ENGINE

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ENGINE 5.9L

DESCRIPTION

The 5.9 Liter (360 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets. This engine is designed for unleaded fuel.

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) .

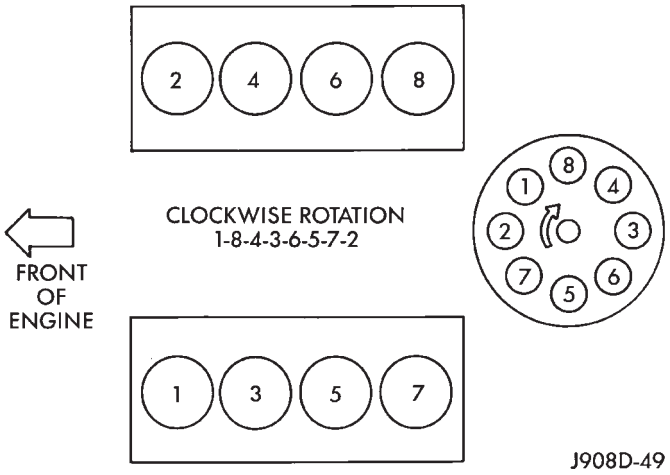

Fig. 1 Firing Order

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

1NK 5.9L XXXY S PPPPP NNNN

1 = 2001 Model
NK = Toluca Engine
5.9L = Displacement In Liters
XXX = Engine Build Day (e.g., 027 = 27th Day of the Year
Y = Last Digit of Year Engine Build (0 = 2000)
S = Shift Engine Built
PPPPP = Last 5 Digits of Engine Assembly Part Number
NNNN = Engine Serial Code (1263 = The 1263rd engine built that day)

8087d8b1

Fig. 2 Engine Identification Number

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - ENGINE DIAGNOSIS - INTRODUCTION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine maintenance.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

(Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Preformance) or (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Mechanical). Refer to 14 - FUEL SYSTEM for fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that cannot be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following:

- Cylinder Compression Pressure Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Combustion Pressure Leakage Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Head Gasket Failure Diagnosis (Refer to 9 - ENGINE/CYLINDER HEAD - DIAGNOSIS AND TESTING)
- Intake Manifold Leakage Diagnosis (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING)
- Lash Adjuster (Tappet) Noise Diagnosis (Refer to 9 - ENGINE/ENGINE BLOCK/HYDRAULIC LIFTERS (CAM IN BLOCK) - DIAGNOSIS AND TESTING)
- Engine Oil Leak Inspection (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)

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DIAGNOSIS AND TESTING—ENGINE
DIAGNOSIS - PERFORMANCE

PERFORMANCE DIAGNOSIS CHART—GASOLINE ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK	1. Weak or dead battery	1. Charge/Replace Battery. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/BATTERY - STANDARD PROCEDURE). Check charging system. (Refer to 8 - ELECTRICAL/ CHARGING - DIAGNOSIS AND TESTING).
	2. Corroded or loose battery connections	2. Clean/tighten suspect battery/ starter connections
	3. Faulty starter or related circuit(s)	3. Check starting system. (Refer to 8 - ELECTRICAL/STARTING - DIAGNOSIS AND TESTING)
	4. Seized accessory drive component	4. Remove accessory drive belt and attempt to start engine. If engine starts, repair/replace seized component.
	5. Engine internal mechanical failure or hydro-static lock	5. Refer to (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
ENGINE CRANKS BUT WILL NOT START	1. No spark	1. Check for spark. (Refer to 8 - ELECTRICAL/IGNITION CONTROL - DESCRIPTION)
	2. No fuel	2. Perform fuel pressure test, and if necessary, inspect fuel injector(s) and driver circuits. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/ FUEL PUMP - DIAGNOSIS AND TESTING).
	3. Low or no engine compression	3. Perform cylinder compression pressure test. (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
ENGINE LOSS OF POWER	1. Worn or burned distributor rotor	1. Install new distributor rotor
	2. Worn distributor shaft	2. Remove and repair distributor (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/ DISTRIBUTOR - REMOVAL).
	3. Worn or incorrect gapped spark plugs	3. Clean plugs and set gap. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - CLEANING).
	4. Dirt or water in fuel system	4. Clean system and replace fuel filter
	5. Faulty fuel pump	5. Install new fuel pump
	6. Incorrect valve timing	6. Correct valve timing

ENGINE 5.9L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	7. Blown cylinder head gasket	7. Install new cylinder head gasket
	8. Low compression	8. Test cylinder compression (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
	9. Burned, warped, or pitted valves	9. Install/Reface valves as necessary
	10. Plugged or restricted exhaust system	10. Install new parts as necessary
	11. Faulty ignition cables	11. Replace any cracked or shorted cables
	12. Faulty ignition coil	12. Test and replace, as necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL).
ENGINE STALLS OR ROUGH IDLE	1. Carbon build-up on throttle plate	1. Remove throttle body and de-carbon. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ THROTTLE BODY - REMOVAL).
	2. Engine idle speed too low	2. Check Idle Air Control circuit. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/IDLE AIR CONTROL MOTOR - DESCRIPTION)
	3. Worn or incorrectly gapped spark plugs	3. Replace or clean and re-gap spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ SPARK PLUG - CLEANING)
	4. Worn or burned distributor rotor	4. Install new distributor rotor
	5. Spark plug cables defective or crossed	5. Check for correct firing order or replace spark plug cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG CABLE - DIAGNOSIS AND TESTING)
	6. Faulty coil	6. Test and replace, if necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL)
	7. Intake manifold vacuum leak	7. Inspect intake manifold gasket and vacuum hoses (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING).
ENGINE MISSES ON ACCELERATION	1. Worn or incorrectly gapped spark plugs	1. Replace spark plugs or clean and set gap. (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/SPARK PLUG - CLEANING)
	2. Spark plug cables defective or crossed	2. Replace or rewire secondary ignition cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ SPARK PLUG CABLE - REMOVAL)

ENGINE 5.9L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	3. Dirt in fuel system	3. Clean fuel system
	4. Burned, warped or pitted valves	4. Install new valves
	5. Faulty coil	5. Test and replace as necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL)

DIAGNOSIS AND TESTING— ENGINE
DIAGNOSIS - MECHANICAL

ENGINE MECHANICAL DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES/LIFTERS	1. High or low oil level in crankcase	1. Check for correct oil level. Adjust oil level by draining or adding as needed
	2. Thin or diluted oil	2. Change oil. (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE)
	3. Low oil pressure	3. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) for engine oil pressure test/ specifications
	4. Dirt in tappets/lash adjusters	4. Clean/replace hydraulic tappets/lash adjusters
	5. Bent push rod(s)	5. Install new push rods
	6. Worn rocker arms	6. Inspect oil supply to rocker arms and replace worn arms as needed
	7. Worn tappets/lash adjusters	7. Install new hydraulic tappets/lash adjusters
	8. Worn valve guides	8. Inspect all valve guides and replace as necessary
	9. Excessive runout of valve seats or valve faces	9. Grind valves and seats
CONNECTING ROD NOISE	1. Insufficient oil supply	1. Check engine oil level.
	2. Low oil pressure	2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) engine oil pressure test/specifications
	3. Thin or diluted oil	3. Change oil to correct viscosity. (Refer to 9 - ENGINE/ LUBRICATION/OIL - STANDARD PROCEDURE) for correct procedure/engine oil specifications

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CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Excessive connecting rod bearing clearance	Measure bearings for correct clearance with plasti-gage. Repair as necessary
	5. Connecting rod journal out of round	5. Replace crankshaft or grind journals
	6. Misaligned connecting rods	6. Replace bent connecting rods
MAIN BEARING NOISE	1. Insufficient oil supply	1. Check engine oil level.
	2. Low oil pressure	2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)
	3. Thin or diluted oil	3. Change oil to correct viscosity.
	4. Excessive main bearing clearance	4. Measure bearings for correct clearance. Repair as necessary
	5. Excessive end play	5. Check crankshaft thrust bearing for excessive wear on flanges
	6. Crankshaft main journal out of round or worn	6. Grind journals or replace crankshaft
	7. Loose flywheel or torque converter	7. Inspect crankshaft, flexplate/ flywheel and bolts for damage. Tighten to correct torque
LOW OIL PRESSURE	1. Low oil level	1. Check oil level and fill if necessary
	2. Faulty oil pressure sending unit	2. Install new sending unit
	3. Clogged oil filter	3. Install new oil filter
	4. Worn oil pump	4. Replace oil pump assembly.
	5. Thin or diluted oil	5. Change oil to correct viscosity.
	6. Excessive bearing clearance	6. Measure bearings for correct clearance
	7. Oil pump relief valve stuck	7. Remove valve to inspect, clean and reinstall
	8. Oil pump suction tube loose, broken, bent or clogged	8. Inspect suction tube and clean or replace if necessary
	9. Oil pump cover warped or cracked	9. Install new oil pump
OIL LEAKS	1. Misaligned or deteriorated gaskets	1. Replace gasket
	2. Loose fastener, broken or porous metal part	2. Tighten, repair or replace the part
	3. Front or rear crankshaft oil seal leaking	3. Replace seal
	4. Leaking oil gallery plug or cup plug	4. Remove and reseal threaded plug. Replace cup style plug

ENGINE 5.9L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. CCV System malfunction	1. (Refer to 25 - EMISSIONS CONTROL/EVAPORATIVE EMISSIONS - DESCRIPTION) for correct operation
	2. Defective valve stem seal(s)	2. Repair or replace seal(s)
	3. Worn or broken piston rings	3. Hone cylinder bores. Install new rings
	4. Scuffed pistons/cylinder walls	4. Hone cylinder bores and replace pistons as required
	5. Carbon in oil control ring groove	5. Remove rings and de-carbon piston
	6. Worn valve guides	6. Inspect/replace valve guides as necessary
	7. Piston rings fitted too tightly in grooves	7. Remove rings and check ring end gap and side clearance. Replace if necessary

DIAGNOSIS AND TESTING—ENGINE
DIAGNOSIS - LUBRICATION

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Gaskets and O-Rings.	1.
	(a) Misaligned or damaged.	(a) Replace as necessary.
	(b) Loose fasteners, broken or porous metal parts.	(b) Tighten fasteners, Repair or replace metal parts.
	2. Crankshaft rear seal	2. Replace as necessary.
	3. Crankshaft seal flange. Scratched, nicked or grooved.	3. Polish or replace crankshaft.
	4. Oil pan flange cracked.	4. Replace oil pan.
	5. Timing chain cover seal, damaged or misaligned.	5. Replace seal.
	6. Scratched or damaged vibration damper hub.	6. Polish or replace damper.
OIL PRESSURE DROP	1. Low oil level.	1. Check and correct oil level.
	2. Faulty oil pressure sending unit.	2. Replace sending unit.
	3. Low oil pressure.	3. Check pump and bearing clearance.
	4. Clogged oil filter.	4. Replace oil filter.
	5. Worn oil pump.	5. Replace as necessary.
	6. Thin or diluted oil.	6. Change oil and filter.
	7. Excessive bearing clearance.	7. Replace as necessary.
	8. Oil pump relief valve stuck.	8. Clean or replace relief valve.
	9. Oil pump suction tube loose or damaged.	9. Replace as necessary.

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CONDITION	POSSIBLE CAUSES	CORRECTION
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn or damaged rings.	1. Hone cylinder bores and replace rings.
	2. Carbon in oil ring slots.	2. Replace rings.
	3. Incorrect ring size installed.	3. Replace rings.
	4. Worn valve guides.	4. Ream guides and replace valves.
	5. Leaking intake gasket.	5. Replace intake gaskets.
	6. Leaking valve guide seals.	6. Replace valve guide seals.

DIAGNOSIS AND TESTING—CYLINDER COMPRESSION PRESSURE

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise, the indicated compression pressures may not be valid for diagnosis purposes.

(1) Clean the spark plug recesses with compressed air.

(2) Remove the spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - REMOVAL).

(3) Secure the throttle in the wide-open position.

(4) Disconnect the ignition coil.

(5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.

(6) Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

(Refer to 9 - ENGINE - SPECIFICATIONS) for the correct engine compression pressures.

DIAGNOSIS AND TESTING - CYLINDER COMBUSTION PRESSURE LEAKAGE

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating)
- Leaks between adjacent cylinders or into water jacket
- Any causes for combustion/compression pressure loss

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

Check the coolant level and fill as required. DO NOT install the radiator cap.

Start and operate the engine until it attains normal operating temperature, then turn OFF the engine.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1,379 kPa (200 psi) maximum and 552 kPa (80 psi) recommended.

Perform the test procedure on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe or oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

FOR EXAMPLE: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART .

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CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

STANDARD PROCEDURE

STANDARD PROCEDURE - FORM-IN-PLACE GASKETS AND SEALERS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results. **Do not use form-in-place gasket material unless specified.** 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 which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

MOPAR® ENGINE RTV GEN II

Mopar® Engine RTV GEN II is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® ATF RTV

Mopar® ATF RTV is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

Mopar® Gasket Maker is an anaerobic type gasket material. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

MOPAR® GASKET SEALANT

Mopar® Gasket Sealant is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material is used on engines with multi-layer steel (MLS) cylinder head gaskets. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4oz./16 oz. can w/applicator.

FORM-IN-PLACE GASKET AND SEALER APPLICATION

Assembling parts using a form-in-place gasket requires care but it's easier then using precut gaskets.

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. 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 material off the location.

Mopar® Engine RTV GEN II or ATF RTV gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All

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mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) 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 usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

STANDARD PROCEDURE - 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.

STANDARD PROCEDURE—HYDROSTATIC LOCK

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

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 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).

(2) Disconnect the negative cable(s) from the battery.

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

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

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

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

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

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

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

(10) Install new spark plugs. Tighten the spark plugs to 41 N·m (30 ft. lbs.) torque.

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

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

(13) Install a new oil filter.

(14) Fill engine crankcase with the specified amount and grade of oil. (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).

(15) Connect the negative cable(s) to the battery.

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

STANDARD PROCEDURE - 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.

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 40° to 60° for proper seating of rings (Fig. 3).

(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 40° to 60° angle. Faster up and down strokes increase the crosshatch angle.

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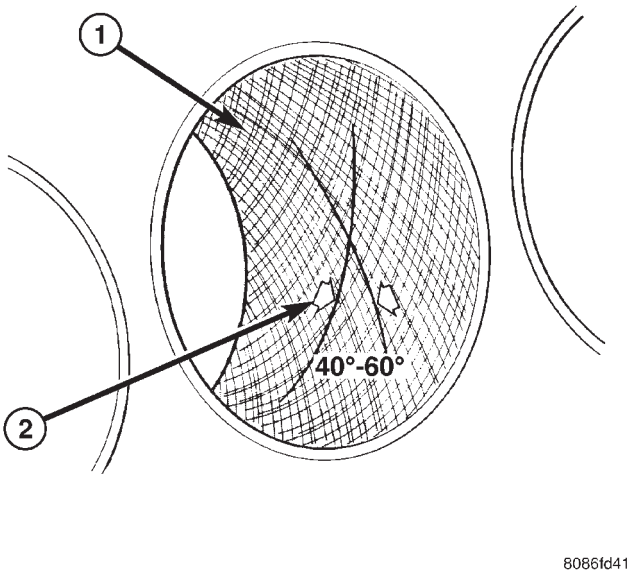

Fig. 3 Cylinder Bore Crosshatch Pattern

1 - CROSSHATCH PATTERN
2 - INTERSECT 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.

REMOVAL

(1) Disconnect the battery negative cable.
(2) Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
(3) Recover refrigerant from a/c system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(4) Remove the a/c condenser, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C CONDENSER - REMOVAL).
(5) Remove the transmission oil cooler (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - REMOVAL).
(6) Remove the washer bottle from the fan shroud.
(7) Remove the viscous fan/drive (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(8) Remove radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).
(9) Remove the upper crossmember and top core support.
(10) Remove the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(11) Remove the A/C compressor with the lines attached. Secure compressor out of the way.
(12) Remove generator assembly (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).
(13) Remove the air cleaner resonator and duct work as an assembly.
(14) Disconnect the throttle linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - REMOVAL).
(15) Remove throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - REMOVAL).
(16) Remove the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).
(17) Remove the distributor cap and wiring.
(18) Disconnect the heater hoses.
(19) Disconnect the power steering hoses, if equipped.
(20) Perform the Fuel System Pressure Release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
(21) Disconnect the fuel supply line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).
(22) On Manual Transmission vehicles, remove the shift lever (Refer to 21 - TRANSMISSION/TRANSAXLE/MANUAL/SHIFT COVER - REMOVAL).
(23) Raise and support the vehicle on a hoist and drain the engine oil.
(24) Remove engine front mount thru-bolt nuts.
(25) Disconnect the transmission oil cooler lines from their retainers at the oil pan bolts.
(26) Disconnect exhaust pipe at manifolds.
(27) Disconnect the starter wires. Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL).
(28) Remove the dust shield and transmission inspection cover.
(29) Remove drive plate to converter bolts (Automatic transmission equipped vehicles).
(30) Remove transmission bell housing to engine block bolts.
(31) Lower the vehicle.
(32) Install an engine lifting fixture.
(33) Separate engine from transmission, remove engine from vehicle, and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the thru-bolt into the support cushion brackets.
(2) Install engine lifting device.

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(3) Lower engine into compartment and align engine with transmission:

- Manual Transmission: Align clutch disc assembly (if disturbed). Install transmission input shaft into clutch disc while mating engine and transmission surfaces. Install two transmission to engine block mounting bolts finger tight.
- Automatic Transmission: Mate engine and transmission and install two transmission to engine block mounting bolts finger tight.

(4) Lower engine assembly until engine mount through bolts rest in mount perches.

(5) Install remaining transmission to engine block mounting bolts and tighten.

(6) Tighten engine mount through bolts.

(7) Install drive plate to torque converter bolts. (Automatic transmission models)

(8) Install the dust shield and transmission cover.

(9) Install the starter and connect the starter wires (Refer to 8 - ELECTRICAL/STARTING/ STARTER MOTOR - INSTALLATION).

(10) Install exhaust pipe to manifold.

(11) Install the transmission cooler line brackets to the oil pan.

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

(13) Lower the vehicle.

(14) Remove engine lifting fixture.

(15) On Manual Transmission vehicles, install the shift lever (Refer to 21 - TRANSMISSION/TRANSAXLE/MANUAL/SHIFT COVER - INSTALLATION).

(16) Connect the fuel supply line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(17) Connect the power steering hoses, if equipped.

(18) Connect the heater hoses.

(19) Install the distributor cap and wiring.

(20) Install the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(21) Using a new gasket, install throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ THROTTLE BODY - INSTALLATION).

(22) Connect the throttle linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - INSTALLATION).

(23) Install the air cleaner resonator and duct work..

(24) Install the generator and wire connections (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).

(25) Install a/c compressor and lines (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).

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

(27) Install upper radiator support crossmember.

(28) Install radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).

(29) Connect the radiator lower hose.

(30) Connect the transmission oil cooler lines to the radiator.

(31) Install the fan shroud.

(32) Install the fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(33) Connect the radiator upper hose.

(34) Install the washer bottle.

(35) Install the transmission oil cooler (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - INSTALLATION).

(36) Connect the transmission cooler lines.

(37) If equipped, install the condenser (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/ A/C CONDENSER - INSTALLATION).

(38) Evacuate and charge the air conditioning system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(39) Add engine oil to crankcase (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - SPECIFICATIONS).

(40) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(41) Connect battery negative cable.

(42) Start engine and inspect for leaks.

(43) Road test vehicle.

SPECIFICATIONS

5.9L ENGINE

ENGINE SPECIFICATIONS

DESCRIPTION	SPECIFICATION
GENERAL SPECIFICATIONS	
Engine Type	90° V-8 OHV
Bore and Stroke	101.6 x 90.9 mm (4.00 x 3.58 in.)
Displacement	5.9L (360 c.i.)
Compression Ratio	9.1:1
Firing Order	1–8–4–3–6–5–7–2
Lubrication	Pressure Feed – Full Flow

ENGINE 5.9L (Continued)

DESCRIPTION	SPECIFICATION
	Filtration
Cooling System	Liquid Cooled – Forced Circulation
Cylinder Block	Cast Iron
Cylinder Head	Cast Iron
Crankshaft	Nodular Iron
Camshaft	Nodular Cast Iron
Pistons	Aluminum Alloy w/strut
Connecting Rods	Forged Steel
Compression Pressure	689.5 kPa (100 psi) (Min.)
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	50.723 – 50.775 mm (1.997 – 1.999 in.)
No. 2	50.317 – 50.368 mm (1.981 – 1.983 in.)
No. 3	49.936 – 49.987 mm (1.966 – 1.968 in.)
No. 4	49.53 – 49.581 mm (1.950 – 1.952 in.)
No. 5	39.611 – 39.662 mm (1.5595 – 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.)
Camshaft 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.)
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.)
Main Bearing Journal	
Diameter	71.361 – 71.387 mm
	(2.8095 – 2.8105 in.)
Out of Round (Max.)	0.127 mm (0.001 in.)
Taper (Max.)	0.0254 mm (0.001 in.)
Bearing Clearance	
Journal #1	0.013 – 0.038 mm (0.0005 – 0.0015 in.)
Journals # 2 - 5	0.013 – 0.051 mm (0.0005 – 0.002 in.)
Service Limit	
Journal #1	0.0381 mm (0.0015 in.)
Journals #2-5	0.064 mm (0.0025 in.)
Crankshaft End Play	0.051 – 0.178 mm (0.002 – 0.007 in.)
Service Limit	0.254 mm (0.010 in.)
CYLINDER BLOCK	
Cylinder Bore	
Diameter	101.60 – 101.65 mm (4.000 – 4.002 in.)

ENGINE 5.9L (Continued)

DESCRIPTION	SPECIFICATION
Out of Round (Max.)	0.0254 mm (0.001 in.)
Taper (Max.)	0.0254 mm (0.001 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 AND VALVES	
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	47.752 mm (1.88 in.)
Exhaust	41.072 (1.617 in.)
Length (Overall)	
Intake	126.21 – 126.85 mm (4.969 – 4.994 in.)
Exhaust	126.44 – 127.30 mm (4.978 – 5.012 in.)
Lift (@ zero lash)	
Intake	10.414 mm (0.410 in.)
Exhaust	10.592 mm (0.417 in.)
Stem Diameter	
Intake	9.449 – 9.474 mm (0.372 – 0.373 in.)
Exhaust	9.423 – 9.449 mm (0.371 – 0.372 in.)
Guide Bore	9.500 – 9.525 mm (0.374 – 0.375 on.)
Stem to Guide Clearance	
Intake	0.0254 – 0.0762 mm (0.001 – 0..003 in.)
Exhaust	0.0508 – 0.1016 mm (0.002 – 0.004 in.)
Service Limit	0.4318 (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	6.8
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.)
Push Rod Length	175.64 – 176.15 mm (6.915 – 6.935 in.)
OIL PRESSURE	
Curb Idle (Min.*)	41.4 kPa (6 psi)
@ 3000 rpm	207 – 552 kPa (30 – 80 psi)
Oil Pressure Bypass Valve Setting	62 – 103 kPa (9 – 15 psi)

ENGINE 5.9L (Continued)

DESCRIPTION	SPECIFICATION
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.)	0.1016 mm (0.004 in.)
Cover Out of Flat (Max.)	0.0381 mm (0.0015 in.)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in.)
Outer Rotor	
Clearance (Max.)	0.3556 mm (0.014 in.)
Diameter (Min.)	62.7126 mm (2.469 in.)
Thickness (Min.)	20.955 mm (0.825 in.)
Tip Clearance between Rotors (Max.)	0.2032 mm (0.008 in.)
PISTONS	
Clearance at Top of Skirt	0.013 – 0.038 mm (0.0005 – 0.0015 in.)
Land Clearance (Diam.)	0.508 – 0.660 mm (0.020 – 0.026 in.)
Piston Length	81.03 mm (3.19 in.)
Piston Ring Groove Depth	
Groove #1&2	4.761 – 4.912 mm (0.187 – 0.193 in.)
Groove #3	3.996 – 4.177 mm (0.157 – 0.164 in.)
Weight	582 – 586 grams (20.53 – 20.67 oz.)
PISTON PINS	
Clearance in Piston	0.006 – 0.019 mm (0.00023 – 0.00074 in.)
Diameter	25.007 – 25.015 mm (0.9845 – 0.9848 in.)
End Play	NONE
Length	67.8 – 68.3 mm (2.67 – 2.69 in.)
PISTON RINGS	
Ring Gap	
Compression Ring (Top)	0.30 – 0.55 mm (0.012 – 0.022 in.)
Compression Ring (2nd)	0.55 – 0.80 mm (0.022 – 0.031 in.)
Oil Control (Steel Rails)	0.381 – 1.397 mm (0.015 – 0.055 in.)
Ring Side Clearance	
Compression Rings	0.040 – 0.085 mm (0.0016 – 0.0033 in.)
Oil Ring (Steel Rails)	0.05 – 0.21 mm (0.002 – 0.008 in.)
Ring Width	
Compression rings	1.530 – 1.555 mm (0.060 – 0.061 in.)
Oil Ring (Steel Rails) – Max.	0.447 –0.473 mm (0.018 – 0.019 in.)
VALVE TIMING	
Exhaust Valve	
Closes (ATDC)	33°
Opens (BBDC)	56°
Duration	269°
Intake Valve	
Closes (ATDC)	62°
Opens (BBDC)	7°
Duration	249°
Valve Overlap	41°

ENGINE 5.9L (Continued)

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS CHART

OS-US	Item	Identification	Location of Identification
U/S .025 MM (.001 in.)	Crankshaft	R or M M-2-3 ect. (indicating No. 2 & 3 main bearing journal) and/or R-1-4 ect. (indicating No. 1 & 4 connecting rod journal)	Milled flat on No. three crankshaft counterweight.
O/S .508 mm (.020 in.)	Cylinder Bores	A	Following engine serial number.
O/S .203 mm (.008 in.)	Tappets	◇	3/8″ diamound -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 3/8″ tapped holes on each end of cylinder head.

TORQUE

TORQUE CHART 5.9L ENGINE

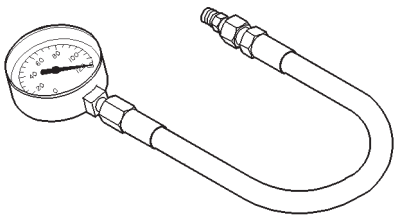
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sprocket—Bolt	68	50	—
Camshaft Thrust Plate—Bolts	24	—	210
Timing Chain Case Cover—Bolts	41	30	—
Connecting Rod Cap—Bolts	61	45	—
Main Bearing Cap—Bolts	115	85	—
Crankshaft Pulley—Bolts	24	—	210
Cylinder Head—Bolts			
Step 1	68	50	—
Step 2	143	105	—
Cylinder 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 (4WD)	102	75	—
Front Insulator to Block—Bolts (2WD)	95	70	—
Generator—Mounting Bolt	41	30	—
Intake Manifold—Bolts	Refer to Procedure		
Oil Pan—Bolts	24	—	215
Oil Pan—Drain Plug	34	25	—
Oil Pump—Attaching Bolts	41	30	—
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—	68	50	—

ENGINE 5.9L (Continued)

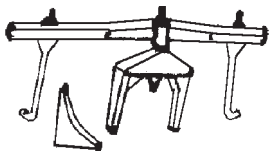
DESCRIPTION	N·m	Ft.	In.
Nuts (4WD)			
Rear Insulator to Transmission— Bolts (4WD)	68	50	—
Rear Insulator Bracket—Bolts (4WD Automatic)	68	50	—
Rear Support Bracket to Crossmember Flange—Nuts	41	30	—
Rear Support Plate to Transfer Case—Bolts	41	30	—
Rocker Arm—Bolts	28	21	—
Spark Plugs	41	30	—
Starter 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	105	—
Transmission Support Bracket— Bolts (2WD)	68	50	—
Vibration Damper—Bolt	244	180	—
Water Pump to Timing Chain Case Cover—Bolts	41	30	—

SPECIAL TOOLS

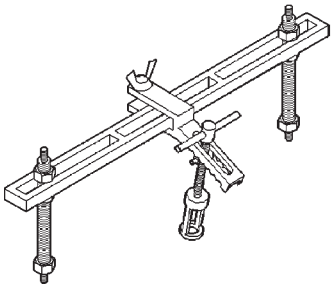
5.9L ENGINE



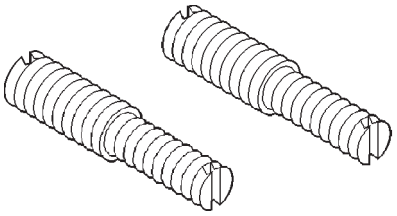
Oil Pressure Gauge C-3292



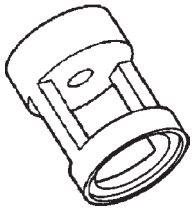
Engine Support Fixture C-3487–A



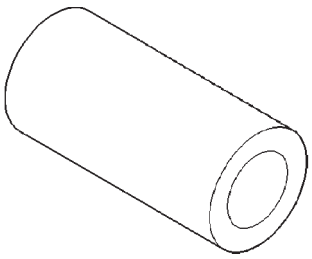
Valve Spring Compressor MD-998772–A



Adaptor 6633

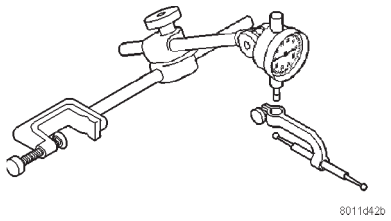


Adaptor 6716A

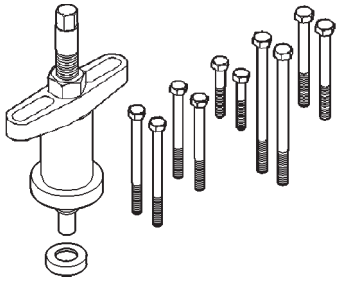


Valve Guide Sleeve C-3973

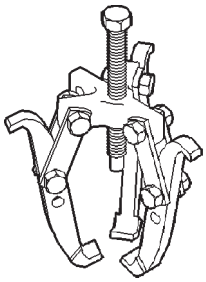
ENGINE 5.9L (Continued)



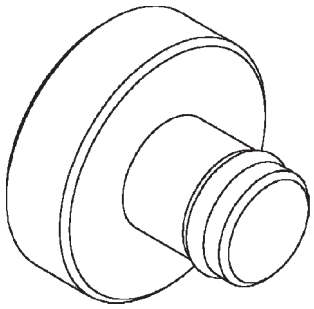
Dial Indicator C-3339



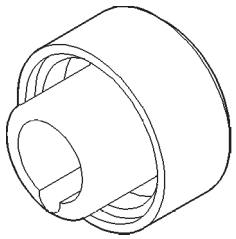
Puller C-3688



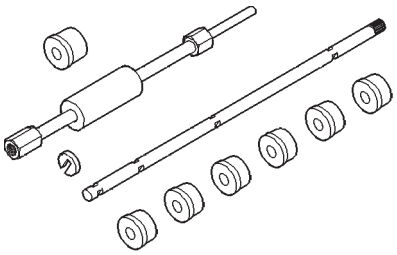
Puller 1026



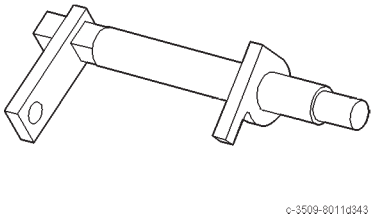
Crankshaft Damper Removal Insert 8513



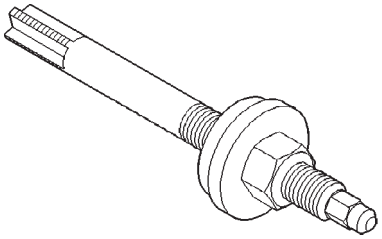
Front Oil Seal Installer 6635



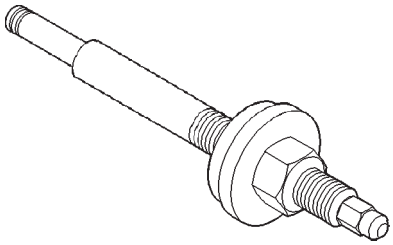
Cam Bearing Remover/Installer C3132–A



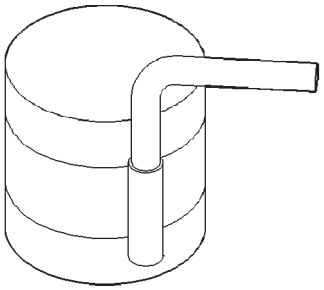
Camshaft Holder C-3509



Distributor Bushing Puller C-3052

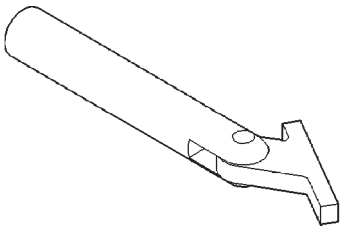


Distributor Bushing Driver/Burnisher C-3053

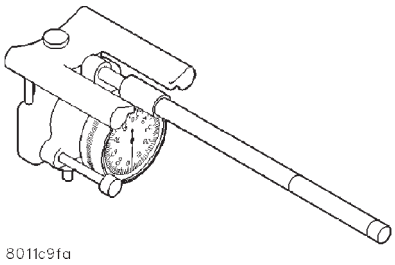


Piston Ring Compressor C-385

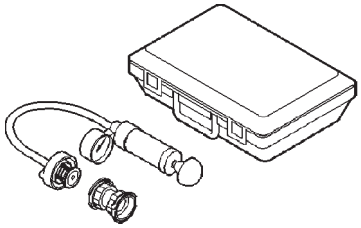
ENGINE 5.9L (Continued)



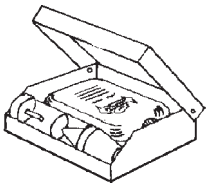
Crankshaft Main Bearing Remover C-3059



Cylinder Bore Gauge C-119



Pressure Tester Kit 7700



Bloc–Check–Kit C-3685–A

CYLINDER HEAD

DESCRIPTION

DESCRIPTION—CYLINDER HEAD

The cast iron cylinder heads (Fig. 4) are mounted to the cylinder block using ten bolts. The spark plugs are located in the peak of the wedge between the valves.

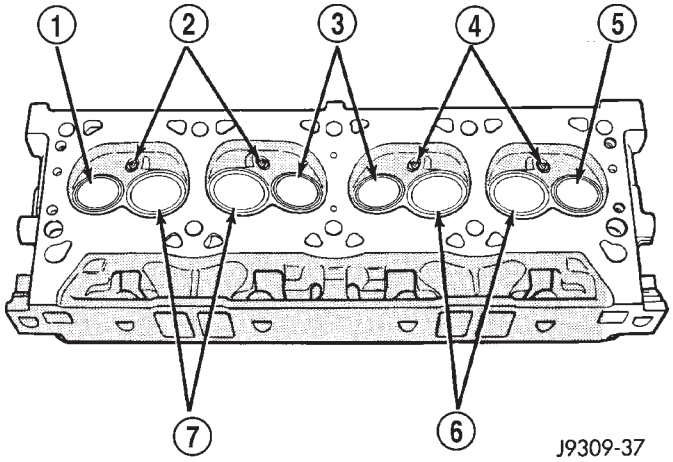


Fig. 4 Cylinder Head Assembly—V-8 Gas Engines

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

DESCRIPTION - CYLINDER HEAD COVER GASKET

The cylinder head cover gasket (Fig. 5) is a steel-backed silicone gasket, designed for long life usage.

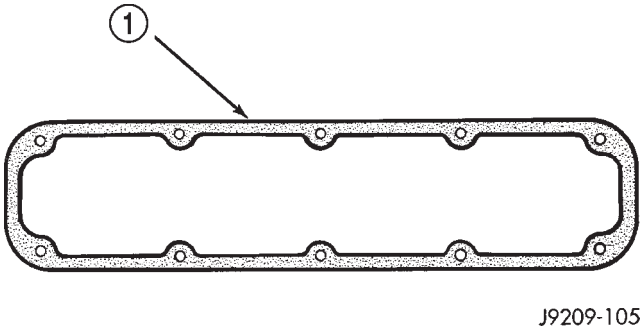


Fig. 5 Cylinder Head Cover Gasket V-8 Gas Engines

1 - CYLINDER HEAD COVER GASKET

CYLINDER HEAD (Continued)

OPERATION

OPERATION—CYLINDER HEAD

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.

OPERATION - CYLINDER HEAD COVER GASKET

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.

DIAGNOSIS AND TESTING—CYLINDER HEAD GASKET FAILURE

A cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

- Possible indications of the cylinder head gasket leaking between adjacent cylinders are:
- Loss of engine power
- Engine misfiring
- Poor fuel economy
- Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:
- Engine overheating
- Loss of coolant
- Excessive steam (white smoke) emitting from exhaust
- Coolant foaming

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures in Cylinder Compression Pressure Test in this section. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50–70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING WITH COOLANT PRESSURE CAP REMOVED.

VISUAL TEST METHOD

With the engine cool, remove the coolant pressure cap. Start the engine and allow it to warm up until thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

COOLING SYSTEM TESTER METHOD

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

Install Cooling System Tester 7700 or equivalent to pressure cap neck. Start the engine and observe the tester's pressure gauge. If gauge pulsates with every power stroke of a cylinder a combustion pressure leak is evident.

CHEMICAL TEST METHOD

Combustion leaks into the cooling system can also be checked by using Bloc-Chek Kit C-3685-A or equivalent. Perform test following the procedures supplied with the tool kit.

REMOVAL

(1) Disconnect the battery negative cable.

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

(3) Remove the air cleaner resonator and duct work.

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

(5) Remove closed crankcase ventilation system.

(6) Disconnect the evaporation control system.

(7) Perform the Fuel System Pressure Release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE). Disconnect the fuel supply line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

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

(9) Remove distributor cap and wires.

(10) Disconnect the coil wires.

(11) Disconnect heat indicator sending unit wire.

(12) Disconnect heater hoses and bypass hose.

(13) Remove cylinder head covers and gaskets (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(14) Remove intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL) and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.

CYLINDER HEAD (Continued)

(15) Remove exhaust manifolds (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - REMOVAL).

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

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

(18) Remove spark plugs.

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 0.00075mm/mm (0.0001in/in.) times the span length in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE:—A 305 mm (12 in.) span is 0.102 mm (0.004 in.) out-of-flat. The allowable out-of-flat is 305 x 0.00075 (12 x 0.00075) equals 0.23 mm (0.009 in.). This amount of out-of-flat is acceptable.

The cylinder head surface finish should be 1.78-3.00 microns (70-125 microinches).

Inspect push rods. Replace worn or bent rods.

INSTALLATION

(1) Clean all surfaces of cylinder block and cylinder heads.

(2) Clean cylinder block front and rear gasket surfaces using a suitable solvent.

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

(4) Position cylinder heads onto head gaskets and cylinder block.

(5) Starting at top center, tighten all cylinder head bolts, in sequence (Fig. 6).

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

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

(7) Install the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION) and throttle body assembly.

(8) Install exhaust manifolds (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - INSTALLATION).

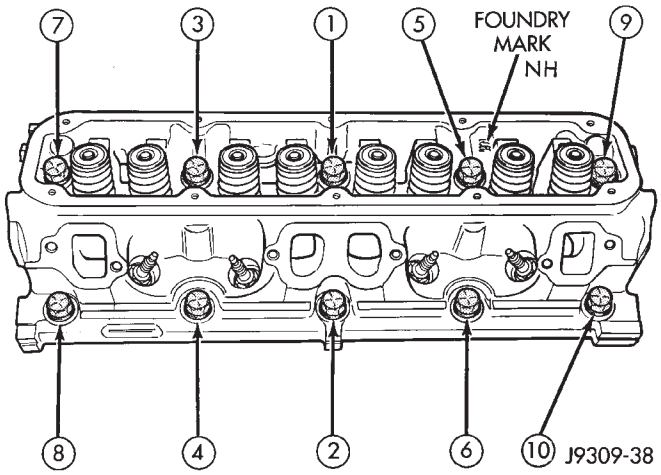


Fig. 6 Cylinder Head Bolt Tightening Sequence

(9) If required, adjust spark plugs to specifications. Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(10) Install coil wire.

(11) Connect heat indicator sending unit wire.

(12) Connect the heater hoses and bypass hose.

(13) Install distributor cap and wires.

(14) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(15) Install the fuel supply line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(16) Install the generator and drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION). Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque.

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

(18) Place the cylinder head cover gaskets in position and install cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(19) Install closed crankcase ventilation system.

(20) Connect the evaporation control system.

(21) Install the air cleaner.

(22) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(23) Connect the negative cable to the battery.

(24) Start engine check for leaks.

CYLINDER HEAD COVER(S)

REMOVAL

NOTE: A steel backed silicon gasket is used with the cylinder head cover (Fig. 7). This gasket can be used again.

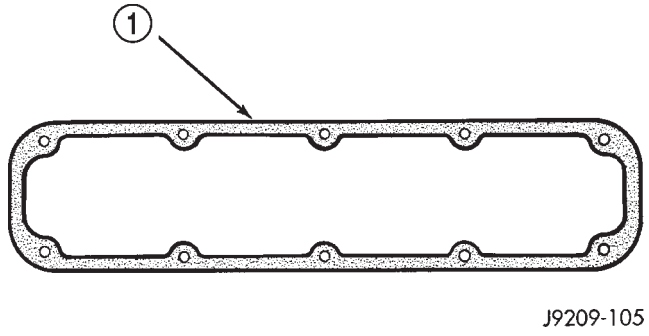


Fig. 7 Cylinder Head Cover Gasket

1 - CYLINDER HEAD COVER GASKET

(1) Disconnect the negative cable from the battery.
(2) Disconnect the spark plug wires form the spark plugs and set aside.
(3) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
(4) Remove cylinder head cover and gasket.

CLEANING

Clean cylinder head cover gasket surface.
Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.
Check the gasket for use in head cover installation. If damaged, use a new gasket.

INSTALLATION

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

INTAKE/EXHAUST VALVES & SEATS

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.

STANDARD PROCEDURE—VALVES, GUIDES AND SPRINGS

VALVE CLEANING

Clean valves thoroughly. Discard burned, warped, or cracked valves.
Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

VALVE GUIDES

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 in.), replace the valve.
Measure valve stem guide clearance as follows:
(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 8). The special sleeve places the valve at the correct height for checking with a dial indicator.

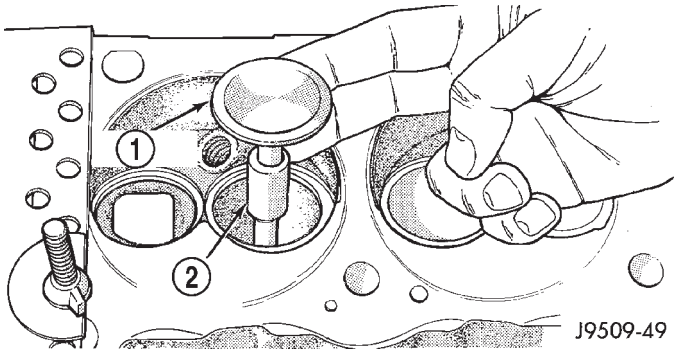


Fig. 8 Positioning Valve with Tool C-3973

1 - VALVE
2 - SPACER TOOL

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 9).
(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.

INTAKE/EXHAUST VALVES & SEATS (Continued)

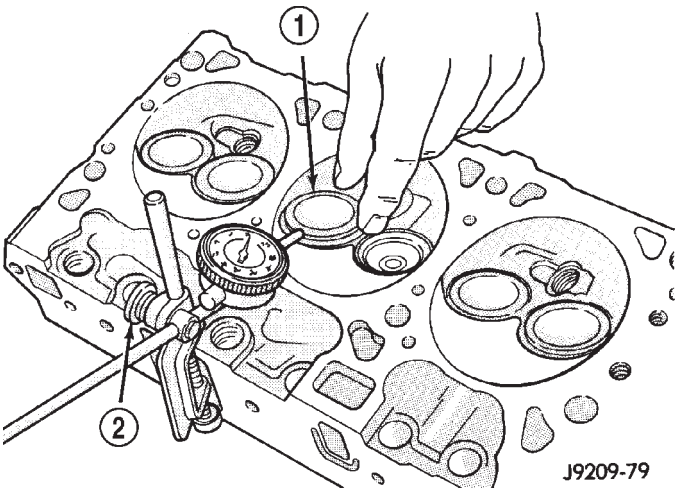


Fig. 9 Measuring Valve Guide Wear

1 - VALVE
2 - SPECIAL TOOL C-3339

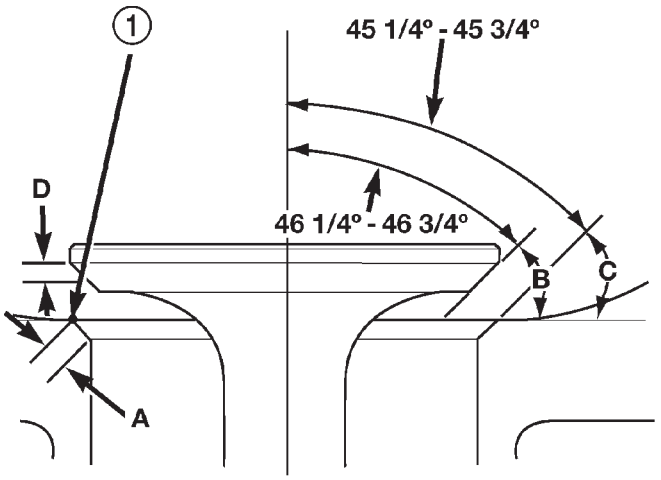


Fig. 10 Valve Face and Seat Angles

1 - CONTACT POINT

VALVE GUIDES

Service valves with oversize stems are available. Refer to REAMER SIZES CHART

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.)

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

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

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 10).

VALVE FACE AND VALVE SEAT ANGLE CHART

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

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 11). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 12).

(1) When refacing valve seats, it is important that the correct size valve guide pilot be used for reseat-

INTAKE/EXHAUST VALVES & SEATS (Continued)

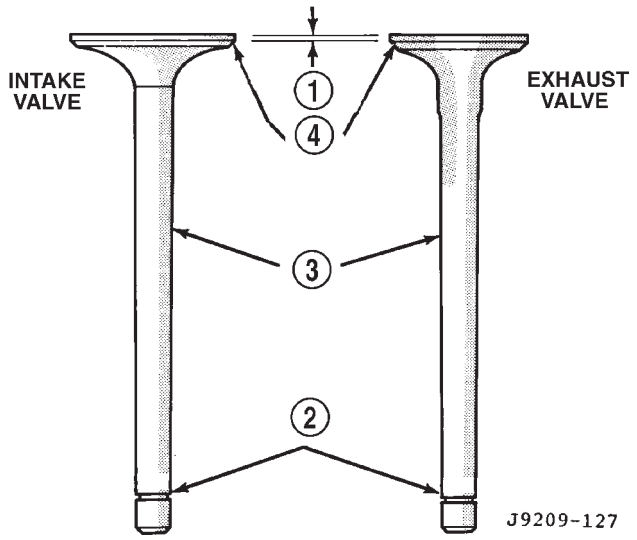


Fig. 11 Intake and Exhaust Valves

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

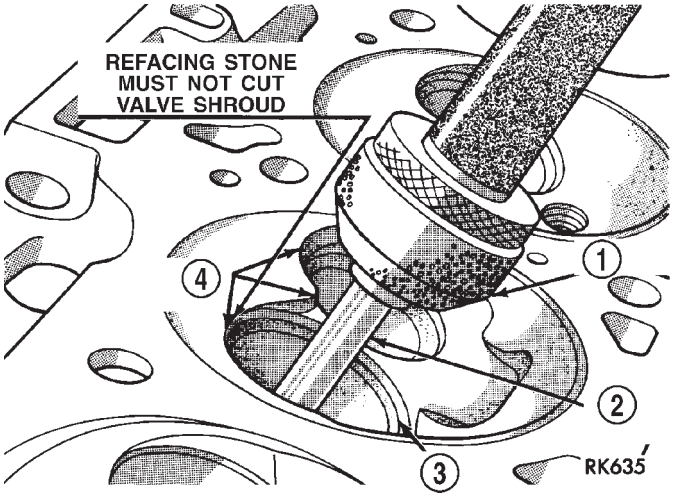


Fig. 12 Refacing Valve Seats

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

ing stones. A true and complete surface must be obtained.

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

(3) Inspect the valve seat with Prussian blue, to determine where the valve contacts the seat. To do this, coat valve seat LIGHTLY with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

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

VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 in.. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 in. mark on the threaded stud. Be sure the zero mark is to the front (Fig. 13). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

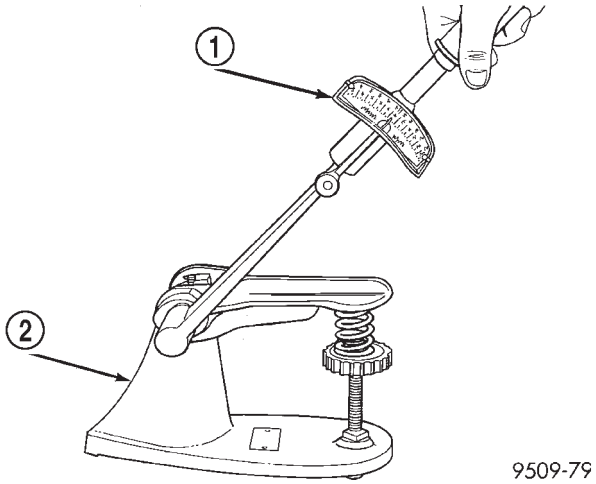


Fig. 13 Testing Valve Spring for Compressed Length

1 - TORQUE WRENCH
2 - VALVE SPRING TESTER

REMOVAL

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

(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.

CLEANING

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

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

INSPECTION

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

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 14). The special sleeve places the valve at the correct height for checking with a dial indicator.

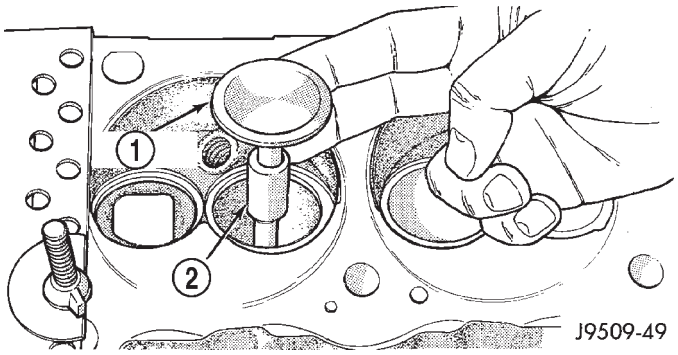


Fig. 14 Positioning Valve with Tool C-3973

1 - VALVE
2 - SPACER TOOL

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 15).

(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.

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.

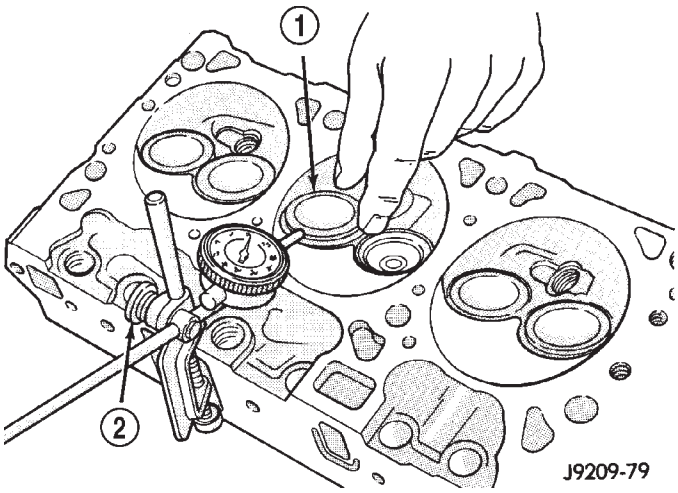


Fig. 15 Measuring Valve Guide Wear

1 - VALVE
2 - SPECIAL TOOL C-3339

(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).

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

ROCKER ARM / ADJUSTER ASSEMBLY

REMOVAL

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

(2) Remove the rocker arm bolts and pivots (Fig. 16). 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.

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.

ROCKER ARM / ADJUSTER ASSEMBLY (Continued)

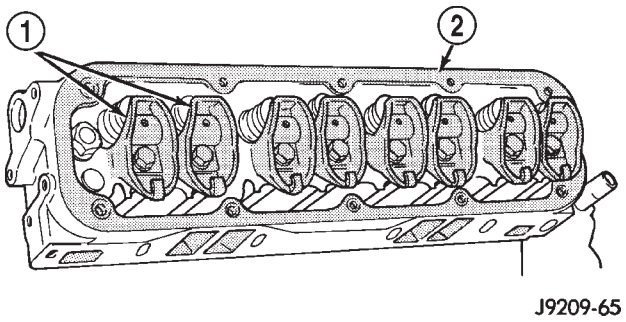


Fig. 16 Rocker Arms

1 - ROCKER ARMS
2 - CYLINDER HEAD

(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 (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

ENGINE BLOCK

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leakage.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper. Refer to Honing Cylinder Bores in the Service Procedures portion of this Section.

Inspect the oil line plug, the oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and oil-from-filter passages (Fig. 17) . Improper installation or missing plug could cause erratic, low, or no oil pressure.

The oil plug must come out the bottom. Use flat dowel, down the oil pressure sending unit hole from the top, to remove oil plug.

(1) Remove oil pressure sending unit from back of block.

(2) Insert a 3.175 mm (1/8 in.) finish wire, or equivalent, into passage.

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 17) . If plug is too high, use a suitable flat dowel to position properly.

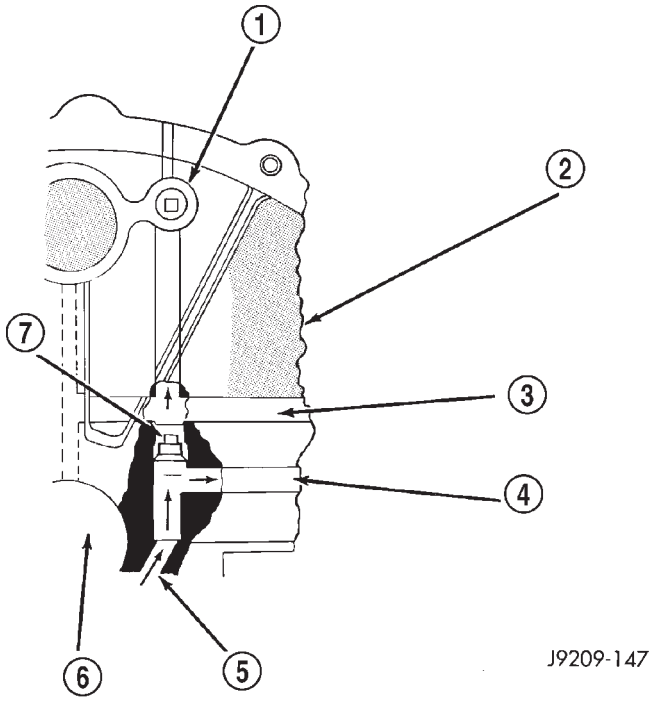


Fig. 17 Oil Line Plug

1 - RIGHT OIL GALLERY
2 - CYLINDER BLOCK
3 - OIL FROM FILTER TO SYSTEM
4 - OIL TO FILTER
5 - FROM OIL PUMP
6 - CRANKSHAFT
7 - PLUG

(4) If plug is too low, remove oil pan and No. 4 main bearing cap. Use suitable flat dowel to position properly. Coat outside diameter of plug with Mopar® Stud and Bearing Mount Adhesive. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 in.) from bottom of the block.

CAMSHAFT & BEARINGS (IN BLOCK)

REMOVAL

REMOVAL—CAMSHAFT BEARINGS

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

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 18).

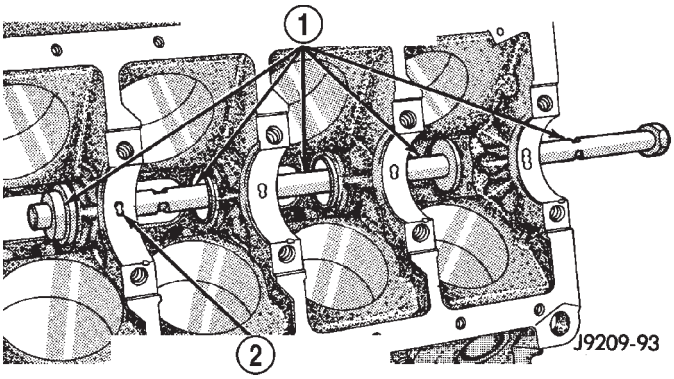


Fig. 18 Camshaft Bearings

1 - SPECIAL TOOL C-3132–A
2 - MAIN BEARING OIL HOLE

REMOVAL—CAMSHAFT

NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 19).

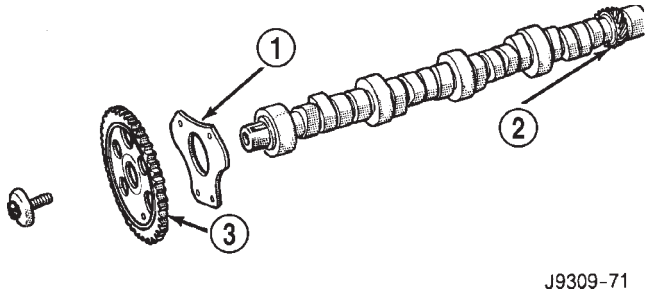


Fig. 19 Camshaft and Sprocket Assembly

1 - THRUST PLATE
2 - OIL PUMP AND DISTRIBUTOR DRIVE GEAR INTEGRAL WITH CAMSHAFT
3 - CAMSHAFT SPROCKET

(1) Remove the radiator (Refer to 7 - COOLING/ ENGINE/RADIATOR - REMOVAL).
(2) Remove the A/C Condenser (if equipped)
(3) Remove the engine cover.
(4) Remove intake manifold (Refer to 9 - ENGINE/ MANIFOLDS/INTAKE MANIFOLD - REMOVAL).
(5) Remove cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(6) Remove timing case cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL) and timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
(7) Remove rocker arms.
(8) Remove push rods and tappets. Identify each part so it can be installed in its original location.
(9) Remove distributor and lift out the oil pump and distributor drive shaft.
(10) Remove camshaft thrust plate, note location of oil tab (Fig. 20).

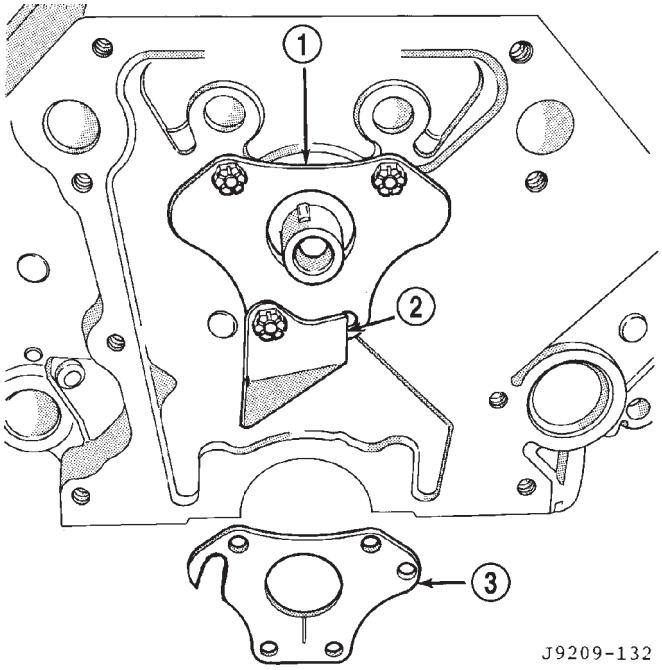


Fig. 20 Timing Chain Oil

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

INSTALLATION—CAMSHAFT BEARINGS

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.
(2) Position rear bearing in the tool. Install horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.
(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

INSTALLATION—CAMSHAFT

(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.

(2) Install Camshaft Holder Tool C-3509 with tongue back of distributor drive gear (Fig. 21).

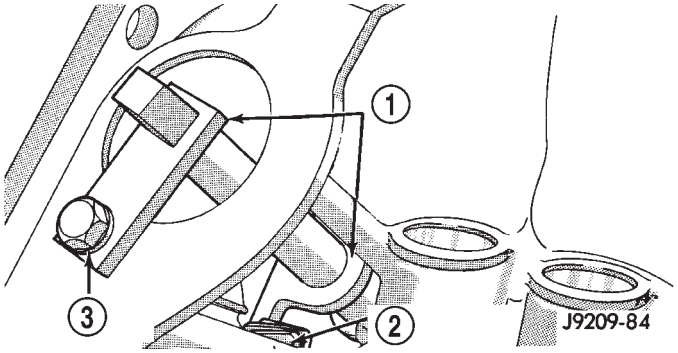


Fig. 21 Camshaft Holding Tool C-3509 (Installed Position)

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

(6) Measure camshaft end play (Refer to 9 - ENGINE - SPECIFICATIONS). If not within limits install a new thrust plate.

(7) 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.**

(8) Install distributor and distributor drive shaft.

(9) Install push rods and tappets.

(10) Install rocker arms.

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

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

(13) Install intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(14) Install the engine cover.

(15) Install the A/C Condenser (if equipped)

(16) Install the radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).

(17) Start engine check for leaks.

CONNECTING ROD BEARINGS

STANDARD PROCEDURE - CONNECTING ROD BEARING 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, be certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

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

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

CRANKSHAFT

DESCRIPTION

The crankshaft (Fig. 22) 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.

OPERATION

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

CRANKSHAFT (Continued)

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

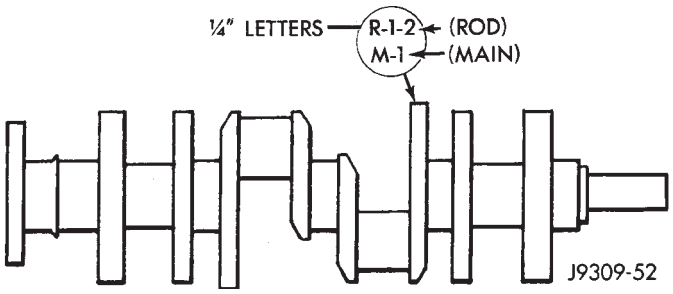


Fig. 22 Crankshaft with Journal Size Identification

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 21 - TRANSMISSION/TRANSAXLE.

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

(3) Remove the oil pump from the rear main bearing cap (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

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

(5) Remove the timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(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.

(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. 23). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

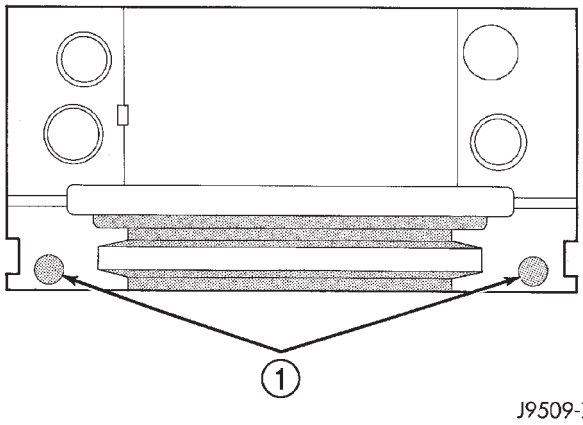


Fig. 23 Sealant Application to Bearing Cap

1 - MOPAR® GASKET MAKER 5 mm (0.20 IN.) 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 (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(11) Install the timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

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

(13) Position the connecting rods onto the crankshaft and install the rod bearing caps. Tighten the nuts to 61 N·m (45 ft. lbs.).

CRANKSHAFT (Continued)

(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. 24). 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 (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - INSTALLATION).

(16) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

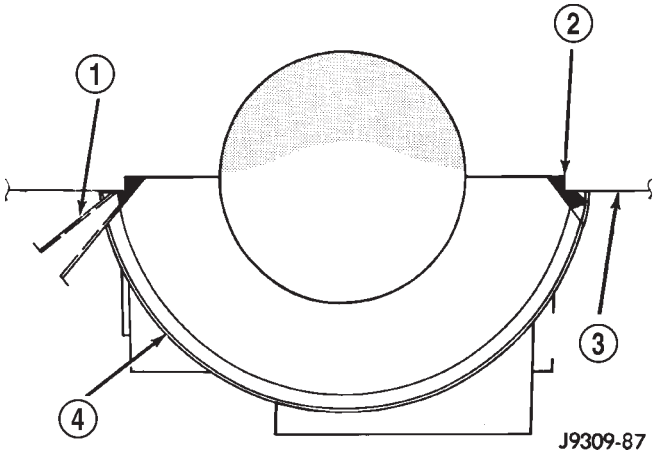


Fig. 24 Apply Sealant to Bearing Cap to Block Joint

1 - MOPAR SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
2 - SEALANT APPLIED
3 - CYLINDER BLOCK
4 - REAR MAIN BEARING CAP

(17) If the transmission was removed, install the transmission. Refer to 21 - TRANSMISSION/TRANSAXLE.

CRANKSHAFT MAIN BEARINGS

DESCRIPTION

Main bearings (Fig. 25) 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. there are five main bearings. Number three main bearing is flanged, this flange controls crankshaft thrust.

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.

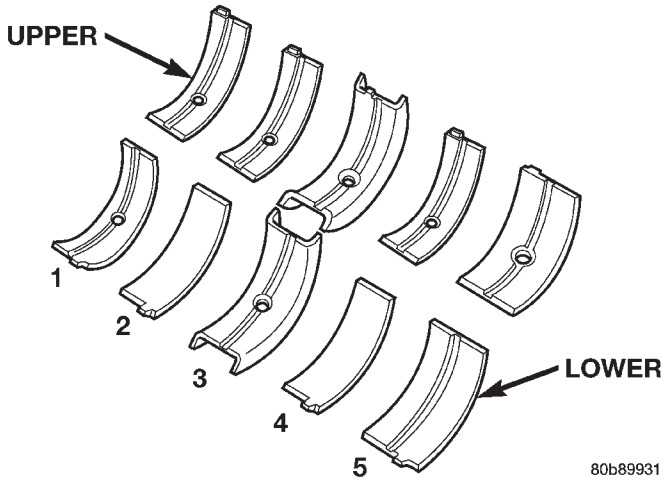


Fig. 25 Main Bearing Orientation

STANDARD PROCEDURE—CRANKSHAFT MAIN BEARING 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. 26). Bearing shells are available in standard and the following undersizes: Never install an undersize bearing that will reduce clearance below specifications.

Main Bearing Undersize Availability List

- 0.25 mm (0.001 inch)
- 0.051 mm (0.002 inch)
- 0.076 mm (0.003 inch)
- 0.254 mm (0.010 inch)
- 0.305 mm (0.012 inch)

REMOVAL

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

(2) Remove the oil pump from the rear main bearing cap (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

(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. 27).

(5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

CRANKSHAFT MAIN BEARINGS (Continued)

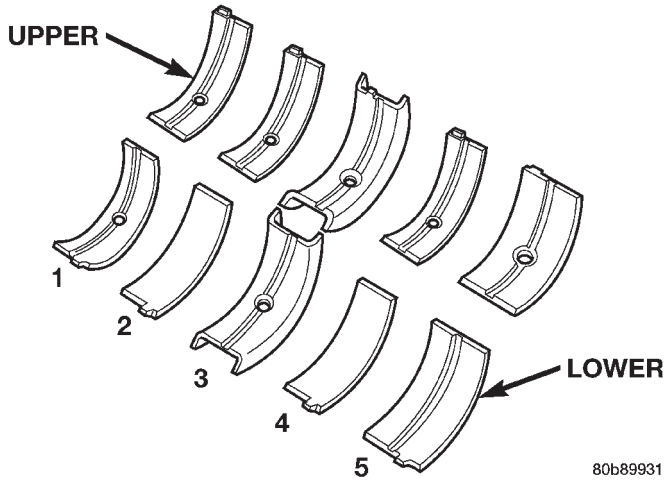


Fig. 26 Main Bearing

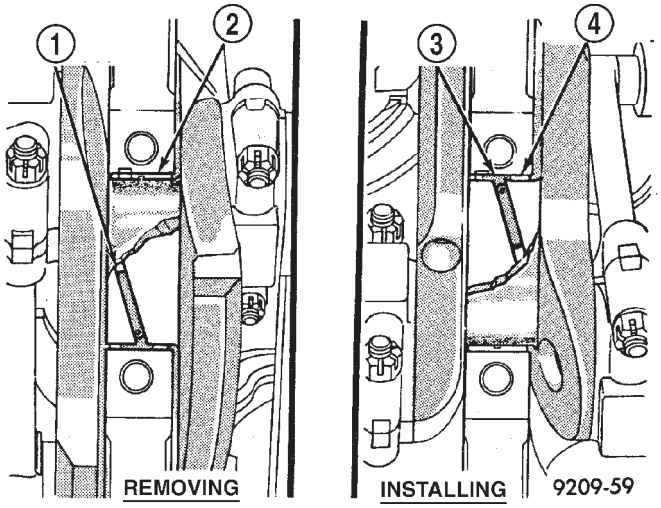


Fig. 27 Upper Main Bearing Removal and Installation with Tool C-3059

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. 27).

(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 (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

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

(6) Start engine check for leaks.

CRANKSHAFT OIL SEAL - FRONT

DESCRIPTION

The crankshaft front seal is a one piece viton seal with a steel housing. The front seal is located in the engine front cover.

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.

REMOVAL

The oil seal can be replaced without removing the timing chain cover, provided that the cover is not misaligned.

(1) Disconnect the negative cable from the battery.

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

(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.

INSTALLATION

(1) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 28). Seat the oil seal in the groove of the tool.

(2) Position the seal and tool onto the crankshaft (Fig. 29).

(3) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 30).

(4) Remove the vibration damper bolt and seal installation tool.

(5) Inspect the seal flange on the vibration damper.

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

(7) Connect the negative cable to the battery.

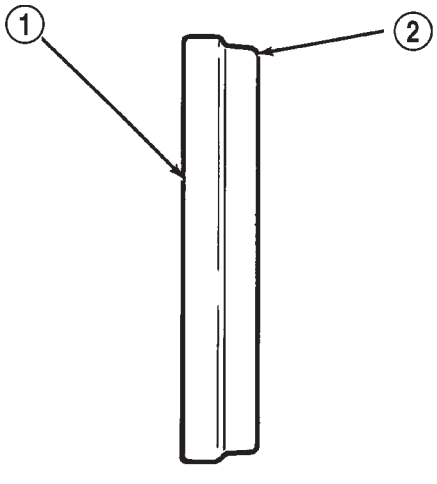


Fig. 28 Placing Oil Seal on Installation Tool 6635

1 - CRANKSHAFT FRONT OIL SEAL
2 - INSTALL THIS END INTO SPECIAL TOOL 6635

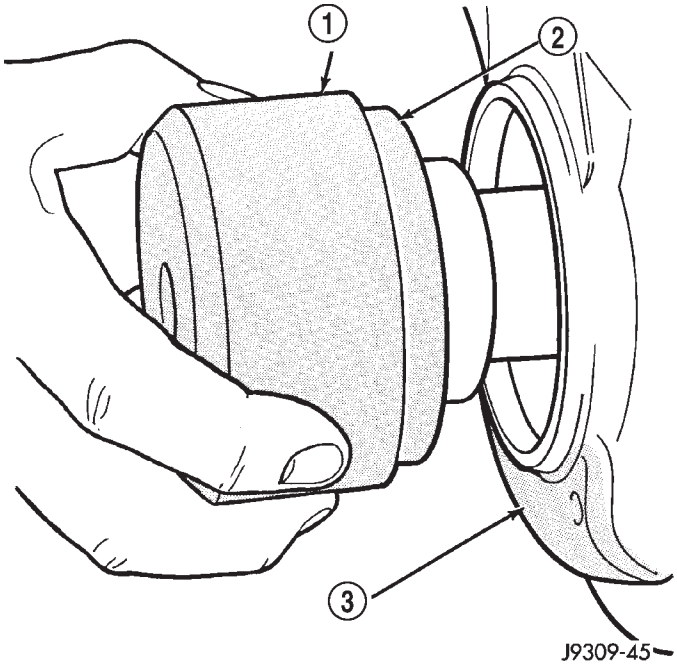


Fig. 29 Position Tool and Seal onto Crankshaft

1 - SPECIAL TOOL 6635
2 - OIL SEAL
3 - TIMING CHAIN COVER

CRANKSHAFT OIL SEAL - REAR

DESCRIPTION

The crankshaft rear seal is a two piece viton seal. One part of the two piece rear seal is located in a slot in the cylinder block oppsite the crankshaft main bearing cap, the second part of the two piece seal is located in the main bearing cap itself.

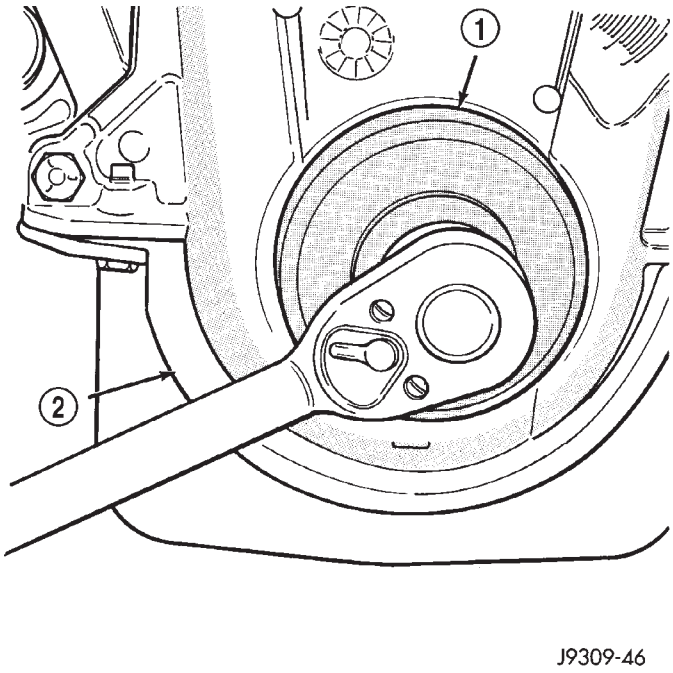


Fig. 30 Installing Oil Seal

1 - SPECIAL TOOL 6635
2 - TIMING CHAIN COVER

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.

REMOVAL

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

(1) Remove the crankshaft (Refer to 9 - ENGINE/ ENGINE BLOCK/CRANKSHAFT - REMOVAL). Discard the old upper seal.

UPPER SEAL—CRANKSHAFT INSTALLED

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

(2) Remove the oil pump (Refer to 9 - ENGINE/ LUBRICATION/OIL PUMP - REMOVAL).

(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.

CRANKSHAFT OIL SEAL - REAR (Continued)

LOWER SEAL

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

(2) Remove the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

(3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

(1) Clean the cylinder block rear cap mating surface. Be sure the seal groove is free of debris. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing toward the rear of the engine.

(4) Position the crankshaft into the cylinder block.

(5) Lightly oil the new lower seal lips with engine oil.

(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(7) Apply 5 mm (0.20 in.) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 31). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(8) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two 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 (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(11) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing (Fig. 32). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Install new front crankshaft oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - INSTALLATION).

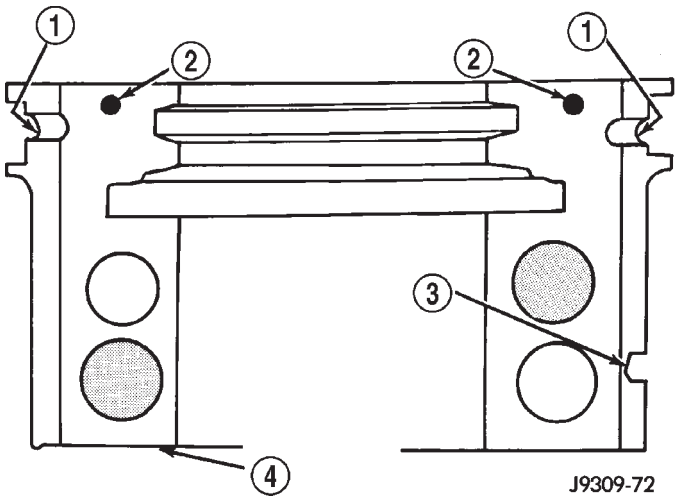


Fig. 31 Sealant Application to Bearing Cap

1 - MOPAR SILICONE RUBBER ADHESIVE SEALANT SLOTS
2 - MOPAR® GASKET MAKER (OR EQUIVALENT)
3 - CAP ALIGNMENT SLOT
4 - REAR MAIN BEARING CAP

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

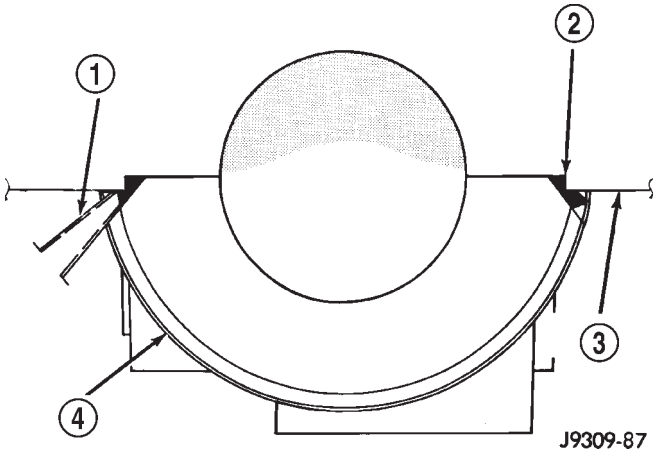


Fig. 32 Apply Sealant to Bearing Cap-to-Block Joint

1 - MOPAR SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
2 - SEALANT APPLIED
3 - CYLINDER BLOCK
4 - REAR MAIN BEARING CAP

UPPER SEAL—CRANKSHAFT INSTALLED

(1) Clean the cylinder block mating surfaces before oil seal installation. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the two main bearing caps forward of the rear bearing cap.

CRANKSHAFT OIL SEAL - REAR (Continued)

(3) Rotate the new upper seal into the cylinder block, being careful not to shave or cut the outer surface of the seal. To ensure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing toward the rear of the engine.

(4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing toward the rear of the engine.

(5) Apply 5 mm (0.20 in.) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 31). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

(6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.

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

(9) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 32). 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 (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

LOWER SEAL

(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—CRANKSHAFT INSTALLED .

(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. 31). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(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 (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(9) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing. Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

DISTRIBUTOR BUSHING

REMOVAL

(1) Remove distributor (Refer to 8 - ELECTRICAL/IGNITION CONTROL/DISTRIBUTOR - REMOVAL).

(2) Remove the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 33).

(4) Hold puller screw and tighten puller nut until bushing is removed.

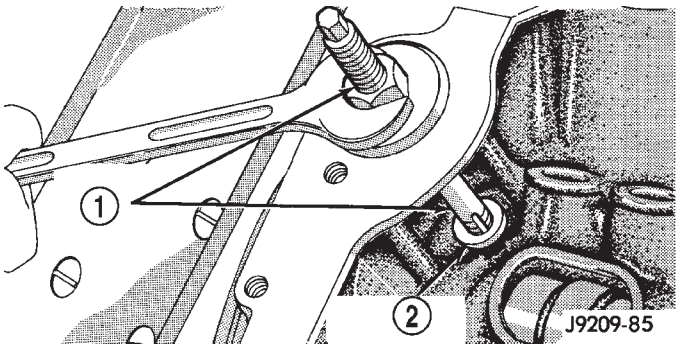


Fig. 33 Distributor Driveshaft Bushing Removal

1 - SPECIAL TOOL C-3052
2 - BUSHING

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. 34).

(3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 35). **DO NOT ream this bushing.**

DISTRIBUTOR BUSHING (Continued)

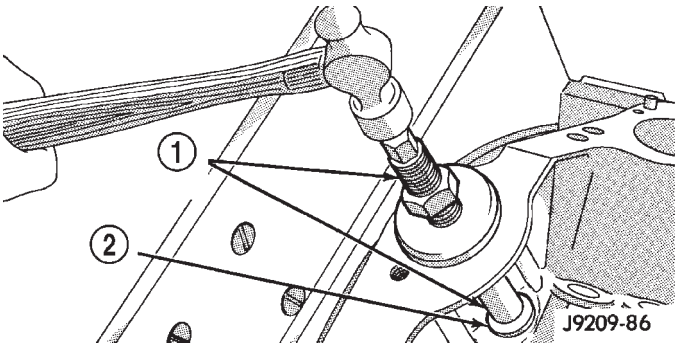


Fig. 34 Distributor Driveshaft Bushing Installation

1 - SPECIAL TOOL C-3053
2 - BUSHING

CAUTION: This procedure MUST be followed when installing a new bushing or seizure to shaft may occur.

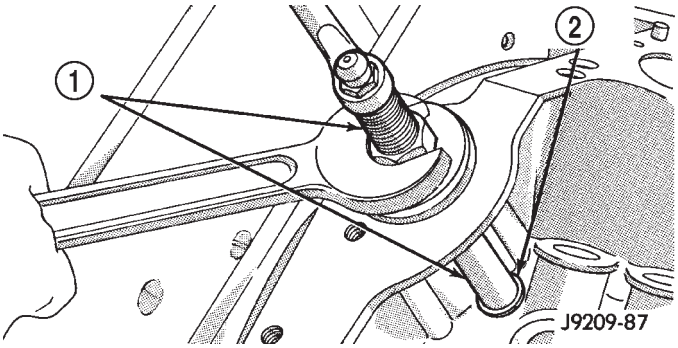


Fig. 35 Burnishing Distributor Driveshaft Bushing

1 - SPECIAL TOOL C-3053
2 - BUSHING

(4) Install the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(5) Install the distributor (Refer to 8 - ELECTRICAL/IGNITION CONTROL/DISTRIBUTOR - INSTALLATION).

HYDRAULIC LIFTERS

DIAGNOSIS AND TESTING—HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at the pressure sending-unit. The pressure should be between 207-552 kPa (30-80 psi) at 3,000 RPM.

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

OIL LEVEL

HIGH

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

LOW

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

TAPPET NOISE DIAGNOSIS

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

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

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

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

(4) The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are mak-

HYDRAULIC LIFTERS (Continued)

ing the noise. If more than one tappet seems to be noisy, it's probably not the tappets.

LEAK-DOWN TEST

After cleaning and inspection, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 36).

Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the Universal Leak-Down Tester.

(1) Place a 7.925-7.950 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(2) Lift the ram and position the tappet (with the ball bearing) inside the tester cup.

(3) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing. DO NOT tighten the hex nut on the ram.

(4) Fill the tester cup with hydraulic valve tappet test oil until the tappet is completely submerged.

(5) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air. When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

(6) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(7) Slowly swing the weighted arm onto the push rod.

(8) Rotate the cup by turning the handle at the base of the tester clockwise one revolution every 2 seconds.

(9) Observe the leak-down time interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark. A normally functioning tappet will require 20-110 seconds to leak-down. Discard tappets with leak-down time interval not within this specification.

REMOVAL

(1) Remove the air cleaner assembly and air in-let hose.

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

(3) Remove rocker assembly and push rods (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL). Identify push rods to ensure installation in original locations.

(4) Remove intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(5) Remove yoke retainer and aligning yokes.

(6) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.

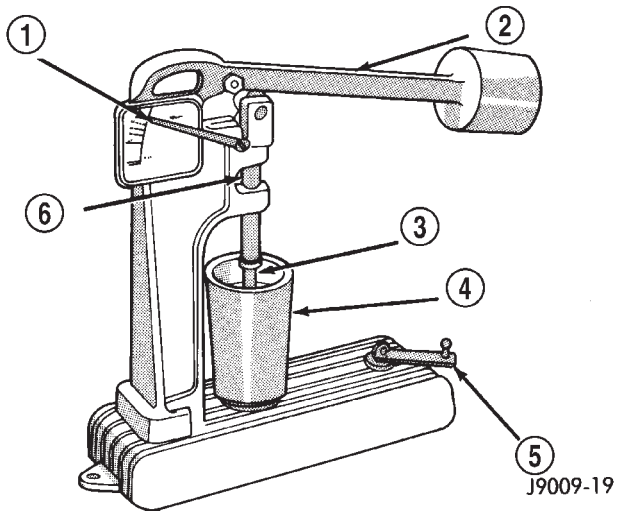


Fig. 36 Leak-Down Tester

1 - POINTER
2 - WEIGHTED ARM
3 - RAM
4 - CUP
5 - HANDLE
6 - PUSH ROD

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

(8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

CLEANING

Clean tappet with a suitable solvent. Rinse in hot water and blow dry with a clean shop rag or compressed air.

INSTALLATION

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

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

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(5) Install rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

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

(7) Install air cleaner assembly and air in-let hose.

HYDRAULIC LIFTERS (Continued)

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

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

PISTON & 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.

STANDARD PROCEDURE - PISTON 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).

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 37).

