upshift pressure for the 4-5 shift is 130 psi. The garage shift pressure when performing a N-R shift is 220 psi. The garage shift pressure for the R-N and N-1 shifts is 120 psi.

AUTOMATIC TRANSMISSION - 545RFE (Continued)

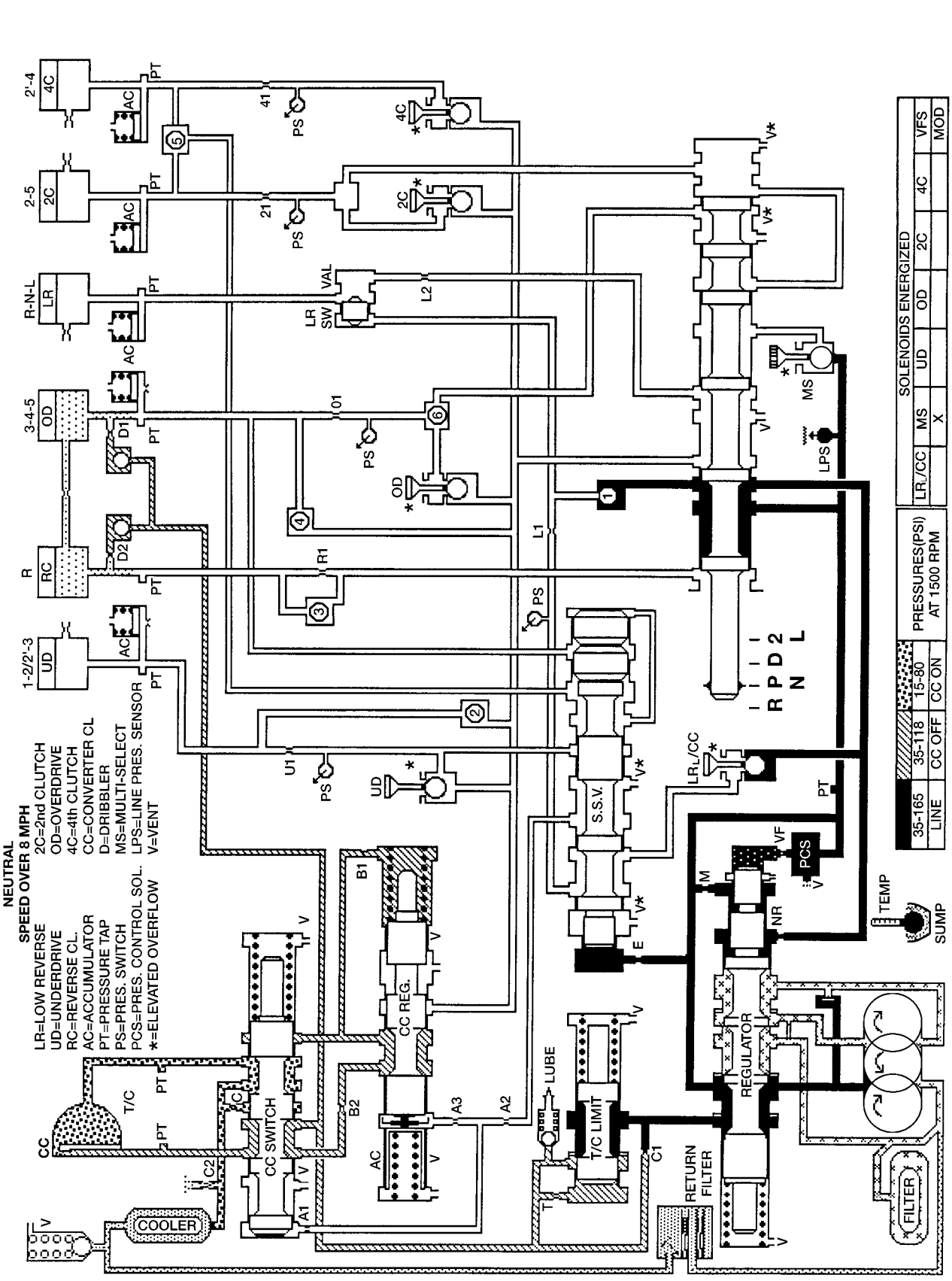
SCHEMATICS AND DIAGRAMS

HYDRAULIC SCHEMATICS



HYDRAULIC FLOW IN PARK/NEUTRAL

AUTOMATIC TRANSMISSION - 545RFE (Continued)



HYDRAULIC FLOW IN NEUTRAL OVER 8MPH

AUTOMATIC TRANSMISSION - 545RFE (Continued)

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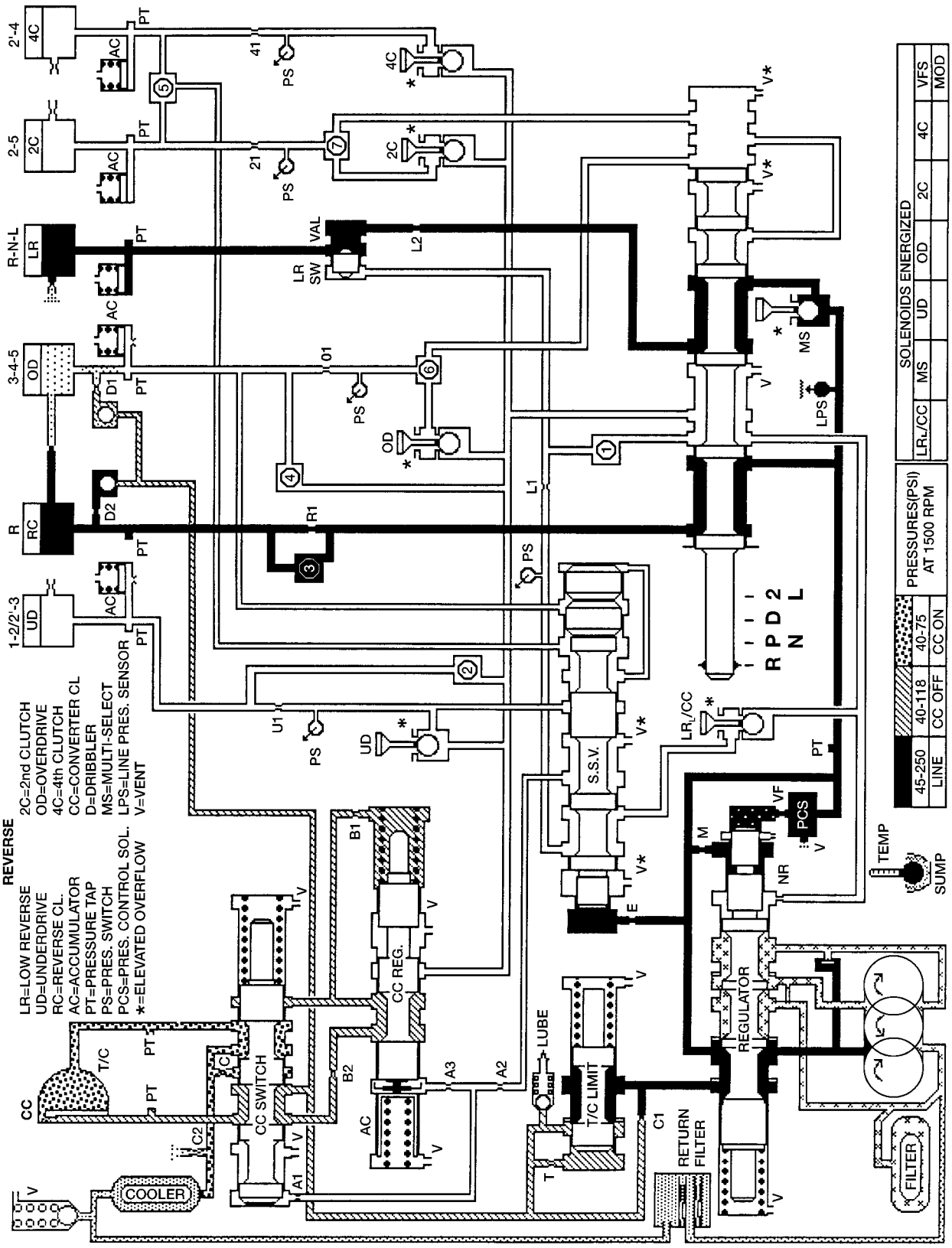
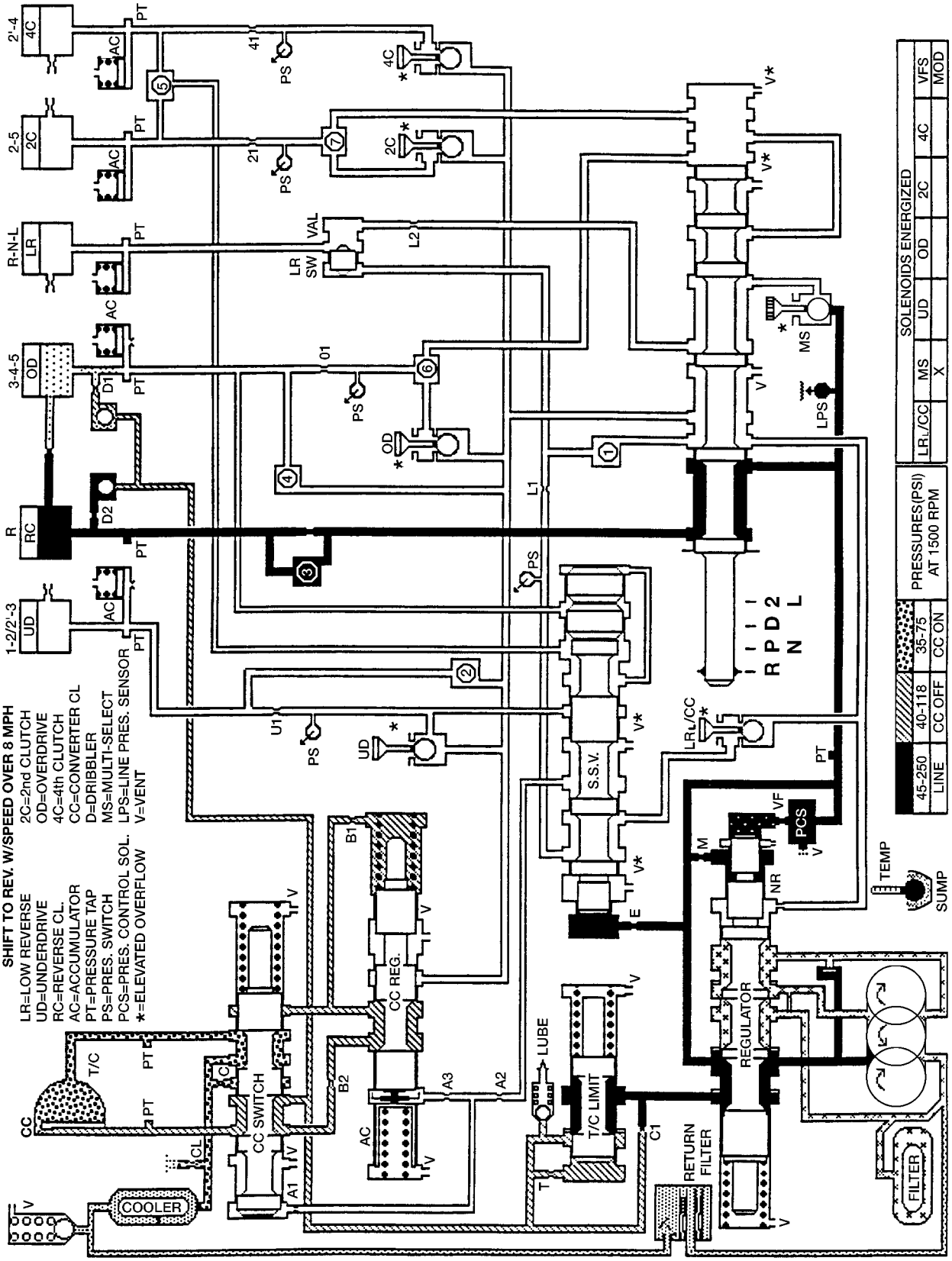


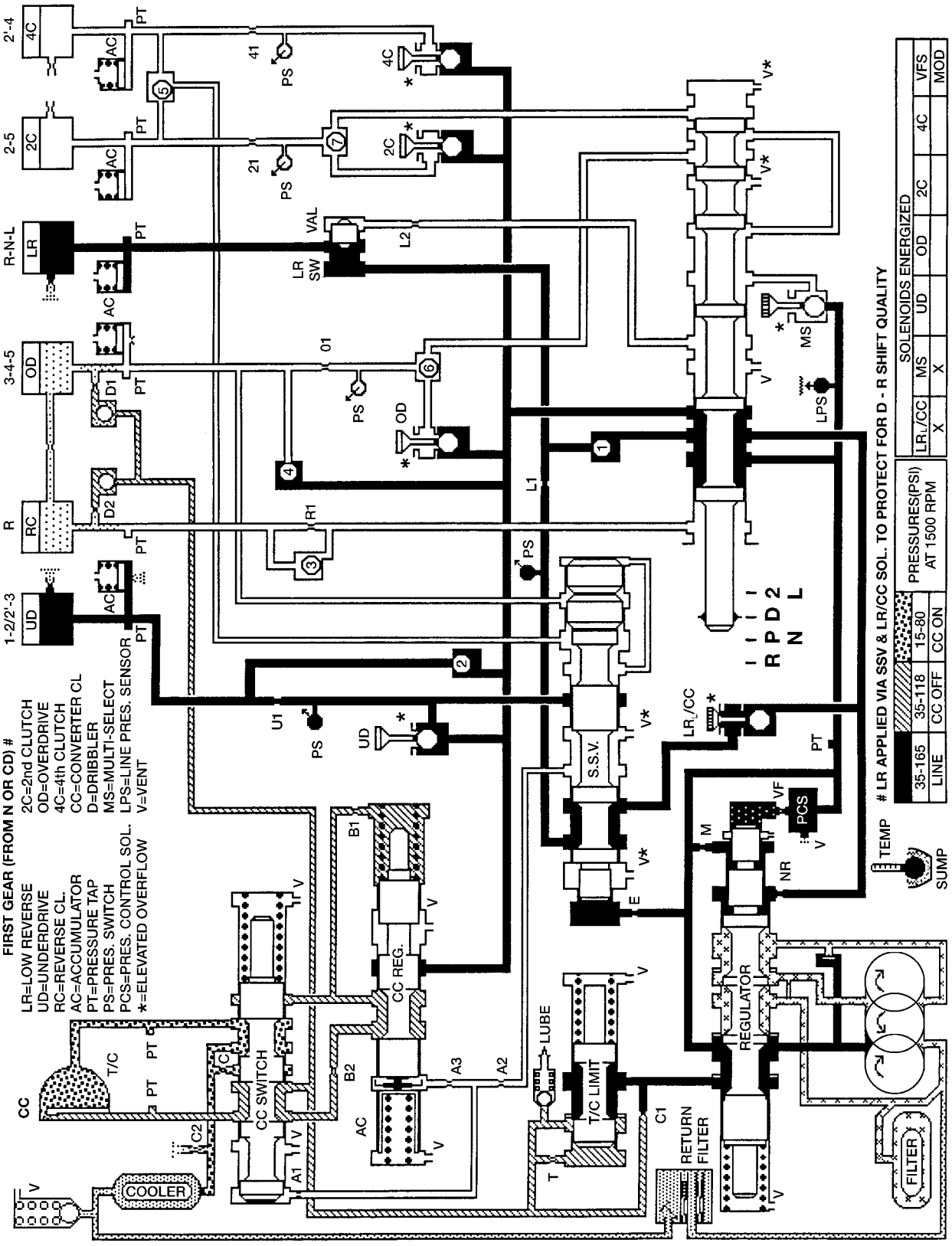
HYDRAULIC FLOW IN REVERSE

AUTOMATIC TRANSMISSION - 545RFE (Continued)



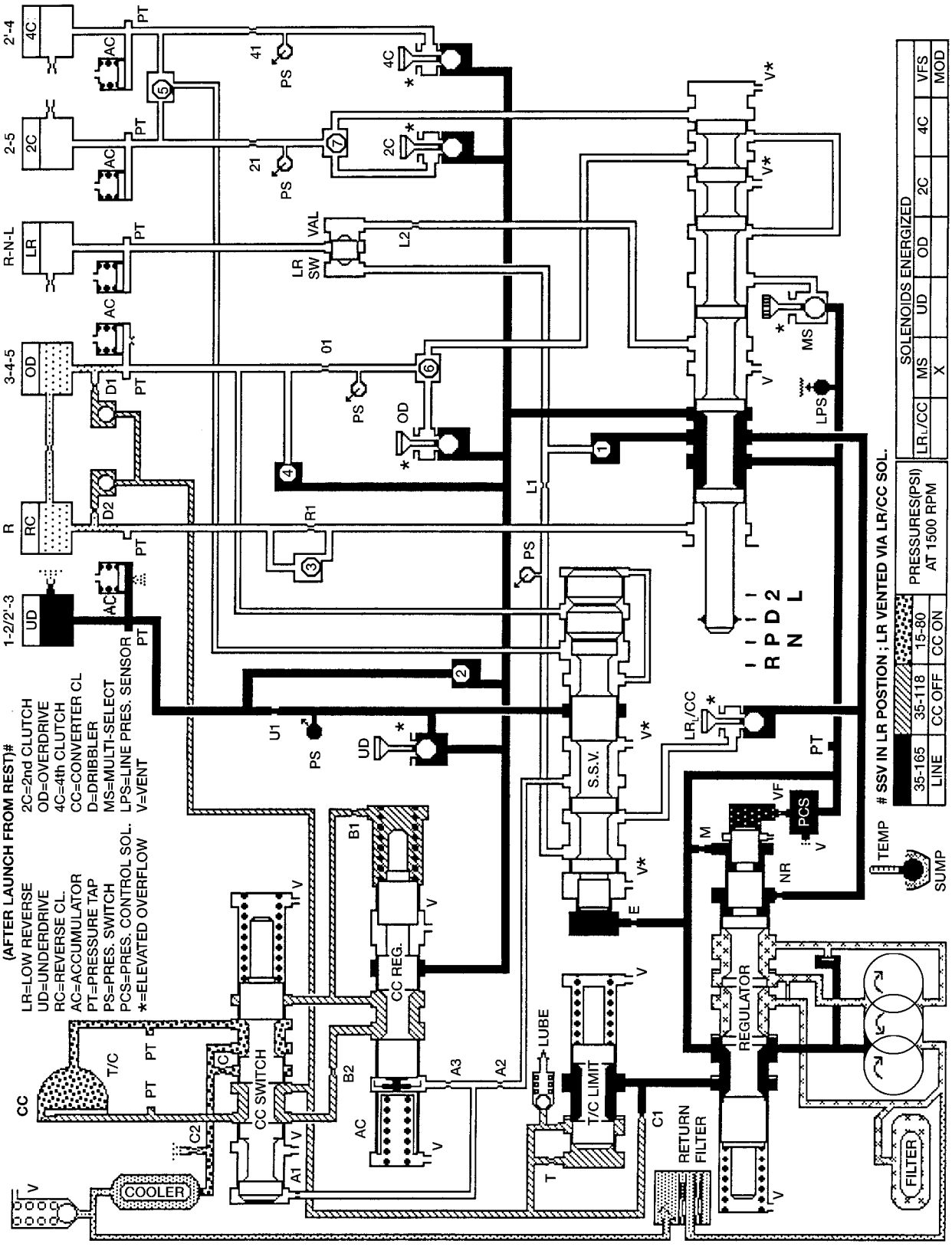
HYDRAULIC FLOW IN REVERSE BLOCK

AUTOMATIC TRANSMISSION - 545RFE (Continued)



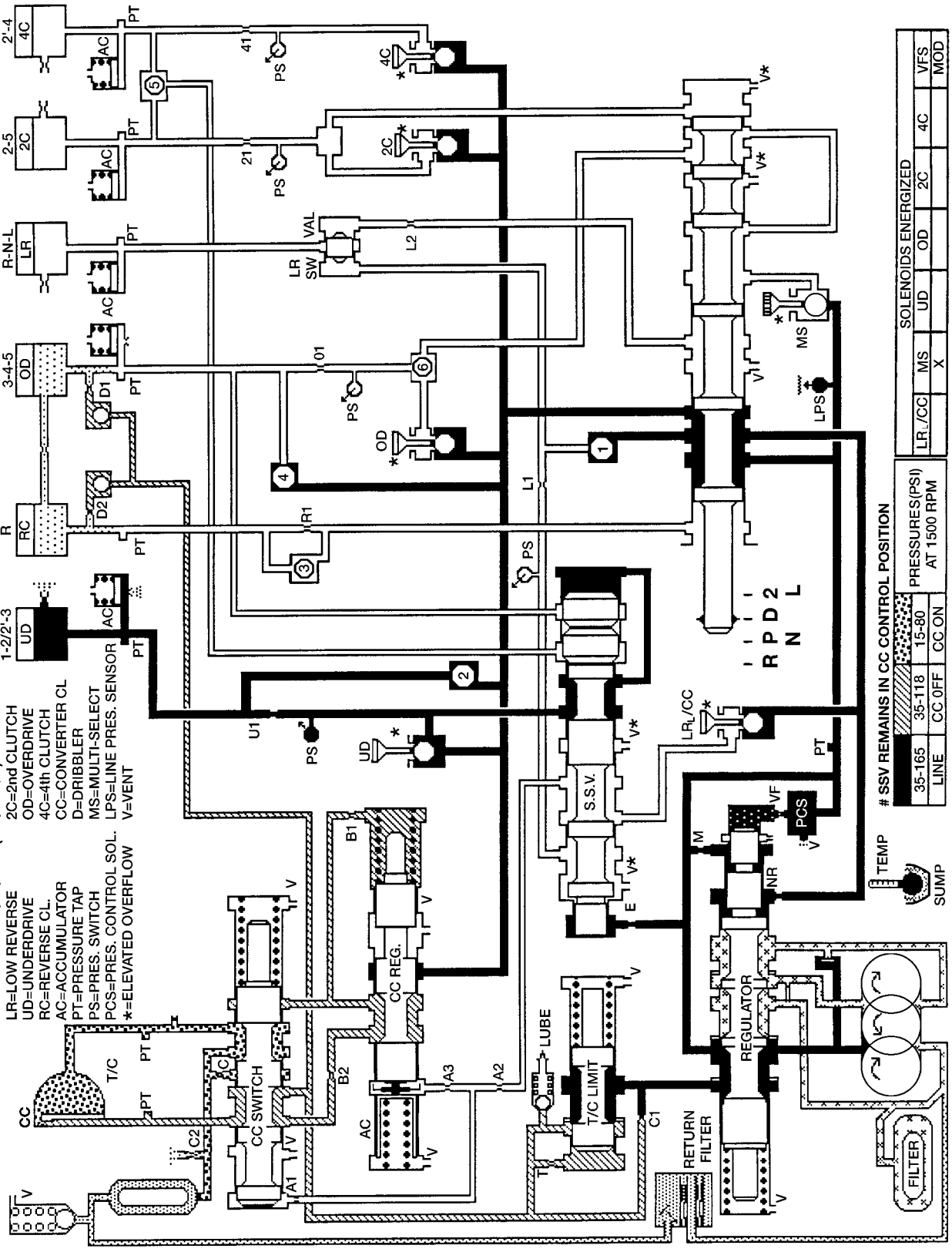
HYDRAULIC FLOW IN FIRST GEAR (FROM N OR OD)

