ENGINE

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS—GASOLINE ENGINES

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

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

MOPAR® SILICONE RUBBER ADHESIVE SEALANT

Mopar® Silicone Rubber Adhesive Sealant, normally black in color, is available in both three ounce tubes and four and one-half ounce power tubes. Moisture in the air causes the sealant material to cure. This material is normally used on flexible metal flanges. The regular tubes have a shelf life of one year and the power tubes a two year shelf life, and will not properly cure if over-aged. Always inspect the package for the expiration date before use.

MOPAR® GASKET MAKER

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

SURFACE PREPARATION

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

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

GENERAL INFORMATION (Continued)

GASKET APPLICATION

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

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

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

ENGINE PERFORMANCE

To provide best vehicle performance and lowest vehicle emissions, it is most important that the tune-up be done accurately. Use the specifications listed on the Vehicle Emission Control Information label found on the engine compartment hood.

(1) Test battery specific gravity. Add water, if necessary. Clean and tighten battery connections.

(2) Test cranking amperage draw (refer to Group 8B, Battery/Starter for the proper procedure).

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

(4) Perform cylinder compression test:

CAUTION: DO NOT overspeed the engine.

(a) Check engine oil level and add oil, if necessary.

(b) Drive the vehicle until engine reaches normal operating temperature.

(c) Select a route free from traffic and other forms of congestion, observe all traffic laws and briskly accelerate through the gears several times. The higher engine speed may help clean out valve seat deposits which can prevent accurate compression readings.

(d) Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators - fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.

(e) Disconnect coil wire from distributor and secure to good ground to prevent a spark from starting a fire.

(f) Be sure throttle blades are fully open during the compression check.

(g) Insert compression gage adaptor into the No.1 spark plug hole. Crank engine until maximum pressure is reached on gauge. Record this pressure as No.1 cylinder pressure.

(h) Repeat for all remaining cylinders.

(i) Compression should not be less than 689 kPa (100 psi) and not vary more than 172 kPa (25 psi) from cylinder to cylinder.

(j) If cylinder(s) have abnormally low compression pressures, repeat procedure.

(k) If the same cylinder(s) repeat an abnormally low reading, it could indicate the existence of a problem in the cylinder.

NOTE: The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should NOT be disassembled to determine the cause of low compression unless some malfunction is present.

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

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

(7) 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).

(8) Set ignition timing to specifications (refer to Specification Label on engine compartment hood).

(9) Perform a combustion analysis.

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

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

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

(13) For emission controls refer to Group 25, Emission Controls System for service procedures.

(14) Inspect and adjust accessory belt drives (refer to Group 7, Cooling System for the proper adjustments).

(15) Road test vehicle as a final test.

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.

GENERAL INFORMATION (Continued)

(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 or 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). 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. 1).

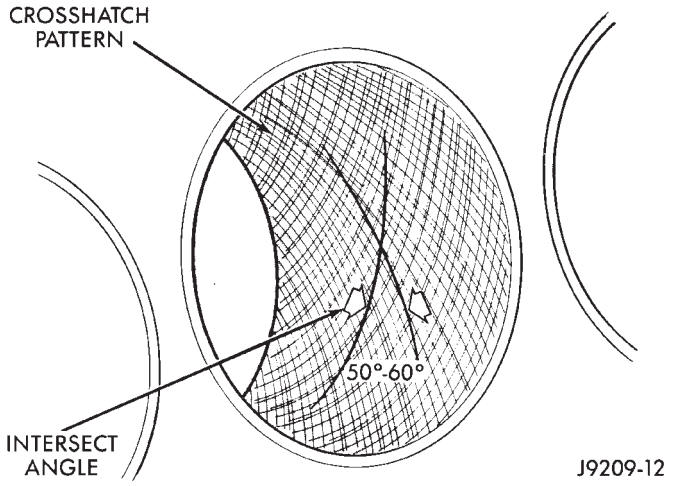


Fig. 1 Cylinder Bore Crosshatch Pattern

(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.

MEASURING WITH PLASTIGAGE

CRANKSHAFT MAIN BEARING CLEARANCE

Engine crankshaft bearing clearances can be determined by use of Plastigage, or equivalent. The following is the recommended procedures 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 only be determined 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 inch) shim between the bearing shell and the adjacent bearing cap. Tighten the bolts to 18 N·m (13 ft. lbs.) torque.

- **ALL ENGINES** —When checking No.1 main bearing; shim No.2 main bearing.
- **ALL ENGINES** —When checking No.2 main bearing; shim No.1 and No.3 main bearing.
- **ALL ENGINES** —When checking No.3 main bearing; shim No.2 and No.4 main bearing.
- **ALL ENGINES** —When checking No.4 main bearing; shim No.3 and No.5 main bearing.
- **5.2/5.9L ENGINE** —When checking No.5 main bearing; shim No.4 main bearing.
- **4.0L ENGINE** —When checking No.5 main bearing; shim No.4 and No.6 main bearing.
- **4.0L ENGINE** —When checking No.6 main bearing; shim No.5 and No.7 main bearing.
- **4.0L ENGINE** —When checking No.7 main bearing; shim No.6 main bearing.

NOTE: Remove all shims before assembling engine.

METHOD - 2 (ALTERNATIVE)

The weight of the crankshaft is supported by a jack 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. 2). 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 that area. Tighten the bearing cap bolts of the bearing being checked to 108 N·m (80 ft. lbs.) torque (4.0L Engine). Tighten the bearing cap bolts of the bearing being checked to 115 N·m (85 ft. lbs.) torque (5.2/5.9L Engine). **DO NOT rotate the crankshaft**

or the Plastigage may be smeared, giving inaccurate results.

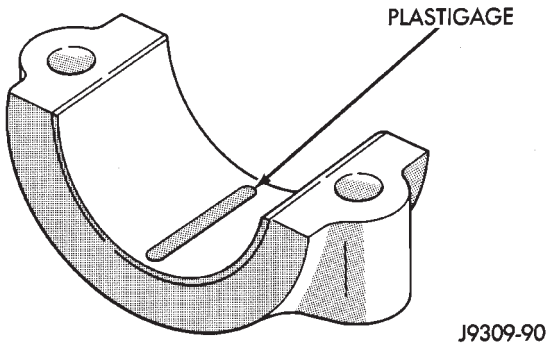


Fig. 2 Placement of Plastigage in BearingShell

(2) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on the package (Fig. 3). Plastigage generally comes in 2 scales (one scale is in inches and the other is a metric scale). Locate the band closest to the same width. This band shows the amount of clearance. Differences in readings between the ends indicate the amount of taper present. Record all readings taken (refer to Engine Specifications).

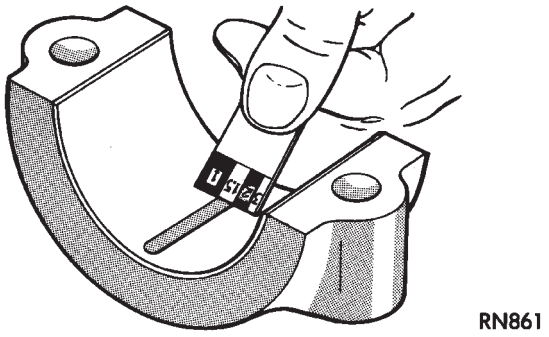


Fig. 3 Clearance Measurement

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

CONNECTING ROD BEARING CLEARANCE

Engine connecting rod bearing clearances can be determined by use of Plastigage, or equivalent. The following is the recommended procedures 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. 2). 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 turned 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 4.0L rod cap nut to 45 N·m (33 ft. lbs.) torque. Tighten the 5.2/5.9L 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 2 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 inch) range is usually the most appropriate for checking engine bearing clearances.

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.

SERVICE ENGINE ASSEMBLY (SHORT BLOCK)

A service replacement engine assembly (short block) may be installed whenever the original cylinder block is defective or damaged beyond repair. It consists of the cylinder block, crankshaft, piston and rod assemblies. If needed, the camshaft must be procured separately and installed before the engine is installed in the vehicle.

A short block is identified with the letter “S” stamped on the same machined surface where the build date code is stamped for complete engine assemblies.

Installation includes the transfer of components from the defective or damaged original engine. Follow the appropriate procedures for cleaning, inspection and torque tightening.

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 negative cable from the battery.

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

(4) Place a shop towel around the spark plugs 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. Tighten the 4.0L engine spark plugs to 37 N·m (27 ft. lbs.) torque. Tighten the 5.2/5.9L engine spark plugs to 41 N·m (30 ft. lbs.) torque.

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

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

(13) Install a new oil filter.

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

(15) Connect the negative cable to the battery.

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

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

Use an engine oil that is API Service Grade Certified or an oil that conforms to the API Service Grade SH or SH/CD. MOPAR provides engine oils that conform to all of these service grades.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 30 specifies a single viscosity engine oil. Engine oils also have multiple viscosities. These are specified with a dual SAE viscosity grade which indicates the cold-to-hot temperature viscosity range. Select an engine oil that is best suited to your particular temperature range and variation (Fig. 4).

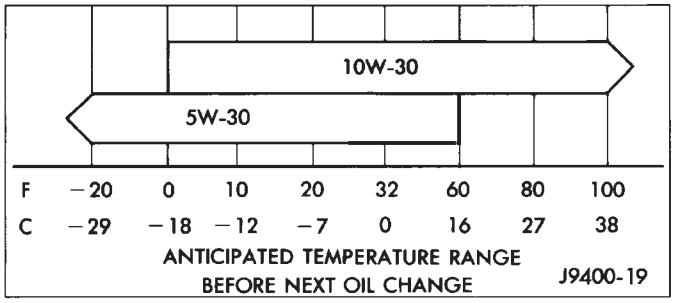


Fig. 4 Temperature/Engine Oil Viscosity

ENERGY CONSERVING OIL

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

CONTAINER IDENTIFICATION

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 (Fig. 5).

ENGINE OIL ADDITIVES

In some instances, such as infrequent operation, short trip driving, and during break-in after a major overhaul, addition of special materials containing anti-rust and anti-scuff additives are beneficial. A suitable product for this purpose is MOPAR Engine Oil Supplement.

GENERAL INFORMATION (Continued)

9400-9

Fig. 5 Engine Oil Container Standard Notations

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right rear of engine on 4.0L engines (Fig. 6) and the right front of the engine on 5.2/5.9L engines (Fig. 7).

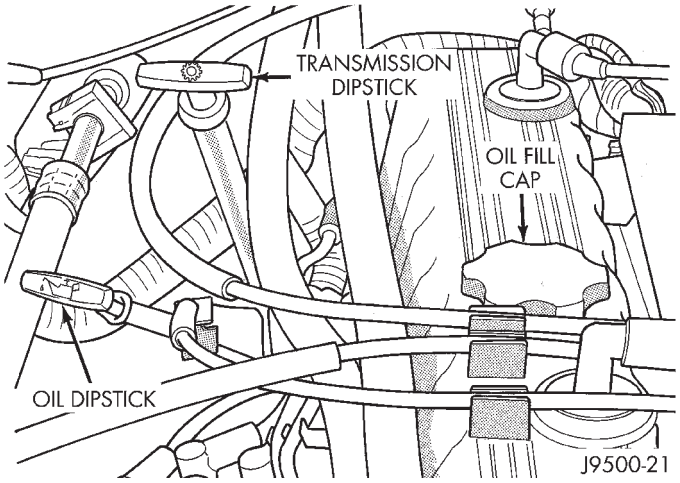


Fig. 6 Engine Oil Dipstick 4.0L Engine

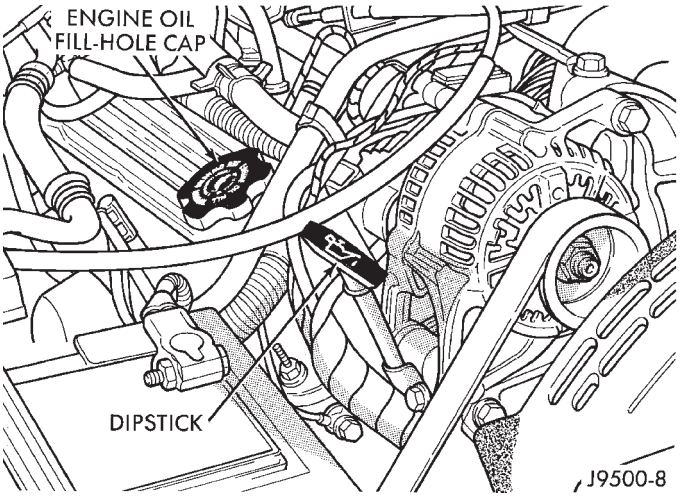


Fig. 7 Engine Oil Dipstick 5.2/5.9L Engine

CRANKCASE OIL LEVEL INSPECTION

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

Inspect engine oil level approximately every 800 kilometers (500 miles). Unless the engine has exhibited loss of oil pressure, run the engine for about five minutes before checking oil level. Checking engine oil level on a cold engine is not accurate.

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 (Fig. 8).

(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 (Fig. 8).

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

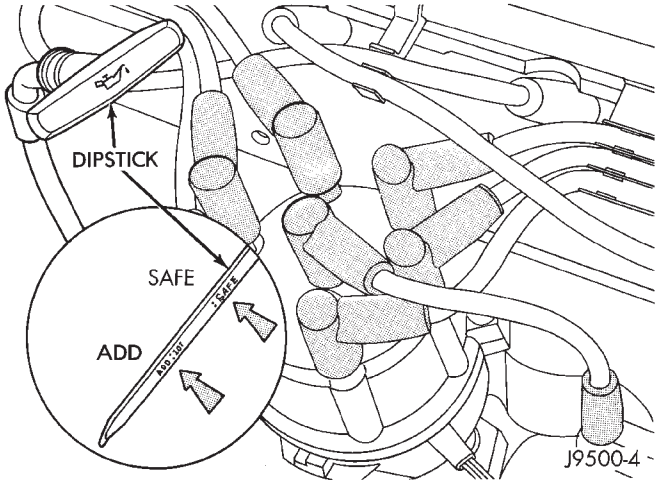


Fig. 8 Engine Oil Dipstick—4.0L Engine

ENGINE OIL CHANGE

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

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.

(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 if damaged.

(6) Install drain plug in crankcase.

GENERAL INFORMATION (Continued)

(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 (Fig. 9) to remove it from the cylinder block oil filter boss.

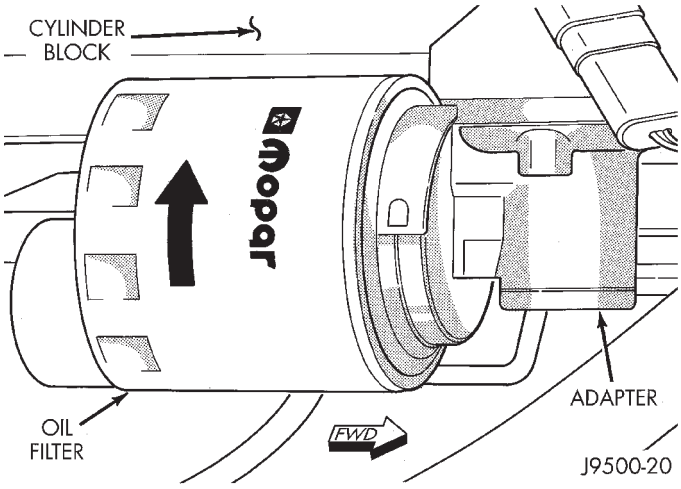


Fig. 9 Oil Filter—4.0L Engine

(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. 10) of oil and grime.

OIL FILTER INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil or chassis grease.
(2) Thread filter onto adapter nipple. When gasket makes contact with sealing surface, (Fig. 10) hand tighten filter one full turn, do not over tighten.
(3) Add oil, verify crankcase oil level and start engine. Inspect for oil leaks.

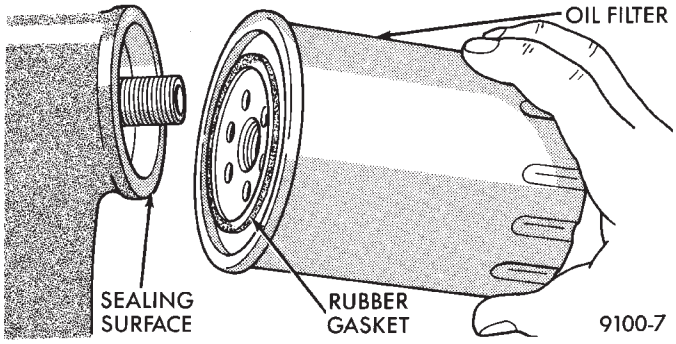


Fig. 10 Oil Filter Sealing Surface—Typical

USED ENGINE OIL DISPOSAL

Care should be exercised when disposing used engine oil after it has been drained from a vehicle engine. Refer to the WARNING at beginning of this section.

ENGINE DIAGNOSIS

INDEX

DIAGNOSIS AND TESTING

GENERAL INFORMATION

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

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) Disconnect the ignition coil.
(5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
(6) Record the compression pressure on the 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.

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders; follow the proce-

DIAGNOSIS AND TESTING (Continued)

dures 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.

INSPECTION (ENGINE OIL LEAKS IN GENERAL)

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

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

(2) Add an oil soluble dye (use as recommended by manufacturer). Start the engine and let idle for

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	INTAKE VALVE BENT, BURNT, OR NOT SEATED PROPERLY	INSPECT VALVE. REFACE OR REPLACE, AS NECESSARY
AIR ESCAPES THROUGH TAILPIPE	EXHAUST VALVE BENT, BURNT, OR NOT SEATED PROPERLY	INSPECT VALVE. REFACE OR REPLACE, AS NECESSARY
AIR ESCAPES THROUGH RADIATIOR	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.

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,

DIAGNOSIS AND TESTING (Continued)

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) Remove oil pressure sending unit.

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

DIAGNOSIS AND TESTING (Continued)

ENGINE—PERFORMANCE

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT START	1. Weak battery.	1. Test battery specific gravity. Charge or replace as necessary.
	2. Corroded or looose battery connections.	2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals.
	3. Faulty starter.	3. Refer to Group 8A, Battery/Starter/Charging System Diagnostics.
	4. Moisture on ignition wires and distributor cap.	4. Wipe wires and cap clean and dry.
	5. Faulty ignition cables.	5. Replace any cracked or shorted cables.
	6. Faulty coil or control unit.	6. Test and replace, if necessary (refer to Group 8D, Ignition System).
	7. Incorrect spark plug gap.	7. Set gap (refer to Group 8D, Ignition System).
	8. Incorrect ignition timing.	8. Refer to Group 8D, Ignition System.
	9. Dirt or water in fuel system.	9. Clean system and replace fuel filter.
	10. Faulty fuel pump, relay or wiring.	10. Refer to Group 14, Fuel System.
ENGINE STALLS OR ROUGH IDLE	1. Idle speed set too low.	1. Refer to Group 14, Fuel System.
	2. Idle mixture too lean or too rich.	2. Refer to Group 14, Fuel System.
	3. Leak in intake manifold.	3. Inspect intake manifold gasket and vacuum hoses. Replace, if necessary (refer to Group 11, Exhaust System & Intake Manifold).
	4. Worn or burned distributor rotor.	4. Install new distributor rotor.
	5. Incorrect ignition wiring.	5. Install correct wiring.
	6. Faulty coil.	6. Test and replace, if necessary (refer to Group 8D, Ignition System).
	7. EGR valve leaking.	7. Test and replace, if necessary (refer to Group 25, Emissions Control System).
	8. Incorrect cam timing.	8. Refer to Timing Belt Service.
ENGINE LOSS OF POWER	1. Incorrect ignition timing.	1. Refer to Group 8D, Ignition System.
	2. Worn or burned distributor rotor.	2. Install new distributor rotor.
	3. Worn distributor shaft.	3. Remove and repair distributor (refer to Group 8D, Ignition System).
	4. Dirty or incorrectly gapped spark plugs.	4. Clean plugs and set gap (refer to Group 8D, Ignition System).
	5. Dirt or water in fuel system.	5. Clean system and repalce fuel filter.
	6. Faulty fuel pump.	6. Install new fuel pump.
	7. Incorrect valve timing.	7. Correct valve timing.
	8. Blown cylinder head gasket.	8. Install new cylinder head gasket.
	9. Low compression.	9. Test compression of each cylinder.
	10. Burned, warped or pitted valves.	10. Install new valves.
	11. Plugged or restricted exhaust system.	11. Install new parts, as necessary.
	12. Faulty ignition cables.	12. Replace any cracked or shorted cables.
	13. Faulty coil.	13. Test and replace, as necessary (refer to Group 8D, Ignition System.)
	14. Incorrect cam timing.	14. Refer to Timing Belt Service.
ENGINE MISSES ON ACCELERATION	1. Dirty or gap sets too wide in spark plug.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).
	2. Incorrect ignition timing.	2. Refer to Group 8D, Ignition System.
	3. Dirt in fuel system.	3. Clean fuel system.
	4. Burned, warped or pitted valves.	4. Install new valves.
	5. Faulty coil.	5. Test and replace, if necessary, (refer to Group 8D, Ignition System).
	6. Incorrect cam timing.	6. Refer to Timing Belt Service.
ENGINE MISSES AT HIGH SPEED	1. Dirty or gap set too wide in spark plug.	1. Clean spark plugs and set gap (refer to Group 8D, Ignition System).
	2. Worn distributor shaft.	2. Remove and repair distributor (refer to Group 8D, Ignition System).
	3. Worn or burned distributor rotor.	3. Install new distributor rotor.
	4. Faulty coil.	4. Test and replace, as necessary (refer to Group 8D, Ignition System).
	5. Incorrect ignition timing.	5. Refer to Group 8D, Ignition System.
	6. Dirty injector in throttle body.	6. Clean injector.
	7. Dirt or water in fuel system.	7. Clean system and replace fuel filter.
	8. Incorrect cam timing.	8. Refer to Timing Belt Service.

DIAGNOSIS AND TESTING (Continued)

ENGINE—MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	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 rods. 6. Worn rocker arms. 7. Worn tappets/lash adjusters. 8. Worn valve guides. 9. Excessive runout of valve seats on valve faces.	1. Check for correct oil level (refer to Group 0, Lubrication and Maintenance.) 2. Change oil (refer to Group 0, Lubrication and Maintenance). 3. Check engine oil level. 4. Clean hydraulic tappets/hydraulic lash adjusters. 5. Install new push rods. 6. Inspect oil supply to rocker arms. 7. Install new hydraulic tappets/hydraulic lash adjusters. 8. Ream and install new valves with oversize stems. 9. Grind valve seats and valves.
CONNECTING ROD NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Misaligned connecting rods.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Replace crankshaft or grind journals. 6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round, worn. 7. Loose flywheel or torque converter.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Check No. 3 main bearing for wear on flanges. 6. Grind journals or replace crankshaft. 7. Tighten to correct torque.

DIAGNOSIS AND TESTING (Continued)

ENGINE—LUBRICATION

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Gaskets and O-Rings.	1.
	(a) Misaligned, deteriorated or torn.	(a) Replace the part.
	(b) Loose fastener, broken or porous metal part.	(b) Tighten, repair or replace the part.
	2. Crankshaft Rear Seal	2.
	(a) Misinstalled, inverted or torn lip	(a) Replace the seal.
	(b) Torn, cut or shaved seal back bead.	(b) Replace the seal.
	3. Crankshaft Seal Flange.	3.
	Scratched, nicked or grooved.	Replace or polish if necessary.
	4. Cylinder block to Cap Mating Surface.	4.
	(a) Inadequate Loctite sealant.	(a) Apply sealant per service manual procedures.
	(b) Oil hole burr.	(b) Carefully stone or chamfer hole.
	5. Oil Pan to Rear Main Cap Sealant	5.
	(Slots 3.9 - 5.2 only).	
	(a) Inadequate or mislocated sealant.	(a) Apply sealant per service manual procedures.
	(b) Torn, cut or misinstalled oil pan.	(b) Replace the gasket.
	(c) Cracked or damaged oil pan flange.	(c) Replace the oil pan.
	6. Chain Case Cover Seal	6.
	(a) Misinstalled, cocked or misaligned	(a) Replace per service manual procedures.
	(b) Torn, cut or damaged seal lips.	(b) Replace the seal.
	(c) Scratched or damaged seal casing or cover bore.	(c) Replace the seal.
	(d) Scratched or damaged vibration damper hub.	(d) Minor damage can be polished out; otherwise replace the part.
OIL PRESSURE DROP	1. Low oil level.	1. Check engine oil level.
	2. Faulty oil pressure sending unit.	2. Install new sending unit.
	3. Low oil pressure.	3. Check sending unit and check main bearing oil clearance.
	4. Clogged oil filter.	4. Install new oil filter.
	5. Worn parts in oil pump.	5. Replace worn parts or pump.
	6. Thin or diluted oil.	6. Change oil to correct viscosity.
	7. Excessive bearing clearance.	7. Measure bearings for correct clearance.
	8. Oil pump relief valve stuck.	8. Remove valve and inspect, clean and install.
	9. Oil pump suction tube loose; bent or cracked.	9. Remove oil pan and install new tube, if necessary.
	10. Oil pump cover warped or cracked.	10. Install new oil pump.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn, scuffed or broken rings.	1. Hone cylinder bores and install new rings.
	2. Carbon in oil ring slot.	2. Install new rings.
	3. Rings fitted too tightly in grooves.	3. Remove the rings. Check grooves. If grooves are not proper width, replace piston.
	4. Worn valve guides.	4. Ream guides and replace valves with oversize valves and seals.
	5. Leaking intake gasket (3.9L & 5.2L engines).	5. Replace gasket and tighten intake manifold to proper torque.
	6. Leaking valve guide seals (3.9L & 5.2L engines).	6. Replace seals.
	7. Dislodged valve guide seals (3.9L & 5.2L engines).	7. Seat valve guide seals or replace, as needed.

