

ENGINE

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS—GASOLINE ENGINES

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

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

MOPAR® SILICONE RUBBER ADHESIVE SEALANT

Mopar® Silicone Rubber Adhesive Sealant, normally black in color, is available in both three ounce tubes and four and one-half ounce power tubes. Moisture in the air causes the sealant material to cure. This material is normally used on flexible metal flanges. The regular tubes have a shelf life of one year and the power tubes a two year shelf life, and

will not properly cure if over-aged. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

Mopar® Gasket Maker, normally red in color, is available in six-cc tubes. This anaerobic type gasket material cures in the absence of air when squeezed between smooth machined metallic surfaces. It will not cure if left in the uncovered tube. DO NOT use on flexible metal flanges.

SURFACE PREPARATION

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

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

GENERAL INFORMATION (Continued)

GASKET APPLICATION

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

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

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

ENGINE PERFORMANCE—GASOLINE ENGINES

It is important that the vehicle is operating to its optimum performance level to maintain fuel economy and the lowest emission levels.

(1) Test cranking amperage draw. Refer to Group 8B, Battery/Starter/Generator Service, for the proper procedures.

(2) Tighten the intake manifold bolts. Refer to Group 11, Exhaust System and Intake Manifold, for the proper procedure and torque specifications.

(3) Clean or replace spark plugs as necessary. Adjust gap. Refer to Group 8D, Ignition System, for gap adjustment and torque specifications.

(4) Test resistance of spark plug cables. Refer to Group 8D, Ignition System, for procedure.

(5) Inspect the primary wire. Test coil output voltage, primary and secondary resistance. Replace parts as necessary. Refer to Group 8D, Ignition System, and make necessary adjustment.

(6) Set ignition timing to specifications. Refer to Specification Label on engine compartment hood. (This step does not apply to 8.0L engines.)

(7) Perform a combustion analysis.

(8) Test fuel pump for pressure and vacuum. Refer to Group 14, Fuel System, for the proper specifications.

(9) Inspect air filter element. Refer to Group 0, Lubrication and Maintenance, for the proper procedure.

(10) Inspect crankcase ventilation system. Refer to Group 0, Lubrication and Maintenance, for the proper procedure.

(11) For emissions controls, refer to Group 25, Emissions Controls System for service procedures.

(12) Inspect accessory belt drives. Refer to Group 7, Cooling System, for the proper adjustments.

(13) Road-test vehicle as a final test.

MEASURING WITH PLASTIGAGE

CRANKSHAFT MAIN BEARING CLEARANCE

Engine crankshaft bearing clearances can be determined by use of Plastigage, or equivalent. The following is the recommended procedure for the use of Plastigage:

(1) Remove oil film from surface to be checked. Plastigage is soluble in oil.

(2) The total clearance of the main bearings can be determined only by removing the weight of the crankshaft. This can be accomplished by either of two methods:

METHOD - 1 (PREFERRED)

Shim the bearings adjacent to the bearing to be checked. This will remove the clearance between upper bearing shell and the crankshaft. Place a minimum of 0.254 mm (0.010 in.) shim between the bearing shell and the adjacent bearing cap. Tighten the bolts to 18 N·m (13 ft. lbs.) torque.

• **CHECK NO. 1 BEARING:** Shim No. 2 main bearing.

• **CHECK NO. 2 BEARING:** Shim No. 1 and No. 3 main bearing.

• **CHECK NO. 3 BEARING:** Shim No. 2 and No. 4 main bearing.

• **CHECK NO. 4 BEARING:** Shim No. 3 main bearing (3.9L). Shim No. 3 and No. 5 main bearing (5.2L, 5.9L, 8.0L and 5.9L-Diesel).

• **CHECK NO. 5 BEARING:** Shim No. 4 main bearing (5.2L and 5.9L). Shim No. 4 and No. 6 main bearing (8.0L and 5.9L-Diesel).

• **CHECK NO. 6 BEARING:** Shim No. 5 main bearing (8.0L). Shim No. 5 and No. 7 main bearing (5.9L-Diesel).

• **CHECK NO. 7 BEARING:** Shim No. 6 main bearing (5.9L-Diesel).

NOTE: Remove all shims before assembling engine.

METHOD - 2 (ALTERNATIVE)

Support the weight of the crankshaft with a jack placed under the counterweight adjacent to the bearing being checked.

(1) Place a piece of Plastigage across the entire width of the bearing cap shell (Fig. 1). Position the Plastigage approximately 6.35 mm (1/4 in.) off center and away from the oil holes. In addition, suspect

GENERAL INFORMATION (Continued)

areas can be checked by placing the Plastigage in that area. Tighten the bearing cap bolts of the bearing being checked to 115 N·m (85 ft. lbs.) torque. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

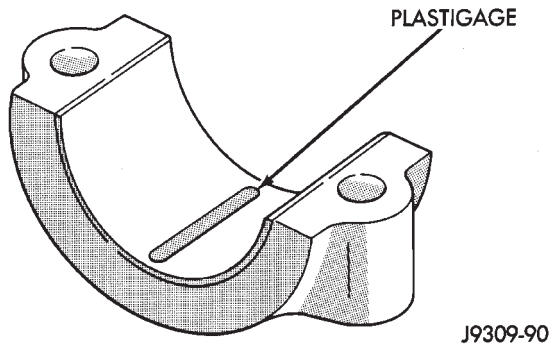


Fig. 1 Placement of Plastigage in Bearing Shell

(2) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on the package (Fig. 2). Plastigage generally comes in two scales (one scale is in inches and the other is a metric scale). Locate the band closest to the same width. This band shows the amount of clearance. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications.

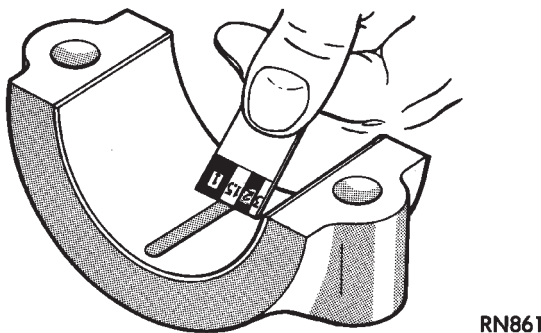


Fig. 2 Clearance Measurement

(3) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 in.) range is usually the most appropriate for checking engine bearing clearances.

CONNECTING ROD BEARING CLEARANCE

Engine connecting rod bearing clearances can be determined by use of Plastigage, or equivalent. The following is the recommended procedure for the use of Plastigage:

(1) Remove oil film from surface to be checked. Plastigage is soluble in oil.

(2) Place a piece of Plastigage across the entire width of the bearing cap shell (Fig. 1). Position the Plastigage approximately 6.35 mm (1/4 inch) off center and away from the oil holes. In addition, suspect

areas can be checked by placing the Plastigage in the suspect area.

(3) The crankshaft must be rotated until the connecting rod to be checked starts moving toward the top of the engine. Only then should the rod cap, with Plastigage in place, be assembled. Tighten the rod cap nut to 61 N·m (45 ft. lbs.) torque. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

(4) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on the package (Fig. 2). Plastigage generally comes in two scales (one scale is in inches and the other is a metric scale). Locate the band closest to the same width. This band shows the amount of clearance. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Refer to Engine Specifications.

(5) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 in.) range is usually the most appropriate for checking engine bearing clearances.

ENGINE OIL SERVICE

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

ENGINE OIL SPECIFICATION

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

API SERVICE GRADE CERTIFIED

In gasoline engines, use an engine oil that is API Service Grade Certified (Fig. 3). In diesel engines, use an engine oil that conforms to API Service Grade CF-4 or CG-4/SH (Fig. 4). MOPAR provides engine oils that conform to all of these service grades.

Standard engine-oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans.

GENERAL INFORMATION (Continued)



9400-9

Fig. 3 API Service Grade Certification Label—Gasoline Engine Oil



Fig. 4 API Service Grade Certification Label—Diesel Engine Oil

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 10W-30 specifies a multiple viscosity engine oil.

When choosing an engine oil, consider the range of temperatures the vehicle will be operated in before the next oil change. Select an engine oil that is best suited to your area's particular ambient temperature range and variation. For gasoline engines, refer to (Fig. 5). For diesel engines, refer to (Fig. 6).

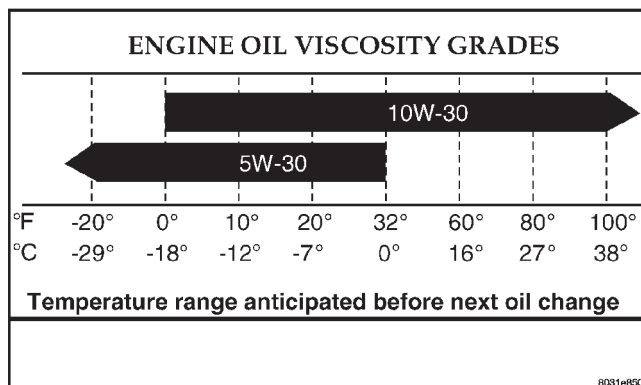


Fig. 5 Engine Oil Viscosity Recommendation—Gasoline Engines

ENERGY-CONSERVING OIL

An Energy Conserving type oil is recommended for gasoline engines. They are designated as either ENERGY CONSERVING or ENERGY CONSERVING II.

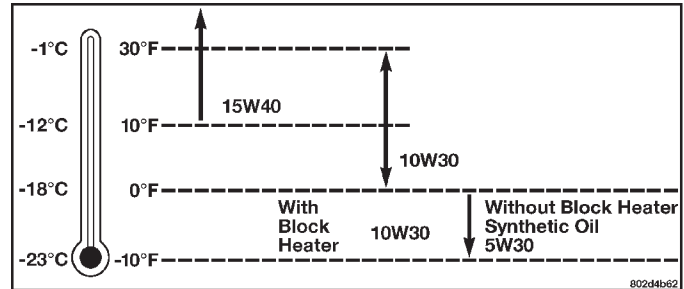


Fig. 6 Engine Oil Viscosity Recommendation—Diesel Engines

CRANKCASE OIL LEVEL INSPECTION

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

To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable oil level is in the SAFE RANGE on the engine oil dipstick (Fig. 7).

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.

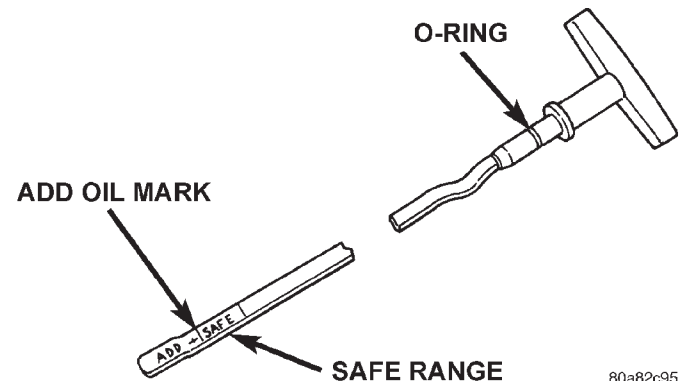


Fig. 7 Oil Level Indicator (Dipstick)

- (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) Replace dipstick and verify it is seated in the tube.
- (5) Remove dipstick, with handle held above the tip, take oil level reading.
- (6) Add oil only if level is below the SAFE RANGE area on the dipstick.
- (7) Replace dipstick

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Maintenance Schedule.

GENERAL INFORMATION (Continued)

TO CHANGE ENGINE OIL

Run engine until normal operating temperature is achieved.

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

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

(3) Remove oil fill cap.

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

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

(6) Install drain plug in crankcase.

(7) Lower vehicle and fill crankcase with specified type and amount of engine oil described in this section.

(8) Install oil fill cap.

(9) Start engine and inspect for leaks.

(10) Stop engine and inspect oil level.

ENGINE OIL FILTER CHANGE

FILTER SPECIFICATION

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

OIL FILTER REMOVAL

(1) Position a drain pan under the oil filter.

(2) Using a suitable oil filter wrench, loosen filter.

(3) Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss (Fig. 8).

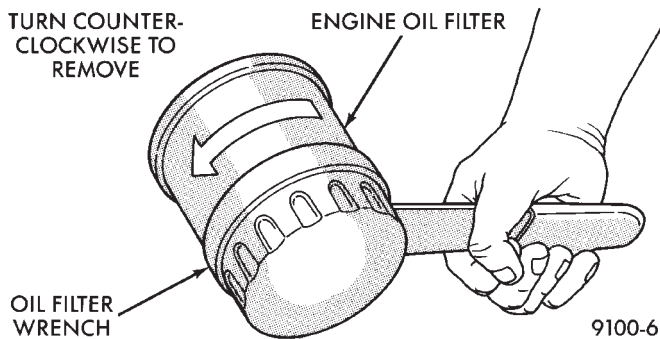


Fig. 8 Oil Filter Removal—Typical

(4) When filter separates from adapter nipple, tip gasket end upward to minimize oil spill. Remove filter from vehicle.

(5) With a wiping cloth, clean the gasket sealing surface (Fig. 9) of oil and grime.

OIL FILTER INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil or chassis grease.

(2) Thread filter onto adapter nipple. When gasket makes contact with sealing surface, (Fig. 9) hand tighten filter one full turn, do not over tighten.

(3) Add oil, verify crankcase oil level, and start engine. Inspect for oil leaks.

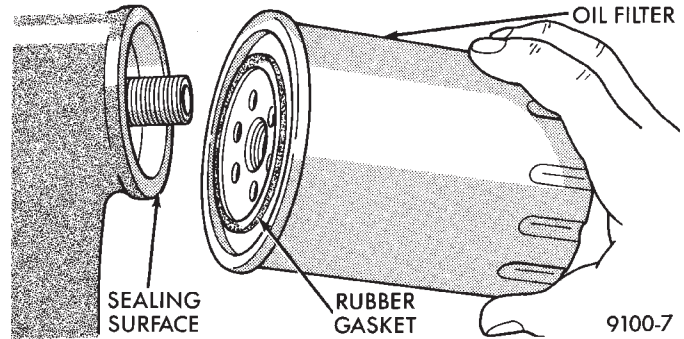


Fig. 9 Oil Filter Sealing Surface—Typical

USED ENGINE OIL DISPOSAL

Care should be exercised when disposing of used engine oil after it has been drained from a vehicle's engine.

SERVICE PROCEDURES

REPAIR DAMAGED OR WORN THREADS

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

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

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

Heli-Coil tools and inserts are readily available from automotive parts jobbers.

HONING CYLINDER BORES

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

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

SERVICE PROCEDURES (Continued)

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. 10).

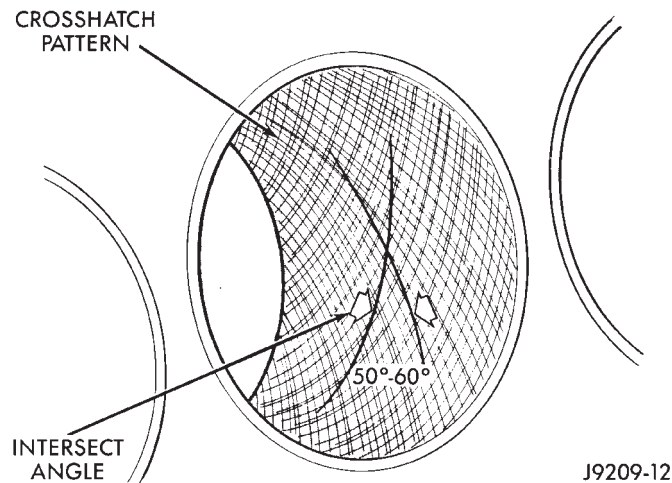


Fig. 10 Cylinder Bore Crosshatch Pattern

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

(5) After honing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-

free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting.

HYDROSTATIC LOCK

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

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

(2) Disconnect the negative cable from the battery.

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

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

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

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

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

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

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

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

(10) Install new spark plugs or fuel injectors (diesel engine). Tighten the spark plugs to 41 N·m (30 ft. lbs.) torque. Tighten the fuel injector nuts to 60 N·m (44 ft. lbs.) torque.

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

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

(13) Install a new oil filter.

(14) Fill engine crankcase with the specified amount and grade of oil. Refer to Group 0, Lubrication and Maintenance.

(15) Connect the negative cable to the battery.

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

ENGINE DIAGNOSIS

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DIAGNOSIS AND TESTING

GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine 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 the Service Diagnosis—Mechanical Chart and the Service Diagnosis—Performance Chart, for possible causes and corrections of malfunctions. Refer to Group 14, Fuel System, for the fuel system diagnosis.

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

- Cylinder Compression Pressure Test
- Cylinder Combustion Pressure Leakage Test
- Engine Cylinder Head Gasket Failure Diagnosis
- Intake Manifold Leakage Diagnosis

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

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

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

- (1) Start the engine.
- (2) Spray a small stream of water at the suspected leak area.
- (3) If a change in RPMs, the area of the suspected leak has been found.

- (4) Repair as required.

CYLINDER COMPRESSION PRESSURE TEST

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

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

- (1) Clean the spark plug recesses with compressed air.
- (2) Remove the spark plugs.
- (3) Secure the throttle in the wide-open position.
- (4) Disconnect the ignition coil.
- (5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
- (6) Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

Refer to Engine Specifications for the correct engine compression pressures.

ENGINE CYLINDER HEAD GASKET FAILURE
DIAGNOSIS

A leaking engine cylinder head gasket usually results in loss of power, loss of coolant, and engine misfiring.

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

- An engine cylinder head gasket leaking between adjacent cylinders is indicated by a loss of power and/or engine misfire.
- An engine cylinder head gasket leaking between a cylinder and an adjacent water jacket is indicated by coolant foaming or overheating and loss of coolant.

DIAGNOSIS AND TESTING (Continued)

CYLINDER-TO-CYLINDER LEAKAGE TEST

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

CYLINDER-TO-WATER JACKET LEAKAGE TEST

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

Remove the radiator cap.

Start the engine and allow it to warm up until the engine thermostat opens.

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

If bubbles are not visible, install a radiator pressure tester and pressurize the coolant system.

If a cylinder is leaking combustion pressure into the water jacket, the tester pointer will pulsate with every combustion stroke of the cylinder.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

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

Combustion pressure leakage testing will detect:

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

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

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

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

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

kPa (200 psi) maximum and 552 kPa (80 psi) recommended.

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

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

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

Refer to the Cylinder Combustion Pressure Leakage Test Diagnosis chart.

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

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

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

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

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

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

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

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

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

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

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

(9) Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the 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.

DIAGNOSIS AND TESTING (Continued)

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

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

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

INSPECTION FOR REAR SEAL AREA LEAKS

Since it is sometimes difficult to determine the source of an oil leak in the rear seal area of the engine, a more involved inspection is necessary. The following steps should be followed to help pinpoint the source of the leak.

If the leakage occurs at the crankshaft rear oil seal area:

- (1) Disconnect the battery.
- (2) Raise the vehicle.
- (3) Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:
 - (a) Circular spray pattern generally indicates seal leakage or crankshaft damage.
 - (b) Where leakage tends to run straight down, possible causes are a porous block, distributor seal, camshaft bore cup plugs, oil galley pipe plugs, oil filter runoff, and main bearing cap to cylinder block mating surfaces. See Group 9, Engines, for proper repair procedures of these items.
- (4) If no leaks are detected, pressurized the crankcase as outlined in the section, Inspection (Engine oil Leaks in general)

CAUTION: Do not exceed 20.6 kPa (3 psi).

(5) If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches that can be polished out with emery cloth.

CAUTION: Use extreme caution when crankshaft polishing is necessary to remove minor nicks or scratches. The crankshaft seal flange is specially machined to complement the function of the rear oil seal.

(6) For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled. Refer to the service Diagnosis—Mechani-

cal, under the Oil Leak row, for components inspections on possible causes and corrections.

(7) After the oil leak root cause and appropriate corrective action have been identified, Refer to Group 9, Engines—Crankshaft Rear Oil Seals, for proper replacement procedures.

HYDRAULIC TAPPETS

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

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

OIL LEVEL**HIGH**

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

LOW

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

TAPPET NOISE DIAGNOSIS

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

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

DIAGNOSIS AND TESTING (Continued)

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

(3) Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak-down around the unit plunger, or by the plunger partially sticking in the tappet body cylinder. The tappet should be replaced. A heavy click is caused by a tappet check valve not seating, or by foreign particles wedged between the plunger and the tappet body. This will cause the plunger to stick in the down position. This heavy click will be accompa-

nied by excessive clearance between the valve stem and rocker arm as valve closes. In either case, tappet assembly should be removed for inspection and cleaning.

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

ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit.

(2) Install Oil Pressure Line and Gauge Tool C-3292. Start engine and record pressure. Refer to Oil Pressure in Engine Specifications for the proper pressures.

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—GASOLINE ENGINES

PERFORMANCE DIAGNOSIS CHART—GASOLINE ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK	<ol style="list-style-type: none"> 1. Weak or dead battery 2. Corroded or loose battery connections 3. Faulty starter or related circuit(s) 4. Seized accessory drive component 5. Engine internal mechanical failure or hydro-static lock 	<ol style="list-style-type: none"> 1. Charge/Replace Battery. Refer to Group 8A, Battery, for correct procedures. Check charging system. Refer to Group 8C, Charging Systems, for correct procedures. 2. Clean/tighten suspect battery/starter connections 3. Check starting system. Refer to Group 8B, Starting Systems, for correct diagnostics/procedures 4. Remove accessory drive belt and attempt to start engine. If engine starts, repair/replace seized component. 5. Refer to Group 9, Engine, for correct diagnostics/procedures
ENGINE CRANKS BUT WILL NOT START	<ol style="list-style-type: none"> 1. No spark 2. No fuel 3. Low or no engine compression 	<ol style="list-style-type: none"> 1. Check for spark. Refer to Group 8D, Ignition System, for correct procedures. 2. Perform fuel pressure test, and if necessary, inspect fuel injector(s) and driver circuits. Refer to Group 14, Fuel System, for correct procedures. 3. Perform cylinder compression pressure test. Refer to Group 9, Engine, for correct procedures.
ENGINE LOSS OF POWER	<ol style="list-style-type: none"> 1. Worn or burned distributor rotor 2. Worn distributor shaft 3. Worn or incorrect gapped spark plugs 4. Dirt or water in fuel system 5. Faulty fuel pump 6. Incorrect valve timing 7. Blown cylinder head gasket 8. Low compression 9. Burned, warped, or pitted valves 10. Plugged or restricted exhaust system 11. Faulty ignition cables 12. Faulty ignition coil 	<ol style="list-style-type: none"> 1. Install new distributor rotor 2. Remove and repair distributor (Refer to group 8D, Ignition System) 3. Clean plugs and set gap. (Refer to group 8D, Ignition System) 4. Clean system and replace fuel filter 5. Install new fuel pump 6. Correct valve timing 7. Install new cylinder head gasket 8. Test cylinder compression 9. Install/Reface valves as necessary 10. Install new parts as necessary 11. Replace any cracked or shorted cables 12. Test and replace, as necessary (Refer to Group 8D, ignition system)

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE STALLS OR ROUGH IDLE	<ol style="list-style-type: none"> 1. Carbon build-up on throttle plate 2. Engine idle speed too low 3. Worn or incorrectly gapped spark plugs 4. Worn or burned distributor rotor 5. Spark plug cables defective or crossed 6. Faulty coil 7. Intake manifold vacuum leak 8. EGR valve leaking or stuck open 	<ol style="list-style-type: none"> 1. Remove throttle body and de-carbon. (Refer to Group 14 for correct procedures) 2. Check Idle Air Control circuit. (Refer to Group 14, Fuel System) 3. Replace or clean and re-gap spark plugs (Refer to group 8D, Ignition System) 4. Install new distributor rotor 5. Check for correct firing order or replace spark plug cables. (Refer to Group 8D, Ignition System for correct procedures.) 6. Test and replace, if necessary (Refer to group 8D, Ignition System) 7. Inspect intake manifold gasket and vacuum hoses. Replace if necessary (Refer to Group 11, Exhaust System & Intake Manifold) 8. Test and replace, if necessary (Refer to group 25, Emission Control Systems)
ENGINE MISSES ON ACCELERATION	<ol style="list-style-type: none"> 1. Worn or incorrectly gapped spark plugs 2. Spark plug cables defective or crossed 3. Dirt in fuel system 4. Burned, warped or pitted valves 5. Faulty coil 	<ol style="list-style-type: none"> 1. Replace spark plugs or clean and set gap. (Refer to group 8D, Ignition System) 2. Replace or rewire secondary ignition cables. Refer to Group 8D, Ignition System 3. Clean fuel system 4. Install new valves 5. Test and replace as necessary (refer to group 8D, Ignition System)

DIAGNOSIS AND TESTING (Continued)

MECHANICAL DIAGNOSIS CHART—GASOLINE ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES/LIFTERS	<ol style="list-style-type: none"> 1. High or low oil level in crankcase 2. Thin or diluted oil 3. Low oil pressure 4. Dirt in tappets/lash adjusters 5. Bent push rod(s) 6. Worn rocker arms 7. Worn tappets/lash adjusters 8. Worn valve guides 9. Excessive runout of valve seats or valve faces 	<ol style="list-style-type: none"> 1. Check for correct oil level. Adjust oil level by draining or adding as needed 2. Change oil (Refer to Engine Oil Service in this group) 3. Check engine oil level. If ok, Perform oil pressure test. Refer to this group for engine oil pressure test/specifications 4. Clean/replace hydraulic tappets/lash adjusters 5. Install new push rods 6. Inspect oil supply to rocker arms and replace worn arms as needed 7. Install new hydraulic tappets/lash adjusters 8. Inspect all valve guides and replace as necessary 9. Grind valves and seats
CONNECTING ROD NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply 2. Low oil pressure 3. Thin or diluted oil 4. Excessive connecting rod bearing clearance 5. Connecting rod journal out of round 6. Misaligned connecting rods 	<ol style="list-style-type: none"> 1. Check engine oil level. (Refer to group 0, Lubrication and Maintenance) 2. Check engine oil level. If ok, Perform oil pressure test. Refer to this group for engine oil pressure test/specifications 3. Change oil to correct viscosity. Refer to this group for correct procedure/engine oil specifications Measure bearings for correct clearance with plasti-gage. Repair as necessary 5. Replace crankshaft or grind journals 6. Replace bent connecting rods
MAIN BEARING NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply 2. Low oil pressure 3. Thin or diluted oil 4. Excessive main bearing clearance 5. Excessive end play 	<ol style="list-style-type: none"> 1. Check engine oil level. (Refer to group 0, Lubrication and Maintenance) 2. Check engine oil level. If ok, Perform oil pressure test. Refer to this group for engine oil pressure test/specifications 3. Change oil to correct viscosity. Refer to this group for correct procedure/engine oil specifications 4. Measure bearings for correct clearance. Repair as necessary 5. Check crankshaft thrust bearing for excessive wear on flanges

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	6. Crankshaft main journal out of round or worn 7. Loose flywheel or torque converter	6. Grind journals or replace crankshaft 7. Inspect crankshaft, flexplate/flywheel and bolts for damage. Tighten to correct torque
LOW OIL PRESSURE	1. Low oil level 2. Faulty oil pressure sending unit 3. Clogged oil filter 4. Worn oil pump 5. Thin or diluted oil 6. Excessive bearing clearance 7. Oil pump relief valve stuck 8. Oil pump suction tube loose, broken, bent or clogged 9. Oil pump cover warped or cracked	1. Check oil level and fill if necessary 2. Install new sending unit 3. Install new oil filter 4. Replace worn gears or oil pump assy 5. Change oil to correct viscosity. Refer to this group for correct procedure/engine oil specifications 6. Measure bearings for correct clearance 7. Remove valve to inspect, clean and reinstall 8. Inspect suction tube and clean or replace if necessary 9. Install new oil pump
OIL LEAKS	1. Misaligned or deteriorated gaskets 2. Loose fastener, broken or porous metal part 3. Front or rear crankshaft oil seal leaking 4. Leaking oil gallery plug or cup plug	1. Replace gasket 2. Tighten, repair or replace the part 3. Replace seal 4. Remove and reseal threaded plug. Replace cup style plug
EXCESSIVE OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. PCV System malfunction 2. Defective valve stem seal(s) 3. Worn or broken piston rings 4. Scuffed pistons/cylinder walls 5. Carbon in oil control ring groove 6. Worn valve guides 7. Piston rings fitted too tightly in grooves	1. Refer to group 25, Emission Control System for correct operation 2. Repair or replace seal(s) 3. Hone cylinder bores. Install new rings 4. Hone cylinder bores and replace pistons as required 5. Remove rings and de-carbon piston 6. Inspect/replace valve guides as necessary 7. Remove rings and check ring end gap and side clearance. Replace if necessary

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—DIESEL ENGINES

PERFORMANCE DIAGNOSIS CHART—DIESEL ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK OR CRANKS SLOWLY	<ol style="list-style-type: none"> 1. Batteries weak or dead. 2. No voltage to starter solenoid or inoperative solenoid. 3. Starting circuit connections loose or corroded. 4. Neutral safety switch or starter relay inoperative. 5. Starting motor operating, but not cranking the engine 6. Crankshaft rotation restricted. 	<ol style="list-style-type: none"> 1. Check battery voltage. Replace battery if charge cannot be held. 2. Check voltage to the solenoid. If necessary, replace starter solenoid. 3. Clean and tighten connections 4. Check starter relay supply voltage and proper operation of neutral safety switch if equipped. Replace defective parts. 5. Remove the starter motor. check for broken flywheel teeth or a broken starter motor spring. 6. Attempt to rotate engine with barring tool. If engine does not turn, suspect internal mechanical failure.
ENGINE CRANKS BUT WILL NOT START—NO SMOKE FROM EXHAUST	<ol style="list-style-type: none"> 1. No Fuel in supply tank. 2. Air intake or exhaust systems plugged. 3. Fuel filter plugged. 4. Excessive fuel inlet restriction. 5. Injection pump is not getting fuel or fuel is aerated. 6. Inoperative fuel transfer (lift) pump. 7. One or more injectors worn or not working properly. 8. Worn or inoperative injection pump. 9. Internal pump timing incorrect. 10. Camshaft out of time. 	<ol style="list-style-type: none"> 1. Fill fuel supply. 2. Remove obstruction. 3. Drain fuel canister and replace filter. 4. Check fuel inlet restriction. Correct cause. 5. Check fuel flow/bleed fuel system. 6. Check fuel lines for restrictions and fuel pressure. 7. Check/replaced bad or improperly operating injectors. 8. Visually check delivery with externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered. 9. Time the injection pump. Refer to group 14, fuel system. 10 Check/correct gear train timing alignment.
ENGINE HARD TO START OR WILL NOT START—SMOKE FROM EXHAUST	<ol style="list-style-type: none"> 1. Incorrect starting procedure. 2. Cranking speed too slow. 3. Intake heater system not working. 4. Insufficient intake air. 	<ol style="list-style-type: none"> 1. the fuel shut off solenoid control must be in the run position. 2. Check the battery, starter motor and wiring for loose connections. 3. Verify system is working. Repair/replace inoperative parts. 4. Inspect or replace filter and check for obstructions to the air supply tube.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Air in fuel system or fuel supply is inadequate. 6. Fuel transfer (lift) pump 7. Injection pump throttle linkage loose or damaged. 8. Contaminated fuel 9. Fuel screen plugged. 10. One or more injectors worn or not operating properly. 11. Worn or inoperative injection pump. 12. Injection pump out of time. 13. Valves incorrectly adjusted. 14. Engine compression low.	5. Check the flow through the filter and bleed the system. 6. Measure transfer pump outlet pressure. If needed, repair or replace the pump. 7. Visually check the linkage. Adjust/replace linkage. 8. Verify by operating the engine with clean fuel from a temporary tank. Check for presence of diesel fuel. Drain and flush the fuel supply tank. Replace fuel/water separator filter. 9. Check fuel screen. 10. Check/replace improperly operating injectors. 11. Visually check delivery with externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered. 12. Check/Time the pump. Refer to group 14, Fuel Systems 13. Adjust valves. 14. Check compression to identify the problem.
ENGINE STARTS, BUT WILL NOT KEEP RUNNING	1. Idle speed too low for the accessories. 2. Intake air or exhaust system restricted. 3. Air in the fuel system or the fuel supply is inadequate. 4. Fuel waxing due to extremely cold weather. 5. Contaminated fuel	1. Adjust the idle speed. 2. Visually check for exhaust restriction and inspect the air intake. Repair/Replace restricting parts. 3. Check flow through the filter and bleed the system. Locate and eliminate the air source. 4. Verify by inspecting the fuel filter. Clean the system and use climatized fuel. Replace fuel/water separator filter. Check fuel heater for proper operation. 5. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline.
SURGING (SPEED CHANGE)	1. If the condition occurs at idle, the idle speed is set too low for the accessories. 2. Improperly operating injection pump.	1. Adjust the idle speed. 2. Replace the injection pump.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
ROUGH IDLE (IRREGULARLY FIRING OR ENGINE SHAKING)	<ol style="list-style-type: none"> 1. If engine is cold, intake heater system defective. 2. Idle speed too low for the accessories. 3. Low pressure fuel problem. 4. Engine mounts damaged or loose. 5. High pressure fuel leaks. 6. Air in the fuel system. 7. Sticking needle valve in an injector. 	<ol style="list-style-type: none"> 1. Refer to intake heater system (see Group 14, Fuel System) 2. Adjust the idle speed. 3. Check for proper lift pump pressure. 4. Repair or replace mounts. 5. Correct leaks in the high pressure lines, fittings or delivery valves. 6. Bleed the fuel system and eliminate the source of the air. 7. Check and replace the injector with the sticking needle valve.
ENGINE RUNS ROUGH	<ol style="list-style-type: none"> 1. Fuel injection line(s) leaking. 2. Air in the fuel or the fuel supply is inadequate. 3. Contaminated fuel 4. Incorrect valve operation. 5. Injection pump timing incorrect. 6. Improperly operating injectors. 7. Defective injection pump delivery valve. 8. Camshaft out of time. 9. Damaged camshaft or tappets. 	<ol style="list-style-type: none"> 1. Correct leaks in high pressure lines, fittings, injector sealing washers or delivery valves. 2. Check the flow through the filter and bleed the system. Locate and eliminate the air source. Check pressures. 3. Verify by operating the engine with clean fuel from a temporary supply tank. Check for presence of gasoline. replace fuel/water separator filter. 4. Check for a bent push rod and adjust valves. Replace push rod if necessary. 5. Check and time pump if necessary. Refer to group 14, Fuel System. 6. Replace inoperative injectors. 7. Repair or replace injection pump. 8. Check/correct gear train timing alignment. 9. Inspect camshaft valve lift. Replace camshaft and tappets.
ENGINE RPM WILL NOT REACH RATED SPEED	<ol style="list-style-type: none"> 1. Intake air system leaks 2. Engine overload 3. Improperly operating tachometer. 4. Throttle linkage worn or incorrectly adjusted. 	<ol style="list-style-type: none"> 1. Verify air duct connections are tight and secure. 2. Verify high idle speed without the load. Investigate operation to be sure correct gear is being used. 3. Verify engine speed with hand-held tachometer, correct as required. 4. Adjust linkage for stop to stop fuel control lever travel. Replace linkage if necessary.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Inadequate fuel supply 6. Air/fuel controls leak. 7. Improperly operating injection pump.	5. Check the fuel flow through the system to locate the reason for inadequate fuel supply, correct as supplied. 6. Check and repair leak. Check AFC tubing for obstruction. 7. Repair or replace injection pump.
LOW POWER	1. Air leak between the turbocharger and the intake manifold. 2. High oil level. 3. Engine overloaded 4. Slow throttle response caused by leaking or obstructed air control tube or improperly operating control in the pump. 5. Inadequate intake air flow 6. Inadequate fuel supply. Air in the fuel. 7. Excessive exhaust restriction. 8. High fuel temperature 9. Poor quality fuel or fuel contaminated with gasoline. 10. Exhaust leak at the manifold or turbocharger 11. Turbocharger wastegate operation 12. Intake/Exhaust valve not opening 13. Worn or improperly operating injectors. 14. Injection pump timing incorrect. 15. Improperly operating injection pump.	1. Check/correct leaks in hoses, gaskets, charge air cooler and around mounting capscrews or through holes in the manifold cover. 2. Check correct oil/level 3. Check for added loading from accessories or driven units, brakes dragging and other changes in vehicle loading. Repair/replace as needed. 4. Check for leaks and obstructions. Tighten the fittings. Repair or replace the pump if the controls are not functioning. 5. Inspect/replace air cleaner element. Look for other restrictions. 6. Inspect/correct leaks in the high pressure lines, fittings, injector sealing washers or delivery valve seals. 7. Check/correct the restriction in the exhaust system. 8. Verify that fuel heater is off when the engine is warm. Check for restricted fuel drain tube. Repair/replace as necessary. 9. Verify by operating from a temporary tank with good fuel. Check for presence of gasoline. replace fuel/water separator filter. 10. Check/correct leaks in the manifold or turbocharger gaskets. If manifold is cracked, replace manifold. 11. Check wastegate operation. 12. Inspect for bent push rod, replace if necessary. 13. Check/replace injectors 14. Verify injection pump timing. Refer to group 14, Fuel System 15. Repair or replace injection pump.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
EXCESSIVE EXHAUST SMOKE	<ol style="list-style-type: none"> 1. Engine running too cold (white smoke) 2. Improper starting procedure (white smoke) 3. Fuel supply inadequate. 4. Injection pump timing. 5. Inadequate intake air. 6. Air leak between turbocharger and intake manifold. 7. Exhaust leak at the manifold or turbocharger. 8. Improperly operating turbocharger. 9. Improperly operating injectors. 10. Improperly operating injector pump. 11. Piston rings not sealing (blue smoke) 	<ol style="list-style-type: none"> 1. Refer to troubleshooting for coolant temperature below normal. Refer to group 7, Cooling System. Inspect intake manifold heater system for proper operation. 2. Use proper starting procedures. 3. Check fuel supply pressure and inlet restriction 4. Check and time pump. Refer to Group 14, Fuel System. 5. Inspect/change air filter. Look for other restriction. Check charge air cooler for obstructions. 6. Check/correct leaks in the air crossover tube, hoses, gaskets, mounting capscrews, or through holes in the manifold cover. 7. Check/correct leaks in the manifold or turbocharger gaskets. If cracked, replace manifold. 8. Inspect/replace turbocharger. 9. Check and replace inoperative injectors. 10. Repair or replace injection pump. 11. Perform blow-by check. Correct as required.
ENGINE WILL NOT SHUT OFF	<ol style="list-style-type: none"> 1. Fuel shut off solenoid or solenoid relay inoperative. 2. Engine running on fumes drawn into the air intake. 3. Fuel injection pump malfunction. 	<ol style="list-style-type: none"> 1. Check/replace fuel shut off solenoid or relay. 2. Check the air intake ducts for the source of fumes. WARNING: In case of engine runaway due to flammable fumes from gasoline spills or turbocharger oil leaks being sucked into the engine, shut off engine ignition switch first and then use a CO2 fire extinguisher and direct the spray under the front bumper to remove the oxygen supply. The air intake is on the passenger side behind the bumper. The fire extinguisher must be directed at this location for emergency shutdown situations. 3. Repair or replace fuel injection pump.

DIAGNOSIS AND TESTING (Continued)

MECHANICAL DIAGNOSIS CHART—DIESEL ENGINES

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE LOW	<ol style="list-style-type: none"> 1. Low oil level. 2. Oil viscosity thin, diluted or wrong specification. 3. Improperly operating pressure switch/gauge. 4. Relief valve stuck open. 5. Plugged oil filter. 6. If cooler was replaced, shipping plugs left in cooler. 7. Worn oil pump. 8. Suction tube loose or seal leaking. 9. Loose main bearing cap. 10. Worn bearings or wrong bearings installed. 11. Oil jet under piston bad fit into main carrier. 	<ol style="list-style-type: none"> 1. A. Check and fill with clean engine oil. B. Check for a severe external oil leak that could reduce the pressure. 2. Verify the correct oil is being used. Check for oil dilution. Refer to Contaminated Lube Oil (Engine Diagnosis Mechanical). 3. Verify the pressure switch is functioning correctly. If not, replace switch/gauge. 4. Check/replace valve. 5. Change oil filter. Oil filter change interval may need to be revised. 6. Check/remove shipping plugs. 7. Check and replace oil pump. 8. Check and replace seal. 9. Check and install new bearing and tighten cap to proper torque. 10. Inspect and replace connecting rod or main bearings. Check and replace piston cooling nozzles. 11. Check oil jet position.
LUBRICATING OIL PRESSURE TOO HIGH	<ol style="list-style-type: none"> 1. Pressure switch/gauge not operating properly. 2. Engine running to cold. 3. Oil viscosity too thick. 4. Oil pressure relief valve stuck closed or binding. 	<ol style="list-style-type: none"> 1. Verify the pressure switch is functioning correctly. If not, replace switch/gauge. 2. Refer to Coolant Temperature Below Normal (Engine Diagnosis Performance). 3. Make sure the correct oil being used, (Refer to Group 0, Lubrication and Maintenance). 4. Check and replace valve.
LUBRICATING OIL LOSS	<ol style="list-style-type: none"> 1. External leaks. 2. Crankcase being overfilled. 3. Incorrect oil specification or viscosity. 4. Oil cooler leak. 5. High blow-by forcing oil out the breather. 6. Turbocharger leaking oil to the air intake. 7. Piston rings not sealing (oil being consumed by the engine). 	<ol style="list-style-type: none"> 1. Visually inspect for oil leaks. Repair as required. 2. Verify that the correct dipstick is being used. 3. A. Make sure the correct oil is being used. B. Look for reduced viscosity from dilution with fuel. C. Review/reduce the oil change intervals. 4. Check and replace the oil cooler. 5. Check the breather tube area for signs of oil loss. Perform the required repairs. 6. Inspect the air ducts for evidence of oil transfer. Repair as required. 7. Perform blow-by check. Repair as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
COMPRESSION KNOCKS	<ol style="list-style-type: none"> 1. Air in the fuel system. 2. Poor quality fuel or water/gasoline contaminated fuel. 3. Engine overloaded. 4. Incorrect injection pump timing. 5. Improperly operating injectors. 	<ol style="list-style-type: none"> 1. Bleed the fuel system (refer to Group 14, Fuel System). 2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tanks. Replace fuel/water separator filter. 3. Verify the engine load rating is not being exceeded. 4. Check and time injection pump (refer to Group 14, Fuel System). 5. Check and replace inoperative injectors.
EXCESSIVE VIBRATION	<ol style="list-style-type: none"> 1. Loose or broken engine mounts. 2. Damaged fan or improperly operating accessories. 3. Improperly operating vibration damper. 4. Improperly operating viscous fan drive. 5. Worn or damaged generator bearing. 6. Flywheel housing misaligned. 7. Loose or broken power component. 8. Worn or unbalanced driveline components. 	<ol style="list-style-type: none"> 1. Replace engine mounts. 2. Check and replace the vibrating components. 3. Inspect/replace the vibration damper. 4. Inspect/replace the fan drive. 5. Check/replace the generator. 6. Check/correct flywheel alignment. 7. Inspect the crankshaft and rods for damage that causes an unbalance. repair/replace as required. 8. Check/repair driveline components.
EXCESSIVE ENGINE NOISES	<ol style="list-style-type: none"> 1. Drive belt squeal, insufficient tension or abnormally high loading. 2. Intake air or exhaust leaks. 3. Excessive valve lash. 4. Turbocharger noise. 5. Gear train noise. 6. Power function knock. 	<ol style="list-style-type: none"> 1. Check the automatic tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub and generator turn freely. 2. Refer to Excessive Exhaust smoke (Engine Diagnosis Performance). 3. Adjust valves. Make sure the push rods are not bent and rocker levers or adjusting screws are not severely worn. Replace bent or severely worn pads. 4. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required. 5. Visually inspect and measure gear backlash. Replace gears as required. 6. Check/replace rod and main bearings.
GENERATOR NOT CHARGING OR INSUFFICIENT CHARGING	<ol style="list-style-type: none"> 1. Loose or corroded battery. 2. Generator belt slipping. 3. Generator pulley loose on shaft. 4. Improperly operating generator. 	<ol style="list-style-type: none"> 1. Clean/tighten battery connection. 2. Check/replace automatic belt tensioner. Check/replace drive belt. 3. Tighten pulley. 4. Check/replace generator.

DIAGNOSIS AND TESTING (Continued)

VACUUM PUMP OUTPUT—DIESEL ENGINE

The vacuum pump supplies necessary vacuum to components in the following systems:

- HEVAC system
- Speed Control System
- EGR System

A quick check to determine if the vacuum pump is the cause of the problem in any of these systems is to road test the vehicle and verify that all of these systems are functioning properly. If only one of these has a vacuum related failure, then it is likely the vacuum pump is not the cause.

A standard vacuum gauge can be used to check pump output when necessary. Simply disconnect the pump supply hose and connect a vacuum gauge to the outlet port for testing purposes. With the engine running, vacuum output should be a minimum of 25 inches, depending on engine speed.

DIAGNOSING LOW VACUUM OUTPUT CONDITION

If the vacuum pump is suspected of low vacuum output, check the pump and vacuum harnesses as follows:

(1) Visually inspect the vacuum harness for obvious failures (i.e. disconnected, cracks, breaks etc.)

(2) Disconnect the vacuum supply hose at the vacuum pump check valve. Connect vacuum gauge to this valve and run engine at various throttle openings. Output should be a minimum 25 inches of vacuum. If vacuum is consistently below 25 inches, the vacuum pump should be replaced. If output is within specified limits, the vacuum harness should be suspected as the cause.

(3) Disconnect and isolate the vacuum supply harness. Cap off open ends and apply roughly 15 inches of vacuum to the harness. If the vacuum gauge does not hold its reading, then there is an open in the harness and it should be repaired or replaced.

(4) If the vacuum loss is still not detected at this point, then the pump and harness are not the cause of the low vacuum condition. Apply vacuum to the related components of the vacuum supply system (i.e. valves, servos, solenoids, etc.) to find the source of the vacuum loss.

3.9L ENGINE

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GENERAL INFORMATION

VALVES AND VALVE SPRINGS

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

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION/IDENTIFICATION

The 3.9 Liter (238 CID) six-cylinder engine is a V-Type, lightweight, single cam, overhead valve engine with hydraulic roller tappets. This engine is designed to use 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 on the left bank and 2, 4, 6 on the right bank. The firing order is 1-6-5-4-3-2 (Fig. 1).

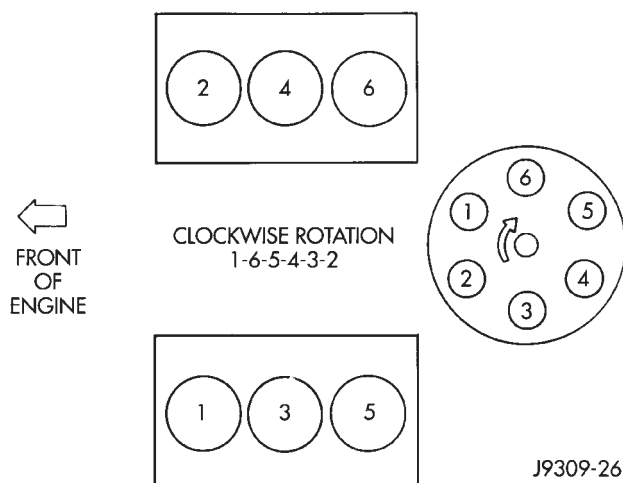


Fig. 1 Firing Order

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).

ENGINE LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the rear main bearing cap. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears 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

X M 3.9L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

3.9L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 2 Engine Identification Number

center outlet of the filter through an oil gallery that channels the oil up to the main gallery, which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block, and into the oil gallery on the left side of the engine.

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

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

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

DESCRIPTION AND OPERATION (Continued)

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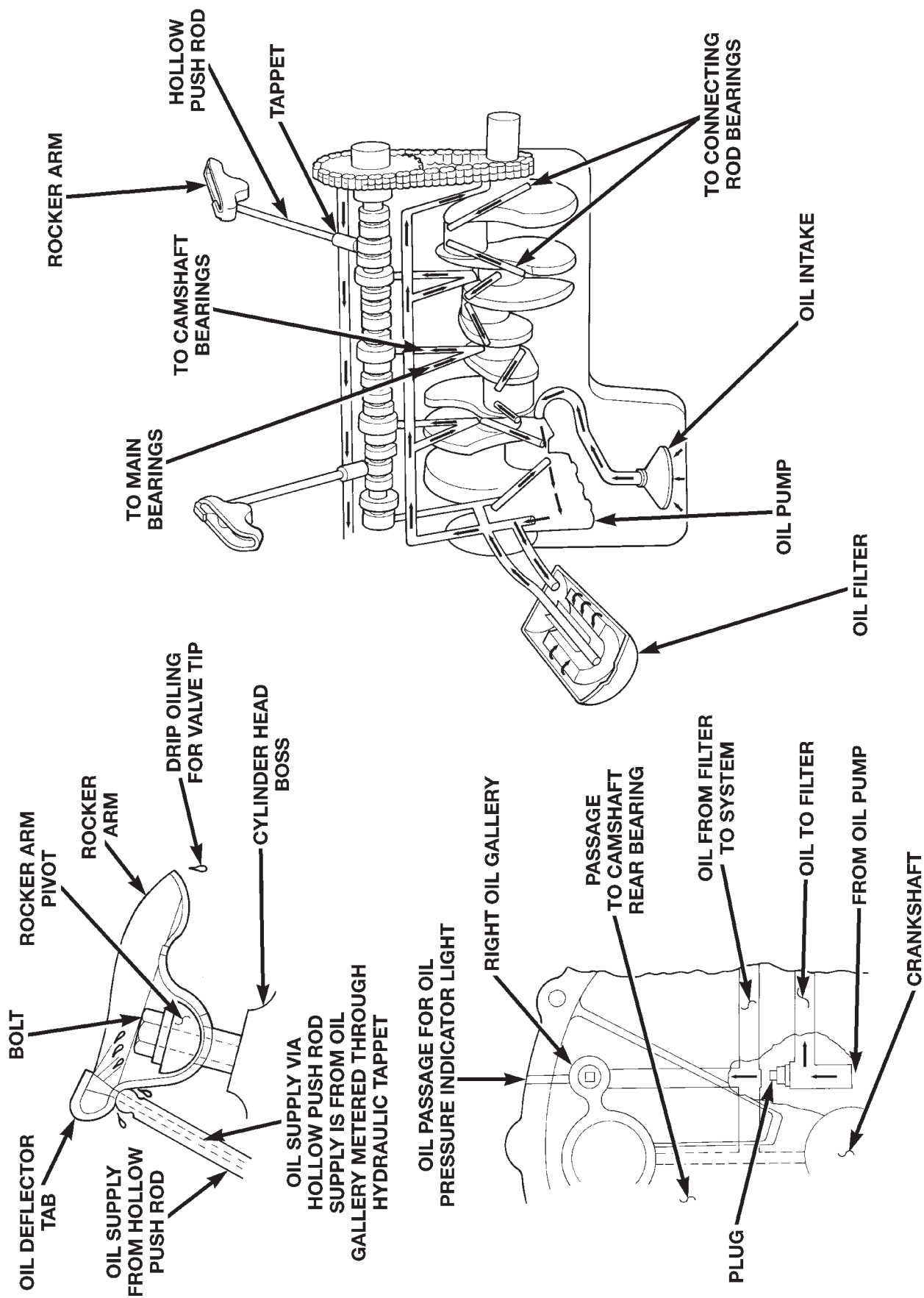


Fig. 3 Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEAD COVER

A steel-backed silicone gasket is used with the cylinder head cover. This gasket is reuseable.

CYLINDER HEADS

The alloy cast iron cylinder heads are held in place by eight bolts. The spark plugs are located in at peak of the wedge between the valves (Fig. 4).

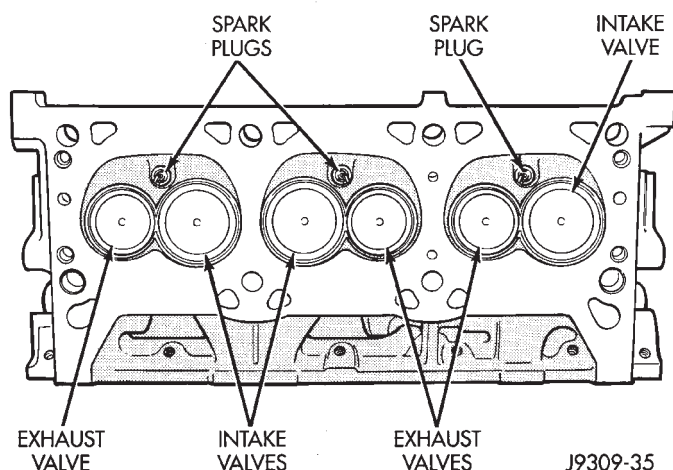


Fig. 4 Cylinder Head Assembly

VALVES AND VALVE SPRINGS

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

TIMING CHAIN TENSIONER

A stamped steel mechanical chain tensioner is mounted to the front of the engine, behind the timing drive, and maintains chain tension by way of a pivoting nylon covered spring steel arm. A fixed, nylon covered pad is used on the opposite side of the tensioner. This tensioner design reduces noise generated by typical chain driven systems.

OIL PUMP

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion

under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

CRANKSHAFT

A crankshaft that has undersize journals is stamped with 1/4 inch letters near the notch of the No. 6 crankshaft counterweight.

FOR EXAMPLE: R2 stamped on the No. 6 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No. 4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No. 3 rod journal and the No. 2 main journal are both 0.025 mm (0.001 in) undersize.

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

CRANKSHAFT MAIN BEARINGS

Bearing caps are NOT interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No.1 and 3 are interchangeable.

Upper and lower No. 2 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine. Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

CRANKSHAFT REAR OIL SEALS

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

SERVICE PROCEDURES

VALVE TIMING

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

SERVICE PROCEDURES (Continued)

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

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

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.254 mm (0.010 inch). The timing of the crankshaft should now read from 10° before top dead center to 2° after top dead center. Remove spacer.

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

(5) If reading is not within specified limits:

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

TIMING CHAIN STRETCH

NOTE: Timing chain tensioner must be removed for this operation.

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 5).

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

FITTING PISTONS

Check the cylinder block bore for out-of-round, taper, scoring, or scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 6).

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

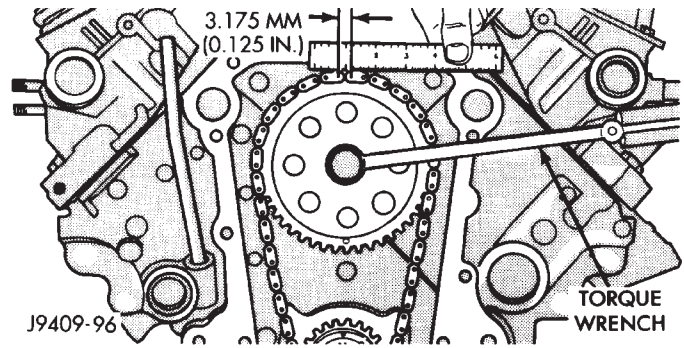
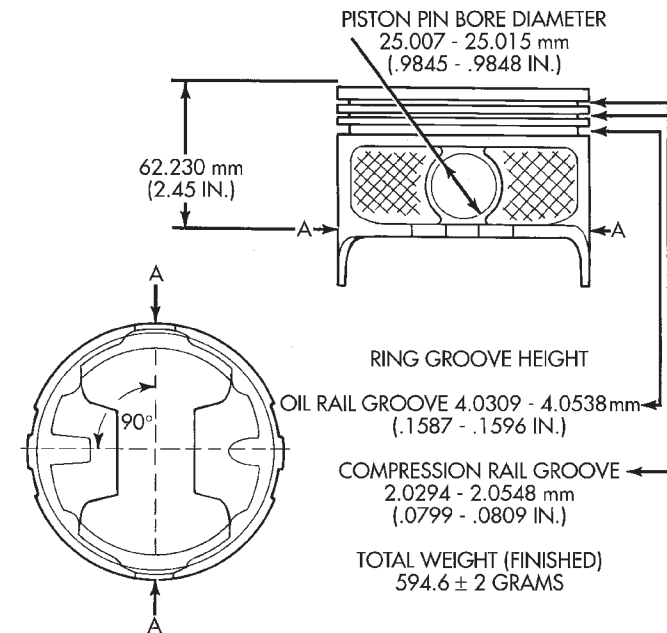


Fig. 5 Measuring Timing Chain Wear and Stretch

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

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



PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (IN.)	MAX. mm (IN.)	MIN. mm (IN.)	MAX. mm (IN.)
A	99.280 (3.9087)	99.294 (3.9092)	99.306 (3.9097)	99.319 (3.9102)
B	99.294 (3.9092)	99.306 (3.9097)	99.319 (3.9102)	99.332 (3.9107)
C	99.306 (3.9097)	99.319 (3.9102)	99.332 (3.9107)	99.344 (3.9112)
D	99.319 (3.9102)	99.332 (3.9107)	99.344 (3.9112)	99.357 (3.9117)
E	99.332 (3.9107)	99.344 (3.9112)	99.357 (3.9117)	99.370 (3.9122)

J9509-80

Fig. 6 Piston Measurements

FITTING RINGS

(1) Measurement of end gaps:

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

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508

SERVICE PROCEDURES (Continued)

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 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. 7) (Fig. 9).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 8) (Fig. 9). 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.

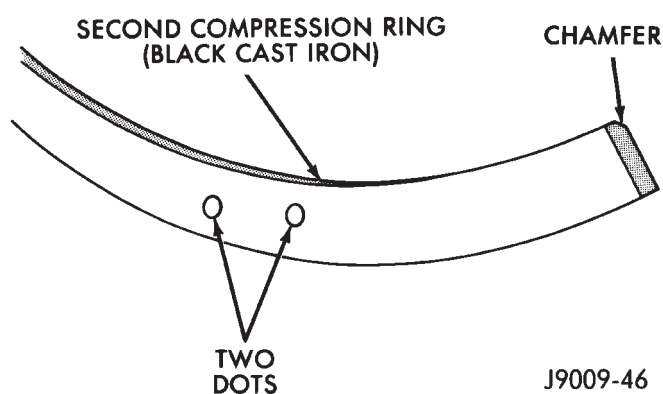


Fig. 7 Second Compression Ring Identification (Typical)

(3) Orient the rings:

(a) Arrange top compression ring 90° counter-clockwise from the oil ring rail gap (Fig. 10).

(b) Arrange second compression ring 90° clockwise from the oil ring rail gap (Fig. 10).

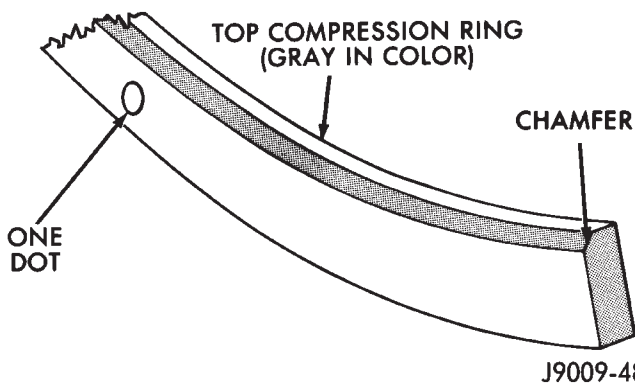


Fig. 8 Top Compression Ring Identification (Typical)

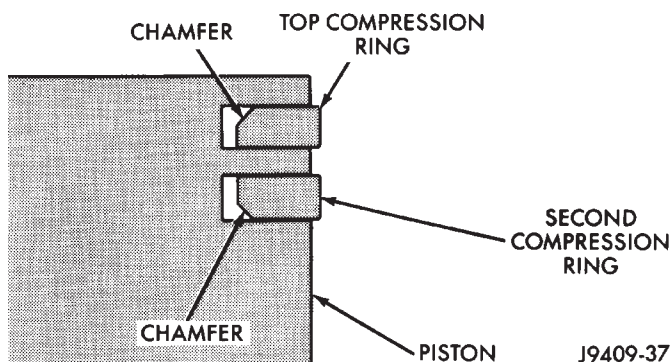


Fig. 9 Compression Ring Chamfer Location (Typical)

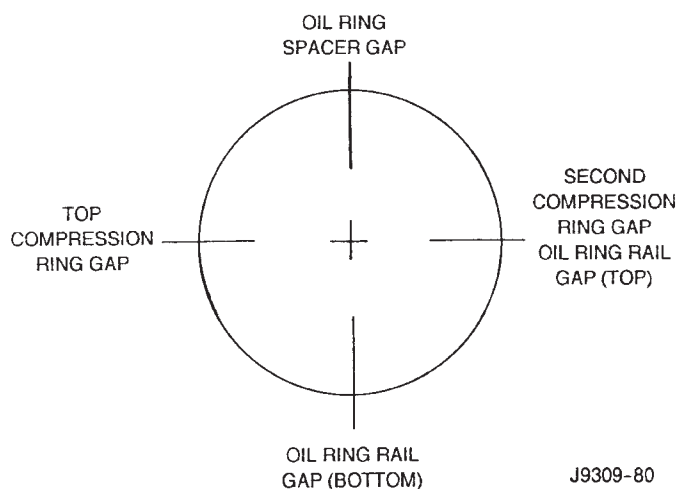


Fig. 10 Proper Ring Installation

CONNECTING ROD BEARINGS

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

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

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

SERVICE PROCEDURES (Continued)

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

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 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 MAIN BEARINGS

Bearing caps are NOT interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No. 1 and 3 are interchangeable.

Upper and lower No. 2 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 11). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

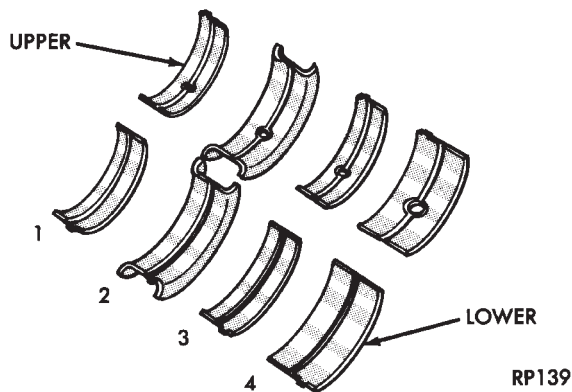


Fig. 11 Main Bearing Identification

CRANKSHAFT

A crankshaft that has undersize journals will be stamped with 1/4 inch letters near the notch of the No.6 crankshaft counterweight (Fig. 12).

FOR EXAMPLE: R2 stamped on the No. 6 crankshaft counterweight indicates that the No. 2 rod journal is 0.025 mm (0.001 in.) undersize. M4 indicates that the No. 4 main journal is 0.025 mm (0.001 in.) undersize. R3 M2 indicates that the No. 3 rod journal and the No. 2 main journal are 0.025 mm (0.001 in.) undersize.

When a crankshaft is replaced, all main and connecting rod bearings should be replaced with new bearings.

Undersize Journal	Identification Stamp
ROD - 0.025mm (0.001 in.)	R1-R2-R3-Etc.
MAIN - 0.025mm (0.001 in.)	M1-M2-M3 or M4

STEEL STAMP IDENTIFICATION
R (ROD) AND/OR M (MAIN) FOLLOWED
BY THE ROD OR MAIN NUMBER

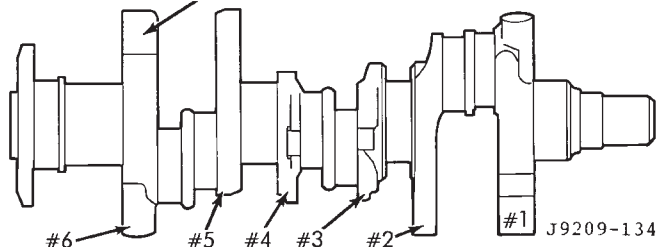


Fig. 12 Location of Crankshaft Identification

Therefore, selective fitting of the bearings is not required when a crankshaft and bearings are replaced.

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

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. 13).
- (6) Remove engine support bracket/cushion bolts (Fig. 13). Remove the support bracket/cushion and heat shields.

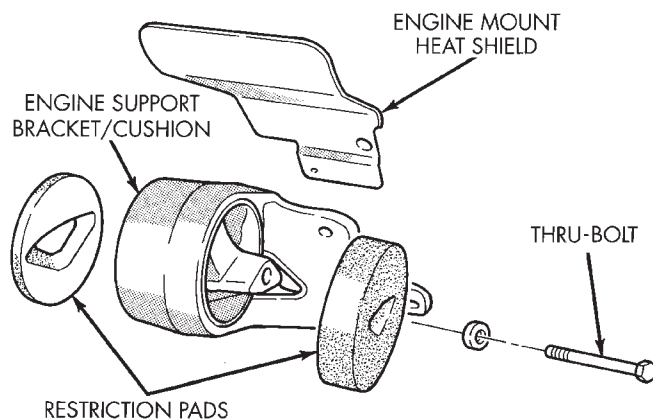


Fig. 13 Engine Front Mounts

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

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

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

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and through-bolt into support cushion brackets (Fig. 14).

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

(5) Lower the vehicle.

(6) Remove lifting fixture.

ENGINE MOUNT— REAR

REMOVAL

(1) Raise the vehicle on a hoist.

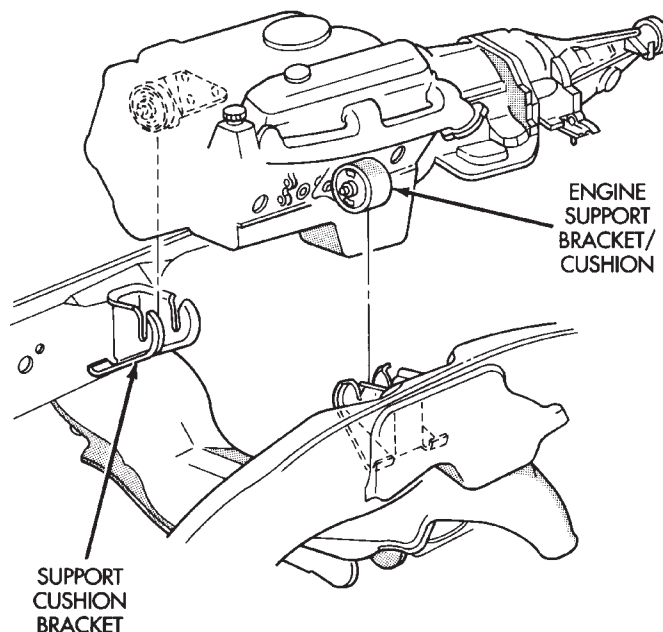
(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 15).

(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.



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Fig. 14 Positioning Engine Front Mounts

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.

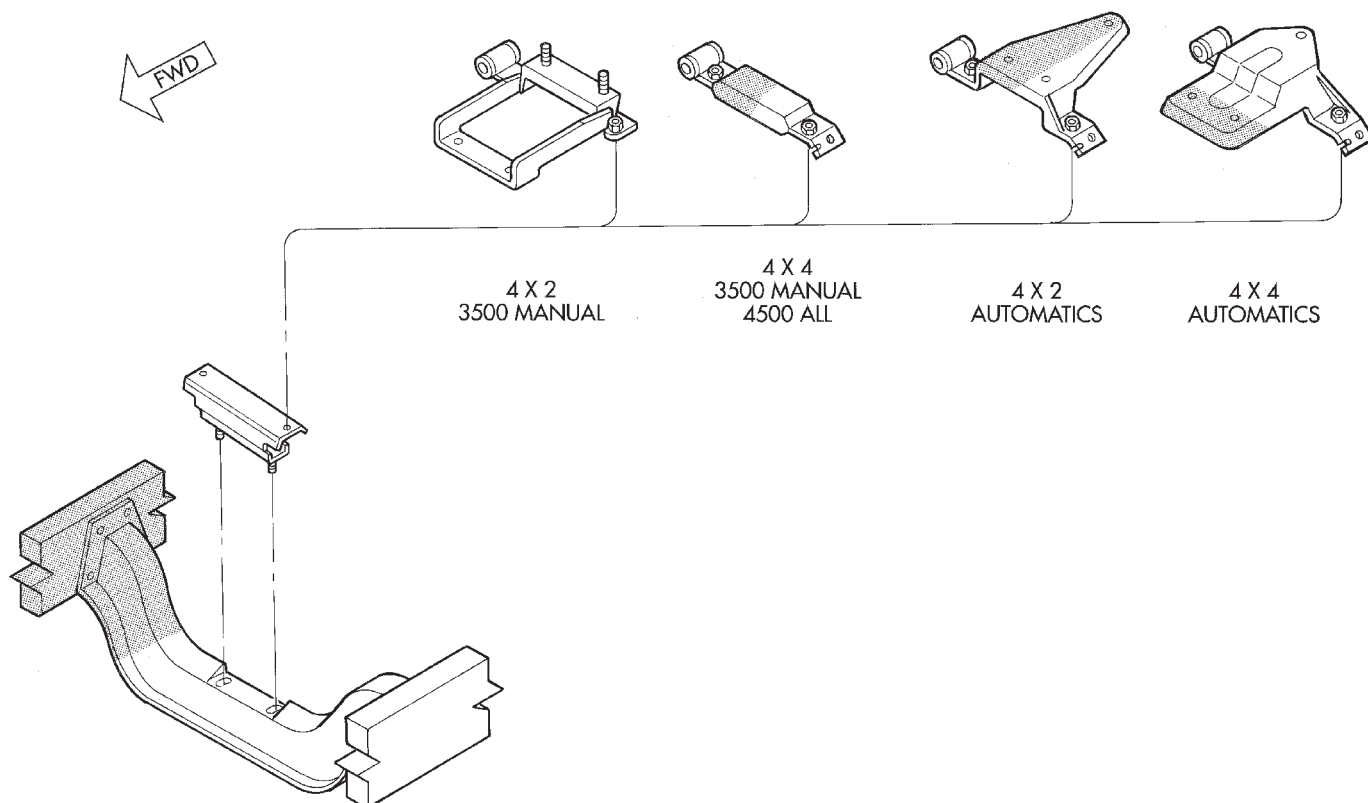


Fig. 15 Engine Rear Support Cushion Assemblies

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REMOVAL AND INSTALLATION (Continued)

(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. 15).

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

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY

REMOVAL

(1) Remove the battery.

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

(3) Remove the upper crossmember and top core support.

(4) Remove the transmission oil cooler.

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

(6) Remove the serpentine belt. Refer to Group 7, Cooling System.

(7) Remove the A/C compressor with the lines attached. Set aside.

(8) If equipped, remove the condenser.

(9) Remove the washer bottle.

(10) Disconnect the top radiator hose.

(11) Remove the fan.

(12) Remove the fan shroud.

(13) Disconnect the lower radiator hose.

(14) Remove radiator. Refer to Group 7, Cooling System.

(15) Remove the generator with the wire connections. Refer to Group 8B, Battery/Starter/Generator Service.

(16) Remove the air cleaner box.

(17) Disconnect the throttle linkage.

(18) Remove throttle body.

(19) Remove the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

(20) Remove the distributor cap and wiring.

(21) Disconnect the heater hoses.

(22) Disconnect the power steering hoses, if equipped.

(23) Disconnect the transmission cooler lines.

(24) Perform the Fuel System Pressure release procedure. Refer to group 14, Fuel system. Disconnect the fuel line.

(25) On Manual Transmission vehicles, remove the shift lever. Refer to Group 21, Transmissions.

(26) Raise and support the vehicle on a hoist.

(27) Remove the drain plug and drain the engine oil.

(28) Remove engine front mount through-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 Group 8B, Battery/Starter/Generator Service.

(32) Remove the dust shield and transmission cover.

(33) Refer to Group 21, Transmissions for transmission removal.

(34) Lower the vehicle.

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

(35) Install an engine lifting fixture.

(36) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment. Position the through-bolt into the support cushion brackets.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group 21, Transmissions for transmission installation.

(5) Install the prop shaft. Refer to Group 16, Propeller Shaft.

(6) Install the dust shield and transmission cover.

(7) Install the starter and connect the starter wires. Refer to Group 8B, Battery/Starter/Generator Service.

(8) Install exhaust pipe to manifold.

(9) Install the transmission cooler line brackets from oil pan.

(10) Install engine front mount through-bolt nuts. Tighten the nuts.

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

(12) Lower the vehicle.

(13) Remove engine-lifting fixture.

(14) On Manual Transmission vehicles, install the shift lever. Refer to Group 21, Transmissions.

(15) Connect the fuel lines.

(16) Connect the transmission cooler lines.

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

(18) Connect the heater hoses.

(19) Install the distributor cap and wiring.

(20) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

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

(22) Connect the throttle linkage.

(23) Install the air cleaner box.

REMOVAL AND INSTALLATION (Continued)

(24) Install the generator and wire connections. Refer to Group 8B, Battery/Starter/Generator Service.

(25) Install radiator. Refer to Group 7, Cooling System.

(26) Connect the lower radiator hose.

(27) Install the fan shroud.

(28) Install the fan.

(29) Connect the top radiator hose.

(30) Install the washer bottle.

(31) If equipped, install the condenser.

(32) Install the A/C compressor with the lines attached.

(33) Install the serpentine belt. Refer to Group 7, Cooling System.

(34) Evacuate and charge the air conditioning system, if equipped. Refer to Group 24, Heating and Air Conditioning for service procedures.

(35) Install the transmission oil cooler.

(36) Install the upper crossmember and top core support.

(37) Add coolant to the cooling system. Refer to Group 7, Cooling System for the proper procedure.

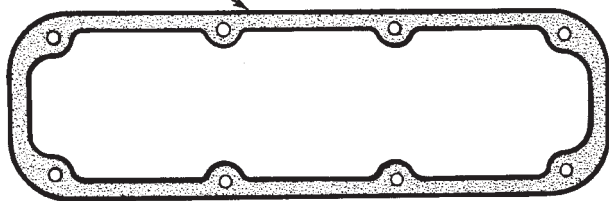
(38) Install the battery.

(39) Road test vehicle.

CYLINDER HEAD COVER

A steel-backed silicone gasket is used with the cylinder head cover (Fig. 16). This gasket can be used again.

CYLINDER HEAD COVER GASKET



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Fig. 16 Cylinder Head Cover Gasket

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.

(3) Remove cylinder head cover and gasket. The gasket may be used again.

INSTALLATION

(1) Install the cylinder head cover gasket onto the head rail.

(2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(3) Install closed crankcase ventilation system and evaporation control system.

(4) Connect the negative cable to the battery.

CYLINDER HEAD COMPONENTS—IN VEHICLE SERVICE

ROCKER ARMS AND PUSH RODS

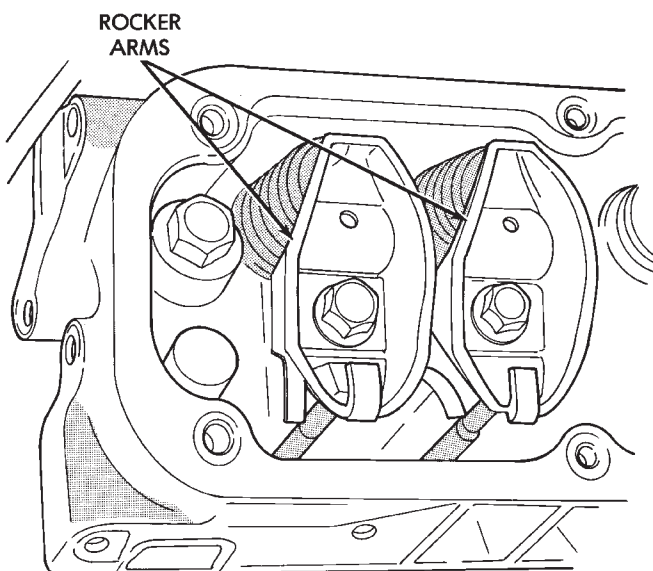
REMOVAL

(1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.

(2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and pivots (Fig. 17). Place them on a bench in the same order as removed.

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



J9209-66

Fig. 17 Rocker Arms

INSTALLATION

(1) Rotate the crankshaft until the V6 mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.

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

(2) Install the push rods in the same order as removed.

(3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

(4) Install cylinder head cover.

REMOVAL AND INSTALLATION (Continued)

- (5) Connect spark plug wires.

VALVE STEM SHIELDS AND SPRINGS

REMOVAL

- (1) Set engine basic timing to Top Dead Center (TDC).
- (2) Remove the air cleaner.
- (3) Remove cylinder head covers and spark plugs.
- (4) Remove coil wire from distributor and secure to good ground to prevent engine from starting.
- (5) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.
- (6) Remove rocker arms.
- (7) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.
- (8) Using Valve Spring Compressor Tool MD-998772A and adapter 6716A, compress valve spring and remove retainer valve locks and valve spring.

INSTALLATION

- (1) Install seals on the exhaust valve stem and position down against valve guides.
- (2) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.
- (3) Follow the same procedure on the remaining 5 cylinders using the firing sequence 1-6-5-4-3-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.
- (4) Remove adapter from the No.1 spark plug hole.
- (5) Install rocker arms.
- (6) Install covers and coil wire to distributor.
- (7) Install air cleaner.
- (8) Road test vehicle.

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 18) are held in place by eight bolts. The spark plugs are located at the peak of the wedge between the valves.

REMOVAL

- (1) Disconnect the battery negative cable from the battery.
- (2) Drain cooling system. Refer to Group 7, Cooling System for the proper procedures.
- (3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.
- (4) Remove closed crankcase ventilation system.
- (5) Disconnect the evaporation control system.
- (6) Remove the air cleaner.

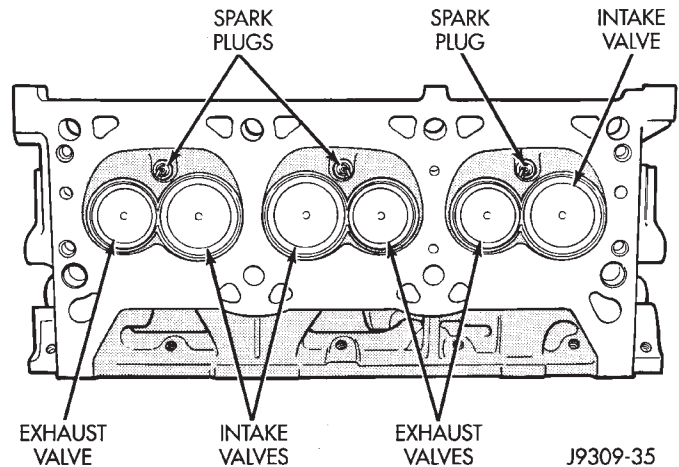


Fig. 18 Cylinder Head Assembly

- (7) Perform fuel system pressure release procedure. Refer to Group 14, Fuel Systems for the correct procedure.
- (8) Disconnect the fuel supply line from the fuel rail. Refer to Group 14, Fuel Systems for the correct procedure.
- (9) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
- (10) Remove distributor cap and wires.
- (11) Disconnect the coil wires.
- (12) Disconnect heat indicator sending unit wire.
- (13) Disconnect heater hoses and bypass hose.
- (14) Remove cylinder head covers and gaskets.
- (15) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.
- (16) Remove exhaust manifolds.
- (17) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.
- (18) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.
- (19) Remove spark plugs.

INSTALLATION

- (1) Position the new cylinder head gaskets onto the cylinder block.
- (2) Position the cylinder heads onto head gaskets and cylinder block.
- (3) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 19). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

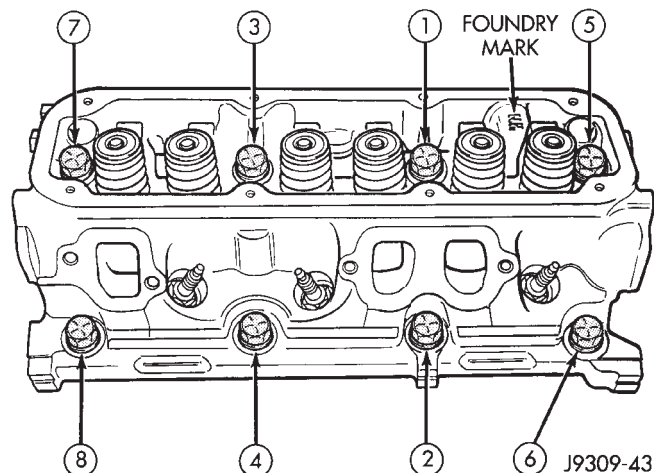


Fig. 19 Cylinder Head Bolt -Tightening Sequence

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

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

(5) Install the intake manifold and throttle body assembly. Refer to Group 11, Exhaust System and Intake Manifold.

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

(7) Adjust spark plugs to specifications. Refer to Group 8D, Ignition System. Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(8) Install coil wires.

(9) Connect heat indicator sending unit wire.

(10) Connect the heater hoses and bypass hose.

(11) Install distributor cap and wires.

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

(13) Install the fuel supply line.

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

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

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

(17) Install closed crankcase ventilation system.

(18) Connect the evaporation control system.

(19) Install the air cleaner.

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

(21) Fill cooling system. Refer to Group 7, Cooling System for proper procedure.

(22) Connect the battery negative cable.

VALVES AND VALVE SPRINGS—CYLINDER HEAD REMOVED

REMOVAL

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

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

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

INSTALLATION

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

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

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

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

HYDRAULIC TAPPETS

REMOVAL

(1) Remove the air cleaner.

(2) Remove cylinder head cover.

(3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original locations.

(4) Remove intake manifold.

(5) Remove yoke retainer and aligning yokes.

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

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

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

INSTALLATION

(1) Lubricate tappets.

REMOVAL AND INSTALLATION (Continued)

- (2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).
- (3) Install aligning yokes with ARROW toward camshaft.
- (4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.
- (5) Install push rods in original positions.
- (6) Install rocker arms.
- (7) Install cylinder head cover.
- (8) Start and operate engine. Warm up to normal operating temperature.

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

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

- (1) Remove distributor. Refer to Group 8D, Ignition Systems for the proper procedure.
- (2) Remove the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.
- (3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 20).
- (4) Hold puller screw and tighten puller nut until bushing is removed.

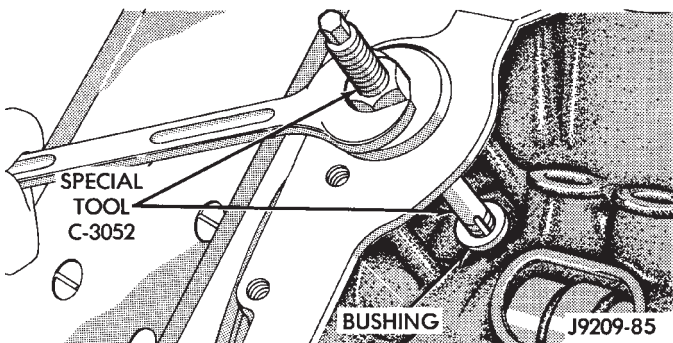


Fig. 20 Distributor Driveshaft Bushing Removal

INSTALLATION

- (1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.
- (2) Drive bushing and tool into position, using a hammer (Fig. 21).
- (3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 22). **DO NOT ream this bushing.**

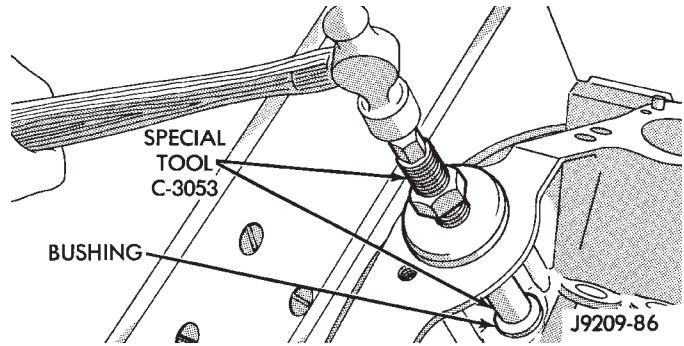


Fig. 21 Distributor Driveshaft Bushing Installation

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

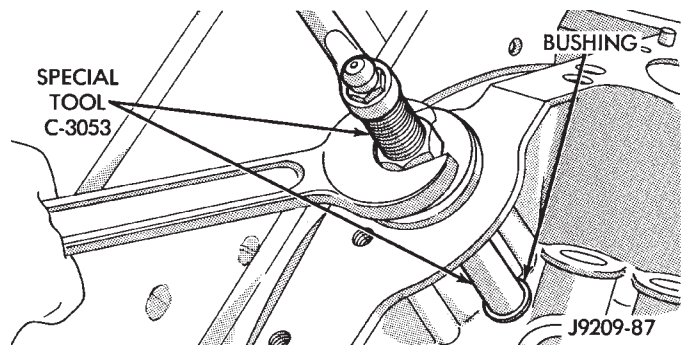


Fig. 22 Burnishing Distributor Driveshaft Bushing

- (4) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

DISTRIBUTOR INSTALLATION

NOTE: Before installing the distributor, the oil pump drive shaft must be aligned to number one cylinder.

- (1) Rotate crankshaft until No. 1 cylinder is at top dead center on the firing stroke.
 - (2) When in this position, the timing mark of vibration damper should be under "0" on the timing indicator.
 - (3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned toward the left front intake manifold attaching bolt hole (Fig. 23).
 - (4) Install distributor. Refer to Group 8D, Ignition Systems for the proper procedure.
- After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition System.

Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on igni-

REMOVAL AND INSTALLATION (Continued)

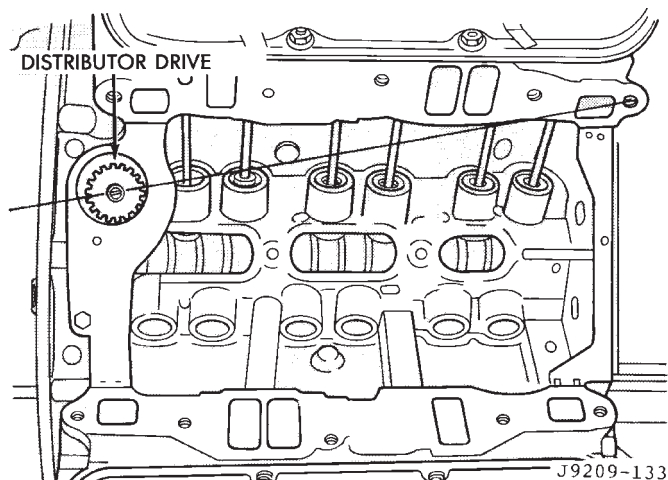


Fig. 23 Position of Oil Pump Shaft Slot

tion timing. Adjusting distributor position will affect fuel synchronization only.

VIBRATION DAMPER

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove fan shroud retainer bolts and set shroud back over engine.
- (3) Remove the cooling system fan.
- (4) Remove the serpentine belt. Refer to Group 7, Cooling System.
- (5) Remove the vibration damper pulley.
- (6) Remove vibration damper bolt and washer from end of crankshaft.
- (7) Install bar and screw from Puller Tool Set C-3688. Install two bolts with washers through the puller tool and into the vibration damper (Fig. 24).

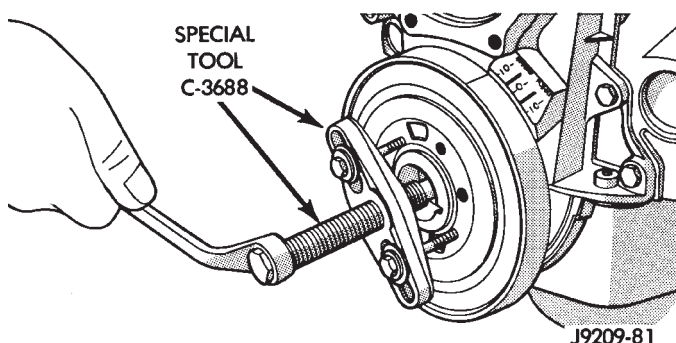


Fig. 24 Vibration Damper Assembly

- (8) Pull vibration damper off of the crankshaft.

INSTALLATION

- (1) Position the vibration damper onto the crankshaft.
- (2) Place installing tool, part of Puller Tool Set C-3688, in position and press the vibration damper onto the crankshaft (Fig. 25).
- (3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

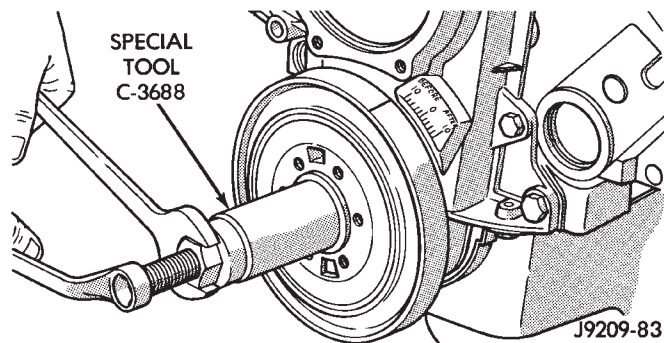


Fig. 25 Installing Vibration Damper

- (4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.
- (5) Install the serpentine belt. Refer to Group 7, Cooling System.
- (6) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.
- (7) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.
- (8) Connect the negative cable to the battery.

TIMING CHAIN COVER

REMOVAL

- (1) Disconnect the battery negative cable.
- (2) Drain cooling system. Refer to Group 7, Cooling System.
- (3) Remove the serpentine belt. Refer to Group 7, Cooling System.
- (4) Remove water pump. Refer to Group 7, Cooling System.
- (5) Remove power steering pump. Refer to Group 19, Steering.
- (6) Remove vibration damper.
- (7) Loosen oil pan bolts and remove the front bolt at each side.
- (8) Remove the cover bolts.
- (9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (10) From the inside of the cover tap the front crankshaft oil seal outward. Be careful not to damage the timing cover sealing surface.

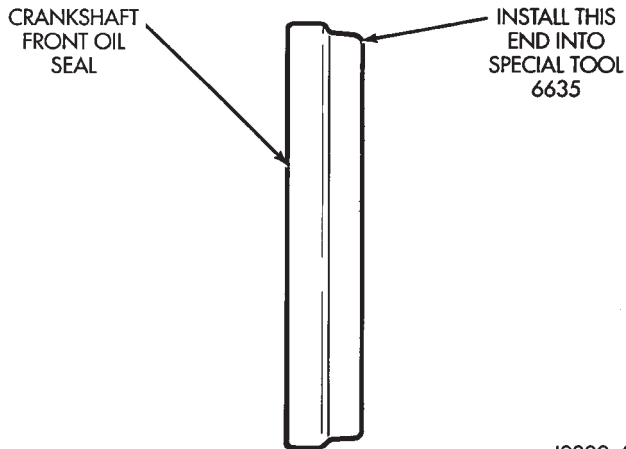
INSTALLATION

- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.
- (2) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

CAUTION: If chain cover is replaced for any reason, be sure the oil hole (passenger side of cover) is plugged.

REMOVAL AND INSTALLATION (Continued)

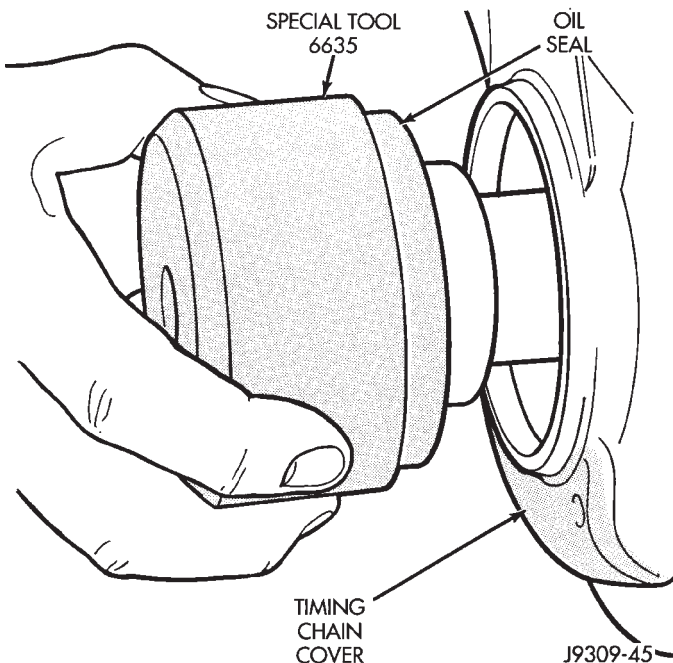
(3) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 26). Seat the oil seal in the groove of the tool.



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Fig. 26 Placing Oil Seal on Installation Tool 6635

(4) Position the seal and tool onto the crankshaft (Fig. 27).



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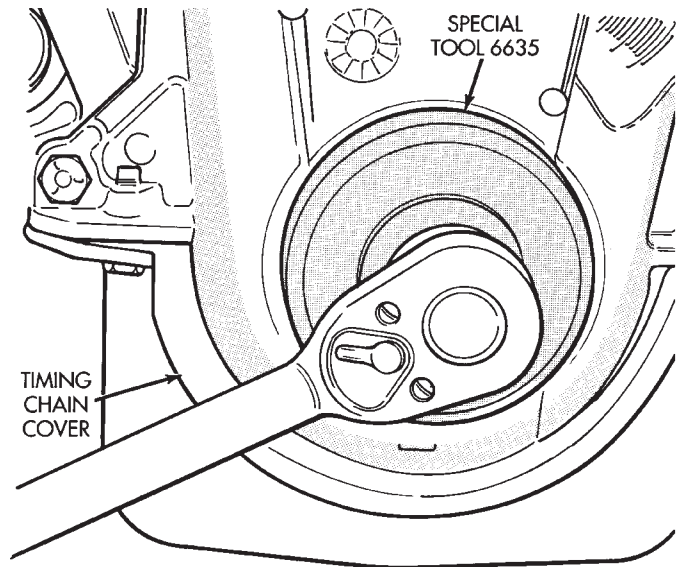
Fig. 27 Position Tool and Seal onto Crankshaft

(5) Tighten the four lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.

(6) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 28).

(7) Loosen the four bolts tightened in Step 4 to allow realignment of front cover assembly.

(8) Tighten chain case cover bolts to 41 N·m (30 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.



J9309-46

Fig. 28 Installing Oil Seal

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

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

(11) Install vibration damper.

(12) Install water pump and housing assembly using new gaskets. Refer to Group 7, Cooling System. Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(13) Install power steering pump. Refer to Group 19, Steering.

(14) Install the serpentine belt. Refer to Group 7, Cooling System.

(15) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

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

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

(18) Connect the negative cable to the battery.

TIMING CHAIN AND TENSIONER

REMOVAL

(1) Disconnect battery negative cable.

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

(3) Remove timing chain cover. Refer to procedure in this group.

(4) Rotate crankshaft to align timing marks (Fig. 30) to #1 TDC.

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

REMOVAL AND INSTALLATION (Continued)

(6) Slip crankshaft sprocket onto crankshaft and compress tensioner shoe by placing a large screwdriver between crankshaft sprocket and tensioner shoe (Fig. 29). Compress shoe until hole in shoe lines up with hole in bracket. Slide a suitable pin into the holes (Fig. 29) and remove screwdriver.

(7) If tensioner assembly is to be replaced, remove the three tensioner to block bolts and remove tensioner assembly.

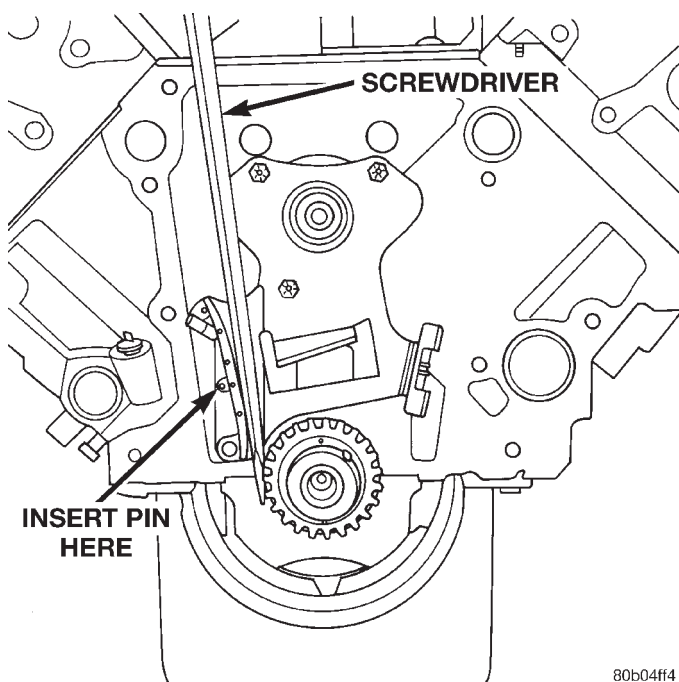


Fig. 29 Compressing Tensioner For Chain Installation

INSTALLATION

(1) If tensioner assembly is being replaced, install tensioner and mounting bolts. Torque bolts to 24 N·m (210 in. lbs.).