AUTOMATIC TRANSMISSION - 545RFE (Continued)



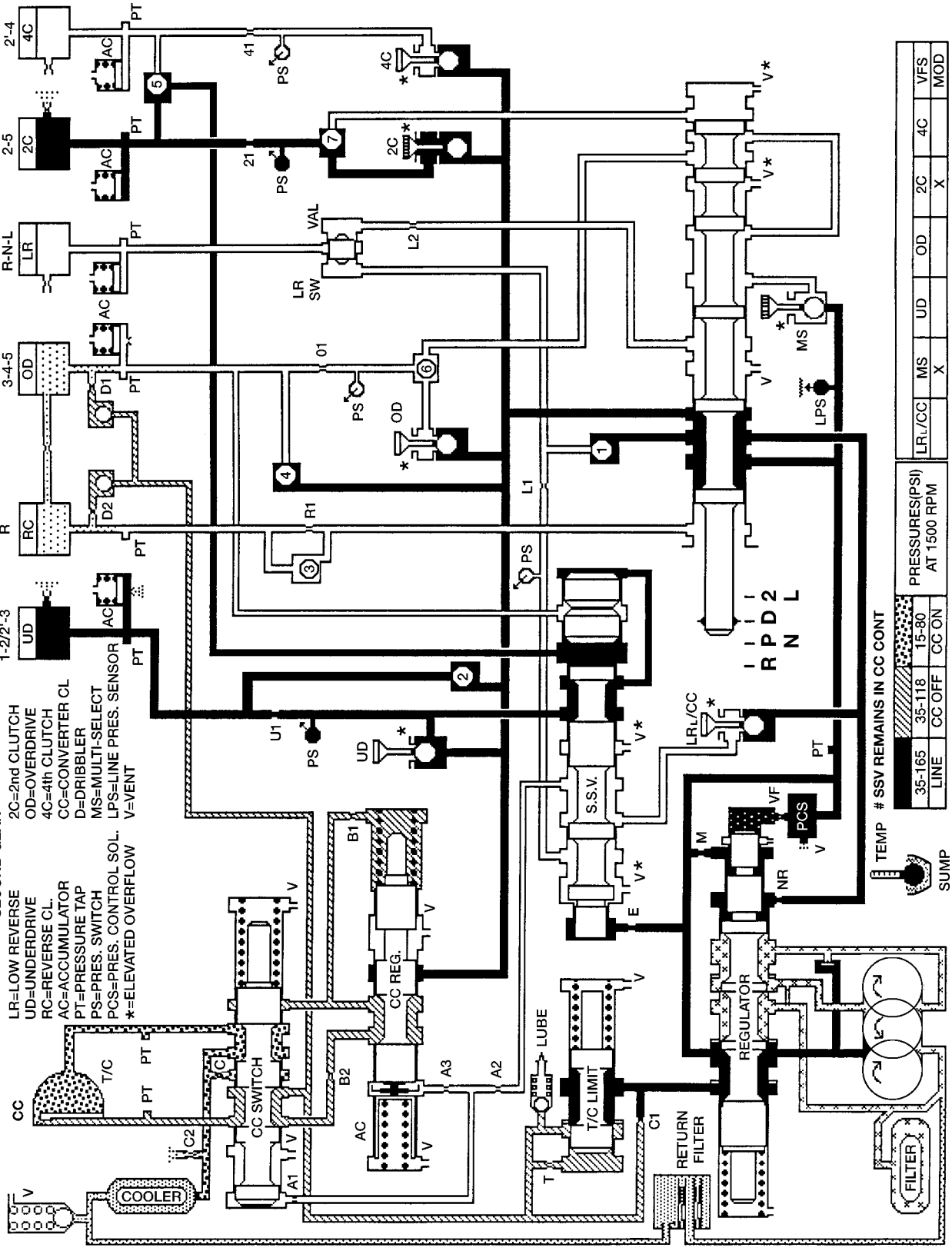
HYDRAULIC FLOW IN FIRST GEAR (AFTER LAUNCH FROM REST)

AUTOMATIC TRANSMISSION - 545RFE (Continued)



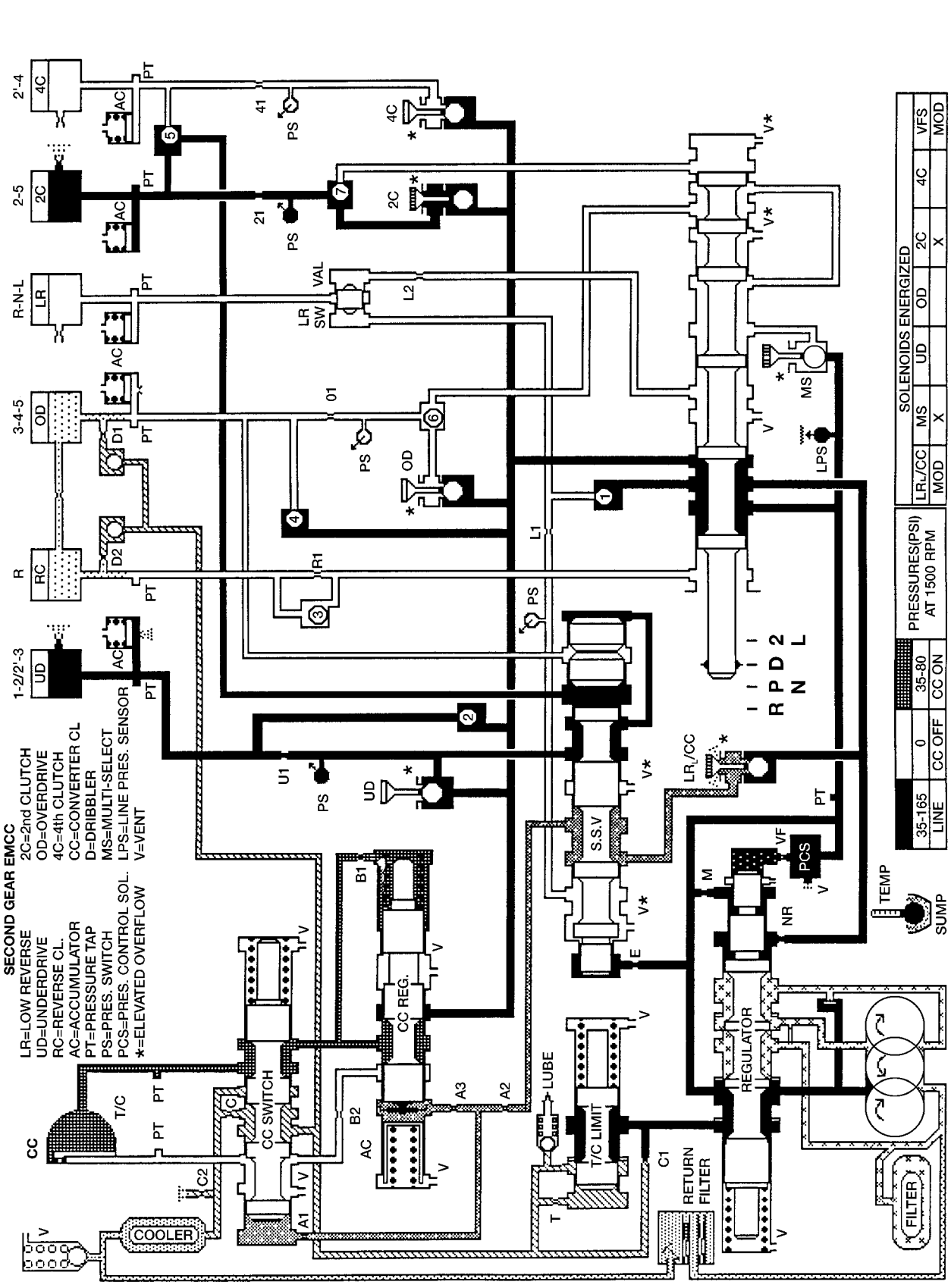
HYDRAULIC FLOW IN FIRST GEAR (FROM K/D)

AUTOMATIC TRANSMISSION - 545RFE (Continued)



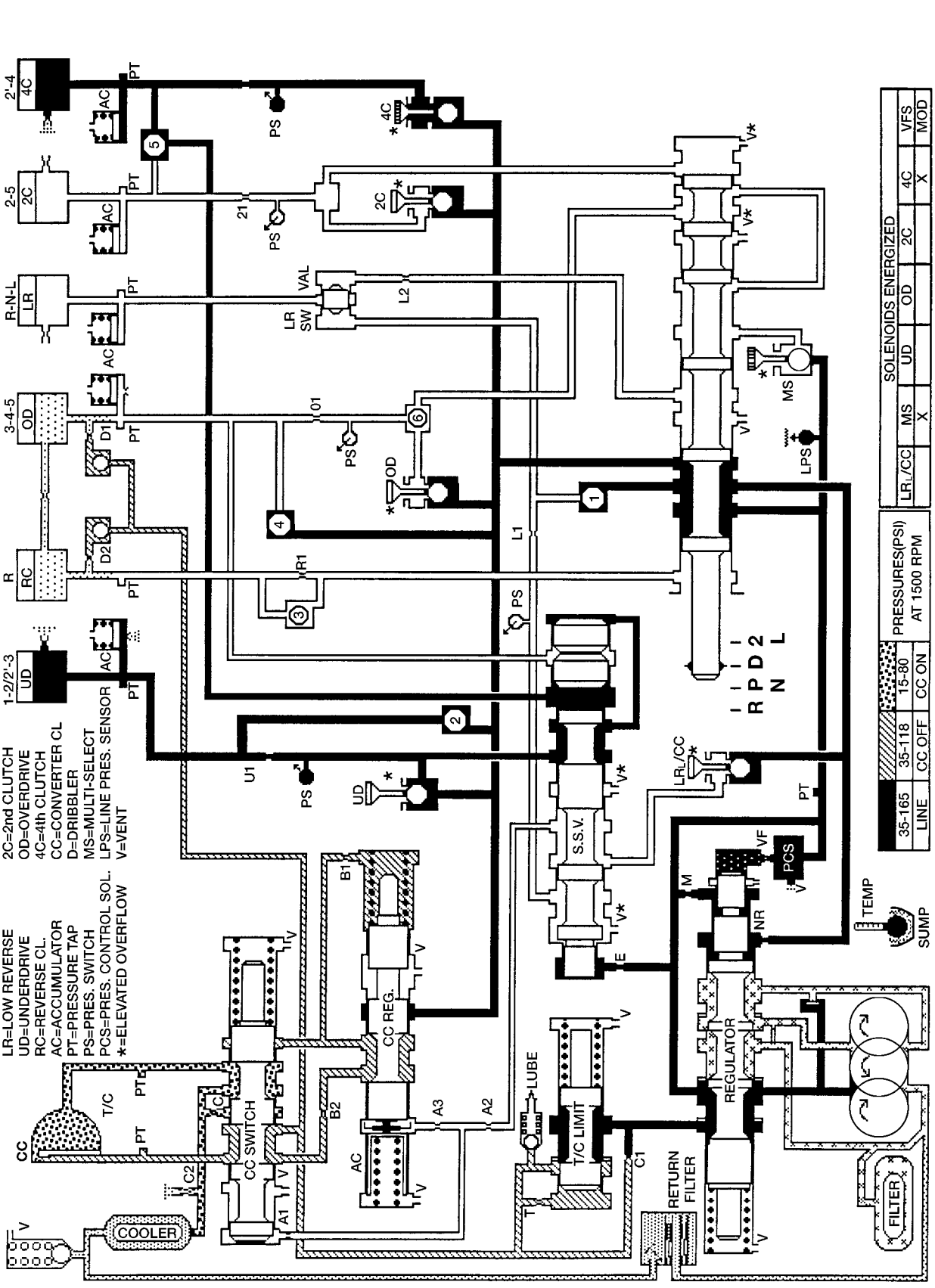
HYDRAULIC FLOW IN SECOND GEAR

AUTOMATIC TRANSMISSION - 545RFE (Continued)



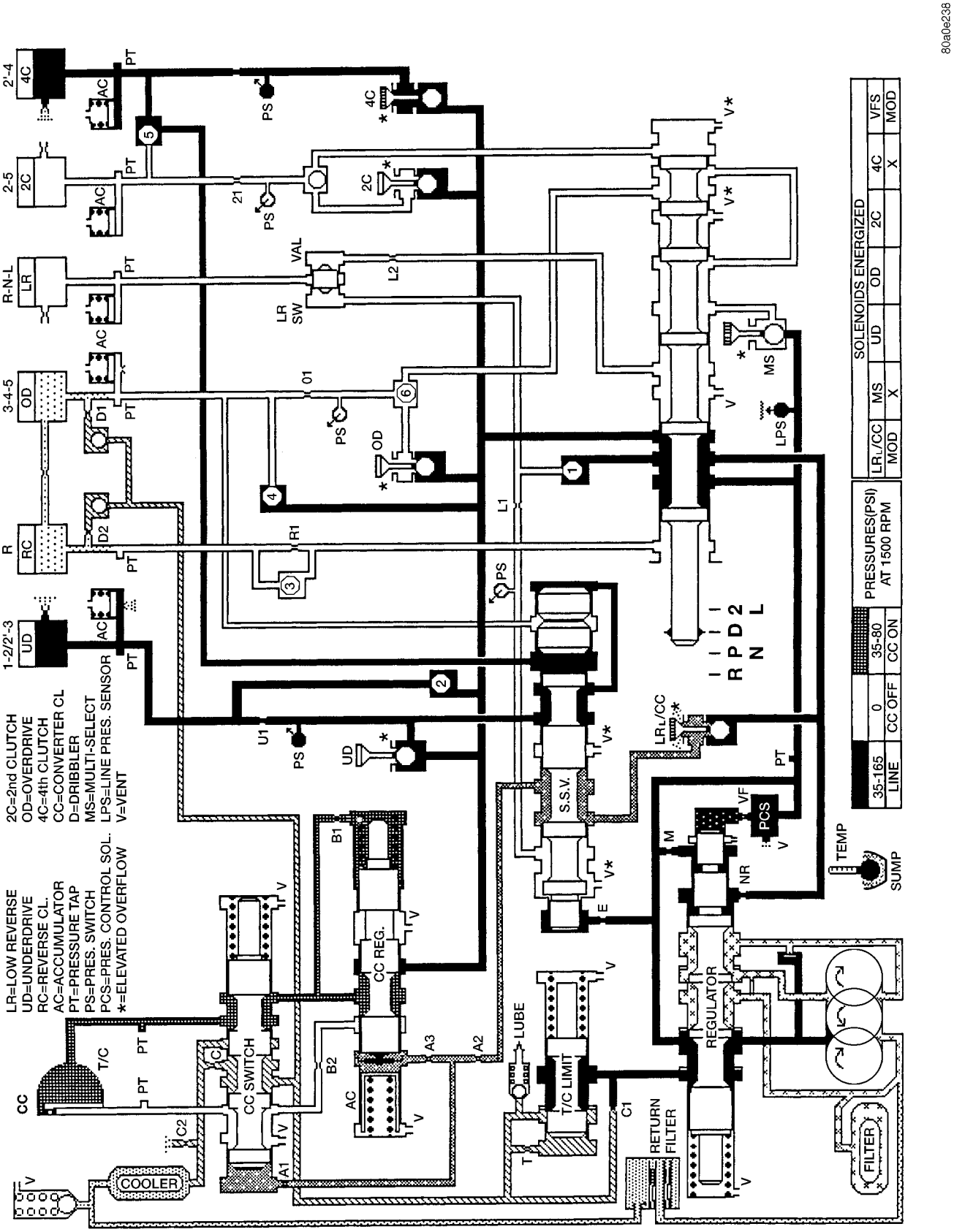
HYDRAULIC FLOW IN SECOND GEAR EMCC

AUTOMATIC TRANSMISSION - 545RFE (Continued)



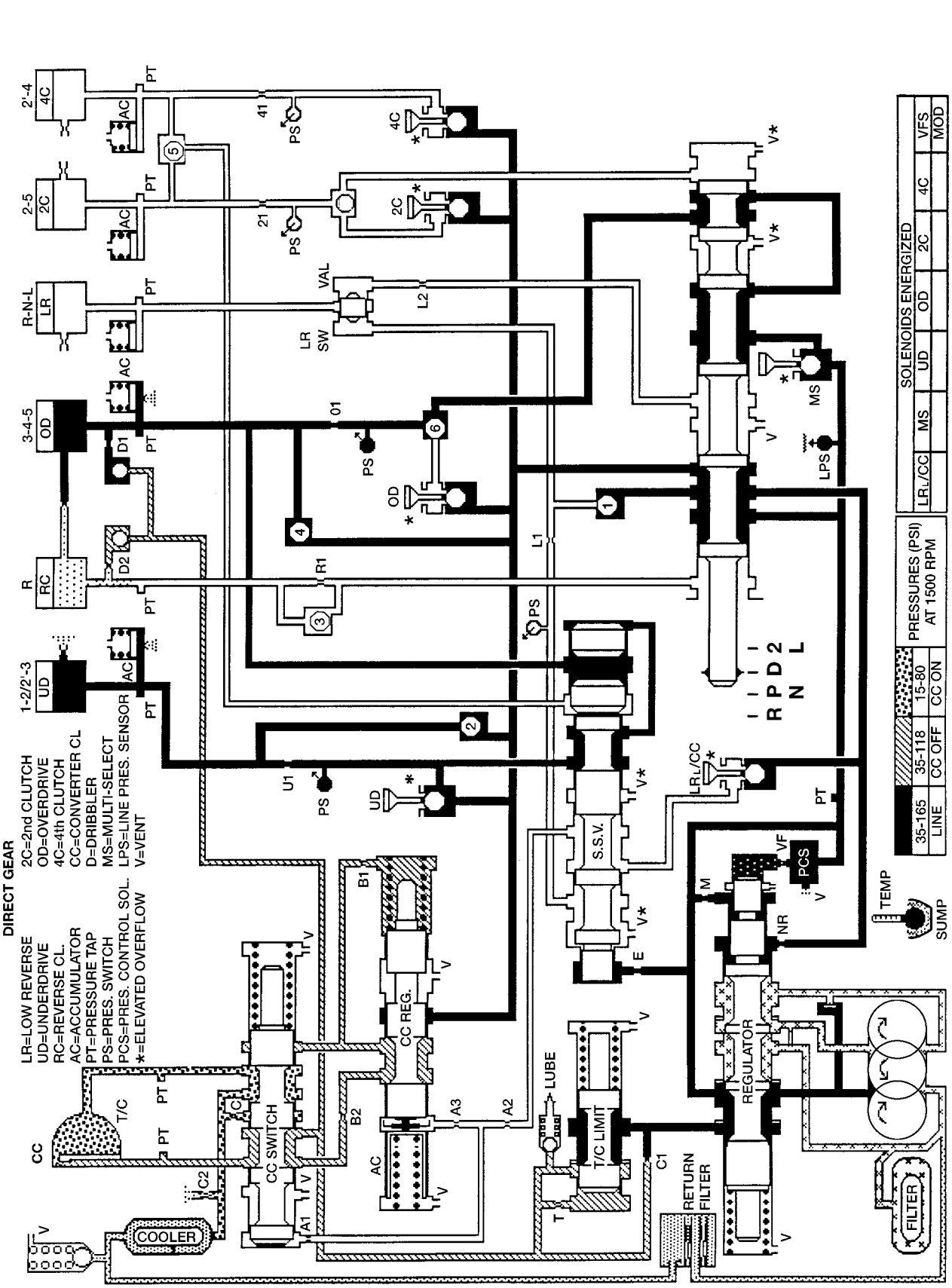
HYDRAULIC FLOW IN SECOND PRIME GEAR

AUTOMATIC TRANSMISSION - 545RFE (Continued)



