

ENGINE

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS

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

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

MOPAR SILICONE RUBBER ADHESIVE SEALANT

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

MOPAR GASKET MAKER

Mopar Gasket Maker, normally red in color, is available in 6 cc tubes. This anaerobic type gasket material cures in the absence of air when squeezed between smooth machined metallic surfaces. It will not cure if left in the uncovered tube. DO NOT use on flexible metal flanges.

SURFACE PREPARATION

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

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

GASKET APPLICATION

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

Mopar Silicone Rubber Adhesive Sealant should be applied in a continuous bead approximately 3 mm (0.12 inch) in diameter. All mounting holes must be circled. For corner sealing, a 3 or 6 mm (1/8 or 1/4

GENERAL INFORMATION (Continued)

inch) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within 10 minutes). The use of a locating dowel is recommended during assembly to prevent smearing the material off location.

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

ENGINE PERFORMANCE

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

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

(2) Check the intake manifold bolts (refer to Group 11, Exhaust System and Intake Manifold for the proper specifications).

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

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

(5) Test resistance of spark plug cables (refer to Group 8D, Ignition System).

(6) 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).

(7) Test fuel pump for pressure (refer to Group 14, Fuel System for the proper specifications).

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

(9) Inspect crankcase ventilation system (refer to Group 0, Lubrication and Maintenance for the proper procedure). For emission controls, refer to Group 25, Emission Controls System for service procedures.

(10) 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 follow-

ing 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 and 5.9L).

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

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 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.**

(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.

(3) Plastigage is available in a variety of clearance ranges. The 0.025-0.076 mm (0.001-0.003 in.) range

GENERAL INFORMATION (Continued)

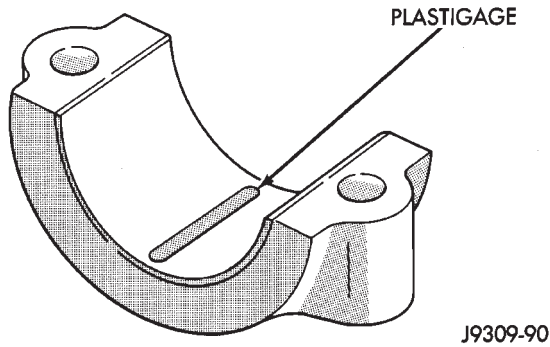


Fig. 1 Placement of Plastigage in Bearing Shell

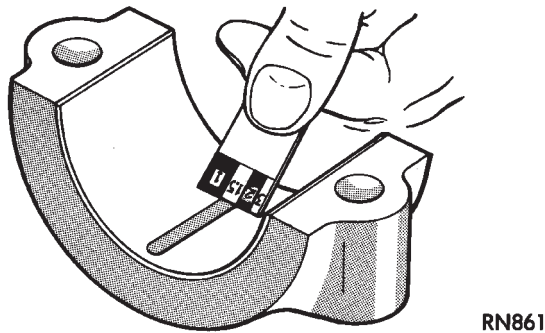


Fig. 2 Clearance Measurement

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

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). Standard engine oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans. MOPAR only provides engine oil that conforms to this certification.



9400-9

Fig. 3 Engine Oil Container Standard Notations

SAE VISCOSITY

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

GENERAL INFORMATION (Continued)

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 (Fig. 4).

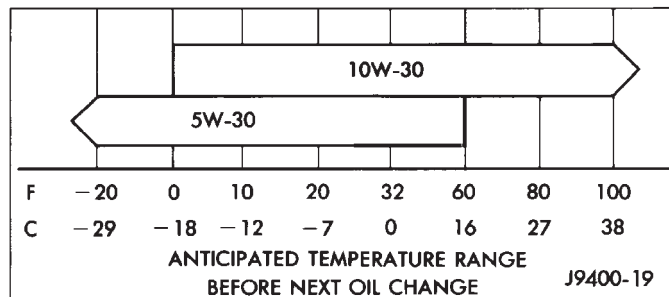


Fig. 4 Temperature/Engine Oil Viscosity Recommendation

ENERGY CONSERVING OIL

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

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right front of the engine, left of the generator on 3.9L and 5.2L/5.9L engines (Fig. 5).

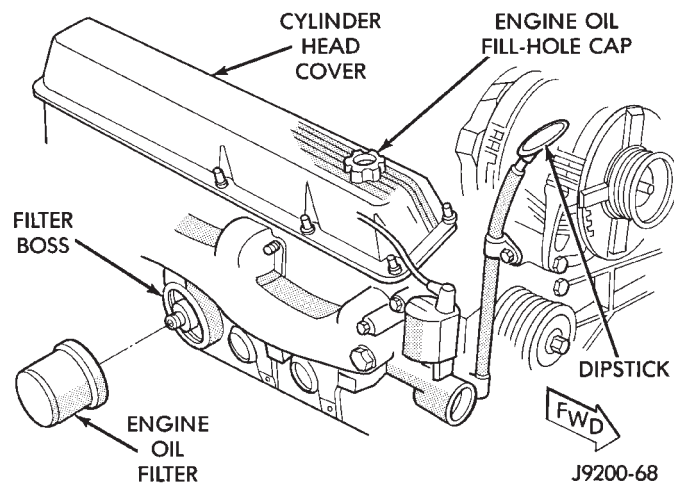


Fig. 5 Engine Oil Dipstick Location—3.9L/5.2L/5.9L Engines

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 levels are indicated between the ADD and SAFE marks on the engine oil dipstick.

- (1) Position vehicle on level surface.

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

- (3) Wipe dipstick clean.

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

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

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

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Maintenance Schedule. This information can be found in your owner's manual.

TO CHANGE ENGINE OIL

Run engine until achieving normal operating temperature.

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

- (2) Hoist 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 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. 6).

- (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. 7) of oil and grime.

GENERAL INFORMATION (Continued)

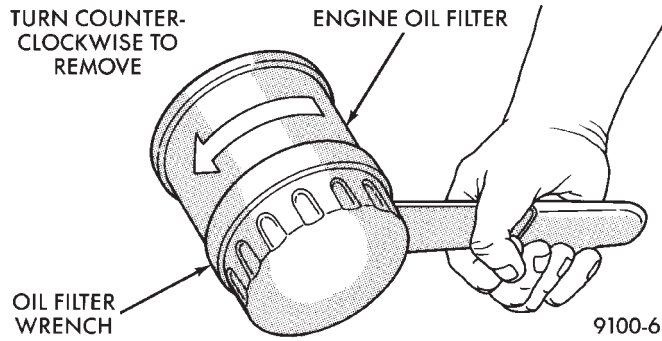


Fig. 6 Oil Filter Removal—Typical

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. 7) hand tighten filter one full turn, do not over tighten.
- (3) Add oil, verify crankcase oil level and start engine. Inspect for oil leaks.

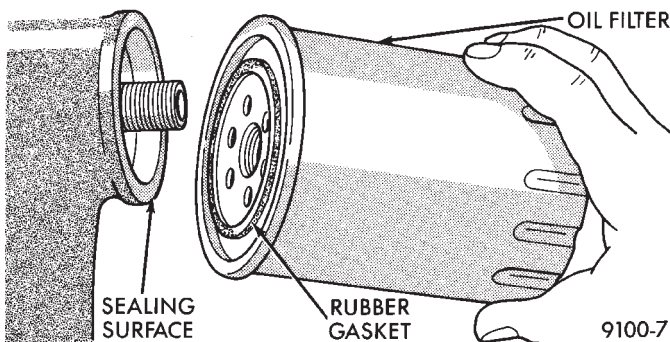


Fig. 7 Oil Filter Sealing Surface—Typical

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.

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. 8).

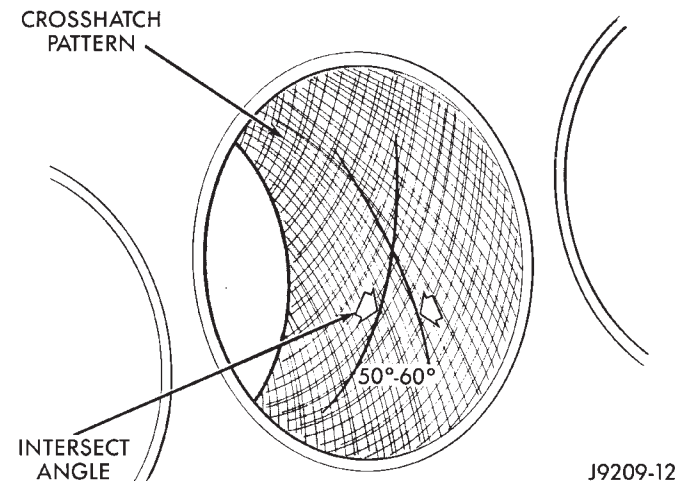


Fig. 8 Cylinder Bore Crosshatch Pattern

- (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.

GENERAL INFORMATION (Continued)

HYDROSTATIC LOCK

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

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

(2) Disconnect the battery negative cable.

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

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

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

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

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

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

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

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

(10) Install new spark plugs.

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

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

(13) Install a new oil filter.

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

(15) Connect the negative cable to the battery.

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

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 performance (e.g., engine idles rough and stalls) or mechanical (e.g., a strange noise).

Refer to the Service Diagnosis—Performance chart and the Service Diagnosis—Mechanical 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 can not be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following diagnosis:

- 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 RPM is observed 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) Disable the fuel system. (Refer to Group 14, Fuel System for the correct procedure)
- (5) Disconnect the ignition coil.
- (6) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
- (7) Record the compression pressure on the 3rd 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.

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

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

(3) Remove the spark plugs.

(4) Remove the oil filler cap.

(5) Remove the air cleaner.

(6) 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.

(7) Perform the test procedures on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe and 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.

ENGINE OIL LEAK INSPECTION

Begin with a thorough 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

CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

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

DIAGNOSIS AND TESTING (Continued)

approximately 15 minutes. Check the oil dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.

(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 inspection.

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

Air Leak Detection Test Method

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

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

(3) 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.

(4) 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.

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

(6) 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.

(7) 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.

(4) If no leaks are detected, pressurize the crankcase as outlined in the, 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 and scratches. The crankshaft seal flange is especially 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.

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(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).

DIAGNOSIS AND TESTING (Continued)

(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—Mechanical, 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.

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

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

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

ENGINE OIL PRESSURE

(1) Disconnect connector and remove oil pressure sending unit.

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

DIAGNOSIS AND TESTING (Continued)

ENGINE PERFORMANCE/MECHANICAL DIAGNOSIS

PERFORMANCE DIAGNOSIS CHART

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

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
MAIN BEARING NOISE (CONT'D)	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

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

The 3.9 Liter (238 CID) six-cylinder engine is a V-Type, lightweight, single cam, overhead valve engine with hydraulic roller tappets.

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

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

This engine is designed for unleaded fuel.

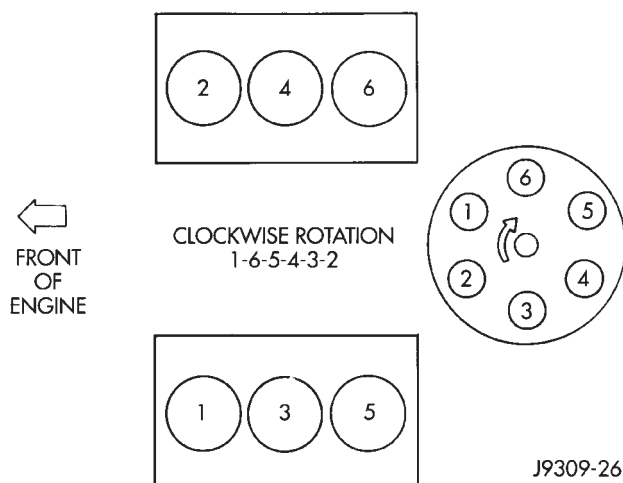


Fig. 1 Firing Order

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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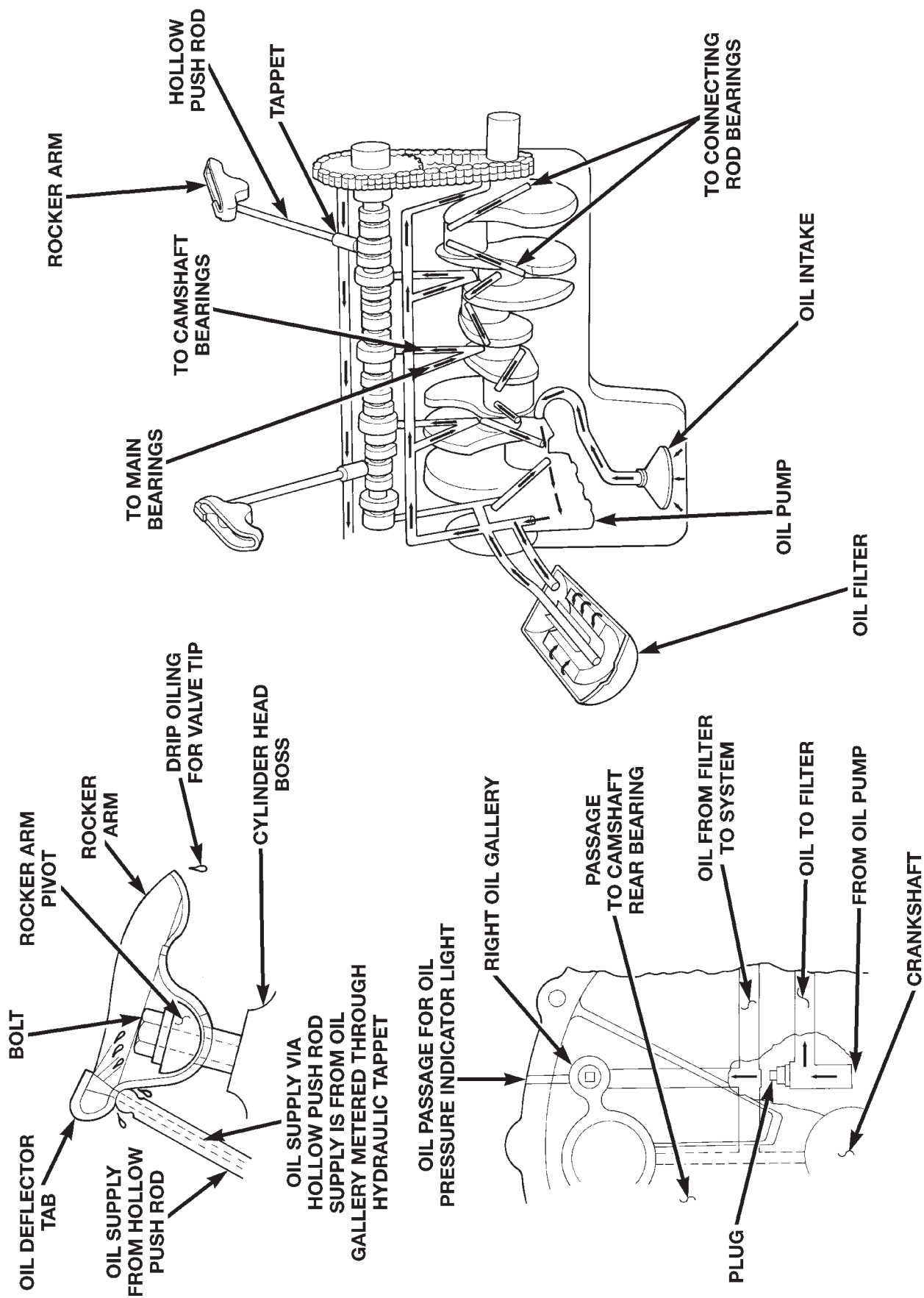


Fig. 3 Oil Lubrication System

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).

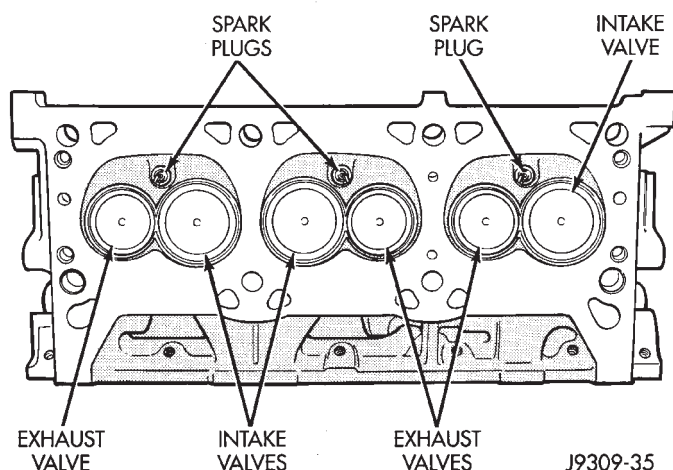


Fig. 4 Cylinder Head Assembly

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).

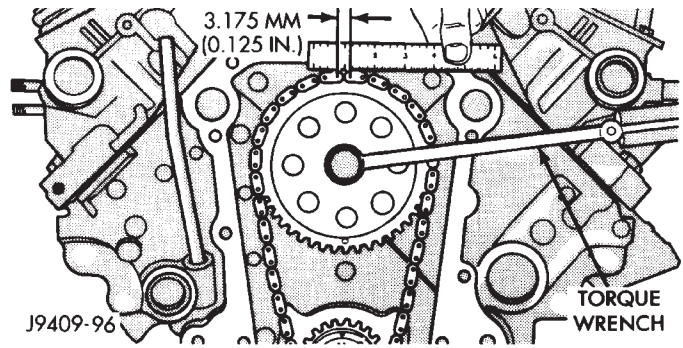
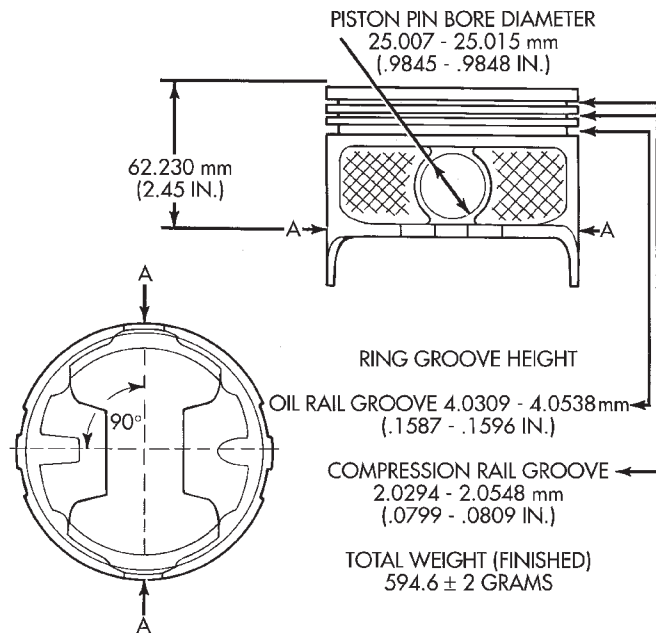


Fig. 5 Measuring Timing Chain Wear and Stretch

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.

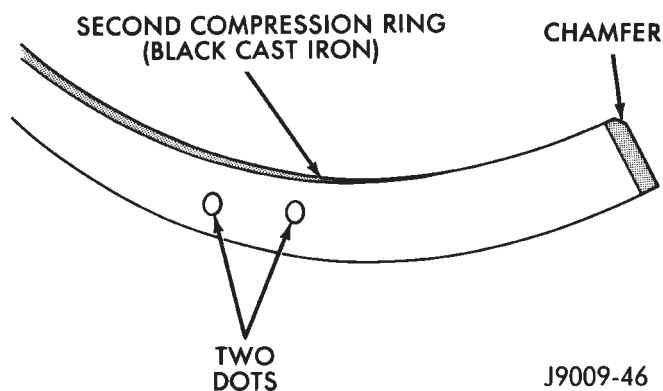


Fig. 7 Second Compression Ring Identification (Typical)

(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).

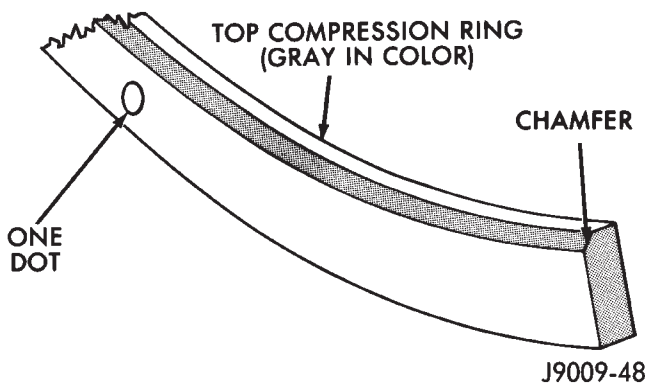


Fig. 8 Top Compression Ring Identification (Typical)

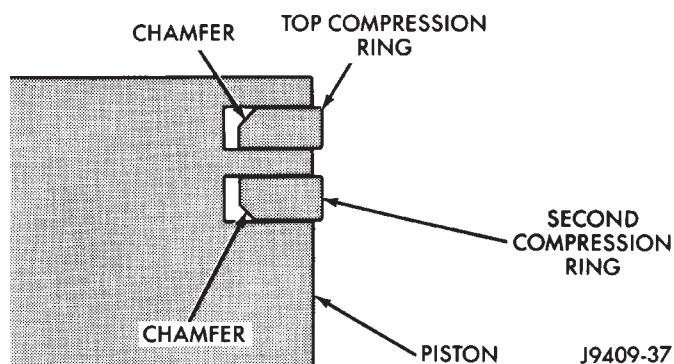


Fig. 9 Compression Ring Chamfer Location (Typical)

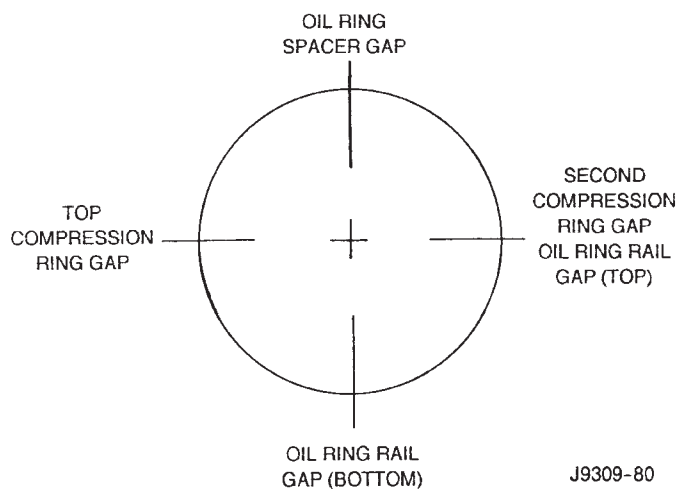


Fig. 10 Proper Ring Installation

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,

SERVICE PROCEDURES (Continued)

be certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

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

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

CRANKSHAFT 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.

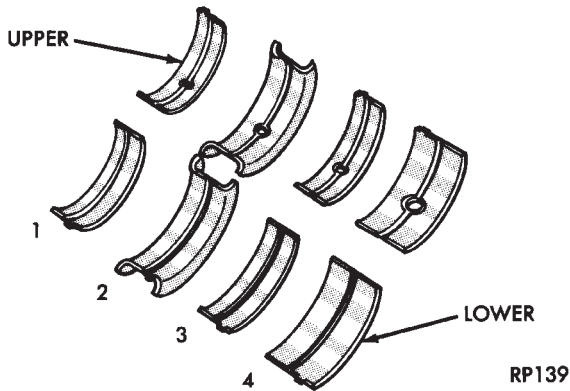


Fig. 11 Main Bearing Identification

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.

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

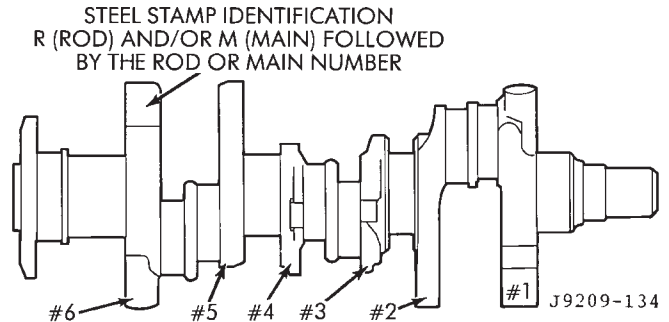


Fig. 12 Location of Crankshaft Identification

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

The engine front support brackets attach directly to engine block and the axle housing. The brackets provide a solid interconnection for these units (Fig. 13) (Fig. 14). Engine and front axle must be supported during any service procedures involving the front support assemblies.

- (1) Disconnect the negative cable from the battery.
- (2) Raise vehicle on hoist.
- (3) Install engine lifting (support) fixture.
- (4) Remove front axle. (Refer to Group 3, Differential and Driveline for the correct procedure.)
- (5) **Left mount insulator only.** Remove starter wires and starter motor assembly.
- (6) Remove insulator to frame through bolt (Fig. 15).
- (7) Raise engine slightly.
- (8) Remove upper insulator to support bracket stud nut and insulator to support through bolt.
- (9) Remove engine mount insulator. (Fig. 13) (Fig. 14).
- (10) If engine support bracket is to be removed/replaced, remove support bracket to transmission bell housing bolt(s) and three (3) support bracket to engine block bolts. Remove support bracket (Fig. 13) (Fig. 14).

REMOVAL AND INSTALLATION (Continued)

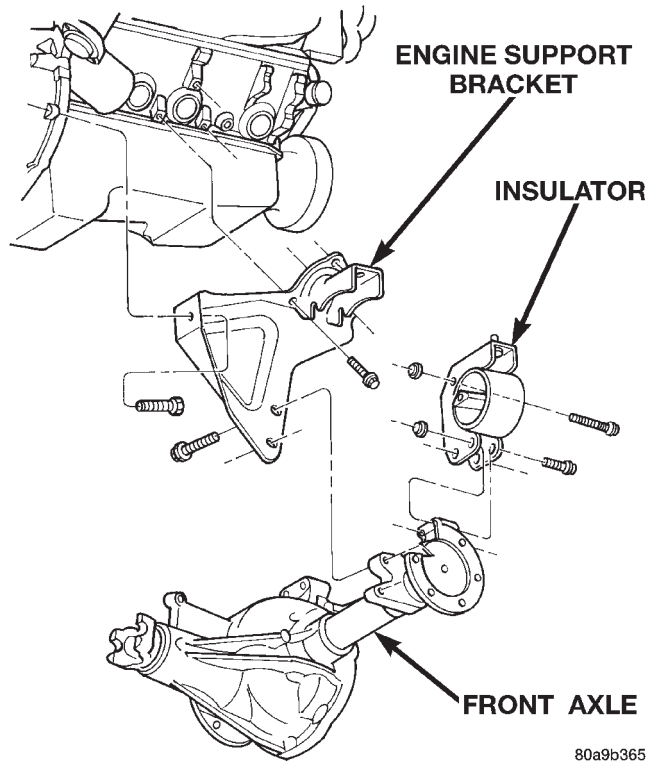


Fig. 13 Right Engine Mount Insulator and Support Bracket—4WD Vehicles

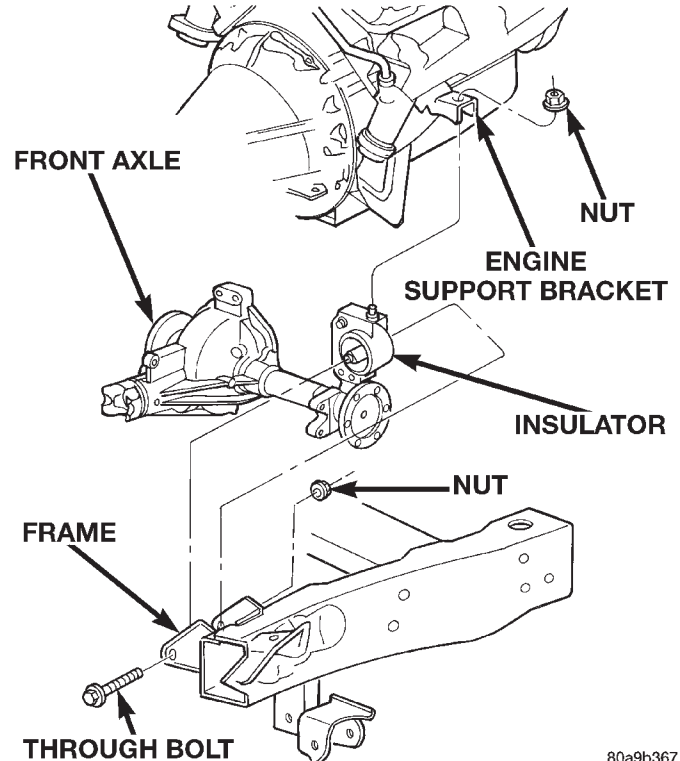


Fig. 15 Engine Mount Insulator at Frame—4WD Vehicles

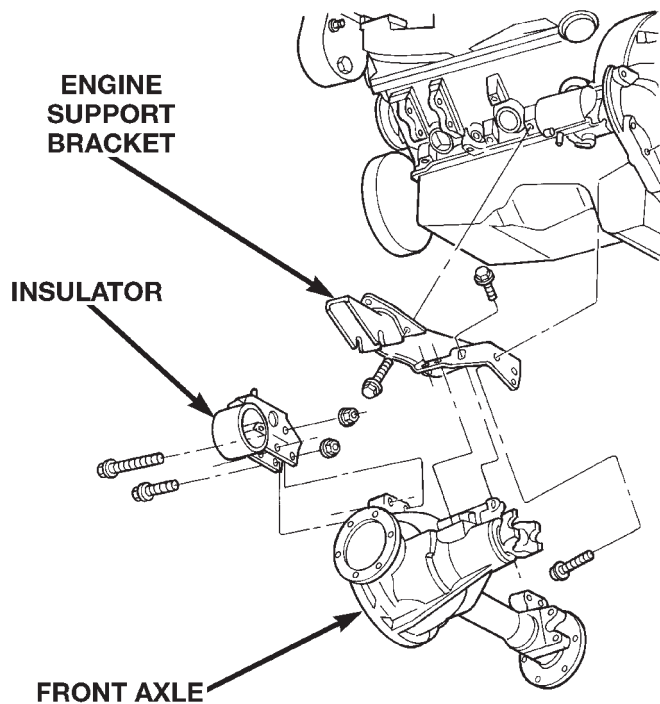


Fig. 14 Left Engine Mount Insulator and Support Bracket—4WD Vehicles

INSTALLATION

(1) If engine support brackets were removed, install them and their fasteners (Fig. 13) (Fig. 14). Tighten support bracket to block bolts to 41 N·m (30 ft. lbs.). Tighten support bracket to transmission bellhousing bolt(s) to 88 N·m (65 ft. lbs.)

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

(3) Lower engine and install insulator to frame through bolt and nut (Fig. 15). Tighten nut to 95 N·m (70 ft. lbs.)

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

(5) Connect starter wires.

(6) Remove engine lifting (support) fixture.

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

(8) Lower the vehicle.

(9) Connect the battery negative cable.

ENGINE MOUNT—REAR**REMOVAL**

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle on a hoist.

(3) Support the transmission with a transmission jack.

REMOVAL AND INSTALLATION (Continued)

- (4) Remove stud nuts holding the insulator to the crossmember (Fig. 16).
- (5) Raise rear of transmission SLIGHTLY.
- (6) Remove bolts holding the insulator to the insulator bracket (Fig. 16). Remove the insulator.

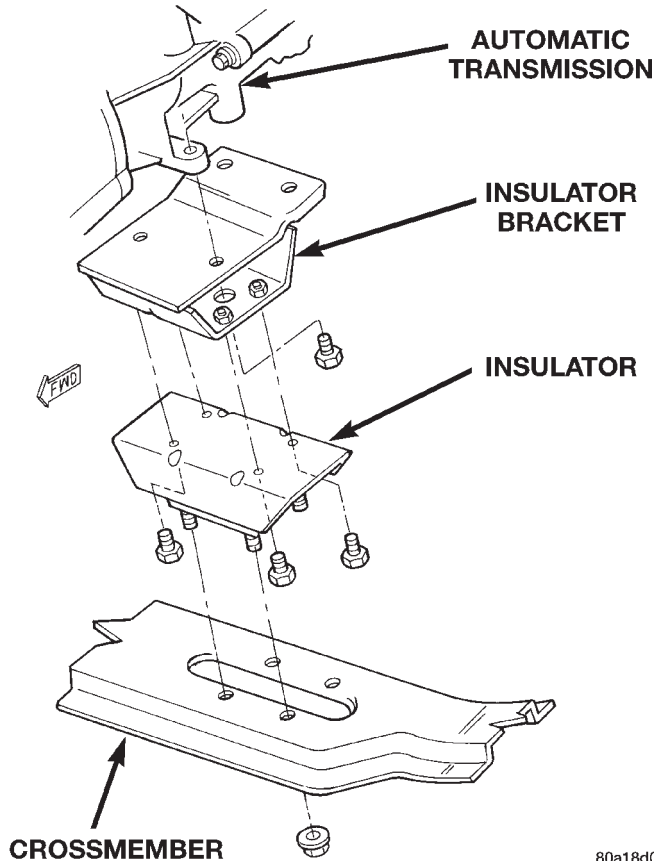


Fig. 16 Rear Engine Mount Insulator Removal/Installation

INSTALLATION

- (1) If the insulator bracket was removed, install the bracket to the transmission (Fig. 16). Tighten the bolts to 68 N·m (50 ft. lbs.) torque.
- (2) Install the bolts holding insulator to insulator bracket. Tighten the bolts to 68 N·m (50 ft. lbs.) torque.
- (3) Lower rear of transmission while aligning the insulator studs into the mounting support bracket. Install stud nuts and tighten to 68 N·m (50 ft. lbs.) torque.
- (4) Remove the transmission jack.
- (5) Lower the vehicle.
- (6) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

- (1) Scribe hood hinge outlines on hood. Remove the hood.
- (2) Disconnect the battery negative cable.

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

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

- (22) Install an engine lifting fixture.
- (23) The engine and front driving axle (engine/axle/transmission) are connected through insulators and support brackets. Separate the engine as follows:
 - **LEFT SIDE**—Remove 2 bolts attaching (engine/pinion nose/transmission) bracket to transmission bell housing. Remove 2 bracket to pinion nose adaptor bolts. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.
 - **RIGHT SIDE**—Remove 2 bracket to axle (disconnect housing) bolts and 1 bracket to bell housing bolt. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.
- (24) Lower the vehicle.
- (25) Disconnect the engine from the torque converter drive plate. On manual transmission vehicles, move engine forward until drive pinion shaft clears the clutch disc. Remove engine from engine compartment.
- (26) Install engine assembly on engine repair stand.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) Remove engine from the repair stand and position in the engine compartment.
- (2) Install an engine support fixture.
- (3) Raise and support the vehicle on a hoist.
- (4) Refer to Group 21, Transmissions for transmission installation.
- (5) Install the front engine mounts.
- (6) Install exhaust pipe to manifold.
- (7) Lower the vehicle.
- (8) Remove engine lifting fixture.
- (9) Install the generator (refer to Group 8B, Battery/Starter/Generator Service).
- (10) Install starter motor (refer to Group 8B, Battery/Starter/Generator Service).
- (11) Connect power steering hoses, if equipped.
- (12) Connect air conditioning hoses.
- (13) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heater and Air Conditioning for service procedures).
- (14) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.
- (15) Connect the accelerator linkage.
- (16) Connect the starter wires.
- (17) Connect the oil pressure wire.
- (18) Install the distributor cap and wiring.
- (19) Connect the vacuum lines.
- (20) Connect the fuel supply line.
- (21) Install the radiator (refer to Group 7, Cooling System). Connect the radiator hoses and heater hoses.
- (22) Install fan shroud in position.
- (23) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
- (24) Install the air cleaner.
- (25) Install the battery.
- (26) Warm engine and adjust.
- (27) Install hood and line up with the scribe marks.
- (28) Road test vehicle.

