ENGINE

TABLE OF CONTENTS

page

2.5L VM DIESEL 1

5.2L ENGINE 56

2.5L VM DIESEL

TABLE OF CONTENTS

page

DESCRIPTION AND OPERATION
ENGINE IDENTIFICATION 2
HYDRAULIC TAPPETS 2
DIAGNOSIS AND TESTING
SERVICE DIAGNOSIS—DIESEL—PERFORMANCE 3
SERVICE DIAGNOSIS—DIESEL—MECHANICAL 9
TAPPET NOISE 11
SERVICE PROCEDURES
VALVE SERVICE 11
REMOVAL AND INSTALLATION
ENGINE MOUNTS 13
2.5L DIESEL ENGINE 15
CYLINDER HEAD COVER 24
HYDRAULIC TAPPETS 24
ROCKER ARMS AND PUSH RODS 25
VALVE SPRINGS 26
ENGINE CYLINDER HEAD 27
VIBRATION DAMPER 31
TIMING GEAR COVER OIL SEAL 32
TIMING GEAR COVER 32
CAMSHAFT 33
CAMSHAFT BEARINGS 34

page

OIL PAN 35
OIL PUMP 35
INTERNAL VACUUM PUMP 35
OIL PUMP PRESSURE RELIEF VALVE 37
OIL FILTER ADAPTER / COOLER 37
PISTONS AND CONNECTING ROD ASSEMBLY 38
CYLINDER WALL LINER ASSEMBLY 40
CRANKSHAFT MAIN BEARINGS 43
DISASSEMBLY AND ASSEMBLY
HYDRAULIC TAPPETS 46
CLEANING AND INSPECTION
CYLINDER HEAD 46
ROCKER ARMS AND PUSH RODS 47
PISTONS AND CONNECTING ROD ASSEMBLY 47
CYLINDER WALL LINER ASSEMBLY 48
OIL PUMP 49
SPECIFICATIONS
ENGINE SPECIFICATIONS 50
TORQUE SPECIFICATIONS 51
SPECIAL TOOLS
SPECIAL TOOLS 52

DESCRIPTION AND OPERATION (Continued)

DESCRIPTION AND OPERATION

ENGINE IDENTIFICATION

DESCRIPTION

The engine model code and serial number are stamped on the left side of the engine block, just below the oil dipstick tube (Fig. 1). The engine code on the R1 2.5L is DD85C followed by a 5 digit serial number.

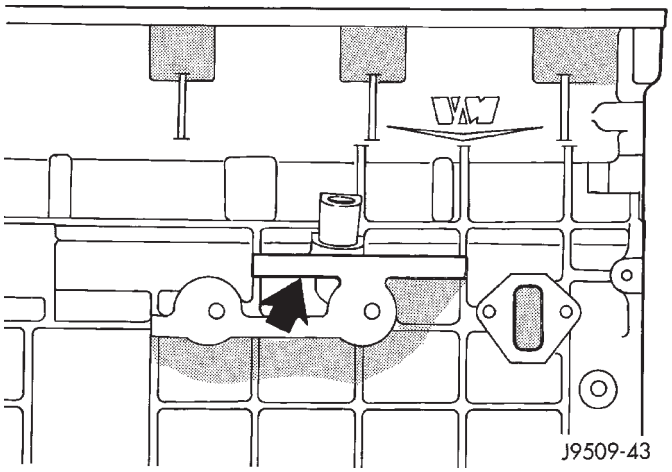


Fig. 1 Engine Code Location

Displacement	2.5L (2499 cc)
Bore	92.00
Stroke	94.00
Compression Ratio	21:1
Vacuum at idle	600 mm/Hg (23.6 In/Hg)
Belt Tension	400/500 N Automatic Tensioner
Thermostat Opening	80°C ± 2°C
Generator Rating	Denso 12V—95A
Cooling System Capacity	9.5 Liter
P/S Capacity	0.75 Liter
Engine Oil Capacity	7.2L w/filter change
Timing System	Pushrod operated overhead valves, with gear-driven camshaft in crankcase.
Air Intake	Dry filter.
Fuel Feed	Vane pump incorporated in injection pump.
Fuel System	Indirect fuel injection (precumbustion chamber).
Combustion Cycle	4 stroke
Cooling System	Water cooling.
Injection Pump	Rotary pump and electronically managed.
Lubrication	Pressure lubrication by rotary pump, full-flow filtration.
Engine Rotation	Clockwise viewed from front cover.

Engine Description

HYDRAULIC TAPPETS

DESCRIPTION

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at the pressure sending unit. The pressure should be 50 psi at 3000 RPM.

Check the oil level after the engine reaches normal operating temperature. Allow 5 minutes to stabilize oil level, check dipstick. The oil level in the pan should never be above the FULL mark or below the ADD OIL mark on dipstick. Either of these 2 conditions could be responsible for noisy tappets:

OIL LEVEL HIGH

If oil level is above the FULL mark, it is possible for the connecting rods to dip into the oil. With the engine running, this condition could create foam in the oil pan. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to lose length and allow valves to seat noisily.

OIL LEVEL LOW

Low oil level may allow oil pump to take in air. When air is fed to the tappets, they lose length which allows valves to seat noisily. Any leaks on intake side of oil pump through which air can be drawn will create the same tappet action. Check the lubrication system from the intake strainer to the pump cover, including the relief valve retainer cap. When tappet noise is due to aeration, it may be intermittent or constant, and usually more than 1 tappet will be noisy. When oil level and leaks have been corrected, operate the engine at fast idle. Run engine for a sufficient time to allow all of the air inside the tappets to be bled out.

DIAGNOSIS AND TESTING

SERVICE DIAGNOSIS—DIESEL—PERFORMANCE

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK OR CRANKS SLOWLY	1. Starting motor operating, but not cranking the engine.	1. Remove the starter motor. Check for broken flywheel teeth or a broken starting motor spring.
	2. Crankshaft rotation restricted.	2. Rotate the engine to check for rotational resistance.
	3. Starting circuit connections loose or corroded.	3. Clean and tighten connections.
	4. Neutral safety switch or starter relay inoperative.	4. Check starter relay supply voltage and proper operation of neutral safety switch (if equipped). Replace defective parts.
	5. Battery charge low.	5. Check battery voltage. Replace battery if a charge cannot be held.
	6. No voltage to starter solenoid.	6. Check voltage to solenoid. If necessary, replace the solenoid.
	7. Solenoid or starter motor inoperative.	7. Replace starter motor.
ENGINE CRANKS, BUT WILL NOT START NO SMOKE	1. No fuel in supply tank.	1. Fill fuel supply.
	2. Electrical fuel shutdown solenoid not operating.	2. Check for loose wires and verify that the fuel shutdown solenoid and fuel shutdown solenoid relay is functioning.
	3. Exhaust plugged.	3. Remove the obstruction.
	4. Fuel filter plugged.	4. Drain fuel/water separator and replace fuel filter.
	5. Excessive fuel inlet restriction.	5. Check fuel inlet restriction. Correct cause.
	6. Injection pump not getting fuel or fuel is aerated.	6. Check fuel flow/bleed fuel system.
	7. Worn or inoperative injection pump.	7. Visually check delivery with externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered.
ENGINE HARD TO START, OR WILL NOT START SMOKE FROM EXHAUST	1. Incorrect starting procedure.	1. The fuel shutoff solenoid control must be in the run position. Ensure proper procedure is being used.
	2. Cranking speed too slow.	2. (A) Verify that the transmission is not engaged. (B) Check the battery, starting motor and look for loose or corroded wiring connections.
	3. Cylinder heads heater plugs relay defective.	3. Verify system is working. Repair/replace inoperative parts.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. One or more cylinder head heater plugs defective.	4. Verify system is working. Repair/replace inoperative parts.
	5. Insufficient intake air.	5. Inspect or replace filter and check for obstruction to the air supply tube.
ENGINE HARD TO START, OR WILL NOT START SMOKE FROM EXHAUST (CONT.)	6. Air in fuel system or the fuel supply is inadequate.	6. Check the flow through the filter and bleed the system. Locate and eliminate the air source.
	7. Contaminated fuel.	7. Verify by operating the engine with clean fuel from a temporary tank. Check for presence of gasoline. Drain and flush fuel supply tank. Replace fuel/water separator filter.
	8. Fuel screen plugged.	8. Check fuel screen.
	9. One or more injectors worn or not operating properly.	9. Check/replace improperly operating injectors.
	10. Worn or inoperative injection pump.	10. Visually check fuel delivery with an externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered.
	11. Injection pump out of time.	11. Check/Time the pump (refer to Group 14, Fuel System).
	12. Engine compression low.	12. Check compression to identify the problem.
	13.Camshaft out of time.	13. Check camshaft timing.
ENGINE STARTS, BUT WILL NOT KEEP RUNNING	1. Cylinder heads heater plugs relay defective.	1. Verify system is working. Repair/replace inoperative parts.
	2. One or more cylinder head heater plugs defective.	2. Verify system is working. Repair/replace inoperative parts.
	3. Intake air or exhaust system restricted.	3. Visually check for exhaust restriction and inspect the air intake.
	4. Air in the fuel supply system or the fuel supply is inadequate.	4. Check flow through the filter and bleed the system. Locate and eliminate the air source.
	5. Fuel waxing due to extremely cold weather.	5. Verify by inspecting the fuel filter. Clean the system and use climatized fuel. Replace fuel/water separator filter. Check fuel heater for proper operation.
	6. Contaminated fuel.	6. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline. Replace fuel/water separator filter.
SURGING (SPEED CHANGE)	1. If the condition occurs at idle, the idle speed is set too low for the accessories.	1. Adjust the idle speed.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	2. High pressure fuel leak.	2. Inspect/correct leaks in the high pressure lines. Fitting and delivery valve sealing washers.
	3. One or more injectors worn or not operating properly.	3. Check/replace the inoperative injectors.
	4. Improperly operating injection pump.	4. Replace the injector pump.
ROUGH IDLE (IRREGULARLY FIRING OR ENGINE SHAKING)	1. If engine is cold, glow plug relay on glow plug(s) defective.	1. Refer to troubleshooting for cylinder head heater plugs (see Group 14, Fuel system).
	2. Engine mounts damaged or loose.	2. Repair or replace mounts.
	3. High pressure fuel leaks.	3. Correct leaks in the high pressure lines, fittings or delivery valves.
	4. Air in the fuel system.	4. Bleed the fuel system and eliminate the source of the air.
	5. Sticking needle valve in an injector.	5. Check and replace the injector with the sticking needle valve.
ENGINE RUNS ROUGH	1. Fuel injection lines leaking.	1. Correct leaks in the high pressure lines, fittings, injectors sealing washers or delivery valves.
	2. Air in the fuel or the fuel supply is inadequate.	2. Check the flow through the filter and bleed the system. Locate and eliminate the air source.
	3. Contaminated fuel.	3. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline. Replace fuel/water separator filter.
	4. Incorrect valve operation.	4. Check for a bent push rod and adjust valves. Replace push rod, if necessary.
	5. Injection pump timing incorrect.	5. Check/time pump (refer to Group 14, Fuel System).
	6. Improperly operating injectors.	6. Replace inoperative injectors.
	7. Defective injection pump (delivery valve).	7. Repair or replace injection pump.
	8. Camshaft out of time.	8. Check/correct gear train timing alignment.
	9. Damaged camshaft or tappets.	9. Inspect camshaft valve lift. Replace camshaft and tappets.
	10. Automatic timing advance not operating.	10. Check injection pump. Check fuel injector sensor at number 1 cylinder injector.
ENGINE RPM WILL NOT REACH RATED SPEED	1. Engine overload.	1. Verify high idle speed without load. Investigate operation to be sure correct gear is being used.
	2. Improperly operating tachometer.	2. Verify engine speed with hand tachometer, correct as required.
	3. Inadequate fuel supply.	3. Check the fuel flow through the system to locate the reason for inadequate fuel supply, correct as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Air/fuel controls leak.	4. Check and repair leak. Check AFC tubing for obstruction.
ENGINE RPM WILL NOT REACH RATED SPEED (CONT.)	6. Improperly operating injection pump.	6. Repair or replace injection pump.
LOW POWER	1. Fuel control lever not moving to full throttle.	1. Check/correct for stop-to-stop travel.
	2. High oil level.	2. Check/correct oil level.
	3. Engine overloaded.	3. Check for added loading from accessories or driven units, brakes dragging and other changes in vehicle loading. Repair/replace as needed.
	4. Slow throttle response caused by leaking or obstructed air control tube or improperly operating control in the pump.	4. Check for leaks and obstructions. Tighten the fittings. Repair or replace the pump if the controls are not functioning.
	5. Inadequate intake air flow.	5. Inspect/replace air cleaner element. Look for other restrictions.
	6. Inadequate fuel supply. Air in the fuel.	6. Check the flow through the filter to locate the source of the restriction. Check fuel pressure and inlet restriction.
	7. Excessive exhaust restriction.	7. Check/correct the restriction in the exhaust system.
	8. High fuel temperature.	8. Verify that fuel heater is off when engine is warm. Check for restricted fuel drain tubes. Repair/replace as needed.
	9. Poor quality fuel or fuel contaminated with gasoline.	9. Verify by operating from a temporary tank with good fuel. Check for presence of gasoline. Replace fuel/water separator filter.
	10. Air leak between the turbocharger and the intake manifold.	10. Check/correct leaks in hoses, gaskets, charge air cooler and around mounting capscrews or through holes in the manifold cover.
	11. Exhaust leak at the manifold or turbocharger.	11. Check/correct leaks in the manifold or turbocharger gaskets. If manifold is cracked, replace manifold.
	12. Improperly operating turbocharger.	12. Inspect/replace turbocharger.
	13. Wastegate operation.	13. Check wastegate operation.
	14. Valve not operating.	14. Check for bent push rod, replace if necessary.
	15. Worn or improperly operating injectors.	15. Check/replace injectors.
	16. Incorrect injection pump timing.	16. Verify injection pump timing (see Group 14, Fuel System).
	17. Improperly operating injection pump.	17. Repair or replace injection pump.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE EXHAUST SMOKE	1. Engine running too cold (white smoke).	1. Refer to troubleshooting for coolant temperature below normal (refer to Group 7, Cooling System). Inspect cylinder head heater plugs for proper operation.
	2. Improper starting procedure (white smoke).	2. Use proper starting procedures.
	3. Fuel supply inadequate.	3. Check fuel supply pressure and inlet restriction.
	4. Injection pump timing.	4. Check and time pump (refer to Group 14, Fuel System).
	5. Inadequate intake air.	5. Inspect/change air filter. Look for other restriction. Check charge air cooler for obstructions.
	6. Air leak between turbocharger and intake manifold.	6. Check/correct leaks in the air crossover tube, hoses, gaskets, mounting capscrews or through holes in the manifold cover.
	7. Exhaust leak at the manifold or turbocharger.	7. Check/correct leaks in the manifold or turbocharger gaskets. If cracked replace manifold.
	8. Improperly operating turbocharger.	8. Inspect/replace turbocharger.
	9. Improperly operating injectors.	9. Check and replace inoperative injectors.
	10. Improperly operating or overfueled injector pump.	10. Repair or replace injection pump.
	11. Piston rings not sealing (blue smoke).	11. Perform blow-by check. Correct as required.
ENGINE WILL NOT SHUT-OFF	1. Fuel shutoff solenoid inoperative.	1. Check/replace fuel shutoff solenoid.
	2. Engine running on fumes drawn into the air intake.	2. Check the air intake ducts for the source of fumes. **WARNING: In case of engine runaway due to flammable fumes from gasoline spills or turbocharger oil leaks being sucked into the engine, shut off engine ignition switch first then use a CO2 fire extinguisher and direct the spray under the front bumper to remove oxygen supply. The engine air intake is on the passenger side behind the bumper. The fire extinguisher must be directed at this location for emergency shutdown conditions.**
	3. Fuel injection pump malfunction	3. Repair or replace fuel injection pump.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
COOLANT TEMPERATURE ABOVE NORMAL	1. Low coolant level.	1. Check coolant level. Add coolant, if necessary. Locate and correct the source of the coolant loss, (refer to Group 7, Cooling).
	2. Incorrect/improperly operating pressure cap.	2. Replace cap with the correct rating for the system.
	3. Loose drive belt on water pump/fan.	3. Check/replace belt or belt tensioner.
	4. Inadequate air flow to the radiator.	4. Check/repair radiator core, fan shroud and viscous fan drive as required.
	5. Radiator fins plugged.	5. Blow debris from fins.
	6. Collapsed radiator hose.	6. Replace the hose. Check coolant tank cap operation, (refer to Group 7, Cooling Tanks).
	7. Improperly operating temperature sensor/gauge.	7. Verify that the gauge and temperature sensor are accurate. Replace gauge/sensor, if bad.
	8. Improperly operating, incorrect or no thermostat.	8. check and replace the thermostat.
	9. Air in the cooling system.	9. (A) make sure the fill rate is not being exceeded and the correct vented thermostat is installed. (B) Check for loose hose clamps. Tighten if loose. (C) If aeration continued, check for a compresssion leak through the head gasket.
	10. Inoperative water pump.	10. Check and replace the water pump.
	11. Incorrect injection pump timing.	11. Verify pump timing marks are aligned. Check/time the injector pump (refer to Group 14, Fuel System).
	12. Overfueled injection pump.	12. Repair or replace the injection pump.
	13. Plugged cooling passages in radiator, head, head gasket or block.	13. Flush the system and fill with clean coolant.
	14. Engine overloaded.	14. Verify that the engine load rating is not being exceeded.
COOLANT TEMPERATURE BELOW NORMAL	1. Too much air flow across the radiator.	1. Check/repair viscous fan drive as required.
	2. Incorrect thermostat or contamination in thermostat.	2. Check and replace thermostat.
	3. Temperature sensor or gauge inoperative.	3. Verify that the gauge and sensor are accurate. If not, replace gauge/sensor.
	4. Coolant not flowing by temperature sensor.	4. Check and clean coolant passages.

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—DIESEL—MECHANICAL.

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE LOW	1. Low oil level.	1. (A) Check and fill with clean engine oil. (B) Check for a severe external oil leak that could reduce the pressure.
	2. Oil viscosity thin, diluted or wrong specification.	2. Verify the correct oil is being used. Check for oil dilution. Refer to Contaminated Lube Oil (Engine Diagnosis Mechanical).
	3. Improperly operating pressure switch/gauge.	3. Verify the pressure switch is functioning correctly. If not, replace switch/gauge.
	4. Relief valve stuck open.	4. Check/replace valve.
	5. Plugged oil filter.	5. Change oil filter. Oil filter change interval may need to be revised.
	6. If cooler was replaced, shipping plugs left in cooler.	6. Check/remove shipping plugs.
	7. Worn oil pump.	7. Check and replace oil pump.
	8. Suction tube loose or seal leaking.	8. Check and replace seal.
	9. Loose main bearing cap.	Check and install new bearing and tighten cap to proper torque.
	10. Worn bearings or wrong bearings installed.	10. Inspect and replace connecting rod or main bearings. Check and replace piston cooling nozzles.
	11. Oil jet under piston bad fit into main carrier.	11. Check oil jet position.
LUBRICATING OIL PRESSURE TOO HIGH	1. Pressure switch/gauge not operating properly.	1. Verify the pressure switch is functioning correctly. If not, replace switch/gauge.
	2. Engine running to cold.	2. Refer to Coolant Temperature Below Normal (Engine Diagnosis Performance).
	3. Oil viscosity too thick.	3. Make sure the correct oil is being used, (Refer to Group 0, Lubrication and Maintenance).
	4. Oil pressure relief valve stuck closed or binding.	4. Check and replace valve.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL LOSS	1. External leaks.	1. Visually inspect for oil leaks. Repair as required.
	2. Crankcase being overfilled.	2. Verify that the correct dipstick is being used.
	3. Incorrect oil specification or viscosity.	3. (A) Make sure the correct oil is being used.
		(B) Look for reduced viscosity from dilution with fuel.
		(C) Review/reduce the oil change intervals.
	4. Oil cooler leak.	4. Check and replace the oil cooler.
	5. High blow-by forcing oil out the breather.	5. Check the breather tube area for signs of oil loss. Perform the required repairs.
LUBRICATING OIL LOSS (CONT.)	6. Turbocharger leaking oil to the air intake.	6. Inspect the air ducts for evidence of oil transfer. Repair as required.
	7. Piston rings not sealing (oil being consumed by the engine).	7. Perform blow-by check. Repair as required.
COMPRESSION KNOCKS	1. Air in the fuel system.	1. Bleed the fuel system (refer to Group 14, Fuel System).
	2. Poor quality fuel or water/ gasoline contaminated fuel	2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tanks. Replace fuel/water separator.
	3. Engine overloaded.	3. Verify the engine load rating is not being exceeded.
	4. Incorrect injection pump timing.	4. Check and time injection pump (refer to Group 14, Fuel System).
	5. Improperly operating injectors.	5. Check and replace inoperative injectors.
EXCESSIVE VIBRATION	1. Loose or broken engine mounts.	1. Replace engine mounts.
	2. Damaged fan or improperly operating accessories.	2. Check and replace the vibrating components.
	3. Improperly operating vibration damper.	3. Inspect/replace the vibration damper.
	4. Improperly operating viscous fan drive.	4. Inspect/replace the fan drive.
	5. Worn or damaged generator bearing.	5. Check/replace the generator.
	6. Flywheel housing misaligned.	6. Check/correct flywheel alignment.
	7. Loose or broken power component.	7. Inspect the crankshaft and rods for damage that causes an unbalance. Repair/replace as required.
	8. Worn or unbalanced driveline components.	8. Check/repair driveline components.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE ENGINE NOISES	1. Drive belt squeal, insufficient tension or abnormally high loading.	1. Check the automatic tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub and generator turn freely.
	2. Intake air or exhaust leaks.	2. Refer to Excessive Exhaust smoke (Engine Diagnosis Performance).
	3. Turbocharger noise.	3. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required.
	4. Gear train noise.	4. Visually inspect and measure gear backlash. Replace gears as required.
	5. Power function knock.	5. Check/replace rod and main bearings.
GENERATOR NOT CHARGING OR INSUFFICIENT CHARGING	1. Loose or corroded battery.	1. Clean/tighten battery connection.
	2. Generator belt slipping.	2. Check/replace automatic abelt tensioner. Check/replace and adjust belt.
	3.Generator pulley loose on shaft.	3. Tighten pulley
	4. Improperly operating generator.	4. Check/replace generator.

TAPPET NOISE

(1) To determine source of tappet noise, operate engine at idle with cylinder head covers removed.

(2) Feel each valve spring or rocker arm to detect noisy tappet. The noisy tappet will cause the affected spring and/or rocker arm to vibrate or feel rough in operation.

NOTE: Worn valve guides or cocked springs are sometimes mistaken for noisy tappets. If such is the case, noise may be dampened by applying side thrust on the valve spring. If noise is not appreciably reduced, it can be assumed the noise is in the tappet. Inspect the rocker arm push rod sockets and push rod ends for wear.

(3) Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak down around the unit plunger or by the plunger partially sticking in the tappet body cylinder. The tappet should be replaced. A heavy click is caused by a tappet check valve not seating or by foreign particles becoming wedged between the plunger and the tappet body. This will cause the plunger to stick in the down position. This heavy click will be accompanied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are making the noise. In general, if more than one tappet seems to be noisy, its probably not the tappets.

SERVICE PROCEDURES

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 an Arkansas 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.

SERVICE PROCEDURES (Continued)

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.

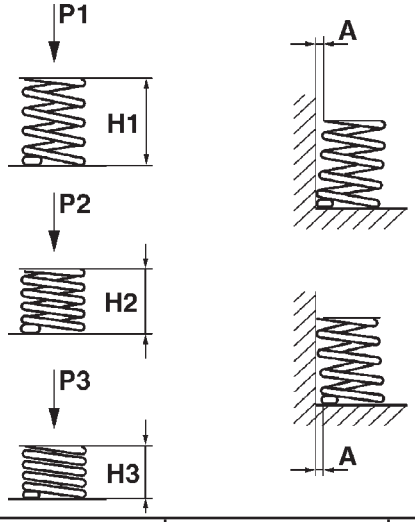
(3) Inspect for cracks in the gasket surface at each coolant passage.

(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. 2).



LOAD Kg		HEIGHT mm		STATE
P1	0.00	H1	44.65	FREE LENGTH
P2	32-36	H2	38.60	VALVE CLOSED
P3	89-96	H3	28.20	VALVE OPEN

80bfe1e8

Fig. 2 Valve Spring Chart

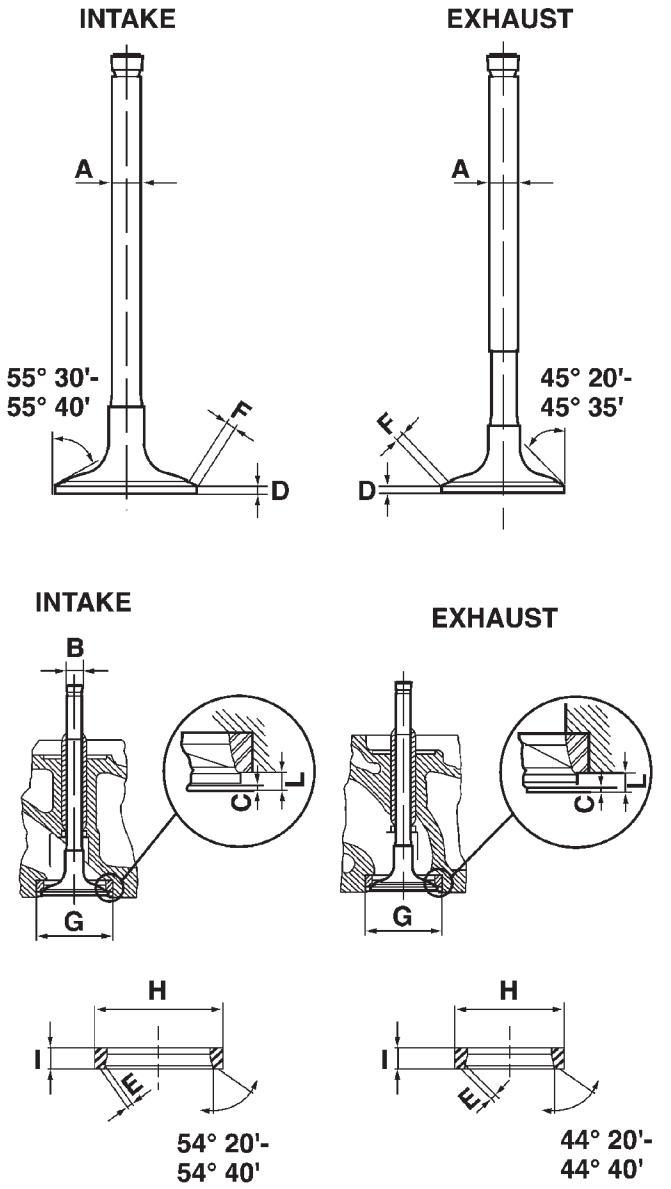
VALVE REFACING

(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. 3). If the margin is less than 4.49 mm (.177 inch), the valve must be replaced.

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.



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
D	2.2 ± 0.08	2.09 +0.07 −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

80bfe1e7

Fig. 3 Valve Specification

(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.

SERVICE PROCEDURES (Continued)

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

(3) Using a straight edge and feeler gauge (Fig. 4), 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.

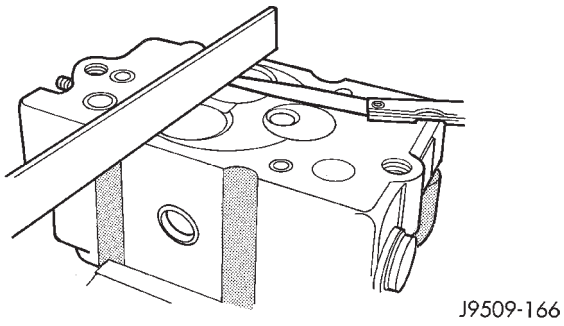


Fig. 4 Checking Valve Stand Down

VALVE GUIDES

(1) Valve Guides height requirement.

(2) Measurement A (Fig. 5): 13.50 - 14.00 mm.

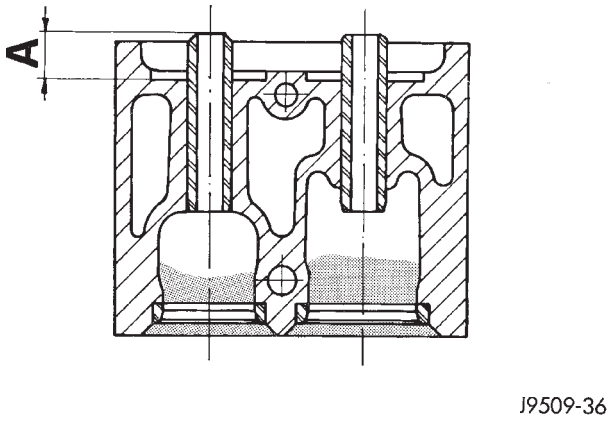


Fig. 5 Valve Guide Height

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.

REMOVAL AND INSTALLATION

ENGINE MOUNTS

REMOVAL-RIGHT SIDE

(1) Disconnect the negative battery cable.

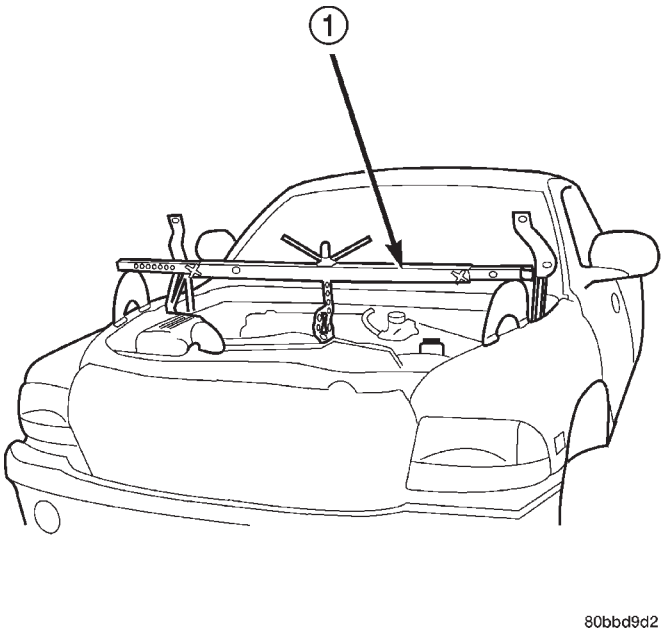


Fig. 6 Engine Bridge Fixture

1 – ENGINE BRIDGE FIXTURE

(2) Install the engine bridge fixture (Fig. 6). Support the engine assembly.

(3) Raise the vehicle on the hoist.

(4) Remove the engine mount through bolt nut. Do not remove the bolt at this time.

(5) Remove the (2) engine mount insulator retaining nuts (Fig. 7).

(6) Remove the oil filter adaptor retaining bolt. Remove the oil filter and adaptor from the vehicle.

(7) Lower the vehicle from the hoist

(8) Raise the right side of the engine enough to remove the engine mount through bolt and insulator from the vehicle.

INSTALLATION – RIGHT SIDE

(1) Position the engine mount and install the engine mount through bolt. Leave loose at this time.

(2) Lower the engine assembly. Remove the engine bridge fixture.

(3) Raise the vehicle on the hoist.

(4) Install the oil filter and adaptor. Torque the oil filter adaptor bolt to 50 N·m (37 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

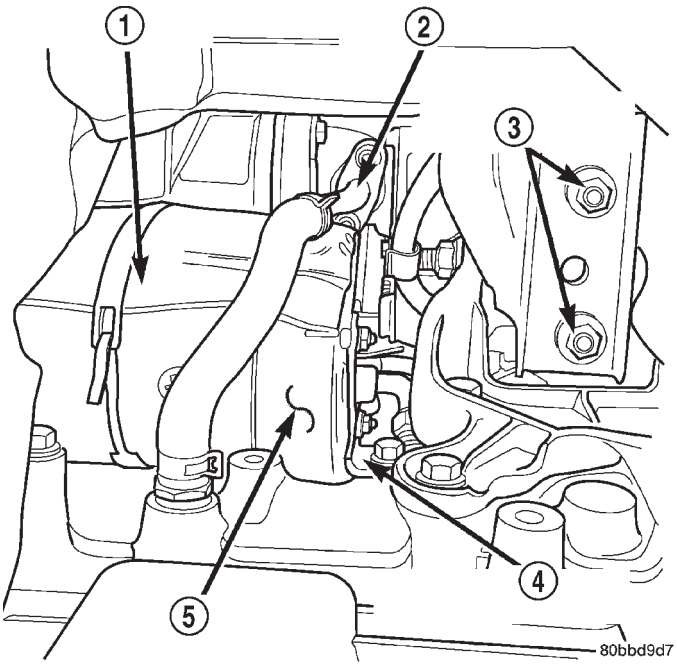


Fig. 7 Right Engine Mount Retaining Nuts

1 – STARTER MOTOR HEATSHIELD
2 – TURBOCHARGER OIL RETURN LINE
3 – RIGHT ENGINE MOUNT RETAINING NUTS
4 – STARTER MOTOR SUPPORT BRACKET
5 – STARTER MOTOR

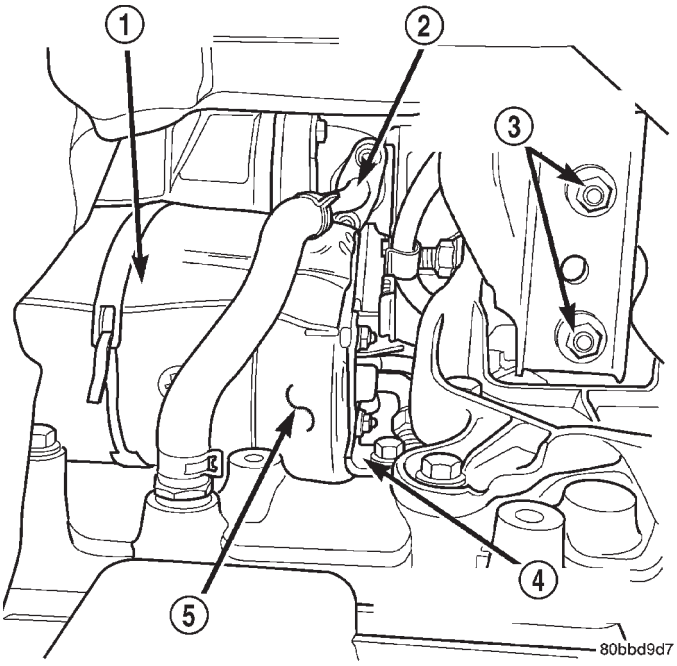


Fig. 8 Right Engine Mount Retaining Nuts

1 – STARTER MOTOR HEATSHIELD
2 – TURBOCHARGER OIL RETURN LINE
3 – RIGHT ENGINE MOUNT RETAINING NUTS
4 – STARTER MOTOR SUPPORT BRACKET
5 – STARTER MOTOR

(5) Install the (2) engine mount insulator retaining nuts (Fig. 8). Torque the nuts to 65 N·m (48 ft. lbs.).
(6) Torque the engine mount through bolt to 65 N·m (48 ft. lbs.).
(7) Connect the negative battery cable.

REMOVAL – LEFT SIDE

(1) Disconnect the negative battery cable.
(2) Install the engine bridge fixture (Fig. 9). Support the engine assembly.

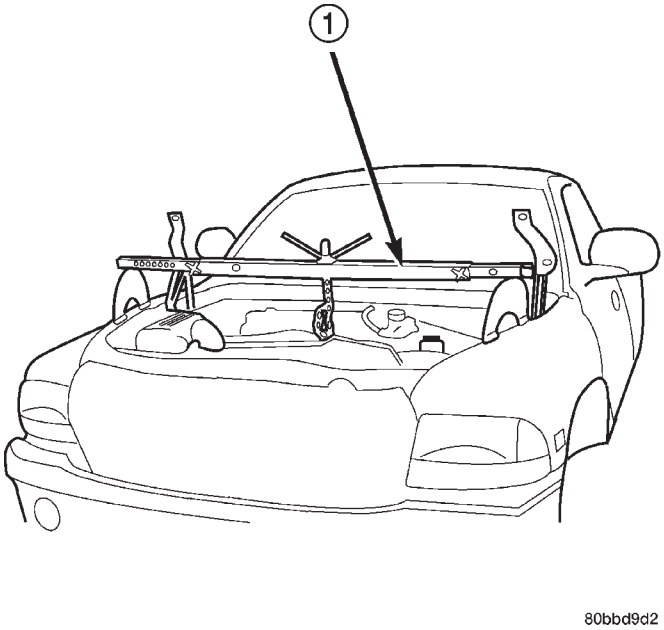


Fig. 9 Engine Bridge Fixture

1 – ENGINE BRIDGE FIXTURE

(3) Raise the vehicle on the hoist.
(4) Remove the engine mount through bolt nut. Do not remove the bolt at this time.
(5) Remove the (2) engine mount insulator retaining nuts (Fig. 10).
(6) Lower the vehicle on the hoist
(7) Raise the left side of the engine enough to remove the engine mount through bolt and insulator from the vehicle.

INSTALLATION – LEFT SIDE

(1) Position the engine mount and install the engine mount through bolt. Leave loose at this time.
(2) Lower the engine assembly. Remove the engine bridge fixture.
(3) Raise the vehicle on the hoist.
(4) Install the (2) engine mount insulator retaining nuts (Fig. 11). Torque the nuts to 65 N·m (48 ft. lbs.).
(5) Torque the engine mount through bolt to 65 N·m (48 ft. lbs.).
(6) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

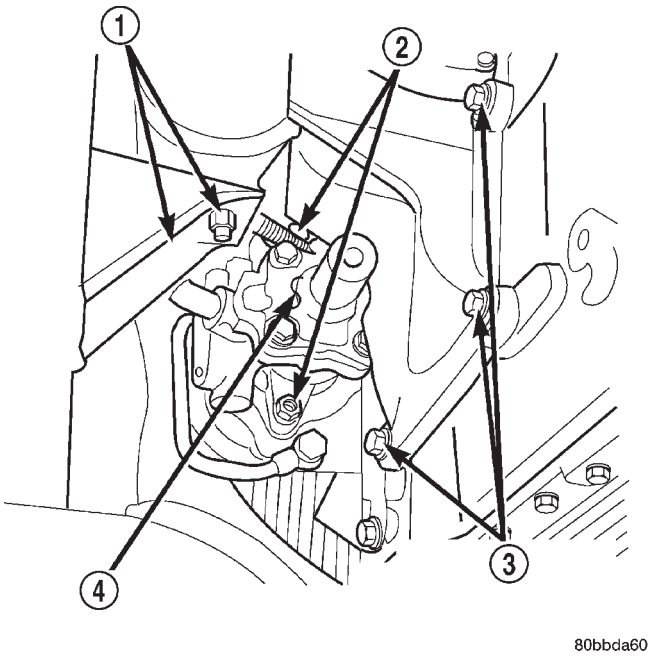


Fig. 10 Left Engine Mount Retaining Nuts

1 – ENGINE MOUNT RETAINING NUTS
2 – POWER STEERING PUMP RETAINING NUTS
3 – ENGINE MOUNT BRACKET RETAINING BOLTS
4 – POWER STEERING PUMP

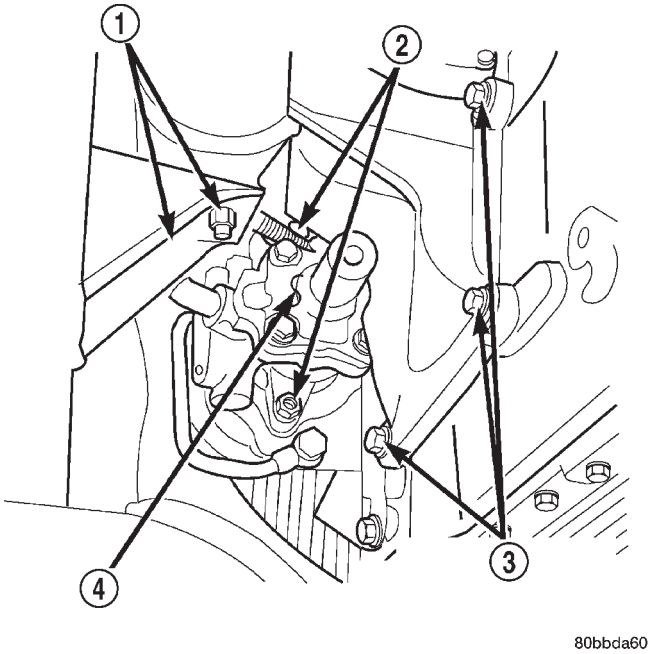


Fig. 11 Left Engine Mount Retaining Nuts

1 – ENGINE MOUNT RETAINING NUTS
2 – POWER STEERING PUMP RETAINING NUTS
3 – ENGINE MOUNT BRACKET RETAINING BOLTS
4 – POWER STEERING PUMP

2.5L DIESEL ENGINE

REMOVAL

(1) Disconnect the positive and negative battery cables.

(2) Recover the refrigerant from the refrigerant system. Refer to Group 24, Heating and Air Conditioning for the procedure.

(3) Disconnect the engine compartment lamp electrical connector (Fig. 12).

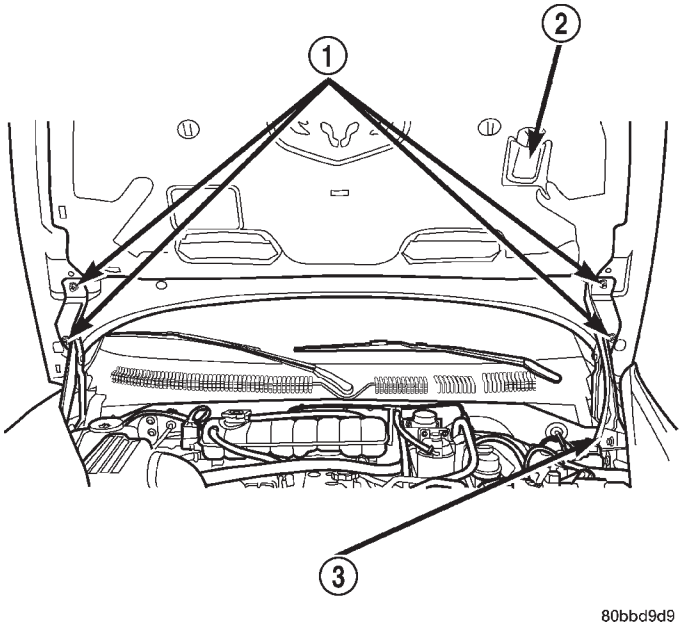


Fig. 12 Hood Position & Orientation

1 – HOOD RETAINING BOLTS
2 – ENGINE COMPARTMENT LAMP
3 – ENGINE COMPARTMENT LAMP ELECTRICAL CONNECTOR

NOTE: Mark the hinge locations on the hood panel for alignment reference during installation.

(4) With assistance from another person, remove the (4) hood retaining bolts (Fig. 12) and remove the hood assembly.

(5) Remove both of the wiper arms from the vehicle. Refer to Group 8K, Wiper and Washer Systems for the procedure.

(6) Disconnect the breather hose from the air intake hose.

(7) Disconnect the air intake hose from the air cleaner and remove the air cleaner assembly

(8) Raise the vehicle on the hoist.

(9) Remove the lower front splash shield.

(10) Drain the cooling system. Refer to Group 7, Cooling System for the procedure.

(11) Remove the lower radiator hose from the engine assembly.

REMOVAL AND INSTALLATION (Continued)

(12) Remove the (2) lower fan shroud retaining bolts.

(13) Remove both refrigerant line retaining bolts from the compressor and remove the lines, cover openings.

(14) Lower the vehicle on the hoist.

(15) Remove the cowl grille (Fig. 13). Refer to Group 23, Body for the procedure.

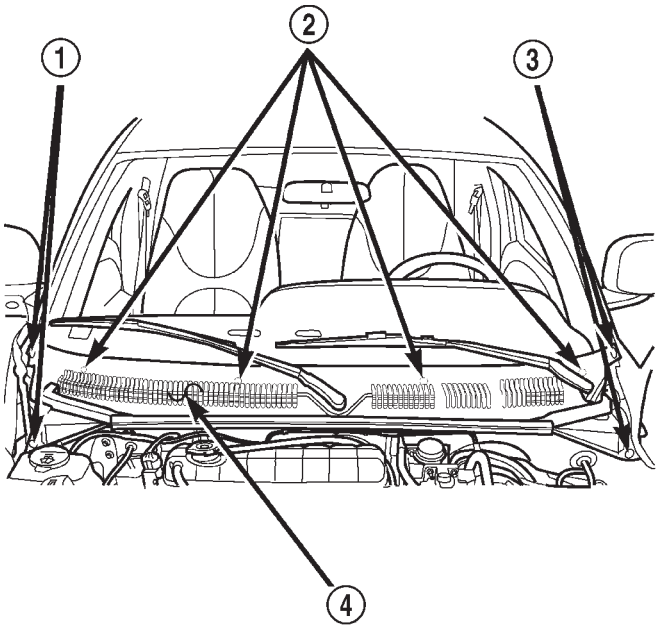


Fig. 13 Cowl Grille Position & Orientation

1 – PUSHPINS
2 – COWL GRILLE RETAINING NUTS
3 – PUSHPINS
4 – COWL GRILLE

(16) Remove the upper radiator support retaining bolts (Fig. 14) and remove the support from the vehicle.

(17) Remove the A/C condenser support bolts from the front closure panel.

(18) Remove the refrigerant line support bracket from the A/C condenser.

(19) Disconnect the refrigerant line at the A/C condenser (Fig. 15).

(20) Disconnect the refrigerant line at the A/C accumulator (Fig. 16).

(21) Remove the refrigerant line support bracket bolts from the generator bracket and water manifold. Remove the refrigerant lines from the vehicle.

(22) Remove the coolant overflow hoses from the coolant reservoir (Fig. 17).

(23) Remove the coolant supply hose from the water manifold (Fig. 17).

(24) Disconnect the EGR solenoid electrical connector (Fig. 17).

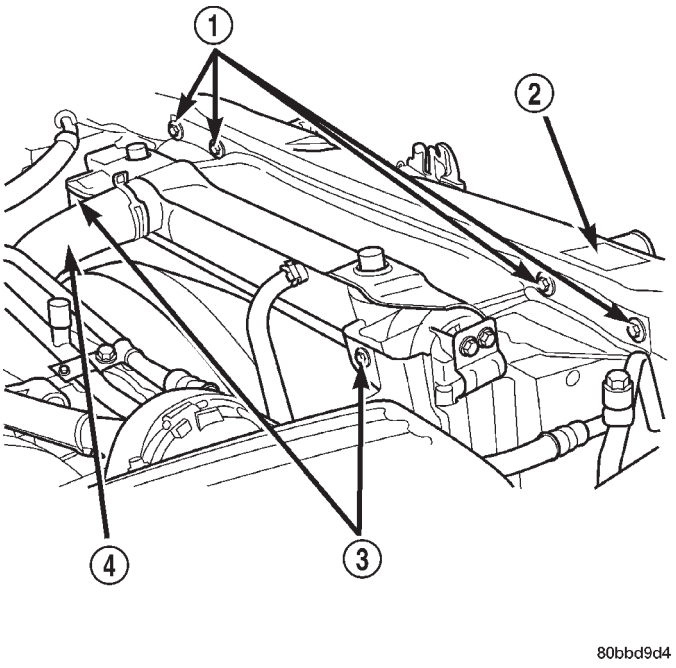


Fig. 14 Upper Radiator Support

1 – UPPER RADIATOR SUPPORT RETAINING BOLTS
2 – FRONT CLOSURE PANEL
3 – UPPER FAN SHROUD RETAINING BOLTS
4 – UPPER RADIATOR HOSE

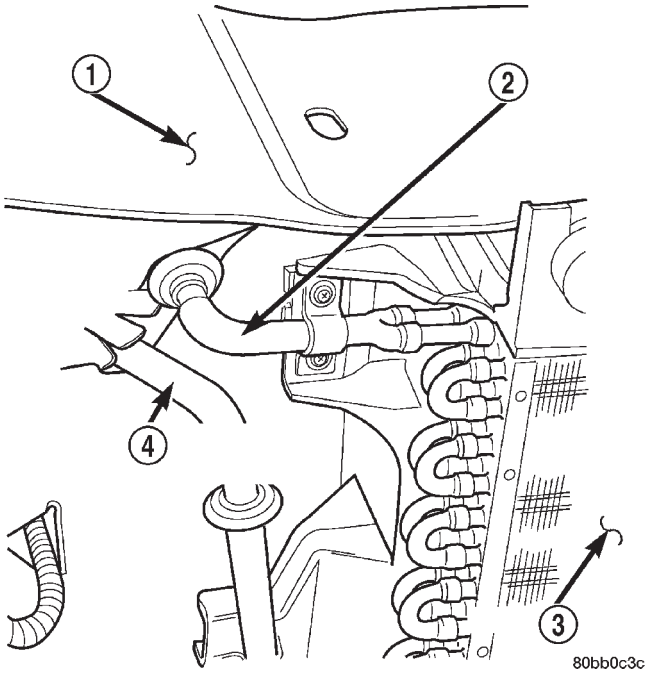


Fig. 15 Refrigerant Lines At Condenser

1 – FRONT CLOSURE PANEL
2 – HIGH PRESSURE REFRIGERANT LINE (FROM COMPRESSOR)
3 – CONDENSER
4 – LIQUID REFRIGERANT LINE (TO EVAPORATOR)

REMOVAL AND INSTALLATION (Continued)

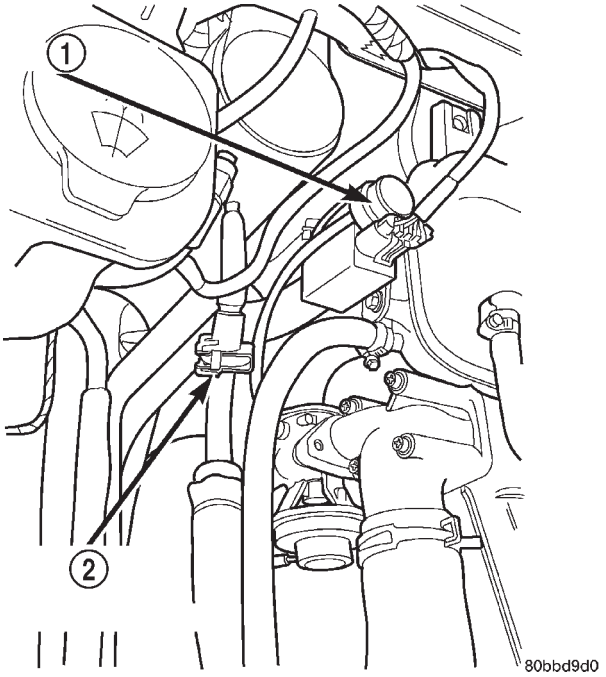


Fig. 16 Refrigerant Line At Accumulator

1 – EGR SOLENOID
2 – REFRIGERANT LINE AT A/C ACCUMULATOR

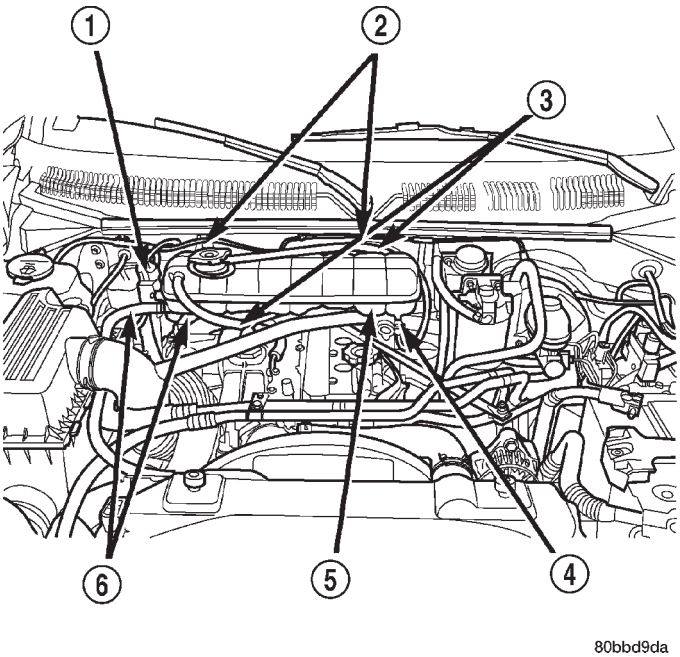


Fig. 17 Coolant Reservoir Position & Orientation

1 – EGR SOLENOID
2 – COOLANT RESERVOIR RETAINING BOLTS
3 – COOLANT OVERFLOW HOSES
4 – COOLANT LEVEL SENSOR
5 – COOLANT RESERVOIR
6 – COOLANT SUPPLY HOSES

(25) Disconnect the EGR solenoid vacuum lines (Fig. 17).