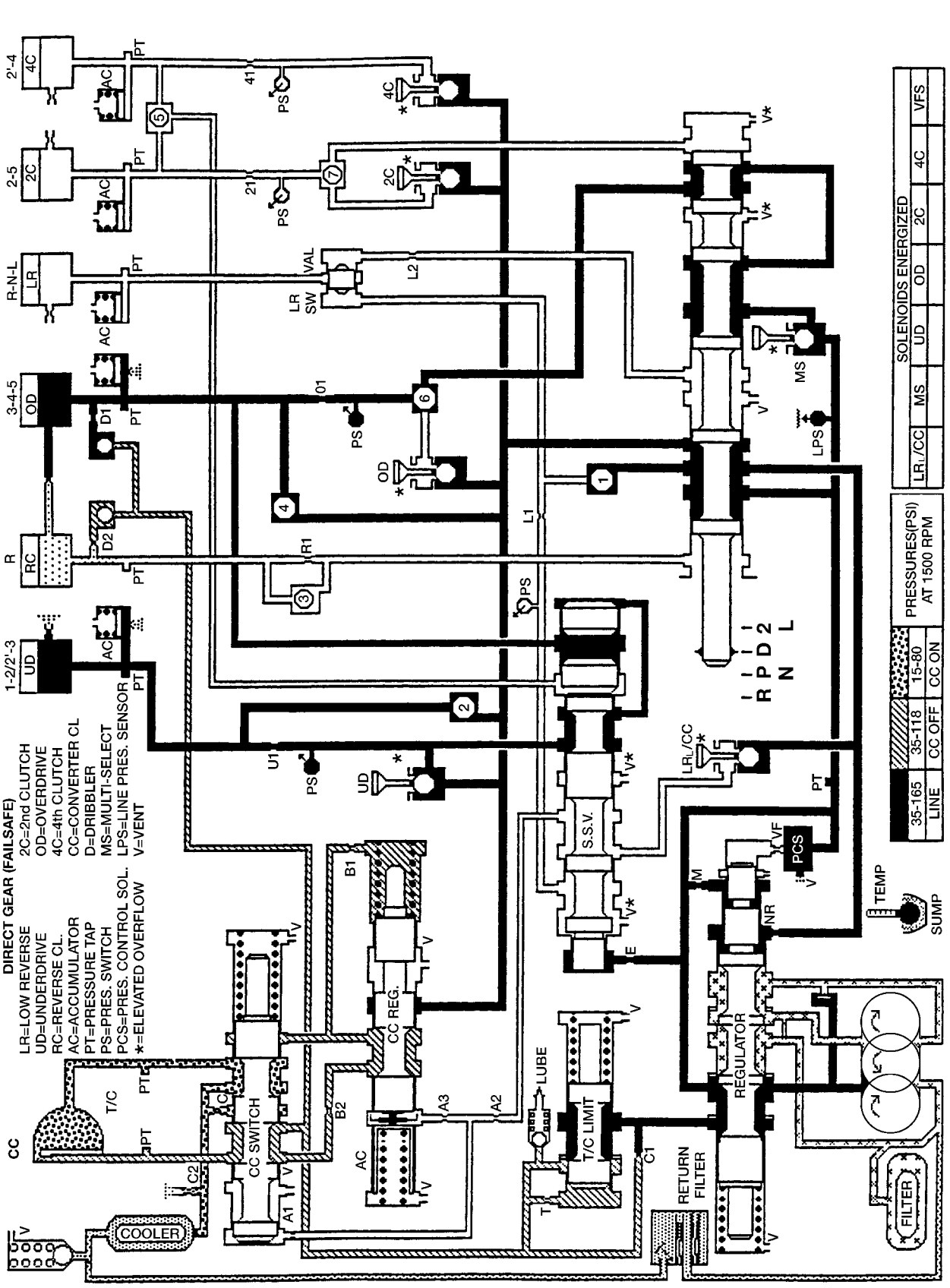
HYDRAULIC FLOW IN SECOND PRIME GEAR EMCC

AUTOMATIC TRANSMISSION - 545RFE (Continued)



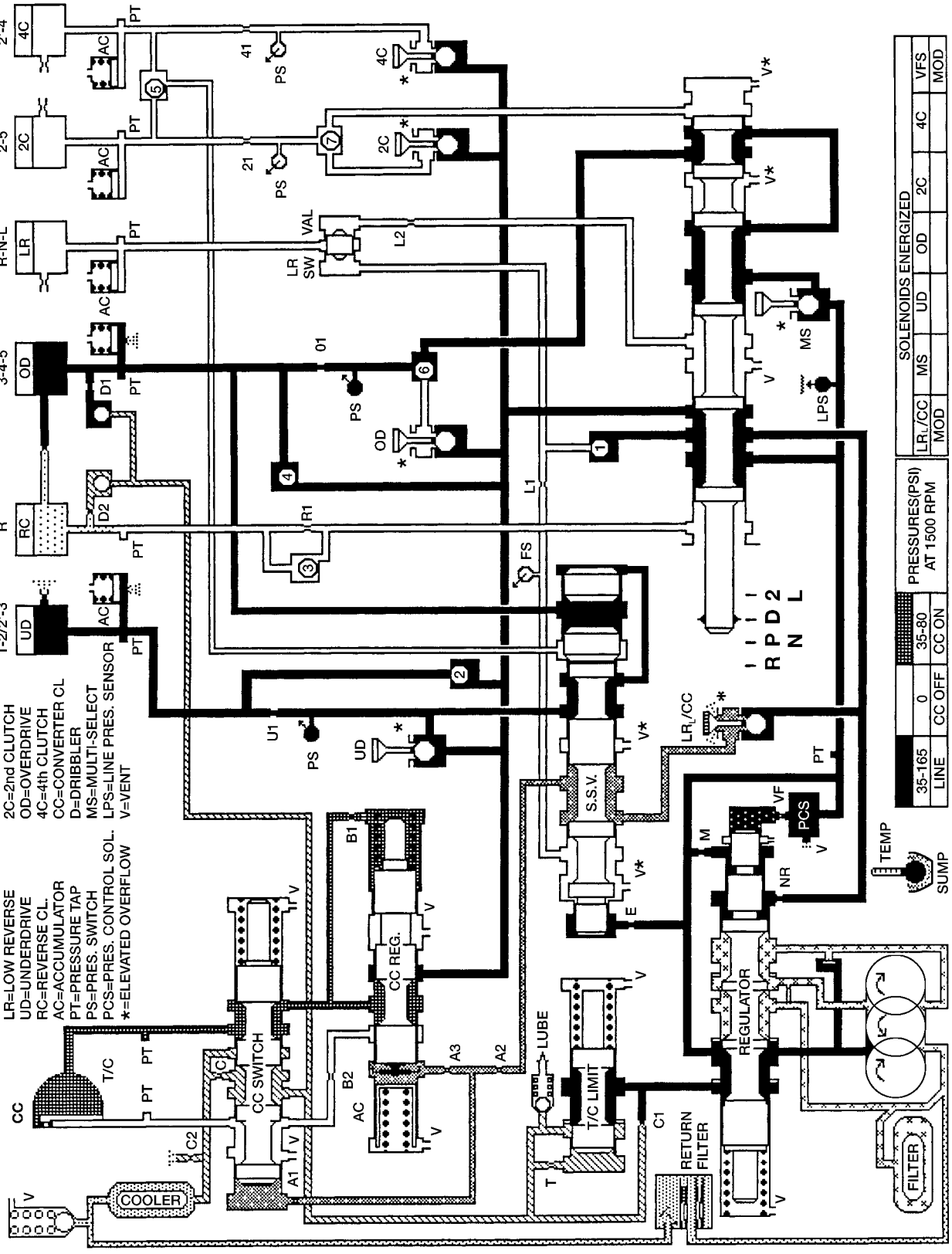
HYDRAULIC FLOW IN DIRECT GEAR

AUTOMATIC TRANSMISSION - 545RFE (Continued)



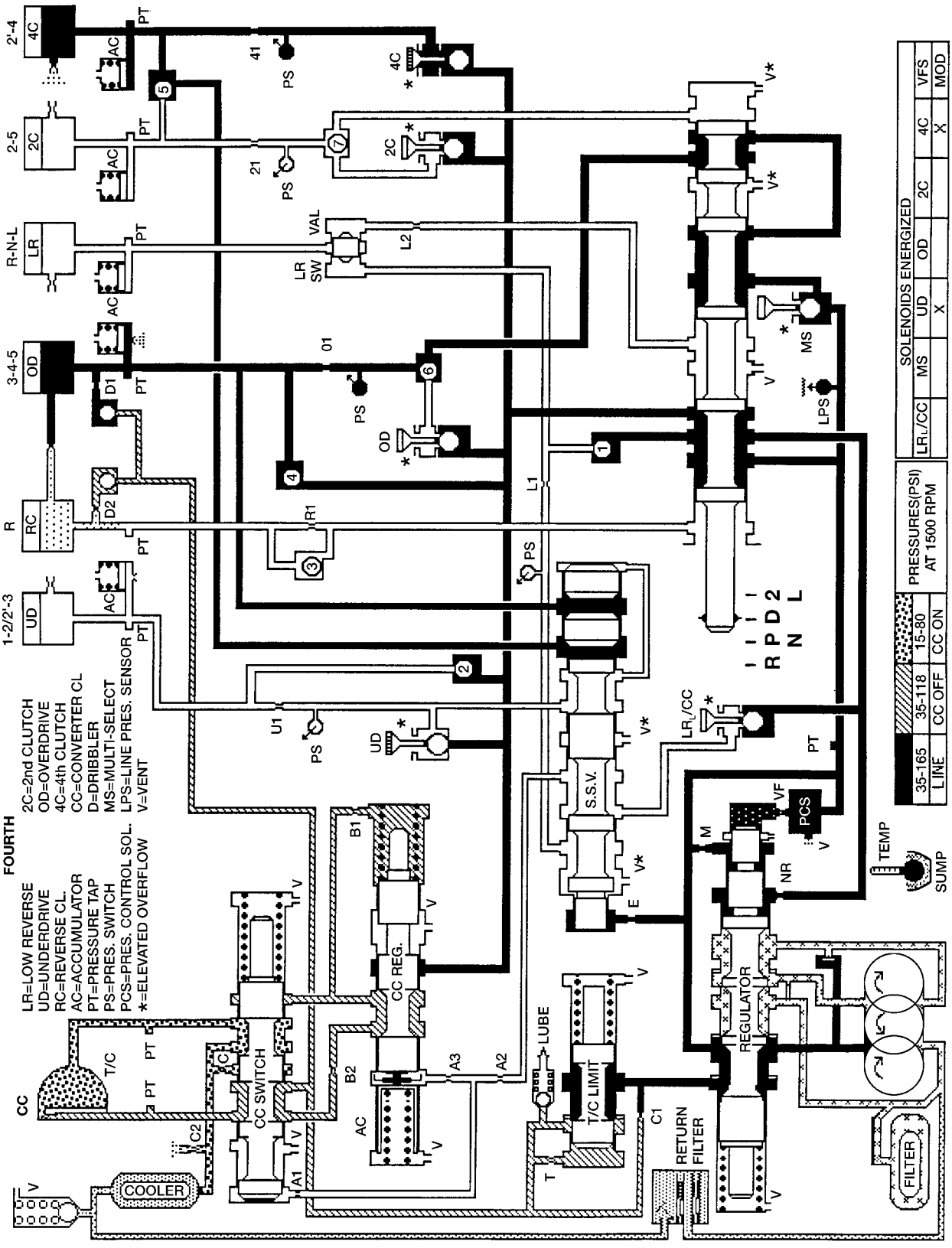
HYDRAULIC FLOW IN DIRECT GEAR (FAILSAFE)

AUTOMATIC TRANSMISSION - 545RFE (Continued)



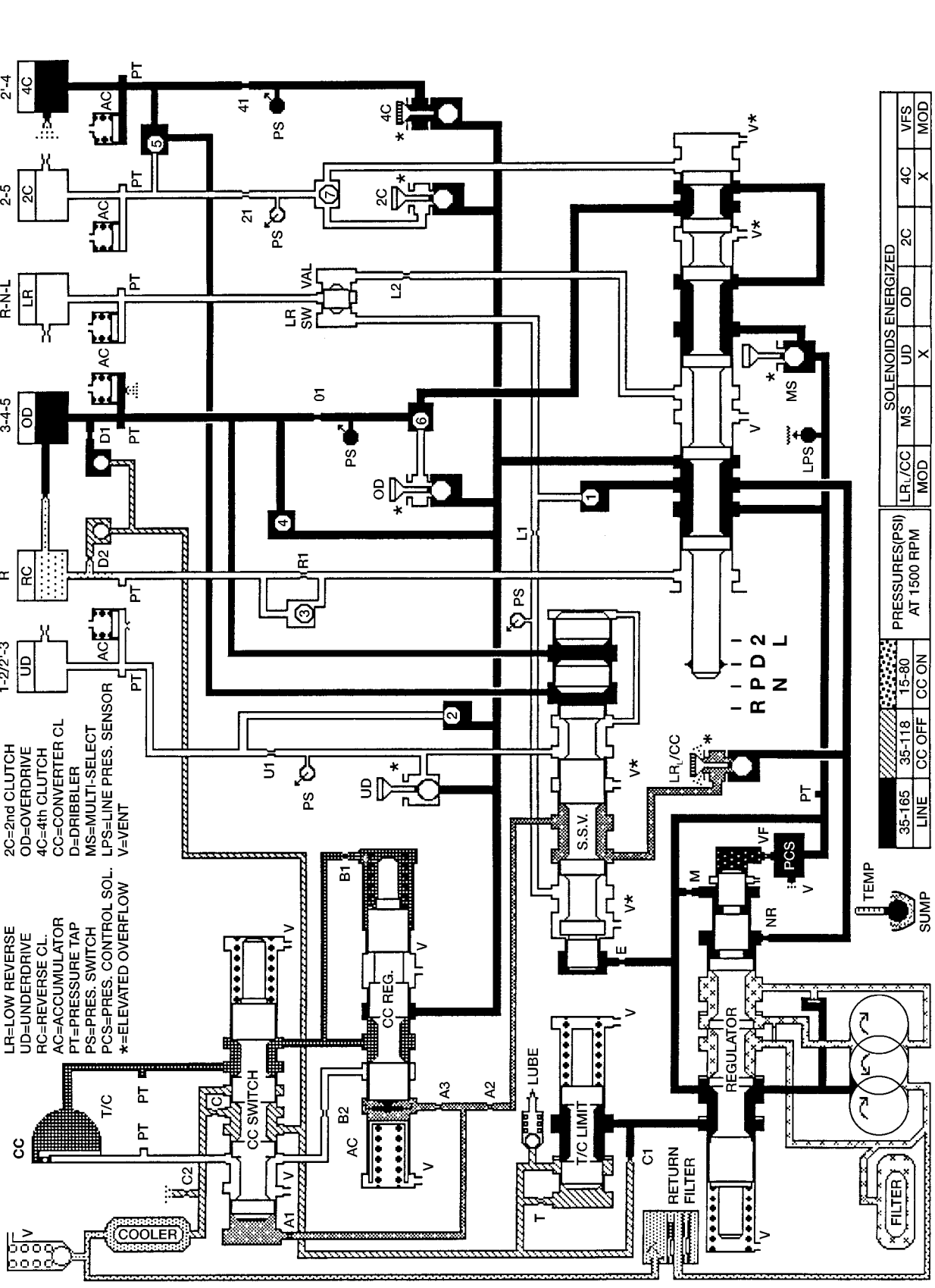
HYDRAULIC FLOW IN DIRECT GEAR EMCC

AUTOMATIC TRANSMISSION - 545RFE (Continued)



HYDRAULIC FLOW IN FOURTH

AUTOMATIC TRANSMISSION - 545RFE (Continued)



HYDRAULIC FLOW IN FOURTH EMCC

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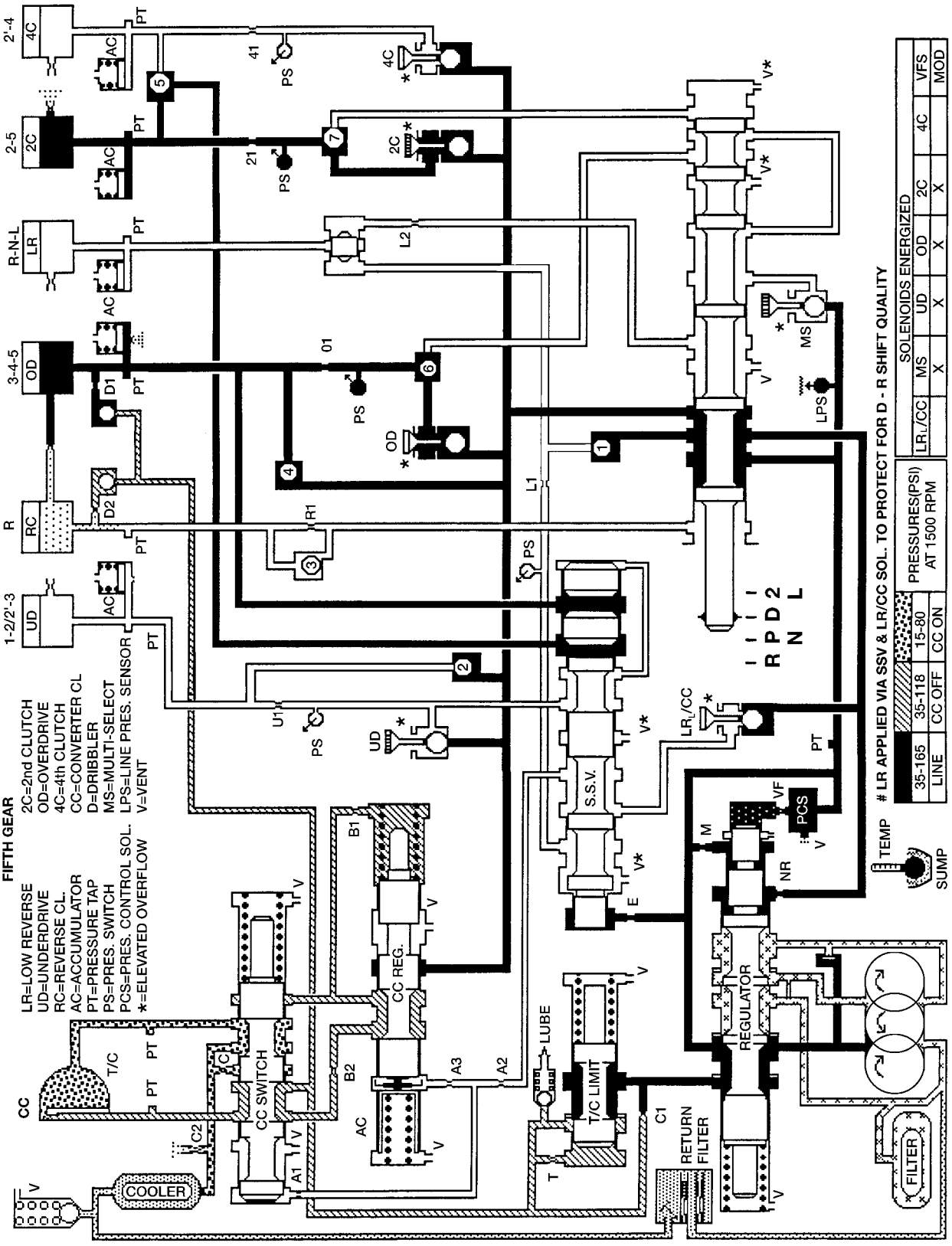
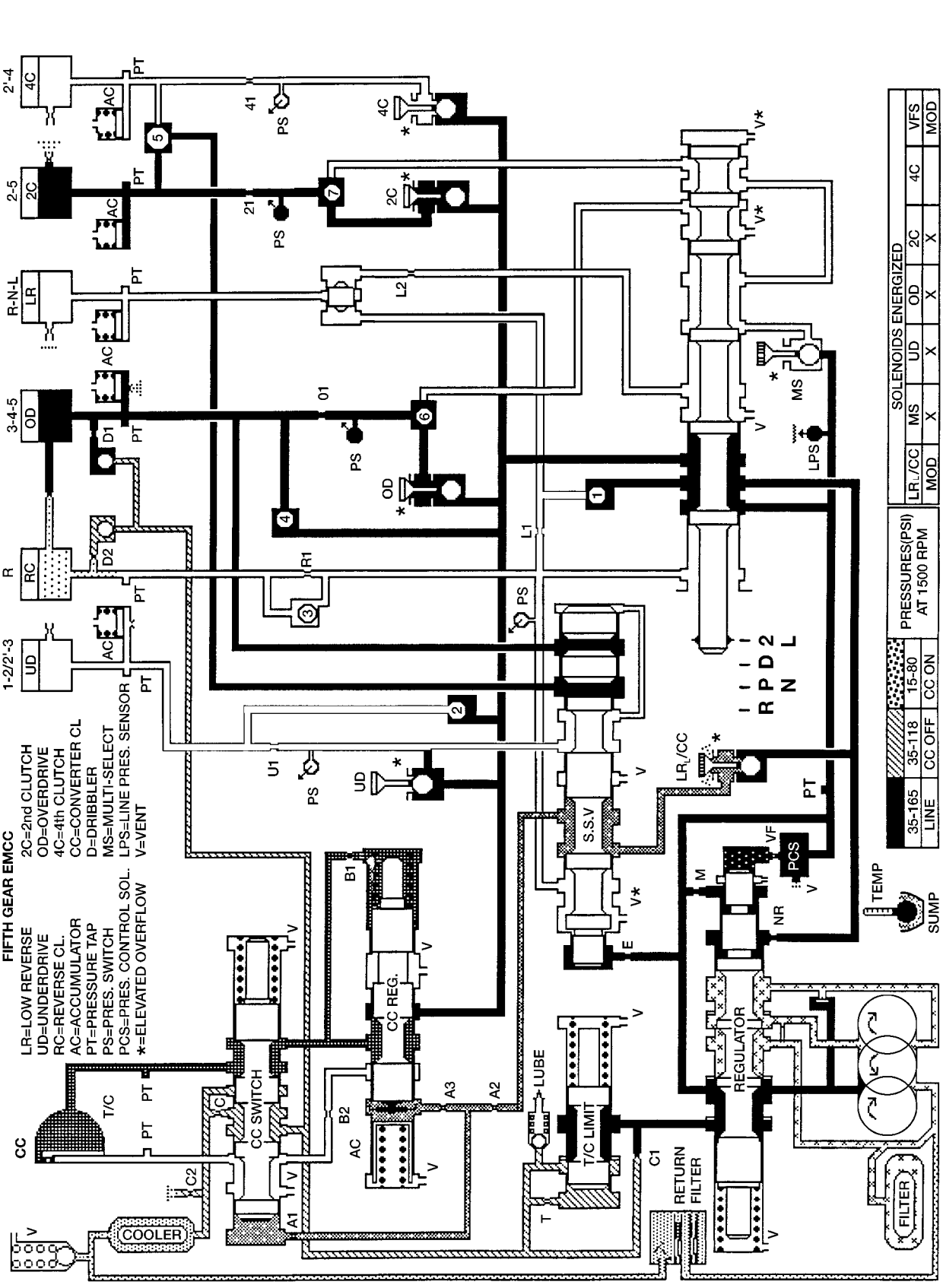