CYLINDER HEAD COVER

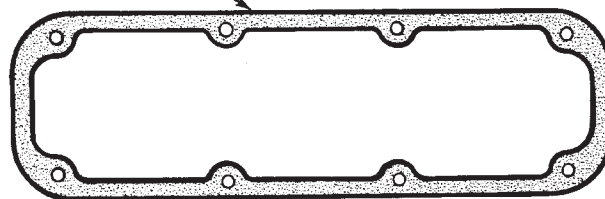
A steel-backed silicone gasket is used with the cylinder head cover (Fig. 17). This gasket can be used again.

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.

INSTALLATION

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

CYLINDER HEAD
COVER GASKET

J9209-104

Fig. 17 Cylinder Head Cover Gasket

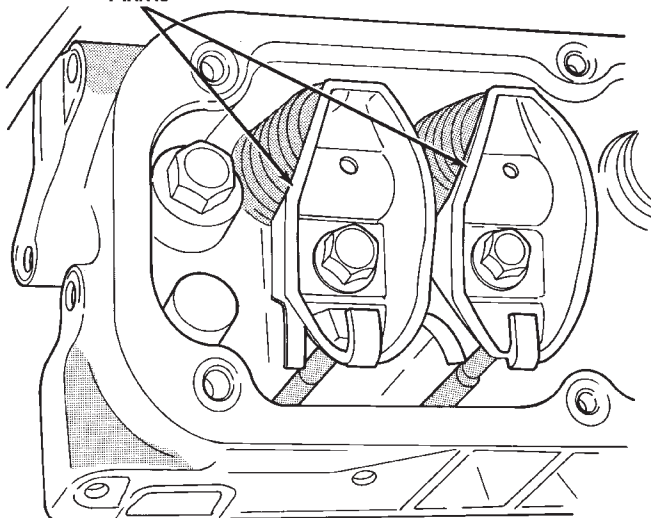
- (2) Position the cylinder head cover onto the gasket. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install closed crankcase ventilation system and evaporation control system.
- (4) Connect the negative cable to the battery.

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. 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.

ROCKER
ARMS

J9209-66

Fig. 18 Rocker Arms

REMOVAL AND INSTALLATION (Continued)

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.

(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. 19) are held in place by eight bolts. The spark plugs are located at the peak of the wedge between the valves.

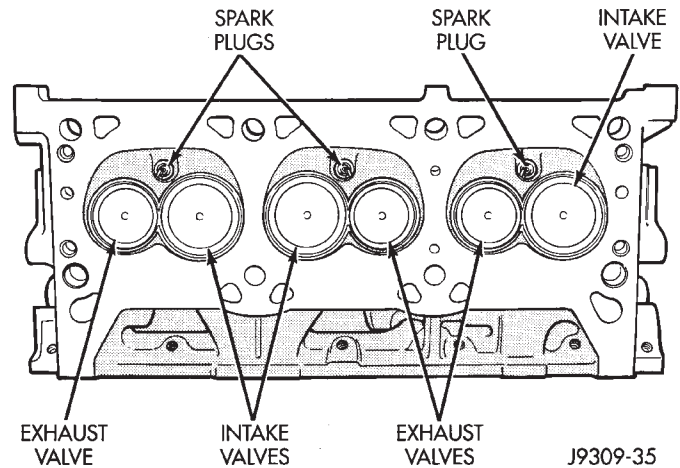


Fig. 19 Cylinder Head Assembly

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.

(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 coolant temperature sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Disconnect the vacuum supply hoses from the intake manifold.

(15) Disconnect the fuel injector harness and secure out of the way.

(16) Remove cylinder head covers and gaskets.

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

(18) Remove exhaust manifolds.

REMOVAL AND INSTALLATION (Continued)

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

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

(21) 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. 20). 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.

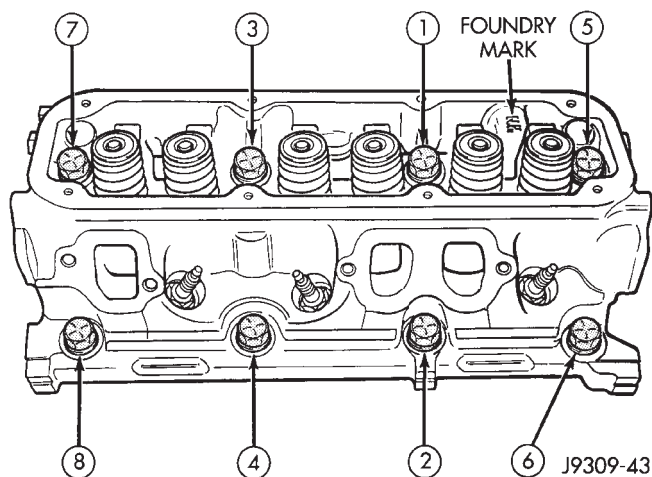


Fig. 20 Cylinder Head Bolt -Tightening Sequence

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 coolant temperature sending unit wire.

(10) Connect the fuel injector harness.

(11) Connect the vacuum supply hoses to the intake manifold.

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

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

(18) Place the cylinder head cover gaskets in position and install cylinder head covers. 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) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

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

(24) 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.).

REMOVAL AND INSTALLATION (Continued)

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.
- (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. 21).
- (4) Hold puller screw and tighten puller nut until bushing is removed.

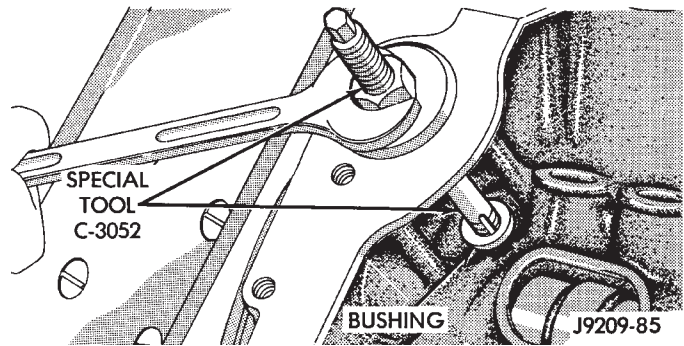


Fig. 21 Distributor Driveshaft Bushing Removal

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. 22).

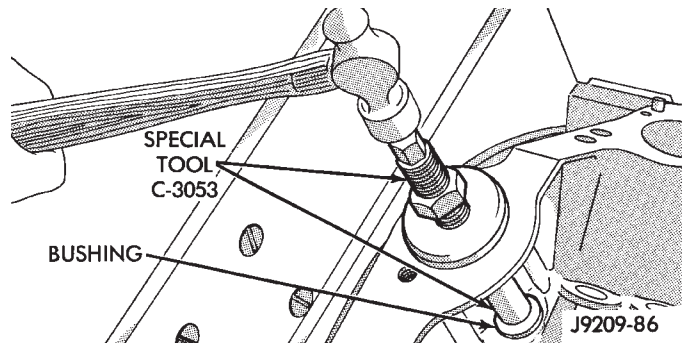


Fig. 22 Distributor Driveshaft Bushing Installation

- (3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 23). **DO NOT ream this bushing.**

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

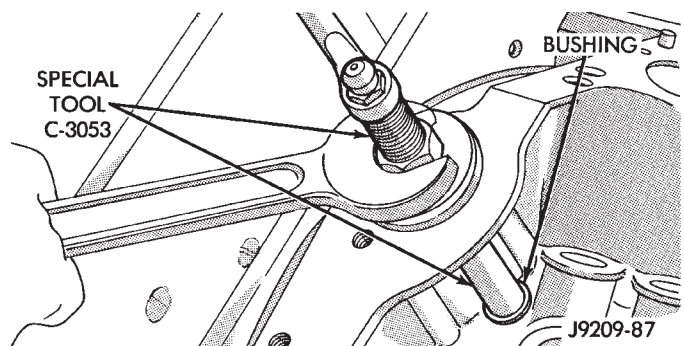


Fig. 23 Burnishing Distributor Driveshaft Bushing

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

REMOVAL AND INSTALLATION (Continued)

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. 24).

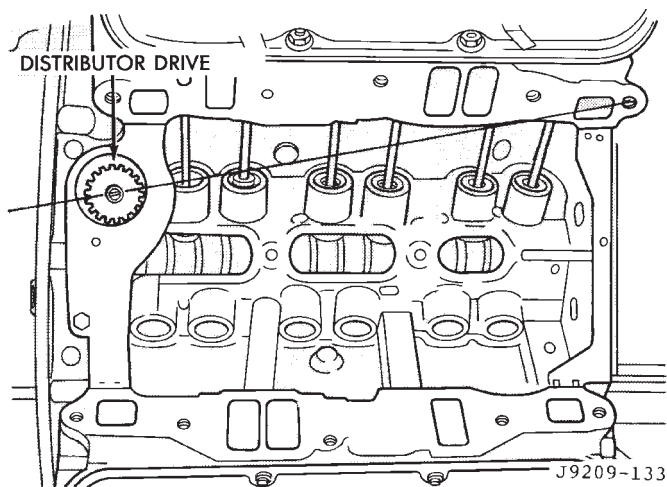


Fig. 24 Position of Oil Pump Shaft Slot

- (4) Install distributor. Refer to Group 8D, Ignition Systems for the proper procedure.

After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition System.

Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on ignition timing. Adjusting distributor position will 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. 25).

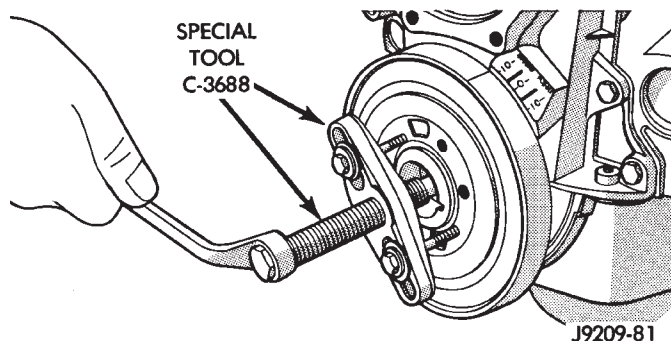


Fig. 25 Vibration Damper Assembly

- (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. 26).

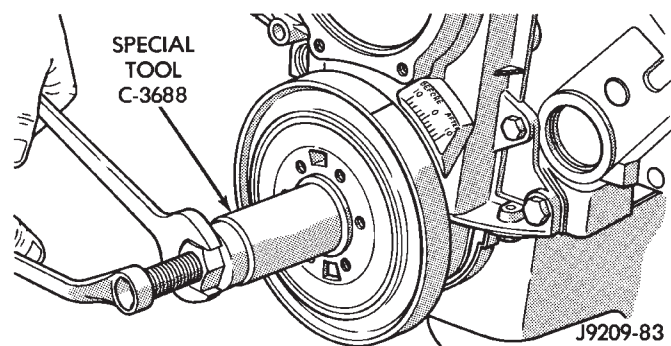


Fig. 26 Installing Vibration Damper

- (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 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.

REMOVAL AND INSTALLATION (Continued)

(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.

(3) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 27). Seat the oil seal in the groove of the tool.

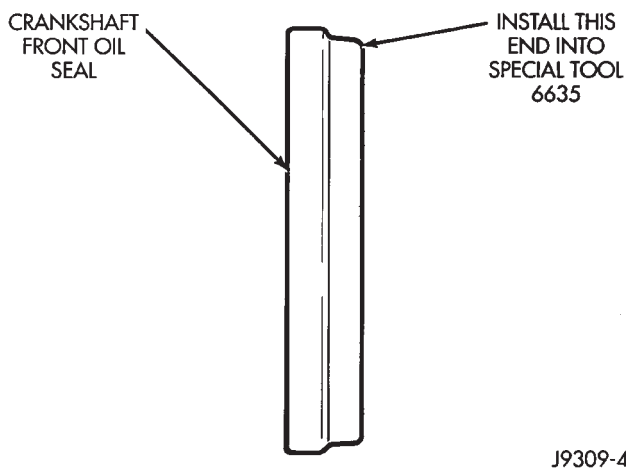


Fig. 27 Placing Oil Seal on Installation Tool 6635

(4) Position the seal and tool onto the crankshaft (Fig. 28).

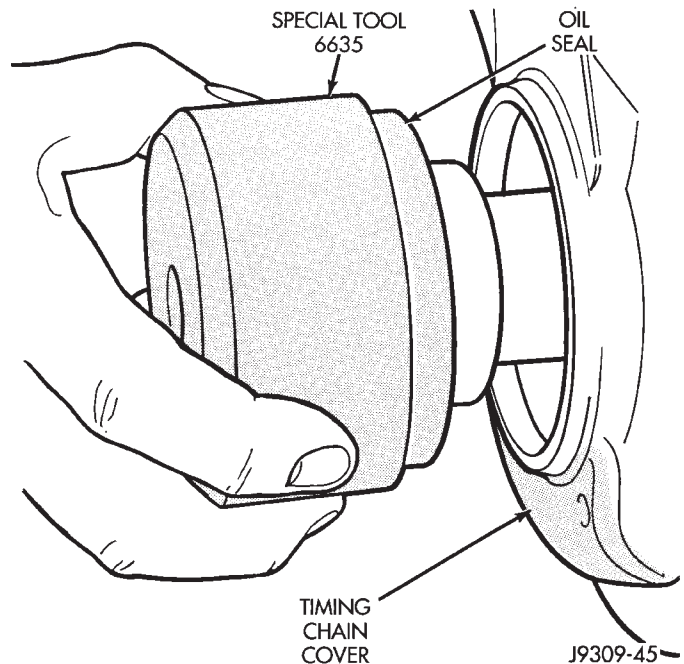


Fig. 28 Position Tool and Seal onto Crankshaft

(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. 29).

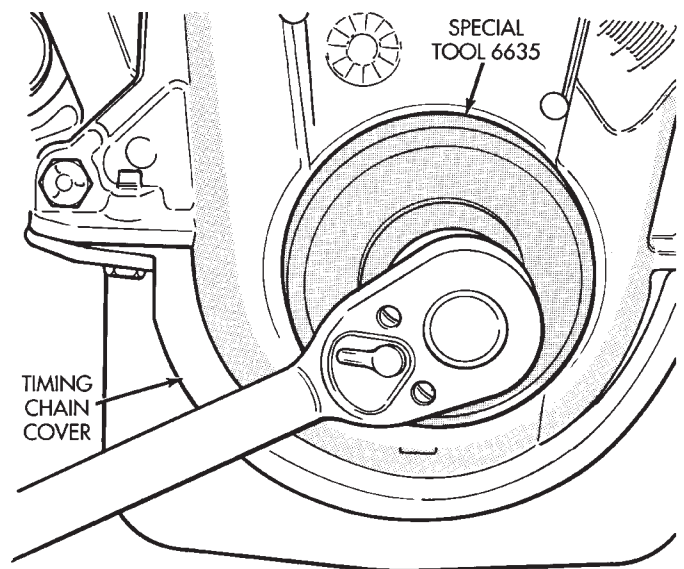


Fig. 29 Installing Oil Seal

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

REMOVAL AND INSTALLATION (Continued)

(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.

(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.

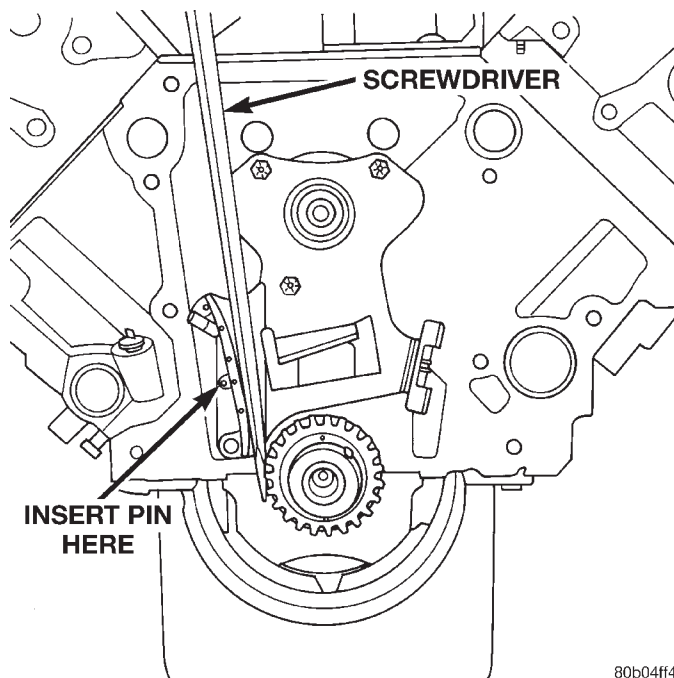
(14) Install the serpentine belt. Refer to Group 7, Cooling System.

(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.

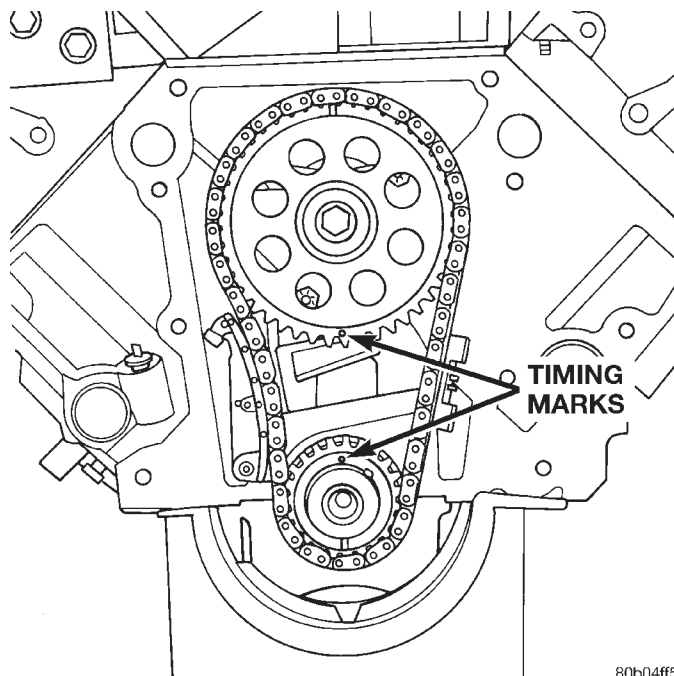
(18) Connect the negative cable to the battery.



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Fig. 30 Compressing Tensioner For Chain Installation

(5) Slide both sprockets evenly over their respective shafts and verify alignment of timing marks (Fig. 31) with a straight-edge if necessary.



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Fig. 31 Alignment of Timing Marks

(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.

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. 31) to #1 TDC.

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

(6) Slip crankshaft sprocket onto crankshaft and compress tensioner shoe by placing a large screwdriver between crankshaft sprocket and tensioner shoe (Fig. 30). Compress shoe until hole in shoe lines up with hole in bracket. Slide a suitable pin into the holes (Fig. 30) and remove screwdriver.

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

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).

REMOVAL AND INSTALLATION (Continued)

- (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.

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 rocker arms.
- (8) Remove push rods and tappets. Identify each part so it can be installed in the original locations.
- (9) Remove timing chain cover. Refer to procedure in this group.
- (10) Align timing marks (Fig. 34) and remove timing chain and sprockets.
- (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. 32).

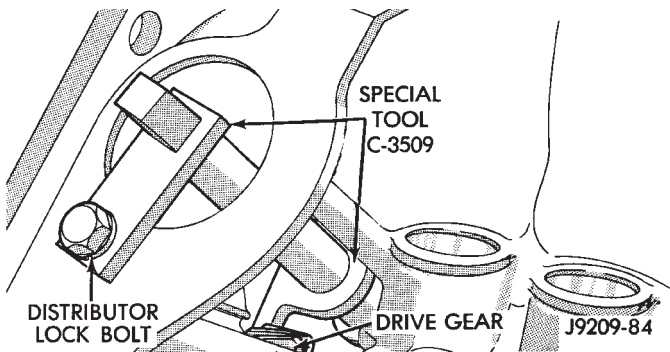


Fig. 32 Camshaft Holding Tool C-3509 (Installed Position)

- (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

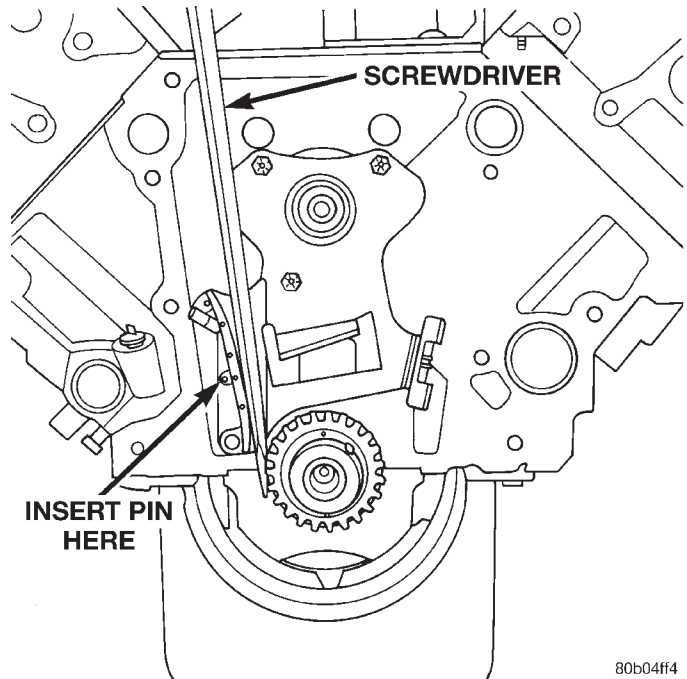


Fig. 33 Compressing Tensioner Shoe For Timing Chain Installation

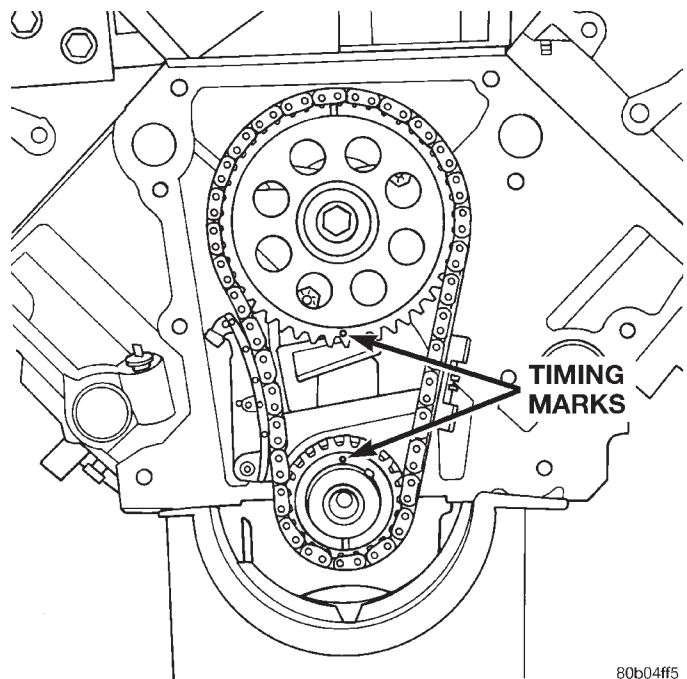


Fig. 34 Alignment of Timing Marks

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. 33) and install a suitable sized pin to retain shoe for chain installation.

REMOVAL AND INSTALLATION (Continued)

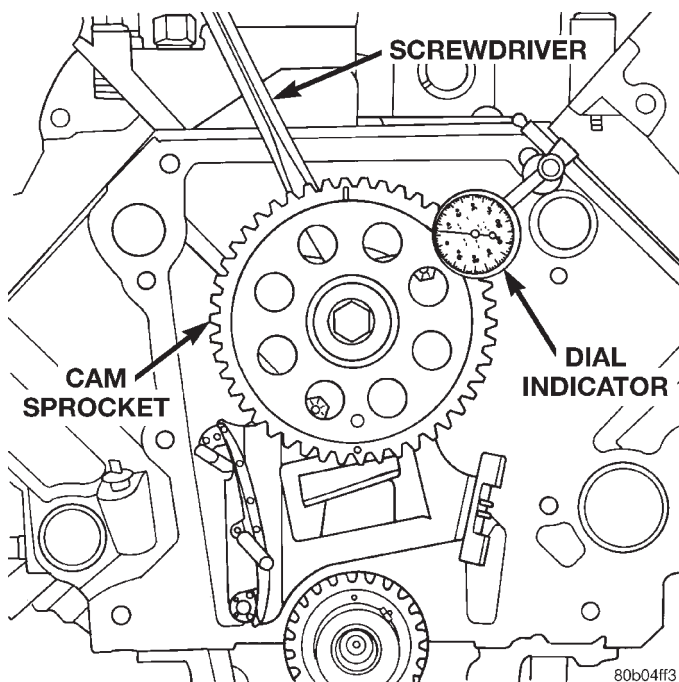


Fig. 35 Checking Camshaft End Play

(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.

(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. 34).

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

(12) Measure camshaft end play (Fig. 35). Refer to Specifications for proper clearance. If not within limits, install a new timing chain tensioner.

(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. 36).

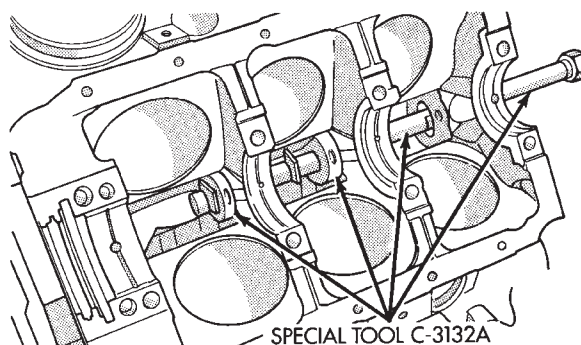


Fig. 36 Camshaft Bearings Removal and Installation with Tool C-3132-A

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. 37).

(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 tight-

REMOVAL AND INSTALLATION (Continued)

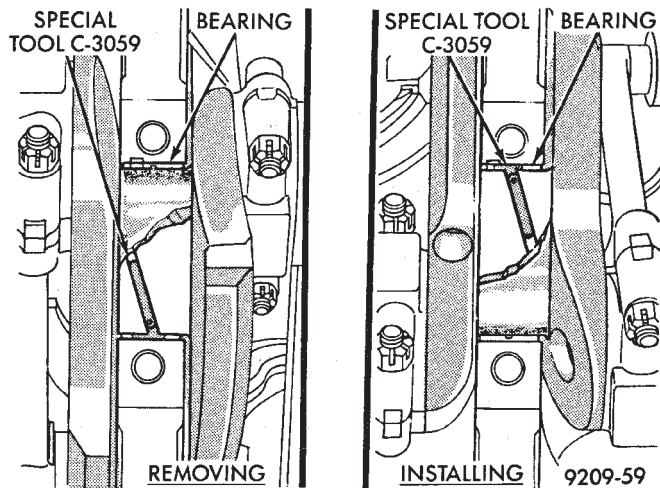


Fig. 37 Upper Main Bearing Removal and Installation with Tool C-3059

ened. 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. 37).

(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.

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove front axle assembly (refer to Group 3, Differential and Driveline).
- (6) Remove both engine mount support brackets (Refer to Engine Mounts in this section).
- (7) Remove transmission inspection cover.
- (8) Remove oil pan and one-piece gasket.

INSTALLATION

- (1) Fabricate 4 alignment dowels from 1 1/2 x 5/16 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 38).
- (2) Install the dowels in the cylinder block (Fig. 39).

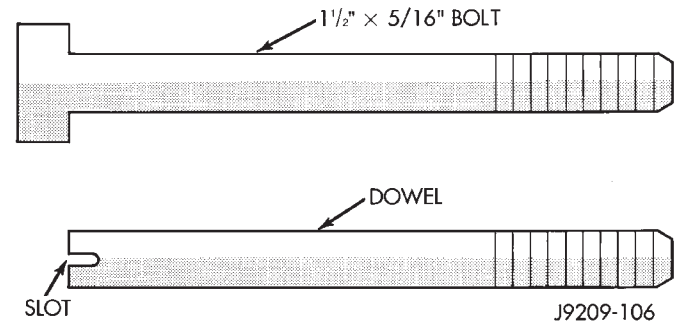


Fig. 38 Fabrication of Alignment Dowels

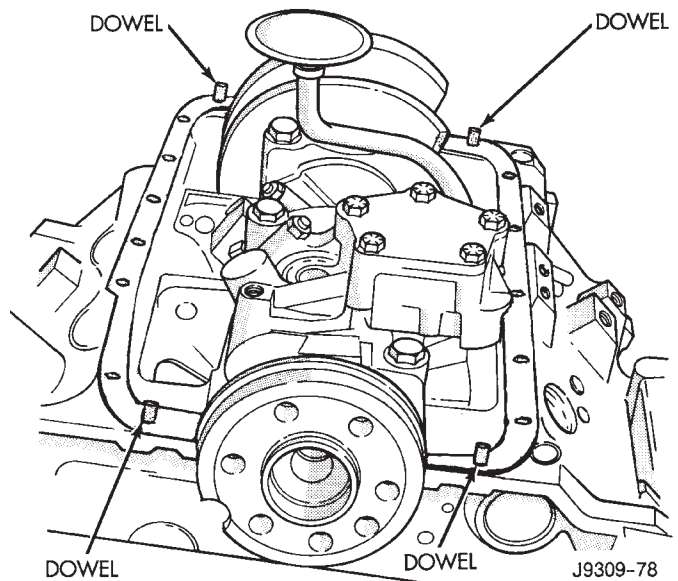


Fig. 39 Position of Dowels in Cylinder Block

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

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

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

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

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

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

(9) Install transmission inspection cover.

(10) Install engine mount support brackets and insulators (Refer to engine mounts in this section)

(11) Install front axle assembly (refer to Group 3, Differential and Driveline for the proper procedures).

(12) Lower vehicle

(13) Connect the distributor cap.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

REMOVAL AND INSTALLATION (Continued)

- (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 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. 40).
- (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

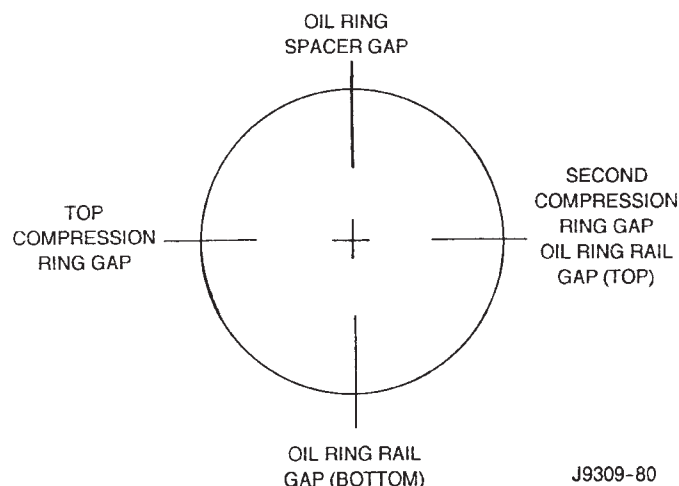


Fig. 40 Proper Ring Installation

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) 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.

REMOVAL AND INSTALLATION (Continued)

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

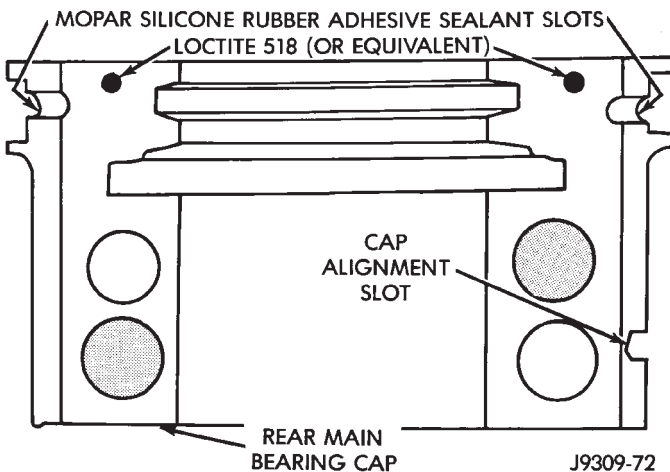


Fig. 41 Sealant Application to Bearing Cap

- (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 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.
- (10) Install the timing chain cover.
- (11) Install the vibration damper.
- (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. 42). 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.

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.

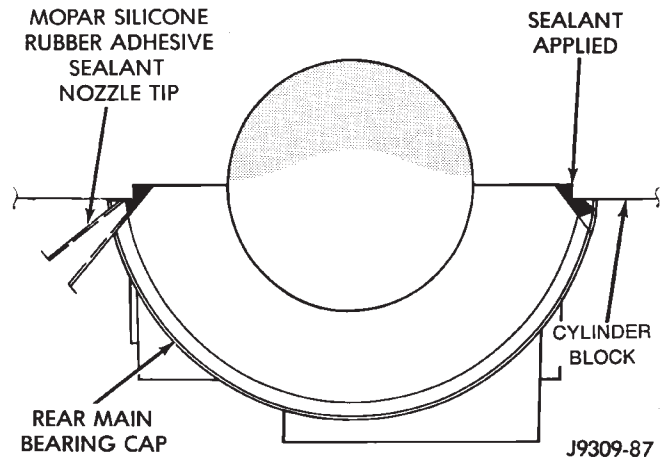


Fig. 42 Apply Sealant to Bearing Cap to Block Joint

- (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. 43). Seat the oil seal in the groove of the tool.

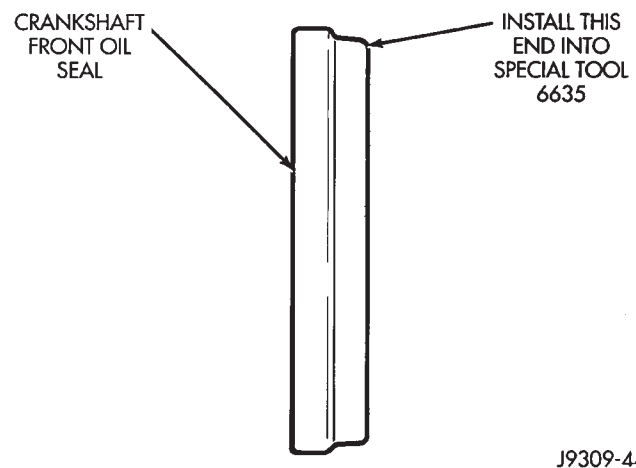
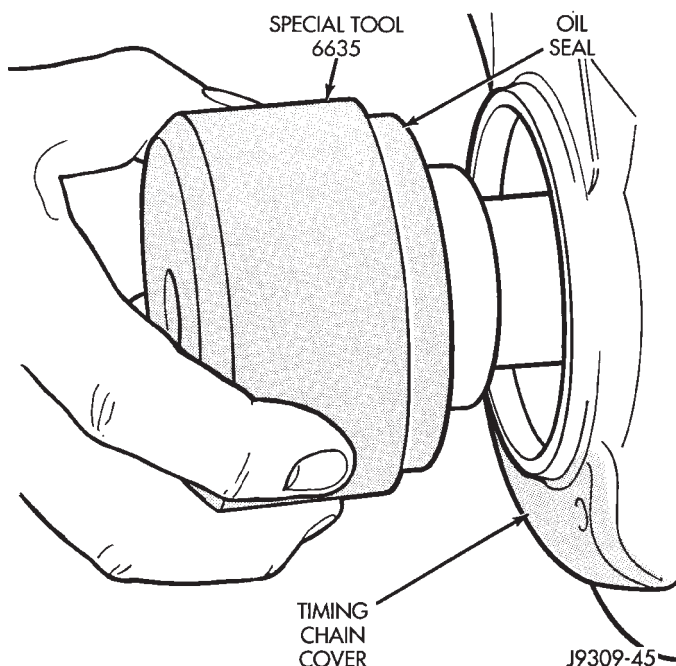


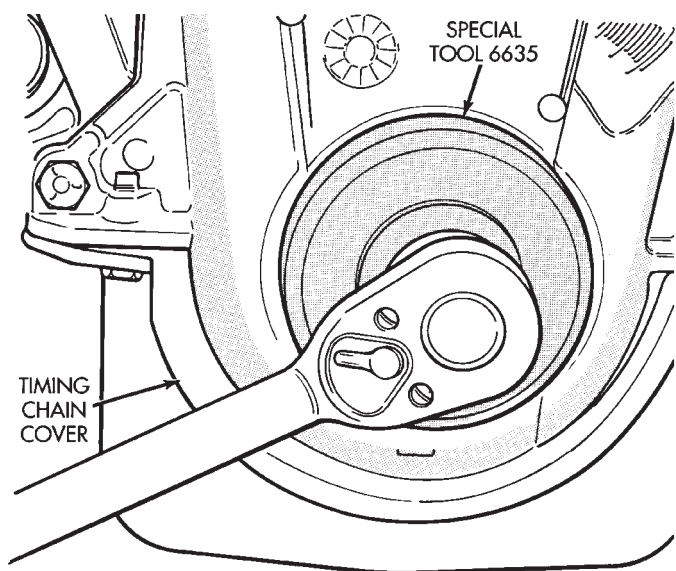
Fig. 43 Placing Oil Seal on Installation Tool 6635

- (2) Position the seal and tool onto the crankshaft (Fig. 44).
- (3) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 45).
- (4) Remove the vibration damper bolt and seal installation tool.
- (5) Inspect the seal flange on the vibration damper.
- (6) Install the vibration damper.