(26) Disconnect the coolant level sensor electrical connector (Fig. 17).

(27) Remove the coolant reservoir retaining bolts from inside the cowl panel.

(28) Disconnect the coolant supply hose from the coolant reservoir (Fig. 17).

(29) Remove the coolant reservoir from the vehicle.

(30) Remove the upper radiator hose from the engine (Fig. 18).

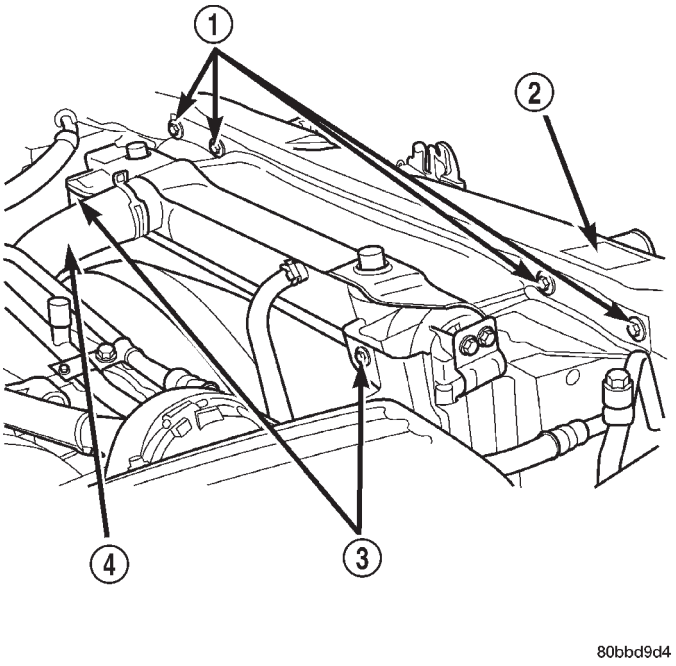


Fig. 18 Upper Fan Shroud Retaining Bolts

1 – UPPER RADIATOR SUPPORT RETAINING BOLTS
2 – FRONT CLOSURE PANEL
3 – UPPER FAN SHROUD RETAINING BOLTS
4 – UPPER RADIATOR HOSE

(31) Disconnect and remove the intercooler inlet and outlet hoses.

(32) Remove the (2) upper fan shroud retaining bolts (Fig. 18).

(33) Remove the radiator and intercooler as an assembly.

(34) Remove the fan shroud.

(35) Disconnect the heater core coolant supply hoses from the engine assembly.

(36) Disconnect the electrical connectors from the bottom of the fuel / water separator (Fig. 19).

(37) Unclip and disconnect the fuel lines (Fig. 19) so the fuel / water separator can be removed.

(38) Remove the (2) clutch fluid reservoir retaining nuts (Fig. 19) and position the reservoir out of the way.

REMOVAL AND INSTALLATION (Continued)

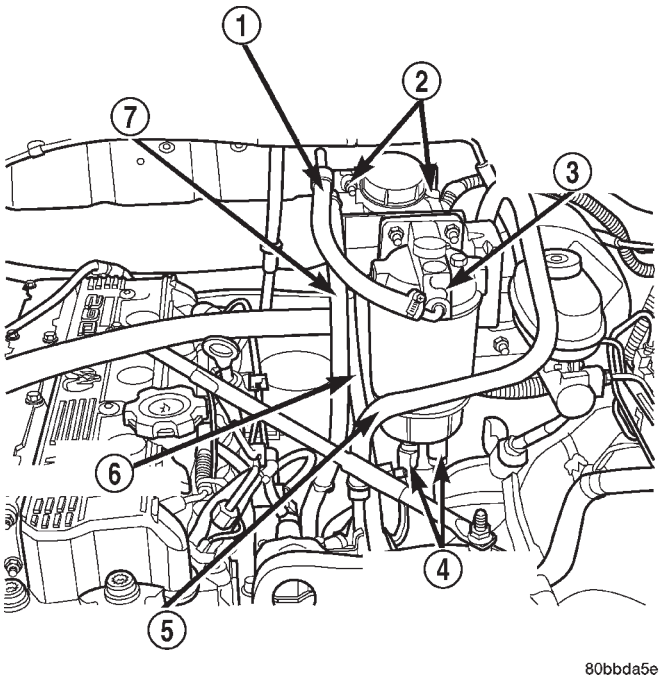


Fig. 19 Fuel / Water Separator Position & Orientation

1 – FUEL SUPPLY LINE (FROM TANK)
2 – HYDRAULIC CLUTCH FLUID RESERVOIR RETAINING NUTS
3 – FUEL/WATER SEPARATOR ASSEMBLY
4 – FUEL/WATER SEPARATOR ELECTRICAL CONNECTORS
5 – POWER BRAKE VACUUM SUPPLY HOSE
6 – FUEL SUPPLY LINE
7 – FUEL RETURN LINE (TO TANK)

(39) Remove the fuel / water separator and mounting bracket from the vehicle as an assembly.

(40) Disconnect the power brake vacuum supply hose from the engine assembly (Fig. 19).

(41) Remove the power steering fluid reservoir cap and siphon as much fluid as possible.

(42) Remove the power steering fluid pressure hose from the power steering pump.

(43) Remove the power steering fluid supply hose from the power steering pump.

(44) Remove the lower radiator hose from the engine assembly.

(45) Remove the power distribution center cover and remove the 12v feed wire coming from the positive battery cable end.

(46) Remove the body ground wire coming from the negative battery cable end.

(47) Disconnect all remaining engine wiring coming from the engine assembly.

(48) Raise the vehicle on the hoist.

(49) Drain the transmission fluid. Refer to Group 21, Transmission for the procedure.

NOTE: Mark the propeller shaft position in relation to the rear axle companion flange. The propeller shaft must be installed in the same position it was in before removal.

(50) Remove the (4) universal joint clamp retaining bolts from the rear axle pinion. Remove propeller shaft from the rear axle companion flange and tape the universal joint bearing caps in place.

CAUTION: Wrap the universal joint bearing caps in place with tape to prevent the bearing caps from falling off.

(51) Remove the (4) center shaft bearing retaining nuts and remove the propeller shaft assembly from the vehicle.

(52) Remove the (2) exhaust system inlet pipe retaining nuts.

(53) Remove the exhaust system support bracket bolt from the clutch bellhousing.

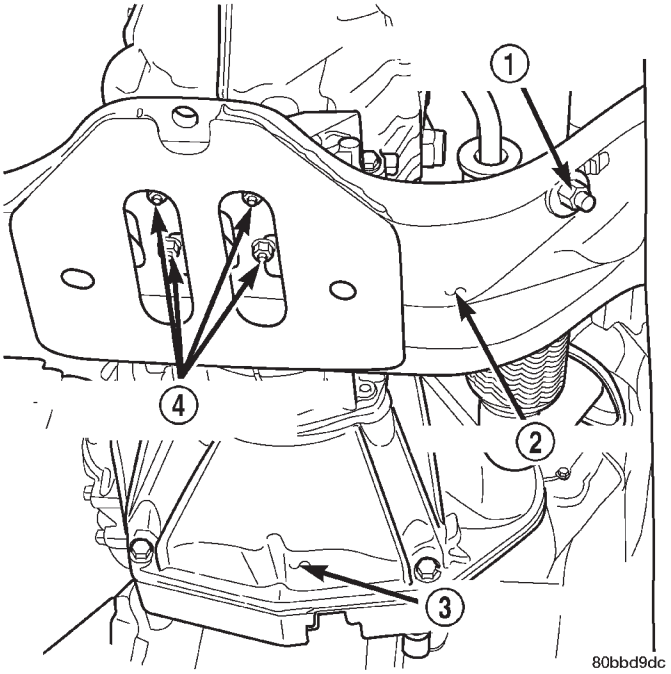


Fig. 20 Exhaust System Support Bracket Location

1 – EXHAUST SYSTEM SUPPORT BRACKET RETAINING NUT
2 – CROSSMEMBER
3 – TRANSMISSION
4 – TRANSMISSION MOUNT RETAINING NUTS

(54) Remove the exhaust system support bracket nut from the transmission support crossmember (Fig. 20).

(55) Remove the (2) clutch slave cylinder retaining nuts (Fig. 21). Remove the slave cylinder by pulling it straight off of the mounting studs.

(56) Remove the (4) transmission mount retaining nuts from the transmission crossmember (Fig. 20).

REMOVAL AND INSTALLATION (Continued)

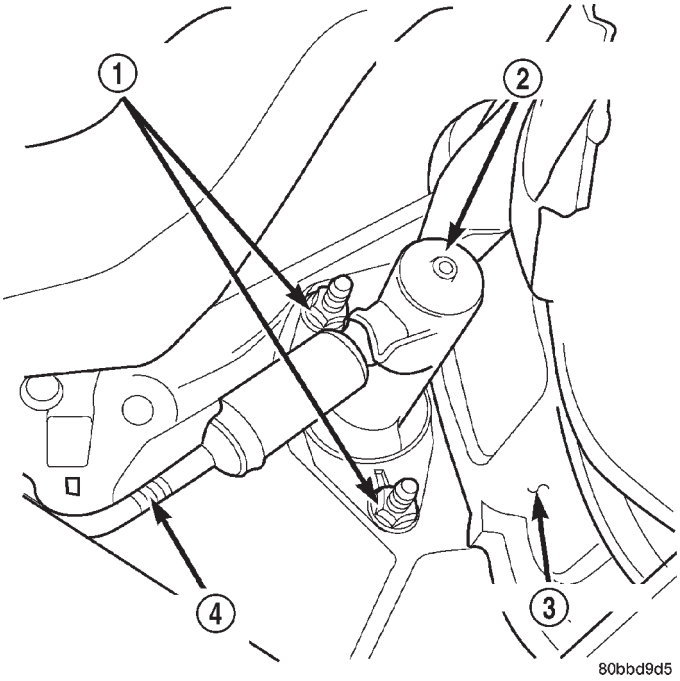


Fig. 21 Clutch Slave Cylinder

1 – SLAVE CYLINDER RETAINING NUTS
2 – HYDRAULIC CLUTCH SLAVE CYLINDER
3 – TRANSMISSION
4 – FLUID SUPPLY LINE

(57) Position a transmission jack and raise the transmission assembly enough to allow the crossmember to be slide straight back.

(58) Remove the fuelline support bracket retaining bolt from the left side of the transmission support crossmember.

(59) Remove the transmission support crossmember retaining bolts. Slide the crossmember as far rearward as possible.

(60) Lower the transmission assembly enough to access the shifter retaining bolts.

(61) Remove the (4) shifter retaining bolts (Fig. 22).

(62) Remove the (2) misfire sensor retaining bolts from the clutch bellhousing.

(63) Be certain all wiring is disconnected from the transmission assembly.

(64) Remove the clutch bellhousing retaining bolts. Pull the transmission straight back until the input shaft clears the clutch assembly. Remove the transmission from the vehicle.

(65) Remove the left and right engine mount insulator retaining nuts (Fig. 23).

(66) Lower the vehicle on the hoist.

NOTE: Raise the engine by the factory installed engine lifting brackets only.

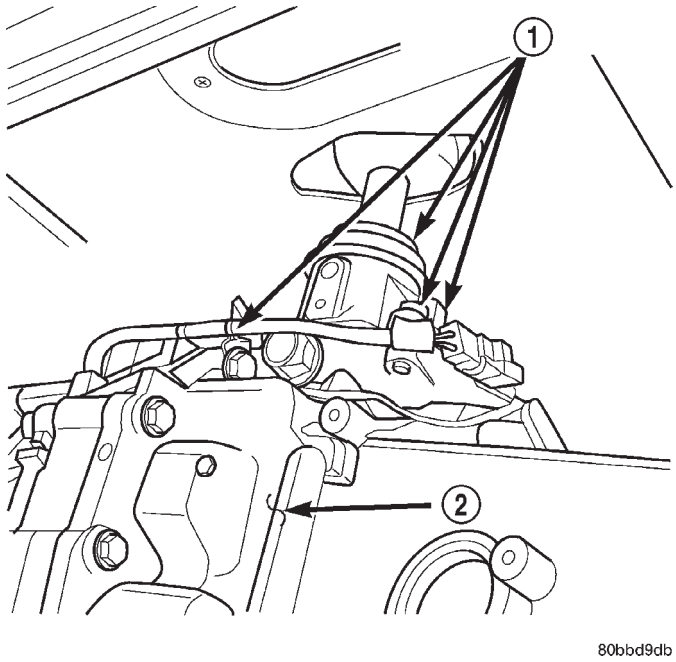


Fig. 22 Shifter Retaining Bolts

1 – SHIFTER ASSEMBLY RETAINING BOLTS
2 – TRANSMISSION

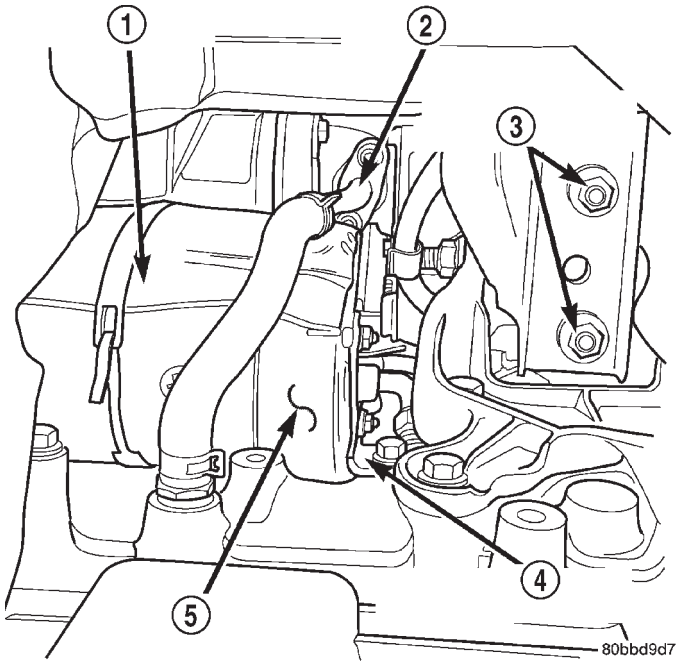


Fig. 23 Right Engine Mount Retaining Nuts

1 – STARTER MOTOR HEATSHIELD
2 – TURBOCHARGER OIL RETURN LINE
3 – RIGHT ENGINE MOUNT RETAINING NUTS
4 – STARTER MOTOR SUPPORT BRACKET
5 – STARTER MOTOR

(67) Set up engine lifting device and lift the engine from the engine compartment.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install the assembled engine assembly into the engine compartment. Be certain the engine mount insulator studs are inserted through the frame rail brackets.

(2) Remove the engine lifting device. Install an engine support fixture, if necessary.

(3) Raise the vehicle on the hoist.

(4) Install the left and right engine mount insulator retaining nuts. Torque the nuts to 65 N·m (48 ft. lbs.).

(5) Position the transmission assembly and install the clutch bellhousing retaining bolts. Torque the bolts to 88 N·m (65 ft. lbs.).

NOTE: Do not install the 3 o–clock positioned bellhousing bolt at this time. This bolt is used to support the exhaust system.

(6) Install the misfire sensor on the clutch bellhousing. Torque the bolts to 27 N·m (20 ft. lbs.).

(7) Install the shifter on the transmission (Fig. 24). Torque the bolts to 27 N·m (20 ft. lbs.).

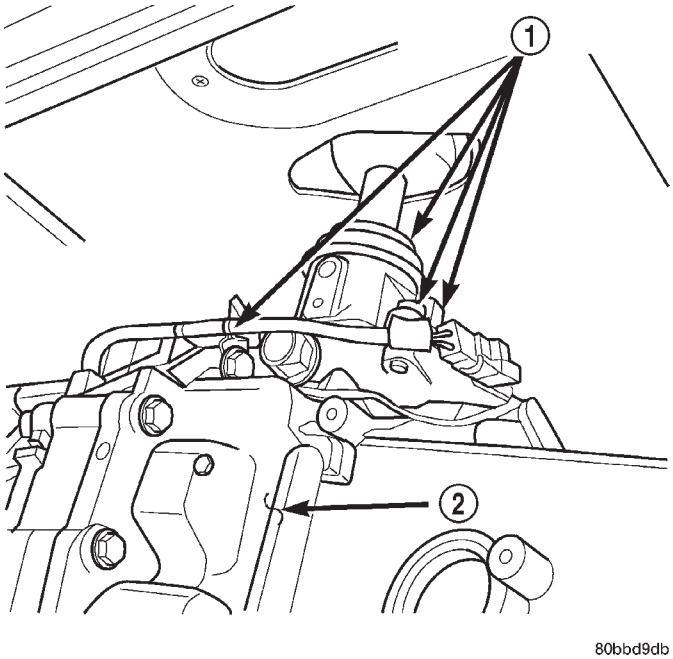


Fig. 24 Shifter Retaining Bolts

1 – SHIFTER ASSEMBLY RETAINING BOLTS
2 – TRANSMISSION

(8) Connect all wiring to the transmission in its original position.

(9) Raise the transmission assembly enough to position the rear support crossmember.

(10) Install the transmission support crossmember. Torque the bolts to 65 N·m (48 ft. lbs.).

(11) Install the fuelline support bracket on the transmission support crossmember.

(12) Install the (4) transmission mount retaining nuts on the transmission support crossmember (Fig. 25). Torque the nuts to 47 N·m (35 ft. lbs.).

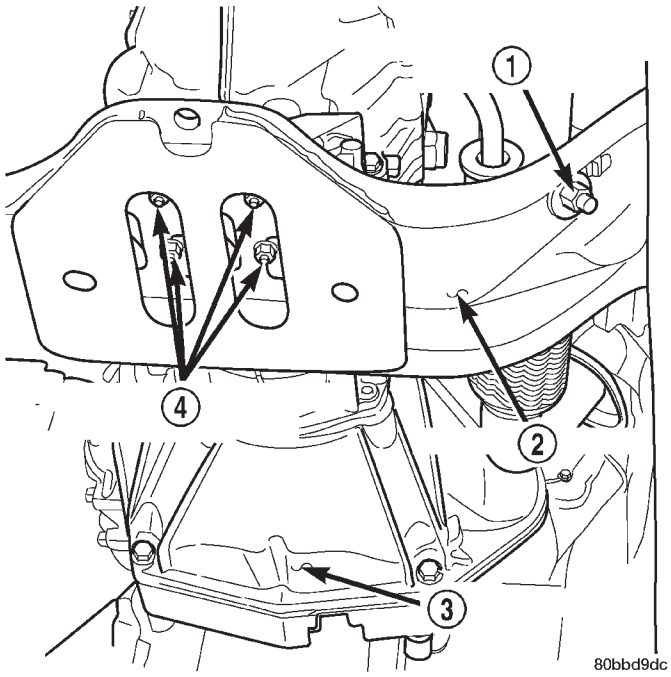


Fig. 25 Transmission Mount Retaining Nuts

1 – EXHAUST SYSTEM SUPPORT BRACKET RETAINING NUT
2 – CROSSMEMBER
3 – TRANSMISSION
4 – TRANSMISSION MOUNT RETAINING NUTS

(13) Install the clutch slave cylinder and the (2) retaining nuts (Fig. 26). Torque the nuts to 40 N·m (30 ft. lbs.).

(14) Install the exhaust system support bracket nut on the transmission support crossmember (Fig. 25). Torque the nut to 67 N·m (50 ft. lbs.).

(15) Install the exhaust system support bracket bolt in the clutch bellhousing. Torque the bolt to 88 N·m (65 ft. lbs.).

(16) Install the (2) exhaust system inlet pipe retaining nuts. Torque the nuts to 36 N·m (27 ft. lbs.).

(17) Install the propeller shaft assembly in the vehicle. Install the (4) center bearing retaining nuts and torque to 61 N·m (45 ft. lbs.).

(18) Remove the tape and position the rear universal joint in the rear axle companion flange. Install the universal joint clamps and torque the retaining bolts to 27 N·m (20 ft. lbs.).

(19) Lower the vehicle on the hoist.

(20) Install the body ground wire coming from the negative battery cable end.

(21) Install the 12v feed wire coming from the positive battery cable end. Torque the nut to 12 N·m (105in. lbs.).

REMOVAL AND INSTALLATION (Continued)

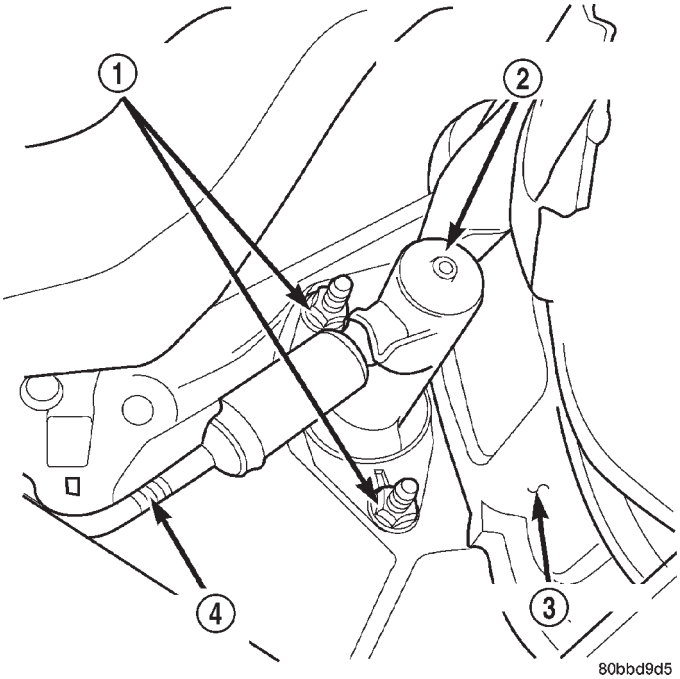


Fig. 26 Clutch Slave Cylinder

1 – SLAVE CYLINDER RETAINING NUTS
2 – HYDRAULIC CLUTCH SLAVE CYLINDER
3 – TRANSMISSION
4 – FLUID SUPPLY LINE

(22) Connect all remaining wiring coming from the engine assembly in its original position.

(23) Install the lower radiator hose on the engine assembly.

(24) Install the power steering fluid supply hose on the power steering pump.

(25) Install the power steering fluid pressure line on the power steering pump. Torque the nut to 28 N·m (21 ft. lbs.).

(26) Connect the power brake vacuum supply hose on the engine assembly (Fig. 27).

(27) Install the fuel / water separator and mounting bracket.

(28) Install the clutch fluid reservoir (Fig. 27). Torque the nuts to 12 N·m (105in. lbs.).

(29) Install and secure the fuel lines (Fig. 27) in there original positions.

(30) Connect the electrical connectors to the bottom of the fuel / water separator (Fig. 27).

(31) Connect the heater core coolant supply hoses on the engine assembly.

(32) Install the fan shroud over the cooling fan.

(33) Install the radiator and intercooler as an assembly.

(34) Install the (2) upper fan shroud retaining bolts (Fig. 28). Torque the bolts to 12 N·m (105in. lbs.).

(35) Install the intercooler inlet and outlet hoses.

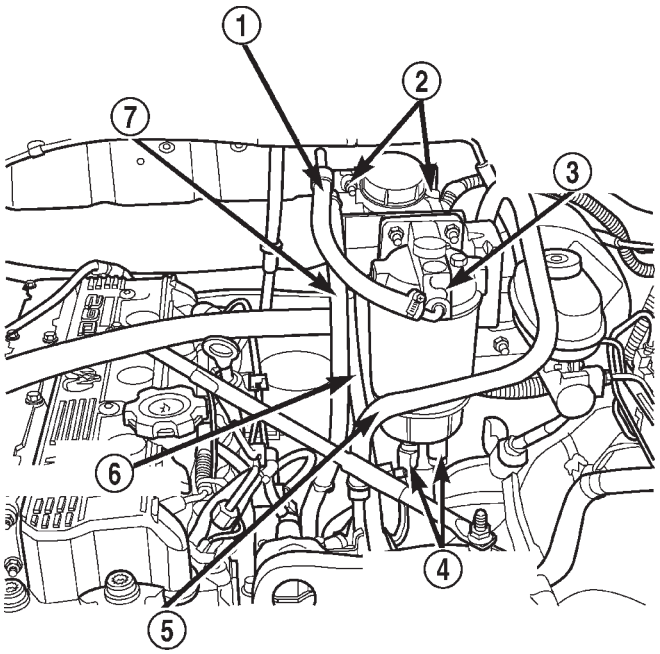


Fig. 27 Fuel / Water Separator Position & Orientation

1 – FUEL SUPPLY LINE (FROM TANK)
2 – HYDRAULIC CLUTCH FLUID RESERVOIR RETAINING NUTS
3 – FUEL/WATER SEPARATOR ASSEMBLY
4 – FUEL/WATER SEPARATOR ELECTRICAL CONNECTORS
5 – POWER BRAKE VACUUM SUPPLY HOSE
6 – FUEL SUPPLY LINE
7 – FUEL RETURN LINE (TO TANK)

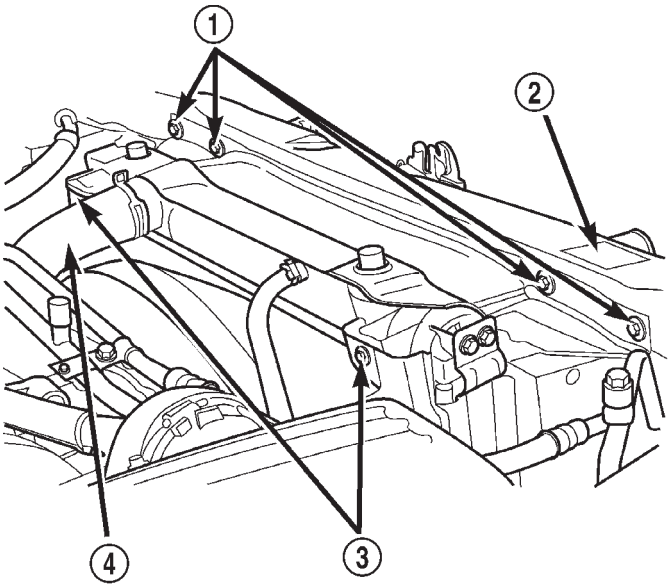


Fig. 28 Upper Fan Shroud Retaining bolts

1 – UPPER RADIATOR SUPPORT RETAINING BOLTS
2 – FRONT CLOSURE PANEL
3 – UPPER FAN SHROUD RETAINING BOLTS
4 – UPPER RADIATOR HOSE

REMOVAL AND INSTALLATION (Continued)

(36) Connect the air intake hose on the turbocharger and install the air cleaner assembly

(37) Install the upper radiator hose on the engine (Fig. 28).

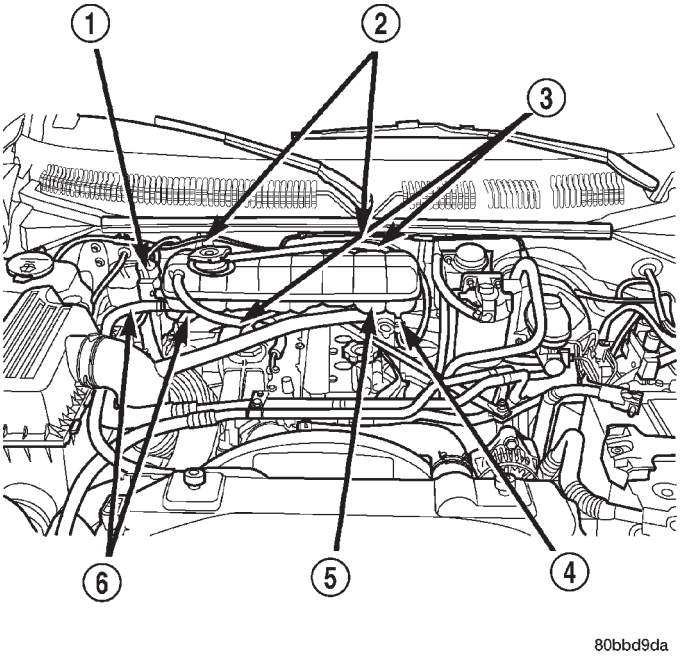


Fig. 29 Coolant Reservoir Position & Orientation

1 – EGR SOLENOID
2 – COOLANT RESERVOIR RETAINING BOLTS
3 – COOLANT OVERFLOW HOSES
4 – COOLANT LEVEL SENSOR
5 – COOLANT RESERVOIR
6 – COOLANT SUPPLY HOSES

(38) Connect the coolant supply hoses on the coolant reservoir (Fig. 29).

(39) Install the coolant reservoir on the bulkhead (Fig. 29).

(40) Connect the coolant level sensor electrical connector (Fig. 29).

(41) Connect the EGR solenoid vacuum line (Fig. 29).

(42) Connect the EGR solenoid electrical connector (Fig. 29).

(43) Install the coolant hose on the water manifold (Fig. 29).

(44) Install the coolant overflow hoses on the coolant reservoir (Fig. 29).

(45) Position the refrigerant lines in the vehicle and install the support bracket bolts in the generator bracket and water manifold.

(46) Connect the refrigerant line at the A/C accumulator (Fig. 30), making sure the sealing o-rings are well lubricated with R134a oil and free of tears. Install the secondary clip.

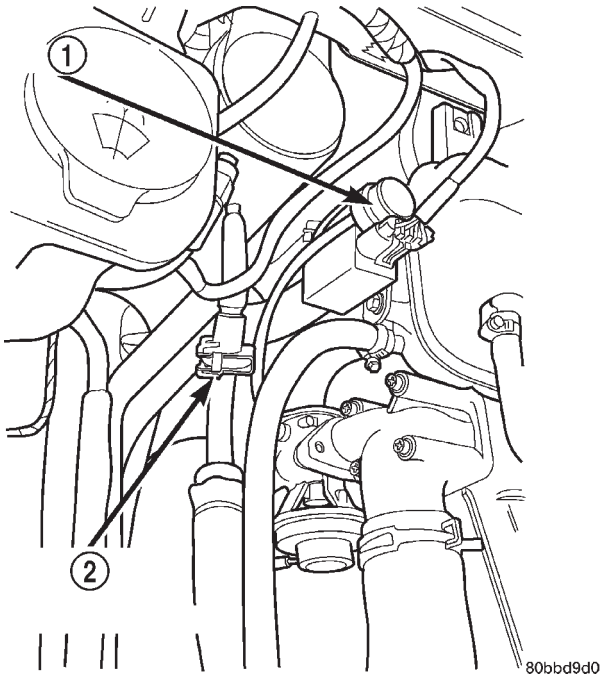


Fig. 30 Refrigerant Line At Accumulator

1 – EGR SOLENOID
2 – REFRIGERANT LINE AT A/C ACCUMULATOR

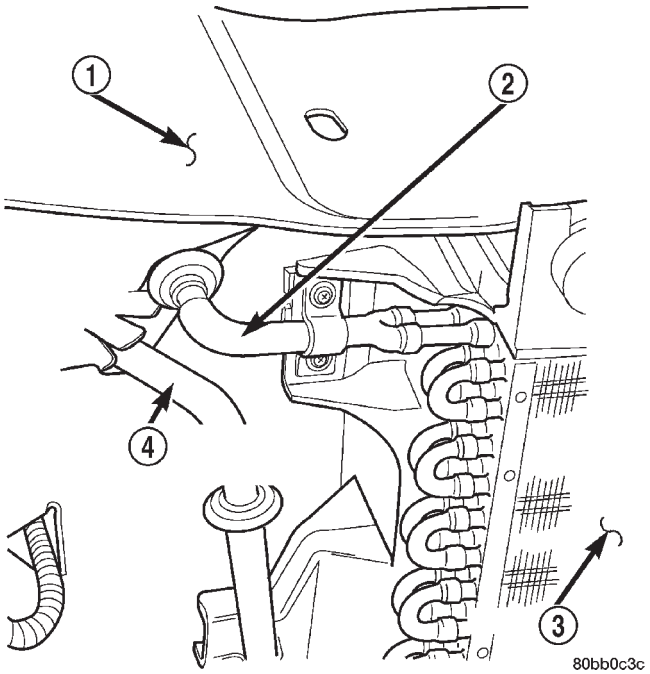


Fig. 31 Refrigerant Line At Accumulator

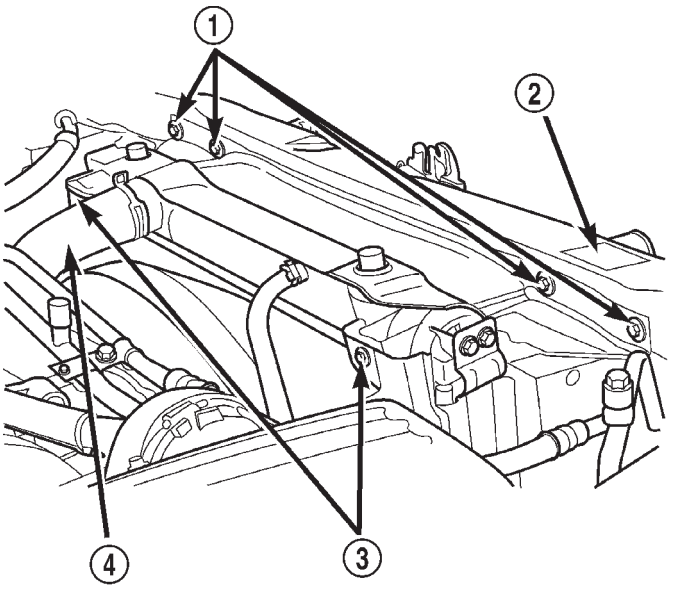
1 – FRONT CLOSURE PANEL
2 – HIGH PRESSURE REFRIGERANT LINE (FROM COMPRESSOR)
3 – CONDENSER
4 – LIQUID REFRIGERANT LINE (TO EVAPORATOR)

REMOVAL AND INSTALLATION (Continued)

(47) Connect the refrigerant line at the A/C condenser (Fig. 31), making sure the sealing o-rings are well lubricated with R134a oil and free of tears. Install the secondary clip.

(48) Install the refrigerant line support bracket on the A/C condenser.

(49) Install the A/C condenser support bolts in the front closure panel. Torque the bolts to 22 N·m (200 in. lbs.).



80bbd9d4

Fig. 32 Upper Radiator Support

1 – UPPER RADIATOR SUPPORT RETAINING BOLTS
2 – FRONT CLOSURE PANEL
3 – UPPER FAN SHROUD RETAINING BOLTS
4 – UPPER RADIATOR HOSE

(50) Install the upper radiator support (Fig. 32). Torque the bolts to 33 N·m (25 ft. lbs.).

(51) Install the cowl grille (Fig. 33). Refer to Group 23, Body for the procedure.

(52) Raise the vehicle on the hoist.

(53) Install both refrigerant lines on the compressor (Fig. 34), making sure the sealing o-rings are well lubricated with R-134A refrigerant oil and free of tears. Torque the bolts to 22 N·m (200 in. lbs.).

(54) Install the (2) lower fan shroud retaining bolts. Torque the bolts to 12 N·m (105in. lbs.).

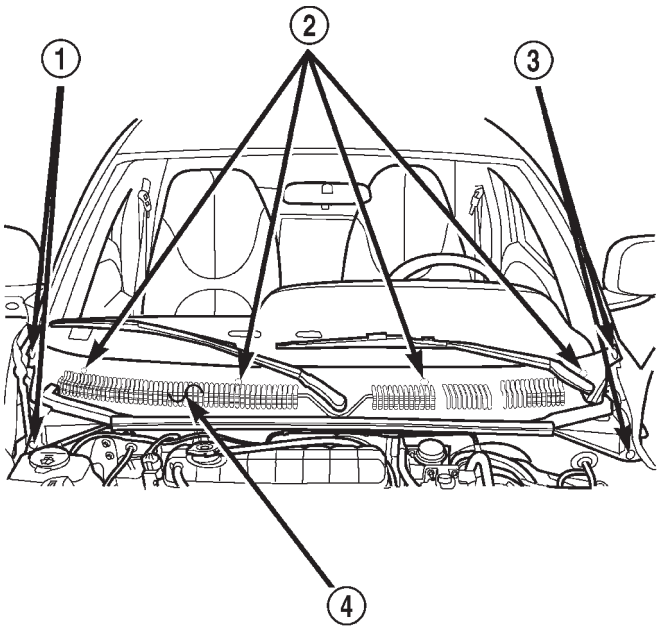
(55) Install the lower radiator hose on the engine assembly.

(56) Install the lower front splash shield.

(57) Fill the transmission. Refer to Group 21, Transmission for the procedure.

(58) Lower the vehicle on the hoist.

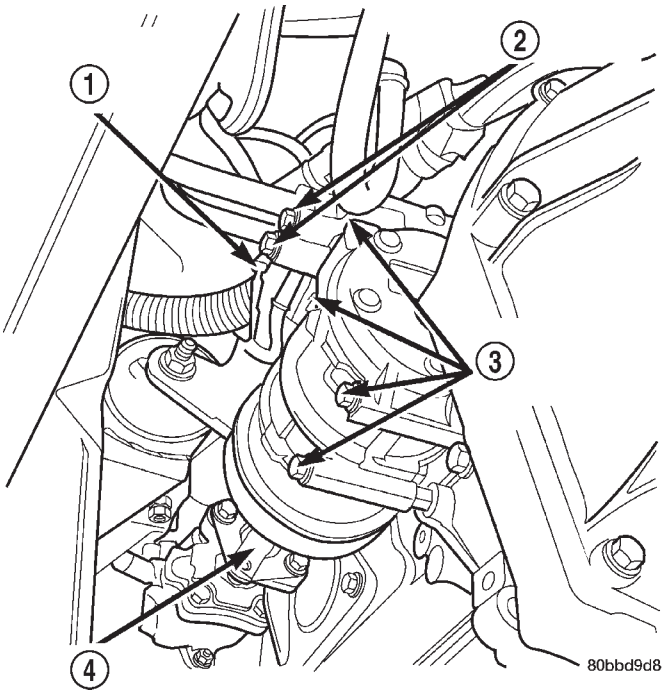
(59) Install both of the wiper arms on the vehicle. Refer to Group 8K, Wiper and Washer Systems for the procedure.



80bbda5f

Fig. 33 Cowl Grille Position & Orientation

1 – PUSHPINS
2 – COWL GRILLE RETAINING NUTS
3 – PUSHPINS
4 – COWL GRILLE



80bbd9d8

Fig. 34 Refrigerant Lines At Compressor

1 – COMPRESSOR ELECTRICAL CONNECTOR
2 – REFRIGERANT LINE RETAINING BOLTS
3 – COMPRESSOR RETAINING BOLTS
4 – H-BLOCK

REMOVAL AND INSTALLATION (Continued)

(60) With assistance from another person, install the hood assembly (Fig. 35). Torque the bolts to 47 N·m (35 ft. lbs.).

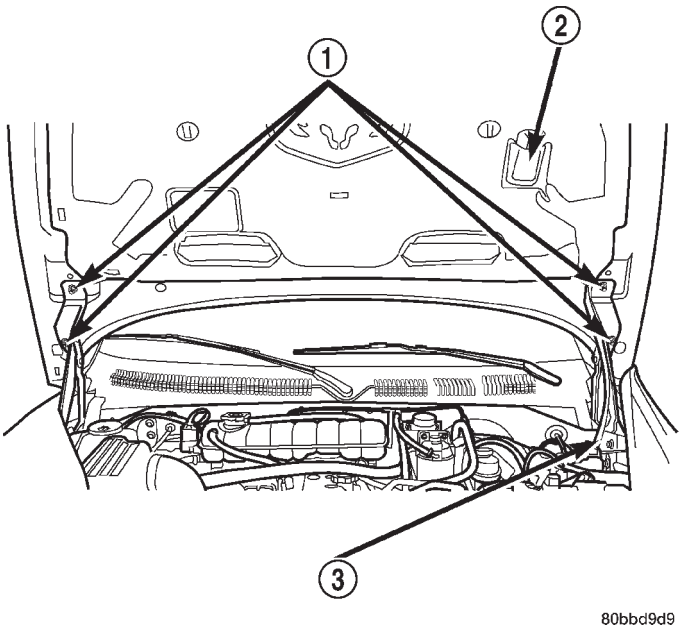


Fig. 35 Hood Position & Orientation

1 – HOOD RETAINING BOLTS
2 – ENGINE COMPARTMENT LAMP
3 – ENGINE COMPARTMENT LAMP ELECTRICAL CONNECTOR

(61) Connect the engine compartment lamp electrical connector.

(62) Recharge the refrigerant. Refer to Group 24, Heating and Air Conditioning for the procedure.

(63) Connect the positive and negative battery cables.

(64) Fill the cooling system. Refer to Group 7, Cooling System for the procedure.

(65) Fill the power steering fluid. Refer to Group 19, Steering – Power Steering Pump – Initial operation for the procedure.

(66) Fill engine oil. Start engine and check for leaks.

CYLINDER HEAD COVER

REMOVAL

(1) Disconnect the negative battery cable.

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

(2) On right hand drive vehicles, drain the cooling system. Refer to Group 7, Cooling System for the procedure.

(3) Recover the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for the procedure.

(4) Remove the A/C lines at the compressor and cap all openings. Refer to Group 24, Heating and Air Conditioning for the procedure. Remove the A/C line support bracket attached to cylinder head cover, and move the A/C, vacuum lines away from the cylinder head.

(5) Remove the generator support brace.

(6) Remove the Crankcase breather hose from the rear of the valve cover

(7) Remove the cylinder head cover bolts.

(8) Remove the cylinder head cover.

INSTALLATION

(1) Install the cylinder head cover. Torque the bolts to 15 N·m (133 in. lbs.).

(2) Connect the crankcase breather hose.

(3) Install the generator support brace. Torque bolt to 27 N·m (20 ft. lbs.) and nut to 11 N·m (8 ft. lbs.).

(4) Install the A/C lines on the compressor and install the support bracket on the cylinder head cover. Torque bolt to 7 N·m (62 in. lbs.).

(5) Connect the negative battery cable.

(6) If equipped with A/C, evacuate and charge the air conditioning system. Refer to Group 24, Heater and Air Conditioning.

(7) On right hand drive vehicles, fill the cooling system. Check for leaks.

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

(8) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

HYDRAULIC TAPPETS

REMOVAL

(1) Disconnect the negative battery cable.

(2) Discharge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for procedure.

(3) If equipped with air conditioning, remove the A/C lines at the compressor and cap.

(4) Remove the A/C line bracket attached to the cylinder head cover and move the lines away from the cylinder head.

(5) Remove cylinder head cover. Refer to cylinder head cover removal and installation procedure in this section.

REMOVAL AND INSTALLATION (Continued)

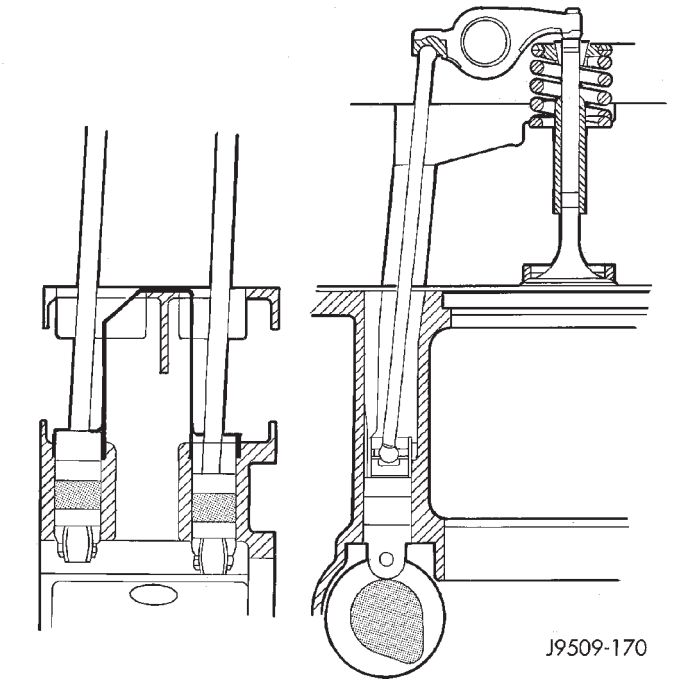


Fig. 36 Tappet And Rocker Arm Assembly

(6) Remove the rocker assemblies and push rods. Refer to rocker arms and push rod removal and installation procedure in this section. Identify push rods to ensure installation in original location.

(7) Remove cylinder head, intake manifold, and exhaust manifold. Refer to cylinder head removal and installation in this section.

(8) Remove the tappet retainers (Fig. 37).

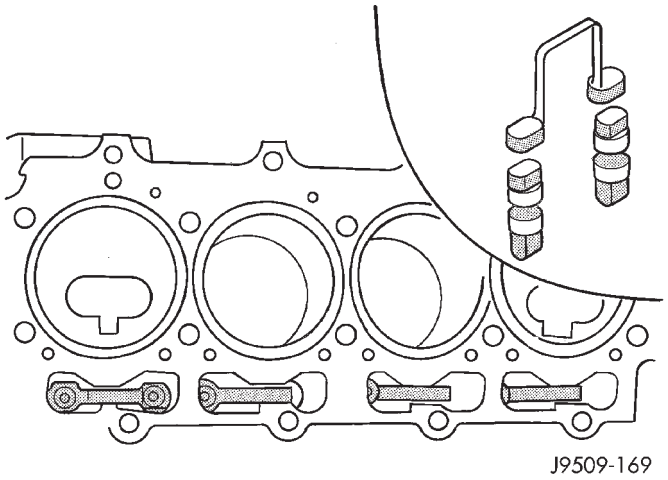


Fig. 37 Tappet And Retainer

(9) Slide Hydraulic Tappet Remover/Installer Tool through opening in block and seat tool firmly in the head of tappet.

(10) Pull the tappet out of the bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

CAUTION: The plunger and tappet bodies are not interchangeable. The plunger and valve must always be fitted to the original body. It is advisable to work on one tappet at a time to avoid mixing of parts. Mixed parts are not compatible. DO NOT disassemble a tappet on a dirty work bench.

INSTALLATION

(1) Lubricate the tappets.

(2) Install the tappets and retainers in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).

(3) Install the cylinder head, intake manifold, and exhaust manifold. Refer to cylinder head removal and installation in this section.

(4) Install the push rods.

(5) Install the rocker arms. Refer to rocker arms and push rod removal and installation in this section.

(6) Install the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(7) Connect the negative battery cable.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

(8) Start and operate engine. Warm up to normal operating temperature.

ROCKER ARMS AND PUSH RODS

REMOVAL

(1) Disconnect the negative battery cable.

(2) Discharge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for procedure.

(3) If equipped with air conditioning, remove the service valves and cap the compressor ports. Refer to Group 24, Heating and Air Conditioning.

(4) Remove the generator bracket.

(5) Remove the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(6) Remove the rocker arm retaining nut (Fig. 38).

(7) Remove the rocker assembly. Place them on a bench in the same order as removed.

(8) Remove the push rods and place them on a bench in the same order as removed.

REMOVAL AND INSTALLATION (Continued)

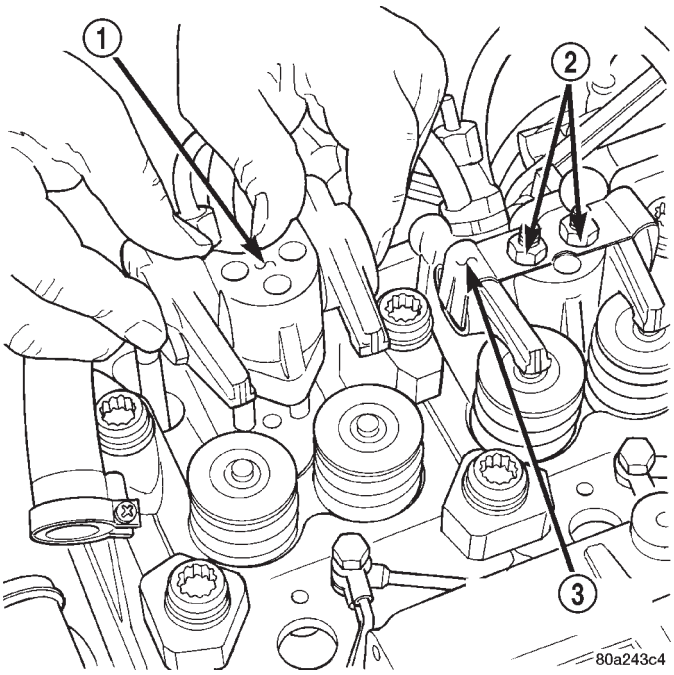


Fig. 38 Rocker Arm Retaining Nut

1 – ROCKER ARM ASSEMBLY
2 – ROCKER ARM RETAINING NUTS
3 – ROCKER ARM SPRING PLATE

INSTALLATION

WARNING: During the installation of the rocker arm assemblies it is possible to cause valve interference between the piston and valve if the piston is near Top Dead Center (TDC). This is due to the slow bleed down rate of the tappets when adjusting the rocker arm assemblies. Follow the procedure below to ensure that engine damage does not occur.

- Install the rocker arm assemblies in the same order as removed.
- Bring piston # 1 to Top Dead Center.
- Rotate the engine 40° counter clockwise and stop.
- At this point tighten all of the rocker arm nuts. Torque nuts to 27 N·m (20 ft. lbs.).

NOTE: You must allow 30 minutes before starting the engine once the rocker arms are torqued. This will allow the hydraulic tappets to stabilize and prevent the possibility of piston to valve contact.

(2) Install the cylinder head cover. Refer to cylinder head cover removal and installation in this group.

(3) Evacuate and charge the air conditioning system. Refer to Group 24, Heater and Air Conditioning.

(4) Connect the negative battery cable.

VALVE SPRINGS

This procedure can be done with the engine cylinder head installed on the block.

REMOVAL

(1) Disconnect the negative battery cable.

Each valve spring is held in place by a retainer and a set of conical valve locks. The locks can be removed only by compressing the valve spring.

(2) Remove the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(3) Remove the rocker arms assemblies and push rods. Refer to rocker arm and push rod removal and installation in this section. Retain the push rods, and rocker arms assemblies in the same order and position as removed.