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

(3) Place timing chain around both sprockets.

(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 verify alignment of timing marks (Fig. 30) with a straight-edge if necessary.

(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

(7) **Remove tensioner pin.** Again, verify alignment of timing marks.

(8) Install timing cover.

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

(10) Connect battery negative cable.

(11) Start engine and check for oil and coolant leaks.

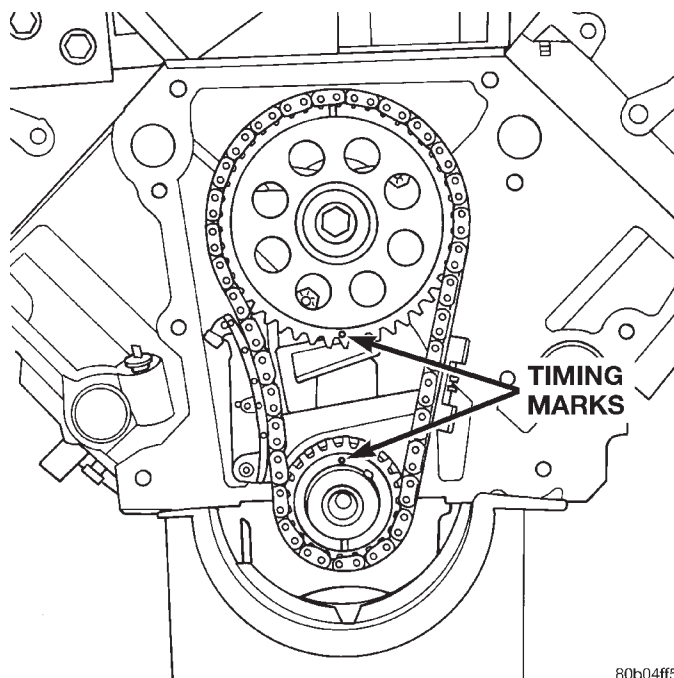


Fig. 30 Alignment of Timing Marks

CAMSHAFT

REMOVAL

(1) Disconnect battery negative cable.

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

(3) Remove radiator.

(4) Remove intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for the correct procedures.

(5) Remove distributor assembly. Refer to Group 8D, Ignition Systems for the correct procedure.

(6) Remove cylinder head covers.

(7) Remove timing chain cover. Refer to procedure in this group.

(8) Remove rocker arms.

(9) Remove push rods and tappets. Identify each part so it can be installed in the original locations.

(10) Remove distributor and lift out the oil pump and distributor drive shaft.

(11) Remove the three tensioner to block mounting bolts and remove tensioner.

(12) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

(2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 31).

REMOVAL AND INSTALLATION (Continued)

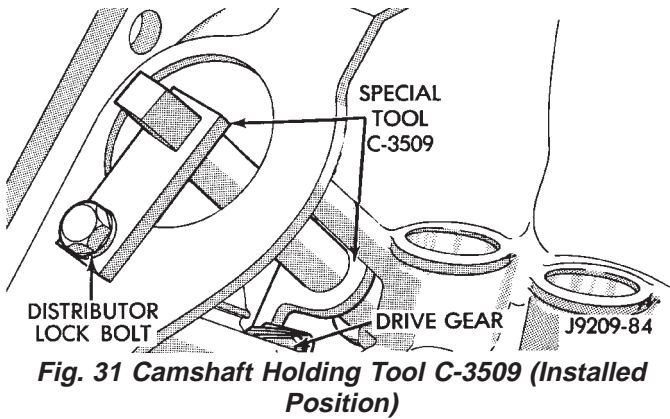


Fig. 31 Camshaft Holding Tool C-3509 (Installed Position)

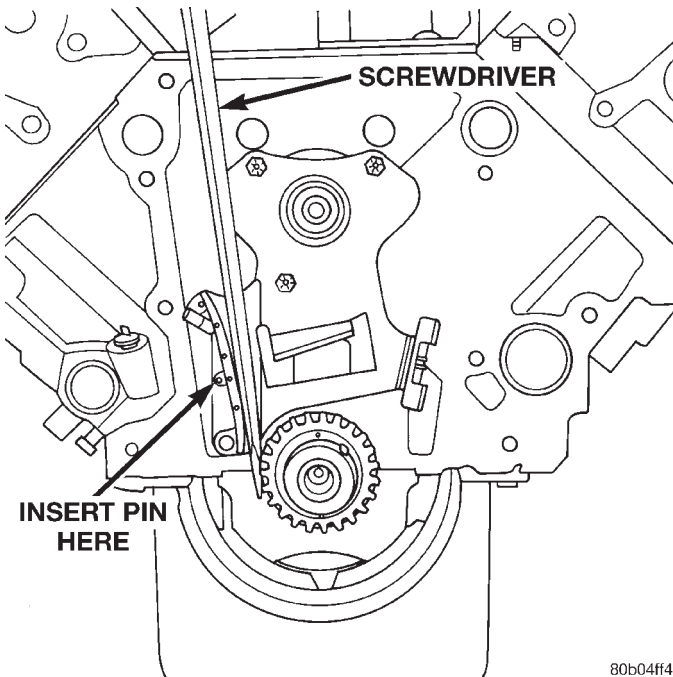


Fig. 32 Compressing Tensioner Shoe For Timing Chain Installation

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install timing chain tensioner. Torque bolts to 24 N·m (210 in. lbs.) torque.

(5) Compress tensioner shoe (Fig. 32) and install a suitable sized pin to retain shoe for chain installation.

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

(7) Place timing chain around both sprockets.

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

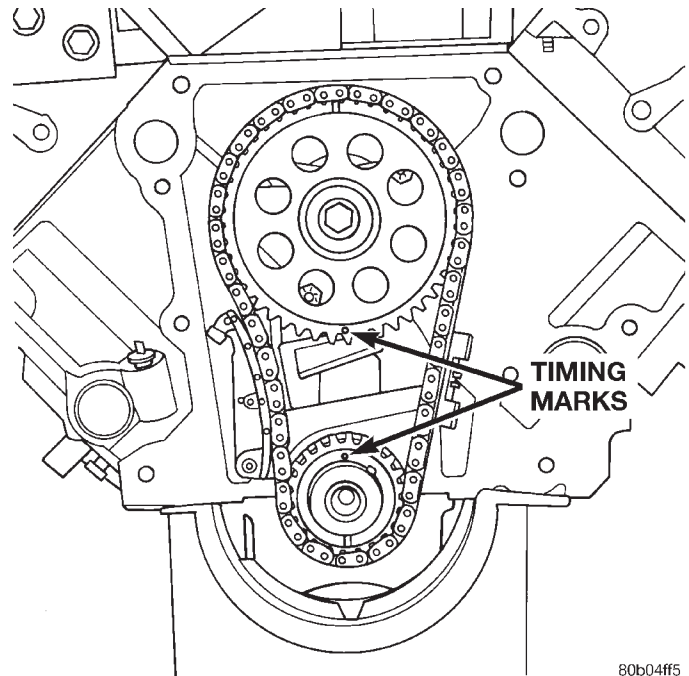


Fig. 33 Alignment of Timing Marks

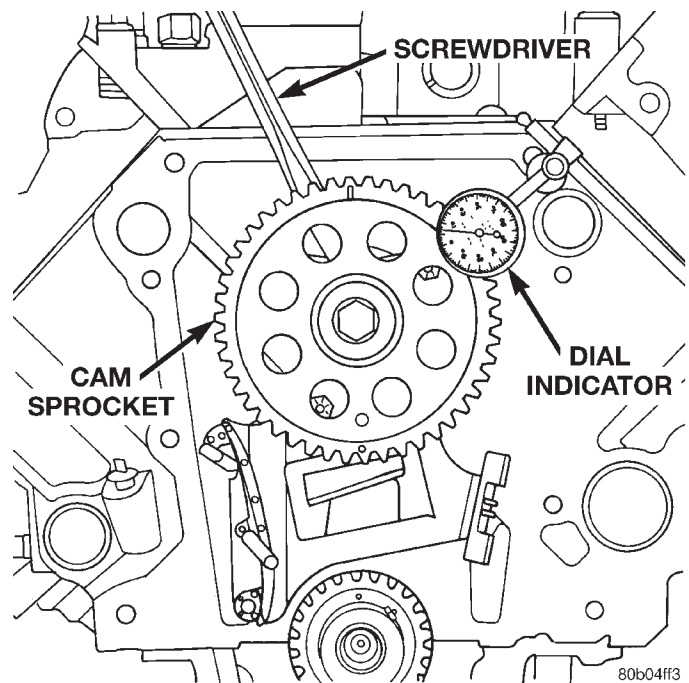


Fig. 34 Checking Camshaft End Play

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

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 33).

(11) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(12) Measure camshaft end play (Fig. 34). Refer to Specifications for proper clearance. If not within limits, install a new timing chain tensioner.

REMOVAL AND INSTALLATION (Continued)

(13) Each tappet reused must be installed in the same position at which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

(14) Install timing chain cover

(15) Install intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for the correct procedure.

(16) Install distributor. Refer to Group 8D, Ignition System for the correct procedure.

(17) Install cylinder head covers.

(18) Install radiator.

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

(20) Connect battery negative cable.

(21) Start engine and check for leaks.

CAMSHAFT BEARINGS

REMOVAL

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 35).

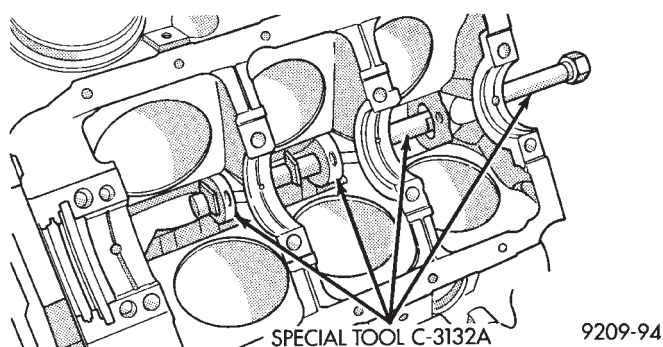


Fig. 35 Camshaft Bearings Removal and Installation with Tool C-3132-A

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

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

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

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

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 36).

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

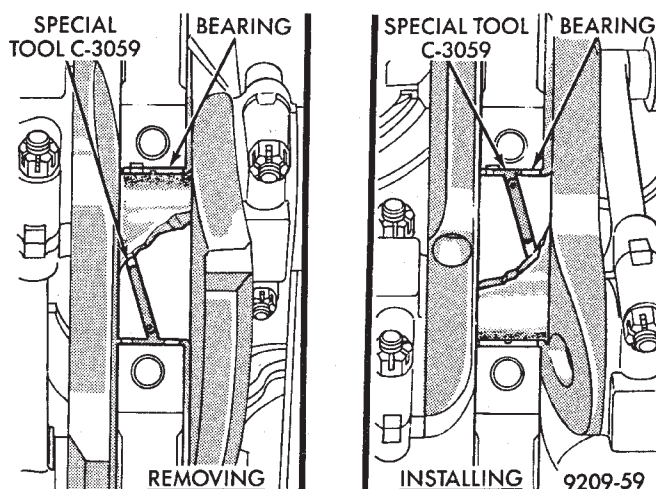


Fig. 36 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation. **DO NOT** use a new bearing half with an old bearing half.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 36).

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

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

REMOVAL AND INSTALLATION (Continued)

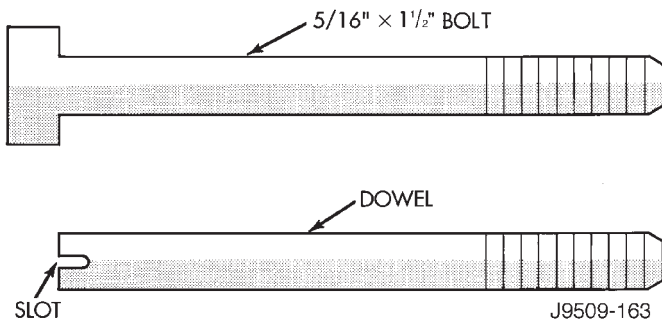
OIL PAN

REMOVAL

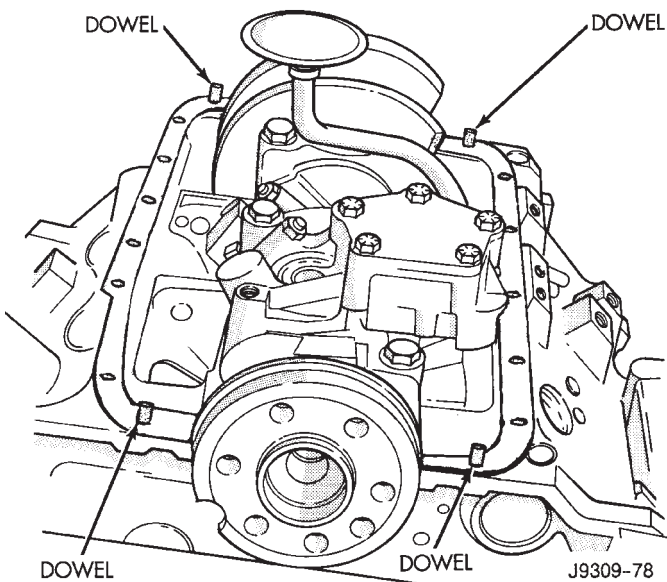
- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion through-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

INSTALLATION

- (1) Clean the block and pan gasket surfaces.
- (2) Fabricate four alignment dowels from 5/16 X 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 37).

**Fig. 37 Fabrication of Alignment Dowels**

- (3) Install the dowels in the cylinder block (Fig. 38).

**Fig. 38 Position of Dowels in Cylinder Block**

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

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

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

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

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

(9) Lower the engine into the support cushion brackets and tighten the through-bolt nut to the proper torque.

(10) Install the drain plug. Tighten drain plug to 34 N·m (27 ft. lbs.) torque.

(11) Install the engine to transmission strut.

(12) Install exhaust pipe.

(13) Lower vehicle.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

(16) Fill crankcase with oil to proper level.

OIL PUMP

REMOVAL

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

INSTALLATION

(1) Install oil pump. During installation, slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.

(2) Hold the oil pump base flush against mating surface on No. 4 main bearing cap. Finger-tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

(1) Remove the engine from the vehicle.

(2) Remove the cylinder head.

(3) Remove the oil pan.

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

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

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing the

REMOVAL AND INSTALLATION (Continued)

assemblies from the engine, rotate crankshaft so that the connecting rod is centered in cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

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

INSTALLATION

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

(2) Before installing the ring compressor, be sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 39).

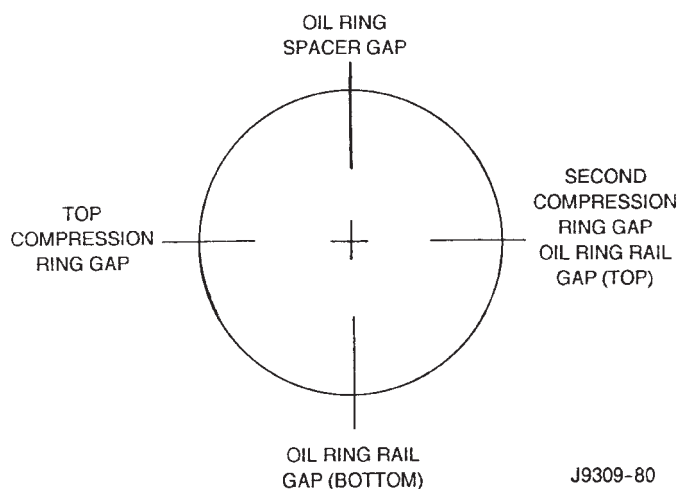


Fig. 39 Proper Ring Installation

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts. The long protector should be installed on the numbered side of the connecting rod.

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

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

(7) The notch, or groove, on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap, and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

(1) Remove the oil pan.

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

(3) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.

(4) Lift the crankshaft out of the block.

(5) Remove and discard the crankshaft rear oil seals.

(6) Remove and discard the front crankshaft oil seal.

INSTALLATION

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

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

(3) Position the crankshaft into the cylinder block.

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

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

(6) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 40). **DO NOT** over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

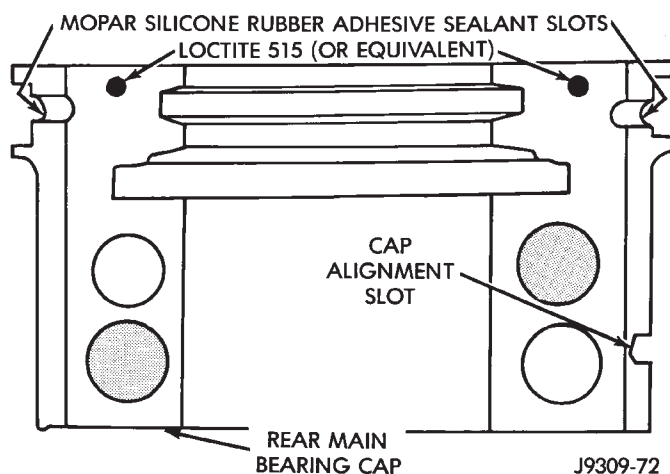


Fig. 40 Sealant Application to Bearing Cap

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

(8) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(9) Install oil pump.

REMOVAL AND INSTALLATION (Continued)

(10) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 41). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(11) Install new front crankshaft oil seal.

(12) Immediately install the oil pan.

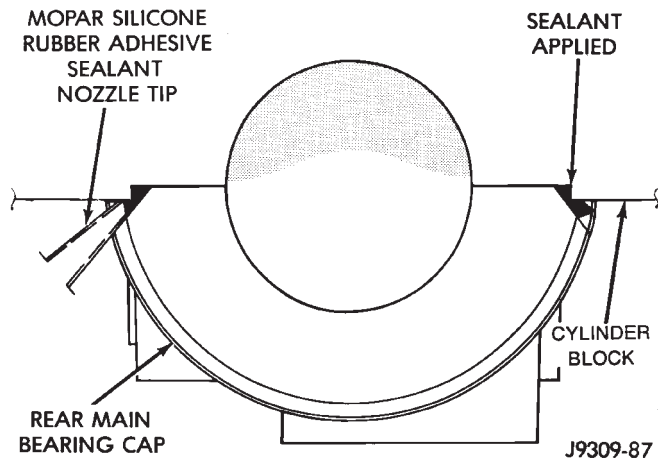


Fig. 41 Apply Sealant to Bearing Cap-to-Block Joint

CRANKSHAFT FRONT OIL SEAL

REMOVAL

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

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment Tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

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

INSTALLATION

(1) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 42). Seat the oil seal in the groove of the tool.

(2) Position the seal and tool onto the crankshaft (Fig. 43).

(3) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 44).

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

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

(6) Install the vibration damper.

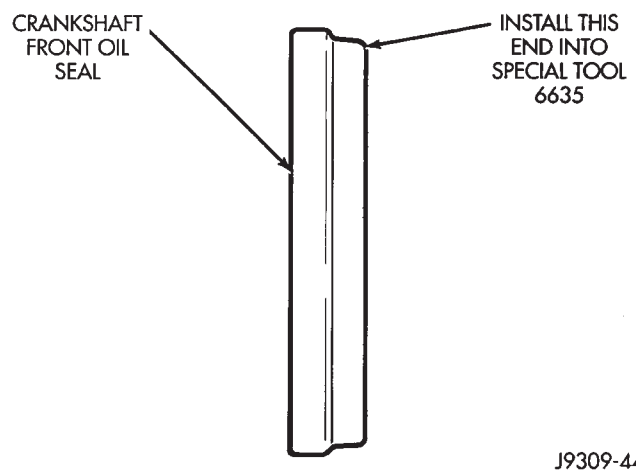


Fig. 42 Placing Oil Seal on Installation Tool 6635

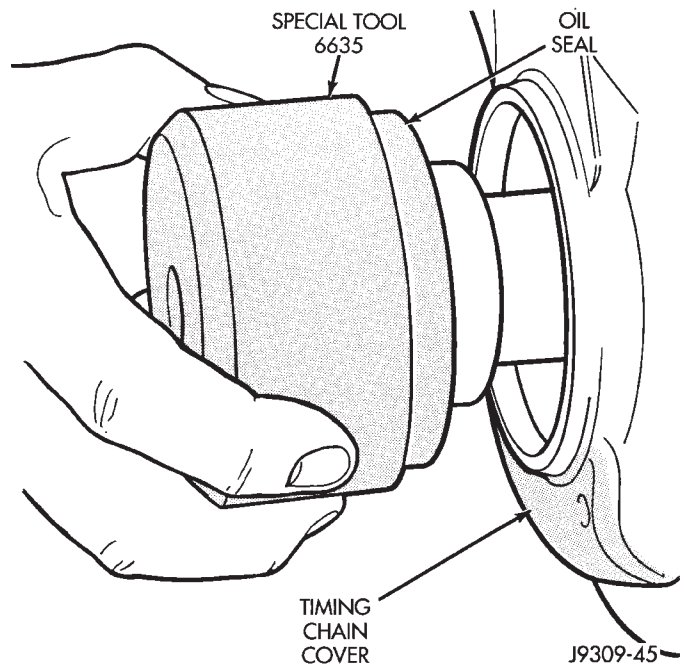


Fig. 43 Position Tool and Seal onto Crankshaft

(7) Connect the negative cable to the battery.

CRANKSHAFT REAR OIL SEALS

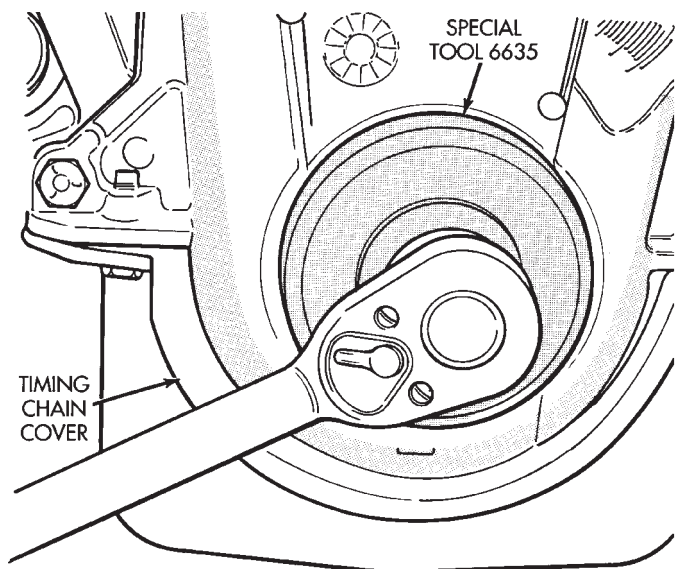
The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

(1) Remove the crankshaft. Discard the old upper seal.

REMOVAL AND INSTALLATION (Continued)



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Fig. 44 Installing Oil Seal**INSTALLATION**

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

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

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

(4) Position the crankshaft into the cylinder block.

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

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

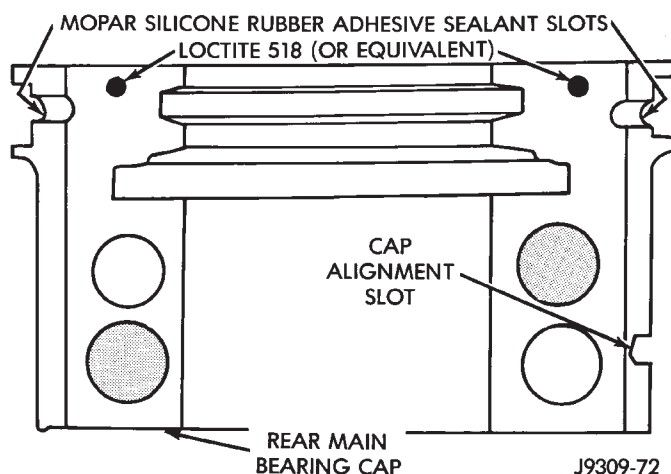
(7) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(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.

(11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing (Fig. 46). Apply enough sealant so that a small amount is



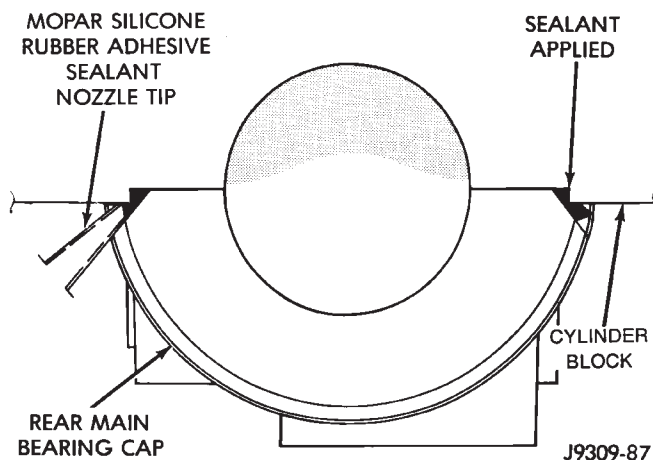
J9309-72

Fig. 45 Sealant Application to Bearing Cap

squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Install new front crankshaft oil seal.

(13) Immediately install the oil pan.



J9309-87

Fig. 46 Apply Sealant to Bearing Cap-to-Block Joint**UPPER SEAL—CRANKSHAFT INSTALLED****REMOVAL**

(1) Remove the oil pan.

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

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

(4) Carefully remove and discard the old upper oil seal.

INSTALLATION

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

(2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at

REMOVAL AND INSTALLATION (Continued)

least the two main bearing caps forward of the rear bearing cap.

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

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

(5) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

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

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

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 46). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

(1) Remove the oil pan.

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

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

INSTALLATION

(1) Clean the rear main cap mating surfaces including the oil pan gasket groove.

(2) Carefully install a new upper seal. Refer to Upper Seal Replacement — Crankshaft Installed procedure above.

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

(4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.

(5) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). 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.

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

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 47). This will reduce internal leakage and help maintain higher oil pressure at idle.

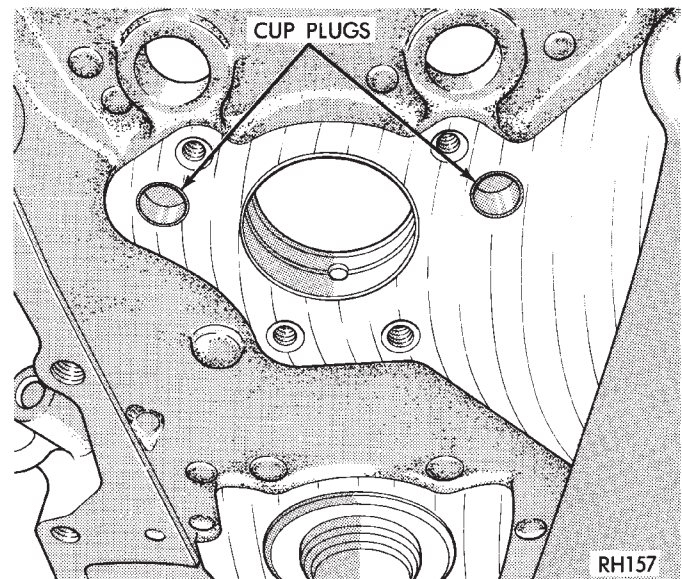


Fig. 47 Location of Cup Plugs in Oil Galleries

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 48).

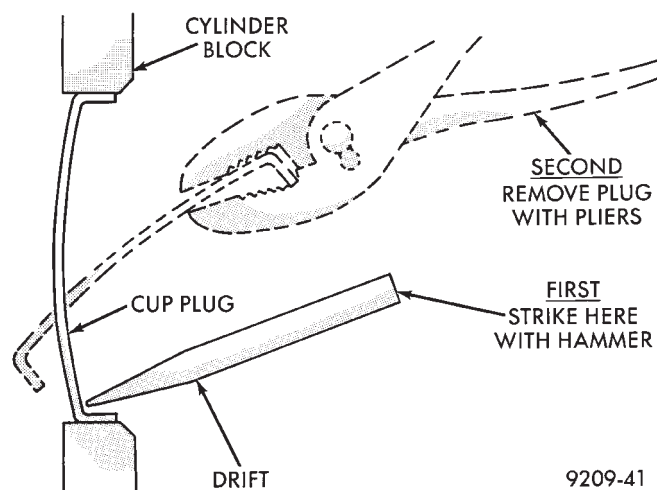
(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 48).

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Be certain the new plug is cleaned of all oil or grease.

REMOVAL AND INSTALLATION (Continued)

**Fig. 48 Core Hole Plug Removal**

(1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting, as restricted coolant flow can result and cause serious engine problems.

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 in.) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

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

DISASSEMBLE

(1) Pry out plunger retainer spring clip (Fig. 49).
 (2) Clean varnish deposits from inside of tappet body above plunger cap.

(3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer, and plunger spring (Fig. 49). Check valve could be flat or ball.

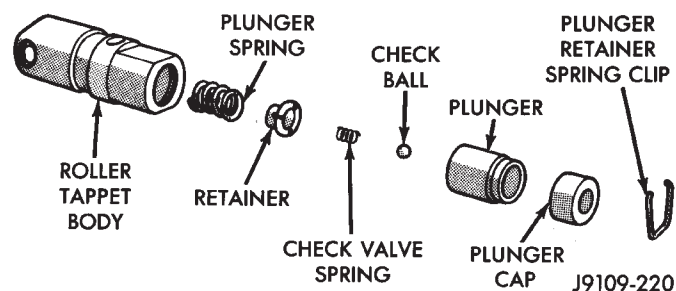
ASSEMBLE

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

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

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

(4) Assemble tappets (Fig. 49).

**Fig. 49 Hydraulic Tappet Assembly**

VALVES, GUIDES AND SPRINGS

VALVE CLEANING

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

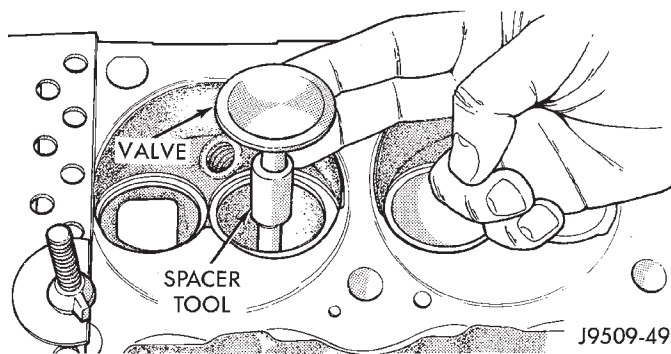
Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

VALVE GUIDES

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

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 50). The special sleeve places the valve at the correct height for checking with a dial indicator.

**Fig. 50 Positioning Valve with Tool C-3973**

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 51).

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

DISASSEMBLY AND ASSEMBLY (Continued)

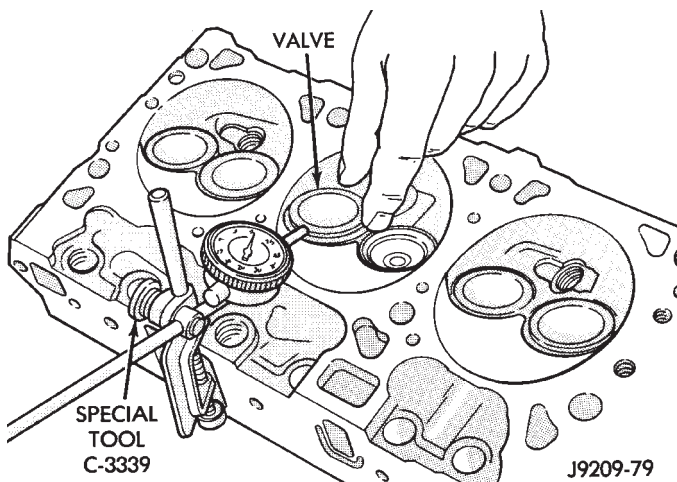


Fig. 51 Measuring Valve Guide Wear

VALVE GUIDES

Service valves with oversize stems are available (Fig. 52).

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

J9309-30

Fig. 52 Reamer Sizes

(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

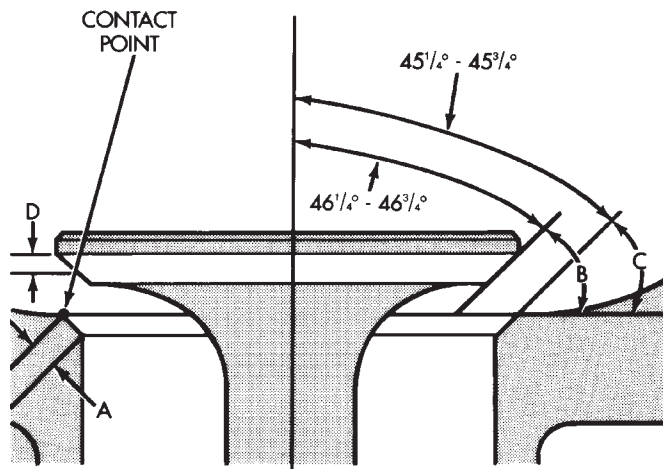
The intake and exhaust valves have a $43\frac{1}{4}^{\circ}$ to $43\frac{3}{4}^{\circ}$ face angle and a $44\frac{1}{4}^{\circ}$ to $44\frac{3}{4}^{\circ}$ seat angle (Fig. 53).

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 54). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

VALVE SEATS

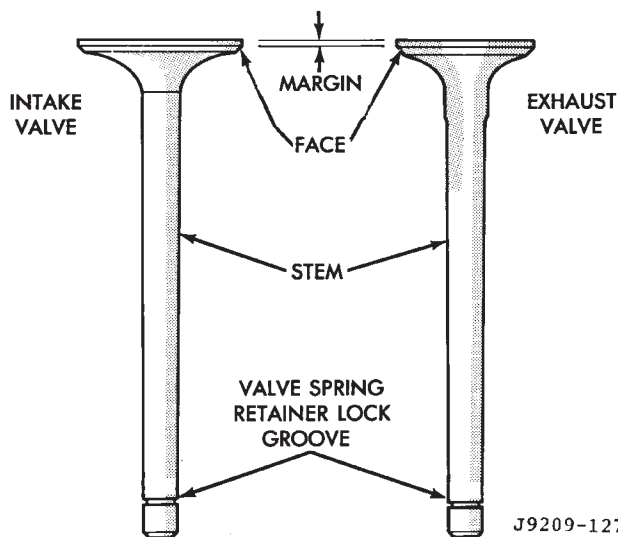
CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 55).



- A - SEAT WIDTH - INTAKE 1.016 – 1.524 mm (0.040 – 0.060 in.)
EXHAUST 1.524 – 2.032 mm (0.060 – 0.080 in.)
B - FACE ANGLE (INTAKE & EXHAUST) $43\frac{1}{4}^{\circ}$ – $43\frac{3}{4}^{\circ}$
C - SEAT ANGLE (INTAKE & EXHAUST) $44\frac{1}{4}^{\circ}$ – $44\frac{3}{4}^{\circ}$
D - CONTACT SURFACE

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Fig. 53 Valve Face and Seat Angles



J9209-127

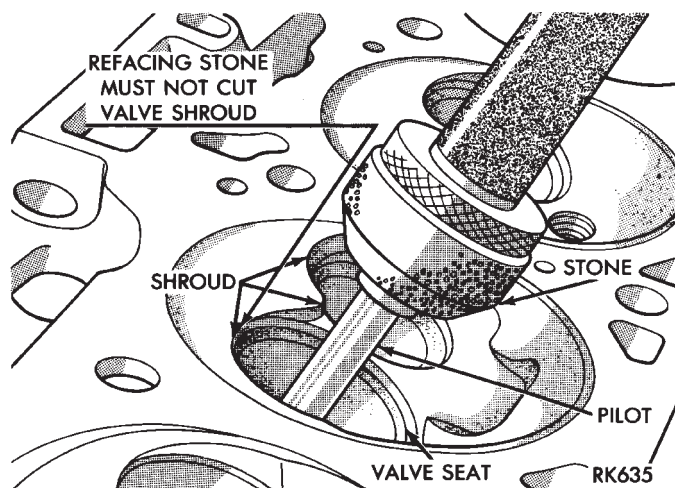
Fig. 54 Intake and Exhaust Valves

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

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

(3) Inspect the valve seat with Prussian blue, to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light 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

DISASSEMBLY AND ASSEMBLY (Continued)

**Fig. 55 Refacing Valve Seats**

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. 56). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

OIL PUMP**DISASSEMBLE**

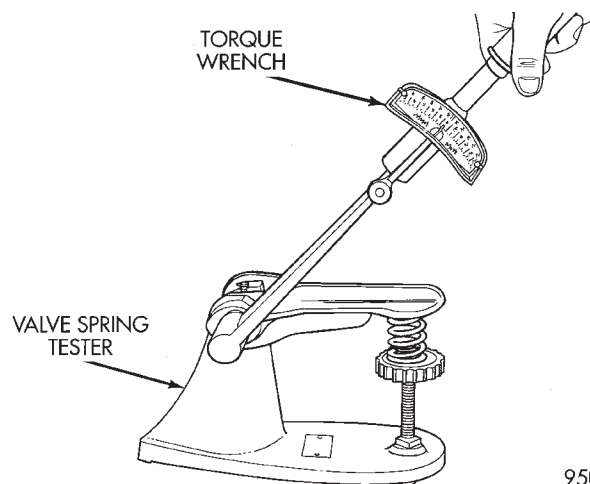
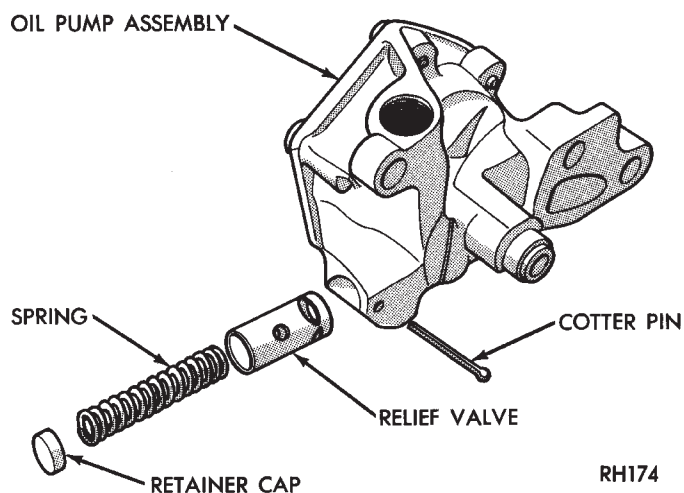
(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 in.) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.

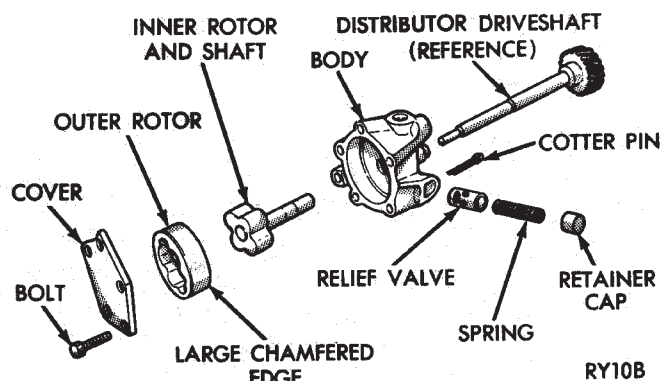
(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 57).

(2) Remove oil pump cover (Fig. 58).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 58).

**Fig. 56 Testing Valve Spring for Compressed Length****Fig. 57 Oil Pressure Relief Valve**

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

**Fig. 58 Oil Pump****ASSEMBLE**

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

DISASSEMBLY AND ASSEMBLY (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.

CYLINDER BLOCK

DISASSEMBLE

Engine assembly removed from vehicle:

(1) Remove the cylinder head.

(2) Remove the oil pan.

(3) Remove the piston and connecting rod assemblies.

ASSEMBLE

(1) Install the piston and connecting rod assembly.

(2) Install the oil pan.

(3) Install the cylinder head.

(4) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEAD COVER

CLEANING

Clean cylinder head cover gasket surface.

Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

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

CYLINDER HEAD

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 in./in.) times the span length in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE:—A 305 mm (12 in.) span is 0.102 mm (0.004 in.) out-of-flat. The allowable out-of-flat is 305 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).

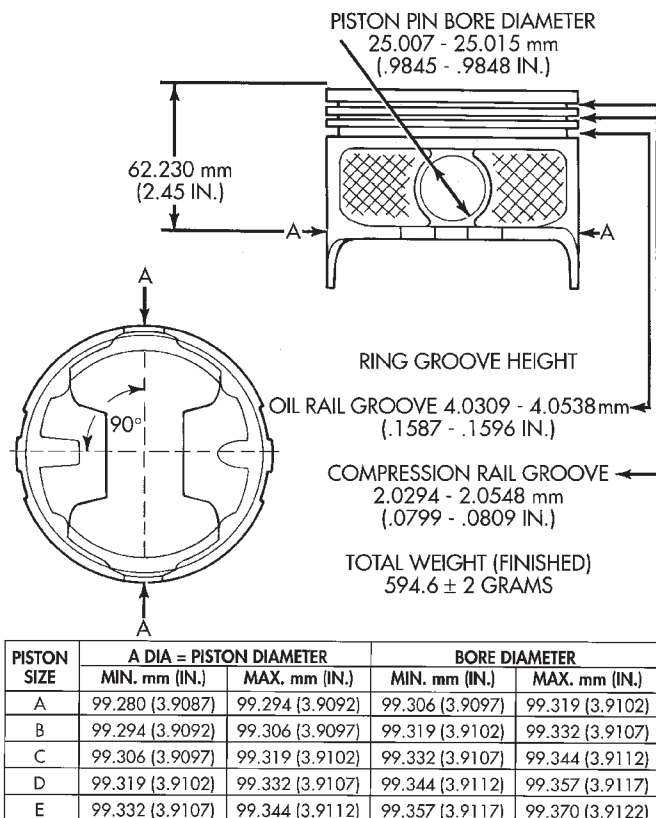
Inspect push rods. Replace worn or bent rods.

PISTON AND CONNECTING ROD INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 59).



J9509-80

Fig. 59 Piston Measurements

CRANKSHAFT INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper or scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 in.).

Journal grinding should not exceed 0.305 mm (0.012 in.) under the standard journal diameter. DO NOT grind thrust faces of No. 2 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction that the engine rotates.

CLEANING AND INSPECTION (Continued)

OIL PUMP

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

INSPECTION

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

Lay a straightedge across the pump cover surface (Fig. 60). If a 0.038 mm (0.0015 in.) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

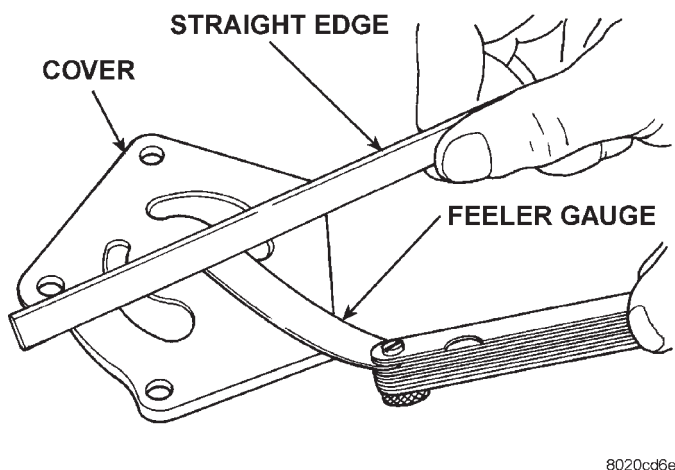


Fig. 60 Checking Oil Pump Cover Flatness

Measure thickness and diameter of outer rotor. If outer rotor thickness measures 20.9 mm (0.825 in.) or less, or if the diameter is 62.7 mm (2.469 in.) or less, replace outer rotor (Fig. 61).

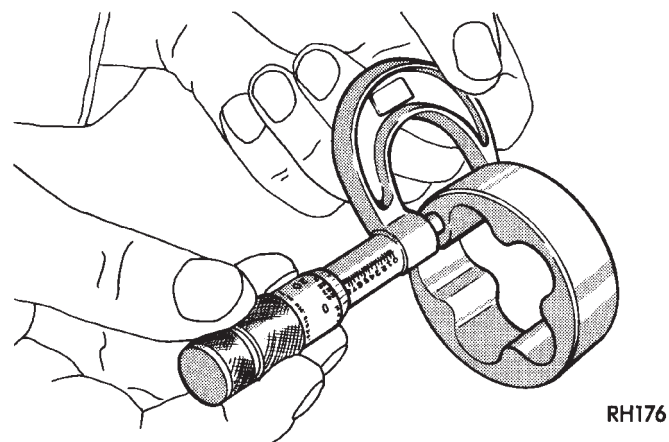


Fig. 61 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 in.) or less, replace inner rotor and shaft assembly (Fig. 62).

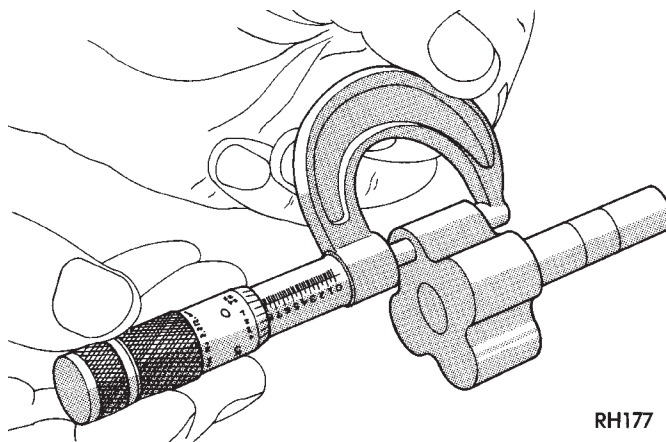


Fig. 62 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 63). If clearance is 0.356 mm (0.014 in.) or more, replace oil pump assembly.

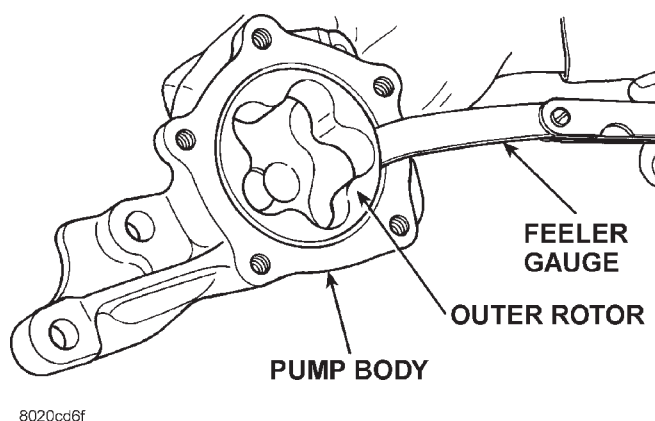


Fig. 63 Measuring Outer Rotor Clearance in Housing

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 in.) or more, replace shaft and both rotors (Fig. 64).

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 65).

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 in.). The spring should test between 19.5 and 20.5 pounds when compressed to

CLEANING AND INSPECTION (Continued)

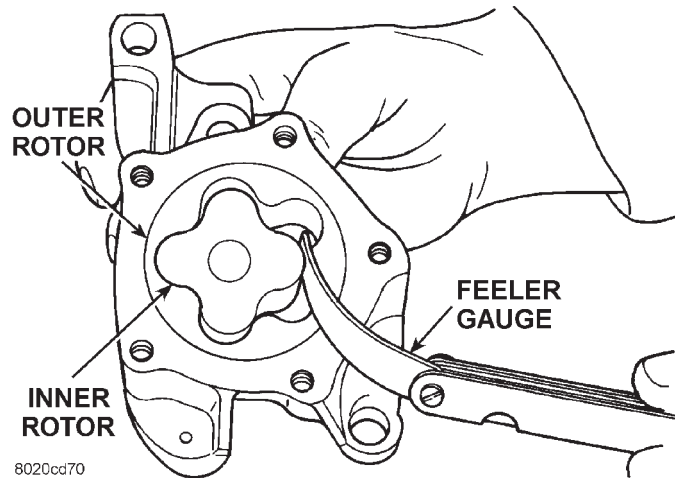


Fig. 64 Measuring Clearance Between Rotors

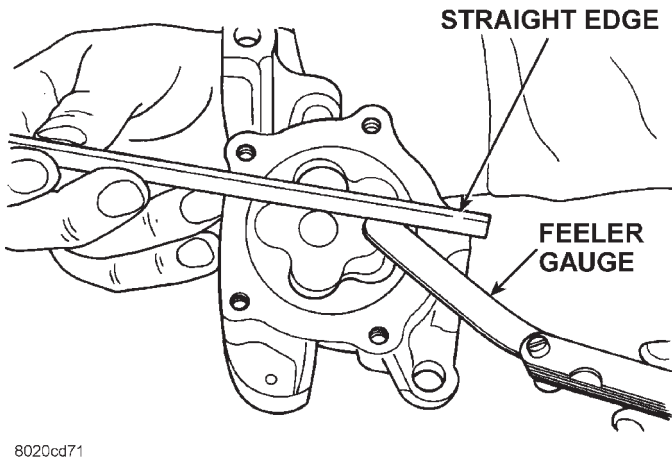


Fig. 65 Measuring Clearance Over Rotors

34 mm (1-11/32 in.). Replace spring that fails to meet these specifications (Fig. 66).

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

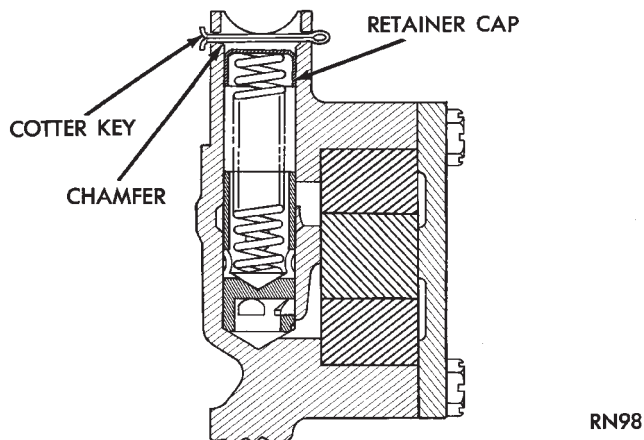


Fig. 66 Proper Installation of Retainer Cap

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

CYLINDER BLOCK

CLEANING

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

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

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

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

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and oil-from-filter passages (Fig. 67). Improper installation or plug missing could cause erratic, low, or no oil pressure.

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

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 67).

CLEANING AND INSPECTION (Continued)

If plug is too high, use a suitable flat dowel to position properly.

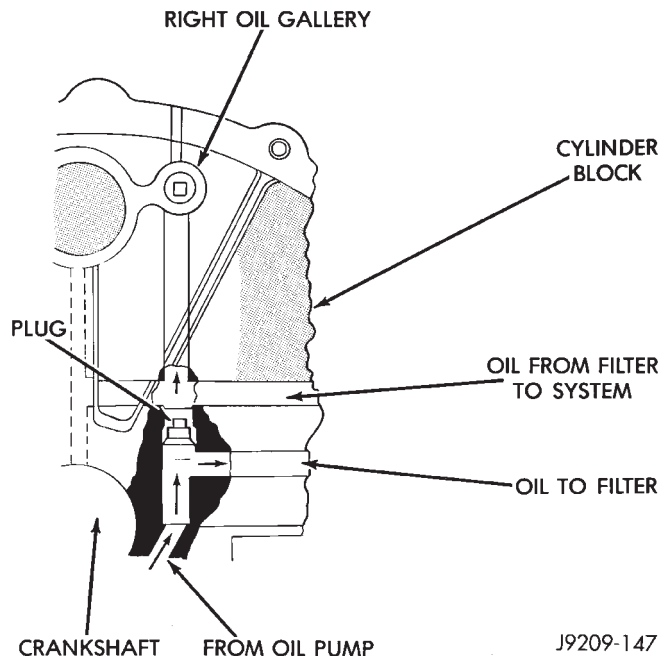


Fig. 67 Oil Line Plug

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

SPECIFICATIONS

3.9L ENGINE SPECIFICATIONS

GENERAL INFORMATION

Engine Type	.90° V-6 OHV
Bore and Stroke	.99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement	.3.9L (238 c.i.)
Compression Ratio	.9.1:1
Firing Order	.1-6-5-4-3-2
Lubrication	.Pressure Feed - Full Flow Filtration
Cooling System	.Liquid Cooled - Forced Circulation
Cylinder Block	.Cast Iron
Cylinder Head	.Cast Iron
Crankshaft	.Nodular Iron
Camshaft	.Nodular Cast Iron
Combustion Chambers	.“Fast Burn” Design
Pistons	.Aluminum Alloy w/strut

Engine Type	.90° V-6 OHV
Connecting Rods	.Forged Steel
Combustion Pressure (Min.)	.689.5 kPa (100 psi)

CAMSHAFT

Bearing Diameter (Inside)

No. 1	.50.800 – 50.825 mm (2.000 – 2.001 in.)
No. 2	.50.394 – 50.419 mm (1.984 – 1.985 in.)
No. 3	.49.606 – 49.632 mm (1.953 – 1.954 in.)
No. 4	.39.688 – 39.713 mm (1.5265 – 1.5635 in.)

Journal Diameter

No. 1	.50.749 – 50.775 mm (1.998 – 1.999 in.)
No. 2	.50.343 – 50.368 mm (1.982 – 1.983 in.)
No. 3	.49.555 – 49.581 mm (1.951 – 1.952 in.)
No. 4	.39.637 – 39.662 mm (1.5605 – 1.5615 in.)

Bearing to Journal Clearance

Standard	.0.0254 – 0.0762 mm (0.001 – 0.003 in.)
----------	--

Max. Allowable	.0.127 mm (0.005 in.)
----------------	-----------------------

Camshaft End Play

End Play	.0.051 – 0.254 mm (0.002 – 0.010 in.)
----------	--

CONNECTING RODS

Piston Pin Bore Diameter	.24.940 – 24.978 mm (0.9819 – 0.9834 in.)
Side Clearance (Two Rods)	.0.152 – 0.356 mm (0.006 – 0.014 in.)
Total Weight	.726 grams (25.61 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	.0.013 – 0.056 mm (0.0005 – 0.0022 in.)
Service Limit	.0.08 mm (0.003 in.)

Main Journal

Diameter	.63.487 – 63.513 mm (2.4995 – 2.5005 in.)
Out of Round (Max.)	.0.0254 mm (0.001 in.)
Taper (Max.)	.0.0254 mm (0.001 in.)
Bearing Clearance (#1)	.0.013 – 0.038 mm (0.0005 – 0.0015 in.)
Bearing Clearance (#2-4)	.0.013 – 0.051 mm (0.0005 – 0.0020 in.)
Service Limit	.0.064 mm (0.0025 in.)

Crankshaft End Play

End Play	.0.051 – 0.178 mm (0.002 – 0.007 in.)
Service Limit	.0.254 mm (0.010 in.)

SPECIFICATIONS (Continued)

CYLINDER BLOCK**Cylinder Bore**

Diameter 99.314 – 99.365 mm
(3.910 – 3.912 in.)

Out of Round (Max.) 0.127 mm (0.005 in.)

Taper (Max.) 0.254 mm (0.010 in.)

Oversize Limit 1.016 mm (0.040 in.)

Lifter Bore

Diameter 22.99 – 23.01 mm
(0.9501 – 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)

CYLINDER HEAD AND VALVES**Valve Seat**

Angle 44.25° – 44.75°

Runout (Max.) 0.0762 mm (0.003 in.)

Width (Finish) – Intake 1.016 – 1.542 mm
(0.040 – 0.060 in.)

Width (Finish) – Exhaust 1.524 – 2.032 mm
(0.060 – 0.080 in.)

Valve

Face Angle 43.25° – 43.75°

Head Diameter – Intake 48.666 mm (1.916 in.)

Head Diameter – Exhaust 41.250 mm (1.624 in.)

Length (Overall) – Intake 124.28 – 125.92 mm
(4.893 – 4.918 in.)

Length (Overall) – Exhaust 124.64 – 125.27 mm
(4.907 – 4.932 in.)

Lift (@ zero lash) 10.973 mm (0.432 in.)

Stem Diameter 7.899 – 7.925 mm
(0.311 – 0.312 in.)

Guide Bore Diameter 7.950 – 7.976 mm
(0.313 – 0.314 in.)

Stem to Guide Clearance 0.0254 – 0.0762 mm
(0.001 – 0.003 in.)

Service Limit (Rocking Method) 0.4318 mm
(0.017 in.)

Valve Spring

Free Length 49.962 mm (1.967 in.)

Spring Tension (valve closed) . . . 378 N @ 41.66 mm
(85 lbs. @ 1.64 in.)

Spring Tension (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 in Block 0.0279 – 0.0610 mm
(0.0011 – 0.0024 in.)

Dry Lash 1.524 – 5.334 mm
(0.060 – 0.210 in.)

Push rod Length 175.64 – 176.15 mm
(6.915 – 6.935 in.)

OIL PRESSURE

@ Curb Idle (Min.)* 41.4 kPa (6 psi)

@ 3000 rpm 207 – 552 kPa (30 – 80 psi)

Bypass Valve Setting 62 – 103 kPa (9 – 15 psi)

Switch Actuating Pressure 34.5 – 48.3 kPa
(5 – 7 psi)

CAUTION: 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.)

Outer Rotor Diameter (Min.) 62.7126 mm
(2.469 in.)

Outer Rotor Thickness (Min.) 20.955 mm
(0.825 in.)

Tip Clearance between Rotors (Max.) . . . 0.2032 mm
(0.008 in.)

PISTONS

Clearance at Top of Skirt 0.0127 – 0.0381 mm
(0.0005 – 0.0015 in.)

Land Clearance (Diam.) 0.635 – 1.016 mm
(0.025 – 0.040 in.)

Piston Length 86.360 mm (3.40 in.)

Ring Groove Depth (#1&2) 4.572 – 4.826 mm
(0.180 – 0.190 in.)

Ring Groove Depth (#3) 3.810 – 4.064 mm
(0.150 – 0.160 in.)

Weight 592.6 – 596.6 grams
(20.90 – 21.04 oz.)

SPECIFICATIONS (Continued)

PISTON PINS

Clearance in Piston	.00064 – 0.0191 mm (0.00025 – 0.00075 in.)
Clearance in Rod (Interference)	.00178 – 0.0356 mm (0.0007 – 0.0014 in.)
Diameter	.24.996 – 25.001 mm (0.9841 – 0.9843 in.)
End Play	NONE
Length	.75.946 – 76.454 mm (2.990 – 3.010 in.)

PISTON RINGS**Ring Gap**

Compression Rings	.0.254 – 0.508 mm (0.010 – 0.020 in.)
Oil Control (Steel Rails)	.0.254 – 1.270 mm (0.010 – 0.050 in.)

Ring Side Clearance

Compression rings	.0.038 – 0.076 mm (0.0015 – 0.0030 in.)
Oil Control (Steel Rails)	.0.06 – 0.21 mm (0.002 – 0.008 in.)

Ring Width

Compression Rings	.1.971 – 1.989 mm (0.0776 – 0.0783 in.)
Oil Control (Steel Rails)	.3.848 – 3.975 mm (0.1515 – 0.1565 in.)

VALVE TIMING**Exhaust Valve**

Closes (ATDC)	.16°
Opens (BBDC)	.52°
Duration	.248°

Intake Valve

Closes (ABDC)	.50°
Opens (BTDC)	.10°
Duration	.240°
Valve Overlap	.26°

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Milled flat on no. 8 crankshaft counterweight.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	♦	Diamond-shaped stamp top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

SPECIFICATIONS (Continued)

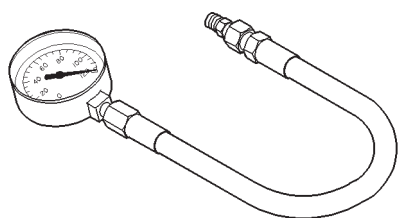
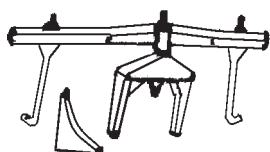
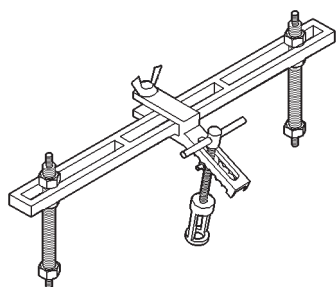
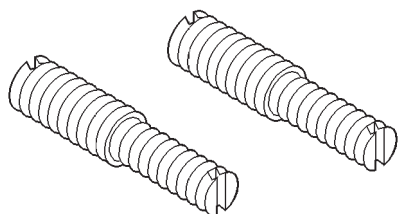
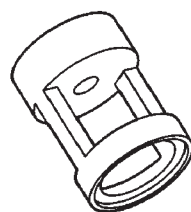
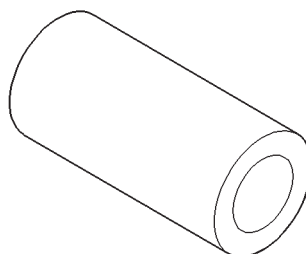
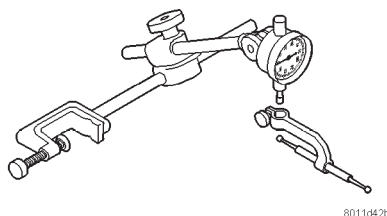
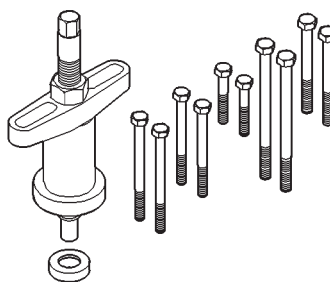
TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
Camshaft	
Bolt . . . . .	.68 N·m (50 ft. lbs.)
Camshaft Thrust Plate	
Bolts . . . . .	.24 N·m (210 in. lbs.)
Chain Case Cover	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Connecting Rod Cap	
Bolts . . . . .	.61 N·m (45 ft. lbs.)
Crankshaft Main Bearing Cap	
Bolts . . . . .	.115 N·m (85 ft. lbs.)
Crankshaft Pulley	
Bolts . . . . .	.24 N·m (210 in. lbs.)
Cylinder Head	
Bolts (1st Step) . . . . .	.68 N·m (50 ft. lbs.)
Bolts (2nd Step) . . . . .	.143 N·m (105 ft. lbs.)
Cylinder Head Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Engine Support Bracket to Block (4wd)	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Exhaust Manifold-to-Cylinder Head	
Bolts/Nuts . . . . .	.34 N·m (25 ft. lbs.)
Flywheel	
Bolts . . . . .	.75 N·m (55 ft. lbs.)
Front Insulator (All)	
Through bolt/nut . . . . .	.95 N·m (70 ft. lbs.)
Front Insulator to Support Bracket (4wd)	
Stud nut . . . . .	.41 N·m (30 ft. lbs.)
Through bolt/nut . . . . .	.102 N·m (75 ft. lbs.)
Front Insulator to Block (2wd)	
Bolts . . . . .	.95 N·m (70 ft. lbs.)
Generator	
Mounting Bolt . . . . .	.41 N·m (30 ft. lbs.)
Intake Manifold	
Bolts . . . . .	.Refer to R & I Procedure
Oil Pan	
Bolts . . . . .	.24 N·m (215 in. lbs.)
Oil Pan	
Drain Plug . . . . .	.34 N·m (25 ft. lbs.)

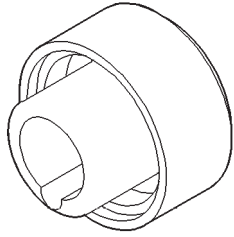
DESCRIPTION	TORQUE
Oil Pump	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Rear Insulator-to-Bracket (2WD)	
Through-Bolt . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Crossmember Support Bracket (2WD)	
Nut . . . . .	.41 N·m (30 ft. lbs.)
Rear Insulator-to-Crossmember (4WD)	
Nuts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Transmission (4WD)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket (4WD Automatic)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Support Bracket-to-Crossmember Flange	
Nuts . . . . .	.41 N·m (30 ft. lbs.)
Rear Support Plate-to-Transfer Case	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Rocker Arm	
Bolts . . . . .	.28 N·m (21 ft. lbs.)
Spark Plugs	
All . . . . .	.41 N·m (30 ft. lbs.)
Starter Motor	
Mounting Bolts . . . . .	.68 N·m (50 ft. lbs.)
Thermostat Housing	
Bolts . . . . .	.25 N·m (225 in. lbs.)
Throttle Body	
Bolts . . . . .	.23 N·m (200 in. lbs.)
Torque Converter Drive Plate	
Bolts . . . . .	.31 N·m (270 in. lbs.)
Transfer Case-to-Insulator Mounting Plate	
Nuts . . . . .	.204 N·m (150 ft. lbs.)
Transmission Support Bracket (2WD)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Vibration Damper	
Retainer Bolt . . . . .	.183 N·m (135 ft. lbs.)
Water Pump-to-Chain Case Cover	
Bolt . . . . .	.41 N·m (30 ft. lbs.)

SPECIAL TOOLS

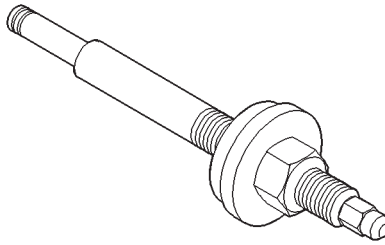
3.9L ENGINE

***Oil Pressure Gauge C-3292******Engine Support Fixture C-3487-A******Valve Spring Compressor MD-998772-A******Adapter 6633******Adapter 6716A******Valve Guide Sleeve C-3973******Dial Indicator C-3339******Puller C-3688***

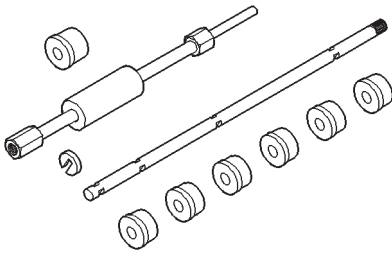
SPECIAL TOOLS (Continued)



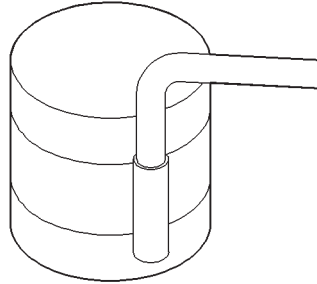
Front Oil Seal Installer 6635



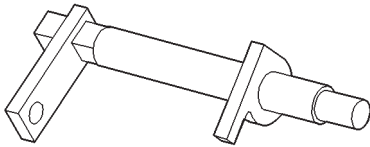
Distributor Bushing Driver/Burnisher C-3053



Cam Bearing Remover/Installer C-3132-A

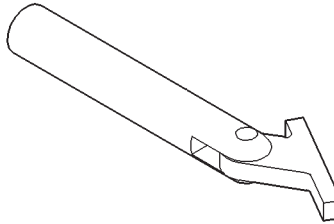


Piston Ring Compressor C-385

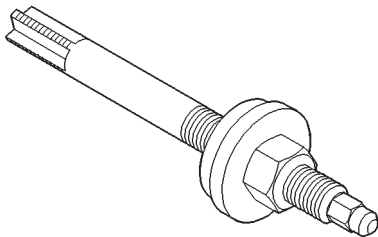


c-3509-8011d343

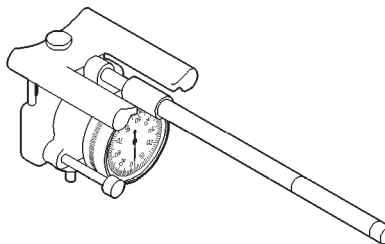
Camshaft Holder C-3509



Crankshaft Main Bearing Remover C-3059



Distributor Bushing Puller C-3052



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Cylinder Bore Gauge C-119

5.2L ENGINE

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GENERAL INFORMATION

VALVES AND VALVE SPRINGS

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

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter

across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION/IDENTIFICATION

The 5.2 Liter (318 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.

DESCRIPTION AND OPERATION (Continued)

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).

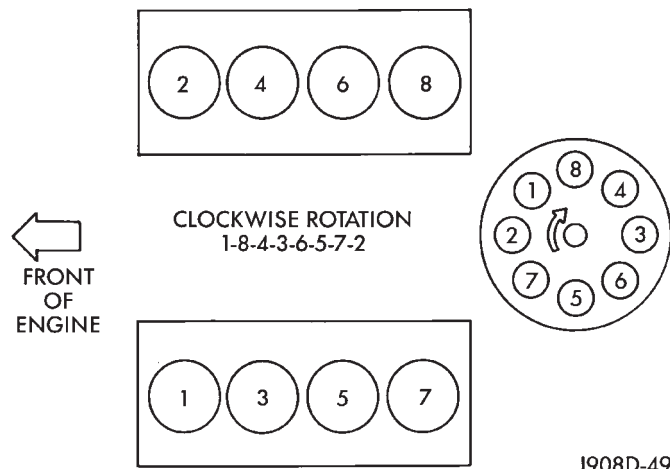


Fig. 1 Firing Order

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).

LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the rear main bearing cap. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears 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 bear-

X M 5.2L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

5.2L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 2 Engine Identification Number

ing, back up to the left side of the block and into the oil gallery on the left side of the engine.

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

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the number one main bearing cap.

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

DESCRIPTION AND OPERATION (Continued)

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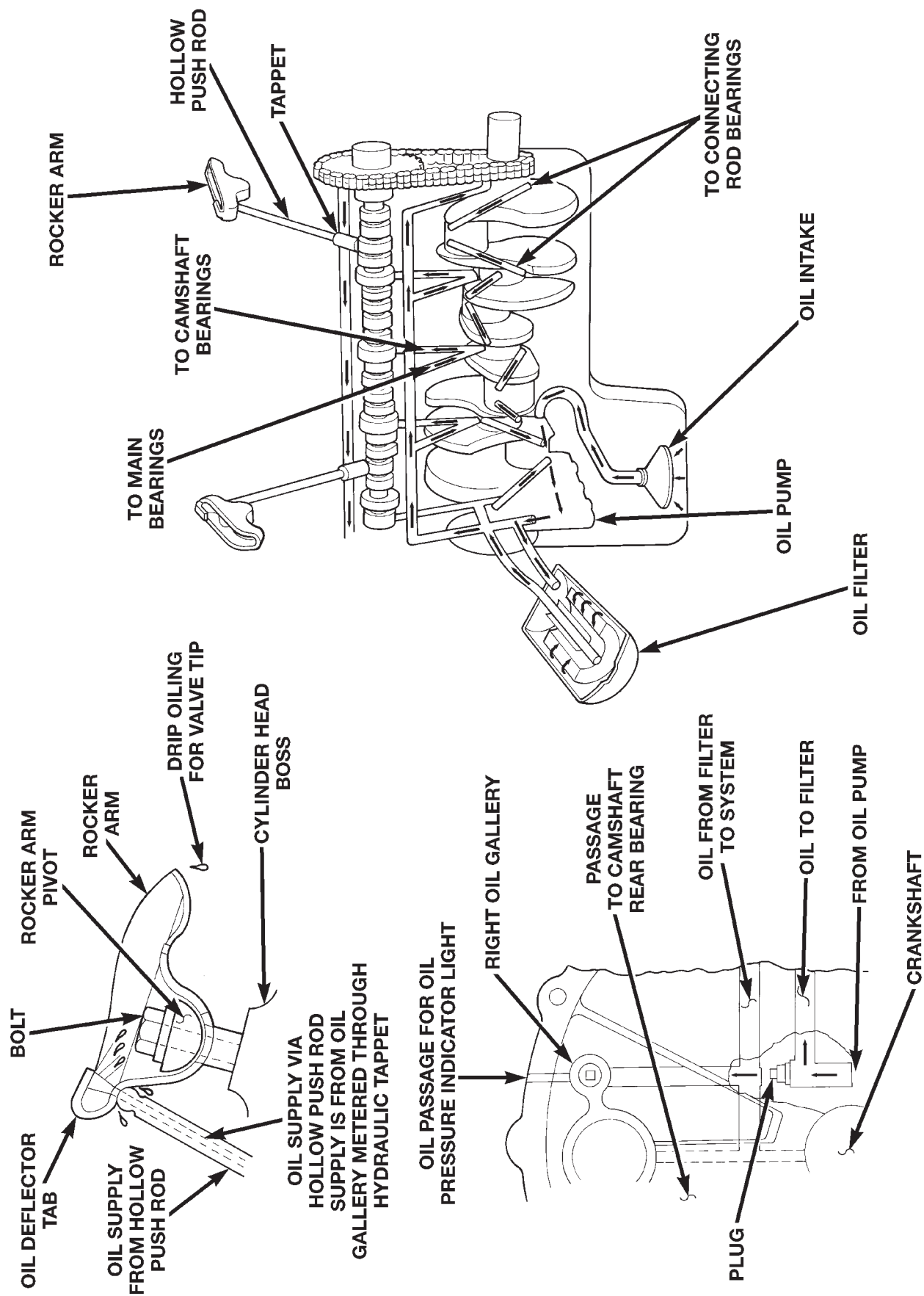


Fig. 3 Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEAD

The alloy cast iron cylinder heads (Fig. 4) are held in place by 10 bolts. The spark plugs are located in the peak of the wedge between the valves.

The 5.2L cylinder head is identified by the foundry mark NH.

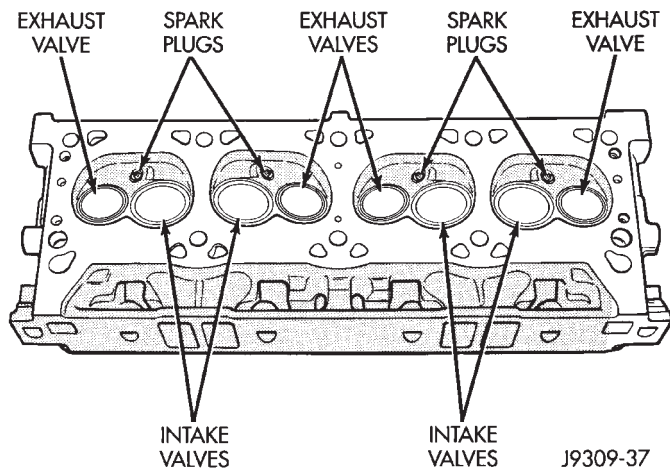


Fig. 4 Cylinder Head Assembly

PISTONS

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

SERVICE PROCEDURES

VALVE TIMING

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

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

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

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should

now read from 10° before top dead center to 2° after top dead center. Remove spacer.

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

If reading is not within specified limits:

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

MEASURING TIMING CHAIN STRETCH

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

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 5).

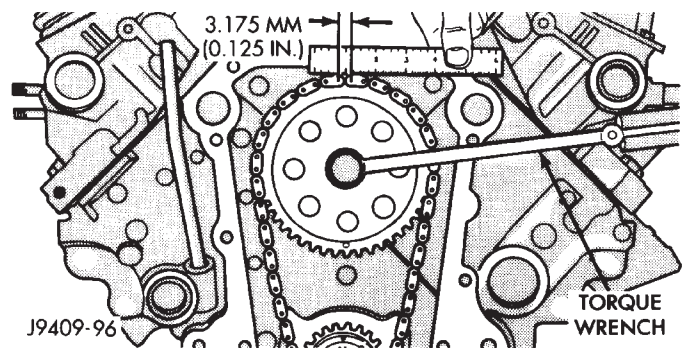


Fig. 5 Measuring Timing Chain Wear and Stretch

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

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

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

(7) Place timing chain around both sprockets.

SERVICE PROCEDURES (Continued)

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

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

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 6).

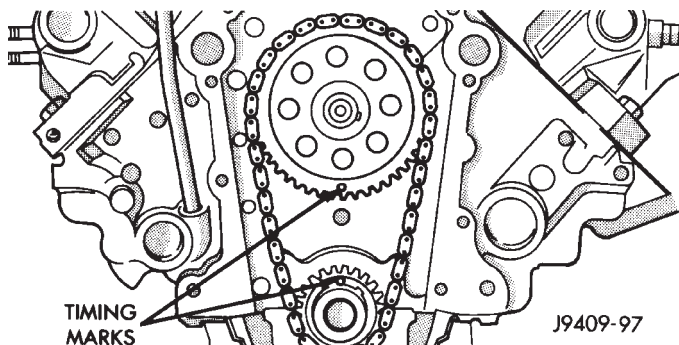


Fig. 6 Alignment of Timing Marks

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

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

FITTING PISTONS

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

Piston diameter should be measured at the top of skirt, 90° to piston pin axis location A in (Fig. 7). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

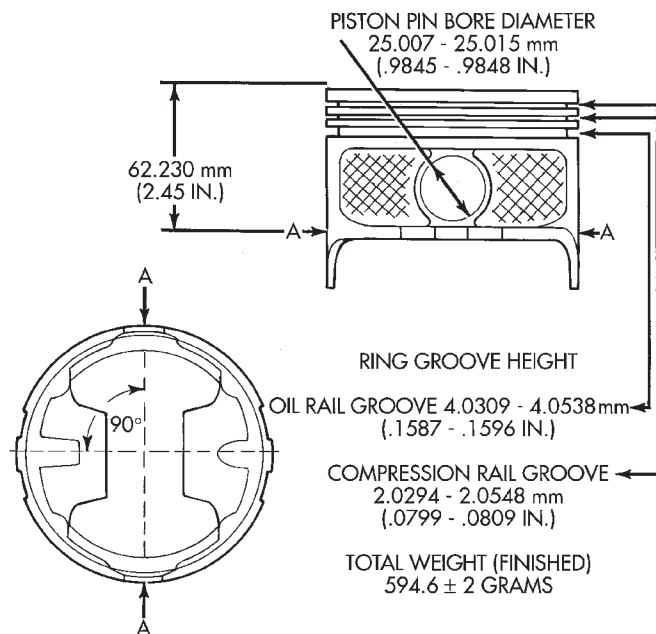
Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

FITTING PISTON RINGS

(1) Measurement of end gaps:

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

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



PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (IN.)	MAX. mm (IN.)	MIN. mm (IN.)	MAX. mm (IN.)
A	99.280 (3.9087)	99.294 (3.9092)	99.306 (3.9097)	99.319 (3.9102)
B	99.294 (3.9092)	99.306 (3.9097)	99.319 (3.9102)	99.332 (3.9107)
C	99.306 (3.9097)	99.319 (3.9102)	99.332 (3.9107)	99.344 (3.9112)
D	99.319 (3.9102)	99.332 (3.9107)	99.344 (3.9112)	99.357 (3.9117)
E	99.332 (3.9107)	99.344 (3.9112)	99.357 (3.9117)	99.370 (3.9122)

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Fig. 7 Piston Measurements

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

(2) Install rings and confirm ring side clearance:

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

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP (Fig. 8) (Fig. 10).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 9) (Fig. 10). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but

SERVICE PROCEDURES (Continued)

should not exceed 0.246 mm (0.0097 inch) side clearance.

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

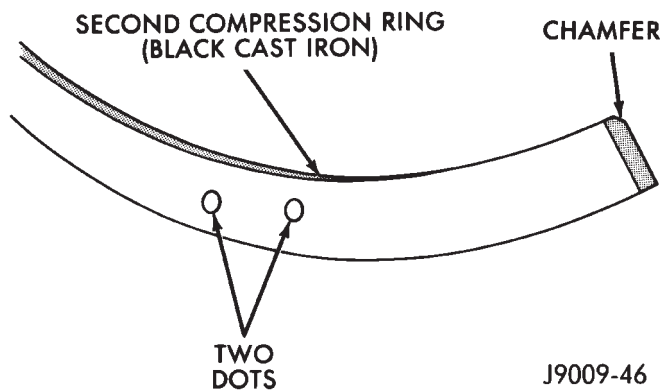


Fig. 8 Second Compression Ring Identification (Typical)

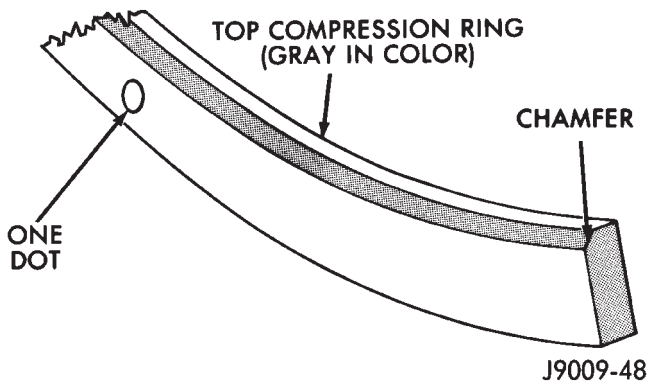


Fig. 9 Top Compression Ring Identification (Typical)

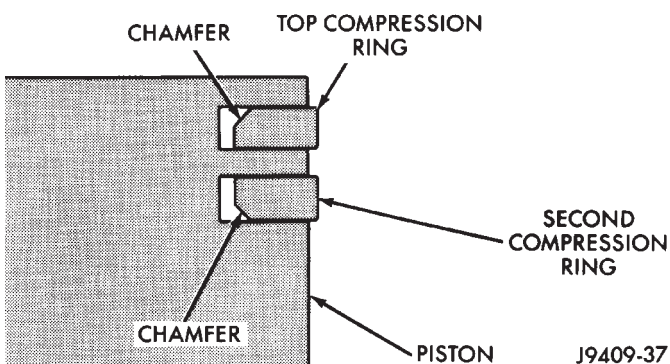


Fig. 10 Compression Ring Chamfer Location (Typical)

FITTING CONNECTING ROD BEARINGS

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

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

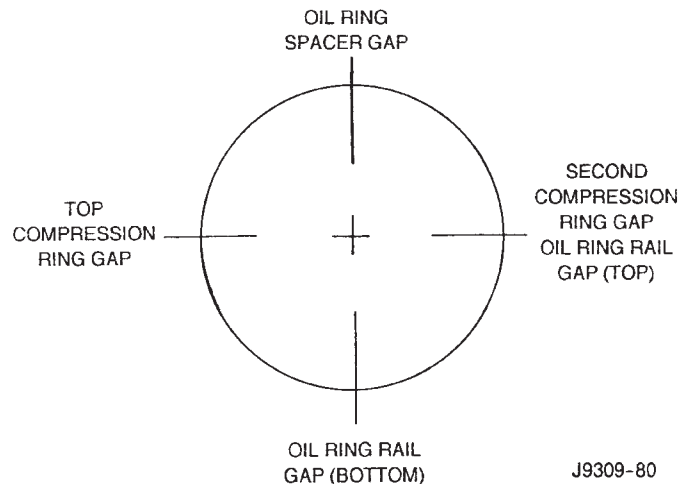


Fig. 11 Proper Ring Installation

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

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

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

CRANKSHAFT MAIN BEARINGS

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

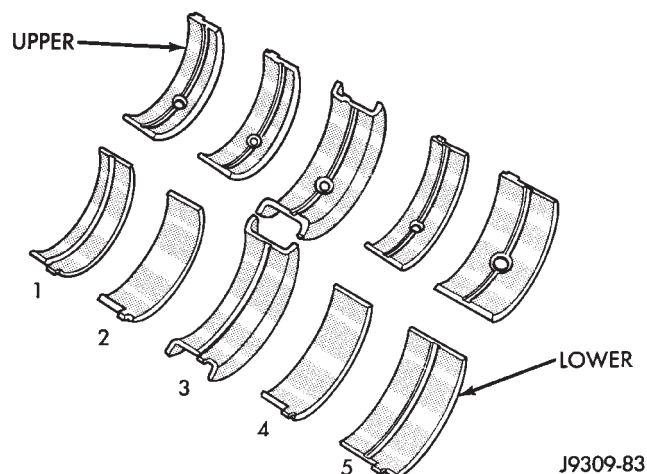
Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 12). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

CRANKSHAFT

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.8 crankshaft counterweight (Fig. 13).

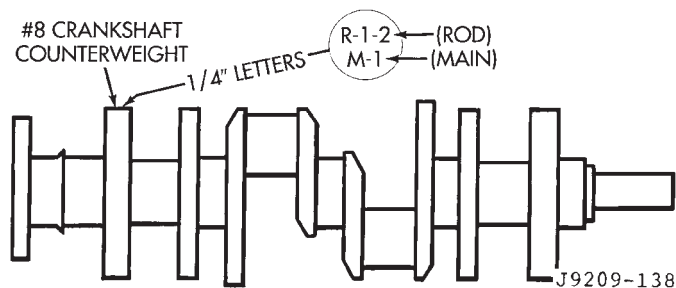
FOR EXAMPLE: R2 stamped on the No.8 crankshaft counterweight indicates that the No.2 rod jour-

SERVICE PROCEDURES (Continued)

**Fig. 12 Main Bearing Identification**

nal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

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

**Fig. 13 Location of Crankshaft Identification**

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

REMOVAL AND INSTALLATION

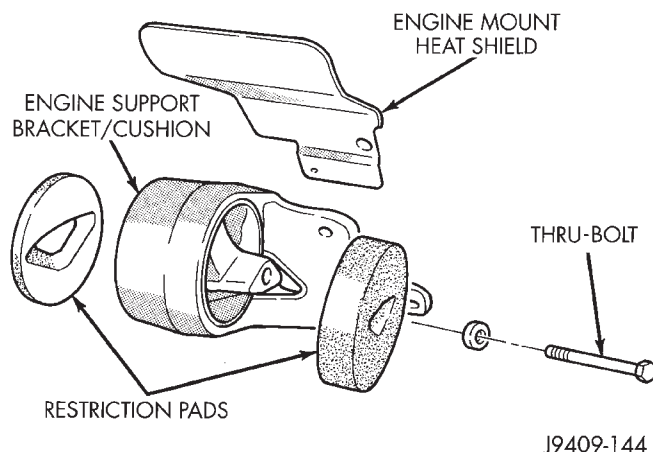
ENGINE MOUNTS—FRONT

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

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

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 14).
- (6) Remove engine support bracket/cushion bolts (Fig. 14). Remove the support bracket/cushion and heat shields.

**Fig. 14 Engine Front Mounts**

INSTALLATION

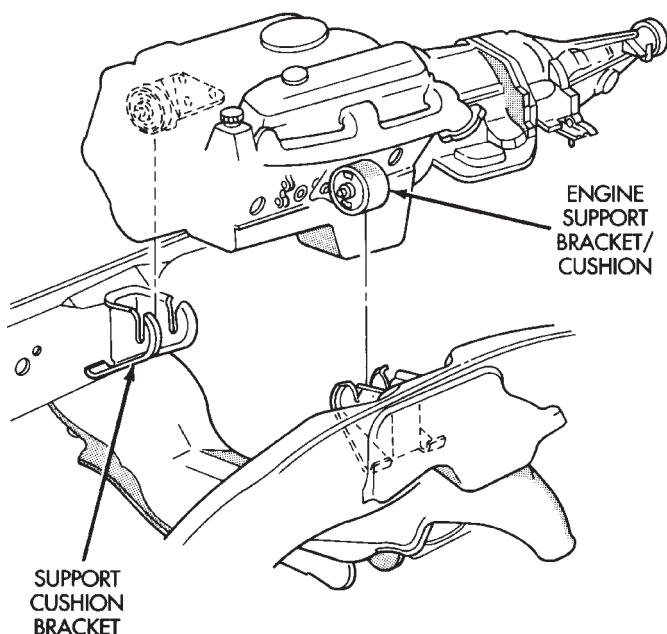
- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion and heat shields to the block. Install new bolts and tighten to 81 N·m (60 ft. lbs.) torque.
- (2) Install the thru-bolt into the engine support bracket/cushion.
- (3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 15).
- (4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Remove lifting fixture.

ENGINE MOUNT—REAR

REMOVAL

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 16).
- (4) Raise rear of transmission and engine SLIGHTLY.
- (5) Remove the bolts holding the support cushion to the transmission support bracket. Remove the support cushion.
- (6) If necessary, remove the bolts holding the transmission support bracket to the transmission.

REMOVAL AND INSTALLATION (Continued)



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Fig. 15 Positioning Engine Front Mounts**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. 16).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Disconnect the battery negative cable.

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

(3) Recover refrigerant from a/c system, if equipped. Refer to Group 24, Heating and Air Conditioning for service procedures.

(4) Remove the a/c condenser, if equipped.

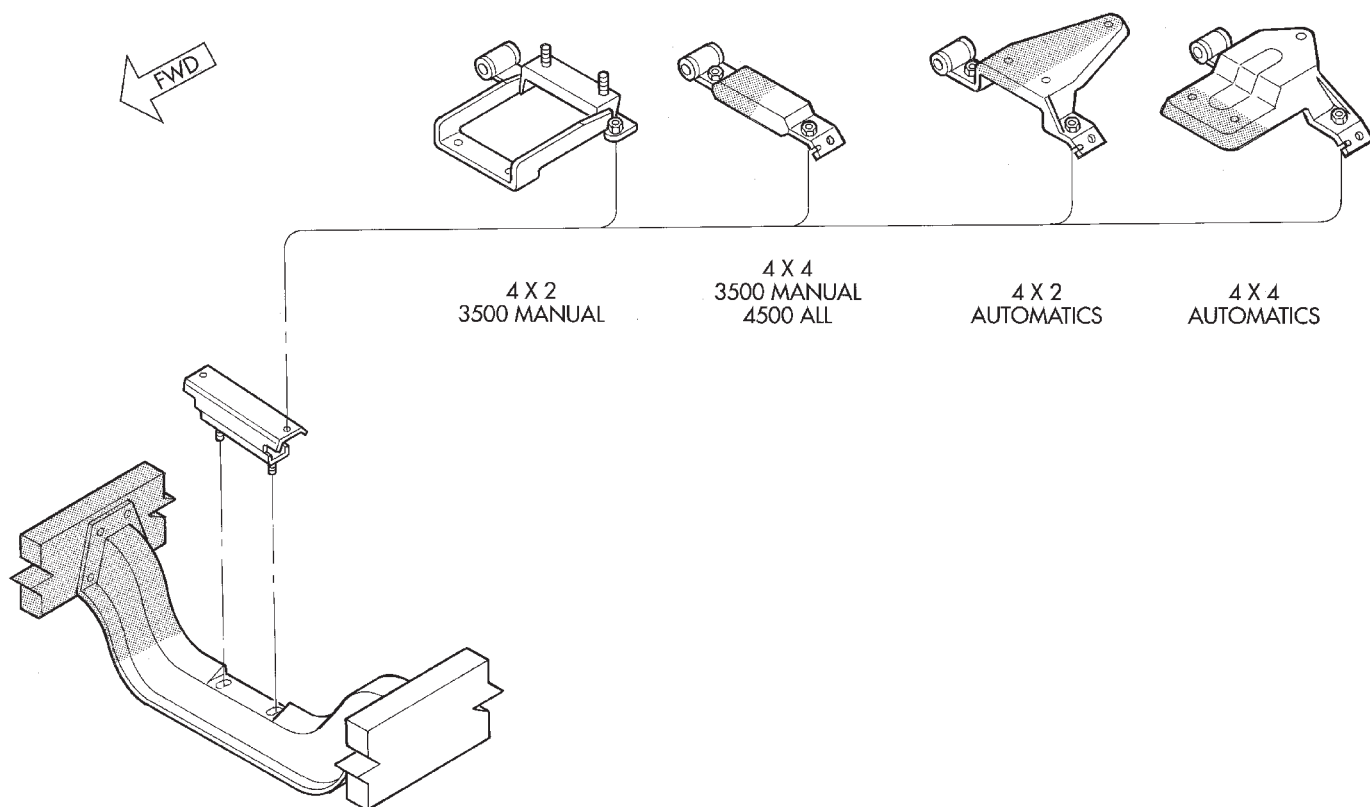
(5) Remove the transmission oil cooler. Refer to Group 7, Cooling for the correct procedure.

(6) Remove the washer bottle from the fan shroud.

(7) Remove the viscous fan/drive.

(8) Disconnect the radiator upper hose from the radiator.

(9) Remove the fan shroud.



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Fig. 16 Engine Rear Support Cushion Assemblies

REMOVAL AND INSTALLATION (Continued)

(10) Disconnect the transmission cooler lines from the radiator.

(11) Disconnect the lower radiator hose at the radiator.

(12) Remove radiator (refer to Group 7, Cooling System).

(13) Remove the upper crossmember and top core support.

(14) Remove the accessory drive belt (refer to Group 7, Cooling System).

(15) Remove the A/C compressor with the lines attached. Secure compressor out of the way.

(16) Remove generator assembly. (refer to Group 8B, Battery/Starter/Generator Service).

(17) Remove the air cleaner resonator and duct work as an assembly.

(18) Disconnect the throttle linkage.

(19) Remove throttle body.

(20) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(21) Remove the distributor cap and wiring.

(22) Disconnect the heater hoses.

(23) Disconnect the power steering hoses, if equipped.

(24) Perform the Fuel System Pressure Release procedure. Refer to Group 14, Fuel System.

(25) Disconnect the fuel supply line. Refer to Group 14, Fuel Systems for the correct procedure..

(26) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(27) Raise and support the vehicle on a hoist and drain the engine oil.

(28) Remove engine front mount thru-bolt nuts.

(29) Disconnect the transmission oil cooler lines from their retainers at the oil pan bolts.

(30) Disconnect exhaust pipe at manifolds.

(31) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(32) Remove the dust shield and transmission inspection cover.

(33) Remove drive plate to converter bolts (Automatic transmission equipped vehicles).

(34) Remove transmission bell housing to engine block bolts.

(35) Lower the vehicle.

(36) Install an engine lifting fixture.

(37) 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.

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

- Manual Transmission: Align clutch disc assembly (if disturbed). Refer to Group 6, Clutch for the correct procedure. 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 Group 8B, Battery/Starter/Generator Service).

(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 Group 21, Transmissions).

(16) Connect the fuel supply line.

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

(18) Connect the heater hoses.

(19) Install the distributor cap and wiring.

(20) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.

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

(22) Connect the throttle linkage.

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

(24) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(25) Install a/c compressor and lines.

(26) Install the accessory drive belt (refer to Group 7, Cooling System).

(27) Install upper radiator support crossmember.

(28) Install radiator (refer to Group 7, Cooling System).

(29) Connect the radiator lower hose.

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

(31) Install the fan shroud.

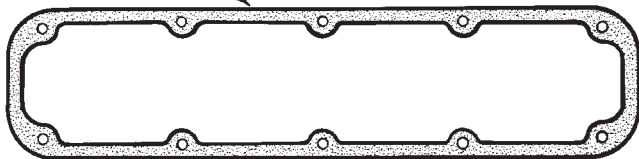
REMOVAL AND INSTALLATION (Continued)

- (32) Install the fan.
- (33) Connect the radiator upper hose.
- (34) Install the washer bottle.
- (35) Install the transmission oil cooler.
- (36) Connect the transmission cooler lines.
- (37) If equipped, install the condenser.
- (38) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
- (39) Add engine oil to crankcase. Refer to Group 0, Lubrication and Maintenance for the correct fill capacity.
- (40) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).
- (41) Connect battery negative cable.
- (42) Start engine and inspect for leaks.
- (43) Road test vehicle.

CYLINDER HEAD COVER

NOTE: A steel backed silicon gasket is used with the cylinder head cover (Fig. 17). This gasket can be used again.

CYLINDER HEAD COVER GASKET



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Fig. 17 Cylinder Head Cover Gasket

REMOVAL

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

CLEANING

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

INSPECTION

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

INSTALLATION

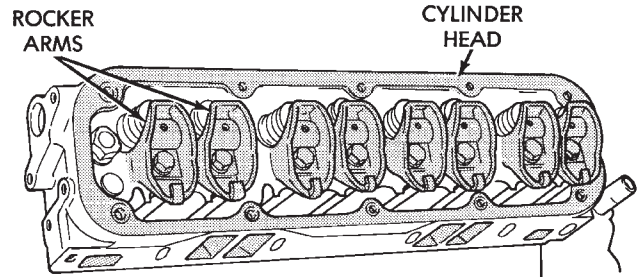
- (1) The cylinder head cover gasket can be used again. Install the gasket onto the head rail.