REMOVAL AND INSTALLATION (Continued)

**Fig. 44 Position Tool and Seal onto Crankshaft**

(7) Connect the negative cable to the battery.

**Fig. 45 Installing Oil Seal****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.

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.

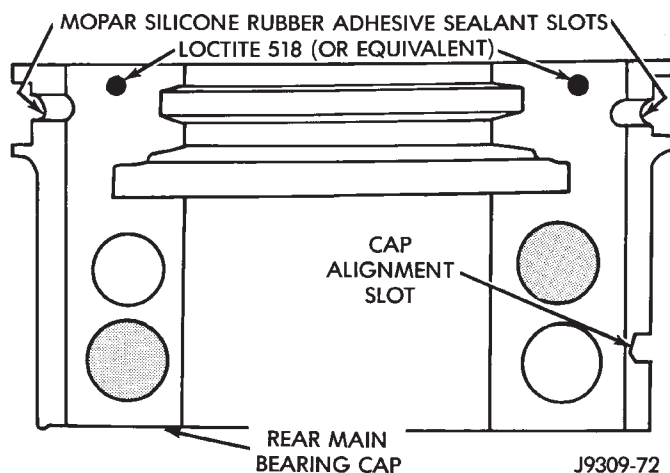
(3) Install the new upper rear bearing oil seal with the white paint facing toward the rear of the engine.

(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. 46). 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. 46 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 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. 47). Apply enough sealant so that a small amount is

REMOVAL AND INSTALLATION (Continued)

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.

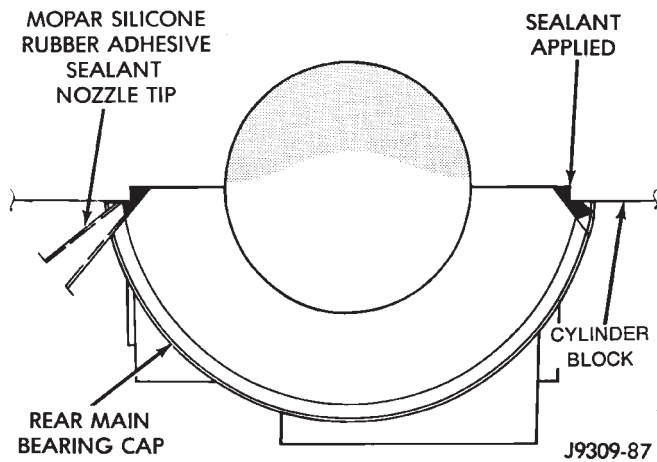


Fig. 47 Apply Sealant to Bearing Cap-to-Block Joint
UPPER SEAL—CRANKSHAFT INSTALLED

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 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. 46). 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. 47). 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. 46). 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.

REMOVAL AND INSTALLATION (Continued)

ENGINE CORE OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 48). This will reduce internal leakage and help maintain higher oil pressure at idle.

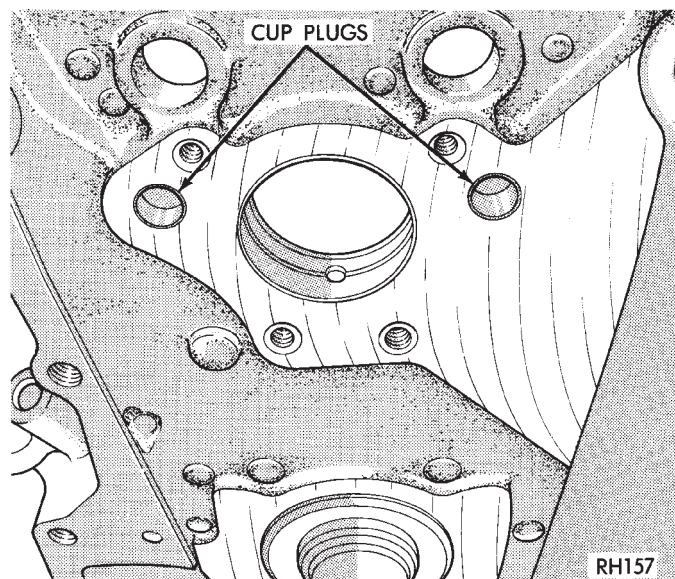


Fig. 48 Location of Cup Plugs in Oil Galleries

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. 49).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 49).

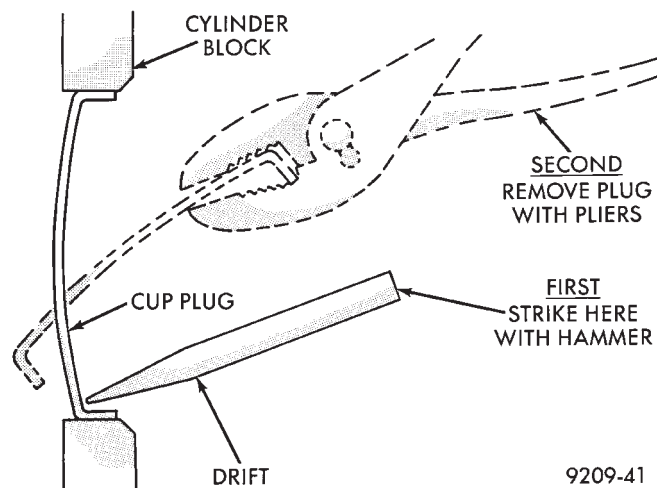


Fig. 49 Core Hole Plug Removal

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. 50).

(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. 50). 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. 50).

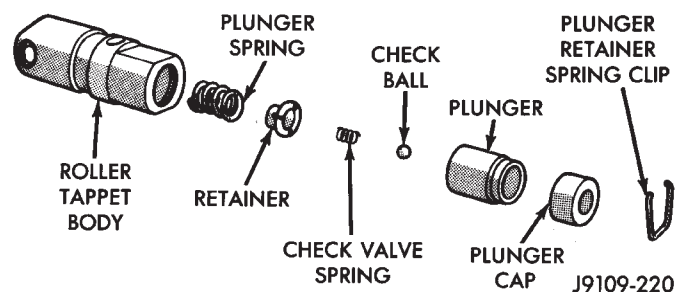


Fig. 50 Hydraulic Tappet Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

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. 51). The special sleeve places the valve at the correct height for checking with a dial indicator.

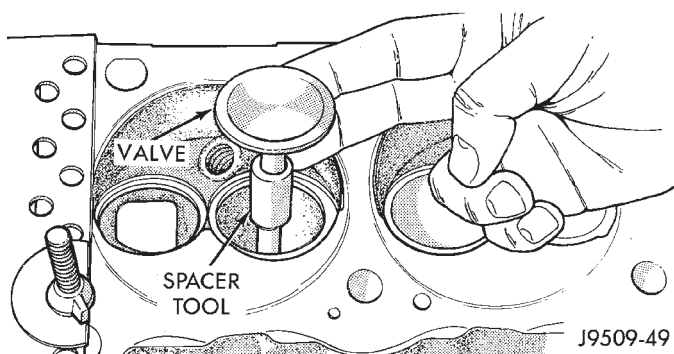


Fig. 51 Positioning Valve with Tool C-3973

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 52).

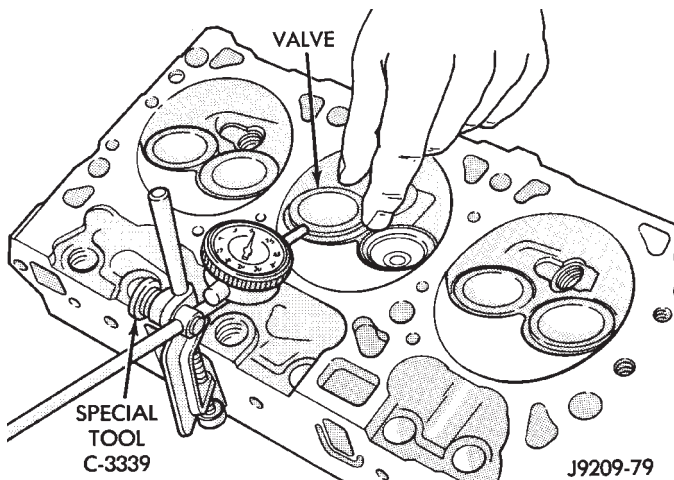


Fig. 52 Measuring Valve Guide Wear

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

VALVE GUIDES

Service valves with oversize stems are available (Fig. 53).

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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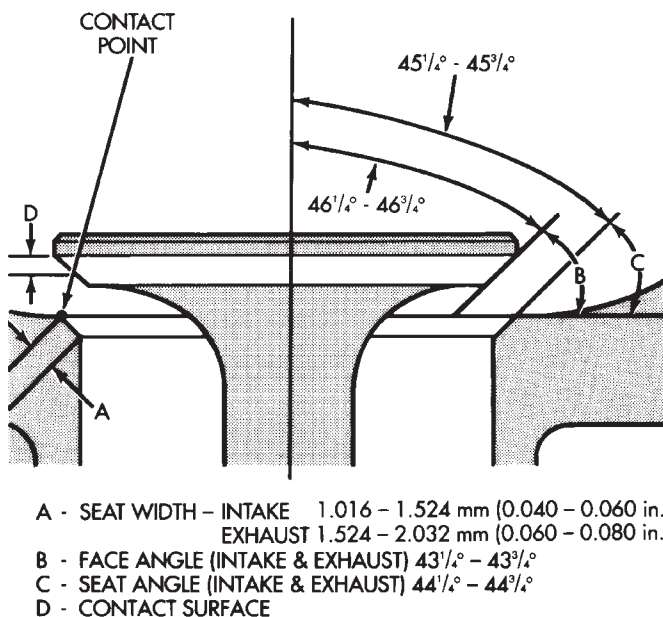
Fig. 53 Reamer Sizes

(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 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 54).



J9309-95

Fig. 54 Valve Face and Seat Angles

DISASSEMBLY AND ASSEMBLY (Continued)

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 55). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

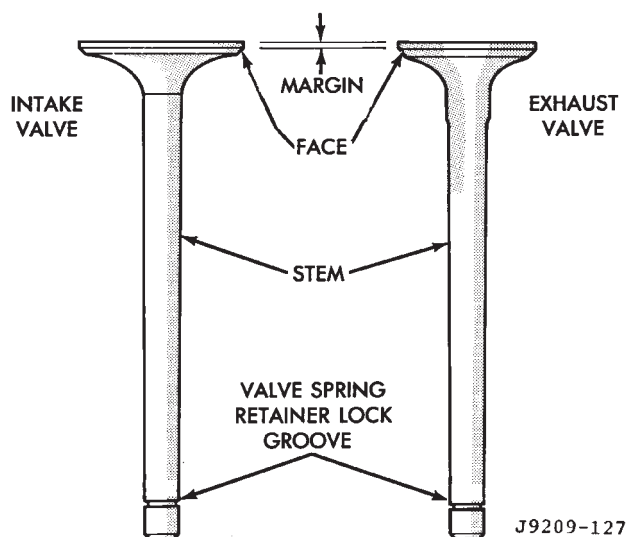


Fig. 55 Intake and Exhaust Valves

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 56).

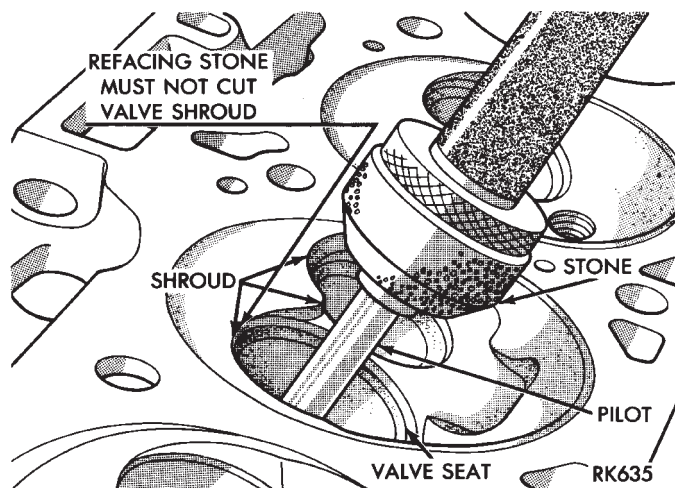


Fig. 56 Refacing Valve Seats

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

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

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

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

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

VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 in.. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 in. mark on the threaded stud. Be sure the zero mark is to the front (Fig. 57). 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.

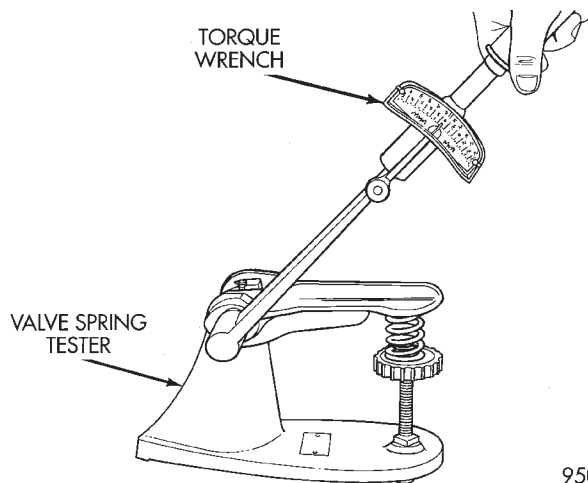


Fig. 57 Testing Valve Spring for Compressed Length

OIL PUMP

DISASSEMBLE

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 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. 58).

DISASSEMBLY AND ASSEMBLY (Continued)

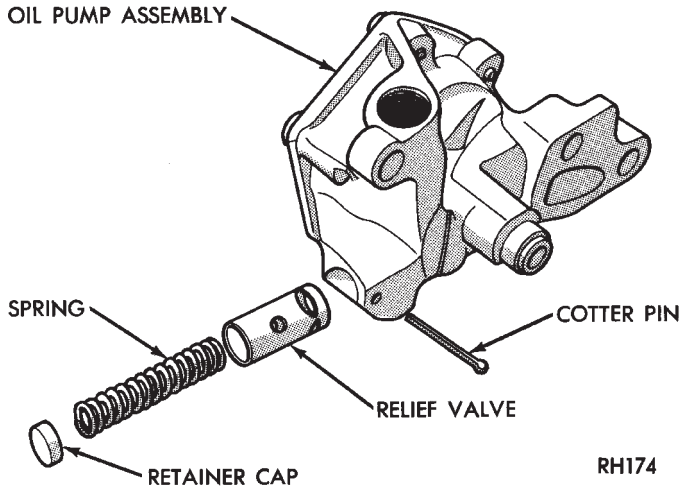


Fig. 58 Oil Pressure Relief Valve

- (2) Remove oil pump cover (Fig. 59).
- (3) Remove pump outer rotor and inner rotor with shaft (Fig. 59).
- (4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

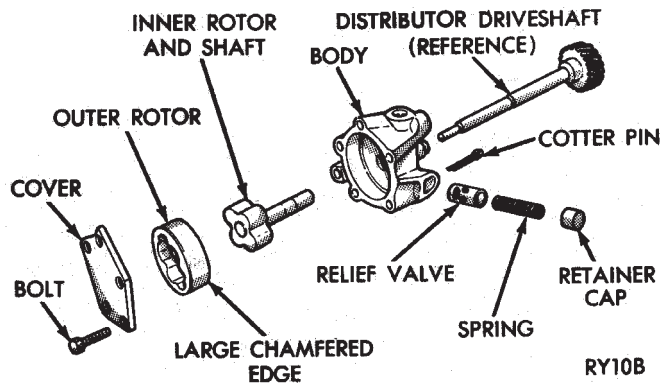


Fig. 59 Oil Pump

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.

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 305×0.00075 (12 \times 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

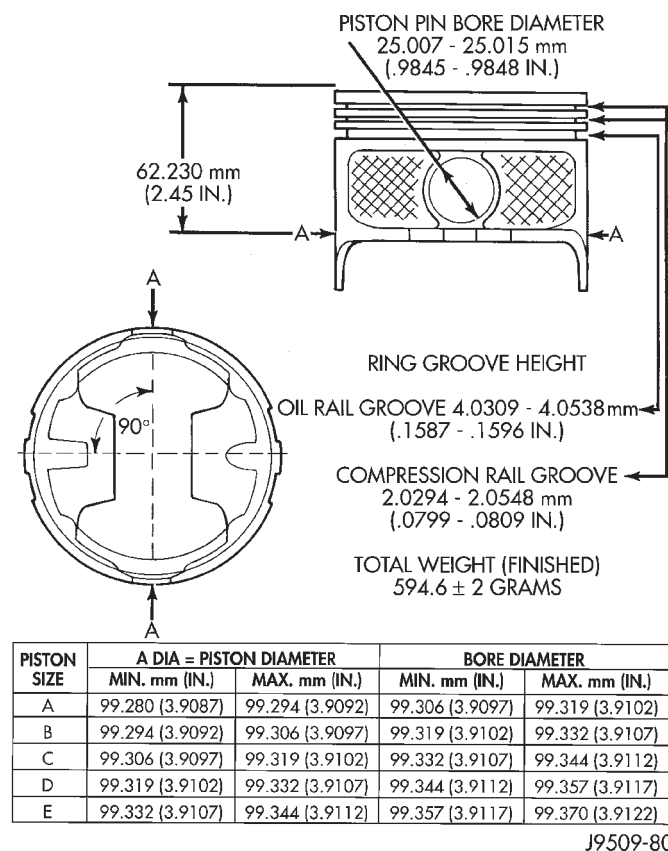
- Check the crankshaft connecting rod journal for excessive wear, taper and scoring.
- Check the cylinder block bore for out-of-round, taper, scoring and scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 60).

CRANKSHAFT JOURNAL INSPECTION

- The crankshaft connecting rod and main journals should be checked for excessive wear, taper or scor-

CLEANING AND INSPECTION (Continued)

**Fig. 60 Piston Measurements**

ing. 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.

OIL PUMP**OIL PUMP PRESSURE**

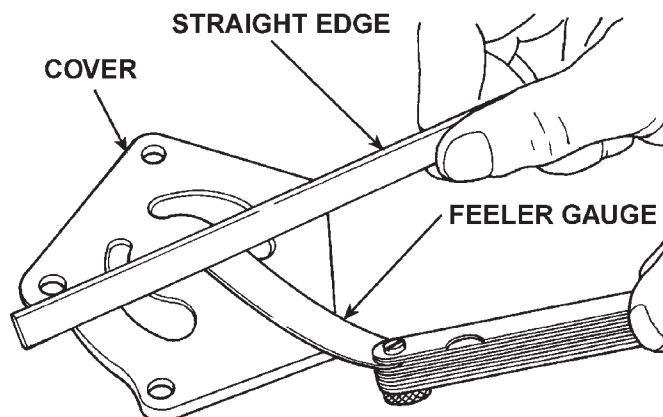
The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The NORMAL oil pump pressure is 207-552 kPa (30-80 psi) at 3,000 RPM or more.

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.

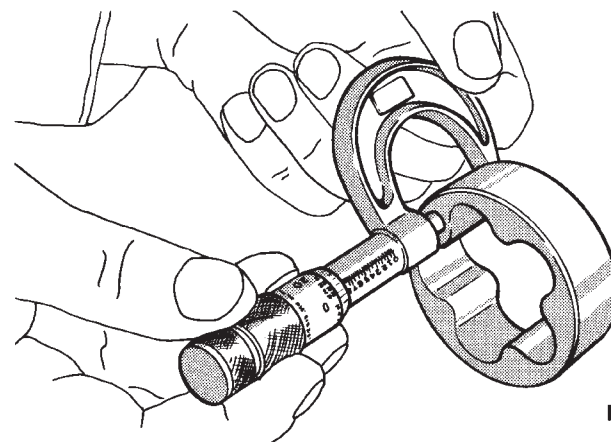
Lay a straightedge across the pump cover surface (Fig. 61). If a 0.038 mm (0.0015 in.) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.



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Fig. 61 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. 62).



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Fig. 62 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 in.) or less, replace inner rotor and shaft assembly (Fig. 63).

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 64). If clearance is 0.356 mm (0.014 in.) or more, replace oil pump assembly.

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 in.) or more, replace shaft and both rotors (Fig. 65).

CLEANING AND INSPECTION (Continued)

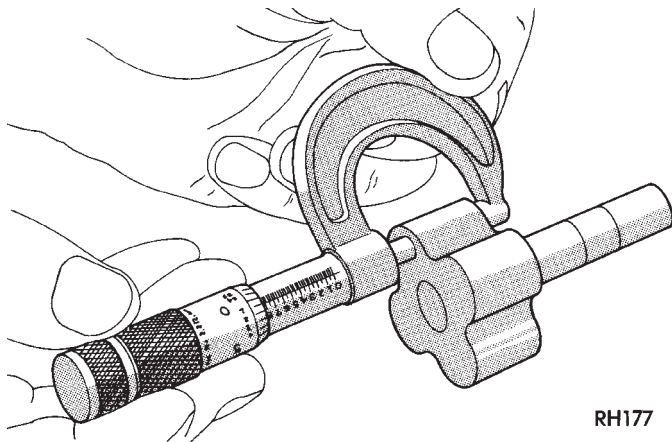


Fig. 63 Measuring Inner Rotor Thickness

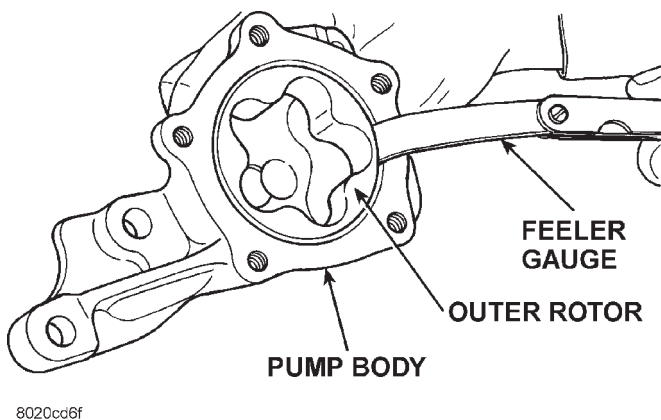


Fig. 64 Measuring Outer Rotor Clearance in Housing

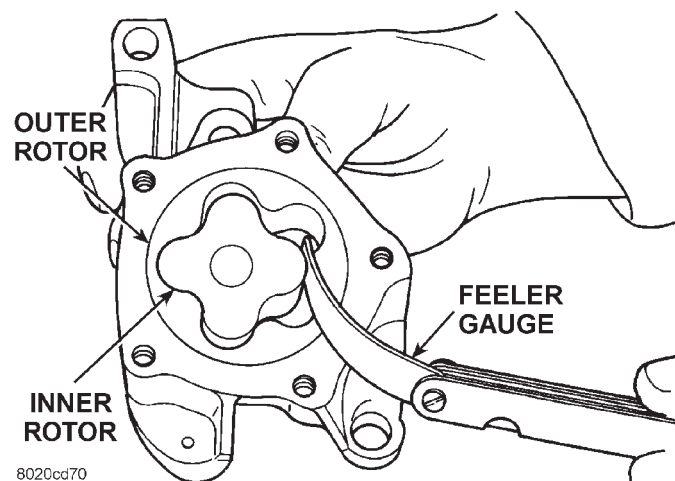


Fig. 65 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 66).

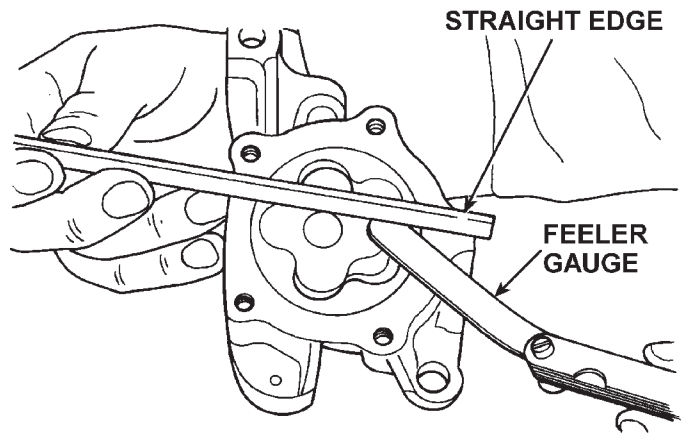


Fig. 66 Measuring Clearance Over Rotors

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 in.). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 in.). Replace spring that fails to meet these specifications (Fig. 67).

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

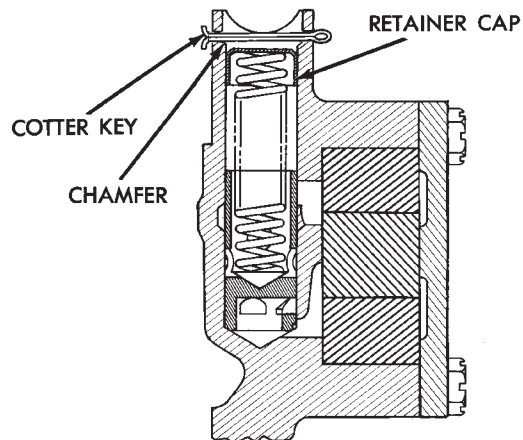


Fig. 67 Proper Installation of Retainer Cap
OIL PAN

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.

CLEANING AND INSPECTION (Continued)

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. 68). Improper installation or plug missing could cause erratic, low, or no oil pressure.

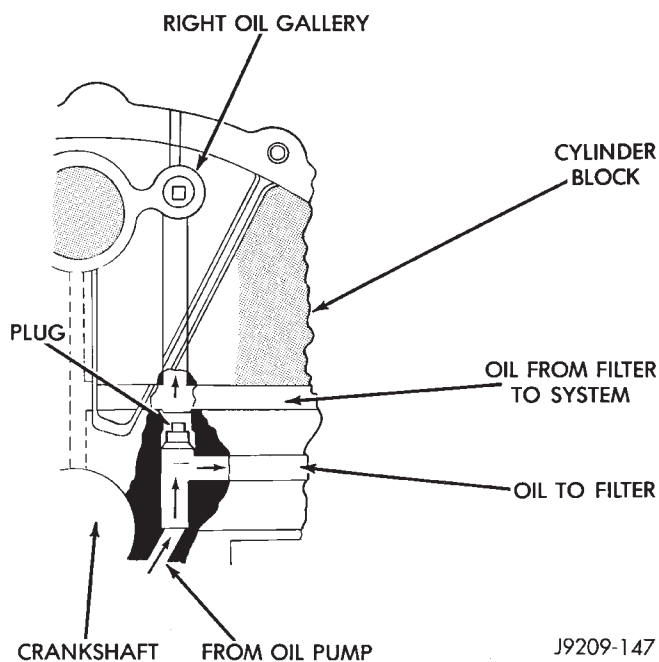
The oil plug must come out the bottom. Use flat dowel, down the oil pressure sending unit hole from the top, to remove oil plug.

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

(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.



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Fig. 68 Oil Line Plug

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
Connecting Rods	. . . . . Forged Steel
Combustion Pressure (Min.)	. . . . . 689.5 kPa (100 psi)

SPECIFICATIONS (Continued)

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.)

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.)

SPECIFICATIONS (Continued)

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.)

PISTON PINS

Clearance in Piston	.0.0064 – 0.0191 mm (0.00025 – 0.00075 in.)
Clearance in Rod (Interference)	.0.0178 – 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°

SPECIFICATIONS (Continued)

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.

J9309-82

TORQUE SPECIFICATIONS

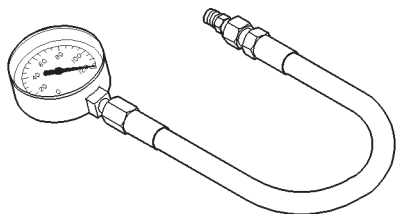
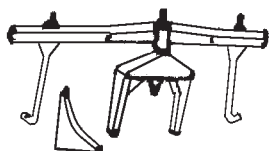
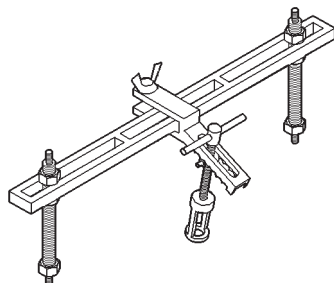
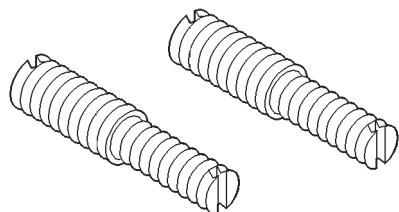
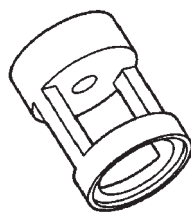
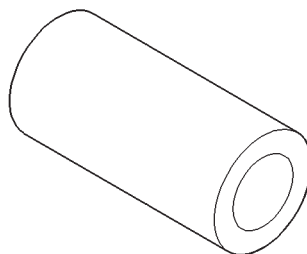
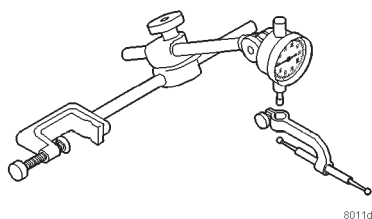
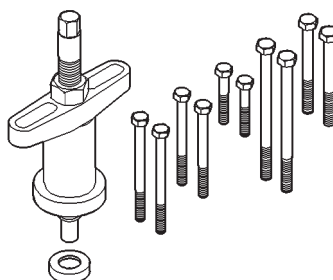
3.9L Engine

DESCRIPTION	TORQUE
Camshaft	
Bolt . . . . .	.68 N·m (50 ft. 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	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Exhaust Manifold-to-Cylinder Head	
Bolts/Nuts . . . . .	.34 N·m (25 ft. lbs.)
Front Insulator	
Through bolt/nut . . . . .	.95 N·m (70 ft. lbs.)
Front Insulator to Support Bracket	
Stud nut . . . . .	.41 N·m (30 ft. lbs.)
Through bolt/nut . . . . .	.102 N·m (75 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.)

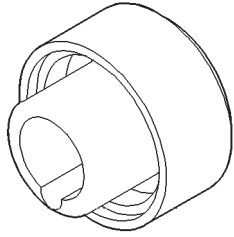
DESCRIPTION	TORQUE
Oil Pump	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Rear Insulator-to-Crossmember	
Nuts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Transmission	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket	
Bolts . . . . .	.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.)
Timing Chain Tensioner	
Bolts . . . . .	.24 N·m (210 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.)
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

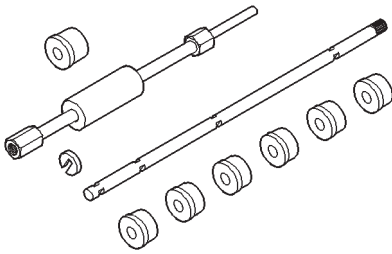
3.9L ENGINE

***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***

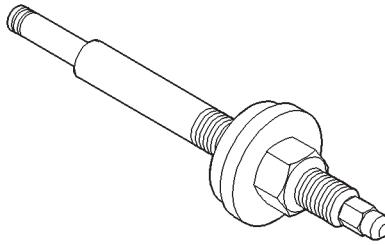
SPECIAL TOOLS (Continued)



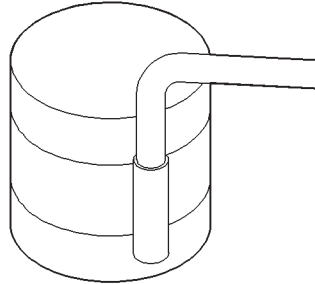
Front Oil Seal Installer 6635



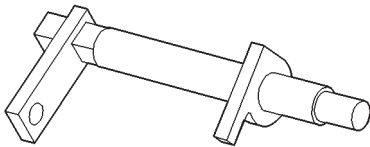
Cam Bearing Remover/Installer C-3132-A



Distributor Bushing Driver/Burnisher C-3053

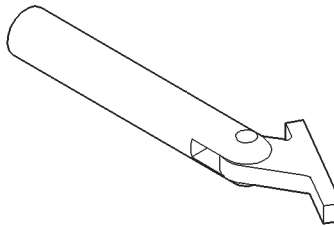


Piston Ring Compressor C-385

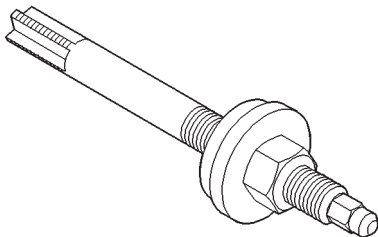


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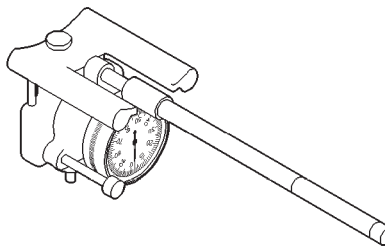
Camshaft Holder C-3509



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

GENERAL INFORMATION

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

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

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

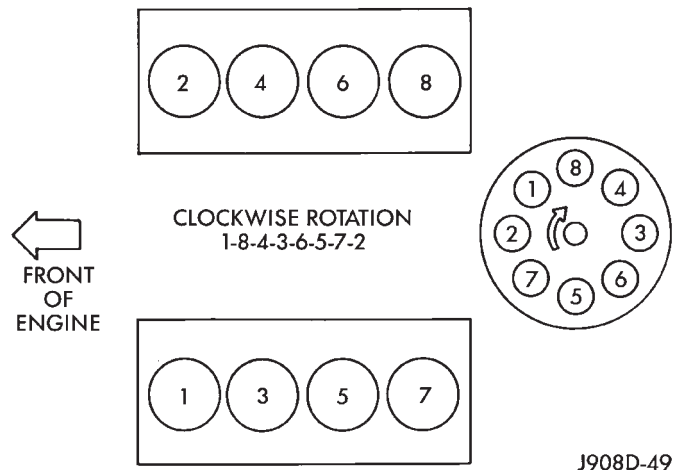


Fig. 1 Firing Order

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

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.