(4) Inspect the springs and retainer for cracks and possible signs of weakening.

(5) Install an air hose adaptor in the fuel injector hole.

(6) Connect an air hose to the adapter and apply air pressure slowly. Maintain at least 621 kPa (90 psi) of air pressure in the cylinder to hold the valves against their seats.

(7) Tap the retainer or tip with a rawhide hammer to loosen the lock from the retainer. Use Valve Spring Compressor Tool to compress the spring and remove the locks.

(8) Remove the valve spring and retainer.

(9) Inspect the valve stems, especially the grooves. An Arkansas smooth stone should be used to remove nicks and high spots.

INSTALLATION

(1) Install the valve spring and retainer.

(2) Compress the valve spring with Valve Spring Compressor Tool and insert the valve locks. Release the spring tension and remove the tool. Tap the spring from side-to-side to ensure that the spring is seated properly on the engine cylinder head.

(3) Disconnect the air hose. Remove the adaptor from the fuel injector hole and install the fuel injector.

(4) Repeat the procedures for each remaining valve spring to be removed.

(5) Install the push rods. Ensure the bottom end of each rod is centered in the plunger cap seat of the hydraulic valve tappet.

(6) Install the rocker arm assemblies, in their original locations. Torque nuts to 29.4 N·m (264 in. lbs.).

(7) Install the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(8) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

ENGINE CYLINDER HEAD

REMOVAL

(1) Disconnect the negative battery cable.

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

(2) Drain the cooling system. Refer to Group 7, Cooling System for procedure.

(3) Discharge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for procedure.

(4) If equipped with air conditioning, remove the A/C lines at the compressor and cap. Refer to Group 24, Heating and Air Conditioning. Remove A/C line bracket attached to cylinder head cover, and move A/C lines away from cylinder head.

(5) Remove the air cleaner hose from turbocharger and breather hose.

(6) Remove the air cleaner assembly and breather hose.

(7) Remove the generator support bracket.

(8) Remove the upper radiator hose and coolant recovery hose.

(9) Remove the water manifold and recovery hose.

(10) Disconnect the heater hoses and coolant recover bottle hose.

(11) Disconnect the EGR tube from EGR valve.

(12) Remove the EGR valve

(13) Remove the exhaust heat shield from exhaust manifold.

(14) Remove the exhaust heat shield from down pipe.

(15) Remove the exhaust down pipe from turbocharger (Fig. 39).

(16) Disconnect the oil feed line from turbocharger.

(17) Disconnect the oil drain line from turbocharger.

(18) Remove the Exhaust manifold. Refer to Group 11, Exhaust System and Turbocharger.

(19) Remove the Intake manifold. Refer to intake manifold removal and installation procedure in this section.

(20) Remove the oil feed line retaining bracket at rear of #4 cylinder head.

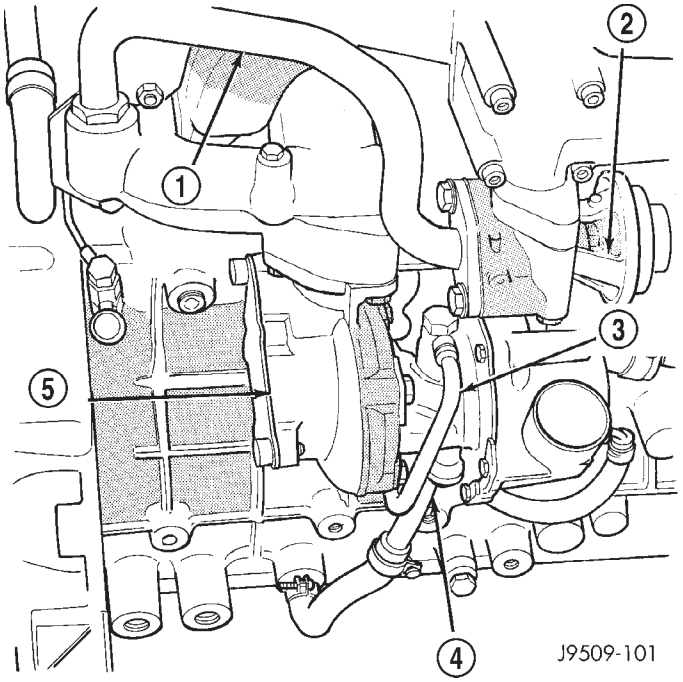


Fig. 39 Turbocharger

1 – EGR TUBE
2 – EGR VALVE
3 – OIL FEED LINE
4 – OIL DRAIN
5 – TURBO

(21) Remove the oil feed line retaining bracket (Fig. 40).

(22) Remove the oil feed line for rocker arm assemblies (Fig. 41).

(23) Remove the Crankcase breather hose from rear of the valve cover

(24) Remove the injector sensor wire and the glow plug hot lead.

(25) Remove the fuel lines and fuel filter. Refer to Group 14, Fuel Systems for procedure.

(26) Remove the injector fuel lines from injectors to pump.

(27) Remove the fuel injectors with tool VM.1012 (Fig. 42). Refer to Group 14, Fuel System for procedure.

(28) Remove the engine cylinder head cover.

(29) Remove the rocker retaining nuts (Fig. 44).

(30) Remove the rocker arm assemblies. Place them on a bench in the same order as removed.

REMOVAL AND INSTALLATION (Continued)

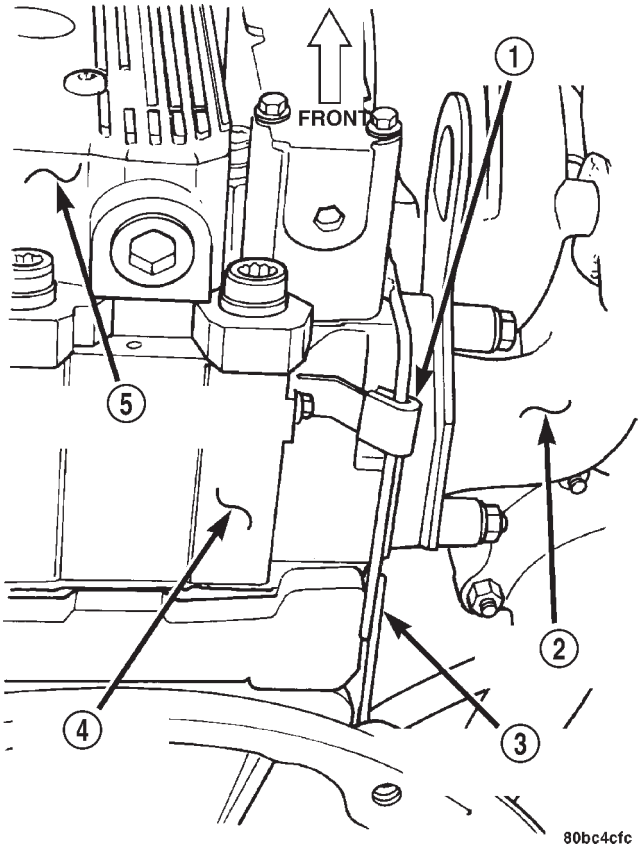


Fig. 40 Oil Feed Line Retainer

1 – CYLINDER HEAD OIL SUPPLY LINE RETAINING CLIP
2 – EXHAUST MANIFOLD
3 – CYLINDER HEAD OIL SUPPLY LINE
4 – REAR OF CYLINDER HEADS
5 – CYLINDER HEAD COVER

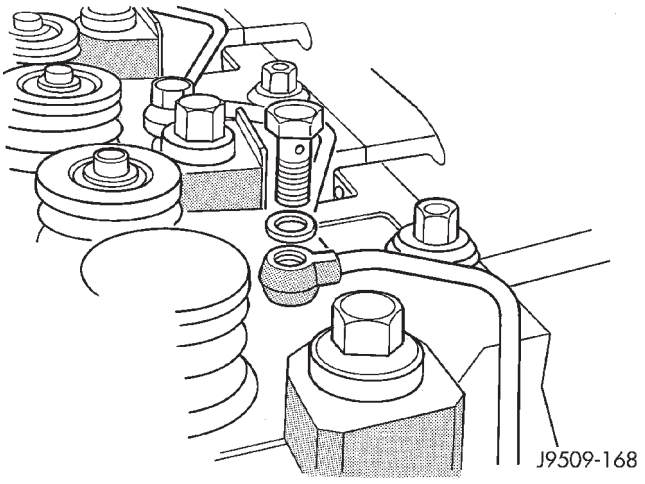


Fig. 41 Rocker Arm Oil Feed Lines

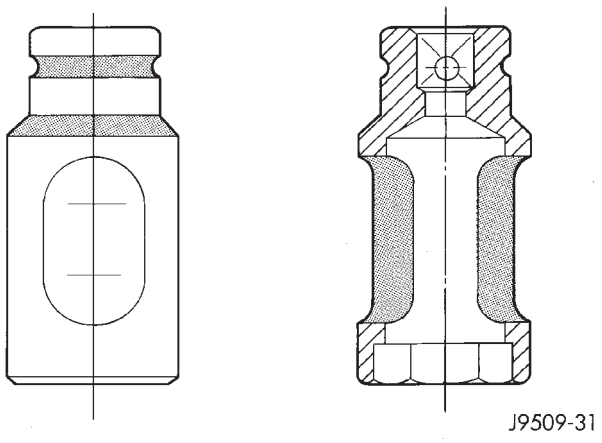


Fig. 42 Fuel Injector Tool VM.1012B

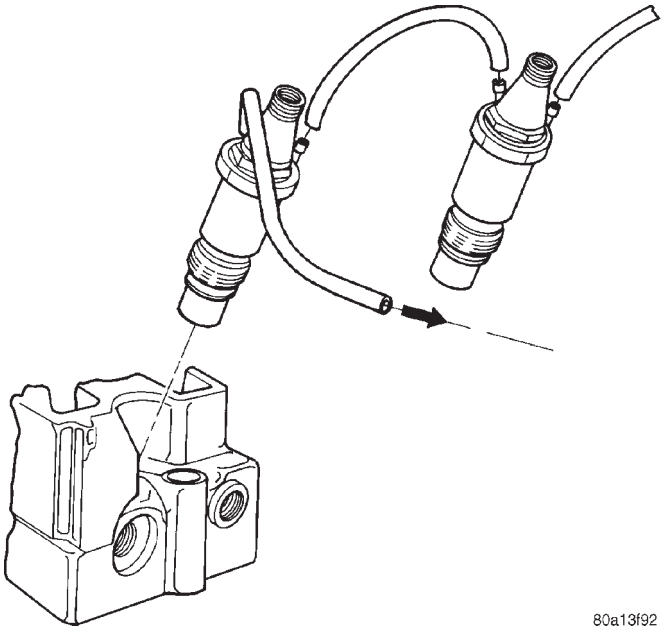


Fig. 43 Fuel Injector

(31) Remove the push rods and place them on a bench in the same order as removed.

(32) Mark the cylinder head positions.

(33) Remove the engine cylinder head bolts with special tool VM.1018 and VM.1019.

(34) Remove the engine cylinder head and gasket.

(35) Stuff clean lint free shop towels into the cylinder bores.

REMOVAL AND INSTALLATION (Continued)

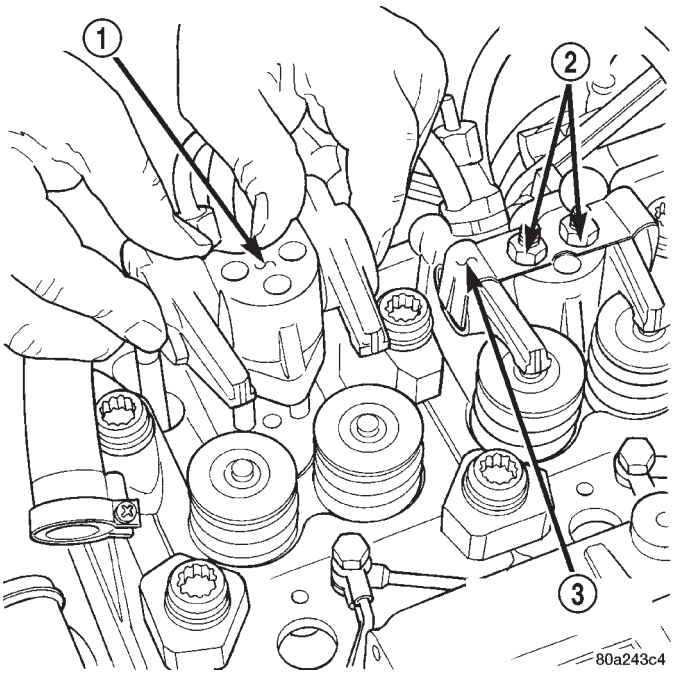


Fig. 44 Rocker Arm Retaining Nuts

1 – ROCKER ARM ASSEMBLY
2 – ROCKER ARM RETAINING NUTS
3 – ROCKER ARM SPRING PLATE

CYLINDER HEAD GASKETS

A steel cylinder head gasket is used for all four cylinder heads.

Cylinder head gaskets are available in three thicknesses. Identification holes in the right front corner of the gasket indicate the thickness of the gasket (Fig. 45).

CAUTION: Piston protrusion must be measured, to determine cylinder head gasket thickness, if one or more cylinder wall liners have been replaced.

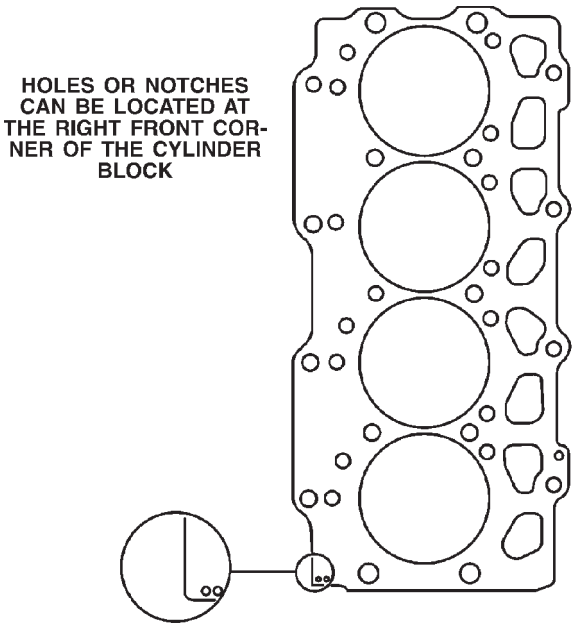
NOTE: If cylinder wall liners have not been removed; the same thickness head gasket removed, may be used.

MEASURING PISTON PROTRUSION

(1) Use special tool VM.1010 with dial indicator special tool VM.1013 (Fig. 46).

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

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



HOW TO IDENTIFY GASKET THICKNESS	
NO HOLES	1.41 mm
2 HOLES	1.51 mm
1 HOLE	1.61 mm

80bfe1e6

Fig. 45 Steel Type Cylinder Head Gasket— identification

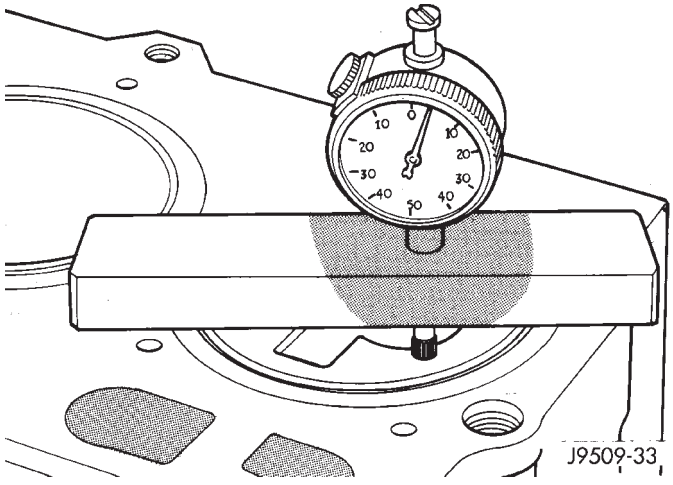


Fig. 46 Measuring Piston Protrusion

(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 (Fig. 47).

REMOVAL AND INSTALLATION (Continued)

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

(6) Establish the thickness of the steel gasket for all four cylinder heads on the basis of the greatest piston protrusion (Fig. 45).

Measured dimension (mm)	0.53-0.62
Cyl. head gasket thickness (mm)	1.41
Piston clearance (mm)	0.80-0.89
Measured dimension (mm)	0.63-0.72
Cyl. head gasket thickness (mm)	1.51
Piston clearance (mm)	0.80-0.89
Measured dimension (mm)	0.73-0.82
Cyl. head gasket thickness (mm)	1.61
Piston clearance (mm)	0.80-0.89

Fig. 47 Piston Protrusion Chart

CAUTION: Gaskets are to be installed DRY. DO NOT use a gasket sealing compound on the gasket.

INSTALLATION

(1) Remove the shop towels from the cylinder bores. Coat the bores with clean engine oil.

(2) Install cylinder head alignment studs VM.1009.

(3) After determining the correct head gasket thickness, clean the block and head mating surfaces, place the engine cylinder head gasket over the alignment studs.

(4) Place the engine cylinder head over the alignment studs.

CAUTION: New cylinder head bolts should be used.

(5) Tighten the engine cylinder head bolts in sequence according to the following procedure (Fig. 48) :

a. The threads and underside heads of the bolts should be lubricated. Use the cylinder head alignment studs tool number VM-1009. Position the heads on the block and secure with the ten large center bolts (14mm) and spacers (clamps), finger tight only.

b. Ensure that the various clamps are installed correctly and the head gasket remains in it's proper position, completely covered. Then, lubricate and install the eight small bolts (12mm), also finger tight.

(6) Install the intake and exhaust manifolds with a new gasket, partially tightening the nuts to a maximum of 5 N·m (44 in. lbs.). This will align the heads. Refer to Group 11, Exhaust System and Turbocharger for the proper procedure. Install lift eye and brake vacuum tube at this time.

(7) Then, tighten the 14mm bolts with special tool VM.1019 in the following manner:

(8) **1st Phase:** Tightening Head Bolts (Fig. 48). Central bolts (A-L): Tighten all bolts, starting with bolt H then G-F-E-D-C-B-A-L-I, to 30 N·m. Tighten all bolts an additional 70°, starting with bolt A and continuing in alphabetical order. Finally, tighten all bolts an additional 70°, starting again with bolt A and continuing in alphabetical order.

(9) Tighten the 12mm bolts in the following manner:

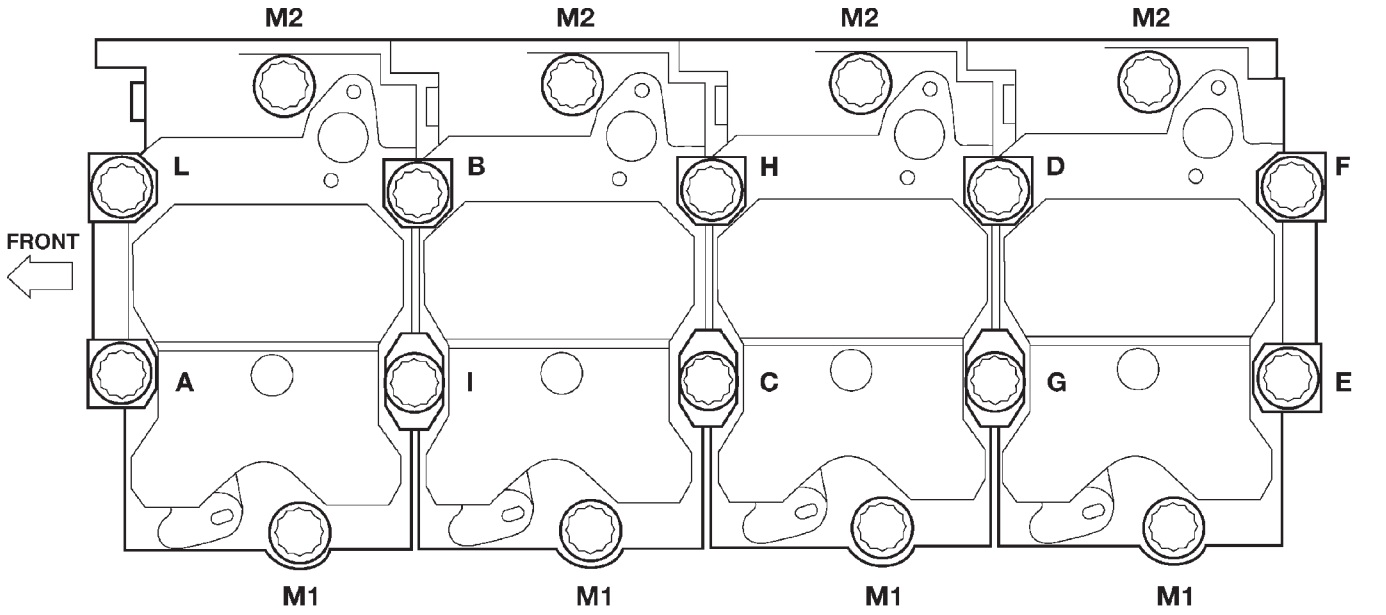


Fig. 48 Engine Cylinder Head Bolt Tightening Sequence

REMOVAL AND INSTALLATION (Continued)

(10) Side bolts (M1-M2): Tighten M1 bolts to 30 N·m, then rotate them 85° (±5). Tighten M2 bolts to 30 N·m, then rotate them 85° (±5).

NOTE: If vehicle is equipped with A/C do not install A/C lines to compressor and charge A/C till Phase 2 is complete.

(11) **2nd Phase:** After 20 minutes of engine operation at operating temperature, allow engine to cool down completely. Then retorque the head bolts as follows:

(12) Central bolts A-L: Completely back off bolts one-by-one and then retighten to 30 N·m plus 130° (±5°). Then proceed in the same way, bolt by bolt, following alphabetical order, as indicated.

(13) Side bolts M1-M2: **Without slackening**, torque bolts M1 then bolts M2 to 90 N·m (66 ft. lbs.).

(14) Torque intake nuts to 32 N·m (24 ft. lbs.) and exhaust manifolds nuts to 32 N·m (24 ft. lbs.) after completing the cylinder head torquing procedure.

(15) Install the oil feed lines for the rocker arm assemblies. Torque oil feed lines to 13 N·m (115 in. lbs.).

(16) Install the oil feed line retaining bracket at rear of #4 cylinder head (Fig. 40).

(17) Install the push rods and rocker arm assemblies. Refer to the rocker arm and pushrod removal and installation procedure in this group.

(18) Install the cylinder head cover. Torque bolts to 15 N·m (133 in. lbs.).

(19) Connect the crankcase breather hose.

(20) Connect the injector sensor wire and the glow plug hot lead.

(21) Install the turbocharger oil feed line. Torque banjo bolts to 27 N·m (20 ft. lbs).

(22) Install the turbocharger oil drain line. Torque bolts to 11 N·m (97 in. lbs.).

(23) Install the water manifold. Torque bolts to 12 N·m (106 in. lbs.).

(24) Install the generator support bracket.

(25) Raise the vehicle on hoist.

(26) Install the exhaust down pipe to turbocharger, tighten bolts to 22 N·m (16 ft. lbs.).

(27) Install the exhaust down pipe heat shield.

(28) Install the exhaust heat shield, Tighten bolts to 11 N·m (8 ft. lbs.).

(29) Install the EGR valve to intake manifold, tighten bolts to 27 N·m (20 ft. lbs.).

(30) Install the EGR tube to EGR valve, tighten bolts to 27 N·m (20 ft. lbs.).

(31) Install the lower charge air cooler hose to turbocharger.

(32) Install the air cleaner assembly and hose.

(33) Install the oil breather hose to air cleaner hose.

(34) Install the upper charge cooler hose to turbocharger.

(35) Connect the recover bottle hose to water manifold.

(36) Install the fuel injectors using special tool VM.1012. Refer to Group 14, Fuel System for procedures.

(37) Install the fuel injector lines from the pump to injectors. Torque nuts to 19 N·m (14 ft. lbs.).

(38) Connect the A/C lines to compressor and install bracket on cylinder head cover, if equipped with air conditioning.

(39) Install the fuel filter, Tighten bolts to 28 N·m (250 in. lbs.)

(40) Connect the fuel supply and return lines

(41) Connect the upper radiator hose.

(42) Connect the negative cable battery.

(43) If equipped with A/C, evacuate and charge the air conditioning system. Refer to Group 24, Heater and Air Conditioning.

(44) Fill the cooling system. Check for leaks.

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

(45) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

NOTE: After rebuild or cylinder head gasket replacement, the cylinder head must be retorqued within the first 20,000km. If individual fiber type head gaskets were used.

NOTE: The one piece steel type head gasket does not require, the above mentioned, retorque procedure.

CYLINDER HEAD RE-TORQUE

Within the first 20,000 km (12,000 miles) after rebuild, retorque the cylinder head bolts as follows: (Fig. 48) Central bolts A-L: Without slackening the bolts, following alphabetical order tighten the bolts through an angle of 15°. Side bolts M1-M2: Without slackening, tighten M1 then M2 bolts through an angle of 15°.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

(2) Remove the fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.
(3) Remove the accessary drive belt. Refer to Group 7, Cooling System for procedure.
(4) Remove the vibration damper nut.
(5) Install special tool VM.1000-A to remove vibration damper.

INSTALLATION

(1) Install the vibration damper and align with key way.
(2) Install the vibration damper nut. Torque nut to 196 N·m (147 ft. lbs.).
(3) Install the accessary drive belt. Refer to Group 7, Cooling System for procedure.
(4) Connect the negateive battery cable.

TIMING GEAR COVER OIL SEAL

REMOVAL

(1) Disconnect the negative battery cable.
(2) Remove the vibration damper. Refer to vibration damper removal and installation in this section.

CAUTION: Use care when removing the old seal. Be sure not to damage the timing gear cover.

(3) Pry out the old seal.

INSTALLATION

Remove the oil seal ring. The seating diameter must be 68.000 - 68.030 mm.
(1) Install the new seal using special tool VM.1015A.
(2) Install the vibration damper. Refer to vibration damper removal and installation in this section.
(3) Connect the negative battery cable.

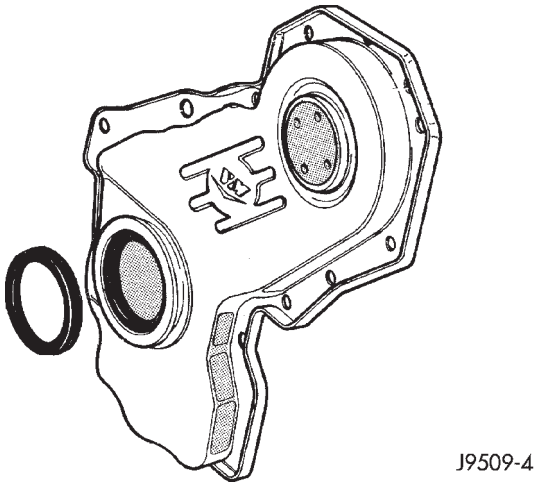


Fig. 49 Timing Gear Cover Oil Seal

TIMING GEAR COVER

REMOVAL

(1) Disconnect the negative battery cable.
(2) Remove the fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.
(3) Remove the accessary drive belt. Refer to Group 7, Cooling System for procedure.
(4) Remove the vibration damper nut.
(5) Install special tool VM.1000-A to remove the vibration damper.
(6) Remove the fan pulley.

NOTE: The idler pulley bolt has left hand thread.

(7) Remove the idler pulley and bracket.
(8) Remove the automatic belt tensioner.
(9) Remove the Power steering pump pulley.
(10) Remove the timing gear retaining bolts and cover.

INSTALLATION

(1) Be sure the mating surfaces of the gear case cover and the cylinder block are clean and free from burrs.
(2) Apply a continuous 3 mm bead of Silicone Sealer (Fig. 50) to timing cover, install within 10 minutes, tighten bolts to 10.3 N·m (91 in. lbs).

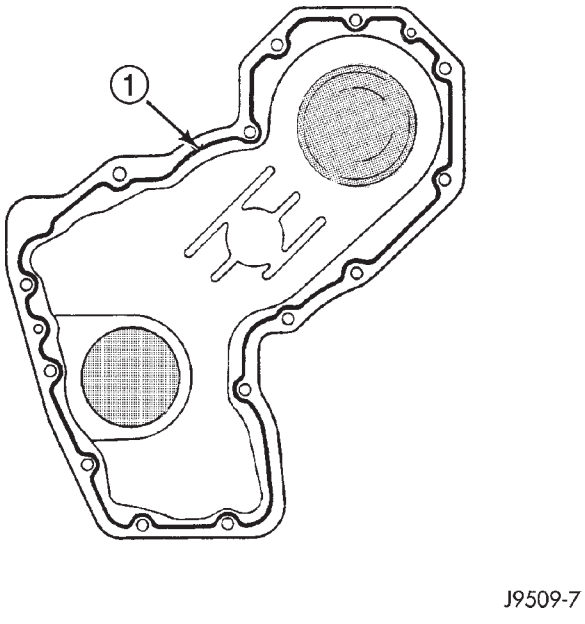


Fig. 50 Front Cover Sealer Location
1 – MOPAR SILICONE RUBBER ADHESIVE SEALANT

(3) Install Power steering pump pulley. Torque bolts to 166 N·m.
(4) Install the automatic belt tensioner.

NOTE: The idler pulley has left hand thread.

REMOVAL AND INSTALLATION (Continued)

(5) Install the idler pulley. Torque nut to 40 N·m (29 ft. lbs.).

(6) Install the fan pulley. Torque bolts to 56 N·m (41 ft. lbs.).

(7) Install the vibration damper. torque nut to 196 N·m (147 ft. lbs.).

(8) Install the accessary drive belt. Refer to Group 7, Cooling System for procedure).

(9) Install the fan and fan shroud.

(10) Connect the negative battery cable.

CAMSHAFT

REMOVAL

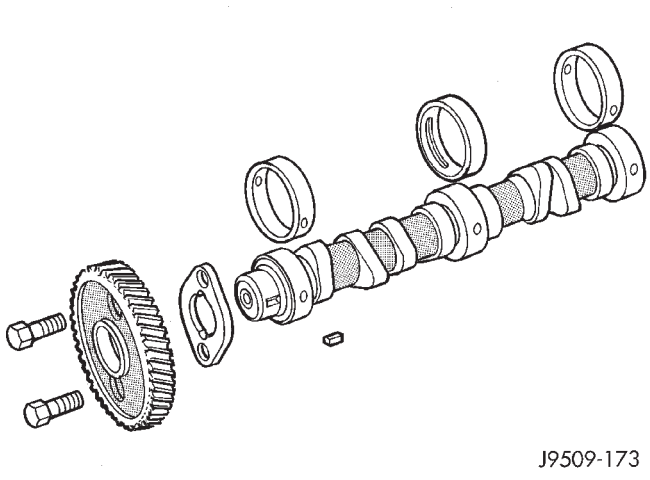


Fig. 51 Camshaft Assembly

(1) Disconnect the negative battery cable.

(2) Remove the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(3) Remove the cylinder heads. Refer to cylinder head removal and installation in this section.

(4) Remove the rocker arm assemblies, push rods, and hydraulic tappets. Refer to the respective groups in this section.

(5) Remove the fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.

(6) Remove the accessary drive belt. Refer to Group 7, Cooling System for procedure.

(7) Remove the radiator. Refer to Group 7, Cooling System for procedure.

(8) Remove the A/C condenser. Refer to Group 24, Heating and Air Conditioning for procedure.

(9) Remove the vibration damper. Refer to vibration damper removal and installation in this section.

(10) Remove the power steering pump pulley.

(11) Remove timing gear cover. Refer to timing gear cover removal and installation in this section.

(12) Rotate the engine to align the timing marks as shown (Fig. 52).

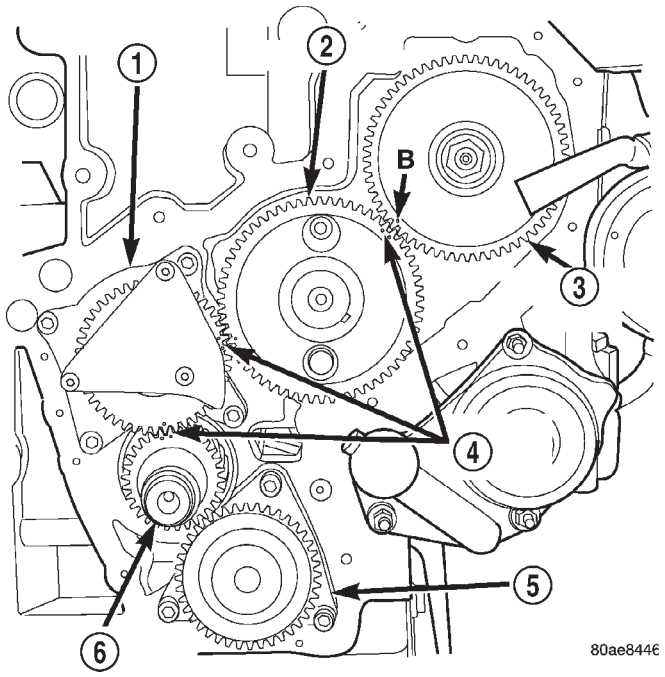


Fig. 52 Timing Marks

1 – VACUUM PUMP
2 – CAMSHAFT
3 – INJECTION PUMP
4 – TIMING MARKS
5 – OIL PUMP
6 – CRANKSHAFT

(13) Unscrew the flange bolts and remove camshaft (Fig. 53).

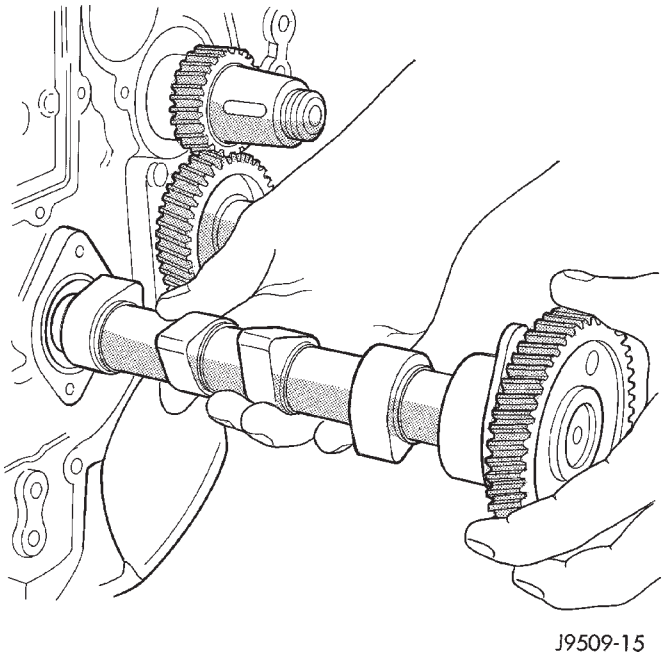


Fig. 53 Camshaft Removal

REMOVAL AND INSTALLATION (Continued)

THRUST PLATE INSPECTION

Check the thickness (Fig. 54) of the plate at points a-b-c-d. If the measurement is not between 3.950 - 4.050 it must be changed.

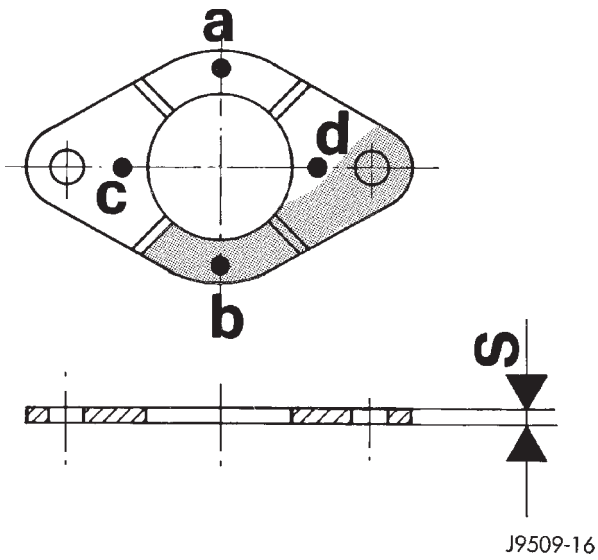


Fig. 54 Camshaft Thrust Plate

INSTALLATION

(1) Coat the camshaft journals with clean engine oil and carefully install the camshaft complete with thrust plate and gear. Tighten retaining bolts to 27.5 N·m (20 ft. lbs.) torque. Be sure to align the timing marks as shown (Fig. 55).

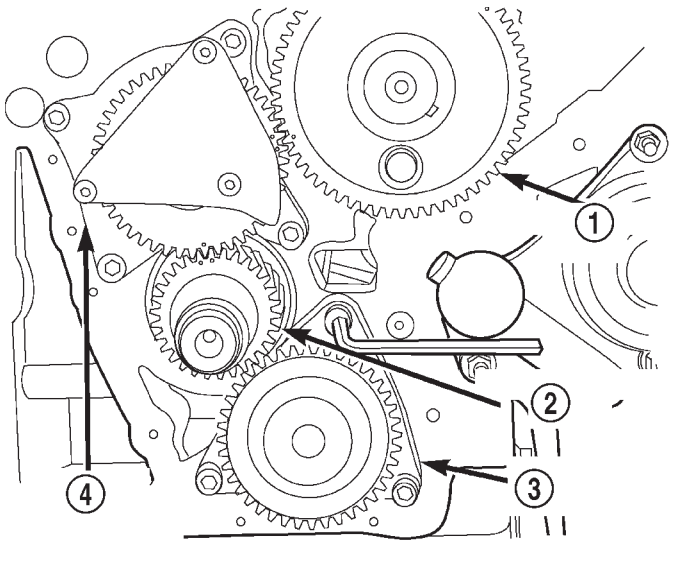


Fig. 55 Timing Marks

1 – CAMSHAFT GEAR
2 – CRANKSHAFT GEAR
3 – OIL PUMP
4 – VACUUM PUMP

(2) Install the hydraulic tappets and retainers. Refer to hydraulic tappet removal and installation in this section.

(3) Install the cylinder heads. Refer to cylinder head removal and installation in this section).

(4) Install the push rods and rocker arm assemblies. Refer to the respective sections.

(5) Install the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(6) Install the timing gear cover. Refer to timing gear cover removal and installation in this section.

(7) Install the vibration damper. Refer to the vibration damper removal and installation in this section.

(8) Install the A/C condenser. Refer to Group 24, Heating and Air Conditioning for procedure.

(9) Install the radiator. Refer to Group 7, Cooling System for procedure.

(10) Install the fan and fan shroud,. Torque fan to 56 N·m (41 ft. lbs.).

(11) If equipped, evacuate and charge the air conditioning system. Refer to Group 24, Heater and Air Conditioning for procedure.

(12) Connect the negative battery cable.

(13) Fill the cooling system. Check for leaks.

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

(14) Operate the engine with the radiator cap off. Inspect for leaks and continue operating the engine until the thermostat opens. Add coolant, if required.

CAMSHAFT BEARINGS

This procedure requires that the engine is removed from the vehicle.

REMOVAL

(1) With the engine completely disassembled, remove camshaft rear plate and o-ring.

(2) Install the proper size adapters and horseshoe washers (part of Crankshaft Bearing Remover/Installer Tool VM-1002) at back of each bearing shell. Drive out the bearing shells.

INSTALLATION

(1) Install the new camshaft bearings with Camshaft Bearing Remover/Installer Tool C3131–A by sliding the new camshaft bearing shell over proper adapter.

(2) Position the rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

REMOVAL AND INSTALLATION (Continued)

(3) Install the remaining bearings in the same manner. **The Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly.**

(4) Install a new rear plate o-ring at the rear of camshaft. **Be sure this seal does not leak.**

OIL PAN

REMOVAL

(1) Disconnect the negative battery cable.
(2) Raise the vehicle on hoist.
(3) Drain the oil from the crankcase.
(4) Remove the front skidplate from the vehicle.
(5) Remove the oil pan lower cover bolts.
(6) Remove the bolts from oil pan. Remove the 6 bolts that are on the inside of the oil pan.
(7) Remove the oil pan.

INSTALLATION

(1) Remove all gasket material from cylinder block. Be careful not gouge or scratch aluminum pan sealing surface.
(2) Apply a continuous 3 mm bead of Silicone Sealer to oil pan, install within 10 minutes. Install the oil pan.
(3) Install the inside oil pan bolts. Torque bolts to 13 N·m (115 in. lbs.).
(4) Torque the smaller oil pan bolts to 13 N·m (115 in. lbs.). Torque the larger oil pan bolts to 25 N·m (18 ft. lbs.).
(5) Install the oil drain plug. Torque to 33 N·m (25 ft. lbs).
(6) Install the front skidplate.
(7) Lower the vehicle from hoist.
(8) Fill engine with proper amount of oil.
(9) Connect the negative battery cable.

OIL PUMP

REMOVAL

(1) Disconnect the negative battery cable.
(2) Remove the timing gear cover. Refer to timing gear cover removal and installation in this section).
(3) Remove the oil pump (Fig. 56).

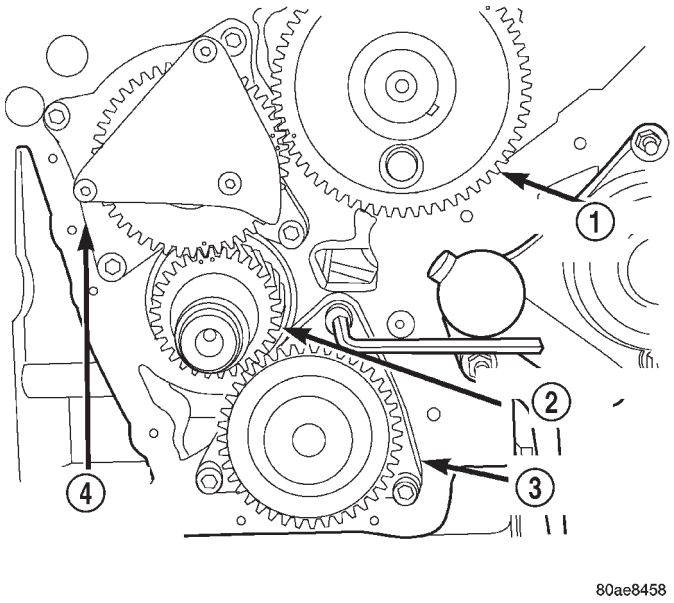


Fig. 56 Oil Pump Removal

1 – CAMSHAFT GEAR
2 – CRANKSHAFT GEAR
3 – OIL PUMP
4 – VACUUM PUMP

INSTALLATION

(1) Install new O-ring and lubricate with clean engine oil.
(2) Install the oil pump. Torque screws to 27.5 N·m (20 ft. lbs.). Check for normal backlash between pump and crankshaft gears.
(3) Install the timing gear cover. Refer to timing gear cover removal and installation in this section.

INTERNAL VACUUM PUMP

REMOVAL

(1) Disconnect the negative battery cable.
(2) Remove the timing gear cover. Refer to timing gear cover removal in this section.
(3) Align all the timing marks before removing the vacuum pump (Fig. 57).
(4) Remove the vacuum pump retaining bolts..
(5) Remove the internal vacuum pump.

REMOVAL AND INSTALLATION (Continued)

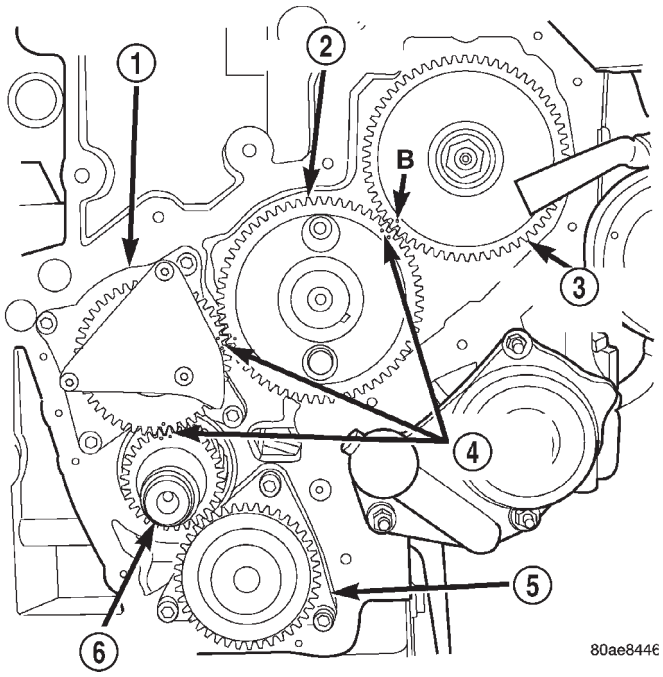


Fig. 57 Timing Marks

1 – VACUUM PUMP
2 – CAMSHAFT
3 – INJECTION PUMP
4 – TIMING MARKS
5 – OIL PUMP
6 – CRANKSHAFT

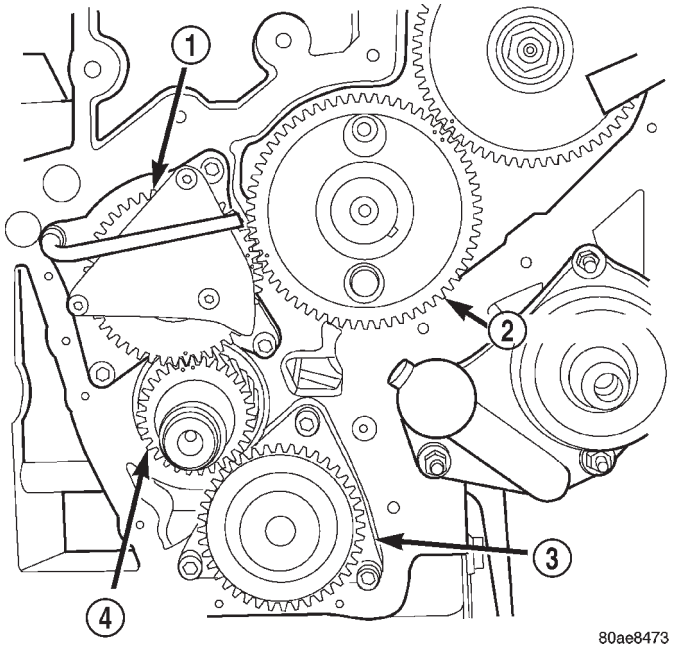


Fig. 58 Vacuum Pump

1 – VACUUM PUMP
2 – CAMSHAFT
3 – OIL PUMP
4 – CRANKSHAFT

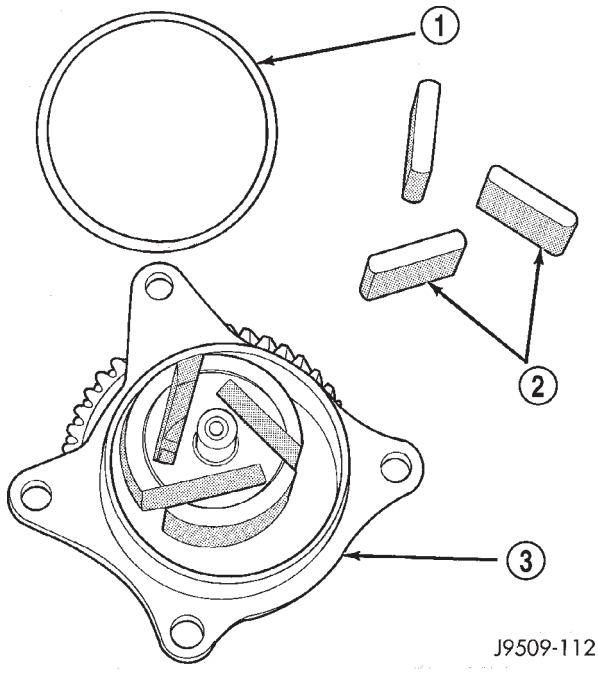


Fig. 59 Vacuum Pump Parts

1 – O-RING
2 – ROTOR BLADES
3 – VACUUM PUMP

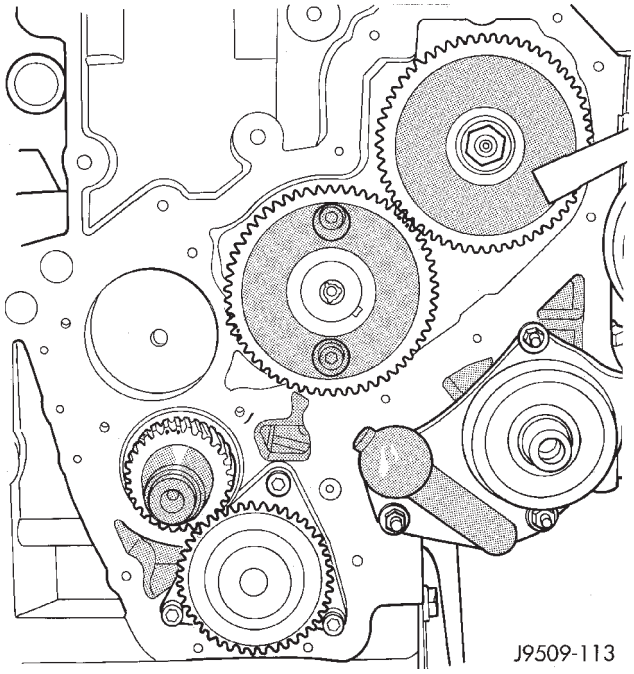


Fig. 60 Vacuum Pump Mounting Hole

INSTALLATION

(1) To install the vacuum pump, align with timing marks on gear set and install (Fig. 57). Torque bolts to 27.5 N·m (20 ft. lbs.).

(2) Install the timing gear cover. Refer to timing gear cover removal in this section.

(3) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

OIL PUMP PRESSURE RELIEF VALVE

REMOVAL

(1) Disconnect the negative battery cable

(2) Remove the oil pan. Refer to oil pan removal and installation procedure in this section.

(3) Remove the relief valve snap ring.

(4) Remove the relief valve cap, spring, and plunger (Fig. 61).

(5) Check the relief valve spring length. Relief valve spring free length is 57.5mm (2.263 in.). If spring length is less or spring is distorted it must be replaced.

(6) Check the plunger for scoring, replace if necessary.

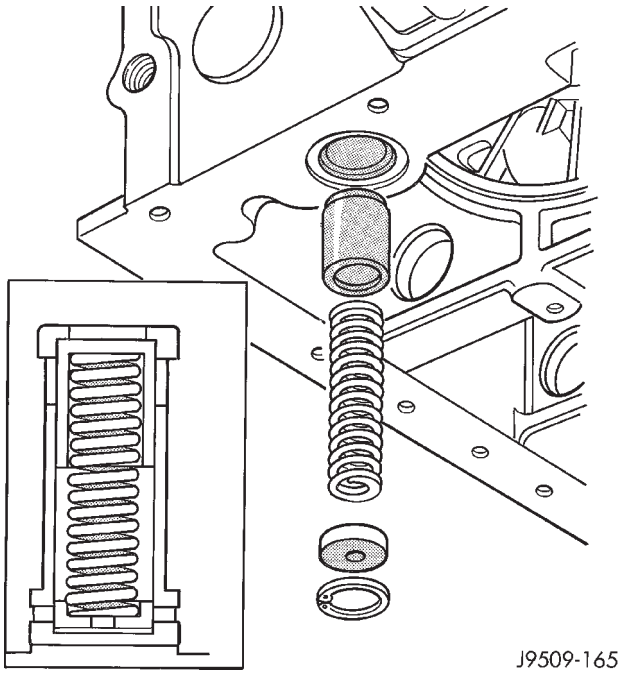


Fig. 61 Oil Pressure Relief Valve

INSTALLATION

(1) Thoroughly clean all components and relief valve pocket in cylinder block.