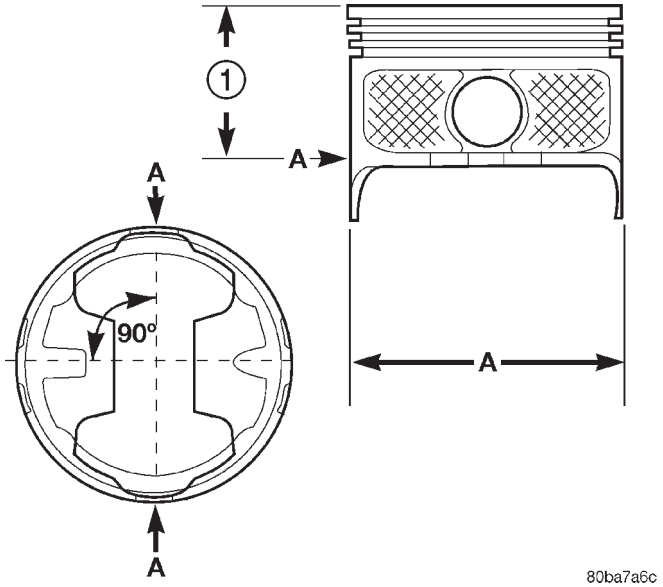


Fig. 37 Piston Measurements

1 - 49.53 mm (1.95 IN.)

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)

REMOVAL

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

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

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

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

(5) Be sure each connecting rod and connecting rod cap is identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

PISTON & CONNECTING ROD (Continued)

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing the assemblies from the engine, rotate crankshaft so that the connecting rod is centered in cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

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

CLEANING

Clean the piston and connecting rod assembly using a suitable solvent.

INSPECTION

Check the connecting rod journal for excessive wear, taper and scoring (Refer to 9 - ENGINE/ENGINE BLOCK/CONNECTING ROD BEARINGS - STANDARD PROCEDURE).

Check the connecting rod for signs of twist or bending.

Check the piston for taper and elliptical shape before it is fitted into the cylinder bore (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - STANDARD PROCEDURE).

Check the piston for scoring, or scraping marks in the piston skirts. Check the ring lands for cracks and/or deterioration.

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.

(2) Before installing the ring compressor, be sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 38).

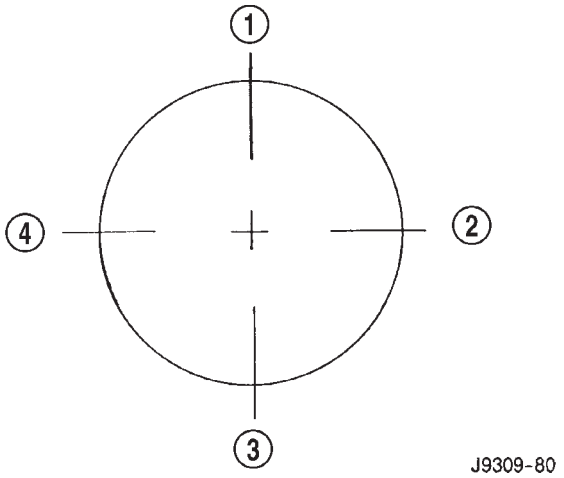


Fig. 38 Proper Ring Installation

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 (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

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

(11) Install the engine into the vehicle (Refer to 9 - ENGINE - INSTALLATION).

PISTON RINGS

STANDARD PROCEDURE - PISTON RING FITTING

(1) Measurement of end gaps:

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

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

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

(2) Install rings, and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and

PISTON RINGS (Continued)

lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter “O”, an oval depression, or the word “TOP” (Fig. 39) (Fig. 41).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 40) (Fig. 41). An identification mark on the ring is a drill point, a stamped letter “O”, an oval depression or the word “TOP” facing up.

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

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

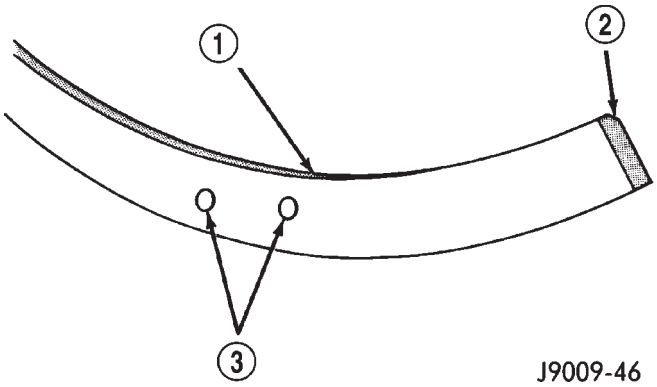


Fig. 39 Second Compression Ring Identification (Typical)

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

(3) Orient the rings:

(a) Arrange top compression ring 90° counterclockwise from the oil ring rail gap (Fig. 42).

(b) Arrange second compression ring 90° clockwise from the oil ring rail gap (Fig. 42).

VIBRATION DAMPER

REMOVAL

(1) Disconnect the battery negative cable.

(2) Remove the cooling system fan (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).

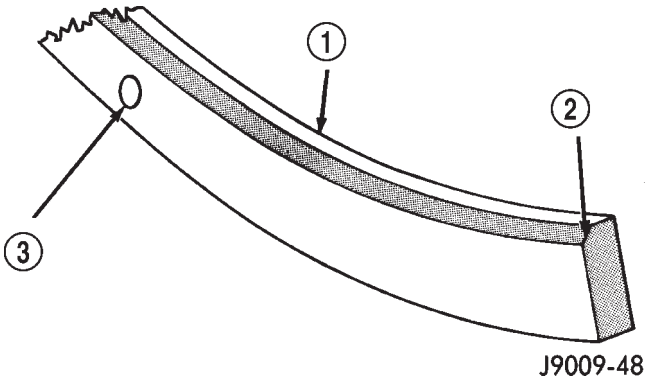


Fig. 40 Top Compression Ring Identification (Typical)

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

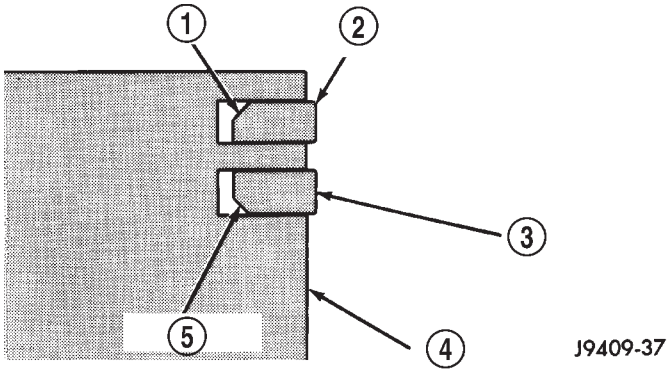


Fig. 41 Compression Ring Chamfer Location (Typical)

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

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

(4) Remove vibration damper bolt and washer from end of crankshaft.

(5) Position Special Tool 8513 Insert into the crankshaft nose.

(6) Install Special Tool 1026 Three Jaw Puller onto the vibration damper (Fig. 43).

(7) Pull vibration damper off of the crankshaft.

INSTALLATION

CAUTION: Thoroughly remove any contaminants from the crankshaft nose and the vibration damper bore. Failure to do so can cause sever damage to the crankshaft.

VIBRATION DAMPER (Continued)

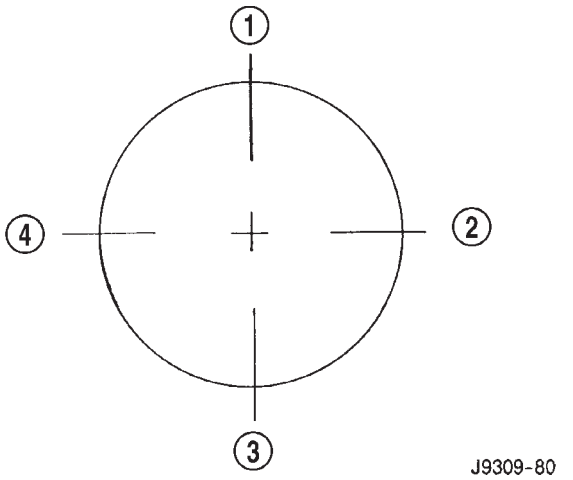


Fig. 42 Proper Ring Installation

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

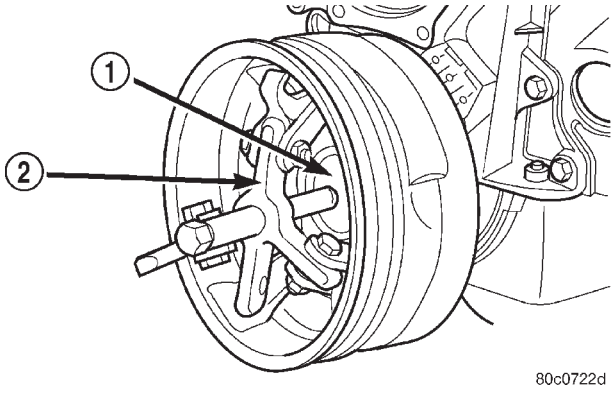


Fig. 43 Vibration Damper Removal

1 - SPECIAL TOOL 8513 INSERT
2 - SPECIAL TOOL 1026

(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. 44).

(3) Install the crankshaft bolt and washer. Tighten the bolt to 244 N·m (180 ft. lbs.) torque.

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

(5) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.

(6) Install the cooling fan (Refer to 7 - COOLING/ ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(7) Connect the battery negative cable.

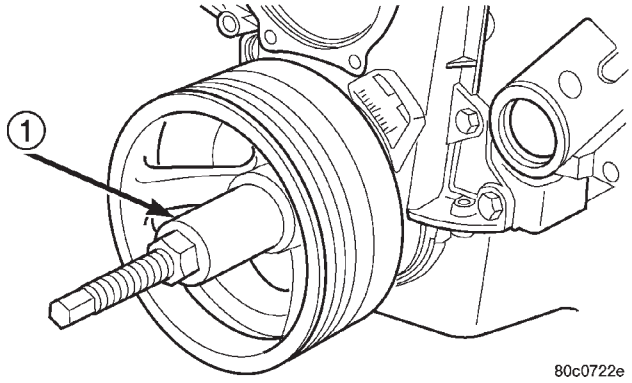


Fig. 44 Vibration Damper Installation

1 - SPECIAL TOOL C-3688

FRONT MOUNT

REMOVAL

(1) Disconnect the battery negative cable.

(2) Position fan to ensure clearance for radiator top tank and hose.

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

(3) Install engine support/lifting fixture.

(4) Raise vehicle on hoist.

(5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 45) .

(6) Remove engine support bracket/cushion bolts (Fig. 45) . Remove the support bracket/cushion and heat shields.

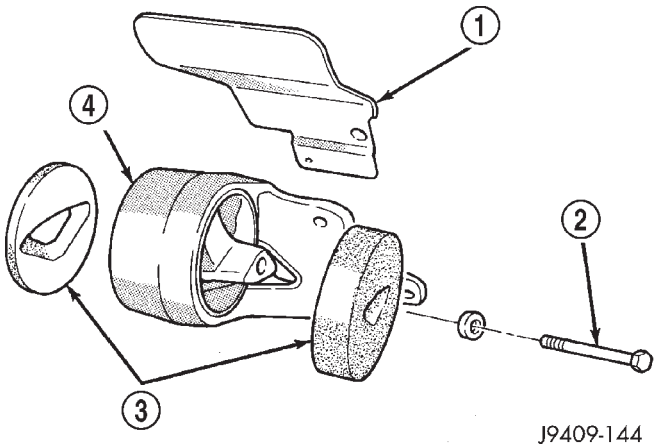


Fig. 45 Engine Front Mounts

1 - ENGINE MOUNT HEAT SHIELD
2 - THRU-BOLT
3 - RESTRICTION PADS
4 - ENGINE SUPPORT BRACKET/CUSHION

FRONT MOUNT (Continued)

INSTALLATION

(1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.

(2) Install the through-bolt into the engine support bracket/cushion.

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and through-bolt into support cushion brackets (Fig. 46) .

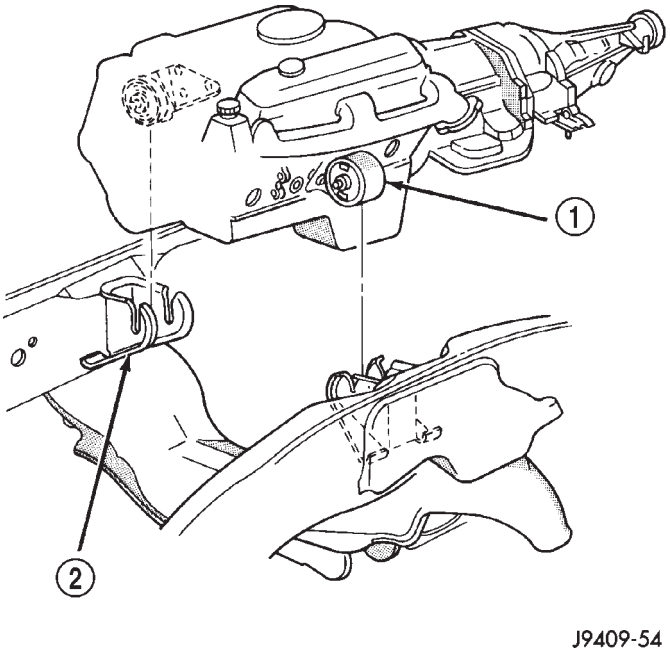


Fig. 46 Positioning Engine Front Mounts

1 - ENGINE SUPPORT BRACKET/CUSHION
2 - SUPPORT CUSHION BRACKET

(4) Install through-bolt nuts and tighten the nuts to 102 N·m (75 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

REAR MOUNT

REMOVAL

(1) Raise the vehicle on a hoist.

(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 47).

(4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 88 N·m (65 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 41 N·m (30 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 47) .

(4) Install the support cushion bolts and tighten to 41 N·m (30 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

LUBRICATION

DESCRIPTION

A gear-type positive displacement pump (Fig. 48) 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.

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

LUBRICATION (Continued)

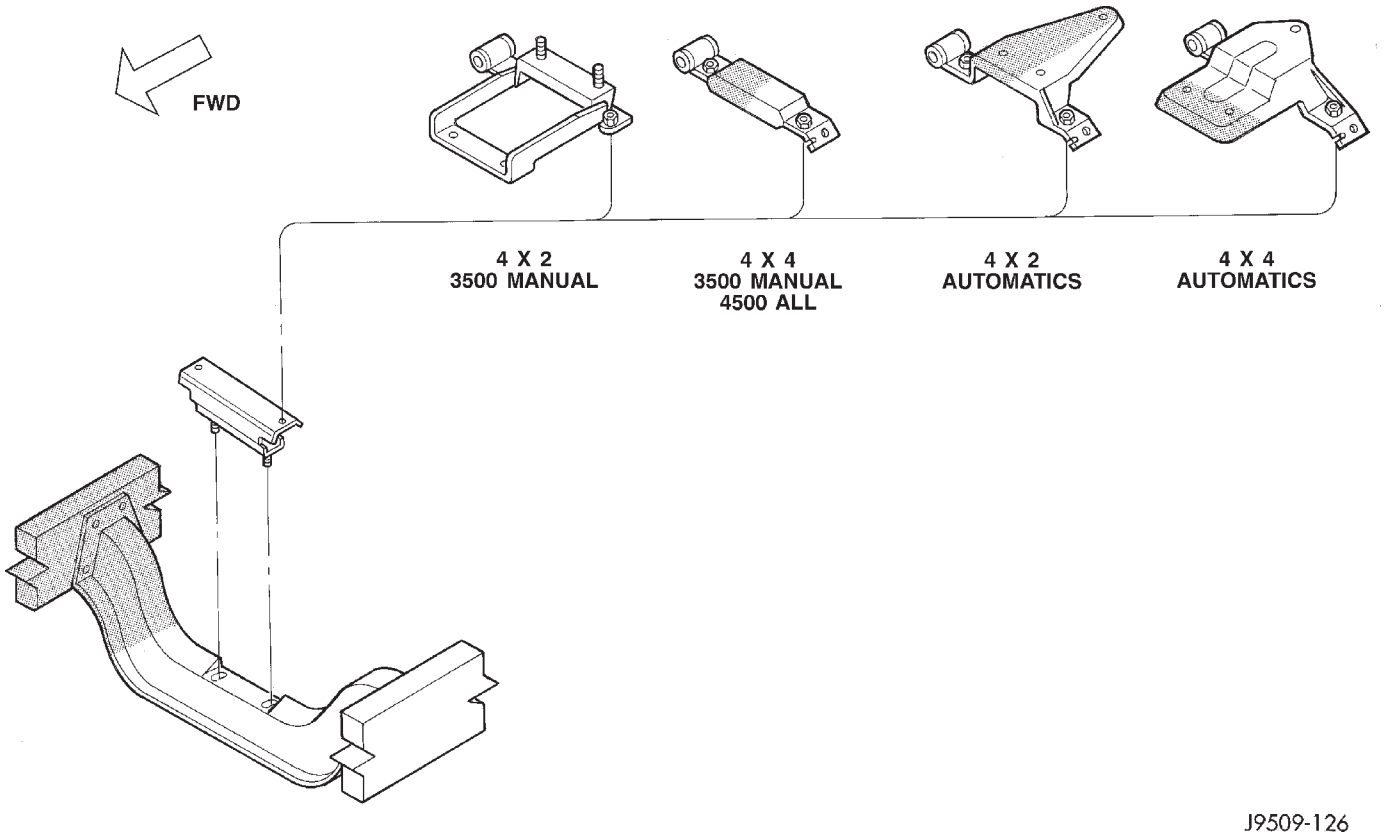


Fig. 47 Engine Rear Support Cushion Assemblies

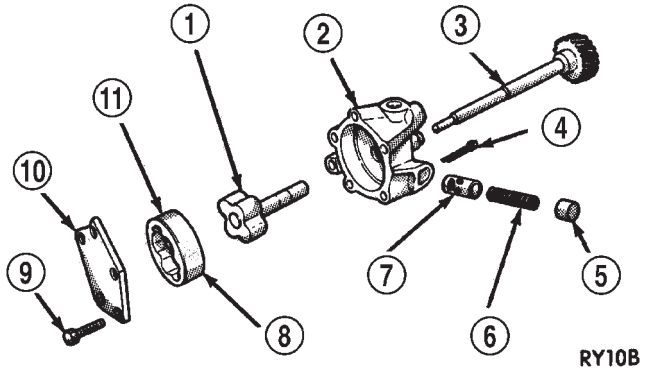


Fig. 48 Positive Displacement Oil Pump—Typical

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

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 (Fig. 49).

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING—ENGINE OIL LEAKS

Begin with a through visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

(1) Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.

(2) Add an oil-soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to be sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light source.

(3) Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service manual instructions.

LUBRICATION (Continued)

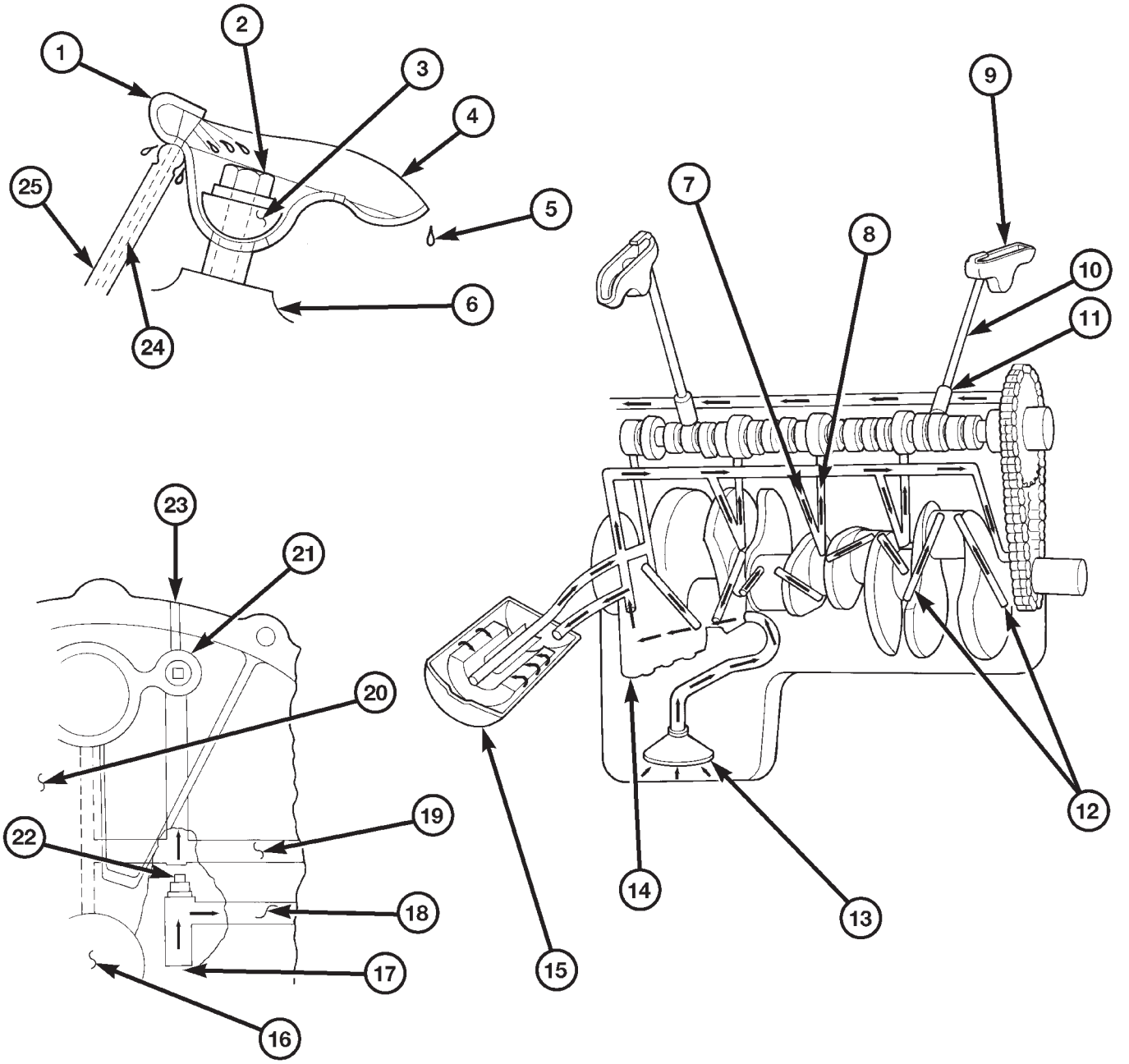


Fig. 49 Oil Lubrication System

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

LUBRICATION (Continued)

(4) If dye is not observed, drive the vehicle at various speeds for approximately 24km (15 miles), and repeat previous step.

(5) If the oil leak source is not positively identified at this time, proceed with the air leak detection test method as follows:

(6) Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.

(7) Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.

(8) Attach an air hose with pressure gauge and regulator to the dipstick tube.

CAUTION: Do not subject the engine assembly to more than 20.6 kpa (3 PSI) of test pressure.

(9) Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provide the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.

(10) If the leakage occurs at the rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.

(11) If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose. Proceed to next step.

(12) Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

DIAGNOSIS AND TESTING—ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit.

(2) Install Oil Pressure Line and Gauge Tool C-3292. Start engine and record pressure. (Refer to 9 - ENGINE - SPECIFICATIONS).

OIL

STANDARD PROCEDURE - ENGINE OIL

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right front of the engine, left of the generator (Fig. 50).

CRANKCASE OIL LEVEL INSPECTION

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

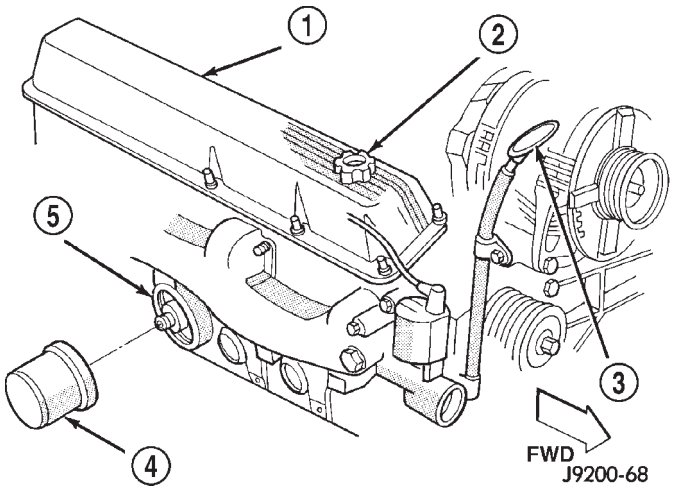


Fig. 50 Oil Level Indicator Location

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

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.

(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 the Maintenance Schedule. This information can be found in the owner's manual.

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 vehicle.

(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

OIL (Continued)

stretching or other damage. Replace drain plug and gasket if damaged.

(6) Install drain plug in crankcase.

(7) Change oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - REMOVAL).

(8) Lower vehicle and fill crankcase with specified type (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION) and amount of engine oil (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).

(9) Install oil fill cap.

(10) Start engine and inspect for leaks.

(11) Stop engine and inspect oil level.

OIL FILTER

REMOVAL

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.

(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. 51).

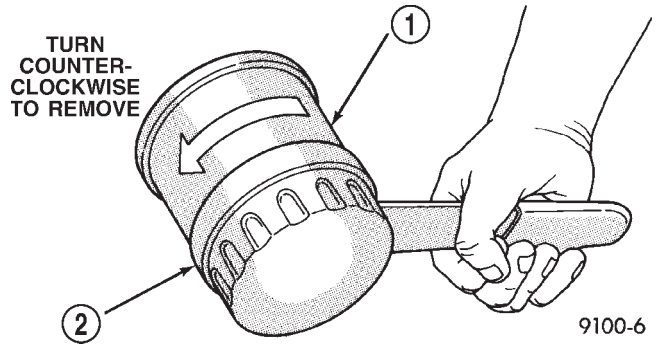


Fig. 51 Oil Filter Removal—Typical

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. 52) of oil and grime.

(6) Install new filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - INSTALLATION).

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. 52) hand tighten filter one full turn, do not over tighten.

(3) Add oil (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE).

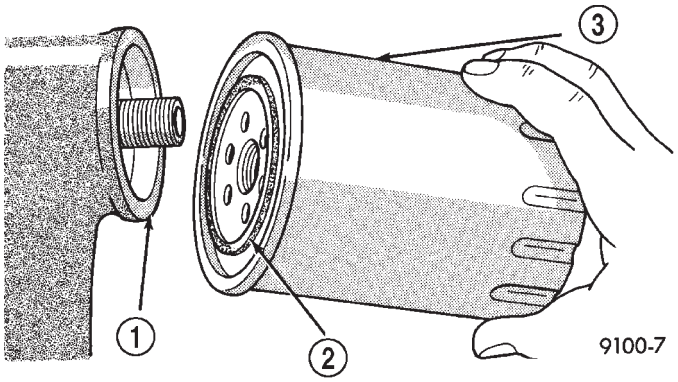


Fig. 52 Oil Filter Sealing Surface—Typical

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

OIL PAN

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove engine oil dipstick.

(3) Raise vehicle.

(4) Drain engine oil.

(5) Remove exhaust pipe.

(6) Remove left engine to transmission strut.

(7) Loosen the right side engine support bracket cushion thru-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.

(8) Remove the one-piece gasket.

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.

INSTALLATION

(1) Clean the block and pan gasket surfaces.

OIL PAN (Continued)

(2) Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**

(3) If present, trim excess sealant from inside the engine.

(4) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 53).

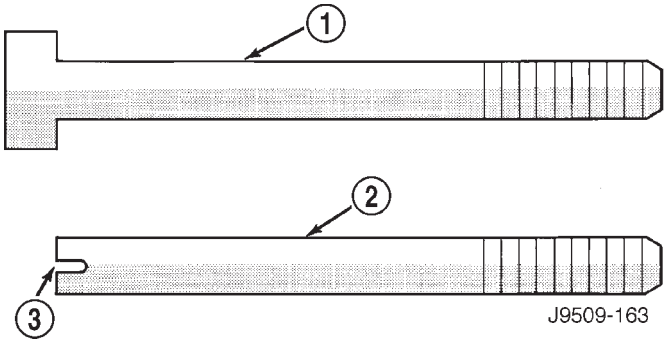


Fig. 53 Fabrication of Alignment Dowels

1 - 5/16" X 1½" BOLT
2 - DOWEL
3 - SLOT

(5) Install the dowels in the cylinder block (Fig. 54) .

(6) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.

(7) Slide the one-piece gasket over the dowels and onto the block.

(8) Position the oil pan over the dowels and onto the gasket.

(9) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.

(10) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.

(11) Lower the engine into the support cushion brackets and tighten the thru bolt nut to the proper torque.

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

(13) Install the engine to transmission strut.

(14) Install exhaust pipe.

(15) Lower vehicle.

(16) Install dipstick.

(17) Connect the negative cable to the battery.

(18) Fill crankcase with oil to proper level.

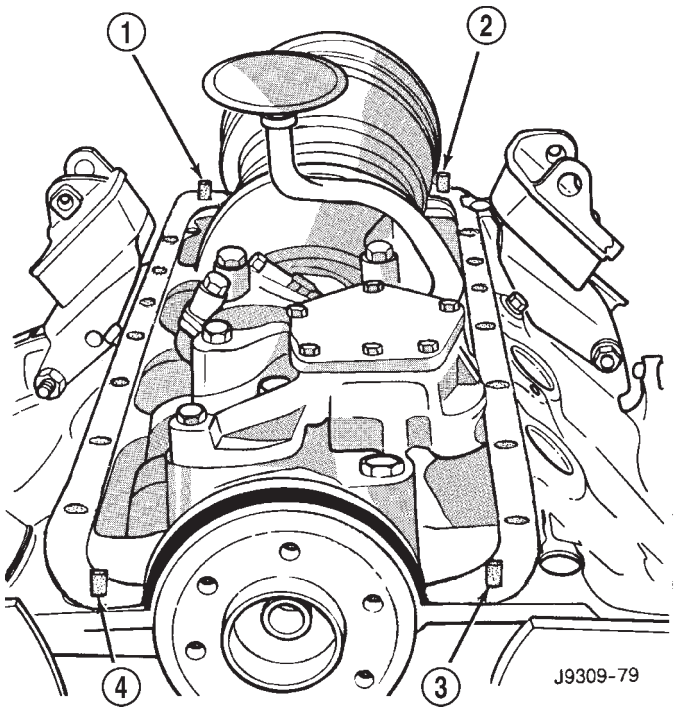


Fig. 54 Position of Dowels in Cylinder Block

1 - DOWEL
2 - DOWEL
3 - DOWEL
4 - DOWEL

OIL PUMP

REMOVAL

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

(2) Remove the oil pump from rear main bearing cap.

DISASSEMBLY

(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. 55).

(2) Remove oil pump cover (Fig. 56).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 56).

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

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

OIL PUMP (Continued)

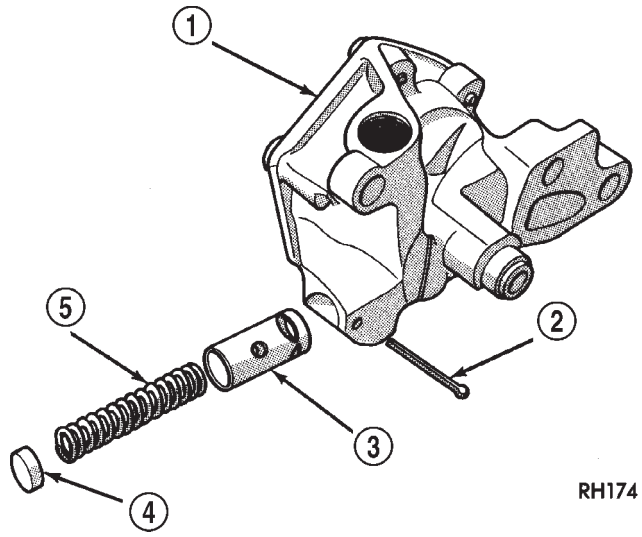


Fig. 55 Oil Pressure Relief Valve

1 - OIL PUMP ASSEMBLY
2 - COTTER PIN
3 - RELIEF VALVE
4 - RETAINER CAP
5 - SPRING

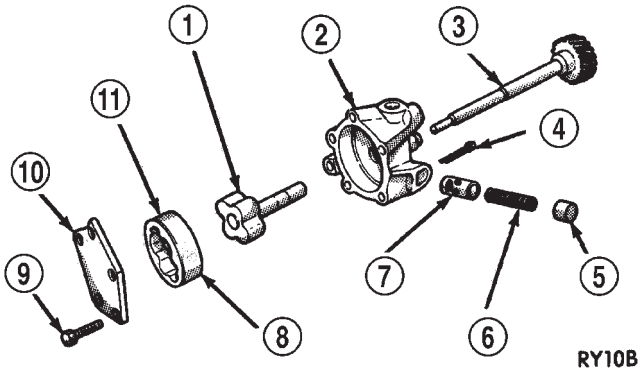


Fig. 56 Oil Pump

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

Lay a straightedge across the pump cover surface (Fig. 57). 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. 58).

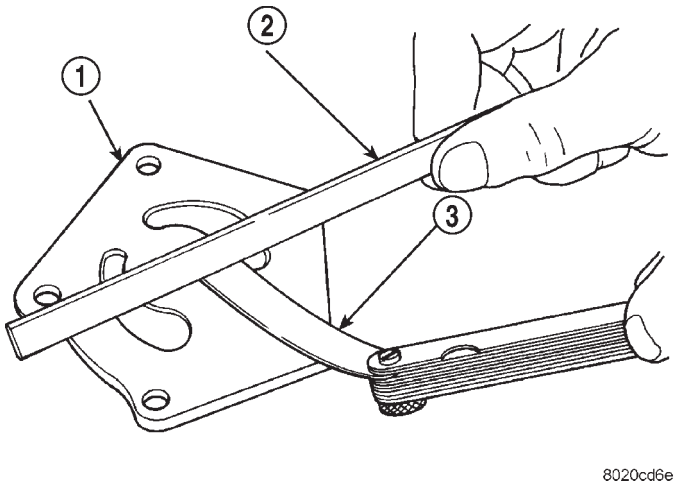


Fig. 57 Checking Oil Pump Cover Flatness

1 - COVER
2 - STRAIGHT EDGE
3 - FEELER GAUGE

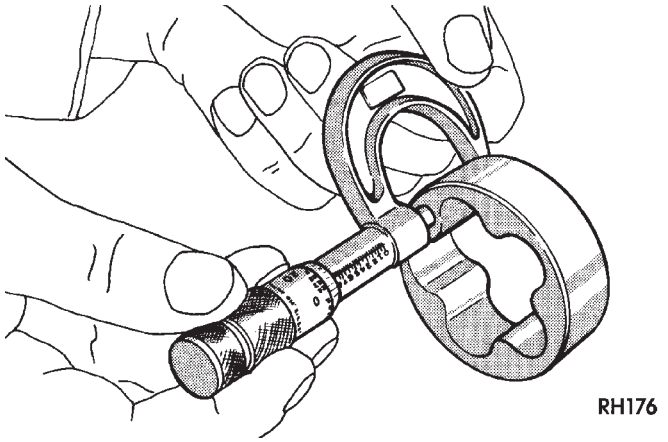


Fig. 58 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 59).

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 60). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.

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. 61).

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. 62).

OIL PUMP (Continued)

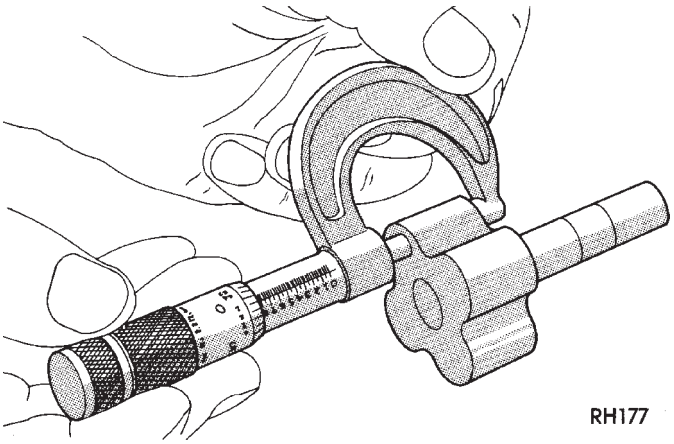


Fig. 59 Measuring Inner Rotor Thickness

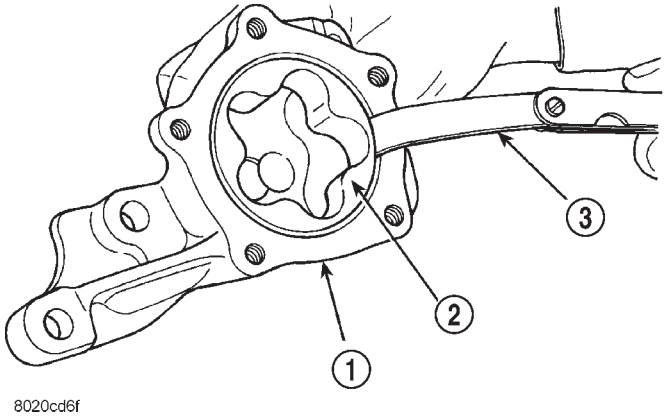


Fig. 60 Measuring Outer Rotor Clearance in Housing

1 - PUMP BODY
2 - OUTER ROTOR
3 - FEELER GAUGE

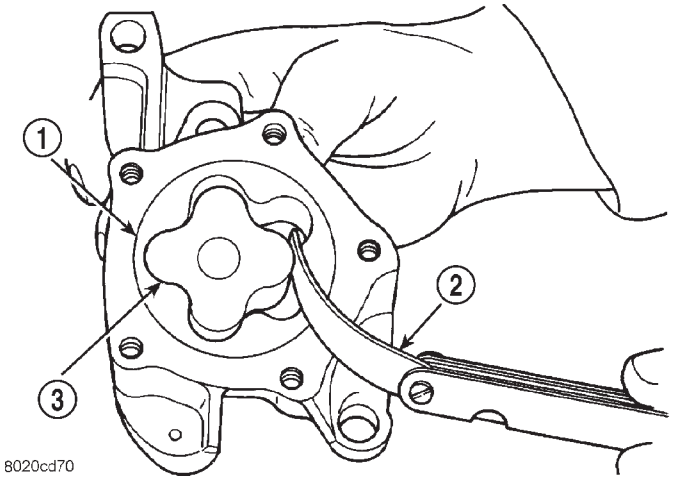


Fig. 61 Measuring Clearance Between Rotors

1 - OUTER ROTOR
2 - FEELER GAUGE
3 - INNER ROTOR

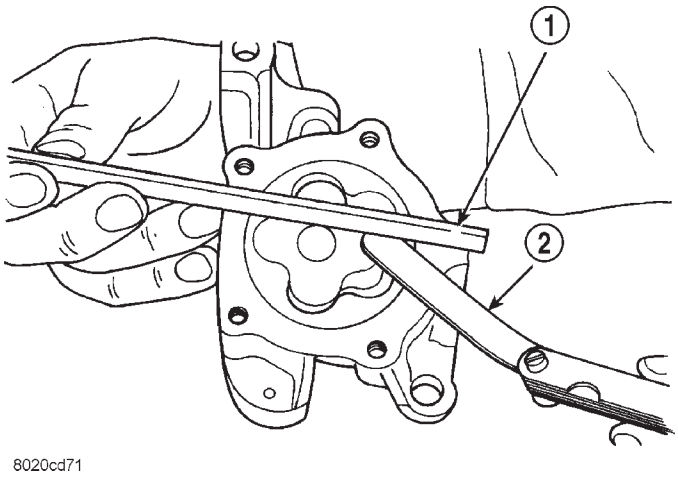


Fig. 62 Measuring Clearance Over Rotors

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. 63).

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

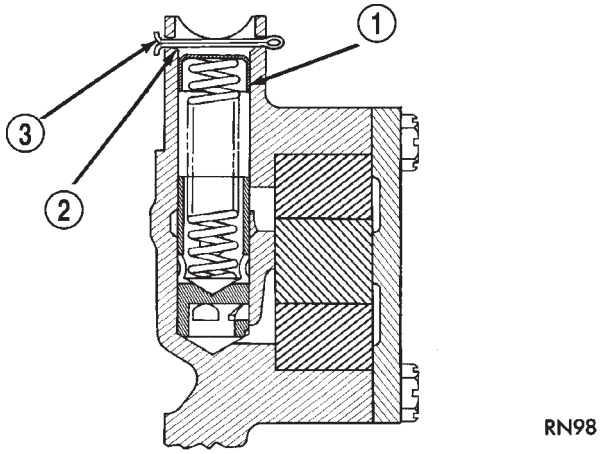


Fig. 63 Proper Installation of Retainer Cap

1 - RETAINER CAP
2 - CHAMFER
3 - COTTER KEY

ASSEMBLY

(1) Install pump rotors and shaft, using new parts as required.

OIL PUMP (Continued)

(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.

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 (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

INTAKE MANIFOLD

DESCRIPTION

The aluminum intake manifold (Fig. 64) 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.

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.

DIAGNOSIS AND TESTING—INTAKE MANIFOLD LEAKAGE

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

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

(1) Start the engine.

(2) Spray a small stream of water at the suspected leak area.

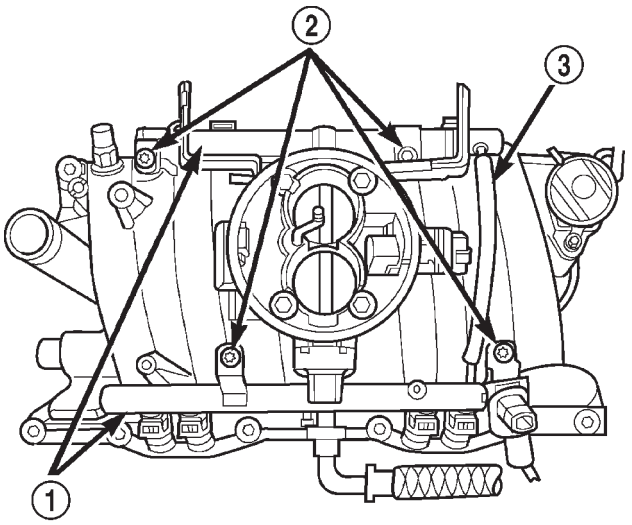


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Fig. 64 Intake Manifold and Throttle Body—V-8 Gas Engines Typical

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

(3) If a change in RPMs occur, the area of the suspected leak has been found.

(4) Repair as required.

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) Remove the A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - REMOVAL).

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

(5) Remove the accessory drive bracket.

(6) Remove the air cleaner.

(7) Perform the Fuel System Pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE). Disconnect the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(8) Disconnect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - REMOVAL) and if so equipped, the speed control and transmission kickdown cables.

(9) Remove the return spring.

(10) Remove the distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect the heat indicator sending unit wire.

INTAKE MANIFOLD (Continued)

(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 end seals.

(18) Remove the throttle body bolts and lift the throttle body off the intake manifold (Fig. 65). Discard the gasket.

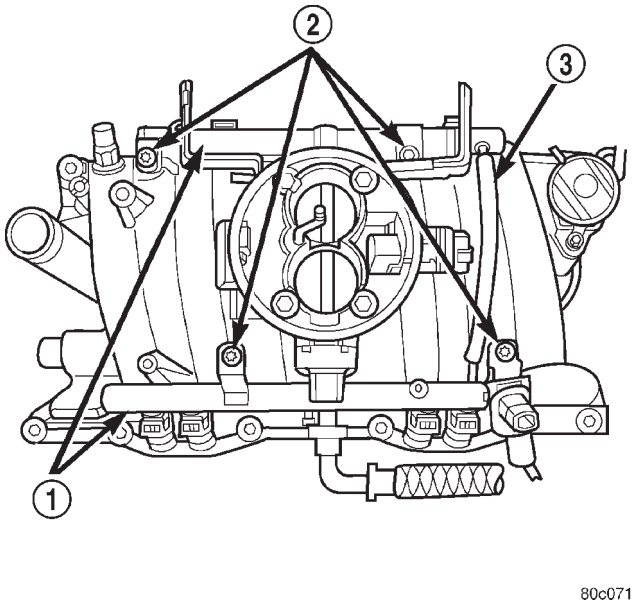

Fig. 65 Throttle Body Assembly

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

(19) If required, remove the plenum pan and gasket. Discard gasket.

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.

INSTALLATION

(1) If removed, position new plenum gasket and install plenum pan (Fig. 66).

(2) Tighten plenum pan mounting bolts as follows:

- Step 1. Tighten bolts to 5.4 N·m (48 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.)

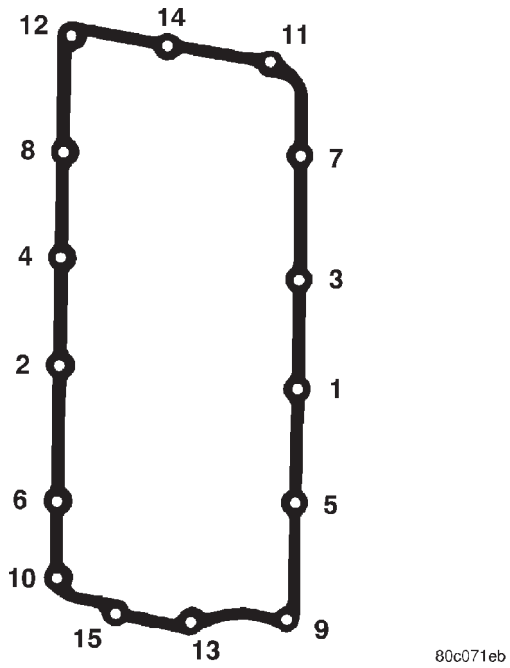

Fig. 66 Plenum Pan Bolt Tightening Sequence

(3) 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. 68). The words MANIFOLD SIDE should be visible on the center of each flange gasket.

(4) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, to the four corner joints. An excessive amount of sealant is not required to ensure a leak proof seal. However, an excessive amount of sealant may reduce the effectiveness of the flange gasket. The sealant should be approximately 5 mm (0.2 in) in diameter and 15 mm (0.6 in.) long.

(5) Install the front and rear end seals (Fig. 67) Make sure the molded dowel pins on the end seals fully enter the corresponding holes in the cylinder block.

(6) Carefully lower intake manifold into position on the cylinder block and cylinder heads. After intake manifold is in place, inspect to make sure seals are in place.

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

(8) Install the intake manifold bolts and tighten as follows (Fig. 69):

INTAKE MANIFOLD (Continued)

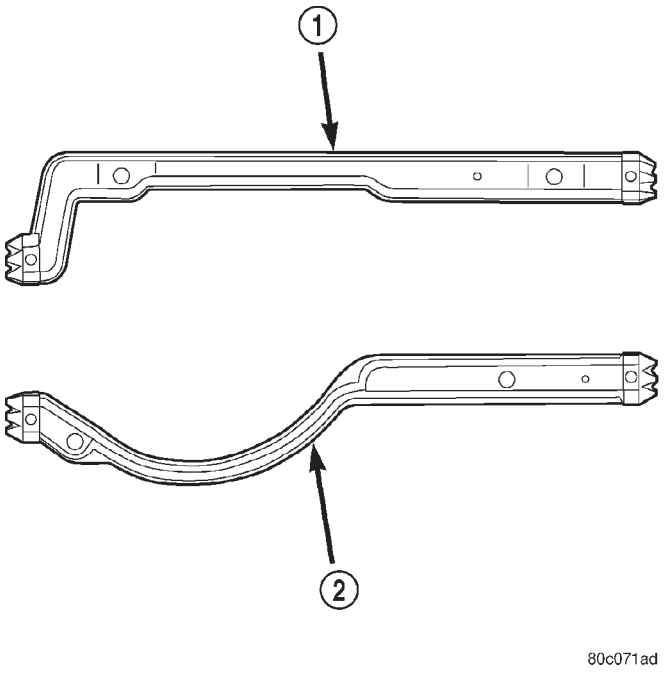

Fig. 67 Front and Rear End Seals

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

- Step 1. Tighten bolts 1 through 4 to 8 N·m (72 in. lbs.) Tighten in alternating steps 1.4 N·m (12 in. lbs.) at a time
- Step 2. Tighten bolts 5 through 12 to 8 N·m (72 in. lbs.)
- Step 3. Check all bolts are torqued to 8 N·m (72 in. lbs.)
- Step 4. Tighten all bolts in sequence to 16 N·m (12 ft. lbs.)
- Step 5. Check all bolts are torqued to 16 N·m (12 ft. lbs.)

(9) Install closed crankcase ventilation and evaporation control systems.

(10) Connect the coil wires.

(11) Connect the heat indicator sending unit wire.

(12) Connect the heater hoses and bypass hose.

(13) Install distributor cap and wires.

(14) Hook up the return spring.

(15) Connect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - INSTALLATION) and if so equipped, the speed control and transmission kick-down cables.

(16) Install the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(17) Install the accessory drive bracket and A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).

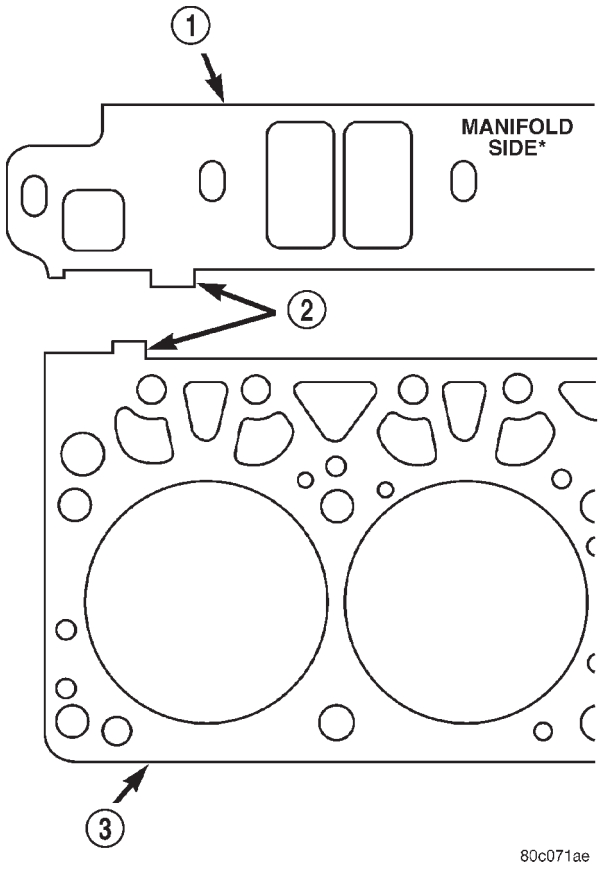

Fig. 68 Intake Manifold Flange Gasket Alignment

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

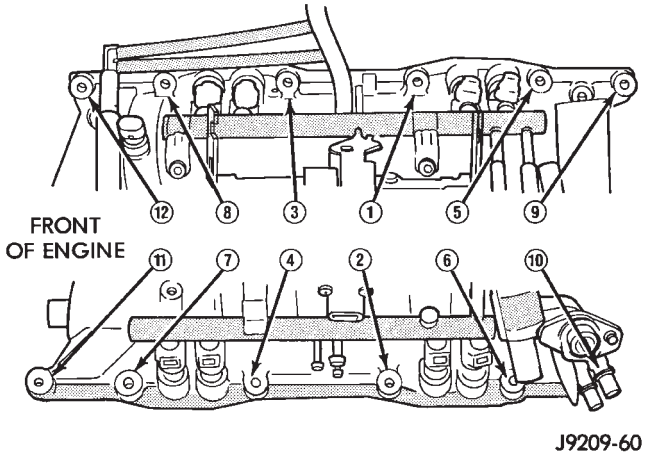

Fig. 69 Intake Manifold Bolt Tightening Sequence

(18) Install the generator and drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION). Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque.

(19) Install the air cleaner.

(20) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(21) Connect the negative cable to the battery.

EXHAUST MANIFOLD

DESCRIPTION

The exhaust manifolds (Fig. 70) are constructed of cast iron and are LOG type with balanced flow. One exhaust manifold is attached to each cylinder head.

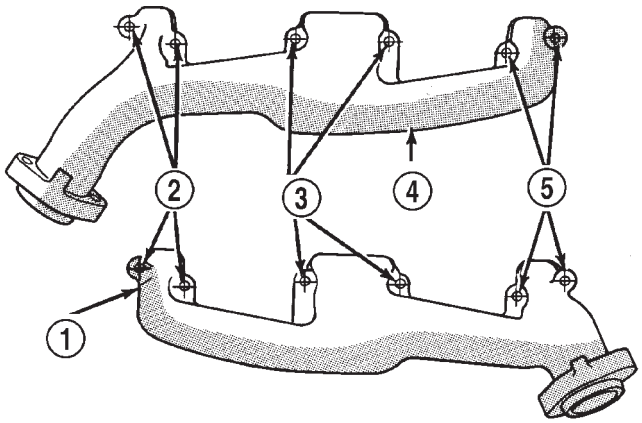

Fig. 70 Exhaust Manifolds—V-8 Gas Engines Typical

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.

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Raise and support the vehicle.
(3) Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold.
(4) Lower the vehicle.
(5) Remove the exhaust heat shields.
(6) Remove bolts, nuts and washers attaching manifold to cylinder head.
(7) Remove manifold from the cylinder head.

CLEANING

Clean mating surfaces on cylinder head and manifold. Wash with solvent and blow dry with compressed air.

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straight edge. Gasket surfaces must be flat within 0.2 mm per 300 mm (0.008 inch per foot).

INSTALLATION

CAUTION: If the studs came out with the nuts when removing the engine exhaust manifold, install new studs. Apply sealer on the coarse thread ends. Water leaks may develop at the studs if this precaution is not taken.

(1) Position the engine exhaust manifolds on the two studs located on the cylinder head. Install conical washers and nuts on these studs (Fig. 71) .
(2) Install two bolts and conical washers at the inner ends of the engine exhaust manifold outboard arms. Install two bolts WITHOUT washers on the center arm of engine exhaust manifold (Fig. 71) . Starting at the center arm and working outward, tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.
(3) Install the exhaust heat shields.
(4) Raise and support the vehicle.
(5) Assemble exhaust pipe to manifold and secure with bolts, nuts and retainers. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.
(6) Lower the vehicle.
(7) Connect the negative cable to the battery.

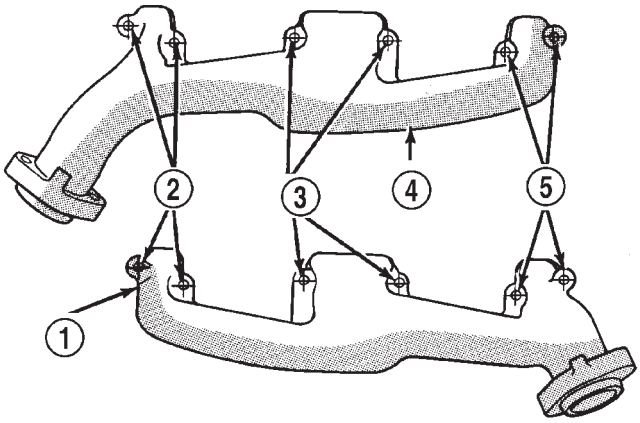

Fig. 71 Engine Exhaust Manifold Installation—5.9L Engines

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

TIMING BELT / CHAIN COVER(S)

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Remove water pump (Refer to 7 - COOLING/ ENGINE/WATER PUMP - REMOVAL).

TIMING BELT / CHAIN COVER(S) (Continued)

(3) Remove power steering pump (Refer to 19 - STEERING/PUMP - REMOVAL).

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

(5) Loosen oil pan bolts and remove the front bolt at each side.

(6) Remove the cover bolts.

(7) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.

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.

NOTE: Special Tool 6635 must be used to align the front cover and seal with the crankshaft.

(4) Position the special tool 6635 onto the crankshaft (Fig. 72).

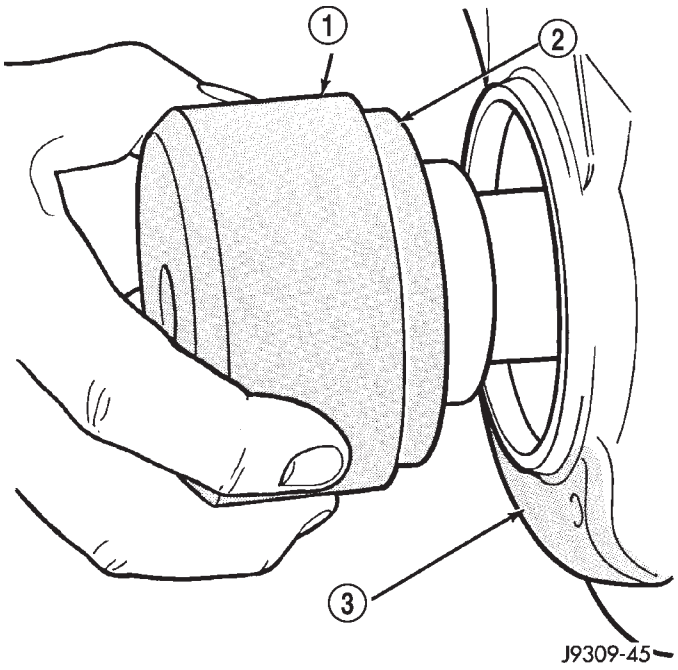

Fig. 72 Position Special Tool 6635 onto Crankshaft

1 - SPECIAL TOOL 6635
2 - OIL SEAL
3 - TIMING CHAIN COVER

(5) 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.

(6) Remove special tool 6635.

(7) Inspect the seal flange on the vibration damper.

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

(9) Install water pump and housing assembly using new gaskets (Refer to 7 - COOLING/ENGINE/WATER PUMP - INSTALLATION).

(10) Install power steering pump (Refer to 19 - STEERING/PUMP - INSTALLATION).

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

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

(13) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(14) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(15) Connect the negative cable to the battery.

(16) Start engine check for leaks.

TIMING BELT/CHAIN AND SPROCKETS

REMOVAL

(1) Disconnect battery negative cable.

(2) Remove Timing Chain Cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(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. 73).

(4) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

INSPECTION—MEASURING TIMING CHAIN STRETCH

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

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

TIMING BELT/CHAIN AND SPROCKETS (Continued)

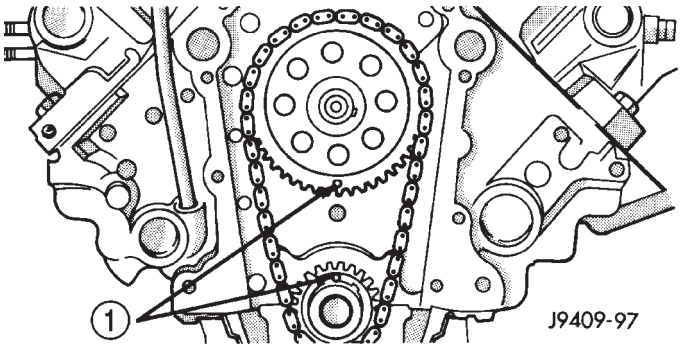

Fig. 73 Alignment of Timing Marks

1 - TIMING MARKS

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. 74).

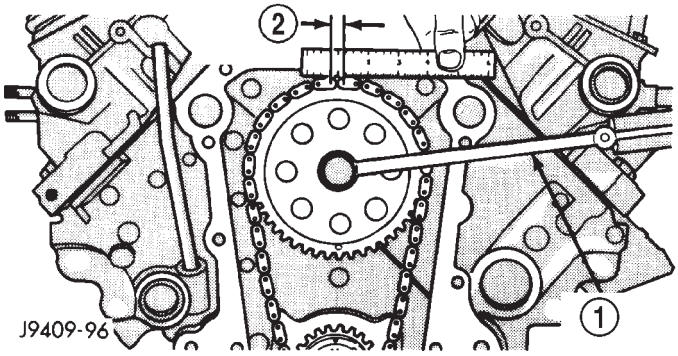

Fig. 74 Measuring Timing Chain Stretch

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

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

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. 75).

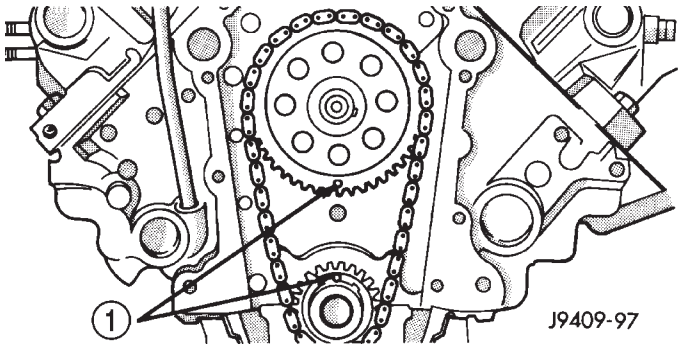

Fig. 75 Alignment of Timing Marks

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 (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

ENGINE 8.0L

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ENGINE 8.0L

DESCRIPTION

The 8.0 Liter (488 CID) ten-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets. This engine is designed for unleaded fuel.

Engine lubrication system consists of a gerotor type oil pump mounted in the timing chain cover and driven by the crankshaft. The V-10 uses a full flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5, 7, 9 on the left bank and 2, 4, 6, 8, 10 on the right bank. The firing order is 1-10-9-4-3-6-5-8-7-2 (Fig. 1) .

The engine serial number is located on the lower left front of the cylinder block in front of the engine mount (Fig. 2) . When component part replacement is necessary, use the engine type and serial number for reference.

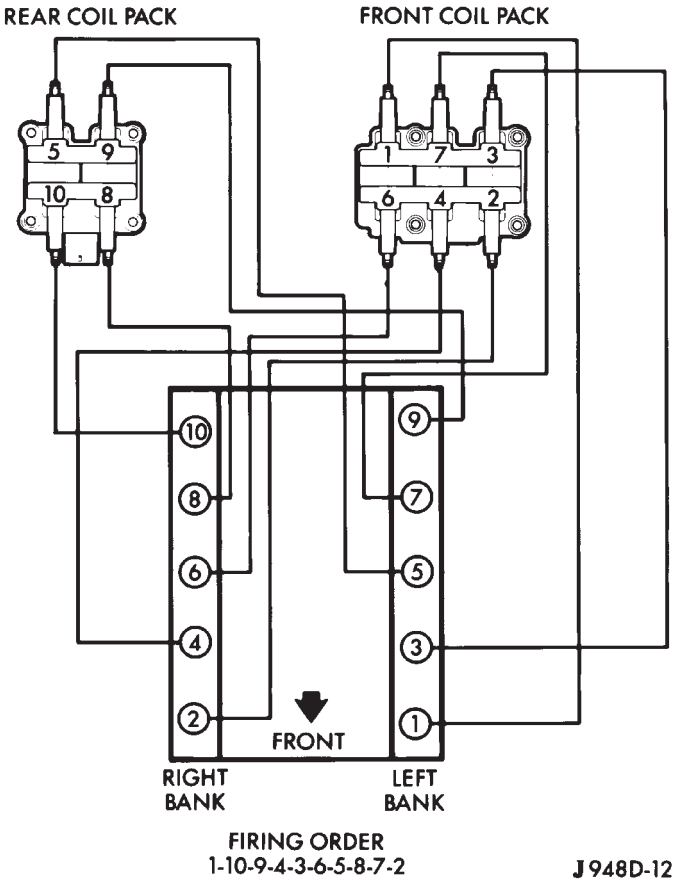


Fig. 1 Firing Order

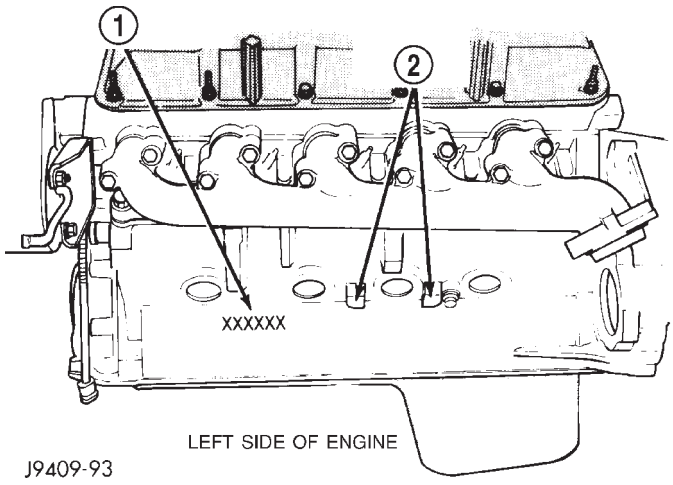


Fig. 2 Engine Identification—(Serial Number)

1 - ENGINE SERIAL NO.
2 - ENGINE MOUNT LOCATION

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - ENGINE DIAGNOSIS - INTRODUCTION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine maintenance.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

(Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Preformance) or (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Mechanical). Refer to 14 - FUEL SYSTEM for fuel system diagnosis.

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that cannot be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following:

- Cylinder Compression Pressure Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Combustion Pressure Leakage Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Head Gasket Failure Diagnosis (Refer to 9 - ENGINE/CYLINDER HEAD - DIAGNOSIS AND TESTING)
- Intake Manifold Leakage Diagnosis (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING)
- Lash Adjuster (Tappet) Noise Diagnosis (Refer to 9 - ENGINE/ENGINE BLOCK/HYDRAULIC LIFTERS (CAM IN BLOCK) - DIAGNOSIS AND TESTING)
- Engine Oil Leak Inspection (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)

ENGINE 8.0L (Continued)

DIAGNOSIS AND TESTING—ENGINE
DIAGNOSIS - PERFORMANCE

PERFORMANCE DIAGNOSIS CHART—GASOLINE ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK	1. Weak or dead battery	1. Charge/Replace Battery. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/BATTERY - STANDARD PROCEDURE). Check charging system. (Refer to 8 - ELECTRICAL/ CHARGING - DIAGNOSIS AND TESTING).
	2. Corroded or loose battery connections	2. Clean/tighten suspect battery/ starter connections
	3. Faulty starter or related circuit(s)	3. Check starting system. (Refer to 8 - ELECTRICAL/STARTING - DIAGNOSIS AND TESTING)
	4. Seized accessory drive component	4. Remove accessory drive belt and attempt to start engine. If engine starts, repair/replace seized component.
	5. Engine internal mechanical failure or hydro-static lock	5. Refer to (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
ENGINE CRANKS BUT WILL NOT START	1. No spark	1. Check for spark. (Refer to 8 - ELECTRICAL/IGNITION CONTROL - DESCRIPTION)
	2. No fuel	2. Perform fuel pressure test, and if necessary, inspect fuel injector(s) and driver circuits. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/ FUEL PUMP - DIAGNOSIS AND TESTING).
	3. Low or no engine compression	3. Perform cylinder compression pressure test. (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
ENGINE LOSS OF POWER	1. Worn or burned distributor rotor	1. Install new distributor rotor
	2. Worn distributor shaft	2. Remove and repair distributor (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/ DISTRIBUTOR - REMOVAL).
	3. Worn or incorrect gapped spark plugs	3. Clean plugs and set gap. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - CLEANING).
	4. Dirt or water in fuel system	4. Clean system and replace fuel filter
	5. Faulty fuel pump	5. Install new fuel pump
	6. Incorrect valve timing	6. Correct valve timing

ENGINE 8.0L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	7. Blown cylinder head gasket	7. Install new cylinder head gasket
	8. Low compression	8. Test cylinder compression (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
	9. Burned, warped, or pitted valves	9. Install/Reface valves as necessary
	10. Plugged or restricted exhaust system	10. Install new parts as necessary
	11. Faulty ignition cables	11. Replace any cracked or shorted cables
	12. Faulty ignition coil	12. Test and replace, as necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL).
ENGINE STALLS OR ROUGH IDLE	1. Carbon build-up on throttle plate	1. Remove throttle body and de-carbon. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/ THROTTLE BODY - REMOVAL).
	2. Engine idle speed too low	2. Check Idle Air Control circuit. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/IDLE AIR CONTROL MOTOR - DESCRIPTION)
	3. Worn or incorrectly gapped spark plugs	3. Replace or clean and re-gap spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ SPARK PLUG - CLEANING)
	4. Worn or burned distributor rotor	4. Install new distributor rotor
	5. Spark plug cables defective or crossed	5. Check for correct firing order or replace spark plug cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG CABLE - DIAGNOSIS AND TESTING)
	6. Faulty coil	6. Test and replace, if necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL)
	7. Intake manifold vacuum leak	7. Inspect intake manifold gasket and vacuum hoses (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING).
ENGINE MISSES ON ACCELERATION	1. Worn or incorrectly gapped spark plugs	1. Replace spark plugs or clean and set gap. (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/SPARK PLUG - CLEANING)
	2. Spark plug cables defective or crossed	2. Replace or rewire secondary ignition cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ SPARK PLUG CABLE - REMOVAL)

ENGINE 8.0L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	3. Dirt in fuel system	3. Clean fuel system
	4. Burned, warped or pitted valves	4. Install new valves
	5. Faulty coil	5. Test and replace as necessary (Refer to 8 - ELECTRICAL/ IGNITION CONTROL/IGNITION COIL - REMOVAL)

DIAGNOSIS AND TESTING— ENGINE
DIAGNOSIS - MECHANICAL

ENGINE MECHANICAL DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES/LIFTERS	1. High or low oil level in crankcase	1. Check for correct oil level. Adjust oil level by draining or adding as needed
	2. Thin or diluted oil	2. Change oil. (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE)
	3. Low oil pressure	3. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) for engine oil pressure test/ specifications
	4. Dirt in tappets/lash adjusters	4. Clean/replace hydraulic tappets/lash adjusters
	5. Bent push rod(s)	5. Install new push rods
	6. Worn rocker arms	6. Inspect oil supply to rocker arms and replace worn arms as needed
	7. Worn tappets/lash adjusters	7. Install new hydraulic tappets/lash adjusters
	8. Worn valve guides	8. Inspect all valve guides and replace as necessary
	9. Excessive runout of valve seats or valve faces	9. Grind valves and seats
CONNECTING ROD NOISE	1. Insufficient oil supply	1. Check engine oil level.
	2. Low oil pressure	2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) engine oil pressure test/specifications
	3. Thin or diluted oil	3. Change oil to correct viscosity. (Refer to 9 - ENGINE/ LUBRICATION/OIL - STANDARD PROCEDURE) for correct procedure/engine oil specifications

ENGINE 8.0L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Excessive connecting rod bearing clearance	Measure bearings for correct clearance with plasti-gage. Repair as necessary
	5. Connecting rod journal out of round	5. Replace crankshaft or grind journals
	6. Misaligned connecting rods	6. Replace bent connecting rods
MAIN BEARING NOISE	1. Insufficient oil supply	1. Check engine oil level.
	2. Low oil pressure	2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)
	3. Thin or diluted oil	3. Change oil to correct viscosity.
	4. Excessive main bearing clearance	4. Measure bearings for correct clearance. Repair as necessary
	5. Excessive end play	5. Check crankshaft thrust bearing for excessive wear on flanges
	6. Crankshaft main journal out of round or worn	6. Grind journals or replace crankshaft
	7. Loose flywheel or torque converter	7. Inspect crankshaft, flexplate/ flywheel and bolts for damage. Tighten to correct torque
LOW OIL PRESSURE	1. Low oil level	1. Check oil level and fill if necessary
	2. Faulty oil pressure sending unit	2. Install new sending unit
	3. Clogged oil filter	3. Install new oil filter
	4. Worn oil pump	4. Replace oil pump assembly.
	5. Thin or diluted oil	5. Change oil to correct viscosity.
	6. Excessive bearing clearance	6. Measure bearings for correct clearance
	7. Oil pump relief valve stuck	7. Remove valve to inspect, clean and reinstall
	8. Oil pump suction tube loose, broken, bent or clogged	8. Inspect suction tube and clean or replace if necessary
	9. Oil pump cover warped or cracked	9. Install new oil pump
OIL LEAKS	1. Misaligned or deteriorated gaskets	1. Replace gasket
	2. Loose fastener, broken or porous metal part	2. Tighten, repair or replace the part
	3. Front or rear crankshaft oil seal leaking	3. Replace seal
	4. Leaking oil gallery plug or cup plug	4. Remove and reseal threaded plug. Replace cup style plug

ENGINE 8.0L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. CCV System malfunction	1. (Refer to 25 - EMISSIONS CONTROL/EVAPORATIVE EMISSIONS - DESCRIPTION) for correct operation
	2. Defective valve stem seal(s)	2. Repair or replace seal(s)
	3. Worn or broken piston rings	3. Hone cylinder bores. Install new rings
	4. Scuffed pistons/cylinder walls	4. Hone cylinder bores and replace pistons as required
	5. Carbon in oil control ring groove	5. Remove rings and de-carbon piston
	6. Worn valve guides	6. Inspect/replace valve guides as necessary
	7. Piston rings fitted too tightly in grooves	7. Remove rings and check ring end gap and side clearance. Replace if necessary

DIAGNOSIS AND TESTING—ENGINE
DIAGNOSIS - LUBRICATION

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Gaskets and O-Rings.	1.
	(a) Misaligned or damaged.	(a) Replace as necessary.
	(b) Loose fasteners, broken or porous metal parts.	(b) Tighten fasteners, Repair or replace metal parts.
	2. Crankshaft rear seal	2. Replace as necessary.
	3. Crankshaft seal flange. Scratched, nicked or grooved.	3. Polish or replace crankshaft.
	4. Oil pan flange cracked.	4. Replace oil pan.
	5. Timing chain cover seal, damaged or misaligned.	5. Replace seal.
	6. Scratched or damaged vibration damper hub.	6. Polish or replace damper.
OIL PRESSURE DROP	1. Low oil level.	1. Check and correct oil level.
	2. Faulty oil pressure sending unit.	2. Replace sending unit.
	3. Low oil pressure.	3. Check pump and bearing clearance.
	4. Clogged oil filter.	4. Replace oil filter.
	5. Worn oil pump.	5. Replace as necessary.
	6. Thin or diluted oil.	6. Change oil and filter.
	7. Excessive bearing clearance.	7. Replace as necessary.
	8. Oil pump relief valve stuck.	8. Clean or replace relief valve.
	9. Oil pump suction tube loose or damaged.	9. Replace as necessary.

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn or damaged rings.	1. Hone cylinder bores and replace rings.
	2. Carbon in oil ring slots.	2. Replace rings.
	3. Incorrect ring size installed.	3. Replace rings.
	4. Worn valve guides.	4. Ream guides and replace valves.
	5. Leaking intake gasket.	5. Replace intake gaskets.
	6. Leaking valve guide seals.	6. Replace valve guide seals.

DIAGNOSIS AND TESTING—CYLINDER COMPRESSION PRESSURE

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise, the indicated compression pressures may not be valid for diagnosis purposes.

(1) Clean the spark plug recesses with compressed air.

(2) Remove the spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - REMOVAL).

(3) Secure the throttle in the wide-open position.

(4) Disconnect the ignition coil.

(5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.

(6) Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

(Refer to 9 - ENGINE - SPECIFICATIONS) for the correct engine compression pressures.

DIAGNOSIS AND TESTING - CYLINDER COMBUSTION PRESSURE LEAKAGE

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating)
- Leaks between adjacent cylinders or into water jacket
- Any causes for combustion/compression pressure loss

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

Check the coolant level and fill as required. DO NOT install the radiator cap.

Start and operate the engine until it attains normal operating temperature, then turn OFF the engine.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1,379 kPa (200 psi) maximum and 552 kPa (80 psi) recommended.

Perform the test procedure on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe or oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

FOR EXAMPLE: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART.

ENGINE 8.0L (Continued)

CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

STANDARD PROCEDURE

STANDARD PROCEDURE—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.

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. 3).

(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.

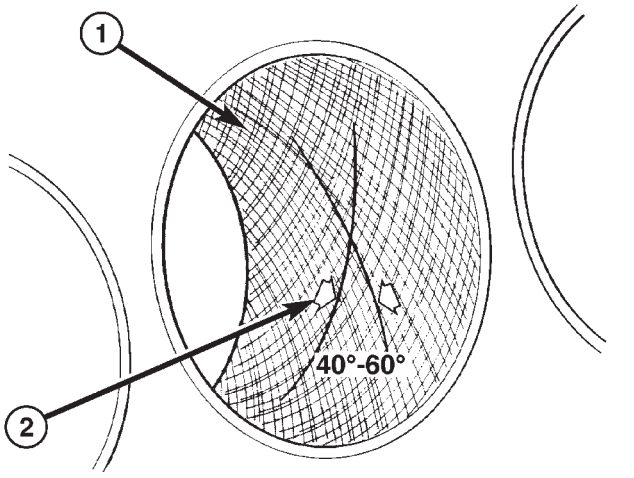


Fig. 3 Cylinder Bore Crosshatch Pattern

1 - CROSSHATCH PATTERN
2 - INTERSECT 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.

ENGINE 8.0L (Continued)

STANDARD PROCEDURE - FORM-IN-PLACE GASKETS AND SEALERS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results. **Do not use form-in-place gasket material unless specified.** 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 which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

MOPAR® ENGINE RTV GEN II

Mopar® Engine RTV GEN II is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® ATF RTV

Mopar® ATF RTV is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

Mopar® Gasket Maker is an anaerobic type gasket material. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

MOPAR® GASKET SEALANT

Mopar® Gasket Sealant is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material is used on engines with multi-layer steel (MLS) cylinder head gaskets. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4oz./16 oz. can w/applicator.

FORM-IN-PLACE GASKET AND SEALER APPLICATION

Assembling parts using a form-in-place gasket requires care but it's easier then using precut gaskets.

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. 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 material off the location.

Mopar® Engine RTV GEN II or ATF RTV gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) 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 usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

STANDARD PROCEDURE - 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.

STANDARD PROCEDURE—HYDROSTATIC LOCK

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

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

ENGINE 8.0L (Continued)

(1) Perform the Fuel Pressure Release Procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
(2) Disconnect the negative cable(s) from the battery.
(3) Inspect air cleaner, induction system, and intake manifold to ensure system is dry and clear of foreign material.
(4) Place a shop towel around the spark plugs to catch any fluid that may possibly be under pressure in the cylinder head. Remove the spark plugs.
(5) With all spark plugs removed, rotate the crankshaft using a breaker bar and socket.
(6) Identify the fluid in the cylinders (coolant, fuel, oil, etc.).
(7) Be sure all fluid has been removed from the cylinders.
(8) Repair engine or components as necessary to prevent this problem from occurring again.
(9) Squirt a small amount of engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.
(10) Install new spark plugs. Tighten the spark plugs to 41 N·m (30 ft. lbs.) torque.
(11) Drain engine oil. Remove and discard the oil filter.
(12) Install the drain plug. Tighten the plug to 34 N·m (25 ft. lbs.) torque.
(13) Install a new oil filter.
(14) Fill engine crankcase with the specified amount and grade of oil. (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).
(15) Connect the negative cable(s) to the battery.
(16) Start the engine and check for any leaks.

REMOVAL

(1) Remove the battery.
(2) Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
(3) Discharge the air conditioning system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(4) Remove the upper crossmember.
(5) Remove the transmission oil cooler (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - REMOVAL).
(6) Remove the serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(7) Remove the A/C compressor with the lines attached (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - REMOVAL). Set aside.
(8) If equipped, remove the condenser (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C CONDENSER - REMOVAL).
(9) Remove the washer fluid reservoir bottle (Refer to 8 - ELECTRICAL/WIPERS/WASHERS - REMOVAL AND INSTALLATION).
(10) Disconnect the top radiator hose.
(11) Remove the fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(12) Remove the fan shroud.
(13) Disconnect the lower radiator hose.
(14) Disconnect the transmission cooler lines.
(15) Remove radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).
(16) Remove the generator with the wire connections (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).
(17) Remove the air cleaner.
(18) Disconnect the throttle linkage.
(19) Remove throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - REMOVAL).
(20) Remove the upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).
(21) Remove the coil assemblies with the ignition cables.
(22) Disconnect the heater hoses.
(23) Disconnect the power steering hoses, if equipped.
(24) Perform the Fuel System Pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE). Disconnect the fuel line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).
(25) On Manual Transmission vehicles, remove the shift lever.
(26) Raise and support the vehicle on a hoist.
(27) Remove the drain plug and drain the engine oil.
(28) Loosen front engine mount thru-bolt nuts.
(29) Remove the transmission cooler line brackets from oil pan.
(30) Disconnect exhaust pipe at manifold.
(31) Disconnect the starter wires. Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL).
(32) Remove transmission.
(33) Lower vehicle.

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

(34) Install an engine lifting fixture.
(35) Remove engine from vehicle and install engine assembly on a repair stand.

ENGINE 8.0L (Continued)

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the thru-bolt into the support cushion brackets.
(2) Install an engine support fixture.
(3) Raise and support the vehicle on a hoist.
(4) Install Transmission.
(5) Install the starter and connect the starter wires (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - INSTALLATION).
(6) Install exhaust pipe to manifold.
(7) Install the transmission cooler line brackets from oil pan.
(8) Tighten the Front mount thru-bolts and nuts to 102N·m (75 ft. lbs.).
(9) Install the drain plug and tighten to 34 N·m (25 ft. lbs.) torque.
(10) Prime oil pump by squirting oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.
(11) Lower the vehicle.
(12) Remove engine lifting fixture.
(13) On Manual Transmission vehicles, install the shift lever.
(14) Connect the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).
(15) Connect the heater hoses.
(16) Install the upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).
(17) Install the coil assemblies with the ignition cables.
(18) Using a new gasket, install throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - INSTALLATION).
(19) Connect the throttle linkage.
(20) Install the air cleaner box.
(21) Install the generator and wire connections (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).
(22) Install the upper crossmember.
(23) Install radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).
(24) Connect the lower radiator hose.
(25) Install the transmission oil cooler (Refer to 7 - COOLING/TRANSMISSION/TRANS COOLER - INSTALLATION).
(26) Connect the transmission cooler lines.
(27) Connect the power steering hoses, if equipped.
(28) Install the fan shroud.
(29) Install the fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).
(30) Connect the top radiator hose.
(31) Install the washer fluid reservoir bottle (Refer to 8 - ELECTRICAL/WIPERS/WASHERS - INSTALLATION).
(32) If equipped, install the condenser (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C CONDENSER - INSTALLATION).
(33) Install the A/C compressor with the lines attached (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).
(34) Install the serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
(35) Evacuate (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE) and charge the air conditioning system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(36) Add coolant to the cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
(37) Install the battery.
(38) Warm engine and adjust as required.
(39) Road test vehicle.

SPECIFICATIONS

8.0L ENGINE

DESCRIPTION	SPECIFICATION
CAMSHAFT	
Bearing Diameter	
No. 1	53.16 – 53.19 mm (2.093 – 2.094 in.)
No. 2	52.76 – 52.78 mm (2.077 – 2.078 in.)
No. 3	52.35 – 52.37 mm
No. 4	51.94 – 51.97 mm (2.045 – 2.046 in.)
No. 5	51.54 – 51.56 mm (2.029 – 2.030 in.)
No. 6	48.74 – 48.77 mm (1.919 – 1.920 in.)
Bearing Journal Diameter	
No. 1	53.11 – 53.14 mm (2.091 – 2.092 in.)
No. 2	52.69 – 52.72 mm

ENGINE 8.0L (Continued)

DESCRIPTION	SPECIFICATION
	(2.0745 – 2.0755 in.)
No. 3	52.30 – 52.32 mm
	(2.059 – 2.060 in.)
No. 4	51.89 – 51.92 mm
	(2.043 – 2.044 in.)
No. 5	51.49 – 51.51 mm
	(2.027 – 2.028 in.)
No. 6	48.69 – 48.72 mm
	(1.917 – 1.918 in.)
Bearing to Journal Clearance	
No. 1,3,4,5,6	0.0254 – 0.0762 mm
	(0.001 – 0.003 in.)
No. 2	0.0381 – 0.0889 mm
	(0.0005 – 0.0035 in.)
Service Limit	0.127 mm (0.005 in.)
End Play	0.127 – 0.381 mm
	(0.005 – 0.015 in.)
CONNECTING RODS	
Piston Pin bore Diameter	24.940 – 24.978 mm
	(0.9819 – 0.9834 in.)
Side Clearance	0.25 – 0.46 mm
	(0.010 – 0.018 in.)
Total Weight (Less Bearing)	744 gms. (26.24 oz.)
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	0.005 – 0.074 mm
	(0.0002 – 0.0029 in.)
Service Limit	0.0762 mm (0.003 in.)
Main Bearing Journal Diameter	76.187 – 76.213 mm
	(2.8995 – 3.0005 in.)
Out of Round (Max.)	0.0254 mm (0.001 in.)