4.0L ENGINE

INDEX

DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 4.0 Liter (242 CID) six-cylinder engine is an In-line, lightweight, overhead valve engine.

Engine Type	In-line 6 Cylinder
Bore and Stroke	98.4 x 86.69 mm (3.88 x 3.413 in.)
Displacement	4.0 (242 cu. in.)
Compression Ratio	8.7:1
Torque	305 N·m (225 ft. lbs.) @ 4000 rpm
Firing Order	1–5–3–6–2–4
Lubrication	Pressure Feed–Full Flow Filtration
Engine Oil Capacity	5.7 L (6 Quarts)
Cooling System	Liquid Cooled–Forced Circulation
Cooling System Capacity	11.4 L (12 Quarts)
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Iron
Camshaft	Cast Iron
Pistons	Aluminum Alloy
Combustion Chamber	Double Quench
Connecting Rods	Cast Iron

This engine is designed for unleaded fuel.

The engine cylinder head has dual quench-type combustion chambers that create turbulence and fast burning of the air/fuel mixture. This results in good fuel economy.

The cylinders are numbered 1 through 6 from front to rear. The firing order is 1-5-3-6-2-4 (Fig. 1).

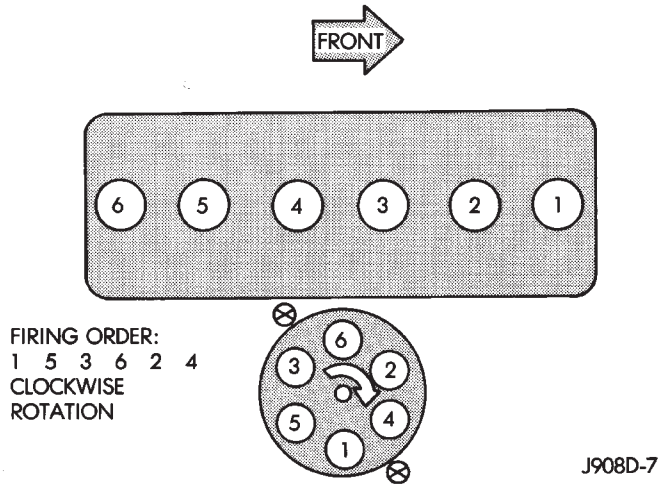


Fig. 1 Engine Firing Order

DESCRIPTION AND OPERATION (Continued)

The crankshaft rotation is clockwise, when viewed from the front of the engine. The crankshaft rotates within seven main bearings. The camshaft rotates within four bearings.

BUILD DATE CODE

The engine Build Date Code is located on a machined surface on the right side of the cylinder block between the No.2 and No.3 cylinders (Fig. 2).

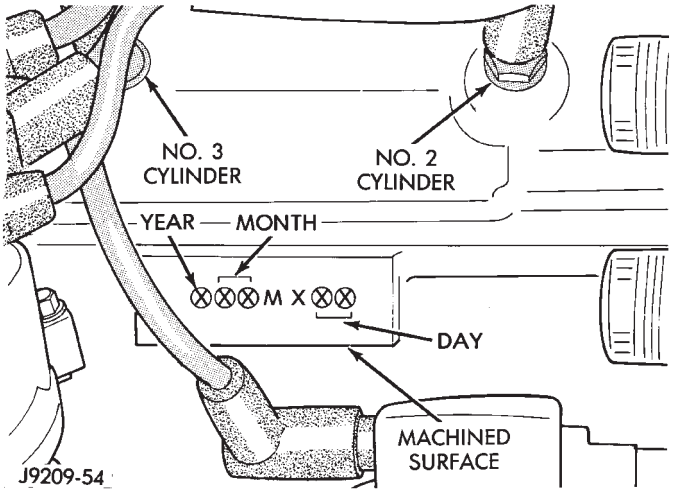


Fig. 2 Build Date Code Location

The digits of the code identify:

- 1st Digit—The year (7 = 1997).
- 2nd & 3rd Digits—The month (01 - 12).
- 4th & 5th Digits—The engine type/fuel system/ compression ratio (MX = A 4.0 Liter (242 CID) 8.7:1 compression ratio engine with a multi-point fuel injection system).
- 6th & 7th Digits—The day of engine build (01 - 31).

(1) **FOR EXAMPLE:** Code * 701MX12 * identifies a 4.0 Liter (242 CID) engine with a multi-point fuel injection system, 8.7:1 compression ratio and built on January 12, 1997.

LUBRICATION SYSTEM

A gear—type positive displacement pump is mounted at the underside of the block opposite the No. 4 main bearing. 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 of the block.

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals (except number 4 main bearing journal) to the connecting rod journals. Each connecting rod bearing cap has a small squirt hole, oil passes through the squirt hole and is thrown off as the rod rotates. This oil throwoff lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

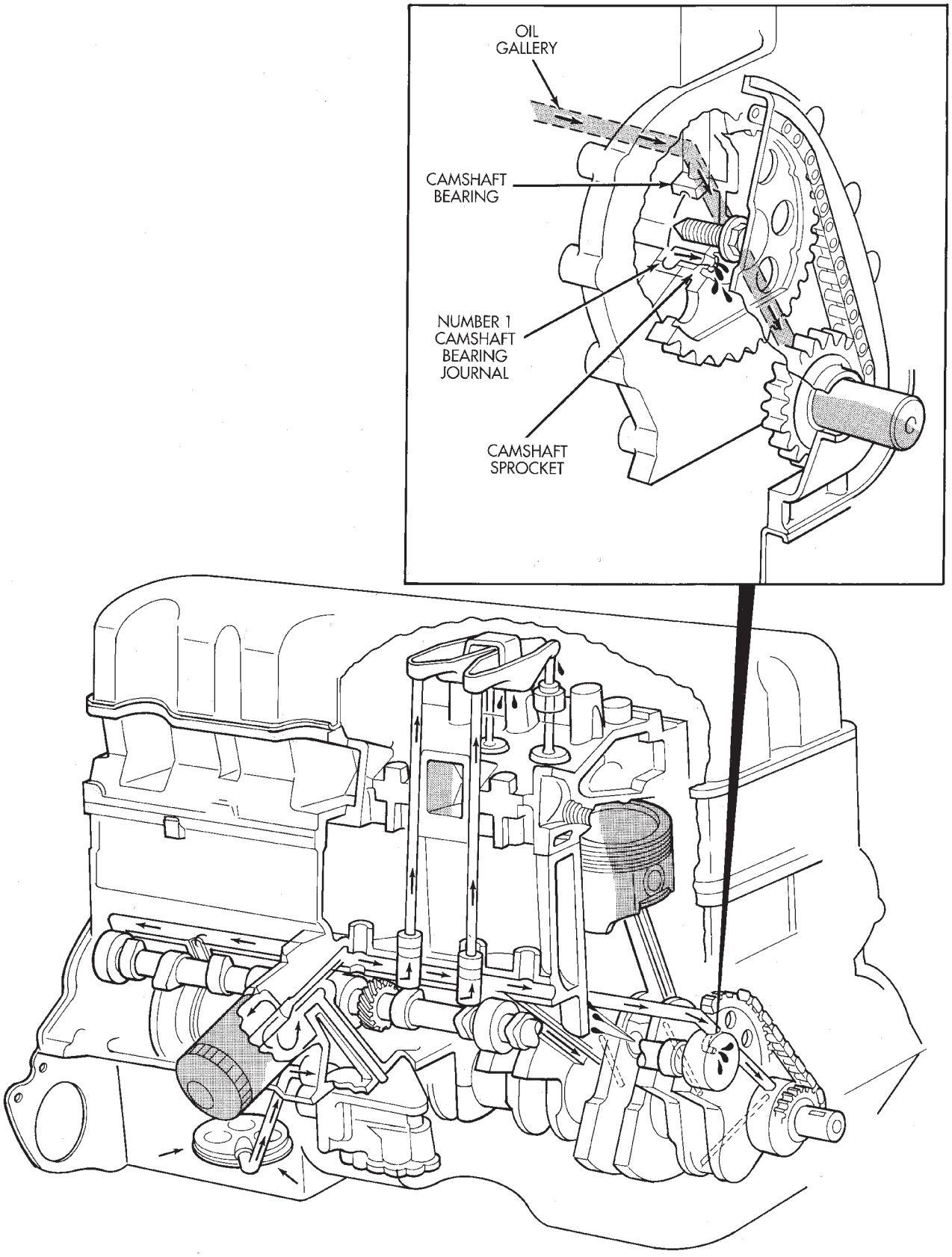
The hydraulic valve tappets receive oil directly from the main oil gallery. Oil is provided to the camshaft bearing through galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the number one main bearing cap.

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, then passes down through the push rod guide holes in the cylinder head past the valve tappet area, and returns to the oil pan.

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 89.6 kPa (13 psi) at 600 rpm. The MAXIMUM oil pump pressure is 517 kPa (75 psi) at 1600 rpm or more.

DESCRIPTION AND OPERATION (Continued)



Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

OVERSIZE AND UNDERSIZE COMPONENT CODES

Some engines may be built with oversize or undersize components such as:

- Oversize cylinder bores.
- Oversize camshaft bearing bores.
- Undersize crankshaft main bearing journals.
- Undersize connecting rod journals.

These engines are identified by a letter code (Fig. 3) stamped on a boss between the ignition coil and the distributor (Fig. 4).

CODE	COMPONENT	UNDERSIZE
P	One or more connecting rod bearing journals	0.254 mm (0.010 in)
M	All crankshaft main bearing journals	0.254 mm (0.010 in)
PM	All crankshaft main bearing journals and one or more connecting rod journals	0.254 mm (0.010 in)
CODE	**COMPONENT**	**OVERSIZE**
B	All cylinder bores	0.254 mm (0.010 in)
C	All camshaft bearing bores	0.254 mm (0.010 in)

J8909-54

Fig. 3 Oversize and Undersize ComponentCodes

SERVICE PROCEDURES

VALVE TIMING

Disconnect the spark plug wires and remove the spark plugs.

Remove the engine cylinder head cover.

Remove the capscrews, bridge and pivot assembly, and rocker arms from above the No.1 cylinder.

Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridge.

Rotate the crankshaft until the No.6 piston is at top dead center (TDC) on the compression stroke.

Rotate the crankshaft counterclockwise (viewed from the front of the engine) 90°.

Install a dial indicator on the end of the No.1 cylinder intake valve push rod. Use rubber tubing to secure the indicator stem on the push rod.

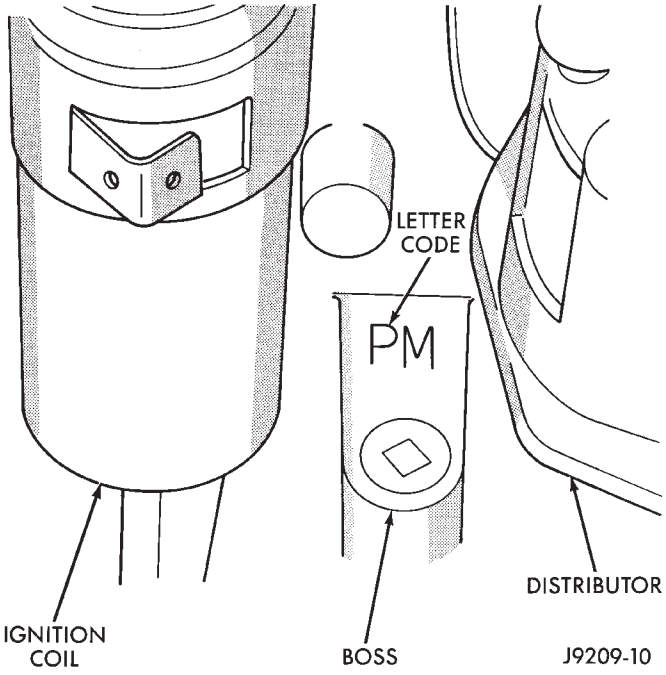


Fig. 4 Oversize and Undersize ComponentCode Location

Set the dial indicator pointer at zero.

Rotate the crankshaft clockwise (viewed from the front of the engine) until the dial indicator pointer indicates 0.305 mm (0.012 inch) travel distance (lift).

The timing notch index on the vibration damper should be aligned with the TDC mark on the timing degree scale.

If the timing notch is more than 13 mm (1/2 inch) away from the TDC mark in either direction, the valve timing is incorrect.

If the valve timing is incorrect, the cause may be a broken camshaft pin. It is not necessary to replace the camshaft because of pin failure. A spring pin is available for service replacement.

PISTON FITTING

BORE GAGE METHOD

(1) To correctly select the proper size piston, a cylinder bore gauge, capable of reading in 0.003 mm (.0001 in.) INCREMENTS is required. If a bore gauge is not available, do not use an inside micrometer.

(2) Measure the inside diameter of the cylinder bore at a point 49.5 mm (1-15/16 inches) below top of bore. Start perpendicular (across or at 90 degrees) to the axis of the crankshaft at point A and then take an additional bore reading 90 degrees to that at point B (Fig. 6).

(3) The coated pistons will be serviced with the piston pin and connecting rod pre-assembled. **The coated piston connecting rod assembly can be used to service previous built engines and**

SERVICE PROCEDURES (Continued)

MUST be replaced as complete sets. Tin coated pistons should not be used as replacements for coated pistons.

(4) The coating material is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results (Fig. 5). Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY.** . To correctly select the proper size piston, a cylinder bore gauge capable of reading in 0.003 mm (.0001 in.) increments is required.

(5) Piston installation into the cylinder bore requires slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

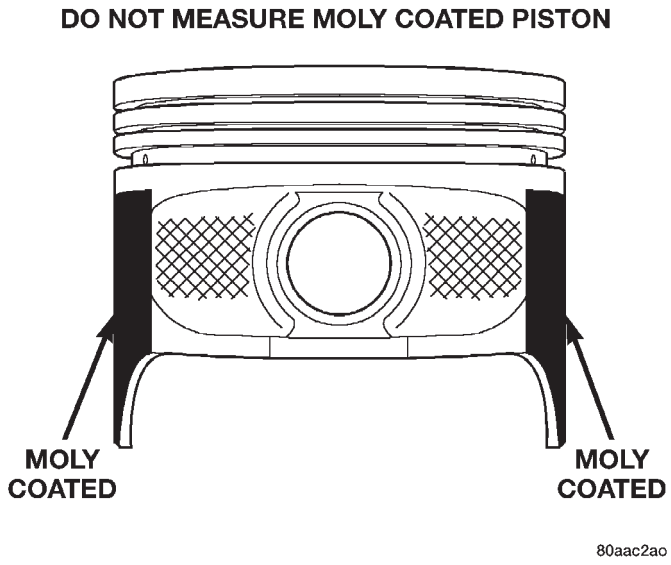


Fig. 5 Moly Coated Piston

PISTON SIZE CHART

CYLINDER BORE SIZE	PISTON LETTER SIZE
98.438 to 98.448 mm (3.8755 to 3.8759 in.)	A
98.448 to 98.458 mm (3.8759 to 3.8763 in.)	B
98.458 to 98.468 mm (3.8763 to 3.8767 in.)	C
98.468 to 98.478 mm (3.8767 to 3.8771 in.)	D
98.478 to 98.488 mm (3.8771 to 3.8775 in.)	E
98.488 to 98.498 mm (3.8775 to 3.8779 in.)	F

PISTON RING FITTING

(1) Carefully clean the carbon from all ring grooves. Oil drain openings in the oil ring groove and pin boss must be clear. DO NOT remove metal from the grooves or lands. This will change ring-to-groove clearances and will damage the ring-to-land seating.

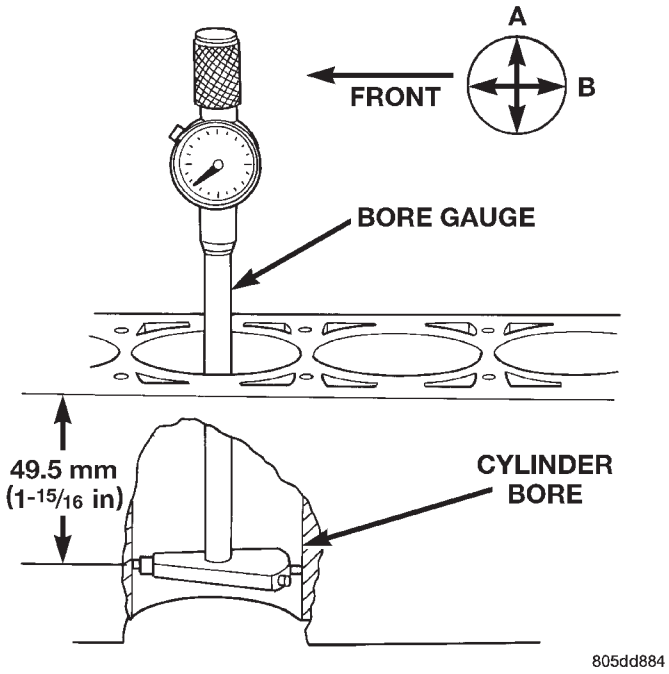


Fig. 6 Bore Gauge

(2) Be sure the piston ring grooves are free of nicks and burrs.

(3) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 7) (Fig. 8). Rotate the ring in the groove. It must move freely around circumference of the groove.

GROOVE HEIGHT

A 1.530-1.555 mm (0.0602-0.0612 in)
B 4.035-4.060 mm (0.1589-0.1598 in)

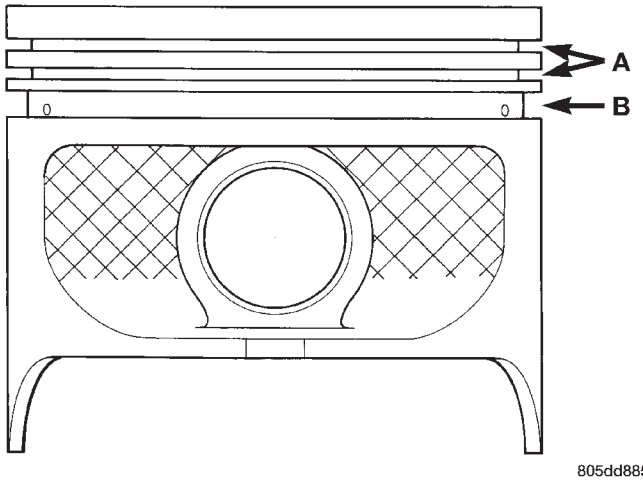


Fig. 7 Piston Dimensions

SERVICE PROCEDURES (Continued)

Ring Side Clearance Measurement

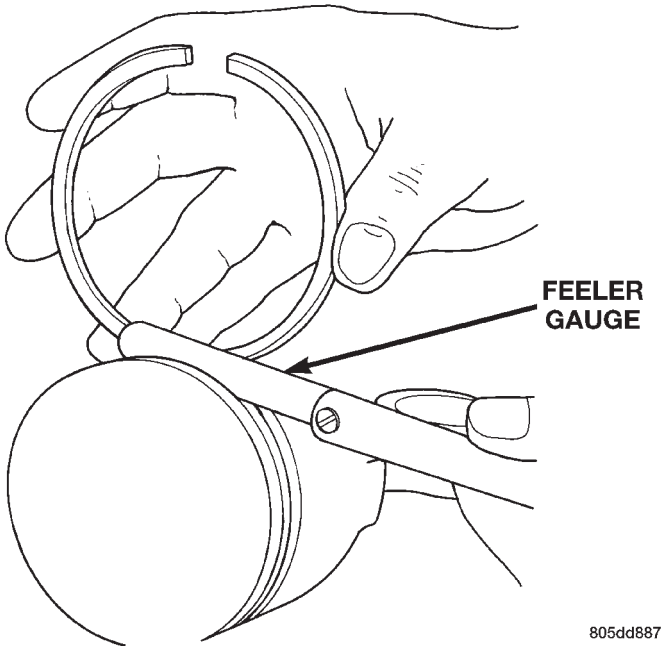


Fig. 8 Ring Side Clearance Measurement

Top Compression Ring . . . . . 0.042 to 0.084 mm
(0.0017 to 0.0033 in.)
Second Compression Ring . . . . . 0.042 to 0.084 mm
(0.0017 to 0.0033 in.)
Oil Control Ring . . . . . 0.06 to 0.21 mm
(0.0024 to 0.0083 in.)

(4) Place ring in the cylinder bore and push down with inverted piston to position near lower end of the ring travel. Measure ring gap with a feeler gauge fitting snugly between ring ends (Fig. 9).

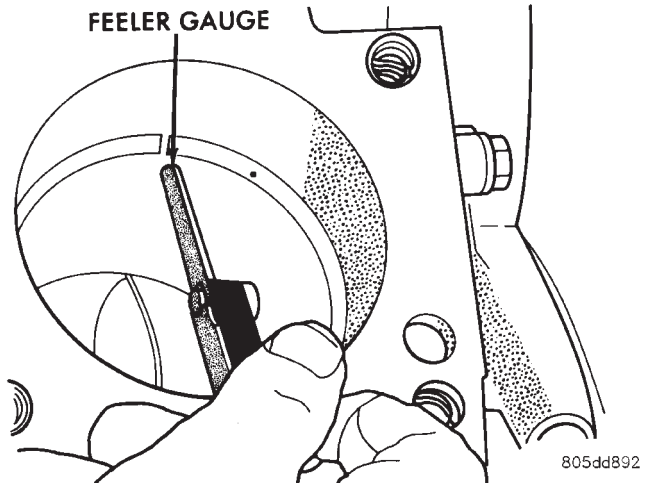


Fig. 9 Gap Measurement

Ring Gap Measurement

Top Compression Ring . . . . . 0.229 to 0.610 mm
(0.0090 to 0.0240 inch)
Second Comparison Ring . . . . . 0.483 to 0.965 mm
(0.0190 to 0.0380 inch)
Oil Control Ring . . . . . 0.254 to 1.500 mm
(0.010 to 0.060 inch)

(5) The oil control rings are symmetrical, and can be installed with either side up. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(6) The two compression rings are different and cannot be interchanged. The top compression ring can be identified by the shiny coating on the outer sealing surface and can be installed with either side up. (Fig. 10).

(7) The second compression ring has a slight chamfer on the bottom of the inside edge and a dot on the top for correct installation (Fig. 11).

(8) Using a ring installer, install the second compression ring with the dot facing up (Fig. 11) (Fig. 13).

(9) Using a ring installer, install the top compression ring (either side up).