J9209-73

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 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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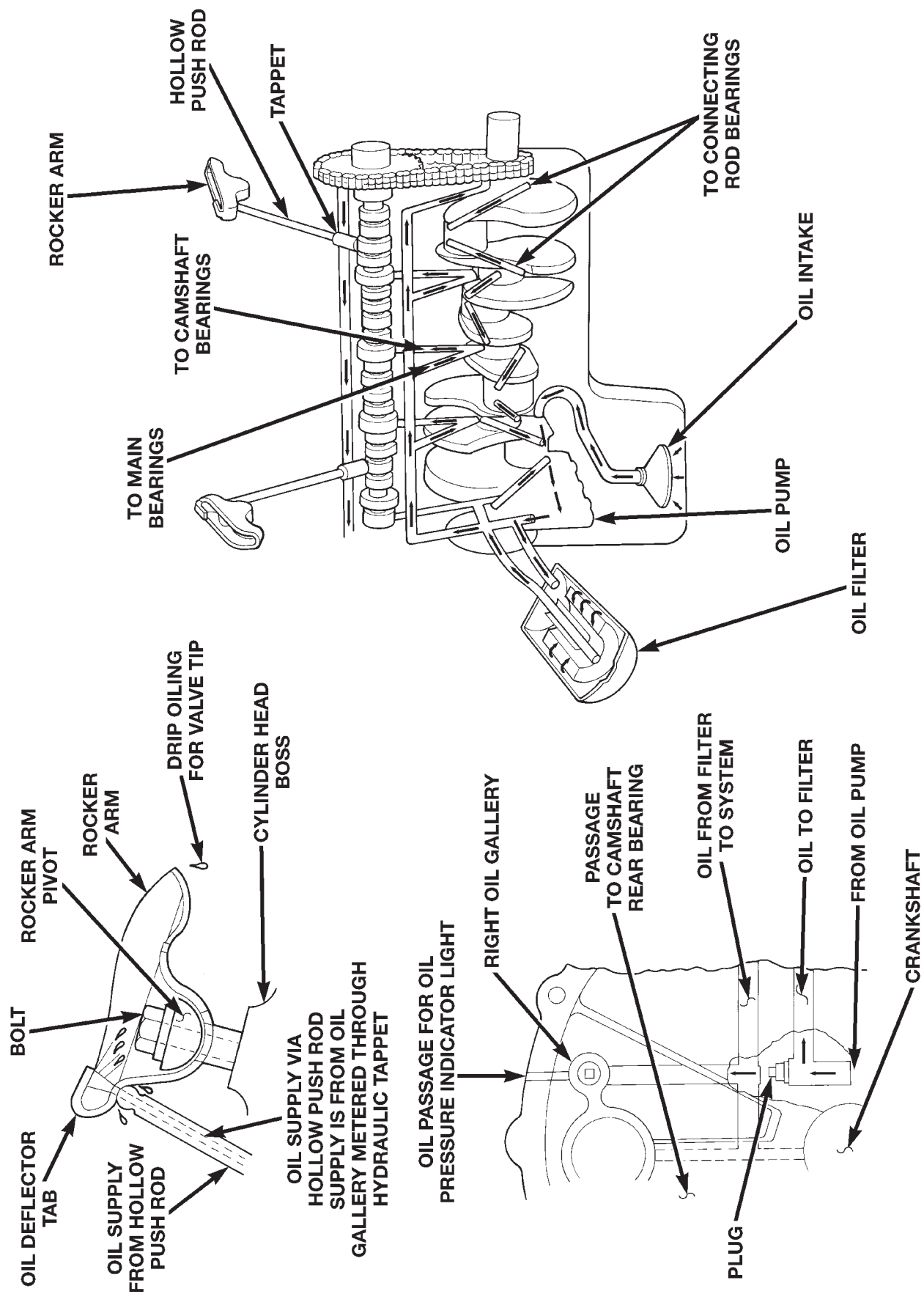


Fig. 3 Oil Lubrication System

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.

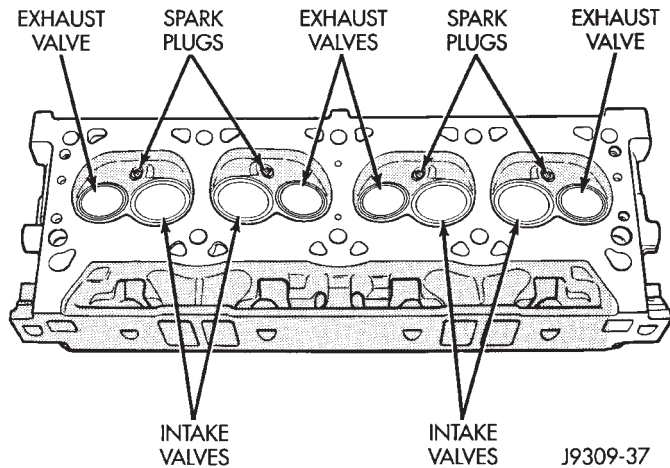


Fig. 4 Cylinder Head Assembly

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 0.254 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.

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).

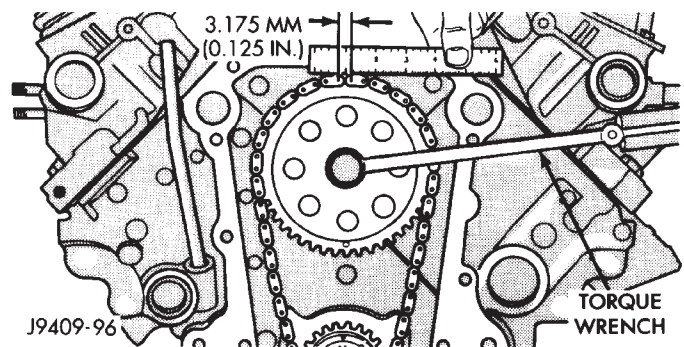


Fig. 5 Measuring Timing Chain Wear and Stretch

(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.

SERVICE PROCEDURES (Continued)

- (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).

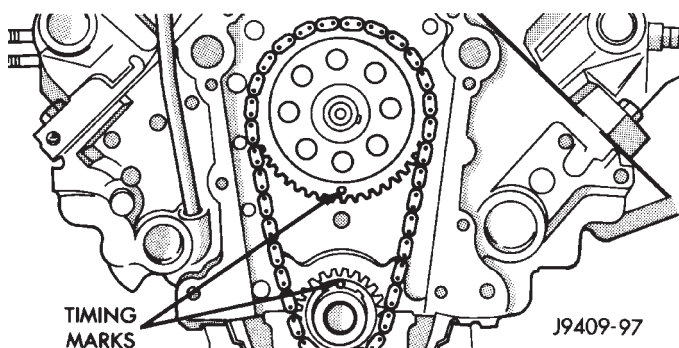


Fig. 6 Alignment of Timing Marks

- (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 location A in (Fig. 7). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

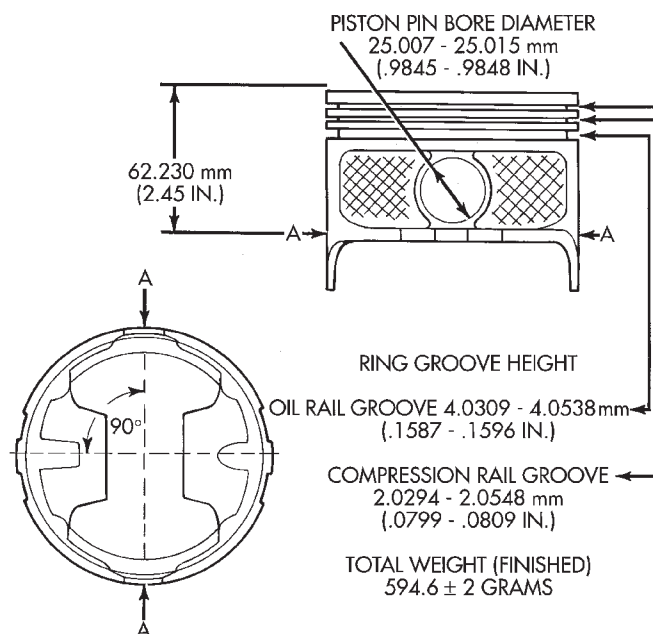
Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

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)

J9509-80

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.

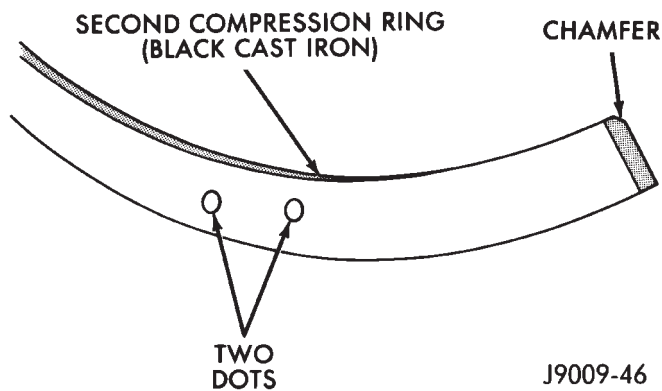


Fig. 8 Second Compression Ring Identification (Typical)

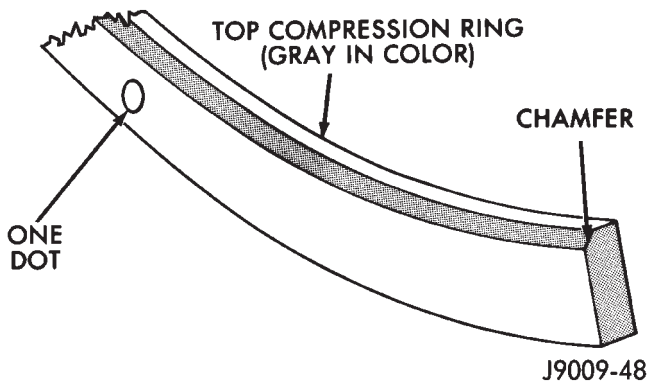


Fig. 9 Top Compression Ring Identification (Typical)

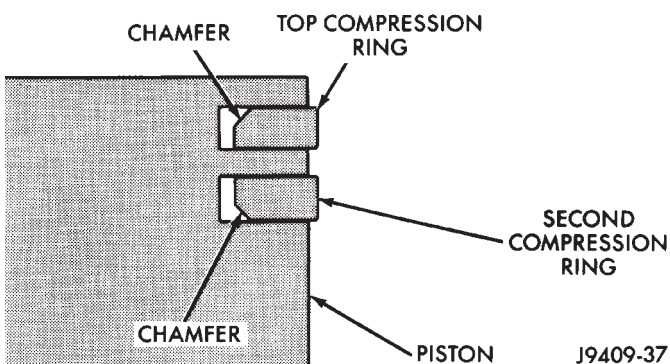


Fig. 10 Compression Ring Chamfer Location (Typical)

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.

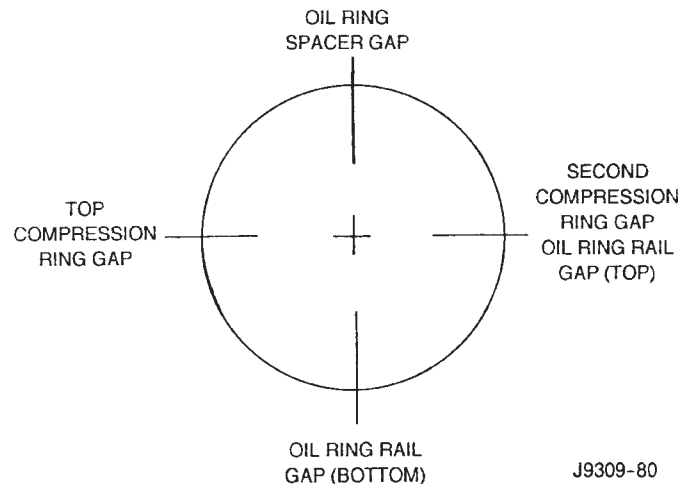


Fig. 11 Proper Ring Installation

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.

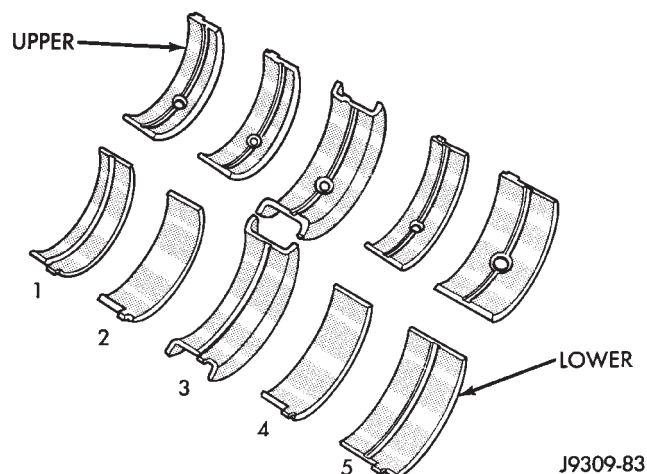
Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 12). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 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).

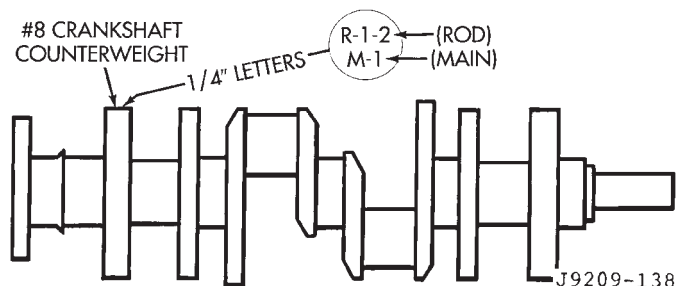
FOR EXAMPLE: R2 stamped on the No.8 crankshaft counterweight indicates that the No.2 rod jour-

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

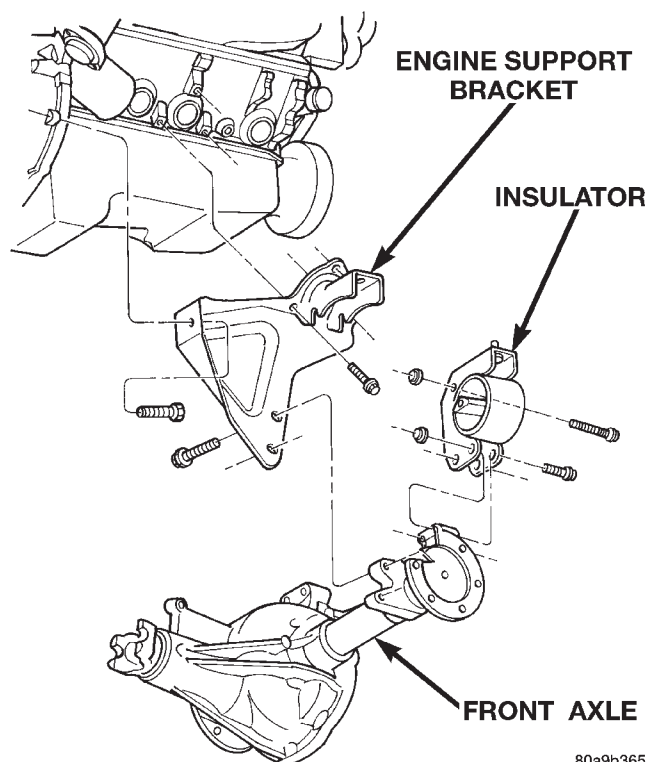
ENGINE MOUNTS—FRONT

REMOVAL

On 4WD vehicles the engine front support brackets attach directly to engine block and the axle housing. The brackets provide a solid interconnection for these units (Fig. 14) (Fig. 15). Engine must be supported

during any service procedures involving the front support assemblies.

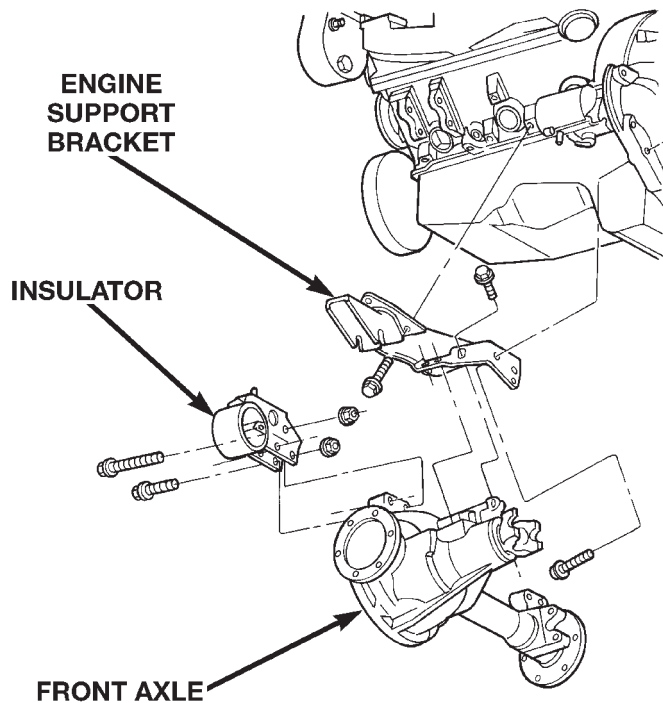
- (1) Disconnect the negative cable from the battery.
- (2) Raise vehicle on hoist.
- (3) Install engine lifting (support) fixture.
- (4) Remove front axle assembly. (Refer to Group 3, Differential and Driveline in this publication.)
- (5) **Left mount insulator only.** Remove starter wires and starter motor assembly.
- (6) Remove insulator to frame through bolt (Fig. 16).
- (7) Raise engine slightly.
- (8) Remove upper insulator to support bracket stud nut and insulator to support through bolt.
- (9) Remove engine mount insulator. (Fig. 14) (Fig. 15).
- (10) If engine support bracket is to be removed/replaced, remove support bracket to transmission bell housing bolt(s) and three (3) support bracket to engine block bolts. Remove support bracket (Fig. 14) (Fig. 15).

**Fig. 14 Right Engine Mount Insulator and Support Bracket**

INSTALLATION—4WD

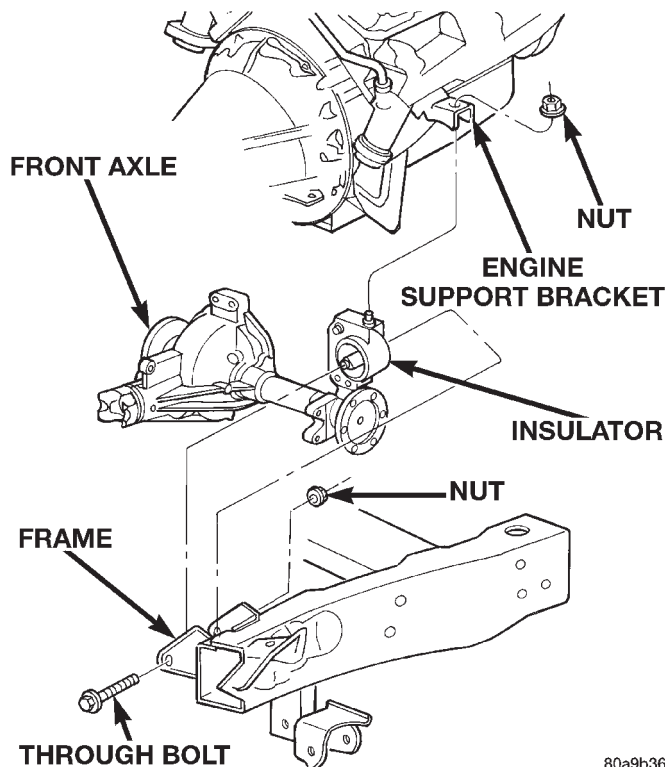
- (1) If engine support brackets were removed, install them and their fasteners (Fig. 14) (Fig. 15). Tighten support bracket to block bolts to 41 N·m (30 ft. lbs.). Tighten support bracket to transmission bellhousing bolt(s) to 88 N·m (65 ft. lbs.).
- (2) Install Engine mount insulator and tighten insulator to support bracket nut to 41 N·m (30 ft.

REMOVAL AND INSTALLATION (Continued)



80a9b366

Fig. 15 Left Engine Mount Insulator and Support Bracket



80a9b367

Fig. 16 Engine Mount Insulator at Frame

lbs.). Tighten insulator to support bracket through bolt nut to 102 N·m (75 ft. lbs.)

(3) Lower engine and install insulator to frame through bolt and nut (Fig. 16). Tighten nut to 95 N·m (70 ft. lbs.)

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

(5) Connect starter wires.

(6) Remove engine lifting (support) fixture.

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

(8) Lower the vehicle.

(9) Connect the negative cable to the battery.

ENGINE MOUNT—REAR

REMOVAL

(1) Disconnect the negative cable from the battery.

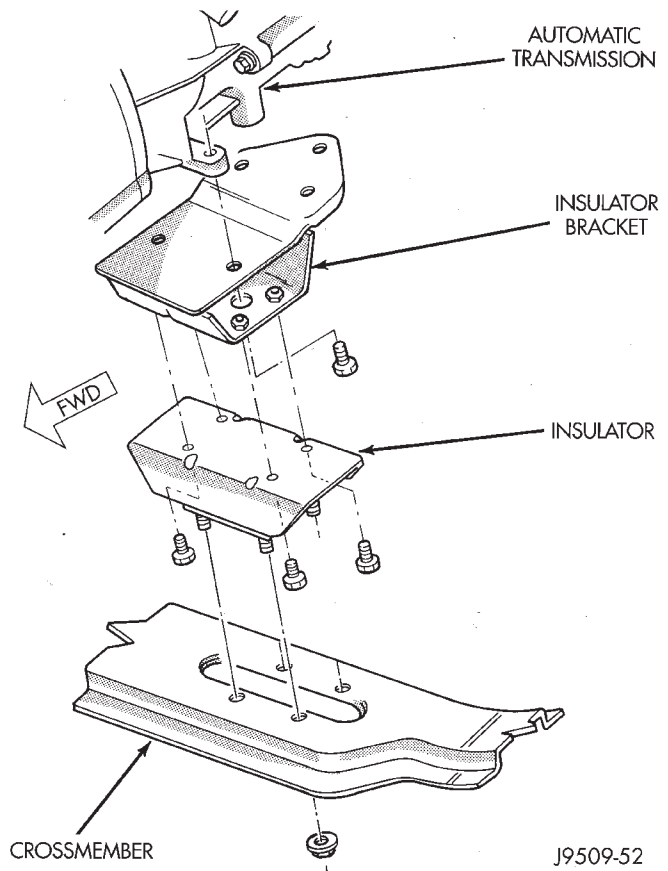
(2) Raise the vehicle on a hoist.

(3) Support the transmission with a transmission jack.

(4) Remove stud nuts holding the insulator to the crossmember (Fig. 17).

(5) Raise rear of transmission SLIGHTLY.

(6) Remove bolts holding the insulator to the insulator bracket (Fig. 17). Remove the insulator.



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Fig. 17 Rear Mount Insulator

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) If the insulator bracket was removed, install the bracket to the transmission (Fig. 17). Tighten the bolts to 28 N·m (250 in. lbs.) torque.

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

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

(4) Remove the transmission jack.

(5) Lower the vehicle.

(6) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

(1) Scribe hood hinge outlines on hood. Remove the hood.

(2) Disconnect the battery negative cable.

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

(4) Remove the air cleaner.

(5) Disconnect the radiator and heater hoses. Remove radiator (refer to Group 7, Cooling System for the correct procedures).

(6) Set fan shroud aside.

(7) Disconnect the vacuum supply lines from the intake manifold.

(8) Remove the distributor cap and wires.

(9) Disconnect the accelerator linkage.

(10) Remove throttle body.

(11) Perform the Fuel System Pressure release procedure (refer to Group 14, fuel System).

(12) Disconnect the fuel supply line.

(13) Disconnect the starter wires.

(14) Disconnect the oil pressure sending unit wire.

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

(16) Disconnect the air conditioning hoses.

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

(18) Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

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

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

(21) Disconnect exhaust pipe at manifold.

(22) Refer to group 21, Transmissions for transmission removal.

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

(23) Install an engine lifting fixture.

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

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

• **RIGHT SIDE**—Remove 2 bracket to axle (disconnect housing) bolts and a bracket to bell housing bolt. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.

(25) Lower the vehicle.

(26) Install engine assembly on engine repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment.

(2) Install an engine support fixture.

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

(4) Install the engine front mounts.

(5) Refer to Group, 21 Transmissions for transmission installation

(6) Install the inspection plate.

(7) Remove transmission support.

(8) Install exhaust pipe to manifold.

(9) Lower the vehicle.

(10) Remove engine lifting fixture.

(11) Install the generator (refer to Group 8B, Battery/Starter/Generator Service).

(12) Install starter motor (refer to Group 8B, Battery/Starter/Generator Service).

(13) Connect power steering hoses, if equipped.

(14) Connect air conditioning hoses.

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

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

(17) Connect the accelerator linkage.

(18) Connect the starter wires.

(19) Connect the oil pressure sending unit wire.

(20) Install the distributor cap and wiring.

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

(22) Connect the fuel supply line.

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

(24) Install fan shroud in position.

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

(26) Install the air cleaner.

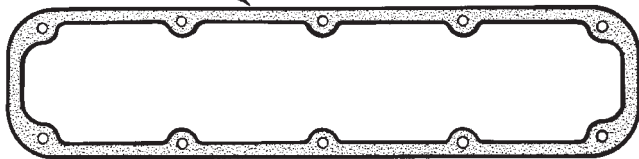
REMOVAL AND INSTALLATION (Continued)

- (27) Install the battery.
- (28) Warm engine and adjust.
- (29) Install hood and line up with the scribe marks.
- (30) Road test vehicle.

CYLINDER HEAD COVER

A steel backed silicon gasket is used with the cylinder head cover (Fig. 18). This gasket can be used again.

CYLINDER HEAD COVER GASKET



J9209-105

Fig. 18 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) 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.

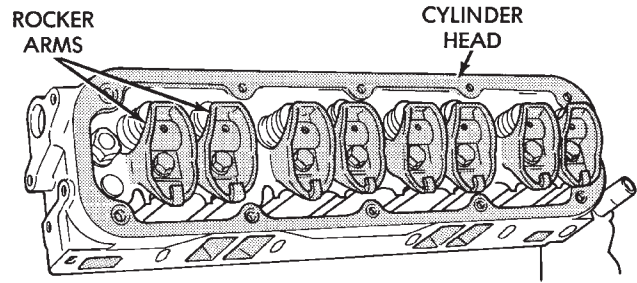
ROCKER ARMS AND PUSH RODS

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. 19). 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.

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.



J9209-65

Fig. 19 Rocker Arms

- (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.
- (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.

REMOVAL AND INSTALLATION (Continued)

- (12) Install rocker arms.
- (13) Install covers and coil wire to distributor.
- (14) Install air cleaner.
- (15) Road test vehicle.

CYLINDER HEAD

REMOVAL

- (1) Disconnect the battery negative cable.
- (2) Drain cooling system (refer to 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.
- (7) Perform fuel system pressure release procedure. Refer to Group 14, Fuel Systems for the correct procedure.
- (8) Disconnect the fuel supply line.
- (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. 20). 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.

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.

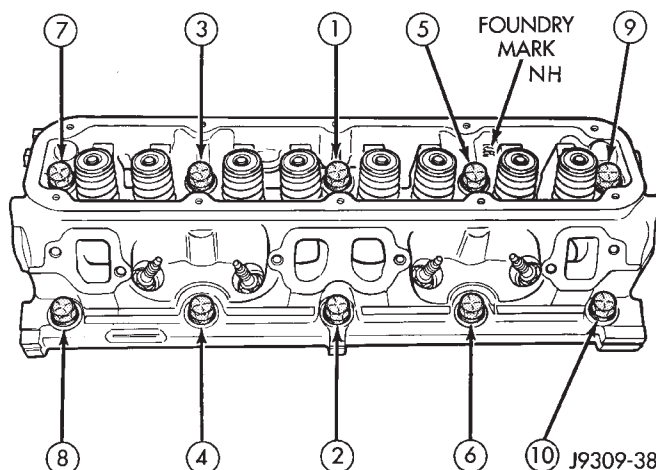


Fig. 20 Cylinder Head Bolt Tightening Sequence

- (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 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 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.
- (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.

REMOVAL AND INSTALLATION (Continued)

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, rocker assembly and push rods. Identify push rods to ensure installation in original location.
- (3) Remove intake manifold, yoke retainer and aligning yokes.
- (4) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.
- (5) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

INSTALLATION

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

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

VIBRATION DAMPER

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove fan shroud retainer bolts and set shroud back over engine.
- (3) Remove the cooling system fan.
- (4) Remove the serpentine belt (refer to Group 7, Cooling System).
- (5) Remove the vibration damper pulley.
- (6) Remove vibration damper bolt and washer from end of crankshaft.
- (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. 21).

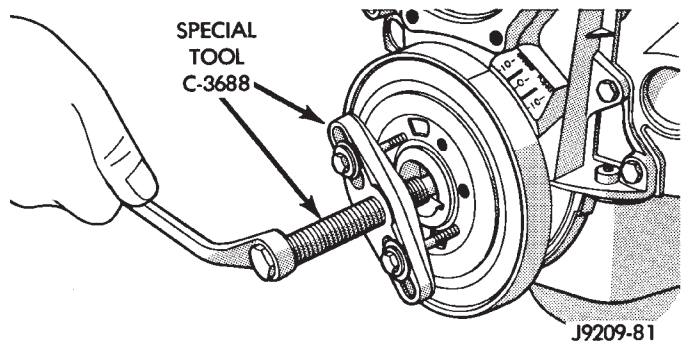


Fig. 21 Vibration Damper Assembly

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

INSTALLATION

- (1) Position the vibration damper onto the crankshaft.

REMOVAL AND INSTALLATION (Continued)

(2) Place installing tool, part of Puller Tool Set C-3688 in position and press the vibration damper onto the crankshaft (Fig. 22).

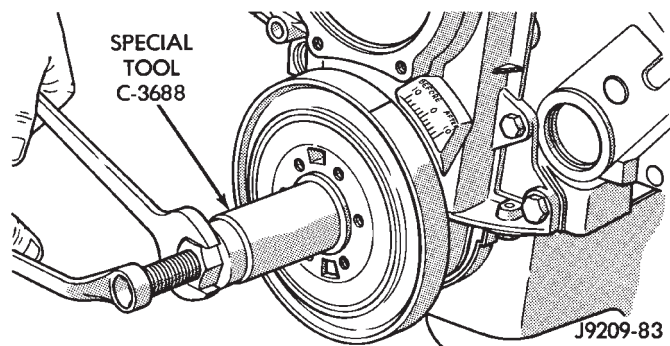


Fig. 22 Installing Vibration Damper

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

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

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

(8) Connect the negative cable to the battery.

TIMING CHAIN COVER

(1) Disconnect the negative cable from the battery.
(2) Drain cooling system (refer to Group 7, Cooling System).

(3) Remove the serpentine belt (refer to Group 7, Cooling System).

(4) Remove water pump (refer to Group 7, Cooling System).

(5) Remove power steering pump (refer to Group 19, Steering).

(6) Remove vibration damper.

(7) Remove fuel lines (refer to Group 14, Fuel System).

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

(9) Remove the cover bolts.

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

(11) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 23).

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.

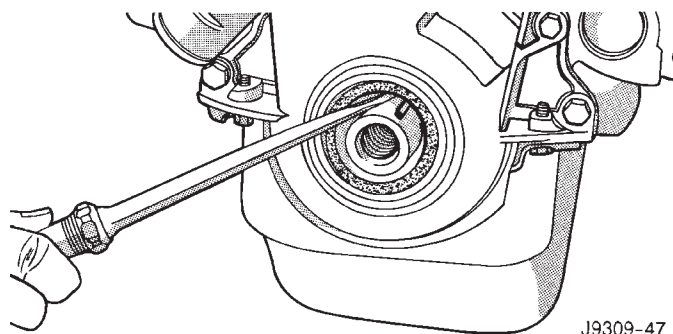


Fig. 23 Removal of Front Crankshaft Oil Seal

(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. 24). Seat the oil seal in the groove of the tool.

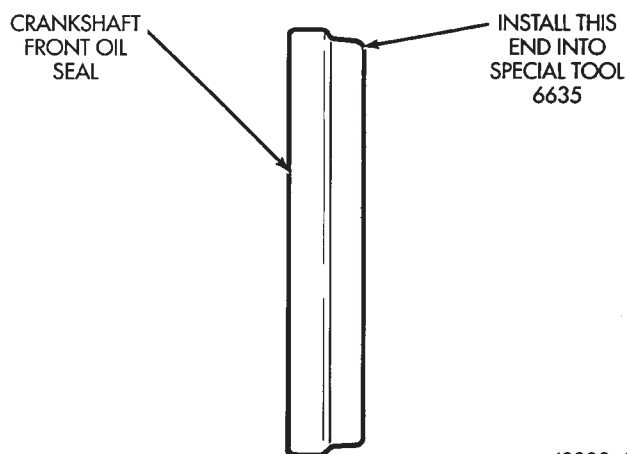


Fig. 24 Placing Oil Seal on Installation Tool 6635

(5) Position the seal and tool onto the crankshaft (Fig. 25).

(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. 26).

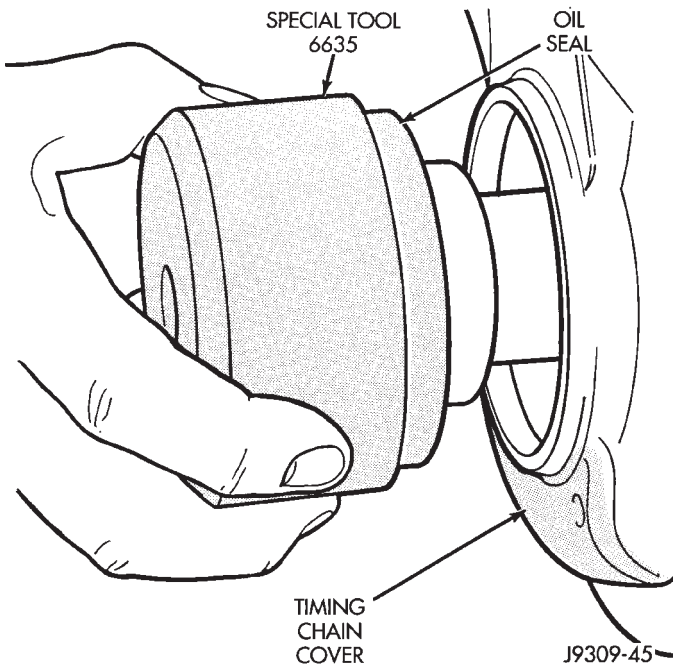
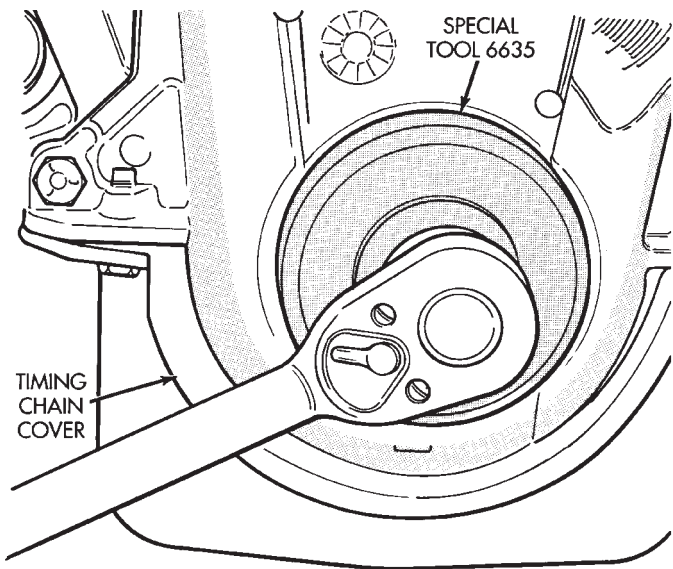
(8) Loosen the 4 bolts tightened in step 4 to allow realignment of front cover assembly.

(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) Install vibration damper.

REMOVAL AND INSTALLATION (Continued)

**Fig. 25 Position Tool and Seal onto Crankshaft****Fig. 26 Installing Oil Seal**

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

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

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

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

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

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

(18) Connect the negative cable to the battery.

TIMING CHAIN**REMOVAL**

(1) 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

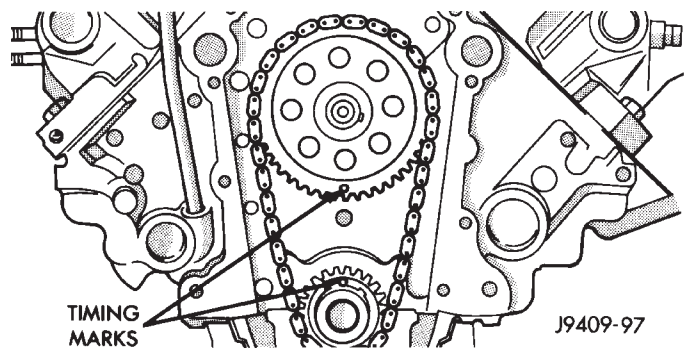
(1) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on exact imaginary center line through both camshaft and crankshaft bores.

(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. 27).