- (2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install closed crankcase ventilation system and evaporation control system.
- (4) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS

REMOVAL

- (1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (2) Remove cylinder head cover and gasket.
- (3) Remove the rocker arm bolts and pivots (Fig. 18). Place them on a bench in the same order as removed.
- (4) Remove the push rods and place them on a bench in the same order as removed.



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Fig. 18 Rocker Arms

INSTALLATION

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

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

- (4) Install cylinder head cover.
- (5) Connect spark plug wires.

VALVE SPRING AND STEM SEAL REPLACEMENT-IN VEHICLE

- (1) Remove the air cleaner.
- (2) Remove cylinder head covers and spark plugs.
- (3) Remove coil wire from distributor and secure to good ground to prevent engine from starting.

REMOVAL AND INSTALLATION (Continued)

(4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.

(5) Remove rocker arms.

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

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

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

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

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

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

(12) Install rocker arms.

(13) Install covers and coil wire to distributor.

(14) Install air cleaner.

(15) Road test vehicle.

CYLINDER HEADS

REMOVAL

(1) Disconnect the battery negative cable.

(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).

(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 Group 14, Fuel System). Disconnect the fuel supply line.

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

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

(15) Remove exhaust manifolds.

(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.

INSTALLATION

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

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

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

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

(5) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 19). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

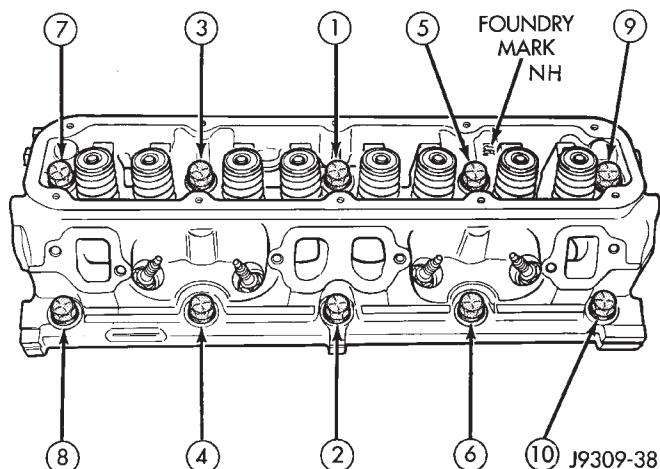


Fig. 19 Cylinder Head Bolt Tightening Sequence

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

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

(7) Install the intake manifold and throttle body assembly (refer to Group 11, Exhaust System and Intake Manifold).

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

(9) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(10) Install coil wire.

REMOVAL AND INSTALLATION (Continued)

- (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.
- (16) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.
- (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. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (19) Install closed crankcase ventilation system.
- (20) Connect the evaporation control system.
- (21) Install the air cleaner.
- (22) Fill cooling system (refer to Group 7, Cooling System for proper procedure).
- (23) Connect the negative cable to the battery.

VALVES AND VALVE SPRINGS

REMOVAL

- (1) Remove the cylinder head. Refer to procedure in this section.
- (2) Compress valve springs using Valve Spring Compressor Tool MD- 998772A and adapter 6716A.
- (3) Remove valve retaining locks, valve spring retainers, valve stem seals and valve springs.
- (4) Before removing valves, remove any burrs from valve stem lock grooves to prevent damage to the valve guides. Identify valves to ensure installation in original location.

INSTALLATION

- (1) Clean valves thoroughly. Discard burned, warped and cracked valves.
- (2) Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
- (3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.
- (4) Coat valve stems with lubrication oil and insert them in cylinder head.
- (5) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.
- (6) Install new seals on all valve guides. Install valve springs and valve retainers.
- (7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of

spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS

REMOVAL

- (1) Remove the air cleaner.
- (2) Remove cylinder head cover.
- (3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original location.
- (4) Remove intake manifold.
- (5) Remove yoke retainer and aligning yokes.
- (6) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.
- (7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.
- (8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

INSTALLATION

- (1) Lubricate tappets.
- (2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).
- (3) Install aligning yokes with ARROW toward camshaft.
- (4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.
- (5) Install push rods in original positions.
- (6) Install rocker arm.
- (7) Install cylinder head cover.
- (8) Start and operate engine. Warm up to normal operating temperature.

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

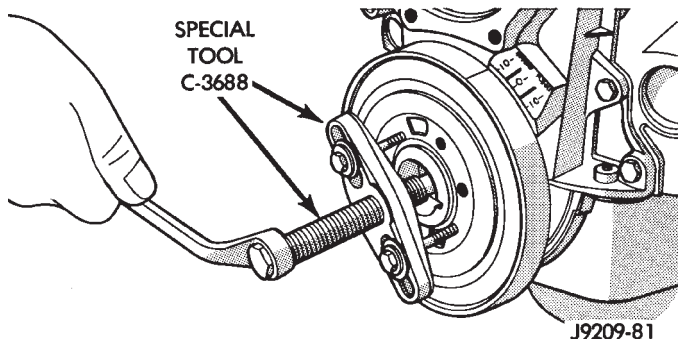
VIBRATION DAMPER

REMOVAL

- (1) Disconnect the battery negative cable.
- (2) Remove the cooling system fan.
- (3) Remove the cooling fan shroud.
- (4) Remove the accessory drive belt (refer to Group 7, Cooling System).

REMOVAL AND INSTALLATION (Continued)

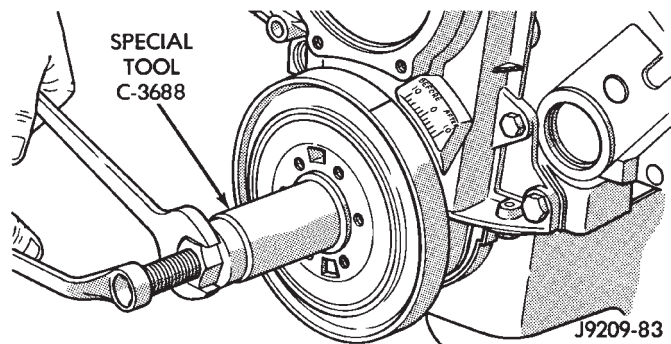
- (5) Remove the vibration damper pulley.
- (6) Remove vibration damper bolt and washer from end of crankshaft.
- (7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 20).

**Fig. 20 Vibration Damper Assembly**

- (8) Pull vibration damper off of the crankshaft.

INSTALLATION

- (1) Position the vibration damper onto the crankshaft.
- (2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 21).

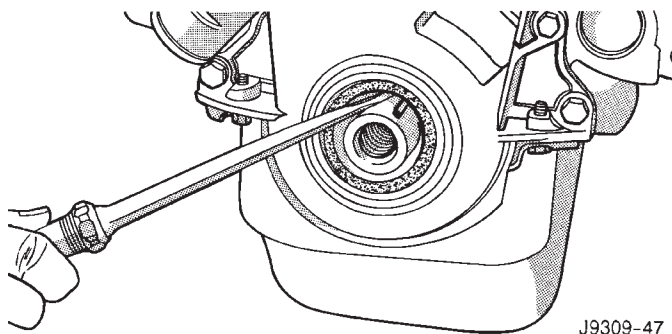
**Fig. 21 Installing Vibration Damper**

- (3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.
- (4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.
- (5) Install the accessory drive belt (refer to Group 7, Cooling System).
- (6) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.
- (7) Install the cooling fan.
- (8) Connect the battery negative cable.

TIMING CHAIN COVER

REMOVAL

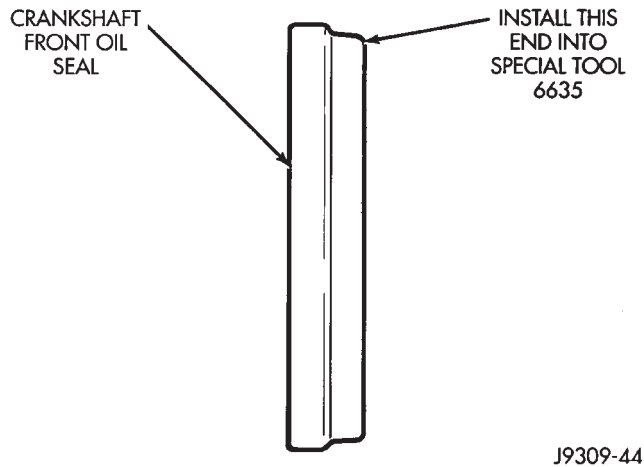
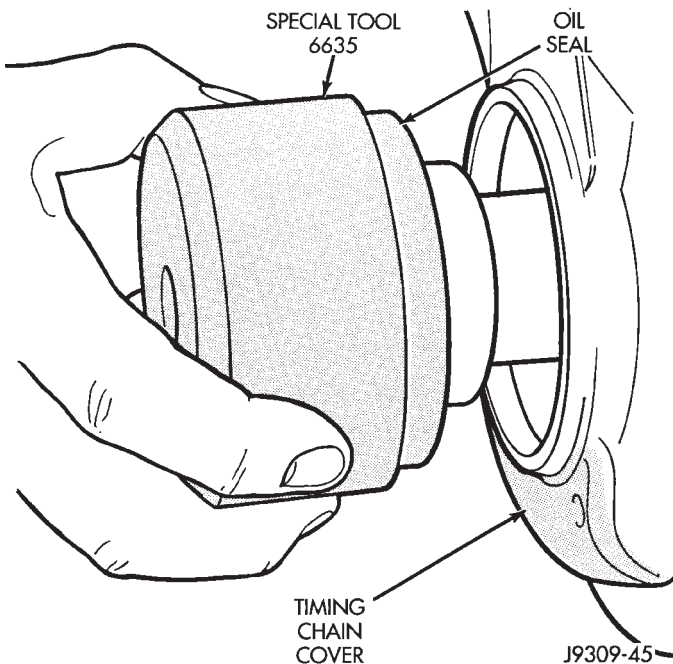
- (1) Disconnect the negative cable from the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System).
- (3) Remove the serpentine belt (refer to Group 7, Cooling System).
- (4) Remove water pump (refer to Group 7, Cooling System).
- (5) Remove power steering pump (refer to Group 19, Steering).
- (6) Remove vibration damper.
- (7) Loosen oil pan bolts and remove the front bolt at each side.
- (8) Remove the cover bolts.
- (9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 22).

**Fig. 22 Removal of Front Crankshaft Oil Seal**

INSTALLATION

- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.
- (2) The water pump mounting surface must be cleaned.
- (3) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.
- (4) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 23). Seat the oil seal in the groove of the tool.
- (5) Position the seal and tool onto the crankshaft (Fig. 24).
- (6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.
- (7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 25).

REMOVAL AND INSTALLATION (Continued)

**Fig. 23 Placing Oil Seal on Installation Tool 6635****Fig. 24 Position Tool and Seal onto Crankshaft**

(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

(9) Tighten chain case cover bolts to 41 N·m (30 ft.lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

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

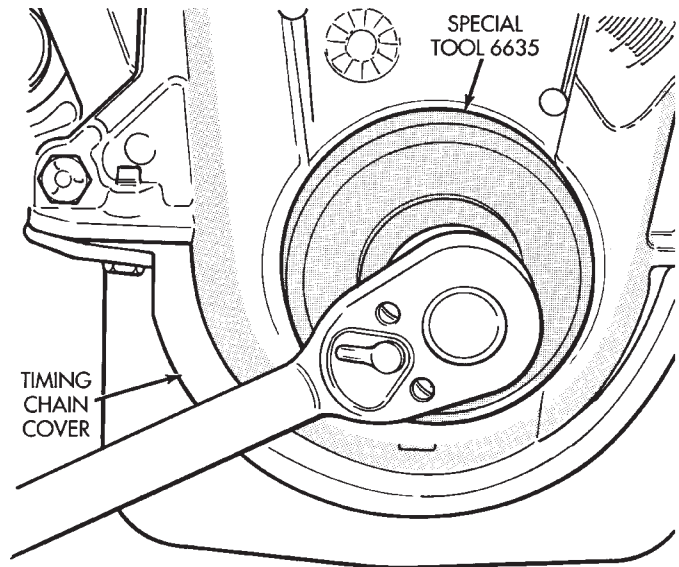
(11) Inspect the seal flange on the vibration damper.

(12) Install vibration damper.

(13) Install water pump and housing assembly using new gaskets (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(14) Install power steering pump (refer to Group 19, Steering).

(15) Install the serpentine belt (refer to Group 7, Cooling System).

**Fig. 25 Installing Oil Seal**

(16) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

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

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

(19) Connect the negative cable to the battery.

TIMING CHAIN**REMOVAL**

(1) Remove Timing Chain Cover Refer to procedure in this section.

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

INSTALLATION

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

(2) Place timing chain around both sprockets.

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

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

(5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 26).

(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

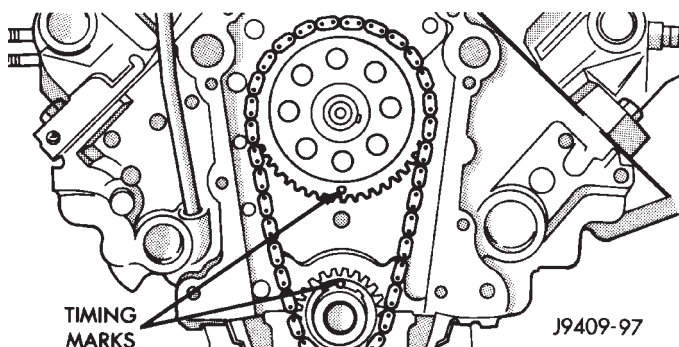


Fig. 26 Alignment of Timing Marks

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

CAMSHAFT

NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 27).

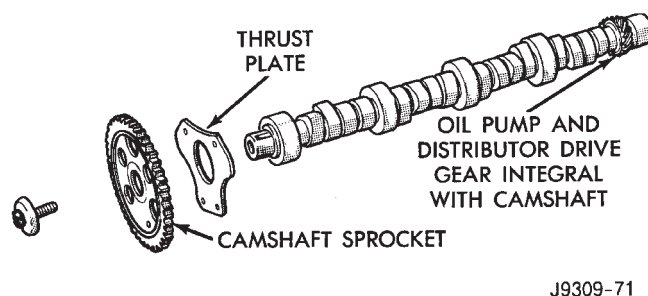


Fig. 27 Camshaft and Sprocket Assembly

REMOVAL

- (1) Remove intake manifold.
- (2) Remove cylinder head covers.
- (3) Remove timing case cover and timing chain.
- (4) Remove rocker arms.
- (5) Remove push rods and tappets. Identify each part so it can be installed in its original location.
- (6) Remove distributor and lift out the oil pump and distributor drive shaft.
- (7) Remove camshaft thrust plate, note location of oil tab (Fig. 28).

(8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

- (1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

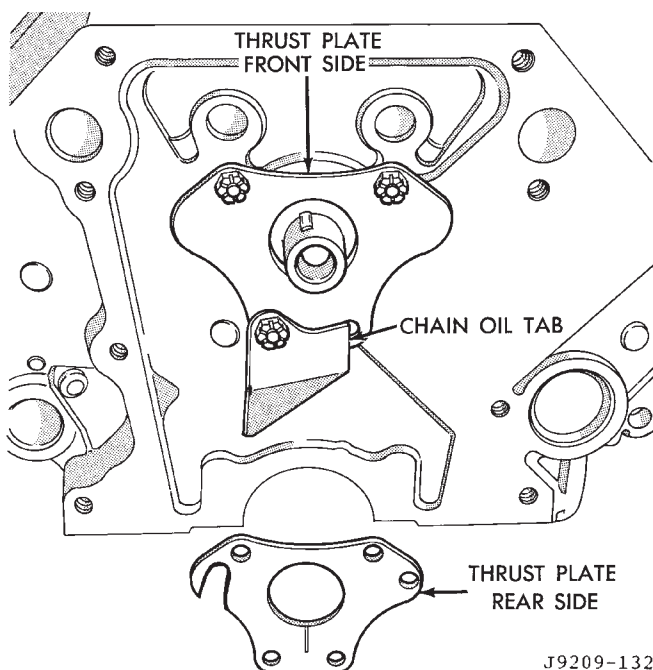


Fig. 28 Timing Chain Oil Tab Installation

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

- (2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 29).

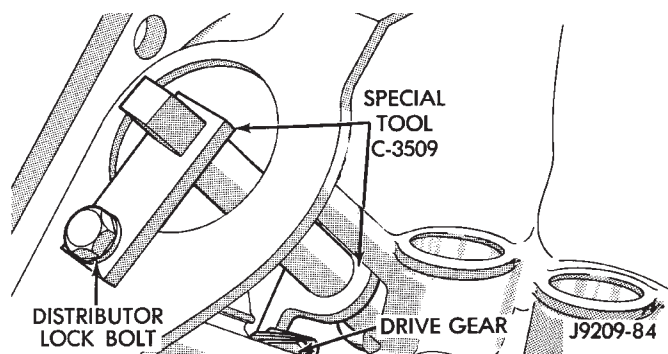


Fig. 29 Camshaft Holding Tool C-3509 (Installed Position)

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

- (4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.)

REMOVAL AND INSTALLATION (Continued)

torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

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

(6) Place timing chain around both sprockets.

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

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

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 30).

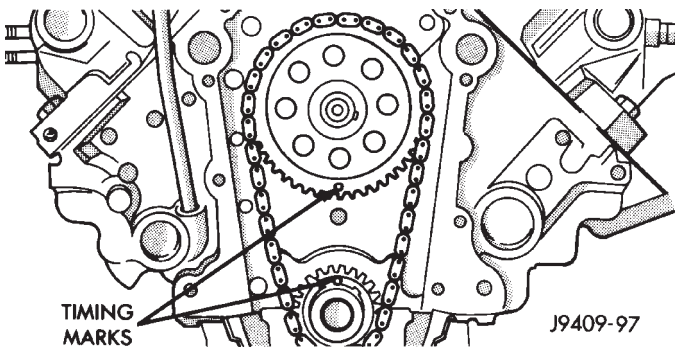


Fig. 30 Alignment of Timing Marks

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

CAMSHAFT BEARINGS

REMOVAL

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

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 31).

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

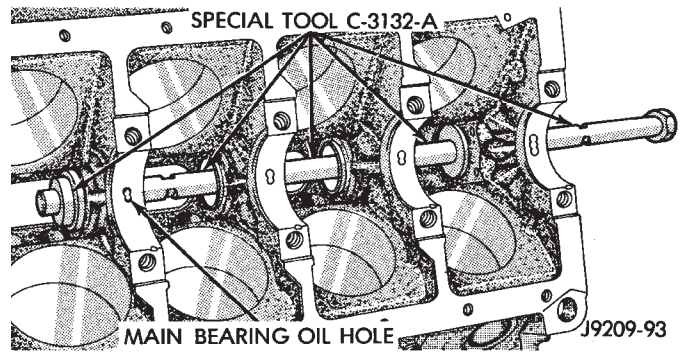


Fig. 31 Camshaft Bearings Removal/Installation with Tool C-3132-A

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

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

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

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 32).

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

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 32).

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

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump.

(5) Install the oil pan.

REMOVAL AND INSTALLATION (Continued)

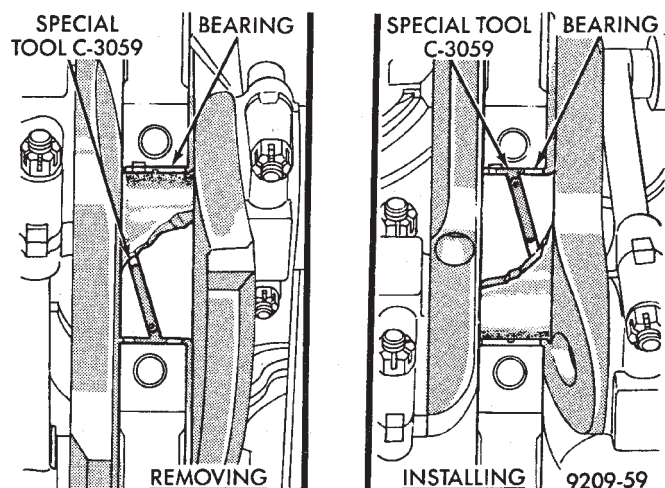


Fig. 32 Upper Main Bearing Removal and Installation with Tool C-3059

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

- (1) Remove distributor, refer to Group 8D, Ignition Systems for the proper procedure.
- (2) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).
- (3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 33).
- (4) Hold puller screw and tighten puller nut until bushing is removed.

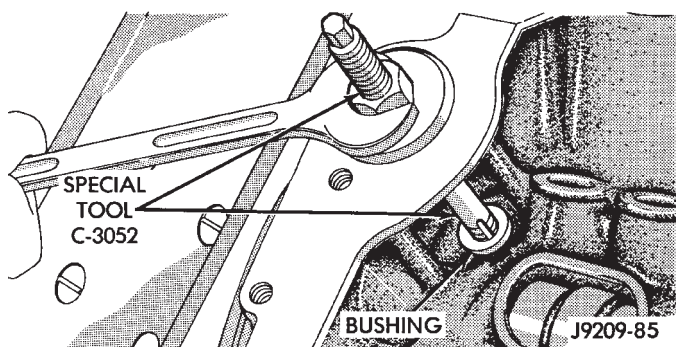


Fig. 33 Distributor Driveshaft Bushing Removal

INSTALLATION

- (1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.
- (2) Drive bushing and tool into position, using a hammer (Fig. 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.**

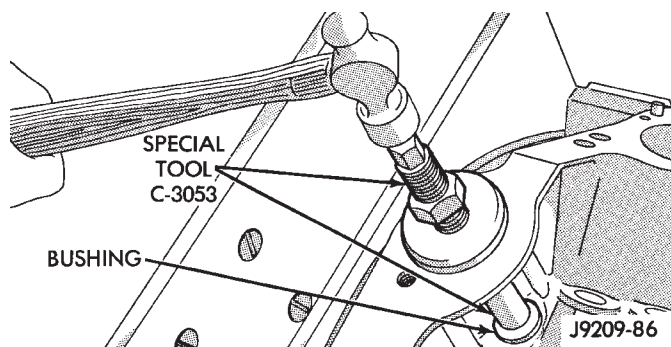


Fig. 34 Distributor Driveshaft Bushing Installation

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

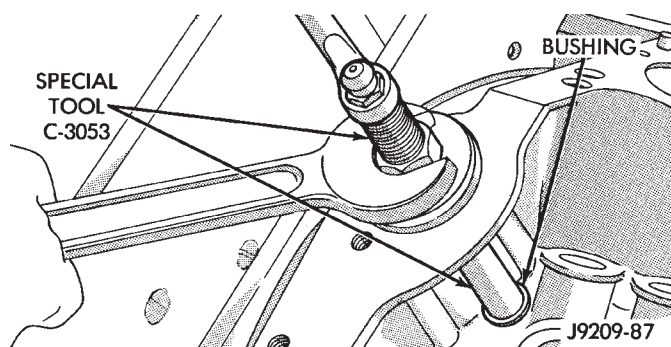


Fig. 35 Burnishing Distributor Driveshaft Bushing

- (4) Install the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

DISTRIBUTOR INSTALLATION

NOTE: Before installing the distributor, the oil pump drive shaft must be aligned to number one cylinder.

- (1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.
 - (2) When in this position, the timing mark of vibration damper should be under "0" on the timing indicator.
 - (3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned towards the left front intake manifold attaching bolt hole (Fig. 36).
 - (4) Install distributor, refer to Group 8D, Ignition Systems for the proper procedure.
- After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition system.
- Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on igni-**

REMOVAL AND INSTALLATION (Continued)

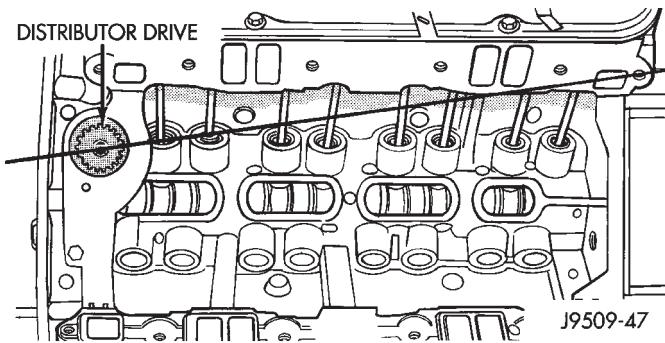


Fig. 36 Position of Oil Pump Shaft Slot

tion timing. Adjusting distributor position will effect fuel synchronization only.

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion thru-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

INSTALLATION

- (1) Clean the block and pan gasket surfaces.
- (2) Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**
- (3) If present, trim excess sealant from inside the engine.
- (4) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 37).

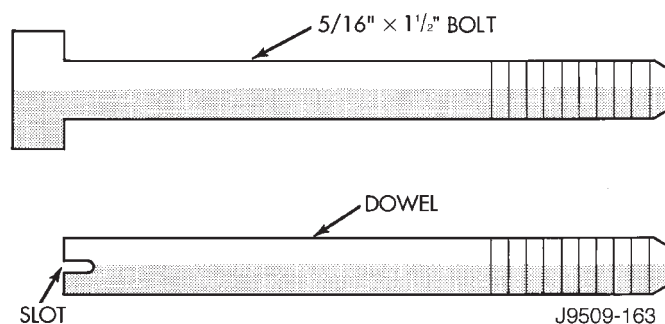


Fig. 37 Fabrication of Alignment Dowels

- (5) Install the dowels in the cylinder block (Fig. 38).

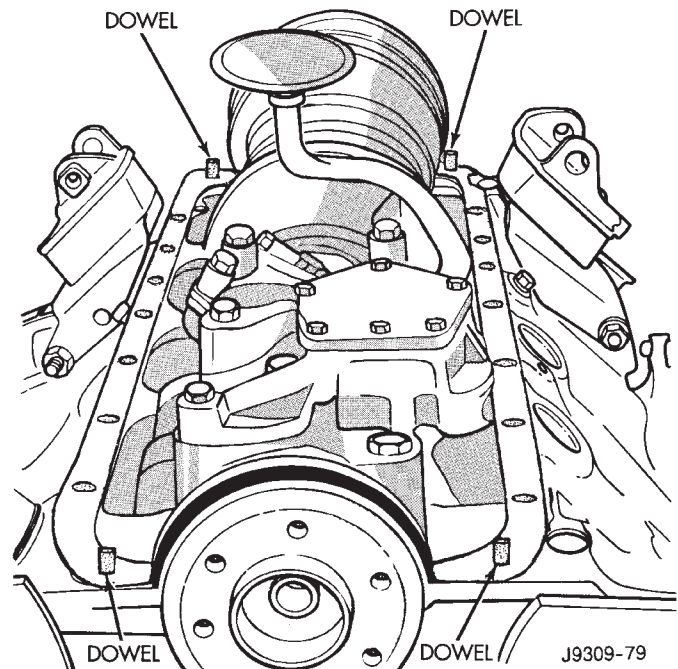


Fig. 38 Position of Dowels in Cylinder Block

- (6) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
- (7) Slide the one-piece gasket over the dowels and onto the block.
- (8) Position the oil pan over the dowels and onto the gasket.
- (9) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.
- (10) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.
- (11) Lower the engine into the support cushion brackets and tighten the thru bolt nut to the proper torque.
- (12) Install the drain plug. Tighten drain plug to 34 N·m (25 ft. lbs.) torque.
- (13) Install the engine to transmission strut.
- (14) Install exhaust pipe.
- (15) Lower vehicle.
- (16) Install dipstick.
- (17) Connect the negative cable to the battery.
- (18) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

- (1) Remove the engine from the vehicle.
- (2) Remove the cylinder head.
- (3) Remove the oil pan.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cyl-

REMOVAL AND INSTALLATION (Continued)

inder block. Be sure to keep tops of pistons covered during this operation.

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

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

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

INSTALLATION

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

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 39).

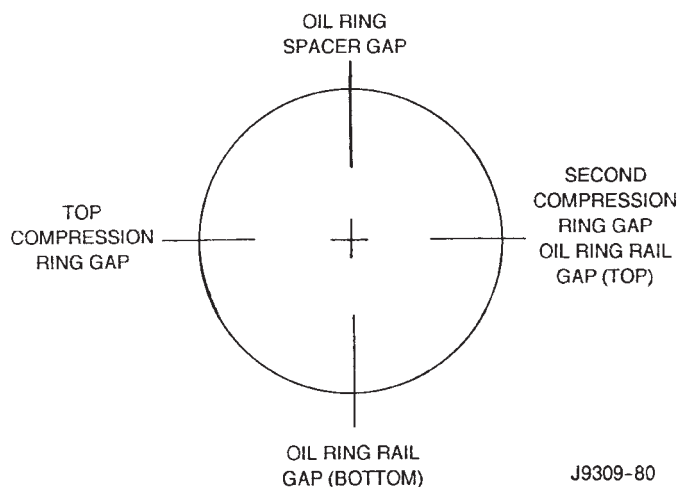


Fig. 39 Proper Ring Installation

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts, the long protector should be installed on the numbered side of the connecting rod.

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

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

(7) The notch or groove on top of piston must be pointing toward front of engine. The larger chamfer

of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

(1) Remove the oil pan.

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

(3) Remove the vibration damper.

(4) Remove the timing chain cover.

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

(6) Lift the crankshaft out of the block.

(7) Remove and discard the crankshaft rear oil seals.

(8) Remove and discard the front crankshaft oil seal.

INSTALLATION

(1) Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.

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

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

(4) Position the crankshaft into the cylinder block.

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

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

(7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 40). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

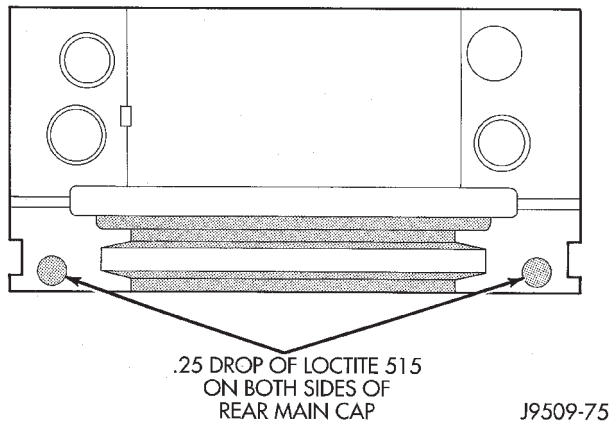
(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump.

(11) Install the timing chain cover.

(12) Install the vibration damper.

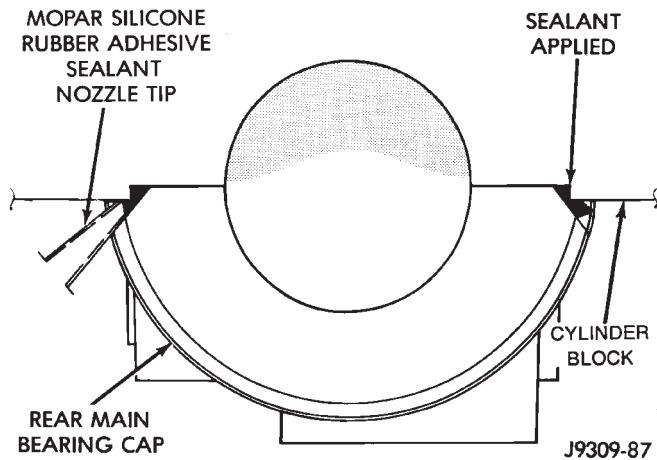
REMOVAL AND INSTALLATION (Continued)

**Fig. 40 Sealant Application to Bearing Cap**

(13) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 41). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(14) Install new front crankshaft oil seal.

(15) Immediately install the oil pan.

**Fig. 41 Apply Sealant to Bearing Cap to Block Joint****REMOVAL**

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

INSTALLATION

- (1) Install oil pump. During installation slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.
- (2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten

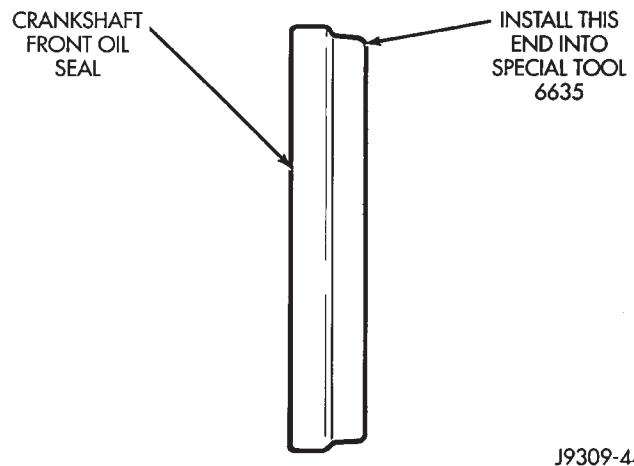
pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

- (3) Install the oil pan.

FRONT CRANKSHAFT OIL SEAL

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

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.
- (4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.
- (5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 42). Seat the oil seal in the groove of the tool.

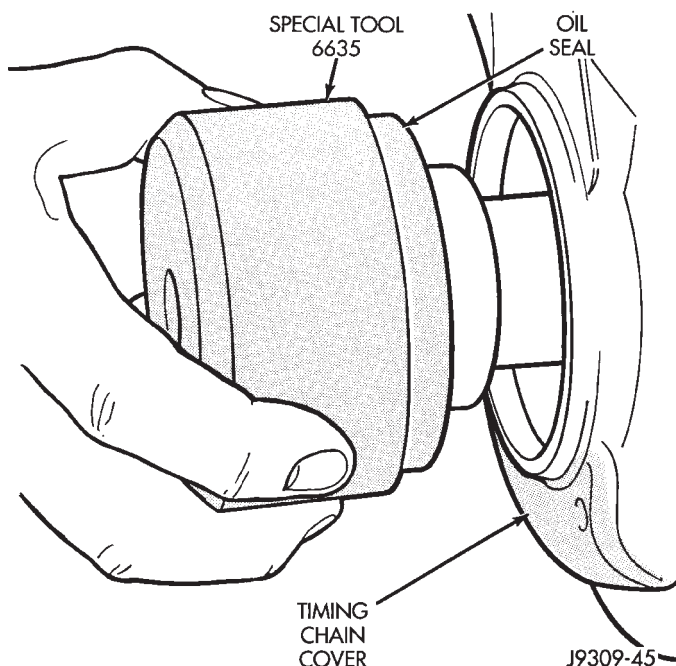
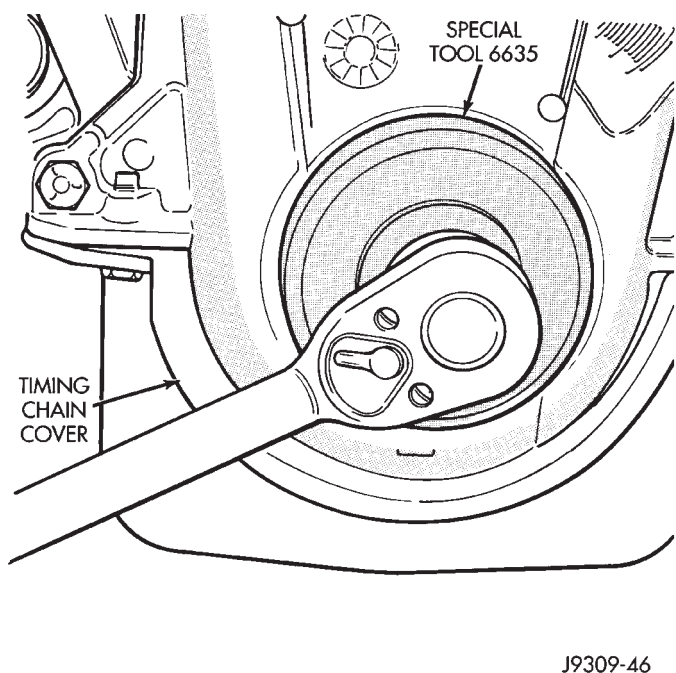
**Fig. 42 Placing Oil Seal on Installation Tool 6635**

- (6) Position the seal and tool onto the crankshaft (Fig. 43).
- (7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 44).
- (8) Remove the vibration damper bolt and seal installation tool.
- (9) Inspect the seal flange on the vibration damper.
- (10) Install the vibration damper.
- (11) Connect the negative cable to the battery.

CRANKSHAFT REAR OIL SEALS

The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal.

REMOVAL AND INSTALLATION (Continued)

**Fig. 43 Position Tool and Seal onto Crankshaft****Fig. 44 Installing Oil Seal**

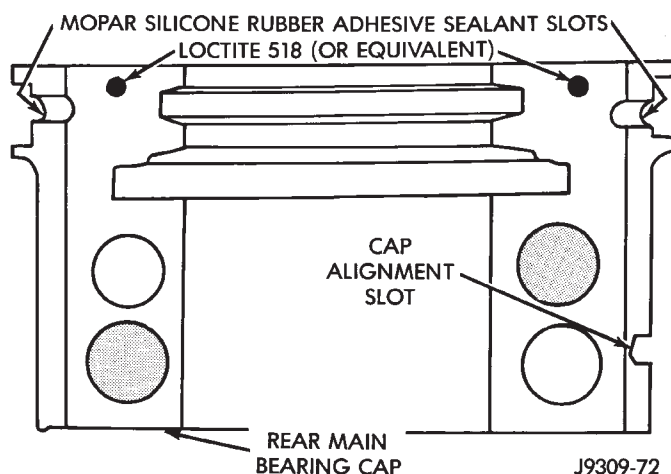
The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED**REMOVAL**

- (1) Remove the crankshaft. Discard the old upper seal.

INSTALLATION

- (1) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.
- (2) Lightly oil the new upper seal lips with engine oil.
- (3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (4) Position the crankshaft into the cylinder block.
- (5) Lightly oil the new lower seal lips with engine oil.
- (6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). 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. 45 Sealant Application to Bearing Cap**

- (8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
- (9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.
- (10) Install oil pump.
- (11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 46). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
- (12) Install new front crankshaft oil seal.
- (13) Immediately install the oil pan.

REMOVAL AND INSTALLATION (Continued)

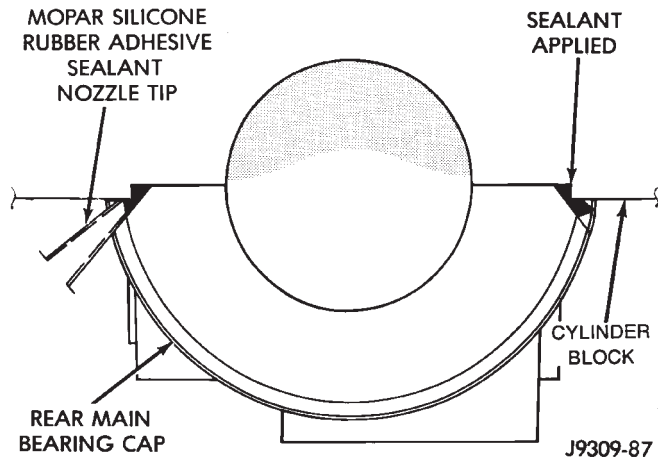


Fig. 46 Apply Sealant to Bearing Cap to Block Joint
UPPER SEAL —CRANKSHAFT INSTALLED

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
- (4) Carefully remove and discard the old upper oil seal.

INSTALLATION

- (1) Clean the cylinder block mating surfaces before oil seal installation. Check for burr at the oil hole on the cylinder block mating surface to rear cap.
- (2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.
- (3) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing towards the rear of the engine.
- (4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (5) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.
- (6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 46). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

- (1) Clean the rear main cap mating surfaces including the oil pan gasket groove.
- (2) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).
- (3) Lightly oil the new lower seal lips with engine oil.
- (4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.
- (5) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.
- (6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 46). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 47).

REMOVAL AND INSTALLATION (Continued)

This will reduce internal leakage and help maintain higher oil pressure at idle.

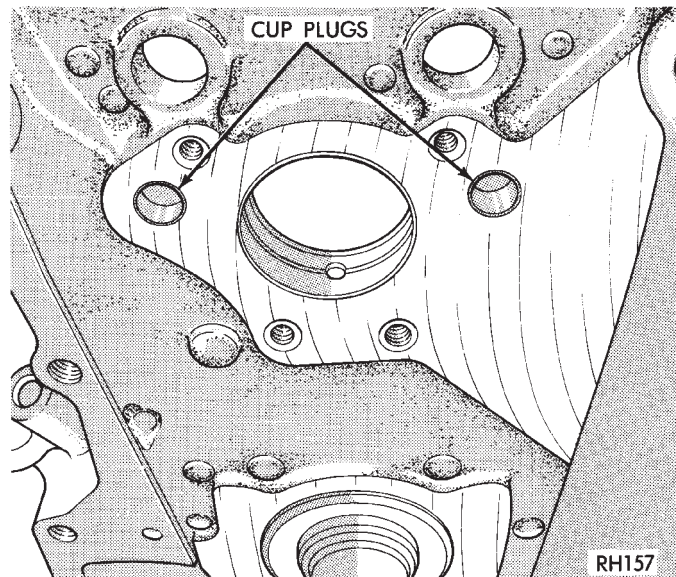


Fig. 47 Location of Cup Plugs in Oil Galleries

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 48).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 48).

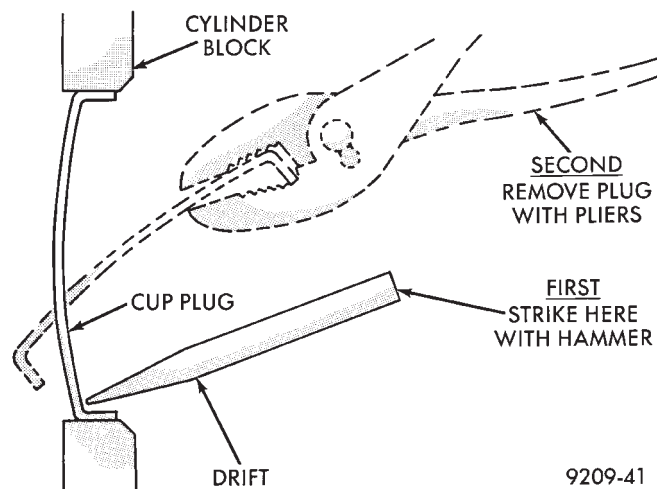


Fig. 48 Core Hole Plug Removal

INSTALLATION

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

Be certain the new plug is cleaned of all oil or grease.

(1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting, as restricted coolant flow can result and cause serious engine problems.

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 in.) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

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

DISASSEMBLE

- (1) Pry out plunger retainer spring clip (Fig. 49).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 49). Check valve could be flat or ball.

ASSEMBLE

- (1) Clean all tappet parts in a solvent that will remove all varnish and carbon.
- (2) Replace tappets that are unfit for further service with new assemblies.
- (3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.
- (4) Assemble tappets (Fig. 49).

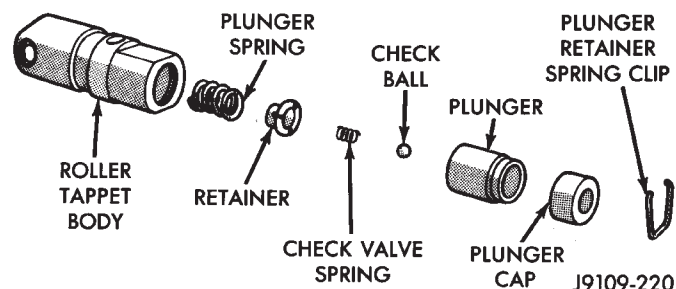


Fig. 49 Hydraulic Tappet Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 50). The special sleeve places the valve at the correct height for checking with a dial indicator.

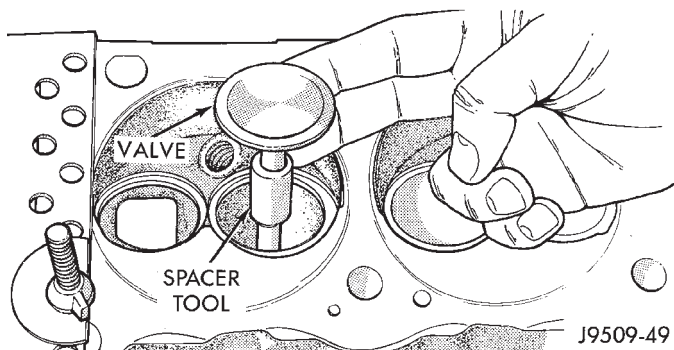


Fig. 50 Positioning Valve with Tool C-3973

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 51).

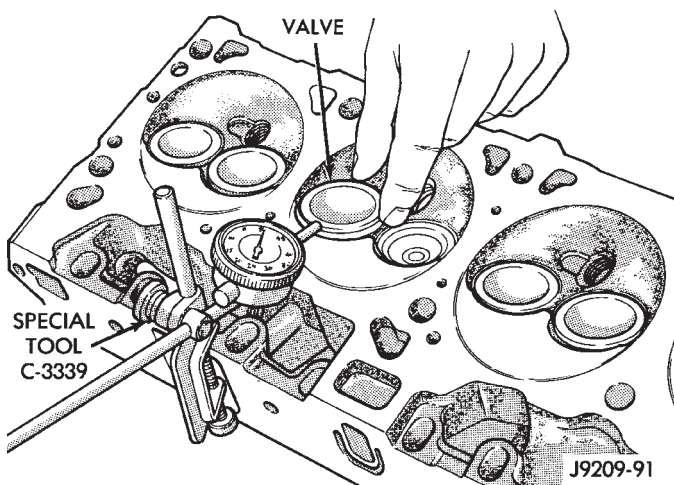


Fig. 51 Measuring Valve Guide Wear

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

(4) Service valves with oversize stems are available (Fig. 52).

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

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

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

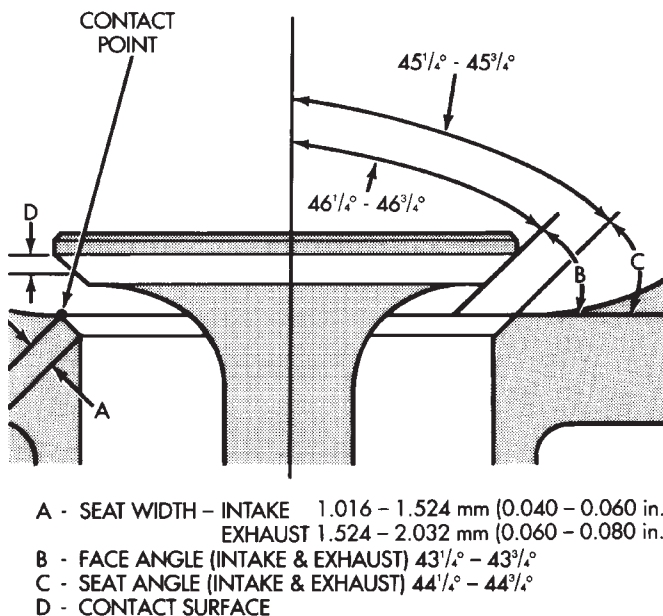
J9309-30

Fig. 52 Reamer Sizes

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

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 53).



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Fig. 53 Valve Face and Seat Angles

VALVES

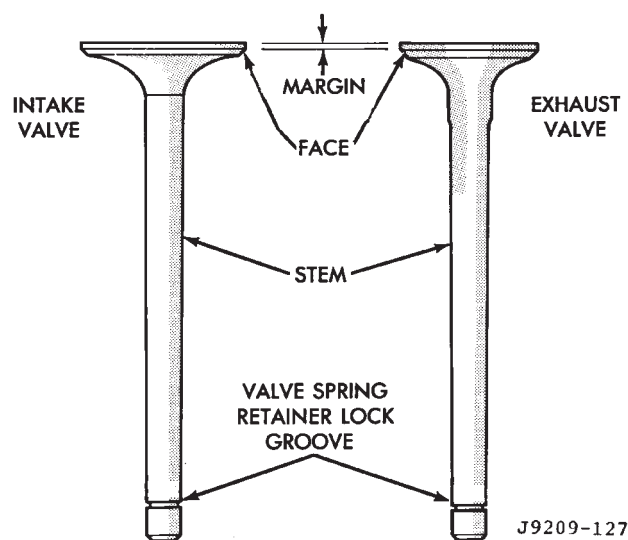
Inspect the remaining margin after the valves are refaced (Fig. 54). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 55).

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

DISASSEMBLY AND ASSEMBLY (Continued)



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Fig. 54 Intake and Exhaust Valves

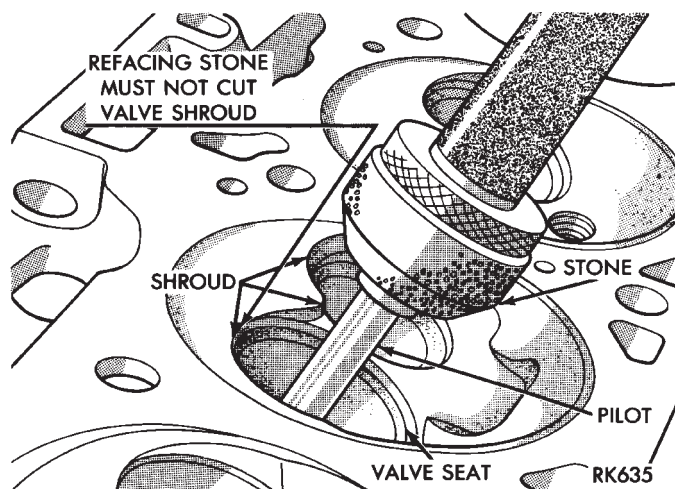


Fig. 55 Refacing Valve Seats

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

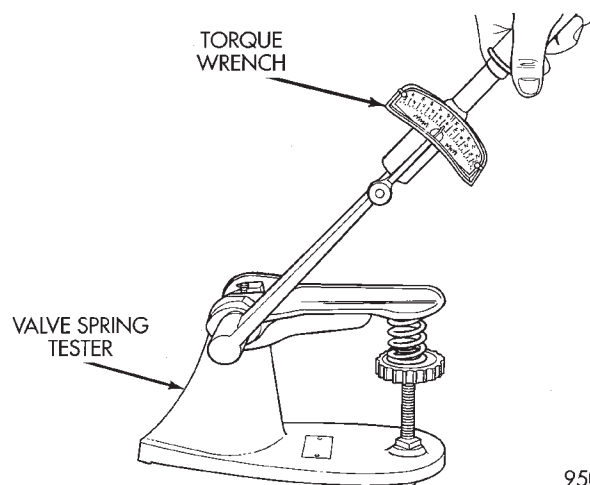
(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat LIGHTLY with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue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

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

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should

be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universals Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 56). Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.



9509-79

Fig. 56 Testing Valve Spring for Compressed Length

OIL PUMP

DISASSEMBLE

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw.

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 57).

(2) Remove oil pump cover (Fig. 58).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 58).

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

ASSEMBLE

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

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.

DISASSEMBLY AND ASSEMBLY (Continued)

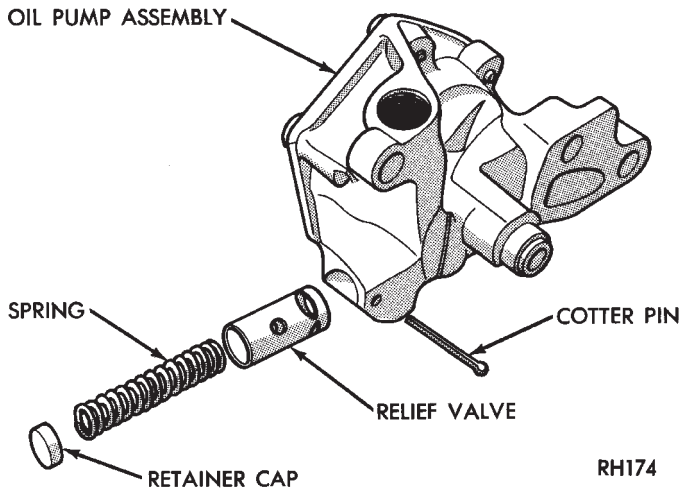


Fig. 57 Oil Pressure Relief Valve

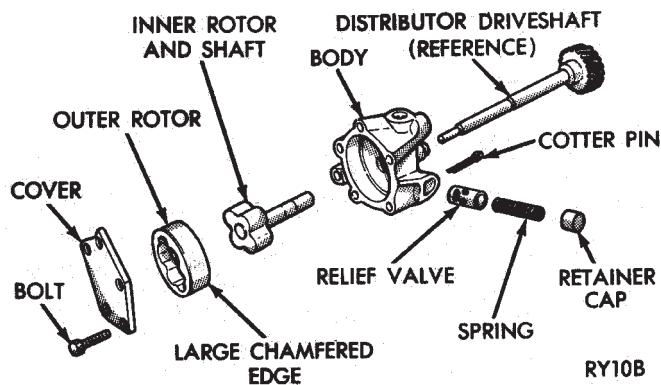


Fig. 58 Oil Pump

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

(5) Prime oil pump before installation by filling rotor cavity with engine oil.

CYLINDER BLOCK

DISASSEMBLE

Engine assembly removed from vehicle:

- (1) Remove the cylinder head.
- (2) Remove the oil pan.
- (3) Remove the piston and connecting rod assemblies.

ASSEMBLE

- (1) Install the piston and connecting rod assembly.
- (2) Install the oil pan.
- (3) Install the cylinder head.
- (4) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEADS

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 inch/inch) times the span length in inches in any direction, either replace head or lightly machine the head surface.

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

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

Inspect push rods. Replace worn or bent rods.

PISTON AND CONNECTING ROD ASSEMBLY

INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 59).

CRANKSHAFT JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

CLEANING AND INSPECTION (Continued)

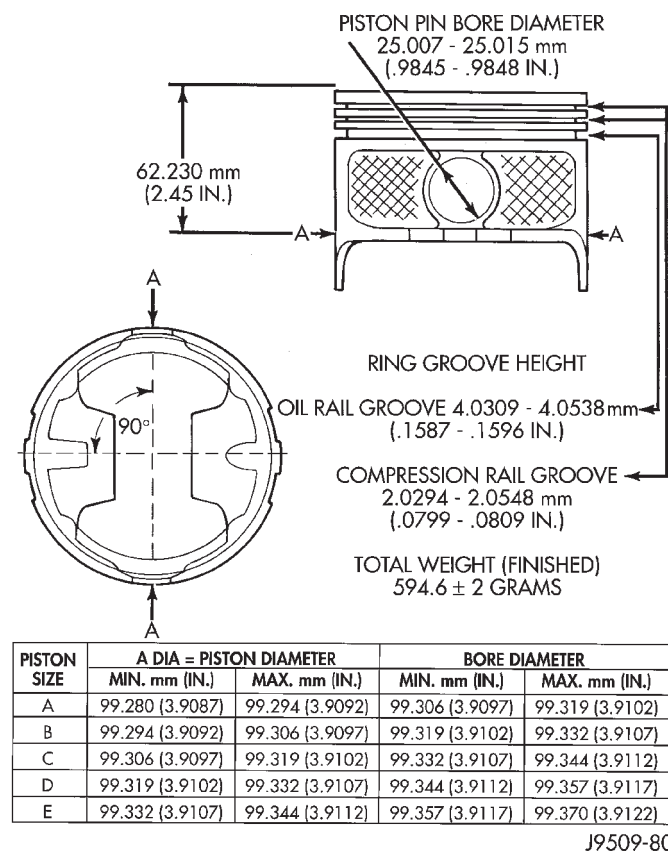


Fig. 59 Piston Measurements

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

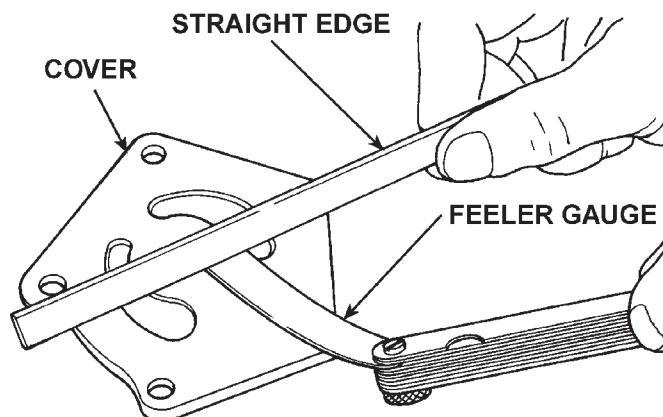
OIL PUMP

INSPECTION

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

Lay a straightedge across the pump cover surface (Fig. 60). If a 0.038 mm (0.0015 inch) feeler gauge

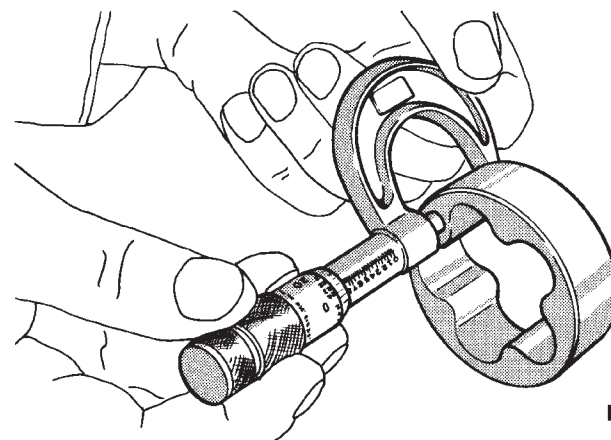
can be inserted between cover and straightedge, pump assembly should be replaced.



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Fig. 60 Checking Oil Pump Cover Flatness

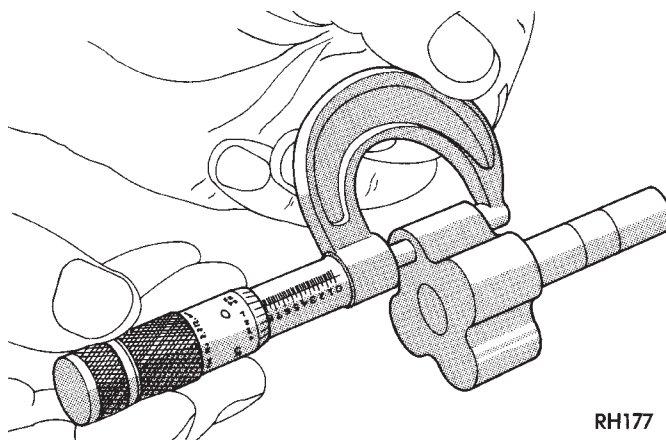
Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 61).



RH176

Fig. 61 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 62).

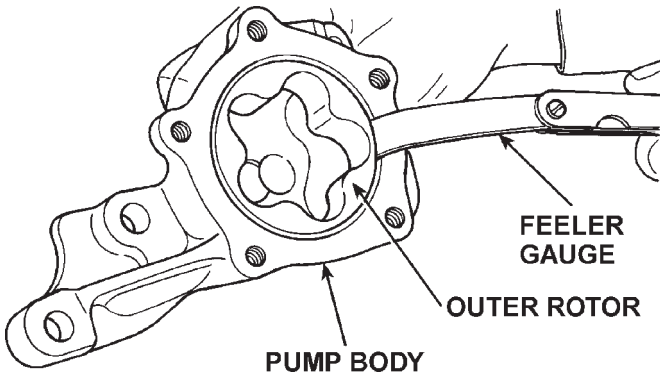


RH177

Fig. 62 Measuring Inner Rotor Thickness

CLEANING AND INSPECTION (Continued)

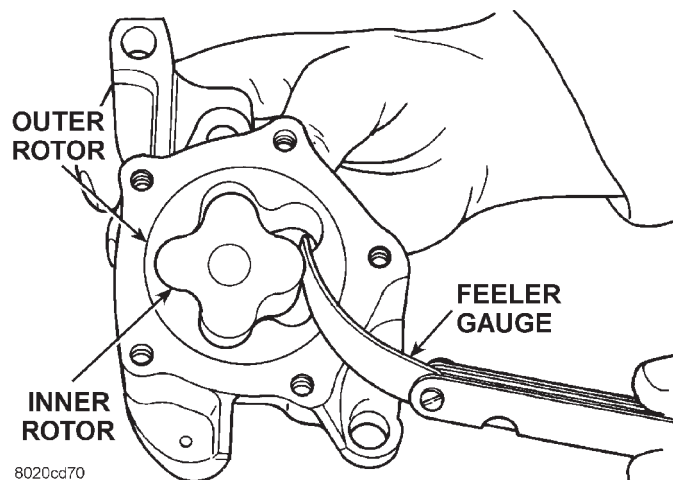
Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 63). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.



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Fig. 63 Measuring Outer Rotor Clearance in Housing

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 64).



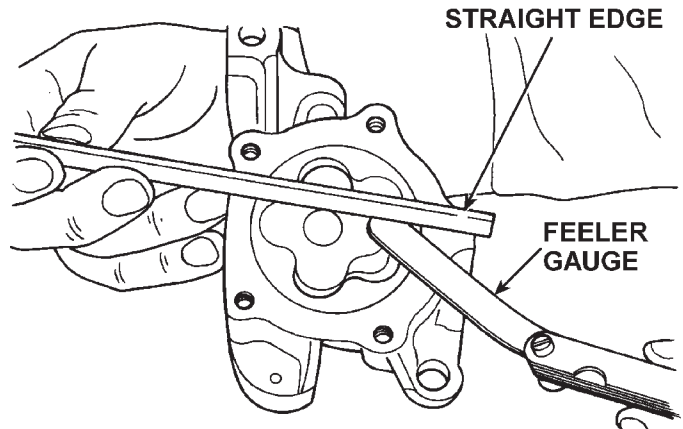
8020cd70

Fig. 64 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 65).

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

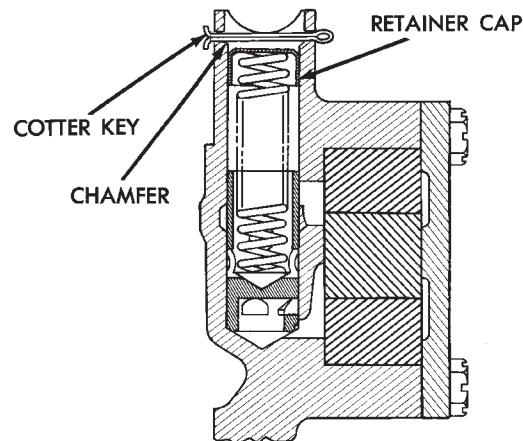
The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 66).



8020cd71

Fig. 65 Measuring Clearance Over Rotors

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



RN98

Fig. 66 Proper Installation of Retainer Cap
CYLINDER BLOCK

CLEANING

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

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

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

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

CLEANING AND INSPECTION (Continued)

OIL LINE PLUG

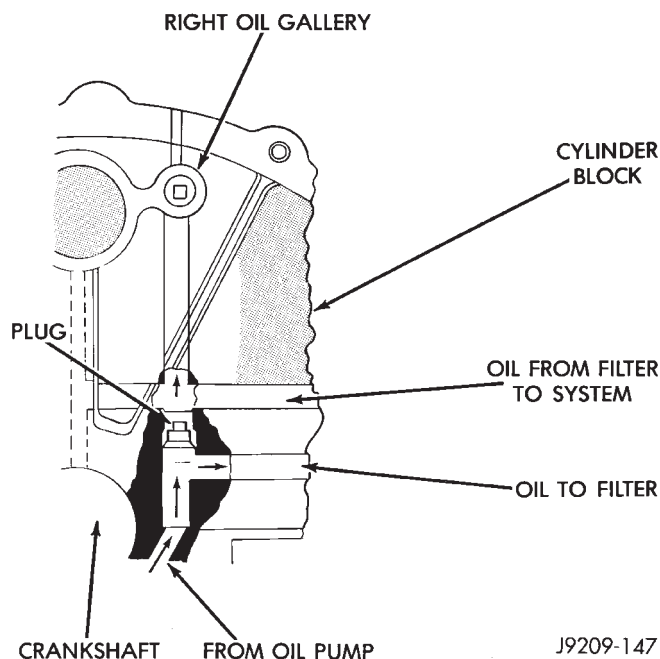
The oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and oil-from-filter passages (Fig. 67). Improper installation or plug missing could cause erratic, low, or no oil pressure.

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

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 67). If plug is too high, use a suitable flat dowel to position properly.



J9209-147

Fig. 67 Oil Line Plug

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

SPECIFICATIONS

5.2L ENGINE SPECIFICATIONS

GENERAL INFORMATION

Engine Type.....	90° V-8 OHV
Bore and Stroke.....	99.3 x 84.0 mm (3.91 x 3.31 in.)

Engine Type.....	90° V-8 OHV
Displacement	5.2L (318 c.i.)
Compression Ratio	9.1:1
Firing Order.....	1-8-4-3-6-5-7-2
Lubrication.....	Pressure Feed— Full Flow Filtration
Cooling System	Liquid Cooled— Forced Circulation
Cylinder Block.....	Cast Iron
Crankshaft.....	Nodular Iron
Cylinder Head.....	Cast Iron
Combustion Chambers....	Wedge-High Swirl Valve shrouding
Camshaft.....	Nodular Cast Iron
Pistons	Aluminum Alloy w/strut
Connecting Rods.....	Forged Steel

CAMSHAFT

Bearing Diameter

No. 1	50.800 – 50.825 mm (2.000 – 2.001 in.)
No. 2	50.394 – 50.419 mm (1.984 – 1.985 in.)
No. 3	50.013 – 50.038 mm (1.969 – 1.970 in.)
No. 4	49.606 – 49.632 mm (1.953 – 1.954 in.)
No. 5	39.688 – 39.713 mm (1.5625 – 1.5635 in.)

Bearing Journal Diameter

No. 1	50.749 – 50.775 mm (1.998 – 1.999 in.)
No. 2	50.343 – 50.368 mm (1.982 – 1.983 in.)
No. 3	49.962 – 49.987 mm (1.967 – 1.968 in.)
No. 4	49.555 – 49.581 mm (1.951 – 1.952 in.)
No. 5	39.637 – 39.662 mm (1.5605 – 1.5615 in.)

Bearing to Journal Clearance

Standard.....	0.0254 – 0.0762 mm (0.001 – 0.003 in.)
Service Limit	0.127 mm (0.005 in.)

Camshaft End Play

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.)

SPECIFICATIONS (Continued)

Rod Journal

Service Limit0.0762 mm (0.003 in.)

Main Bearing JournalDiameter63.487 – 63.513 mm
(2.4995 – 2.5005 in.)

Out of Round (Max.)0.127 mm (0.001 in.)

Taper (Max.)0.0254 mm (0.001 in.)

Bearing Clearance (#1 Journal) . . .0.013 – 0.038 mm
(0.0005 – 0.0015 in.)Service Limit (#1 Journal)0.0381 mm
(0.0015 in.)**Bearing Clearance**(#2-5 Journals)0.013 – 0.051 mm
(0.0005 – 0.002 in.)Service Limit (#2-5 Journals)0.064 mm
(0.0025 in.)**Crankshaft End Play**End Play0.051 – 0.178 mm
(0.002 – 0.007 in.)

Service Limit0.254 mm (0.010 in.)

CYLINDER BLOCK**Cylinder Bore**Diameter99.314 – 99.365 mm
(3.910 – 3.912 in.)

Out of Round (Max.)0.127 mm (0.005 in.)

Taper (Max.)0.254 mm (0.010 in.)

Oversize Limit1.016 mm (0.040 in.)

Lifter BoreDiameter22.99 – 23.01 mm
(0.9051 – 0.9059 in.)**Distributor Drive Bushing (Press Fit)**Bushings to Bore Interference . . .0.0127 – 0.3556 mm
(0.0005 – 0.0140 in.)Shaft to Bushing Clearance0.0178 – 0.0686 mm
(0.0007 – 0.0027 in.)**CYLINDER HEAD AND VALVES****Valve Seat**

Angle44.25° – 44.75°

Runout (Max.)0.0762 mm (0.003 in.)

Width (Finish) – Intake1.016 – 1.524 mm
(0.040 – 0.060 in.)Width (Finish) – Exhaust1.524 – 2.032 mm
(0.060 – 0.080 in.)**Valves**

Face Angle43.25° – 43.75°

Head Diameter – Intake48.666 mm (1.916 in.)

Head Diameter – Exhaust41.250 (1.624 in.)

Length (Overall) – Intake124.28 – 125.92 mm
(4.893 – 4.918 in.)Length (Overall) – Exhaust124.64 – 125.27 mm
(4.907 – 4.932 in.)

Lift (@ zero lash)10.973 mm (0.432 in.)

Stem Diameter7.899 – 7.925 mm
(0.311 – 0.312 in.)Guide Bore7.950 – 7.976 mm
(0.313 – 0.314 in.)Stem to Guide Clearance0.0254 – 0.0762 mm
(0.001 – 0.003 in.)

Service Limit (rocking method) . .0.4318 (0.017 in.)

Valve Springs

Free Length49.962 mm (1.967 in.)

Spring Tension – (valve closed) . .378 N @ 41.66 mm
(85 lbs. @ 1.64 in.)Spring Tension – (valve open) . . .890 N @ 30.89 mm
(200 lbs. @ 1.212 in.)

Number of Coils6.5

Installed Height41.66 mm (1.64 in.)

Wire Diameter4.50 mm (0.177 in.)

HYDRAULIC TAPPETSBody Diameter22.949 – 22.962 mm
(0.9035 – 0.9040 in.)Clearance (to bore)0.0279 – 0.0610 mm
(0.0011 – 0.0024 in.)Dry Lash1.524 – 5.334 mm
(0.060 – 0.210 in.)Push Rod Length175.64 – 176.15 mm
(6.915 – 6.935 in.)**OIL PRESSURE**

Curb Idle (Min.)*41.4 kPa (6 psi)

3000 rpm207 – 552 kPa
(30 – 80 psi)Oil Pressure Bypass Valve Setting . . .62 – 103 kPa
(9 – 15 psi)Switch Actuating Pressure34.5 – 48.3 kPa
(5 – 7 psi)**CAUTION:** 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.)Outer Rotor Diameter (Min.)62.7126 mm
(2.469 in.)Outer Rotor Thickness (Min.)20.955 mm
(0.825 in.)

SPECIFICATIONS (Continued)

Tip Clearance between Rotors (Max.)0.2032 mm
(0.008 in.)

PISTONS

Clearance at Top of Skirt0.013 – 0.038 mm
(0.0005 – 0.0015 in.)

Land Clearance (Diam.)0.635 – 1.016 mm
(0.025 – 0.040 in.)

Piston Length86.360 mm (3.40 in.)

Piston Ring Groove

Depth – #1&24.572 – 4.826 mm
(0.180 – 0.190 in.)

Piston Ring Groove

Depth – #33.810 – 4.064 mm
(0.150 – 0.160 in.)

Weight592.6 – 596.6 grams
(20.90 – 21.04 oz.)

PISTON PINS

Clearance in Piston0.00635 – 0.01905 mm
(0.00025 – 0.00075 in.)

Diameter24.996 – 25.001 mm
(0.9841 – 0.9843 in.)

End PlayNONE

Length75.946 – 76.454 mm
(2.990 – 3.010 in.)

PISTON RINGS**Ring Gap**

Compression Rings0.254 – 0.508 mm
(0.010 – 0.020 in.)

Oil Control (Steel Rails)0.254 – 1.270 mm
(0.010 – 0.050 in.)

Ring Side Clearance

Compression Rings0.038 – 0.076 mm
(0.0015 – 0.0030 in.)

Oil Ring (Steel Rails)0.06 – 0.21 mm
(0.002 – 0.008 in.)

Ring Width

Compression rings1.971 – 1.989 mm
(0.0776 – 0.0783 in.)

Oil Ring (Steel Rails) – Max.3.848 – 3.975 mm
(0.1515 – 0.1565 in.)

VALVE TIMING**Exhaust Valve**

Closes (ATDC)21°

Opens (BBDC)60°

Duration264°

Intake Valve

Closes (ATDC)61°

Opens (BBDC)10°

Duration250°

Valve Overlap31°

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Milled flat on no. 8 crankshaft counterweight.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	♦	Diamond-shaped stamp top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

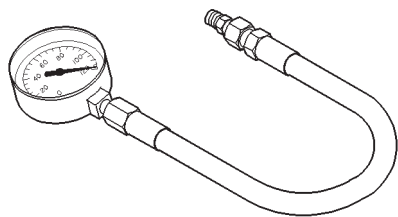
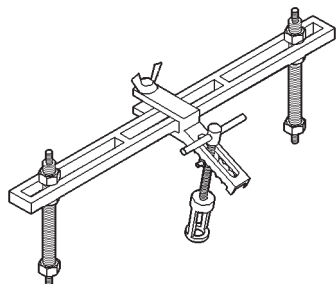
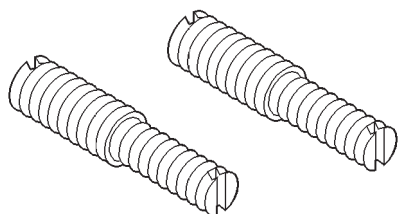
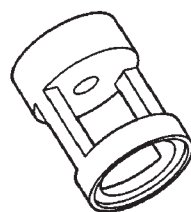
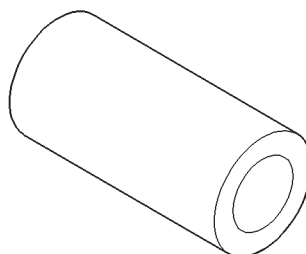
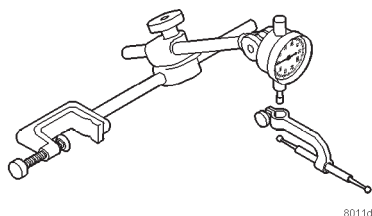
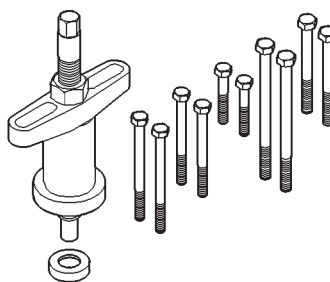
5.2L ENGINE

DESCRIPTION	TORQUE
Camshaft	
Bolt . . . . .	.68 N·m (50 ft. lbs.)
Camshaft Thrust Plate	
Bolts . . . . .	.24 N·m (210 in. lbs.)
Chain Case Cover	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Connecting Rod Cap	
Bolts . . . . .	.61 N·m (45 ft. lbs.)
Crankshaft Main Bearing Cap	
Bolts . . . . .	.115 N·m (85 ft. lbs.)
Crankshaft Pulley	
Bolts . . . . .	.24 N·m (210 in. lbs.)
Cylinder Head	
Bolts (1st Step) . . . . .	.68 N·m (50 ft. lbs.)
Bolts (2nd Step) . . . . .	.143 N·m (105 ft. lbs.)
Cylinder Head Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Engine Support Bracket to Block (4wd)	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Exhaust Manifold-to-Cylinder Head	
Bolts/Nuts . . . . .	.34 N·m (25 ft. lbs.)
Flywheel	
Bolts . . . . .	.75 N·m (55 ft. lbs.)
Front Insulator (All)	
Through bolt/nut . . . . .	.95 N·m (70 ft. lbs.)
Front Insulator to Support Bracket (4wd)	
Stud nut . . . . .	.41 N·m (30 ft. lbs.)
Through bolt/nut . . . . .	.102 N·m (75 ft. lbs.)
Front Insulator to Block (2wd)	
Bolts . . . . .	.95 N·m (70 ft. lbs.)
Generator	
Mounting Bolt . . . . .	.41 N·m (30 ft. lbs.)
Intake Manifold	
Bolts	Refer to R & I Procedure
Oil Pan	
Bolts . . . . .	.24 N·m (215 in. lbs.)
Oil Pan	
Drain Plug . . . . .	.34 N·m (25 ft. lbs.)

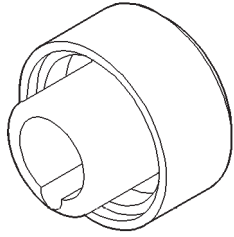
DESCRIPTION	TORQUE
Oil Pump	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Rear Insulator-to-Bracket (2WD)	
Through-Bolt . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Crossmember Support Bracket (2WD)	
Nut . . . . .	.41 N·m (30 ft. lbs.)
Rear Insulator-to-Crossmember (4WD)	
Nuts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Transmission (4WD)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket (4WD Automatic)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Support Bracket-to-Crossmember Flange	
Nuts . . . . .	.41 N·m (30 ft. lbs.)
Rear Support Plate-to-Transfer Case	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Rocker Arm	
Bolts . . . . .	.28 N·m (21 ft. lbs.)
Spark Plugs	
All . . . . .	.41 N·m (30 ft. lbs.)
Starter Motor	
Mounting Bolts . . . . .	.68 N·m (50 ft. lbs.)
Thermostat Housing	
Bolts . . . . .	.25 N·m (225 in. lbs.)
Throttle Body	
Bolts . . . . .	.23 N·m (200 in. lbs.)
Torque Converter Drive Plate	
Bolts . . . . .	.31 N·m (270 in. lbs.)
Transfer Case-to-Insulator Mounting Plate	
Nuts . . . . .	.204 N·m (150 ft. lbs.)
Transmission Support Bracket (2WD)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Vibration Damper	
Retainer Bolt . . . . .	.183 N·m (135 ft. lbs.)
Water Pump-to-Chain Case Cover	
Bolt . . . . .	.41 N·m (30 ft. lbs.)

SPECIAL TOOLS

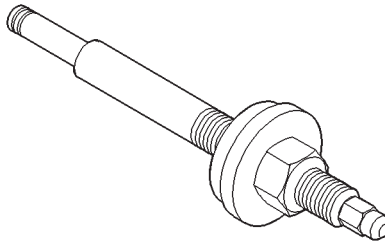
5.2L ENGINE

***Oil Pressure Gauge C-3292******Engine Support Fixture C-3487-A******Valve Spring Compressor MD-998772-A******Adapter 6633******Adapter 6716A******Valve Guide Sleeve C-3973******Dial Indicator C-3339******Puller C-3688***

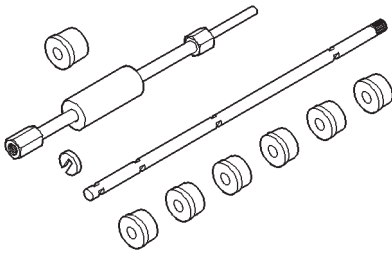
SPECIAL TOOLS (Continued)



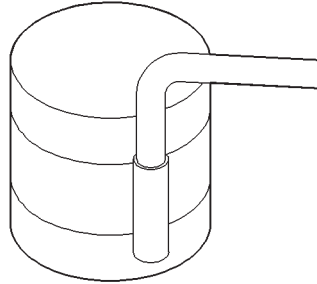
Front Oil Seal Installer 6635



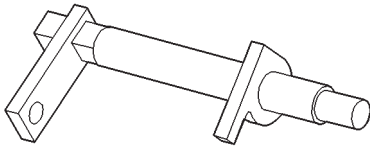
Distributor Bushing Driver/Burnisher C-3053



Cam Bearing Remover/Installer C-3132-A

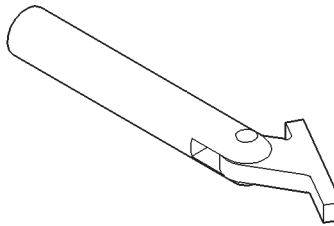


Piston Ring Compressor C-385

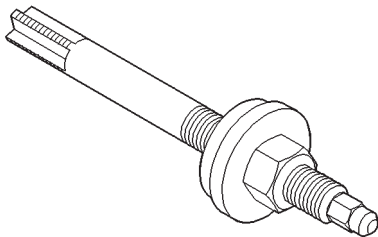


c-3509-8011d343

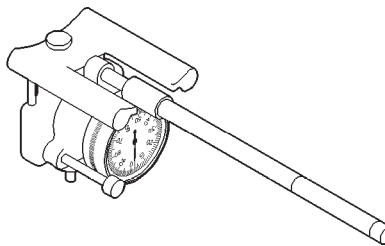
Camshaft Holder C-3509



Crankshaft Main Bearing Remover C-3059



Distributor Bushing Puller C-3052



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Cylinder Bore Gauge C-119

5.9L ENGINE

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GENERAL INFORMATION

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

DESCRIPTION AND OPERATION

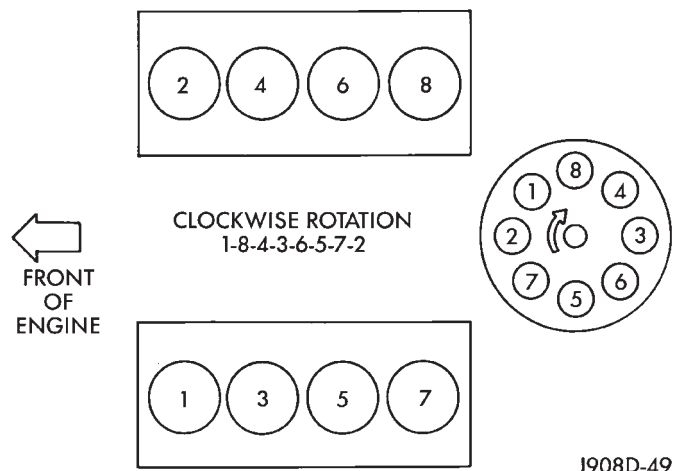
ENGINE DESCRIPTION/IDENTIFICATION

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).

DESCRIPTION AND OPERATION (Continued)

**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).

X M 5.9L T XXXX XXXXXXXX

X = Last Digit of Model Year

M = Plant - M Mound Road

S Saltillo

T Trenton

K Toluca

5.9L = Engine Displacement

T = Usage - T Truck

XXXX = Month/Day

XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 2 Engine Identification Number**LUBRICATION SYSTEM**

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

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

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the number one main bearing cap.

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

DESCRIPTION AND OPERATION (Continued)

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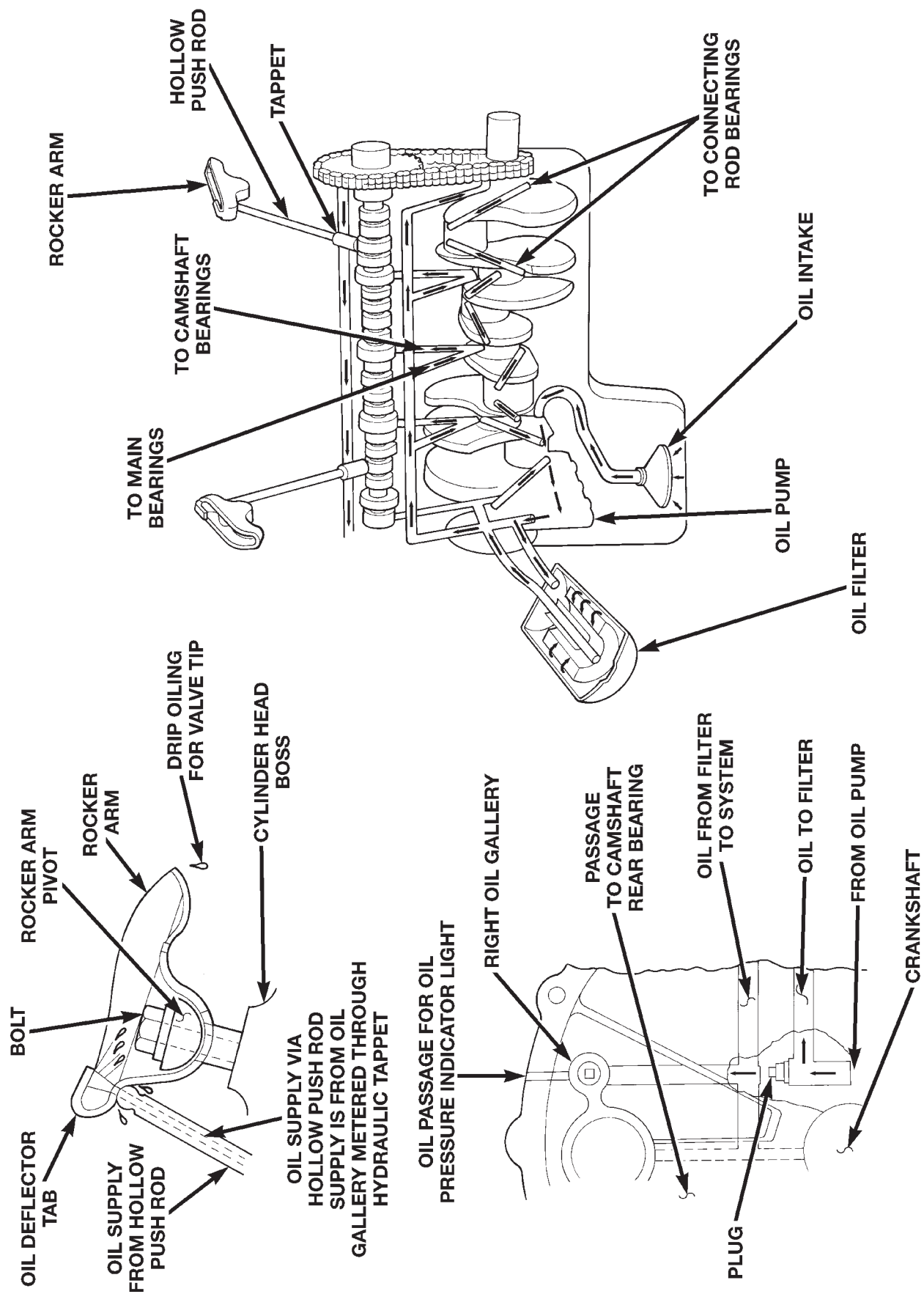


Fig. 3 Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 4) are held in place by 10 bolts. The spark plugs are located in the peak of the wedge between the valves.

The 5.9L cylinder head is identified by the foundry mark CF.

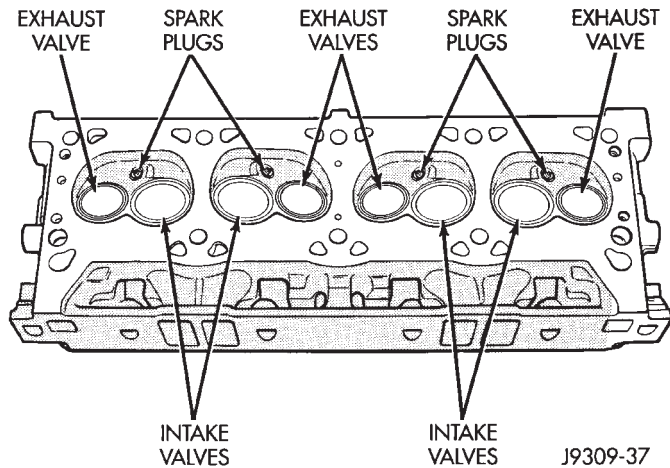


Fig. 4 Cylinder Head Assembly

PISTONS

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

VALVES AND VALVE SPRINGS

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

SERVICE PROCEDURES

VALVE TIMING

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

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

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

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

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

If reading is not within specified limits:

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

MEASURING TIMING CHAIN STRETCH

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

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 5).

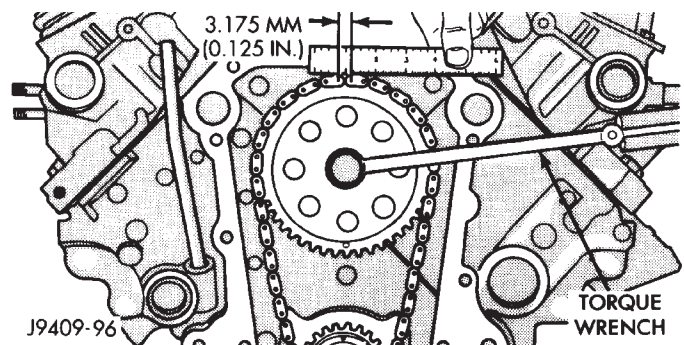


Fig. 5 Measuring Timing Chain Wear and Stretch

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

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

(6) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact

SERVICE PROCEDURES (Continued)

imaginary center line through both camshaft and crankshaft bores.

(7) Place timing chain around both sprockets.

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

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

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 6).

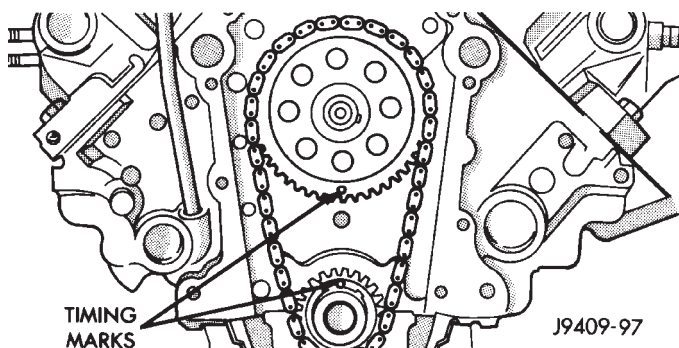


Fig. 6 Alignment of Timing Marks

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

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

FITTING PISTONS

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

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

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

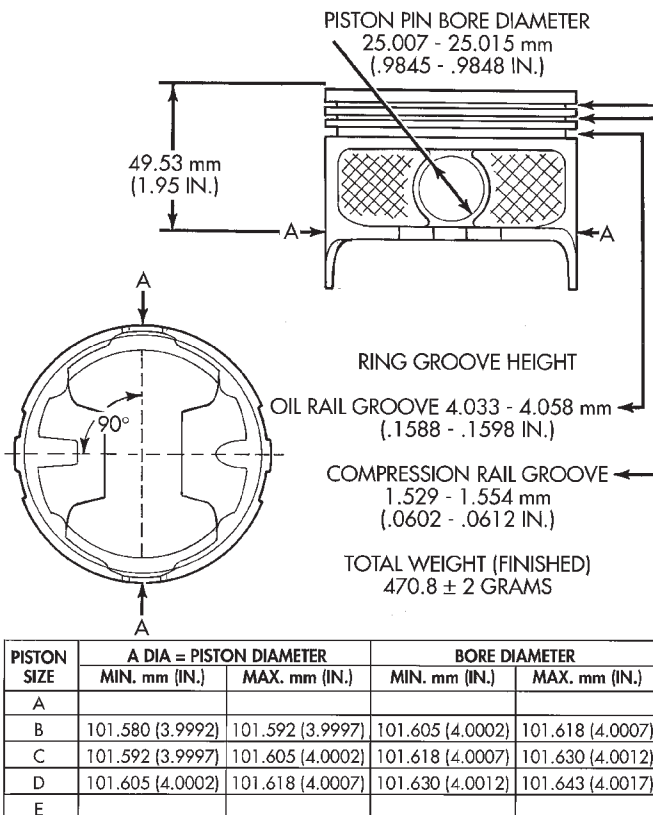
Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 7).

FITTING PISTON RINGS

(1) Measurement of end gaps:

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

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



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Fig. 7 Piston Measurements

ring gap should be between 0.508-0.762 mm (0.020-0.030 inch). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 inch).

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

(2) Install rings and confirm ring side clearance:

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

(b) Install the second compression rings using Installation Tool C-4184. The compression rings must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP (Fig. 8) (Fig. 10).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 9) (Fig. 10). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word TOP facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm

SERVICE PROCEDURES (Continued)

(0.0029-0.0038 inch) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 inch) side clearance.

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

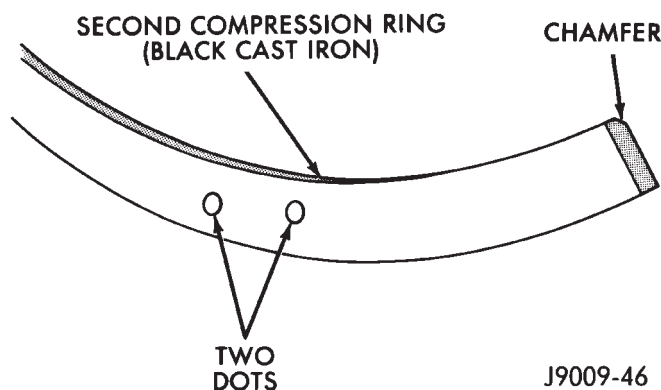


Fig. 8 Second Compression Ring Identification (Typical)

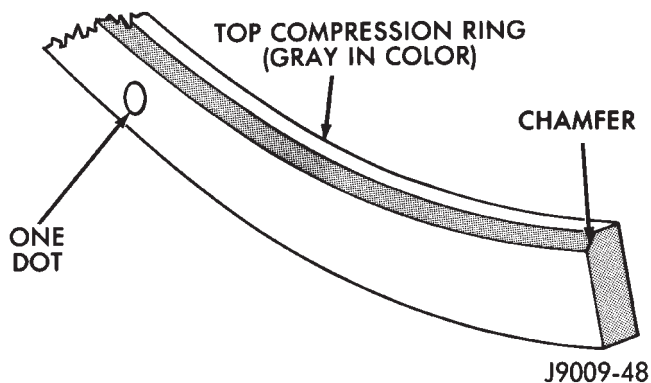


Fig. 9 Top Compression Ring Identification (Typical)

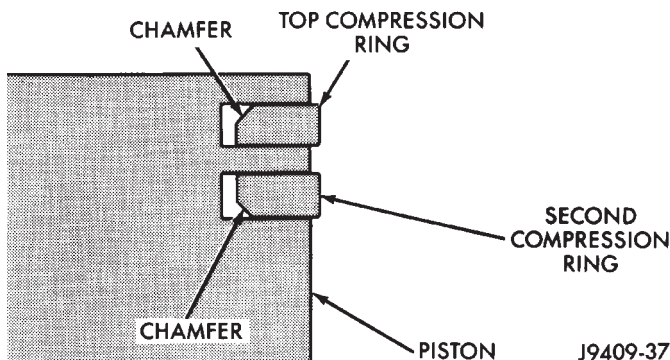


Fig. 10 Compression Ring Chamfer Location (Typical)

FITTING CONNECTING ROD BEARINGS

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

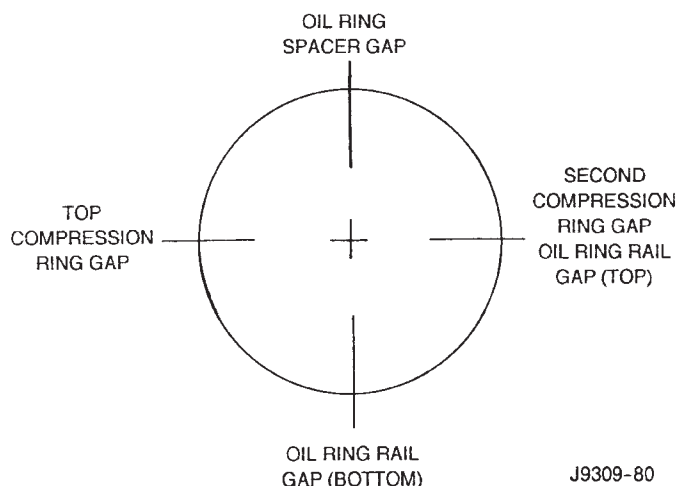


Fig. 11 Proper Ring Installation

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

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

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

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

FITTING CRANKSHAFT MAIN BEARINGS

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

Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 12). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

SERVICE PROCEDURES (Continued)

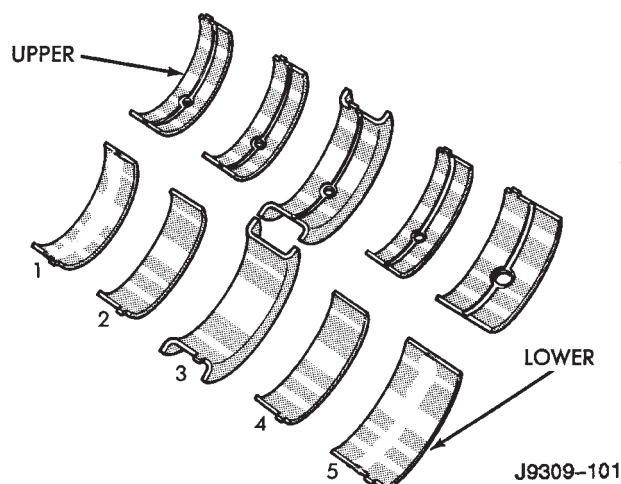


Fig. 12 Main Bearing Identification

CRANKSHAFT SERVICE

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.3 crankshaft counterweight (Fig. 13).