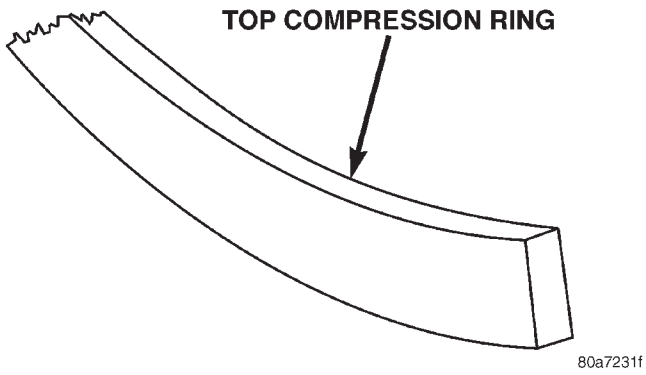


Fig. 10 Top Compression ringidentification

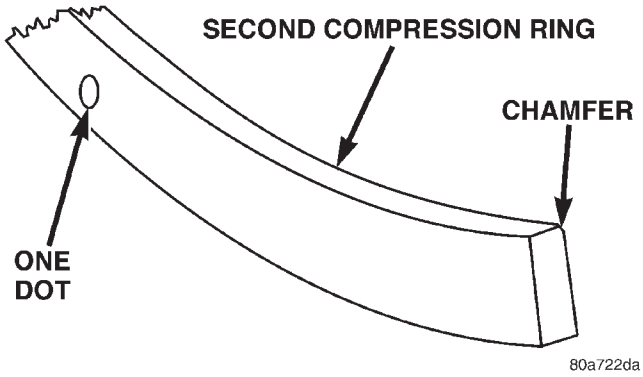


Fig. 11 Second Compression Ring Identification

SERVICE PROCEDURES (Continued)

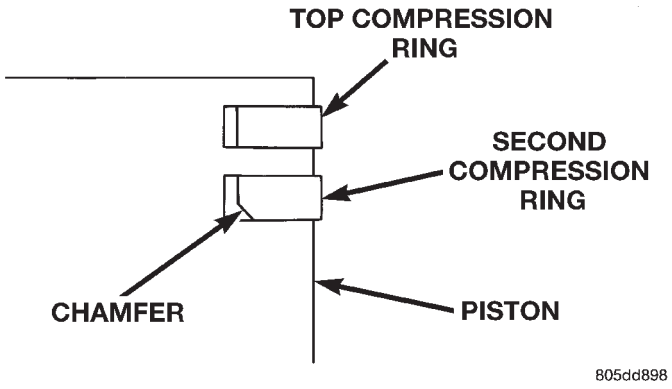


Fig. 12 Compression Ring Chamfer Location

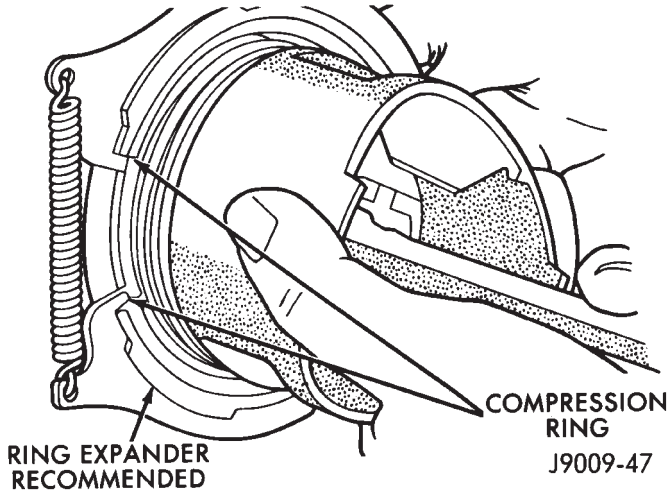


Fig. 13 Compression Ring Installation

Ring Gap Orientation

- Position the gaps on the piston as shown (Fig. 14).
- Oil spacer - Gap on center line of piston skirt.
- Oil rails - gap 180° apart on centerline of piston pin bore.
- No. 2 Compression ring - Gap 180° from top oil rail gap.
- No. 1 Compression ring - Gap 180° from No. 2 compression ring gap.

FITTING CONNECTING ROD BEARINGS

INSPECTION

BEARINGS

Inspect the connecting rod bearings for scoring and bent alignment tabs (Fig. 15) (Fig. 16). Check the bearings for normal wear patterns, scoring, grooving, fatigue and pitting (Fig. 17). Replace any bearing that shows abnormal wear.

Inspect the connecting rod journals for signs of scoring, nicks and burrs.

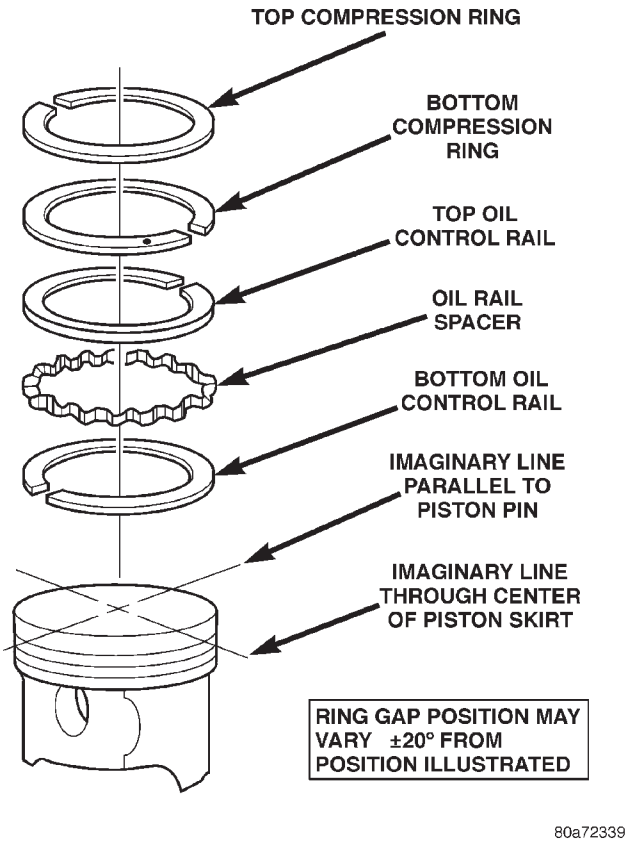


Fig. 14 Ring Gap Orientation

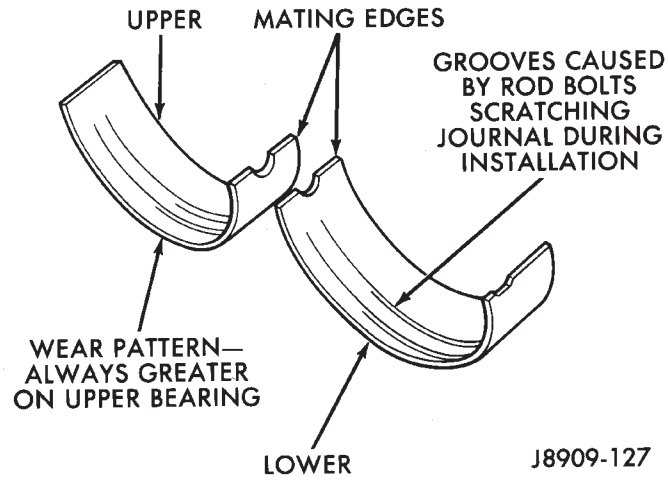


Fig. 15 Connecting Rod Bearing Inspection

CONNECTING RODS

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

SERVICE PROCEDURES (Continued)

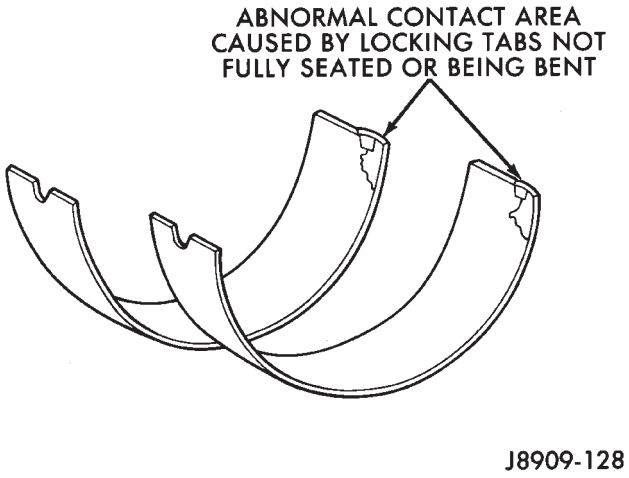


Fig. 16 Locking Tab Inspection

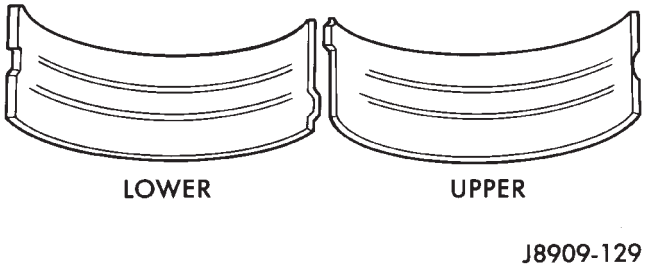


Fig. 17 Scoring Caused by Insufficient Lubricationor by Damaged Crankshaft Pin Journal

BEARING-TO-JOURNAL CLEARANCE

(1) Wipe the oil from the connecting rod journal.

(2) Use short rubber hose sections over rod bolts during installation.

(3) Lubricate the upper bearing insert and install in connecting rod.

(4) Use piston ring compressor to install the rod and piston assemblies. The oil squirt holes in the rods must face the camshaft. The arrow on the piston crown should point to the front of the engine (Fig. 18). Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(5) Install the lower bearing insert in the bearing cap. The lower insert must be dry. Place strip of Plastigage across full width of the lower insert at the center of bearing cap. Plastigage must not crumble in use. If brittle, obtain fresh stock.

(6) Install bearing cap and connecting rod on the journal and tighten nuts to 45 N·m (33 ft. lbs.) torque. DO NOT rotate crankshaft. Plastigage will smear, resulting in inaccurate indication.

(7) Remove the bearing cap and determine amount of bearing-to- journal clearance by measuring the width of compressed Plastigage (Fig. 19). Refer to Engine Specifications for the proper clearance. **Plastigage should indicate the same clearance across the entire width of the insert. If the clearance varies, it may be caused by either a tapered journal, bent connecting rod or foreign material trapped between the insert and cap or rod.**

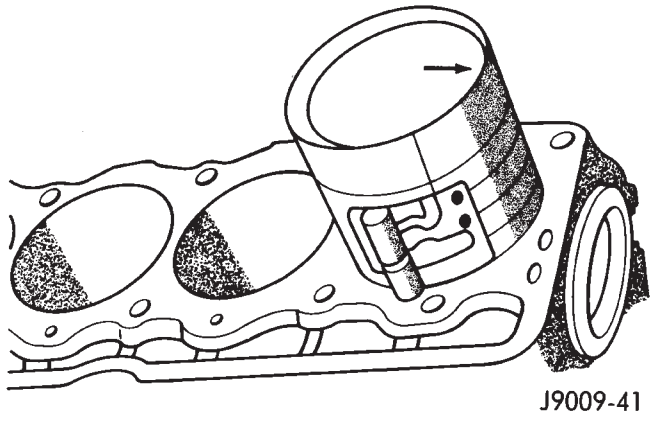


Fig. 18 Rod and Piston Assembly Installation

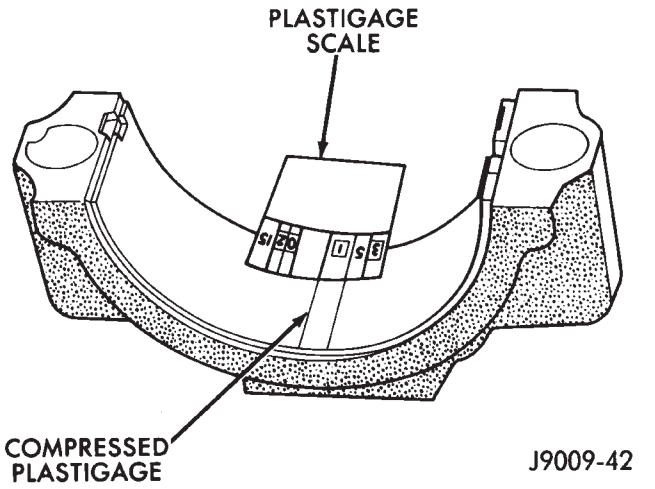


Fig. 19 Measuring Bearing Clearance withPlastigage

(8) If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove the Plastigage from crankshaft journal and bearing insert. Proceed with installation.

(9) If bearing-to-journal clearance exceeds the specification, install a pair of 0.0254 mm (0.001 inch) undersize bearing inserts. All the odd size inserts must be on the bottom. The sizes of the service replacement bearing inserts are stamped on the backs of the inserts. Measure the clearance as described in the previous steps.

(10) The clearance is measured with a pair of 0.0254 mm (0.001 inch) undersize bearing inserts installed. This will determine if two 0.0254 mm (0.001 inch) undersize inserts or another combination is needed to provide the correct clearance (refer to Connecting Rod Bearing Fitting Chart).

(11) **FOR EXAMPLE:** If the initial clearance was 0.0762 mm (0.003 inch), 0.025 mm (0.001 inch)

SERVICE PROCEDURES (Continued)

Crankshaft Journal		Corresponding Connecting Rod Bearing Insert	
Color Code	Diameter	Upper Insert Size	Lower Insert Size
Yellow	53.2257-53.2079 mm (2.0955-2.0948 in.)	Yellow - Standard	Yellow - Standard
Orange	53.2079-53.1901 mm (2.0948-2.0941 in.) 0.0178 mm (0.0007 in.) Undersize	Yellow - Standard	Blue - Undersize 0.025 mm (0.001 in.)
Blue	53.1901-53.1724 mm (2.0941-2.0934 in.) 0.0356 mm (0.0014 in.) Undersize	Blue - Undersize 0.025 mm (0.001 in.)	Blue - Undersize 0.025 mm (0.001 in.)
Red	52.9717-52.9539 mm (2.0855-2.0848 in.) 0.254 mm (0.010 in.) Undersize	Red - Undersize 0.254 mm (0.010 in.)	Red - Undersize 0.254 mm (0.010 in.)

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CONNECTING ROD BEARING FITTING CHART

undersize inserts would reduce the clearance by 0.025 mm (0.001 inch). The clearance would be 0.002 inch and within specification. A 0.051 mm (0.002 inch) undersize insert would reduce the initial clearance an additional 0.013 mm (0.0005 inch). The clearance would then be 0.038 mm (0.0015 inch).

(12) Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.

(13) Once you have selected the proper insert, install the insert and cap. Tighten the connecting rod bolts to 45 N·m (33 ft. lbs.) torque.

SIDE CLEARANCE MEASUREMENT

Slide snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. Refer to Engine Specifications for the proper clearance. Replace the connecting rod if the side clearance is not within specification.

FITTING CRANKSHAFT MAIN BEARINGS

INSPECTION

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated (Fig. 20).

NOTE: If any of the crankshaft journals are scored, remove the engine for crankshaft repair.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

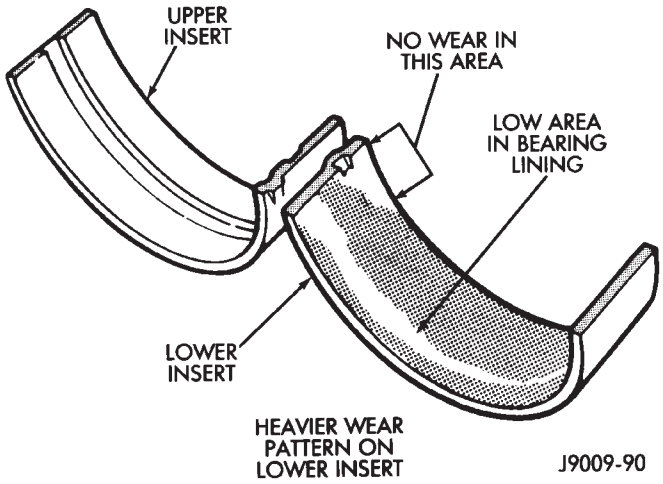

Fig. 20 Main Bearing Wear Patterns

FITTING BEARINGS (CRANKSHAFT INSTALLED)

The main bearing caps, numbered (front to rear) from 1 through 7 have an arrow to indicate the forward position. The upper main bearing inserts are grooved to provide oil channels while the lower inserts are smooth.

Each bearing insert pair is selectively fitted to its respective journal to obtain the specified operating clearance. In production, the select fit is obtained by using various-sized color-coded bearing insert pairs as listed in the Main Bearing Fitting Chart. The bearing color code appears on the edge of the insert. **The size is not stamped on bearing inserts used for engine production.**

SERVICE PROCEDURES (Continued)

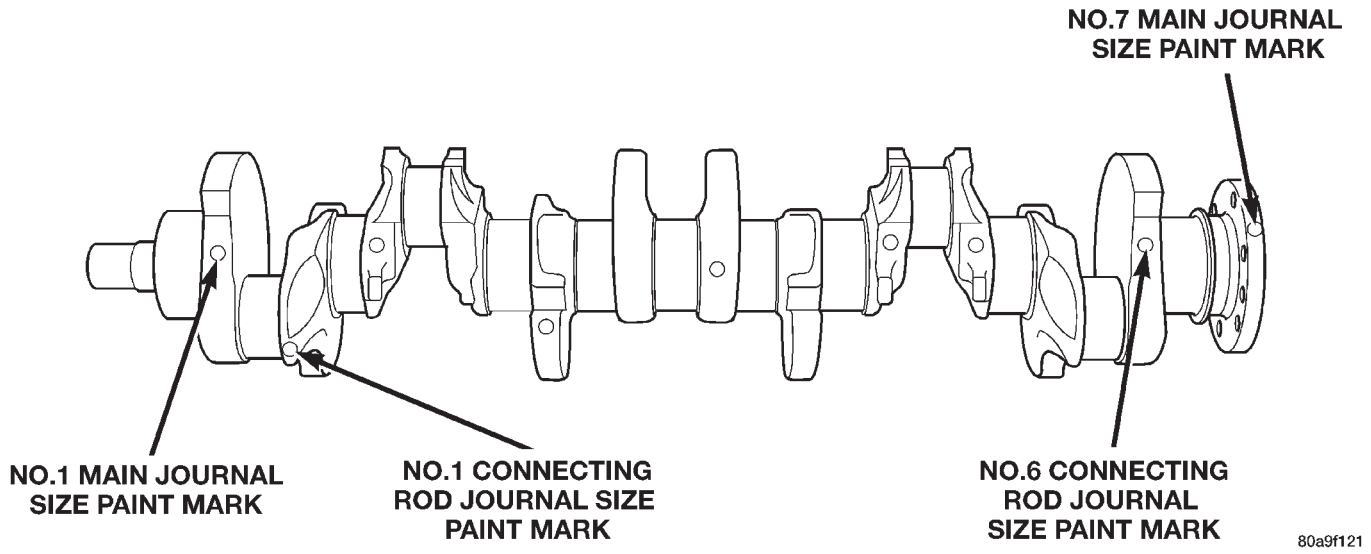

Fig. 21 Crankshaft Journal Size Paint I.D.Location

The main bearing journal size (diameter) is identified by a color-coded paint mark (Fig. 21) on the adjacent cheek or counterweight towards the rear of the crankshaft (flange end). The rear main journal, is identified by a color-coded paint mark on the crankshaft rear flange.

When required, upper and lower bearing inserts of different sizes may be used as a pair. A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce the clearance by 0.013 mm (0.0005 inch). **Never use a pair of bearing inserts with greater than a 0.025 mm (0.001 inch) difference in size (Fig. 22).**

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.025 mm (0.001 in.) Undersize	0.051 mm (0.002 in.) Undersize

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Fig. 22 Bearing Insert Pairs

NOTE: When replacing inserts, the odd size inserts must be either all on the top (in cylinder block) or all on the bottom (in main bearing cap).

Once the bearings have been properly fitted, proceed to Crankshaft Main Bearing—Installation.

BEARING-TO-JOURNAL CLEARANCE (CRANKSHAFT INSTALLED)

When using Plastigage, check only one bearing clearance at a time.

Install the grooved main bearings into the cylinder block and the non-grooved bearings into the bearing caps.

Install the crankshaft into the upper bearings dry.

Place a strip of Plastigage across full width of the crankshaft journal to be checked.

Install the bearing cap and tighten the bolts to 108 N·m (80 ft. lbs.) torque.

NOTE: DO NOT rotate the crankshaft. This will cause the Plastigage to shift, resulting in an inaccurate reading. Plastigage must not be permitted to crumble. If brittle, obtain fresh stock.

Remove the bearing cap. Determine the amount of clearance by measuring the width of the compressed Plastigage with the scale on the Plastigage envelope (Fig. 23). Refer to Engine Specifications for the proper clearance.

Plastigage should indicate the same clearance across the entire width of the insert. If clearance varies, it may indicate a tapered journal or foreign material trapped behind the insert.

If the specified clearance is indicated and there are no abnormal wear patterns, replacement of the bearing inserts is not necessary. Remove the Plastigage from the crankshaft journal and bearing insert. Proceed to Crankshaft Main Bearing—Installation.

If the clearance exceeds specification, install a pair of 0.025 mm (0.001 inch) undersize bearing inserts and measure the clearance as described in the previous steps.

SERVICE PROCEDURES (Continued)

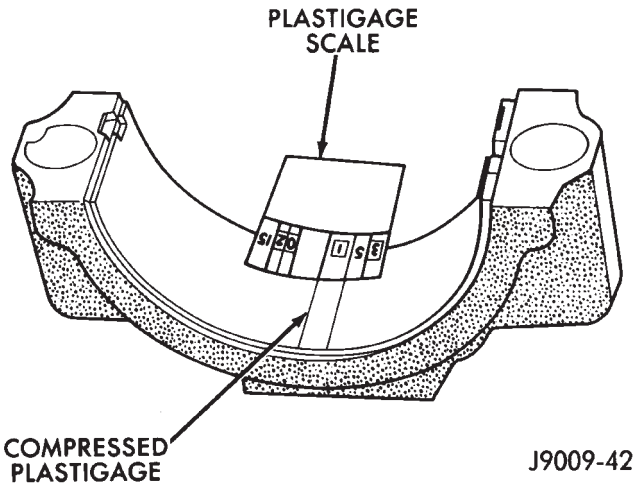


Fig. 23 Measuring Bearing Clearance withPlastigage

The clearance indicate with the 0.025 mm (0.001 inch) undersize insert pair installed will determine if this insert size or some other combination will provide the specified clearance. **FOR EXAMPLE:** If the clearance was 0.762 mm (0.003 inch) originally, a pair of 0.0254 mm (0.001 inch) undersize inserts would reduce the clearance by 0.0254 mm (0.001 inch). The clearance would then be 0.0508 mm (0.002 inch) and within the specification. A 0.051 mm (0.002 inch) undersize bearing insert and a 0.0254 mm (0.001 inch) undersize insert would reduce the original clearance an additional 0.0127 mm (0.0005 inch). The clearance would then be 0.0381 mm (0.0015 inch).

CAUTION: Never use a pair of inserts that differ more than one bearing size as a pair.

FOR EXAMPLE: DO NOT use a standard size upper insert and a 0.051 mm (0.002 inch) undersize lower insert.

If the clearance exceeds specification using a pair of 0.051 mm (0.002 inch) undersize bearing inserts, measure crankshaft journal diameter with a micrometer. If the journal diameter is correct, the crankshaft bore in the cylinder block may be misaligned, which requires cylinder block replacement or machining to true bore.

Replace the crankshaft or grind to accept the appropriate undersize bearing inserts if:

- Journal diameters 1 through 6 are less than 63.4517 mm (2.4981 inches)
- Journal 7 diameter is less than 63.4365 mm (2.4975 inches).

Once the proper clearances have been obtained, proceed to Crankshaft Main Bearing—Installation.

MAIN BEARING JOURNAL DIAMETER (CRANKSHAFT REMOVED)

Remove the crankshaft from the cylinder block (refer to Cylinder Block - Disassemble).

Clean the oil off the main bearing journal.

Determine the maximum diameter of the journal with a micrometer. Measure at two locations 90° apart at each end of the journal.

The maximum allowable taper and out of round is 0.013 mm (0.0005 inch). Compare the measured diameter with the journal diameter specification (Main Bearing Fitting Chart). Select inserts required to obtain the specified bearing-to-journal clearance.

Install the crankshaft into the cylinder block (refer to Cylinder Block - Assemble and Crankshaft Main Bearings - Installation).

SERVICE PROCEDURES (Continued)

MAIN BEARING FITTING CHART

Crankshaft Journals #1-6		Corresponding Crankshaft Bearing Insert	
Color Code	**Diameter**	**Upper Insert Size**	**Lower Insert Size**
Yellow	63.5025 -63.4898 mm (2.5001 - 2.4996 in.)	Yellow - Standard	Yellow - Standard
Orange	63.4898 - 63.4771 mm (2.4996 - 2.4991 in.) 0.0127 mm (0.0015 in.) Undersize	Yellow - Standard	Blue - Undersize 0.025 mm (0.001 in.)
Blue	63.4771 - 63.4644 mm (2.4991 - 2.4986 in.) 0.0254 mm (0.001 in.) Undersize	Blue - Undersize 0.025 mm (0.001 in.)	Blue - Undersize 0.025 mm (0.001 in.)
Green	63.4644 - 63.4517 mm (2.4986 - 2.4981 in.) 0.0381 mm (0.0015 in.) Undersize	Blue - Undersize 0.025 mm (0.001 in.)	Green - Undersize 0.051 mm (0.002 in.)
Red	63.2485 - 63.2358 mm (2.4901 - 2.4896 in.) 0.254 mm (0.010 in.) Undersize	Red - Undersize 0.254 mm (0.010 in.)	Red - Undersize 0.254 mm (0.010 in.)