(2) Fit plunger, spring and cap into block.

(3) Compress spring and install the snap ring. Ensure the snap ring is completely seated in groove.

(4) Install the oil pan. Refer to oil pan removal and installation procedure in this section.

(5) Connect the negative battery cable.

OIL FILTER ADAPTER / COOLER

REMOVAL

(1) Raise the vehicle on the hoist..

(2) Remove the right front wheel and tire assembly.

(3) Drain the cooling system. Refer to Group 7, Cooling System for the procedure.

(4) Working through the right wheel well, position the splash shield out of the way and remove the oil filter adapter and cooler retaining bolt.

(5) Remove the oil filter and adapter from the vehicle.

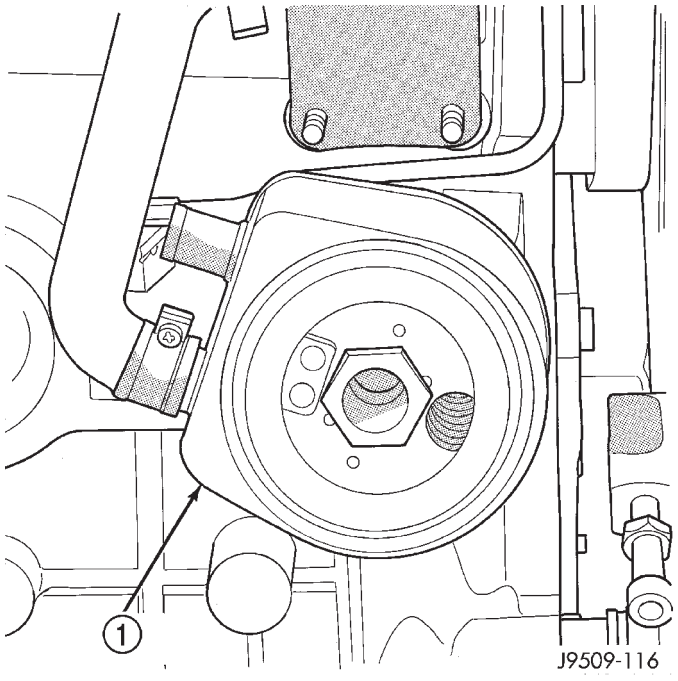


Fig. 62 Oil Cooler

1 – OIL COOLER

(6) Remove the upper coolant supply hose from the cooler assembly. (Fig. 62).

(7) Position the cooler assembly and remove the remaining coolant hose from the cooler assembly.

(8) Remove the oil cooler from the vehicle.

INSTALLATION

CAUTION: There are two o-ring seals associated with these components, one is located between the engine block and oil cooler the other between the cooler and adapter. Use petroleum jelly to hold these seals in position during installation. If either of these seals are not positioned correctly a oil leak will result.

(1) Position the oil cooler and install the coolant hoses.

(2) Install the oil filter and adapter on the oil cooler base. Torque the bolt to 46.6 N·m (34 ft. lbs.).

(3) Install the right front wheel and tire assembly.

(4) Lower the vehicle on the hoist.

(5) Fill the cooling system. Refer to Group 7, Cooling System for the procedure.

REMOVAL AND INSTALLATION (Continued)

PISTONS AND CONNECTING ROD ASSEMBLY

REMOVAL

(1) Disconnect the battery cable.
(2) Remove cylinder heads, refer to cylinder head removal in this section.
(3) Raise vehicle on host.
(4) Remove oil pan, refer to oil pan removal in this section.
(5) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation**. Mark piston with matching cylinder number.
(6) Pistons and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.
(7) Remove connecting rod cap. Install connecting rod bolt protectors on connecting rod bolts. Push each piston and rod assembly out of cylinder bore.

NOTE: Be careful not to nick crankshaft journals.

(8) After removal, install bearing cap on the mating rod.

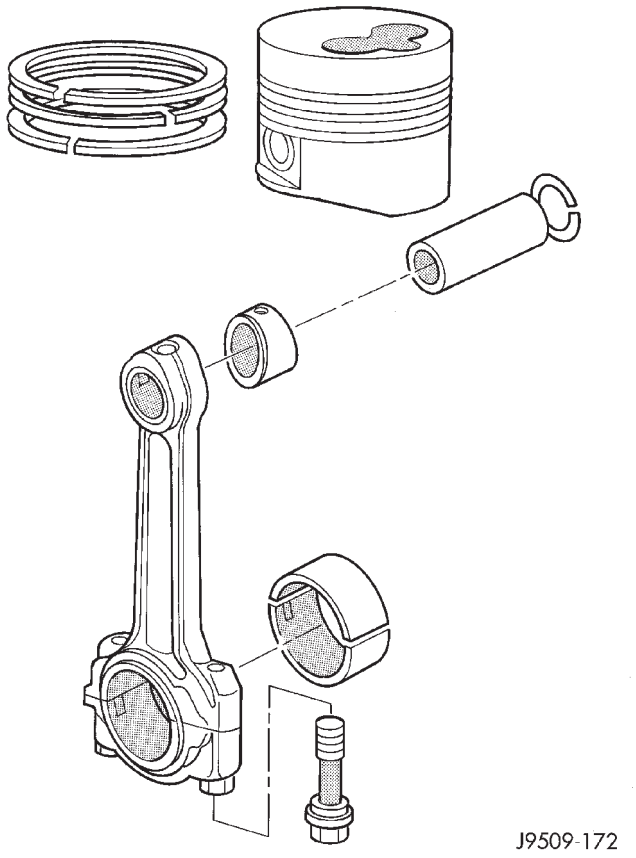


Fig. 63 Piston Assembly

PISTON PIN—REMOVAL

(1) Secure connecting rod in a soft jawed vice.
(2) Remove 2 clips securing piston pin.
(3) Push piston pin out of piston and connecting rod.

PISTON RING—REMOVAL

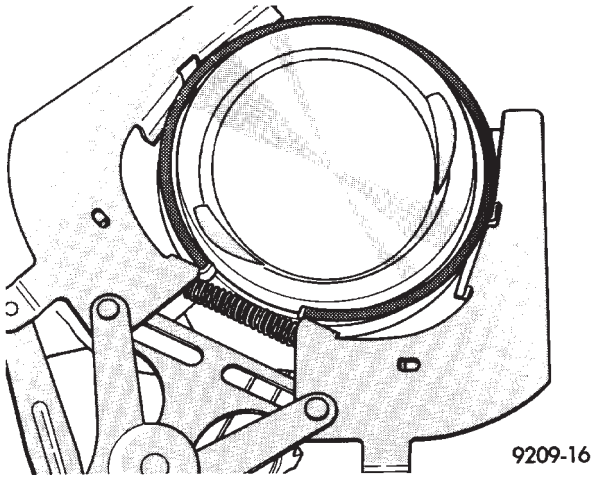


Fig. 64 Piston Rings—Removing and Installing

(1) ID mark on face of upper and intermediate piston rings must point toward piston crown.
(2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 64).
(3) Remove the upper oil ring side rail, lower oil ring side rail and then oil ring 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.

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. Check gap with feeler gauge. Top compression ring gap.25 to.50mm (.0098 to.0196 in.). Second compression ring gap.25 to.35mm (.0098 to.0137 in.). Oil control ring gap.25 to.58mm (.0098 to.0228 in.).
(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. 66). Top compression ring gap.08 to.130mm (.0031 to.0051 in.). Second compression ring gap.070 to.102mm (.0027 to.0040 in.). Oil control ring gap.040 to.072mm (.0015 to.0028 in.).

PISTON RINGS—INSTALLATION

(1) Install rings on the pistons using a suitable ring expander (Fig. 67).

REMOVAL AND INSTALLATION (Continued)

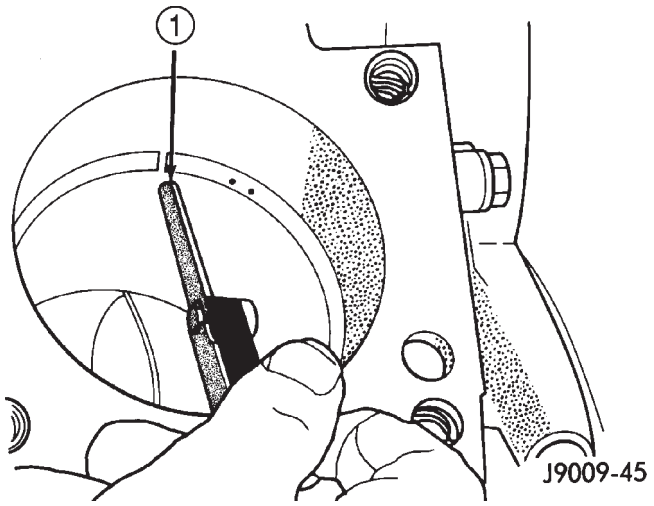


Fig. 65 Ring Gap Measurement

1 – FEELER GAUGE

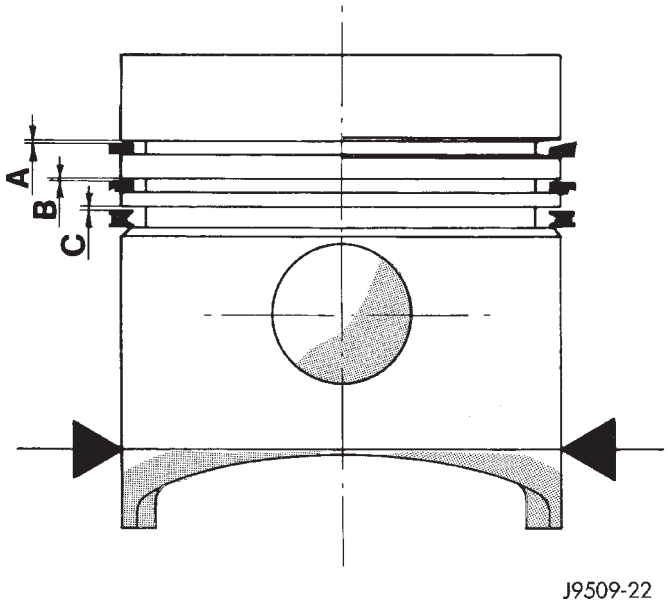


Fig. 66 Piston Ring to Groove Clearance

(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 (Fig. 69).

(3) Top ring gap must be positioned at 30 degrees to the right of the combustion chamber recess (looking at the piston crown from above).

(4) Second piston ring gap should be positioned on the opposite side of the combustion chamber recess.

(5) Oil control ring gap to be located 30 degrees to the left of combustion chamber recess.

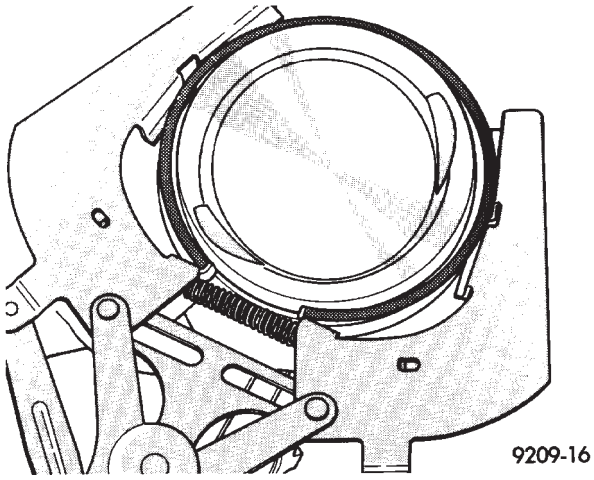


Fig. 67 Piston Rings—Removing and Installing

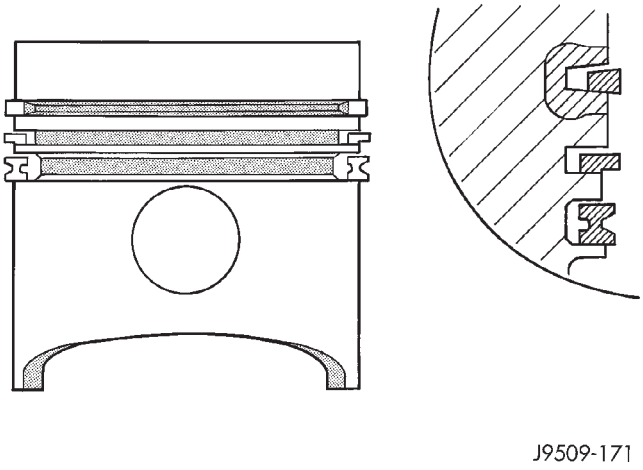


Fig. 68 Piston Ring Identification

(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. **Face chamber recess side of piston towards camshaft**. Therefore, the numbers stamped on con rod big end should also face in the same direction. To insert piston into cylinder use a ring compressor as shown in (Fig. 67).

PISTON PIN INSTALLATION

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

CAUTION: Ensure combustion recess in piston crown and the bearing cap numbers on the connecting rod are on the same side.

(4) Install piston pin.
(5) Install clips in piston to retain piston pin.
(6) Remove connecting rod from vice.

REMOVAL AND INSTALLATION (Continued)

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. 69).

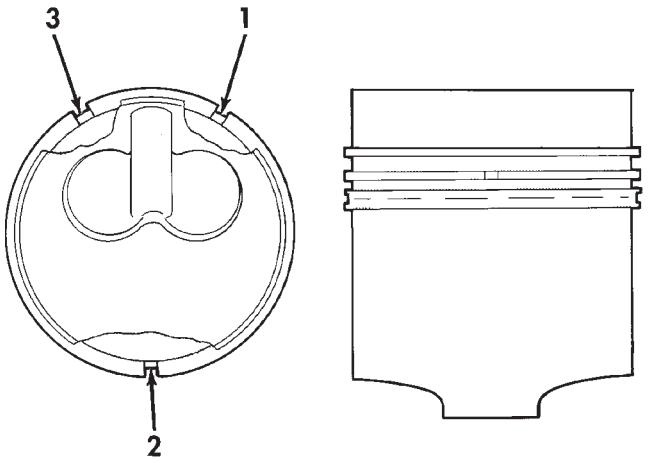


Fig. 69 Piston Ring Gap Location

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 69).

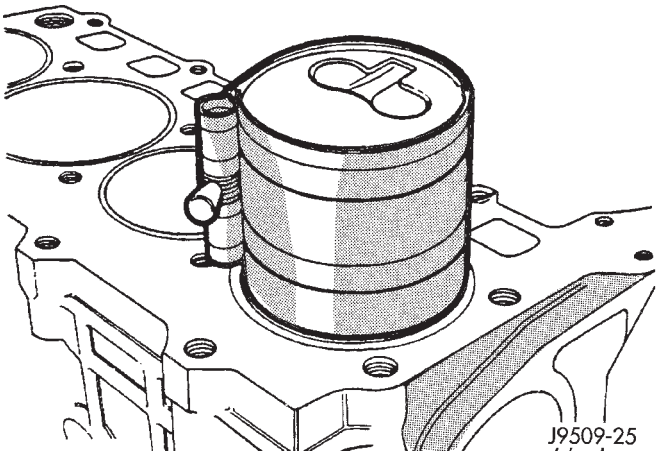


Fig. 70 Installing Piston

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten with the special wrench (Fig. 70). **Ensure position of rings does not change during this operation**.

(4) Face chamber recess side of piston towards camshaft.

CAUTION: During piston and rod removal. DO NOT rotate piston and connecting rod or damage to the oil jets extending out into the cylinder bore will occur (Fig. 71).

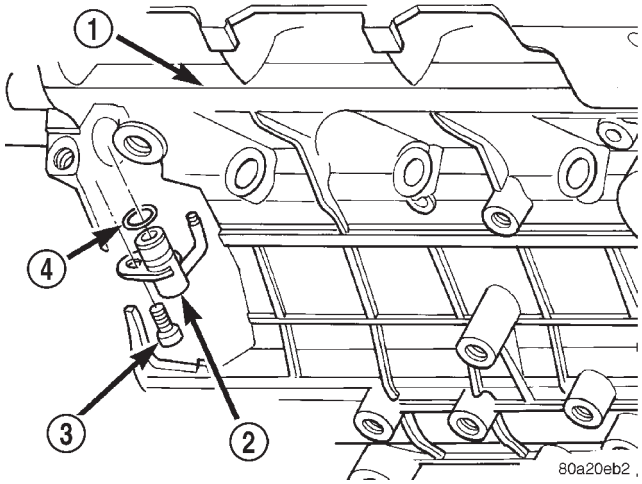


Fig. 71 Oil Jets

1 – CYLINDER BLOCK
2 – OIL COOLING JETS (4)
3 – FASTENER
4 – O-RING

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.

(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 rod caps. Install rod bolts and tighten to 29 N·m (21 ft. lb.) plus 60°.

CYLINDER WALL LINER ASSEMBLY

REMOVAL

(1) Remove cylinder heads.
(2) Remove Oil pan.
(3) Remove pistons.
(4) Use tool VM-1001 to remove liners (Fig. 72).
(5) Remove shims from cylinder liner or cylinder block recess. Keep shims with each cylinder liner.

REMOVAL AND INSTALLATION (Continued)

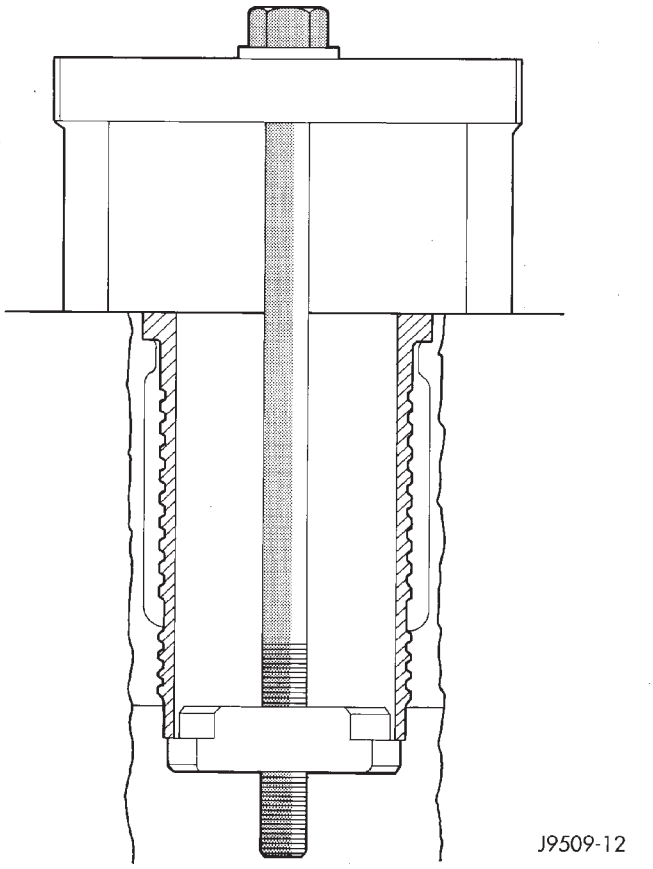


Fig. 72 Liner Removal Tool

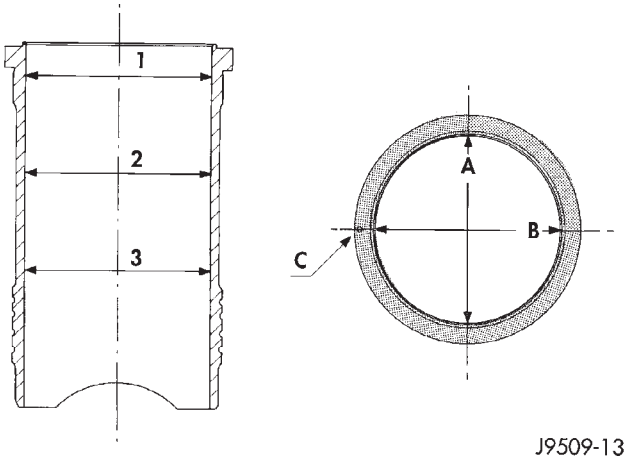


Fig. 73 Liner Inspection

INSTALLATION

(1) Carefully clean residual LOCTITE from liner and crankcase, and degrease the crankcase where it comes into contact with the liners. Install the liners in the crankcase as shown (A), rotating them back and forth by 45° in order to guarantee correct positioning (Fig. 74).

(2) Measure the liner recess relative to block deck with a dial indicator mounted on a special tool VM-1010 A. **All the measurements must be taken on camshaft side**. 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 (0.01 - 0.06 mm).

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

(7) Lubricate the lower liner location in the block. Apply LOCTITE AVX to the corner of the liner seat. Apply LOCTITE AVX uniformly to the upper part of the liner at area.

(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-1016) and bolts (Fig. 75). Clean the residual LOCTITE on the upper surface of the block deck.

(9) Recheck the liner protrusion. It should be 0.01 - 0.06 mm.

NOTE: A period of six hours must elapse between the liners being installed and engine start-up. If engine assembly is not continued after liner installation, the liners need to be clamped for twelve hours minimum.

REMOVAL AND INSTALLATION (Continued)

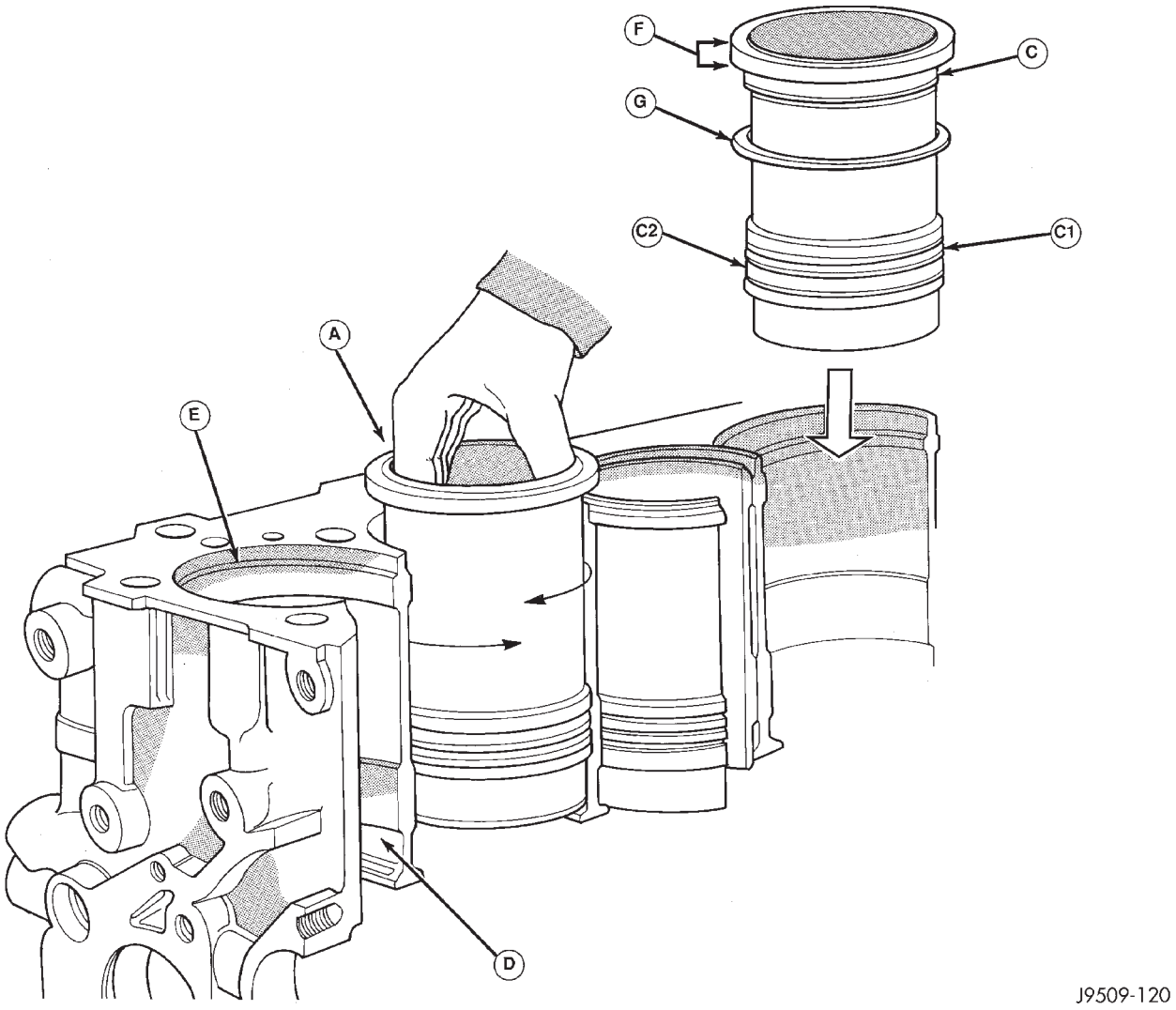


Fig. 74 Liner Installation

REMOVAL AND INSTALLATION (Continued)

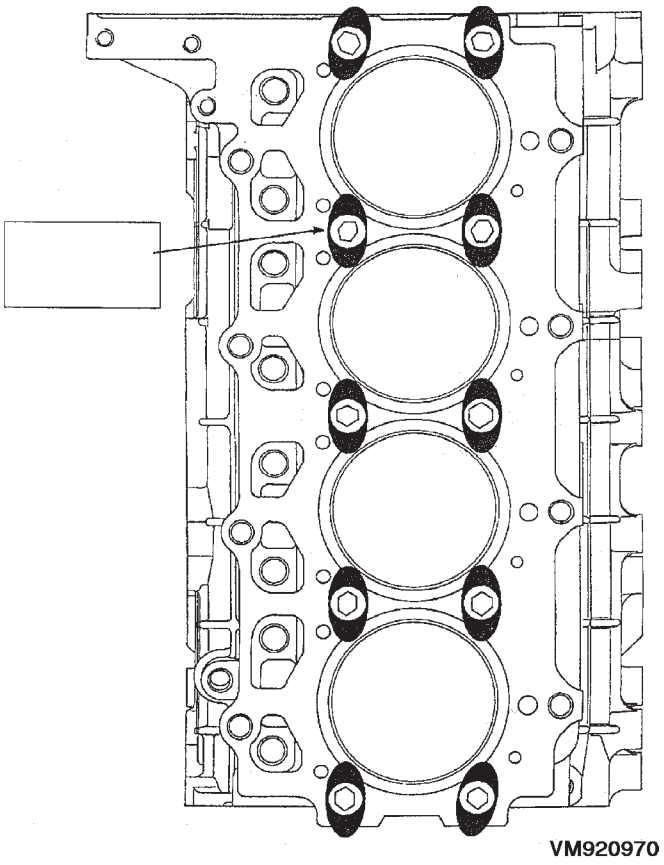


Fig. 75 Liner Clamp Location

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Disconnect the negative battery cable.
(2) Remove the engine from vehicle. Refer to engine removal and installation in this section.
(3) Install the engine on an engine stand.
(4) Remove the accessary drive system.
(5) Remove the cylinder head cover. Refer to cylinder head cover removal and installation in this section.
(6) Remove the rocker arm assemblies and push rods. Refer to rocker arm and push rod removal and installation in this section.
(7) Remove the intake manifold, exhaust manifold and turbocharger. Refer to Group 11, Exhaust System and Turbocharger.
(8) Remove the water manifold.
(9) Remove the oil feed lines to rocker arms.
(10) Remove the cylinder heads. Refer to cylinder head removal and installation in this section.
(11) Remove the oil pan and oil pick-up.
(12) Remove the pistons and connecting rods.
(13) Remove the vibration damper. Refer to vibration damper removal and installation in this section.
(14) Remove the timing gear cover. Refer to timing gear cover removal and installation in this section.
(15) Remove the oil pump and vacuum pump from block.
(16) Install special tool VM.1004 onto crankshaft over gear (Fig. 77).
(17) Remove the main bearing oil feed and crankshaft carrier locators from block.
(18) Remove the flywheel and adaptor plate from engine block.

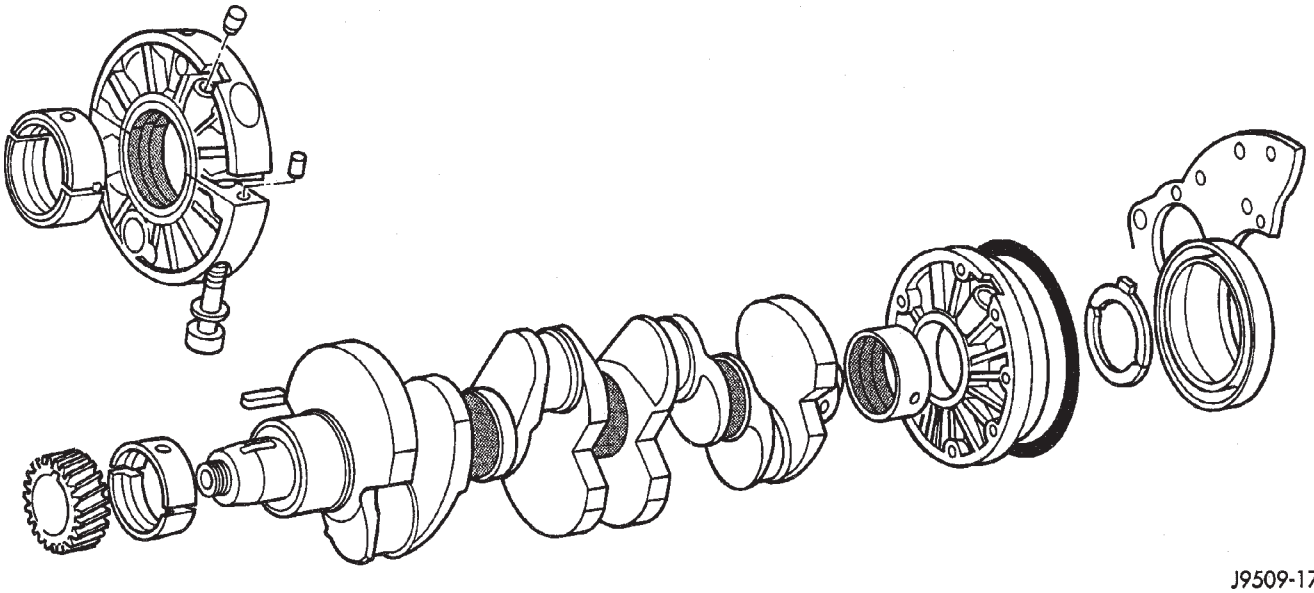


Fig. 76 Crankshaft and Bearing Assembly

REMOVAL AND INSTALLATION (Continued)

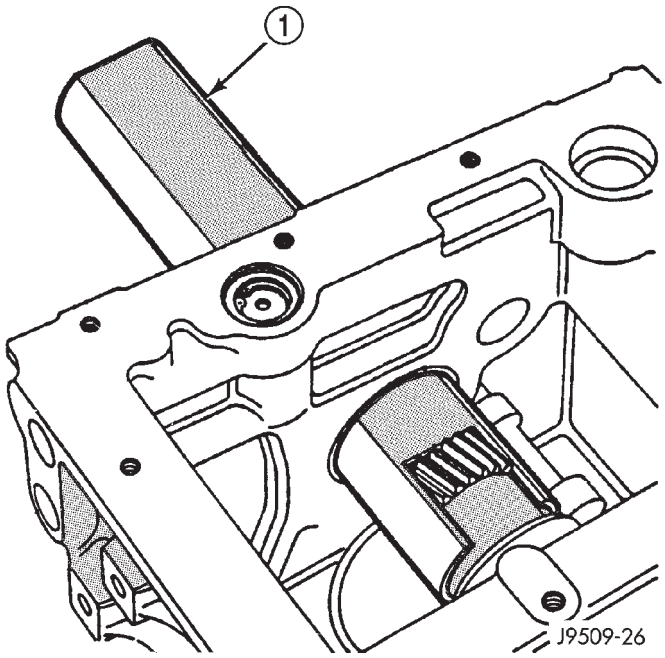


Fig. 77 Crankshaft Special Tool VM.1004

1 – TOOL

(19) Remove the thrust bearings from rear main bearing carrier.

(20) Slide the crankshaft and bearing carriers rearward to rear of block. If you encounter difficulty in removing the complete assembly as previously described, slide the assembly rearward sufficiently to gain access to the main bearing carrier bolts. Mark the carriers for assembly and remove the bolts, two for each carrier (Fig. 78).

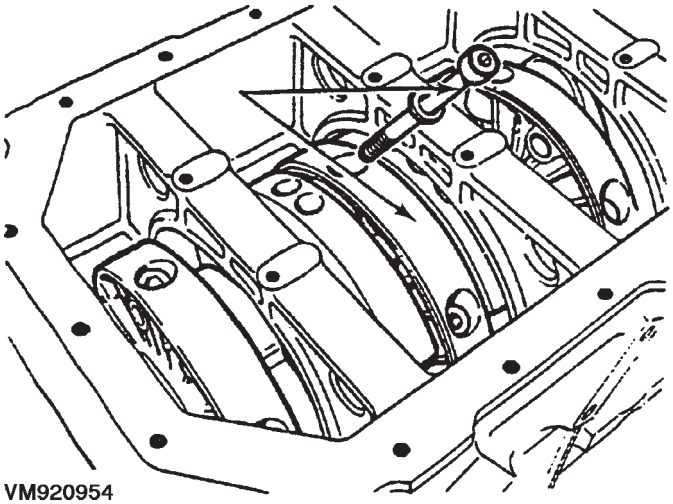


Fig. 78 Crankshaft Support Locator Bolts

(21) Separate the two halves of each carrier, remove from the crankshaft and temporarily re-assemble the carriers (Fig. 79). Withdraw the crankshaft through the rear of the crankcase.

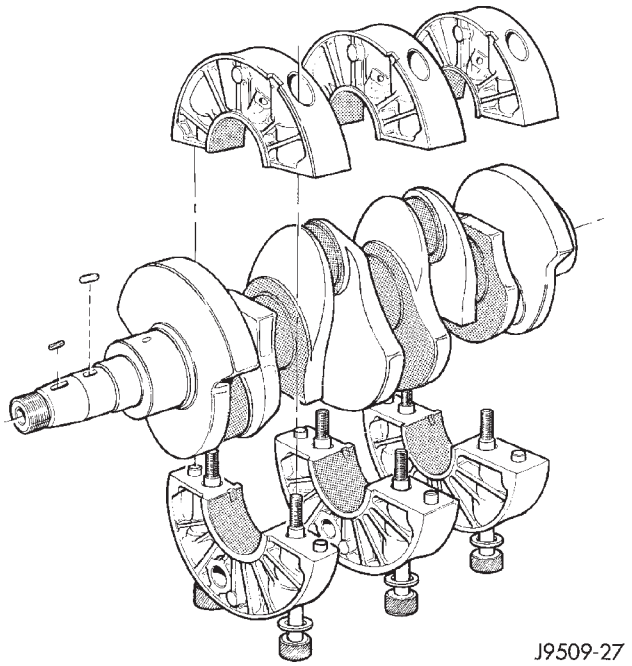


Fig. 79 Crankshaft and Carrier Bearing Assembly

INSTALLATION

(1) Fit the main bearing supports together. Torque to 44 N·m (32 ft. lbs.)

(2) Check internal diameter of bearings.

(3) If internal diameter of original bearing is being checked and figures are not within specifications, new bearings must be used.

(4) Check the crankshaft main bearing journals to bearing clearances. Clearances of main bearings is.03 to.088mm (.0011 to.0035 in.).

NOTE: Assemble engine according to sequence described, thus saving time and preventing damages to engine components. Clean parts with a suitable solvent and dry them with compressed air before assembly. Use new gaskets where applicable and torque wrenches for correct tightening of components.

(5) Thoroughly clean crankcase and oil passages, and blow dry with compressed air.

(6) Install new main bearing shells in each of the carrier halves. Assemble the carriers to the crankshaft journals, ensuring that the carriers are installed in their original locations and that the **piston jet notch is towards the front of the crankshaft**. Secure each carrier with the two bolts tightening evenly to 44 N·m (32 ft. lbs.). Check that the oil jet is in position (Fig. 79).

(7) Slide special tool VM.1004 over the crankshaft gear and, insert the crankshaft and carrier assembly into the crankcase in the same manner used for removal.

REMOVAL AND INSTALLATION (Continued)

(8) Align the holes in the lower supports, with the center of the crankcase webs (Fig. 80).

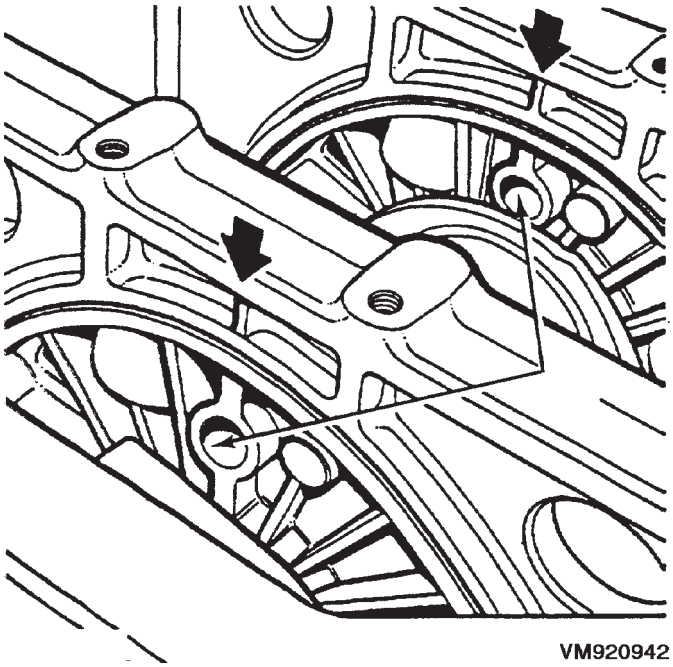


Fig. 80 Main Bearing Support Alignment

(9) Secure each support assembly to the crankcase with the main bearing oil feed and support locators. Torque to 54 N·m (40 ft. lbs).

(10) Install the rear main bearing support onto crankshaft ensuring arrow on bearing support aligns with vertical web in center of crankcase.

(11) Install the rear oil seal.

(12) Install the new O-rings in adaptor plate.

(13) Install the adaptor plate to block. Torque nuts to 26.5 N·m (20 ft. lbs.).

(14) Install the Allen bolts through adaptor plate to rear main bearing support. Torque to 11 N·m (97 in. lbs.).

(15) Position the flywheel and O-ring on crankshaft and align bolt holes.

NOTE: For purposes of checking crankshaft end play, used flywheel bolts may be used. Final assembly requires new flywheel bolts.

(16) Install 2 flywheel bolts, 180° apart, and tighten bolts to 20 N·m plus 60° (15 ft. lbs.) plus 60°.

(17) Attach dial indicator to engine block.

(18) Move crankshaft toward front of engine and zero indicator.

(19) Move crankshaft toward the rear of engine and record measurement.

(20) Subtract specified crankshaft end play from figure obtained. Crankshaft end play.153 to.304mm (.0060 to.0119 in.).

(21) Select thrust washers which will give correct end play.

(22) Remove tools and flywheel.

(23) Lubricate thrust washer halves and fit them into the rear main bearing carrier.

(24) Ensure that crankshaft end and flywheel mating surfaces are clean and dry. Install “O” ring in flywheel groove.

(25) To verify correct end play, install 2 flywheel bolts 180° apart, and tighten bolts to 20 N·m plus 60° (15 ft. lbs. plus 60°).

(26) Measure crankshaft end play with a dial gauge. Crankshaft end play should not exceed.153 to.304mm (.0060 to.0119 in.) (Fig. 81).

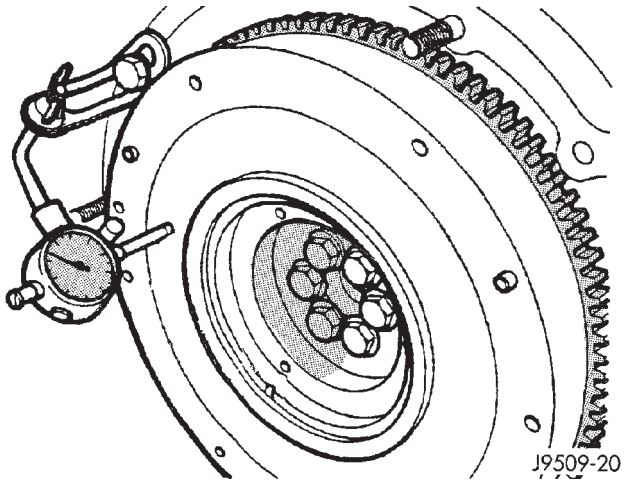


Fig. 81 Measuring Crankshaft End Play

CAUTION: Use NEW flywheel bolts for the following procedure.

(27) Install a new O-ring on flywheel. Install flywheel on crankshaft. The 6 flywheel bolts must be tightened as follows:

a. Lubricate and install the 6 new flywheel bolts.

b. Torque the 6 flywheel bolts to 49 N·m (36 ft. lbs.) starting one bolt and following with the opposite one (cross tightening) until completion, in a clockwise direction..

c. Loosen one bolt at a time and tighten to 19.6 N·m (14 ft. lbs.) plus 75° using the cross tightening method.

(28) Install the pistons and connecting rod assemblies. Refer to piston and connecting rods removal and installation in this section.

(29) Install the oil pick up tube. Torque bolts to 25 N·m (18 ft. lbs.).

(30) Install the oil pan. Refer to oil pan removal and installation in this section.

(31) Install the vacuum pump, being careful to align the gear timing marks with those on the crankshaft gear. Torque screws to 20 N·m (15 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

(32) Before installing the oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 82). Difference between A and B should be 0.020-0.082 mm (.0007 to 0032 in.).

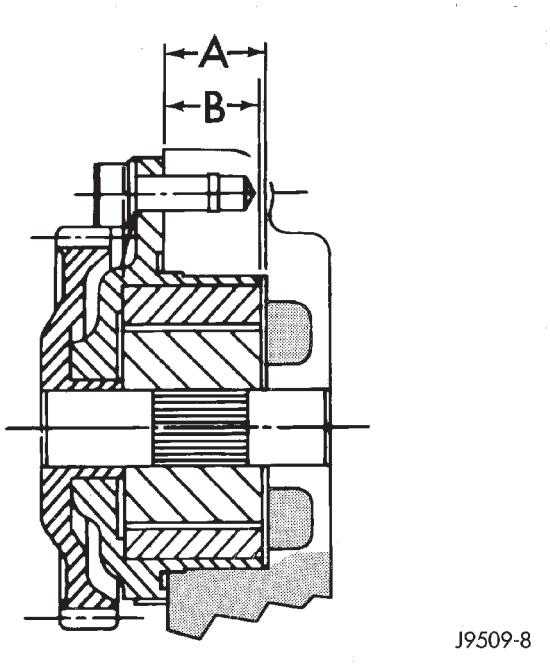


Fig. 82 Oil Pump Bore Depth

(33) Install the oil pump. Torque screws to 27 N·M (20 ft.lbs.). Check for normal backlash between pump and crankshaft gears.

(34) Install the timing gear cover. Refer to timing gear cover removal and installation in this section.

(35) Install the vibration damper. Refer to vibration damper removal and installation in this section.

(36) Install the cylinder heads. Refer to cylinder head removal and installation in this section.

(37) Install the rocker arms and push rods. Refer to rocker arm and push rod removal and installation in this section.

(38) Install the cylinder head cover. Refer to cylinder head cover removal and installation in this section.

(39) Install the accessary drive system.

(40) Install the engine in vehicle. Refer to engine removal and installation in this section.

(41) Fill engine with the correct amount of fluids specified.

(42) Connect the negativre battery cable.

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

DISASSEMBLE

(1) Pry out plunger retainer spring clip.

(2) Clean varnish deposits from inside of tappet body above plunger cap.

(3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring. Check valve could be flat or ball.

ASSEMBLE

(1) Clean all tappet parts in a solvent that will remove all varnish and carbon.

(2) Replace tappets that are unfit for further service with new assemblies.

(3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.

(4) Assemble tappets.

CLEANING AND INSPECTION

CYLINDER HEAD

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 (Fig. 83).

Minimum cylinder head thickness 89.95mm (3.541 in.)

CAUTION: If only one cylinder head is found to be distorted and requires machining, it will also be necessary to machine the remaining cylinders heads and end plates by a corresponding amount to maintain correct cylinder alignment.

CLEANING AND INSPECTION (Continued)

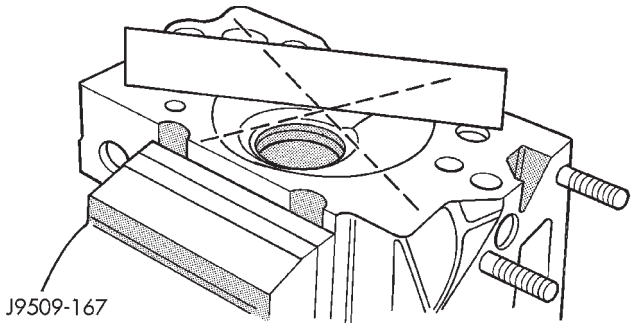


Fig. 83 Checking Cylinder Head Flatness

ROCKER ARMS AND PUSH RODS

CLEANING

Clean all the components (Fig. 84) with cleaning solvent.

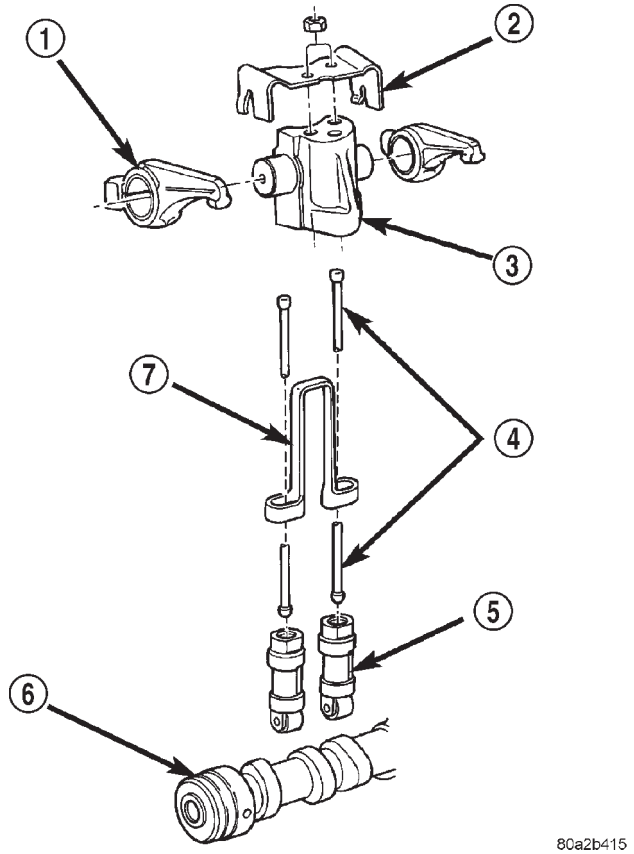


Fig. 84 Rocker Arm Components

1 – ROCKER ARM
2 – SPRING PLATE
3 – ROCKER SUPPORT
4 – PUSH ROD
5 – HYDRAULIC TAPPET
6 – CAMSHAFT
7 – ANTIROTATION BRACKET

Use compressed air to blow out the oil passages in the rocker arms and push rods.

INSPECTION

Inspect the pivot surface area of each rocker arm. Replace any that are scuffed, pitted, cracked or excessively worn.

Inspect the valve stem tip contact surface of each rocker arm and replace any rocker arm that is deeply pitted.

Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn because of lack of oil, replace it and inspect the corresponding hydraulic tappet for excessive wear.

Inspect the push rods for straightness by rolling them on a flat surface or by shining a light between the push rod and the flat surface.

A wear pattern along the length of the push rod is not normal. Inspect the engine cylinder head for obstruction if this condition exists.

PISTONS AND CONNECTING ROD ASSEMBLY

INSPECTION—PISTONS

(1) Piston Diameter: Size: 91.93-91.94mm (3.6191-3.6196 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 0.25 mm (.0009 in.).

(6) Make sure the weight of the pistons does not differ by more than 5 g.

INSPECTION—CONNECTING ROD

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

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

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

NOTE: When changing connecting rods, all five must have the same weight and be stamped with the same number. Replacement connecting rods will only be supplied in sets of five.

Connecting rods are supplied in sets of five since they all must be of the same weight category. Max allowable weight difference is 18 gr.

CLEANING AND INSPECTION (Continued)

NOTE: On one side of the big end of the con-rod there is a two-digit number which refers to the weight category. On the other side of the big end there is a four digit number on both the rod and the cap. These numbers must both face the camshaft as well as the recess on the piston crown (Fig. 86). Lightly heat the piston in oven. Insert piston pin in position and secure it with provided snap rings.

The Four digit numbers marked on con rod big end and rod cap must be on the same side as the camshaft (Fig. 86). After having coated threads with Molyguard, tighten con rod bolts to 29 N·m (21 ft. lbs.) plus 60°.

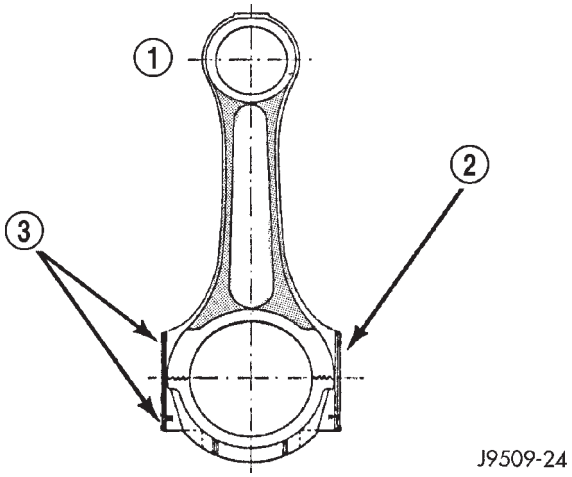


Fig. 85 Connecting Rod Identification

1 – CAMSHAFT SIDE
2 – 2–DIGIT NUMBER FOR WEIGHT CATEGORY
3 – 4–DIGIT REFERENCE NUMBERS FOR CORRECT ASSEMBLING

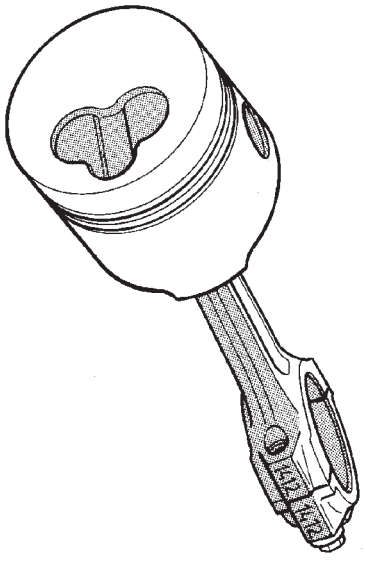


Fig. 86 Piston and Connecting Rod Assembly

INSPECTION—PISTON PIN

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

(2) Piston pin diameter is 29.990 to 29.996mm (1.1807 to 1.1809 in.).

INSPECTION—CRANKSHAFT JOURNALS

(1) Using a micrometer, measure and record crankshaft connecting rod journals, take reading of each journal 120° apart. Crankshaft journal diameter is 53.84 to 53.955mm (2.1196 to 2.1242 in.).

(2) Crankshaft journals worn beyond limits or show signs of out of roundness must be reground or replaced. Minimum reground diameter is 53.69mm (2.1137 in.).

BEARING-TO-JOURNAL CLEARANCE

Compare internal diameters of connecting rod with crankshaft journal diameter. Maximum clearance between connecting rod and crankshaft journals.022 to.076mm (.0008 to.0029 in.).