FOR EXAMPLE: R2 stamped on the No.3 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

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

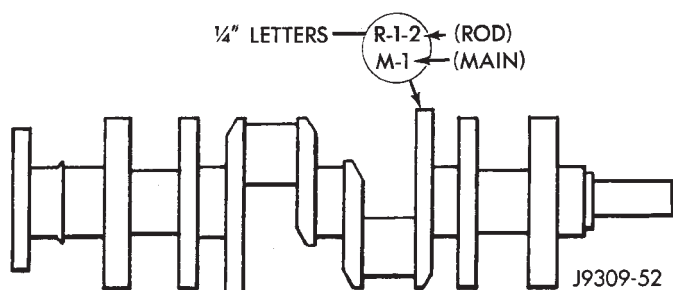


Fig. 13 Location of Crankshaft Identification

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

INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scor-

ing. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. **DO NOT** grind thrust faces of No.3 main bearing. **DO NOT** nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

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

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine **SLIGHTLY** and remove the thru-bolt and nut (Fig. 14).
- (6) Remove engine support bracket/cushion bolts (Fig. 14). Remove the support bracket/cushion and heat shields.

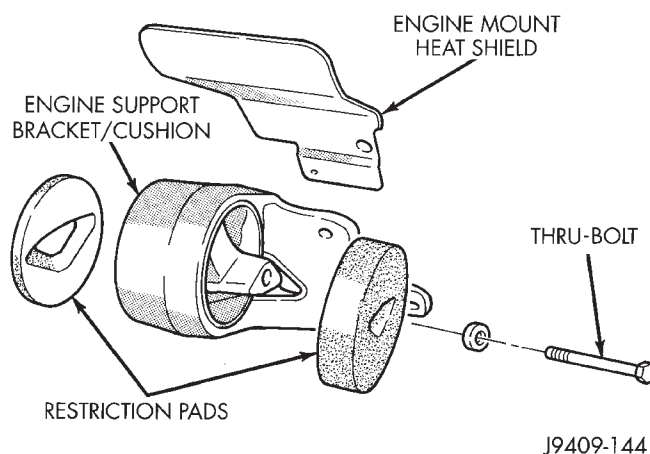


Fig. 14 Engine Front Mounts

INSTALLATION

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

REMOVAL AND INSTALLATION (Continued)

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

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 15).

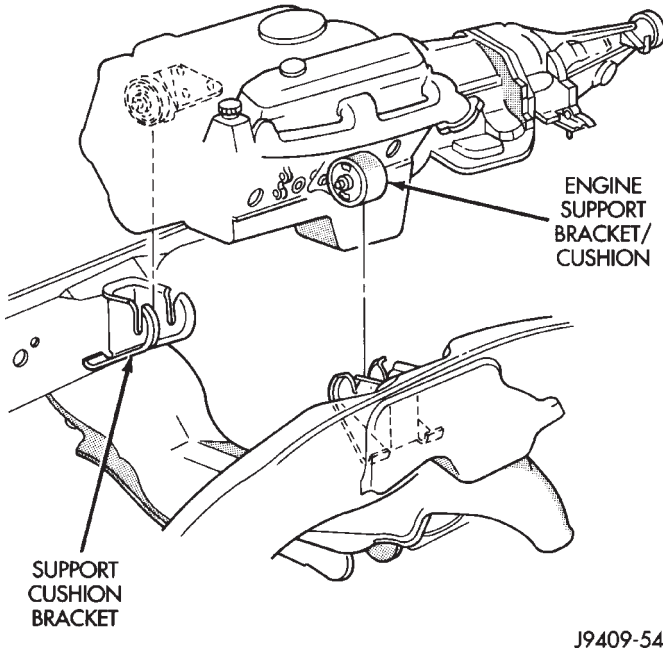


Fig. 15 Positioning Engine Front Mounts

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

(5) Lower the vehicle.

(6) Remove lifting fixture.

ENGINE MOUNT—REAR**REMOVAL**

(1) Raise the vehicle on a hoist.

(2) Position a transmission jack in place.

(3) Remove support cushion stud nuts (Fig. 16).

(4) Raise rear of transmission and engine SLIGHTLY.

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

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

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission. Install new attaching bolts and tighten to 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. 16).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Disconnect the battery negative cable.

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

(3) Recover refrigerant from a/c system, if equipped. Refer to Group 24, Heating and Air Conditioning for service procedures.

(4) Remove the a/c condenser, if equipped.

(5) Remove the transmission oil cooler. Refer to Group 7, Cooling for the correct procedure.

(6) Remove the washer bottle from the fan shroud.

(7) Remove the viscous fan/drive.

(8) Disconnect the radiator upper hose from the radiator.

(9) Remove the fan shroud.

(10) Disconnect the transmission cooler lines from the radiator.

(11) Disconnect the lower radiator hose at the radiator.

(12) Remove radiator (refer to Group 7, Cooling System).

(13) Remove the upper crossmember and top core support.

(14) Remove the accessory drive belt (refer to Group 7, Cooling System).

(15) Remove the A/C compressor with the lines attached. Secure compressor out of the way.

(16) Remove generator assembly. (refer to Group 8B, Battery/Starter/Generator Service).

(17) Remove the air cleaner resonator and duct work as an assembly.

(18) Disconnect the throttle linkage.

(19) Remove throttle body.

(20) Remove the intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(21) Remove the distributor cap and wiring.

(22) Disconnect the heater hoses.

(23) Disconnect the power steering hoses, if equipped.

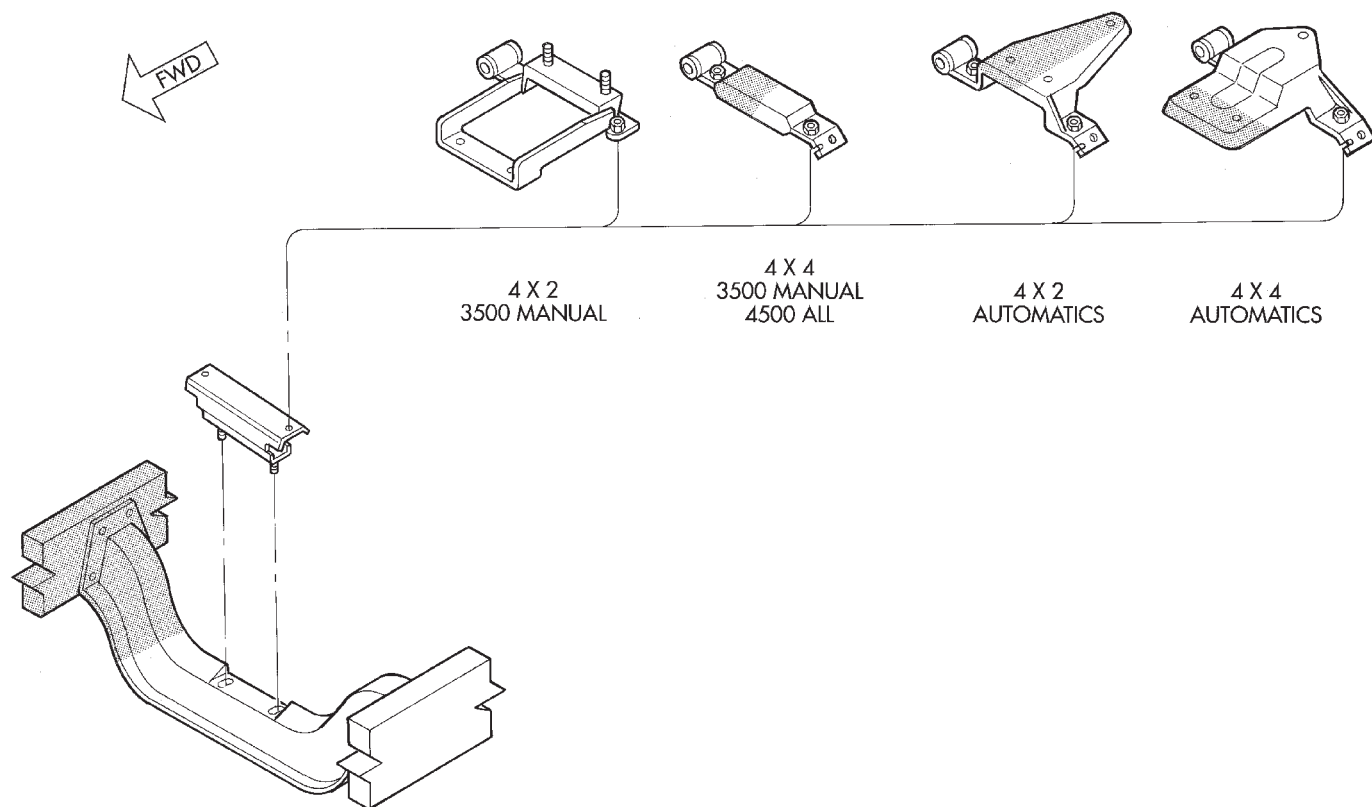
(24) Perform the Fuel System Pressure Release procedure. Refer to Group 14, Fuel System.

(25) Disconnect the fuel supply line. Refer to Group 14, Fuel Systems for the correct procedure..

(26) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(27) Raise and support the vehicle on a hoist and drain the engine oil.

REMOVAL AND INSTALLATION (Continued)



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Fig. 16 Engine Rear Support Cushion Assemblies

- (28) Remove engine front mount thru-bolt nuts.
- (29) Disconnect the transmission oil cooler lines from their retainers at the oil pan bolts.
- (30) Disconnect exhaust pipe at manifolds.
- (31) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).
- (32) Remove the dust shield and transmission inspection cover.
- (33) Remove drive plate to converter bolts (Automatic transmission equipped vehicles).
- (34) Remove transmission bell housing to engine block bolts.
- (35) Lower the vehicle.
- (36) Install an engine lifting fixture.
- (37) 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.
- (3) Lower engine into compartment and align engine with transmission:
 - Manual Transmission: Align clutch disc assembly (if disturbed). Refer to Group 6, Clutch for the

correct procedure. 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 Group 8B, Battery/Starter/Generator Service).

(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 Group 21, Transmissions).

REMOVAL AND INSTALLATION (Continued)

- (16) Connect the fuel supply line.
- (17) Connect the power steering hoses, if equipped.
- (18) Connect the heater hoses.
- (19) Install the distributor cap and wiring.
- (20) Install the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold.
- (21) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.
- (22) Connect the throttle linkage.
- (23) Install the air cleaner resonator and duct work..
- (24) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).
- (25) Install a/c compressor and lines.
- (26) Install the accessory drive belt (refer to Group 7, Cooling System).
- (27) Install upper radiator support crossmember.
- (28) Install radiator (refer to Group 7, Cooling System).
- (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.
- (33) Connect the radiator upper hose.
- (34) Install the washer bottle.
- (35) Install the transmission oil cooler.
- (36) Connect the transmission cooler lines.
- (37) If equipped, install the condenser.
- (38) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
- (39) Add engine oil to crankcase. Refer to Group 0, Lubrication and Maintenance for the correct fill capacity.
- (40) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).
- (41) Connect battery negative cable.
- (42) Start engine and inspect for leaks.
- (43) Road test vehicle.

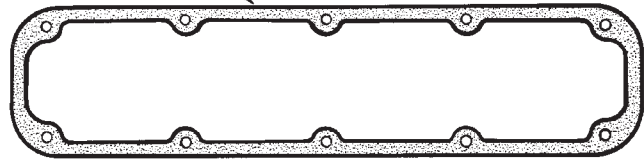
CYLINDER HEAD COVER

A steel backed silicon gasket is used with the cylinder head cover (Fig. 17). This gasket can be used again.

REMOVAL

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

CYLINDER HEAD COVER GASKET



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Fig. 17 Cylinder Head Cover Gasket

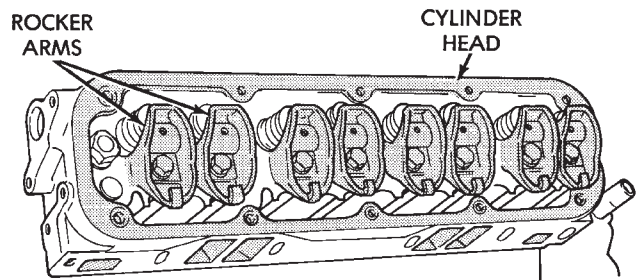
INSTALLATION

- (1) Clean cylinder head cover gasket surface.
- (2) Clean head rail, if necessary.
- (3) Inspect cover for distortion and straighten, if necessary.
- (4) Check the gasket for use in head cover installation. If damaged, use a new gasket.
- (5) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (6) Install closed crankcase ventilation system and evaporation control system.
- (7) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS

REMOVAL

- (1) Disconnect spark plug wires by pulling on the boot straight out in line with plug.
- (2) Remove cylinder head cover and gasket.
- (3) Remove the rocker arm bolts and pivots (Fig. 18). Place them on a bench in the same order as removed.
- (4) Remove the push rods and place them on a bench in the same order as removed.



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Fig. 18 Rocker Arms

INSTALLATION

- (1) Rotate the crankshaft until the "V8" mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.
- (2) Install the push rods in the same order as removed.

REMOVAL AND INSTALLATION (Continued)

(3) Install rocker arm and pivot assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

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

- (4) Install cylinder head cover.
- (5) Connect spark plug wires.

VALVE SPRING AND STEM SEAL REPLACEMENT-
IN VEHICLE

- (1) Remove the air cleaner.
- (2) Remove cylinder head covers and spark plugs.
- (3) Remove coil wire from distributor and secure to good ground to prevent engine from starting.
- (4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.
- (5) Remove rocker arms.
- (6) With air hose attached to an adapter installed in No.1 spark plug hole, apply 620-689 kPa (90-100 psi) air pressure.
- (7) Using Valve Spring Compressor Tool MD-998772A with adaptor 6716A, compress valve spring and remove retainer valve locks and valve spring.
- (8) Install seals on the exhaust valve stem and position down against valve guides.
- (9) The intake valve stem seals should be pushed firmly and squarely over the valve guide using the valve stem as a guide. DO NOT force seal against top of guide. When installing the valve retainer locks, compress the spring only enough to install the locks.
- (10) Follow the same procedure on the remaining 7 cylinders using the firing sequence 1-8-4-3-6-5-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.
- (11) Remove adapter from the No.1 spark plug hole.
- (12) Install rocker arms.
- (13) Install covers and coil wire to distributor.
- (14) Install air cleaner.
- (15) Road test vehicle.

CYLINDER HEADS

REMOVAL

- (1) Disconnect the battery negative cable.
- (2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).
- (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 Group 14, Fuel System). Disconnect the fuel supply line.
- (8) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down 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.
- (14) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.
- (15) Remove exhaust manifolds.
- (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.

INSTALLATION

- (1) Clean all surfaces of cylinder block and cylinder heads.
- (2) Clean cylinder block front and rear gasket surfaces using a suitable solvent.
- (3) Position the new cylinder head gaskets onto the cylinder block.
- (4) Position the cylinder heads onto head gaskets and cylinder block.
- (5) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 19). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

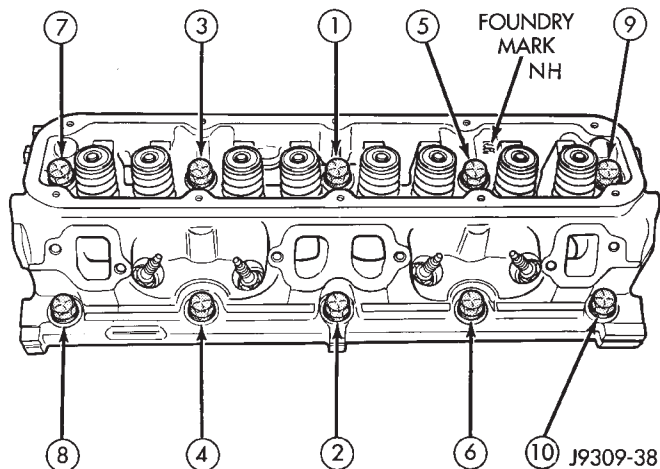


Fig. 19 Cylinder Head Bolt Tightening Sequence

REMOVAL AND INSTALLATION (Continued)

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

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

(7) Install the intake manifold and throttle body assembly (refer to Group 11, Exhaust System and Intake Manifold).

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

(9) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(10) Install coil 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.

(16) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

(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. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(19) Install closed crankcase ventilation system.

(20) Connect the evaporation control system.

(21) Install the air cleaner.

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

(23) Connect the negative cable to the battery.

VALVES AND VALVE SPRINGS

REMOVAL

(1) Remove the cylinder head. Refer to procedure in this section.

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

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

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

INSTALLATION

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

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

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

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

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

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

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

HYDRAULIC TAPPETS

REMOVAL

(1) Remove the air cleaner.

(2) Remove cylinder head cover.

(3) Remove rocker assembly and push rods. Identify push rods to ensure installation in original location.

(4) Remove intake manifold.

(5) Remove yoke retainer and aligning yokes.

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

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

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

INSTALLATION

(1) Lubricate tappets.

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

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold.

(5) Install push rods in original positions.

REMOVAL AND INSTALLATION (Continued)

- (6) Install rocker arm.
- (7) Install cylinder head cover.
- (8) Install distributor, start engine and reset timing.

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

VIBRATION DAMPER

REMOVAL

- (1) Disconnect the battery negative cable.
- (2) Remove the cooling system fan.
- (3) Remove the cooling fan shroud.
- (4) Remove the accessory drive belt (refer to Group 7, Cooling System).
- (5) Remove the vibration damper pulley.
- (6) Remove vibration damper bolt and washer from end of crankshaft.
- (7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 20).

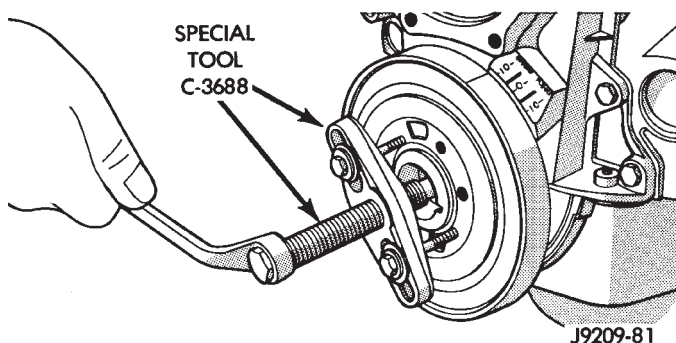


Fig. 20 Vibration Damper Assembly

- (8) Pull vibration damper off of the crankshaft.

INSTALLATION

- (1) Position the vibration damper onto the crankshaft.
- (2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 21).
- (3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.
- (4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.
- (5) Install the accessory drive belt (refer to Group 7, Cooling System).
- (6) Position the fan shroud and install the bolts. Tighten the retainer bolts to 11 N·m (95 in. lbs.) torque.
- (7) Install the cooling fan.
- (8) Connect the battery negative cable.

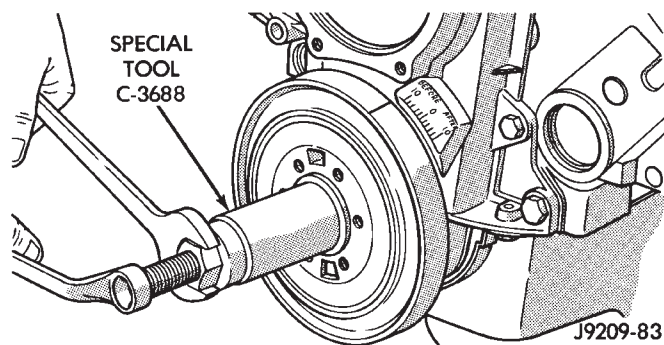


Fig. 21 Installing Vibration Damper

TIMING CHAIN COVER

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System).
- (3) Remove the serpentine belt (refer to Group 7, Cooling System).
- (4) Remove water pump (refer to Group 7, Cooling System).
- (5) Remove power steering pump (refer to Group 19, Steering).
- (6) Remove vibration damper.
- (7) Loosen oil pan bolts and remove the front bolt at each side.
- (8) Remove the cover bolts.
- (9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 22).

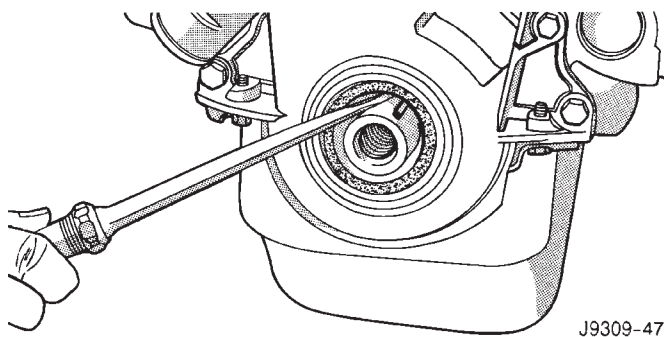


Fig. 22 Removal of Front Crankshaft Oil Seal

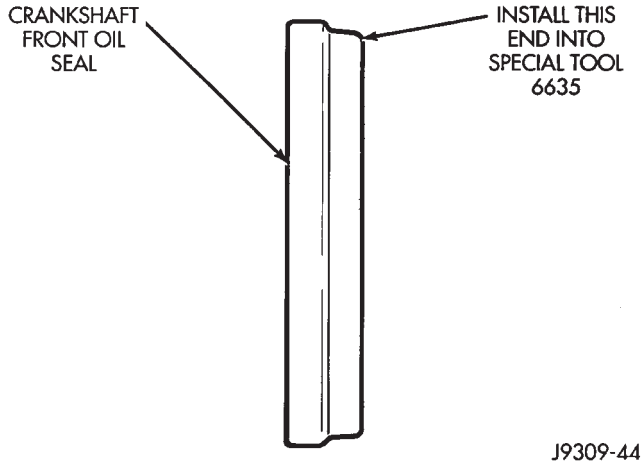
INSTALLATION

- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.
- (2) The water pump mounting surface must be cleaned.
- (3) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between tim-

REMOVAL AND INSTALLATION (Continued)

ing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

(4) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 23). Seat the oil seal in the groove of the tool.

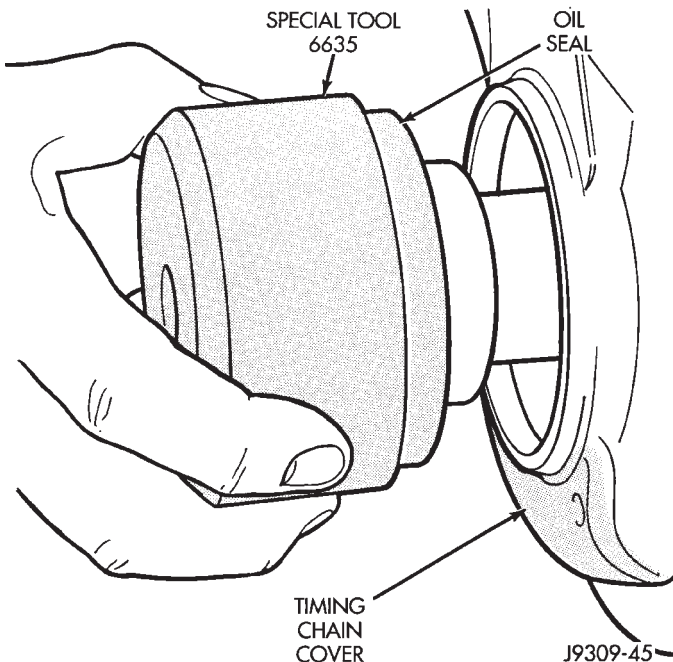


J9309-44

Fig. 23 Placing Oil Seal on Installation Tool 6635

(5) Position the seal and tool onto the crankshaft (Fig. 24).

(6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.



J9309-45

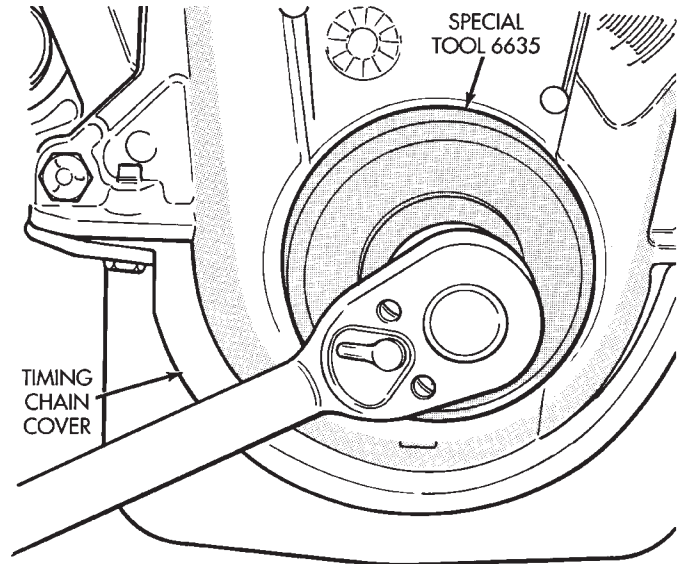
Fig. 24 Position Tool and Seal onto Crankshaft

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 25).

(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

(9) Tighten chain case cover bolts to 41 N·m (30 ft.lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

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



J9309-46

Fig. 25 Installing Oil Seal

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

(12) Install vibration damper.

(13) Install water pump and housing assembly using new gaskets (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

(14) Install power steering pump (refer to Group 19, Steering).

(15) Install the serpentine belt (refer to Group 7, Cooling System).

(16) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

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

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

(19) Connect the negative cable to the battery.

TIMING CHAIN

REMOVAL

(1) Remove Timing Chain Cover Refer to procedure in this section.

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

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

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

(2) Place timing chain around both sprockets.

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

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

(5) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 26).

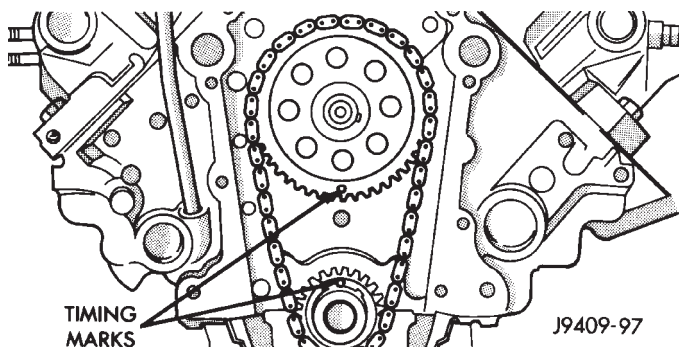


Fig. 26 Alignment of Timing Marks

(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

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

CAMSHAFT

NOTE: The camshaft has an integral oil pump and distributor drive gear (Fig. 27).

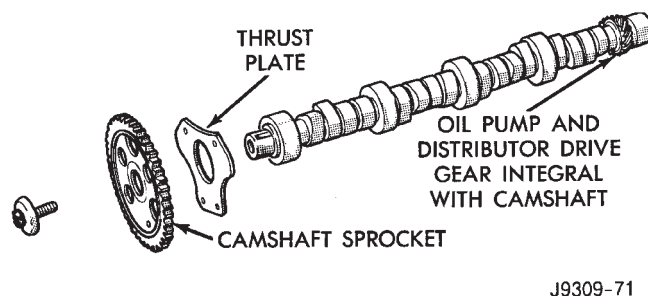


Fig. 27 Camshaft and Sprocket Assembly

REMOVAL

- (1) Remove intake manifold.
- (2) Remove cylinder head covers.
- (3) Remove timing case cover and timing chain.
- (4) Remove rocker arms.

(5) Remove push rods and tappets. Identify each part so it can be installed in its original location.

(6) Remove distributor and lift out the oil pump and distributor drive shaft.

(7) Remove camshaft thrust plate, note location of oil tab (Fig. 28).

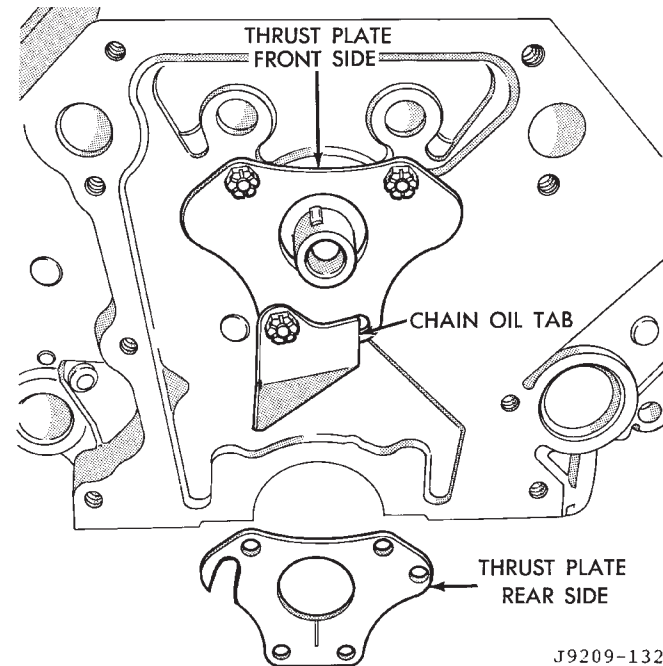


Fig. 28 Timing Chain Oil Tab Installation

(8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

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

(2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 29).

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in**

REMOVAL AND INSTALLATION (Continued)

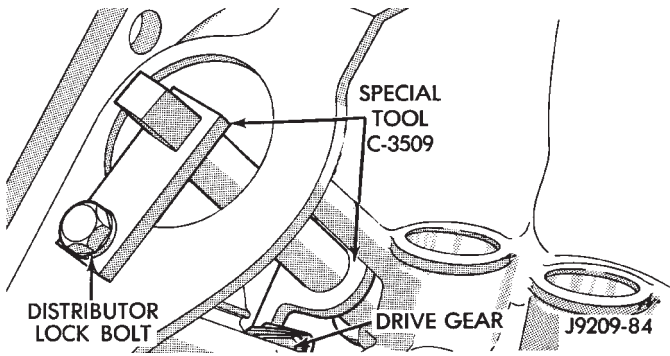


Fig. 29 Camshaft Holding Tool C-3509 (Installed Position)

thrust plate. Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

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

(6) Place timing chain around both sprockets.

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

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

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 30).

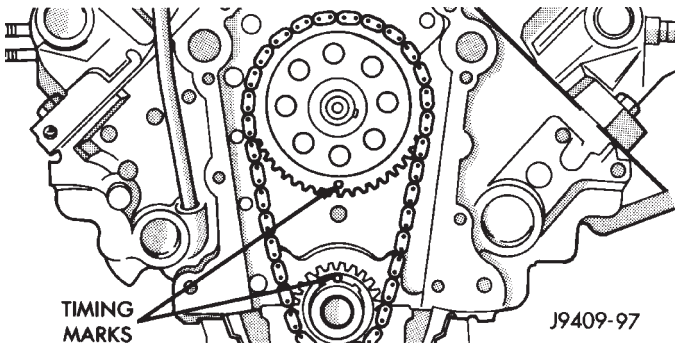


Fig. 30 Alignment of Timing Marks

(10) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

CAMSHAFT BEARINGS

REMOVAL

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

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 31).

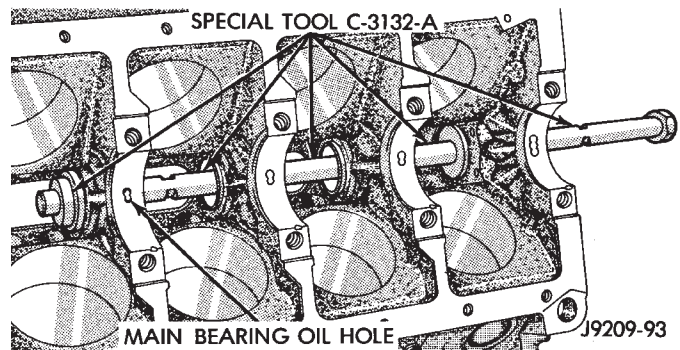


Fig. 31 Camshaft Bearings Removal/Installation with Tool C-3132-A

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

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

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

CAMSHAFT BEARINGS

REMOVAL

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

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REMOVAL AND INSTALLATION (Continued)

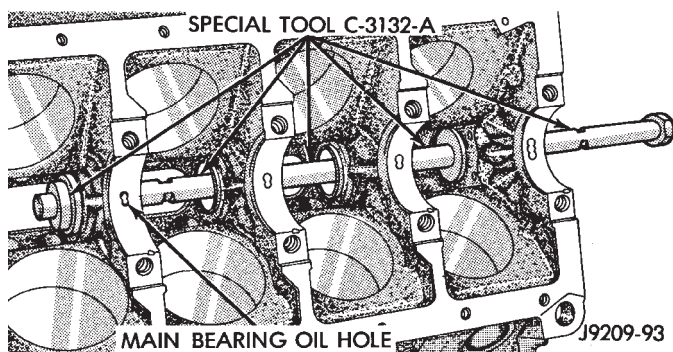


Fig. 32 Camshaft Bearings Removal/Installation with Tool C-3132-A

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

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

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion thru-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

INSTALLATION

- (1) Clean the block and pan gasket surfaces.
- (2) Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**
- (3) If present, trim excess sealant from inside the engine.
- (4) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 33).
- (5) Install the dowels in the cylinder block (Fig. 34).

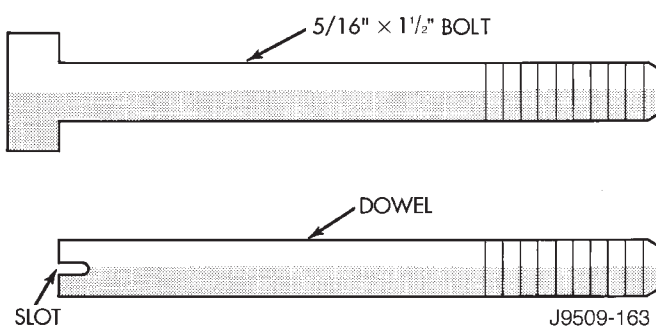


Fig. 33 Fabrication of Alignment Dowels

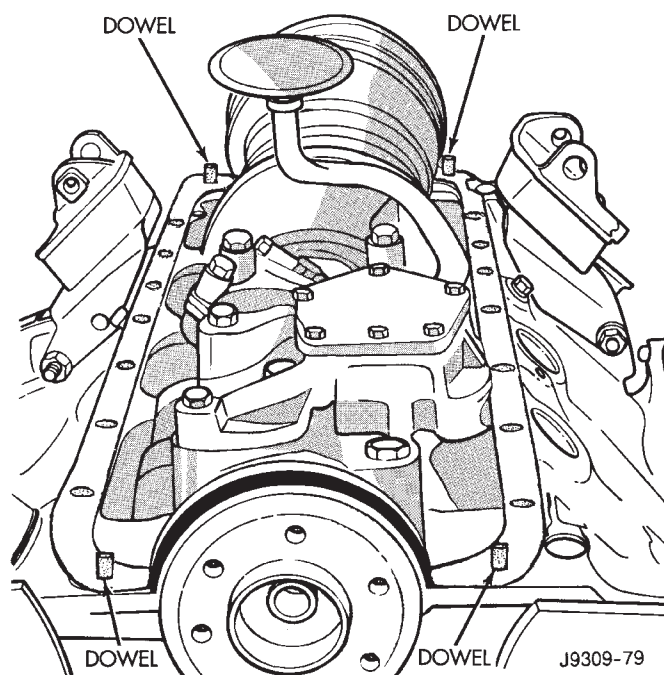


Fig. 34 Position of Dowels in Cylinder Block

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

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

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

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

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

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

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

(13) Install the engine to transmission strut.

(14) Install exhaust pipe.

(15) Lower vehicle.

(16) Install dipstick.

REMOVAL AND INSTALLATION (Continued)

- (17) Connect the negative cable to the battery.
- (18) Fill crankcase with oil to proper level.

CRANKSHAFT MAIN BEARINGS

REMOVAL

- (1) Remove the oil pan.
- (2) Remove the oil pump from the rear main bearing cap.
- (3) Identify bearing caps before removal. Remove bearing caps one at a time.
- (4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 35).
- (5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

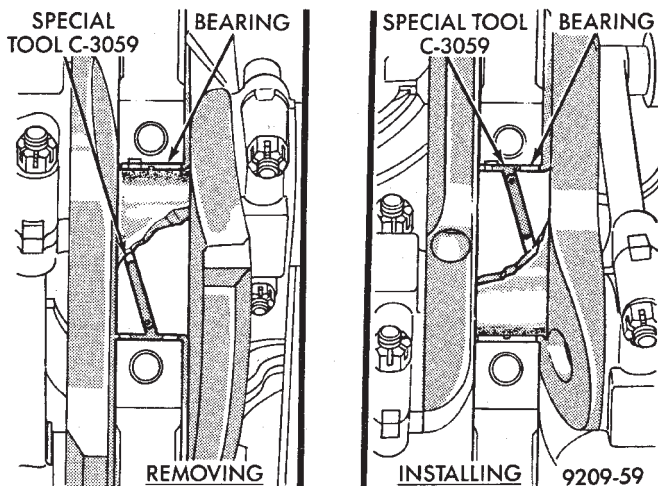


Fig. 35 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

- (1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 35).
- (2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.
- (3) Install the bearing cap. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.
- (4) Install the oil pump.
- (5) Install the oil pan.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

- (1) Remove the engine from the vehicle.
- (2) Remove the cylinder head.
- (3) Remove the oil pan.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.
- (5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.
- (6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft to center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**
- (7) After removal, install bearing cap on the mating rod.

INSTALLATION

- (1) Be sure that compression ring gaps are staggered so that neither is in-line with oil ring rail gap.
- (2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 36).

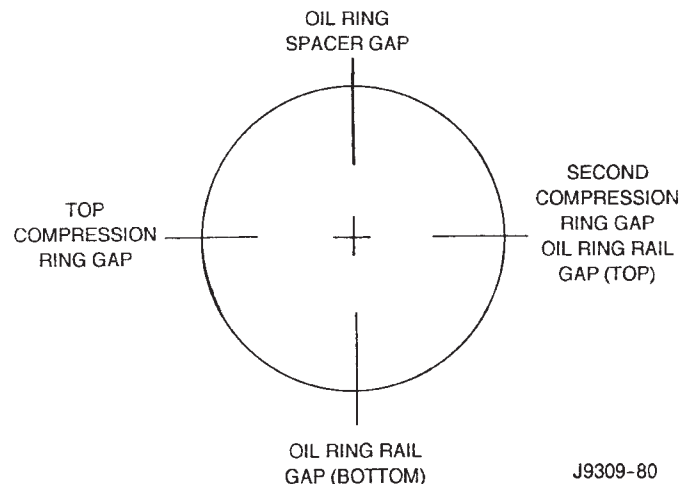


Fig. 36 Proper Ring Installation

- (3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**

- (4) Install connecting rod bolt protectors on rod bolts, the long protector should be installed on the numbered side of the connecting rod.

- (5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Be sure connecting rod and cylinder bore number are the

REMOVAL AND INSTALLATION (Continued)

same. Insert rod and piston into cylinder bore and guide rod over the crankshaft journal.

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

(7) The notch or groove on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.3 crankshaft counterweight (Fig. 37).

FOR EXAMPLE: R2 stamped on the No.3 crankshaft counterweight indicates that the No.2 rod journal is 0.025 mm (0.001 in) undersize. M4 indicates that the No.4 main journal is 0.025 mm (0.001 in) undersize. R3 M2 indicates that the No.3 rod journal and the No.2 main journal are 0.025 mm (0.001 in) undersize.

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

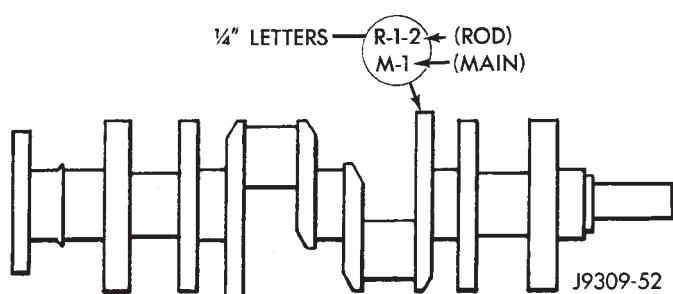


Fig. 37 Location of Crankshaft Identification

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

REMOVAL

(1) Remove the oil pan.

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

(3) Remove the vibration damper.

(4) Remove the timing chain cover.

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

(6) Lift the crankshaft out of the block.

(7) Remove and discard the crankshaft rear oil seals.

(8) Remove and discard the front crankshaft oil seal.

INSPECTION OF JOURNALS

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

CLEANING

Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.

INSTALLATION

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

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

(3) Position the crankshaft into the cylinder block.

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

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

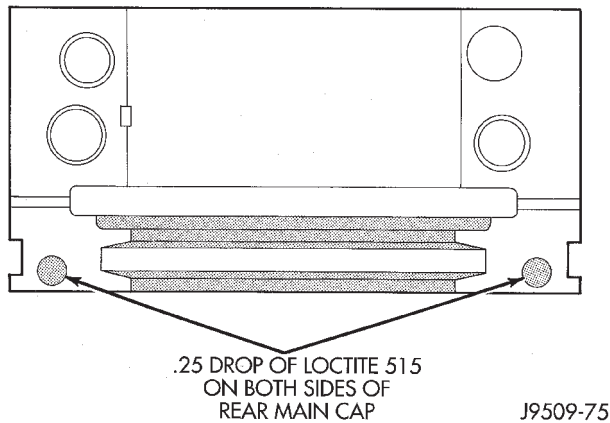
(6) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 38). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(7) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(8) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

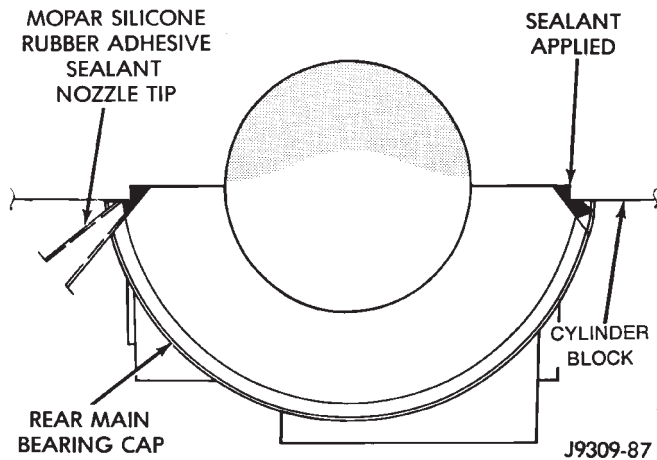
(9) Install oil pump.

REMOVAL AND INSTALLATION (Continued)

**Fig. 38 Sealant Application to Bearing Cap**

Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 39). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

- (10) Install new front crankshaft oil seal.
- (11) Immediately install the oil pan.

**Fig. 39 Apply Sealant to Bearing Cap to Block Joint OIL PUMP****REMOVAL**

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

INSTALLATION

- (1) Install oil pump. During installation slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.
- (2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten

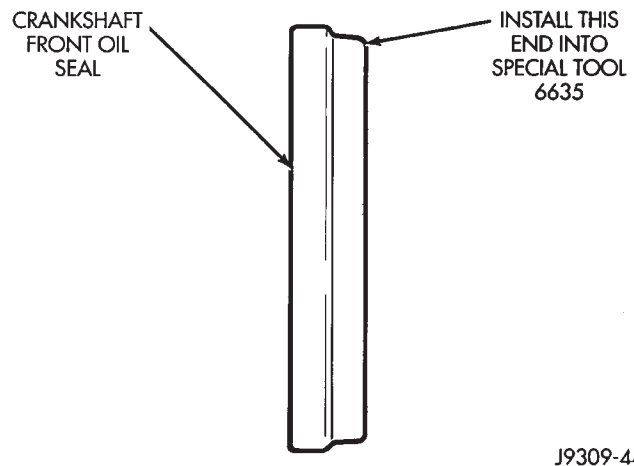
pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

- (3) Install the oil pan.

FRONT CRANKSHAFT OIL SEAL

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

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.
- (4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.
- (5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 40). Seat the oil seal in the groove of the tool.

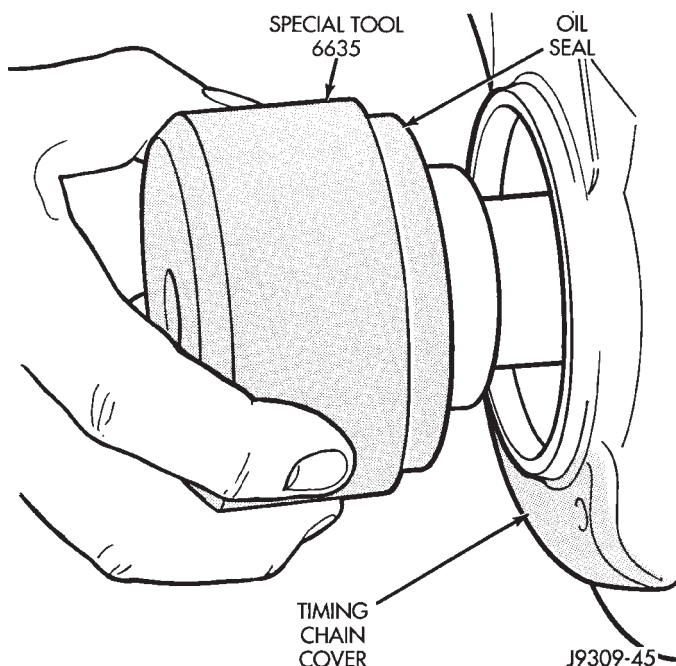
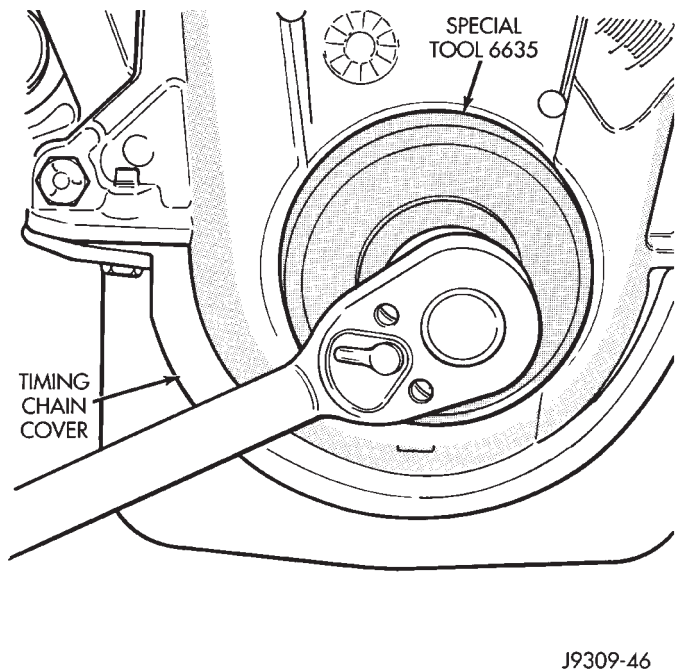
**Fig. 40 Placing Oil Seal on Installation Tool 6635**

- (6) Position the seal and tool onto the crankshaft (Fig. 41).
- (7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 42).
- (8) Remove the vibration damper bolt and seal installation tool.
- (9) Inspect the seal flange on the vibration damper.
- (10) Install the vibration damper.
- (11) Connect the negative cable to the battery.

CRANKSHAFT REAR OIL SEALS

The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal.

REMOVAL AND INSTALLATION (Continued)

**Fig. 41 Position Tool and Seal onto Crankshaft****Fig. 42 Installing Oil Seal**

The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL REPLACEMENT—CRANKSHAFT REMOVED

- (1) Remove the crankshaft. Discard the old upper seal.
- (2) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.

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

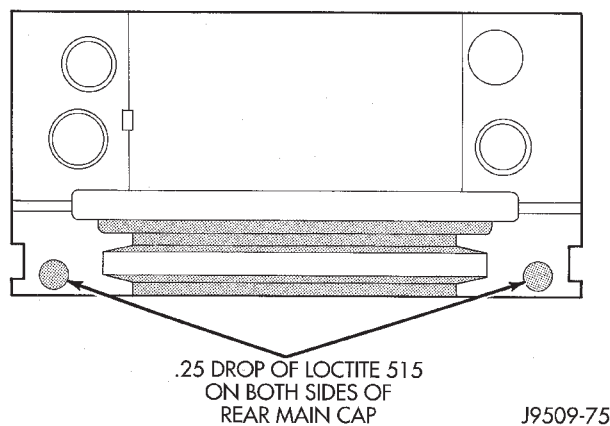
(4) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.

(5) Position the crankshaft into the cylinder block.

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

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

(8) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 43). 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. 43 Sealant Application to Bearing Cap**

(9) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

(10) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(11) Install oil pump.

(12) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 44). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(13) Install new front crankshaft oil seal.

(14) Immediately install the oil pan.

UPPER SEAL REPLACEMENT—CRANKSHAFT INSTALLED

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

REMOVAL AND INSTALLATION (Continued)

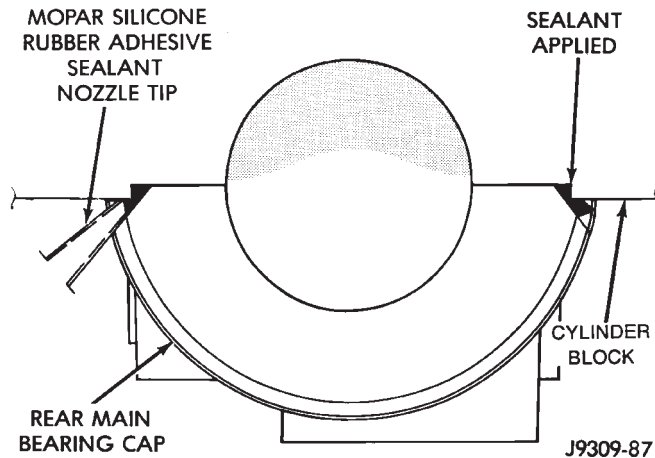


Fig. 44 Apply Sealant to Bearing Cap to Block Joint

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

(4) Carefully remove and discard the old upper oil seal.

(5) Clean the cylinder block mating surfaces before oil seal installation.

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

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

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

(9) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 43). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

(10) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(12) Install oil pump.

(13) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 44) (Fig. 8). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(14) Immediately install the oil pan.

LOWER SEAL REPLACEMENT

(1) Remove the oil pan.

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

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

(4) Clean the rear main cap mating surfaces including the oil pan seal grooves.

(5) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).

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

(7) Install a new lower seal in bearing cap with white paint facing the rear of engine.

(8) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 43). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(9) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(11) Install oil pump.

(12) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 44). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(13) Immediately install the oil pan.

ENGINE CORE PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 45). This will reduce internal leakage and help maintain higher oil pressure at idle.

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 46).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 46).

CLEANING

Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.

REMOVAL AND INSTALLATION (Continued)

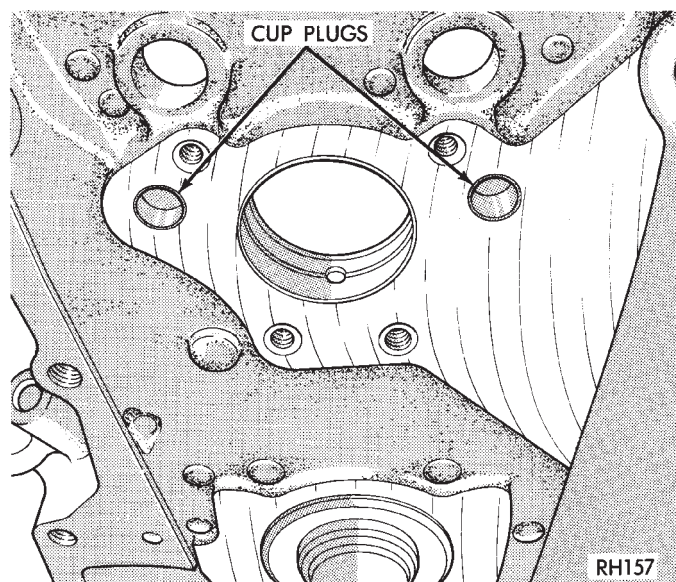


Fig. 45 Location of Cup Plugs in Oil Galleries

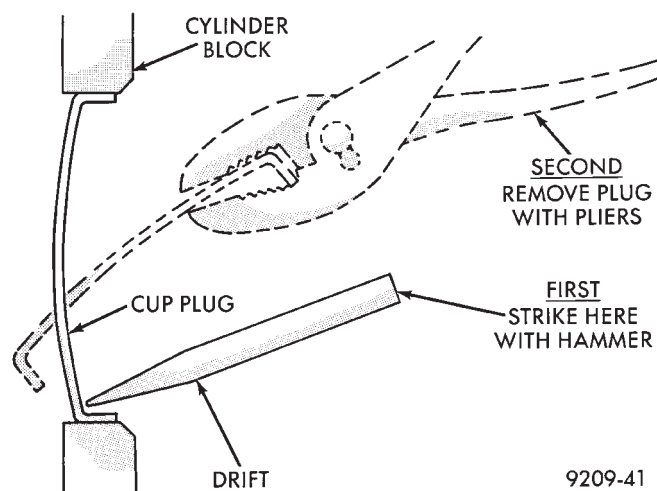


Fig. 46 Core Hole Plug Removal

Make certain the new plug is cleaned of all oil or grease.

INSTALLATION

(1) Coat edges of plug and core hole with Mopar Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting as restricted coolant flow can result and cause serious engine problems.

(2) Using proper plug drive, drive cup plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 inch) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

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

DISASSEMBLE

- (1) Pry out plunger retainer spring clip (Fig. 47).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 47). Check valve could be flat or ball.

ASSEMBLE

- (1) Clean all tappet parts in a solvent that will remove all varnish and carbon.
- (2) Replace tappets that are unfit for further service with new assemblies.
- (3) If plunger shows signs of scoring or wear, install a new tappet assembly. If valve is pitted, or valve seat on end of plunger is prevented from seating, install a new tappet assembly.
- (4) Assemble tappets (Fig. 47).

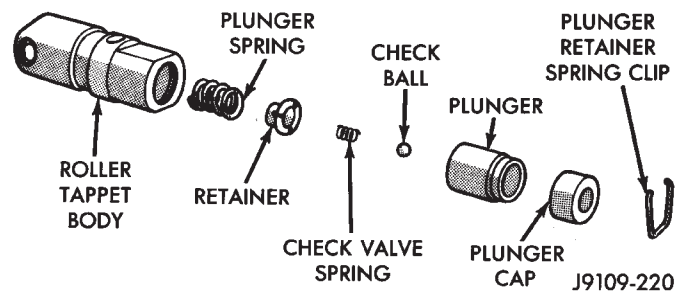


Fig. 47 Hydraulic Tappet Assembly

CYLINDER BLOCK

DISASSEMBLE

- (1) Remove the cylinder head.
- (2) Remove the oil pan.
- (3) Remove the piston/connecting rod assembly.

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the Oil-To-Filter and Oil-From-Filter passages (Fig. 48). Improper installation or plug missing could cause erratic, low or no oil pressure.

DISASSEMBLY AND ASSEMBLY (Continued)

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 inches) from machined surface of block (Fig. 48). If plug is too high, use a suitable flat dowel drift to position properly.

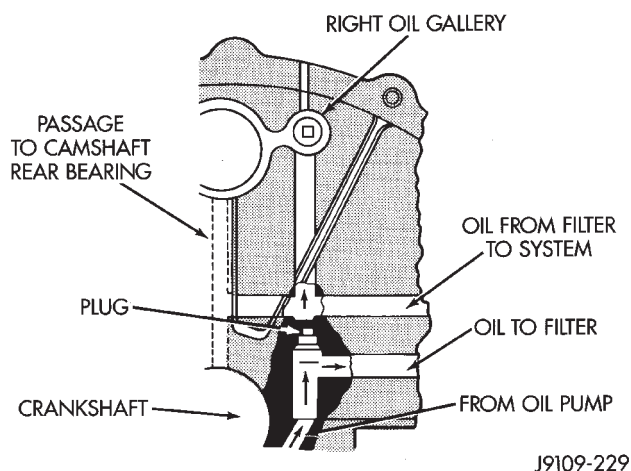


Fig. 48 Oil Line Plug

(4) If plug is too low, remove oil pan and rear main bearing cap. Use suitable flat dowel to properly position. Coat outside diameter of plug with Mopar® (stud and bearing mount adhesive), or equivalent. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 inches) from bottom of the block.

(5) Assemble engine and check oil pressure.

ASSEMBLE

- (1) Install the piston/connecting rod assembly.
- (2) Install the oil pan.
- (3) Install the cylinder head.
- (4) Install the engine into the vehicle.

VALVE SERVICE

VALVE CLEANING

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

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

VALVE INSPECTION

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

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 49). The special

sleeve places the valve at the correct height for checking with a dial indicator.

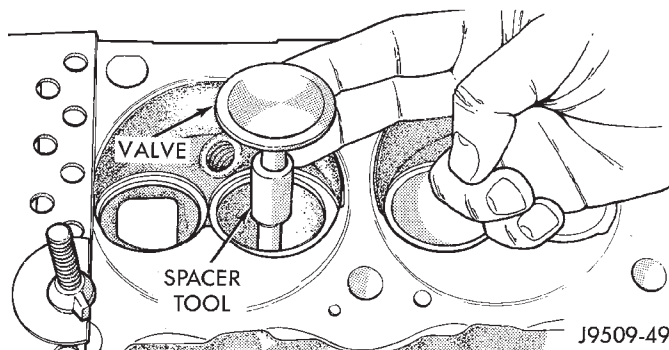


Fig. 49 Positioning Valve with Tool C-3973

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 50).

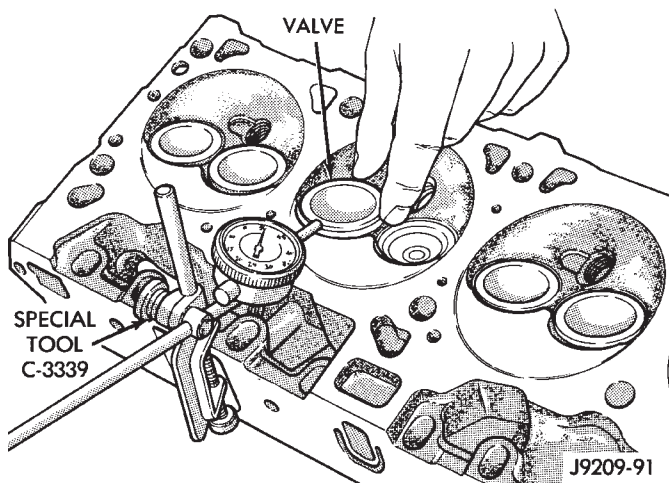


Fig. 50 Measuring Valve Guide Wear

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

Service valves with oversize stems are available (Fig. 51).

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

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Fig. 51 Reamer Sizes

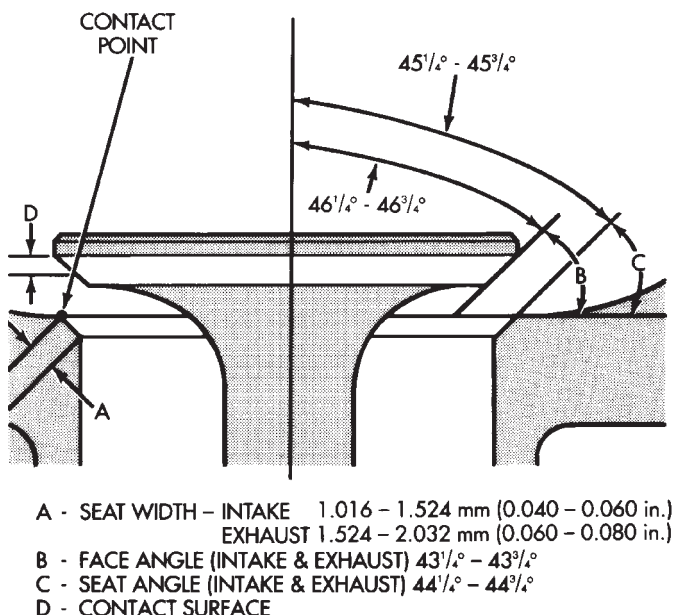
DISASSEMBLY AND ASSEMBLY (Continued)

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

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

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a $43\frac{1}{4}^{\circ}$ to $43\frac{3}{4}^{\circ}$ face angle and a $44\frac{1}{4}^{\circ}$ to $44\frac{3}{4}^{\circ}$ seat angle (Fig. 52).



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Fig. 52 Valve Face and Seat Angles

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 53). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 54).

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

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

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of

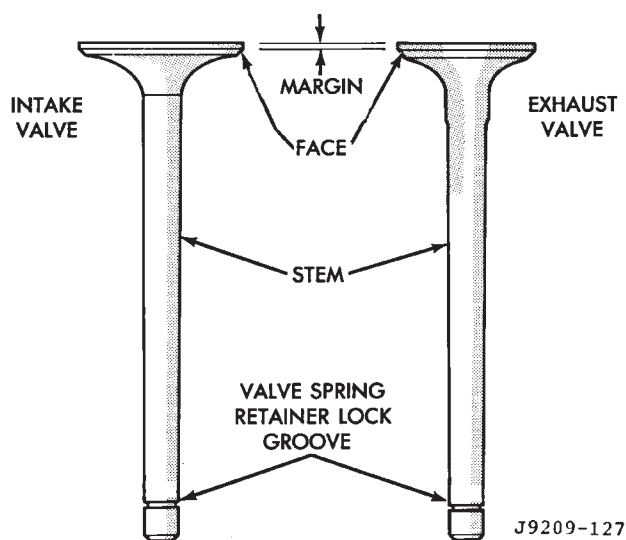


Fig. 53 Intake and Exhaust Valves

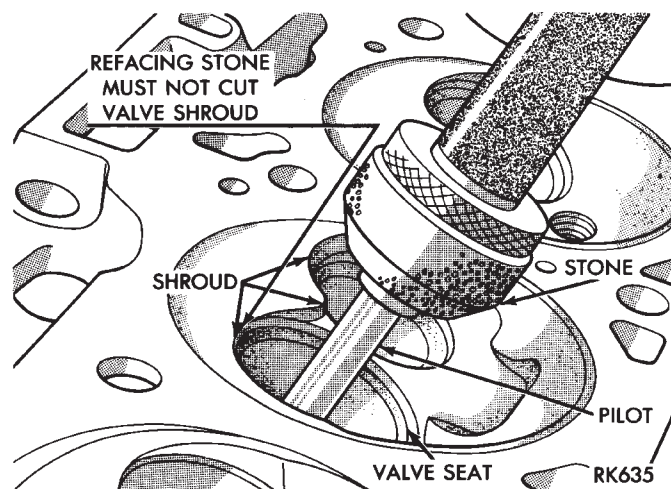


Fig. 54 Refacing Valve Seats

valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

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

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is $1\frac{5}{16}$ inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the $1\frac{5}{16}$ inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 55). 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

DISASSEMBLY AND ASSEMBLY (Continued)

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.

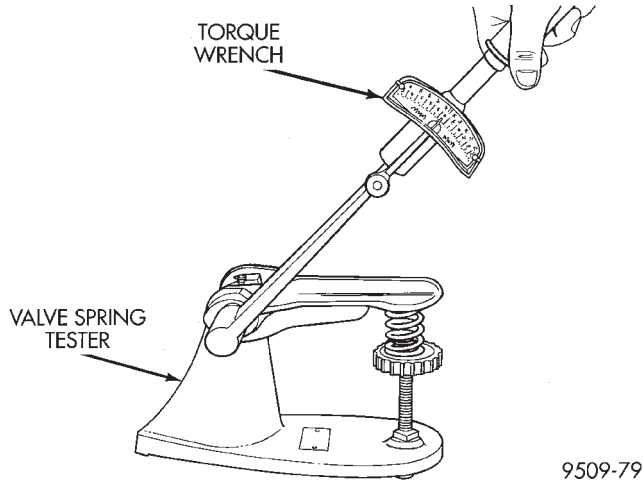


Fig. 55 Testing Valve Spring for Compressed Length

OIL PUMP

DISASSEMBLE

- (1) Remove the relief valve as follows:
 - (a) Remove cotter pin. Drill a 3.175 mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw.
 - (b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 56).

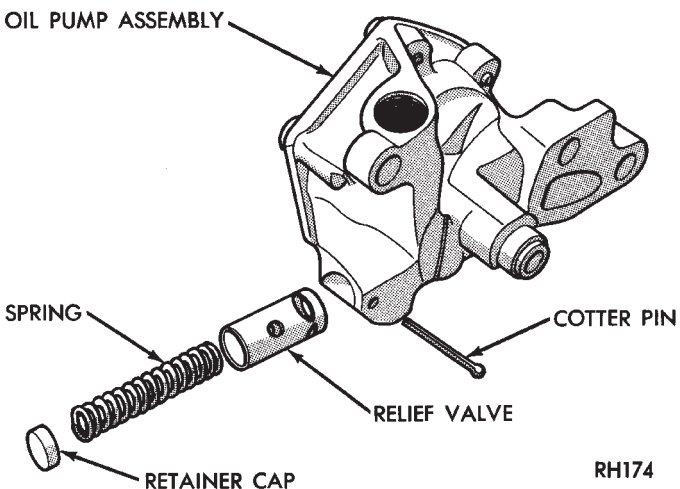


Fig. 56 Oil Pressure Relief Valve

- (2) Remove oil pump cover (Fig. 57).
- (3) Remove pump outer rotor and inner rotor with shaft (Fig. 57).

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

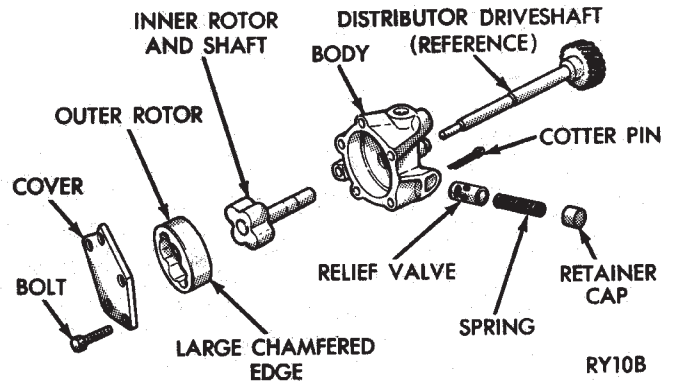


Fig. 57 Oil Pump

ASSEMBLE

- (1) Install pump rotors and shaft, using new parts as required.
- (2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install the relief valve and spring. Insert the cotter pin.
- (4) Tap on a new retainer cap.
- (5) Prime oil pump before installation by filling rotor cavity with engine oil.

CLEANING AND INSPECTION

CYLINDER HEAD ASSEMBLY

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075 mm/mm (0.00075 inch/inch) times the span length in inches in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE: A 305 mm (12 inch) span is 0.102 mm (0.004 inch) out-of-flat. The allowable out-of-flat is 305×0.00075 (12 \times 0.00075) equals 0.23 mm (0.009 inch). This amount of out-of-flat is acceptable.

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

CLEANING AND INSPECTION (Continued)

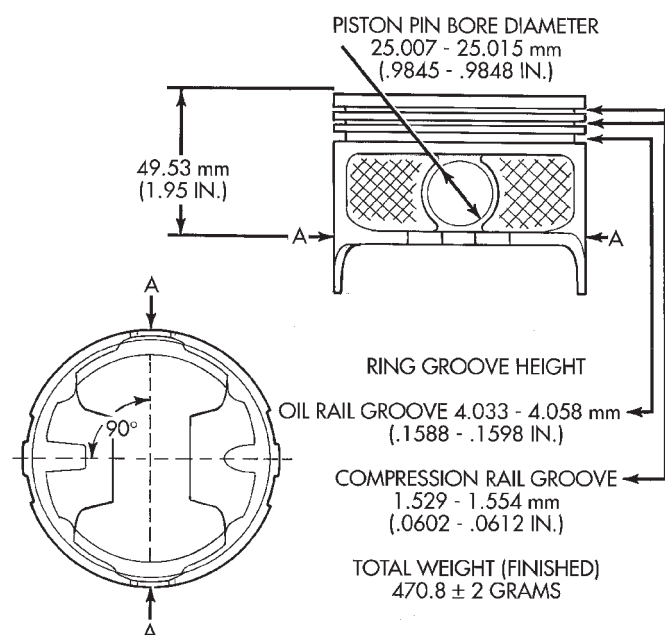
PISTON AND CONNECTING ROD ASSEMBLY

INSPECTION

Check the crankshaft connecting rod journal for excessive wear, taper and scoring.

Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 58).



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				

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Fig. 58 Piston Measurements

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

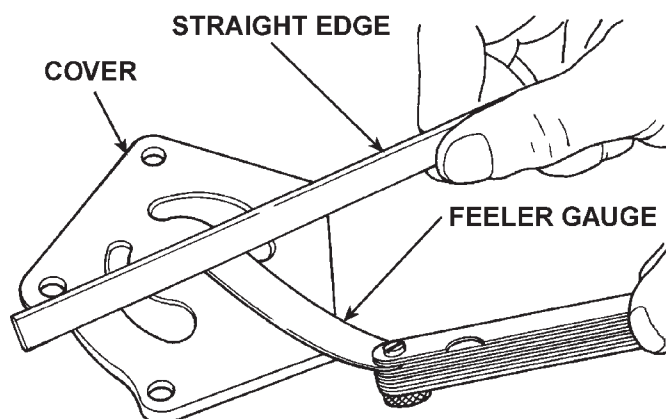
Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

OIL PUMP

INSPECTION

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

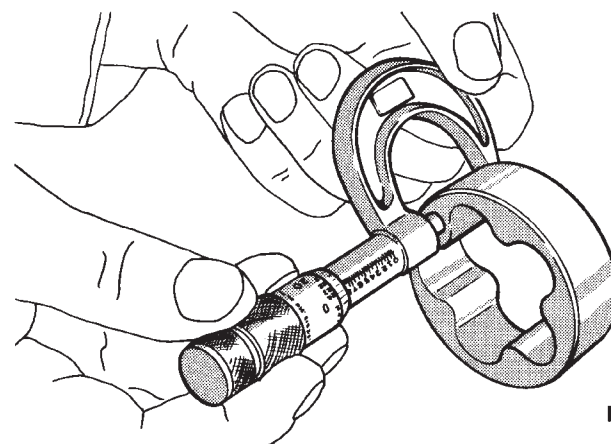
Lay a straightedge across the pump cover surface (Fig. 59). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.



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Fig. 59 Checking Oil Pump Cover Flatness

Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 60).



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Fig. 60 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 61).

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 62). If clearance

CLEANING AND INSPECTION (Continued)

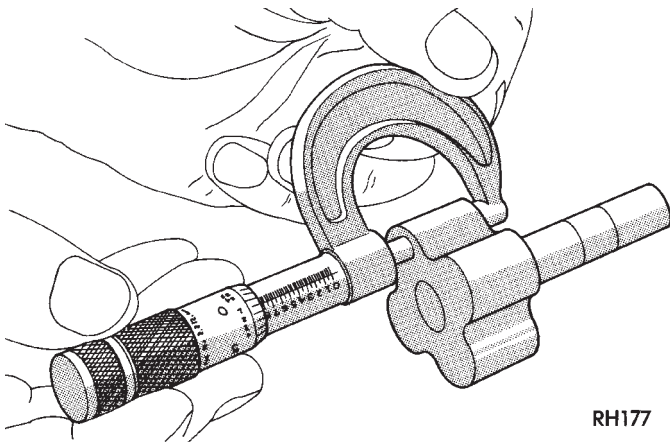


Fig. 61 Measuring Inner Rotor Thickness
is 0.356 mm (0.014 inch) or more, replace oil pump assembly.

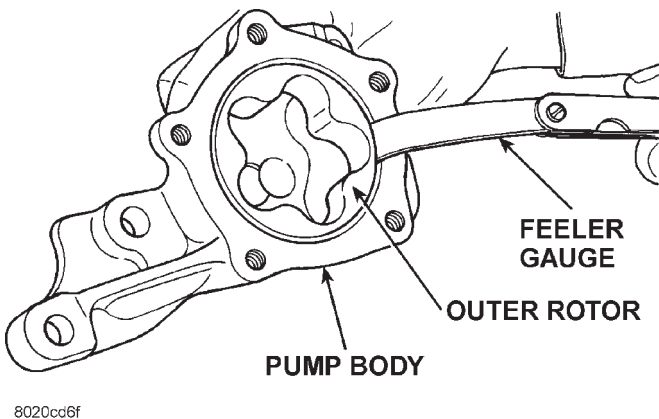


Fig. 62 Measuring Outer Rotor Clearance in Housing

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 63).

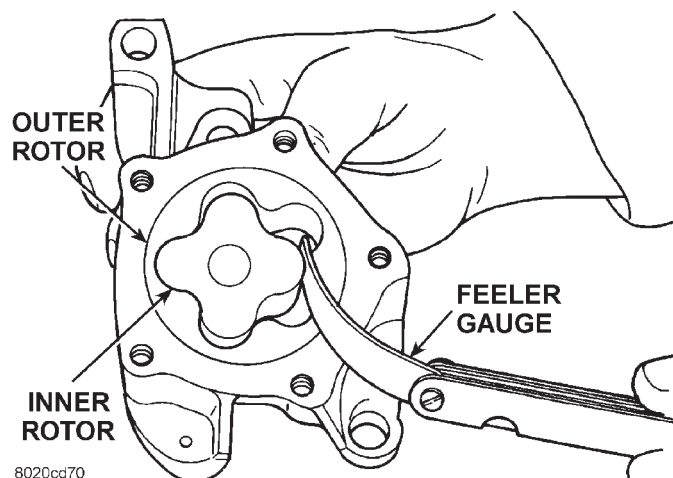


Fig. 63 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 64).

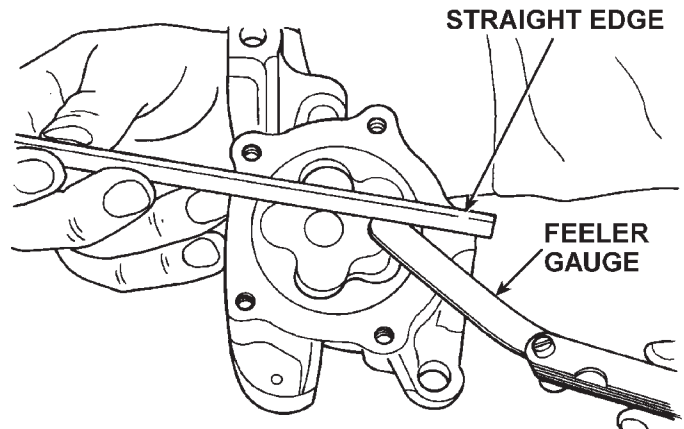


Fig. 64 Measuring Clearance Over Rotors

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 65).

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

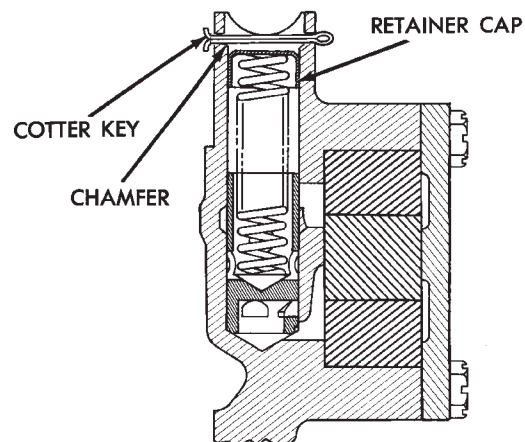


Fig. 65 Proper Installation of Retainer Cap
CYLINDER BLOCK

CLEANING

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

CLEANING AND INSPECTION (Continued)

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper with Cylinder Bore Indicator Tool C-119. The cylinder block should be bored and honed with new pistons and rings fitted if:

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

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

Refer to Standard Service Procedures in the beginning of this Group for the proper honing of cylinder bores.

SPECIFICATIONS

5.9L ENGINE SPECIFICATIONS

GENERAL INFORMATION

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 Filtration
 Cooling System . . Liquid Cooled - Forced Circulation
 Cylinder Block . . . Cast Iron
 Cylinder Head . . . Cast Iron
 Crankshaft Nodular Iron
 Camshaft Nodular Cast Iron
 Combustion Chambers . . . Wedge - High Swirl Valve Shrouding
 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 50.749 - 50.775 mm (1.998 - 1.999 in.)
 No. 2 50.343 - 50.368 mm (1.982 - 1.983 in.)
 No. 3 49.962 - 49.987 mm (1.967 - 1.968 in.)
 No. 4 49.555 - 49.581 mm (1.951 - 1.952 in.)
 No. 5 39.637 - 39.662 mm (1.5605 - 1.5615 in.)

Bearing Diameter

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

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.)

Service Limit 0.0762 mm (0.003 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 (#1 Journal) . . . 0.013 - 0.038 mm
 (0.0005 - 0.0015 in.)

Service Limit (#1 Journal) 0.0381 mm
 (0.0015 in.)

Bearing Clearance

(#2-5 Journals) 0.013 - 0.051 mm
 (0.0005 - 0.002 in.)

Service Limit

(#2-5 Journals) 0.064 mm (0.0025 in.)

Crankshaft End Play

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.)

Out of Round (Max.) 0.127 mm (0.005 in.)

Taper (Max.) 0.254 mm (0.010 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.)

SPECIFICATIONS (Continued)

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.)
 Width (Finish) –
 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.)
 Head Diameter – Exhaust. 41.072 (1.617 in.)
 Length (Overall) –
 Intake 126.21 – 126.85 mm (4.969 – 4.994 in.)
 Length (Overall) –
 Exhaust. 126.44 – 127.30 mm (4.978 – 5.012 in.)
 Lift (@ zero lash) – Intake 10.414 mm (0.410 in.)
 Lift (@ zero lash) – Exhaust. 10.592 mm (0.417 in.)
 Stem Diameter –
 Intake 9.449 – 9.474 mm (0.372 – 0.373 in.)
 Stem Diameter –
 Exhaust. 9.423 – 9.449 mm (0.371 – 0.372 in.)
 Guide Bore 9.500 – 9.525 mm (0.374 – 0.375 in.)
 Stem to Guide Clearance –
 Intake. 0.0254 – 0.0762 mm (0.001 – 0.003 in.)
 Stem to Guide Clearance –
 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.)
 Spring Tension – (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)

Curb Idle (Min.)* 41.4 kPa (6 psi)
 Switch Actuating
 Pressure 34.5 – 48.3 kPa (5 – 7 psi)

CAUTION: 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.)
 Outer Rotor Diameter
 (Min.) 62.7126 mm (2.469 in.)
 Outer Rotor Thickness
 (Min.) 20.955 mm (0.825 in.)
 Tip Clearance between Rotors
 (Max.) 0.2032 mm (0.008 in.)

PISTONS

Clearance at Top of Skirt 0.013 – 0.038 mm
 (0.0005 – 0.0015 in.)
 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 –
 #1&2 4.761 – 4.912 mm (0.187 – 0.193 in.)
 Piston Ring Groove Depth –
 #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.)

SPECIFICATIONS (Continued)

Ring Gap**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°

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
0.025 mm (0.001 inch) U/S Crankshaft	R or M M-2-3 etc. (Indicating No. 2 & 3 main bearing journal) and/or R-1-4 etc. (Indicating No. 1 & 4 connecting rod journal)	Milled flat on number three crankshaft counterweight
0.508 mm (0.020 inch) O/S Cylinder Bores	A	Following engine serial number.
0.203 mm (0.008 inch) O/S Tappets	◆	3/8" diamond-shaped stamp Top pad — Front of engine and flat ground on outside surface of each O/S tappet bore.
0.127 mm (0.005 inch) O/S Valve Stems	X	Milled pad adjacent to two 3/8" tapped holes on each end of cylinder head.

J9209-120

TORQUE SPECIFICATIONS

5.9L ENGINE**DESCRIPTION****TORQUE****Camshaft**

Bolt 68 N·m (50 ft. lbs.)

Camshaft Thrust Plate

Bolts 24 N·m (210 in. lbs.)

Chain Case Cover

Bolts 41 N·m (30 ft. lbs.)

Connecting Rod Cap

Bolts 61 N·m (45 ft. lbs.)

Crankshaft Main Bearing Cap

Bolts 115 N·m (85 ft. lbs.)

Crankshaft Pulley

Bolts 24 N·m (210 in. lbs.)

Cylinder Head

Bolts (1st Step) 68 N·m (50 ft. lbs.)

DESCRIPTION**TORQUE**

Bolts (2nd Step) 143 N·m (105 ft. lbs.)

Cylinder Head Cover

Bolts 11 N·m (95 in. lbs.)

Engine Support Bracket to Block (4wd)

Bolts 41 N·m (30 ft. lbs.)

Exhaust Manifold-to-Cylinder Head

Bolts/Nuts 34 N·m (25 ft. lbs.)

Flywheel

Bolts 75 N·m (55 ft. lbs.)

Front Insulator (All)

Through bolt/nut 95 N·m (70 ft. lbs.)

Front Insulator to Support Bracket (4wd)

Stud nut 41 N·m (30 ft. lbs.)

Through bolt/nut 102 N·m (75 ft. lbs.)

Front Insulator to Block (2wd)

Bolts 95 N·m (70 ft. lbs.)

Generator

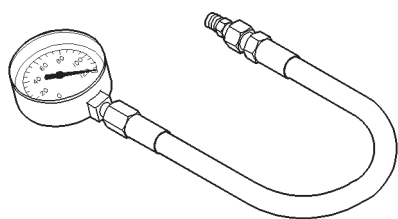
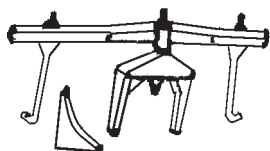
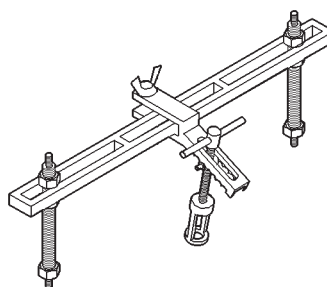
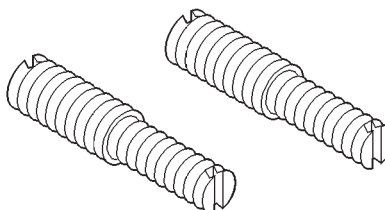
Mounting Bolt 41 N·m (30 ft. lbs.)

SPECIFICATIONS (Continued)

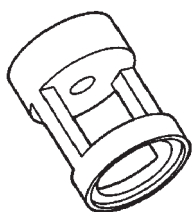
DESCRIPTION	TORQUE	DESCRIPTION	TORQUE
Intake Manifold		Rear Support Plate-to-Transfer Case	
Bolts	Refer to R & I Procedure	Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pan		Rocker Arm	
Bolts . . . . .	.24 N·m (215 in. lbs.)	Bolts . . . . .	.28 N·m (21 ft. lbs.)
Oil Pan		Spark Plugs	
Drain Plug. . . . .	.34 N·m (25 ft. lbs.)	All . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump		Starter Motor	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)	Mounting Bolts . . . . .	.68 N·m (50 ft. lbs.)
Oil Pump Cover		Thermostat Housing	
Bolts . . . . .	.11 N·m (95 in. lbs.)	Bolts . . . . .	.25 N·m (225 in. lbs.)
Rear Insulator-to-Bracket (2WD)		Throttle Body	
Through-Bolt . . . . .	.68 N·m (50 ft. lbs.)	Bolts . . . . .	.23 N·m (200 in. lbs.)
Rear Insulator-to-Crossmember Support Bracket (2WD)		Torque Converter Drive Plate	
Nut . . . . .	.41 N·m (30 ft. lbs.)	Bolts . . . . .	.31 N·m (270 in. lbs.)
Rear Insulator-to-Crossmember (4WD)		Transfer Case-to-Insulator Mounting Plate	
Nuts . . . . .	.68 N·m (50 ft. lbs.)	Nuts . . . . .	.204 N·m (150 ft. lbs.)
Rear Insulator-to-Transmission (4WD)		Transmission Support Bracket (2WD)	
Bolts . . . . .	.68 N·m (50 ft. lbs.)	Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket (4WD Automatic)		Vibration Damper	
Bolts . . . . .	.68 N·m (50 ft. lbs.)	Retainer Bolt . . . . .	.183 N·m (135 ft. lbs.)
Rear Support Bracket-to-Crossmember Flange		Water Pump-to-Chain Case Cover	
Nuts . . . . .	.41 N·m (30 ft. lbs.)	Bolt . . . . .	.41 N·m (30 ft. lbs.)

SPECIAL TOOLS

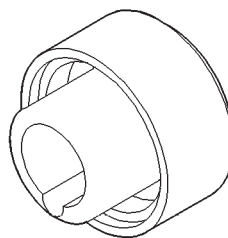
5.9L ENGINE

*Oil Pressure Gauge C-3292**Engine Support Fixture C-3487-A**Valve Spring Compressor MD-998772-A**Adaptor 6633*

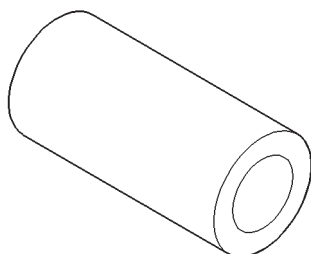
SPECIAL TOOLS (Continued)



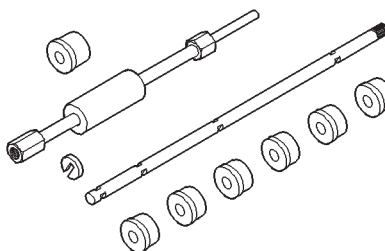
Adaptor 6716A



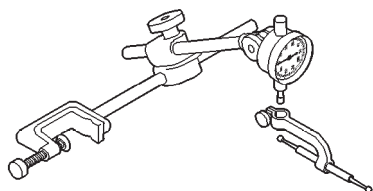
Front Oil Seal Installer 6635



Valve Guide Sleeve C-3973

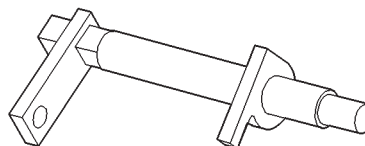


Cam Bearing Remover/Installer C-3132-A



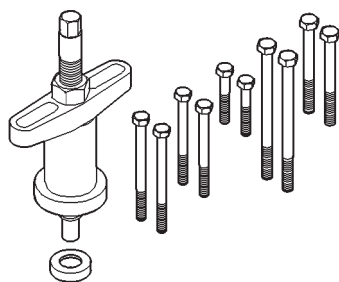
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Dial Indicator C-3339

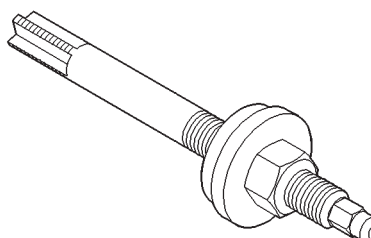


c-3509-8011d343

Camshaft Holder C-3509

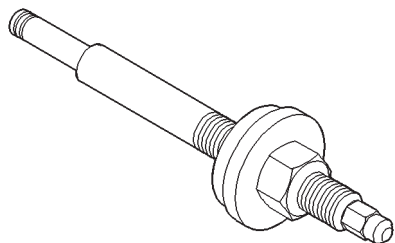


Puller C-3688

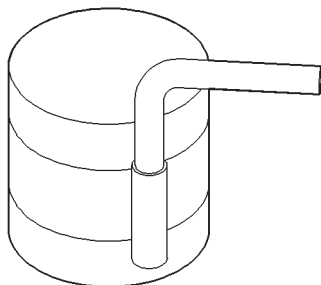


Distributor Bushing Puller C-3052

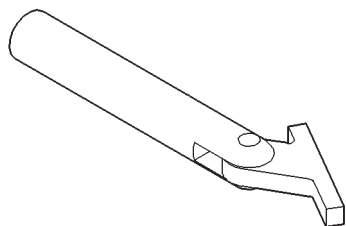
SPECIAL TOOLS (Continued)



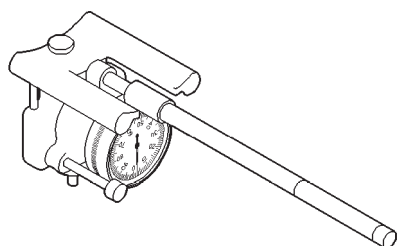
Distributor Bushing Driver/Burnisher C-3053



Piston Ring Compressor C-385



Crankshaft Main Bearing Remover C-3059



8011c9fa

Cylinder Bore Gauge C-119

8.0L ENGINE

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DESCRIPTION AND OPERATION

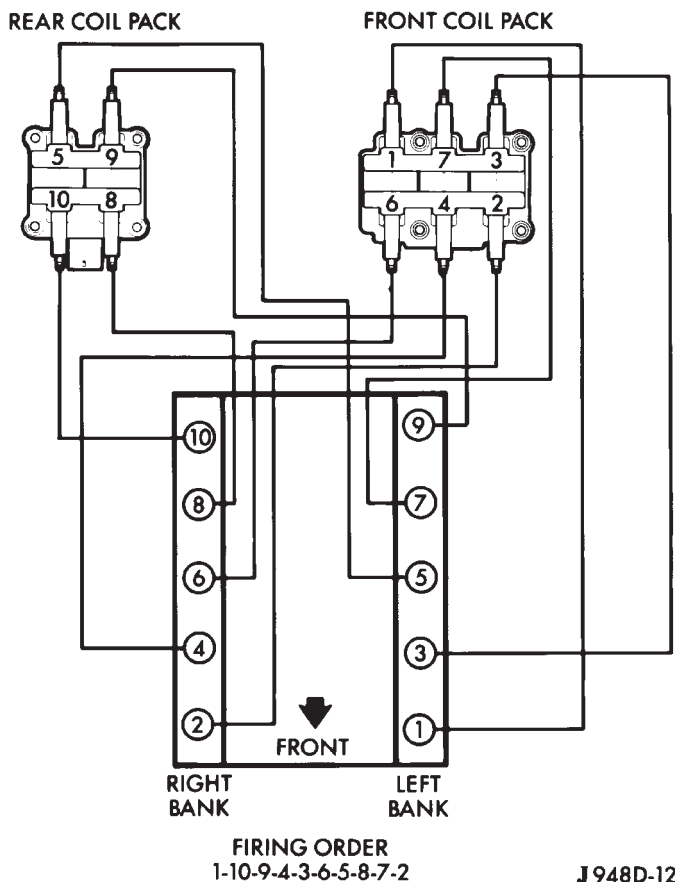
ENGINE DESCRIPTION/IDENTIFICATION

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.

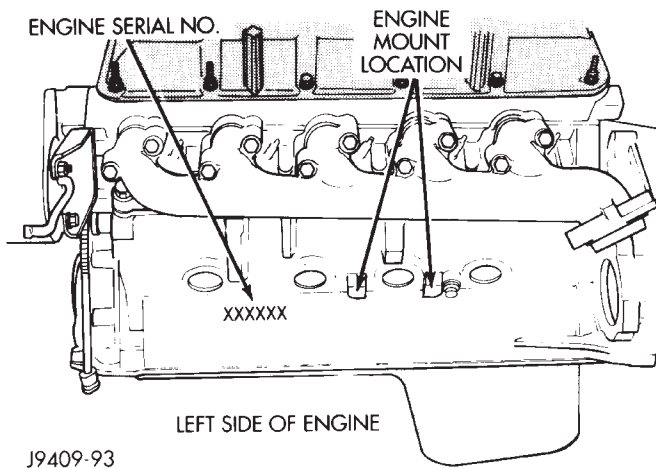
The cylinders are numbered from front to rear; 1, 3, 5, 7, 9 on the left bank and 2, 4, 6, 8, 10 on the right bank. The firing order is 1-10-9-4-3-6-5-8-7-2 (Fig. 1).

DESCRIPTION AND OPERATION (Continued)

**Fig. 1 Firing Order**

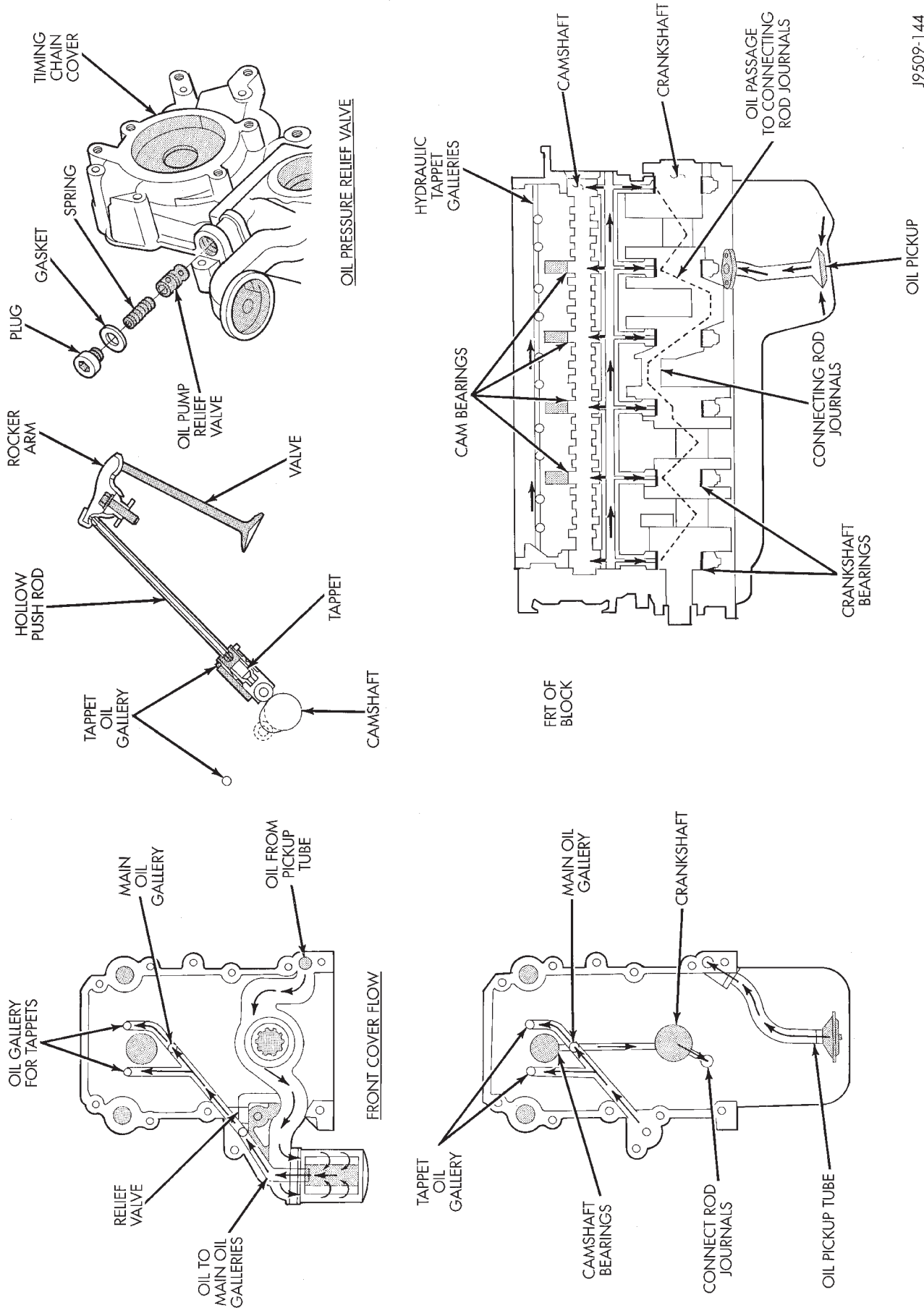
The engine serial number is located on the lower left front of the cylinder block in front of the engine mount (Fig. 2). When component part replacement is

necessary, use the engine type and serial number for reference.

**Fig. 2 Engine Identification****LUBRICATION SYSTEM**

The lubrication system is a full flow filtration pressure feed type. Oil stored in the oil pan is taken in and discharged by an internal gear pump directly coupled to the crankshaft. Its pressure is regulated by the relief valve located in the chain case cover. The oil is pump through an oil filter and feeds three main oil gallery. This oil gallery feeds oil under pressure to the main and rod bearings and camshaft bearings. Passages in the cylinder block feed oil to the hydraulic lifters through hollow push rods which feeds the rocker arm sockets.

DESCRIPTION AND OPERATION (Continued)



J9509-144

Fig. 3 Engine Lubrication System

DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEAD COVER

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

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 4) are held in place by 12 bolts. The spark plugs are located in the peak of the wedge between the valves.