Crankshaft Journal #7 Only		Corresponding Bearing Insert	
Color Code	**Diameter**	**Upper Insert Size**	**Lower Insert Size**
Yellow	63.4873 - 63.4746 mm (2.4995 - 2.4990 in.)	Yellow - Standard	Yellow - Standard
Orange	63.4746 - 63.4619 mm (2.4996 - 2.4991 in.) 0.0127 mm (0.0005 in.) Undersize	Yellow - Standard	Blue - Undersize 0.025 mm (0.001 in.)
Blue	63.4619 - 63.4492 mm (2.4985 - 2.4980 in.) 0.0254 mm (0.001 in.) Undersize	Blue - Undersize 0.025 mm (0.001 in.)	Blue - Undersize 0.025 mm (0.001 in.)
Green	63.4492 - 63.4365 mm (2.4980 - 2.4975 in.) 0.0381 mm (0.0015 in.) Undersize	Blue - Undersize 0.025 mm (0.001 in.)	Green - Undersize 0.051 mm (0.002 in.)
Red	63.2333 - 63.2206 mm (2.4895 - 2.4890 in.) 0.254 mm (0.010 in.) Undersize	Red - Undersize 0.254 mm (0.010 in.)	Red - Undersize 0.254 mm (0.010 in.)

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

The front mounts support the engine at each side. These insulators are made of resilient rubber.

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Support the engine.
(3) Raise the vehicle.
(4) Remove the insulator assembly-to-lower front sill bolts (Fig. 24) (Fig. 25).
(5) Raise the engine slightly.
(6) Remove the thru-bolt nut and thru-bolt (Fig. 24) (Fig. 25). Remove the insulator.

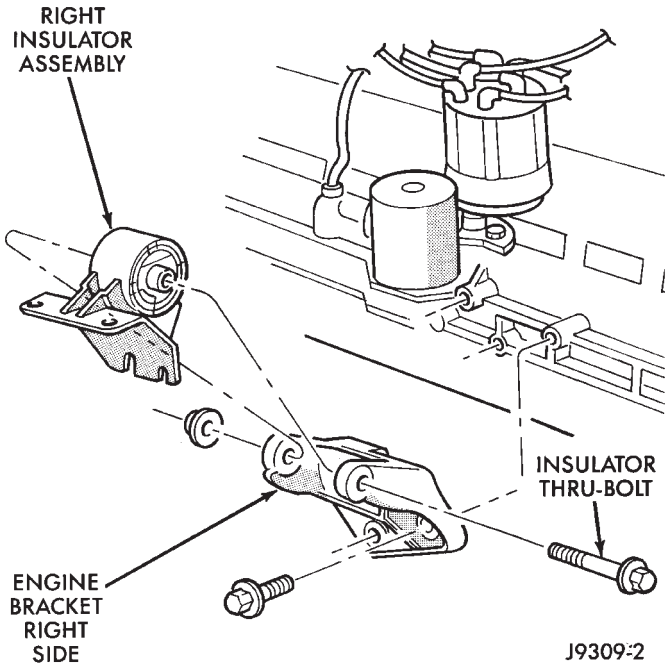


Fig. 24 Front Engine Mount—Right Side

(7) If required, remove the engine bracket from the block (Fig. 24) (Fig. 25).

INSTALLATION

(1) If removed, install the engine bracket to the block (Fig. 24) (Fig. 25). Tighten the bolts to 61 N·m (45 ft. lbs.) torque.
(2) Install the insulator assembly to the lower front sill. Tighten the bolts to 65 N·m (48 ft. lbs.) torque.
(3) With the engine insulator assembly and engine bracket in position, install the thru-bolt and nut (Fig. 24) (Fig. 25). Tighten the thru- bolt nut to 121 N·m (89 ft. lbs.) torque.
(4) Lower the vehicle.
(5) Remove the engine support.
(6) Connect the negative cable to the battery.

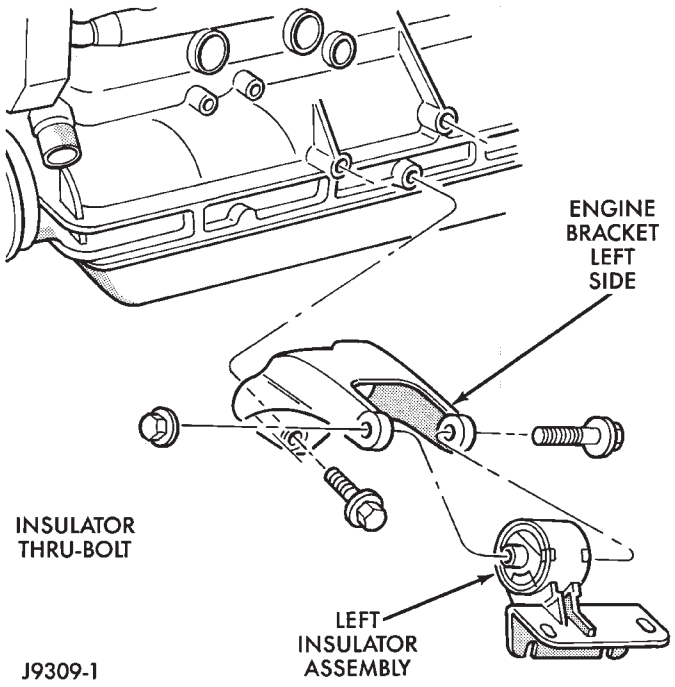


Fig. 25 Front Engine Mount—Left Side

ENGINE MOUNT—REAR

A resilient rubber cushion bracket assembly supports the transmission at the rear. This bracket is attached to the crossmember (Fig. 26) (Fig. 27).

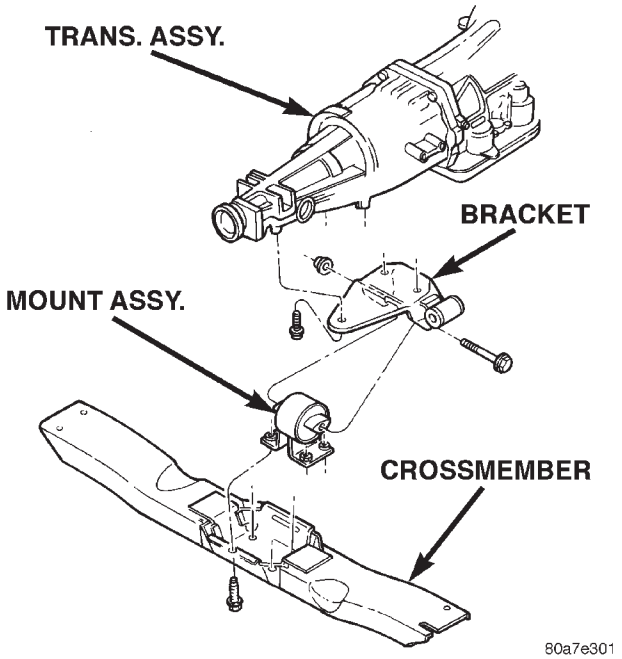


Fig. 26 Rear Engine Mount—(4x2)

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Raise the vehicle and support the transmission.
(3) Remove the bolts holding the mount assy. to the crossmember.

REMOVAL AND INSTALLATION (Continued)

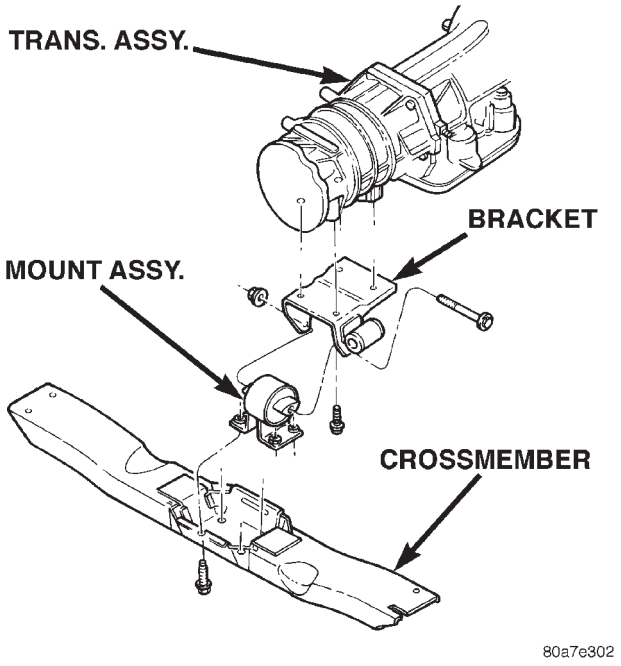


Fig. 27 Rear Engine Mount—(4x4)

(4) Raise the transmission SLIGHTLY.

(5) Remove the thru-bolt and nut. Remove the rear mount assy (Fig. 26) (Fig. 27).

(6) If necessary, remove the bolts holding the rear mount bracket to the transmission. Remove the bracket from the exhaust pipe hanger. Remove the bracket.

INSTALLATION

(1) Position the rear mount bracket onto the exhaust hanger (if previously removed). Position the rear mount bracket assembly onto the transmission and install the bolts. Tighten the bolts to 46 N·m (34 ft. lbs.)

(2) Position mount into mount bracket and install thru-bolt and nut. DO NOT tighten the bolt at this time.

(3) Lower the transmission until the mount fastening studs are in position in the crossmember.

(4) Remove the transmission support.

(5) Install the mount fastening nuts and tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(6) Tighten the thru-bolt nut to 65 N·m (48 ft. lbs.) torque.

(7) Lower the vehicle.

(8) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

(1) Disconnect the battery cables. Remove the battery.

(2) Mark the hinge locations on the hood panel for alignment reference during installation. Remove the engine compartment lamp. Remove the hood.

(3) Remove the radiator drain cock and radiator cap to drain the coolant. DO NOT waste usable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(4) Remove the upper radiator hose and coolant recovery hose (Fig. 28).

(5) Remove the lower radiator hose.

(6) Remove upper radiator support retaining bolts and remove radiator support.

(7) Remove the fan assembly from the water pump.

(8) Remove the fan shroud (Fig. 28).

(9) Disconnect the transmission fluid cooler tubing (automatic transmission).

(10) **Vehicles with Air Conditioning:**

(a) Discharge the A/C system (refer to Group 24, Heating and Air Conditioning).

(b) Remove the service valves and cap the compressor ports.

(11) Remove the radiator or radiator/condenser (if equipped with A/C).

(12) Disconnect the heater hoses at the engine thermostat housing and water pump (Fig. 28).

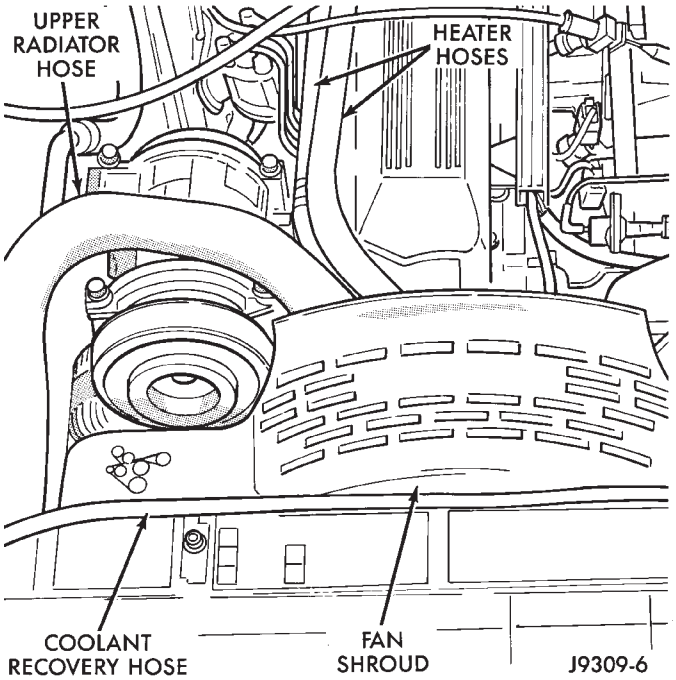


Fig. 28 Upper Radiator Hose, Coolant RecoveryHose, Fan Shroud & Heater hose

(13) Disconnect the throttle linkages (Fig. 29).

(14) Disconnect the vehicle speed control cable (if equipped) (Fig. 29).

(15) Disconnect the line pressure cable (if equipped with automatic transmission).

REMOVAL AND INSTALLATION (Continued)

(16) Disconnect injection system wire harness connector at each injector. Mark the wires for proper installation.

(17) Disconnect the distributor electrical connection and the oil pressure switch connector.

(18) Disconnect the quick-connect fuel lines at the fuel rail and return line by squeezing the two retaining tabs against the fuel tube (Fig. 29). Pull the fuel tube and retainer from the quick-connect fitting (refer to Group 14, Fuel System for the proper procedure).

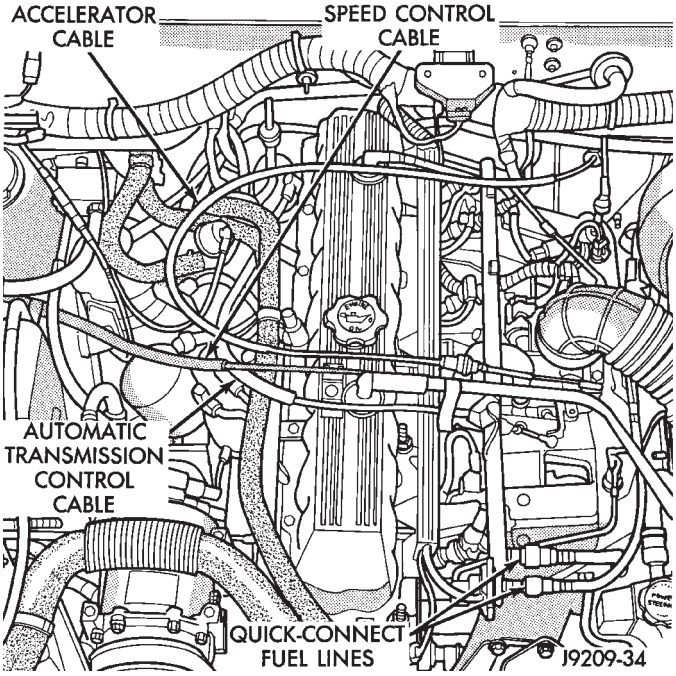


Fig. 29 Accelerator Cable, Vehicle SpeedControl Cable, Automatic Transmission Control Cable & Quick-Connect Fuel Lines

(19) Remove the fuel line bracket from the intake manifold.

(20) Remove the air cleaner assembly (Fig. 30).

(21) Remove the power brake vacuum check valve from the booster, if equipped.

(22) **Vehicles with Power Steering (Fig. 30):**

(a) Disconnect the hoses from the fittings at the steering gear.

(b) Drain the pump reservoir.

(c) Cap the fittings on the hoses and steering gear to prevent foreign objects from entering the system.

(23) Identify, tag and disconnect all necessary wire connectors and vacuum hoses.

(24) Raise and support the vehicle.

(25) Disconnect the wires from the engine starter motor solenoid.

(26) Remove the engine starter motor.

(27) Disconnect the oxygen sensor from the exhaust pipe.

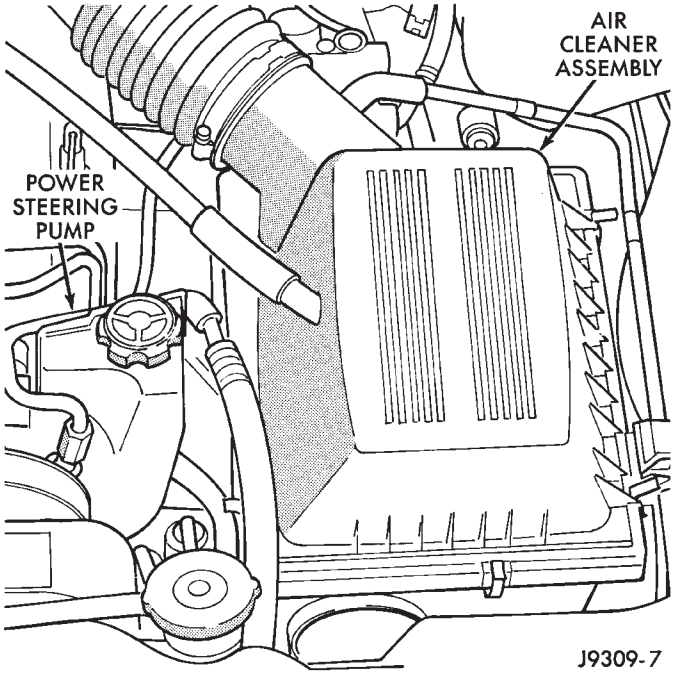


Fig. 30 Air Cleaner Assembly & PowerSteering Pump

(28) Disconnect the exhaust pipe from the manifold.

(29) Disconnect the vehicle speed sensor wire connection.

(30) Remove the exhaust pipe support.

(31) Remove the engine flywheel/converter housing access cover.

(32) **Vehicles with Automatic Transmission:**

(a) Mark the converter and drive plate location.

(b) Remove the converter-to-drive plate bolts.

(33) Remove the upper engine flywheel/converter housing bolts and loosen the bottom bolts.

(34) Remove the engine mount cushion-to-engine compartment bracket bolts.

(35) Lower the vehicle.

(36) Attach a lifting device to the engine.

(37) Raise the engine off the front supports.

(38) Place a support or floor jack under the converter (or engine flywheel) housing.

(39) Remove the remaining converter (or engine flywheel) housing bolts.

(40) Lift the engine out of the engine compartment.

INSTALLATION

CAUTION: When installing the engine into a vehicle equipped with an automatic transmission, be careful not to damage the trigger wheel on the engine flywheel.

(1) Attach a lifting device to the engine and lower the engine into the engine compartment. For easier

REMOVAL AND INSTALLATION (Continued)

installation, it may be necessary to remove the engine mount bracket as an aid in alignment of the engine to the transmission.

(2) **Vehicles with Manual Transmission:**

(a) Insert the transmission shaft into the clutch spline.

(b) Align the engine flywheel housing with the engine.

(c) Install and tighten the engine flywheel housing lower bolts finger tight.

(3) **Vehicles with Automatic Transmission:**

(a) Align the transmission torque converter housing with the engine.

(b) Loosely install the converter housing lower bolts and install the next higher bolt and nut on each side.

(c) Tighten all 4 bolts finger tight.

(4) Install the engine mount brackets (if removed).

(5) Lower the engine and engine mount brackets onto the engine compartment cushions. Install the bolts and finger tighten the nuts.

(6) Remove the engine lifting device.

(7) Raise and support the vehicle.

(8) Install the remaining engine flywheel/converter housing bolts. Tighten all bolts to 38 N·m (28 ft. lbs.) torque.

(9) **Vehicles with Automatic Transmission:**

(a) Install the converter-to-drive plate bolts.

(b) Ensure the installation reference marks are aligned.

(10) Install the engine flywheel/converter housing access cover.

(11) Install the exhaust pipe support and tighten the screw.

(12) Tighten the engine mount-to-bracket bolts.

(13) Connect the vehicle speed sensor wire connections and tighten the screws.

(14) Connect the exhaust pipe to the manifold.

(15) Install the engine starter motor and connect the cable.

(16) Connect the wires to the engine starter motor solenoid.

(17) Lower the vehicle.

(18) Connect all the vacuum hoses and wire connectors identified during engine removal.

(19) **Vehicles equipped with Power Steering:**

(a) Remove the protective caps

(b) Connect the hoses to the fittings at the steering gear. Tighten the nut to 52 N·m (38 ft. lbs.) torque.

(c) Fill the pump reservoir with fluid.

(20) Install the power brake vacuum check valve from the booster, if equipped.

(21) Connect the fuel inlet and return hoses at the fuel rail. Verify that the quick-connect fitting assembly fits securely over the fuel lines by giving the fuel lines a firm tug.

(22) Install the fuel line bracket to the intake manifold.

(23) Connect the distributor electrical connector and oil pressure switch connector.

(24) Connect the injection system wires to the injectors.

(25) Connect the line pressure cable (if equipped with automatic transmission).

(26) Connect the vehicle speed control cable, if equipped.

(27) Connect the throttle cable linkages.

(28) Connect the heater hoses at the engine thermostat housing and water pump.

(29) Install the fan assembly to the water pump.

(30) Place the fan shroud in position over the fan.

(31) Install the radiator or radiator/condenser (if equipped with A/C).

(32) Connect the service valves to the A/C compressor ports, if equipped with A/C.

(33) Charge the air conditioner system (refer to Group 24, Heating and Air Conditioning).

(34) Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped.

(35) Install the fan shroud to the radiator or radiator/condenser (if equipped with A/C).

(36) Install upper radiator support.

(37) Connect the upper radiator hose and tighten the clamp.

(38) Connect the lower radiator hose and tighten the clamp.

(39) Fill the cooling system with reusable coolant or new coolant (refer to Group 7, Cooling System).

(40) Align the hood to the scribe marks. Install the hood.

(41) Connect the vacuum harness connector.

(a) Firmly push the connectors together ensuring that the retaining tabs are engaged.

(b) Insert the vacuum connector assembly into the retaining bracket on the intake manifold.

(42) Install the air cleaner assembly.

(43) Install the battery and connect the battery cable.

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

(44) Start the engine, inspect for leaks and correct the fluid levels, as necessary.

ENGINE CYLINDER HEAD COVER

The cylinder head cover is isolated from the cylinder head via grommets and a reusable molded rubber

REMOVAL AND INSTALLATION (Continued)

gasket. The grommet and limiter are retained in the cylinder head cover.

There are two cylinder head bolts that have a pin to locate the cylinder head cover gasket, they are located at position 8 and 9 (Fig. 32)

REMOVAL

(1) Disconnect negative cable from battery.

(2) Disconnect the Crankcase Ventilation (CCV) vacuum hose from engine cylinder head cover.

(3) Disconnect the fresh air inlet hose from the engine cylinder head cover.

(4) Disconnect the accelerator, transmission, and speed (if equipped) control cables from the throttle body (Fig. 31).

(5) Remove the three bolts that fasten the control cable bracket to the intake manifold.

(6) Remove control cables from cylinder head cover clip.

(7) Position control cables and bracket away from cylinder head cover secure with tie straps.

(8) Remove the engine cylinder head cover mounting bolts.

(9) Remove the engine cylinder head cover and gasket.

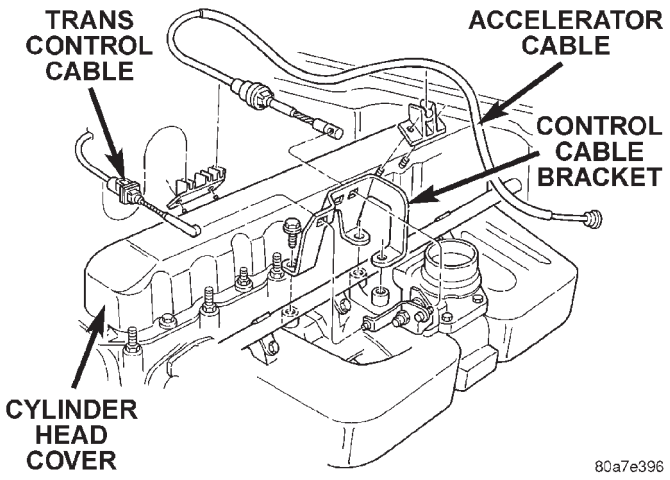


Fig. 31 Engine Cylinder Head Cover

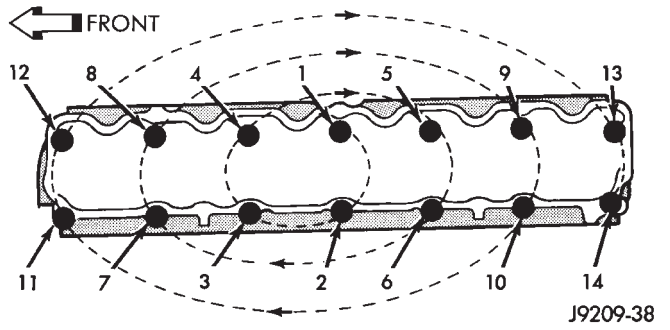


Fig. 32 Cylinder Head Cover GasketLocator Pins at #8 & #9

INSTALLATION

(1) If a replacement cover is installed, transfer the CCV valve grommet and oil filler cap from the original cover to the replacement cover.

(2) Install cylinder head cover and gasket. Tighten the mounting bolts to 8.5 N·m (75 in. lbs.) torque.

(3) Connect the CCV hoses.

(4) Install control cables and bracket on intake manifold and tighten bolts to 8.7 N·m (77 in. lbs.) torque.

(5) Connect control cables to throttle body linkage.

(6) Snap control cables into cylinder head cover clip.

(7) Connect negative cable to battery.

ROCKER ARMS AND PUSH RODS

This procedure can be done with the engine in or out of the vehicle.

REMOVAL

(1) Remove the engine cylinder head cover.

(2) Remove the capscrews at each bridge and pivot assembly (Fig. 33). Alternately loosen the capscrews one turn at a time to avoid damaging the bridges.