DESCRIPTION	SPECIFICATION
Taper (Max.)	0.0254 mm (0.001 in.)
Bearing Clearance	0.0051 – 0.058 mm
	(0.0002 – 0.0023 in.)
Service Limit	0.071 mm (0.0028 in.)
End Play	0.076 – 0.305 mm
	(0.003 – 0.012 in.)
Service Limit—End Play	0.381 mm (0.015 in.)
CYLINDER BLOCK	
Cylinder Bore Diameter	101.60 – 101.65 mm
	(4.0003 – 4.0008 in.)
Out of Round (Max.)	0.0762 mm (0.003 in.)
Taper (Max.)	0.127 mm (0.005 in.)
Lifter Bore Diameter	22.982 – 23.010 mm
	(0.9048 – 0.9059 in.)
CYLINDER HEAD AND VALVES	
Valve Seat Angle	44.5°
Runout (Max.)	0.0762 mm (0.003 in.)
Width (Finish) – Intake	1.016 – 1.524 mm
	(0.040 – 0.060 in.)
Valve Face Angle	45°
Valve Head Diameter	
Intake	48.640 – 48.900 mm
	(1.915 – 1.925 in.)
Exhaust	41.123 – 41.377 mm
	(1.619 – 1.629 in.)
Overall Length	
Intake	145.19 – 145.82 mm
	(5.716 – 5.741 in.)
Exhaust	145.54 – 146.18 mm
	(5.730 – 5.755 in.)
Lift (@ zero lash)	
Intake	9.91 mm (0.390 in.)
Exhaust	10.34 mm (0.407 in.)
Stem Diameter	7.900 – 7.920 mm
	(0.311 – 0.312 in.)

ENGINE 8.0L (Continued)

DESCRIPTION	SPECIFICATION
Guide Bore	9.500 – 9.525 mm (0.374 – 0.375 on.)
Stem to Guide Clearance	0.025 – 0.076 mm (0.001 – 0..003 in.)
Service Limit	0.4318 (0.017 in.)
Valve Spring 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	6.8
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)	0.0203 – 0.0610 mm (0.0008 – 0.0024 in.)
Dry Lash	1.524 – 5.334 mm (0.060 – 0.210 in.)
Push Rod Length	195.52 – 196.02 mm (7.698 – 7.717 in.)
OIL PRESSURE	
Curb Idle (Min.*)	83 kPa (12 psi)
@ 3000 rpm	345 – 414 kPa (50 – 60 psi)
* If oil pressure is zero at curb idle, DO NOT RUN ENGINE.	
OIL PUMP	
Clearance over Rotors (Max.)	0.1906 mm (0.0075 in.)
Cover Out of Flat (Max.)	0.051 mm (0.002 in.)
Inner Rotor Thickness (Min.)	14.925 – 14.950 mm (0.5876 – 0.5886 in.)

DESCRIPTION	SPECIFICATION
Outer Rotor	
Clearance (Max.)	0.1626 mm (0.006 in.)
Diameter (Min.)	82.461 mm (3.246 in.)
Thickness (Min.)	14.925 mm (0.5876 in.)
Tip Clearance between Rotors (Max.)	0.584 mm (0.0230 in.)
PISTONS	
Clearance at Top of Skirt	0.013 – 0.038 mm (0.0005 – 0.0015 in.)
Piston Length	82.5 mm (3.25 in.)
Piston Ring Groove Depth	
#1&2	91.30 – 91.55 mm (3.594 – 3.604 in.)
#3	92.90 – 93.15 mm (3.657 – 3.667 in.)
Weight	463 – 473 grams (16.33 – 16.68 oz.)
Piston to Bore Clearance	0.013 – 0.038 mm (0.0005 – 0.0015 in.)
Service Limit	0.0762 mm (0.003 in.)
PISTON PINS	
Clearance in Piston	0.010 – 0.020 mm (0.0004 – 0.0008 in.)
Diameter	24.996 – 25.001 mm (0.9841 – 0.9843 in.)
End Play	NONE
Length	67.8 – 68.3 mm (2.67 – 2.69 in.)
PISTON RINGS	
Ring Gap	
Compression Rings	0.254 – 0.508 mm (0.010 – 0.020 in.)
Oil Control (Steel Rails)	0.381 – 1.397 mm (0.015 – 0.055 in.)

ENGINE 8.0L (Continued)

DESCRIPTION	SPECIFICATION
Ring Side Clearance	
Compression Rings	0.074 – 0.097 mm (0.0029 – 0.0038 in.)
Oil Ring (Steel Rails)	2.591 – 2.743 mm (0.102 – 0.108 in.)
VALVE TIMING	
Exhaust Valve	
Closes (ATDC)	25°
Opens (BBDC)	60°
Duration	265°
Intake Valve	
Closes (ATDC)	61°
Opens (BBDC)	6°
Duration	246°
Valve Overlap	31°

CRANKSHAFT JOURNAL MARKING LOCATION

MEASURE-MENT	ITEM	IDENTI-FICATION	LOCATION OF IDENTI-FICATION
0.0254 mm (0.001 in.) U/S	Crankshaft Journals	R or M M-2-3 ect. (indicating No. 2 and 3 main bearing journal) and/or R-1-4 ect. (indicating No. 1 and 4 connecting rod journal)	Milled flat on No. 8 crankshaft counter-weight.
0.508 mm (0.020 in.) O/S	Cylinder Bores	A	Following engine serial number.
0.2032 mm (0.008 in.) O/S	Hydraulic Tappets	◇	Diamond-shaped stamp top pad - front of engine and flat ground on outside surface of each O/S tappet bore.
0.127 mm (0.005 in.)	Valve Stems	X	Milled pad adjacent to two tapped holes 3/8″ on each end of cylinder head.

TORQUE

TORQUE CHART 8.0L ENGINE

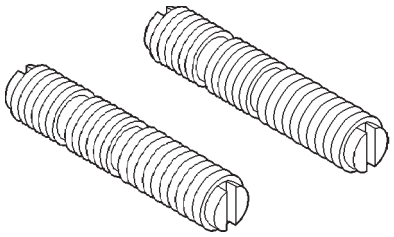
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sprocket—Bolt	75	55	—
Camshaft Thrust Plate—Bolts	22	16	—
Coil Pack Bracket—Bolts	21	—	190
Connecting Rod Cap—Bolts	61	45	—
Main Bearing—Bolts			
Step 1	27	20	—
Step 2	115	85	—
Crankshaft Pulley/Damper—Bolt	312	230	—
Crankshaft Rear Seal Retainer—Bolts	22	16	—
Cylinder Head—Bolts			
Step 1	58	43	—
Step 2	143	105	—
Cylinder Head Cover—Bolts	16	—	144

ENGINE 8.0L (Continued)

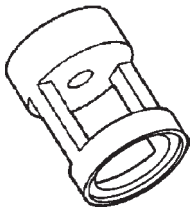
DESCRIPTION	N·m	Ft.	In.
Drive Plate to Crankshaft—Bolts	75	55	—
Drive Plate to Torque Converter—Bolts	47	35	—
EGR Tube—Nut	34	25	—
EGR Valve—Bolts	20	—	174
Engine Support Bracket/Insulator—Through Bolt	68	50	—
Engine Support Bracket/Insulator to Block—Bolts	47	35	—
Exhaust Manifold to Cylinder Head—Bolt	22	16	—
Generator Mounting—Bolt	41	30	—
Generator to Intake Manifold Bracket—Bolts	41	30	—
Heat Shield—Nuts	20	—	175
Hydraulic Tappet Yoke Retaining Spider—Bolts	22	16	—
Intake Manifold (Lower)—Bolts	54	40	—
Intake Manifold (Upper)—Bolts	22	16	—
Oil Filter	9	—	80 + 45°
Oil Filter Connector	46	34	—
Oil Pan			
—1/4 - 20 Bolts	11	—	96
—5/16 - 18 Bolts	16	—	144
—Stud Bolts	16	—	144
—Drain Plug	34	25	—
Oil Pan Pick Up Tube—Bolts	16	—	144
Oil Pump Attaching—Bolts	41	30	—
Oil Pump Cover—Bolts	14	—	125
Oil Pump Pressure Relief—Plug	20	15	—
Rocker Arm—Bolts	28	21	—
Spark Plugs	41	30	—
Starter Mounting—Bolts	68	50	—
Timing Chain Cover—Bolts	47	35	—
Thermostat Housing—Bolts	25	—	220
Throttle Body—Nuts	11	—	96
Transfer Case to Insulator Mounting Plate—Nuts	204	150	—
Transmission Support Bracket—Bolts	102	75	—
Transmission Support Cushion—Bolts	47	35	—
Transmission Support Cushion Stud—Nuts	47	35	—
Water Pump to Chain Case Cover—Bolts	41	30	—

SPECIAL TOOLS

8.0L ENGINE

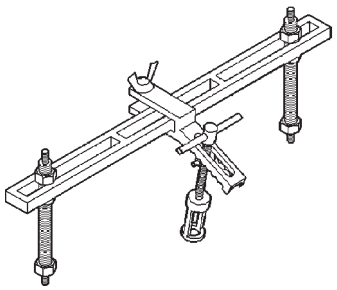


Valve Compressor Adapting Stud Tool 6715

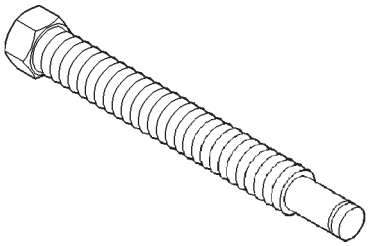


Valve Spring Compressor Adapter Tool 6716A

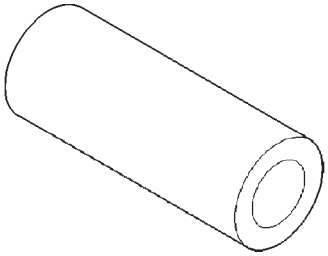
ENGINE 8.0L (Continued)



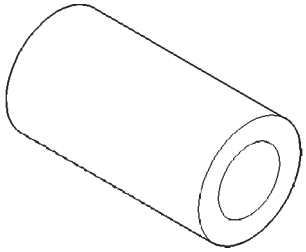
Valve Spring Compressor Tool MD-998772A



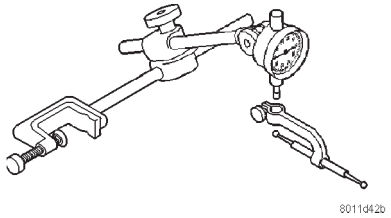
Valve Spring Compressor Screw Tool 6756



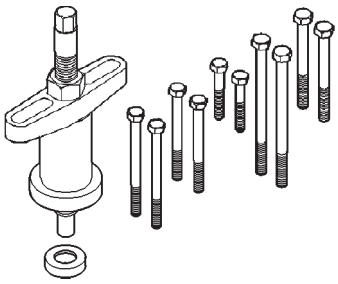
Black Valve Guide Sleeve Tool C6819



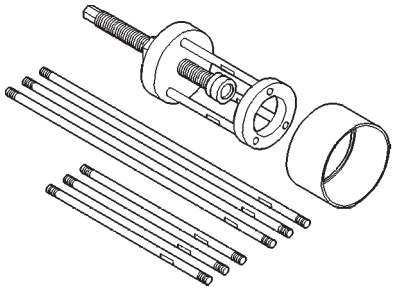
Silver Valve Guide Sleeve Tool C6818



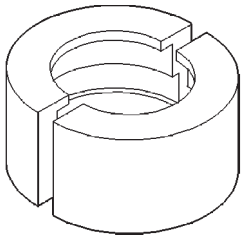
Dial Indicator Tool C3339



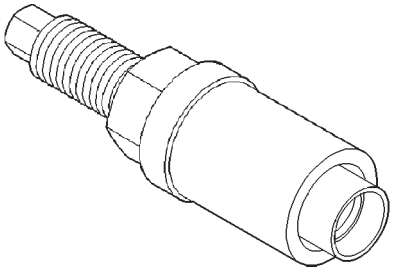
Crankshaft Pulley/Damper Installer Tool C3688



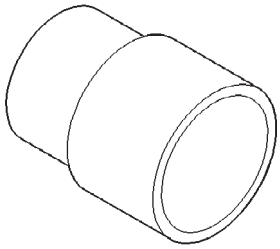
Crankshaft Sprocket Puller Tool 6444



Crankshaft Sprocket Puller Jaws Tool 6820

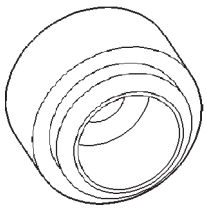


Crankshaft Sprocket Installer Tool 3718

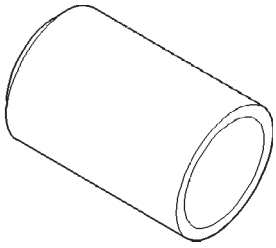


Crankshaft Sprocket Installer Tool MD990799

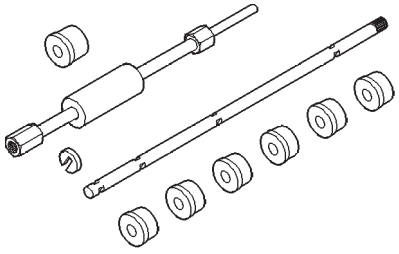
ENGINE 8.0L (Continued)



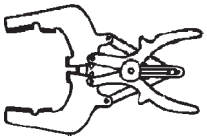
Front Oil Seal Installer Tool 6806



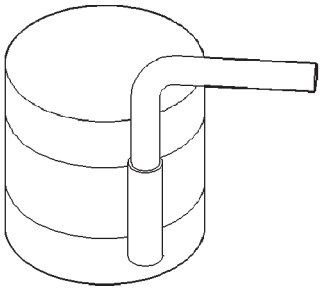
Front Oil Seal Installer Tool 6761



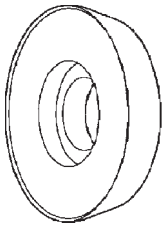
Camshaft Bearing Installer Tool C3132A



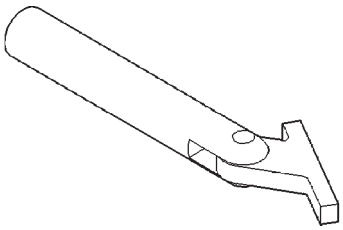
Compression Ring Installer Tool C4184



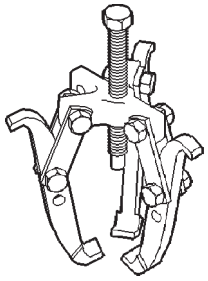
Piston Ring Compressor Tool C385



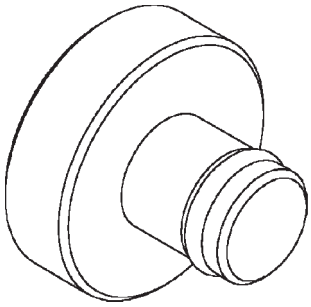
Seal Installer Tool 6687



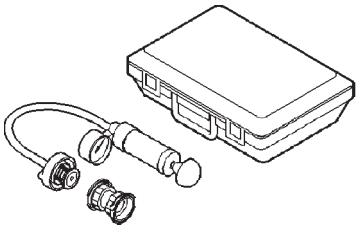
Crankshaft Main Bearing Remover/Installer Tool C3059



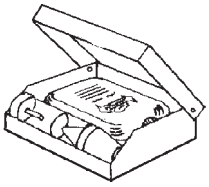
Puller 1026



Crankshaft Damper Removal Insert 8513



Pressure Tester Kit 7700



Bloc–Chek–Kit C-3685–A

AIR CLEANER ELEMENT

REMOVAL - 8.0L

For air cleaner element required maintenance schedules (listed in time or mileage intervals), refer to 0, Lubrication and Maintenance.

A small amount of engine oil wetting the inside of the air cleaner housing is normal. When servicing, wipe out oil from air cleaner housing.

(1) Loosen clamp (Fig. 4) and remove air inlet tube (Fig. 5) at front of air cleaner housing cover.

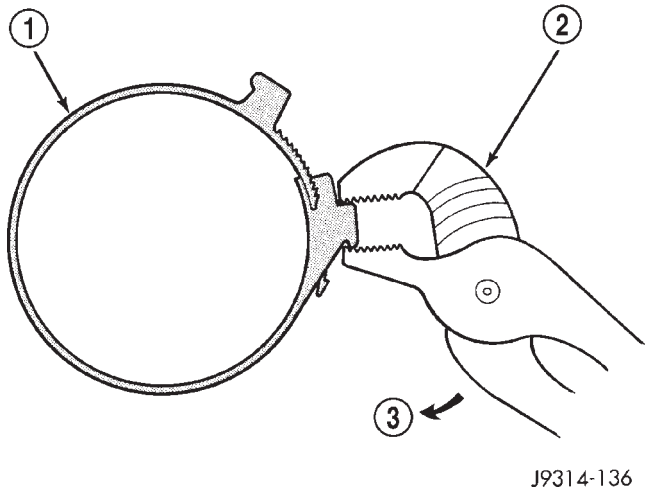


Fig. 4 Clamp Removal—8.0L Engine

1 - CLAMP
2 - ADJUSTABLE PLIERS
3 - REMOVAL

(2) The air cleaner housing and air cleaner element cover are equipped with spring clips to seal cover to housing (Fig. 5). Unlatch clips from air cleaner cover and remove cover from air cleaner housing.

(3) Remove air cleaner element from air cleaner cover.

(4) Before installing a new air cleaner element, clean inside of air cleaner housing.

(5) If housing removal is necessary, disconnect crankcase vent hose and remove 4 housing-to-throttle body nuts.

INSTALLATION - 8.0L

For air cleaner element required maintenance schedules (listed in time or mileage intervals), refer to Group 0, Lubrication and Maintenance.

(1) After installing housing, tighten 4 nuts to 11 N·m (96 in. lbs.) torque and connect crankcase vent hose.

(2) Position air cleaner element (filter) into air cleaner cover. Latch spring clips to seal cover to housing.

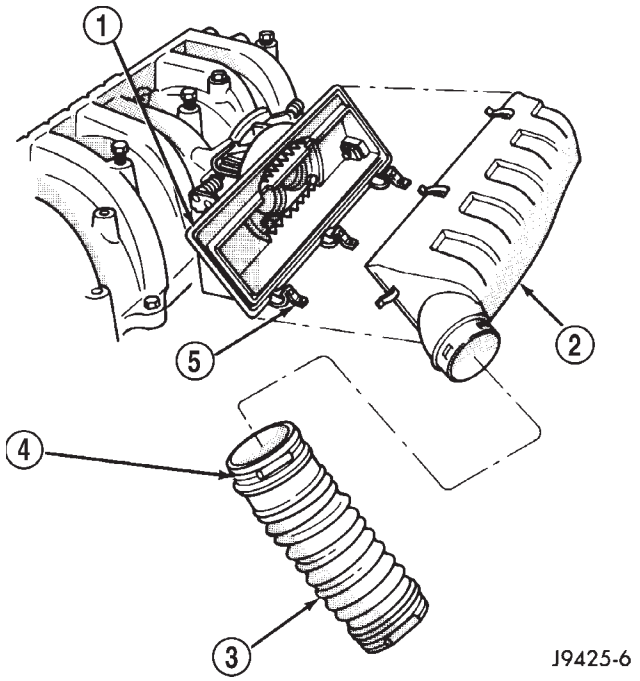


Fig. 5 Air Cleaner Housing—8.0L V-10 Engine

1 - HOUSING
2 - HOUSING COVER
3 - AIR INLET TUBE
4 - CLAMP
5 - SPRING CLIPS

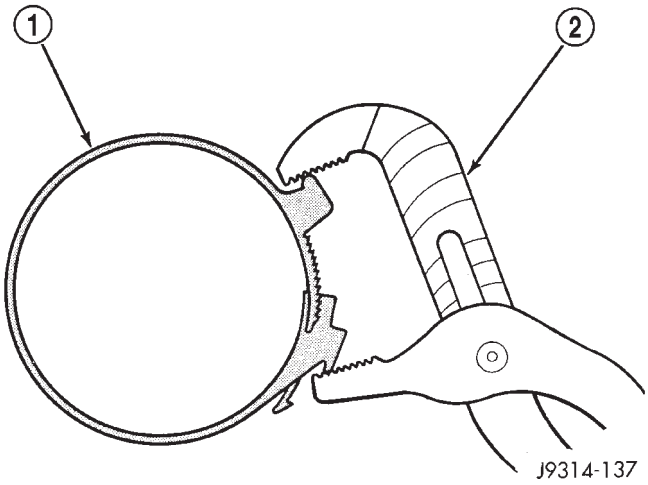


Fig. 6 Clamp Installation—8.0L Engine

1 - CLAMP
2 - ADJUSTABLE PLIERS

(3) Install air inlet tube at air cleaner housing inlet.

(4) Install and tighten clamp at air inlet tube (Fig. 6).

CYLINDER HEAD

DESCRIPTION

The alloy cast iron cylinder heads (Fig. 7) are held in place by 12 bolts. The spark plugs are located in the peak of the wedge between the valves.

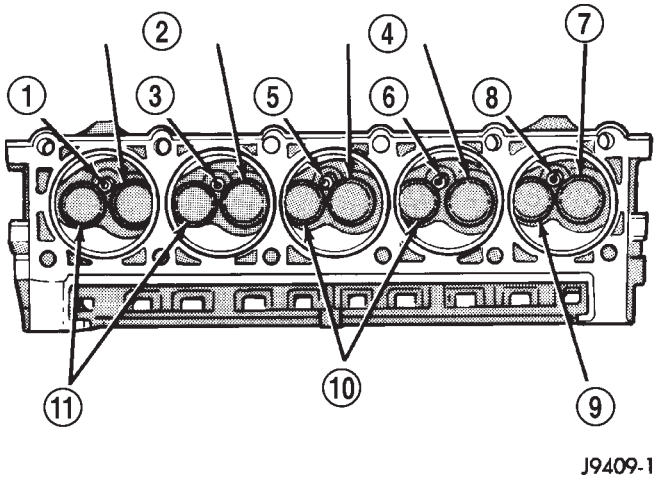


Fig. 7 Cylinder Head Assembly

1 - SPARK PLUG
2 - INTAKE VALVES
3 - SPARK PLUG
4 - INTAKE VALVES
5 - SPARK PLUG
6 - SPARK PLUG
7 - INTAKE VALVE
8 - SPARK PLUG
9 - EXHAUST VALVE
10 - EXHAUST VALVES
11 - EXHAUST VALVES

DIAGNOSIS AND TESTING—CYLINDER HEAD GASKET FAILURE

A cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

- Possible indications of the cylinder head gasket leaking between adjacent cylinders are:
- Loss of engine power
- Engine misfiring
- Poor fuel economy
- Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:
- Engine overheating
- Loss of coolant
- Excessive steam (white smoke) emitting from exhaust
- Coolant foaming

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures in Cylinder Compression Pressure Test in this section. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50–70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING WITH COOLANT PRESSURE CAP REMOVED.

VISUAL TEST METHOD

With the engine cool, remove the coolant pressure cap. Start the engine and allow it to warm up until thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

COOLING SYSTEM TESTER METHOD

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

Install Cooling System Tester 7700 or equivalent to pressure cap neck. Start the engine and observe the tester's pressure gauge. If gauge pulsates with every power stroke of a cylinder a combustion pressure leak is evident.

CHEMICAL TEST METHOD

Combustion leaks into the cooling system can also be checked by using Bloc-Chek Kit C-3685-A or equivalent. Perform test following the procedures supplied with the tool kit.

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
(3) Remove the heat shields (Fig. 8).
(4) Remove the intake manifold-to-generator bracket support rod. Remove the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).
(5) Remove closed crankcase ventilation system.
(6) Disconnect the evaporation control system.
(7) Remove the air cleaner.
(8) Perform the Fuel System Pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIV-

CYLINDER HEAD (Continued)

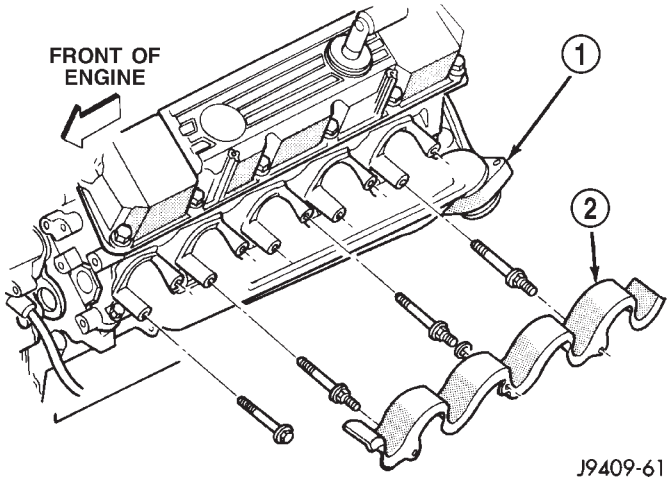


Fig. 8 Spark Plug Wire Heat Shields (Left Side Shown)

1 - EXHAUST MANIFOLD
2 - HEAT SHIELD

ERY - STANDARD PROCEDURE). Disconnect the fuel line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

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

(10) Remove coil pack and bracket (Fig. 9).

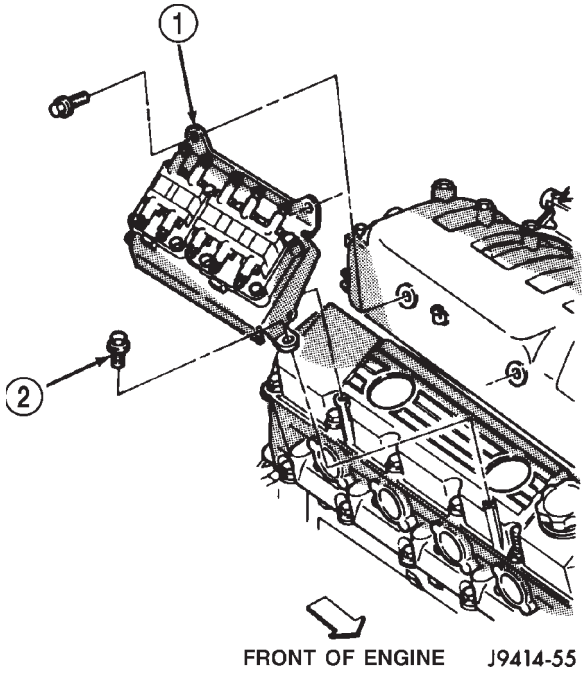


Fig. 9 Coil Pack and Bracket

1 - COIL PACKS AND BRACKET
2 - MOUNTING BOLTS (4)

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Remove upper intake manifold and throttle body as an assembly (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(15) Remove cylinder head covers and gaskets (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(16) Remove the EGR tube. Discard the gasket, for right side only.

(17) Remove lower intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL). Discard the flange side gaskets and the front and rear cross-over gaskets.

(18) Disconnect exhaust pipe from exhaust manifold.

(19) Remove exhaust manifolds and gaskets (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - REMOVAL).

(20) Remove rocker arm assemblies and push rods (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL). Identify to ensure installation in original locations.

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

(22) Remove spark plugs.

CLEANING

Clean all surfaces of cylinder block and cylinder heads. Be sure material does not fall into the lifters and surrounding valley.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

Clean the exhaust manifold to cylinder head mating areas.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. The out-of-flatness specifications are 0.0007 mm/mm (0.0004 inch/inch), 0.127 mm/152 mm (0.005 inch/6 inches) any direction or 0.254 mm (0.010 inch) overall across head. If exceeded, either replace head or lightly machine the head surface.

The cylinder head surface finish should be 1.78-4.57 microns (15-80 microinches).

Inspect push rods. Replace worn or bent rods.

Inspect rocker arms. Replace if worn or scored.

INSTALLATION

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

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

CYLINDER HEAD (Continued)

(3) Tighten the cylinder head bolts in two steps (Fig. 10):

- Step 1—Tighten all cylinder head bolts, in sequence, to 58 N·m (43 ft. lbs.) torque.
- Step 2—Tighten all cylinder head bolts, in sequence, to 143 N·m (105 ft. lbs.) torque.
-

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

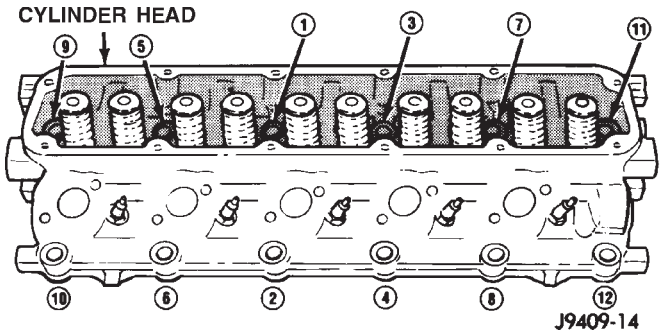


Fig. 10 Cylinder Head Bolt Tightening Sequence

(4) Install push rods and rocker arm assemblies in their original position (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

(5) Install lower intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(6) Install the upper intake manifold onto the lower intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(7) Install the exhaust manifolds and new gaskets (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - INSTALLATION).

(8) Install exhaust pipe to the exhaust manifold. Tighten the bolts to 34 n·m (25 ft. lbs.) torque.

(9) Using a new gasket, position the EGR tube to the intake manifold and the exhaust manifold. Tighten the EGR tube nut to 34 N·m (25 ft. lbs.) torque. Tighten the bolts to 20 N·m (174 in. lbs.) torque.

(10) Install the heat shields and the washers. **Make sure that heat shields tabs hook over the exhaust gasket.** Tighten the nuts to 15 N·m (132 in. lbs.) torque.

(11) Adjust and Install the spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - INSTALLATION).

(12) Install coil packs and bracket. Tighten the bracket bolts to 21 N·m (190 in. lbs.) torque. Connect the coil wires.

(13) Connect heat indicator sending unit wire.

(14) Connect the heater hoses and bypass hose.

(15) Connect the accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(16) Install the fuel line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(17) Install the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION) and drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(18) Install the intake manifold-to-generator bracket support rod. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(19) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. DO NOT use alternative fasteners.

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

(21) Install closed crankcase ventilation system.

(22) Connect the evaporation control system.

(23) Install the air cleaner.

(24) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(25) Connect the negative cable to the battery.

(26) Check for leaks (fuel, oil, antifreeze, etc.).

CYLINDER HEAD COVER(S)

DESCRIPTION

Die-cast magnesium cylinder head covers (Fig. 11) reduce noise and provide a good sealing surface. A steel backed silicon gasket is used with the cylinder head cover. This gasket can be used again.

REMOVAL

Die-cast magnesium cylinder head covers (Fig. 13) reduce noise and provide a good sealing surface. A steel backed silicon gasket is used with the cylinder head cover (Fig. 12).

(1) Disconnect the negative cable from the battery.

(2) Disconnect closed ventilation system and evaporation control system from cylinder head cover. Identify each system for installation.

(3) Remove the upper intake manifold to remove the right side head cover (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

CYLINDER HEAD COVER(S) (Continued)

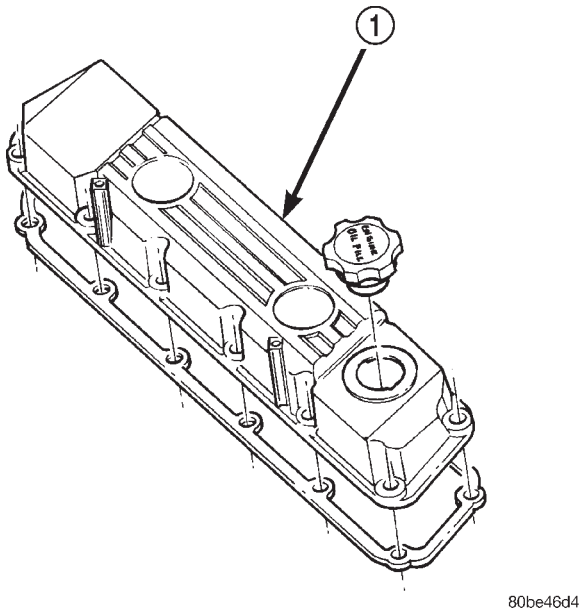


Fig. 11 Cylinder Head Cover

1 - CYLINDER HEAD COVER

(4) Remove cylinder head cover bolts and stud bolts. Remove the covers and gaskets (Fig. 12). The gasket may be used again.

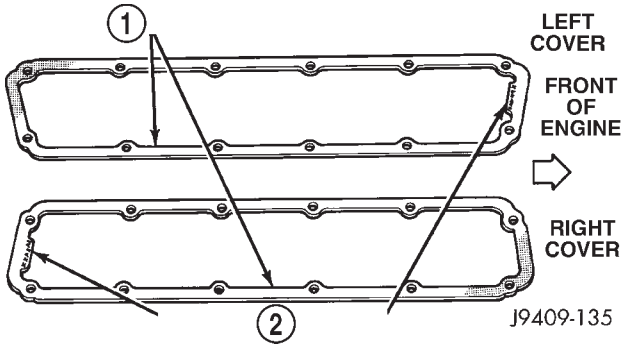


Fig. 12 Cylinder Head Cover Gaskets

1 - CYLINDER HEAD COVER GASKETS
2 - TAB WITH NUMBER UP

CLEANING

Clean cylinder head cover gasket surface.

Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

Check the gasket for use in head cover installation. If damaged, use a new gasket.

INSTALLATION

(1) Check the gasket for use in head cover installation. If damaged, use a new gasket.

(2) Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. DO NOT use alternative fasteners.

(3) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 13). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

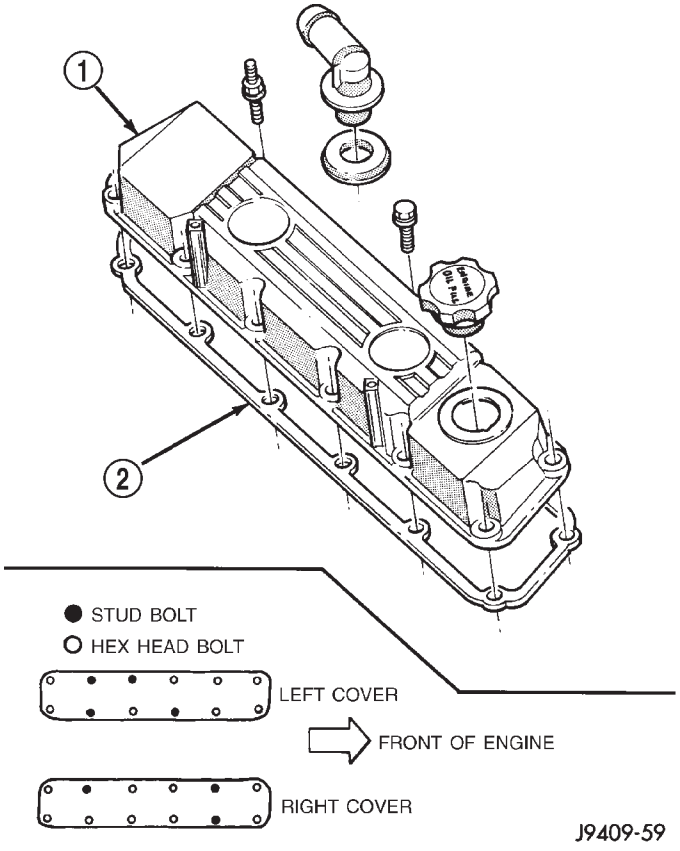


Fig. 13 Cylinder Head Covers

1 - CYLINDER HEAD COVER
2 - CYLINDER HEAD COVER GASKET

(4) If removed, install the upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(5) Install closed crankcase ventilation system and evaporation control system onto the proper head cover. DO NOT switch the systems.

(6) Connect the negative cable to the battery.

(7) Start engine and check for leaks.

INTAKE/EXHAUST VALVES & SEATS

DESCRIPTION

The valves (Fig. 14) are arranged in-line and inclined 18°. The rocker pivot support and the valve guides are cast integral with the heads.

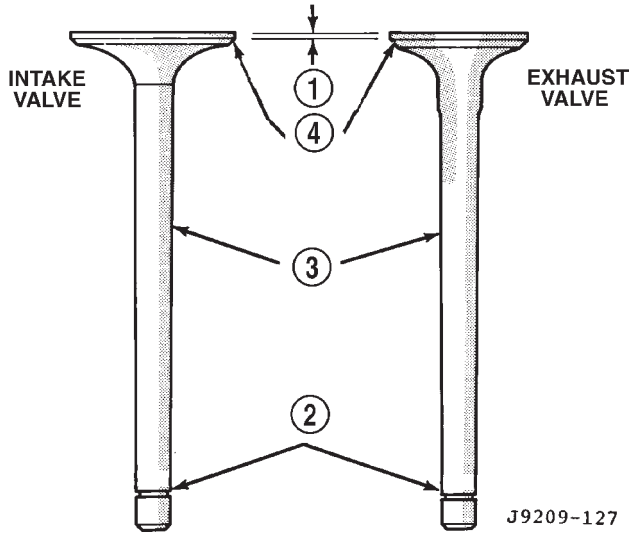


Fig. 14 Intake and Exhaust Valves—8.0L Engine

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

STANDARD PROCEDURE

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Black Valve Guide Sleeve Tool C-6819 over valve stem for the **INTAKE** valve and install valve (Fig. 15). The special sleeve places the valve at the correct height for checking with a dial indicator.

(2) Install Silver Valve Guide Sleeve Tool C-6818 over valve stem for the **EXHAUST** valve and install valve. The special sleeve places the valve at the correct height for checking with a dial indicator.

(3) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 16).

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

Service valves with oversize stems are available as shown below

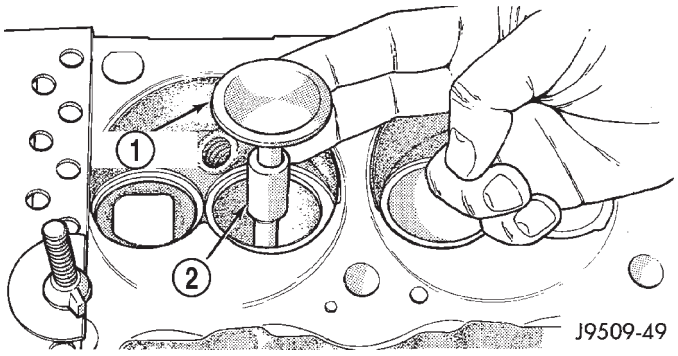


Fig. 15 Positioning Valve Spacer Tool (Typical)

1 - VALVE
2 - SPACER TOOL

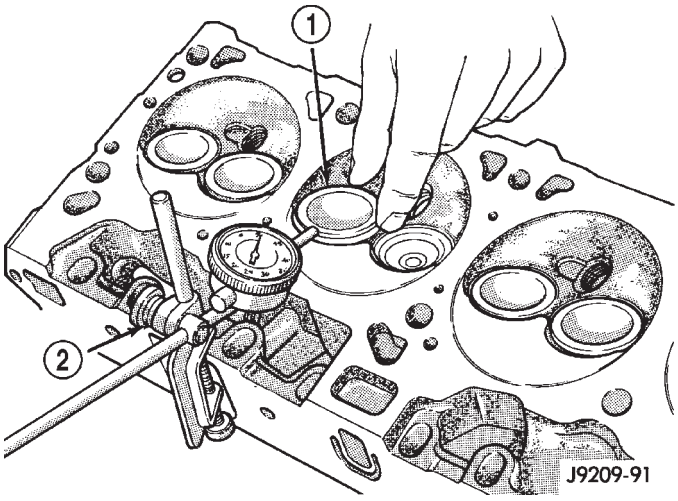


Fig. 16 Measuring Valve Guide Wear

1 - VALVE
2 - SPECIAL TOOL C-3339

REAMER SIZE 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 (0.316 - 0.329 in.)

(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).

INTAKE/EXHAUST VALVES & SEATS (Continued)

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 45° face angle and a 45° to 44 1/2° seat angle (Fig. 17).

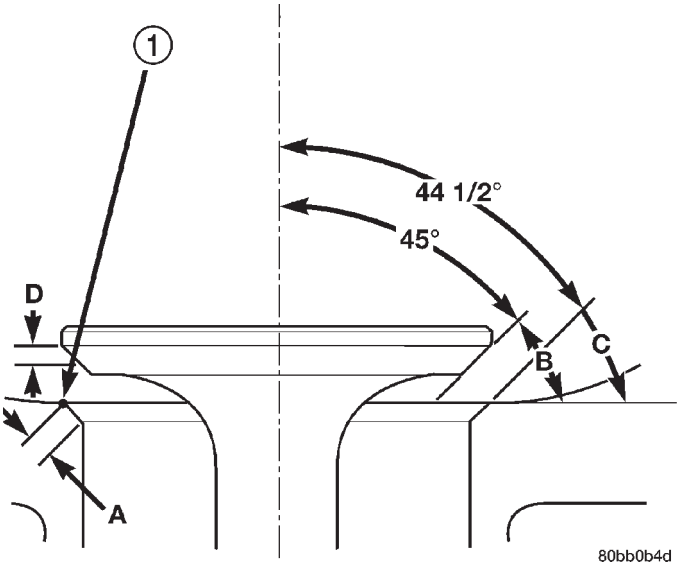


Fig. 17 Valve Face and Seat Angles

1 - CONTACT POINT

VALVE FACE AND SEAT ANGLES CHART

ITEM	DESCRIPTION	SPECIFICATION
A	SEAT WIDTH INTAKE	1.016 - 1.524 mm (0.040 - 0.060 in.)
	SEAT WIDTH EXHAUST	1.016 - 1.524 mm (0.040 - 0.060 in.)
B	FACE ANGLE (INT. and EXT.)	45°
C	SEAT ANGLE (INT. and EXT.)	44½°
D	CONTACT SURFACE	—

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 18). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

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

(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.038 mm (0.0015 inch) total indicator reading.

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat LIGHTLY with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of valve seats should be 1.016-1.524 mm (0.040-0.060 inch).

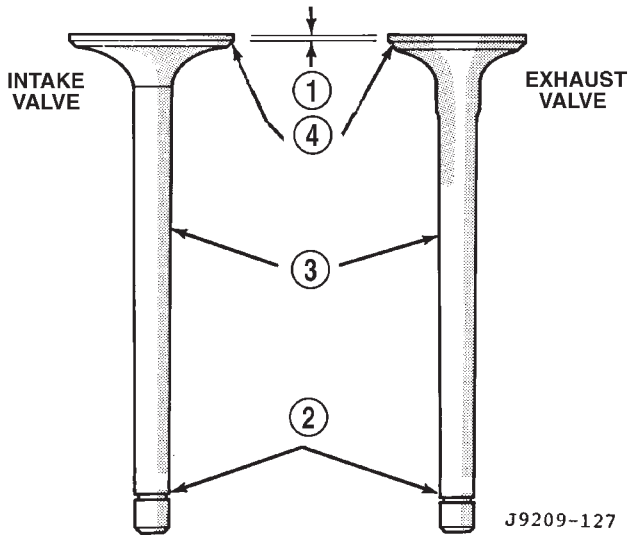


Fig. 18 Intake and Exhaust Valves

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

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. 19). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and

allowable tensions. Discard the springs that do not meet specifications.

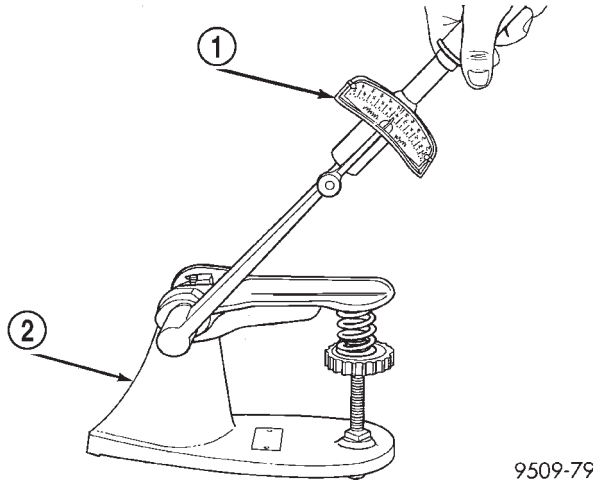


Fig. 19 Testing Valve Spring for Compressed

1 - TORQUE WRENCH
2 - VALVE SPRING TESTER

REMOVAL

REMOVAL—VALVE STEM SEALS

NOTE: This procedure is done with the cylinder head installed.

(1) Disconnect the negative cable from the battery.
(2) Set engine basic timing to Top Dead Center (TDC) and remove air cleaner.
(3) Remove cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL) and spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - REMOVAL).
(4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so that the piston of the cylinder to be worked on, is at TDC on the compression stroke.
(5) Remove rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL).
(6) With air hose attached to an adapter installed in the spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.
(7) Using Valve Spring Compressor Tool MD-998772A with adapter 6716A (Fig. 20), compress valve spring and remove retainer valve locks and valve spring.
(8) Remove the valve stem seal.

REMOVAL—VALVES AND VALVE SPRINGS

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

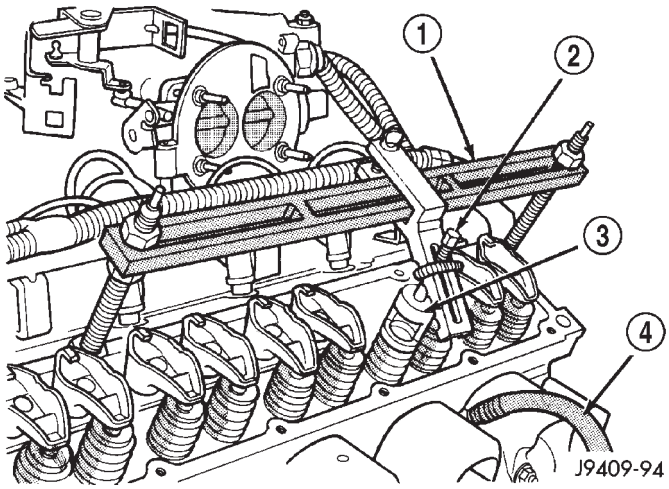


Fig. 20 Valve Spring Compressor MD-998772A with Adaptor 6716-A and Screw 6765

1 - SPECIAL TOOL MD 998772A
2 - SPECIAL TOOL 6765
3 - SPECIAL TOOL 6716A
4 - AIR HOSE

(2) Special studs must be used to adapt the Valve Spring Compressor Tool to the V-10 cylinder head (Fig. 21). Install the metric end into the Special Tool MD998772A and the 5/16 end into the cylinder head.

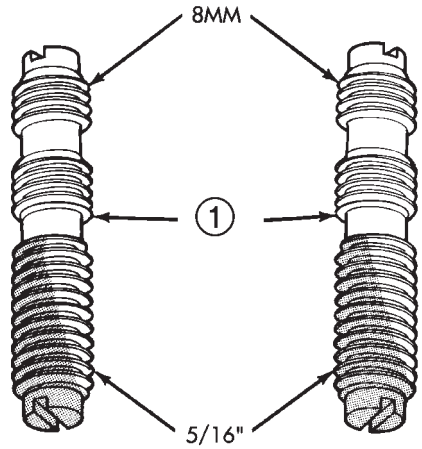


Fig. 21 Special Studs 6715 for V-10 Engine

1 - SPECIAL TOOL 6715

(3) Compress valve springs using Valve Spring Compressor Tool MD-998772A with Adapter 6716A and Screw 6765 (Fig. 22). Tap the retainer using a brass drift and ball peen hammer to loosen locks away from retainer.

INTAKE/EXHAUST VALVES & SEATS (Continued)

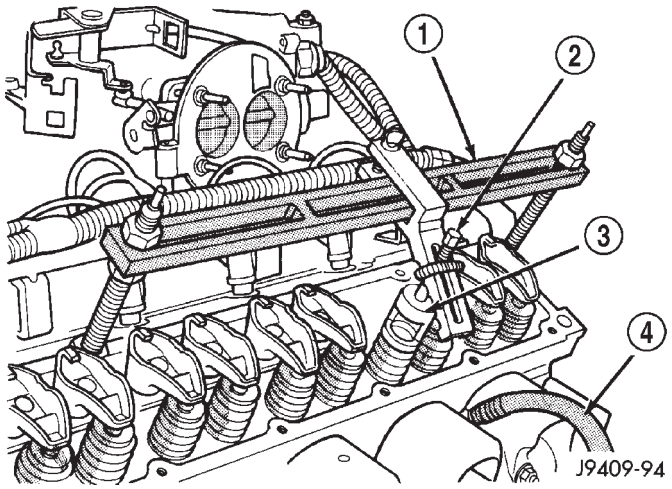


Fig. 22 Valve Spring Compressor MD-998772A with Adaptor 6716-A and Screw 6765

1 - SPECIAL TOOL MD 998772A
2 - SPECIAL TOOL 6765
3 - SPECIAL TOOL 6716A
4 - AIR HOSE

(4) Remove valve retaining locks, valve spring retainers and valve springs. Check for abnormal wear, replace as required.

(5) Remove the valve stem seals.

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

CLEANING

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

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

INSPECTION

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

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 23). The special sleeve places the valve at the correct height for checking with a dial indicator.

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 24).

(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.

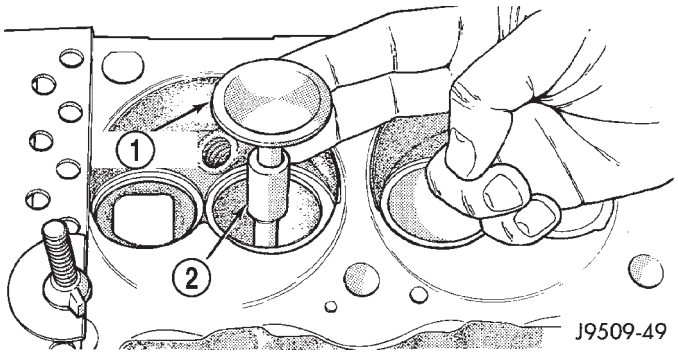


Fig. 23 Positioning Valve with Tool C-3973

1 - VALVE
2 - SPACER TOOL

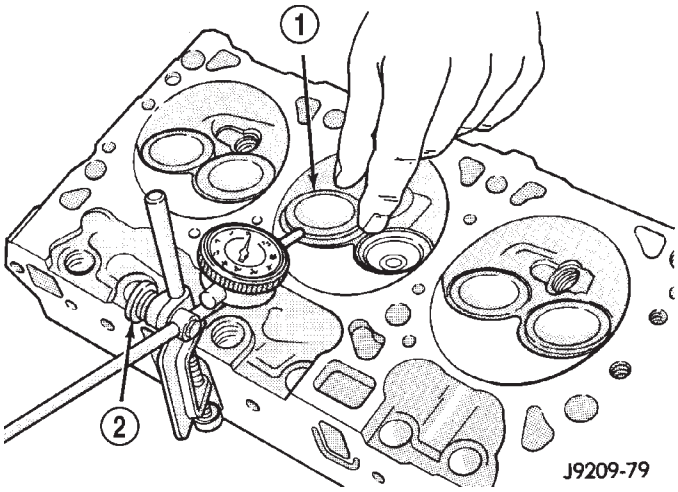


Fig. 24 Measuring Valve Guide Wear

1 - VALVE
2 - SPECIAL TOOL C-3339

INSTALLATION

INSTALLATION—VALVE STEM SEAL

(1) Install new seal onto valve stem.

(2) Position valve spring onto valve stem.

(3) Position Valve Spring Compressor with Adapter Studs onto cylinder head

(4) Compress valve spring and install retainer valve locks.

(5) Remove air hose and adapter from spark plug hole.

(6) Remove Valve Spring Compressor and Adapter Studs.

(7) Install rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

(8) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of**

engine with the number up. For the right side the number tab is at the rear of engine with the number up.

CAUTION: The cylinder head cover fasteners have a special plating. DO NOT use alternative fasteners.

(9) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION) (Fig. 25).

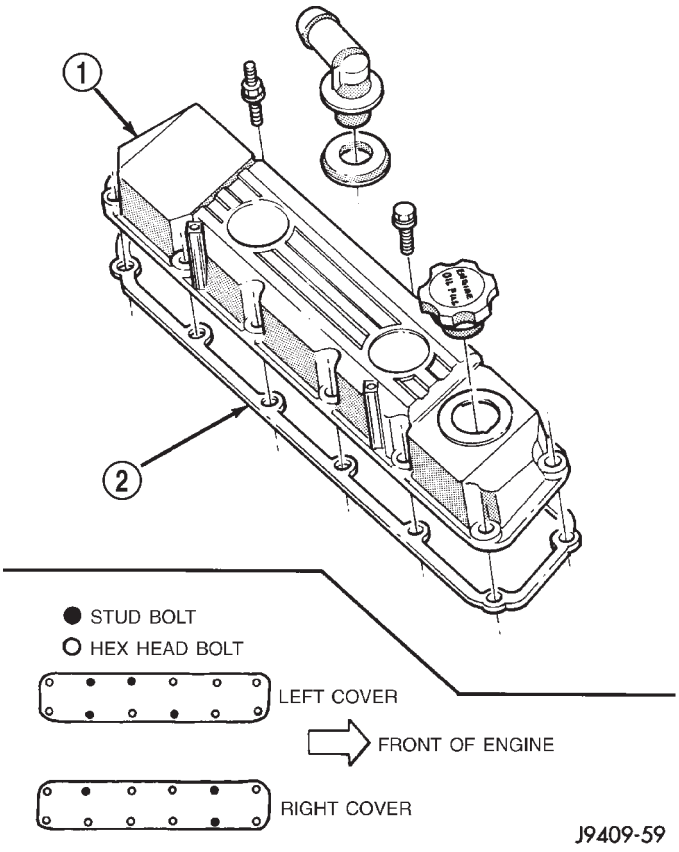


Fig. 25 Cylinder Head Covers

1 - CYLINDER HEAD COVER
2 - CYLINDER HEAD COVER GASKET

(10) Install closed crankcase ventilation system.
(11) Connect the evaporation control system.
(12) Install air cleaner.
(13) Connect the negative cable to the battery.
(14) Road test vehicle and check for leaks.

INSTALLATION—VALVES AND VALVE SPRINGS

(1) Clean valves thoroughly. Discard burned, warped and cracked valves.
(2) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
(3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.
(4) Make sure there are no burrs on valve stems.
(5) Coat valve stems with lubrication oil. Insert valves into valve guides in cylinder head.
(6) Install new seals on all valve guides **(BLACK on intake and BROWN on exhaust)**. Install valve springs and valve retainers.
(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. Tap the retainer with a brass or heavy plastic hammer to ensure locks have been seated.
(8) If valves and/or seats were ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. Ensure this brings spring height back to normal, 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).
(9) Install the cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

ROCKER ARM / ADJUSTER ASSY

REMOVAL

(1) Disconnect spark plug wires by pulling the boot straight out in line with plug.
(2) Remove cylinder head cover and gasket (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
(3) Remove the rocker arm bolts and the rocker arm assembly (Fig. 26). Place rocker arm assemblies on a bench in the same order as removed.
(4) Remove the push rods and place them on a bench in the same order as removed.

INSTALLATION

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

(1) Install the push rods in the same order as removed.
(2) Install rocker arm assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.
(3) Install cylinder head cover and gasket (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).
(4) Connect spark plug wires.

ROCKER ARM / ADJUSTER ASSY (Continued)

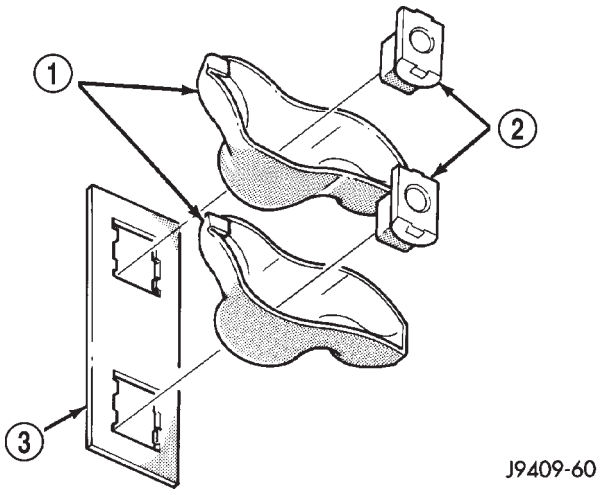


Fig. 26 Rocker Arm

1 - ROCKER ARMS
2 - ROCKER ARM PEDESTALS
3 - RETAINER

ENGINE BLOCK

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool, Special tool 6879 or equivalent. The cylinder block should be bored and honed with new pistons and rings fitted if:

- The cylinder bores show more than 0.127 mm (0.005 inch) out-of-round.
- The cylinder bores show a taper of more than 0.254 mm (0.010 inch).
- The cylinder walls are badly scuffed or scored.

Boring and honing operation should be closely coordinated with the fitting of pistons and rings so specified clearances may be maintained.

CAMSHAFT & BEARINGS (IN BLOCK)

REMOVAL

REMOVAL—CAMSHAFT BEARINGS

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

(1) With engine completely disassembled, drive out rear cam bearing core hole plug.

NOTE: It is not advisable to attempt to replace camshaft bearings unless special removal and installation tools are available, such as recommended tool 8544 Camshaft Bushing Remover Installer.

(2) Using recommended tool 8544 Camshaft Bushing Remover Installer, Drive out bearing shells.

REMOVAL—CAMSHAFT

(1) Remove rocker arms and push rods (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL). Identify each part so it can be installed in its original location.

NOTE: The 4 corner tappets can not be removed without removing the cylinder heads and gaskets. However, they can be lifted and retained for camshaft removal.

(2) Remove the Bolts retaining the yoke retaining spider. Remove the yoke retaining spider, tappet aligning yokes and tappets.

(3) Remove upper and lower intake manifolds (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(4) Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL) and timing chain and sprockets (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

(5) Remove camshaft thrust plate (Fig. 27).

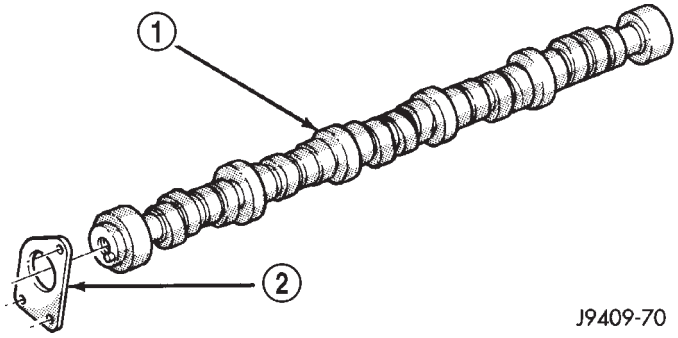


Fig. 27 Camshaft

1 - CAMSHAFT
2 - THRUST PLATE

(6) 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.

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

INSTALLATION

INSTALLATION—CAMSHAFT BEARINGS

(1) Install new camshaft bearings using recommended Tool 8544 Camshaft Bushing Remover Installer, by sliding the new camshaft bearing shell over proper adapter.

(2) 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.**

INSTALLATION—CAMSHAFT

(1) Lubricate camshaft lobes and camshaft bearing journals. Using a long bolt, insert the camshaft into the cylinder block.

NOTE: Whenever an engine has been rebuilt, a new camshaft and/or new tappets installed, add 1 pint of Mopar® Crankcase Conditioner, or equivalent. The oil mixture should be left in engine for a minimum of 805 km (500 miles). Drain at the next normal oil change.

(2) Install camshaft thrust plate. Tighten the torx bolts to 22 N·m (16 ft. lbs.) torque.

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

(4) Line up key with keyway in sprocket, then using Special Tools C-3688, C-3718 and MB990799 install crankshaft timing sprocket. Make sure the sprocket seats against the crankshaft shoulder (Fig. 28).

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

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

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

(8) Prime oil pump by squirting oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(9) 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.**

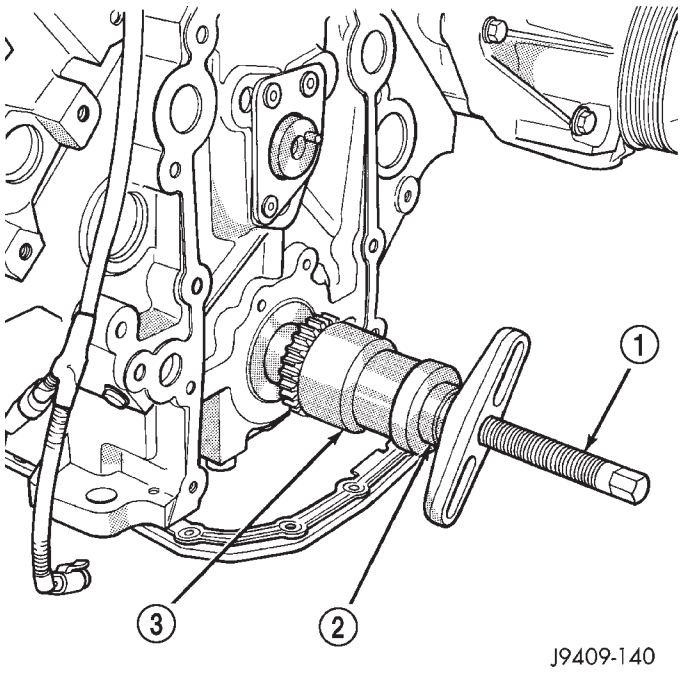


Fig. 28 Crankshaft Sprocket Installation

1 - SPECIAL TOOL C-3688
2 - SPECIAL TOOL C-3718
3 - SPECIAL TOOL MD990799

(10) Install tappets and push rods in their original location.

(11) Position the tappet aligning yokes and yoke retaing spider.

(12) Install the retaining spider mounting bolts. Tighten bolts to 22 N·m (16 ft. lbs.).

(13) Install the rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

(14) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

CAUTION: The cylinder head cover fasteners have a special plating. DO NOT use alternative fasteners.

(15) Install cylinder head cover (Fig. 29) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(16) Install the intake manifolds (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(17) Start engine and check for leaks.

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

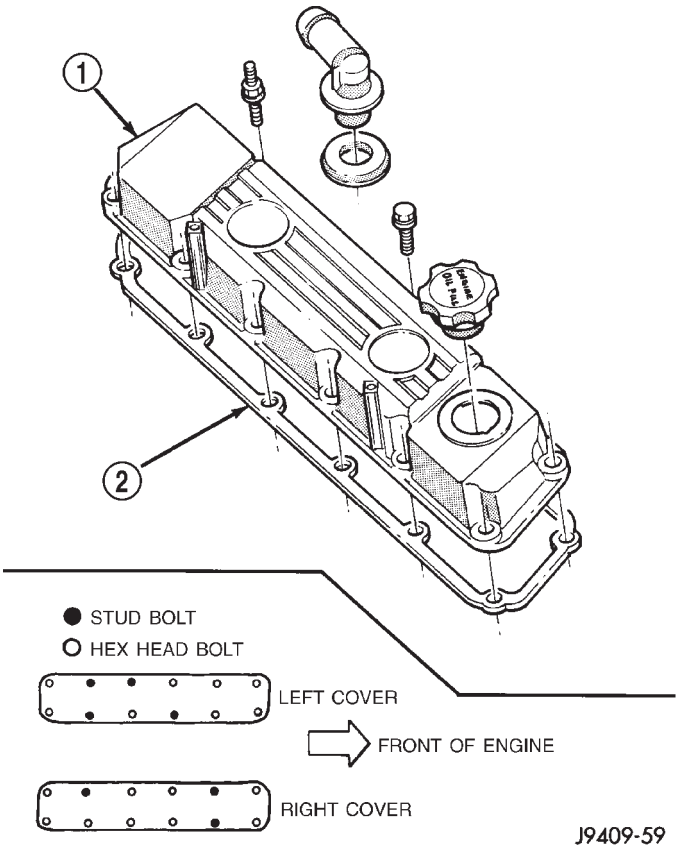


Fig. 29 Cylinder Head Cover

1 - CYLINDER HEAD COVER
2 - CYLINDER HEAD COVER GASKET

CONNECTING ROD BEARINGS

STANDARD PROCEDURE - CONNECTING ROD BEARING 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, be certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

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

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

CRANKSHAFT

REMOVAL

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

(1) Remove the oil pan and oil pickup tube (refer to Oil Pan in this section for correct procedure).

(2) Remove the timing chain cover and gasket. Remove and discard the front crankshaft oil seal and cover gasket.

(3) Remove Transmission (refer to Group 21, Transmission).

(4) Remove the rear seal retainer (refer to Crankshaft Rear Seal Retainer in this section for correct procedure).

(5) Identify main bearing caps before removal (Fig. 30) . Remove bearing caps and lower bearings one at a time.

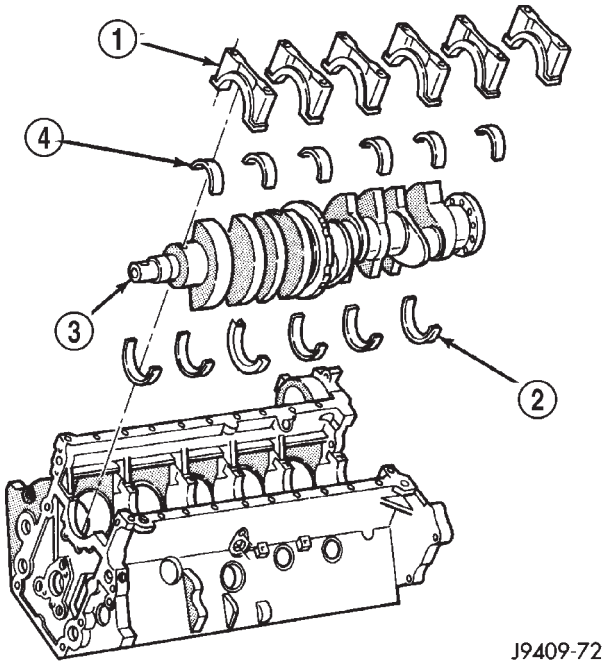


Fig. 30 Main Bearing Identification

1 - MAIN BEARING CAP
2 - UPPER MAIN BEARINGS
3 - CRANKSHAFT
4 - LOWER MAIN BEARINGS

(6) Remove the connecting rod bearing caps.

(7) Lift the crankshaft straight out of the block.

CRANKSHAFT (Continued)

(8) Remove the upper main bearings from the block.

INSTALLATION

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings. Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

NOTE: Lubricate crankshaft main bearings with clean engine oil.

(1) Position upper main bearings into block.
(2) Position the crankshaft into the cylinder block.
(3) Lubricate the main journals with clean engine oil. Install upper main bearings, caps and bolts. Follow the 2 step tightening sequence, starting with main bearing cap 1.
(4) Lubricate the connecting rod bearings and journals with clean engine oil. Carefully install connecting rods to the crankshaft.
(5) Using Special Tool 8359 Seal Installer install new oil into oil seal retainer.
(6) Using Special Tool 6687 Guide, install the rear seal retainer with a new gasket.
(7) Install the timing chain cover with a new gasket and oil seal.
(8) Prime oil pump by squirt oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.
(9) Apply a rearward axial load of 667 N (150 lbs-f) on crankshaft centerline, driving No.3 main cap and thrust bearing against No.3 bulkhead. Repeat procedure, driving crankshaft forward to align rear flange of thrust bearings in a common plane. Front face of No.1 main cap must not extend forward in front of face of No.1 bulkhead.
(10) Install the oil pickup tube. Tighten the bolts to 16 N·m (144 in. lbs.) torque.
(11) Install the oil pan.

CRANKSHAFT MAIN BEARINGS

STANDARD PROCEDURE—FITTING CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. All lower main bearing halves are interchangeable. Upper main bearing halves of No. 2, 4, and 5 are interchangeable. Upper main bearing halves of No. 1 and 6 are interchangeable, this also applies to the lower bearing halves.

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

REMOVAL

(1) Remove the oil pan and oil pump pick-up tube (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
(2) Identify bearing caps before removal. Remove bearing caps one at a time.
(3) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 31).
(4) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

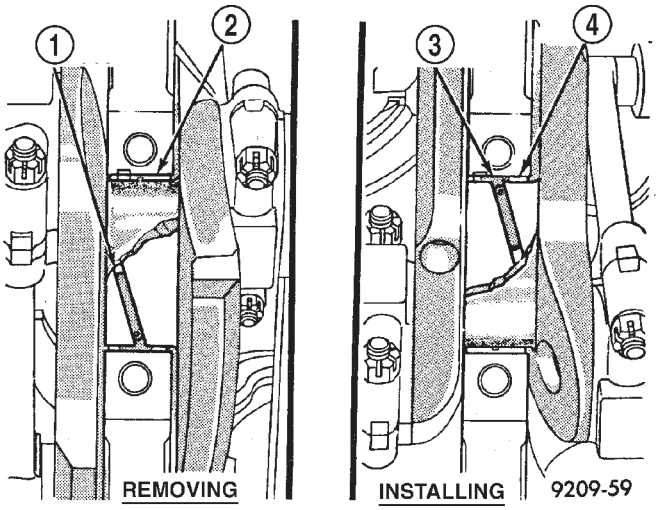


Fig. 31 Upper Main Bearing Removal and Installation with Tool C-3059

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.

CRANKSHAFT MAIN BEARINGS (Continued)

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 31).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Lubricate the main journals with clean engine oil. Install main bearing caps and bolts. Follow the 2 step tightening sequence, starting with No. 1 main bearing cap.

(4) Apply a rearward axial load of 667 N (150 lbs-f) on crankshaft centerline, driving No.3 main cap and thrust bearing against No.3 bulkhead. Repeat procedure, driving crankshaft forward to align rear flange of thrust bearings in a common plane. Front face of No.1 main cap must not extend forward in front of face of No.1 bulkhead.

(5) Install the oil pump pick-up tube and oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

CRANKSHAFT OIL SEAL - FRONT

REMOVAL

REMOVAL—FRONT OIL SEAL - FRONT COVER INSTALLED

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper from the crankshaft (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(3) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover (Fig. 32).

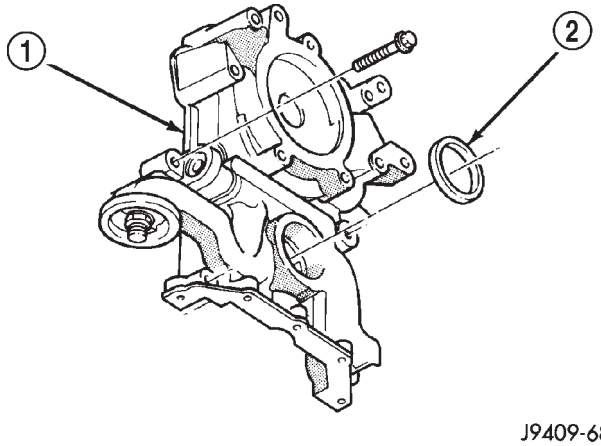


Fig. 32 Timing Chain Cover and Oil Seal

1 - TIMING CHAIN COVER
2 - OIL SEAL

REMOVAL—FRONT OIL SEAL - FRONT COVER REMOVED

(1) Remove engine front cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(2) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover.

INSTALLATION

INSTALLATION—FRONT OIL SEAL – FRONT COVER INSTALLED

(1) Position the crankshaft front oil seal onto seal installer special tool 6806 and C-3688 (Fig. 33). Install seal.

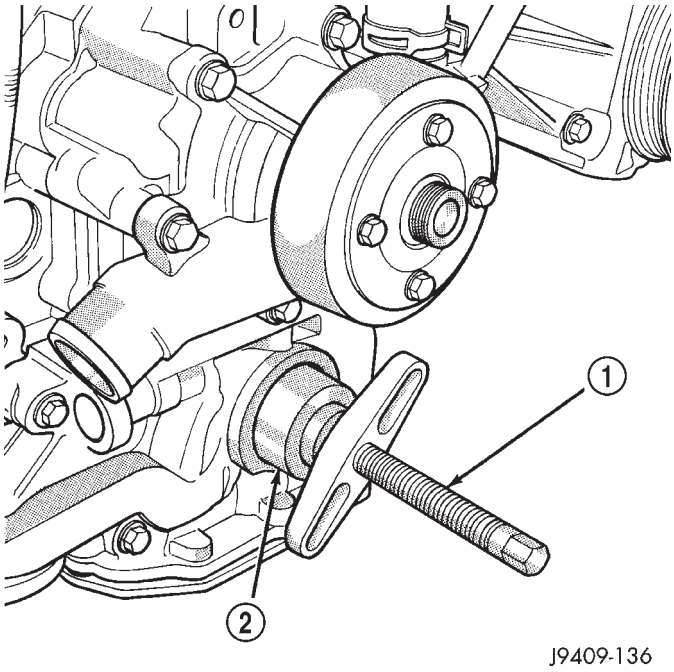


Fig. 33 Timing Chain Cover and Oil Seal

1 - SPECIAL TOOL C-3688
2 - SPECIAL TOOL 6806

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

(3) Install serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

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

(5) Connect negative cable to the battery.

(6) Start engine and check for leaks.

CRANKSHAFT OIL SEAL - FRONT (Continued)

INSTALLATION—FRONT OIL SEAL - FRONT COVER REMOVED

(1) Position the crankshaft front oil seal onto seal installer special tool 6806.

(2) Use tool 6761 to support timing chain cover when installing oil seal with tool 6806 (Fig. 34), install seal (Fig. 35).

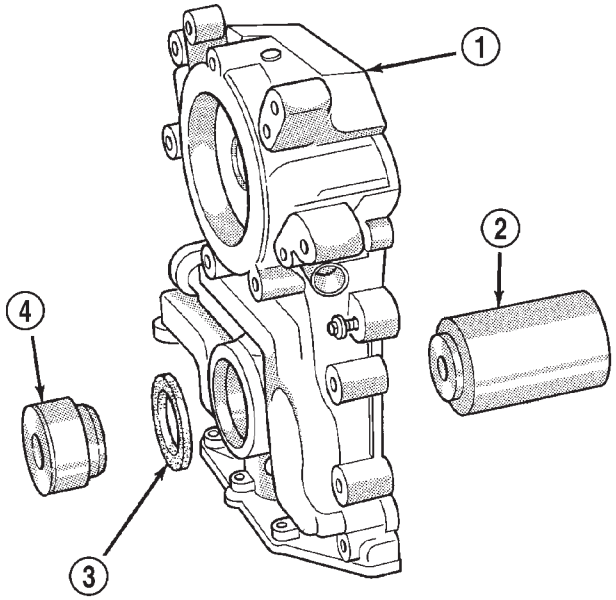


Fig. 34 Oil Seal, Tools—6806 and 6761

1 - FRONT COVER
2 - SPECIAL TOOL 6761
3 - FRONT OIL SEAL
4 - SPECIAL TOOL 6806

(3) Install engine front cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

CRANKSHAFT OIL SEAL - REAR

REMOVAL

NOTE: This procedure does not require the removal of the seal retainer from the engine block.

(1) Remove the transmission.

(2) Carefully, remove the rear seal from the retainer. Discard the oil seal.

INSTALLATION

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

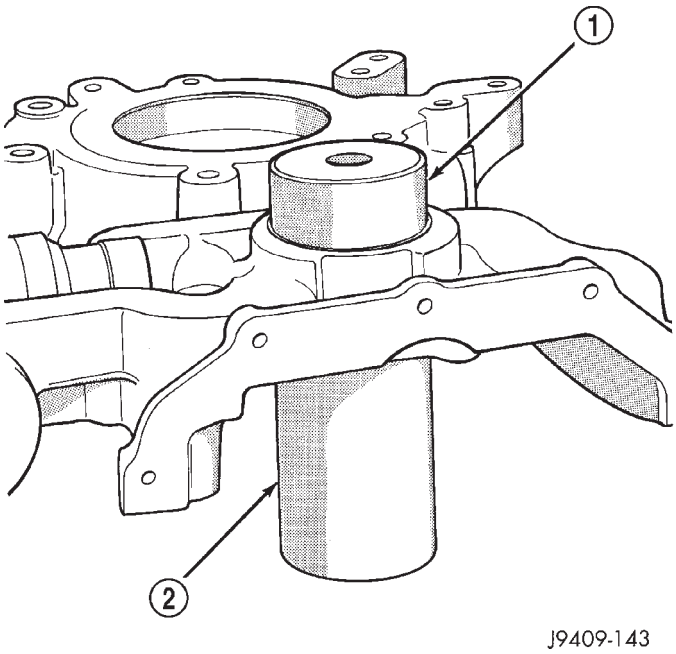


Fig. 35 Oil Seal Installed

1 - SPECIAL TOOL 6806
2 - SPECIAL TOOL 6761

(2) Position Special Tool 6687 Seal Guide, onto the crankshaft.

(3) Position the oil seal onto the Seal guide, then using Special Tool 8359 Seal Installer and C–4171 Driver Handle, Install the oil seal.

(4) The seal face surface must be countersunk into the retainer .762–1.27mm (0.030–0.050 in.).

(5) Install the transmission.

(6) Check and verify engine oil is at correct level.

(7) Start engine and check for leaks.

CRANKSHAFT REAR OIL SEAL RETAINER

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the transmission.

(3) Remove the drive plate / flywheel.

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

(5) Remove the rear oil seal retainer mounting bolts.

(6) Carefully remove the retainer from the engine block.

INSTALLATION

(1) Throughly clean all gasket resdue from the engine block.

(2) Use extream care and clean all gasket resdue from the retainer.

(3) Apply a small amount of Mopar® Silicone Rubber Adhesive Sealant to the retainer gasket. Position the gasket onto the retainer.

(4) Position Special Tool 6687 Seal Guide onto the crankshaft.

(5) Position the retainer and seal over the guide and onto the engine block.

(6) Install the retainer mounting bolts. Tighten the bolts to 22 N·m (16 ft. lbs.).

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

(8) Install the drive plate / flywheel.

(9) Install the transmission.

(10) Check and verify engine oil level.

(11) Start engine and check for leaks.

HYDRAULIC LIFTERS

DIAGNOSIS AND TESTING—HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at the pressure sending-unit. The pressure should be between 207-552 kPa (30-80 psi) at 3,000 RPM.

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

OIL LEVEL

HIGH

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

LOW

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

TAPPET NOISE DIAGNOSIS

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

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

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

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

(4) The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are making the noise. If more than one tappet seems to be noisy, it's probably not the tappets.

LEAK-DOWN TEST

After cleaning and inspection, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 36).

Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the Universal Leak-Down Tester.

(1) Place a 7.925-7.950 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(2) Lift the ram and position the tappet (with the ball bearing) inside the tester cup.

(3) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing. DO NOT tighten the hex nut on the ram.

(4) Fill the tester cup with hydraulic valve tappet test oil until the tappet is completely submerged.

HYDRAULIC LIFTERS (Continued)

(5) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air. When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

(6) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(7) Slowly swing the weighted arm onto the push rod.

(8) Rotate the cup by turning the handle at the base of the tester clockwise one revolution every 2 seconds.

(9) Observe the leak-down time interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark. A normally functioning tappet will require 20-110 seconds to leak-down. Discard tappets with leak-down time interval not within this specification.

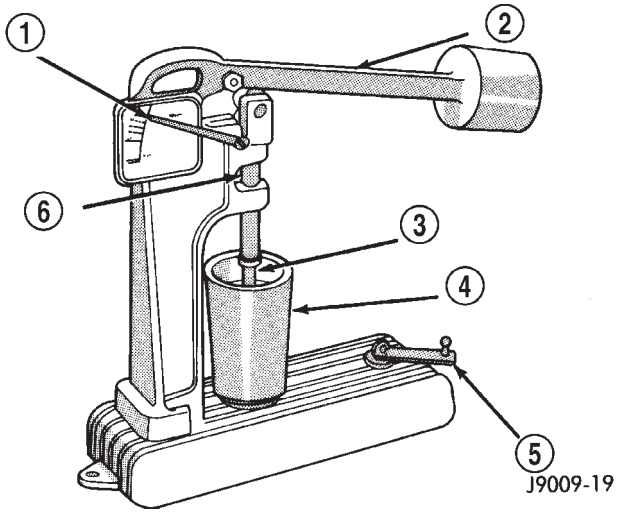


Fig. 36 Leak-Down Tester

1 - POINTER
2 - WEIGHTED ARM
3 - RAM
4 - CUP
5 - HANDLE
6 - PUSH ROD

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove the air cleaner.

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

(4) Remove rocker arm assembly and push rods (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL). Identify push rods to ensure installation in original location.

(5) Remove upper and lower intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(6) Cut the cylinder head gasket for accessibility if the end tappets are to be removed.

(7) Remove yoke retainer spider and tappet aligning yokes (Fig. 37).

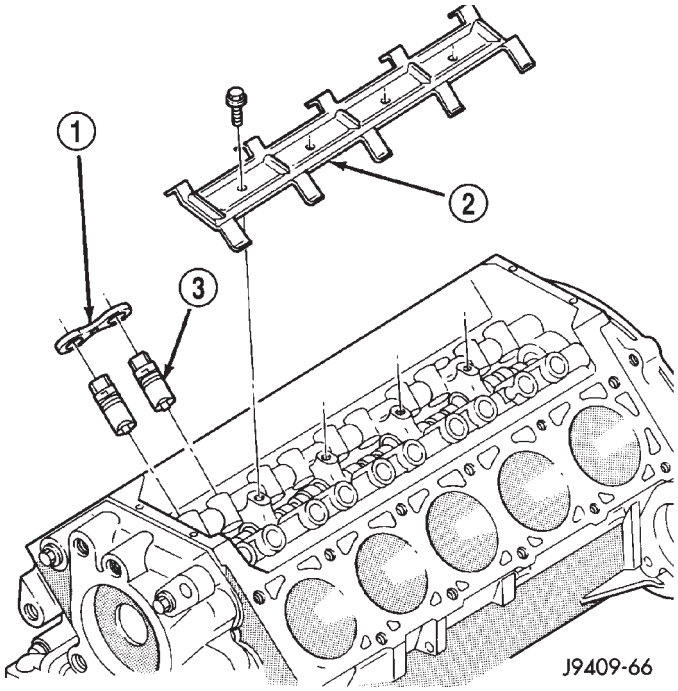


Fig. 37 Tappets, Aligning Yoke and Yoke Retaining Spider

1 - TAPPET ALIGNING YOLK
2 - YOKE RETAINING SPIDER
3 - TAPPET

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

(9) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

(10) Check camshaft lobes for abnormal wear.

CLEANING

Clean tappet with a suitable solvent. Rinse in hot water and blow dry with a clean shop rag or compressed air.

INSTALLATION

(1) Lubricate tappets.

(2) Install tappets in their original positions. **Ensure that the oil bleed hole (if so equipped) faces forward.**

(3) Install tappet aligning yokes. Position the yoke retainer spider over the tappet aligning yokes (Fig.

HYDRAULIC LIFTERS (Continued)

37). Install the yoke retaining spider bolts and tighten to 22 N·m (16 ft. lbs.) torque.

(4) Install the push rods in their original location.

(5) Install the rocker arms (Refer to 9 - ENGINE/ CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

(6) Install lower and upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(7) The cylinder head cover gasket can be used again. Install the gasket onto the head rail. **For the left side the number tab is at the front of engine with the number up. For the right side the number tab is at the rear of engine with the number up.**

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

(9) Install the air cleaner.

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

(10) Connect the negative cable to the battery.

(11) Road test vehicle and check for leaks.

PISTON & CONNECTING ROD

DESCRIPTION

The pistons (Fig. 38) are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

The pistons have a unique dry-film lubricant coating baked onto the skirts to reduce friction. The lubricant is particularly effective during engine break-in, but with time, the material becomes embedded into cylinder bore walls and continues to reduce friction.

The pistons are LH and RH bank specific.

STANDARD PROCEDURE—PISTON 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). The max. allowable clearance is 0.0762 mm (0.003 in.).

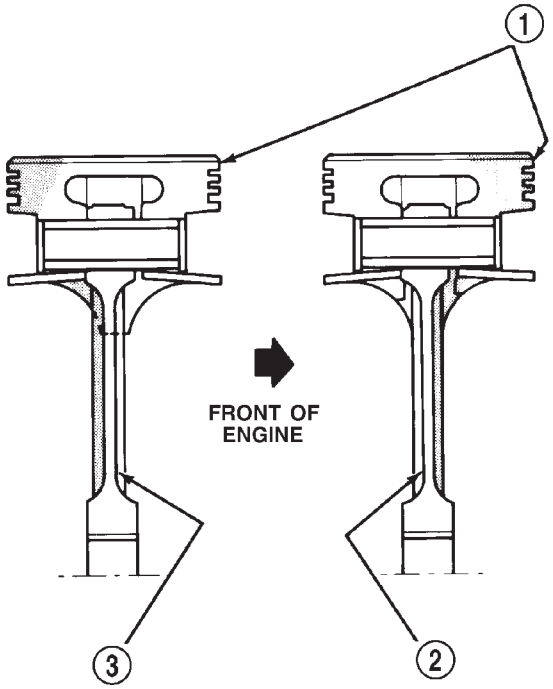


Fig. 38 Piston and Connecting Rod—8.0L Engine

1 - FRONT I.D. TOWARDS THIS SIDE
2 - ORIENTATION BUTTON TOWARDS REAR (R.H. ONLY)
2, 4, 6, 8, 10
3 - ORIENTATION BUTTON TOWARDS FRONT (L.H. ONLY)
1, 3, 5, 7, 9

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

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

(1) To correctly select the proper size piston, a cylinder bore gauge, capable of reading in .0001″ INCREMENTS is required (Fig. 39). If a bore gauge is not available, do not use an inside micrometer.The coating material is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results. Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY.** . To correctly select the proper size piston, a cylinder bore gauge capable of reading in .0001″ increments is required.Piston installation into the cylinder bore require slightly more pressure than that required for non-coated pistons. The bonded

PISTON & CONNECTING ROD (Continued)

coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

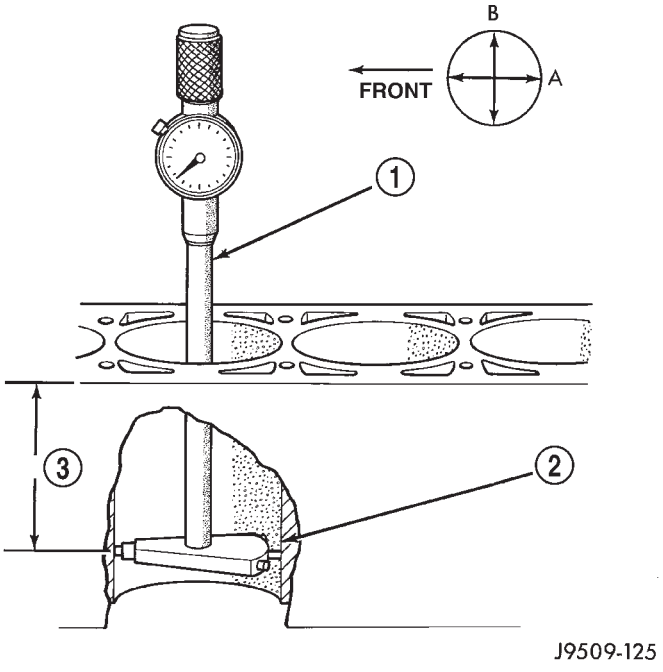


Fig. 39 Bore Gauge

1 - BORE GAUGE
2 - CYLINDER BORE
3 - 2-5/16 in.