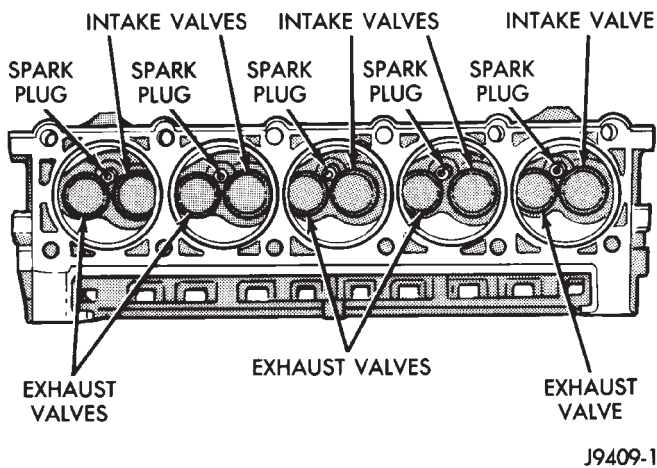


Fig. 4 Cylinder Head Assembly

VALVES AND VALVE SPRINGS

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

PISTON AND CONNECTING ROD ASSEMBLY

The pistons are elliptically turned so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, causing the piston to assume a more nearly round shape.

All pistons are machined to the same weight, regardless of size, to maintain piston balance.

The piston pin rotates in the piston only and is retained by the press interference fit of the piston pin in the connecting rod.

The pistons have a unique dry-film lubricant coating baked onto the skirts to reduce friction. The lubricant is particularly effective during engine break-in, but with time, the material becomes embedded into cylinder bore walls and continues to reduce friction.

SERVICE PROCEDURES

VALVE TIMING

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

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

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

(4) Rotate the crankshaft clockwise (normal running direction) until the valve has lifted 0.863 mm (0.034 inch). The timing of the crankshaft should now read from 10° before top dead center to 2° after top dead center. Use a protractor as there are no timing marks on the engine.

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

(5) If reading is not within specified limits:

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

MEASURING TIMING CHAIN STRETCH

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 5).

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

FITTING PISTONS

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 inch). The max. allowable clearance is 0.0762 mm (0.003 in.).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be

SERVICE PROCEDURES (Continued)

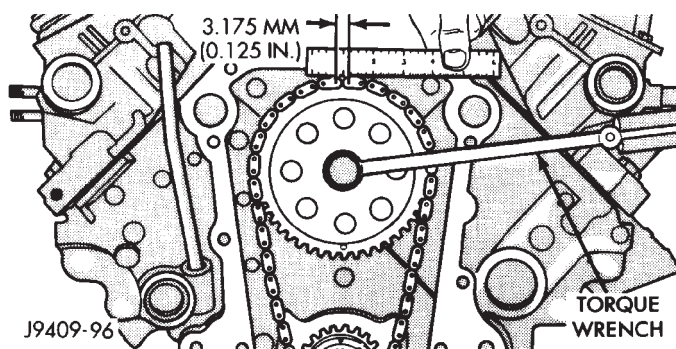


Fig. 5 Measuring Timing Chain Wear and Stretch

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. 6). If a bore gauge is not available, do not use an inside micrometer.

(2) The coating material is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results. Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY**. To correctly select the proper size piston, a cylinder bore gauge capable of reading in .0001" increments is required.

(3) Piston installation into the cylinder bore require slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

FITTING RINGS

(1) Measurement of end gaps:

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

(b) Insert feeler stock in the gap. Gap for compression rings should be between 0.254-0.508 mm (0.010-0.020 inch). The oil ring gap should be 0.381- 1.397 mm (0.015-0.055 inch).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Ends should be stoned smooth after filing with Arkansas White Stone. Rings with excess gaps should not be used.

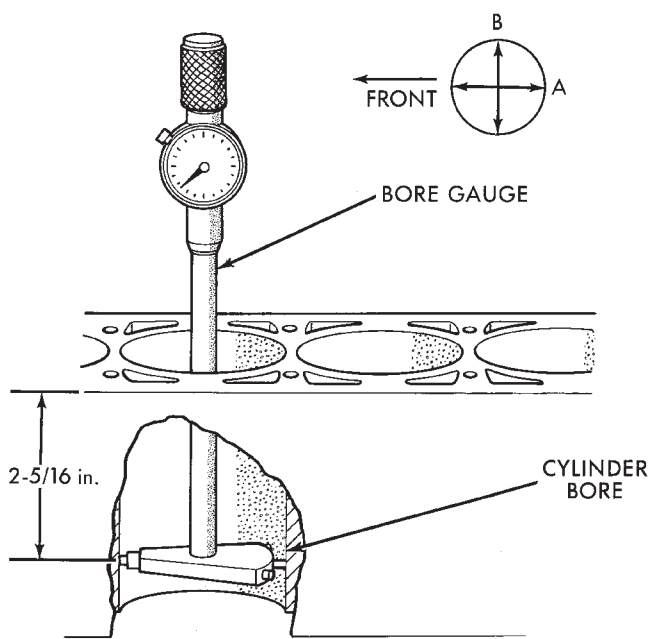


Fig. 6 Bore Gauge

(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. 7) (Fig. 9).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 9). An identification mark on the ring is a drill point, a stamped letter O, an oval depression or the word TOP facing up.

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

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

(3) Arrange ring gaps 180° apart as shown in (Fig. 10).

SERVICE PROCEDURES (Continued)

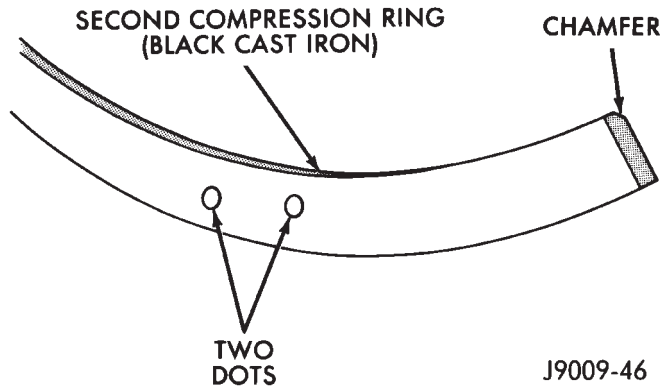


Fig. 7 Second Compression Ring Identification—Typical

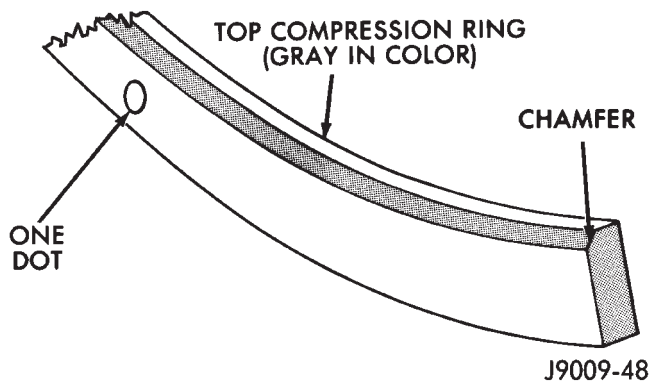


Fig. 8 Top Compression Ring Identification—Typical

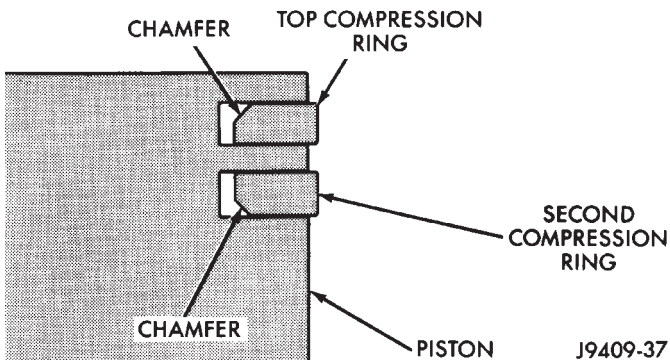


Fig. 9 Compression Ring Chamfer Location—Typical

FITTING CONNECTING ROD BEARINGS

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

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

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, make certain that the V-groove in the shell is in line

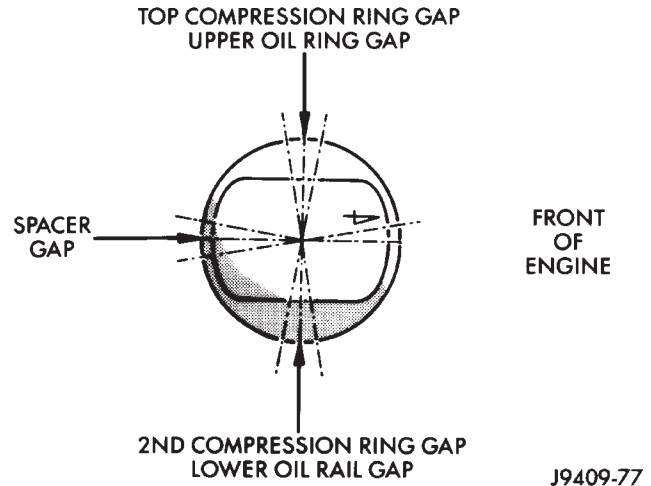


Fig. 10 Proper Ring Installation

with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

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

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

FITTING CRANKSHAFT MAIN BEARINGS

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

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

CRANKSHAFT SERVICE

The crankshaft connecting rod and main journals should be checked for excessive wear, taper and scoring. The maximum taper or out-of-round on any crankshaft journal is 0.025 mm (0.001 inch).

SERVICE PROCEDURES (Continued)

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

CAUTION: After any journal grind, it is important that the final paper or cloth polish be in the same direction as the engine rotates.

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.

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

- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut and rubber engine restrictors. (Fig. 11).
- (6) Remove engine support bracket/cushion bolts (Fig. 11). Remove the support bracket/cushion and heat shields.

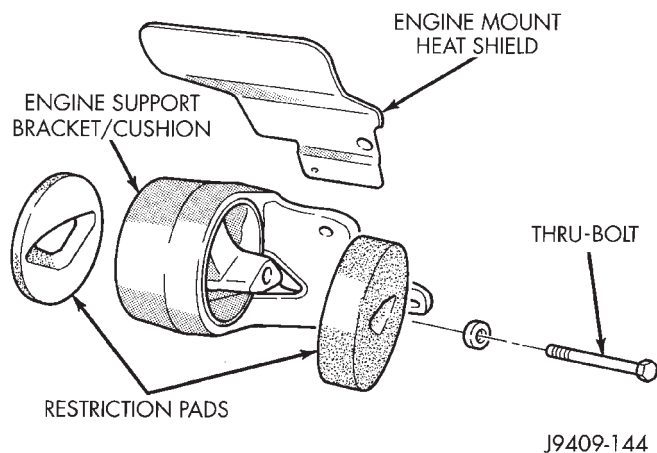


Fig. 11 Engine Mounts—Front

INSTALLATION

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

- (2) Install the thru-bolt and 2 piece rubber engine rubber restrictors onto the engine support bracket/cushion.

- (3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 12).

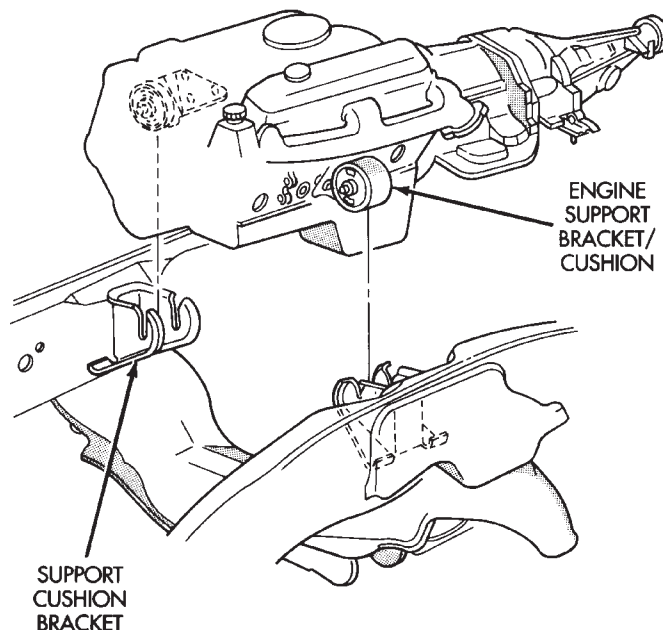


Fig. 12 Positioning Engine Mounts—Front

- (4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.
- (5) Lower the vehicle.
- (6) Remove lifting fixture.

ENGINE MOUNT—REAR

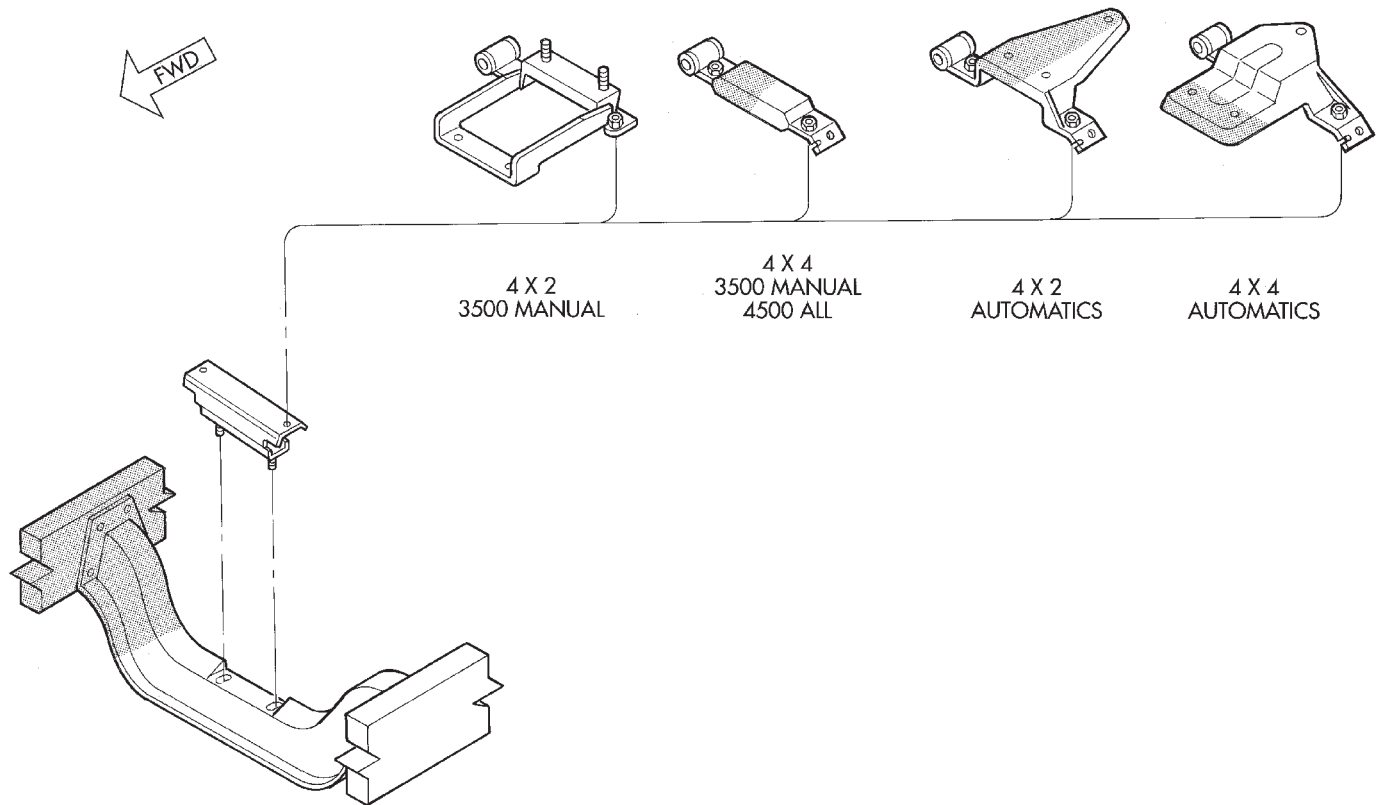
REMOVAL

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 13).
- (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.

REMOVAL AND INSTALLATION (Continued)



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Fig. 13 Engine Rear Support Cushion Assembly

(3) Using the transmission jack, lower the transmission and support cushion onto the crossmember (Fig. 13).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Remove the battery.

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

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

(4) Remove the upper crossmember.

(5) Remove the transmission oil cooler.

(6) Remove the serpentine belt (refer to Group 7, Cooling System).

(7) Remove the A/C compressor with the lines attached. Set aside.

(8) If equipped, remove the condenser.

(9) Remove the washer bottle.

(10) Disconnect the top radiator hose.

(11) Remove the fan.

(12) Remove the fan shroud.

(13) Disconnect the lower radiator hose.

(14) Disconnect the transmission cooler lines.

(15) Remove radiator (refer to Group 7, Cooling System).

(16) Remove the generator with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(17) Remove the air cleaner.

(18) Disconnect the throttle linkage.

(19) Remove throttle body.

(20) Remove the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(21) Remove the coil assemblies with the ignition cables.

(22) Disconnect the heater hoses.

(23) Disconnect the power steering hoses, if equipped.

(24) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel line.

(25) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(26) Raise and support the vehicle on a hoist.

(27) Remove the drain plug and drain the engine oil.

(28) Loosen front engine mount thru-bolt nuts.

REMOVAL AND INSTALLATION (Continued)

(29) Remove the transmission cooler line brackets from oil pan.

(30) Disconnect exhaust pipe at manifold (refer to Group 11, Exhaust System and Intake Manifold).

(31) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(32) Refer to Group 21, Transmissions for transmission removal.

(33) Lower vehicle.

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

(34) Install an engine lifting fixture.

(35) Remove engine from vehicle and install engine assembly on a repair stand.

INSTALLATION

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

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Refer to Group 21, Transmissions for transmission installation.

(5) Install the prop shaft (refer to Group 16, Propeller Shaft).

(6) Install the starter and connect the starter wires (refer to Group 8B, Battery/Starter/Generator Service).

(7) Install exhaust pipe to manifold (refer to Group 11, Exhaust System and Intake Manifold).

(8) Install the transmission cooler line brackets from oil pan.

(9) Tighten the Front mount thru-bolts and nuts to 102N·m (75 ft. lbs.).

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

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

(12) Lower the vehicle.

(13) Remove engine lifting fixture.

(14) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).

(15) Connect the fuel lines.

(16) Connect the heater hoses.

(17) Install the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(18) Install the coil assemblies with the ignition cables.

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

(20) Connect the throttle linkage.

(21) Install the air cleaner box.

(22) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(23) Install the upper crossmember.

(24) Install radiator (refer to Group 7, Cooling System).

(25) Connect the lower radiator hose.

(26) Install the transmission oil cooler.

(27) Connect the transmission cooler lines.

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

(29) Install the fan shroud.

(30) Install the fan.

(31) Connect the top radiator hose.

(32) Install the washer bottle.

(33) If equipped, install the condenser.

(34) Install the A/C compressor with the lines attached.

(35) Install the serpentine belt (refer to Group 7, Cooling System).

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

(37) Add coolant to the cooling system (refer to Group 7, Cooling System for the proper procedure).

(38) Install the battery.

(39) Warm engine and adjust.

(40) Road test vehicle.

CYLINDER HEAD COVER

Die-cast magnesium cylinder head covers (Fig. 14) reduce noise and provide a good sealing surface. A steel backed silicon gasket is used with the cylinder head cover (Fig. 15).

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) Remove the upper intake manifold to remove the right side head cover (refer to Group 11, Exhaust System and Intake Manifold).

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

INSTALLATION

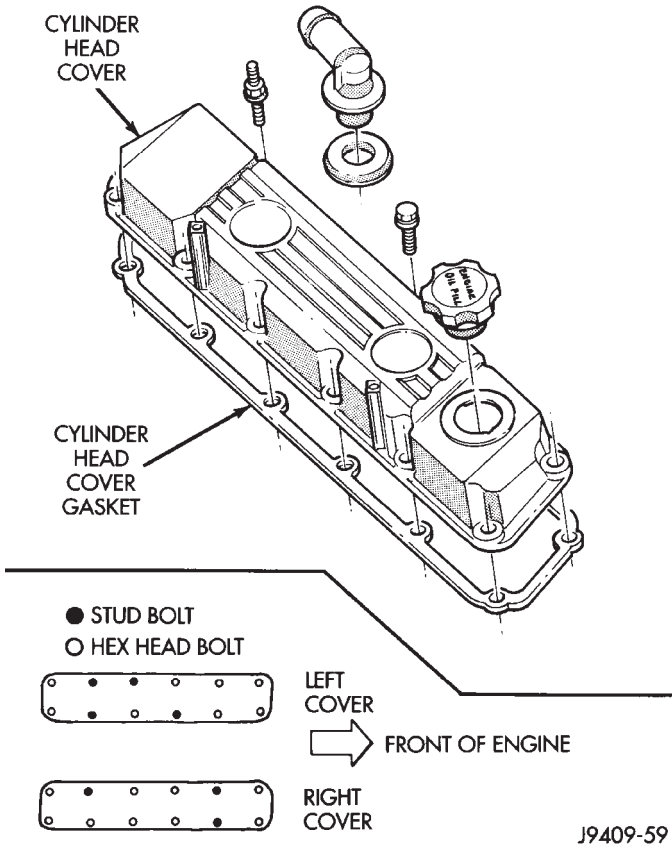
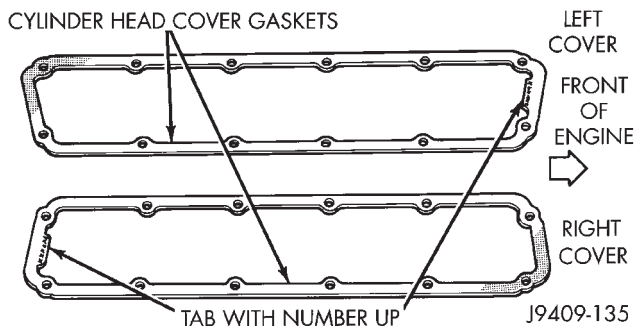
(1) Clean cylinder head cover gasket surface.

(2) Clean head rail, if necessary.

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

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

REMOVAL AND INSTALLATION (Continued)

**Fig. 14 Cylinder Head Covers****Fig. 15 Cylinder Head Cover Gaskets**

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

(5) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 14). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(6) If removed, install the upper intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

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

(8) Connect the negative cable to the battery.

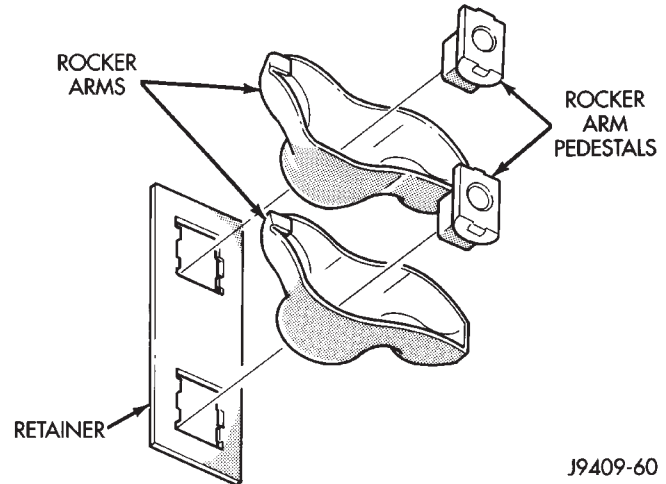
ROCKER ARMS AND PUSH RODS**REMOVAL**

(1) Disconnect spark plug wires by pulling the boot straight out in line with plug.

(2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and the rocker arm assembly (Fig. 16). Place rocker arm assemblies on a bench in the same order as removed.

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

**Fig. 16 Rocker Arm Assembly****INSTALLATION**

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

(1) Install the push rods in the same order as removed.

(2) Install rocker arm assemblies in the same order as removed. Tighten the rocker arm bolts to 28 N·m (21 ft. lbs.) torque.

(3) Install cylinder head cover and gasket. **DO NOT** use alternative fasteners.

(4) Connect spark plug wires.

VALVE STEM SEAL AND SPRING REPLACEMENT

This procedure is done with the cylinder head installed.

(1) Disconnect the negative cable from the battery.

(2) Set engine basic timing to Top Dead Center (TDC) and remove air cleaner.

(3) Remove cylinder head covers and spark plugs.

(4) Using suitable socket and flex handle at crankshaft retaining bolt, turn engine so the No.1 piston is at TDC on the compression stroke.

(5) Remove rocker arms.

REMOVAL AND INSTALLATION (Continued)

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

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

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

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

(10) Follow the same procedure on the remaining 9 cylinders using the firing sequence 1-10-9-4-3-6-5-8-7-2. Make sure piston in cylinder is at TDC on the valve spring that is being removed.

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

(12) Install rocker arms.

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

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

(14) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 17). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(15) Install closed crankcase ventilation system.

(16) Connect the evaporation control system.

(17) Install air cleaner.

(18) Connect the negative cable to the battery.

(19) Road test vehicle and check for leaks.

CYLINDER HEADS

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Drain cooling system (refer to Group 7, Cooling System for the proper procedures).

(3) Remove the heat shields (Fig. 18).

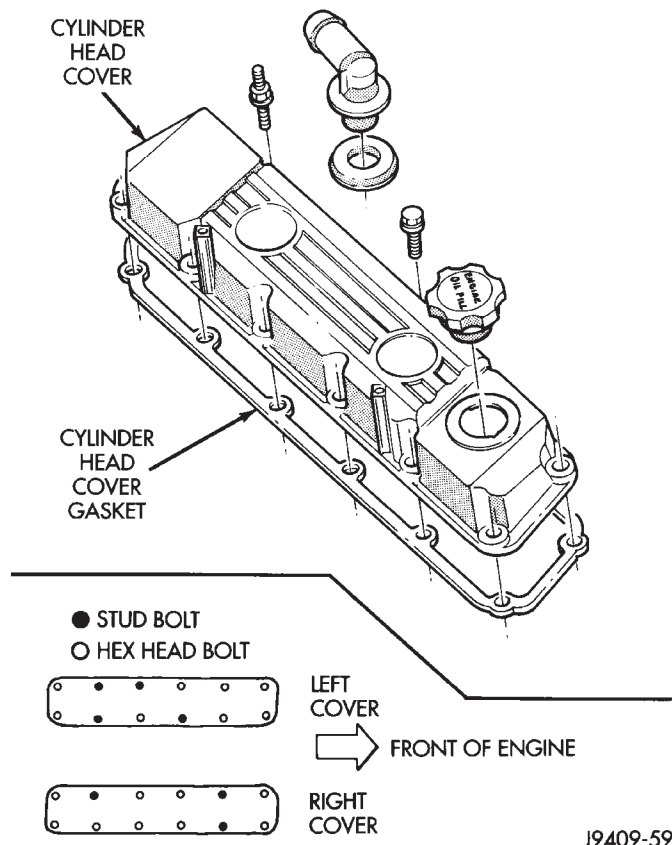
(4) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(5) Remove closed crankcase ventilation system.

(6) Disconnect the evaporation control system.

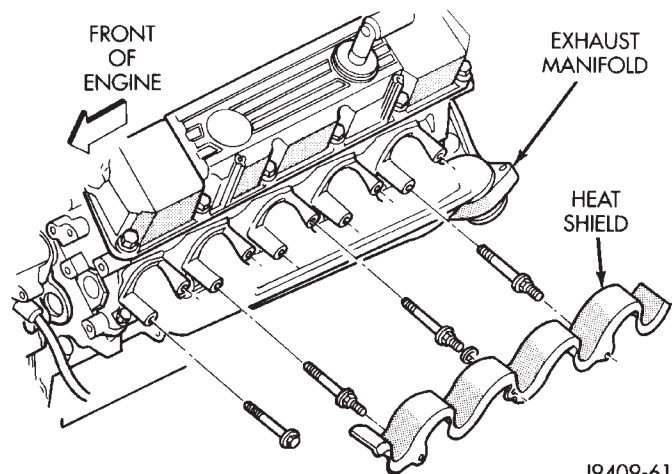
(7) Remove the air cleaner.

(8) Perform the Fuel System Pressure release procedure (refer to Group 14, Fuel System). Disconnect the fuel line.



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Fig. 17 Cylinder Head Covers



J9409-61

Fig. 18 Spark Plug Wire Heat Shields (Left Side Shown)

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

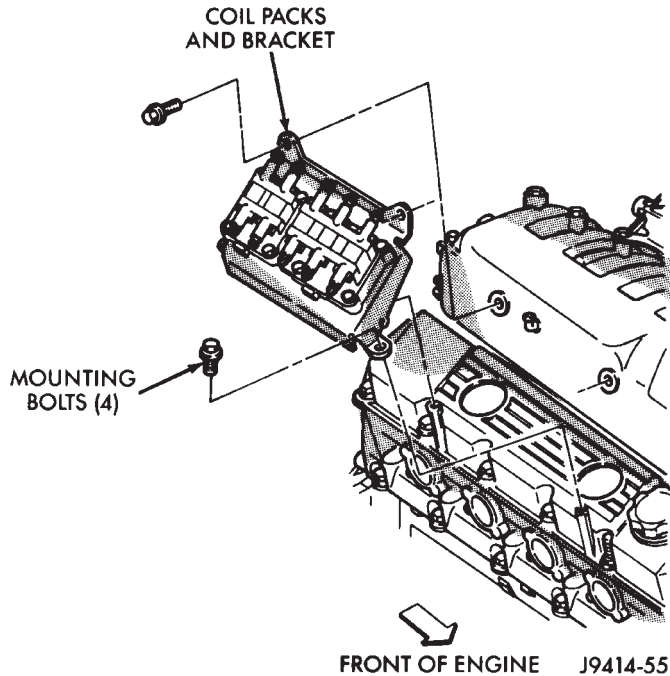
(10) Remove coil pack and bracket (Fig. 19).

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

REMOVAL AND INSTALLATION (Continued)

**Fig. 19 Coil Pack and Bracket**

(14) Remove upper intake manifold and throttle body as an assembly.

(15) Remove cylinder head covers and gaskets.

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

(17) Remove lower intake manifold. Discard the flange side gaskets and the front and rear cross-over gaskets.

(18) Disconnect exhaust pipe from exhaust manifold (refer to Group 11, Exhaust System and Intake Manifold).

(19) Remove exhaust manifolds and gaskets (refer to Group 11, Exhaust System and Intake Manifold).

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

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

(22) Remove spark plugs.

INSTALLATION

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

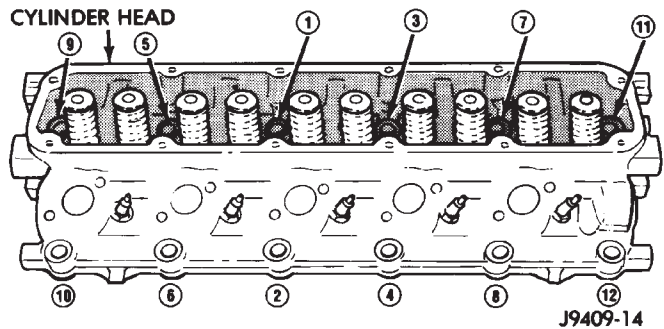
(2) Position the cylinder heads onto head gaskets and cylinder block.

(3) Tighten the cylinder head bolts in two steps (Fig. 20):

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

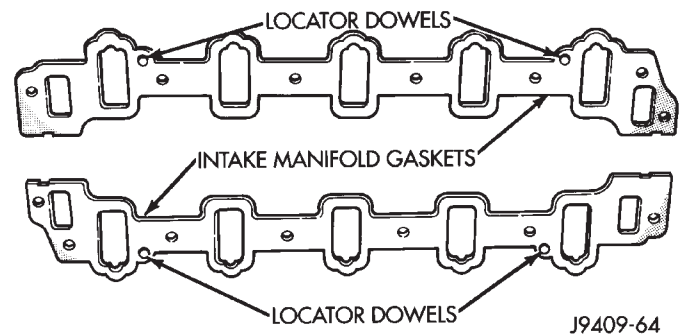
- Step 2—Tighten all cylinder head bolts, in sequence, to 143 N·m (105 ft. lbs.) torque.

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. 20 Cylinder Head Bolt Tightening Sequence**

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

(5) Install the side intake manifold gaskets. Be sure that the locator dowels are positioned in the head (Fig. 21).

**Fig. 21 Intake Manifold Flange Gasket Alignment**

(6) Peel off the protective paper (blue - rear and brown - front) and press firmly onto the block (Fig. 22). **BE SURE THE BLOCK IS OIL FREE.** Aligning slots in end seals with notches in intake manifold gaskets.

(7) Insert Mopar® Silicone Rubber Adhesive Sealant, or equivalent, into the four corner pockets (Fig. 23). **Fill the pocket, but DO NOT overfill.**

(8) The lower intake manifold **MUST** be installed within 3 minutes of sealant application. Carefully lower intake manifold into position on the cylinder block and cylinder heads. After intake manifold is in place, inspect to make sure seals and gaskets are in place.

(9) Finger start all bolts, alternate one side to the other.

(10) Tighten the lower intake manifold bolts to 54 N·m (40 ft. lbs.) torque.

(11) Using a new gasket, position the upper intake manifold onto the lower intake manifold.

REMOVAL AND INSTALLATION (Continued)

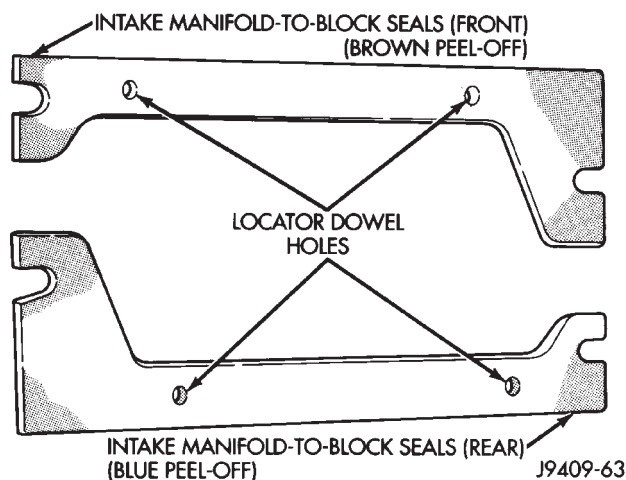


Fig. 22 Intake Manifold-to-Block Seals

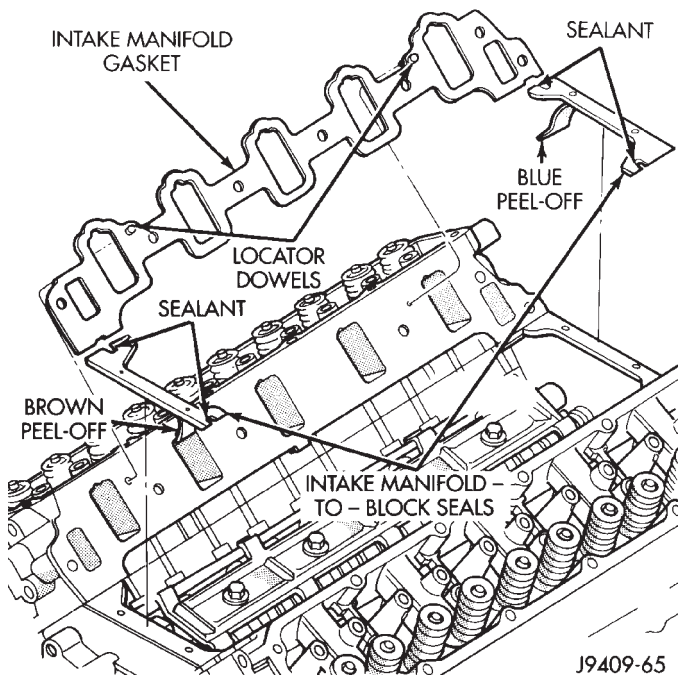


Fig. 23 Mopar® Silicone Rubber Adhesive Sealant Application Locations

(12) Tighten upper intake manifold bolts to 22 N·m (16 ft. lbs.) torque.

(13) Install the exhaust manifolds and new gaskets. Tighten the bolts and stud bolts to 22 N·m (16 ft. lbs.) torque.

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

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

(16) Install the heat shields and the washers. **Make sure that heat shields tabs hook over the**

exhaust gasket. Tighten the nuts to 15 N·m (132 in. lbs.) torque.

(17) Adjust spark plugs to specifications (refer to Group 8D, Ignition System). Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

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

(19) Connect heat indicator sending unit wire.

(20) Connect the heater hoses and bypass hose.

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

(22) Install the fuel line.

(23) Install the generator and drive belt. Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N·m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

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

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

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

(26) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 1). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(27) Install closed crankcase ventilation system.

(28) Connect the evaporation control system.

(29) Install the air cleaner.

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

(31) Connect the negative cable to the battery.

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

VALVES AND VALVE SPRINGS

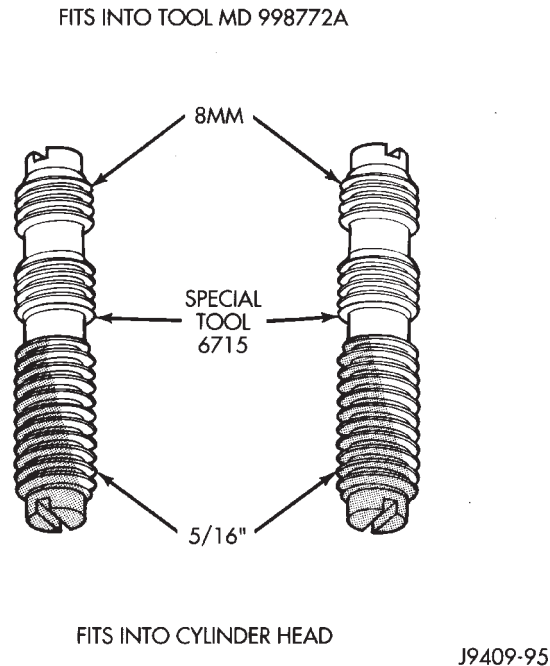
REMOVAL

(1) Remove the cylinder head.

(2) Special studs must be used to adapt the Valve Spring Compressor Tool to the V-10 cylinder head (Fig. 24). Install the metric end into the Special Tool MD998772A and the 5/16 end into the cylinder head.

(3) Compress valve springs using Valve Spring Compressor Tool MD-998772A with Adapter 6716A and Screw 6765 (Fig. 25). Tap the retainer using a brass drift and ball peen hammer to loosen locks away from retainer.

REMOVAL AND INSTALLATION (Continued)



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Fig. 24 Special Studs 6715 for V-10 Engine

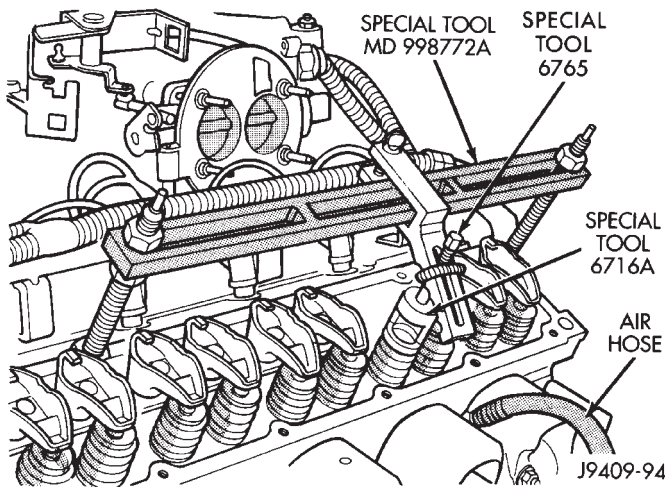


Fig. 25 Valve Spring Compressor MD-998772A with Adaptor 6716-A and Screw 6765

(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.

INSTALLATION

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

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

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

(4) Make sure there are no burrs on valve stems.

(5) Coat valve stems with lubrication oil. Insert valves into valve guides in cylinder head.

(6) Install new seals on all valve guides (**BLACK on intake and BROWN on exhaust**). Install valve springs and valve retainers.

(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. Tap the retainer with a brass or heavy plastic hammer to ensure locks have been seated.

(8) If valves and/or seats were ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. Ensure this brings spring height back to normal, 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

HYDRAULIC TAPPETS

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove the air cleaner.

(3) Remove cylinder head cover.

(4) Remove rocker arm assembly and push rods. Identify push rods to ensure installation in original location.

(5) Remove upper and lower intake manifold.

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

(7) Remove yoke retainer spider and tappet aligning yokes (Fig. 26).

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

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

(10) Check camshaft lobes for abnormal wear.

INSTALLATION

(1) Lubricate tappets.

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

(3) Install tappet aligning yokes. Position the yoke retainer spider over the tappet aligning yokes (Fig. 26) 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.

REMOVAL AND INSTALLATION (Continued)

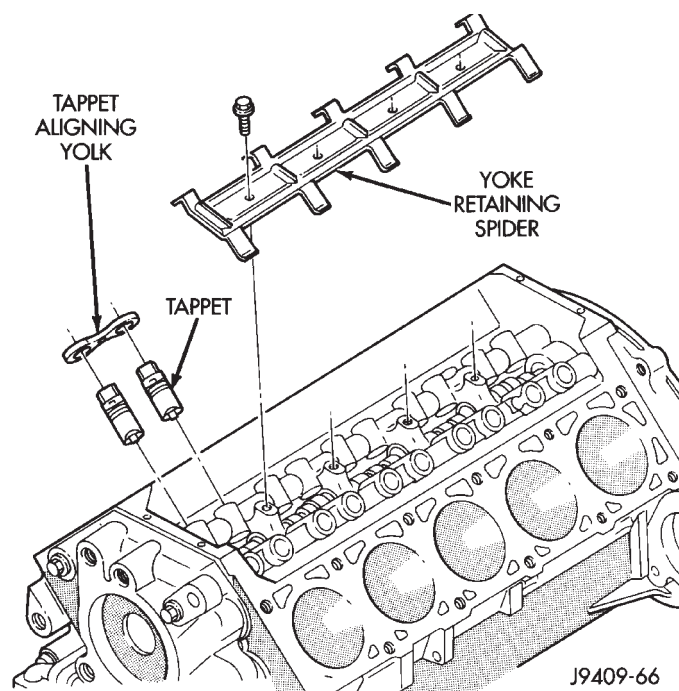


Fig. 26 Tappets, Aligning Yoke and Yoke Retaining Spider

(5) Position the rocker arm assembly on the pedestal and align to the push rods. Install the bolts and tighten to 28 N·m (21 ft. lbs.) torque.

(6) Install lower and upper intake manifold.

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

(8) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 26). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(9) Install the air cleaner.

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

(10) Connect the negative cable to the battery.

(11) Road test vehicle and check for leaks.

VIBRATION DAMPER

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove fan shroud retainer bolts and set shroud back over engine.
- (3) Remove the cooling system fan.

(4) Remove the serpentine belt (refer to Group 7, Cooling System).

(5) Remove crankshaft pulley/damper bolt and washer from end of crankshaft (Fig. 27).

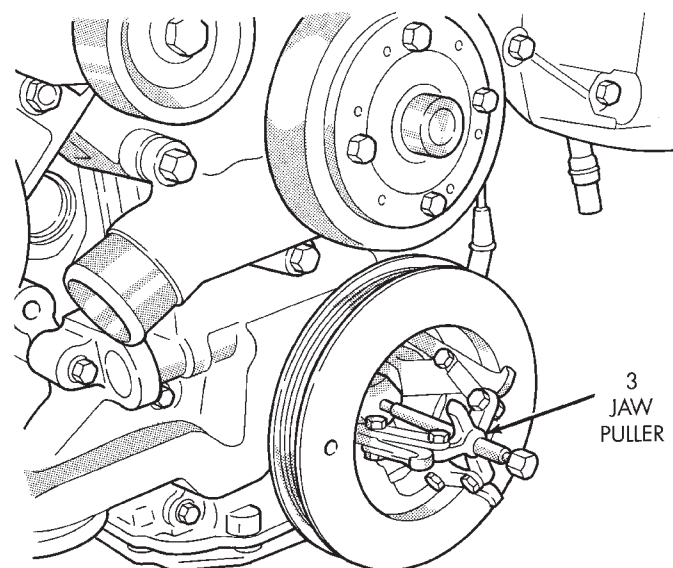


Fig. 27 Crankshaft Pulley—Damper

(6) Using a 3-prong puller tool, pull pulley—damper off of the crankshaft.

(7) Inspect crankshaft oil seal (Fig. 28).

INSTALLATION

(1) Position the crankshaft pulley/damper onto the crankshaft.

(2) Use tool C-3688 to press the pulley/damper onto the crankshaft. Install crankshaft bolt and washer and tighten to 183 N·m (135 ft. lbs.) torque (Fig. 28).

(3) Install the serpentine belt (refer to Group 7, Cooling System).

(4) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.

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

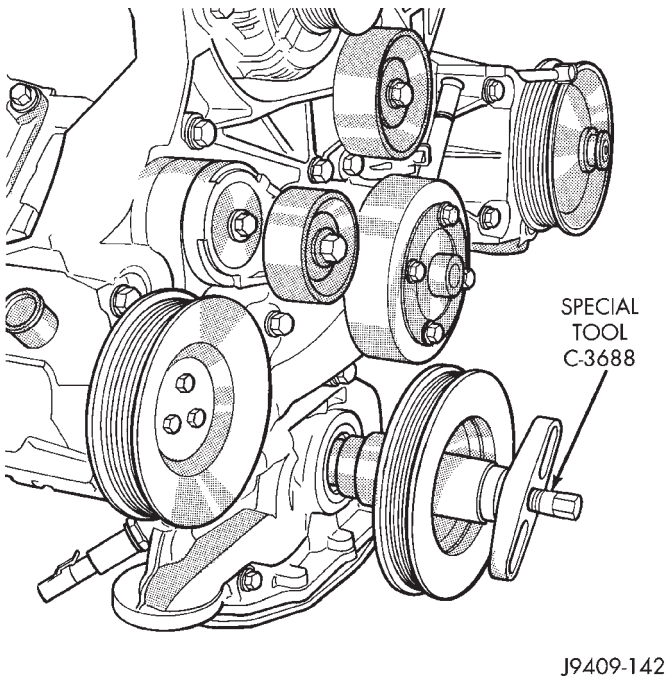
(6) Connect the negative cable to the battery.

TIMING CHAIN COVER

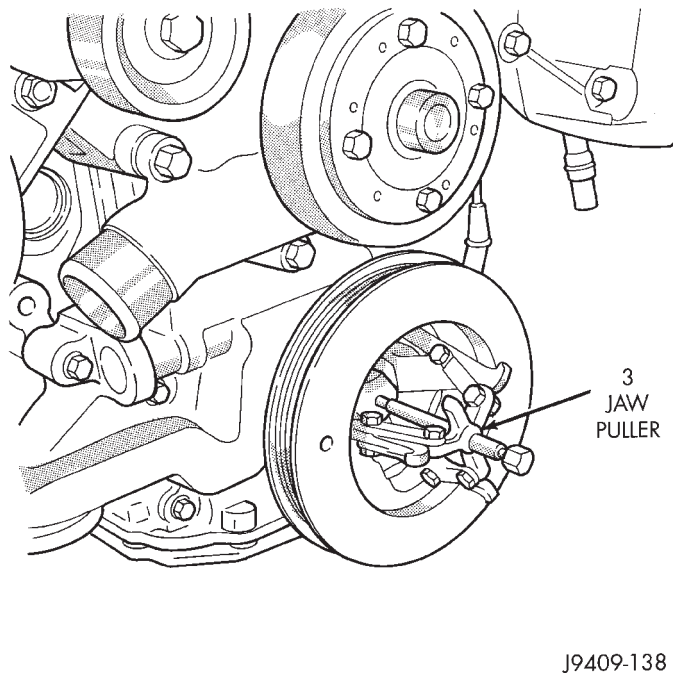
REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Drain cooling system (refer to Group 7, Cooling System).
- (3) Remove the serpentine belt (refer to Group 7, Cooling System).
- (4) Remove fan shroud.
- (5) Remove fan.

REMOVAL AND INSTALLATION (Continued)

**Fig. 28 Installing Crankshaft Pulley—Damper**

- (6) Unbolt A/C compressor and set on top of engine.
- (7) Remove generator, air pump, and bracket assembly.
- (8) Remove water pump (refer to Group 7, Cooling System).
- (9) Using a 3-prong puller to remove pulley/damper from the crankshaft. (Fig. 29)

**Fig. 29 Pulley—Damper Removal**

(10) Loosen oil pan bolts and remove the front oil pan bolts that mount the pan to the timing chain cover.

(11) Remove the cover bolts.

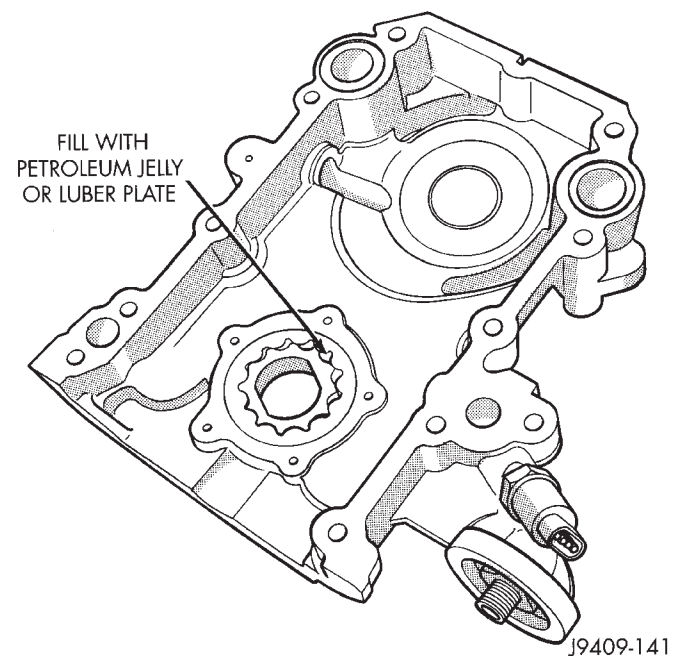
(12) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket.

(13) Inspect surface of cover. Remove any burrs or high spots.

INSTALLATION

(1) Be sure mating surfaces of timing chain cover and cylinder block are clean and free from burrs.

(2) Lubricate the pump rotors using petroleum jelly or lubriplate and install in the timing chain cover (Fig. 30).

**Fig. 30 Priming Oil Pump.**

(3) Using a new cover gasket, carefully install timing chain cover to avoid damaging oil pan gasket. Use a small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

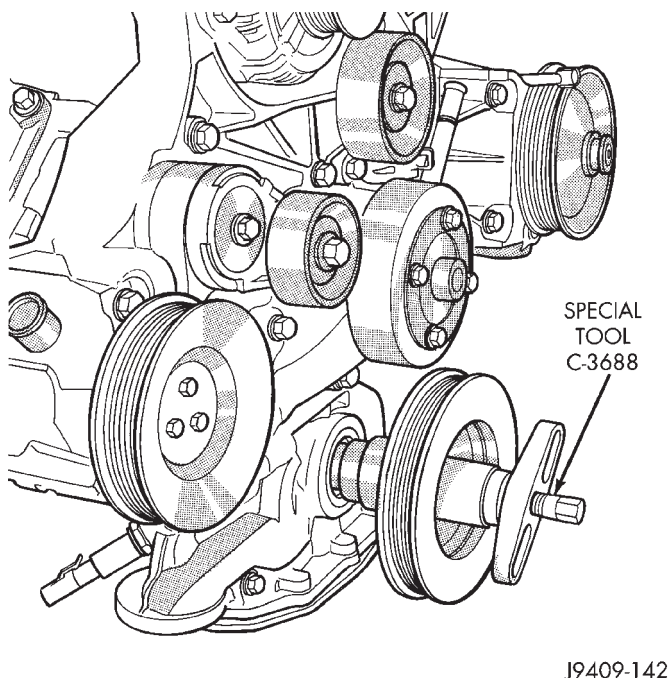
(4) Tighten timing chain cover bolts to 47 N·m (35 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

(5) Install pulley/vibration damper use tool C-3688 (Fig. 31)

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

(7) Install water pump and housing assembly using o-ring (refer to Group 7, Cooling System). Tighten bolts to 41 N·m (30 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

**Fig. 31 Installing Crankshaft Pulley/Damper**

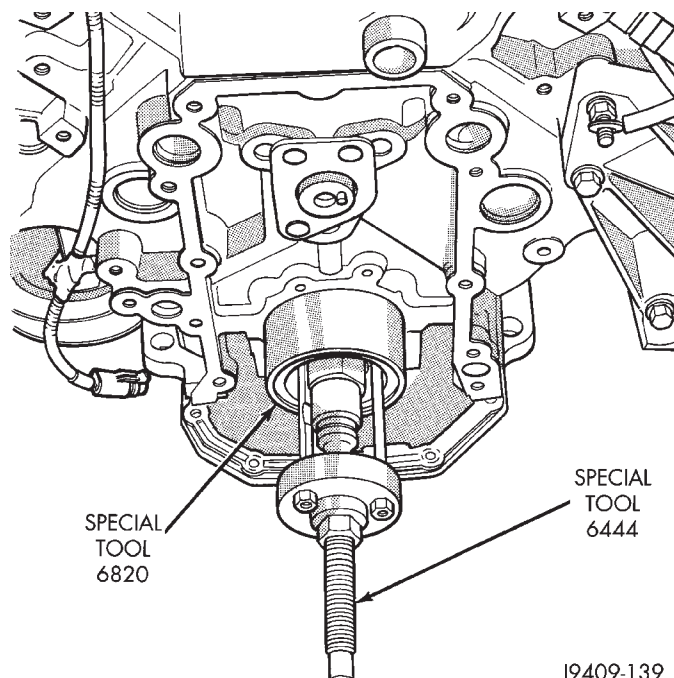
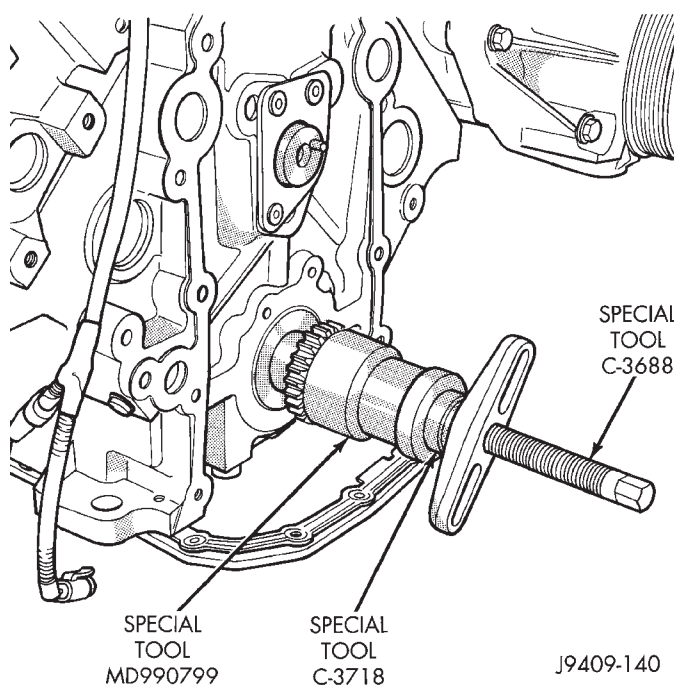
- (8) Install generator, air pump, and bracket assembly.
- (9) Install A/C compressor.
- (10) (10) Install the cooling system fan. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.
- (11) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (12) Install the serpentine belt (refer to Group 7, Cooling System).
- (13) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
- (14) Connect the negative cable to the battery.
- (15) Road test vehicle and check for leaks.

TIMING CHAIN**REMOVAL**

- (1) Remove timing chain cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (2) Aline camshaft and crankshaft centerline. Remove camshaft sprocket attaching bolt and remove timing chain and camshaft sprockets.
- (3) Use puller 6444 and jaws 6820 to remove crankshaft sprocket (Fig. 32).

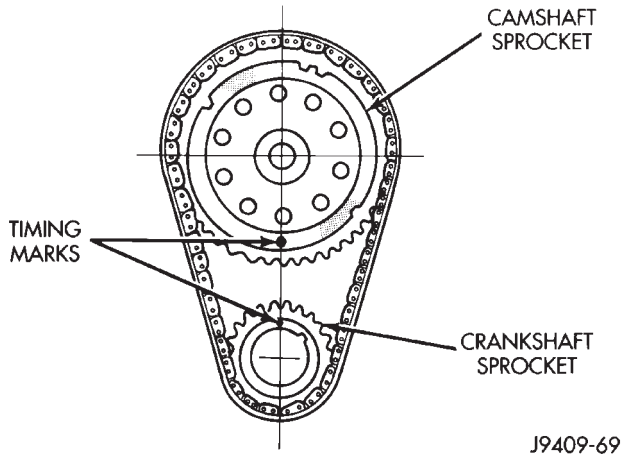
INSTALLATION

- (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. 33).
- (2) Turn crankshaft to line up the timing mark with the crankshaft and camshaft centerline.
- (3) Put chain on camshaft sprocket.

**Fig. 32 Crankshaft Sprocket Removal.****Fig. 33 Crankshaft Sprocket Installation**

- (4) Take chain and camshaft sprocket, align timing marks and install chain and cam sprocket onto crankshaft sprocket. Check to see that timing marks are on the centerline of the crankshaft and camshaft centerline (Fig. 34).
- (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

REMOVAL AND INSTALLATION (Continued)

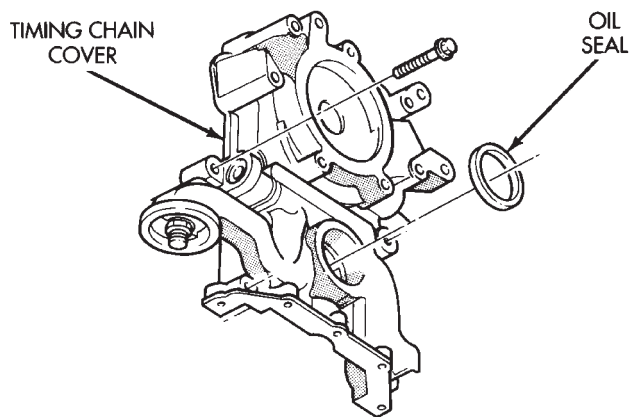
**Fig. 34 Alignment of Timing Marks**

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.

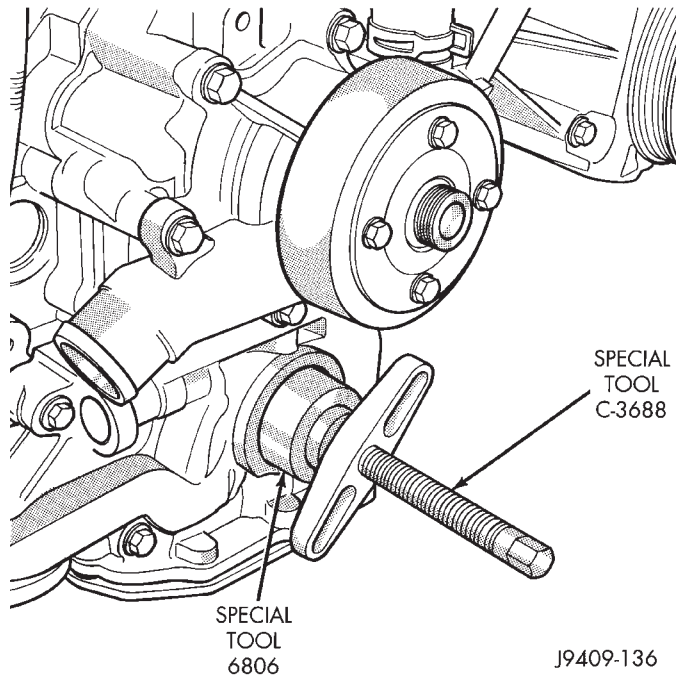
- (7) Install timing chain cover.

TIMING CHAIN COVER OIL SEAL (COVER NOT REMOVED)**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Remove the cooling fan and shroud.
- (3) Remove the serpentine belt (refer to Group 7, Cooling Systems).
- (4) Using a 3-jaw puller tool, pull pulley/damper off of the crankshaft.
- (5) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover (Fig. 35).

**Fig. 35 Timing Chain Cover and Oil Seal****INSTALLATION**

- (1) Position the crankshaft front oil seal onto seal installer special tool 6806 and C-3688 (Fig. 36). Install seal.

**Fig. 36 Timing Chain Cover and Oil Seal**

- (2) Install crankshaft pulley/damper using tool C-3688.
- (3) Install serpentine belt (refer to Group 7, Cooling System).
- (4) Install cooling fan and shroud.
- (5) Connect negative cable to the battery.

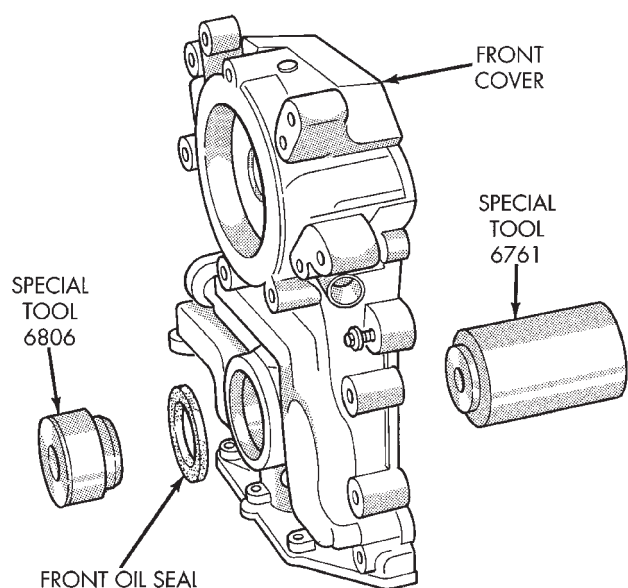
TIMING CHAIN COVER OIL SEAL (COVER REMOVED)**REMOVAL**

- (1) With timing cover removed from engine place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of the cover.

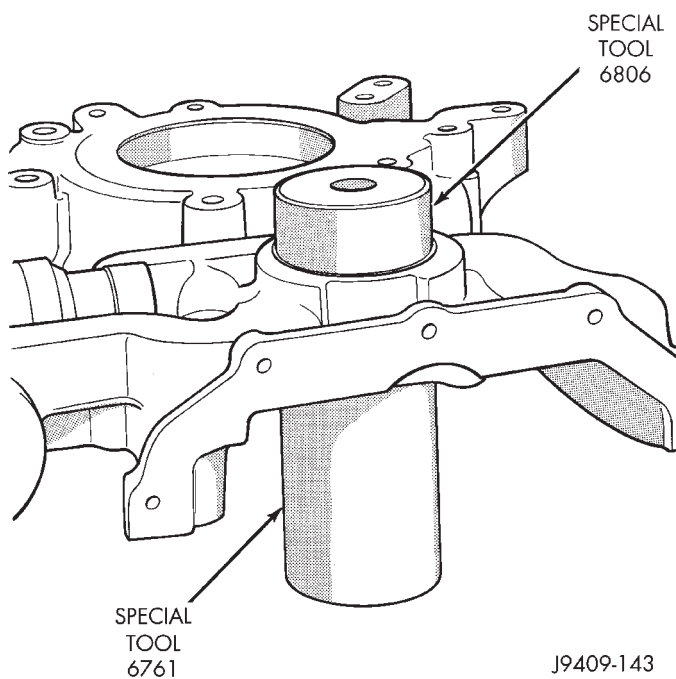
INSTALLATION

- (1) Position the crankshaft front oil seal onto seal installer special tool 6806.
- (2) Use tool 6761 to support timing chain cover when installing oil seal with tool 6806 (Fig. 37), install seal.

REMOVAL AND INSTALLATION (Continued)



J9409-137

Fig. 37 Oil Seal, Tools—6806 and 6761

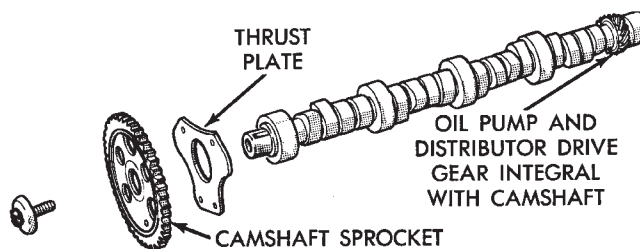
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Fig. 38 Oil Seal Installed**CAMSHAFT**

The camshaft has an integral oil pump and distributor drive gear (Fig. 39).

REMOVAL

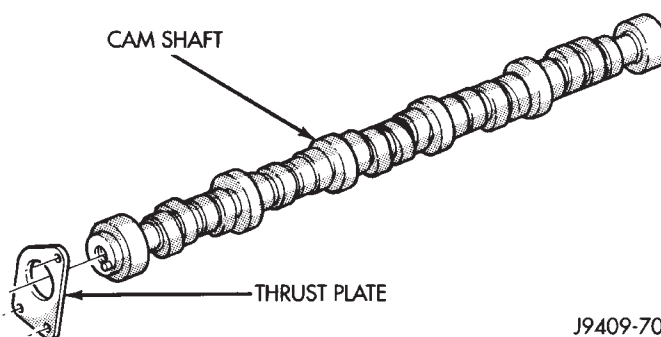
- (1) Remove cylinder head covers.
- (2) Remove rocker arm assemblies, identify each part so it can be installed in its original location..
- (3) Remove push rods and tappets. Identify each part so it can be installed in its original location.



J9309-71

Fig. 39 Camshaft and Sprocket Assembly

- (4) The 4 corner tappets can not be removed without removing the cylinder heads and gaskets. They can be lifted and retained for camshaft removal.
- (5) Remove upper and lower intake manifold (refer to Group 11 Intake and Exhaust Systems).
- (6) Remove timing chain cover and timing chain.
- (7) Remove camshaft thrust plate (Fig. 40).



J9409-70

Fig. 40 Camshaft

- (8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

INSTALLATION

- (1) Lubricate camshaft lobes and camshaft bearing journals. 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.

REMOVAL AND INSTALLATION (Continued)

(4) Line up key with keyway in sprocket, press on crankshaft timing sprocket, use tools C-3688, C-3718 and MB990799, to seat sprocket against crankshaft shoulder (Fig. 41).

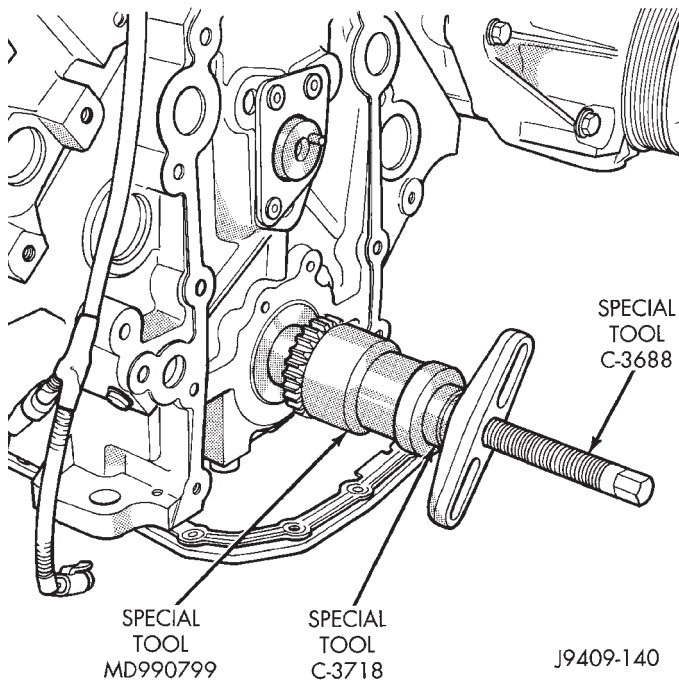


Fig. 41 Crankshaft Sprocket Installation

(5) Align timing mark on crankshaft sprocket with center line of crankshaft and camshaft.

(6) Put chain on camshaft sprocket.

(7) Take chain and camshaft sprocket and align mark with centerline of crankshaft and camshaft install camshaft sprocket and chain to camshaft.

(8) Install the camshaft bolt. Tighten bolt to 75 N·m (55 ft. lbs.) torque.

(9) Install the timing chain cover.

(10) Install the crankshaft pulley/damper use tool C-3688.

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

(12) Each tappet reused must be installed in the same position from which it was removed. **When camshaft is replaced, all of the tappets must be replaced.**

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

(14) Install the rocker arms.

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

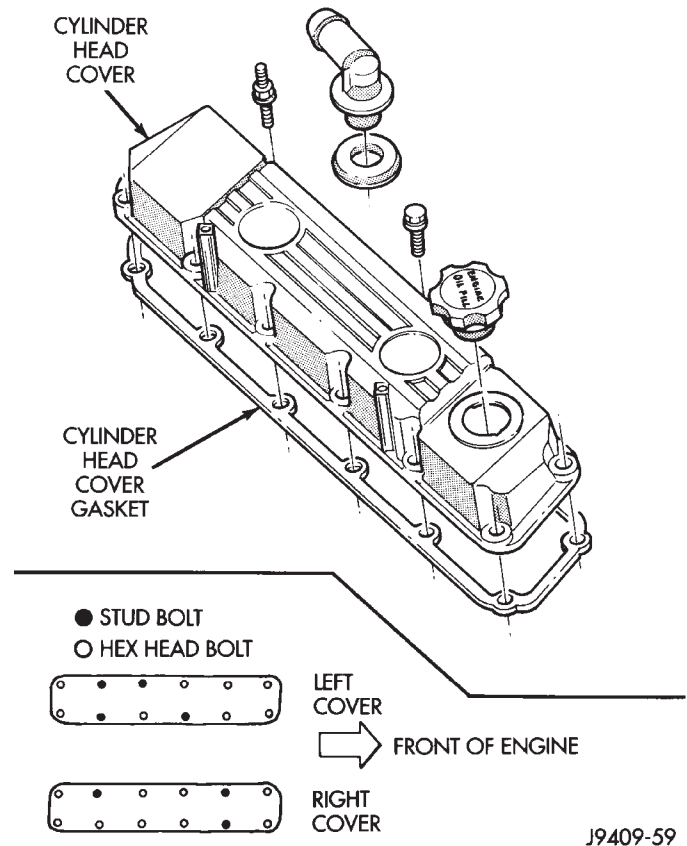


Fig. 42 Cylinder Head Cover

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

(16) Position the cylinder head cover onto the gasket. Install the stud bolts and hex head bolts in the proper positions (Fig. 42). Tighten the stud bolts and the bolts to 16 N·m (144 in. lbs.) torque.

(17) Install the intake manifolds, (refer to Group 11 Intake and Exhaust Systems).

CAMSHAFT BEARING

REMOVAL

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

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 43).

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool C-3132-A by sliding the new camshaft bearing shell over proper adapter.

REMOVAL AND INSTALLATION (Continued)

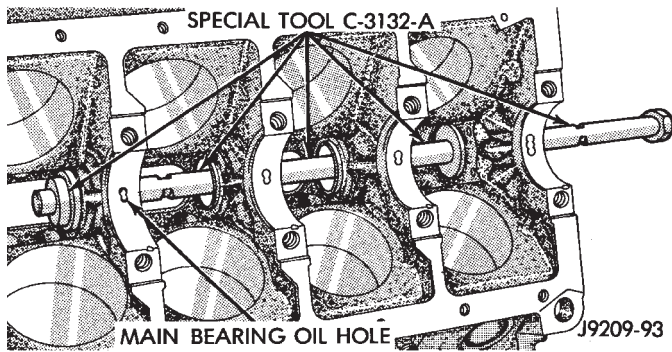


Fig. 43 Camshaft Bearings Removal and Installation with Tool C-3132-A

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

(3) Install remaining bearings in the same manner. Bearings must be carefully aligned to bring oil holes into full register with oil passages from the main bearing. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Raise vehicle.
- (3) Drain engine oil.
- (4) Remove left engine to transmission strut.
- (5) Remove oil pan and one-piece gasket. The engine may have to be raised slightly on 2WD vehicles.
- (6) Remove the oil pick-up tube assembly (Fig. 44). Discard the gasket.

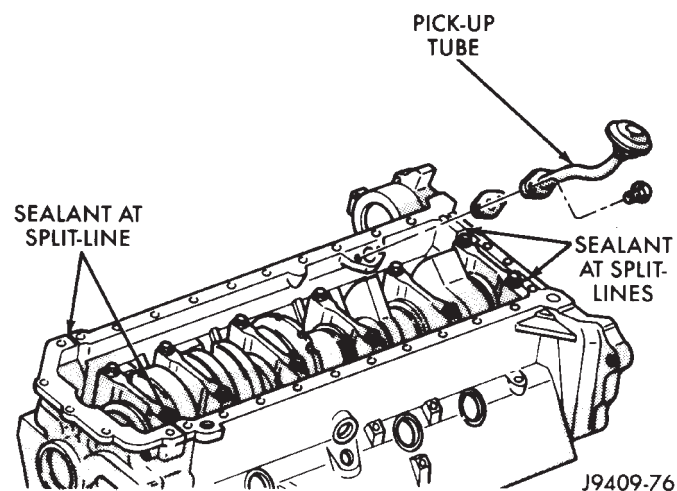


Fig. 44 Oil Pick-Up Tube

INSTALLATION

(1) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 45).

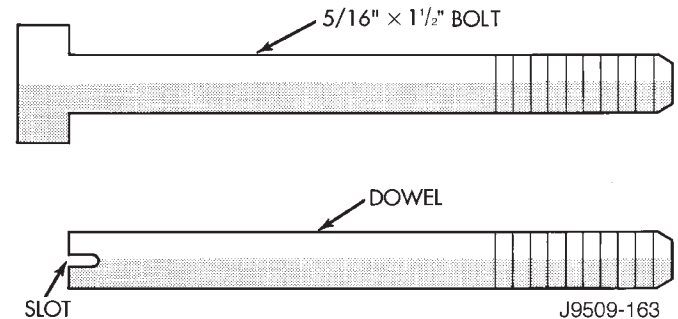


Fig. 45 Fabrication of Alignment Dowels

(2) Install the dowels in the cylinder block at the four corners.

(3) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent at the split lines. The split lines are between the cylinder block, the timing chain cover and the rear crankshaft seal assembly (Fig. 44). **After the sealant is applied you have 3 minutes to install the gasket and oil pan.**

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

(5) Position the oil pan over the dowels and onto the gasket. The engine may have to be slightly raised on 2WD vehicles.

(6) Install the oil pan bolts (Fig. 46). Tighten the 1/4 inch bolts to 11 N·m (96 in. lbs.) torque. Tighten the stud bolts to 16 N·m (144 in. lbs.) torque. Tighten the 5/16 inch bolts to 16 N·m (144 in. lbs.) torque.

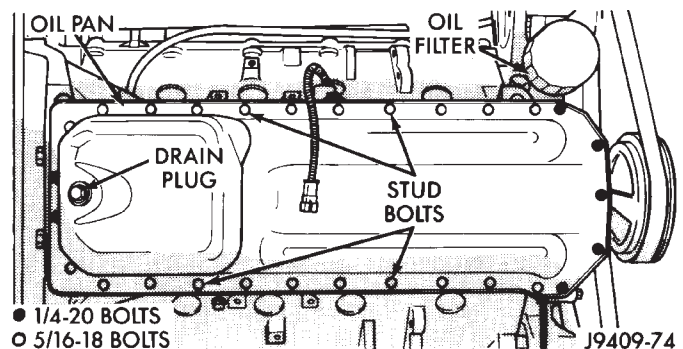


Fig. 46 Oil Pan Bolt Location

(7) Remove the dowels. Install the remaining 5/16 inch oil pan bolts. Tighten these bolts to 16 N·m (144 in. lbs.) torque.

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

(9) Install the engine to transmission strut.

(10) Lower vehicle.

REMOVAL AND INSTALLATION (Continued)

- (11) Connect the negative cable to the battery.
- (12) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

- (1) Remove the engine from the vehicle (refer to Engine Removal of this manual).
- (2) Remove the valve cover, rocker arms, push rods and cylinder head. Mark parts as removed.
- (3) Remove the oil pan and oil pump pick-up tube.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.
- (5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.
- (6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft center the connecting rod in the cylinder bore and at BDC. **Be careful not to nick crankshaft journals. DO NOT try to remove black coating on skirt. This is the dry film lubricant.**
- (7) After removal, install bearing cap on the mating rod.

INSTALLATION

- (1) Check the crankshaft connecting rod journal for excessive wear, taper and scoring.
- (2) Check the cylinder block bore for out-of-round, taper, scoring and scuffing.
- (3) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.
- (4) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 47).
- (5) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench (part of Tool C-385). **Be sure position of rings does not change during this operation.**
- (6) Install connecting rod bolt protectors on rod bolts, a long protector should be installed on the numbered side of the connecting rod.
- (7) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore in the bottom dead center position. Be sure connecting rod and cylinder bore number are the same. Insert rod and piston into cylinder bore. Be sure the piston and rod assemblies are installed in the proper orientation (Fig. 48).
- (8) The notch, groove or arrow on top of piston must be pointing toward front of engine. The larger

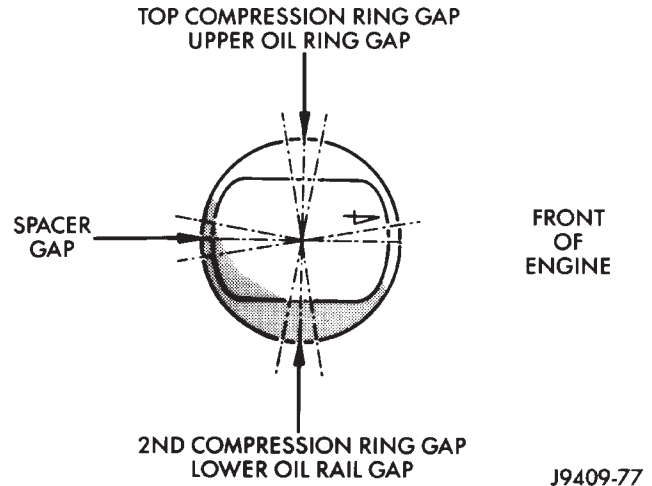


Fig. 47 Proper Ring Installation

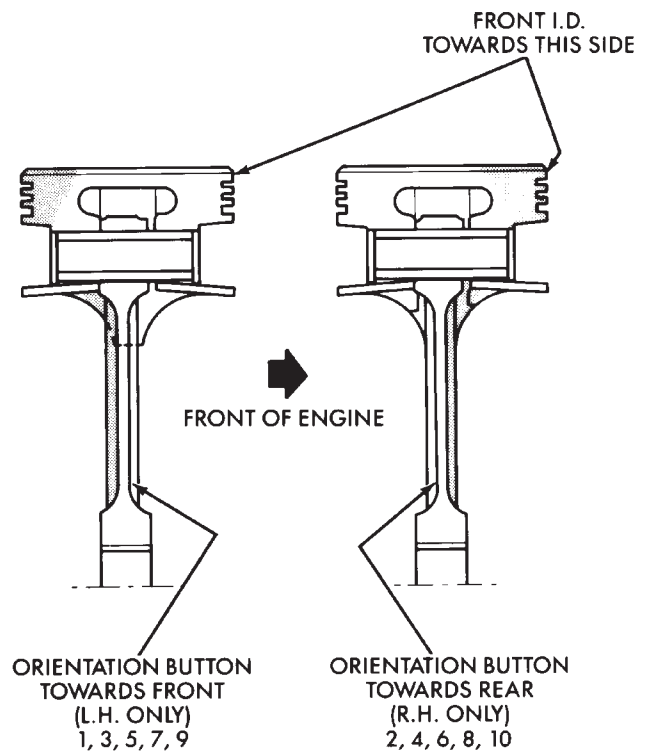


Fig. 48 Piston and Rod Orientation

chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(9) While tapping the piston down in cylinder bore with the handle of a hammer, guide the connecting rod over the crankshaft journal.

(10) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(11) Install the oil pump pick-up tube and oil pan.

REMOVAL AND INSTALLATION (Continued)

(12) Install the cylinder head, push rods, rocker arms and valve cover.

(13) Install lower intake manifold.

(14) Install the engine into the vehicle.(refer to Engine Installation of this manual).

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan and oil pump pick-up tube.

(2) Identify bearing caps before removal. Remove bearing caps one at a time.

(3) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 49).

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

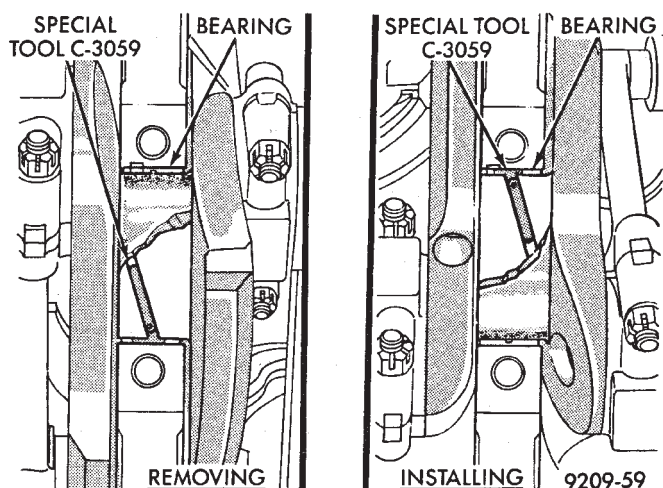


Fig. 49 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 49).

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

(3) Lubricate the main journals with clean engine oil. Install main bearing caps and bolts. Follow the 2 step tightening sequence.

- Step 1—Starting with bearing cap No.1, tighten the bolts to 27 N·m (20 ft. lbs.) torque.

- Step 2—Starting with bearing cap No.1, tighten the bolts to 115 N·m (85 ft. lbs.) torque.

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

(5) Install the oil pump pick-up tube and oil pan.

CRANKSHAFT

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

REMOVAL

(1) Remove the oil pan.

(2) Remove the oil pickup tube.

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

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

(5) Remove the rear seal retainer. Remove and discard the crankshaft rear oil seal and retainer gasket.

(6) Identify main bearing caps before removal (Fig. 50). Remove bearing caps and bearings one at a time.

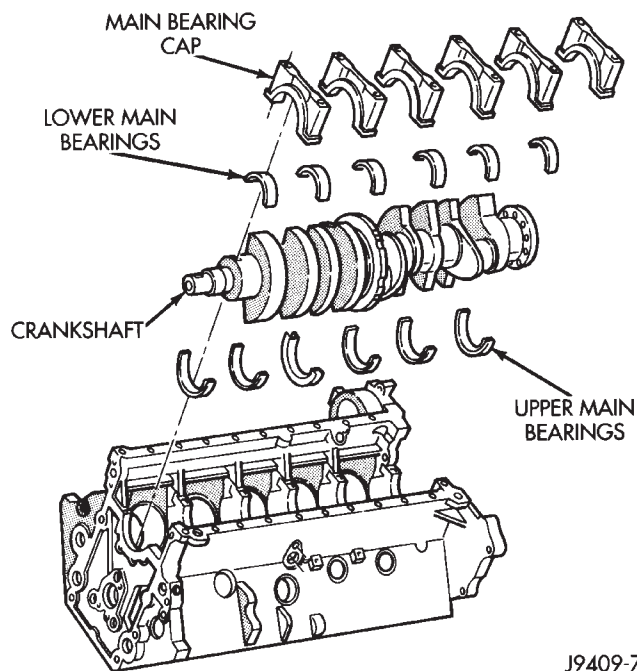


Fig. 50 Main Bearing Identification

(7) Remove the connecting rod bearing caps.

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

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Lubricate crankshaft main bearings with clean engine oil.

(2) Install the crankshaft into the cylinder block.

(3) Lubricate the main journals with clean engine oil. Install main bearing caps and bolts. Follow the 2 step tightening sequence.

- Step 1—Starting with bearing cap No.1, tighten the bolts to 27 N·m (20 ft. lbs.) torque.

- Step 2—Starting with bearing cap No.1, tighten the bolts to 115 N·m (85 ft. lbs.) torque.

(4) Lubricate the connecting rod bearings and journals with clean engine oil. Carefully install connecting rods to the crankshaft.

(5) Install the rear seal retainer with a new gasket and oil seal. Use seal installer 6687 when installing the oil seal.

(6) Install the timing chain cover with a new gasket and oil seal.

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

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

(9) Install the oil pickup tube. Tighten the bolts to 16 N·m (144 in. lbs.) torque.

(10) Install the oil pan.

OIL PUMP

REMOVAL

(1) Remove the timing chain cover.

(2) Remove the relief valve plug, gasket, spring and valve (Fig. 51). Discard the gasket.

(3) Remove oil pump cover (Fig. 52).

(4) Remove pump rotors (Fig. 52).

INSTALLATION

(1) Lubricate the pump rotors using petroleum jelly or lubriplate and install in the timing chain cover. Use new parts as required (Fig. 53).

(2) Position the oil pump cover onto the timing chain cover. Tighten cover bolts to 14 N·m (125 in. lbs.) torque.

(3) Make sure that inner ring moves freely after cover is installed.

(4) Install the timing chain cover.

(5) Squirt oil into relief valve hole until oil runs out.

(6) Install the relief valve and spring.

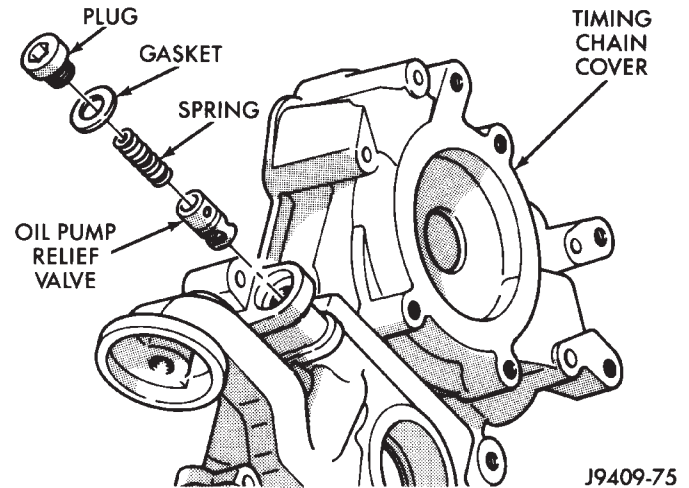


Fig. 51 Oil Pressure Relief Valve

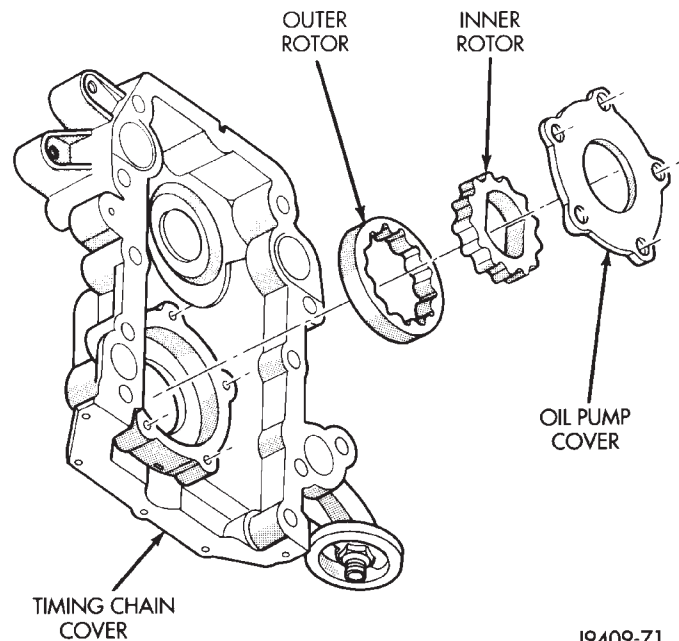


Fig. 52 Oil Pump

(7) Using a new pressure relief valve gasket, install the relief valve plug. Tighten the plug to 20 N·m (15 ft. lbs.) torque.

(8) Install oil filter that has been filled with oil.

CRANKSHAFT REAR SEAL/ RETAINER

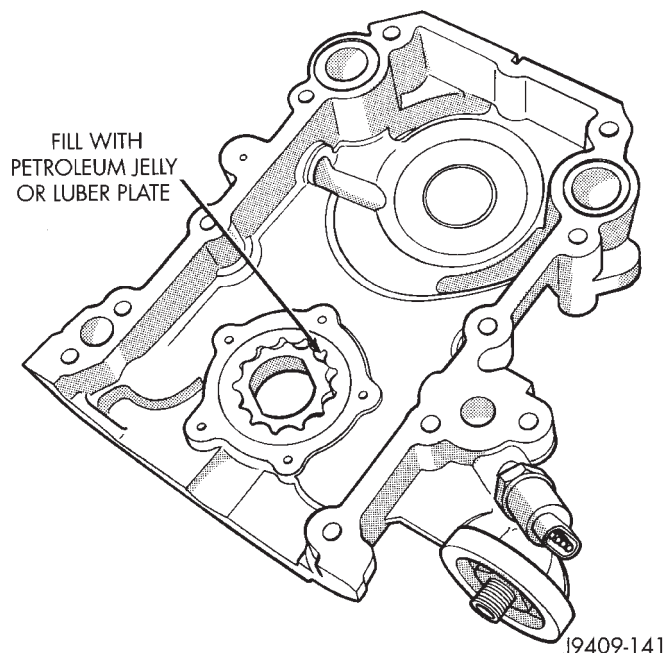
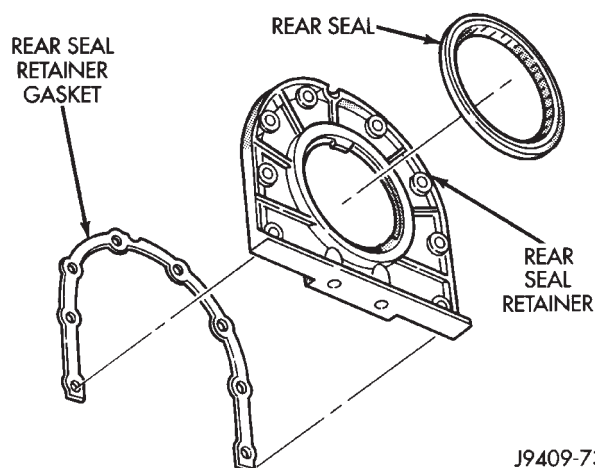
REMOVAL

(1) Remove the transmission (refer to Group 21, Transmissions).

(2) Remove the oil pan.

(3) Remove the rear seal retainer. Discard the oil seal and the gasket (Fig. 54).

REMOVAL AND INSTALLATION (Continued)

**Fig. 53 Priming Oil Pump.****Fig. 54 Crankshaft Rear Seal Retainer****INSTALLATION**

- (1) Wash all parts in a suitable solvent and inspect carefully for damage or wear.
- (2) Position the rear seal in the retainer.
- (3) Using Special Tool 6687, position the retainer and oil seal over the crankshaft. Install the bolts and tighten to 22 N·m (16 ft. lbs.) torque.
- (4) The seal face surface must be within 0.508 mm (0.020 in) full indicator movement relative to rear face of crankshaft. If out of limits, gently tap the high side into the retainer.
- (5) Add a small amount of Mopar® Silicone Rubber Adhesive Sealant at split-line.
- (6) Install the oil pan.

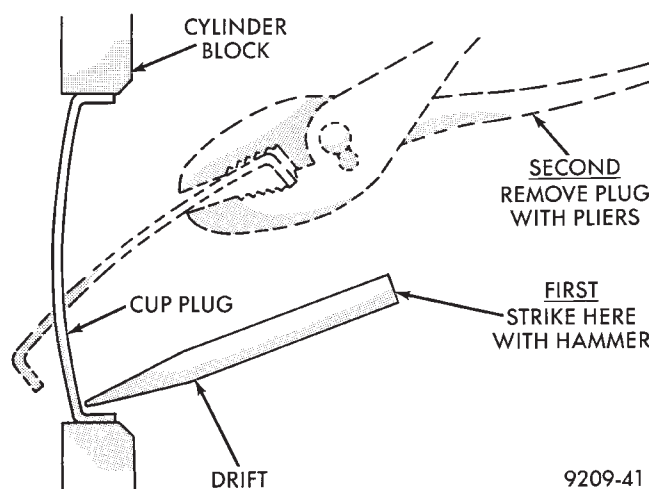
- (7) Install the transmission (refer to group 21, Transmissions).

ENGINE CORE OIL—CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate. This will reduce internal leakage and help maintain higher oil pressure at idle.

REMOVAL

- (1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 55).
- (2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 55).

**Fig. 55 Core Hole Plug Removal****INSTALLATION**

- (1) Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer.
- (2) Make certain the new plug is cleaned of all oil or grease.
- (3) Coat edges of plug and core hole with Mopar® Gasket Maker, or equivalent.

CAUTION: DO NOT drive cup plug into the casting as restricted coolant flow can result and cause serious engine problems.

- (4) Using proper drive plug, drive plug into hole. The sharp edge of the plug should be at least 0.50 mm (0.020 inch) inside the lead-in chamfer.

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

DISASSEMBLY AND ASSEMBLY

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Black Valve Guide Sleeve Tool C-6819 over valve stem for the **INTAKE** valve and install valve (Fig. 56). The special sleeve places the valve at the correct height for checking with a dial indicator.

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

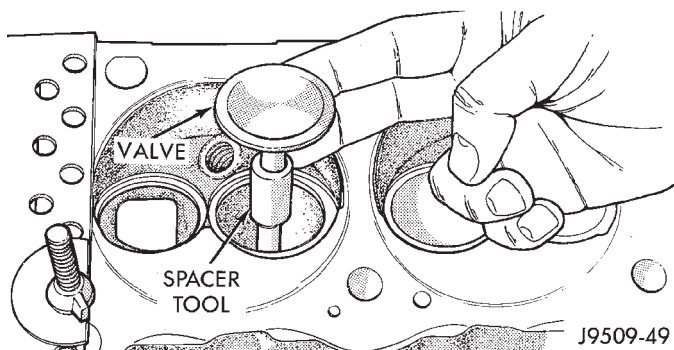


Fig. 56 Positioning Valve Spacer Tool (Typical)

(3) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 57).

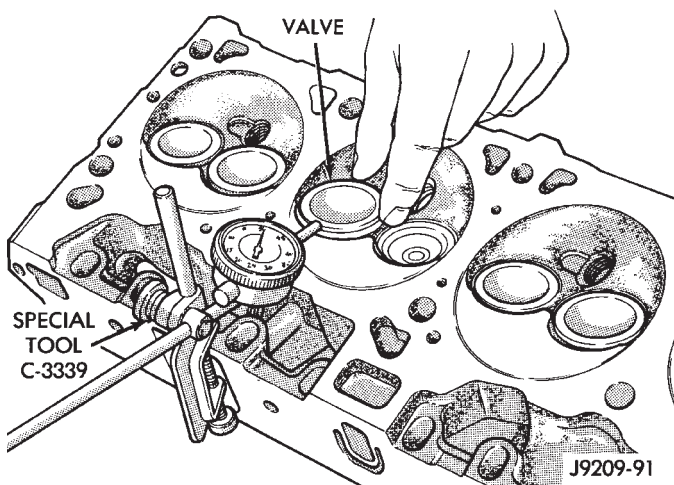


Fig. 57 Measuring Valve Guide Wear

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

Service valves with oversize stems are available (Fig. 58).

Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

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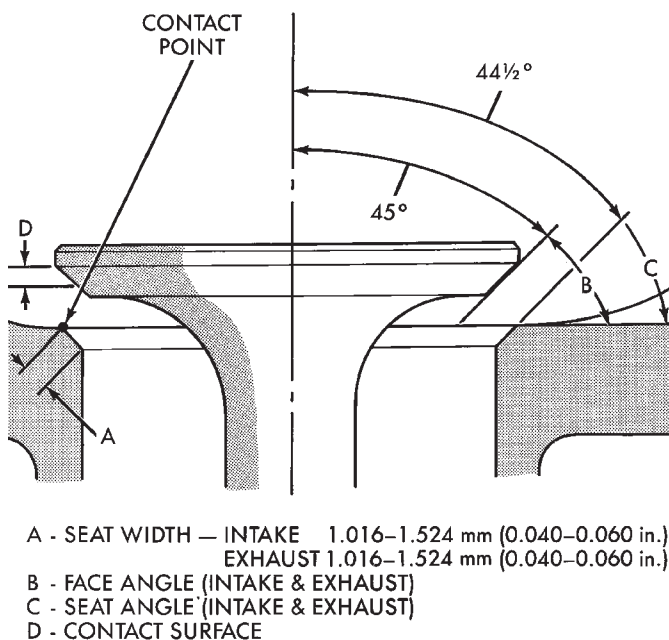
Fig. 58 Reamer Sizes

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

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

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 45° face angle and a 45° to 44 1/2° seat angle (Fig. 59).