(3) Check for rocker arm bridges which are causing misalignment of the rocker arm to valve tip area.

(4) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 33). Place them on a bench in the same order as removed.

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

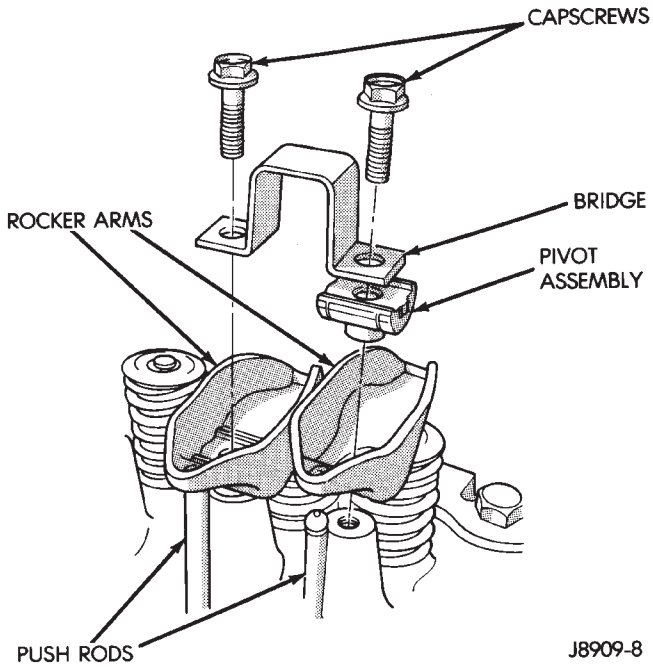


Fig. 33 Rocker Arm Assembly

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Lubricate the ball ends of the push rods with Mopar Engine Oil Supplement, or equivalent and install push rods in their original locations. Ensure that the bottom end of each push rod is centered in the tappet plunger cap seat.

(2) Using Mopar Engine Oil Supplement, or equivalent, lubricate the area of the rocker arm that the pivot contacts. Install rocker arms, pivots and bridge above each cylinder in their originally position.

(3) Loosely install the capscrews through each bridge.

(4) At each bridge, tighten the capscrews alternately, one turn at a time, to avoid damaging the bridge. Tighten the capscrews to 28 N·m (21 ft. lbs.) torque.

(5) Install the engine cylinder head cover.

VALVE STEM SEAL AND SPRING

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

REMOVAL

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

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

(1) Remove the engine cylinder head cover.

(2) Remove capscrews, bridge and pivot assemblies and rocker arms for access to each valve spring to be removed.

(3) Remove push rods. Retain the push rods, bridges, pivots and rocker arms in the same order and position as removed.

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

(5) Remove the spark plug(s) adjacent to the cylinder(s) below the valve springs to be removed.

(6) Connect an air hose to the adapter and apply air pressure slowly. Maintain at least 621 kPa (90 psi) of air pressure in the cylinder to hold the valves against their seats. For vehicles equipped with an air conditioner, use a flexible air adaptor when servicing the No.1 cylinder.

(7) Tap the retainer or tip with a rawhide hammer to loosen the lock from the retainer. Use Valve Spring Compressor Tool MD-998772A to compress the spring and remove the locks (Fig. 34).

(8) Remove valve spring and retainer (Fig. 34).

(9) Remove valve stem oil seals (Fig. 34). Note the valve seals are different for intake and exhaust valves. The top of each seal is marked either INT (Intake) or EXH (Exhaust). DO NOT mix the seals.

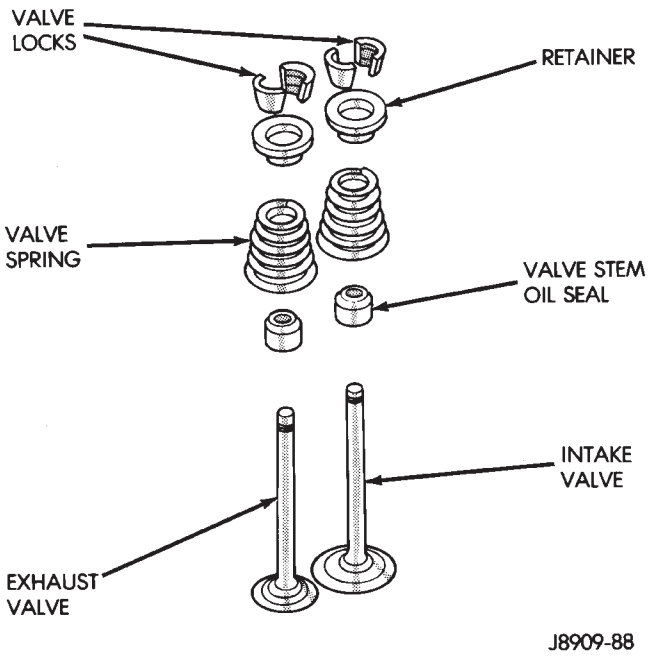


Fig. 34 Valve and Valve Components

INSTALLATION

CAUTION: Install oil seals carefully to prevent damage from the sharp edges of the valve spring lock grove.

(1) Lightly push the valve seal over the valve stem and valve guide boss. Be sure the seal is completely seated on the valve guide boss.

(2) Install valve spring and retainer.

(3) Compress the valve spring with Valve Spring Compressor Tool MD-998772A and insert the valve locks. Release the spring tension and remove the tool. Tap the spring from side-to-side to ensure that the spring is seated properly on the engine cylinder head.

(4) Disconnect the air hose. Remove the adaptor from the spark plug hole and install the spark plug.

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

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

(7) Install the rocker arms, pivots and bridge at their original location.

(8) Tighten the bridge capscrews alternately, one at a time, to avoid damaging the bridge. Tighten the capscrews to 28 N·m (21 ft. lbs.) torque.

(9) Install the engine cylinder head cover.

ENGINE CYLINDER HEAD

This procedure can be done with the engine in or out of the vehicle.

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Disconnect negative cable from battery.

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

(2) Drain the coolant and disconnect the hoses at the engine thermostat housing. DO NOT waste reusable coolant. If the solution is clean and is being drained only to service the engine or cooling system, drain the coolant into a clean container for reuse.

(3) Remove the air cleaner assembly.

(4) Remove the engine cylinder head cover.

(5) Remove the capscrews, bridge and pivot assemblies and rocker arms.

(6) Remove the push rods. **Retain the push rods, bridges, pivots and rocker arms in the same order as removed.**

(7) Loosen the serpentine drive belt at the power steering pump, if equipped or at the idler pulley (refer to Group 7, Cooling System for the proper procedure).

(8) If equipped with air conditioning, remove the air conditioning compressor, (refer to Group 24, Heating and Air Conditioning).

(9) If equipped, disconnect the power steering pump bracket. Set the pump and bracket aside. DO NOT disconnect the hoses.

(10) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System).

(11) Remove the fuel lines.

(12) Remove the intake and engine exhaust manifolds from the engine cylinder head (refer to Group 11, Exhaust System and Intake Manifold for the proper procedures).

(13) Disconnect the ignition wires and remove the spark plugs.

(14) Disconnect the temperature sending unit wire connector.

(15) Remove the ignition coil and bracket assembly.

(16) Remove the engine cylinder head bolts. Bolt No.14 cannot be removed until the head is moved forward (Fig. 35). Pull bolt No.14 out as far as it will go and then suspend the bolt in this position (tape around the bolt).

(17) Remove the engine cylinder head and gasket (Fig. 35).

(18) If this was the first time the bolts were removed, put a paint dab on the top of the bolt. If the bolts have a paint dab on the top of the bolt or it isn't known if they were used before, discard the bolts.

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

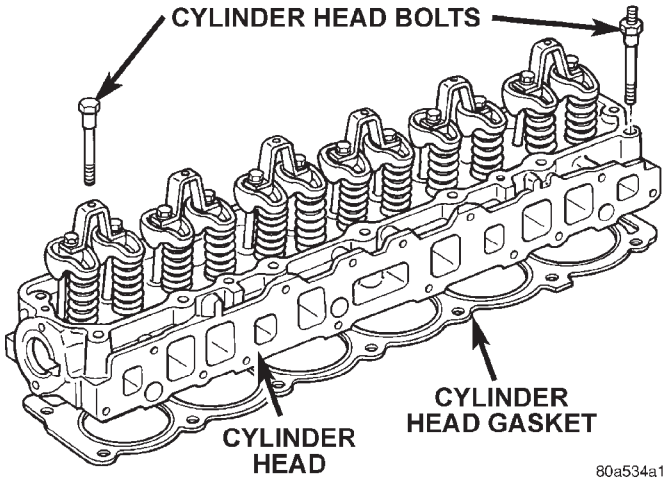


Fig. 35 Engine Cylinder Head Assembly

INSTALLATION

The engine cylinder head gasket is a composition gasket. The gasket is to be installed DRY. **DO NOT use a gasket sealing compound on the gasket.**

If the engine cylinder head is to be replaced and the original valves used, measure the valve stem diameter. Only standard size valves can be used with a service replacement engine cylinder head unless the replacement head valve stem guide bores are reamed to accommodate oversize valve stems. Remove all carbon buildup and reface the valves.

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

(2) Position the engine cylinder head gasket (with the numbers facing up) using the alignment dowels in the cylinder block, to position the gasket.

CAUTION: Engine cylinder head bolts should be reused only once. Replace the head bolts if they were used before or if they have a paint dab on the top of the bolt.

(3) With bolt No.14 held in place (tape around bolt), install the engine cylinder head over the same dowels used to locate the gasket. Remove the tape from bolt No.14.

(4) Coat the threads of stud bolt No.11 with Loctite 592 sealant, or equivalent.

(5) Tighten the engine cylinder head bolts in sequence according to the following procedure (Fig. 36).

CAUTION: During the final tightening sequence, bolt No.11 will be tightened to a lower torque than the rest of the bolts. DO NOT overtighten bolt No.11.

REMOVAL AND INSTALLATION (Continued)

(a) Tighten all bolts in sequence (1 through 14) to 30 N·m (22 ft. lbs.) torque.

(b) Tighten all bolts in sequence (1 through 14) to 61 N·m (45 ft. lbs.) torque.

(c) Check all bolts to verify they are set to 61 N·m (45 ft. lbs.) torque.

(d) Tighten bolts in sequence:

- Bolts 1 through 10 to 149 N·m (110 ft. lbs.) torque.
- Bolt 11 to 13 N·m (100 ft. lbs.) torque.
- Bolts 12 through 14 to 149 N·m (110 ft. lbs.) torque.

CYLINDER HEAD BOLTS

POSITION	DESCRIPTION
1,4,5,12,13	1/2 in.-13 BOLT
8,9	1/2 in.-13 BOLT WITH DOWEL POINT
2,3,6,7,10,11,14	1/2 in.-13 WITH 7/16 in.-14 STUD END
All bolts are 12 point drives for rocker cover clearance	

(e) Check all bolts in sequence to verify the correct torque.

(f) If not already done, clean and mark each bolt with a dab of paint after tightening. Should you encounter bolts which were painted in an earlier service operation, replace them.

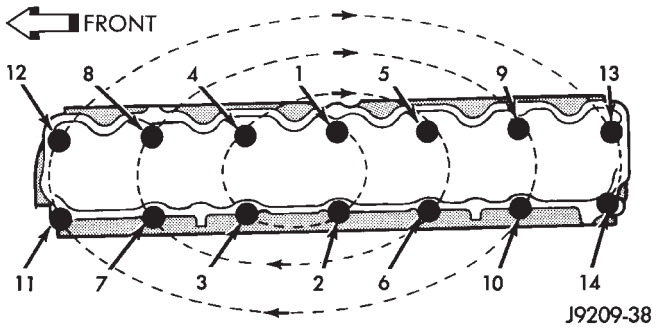


Fig. 36 Engine Cylinder Head Bolt TighteningSequence

(6) Install the ignition coil and bracket assembly.

(7) Connect the temperature sending unit wire connector.

(8) Install the spark plugs and tighten to 37 N·m (27 ft. lbs.) torque. Connect the ignition wires.

(9) Install the intake and engine exhaust manifolds (refer to Group 11, Exhaust System and Intake Manifold for the proper procedures).

(10) Install the fuel lines and the vacuum advance hose.

(11) If equipped, attach the power steering pump and bracket.

(12) Install the push rods, rocker arms, pivots and bridges in the order they were removed (refer to Rocker Arms and Push Rods in this section).

(13) Install the engine cylinder head cover.

(14) Attach the air conditioner compressor mounting bracket to the engine cylinder head and block. Tighten the bolts to 40 N·m (30 ft. lbs.) torque.

(15) Attach the air conditioning compressor to the bracket. Tighten the bolts to 27 N·m (20 ft. lbs.) torque.

CAUTION: The serpentine drive belt must be routed correctly. Incorrect routing can cause the water pump to turn in the opposite direction causing the engine to overheat.

(16) Install the serpentine drive belt and correctly tension the belt (refer to Group 7, Cooling System for the proper procedure).

(17) Install the air cleaner and ducting.

(18) Install the engine cylinder head cover.

(19) Connect the hoses to the engine thermostat housing and fill the cooling system to the specified level (refer to Group 7, Cooling Systems for the proper procedure).

(20) The automatic transmission throttle linkage and cable must be adjusted after completing the engine cylinder head installation (refer to Group 21, Transmissions for the proper procedures).

(21) Install the temperature sending unit and connect the wire connector.

(22) Connect the fuel line.

(23) If equipped with air conditioning, install air compressor and charge A/C system (refer to Group 24 Heating and Air Conditioning).

(24) Connect negative cable to battery.

(25) Connect the upper radiator hose and heater hose at the engine thermostat housing.

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

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

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

VALVES AND VALVE SPRINGS

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

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Remove the engine cylinder head from the cylinder block.

(2) Use Valve Spring Compressor Tool MD-998772A and compress each valve spring.

(3) Remove the valve locks, retainers, springs and valve stem oil seals. Discard the oil seals.

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

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

INSTALLATION

(1) Thoroughly clean the valve stems and the valve guide bores.

(2) Lightly lubricate the stem.

(3) Install the valve in the original valve guide bore.

(4) Install the replacement valve stem oil seals on the valve stems. If the 0.381 mm (0.015 inch) oversize valve stems are used, oversize oil seals are required.

(5) Position the valve spring and retainer on the engine cylinder head and compress the valve spring with Valve Spring Compressor Tool MD-998772A.

(6) Install the valve locks and release the tool.

(7) Tap the valve spring from side to side with a hammer to ensure that the spring is properly seated at the engine cylinder head. Also tap the top of the retainer to seat the valve locks.

(8) Install the engine cylinder head.

HYDRAULIC TAPPETS

Retain all the components in the same order as removed.

REMOVAL

(1) Remove the engine cylinder head (Refer to cylinder head r&i in this section).

(2) Remove the push rods.

(3) Remove the tappets through the push rod openings in the cylinder block with a Hydraulic Valve Tappet Removal/Installation Tool (Fig. 37).

INSTALLATION

It is not necessary to charge the tappets with engine oil. They will charge themselves within a very short period of engine operation.

(1) Dip each tappet in Mopar Engine Oil Supplement, or equivalent.

(2) Use Hydraulic Valve Tappet Removal/Installation Tool to install each tappet in the same bore from where it was originally removed.

(3) Install the cylinder head assy (Refer to cylinder head r&i in this section).

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

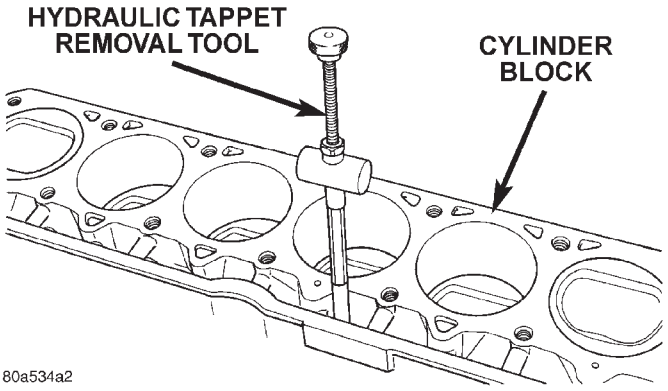


Fig. 37 Hydraulic Valve Tappet Removal—InstallationTool

(5) Install the rocker arms and bridge and pivot assemblies at their original locations. Loosely install the capscrews at each bridge.

(6) Tighten the capscrews alternately, one turn at a time, to avoid damaging the bridges. Tighten the capscrews to 28 N·m (21 ft. lbs.) torque.

(7) Pour the remaining Mopar Engine Oil Supplement, or equivalent over the entire valve actuating assembly. The Mopar Engine Oil Supplement, or equivalent must remain with the engine oil for at least 1 609 km (1,000 miles). The oil supplement need not be drained until the next scheduled oil change.

(8) Install the engine cylinder head cover.

VIBRATION DAMPER

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the serpentine drive belt and fan shroud.

(3) Remove the vibration damper retaining bolt and washer.

(4) Use Vibration Damper Removal Tool 7697 to remove the damper from the crankshaft (Fig. 38).

INSTALLATION

(1) Apply Mopar Silicone Rubber Adhesive Sealant to the keyway in the crankshaft and insert the key. With the key in position, align the keyway on the vibration damper hub with the crankshaft key and tap the damper onto the crankshaft.

(2) Install the vibration damper retaining bolt and washer.

(3) Tighten the damper retaining bolt to 108 N·m (80 ft. lbs.) torque.

(4) Install the serpentine drive belt and tighten to the specified tension (refer to Group 7, Cooling Systems for the proper specifications and procedures).

(5) Connect negative cable to battery.

REMOVAL AND INSTALLATION (Continued)

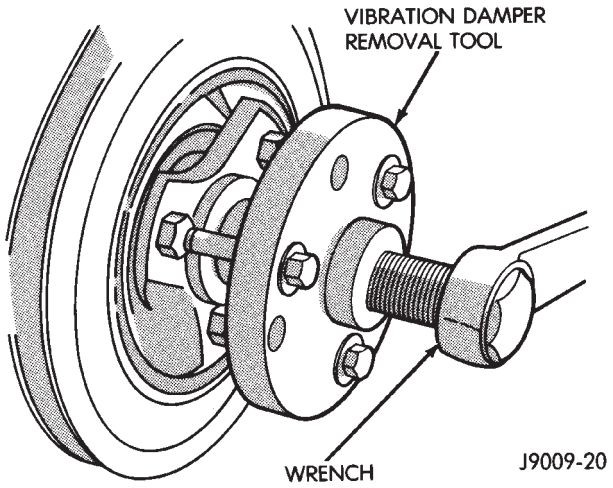


Fig. 38 Vibration Damper Removal Tool 7697

TIMING CASE COVER

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the vibration damper.

(3) Remove the fan and hub assembly and remove the fan shroud.

(4) Remove the accessory drive brackets that are attached to the timing case cover.

(5) Remove the A/C compressor (if equipped) and generator bracket assembly from the engine cylinder head and move to one side.

(6) Remove the oil pan-to-timing case cover bolts and timing case cover-to-cylinder block bolts.

(7) Remove the timing case cover and gasket from the engine. Make sure the tension spring and thrust pin do not fall out of the preload bolt.

(8) Pry the crankshaft oil seal from the front of the timing case cover (Fig. 39).

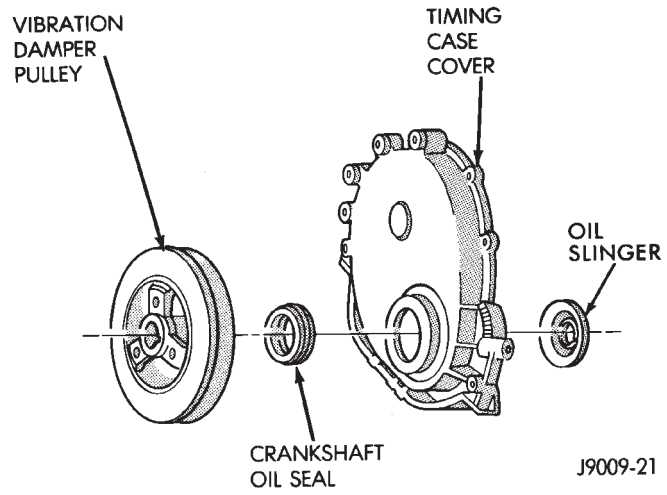


Fig. 39 Timing Case Cover Components

INSTALLATION

Clean the timing case cover, oil pan and cylinder block gasket surfaces.

(1) Install a new crankshaft oil seal in the timing case cover. The open end of the seal should be toward the inside of the cover. Support the cover at the seal area while installing the seal. Force it into position with Seal Installation Tool 6139.

(2) Position the gasket on the cylinder block.

(3) Position the timing case cover on the oil pan gasket and the cylinder block. Make sure the tension spring and thrust pin are in place in the camshaft preload bolt.

(4) Insert Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 40).

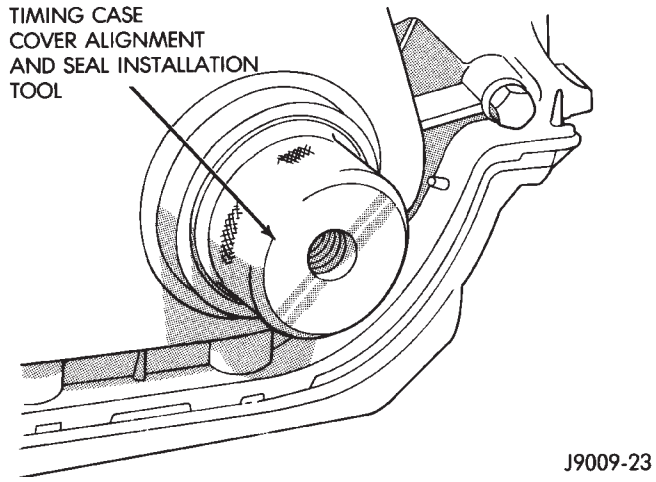


Fig. 40 Timing Case Cover Alignment and SealInstallation Tool 6139

(5) Install the timing case cover-to-cylinder block and the oil pan-to-timing case cover bolts.

(6) Tighten the 1/4 inch cover-to-block bolts to 7 N·m (60 in. lbs.) torque. Tighten the 5/16 inch front cover-to-block bolts to 22 N·m (192 in. lbs.) torque. Tighten the oil pan-to-cover 1/4 inch bolts to 9.5 N·m (84 in. lbs.) torque. Tighten the oil pan-to-cover 5/16 inch bolts to 15 N·m (132 in. lbs.) torque.

(7) Remove the cover alignment tool.

(8) Apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(9) Apply Mopar Silicone Rubber Adhesive Sealant to the keyway in the crankshaft and insert the key. With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N·m (80 ft. lbs.) torque.

(10) Install the A/C compressor (if equipped) and generator bracket assembly.

(11) Install the engine fan and hub assembly and shroud.

REMOVAL AND INSTALLATION (Continued)

(12) Install the serpentine drive belt and tighten to obtain the specified tension.

(13) Connect negative cable to battery.

TIMING CHAIN AND SPROCKETS

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the fan and shroud.

(3) Remove the serpentine drive belt.

(4) Remove the crankshaft vibration damper.

(5) Remove the timing case cover.

(6) Rotate crankshaft until the "0" timing mark is closest to and on the center line with camshaft sprocket timing mark (Fig. 41).

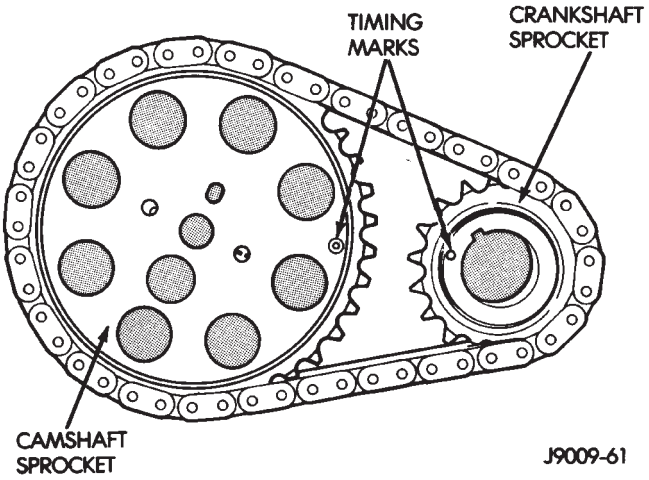


Fig. 41 Crankshaft—Camshaft Alignment—Typical

(7) Remove the oil slinger from the crankshaft.

(8) Remove the tension spring and thrust pin from the preload bolt (Fig. 42). Remove the camshaft sprocket retaining preload bolt and washer.