REMOVAL

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

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

(3) Remove the oil pan and oil pump pick-up tube (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

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

(5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals. DO NOT try to remove black coating on skirt. This is the dry film lubricant.**

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

CLEANING

Clean the piston and connecting rod assembly using a suitable solvent.

INSPECTION

Check the connecting rod journal for excessive wear, taper and scoring (Refer to 9 - ENGINE/ENGINE BLOCK/CONNECTING ROD BEARINGS - STANDARD PROCEDURE).

Check the connecting rod for signs of twist or bending.

Check the piston for taper and elliptical shape before it is fitted into the cylinder bore (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - STANDARD PROCEDURE).

Check the piston for scoring, or scraping marks in the piston skirts. Check the ring lands for cracks and/or deterioration.

INSTALLATION

(1) Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

(2) Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

(3) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.

(4) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 40).

NOTE: Be sure position of rings does not change during the following step.

(5) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385).

(6) Install connecting rod bolt protectors on rod bolts, a long protector should be installed on the numbered side of the connecting rod.

(7) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore in the bottom dead center (BDC) position. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore. Be sure the piston and rod assemblies are installed in the proper orientation (Fig. 41).

(8) The notch, groove or arrow 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.

(9) While tapping the piston down in cylinder bore with the handle of a hammer, guide the connecting rod over the crankshaft journal.

PISTON & CONNECTING ROD (Continued)

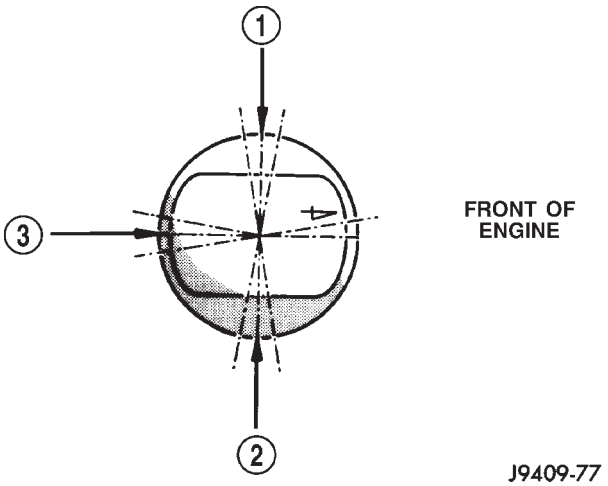


Fig. 40 Proper Ring Installation

1 - TOP COMPRESSION RING GAP
UPPER OIL RING GAP
2 - 2ND COMPRESSION RING GAP
LOWER OIL RAIL GAP
3 - SPACER GAP

(10) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(11) Install the oil pump pick-up tube and oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

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

(13) Install intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(14) Install the engine into the vehicle (Refer to 9 - ENGINE - INSTALLATION).

PISTON RINGS

STANDARD PROCEDURE—FITTING PISTON RINGS

(1) Measurement of end gaps:

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

(b) Insert feeler stock in the gap. Gap for compression rings should be between 0.254-0.508 mm (0.010-0.020 inch). The oil ring gap should be 0.381- 1.397 mm (0.015-0.055 inch).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Ends should be stoned smooth after filing with Arkansas White Stone. Rings with excess gaps should not be used.

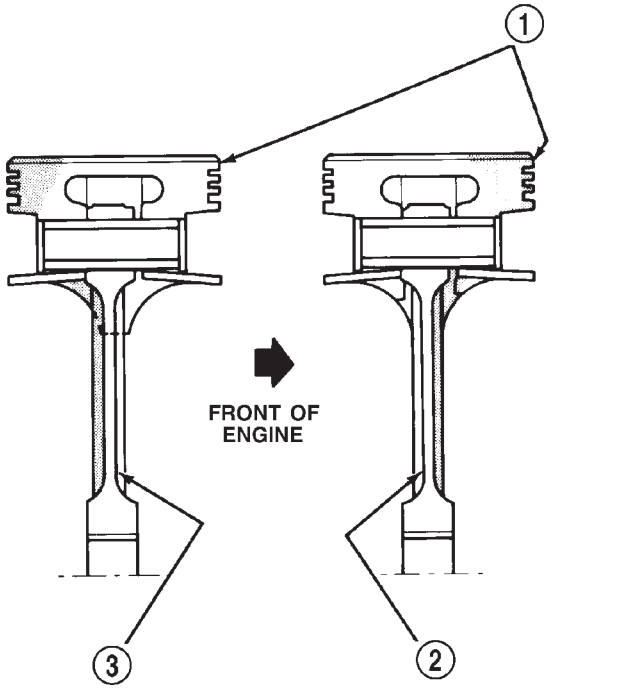


Fig. 41 Piston and Rod Orientation

1 - FRONT I.D. TOWARDS THIS SIDE
2 - ORIENTATION BUTTON TOWARDS REAR (R.H. ONLY)
2, 4, 6, 8, 10
3 - ORIENTATION BUTTON TOWARDS FRONT (L.H. ONLY)
1, 3, 5, 7, 9

(2) Install rings and confirm ring side clearance:

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

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter O, an oval depression or the word TOP (Fig. 42) (Fig. 44).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 44). An identification mark on the ring is a drill point,

PISTON RINGS (Continued)

a stamped letter O, an oval depression or the word TOP facing up (Fig. 43).

(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.

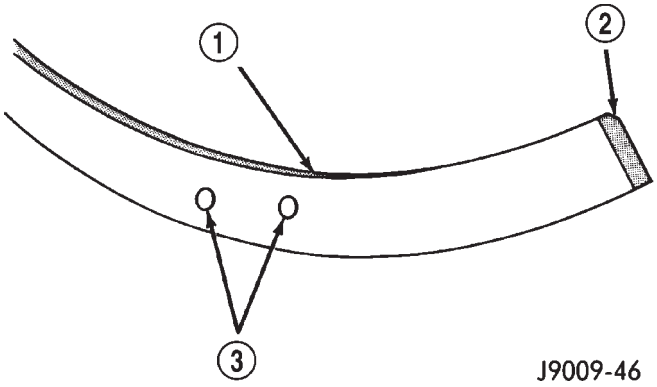


Fig. 42 Second Compression Ring Identification—Typical

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

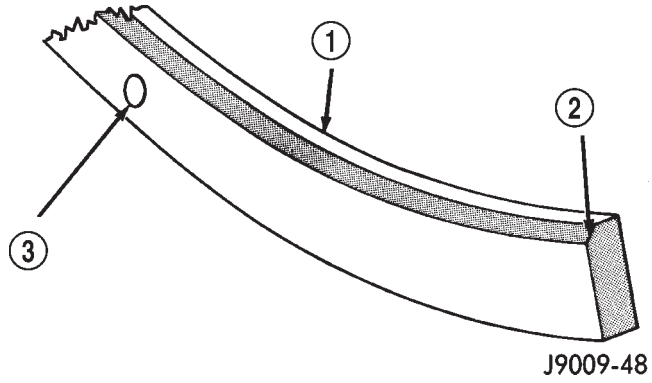


Fig. 43 Top Compression Ring Identification—Typical

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

(3) Arrange ring gaps 180° apart as shown in (Fig. 45).

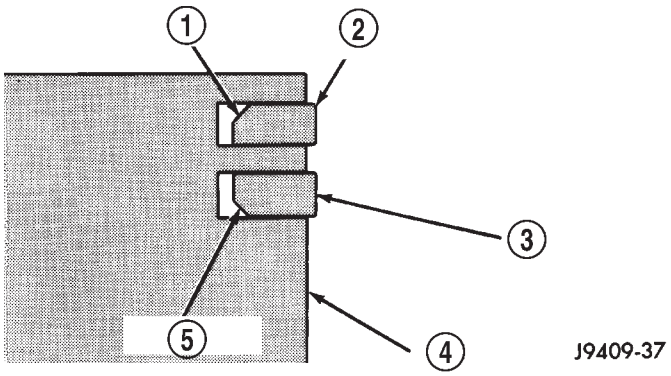


Fig. 44 Compression Ring Chamfer Location—Typical

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

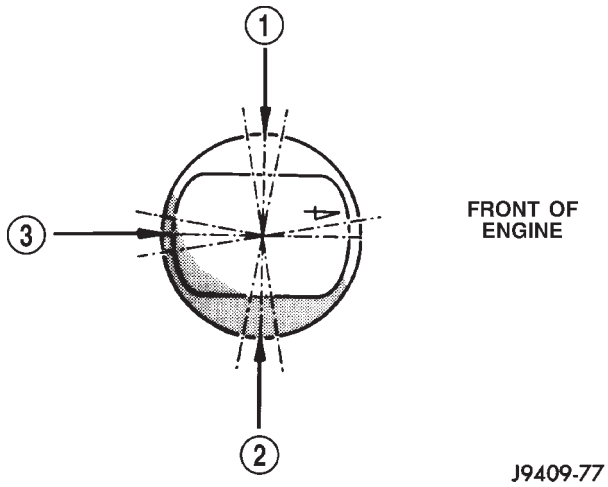


Fig. 45 Proper Ring Installation

1 - TOP COMPRESSION RING GAP
UPPER OIL RING GAP
2 - 2ND COMPRESSION RING GAP
LOWER OIL RAIL GAP
3 - SPACER GAP

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove the following:

- Radiator fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL)
- Accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL)
- Radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL)

(3) Remove crankshaft pulley/damper bolt and washer from end of crankshaft.

VIBRATION DAMPER (Continued)

(4) Using Special Tool, 1026 3 Jaw Puller and Special Tool 8513 Insert, remove pulley—damper from the crankshaft (Fig. 46).

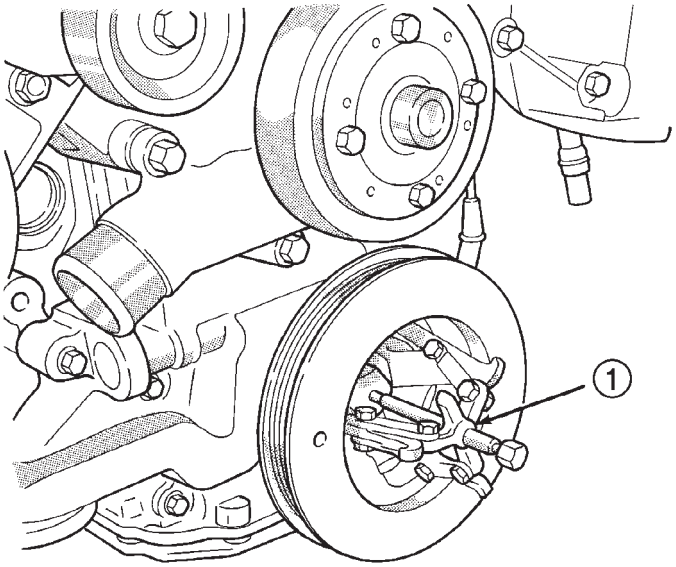


Fig. 46 Crankshaft Pulley—Damper Removal

1 - 3 JAW PULLER

(5) Inspect crankshaft oil seal. If damaged or worn, replace the front oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - REMOVAL).

INSTALLATION

(1) Position the crankshaft pulley/damper onto the crankshaft.

(2) Use Special Tool, C-3688 Crankshaft Pulley/Damper Installer to press the pulley—damper onto the crankshaft. Install crankshaft bolt and washer and tighten to 312 N·m (230 ft. lbs.) torque (Fig. 47).

(3) Install the following:

- Radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION)
- Accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION)
- Radiator fan (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION)

(4) Connect the negative cable to the battery.

FRONT MOUNT

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Position fan to assure clearance for radiator top tank and hose.

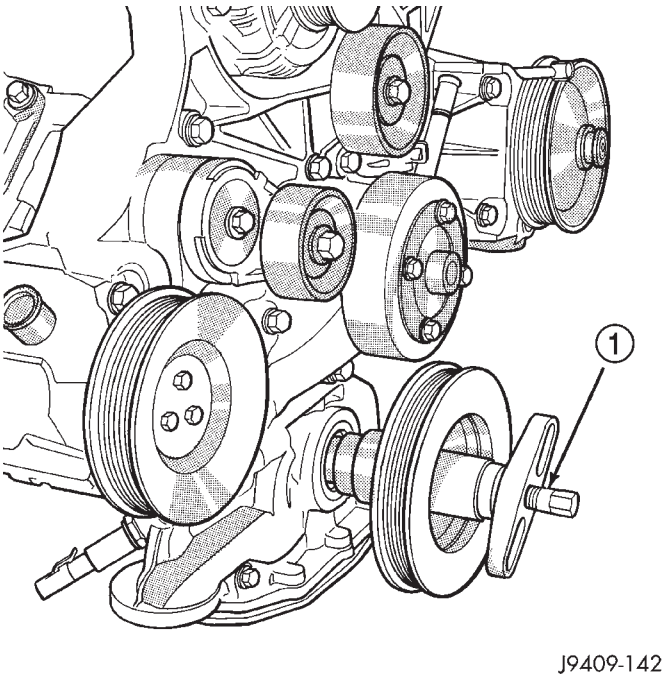


Fig. 47 Installing Crankshaft Pulley—Damper

1 - SPECIAL TOOL C-3688

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

(3) Install engine support/lifting fixture.

(4) Raise vehicle on hoist.

(5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 48) .

(6) Remove engine support bracket/cushion bolts (Fig. 48) . Remove the support bracket/cushion and heat shields.

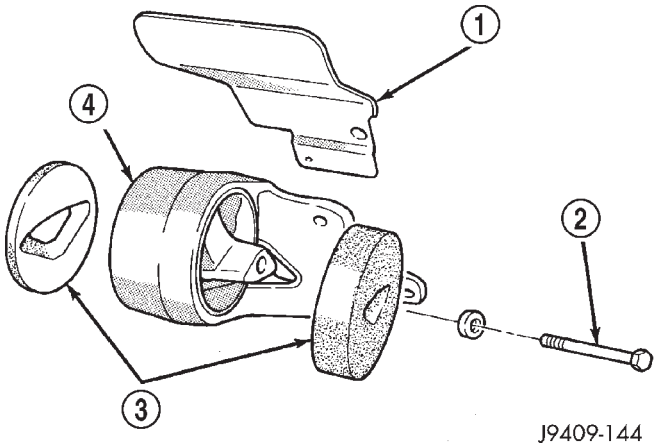


Fig. 48 Engine Front Mounts

1 - ENGINE MOUNT HEAT SHIELD
2 - THRU-BOLT
3 - RESTRICTION PADS
4 - ENGINE SUPPORT BRACKET/CUSHION

FRONT MOUNT (Continued)

INSTALLATION

(1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.

(2) Install the thru-bolt and 2 piece rubber engine rubber restrictors onto the engine support bracket/ cushion.

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 49) .

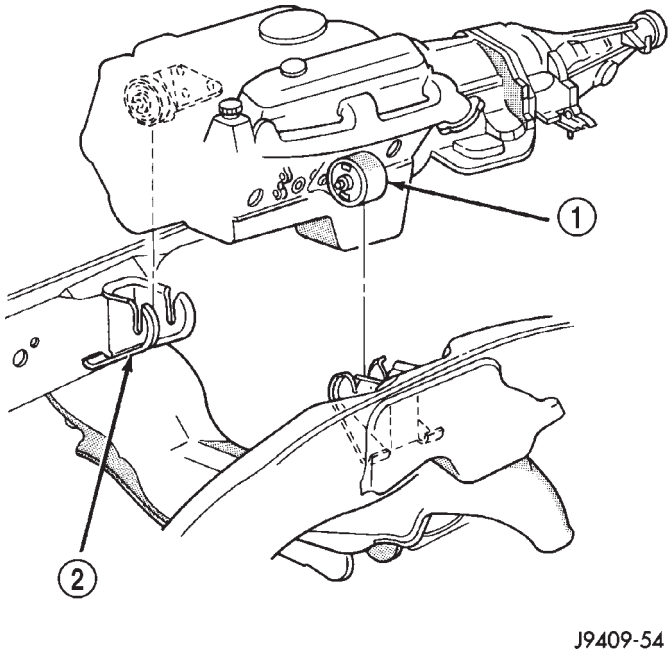


Fig. 49 Positioning Engine Mounts—Front

1 - ENGINE SUPPORT BRACKET/CUSHION
2 - SUPPORT CUSHION BRACKET

(4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

REAR MOUNT

REMOVAL

(1) Raise the vehicle on a hoist.

(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 50).

(4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 50) .

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

LUBRICATION

DESCRIPTION

A pressure feed type (gerotor) oil pump is located in the engine front cover. The pump uses a pick-up tube and screen assembly to gather engine oil from the oil pan (Fig. 51).

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 inner and outer gears of the oil pump, then forced through the outlet in the engine front cover. An oil gallery in the front cover 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 tappet galleries, which extends the entire length of block.

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, 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

LUBRICATION (Continued)

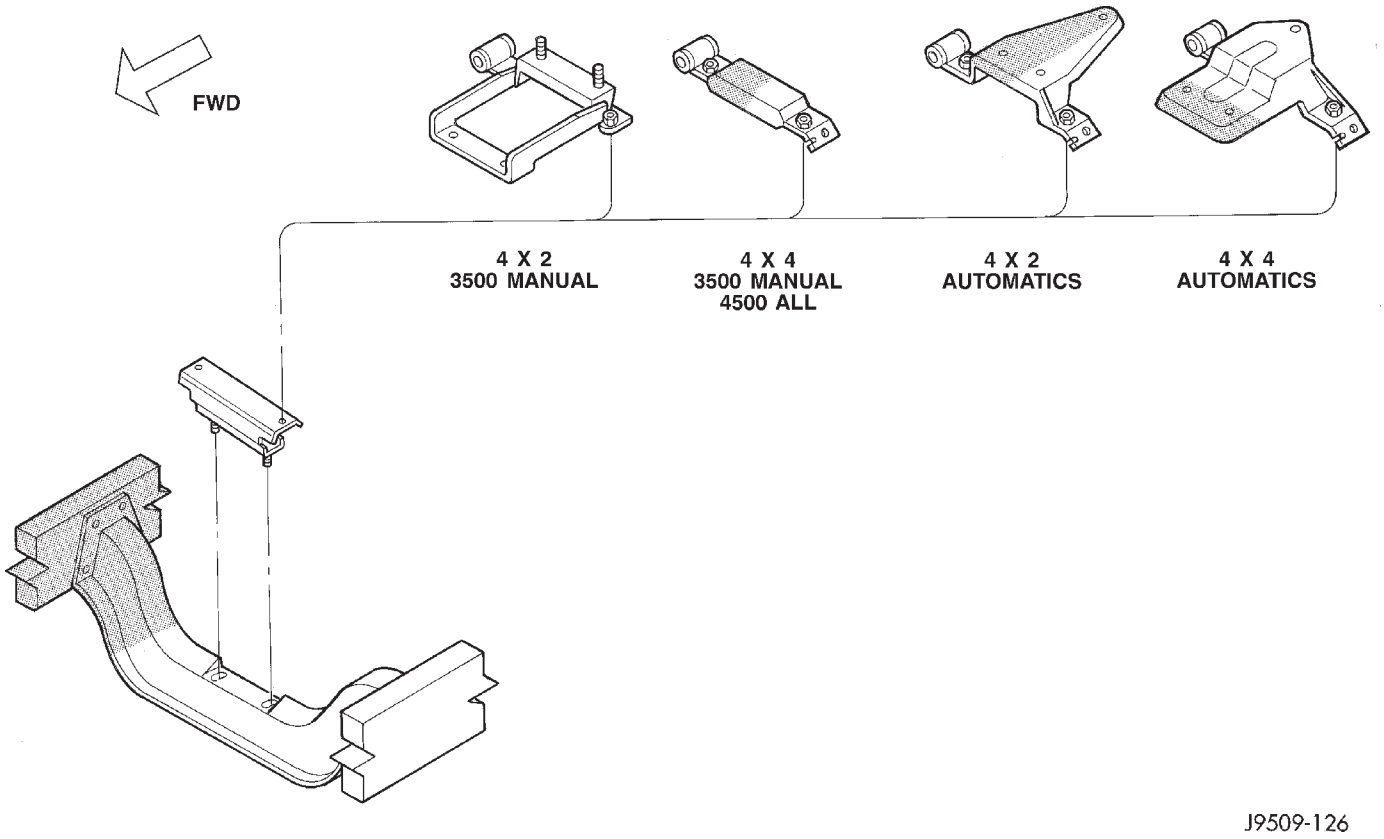


Fig. 50 Engine Rear Support Cushion Assembly

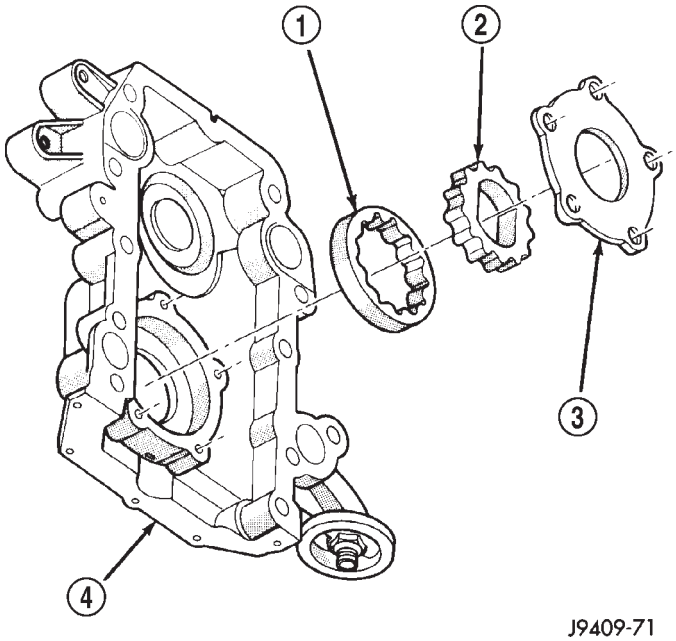


Fig. 51 Pressure Feed Type (Gerotor) Oil Pump—Typical

1 - OUTER ROTOR
2 - INNER ROTOR
3 - OIL PUMP COVER
4 - TIMING CHAIN COVER

holes and the oil drain-back passages in the cylinder head, past the valve tappet area, and then returns to the oil pan (Fig. 52).

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING—ENGINE OIL LEAKS

Begin with a through visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

(1) Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.

(2) Add an oil-soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to be sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light source.

(3) Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service manual instructions.

(4) If dye is not observed, drive the vehicle at various speeds for approximately 24km (15 miles), and repeat previous step.

LUBRICATION (Continued)

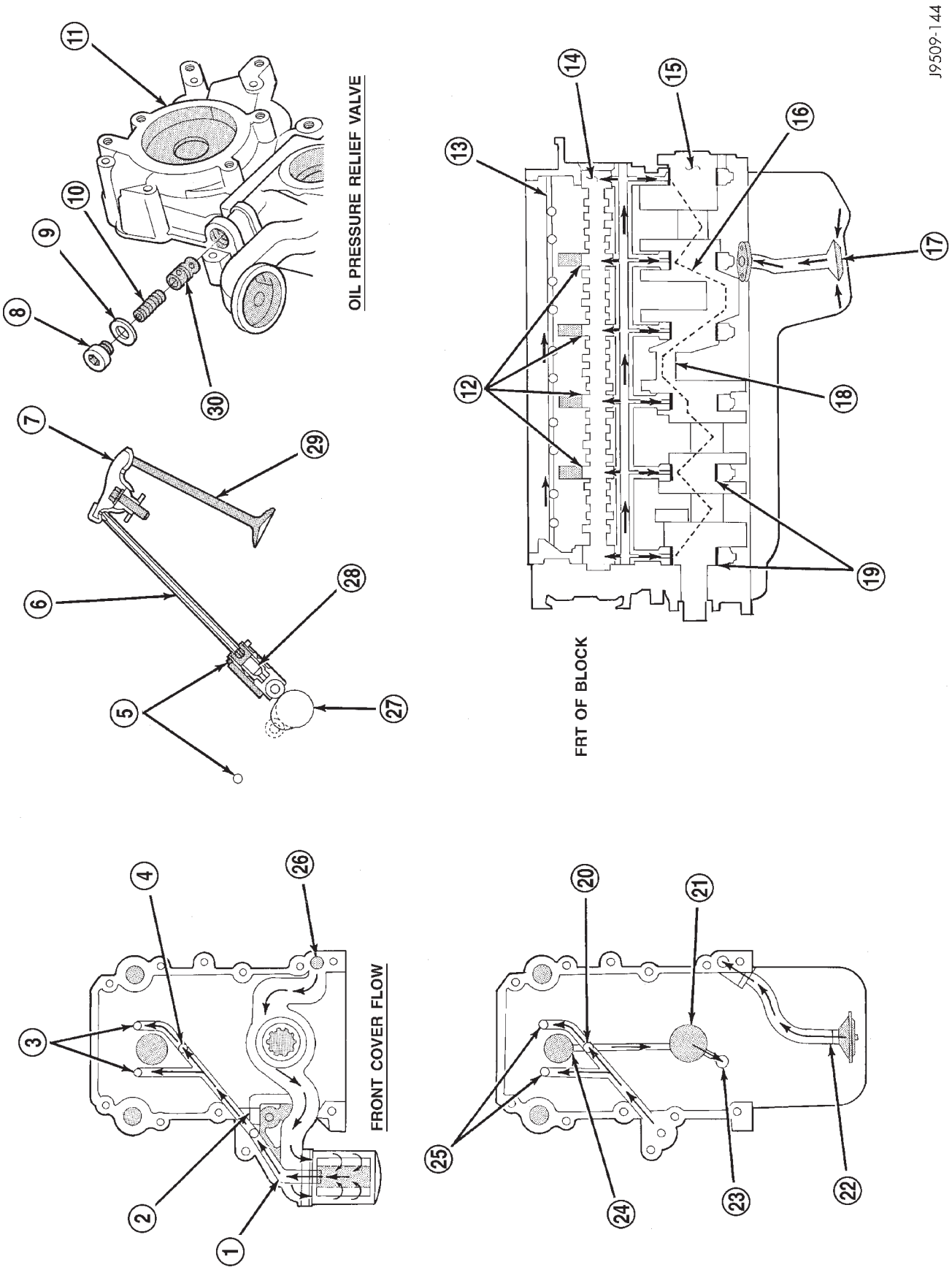


Fig. 52 Engine Lubrication System

LUBRICATION (Continued)

1 - OIL TO MAIN OIL GALLERIES
2 - RELIEF VALVE
3 - OIL GALLERY FOR TAPPETS
4 - MAIN OIL GALLERY
5 - TAPPET OIL GALLERY
6 - HOLLOW PUSH ROD
7 - ROCKER ARM
8 - PLUG
9 - GASKET
10 - SPRING
11 - TIMING CHAIN COVER
12 - CAM BEARINGS
13 - HYDRAULIC TAPPET GALLERIES
14 - CAMSHAFT
15 - CRANKSHAFT
16 - OIL PASSAGE TO CONNECTING ROD JOURNALS
17 - OIL PICKUP
18 - CONNECTING ROD JOURNALS
19 - CRANKSHAFT BEARINGS
20 - MAIN OIL GALLERY
21 - CRANKSHAFT
22 - OIL PICKUP TUBE
23 - CONNECT ROD JOURNALS
24 - CAMSHAFT BEARINGS
25 - TAPPET OIL GALLERY
26 - OIL FROM PICKUP TUBE
27 - CAMSHAFT
28 - TAPPET
29 - VALVE
30 - OIL PUMP RELIEF VALVE

(5) If the oil leak source is not positively identified at this time, proceed with the air leak detection test method as follows:

(6) Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.

(7) Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.

(8) Attach an air hose with pressure gauge and regulator to the dipstick tube.

CAUTION: Do not subject the engine assembly to more than 20.6 kpa (3 PSI) of test pressure.

(9) Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provide the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.

(10) If the leakage occurs at the rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.

(11) If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose. Proceed to next step.

(12) Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

DIAGNOSIS AND TESTING—ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit.

(2) Install Oil Pressure Line and Gauge Tool C-3292. Start engine and record pressure. (Refer to 9 - ENGINE - SPECIFICATIONS).

OIL

STANDARD PROCEDURE - ENGINE OIL

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right front of the engine, left of the generator (Fig. 53).

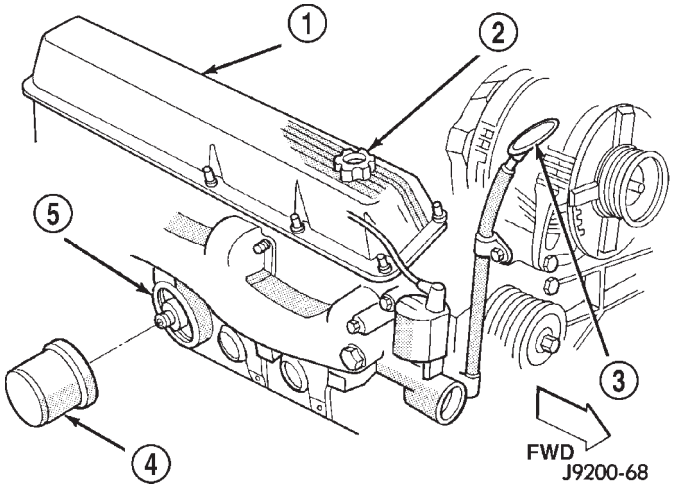


Fig. 53 Oil Level Indicator Location

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

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.

OIL (Continued)

The acceptable levels are indicated between the ADD and SAFE marks on the engine oil dipstick.

(1) Position vehicle on level surface.

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

(3) Wipe dipstick clean.

(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 the Maintenance Schedule. This information can be found in the owner's manual.

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 vehicle.

(3) Remove oil fill cap.

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

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

(6) Install drain plug in crankcase.

(7) Change oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - REMOVAL).

(8) Lower vehicle and fill crankcase with specified type (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION) and amount of engine oil (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).

(9) Install oil fill cap.

(10) Start engine and inspect for leaks.

(11) Stop engine and inspect oil level.

OIL FILTER

REMOVAL

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.

(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. 54).

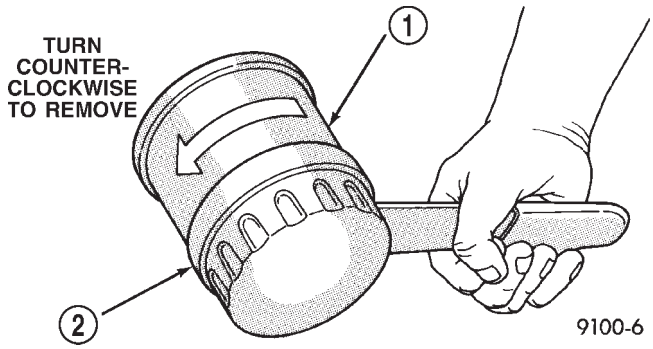


Fig. 54 Oil Filter Removal—Typical

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. 52) of oil and grime.

(6) Install new filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - INSTALLATION).

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. 55) hand tighten filter one full turn, do not over tighten.

(3) Add oil (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE).

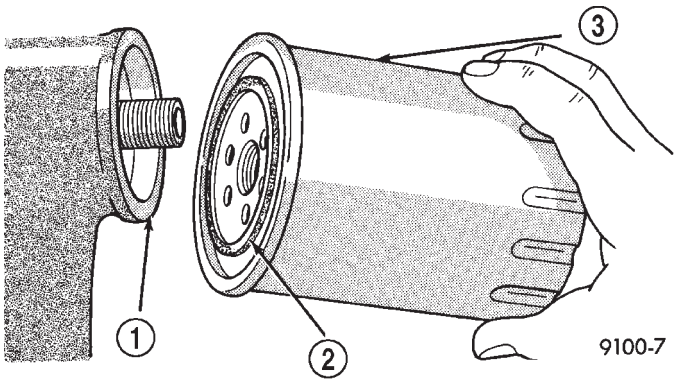


Fig. 55 Oil Filter Sealing Surface—Typical

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

OIL PAN

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise vehicle.

OIL PAN (Continued)

(3) Drain engine oil.
(4) Remove left engine to transmission strut.
(5) Remove oil pan mounting bolts, pan and one-piece gasket. The engine may have to be raised slightly on 2WD vehicles.
(6) Remove the oil pick-up tube assembly (Fig. 56) . Discard the gasket.

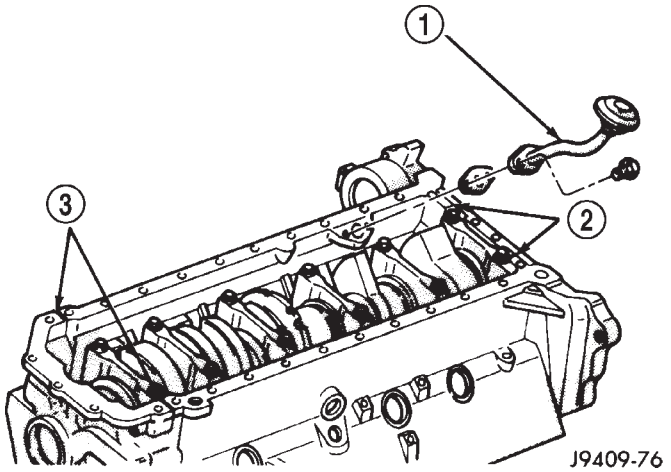


Fig. 56 Oil Pick-Up Tube

1 - PICK—UP TUBE
2 - SEALANT AT SPLIT-LINES
3 - SEALANT AT SPLIT-LINE

CLEANING

Clean the block and pan gasket surfaces.

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

INSTALLATION

(1) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 57) .

(2) Install the dowels in the cylinder block at the four corners.

(3) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent at the split lines. The split lines are between the cylinder block, the timing chain cover and the rear crankshaft seal assembly (Fig. 56) . **After the sealant is applied**

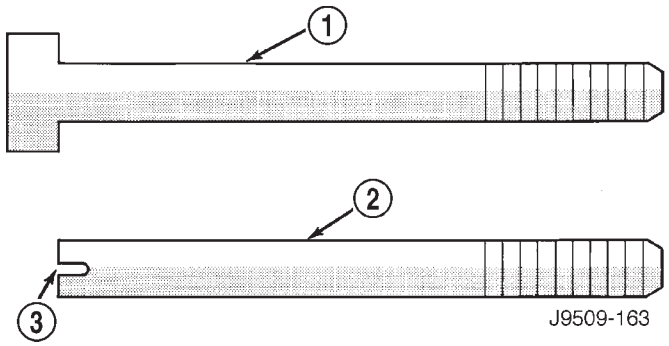


Fig. 57 Fabrication of Alignment Dowels

1 - 5/16" X 1½" BOLT
2 - DOWEL
3 - SLOT

you have 3 minutes to install the gasket and oil pan.

(4) Slide the one-piece gasket over the dowels and onto the block.

(5) Position the oil pan over the dowels and onto the gasket. The engine may have to be slightly raised on 2WD vehicles.

(6) Install the oil pan bolts (Fig. 58) . Tighten the bolts to as shown in Oil Pan Bolts Torque Chart.

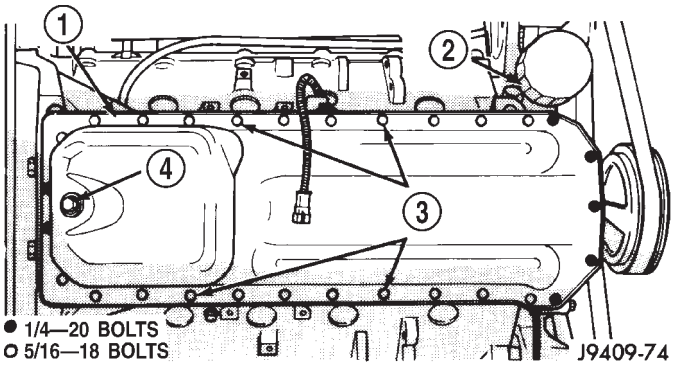


Fig. 58 Oil Pan Bolt Location

1 - OIL PAN
2 - OIL FILTER
3 - STUD BOLTS
4 - DRAIN PLUG

(7) Remove the dowels. Install the remaining 5/16 inch oil pan bolts. Torque these bolts as shown in Oil Pan Bolts Torque Chart.

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

(9) Install the engine to transmission strut.

(10) Lower vehicle.

(11) Connect the negative cable to the battery.

(12) Fill crankcase with oil to proper level.

(13) Start engine and check for leaks.

OIL PUMP

REMOVAL

(1) Remove the timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(2) Remove the relief valve plug, gasket, spring and valve (Fig. 59). Discard the gasket.

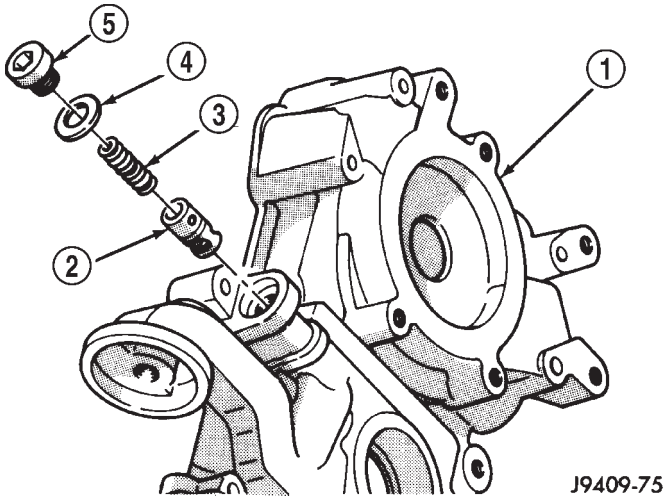


Fig. 59 Oil Pressure Relief Valve

1 - TIMING CHAIN COVER
2 - OIL PUMP RELIEF VALVE
3 - SPRING
4 - GASKET
5 - PLUG

(3) Remove mounting screws and oil pump cover (Fig. 60).

(4) Remove oil pump inner and outer rotors (Fig. 60).

(5) Inspect oil pump for wear (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSPECTION).

CLEANING

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

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump cover if scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 61) . If a 0.076 mm (0.003 inch) feeler gauge can be inserted between cover and straightedge, cover should be replaced.

Measure thickness (Fig. 62) (Fig. 63) and diameter of rotors. If either rotor thickness measures 14.956 mm (0.5876 inch) or less, or if the diameter is 82.45 mm (3.246 inches) or less, replace rotor set.

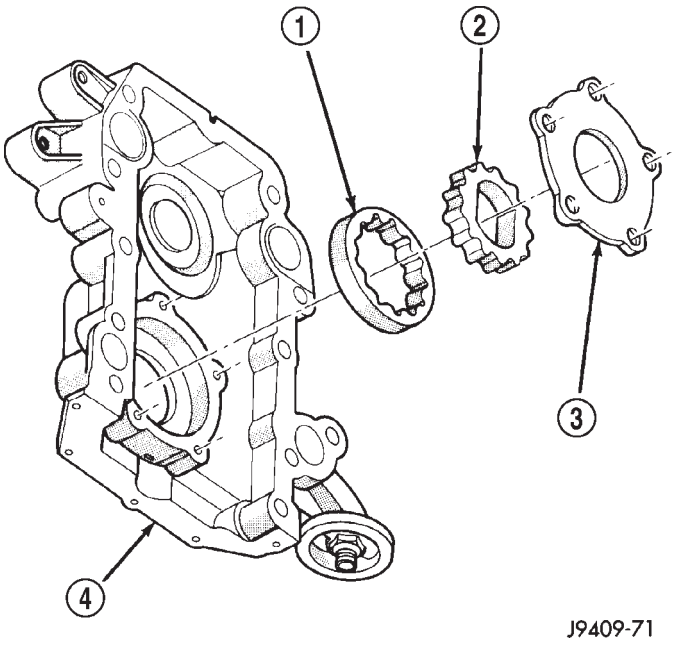


Fig. 60 Oil Pump

1 - OUTER ROTOR
2 - INNER ROTOR
3 - OIL PUMP COVER
4 - TIMING CHAIN COVER

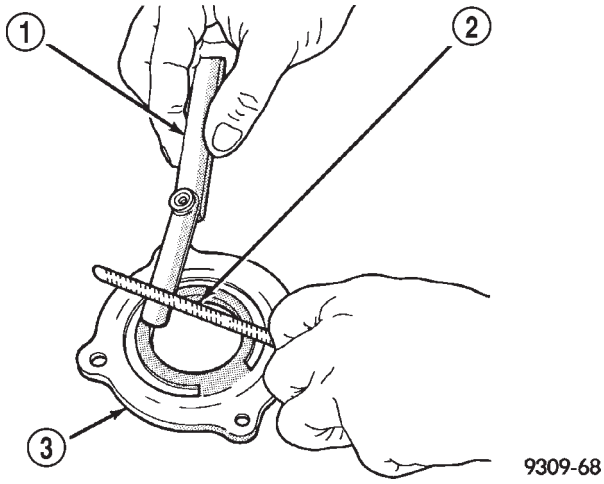


Fig. 61 Checking Oil Pump Cover Flatness

1 - FEELER GAUGE
2 - STRAIGHT EDGE
3 - OIL PUMP COVER

Slide outer rotor into timing chain cover pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 64) . If clearance is 0.19 mm (0.007 inch) or more, and outer rotor is within specifications, replace timing chain cover.

Install inner rotor into timing chain cover pump body (Fig. 65) . Inner rotor should be positioned with

OIL PUMP (Continued)

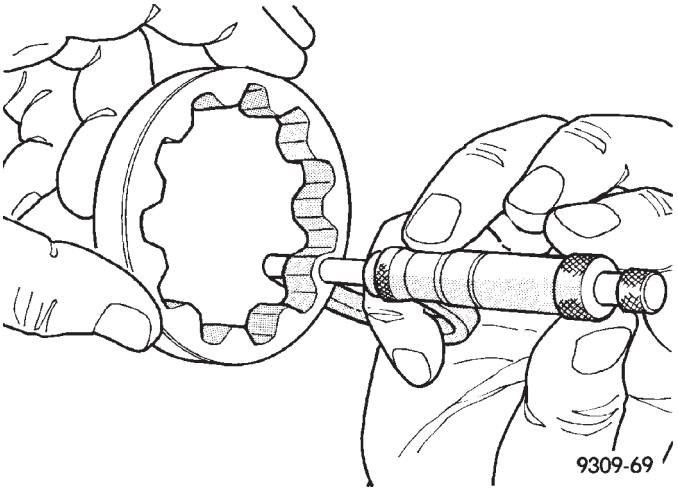


Fig. 62 Measuring Outer Rotor Thickness

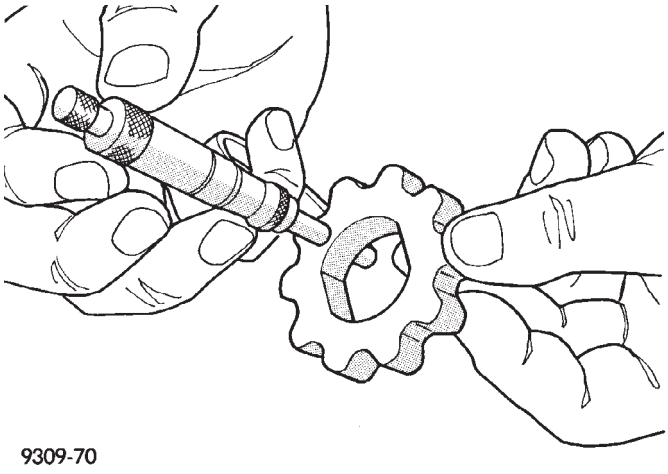


Fig. 63 Measuring Inner Rotor Thickness

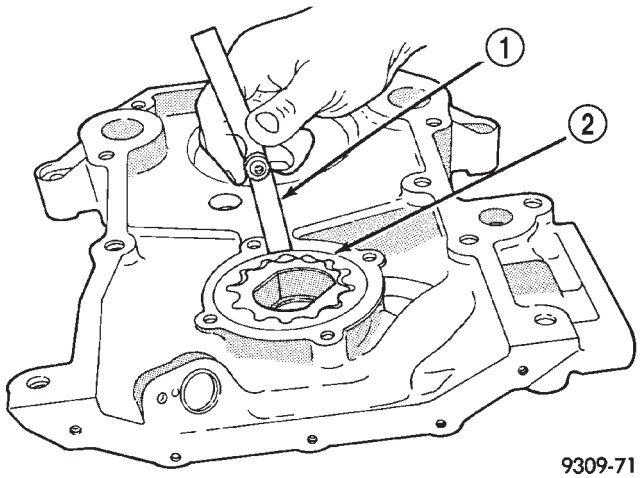


Fig. 64 Measuring Outer Rotor Clearance in Cover

1 - FEELER GAUGE
2 - OUTER ROTOR

chamfer up or toward engine when cover is installed. This allows easy installation over crankshaft. If clearance between inner and outer rotors is 0.150 mm (0.006 inch) or more, replace both rotors.

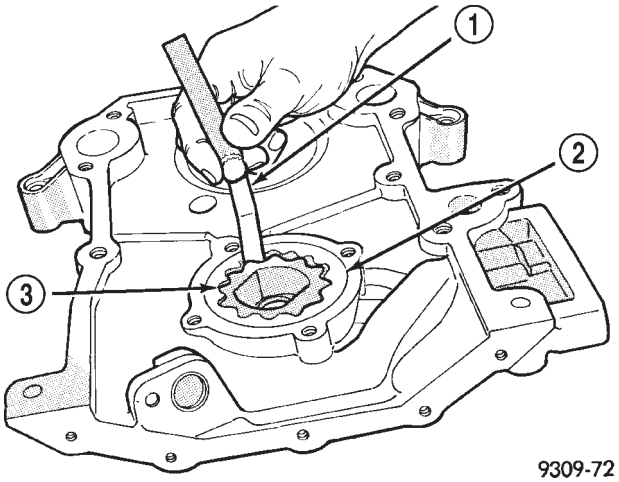


Fig. 65 Measuring Inner Rotor Clearance in Cover

1 - FEELER GAUGE
2 - OUTER ROTOR
3 - INNER ROTOR

Place a straightedge across the face of the timing chain cover pump body, between bolt holes (Fig. 66) . If a feeler gauge of 0.077 mm (0.003 inch) or more can be inserted between rotors and the straightedge, and the rotors are within specifications, replace timing chain cover.

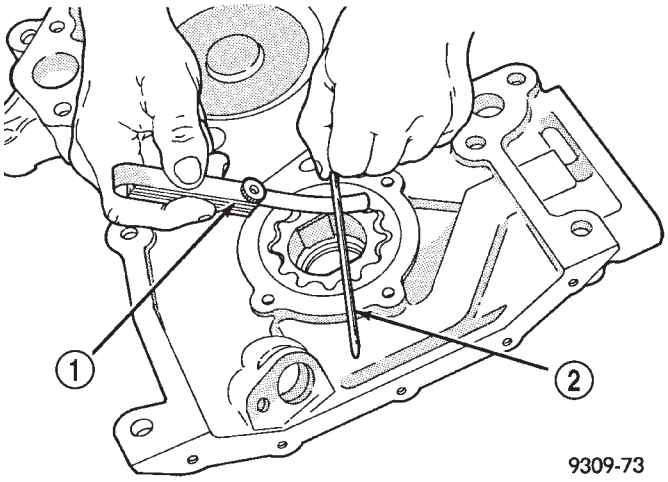


Fig. 66 Measuring Clearance Over Rotors

1 - FEELER GAUGE
2 - STRAIGHT EDGE

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 100 and 109 N (22.5 and 24.5 pounds)

OIL PUMP (Continued)

when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications.

If oil pressure was low and pump is within specifications, inspect for worn engine bearings or other reasons for oil pressure loss.

INSTALLATION

(1) Lubricate both oil pump rotors using petroleum jelly or lubriplate and install in the timing chain cover. Use new parts as required (Fig. 67).

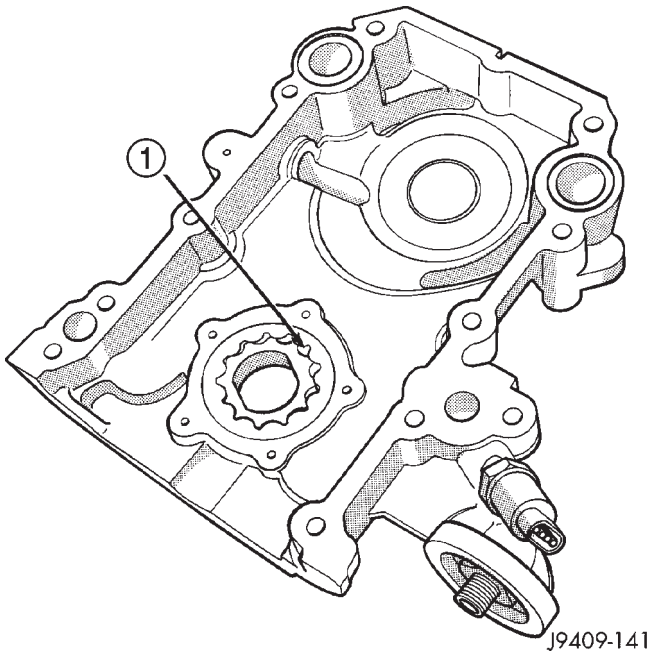


Fig. 67 Priming Oil Pump.

1 - FILL WITH PETROLEUM JELLY OR LUBER PLATE

(2) Position the oil pump cover onto the timing chain cover. Tighten cover screws to 14 N·m (125 in. lbs.) torque.

(3) Make sure that inner ring moves freely after cover is installed.

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

(5) Squirt oil into relief valve hole until oil runs out.

(6) Install the relief valve and spring.

(7) Using a new pressure relief valve gasket, install the relief valve plug. Tighten the plug to 20 N·m (15 ft. lbs.) torque.

(8) Install oil filter that has been filled with oil.

INTAKE MANIFOLD

DESCRIPTION

The aluminum intake manifold (Fig. 68) has two plenum chambers an upper and lower which supply air to five runners each. Passages across the longitudinal center of the manifold feed air from the throttle body to the plenum chambers.

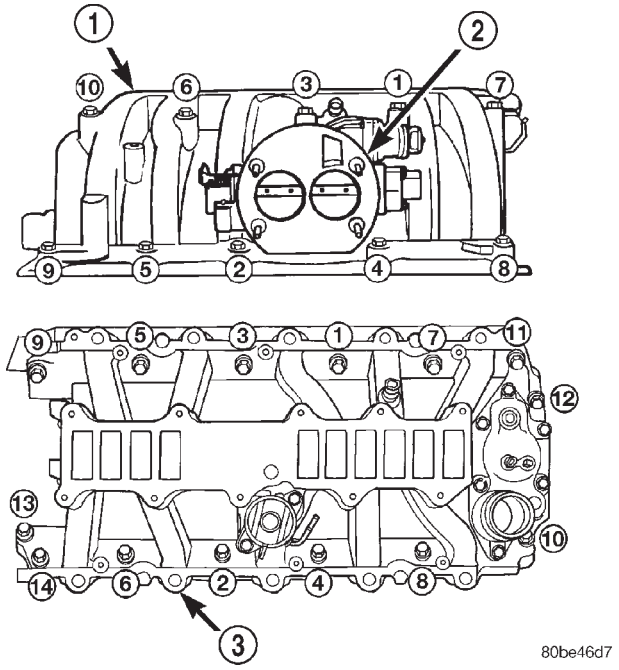


Fig. 68 Upper and Lower Intake Manifold—8.0L Engine

1 - UPPER INTAKE MANIFOLD
2 - THROTTLE BODY (MPI)
3 - LOWER INTAKE MANIFOLD

DIAGNOSIS AND TESTING—INTAKE MANIFOLD LEAKAGE

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

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

(1) Start the engine.

(2) Spray a small stream of water at the suspected leak area.

(3) If a change in RPMs occur, the area of the suspected leak has been found.

(4) Repair as required.

INTAKE MANIFOLD (Continued)

REMOVAL

(1) Disconnect the negative cable from the battery.

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

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

(4) Remove the generator brace and generator (Fig. 69).

(5) Remove the A/C compressor brace (Fig. 69). Remove the compressor and set aside.

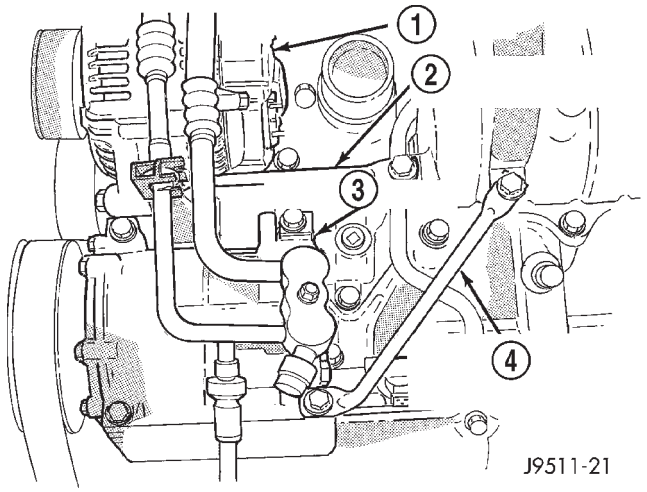


Fig. 69 Generator and A/C Compressor Braces

1 - GENERATOR
2 - INTAKE MANIFOLD TO GENERATOR BRACE
3 - A/C COMPRESSOR
4 - INTAKE MANIFOLD TO A/C COMPRESSOR BRACE

(6) Remove the air cleaner cover and filter. Remove the air cleaner housing (Fig. 70). Discard the gasket.

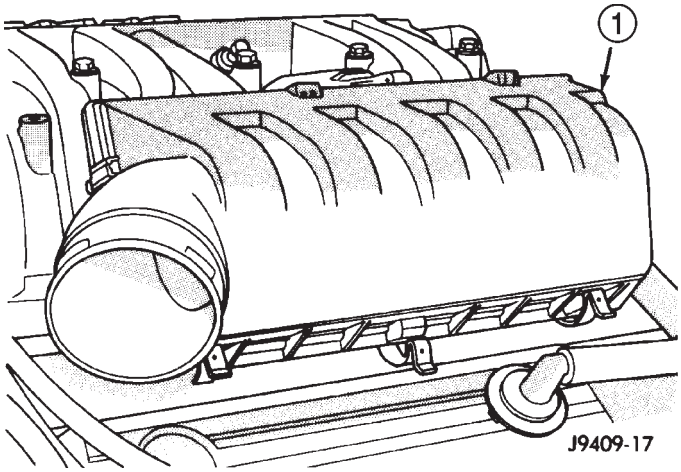


Fig. 70 Air Intake Housing

1 - AIR INTAKE HOUSING

(7) Perform the Fuel System Pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE). Disconnect the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

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

(9) Remove the coil assemblies with the ignition wires.

(10) Disconnect the vacuum lines.

(11) Disconnect the heater hoses and bypass hose.

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

(13) Remove the throttle body bolts and lift the throttle body off the upper intake manifold (Fig. 71). Discard the gasket.

(14) Remove upper intake manifold bolts.

(15) Lift the upper intake manifold out of the engine compartment (Fig. 71). Discard the gasket.

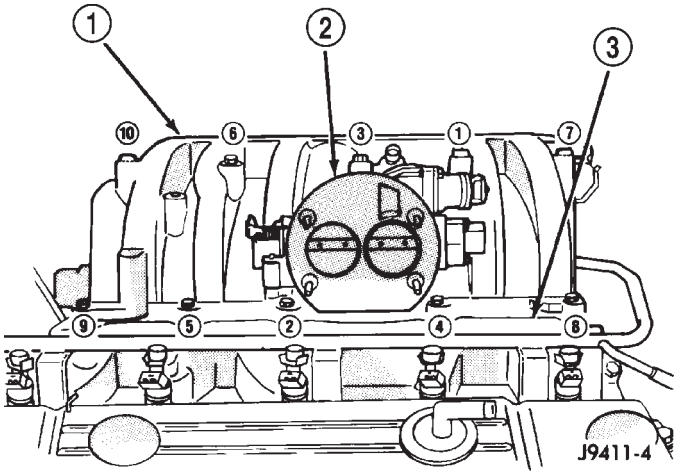


Fig. 71 Upper Intake Manifold and Throttle Body

1 - UPPER INTAKE MANIFOLD
2 - THROTTLE BODY (MPI)
3 - LOWER INTAKE MANIFOLD

(16) Remove the lower intake manifold bolts and remove the manifold (Fig. 72).

(17) Discard the lower intake manifold gaskets (Fig. 73).

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).

INTAKE MANIFOLD (Continued)

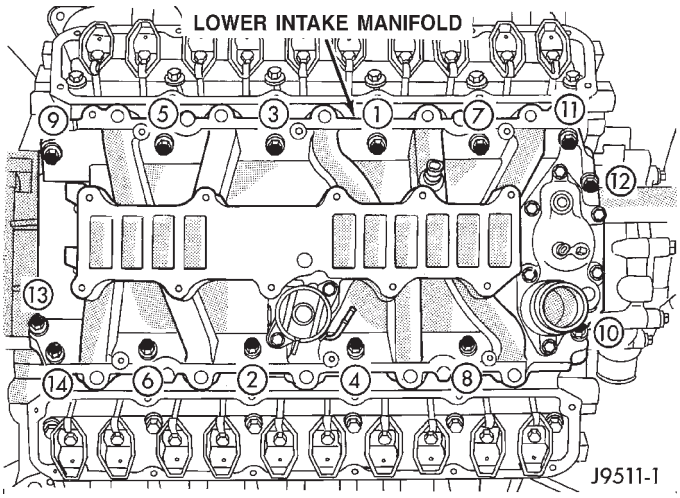


Fig. 72 Lower Intake Manifold

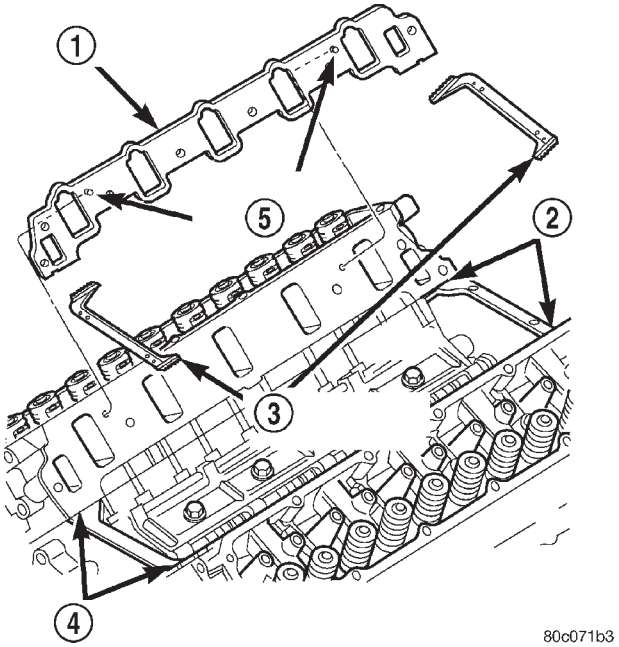


Fig. 73 Lower Intake Manifold Gaskets

1 - INTAKE MANIFOLD GASKET
2 - SEALANT
3 - CROSS-OVER GASKETS
4 - SEALANT
5 - LOCATOR DOWELS

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straightedge.

INSTALLATION

(1) Install the intake manifold side gaskets. Be sure that the locator dowels are positioned in the head (Fig. 74).

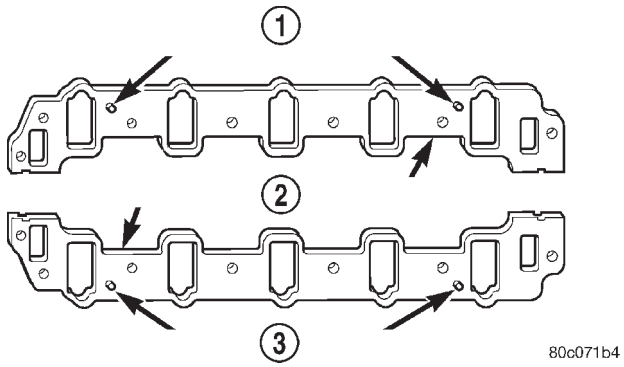


Fig. 74 Intake Manifold Flange

1 - LOCATOR DOWELS
2 - INTAKE MANIFOLD GASKETS
3 - LOCATOR DOWELS

(2) Insert Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, into the four corner joints an excessive amount of sealant is not required to ensure a leak proof seal. However, an excessive amount of sealant may reduce the effectiveness of the flange gasket. The sealant should be approximately 5 mm (0.2 in.) in diameter. (Fig. 73).

(3) Position the cross-over gaskets and press firmly onto the block (Fig. 73). **BE SURE THE BLOCK IS OIL FREE.**

(4) The lower intake manifold MUST be installed within 3 minutes of sealant application. Carefully lower intake manifold into position on the cylinder block and heads. After intake manifold is in place, inspect to make sure seals and gaskets are in place. Finger start all the lower intake bolts.

(5) Tighten the lower intake manifold bolts in sequence to 54 N·m (40 ft. lbs.) torque (Fig. 72). Recheck all bolts are tightened to 54 N·m (40 ft. lbs.) torque.

(6) Using a new gasket, position the upper intake manifold onto the lower intake manifold.

(7) Finger start all bolts, alternate one side to the other.

(8) Tighten upper intake manifold bolts in sequence to 22 N·m (16 ft. lbs.) torque (Fig. 71).

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

(10) Install closed crankcase ventilation and evaporation control systems.

(11) Connect the heater hoses and bypass hose.

(12) Connect the vacuum lines.

(13) Install the coil assemblies and the ignition wires.

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

INTAKE MANIFOLD (Continued)

(15) Install the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(16) Using a new gasket, install the air cleaner housing. Tighten the nuts to 11 N·m (96 in. lbs.) torque. Install the air cleaner filter and cover.

(17) Install the A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION). Position the compressor brace and install the bolts. Tighten the brace bolts to 41 N·m (30 ft. lbs.) torque.

(18) Install the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION). Position the generator brace and install the bolts. Tighten the brace bolts to 41 N·m (30 ft. lbs.) torque.

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

(20) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(21) Connect the negative cable to the battery.

(22) Start engine check for leaks.

EXHAUST MANIFOLD

DESCRIPTION

Engine exhaust manifolds (Fig. 75) are made of high molybdenum ductile cast iron. A special ribbed design helps control permanent dimensional changes during heat cycles.

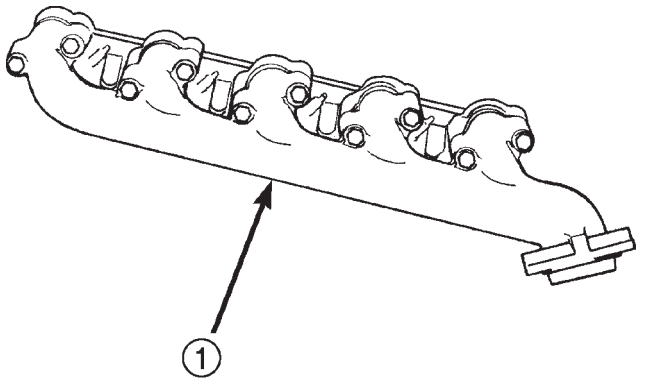


Fig. 75 Exhaust Manifold—8.0L Engine

1 - EXHAUST MANIFOLD

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.

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise and support the vehicle.

(3) Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold..

(4) Lower the vehicle.

(5) Remove the exhaust heat shields (Fig. 76).

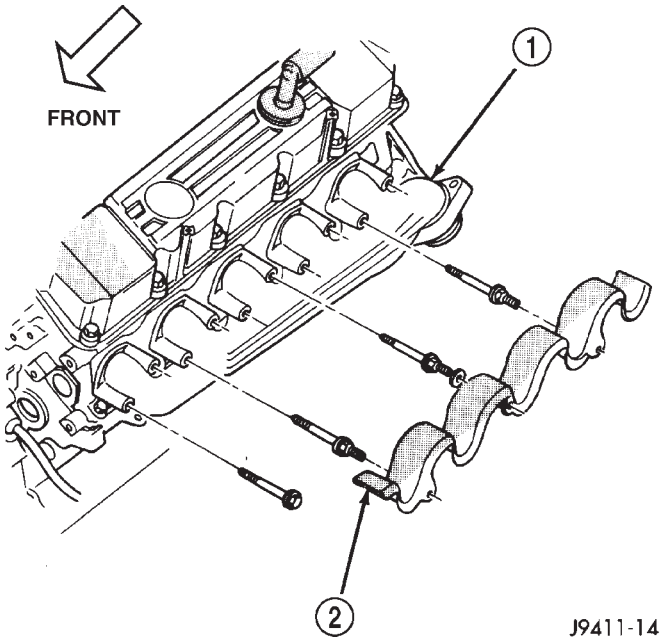


Fig. 76 8.0L Engine Exhaust Manifold—Typical

1 - EXHAUST MANIFOLD
2 - HEAT SHIELD

(6) Remove the dipstick bracket from the exhaust manifold (right side only).

(7) Remove bolts attaching manifold to cylinder head.

(8) Remove manifold from the cylinder head. Discard the gasket.

CLEANING

Clean mating surfaces on cylinder head and manifold. Wash with solvent and blow dry with compressed air.

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straight edge. Gasket surfaces must be flat within 0.2 mm per 300 mm (0.008 inch per foot).

INSTALLATION

(1) Using a new gasket position the engine exhaust manifold onto the cylinder head. Install bolts and stud bolts in the proper position (Fig. 76). Tighten the bolts to 22 N·m (16 ft. lbs.) torque.

EXHAUST MANIFOLD (Continued)

(2) Install the dipstick bracket on to the exhaust manifold (right side only).

(3) Position washers and exhaust heat shields onto the manifold stud bolts (Fig. 76). Be sure the tabs on the heat shields are hooked over the top of the exhaust gasket. Install the nuts and tighten to 20 N·m (175 in. lbs.) torque.

(4) Raise and support the vehicle.

(5) Assemble exhaust pipe to manifold.

(6) Lower the vehicle.

(7) Connect the negative cable to the battery.

(8) Start engine check for leaks.

TIMING BELT / CHAIN COVER(S)

REMOVAL

(1) Disconnect the negative cable from the battery.

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

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

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

(5) Unbolt A/C compressor and set on top of engine.

(6) Remove generator, air pump, and bracket assembly.

(7) Remove water pump (Refer to 7 - COOLING/ENGINE/WATER PUMP - REMOVAL).

(8) Remove damper bolt and washer.

(9) Using Special Tool 1026 3-Jaw Puller remove pulley/damper from the crankshaft. (Fig. 77)

(10) Loosen oil pan bolts and remove the front oil pan bolts that mount the pan to the timing chain cover.

(11) Remove the cover bolts.

(12) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket.

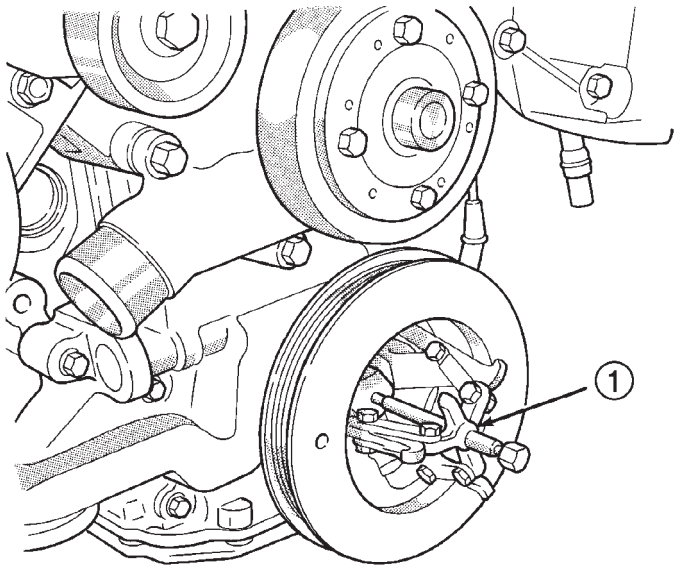
(13) Inspect surface of cover. Remove any burrs or high spots.

INSTALLATION

(1) Be sure mating surfaces of timing chain cover and cylinder block are clean and free from burrs.

(2) Lubricate the pump rotors using petroleum jelly or lubriplate (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(3) Using a new cover gasket, carefully install timing chain cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.



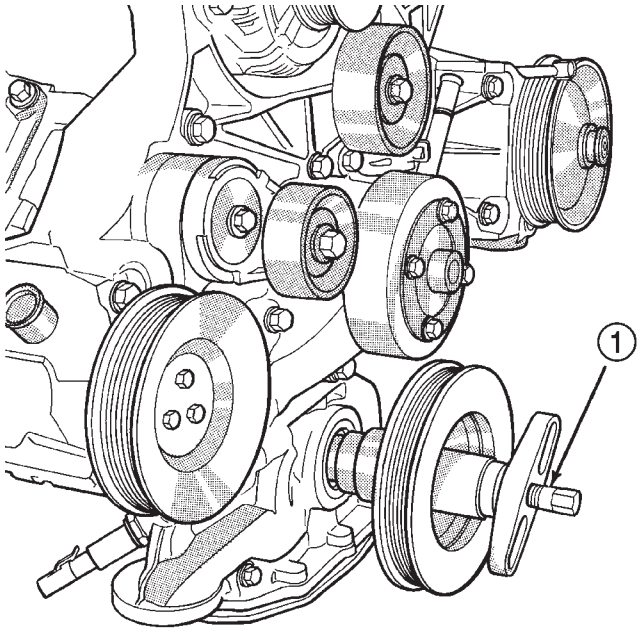
J9409-138

Fig. 77 Pulley—Damper Removal

1 - 3 JAW PULLER

(4) Tighten timing chain cover bolts to 47 N·m (35 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(5) Using Special Tool C-3688 Crankshaft Pulley/Damper Installer Install pulley/vibration damper (Fig. 78)



J9409-142

Fig. 78 Installing Crankshaft

1 - SPECIAL TOOL C-3688

TIMING BELT / CHAIN COVER(S) (Continued)

(6) Prime oil pump by squirting oil in the oil filter mounting hole and filling the J-trap of the front timing cover. When oil is running out, install oil filter that has been filled with oil.

(7) Install water pump and housing assembly using new o-ring (Refer to 7 - COOLING/ENGINE/WATER PUMP - INSTALLATION).

(8) Install generator, air pump, and bracket assembly.

(9) Install A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).

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

(11) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

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

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

(14) Connect the negative cable to the battery.

(15) Road test vehicle and check for leaks.

TIMING BELT/CHAIN AND SPROCKETS

REMOVAL

(1) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(2) Aline camshaft and crankshaft centerline. Remove camshaft sprocket attaching bolt and remove timing chain and camshaft sprockets.

(3) Use puller 6444 and jaws 6820 to remove crankshaft sprocket (Fig. 79).

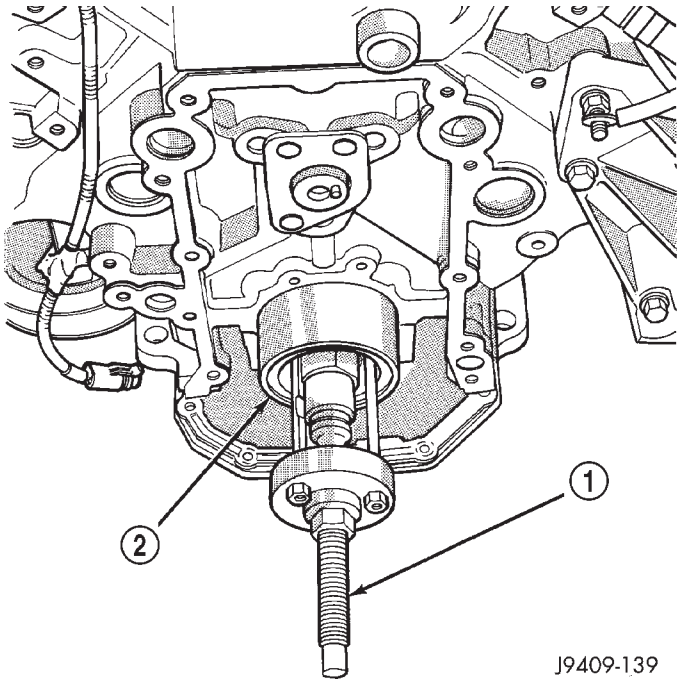


Fig. 79 Crankshaft Sprocket Removal.

1 - SPECIAL TOOL 6444
2 - SPECIAL TOOL 6820

INSPECTION—MEASURING TIMING CHAIN STRETCH

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 80).

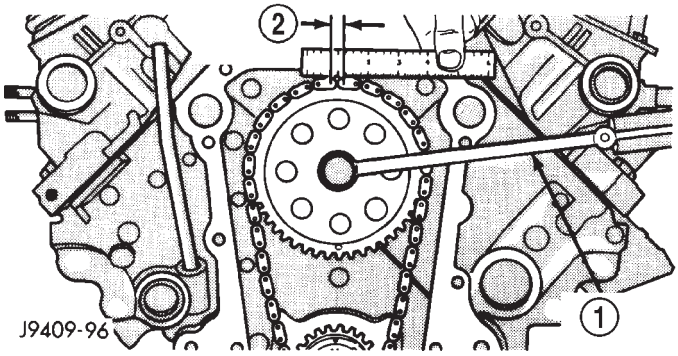


Fig. 80 Measuring Timing Chain Stretch

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

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

INSTALLATION

(1) Line up key in crankshaft with keyway in sprocket, press on crankshaft timing sprocket, use tools C-3688, C-3718 and MB-990799, seat sprocket against crankshaft shoulder (Fig. 81).

TIMING BELT/CHAIN AND SPROCKETS (Continued)

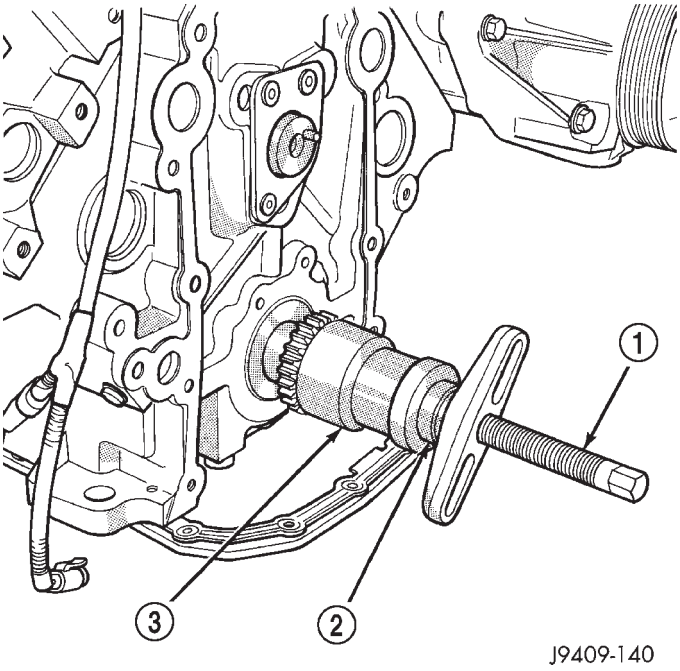


Fig. 81 Crankshaft Sprocket Installation

1 - SPECIAL TOOL C-3688
2 - SPECIAL TOOL C-3718
3 - SPECIAL TOOL MD990799

(2) Turn crankshaft to line up the timing mark with the crankshaft and camshaft centerline.

(3) Put chain on camshaft sprocket.

(4) Align timing marks and install chain and camshaft sprocket onto crankshaft sprocket. Check to see that timing marks are on the centerline of the crankshaft and camshaft centerline (Fig. 82).

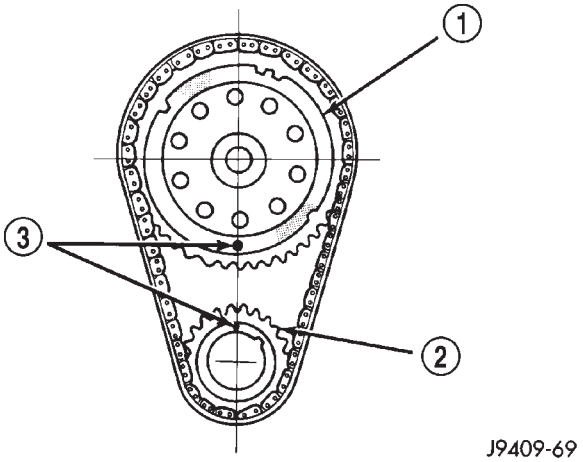


Fig. 82 Alignment of Timing Marks

1 - CAMSHAFT SPROCKET
2 - CRANKSHAFT SPROCKET
3 - TIMING MARKS

(5) Install the camshaft bolt. Tighten the bolt to 61 N·m (45 ft. lbs.) torque.

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

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

ENGINE 5.9L DIESEL

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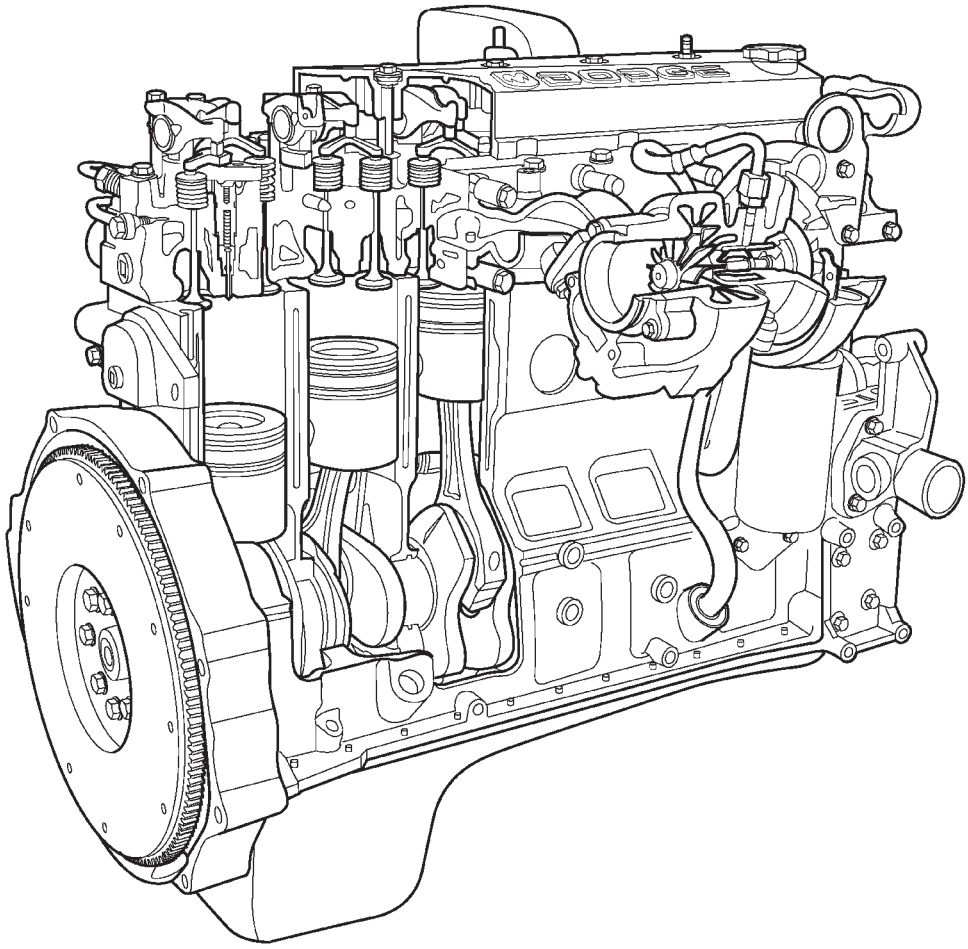
ENGINE 5.9L DIESEL

DESCRIPTION



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Cummins® 24 Valve Turbo Diesel Engine

The cylinder block is constructed of cast iron. The casting is a skirted design which incorporates longitudal ribs for superior strength and noise reduction. The block incorporates metric straight thread o-ring fittings at lubrication oil access points. The engine is manufactured with the cylinders being a non-sleeved type cylinder. However, one approved service method is to bore out the cylinders and add cylinder sleeves to the cylinder block.

ENGINE 5.9L DIESEL (Continued)

The cylinders are numbered front front to rear (Fig. 1) ; 1 to 6. The firing order is 1–5–3–6–2–4.

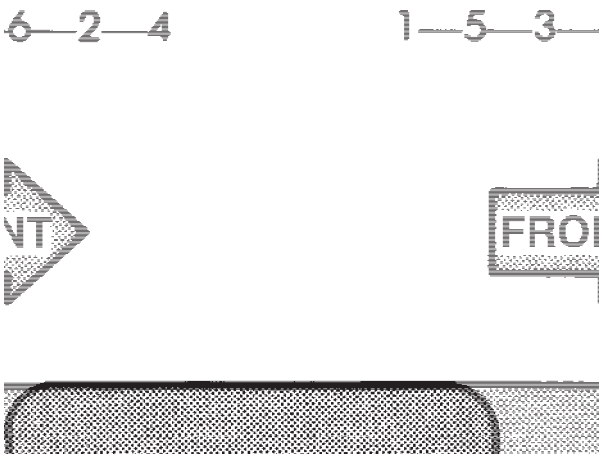


Fig. 1 Cylinder Numbering

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING—ENGINE
DIAGNOSIS - 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 engine oil is being used. (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).
	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.
	6. If cooler was replaced, shipping plugs may have been 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.	9. Check and install new bearing. 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.

ENGINE 5.9L DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE TOO HIGH	1. Pressure switch/gauge not operating properly.	1. Verify pressure switch is functioning correctly. If not, replace switch/gauge.
	2. Engine running to cold.	2. Refer to Coolant Temperature Below Normal (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).
	3. Oil viscosity too thick.	3. Make sure the correct oil is being used. (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).
	4. Oil pressure relief valve stuck closed or binding	4. Check and replace valve.
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 (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).
		(b) Look for reduced viscosity from dilution with fuel.
		(c) Review/reduce 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.
	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 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
	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 tank. Replace fuel/water separator filter.
	3. Engine overloaded.	3. Verify the engine load rating is not being exceeded.
	4. Incorrect injection pump timing.	4. Check injection pump for proper installation.
	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 vibration damper.

ENGINE 5.9L DIESEL (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	4. Improperly operating viscous fan drive.	4. Inspect/replace fan drive.
	5. Worn or damaged generator bearing.	5. Check/replace 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 condition. Repair/replace as required.
	8. Worn or unbalanced driveline components.	8. Check/repair driveline components.
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 (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
	3. Excessive valve lash.	3. Adjust valves. Make sure the push rods are not bent and rocker arms, adjusting screws, crossheads, are not severely worn. Replace bent or severely worn components.
	4. Turbocharger noise.	4. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required.
	5. Gear train noise.	5. Visually inspect and measure gear backlash. Replace gears as required.
	6. Power function knock.	6. Check/replace rod and main bearings.

DIAGNOSIS AND TESTING—SMOKE DIAGNOSIS CHARTS

The following charts include possible causes and corrections for **excess or abnormal** exhaust smoke. Small amounts of exhaust smoke (at certain times) are to be considered normal for a diesel powered engine.

EXCESSIVE BLACK SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Air filter dirty or plugged.	Check Filter Minder® at air filter (Refer to 9 - ENGINE/ AIR INTAKE SYSTEM/AIR CLEANER ELEMENT - REMOVAL).
Air intake system restricted.	Check entire air intake system including all hoses and tubes for restrictions, collapsed parts or damage. Repair/replace as necessary.
Air Leak in Intake System.	Check entire air intake system including all hoses and tubes for cracks, loose clamps and/or holes in rubber ducts. Also check intake manifold for loose mounting hardware.
Diagnostic Trouble Codes (DTC's) active or multiple, intermittent DTC's.	Refer to Powertrain Diagnostic Procedures Information.