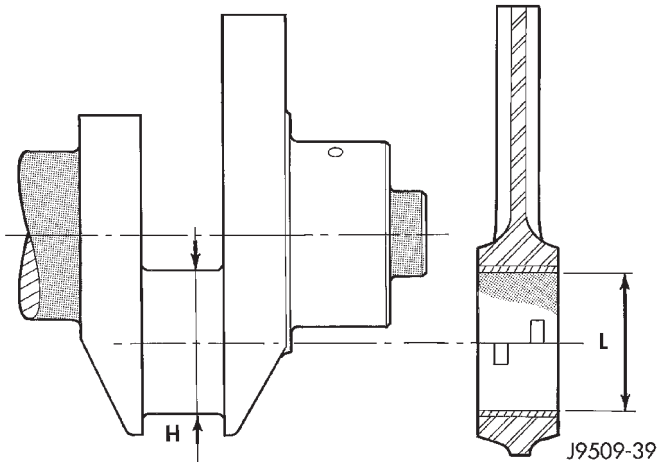


Fig. 87 Bearing Clearance

CYLINDER WALL LINER ASSEMBLY

INSPECTION

The cylinder walls should be checked for out-of-round and taper with dail bore gauge. The cylinder bore out-of-round is 0.100 mm (.0039 inch) maximum and cylinder bore taper is 0.100 mm (0.0039 inch) 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. 88). Top measurement should be 10 mm (3/8 inch) down and bottom measurement should be 10 mm (3/8 inch.) up from bottom of bore.

CLEANING AND INSPECTION (Continued)

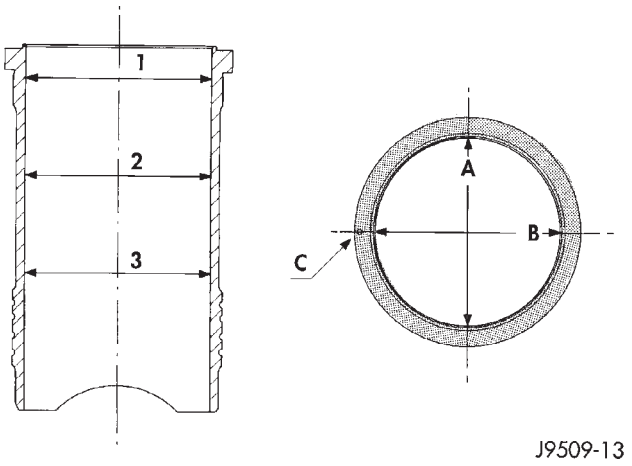


Fig. 88 Liner Inspection

OIL PUMP

CLEANING

Wash all parts in a suitable solvent and inspect carefully for damage or wear.

INSPECTION

(1) Before installing oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 89). Difference between A and B should be 0.020-0.082 mm.

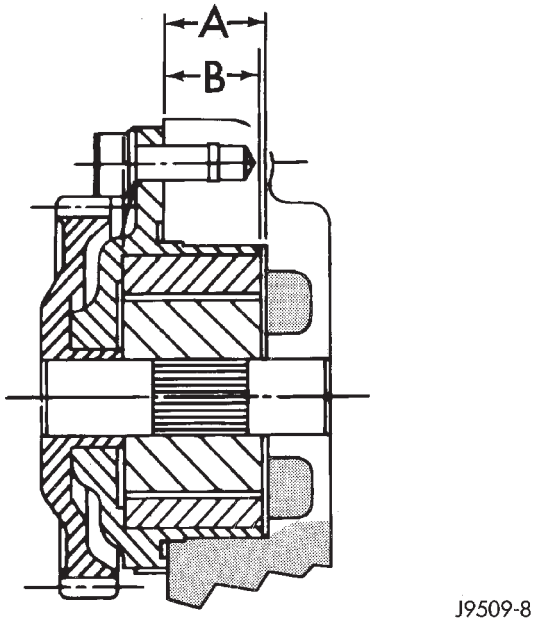


Fig. 89 Oil Pump Bore Depth

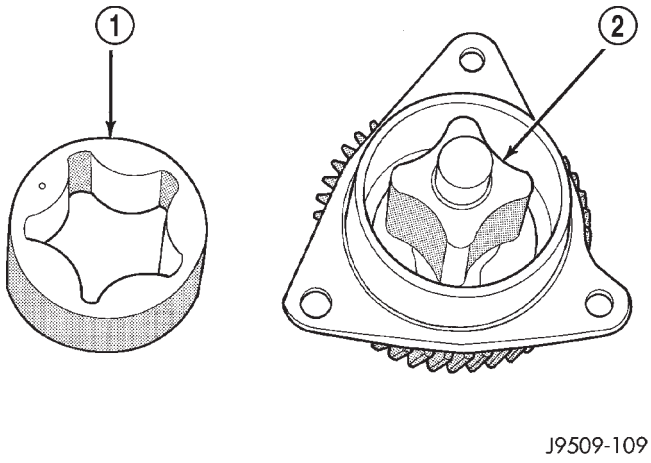


Fig. 90 Oil Pump Inner and Outer Rotors

1 – OUTER ROTOR
2 – INNER ROTOR

(2) Check clearance between rotors (Fig. 91).

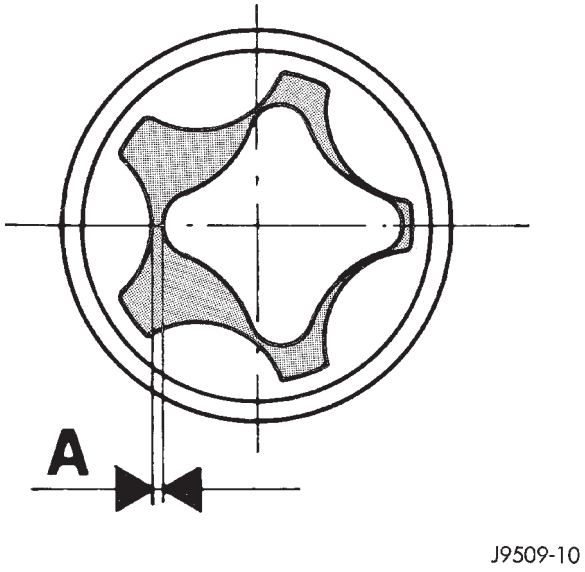


Fig. 91 Checking Rotor Clearance

SPECIFICATIONS

ENGINE SPECIFICATIONS

DESCRIPTION	SPECIFICATIONS
Type	425 CX2
Number of cylinders	4
Bore	92 mm
Stroke	94 mm
Capacity	2499.5cc
Injection order	1–3–4–2
Compression ratio	21 : 1 (+/− 0.5)
Gasket	Asbestos free
Crankshaft	
Front journal diameter	
Nominal	62.985-63.005 mm
−0.25	62.735-62.755 mm
−0.125	62.860-62.880 mm
Front bearing diameter	
Nominal	63.043-63.088 mm
−0.25	62.793-62.838
−0.125	62.919-62.964 mm
Clearance between journal and bearing: 0.038-0.103 mm	
Center journal diameter	
Nominal	63.005-63.020 mm
−0.25	62.755-62.770 mm
−0.125	62.880-62.895 mm
Center bearing diameter	
Nominal	63.050-63.093 mm
−0.25	62.800-62.843 mm
−0.125	62.925-62.968 mm
Clearance between journal and bearing: 0.030-0.088 mm	
Rear journal diameter	
Nominal	79.980-80.000 mm
−0.25	79.730-79.750 mm
−0.125	79.855-79.875 mm
Rear bearing diameter	
Nominal	80.045-80.070 mm
−0.25	79.795-79.820 mm
−0.125	79.920-79.945 mm
Clearance between journal and bearing: 0.045-0.090 mm	
Wear limit: 0.200 mm.	
Connecting rod journal	
Nominal	53.940-53.955 mm
−0.25	53.690-53.705 mm
−0.125	53.815-53.830 mm
Connecting rod bearing	
Nominal	53.977-54.016 mm
−0.25	53.727-53.766 mm
−0.125	53.852-53.891 mm

DESCRIPTION	SPECIFICATIONS
Clearance between journal and bearing: 0.022-0.076 mm	
Wear limit: 0.200 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
Main bearing carriers	
Internal diameter	
Front	67.025-67.050 mm
Center	66.670-66.687 mm
Rear	85.985-86.005 mm
Liners	
Internal diameter	91.997-92.015 mm
Protrusion	0.01-0.06 mm
Adjustment	Shims
Available shims:	0.15 mm
	0.17 mm
	0.20 mm
	0.23 mm
	0.25 mm
Cylinder head	
Minimum thickness	89.95-90.05 mm
Gaskets thickness	1.41 mm +/− 0.08, 0 notches
	1.61 mm +/− 0.08, 1 notch
	1.51 mm +/− 0.08, 2 notches
End plates:	
Height	89.92−90.00 mm
Connecting rods	
Weight (without the crank bearing): 966 grams	
Small end bearing	
Internal diameter	
Minimum	30.035 mm
Maximum	30.050 mm
Crankshaft bearings	
Standard Internal diameter	53.977−54.016 mm
Pistons	
Skirt diameter	91.918-91.932 mm
(measured at approximately 10 mm above the bottom of the skirt).	
Piston clearance:	0.065-0.083 mm
Top of piston to cylinder head	0.80-0.89 mm
Piston protrusion	0.53 - 0.62 Fit gasket
	Number (1.41), 0 notches or holes
	0.73 - 0.82 Fit gasket
	Number (1.61), 1 notch or hole
	0.63 - 0.72 Fit gasket
	Number (1.51), 2 notches or holes

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATIONS
Piston pins	
Type	Fully floating
Pin diameter	29.992-29.996 mm
Clearance	0.004-0.012 mm
Piston rings	
Clearance in groove:	
Top	0.080-0.130 mm
Second	0.070-0.110 mm
Oil control	0.040-0.080 mm
Fitted gap:	
Top	0.30 - 0.45 mm
Second	0.30 - 0.45 mm
Oil control	0.25 - 0.50 mm
Camshaft	
Journal diameter, front	53.495-53.51 mm
Bearing clearance	0.030-0.095 mm
Center	53.45-53.47 mm
Bearing clearance	0.07-0.14 mm
Rear	53.48-53.50 mm
Bearing clearance	0.04-0.11 mm
Tappets	
Outside diameter	22.195-22.212 mm
Rocker gear	
Shaft diameter	21.979-22.00 mm
Bush internal diameter	22.020-22.041 mm
Assembly clearance	0.020-0.062 mm
Valves	
Intake valve:	
Opens	26° B.T.D.C.
Closes	58° A.B.D.C.
Exhaust valve:	
Opens	66° B.B.D.C.
Closes	36° A.T.D.C.
Face angle:	
Intake	55° 30′ - 55° 40′
Exhaust	45° 25′ - 45° 35′
Head diameter:	
Intake	40.05-40.25 mm
Exhaust	33.8-34.0 mm
Head stand down:	
Intake	1.08-1.34 mm
Exhaust	0.99-1.25 mm
Stem diameter:	
Intake	7.940-7.960 mm
Exhaust	7.922-7.940 mm
Clearance in guide:	
Intake	0.040-0.075 mm
Exhaust	0.060-0.093 mm
Valve guide	
Inside diameter	8.0-8.015 mm
Fitted height	13.5-14 mm

DESCRIPTION	SPECIFICATIONS
Valve springs	
Free length	44.65 mm
Fitted length	38.6 mm
Load at fitted length	34 +/− 6% Kg
Load at top of lift	92.5 +/- 4% Kg
Number of coils	5.33 Valve timing
Lubrication	
System pressure at 4000 rev/min	3.5 to 5.0 bar (oil at 90-100°C)
Pressure relief valve opens	6.84 bar
Pressure relief valve spring - free length	57.5 mm
Oil pump:	
Outer rotor end float	0.030-0.107 mm
Inner rotor end float	0.030-0.107 mm
Outer rotor to body diam. clearance	0.130-0.230 mm
Rotor body to drive gear clearance (pump not fitted)	0.30-0.50 mm

TORQUE SPECIFICATIONS

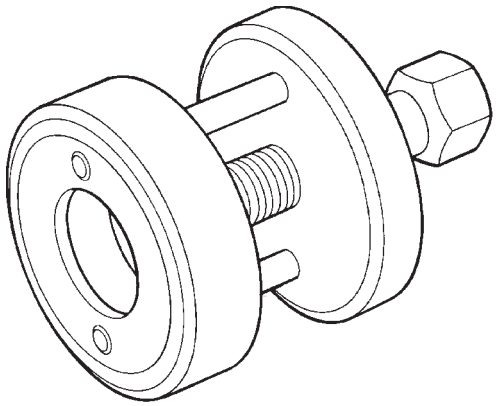
DESCRIPTION	TORQUE
Adaptor Plate to Block	
Nuts (6)	27 N·m (20 ft. lbs.)
Automatic Belt Tensioner to Block	
Bolts (2)	121 N·m
Automatic Belt Tensioner to Mounting Bracket	
Bolt (1)	75 N·m
Generator bracket	
Mounting bolts (6 mm)	10 N·m
Mounting bolts (8 mm)	24.4 N·m
Generator	
Mounting bolt	47 N·m
Camshaft thrust plate	
Bolts	24 N·m
Connecting rod	
Mounting bolt	29.5 N·m +60°
Crankshaft bearing	
Carrier screw	42 N·m
Crankshaft pulley	
Locknut	160 N·m
Crossmember	
Bolts	42 N·m
Diesel delivery	
Union nut	18.5 N·m
EGR valve	
To intake manifold	26 N·m
EGR tube	
To EGR valve	27 N·m
Engine mount—Front	
Engine support bracket	61 N·m
Support Cushion	47 N·m
Support cushion bracket bolts	54 N·m
Support cushion bracket stud nuts	41 N·m

SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Support Cushion through bolt	65 N·m
Engine mount—Rear	
Transmission support bracket	46 N·m
Support Cushion nuts	75 N·m
Support Cushion through bolt	65 N·m
Exhaust down pipe	
To turbocharger	22 N·m
Exhaust heat shield	
Screws	11 N·m
Exhaust manifold collar	
Mounting nut	24.5 to 29.5 N·m
Exhaust manifold	
Mounting nut	32.5 N·m
Fan drive	
To fan hub	56 N·m
Flywheel	
Lock bolt	20 N·m +60°
Front timing cover	
6 mm bolts	10 N·m
8 mm bolts	26 N·m
Fuel filter	
Nuts	28 N·m
Glow plug	
Torque	13.0 N·m
Idler pulley	
Bolt (left hand thread)	47 N·m
Injection pump fuel lines	
Nut	23 N·m
Injection pump gear	
Lock nut	86 N·m
Injection pump	
Mounting nut	27.5 N·m
Injector	
Torque	68.5 N·m
Intake manifold	
Mounting nut	32.5 N·m
Main bearing oil delivery	
Union	54 N·m
Water hose to cylinder head	
Nut	8 to 10 N·m
Oil cooler adaptor	
Bolt	60 N·m
Oil feed line	
For rocker arms	12 N·m
To block	27 N·m
To vacuum pump	15 N·m
Oil filter	
Torque	18 N·m
Oil filter adapter	
Torque	46.6 N·m
Oil filter base	
Torque	46.6 N·m
Oil pan	
Mounting bolts	13 N·m
Oil pickup tube	
Torque	25 N·m
Oil pump	
Mounting screw	27 N·m
Oil sump drain plug	
Torque	54 N·m
Power steering pressure hose	
Nut	28 N·m
Power steering pulley	
Nut	130 N·m
Rear crankshaft bearing carrier Allen Bolts	
Torque	11 N·m
Rocker cover	
Bolts	19 N·m
Rocker mounting	
Lock Nut	35 N·m
Steering pump	
Bolts	28 N·m
Turbocharger	
Mounting nuts	32.5 N·m
Turbocharger	
Oil delivery fitting	27.5 N·m
Turbocharger oil drain	
Plug	10.8 N·m
Vacuum pump	
Torque	27 N·m
Water manifold	
Bolts	12 N·m
Water pump pulley	
Nut	27 N·m

SPECIAL TOOLS

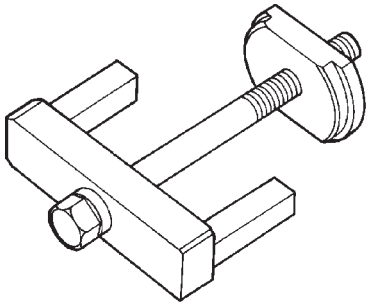
SPECIAL TOOLS



803fd6a1

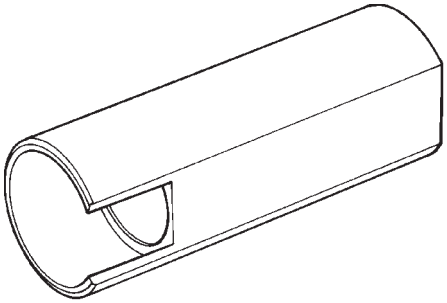
Crankshaft Pulley and Gear Remover VM. 1000A

SPECIAL TOOLS (Continued)



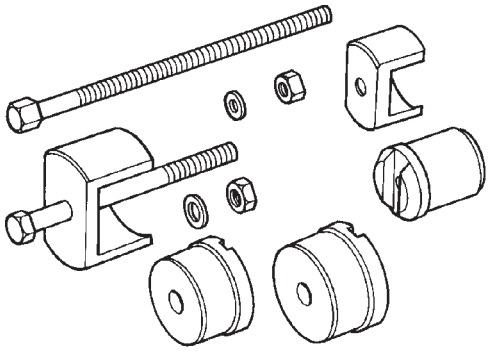
803fd6a2

Cylinder Liner Puller VM, 1001



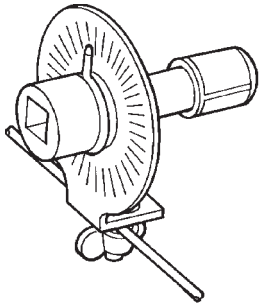
803fd6a5

Crankshaft Remover/Replacer Sleeve VM. 1004



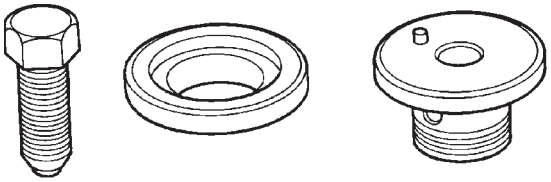
803fd6a3

Crankshaft Bearing Remover/Replacer VM. 1002



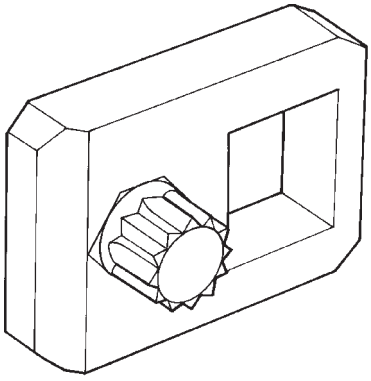
803fd6a6

Torque Angle Gauge VM. 1005



803fd6a4

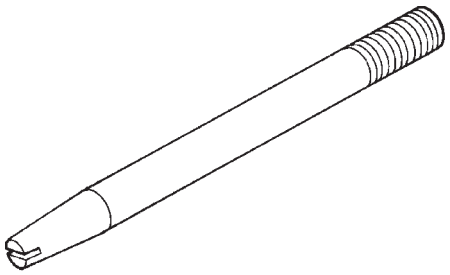
Injection Pump Puller and Gear retainer VM. 1003



803fd6a7

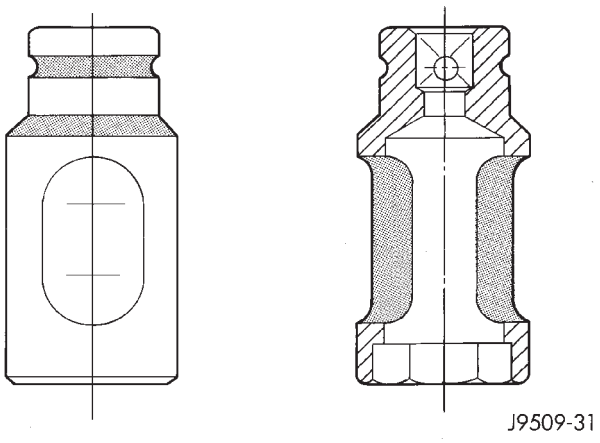
Cylinder Head Bolt Wrench VM. 1006A

SPECIAL TOOLS (Continued)



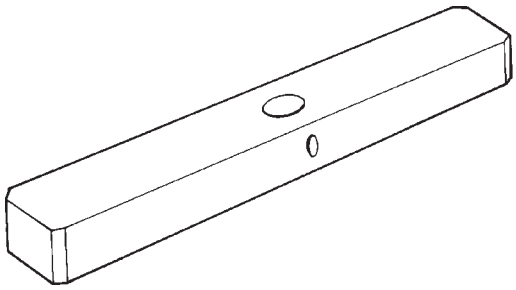
803fd6a9

Cylinder Head Guide Studs VM. 1009



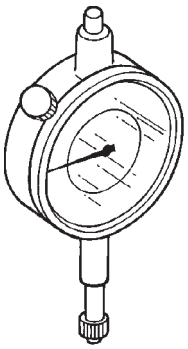
J9509-31

Injector Remover/Replacer Socket VM. 1012B



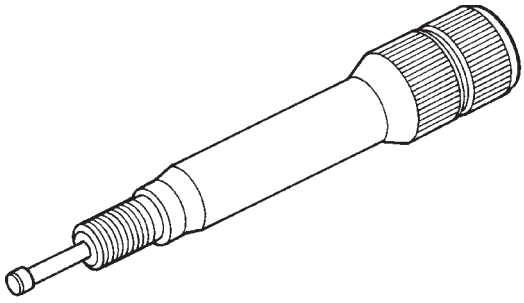
80a1aa43

Cylinder Liner Protrusion Tool VM. 1010



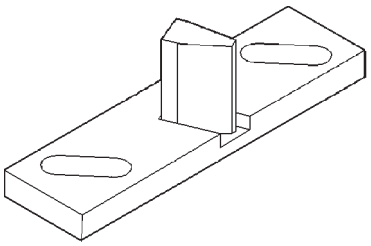
80a1aa46

Dial Indicator Gauge VM. 1013

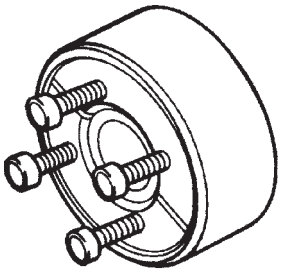


80a1aa44

Bosch Pump Timing Adapter VM. 1011



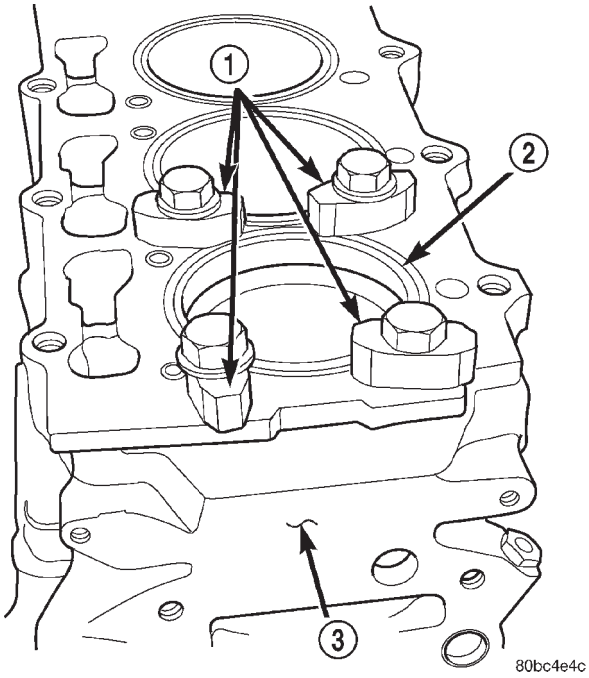
Flywheel Locking Tool VM. 1014



80b897ec

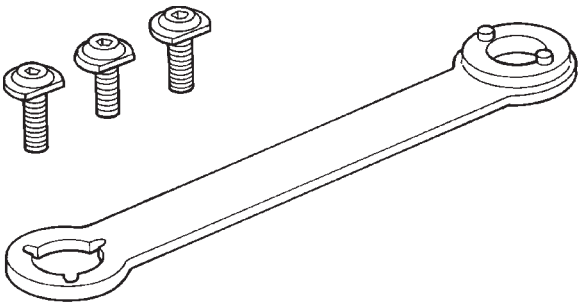
Timing Cover Oil Seal Replacer VM. 1015A

SPECIAL TOOLS (Continued)

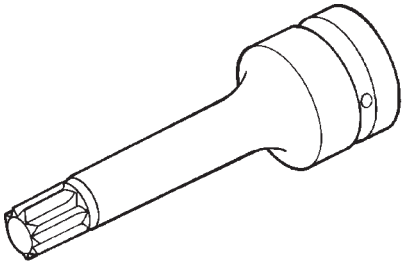


Cylinder Retainer VM. 1016

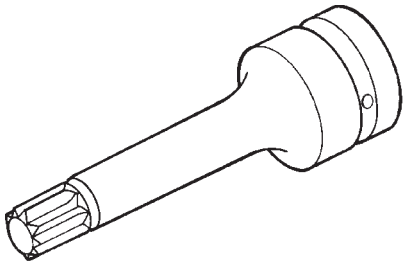
1 – VM.1016
2 – CYLINDER LINER
3 – CYLINDER BLOCK



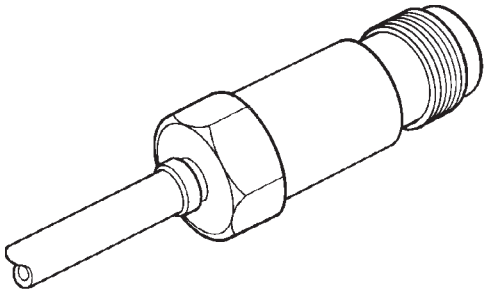
Crankshaft and Water Pump Pulley Holder VM. 1017



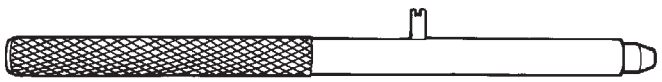
Cylinder Head Bolt Wrench M12 VM. 1018



Cylinder Head Bolt Wrench M14 VM. 1019



Cylinder Leakage Tester Adapter VM. 1021



5.2L ENGINE

TABLE OF CONTENTS

page

DESCRIPTION AND OPERATION
ENGINE . . . 56
ENGINE LUBRICATION SYSTEM . . . 57
EXHAUST MANIFOLD . . . 59
INTAKE MANIFOLD . . . 59
CYLINDER HEAD COVER GASKET . . . 60
CYLINDER HEAD . . . 60
VALVES AND VALVE SPRINGS . . . 60
ENGINE OIL PAN . . . 60
CRANKSHAFT OIL SEALS . . . 60
PISTON AND CONNECTING ROD . . . 61
CRANKSHAFT MAIN BEARINGS . . . 61
CRANKSHAFT . . . 61
SERVICE PROCEDURES
FORM-IN-PLACE GASKETS . . . 61
ENGINE PERFORMANCE . . . 62
ENGINE OIL . . . 62
REPAIR DAMAGED OR WORN THREADS . . . 64
CYLINDER BORE—HONING . . . 64
HYDROSTATIC LOCK . . . 65
VALVE TIMING . . . 65
VALVE SERVICE . . . 65
MEASURING TIMING CHAIN STRETCH . . . 68
PISTONS—FITTING . . . 68
PISTON RINGS—FITTING . . . 69
CONNECTING ROD BEARINGS—FITTING . . . 70
CRANKSHAFT MAIN BEARINGS—FITTING . . . 71
REMOVAL AND INSTALLATION
ENGINE MOUNTS—FRONT . . . 71
ENGINE MOUNT—REAR . . . 72
ENGINE ASSEMBLY . . . 73
INTAKE MANIFOLD . . . 74
EXHAUST MANIFOLD . . . 76
CYLINDER HEAD COVER . . . 77
ROCKER ARMS AND PUSH RODS . . . 77
VALVE SPRING AND STEM SEAL REPLACEMENT-IN VEHICLE . . . 77

page

CYLINDER HEAD . . . 78
VALVES AND VALVE SPRINGS . . . 79
HYDRAULIC TAPPETS . . . 79
VIBRATION DAMPER . . . 79
TIMING CHAIN COVER . . . 80
TIMING CHAIN . . . 81
CAMSHAFT . . . 82
CAMSHAFT BEARINGS . . . 83
CRANKSHAFT MAIN BEARINGS . . . 84
DISTRIBUTOR DRIVE SHAFT BUSHING . . . 84
OIL PAN . . . 86
PISTON AND CONNECTING ROD ASSEMBLY . . . 86
CRANKSHAFT . . . 87
OIL PUMP . . . 88
CRANKSHAFT OIL SEAL—FRONT . . . 88
CRANKSHAFT OIL SEALS—REAR . . . 89
ENGINE CORE OIL AND CAMSHAFT PLUGS . . . 91
DISASSEMBLY AND ASSEMBLY
VALVE SERVICE . . . 92
OIL PUMP . . . 94
CYLINDER BLOCK . . . 94
CLEANING AND INSPECTION
CYLINDER HEAD COVER . . . 95
CYLINDER HEAD ASSEMBLY . . . 95
PISTON AND CONNECTING ROD ASSEMBLY . . . 95
OIL PAN . . . 95
OIL PUMP . . . 96
CYLINDER BLOCK . . . 98
INTAKE MANIFOLD . . . 98
EXHAUST MANIFOLD . . . 98
SPECIFICATIONS
5.2L ENGINE SPECIFICATIONS . . . 98
TORQUE SPECIFICATIONS . . . 102
SPECIAL TOOLS
5.2L ENGINE . . . 103

DESCRIPTION AND OPERATION

ENGINE

DESCRIPTION

The 5.2 Liter (318 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets.

The engine lubrication system consists of a rotor type oil pump and a full flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5, 7 on the left bank and 2, 4, 6, 8 on the right bank. The firing order is 1-8-4-3-6-5-7-2 (Fig. 1). This engine is designed for unleaded fuel.

The engine serial number is stamped into a machined pad located on the left, front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 2).

DESCRIPTION AND OPERATION (Continued)

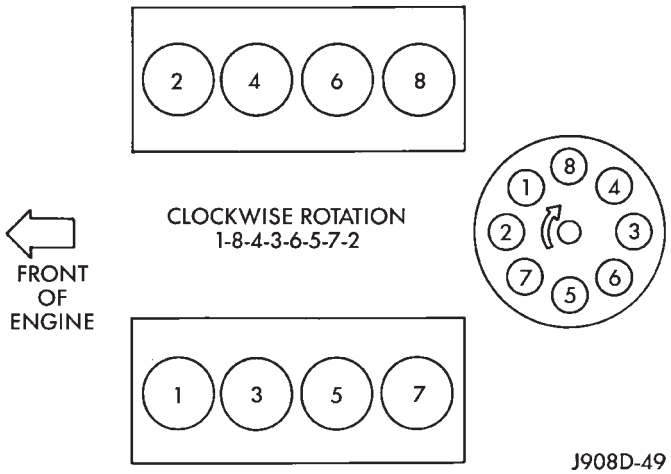


Fig. 1 Firing Order

X M AAA YYYY 0000

X = Last Digit of Model Year
M = Plant-M Mound Road
S Saltillo
T Trenton
K Toluca
AAA = Engine Displacement (CID)
YYYY = Month/Day
0000 = Engine Serial Code

80bbd9ce

Fig. 2 Engine Identification Number

ENGINE LUBRICATION SYSTEM

DESCRIPTION

A gear-type positive displacement pump (Fig. 3) is mounted at the underside of the rear main bearing cap. The pump uses a pick-up tube and screen assembly to gather engine oil from the oil pan.

OPERATION

The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main gallery, which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block, and into the oil gallery on the left side of the engine.

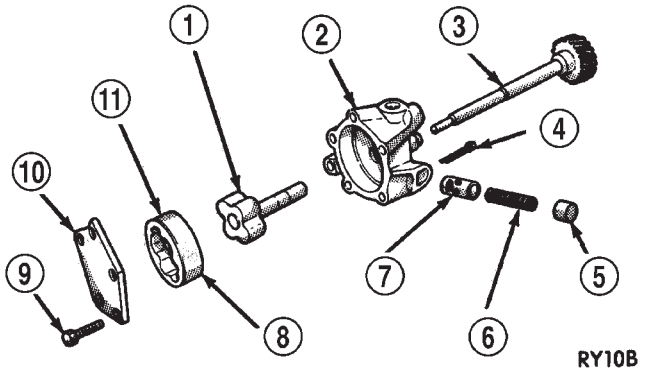


Fig. 3 Positive Displacement Oil Pump—Typical

1 – INNER ROTOR AND SHAFT
2 – BODY
3 – DISTRIBUTOR DRIVESHAFT (REFERENCE)
4 – COTTER PIN
5 – RETAINER CAP
6 – SPRING
7 – RELIEF VALVE
8 – LARGE CHAMFERED EDGE
9 – BOLT
10 – COVER
11 – OUTER ROTOR

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing has half a hole in it, oil passes through the hole when the rods rotate and the hole lines up, oil is then thrown off as the rod rotates. This oil throwoff lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the No. 1 main bearing cap.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets, which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components. The oil then passes down through the push rod guide holes and the oil drain-back passages in the cylinder head, past the valve tappet area, and then returns to the oil pan.

DESCRIPTION AND OPERATION (Continued)

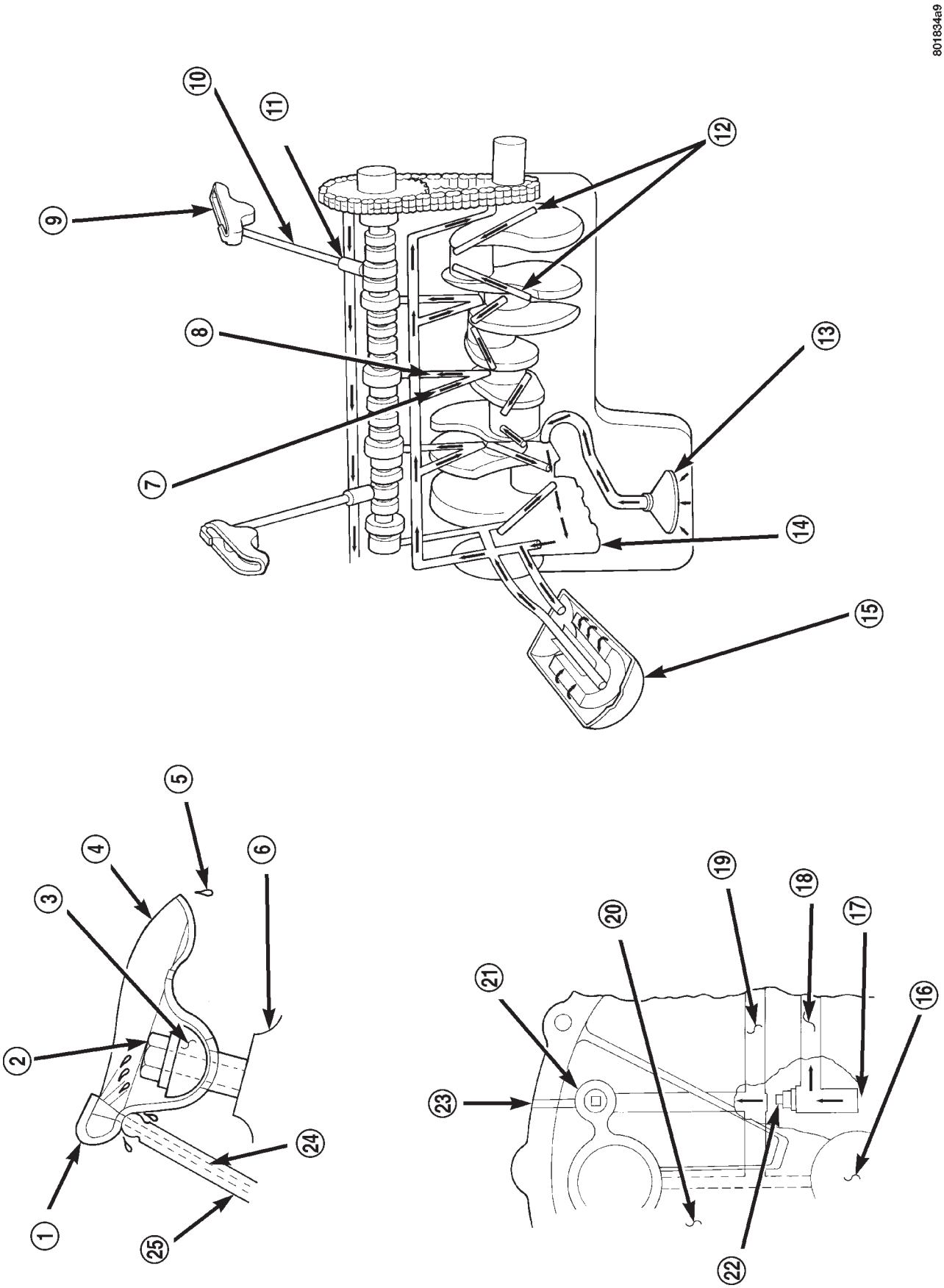


Fig. 4 Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

1 – OIL DEFLECTOR TAB
2 – BOLT
3 – ROCKER ARM PIVOT
4 – ROCKER ARM
5 – DRIP OILING FOR VALVE TIP
6 – CYLINDER HEAD BOSS
7 – TO MAIN BEARINGS
8 – TO CAMSHAFT BEARINGS
9 – ROCKER ARM
10 – HOLLOW PUSH ROD
11 – TAPPET
12 – TO CONNECTING ROD BEARINGS
13 – OIL INTAKE
14 – OIL PUMP
15 – OIL FILTER
16 – CRANKSHAFT
17 – FROM OIL PUMP
18 – OIL TO FILTER
19 – OIL FROM FILTER TO SYSTEM
20 – PASSAGE TO CAMSHAFT REAR BEARING
21 – RIGHT OIL GALLERY
22 – PLUG
23 – OIL PASSAGE FOR OIL PRESSURE INDICATOR LIGHT
24 – OIL SUPPLY VIA HOLLOW PUSH ROD SUPPLY IS FROM OIL GALLERY METERED THROUGH HYDRAULIC TAPPET
25 – OIL SUPPLY FROM HOLLOW PUSH ROD

EXHAUST MANIFOLD

DESCRIPTION

The exhaust manifolds (Fig. 5) are constructed of cast iron and are LOG type with balanced flow. One exhaust manifold is attached to each cylinder head.

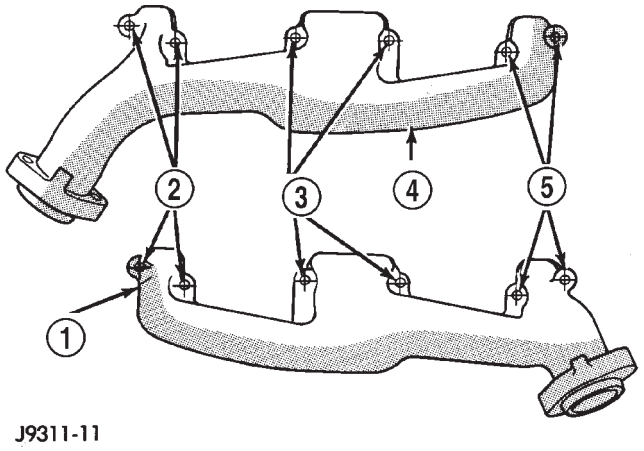


Fig. 5 Exhaust Manifolds—V-8 Gas Engines Typical

1 – EXHAUST MANIFOLD (LEFT)
2 – BOLTS & WASHERS
3 – NUTS & WASHERS
4 – EXHAUST MANIFOLD (RIGHT)
5 – BOLTS & WASHERS

OPERATION

The exhaust manifolds collect the engine exhaust exiting the combustion chambers, then channels the exhaust gases to the exhaust pipes attached to the manifolds.

INTAKE MANIFOLD

DESCRIPTION

The aluminum intake manifold (Fig. 6) is a single plane design with equal length runners and uses a separate plenum, therefore the manifold does have a plenum gasket. It also uses separate flange gaskets and front and rear cross-over gaskets. Extreme care must be used when sealing the gaskets to ensure that excess sealant does not enter the intake runners causing a restriction. Whenever the intake manifold is removed inspect the plenum pan for evidence of excess oil buildup, this condition indicates that the plenum pan gasket is leaking.

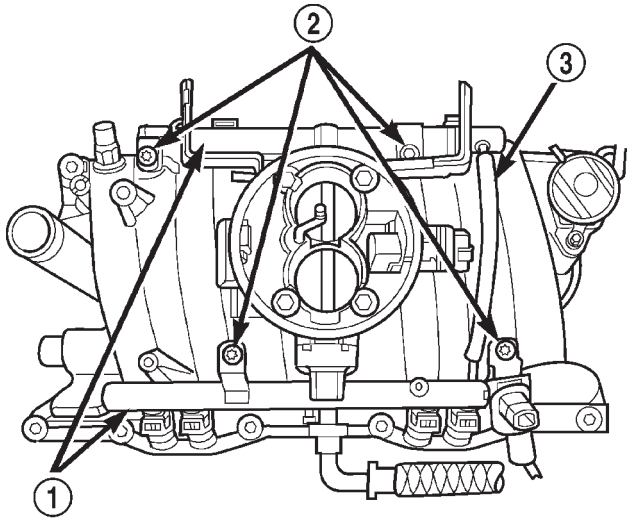


Fig. 6 Intake Manifold and Throttle Body—V-8 Gas Engines Typical

1 – FUEL RAIL ASSEMBLY
2 – FUEL RAIL MOUNTING BOLTS
3 – FUEL RAIL CONNECTING HOSES

OPERATION

The intake manifold, meters and delivers air to the combustion chambers allowing the fuel delivered by the fuel injectors to ignite, thus producing power.

DESCRIPTION AND OPERATION (Continued)

CYLINDER HEAD COVER GASKET

DESCRIPTION

The cylinder head cover gasket (Fig. 7) is a steel-backed silicone gasket, designed for long life usage.

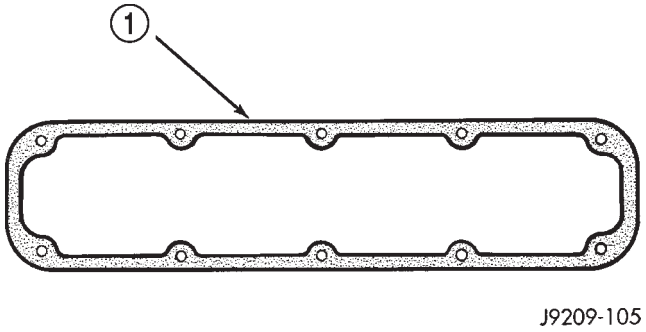


Fig. 7 Cylinder Head Cover Gasket V-8 Gas Engines

1 – CYLINDER HEAD COVER GASKET

OPERATION

The steel-backed silicone gasket is designed to seal the cylinder head cover for long periods of time through extensive heat and cold, without failure. The gasket is designed to be reusable.

CYLINDER HEAD

DESCRIPTION

The cast iron cylinder heads (Fig. 8) are mounted to the cylinder block using ten bolts. The spark plugs are located in the peak of the wedge between the valves.

OPERATION

The cylinder head closes the combustion chamber allowing the pistons to compress the air fuel mixture to the correct ratio for ignition. The valves located in the cylinder head open and close to either allow clean air into the combustion chamber or to allow the exhaust gases out, depending on the stroke of the engine.

VALVES AND VALVE SPRINGS

DESCRIPTION

Both the intake and exhaust valves are made of steel. The intake valve is 48.768 mm (1.92 inches) in diameter and the exhaust valve is 41.148 mm (1.62 inches) in diameter and has a 2.032 mm (0.080 inch) wafer interia welded to the tip for durability. These valves are not splayed.

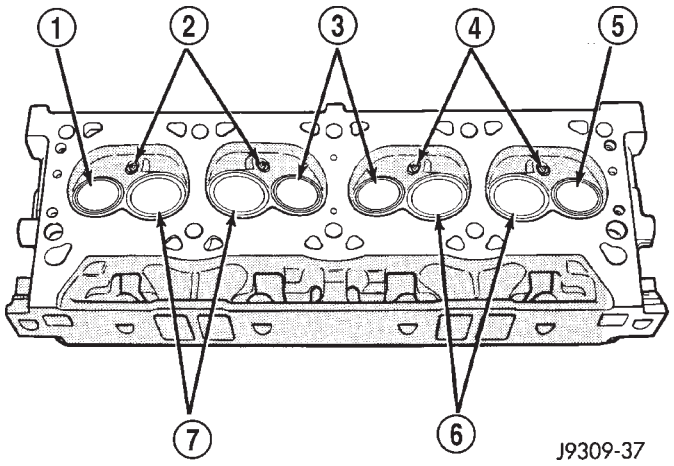


Fig. 8 Cylinder Head Assembly—V-8 Gas Engines

1 – EXHAUST VALVE
2 – SPARK PLUGS
3 – EXHAUST VALVES
4 – SPARK PLUGS
5 – EXHAUST VALVE
6 – INTAKE VALVES
7 – INTAKE VALVES

ENGINE OIL PAN

DESCRIPTION

The stamped steel engine oil pan is located at the bottom of the engine, and contains a drain plug for draining the engine oil.

OPERATION

The oil pan holds the engine oil and seals and protects the engine lower components from contaminates.

CRANKSHAFT OIL SEALS

DESCRIPTION

The crankshaft rear seal is a two piece viton seal. The crankshaft front seal is a one piece viton seal with a steel housing. The front seal is located in the engine front cover. One part of the two piece rear seal is located in a slot in the number five (5) crankshaft main bore, the second part of the two piece seal is located in the number five (5) main bearing cap.

OPERATION

The crankshaft seals prevent oil from leaking from around the crankshaft, either from the rear of the engine or from the engine front cover.

DESCRIPTION AND OPERATION (Continued)

PISTON AND CONNECTING ROD

DESCRIPTION

The pistons are made of aluminum and have three ring grooves, the top two grooves are for the compression rings and the bottom groove is for the oil control ring. The connecting rods are forged steel and are coined prior to heat treat. The piston pins are press fit.

CRANKSHAFT MAIN BEARINGS

DESCRIPTION

Main bearings are located in the cylinder block. One half of the main bearing is located in the crankshaft main bore the other half of the matching bearing is located in the main bearing cap (Fig. 9). There are five main bearings. Number three main bearing is flanged, this flange controls crankshaft thrust.

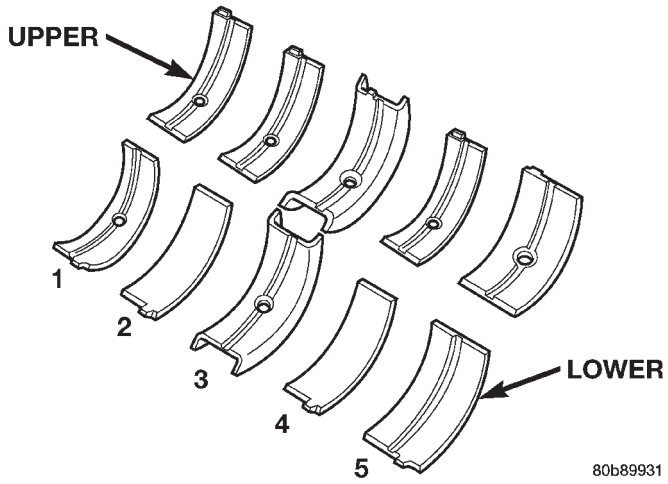


Fig. 9 Main Bearing Orientation

OPERATION

The main bearings encircle the crankshaft main bearing journals, this aligns the crankshaft to the centerline of the engine and allows the crankshaft to turn without wobbling or shaking therefore eliminating vibration. The main bearings are available in standard and undersizes.

CRANKSHAFT

DESCRIPTION

The crankshaft is of a cast nodular steel splayed type design, with five main bearing journals.The crankshaft is located at the bottom of the engine block and is held in place with five main bearing caps. The number 3 counterweight is the location for journal size identification.

Undersize Journal	Identification Stamp
0.025 mm (0.001 inch) (Rod)	R1-R2-R3 or R4
0.025 mm (0.001 inch) (Main)	M1-M2-M3-M4 or M5

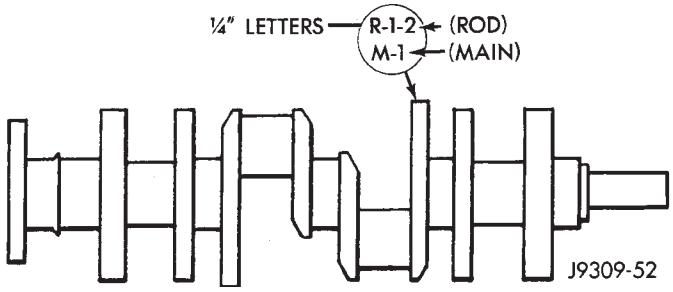


Fig. 10 Crankshaft with Journal Size Identification

OPERATION

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

SERVICE PROCEDURES

FORM-IN-PLACE GASKETS

There are several places where form-in-place gaskets are used on the engine. **DO NOT use form-in-place gasket material unless specified.** Care must be taken when applying form-in-place gaskets. Bead size, continuity and location are of great importance. Too thin a bead can result in leakage while too much can result in spill-over. A continuous bead of the proper width is essential to obtain a leak-free joint.

Two types of form-in-place gasket materials are used in the engine area (Mopar Silicone Rubber Adhesive Sealant and Mopar Gasket Maker). Each have different properties and cannot be used interchangeably.

MOPAR SILICONE RUBBER ADHESIVE SEALANT

Mopar Silicone Rubber Adhesive Sealant, normally black in color, is available in 3 ounce tubes. Moisture in the air causes the sealant material to cure. This material is normally used on flexible metal flanges. It has a shelf life of a year and will not properly cure if over aged. Always inspect the package for the expiration date before use.

MOPAR GASKET MAKER

Mopar Gasket Maker, normally red in color, is available in 6 cc tubes. This anaerobic type gasket material cures in the absence of air when squeezed between smooth machined metallic surfaces. It will

not cure if left in the uncovered tube. DO NOT use on flexible metal flanges.

SURFACE PREPARATION

Parts assembled with form-in-place gaskets may be disassembled without unusual effort. In some instances, it may be necessary to lightly tap the part with a mallet or other suitable tool to break the seal between the mating surfaces. A flat gasket scraper may also be lightly tapped into the joint but care must be taken not to damage the mating surfaces.

Scrape or wire brush all gasket surfaces to remove all loose material. Inspect stamped parts to ensure gasket rails are flat. Flatten rails with a hammer on a flat plate, if required. Gasket surfaces must be free of oil and dirt. Make sure the old gasket material is removed from blind attaching holes.

GASKET APPLICATION

Assembling parts using a form-in-place gasket requires care.

Mopar Silicone Rubber Adhesive Sealant should be applied in a continuous bead approximately 3 mm (0.12 inch) in diameter. All mounting holes must be circled. For corner sealing, a 3 or 6 mm (1/8 or 1/4 inch) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within 10 minutes). The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

Mopar Gasket Maker should be applied sparingly to one gasket surface. The sealant diameter should be 1.00 mm (0.04 inch) or less. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

ENGINE PERFORMANCE

It is important that the vehicle is operating to its optimum performance level to maintain fuel economy and the lowest emission levels. If vehicle is not operating to these standards, refer to Engine Diagnosis outlined in this section. The following procedures can assist in achieving the proper engine diagnosis.