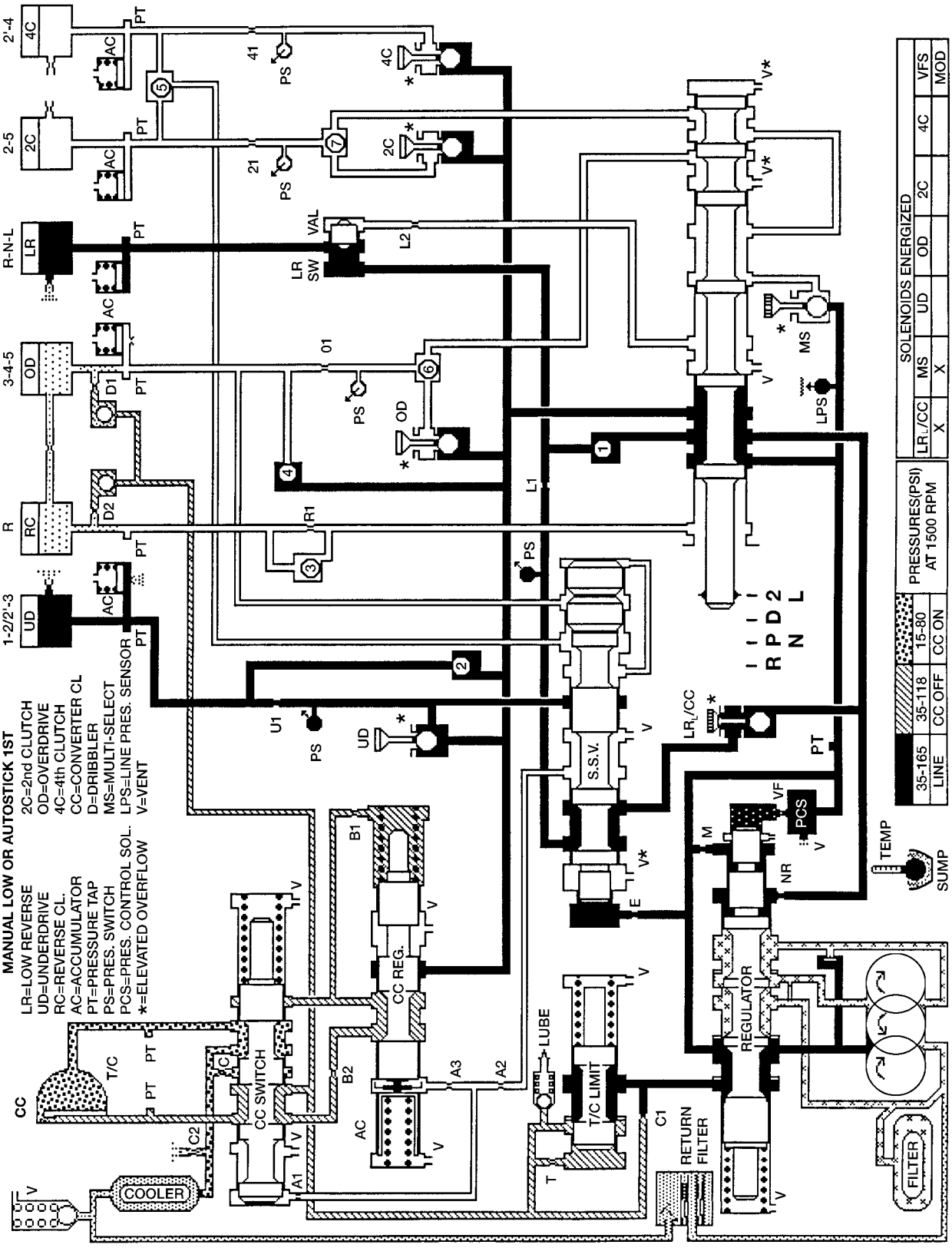
HYDRAULIC FLOW IN FIFTH

AUTOMATIC TRANSMISSION - 545RFE (Continued)



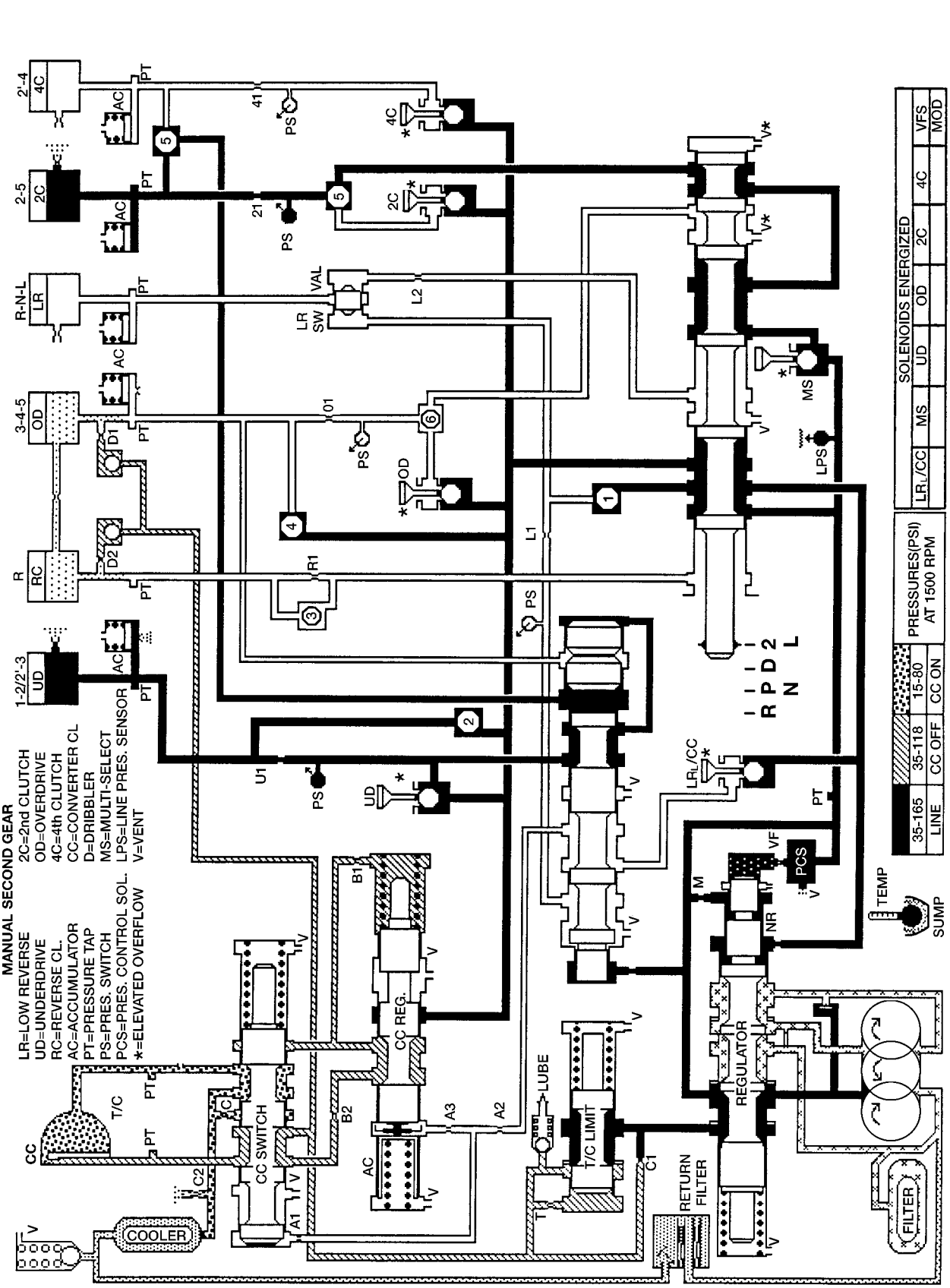
HYDRAULIC FLOW IN FIFTH EMCC

AUTOMATIC TRANSMISSION - 545RFE (Continued)



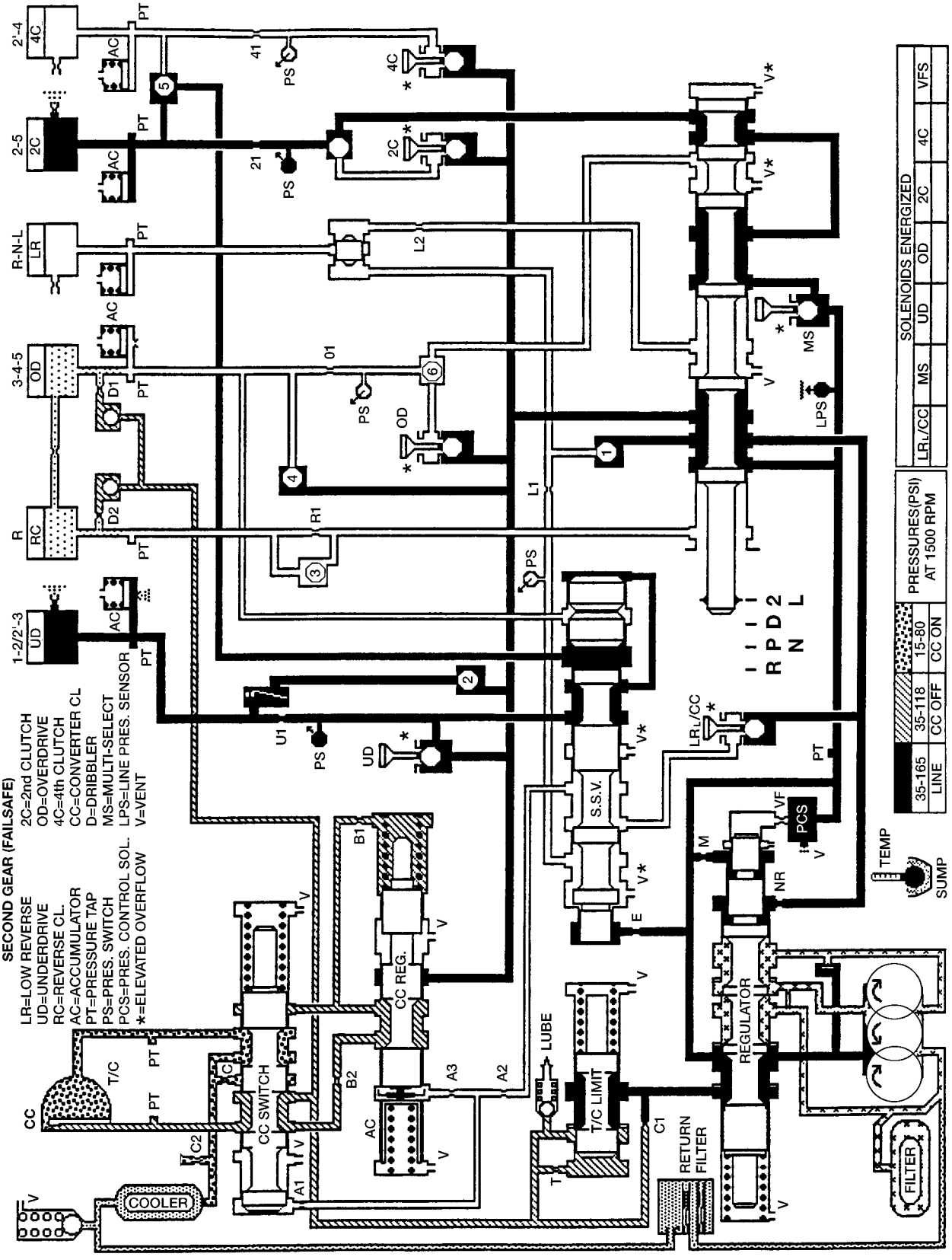
HYDRAULIC FLOW IN MANUAL LOW OR AUTOSTICK 1ST

AUTOMATIC TRANSMISSION - 545RFE (Continued)



HYDRAULIC FLOW IN MANUAL SECOND

AUTOMATIC TRANSMISSION - 545RFE (Continued)



HYDRAULIC FLOW IN MANUAL SECOND (FAILSAFE)

AUTOMATIC TRANSMISSION - 545RFE (Continued)

SPECIFICATIONS

TRANSMISSION

GENERAL

Component	Metric	Inch
Output Shaft End Play	0.22-0.55 mm	0.009-0.021 in.
Input Shaft End Play	0.46-0.89 mm	0.018-0.035 in.
2C Clutch Pack Clearance	0.455-1.335 mm	0.018-0.053 in.
4C Clutch Pack Clearance	0.770-1.390 mm	0.030-0.055 in.
L/R Clutch Pack Clearance	1.00-1.74 mm	0.039-0.069 in.
OD Clutch Pack Clearance	1.103-1.856 mm	0.043-0.073 in.
UD Clutch Pack Clearance	0.84-1.54 mm	0.033-0.061 in.
Reverse Clutch Pack Clearance	0.81-1.24 mm	0.032-0.049 in.
Recommended fluid	Mopar® ATF +4	

GEAR RATIOS

1ST	3.00:1
2ND	1.67:1
2ND Prime	1.50:1
3RD	1.0:1
4TH	0.75:1
5TH	0.67:1
REVERSE	3.00:1

TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Fitting, cooler line at trans	17.5	-	155
Bolt, torque convertor	31	23	-
Bolt/nut, crossmember	68	50	-
Bolt, driveplate to crankshaft	75	55	-
Bolt, oil pan	11.8	-	105
Screw, primary fluid filter	4.5	-	40
Bolt, oil pump	28.2	-	250
Bolt, oil pump body to cover	4.5	-	40
Screw, plate to oil pump body	4.5	-	40
Bolt, valve body to case	11.8	-	105
Plug, pressure test port	5.1	-	45
Bolt, reaction shaft support	11.8	-	105
Screw, valve body to transfer plate	5.6	-	50
Screw, solenoid module to transfer plate	5.7	-	50
Screw, accumulator cover	4.5	-	40
Screw, detent spring	4.5	-	40
Bolt, input speed sensor	11.8	-	105
Bolt, output speed sensor	11.8	-	105
Bolt, line pressure sensor	11.8	-	105
Bolt, extension housing	54	40	-
Valve, cooler return filter bypass	4.5	-	40
Screw, manual valve cam retaining	4.5	-	40
Bolt, manual lever	28.2	-	250

HOLDING CLUTCHES

DESCRIPTION

Three hydraulically applied multi-disc clutches are used to hold some planetary geartrain components stationary while the input clutches drive others. The 2C, 4C, and Low/Reverse clutches are considered holding clutches. The 2C and 4C clutches are located in the 4C retainer/bulkhead (Fig. 6), while the Low/Reverse clutch is located at the rear of the transmission case (Fig. 7).

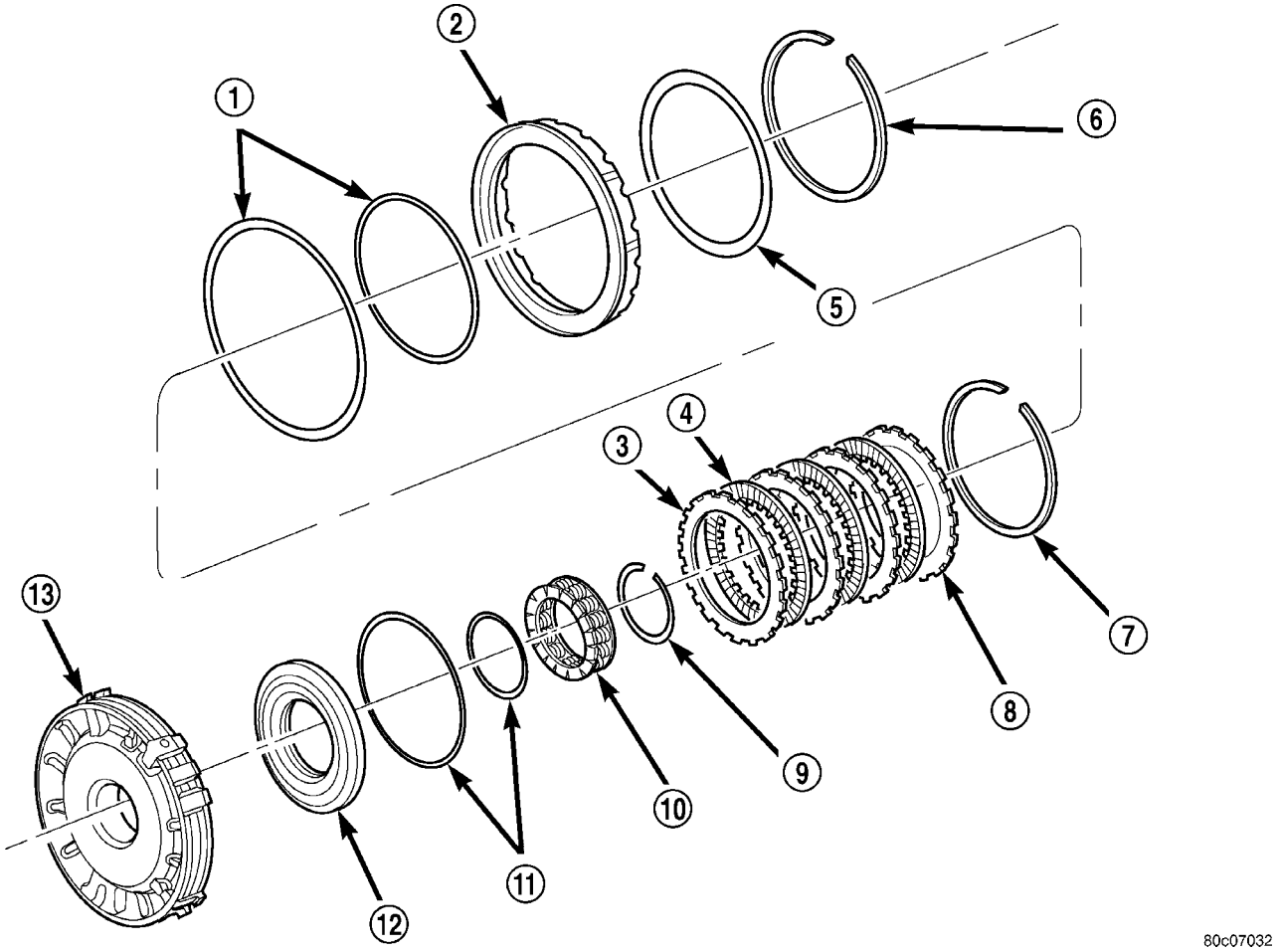


Fig. 6 2C and 4C Clutches

1 - SEAL
2 - 2C PISTON
3 - PLATE
4 - DISC
5 - 2C BELLEVILLE SPRING
6 - SNAP-RING
7 - SNAP-RING (SELECT)
8 - REACTION PLATE
9 - SNAP-RING
10 - RETURN SPRING
11 - SEAL
12 - 4C PISTON
13 - 4C RETAINER/BULKHEAD

HOLDING CLUTCHES (Continued)

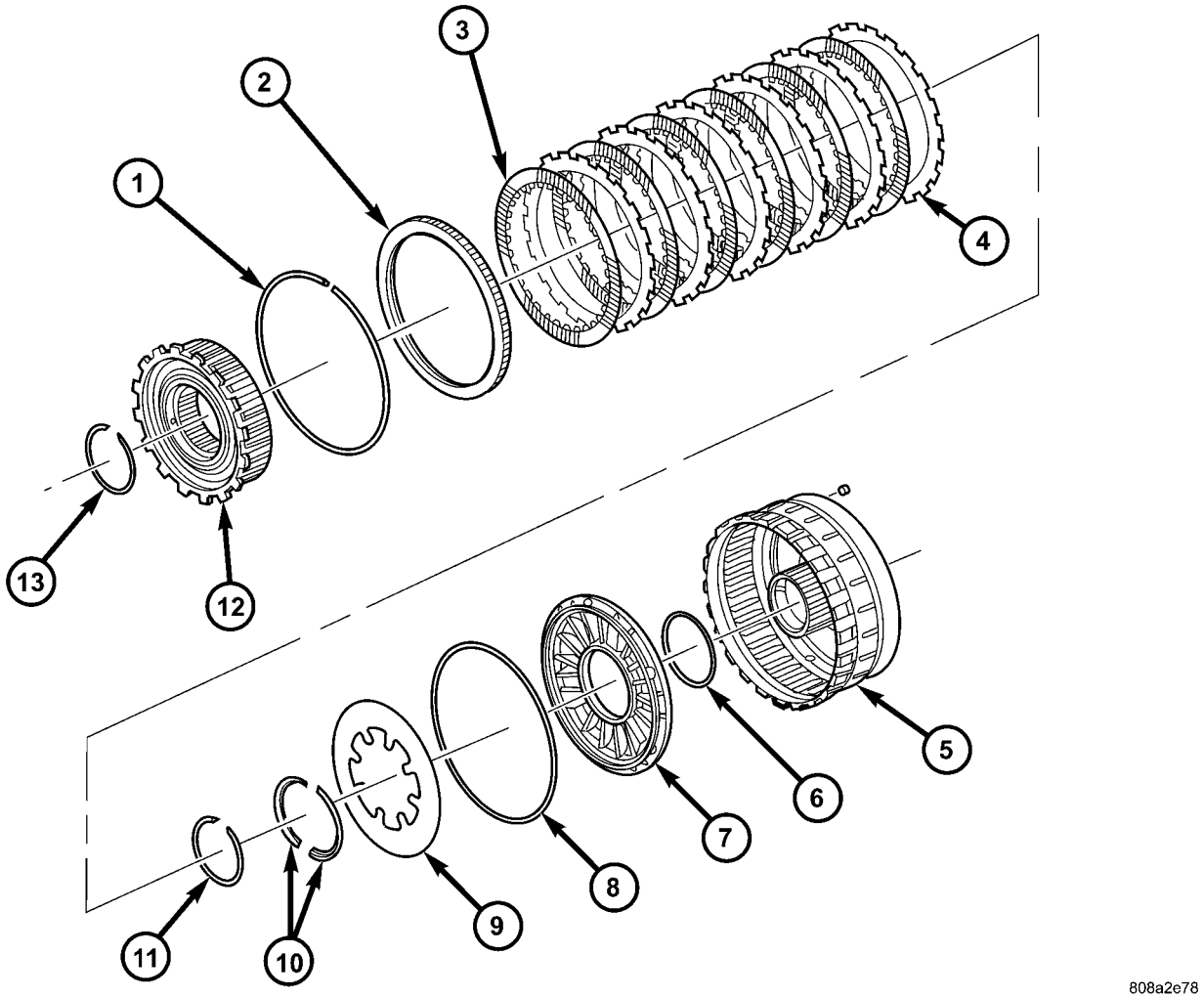


Fig. 7 Low/Reverse Clutch

1 - SNAP-RING (SELECT)
2 - REACTION PLATE
3 - DISC
4 - PLATE
5 - L/R CLUTCH RETAINER
6 - SEAL
7 - PISTON
8 - SEAL
9 - BELLEVILLE SPRING
10 - RETAINER
11 - SNAP-RING
12 - OVERRUNNING CLUTCH
13 - SNAP-RING

HOLDING CLUTCHES (Continued)

OPERATION

2C CLUTCH

The 2C clutch is hydraulically applied in second and fifth gear by pressurized fluid against the 2C piston. When the 2C clutch is applied, the reverse sun gear assembly is held or grounded to the transmission case by holding the reaction planetary carrier.