ENGINE 5.9L DIESEL (Continued)

EXCESSIVE BLACK SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Engine Control Module (ECM) not calibrated or ECM has incorrect calibration.	Refer to Powertrain Diagnostic Procedures Information.
Exhaust system restriction is above specifications.	Check exhaust pipes for damage/restrictions. Repair as necessary.
Fuel grade is not correct or fuel quality is poor.	Temporarily change fuel brands and note condition. Change brand if necessary.
Fuel injection pump malfunctioning.	A DTC should have been set. If so, refer to Powertrain Diagnostic Procedures Information.
Fuel injector malfunctioning.	A DTC should have been set. Perform ″Cylinder Balance Test″ using DRB scan tool to isolate individual cylinders. Also refer to Powertrain Diagnostic Procedures Information and, to (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - DIAGNOSIS AND TESTING).
Fuel return system restricted.	Check fuel return line by checking overflow valve (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - DIAGNOSIS AND TESTING).
Intake manifold restricted.	Remove restriction.
Manifold Air Pressure (Boost) Sensor or sensor circuit malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Raw fuel in intake manifold.	Fuel injectors leaking on engine shutdown. Do Fuel Injector Test (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - DIAGNOSIS AND TESTING).
Static timing not correct.	A DTC should have been set. If so, refer to Powertrain Diagnostic Procedures Information. Also (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - DIAGNOSIS AND TESTING).
Turbocharger air intake restriction.	Remove restriction.
Turbocharger damaged.	(Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSPECTION).
Turbocharger has excess build up on compressor wheel and/or diffuser vanes.	(Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - CLEANING).
Turbocharger wheel clearance out of specification.	(Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSPECTION).

EXCESSIVE WHITE SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Air in fuel supply: Possible leak in fuel supply side (between transfer pump and fuel tank module).	(Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TRANSFER PUMP - DIAGNOSIS AND TESTING).
Coolant leaking into combustion chamber.	Do pressure test of cooling system (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).
Diagnostic Trouble Codes (DTC’s) active or multiple, intermittent DTC’s.	Refer to Powertrain Diagnostic Procedures Information.
In very cold ambient temperatures, engine block heater is malfunctioning (if equipped).	(Refer to 7 - COOLING/ENGINE/ENGINE BLOCK HEATER - REMOVAL).

ENGINE 5.9L DIESEL (Continued)

EXCESSIVE WHITE SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Engine coolant temperature sensor malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information. Also check thermostat operation (Refer to 7 - COOLING/ENGINE/ ENGINE COOLANT THERMOSTAT - DIAGNOSIS AND TESTING).
Engine Control Module (ECM) not calibrated or has incorrect calibration.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Fuel filter plugged.	Perform Fuel Pressure Drop Test (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TRANSFER PUMP - DIAGNOSIS AND TESTING).
Fuel grade not correct or fuel quality is poor.	Temporarily change fuel brands and note condition. Change brand if necessary.
Fuel heater element or fuel heater temperature sensor malfunctioning. This will cause wax type build-up in fuel filter.	Refer to Fuel Heater Testing (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL HEATER - DIAGNOSIS AND TESTING).
Fuel injector malfunctioning.	A DTC should have been set. Perform ″Cylinder Balance Test″ using DRB scan tool to isolate individual cylinders. Also refer to Powertrain Diagnostic Procedures Information and, (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - DIAGNOSIS AND TESTING).
Fuel injector hold-downs loose.	Torque to specifications.
Fuel injector protrusion not correct.	Check washer (shim) at bottom of fuel injector for correct thickness. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION)
Fuel injection pump malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Fuel supply side restriction to transfer pump.	Refer to Fuel Transfer Pump Pressure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TRANSFER PUMP - DIAGNOSIS AND TESTING)
Fuel transfer (lift) pump malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information. Also refer to Fuel Transfer Pump Pressure Testing (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TRANSFER PUMP - DIAGNOSIS AND TESTING).
Intake/Exhaust valve adjustments not correct (too tight).	(Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/ EXHAUST VALVES & SEATS - STANDARD PROCEDURE).
Intake manifold air temperature sensor malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Intake manifold heater circuit not functioning correctly in cold weather.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information. Also check heater elements for correct operation.
Intake manifold heater elements not functioning correctly in cold weather.	A diagnostic trouble code WILL NOT BE SET if heater elements are malfunctioning. Refer to NTC tests in Powertrain Diagnostic Procedures Information.
Internal engine damage (scuffed cylinder).	Analyze engine oil and inspect oil filter to locate area of probable damage.

ENGINE 5.9L DIESEL (Continued)

EXCESSIVE WHITE SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Restriction in fuel supply side of fuel system.	Refer to Fuel Transfer Pump Pressure Testing (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL TRANSFER PUMP - DIAGNOSIS AND TESTING).
Static timing incorrect.	A DTC should have been set. If so, (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - DIAGNOSIS AND TESTING).

EXCESSIVE BLUE SMOKE	
POSSIBLE CAUSE	**CORRECTION**
Dirty air cleaner or restricted turbocharger intake duct.	Check Filter Minder® at air filter housing. (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER ELEMENT - REMOVAL).
Air leak in boost system between turbocharger compressor outlet and intake manifold.	Service air charge system..
Obstruction in exhaust manifold.	Remove exhaust manifold and inspect for blockage (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - REMOVAL).
Restricted turbocharger drain tube.	Remove turbocharger drain tube and remove obstruction.
Crankcase ventilation system plugged.	Inspect crankcase breather and vent tube for sludge formation or obstructions.
Valve seals are worn, brittle, or improperly installed.	Replace valve stem oil seals (Refer to 9 - ENGINE/ CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - REMOVAL).
Valve stems and/or guides are worn.	Remove valves and inspect valves and guides. (Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - STANDARD PROCEDURE).
Broken or Improperly installed piston rings.	Tear down engine and inspect piston rings.
Excessive piston ring end gap.	Remove pistons and measure piston ring end gap (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON RINGS - STANDARD PROCEDURE).
Excessive cylinder bore wear and taper.	Remove pistons and measure cylinder bore wear and taper (Refer to 9 - ENGINE/ENGINE BLOCK - STANDARD PROCEDURE).
Cylinder damage.	Remove pistons and inspect cylinder bore for cracks or porosity. Repair with cylinder liner if necessary. (Refer to 9 - ENGINE/ENGINE BLOCK - STANDARD PROCEDURE).
Piston damage.	Remove pistons and inspect for cracks, holes. Measure piston for out-of-round and taper (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - INSPECTION).
Turbocharger failure.	(Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSPECTION).

STANDARD PROCEDURE

STANDARD PROCEDURE - FORM-IN-PLACE GASKETS AND SEALERS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results. **Do not use form-in-place gasket material unless specified.** 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 which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

MOPAR® ENGINE RTV GEN II

Mopar® Engine RTV GEN II is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® ATF RTV

Mopar® ATF RTV is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

Mopar® Gasket Maker is an anaerobic type gasket material. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

MOPAR® GASKET SEALANT

Mopar® Gasket Sealant is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material is used on engines with multi-layer steel (MLS) cylinder head gaskets. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4oz./16 oz. can w/applicator.

FORM-IN-PLACE GASKET AND SEALER APPLICATION

Assembling parts using a form-in-place gasket requires care but it's easier then using precut gaskets.

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. 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 material off the location.

Mopar® Engine RTV GEN II or ATF RTV gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) 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 usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

STANDARD PROCEDURE - 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.

STANDARD PROCEDURE—HYDROSTATIC LOCK

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

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

ENGINE 5.9L DIESEL (Continued)

(1) Disconnect the negative cable(s) from the battery.
(2) Inspect air cleaner, induction system, and intake manifold to ensure system is dry and clear of foreign material.
(3) Place a shop towel around the fuel injectors to catch any fluid that may possibly be under pressure in the cylinder head. Remove the fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).
(4) With all injectors removed, rotate the crankshaft using a breaker bar and socket.
(5) Identify the fluid in the cylinders (coolant, fuel, oil, etc.).
(6) Be sure all fluid has been removed from the cylinders.
(7) Repair engine or components as necessary to prevent this problem from occurring again.
(8) Squirt a small amount of engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.
(9) Install new fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).
(10) Drain engine oil. Remove and discard the oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - REMOVAL).
(11) Install the drain plug. Tighten the plug to 34 N·m (25 ft. lbs.) torque.
(12) Install a new oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - INSTALLATION).
(13) Fill engine crankcase with the specified amount and grade of oil (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - SPECIFICATIONS).
(14) Connect the negative cable(s) to the battery.
(15) Start the engine and check for any leaks.

REMOVAL

REMOVAL—ENGINE

(1) Disconnect both battery negative cables.
(2) Recover A/C refrigerant (if A/C equipped) (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).
(3) Raise vehicle on hoist.
(4) Drain engine coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).
(5) Remove engine oil drain plug and drain engine oil.
(6) Lower vehicle.
(7) Remove radiator upper hose.
(8) Remove the cooling fan shroud-to-radiator mounting bolts.
(9) Remove viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL). Remove the cooling fan and shroud together.
(10) Disconnect the coolant recovery bottle hose from the radiator filler neck and remove bottle from fan shroud (Fig. 2).

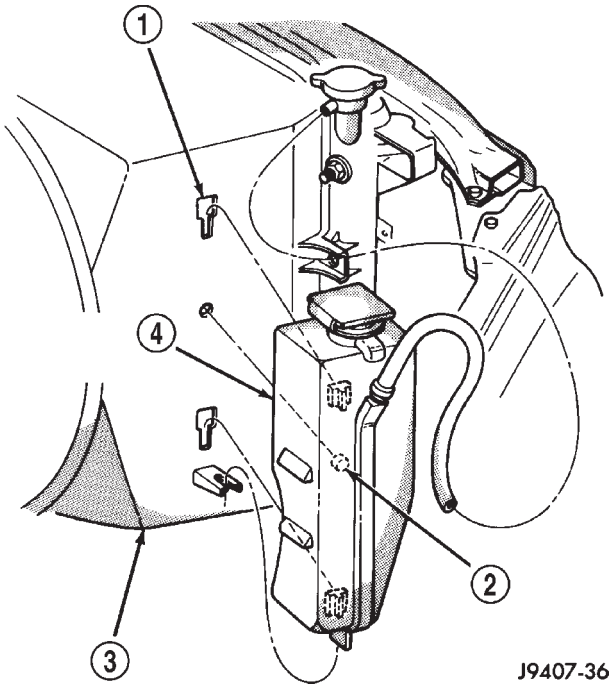


Fig. 2 Coolant Recovery Bottle

1 - T-SLOTS
2 - ALIGNMENT PIN
3 - FAN SHROUD
4 - COOLANT RESERVE/OVERFLOW TANK

(11) Disconnect heater core supply and return hoses from the cylinder head fitting and coolant pipe.
(12) Raise vehicle on hoist.
(13) Remove transmission and transfer case (if equipped.).
(14) Disconnect exhaust pipe from turbocharger extension pipe (Fig. 3).
(15) Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL).
(16) Disconnect A/C suction/discharge hose from the rear of the A/C compressor.
(17) Lower vehicle.
(18) Disconnect lower radiator hose from radiator outlet.
(19) **Automatic Transmission models:** Disconnect transmission oil cooler lines from radiator using special tool #6931.
(20) Remove radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).
(21) Remove upper radiator support panel.

ENGINE 5.9L DIESEL (Continued)

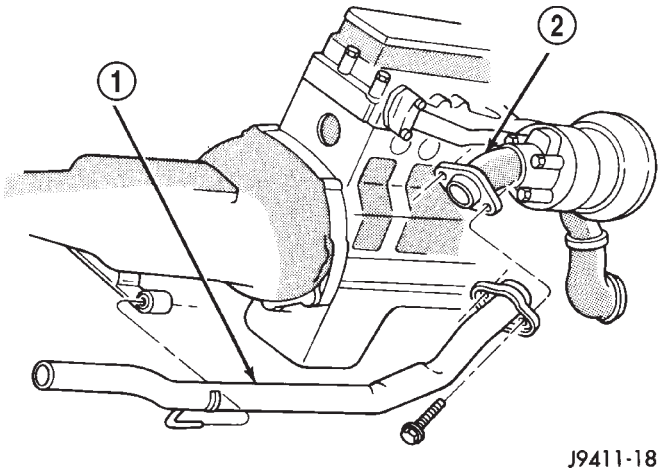


Fig. 3 Exhaust Pipe Connection at Turbocharger

1 - EXHAUST PIPE
2 - TURBOCHARGER EXHAUST PIPE

(22) Remove front bumper (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT BUMPER - REMOVAL).

(23) If A/C equipped, disconnect A/C condenser refrigerant lines.

(24) Disconnect charge air cooler piping.

(25) Remove the two charge air cooler mounting bolts.

(26) Remove charge air cooler (and A/C condenser if equipped) from vehicle.

(27) Disconnect engine block heater connector.

(28) Disconnect A/C compressor electrical connectors.

(29) Remove the passenger battery ground cable from the engine block.

(30) Disconnect power steering pump pressure and return lines.

(31) Remove accelerator linkage cover.

(32) Leaving all cables attached, remove accelerator pedal position sensor assy. (APPS) (Fig. 4) from cylinder head bracket and secure out of the way.

(33) Disconnect APPS connector (Fig. 5).

(34) Disconnect vacuum pump supply hose (Fig. 6).

(35) Disconnect the engine harness and ground cable from the PDC.

(36) Disconnect the fuel supply and return hoses (Fig. 7).

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

(38) Remove the #5 and #6 cylinder intake and exhaust rocker arms and pedestals (Fig. 8). Note the original location for re-assembly.

(39) Loosen but do not remove engine mount through bolts and nuts.

(40) Attach chain accross engine lift brackets.

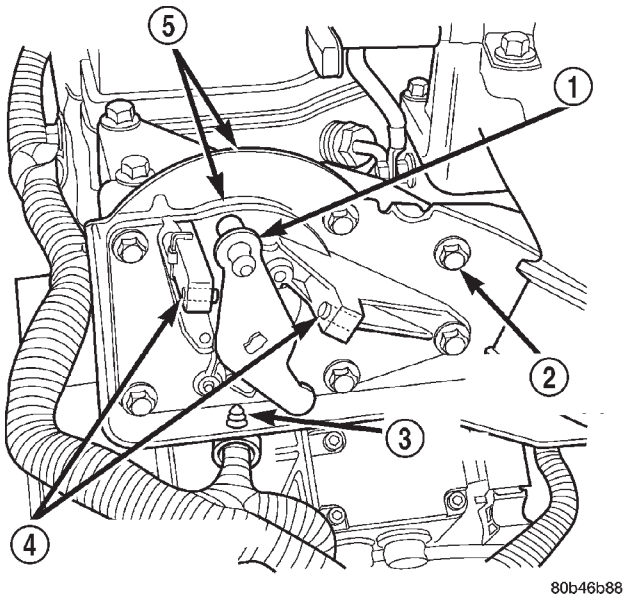


Fig. 4 APPS Assembly

1 - LEVER
2 - MOUNTING BOLTS (6)
3 - WIRE HARNESS CLIP
4 - CALIBRATION SCREWS (NO ADJUSTMENT)
5 - APPS ASSEMBLY

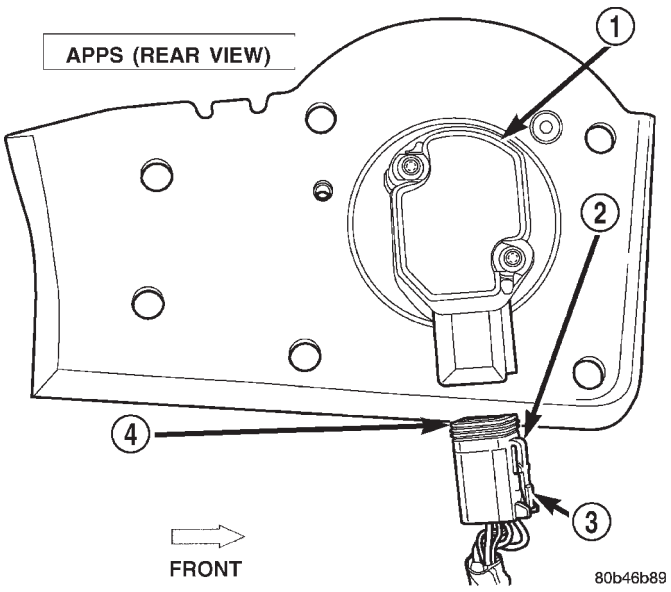


Fig. 5 APPS Connector

1 - APPS
2 - TAB
3 - PUSH FOR REMOVAL
4 - APPS CONNECTOR

(41) Lift engine up and out of engine compartment.

(42) Install engine to suitable engine stand.

ENGINE 5.9L DIESEL (Continued)

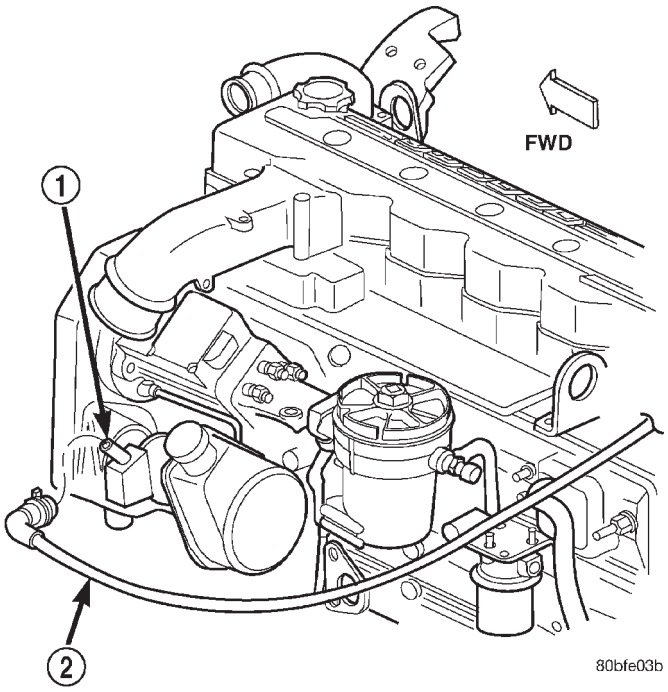


Fig. 6 Vacuum Pump Supply Hose

1 - VACUUM CHECK VALVE
2 - VACUUM SUPPLY LINE

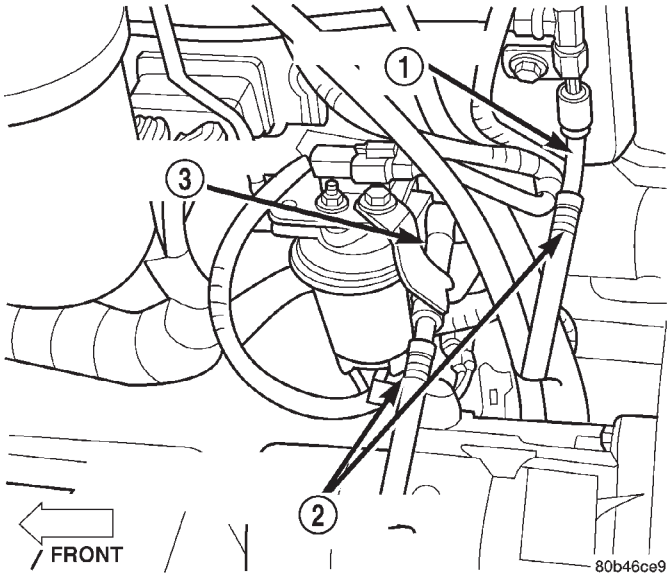


Fig. 7 Fuel Return and Supply Line Quick-Connect Locations

1 - FUEL RETURN LINE
2 - QUICK-CONNECT FITTINGS
3 - FUEL SUPPLY LINE

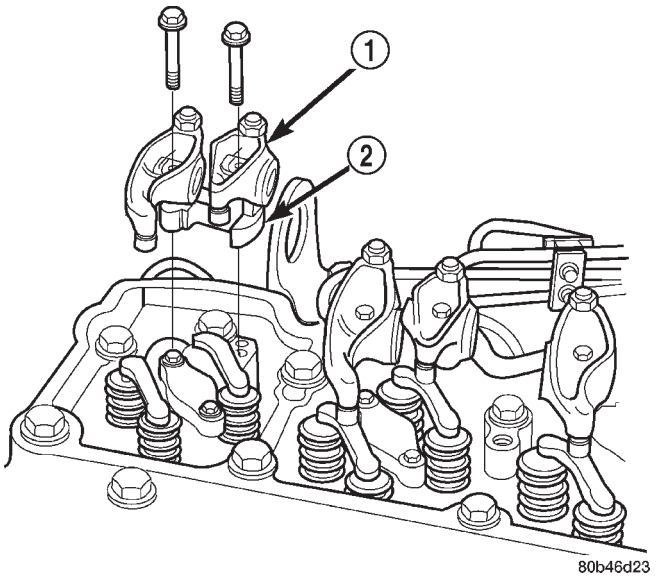


Fig. 8 Rocker Arm and Pedestal—Removal/ Installation

1 - ROCKER ARM
2 - PEDESTAL

REMOVAL—CRANKCASE BREATHER VAPOR CANISTER

NOTE: It is recommended to empty the contents of the vapor canister at each oil and filter service interval.

(1) Loosen cap from top of vapor canister.
(2) Remove nut retaining canister to engine front cover.
(3) Slide clamp upwards on hose, then remove hose from crankcase breather.

INSTALLATION

INSTALLATION—ENGINE

(1) Install the engine with the cylinder head cover and the #5 and 6 rocker arm assemblies removed.
(2) Lower the engine into the compartment and install the engine mount through bolts and nuts.
(3) Tighten the mount through bolts and nuts to 88 N·m (65 ft. lbs.) torque.
(4) Remove the engine lifting device.
(5) Install the #5 and #6 rocker arms and pedestals in their original locations (Fig. 8). Torque the mounting bolts to 36 N·m (27 ft. lbs.) torque.
(6) Install the cylinder head cover and gasket (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
(7) Connect the fuel supply and return hoses (Fig. 7).

ENGINE 5.9L DIESEL (Continued)

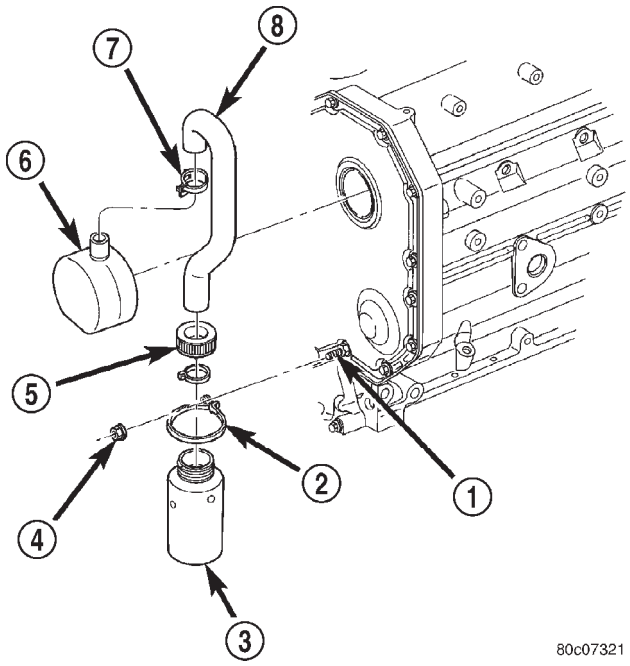


Fig. 9 Crankcase Breather Vapor Canister

1 - ENGINE FRONT COVER STUD
2 - STRAP
3 - VAPOR CANISTER
4 - NUT
5 - CAP
6 - CRANKCASE BREATHER
7 - CLAMP
8 - HOSE

(8) Connect the engine harness connector and ground cable to the PDC.

(9) Connect the vacuum pump supply hose.

(10) Connect the APPS connector (Fig. 5).

(11) Install the APPS assembly bracket to the cylinder head bracket.

(12) Install the throttle linkage cover.

(13) Connect the power steering pressure and return lines.

(14) Connect the passenger battery ground cable to the engine block. Tighten the bolt to 77 N·m (57 ft. lbs.) torque.

(15) Connect the engine block heater connector.

(16) Connect the a/c compressor electrical connectors.

(17) Install the charge air cooler and a/c condenser (if a/c equipped). Install and tighten the charge air cooler mounting bolts to 2 N·m (17 in. lbs.) torque.

(18) Connect the charge air cooler piping. Torque all clamps to 8 N·m (72 in. lbs.) torque.

(19) Connect the a/c refrigerant lines to the a/c condenser (if equipped).

(20) Install the front bumper (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT BUMPER - INSTALLATION).

(21) Install the radiator upper support panel.

(22) Install the radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).

(23) Connect the transmission quick-connect oil cooler lines to the radiator. Push together until an audible “click” is heard. Verify connection by pulling apart.

(24) Raise vehicle.

(25) Connect a/c compressor suction/discharge hose (if a/c equipped).

(26) Install the radiator lower hose and clamps.

(27) Install the starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - INSTALLATION).

(28) Install the transmission and transfer case (if equipped).

(29) Connect the exhaust pipe to the turbocharger elbow (Fig. 3). Torque the bolts to 34 N·m (25 ft. lbs.) torque.

(30) Connect the transmission auxiliary oil cooler lines (if equipped).

(31) Lower the vehicle

(32) Connect the heater core supply and return hoses.

(33) Install the cooling fan and shroud at the same time (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(34) Install the coolant recovery bottle to the fan shroud (Fig. 2) and connect the hose to the radiator filler neck.

(35) Install the windshield washer bottle to the fan shroud and connect the pump supply hose and electrical connections.

(36) Install the radiator upper hose and clamps.

(37) Change oil filter and install new engine oil.

(38) Fill cooling system with coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).

(39) Connect battery negative cables.

(40) Perform the fuel line air bleed procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).

(41) Start engine and inspect for engine oil, coolant, and fuel leaks.

INSTALLATION—CRANKCASE BREATHER VAPOR CANISTER

(1) Position vapor canister with strap over stud on engine front cover. Install retaining nut. Tighten nut 10 N·m (89 in. lbs.).

(2) If removed, position hose onto crankcase breather, then position clamp.

(3) Position lower portion of hose into vapor canister, then install and tighten cap.

ENGINE 5.9L DIESEL (Continued)

SPECIFICATIONS

5.9L DIESEL

DESCRIPTION	SPECIFICATION
Engine Type	In-Line 6 Cyl. Turbo Diesel
Bore and Stroke	102.0 X 120.0 mm (4.02 X 4.72 in.)
Displacement	5.9L (359 cu. in.)
Compression Ratio	
245 H.P. Version	17.0:1
235 H.P. Version	16.3:1
Horsepower (A/T and 5 Speed M/T)	235 @ 2700 rpm
Horsepower (6 Speed M/T Only)	245 @ 2700 rpm
Torque Rating (A/T and 5 Speed M/T)	460 ft. lbs. @ 1600 rpm
Torque Rating (6 Speed M/T Only)	505 ft. lbs. @ 1600 rpm
Firing Order	1-5-3-6-2-4
Lubrication System	Pressure Feed-Full Flow With Bypass Valve
Cylinder Block	Cast Iron
Crankshaft	Induction Hardened Forged Steel
Cylinder Head	Cast Iron With Valve Seat Inserts
Combustion Chambers	High Swirl Bowl
Camshaft	Chilled Ductile Iron
Pistons	Cast Aluminum
Connecting Rods	Cross Rolled Micro Alloy
PISTONS AND CONNECTING RODS	
Piston	
Skirt Diameter	101.864 – 101.88 mm (4.0104 – 4.011 in.)
Ring Groove Clearance	
Intermediate (Max.)	0.095 mm (0.0037 in.)
Oil Control (Max.)	0.085 mm (0.0033 in.)
Piston Pins	
Pin Diameter (Min.)	39.990 mm (1.5744 in.)
Bore Diameter (Max.)	40.025 mm (1.5758 in.)
Piston Ring End Gap	
Top Ring	0.35 – 0.45 mm (0.014 – 0.0177 in.)
Intermediate	0.85 – 1.15 mm (0.0334 – 0.0452 in.)
Oil Control	0.250 – 0.550 mm (0.010 – 0.0215 in.)
Connecting Rods	
Pin Bore Diameter (Max.)	40.042 mm (1.5764 in.)
Side Clearance	0.100 – 0.330 mm (0.004 – 0.013 in.)
CYLINDER HEAD	
Overall Flatness End to End (Max.)	0.30 mm (0.012 in.)
Overall Flatness Side to Side (Max.)	0.076 mm (0.003 in.)
Intake Valve Seat Angle	30°
Exhaust Valve Seat Angle	45°
Valve Seat Width	
(Min.)	1.49 mm (0.059 in.)
(Max.)	1.80 mm (0.071 in.)
Valve Margin (Min.)	0.72 mm (0.031 in.)
OIL PRESSURE	
At Idle	69 kPa (10 psi)
At 2,500 rpm	207 kPa (30 psi)
Regulating Valve Opening Pressure	448 kPa (65 psi)
Oil Filter Bypass Pressure Setting	344.75 kPa (50 psi)

TORQUE

TORQUE CHART 5.9L DIESEL ENGINE

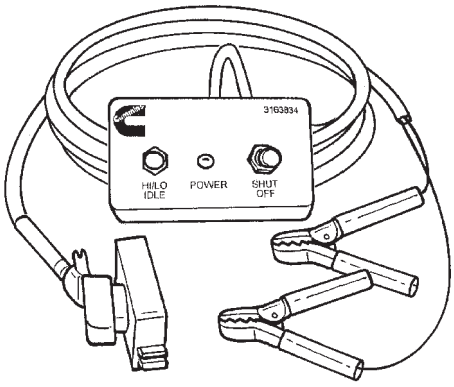
DESCRIPTION	N·m	In. Lbs.	Ft. Lbs.
Connecting Rod—Bolts			
Step 1	35	—	26
Step 2	70	—	51
Step 3	100	—	73
Cylinder Head—Bolts			
Step 1	80	—	59
Step 2	105	—	77
Step 3 Verify	105	—	77

ENGINE 5.9L DIESEL (Continued)

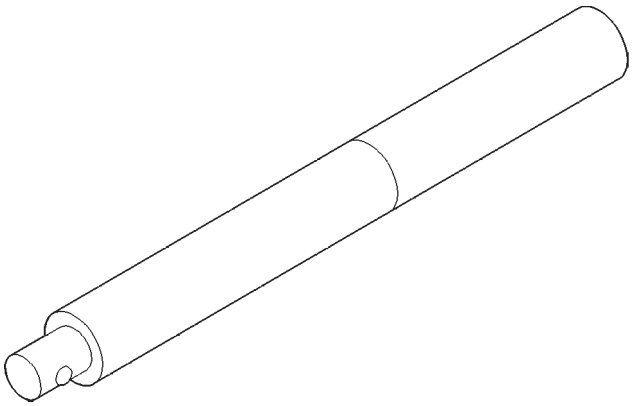
DESCRIPTION	N·m	In.	Ft.
Step 4	Rotate All Bolts 1/4 Turn		
Cylinder Head Cover—Bolts	24	18	—
Fuel Delivery Lines (High Pressure)			
At Pump	24	—	18
At Cylinder Head	38	—	28
Fuel Drain Line—Banjo (rear of head)	24	—	18
Oil Pan—Bolts	24	—	18
Oil Pan—Drain Plug	50	—	37
Oil Pressure Regulator—Plug	80	—	60
Oil Pressure Sender/Switch	16	—	12
Oil Pump—Bolts	24	—	18
Oil Suction Tube (Flange)—Bolts	24	—	18
Oil Suction Tube (Brace)—Bolt	24	—	18
Rocker Arm/Pedestal—Bolts	36	—	27

SPECIAL TOOLS

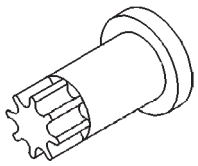
5.9L DIESEL ENGINE



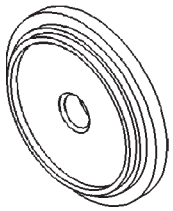
FUEL PUMP TESTER - 3163834



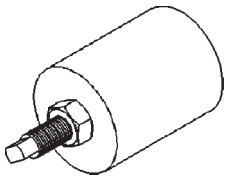
Universal Driver Handle - C 4171



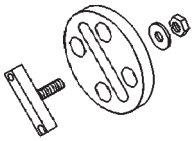
Crankshaft Barring Tool - 7471 - B



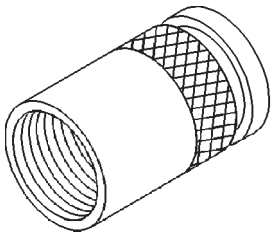
Crankshaft Front Oil Seal Installer - 8281



Injector Removal Tool - 8318

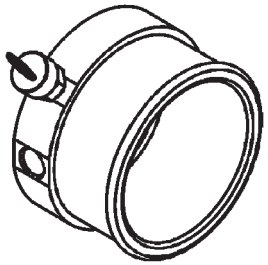


Valve Spring Compressor - 8319 - A

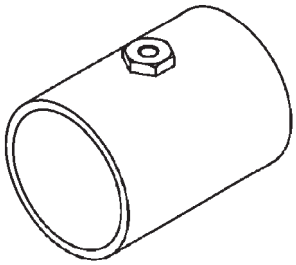


Injector Connector Removal Tool - 8324

ENGINE 5.9L DIESEL (Continued)



TEST PLUG - 8442



ADAPTER - 8462

ENGINE DATA PLATE

DESCRIPTION

The engine data plate contains specific information that is helpful to servicing and obtaining parts for the engine. The data plate is located on the left side of the engine, affixed to the gear housing. Information that can be found on the data plate includes:

- Date of Engine Manufacture
- Engine Serial Number
- Control Parts List (CPL)
- Engine Rated Horsepower
- Engine Firing Order
- Engine Displacement
- Valve Lash Reset Specifications

If the engine data plate is missing or not legible, the engine serial number is used for engine identification. The engine serial number is stamped on the right side of the block, on top of the oil cooler cavity (Fig. 10) .

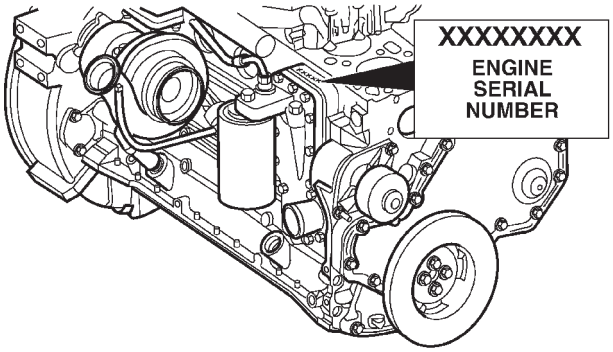


Fig. 10 Engine Serial Number Location

AIR CLEANER ELEMENT

REMOVAL

Testing Air Cleaner Element using Filter Minder

Do not attempt to unnecessarily remove the top of the air cleaner housing for air cleaner element inspection on diesel engines.

The air cleaner (filter) housing is equipped with an air Filter Minder™ gauge (Fig. 11). This air flow restriction gauge will determine when the air cleaner element is restricted and should be replaced.

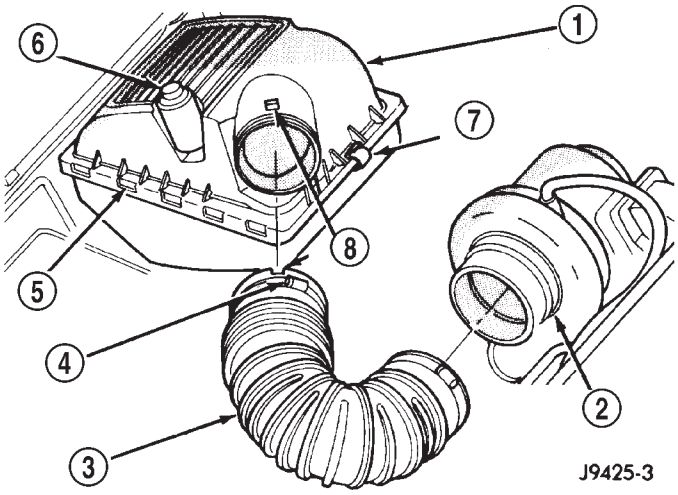


Fig. 11 Filter Minder™—Location—Diesel Engine

1 - AIR FILTER HOUSING COVER
2 - TURBOCHARGER
3 - AIR INLET TUBE
4 - HOSE CLAMP
5 - HINGE TABS
6 - FILTER MINDER
7 - CLIPS (4)
8 - TUBE ALIGNMENT NOTCHES

The Filter Minder™ consists of a diaphragm and calibrated spring sealed inside of a plastic housing (Fig. 12). A yellow colored disc attached to the diaphragm moves along a graduated scale on the side of the Filter Minder. After the engine has been shut off, a ratcheting device located within the Filter Minder will hold the yellow disc at the highest restriction that the air cleaner element has experienced. A drop in air pressure due to an air cleaner element restriction moves the diaphragm and the yellow disc will indicate the size of the air drop.

AIR CLEANER ELEMENT (Continued)

CAUTION: Certain engine degreasers or cleaners may discolor or damage the plastic housing of the Filter Minder. Cover and tape the Filter Minder if any engine degreasers or cleaners are to be used.

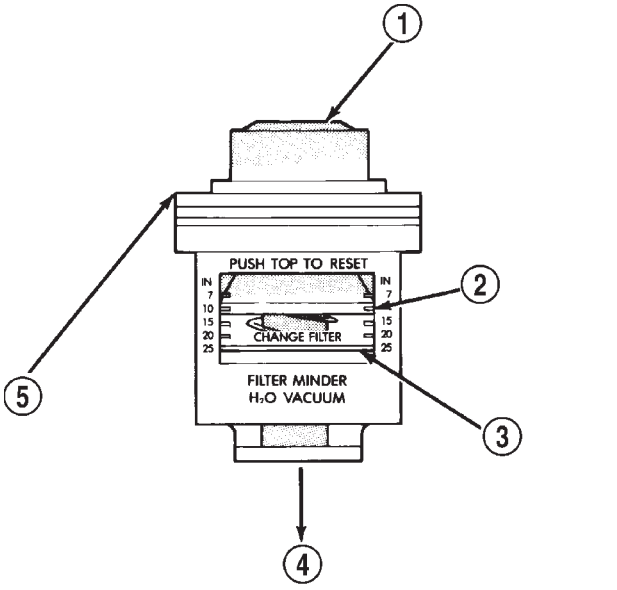


Fig. 12 Filter Minder™—Diesel Engine

1 - PRESS BUTTON TO RESET
2 - YELLOW DISC
3 - RED ZONE
4 - TO AIR FILTER HOUSING
5 - FILTER MINDER

To test, turn the engine off. If the yellow disc (Fig. 12) has reached the red colored zone on the graduated scale, the air cleaner element should be replaced. Refer to the proceeding removal/installation paragraphs.

Resetting the Filter Minder: After the air cleaner (filter) element has been replaced, press the rubber button on the top of the Filter Minder (Fig. 12). This will allow the yellow colored disc to reset. After the button has been pressed, the yellow disc should spring back to the UP position.

If the Filter Minder gauge has reached the red colored zone, and after an examination of the air cleaner (filter) element, the element appears to be clean, the high reading may be due to a temporary condition such as snow build-up at the air intake. Temporary high restrictions may also occur if the air cleaner (filter) element has gotten wet such as during a heavy rain or snow. If this occurs, allow the element to dry out during normal engine operation. Reset the rubber button on the top of the Filter Minder and retest after the element has dried.

Removal

(1) Loosen air inlet tube clamp at air cleaner housing inlet (Fig. 11). Remove this tube at air cleaner housing cover.

(2) The housing cover is equipped with four (4) spring clips (Fig. 11) and is hinged at front with plastic tabs. Unlatch clips from top of air cleaner housing and tilt housing cover up and forward for cover removal.

(3) Remove air cleaner element from air cleaner housing.

INSTALLATION

(1) Before installing a new air cleaner element, clean inside of air cleaner housing.

(2) Position air cleaner cover to tabs on front of air cleaner housing. Latch four spring clips to seal cover to housing.

(3) Install air inlet tube at air cleaner housing inlet. Note hose alignment notches at both inlet hose and air cleaner cover (Fig. 11).

(4) Position tube clamp to inlet tube and tighten to 3 N·m (25 in. lbs.) torque.

CYLINDER HEAD

DESCRIPTION

The cylinder head (Fig. 13) is constructed of cast iron and is a one piece cross flow design with four valves per cylinder. The arrangement of two intake and two exhaust valves per cylinder allows for a centrally located injector. The cylinder head also includes an integral intake manifold, an integral thermostat housing, and a longitudal fuel return rifle, which exits at the rear of the head. The 24 valve design also includes integrally cast valve guides and hardened intake and exhaust valve seat inserts.

REMOVAL

(1) Disconnect battery negative cables.

(2) Raise vehicle on hoist.

(3) Drain engine coolant.

(4) Disconnect exhaust pipe from turbocharger elbow (Fig. 14).

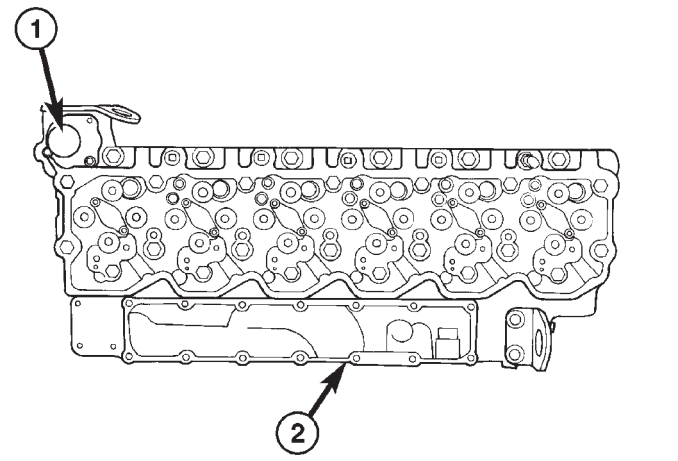
(5) Lower vehicle.

(6) Remove air cleaner housing and snorkel from the vehicle. Cap off turbocharger air inlet to prevent intrusion of dirt or foreign material.

(7) Disconnect cab heater core supply and return hoses from the cylinder head and heater pipe.

(8) Disconnect turbocharger oil drain tube at rubber hose connection. Cap off open ports to prevent intrusion of dirt or foreign material.

CYLINDER HEAD (Continued)



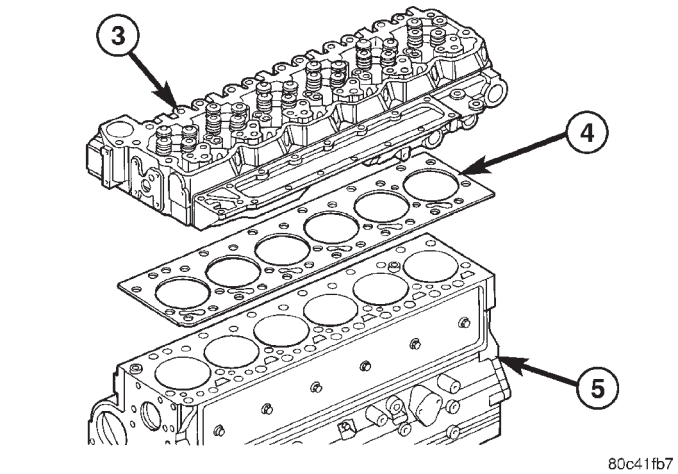


Fig. 13 Cylinder Head and Gasket

1 - THERMOSTAT BORE
2 - INTAKE RUNNER
3 - CYLINDER HEAD
4 - CYLINDER HEAD GASKET
5 - CYLINDER BLOCK

(9) Disconnect turbocharger oil supply line at the turbocharger end. Cap off open ports to prevent intrusion of dirt or foreign material.

(10) Remove exhaust manifold-to-cylinder head bolts and spacers. Remove exhaust manifold and turbocharger from the vehicle as an assembly.

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

(12) Remove generator upper bracket.

(13) Disconnect radiator upper hose from the thermostat housing.

(14) Disconnect the coolant temperature sensor connector.

(15) Remove the engine harness to cylinder head attaching bolt at front of head.

(16) Remove the engine harness ground fastener at front of head below the thermostat housing.

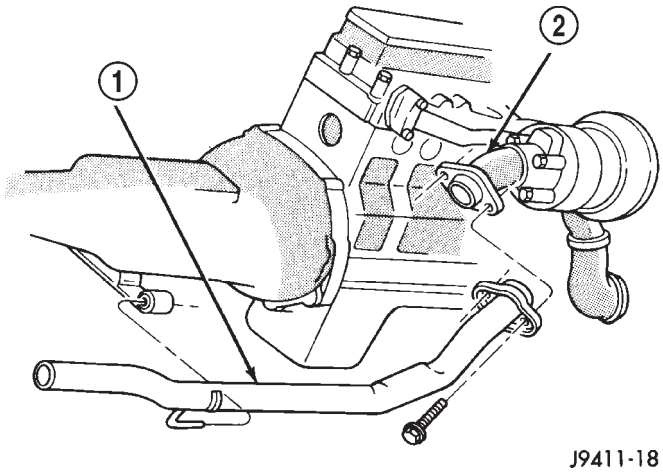


Fig. 14 Exhaust Pipe-to-Turbocharger Elbow

1 - EXHAUST PIPE
2 - TURBOCHARGER EXHAUST PIPE

(17) Remove the throttle linkage cover (Fig. 15).

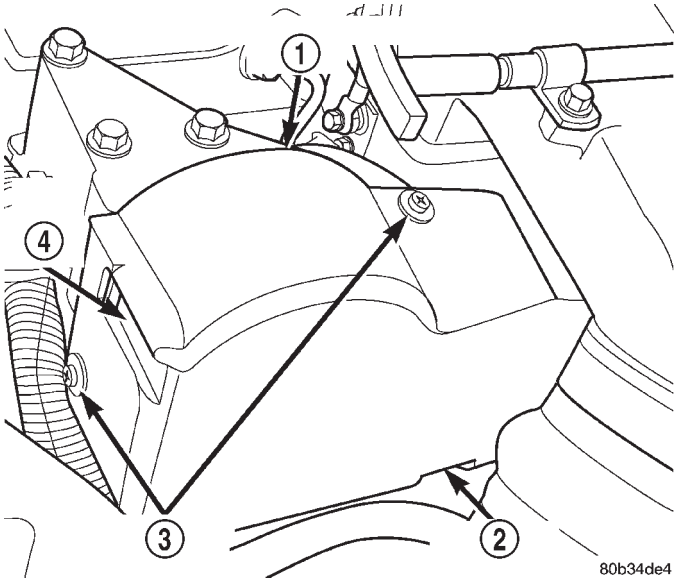


Fig. 15 Throttle Linkage Cover

1 - CABLE/LEVER/LINKAGE COVER
2 - PUSH UP LOWER TAB
3 - SCREWS/CLIPS (2)
4 - TAB PUSH HERE

(18) Remove the six (6) accelerator pedal position sensor assembly-to-cylinder head bracket bolts (Fig. 16) and secure the entire assembly out of the way. Disconnect the APPS connector (Fig. 17). **It is not necessary to disconnect the cables from the throttle control assembly.**

(19) Remove the intake air grid heater wires from the grid heater.

(20) Remove engine oil level indicator tube attaching bolt from the air inlet housing.

CYLINDER HEAD (Continued)

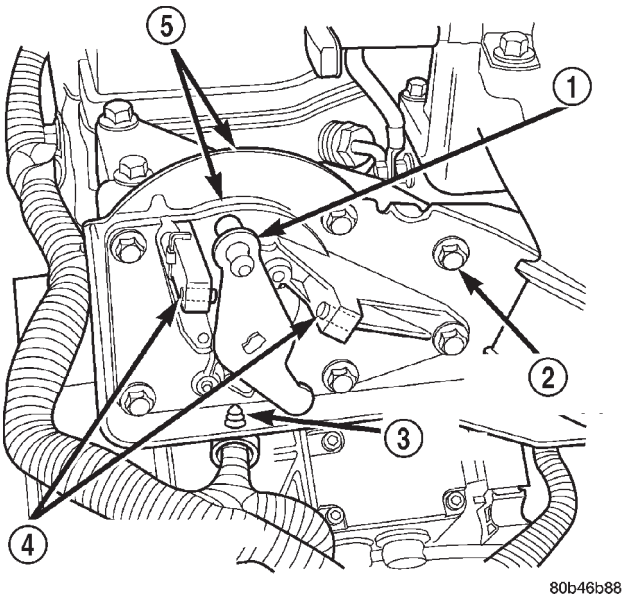


Fig. 16 APPS Assembly

1 - LEVER
2 - MOUNTING BOLTS (6)
3 - WIRE HARNESS CLIP
4 - CALIBRATION SCREWS (NO ADJUSTMENT)
5 - APPS ASSEMBLY

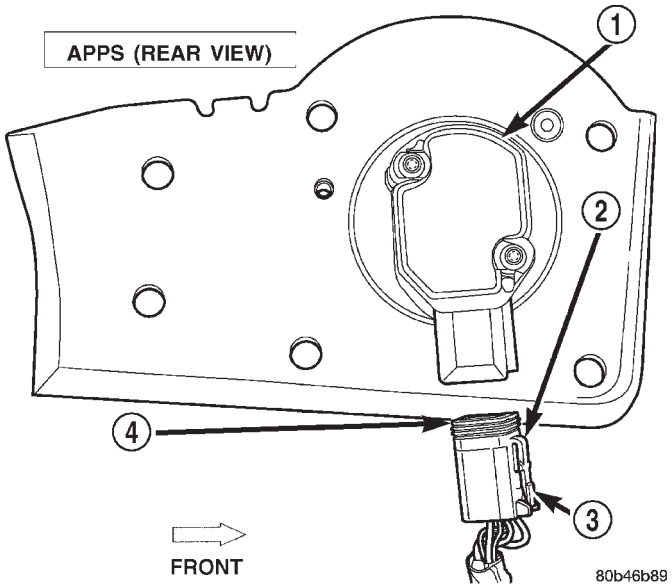


Fig. 17 APPS Connector

1 - APPS
2 - TAB
3 - PUSH FOR REMOVAL
4 - APPS CONNECTOR

(21) Remove the charge air cooler-to-air inlet housing pipe.

(22) Remove the air inlet housing and intake grid heater from the intake manifold cover.

(23) Remove the engine lift bracket from the rear of the cylinder head.

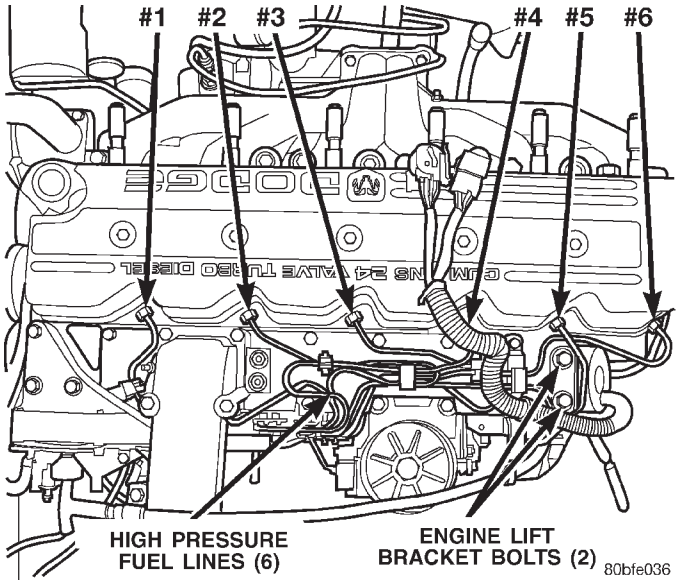


Fig. 18 High-Pressure Lines at Cylinder Head

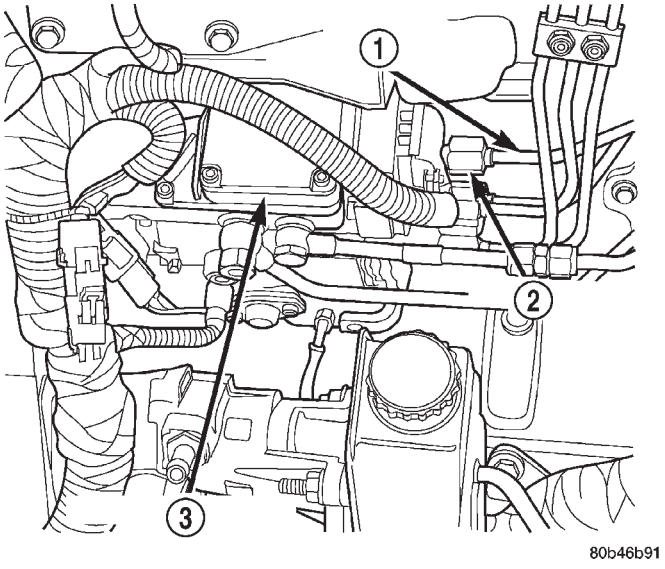


Fig. 19 High-Pressure Lines at Fuel Injection Pump

1 - HIGH-PRESSURE LINES AT INJECTION PUMP
2 - FITTINGS
3 - FUEL INJECTION PUMP

(24) **Remove the high pressure fuel lines (Fig. 18) (Fig. 19) from the engine as follows:**

(a) Remove all injection line-to-intake manifold cover support bracket bolts.

(b) Loosen the #1, 2, and 4 cylinder high pressure lines at the injection pump.

(c) Loosen the #1, 2, and 4 cylinder high pressure lines at the cylinder head.

(d) Remove the #1, 2, and 4 cylinder high pressure line bundle from the engine.

CYLINDER HEAD (Continued)

(e) Loosen the #3, 5, and 6 cylinder high pressure lines at the injection pump.

(f) Loosen the #3, 5, and 6 cylinder high pressure lines at the cylinder head.

(g) Remove the #3, 5, and 6 cylinder high pressure line bundle from the engine.

(25) Remove the lift pump-to-fuel filter low pressure line.

(26) Remove the fuel filter-to-injection pump low pressure line.

(27) Disconnect the water-in-fuel and fuel heater connectors.

(28) Remove the fuel filter assembly-to-manifold cover bolts and remove filter assembly from vehicle.

(29) Disconnect the Intake Air Temperature and Manifold Air Pressure sensor connectors (Fig. 20).

(30) Remove the cylinder head cover (Fig. 21) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(31) Remove the rocker levers (Fig. 22), cross heads and push rods (Fig. 23). Mark each component so they can be installed in their original positions.

NOTE: The #5 cylinder exhaust and the #6 cylinder intake and exhaust push rods are removed by lifting them up and through the provided cowl panel access holes. Remove the rubber plugs to expose these relief holes.

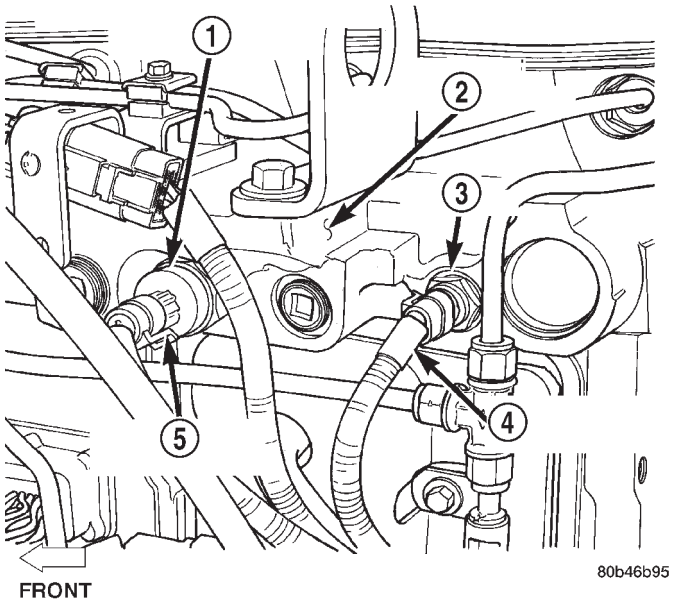


Fig. 20 IAT and MAP Sensor Location

1 - MANIFOLD AIR PRESSURE (MAP) SENSOR
2 - REAR OF CYLINDER HEAD
3 - IAT SENSOR
4 - ELECTRICAL CONNECTOR
5 - ELECTRICAL CONNECTOR

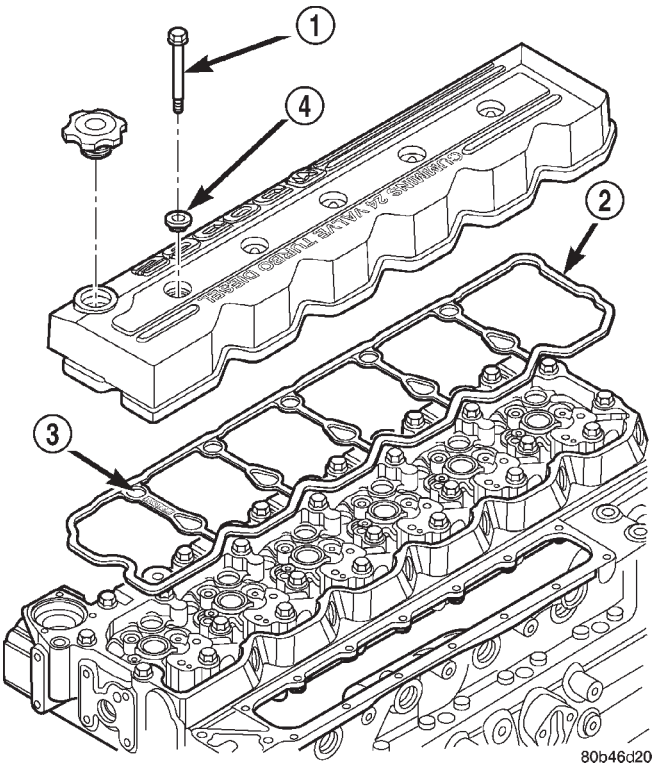


Fig. 21 Cylinder Head Cover Removal

1 - BOLT (5)
2 - GASKET
3 - “TOP FRONT”
4 - ISOLATOR (5)

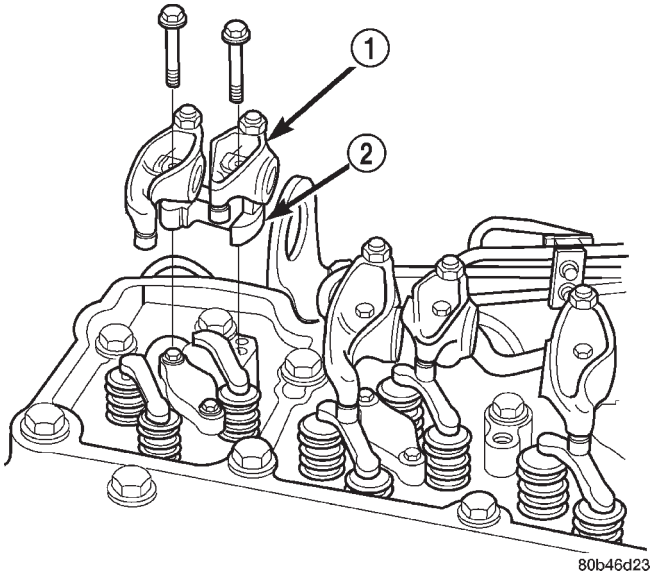


Fig. 22 Rocker Arms and Pedestal Removal

1 - ROCKER ARM
2 - PEDESTAL

CYLINDER HEAD (Continued)

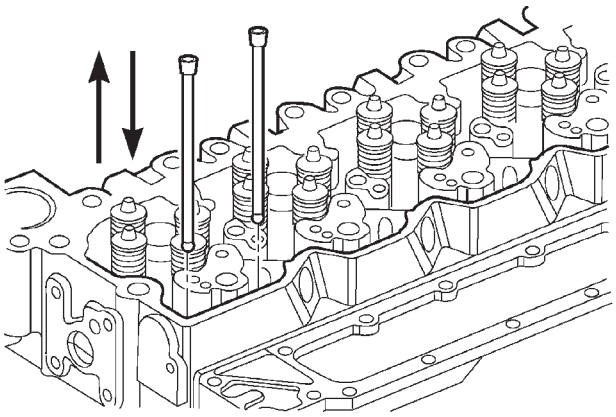


Fig. 23 Push Rod Removal

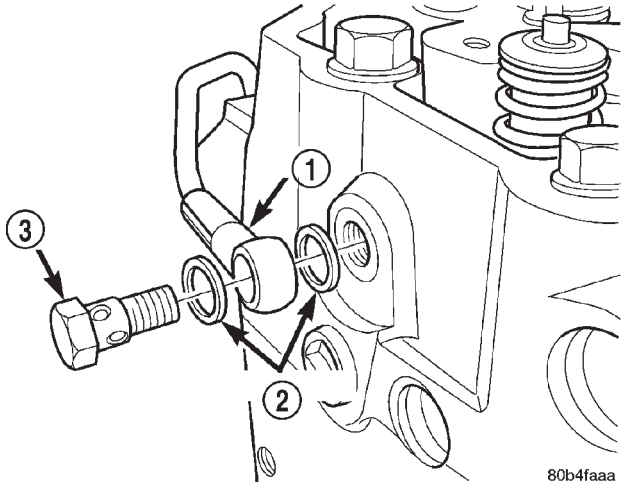


Fig. 24 Fuel Drain Fitting at Rear of Head

1 - LINE
2 - WASHERS
3 - BANJO BOLT

(32) Remove the fuel return line banjo bolt at the rear of the cylinder head (Fig. 24). Be careful not to drop the two (2) sealing washers.

(33) Reinstall the engine lift bracket at the rear of cylinder head.

(34) Remove twenty six (26) cylinder head-to-block bolts.

(35) Attach an engine lift crane to engine lift brackets and lift cylinder head off engine and out of vehicle.

(36) Remove the head gasket and inspect for failure.

CLEANING

CLEANING—CYLINDER HEAD

CAUTION: Do not wire brush head surface while fuel injectors are still installed. Fuel injector damage can result.

Clean the carbon from the injector nozzle seat with a nylon or brass brush.

Scrape the gasket residue from all gasket surfaces.

Wash the cylinder head in hot soapy water solution (88°C or 140°F).

After rinsing, use compressed air to dry the cylinder head.

Polish the gasket surface with 400 grit paper. Use an orbital sander or sanding block to maintain a flat surface.

CLEANING—CROSSHEADS

Clean all crossheads in a suitable solvent. If necessary, use a wire brush or wheel to remove stubborn deposits. Rinse in hot water and blow dry with compressed air.

CLEANING—PUSHRODS

Clean the pushrods in a suitable solvent. Rinse in hot water and blow dry with compressed air. If necessary, use a wire brush or wheel to remove stubborn deposits.

INSPECTION

INSPECTION—CYLINDER HEAD

Inspect the cylinder head for cracks in the combustion surface. Pressure test any cylinder head that is visibly cracked. A cylinder head that is cracked between the injector bore and valve seat can be pressure tested and reused if OK; however, if the crack extends **into** the valve seat, the valve seat **must** be replaced.

Visually inspect the cylinder block and head combustion surfaces for localized dips or imperfections. Check the cylinder head and block combustion surfaces for overall out-of-flatness. If either the visual or manual inspection exceeds the limits, then the head or block must be surfaced.

Check the top surface for damage caused by the cylinder head gasket leaking between cylinders.

Inspect the block and head surface for nicks, erosion, etc.

Check the head distortion (Fig. 25). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.8 mm (2.00 inch) diame-

CYLINDER HEAD (Continued)

ter. Overall variation end to end or side to side 0.30 mm (0.012 inch).

DO NOT proceed with the in-chassis overhaul if the cylinder head or block surface is damaged or not flat (within specifications).

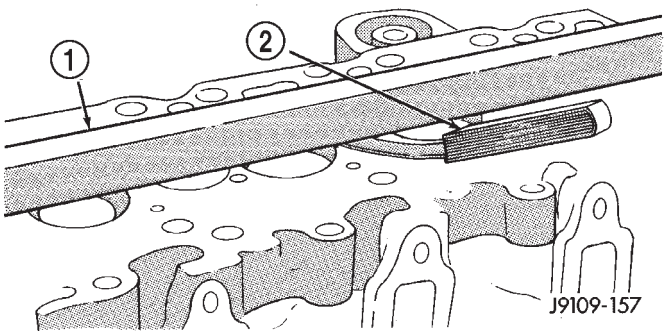


Fig. 25 Cylinder Head Combustion Deck Face

1 - STRAIGHT EDGE
2 - FEELER GAUGE

Visually inspect the cylinder head bolts for damaged threads, corroded/pitted surfaces, or a reduced diameter due to bolt stretching.

If the bolts are not damaged, their “free length” should be measured using the cap screw stretch gauge provided with the replacement head gasket. Place the head of the bolt against the base of the slot and align the bolt with the straight edge of gauge (Fig. 26). If the end of the bolt touches the foot of the gauge, the bolt **must**be discarded. **The maximum bolt free length is 132.1 mm (5.200 in.).**

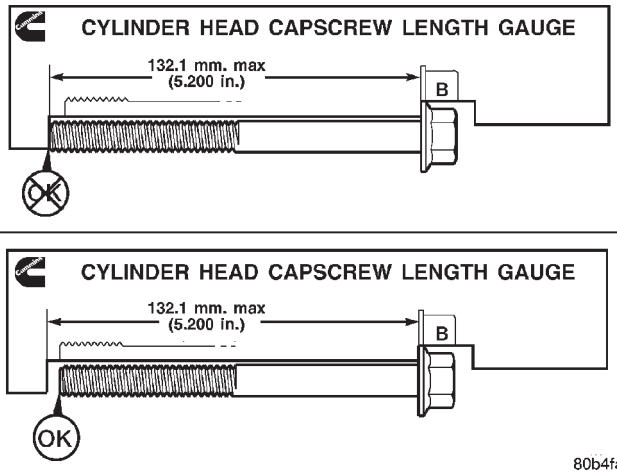


Fig. 26 Head Bolt Stretch Gauge

INSPECTION—CROSSHEADS

Inspect the crossheads for cracks and/or excessive wear on rocker lever and valve tip mating surfaces (Fig. 27). Replace any crossheads that exhibit abnormal wear or cracks.

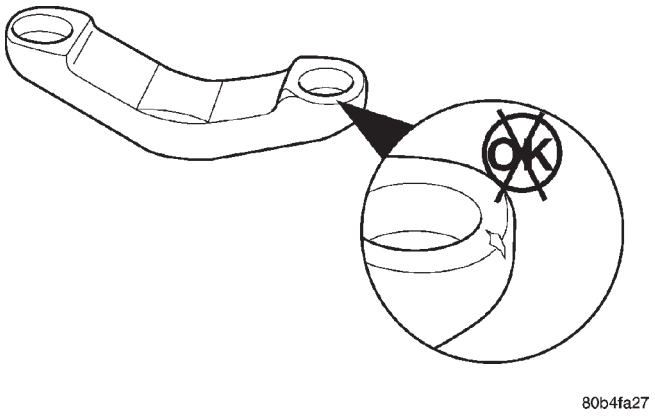


Fig. 27 Inspecting Crosshead for Cracks

INSPECTION—PUSHRODS

Inspect the push rod ball and socket for signs of scoring. Check for cracks where the ball and the socket are pressed into the tube (Fig. 28).

Roll the push rod on a flat work surface with the socket end hanging off the edge (Fig. 29). Replace any push rod that appears to be bent.

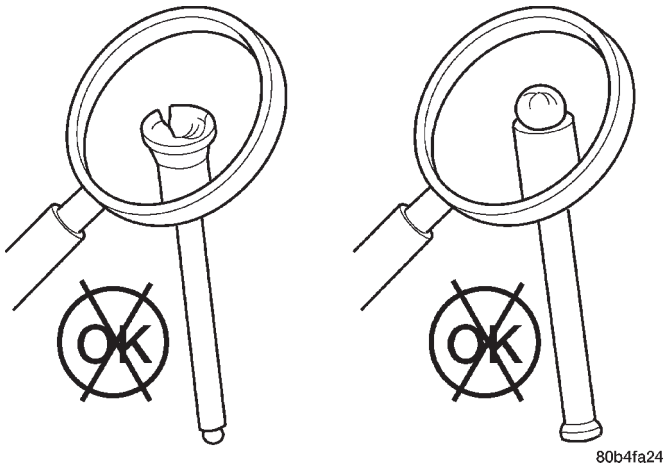


Fig. 28 Inspecting Push Rod for Cracks

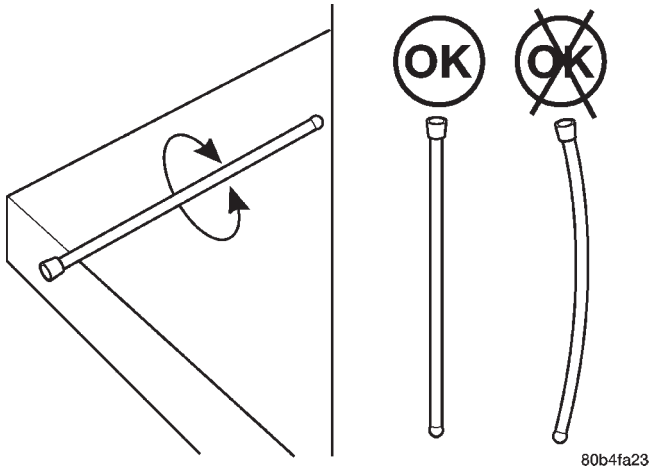


Fig. 29 Inspecting Push Rod for Flatness

CYLINDER HEAD (Continued)

INSTALLATION

WARNING: THE OUTSIDE EDGE OF THE HEAD GASKET IS VERY SHARP. WHEN HANDLING THE NEW HEAD GASKET, USE CARE NOT TO INJURE YOURSELF.

(1) Install a new gasket with the part number side up, and locate the gasket over the dowel sleeves.

(2) Using an engine lifting crane, lower the cylinder head onto the engine.

(3) Lightly lubricate head bolts with engine oil and install. Using the sequence shown in (Fig. 30), tighten bolts in the following steps:

(a) Torque bolts to 80 N·m (59 ft. lbs.)

(b) Torque bolts to 105 N·m (77 ft. lbs.)

(c) Re-check all bolts to 105 N·m (77 ft. lbs.)

(d) Tighten all bolts an additional ¼ turn (90°)

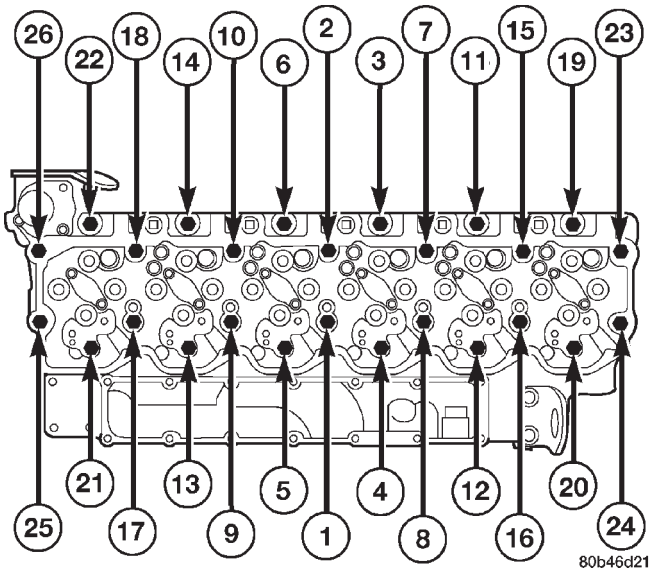


Fig. 30 Cylinder Head Bolt Torque Sequence

(4) Connect fuel return line at rear of head (Fig. 24). Install both sealing washers and torque banjo bolt to 24 N·m (18 ft. lbs.).

(5) Install push rods into their original locations (Fig. 31). **Verify that they are seated in the tappets**.

(6) Lubricate valve stem tips and install the crossheads in their original locations.

(7) Lubricate the rocker arms and pedestals and install them in their original locations (Fig. 32). Install the bolts and torque them to 36 N·m (27 ft. lbs.).

(8) Verify that the valve lash settings are maintained (Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - STANDARD PROCEDURE).

(9) Install cylinder head cover (Fig. 33) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

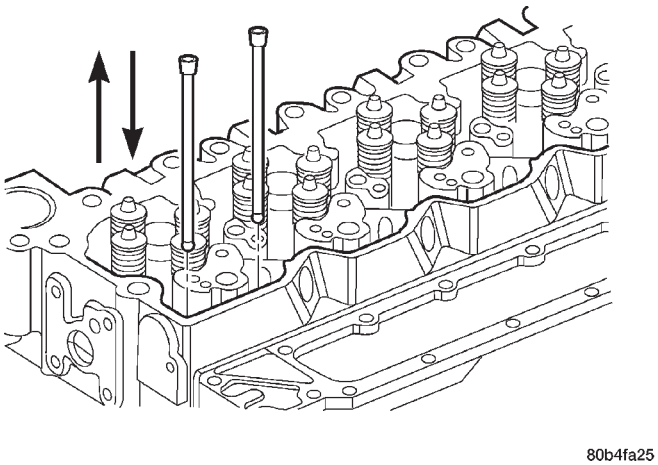


Fig. 31 Push Rod Installation

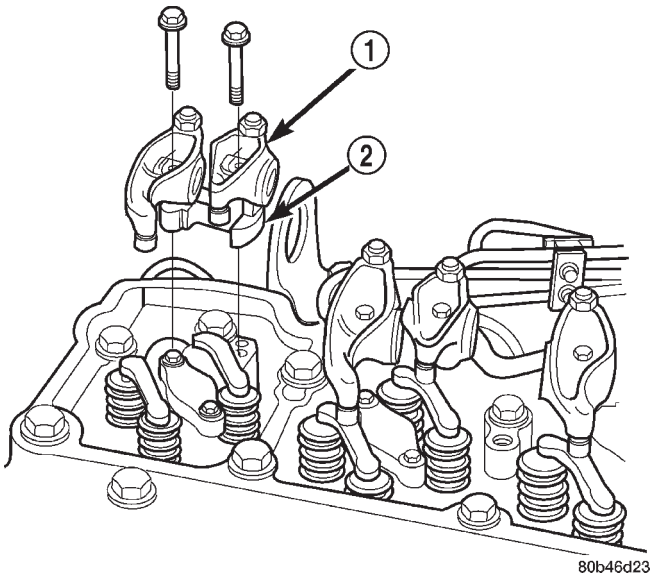


Fig. 32 Rocker Arms and Pedestal Installation

1 - ROCKER ARM
2 - PEDESTAL

(10) Connect the IAT and MAP sensor connectors.

(11) Install the fuel filter canister assembly and torque mounting bolts to 24 N·m (18 ft. lbs.).

(12) Connect the lift pump to fuel filter low pressure line. Torque fittings to 24 N·m (18 ft. lbs.).

(13) Connect the Water-in-Fuel and Fuel Heater Element connectors at the filter assembly.

(14) Remove the engine lift bracket at rear of cylinder head.

(15) **Install the high pressure fuel lines (Fig. 18) (Fig. 19) as follows:**

(a) Lubricate the threads (both ends) of the high pressure line nuts with diesel fuel or engine oil.

CYLINDER HEAD (Continued)

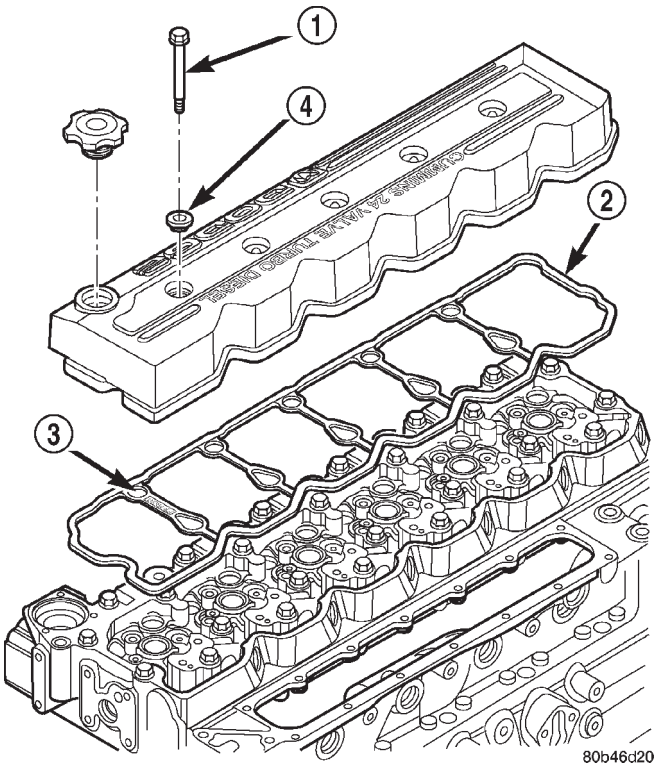


Fig. 33 Cylinder Head Cover Installation

1 - BOLT (5)
2 - GASKET
3 - "TOP FRONT"
4 - ISOLATOR (5)

(b) Install the rear line bundle (cyls. #3, 5, and 6), and tighten the threads at the head and pump by hand.

(c) Torque the connections at the cylinder head first. Torque connections to 38 N·m (28 ft. lbs.).

(d) Torque the line connections at the injection pump to 24 N·m (18 ft. lbs.).

(e) Install the front line bundle (cyls. #1, 2, and 4) following the same procedure used for the rear line bundle.

(f) Torque the connections at the cylinder head first. Torque connections to 38 N·m (28 ft. lbs.).

(g) Torque the line connections at the injection pump to 24 N·m (18 ft. lbs.).

(h) Install the injection line support bracket to intake cover/cylinder head bolts and torque to 24 N·m (18 ft. lbs.).

(16) Install the engine lift bracket at the rear of cylinder head. Torque to 77 N·m (57 ft. lbs.).

(17) Install the fuel filter to injection pump low pressure line. Inspect and replace sealing washers if necessary. Torque banjo bolts to 24 N·m (18 ft. lbs.).

(18) Using new gaskets, install the intake grid heater and air inlet housing. Torque bolts to 24 N·m (18 ft. lbs.).

(19) Connect the APPS connector (Fig. 17).

(20) Install the APPS assembly. to the cylinder head bracket and torque bolts to 12 N·m (105 in. lbs.).

(21) Install the throttle linkage cover (Fig. 15).

(22) Install the charge air cooler-to-air inlet housing duct assembly. Torque all clamps to 11 N·m (100 in. lbs.).

(23) Connect intake grid heater wires.

(24) Fasten engine harness to front of cylinder head with bolt.

(25) Install engine harness ground wire and torque bolt to 24 N·m (18 ft. lbs.).

(26) Connect engine coolant temperature sensor connector.

(27) Connect radiator upper hose to thermostat housing.

(28) Install generator upper bracket and torque bolts to 41 N·m (31 ft. lbs.).

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

(30) Install exhaust manifold/turbocharger assembly. and start all bolts/spacers by hand. Torque bolts to 43 N·m (32 ft. lbs.).

(31) Connect turbocharger oil drain tube.

(32) Perform the turbocharger pre-lube procedure. Refer to Group 11, Exhaust System and Turbocharger for the correct procedure.

(33) Connect the turbocharger oil supply line.

(34) Install air cleaner housing and duct.

(35) Raise vehicle on hoist.

(36) Install exhaust pipe to turbocharger elbow (Fig. 14). Torque bolts to 34 N·m (25 ft. lbs.).

(37) Lower vehicle.

(38) Fill engine coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).

(39) Start engine and check for leaks.

CYLINDER HEAD COVER(S)

REMOVAL

(1) Disconnect both battery negative cables.

(2) Loosen the five (5) cylinder head cover bolts (Fig. 34) . Remove the front three bolts and leave the rear two bolts in the cover.

(3) Lift cover off of cylinder head.

CLEANING

Using a suitable solvent, Clean and dry gasket mating surfaces on cylinder head and cover. Wipe gasket dry and inspect for re-use.

CYLINDER HEAD COVER(S) (Continued)

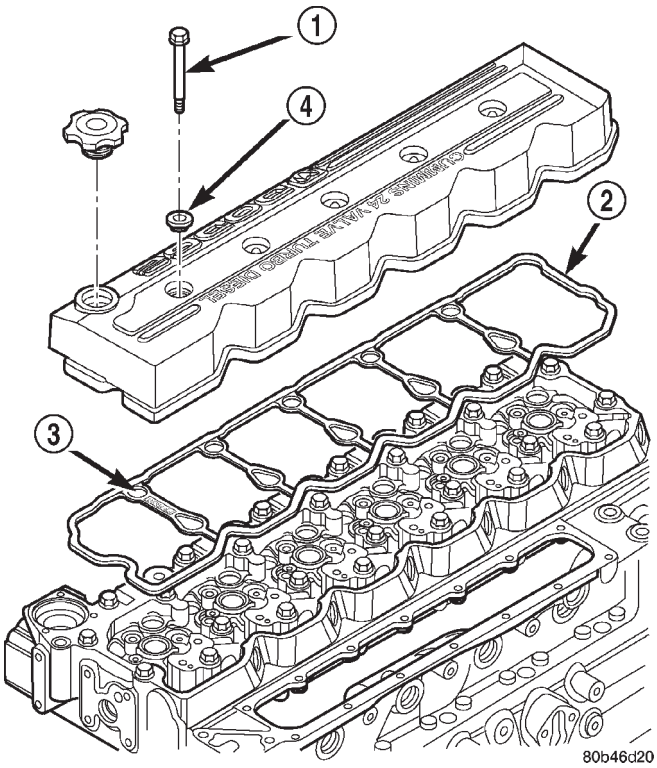


Fig. 34 Cylinder Head Cover and Gasket

1 - BOLT (5)
2 - GASKET
3 - “TOP FRONT”
4 - ISOLATOR (5)

INSPECTION

The cylinder head cover gasket and isolators are reusable. However, should cracks be present in the rubber/silicone construction, the defective components should be replaced.

INSTALLATION

(1) Install the gasket as shown in (Fig. 34). Make sure the gasket is properly located around the cylinder head bolts, with the words “top front” facing up and towards front of engine.

(2) Place two bolts and isolators into the rear two mounting holes and install the cover.

(3) Install the remaining bolts and isolators. Starting with the center bolt, torque in a circular pattern to 24 N·m (18 ft. lbs.).

(4) Connect both battery negative cables.

INTAKE/EXHAUST VALVES & SEATS

DESCRIPTION

The valves are made of heat resistant steel, and have chrome plated stems to prevent scuffing. The intake and exhaust valves are both similar in head diameter and overall length, but they have unique face angles which makes them non-interchangeable. The valves are distinguished by unique dimples on the exhaust valve head (Fig. 35) .

The exhaust valve springs are made from high strength, chrome silicon steel. The exhaust valve springs are also exhaust brake compatible.

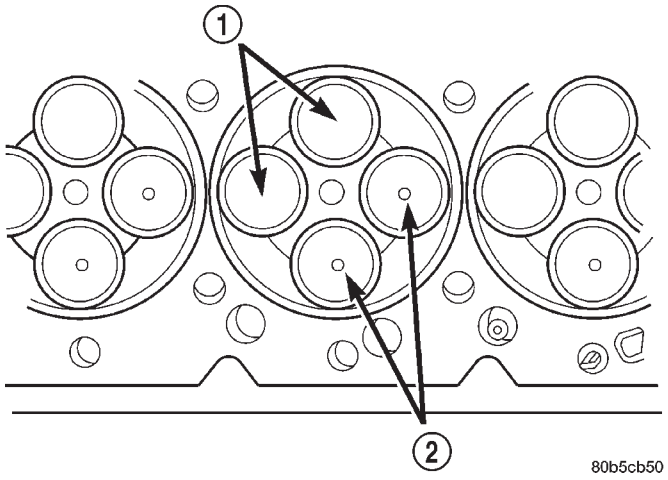


Fig. 35 Valve Identification

1 - INTAKE VALVES
2 - EXHAUST VALVES

STANDARD PROCEDURE

STANDARD PROCEDURE - VALVES,GUIDES AND SPRINGS

REMOVAL

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

(2) Support cylinder head on stands, or install head bolts upside down (through combustion surface side) to protect injector tips from damage from work bench.

(3) Remove the injector clamp (Fig. 36) from the cylinder(s) to be serviced. **Do not remove the bolt shown in (Fig. 36).**

(4) Install the valve spring compressor mounting base (special tool 8319–A) as shown in (Fig. 37). Reinstall the injector clamp bolt finger tight.

(5) Install the compressor top plate, washer, and nut. Using a suitable wrench, tighten the nut (clockwise) to compress the valve springs (Fig. 38) and remove the locks.

(6) Rotate the compressor nut counter-clockwise to relieve tension on the springs. Remove the spring compressor.

(7) Remove the retainers, springs, valve seals (if necessary), and valves (Fig. 39). Arrange or number

all components so they can be installed in their original locations.

(8) Repeat the procedure on all cylinders to be serviced.