(1) Test cranking amperage draw. Refer to Electrical Group 8B, Cold Cranking Test.

(2) Check intake manifold bolt torque.

(3) Perform cylinder compression test. Refer to Cylinder Compression Pressure Test in the Engine Diagnosis area of this section.

(4) Clean or replace spark plugs as necessary and adjust gap as specified in Electrical Group 8D. Tighten to specifications.

(5) Test resistance of spark plug cables. Refer to Electrical Group 8D, Spark Plug Cables.

(6) Inspect the primary wires. Test coil output voltage and primary resistance. Replace parts as necessary. Refer to Electrical Group 8D, for specifications.

(7) Test fuel pump for pressure. Refer to Group 14, Fuel System Specifications.

(8) The air filter elements should be replaced as specified in Lubrication and Maintenance, Group 0.

(9) Inspect crankcase ventilation system as out lined in Group 0, Lubrication and Maintenance. For emission controls see Group 25, Emission Controls for service procedures.

(10) Road test vehicle as a final test.

ENGINE OIL

WARNING: NEW OR USED ENGINE OIL CAN BE IRRITATING TO THE SKIN. AVOID PROLONGED OR REPEATED SKIN CONTACT WITH ENGINE OIL. CONTAMINANTS IN USED ENGINE OIL, CAUSED BY INTERNAL COMBUSTION, CAN BE HAZARDOUS TO YOUR HEALTH. THOROUGHLY WASH EXPOSED SKIN WITH SOAP AND WATER. DO NOT WASH SKIN WITH GASOLINE, DIESEL FUEL, THINNER, OR SOLVENTS, HEALTH PROBLEMS CAN RESULT. DO NOT POLLUTE, DISPOSE OF USED ENGINE OIL PROPERLY.

ENGINE OIL SPECIFICATION

CAUTION: Do not use non-detergent or straight mineral oil when adding or changing crankcase lubricant. Engine failure can result.

API SERVICE GRADE CERTIFIED

In gasoline engines, use an engine oil that is API Service Grade Certified (Fig. 11). Standard engine oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans. MOPAR only provides engine oil that conforms to this certification.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 10W-30 specifies a multiple viscosity engine oil. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. When choosing an engine oil, consider the range of temperatures the vehicle will be operated in before the next oil change.

SERVICE PROCEDURES (Continued)

9400-9

Fig. 11 Engine Oil Container Standard Notations

Select an engine oil that is best suited to your area's particular ambient temperature range and variation (Fig. 12).

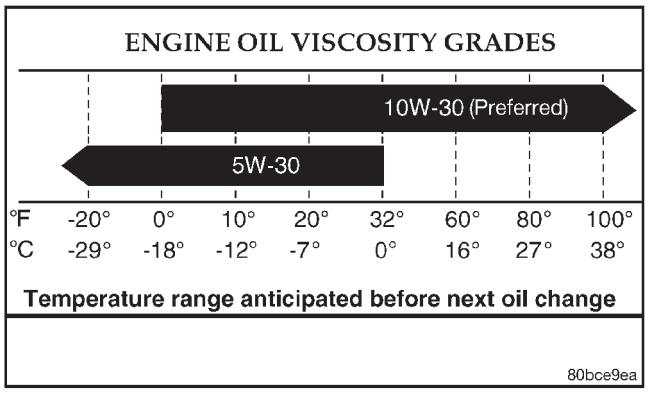


Fig. 12 Temperature/Engine Oil Viscosity Recommendation

ENERGY CONSERVING OIL

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

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right front of the engine, left of the generator on 5.2L engines (Fig. 13).

CRANKCASE OIL LEVEL INSPECTION

CAUTION: Do not overfill crankcase with engine oil, oil foaming and oil pressure loss can result.

To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable levels are indicated between the ADD and SAFE marks on the engine oil dipstick.

(1) Position vehicle on level surface.

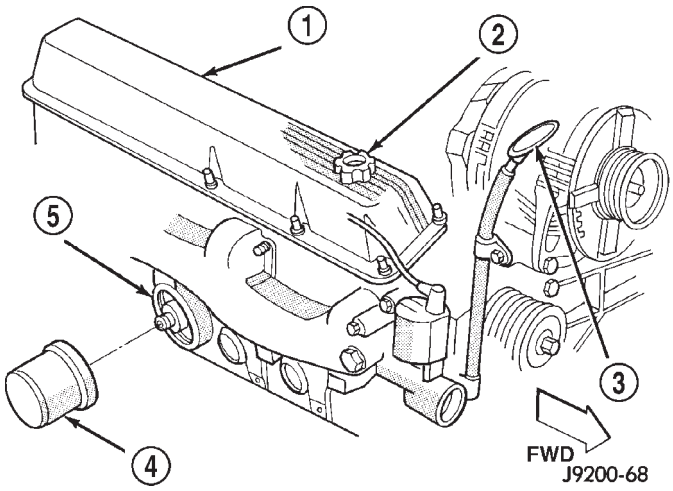


Fig. 13 Engine Oil Dipstick Location—5.2L Engines

1 – CYLINDER HEAD COVER
2 – ENGINE OIL FILL-HOLE CAP
3 – DIPSTICK
4 – ENGINE OIL FILTER
5 – FILTER BOSS

(2) With engine OFF, allow approximately ten minutes for oil to settle to bottom of crankcase, remove engine oil dipstick.

(3) Wipe dipstick clean.

(4) Install dipstick and verify it is seated in the tube.

(5) Remove dipstick, with handle held above the tip, take oil level reading.

(6) Add oil only if level is below the ADD mark on dipstick.

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in LUBRICATION and MAINTENANCE.

TO CHANGE ENGINE OIL

Run engine until achieving normal operating temperature.

(1) Position the vehicle on a level surface and turn engine off.

(2) Hoist and support vehicle on safety stands. Refer to Hoisting and Jacking Recommendations.

(3) Remove oil fill cap.

(4) Place a suitable drain pan under crankcase drain.

(5) Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket if damaged.

SERVICE PROCEDURES (Continued)

(6) Install drain plug in crankcase.
(7) Lower vehicle and fill crankcase with specified type and amount of engine oil described in this section.
(8) Install oil fill cap.
(9) Start engine and inspect for leaks.
(10) Stop engine and inspect oil level.

ENGINE OIL FILTER CHANGE

FILTER SPECIFICATION

All engines are equipped with a high quality full-flow, disposable type oil filter. DaimlerChrysler Corporation recommends a Mopar or equivalent oil filter be used.

OIL FILTER REMOVAL

(1) Position a drain pan under the oil filter.
(2) Using a suitable oil filter wrench loosen filter.
(3) Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss (Fig. 14).

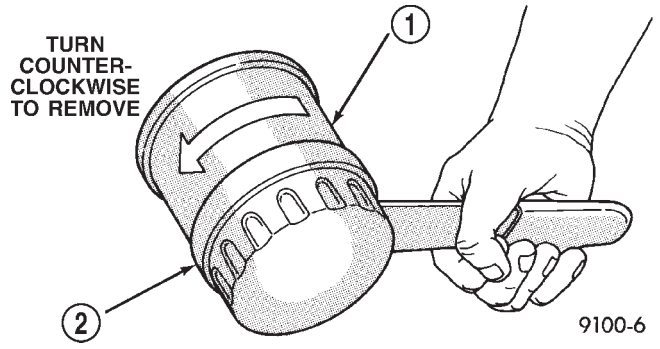


Fig. 14 Oil Filter Removal—Typical

1 – ENGINE OIL FILTER
2 – OIL FILTER WRENCH

(4) When filter separates from adapter nipple, tip gasket end upward to minimize oil spill. Remove filter from vehicle.
(5) With a wiping cloth, clean the gasket sealing surface (Fig. 15) of oil and grime.

OIL FILTER INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil or chassis grease.
(2) Thread filter onto adapter nipple. When gasket makes contact with sealing surface, (Fig. 15) hand tighten filter one full turn, do not over tighten.
(3) Add oil, verify crankcase oil level and start engine. Inspect for oil leaks.

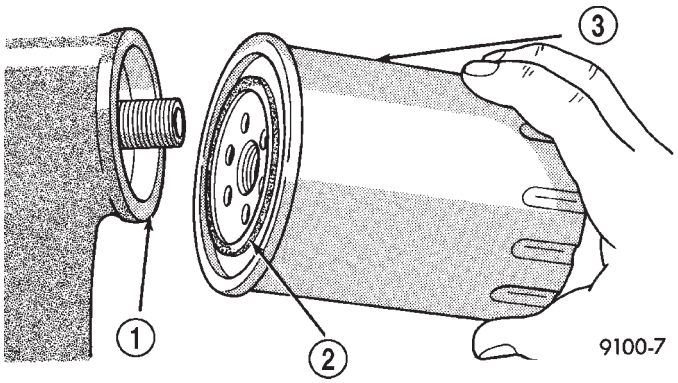


Fig. 15 Oil Filter Sealing Surface—Typical

1 – SEALING SURFACE
2 – RUBBER GASKET
3 – OIL FILTER

REPAIR DAMAGED OR WORN THREADS

CAUTION: Be sure that the tapped holes maintain the original center line.

Damaged or worn threads can be repaired. Essentially, this repair consists of:

- Drilling out worn or damaged threads.
- Tapping the hole with a special Heli-Coil Tap, or equivalent.
- Installing an insert into the tapped hole to bring the hole back to its original thread size.

CYLINDER BORE—HONING

Before honing, stuff plenty of clean shop towels under the bores and over the crankshaft to keep abrasive materials from entering the crankshaft area.

(1) Used carefully, the Cylinder Bore Sizing Hone C-823, equipped with 220 grit stones, is the best tool for this job. In addition to deglazing, it will reduce taper and out-of-round, as well as removing light scuffing, scoring and scratches. Usually, a few strokes will clean up a bore and maintain the required limits.

CAUTION: DO NOT use rigid type hones to remove cylinder wall glaze.

(2) Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. Use a cylinder surfacing hone, Honing Tool C-3501, equipped with 280 grit stones (C-3501-3810). about 20-60 strokes, depending on the bore condition, will be sufficient to provide a satisfactory surface. Using honing oil C-3501-3880, or a light honing oil, available from major oil distributors.

SERVICE PROCEDURES (Continued)

CAUTION: DO NOT use engine or transmission oil, mineral spirits, or kerosene.

(3) Honing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should INTERSECT at 50° to 60° for proper seating of rings (Fig. 16).

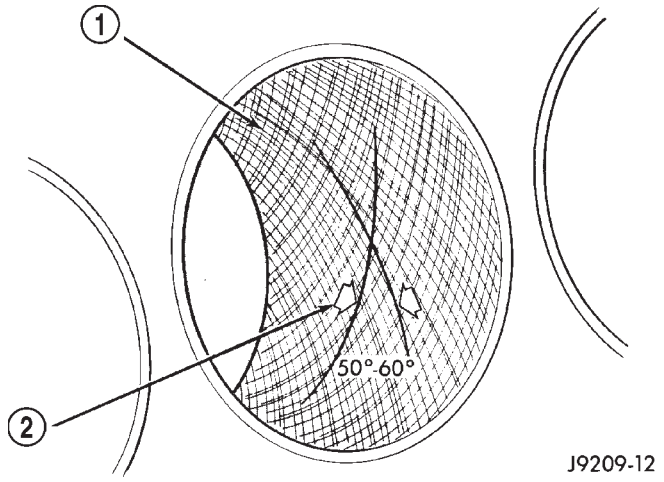


Fig. 16 Cylinder Bore Crosshatch Pattern

1 – CROSSHATCH PATTERN
2 – INTERSECT ANGLE

(4) A controlled hone motor speed between 200 and 300 RPM is necessary to obtain the proper crosshatch angle. The number of up and down strokes per minute can be regulated to get the desired 50° to 60° angle. Faster up and down strokes increase the crosshatch angle.

(5) After honing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting.

HYDROSTATIC LOCK

When an engine is suspected of hydrostatic lock (regardless of what caused the problem), follow the steps below.

(1) Perform the Fuel Pressure Release Procedure (refer to Group 14, Fuel System).

(2) Disconnect the battery negative cable.

(3) Inspect air cleaner, induction system and intake manifold to ensure system is dry and clear of foreign material.

(4) Place a shop towel around the spark plugs to catch any fluid that may possibly be under pressure in the cylinder head. Remove the plugs from the engine.

CAUTION: DO NOT use the starter motor to rotate the crankshaft. Severe damage could occur.

(5) With all spark plugs removed, rotate the crankshaft using a breaker bar and socket.

(6) Identify the fluid in the cylinders (i.e. coolant, fuel, oil, etc.).

(7) Make sure all fluid has been removed from the cylinders.

(8) Repair engine or components as necessary to prevent this problem from occurring again.

(9) Squirt engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.

(10) Install new spark plugs.

(11) Drain engine oil. Remove and discard the oil filter.

(12) Install the drain plug. Tighten the plug to 34 N·m (25 ft. lbs.) torque.

(13) Install a new oil filter.

(14) Fill engine crankcase with the specified amount and grade of oil.

(15) Connect the negative cable to the battery.

(16) Start the engine and check for any leaks.

VALVE TIMING

(1) Turn crankshaft until the No.6 exhaust valve is closing and No.6 intake valve is opening.

(2) Insert a 6.350 mm (1/4 inch) spacer between rocker arm pad and stem tip of No.1 intake valve. Allow spring load to bleed tappet down giving in effect a solid tappet.

(3) Install a dial indicator so plunger contacts valve spring retainer as nearly perpendicular as possible. Zero the indicator.

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should now read from 10° before top dead center to 2° after top dead center. Remove spacer.

CAUTION: DO NOT turn crankshaft any further clockwise as valve spring might bottom and result in serious damage.

If reading is not within specified limits:

- Check sprocket index marks.
- Inspect timing chain for wear.
- Check accuracy of DC mark on timing indicator.

VALVE SERVICE

VALVE CLEANING

Clean valves thoroughly. Discard burned, warped and cracked valves.

Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

SERVICE PROCEDURES (Continued)

VALVE INSPECTION

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 in.), replace the valve.

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 17). The special sleeve places the valve at the correct height for checking with a dial indicator.

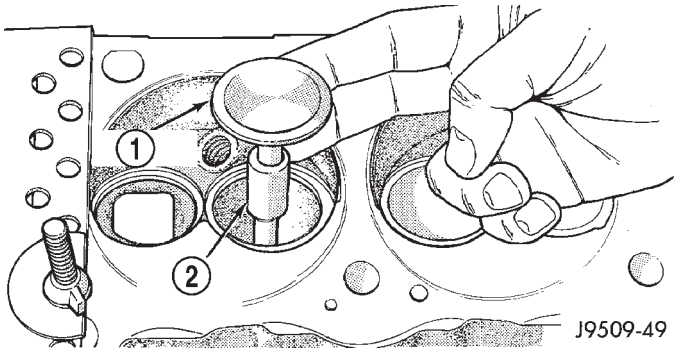


Fig. 17 Positioning Valve with Tool C-3973

1 – VALVE
2 – SPACER TOOL

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 18).

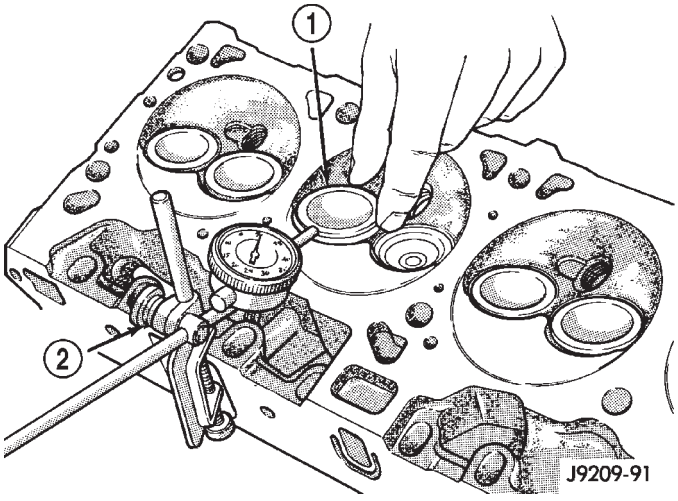


Fig. 18 Measuring Valve Guide Wear

1 – VALVE
2 – SPECIAL TOOL C-3339

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 in.). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

Service valves with oversize stems are available as shown below.

REAMER SIZES

REAMER O/S	VALVE GUIDE SIZE
0.076 mm (0.003 in.)	8.026 - 8.052 mm (0.316 - 0.317 in.)
0.381 mm (0.015 in.)	8.331 - 8.357 mm (0.328 - 0.329 in.)

Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 in.). Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:**

- Step 1—Ream to 0.0763 mm (0.003 in.).
- Step 2—Ream to 0.381 mm (0.015 in.).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 19).

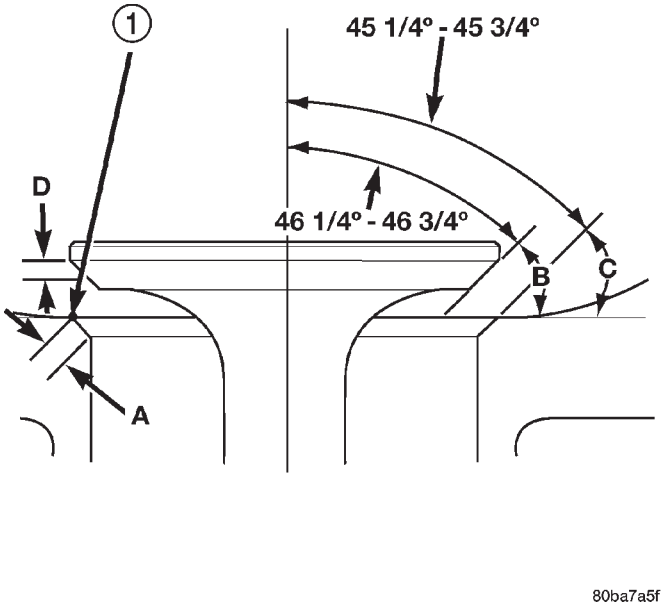


Fig. 19 Valve Face and Seat Angles

1 – CONTACT POINT

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 20). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

SERVICE PROCEDURES (Continued)

VALVE FACE AND VALVE SEAT ANGLE CHART

ITEM	DESCRIPTION	SPECIFICATION
A	SEAT WIDTH–INTAKE	1.016 - 1.524 mm (0.040 - 0.060 in.)
	SEAT WIDTH–EXHAUST	1.524 - 2.032 mm (0.060 - 0.080 in.)
B	FACE ANGLE (INT. and EXT.)	43¼° - 43¾°
C	SEAT ANGLE (INT. and EXT.)	44¼° - 44¾°
D	CONTACT SURFACE	—

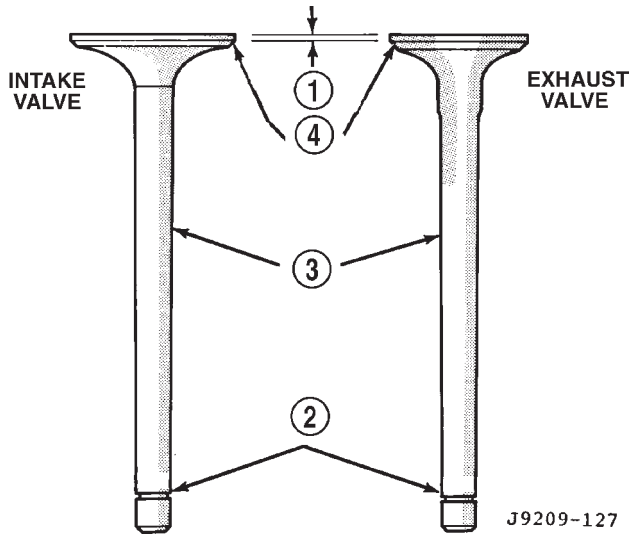


Fig. 20 Intake and Exhaust Valves

1 – MARGIN
2 – VALVE SPRING RETAINER LOCK GROOVE
3 – STEM
4 – FACE

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 21).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 in.) total indicator reading.

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue

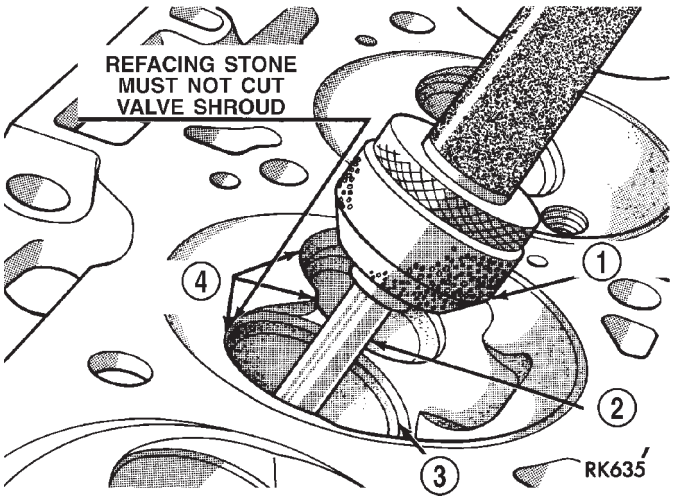


Fig. 21 Refacing Valve Seats

1 – STONE
2 – PILOT
3 – VALVE SEAT
4 – SHROUD

then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 inch). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 in.).

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 22). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

SERVICE PROCEDURES (Continued)

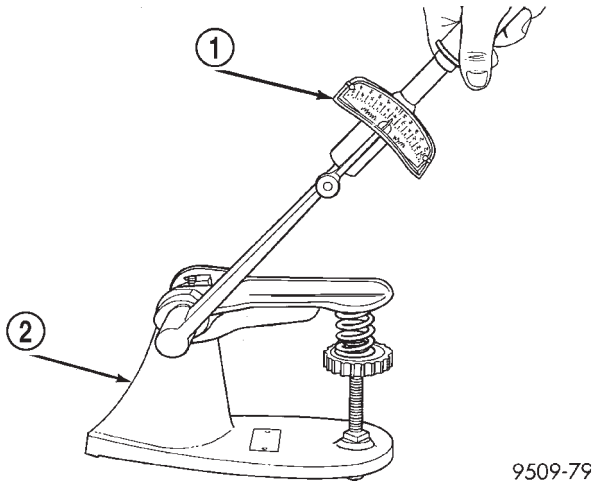


Fig. 22 Testing Valve Spring for Compressed Length

1 – TORQUE WRENCH
2 – VALVE SPRING TESTER

MEASURING TIMING CHAIN STRETCH

NOTE: To access timing chain Refer to Timing Chain Cover in Removal and Installation Section.

(1) Place a scale next to the timing chain so that any movement of the chain may be measured.

(2) Place a torque wrench and socket over camshaft sprocket attaching bolt. Apply torque in the direction of crankshaft rotation to take up slack; 41 N·m (30 ft. lbs.) torque with cylinder head installed or 20 N·m (15 ft. lbs.) torque with cylinder head removed. With a torque applied to the camshaft sprocket bolt, crankshaft should not be permitted to move. It may be necessary to block the crankshaft to prevent rotation.

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 23).

(4) Install a new timing chain, if its movement exceeds 3.175 mm (1/8 inch).

(5) If chain is not satisfactory, remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

(6) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(7) Place timing chain around both sprockets.

(8) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

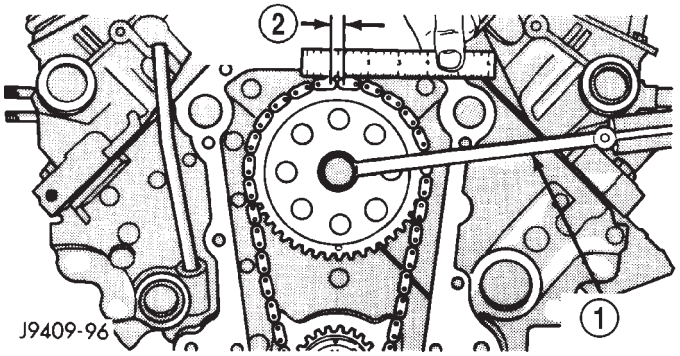


Fig. 23 Measuring Timing Chain Wear and Stretch

1 – TORQUE WRENCH
2 – 3.175 MM (0.125 IN.)

(9) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 24).

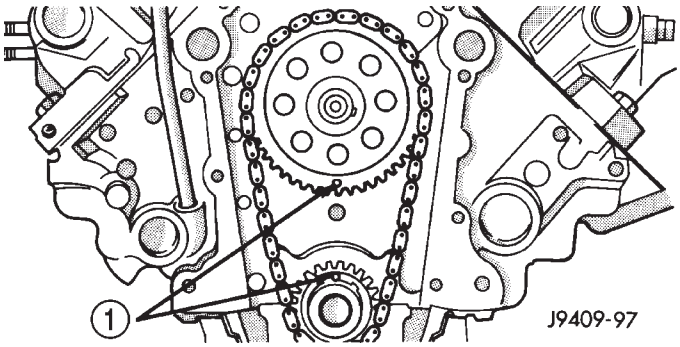


Fig. 24 Alignment of Timing Marks

1 – TIMING MARKS

(11) Install the camshaft bolt. Tighten the bolt to 47 N·m (35 ft. lbs.) torque.

(12) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

PISTONS—FITTING

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 inch) at 21°C (70°F).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

SERVICE PROCEDURES (Continued)

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 25).

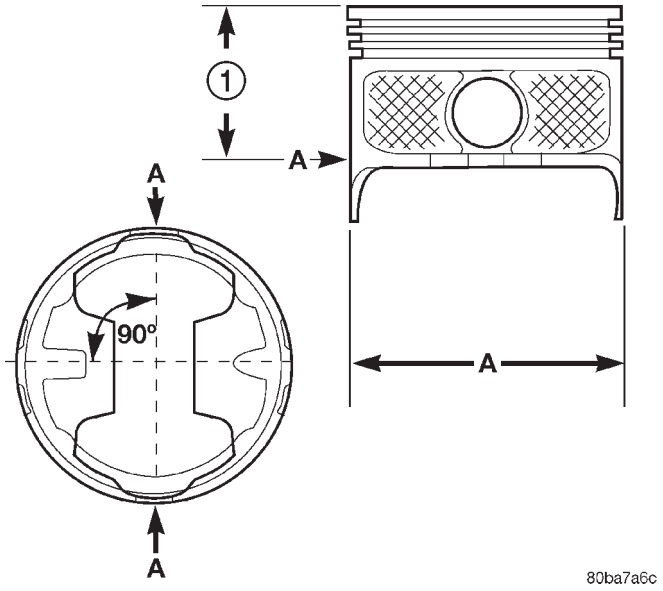


Fig. 25 Piston Measurements

1 – 49.53 mm (1.95 IN.)

PISTON RINGS—FITTING

(1) Measurement of end gaps:

(a) Measure piston ring gap 2 inches from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 inch). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 inch). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 inch).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Rings with excess gaps should not be used.

(2) Install rings and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

PISTON MEASUREMENT CHART

PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (in.)	MAX. mm (in.)	MIN. mm (in.)	MAX. mm (in.)
A	—	—	—	—
B	101.580 (3.9992)	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)
C	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)
D	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)	101.643 (4.0017)
E	—	—	—	—

DESCRIPTION	SPECIFICATION
PISTON PIN BORE	25.007 - 25.015 mm (.9845 -.9848 in.)
RING GROOVE HEIGHT	
OIL RAIL	4.033 - 4.058 mm (.1588 -.1598 in.)
COMPRESSION RAIL	1.529 - 1.554 mm (.0602 -.0612 in.)
TOTAL FINISHED WEIGHT	470.8 ± 2 grams (16.607 ±.0706 ounces)

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter “O”, an oval depression or the word TOP (Fig. 26) (Fig. 28).

SERVICE PROCEDURES (Continued)

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 27) (Fig. 28). An identification mark on the ring is a drill point, a stamped letter “O”, an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 inch) side clearance.

(e) Pistons with insufficient or excessive side clearance should be replaced.

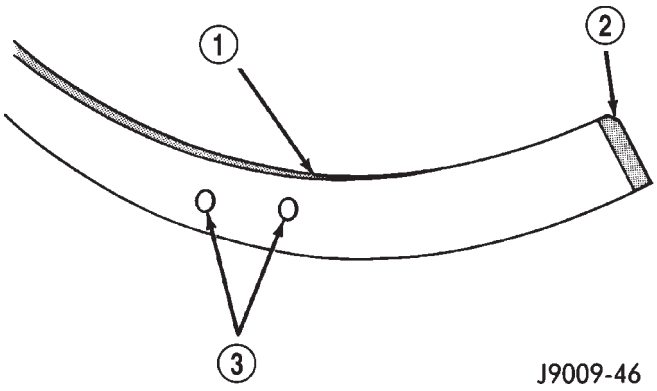


Fig. 26 Second Compression Ring Identification (Typical)

1 – SECOND COMPRESSION RING (BLACK CAST IRON)
2 – CHAMFER
3 – TWO DOTS

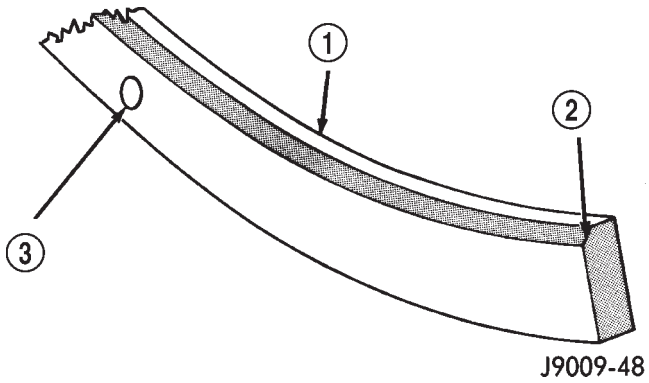


Fig. 27 Top Compression Ring Identification (Typical)

1 – TOP COMPRESSION RING (GRAY IN COLOR)
2 – CHAMFER
3 – ONE DOT

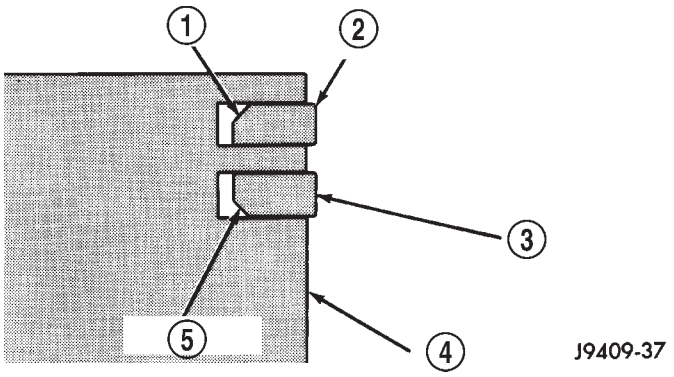


Fig. 28 Compression Ring Chamfer Location (Typical)

1 – CHAMFER
2 – TOP COMPRESSION RING
3 – SECOND COMPRESSION RING
4 – PISTON
5 – CHAMFER

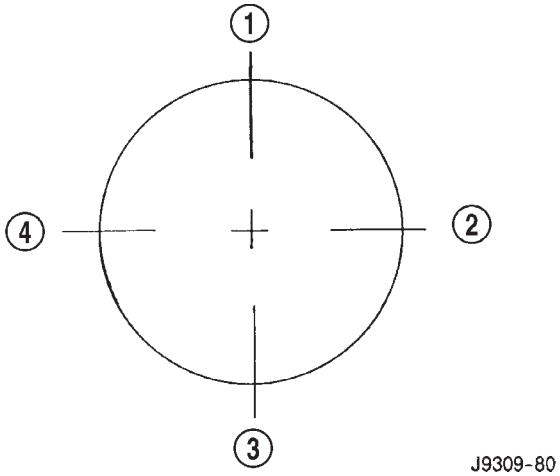


Fig. 29 Proper Ring Installation

1 – OIL RING SPACER GAP
2 – SECOND COMPRESSION RING GAP OIL RING RAIL GAP (TOP)
3 – OIL RING RAIL GAP (BOTTOM)
4 – TOP COMPRESSION RING GAP

CONNECTING ROD BEARINGS—FITTING

Fit all rods on a bank until completed. DO NOT alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

The bearing caps are not interchangeable and should be marked at removal to ensure correct assembly.

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, make certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

SERVICE PROCEDURES (Continued)

The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch). Bearings are available in 0.025 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch) undersize. **Install the bearings in pairs. DO NOT use a new bearing half with an old bearing half. DO NOT file the rods or bearing caps.**

CRANKSHAFT MAIN BEARINGS—FITTING

Bearing caps are not interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No.2 and 4 are interchangeable.

Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 30). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

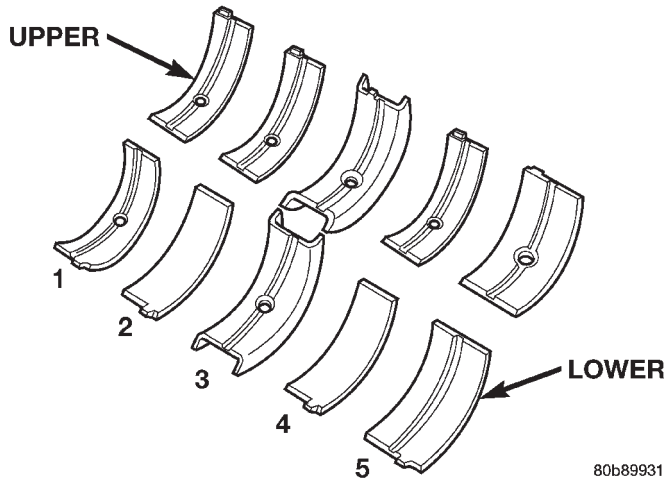


Fig. 30 Main Bearing Identification

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

On 4WD vehicles the engine front support brackets attach directly to engine block and the axle housing. The brackets provide a solid interconnection for these units (Fig. 31) (Fig. 32). Engine must be supported during any service procedures involving the front support assemblies.

(1) Disconnect the negative cable from the battery.
(2) Raise vehicle on hoist.
(3) Install engine lifting (support) fixture.
(4) Remove front axle assembly. (Refer to Group 3, Differential and Driveline in this publication.)
(5) **Left mount insulator only.** Remove starter wires and starter motor assembly.
(6) Remove insulator to frame through bolt (Fig. 33).
(7) Raise engine slightly.
(8) Remove upper insulator to support bracket stud nut and insulator to support through bolt.
(9) Remove engine mount insulator (Fig. 31) (Fig. 32).
(10) If engine support bracket is to be removed/replaced, remove support bracket to transmission bell housing bolt(s) and three (3) support bracket to engine block bolts. Remove support bracket (Fig. 31) (Fig. 32).

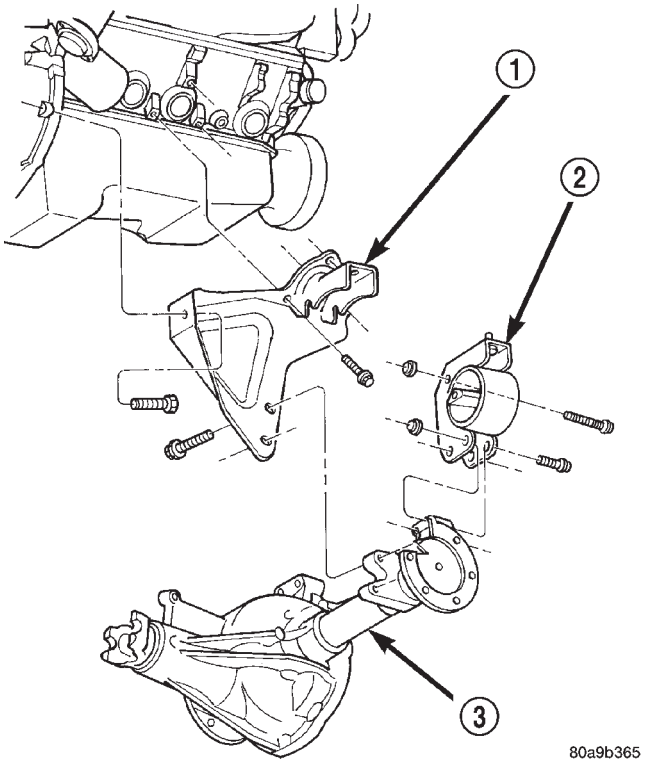


Fig. 31 Right Engine Mount Insulator and Support Bracket

1 – ENGINE SUPPORT BRACKET
2 – INSULATOR
3 – FRONT AXLE

INSTALLATION—4WD

(1) If engine support brackets were removed, install them and their fasteners (Fig. 31) (Fig. 32). Tighten support bracket to block bolts to 41 N·m (30 ft. lbs.). Tighten support bracket to transmission bell housing bolt(s) to 88 N·m (65 ft. lbs.).

REMOVAL AND INSTALLATION (Continued)

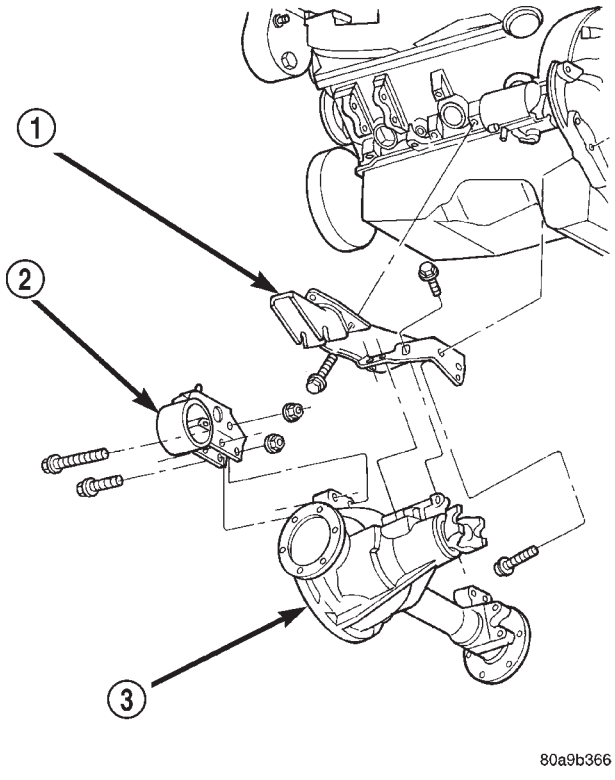


Fig. 32 Left Engine Mount Insulator and Support Bracket

1 – ENGINE SUPPORT BRACKET
2 – INSULATOR
3 – FRONT AXLE

(2) Install Engine mount insulator and tighten insulator to support bracket nut to 41 N·m (30 ft. lbs.). Tighten insulator to support bracket through bolt nut to 102 N·m (75 ft. lbs.).

(3) Lower engine and install insulator to frame through bolt and nut (Fig. 33). Tighten nut to 95 N·m (70 ft. lbs.).

(4) Install starter motor and mounting bolts. Tighten bolts to 68 N·m (50 ft. lbs.).

(5) Connect starter wires.

(6) Remove engine lifting (support) fixture.

(7) Install front axle assembly. (Refer to Group 3, Differential and Driveline)

(8) Lower the vehicle.

(9) Connect the negative cable to the battery.

ENGINE MOUNT—REAR

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle on a hoist.

(3) Support the transmission with a transmission jack.

(4) Remove stud nuts holding the insulator to the crossmember (Fig. 34).

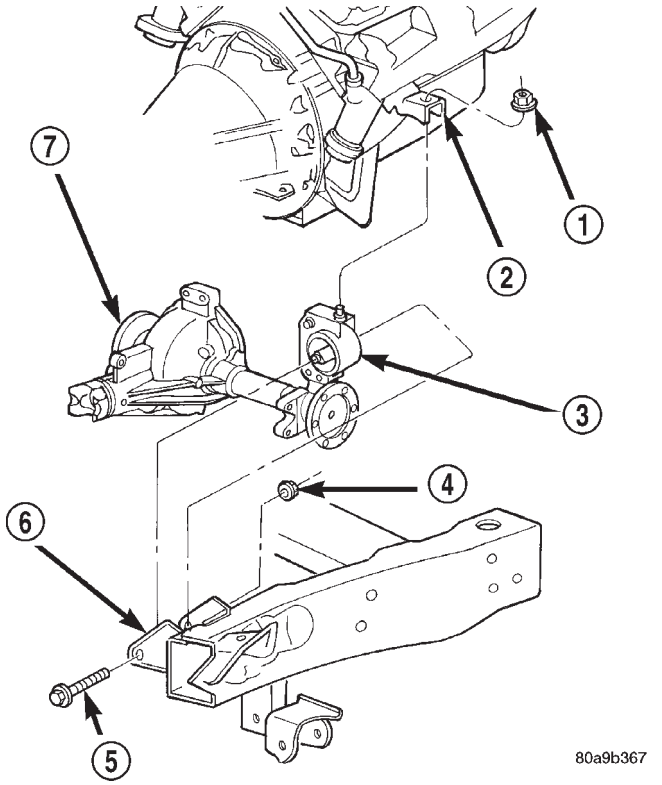


Fig. 33 Engine Mount Insulator at Frame

1 – NUT
2 – ENGINE SUPPORT BRACKET
3 – INSULATOR
4 – NUT
5 – THROUGH BOLT
6 – FRAME
7 – FRONT AXLE

(5) Raise rear of transmission SLIGHTLY.

(6) Remove bolts holding the insulator to the insulator bracket (Fig. 34). Remove the insulator.

INSTALLATION

(1) If the insulator bracket was removed, install the bracket to the transmission (Fig. 34). Tighten the bolts to 28 N·m (250 in. lbs.) torque.

(2) Install the bolts holding insulator to insulator bracket. Tighten the bolts to 28 N·m (250 in. lbs.) torque.

(3) Lower rear of transmission while aligning the insulator studs into the mounting support bracket. Install stud nuts and tighten to 28 N·m (250 in. lbs.) torque.

(4) Remove the transmission jack.

(5) Lower the vehicle.

(6) Connect the negative cable to the battery.

REMOVAL AND INSTALLATION (Continued)

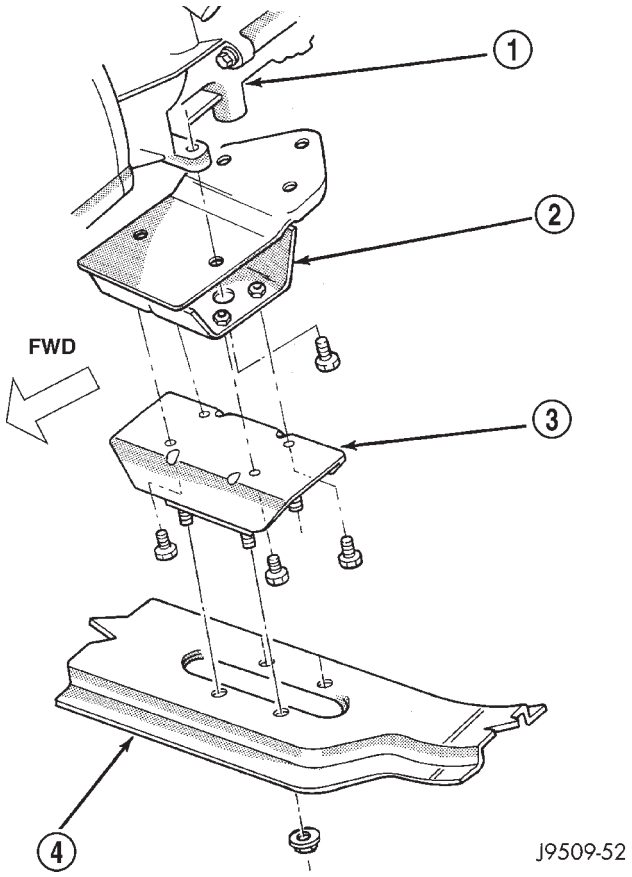


Fig. 34 Rear Mount Insulator

1 – AUTOMATIC TRANSMISSION
2 – INSULATOR BRACKET
3 – INSULATOR
4 – CROSSMEMBER

ENGINE ASSEMBLY

REMOVAL

(1) Scribe hood hinge outlines on hood. Remove the hood.
(2) Disconnect the battery negative cable.
(3) Drain cooling system (refer to Group 7, Cooling System for the proper procedure).
(4) Remove the air cleaner.
(5) Disconnect the radiator and heater hoses. Remove radiator (refer to Group 7, Cooling System for the correct procedures).
(6) Set fan shroud aside.
(7) Disconnect the vacuum supply lines from the intake manifold.
(8) Remove the distributor cap and wires.
(9) Disconnect the accelerator linkage.
(10) Remove throttle body.
(11) Perform the Fuel System Pressure release procedure (refer to Group 14, fuel System).
(12) Disconnect the fuel supply line.
(13) Disconnect the starter wires.
(14) Disconnect the oil pressure sending unit wire.
(15) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
(16) Disconnect the air conditioning hoses.
(17) Disconnect the power steering hoses, if equipped.
(18) Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).
(19) Remove the generator (refer to Group 8B, Battery/Starter/Generator Service).
(20) Raise and support the vehicle on a hoist.
(21) Disconnect exhaust pipe at manifold.
(22) Refer to Group 21, Transmissions for transmission removal.

CAUTION: DO NOT lift the engine by the intake manifold.

(23) Install an engine lifting fixture.
(24) The engine and front driving axle (engine/axle/transmission) are connected through insulators and support brackets. Separate the engine as follows:

- **LEFT SIDE** —Remove 2 bolts attaching (engine/pinion nose/transmission) bracket to transmission bell housing. Remove 2 bracket to pinion nose adaptor bolts. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.
- **RIGHT SIDE** —Remove 2 bracket to axle (disconnect housing) bolts and a bracket to bell housing bolt. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.

(25) Lower the vehicle.
(26) Install engine assembly on engine repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment.
(2) Install an engine support fixture.
(3) Raise and support the vehicle on a hoist.
(4) Install the engine front mounts.
(5) Refer to Group, 21 Transmissions for transmission installation
(6) Install the inspection plate.
(7) Remove transmission support.
(8) Install exhaust pipe to manifold.
(9) Lower the vehicle.
(10) Remove engine lifting fixture.
(11) Install the generator (refer to Group 8B, Battery/Starter/Generator Service).
(12) Install starter motor (refer to Group 8B, Battery/Starter/Generator Service).
(13) Connect power steering hoses, if equipped.
(14) Connect air conditioning hoses.

REMOVAL AND INSTALLATION (Continued)

(15) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heater and Air Conditioning for service procedures).

(16) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.

(17) Connect the accelerator linkage.

(18) Connect the starter wires.

(19) Connect the oil pressure sending unit wire.

(20) Install the distributor cap and wiring.

(21) Connect the vacuum supply lines to the intake manifold.

(22) Connect the fuel supply lines.

(23) Install the radiator (refer to Group 7, Cooling System). Connect the radiator hoses and heater hoses.

(24) Install fan shroud in position.

(25) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).

(26) Install the air cleaner.

(27) Install the battery.

(28) Warm engine and adjust.

(29) Install hood and line up with the scribe marks.

(30) Road test vehicle.

INTAKE MANIFOLD

REMOVAL

(1) Disconnect the battery negative cable.

(2) Drain the cooling system. Refer to COOLING SYSTEM.

(3) Remove the A/C compressor. Refer to HEATING and AIR CONDITIONING.

(4) Remove the generator. Refer to CHARGING SYSTEM.

(5) Remove the accessory drive bracket.

(6) Remove the air cleaner assembly and air inlet hose.

(7) Perform the fuel pressure release procedure. Refer to FUEL SYSTEM.

(8) Disconnect the fuel supply line from the fuel rail. Refer to FUEL SYSTEM.

(9) Disconnect the accelerator linkage and, if so equipped, the speed control and transmission kickdown cables.

(10) Remove the distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect the coolant temperature sending unit wire.

(13) Disconnect the heater hoses and bypass hose.

(14) Remove the closed crankcase ventilation and evaporation control systems.

(15) Remove intake manifold bolts.

(16) Lift the intake manifold and throttle body out of the engine compartment as an assembly.

(17) Remove and discard the flange side gaskets and the front and rear cross-over gaskets.

(18) Remove the throttle body bolts and lift the throttle body off the intake manifold (Fig. 35). Discard the throttle body gasket.

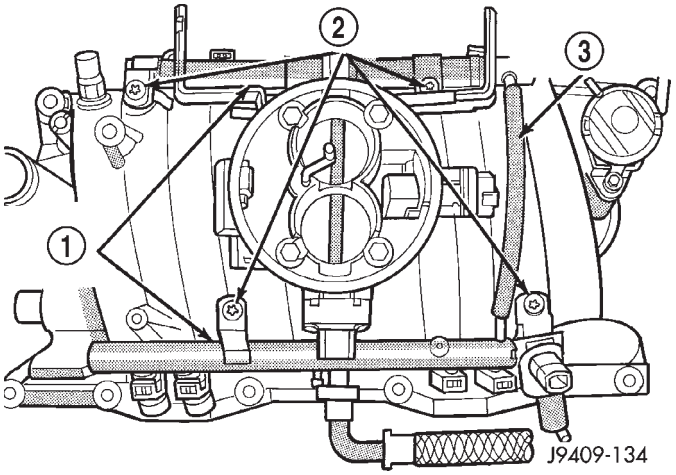


Fig. 35 Throttle Body Assembly

1 – FUEL RAIL ASSEMBLY
2 – FUEL RAIL MOUNTING BOLTS
3 – FUEL RAIL CONNECTING HOSES

INSTALLATION

(1) If the plenum pan was removed, position pan gasket and pan.

(2) Install plenum pan retaining bolts. (Fig. 36).

(3) Tighten plenum pan mounting bolts as follows:

- Step 1. Tighten bolts to 5.4 N·m (24 in. lbs.)
- Step 2. Tighten bolts to 9.5 N·m (84 in. lbs.)
- Step 3. Check all bolts are at 9.5 N·m (84 in. lbs.)

(4) Using a new gasket, install the throttle body onto the intake manifold. Tighten the bolts to 23 N·m (200 in. lbs.) torque.

(5) Apply a bead of Mopar Silicone Rubber Adhesive Sealant, or equivalent, to the four corner joints. The sealant bead height should be slightly higher than the cross-over gaskets, approximately 5 mm (0.2 in). An excessive amount of sealant is not required to ensure a leak proof seal, and an excessive amount of sealant may reduce the effectiveness of the flange gasket.

(6) Install the front and rear cross-over gaskets onto the engine (Fig. 37).

(7) Install the flange gaskets. Ensure that the vertical port alignment tab is resting on the deck face of the block. Also the horizontal alignment tabs must be in position with the mating cylinder head gasket tabs (Fig. 38). The words MANIFOLD SIDE should be visible on the center of each flange gasket.