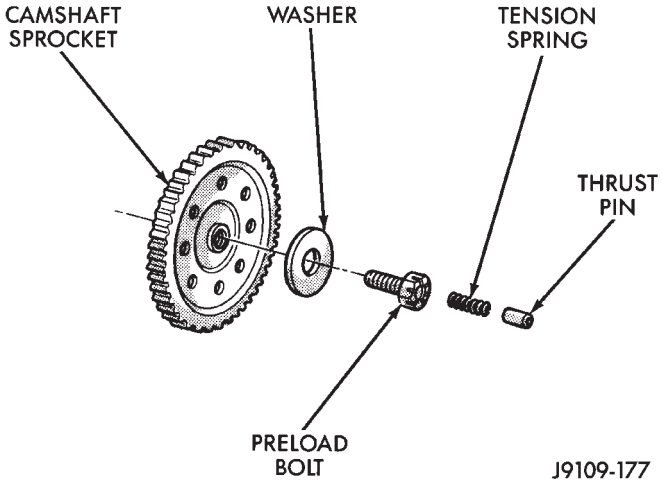


Fig. 42 Camshaft Sprocket Preload Bolt

(9) Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly.

(10) Installation of the timing chain with the timing marks on the crankshaft and camshaft sprockets properly aligned ensures correct valve timing. A worn or stretched timing chain will adversely affect valve timing. If the timing chain deflects more than 12.7 mm (1/2 inch) replace it. The correct timing chain has 48 pins. A chain with more than 48 pins will cause excessive slack.

INSTALLATION

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned (Fig. 43).

(1) Apply Mopar Silicone Rubber Adhesive Sealant to the keyway in the crankshaft and insert the key. With the key in the keyway on the crankshaft, install the assembly on the crankshaft and camshaft.

(2) Install the camshaft sprocket retaining preload bolt and washer (Fig. 42). Tighten the preload bolt to 108 N·m (80 ft. lbs.) torque.

(3) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark as shown in (Fig. 43). Count the number of chain pins between the timing marks of both sprockets. There must be 15 pins.

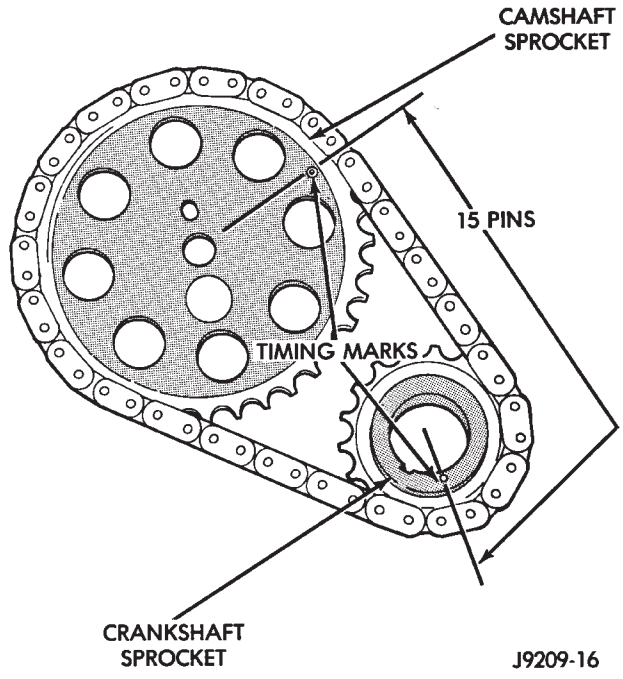


Fig. 43 Verify Sprocket—Chain Installation—Typical

(4) Install the crankshaft oil slinger.

(5) Replace the oil seal in the timing case cover.

(6) Lubricate the tension spring, thrust pin and pin bore in the preload bolt with Mopar Engine Oil Supplement, or equivalent. Install the spring and thrust pin in the preload bolt head (Fig. 42).

(7) Install the timing case cover and gasket.

REMOVAL AND INSTALLATION (Continued)

(8) With the key installed in the crankshaft keyway, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N·m (80 ft. lbs.) torque.

(9) Install the serpentine drive belt and tighten to the specified tension (refer to Group 7, Cooling System for the proper procedure).

(10) Install the fan and hub assembly. Install the shroud.

(11) Connect negative cable to battery.

CAMSHAFT

REMOVAL

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. RELEASE THE PRESSURE BEFORE REMOVING THE DRAIN COCK, CAP AND DRAIN PLUGS.

(1) Disconnect negative cable from battery.

(2) Drain the cooling system. DO NOT waste reusable coolant. If the solution is clean, drain it into a clean container for reuse.

(3) Remove the radiator or radiator and condenser, if equipped with A/C (refer to Group 7, Cooling System for the proper procedure).

(4) Remove the air conditioner condenser and receiver/drier assembly as a charged unit, if equipped (refer to Group 24, Heating and Air Conditioning).

(5) Remove the distributor cap and mark the position of the rotor.

(6) Remove the distributor and ignition wires.

(7) Remove the engine cylinder head cover.

(8) Remove the rocker arms, bridges and pivots.

(9) Remove the push rods.

(10) Remove the engine cylinder head and gasket.

(11) Remove the hydraulic valve tappets from the engine cylinder block.

(12) Remove the vibration damper.

(13) Remove the timing case cover.

(14) Remove the timing chain and sprockets.

(15) Remove the front bumper and/or grille, as required.

(16) Remove the camshaft (Fig. 44).

INSTALLATION

(1) Inspect the cam lobes for wear.

(2) Inspect the bearing journals for uneven wear pattern or finish.

(3) Inspect the bearings for wear.

(4) Inspect the distributor drive gear for wear.

(5) If the camshaft appears to have been rubbing against the timing case cover, examine the oil pressure relief holes in the rear cam journal. The oil pressure relief holes must be free of debris.

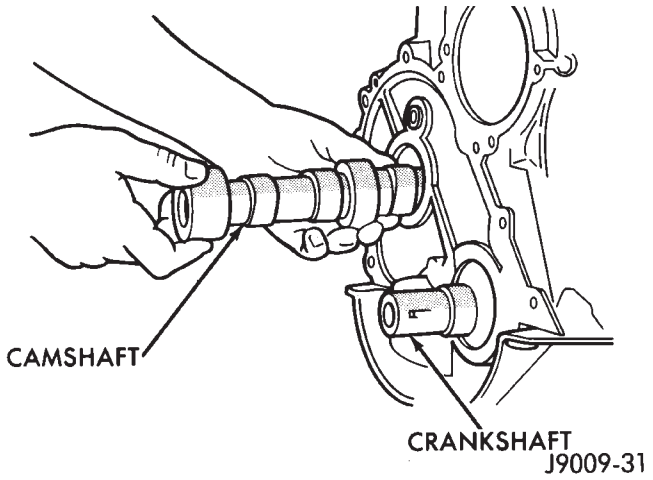


Fig. 44 Camshaft

(6) Lubricate the camshaft with Mopar Engine Oil Supplement, or equivalent.

(7) Carefully install the camshaft to prevent damage to the camshaft bearings (Fig. 44).

(8) Install the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned.

(9) Install the camshaft sprocket retaining preload bolt. Tighten the bolt to 108 N·m (80 ft. lbs.) torque.

(10) Lubricate the tension spring, the thrust pin and the pin bore in the preload bolt with Mopar Engine Oil Supplement, or equivalent. Install the spring and thrust pin in the preload bolt head.

(11) Install the timing case cover with a replacement oil seal (Fig. 45). Refer to Timing Case Cover Installation.

(12) Install the vibration damper (Fig. 45).

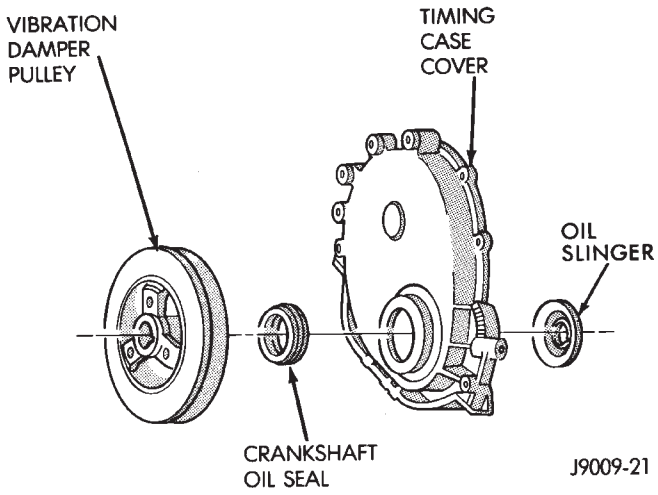


Fig. 45 Timing Case Cover Components

(13) Install the hydraulic valve tappets.

(14) Install the cylinder head gasket with the numbers facing up.

REMOVAL AND INSTALLATION (Continued)

(15) Install the cylinder head and head bolts (Refer to cylinder head R&I in this section for torque values and tightening sequence).

(16) Install the push rods.

(17) Install the rocker arms and pivot and bridge assemblies. Tighten each of the capscrews for each bridge alternately, one turn at a time, to avoid damaging the bridge (Refer to Rocker Arms and Push Rods in this section).

(18) Install the engine cylinder head cover.

(19) Position the oil pump gear. Refer to Distributor in the Component Removal/Installation section of Group 8D, Ignition Systems.

(20) Install the distributor and ignition wires. Refer to Distributor in the Component Removal/Installation section of Group 8D, Ignition Systems.

(21) Install the serpentine drive belt and tighten to the specified tension (refer to Group 7, Cooling System for the proper procedure).

NOTE: During installation, lubricate the hydraulic valve tappets and all valve components with Mopar Engine Oil Supplement, or equivalent. The Mopar Engine Oil Supplement, or equivalent must remain with the engine oil for at least 1609 km (1,000 miles). The oil supplement need not be drained until the next scheduled oil change.

(22) Install the A/C condenser and receiver/drier assembly, if equipped (refer to Group 24, Heating and Air Conditioning).

CAUTION: Both service valves must be opened before the air conditioning system is operated.

(23) Install the radiator, connect the hoses and fill the cooling system to the specified level (refer to Group 7, Cooling System for the proper procedure).

(24) Check the ignition timing and adjust as necessary.

(25) Install the grille and bumper, if removed.

(26) Connect negative cable to battery.

CAMSHAFT PIN REPLACEMENT

REMOVAL

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

(1) Disconnect negative cable from battery.

(2) Drain the radiator. DO NOT waste reusable coolant. Drain the coolant into a clean container.

(3) Remove the fan and shroud.

(4) Disconnect the radiator overflow tube, radiator hoses, automatic transmission fluid cooler pipes (if equipped).

(5) Remove the radiator.

(6) If equipped with air conditioning:

CAUTION: DO NOT loosen or disconnect any air conditioner system fittings. Move the condenser and receiver/drier aside as a complete assembly.

(a) Remove the A/C compressor serpentine drive belt idler pulley.

(b) Disconnect and remove the generator.

(c) Remove the A/C condenser attaching bolts and move the condenser and receiver/drier assembly up and out of the way.

(7) Remove the serpentine drive belt.

(8) Remove the crankshaft vibration damper.

(9) Remove the timing case cover. Clean the gasket material from the cover.

(10) Remove the thrust pin and tension spring from the preload bolt head.

(11) Rotate crankshaft until the crankshaft sprocket timing mark is closest to and on the center line with the camshaft sprocket timing mark (Fig. 46).

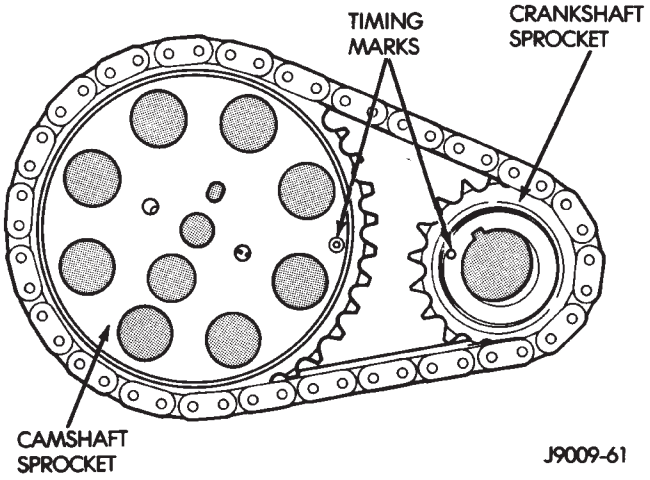


Fig. 46 Timing Chain Alignment—Typical

(12) Remove the camshaft sprocket preload retaining bolt and washer.

(13) Remove the crankshaft oil slinger.

(14) Remove the sprockets and chain as an assembly.

CAUTION: The following procedural step must be accomplished to prevent the camshaft from damaging the rear camshaft plug during pin installation.

(15) Inspect the damaged camshaft pin.

(16) If the pin is a spring-type pin, remove the broken pin by inserting a self-tapping screw into the pin and carefully pulling the pin from the camshaft.

REMOVAL AND INSTALLATION (Continued)

(17) If the pin is a dowel-type pin, center-punch it. Ensure the exact center is located when center-punching the pin.

CAUTION: Cover the opened oil pan area to prevent metal chips from entering the pan.

(18) Drill into the pin center with a 4 mm (5/32 inch) drill bit.

(19) Insert a self-tapping screw into the drilled pin and carefully pull the pin from the camshaft.

CAMSHAFT BEARINGS

The camshaft rotates within four steel-shelled, babbitt-lined bearings that are pressed into the cylinder block and then line reamed. The camshaft bearing bores and bearing diameters are not the same size. They are stepped down in 0.254 mm (0.010 inch) increments from the front bearing (largest) to the rear bearing (smallest). This permits easier removal and installation of the camshaft. The camshaft bearings are pressure lubricated.

NOTE: It is not advisable to attempt to replace camshaft bearings unless special removal and installation tools are available.

Camshaft end play is maintained by the load placed on the camshaft by the sprocket preload bolt tension spring and thrust pin.

INSTALLATION

(1) Clean the camshaft pin hole.

(2) Compress the center of the replacement spring pin with vise grips.

(3) Carefully drive the pin into the camshaft pin hole until it is seated.

(4) Install the camshaft sprocket, crankshaft sprocket and timing chain with the timing marks aligned (Fig. 46).

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark as shown in (Fig. 47). Count the number of chain pins between the timing marks of both sprockets. There must be 15 pins.

(6) Install the crankshaft oil slinger.

(7) Tighten the camshaft sprocket preload bolt to 108 N·m (80 ft. lbs.) torque.

(8) Check the valve timing.

(9) Lubricate the tension spring, the thrust pin and the pin bore in the preload bolt with Mopar Engine Oil Supplement, or equivalent. Install the spring and thrust pin in the preload bolt head.

(10) Coat both sides of the replacement timing case cover gasket with gasket sealer. Apply a 3 mm (1/8 inch) bead of Mopar Silicone Rubber Adhesive

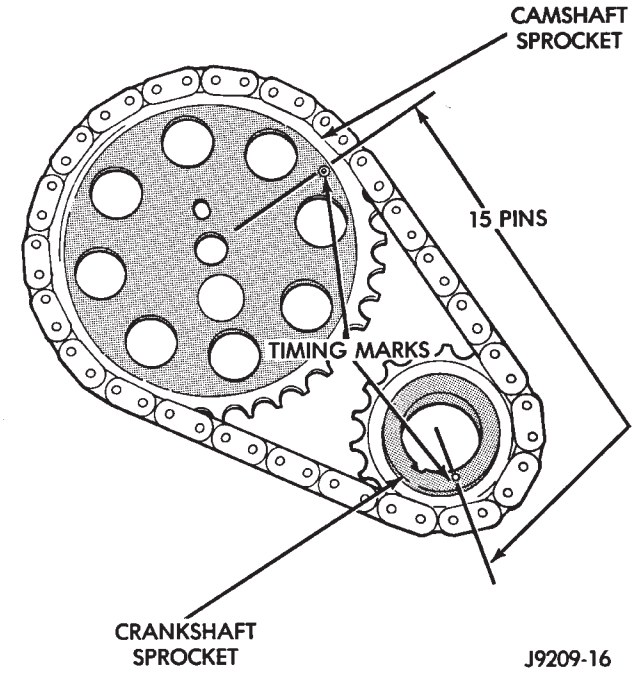


Fig. 47 Verify Crankshaft—CamshaftInstallation—Typical

Sealant, or equivalent to the joint formed at the oil pan and cylinder block.

(11) Position the timing case cover on the oil pan gasket and the cylinder block.

(12) Place Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 48).

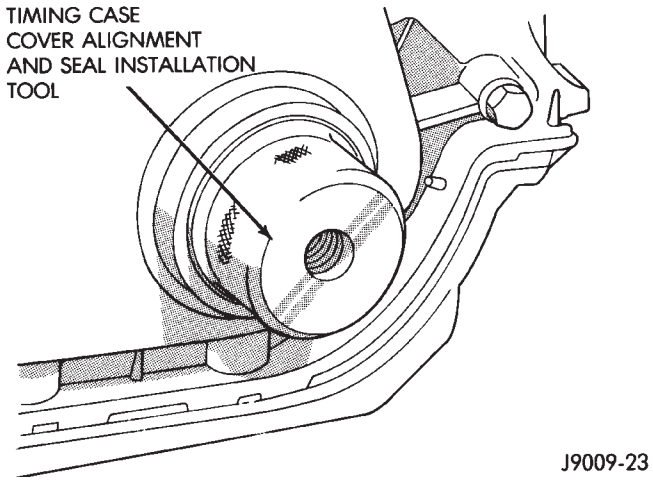


Fig. 48 Timing Case Cover Alignment and SealInstallation Tool 6139

(13) Install the timing case cover-to-cylinder block bolts. Install the oil pan-to-timing case cover bolts.

(14) Tighten the 1/4 inch cover-to-block bolts to 7 N·m (60 in. lbs.) torque. Tighten the 5/16 inch front cover-to-block bolts to 22 N·m (192 in. lbs.) torque. Tighten the oil pan-to-cover 1/4 inch bolts to 14 N·m

REMOVAL AND INSTALLATION (Continued)

(120 in. lbs.) torque. Tighten the oil pan-to-cover 5/16 inch bolts to 18 N·m (156 in. lbs.) torque.

(15) Remove the cover alignment tool and install a replacement oil seal into the cover.

(16) Install the vibration damper on the crankshaft.

(17) Lubricate and tighten the damper bolt to 108 N·m (80 ft. lbs.) torque.

(18) If equipped with air conditioning:

(a) Install the A/C compressor serpentine drive belt idler pulley.

(b) Install the generator.

(c) Install the A/C condenser and receiver/drier assembly.

(19) Install the serpentine drive belt on the pulleys and tighten (refer to Group 7, Cooling System for the specifications and procedures).

(20) Install the radiator. Connect the radiator hoses and automatic transmission fluid cooler pipes, if equipped. Fill the cooling system.

(21) Install the fan and shroud.

(22) Connect negative cable to battery.

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the spark plugs.

(3) Raise the vehicle.

(4) Remove the oil pan and oil pump.

(5) Remove main bearing cap brace (Fig. 49).

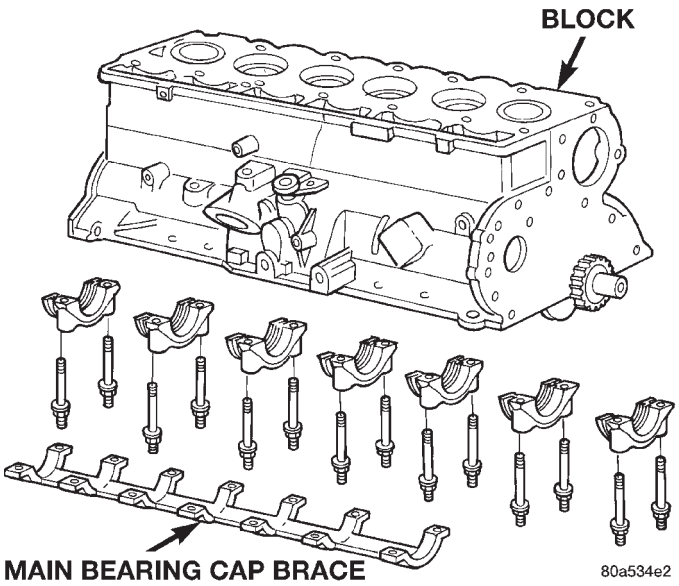


Fig. 49 Main Bearing Caps and Brace.

(6) Remove only one main bearing cap and lower insert at a time (Fig. 50).

(7) Remove the lower insert from the bearing cap.

(8) Remove the upper insert by LOOSENING (DO NOT REMOVE) all of the other bearing caps. Now

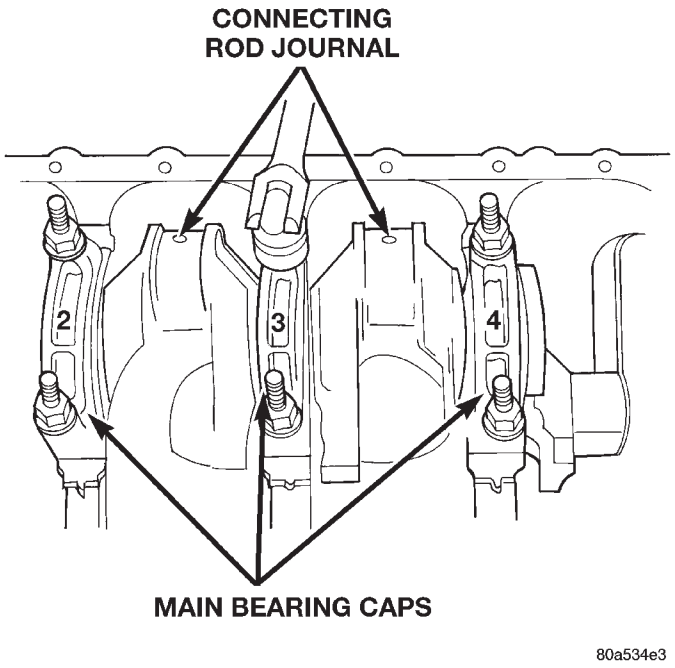


Fig. 50 Removing Main Bearing Caps and LowerInserts

insert a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fabricate the tool (Fig. 51). With the cotter pin tool in place, rotate the crankshaft so that the upper bearing insert will rotate in the direction of its locking tab. Because there is no hole in the No.3 main journal, use a tongue depressor or similar soft-faced tool to remove the bearing insert (Fig. 51). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.

(9) Using the same procedure described above, remove the remaining bearing inserts one at a time for inspection.

INSTALLATION

(1) Lubricate the bearing surface of each insert with engine oil.

(2) Loosen all the main bearing caps. Install the main bearing upper inserts.

(3) Install the lower bearing inserts into the main bearing caps.

(4) Install the main bearing cap(s) and lower insert(s).

(5) Tighten the bolts of caps 1, 2, 4, 5, 6, and 7 to 54 N·m (40 ft. lbs.) torque. Now tighten these bolts to 95 N·m (70 ft. lbs.) torque. Finally, tighten these bolts to 108 N·m (80 ft. lbs.) torque.

(6) Push the crankshaft forward and backward. Load the crankshaft front or rear and tighten cap bolt No.3 to 54 N·m (40 ft. lbs.) torque. Then tighten to 95 N·m (70 ft. lbs.) torque and finally tighten to 108 N·m (80 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

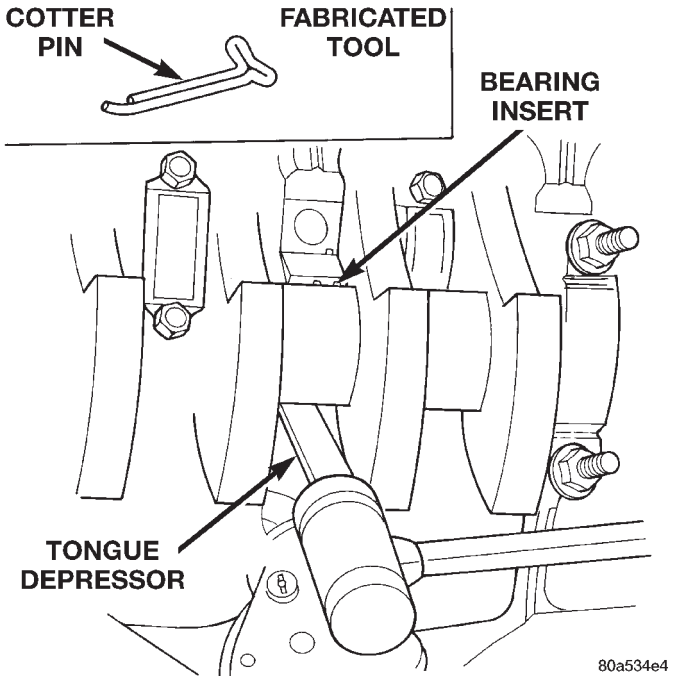


Fig. 51 Removing Upper Inserts

(7) Rotate the crankshaft after tightening each main bearing cap to ensure the crankshaft rotates freely.