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Fig. 59 Valve Face and Seat Angles

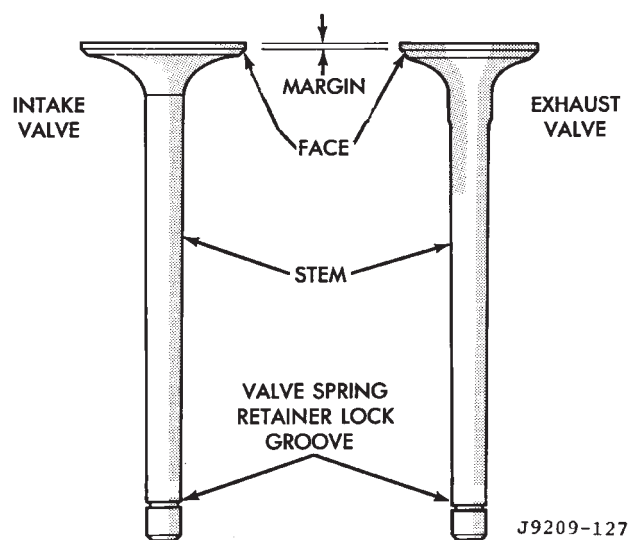
VALVES

Inspect the remaining margin after the valves are refaced (Fig. 17). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

VALVE SEATS

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

DISASSEMBLY AND ASSEMBLY (Continued)

**Fig. 60 Intake and Exhaust Valves**

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

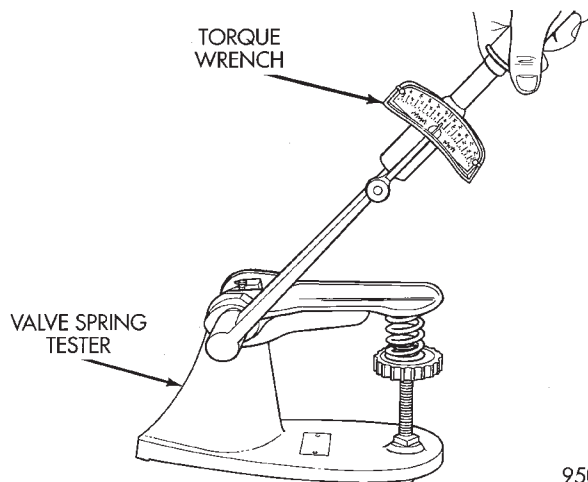
(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.038 mm (0.0015 inch) total indicator reading.

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

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

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 61). 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. 61 Testing Valve Spring for Compressed Length****CYLINDER BLOCK**

Remove the engine assembly from the vehicle.

DISASSEMBLE

- (1) Remove the cylinder head and valve train.
- (2) Remove the intake system.
- (3) Remove the timing cover and timing chain with sprockets.
- (4) Remove the oil pan.
- (5) Remove the piston-connecting rod assemblies.
- (6) Remove the crankshaft and bearings.

ASSEMBLE

- (1) Install crankshaft and bearings.
- (2) Install the piston/connecting rod assembly.
- (3) Install the oil pan.
- (4) Install timing cover, timing chain and sprockets.
- (5) Install the cylinder head and valve train.
- (6) Install the engine into the vehicle.
- (7) Install intake system.

CLEANING AND INSPECTION**CYLINDER HEADS****CLEANING**

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

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

Clean the exhaust manifold to cylinder head mating areas.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. The out-of-flatness

CLEANING AND INSPECTION (Continued)

specifications are 0.0007 mm/mm (0.0004 inch/inch), 0.127 mm/152 mm (0.005 inch/6 inches) any direction or 0.254 mm (0.010 inch) overall across head. If exceeded, either replace head or lightly machine the head surface.

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

Inspect push rods. Replace worn or bent rods.

Inspect rocker arms. Replace if worn or scored.

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

OIL PUMP

CLEANING

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

INSPECTION

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

Lay a straightedge across the pump cover surface (Fig. 62). If a 0.076 mm (0.003 inch) feeler gauge can be inserted between cover and straightedge, cover should be replaced.

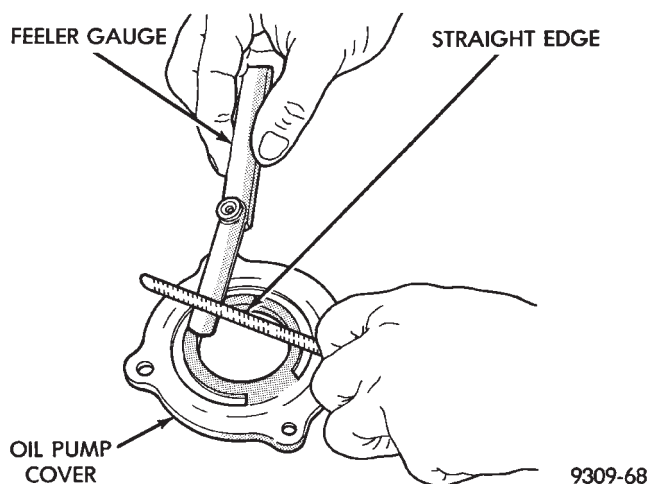


Fig. 62 Checking Oil Pump Cover Flatness

Measure thickness (Fig. 63) (Fig. 64) 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.

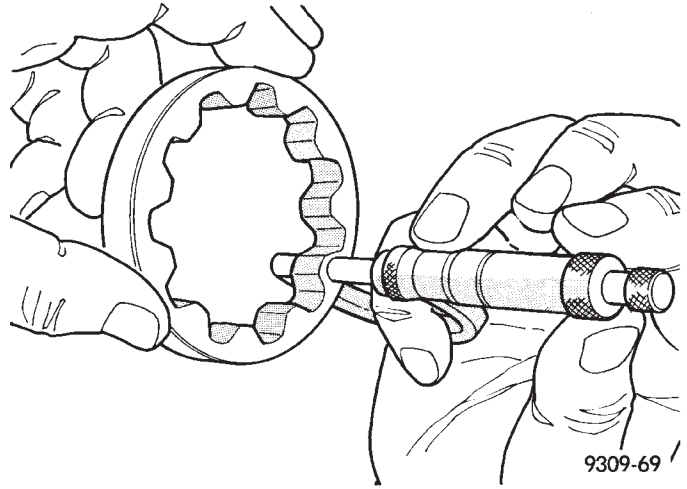


Fig. 63 Measuring Outer Rotor Thickness

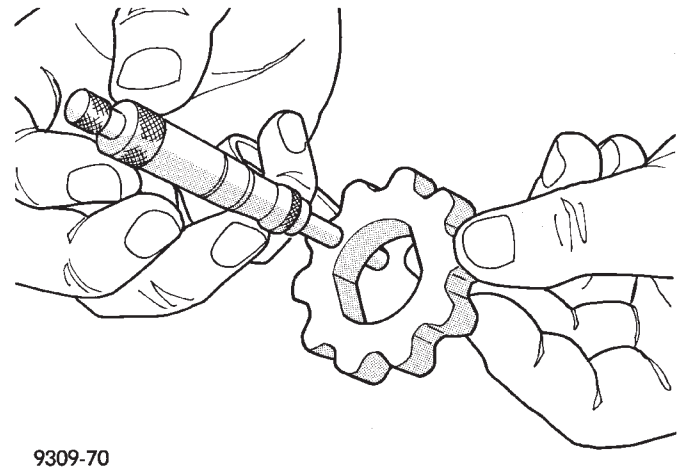


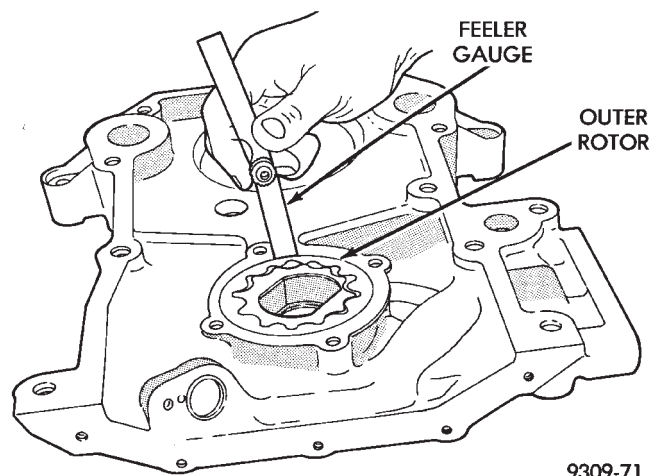
Fig. 64 Measuring Inner Rotor Thickness

Slide outer rotor into timing chain cover pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 65). If clearance is 0.19 mm (0.007 inch) or more, and outer rotor is within specifications, replace timing chain cover.

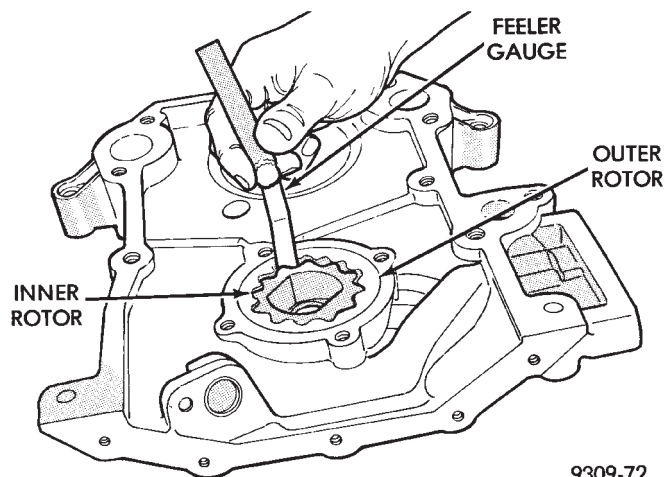
Install inner rotor into timing chain cover pump body (Fig. 66). Inner rotor should be positioned with chamfer up or toward engine when cover is installed. This allows easy installation over crankshaft. If clearance between inner and outer rotors is 0.150 mm (0.006 inch) or more, replace both rotors.

Place a straightedge across the face of the timing chain cover pump body, between bolt holes (Fig. 67). If a feeler gauge of 0.077 mm (0.003 inch) or more can be inserted between rotors and the straightedge,

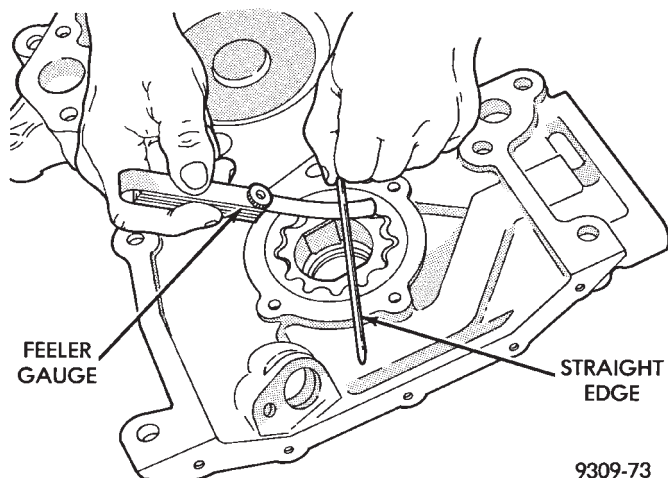
CLEANING AND INSPECTION (Continued)



9309-71

Fig. 65 Measuring Outer Rotor Clearance in Cover

9309-72

Fig. 66 Measuring Inner Rotor Clearance in Cover
and the rotors are within specifications, replace timing chain cover.

9309-73

Fig. 67 Measuring Clearance Over Rotors

Inspect oil pressure relief valve plunger for scoring and free operation in its bore. Small marks may be removed with 400-grit wet or dry sandpaper.

The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 100 and 109 N (22.5 and 24.5 pounds) when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications.

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

CYLINDER BLOCK**CLEANING**

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

INSPECTION

Examine block for cracks or fractures.

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

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

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

SPECIFICATIONS**8.0L ENGINE SPECIFICATIONS****GENERAL INFORMATION**

Engine Type . . . . .	.90° V-10 OHV
Bore and Stroke . . .	101.6 x 98.6 mm (4.00 x 3.88 in.)
Displacement	8.0L (488 c.i.)
Compression Ratio	8.4:1
Firing Order	1-10-9-4-3-6-5-8-7-2
Lubrication	Pressure Feed - Full Flow Filtration
Cooling System . . .	Liquid Cooled - Forced Circulation
Cylinder Block	Cast Iron
Cylinder Head	Cast Iron
Crankshaft	Nodular Iron
Camshaft	Nodular Cast Iron
Combustion Chambers . . .	Wedge - High Swirl Valve Shrouding
Pistons	Aluminum Alloy
Connecting Rods	Forged Steel
Compression Pressure . . .	.689.5 kPa (100 psi) (Min.)

SPECIFICATIONS (Continued)

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 (2.061 – 2.062 in.)
No. 4	.51.94 – 51.97 mm (2.045 – 2.046 in.)
No. 5	.51.54 – 51.56 mm (2.029 – 2.030 in.)
No. 6	.48.74 – 48.77 mm (1.919 – 1.920 in.)

Bearing Journal Diameter

No. 1	.53.11 – 53.14 mm (2.091 – 2.092 in.)
No. 2	.52.69 – 52.72 mm (2.0745 – 2.0755 in.)
No. 3	.52.30 – 52.32 mm (2.059 – 2.060 in.)
No. 4	.51.89 – 51.92 mm (2.043 – 2.044 in.)
No. 5	.51.49 – 51.51 mm (2.027 – 2.028 in.)
No. 6	.48.69 – 48.72 mm (1.917 – 1.918 in.)

Bearing to Journal Clearance

No. 1,3,4,5,6	.00254 – 0.0762 mm (0.001 – 0.003 in.)
No. 2	.00381 – 0.0889 mm (0.0005 – 0.0035 in.)
Service Limit	.0127 mm (0.005 in.)

Camshaft End Play

End Play	.0127 – 0.381 mm (0.005 – 0.015 in.)
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CONNECTING RODS

Piston Pin bore Diameter	.24.940 – 24.978 mm (0.9819 – 0.9834 in.)
Side Clearance	.025 – 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.)	.00254 mm (0.001 in.)
Taper (Max.)	.00254 mm (0.001 in.)
Bearing Clearance	.0005 – 0.074 mm (0.0002 – 0.0029 in.)
Service Limit	.0762 mm (0.003 in.)

Main Bearing Journal

Diameter	.76.187 – 76.213 mm (2.9995 – 3.0005 in.)
Out of Round (Max.)	.00254 mm (0.001 in.)
Taper (Max.)	.00254 mm (0.001 in.)
Bearing Clearance	.00051 – 0.058 mm (0.0002 – 0.0023 in.)
Service Limit	.071 mm (0.0028 in.)

Crankshaft End Play

End Play	.076 – 0.305 mm (0.003 – 0.012 in.)
Service Limit	.0381 mm (0.015 in.)

CYLINDER BLOCK**Cylinder Bore**

Diameter	.101.60 – 101.65 mm (4.0003 – 4.0008 in.)
Out of Round (Max.)	.00762 mm (0.003 in.)
Taper (Max.)	.0127 mm (0.005 in.)

Lifter Bore

Diameter	.22.982 – 23.010 mm (0.9048 – 0.9059 in.)
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CYLINDER HEAD AND VALVES**Valve Seat**

Angle	.44.5°
Runout (Max.)	.00762 mm (0.003 in.)
Width (Finish) –	
Intake	.1016 – 1.524 mm (0.040 – 0.060 in.)

Valves

Face Angle	.45°
Head Diameter –	
Intake	.48.640 – 48.900 mm (1.915 – 1.925 in.)
Head Diameter –	
Exhaust	.41.123 – 41.377 mm (1.619 – 1.629 in.)
Length (Overall) –	
Intake	.145.19 – 145.82 mm (5.716 – 5.741 in.)
Length (Overall) –	
Exhaust	.145.54 – 146.18 mm (5.730 – 5.755 in.)
Lift (@ zero lash) – Intake	.9.91 mm (0.390 in.)
Lift (@ zero lash) – Exhaust	.10.34 mm (0.407 in.)
Stem Diameter	.7.900 – 7.920 mm (0.311 – 0.312 in.)
Guide Bore	.9.500 – 9.525 mm (0.374 – 0.375 in.)
Stem to Guide Clearance	.0025 – 0.076 mm (0.001 – 0.003 in.)
Service Limit	.04318 (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.)

Spring Tension –

(valve open)	.890 N @ 30.89 mm (200 lbs. @ 1.212 in.)
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Number of Coils	.6.8
Installed Height	.41.66 mm (1.64 in.)
Wire Diameter	.4.50 mm (0.177 in.)

SPECIFICATIONS (Continued)

HYDRAULIC TAPPETS

Body Diameter	22.949 – 22.962 mm (0.9035 – 0.9040 in.)
Clearance (to bore)	.00203 – 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)

CAUTION: If oil pressure is zero at curb idle, DO NOT RUN ENGINE.

OIL PUMP

Clearance over Rotors (Max.)	.01906 mm (0.0075 in.)
Cover Out of Flat (Max.)	.0051 mm (0.002 in.)
Inner Rotor Thickness (Min.)	.14.925 – 14.950 mm (0.5876 – 0.5886 in.)
Outer Rotor Clearance (Max.)	.01626 mm (0.006 in.)
Outer Rotor Diameter (Min.)	.82.461 mm (3.246 in.)
Outer Rotor Thickness (Min.)	.14.925 mm (0.5876 in.)
Tip Clearance between Rotors (Max.)	.0584 mm (0.0230 in.)

PISTONS

Clearance at Top of Skirt	.0013 – 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.)
Piston Ring Groove Depth – #3	.92.90 – 93.15 mm (3.657 – 3.667 in.)
Weight	.463 – 473 grams (16.33 – 16.68 oz.)
Piston to Bore Clearance	.0013 – 0.038 mm (0.0005 – 0.0015 in.)
Service Limit	.0762 mm (0.003 in.)

PISTON PINS

Clearance in Piston	.0010 – 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.)

Ring Side Clearance

Compression Rings	.0.074 – 0.097 mm (0.0029 – 0.0038 in.)
Oil Ring (Steel Rails)	.0.185 – 0.246 mm (0.0073 – 0.0097 in.)

Ring Width

Compression rings	.4.115 – 4.369 mm (0.162 – 0.172 in.)
Oil Ring (Steel Rails)	.2.591 – 2.743 mm (0.102 – 0.108 in.)

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°

SPECIFICATIONS (Continued)

CONDITION	IDENTIFICATION	LOCATION OF IDENTIFICATION
CRANKSHAFT JOURNALS (UNDERSIZE) 0.0254 mm (0.001 in.)	R or M M-2-3 etc. (indicating no. 2 and 3 main bearing journal) and/or R-1-4 etc. (indicating no. 1 and 4 connecting rod journal)	Milled flat on no. 8 crankshaft counterweight.
CYLINDER BORES (OVERSIZE) 0.508 mm (0.020 in.)	A	Following engine serial number.
HYDRAULIC TAPPETS (OVERSIZE) 0.2032 mm (0.008 in.)	♦	Diamond-shaped stamp top pad – front of engine and flat ground on outside surface of each O/S tappet bore.
VALVE STEMS (OVERSIZE) 0.127 mm (0.005 in.)	X	Milled pad adjacent to two tapped holes (3/8 in.) on each end of cylinder head.

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ENGINE SPECIFICATIONS—CONT.

TORQUE SPECIFICATIONS

8.0L ENGINE

DESCRIPTION	TORQUE
Camshaft Sprocket	
Bolt	75 N·m (55 ft. lbs.)
Camshaft Thrust Plate	
Bolts	22 N·m (16 ft. lbs.)
Coil Pack Bracket	
Bolts	21 N·m (190 in. lbs.)
Connecting Rod Cap	
Bolts	61 N·m (45 ft. lbs.)
Crankshaft Main Bearing Bolts	
Step 1 – Initial	27 N·m (20 ft. lbs.)
Step 2 – Final	115 N·m (85 ft. lbs.)
Crankshaft Pulley/Damper	
Bolt	183 N·m (135 ft. lbs.)
Crankshaft Rear Seal Retainer	
Bolts	22 N·m (16 ft. lbs.)
Cylinder Head Bolts	
Step 1 – Initial	58 N·m (43 ft. lbs.)
Step 2 – Final	143 N·m (105 ft. lbs.)
Cylinder Head Cover	
Bolts/Studs	16 N·m (144 in. lbs.)
Drive Plate to Crankshaft	
Bolts	75 N·m (55 ft. lbs.)
Drive Plate to Torque Converter	
Bolts	47 N·m (35 ft. lbs.)
EGR Tube	
Nut	34 N·m (25 ft. lbs.)

DESCRIPTION	TORQUE
EGR Valve	
Bolts	20 N·m (174 in. lbs.)
Engine Support Bracket/Insulator	
Through Bolt	68 N·m (50 ft. lbs.)
Engine Support Bracket/Insulator to Block	
Bolts	47 N·m (35 ft. lbs.)
Exhaust Manifold to Cylinder Head	
Bolts	22 N·m (16 ft. lbs.)
Generator Mounting	
Bolt	41 N·m (30 ft. lbs.)
Generator to Intake Manifold Bracket	
Bolts	41 N·m (30 ft. lbs.)
Heat Shield	
Nuts	20 N·m (175 in. lbs.)
Hydraulic Tappet Yoke Retaining Spider	
Bolts	22 N·m (16 ft. lbs.)
Intake Manifold (Lower)	
Bolts	54 N·m (40 ft. lbs.)
Intake Manifold (Upper)	
Bolts	22 N·m (16 ft. lbs.)
Oil Filter	
Filter	9 N·m (80 in. lbs.) + 45°
Oil Filter Connector	
.	46 N·m (34 ft. lbs.)
Oil Pan	
1/4 – 20 Bolts	11 N·m (96 in. lbs.)
5/16 – 18 Bolts	16 N·m (144 in. lbs.)
Stud Bolts	16 N·m (144 in. lbs.)
Drain Plug	34 N·m (25 ft. lbs.)

SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Oil Pan Pick Up Tube	
Bolts.....	16 N·m (144 in. lbs.)
Oil Pump Attaching	
Bolts.....	41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts.....	14 N·m (125 in. lbs.)
Oil Pump Pressure Relief Plug	
Plug.....	20 N·m (15 ft. lbs.)
Rocker Arm	
Bolts.....	28 N·m (21 ft. lbs.)
Spark Plugs	
Plugs.....	41 N·m (30 ft. lbs.)
Starter Mounting	
Bolts.....	68 N·m (50 ft. lbs.)
Timing Chain Cover	
Bolts.....	47 N·m (35 ft. lbs.)
Thermostat Housing	
Bolts.....	25 N·m (220 in. lbs.)
Throttle Body	
Nuts.....	11 N·m (96 in. lbs.)
Transfer Case to Insulator Mounting Plate	
Nuts.....	204 N·m (150 ft. lbs.)
Transmission Support Bracket	
Bolts.....	102 N·m (75 ft. lbs.)
Transmission Support Cushion	
Bolts.....	47 N·m (35 ft. lbs.)
Transmission Support Cushion Stud	
Nuts.....	47 N·m (35 ft. lbs.)
Water Pump to Chain Case Cover	
Bolts.....	41 N·m (30 ft. lbs.)
Water Pump Pulley	
Bolts.....	22 N·m (16 ft. lbs.)

SPECIAL TOOLS

8.0L ENGINE

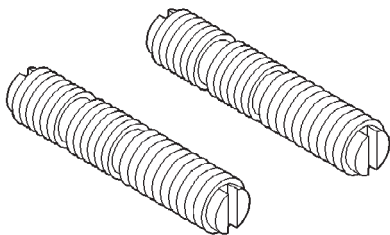


Fig. 68 Valve Compressor Adapting Stud Tool 6715

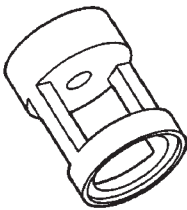


Fig. 69 Valve Spring Compressor Adapter Tool 6716A

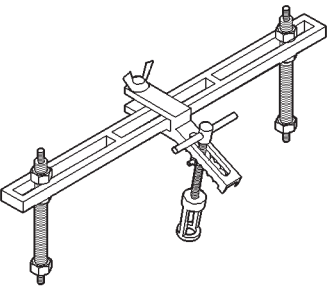


Fig. 70 Valve Spring Compressor Tool MD-998772A

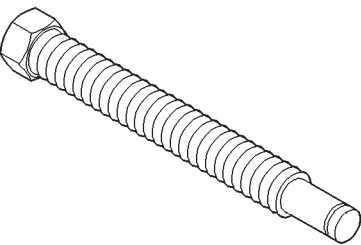


Fig. 71 Valve Spring Compressor Screw Tool 6756

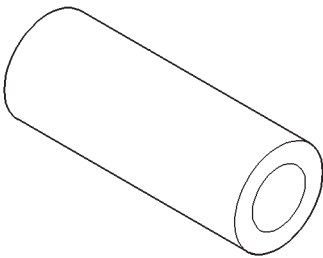


Fig. 72 Black Valve Guide Sleeve Tool C6819

SPECIAL TOOLS (Continued)

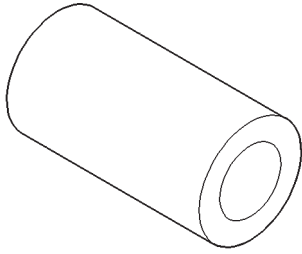


Fig. 73 Silver Valve Guide Sleeve Tool C6818

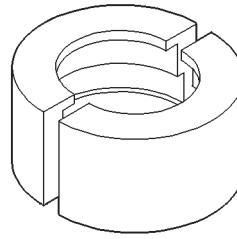


Fig. 77 Crankshaft Sprocket Puller Jaws Tool 6820

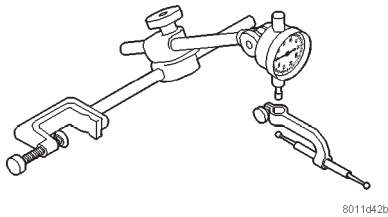


Fig. 74 Dial Indicator Tool C3339

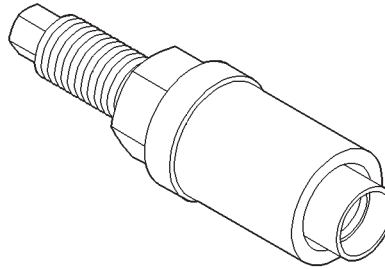


Fig. 78 Crankshaft Sprocket Installer Tool 3718

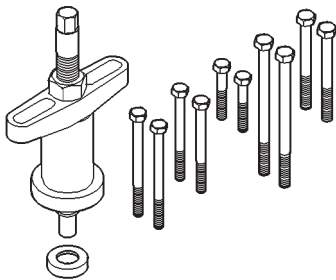


Fig. 75 Crankshaft Pulley/Damper Installer Tool C3688

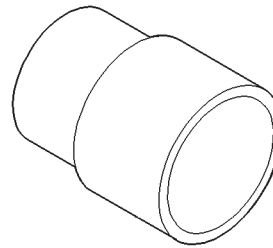


Fig. 79 Crankshaft Sprocket Installer Tool MD990799

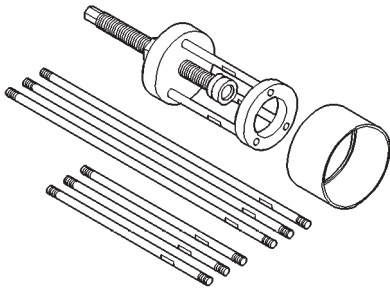


Fig. 76 Crankshaft Sprocket Puller Tool 6444

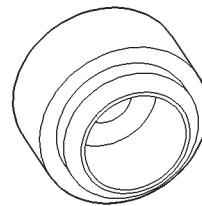


Fig. 80 Front Oil Seal Installer Tool 6806

SPECIAL TOOLS (Continued)

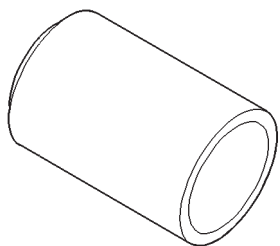


Fig. 81 Front Oil Seal Installer Tool 6761

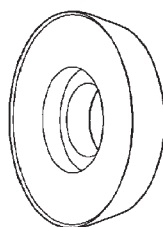


Fig. 85 Seal Installer Tool 6687

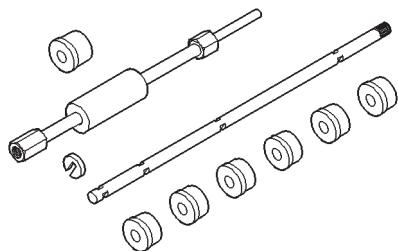


Fig. 82 Camshaft Bearing Installer Tool C3132A

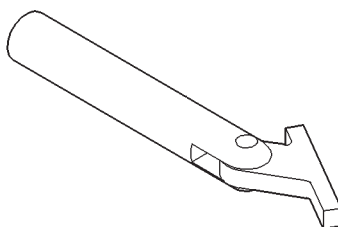


Fig. 86 Crankshaft Main Bearing Remover/Installer Tool C3059

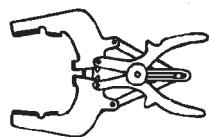


Fig. 83 Compression Ring Installer Tool C4184

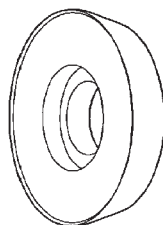


Fig. 87 Seal Installer Tool 6687

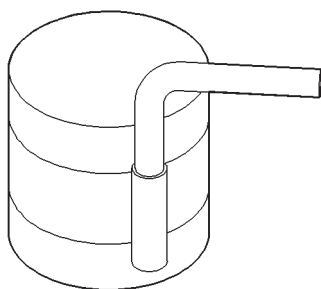


Fig. 84 Piston Ring Compressor Tool C385

5.9L DIESEL ENGINE

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GENERAL INFORMATION

PISTON GRADING

When rebuilding an engine with the original cylinder block, crankshaft and pistons, make sure the pistons are installed in the original cylinder.

If replacing the piston(s), make sure the replacement piston(s) are the same grade as the original piston.

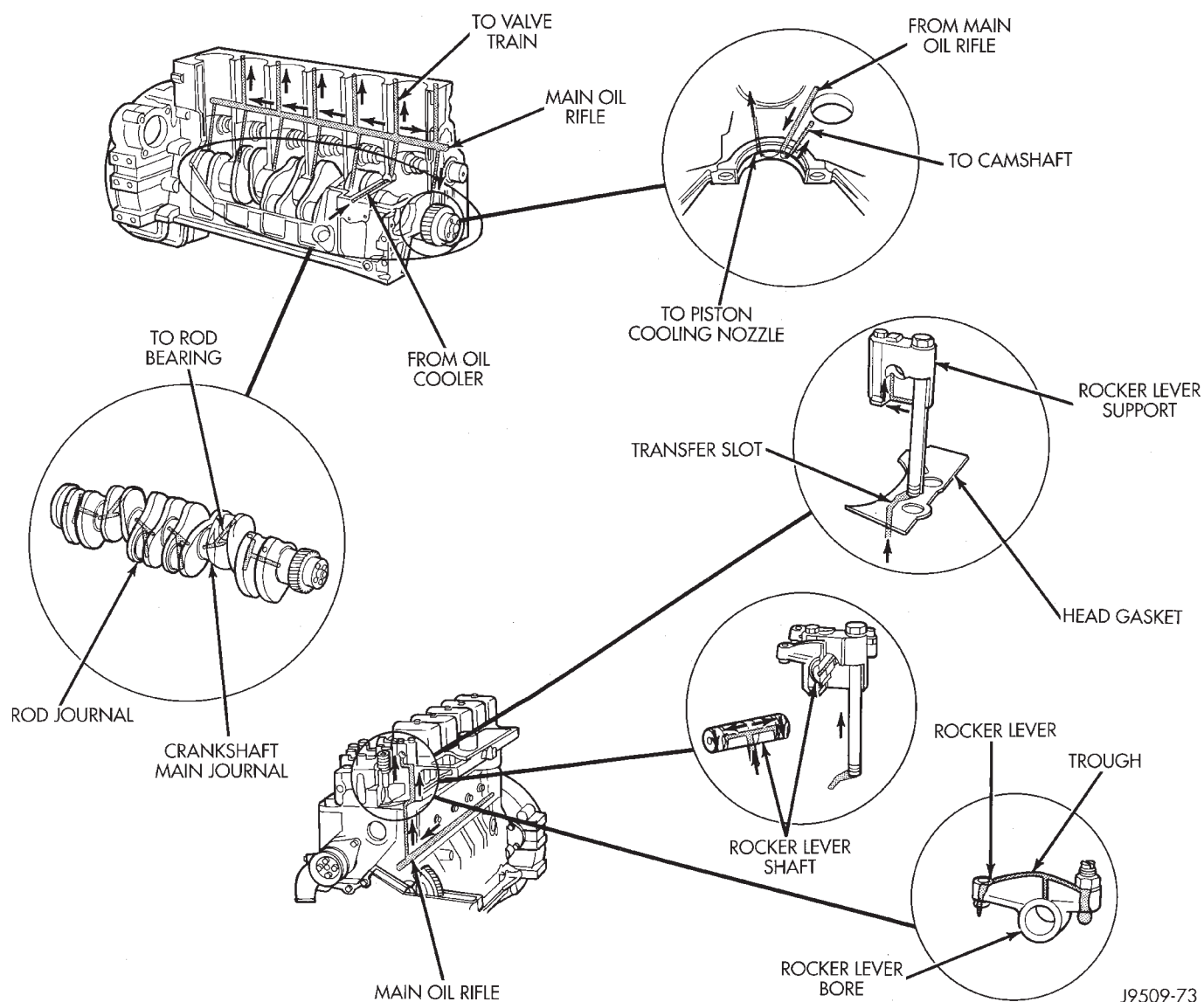
If a new cylinder block or crankshaft is used, the piston grading procedure **MUST** be performed to determine the proper piston grade for each cylinder.

OIL FILTER

When replacing the oil filter, use replacement filter specified in your Operator's Manual.

CAUTION: The internal filtering medium of some filters has been known to disintegrate. Debris from failed filters may plug the piston oil cooling nozzles, resulting in scuffed pistons and eventual engine failure.

DESCRIPTION AND OPERATION (Continued)

**Fig. 2 Lubricating System Components**

DESCRIPTION AND OPERATION (Continued)

OIL PRESSURE REGULATOR VALVE

The vacuum pump is a constant displacement,

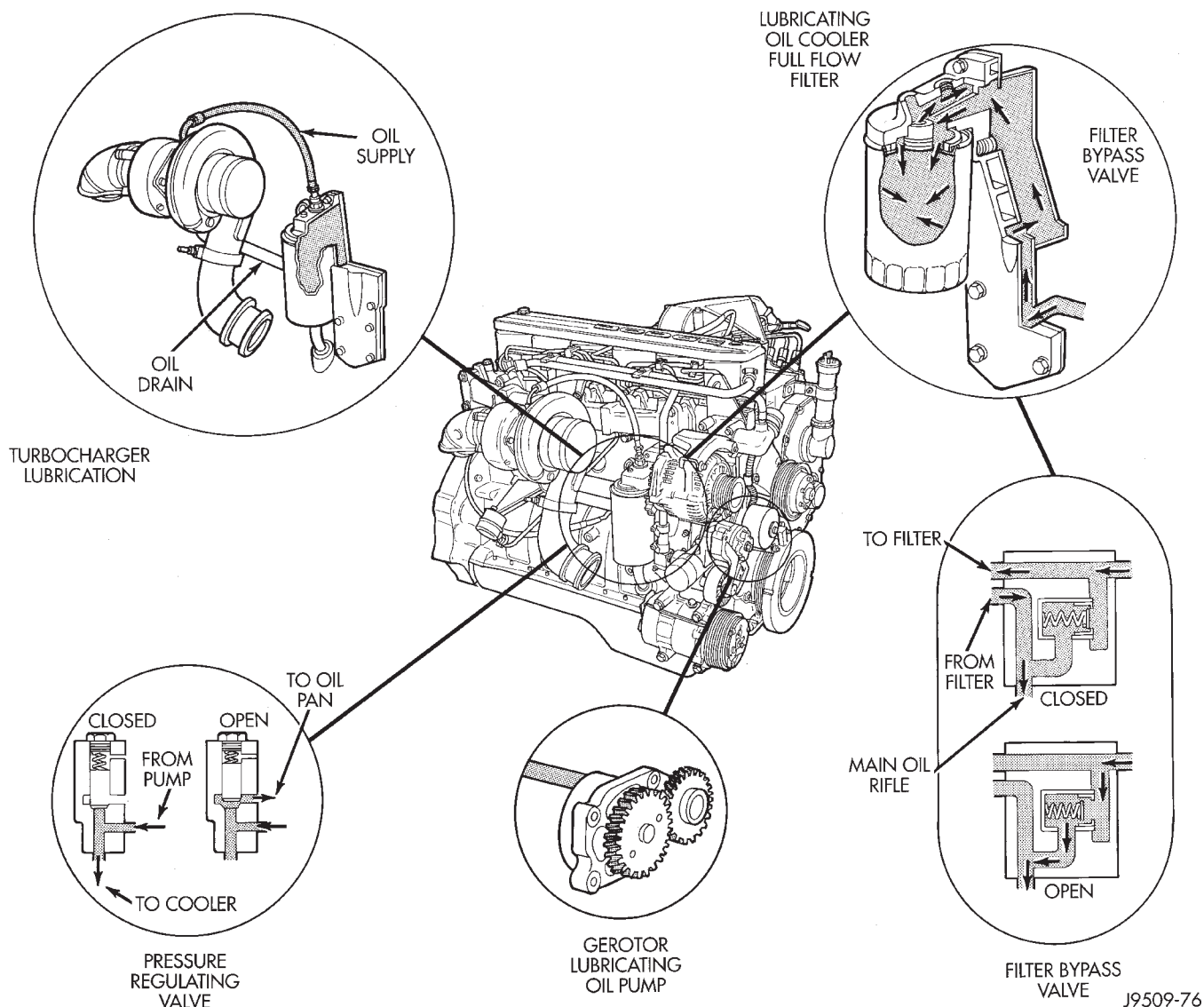


Fig. 3 Lubricating System Passages

When oil pressure from the oil pump exceeds 448 kPa (65 psi), the regulator valve opens to allow oil to drain back into the pan.

TIMING PIN

The timing pin is used for three different procedures:

- Valve adjustment
- Top Dead Center (TDC) location
- Fuel injector pump timing procedure

VACUUM PUMP

The vacuum pump and the power steering pump are combined into a single assembly on diesel engine models (Fig. 4). Both pumps are operated by a drive gear attached to the vacuum pump shaft. The shaft gear is driven by the camshaft gear.

vane-type pump. Vacuum is generated by four vanes mounted in the pump rotor. The rotor is located in the pump housing and is pressed onto the pump shaft.

The vacuum and steering pumps are operated by a single drive gear pressed onto the vacuum pump shaft. The drive gear is operated by the engine camshaft gear.

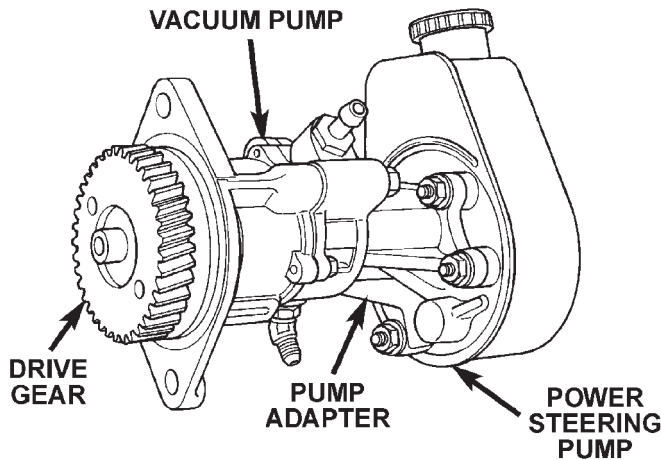
The vacuum and power steering pump shafts are connected by a coupling. Each pump shaft has an adapter with drive lugs that engage in the coupling.

The vacuum pump rotating components are lubricated by engine oil. Lubricating oil is supplied to the pump through an oil line at the underside of the pump housing.

The complete assembly must be removed in order to service either pump. However, the power steering

DESCRIPTION AND OPERATION (Continued)

pump can be removed and serviced separately when necessary.



80a611d3

Fig. 4 Diesel Vacuum & Power Steering Pump Assembly

The vacuum pump is not a serviceable component. If diagnosis indicates a pump malfunction, the pump must be replaced as an assembly. Do not disassemble or attempt to repair the pump.

The combined vacuum and steering pump assembly must be removed for access to either pump. However, the vacuum pump can be removed without having to disassemble the power steering pump.

If the power steering pump requires service, simply remove the assembly and separate the two pumps. Refer to the pump removal and installation procedures in this section.

VACUUM PUMP OPERATION

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

Pump output ranges from a minimum of 8.5 to 25 inches vacuum.

The pump rotor and vanes are rotated by the pump drive gear. The drive gear is operated by the camshaft gear.

SERVICE PROCEDURES

ENGINE OIL SERVICE

When replacing the oil filter, use replacement filter specified in your Operator's Manual.

CAUTION: The internal filtering medium of some filters has been known to disintegrate. Debris from failed filters may plug the piston oil cooling noz-

zles, resulting in scuffed pistons and eventual engine failure.

REMOVAL

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

(1) Operate the engine until the water temperature reaches 60°C (140°F). Shut the engine off.

(2) Use a container that can hold at least 14 liters (15 quarts) to hold the used oil. Remove the oil drain plug and drain the used engine oil into the container.

(3) Always check the condition of the used oil. This can give you an indication of some engine problems that might exist.

- Thin, black oil indicates fuel dilution.
- Milky discoloration indicates coolant dilution.

(4) Clean the area around the lubricating oil filter head. Remove the filter using a 90-95 mm filter wrench.

(5) Clean the gasket surface of the filter head. The filter canister O-Ring seal can stick on the filter head. Make sure it is removed.

INSTALLATION

(1) Fill the oil filter element with clean oil before installation. Use the same type oil that will be used in the engine.

(2) Apply a light film of lubricating oil to the sealing surface before installing the filter.

CAUTION: Mechanical over-tightening may distort the threads or damage the filter element seal.

(3) Install the filter as specified by the filter manufacturer.

(4) Clean the drain plug and the sealing surface of the pan. Check the condition of the threads and sealing surface on the oil pan and drain plug.

(5) Install the drain plug. Tighten the plug to 60 N·m (44 ft. lbs.) torque.

(6) Use only High-Quality Multi-Viscosity lubricating oil in the Cummins Turbo Diesel engine. Choose the correct oil for the operating conditions outlined in Group 0, Lubrication and Maintenance.

(7) Fill the engine with the correct grade of new oil. Refer to Group 0, Lubrication and Maintenance for the correct oil fill capacity.

(8) Start the engine and operate it at idle for several minutes. Check for leaks at the filter and drain plug.

(9) Stop engine. Wait several minutes to allow the oil to drain back to the pan and check the level again.

SERVICE PROCEDURES (Continued)

VALVE SERVICE

VALVE GUIDE INSTALLATION

THIN WALL—SERVICE GUIDES

Machine the cylinder head valve guide bores to 11.125 ± 0.013 mm (0.4380 ± 0.0005 inch) in diameter (Fig. 5).

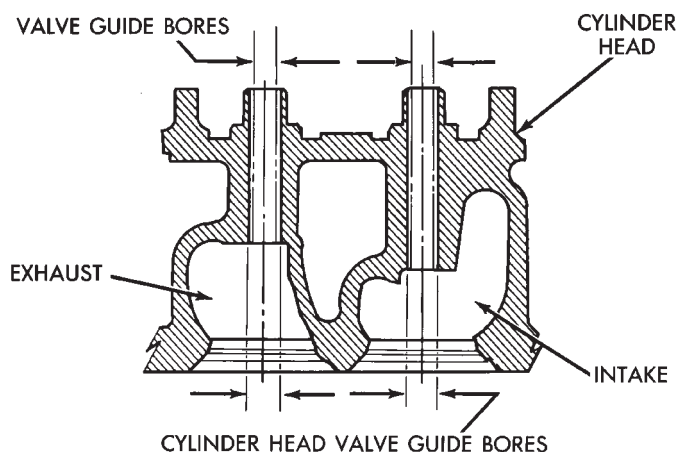
Service valve guides must be centered with valve seats within 0.35 mm (0.01378 inch) diameter. They must also be square with the combustion face within 0.10 mm (0.004 inch) at 50.0 mm (1.9685 inch) radius.

Lubricate the valve guides with oil and press the guides flush to the bottom of the bosses.

Trim off the top of the valve guides flush to top of guide bosses, if necessary.

Machine the valve guide bores to 8.029 ± 0.010 mm (0.3161 ± 0.0004 inch) - (Fig. 5).

The valve guide bore must be centered with the valve seat within 0.35 mm (0.0138 inch) diameter. It also must be square with the combustion face within 0.010 mm (0.0004 inch) at 50.0 mm (2.0 inch) radius.



CYLINDER HEAD VALVE GUIDE BORES	
	11.125 ± 0.013 mm (0.438 ± 0.0005 in)
VALVE GUIDE BORES	
	8.029 ± 0.010 mm (0.3161 ± 0.0004 in)

J9109-136

Fig. 5 Service Valve Guides—Thin Wall

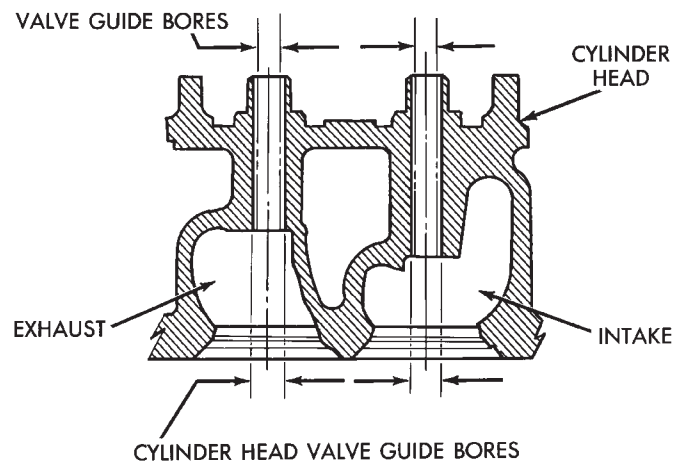
THICK WALL—SERVICE GUIDES

Machine the cylinder head valve guide bores to 14.000 ± 0.013 mm (0.5512 ± 0.0005 inch) diameter (Fig. 6).

Valve guides must be centered with valve seats within 0.35 mm (0.01378 inch) diameter. Valve guides must also be square with the combustion face within 0.10 mm (0.004 inch) at 50.0 mm (2.0 inch) radius.

Lubricate the valve guides with oil and press in the guides to 12.25 ± 0.50 mm (0.4823 ± 0.020 inch) protrusion above the cylinder head.

Ream the bores to 8.029 ± 0.010 mm (0.3161 ± 0.0004 inch) - (Fig. 6).



CYLINDER HEAD VALVE GUIDE BORES	
	14.000 ± 0.013 mm (0.5512 ± 0.0005 in)
VALVE GUIDE BORES	
	8.029 ± 0.010 mm (0.3161 ± 0.0004 in)

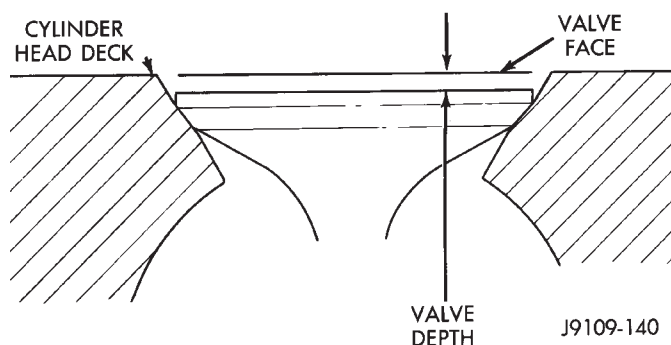
J9109-137

Fig. 6 Service Valve Guides—Thick Wall

VALVE SEATS

INTEGRAL VALVE SEAT GRINDING

After resurfacing the valves and determining that all valves meet specifications, install the valves in their designated locations and measure valve depth (Fig. 7). The valve depth is the distance from the valve face to the head deck. Record the depth of each valve.



J9109-140

Fig. 7 Valve Depth

Grind the valve seats to remove scores, scratches and burns. The seat angle should be—Intake 30° and Exhaust 45°.

SERVICE PROCEDURES (Continued)

Install the valves in their respective bores and measure the depth again (Fig. 7). Record the depth of each valve.

The grinding depth is the difference between the measurement before grinding and the measurement after grinding. The grinding depth maximum limit (integral seats only) is 0.254 mm (0.010 inch). Service valve seats are available for over limit integral valve seats.

Identify ground valve seats by stamping the cylinder head.

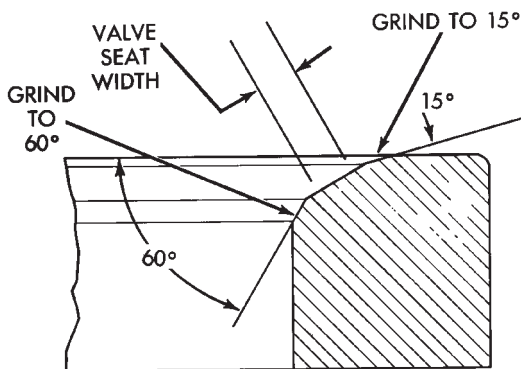
Install the valves in their designated locations and measure the depth of each. The valve depth limit (Integral and Inserted Seats) is 0.99 mm to 1.52 mm (0.039 inch to 0.060 inch). Replace the valve if the depth is over this limit.

Apply a light coat of valve lapping compound to each valve and lap each valve to its mating seat.

Remove the valves and clean lapping compound from the valves and seats.

Measure the valve seat width indicated by the lapped surface. The valve seat width limit is 1.50-2.00 mm (0.060-0.080 inch).

If required, grind the areas with a 60° stone and a 15° stone to center the seat on the valve face. Maintain the valve seat width limits (Fig. 8).



J9109-141

Fig. 8 Grind Valve Seat

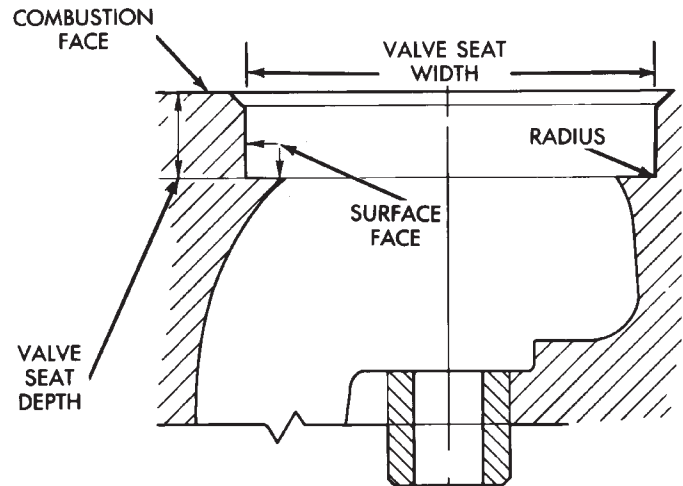
SERVICE VALVE SEAT INSTALLATION

Inspect the valve guide bores as described in the Cleaning and Inspection section of this group. If it is necessary to install valve guides, install the guides before installing the service seats.

Replacement valve seat inserts must be installed if the valve seats have been ground previously. The illustrated marks indicate valve seats have been ground previously.

Machine the cylinder head to install the service valve seats (Fig. 9) (Fig. 10).

Press service seats into the machined pockets. Stake the valve seats into the pockets.



VALVE SEAT DEPTH
10.40 ± 0.10 mm (0.4094 ± 0.004 inch)
VALVE SEAT WIDTH
47.0 ± 0.013 mm (1.8504 ± 0.0005 in)
MAXIMUM RADIUS
0.40 mm (0.0157 inch) MAX.
SURFACE FINISH
3.2 micrometers (128.0 microinch)

J9409-115

Fig. 9 Machining for Service Valve Seats—Intake Valve

SERVICE VALVE SEAT GRINDING

Install the valves in their designated location and measure the valve depth. The valve depth is the distance from the valve face to the head deck.

Record the depth of each valve (Fig. 11). The depth is 0.99-1.52 mm (0.039-0.060 inch).

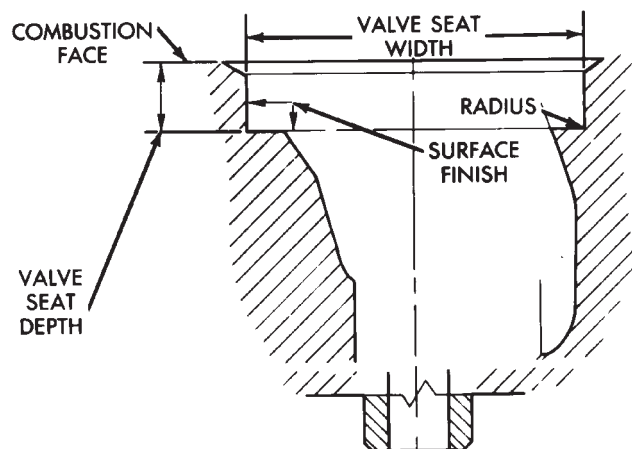
Grind the valve seats to remove scores, scratches and burns. The valve seat angle is 30° (Intake) and 45° (Exhaust).

Install the valves in their respective bores and measure the depth again (Fig. 11). The valve depth limit is 0.99-1.52 mm (0.039-0.060 inch). Replace the valve if the depth is over the limit.

Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat. Remove the valves and clean the lapping compound from the valve and seats.

Measure the valve seat width indicated by the lapped surface (Fig. 12). The width limits are 1.5-2.0 mm (0.060-0.080 inch). If required, grind lower area with 60° stone and upper area with 15° stone (Fig. 12). Be sure to center the seat on the valve face. Maintain the valve seat within limits.

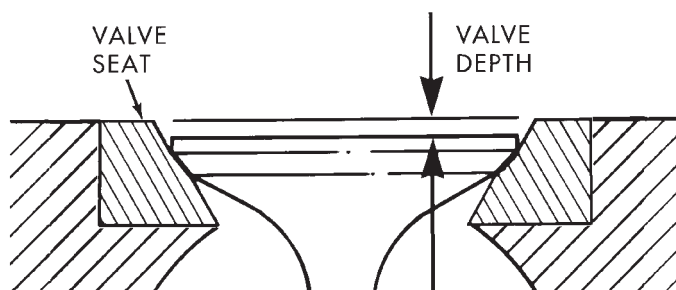
SERVICE PROCEDURES (Continued)



VALVE SEAT DEPTH
10.20 ± 0.10 mm (0.4015 ± 0.004 inch)
VALVE SEAT WIDTH
43.65 ± 0.013 mm (1.7185 ± 0.0005 in)
MAXIMUM RADIUS
0.40 mm (0.0157 inch) MAX.
SURFACE FINISH
3.2 micrometers (128.0 microinch)

J9409-116

Fig. 10 Machining for Service Valve Seats—Exhaust Valve



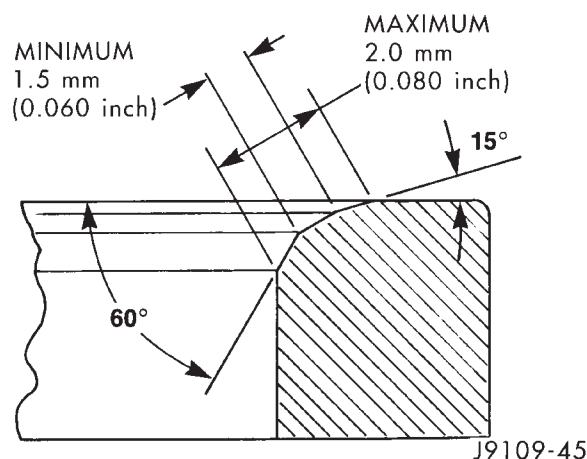
MIN. - 0.990 mm (0.039 inch)
MAX. - 1.520 mm (0.060 inch)

J9109-44

Fig. 11 Valve Depth with Seat Insert

SERVICE VALVE SEAT REPLACEMENT

To replace service seat inserts, machine the insert in the same manner as if machining out the internal seat. Hold the same tolerances and follow the same installation procedures.



J9109-45

Fig. 12 Valve Seat Width

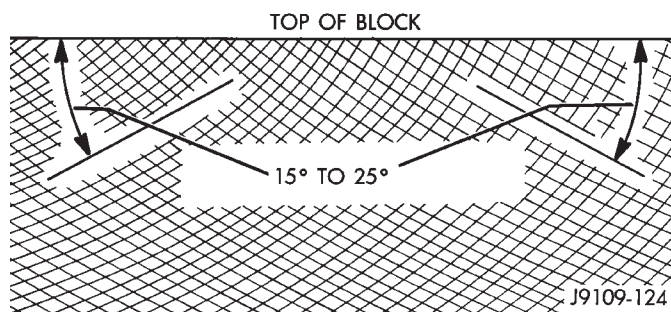
CYLINDER BORES—DE-GLAZE

(1) New piston rings may not seat in glazed cylinder bores.

(2) De-glazing gives the bore the correct surface finish required to seat the rings. The size of the bore is not changed by proper de-glazing.

(3) Cover the lube holes in the top of the block with waterproof tape.

(4) A correctly honed surface will have a cross-hatch appearance with the lines at 15° to 25° angles (Fig. 13). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.



J9109-124

Fig. 13 Cylinder Bore Crosshatch Pattern

(5) Use a drill, a fine grit Flex-hone and a mixture of equal parts of mineral spirits and SAE 30W engine oil to de-glaze the bores.

(6) The crosshatch angle is a function of drill speed and how fast the hone is moved vertically (Fig. 14).

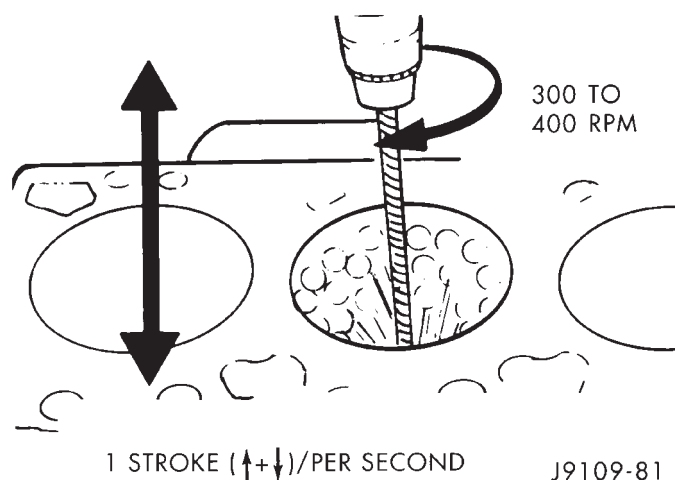
(7) Vertical strokes MUST be smooth continuous passes along the full length of the bore (Fig. 14).

(8) Inspect the bore after 10 strokes.

(9) Use a strong solution of hot water and laundry detergent to clean the bores. Clean the cylinder bores immediately after de-glazing.

(10) Rinse the bores until the detergent is removed and blow the block dry with compressed air.

SERVICE PROCEDURES (Continued)

**Fig. 14 De-Glazing Drill Speed and Vertical Speed**

(11) Check the bore cleanliness by wiping with a white, lint free, lightly oiled cloth. If grit residue is still present, repeat the cleaning process until all residue is removed. Wash the bores and the complete block assembly with solvent and dry with compressed air.

(12) Be sure to remove the tape covering the lube holes after the cleaning process is complete.

CYLINDER BLOCK REFACING

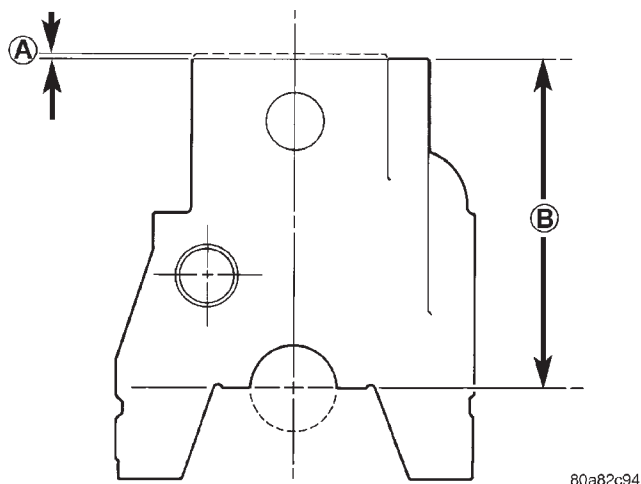
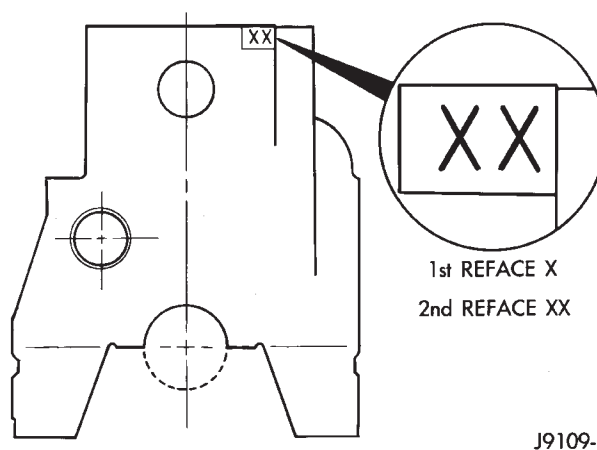
(1) The combustion deck can be refaced twice. The first reface should be 0.25 mm (0.0098 inch). If additional refacing is required, an additional 0.25 mm (0.0098 inch) can be removed. Total allowed refacing is 0.50 mm (0.0197 inch) - (Fig. 15).

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.)

(2) The upper right corner of the rear face of the block must be stamped with a X when the block is refaced to 0.25 mm (0.0098 inch). A second X must be stamped beside the first when the block is refaced to 0.50 mm (0.0197 inch) - (Fig. 16).

(3) Consult the parts catalog for the proper head gaskets which must be used with refaced blocks to ensure proper piston-to-valve clearance.

**Fig. 15 Refacing Dimensions of the Cylinder Block****Fig. 16 Stamp Block after Reface****CYLINDER BORE REPAIR**

Cylinder bore(s) can be repaired by one of two methods:

- Method 1:—Over boring and using oversize pistons and rings.
- Method 2:—Boring and installing a repair sleeve to return the bore to standard dimensions.

METHOD 1—OVERSIZE BORE

Oversize pistons and rings are available in two sizes - 0.50 mm (0.0197 inch) and 1.00 mm (0.0393 inch).

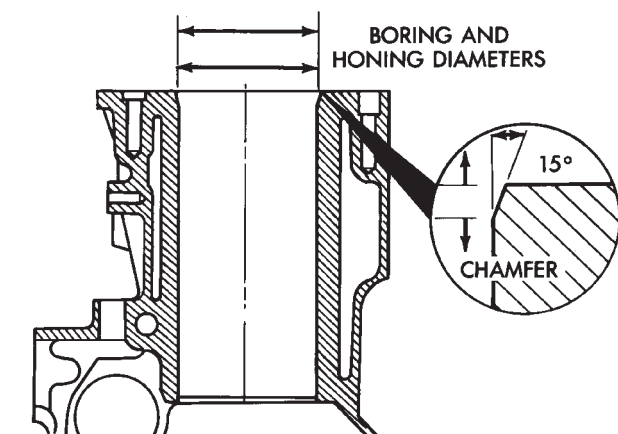
Any combination of standard, 0.50 mm (0.0197 inch) or 1.00 mm (0.0393 inch) overbore may be used in the same engine.

If more than 1.00 mm (0.0393 inch) overbore is needed, a repair sleeve can be installed (refer to Method 2—Repair Sleeve).

Cylinder block bores may be bored twice before use of a repair sleeve is required (Fig. 17). The first bore is 0.50 mm (0.0197 inch) oversize. The second bore is 1.00 mm (0.0393 inch) oversize.

SERVICE PROCEDURES (Continued)

After boring to size, use a honing stone to chamfer the edge of the bore (Fig. 17).



BORING DIAMETER DIMENSION	
1st REBORE	102.469 mm (4.0342 inch)
2nd REBORE	102.969 mm (4.0539 inch)
HONING DIAMETER DIMENSIONS	
STANDARD	102.020 \pm 0.020 mm (4.0165 \pm 0.0008 inch)
1st REBORE	102.520 \pm 0.020 mm (4.0362 \pm 0.0008 inch)
2nd REBORE	103.020 \pm 0.020 mm (4.0559 \pm 0.0008 inch)
CHAMFER DIMENSIONS	
Approx. 1.25 mm (0.049 inch) by 15°	

J9109-119

Fig. 17 Cylinder Bore Dimensions

A correctly honed surface will have a crosshatch appearance with the lines at 15° to 25° angles with the top of the cylinder block (Fig. 18). For the rough hone, use 80 grit honing stones. To finish hone, use 280 grit honing stones.

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.

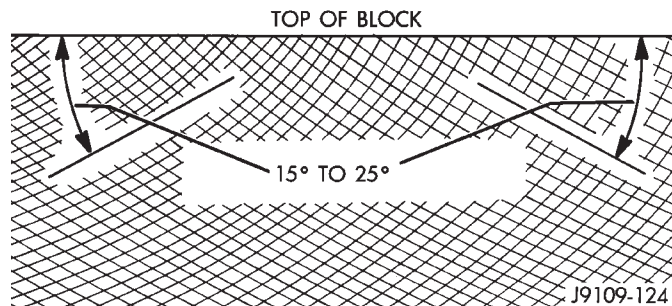


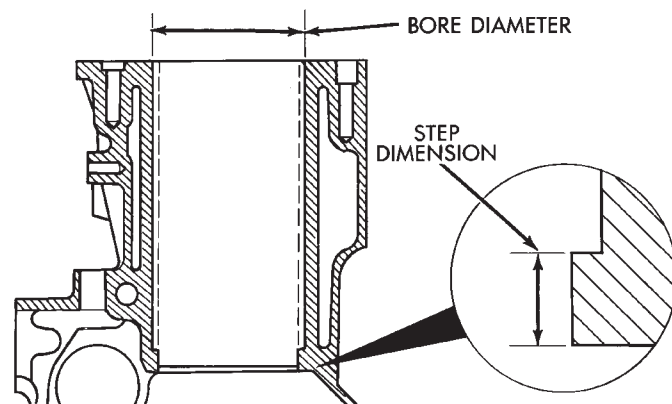
Fig. 18 Crosshatch Pattern of Repaired Sleeve(s)

METHOD 2—REPAIR SLEEVE

If more than a 1.00 mm (0.03937 inch) diameter oversize bore is required, the block must be bored and a repair sleeve installed.

Bore the block cylinder bore to 104.500-104.515 mm (4.1142-4.1148 inch) - (Fig. 19).

Repair sleeves can be replaced by using a boring bar to bore out the old sleeve. DO NOT cut the cylinder bore beyond the oversize limit.



BLOCK REBORE FOR REPAIR SLEEVE

BORE DIA. - 104.500 +0.015 mm
(4.1142 +0.0006 inch)
STEP DIM. - 6.35 mm (0.25 inch)

J9109-120

Fig. 19 Block Bore for Repair Sleeve Dimensions

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.

SERVICE PROCEDURES (Continued)

Using a sleeve driver, drive the sleeve downward until it contacts the step at the bottom of the bore (Fig. 20).

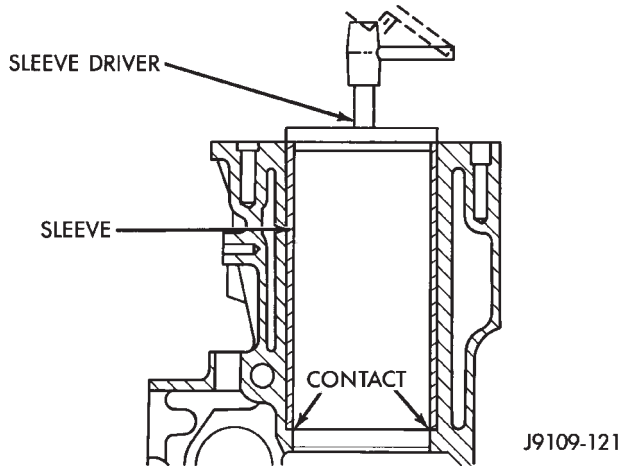
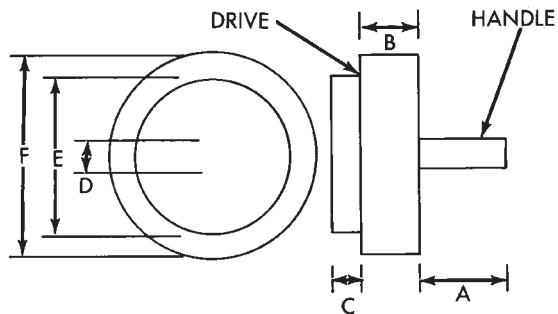


Fig. 20 Sleeve Installation

A sleeve driver can be constructed as follows (Fig. 21).



DRIVE - ALUMINUM
HANDLE - STEEL

A = 127 mm (5 inch)
B = 38 mm (1.5 inch)
C = 6.35 mm (0.25 inch)
D = 25.4 mm (1 inch)
E = 101 mm (3.976 inch)
F = 107.343 mm (4.226 inch)

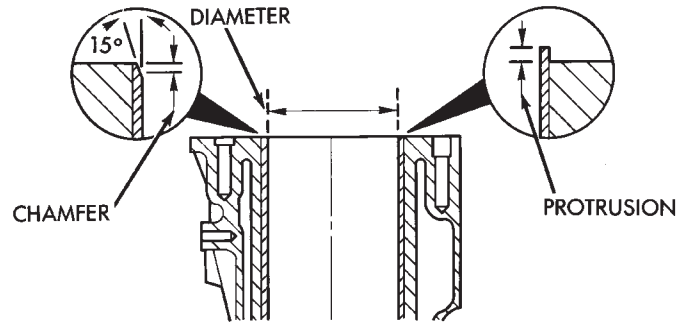
J9109-122

Fig. 21 Sleeve Driver Construction

Set up a boring bar and machine the sleeve to 101.956 mm (4.014 inch) - (Fig. 22).

After removing the boring bar, use a honing stone to chamfer the corner of the repair sleeve(s) - (Fig. 22).

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.



SLEEVE DIAMETER - 101.956 mm
(4.014 inch)
SLEEVE PROTRUSION
MIN. - FLUSH WITH BLOCK
MAX. - 0.050 mm (0.0019 inch)
SLEEVE CHAMFER
APPROX. 1.25 mm (0.049 inch)
BY 15°

J9109-123

Fig. 22 Sleeve Machining Dimensions

Finished bore inside dimension is 102.020 \pm 0.020 mm (4.0165 \pm 0.0008 inch).

A maximum of 1.2 micrometer (48 microinch) surface finish must be obtained.

After finish honing is complete, immediately clean the cylinder bores with a strong solution of laundry detergent and hot water.

After rinsing, blow the block dry with compressed air.

Wipe the bore with a white, lint-free, lightly oiled cloth. Make sure there is no grit residue present.

Apply a rust-preventing compound if the block will not be used immediately.

A standard diameter piston and a piston ring set must be used with a sleeved cylinder bore.

CAM BORE REPAIR

The front cam bushing bore can be bored to 59.235 Mm \pm 0.013 mm (2.332 inch \pm 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 \pm 0.013 mm (2.253 inch \pm 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.

SERVICE PROCEDURES (Continued)

Install all cam bushings flush or below the front cam bore surface. The oil hole must align to allow a 3.2 mm (0.125 inch) rod to pass through freely (Fig. 23).

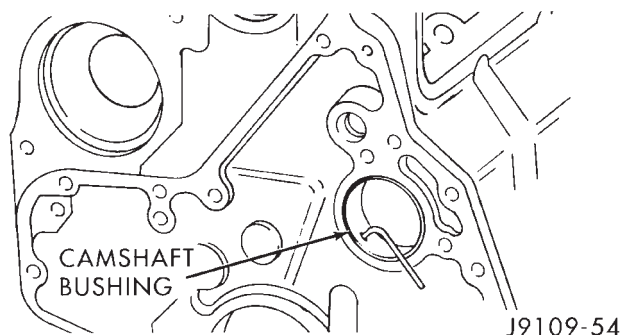


Fig. 23 Oil Hole Alignment

CYLINDER BLOCK CUP PLUG REPLACEMENT

- (1) Remove the cup plugs from the oil passages (Fig. 24).
- (2) Apply a bead of Loctite 277 around the outside diameter of the oil passage cup plugs.
- (3) Drive the cup plugs in until they bottom in the bore (Fig. 24).
- (4) Fill the engine with oil. Run the engine and check for leaks.
- (5) Stop the engine and check the oil level with the dipstick.

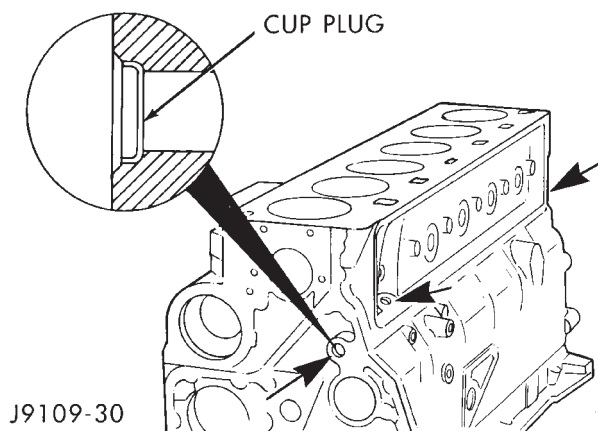


Fig. 24 Cup Plug Locations in Cylinder Block

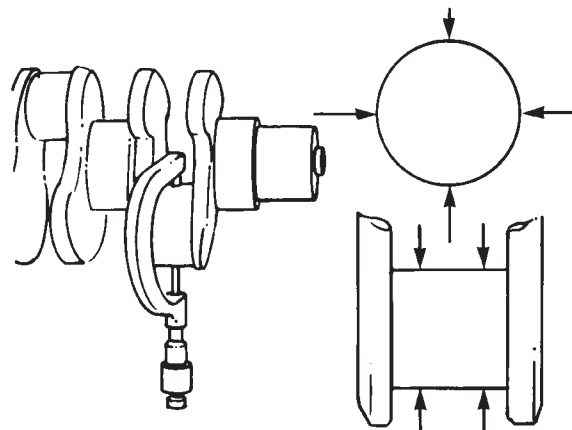
CONNECTING ROD BEARING AND CRANKSHAFT JOURNAL CLEARANCE

Measure the connecting rod bore with the bearings installed and the bolts tightened to 100 N·m (73 ft. lbs.) torque.

Record the smaller diameter.

Measure the diameter of the rod journal at the location shown (Fig. 25). Calculate the average diameter for each side of the journal.

The clearance is the difference between the connecting rod bore (smallest diameter) and the average diameter for each side of the crankshaft journal.



MIN.	68.962 mm	(2.715 inch)
MAX.	69.013 mm	(2.717 inch)

Out-of-Round - Max.
0.050 mm (0.002 inch)

Taper - Max.
0.013 mm (0.0005 inch)

Bearing Clearance - Max.
0.089 mm (0.0035 inch)

J9109-91

Fig. 25 Connecting Rod Journal Diameter Limits

If the crankshaft is within limits, replace the bearing. If the crankshaft is out of limits, grind the crankshaft to the next smaller size and use oversize rod bearings.

PISTON GRADING PROCEDURE

- 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.

(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

SERVICE PROCEDURES (Continued)

cap. Use clean lubricating oil to coat the inside diameter of the connecting rod bearing shell.

(3) Install the bearing shell in the connecting rod cap with the tang of the bearing in the slot to the cap. Use clean lubricating oil to coat the inside diameter of the bearing shell.

(4) The four digit number stamped on the connecting rod and cap at the parting line must match and be installed on the oil cooler side of the engine. Install the connecting rod cap and capscrews. Tighten the capscrews to 35 N·m (26 ft. lbs.) torque.

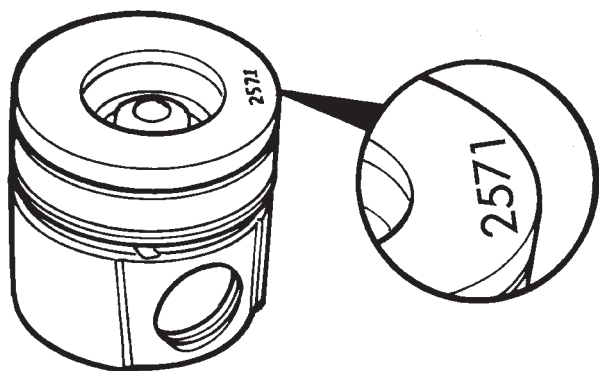
(5) Use a fine grit stone to remove any burrs from the cylinder block head deck. Zero the dial indicator to the cylinder block head deck.

(6) Move the dial indicator directly over the piston pin to eliminate any side-to-side movement.

(7) Rotate the crankshaft to top dead center (TDC). Rotate the crankshaft clockwise and counter-clockwise to find the highest dial indicator reading. Record the reading.

(8) Remove the piston and connecting rod assembly from the No.1 cylinder and install the assembly into the No.2 cylinder. Repeat the procedure for every cylinder using the same piston and connecting rod assembly.

(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 Chrysler part number for replacement (Fig. 26). 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. 27).



J9509-2

Fig. 26 Piston Grading Number Location

NOTE: Use the table below when piston grading numbers are missing or not legible.

PISTON PROTRUSION CHART

IF MEASURING PISTON IS GRADING NUMBER:		AND PROTRUSION IS:	USE GRADE:
180 H.P. (A/T)	21 5H.P. (M/T)		
2571	6631	0.609-0.711 mm (0.024-0.028 in.)	A
2571	6631	0.508-0.609mm (0.020-0.024 in.)	B
2571	6631	0.406-0.508 mm (0.016-0.020 in.)	C
2572	6632	0.711-0.813 mm (0.028-0.032 in.)	A
2572	6632	0.609-0.711 mm (0.024-0.028 in.)	B
2572	6632	0.508-0.609 mm (0.020-0.024 in.)	C
2573	6633	0.813-0.914 mm (0.032-0.036 in.)	A
2573	6633	0.711-0.813 mm (0.028-0.032 in.)	B
2573	6633	0.609-0.711 mm (0.024-0.028 in.)	C

ALTERNATIVE GRADE IDENTIFICATION METHOD

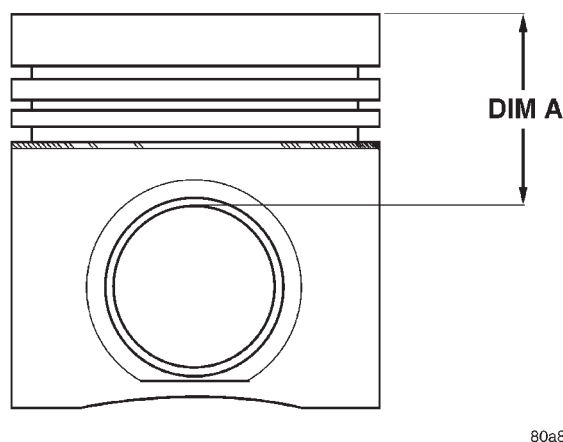
DIMENSION "A"	REF. NUMBER	GRADE
51.554-51.607 mm (2.029-2.031 in.)	2571/6631	A
51.654-51.707 mm (2.033-2.035 in.)	2572/6632	B
51.754-51.807 mm (2.037-2.039 in.)	2573/6633	C

CRANKSHAFT REWORK

Crankshaft main and rod journals may be ground in increments of 0.25 mm (0.0098 inch) up to a total of 1.00 mm (0.0394 inch).

The only exception is the main journal thrust width surface. This journal must be ground in increments of 0.50 mm (0.0197 inch) up to a total of 1.00 mm (0.0394 inch). The thrust surface is located on the No.6 main bearing. When the thrust surface

SERVICE PROCEDURES (Continued)



80a82c90

Fig. 27 Piston Grading Measurement

requires grinding, the main journal must be ground to the same undersize dimension.

CAUTION: Welding of the crankshaft is not allowed. Failure of the crankshaft will result.

MAIN JOURNAL

All main journals are to be ground in the opposite direction of engine rotation (clockwise as viewed from the front of crankshaft). Polish the journals in the same direction as engine rotation.

The main bearing grinding specifications are shown in (Fig. 28).

STANDARD MAIN JOURNAL DIAMETER	
83.000 \pm 0.013 mm (3.2677 \pm 0.0005 inch)	
WORN MAIN JOURNAL DIAMETER LIMIT	
82.962 (3.2662 inch)	
UNDERSIZES	REGRIND TO
0.25 mm (0.0098 inch)	82.750 \pm 0.013 mm (3.2579 \pm 0.0005 inch)
0.50 mm (0.0197 inch)	82.500 \pm 0.013 mm (3.2480 \pm 0.0005 inch)
0.75 mm (0.0295 inch)	82.250 \pm 0.013 mm (3.2381 \pm 0.0005 inch)
1.00 mm (0.0394 inch)	82.000 \pm 0.013 mm (3.2283 \pm 0.0005 inch)
OUT-OF ROUND & TAPER (MAX.)	
0.005 mm (0.0002 inch)	
ALL MAIN JOURNALS ARE TO BE PARALLEL TO THE FRONT AND REAR MAINS WITHIN:	
0.030 mm (0.001 inch)	

J9109-125

Fig. 28 Crankshaft Main Journal Dimensions

Thrust journals can be ground in the same increments and using the same specifications as all other

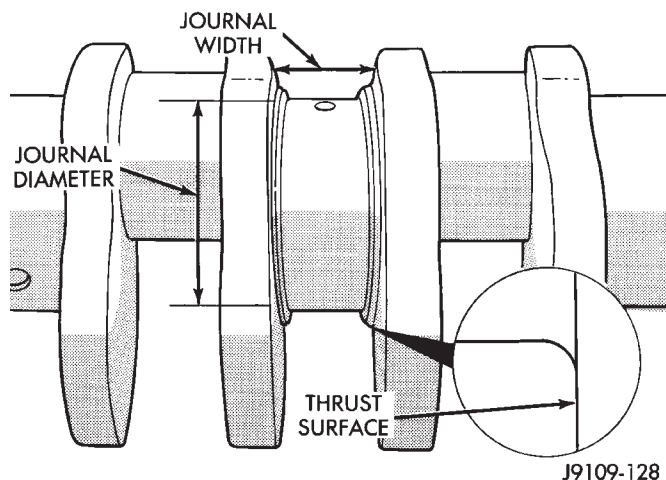
main journals. The main journal radius may be ground using either the preferred or the alternative procedure providing the thrust surface width is not being ground. The preferred procedure must be used when the main bearing thrust width surface is ground. When the thrust surface width requires grinding, the main journal must be ground to the same undersize dimension (Fig. 29).

THRUST JOURNAL WIDTH	
37.500 \pm 0.025 mm (1.4764 \pm 0.001 inch)	
UNDERSIZES	REGRIND WIDTH TO
0.50 mm (0.0197 inch)	38.000 \pm 0.025 mm (1.4961 \pm 0.001 inch)
1.00 mm (0.0394 inch)	38.500 \pm 0.025 mm (1.5158 \pm 0.001 inch)

J9109-127

Fig. 29 Crankshaft Thrust Journal Width Dimensions

The thrust surface is to be ground on center within 0.10 mm (0.004 inch). It also must be perpendicular to the front and rear mains within 0.0015 mm (0.00006 inch) per radial inch on the thrust area (Fig. 30). The surface finish requirement is 0.04 micrometer (16.0 microinch).



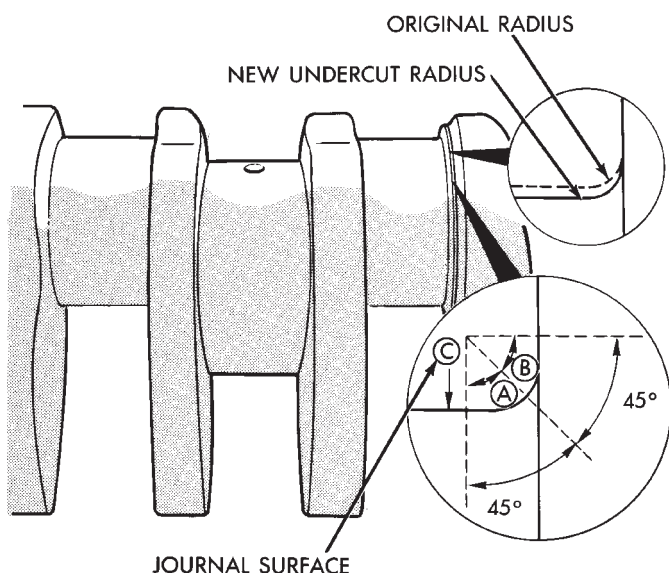
J9109-128

Fig. 30 Crankshaft Thrust Surface**PREFERRED PROCEDURE:**

Smoothly blend a 4.20 \pm 0.020 mm (0.1654 \pm 0.0008 inch) radius to the ground diameters (Fig. 31).

CAUTION: DO NOT use the Alternative Procedure when the thrust surface width is ground.

SERVICE PROCEDURES (Continued)



JOURNAL SURFACE

SURFACE FINISH

- (A) 0.8 micrometer (32.0 microinch)
for a minimum of 45° into the
fillet beyond journal surface
- (B) 1.6 micrometer (64.0 microinch)
for remainder of fillet
- (C) 0.4 micrometer (16.0 microinch)

J9109-129

Fig. 31 Grind Crankshaft Main Journal—Preferred Method**ALTERNATIVE PROCEDURE:**

Smoothly blend a 1.25 ± 0.020 mm (0.0492 \pm 0.0008 inch) radius to the ground diameters (Fig. 32).

ROD JOURNAL

All rod journals are to be ground in the opposite direction of engine rotation (clockwise as viewed from the front of crankshaft). Polish the journals in the same direction as engine rotation.

The rod bearing grinding specifications are shown in (Fig. 33).

PREFERRED PROCEDURE:

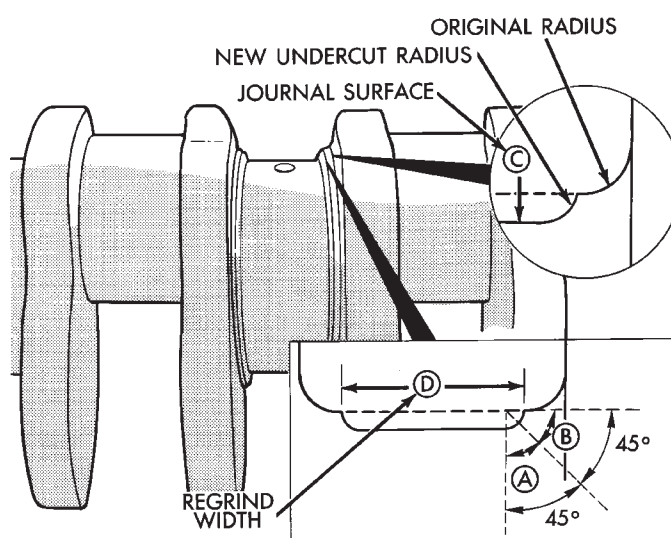
Smoothly blend a 4.00 ± 0.020 (0.1575 \pm 0.0008 inch) radius to the ground diameters and side faces (Fig. 34).

ALTERNATIVE PROCEDURE:

Smoothly blend a 1.25 ± 0.020 mm (0.0492 \pm 0.0008 inch) radius to the ground journals (Fig. 35).

MAIN BEARING CLEARANCE

Inspect the main bearing bores for damage or abnormal wear.

REGRIND
WIDTH**SURFACE FINISH**

- (A) 0.8 micrometer (32.0 microinch)
for a minimum of 45° into the
fillet beyond journal surface
- (B) 1.6 micrometer (64.0 microinch)
for remainder of fillet
- (C) 0.4 micrometer (16.0 microinch)

WIDTH OF REGRIND/UNDERCUT RADIUS

- (D) 34.5 ± 0.025 mm (1.358 ± 0.001 in)

J9109-130

Fig. 32 Grind Crankshaft Main Journal—Alternative Method**STANDARD ROD JOURNAL DIAMETER**

69.000 ± 0.013 mm
(2.7165 ± 0.0005 inch)

WORN ROD JOURNAL DIAMETER LIMIT

68.962 (2.7150 inch)

UNDERSIZES**REGRIND TO**

0.25 mm (0.0098 inch)	68.750 ± 0.013 mm (2.7067 ± 0.0005 inch)
0.50 mm (0.0197 inch)	68.500 ± 0.013 mm (2.6969 ± 0.0005 inch)
0.75 mm (0.0295 inch)	68.250 ± 0.013 mm (2.6870 ± 0.0005 inch)
1.00 mm (0.0394 inch)	68.000 ± 0.013 mm (2.6772 ± 0.0005 inch)

OUT-OF ROUND & TAPER (MAX.)

0.005 mm (0.0002 inch)

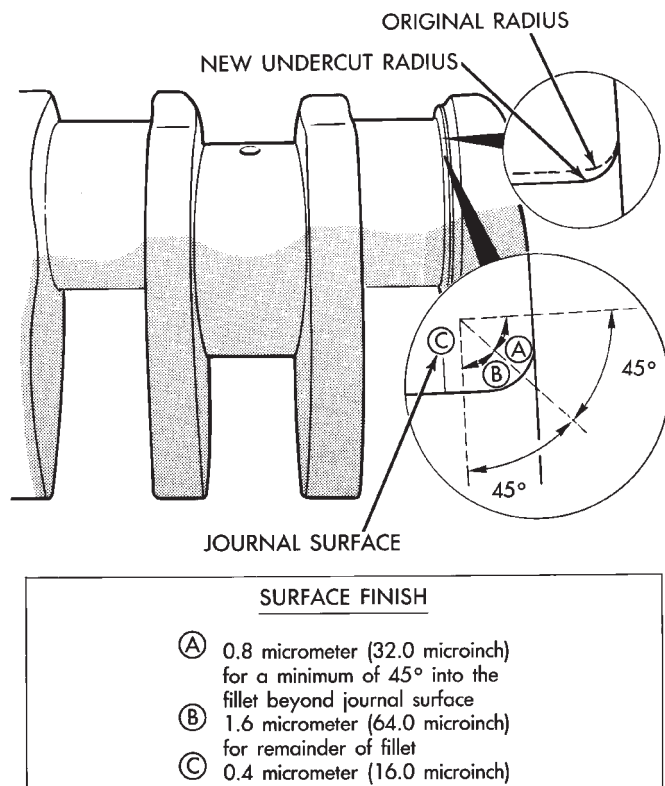
ALL MAIN JOURNALS ARE TO BE PARALLEL
TO THE FRONT AND REAR MAINS WITHIN:
0.030 mm (0.001 inch)

J9109-126

Fig. 33 Crankshaft Rod Journal Dimensions

SERVICE PROCEDURES (Continued)

1998 Ram Truck BR/BE
Publication No. 81-370-8108
TSB 26-01-99 January, 1999



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Fig. 34 Crankshaft Rod Journal Grind—Preferred Method

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. 36).

Measure the diameter of the main journal at the locations shown (Fig. 37). Calculate the average diameter for each side of the journal.

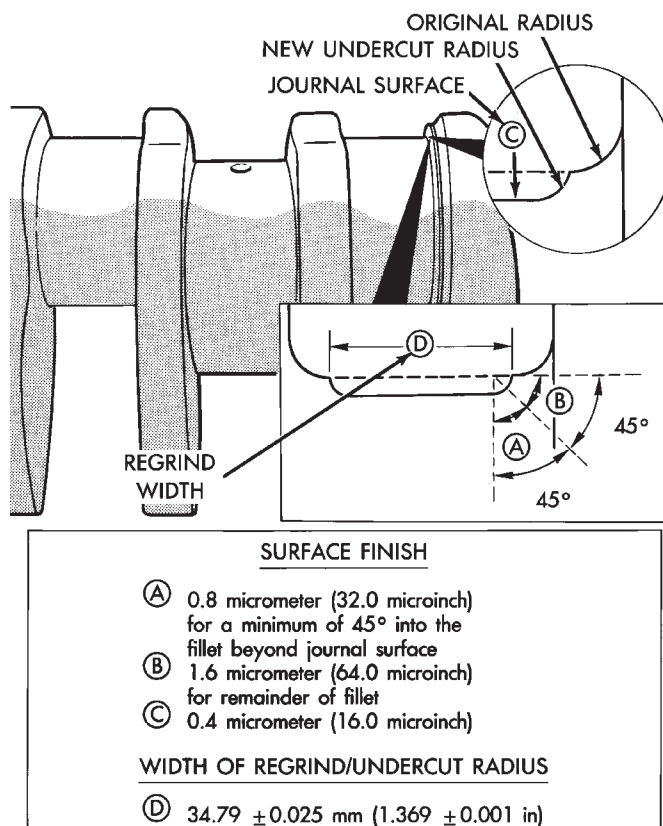
Calculate the main bearing journal to bearing clearance. the clearance specifications are 0.119 mm (0.00475 inch). If the crankshaft journal is within limits, replace the main bearings. If not within specifications, grind the crankshaft to next size and use oversize bearings.

REMOVAL AND INSTALLATION

ENGINE FRONT MOUNTS

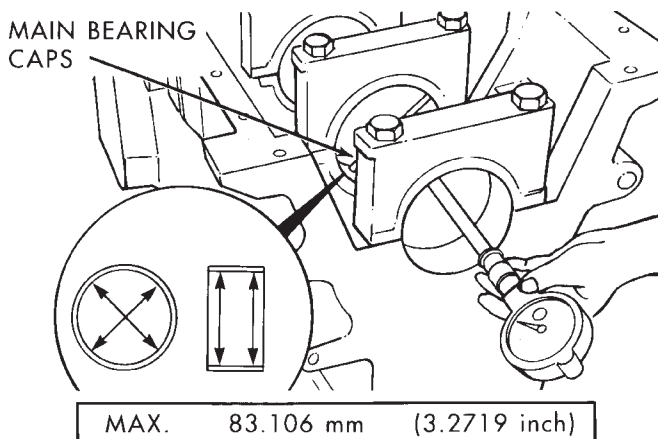
REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Position fan to assure clearance for radiator top tank and hose.
- (3) Install engine support/lifting fixture.
- (4) Raise vehicle on hoist.
- (5) Lift the engine SLIGHTLY and remove the thru-bolt and nut (Fig. 38).



J9109-132

Fig. 35 Grind Crankshaft Rod Journal—Alternative Method



J9109-92

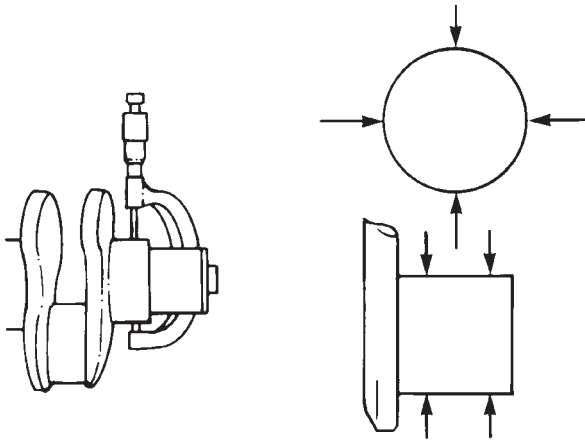
Fig. 36 Crankshaft Main Bearing Bore Diameter

- (6) Remove engine support bracket/cushion bolts (Fig. 38). Remove the support bracket/cushion.