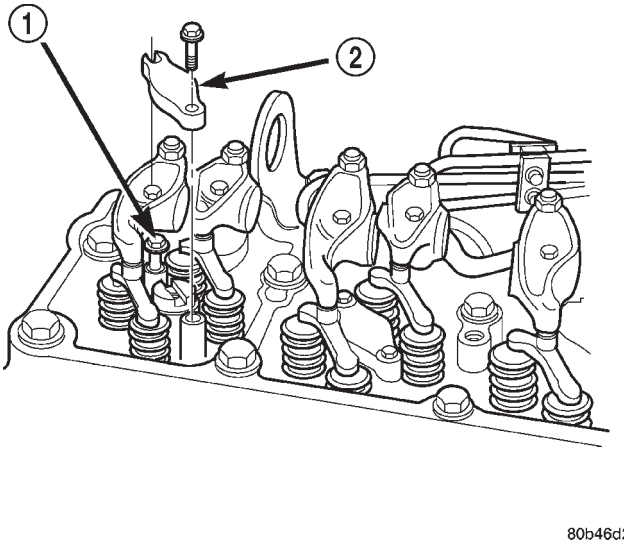


Fig. 36 Injector Clamp Removal/Installation

1 - DO NOT REMOVE
2 - INJECTOR CLAMP

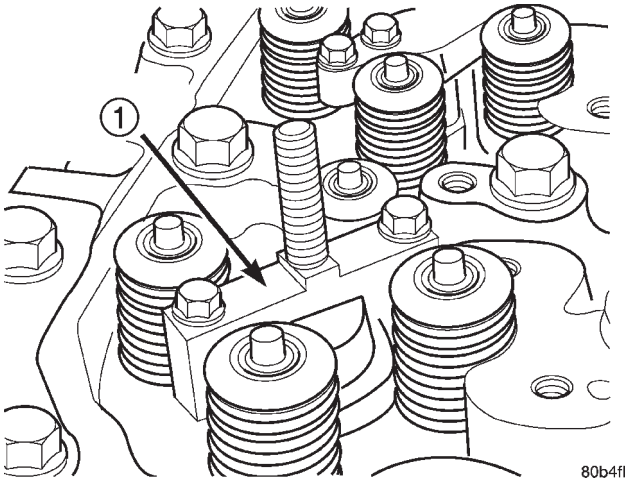


Fig. 37 Spring Compressor Mounting Base—Part of Tool 8319–A

1 - COMPRESSOR MOUNTING BASE

CLEANING

Clean the valve stems with crocus cloth or a Scotch-Brite™ pad. Remove carbon with a soft wire brush. Clean valves, springs, retainers, and valve retaining locks in a suitable solvent. Rinse in hot water and blow dry with compressed air.

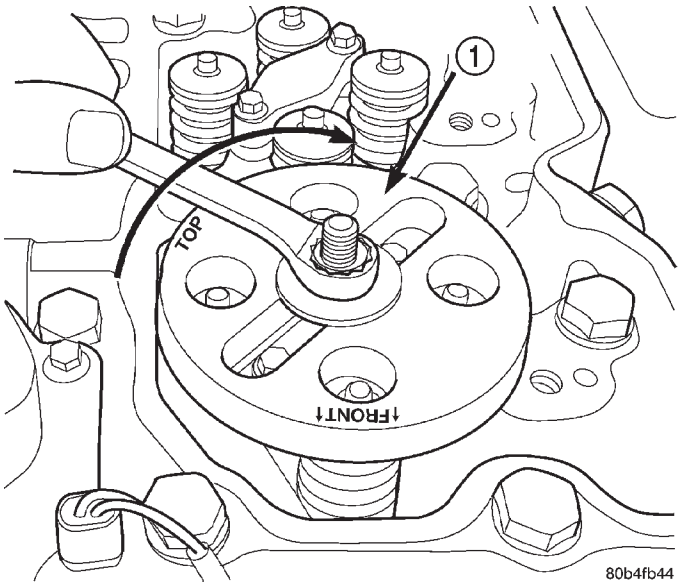


Fig. 38 Compressing Valve Springs with Tool 8319–A

1 - SPECIAL TOOL 8319

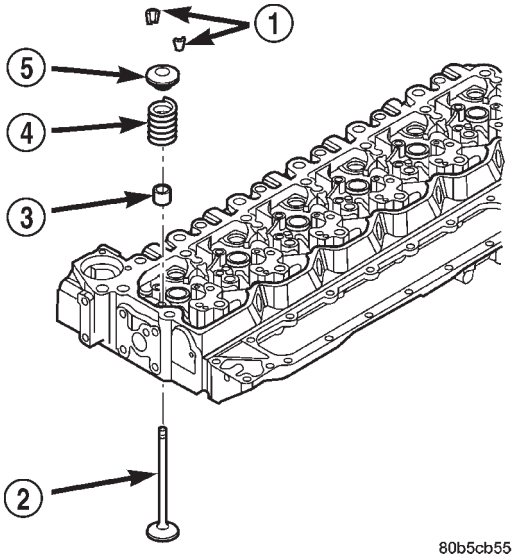


Fig. 39 Valve Spring, Seal, and Retainers

1 - VALVE RETAINING LOCKS
2 - VALVE
3 - SEAL
4 - SPRING
5 - RETAINER

INSPECTION

Visually inspect the valves for abnormal wear on the heads, stems, and tips. Replace any valve that is worn out or bent (Fig. 40).

Measure the valve stem diameter in three places as shown in (Fig. 41). Measure the cylinder head valve guide bore (Fig. 42). Subtract the corresponding

INTAKE/EXHAUST VALVES & SEATS (Continued)

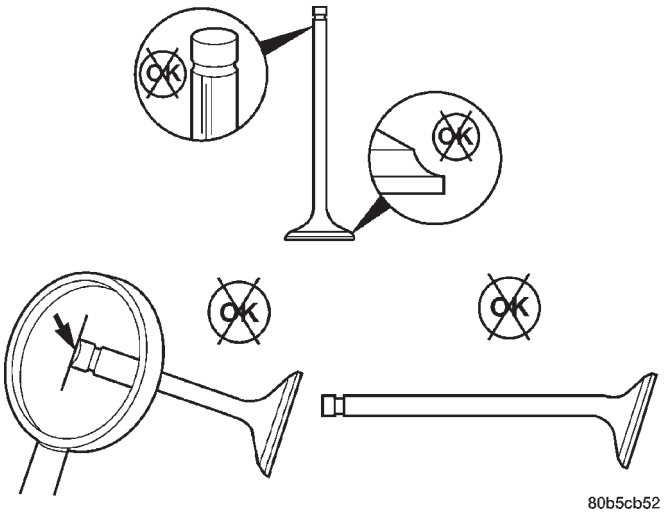


Fig. 40 Visually Inspect Valves for Abnormal Wear

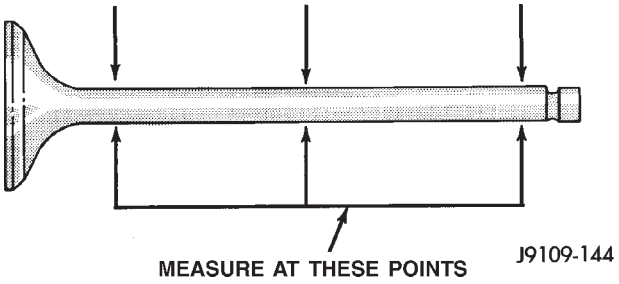


Fig. 41 Measure Valve Stem Diameter

VALVE STEM DIAMETER
6.990 mm (0.2752 in.) MIN
7.010 mm (0.2760 in.) MAX

valve stem diameter to obtain valve stem-to-guide clearance. Measure valve margin (rim thickness)

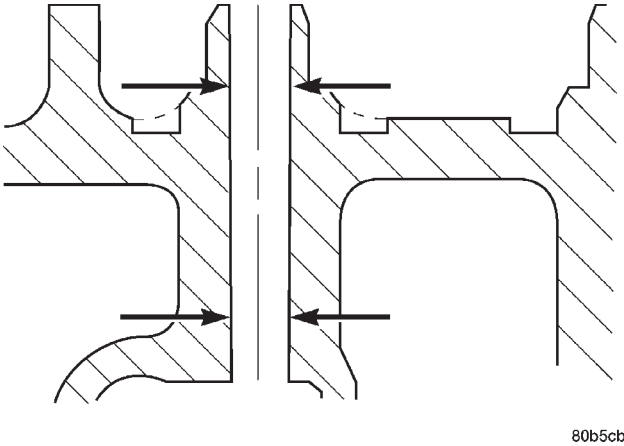


Fig. 42 Measure Valve Guide Bore

(Fig. 43). Measure the valve spring free length and maximum inclination (Fig. 44). Test valve spring force with tool C-647 (Fig. 45).

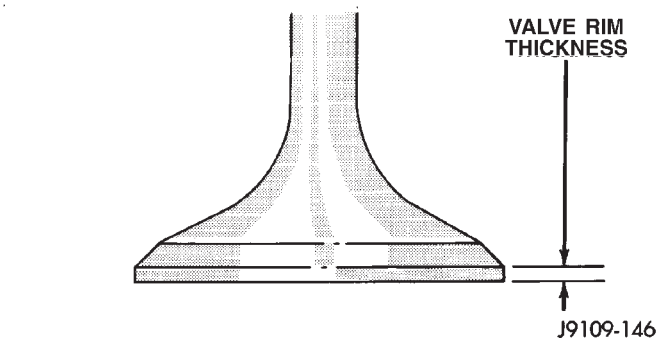


Fig. 43 Measure Valve Margin (Rim Thickness)

VALVE MARGIN (RIM THICKNESS)
0.72 mm (0.031 in.) MIN.

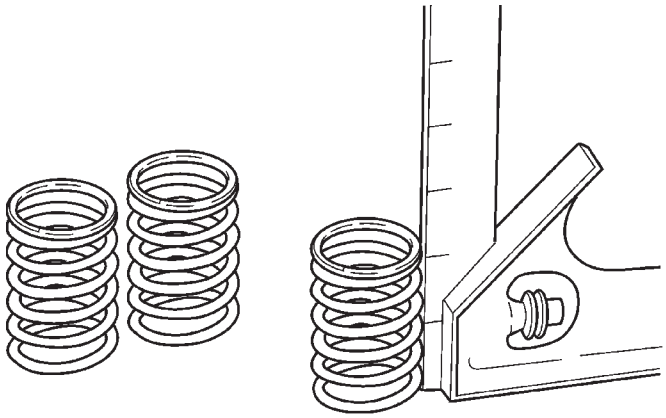


Fig. 44 Measure Valve Spring Free Length and Max. Inclination

VALVE SPRING FREE LENGTH
47.75 mm (1.88 in.)

MAX INCLINATION
1.5 mm (.059 in.)

INSTALLATION

(1) Install new valve seals. The yellow springs are for the intake valves and the green seals are for the exhaust valves.

(2) Install the valves in their original postion. The exhaust valves are identified by a dimple on the valve head (Fig. 46).

(3) Install the valve springs and retainer.

(4) Install the valve spring compressor tool 8319–A as shown in (Fig. 37) and (Fig. 38).

(5) Compress the valve springs and install the valve retaining locks (Fig. 39).

(6) Remove the compressor and repeat the procedure on the remaining cylinders.

(7) Install the injector clamp and hold down bolts and tighten to 10 N·m (89 in. lbs.) torque.

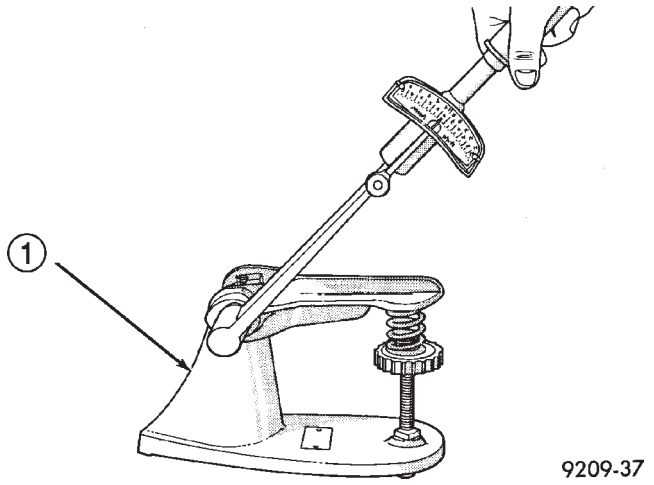


Fig. 45 Testing Valve Spring with Tool C-647

1 - SPECIAL TOOL C-647
VALVE SPRING FORCE 35.33 mm @ 339.8 N (1.39 IN. @76.4 lbs.)

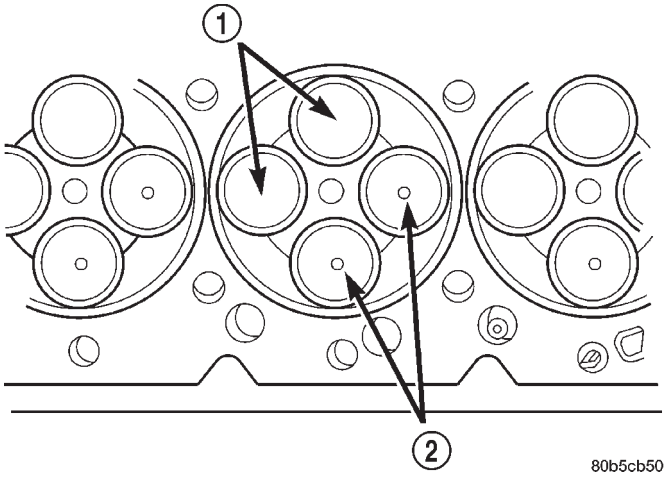


Fig. 46 Valve Identification

1 - INTAKE VALVES
2 - EXHAUST VALVES

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

STANDARD PROCEDURE—VALVE LASH ADJUSTMENT AND VERIFICATION

NOTE: To obtain accurate readings, valve lash measurements AND adjustments should only be performed when the engine coolant temperature is less than 60° C (140° F).

The 24–valve overhead system is a "low-maintenance" design. Routine adjustments are no longer necessary, however, measurement should still take place when trouble-shooting performance problems, or upon completion of a repair that includes removal and installation of the valve train components.

(1) Disconnect battery negative cables.

(2) Remove cylinder head cover (Fig. 47) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(3) Remove the crankcase breather and vapor canister (Fig. 48).

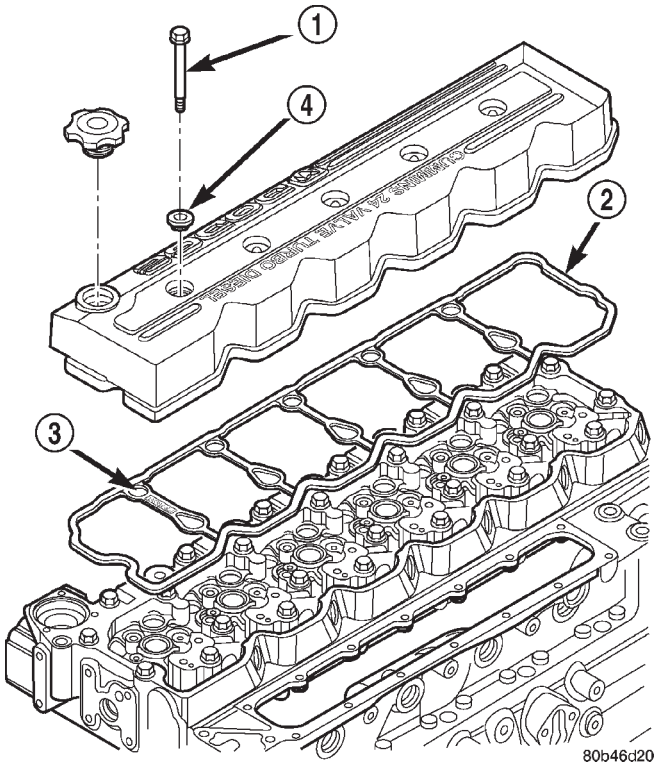


Fig. 47 Cylinder Head Cover and Gasket

1 - BOLT (5)
2 - GASKET
3 - "TOP FRONT"
4 - ISOLATOR (5)

(4) Using the crankshaft barring tool #7471–B, rotate the engine and align the pump gear mark with the top dead center (TDC) mark on the gear housing cover (Fig. 49).

(5) With the engine in this position (pump gear mark at 12 o'clock), valve lash can be measured at the following rocker arms: **INTAKE 1–2–4 / EXHAUST 1–3–5**. Measure the valve lash by inserting a feeler gauge between the rocker arm socket and crosshead (Fig. 50). Refer to VALVE LASH LIMIT CHART for the correct specifications. If the measurement falls **within** the limits, adjustment/resetting **is not** necessary. If measurement finds the lash **outside** of the limits, adjustment/resetting **is** required.

INTAKE/EXHAUST VALVES & SEATS (Continued)

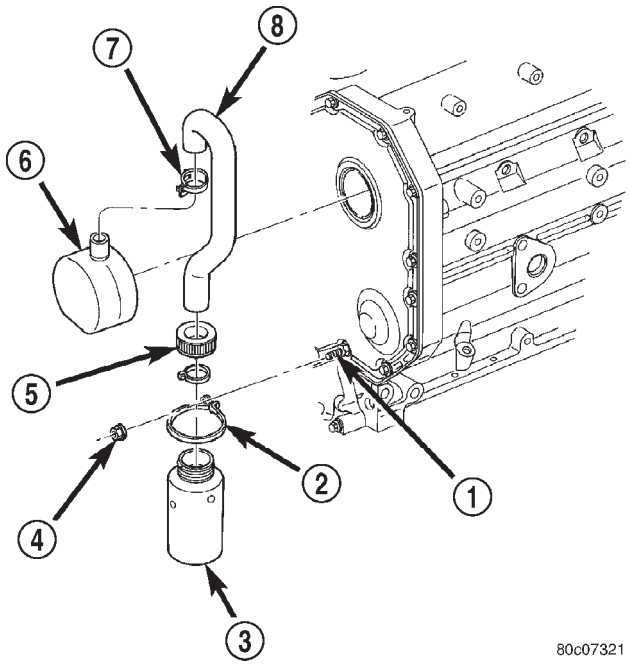


Fig. 48 Crankcase Breather Vapor Canister

1 - ENGINE FRONT COVER STUD
2 - STRAP
3 - VAVOR CANISTER
4 - NUT
5 - CAP
6 - CRANKCASE BREATHER
7 - CLAMP
8 - HOSE

VALVE LASH LIMIT CHART

INTAKE	EXHAUST
0.152 mm (0.006 in.) MIN.	0.381 mm (0.015 in.) MIN.
0.381 mm (0.015 in.) MAX.	0.762 mm (0.030 in.) MAX.

note:
If measured valve lash falls within these specifications, no adjustment/reset is necessary. Engine operation within these ranges has no adverse affect on performance, emissions, fuel economy or level of engine noise.

(6) If adjustment/resetting is required, loosen the lock nut on rocker arms and turn the adjusting screw until the desired lash is obtained:

- **INTAKE** 0.254 mm (0.010 in.)
- **EXHAUST** 0.508 mm (0.020 in.) Tighten the lock nut and re-check the valve lash.

(7) Using the crankshaft barring tool, rotate the **crankshaft** one revolution (360°) to align the pump gear mark to the 6 o'clock position in relation to the TDC mark on the gear housing cover (Fig. 49).

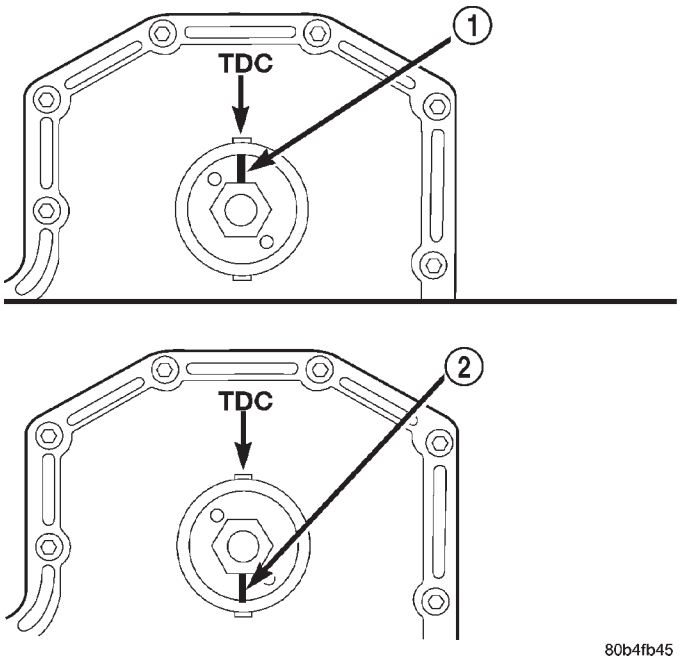


Fig. 49 Fuel Pump Gear Timing Mark Orientation

1 - MEASURE/ADJUST
INTAKE 1, 2, 4
EXHAUST 1, 3, 5
2 - MEASURE/ADJUST
INTAKE 3, 5, 6
EXHAUST 2, 4, 6

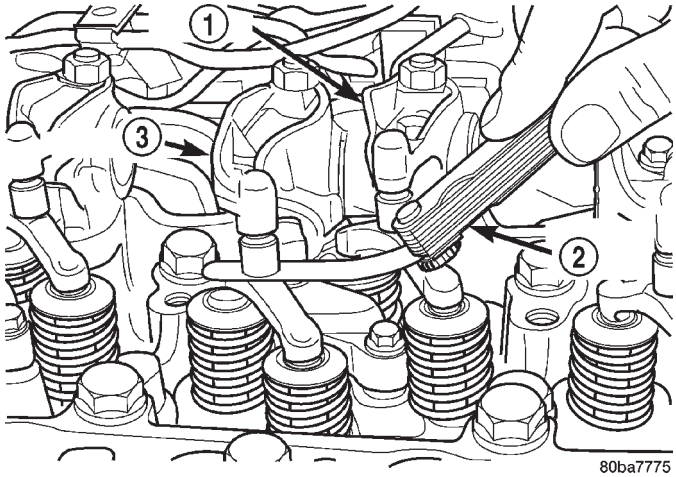


Fig. 50 Measuring Valve Lash

1 - INTAKE
2 - FEELER GAUGE
3 - EXHAUST

(8) With the engine in this position (pump gear mark at 6 o'clock), valve lash can be measured at the remaining rocker arms: **INTAKE 3–5–6 / EXHAUST 2–4–6**. Use the same method as above for determining whether adjustment is necessary, and adjust those that are found to be outside of the limits.

INTAKE/EXHAUST VALVES & SEATS (Continued)

(9) Install the cylinder head cover (Fig. 47) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(10) Install the fuel pump gear access cover.

(11) Connect the battery negative cables.

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove the cylinder head cover (Fig. 52) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(3) Remove the rocker arms and crossheads (Fig. 53) from the cylinder(s) to be serviced. Mark each component so they can be installed in their original position.

(4) Remove the crankcase breather vapor canister and breather housing (Fig. 55).

(5) Using the crankshaft barring tool #7471–B (Fig. 51), rotate the engine to line up the mark on the pump gear with the TDC mark on the cover. **At this engine position, cylinders #1 and #6 can be serviced.**

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

(7) With the fuel injection pump gear mark aligned at TDC, add a paint mark anywhere on the gear housing cover next to the crankshaft damper. Place another mark on the vibration damper in alignment with the mark you just made on the cover.

(8) Divide the crankshaft damper into three equally sized segments as follows:

(a) Using a tape measure, measure the circumference of the crankshaft damper and divide the measurement by three (3).

(b) Measure that distance in a counter-clockwise direction from the first balancer mark and place another mark on the balancer.

(c) From the second damper mark, again measure in a counter-clockwise direction and place a mark on the damper at the same distance you measured when placing the second damper mark.

The damper should now be marked in three equally spaced locations and the fuel pump gear mark should still be aligned with the TDC mark on the cover.

(9) Compress the valve springs at cyls. #1 and #6 as follows:

(a) Remove the injector clamp (Fig. 54) from the cylinder(s) to be serviced. **Do not remove the bolt shown in (Fig. 54).**

(b) Install the valve spring compressor mounting base as shown in (Fig. 56). Reinstall the injector clamp bolt finger tight.

(c) Install the top plate, washer, and nut. Using a suitable wrench tighten the nut (clock-wise) (Fig. 57) to compress the valve springs and remove the collets.

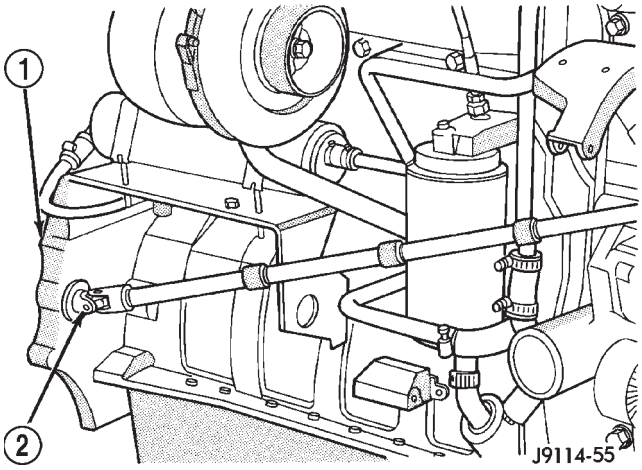


Fig. 51 Rotating Engine with Barring Tool

1 - REAR FLANGE
2 - BARRING TOOL

(d) Rotate the compressor nut counter-clockwise to relieve tension on springs. Remove spring compressor.

(e) Remove and replace retainers, springs, and seals as necessary.

(f) **Do not rotate the engine until the springs and retainers are re-installed.**

(g) Install seals, springs and retainers. Install spring compressor, compress valve springs and install the collets.

(h) Release the spring tension and remove the compressor. Verify that the collets are seated by tapping on the valve stem with a plastic hammer.

(10) Using the crankshaft barring tool, rotate the engine until the next crankshaft damper paint mark aligns with the mark you placed on the cover. **In this position, cylinders #2 and #5 can be serviced.**

(11) Repeat the valve spring compressing procedure previously performed and service the retainers, springs, and seals as necessary.

(12) Using the crankshaft barring tool, rotate the engine until the next crankshaft damper paint mark aligns with the mark you placed on the cover. **In this position, cylinders #3 and #4 can be serviced.**

(13) Repeat the spring compressing procedure previously performed and service the retainers, springs, and seals as necessary.

INSTALLATION

(1) Install all injector clamps into their original location (Fig. 54). Tighten the hold down bolt to 10 N·m (89 in. lbs.) torque.

(2) Lubricate the valve tips and install the crossheads in their original locations.

INTAKE/EXHAUST VALVES & SEATS (Continued)

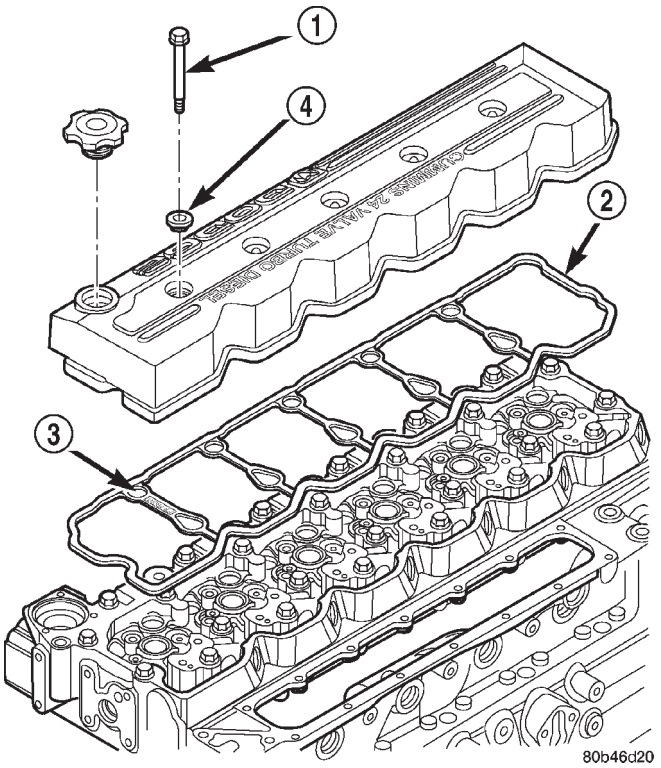


Fig. 52 Cylinder Head Cover Removal/Installation

1 - BOLT (5)
2 - GASKET
3 - “TOP FRONT”
4 - ISOLATOR (5)

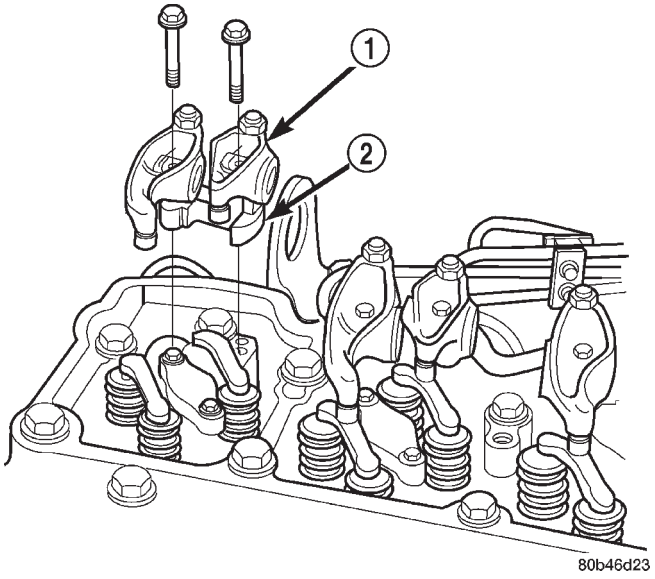


Fig. 53 Rocker Arm and Crosshead Removal/ Installation

1 - ROCKER ARM
2 - PEDESTAL

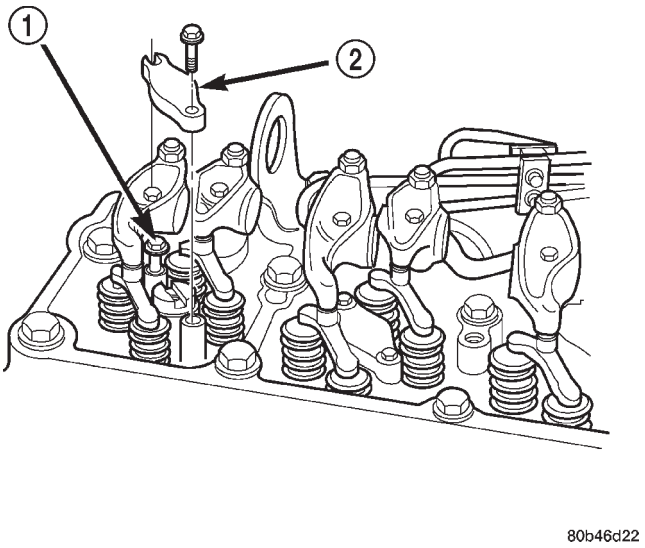


Fig. 54 Injector Clamp Removal/Installation

1 - DO NOT REMOVE
2 - INJECTOR CLAMP

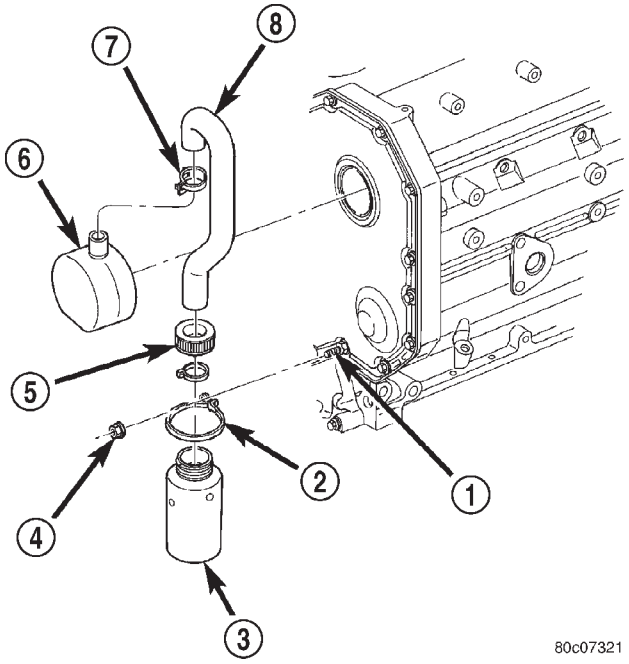


Fig. 55 Crankcase Breather Vapor Canister

1 - ENGINE FRONT COVER STUD
2 - STRAP
3 - VAPOR CANISTER
4 - NUT
5 - CAP
6 - CRANKCASE BREATHER
7 - CLAMP
8 - HOSE

(3) Lubricate the crossheads and push rod sockets and install the rocker arms and pedestals in their

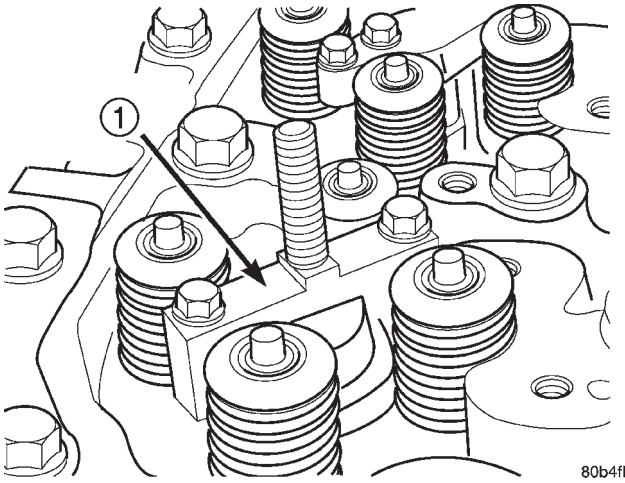


Fig. 56 Spring Compressor Mounting Base—Part of Tool 8319–A

1 - COMPRESSOR MOUNTING BASE

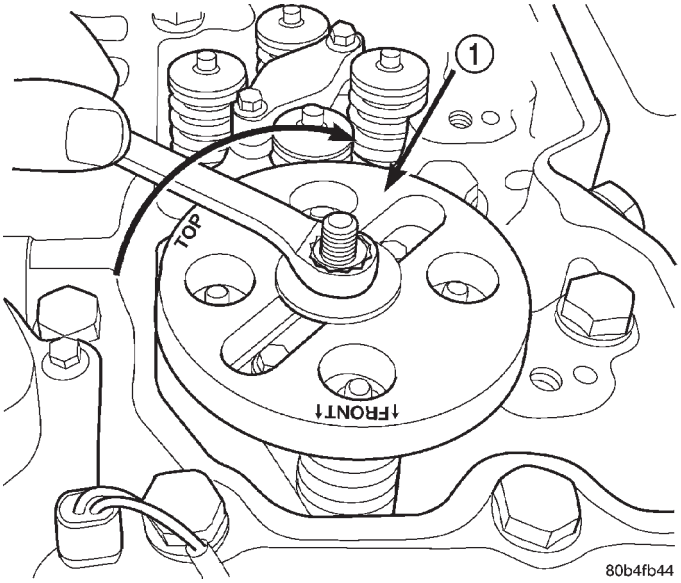


Fig. 57 Compressing Valve Springs with Tool 8319–A

1 - SPECIAL TOOL 8319

original locations (Fig. 53). Tighten bolts to 36 N·m (27 ft. lbs.) torque.

(4) **Verify valve lash adjustment (Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - STANDARD PROCEDURE).**

(5) Install cylinder head cover and reusable gasket (Fig. 52) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

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

(7) Connect battery negative cables.

ROCKER ARM / ADJUSTER ASSY

DESCRIPTION

The 24–valve overhead system incorporates rocker arms that are designed to allow fuel injector service without removing the rocker arms and pedestals. The unique intake and exhaust rocker arms have their own rocker shafts and are lubricated by passages intersecting the cylinder block main oil rifle. Crossheads are used (Fig. 58), which allow each rocker arm to operate two valves.

The solid push rods are hardened at the rocker arm and tappet contact areas for superior strength and durability.

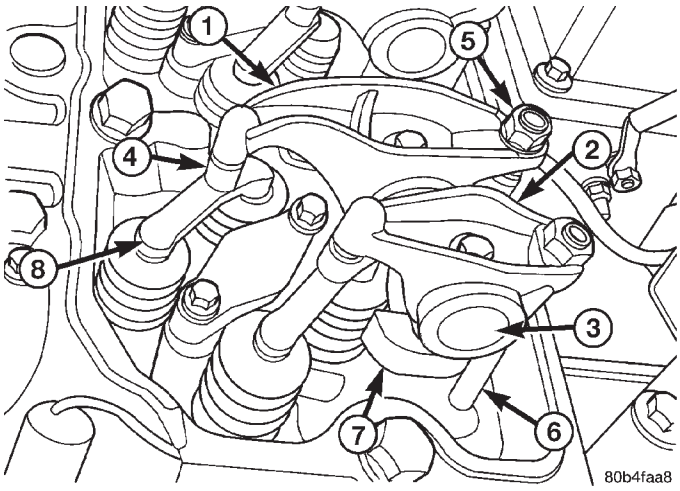


Fig. 58 Overhead System Components

1 - EXHAUST ROCKER ARM
2 - INTAKE ROCKER ARM
3 - ROCKER SHAFT
4 - SOCKET
5 - ADJUSTING SCREW LOCK NUT
6 - PUSH ROD
7 - PEDESTAL
8 - CROSSHEAD

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove cylinder head cover (Fig. 59) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(3) Remove the rocker arm/pedestal fasteners (Fig. 60) and remove rocker arm and pedestal from cylinder head. Mark the arms and pedestals so they can be installed in their original position.

CAUTION: When removing the rocker arms, the sockets (Fig. 61) may come loose and fall into the engine. Make sure they stay with the arm upon removal/installation.

ROCKER ARM / ADJUSTER ASSY (Continued)

(4) Lift the push rod(s) up and out of the engine (Fig. 62). Mark them so they can be installed in their original position.

NOTE: The #5 cyl. exhaust and #6 cyl. intake and exhaust push rods must be raised through the provided cowl panel access holes.

(5) Lift the crosshead(s) off of the valve stems. Mark them so they can be installed in their original position.

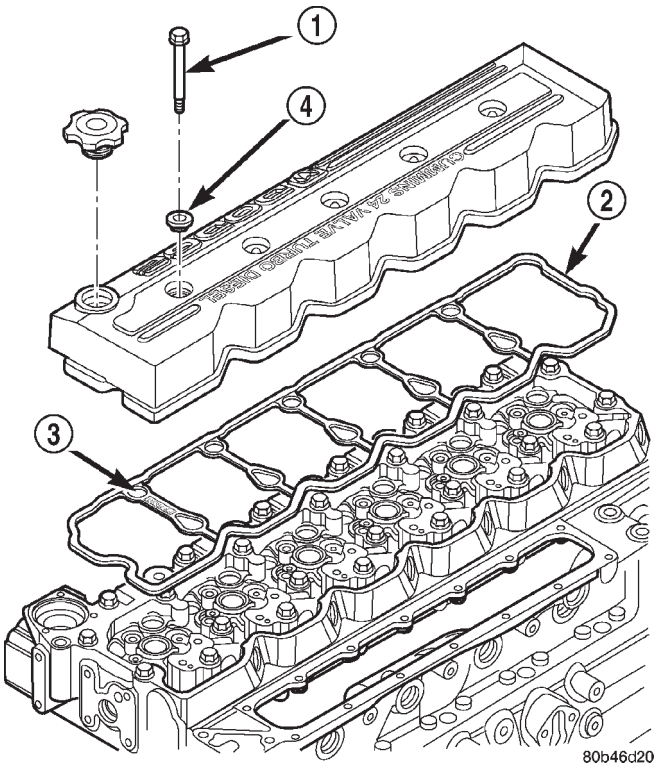


Fig. 59 Cylinder Head Cover—Removal/Installation

1 - BOLT (5)
2 - GASKET
3 - "TOP FRONT"
4 - ISOLATOR (5)

CLEANING

Clean all components in a suitable solvent. If necessary, use a wire brush or wheel to remove stubborn deposits. Rinse in hot water and blow dry with compressed air. Inspect oil passages in rocker arms and pedestals. Apply compressed air to lubrication orifices to purge contaminants.

INSPECTION

Rocker Arms

(1) Remove rocker shaft and inspect for cracks and excessive wear in the bore or shaft. Remove socket and inspect ball insert and socket for signs of wear. Replace retainer if necessary.

Measure the rocker arm bore and shaft (Fig. 63) (Fig. 64).

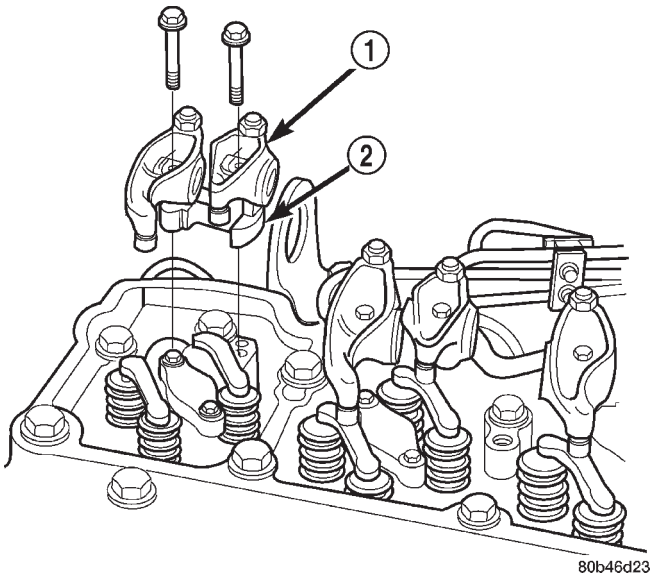


Fig. 60 Rocker Arms and Pedestals—Removal/Installation

1 - ROCKER ARM
2 - PEDESTAL

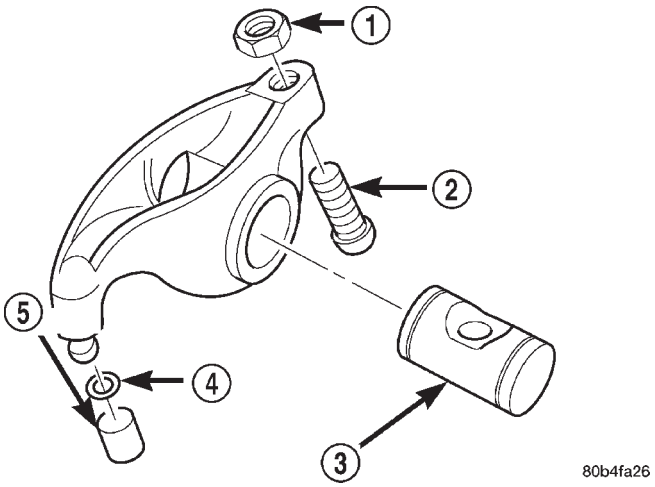


Fig. 61 Rocker Arm Assembly Identification

1 - NUT
2 - ADJUSTING SCREW
3 - ROCKER SHAFT
4 - RETAINER
5 - SOCKET

Push Rods

Inspect the push rod ball and socket for signs of scoring. Check for cracks where the ball and the socket are pressed into the tube (Fig. 65).

ROCKER ARM / ADJUSTER ASSY (Continued)

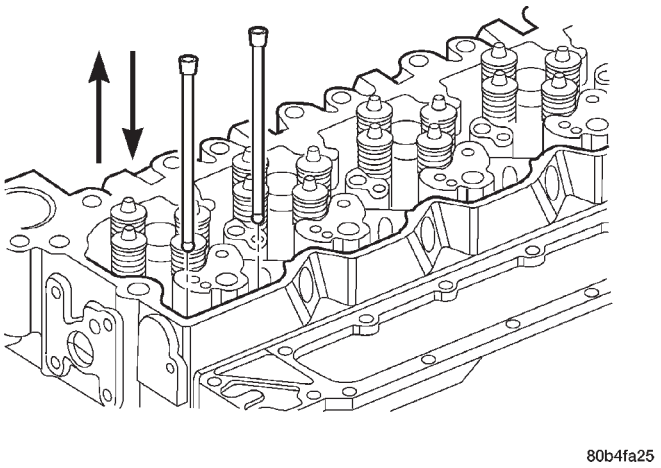


Fig. 62 Push Rod Removal/Installation

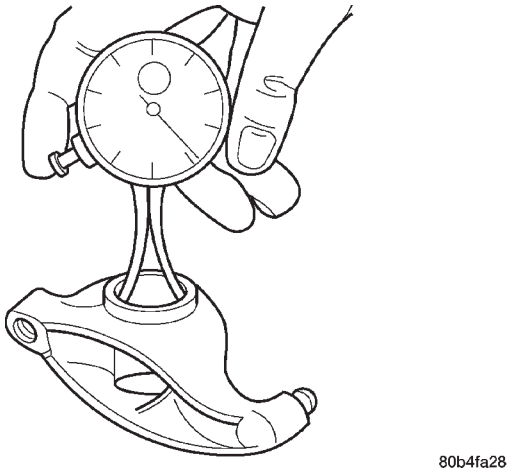


Fig. 63 Measuring Rocker Arm Bore

ROCKER ARM BORE (MAX.)
22.027 mm (.867 in.)

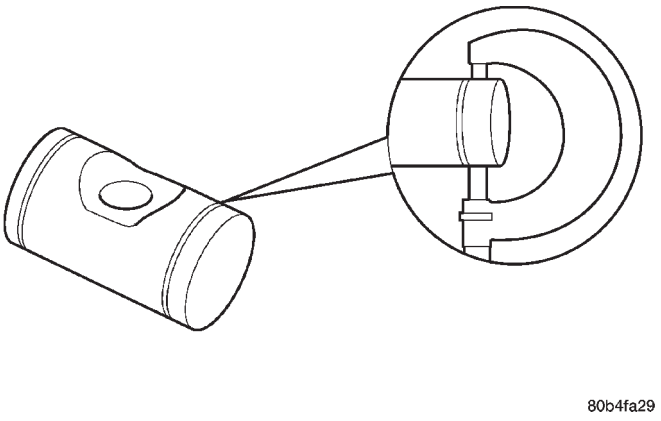


Fig. 64 Measuring Rocker Arm Shaft

ROCKER ARM SHAFT (MIN.)
21.965 mm (.865 in.)

Roll the push rod on a flat work surface with the socket end hanging off the edge (Fig. 66). Replace any push rod that appears to be bent.

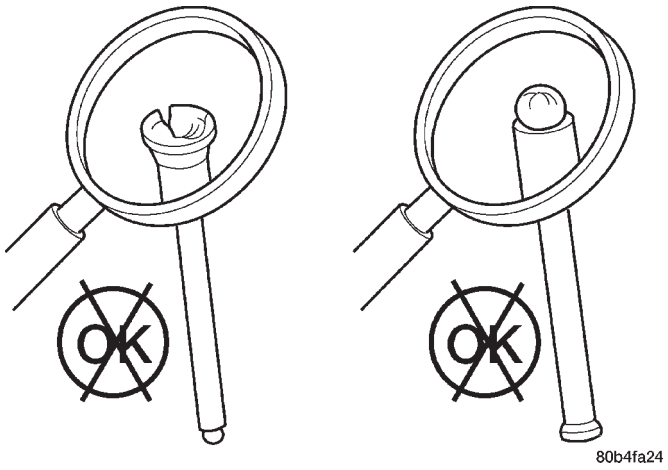


Fig. 65 Inspecting Push Rod for Cracks

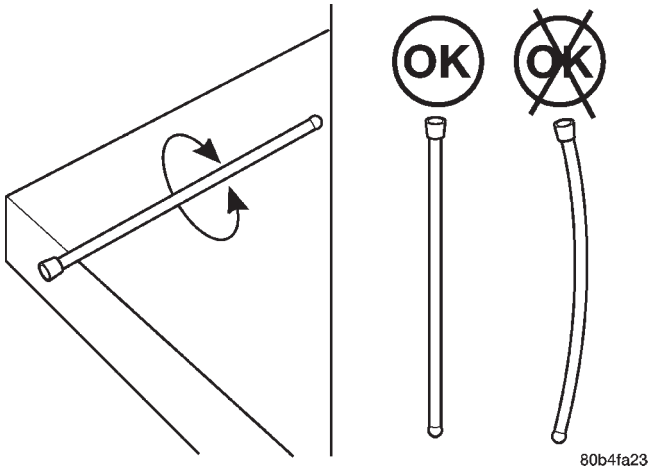


Fig. 66 Inspecting Push Rod for Flatness

Crossheads

Inspect the crossheads for cracks and/or excessive wear on rocker lever and valve tip mating surfaces (Fig. 67).

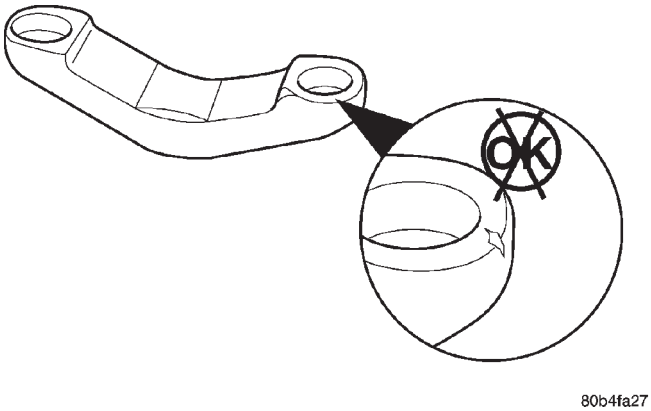


Fig. 67 Inspecting Crosshead for Cracks

ROCKER ARM / ADJUSTER ASSY (Continued)

INSTALLATION

(1) If previously removed, install the push rods in their original location (Fig. 62). **Verify that they are seated in the tappets.**

(2) Lubricate the valve tips and install the crossheads in their original locations.

(3) Lubricate the crossheads and push rod sockets and install the rocker arms and pedestals (Fig. 60) in their original locations. Tighten bolts to 36 N·m (27 ft. lbs.) torque.

(4) **Verify valve lash adjustment (Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - STANDARD PROCEDURE).**

(5) Install cylinder head cover and reusable gasket (Fig. 59) (Refer to 9 - ENGINE/CYLINDER HEAD/ CYLINDER HEAD COVER(S) - INSTALLATION).

(6) Connect battery negative cables.

ENGINE BLOCK

STANDARD PROCEDURE

STANDARD PROCEDURE - CYLINDER BLOCK REFACING

(1) The combustion deck can be refaced twice. The first reface should be 0.25 mm (0.0098 inch). If additional refacing is required, an additional 0.25 mm (0.0098 inch) can be removed. Total allowed refacing is 0.50 mm (0.0197 inch) - (Fig. 68).

(2) The upper right corner of the rear face of the block must be stamped with a X when the block is refaced to 0.25 mm (0.0098 inch). A second X must be stamped beside the first when the block is refaced to 0.50 mm (0.0197 inch) - (Fig. 69).

(3) Consult the parts catalog for the proper head gaskets which must be used with refaced blocks to ensure proper piston-to-valve clearance.

STANDARD PROCEDURE - CYLINDER BORE - DE-GLAZE

(1) New piston rings may not seat in glazed cylinder bores.

(2) De-glazing gives the bore the correct surface finish required to seat the rings. The size of the bore is not changed by proper de-glazing.

(3) Cover the lube holes in the top of the block with waterproof tape.

(4) A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles (Fig. 70). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

(5) Use a drill, a fine grit Flex-hone and a mixture of equal parts of mineral spirits and SAE 30W engine oil to de-glaze the bores.

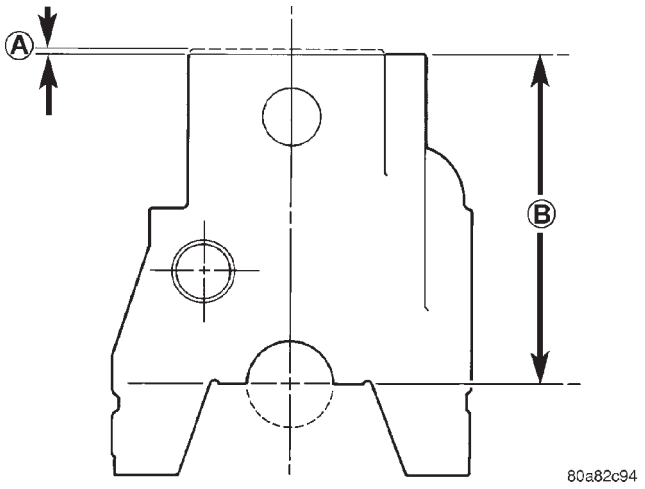


Fig. 68 Refacing Dimensions of the Cylinder Block

CYLINDER BLOCK REFACING DIMENSIONS

DIMENSION ″A″		
1st Reface	0.25mm	(0.0098 in.)
2nd Reface	0.25mm	(0.0098 in.)
Dim (A) Total	0.50 mm	(0.0197 in.)

		DIMENSION ″B″
Dim. ″B″ (STD.)	323.00 mm ± 0.10 mm	(12.7165 in. ± 0.0039 in.)
1st Reface	322.75 mm ± 0.10 mm	(12.7067 in. ± 0.0039 in.)
2nd Reface	322.50 mm ± 0.10 mm	(12.6968 in. ± 0.0039 in.)

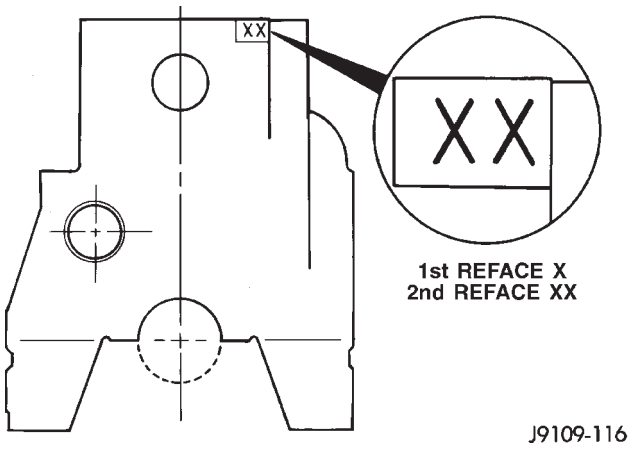


Fig. 69 Stamp Block after Reface

(6) The crosshatch angle is a function of drill speed and how fast the hone is moved vertically (Fig. 71).

(7) Vertical strokes MUST be smooth continuous passes along the full length of the bore (Fig. 71).

(8) Inspect the bore after 10 strokes.

(9) Use a strong solution of hot water and laundry detergent to clean the bores. Clean the cylinder bores immediately after de-glazing.

ENGINE BLOCK (Continued)

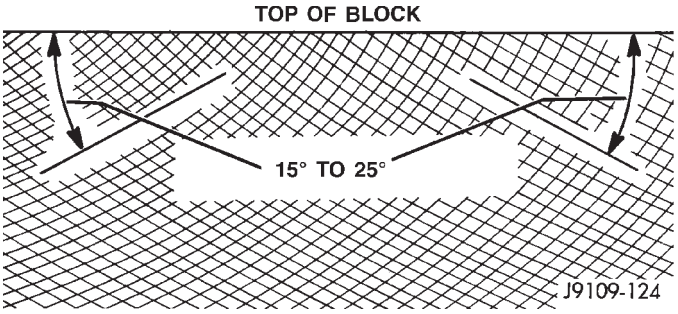


Fig. 70 Cylinder Bore Crosshatch Pattern

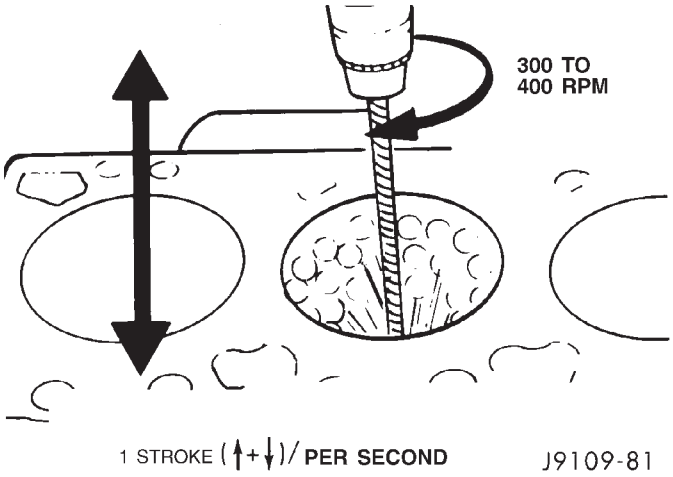


Fig. 71 De-Glazing Drill Speed and Vertical Speed

(10) Rinse the bores until the detergent is removed and blow the block dry with compressed air.

(11) Check the bore cleanliness by wiping with a white, lint free, lightly oiled cloth. If grit residue is still present, repeat the cleaning process until all residue is removed. Wash the bores and the complete block assembly with solvent and dry with compressed air.

(12) Be sure to remove the tape covering the lube holes after the cleaning process is complete.

STANDARD PROCEDURE—CYLINDER BORE REPAIR

Cylinder bore(s) can be repaired by one of two methods:

- Method 1:—Over boring and using oversize pistons and rings.
- Method 2:—Boring and installing a repair sleeve to return the bore to standard dimensions.

METHOD 1—OVERSIZE BORE

Cylinder bore(s) can be repaired by one of two methods:

Oversize pistons and rings are available in two sizes - 0.50 mm (0.0197 inch) and 1.00 mm (0.0393 inch).

Any combination of standard, 0.50 mm (0.0197 inch) or 1.00 mm (0.0393 inch) overbore may be used in the same engine.

If more than 1.00 mm (0.0393 inch) overbore is needed, a repair sleeve can be installed (refer to Method 2—Repair Sleeve).

Cylinder block bores may be bored twice before use of a repair sleeve is required (Fig. 72). The first bore is 0.50 mm (0.0197 inch) oversize. The second bore is 1.00 mm (0.0393 inch) oversize.

After boring to size, use a honing stone to chamfer the edge of the bore (Fig. 72).

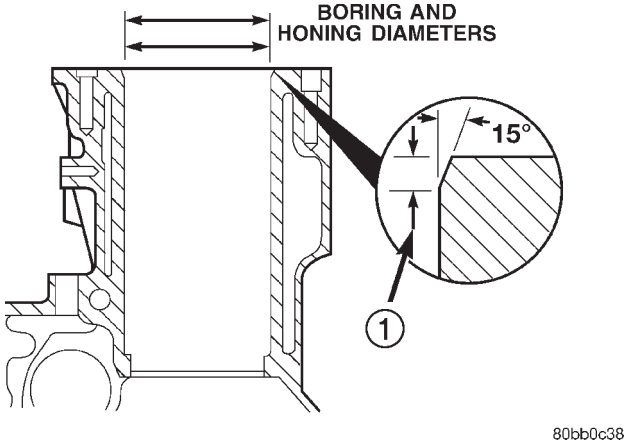


Fig. 72 Cylinder Bore Dimensions

1 - CHAMFER

CYLINDER BORE DIMENSION CHART

DESCRIPTION	MEASUREMENT
BORING DIAMETER DIMENSION	1st. REBORE - 102.469 mm (4.0342 in.)
	2nd. REBORE - 102.969 mm (4.0539 in.)
HONING DIAMETER DIMENSIONS	STANDARD - 102.020 ± 0.020 mm (4.0165 ± 0.0008 in.)
	1st. REBORE - 102.520 ± 0.020 mm (4.0362 ± 0.0008 in.)
	2nd. REBORE - 103.020 ± 0.020 mm 4.0559 ± 0.0008 in.)
CHAMFER DIMENSIONS	Approx. 1.25 mm (0.049 in.) by 15°

A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles with the top of the cylinder block (Fig. 73). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

ENGINE BLOCK (Continued)

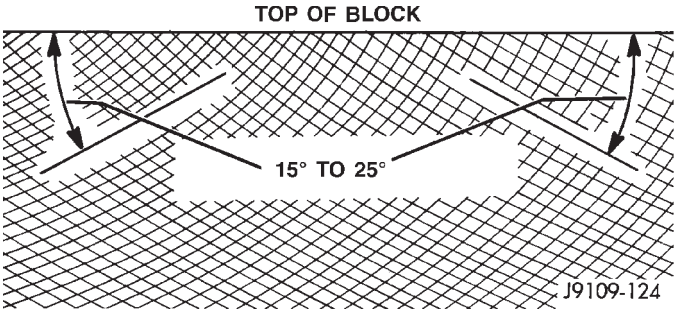


Fig. 73 Crosshatch Pattern of Repaired Sleeve(s)

A maximum of 1.2 micrometer (48 microinch) surface finish must be obtained.

After finish honing is complete, immediately clean the cylinder bores with a strong solution of laundry detergent and hot water.

After rinsing, blow the block dry.

Check the bore cleanliness by wiping with a white, lint-free, lightly- oiled cloth. There should be no grit residue present.

If the block is not to be used right away, coat it with a rust- preventing compound.

METHOD 2—REPAIR SLEEVE

If more than a 1.00 mm (0.03937 inch) diameter oversize bore is required, the block must be bored and a repair sleeve installed.

Bore the block cylinder bore to 104.500-104.515 mm (4.1142-4.1148 inch) - (Fig. 74).

Repair sleeves can be replaced by using a boring bar to bore out the old sleeve. DO NOT cut the cylinder bore beyond the oversize limit.

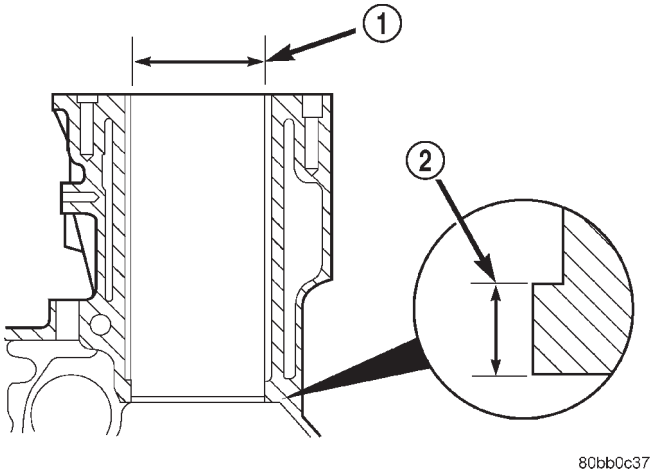


Fig. 74 Block Bore for Repair Sleeve Dimensions

1 - BORE DIAMETER
2 - STEP DIMENSION

REPAIR SLEEVE BLOCK REBORE DIMENSIONS CHART

BORE DIAMETER	STEP DIAMETER
104.500 + 0.015 mm (4.1142 + 0.0006 in.)	6.35 mm (0.25 in.)

After machining the block for the new repair sleeve, thoroughly clean the bore of all metal chips, debris and oil residue before installing the sleeve.

Cool the repair sleeve(s) to a temperature of -12°C (10°F) or below for a minimum of one hour. Be ready to install the sleeve immediately after removing it from the freezer.

Apply a coat of Loctite 620, or equivalent to the bore that is to be sleeved.

Wear protective gloves to push the cold sleeve into the bore as far as possible.

Using a sleeve driver, drive the sleeve downward until it contacts the step at the bottom of the bore (Fig. 75).

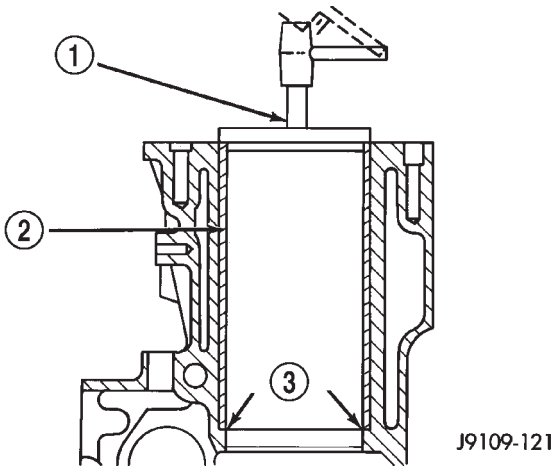


Fig. 75 Sleeve Installation

1 - SLEEVE DRIVER
2 - SLEEVE
3 - CONTACT

A sleeve driver can be constructed as follows (Fig. 76).

SLEEVE DRIVER CONSTRUCTION SPECIFICATION CHART

ITEM	MEASUREMENT
A	127 mm (5 in.)
B	38 mm (1.5 in.)
C	6.35 mm (0.25 in.)
D	25.4 mm (1 in.)
E	101 mm (3.976 in.)
F	107.343 mm (4.226 in.)

Set up a boring bar and machine the sleeve to 101.956 mm (4.014 inch) - (Fig. 77).

ENGINE BLOCK (Continued)

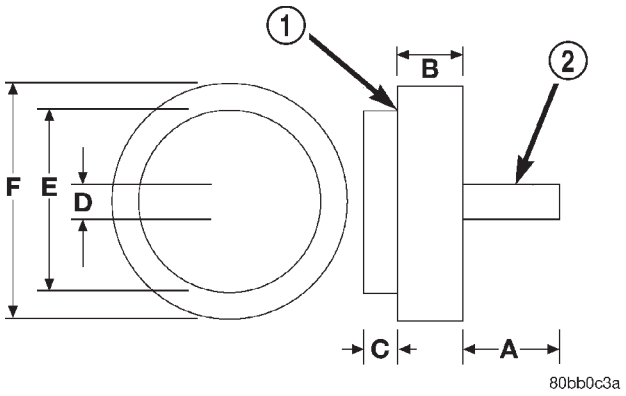


Fig. 76 Sleeve Driver Construction

1 - DRIVE
2 - HANDLE

After removing the boring bar, use a honing stone to chamfer the corner of the repair sleeve(s) - (Fig. 77).

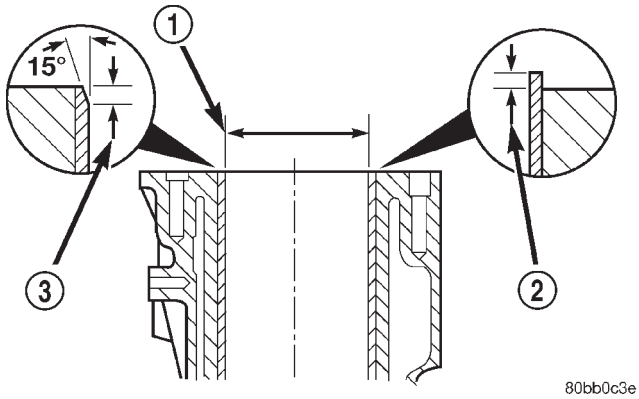


Fig. 77 Sleeve Machining Dimensions

1 - DIAMETER
2 - PROTRUSION
3 - CHAMFER

SLEEVE MACHINING DIMENSIONS CHART

ITEM	MEASUREMENT
SLEEVE PROTRUSION	MIN. - FLUSH WITH BLOCK
	MAX. - 0.050 mm (0.0019 in.)
SLEEVE DIAMETER	101.956 mm (4.014 in.)
SLEEVE CHAMFER	APPROX. 1.25 mm (0.049 in.) by 15°

A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles with the top of the cylinder block. For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

Finished bore inside dimension is 102.020 ±0.020 mm (4.0165 ±0.0008 inch).

A maximum of 1.2 micrometer (48 microinch) surface finish must be obtained.

After finish honing is complete, immediately clean the cylinder bores with a strong solution of laundry detergent and hot water.

After rinsing, blow the block dry with compressed air.

Wipe the bore with a white, lint-free, lightly oiled cloth. Make sure there is no grit residue present.

Apply a rust-preventing compound if the block will not be used immediately.

A standard diameter piston and a piston ring set must be used with a sleeved cylinder bore.

STANDARD PROCEDURE—CAM BORE REPAIR

The front cam bushing bore can be bored to 59.235 Mm ±0.013 mm (2.332 inch ±0.0006 inch) oversize. DO NOT bore the intermediate or rear cam bore to the front cam bore oversize dimensions. Intermediate and rear cam bores may be bored to 57.235 mm ±0.013 mm (2.253 inch ±0.0006– inch) oversize.

A surface finish of 2.3 micrometers (92 microinch) must be maintained. Not more than 20% of an area of any one bore may be 3.2 micrometers (126 microinch).

Camshaft bores can be repaired individually. It is not necessary to repair undamaged cam bores in order to repair individually damaged cam bores. The standard front bushing cannot be used to repair intermediate or rear bores.

Install all cam bushings flush or below the front cam bore surface. The oil hole must align to allow a 3.2 mm (0.125 inch) rod to pass through freely (Fig. 78).

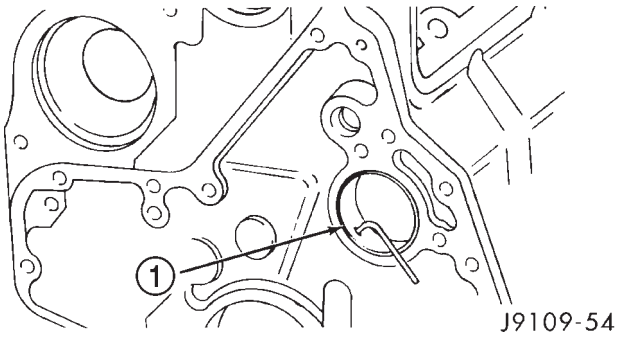


Fig. 78 Oil Hole Alignment

1 - CAMSHAFT BUSHING

INSPECTION

Measure the combustion deck face using a straight edge and a feeler gauge (Fig. 79). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.00 mm (2.0 inch) diameter.

ENGINE BLOCK (Continued)

Overall variation end to end or side to side is 0.075 mm (0.003 inch).

If the surface exceeds the limit, .

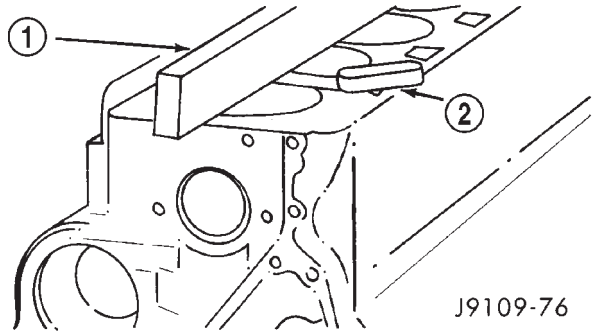


Fig. 79 Combustion Deck Face Measurement

1 - STRAIGHT EDGE
2 - FEELER GAUGE

Inspect the cylinder bores for damage or excessive wear.

Measure the cylinder bores (Fig. 80). If the cylinder bores exceeds the limit, (Refer to 9 - ENGINE/ ENGINE BLOCK - STANDARD PROCEDURE).

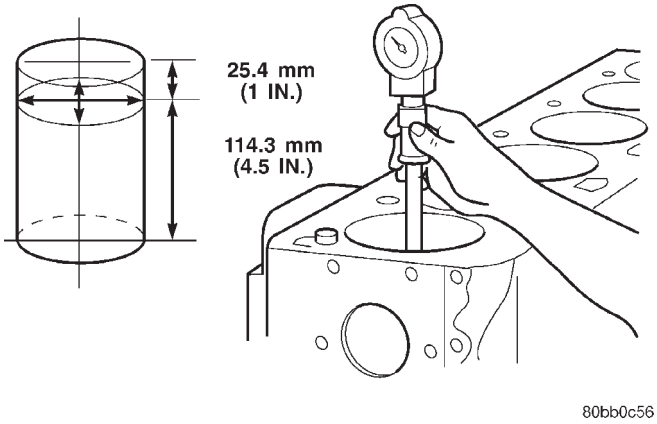


Fig. 80 Cylinder Bore Diameter

Inspect the camshaft bores for scoring or excessive wear.

Measure the camshaft bores (Refer to 9 - ENGINE - SPECIFICATIONS). Limit for the No.1 bore applies to the ID of the bushing.

If a bore exceeds the limit, (Refer to 9 - ENGINE/ ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - STANDARD PROCEDURE).

Inspect the tappet bores for scoring or excessive wear 16.000 mm min - 16.055 mm max (.63 in. min - .6321 in. max) (Fig. 81). If out of limits, replace the cylinder block.

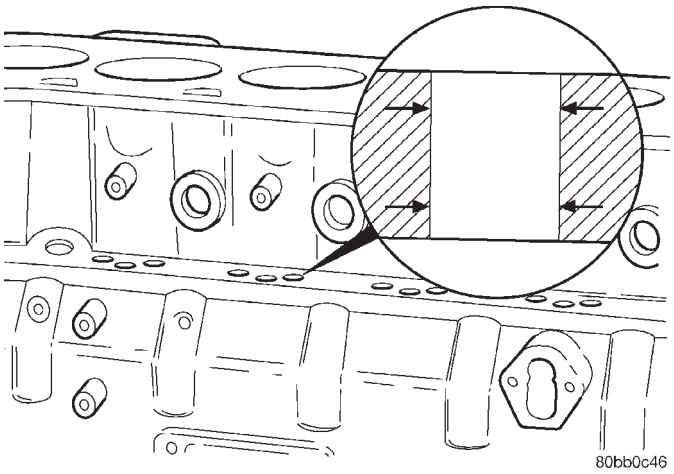


Fig. 81 Tappet Bore Diameter

CAMSHAFT & BEARINGS (IN BLOCK)

REMOVAL

REMOVAL—CAMSHAFT BEARINGS

NOTE: Measure the diameter of each bore. (The limit for the bushing in the No.1 bore is the same as for the other bores without bushings). The limit of the inside diameter is 54.089 min. - 54.164 max. mm (2.1295 min. - 2.1325 max. inch). If the camshaft bore for the first cam bushing is worn beyond the limit, install a new service bushing. Inspect the rest of the camshaft bores for damage or excessive wear.If the bores without a bushing are worn beyond the limit, the engine must be removed for machining and installation of service bushings. If badly worn, replace the cylinder block.

(1) Remove the camshaft (Refer to 9 - ENGINE/ ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - REMOVAL).

(2) Remove the bushing from the No.1 bore, using a universal cam bushing tool.

(3) Mark the cylinder block so you can align the oil hole in the cylinder block with the oil hole in the bushing.

REMOVAL—CAMSHAFT

(1) Disconnect both battery negative cables.

(2) Recover A/C refrigerant (if A/C equipped) (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(3) Raise vehicle on hoist.

(4) Drain engine coolant into container suitable for re-use (Refer to 7 - COOLING - STANDARD PROCEDURE).

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

(5) Lower vehicle.
(6) Remove radiator upper hose.
(7) Remove viscous fan/drive assembly and fan shroud (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(8) Disconnect the coolant recovery bottle hose from the radiator filler neck.
(9) Disconnect lower radiator hose from radiator outlet.
(10) **Automatic Transmission models:** Disconnect transmission oil cooler lines from radiator using Special Tool 6931 (unless equipped with finger-release disconnect).
(11) Remove radiator mounting screws and lift radiator out of engine compartment.
(12) Remove upper radiator support panel.
(13) Remove front bumper assembly (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT BUMPER - REMOVAL).
(14) If A/C equipped, disconnect A/C condenser refrigerant lines.
(15) Disconnect charge air cooler piping from the cooler inlet and outlet.
(16) Remove the two charge air cooler mounting bolts.
(17) Remove charge air cooler (and A/C condenser if equipped) from vehicle.
(18) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(19) Remove the fan support/hub assembly (Fig. 82).
(20) Remove crankshaft damper (Fig. 83) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
(21) Remove the crankcase breather vapor canister from the gear housing cover (Fig. 84).

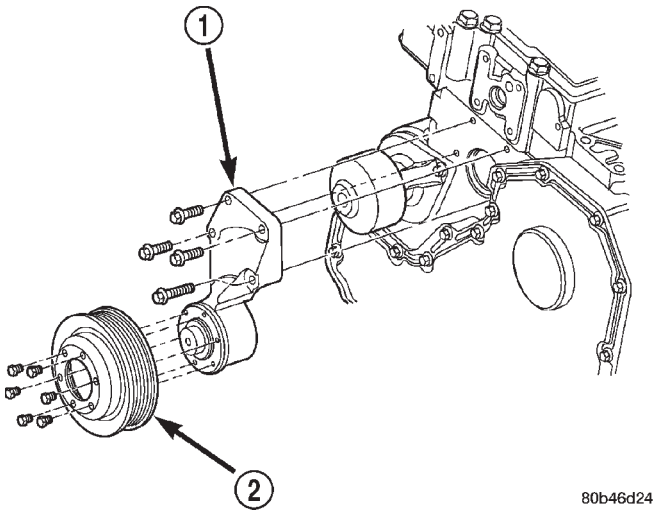


Fig. 82 Fan Support/Hub Removal/Installation

1 - FAN SUPPORT/HUB
2 - FAN PULLEY

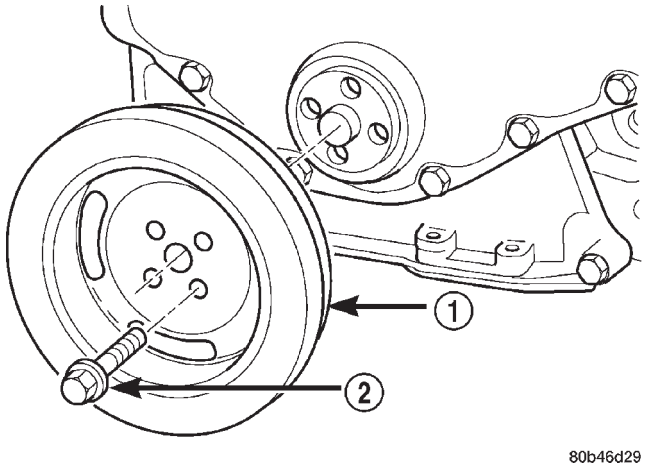


Fig. 83 Crankshaft Damper Removal/Installation

1 - DAMPER
2 - BOLT

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

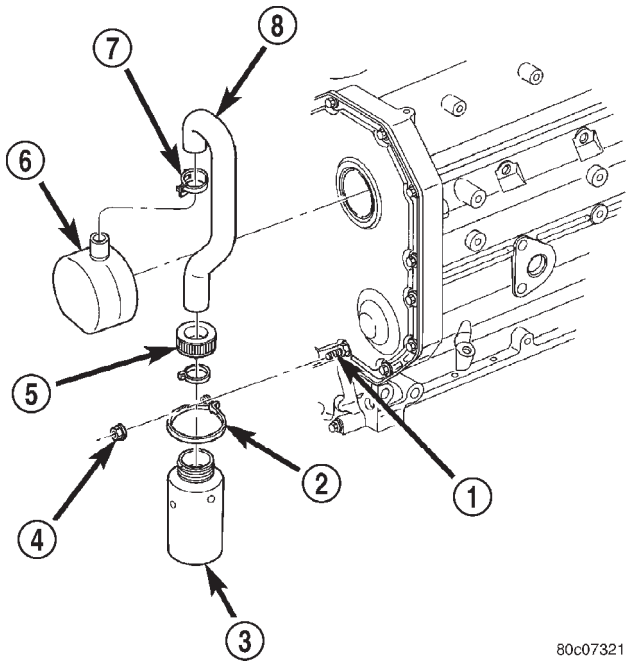


Fig. 84 Crankcase Breather Vapor Canister

1 - ENGINE FRONT COVER STUD
2 - STRAP
3 - VAPOR CANISTER
4 - NUT
5 - CAP
6 - CRANKCASE BREATHER
7 - CLAMP
8 - HOSE

(22) Using Special Tool 7471–B Crankshaft Barring Tool, rotate the crankshaft to bring the engine to TDC #1.

(23) Remove the gear cover-to-housing bolts and gently pry the cover away from the housing, taking care not to mar the sealing surfaces.

(24) Remove the cylinder head cover (Fig. 85) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(25) Remove the rocker arms (Fig. 86), cross heads, and push rods (Fig. 87). Mark each component so they can be installed in their original positions.

NOTE: The #5 cylinder exhaust and the #6 cylinder intake and exhaust pushrods are removed by lifting them up and through the provided cowl panel access holes. Remove the rubber plugs to expose these relief holes.

(26) Raise the tappets as follows, using the wooden dowel rods (Fig. 88)provided with the Miller Tool Kit 8502 or Cummins tappet replacement tool kit #3822513:

(a) Insert the slotted end of the dowel rod into the tappet. **The dowel rods for the rear two**

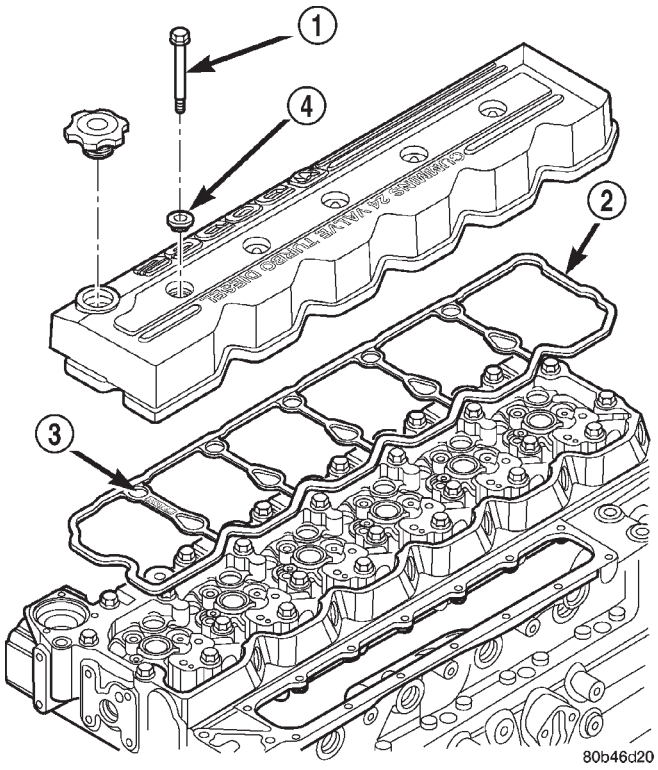


Fig. 85 Cylinder Head Cover Removal/Installation

1 - BOLT (5)
2 - GASKET
3 - “TOP FRONT”
4 - ISOLATOR (5)

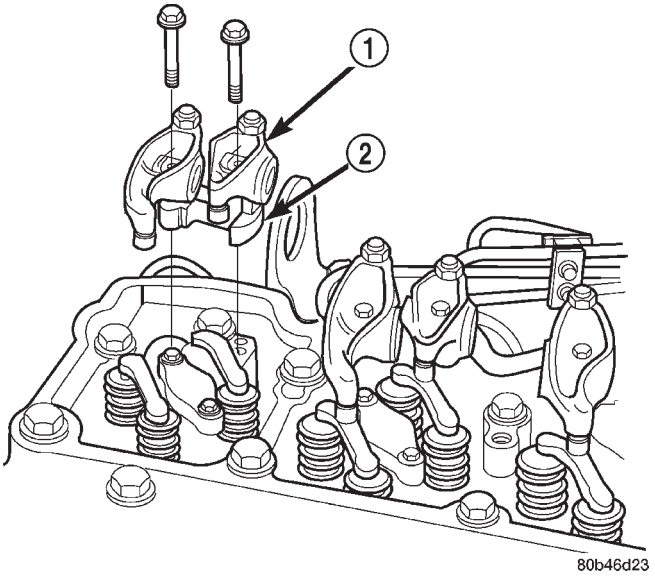


Fig. 86 Rocker Arm and Pedestal Removal/ Installation

1 - ROCKER ARM
2 - PEDESTAL

cylinders will have to be cut for cowl panel

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

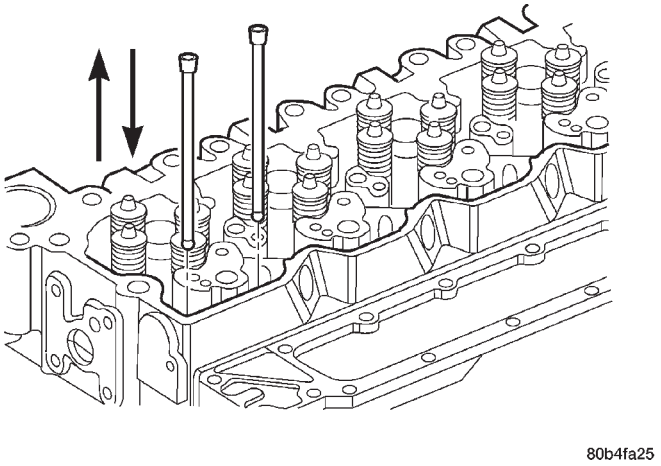


Fig. 87 Push Rod Removal/Installation

clearance. Press firmly to ensure that it is seated in the tappet.

(b) Raise the dowel rod to bring the tappet to the top of its travel, and wrap a rubber band around the dowel rods (Fig. 88) to prevent the tappets from dropping into the crankcase.

(c) Repeat this procedure for the remaining cylinders.

(27) Verify that the camshaft timing marks are aligned with the crankshaft and injection pump marks (Fig. 89).

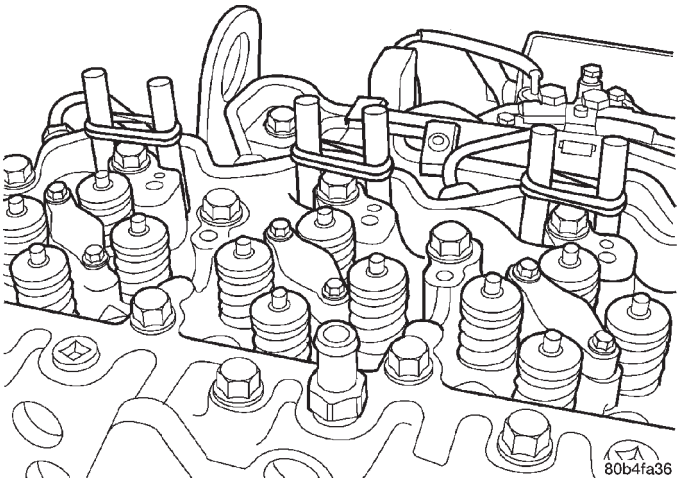


Fig. 88 Use Wooden Dowel Rods to Secure Tappets in Place

(28) Remove the bolts from the thrust plate (Fig. 90).