(8) Carefully lower intake manifold into position on the cylinder block and cylinder heads. long studs

REMOVAL AND INSTALLATION (Continued)

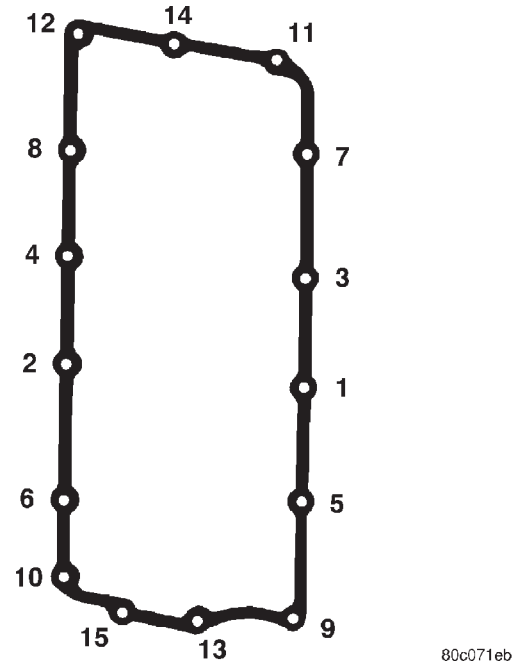


Fig. 36 Plenum Pan Bolt Tightening Sequence

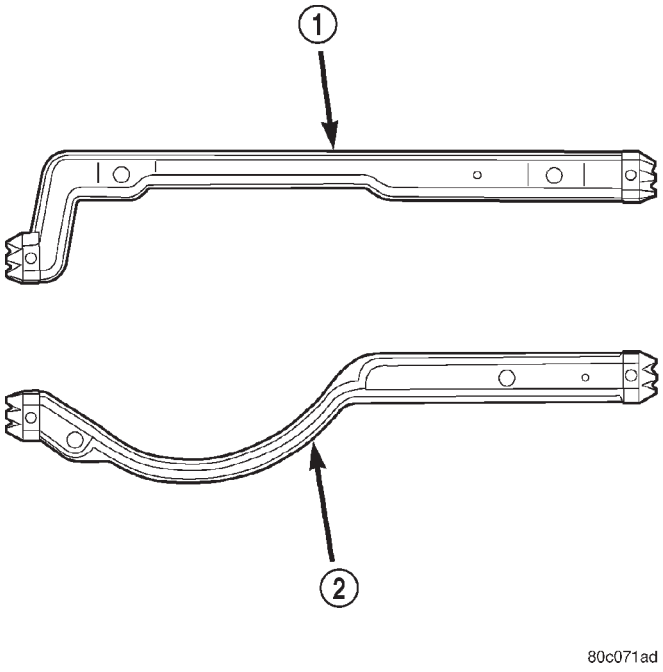


Fig. 37 Cross-Over Gaskets

1 – FRONT CROSS-OVER GASKET
2 – REAR CROSS-OVER GASKET

at the front and rear of the manifold will help to align the intake manifold. After intake manifold is in place, inspect to make sure seals are in place. Remove alignment studs if used.

(9) The following torque sequence duplicates the expected results of the automated assembly system (Fig. 39).

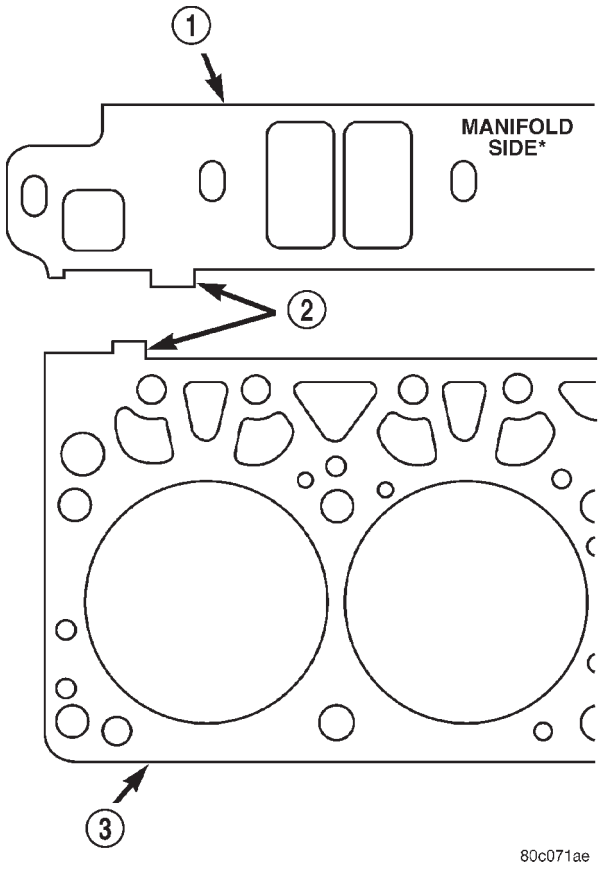


Fig. 38 Intake Manifold Flange Gasket Alignment

1 – FLANGE GASKET
2 – ALIGNMENT TABS
3 – CYLINDER HEAD GASKET

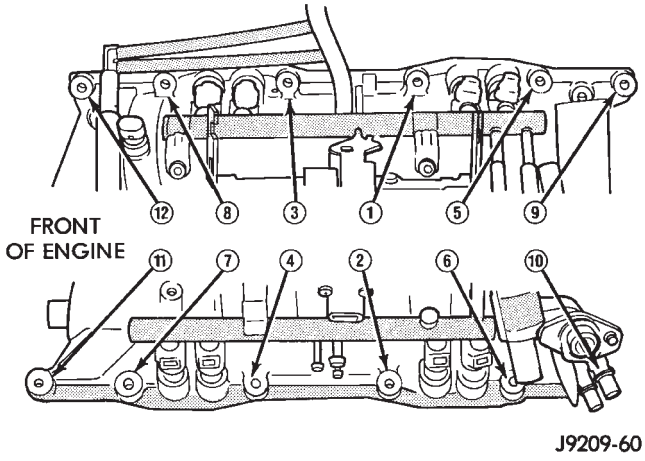


Fig. 39 Intake Manifold Bolt Tightening Sequence—5.9L Engine

- Step 1—Tighten bolts 1 thru 4, in sequence, to 8 N·m (72 in. lbs.) torque. Tighten in alternating steps 1.4 N·m (12 in. lbs.) torque at a time.
- Step 2—Tighten bolts 5 thru 12, in sequence, to 8 N·m (72 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

- Step 3—Check that all bolts are tightened to 8 N·m (72 in. lbs.) torque.
- Step 4—Tighten all bolts, in sequence, to 16 N·m (12 ft. lbs.) torque.
- Step 5—Check that all bolts are tightened to 16 N·m (12 ft. lbs.) torque.

(10) Install closed crankcase ventilation and evaporation control systems.
(11) Install the coil wires.
(12) Connect the coolant temperature sending unit wire.
(13) Connect the heater hoses and bypass hose.
(14) Install distributor cap and wires.
(15) Connect the accelerator linkage and, if so equipped, the speed control and transmission kickdown cables.
(16) Install the fuel supply line to the fuel rail.
(17) Install the accessory drive bracket and A/C compressor.
(18) Install the generator and accessory drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque.
(19) Install the air cleaner assembly and air inlet hose.
(20) Fill cooling system.
(21) Connect the battery negative cable.

EXHAUST MANIFOLD

REMOVAL

(1) Disconnect the battery negative cable.
(2) Raise the vehicle.
(3) Remove the exhaust pipe to manifold nuts.
(4) Lower the vehicle.
(5) Remove three nuts, heat shield and washers from the right side exhaust manifold, if necessary (Fig. 40).
(6) Remove two nuts, heat shield and washers from the left side exhaust manifold, if necessary (Fig. 41).
(7) Remove bolts, nuts and washers attaching manifold to cylinder head.
(8) Remove manifold from the cylinder head.

INSTALLATION

CAUTION: If the studs came out with the nuts when removing the exhaust manifold, install new studs.

(1) Position the exhaust manifolds on the two studs located on the cylinder head. Install conical washers and nuts on these studs (Fig. 42).
(2) Install new bolt and washer assemblies in the remaining holes (Fig. 42). Start at the center arm and work outward. Tighten the bolts and nuts to 24 N·m (18 ft. lbs.) torque.

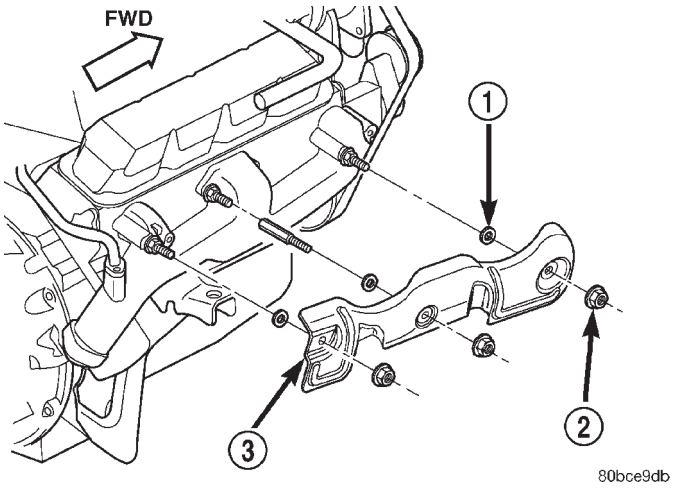


Fig. 40 Exhaust Manifold Heat Shield—Right Side
1 – WASHER
2 – NUT AND WASHER
3 – EXHAUST MANIFOLD HEAT SHIELD

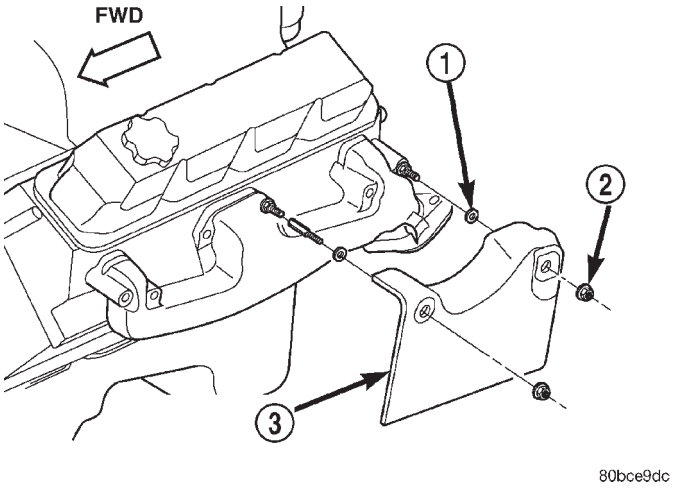


Fig. 41 Exhaust Manifold Heat Shield—Left Side
1 – WASHER
2 – NUT AND WASHER
3 – EXHAUST MANIFOLD HEAT SHIELD

(3) Position three washers, heat shield and nuts on the right side exhaust manifold. Tighten nuts to 24 N·m (18 ft. lbs.).
(4) Position two washers, heat shield and nuts on the left side exhaust manifold. Tighten nuts to 24 N·m (18 ft. lbs.).
(5) Raise the vehicle.
(6) Assemble the exhaust pipe to the exhaust manifold and secure with bolts, nuts and washers. Tighten these nuts to 27 N·m (20 ft. lbs.) torque.
(7) Lower the vehicle.
(8) Connect the battery negative cable.

REMOVAL AND INSTALLATION (Continued)

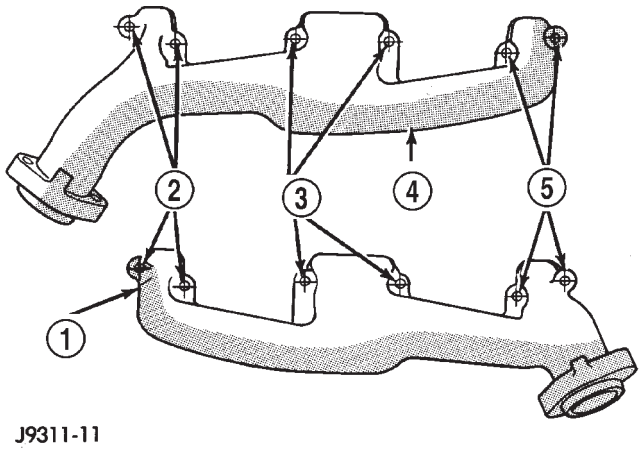


Fig. 42 Exhaust Manifold Installation—5.9L Engine

1 – EXHAUST MANIFOLD (LEFT)
2 – BOLTS & WASHERS
3 – NUTS & WASHERS
4 – EXHAUST MANIFOLD (RIGHT)
5 – BOLTS & WASHERS

CYLINDER HEAD COVER

A steel backed silicon gasket is used with the cylinder head cover (Fig. 43). This gasket can be used again.

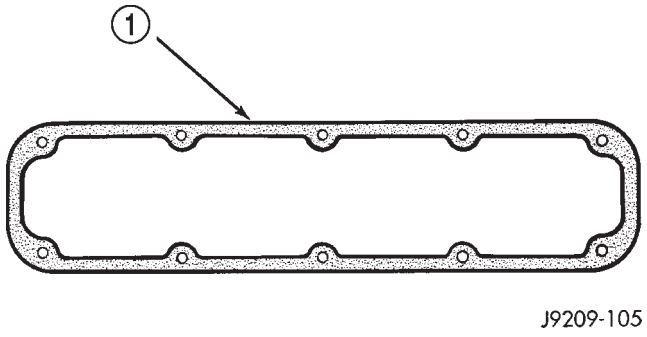


Fig. 43 Cylinder Head Cover Gasket

1 – CYLINDER HEAD COVER GASKET

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
(3) Remove the air inlet hose.
(4) Remove cylinder head cover and gasket. The gasket may be used again.

INSTALLATION

(1) The cylinder head cover gasket can be used again. Install the gasket onto the head rail.
(2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
(3) Install closed crankcase ventilation system and evaporation control system.
(4) Install the air inlet hose.
(5) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS

REMOVAL

(1) Remove cylinder head cover and gasket. Refer to Cylinder Head Cover in this section for correct procedure.
(2) Remove the rocker arm bolts and pivots (Fig. 44). Place them on a bench in the same order as removed.
(3) Remove the push rods and place them on a bench in the same order as removed.

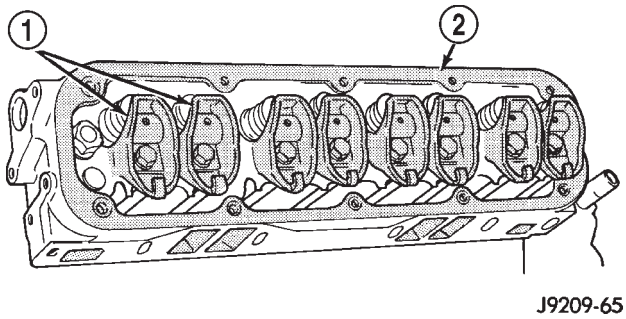


Fig. 44 Rocker Arms

1 – ROCKER ARMS
2 – CYLINDER HEAD

INSTALLATION

(1) Rotate the crankshaft until the “V8” mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.
(2) Install the push rods in the same order as removed.
(3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

CAUTION: DO NOT rotate or crank the engine during or immediately after rocker arm installation. Allow the hydraulic roller tappets adequate time to bleed down (about 5 minutes).

(4) Install cylinder head cover.

VALVE SPRING AND STEM SEAL REPLACEMENT-IN VEHICLE

(1) Remove the air cleaner.
(2) Remove cylinder head covers and spark plugs.
(3) Remove coil wire from distributor and secure to good ground to prevent engine from starting.
(4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.

REMOVAL AND INSTALLATION (Continued)

(5) Remove rocker arms.

(6) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.

(7) Using Valve Spring Compressor Tool MD-998772A with adaptor 6716A, compress valve spring and remove retainer valve locks and valve spring.

(8) Install seals on the exhaust valve stem and position down against valve guides.

(9) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.

(10) Follow the same procedure on the remaining 7 cylinders using the firing sequence 1-8-4-3-6-5-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.

(11) Remove adapter from the No.1 spark plug hole and install spark plugs.

(12) Install rocker arms.

(13) Install covers and coil wire to distributor.

(14) Install air cleaner.

(15) Road test vehicle.

CYLINDER HEAD

REMOVAL

(1) Disconnect the battery negative cable.

(2) Drain cooling system Refer to COOLING SYSTEM.

(3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

(6) Remove the air cleaner assembly and air inlet hose.

(7) Perform fuel system pressure release procedure. Refer to FUEL SYSTEM.

(8) Disconnect the fuel supply line.

(9) Disconnect accelerator linkage and if so equipped, the speed control and transmission kickdown cables.

(10) Remove distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Remove cylinder head covers and gaskets.

(15) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.

(16) Remove exhaust manifolds.

(17) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.

(18) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.

(19) Remove spark plugs.

INSTALLATION

(1) Position the new cylinder head gaskets onto the cylinder block.

(2) Position the cylinder heads onto head gaskets and cylinder block.

(3) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 45). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

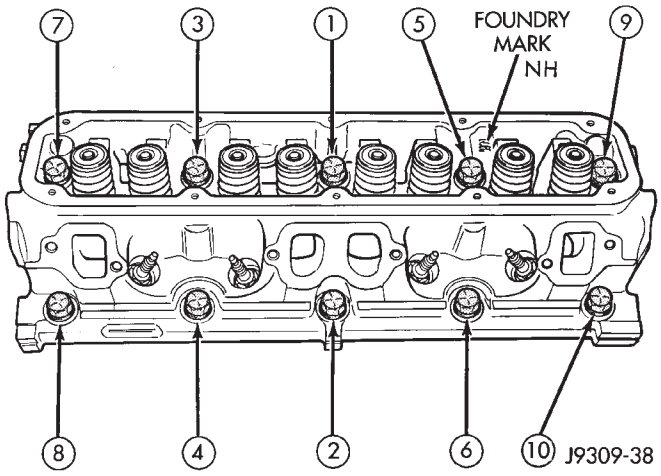


Fig. 45 Cylinder Head Bolt Tightening Sequence

CAUTION: When tightening the rocker arm bolts, make sure the piston in that cylinder is NOT at TDC. Contact between the valves and piston could occur.

(4) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.

(5) Install the intake manifold and throttle body assembly.

(6) Install exhaust manifolds. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.

(7) Adjust spark plugs to specifications. Refer to IGNITION SYSTEM. Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(8) Install coil wires.

(9) Connect heat indicator sending unit wire.

(10) Connect the heater hoses and bypass hose.

(11) Install distributor cap and wires.

(12) Connect the accelerator linkage and if so equipped, the speed control and transmission kickdown cables.

(13) Install the fuel supply line.

REMOVAL AND INSTALLATION (Continued)

(14) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque.

(15) Install the intake manifold-to-generator bracket support rod. Tighten the bolts.

(16) Place the cylinder head cover gaskets in position and install cylinder head covers. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(17) Install closed crankcase ventilation system.

(18) Connect the evaporation control system.

(19) Install the air cleaner assembly and air inlet hose.

(20) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(21) Fill cooling system.

(22) Connect the battery negative cable.

VALVES AND VALVE SPRINGS

REMOVAL

(1) Remove the cylinder head. Refer to Cylinder Head in this section for correct procedure.

(2) Compress valve springs using Valve Spring Compressor Tool MD- 998772A and adapter 6716A.

(3) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.

(4) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the valve guides. Identify valves to ensure installation in original location.

INSTALLATION

(1) Clean valves thoroughly. Discard burned, warped and cracked valves.

(2) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

(3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.

(4) Coat valve stems with lubrication oil and insert them in cylinder head.

(5) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.

(6) Install new seals on all valve guides. Install valve springs and valve retainers.

(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS

REMOVAL

(1) Remove the air cleaner assembly and air inlet hose.

(2) Remove cylinder head cover, rocker assembly and push rods. Identify push rods to ensure installation in original location.

(3) Remove intake manifold, yoke retainer and aligning yokes.

(4) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.

(5) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

INSTALLATION

(1) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

(2) Lubricate tappets.

(3) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).

(4) Install aligning yokes with ARROW toward camshaft.

(5) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.

(6) Install push rods in original positions.

(7) Install rocker arm.

(8) Install cylinder head cover.

(9) Install air cleaner assembly and air inlet hose.

(10) Start and operate engine. Warm up to normal operating temperature.

CAUTION: To prevent damage to valve mechanism, engine must not be run above fast idle until all hydraulic tappets have filled with oil and have become quiet.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove fan shroud retainer bolts and set shroud back over engine.

(3) Remove the cooling system fan.

(4) Remove the serpentine belt (refer to Group 7, Cooling System).

(5) Remove the vibration damper pulley.

(6) Remove vibration damper bolt and washer from end of crankshaft.

REMOVAL AND INSTALLATION (Continued)

(7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 46).

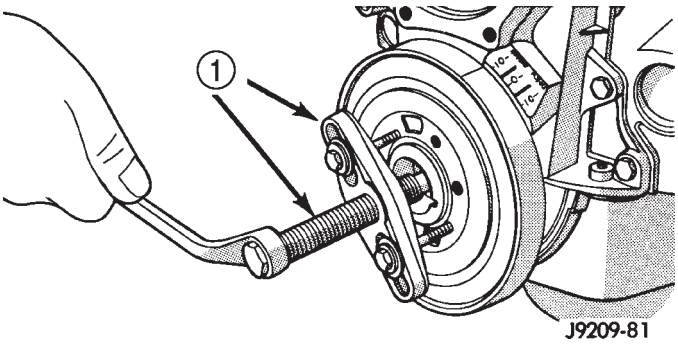


Fig. 46 Vibration Damper Assembly

1 – SPECIAL TOOL C-3688

(8) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

(2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 47).

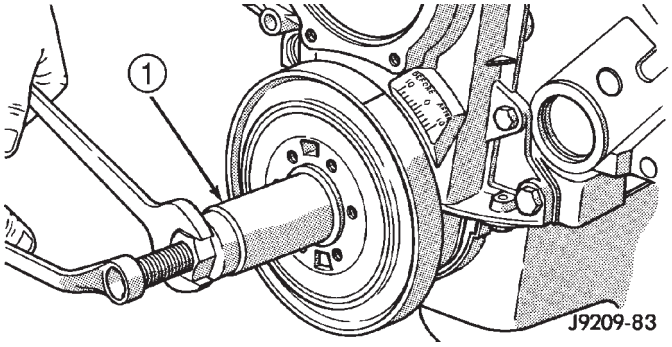


Fig. 47 Installing Vibration Damper

1 – SPECIAL TOOL C-3688

(3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

(4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.

(5) Install the serpentine belt (refer to Group 7, Cooling System).

(6) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(7) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.

(8) Connect the negative cable to the battery.

TIMING CHAIN COVER

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System).

(3) Remove the serpentine belt (refer to Group 7, Cooling System).

(4) Remove water pump (refer to Group 7, Cooling System).

(5) Remove power steering pump (refer to Group 19, Steering).

(6) Remove vibration damper.

(7) Remove fuel lines (refer to Group 14, Fuel System).

(8) Loosen oil pan bolts and remove the front bolt at each side.

(9) Remove the cover bolts.

(10) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.

(11) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 48).

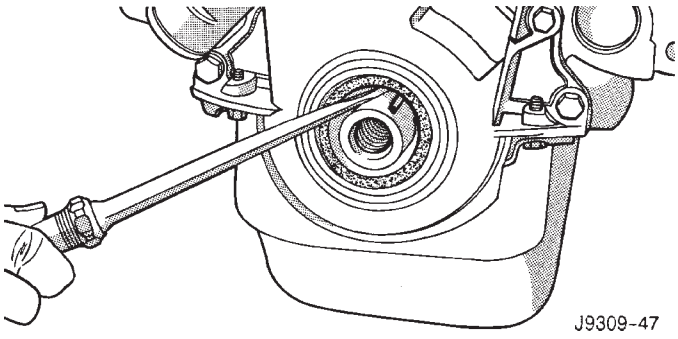


Fig. 48 Removal of Front Crankshaft Oil Seal

INSTALLATION

(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

(2) The water pump mounting surface must be cleaned.

(3) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

(4) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 49). Seat the oil seal in the groove of the tool.

(5) Position the seal and tool onto the crankshaft (Fig. 50).

(6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.

REMOVAL AND INSTALLATION (Continued)

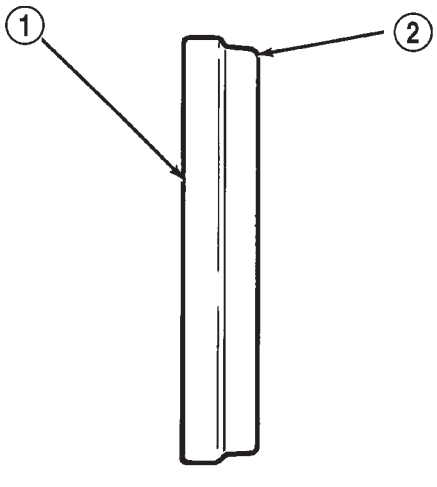


Fig. 49 Placing Oil Seal on Installation Tool 6635

1 – CRANKSHAFT FRONT OIL SEAL
2 – INSTALL THIS END INTO SPECIAL TOOL 6635

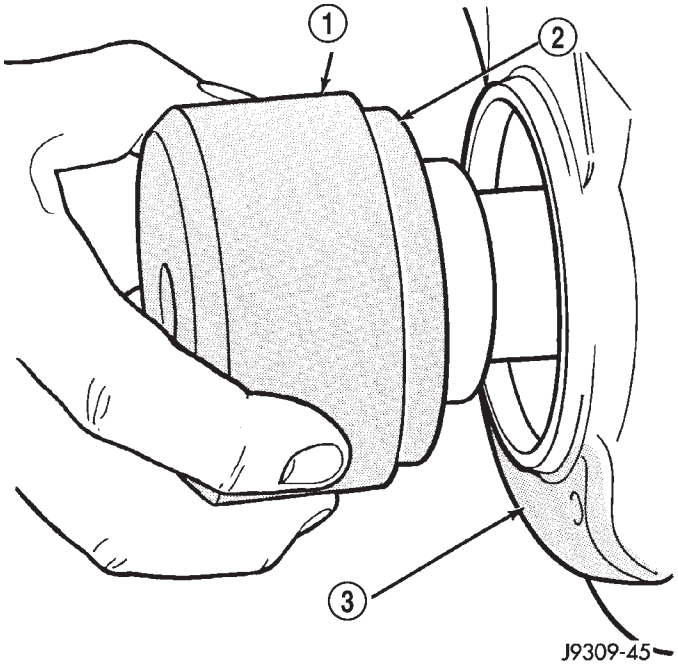


Fig. 50 Position Tool and Seal onto Crankshaft

1 – SPECIAL TOOL 6635
2 – OIL SEAL
3 – TIMING CHAIN COVER

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 51).

(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

(9) Tighten chain case cover bolts to 41 N·m (30 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(10) Remove the vibration damper bolt and seal installation tool.

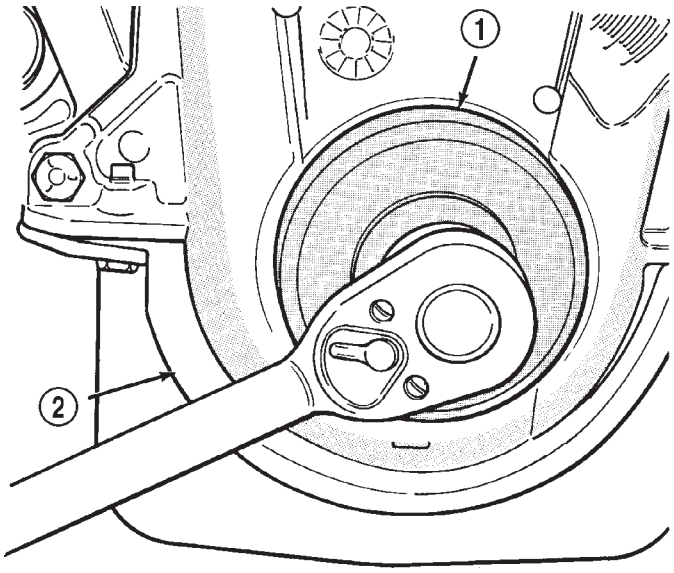


Fig. 51 Installing Oil Seal

1 – SPECIAL TOOL 6635
2 – TIMING CHAIN COVER

(11) Install vibration damper.

(12) Install water pump and housing assembly using new gaskets (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(13) Install power steering pump (refer to Group 19, Steering).

(14) Install the serpentine belt (refer to Group 7, Cooling System).

(15) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

(16) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(17) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).

(18) Connect the negative cable to the battery.

TIMING CHAIN

REMOVAL

(1) Disconnect battery negative cable.

(2) Remove Timing Chain Cover. Refer to Timing Chain Cover in this section for correct procedure.

(3) Re-install the vibration damper bolt finger tight. Using a suitable socket and breaker bar, rotate the crankshaft to align timing marks as shown in (Fig. 52).

(4) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(2) Place timing chain around both sprockets.

(3) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(4) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 52).

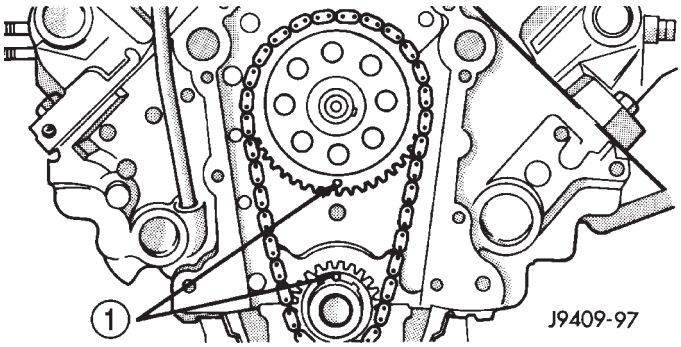


Fig. 52 Alignment of Timing Marks

1 – TIMING MARKS

(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

(7) Check camshaft end play. The end play should be 0.051-0.152 mm (0.002-0.006 inch) with a new thrust plate and up to 0.254 mm (0.010 inch) with a used thrust plate. If not within these limits install a new thrust plate.

(8) Install the timing chain cover.

CAMSHAFT

NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 53).

REMOVAL

(1) Remove the radiator. Refer to Group 7, Cooling for the correct procedures.

(2) Remove the A/C Condenser (if equipped).

(3) Remove the engine cover.

(4) Remove intake manifold. Refer to Intake Manifold in this section for the correct procedure.

(5) Remove cylinder head covers.

(6) Remove timing case cover and timing chain.

(7) Remove rocker arms.

(8) Remove push rods and tappets. Identify each part so it can be installed in its original location.

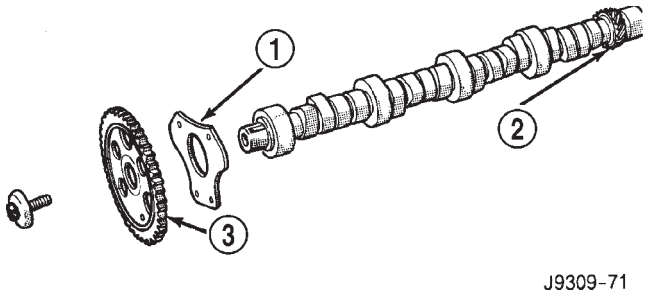


Fig. 53 Camshaft and Sprocket Assembly

1 – THRUST PLATE
2 – OIL PUMP AND DISTRIBUTOR DRIVE GEAR INTEGRAL WITH CAMSHAFT
3 – CAMSHAFT SPROCKET

(9) Remove distributor and lift out the oil pump and distributor drive shaft.

(10) Remove camshaft thrust plate, note location of oil tab (Fig. 54).

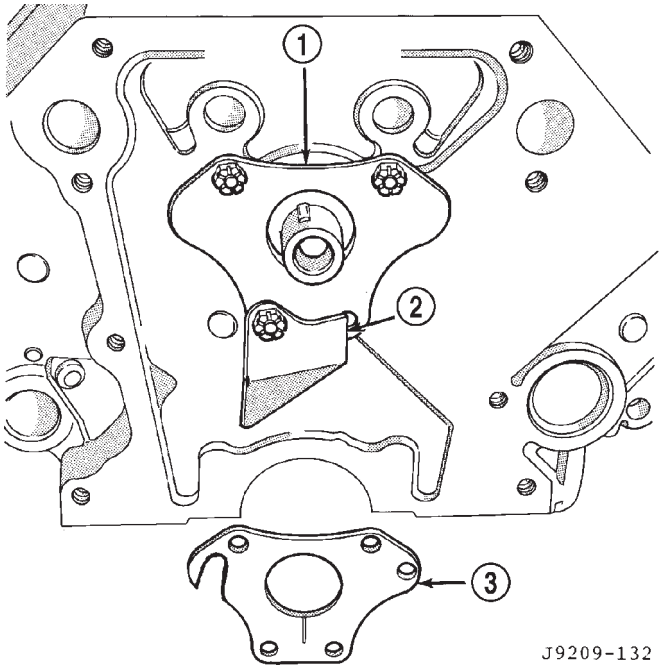


Fig. 54 Timing Chain Oil Tab Installation

1 – THRUST PLATE FRONT SIDE
2 – CHAIN OIL TAB
3 – THRUST PLATE REAR SIDE

(11) Install a long bolt into front of camshaft to aid in removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

REMOVAL AND INSTALLATION (Continued)

(2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 55).

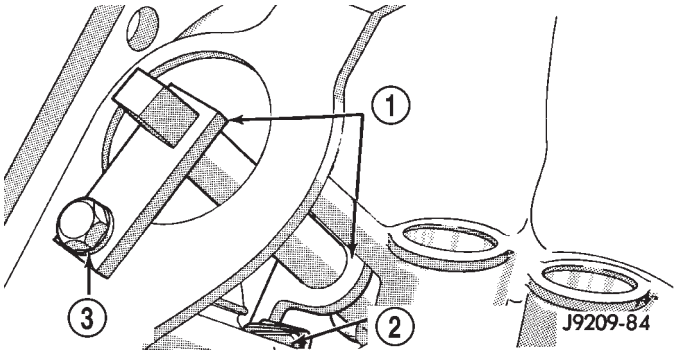


Fig. 55 Camshaft Holding Tool C-3509 (Installed Position)

1 – SPECIAL TOOL C-3509
2 – DRIVE GEAR
3 – DISTRIBUTOR LOCK BOLT

(3) Hold tool in position with a distributor lockplate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

(5) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(6) Place timing chain around both sprockets.

(7) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(8) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 56).

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

(13) Install distributor and distributor drive shaft.

(14) Install push rods and tappets.

(15) Install rocker arms.

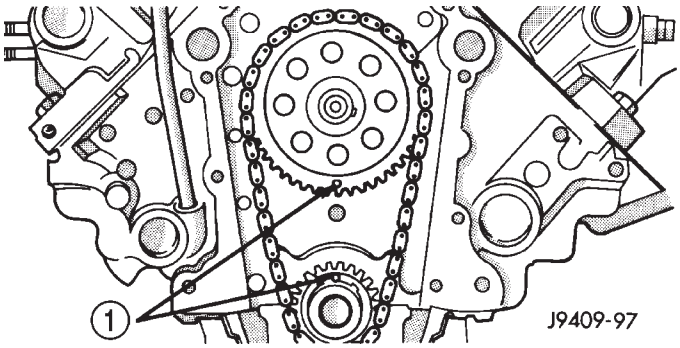


Fig. 56 Alignment of Timing Marks

1 – TIMING MARKS

(16) Install timing case cover.

(17) Install cylinder head covers.

(18) Install intake manifold.

(19) Install the engine cover.

(20) Install the A/C Condenser (if equipped).

(21) Install the radiator. Refer toCOOLING SYSTEM for the correct procedures.

(22) Refill cooling system. Refer to COOLING SYSTEM for the correct procedures.

(23) Start engine check for leaks.

CAMSHAFT BEARINGS

REMOVAL

NOTE: This procedure requires that the engine is removed from the vehicle.

(1) With engine completely disassembled, drive out rear cam bearing core plug.

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 57).

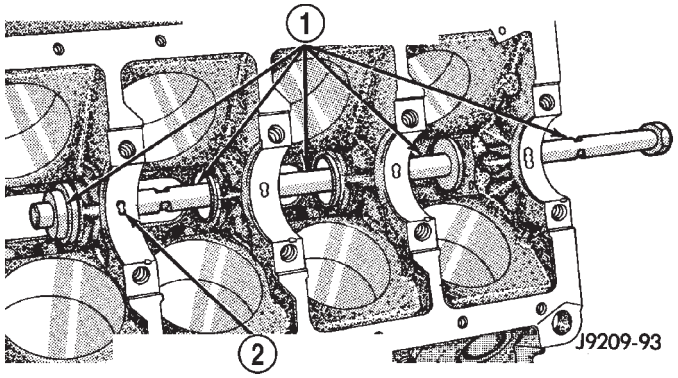


Fig. 57 Camshaft Bearings Removal/Installation with Tool C-3132-A

1 – SPECIAL TOOL C-3132–A
2 – MAIN BEARING OIL HOLE

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 58).

(5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

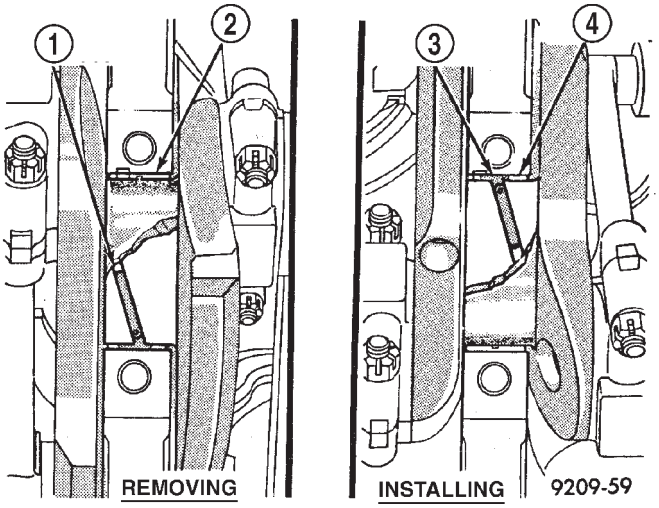


Fig. 58 Upper Main Bearing Removal and Installation with Tool C-3059

1 – SPECIAL TOOL C-3059
2 – BEARING
3 – SPECIAL TOOL C-3059
4 – BEARING

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 58).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

(6) Start engine check for leaks.

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

(1) Remove distributor, refer to Group 8D, Ignition Systems for the proper procedure.

(2) Remove the intake manifold. Refer to Intake Manifold in this section for correct procedure.

(3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 59).

(4) Hold puller screw and tighten puller nut until bushing is removed.

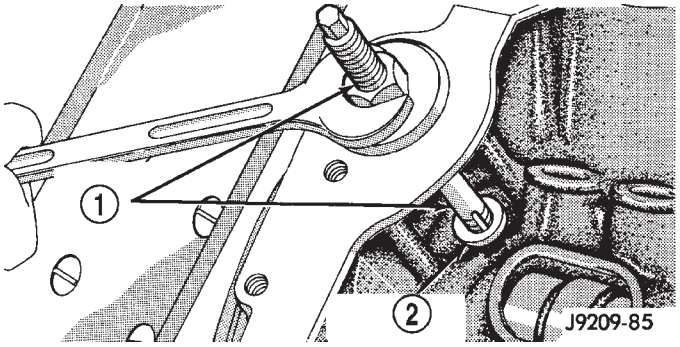


Fig. 59 Distributor Driveshaft Bushing Removal

1 – SPECIAL TOOL C-3052
2 – BUSHING

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.

(2) Drive bushing and tool into position, using a hammer (Fig. 60).

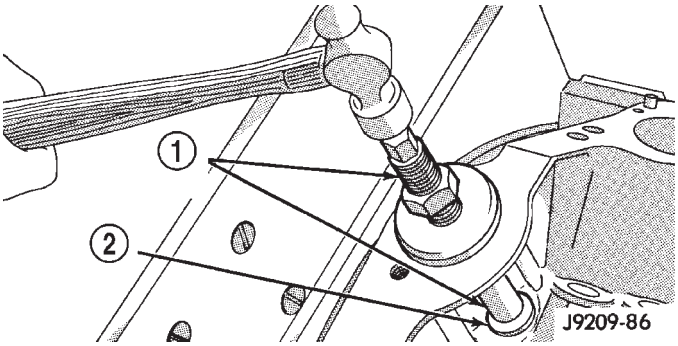


Fig. 60 Distributor Driveshaft Bushing Installation

1 – SPECIAL TOOL C-3053
2 – BUSHING

(3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 61). **DO NOT ream this bushing.**

CAUTION: This procedure MUST be followed when installing a new bushing or seizure to shaft may occur.

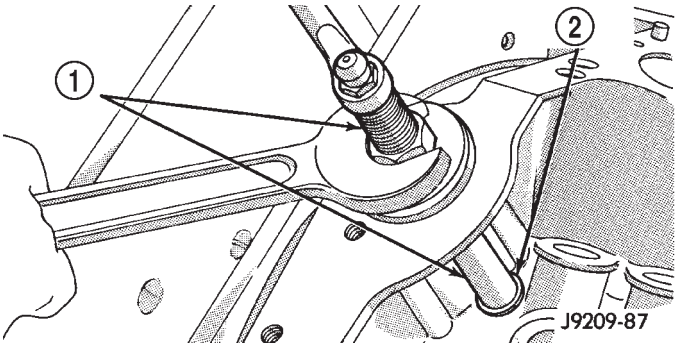


Fig. 61 Burnishing Distributor Driveshaft Bushing

1 – SPECIAL TOOL C-3053
2 – BUSHING

(4) Install the intake manifold.

DISTRIBUTOR INSTALLATION

NOTE: Before installing the distributor, the oil pump drive shaft must be aligned to number one cylinder.

(1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.

(2) When in this position, the timing mark of vibration damper should be under “0” on the timing indicator.

(3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned towards the left front intake manifold attaching bolt hole (Fig. 62).

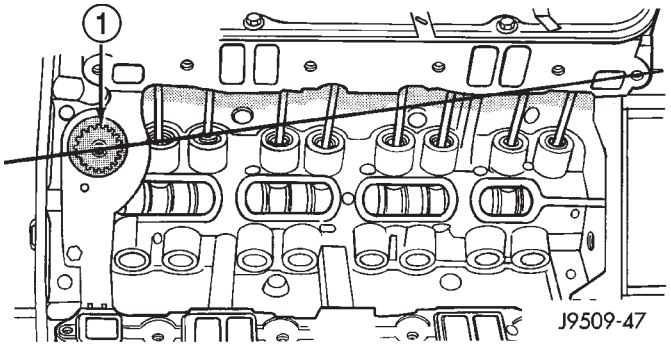


Fig. 62 Position of Oil Pump Shaft Slot

1 – DISTRIBUTOR DRIVE

(4) Install distributor, refer to Group 8D, Ignition Systems for the proper procedure.

After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition system.

Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on ignition timing. Adjusting distributor position will effect fuel synchronization only.

REMOVAL AND INSTALLATION (Continued)

OIL PAN

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Remove engine oil dipstick.
(3) Raise vehicle.
(4) Drain engine oil.
(5) Remove front axle assembly (refer to Group 3, Differential and Driveline).
(6) Remove both engine mount support brackets (Refer to Engine Mounts in this section).
(7) Remove transmission inspection cover.
(8) Remove oil pan and one-piece gasket.

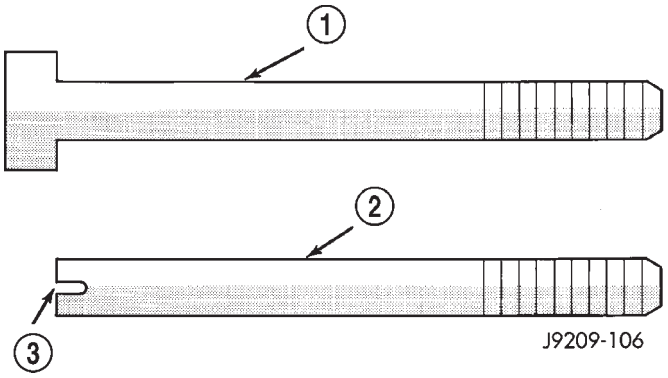


Fig. 63 Fabrication of Alignment Dowels

1 – 1 1/2" x 5/16" BOLT
2 – DOWEL
3 – SLOT

INSTALLATION

(1) Fabricate 4 alignment dowels from 1 1/2 x 5/16 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 63).
(2) Install the dowels in the cylinder block (Fig. 64).
(3) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
(4) Slide the one-piece gasket over the dowels and onto the block.
(5) Position the oil pan over the dowels and onto the gasket.
(6) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.
(7) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.
(8) Install the drain plug. Tighten drain plug to 34 N·m (25 ft. lbs.) torque.
(9) Install transmission inspection cover.
(10) Install engine mount support brackets and insulators (Refer to engine mounts in this section).

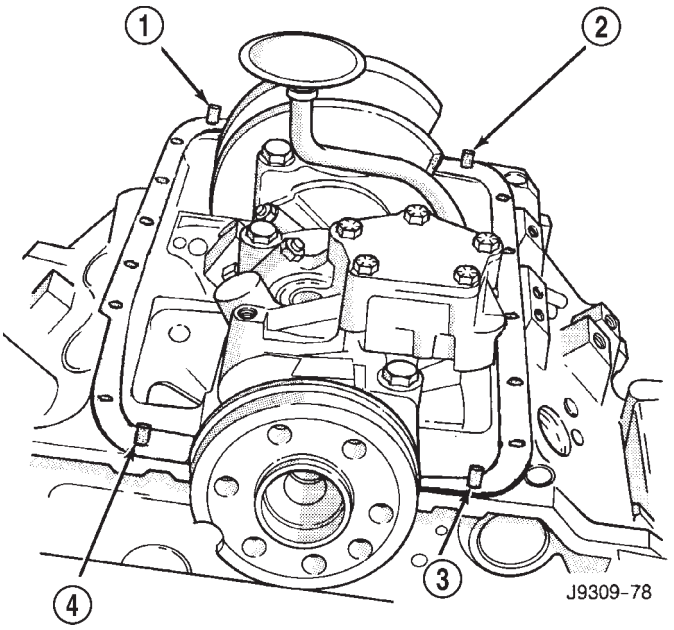


Fig. 64 Position of Dowels in Cylinder Block

1 – DOWEL
2 – DOWEL
3 – DOWEL
4 – DOWEL

(11) Install front axle assembly (refer to Group 3, Differential and Driveline for the proper procedures).
(12) Lower vehicle.
(13) Connect the distributor cap.
(14) Install dipstick.
(15) Connect the negative cable to the battery.
(16) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

(1) Remove the engine from the vehicle.
(2) Remove the cylinder head.
(3) Remove the oil pan.
(4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.
(5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.
(6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft to center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**
(7) After removal, install bearing cap on the mating rod.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in-line with oil ring rail gap.

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 65).

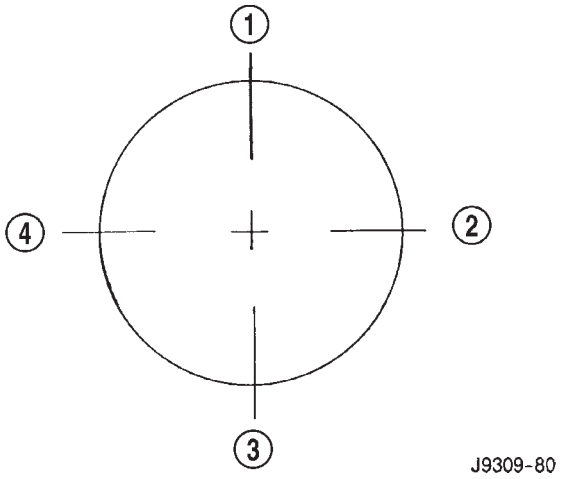


Fig. 65 Proper Ring Installation

1 – OIL RING SPACER GAP
2 – SECOND COMPRESSION RING GAP OIL RING RAIL GAP (TOP)
3 – OIL RING RAIL GAP (BOTTOM)
4 – TOP COMPRESSION RING GAP

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts, the long protector should be installed on the numbered side of the connecting rod.

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

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

(7) The notch or groove on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

NOTE: This procedure can be done in vehicle. However the transmission must be removed first.

(1) If crankshaft is to be removed while engine is in vehicle remove the transmission. Refer to Group 21, for correct procedure.

(2) Remove the oil pan.

(3) Remove the oil pump from the rear main bearing cap.

(4) Remove the vibration damper.

(5) Remove the timing chain cover.

(6) Identify rod bearing caps before removal. Remove rod bearing caps with bearings.

CAUTION: Support crankshaft before removing main bearing caps. failure to do so will allow the crankshaft to fall damaging the crankshaft.

(7) Using a suitable jack, support the crankshaft.

(8) Identify main bearing caps before removal. Remove main bearing caps and bearings one at a time.

(9) Lower the crankshaft out of the block.

(10) Remove and discard the crankshaft rear oil seals.

(11) Remove and discard the front crankshaft oil seal.

INSTALLATION

(1) Clean Gasket Maker residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Mopar® Gasket Maker and the installation of rear cap.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.

(4) Position the crankshaft into the cylinder block.

REMOVAL AND INSTALLATION (Continued)

(5) Lightly oil the new lower seal lips with engine oil.

(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(7) Apply 5 mm (0.20 in) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 66). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

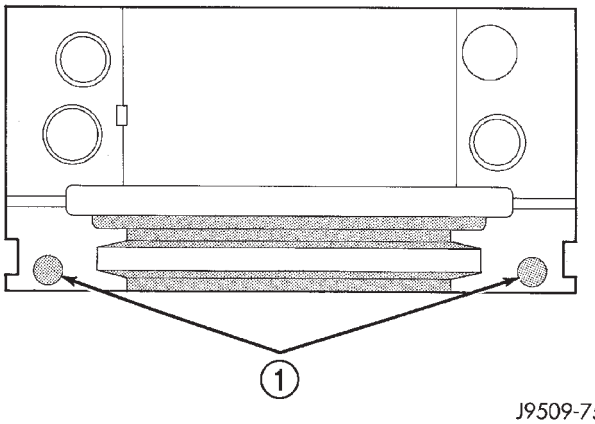


Fig. 66 Sealant Application to Bearing Cap

1 – .25 DROP OF LOCTITE 515 ON BOTH SIDES OF REAR MAIN CAP

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump.

(11) Install the timing chain cover.

(12) Install the vibration damper.

(13) Position the connecting rods onto the crankshaft and install the rod bearing caps. Tighten the nuts to 61 N·m (45 ft. lbs.).

(14) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 67). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(15) Install new front crankshaft oil seal.

(16) Immediately install the oil pan.

(17) If the transmission was removed, install the transmission.

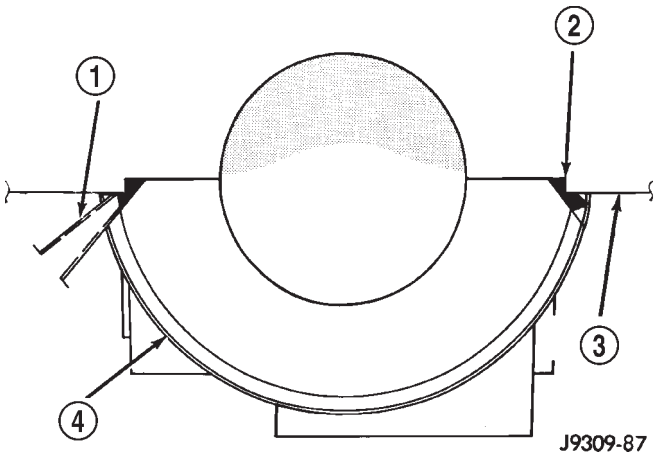


Fig. 67 Apply Sealant to Bearing Cap to Block Joint

1 – MOPAR SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
2 – SEALANT APPLIED
3 – CYLINDER BLOCK
4 – REAR MAIN BEARING CAP

OIL PUMP

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from rear main bearing cap.

INSTALLATION

(1) Install oil pump. During installation slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.

(2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan.

CRANKSHAFT OIL SEAL—FRONT

The oil seal can be replaced without removing the timing chain cover provided the cover is not misaligned.