4C CLUTCH

The 4C clutch is hydraulically applied in second prime and fourth gear by pressurized fluid against the 4C clutch piston. When the 4C clutch is applied, the reaction annulus gear is held or grounded to the transmission case.

LOW/REVERSE CLUTCH

The Low/Reverse clutch is hydraulically applied in park, reverse, neutral, and first gear, only at low speeds, by pressurized fluid against the Low/Reverse clutch piston. When the Low/Reverse clutch is applied, the input annulus assembly is held or grounded to the transmission case.

INPUT CLUTCH ASSEMBLY

DESCRIPTION

Three hydraulically applied input clutches are used to drive planetary components. The underdrive, overdrive, and reverse clutches are considered input clutches and are contained within the input clutch assembly (Fig. 8) and (Fig. 9). The input clutch assembly also contains:

- Input shaft
- Input hub
- Clutch retainer
- Underdrive piston
- Overdrive/reverse piston
- Overdrive hub
- Underdrive hub

OPERATION

The three input clutches are responsible for driving different components of the planetary geartrain.

UNDERDRIVE CLUTCH

The underdrive clutch is hydraulically applied in first, second, second prime, and third (direct) gears by pressurized fluid against the underdrive piston. When the underdrive clutch is applied, the underdrive hub drives the input sun gear.

OVERDRIVE CLUTCH

The overdrive clutch is hydraulically applied in third (direct), fourth, and fifth gears by pressurized fluid against the overdrive/reverse piston. When the overdrive clutch is applied, the overdrive hub drives the reverse carrier/input annulus assembly.

REVERSE CLUTCH

The reverse clutch is hydraulically applied in reverse gear by pressurized fluid against the overdrive/reverse piston. When the reverse clutch is applied, the reaction annulus gear is driven.

INPUT CLUTCH ASSEMBLY (Continued)

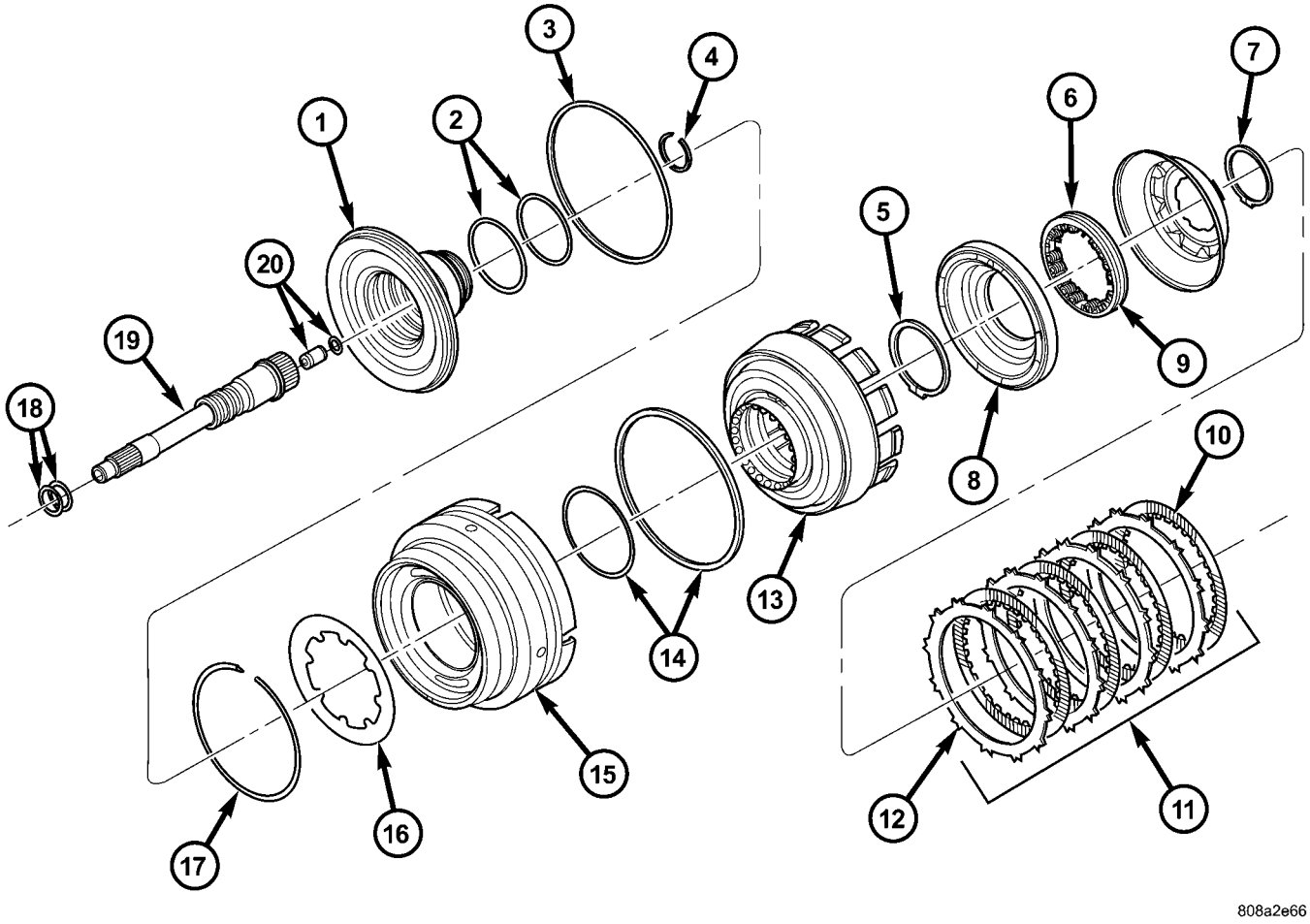


Fig. 8 Input Clutch Assembly - Part 1

1 - INPUT CLUTCH HUB
2 - O-RING SEALS
3 - SEAL
4 - SNAP-RING
5 - SNAP-RING
6 - UD BALANCE PISTON
7 - SNAP-RING
8 - UD PISTON
9 - SPRING
10 - DISC
11 - UD CLUTCH
12 - PLATE
13 - CLUTCH RETAINER
14 - SEAL
15 - OD/REV PISTON
16 - BELLEVILLE SPRING
17 - SNAP-RING
18 - SEAL RINGS
19 - INPUT SHAFT
20 - LUBRICATION CHECK VALVE AND SNAP-RING

INPUT CLUTCH ASSEMBLY (Continued)

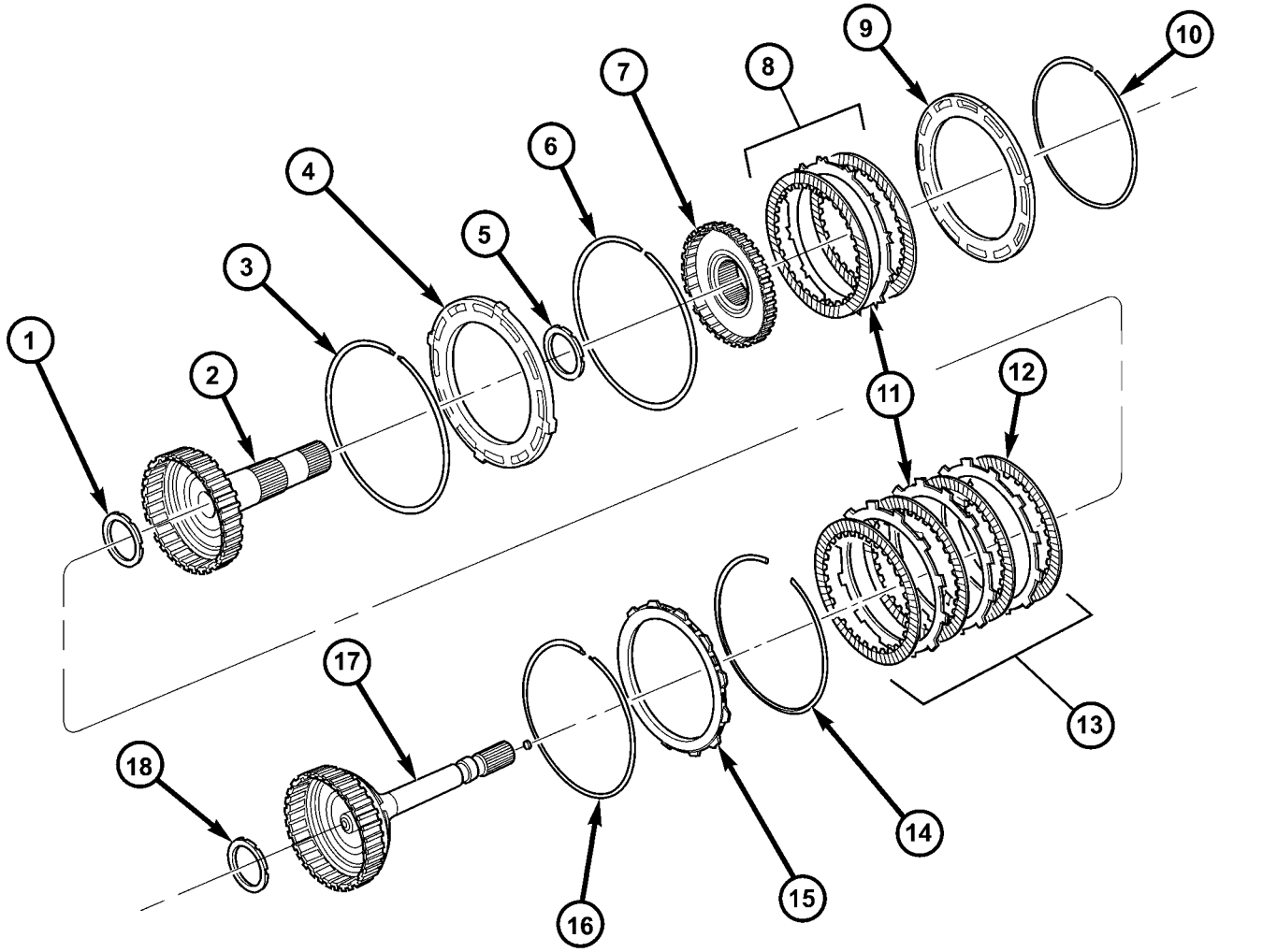


Fig. 9 Input Clutch Assembly - Part 2

1 - BEARING NUMBER 3
2 - OD HUB/SHAFT
3 - SNAP-RING (WAVE)
4 - REV/OD REACTION PLATE
5 - BEARING NUMBER 4
6 - SNAP-RING (FLAT)
7 - REVERSE HUB/SHAFT
8 - REVERSE CLUTCH
9 - REVERSE REACTION PLATE
10 - SNAP-RING (SELECT)
11 - PLATE
12 - DISC
13 - OD CLUTCH
14 - SNAP-RING (TAPERED)
15 - UD/OD REACTION PLATE
16 - SNAP-RING (FLAT)
17 - UD HUB/SHAFT
18 - BEARING NUMBER 2

INPUT CLUTCH ASSEMBLY (Continued)

DISASSEMBLY

(1) Remove the reverse reaction plate selective snap-ring from the input clutch retainer (Fig. 10).

(2) Remove the reverse reaction plate from the input clutch retainer.

(3) Remove the reverse hub and reverse clutch pack from the input clutch retainer.

(4) Remove the number 4 bearing from the overdrive hub.

(5) Remove the overdrive hub from the input clutch retainer (Fig. 10).

(6) Remove the number 3 bearing from the underdrive hub.

(7) Remove the OD/reverse reaction plate snap-ring from the input clutch retainer.

(8) Remove the underdrive hub, overdrive clutch, and overdrive reaction plate from the input clutch retainer (Fig. 10).

NOTE: The overdrive friction discs and steel discs are thicker than the matching components in the underdrive and reverse clutches.

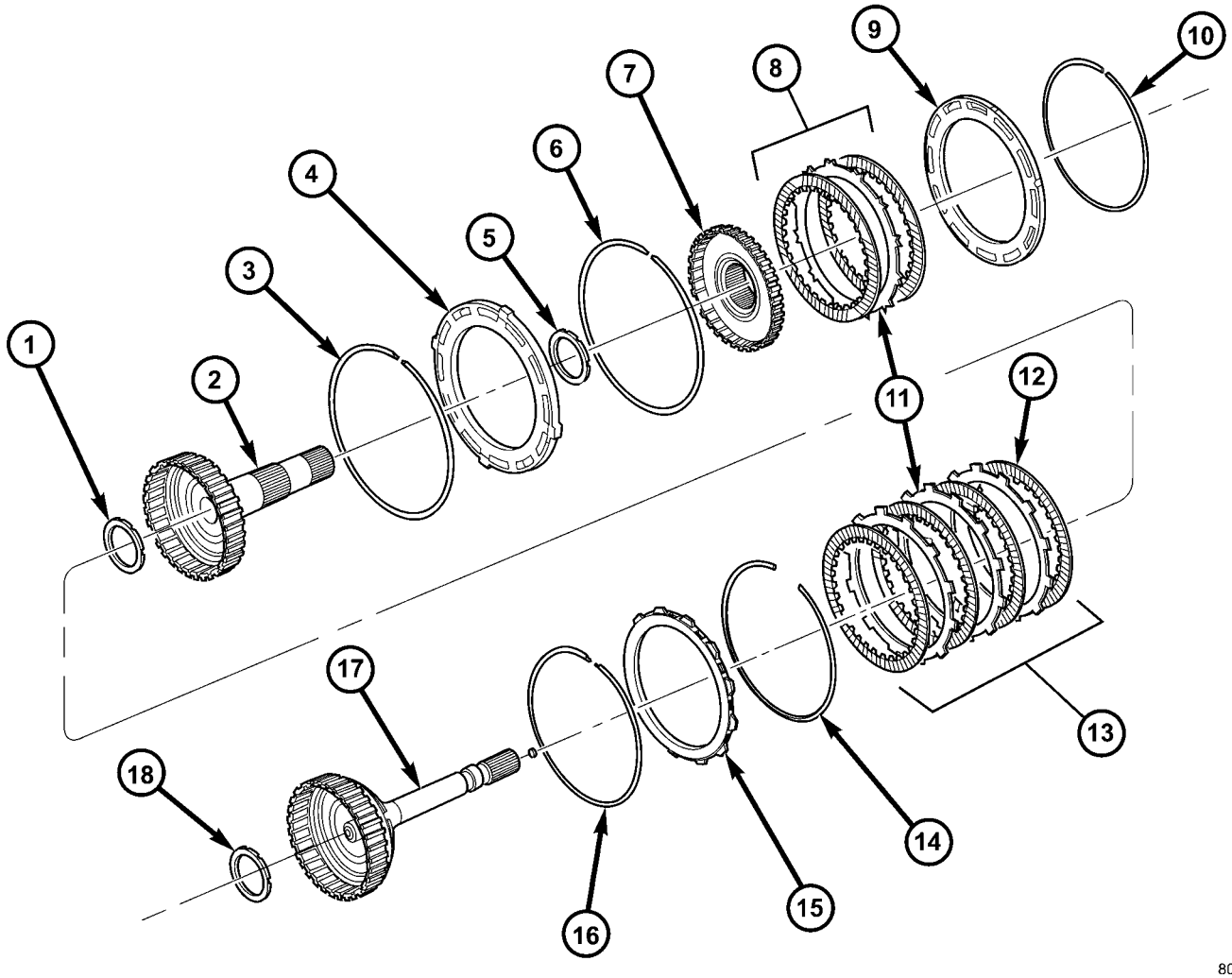


Fig. 10 Input Clutch Assembly - Part 2

1 - BEARING NUMBER 3
2 - OD HUB/SHAFT
3 - SNAP-RING (WAVE)
4 - REV/OD REACTION PLATE
5 - BEARING NUMBER 4
6 - SNAP-RING (FLAT)
7 - REVERSE HUB/SHAFT
8 - REVERSE CLUTCH
9 - REVERSE REACTION PLATE
10 - SNAP-RING (SELECT)
11 - PLATE
12 - DISC
13 - OD CLUTCH
14 - SNAP-RING (TAPERED)
15 - UD/OD REACTION PLATE
16 - SNAP-RING (FLAT)
17 - UD HUB/SHAFT
18 - BEARING NUMBER 2

INPUT CLUTCH ASSEMBLY (Continued)

(9) Remove the number 2 bearing from the input clutch hub.

(10) Remove the overdrive clutch wave snap-ring from the input clutch retainer.

(11) Remove the UD/OD reaction plate tapered snap-ring from the input clutch retainer.

(12) Remove the UD/OD reaction plate from the input clutch retainer.

(13) Remove the UD/OD reaction plate flat snap-ring from the input clutch retainer (Fig. 10).

(14) Remove the underdrive clutch pack from the input clutch retainer (Fig. 12).

(15) Using Spring Compressor 8251, compress the UD/OD balance piston and remove the snap-ring from the input clutch hub (Fig. 11).

(16) Remove the UD/OD balance piston and piston return spring from the input clutch retainer (Fig. 12).

(17) Remove the underdrive piston from the input clutch retainer (Fig. 12).

NOTE: Both the UD/OD balance piston and the underdrive piston have seals molded onto them. If the seal is damaged, do not attempt to install a new seal onto the piston. The piston/seal must be replaced as an assembly.

(18) Remove the input clutch retainer tapered snap-ring.

(19) Separate input clutch retainer from input clutch hub.

(20) Separate OD/reverse piston from input clutch hub retainer (Fig. 12).

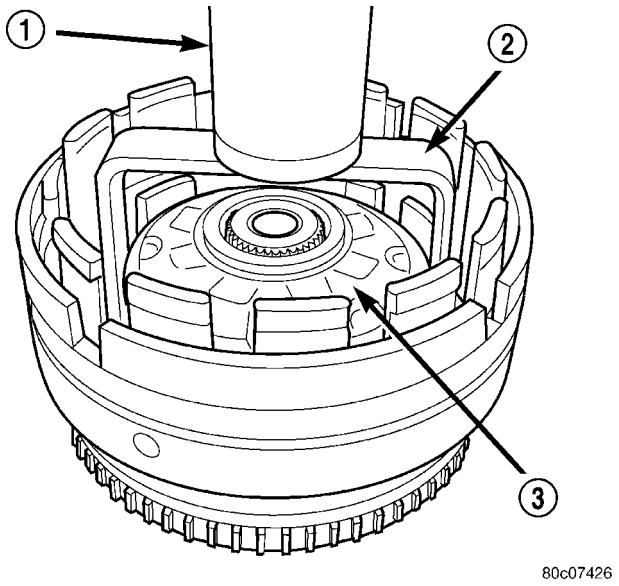


Fig. 11 Compressing UD/OD Balance Piston Using Tool 8251

1 - PRESS
2 - TOOL 8251
3 - BALANCE PISTON

(21) Remove all seals and o-rings from the input shaft and input hub. The o-rings on the input hub are color coded. Be sure to make note of which o-ring belongs in which location.

INPUT CLUTCH ASSEMBLY (Continued)

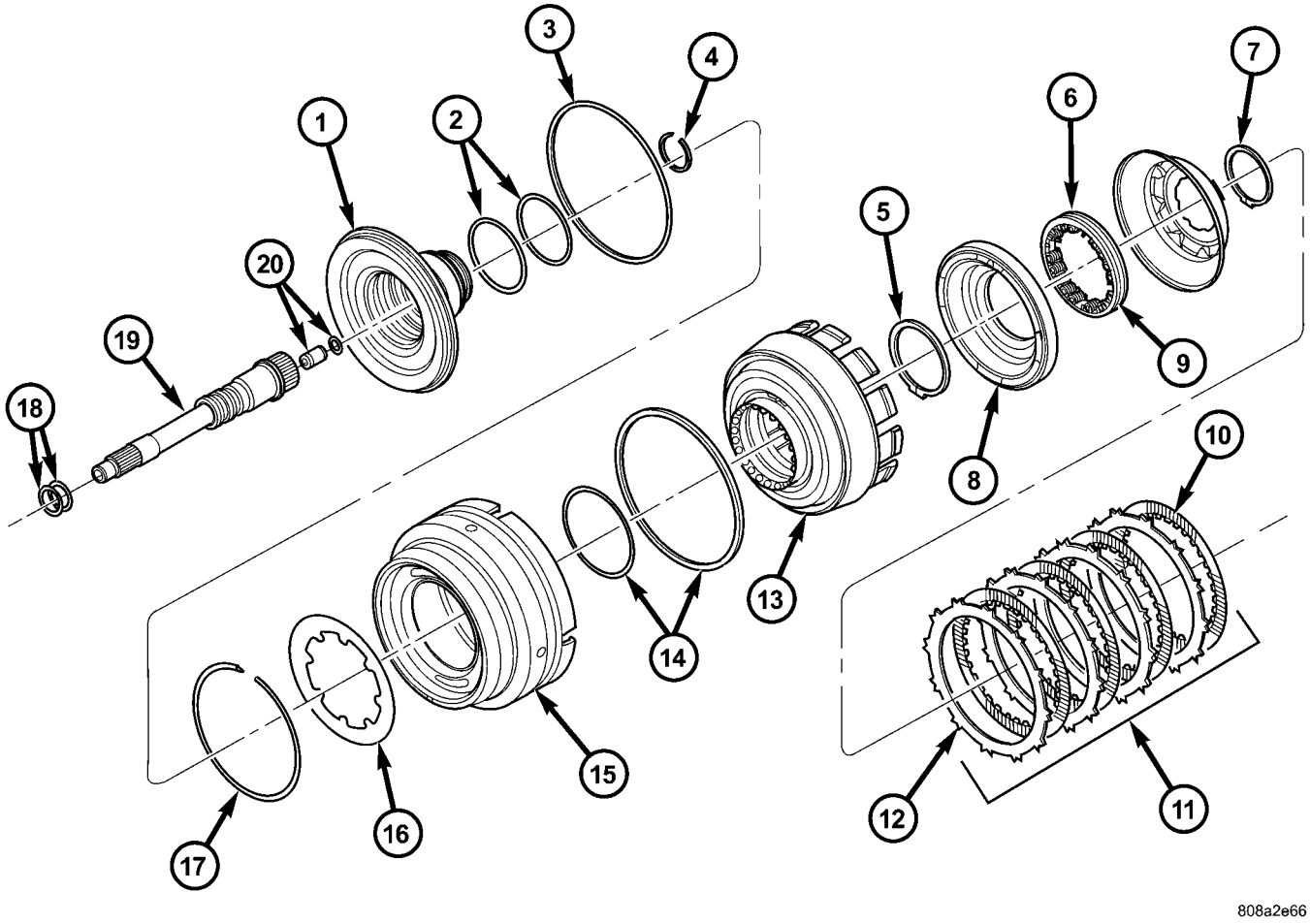


Fig. 12 Input Clutch Assembly - Part 1

1 - INPUT CLUTCH HUB
2 - O-RING SEALS
3 - SEAL
4 - SNAP-RING
5 - SNAP-RING
6 - UD BALANCE PISTON
7 - SNAP-RING
8 - UD PISTON
9 - SPRING
10 - DISC
11 - UD CLUTCH
12 - PLATE
13 - CLUTCH RETAINER
14 - SEAL
15 - OD/REV PISTON
16 - BELLEVILLE SPRING
17 - SNAP-RING
18 - SEAL RINGS
19 - INPUT SHAFT
20 - LUBRICATION CHECK VALVE AND SNAP-RING

INPUT CLUTCH ASSEMBLY (Continued)

ASSEMBLY

(1) Install all new seals and o-rings onto the input shaft and input hub. The o-rings on the input hub are color coded. Be sure to install the correct o-ring in the correct location.