(8) Check crankshaft end play. Crankshaft end play is controlled by the thrust bearing which is flange and installed at the No.2 main bearing position.

(a) Attach a magnetic base dial indicator to the cylinder block at either the front or rear of the engine.

(b) Position the dial indicator rod so that it is parallel to the center line of the crankshaft.

(c) Pry the crankshaft forward, position the dial indicator to zero.

(d) Pry the crankshaft forward and backward. Note the dial indicator readings. End play is the difference between the high and low measurements (Fig. 52). Correct end play is 0.038-0.165 mm (0.0015-0.0065 inch). The desired specifications are 0.051-0.064 mm (0.002-0.0025 inch).

(e) If end play is not within specification, inspect crankshaft thrust faces for wear. If no wear is apparent, replace the thrust bearing and measure end play. If end play is still not within specification, replace the crankshaft.

(9) If the crankshaft was removed, install the crankshaft into the cylinder block (refer to Cylinder Block - Assemble).

(10) Install main bearing cap brace tighten nuts to 47 N·m (35 ft. lbs.) torque.

(11) Install oil pump assy. and tighten attaching bolts to 23 N·m (17 ft. lbs.)

(12) Install the oil pan.

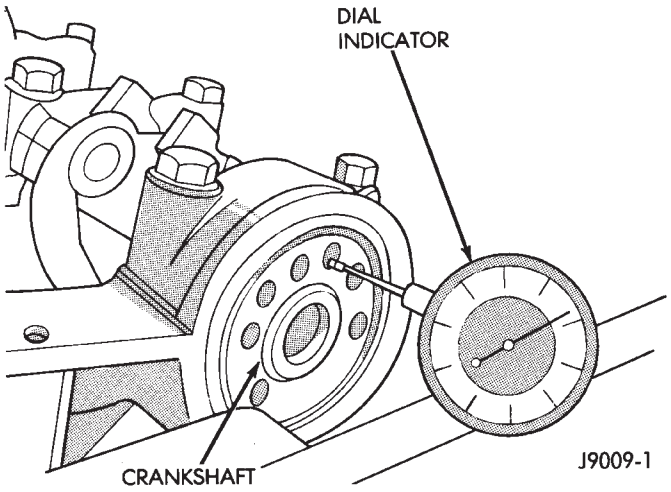


Fig. 52 Crankshaft End Play Measurement

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

(14) Lower the vehicle.

(15) Install the spark plugs. Tighten the plugs to 37 N·m (27 ft. lbs.) torque.

(16) Fill the oil pan with engine oil to the full mark on the dipstick level.

(17) Connect negative cable to battery.

OIL PAN

REMOVAL

(1) Disconnect negative cable from battery.

(2) Raise the vehicle.

(3) Remove the oil pan drain plug and drain the engine oil.

(4) Disconnect the exhaust pipe at the exhaust manifold.

(5) Disconnect the exhaust hanger at the catalytic converter and lower the pipe.

(6) Remove the starter motor.

(7) Remove the engine flywheel and transmission torque converter housing access cover.

(8) If equipped with an oil level sensor, disconnect the sensor.

(9) Position a jack stand directly under the engine vibration damper.

(10) Place a piece of wood (2 x 2) between the jack stand and the engine vibration damper.

(11) Remove the engine mount through bolts.

(12) Using the jack stand, raise the engine until adequate clearance is obtained to remove the oil pan.

(13) Remove the oil pan bolts. Carefully slide the oil pan and gasket to the rear. If equipped with an oil level sensor, take care not to damage the sensor.

INSTALLATION

(1) Clean the block and pan gasket surfaces.

REMOVAL AND INSTALLATION (Continued)

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

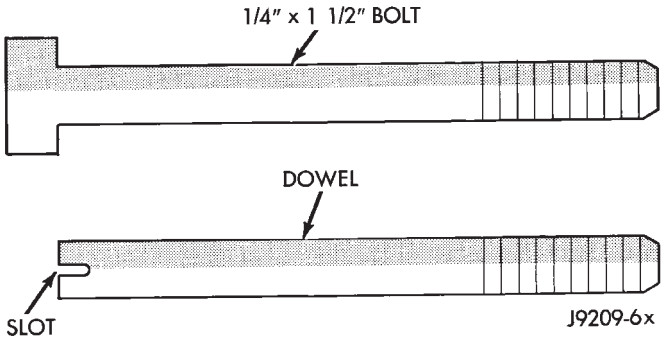


Fig. 53 Fabrication of Alignment Dowels

(3) Install two dowels in the timing case cover. Install the other two dowels in the cylinder block (Fig. 54).

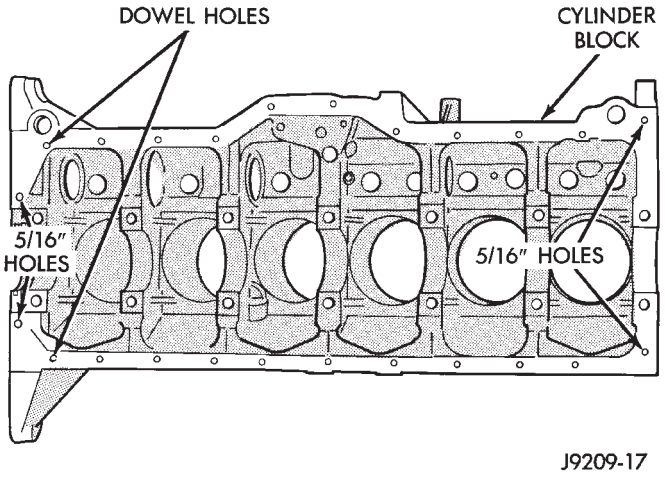


Fig. 54 Position of Dowels in Cylinder Block

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

(5) Position the oil pan over the dowels and onto the gasket. If equipped with an oil level sensor, take care not to damage the sensor.

(6) Install the 1/4 inch oil pan bolts. Tighten these bolts to 9.5 N·m (84 in. lbs.) torque. Install the 5/16 inch oil pan bolts (Fig. 55). Tighten these bolts to 15 N·m (132 in. lbs.) torque.

(7) Remove the dowels. Install the remaining 1/4 inch oil pan bolts. Tighten these bolts to 9.5 N·m (84 in. lbs.) torque.

(8) Lower the engine until it is properly located on the engine mounts.

(9) Install the through bolts and tighten the nuts.

(10) Lower the jack stand and remove the piece of wood.

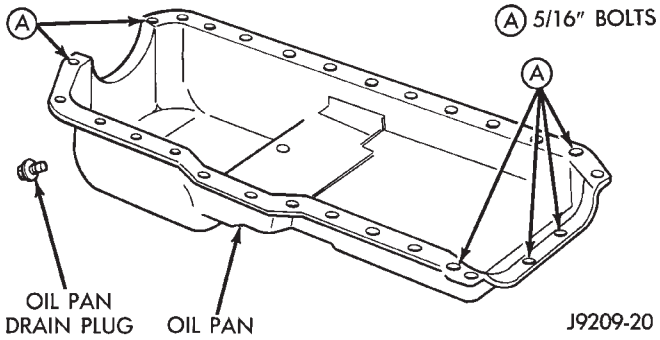


Fig. 55 Position of 5/16 inch Oil Pan Bolts

(11) Install the engine flywheel and transmission torque converter housing access cover.

(12) Install the engine starter motor.

(13) Connect the exhaust pipe to the hanger and to the engine exhaust manifold.

(14) Install the oil pan drain plug (Fig. 55). Tighten the plug to 34 N·m (25 ft. lbs.) torque.

(15) Lower the vehicle.

(16) Connect negative cable to battery.

(17) Fill the oil pan with engine oil to the specified level.

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

(18) Start the engine and inspect for leaks.

PISTONS AND CONNECTING RODS

REMOVAL

(1) Remove the engine cylinder head cover.

(2) Remove the rocker arms, bridges and pivots.

(3) Remove the push rods.

(4) Remove the engine cylinder head.

(5) Position the pistons one at a time near the bottom of the stroke. Use a ridge reamer to remove the ridge from the top end of the cylinder walls. Use a protective cloth to collect the cuttings.

(6) Raise the vehicle.

(7) Drain the engine oil.

(8) Remove the oil pan and gasket.

(9) Remove the connecting rod bearing caps and inserts. Mark the caps and rods with the cylinder bore location. The connecting rods and caps are stamped with a two letter combination (Fig. 56).

(10) Lower the vehicle until it is about 2 feet from the floor.

REMOVAL AND INSTALLATION (Continued)

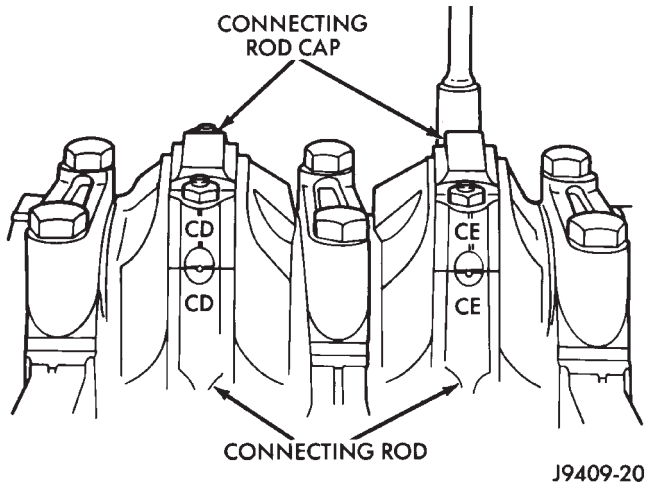


Fig. 56 Stamped Connecting Rods and Caps

CAUTION: Ensure that the connecting rod bolts DO NOT scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose, slipped over the rod bolts will provide protection during removal.

(11) Have an assistant push the piston and connecting rod assemblies up and through the top of the cylinder bores (Fig. 57).

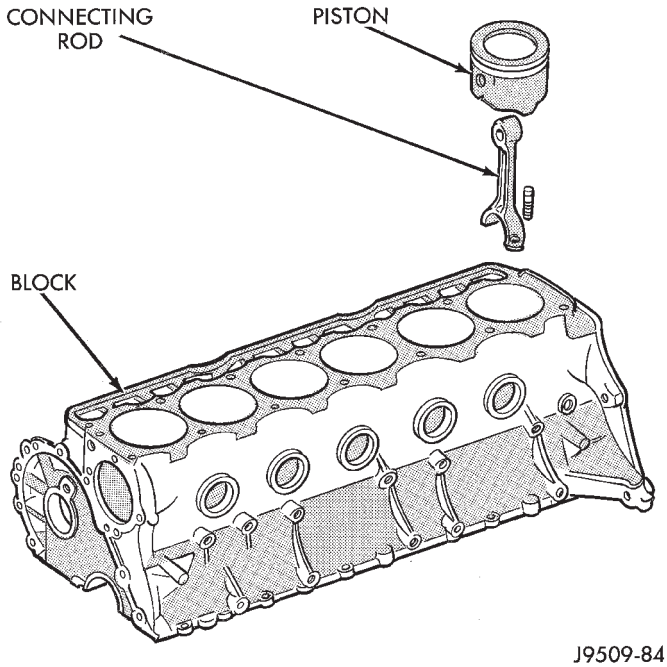


Fig. 57 Removal of Connecting Rod and PistonAssembly

INSTALLATION

(1) Clean the cylinder bores thoroughly. Apply a light film of clean engine oil to the bores with a clean lint-free cloth.

(2) Install the piston rings on the pistons if removed.

(3) Lubricate the piston and rings with clean engine oil.

CAUTION: Ensure that connecting rod bolts DO NOT scratch the crankshaft journals or cylinder walls. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during installation.

(4) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 58).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 58).

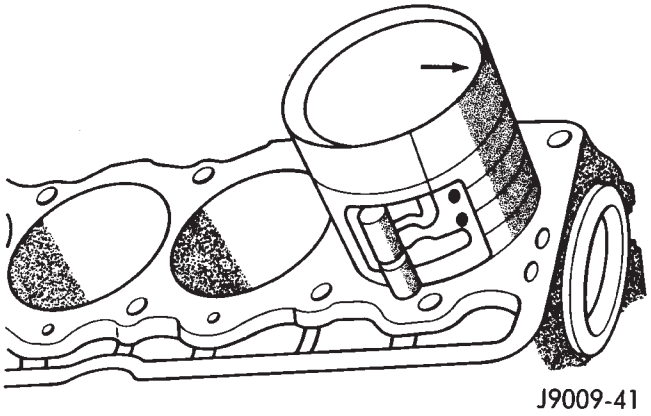


Fig. 58 Rod and Piston Assembly Installation

(6) Raise the vehicle.

(7) Each bearing insert is fitted to its respective journal to obtain the specified clearance between the bearing and the journal. In production, the select fit is obtained by using various-sized, color-coded bearing inserts as listed in the Connecting Rod Bearing Fitting Chart. The color code appears on the edge of the bearing insert. The size is not stamped on inserts used for production of engines.

(8) The rod journal is identified during the engine production by a color-coded paint mark on the adjacent cheek or counterweight toward the flange (rear) end of the crankshaft. The color codes used to indicate journal sizes are listed in the Connecting Rod Bearing Fitting Chart.

(9) When required, upper and lower bearing inserts of different sizes may be used as a pair (refer to Connecting Rod Bearing Fitting Chart). A standard size insert is sometimes used in combination with a 0.025 mm (0.001 inch) undersize insert to reduce clearance 0.013 mm (0.0005 inch).

CAUTION: DO NOT intermix bearing caps. Each connecting rod and bearing cap are stamped with the cylinder number. The stamp is located on a machined surface adjacent to the oil squirt hole that faces the camshaft side of the cylinder block.

REMOVAL AND INSTALLATION (Continued)

(10) Install the connecting rod bearing caps and inserts in the same positions as removed.

CAUTION: Verify that the oil squirt holes in the rods face the camshaft and that the arrows on the pistons face the front of the engine.

(11) Install the oil pan and gaskets as outlined in the installation procedure.
(12) Lower the vehicle.
(13) Install the engine cylinder head, push rods, rocker arms, bridges, pivots and engine cylinder head cover.
(14) Fill the crankcase with engine oil.

REAR MAIN OIL SEALS

The crankshaft rear main bearing oil seal consists of two half pieces of viton with a single lip that effectively seals the rear of the crankshaft. Replace the upper and lower seal halves as a unit to ensure leak-free operation.

REMOVAL

(1) Remove the transmission inspection cover.
(2) Remove the oil pan.
(3) Remove the rear main bearing cap (No.7).
(4) Push the upper seal out of the groove. Ensure that the crankshaft and seal groove are not damaged.
(5) Remove the lower half of the seal from the bearing cap.

INSTALLATION

(1) Wipe the seal surface area of the crankshaft until it is clean.
(2) Apply a thin coat of engine oil.
(3) Coat the lip of the seal with engine oil.
(4) Carefully position the upper seal into the groove in the cylinder block. The lip of the seal faces toward the front of the engine.
(5) Place the lower half of the seal into bearing cap No.7 (Fig. 59).
(6) Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil (Fig. 59).
(7) Position the lower seal into the bearing cap recess and seat it firmly. Be sure the seal is flush with the cylinder block pan rail.
(8) Apply Loctite 518, or equivalent on the rear bearing cap (Fig. 60). The bead should be 3 mm (0.125 in) thick. DO NOT apply Loctite 518, or equivalent to the lip of the seal.
(9) Install the rear main bearing cap. DO NOT strike the cap more than twice for proper engagement.
(10) Tighten all main bearing bolts to 108 N·m (80 ft. lbs.) torque.
(11) Install the oil pan gasket and oil pan.

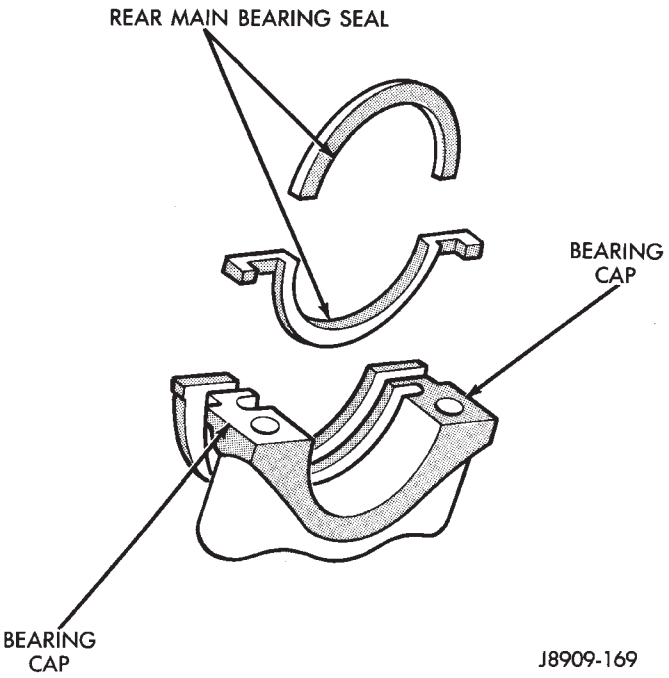


Fig. 59 Rear Main Bearing Oil Seal

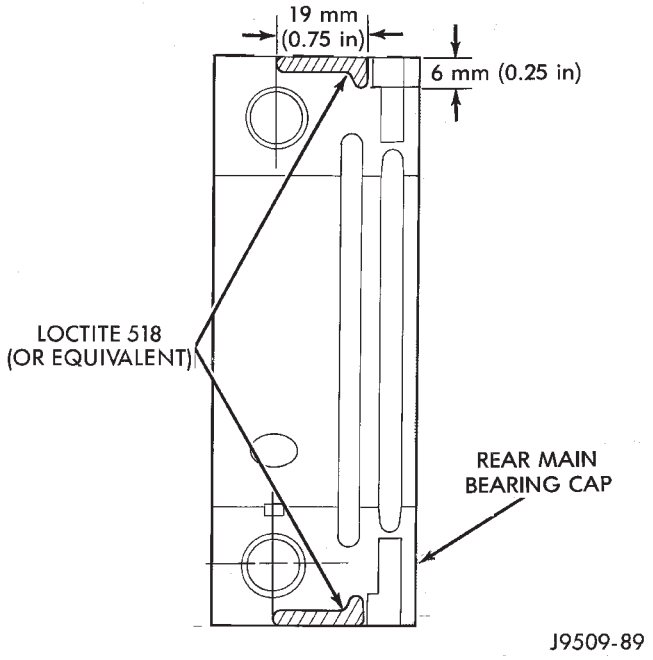


Fig. 60 Location of Loctite 518 (or equivalent)

(12) Install the engine flywheel or converter drive plate.

OIL PUMP

A gear-type oil pump is mounted at the underside of the cylinder block opposite the No.4 main bearing.

The pump incorporates a nonadjustable pressure relief valve to limit maximum pressure to 517 kPa (75 psi). In the relief position, the valve permits oil to

REMOVAL AND INSTALLATION (Continued)

bypass through a passage in the pump body to the inlet side of the pump.

Oil pump removal or replacement will not affect the distributor timing because the distributor drive gear remains in mesh with the camshaft gear.

REMOVAL

(1) Drain the engine oil.
(2) Remove the oil pan.
(3) Remove the pump-to-cylinder block attaching bolts. Remove the pump assembly with gasket (Fig. 61).

CAUTION: If the oil pump is not to be serviced, DO NOT disturb position of oil inlet tube and strainer assembly in pump body. If the tube is moved within the pump body, a replacement tube and strainer assembly must be installed to assure an airtight seal.

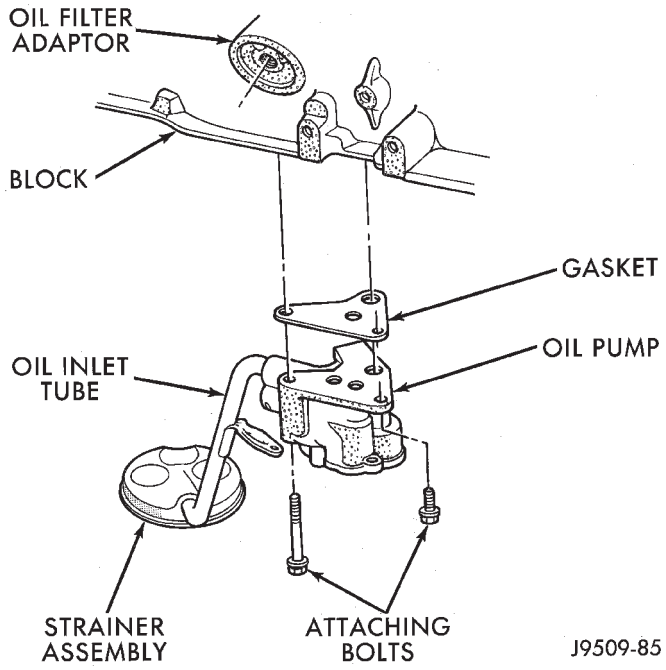


Fig. 61 Oil Pump Assembly

INSTALLATION

(1) Install the oil pump on the cylinder block using a replacement gasket. Tighten the bolts to 23 N·m (17 ft. lbs.) torque.
(2) Install the oil pan.
(3) Fill the oil pan with oil to the specified level.

TIMING CASE COVER OIL SEAL

This procedure is done with the timing case cover installed.

REMOVAL

(1) Disconnect negative cable from battery.
(2) Remove the serpentine drive belt.
(3) Remove the vibration damper.
(4) Remove the radiator shroud.
(5) Carefully remove the oil seal. Make sure seal bore is clean.

INSTALLATION

(1) Position the replacement oil seal on Timing Case Cover Alignment and Seal Installation Tool 6139 with seal open end facing inward. Apply a light film of Perfect Seal, or equivalent, on the outside diameter of the seal. Lightly coat the crankshaft with engine oil.

(2) Position the tool and seal over the end of the crankshaft and insert a draw screw tool into Seal Installation Tool 6139 (Fig. 62). Tighten the nut against the tool until it contacts the cover.

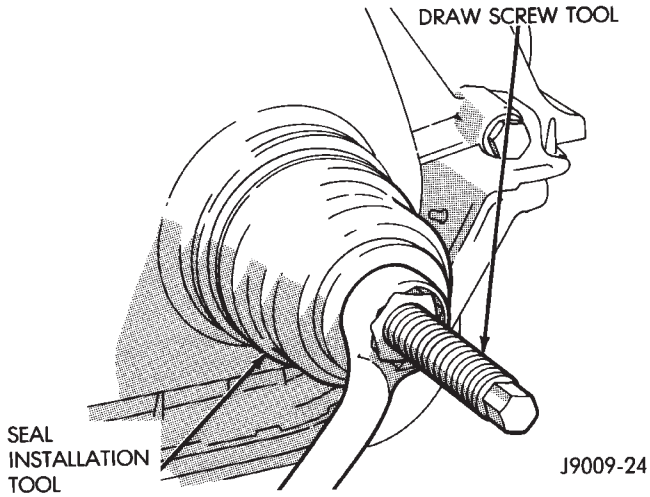


Fig. 62 Timing Case Cover Oil Seal Installation

(3) Remove the tools. Apply a light film of engine oil on the vibration damper hub contact surface of the seal.

(4) Apply Mopar Silicone Rubber Adhesive Sealant to the keyway in the crankshaft and insert the key. With the key inserted in the keyway in the crankshaft, install the vibration damper, washer and bolt. Lubricate and tighten the bolt to 108 N·m (80 ft. lbs.) torque.

(5) Install the serpentine belt and tighten to the specified tension (refer to Group 7, Cooling Systems for the proper specifications and procedures).

(6) Install the radiator shroud.

(7) Connect negative cable to battery.

DISASSEMBLY AND ASSEMBLY

VALVE SERVICE

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

DISASSEMBLY AND ASSEMBLY (Continued)

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

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seat.

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

Inspect valves for burned, cracked or warped heads.

Inspect for scuffed or bent valve stems.

Replace valves displaying any damage.

VALVE REFACING

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

(2) After refacing, a margin of at least 0.787 mm (0.031 inch) must remain (Fig. 63). If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced.

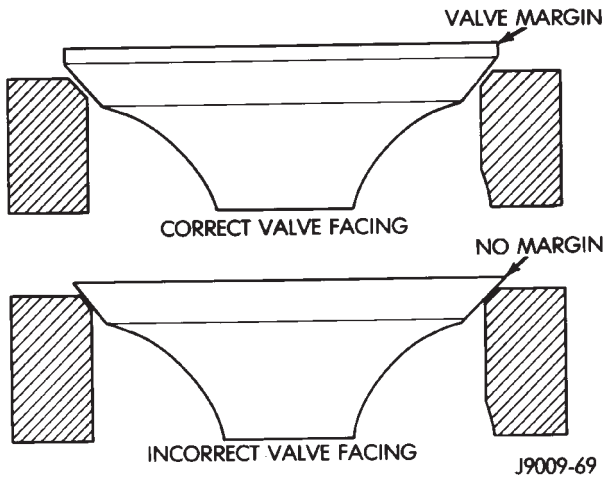


Fig. 63 Valve Facing Margin

VALVE SEAT REFACING

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

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

(3) Control valve seat runout to a maximum of 0.0635 mm (0.0025 in.) (Fig. 64).