**Fig. 27 Alignment of Timing Marks**

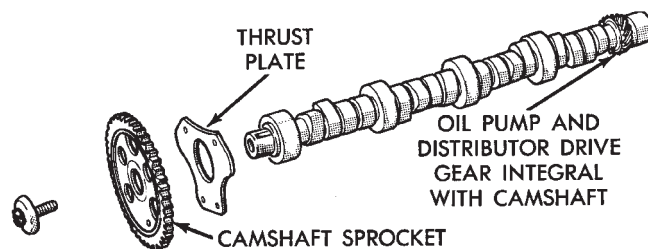
(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

(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. 28).

REMOVAL AND INSTALLATION (Continued)

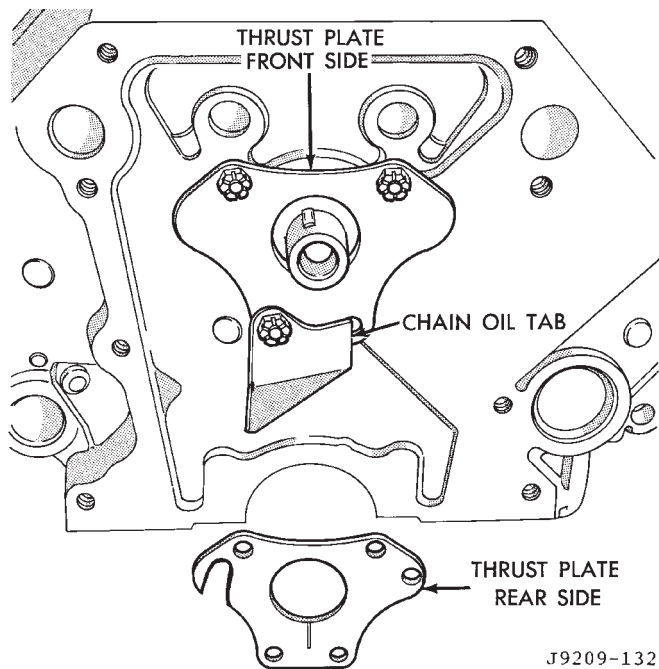


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Fig. 28 Camshaft and Sprocket Assembly

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. 29).



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Fig. 29 Timing Chain Oil Tab Installation

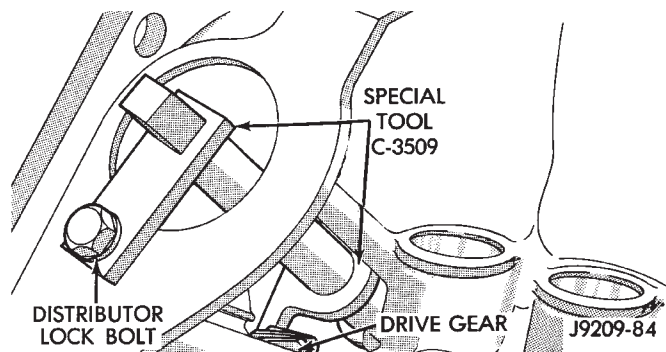
- (8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

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. 30).

**Fig. 30 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.) 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. 31).

- (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.**

REMOVAL AND INSTALLATION (Continued)

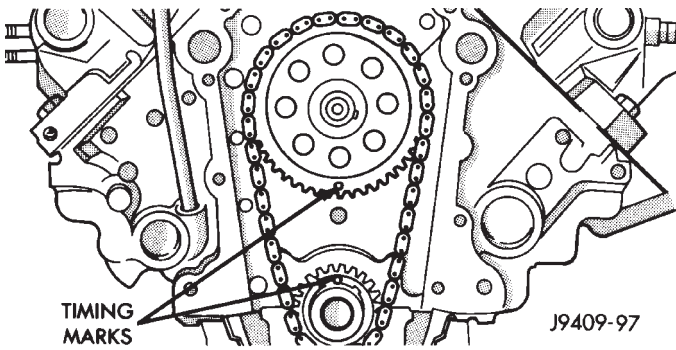


Fig. 31 Alignment of Timing Marks

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. 32).

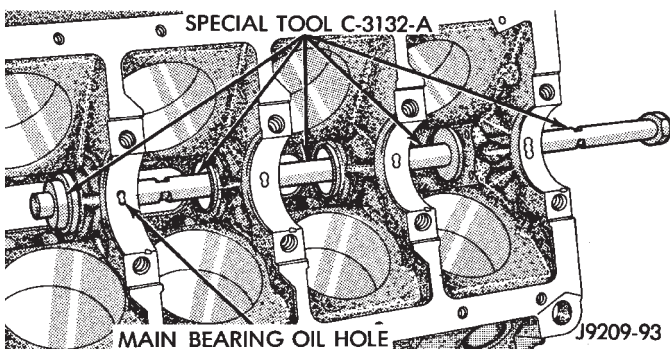


Fig. 32 Camshaft Bearings Removal/Installation with Tool C-3132-A

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 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. 33).
- (5) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

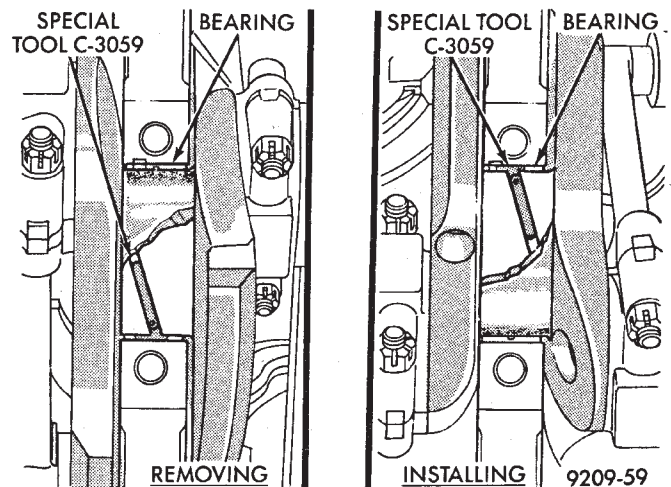


Fig. 33 Upper Main Bearing Removal and Installation with Tool C-3059

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. 33).
- (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.

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

- (1) Remove distributor, refer to Group 8D, Ignition Systems for the proper procedure.

REMOVAL AND INSTALLATION (Continued)

(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. 34).

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

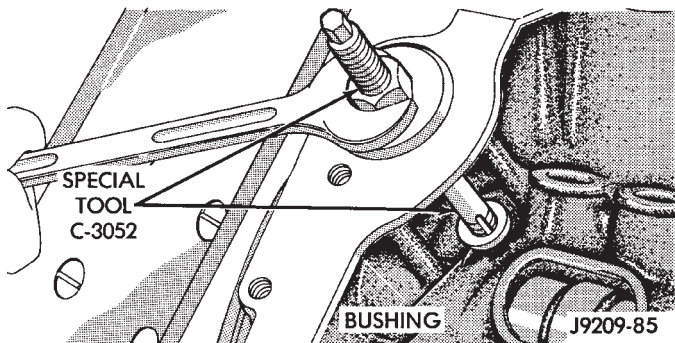


Fig. 34 Distributor Driveshaft Bushing Removal

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. 35).

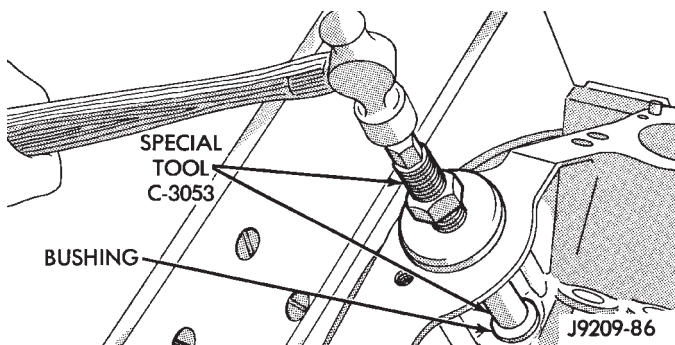


Fig. 35 Distributor Driveshaft Bushing Installation

(3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 36). **DO NOT ream this bushing.**

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

(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.

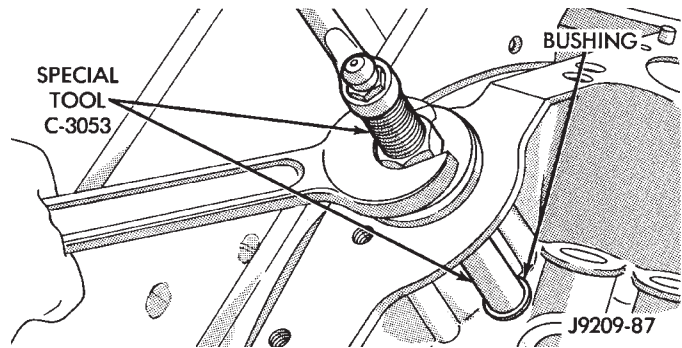


Fig. 36 Burnishing Distributor Driveshaft Bushing

(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. 37).

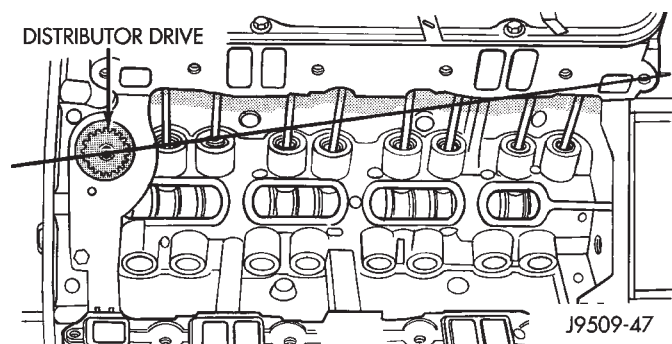


Fig. 37 Position of Oil Pump Shaft Slot

(4) Install distributor, refer to Group 8D, Ignition Systems for the proper procedure.

After the distributor has been installed, its rotational position must be set using the **SET SYNC** mode of the DRB scan tool. Refer to Checking Distributor Position following the Distributor Installation section in Group 8D, Ignition system.

Do not attempt to adjust ignition timing by rotating the distributor. It has no effect on ignition timing. Adjusting distributor position will effect fuel synchronization only.

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.

REMOVAL AND INSTALLATION (Continued)

- (5) Remove front axle assembly (refer to Group 3, Differential and Driveline).
- (6) Remove both engine mount support brackets (Refer to Engine Mounts in this section).
- (7) Remove transmission inspection cover.
- (8) Remove oil pan and one-piece gasket.

INSTALLATION

- (1) Fabricate 4 alignment dowels from 1 1/2 x 5/16 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 38).
- (2) Install the dowels in the cylinder block (Fig. 39).

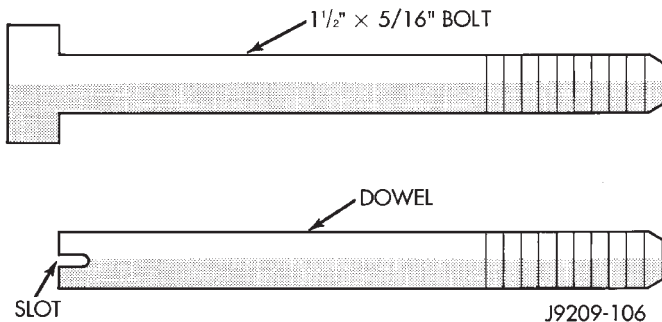


Fig. 38 Fabrication of Alignment Dowels

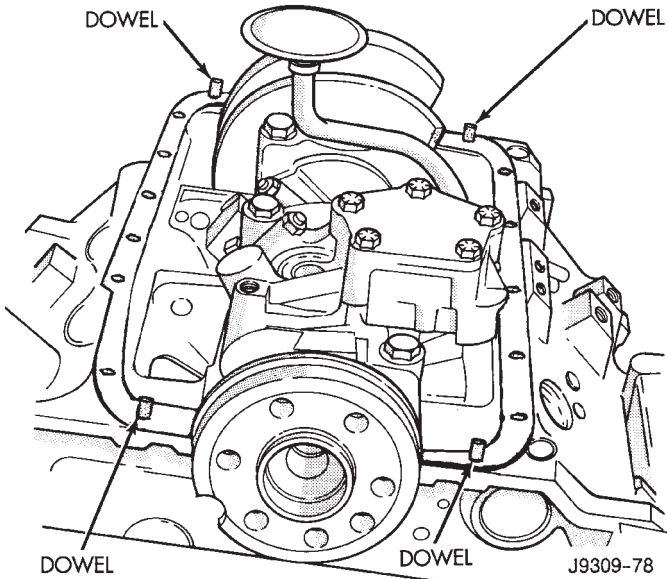


Fig. 39 Position of Dowels in Cylinder Block

- (3) Apply small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
- (4) Slide the one-piece gasket over the dowels and onto the block.
- (5) Position the oil pan over the dowels and onto the gasket.
- (6) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.

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

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

(9) Install transmission inspection cover.

(10) Install engine mount support brackets and insulators (Refer to engine mounts in this section)

(11) Install front axle assembly (refer to Group 3, Differential and Driveline for the proper procedures).

(12) Lower vehicle

(13) Connect the distributor cap.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

(16) Fill crankcase with oil to proper level.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

- (1) Remove the engine from the vehicle.
- (2) Remove the cylinder head.
- (3) Remove the oil pan.
- (4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.

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

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

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

INSTALLATION

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

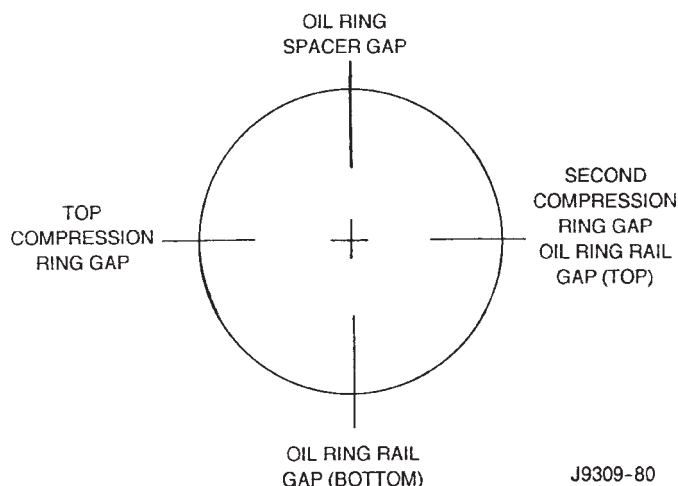
(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 40).

(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.

REMOVAL AND INSTALLATION (Continued)

**Fig. 40 Proper Ring Installation**

(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.

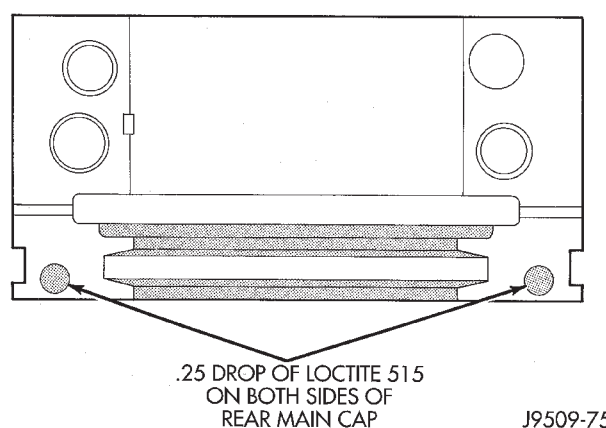
(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.

(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. 41). 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. 41 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) Install the timing chain cover.

(12) Install the vibration damper.

(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. 42). 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.

OIL PUMP**REMOVAL**

(1) Remove the oil pan.

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

REMOVAL AND INSTALLATION (Continued)

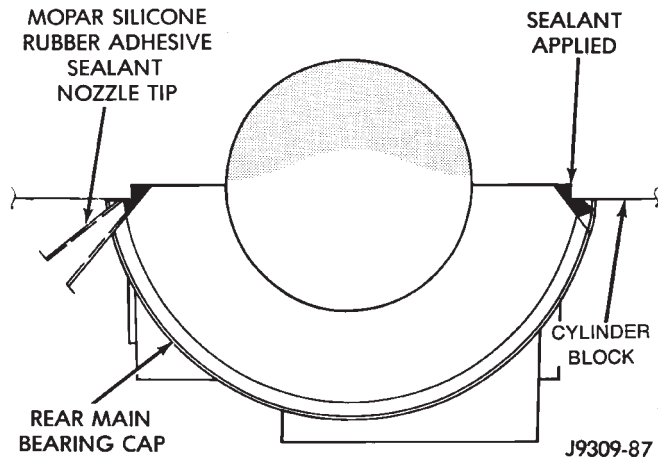


Fig. 42 Apply Sealant to Bearing Cap to Block Joint
INSTALLATION

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

(2) Hold the oil pump base flush against mating surface on No.5 main bearing cap. Finger tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan.

CRANKSHAFT OIL SEAL—FRONT

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

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

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

(5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 43). Seat the oil seal in the groove of the tool.

(6) Position the seal and tool onto the crankshaft (Fig. 44).

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 45).

(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.

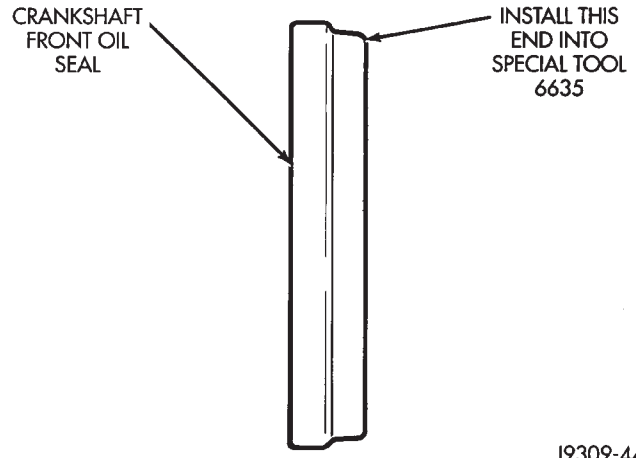


Fig. 43 Placing Oil Seal on Installation Tool 6635

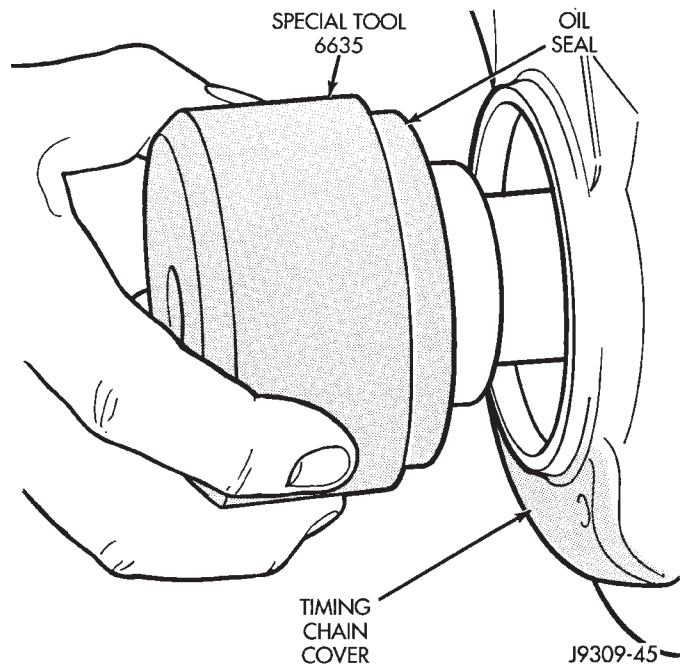


Fig. 44 Position Tool and Seal onto Crankshaft

CRANKSHAFT OIL SEALS—REAR

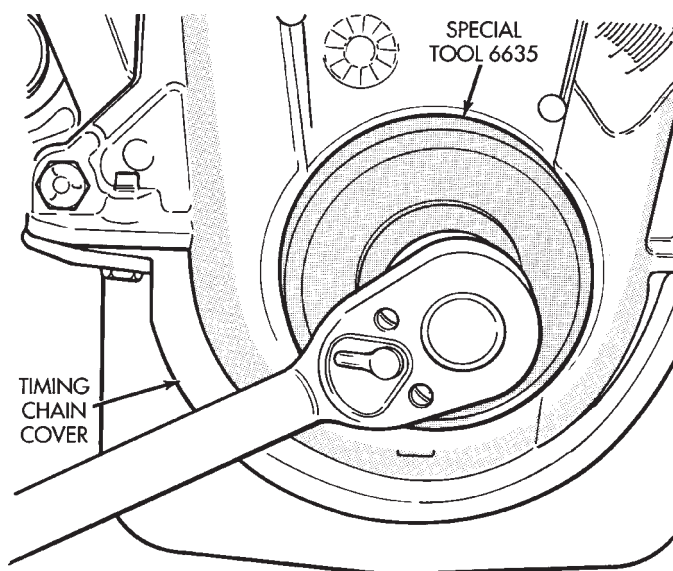
The service seal is a 2 piece, viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can only be installed with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

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

REMOVAL AND INSTALLATION (Continued)



J9309-46

Fig. 45 Installing Oil 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.

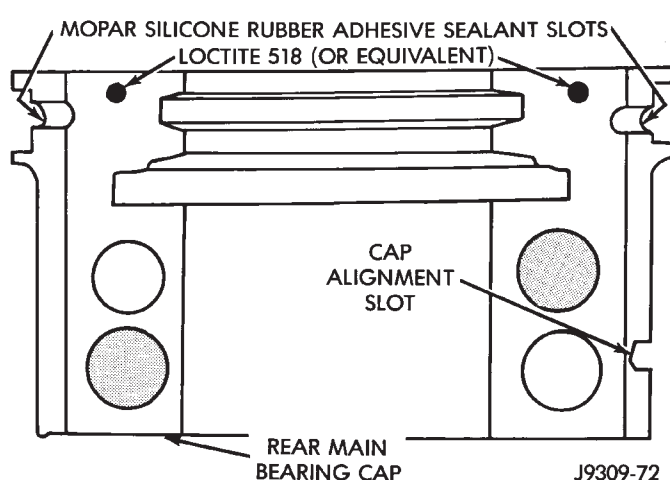
(7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 46). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(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) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 47). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

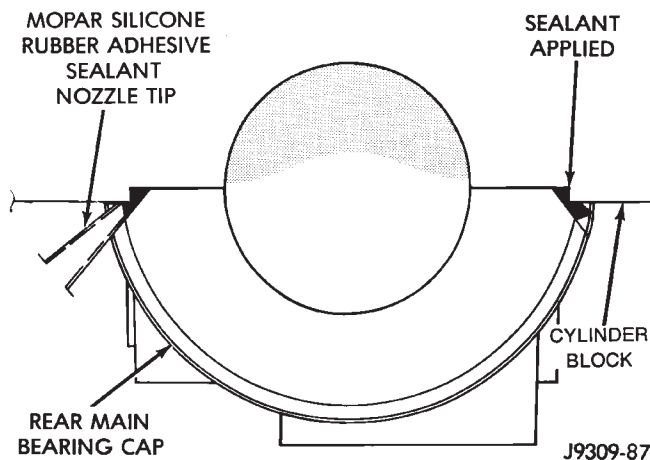


J9309-72

Fig. 46 Sealant Application to Bearing Cap

(12) Install new front crankshaft oil seal.

(13) Immediately install the oil pan.



J9309-87

Fig. 47 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.

REMOVAL AND INSTALLATION (Continued)

(3) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To 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. 46). 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. 47). 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. 46). 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. 47). 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. 48). This will reduce internal leakage and help maintain higher oil pressure at idle.

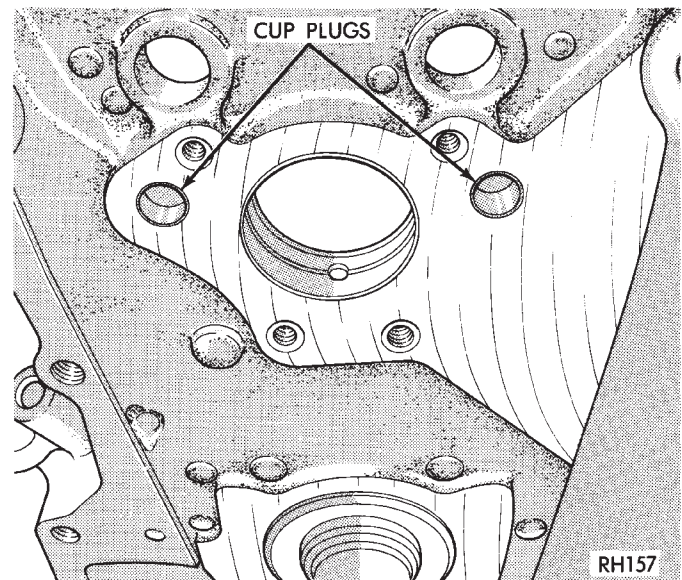


Fig. 48 Location of Cup Plugs in Oil Galleries

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. 49).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 49).

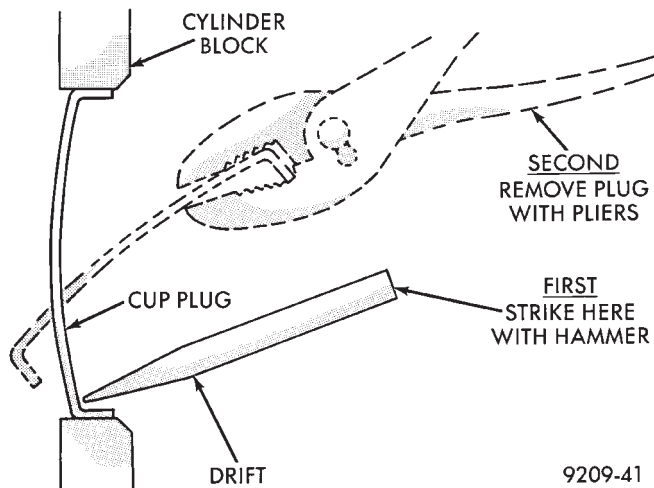
INSTALLATION

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

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

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

REMOVAL AND INSTALLATION (Continued)



9209-41

Fig. 49 Core Hole Plug Removal

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

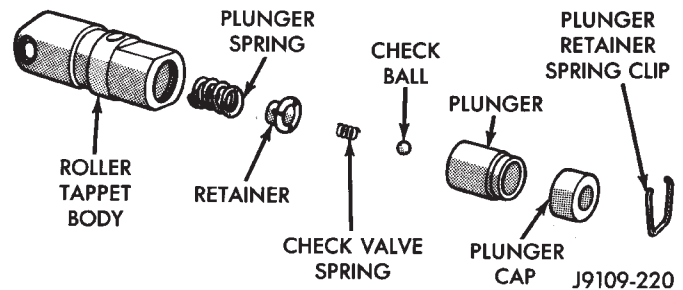
- (1) Pry out plunger retainer spring clip (Fig. 50).
- (2) Clean varnish deposits from inside of tappet body above plunger cap.
- (3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 50). Check valve could be flat or ball.

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. 50).

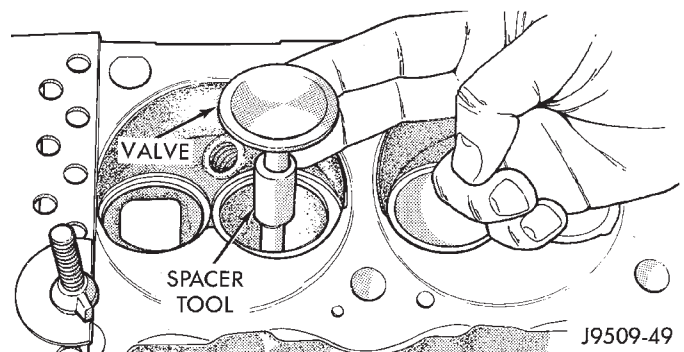
**Fig. 50 Hydraulic Tappet Assembly**

VALVE SERVICE

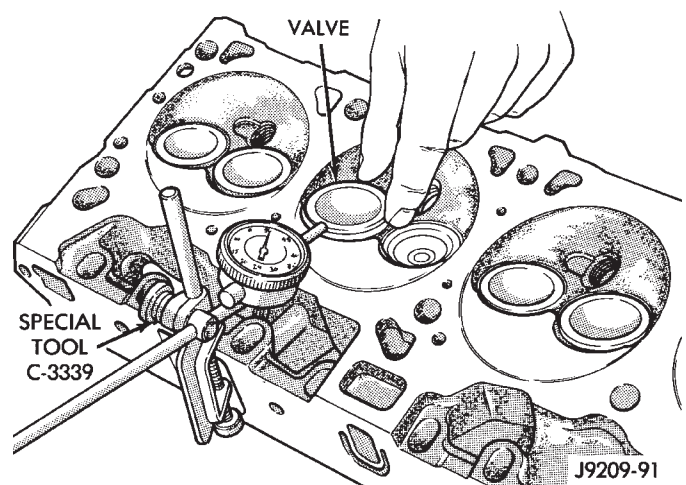
VALVE GUIDES

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 51). The special sleeve places the valve at the correct height for checking with a dial indicator.

**Fig. 51 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. 52).

**Fig. 52 Measuring Valve Guide Wear**

DISASSEMBLY AND ASSEMBLY (Continued)

(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. 53).

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

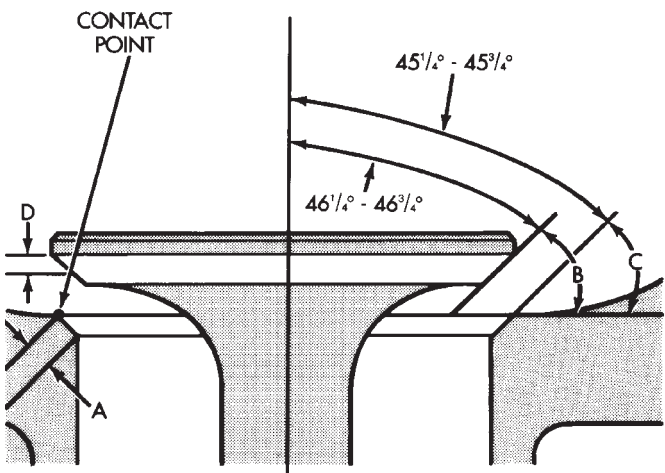
Fig. 53 Reamer Sizes

(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 $43\frac{1}{4}^\circ$ to $43\frac{3}{4}^\circ$ face angle and a $44\frac{1}{4}^\circ$ to $44\frac{3}{4}^\circ$ seat angle (Fig. 54).



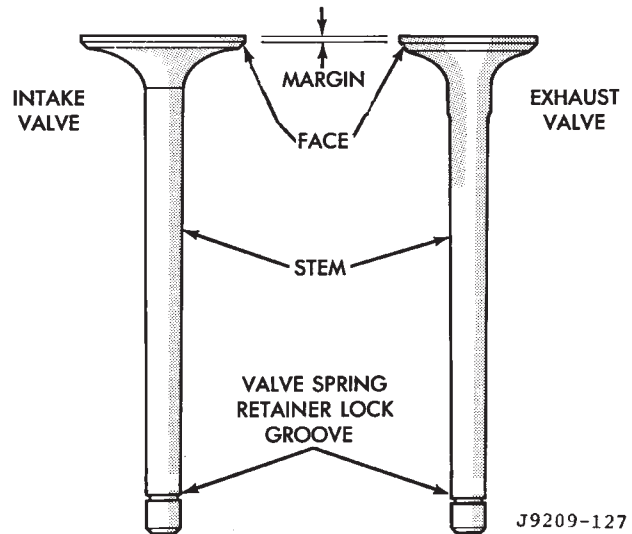
- A - SEAT WIDTH - INTAKE 1.016 – 1.524 mm (0.040 – 0.060 in.)
EXHAUST 1.524 – 2.032 mm (0.060 – 0.080 in.)
B - FACE ANGLE (INTAKE & EXHAUST) $43\frac{1}{4}^\circ$ – $43\frac{3}{4}^\circ$
C - SEAT ANGLE (INTAKE & EXHAUST) $44\frac{1}{4}^\circ$ – $44\frac{3}{4}^\circ$
D - CONTACT SURFACE

J9309-95

Fig. 54 Valve Face and Seat Angles

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 55). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.



J9209-127

Fig. 55 Intake and Exhaust Valves

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 56).

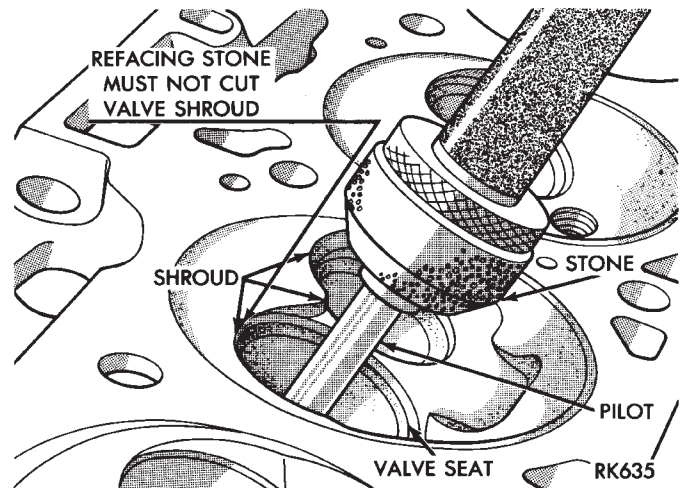


Fig. 56 Refacing Valve Seats

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

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

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

DISASSEMBLY AND ASSEMBLY (Continued)

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. 57). 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.

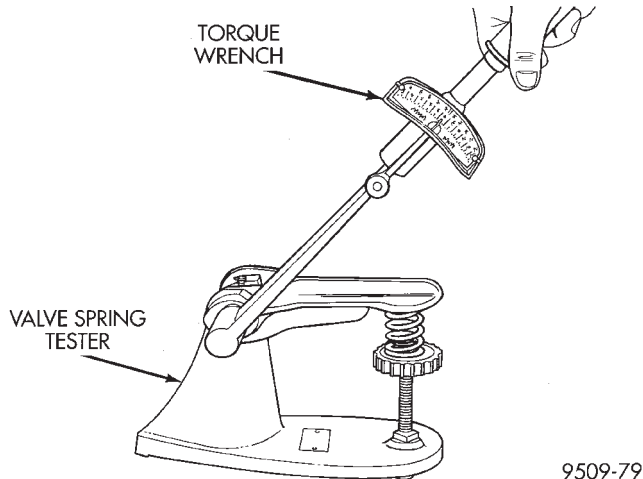


Fig. 57 Testing Valve Spring for Compressed Length

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. 58).

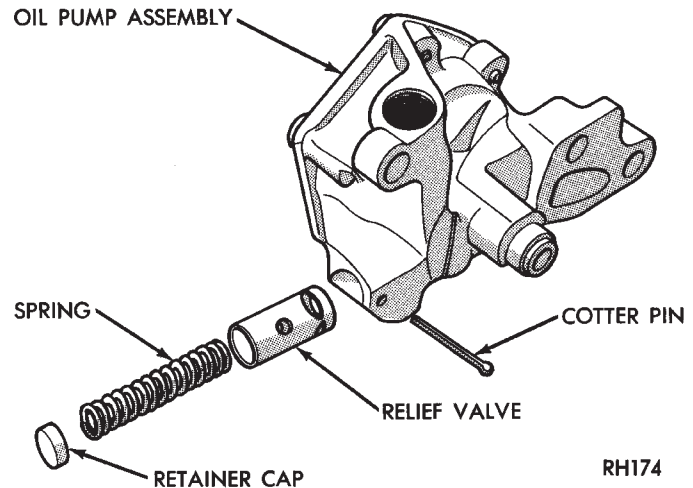


Fig. 58 Oil Pressure Relief Valve

- (2) Remove oil pump cover (Fig. 59).
- (3) Remove pump outer rotor and inner rotor with shaft (Fig. 59).
- (4) Wash all parts in a suitable solvent and inspect carefully for damage or wear.