(2) Check the transmission lubrication check valve located in the input shaft using shop air. The valve should only allow air flow in one direction. If the valve allows no air flow, or air flow in both directions, the valve will need to be replaced.

(3) Lubricate all seals with Mopar® ATF +4, Automatic Transmission Fluid, prior to installation.

(4) Assemble the OD/reverse piston onto the input clutch hub (Fig. 13).

(5) Assemble the input clutch retainer onto the input clutch hub.

(6) Install the input clutch retainer tapered snap-ring with tapered side up onto the input clutch hub.

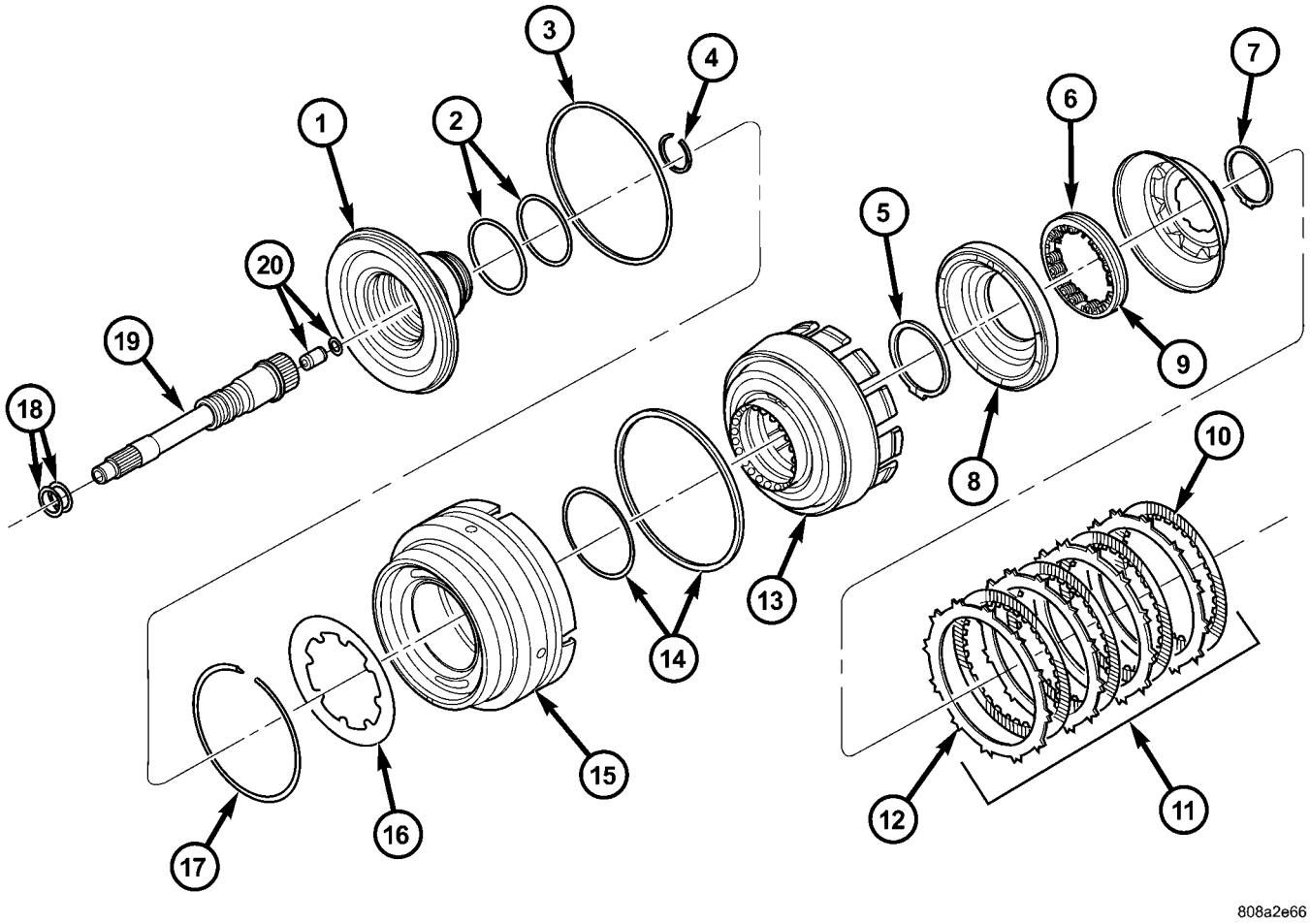


Fig. 13 Input Clutch Assembly - Part I

1 - INPUT CLUTCH HUB
2 - O-RING SEALS
3 - SEAL
4 - SNAP-RING
5 - SNAP-RING
6 - UD BALANCE PISTON
7 - SNAP-RING
8 - UD PISTON
9 - SPRING
10 - DISC
11 - UD CLUTCH
12 - PLATE
13 - CLUTCH RETAINER
14 - SEAL
15 - OD/REV PISTON
16 - BELLEVILLE SPRING
17 - SNAP-RING
18 - SEAL RINGS
19 - INPUT SHAFT
20 - LUBRICATION CHECK VALVE AND SNAP-RING

INPUT CLUTCH ASSEMBLY (Continued)

(7) Install Piston Guides 8504 into the input clutch retainer (Fig. 14) and onto the input clutch hub to guide the inner and outer underdrive piston seals into position.

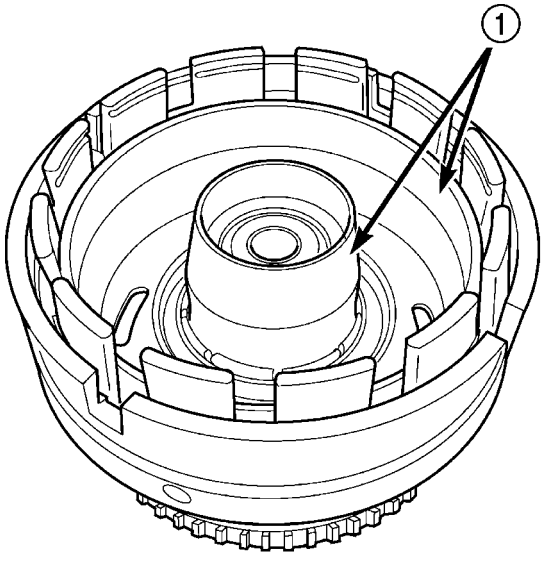


Fig. 14 Install Underdrive Piston Using Tool 8504

1 - TOOL 8504

(8) Install the underdrive piston into the input clutch retainer and over the input clutch hub (Fig. 13).

(9) Install the UD/OD balance piston return spring pack into the input clutch retainer.

(10) Install Piston Guide 8252 into the input clutch retainer (Fig. 15) to guide the UD/OD balance piston seal into position inside the underdrive piston.

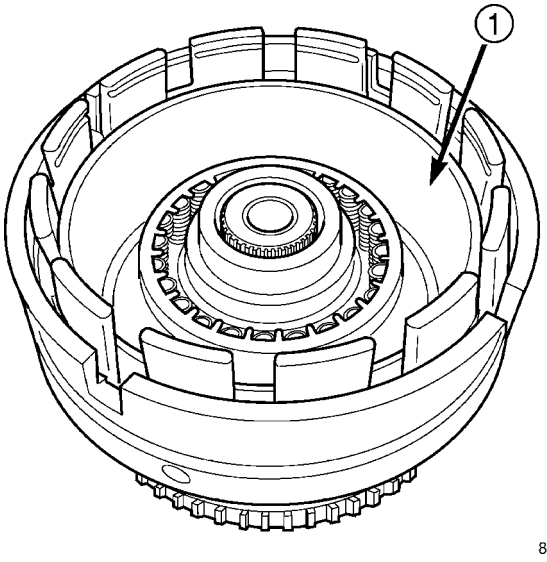


Fig. 15 Install Balance Piston Using Tool 8252

1 - TOOL 8252

(11) Install the UD/OD balance piston into the input clutch retainer and the underdrive piston.

(12) Using Spring Compressor 8251, compress the UD/OD return spring pack and secure the piston in place with the snap-ring (Fig. 16).

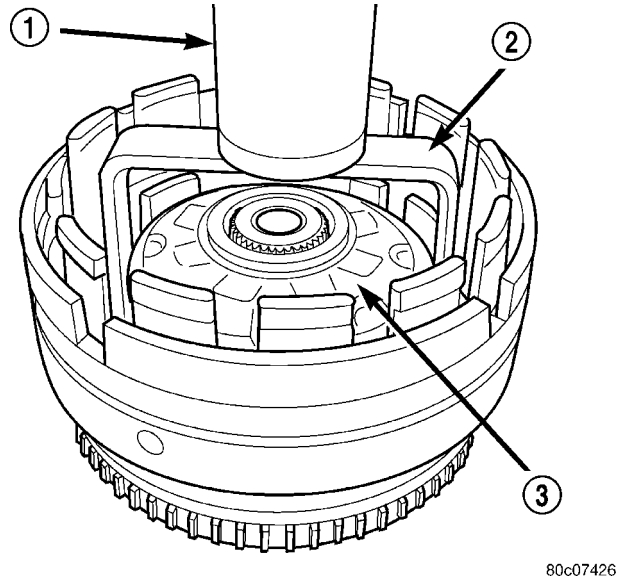


Fig. 16 Compressing UD/OD Balance Piston Using Tool 8251

1 - PRESS
2 - TOOL 8251
3 - BALANCE PISTON

(13) Install the underdrive clutch pack into the input clutch retainer (Fig. 13).

(14) Install the UD/OD reaction plate lower flat snap-ring (Fig. 17). The correct snap-ring can be identified by the two tabbed ears.

(15) Install the UD/OD reaction plate into the input clutch retainer. The reaction plate is to be installed with the big step down.

(16) Install the UD/OD reaction plate upper tapered snap-ring with tapered side up.

(17) Install the input clutch assembly into Input Clutch Pressure Fixture 8260 (Fig. 18). Mount a dial indicator to the assembly, push down on the clutch discs and zero the indicator against the underdrive clutch discs (Fig. 19). Apply 20 psi of air pressure to the underdrive clutch and record the dial indicator reading. Measure and record UD clutch pack measurement in four (4) places, 90° apart. Take average of four measurements and compare with UD clutch pack clearance specification. The correct clutch clearance is 0.84-1.54 mm (0.033-0.061 in.). The reaction plate is not selective. If the clutch clearance is not within specification, replace the reaction plate along with all the friction and steel discs.

INPUT CLUTCH ASSEMBLY (Continued)

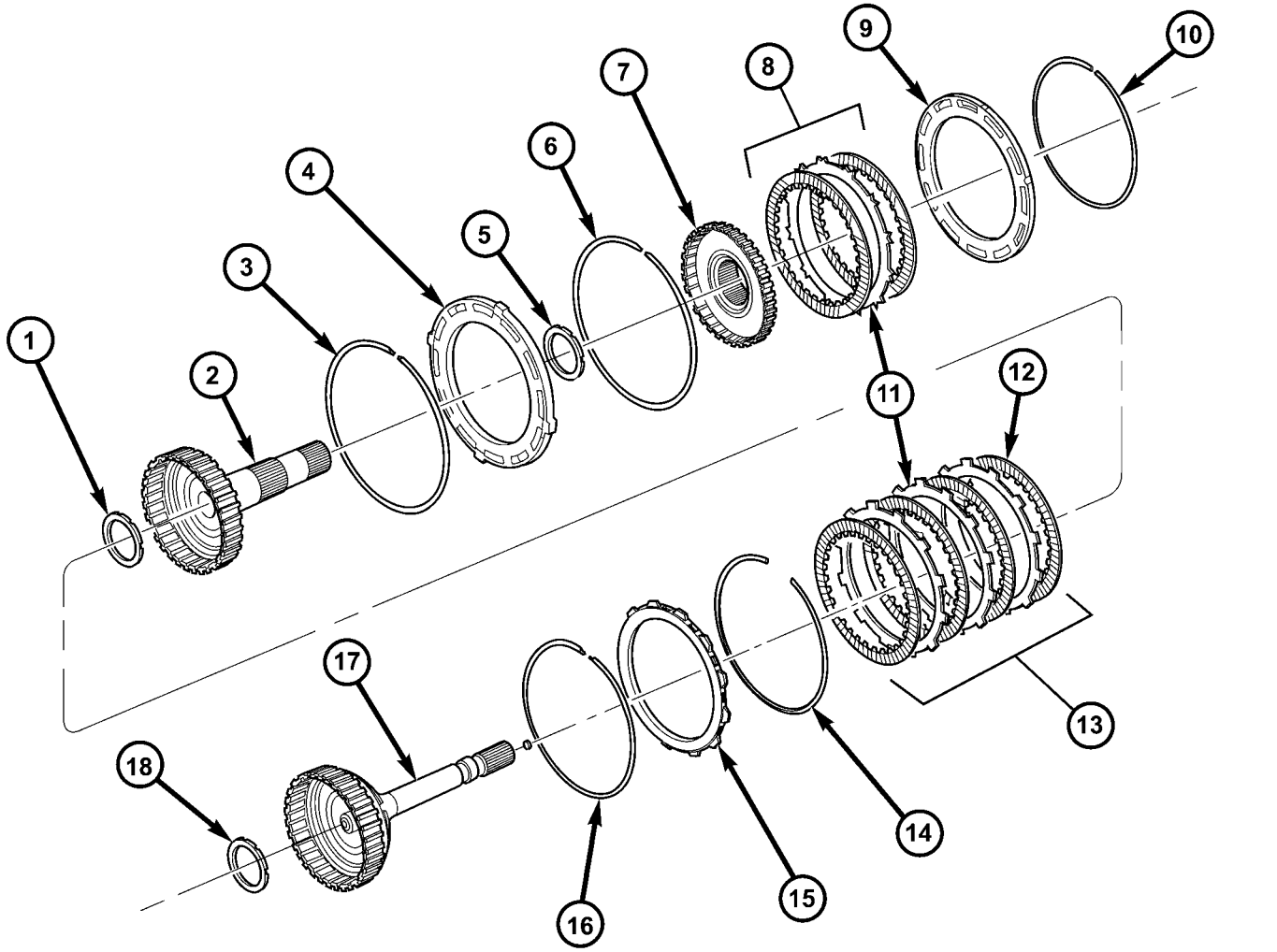


Fig. 17 Input Clutch Assembly - Part II

1 - BEARING NUMBER 3
2 - OD HUB/SHAFT
3 - SNAP-RING (WAVE)
4 - REV/OD REACTION PLATE
5 - BEARING NUMBER 4
6 - SNAP-RING (FLAT)
7 - REVERSE HUB/SHAFT
8 - REVERSE CLUTCH
9 - REVERSE REACTION PLATE
10 - SNAP-RING (SELECT)
11 - PLATE
12 - DISC
13 - OD CLUTCH
14 - SNAP-RING (TAPERED)
15 - UD/OD REACTION PLATE
16 - SNAP-RING (FLAT)
17 - UD HUB/SHAFT
18 - BEARING NUMBER 2

(18) Install the overdrive clutch pack into the input clutch retainer (Fig. 17). The overdrive steel separator plates can be identified by the lack of the half-moon cuts in the locating tabs.

(19) Install the overdrive clutch wavy snap-ring with the two tabbed ears into the input clutch retainer.

(20) Install the OD/reverse reaction plate into the input clutch retainer. The reaction plate is non-directional (Fig. 17).

(21) Install the OD/reverse reaction plate flat snap-ring into the input clutch retainer.

(22) Mount a dial indicator to the assembly and zero the indicator against the OD/reverse reaction plate (Fig. 20). Apply 20 psi of air pressure to the overdrive clutch and record the dial indicator reading. Measure and record OD clutch pack measurement in four (4) places, 90° apart. Take average of four measurements and compare with OD clutch pack clearance specification.Verify that the clutch clearance is 1.103-1.856 mm (0.043-0.073 in.). The reaction plate is not selective. If the clutch clearance is not within specification, replace the reaction plate along with all the friction and steel discs.

INPUT CLUTCH ASSEMBLY (Continued)

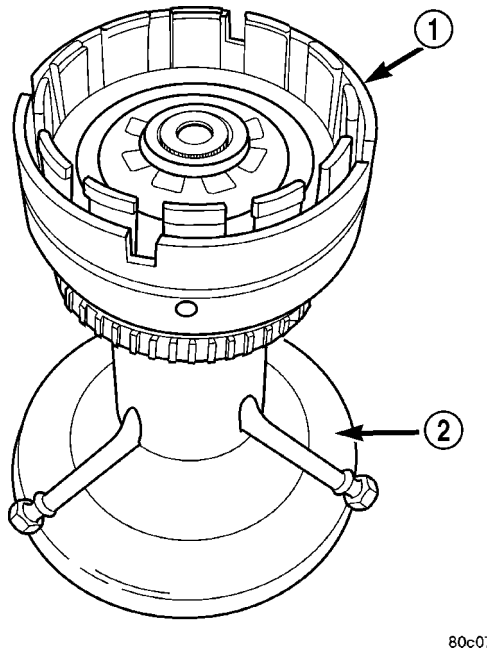


Fig. 18 Input Clutch Assembly Mounted on Tool 8260

1 - INPUT CLUTCH ASSEMBLY
2 - TOOL 8260

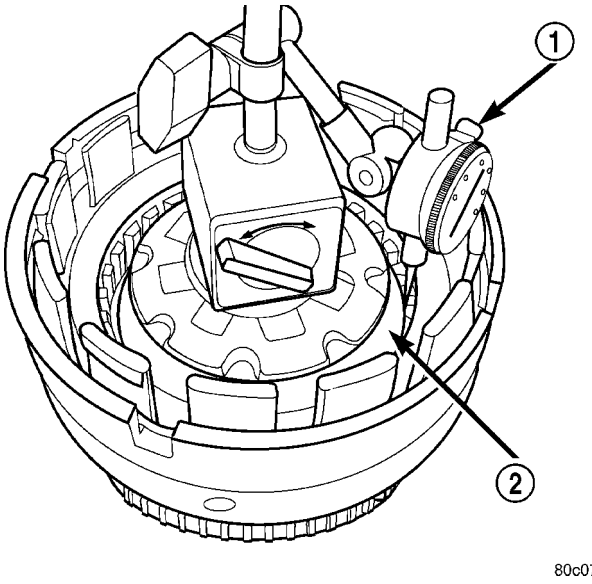


Fig. 19 Measuring UD Clutch Clearance

1 - TOOL C-3339
2 - UNDERDRIVE CLUTCH PACK

(23) Install the reverse clutch pack into the input clutch retainer (Fig. 17).

(24) Install the reverse reaction plate into the input clutch retainer.

(25) Install the reverse reaction plate selective snap-ring into the input clutch retainer.

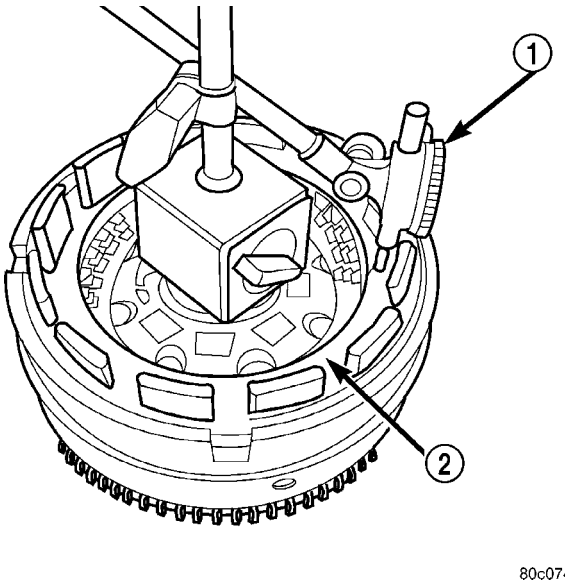


Fig. 20 Measuring OD Clutch Clearance

1 - TOOL C-3339
2 - OD/REV REACTION PLATE

(26) Mount a dial indicator to the assembly, push down on the clutch discs, pull up on the reaction plate to ensure the plate is properly seated and zero the indicator against the reverse clutch discs (Fig. 21). Apply 20 psi of air pressure to the reverse clutch and record the dial indicator reading. Measure and record Reverse clutch pack measurement in four (4) places, 90° apart. Take average of four measurements and compare with Reverse clutch pack clearance specification. The correct clutch clearance is 0.58-1.47 mm (0.023-0.058 in.). Adjust as necessary. Install the chosen snap-ring and re-measure to verify selection.