CAUTION: When removing the camshaft and thrust plate, grab the thrust plate to prevent it from falling into the crankcase.

(29) Remove the camshaft (Fig. 91) and thrust plate.

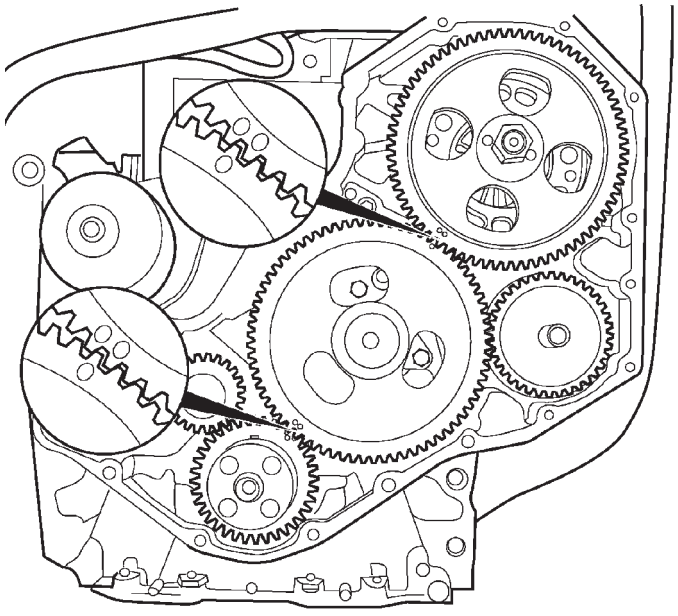


Fig. 89 Timing Mark Alignment

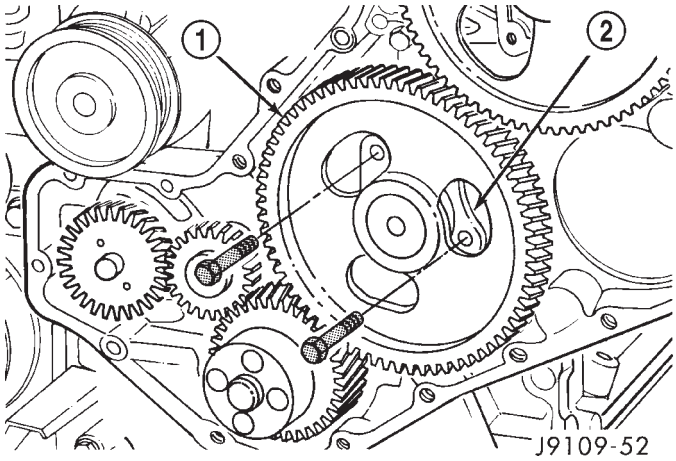


Fig. 90 Thrust Plate Bolt Location

1 - CAMSHAFT GEAR
2 - THRUST PLATE

INSPECTION

Camshaft

(1) Inspect the valve lobes and bearing journals for cracks, pitting, scoring, or generally excessive wear. Replace any camshaft that exceeds the allowable limits.

(2) Measure the bearing journals and lobes (Fig. 92).

CAUTION: If Camshaft lobes are worn, requiring camshaft replacement, it is necessary to replace the tappets also. (Refer to 9 - ENGINE/ENGINE BLOCK/ SOLID LIFTERS - REMOVAL).

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

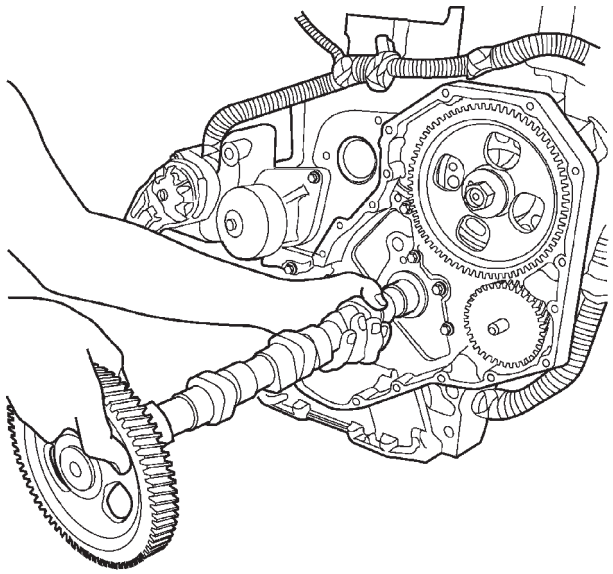


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Fig. 91 Camshaft Removal/Installation

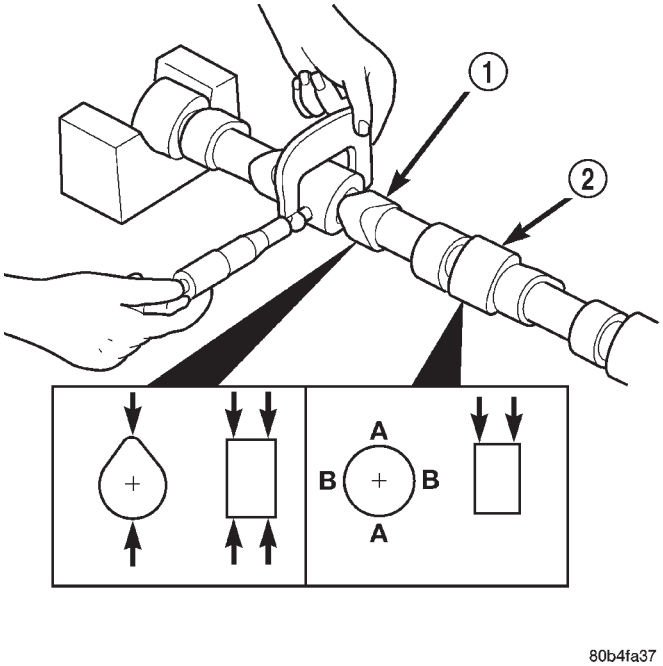

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Fig. 92 Measuring

1 - VALVE LOBE
2 - CAMSHAFT JOURNAL

Camshaft Bushing/Bores

Camshaft bores No. 2–7 **do not** use a bushing.

(1) Inspect the camshaft bushing and bores for signs of excessive wear.

(2) Measure the camshaft bushing and bores (Fig. 93) with a telescoping bore gauge and micrometer. If out of specification, (Refer to 9 - ENGINE/ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - REMOVAL).

(3) Inspect the camshaft bushing oil hole for alignment with cylinder block (Fig. 94).

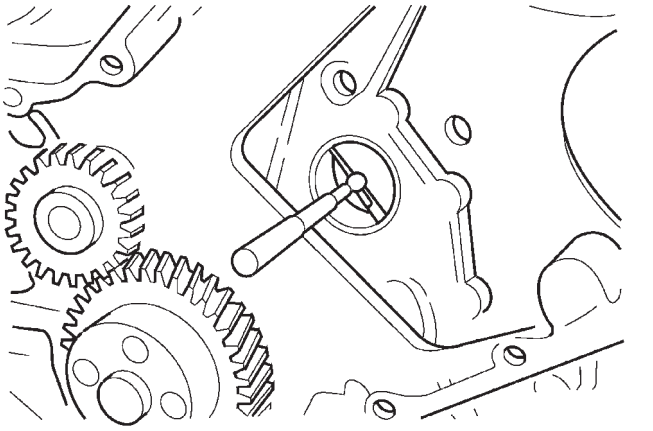

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Fig. 93 Measuring Camshaft Bushing and Bores

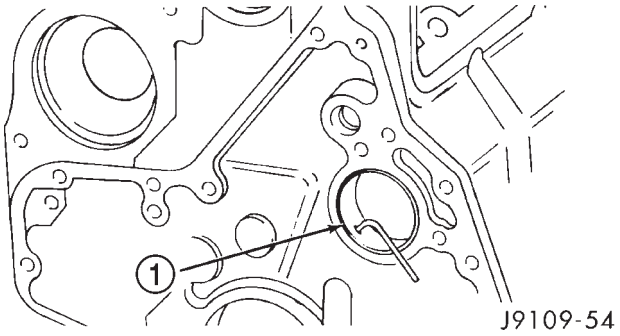

Fig. 94 Inspecting Oil Hole Alignment

1 - CAMSHAFT BUSHING

Camshaft Gear

Inspect the camshaft gear for cracks (gear and hub) (Fig. 95), and chipped/broken/fretted teeth (Fig. 96). If replacement is necessary, (Refer to 9 - ENGINE/ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - REMOVAL).

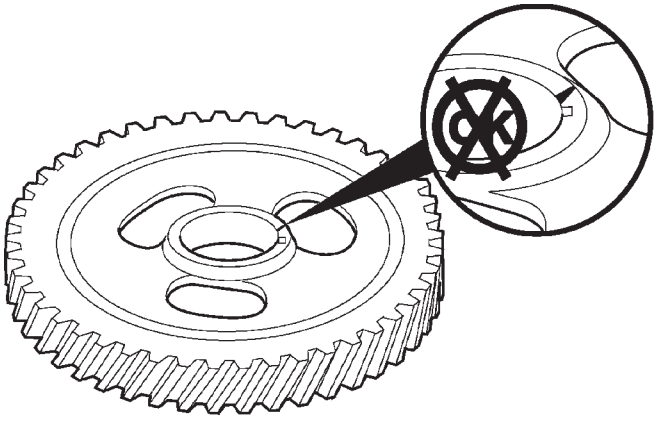

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Fig. 95 Inspect Camshaft Gear Hub for Cracks

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

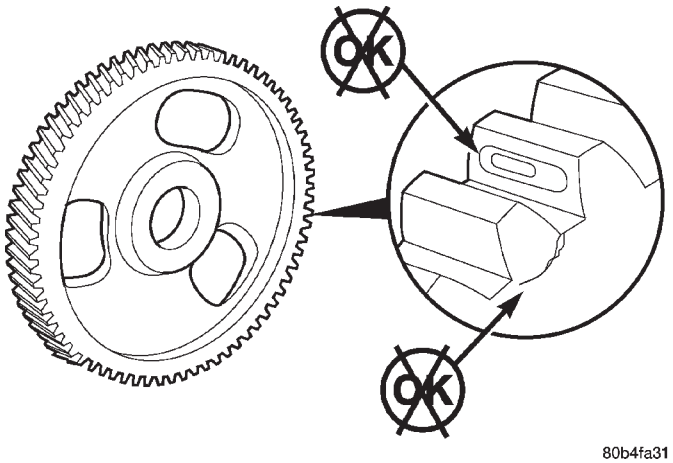

Fig. 96 Inspect Camshaft Gear for Cracks and Fretting

Thrust Plate

Inspect the camshaft thrust plate for excessive wear in the camshaft contact area. Measure thrust plate thickness using the CAMSHAFT THRUST PLATE THICKNESS CHART . Replace any thrust plate that falls outside of these specifications:

CAMSHAFT THRUST PLATE THICKNESS CHART

9.34 mm (0.368 in.) MIN.
9.58 mm (0.377 in.) MAX.

INSTALLATION

INSTALLATION—CAMSHAFT BEARINGS

(1) Apply a coating of Loctite® 640 Adhesive to the backside of the new bushing. Avoid getting adhesive in the oil hole.

(2) Use a universal cam bushing installation tool and install the bushing so that it is even with the front face of the cylinder block. The oil hole must be aligned. A 3.2 mm (0.128 inch) diameter rod must be able to pass through the hole (Fig. 97).

(3) Measure the installed bushing. The limit of the inside diameter is 54.133 mm (2.1312 inch).

INSTALLATION—CAMSHAFT

(1) Lubricate the camshaft bushing and bores with fresh engine oil or suitable equivalent.

(2) Liberally coat the camshaft lobes, journals, and thrust washer with fresh engine oil or suitable equivalent.

CAUTION: When installing the camshaft (Fig. 91), DO NOT push it in farther than it will go with the thrust washer in place. Pushing it too far can dislodge the plug in the rear of the camshaft bore and cause an oil leak.

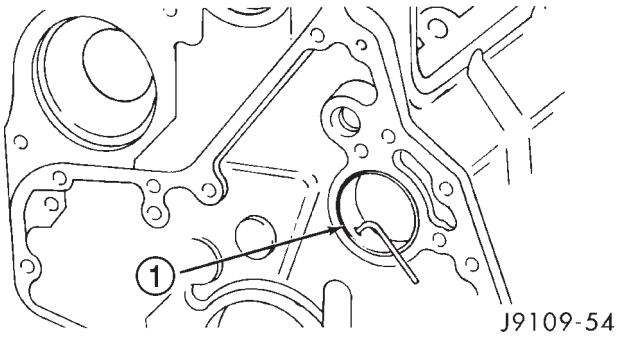

Fig. 97 Oil Hole Alignment

1 - CAMSHAFT BUSHING

(3) Install the camshaft (Fig. 91) and thrust plate. Align the timing marks as shown in (Fig. 89).

(4) Install the thrust plate bolts and tighten to 24 N·m (18 ft. lbs.) torque.

(5) Measure camshaft back lash and end clearance (Fig. 98).

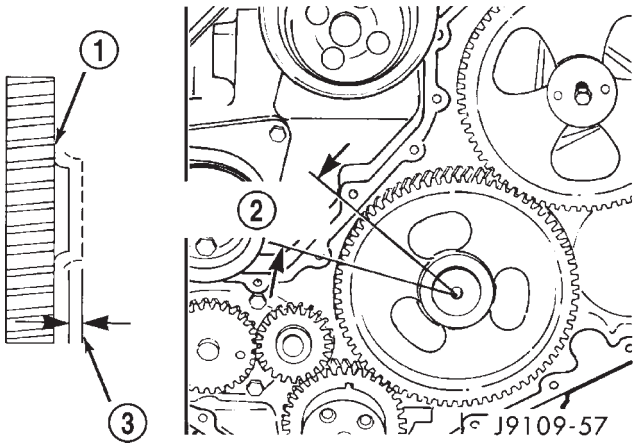

Fig. 98 Camshaft Backlash and End Clearance

BACKLASH — 0.080—0.330 mm
(0.003—0.013 inch)
CLEARANCE — 0.152—0.254 mm
(0.006—0.010 inch)

(6) Remove the wooden dowel rods and rubber bands from the tappets.

(7) Lubricate the push rods with engine oil and install in their original location (Fig. 87). **Verify that they are seated in the tappets.**

(8) Lubricate the valve tips with engine oil and install the crossheads in their original locations.

(9) Lubricate the crossheads and push rod sockets with engine oil and install the rocker arms and pedestals in their original locations (Fig. 86). Tighten bolts to 36 N·m (27 ft. lbs.) torque.

(10) **Verify valve lash adjustment (Refer to 9 - ENGINE/CYLINDER HEAD/INTAKE/EXHAUST VALVES & SEATS - STANDARD PROCEDURE).**

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

(11) Install the cylinder head cover and reusable gasket (Fig. 85) (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(12) Install gear housing cover (Refer to 9 - ENGINE/VALVE TIMING/GEAR HOUSING COVER - INSTALLATION).

(13) Install the crankshaft damper (Fig. 83) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(14) Install the fan support/hub assembly (Fig. 82) and tighten bolts to 24 N·m (18 ft. lbs.) torque.

(15) Install the crankcase breather housing (Refer to 9 - ENGINE - INSTALLATION).

(16) Install the charge air cooler (with a/c condenser and auxiliary transmission oil cooler, if equipped) and tighten the mounting bolts to 2 N·m (17 in. lbs.) torque.

(17) Connect charge air cooler inlet and outlet pipes. Tighten clamps to 10 N·m (100 in. lbs.) torque.

(18) Install the radiator upper support panel.

(19) Close radiator petcock and lower the radiator into the engine compartment. Tighten the mounting bolts to 11 N·m (95 in. lbs.) torque.

(20) Raise vehicle on hoist.

(21) Connect radiator lower hose and install clamp.

(22) Connect transmission auxiliary oil cooler lines (if equipped).

(23) Lower vehicle.

(24) Install the fan shroud and tighten the mounting screws to 6 N·m (50 in. lbs.) torque.

(25) Install the viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(26) Install the coolant recovery and windshield washer fluid reservoirs to the fan shroud.

(27) Connect the coolant recovery hose to the radiator filler neck.

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

(29) Install the front bumper assembly (Refer to 13 - FRAMES & BUMPERS/BUMPERS/FRONT BUMPER - INSTALLATION).

(30) Add engine coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).

(31) Charge A/C system with refrigerant (if A/C equipped) (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE).

(32) Connect the battery negative cables.

(33) Start engine and check for engine oil and coolant leaks.

CONNECTING ROD BEARINGS

STANDARD PROCEDURE—CONNECTING ROD BEARING AND CRANKSHAFT JOURNAL CLEARANCE

Measure the connecting rod bore with the bearings installed and the bolts tightened to 100 N·m (73 ft. lbs.) torque.

Record the smaller diameter.

Measure the diameter of the rod journal at the location shown (Fig. 99). Calculate the average diameter for each side of the journal.

The clearance is the difference between the connecting rod bore (smallest diameter) and the average diameter for each side of the crankshaft journal.

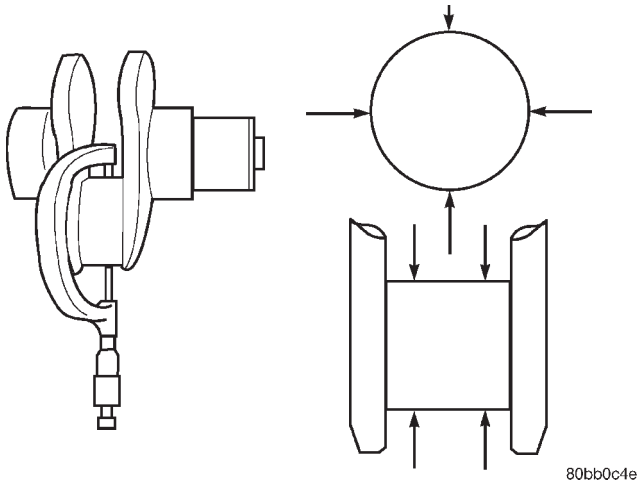

Fig. 99 Connecting Rod Journal Diameter Limits

CONNECTING ROD JOURNAL DIAMETER LIMITS CHART

DESCRIPTION	MEASUREMENT
CRANKSHAFT ROD JOURNAL DIAMETER	MINIMUM 68.962 mm (2.715 in.)
	MAXIMUM 69.013 mm (2.717 in.)
OUT-OF-ROUND	MAXIMUM 0.050 mm (0.002 in.)
TAPER	MAXIMUM 0.013 mm (0.0005 in.)
BEARING CLEARANCE	MAXIMUM 0.089 mm (0.0035 in.)

CONNECTING ROD BEARINGS (Continued)

CONNECTING ROD JOURNAL DIAMETER LIMITS CHART

DESCRIPTION	MEASUREMENT
CRANKSHAFT ROD JOURNAL DIAMETER	MINIMUM 68.962 mm (2.715 in.)
	MAXIMUM 69.013 mm (2.717 in.)
OUT-OF-ROUND	MAXIMUM 0.050 mm (0.002 in.)
TAPER	MAXIMUM 0.013 mm (0.0005 in.)
BEARING CLEARANCE	MAXIMUM 0.089 mm (0.0035 in.)

If the crankshaft is within limits, replace the bearing. If the crankshaft is out of limits, grind the crankshaft to the next smaller size and use oversize rod bearings.

CRANKSHAFT

DESCRIPTION

The crankshaft (Fig. 100) is a forged steel, integrally balanced unit. It is supported by seven main bearings, with position number six designated as the thrust journal. The crankshaft is held in place by main caps and 12 mm capscrews. The crankshaft also has internal cross drillings to supply the connecting rods with engine oil.

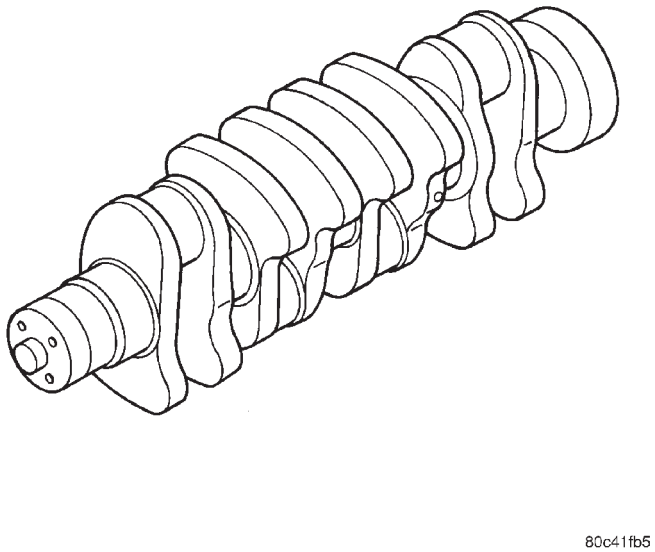

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Fig. 100 Crankshaft

CRANKSHAFT MAIN BEARINGS

STANDARD PROCEDURE—MAIN BEARING CLEARANCE

Inspect the main bearing bores for damage or abnormal wear.

Install the crankshaft main bearings and measure main bearing bore diameter with the main bolts tightened to 176 N·m (130 ft. lbs.) torque (Fig. 101).

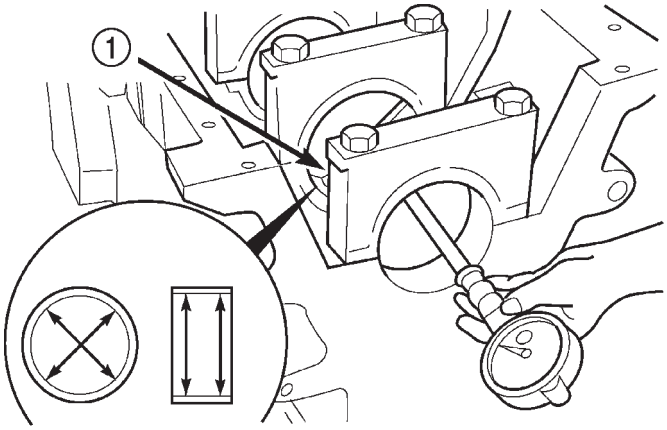

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Fig. 101 Crankshaft Main Bearing Bore Diameter

1 - MAIN BEARING CAPS

MAIN BEARING BORE DIAMETER CHART

ITEM	MAIN BEARING BORE DIAMETER (MAXIMUM)
A	83.106 mm 3.2719 in.)

Measure the diameter of the main journal at the locations shown (Fig. 102). Calculate the average diameter for each side of the journal.

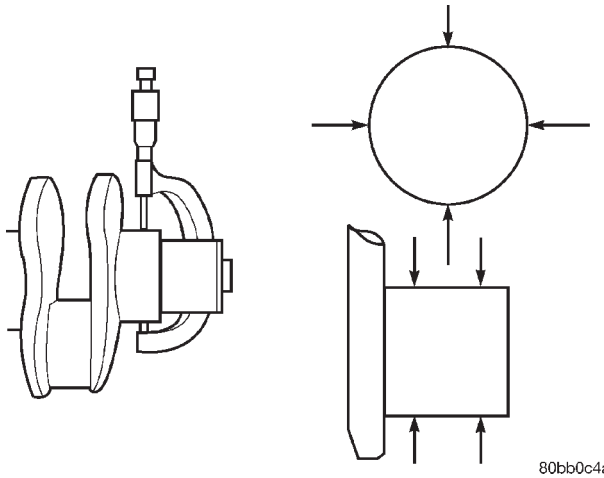

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Fig. 102 Crankshaft Main Journal Diameter

CRANKSHAFT MAIN BEARINGS (Continued)

CRANKSHAFT MAIN JOURNAL DIAMETER CHART

ITEM	SPECIFICATION
MINIMUM DIAMETER	82.962 mm (3.2662 in.)
MAXIMUM DIAMETER	83.013 mm (3.2682 in.)

Calculate the main bearing journal to bearing clearance. the clearance specifications are 0.119 mm (0.00475 inch). If the crankshaft journal is within limits, replace the main bearings. If not within specifications, grind the crankshaft to next size and use oversize bearings.

CRANKSHAFT OIL SEAL - FRONT

REMOVAL

(1) Disconnect both battery negative cables.
(2) Raise vehicle on hoist.
(3) Partially drain engine coolant into container suitable for re-use (Refer to 7 - COOLING - STANDARD PROCEDURE).
(4) Lower vehicle.
(5) Remove radiator upper hose.
(6) Disconnect coolant recovery bottle from radiator filler neck and lift bottle off of fan shroud.
(7) Disconnect windshield washer pump supply hose and electrical connections and lift washer bottle off of fan shroud.
(8) Remove the fan shroud-to-radiator mounting bolts.
(9) Remove viscous fan/drive assembly. **The fan drive nut has left handed threads.** (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(10) Remove cooling fan shroud and fan assembly from the vehicle.
(11) Remove the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(12) Remove the cooling fan support/hub from the front of the engine (Fig. 103).
(13) Raise the vehicle on hoist.
(14) Remove the crankshaft damper (Fig. 104).
(15) Remove the gear cover-to-housing bolts and gently pry the cover away from the housing, taking care not to mar the gasket surfaces.
(16) Support the cover on a flat work surface with wooden blocks (Fig. 105), and using a suitable punch and hammer, drive the old seal out of the cover from the outside of the cover (Fig. 105).

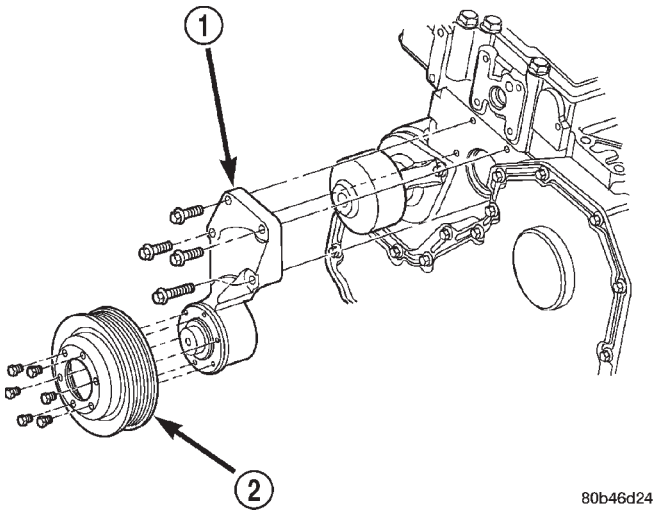

Fig. 103 Fan Support Hub Assembly—Removal/Installation

1 - FAN SUPPORT/HUB
2 - FAN PULLEY

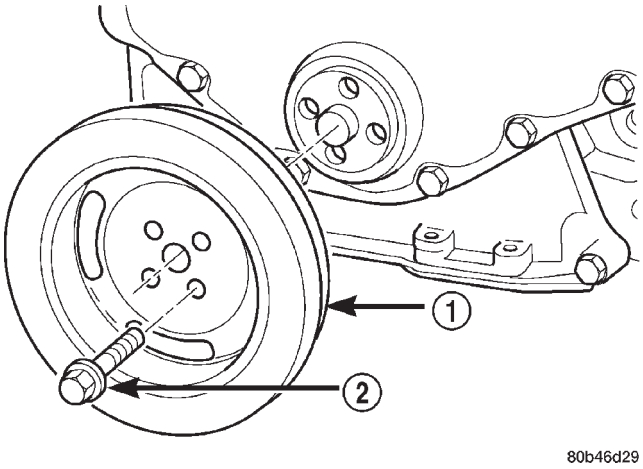

Fig. 104 Crankshaft Damper—Removal/Installation

1 - DAMPER
2 - BOLT

INSTALLATION

(1) Clean cover and housing gasket mating surfaces. Use a suitable scraper and be careful not to damage the gear housing surface, since it is aluminum. Remove any old sealer from the oil seal bore. Thoroughly clean the front seal area of the crankshaft. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.
(2) Inspect the gear housing and cover for cracks and replace if necessary. Carefully straighten any bends or imperfections in the gear cover with a ball-peen hammer on a flat surface. Inspect the crankshaft front journal for any grooves or nicks that would affect the integrity of the new seal.
(3) Apply a bead of Mopar® Stud & Bearing Mount to the outside diameter of the seal. Do not lubricate the inside diameter of the new seal.

CRANKSHAFT OIL SEAL - FRONT (Continued)

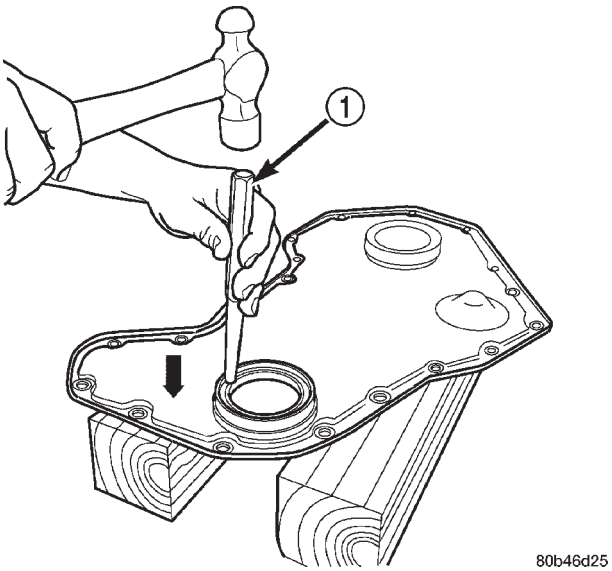

Fig. 105 Removing Seal from Cover

1 - PUNCH

(4) With the cover supported by wood blocks, install the seal into the rear of the cover using crankshaft seal installer Special Tool 8281 and driver handle C-4171 (Fig. 106). Strike the driver handle until the installation tool bottoms out on the inside of the cover.

(5) Install the plastic seal pilot (provided with seal kit) into the crankshaft seal.

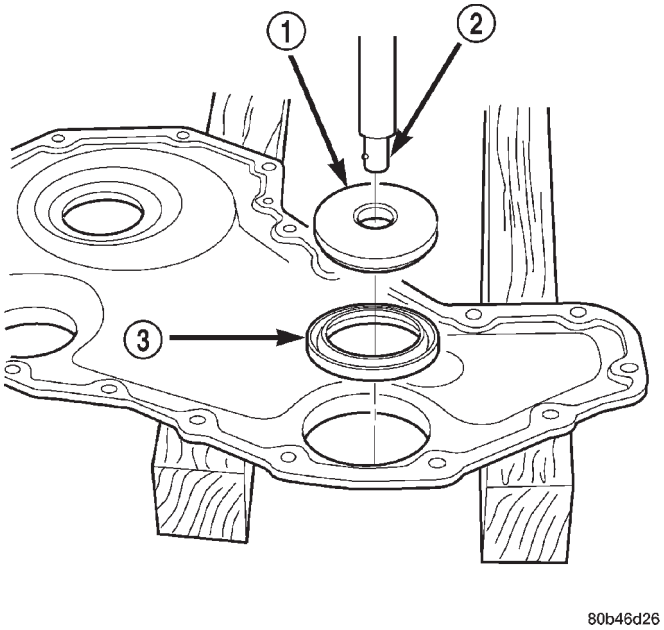

Fig. 106 Installing Seal Into Cover With Tool 8281

1 - SEAL INSTALLER 8281
2 - DRIVER HANDLE C4171
3 - SEAL

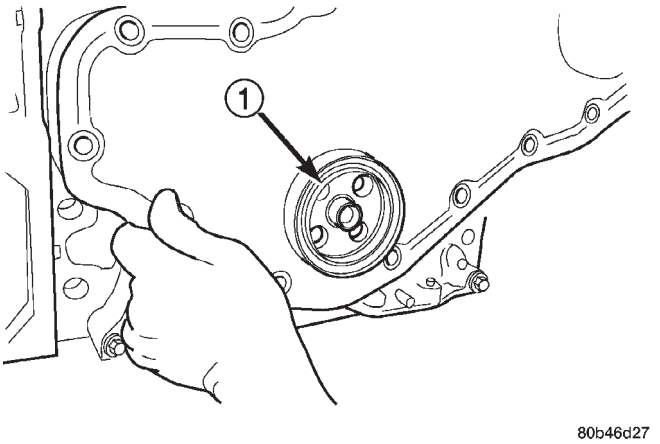

Fig. 107 Installing Front Cover with Seal Pilot

1 - SEAL PILOT

(6) Apply a bead of Mopar® Silicone Rubber Adhesive Sealant or equivalent to the gear housing cover sealing surface.

(7) Install the cover to the gear housing, aligning the seal pilot with the nose of the crankshaft (Fig. 107).

(8) Install the cover bolts and tighten to 24 N·m (18 ft. lbs.) torque. Remove pilot tool.

(9) Install the crankshaft damper (Fig. 104) and torque the bolts to 125 N·m (92 ft. lbs.). Use the engine barring tool to keep the engine from rotating during tightening operation.

(10) Install the fan support/hub assembly (Fig. 103) and torque bolts to 24 N·m (18 ft. lbs.).

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

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

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

(14) Connect battery negative cables.

(15) Start engine and check for oil leaks.

CRANKSHAFT OIL SEAL - REAR

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove the transmission and transfer case (if equipped).

(3) Remove the clutch cover and disc (if manual transmission equipped) (Refer to 6 - CLUTCH/CLUTCH DISC - REMOVAL).

(4) Remove the flywheel or converter drive plate.

(5) Drill holes 180° apart into the seal. Be careful not to contact the drill against the crankshaft.

CRANKSHAFT OIL SEAL - REAR (Continued)

(6) Install #10 sheet metal screws in the drilled holes and remove the rear seal with a slide hammer (Fig. 108).

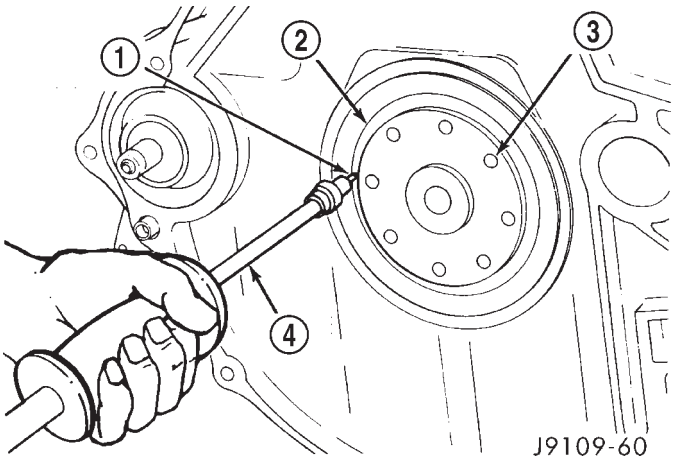

Fig. 108 Crankshaft Rear Seal Removal

1 - NO. 10 SCREW
2 - REAR SEAL
3 - CRANKSHAFT
4 - SLIDE HAMMER

INSTALLATION

CAUTION: The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks. The crankshaft and seal surfaces must be completely dry when the seal is installed. Use a soap and water solution on outside diameter of seal to ease assembly.

(1) Clean the crankshaft journal with a suitable solvent and dry with a clean shop towel or compressed air. Wipe the inside bore of the crankshaft seal retainer with a clean shop towel.

(2) Inspect the crankshaft journal for gouges, nicks, or other imperfections. If the seal groove in the crankshaft is excessively deep, install the new seal 1/8” deeper into the retainer bore, or obtain a crankshaft wear sleeve that is available in the aftermarket.

(3) Install the seal pilot, provided in the replacement kit, onto the crankshaft.

(4) Using the provided alignment/installation tool, start the seal over the pilot and into the retainer by hand.

(5) Using a ball peen hammer, strike the tool at the 12, 3, 6, and 9 o’clock positions until the alignment tool bottoms out on the retainer (Fig. 109).

(6) Remove the seal pilot.

(7) Install the flywheel or converter drive plate. Tighten the bolts to 137 N·m (101 ft. lbs.) torque.

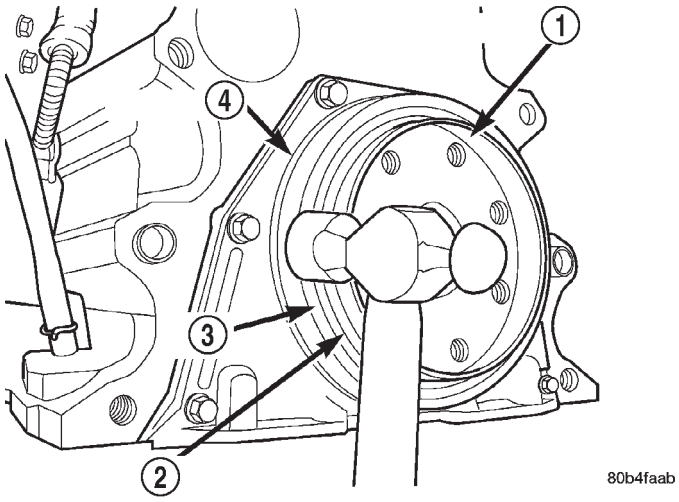

Fig. 109 Seal Installation Using Alignment Tool and Hammer

1 - SEAL PILOT TOOL
2 - INSTALLATION TOOL
3 - SEAL
4 - RETAINER

(8) Install the clutch cover and disc (if equipped) (Refer to 6 - CLUTCH/CLUTCH DISC - INSTALLATION).

(9) Install the transmission and transfer case (if equipped).

(10) Lower vehicle.

(11) Connect battery negative cables.

(12) Check engine oil level and adjust, if necessary.

(13) Start engine and check for oil leaks.

CRANKSHAFT REAR OIL SEAL RETAINER

REMOVAL

(1) Disconnect the battery negative cables.

(2) Raise vehicle on hoist.

(3) Remove the oil pan drain plug and drain the engine oil. Re-install plug and torque to 60 N·m (44 ft. lbs.) torque.

(4) Remove transmission and transfer case (if equipped) from vehicle.

(5) Remove flywheel or torque converter drive plate.

(6) Disconnect starter cables from starter motor.

(7) Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL) and transmission adapter plate assembly.

(8) Disconnect cables from starter motor.

(9) Remove the eight flywheel housing to block bolts and remove housing and starter motor as an assembly.

CRANKSHAFT REAR OIL SEAL RETAINER (Continued)

(10) Remove oil pan bolts, break the pan to block seal, and lower pan slightly and remove oil suction tube fasteners.

(11) Remove oil pan and suction tube (Fig. 110) (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

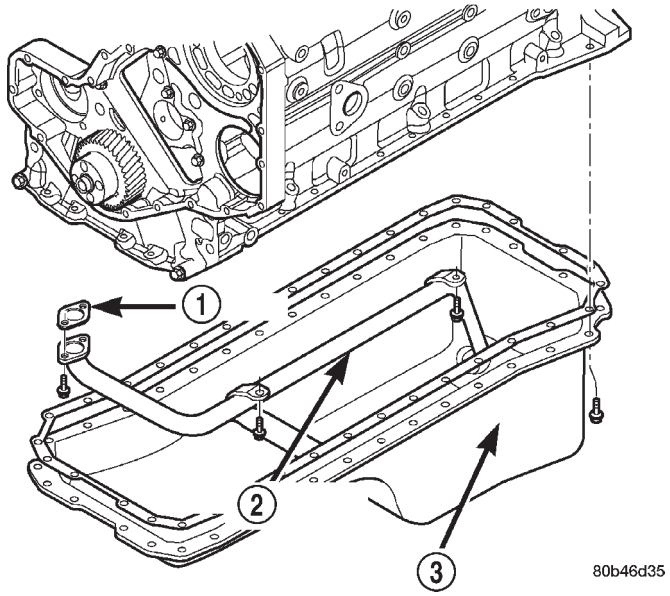

Fig. 110 Oil Pan, Suction Tube and Gasket

1 - GASKET
2 - SUCTION TUBE
3 - OIL PAN

(12) Remove the six (6) retainer-to-block bolts (Fig. 111).

(13) Remove the rear seal retainer and gasket (Fig. 111).

(14) Support the seal retainer and drive out the crankshaft seal with a hammer and suitable punch.

INSTALLATION

(1) If using the old seal retainer, it is recommended that the crankshaft seal is replaced. Support the seal retainer and drive out the old seal.

(2) Using the retainer alignment/seal installation tool provided in the seal service kit, install the alignment tool into the retainer and install to the cylinder block (Fig. 112), using a new gasket. Tighten the six (6) mounting bolts by hand.

(3) Starting with the center two bolts, tighten the retainer in a circular pattern to 9 N·m (80 in. lbs.). Remove the alignment tool.

CAUTION: The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks. The crankshaft and seal surfaces must be completely dry when the seal is installed. Use a soap and water solution on outside diameter of seal to ease assembly.

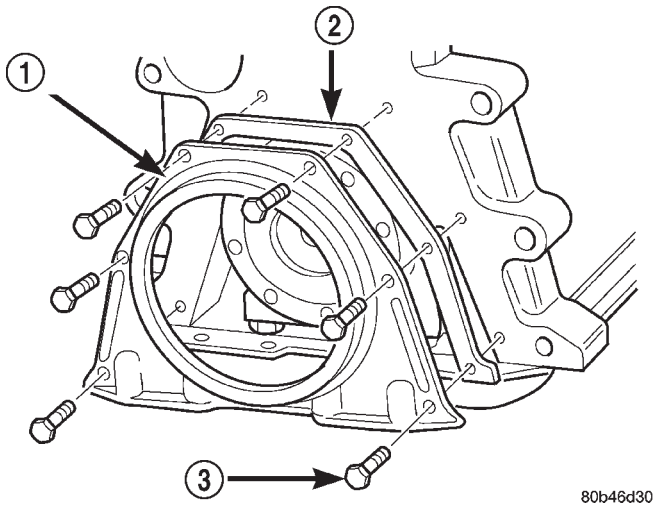

Fig. 111 Crankshaft Rear Seal Retainer and Gasket

1 - RETAINER
2 - GASKET
3 - BOLT

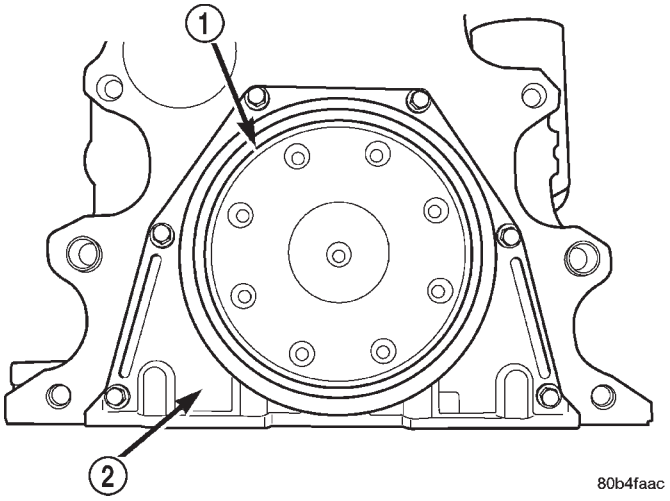

Fig. 112 Aligning Seal Retainer with Alignment/ Installation Tool

1 - ALIGNMENT / INSTALLATION TOOL
2 - SEAL RETAINER

(4) Make sure the provided seal pilot is installed into the new crankshaft seal. Use the alignment/installation tool and press the seal onto the crankshaft (Fig. 113). Alternately drive the seal at the 12, 3, 6 and 9 o'clock positions.

(5) Remove the alignment tool and trim the retainer gasket even with the oil pan mounting surface (Fig. 114).

(6) Remove the seal pilot.

(7) Apply a small amount of Mopar® Silicone Rubber Adhesive Sealant to the oil pan rail T-joints.

CRANKSHAFT REAR OIL SEAL RETAINER (Continued)

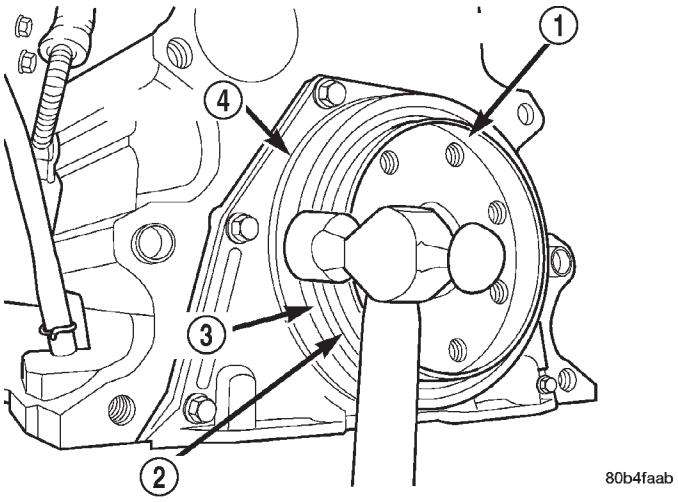

Fig. 113 Installing Seal Using Alignment Tool and Hammer

1 - SEAL PILOT TOOL
2 - INSTALLATION TOOL
3 - SEAL
4 - RETAINER

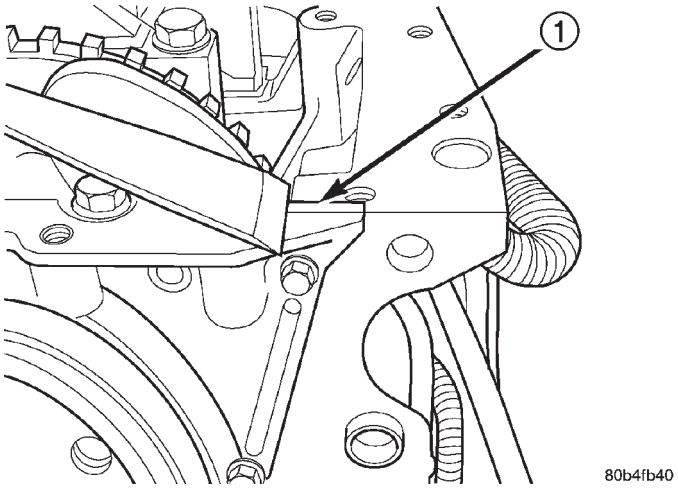

Fig. 114 Trimming Excess Gasket Material

1 - GASKET

(8) Install the oil pan, suction tube and gaskets (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(9) Install the flywheel housing and bolts. Tighten the bolts to 60 N·m (44 ft. lbs.) torque.

(10) Install the starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - INSTALLATION).

(11) Install the flywheel or converter drive plate. Tighten bolts to 137 N·m (101 ft. lbs.)

(12) Install the transmission and transfer case (if equipped).

(13) Lower vehicle.

(14) Fill the crankcase with new engine oil.

(15) Connect the battery negative cables.

(16) Start engine and check for oil leaks.

SOLID LIFTERS/TAPPETS

REMOVAL

NOTE: This procedure requires use of Miller Tool 8502 Tappet Replacement Kit, or Cummins Tool Kit #3822513.

(1) Remove camshaft (Refer to 9 - ENGINE/ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - REMOVAL).

(2) Insert the trough (provided with tool kit) the full length of the camshaft bore (Fig. 115). Make sure the cap end goes in first and the open side faces up (towards tappets).

(3) **Remove only one tappet at a time.** Remove rubber band from one cylinder pair and attach tappet dowel not being removed to the next cylinder pair (Fig. 116).

(4) Raise dowel rod (disengage from tappet) and allow tappet to fall into trough (Fig. 117).

(5) Carefully remove trough **(do not rotate)** and tappet. If the tappet is not being replaced, mark it so it can be installed in its original location.

(6) Re-install trough and repeat procedure on remaining tappets.

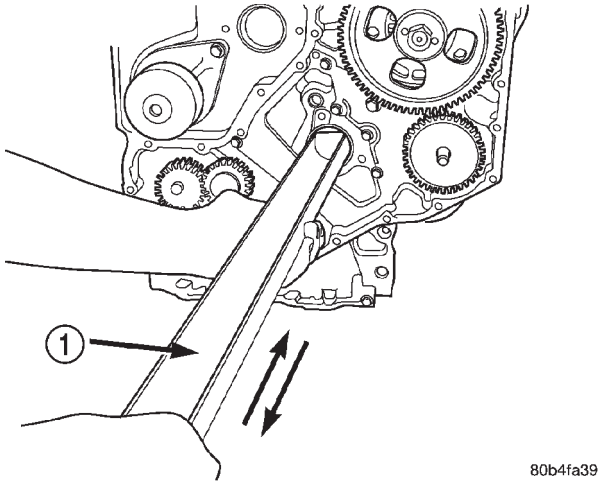

Fig. 115 Inserting the Trough

1 - TROUGH

CLEANING

Clean tappet with a suitable solvent. Rinse in hot water and blow dry with a clean shop rag or compressed air.

SOLID LIFTERS/TAPPETS (Continued)

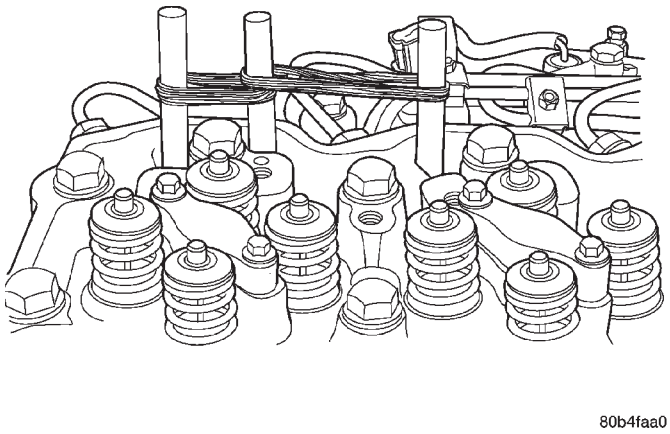

Fig. 116 Secure Dowel/Tappet to Adjacent Cylinder

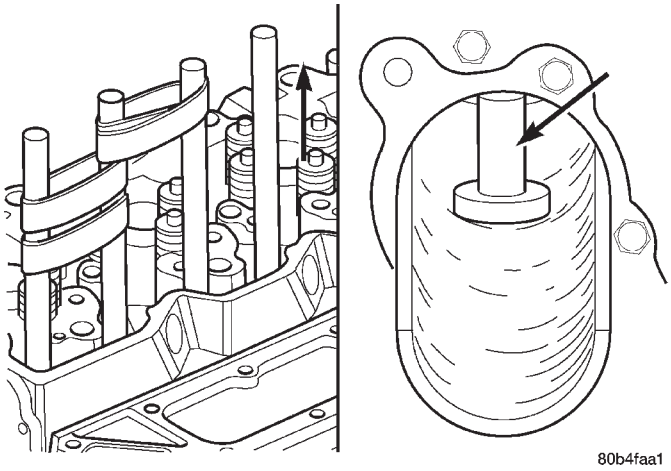

Fig. 117 Lift Dowel Rod to Disengage from Tappet

INSPECTION

(1) Visually inspect the tappet the tappet socket, stem, and face for excessive wear, cracks, or obvious damage (Fig. 118).

(2) Measure the tappet stem diameter. Replace the tappet if it falls below the minimum size (Fig. 118).

INSTALLATION

(1) Insert the trough the full length of the camshaft bore (Fig. 115). Again, make sure the cap end goes in first and the open side faces up (towards tappets).

(2) Lower the tappet installation tool through the push rod hole (Fig. 119) and into the trough.

(3) Retrieve the tappet installation tool using the hooked rod provided with the tool kit (Fig. 120).

(4) Lubricate the tappet with clean engine oil or suitable equivalent and install the tappet to the installation tool (Fig. 121).

(5) Pull the tappet up and into position (Fig. 121). If difficulty is experienced getting the tappet to make the turn into the tappet bore, wiggle the trough while **gently** pulling up on the tappet.

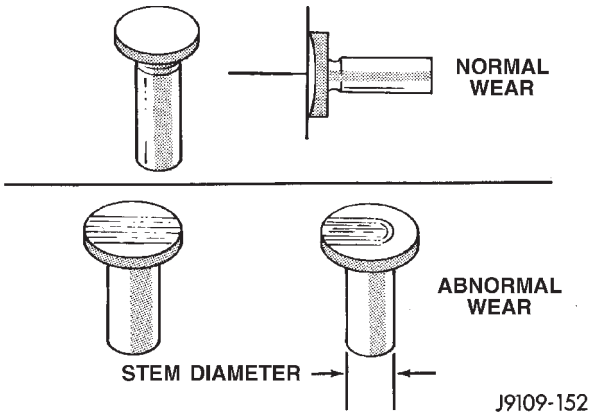

Fig. 118 Tappet Inspection

TAPPET STEM DIAMETER

15.925 mm (0.627 in.) MIN.

15.977 mm (0.629 in.) MAX.

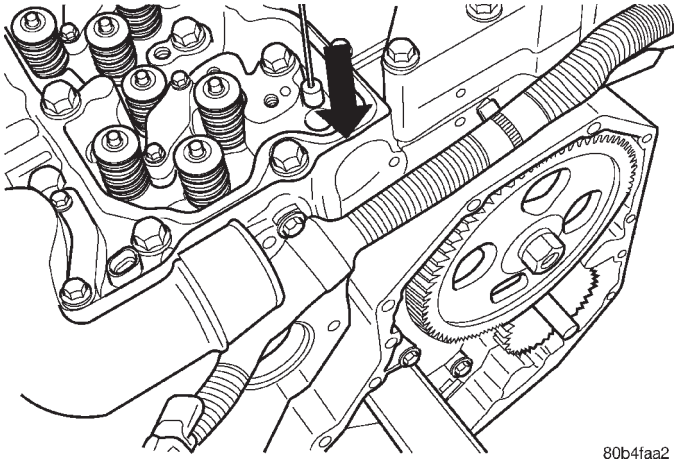

Fig. 119 Insert Installation Tool through Push Rod Hole

(6) With the tappet in place, rotate the trough one half turn so the open side is down (toward crankshaft) (Fig. 122).

(7) Remove the tappet installation tool from the tappet.

(8) Re-install a dowel rod and secure the rod with a rubber band.

(9) Rotate the trough one half turn and repeat the procedure for the remaining tappets.

(10) Install the camshaft (Refer to 9 - ENGINE/ ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - INSTALLATION).

PISTON & CONNECTING ROD

DESCRIPTION

The piston (Fig. 123) is constructed of aluminum and is gravity cast, free floating design. The piston

PISTON & CONNECTING ROD (Continued)

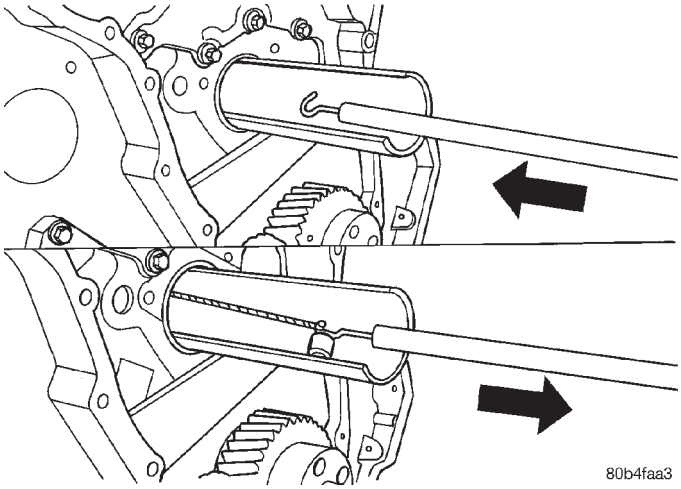

Fig. 120 Retrieve Tappet Installation Tool through Cam Bore

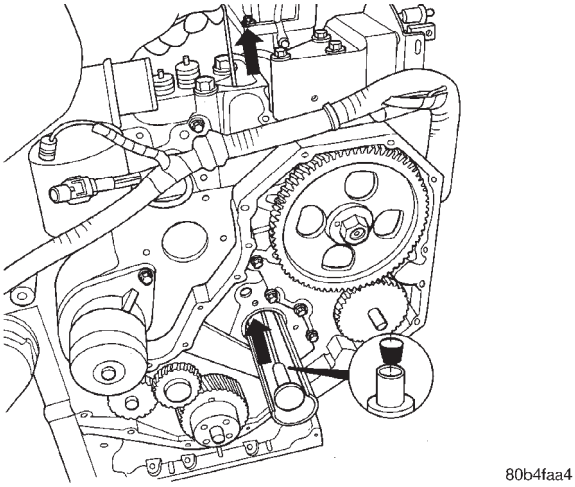

Fig. 121 Insert Tool and Pull Tappet Into Place

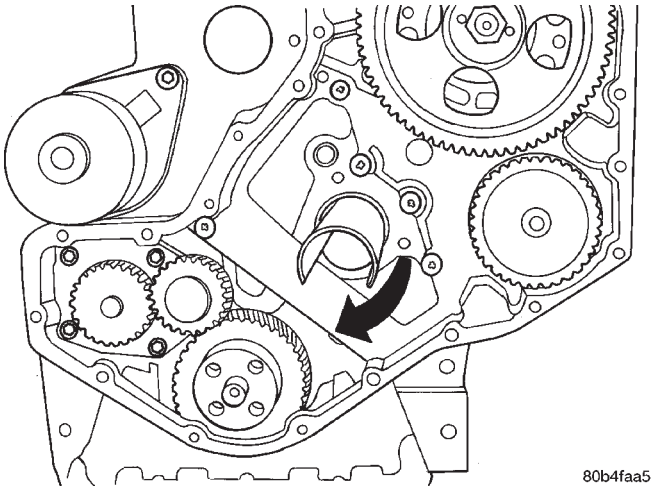

Fig. 122 Rotate Trough One Half Turn (180°)

incorporates a centrally located high swirl combustion bowl, and utilizes a "keystone" style top compression ring (Fig. 124) , and a "Tapered Face" intermediate ring (Fig. 124) , for superior cylinder wall scraping. Piston cooling nozzles cool the piston and pin with engine oil supplied by the crankshaft main journals.

The connecting rods (Fig. 125) are a split angle design constructed of micro alloy. The rods have a pressed in place wrist pin bushing which is lubricated by the piston cooling nozzle oil spray.

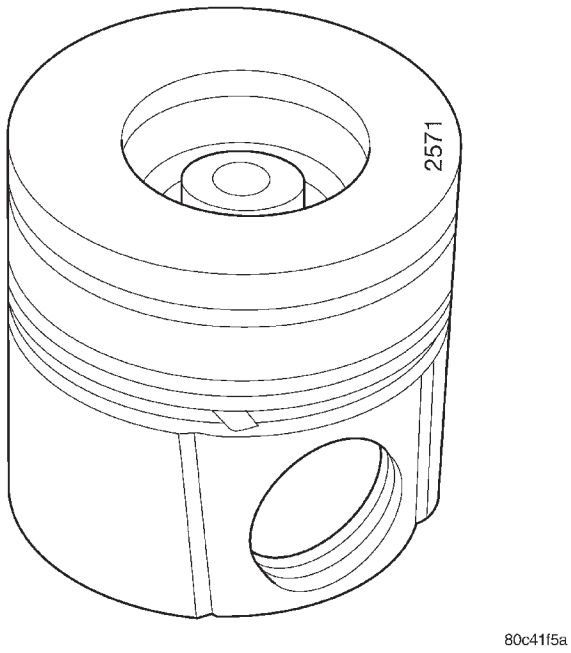

Fig. 123 Piston

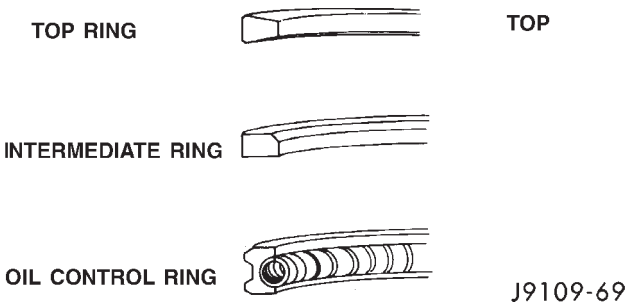

Fig. 124 Piston Ring Identification

STANDARD PROCEDURE—PISTON GRADING

- When rebuilding an engine with the original cylinder block, crankshaft and pistons, make sure the pistons are installed in their original cylinder.
- If replacing the piston(s), make sure the replacement piston(s) are the same grade as the one being replaced.
- If a new cylinder block and/or crankshaft is used, the piston grading procedure **MUST** be performed to determine the proper piston grade for each cylinder.

PISTON & CONNECTING ROD (Continued)

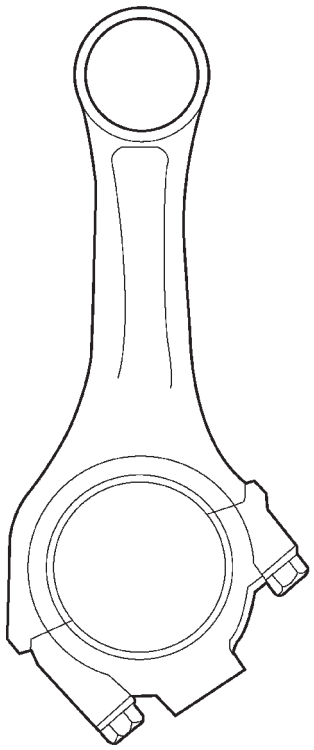

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Fig. 125 Connecting Rod

(1) Install any of the original connecting rod and piston assemblies into the No.1 cylinder. DO NOT install the piston rings.

(2) Install the upper bearing shell in the connecting rod with the tang of the bearing in the slot of the connecting rod. The connecting rod bearing shell must be installed in the original connecting rod and cap. Use clean lubricating oil to coat the inside diameter of the connecting rod bearing shell.

(3) Install the bearing shell in the connecting rod cap with the tang of the bearing in the slot to the cap. Use clean lubricating oil to coat the inside diameter of the bearing shell.

(4) The four digit number stamped on the connecting rod and cap at the parting line must match and be installed on the oil cooler side of the engine. Install the connecting rod cap and cap screws. Tighten the cap screws to 35 N·m (26 ft. lbs.) torque.

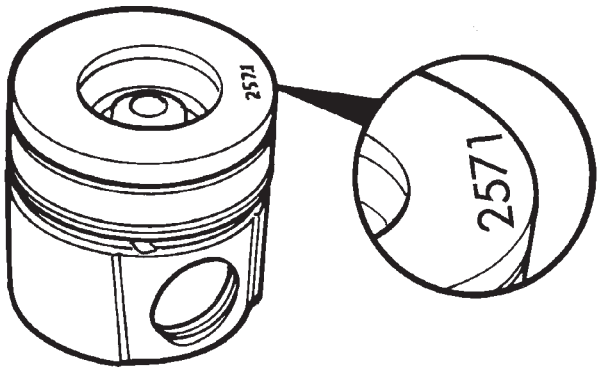
(5) Use a fine grit stone to remove any burrs from the cylinder block head deck. Zero the dial indicator to the cylinder block head deck.

(6) Move the dial indicator directly over the piston pin to eliminate any side-to-side movement.

(7) Rotate the crankshaft to top dead center (TDC). Rotate the crankshaft clockwise and counterclockwise to find the highest dial indicator reading. Record the reading.

(8) Remove the piston and connecting rod assembly from the No.1 cylinder and install the assembly into the No.2 cylinder. Repeat the procedure for every cylinder using the same piston and connecting rod assembly.

(9) Determine the grade of the piston being used by referring to the Piston Protrusion Chart below. Four digits on top of the piston can be cross referenced to a DaimlerChrysler part number for replacement (Fig. 126). If the number on the piston cannot be seen, measure from the top of the piston to the top of the piston pin to see what grade piston is used (Fig. 127).



J9509-2

Fig. 126 Piston Grading Number Location

NOTE: NEVER INTERMIX PISTONS FROM ONE ENGINE APPLICATION TO ANOTHER ENGINE APPLICATION. SEVER DRIVEABILITY CONCERNS MAY RESULT.

PISTON & CONNECTING ROD (Continued)

PISTON PROTRUSION CHART

IF MEASURING PISTON IS GRADING #:		AND PROTRUSION IS	USE GRADE:
245 HP	235 HP		
6050	6153	0.609-0.711 mm (0.024-0.028 in.)	A
6050	6153	0.508-0.609mm (0.020-0.024 in.)	B
6050	6153	0.406-0.508 mm (0.016-0.020 in.)	C
6051	6154	0.711-0.813 mm (0.028-0.032 in.)	A
6051	6154	0.609-0.711 mm (0.024-0.028 in.)	B
6051	6154	0.508-0.609 mm (0.020-0.024 in.)	C
6052	6155	0.813-0.914 mm (0.032-0.036 in.)	A
6052	6155	0.711-0.813 mm (0.028-0.032 in.)	B
6052	6155	0.609-0.711 mm (0.024-0.028 in.)	C

NOTE: Use the table below when piston grading numbers are missing or not legible.

ALTERNATIVE GRADE IDENTIFICATION METHOD

DIMENSION ″A″	REF. NUMBER		GRADE
	235 HP	245 HP	
51.554-51.607 mm (2.029-2.031 in.)	6153	6050	A
51.654-51.707 mm (2.033-2.035 in.)	6154	6051	B
51.754-51.807 mm (2.037-2.039 in.)	6155	6052	C

REMOVAL

(1) Disconnect the battery cables.

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

(3) Remove the oil pan and suction tube (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(4) Using Miller Tool 7471-B crankshaft barring tool, rotate the crankshaft so all of the pistons are below TDC.

PISTON & CONNECTING ROD (Continued)

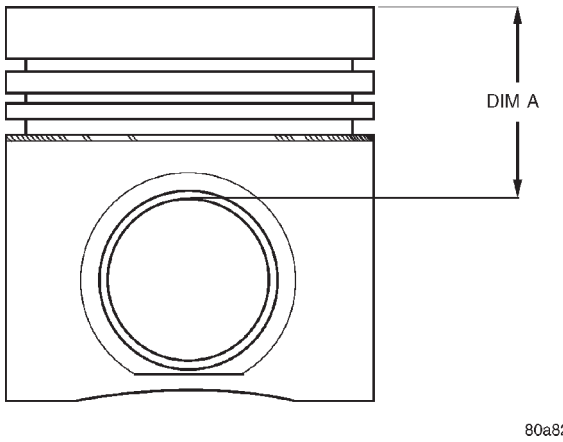


Fig. 127 Piston Grading Measurement

(5) Before removing the piston(s) from the bore(s):

(a) Remove any carbon ridge formations or deposits at the top of the bore with a dull scraper or soft wire brush.

(b) If cylinder bore wear ridges are found, use a ridge reamer to cut the ridge from the bore. DO NOT remove more metal than necessary to remove the ridge.

NOTE: If cylinders have ridges, the cylinders are oversize and will more than likely need boring.

(6) Using a hammer and steel stamp, identify the front of the piston by stamping the cylinder number in each piston to be removed at the top of the piston toward the front of the engine. DO NOT stamp in the outside 5 mm (.197 in.) of the piston diameter.

(7) Mark the connecting rod and cap with the corresponding cylinder numbers.

(8) Remove the connecting rod bolts and rod caps. Use care so the cylinder bores and connecting rods are not damaged.

(9) Use a hammer handle or similar object to push the piston and connecting rod through the cylinder bore.

(10) Store the piston/rod assemblies in a rack.

(11) If a piston must be replaced, replace with the same part number (grading) that was removed.

CLEANING

CAUTION: DO NOT use bead blast to clean the pistons. DO NOT clean the pistons and rods in an acid tank.

Clean the pistons and pins in a suitable solvent, rinse in hot water and blow dry with compressed air. Soaking the pistons over night will loosen most of the carbon build up. De-carbon the ring grooves with a broken piston ring and again clean the pistons in solvent. Rinse in hot water and blow dry with compressed air.

INSPECTION

INSPECTION

Inspect the pistons for damage and excessive wear. Check top of the piston, ring grooves, skirt and pin bore. Measure the piston skirt diameter (Fig. 128). If the piston is out of limits, replace the piston.

The upper groove only needs to be inspected for damage. Use a new piston ring to measure the clearance in the intermediate ring groove (Fig. 129). If the clearance of the intermediate ring exceeds 0.095 mm (0.0038 inch), replace the piston.

Use a new oil ring to measure the clearance in the oil groove (Fig. 129). If the clearance exceeds 0.085 mm (0.0034 inch), replace the piston.

Measure the pin bore (Fig. 130). The maximum diameter is 40.012 mm (1.5753 inch). If the bore is over limits, replace the piston.

Inspect the piston pin for nicks, gouges and excessive wear. Measure the pin diameter (Fig. 131). The minimum diameter is 39.990 mm (1.5744 inch). If the diameter is out of limits, replace the pin.

Connecting Rods

CLEANING

Clean the connecting rods in a suitable solvent, rinse in hot water and blow dry with compressed air.

INSPECTION

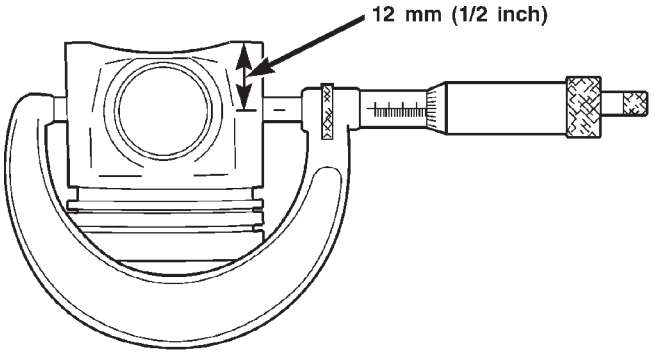


Fig. 128 Piston Skirt Diameter

PISTON SKIRT DIAMETER (MIN.)
101.864 mm (4.0104 in.)

Inspect the connecting rod for damage and wear. The I-Beam section of the connecting rod cannot have dents or other damage. Damage to this part can cause stress risers which will progress to breakage.

PISTON & CONNECTING ROD (Continued)

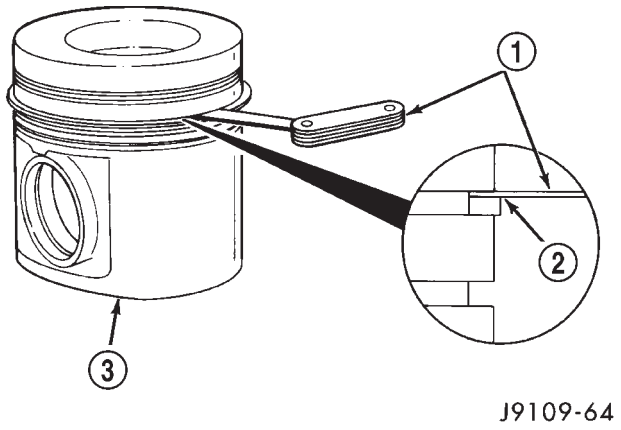


Fig. 129 Intermediate and Oil Ring Clearances

1 - FEELER GAUGE
2 - RING
3 - PISTON

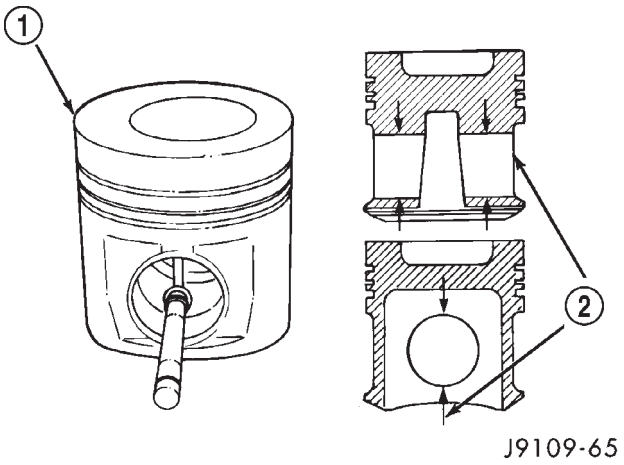


Fig. 130 Piston Pin Bore

1 - PISTON
2 - PIN BORE

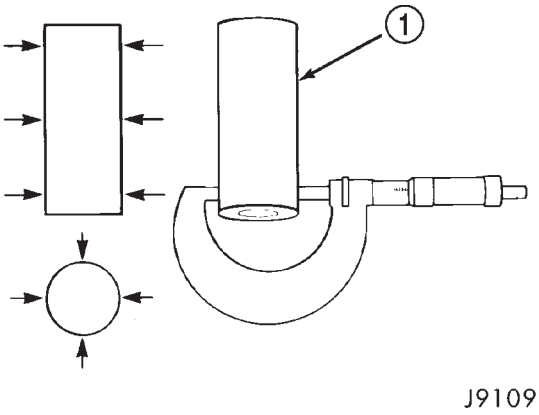


Fig. 131 Piston Pin Diameter

1 - PISTON PIN

Measure the connecting rod pin bore (Fig. 132). The maximum diameter is 40.042 mm (1.5764 inch). If out of limits, replace the connecting rod.

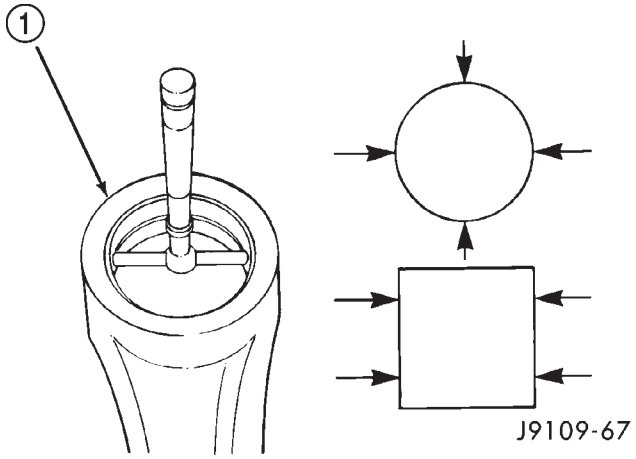


Fig. 132 Connecting Rod Pin Bore

1 - CONNECTING ROD

INSTALLATION

(1) Lubricate the cylinder bores with clean engine oil.

(2) Generously lubricate the rings and piston skirts with clean engine oil.

(3) Compress the rings using a piston ring compressor tool (Fig. 133). If using a strap-type ring compressor, make sure the inside end of the strap does not hook on a ring gap and break the ring.

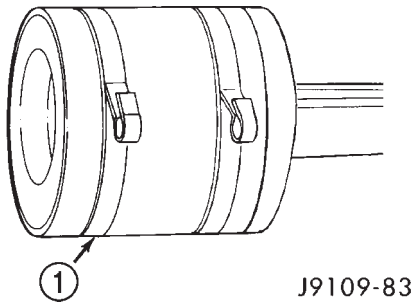


Fig. 133 Piston Ring Compressor Tool

1 - PISTON RING COMPRESSOR TOOL

(4) Bar the crankshaft so the rod journal for the piston to be installed is at BDC (Bottom Dead Center) - (Fig. 134).

(5) Be sure the mark you made on the piston and the numbers on the rod and cap are oriented as illustrated.

(6) Position the piston and rod assembly into the cylinder bore with the mark you made on the piston towards the front of the cylinder block. In this position the numbers on the connecting rod should be facing the oil cooler side of the engine, and the rod

PISTON & CONNECTING ROD (Continued)

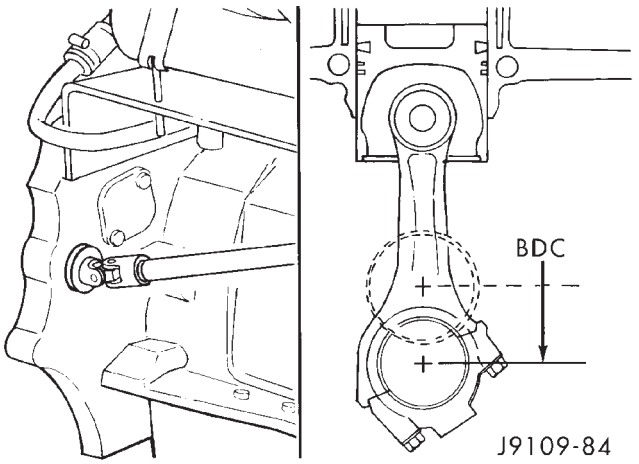


Fig. 134 Piston/Rod Assembly at BDC

bolt holes toward the camshaft. Use care when you install the piston and connecting rod so the cylinder bore is not damaged.

(7) Push the piston into the bore until the top of the piston is approximately 50 mm (2 inch) below the top of the block. Carefully pull the connecting rod onto the crankshaft journal.

(8) Use clean engine oil to lubricate the threads and under the heads of the connecting rod bolts.

(9) The number stamped on the rod cap at the parting line must match and be installed towards the oil cooler side of the engine (Fig. 135).

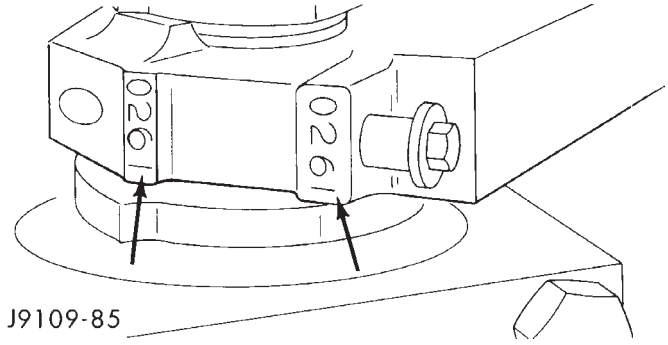


Fig. 135 Correct Rod Cap Installation

(10) Install the rod cap and bolts to the connecting rod. Tighten the connecting rod and bolt evenly in 3 steps.

- Tighten the bolts to 35 N·m (26 ft. lbs.) torque.
- Tighten the bolts to 70 N·m (51 ft. lbs.) torque.
- Tighten the bolts to 100 N·m (73 ft. lbs.) torque.

(11) The crankshaft must rotate freely. Check for freedom of rotation as the caps are installed. If the crankshaft does not rotate freely, check the installation of the rod bearing and the bearing size.

(12) Measure the side clearance between the connecting rod and the crankshaft (Fig. 136). DO NOT measure the clearance between the cap and crankshaft.

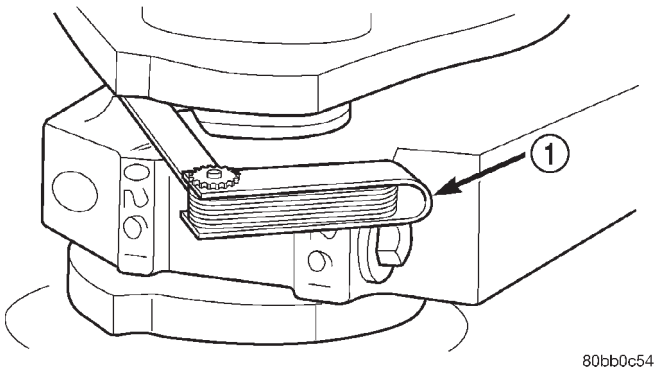


Fig. 136 Side Clearance between Connecting Rod/Crankshaft

1 - FEELER GAUGE

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

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

(15) Install a new filter and fill the crankcase with new engine oil.

(16) Connect the battery negative cables and start engine.

PISTON RINGS

STANDARD PROCEDURE - PISTON RING FITTING

(1) Determine the piston diameter and obtain the appropriate ring set. The piston rings can be identified as shown in (Fig. 137).

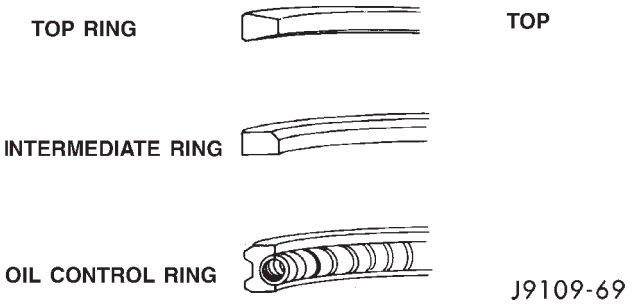


Fig. 137 Piston Ring Identification

(2) Position each ring in the cylinder and use a piston to square it with the bore at a depth of 89.0 mm (3.5 inch) - (Fig. 138).

(3) Use a feeler gauge to measure the piston ring gap.

PISTON RINGS (Continued)

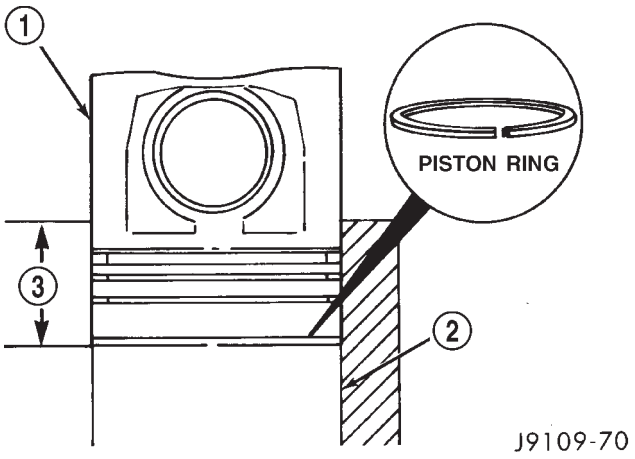


Fig. 138 Position of Ring in Cylinder Bore

1 - PISTON
2 - CYLINDER BORE
3 - DEPTH

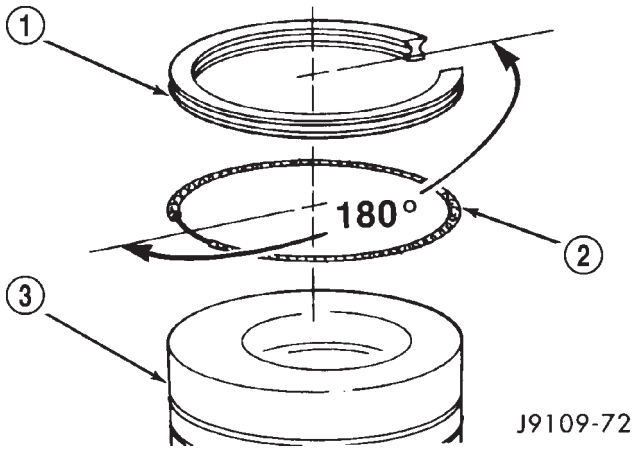


Fig. 139 Oil Control Ring/Expander Location in Groove

1 - OIL CONTROL RING
2 - EXPANDER
3 - PISTON

PISTON RING GAP CHART		
TOP RING	0.35 - 0.45 mm	(0.014 - 0.0177 in.)
INTERMEDIATE RING	0.85-1.15 mm	(0.0334 - 0.0452 in.)
OIL CONTROL RING	0.250-0.550 mm	(0.0100 - 0.0215 in.)

(4) The top surface of all of the rings are identified with the word TOP or the supplier's MARK. Assemble the rings with the word TOP or the supplier's MARK up.

(5) Position the oil ring expander in the oil control ring groove (bottom groove).

(6) Install the oil control ring with the end gap OPPOSITE the ends on the expander (Fig. 139).

(7) Install the intermediate piston ring in the second groove.

(8) Install the top piston ring in the top groove (Fig. 140).

(9) Position the rings as shown in (Fig. 141).

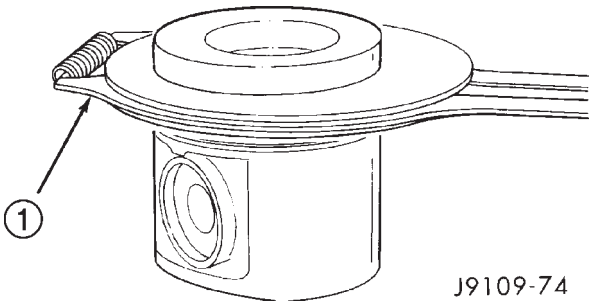


Fig. 140 Piston Ring Installation Tool

1 - PISTON RING INSTALLATION TOOL

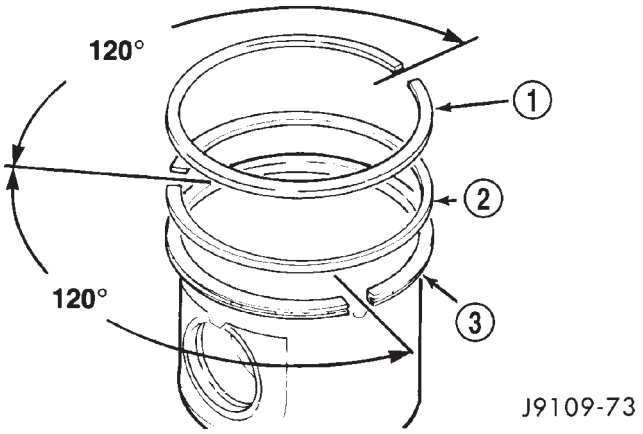


Fig. 141 Piston Ring Orientation

1 - TOP RING
2 - INTERMEDIATE RING
3 - OIL CONTROL RING

VIBRATION DAMPER

REMOVAL

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

(2) Remove the four (4) damper to crankshaft bolts and remove damper (Fig. 142).