INSTALLATION

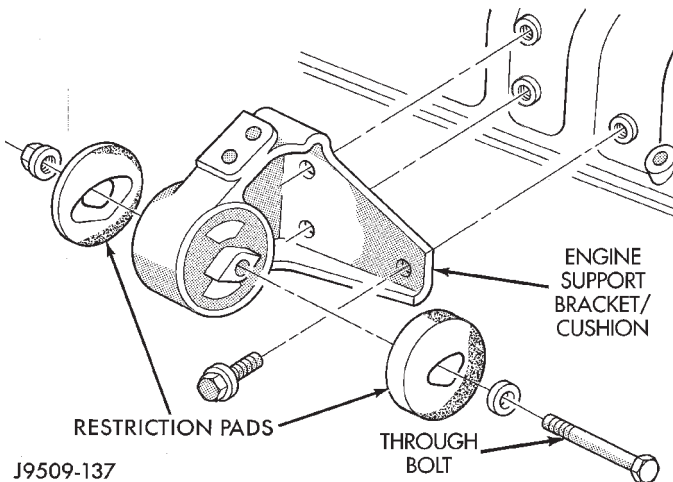
- (1) With engine raised SLIGHTLY, position the engine support bracket/cushion to the block. Install new bolts and tighten to 149 N·m (110 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)



MIN.	82.962 mm	(3.2662 inch)
MAX.	83.103 mm	(3.2682 inch)

J9109-93

Fig. 37 Crankshaft Main Journal Diameter

J9509-137

Fig. 38 Front Engine Mounts

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

(3) Lower engine with support/lifting fixture while guiding the engine bracket/cushion and thru-bolt into support cushion brackets (Fig. 39).

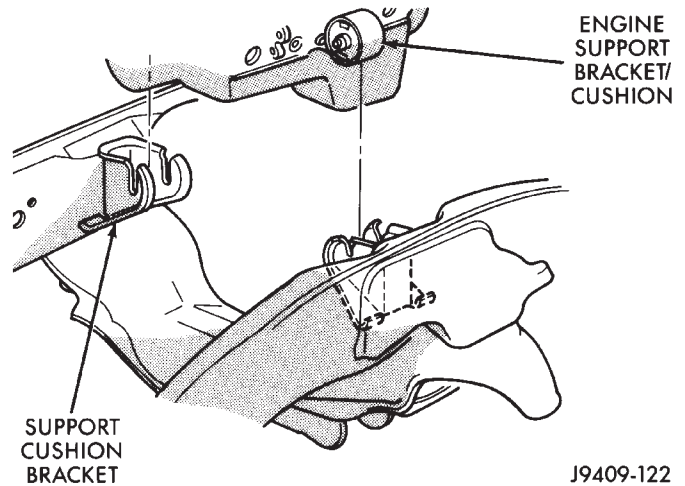
(4) Install thru-bolt nuts and tighten the nuts to 68 N·m (50 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

ENGINE REAR MOUNT**REMOVAL**

- (1) Raise the vehicle on a hoist.
- (2) Position a transmission jack in place.
- (3) Remove support cushion stud nuts (Fig. 40).



J9409-122

Fig. 39 Positioning Engine Front Mounts

(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. 40).

(4) Install the support cushion bolts and tighten to 47 N·m (35 ft. lbs.) torque.

(5) Remove the transmission jack.

(6) Lower the vehicle.

ENGINE ASSEMBLY**REMOVAL**

(1) Remove the battery.

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

(3) Remove the upper crossmember and top core support.

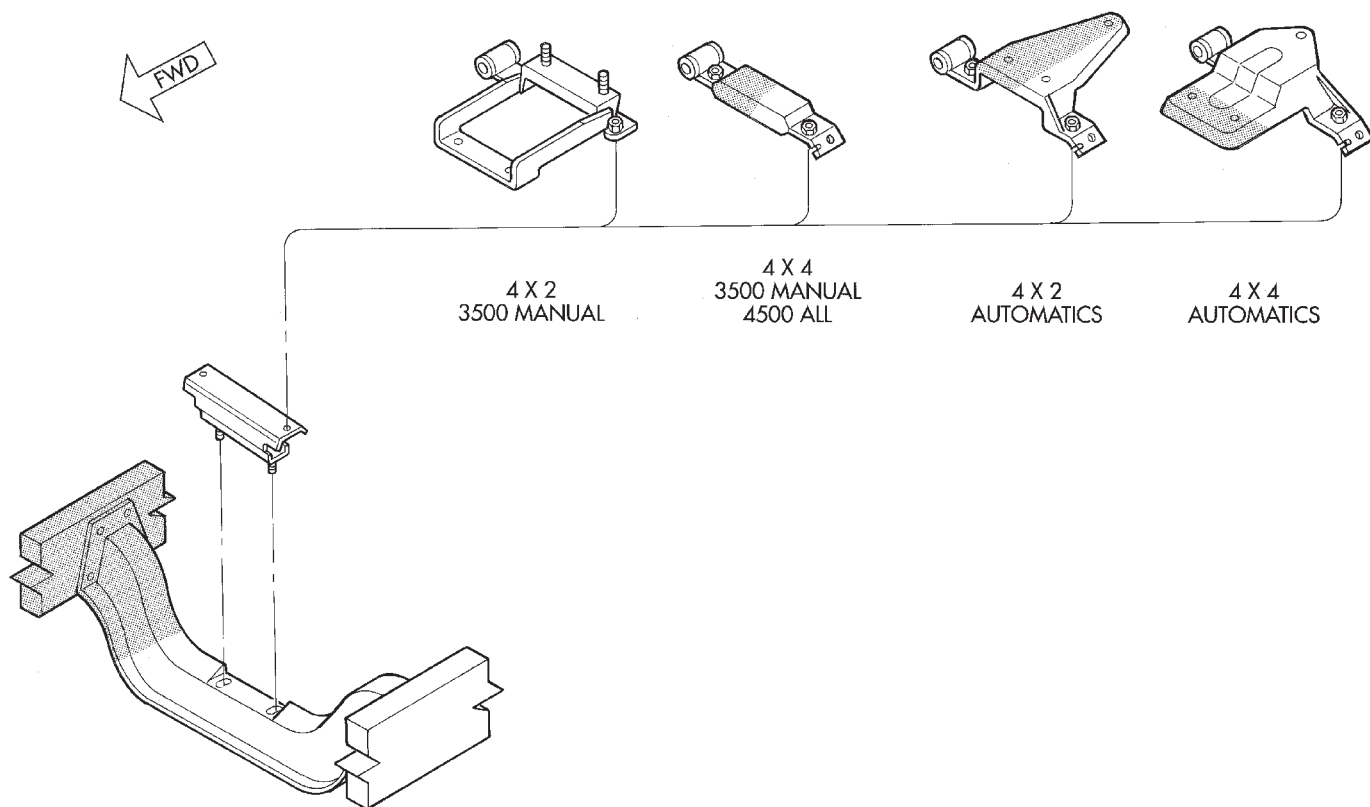
(4) Remove the transmission oil cooler.

(5) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).

(6) Remove the serpentine belt (refer to Group 7, Cooling System).

(7) Remove the A/C compressor with the lines attached. Set aside.

REMOVAL AND INSTALLATION (Continued)



J9509-126

Fig. 40 Engine Rear Support Cushion Assemblies

- (8) If equipped, remove the condenser.
- (9) Remove the washer bottle.
- (10) Remove the radiator overflow bottle.
- (11) Disconnect the top radiator hose.
- (12) Remove the fan.
- (13) Remove the fan shroud.
- (14) Disconnect the lower radiator hose.
- (15) Remove radiator (refer to Group 7, Cooling System).

(16) Remove the generator (Fig. 41) with the wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(17) Disconnect the heater hoses at the dash panel and at the water valve (Fig. 42).

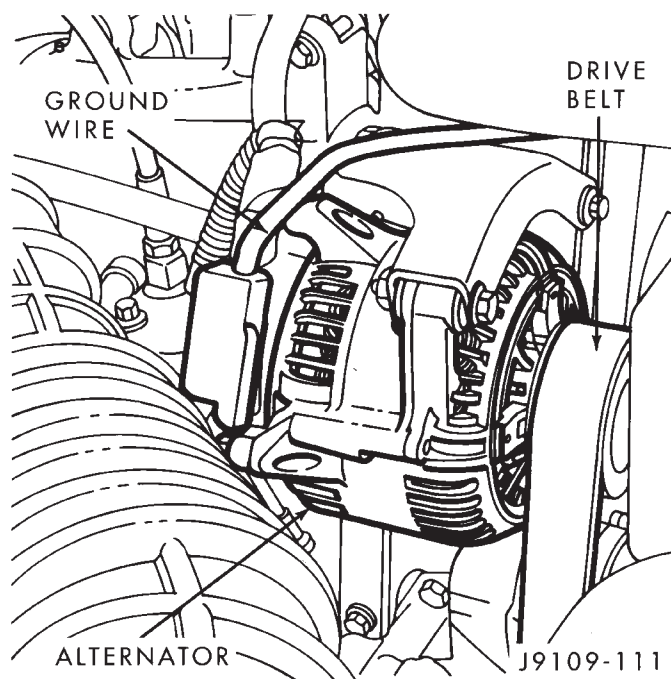
(18) Disconnect the air inlet tube from the turbo-charger (Fig. 43) and the air intake housing. Remove the tube.

(19) Remove the exhaust pipe from the turbo-charger outlet flange (Fig. 43).

(20) Disconnect the intercooler inlet duct from the turbocharger and the intercooler. Remove the inlet duct.

(21) Disconnect the intercooler outlet duct from the air inlet housing and the intercooler. Remove the outlet duct.

(22) Disconnect the accelerator linkage, the speed control linkage and the throttle valve linkage.

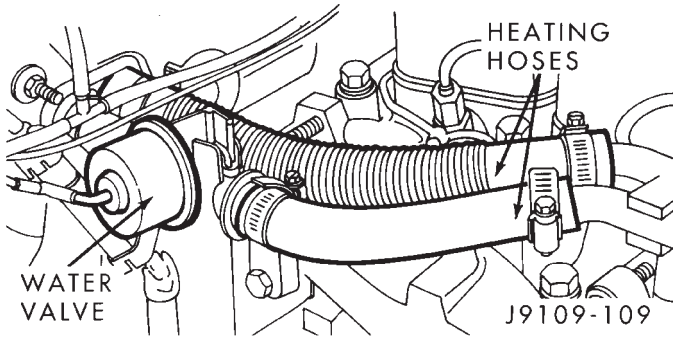
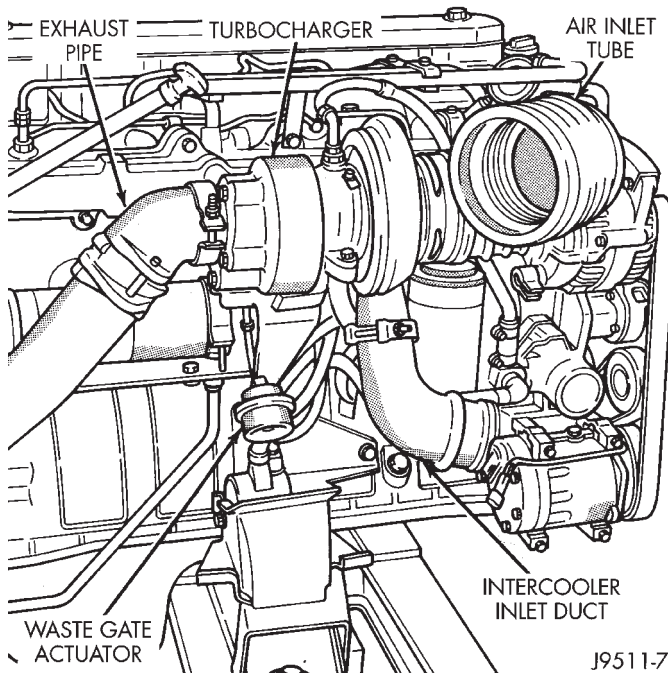


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Fig. 41 Generator Removal

- (23) Disconnect the power steering hoses, if equipped.
- (24) Disconnect the transmission cooler lines.

REMOVAL AND INSTALLATION (Continued)

**Fig. 42 Heater Hoses****Fig. 43 Air Inlet Tube and Exhaust Pipe Connection**

(25) Disconnect all electrical connections from the engine. Put tags on the connections to identify their locations.

(26) Disconnect the fuel lines to the lift pump and fuel return. Use tags to identify the lines.

(27) On Manual Transmission vehicles, remove the shift lever (refer to Group 21, Transmissions).

(28) Raise and support the vehicle on a hoist.

(29) Drain the engine lubricating oil. Dispose of the oil according to all applicable regulations.

(30) Remove the oil pan.

(31) Remove engine front mount thru-bolt nuts.

(32) Remove the transmission cooler line brackets from oil pan.

(33) Disconnect exhaust pipe at manifold.

(34) Disconnect the starter wires. Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(35) Remove the dust shield and transmission cover.

(36) Refer to Group 21, Transmissions for transmission removal.

(37) Lower the vehicle.

(38) Put a cover or tape over all engine openings.

(39) Lift the engine out of the vehicle.

(40) Install the engine on a suitable stand.

(41) Remove all accessories and brackets not previously removed for use with the replacement engine.

INSTALLATION

(1) Check the data plate to verify that the replacement engine is the same model and rating as the engine that was removed.

(2) Install all accessories and brackets that had been removed from the previous engine.

(3) Use the lifting brackets to lift the engine off of the stand.

(4) Position the engine in the chassis with the thru-bolt installed.

(5) Remove the covers or tape covering the engine openings.

(6) Raise and support the vehicle.

(7) Refer to Group 21, Transmissions for transmission installation.

(8) Install the dust shield and transmission cover.
(9) Install the prop shaft (refer to Group 16, Propeller Shaft).

(10) Install the starter motor (refer to Group 8B, Battery/Starter/Generator Service). Connect the starter wires.

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

(12) Install and tighten engine front mount thru-bolt nuts.

(13) Install the oil pan. Install the drain plug.

(14) Lower the vehicle.

(15) On Manual Transmission vehicles, install the shift lever (refer to Group 21, Transmissions).

(16) Connect the fuel lines to the lift pump and fuel return. Use tags to identify the lines.

(17) Connect all electrical connections to the engine. Use tags to identify their locations.

(18) Connect the transmission cooler lines.

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

(20) Connect the accelerator linkage, the speed control linkage and the throttle valve linkage.

(21) Install the outlet duct. Connect the intercooler outlet duct to the air inlet housing and the intercooler.

(22) Install the inlet duct. Connect the intercooler inlet duct to the turbocharger and the intercooler.

(23) Install the exhaust pipe to the turbocharger outlet flange.

(24) Install the air inlet tube. Connect the air inlet tube to the turbocharger and the air intake housing.

(25) Connect the heater hoses at the dash panel and at the water valve.

REMOVAL AND INSTALLATION (Continued)

(26) Install the generator and wire connections (refer to Group 8B, Battery/Starter/Generator Service).

(27) Install the radiator (refer to Group 7, Cooling System).

(28) Connect the lower radiator hose.

(29) Install the fan shroud.

(30) Install the fan.

(31) Connect the top radiator hose.

(32) Install the radiator overflow bottle.

(33) Install the washer bottle.

(34) If equipped, install the condenser.

(35) Install the A/C compressor with the lines attached.

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

(37) Install the transmission oil cooler.

(38) Install the upper crossmember and top core support.

(39) Install the serpentine belt (refer to Group 7, Cooling System).

(40) Fill the cooling system with a mixture of 50% water and 50% ethylene-glycol base antifreeze (refer Group 7, Cooling System for the proper procedure).

(41) Fill the engine with the required amount of clean engine lubricating oil (refer to Group 0, Lubrication and Maintenance).

(42) Install the battery and connect the battery cables.

(43) Check the oil level after the engine has run for 2 or 3 minutes. Oil held in the oil filter and oil passages will cause the oil level in the pan to be lower than normal for a short period of time.

(44) Operate the engine at idle for 5 to 10 minutes and check for leaks and loose parts.

ROCKER LEVERS AND PUSH RODS

REMOVAL

(1) Remove the EGR tube and gaskets.

(2) Remove the valve covers.

(3) Loosen the adjusting screw locknuts. Loosen the adjusting screws until they stop (Fig. 44).

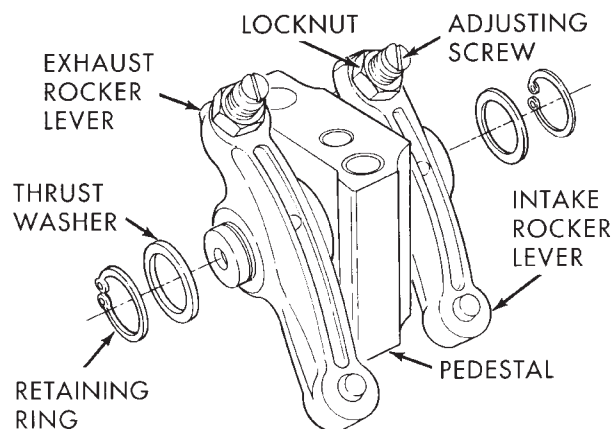
(4) Remove the bolts from the rocker lever pedestals. Remove the pedestals and rocker lever assemblies (Fig. 44).

(5) Remove the push rods. The rear two push rods must be raised through holes in cab overhang.

INSTALLATION

(1) Make sure the dowel rings in the pedestals are installed into the dowel bores in the cylinder head.

(2) If the push rod is holding pedestal off head, bar the engine until the pedestal will set on the head surface without interference.



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Fig. 44 Location of Rocker Lever Components

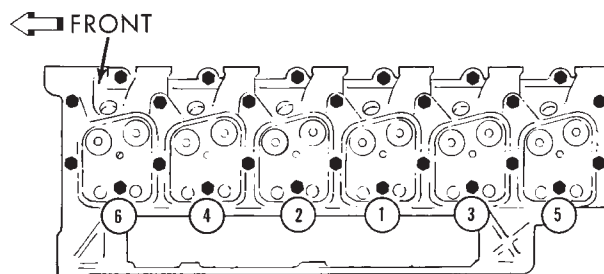
(3) Use clean engine oil to lubricate the cylinder head bolt threads and under the bolt heads.

(4) Install the long bolts (12 mm) into the rocker lever pedestals. Tighten the bolts as follows:

- Step 1—Tighten the bolts, in sequence (Fig. 45), to 90 N·m (66 ft. lbs.) torque. Check the torque. If lower than 90 N·m (66 ft. lbs.), tighten to this torque.

- Step 2—Tighten the bolts, in sequence (Fig. 45), to 120 N·m (89 ft. lbs.) torque. Check the torque. If lower than 120 N·m (89 ft. lbs.), tighten to this torque.

- Step 3—Tighten the bolts, in sequence (Fig. 45), an additional 90°.



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Fig. 45 Rocker Lever (Head Bolts) Tightening Sequence

(5) Tighten the 8 mm bolts to 24 N·m (18 ft. lbs.) torque.

(6) Install the valve cover. Tighten the valve cover bolt to 24 N·m (18 ft. lbs.) torque.

(7) Install the EGR tube and start fasteners by hand.

(8) Tighten all bolts/nuts to 24 N·m (212 in. lbs.) torque. **When tightening bolts at EGR valve end of tube, alternate between the upper and lower bolt to allow face of EGR valve to remain square to tube mounting flange on EGR tube.**

REMOVAL AND INSTALLATION (Continued)

CYLINDER HEAD

These cylinder heads can only be used on engines with an intercooler. DO NOT interchange with earlier models.

REMOVAL

- (1) Drain the coolant. DO NOT waste reusable coolant. If the solution is clean, drain the coolant into a clean container for reuse.
- (2) Drain the engine oil. Dispose of the used oil properly.
- (3) Disconnect the radiator and heater hoses (refer to Group 7, Cooling System).
- (4) Remove the turbocharger.
- (5) Remove the EGR tube and gaskets.
- (6) Remove the exhaust manifold (Fig. 46).

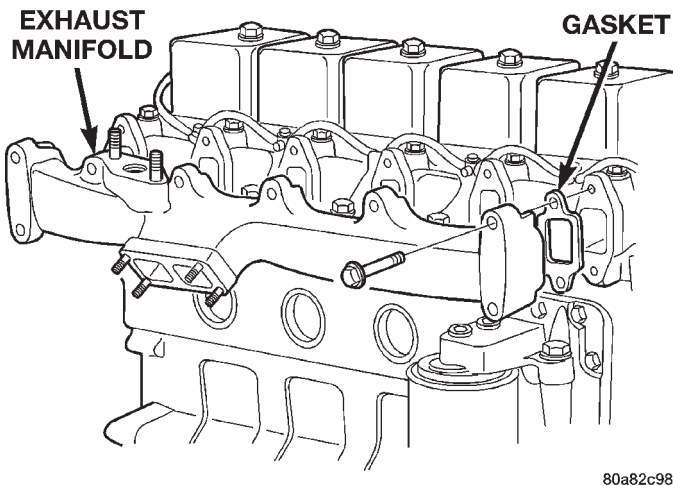


Fig. 46 Exhaust Manifold

- (7) Remove the fuel lines and injector nozzles as an assembly (refer to Group 14, Fuel System).
- (8) Remove the valve covers.
- (9) Remove the rocker levers and push rods.
- (10) Remove the fuel filter/water separator (Fig. 47). Refer to Group 14, Fuel System, for the proper procedures. Remove the remote fuel filter/water separator head.
- (11) If the engine is hot, remove the cylinder head bolts in the sequence shown in (Fig. 48). The removal sequence is not important if the engine is cold. There are 3 sizes of head bolts. Note the position of each bolt for future installation.
- (12) Remove the cylinder head and gasket from the cylinder block.

INSTALLATION

- (1) The cylinder block and head must be clean and dry.
- (2) Position the gasket onto the dowels (Fig. 49). Make sure the gasket is correctly aligned with the holes in the cylinder block.

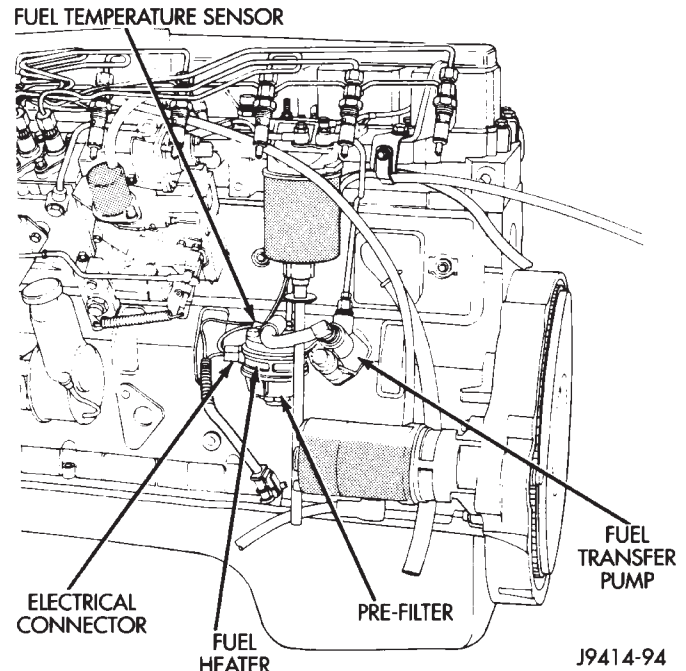


Fig. 47 Fuel/Water Separator Filter

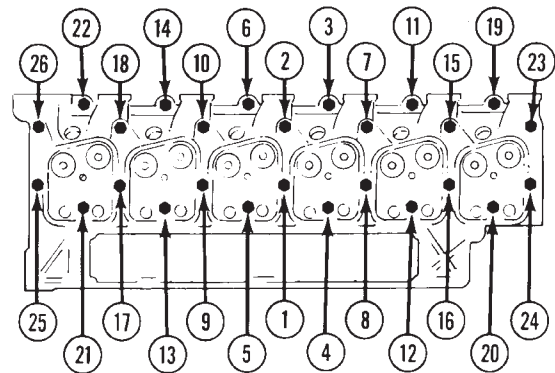


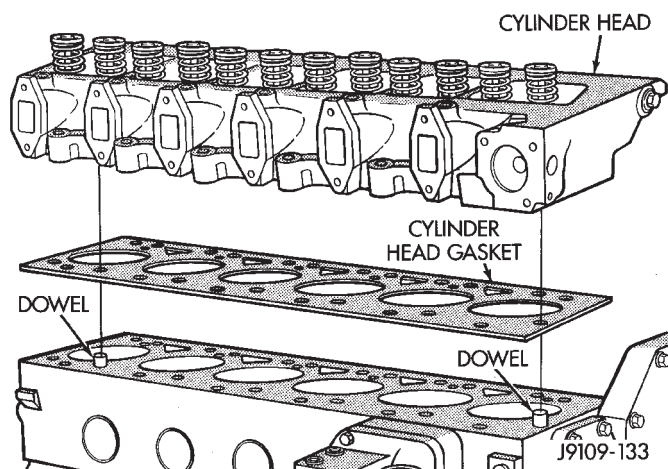
Fig. 48 Cylinder Head Bolt Removal Sequence—Cylinder Head Hot

- (3) Carefully put the cylinder head onto the gasket and cylinder block. Make sure the cylinder head is installed onto the dowels in the cylinder block (Fig. 49).

- (4) Install the push rods and rocker levers.
- (5) Use clean engine oil to lubricate the cylinder head bolt threads and under the bolt heads.
- (6) The cylinder head bolts are 3 different sizes. Install the bolts in the proper hole. Tighten the bolts as follows:

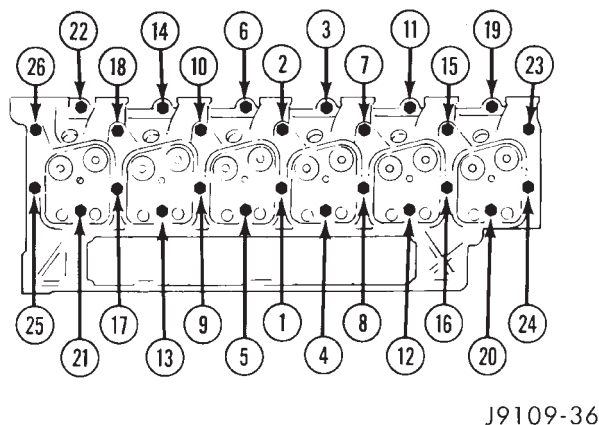
- Step 1—Tighten all bolts, in sequence (Fig. 10), to 90 N·m (66 ft. lbs.) torque. Check the torque. If lower than 90 N·m (66 ft. lbs.), tighten to this torque.
- Step 2—Tighten all long 12 mm bolts (Nos. 4, 5, 12, 13, 20 and 21), in sequence (Fig. 50), to 120 N·m

REMOVAL AND INSTALLATION (Continued)

**Fig. 49 Cylinder Head/Gasket Alignment**

(89 ft. lbs.) torque. Check the torque. If lower than 120 N·m (89 ft. lbs.), tighten to this torque.

- Step 3—Tighten all bolts, in sequence (Fig. 50), an additional 90°.

**Fig. 50 Cylinder Head Tightening Sequence**

(7) Be sure to lubricate the push rod sockets with clean engine oil. Be sure push rod is seated properly in the tappet.

(8) Install the rocker lever pedestal bolts and tighten to 24 N·m (18 ft. lbs.) torque.

(9) Adjust the valve clearance.

(10) Install the valve covers. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(11) Install the injector nozzles and fuel lines (refer to Group 14, Fuel System).

(12) Install the remote fuel filter/water separator head. Install the fuel filter/water separator (refer to Group 14, Fuel System for the proper procedures).

(13) Install the exhaust manifold (refer to Group 11, Exhaust System and Intake Manifold).

(14) Install the EGR tube and start fasteners by hand.

(15) Tighten all bolts/nuts to 24 N·m (212 in. lbs.) torque. **When tightening bolts at EGR valve end**

of tube, alternate between the upper and lower bolt to allow face of EGR valve to remain square to tube mounting flange on EGR tube.

(16) Install the turbocharger.

(17) Connect the radiator and heater hoses.

(18) Fill the engine with new coolant or the clean drained coolant (refer to Group 7, Cooling System for the proper procedure).

(19) Fill the engine with clean lubricating oil (refer to Group 0, Lubrication and Maintenance).

VALVES AND VALVE SPRINGS**REMOVAL**

(1) Remove the cylinder head (Refer to Cylinder Head Removal and Installation in this section).

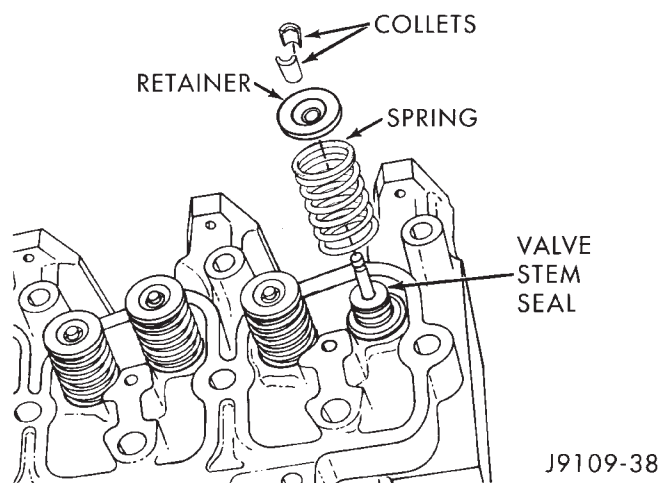
(2) Mark the valves to identify their position.

(3) Compress the valve spring and remove the valve stem collets (Fig. 51).

(4) Release valve spring and remove the retainer and spring (Fig. 51).

(5) Remove the remaining collets, retainers, springs and valves. Keep the valves in a labeled rack.

(6) Remove the valve stem seals (Fig. 51).

**Fig. 51 Valve Removal****INSTALLATION**

(1) Clean all cylinder head components before assembling.

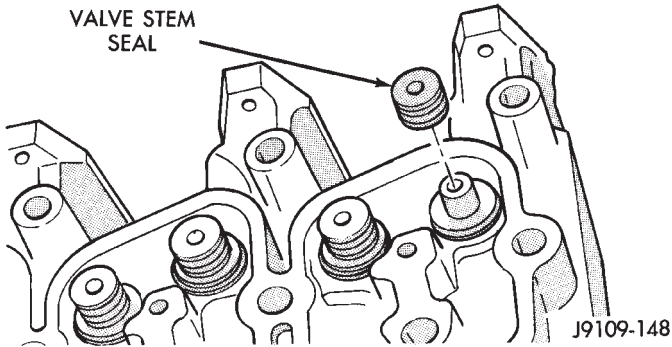
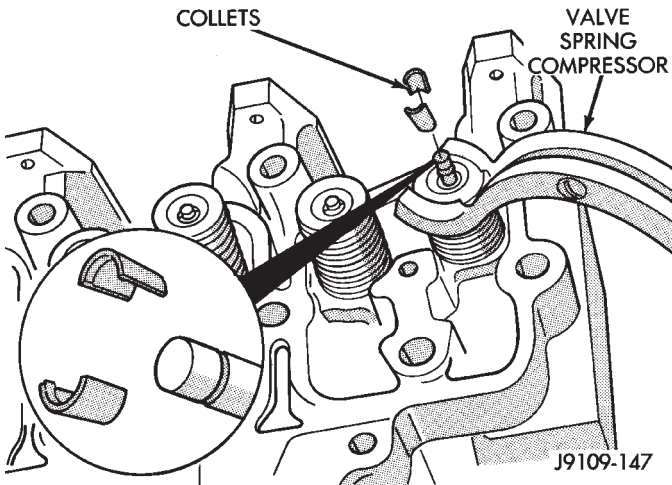
(2) Install the valve stem seals (Fig. 52). The intake and exhaust valve seals are the same.

(3) Lubricate the stems with SAE 90W oil before installing the valves. Install the valves in the same positions as removed.

(4) Compress the valve spring after installing the spring and retainer (Fig. 53).

(5) Install new valve collets and release the spring tension (Fig. 53).

REMOVAL AND INSTALLATION (Continued)

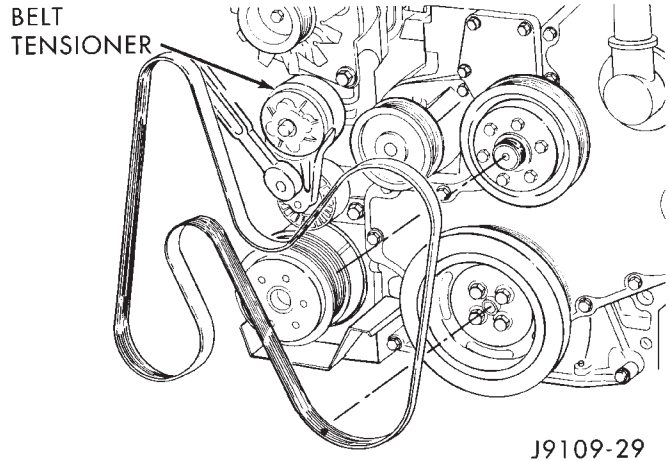
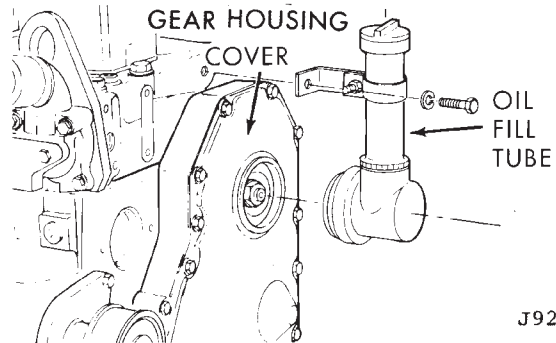
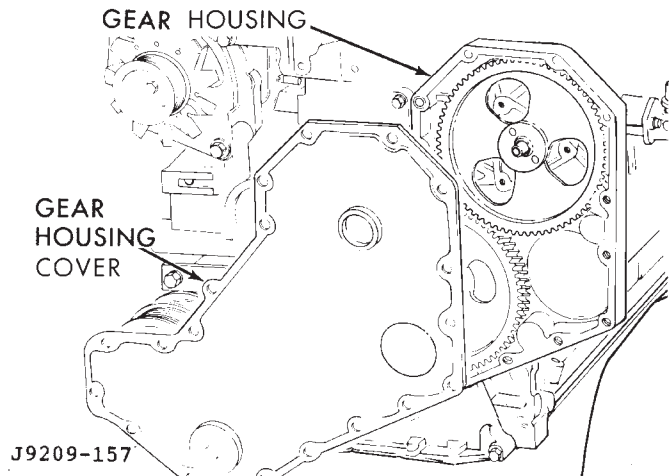
**Fig. 52 Valve Stem Seal Installation****Fig. 53 Valve, Valve Spring and Collet Installation**

WARNING: WEAR PROTECTIVE EQUIPMENT AND DO NOT STAND IN LINE WITH THE VALVE STEM WHEN TAPPING THE VALVES.

- (6) Tap the ends of the valve stems with a mallet to verify the collets are seated.
- (7) Install the cylinder head (Refer to Cylinder Head Removal and Installation in this section).
- (8) Check the valve clearance adjustment.

GEAR HOUSING COVER**REMOVAL**

- (1) Remove fan drive assembly.
- (2) Remove the fan belt (Fig. 54).
- (3) Remove belt tensioner (Fig. 54).
- (4) Remove oil fill tube and adaptor (Fig. 55).
- (5) Remove vibration damper.
- (6) Remove the bolts that hold the gear cover to the gear housing.
- (7) Gently pry the cover away from the housing, taking care not to mar the gasket surfaces (Fig. 56).
- (8) Clean the old gasket residue from the back of the gear cover and front of the gear housing.

**Fig. 54 Drive Belt Installation****Fig. 55 Oil Fill Tube****Fig. 56 Gear Housing and Cover****INSTALLATION**

- (1) Lubricate the front gear train with clean engine oil.
- (2) Thoroughly clean the front seal area of the crankshaft. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.
- (3) Apply a bead of Loctite 277 to the outside diameter of the seal.

REMOVAL AND INSTALLATION (Continued)

(4) Install the seal into the rear of the cover using a plastic hammer and the alignment/installation tool provided in the seal kit to prevent damage to the seal carrier, hit the alignment/installation tool alternately at the 12, 3, 6 and 9 o'clock positions.

(5) Install the pilot from the seal kit onto the crankshaft.

(6) Using the pilot as an alignment tool, install the cover and a new gasket.

(7) Install the cover bolts and tighten to 24 N·m (18 ft. lbs.) torque. Remove pilot tool.

(8) Install the oil fill tube and mounting bolts. Tighten the bolts to 43 N·m (32 ft. lbs.) torque.

(9) Install the vibration damper. DO NOT tighten the bolts to the correct torque value at this time.

(10) Install the belt tensioner. Tighten the mounting bolts to 43 N·m (32 ft. lbs.) torque.

(11) Raise the belt tensioner to install the belt.

(12) Tighten the vibration damper bolts to 125 N·m (92 ft. lbs.) torque. Use an engine barring tool to keep the engine from rotating during tightening operation.

(13) Install the fan drive assembly.

GEAR HOUSING

REMOVAL

(1) Remove the engine assembly from the vehicle.

(2) Remove the front end components and the gear housing cover (refer to Gear Housing Cover Removal for the proper procedures).

(3) Remove the following:

- Camshaft
- Gear driven accessories
- Fuel injection pump (refer to Group 14, Fuel System)
- Fan hub assembly (refer to Group 7, Cooling System)

(4) Remove the gear housing and gasket (Fig. 57).

(5) Clean the gasket material from the cylinder block.

INSTALLATION

(1) Install a new gasket and the gear housing. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

(2) Install the camshaft. Make sure the alignment marks on the camshaft and crankshaft gears are aligned (Fig. 58).

(3) If a new housing is installed, the timing pin assembly must be accurately located.

(4) Install the following:

- Fan hub assembly (refer to Group 7, Cooling System)
- Fuel injection pump (refer to Group 14, Fuel System)
- Gear driven accessories

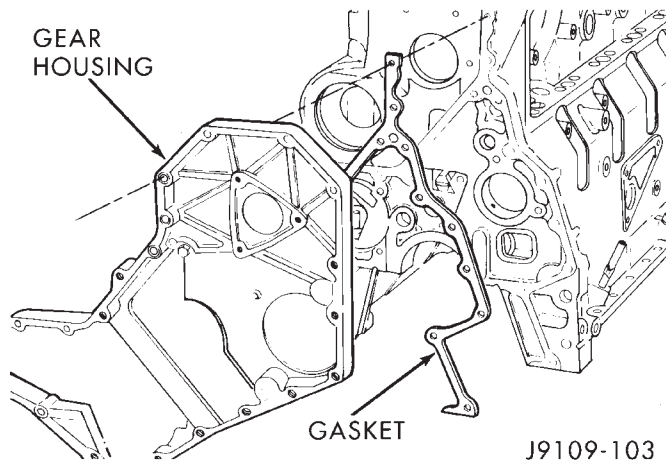


Fig. 57 Gear Housing/Gasket

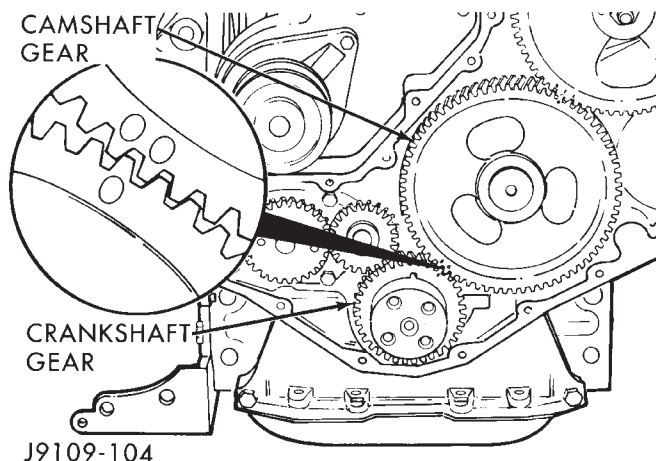


Fig. 58 Camshaft/Crankshaft Gear Alignment

(5) Install the gear housing cover (refer to Gear Housing Cover Installation for the proper procedures).

(6) Install the front end components.

(7) Install the engine assembly into the vehicle.

TIMING PIN

The timing pin can be replaced without removing the assembly from the gear housing.

REMOVAL

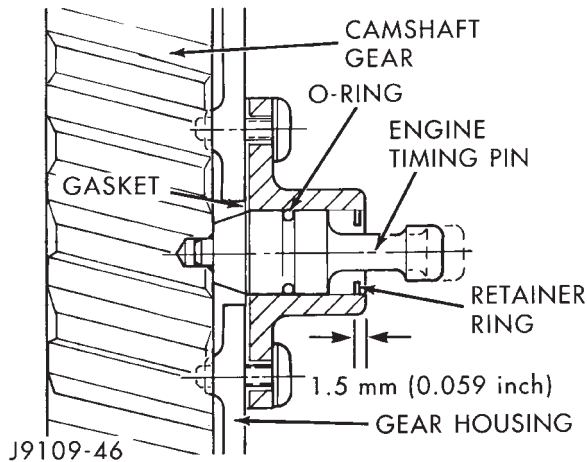
(1) Remove the timing pin by prying the retaining ring out with a small screwdriver. Replace the retaining ring if it is damaged during removal.

INSTALLATION

(1) If timing pin assembly is removed from gear housing, it must be precisely reset to obtain exact TDC.

(2) Install a new O-Ring, lubricate the pin and position in the housing (Fig. 59). Install the new retaining ring to 1.5 mm (0.059 inch).

REMOVAL AND INSTALLATION (Continued)

**Fig. 59 Engine Timing Pin Location****TIMING PIN HOUSING ASSEMBLY****REMOVAL**

- (1) Locate TDC for cylinder No.1.
- (2) Remove the timing pin housing assembly and gasket.
- (3) Clean any gasket material from the gear housing and from the timing pin housing assembly.

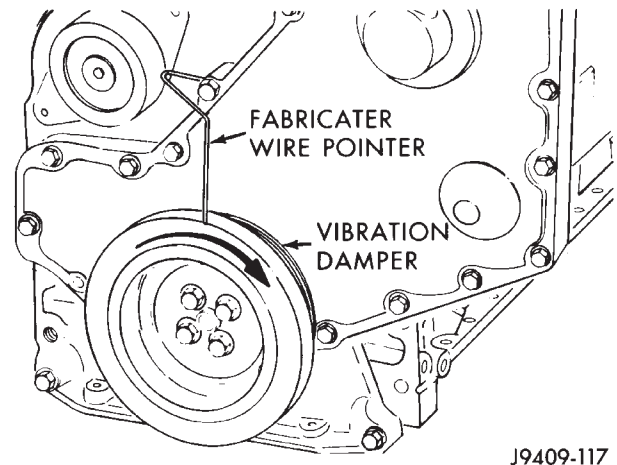
INSTALLATION—CYLINDER HEAD ON

The location of the timing pin assembly on the gear housing is critical for correct engine adjustment. Follow this procedure to install the assembly so that it corresponds to TDC for cylinder No.1.

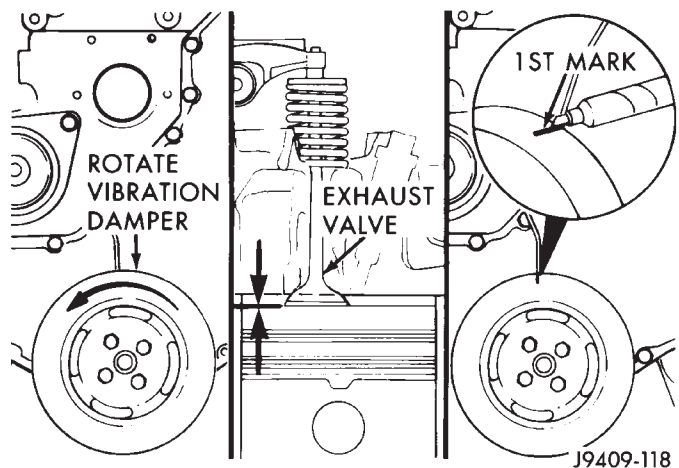
- (1) Look through the hole in the gear housing and rotate the engine until the hole in the cam gear can be seen.
- (2) Remove the injector nozzles from all of the cylinders. This step is important to vent the cylinders so the crankshaft can be rotated smoothly to locate TDC for cylinder No.1.
- (3) Temporarily install the vibration damper.
- (4) Fabricate and install a wire pointer (Fig. 60). This can be done by forming a piece of wire that can be tighten under one of the gear housing capscrews. The wire should extend from the gear cover to a place on the crankshaft vibration damper that is easily seen.
- (5) Rotate the crankshaft one-quarter rotation in the direction of engine rotation.
- (6) Tighten the adjusting screw for the No.1 intake valve to zero lash plus 5 turns.

CAUTION: Use extreme care when rotating the crankshaft. Use of too much force could damage the valve or push rod (Fig. 61).

- (7) Rotate the crankshaft slowly in the opposite direction of normal engine rotation until the piston touches the intake valve (Fig. 61).

**Fig. 60 Fabricated Wire Pointer**

- (8) Mark the vibration damper at the wire pointer (Fig. 61).

**Fig. 61 Locate and Mark Vibration Damper—First Mark**

- (9) Rotate the crankshaft in the direction of normal engine rotation until the piston touches the intake valve (Fig. 62). **Make sure that the piston touches the intake valve with approximately the same amount of force as in the previous step (Fig. 62).**

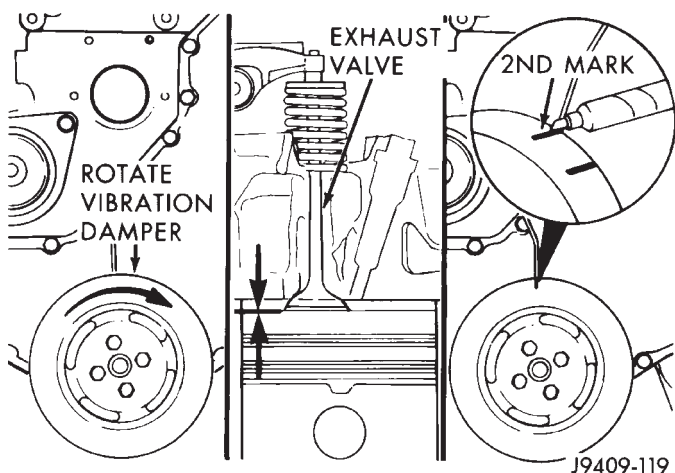
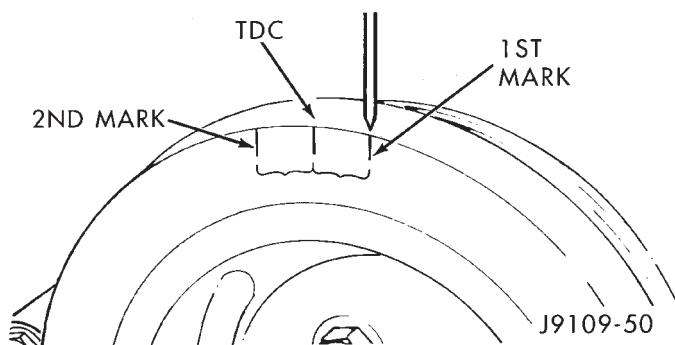
- (10) Mark the vibration damper at the wire pointer (Fig. 62).

- (11) Measure the distance and mark the vibration damper at one-half that distance between the two marks. This mark is the TDC mark (Fig. 63).

- (12) Completely loosen the intake valve adjusting screw. If not done, damage to the intake valve or push rod could occur when the crankshaft is rotated.

- (13) Rotate the crankshaft in the direction of normal engine rotation until the pointer is aligned with the TDC mark. Rotate crankshaft one additional turn.

REMOVAL AND INSTALLATION (Continued)

**Fig. 62 Mark Vibration Damper—Second Mark****Fig. 63 Location of Top Dead Center (TDC)**

(14) The timing pin hole in the cam gear should be visible or felt through the back side of the gear housing. If not, the crankshaft must be rotated one revolution in the direction of engine rotation.

(15) Apply a coat of Loctite[®] 59241 (Liquid Teflon), or equivalent to the threads of the Torx head bolts. Install the timing pin assembly and new O-ring.

(16) Hold the timing pin in the hole to align the housing and install the Torx head bolts. Tighten the Torx bolts to 5 N·m (44 in. lbs.) torque.

(17) Install the remaining rocker lever pedestal assemblies. Tighten the rocker lever pedestal mounting capscrews.

(18) Adjust the valves.

(19) Install the injectors and bleed the fuel system (refer to Group 14, Fuel System).

(20) Install the fuel pump (refer to Group 14, Fuel System).

(21) Install the gear cover.

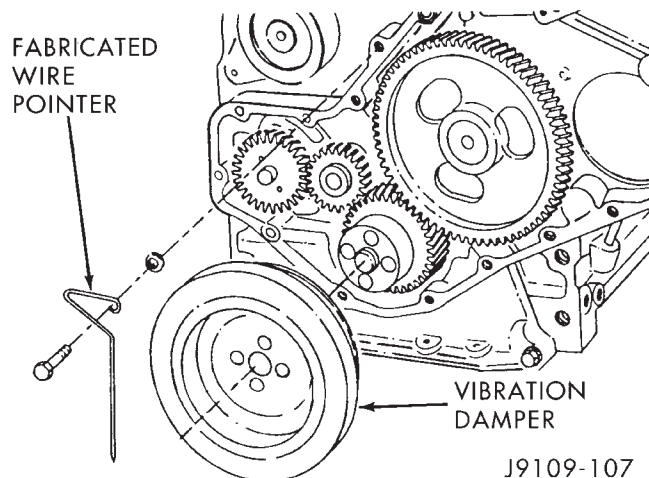
(22) Remove the pointer. Install the crankshaft vibration damper.

INSTALLATION—CYLINDER HEAD REMOVED

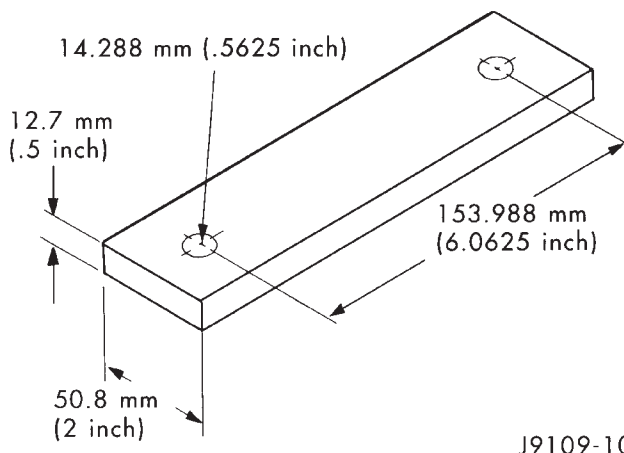
The timing pin assembly is precisely located on the gear housing to correspond to TDC for Cylinder No.1.

The timing pin assembly must be relocated if the gear housing is interchanged.

(1) Temporarily install the vibration damper and a fabricated wire pointer (Fig. 64). Put a flat washer between the pointer and gear housing to prevent damage to the gear housing.

**Fig. 64 Fabricated Wire Pointer**

(2) Fabricate a steel plate (Fig. 65).

**Fig. 65 Fabricated Steel Plate**

(3) Use two flywheel housing bolts to assemble the plate over No.1 cylinder (Fig. 66).

(4) Rotate the crankshaft in the direction of rotation until the piston contacts the plate.

(5) Mark the vibration damper (Fig. 63).

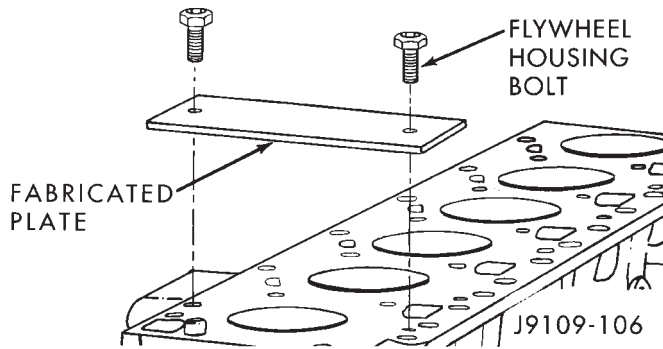
(6) Rotate the engine in the opposite direction until the piston contacts the plate.

(7) Mark the vibration damper (Fig. 63).

(8) Mark the vibration damper for TDC. TDC will be one-half the distance between the first two marks (Fig. 63).

(9) Remove the plate and rotate the engine in the direction of rotation until the pointer aligns with the TDC mark.

REMOVAL AND INSTALLATION (Continued)

**Fig. 66 Fabricated Plate Location on No.1 Cylinder**

(10) Look for the timing pin hole in the camshaft gear. If it is not visible, rotate the crankshaft one complete rotation. Align the pointer with the TDC mark.

(11) Install the timing pin housing assembly with a new gasket.

(12) Apply a coat of Loctite 59241 liquid teflon, or equivalent to the threads of the torx head bolts.

(13) Push the pin into the hole in the cam gear to align the timing pin housing.

(14) Hold the pin in while tightening the torx head bolts to 5 N·m (44 in. lbs.) torque. Be sure timing pin is disengaged before rotating the engine.

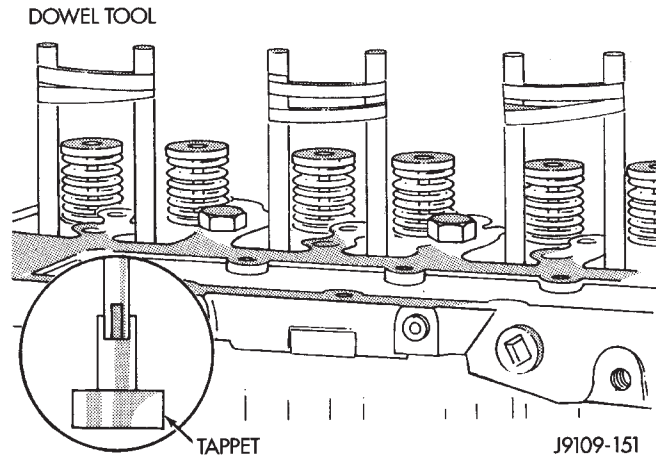
(15) Remove the vibration damper and wire pointer.

CAMSHAFT**REMOVAL**

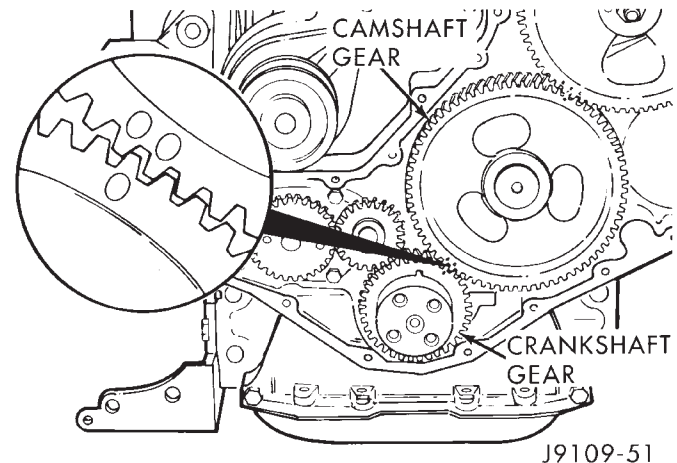
- (1) Disconnect battery negative cable.
- (2) Drain cooling system.
- (3) Remove the following parts:
 - Fan Shroud
 - Radiator
 - A/C Condenser (if equipped)
 - Intercooler
 - Auxiliary Transmission Cooler
 - Upper Radiator Support
 - EGR Tube
 - Name Plate
 - Valve covers
 - Rocker lever assemblies
 - Push rods
 - Drive belt
 - Fan hub assembly
 - Vibration damper
 - Gear housing cover
 - Lift pump

(4) Insert the dowels through the push tube holes and into the top of each tappet. When properly installed, the dowels can be used to pull the tappets up (Fig. 67).

(5) Pull the tappets up and wrap a rubber band around the top of the dowel rods (Fig. 67). This will prevent the tappets from dropping down.

**Fig. 67 Holding Tappets in Place**

(6) Rotate the crankshaft to align the crankshaft to camshaft timing marks. (Fig. 68)

**Fig. 68 Align Crankshaft to Camshaft**

(7) Remove the bolts from the thrust plate (Fig. 69).

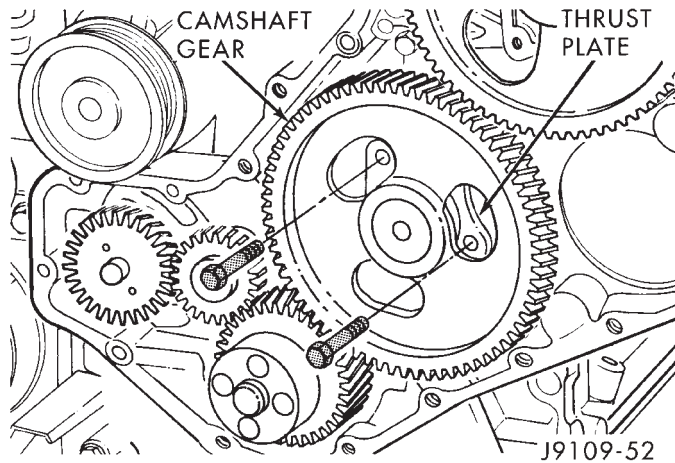
(8) Remove the camshaft, gear and thrust plate.

BUSHING REPLACEMENT

(1) Measure the diameter of each bore. (The limit for the bushing in the No.1 bore is the same as for the other bores without bushings). The limit of the inside diameter is 54.133 mm (2.1312 inch). If the camshaft bore for the first cam bushing is worn beyond the limit, install a new service bushing. Inspect the rest of the camshaft bores for damage or excessive wear.

(2) If the bores without a bushing are worn beyond the limit, the engine must be removed for machining and installation of service bushings. If badly worn, replace the cylinder block.

REMOVAL AND INSTALLATION (Continued)

**Fig. 69 Thrust Plate Bolt Location**

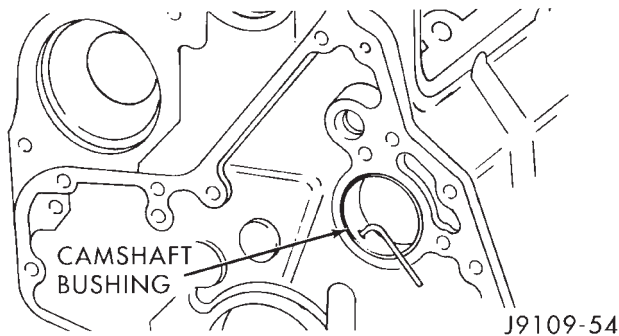
(3) Remove the bushing from the No.1 bore, using a universal cam bushing tool.

(4) Mark the cylinder block so you can align the oil hole in the cylinder block with the oil hole in the bushing.

Apply a coating of Loctite® 609 to the backside of the new bushing. Avoid getting Loctite® in the oil hole.

(5) Use a universal cam bushing installation tool and install the bushing so that it is even with the front face of the cylinder block. The oil hole must be aligned. A 3.2 mm (0.128 inch) diameter rod must be able to pass through the hole (Fig. 70).

(6) Measure the installed bushing. The limit of the inside diameter is 54.133 mm (2.1312 inch).

**Fig. 70 Oil Hole Alignment****GEAR REPLACEMENT**

- (1) Press the camshaft out of the gear.
- (2) Remove all burrs and smooth any rough surfaces caused by removing the gear.
- (3) Install the camshaft key.
- (4) Lubricate the camshaft surface with Lubriplate 105, or equivalent.

CAUTION: The camshaft gear will be permanently distorted if overheated. The oven temperature should never exceed 177°C (350°F).

(5) Heat the gear in an oven at 177°C (350°F) for 45 minutes.

WARNING: WEAR PROTECTIVE GLOVES TO HANDLE THE HOT GEAR.

(6) Install the gear with the timing marks visible. Be sure the gear is seated against the camshaft shoulder.

(7) If the camshaft is not to be used immediately, lubricate the lobes and journals to prevent rust.

INSTALLATION

(1) Apply a coat of Lubriplate 105 to the camshaft bores.

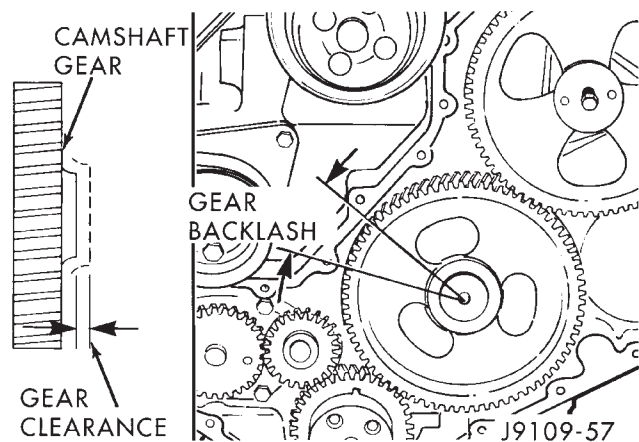
(2) Lubricate the camshaft lobes, journals and thrust washer with Lubriplate 105, or equivalent.

CAUTION: When installing the camshaft, **DO NOT** push it in farther than it will go with the thrust washer in place. Pushing it too far can dislodge the plug in the rear of the camshaft bore and cause an oil leak.

(3) Install the camshaft/thrust washer. Align the timing marks as illustrated (Fig. 68).

(4) Install the thrust washer bolts and tighten to 24 N·m (18 ft. lbs.) torque.

(5) Verify the camshaft has the correct amount of backlash and end clearance (Fig. 71).



BACKLASH - 0.080-0.330 mm
(0.003-0.013 inch)

CLEARANCE - 0.152-0.254 mm
(0.006-0.010 inch)

Fig. 71 Camshaft Backlash and End Clearance

(6) Install the following parts:

- Lift pump
- Gear housing cover
- Vibration damper
- Fan hub assembly
- Drive belt

REMOVAL AND INSTALLATION (Continued)

- Push rods
- Rocker lever assemblies
- Valve covers
- Name Plate
- Upper Radiator Support
- A/C Condenser (if equipped)
- Auxiliary Transmission Cooler
- Intercooler
- Radiator
- Fan Shroud

(7) Install the EGR tube and start fasteners by hand.

(8) Tighten all bolts/nuts to 24 N·m (212 in. lbs.) torque. **When tightening bolts at EGR valve end of tube, alternate between the upper and lower bolt to allow face of EGR valve to remain square to tube mounting flange on EGR tube.**

(9) Refill cooling system.

(10) Operate the engine at idle for five to ten minutes and check for leaks and loose parts.

TAPPET

REMOVAL

- (1) Remove the camshaft.
- (2) Insert a trough the full length of the cam bore (Fig. 72). Cummins Tappet Changing Tool 3822513 is available for this job.
- (3) Make sure the trough is positioned so it will catch the tappet when the wooden dowel is removed.
- (4) Identify the location of each tappet as it is removed. The tappets must be installed in their original locations.

(5) Only remove one tappet at a time. Remove the rubber band from the two companion tappets, securing the tappet not to be removed with the rubber band.

(6) Pull the wooden dowel from the tappet bore allowing the tappet to fall into the trough (Fig. 72).

(7) Normally the tappet will fall over when it drops into the trough. Use a flashlight to determine this. If the tappet does not fall over, shake the trough gently to get it to do so.

(8) Special care should be taken, when removing the No.6 cylinder tappets. DO NOT knock or shake the tappet over the end barrier of the trough.

(9) Carefully pull the trough and tappet from the cam bore and remove the tappet. Repeat the process until all tappets are removed.

INSTALLATION

- (1) Insert the trough the full length of the cam bore.
- (2) Feed the installation tool down the tappet bore and into the trough (Fig. 73).
- (3) Feed the installation tool cord through the cam bores. Carefully pull the trough and installation tool

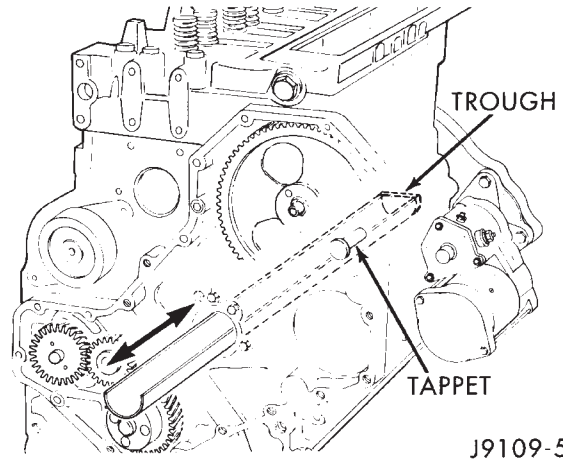


Fig. 72 Tappet Removal using a Trough

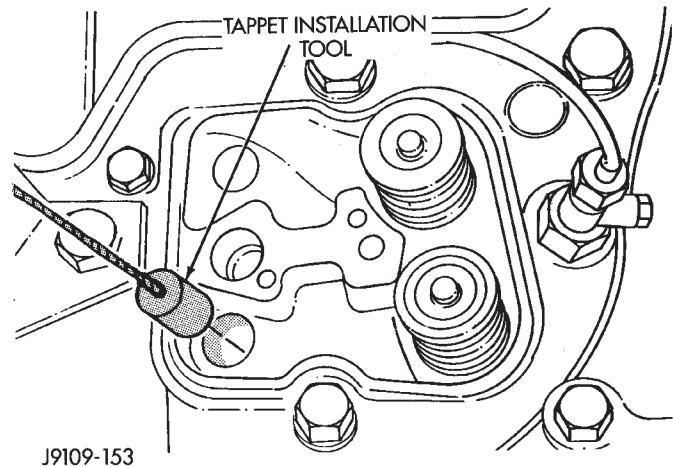


Fig. 73 Tappet Installation Tool

out the front. The barrier at the rear of the trough will assure the tool will be pulled out with it.

(4) Lubricate the tappets with Lubriplate 105, or equivalent.

(5) Insert the installation tool into the tappet (Fig. 74). To aid in removing the installation tool after the tappets is installed, work the tool in and out of the tappet several times before installing the tappets.

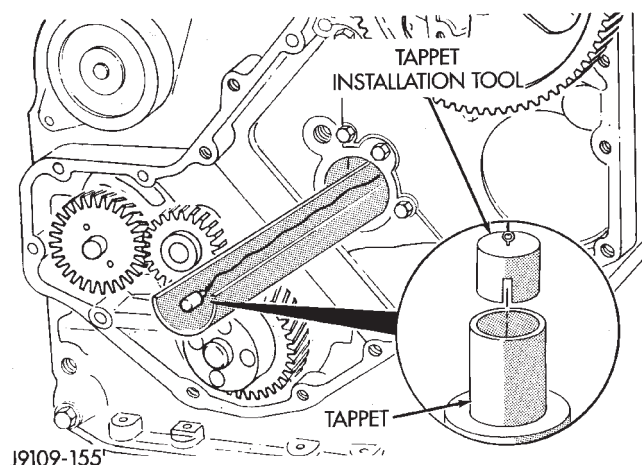
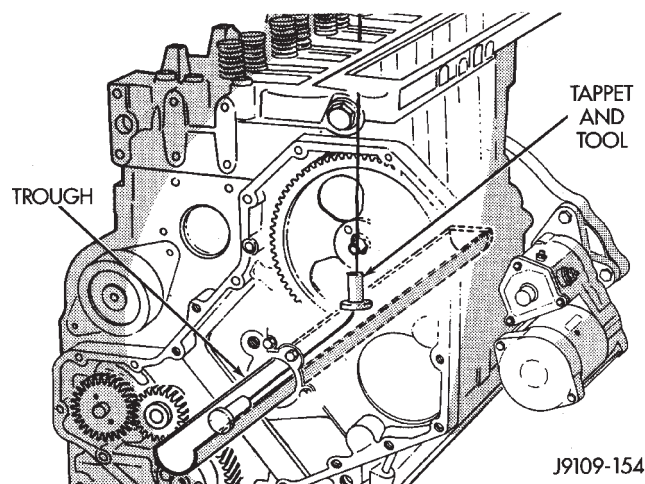
(6) Place the tappet and tool in the trough and slide the trough back into the cam bore (Fig. 74).

(7) Pull the tool/tappet through the cam bore and up into the tappet bore (Fig. 75).

(8) Difficulty could be experienced in getting the tappet to make the bend from the trough up to the tappet bore (due to the webbing of the block). If this occurs, pull the trough out enough to allow the tappet to drop down and align itself. Now pull the tappet up into the bore carefully.

(9) After the tappet has been pulled up into position, slide the trough back into the cam bore and rotate it 1/2 turn. This will position the round side of the trough up, which will hold the tappet in place.

REMOVAL AND INSTALLATION (Continued)

**Fig. 74 Insert Installation Tool into Tappet****Fig. 75 Pull Tappet/Tool into Position**

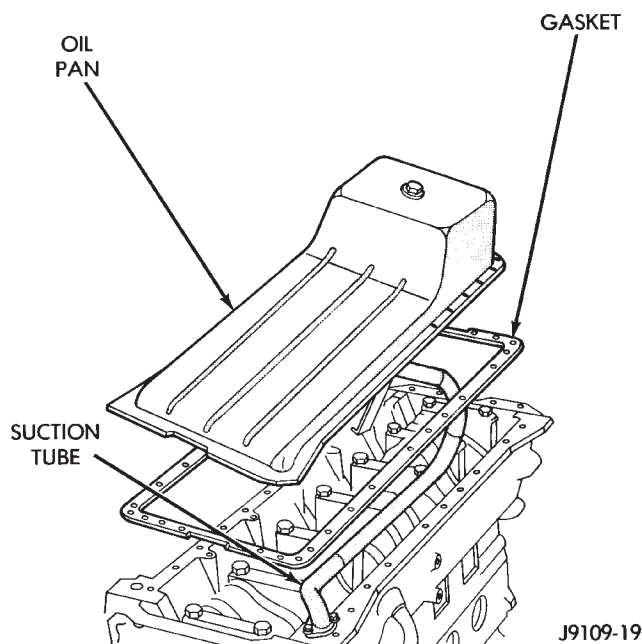
- (10) Remove the installation tool from the tappet.
- (11) Install a wooden dowel into the top of the tappet and secure it with a rubber band.
- (12) Repeat this process until all tappets have been installed.
- (13) Install the camshaft.

OIL PAN AND SUCTION TUBE**REMOVAL**

- (1) Disconnect the negative cable from the battery.
- (2) Remove transmission from vehicle, refer to Group 21 Transmission and Transfer Case.
- (3) Remove flywheel ring gear assembly.
- (4) Disconnect starter cables from starter motor.
- (5) Remove transmission oil cooler bolts.
- (6) Remove starter motor and spacer plate assembly.

WARNING: HOT OIL CAN CAUSE PERSONAL INJURY.

- (7) Drain the used engine oil. Dispose of the used oil properly.
- (8) Remove oil pan bolts, lower pan slightly and remove oil suction tube.
- (9) Remove oil pan.

**Fig. 76 Oil Pan, Suction Tube and Gasket****INSTALLATION**

- (1) Clean the oil pan and engine block sealing surfaces.
- (2) Install the suction tube and gasket. Tighten the bolts to 24 N·m (18 ft. lbs.) torque.
- (3) Fill the joint between the pan rail/gear housing and pan rail/rear cover with sealant. Use Three Bond 1207-C, or equivalent.
- (4) Install the pan and gasket (Fig. 76). Tighten the bolts to 24 N·m (18 ft. lbs.) torque.
- (5) Install the drain plug with a new sealing washer and tighten to 60 N·m (44 ft. lbs.) torque.
- (6) Install the spacer plate assembly with the starter motor attached.
- (7) Install transmission oil cooler tank bolts. Tighten bolts to 35 N·m (25 ft. lbs.) torque.
- (8) Install transmission assy. and transfer case (if equipped). Refer to Group 21 Transmission and Transfer Case.
- (9) Install battery negative cable.
- (10) Fill the engine with clean lubrication oil. Run the engine and check for leaks.
- (11) Stop the engine for five minutes. Check the oil level, and add oil if needed.

PISTON AND CONNECTING ROD ASSEMBLY

The turbocharged intercooler piston has a Ni-Re-sist insert with a keystone profile for the top com-

REMOVAL AND INSTALLATION (Continued)

pression ring. The new piston has a new design bowl and a 7 mm longer piston pin. These pistons can not be interchanged with earlier models.

REMOVAL

(1) Remove the engine assembly from the vehicle (Refer to Engine Remove and Install procedure in this section).

(2) Remove the cylinder head from the block.

(3) Remove the oil pan and suction tube.

(4) If the cylinder bores have ridges, use a ridge reamer to cut the ridge from the top of the cylinder bore before removing the piston. Make sure the ridge reamer does not make a deep cut into the bore. **DO NOT** remove more metal than is necessary to remove the ridge.

(5) If cylinders have ridges, the cylinders are over-size and will need boring.

(6) Use a hammer and a steel stamp to mark the cylinder number onto each connecting rod cap. Mark the cylinder number onto the top of each piston.

(7) Remove the connecting rod bolts and rod caps. Use care so the cylinder bores and connecting rods are not damaged.

(8) Use a hammer handle or similar object to push the piston and connecting rod through the cylinder bore.

(9) Store the piston/rod assemblies in a rack.

(10) If a piston must be replaced, replace with the same part number (grading) that was removed.

INSTALLATION

(1) Lubricate the cylinder bore with clean engine oil.

(2) Generously lubricate the rings and piston skirts with clean engine oil.

(3) Compress the rings using a piston ring compressor tool (Fig. 77). 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.

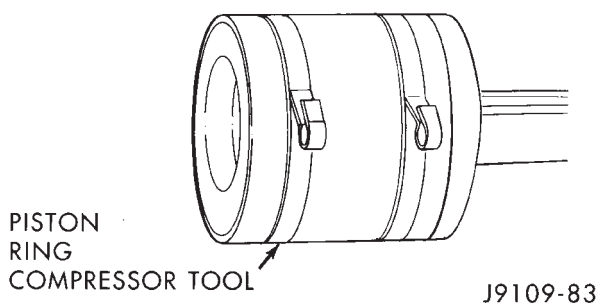


Fig. 77 Piston Ring Compressor Tool

(4) Bar the crankshaft so the rod journal for the piston to be installed is at BDC (Bottom Dead Center) - (Fig. 78).

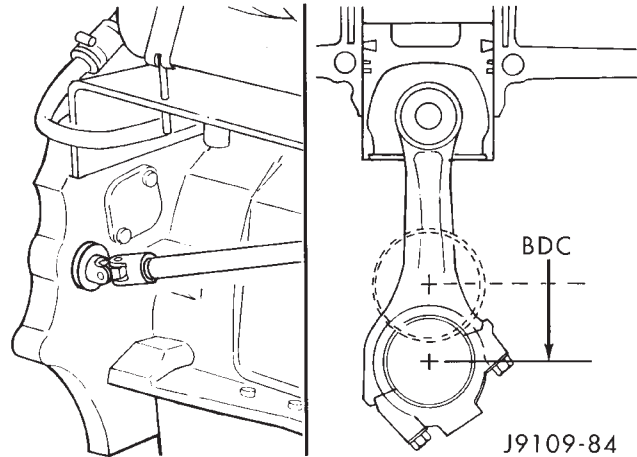


Fig. 78 Piston/Rod Assembly at BDC

(5) Be sure the **FRONT** marking on the piston and the numbers on the rod and cap are oriented as illustrated.

(6) Position the piston and rod assembly into the cylinder bore with the word **FRONT** on the piston towards the front of the cylinder block. Use care when you install the piston and connecting rod so the cylinder bore is not damaged.

(7) Push the piston into the bore until the top of the piston is approximately 50 mm (2 inch) below the top of the block. Carefully pull the connecting rod onto the crankshaft journal.

(8) Use clean engine oil to lubricate the threads and under the heads of the connecting rod bolts.

(9) The 4 digit number stamped on the rod cap at the parting line must match and be installed towards the oil cooler side of the engine (Fig. 79).

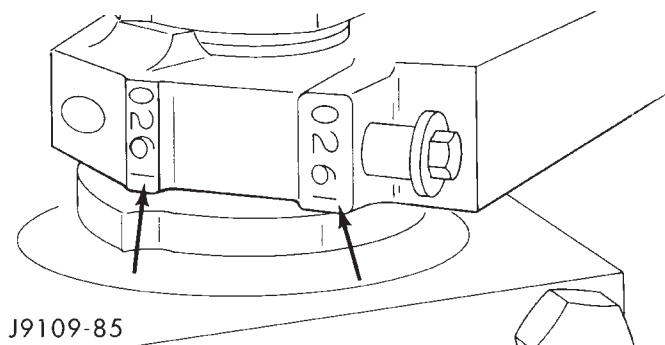


Fig. 79 Correct Rod Cap Installation

(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

REMOVAL AND INSTALLATION (Continued)

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. 80). DO NOT measure the clearance between the cap and crankshaft.

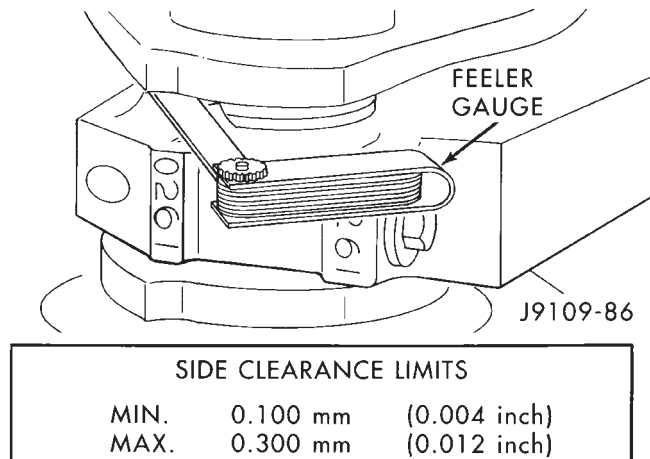


Fig. 80 Side Clearance between Connecting Rod/Crankshaft

- (13) Install the suction tube and oil pan.
- (14) Install the cylinder head onto the block.
- (15) Install the engine assembly into the vehicle.

CRANKSHAFT

REMOVAL

- (1) Remove the rear crankshaft seal housing.
- (2) Remove the gear housing.
- (3) Rotate the engine to a horizontal position and remove the main bearing bolts.
- (4) The main bearing caps should be numbered. If they are not, be sure to mark them, beginning with number one at the front and ending with number seven at the rear (Fig. 81).

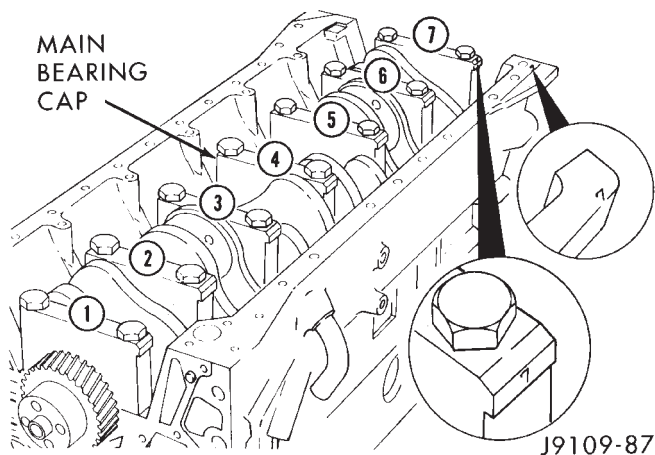


Fig. 81 Numbering Main Bearing Caps

CAUTION: DO NOT pry on the main caps to free them from the cylinder block.

- (5) Use two of the main bearing cap bolts to wiggle the main cap loose, being careful not to damage the bolt threads (Fig. 82). Remove the caps.

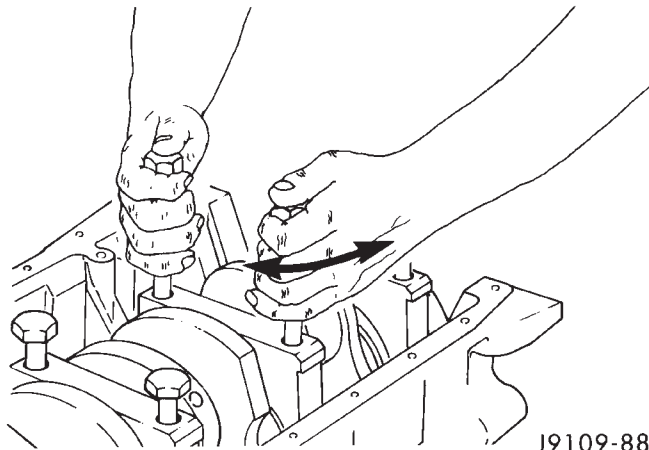


Fig. 82 Main Bearing Cap Removal

WARNING: USE A HOIST TO AVOID INJURY.

- (6) Lift the crankshaft and gear from the cylinder block (Fig. 83).

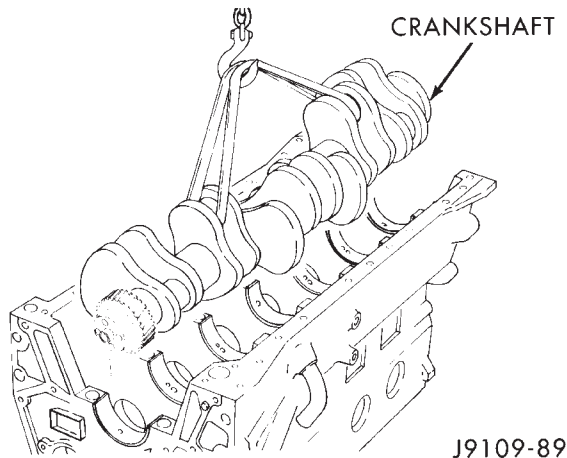


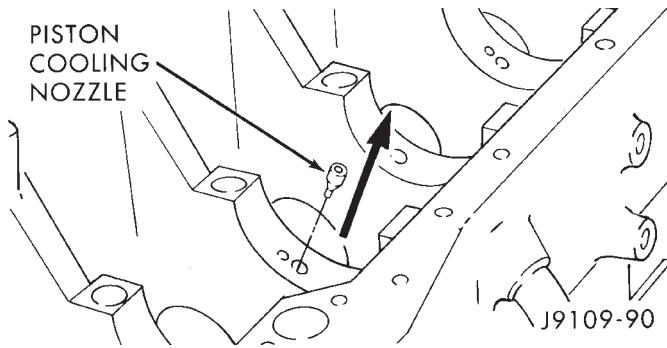
Fig. 83 Lifting Crankshaft out of Cylinder Block

- (7) Remove the main bearings from the block and the main caps.
- (8) Remove the piston cooling nozzles by using a 3/16 inch pin punch to push them out (Fig. 84).

INSTALLATION

CAUTION: Use only hand force to push the nozzle in place. If driven with a hammer, the nozzle will be damaged.

REMOVAL AND INSTALLATION (Continued)

**Fig. 84 Piston Cooling Nozzles**

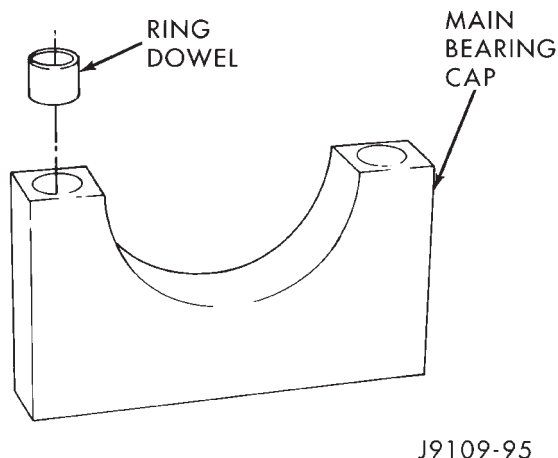
- (1) Use a center punch to push the piston cooling nozzle into place. Install nozzles so they are even with or slightly below the saddle surface.
- (2) Make sure the saddle surface is clean and dry. Install the upper main bearings.
- (3) Install the combination thrust/main bearing in the number six main bearing location.
- (4) Lubricate the bearings with Lubriplate 105, or equivalent.

WARNING: TO AVOID INJURY, USE A HOIST TO INSTALL THE CRANKSHAFT.

- (5) Install the crankshaft.

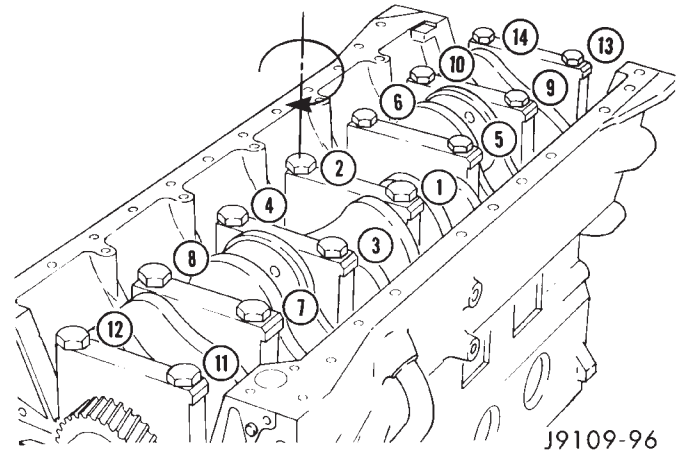
CAUTION: Crankshaft must be lowered onto the bearings straight to prevent damage to thrust bearings.

- (6) Install the ring dowels in the main bearing caps (Fig. 85).

**Fig. 85 Install Ring Dowels**

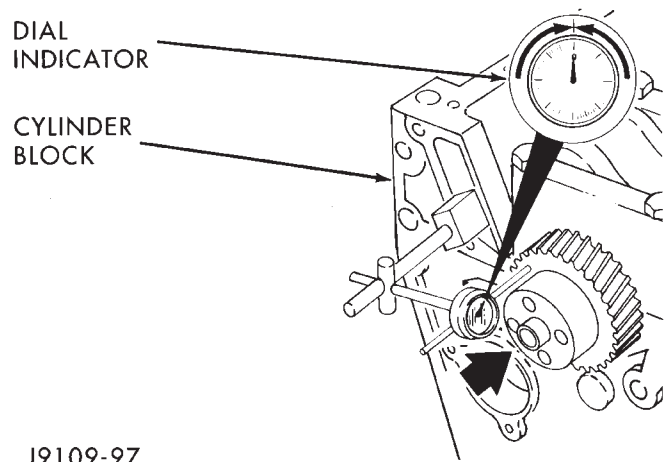
- (7) Install the lower main bearings in the caps.
- (8) Lubricate the bearings with Lubriplate, or equivalent.
- (9) Numbers on the main bearings caps face the oil cooler side of the engine with number one at the front of the engine.

- (10) Place the caps in their respective positions.
- (11) Lubricate the main bearing bolt threads and underside of the bolt head with clean engine oil.
- (12) Tighten the bolts evenly in the sequence shown using the following torque steps (Fig. 86).
 - STEP 1—Tighten all bolts in sequence to 60 N·m (44 ft. lbs.) torque.
 - STEP 2—Tighten all bolts in sequence to 90 N·m (60 ft. lbs.) torque.
 - STEP 3—Tighten all bolts in sequence an additional 90°.

**Fig. 86 Main Bearing Bolt Tightening Sequence**

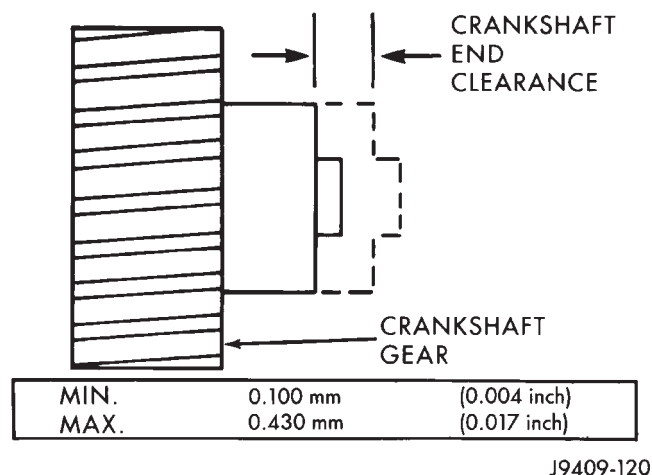
- (13) Turn the crankshaft to determine that it will rotate freely all 360°. Check the main bearing cap installations and/or the bearing sizes if the shaft does not turn easily.

- (14) Push the crankshaft towards one end of its thrust and place a dial indicator as shown (Fig. 87).

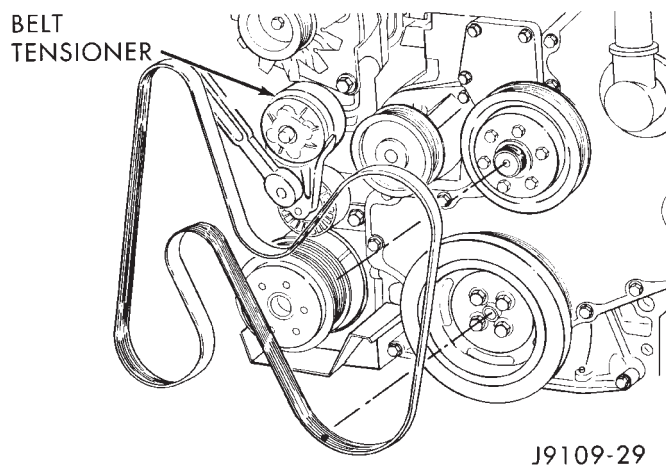
**Fig. 87 Position of Dial Indicator**

- (15) Zero the indicator needle and push the crankshaft towards the other end of its thrust and record the crankshaft end clearance (Fig. 88).

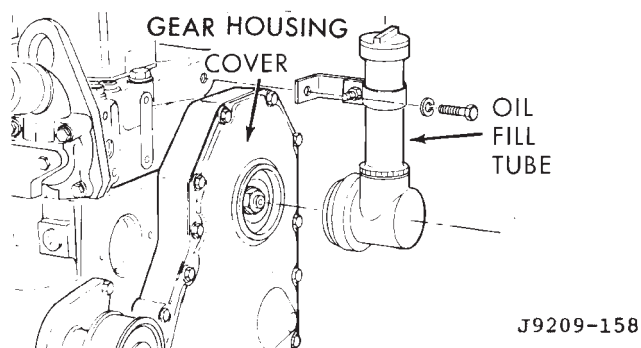
REMOVAL AND INSTALLATION (Continued)

**Fig. 88 Crankshaft End Clearance****CRANKSHAFT FRONT SEAL****REMOVAL**

- (1) Remove fan drive assembly.
- (2) Remove the fan belt (Fig. 89).
- (3) Remove belt tensioner (Fig. 89).

**Fig. 89 Drive Belt Installation**

- (4) Remove oil fill tube and adaptor (Fig. 90).

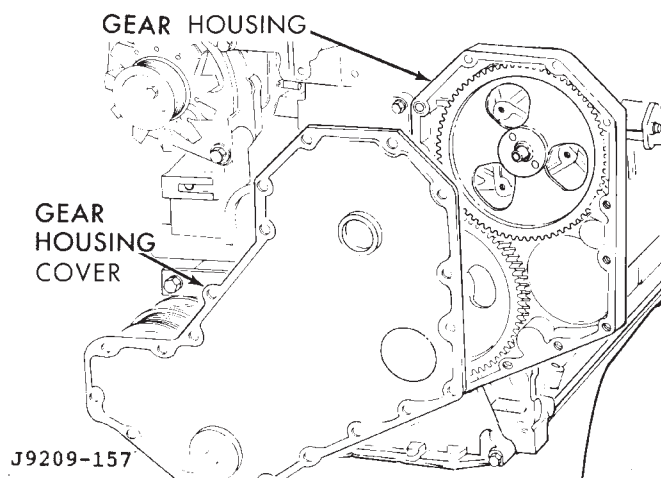
**Fig. 90 Oil Fill Tube**

- (5) Remove vibration damper.

- (6) Remove the bolts that hold the gear cover to the gear housing.

- (7) Gently pry the cover away from the housing, taking care not to mar the gasket surfaces (Fig. 91).

- (8) Clean the old gasket residue from the back of the gear cover and front of the gear housing.

**Fig. 91 Gear Housing and Cover****INSTALLATION**

- (1) Lubricate the front gear train with clean engine oil.

- (2) Thoroughly clean the front seal area of the crankshaft. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

- (3) Apply a bead of Loctite 277 to the outside diameter of the seal.

- (4) Install the seal into the rear of the cover using a plastic hammer and the alignment/installation tool provided in the seal kit to prevent damage to the seal carrier, hit the alignment/installation tool alternately at the 12, 3, 6 and 9 o'clock positions.

- (5) Install the pilot from the seal kit onto the crankshaft.

- (6) Using the pilot as an alignment tool, install the cover and a new gasket.

- (7) Install the cover bolts and tighten to 24 N·m (18 ft. lbs.) torque. Remove pilot tool.

- (8) Install the oil fill tube and mounting bolts. Tighten the bolts to 43 N·m (32 ft. lbs.) torque.

- (9) Install the vibration damper. DO NOT tighten the bolts to the correct torque value at this time.

- (10) Install the belt tensioner. Tighten the mounting bolts to 43 N·m (32 ft. lbs.) torque.

- (11) Raise the belt tensioner to install the belt.

- (12) Tighten the vibration damper bolts to 125 N·m (92 ft. lbs.) torque. Use an engine barring tool to keep the engine from rotating during tightening operation.

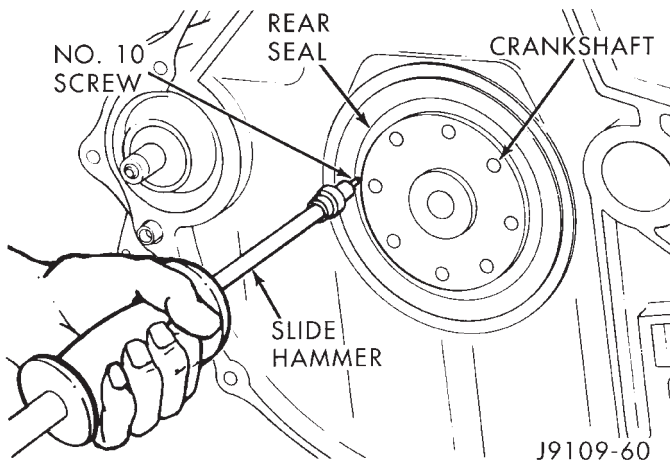
- (13) Install the fan drive assembly.

REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT REAR SEAL

REMOVAL

- (1) Remove the transmission (refer to Group 21, Transmission for the proper procedure).
- (2) Remove the clutch cover.
- (3) Remove the clutch plate.
- (4) Remove the flywheel.
- (5) Drill holes 180° apart into the seal. Be careful not to get the drill against the crankshaft.
- (6) Install #10 sheet metal screws in the drilled holes and remove the rear seal with a slide hammer (Fig. 92).

**Fig. 92 Crankshaft Rear Seal Removal**

INSTALLATION

CAUTION: The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.

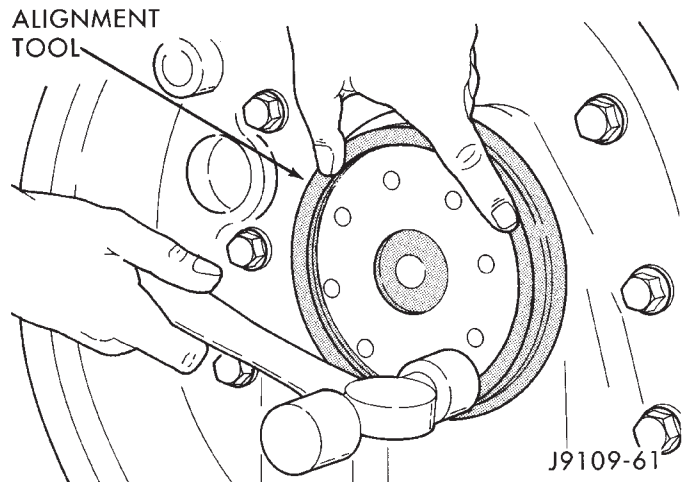
The crankshaft and seal must be dry when the seal is installed.