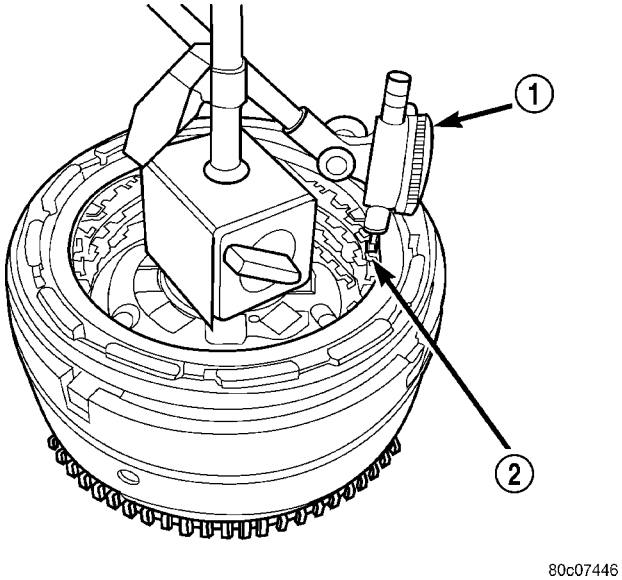


Fig. 21 Measuring Reverse Clutch Clearance

1 - TOOL C-3339
2 - REVERSE CLUTCH PACK

INPUT CLUTCH ASSEMBLY (Continued)

(27) Remove the reverse clutch pack from the input clutch retainer.

(28) Install the number 2 bearing onto the underdrive hub with outer race against the hub with petroleum jelly.

(29) Install the underdrive hub into the input clutch retainer.

(30) Install the number 3 bearing into the overdrive hub with the outer race against the hub with petroleum jelly.

(31) Install the overdrive hub into the input clutch retainer.

(32) Install the number 4 bearing into the reverse hub with outer race against the hub with petroleum jelly.

(33) Install the reverse hub into the input clutch retainer.

(34) Install the complete reverse clutch pack.

(35) Install the reverse reaction plate and snapring.

(36) Push up on reaction plate to allow reverse clutch to move freely.

SHIFT MECHANISM

DESCRIPTION

The gear shift mechanism provides six shift positions which are:

- Park (P)
- Reverse (R)
- Neutral (N)
- Drive (D)
- Manual second (2)
- Manual low (1)

OPERATION

MANUAL LOW (1) range provides FIRST gear only. Overrun braking is also provided in this range. MANUAL SECOND (2) range provides FIRST and SECOND gear only.

DRIVE range provides FIRST, SECOND, THIRD and OVERDRIVE FOURTH and FIFTH gear ranges. The shift into OVERDRIVE FOURTH and FIFTH gear range occurs only after the transmission has completed the shift into D THIRD gear range. No further movement of the shift mechanism is required to complete the 3-4 or 4-5 shifts.

The FOURTH and FIFTH gear upshifts occurs automatically when the overdrive selector switch is in the ON position. An upshift to FOURTH and FIFTH gears may not occur or may be delayed in some of the possible shift schedules. (Refer to 8 - ELECTRICAL/ELECTRONIC CONTROL MODULES/TRANSMISSION CONTROL MODULE - OPERATION)

SOLENOID SWITCH VALVE

DESCRIPTION

The Solenoid Switch Valve (SSV) is located in the valve body and controls the direction of the transmission fluid when the L/R-TCC solenoid is energized.

OPERATION

The Solenoid Switch Valve controls line pressure from the LR-TCC solenoid. In 1st gear, the SSV will be in the downshifted position, thus directing fluid to the L/R clutch circuit. In 2nd, 3rd, 4th, and 5th gears, the solenoid switch valve will be in the upshifted position and directs the fluid into the torque converter clutch (TCC) circuit.

When shifting into 1st gear, a special hydraulic sequence is performed to ensure SSV movement into the downshifted position. The L/R pressure switch is monitored to confirm SSV movement. If the movement is not confirmed (the L/R pressure switch does not close), 2nd gear is substituted for 1st. A DTC will be set after three unsuccessful attempts are made to get into 1st gear in one given key start.

TORQUE CONVERTER

OPERATION

The converter impeller (Fig. 22) (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.

STATOR

Torque multiplication is achieved by locking the stator's over-running clutch to its shaft (Fig. 23). 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 counterclockwise direction. When this happens the over-running clutch of the stator locks and holds the stator

TORQUE CONVERTER (Continued)

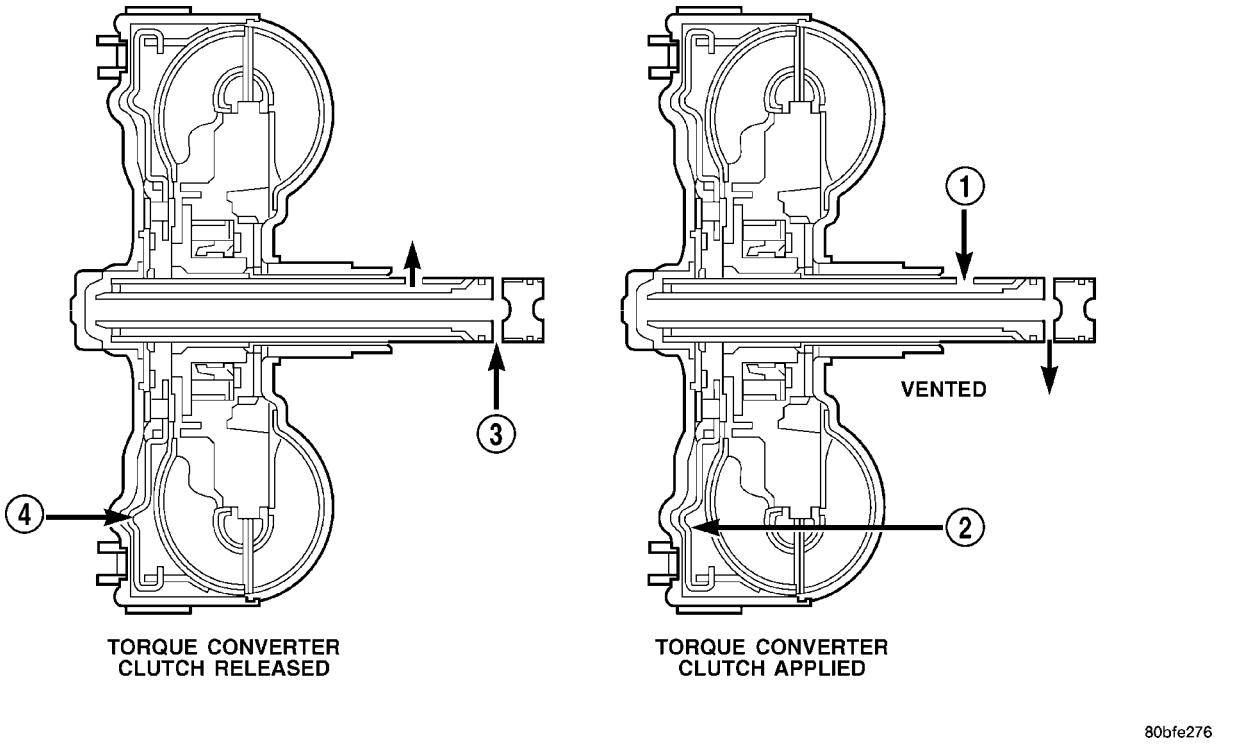


Fig. 22 Torque Converter Fluid Operation - Typical

1 - APPLY PRESSURE
2 - THE PISTON MOVES SLIGHTLY FORWARD
3 - RELEASE PRESSURE
4 - THE PISTON MOVES SLIGHTLY REARWARD

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 2.4:1. 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.

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 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 depending on overdrive control switch position. If the overdrive control switch is in the normal ON position, the clutch will engage after the shift to fourth gear, and above approximately 72 km/h (45 mph). If the control switch is in the OFF position, the clutch will engage after the shift to third gear, at approximately 56 km/h (35 mph) at light throttle.

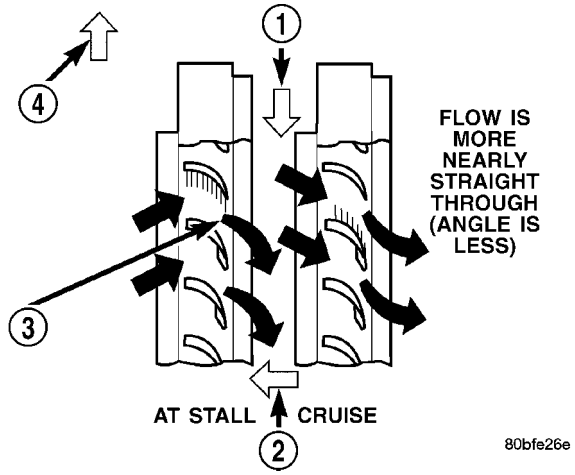


Fig. 23 Stator Operation

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

The TCM controls the torque converter by way of internal logic software. The programming of the software provides the TCM with control over the L/R-CC

TORQUE CONVERTER (Continued)

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 L/R 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.

PARTIAL EMCC

Partial EMCC operation modulates the L/R 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 L/R 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 L/R Solenoid duty cycle.

TRANSMISSION SOLENOID/ TRS ASSEMBLY

DESCRIPTION

The transmission solenoid/TRS assembly is internal to the transmission and mounted on the valve body assembly (Fig. 24). The assembly consists of six solenoids that control hydraulic pressure to the six friction elements (transmission clutches), and the torque converter clutch. The pressure control solenoid is located on the side of the solenoid/TRS assembly. The solenoid/TRS assembly also contains five pressure switches that feed information to the TCM.

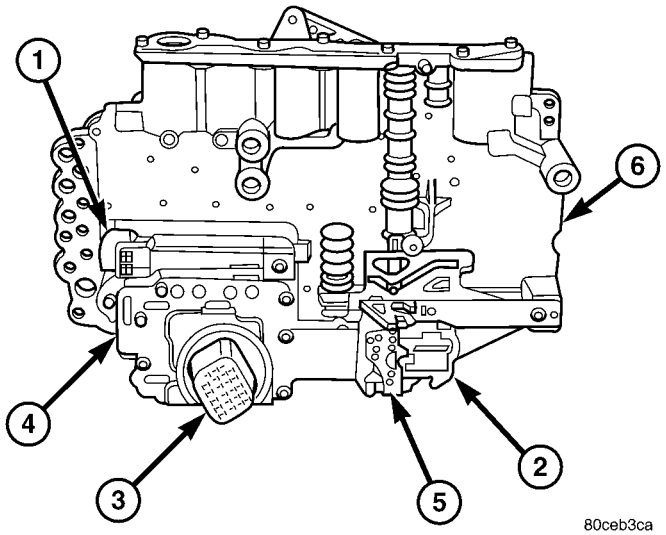


Fig. 24 Transmission Solenoid/TRS Assembly

1 - PRESSURE CONTROL SOLENOID
2 - TRANSMISSION RANGE SELECTOR PLATE
3 - 23-WAY CONNECTOR
4 - SOLENOID PACK
5 - TRANSMISSION RANGE SENSOR
6 - VALVE BODY

OPERATION

SOLENOIDS

Solenoids are used to control the L/R, 2C, 4C, OD, and UD friction elements. The reverse clutch is controlled by line pressure and the position of the manual valve in the valve body. All the solenoids are contained within the Solenoid and Pressure Switch Assembly. The solenoid and pressure switch assembly contains one additional solenoid, Multi-Select (MS), which serves primarily to provide 2nd and 3rd gear limp-in operation.

The solenoids receive electrical power from the Transmission Control Relay through a single wire. The TCM energizes or operates the solenoids individually by grounding the return wire of the solenoid as necessary. When a solenoid is energized, the solenoid valve shifts, and a fluid passage is opened or closed (vented or applied), depending on its default operating state. The result is an apply or release of a frictional element.

The MS and UD solenoids are normally applied to allow transmission limp-in in the event of an electrical failure.

The continuity of the solenoids and circuits are periodically tested. Each solenoid is turned on or off depending on its current state. An inductive spike should be detected by the TCM during this test. If no spike is detected, the circuit is tested again to verify the failure. In addition to the periodic testing, the solenoid circuits are tested if a speed ratio or pressure switch error occurs.

PRESSURE SWITCHES

The TCM relies on five pressure switches to monitor fluid pressure in the L/R, 2C, 4C, UD, and OD

TRANSMISSION SOLENOID/TRS ASSEMBLY (Continued)

hydraulic circuits. The primary purpose of these switches is to help the TCM detect when clutch circuit hydraulic failures occur. The switches close at 23 psi and open at 11 psi, and simply indicate whether or not pressure exists. The switches are continuously monitored by the TCM for the correct states (open or closed) in each gear as shown in the following chart:

GEAR	L/R	2C	4C	UD	OD
R	OP	OP	OP	OP	OP
P/N	CL	OP	OP	OP	OP
1ST	CL*	OP	OP	CL	OP
2ND	OP	CL	OP	CL	OP
2ND PRIME	OP	OP	CL	CL	OP
D	OP	OP	OP	CL	CL
4TH	OP	OP	CL	OP	CL
5TH	OP	CL	OP	OP	CL

*L/R is closed if output speed is below 100 rpm in Drive and Manual 2. L/R is open in Manual 1.

A Diagnostic Trouble Code (DTC) will set if the TCM senses any switch open or closed at the wrong time in a given gear.

REMOVAL

(1) Remove the valve body from the transmission (Fig. 25).

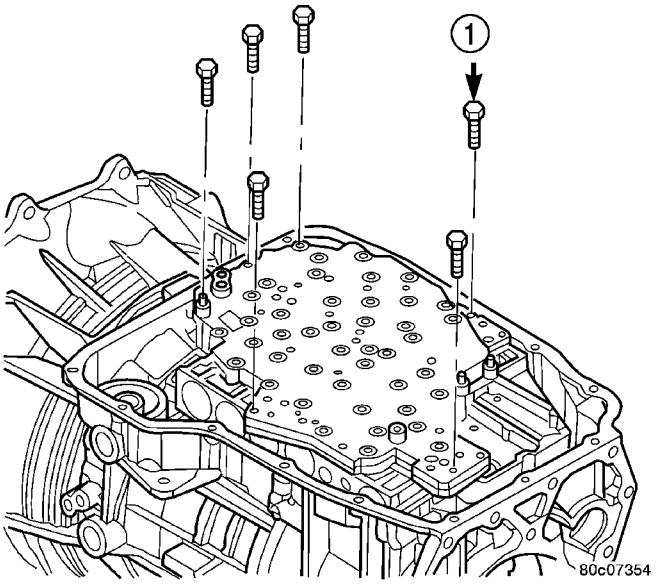


Fig. 25 Valve Body Bolts

1 - VALVE BODY TO CASE BOLT (6)

(2) Remove the screws holding the transmission solenoid/TRS assembly onto the valve body (Fig. 26).

(3) Separate the transmission solenoid/TRS assembly from the valve body.

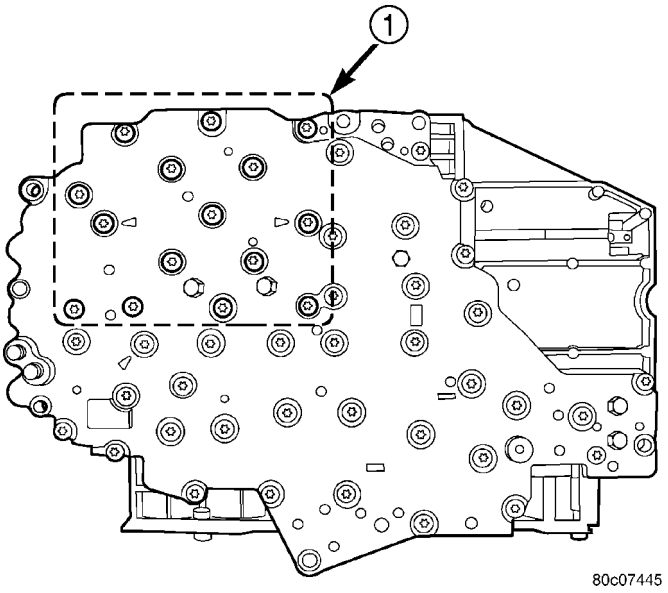


Fig. 26 Transmission Solenoid/TRS Assembly Screws

1 - SOLENOID PACK BOLTS (15)

INSTALLATION

(1) Place TRS selector plate in the PARK position.

(2) Position the transmission solenoid/TRS assembly onto the valve body. Be sure that both alignment dowels are fully seated in the valve body and that the TRS switch contacts are properly positioned in the selector plate

(3) Install the screws to hold the transmission solenoid/TRS assembly onto the valve body.

(4) Tighten the solenoid assembly screws adjacent to the arrows cast into the bottom of the valve body first. Tighten the screws to 5.7 N·m (50 in.lbs.).

(5) Tighten the remainder of the solenoid assembly screws to 5.7 N·m (50 in.lbs.).

(6) Install the valve body into the transmission.

VALVE BODY

DESCRIPTION

The valve body consists of a cast aluminum valve body, a separator plate, and a transfer plate. The valve body contains valves and check balls that control fluid delivery to the torque converter clutch, bands, and frictional clutches. The valve body contains the following components (Fig. 27) and (Fig. 28):

- Solenoid switch valve
- Manual valve
- Low/reverse switch valve
- 5 Accumulators
- 7 check balls

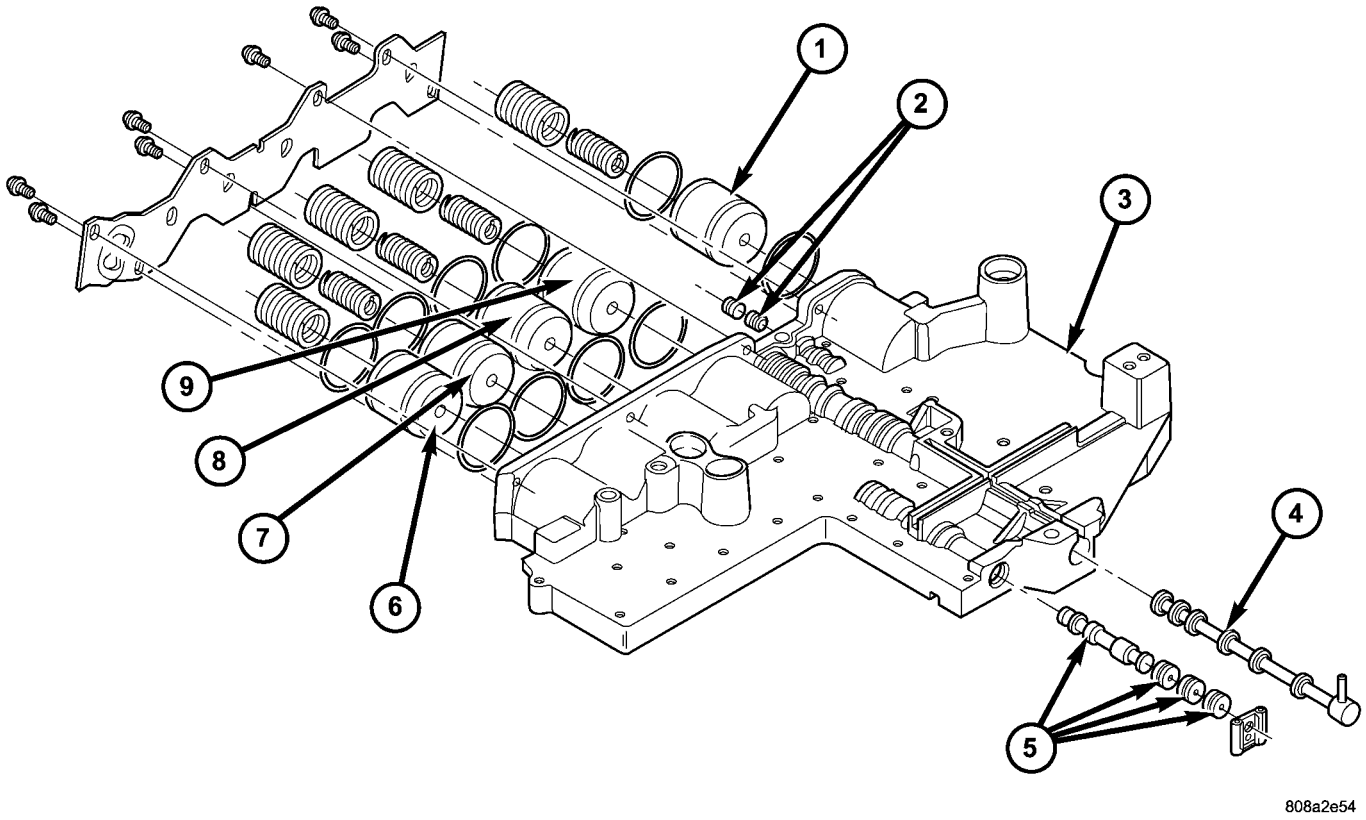


Fig. 27 Valve Body Components

1 - LOW/REVERSE ACCUMULATOR
2 - LOW/REVERSE SWITCH VALVE
3 - UPPER VALVE BODY
4 - MANUAL VALVE
5 - SOLENOID SWITCH VALVE
6 - OVERDRIVE ACCUMULATOR
7 - UNDERDRIVE ACCUMULATOR
8 - 4C ACCUMULATOR
9 - 2C ACCUMULATOR

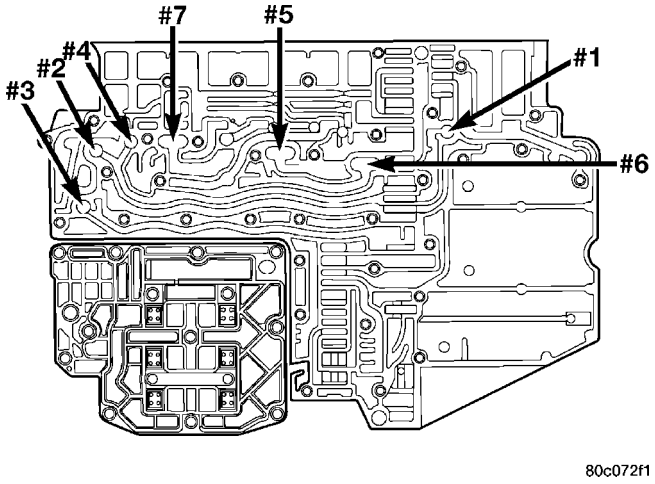


Fig. 28 Check Ball Locations

OPERATION

NOTE: Refer to the Hydraulic Schematics for a visual aid in determining valve location, operation and design.