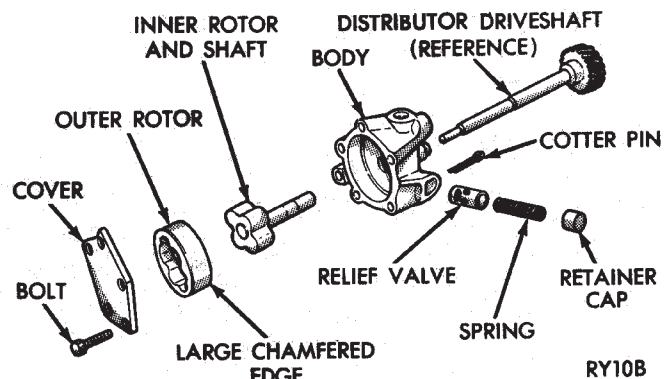


Fig. 59 Oil Pump

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.

CYLINDER BLOCK

DISASSEMBLE

Engine assembly removed from vehicle:

- (1) Remove the cylinder head.
- (2) Remove the oil pan.

DISASSEMBLY AND ASSEMBLY (Continued)

- (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 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 x 0.00075 (12 x 0.00075) equals 0.23 mm (0.009 inch). This amount of out-of-flat is acceptable.
The cylinder head surface finish should be 1.78-3.00 microns (70-125 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. 60).

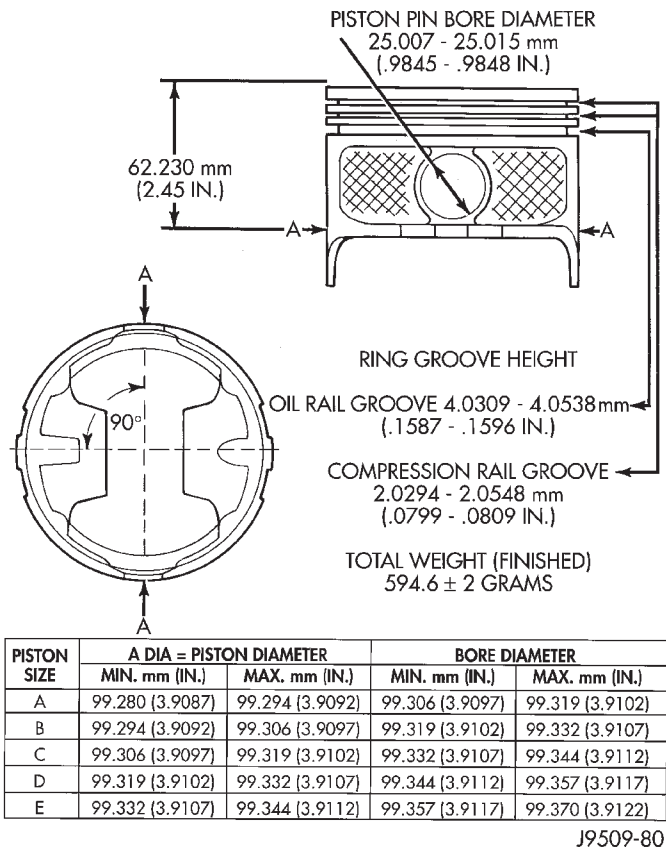


Fig. 60 Piston Measurements

CRANKSHAFT JOURNAL INSPECTION

- 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.

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.

CLEANING AND INSPECTION (Continued)

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

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. 61). If a 0.038 mm (0.0015 in.) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

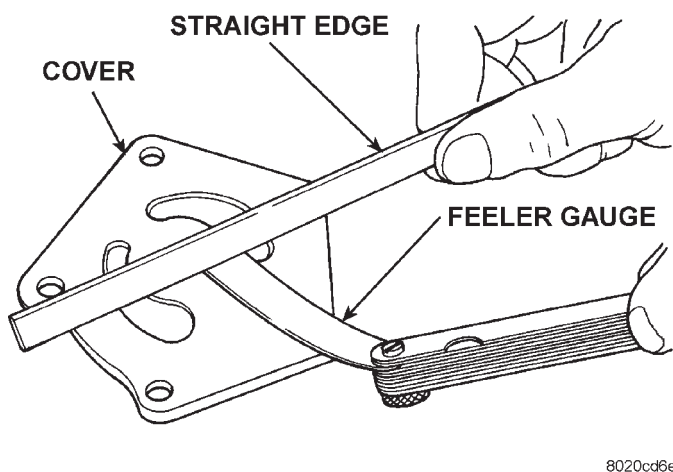


Fig. 61 Checking Oil Pump Cover Flatness

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. 62).

If inner rotor measures 20.9 mm (0.825 in.) or less, replace inner rotor and shaft assembly (Fig. 63).

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 64). If clearance

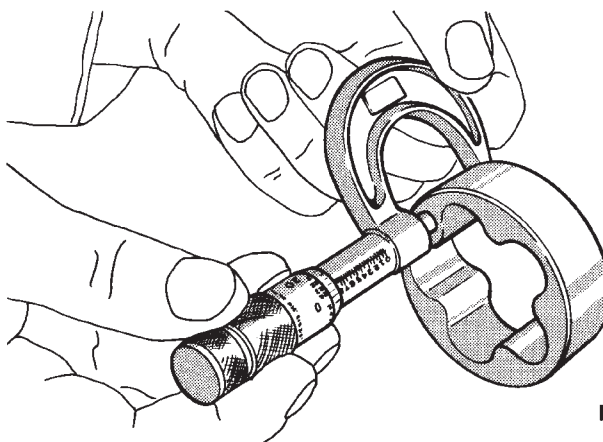


Fig. 62 Measuring Outer Rotor Thickness

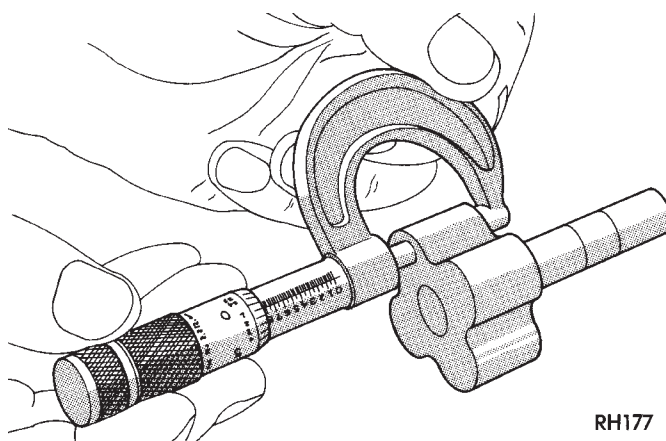


Fig. 63 Measuring Inner Rotor Thickness

is 0.356 mm (0.014 in.) or more, replace oil pump assembly.

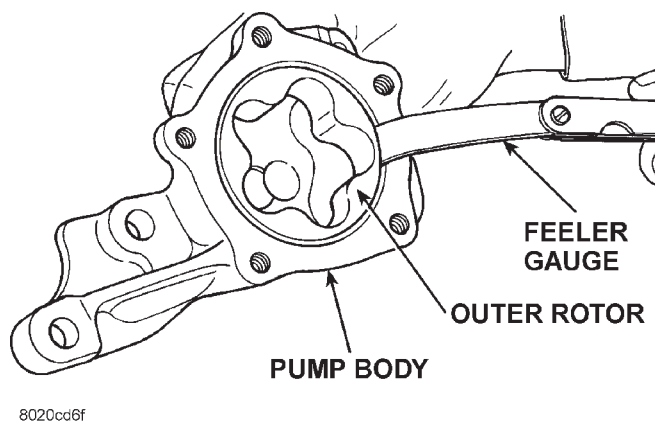


Fig. 64 Measuring Outer Rotor Clearance in Housing

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. 65).

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm

CLEANING AND INSPECTION (Continued)

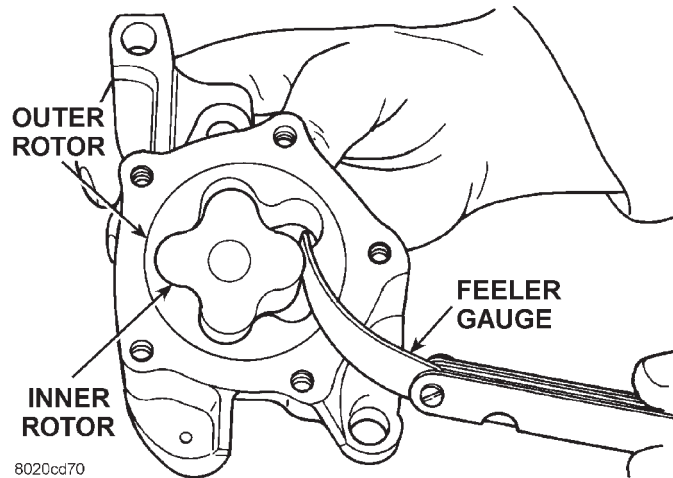


Fig. 65 Measuring Clearance Between Rotors

(0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 66).

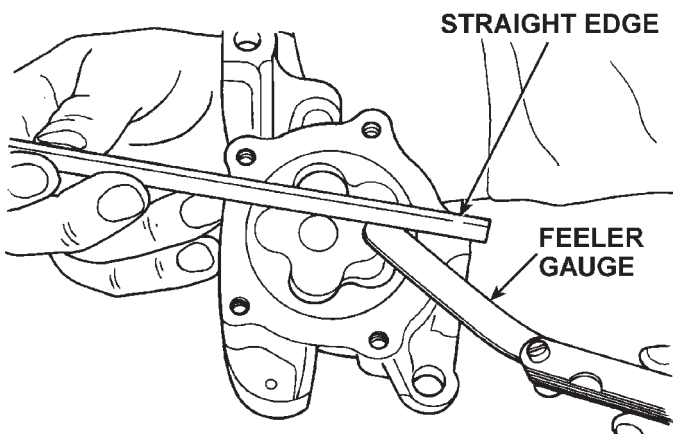


Fig. 66 Measuring Clearance Over Rotors

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 in.). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 in.). Replace spring that fails to meet these specifications (Fig. 67).

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

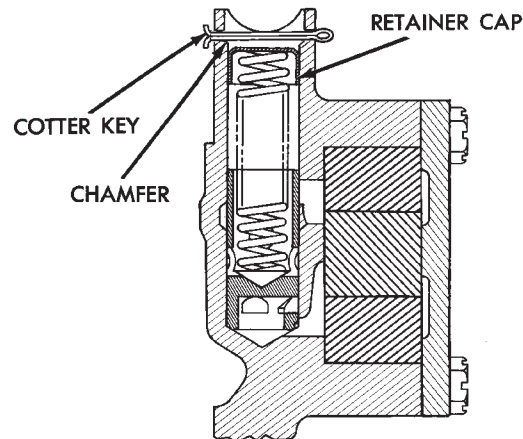


Fig. 67 Proper Installation of Retainer Cap
CYLINDER BLOCK

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

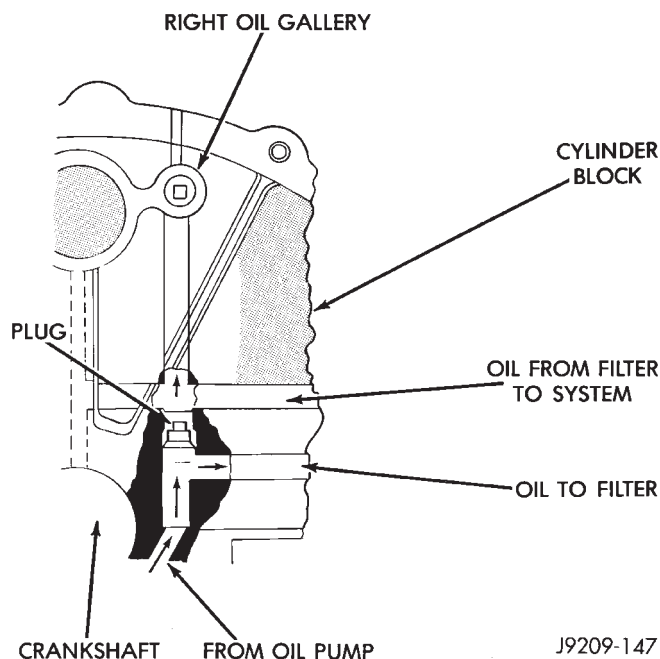


Fig. 68 Oil Line Plug

(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.)
 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
 Combustion Pressure (Min.) 689.5 kPa (100 psi)

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.)

SPECIFICATIONS (Continued)

CRANKSHAFT

Rod Journal

Diameter	53.950 – 53.975 mm (2.124 – 2.125 in.)
Out of Round (Max.) . . . . .	.0254 mm (0.001 in.)
Taper (Max.) . . . . .	.0254 mm (0.001 in.)
Bearing Clearance . . . . .	.0013 – 0.056 mm (0.0005 – 0.0022 in.)
Service Limit . . . . .	.0762 mm (0.003 in.)

Main Bearing Journal

Diameter	63.487 – 63.513 mm (2.4995 – 2.5005 in.)
Out of Round (Max.) . . . . .	.0127 mm (0.001 in.)
Taper (Max.) . . . . .	.0254 mm (0.001 in.)
Bearing Clearance (#1 Journal) . . . . .	.0013 – 0.038 mm (0.0005 – 0.0015 in.)
Service Limit (#1 Journal) . . . . .	.0381 mm (0.0015 in.)
Bearing Clearance (#2-5 Journals) . . . . .	.0013 – 0.051 mm (0.0005 – 0.002 in.)
Service Limit (#2-5 Journals) . . . . .	.064 mm (0.0025 in.)

Crankshaft End Play

End Play . . . . .	.051 – 0.178 mm (0.002 – 0.007 in.)
Service Limit . . . . .	.0254 mm (0.010 in.)

CYLINDER BLOCK

Cylinder Bore

Diameter	99.314 – 99.365 mm (3.910 – 3.912 in.)
Out of Round (Max.) . . . . .	.0127 mm (0.005 in.)
Taper (Max.) . . . . .	.0254 mm (0.010 in.)
Oversize Limit	1.016 mm (0.040 in.)

Lifter Bore

Diameter	22.99 – 23.01 mm (0.9051 – 0.9059 in.)
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Distributor Drive Bushing (Press Fit)

Bushing to Bore Interference00127 – 0.3556 mm (0.0005 – 0.0140 in.)
Shaft to Bushing Clearance . . . . .	.00178 – 0.0686 mm (0.0007 – 0.0027 in.)

CYLINDER HEAD AND VALVES

Valve Seat

Angle	44.25° – 44.75°
Runout (Max.) . . . . .	.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	48.666 mm (1.916 in.)
Head Diameter – Exhaust	41.250 (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	7.950 – 7.976 mm (0.313 – 0.314 in.)
Stem to Guide Clearance . . . . .	.00254 – 0.0762 mm (0.001 – 0.003 in.)
Service Limit (rocking method) . . . . .	.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.)
Number of Coils	6.5
Installed Height	41.66 mm (1.64 in.)
Wire Diameter	4.50 mm (0.177 in.)

HYDRAULIC TAPPETS

Body Diameter	22.949 – 22.962 mm (0.9035 – 0.9040 in.)
Clearance (to bore) . . . . .	.00279 – 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)
Switch Actuating Pressure	34.5 – 48.3 kPa (5 – 7 psi)

CAUTION: If oil pressure is zero at curb idle, DO NOT RUN ENGINE.

SPECIFICATIONS (Continued)

OIL PUMP

Clearance over Rotors (Max.) . . . . .	.01016 mm (0.004 in.)
Cover Out of Flat (Max.) . . . . .	.00381 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.) . . . . .	.0.635 – 1.016 mm (0.025 – 0.040 in.)
Piston Length . . . . .	.86.360 mm (3.40 in.)
Piston Ring Groove Depth – #1&2 . . . . .	.4.572 – 4.826 mm (0.180 – 0.190 in.)
Piston 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.)

PISTON PINS

Clearance in Piston . . . . .	.0.00635 – 0.01905 mm (0.00025 – 0.00075 in.)
Diameter . . . . .	.24.996 – 25.001 mm (0.9841 – 0.9843 in.)
End Play . . . . .	.NONE
Length . . . . .	.75.946 – 76.454 mm (2.990 – 3.010 in.)

PISTON RINGS**Ring Gap**

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

Ring Side Clearance

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

Ring Width

Compression rings . . . . .	.1.971 – 1.989 mm (0.0776 – 0.0783 in.)
Oil Ring (Steel Rails) – Max. . . . .	.3.848 – 3.975 mm (0.1515 – 0.1565 in.)

VALVE TIMING**Exhaust Valve**

Closes (ATDC) . . . . .	.21°
Opens (BBDC) . . . . .	.60°
Duration . . . . .	.264°

Intake Valve

Closes (ATDC) . . . . .	.61°
Opens (BBDC) . . . . .	.10°
Duration . . . . .	.250°
Valve Overlap . . . . .	.31°

SPECIFICATIONS (Continued)

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.

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TORQUE SPECIFICATIONS

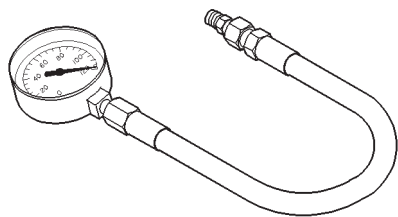
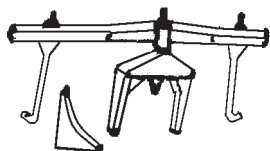
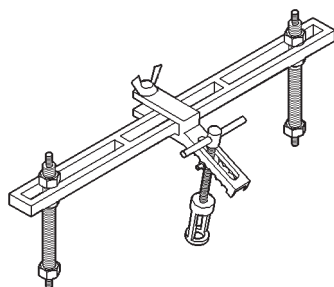
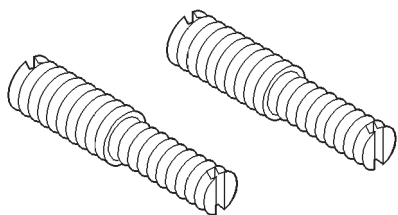
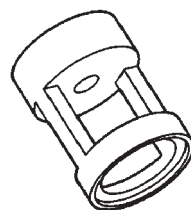
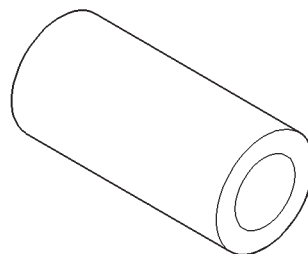
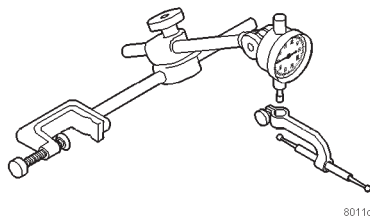
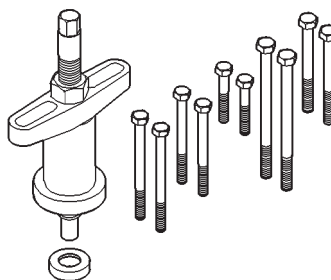
5.2L ENGINE

DESCRIPTION	TORQUE
Camshaft	
Bolt68 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	
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	
Stud nut . . . . .	.41 N·m (30 ft. lbs.)
Through bolt/nut . . . . .	.102 N·m (75 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.)

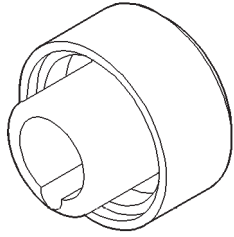
DESCRIPTION	TORQUE
Oil Pan	
Drain Plug. . . . .	.34 N·m (25 ft. lbs.)
Oil Pump	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Rear Insulator-to-Crossmember	
Nuts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Transmission	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket	
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.)
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

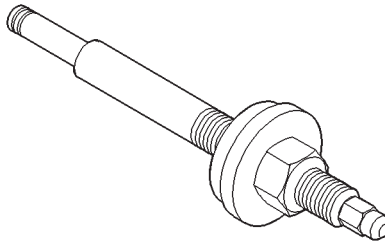
5.9L ENGINE

***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***

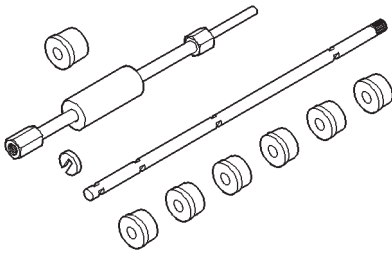
SPECIAL TOOLS (Continued)



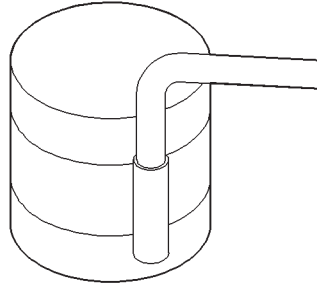
Front Oil Seal Installer 6635



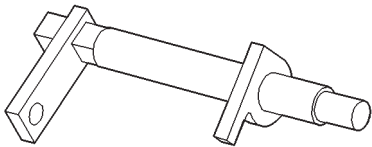
Distributor Bushing Driver/Burnisher C-3053



Cam Bearing Remover/Installer C-3132-A

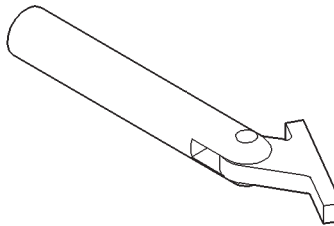


Piston Ring Compressor C-385

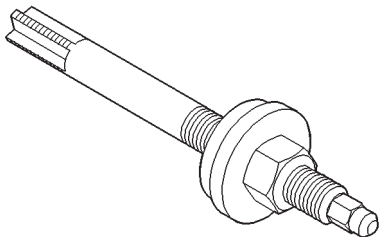


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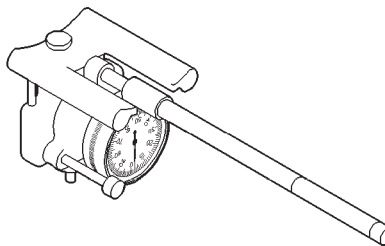
Camshaft Holder C-3509



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)

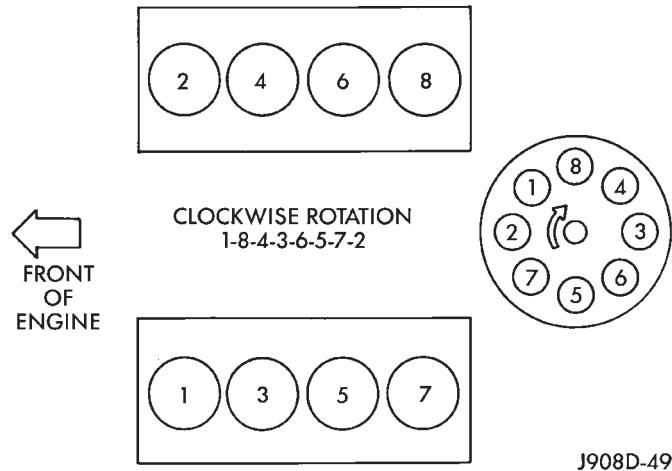


Fig. 1 Firing Order

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 = 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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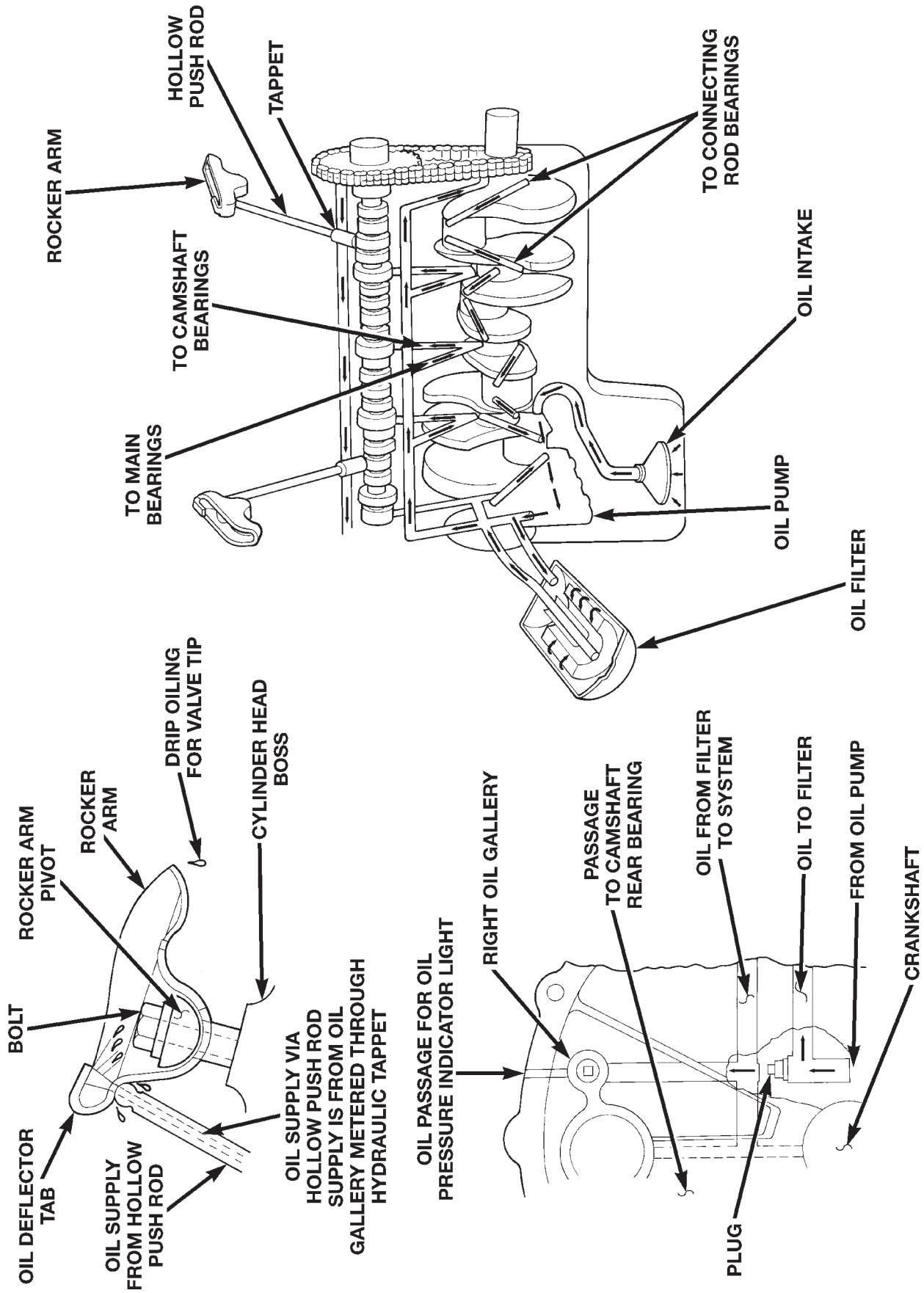


Fig. 3 Oil Lubrication System

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.

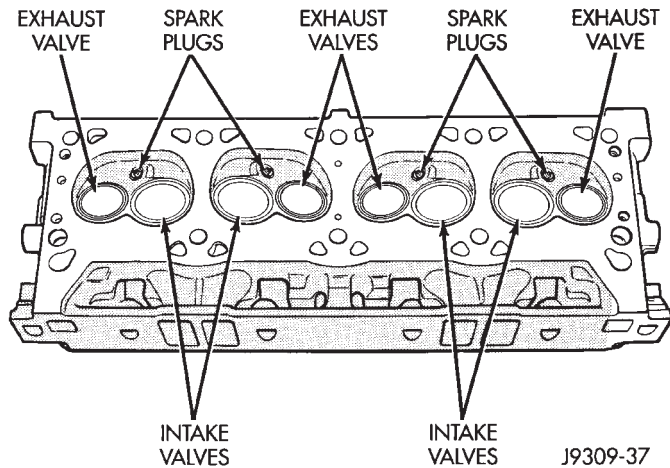


Fig. 4 Cylinder Head Assembly

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).

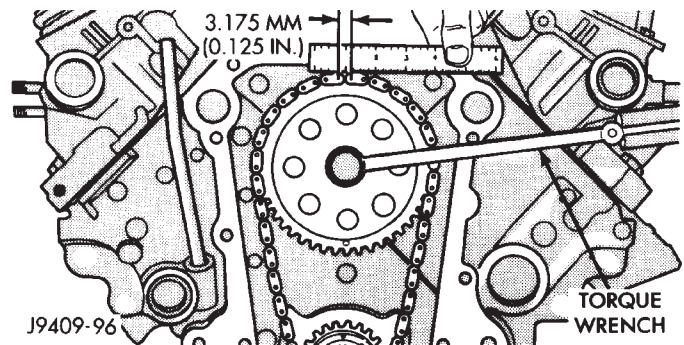


Fig. 5 Measuring Timing Chain Wear and Stretch

(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).

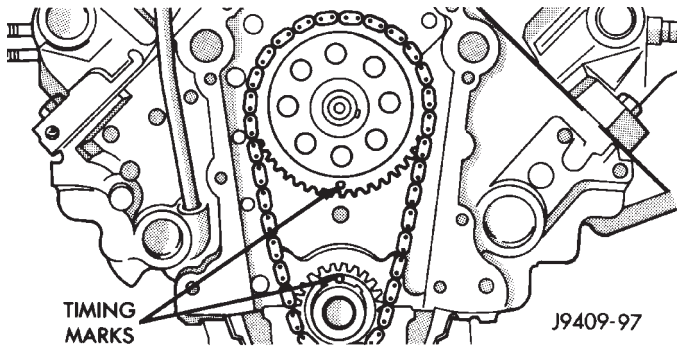


Fig. 6 Alignment of Timing Marks

(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).

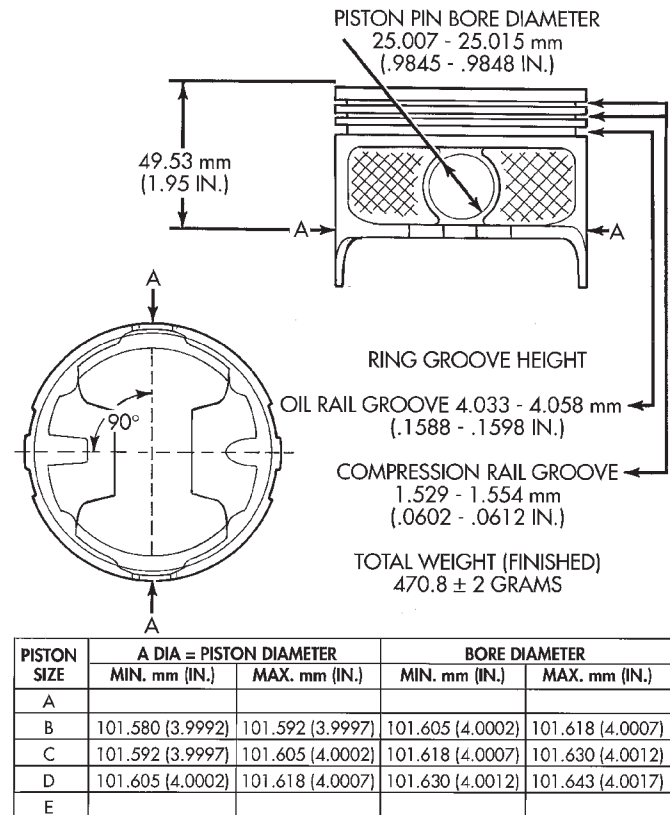
Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 7).

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.

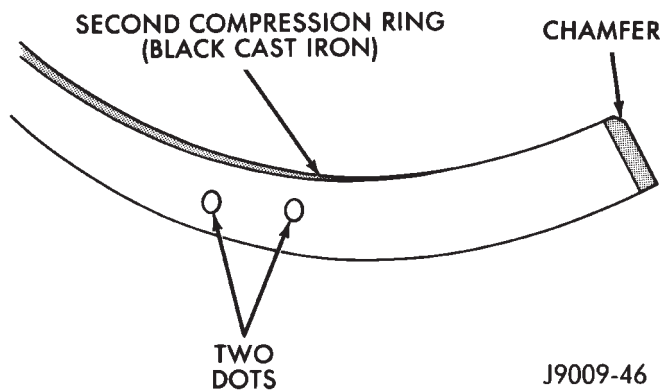


Fig. 8 Second Compression Ring Identification (Typical)

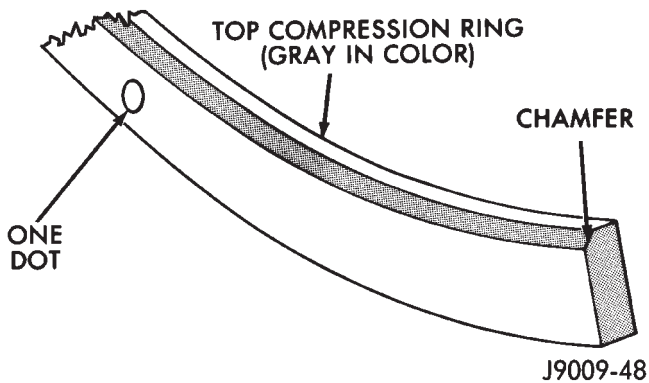


Fig. 9 Top Compression Ring Identification (Typical)

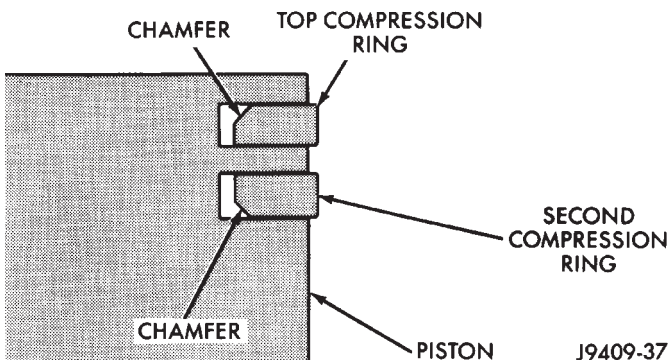


Fig. 10 Compression Ring Chamfer Location (Typical)

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.

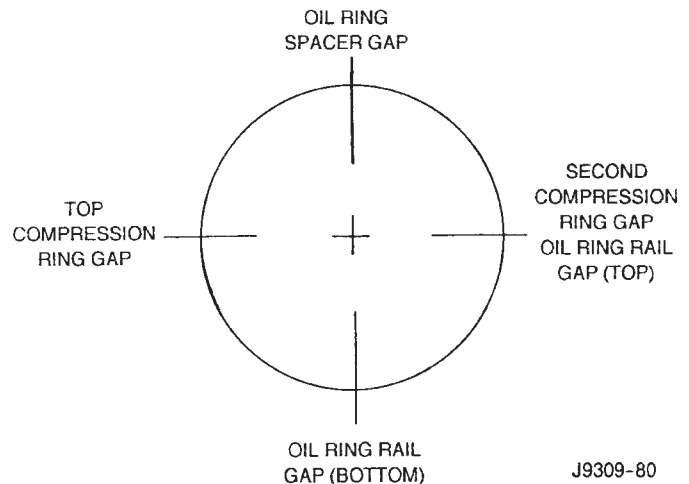


Fig. 11 Proper Ring Installation

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)

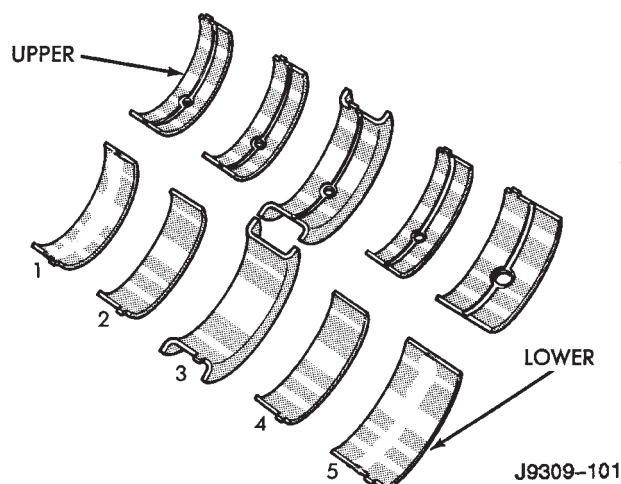


Fig. 12 Main Bearing Identification

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

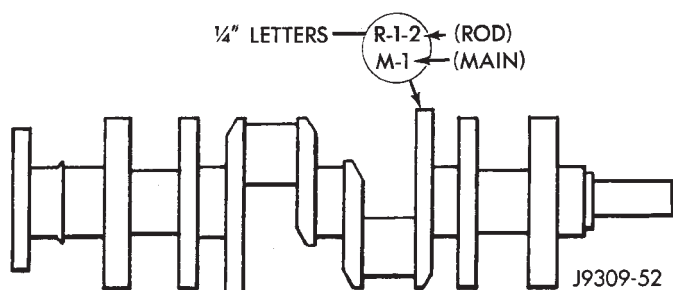


Fig. 13 Location of Crankshaft Identification

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

On 4WD vehicles the engine front support brackets attach directly to engine block and the axle housing. The brackets provide a solid interconnection for these units (Fig. 14) (Fig. 15). Engine must be supported during any service procedures involving the front support assemblies.