- (1) Install the seal pilot, provided in the replacement kit, on the crankshaft. Push the seal on the pilot and crankshaft.
- (2) Remove the seal pilot.
- (3) Use the alignment tool to install the seal to the correct depth in the housing. Use a hammer to drive the seal into the housing until the alignment tool stops against the housing (Fig. 93).
- (4) Hit the tool at the 12, 3, 6 and 9 o'clock positions to drive the seal evenly and prevent bending the seal housing.

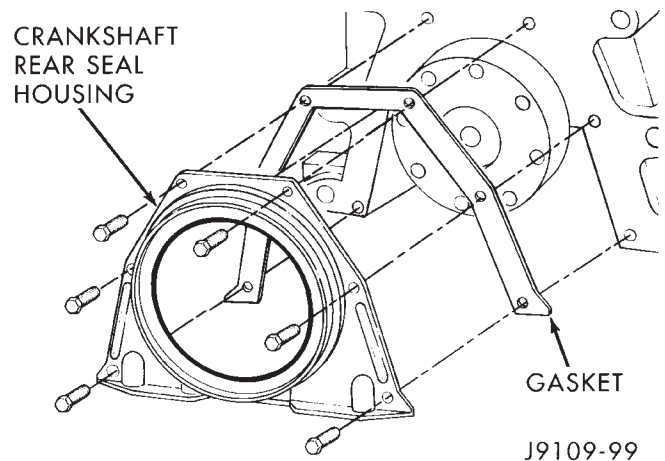
CRANKSHAFT REAR SEAL HOUSING

REMOVAL

- (1) Remove the rear seal housing and gasket (Fig. 94).

**Fig. 93 Seal Installation using Alignment Tool**

- (2) Support the seal area of the rear seal housing and press/drive out the seal using a hammer and a pin pinch.
- (3) Clean the rear seal housing.

**Fig. 94 Crankshaft Rear Seal Housing/Gasket**

INSTALLATION

- (1) Clean and dry the rear crankshaft sealing surface. The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.
- (2) Assemble the rear seal housing and gasket to the cylinder block with the bolts.
- (3) Align the seal housing to the crankshaft with the alignment tool provided in the seal kit (Fig. 14). Make sure the seal housing is level with both sides of the block oil pan rail. Tighten the bolts to 9 N·m (7 ft. lbs.) torque.
- (4) Remove the alignment tool and trim the gasket even with the oil pan mounting surface (Fig. 95).
- (5) Install the seal pilot (provided with the replacement kit) onto the crankshaft. Push the seal onto the crankshaft (Fig. 96).
- (6) Remove the seal pilot.

REMOVAL AND INSTALLATION (Continued)

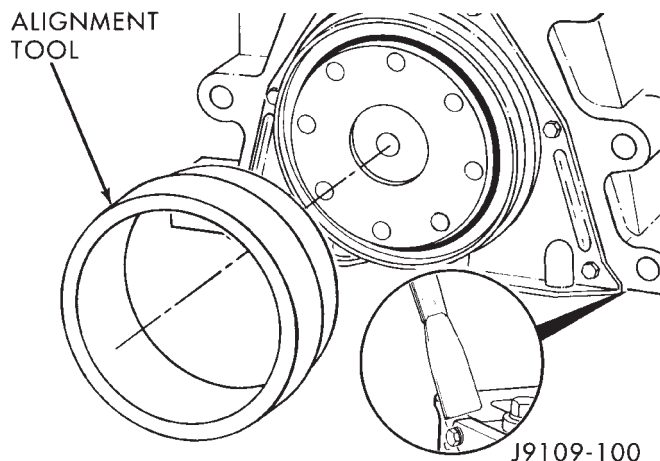


Fig. 95 Crankshaft Rear Seal Housing Alignment Tool

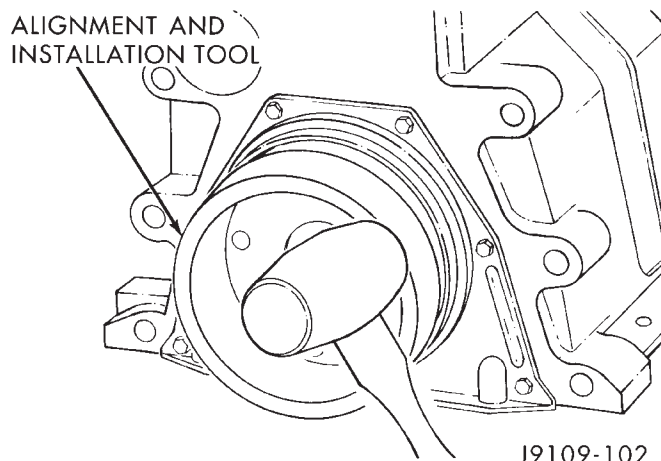


Fig. 97 Crankshaft Rear Seal Alignment/Installation Tool

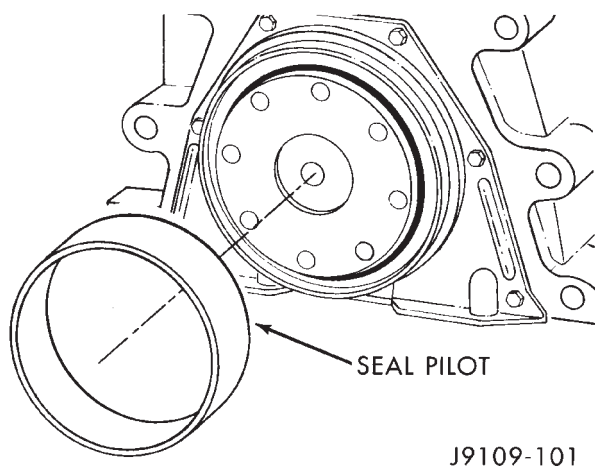


Fig. 96 Crankshaft Rear Seal Pilot

(7) Use alignment and installation tool packaged in the seal kit (Fig. 97). Alternately, drive the seal at the 12, 3, 6 and 9 o'clock positions to prevent bending the seal carrier during installation.

FLYWHEEL RING GEAR

REMOVAL

- (1) Remove the transmission.
- (2) Remove the clutch cover.
- (3) Remove the clutch plate.
- (4) Remove the flywheel.
- (5) Use a drift pin to drive the ring gear from the flywheel (Fig. 19). Strike the gear at several points around the wheel until it is off.
- (6) Heat the new ring for 20 minutes in an oven preheated to 127°C (250°F).
- (7) Install the gear. The gear must be installed so the bevel on the teeth is towards the crankshaft side of the flywheel (Fig. 98).

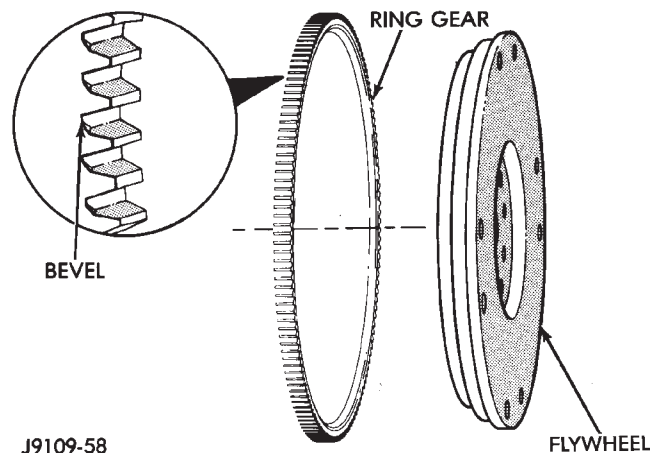


Fig. 98 Flywheel/Ring Gear Position

INSTALLATION

CAUTION: Never use the timing pin to hold the crankshaft in position.

- (1) Use the engine barring tool to hold the crankshaft when the flywheel bolts are being tightened.
- (2) Tighten the bolts in a criss-cross pattern to 137 N·m (101 ft. lbs.) torque.

CRANKSHAFT GEAR

REMOVAL

Remove the crankshaft gear using a heavy duty puller.

INSTALLATION

Remove all burrs and make sure the gear surface on the end of the crankshaft is smooth.

If removed, install a new alignment pin. Drive the pin in using a ball-peen hammer, leaving it protrud-

REMOVAL AND INSTALLATION (Continued)

ing 1.60 mm (0.063 inch) to 2.39 mm (0.094 inch) above the crankshaft (Fig. 99).

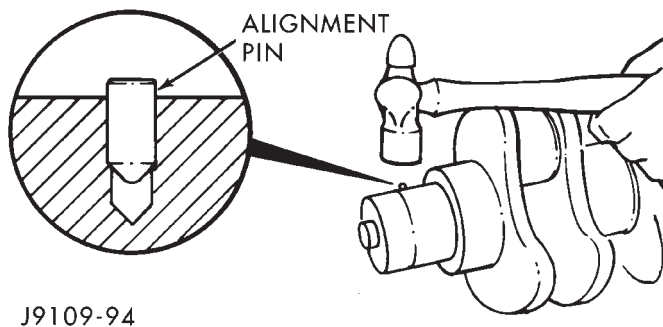


Fig. 99 Installing Alignment Pin

Heat the crankshaft gear for 45 minutes at a temperature of 121°C (250°F).

CAUTION: DO NOT heat the gear longer than 45 minutes.

WARNING: WEAR PROTECTIVE GLOVES TO PREVENT INJURY.

Position the gear with the timing mark out and install it on the crankshaft using the alignment pin. Make sure the gear contacts the shoulder.

OIL PUMP

The non-intercooled turbocharged engine oil pumps can not be used on intercooled engines.

REMOVAL

- (1) Remove the radiator (refer to Group 7, Cooling System for the proper procedure).
- (2) Loosen the crankshaft vibration damper and remove the drive belt.
- (3) Remove the fan clutch assembly.
- (4) Remove the fan hub.
- (5) Remove the oil fill tube.
- (6) Remove the crankshaft vibration damper.
- (7) Remove the gear housing cover.
- (8) Remove the four mounting bolts and pull the pump from the bore in the cylinder block (Fig. 100).

INSTALLATION

(1) Lubricate the pump with clean engine oil. Filling the pump with clean engine oil during installation will help to prime the pump at engine start up. Make sure the idler gear pin is installed in the locating bore in the cylinder block.

(2) Install the pump. Tighten the oil pump mounting bolts in two steps and in the sequence shown (Fig. 100).

- Step 1—Tighten to 5 N·m (44 in. lbs.) torque.
- Step 2—Tighten to 24 N·m (18 ft. lbs.) torque.

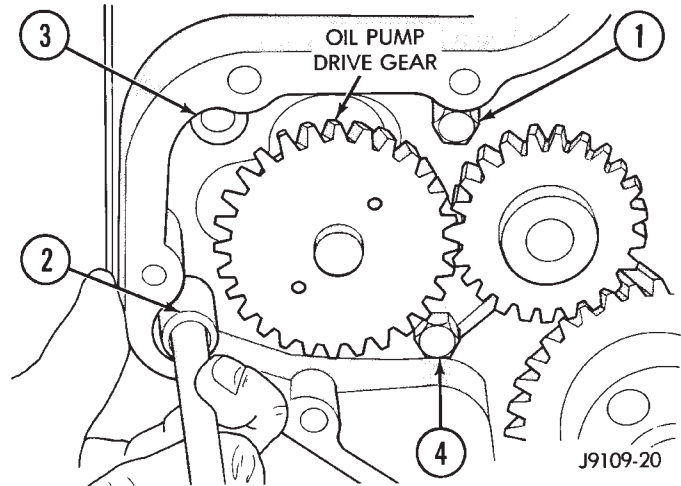


Fig. 100 Oil Pump Removal

(3) The back plate on the pump seats against the bottom of the bore in the cylinder block. When the pump is correctly installed, the flange on the pump will not touch the cylinder block.

(4) Measure the idler gear to pump drive gear backlash and the idler gear to crankshaft gear backlash (Fig. 101). The backlash should be 0.080- 0.330 mm (0.003-0.013 inch). If the backlash is out of limits, replace the oil pump drive gear and the idler gear.

(5) If the adjoining gear moves when you measure the backlash, the reading will be incorrect.

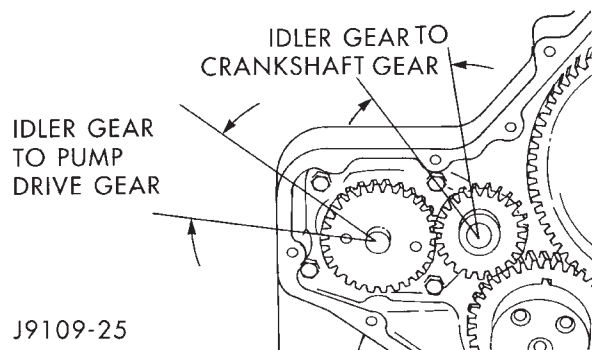


Fig. 101 Idler Gear to Pump Drive Gear and Crankshaft Gear Backlash

OIL FILTER BYPASS VALVE

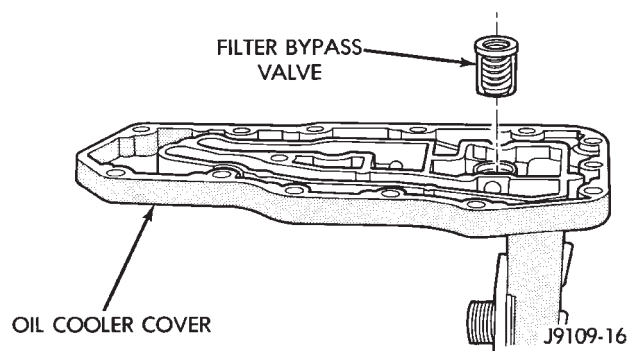
REMOVAL

- (1) Remove the oil cooler cover (Fig. 102).
- (2) Remove the valve from the cooler cover (Fig. 102).

INSTALLATION

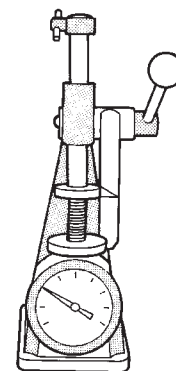
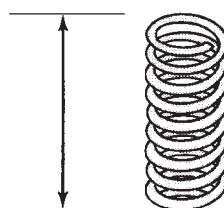
- (1) Drive the new valve in until it bottoms against the step in the bypass valve bore (Fig. 103).
- (2) Install the oil cooler cover.

REMOVAL AND INSTALLATION (Continued)

**Fig. 102 Removing Filter Bypass Valve****VALVE OPEN**

- HEIGHT: 41.25mm (1.62 inch)
- LOAD: 126 N (28.4 lb)

FREE LENGTH: 66mm (2.6 inch)



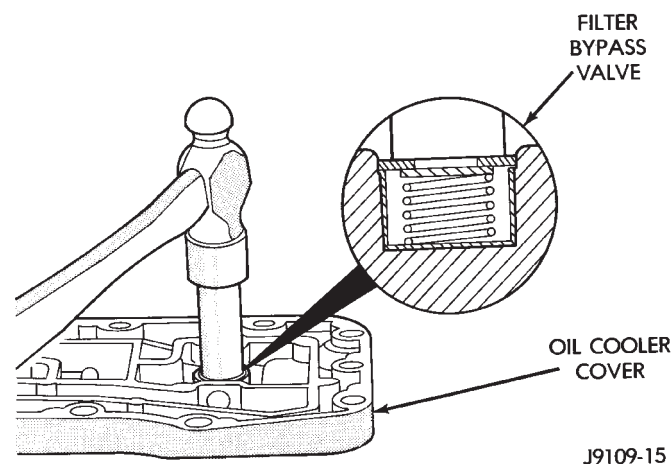
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Fig. 105 Oil Pressure Regulator Spring Check**INSTALLATION**

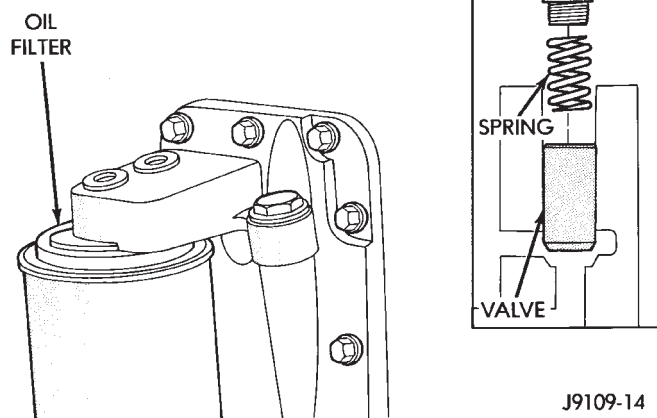
- (1) Clean and inspect the plunger, bore and seat before assembly. The plunger must move freely in the valve bore.
- (2) Install the valve, spring, gasket and plug. Tighten the plug to 80 N·m (60 ft. lbs.) torque.

VACUUM PUMP**REMOVAL**

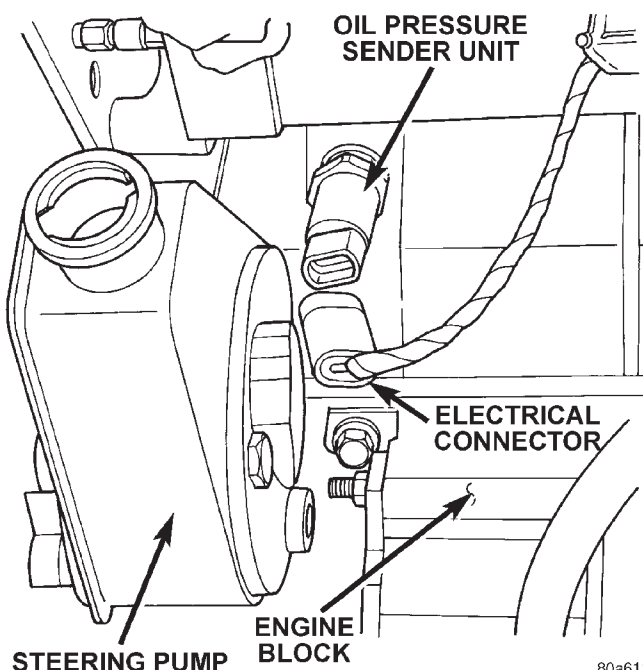
- (1) Disconnect battery negative cable.
- (2) Position drain pan under power steering pump.
- (3) Disconnect vacuum and steering pump hoses.
- (4) Disconnect oil pressure sender wires and remove sending unit (Fig. 106).

**Fig. 103 Installing New Filter Bypass Valve****OIL PRESSURE REGULATOR VALVE AND SPRING****REMOVAL**

- (1) Remove the threaded plug, gasket, spring and valve (Fig. 104).

**Fig. 104 Oil Pressure Regulator**

- (2) Check the spring for height and load limitations (Fig. 105). Replace the spring if out of limits.

**Fig. 106 Oil Pressure Sender Unit**

REMOVAL AND INSTALLATION (Continued)

(5) Disconnect lubricating oil feed line from fitting at underside of vacuum pump (Fig. 107).

(6) Remove lower bolt that attaches pump assembly to engine block (Fig. 108).

(7) Remove bottom, inboard nut that attaches adapter to steering pump. This nut secures a small bracket to engine block. Nut and bracket must be removed before pump assembly can be removed from block.

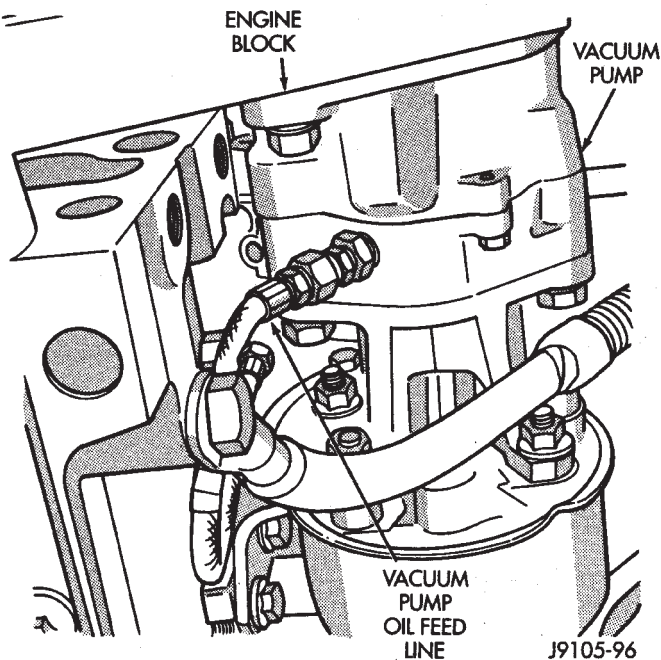


Fig. 107 Vacuum Pump Oil Feed Line

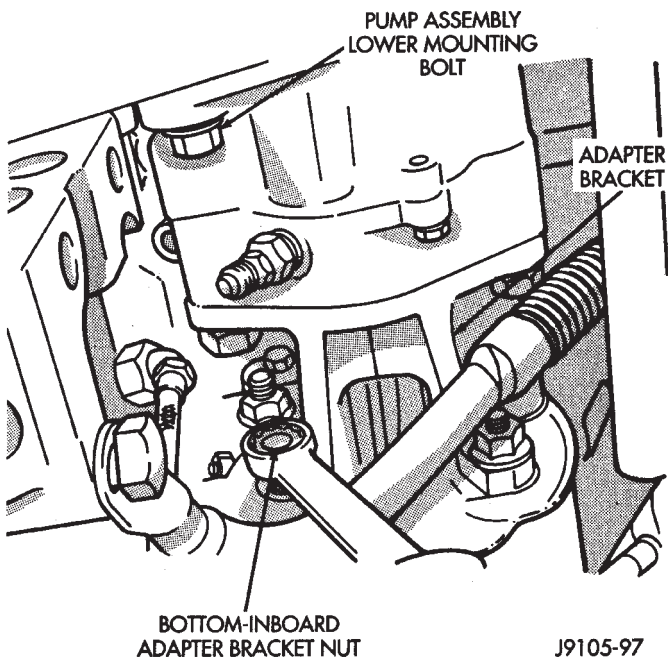


Fig. 108 Vacuum Pump Mounting

(8) Remove upper bolt that attaches pump assembly to engine block (Fig. 109).

(9) Remove pump assembly from vehicle.

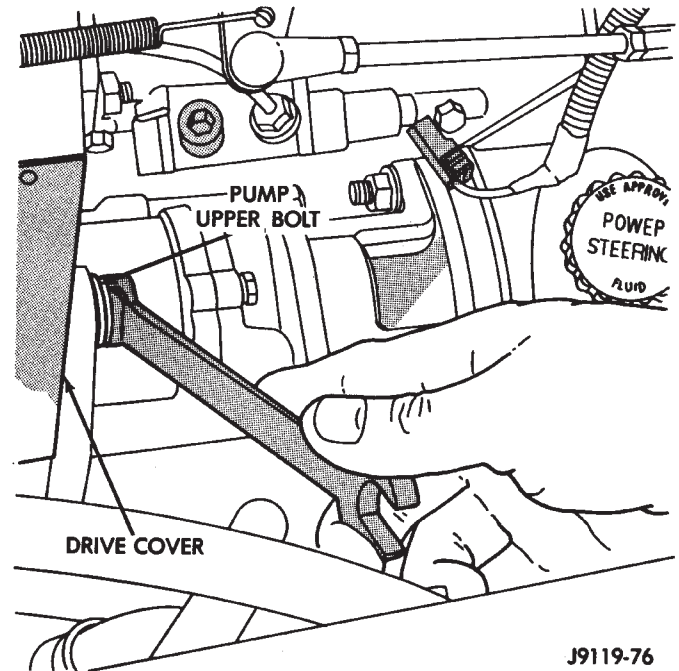


Fig. 109 Pump Assembly Upper Mounting Bolt

(10) Remove nuts attaching vacuum pump to adapter (Fig. 110).

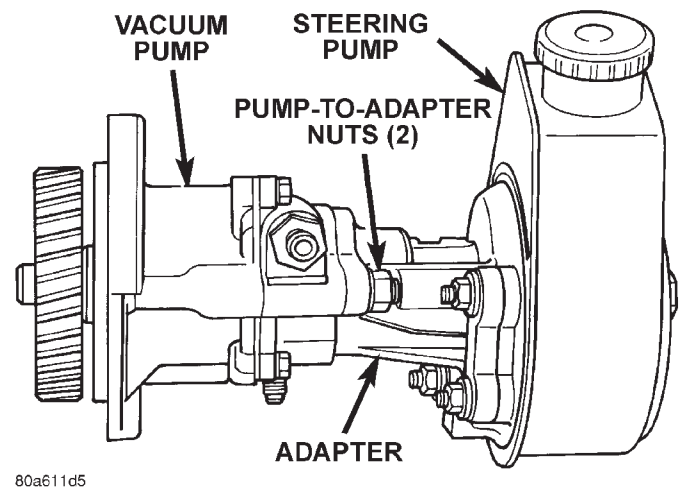


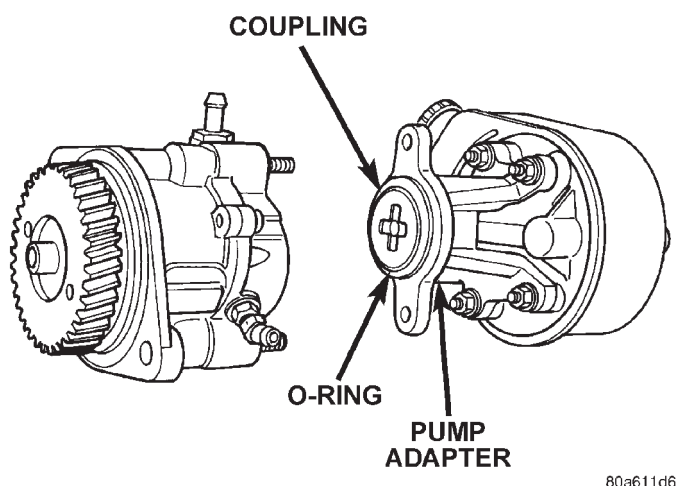
Fig. 110 Pump Assembly

(11) Remove vacuum pump from adapter (Fig. 111). Turn pump gear back and forth to disengage pump shaft from coupling.

(12) Remove coupling from adapter (Fig. 112).

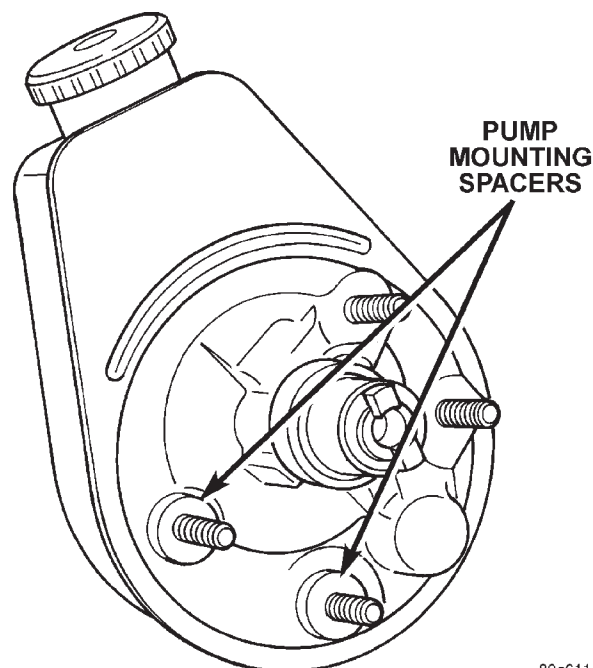
(13) Remove remaining adapter attaching nuts and remove adapter from steering pump (Fig. 113). If steering pump will be serviced, remove spacer from each inboard mounting stud on pump.

REMOVAL AND INSTALLATION (Continued)



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Fig. 111 Vacuum Pump Adapter



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Fig. 113 Steering Pump Mounting Stud Spacers

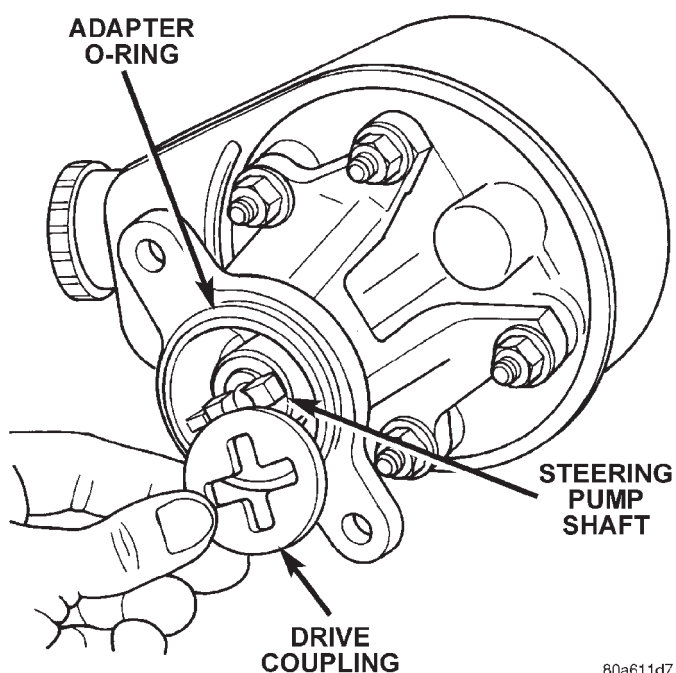
Verify that pump is seated before installing attaching nuts.

(8) Install and tighten vacuum pump attaching nuts.

(9) Inspect adapter O-ring and replace O-ring if cut or torn.

(10) Lubricate adapter O-ring with engine oil.

(11) Note position of drive slots in coupling (Fig. 114). Then rotate drive gear to align tangs on vacuum pump shaft with coupling.



80a611d7

Fig. 112 Pump Drive Coupling

INSTALLATION

(1) Clean and lubricate pump shaft with engine oil.

(2) Install spacers on steering pump studs.

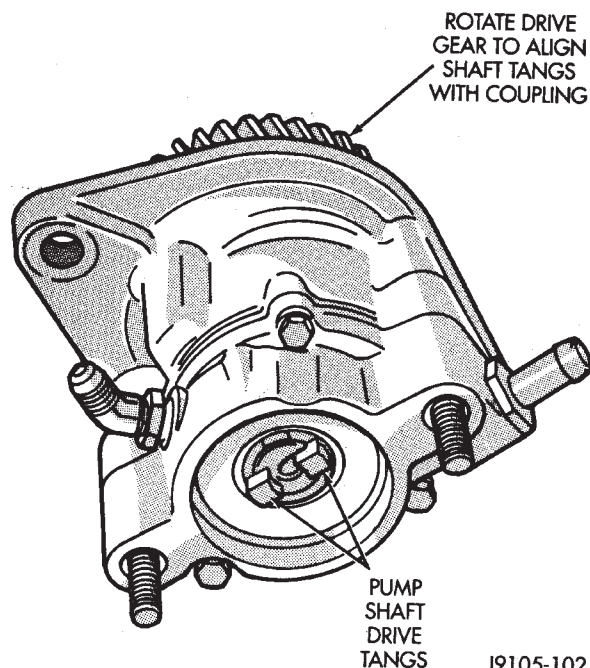
(3) Install O-ring on adapter.

(4) Position adapter on pump studs.

(5) Install attaching nuts on outboard stud and on the two upper pump studs. Do **not** install nut on lower, inboard stud at this time. Tighten nuts to 24 N·m (18 ft. lbs.).

(6) Install coupling on pump shaft. Be sure coupling is securely engaged in shaft drive tangs.

(7) Install vacuum pump on adapter. Rotate drive gear until tangs on pump shaft engage in coupling.



J9105-102

Fig. 114 Pump Shaft Drive Tangs

REMOVAL AND INSTALLATION (Continued)

(12) Verify that pump is seated in adapter and coupling.

(13) Install and tighten pump attaching nuts and washers.

(14) Position new gasket on vacuum pump mounting flange (Fig. 115). Use Mopar Perfect Seal, or silicone adhesive/sealer to hold gasket in place.

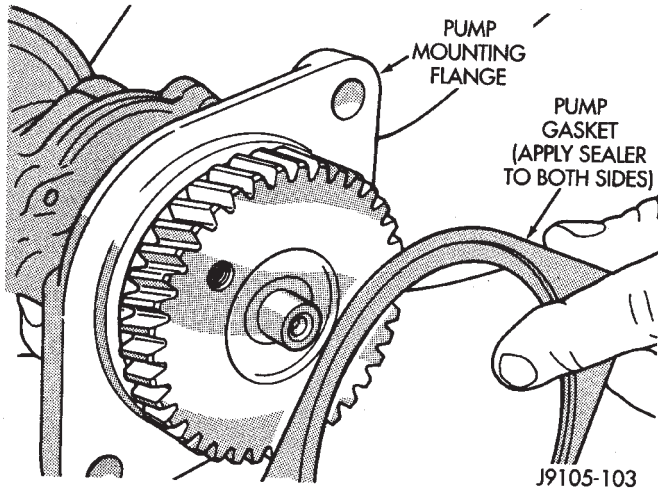


Fig. 115 Pump Mounting Flange Gasket

(15) Insert pump assembly upper attaching bolt in mounting flange and gasket. Use sealer or grease to hold bolt in place if necessary.

(16) Position pump assembly on engine and install upper bolt (Fig. 116). Tighten upper bolt only enough to hold assembly in place at this time.

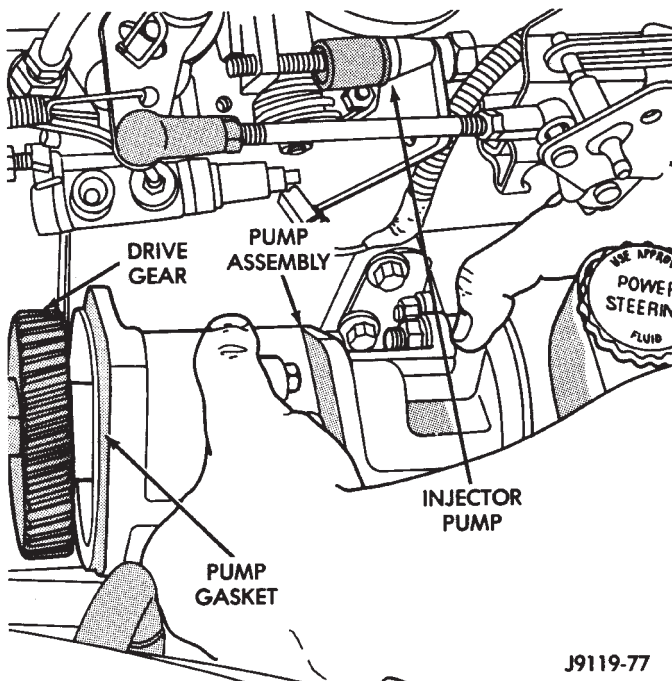


Fig. 116 Installing Pump Assembly On Engine

(17) Working from under vehicle, install pump assembly lower attaching bolt. Then tighten upper and lower bolt to 77 N·m (57 ft. lbs.).

(18) Position bracket on steering pump inboard stud. Then install remaining adapter attaching nut on stud. Tighten nut to 24 N·m (18 ft. lbs.).

(19) Connect oil feed line to vacuum pump connector and tighten line fitting.

(20) Install oil pressure sender and connect sender wires.

(21) Connect steering pump pressure and return lines to pump. Tighten pressure line fitting to 30 N·m (22 ft. lbs.).

(22) Connect vacuum hose to vacuum pump.

(23) Connect battery cables, if removed.

(24) Fill power steering pump reservoir.

(25) Purge air from steering pump lines. Start engine and slowly turn steering wheel left and right to circulate fluid and purge air from system.

(26) Stop engine and top off power steering reservoir fluid level.

(27) Start engine and verify that steering action is correct. Do this before moving vehicle.

DISASSEMBLY AND ASSEMBLY

ROCKER LEVERS

DISASSEMBLE

(1) Remove the retaining rings and thrust washers (Fig. 117).

(2) Remove the rocker levers (Fig. 117). DO NOT disassemble the rocker lever shaft and pedestal. The pedestal and shaft must be replaced as an assembly.

(3) Remove the locknut and adjusting screw (Fig. 117).

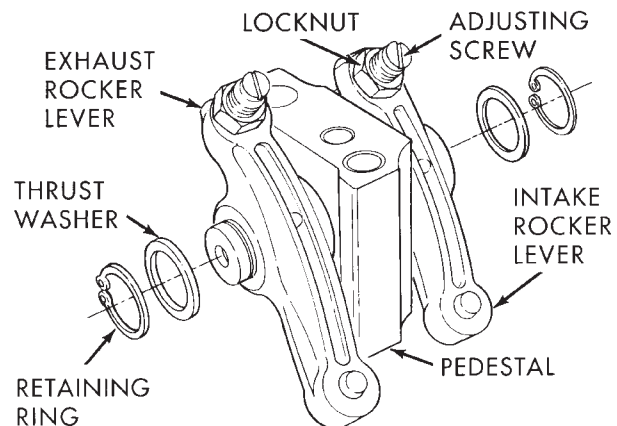


Fig. 117 Rocker Lever Components

(4) Clean all parts in a strong solution of laundry detergent in hot water.

DISASSEMBLY AND ASSEMBLY (Continued)

(5) Use compressed air to dry the parts after rinsing in clean hot water. The pedestals are made from powdered metal and may continue to show wetness after they have been cleaned and dried.

(6) Inspect for excessive wear in the bore and the contact surface for the valve stem.

(7) Measure the rocker lever bore diameter. The maximum diameter is 19.05 mm (0.75 inch). Replace if out of limits.

(8) Inspect the pedestal and shaft.

(9) Measure the shaft diameter. The minimum diameter is 18.94 mm (0.746 inch). Replace if out of limits.

ASSEMBLE

(1) Install the adjusting screw and locknut.

(2) Lubricate the shaft with clean engine oil. Be sure to assemble the intake and exhaust rocker levers in the correct location.

(3) Position the levers on the rocker shaft. Install the thrust washers.

(4) Clean the push rods in the hot soapy water.

(5) Inspect the push rod ball and socket for signs of scoring or cracks where the ball and the socket are pressed into the tube.

(6) Check the push rods for roundness and straightness.

(7) Install the push rods into the sockets of the valve tappets. Lubricate the push rod sockets with clean engine oil.

(8) Make sure the rocker lever adjusting screws are completely backed out.

PISTON AND CONNECTING ROD ASSEMBLY

DISASSEMBLE

(1) Remove the retainer rings from the piston (Fig. 118).

(2) Remove the piston pin. Heating the piston is not required.

(3) Remove the piston rings (Fig. 118).

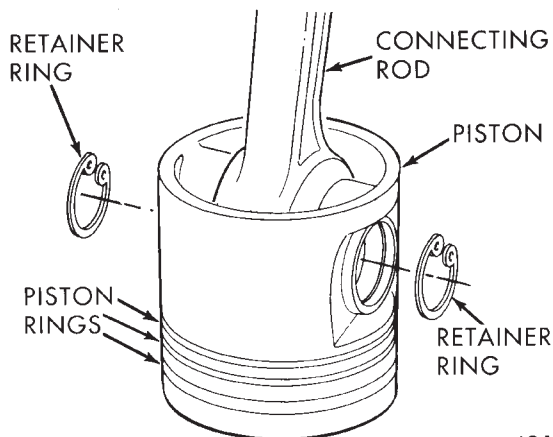
ASSEMBLE

(1) Be sure the FRONT marking on the piston and the numbers on the rod and cap are oriented (Fig. 119). Install the retaining ring into the pin groove on the FRONT side of the piston.

(2) Lubricate the pin and bore with engine oil.

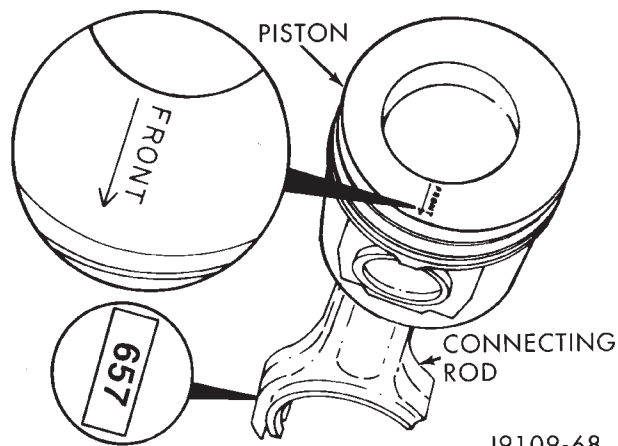
(3) Install the piston pin in the opposite side of the installed retaining pin. Pistons do not require heating to install the pin, however, the piston does need to be at room temperature or above.

(4) Determine the piston diameter and obtain the appropriate ring set. The piston rings can be identified as shown in (Fig. 120).



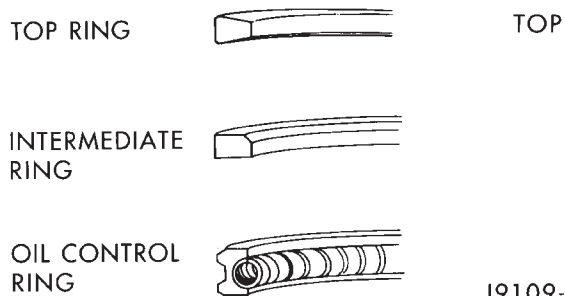
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Fig. 118 Retainer Rings



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Fig. 119 Proper Markings on the Piston and Connecting Rod



J9109-69

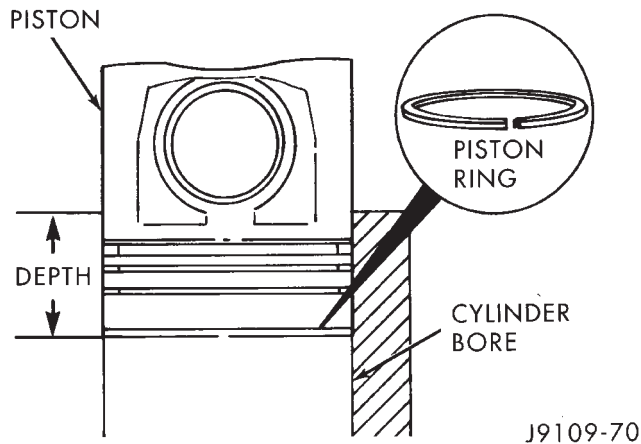
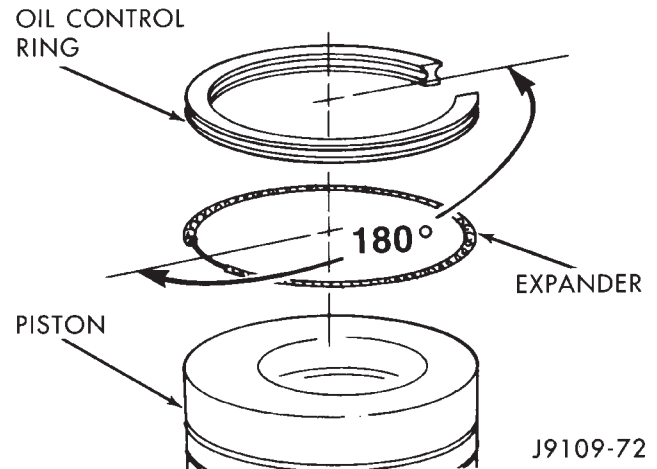
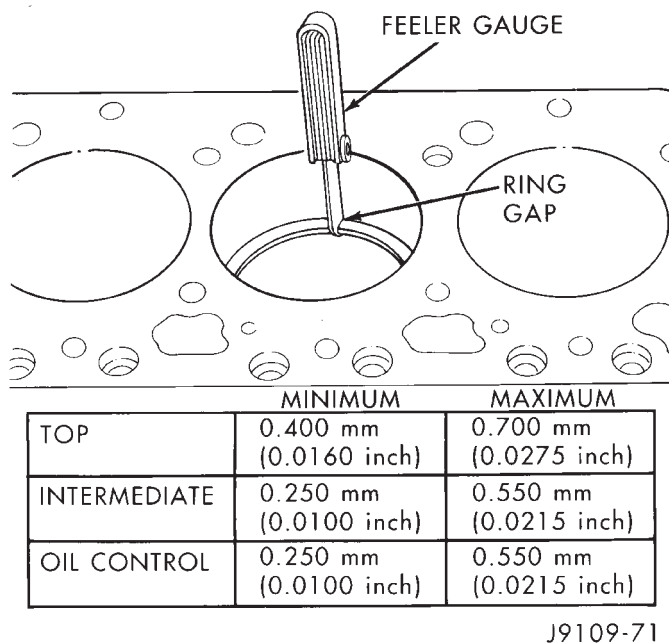
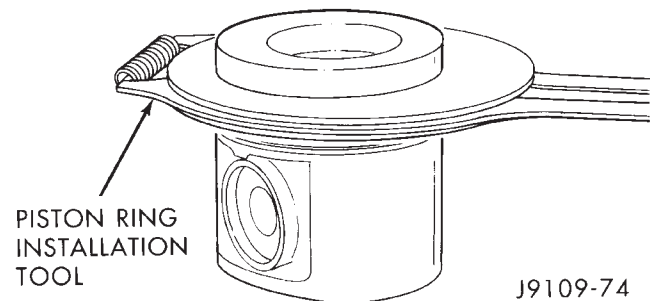
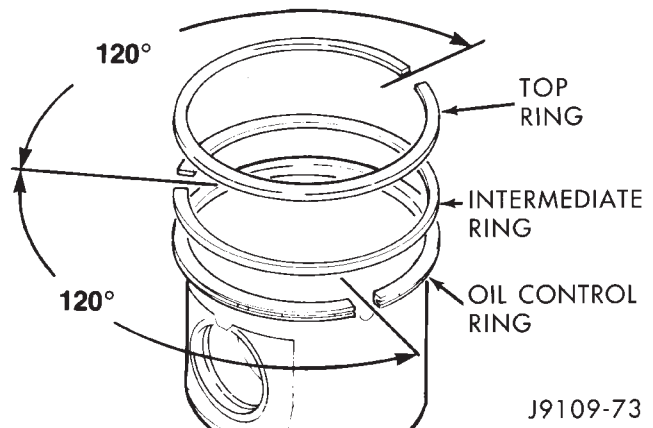
Fig. 120 Piston Ring Identification

(5) Position each ring in the cylinder and use a piston to square it with the bore at a depth of 89.0 mm (3.5 inch) - (Fig. 121).

(6) Use a feeler gauge to measure the piston ring gap (Fig. 122).

(7) The top surface of all of the rings are identified with the word TOP or the supplier's MARK. Assemble the rings with the word TOP or the supplier's MARK up.

DISASSEMBLY AND ASSEMBLY (Continued)

**Fig. 121 Position of Ring in Cylinder Bore****Fig. 123 Oil Control Ring/Expander Location in Groove****Fig. 122 Piston Ring Gap****Fig. 124 Piston Ring Installation Tool****Fig. 125 Piston Ring Positioning**

(8) Position the oil ring expander in the oil control ring groove (bottom groove).

(9) Install the oil control ring with the end gap OPPOSITE the ends on the expander (Fig. 123).

(10) Install the intermediate piston ring in the second groove (Fig. 121).

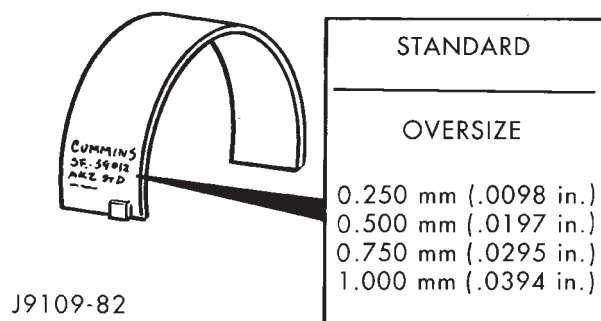
(11) Install the top piston ring in the top groove (Fig. 124).

(12) Position the rings as shown in (Fig. 125).

(13) Install the original bearings as removed or install new bearings. If new bearings are used, be sure to obtain the proper bearing clearance (Fig. 126).

(14) DO NOT lubricate the side of the bearing that is against the connecting rod or cap. Apply a coat of Lubriplate 105, or equivalent to the new upper and lower connecting rod bearings.

CLEANING AND INSPECTION (Continued)

**Fig. 126 Connecting Rod Bearing Size Location**

CLEANING AND INSPECTION

OIL COOLER ELEMENT AND GASKET

CLEANING AND INSPECTION

Clean the sealing surfaces.

Apply 483 kPa (70 psi) air pressure to the element to check for leaks. If the element leaks, replace the element.

CYLINDER HEAD

INSPECTION

Remove the cup plugs and inspect the coolant passages. A large build up of rust and lime will require removal of the cylinder block for cleaning in a hot tank.

Inspect the cylinder bores for damage or excessive wear. Rotate the crankshaft so the piston is at Bottom Dead Center (BDC) to inspect the bores.

Measure the cylinder bores (Fig. 127). DO NOT proceed with in-chassis repair if the bores are damaged or worn beyond the limits (refer to Cylinder Bore Repair - Cylinder Block).

Check the top surface for damage caused by the cylinder head gasket leaking between cylinders.

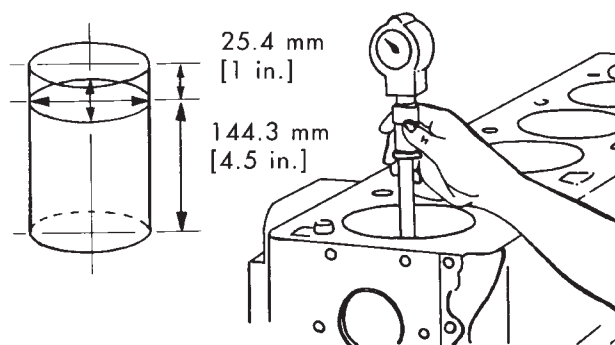
Inspect the block and head surface for nicks, erosion, etc.

Check the head distortion (Fig. 128). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.8 mm (2.00 inch) diameter. Overall variation end to end or side to side 0.30 mm (0.012 inch).

DO NOT proceed with the in-chassis overhaul if the cylinder head or block surface is damaged or not flat (within specifications).

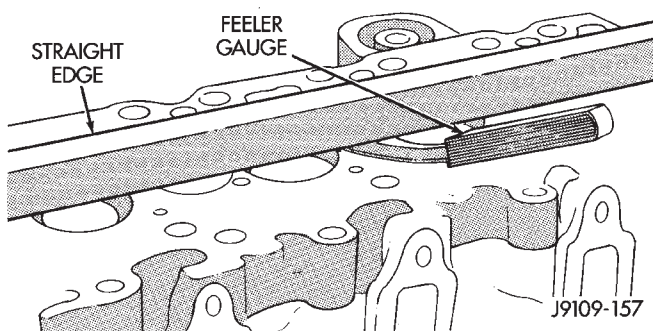
REFACING HEAD SURFACE

The cylinder head combustion deck may be refaced in whatever increments necessary to clean up the surface and maintain the surface finish and flatness tolerances. The combined total of stock removed must not exceed 1.00 mm (0.03937 inch). The amount of stock removed each time must be steel stamped



MIN.	102.0 mm	(4.0157 inch)
MAX.	102.116 mm	(4.0203 inch)
Out-of-Round	0.038 mm	(0.0015 inch)
Taper	0.76 mm	(0.003 inch)
Oversize pistons and rings are available for bored cylinder blocks.		

J9109-75

Fig. 127 Cylinder Bore Diameter**Fig. 128 Cylinder Head Combustion Deck Face Measurement**

above combustion deck edge, on the lower right hand corner of the rear face (Fig. 129). Check valve protrusion after head surface refacing.

Surface finish requirements are 1.5-3.2 micrometers (60-126 microinch).

CLEANING

Clean the carbon from the injector nozzle seat with a nylon or brass brush.

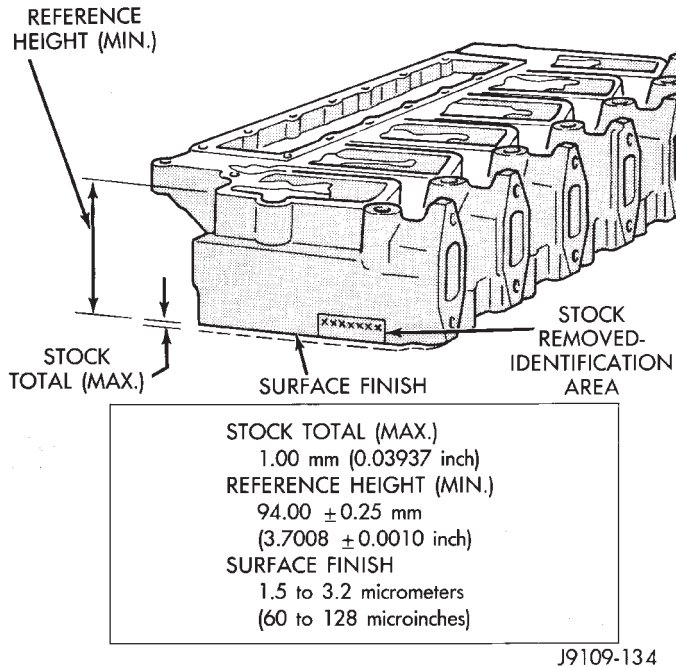
Scrape the gasket residue from all gasket surfaces.

Wash the cylinder head in hot soapy water solution (88°C or 140°F).

After rinsing, use compressed air to dry the cylinder head.

Polish the gasket surface with 400 grid paper. Use an orbital sander or sanding block to maintain a flat surface.

CLEANING AND INSPECTION (Continued)



J9109-134

Fig. 129 Cylinder Head Stock Removal

VALVES AND VALVE SPRINGS

VALVES

CLEANING AND INSPECTION

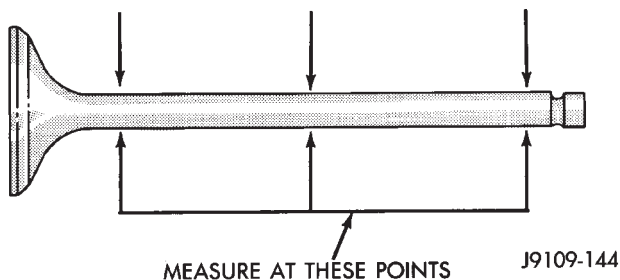
Before cleaning, note the valve number. Clean the valve heads with a soft wire wheel. Mark the valve with the number noted above.

Polish the valve stems with crocus cloth.

Inspect for abnormal wear on the valve heads and stems. Replace badly worn valves.

Check for bent valves. Replace bent valves.

Measure the valve stem diameter (Fig. 130). The valve stem diameter should be 7.935-7.960 mm (0.3126-0.3134 inch). If out of limits, replace the valve. Mark the new valves with the replacement location.



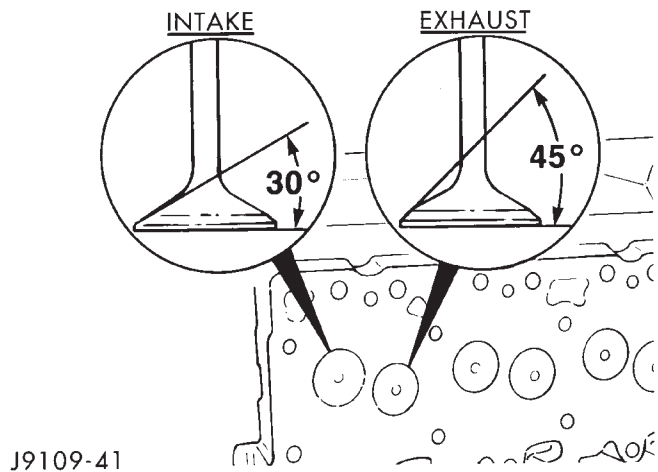
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Fig. 130 Measure Valve Stem Diameter

Inspect the end of the valve stem for flatness. If required, resurface the valve end.

VALVE GRINDING

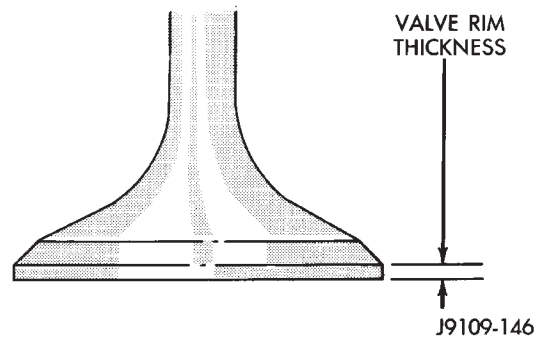
The valve seat angle should be 30° (Intake Valve) and 45° (Exhaust Valve) - (Fig. 131).



J9109-41

Fig. 131 Valve Seat Angle

Measure the rim thickness (Fig. 132). The minimum valve rim thickness is 0.79 mm (0.031 inch).



J9109-146

Fig. 132 Valve Rim Thickness

Grind the face of valves to be reused.

Check the valve stem tip for flatness. If required, re-surface the tip.

VALVE GUIDES

INSPECTION

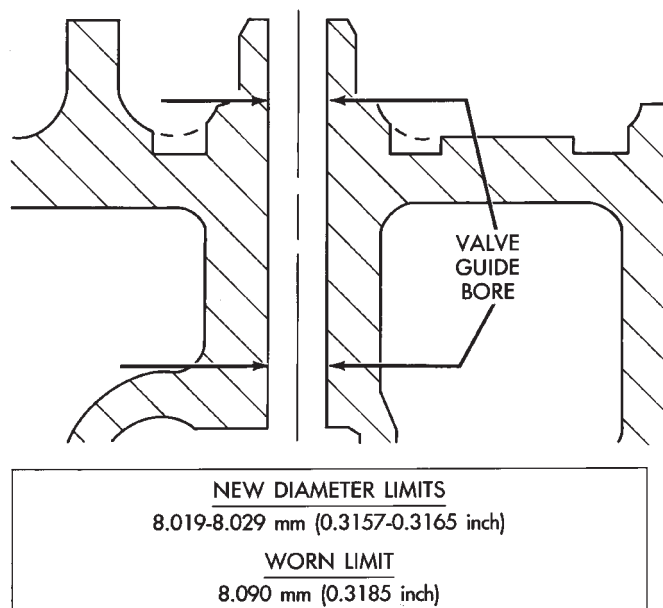
Inspect the valve guides for scuffing or scoring.

Measure the valve guide bore (Fig. 133). The bore diameter should be 8.019-8.089 mm (0.3157-0.3185 inch).

If the valve guide bores are larger than the worn limit, the cylinder head must be machined for service valve guides. New valve guides must be reamed to size after they are installed.

If the cylinder head needs service valve guides and valve seat inserts, the valve guides should be installed first.

CLEANING AND INSPECTION (Continued)



J9109-135

Fig. 133 Valve Guide Bore

VALVE SPRINGS

INSPECTION

Measure the valve spring length. The approximate free length is 60 mm (2.36 inch) with the maximum inclination of 1.0 mm (0.039 inch).

Measure the valve spring force. 359 N (81 lbs.) is the minimum acceptable load required to compress the spring to a height of 49.25 mm (1.94 inch).

If the valve spring does not meet the limits above, replace the spring.

VALVE SEATS

INSPECTION

Cylinder head with integral valve seats can be ground only once. Previously ground integral seats must be replaced with service seats.

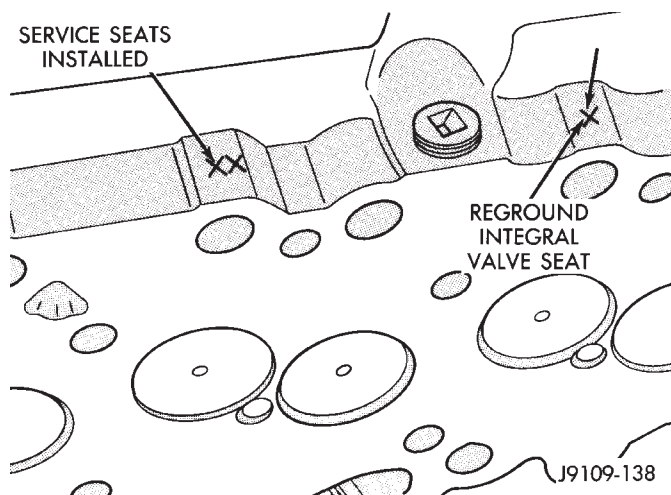
One X stamped into the head casting identify seats that have been ground previously (Fig. 134).

Two X's stamped on the head indicate service seats have been installed (Fig. 134). Service seats can be ground.

On the integral seat head, if 0.254 mm (0.010 inch) or more has been removed from the head combustion surface, service seats must be installed.

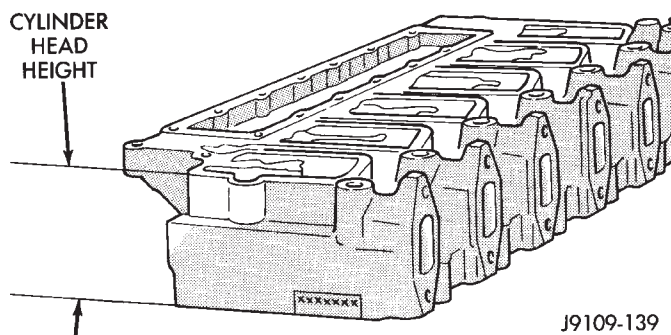
To determine if the head has been previously resurfaced, before calculating valve depth, process as follows:

(1) Check the rear lower right corner of the head for a stamping that would indicate previous resurfacing (.003).

**Fig. 134 Reworked Cylinder Head Seats—Stamped Identification**

(2) To verify the information, or if no amount is indicated, measure the head height (Fig. 135).

(3) If the head height is 94.75 mm (3.730 inch) or greater, the valve seats may be ground, if they have not been ground previously.

**Fig. 135 Cylinder Head Height**

TAPPET

INSPECTION

Inspect the tappet socket, stem and face for excessive wear, cracks and other damage (Fig. 136).

The minimum tappet stem diameter is 15.925 mm (0.627 inch) - (Fig. 136). If the tappet is out of limits, replace the tappet.

CAMSHAFT

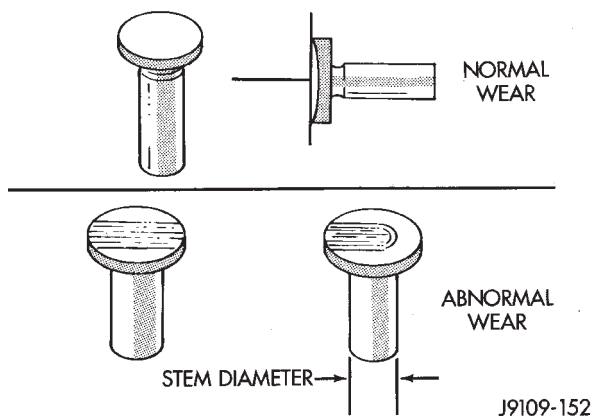
INSPECTION

Inspect the lift pump lobe, valve lobes and bearing journals for wear, cracking, pitting and other damage.

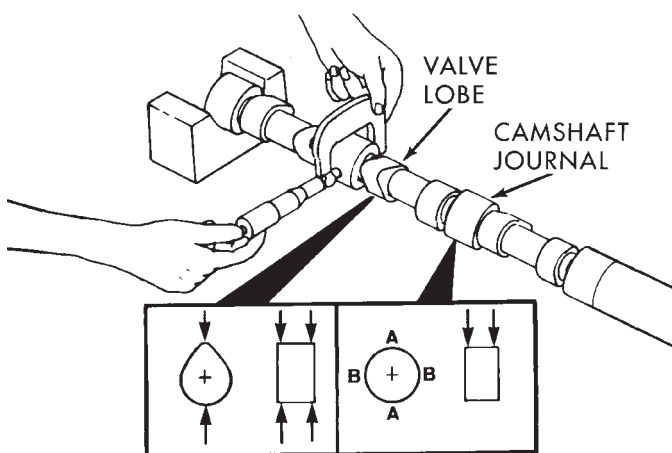
Clean the camshaft and gear with solvent and a lint free cloth.

Inspect the gear teeth for wear and damage. Look for cracks at the root of the teeth.

CLEANING AND INSPECTION (Continued)

**Fig. 136 Tappet Inspection**

Measure the bearing journals, lift pump lobe and valve lobes (Fig. 137).



CAMSHAFT JOURNAL DIAMETER (MIN.)
53.962 mm (2.1245 inch)

VALVE LOBE HEIGHT (MIN.)
INTAKE - 47.040 mm (1.852 inch)
EXHAUST - 46.770 mm (1.841 inch)

LIFT PUMP LOBE DIAMETER (MIN.)
35.500 mm (1.398 inch)

J9109-53

Fig. 137 Bearing Journal/Valve Lobe Measurements

OIL PUMP

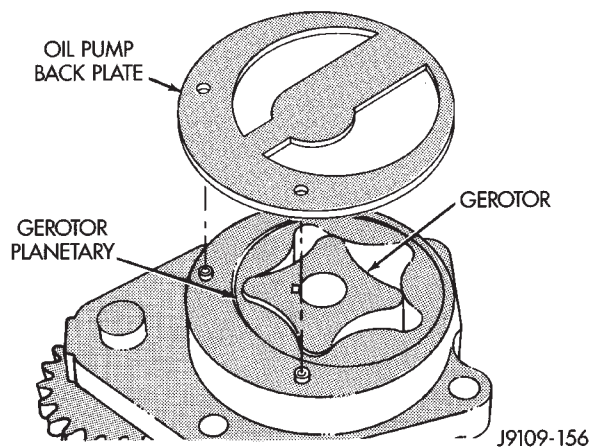
CLEAN AND INSPECT

Visually inspect the lube pump gears for chips, cracks or excessive wear.

Remove the back plate (Fig. 138).

Mark TOP on the gerotor planetary using a felt tip pen (Fig. 138).

Remove the gerotor planetary (Fig. 138).

**Fig. 138 Gerotor Planetary and Gerotor**

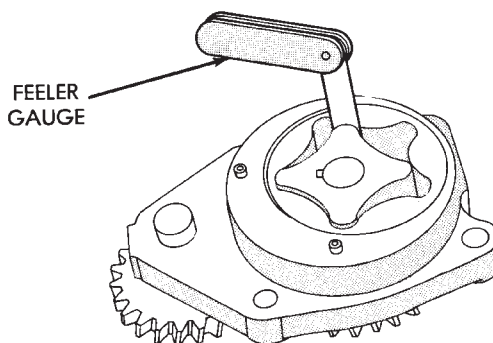
Inspect for excessive wear or damage.

Clean all parts in solvent and dry with compressed air.

Inspect the pump housing and gerotor drive for damaged and excessive wear.

Install the gerotor planetary in the original position. The chamfer must be on the O.D. and down.

Measure the tip clearance (Fig. 139). Maximum clearance is 0.1778 mm (0.007 inch). If the oil pump is out of limits, replace the pump.



J9109-21

Fig. 139 Tip Clearance

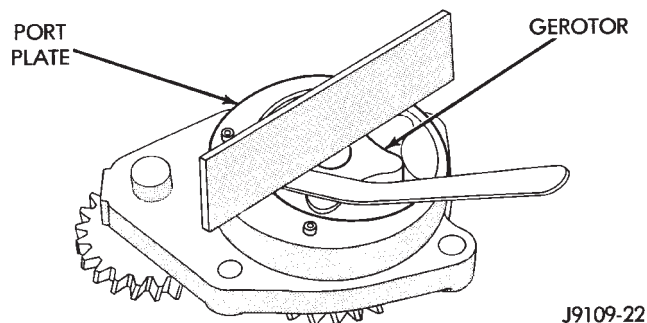
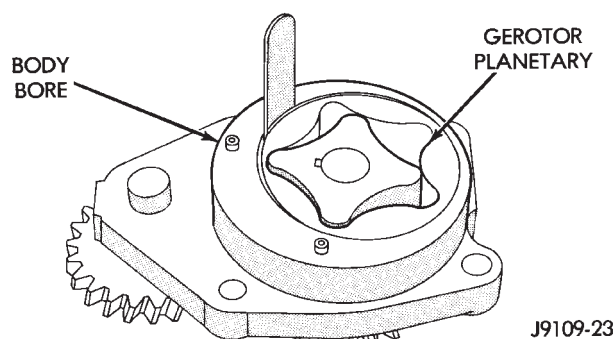
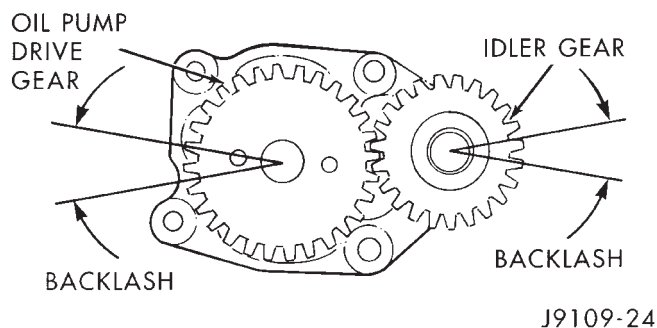
Measure the clearance of the gerotor drive/gerotor planetary to port plate (Fig. 140). Maximum clearance is 0.127 mm (0.005 inch). If the oil pump is out of limits, replace the pump.

Measure the clearance of the gerotor planetary to the body bore (Fig. 141). Maximum clearance is 0.381 mm (0.015 inch). If the oil pump is out of limits, replace the pump.

Measure the gears backlash (Fig. 142). The limits of a used pump is 0.080- 0.380 mm (0.003-0.015 inch). If the backlash is out of limits, replace the oil pump.

Install the back plate.

CLEANING AND INSPECTION (Continued)

**Fig. 140 Gerotor to Port Plate Clearance****Fig. 141 Gerotor Planetary to Body Bore Clearance****Fig. 142 Measure Gear Backlash****CYLINDER BLOCK**

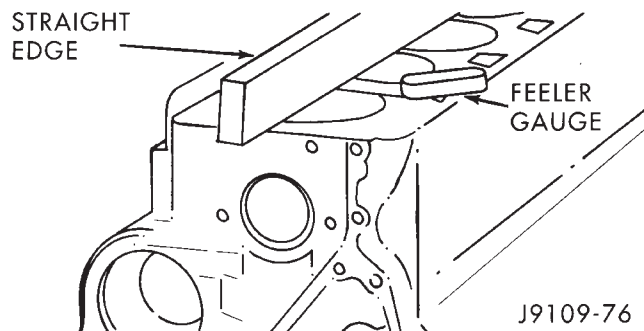
- (1) Remove the engine assembly from the vehicle.
- (2) Remove the cylinder head from the block.
- (3) Remove the camshaft.
- (4) Remove the piston/connecting rod assemblies.

INSPECTION

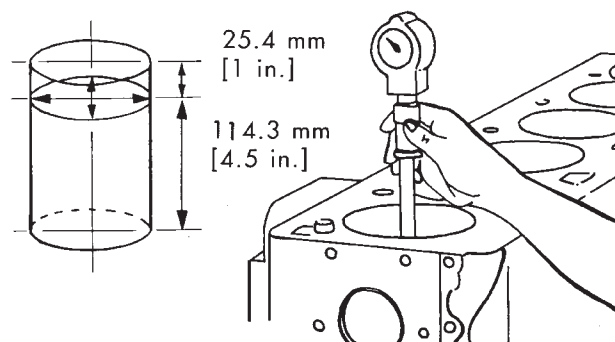
Measure the combustion deck face using a straight edge and a feeler gauge (Fig. 143). The distortion of the combustion deck face is not to exceed 0.010 mm (0.0004 inch) in any 50.00 mm (2.0 inch) diameter. Overall variation end to end or side to side is 0.075 mm (0.003 inch).

If the surface exceeds the limit, refer to Cylinder Block Refacing.

Inspect the cylinder bores for damage or excessive wear.

**Fig. 143 Combustion Deck Face Measurement**

Measure the cylinder bores (Fig. 144). If the cylinder bores exceeds the limit, refer to Cylinder Bore Repair.



MIN.	102.0 mm	(4.0157 inch)
MAX.	102.116 mm	(4.0203 inch)
Out-of-Round	0.038 mm	(0.0015 inch)
Taper	0.076 mm	(0.003 inch)
Oversize pistons and rings are available for bored cylinder blocks.		

J9209-167

Fig. 144 Cylinder Bore Diameter

Inspect the camshaft bores for scoring or excessive wear.

Measure the camshaft bores. Refer to engine specifications at the rear of this section. Limit for the No.1 bore applies to the ID of the bushing.

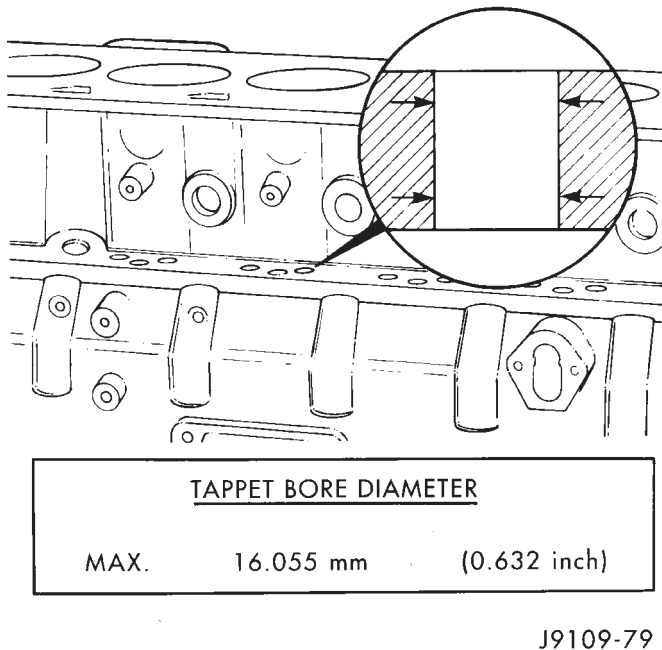
If a bore exceeds the limit, refer to Camshaft Bore Repair.

Inspect the tappet bores for scoring or excessive wear (Fig. 145). If out of limits, replace the cylinder block.

PISTON AND CONNECTING ROD ASSEMBLY**CLEANING**

CAUTION: DO NOT use bead blast to clean the pistons. DO NOT clean the pistons and rods in an acid tank.

CLEANING AND INSPECTION (Continued)

**Fig. 145 Tappet Bore Diameter**

Soak the pistons in cold parts cleaner. Soaking the pistons overnight will usually loosen the carbon deposits.

Wash the pistons and rods in a strong solution of laundry detergent and hot water.

Clean the remaining deposits from the ring grooves with the square end of a broken ring. DO NOT use a ring groove cleaner and be sure not to scratch the ring sealing surface in the piston groove.

Wash the pistons again in a detergent solution or solvent.

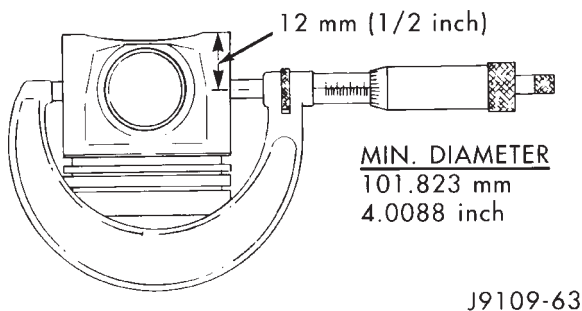
Rinse the pistons. Use compressed air to dry.

INSPECTION

Inspect the rod journals for deep scratches, indication of overheating and other damage.

Inspect the pistons for damage and excessive wear. Check top of the piston, ring grooves, skirt and pin bore.

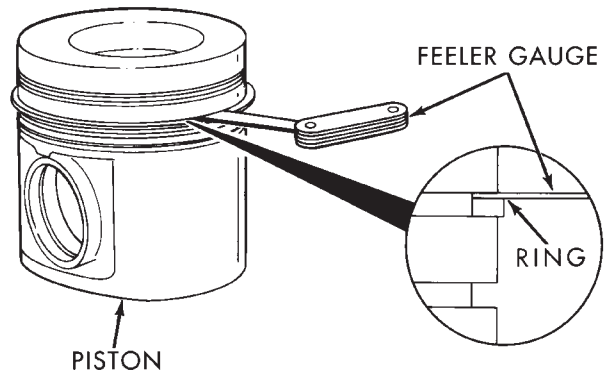
Measure the piston skirt diameter (Fig. 146). If the piston is out of limits, replace the piston.

**Fig. 146 Piston Skirt Diameter**

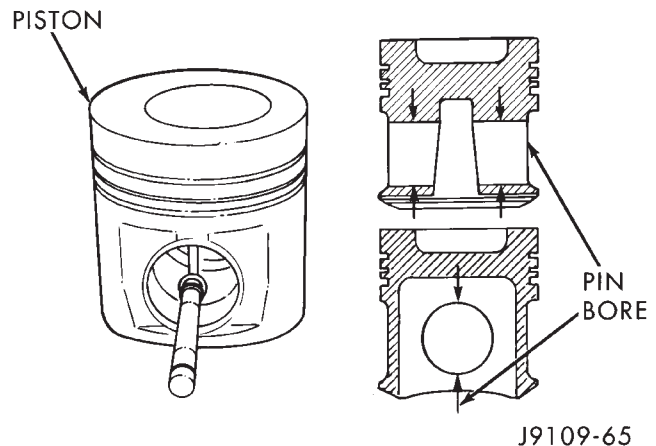
The upper groove only needs to be inspected for damage.

Use a new piston ring to measure the clearance in the intermediate ring groove (Fig. 147). If the clearance of the intermediate ring exceeds 0.152 mm (0.006 inch), replace the piston.

Use a new oil ring to measure the clearance in the oil groove (Fig. 147). If the clearance exceeds 0.127 mm (0.005 inch), replace the piston.

**Fig. 147 Intermediate and Oil Ring Clearances**

Measure the pin bore (Fig. 148). The maximum diameter is 40.025 mm (1.5758 inch). If the bore is over limits, replace the piston.

**Fig. 148 Piston Pin Bore**

Inspect the piston pin for nicks, gouges and excessive wear.

Measure the pin diameter (Fig. 149). The minimum diameter is 39.990 mm (1.5744 inch). If the diameter is out of limits, replace the pin.

Inspect the rod for damage and wear. The I-Beam section of the connecting rod cannot have dents or other damage. Damage to this part can cause stress risers which will progress to breakage.

Measure the connecting rod pin bore (Fig. 150). The maximum diameter is 40.042 mm (1.5764 inch). If out of limits, replace the connecting rod.

CLEANING AND INSPECTION (Continued)

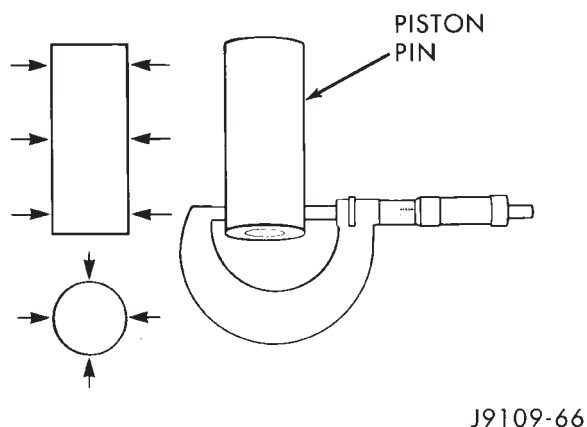


Fig. 149 Piston Pin Diameter

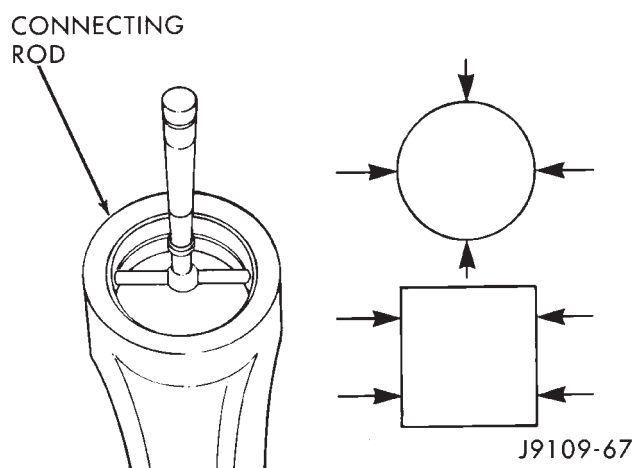


Fig. 150 Connecting Rod Pin Bore

CRANKSHAFT

CLEANING AND INSPECTION

Clean the crankshaft oil galley holes with a nylon brush.

Rinse in clean solvent and dry with compressed air.

Inspect the front and rear seal contact areas of the crankshaft for scratches or grooving.

The service seal kit will position the seal slightly deeper into the seal bore so it will contact the crankshaft at a different location. If this has already been done and the crankshaft has two worn areas, install a wear sleeve to provide a new contact surface for the seal.

Inspect the rod and main journal for deep scores, signs of overheating and other abnormal marks.

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Use the timing pin to locate Top Dead Center (TDC) for cylinder No.1 (Fig. 151). The timing pin is located at the back of the gear housing and below the

injection pump. **Be sure to disengage the timing pin after locating top dead center. Refer to TIMING PIN for more information.**

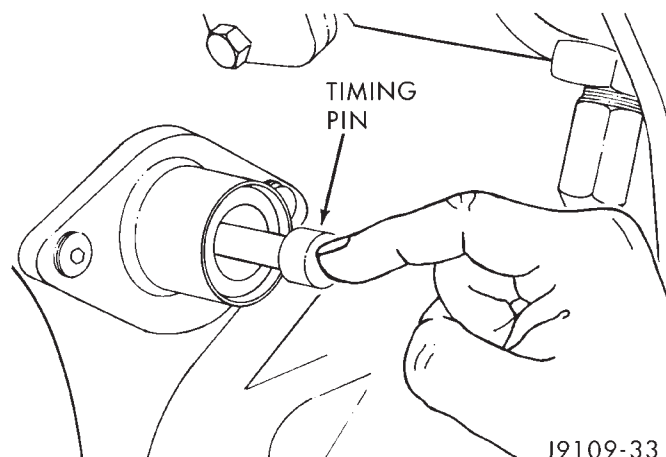


Fig. 151 Locating TDC using Timing Pin

Adjust the valves when the engine is cold, below 60°C (140°F).

STEP 1

Adjust the clearance for the valves shown in (Fig. 152). The valve lash adjustment is 0.254 mm (0.010 inch) for the intake valve. The valve lash adjustment is 0.508 mm (0.020 inch) for the exhaust valve.

Tighten the valve adjusting nuts to 24 N·m (18 ft. lbs.) torque. **Be sure timing pin is disengaged before rotating the crankshaft.** Mark the pulley and rotate the crankshaft 360°.

I = INTAKE E = EXHAUST

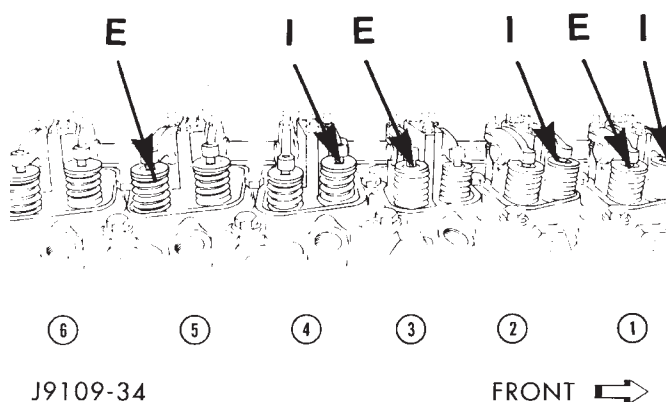


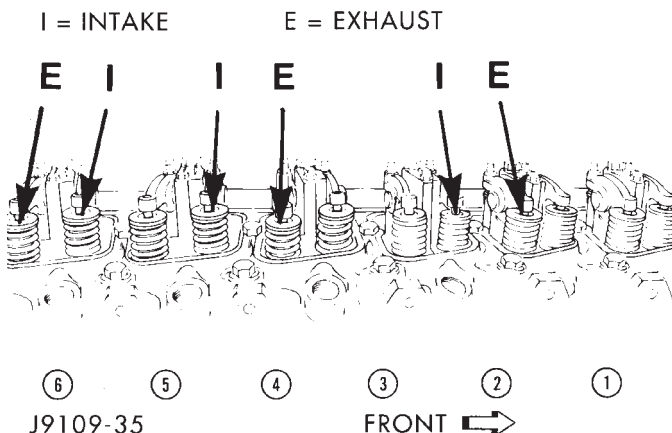
Fig. 152 Adjust Valve Clearance—Step 1

STEP 2

Adjust the clearance for the valves shown in (Fig. 153). The valve lash adjustment is 0.254 mm (0.010 inch) for the intake valve. The valve lash adjustment is 0.508 mm (0.020 inch) for the exhaust valve.

Tighten the bolts to 24 N·m (18 ft. lbs.) torque.

SPECIFICATIONS (Continued)

**Fig. 153 Adjust Valve Clearance—Step 2**

SPECIFICATIONS

5.9L DIESEL ENGINE SPECIFICATIONS

Camshaft

Journal Diameter (Min.)	. . . . .53.962 mm (2.1245 in.)
Intake Lobe	
(Min. dia. @ peak)	. . . . .47.040 mm (1.852 in.)
Exhaust Lobe	
(Min. dia. @ peak)	. . . . .46.770 mm (1.841 in.)
Lift Pump Lobe	
(Min. dia. @ peak)	. . . . .35.500 mm (1.398 in.)
End Clearance	. . . . .0.152 – 0.254 mm (0.006 – 0.010 in.)
Gear Backlash	. . . . .0.080 – 0.330 mm (0.003 – 0.013 in.)

Connecting Rods

Pin Bore Diameter (Max.)	. . . 40.042 mm (1.5764 in.)
Side Clearance	. . . . .0.100 – 0.300 mm (0.004 – 0.012 in.)

Crankshaft

Main Bearing Journal Diameter (Std.)	. . .82.962 mm (3.2662 in.)
Main Journal Out of Round	
(Max.)	. . . . .0.050 mm (0.002 in.)
Main Journal Taper (Max.)	. . .0.013 mm (0.0005 in.)
Main Journal Oil Clearance	
(Max.)	. . . . .0.119 mm (0.0047 in.)
Rod Bearing Journal Diameter	
(Std.)	. . . . .68.962 mm (2.7150 in.)
Rod Journal Out of Round	
(Max.)	. . . . .0.050 mm (0.002 in.)

Camshaft

Rod Journal Taper (Max.)	. . . .0.013 mm (0.0005 in.)
Rod Journal Oil Clearance	
(Max.)	. . . . .0.089 mm (0.0035 in.)
End Play	. . . . .0.100 – 0.430 mm (0.004 – 0.017 in.)
Gear Backlash	. . . . .0.080 – 0.330 mm (0.003 – 0.030 in.)

Cylinder Block

Cylinder Bore Diameter	. . .102.116 mm (4.0203 in.)
Cylinder Bore Out of Round	
(Max.)	. . . . .0.038 mm (0.0015 in.)
Cylinder Bore Taper (Max.)	. . . .0.076 mm (0.003 in.)
Tappet Bore Diameter	. . . . .16.055 mm (0.632 in.)
Deck Surface Flatness	
(Max. Overall)	. . . . .0.075 mm (0.003 in.)
First Reface	. . . . .0.250 mm (0.0098 in.)
Second Reface	. . . . .0.250 mm (0.0098 in.)
Total Reface	. . . . .0.500 mm (0.197 in.)
Surface Finish	. . . . .1.50 – 3.20 micrometers (60–126 microinches)

Main bearing Bore Dia.

(Bearing Installed)	. . . . .83.106 mm (3.2719 in.)
Cam Bore Dia. (Max.)	
#1 w/o bushing	. . . . .59.248 mm (2.3326 in.)
Cam Bore Dia. (Max.)	
#1–7 w/bushing	. . . . .54.139 mm (2.1314 in.)

Cylinder Head

Overall Flatness (Max.)	. . . . .0.030 mm (0.012 in.)
Intake Valve Seat Angle	. . . . .30°
Exhaust Valve Seat Angle	. . . . .45°
Valve Seat Width (Min.)	. . . . .1.52 mm (0.060 in.)
Valve Seat Width (Max.)	. . . . .2.03 mm (0.080 in.)

Tappets

Stem Diameter15.925 mm (0.627 in.)
---------------	--------------------------------

Oil Pump

Tip Clearance (Max.)	. . . . .0.1778 mm (0.007 in.)
Gerotor Drive/Planetary to Port Plate	
Clearance (Max.)	. . . . .0.127 mm (0.005 in.)
Gerotor Planetary to Body	
Clearance (Max.)	. . . . .0.381 mm (0.015 in.)
Gear Backlash (Used Pump)0.080 – 0.380 mm (0.003 – 0.015 in.)

Oil Pressure (Min.)

At Idle Speed*	. . . . .69 kPa (10 psi)
At 2,500 rpm*	. . . . .207 kPa (30 psi)
Regulating Valve Opening	
Pressure	. . . . .448 kPa (65 psi)

SPECIFICATIONS (Continued)

CAUTION: If oil pressure is ZERO at curb idle, DO NOT run engine.

Oil Filter

Diff. Pressure to Open

Filter Bypass172.3 kPa (25 psi)

Pistons

Skirt Diameter101.880 – 101.823 mm
(4.0110 – 4.0088 in.)

Ring Groove Depth (Intermediate)0.150 mm
(0.006 in.)

Ring Groove Depth

(Oil Control)0.130 mm (0.005 in.)

Piston Pins

Diameter (Min.)39.990 mm (1.5744 in.)

Bore Diameter (Max.)40.025 mm (1.5758 in.)

Piston Rings

End Gap (Top)0.400 – 0.700 mm
(0.016 – 0.0275 in.)

End Gap (Intermediate)0.250 – 0.550 mm
(0.010 – 0.0215 in.)

End Gap (Oil Control)0.250 – 0.550 mm
(0.010 – 0.0215 in.)

Valves

Clearance (Intake)0.25 mm (0.010 in.)

Clearance (Exhaust)0.51 mm (0.020 in.)

Guide Diameter8.019 – 8.089 mm
(0.3157 – 0.3185 in.)

Stem Diameter7.935 – 7.960 mm
(0.3126 – 0.3134 in.)

Depth (Installed)0.99 – 1.52 mm
(0.039 – 0.060 in.)

Valve Springs

Free Length60 mm (2.36 in.)

Inclination (Max.)1.00 mm (0.039 in.)

Minimum Load@49.25 mm — 359 N
(@1.94 in. — 81 lbs.)

TORQUE SPECIFICATIONS

5.9L DIESEL ENGINE

Description	Torque
Air Fuel Control	
Fitting.....	8 N·m (72 in. lbs.)
Battery Cable (Negative) to Block	
Bolt.....	77 N·m (57 ft. lbs.)
Belt Tensioner Mounting	
Bolt.....	43 N·m (32 ft. lbs.)
Block Heater Mounting	
Bolt.....	12 N·m (108 in. lbs.)
Cab Heater Hose Clamp	
Screw.....	4 N·m (35 in. lbs.)
Cab Heater Tubing Bracket	
Bolt.....	9 N·m (84 in. lbs.)

Description	Torque
Camshaft Thrust Plate	
Bolts.....	24 N·m (18 ft. lbs.)
Clutch Cover to Flywheel	
Bolts.....	23 N·m (17 ft. lbs.)
Connecting Rod Nuts	
Step 1 – Preliminary.....	35 N·m (26 ft. lbs.)
Step 2 – Secondary.....	70 N·m (51 ft. lbs.)
Step 3 – Final.....	100 N·m (73 ft. lbs.)
Cooling Fan to Fan Clutch	
Bolts.....	20 N·m (15 ft. lbs.)
Crankshaft Main Bearing Bolts	
Step 1 – Preliminary.....	60 N·m (45 ft. lbs.)
Step 2 – Secondary.....	90 N·m (60 ft. lbs.)
Step 3 – Final.....	Additional 90°
Cylinder Head Bolts	
Step 1 – (All Bolts).....	90 N·m (66 ft. lbs.)
Step 2 – (Re-check All Bolts).....	90 N·m (66 ft. lbs.)
Step 3 – (Long Bolts).....	120 N·m (90 ft. lbs.)
Step 4 – (Re-check Long Bolts).....	120 N·m (90 ft. lbs.)
Step 5 – (Rotate All).....	Additional ¼ Turn (90°)
Exhaust Manifold	
Bolts.....	43 N·m (32 ft. lbs.)
Fan Clutch Mounting to Fan Hub	
Left Hand Thread.....	57 N·m (42 ft. lbs.)
Fan Hub Bracket	
Bolts.....	24 N·m (18 ft. lbs.)
Fan Hub Bearing	
Bolt.....	77 N·m (57 ft. lbs.)
Fan Pulley to Fan Hub	
Bolts.....	9 N·m (84 in. lbs.)
Fan Shroud Mounting	
Bolts.....	11 N·m (95 in. lbs.)
Flywheel	
Bolts.....	137 N·m (101 ft. lbs.)
Flywheel Housing Adaptor	
Bolts.....	77 N·m (57 ft. lbs.)
Generator Mounting	
Bolts.....	41 N·m (30 ft. lbs.)
Generator Pulley	
Nut.....	80 N·m (59 ft. lbs.)
Generator Support	
Bolt.....	24 N·m (18 ft. lbs.)
Gear Cover	
Bolts.....	24 N·m (18 ft. lbs.)
Gear Cover Housing	
Bolts.....	24 N·m (18 ft. lbs.)
Intake Manifold Cover	
Bolts.....	24 N·m (18 ft. lbs.)
Intercooler Attaching	
Bolts.....	2 N·m (17 in. lbs.)
Intercooler Duct Clamp	
Nuts.....	8 N·m (72 in. lbs.)

SPECIFICATIONS (Continued)

1998 BR/BR Ram Truck
 Publication No. 81-370-8108
 TSB 26-06-98 June 1998

Description	Torque
Lift Bracket (Rear)	
Bolts	77 N·m (57 ft. lbs.)
Oil Cooler Assembly	
Bolts	24 N·m (18 ft. lbs.)
Oil Fill Tube Bracket	
Bolt	43 N·m (32 ft. lbs.)
Oil Filter	
Gasket	¾ Turn After Gasket Contact
Oil Pan	
Bolts	24 N·m (18 ft. lbs.)
Oil Pan Drain Plug	
Plug	60 N·m (44 ft. lbs.)
Oil Pressure Regulator	
Plug	80 N·m (60 ft. lbs.)
Oil Pressure Sender/Switch	
Sender/Switch	16 (144 ft. lbs.)
Oil Pump Mounting	
Bolts	24 N·m (18 ft. lbs.)
Oil Suction Tube (Flange)	
Bolts	24 N·m (18 ft. lbs.)
Oil Suction Tube (Brace)	
Bolt	24 N·m (18 ft. lbs.)
Oil Supply to Vacuum Pump	
Fitting	10 N·m (89 in. lbs.)
Rear Mount – Support Cushion to Crossmember	
Nut	47 N·m (35 ft. lbs.)
Rear Mount – Support Cushion to Support Bracket	
Nuts	47 N·m (35 ft. lbs.)
Rear Mount – Support Bracket to Transmission	
Bolts	102 N·m (75 ft. lbs.)

Description	Torque
Rear Support Plate to Transfer Case	
Bolts	41 N·m (30 ft. lbs.)
Rocker Arm	
Bolts	24 N·m (18 ft. lbs.)
Starter Mounting	
Bolts	68 N·m (50 ft. lbs.)
Torque Converter Drive Plate	
Bolts	47 N·m (35 ft. lbs.)
Transfer Case to Insulator Mounting Plate	
Nuts	204 N·m (150 ft. lbs.)
Transmission Support Bracket – (2wd)	
Bolts	68 N·m (50 ft. lbs.)
Transmission Support Spacer – (4wd)	
Bolts	68 N·m (50 ft. lbs.)
Transmission Support Spacer to Insulator Mounting Plate – (4wd)	
Bolts	204 N·m (150 ft. lbs.)
Vacuum Pump to Adaptor	
Nuts	24 N·m (18 ft. lbs.)
Vacuum Pump Adaptor to P/S Pump	
Nuts	24 N·m (18 ft. lbs.)
Vacuum Pump Assy. to Gear Cover	
Bolts	77 N·m (57 ft. lbs.)
Vacuum Pump Oil Supply Line	
Fitting	10 N·m (89 in. lbs.)
Vibration Damper	
Bolts	125 N·m (92 ft. lbs.)
Water Pump	
Bolts	24 N·m (18 ft. lbs.)