SOLENOID SWITCH VALVE

The Solenoid Switch Valve (SSV) controls the direction of the transmission fluid when the L/R-TCC solenoid is energized.

The Solenoid Switch Valve controls line pressure from the LR-TCC solenoid. In 1st gear, the SSV will be in the downshifted position, thus directing fluid to the L/R clutch circuit. In 2nd, 3rd, 4th, and fifth gears, the solenoid switch valve will be in the upshifted position and directs the fluid into the torque converter clutch (TCC) circuit.

When shifting into 1st gear, a special hydraulic sequence is performed to ensure SSV movement into the downshifted position. The L/R pressure switch is monitored to confirm SSV movement. If the move-

VALVE BODY (Continued)

ment is not confirmed (the L/R pressure switch does not close), 2nd gear is substituted for 1st. A DTC will be set after three unsuccessful attempts are made to get into 1st gear in one given key start.

MANUAL VALVE

The manual valve is a relay valve. The purpose of the manual valve is to direct fluid to the correct circuit needed for a specific gear or driving range. The manual valve, as the name implies, is manually operated by the driver with a lever located on the top of the valve body. The valve is connected mechanically by a cable to the gearshift mechanism. The valve is held in each of its positions by a roller detent spring (Fig. 29) that engages the “roostercomb” of the TRS selector plate.

LOW/REVERSE SWITCH VALVE

The low/reverse switch valve allows the low/reverse clutch to be operated by either the LR/CC solenoid or the MS solenoid.

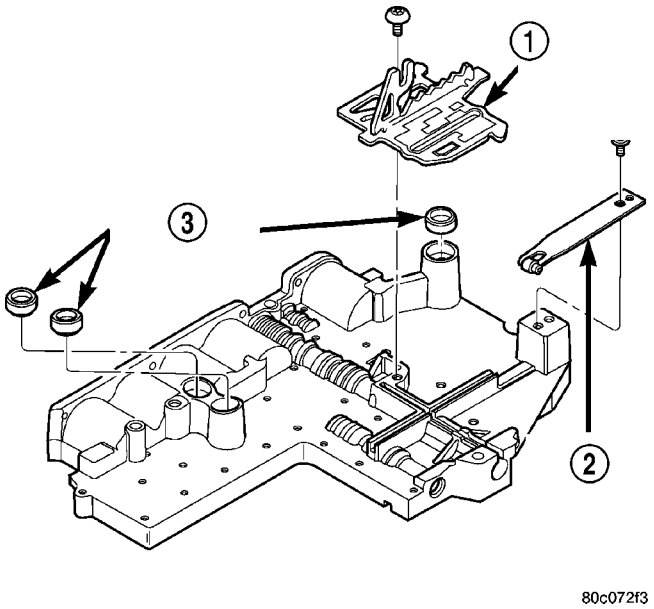


Fig. 29 TRS Selector Plate and Detent Spring

1 - TRS SELECTOR PLATE
2 - DETENT SPRING
3 - CLUTCH PASSAGE SEALS

EMISSIONS CONTROL - 2.5L/2.8L TURBO DIESEL

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EMISSIONS CONTROL - 2.5L/2.8L TURBO DIESEL

DESCRIPTION

The 2.5L/2.8L diesel Engine Control Module (ECM) controls many different circuits in the fuel injection pump 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 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: High fuel pressure is controlled by the fuel injection pump, fuel pressure solenoid, and fuel pressure sensor. The ECM uses inputs from the sensor and solenoid to calculate and determine if a high 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. There are high and low limits that are programmed into the ECM 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.

EMISSIONS CONTROL - 2.5L/2.8L TURBO DIESEL (Continued)

SPECIFICATIONS - TORQUE

2.5L / 2.8L DIESEL - TORQUE SPECIFICATIONS

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
EGR Pipe to EGR Bolts	32.4	24	—
EGR Pipe to Exhaust Manifold Bolt	24.5	18	—
EGR Cooler to EGR Valve Bolts	32.4	24	—
EGR Cooler to Exhaust Manifold Bolt	24.5	18	—
EGR Valve Nuts	32.4	24	—

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 2.5L/2.8L 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

ERASING TROUBLE CODES

After the problem has been repaired, use the DRB III® scan tool to erase a DTC.

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 Plausibility Mass Air Flow Sensor Plausibility Positive Area Mass Air Flow Sensor Signal Voltage Too High Mass Air Flow Sensor Signal Voltage Too Low Mass Air Flow Sensor Supply Voltage Too High Or Low
P0105	Barometric Pressure Circuit Signal Voltage To High Barometric Pressure Circuit Signal Voltage To Low
P0110	Intake Air Temperature Sensor Circuit Signal Too High Intake Air Temperature Sensor Circuit Signal Too Low
P0115	Engine Coolant Temperature Sensor Circuit Engine Is Cold Too Long Engine Coolant Temperature Sensor Circuit Voltage To Low Engine Coolant Temperature Sensor Circuit Voltage To High
P0190	Fuel Pressure Sensor Circuit MALF Signal Voltage Too High Fuel Pressure Sensor Circuit MALF Signal Voltage Too Low

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P0195	Oil Temperature Sensor Circuit MALF Signal Voltage Too High Oil Temperature Sensor Circuit MALF Signal Voltage Too Low
P0201	Cylinder 1 Injector Circuit Current Decrease Cylinder 1 Injector Circuit Load Drop Cylinder 1 Injector Circuit Overcurrent High Side Cylinder 1 Injector Circuit Overcurrent Low Side
P0202	Cylinder 2 Injector Circuit Current Decrease Cylinder 2 Injector Circuit Load Drop Cylinder 2 Injector Circuit Overcurrent High Side Cylinder 2 Injector Circuit Overcurrent Low Side
P0203	Cylinder 3 Injector Circuit Current Decrease Cylinder 3 Injector Circuit Load Drop Cylinder 3 Injector Circuit Overcurrent High Side Cylinder 3 Injector Circuit Overcurrent Low Side
P0204	Cylinder 4 Injector Circuit Current Decrease Cylinder 4 Injector Circuit Load Drop Cylinder 4 Injector Circuit Overcurrent High Side Cylinder 4 Injector Circuit Overcurrent Low Side
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
P0335	CKP Position Sensor Circuit Dynamic Plausibility CKP Position Sensor Circuit Overspeed Recognition CKP Position Sensor Circuit Static Plausibility
P0340	CMP Position Sensor Circuit CMP/CKP Sync. Failure CMP Position Sensor Circuit Dynamic Plausibility CMP Position Sensor Circuit Fuel Shut-Off Activated CMP Position Sensor Circuit Signal Frequency Too High CMP Position Sensor Circuit Static Plausibility
P0380	Glow Plug Circuit A Open Circuit Glow Plug Circuit A Short Circuit
P0403	EGR Solenoid Circuit Open Circuit EGR Solenoid Circuit Short Circuit
P0480	Fan 1 Control Circuit Open Circuit Fan 1 Control Circuit Short Circuit
P0481	Fan 2 Control Circuit Open Circuit Fan 2 Control Circuit Short Circuit

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P0500	Vehicle Speed Sensor Frequency Too High Vehicle Speed Sensor Frequency High Level Duration Vehicle Speed Sensor Plausibility Vehicle Speed Sensor Signal Voltage Too High
P0514	Battery Temperature Sensor Circuit Signal Voltage Too High
P0520	Oil Pressure Sensor Circuit MALF Signal Voltage Too High Oil Pressure Sensor Circuit MALF Signal Voltage Too Low Oil Pressure Sensor Circuit MALF Signal Voltage Too Low or High
P0530	A/C Pressure Sensor Circuit Plausibility A/C Pressure Sensor Circuit Signal Voltage Too High A/C Pressure Sensor Circuit Signal Voltage Too Low A/C Pressure Sensor Circuit Supply Voltage Too High Or Low
P0560	System Voltage Too High System Voltage Too Low
P0579	Speed Control Switch Signal Circuit Voltage Too High Speed Control Switch Signal Circuit Voltage Too Low
P0606	ECM Error Gate Array - Communication ECM Error Gate Array - Communication Not Verified ECM Error Gate Array - Quantity Stop ECM Error Gate Array - Has Occurred ECM Error Redundant Overrun Monitoring
P0615	Starter Relay Circuit Open Circuit Starter Relay Circuit Short Circuit
P0620	Generator Field Control MALF Open Circuit Generator Field Control MALF Short Circuit
P0641	Sensor Reference Voltage A CKT Voltage Too High Sensor Reference Voltage A CKT Voltage Too Low
P0645	A/C Clutch Relay Circuit Open Circuit A/C Clutch Relay Circuit Short Circuit
P0651	Sensor Reference Voltage B CKT Voltage Too Low Sensor Reference Voltage B CKT Voltage Too High
P0685	ECM/PCM Relay Control Circuit Shuts Off Too Early ECM/PCM Relay Control Circuit Shuts Off Too Late
P0703	Brake Switch Signal Circuits Incorrect Can Message Brake Switch Signal Circuits Plausibility With Redundant Contact
P1130	Fuel Rail Pressure Malfunction Small Leakage Detected Fuel Rail Pressure Malfunction Small Leakage Detected

ON-BOARD DIAGNOSTICS (Continued)

Generic Scan Tool Code	DRB III® Scan Tool Display
P1131	Fuel Pressure Solenoid Open Circuit Fuel Pressure Solenoid Short Circuit
P1206	Calculated Injector Voltage #1 Too Low Calculated Injector Voltage #2 Too Low
P1511	Battery Sense Line 1 Voltage Too High Battery Sense Line 1 Voltage Too Low
P1601	Capacitor Voltage 1 Voltage Too High Capacitor Voltage 1 Voltage Too Low
P1602	Capacitor Voltage 2 Voltage Too High Capacitor Voltage 2 Voltage Too Low
P1605	Ignition Switch Plausibility
P1610	Voltage Regulator Signal Voltage Too High Voltage Regulator Signal Voltage Too Low
P1680	EEPROM Plausibility Checksum Error EEPROM Plausibility Code Word Incorrect Or Missing EEPROM Plausibility Communication Error EEPROM Plausibility Variation Number Error EEPROM Plausibility VIN Checksum Error EEPROM Plausibility VIN Write Error
P1685	SKIM System Invalid Key Code Received SKIM System Invalid Secret Key In EEPROM SKIM System Key Communication Timed Out SKIM System SKIM Error SKIM System Write Access To EEPROM Failure
P1696	EEPROM Communication Error EEPROM Communication Not Verified EEPROM Quanity Stop EEPROM Recovery Occured EEPROM Redundant Overrun Monitoring
P1703	Brake Switch Signal CKTS Plaus. With Redundant Contact After Initialization
P2120	Acc. Pedal Position Sensor 1 CKT Plausibility Acc. Pedal Position Sensor 1 CKT Plausibility With Brake Switch Acc. Pedal Position Sensor 1 CKT Plausibility With Potentiometer Acc. Pedal Position Sensor 1 CKT Signal Voltage Too High Acc. Pedal Position Sensor 1 CKT Signal Voltage Too Low Acc. Pedal Position Sensor 1 CKT Signal Voltage Too High or Low

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 charge air.

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. The valve is located on the right side of the engine above the exhaust manifold.
- An EGR solenoid.The EGR solenoid controls the “on time” of the EGR valve.
- The ECM operates the EGR solenoid. The ECM is located in the left-rear side of the engine compartment.
- 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 internally in the front of the engine block and is driven by the crankshaft gear.
- Vacuum lines and hoses connect the various components.

When the ECM supplies a variable ground signal to the EGR solenoid, EGR system operation starts to occur. 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 Cooler (2.8L) further cools the hot exhaust gasses before recirculation

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 system consists of (Fig. 1):

- EGR valve
- Vacuum hoses
- EGR cooler - (2.8L)
- EGR solenoid

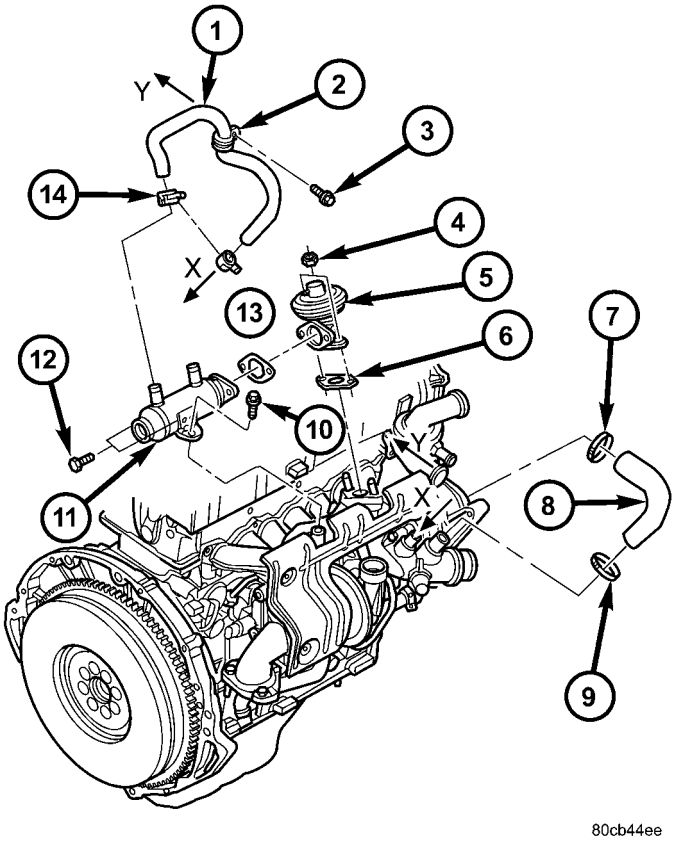

Fig. 1 EGR VALVE, COOLER, AND COMPONENTS

1 - COOLANT HOSE
2 - HOSE RETAINER
3 - RETAINING BOLT
4 - EGR VALVE RETAINING NUTS
5 - EGR VALVE
6 - EGR VALVE GASKET
7 - HOSE CLAMP
8 - COOLANT HOSE
9 - HOSE CLAMP
10 - EGR COOLER TO EXHAUST MANIFOLD RETAINING BOLT (2.8L)
11 - EGR COOLER (2.8L)
12 - EGR COOLER TO EGR VALVE RETAINING BOLTS (2.8L)
13 - EGR COOLER TO EGR VALVE GASKET (2.8L)
14 - HOSE CLAMP

OPERATION

The EGR system reduces oxides of nitrogen (NOx) in engine exhaust. 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 charge air. The diluted air mixture reduces peak flame temperature during combustion.

REMOVAL

(1) Remove engine cover.
(2) Partially drain cooling system.
(3) Disconnect vacuum line at EGR valve (Fig. 1).
(4) Disconnect coolant hoses at EGR valve (Fig. 1).
(5) Remove the EGR pipe to exhaust manifold bolt retaining bolt (2.5L).
(6) Disconnect tube at rear of EGR valve cooler (2.8L) (Fig. 1).
(7) Remove EGR valve cooler to exhaust manifold retaining bolt (2.8L) (Fig. 1).
(8) Remove EGR valve to exhaust manifold retaining bolt (Fig. 1).
(9) Remove EGR valve (2.5L) and cooler assembly (2.8L) from vehicle.
(10) Remove EGR valve to cooler retaining bolts (2.8L) and separate EGR valve from cooler.

INSTALLATION

(1) Connect EGR valve to cooler with new gasket (2.8L). Torque bolts to 32.4N·m.
(2) Install EGR valve/cooler assembly on EGR valve mounting studs with new gasket (Fig. 1).
(3) Install EGR valve retaining nuts (Fig. 1). Torque nuts to 32.4N·m.
(4) Install EGR pipe with new gasket to EGR valve bolts (2.5L). Torque bolts to 32.4N·m.
(5) Install EGR pipe or cooler to exhaust manifold retaining bolts (Fig. 1). Torque bolt to 24.5N·m.
(6) Connect tube at rear of EGR cooler (2.8L).
(7) Connect EGR cooler coolant hoses (2.8L).
(8) Connect vacuum line at EGR valve.
(9) Refill cooling system.
(10) Install engine cover.

VALVE COOLER

DESCRIPTION

The EGR valve on the 2.8L engine uses a cooler to cool the exhaust gases before they return to the intake manifold (Fig. 2). The EGR cooler attaches to the EGR valve and is cooled with engine coolant.

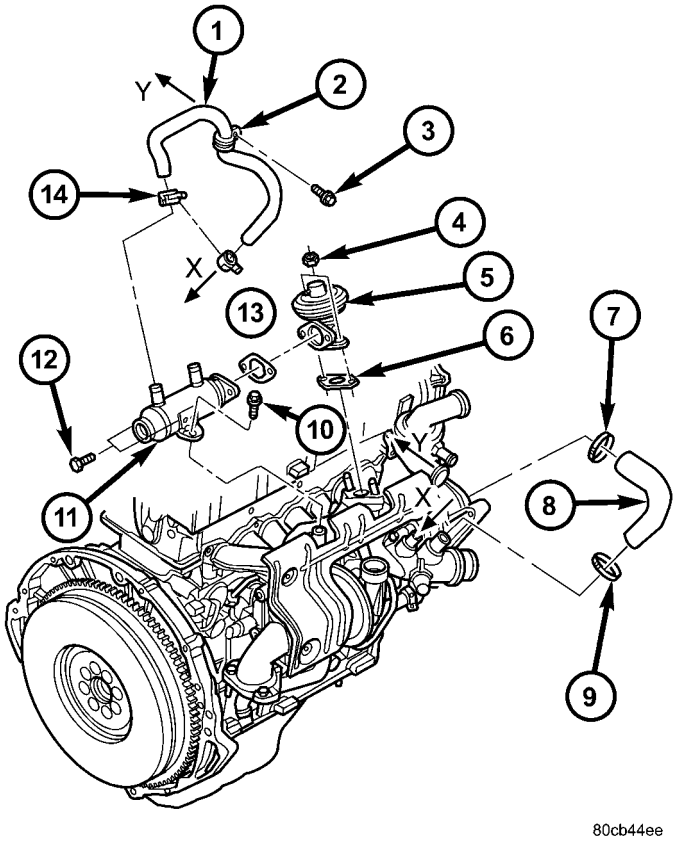

Fig. 2 EGR VALVE, COOLER, AND COMPONENTS

1 - COOLANT HOSE
2 - HOSE RETAINER
3 - RETAINING BOLT
4 - EGR VALVE RETAINING NUTS
5 - EGR VALVE
6 - EGR VALVE GASKET
7 - HOSE CLAMP
8 - COOLANT HOSE
9 - HOSE CLAMP
10 - EGR COOLER TO EXHAUST MANIFOLD RETAINING BOLT (2.8L)
11 - EGR COOLER (2.8L)
12 - EGR COOLER TO EGR VALVE RETAINING BOLTS (2.8L)
13 - EGR COOLER TO EGR VALVE GASKET (2.8L)
14 - HOSE CLAMP

REMOVAL

(1) (Refer to 25 - EMISSIONS CONTROL/EXHAUST GAS RECIRCULATION/VALVE - REMOVAL)

INSTALLATION

(1) (Refer to 25 - EMISSIONS CONTROL/EXHAUST GAS RECIRCULATION/VALVE - 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.

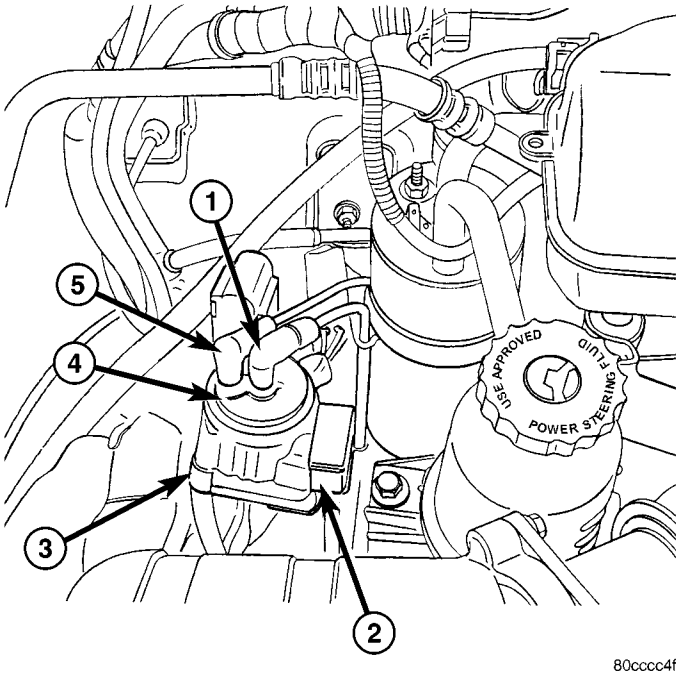

Fig. 3 EGR SOLENOID

1 - EGR SOLENOID VACUUM SUPPLY LINE
2 - EGR SOLENOID MOUNT
3 - EGR SOLENOID ELECTRICAL CONNECTOR
4 - EGR SOLENOID
5 - VACUUM LINE TO EGR VALVE

REMOVAL

(1) Disconnect negative battery cable.
(2) Disconnect EGR solenoid electrical connector (Fig. 3).
(3) Disconnect both vacuum lines at solenoid (Fig. 3).
(4) Remove EGR solenoid from rubber mount (Fig. 3).

INSTALLATION

(1) Install EGR solenoid in rubber mount (Fig. 3).
(2) Connect EGR solenoid vacuum lines (Fig. 3).
(3) Connect EGR solenoid electrical connector (Fig. 3).
(4) Connect negative battery cable.

SERVICE MANUAL COMMENTS

What errors(s) have you found?

_____

_____

_____

_____

In order for us to assist you, please include as much details as possible when reporting an error

Comments / Suggestions

_____

_____

_____

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