- (1) Disconnect the negative cable from the battery.
- (2) Raise vehicle on hoist.
- (3) Install engine lifting (support) fixture.
- (4) Remove front axle assembly. (Refer to Group 3, Differential and Driveline in this publication.)
- (5) **Left mount insulator only.** Remove starter wires and starter motor assembly.
- (6) Remove insulator to frame through bolt (Fig. 16).
- (7) Raise engine slightly.
- (8) Remove upper insulator to support bracket stud nut and insulator to support through bolt.
- (9) Remove engine mount insulator. (Fig. 14) (Fig. 15).
- (10) If engine support bracket is to be removed/replaced, remove support bracket to transmission bell housing bolt(s) and three (3) support bracket to engine block bolts. Remove support bracket (Fig. 14) (Fig. 15).

INSTALLATION—4WD

(1) If engine support brackets were removed, install them and their fasteners (Fig. 14) (Fig. 15). Tighten support bracket to block bolts to 41 N·m (30 ft. lbs.). Tighten support bracket to transmission bell-housing bolt(s) to 88 N·m (65 ft. lbs.).

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

REMOVAL AND INSTALLATION (Continued)

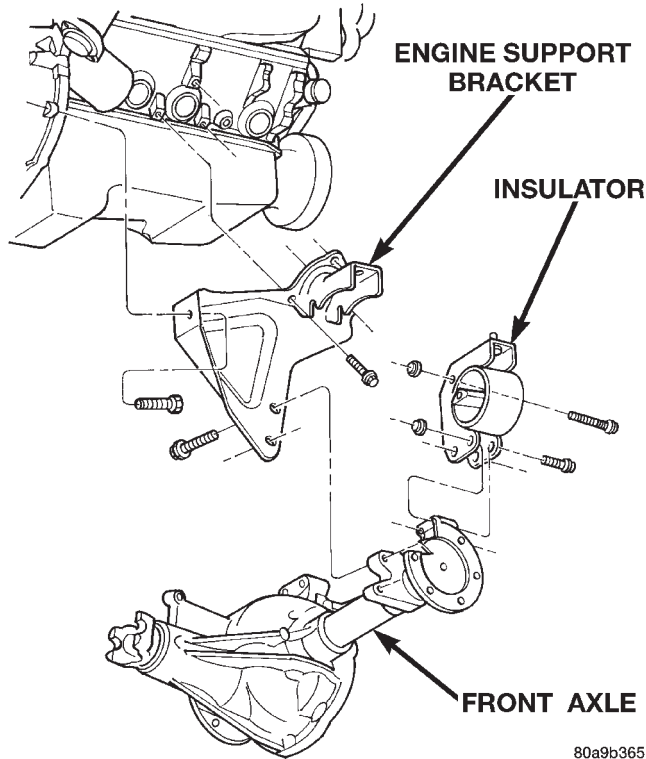


Fig. 14 Right Engine Mount Insulator and Support Bracket

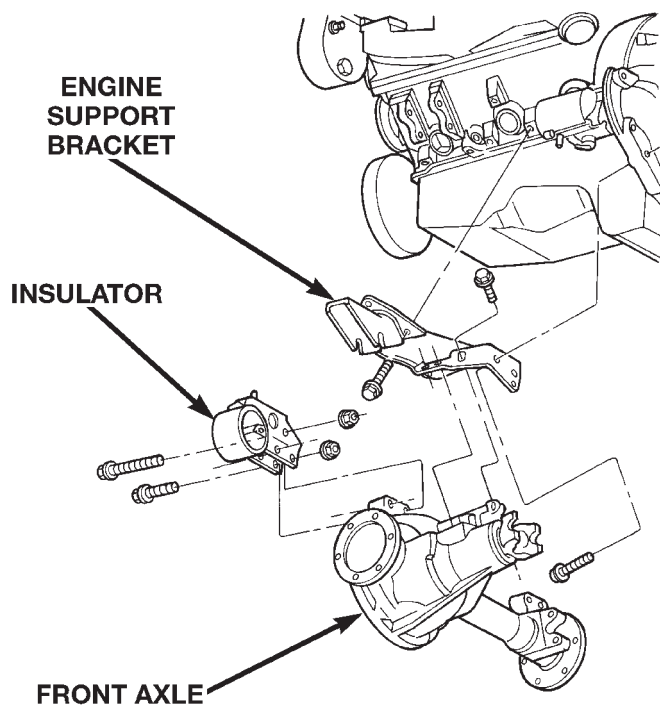


Fig. 15 Left Engine Mount Insulator and Support Bracket

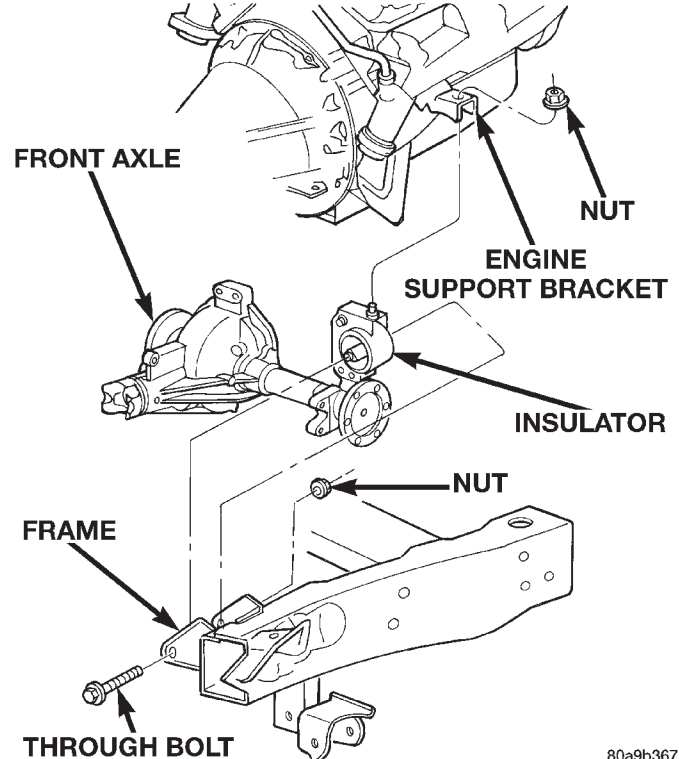


Fig. 16 Engine Mount Insulator at Frame

(3) Lower engine and install insulator to frame through bolt and nut (Fig. 16). Tighten nut to 95 N·m (70 ft. lbs.)

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

(5) Connect starter wires.

(6) Remove engine lifting (support) fixture.

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

(8) Lower the vehicle.

(9) Connect the negative cable to the battery.

ENGINE MOUNT—REAR

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Raise the vehicle on a hoist.
(3) Support the transmission with a transmission jack.

(4) Remove stud nuts holding the insulator to the crossmember (Fig. 17).

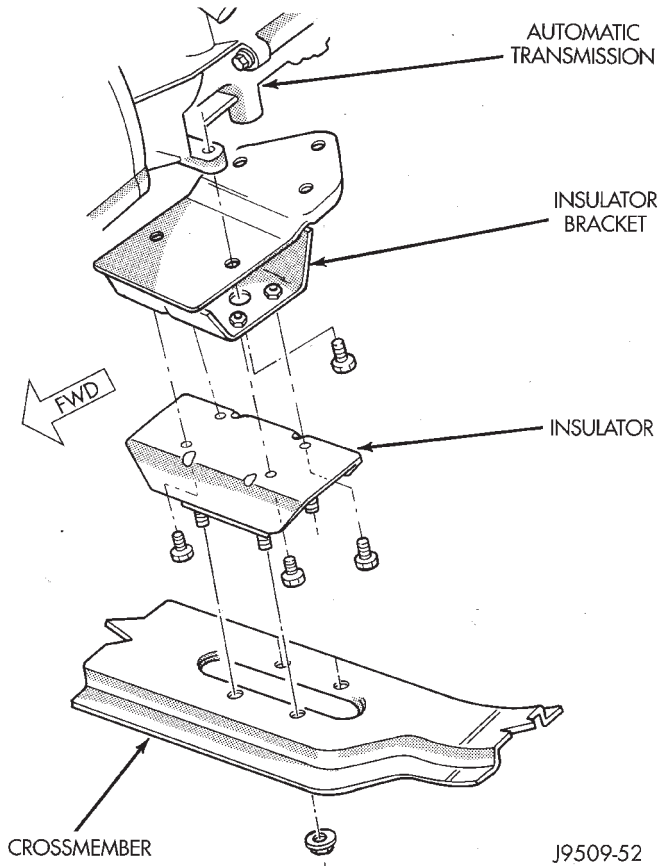
(5) Raise rear of transmission **SLIGHTLY**.

(6) Remove bolts holding the insulator to the insulator bracket (Fig. 17). Remove the insulator.

INSTALLATION

(1) If the insulator bracket was removed, install the bracket to the transmission (Fig. 17). Tighten the bolts to 28 N·m (250 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

**Fig. 17 Rear Mount Insulator**

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

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

(4) Remove the transmission jack.

(5) Lower the vehicle.

(6) Connect the negative cable to the battery.

ENGINE ASSEMBLY**REMOVAL**

(1) Scribe hood hinge outlines on hood. Remove the hood.

(2) Disconnect the battery negative cable.

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

(4) Remove the air cleaner.

(5) Disconnect the radiator and heater hoses. Remove radiator (refer to Group 7, Cooling System for the correct procedures).

(6) Set fan shroud aside.

(7) Disconnect the vacuum supply lines from the intake manifold.

(8) Remove the distributor cap and wires.

(9) Disconnect the accelerator linkage.

(10) Remove throttle body.

(11) Perform the Fuel System Pressure release procedure (refer to Group 14, fuel System).

(12) Disconnect the fuel supply line.

(13) Disconnect the starter wires.

(14) Disconnect the oil pressure sending unit wire.

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

(16) Disconnect the air conditioning hoses.

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

(18) Remove starter motor (refer to Group 8B, Battery/Starter/Generator Service).

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

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

(21) Disconnect exhaust pipe at manifold.

(22) Refer to group 21, Transmissions for transmission removal.

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

(23) Install an engine lifting fixture.

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

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

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

(25) Lower the vehicle.

(26) Install engine assembly on engine repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment.

(2) Install an engine support fixture.

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

(4) Install the engine front mounts.

(5) Refer to Group 21 Transmissions for transmission installation

(6) Install the inspection plate.

(7) Remove transmission support.

(8) Install exhaust pipe to manifold.

(9) Lower the vehicle.

(10) Remove engine lifting fixture.

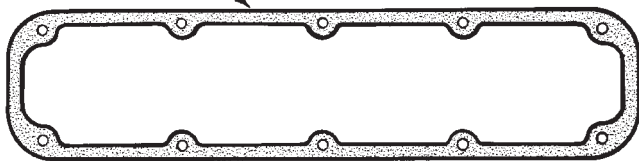
REMOVAL AND INSTALLATION (Continued)

- (11) Install the generator (refer to Group 8B, Battery/Starter/Generator Service).
- (12) Install starter motor (refer to Group 8B, Battery/Starter/Generator Service).
- (13) Connect power steering hoses, if equipped.
- (14) Connect air conditioning hoses.
- (15) Evacuate and charge the air conditioning system, if equipped (refer to Group 24, Heater and Air Conditioning for service procedures).
- (16) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.
- (17) Connect the accelerator linkage.
- (18) Connect the starter wires.
- (19) Connect the oil pressure sending unit wire.
- (20) Install the distributor cap and wiring.
- (21) Connect the vacuum supply lines to the intake manifold.
- (22) Connect the fuel supply lines.
- (23) Install the radiator (refer to Group 7, Cooling System). Connect the radiator hoses and heater hoses.
- (24) Install fan shroud in position.
- (25) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
- (26) Install the air cleaner.
- (27) Install the battery.
- (28) Warm engine and adjust.
- (29) Install hood and line up with the scribe marks.
- (30) Road test vehicle.

CYLINDER HEAD COVER

A steel backed silicon gasket is used with the cylinder head cover (Fig. 18). This gasket can be used again.

CYLINDER HEAD COVER GASKET



J9209-105

Fig. 18 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.

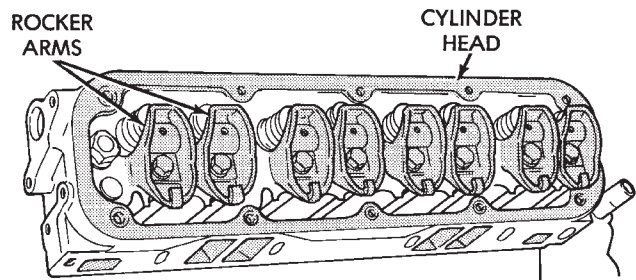
INSTALLATION

- (1) 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. 19). 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.



J9209-65

Fig. 19 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.

REMOVAL AND INSTALLATION (Continued)

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 HEAD

REMOVAL

- (1) Disconnect the battery negative cable.
- (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.
- (7) Perform fuel system pressure release procedure. Refer to Group 14, Fuel Systems for the correct procedure.
- (8) Disconnect the fuel supply line.
- (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. 20). 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.

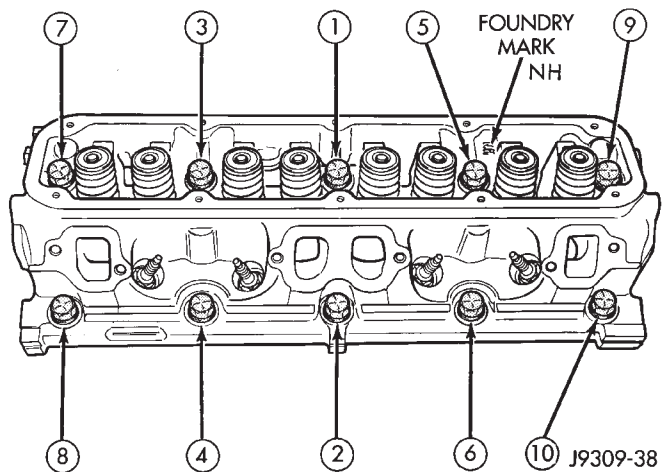


Fig. 20 Cylinder Head Bolt Tightening Sequence

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

- (4) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.
- (5) Install the intake manifold and throttle body assembly (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.

REMOVAL AND INSTALLATION (Continued)

(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 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.

(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

REMOVAL

(1) Remove the cylinder head.

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

(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) 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, 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.

(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.

REMOVAL AND INSTALLATION (Continued)

(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. 21).

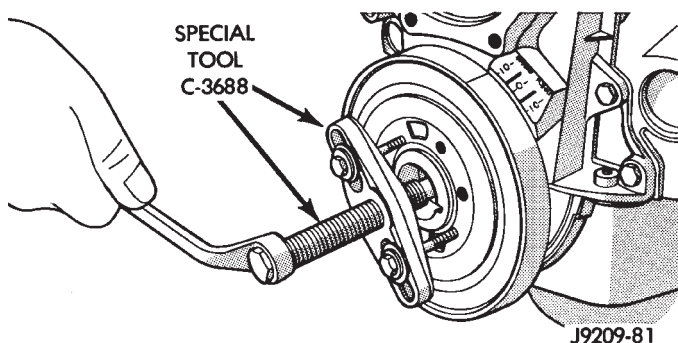


Fig. 21 Vibration Damper Assembly

(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. 22).

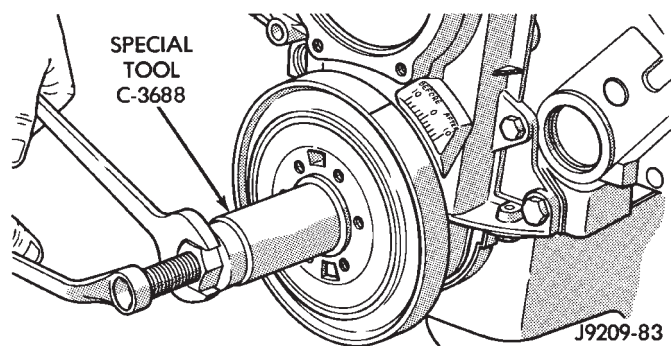


Fig. 22 Installing Vibration Damper

(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. 23).

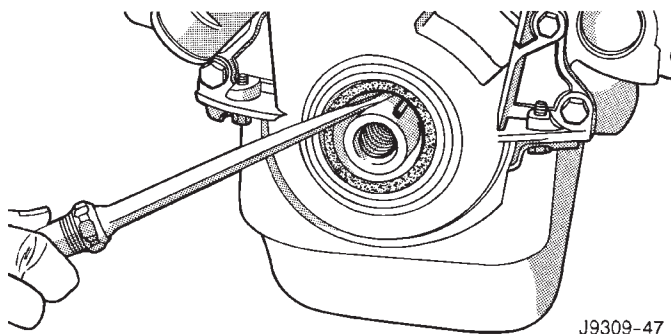


Fig. 23 Removal of Front Crankshaft Oil Seal

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. 24). Seat the oil seal in the groove of the tool.

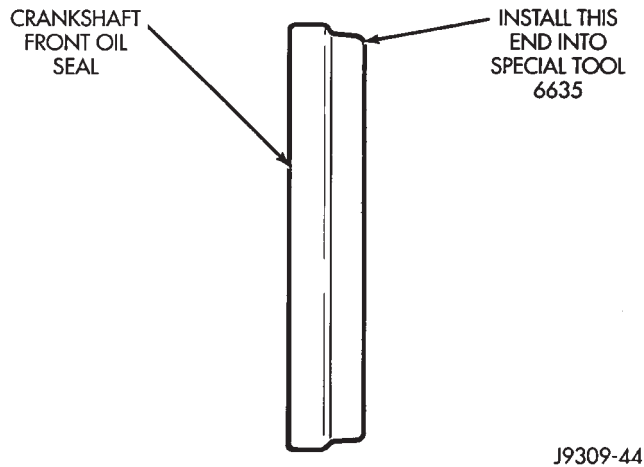
(5) Position the seal and tool onto the crankshaft (Fig. 25).

(6) Tighten the 4 lower chain case cover bolts to 13N·m (10 ft.lbs.) to prevent the cover from tipping during seal installation.

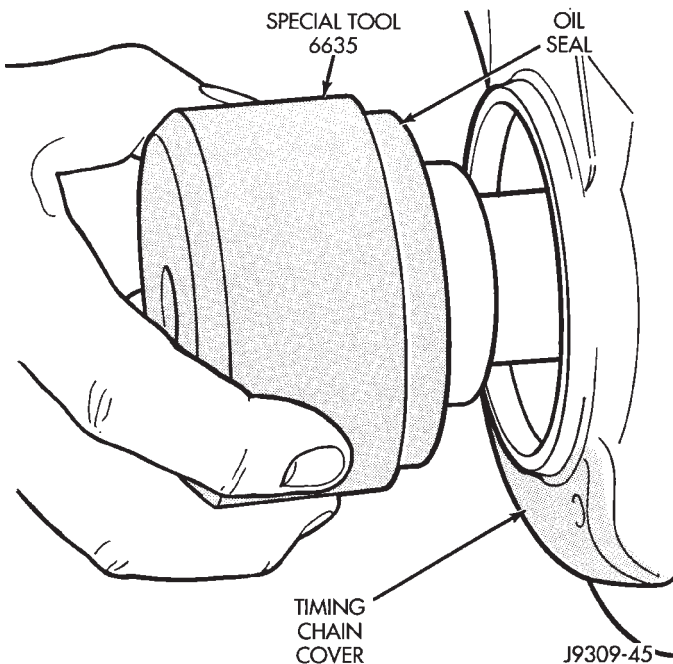
(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 26).

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

REMOVAL AND INSTALLATION (Continued)



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Fig. 24 Placing Oil Seal on Installation Tool 6635

J9309-45

Fig. 25 Position Tool and Seal onto Crankshaft

(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.

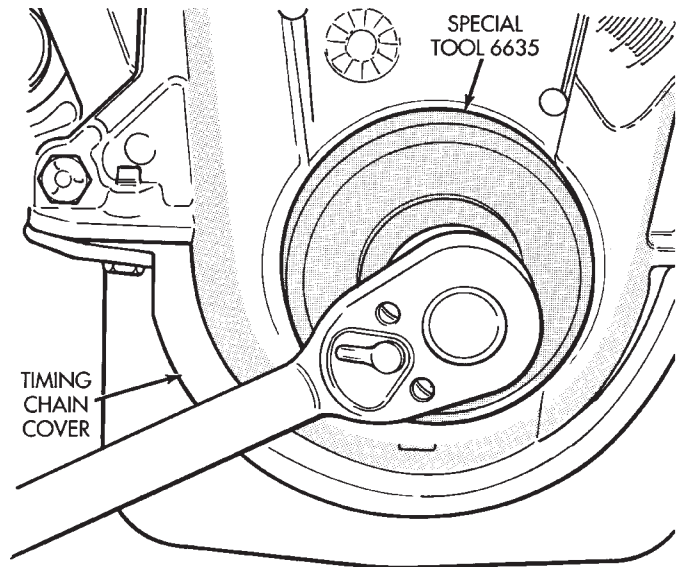
(11) Inspect the seal flange on the vibration damper.

(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).



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Fig. 26 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. 27).

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

REMOVAL AND INSTALLATION (Continued)

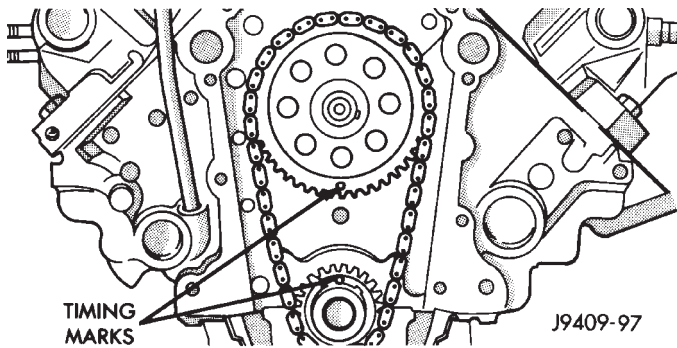


Fig. 27 Alignment of Timing Marks

(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. 28).

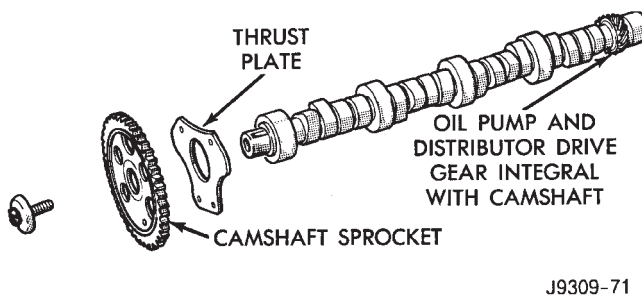


Fig. 28 Camshaft and Sprocket Assembly

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. 29).

(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.

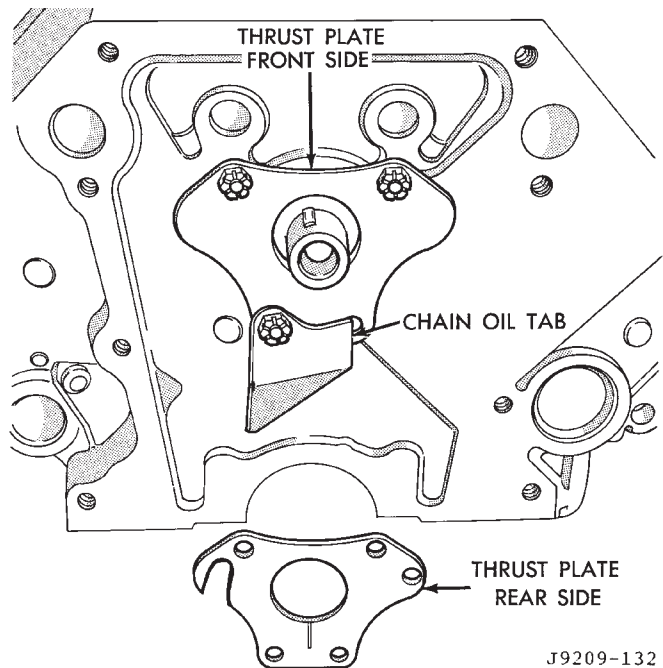


Fig. 29 Timing Chain Oil Tab Installation

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. 30).

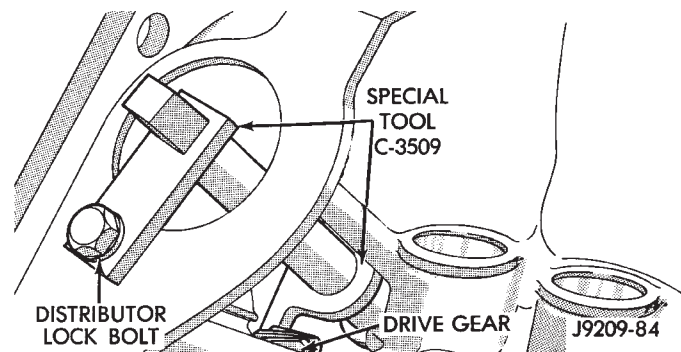


Fig. 30 Camshaft Holding Tool C-3509 (Installed Position)

(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. 31).

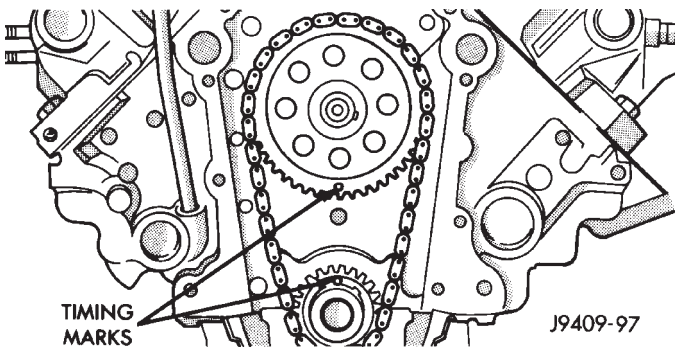


Fig. 31 Alignment of Timing Marks

(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. 32).

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.

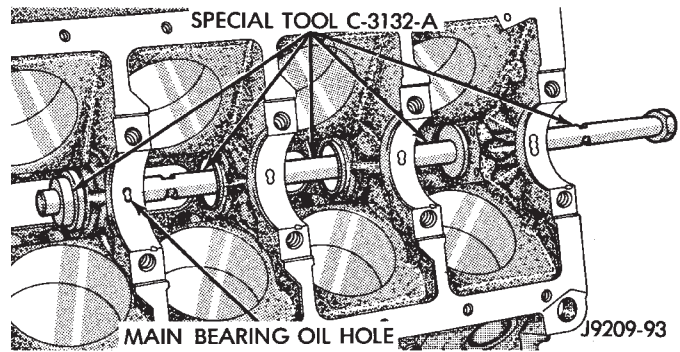


Fig. 32 Camshaft Bearings Removal/Installation with Tool C-3132-A

(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.**

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. 33).

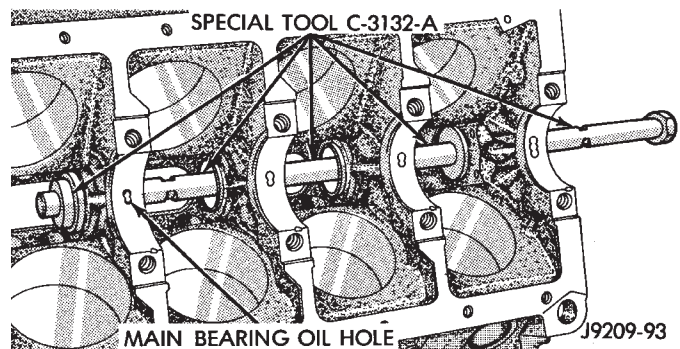


Fig. 33 Camshaft Bearings Removal/Installation with Tool C-3132-A

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.

REMOVAL AND INSTALLATION (Continued)

(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 front axle assembly (refer to Group 3, Differential and Driveline).
- (6) Remove both engine mount support brackets (Refer to Engine Mounts in this section).
- (7) Remove transmission inspection cover.
- (8) Remove oil pan and one-piece gasket.

INSTALLATION

- (1) Fabricate 4 alignment dowels from 1 1/2 x 5/16 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 34).
- (2) Install the dowels in the cylinder block (Fig. 35).

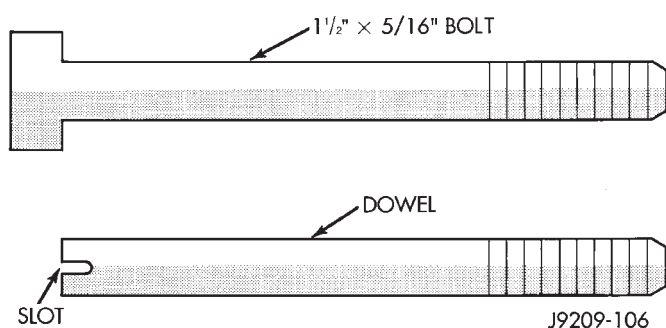


Fig. 34 Fabrication of Alignment Dowels

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

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

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

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

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

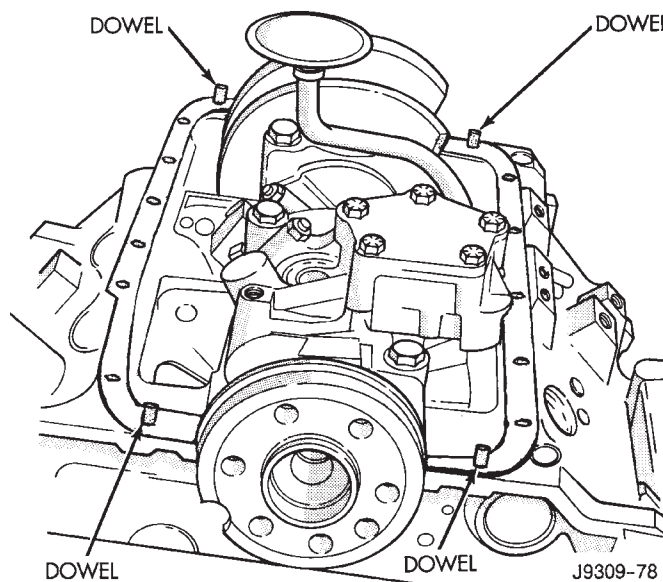


Fig. 35 Position of Dowels in Cylinder Block

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

(9) Install transmission inspection cover.

(10) Install engine mount support brackets and insulators (Refer to engine mounts in this section)

(11) Install front axle assembly (refer to Group 3, Differential and Driveline for the proper procedures).

(12) Lower vehicle

(13) Connect the distributor cap.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

(16) Fill crankcase with oil to proper level.

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.

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.

REMOVAL AND INSTALLATION (Continued)

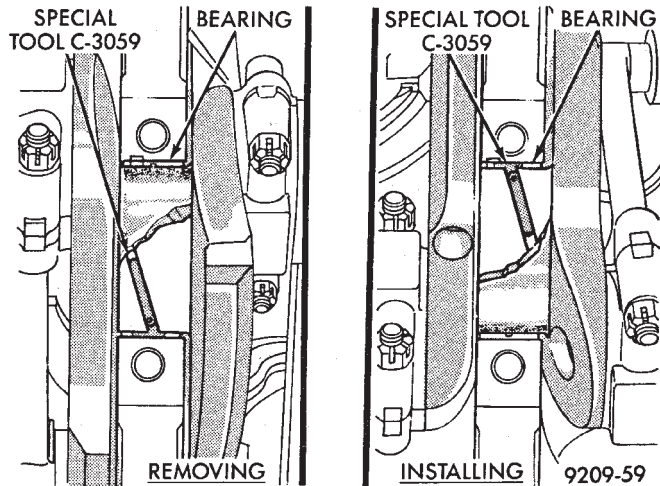


Fig. 36 Upper Main Bearing Removal and Installation with Tool C-3059

- (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 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. 37).

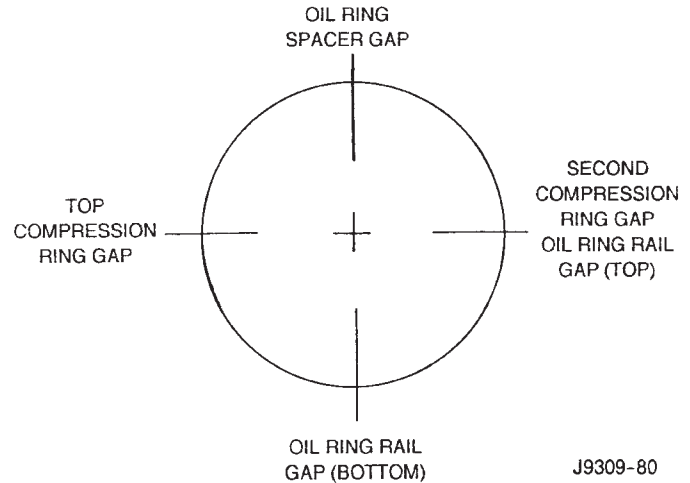


Fig. 37 Proper Ring Installation

- (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

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. 38).

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.

REMOVAL AND INSTALLATION (Continued)

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

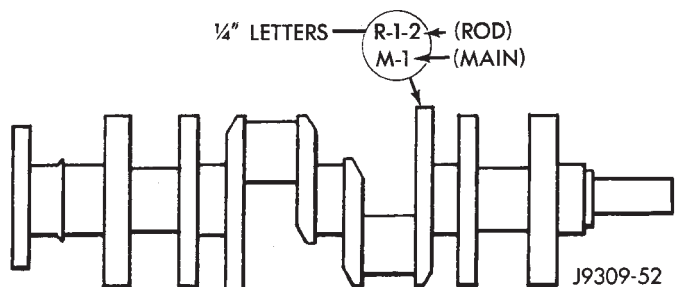


Fig. 38 Location of Crankshaft Identification

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

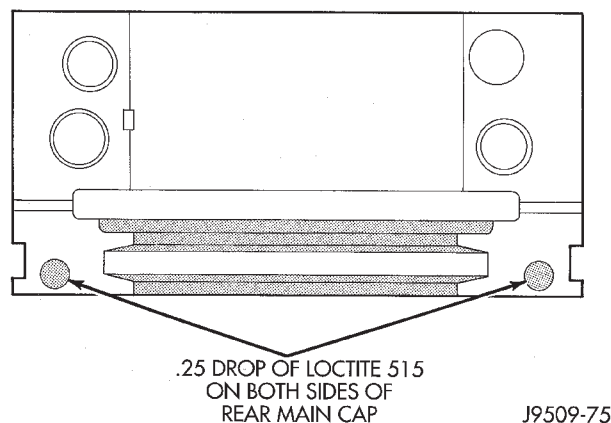


Fig. 39 Sealant Application to Bearing Cap

- (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 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.

Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 40). 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.