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper.

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

(4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.

(5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 68). Seat the oil seal in the groove of the tool.

REMOVAL AND INSTALLATION (Continued)

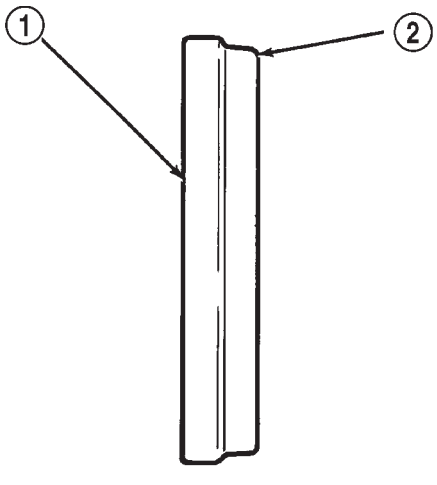


Fig. 68 Placing Oil Seal on Installation Tool 6635

1 – CRANKSHAFT FRONT OIL SEAL
2 – INSTALL THIS END INTO SPECIAL TOOL 6635

(6) Position the seal and tool onto the crankshaft (Fig. 69).

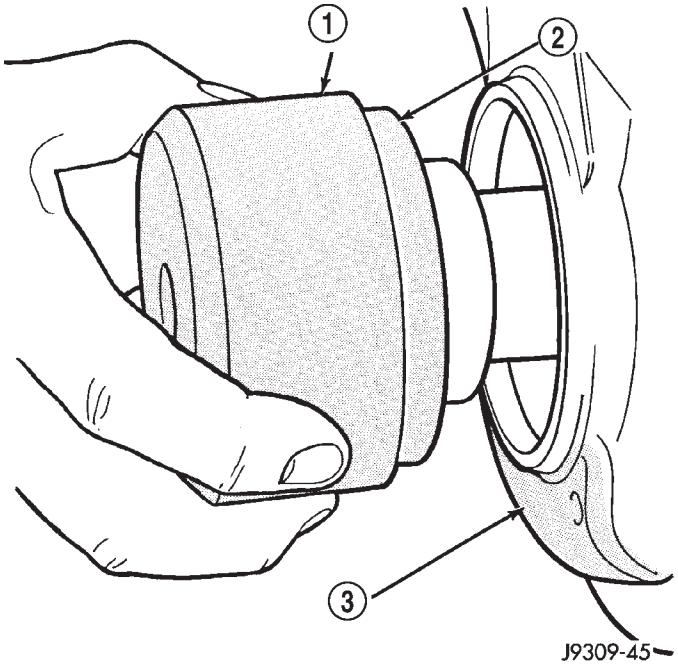


Fig. 69 Position Tool and Seal onto Crankshaft

1 – SPECIAL TOOL 6635
2 – OIL SEAL
3 – TIMING CHAIN COVER

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 70).

(8) Remove the vibration damper bolt and seal installation tool.

(9) Inspect the seal flange on the vibration damper.

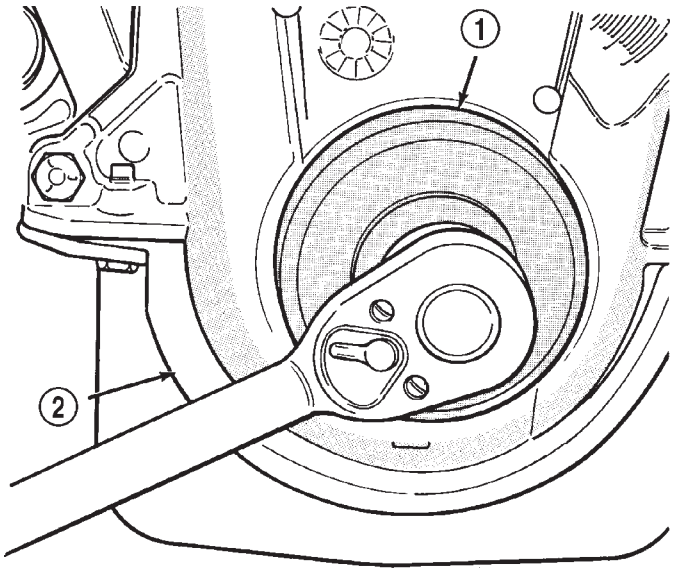


Fig. 70 Installing Oil Seal

1 – SPECIAL TOOL 6635
2 – TIMING CHAIN COVER

(10) Install the vibration damper.

(11) Connect the negative cable to the battery.

CRANKSHAFT OIL SEALS—REAR

The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

(1) Remove the crankshaft. Discard the old upper seal.

INSTALLATION

(1) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.

(4) Position the crankshaft into the cylinder block.

(5) Lightly oil the new lower seal lips with engine oil.

(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

REMOVAL AND INSTALLATION (Continued)

(7) Apply 5 mm (0.20 in) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 71). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

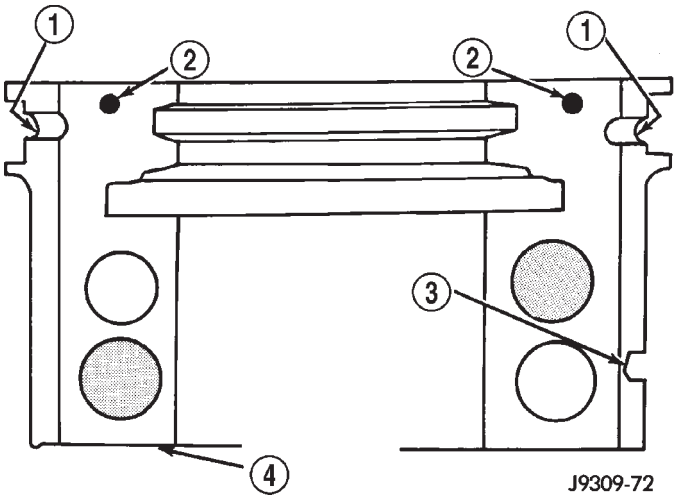


Fig. 71 Sealant Application to Bearing Cap

1 – MOPAR SILICONE RUBBER ADHESIVE SEALANT SLOTS
2 – LOCTITE 518 (OR EQUIVALENT)
3 – CAP ALIGNMENT SLOT
4 – REAR MAIN BEARING CAP

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump.

(11) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 72). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Install new front crankshaft oil seal.

(13) Immediately install the oil pan.

UPPER SEAL —CRANKSHAFT INSTALLED

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.

(4) Carefully remove and discard the old upper oil seal.

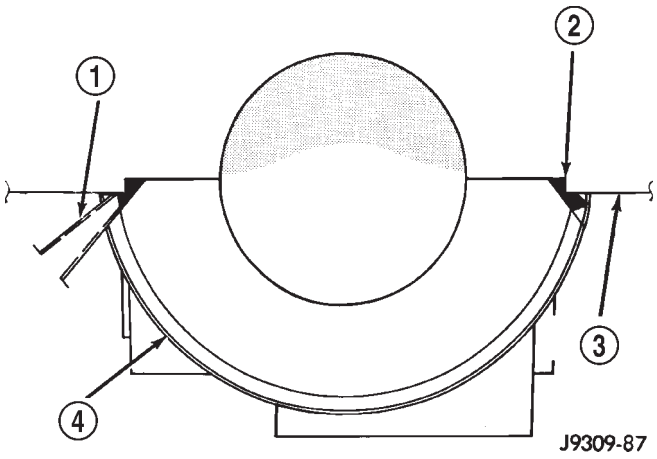


Fig. 72 Apply Sealant to Bearing Cap to Block Joint

1 – MOPAR SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
2 – SEALANT APPLIED
3 – CYLINDER BLOCK
4 – REAR MAIN BEARING CAP

INSTALLATION

(1) Clean the cylinder block mating surfaces before oil seal installation. Check for burr at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.

(3) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing towards the rear of the engine.

(4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(5) Apply 5 mm (0.20 in) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 71). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump.

(9) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 72).

REMOVAL AND INSTALLATION (Continued)

Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pump from the rear main bearing cap.

(3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

(1) Clean the rear main cap mating surfaces including the oil pan gasket groove.

(2) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).

(3) Lightly oil the new lower seal lips with engine oil.

(4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.

(5) Apply 5 mm (0.20 in) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 71). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten the cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump.

(9) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 72). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 73). This will reduce internal leakage and help maintain higher oil pressure at idle.

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 74).

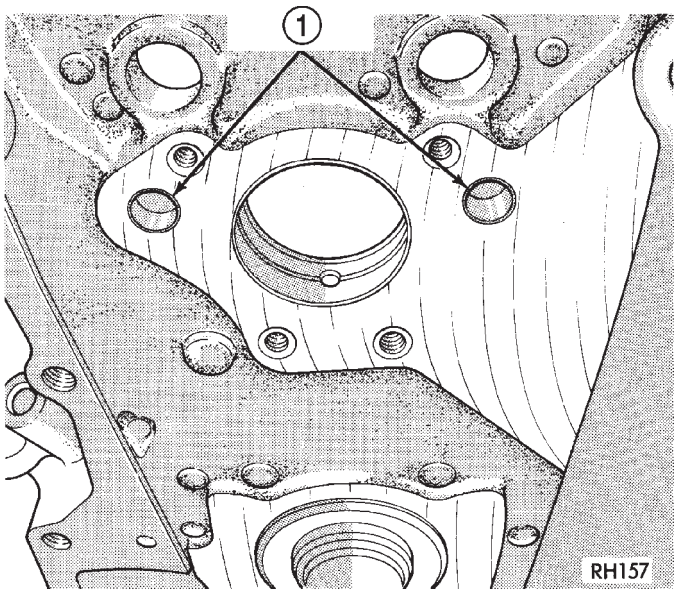


Fig. 73 Location of Cup Plugs in Oil Galleries

1 – CUP PLUGS

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 74).

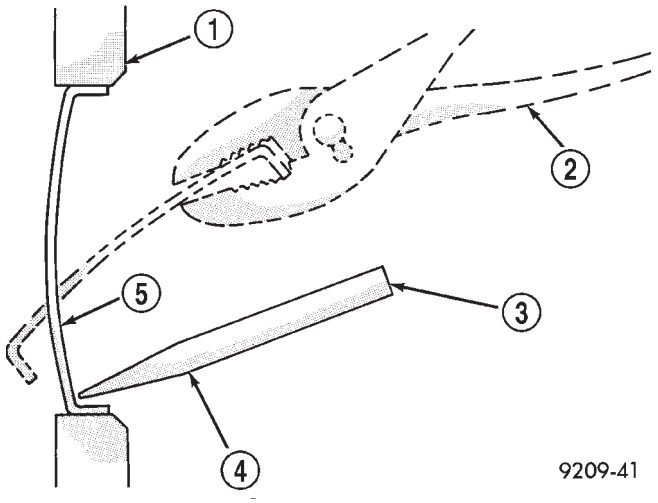


Fig. 74 Core Hole Plug Removal

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

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Be certain the new plug is cleaned of all oil or grease.

(1) Coat edges of plug and core hole with Mopar® Gasket Maker, or equivalent.

REMOVAL AND INSTALLATION (Continued)

CAUTION: DO NOT drive cup plug into the casting, as restricted coolant flow can result and cause serious engine problems.

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 in.) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 75). The special sleeve places the valve at the correct height for checking with a dial indicator.

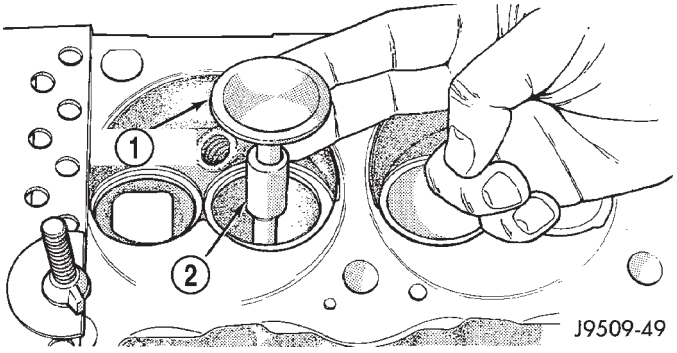


Fig. 75 Positioning Valve with Tool C-3973

1 – VALVE
2 – SPACER TOOL

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 76).

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 inch). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

(4) Service valves with oversize stems are available as shown below.

(5) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 inch). Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:**

- Step 1—Ream to 0.0763 mm (0.003 inch).
- Step 2—Ream to 0.381 mm (0.015 inch).

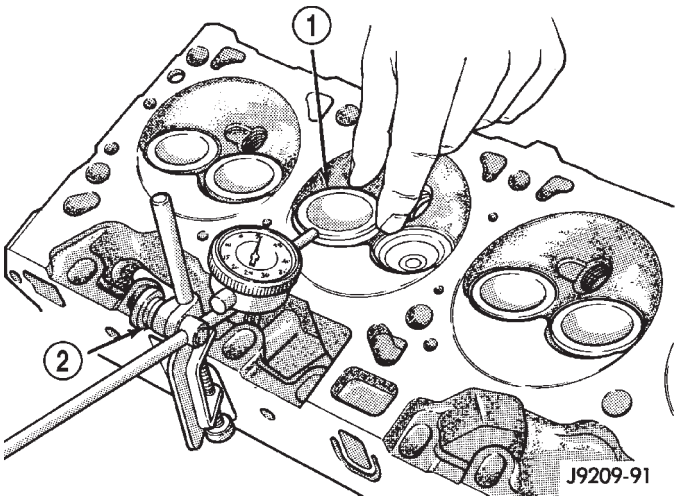


Fig. 76 Measuring Valve Guide Wear

1 – VALVE
2 – SPECIAL TOOL C-3339

REAMER SIZES CHART

REAMER O/S	VALVE GUIDE SIZE
0.076 mm (0.003 in.)	8.026 - 8.052 mm (0.316 - 0.317 in.)
0.381 mm (0.015 in.)	8.331 - 8.357 mm (0.328 - 0.329 in.)

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 77).

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 78). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 79).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 inch) total indicator reading.

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat LIGHTLY with Prussian blue then set valve in place. Rotate the valve with light

DISASSEMBLY AND ASSEMBLY (Continued)

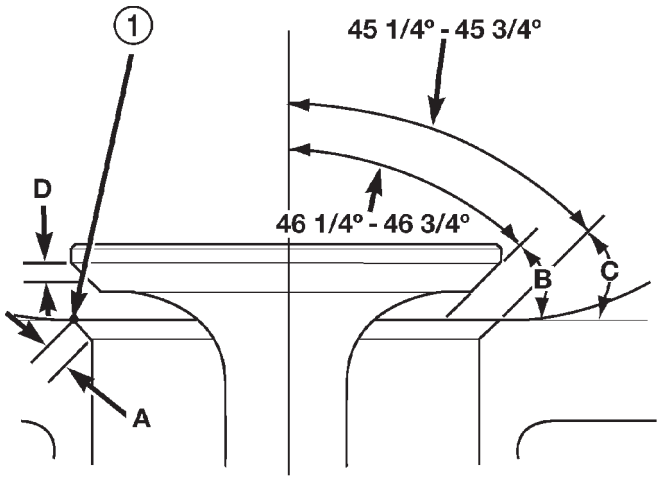


Fig. 77 Valve Face and Seat Angles

1 – CONTACT POINT

ITEM	DESCRIPTION	SPECIFICATION
A	SEAT WIDTH - INTAKE EXHAUST	1.016 - 1.524 mm (0.040 - 0.060 in.) 1.524 - 2.032 mm (0.060 - 0.080 in.)
B	FACE ANGLE (INT. AND EXT.)	43¼° - 43¾°
C	SEAT ANGLE (INT. AND EXT.)	44 ¼° - 44¾°
D	CONTACT SURFACE	—

pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 inch). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 inch).

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universals Valve Spring Tester Tool until surface is

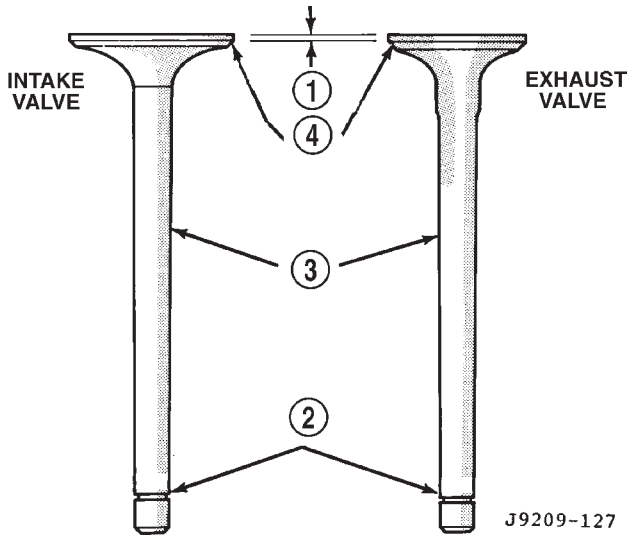


Fig. 78 Intake and Exhaust Valves

1 – MARGIN
2 – VALVE SPRING RETAINER LOCK GROOVE
3 – STEM
4 – FACE

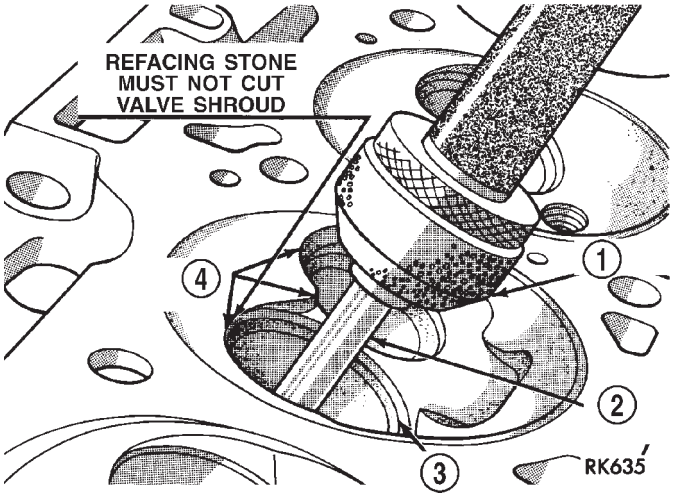


Fig. 79 Refacing Valve Seats

1 – STONE
2 – PILOT
3 – VALVE SEAT
4 – SHROUD

in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 80). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

DISASSEMBLY AND ASSEMBLY (Continued)

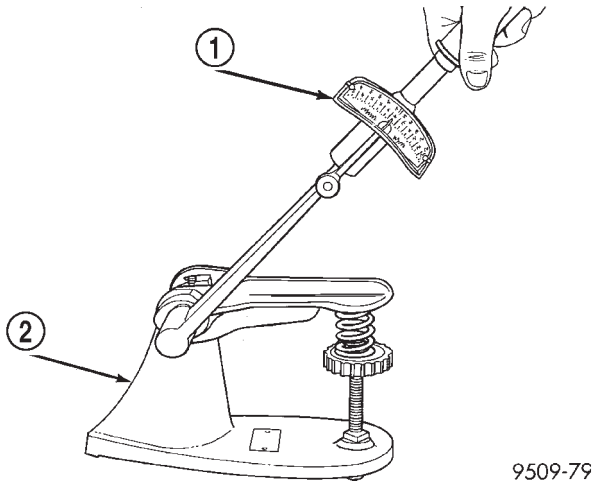


Fig. 80 Testing Valve Spring for Compressed Length

1 – TORQUE WRENCH
2 – VALVE SPRING TESTER

OIL PUMP

DISASSEMBLE

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw.

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 81).

(2) Remove oil pump cover (Fig. 82).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 82).

(4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

ASSEMBLE

(1) Install pump rotors and shaft, using new parts as required.

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

(5) Prime oil pump before installation by filling rotor cavity with engine oil.

CYLINDER BLOCK

DISASSEMBLE

With Engine removed from vehicle:

(1) Remove the cylinder heads. refer to Cylinder Head in this section for correct procedure.

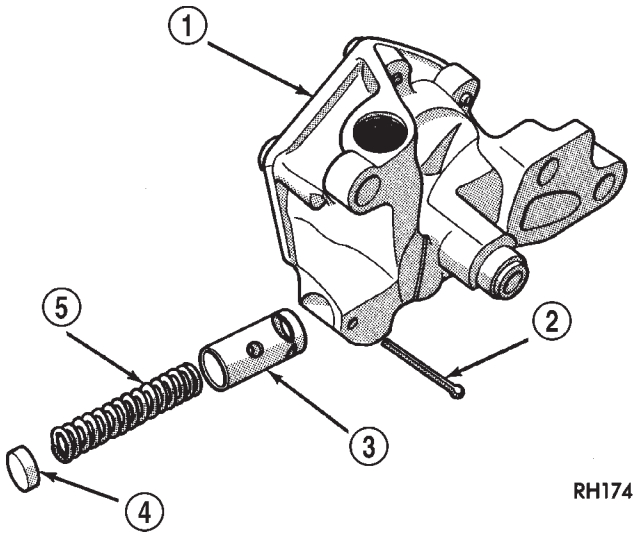


Fig. 81 Oil Pressure Relief Valve

1 – OIL PUMP ASSEMBLY
2 – COTTER PIN
3 – RELIEF VALVE
4 – RETAINER CAP
5 – SPRING

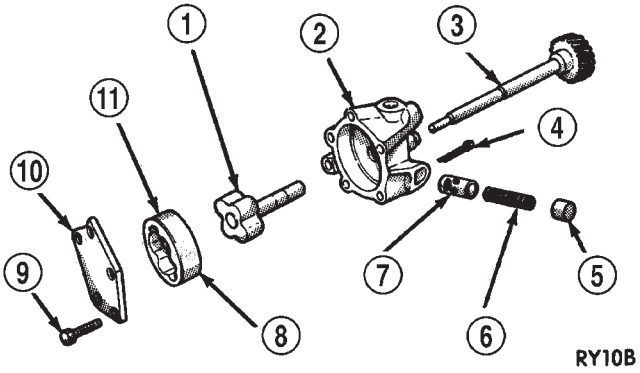


Fig. 82 Oil Pump

1 – INNER ROTOR AND SHAFT
2 – BODY
3 – DISTRIBUTOR DRIVESHAFT (REFERENCE)
4 – COTTER PIN
5 – RETAINER CAP
6 – SPRING
7 – RELIEF VALVE
8 – LARGE CHAMFERED EDGE
9 – BOLT
10 – COVER
11 – OUTER ROTOR

(2) Remove the exhaust manifolds. Refer to Exhaust Manifolds in this section.

(3) Remove the oil pan. Refer to Oil Pan in this section.

(4) Remove the piston and connecting rod assemblies. Refer to Piston and Connecting Rod in this section.

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Remove the crankshaft. Refer to Crankshaft in this section.
(6) Remove the core plugs.

ASSEMBLE

(1) Install the core plugs.
(2) Install the crankshaft.
(3) Install the piston and connecting rods.
(4) Install the oil pan.
(5) Install the cylinder heads.
(6) Install the exhaust manifolds.
(7) Install the intake manifold.
(8) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEAD COVER

CLEANING

Clean cylinder head cover gasket surface.
Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.
Check the gasket for use in head cover installation. If damaged, use a new gasket.

CYLINDER HEAD ASSEMBLY

CLEANING

Clean all surfaces of cylinder block and cylinder heads.
Clean cylinder block front and rear gasket surfaces using a suitable solvent.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 inch/inch) times the span length in inches in any direction, either replace head or lightly machine the head surface.
FOR EXAMPLE: A 305 mm (12 inch) span is 0.102 mm (0.004 inch) out-of-flat. The allowable out-of-flat is 305 X 0.00075 (12 X 0.00075) equals 0.23 mm (0.009 inch). This amount of out-of-flat is acceptable.
The cylinder head surface finish should be 1.78-3.00 microns (70-125 microinches).

PISTON AND CONNECTING ROD ASSEMBLY

INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.
Check the cylinder block bore for out-of-round, taper, scoring and scuffing.
Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 83).

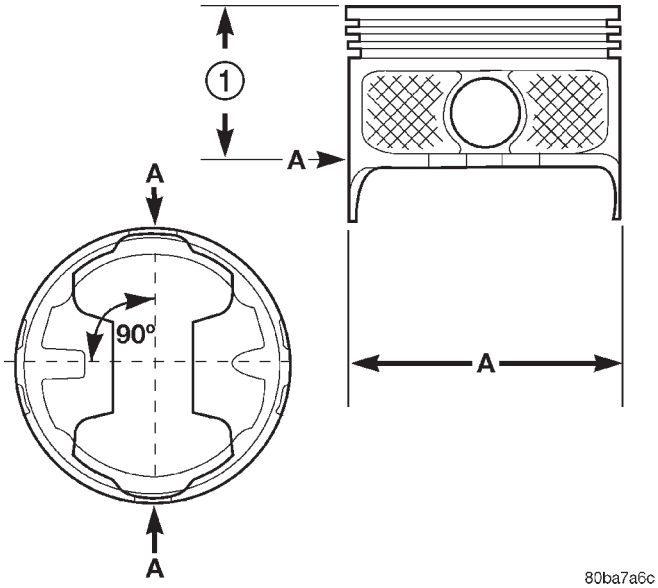


Fig. 83 Piston Measurements

1 – 49.53 mm (1.95 IN.)

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.
Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**
If present, trim excess sealant from inside the engine.
Clean oil pan in solvent and wipe dry with a clean cloth.
Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.
Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

CLEANING AND INSPECTION (Continued)

PISTON MEASUREMENT CHART

PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (in.)	MAX. mm (in.)	MIN. mm (in.)	MAX. mm (in.)
A	—	—	—	—
B	101.580 (3.9992)	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)
C	101.592 (3.9997)	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)
D	101.605 (4.0002)	101.618 (4.0007)	101.630 (4.0012)	101.643 (4.0017)
E	—	—	—	—

DESCRIPTION	SPECIFICATION
PISTON PIN BORE	25.007 - 25.015 mm (.9845 -.9848 in.)
RING GROOVE HEIGHT	
OIL RAIL	4.033 - 4.058 mm (.1588 -.1598 in.)
COMPRESSION RAIL	1.529 - 1.554 mm (.0602 -.0612 in.)
TOTAL FINISHED WEIGHT	470.8 ± 2 grams (16.607 ±.0706 ounces)

OIL PUMP

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 84). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 85).

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 86).

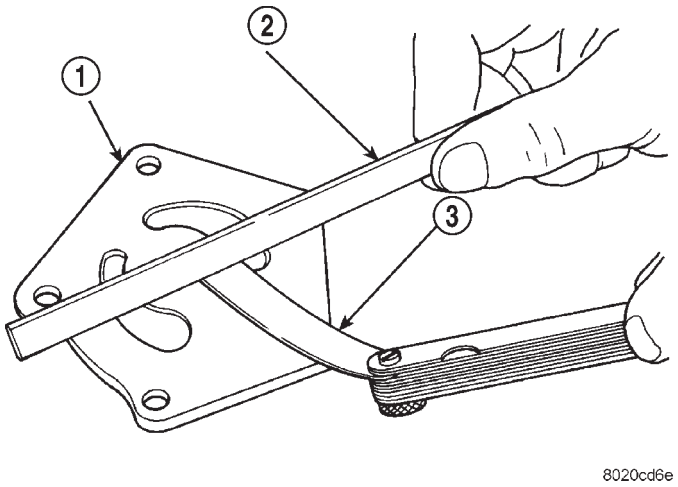


Fig. 84 Checking Oil Pump Cover Flatness

1 – COVER
2 – STRAIGHT EDGE
3 – FEELER GAUGE

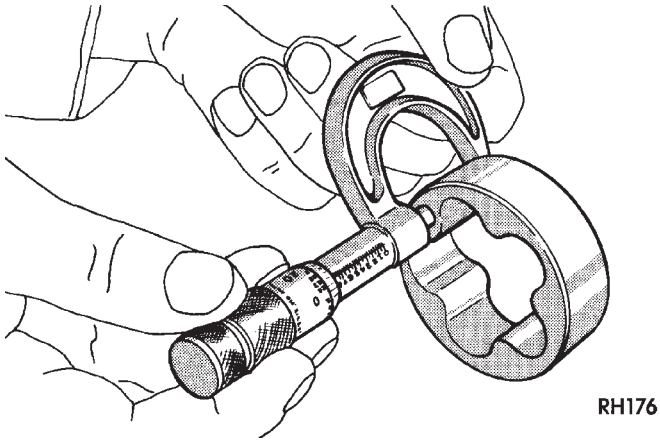


Fig. 85 Measuring Outer Rotor Thickness

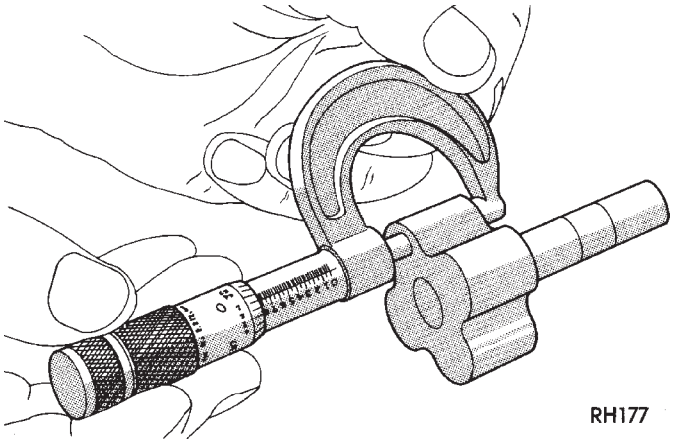


Fig. 86 Measuring Inner Rotor Thickness

CLEANING AND INSPECTION (Continued)

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 87). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.

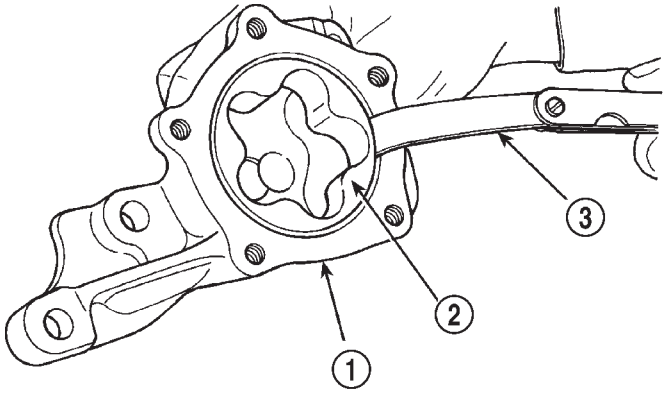


Fig. 87 Measuring Outer Rotor Clearance in Housing

1 – PUMP BODY
2 – OUTER ROTOR
3 – FEELER GAUGE

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 88).

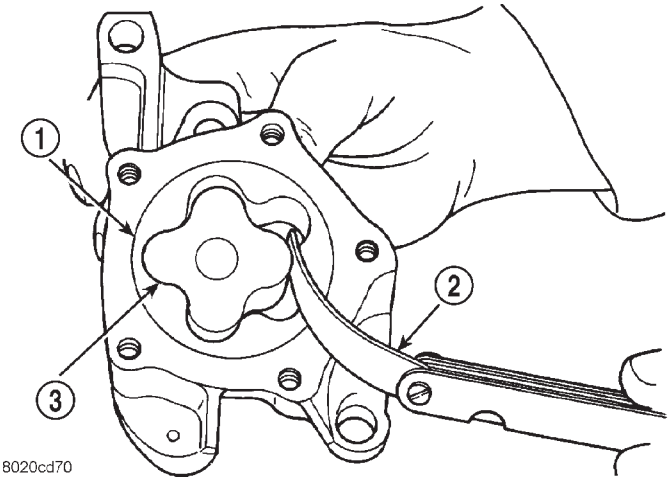


Fig. 88 Measuring Clearance Between Rotors

1 – OUTER ROTOR
2 – FEELER GAUGE
3 – INNER ROTOR

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 89).

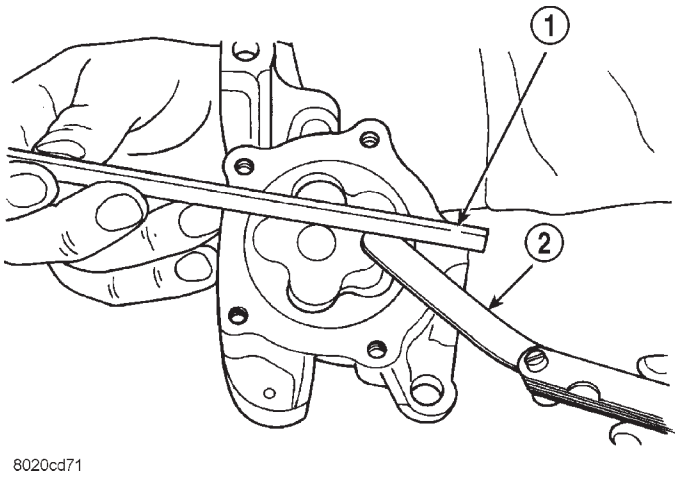


Fig. 89 Measuring Clearance Over Rotors

1 – STRAIGHT EDGE
2 – FEELER GAUGE

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 90).

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

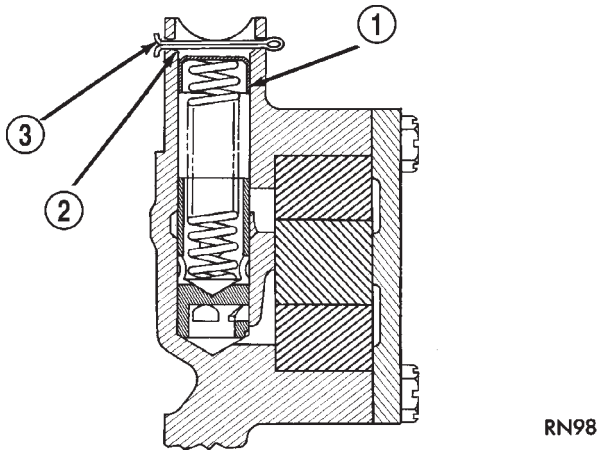


Fig. 90 Proper Installation of Retainer Cap

1 – RETAINER CAP
2 – CHAMFER
3 – COTTER KEY

CLEANING AND INSPECTION (Continued)

CYLINDER BLOCK

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 inch) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 inch).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings so specified clearances may be maintained.

Refer to Standard Service Procedures in the beginning of this Group for the proper honing of cylinder bores.

INTAKE MANIFOLD

CLEANING

Clean manifold in solvent and blow dry with compressed air.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

The plenum pan rail must be clean and dry (free of all foreign material).

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straightedge.

EXHAUST MANIFOLD

CLEANING

Clean mating surfaces on cylinder head and manifold, wash with solvent and blow dry with compressed air.

INSPECTION

Inspect manifold for cracks, Inspect mating surfaces of manifold for flatness with a straight edge. Seal surfaces must be flat within 0.1 mm (0.004 inch) overall.

SPECIFICATIONS

5.2L ENGINE SPECIFICATIONS

ENGINE SPECIFICATIONS

DESCRIPTION	SPECIFICATION
GENERAL SPECIFICATIONS	
Engine Type	90° V-8 OHV
Bore and Stroke	99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement	5.2L (318 c.i.)
Compression Ratio	9.1:1
Firing Order	1–8–4–3–6–5–7–2
Lubrication	Pressure Feed— Full Flow Filtration
Cooling System	Liquid Cooled— Forced Circulation
Cylinder Block	Cast Iron
Crankshaft	Nodular Iron
Cylinder Head	Cast Iron
Combustion Chambers	Wedge-High Swirl Valve shrouding
Camshaft	Nodular Cast Iron
Pistons	Aluminum Alloy w/strut
Connecting Rods	Forged Steel
Cylinder Compression Pressure (Min.)	689.5 kPa (100 psi)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
CAMSHAFT	
Bearing Diameter	
No. 1	50.800 – 50.825 mm (2.000 – 2.001 in.)
No. 2	50.394 – 50.419 mm (1.984 – 1.985 in.)
No. 3	50.013 – 50.038 mm (1.969 – 1.970 in.)
No. 4	49.606 – 49.632 mm (1.953 – 1.954 in.)
No. 5	39.688 – 39.713 mm (1.5625 – 1.5635 in.)
Bearing Journal Diameter	
No. 1	50.749 – 50.775 mm (1.998 – 1.999 in.)
No. 2	50.343 – 50.368 mm (1.982 – 1.983 in.)
No. 3	49.962 – 49.987 mm (1.967 – 1.968 in.)
No. 4	49.555 – 49.581 mm (1.951 – 1.952 in.)
No. 5	39.637 – 39.662 mm (1.5605 – 1.5615 in.)
Bearing to Journal Clearance	
Standard	0.0254 – 0.0762 mm (0.001 – 0.003 in.)
Service Limit	0.127 mm (0.005 in.)
End Play	0.051 – 0.254 mm (0.002 – 0.010 in.)
CONNECTING RODS	
Piston Pin bore Diameter	24.966 – 24.978 mm (0.9829 – 0.9834 in.)
Side Clearance	0.152 – 0.356 mm (0.006 – 0.014 in.)

DESCRIPTION	SPECIFICATION
CRANKSHAFT	
Rod Journal	
Diameter	53.950 – 53.975 mm (2.124 – 2.125 in.)
Out of Round (Max.)	0.0254 mm (0.001 in.)
Taper (Max.)	0.0254 mm (0.001 in.)
Bearing Clearance	0.013 – 0.056 mm (0.0005 – 0.0022 in.)
Service Limit	0.0762 mm (0.003 in.)
Main Bearing Journal	
Diameter	63.487 – 63.513 mm (2.4995 – 2.5005 in.)
Out of Round (Max.)	0.127 mm (0.001 in.)
Taper (Max.)	0.0254 mm (0.001 in.)
Bearing Clearance	
(#1 Journal)	0.013 – 0.038 mm (0.0005 – 0.0015 in.)
(#2-5 Journals)	0.013 – 0.051 mm (0.0005 – 0.002 in.)
Service Limit	
(#1 Journal)	0.0381 mm (0.0015 in.)
(#2-5 Journals)	0.064 mm (0.0025 in.)
End Play	0.051 – 0.178 mm (0.002 – 0.007 in.)
Service Limit	0.254 mm (0.010 in.)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
CYLINDER BLOCK	
Cylinder Bore	
Diameter	99.308 – 99.371 mm (3.9098 – 3.9122 in.)
Out of Round (Max.)	0.025 mm (0.001 in.)
Taper (Max.)	0.025 mm (0.001 in.)
Oversize Limit	1.016 mm (0.040 in.)
Lifter Bore Diameter	22.99 – 23.01 mm (0.9051 – 0.9059 in.)
Distributor Drive Bushing (Press Fit)	
Bushing to Bore Interference	0.0127 – 0.3556 mm (0.0005 – 0.0140 in.)
Shaft to Bushing Clearance	0.0178 – 0.0686 mm (0.0007 – 0.0027 in.)
CYLINDER HEAD	
Valve Seat	
Angle	44.25° – 44.75°
Runout (Max.)	0.0762 mm (0.003 in.)
Width (Finish)	
Intake	1.016 – 1.524 mm (0.040 – 0.060 in.)
Exhaust	1.524 – 2.032 mm (0.060 – 0.080 in.)
VALVES	
Face Angle	43.25° – 43.75°
Head Diameter	
Intake	48.666 mm (1.916 in.)
Exhaust	41.250 mm (1.624 in.)

DESCRIPTION	SPECIFICATION
Length (Overall)	
Intake	124.28 – 125.92 mm (4.893 – 4.918 in.)
Exhaust	124.64 – 125.27 mm (4.907 – 4.932 in.)
Lift (@ zero lash)	10.973 mm (0.432 in.)
Stem Diameter	7.899 – 7.925 mm (0.311 – 0.312 in.)
Guide Bore	7.950 – 7.976 mm (0.313 – 0.314 in.)
Stem to Guide Clearance	0.0254 – 0.0762 mm (0.001 – 0.003 in.)
Service Limit (rocking method)	0.4318 mm (0.017 in.)
VALVE SPRINGS	
Free Length	49.962 mm (1.967 in.)
Spring Tension	
valve closed	378 N @ 41.66 mm (85 lbs. @ 1.64 in.)
valve open	890 N @ 30.89 mm (200 lbs. @ 1.212 in.)
Number of Coils	6.5
Installed Height	41.66 mm (1.64 in.)
Wire Diameter	4.50 mm (0.177 in.)
HYDRAULIC TAPPETS	
Body Diameter	22.949 – 22.962 mm (0.9035 – 0.9040 in.)
Clearance (to bore)	0.0279 – 0.0610 mm (0.0011 – 0.0024 in.)
Dry Lash	1.524 – 5.334 mm (0.060 – 0.210 in.)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
Push Rod Length	175.64 – 176.15 mm (6.915 – 6.935 in.)
OIL PRESSURE	
Curb Idle (Min.*) @ 3000 rpm	41.4 kPa (6 psi) 207 – 552 kPa (30 – 80 psi)
Oil Pressure Bypass Valve Setting	62 – 103 kPa (9 – 15 psi)
Switch Actuating Pressure	34.5 – 48.3 kPa (5 – 7 psi)
*** If oil pressure is zero at curb idle, DO NOT RUN ENGINE.**	
OIL PUMP	
Clearance over Rotors (Max.)	0.0381 mm (0.0015 in.)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in.)
Outer Rotor Clearance (Max.)	0.3556 mm (0.014 in.)
Outer Rotor Diameter (Min.)	62.7126 mm (2.469 in.)
Outer Rotor Thickness (Min.)	20.955 mm (0.825 in.)
Tip Clearance between Rotors (Max.)	0.2032 mm (0.008 in.)
PISTONS	
Clearance at Top of Skirt	0.013 – 0.038 mm (0.0005 – 0.0015 in.)

DESCRIPTION	SPECIFICATION
Land Clearance (Diam.)	0.635 – 1.016 mm (0.025 – 0.040 in.)
Piston Length	86.360 mm (3.40 in.)
Piston Ring Groove Depth	
Groove #1&2	4.572 – 4.826 mm (0.180 – 0.190 in.)
Groove #3	3.810 – 4.064 mm (0.150 – 0.160 in.)
Weight	592.6 – 596.6 grams (20.90 – 21.04 oz.)
PISTON PIN	
Clearance in Piston	0.00635 – 0.01905 mm (0.00025 – 0.00075 in.)
Diameter	24.996 – 25.001 mm (0.9841 – 0.9843 in.)
End Play	NONE
Length	75.946 – 76.454 mm (2.990 – 3.010 in.)
PISTON RINGS	
Ring Gap	
Compression Rings	0.254 – 0.508 mm (0.010 – 0.020 in.)
Oil Control (Steel Rails)	0.254 – 1.270 mm (0.010 – 0.050 in.)
Ring Side Clearance	
Compression Rings	0.038 – 0.076 mm (0.0015 – 0.0030 in.)
Oil Ring (Steel Rails)	0.06 – 0.21 mm (0.002 – 0.008 in.)
Ring Width	
Compression rings	1.971 – 1.989 mm (0.0776 – 0.0783 in.)
Oil Ring (Steel Rails) – Max.	3.848 – 3.975 mm (0.1515 – 0.1565 in.)

SPECIFICATIONS (Continued)

DESCRIPTION	SPECIFICATION
VALVE TIMING	
Exhaust Valve	
Closes (ATDC)	21°
Opens (BBDC)	60°
Duration	264°
Intake Valve	
Closes (ATDC)	61°
Opens (BBDC)	10°
Duration	250°
Valve Overlap	31°

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS CHART

U/S-O/S	Item	Identification	Identification Location
U/S .0254 mm (0.001 in.)	Rod/ Main Journal	R or M R-1-4 ect. (indicating No. 1 and 4 connecting rod journal) and/or M-2-3 ect. (indicating No. 2 and 3 main bearing journal)	Milled flat on No.8 crankshaft counterweight.
O/S .2032 mm (.008 in.)	Hydraulic Tappets	♦	Diamond-shaped stamp top pad - front of engine and flat ground on outside surface of each O/S tappet bore.
O/S .127 mm (.005 in.)	Valve Stems	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

TORQUE SPECIFICATIONS

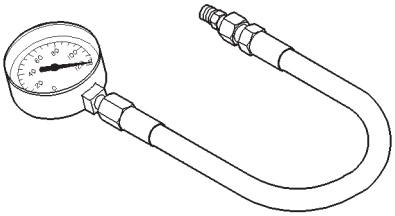
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sprocket—Bolt	68	50	—
Camshaft Thrust Plate—Bolts	24	—	210
Chain Case Cover—Bolts	41	30	—
Connecting Rod Cap—Bolts	61	45	—
Main Bearing Cap—Bolts	115	85	—
Crankshaft Pulley—Bolts	24	—	210
Cylinder Head—Bolts			
Step 1	68	50	—
Step 2	143	105	—
Cylinder Head Cover—Bolts	11	—	95
Engine Support Bracket to Block—Bolts (4WD)	41	30	—
Exhaust Manifold to Cylinder Head—Bolts/Nuts	34	25	—
Flywheel—Bolts	75	55	—
Front Insulator—Through bolt/nut	95	70	—
Front Insulator to Support Bracket—			
Stud Nut (4WD)	41	30	—
Through Bolt/Nut	102	75	—
Front Insulator to Block—Bolts (2WD)	95	70	—
Generator—Mounting Bolts	41	30	—
Intake Manifold—Bolts	Refer to Procedure		
Oil Pan—Bolts	24	—	215
Oil Pan—Drain Plug	34	25	—
Oil Pump—Mounting Bolts	41	30	—

SPECIFICATIONS (Continued)

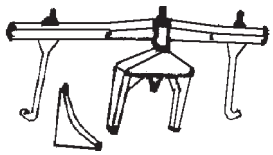
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Oil Pump Cover—Bolts	11	—	95
Rear Insulator to Bracket—Through Bolt (2WD)	68	50	—
Rear Insulator to Crossmember Support Bracket—Nut (2WD)	41	30	—
Rear Insulator to Crossmember—Nuts (4WD)	68	50	—
Rear Insulator to Transmission—Bolts (4WD)	68	50	—
Rear Insulator Bracket—Bolts (4WD Automatic)	68	50	—
Rear Support Plate to Transfer Case—Bolts	41	30	—
Rocker Arm—Bolts	28	21	—
Spark Plugs	41	30	—
Starter Motor—Mounting Bolts	68	50	—
Thermostat Housing—Bolts	25	—	225
Throttle Body—Bolts	23	—	200
Torque Converter Drive Plate—Bolts	31	—	270
Transfer Case to Insulator Mounting Plate—Nuts	204	150	—
Transmission Support Bracket—Bolts (2WD)	68	50	—
Vibration Damper—Bolt	183	135	—
Water Pump to Timing Chain Case Cover—Bolts	41	30	—

SPECIAL TOOLS

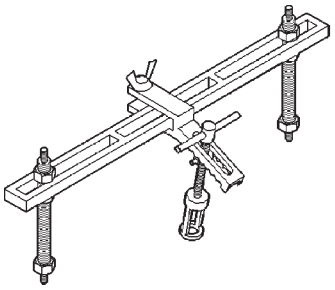
5.2L ENGINE



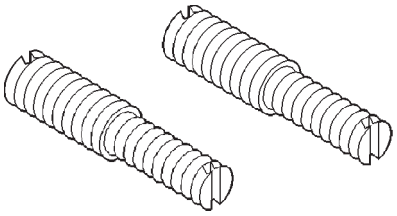
Oil Pressure Gauge C-3292



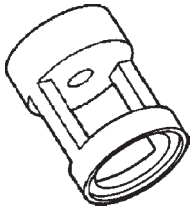
Engine Support Fixture C-3487–A



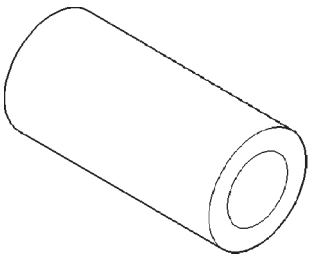
Valve Spring Compressor MD-998772–A



Adapter 6633

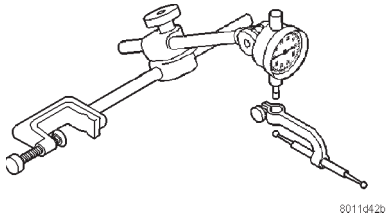


Adapter 6716A

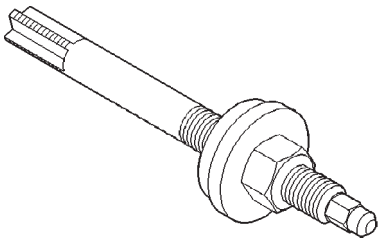


Valve Guide Sleeve C-3973

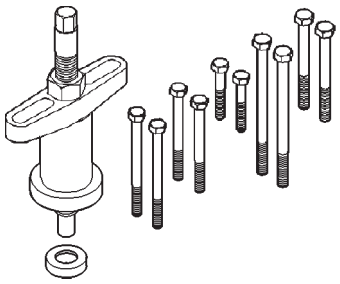
SPECIAL TOOLS (Continued)



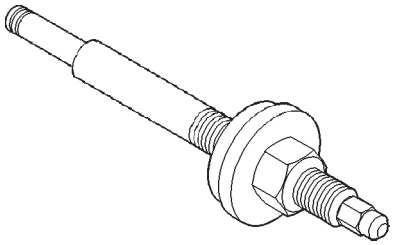
Dial Indicator C-3339



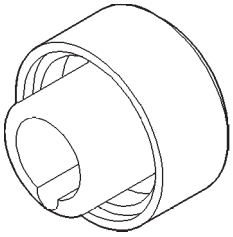
Distributor Bushing Puller C-3052



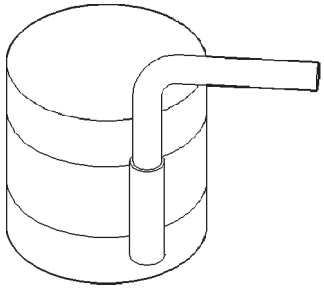
Puller C-3688



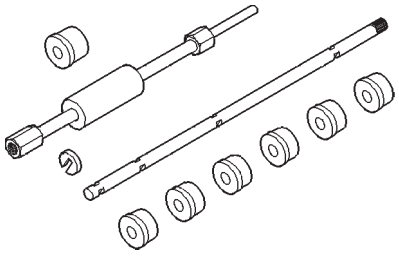
Distributor Bushing Driver/Burnisher C-3053



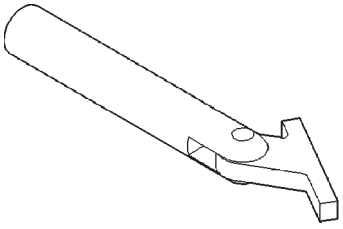
Front Oil Seal Installer 6635



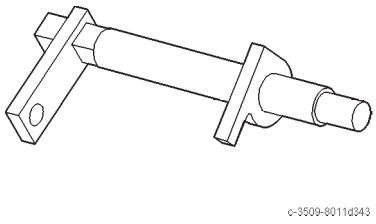
Piston Ring Compressor C-385



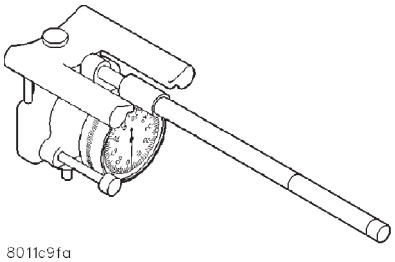
Cam Bearing Remover/Installer C-3132–A



Crankshaft Main Bearing Remover C-3059



Camshaft Holder C-3509



Cylinder Bore Gauge C-119