INSPECTION

(1) Inspect the damper hub for cracks and replace if any are found.

(2) Inspect the index lines on the damper hub and the inertia member (Fig. 143). If the lines are more

VIBRATION DAMPER (Continued)

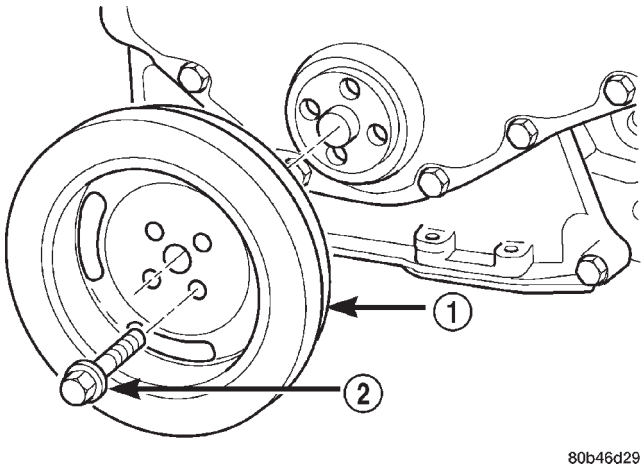


Fig. 142 Crankshaft Damper Removal/Installation

1 - DAMPER
2 - BOLT

than 1.59 mm (1/16 in.) out of alignment, replace the damper.

(3) Inspect the rubber member for deterioration or missing segments (Fig. 144).

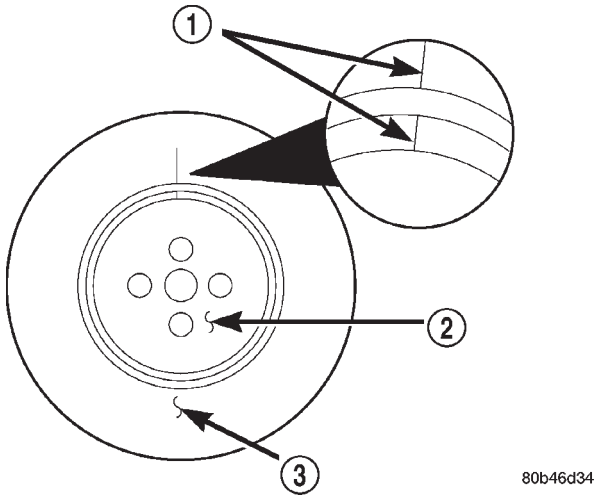


Fig. 143 Inspect Index Lines for Alignment

1 - INDEX LINES
2 - HUB
3 - INERTIA MEMBER

INSTALLATION

(1) Install the crankshaft damper and bolts (Fig. 142). Tighten bolts to 125 N·m (92 ft. lbs.) torque.

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

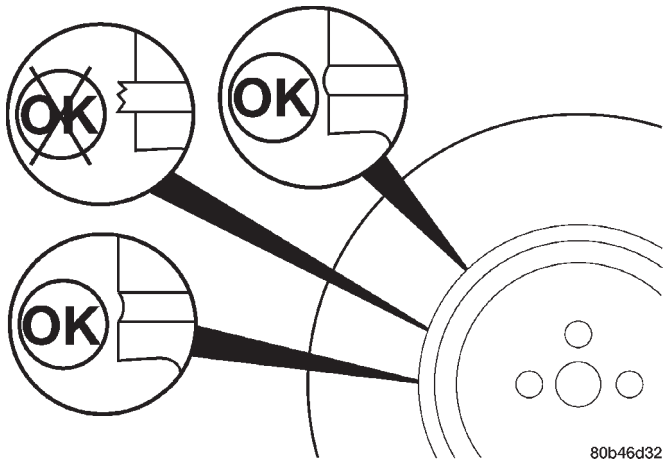


Fig. 144 Inspect Damper Rubber Member

FRONT MOUNT

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove the viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

(3) Raise vehicle on hoist.

(4) Support engine with a screw jack and wood block.

(5) Loosen the thru-bolt and nut (Fig. 145).

(6) Passenger side mount: Remove the two (2) transmission oil cooler bracket to engine mount bolts.

(7) Lift the engine SLIGHTLY and remove the four (4) mount to block bolts.

(8) Remove the mount from the vehicle.

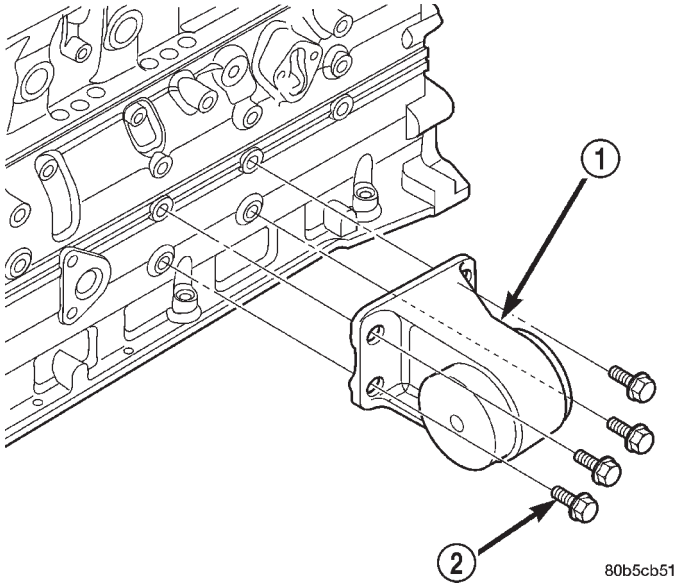


Fig. 145 Front Engine Mount—Typical

1 - MOUNT
2 - BOLT (4)

FRONT MOUNT (Continued)

INSTALLATION

(1) With engine raised SLIGHTLY, position the engine mount to the block. Install the bolts and tighten to 149 N·m (110 ft. lbs.) torque.

(2) Install the thru-bolt into the engine mount.

(3) Lower the engine while guiding the mount and thru-bolt into the frame mounted support cushion brackets (Fig. 146).

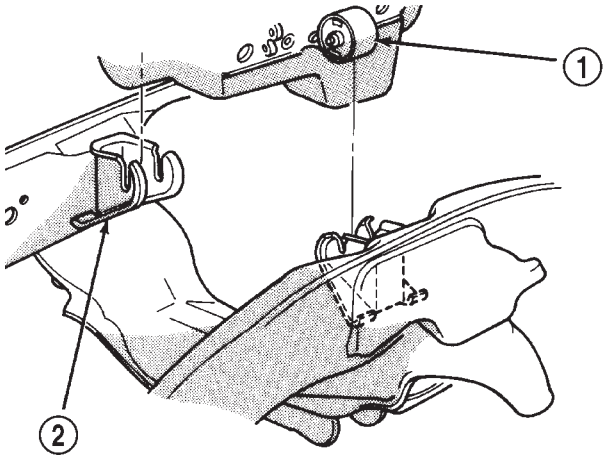


Fig. 146 Positioning Engine Front Mounts

1 - ENGINE SUPPORT BRACKET/CUSHION
2 - SUPPORT CUSHION BRACKET

(4) Install the thru-bolt nut and tighten the nut to 88 N·m (65 ft. lbs.) torque.

(5) Passenger side: Install the two (2) transmission oil cooler bracket to mount bolts. Tighten the bolts to 47 N·m (35 ft. lbs.) torque.

(6) Remove lifting fixture.

(7) Lower the vehicle.

(8) Install the viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(9) Connect the battery negative cables.

REAR MOUNT

REMOVAL

(1) Raise the vehicle on a hoist.

(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 147).

(4) Raise rear of transmission and engine SLIGHTLY.

(5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.

(6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 102 N·m (75 ft. lbs.) torque.

(2) Position support cushion to transmission support bracket. Install stud nuts and tighten to 47 N·m (35 ft. lbs.) torque.

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 50) .

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

LUBRICATION

DESCRIPTION

NOTE: Refer to (Fig. 148) and (Fig. 149) for circuit illustrations.

A gear driven gerotor type oil pump is mounted behind the front gear cover in the lower right portion on the engine.

OPERATION

A gerotor style oil pump draws oil from the crankcase through the suction tube and delivers it through the block where it enters the oil cooler cover and pressure regulator valve. When oil pressure exceeds 449 kPa (65 PSI), the valve opens exposing the dump port, which routes excess oil back to the oil sump.

At the same time, oil is directed to a cast in passage in the oil cooler cover, leading to the oil cooler element. As the oil travels through the element plates, it is cooled by engine coolant traveling past the outside of the plates. It is then routed to the oil filter head and through a full flow oil filter. If a plugged filter is encountered, the filter by-pass valve opens, allowing unfiltered oil to lubricate the engine. This condition can be avoided by frequent oil and filter changes, per the maintenance schedules found in the owners manual. The by-pass valve is calibrated to open when it sees a pressure drop of more than 344 kPa (50 psi) across the oil filter.

The oil filter head then divides the oil between the engine and the turbocharger. The turbocharger receives filtered, cooled and pressurized oil through a supply line from the filter head. The oil lubricates the turbocharger and returns to the pan by way of a drain tube connecting the bottom of the turbocharger to a pressed in tube in the cylinder block.

Oil is then carried across the block to an angle drilling which intersects the main oil rifle. The main

LUBRICATION (Continued)

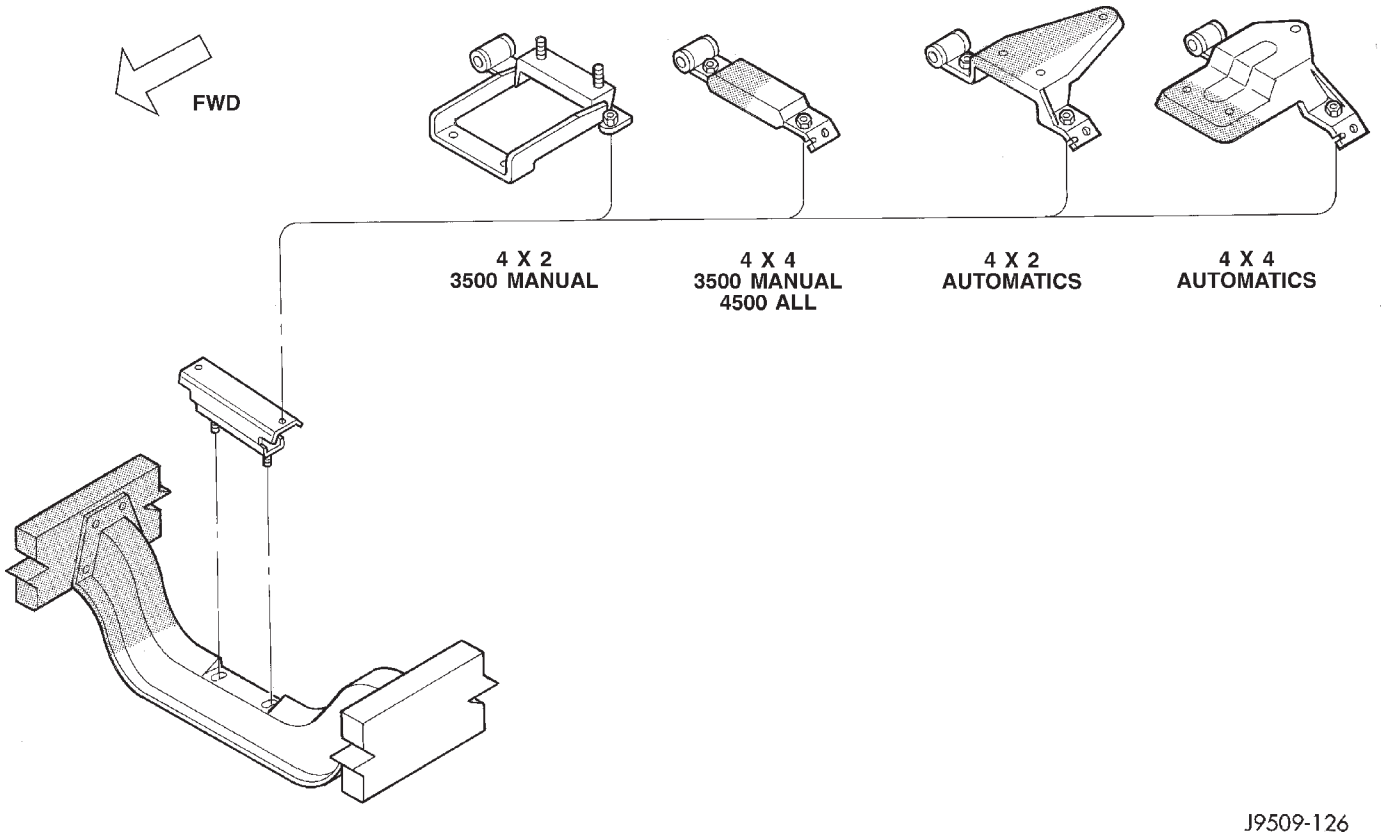


Fig. 147 Engine Rear Support Cushion Assembly

oil rifle runs the length of the block and delivers oil to the crankshaft main journals and valve train. Oil travels to the crankshaft through a series of transfer drillings (one for each main bearing) and lubricates a groove in the main bearing upper shell. From there another drilling feeds the camshaft main journals. The piston cooling nozzles are also supplied by the main bearing upper shell. Crankshaft internal cross-drillings supply oil to the connecting rod journals.

Another series of transfer drillings intersecting the main oil rifle supply the valve train components. Oil travels up the drilling, through a hole in the head gasket, and through a drilling in the cylinder head (one per cylinder), where it enters the rocker arm pedestal and is divided between the intake and exhaust rocker arm. Oil travels up and around the rocker arm mounting bolt, and lubricates the rocker shaft by cross drillings that intersect the mounting bolt hole. Grooves at both ends of the rocker shaft supply oil through the rocker arm where the oil travels to the push rod and socket balls (Fig. 148) and (Fig. 149).

LUBRICATION (Continued)

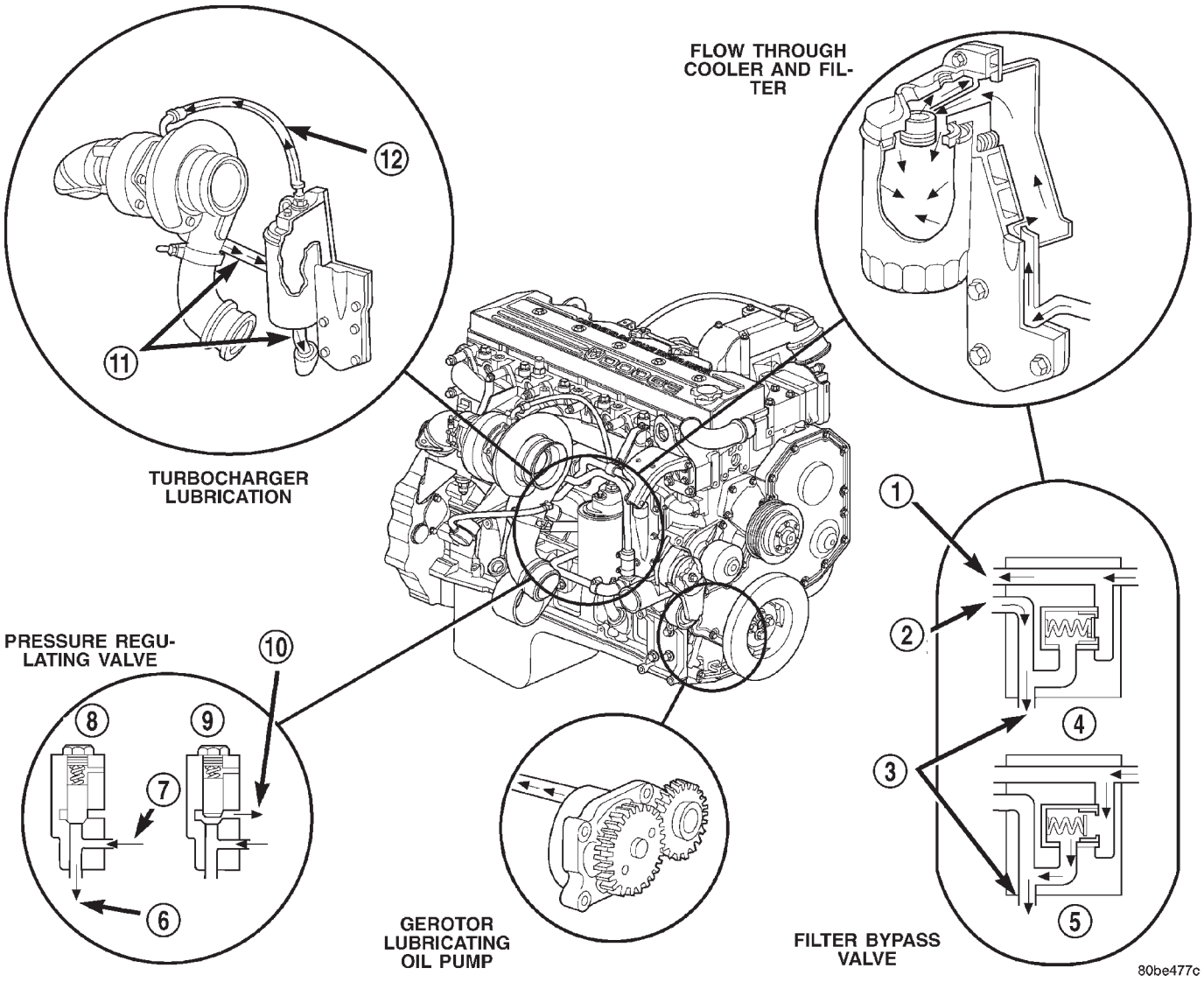


Fig. 148 Lubrication System Circulation

1 - TO FILTER
2 - FROM FILTER
3 - TO MAIN OIL RIFLE
4 - CLOSED
5 - OPEN
6 - TO COOLER
7 - FROM PUMP
8 - CLOSED
9 - OPEN
10 - TO OIL SUMP
11 - OIL DRAIN
12 - OIL SUPPLY

LUBRICATION (Continued)

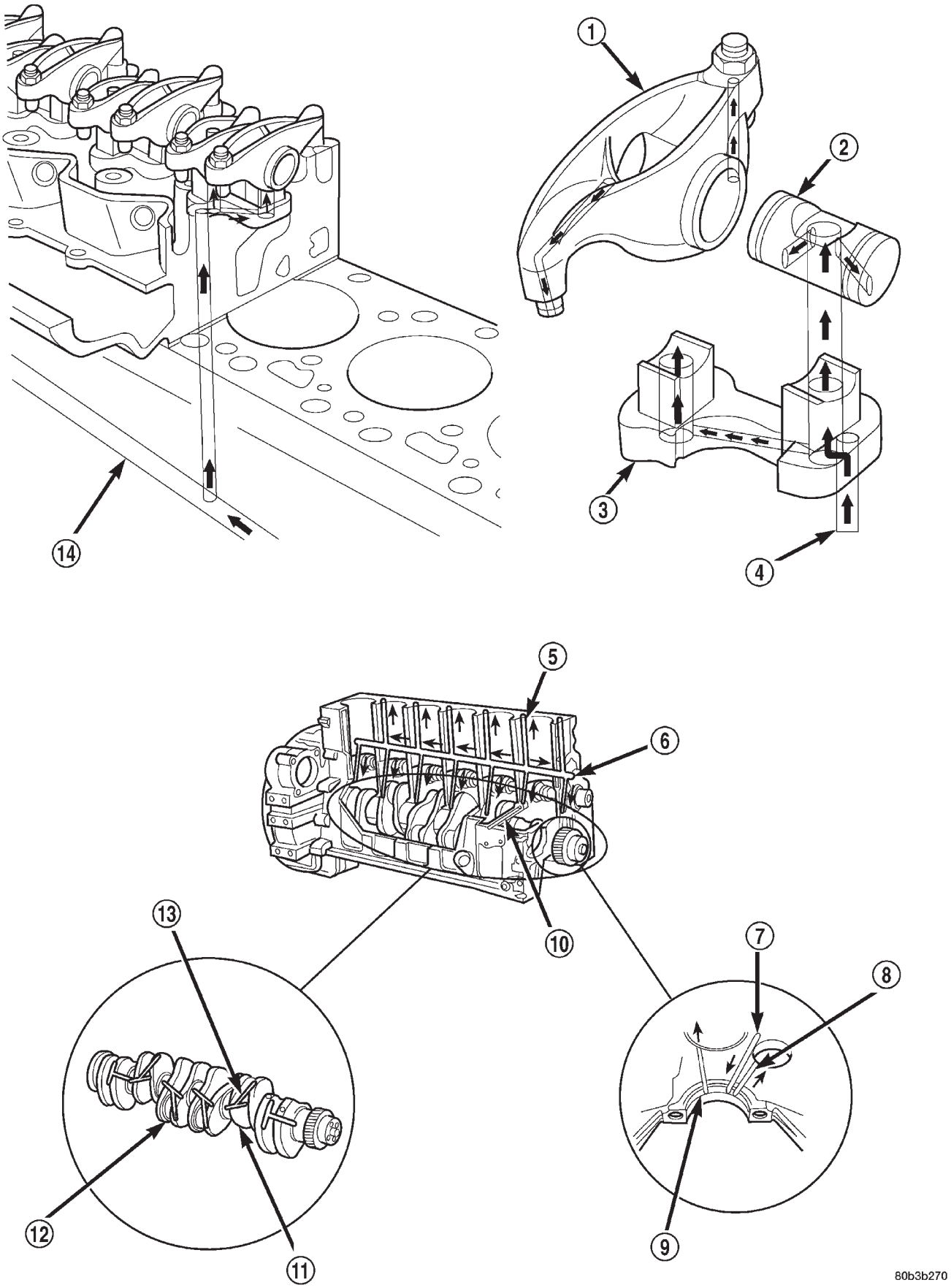


Fig. 149 Lubrication System Circulation—Cont'd

LUBRICATION (Continued)

1 - ROCKER ARM
2 - ROCKER SHAFT
3 - PEDESTAL
4 - FROM MAIN OIL RIFLE
5 - TO VALVE TRAIN
6 - MAIN OIL RIFLE
7 - FROM MAIN OIL RIFLE
8 - TO CAMSHAFT
9 - TO PISTON COOLING NOZZLE
10 - FROM OIL COOLER
11 - CRANKSHAFT MAIN JOURNAL
12 - ROD JOURNAL
13 - TO ROD BEARING
14 - MAIN OIL RIFLE

DIAGNOSIS AND TESTING—ENGINE OIL PRESSURE

(1) Remove the engine oil pressure sensor and install Oil Pressure Line and Gauge Tool C-3292 with a suitable adapter.

(2) Start engine and warm to operating temperature.

(3) Record engine oil pressure and compare with engine oil pressure chart.

CAUTION: If engine oil pressure is zero at idle, DO NOT RUN THE ENGINE.

Engine Oil Pressure (MIN)	
At Idle	103.4 kPa (15 psi)
At 2000 rpm	310.2 kPa (45 psi)

If minimum engine oil pressure is below these ranges, (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).

(4) Remove oil pressure gauge and install the oil pressure sensor. Tighten the sensor to 16 N·m (144 in. lbs.) torque.

OIL

STANDARD PROCEDURE

STANDARD PROCEDURE - ENGINE OIL LEVEL

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

To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable oil level is in the SAFE RANGE on the engine oil dipstick (Fig. 150).

Unless the engine has exhibited loss of oil pressure, run the engine for about five minutes before checking oil level. Checking engine oil level of a cold engine is not accurate.

(1) Position vehicle on level surface.

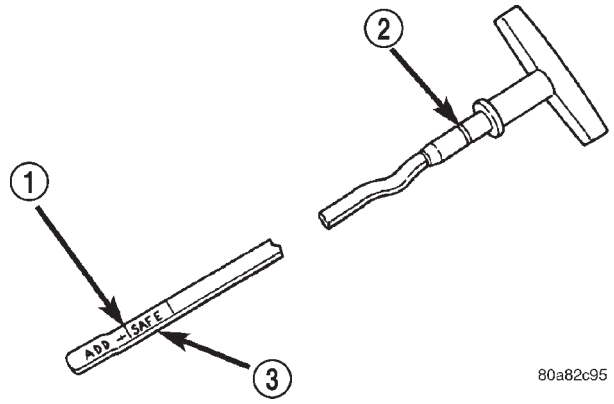


Fig. 150 Oil Level Indicator (Dipstick)

1 - ADD OIL MARK
2 - O-RING
3 - SAFE RANGE

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

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

(6) Add oil only if level is below the SAFE RANGE area on the dipstick.

(7) Replace dipstick

STANDARD PROCEDURE - ENGINE OIL SERVICE

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

NOTE: Change engine oil and filter at intervals specified in the owner's manual.

(1) Operate the engine until the water temperature reaches 60°C (140°F). Shut the engine off.

(2) Use a container that can hold at least 14 liters (15 quarts) to hold the used oil. Remove the oil drain plug and drain the used engine oil into the container.

OIL (Continued)

(3) Always check the condition of the used oil. This can give you an indication of engine problems that might exist.

- Thin, black oil indicates fuel dilution.
- Milky discoloration indicates coolant dilution.

(4) Clean the area around the oil filter head. Remove the filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - REMOVAL).

(5) Install new oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - INSTALLATION).

(6) Clean the drain plug and the sealing surface of the pan. Check the condition of the threads and sealing surface on the oil pan and drain plug.

(7) Install the drain plug. Tighten the plug to 50 N·m (37 ft. lbs.) torque.

(8) Use only High-Quality Multi-Viscosity lubricating oil in the Cummins Turbo Diesel engine. Choose the correct oil for the operating conditions (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).

(9) Fill the engine with the correct grade of new oil (Refer to LUBRICATION & MAINTENANCE/FLUID CAPACITIES - SPECIFICATIONS).

(10) Start the engine and operate it at idle for several minutes. Check for leaks at the filter and drain plug.

(11) Stop engine. Wait several minutes to allow the oil to drain back to the pan and check the level again.

USED ENGINE OIL DISPOSAL Care should be exercised when disposing of used engine oil after it has been drained from a vehicle's engine.

OIL COOLER & LINES

CLEANING AND INSPECTION

Clean the sealing surfaces.

Apply 483 kPa (70 psi) air pressure to the element to check for leaks. If the element leaks, replace the element.

OIL FILTER

REMOVAL

(1) Clean the area around the oil filter head. Remove the filter using a 90-95 mm filter wrench.

(2) Clean the gasket surface of the filter head. The filter canister O-Ring seal can stick on the filter head. Make sure it is removed.

INSTALLATION

(1) Fill the oil filter element with clean oil before installation. Use the same type oil that will be used in the engine.

(2) Apply a light film of lubricating oil to the sealing surface before installing the filter.

CAUTION: Mechanical over-tightening may distort the threads or damage the filter element seal.

(3) Install the filter until it contacts the sealing surface of the oil filter adapter. Tighten filter an additional ½ turn.

OIL PAN

REMOVAL

(1) Disconnect the battery negative cables.

(2) Raise vehicle on hoist.

(3) Remove transmission and transfer case (if equipped).

(4) Remove flywheel.

(5) Disconnect starter cables from starter motor.

(6) Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL) and transmission adapter plate assembly.

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

(7) Drain the engine oil (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE).

(8) Install the oil pan drain plug with a new sealing washer and tighten to 60 N·m (44 ft. lbs.) torque.

(9) Remove oil pan bolts, break the pan to block seal, and lower pan slightly and remove oil suction tube fasteners.

(10) Remove oil pan and suction tube (Fig. 151).

CLEANING

Remove all gasket material from the oil pan and cylinder block sealing surfaces. Extra effort may be required around T-joint areas. Clean oil pan and flush suction tube with a suitable solvent.

INSPECTION

Inspect the oil pan, suction tube, and tube braces for cracks and damage. Replace any defective component. Inspect the oil drain plug and drain hole threads. Inspect the oil pan sealing surface for straightness. Repair any minor imperfections with a ball-peen hammer. Do not attempt to repair an oil pan by welding.

OIL PAN (Continued)

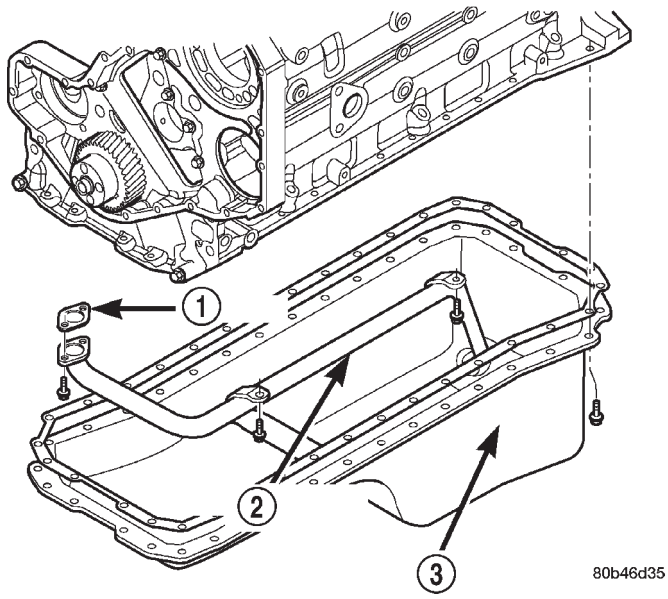


Fig. 151 Oil Pan, Suction Tube and Gasket

1 - GASKET
2 - SUCTION TUBE
3 - OIL PAN

INSTALLATION

(1) Fill the T-joint between the pan rail/gear housing and pan rail/rear seal retainer with sealant. Use Mopar® Silicone Rubber Adhesive Sealant or equivalent.

(2) Apply a film of Mopar® Silicone Rubber Adhesive Sealant or equivalent to the oil pan gasket. Apply sealant only to the side that faces the oil pan.

(3) Place suction tube in oil pan and guide them into place (Fig. 151). Using a new tube to oil pump gasket, install and tighten the suction tube bolts by hand. Starting with the oil pump inlet bolts, tighten the bolts to 24 N·m (18 ft. lbs.) torque. Tighten the remaining tube brace bolts to 24 N·m (18 ft. lbs.) torque.

(4) Starting in the center and working outward, tighten the oil pan bolts to 24 N·m (18 ft. lbs.) torque.

(5) Install the flywheel housing assembly with the starter motor attached and tighten bolts to 60 N·m (44 ft. lbs.) torque.

(6) Connect starter motor cables.

(7) Install transmission and transfer case (if equipped).

(8) Lower vehicle.

(9) Install battery negative cables.

(10) Fill the crankcase with new engine oil.

(11) Start engine and check for leaks. Stop engine, check oil level, and adjust, if necessary.

OIL PRESSURE RELIEF VALVE

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove the threaded plug, spring and plunger (Fig. 152). Insert a finger or a seal pick to lift the plunger from the bore.

NOTE: If the plunger is stuck in the bore, it will be necessary to remove the filter head.

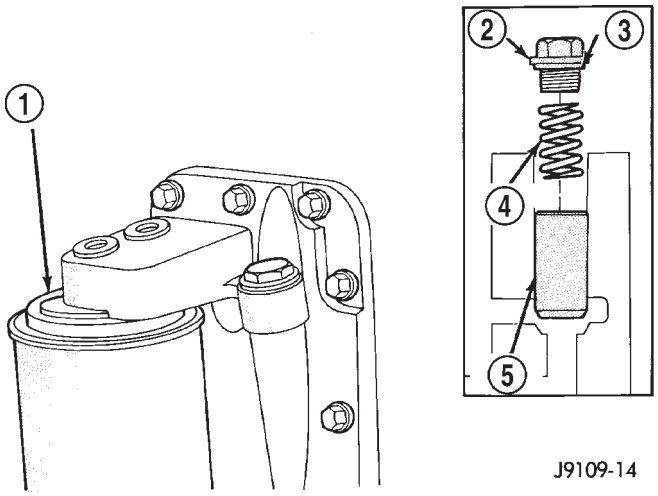


Fig. 152 Oil Pressure Regulator

1 - OIL FILTER
2 - PLUG
3 - GASKET
4 - SPRING
5 - VALVE

CLEANING

(1) Clean the regulator spring and plunger with a suitable solvent and blow dry with compressed air. If the plunger bore requires cleaning, it is necessary to remove the oil filter head to avoid getting debris into the engine.

INSPECTION

Inspect the plunger and plunger bore for cracks and excessive wear. Polished surfaces are acceptable. Verify that the plunger moves freely in the bore.

Check the spring for height and load limitations (Fig. 153) . Replace the spring if out of limits shown in the figure.

INSTALLATION

(1) Install the plunger, spring, and plug as shown in (Fig. 152). Tighten the plug to 80 N·m (60 ft. lbs.) torque.

(2) Connect the battery negative cables.

(3) Start the engine and verify that it has oil pressure.

OIL PRESSURE RELIEF VALVE (Continued)

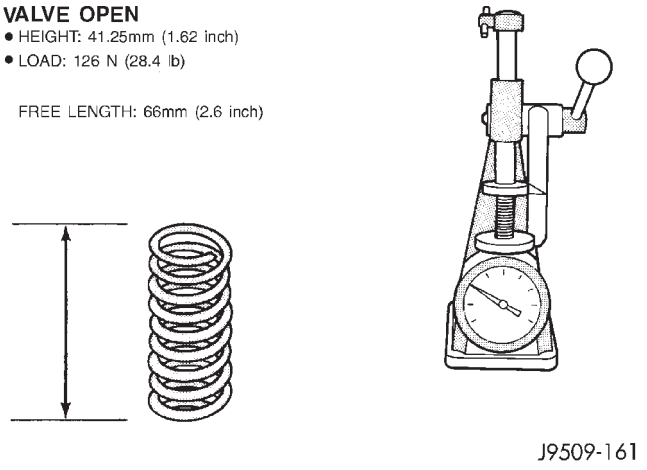


Fig. 153 Oil Pressure Regulator Spring Check

OIL PRESSURE SENSOR/ SWITCH

REMOVAL

(1) Disconnect the battery negative cables.

(2) Disconnect the oil pressure sensor connector (Fig. 154).

(3) Using a suitable socket, remove the oil pressure sensor from the block (counter-clockwise).

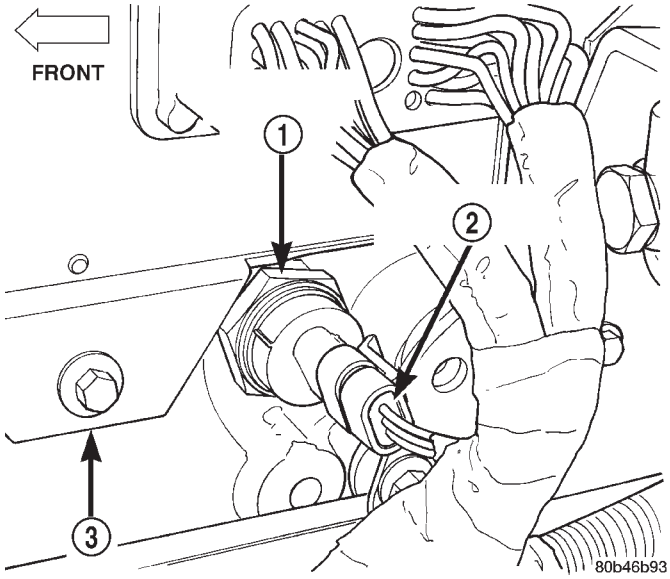


Fig. 154 Oil Pressure Sensor Location

1 - ENGINE OIL PRESSURE SENSOR
2 - ELECTRIAL CONNECTOR
3 - ECM

INSTALLATION

(1) If the sensor is not being replaced, inspect the o-ring (Fig. 155) and replace if necessary.

(2) Install the oil pressure sensor and tighten to 16 N·m (144 in. lbs.) torque.

(3) Connect the battery negative cables.

(4) Start engine and check for oil leaks at the sensor.

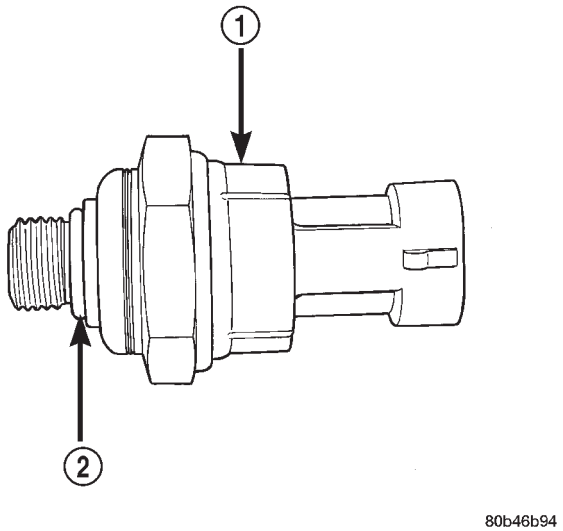


Fig. 155 Oil Pressure Sensor and

1 - ENGINE OIL PRESSURE SENSOR
2 - O-RING

OIL PUMP

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

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

(4) Remove the fan support/hub assembly.

(5) Remove crankshaft damper (Fig. 156) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(6) Remove the gear housing cover (Fig. 157) (Refer to 9 - ENGINE/VALVE TIMING/GEAR HOUSING COVER - REMOVAL).

(7) Remove the four mounting bolts and pull the pump from the bore in the cylinder block (Fig. 158).

CLEANING

Clean all parts in solvent and dry with compressed air. Clean the old sealer residue from the back of the gear housing cover and front of the gear housing.

INSPECTION

Disassemble and inspect the oil pump as follows:

(1) Visually inspect the lube pump gears for chips, cracks or excessive wear.

OIL PUMP (Continued)

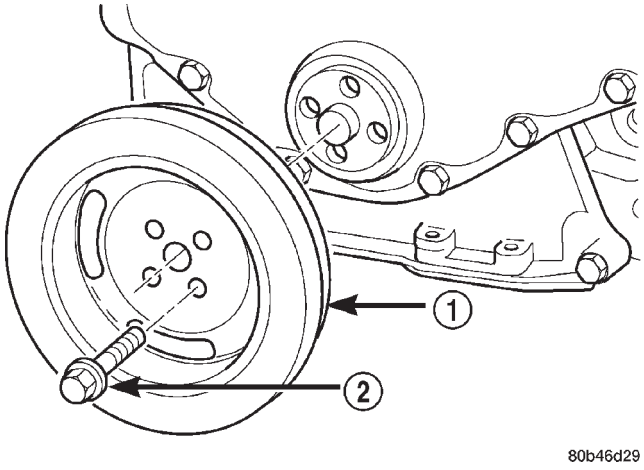


Fig. 156 Crankshaft Damper Removal/Installation

1 - DAMPER
2 - BOLT

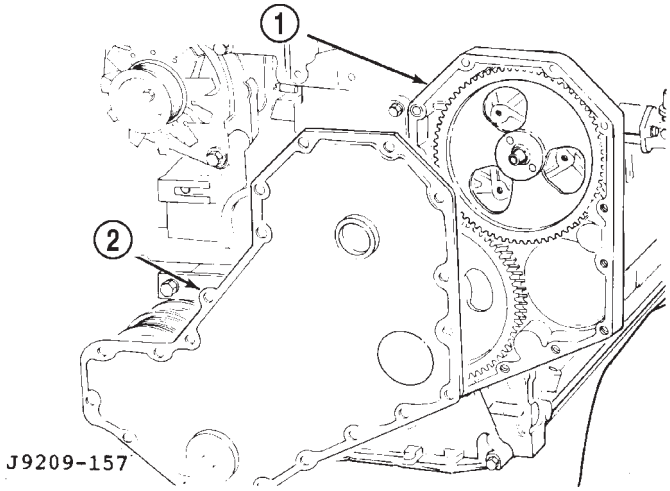


Fig. 157 Gear Housing and Cover

1 - GEAR HOUSING
2 - GEAR HOUSING COVER

(2) Remove the back plate (Fig. 159).

(3) Mark TOP on the gerotor planetary using a felt tip pen (Fig. 159).

(4) Remove the gerotor planetary (Fig. 159). Inspect for excessive wear or damage. Inspect the pump housing and gerotor drive for damaged and excessive wear.

(5) Install the gerotor planetary in the original position. The chamfer must be on the O.D. and down.

(6) Measure the tip clearance (Fig. 160). Maximum clearance is 0.1778 mm (0.007 inch). If the oil pump is out of limits, replace the pump.

(7) Measure the clearance of the gerotor drive/ gerotor planetary to port plate (Fig. 161). Maximum clearance is 0.127 mm (0.005 inch). If the oil pump is out of limits, replace the pump.

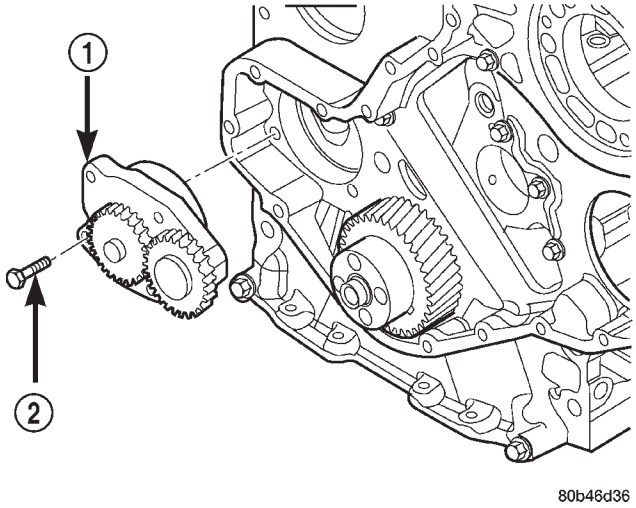


Fig. 158 Oil Pump Removal/Installation

1 - OIL PUMP
2 - BOLT (4)

(8) Measure the clearance of the gerotor planetary to the body bore (Fig. 162). Maximum clearance is 0.381 mm (0.015 inch). If the oil pump is out of limits, replace the pump.

(9) Measure the gears backlash (Fig. 163). The limits of a used pump is 0.075- 0.85 mm (0.0296-0.0335 inch). If the backlash is out of limits, replace the oil pump.

(10) Install the back plate.

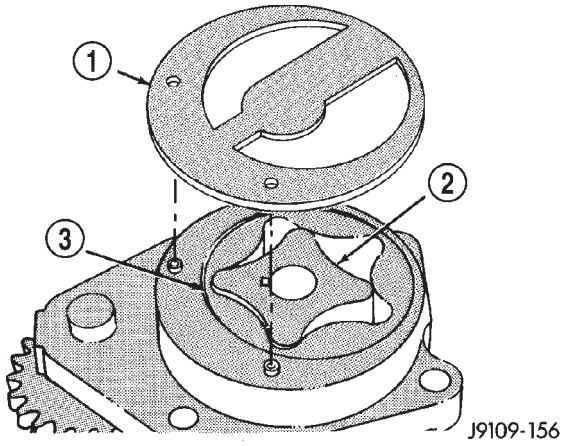


Fig. 159 Gerotor Planetary and Gerotor

1 - OIL PUMP BACK PLATE
2 - GEROTOR
3 - GEROTOR PLANETARY

INSTALLATION

(1) Lubricate the pump with clean engine oil. Filling the pump with clean engine oil during installation will help to prime the pump at engine start up.

(2) Verify the idler gear pin is installed in the locating bore in the cylinder block.

OIL PUMP (Continued)

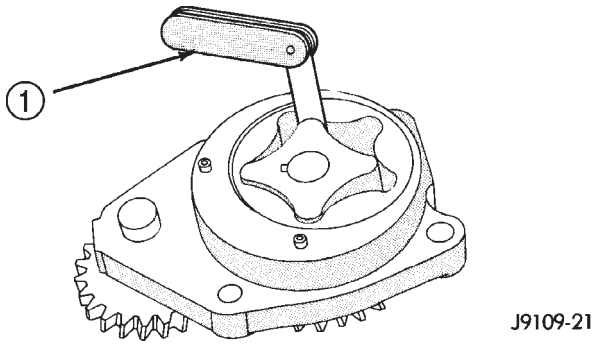


Fig. 160 Measuring Tip Clearance

1 - FEELER GAUGE

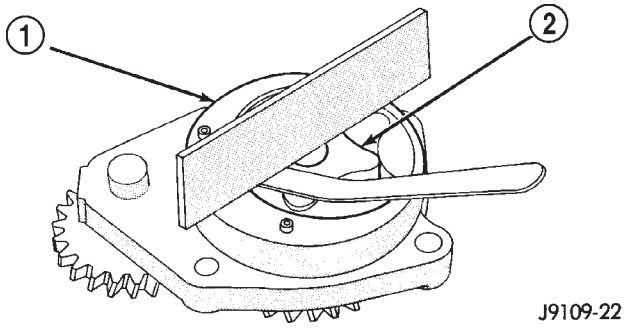


Fig. 161 Measuring Gerotor to Port Plate Clearance

1 - PORT PLATE
2 - GEROTOR

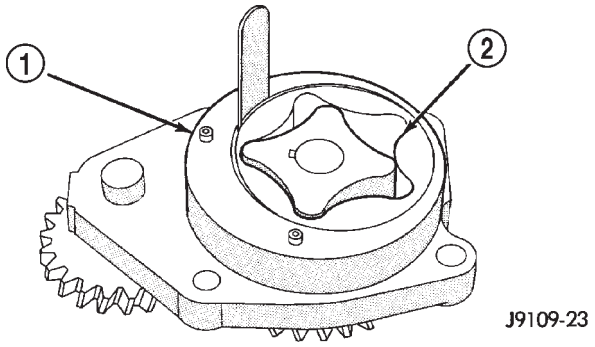


Fig. 162 Measuring Gerotor Planetary to Body Bore Clearance

1 - BODY BORE
2 - GEROTOR PLANETARY

(3) Install the pump (Fig. 158). Tighten the oil pump mounting bolts in two steps, in the sequence shown in (Fig. 164).

- Step 1—Tighten to 5 N·m (44 in. lbs.) torque.
- Step 2—Tighten to 24 N·m (18 ft. lbs.) torque.

(4) The back plate on the pump seats against the bottom of the bore in the cylinder block. When the pump is correctly installed, the flange on the pump will not touch the cylinder block.

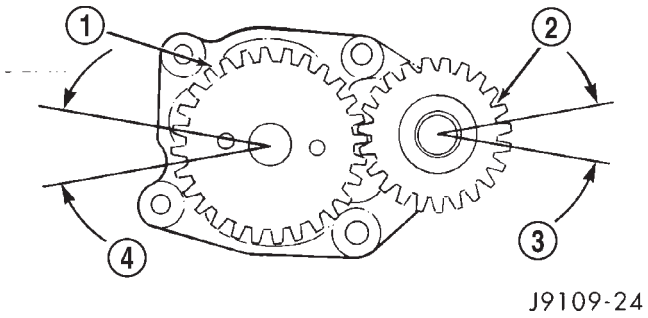


Fig. 163 Measure Gear Backlash

1 - OIL PUMP DRIVE GEAR
2 - IDLER GEAR
3 - BACKLASH
4 - BACKLASH

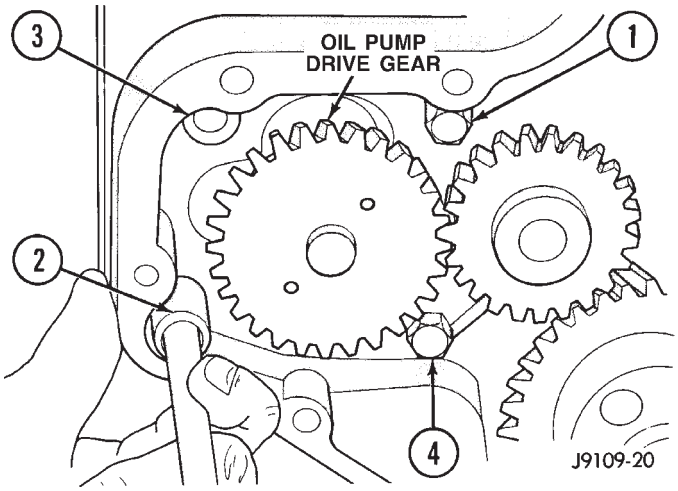


Fig. 164 Oil Pump Mounting Bolt Torque Sequence

(5) Measure the idler gear to pump drive gear backlash and the idler gear to crankshaft gear backlash (Fig. 165). The backlash should be 0.75- 0.85 mm (0.0296-0.0335 inch). If the backlash is out of limits, replace the oil pump.

(6) If the adjoining gear moves when you measure the backlash, the reading will be incorrect.

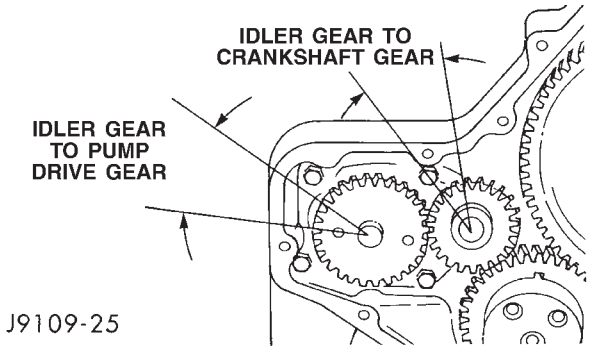


Fig. 165 Idler Gear to Pump Drive Gear and Crankshaft Gear Backlash

OIL PUMP (Continued)

(7) Apply a bead of Mopar® Silicone Rubber Adhesive Sealant or equivalent to the gear housing cover sealing surface.

(8) Install the gear housing cover (Refer to 9 - ENGINE/VALVE TIMING/GEAR HOUSING COVER - INSTALLATION).

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

(10) Install the fan support/hub assembly and torque bolts to 24 N·m (18 ft. lbs.).

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

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

(13) Connect battery negative cables.

(14) Start engine and check for oil leaks.

INTAKE MANIFOLD

REMOVAL

(1) Disconnect the battery negative cables.

(2) Remove the charge air cooler outlet tube from the air inlet housing (Fig. 166).

(3) Remove the engine oil dipstick tube mounting bolt (Fig. 166). Position dipstick tube to the side.

(4) Disconnect the air grid heater power cables at the cable mounting studs (Fig. 167).

(5) Remove the four (4) air inlet housing mounting bolts (Fig. 167) and remove the housing from top of the heater elements.

(6) Remove the intake air grid heater from the manifold (Fig. 168).

(7) Remove the high pressure fuel lines.(Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - REMOVAL).

(8) Remove the remaining intake manifold cover-to-cylinder head bolts.

(9) Remove the intake manifold cover and gasket. Keep the gasket material and any other material out of the air intake.

(10) Clean the intake manifold cover and cylinder head sealing surface.

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.

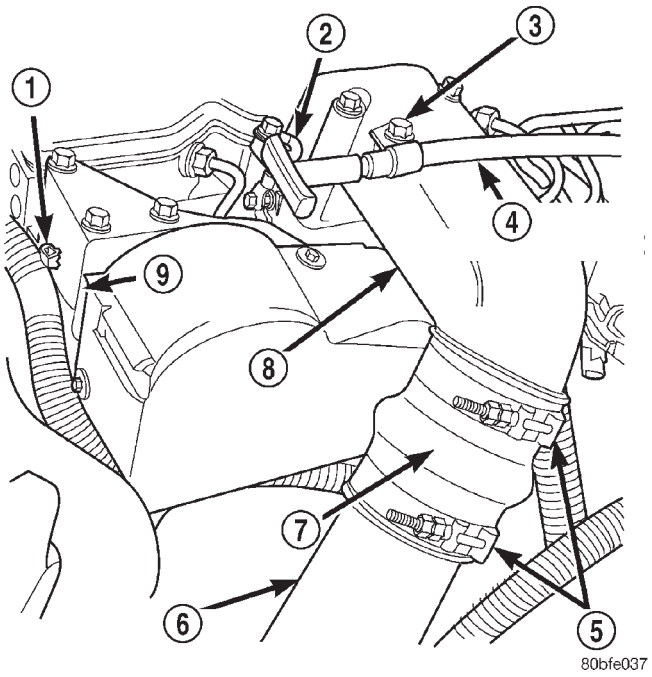


Fig. 166 Charge Air Cooler Air Tube

1 - FRONT WIRING CLIP
2 - GROUND CABLE
3 - TUBE BOLT
4 - ENGINE OIL DIPSTICK TUBE
5 - CLAMPS
6 - AIR TUBE (INT. MAN.-TO-INTERCOOLER)
7 - RUBBER HOSE
8 - AIR INTAKE HOUSING
9 - CABLE BRACKET HOUSING

Inspect mating surfaces of manifold for flatness with a straightedge.

INSTALLATION

(1) Using a new gasket, install the intake manifold cover.

(2) Install the cover-to-cylinder head bolts that do not hold down the high pressure fuel line support brackets. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(3) Install the high pressure fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - INSTALLATION).

(4) Install the high pressure fuel line support bracket-to-intake manifold cover bolts and tighten to 24 N·m (18 ft. lbs.) torque.

(5) Using two (2) new gaskets, install the intake air grid heater and air inlet housing (Fig. 167). Position the ground cable and install and tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(6) Install and tighten the air intake heater power supply nuts to 14 N·m (120 in. lbs.) torque.

(7) Install the engine oil dipstick tube and mounting bolt (Fig. 166).

INTAKE MANIFOLD (Continued)

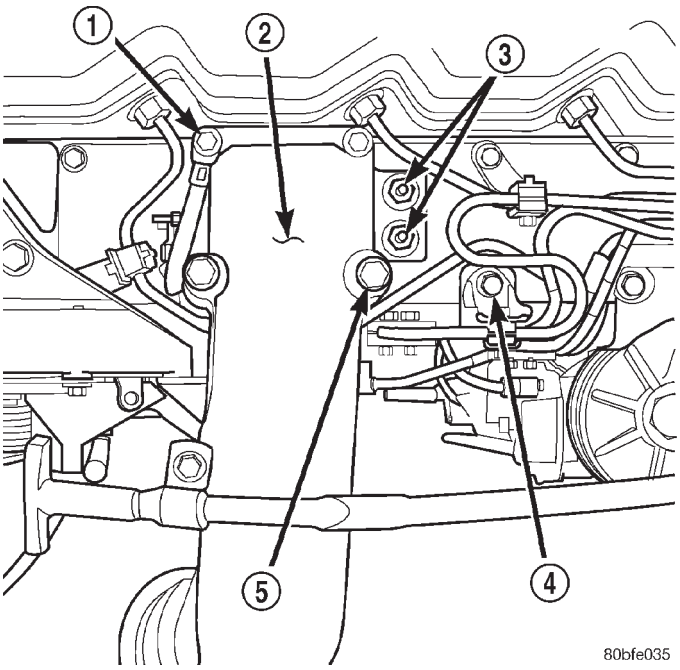


Fig. 167 Air Inlet Housing

1 - GROUND STRAP
2 - AIR INTAKE HOUSING
3 - HEATER POWER CABLE MOUNTING STUDS
4 - FUEL LINE BRACKET BOLT
5 - HOUSING BOLTS (4)

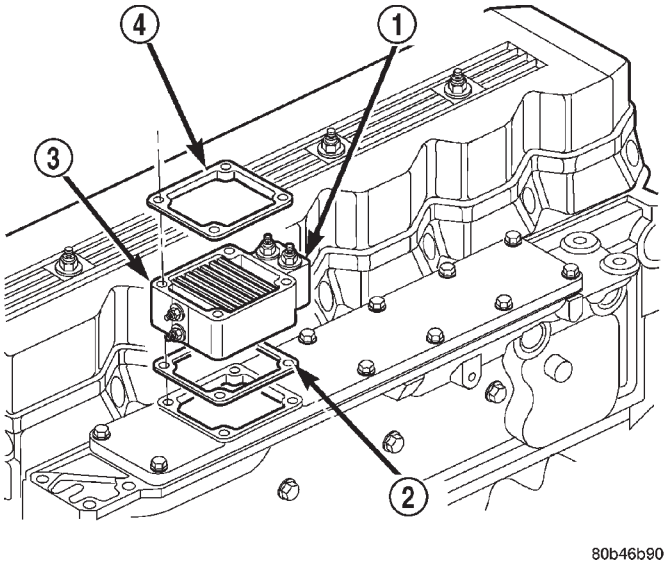


Fig. 168 Intake Air Grid Heater

1 - AIR HEATER ELEMENTS
2 - LOWER GASKET
3 - BLOCK
4 - UPPER GASKET

(8) Position the charge air cooler outlet tube onto the air inlet housing (Fig. 166). Tighten the clamps to 8 N·m (72 in. lbs.) torque.

(9) Perform the fuel system air bleed procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).

(10) Connect the battery negative cables.

EXHAUST MANIFOLD

REMOVAL

(1) Disconnect the battery negative cables.

(2) Raise vehicle on hoist.

(3) Disconnect the exhaust pipe from the turbocharger elbow (Fig. 169) .

(4) Lower vehicle.

(5) Disconnect the turbocharger air inlet hose (Fig. 170) .

(6) Disconnect the turbocharger oil supply line and the oil drain tube from the turbocharger (Fig. 171) .

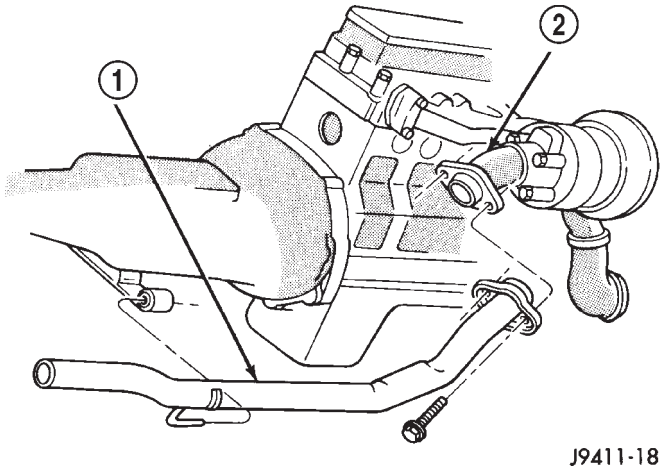


Fig. 169 Exhaust Pipe

1 - EXHAUST PIPE
2 - TURBOCHARGER EXHAUST PIPE

(7) Disconnect the charge air cooler inlet pipe from the turbocharger (Fig. 171) .

(8) Remove the turbocharger and gasket from the exhaust manifold.

(9) Remove the cab heater return pipe nut from the exhaust manifold stud. Position the tube out of the way.

(10) Remove the exhaust manifold-to-cylinder head bolts and spacers (Fig. 172) .

(11) Remove the exhaust manifold and gaskets (Fig. 172) .

CLEANING

Clean the cylinder head and exhaust manifold sealing surfaces with a suitable scraper. Use a Scotch-Brite™ pad or equivalent.

EXHAUST MANIFOLD (Continued)

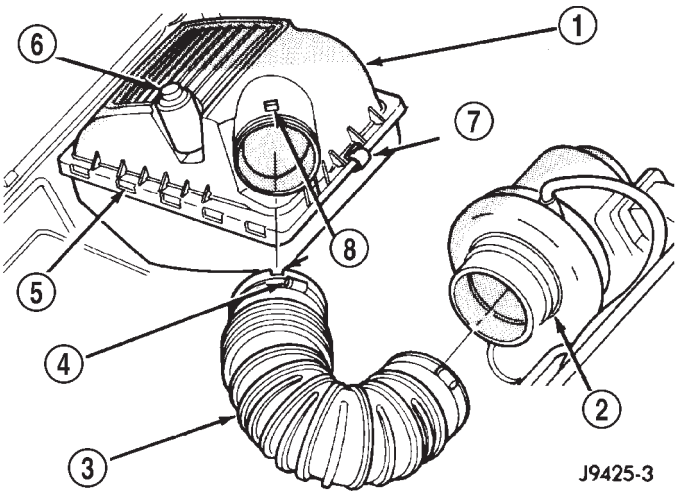


Fig. 170 Turbocharger Air Inlet Hose

1 - AIR FILTER HOUSING COVER
2 - TURBOCHARGER
3 - AIR INLET TUBE
4 - HOSE CLAMP
5 - HINGE TABS
6 - FILTER MINDER
7 - CLIPS (4)
8 - TUBE ALIGNMENT NOTCHES

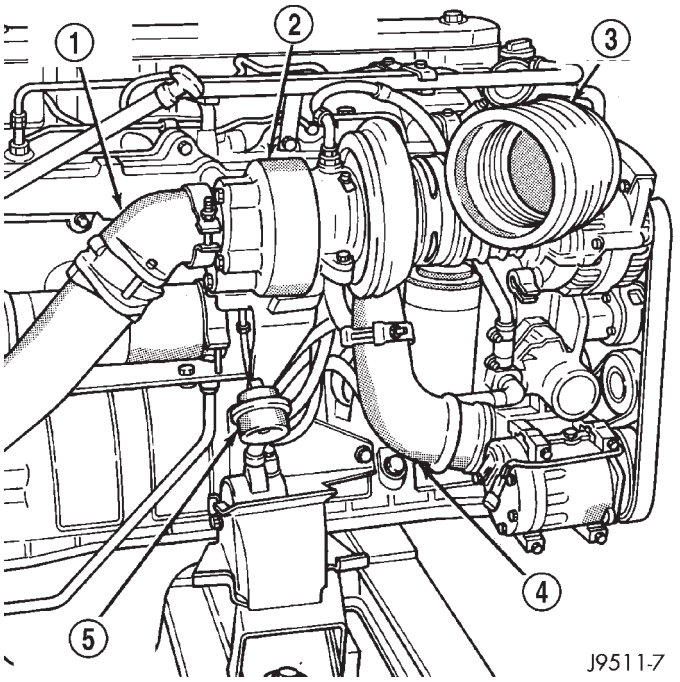


Fig. 171 Oil Supply Line and Charge Air Cooler Inlet Duct

1 - EXHAUST PIPE
2 - TURBOCHARGER
3 - AIR INLET TUBE
4 - INTERCOOLER INLET DUCT
5 - WASTE GATE ACTUATOR

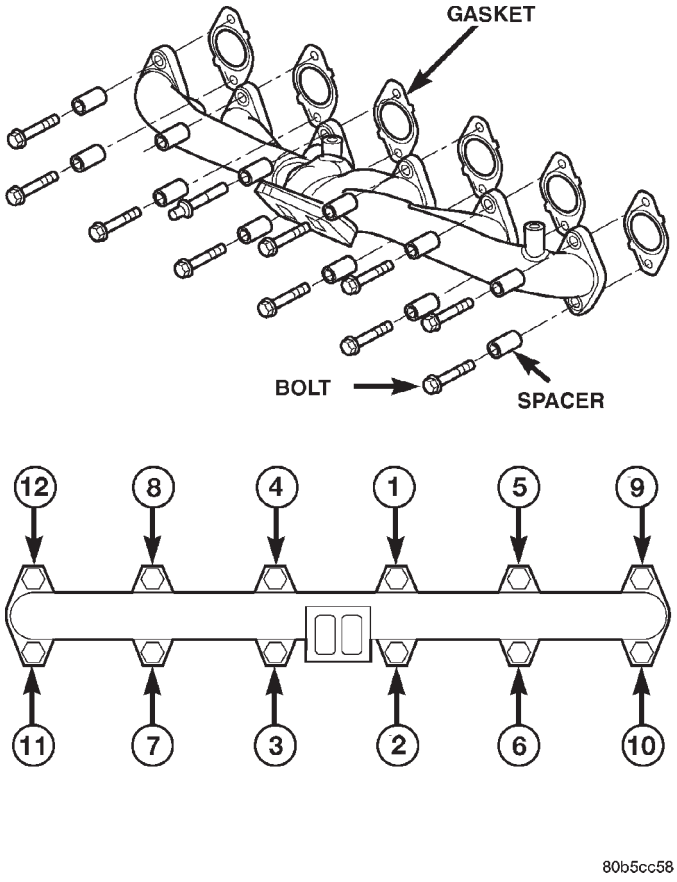


Fig. 172 Exhaust Manifold and Gaskets

INSPECTION

Inspect the exhaust manifold for cracks. Measure the exhaust manifold for flatness. Place a ruler over all of the exhaust ports and insert a feeler gauge between the port flange and the ruler.

INSTALLATION

(1) Using new gaskets, install the exhaust manifold and gaskets. Install the bolts and spacers and tighten the bolts in the sequence shown in (Fig. 172) to 43 N·m (32 ft. lbs.) torque.

(2) Install the cab heater return hose to the manifold bolt stud. Tighten the nut to 24 N·m (18 ft. lbs.) torque.

(3) Install the turbocharger. Apply anti-seize to the studs and then tighten the turbocharger mounting nuts to 32 N·m (24 ft. lbs.) torque.

(4) Install the oil drain tube and oil supply line to the turbocharger. Tighten the drain tube bolts to 24 N·m (18 ft. lbs.) torque.

(5) **Pre-lube the turbocharger.** Pour 50 to 60 cc (2 to 3 oz.) clean engine oil in the oil supply line fitting. Rotate the turbocharger impeller by hand to distrubute the oil thoroughly.

(6) Install and tighten the oil supply line fitting nut to 20 N·m (133 in. lbs.) torque.

EXHAUST MANIFOLD (Continued)

(7) Position the charge air cooler inlet pipe to the turbocharger. With the clamp in position, tighten the clamp nut to 8 N·m (72 in. lbs.) torque.
(8) Position the air inlet hose to the turbocharger (Fig. 170). Tighten the clamp to 8 N·m (72 in. lbs.) torque.
(9) Raise vehicle on hoist.
(10) Connect the exhaust pipe to the turbocharger (Fig. 169) and tighten the bolts to 34 N·m (25 ft. lbs.) torque.
(11) Lower the vehicle.
(12) Connect the battery negative cables.
(13) Start the engine to check for leaks.

VALVE TIMING

STANDARD PROCEDURE - TIMING VERIFICATION

(1) Remove the cylinder head cover.
(2) Remove fuel injector from cylinder number 1.
(3) Remove the crankcase breather from the gear housing cover.
(4) Using Special Tool 7471B rotate the engine until the timing mark on the fuel pump gear is aligned with the TDC mark on the gear housing cover.
(5) Using a 8 in.x 1/4 in. dowel rod inserted into cylinder number 1, rock the crankshaft back and forth to verify piston number 1 is at TDC.
(6) With piston number 1 at TDC the timing mark on the fuel pump gear should be aligned with the TDC mark on the gear housing cover. If marks do not line up, remove the gear housing cover.
(7) With cylinder number still at TDC, inspect the keyway on the crankshaft gear for proper alignment (12 o'clock position).
(8) If the keyway is not at 12 o'clock position replace the crankshaft gear assembly.
(9) If the keyway is at 12 o'clock position, verify timing mark alignment between the camshaft gear, crankshaft gear and the fuel pump gear, if not aligned inspect keyway on camshaft gear.
(10) Inspect keyway on camshaft gear for proper alignment with the key in the camshaft, if alignment is off replace the camshaft/gear assembly.
(11) If timing marks alignment is off and no damage is found at either the crankshaft or camshaft gear keyways, realign timing marks as necessary.

GEAR HOUSING

REMOVAL

(1) Disconnect the battery negative cables.
(2) Raise vehicle on hoist.
(3) Partially drain engine coolant into container suitable for re-use (Refer to 7 - COOLING - STANDARD PROCEDURE).
(4) Lower vehicle.
(5) Remove radiator upper hose.
(6) Disconnect coolant recovery bottle hose from radiator filler neck and lift bottle off of fan shroud.
(7) Disconnect windshield washer pump supply hose and electrical connections and lift washer bottle off of fan shroud.
(8) Remove the fan shroud-to-radiator mounting bolts.
(9) Remove viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).
(10) Remove the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
(11) Remove the cooling fan support/hub from the front of the engine (Fig. 173).
(12) Raise the vehicle on hoist.
(13) Remove the crankshaft damper (Fig. 174) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
(14) Lower the vehicle.
(15) Remove the gear cover-to-housing bolts and gently pry the cover away from the housing (Fig. 175), taking care not to mar the gasket surfaces.

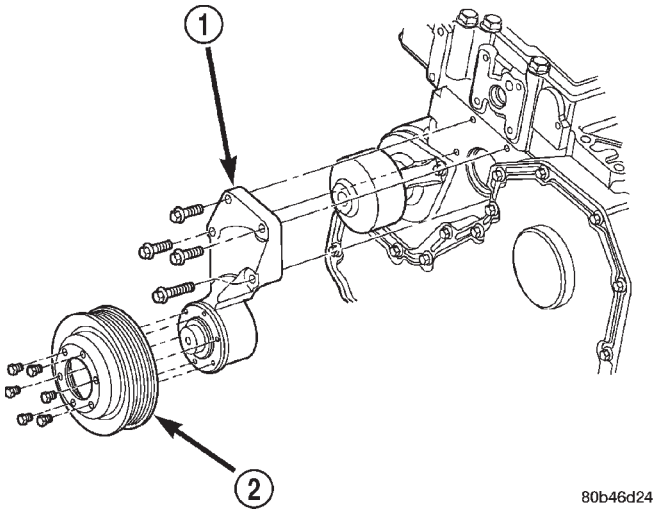


Fig. 173 Fan Support/Hub Assembly - Removal/ Installation

1 - FAN SUPPORT/HUB
2 - FAN PULLEY

(16) Remove the fuel injection pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).
(17) Disconnect the camshaft position sensor connector.

GEAR HOUSING (Continued)

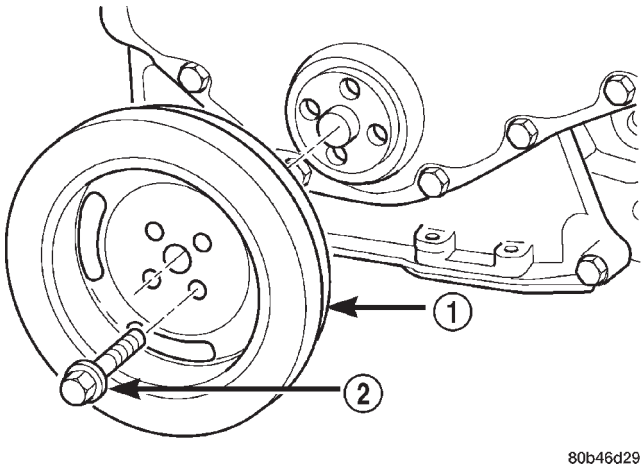


Fig. 174 Crankshaft Damper - Removal/Installation

1 - DAMPER
2 - BOLT

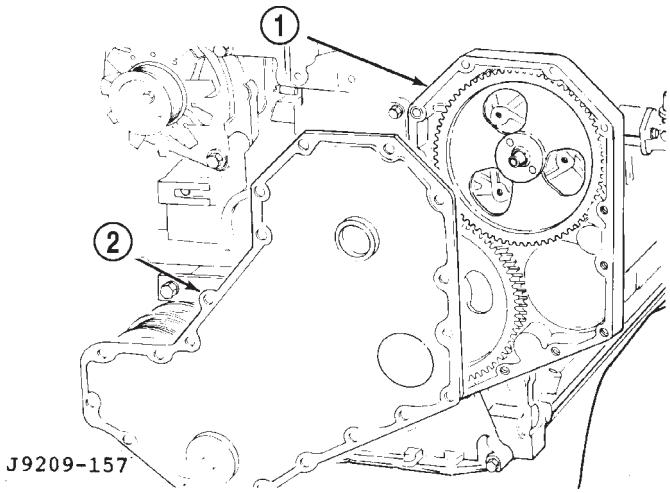


Fig. 175 Gear Housing and Cover

1 - GEAR HOUSING
2 - GEAR HOUSING COVER

(18) Remove the camshaft (Refer to 9 - ENGINE/ ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - REMOVAL).

(19) Remove the six front oil pan fasteners.

(20) Remove the gear housing fasteners.

NOTE: Use care when removing the gear housing, to avoid damage to the oil pan gasket, as the gasket will be reused if it is not damaged.

(21) Slide a feeler gauge between the gear housing and oil pan gasket, to break the gasket seal.

(22) Remove the gear housing and gasket (Fig. 176).

(23) Clean the gasket material from the cylinder block and gear housing.

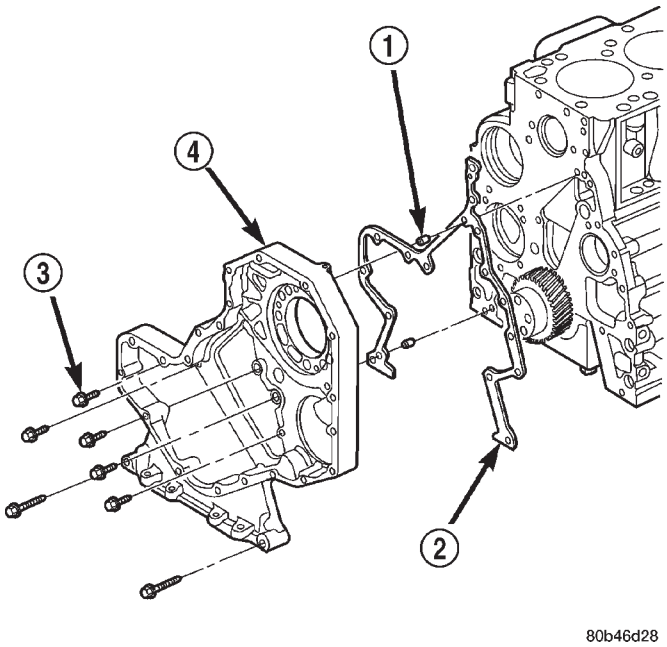


Fig. 176 Gear Housing and Gasket

1 - DOWEL
2 - GASKET
3 - BOLT
4 - GEAR HOUSING

INSTALLATION

(1) Inspect the oil pan gasket, if the gasket can be reused, coat both sides with a film of Mopar® Silicone Rubber Adhesive Sealant.

(2) If the gasket is torn, it can be repaired. Cut the old gasket off even with the front of the cylinder block.

(3) Using the old gasket as a pattern, cut the front section of a new gasket to the same size.

(4) Clean the sealing surfaces and coat the new gasket on both sides with a film of Mopar® Silicone Rubber Adhesive Sealant.

(5) Mark and trim 1.59mm (1/16 in.) off of the bottom of the new gear housing gasket. Only trim the part of the gasket that meets the oil pan.

NOTE: When properly trimmed, the gear housing gasket should be even with the oil pan gasket when installed.

(6) Install the new gear housing gasket on the alignment dowels

NOTE: (M8×1.25×50) guide pins can be used to assist in aligning the gasket and gear housing. Be sure to remove the guide pins after alignment.

(7) Carefully install the gear housing, making sure both gaskets stay in place (Fig. 176).

GEAR HOUSING (Continued)

(8) Install and tighten the gear housing bolts to 24 N·m (18 ft. lbs.) torque.

(9) Install and tighten the oil pan bolts to 24 N·m (18 ft. lbs.) torque.

(10) Install the camshaft (Refer to 9 - ENGINE/ ENGINE BLOCK/CAMSHAFT & BEARINGS (IN BLOCK) - INSTALLATION). Align the crankshaft, camshaft, and injection pump gear marks as shown in (Fig. 177).

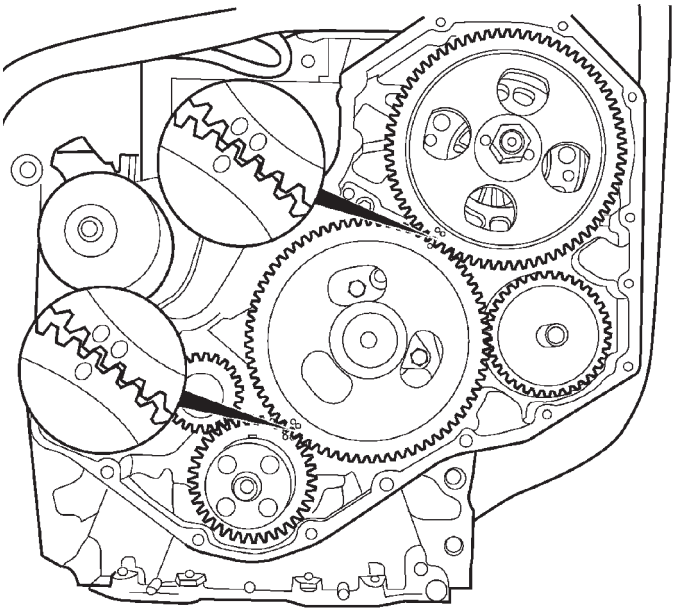


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Fig. 177 Camshaft/Crankshaft Gear Alignment

(11) If a new housing is installed, the camshaft position sensor must be transferred to the new housing.

(12) Connect the camshaft position sensor connector.

(13) Install the injection pump (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - INSTALLATION).

(14) Obtain a seal pilot/installation tool from a crankshaft front seal service kit and install the pilot into the crankshaft front oil seal.

(15) Apply a bead of Mopar® Silicone Rubber Adhesive Sealant or equivalent to the gear housing cover. Be sure to surround all through holes.

(16) Using the seal pilot to align the cover (Fig. 178), install the cover to the housing and install the bolts. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(17) Remove the seal pilot.

(18) Raise the vehicle.

(19) Install the crankshaft damper (Fig. 174) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(20) Lower vehicle.

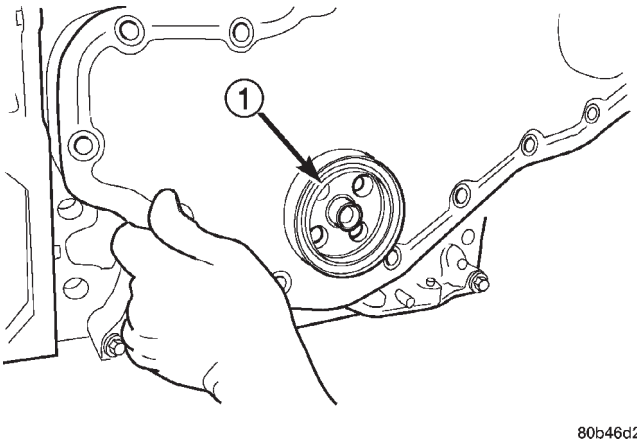

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Fig. 178 Installing Cover with Seal Pilot

1 - SEAL PILOT

(21) Install the fan support/hub assembly (Fig. 173) and tighten bolts to 24 N·m (18 ft. lbs.) torque.

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

(23) Install the cooling fan and shroud together (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(24) Install the windshield washer reservoir to the fan shroud and connect the washer pump supply hose and electrical connection.

(25) Install the coolant recovery bottle to the fan shroud and connect the hose to the radiator filler neck.

(26) Install the radiator upper hose and clamps.

(27) Add engine oil.

(28) Add coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).

(29) Connect the battery cables.

(30) Start engine and inspect for leaks.

GEAR HOUSING COVER

REMOVAL

(1) Disconnect both battery negative cables.

(2) Raise vehicle on hoist.

(3) Partially drain engine coolant into container suitable for re-use (Refer to 7 - COOLING - STANDARD PROCEDURE).

(4) Lower vehicle.

(5) Remove radiator upper hose.

(6) Disconnect coolant recovery bottle hose from radiator filler neck and lift bottle off of fan shroud.

(7) Disconnect windshield washer pump supply hose and electrical connections and lift washer bottle off of fan shroud.

GEAR HOUSING COVER (Continued)

(8) Remove viscous fan/drive assembly (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL).

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

(10) Remove the cooling fan support/hub from the front of the engine (Fig. 179).

(11) Raise the vehicle on hoist.

(12) Remove the crankshaft damper (Fig. 180) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(13) Lower the vehicle.

(14) Remove the gear cover-to-housing bolts and gently pry the cover away from the housing, taking care not to mar the gasket surfaces.

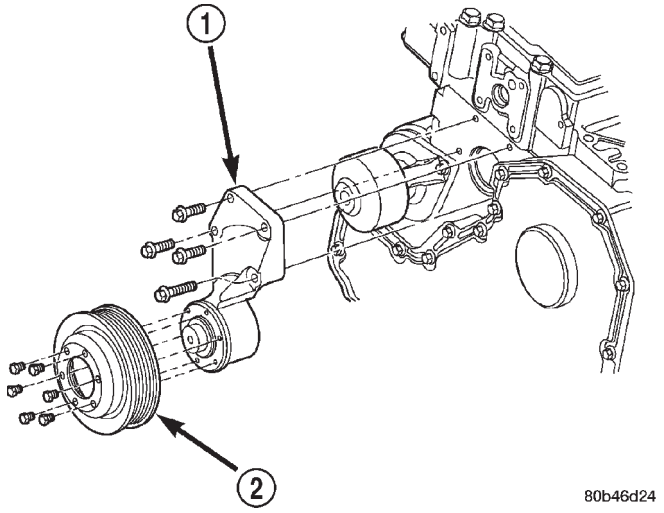

Fig. 179 Fan Support/Hub Assembly—Removal/Installation

1 - FAN SUPPORT/HUB
2 - FAN PULLEY

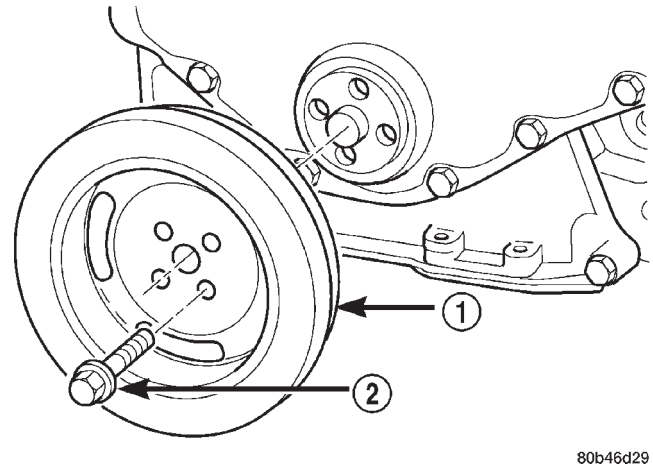

Fig. 180 Crankshaft Damper—Removal/Installation

1 - DAMPER
2 - BOLT

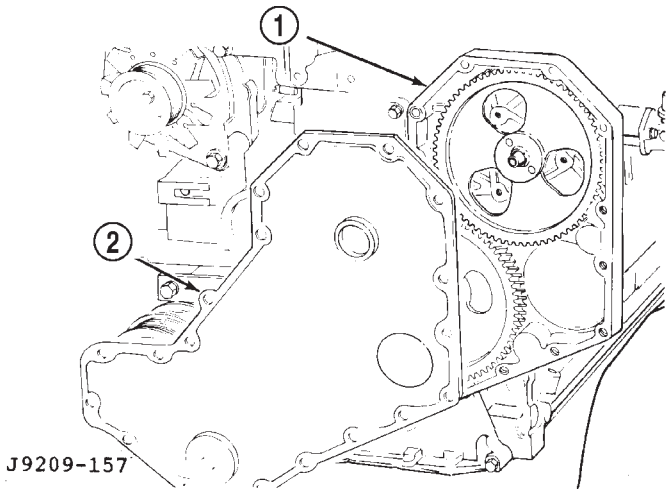

Fig. 181 Gear Housing and Cover

1 - GEAR HOUSING
2 - GEAR HOUSING COVER

INSTALLATION

(1) Obtain a seal pilot/installation tool from a crankshaft front seal service kit and install the pilot into the seal.

(2) Apply a bead of Mopar® Silicone Rubber Adhesive Sealant or equivalent to the gear housing cover. Be sure to surround all through holes.

(3) Using the seal pilot to align the cover (Fig. 182), install the cover to the housing and install the bolts. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

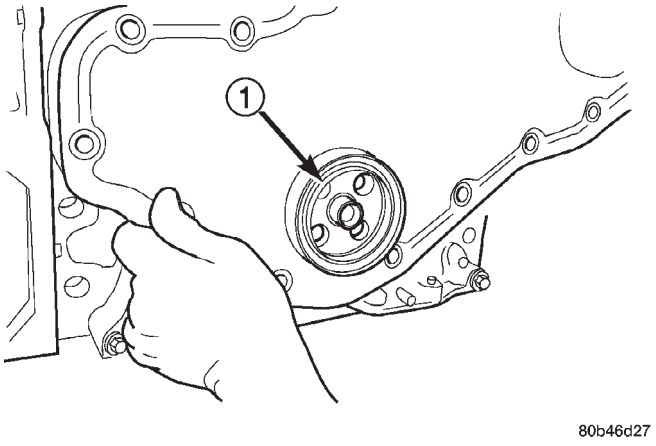

Fig. 182 Installing Cover with Seal Pilot

1 - SEAL PILOT

(4) Remove the seal pilot.

(5) Raise the vehicle.

(6) Install the crankshaft damper (Fig. 180) (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

(7) Lower vehicle.

GEAR HOUSING COVER (Continued)

(8) Install the fan support/hub assy. (Fig. 179) and tighten bolts to 24 N·m (18 ft. lbs.) torque.

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

(10) Install the cooling fan and shroud together (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - INSTALLATION).

(11) Install the windshield washer reservoir to the fan shroud and connect the washer pump supply hose and electrical connection.

(12) Install the coolant recovery bottle to the fan shroud and connect the hose to the radiator filler neck.

(13) Install the radiator upper hose and clamps.

(14) Add coolant (Refer to 7 - COOLING - STANDARD PROCEDURE).

(15) Connect the battery cables.

(16) Start engine and inspect for leaks.