REMOVAL AND INSTALLATION (Continued)

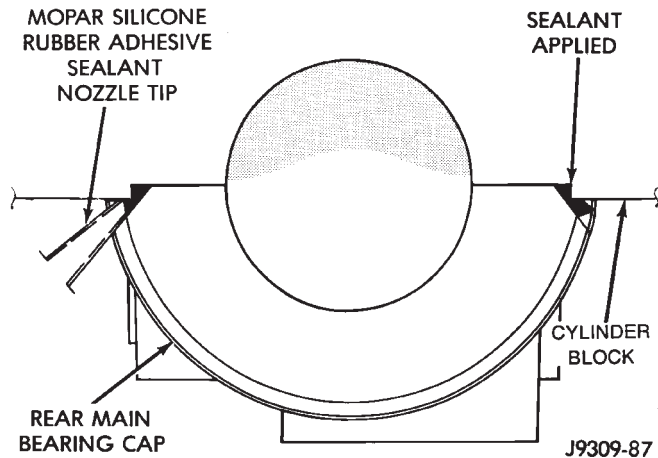


Fig. 40 Apply Sealant to Bearing Cap to Block Joint OIL PUMP

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.

CRANKSHAFT OIL SEAL—FRONT

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

- (1) Disconnect the negative cable from the battery.
- (2) Remove vibration damper.
- (3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.
- (4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.
- (5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 41). Seat the oil seal in the groove of the tool.
- (6) Position the seal and tool onto the crankshaft (Fig. 42).
- (7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 43).

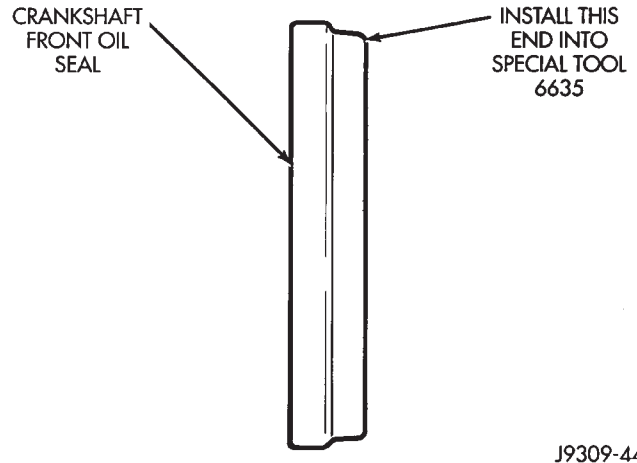


Fig. 41 Placing Oil Seal on Installation Tool 6635

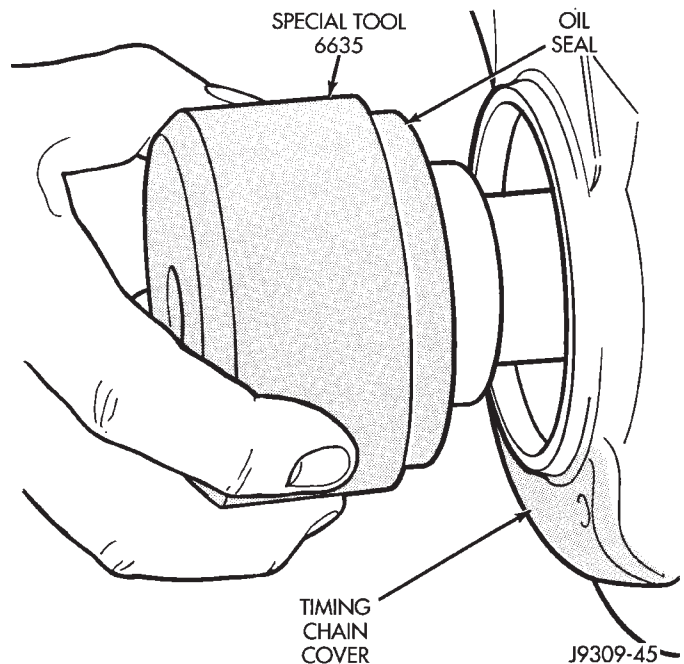


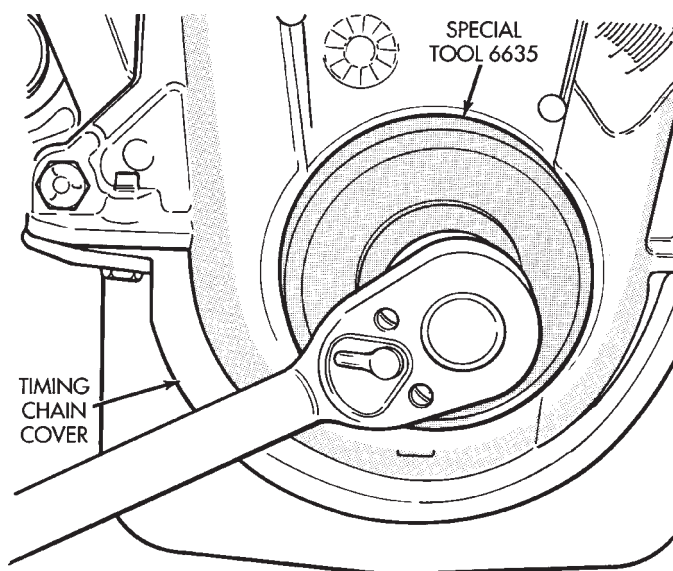
Fig. 42 Position Tool and Seal onto Crankshaft

- (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. The lower seal half can only be installed with the rear main bearing cap removed.

REMOVAL AND INSTALLATION (Continued)



J9309-46

Fig. 43 Installing Oil Seal**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.

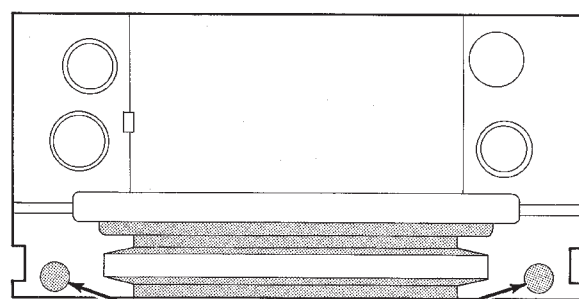
(8) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 44). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(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) 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. 45).

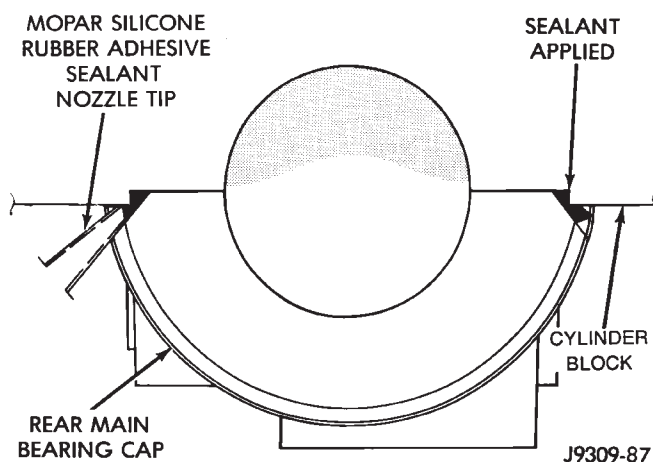


.25 DROP OF LOCTITE 515
ON BOTH SIDES OF
REAR MAIN CAP

J9509-75

Fig. 44 Sealant Application to Bearing Cap

Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.



J9309-87

Fig. 45 Apply Sealant to Bearing Cap to Block Joint

- (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.
- (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.

REMOVAL AND INSTALLATION (Continued)

(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. 44). 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. 45) (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. 44). 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. 45). 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. 46). This will reduce internal leakage and help maintain higher oil pressure at idle.

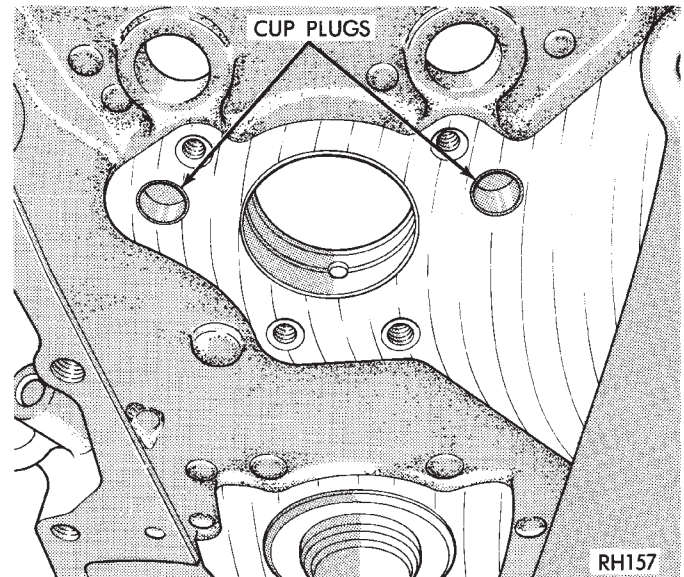


Fig. 46 Location of Cup Plugs in Oil Galleries

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. 47).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 47).

CLEANING

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

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.

REMOVAL AND INSTALLATION (Continued)

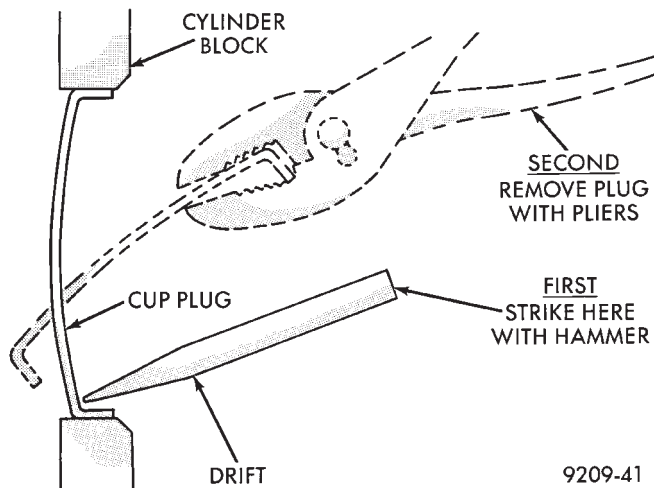


Fig. 47 Core Hole Plug Removal

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. 48).
- (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. 48). 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. 48).

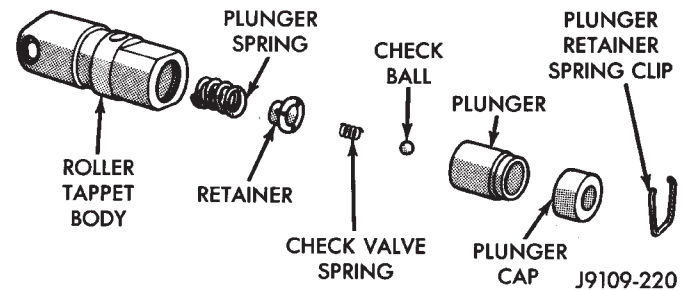


Fig. 48 Hydraulic Tappet Assembly

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. 49). Improper installation or plug missing could cause erratic, low or no oil pressure.

- (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. 49). If plug is too high, use a suitable flat dowel drift to position properly.

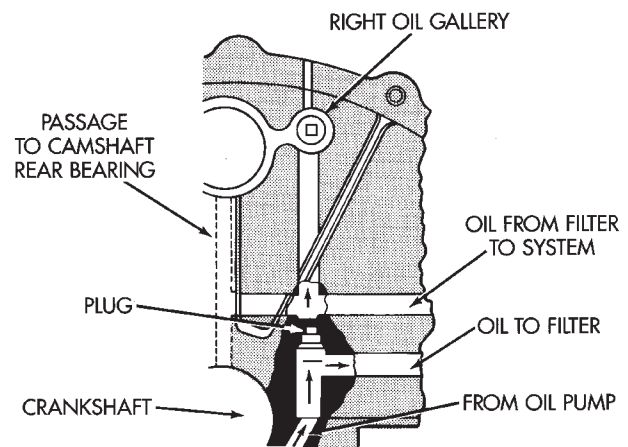


Fig. 49 Oil Line Plug

- (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®

DISASSEMBLY AND ASSEMBLY (Continued)

(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. 50). The special sleeve places the valve at the correct height for checking with a dial indicator.

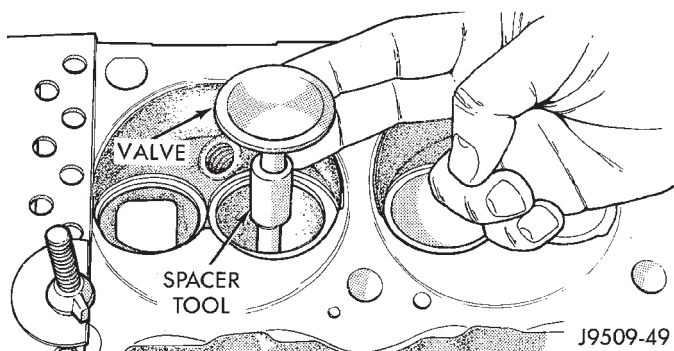


Fig. 50 Positioning Valve with Tool C-3973

(2) Attach Dial Indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 51).

(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. 52).

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).**

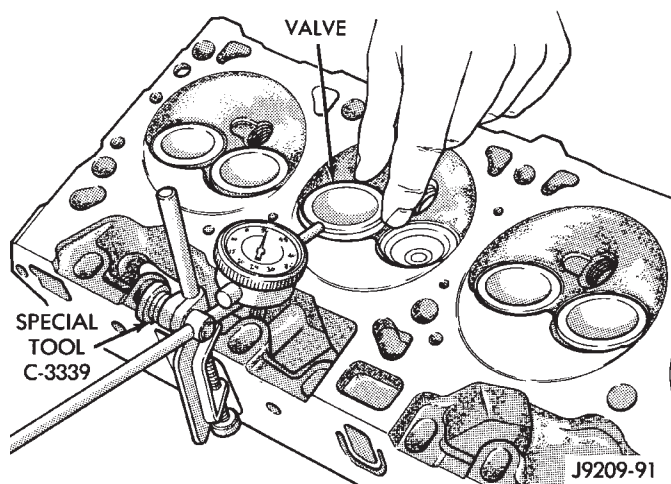


Fig. 51 Measuring Valve Guide Wear

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

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 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° 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 inch) margin should be discarded.

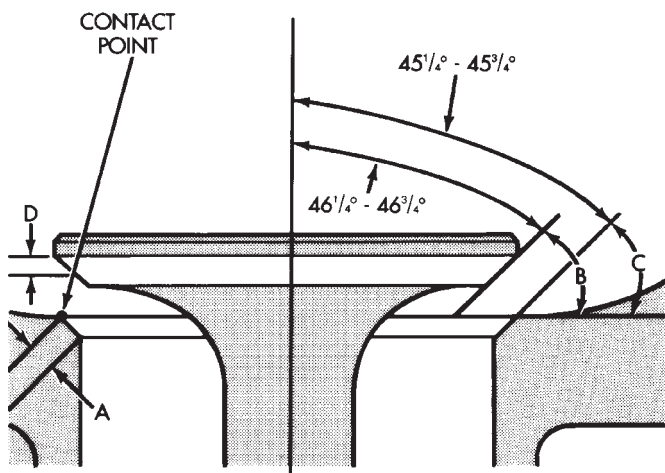
VALVE SEATS

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.

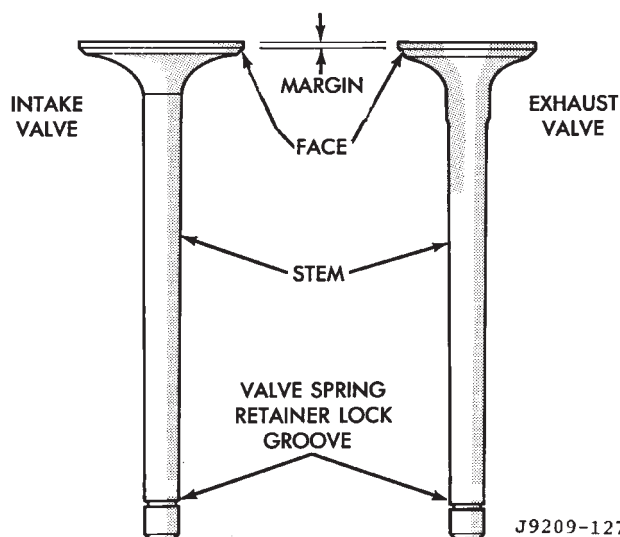
(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 inch) total indicator reading.

DISASSEMBLY AND ASSEMBLY (Continued)



- 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) $45\frac{1}{4}^{\circ}$ - $45\frac{3}{4}^{\circ}$
 C - SEAT ANGLE (INTAKE & EXHAUST) $46\frac{1}{4}^{\circ}$ - $46\frac{3}{4}^{\circ}$
 D - CONTACT SURFACE

J9309-95

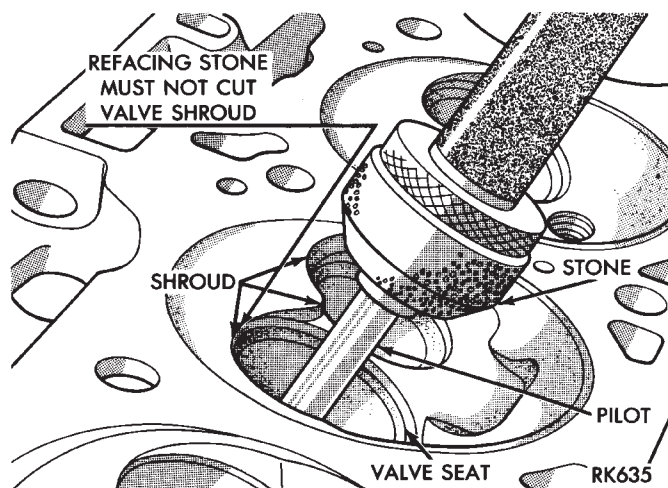
Fig. 53 Valve Face and Seat Angles

J9209-127

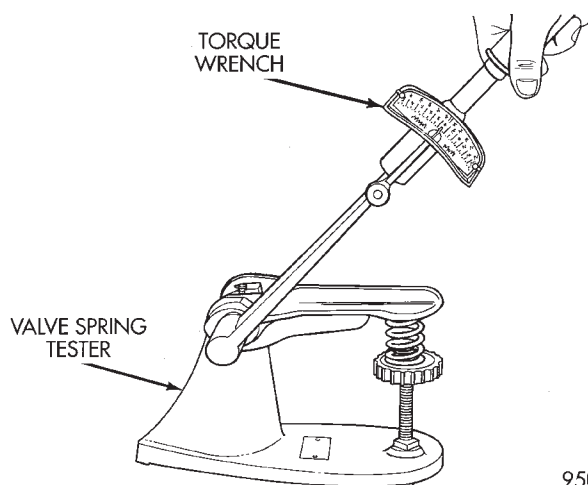
Fig. 54 Intake and Exhaust Valves

(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).

**Fig. 55 Refacing Valve Seats****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. 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

DISASSEMBLY AND ASSEMBLY (Continued)

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).

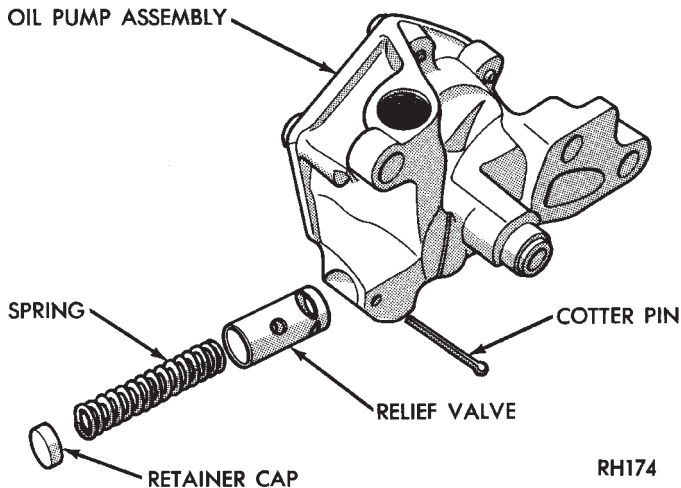


Fig. 57 Oil Pressure Relief Valve

(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.

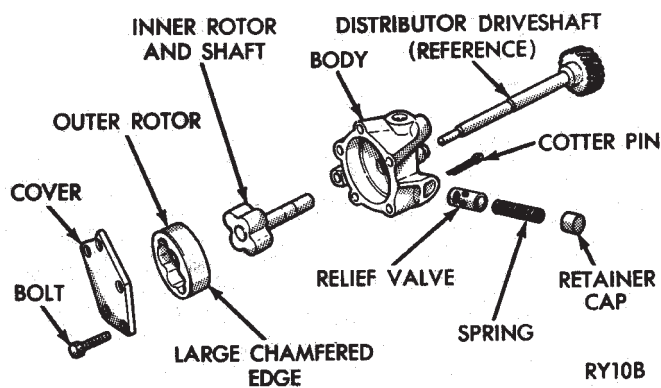


Fig. 58 Oil Pump

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).

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).

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

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

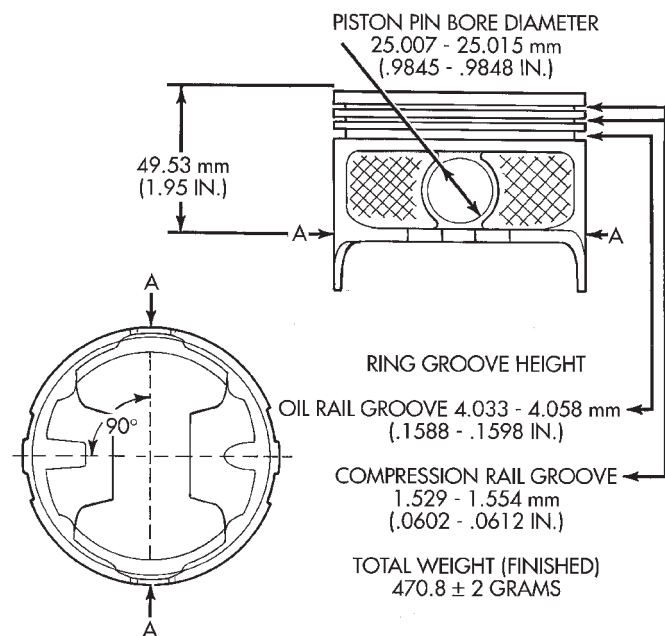
Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

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

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

CLEANING AND INSPECTION (Continued)

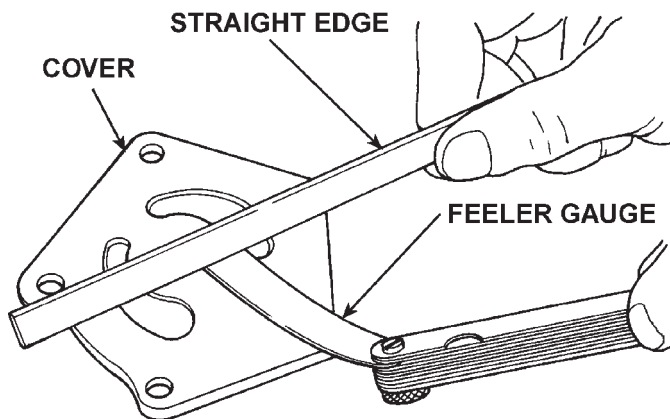


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Fig. 59 Piston Measurements**OIL PUMP****INSPECTION**

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

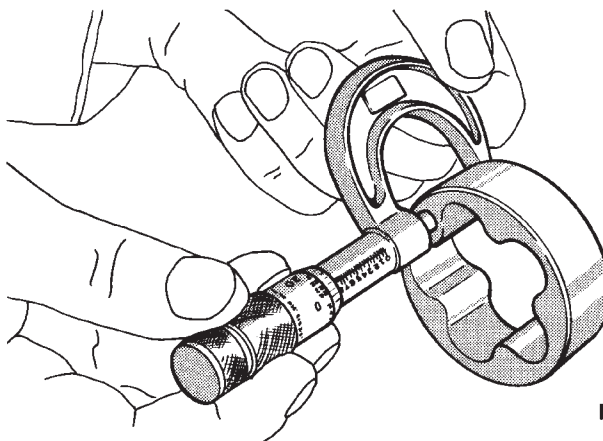
Lay a straightedge across the pump cover surface (Fig. 60). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.



8020cd6e

Fig. 60 Checking Oil Pump Cover Flatness

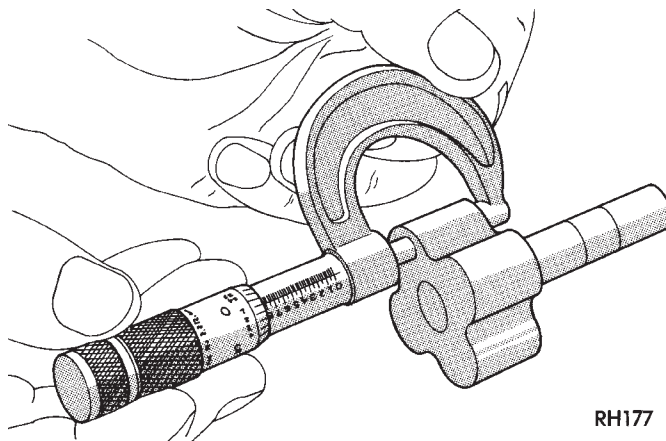
Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 61).



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).

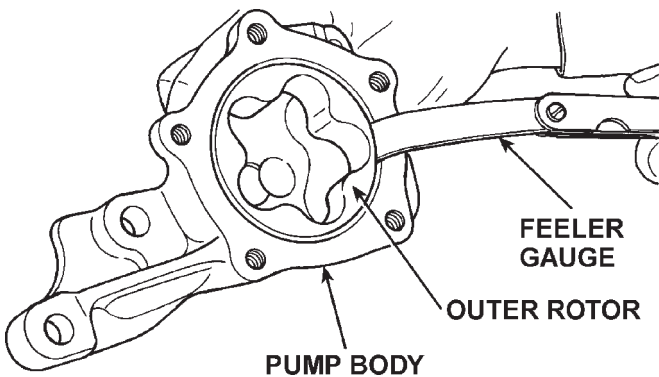


RH177

Fig. 62 Measuring Inner Rotor Thickness

CLEANING AND INSPECTION (Continued)

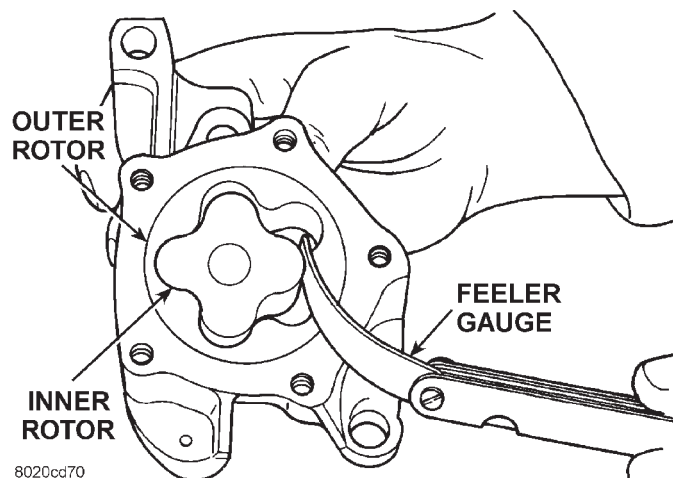
Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 63). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.



8020cd6f

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).



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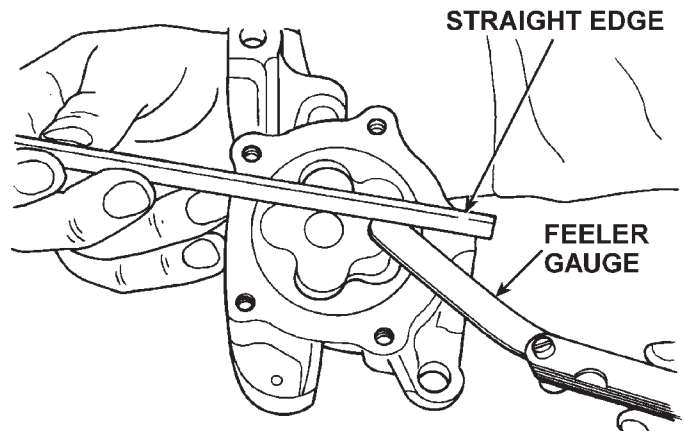
Fig. 64 Measuring Clearance Between Rotors

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.

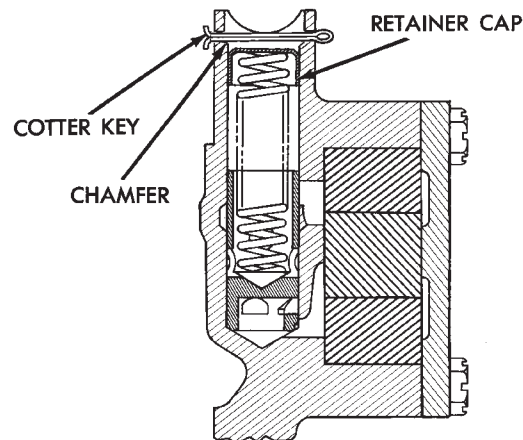
The relief valve spring has a free length of approximately 49.5 mm (1.95 inches). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 inches). Replace spring that fails to meet these specifications (Fig. 66).

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



8020cd71

Fig. 65 Measuring Clearance Over Rotors



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 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.

Shaft to Bushing Clearance00178 – 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)
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.)

SPECIFICATIONS (Continued)

PISTON RINGS**Ring Gap**

Compression Ring (Top) 0.30 – 0.55 mm
(0.012 – 0.022 in.)

Compression Ring (2nd) 0.55 – 0.80 mm \
(0.022 – 0.031 in.)

Oil Control (Steel Rails) 0.381 – 1.397 mm
(0.015 – 0.055 in.)

Ring Side Clearance

Compression Rings 0.040 – 0.085 mm
(0.0016 – 0.0033 in.)

Oil Ring (Steel Rails) 0.05 – 0.21 mm
(0.002 – 0.008 in.)

Ring Width

Compression rings 1.530 – 1.555 mm
(0.060 – 0.061 in.)

Oil Ring (Steel Rails) – Max. 0.447 – 0.473 mm
(0.018 – 0.019 in.)

VALVE TIMING**Exhaust Valve**

Closes (ATDC) 33°

Opens (BBDC) 56°

Duration 269°

Intake Valve

Closes (ATDC) 62°

Opens (BBDC) 7°

Duration 249°

Valve Overlap 41°

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.

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

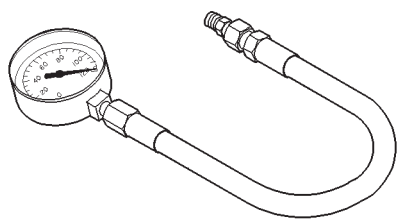
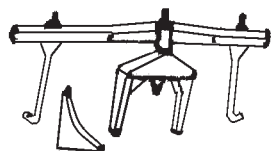
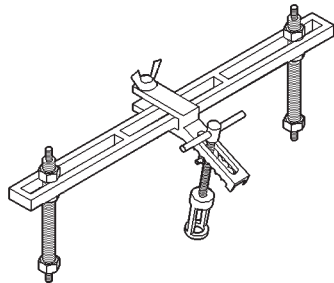
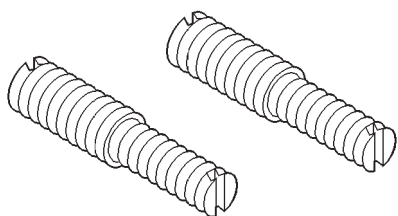
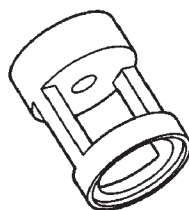
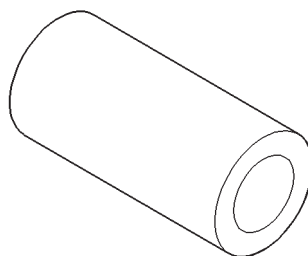
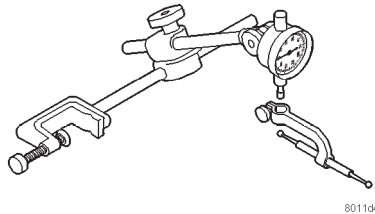
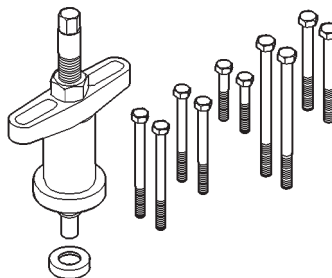
5.9L ENGINE

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.)
Bolts (2nd Step) . . . . .	.143 N·m (105 ft. lbs.)
Cylinder Head Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Engine Support Bracket to Block	
Bolts . . . . .	.41 N·m (30 ft. lbs.)
Exhaust Manifold-to-Cylinder Head	
Bolts/Nuts . . . . .	.34 N·m (25 ft. lbs.)
Front Insulator (All)	
Through bolt/nut . . . . .	.95 N·m (70 ft. lbs.)
Front Insulator to Support Bracket	
Stud nut . . . . .	.41 N·m (30 ft. lbs.)
Through bolt/nut . . . . .	.102 N·m (75 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.)

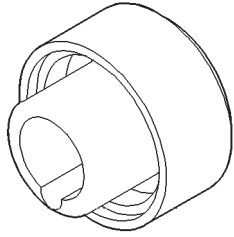
DESCRIPTION	TORQUE
Oil Pump	
Attaching Bolts . . . . .	.41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts . . . . .	.11 N·m (95 in. lbs.)
Rear Insulator-to-Crossmember	
Nuts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator-to-Transmission	
Bolts . . . . .	.68 N·m (50 ft. lbs.)
Rear Insulator Bracket	
Bolts . . . . .	.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.)
Vibration Damper	
Bolt . . . . .	.183 N·m (135 ft. lbs.)
Water Pump-to-Chain Case Cover	
Bolt . . . . .	.41 N·m (30 ft. lbs.)

SPECIAL TOOLS

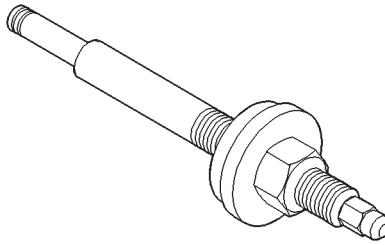
5.9L ENGINE

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

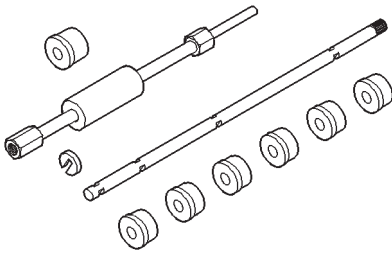
SPECIAL TOOLS (Continued)



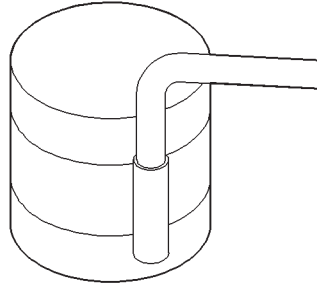
Front Oil Seal Installer 6635



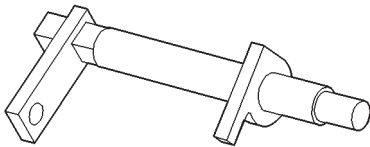
Distributor Bushing Driver/Burnisher C-3053



Cam Bearing Remover/Installer C-3132-A

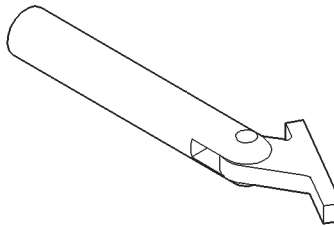


Piston Ring Compressor C-385

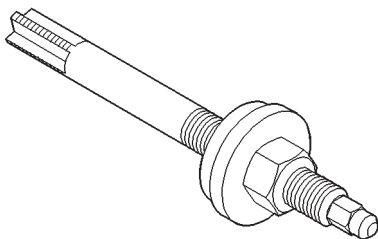


c-3509-8011d343

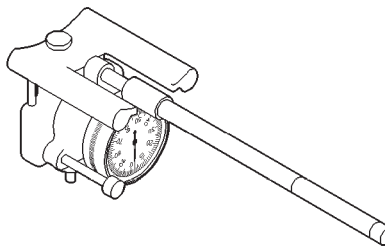
Camshaft Holder C-3509



Crankshaft Main Bearing Remover C-3059



Distributor Bushing Puller C-3052



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Cylinder Bore Gauge C-119