VALVE STEM OIL SEAL REPLACEMENT

Valve stem oil seals are installed on each valve stem to prevent rocker arm lubricating oil from entering the combustion chamber through the valve guide bores. One seal is marked INT (intake valve) and the other is marked EXH (exhaust valve).

Replace the oil seals whenever valve service is performed or if the seals have deteriorated.

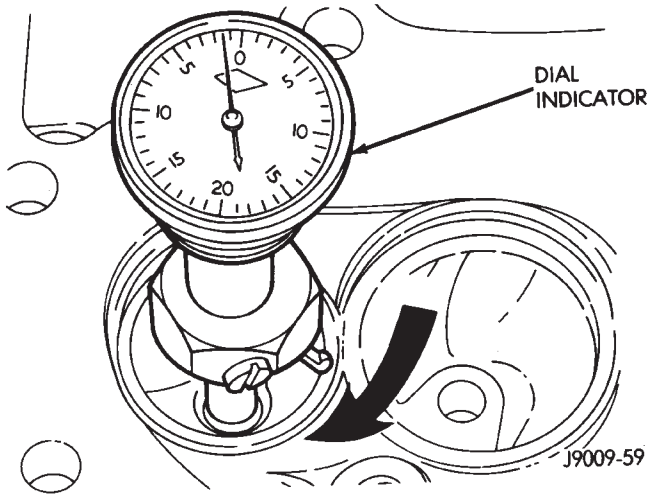


Fig. 64 Measurement of Valve Seat Runout

VALVE GUIDES

The valve guides are an integral part of the engine cylinder head and are not replaceable.

When the valve stem guide clearance is excessive, the valve guide bores must be reamed oversize. Service valves with oversize stems are available in 0.076 mm (0.003 inch) and 0.381 mm (0.015 inch) increments.

Corresponding oversize valve stem seals are also available and must be used with valves having 0.381 mm (0.015 inch) oversize stems.

NOTE: If the valve guides are reamed oversize, the valve seats must be ground to ensure that the valve seat is concentric to the valve guide.

VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

Valve stem-to-guide clearance may be measured by either of the following two methods.

PREFERRED METHOD

(1) Remove the valve from the head.

(2) Clean the valve stem guide bore with solvent and a bristle brush.

(3) Insert a telescoping gauge into the valve stem guide bore approximately 9.525 mm (.375 inch) from the valve spring side of the head (Fig. 65).

(4) Remove and measure telescoping gauge with a micrometer.

(5) Repeat the measurement with contacts lengthwise to engine cylinder head.

(6) Compare the crosswise to lengthwise measurements to determine out-of-roundness. If the measurements differ by more than 0.0635 mm (0.0025 in.), ream the guide bore to accommodate an oversize valve stem.

DISASSEMBLY AND ASSEMBLY (Continued)

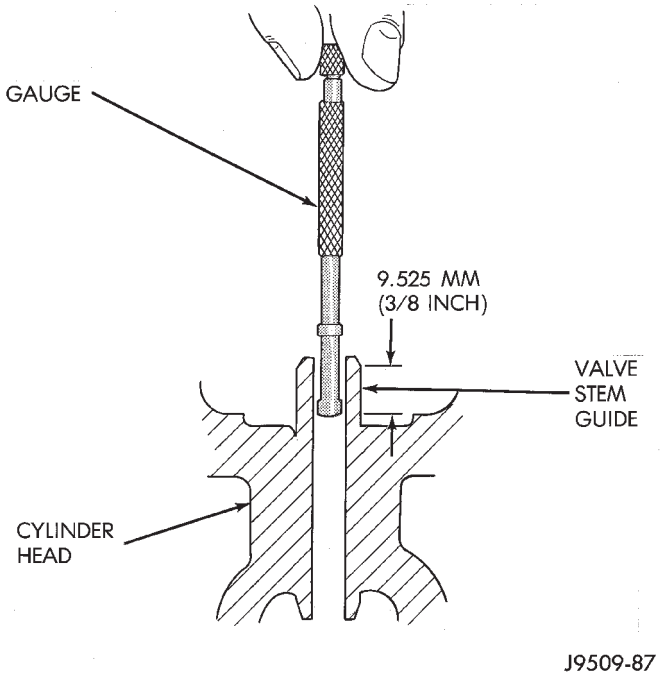


Fig. 65 Measurement of Valve Guide Bore Diameter

(7) Compare the measured valve guide bore diameter with specifications (7.95-7.97 mm or 0.313-0.314 inch). If the measurement differs from specification by more than 0.076 mm (0.003 inch), ream the guide bore to accommodate an oversize valve stem.

ALTERNATIVE METHOD

(1) Use a dial indicator to measure the lateral movement of the valve stem (stem-to-guide clearance). This must be done with the valve installed in its guide and just off the valve seat (Fig. 66).

(2) Correct clearance is 0.025-0.0762 mm (0.001-0.003 inch). If indicated movement exceeds the specification ream the valve guide to accommodate an oversize valve stem.

NOTE: Valve seats must be ground after reaming the valve guides to ensure that the valve seat is concentric to the valve guide.

VALVE SPRING TENSION TEST

Use a universal Valve Spring Tester and a torque wrench to test each valve spring for the specified tension value (Fig. 67).

Replace valve springs that are not within specifications.

CYLINDER BLOCK

DISASSEMBLY

Refer to the applicable sections for detailed instructions.

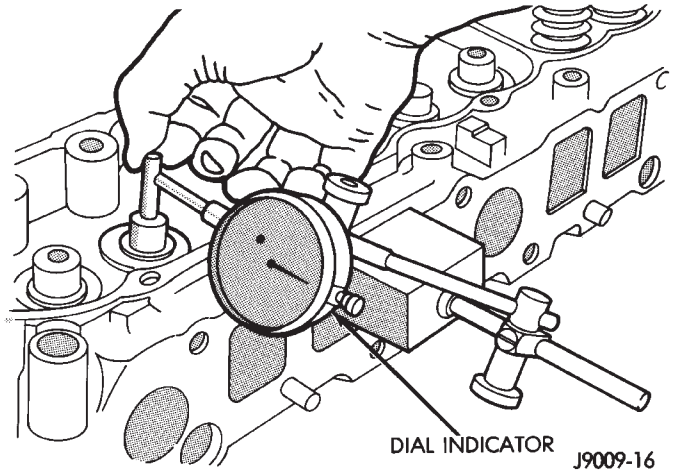


Fig. 66 Measurement of Lateral Movement ofValve Stem

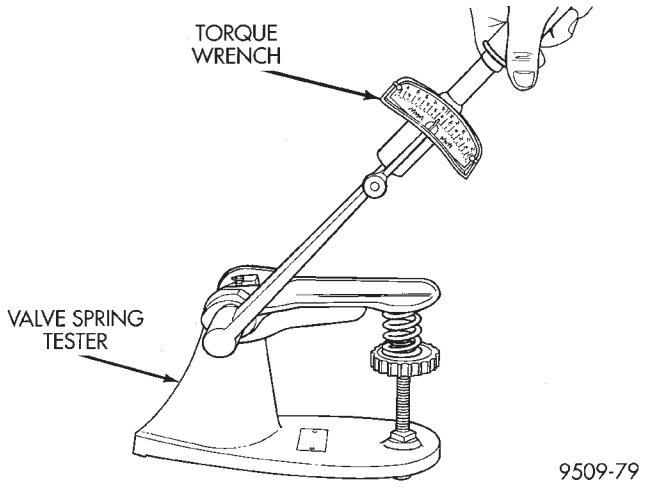


Fig. 67 Valve Spring Tester

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

(2) Remove the water pump from the cylinder block.

(3) Remove the vibration damper.

(4) Remove the timing case cover and lay the cover upside down.

(5) Position a drift punch into the slot in the back of the cover and tap the old seal out.

(6) Remove the oil slinger from crankshaft.

(7) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly.

(8) Remove the camshaft.

(9) Remove the oil pan and gasket.

(10) Remove the front and rear oil galley plugs.

(11) Remove the oil pump.

(12) Remove the connecting rods and the pistons. Remove the connecting rod and piston assemblies through the top of the cylinder bores.

(13) Remove the crankshaft.

DISASSEMBLY AND ASSEMBLY (Continued)

ASSEMBLY

Refer to the applicable sections for detailed instructions.

(1) Install the crankshaft.
(2) Install the connecting rods and the pistons through the top of the cylinder bores.
(3) Install the oil pump.
(4) Install the oil pan and gasket.
(5) Install the camshaft.
(6) Install the sprockets and chain as an assembly.
(7) Install the oil slinger from the crankshaft.
(8) Install the timing case cover seal.
(9) Install the timing case cover.
(10) Install the vibration damper.
(11) Install the water pump. Tighten the mounting bolts to 31 N·m (23 ft. lbs.) torque.
(12) Lubricate the oil filter seal with clean engine oil. Tighten oil filter to 18 N·m (156 in. lbs.) torque.
(13) Install the engine into the vehicle.
(14) Fill the engine with clean lubrication oil (refer to Group 0, Lubrication and Maintenance).
(15) Fill the cooling system.

CLEANING AND INSPECTION

ENGINE CYLINDER HEAD

CLEANING

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

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

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

INSPECTION

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

ENGINE CYLINDER HEAD COVER

CLEANING

Remove any original sealer from the cover sealing surface of the engine cylinder head and clean the surface using a fabric cleaner.

Remove all residue from the sealing surface using a clean, dry cloth.

INSPECTION

Inspect the engine cylinder head cover for cracks. Replace the cover, if cracked.

The original dark grey gasket material should NOT be removed. If sections of the gasket material are missing or are compressed, replace the engine cylinder head cover. However, sections with minor damage such as small cracks, cuts or chips may be repaired with a hand held applicator. The new material must be smoothed over to maintain gasket height. Allow the gasket material to cure prior to engine cylinder head cover installation.

ROCKER ARMS AND PUSH RODS

CLEANING

Clean all the components with cleaning solvent.

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

INSPECTION

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

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

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

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

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

HYDRAULIC TAPPETS

CLEANING

Clean each tappet assembly in cleaning solvent to remove all varnish, gum and sludge deposits.

INSPECTION

Inspect for indications of scuffing on the side and base of each tappet body.

Inspect each tappet base for concave wear with a straightedge positioned across the base. If the base is concave, the corresponding lobe on the camshaft is also worn. Replace the camshaft and defective tappets.

LEAK-DOWN TEST

After cleaning and inspection, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 68).

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

CLEANING AND INSPECTION (Continued)

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

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

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

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

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

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

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

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

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

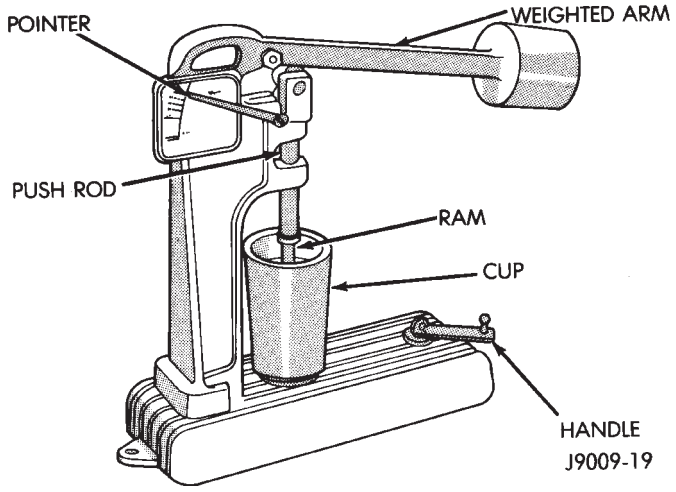


Fig. 68 Leak-Down Tester

CYLINDER BLOCK

CLEANING

Thoroughly clean the oil pan and engine block gasket surfaces.

Use compressed air to clean out:

- The galley at the oil filter adaptor hole.
- The front and rear oil galley holes.
- The feed holes for the crankshaft main bearings.

Once the block has been completely cleaned, apply Loctite PST pipe sealant with Teflon 592 to the threads of the front and rear oil galley plugs. Tighten the plugs to 34 N·m (25 ft. lbs.) torque.

INSPECTION—CYLINDER BORE

(1) It is mandatory to use a dial bore gauge to measure each cylinder bore diameter (Fig. 69). To correctly select the proper size piston, a cylinder bore gauge, capable of reading in 0.003 mm (.0001 in.) INCREMENTS is required. If a bore gauge is not available, do not use an inside micrometer.

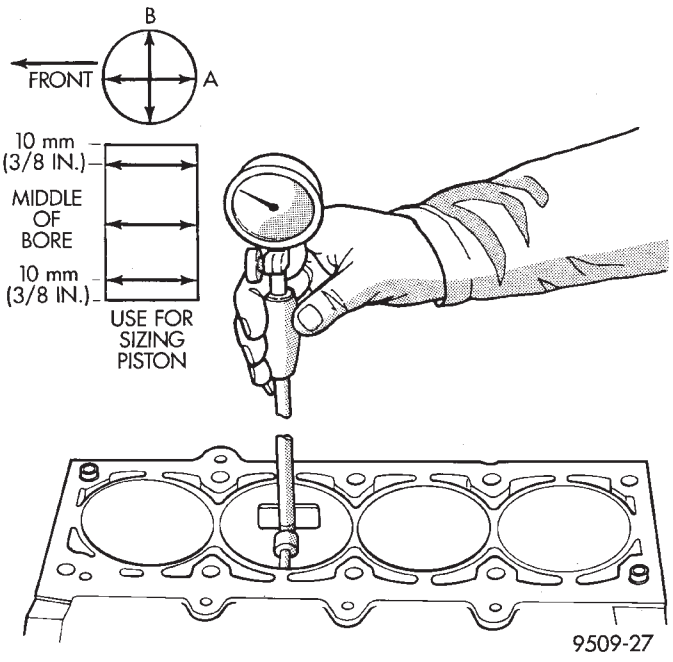


Fig. 69 Cylinder Bore Measurement

(2) Measure the inside diameter of the cylinder bore at three levels below top of bore. Start perpendicular (across or at 90 degrees) to the axis of the crankshaft and then take two additional reading.

(3) Measure the cylinder bore diameter crosswise to the cylinder block near the top of the bore. Repeat the measurement near the middle of the bore, then repeat the measurement near the bottom of the bore.

(4) Determine taper by subtracting the smaller diameter from the larger diameter.

(5) Rotate measuring device 90° and repeat steps above.

(6) Determine out-of-roundness by comparing the difference between each measurement.

(7) If cylinder bore taper does not exceed 0.025 mm (0.001 inch) and out-of-roundness does not exceed 0.025 mm (0.001 inch), the cylinder bore can be honed. If the cylinder bore taper or out- of-round condition exceeds these maximum limits, the cylinder must be bored and then honed to accept an oversize piston. A slight amount of taper always exists in the

CLEANING AND INSPECTION (Continued)

cylinder bore after the engine has been in use for a period of time.

HONING—CYLINDER BORE

The honing operation should be closely coordinated with the fitting of pistons and rings. This will ensure specified clearances are maintained.

Refer to Standard Service Procedures in the beginning of this Group for the proper honing of cylinder bores.

SPECIFICATIONS

4.0L ENGINE SPECIFICATIONS

Camshaft

Hydraulic Tappet Clearance . . . . . Zero Lash
Bearing Clearance . . . . . 0.025 to 0.076 mm (0.001 to 0.003 in.)

Bearing Journal Diameter

No. 1 . . . . . 51.54 to 51.56 mm (2.029 to 2.030 in.)
No. 2 . . . . . 51.28 to 51.31 mm (2.019 to 2.020 in.)
No. 3 . . . . . 51.03 to 51.05 mm (2.009 to 2.010 in.)
No. 4 . . . . . 50.78 to 50.80 mm (1.999 to 2.000 in.)
Base Circle Runout . . . . . 0.03 mm - max. (0.001 in. - max.)
Valve Lift . . . . . 10.29 mm (0.405 in.)

Intake Valve Timing

Opens . . . . . 12.4° BTDC
Closes . . . . . 60.9° ABDC

Exhaust Valve Timing

Opens . . . . . 49.8 BBDC
Closes . . . . . 29.2° ATDC
Valve Overlap . . . . . 42.6°
Intake Duration . . . . . 253.3°
Exhaust Duration . . . . . 259.°

Crankshaft

End Play . . . . . 0.038 to 0.165 mm (0.0015 to 0.0065 in.)
Main Bearing Journal Diameter
No. 1-6 . . . . . 63.489 to 63.502 mm (2.4996 to 2.5001 in.)
Main Bearing Journal Diameter
No. 7 . . . . . 63.449 to 63.487 mm (2.4980 to 2.4995 in.)
Main Bearing Journal Width
No. 1 . . . . . 27.58 to 27.89 mm (1.086 to 1.098 in.)
Main Bearing Journal Width
No. 3 . . . . . 32.28 to 32.33 mm (1.271 to 1.273 in.)
Main Bearing Journal Width
No. 2-4-5-6-7 . . . . . 30.02 to 30.18 mm (1.182 to 1.188 in.)
Main Bearing Clearance . . . . . 0.03 to 0.06 mm (0.001 to 0.0025 in.)
Main Bearing Clearance (Preferred) . . . . . 0.051 mm (0.002 in.)
Connecting Rod Journal Diameter . . . . . 53.17 to 53.23 mm (2.0934 to 2.0955 in.)
Connecting Rod Journal Width . . . . . 27.18 to 27.33 mm (1.070 to 1.076 in.)
Out-of-Round (Max. All Journals) . . . . . 0.013 mm (0.0005 in.)
Taper (Max. – All Journals) . . . . . 0.013 mm (0.0005 in.)

Cylinder Block

Deck Height . . . . . 240.03 to 240.18 mm (9.450 to 9.456 in.)
Deck Clearance (Below Block) . . . . . 0.546 mm (0.0215 in.)
Cylinder Bore Diameter— Standard . . . . . 98.45 to 98.48 mm (3.8759 to 3.8775 in.)
Cylinder Bore Diameter— Taper (Max.) . . . . . 0.025 mm (0.001 in.)
Cylinder Bore Diameter— Out-of-Round . . . . . 0.025 mm (0.001 in.)
Tappet Bore Diameter . . . . . 23.000 to 23.025 mm (0.9055 to 0.9065 in.)
Flatness . . . . . 0.03 mm per 25 mm (0.001 in. per 1 in.)
Flatness . . . . . 0.05 mm per 152 mm (0.002 in. per 6 in.)
Flatness Max. . . . . 0.20 mm max. for total length (0.008 in. max. for total length)
Main Bearing Bore Diameter . . . . . 68.3514 to 68.3768 mm (2.691 to 2.692 in.)

Connecting Rods

Total Weight (Less Bearing) . . . 657 to 665 grams (23.17 to 23.45 oz.)
Length (Center-to-Center) . . 155.52 to 155.62 mm (6.123 to 6.127 in)
Piston Pin Bore Diameter . . . . 23.59 to 23.62 mm (0.9288 to 0.9298 in.)
Bore (Less Bearings) . . . . . 56.08 to 56.09 mm (2.2080 to 2.2085 in.)
Bearing Clearance . . . . . 0.025 to 0.076 mm (0.001 to 0.003 in.)
Bearing Clearance (Preferred) . 0.044 to 0.050 mm (0.0015 to 0.0020 in.)
Side Clearance . 0.25 to 0.48 mm (0.010 to 0.019 in.)
Twist (Max.) . . . . . 0.001 mm per mm (0.001 in. per inch)
Bend (Max.) . . . . . 0.001 mm per mm (0.001 in. per inch.)

SPECIFICATIONS (Continued)

Cylinder Compression Pressure

Ratio 8.7:1
Pressure Range . . . . . 827 to 1,034 kPa (120 to 150 psi)
Max. Variation Between Cylinders . . . . . 206 kPa (30 psi)

Cylinder Head

Combustion Chamber . . . . . 52.22 to 58.22 cc (3.37 to 3.55 cu. in.)
Valve Guide I.D. (Integral) . . . . 7.9 mm (0.312 in.)
Valve Stem-to-Guide Clearance . 0.025 to 0.076 mm (0.001 to 0.003 in.)
Intake Valve Seat Angle . . . . . 44.5°
Exhaust Valve Seat Angle . . . . . 44.5°
Valve Seat Width . . . . . 1.02 to 1.52 mm (0.040 to 0.060 in.)
Valve Seat Runout . . . . . 0.064 mm (0.0025 in.)
Flatness . . . . . 0.03 mm per 25 mm (0.001 in. per 1 in.)
Flatness . . . . . 0.05 mm per 152 mm (0.002 in. per 6 in.)
Flatness Max. . . . 0.20 mm - max. for total length (0.008 in. max. for total length)

Rocker Arms, Push Rods & Tappets

Rocker Arm Ratio 1.6:1
Push Rod Length . . . . . 244.856 to 245.364 mm (9.640 to 9.660 in.)
Push Rod Diameter . . . . . 7.92 to 8.00 mm (0.312 to 0.315 in.)
Hydraulic Tappet Diameter . 22.962 to 22.974 mm (0.904 to 0.9045 in.)
Tappet-to-Bore Clearance . . . . 0.025 to 0.063 mm (0.001 to 0.0025 in.)

Valves

Length (Tip-to-Gauge Dimension Line) Intake . . . . . 122.479 to 122.860 mm (4.822 to 4.837 in.)
Length (Tip-to-Gauge Dimension Line) Exhaust . . . . . 122.860 to 123.241 mm (4.837 to 4.852 in.)
Valve Stem Diameter . . . . . 7.899 to 7.925 mm (0.311 to 0.312 in.)
Stem-to-Guide Clearance . . . . . 0.025 to 0.076 mm (0.001 to 0.003 in.)
Valve Head Diameter—Intake . . . . . 48.387 to 48.641 mm (1.905 to 1.915 in.)
Valve Head Diameter—Exhaust . . . . . 37.973 to 38.227 mm (1.495 to 1.505 in.)
Valve Face Angle—Intake . . . . . 45°
Valve Face Angle—Exhaust . . . . . 45°
Tip Refinishing (Max. Allowable) . . . . . 0.25 mm (0.010 in.)

Valve Springs

Free Length (Approx.) . . . . . 47.65 mm (1.876 in.)
Spring Tension—Valve Closed . . . . . 271 to 307 N @ 41.656 mm (61 to 69 lbf. @ 1.64 in.)
Spring Tension—Valve Open . . . . . 818.5 to 871.9 N @ 30.89 mm (184 to 196 lbf @ 1.216 in.)
Inside Diameter . . . . . 21.0 mm to 21.51 mm (0.827 to 0.847 in.)

Pistons

Weight (Less Pin) . . . . . 563 to 567 grams (19.86 to 20.00 oz.)
Piston Pin Bore (Centerline to Piston Top) . . . . . 40.61 to 40.72 mm (1.599 to 1.603 in.)
Piston-to-Bore Clearance . . . . . 0.033 to 0.053 mm (0.0013 to 0.0021 in.)
Piston-to-Bore Clearance (Preferred) . . . . . 0.033 to 0.038 mm (0.0013 to 0.0015 in.)
Ring Gap Clearance— Top Compression Ring . . . . . 0.229 to 0.610mm (0.0090 to 0.0240 in.)
Ring Gap Clearance— 2nd Compression Ring . . . . . 0.483 to 0.965 mm (0.0190 to 0.0380 in.)
Ring Gap Clearance—Oil Control Steel Rails . . . . . 0.254 to 1.500 mm (0.010 to 0.060 in.)
Ring Side Clearance—Compression Rings . . . . . 0.042 to 0.084 mm (0.0017 to 0.0033 in.)
Ring Side Clearance—Oil Control Rings . . . . . 0.06 to 0.21 mm (0.0024 to 0.0083 in.)
Piston Ring Groove Height—Compression Rings . . . . . 1.530 to 1.555 mm (0.0602 to 0.0612 in.)
Piston Ring Groove Height—Oil Control Ring . . . . . 4.035 to 4.060 mm (0.1589 to 0.1598 in.)
Piston Ring Groove Diameter—Compression Rings . . . . . 88.3 to 88.55 mm (3.476 to 3.486 in.)
Piston Ring Groove Diameter—Oil Control Ring . . . . . 90.35 to 90.60 mm (3.557 to 3.566 in.)
Piston Pin Bore Diameter . . . . . 23.647 to 23.655 mm (0.9310 to 0.9313 in.)
Piston Pin Diameter . . . . . 23.637 to 23.640 mm (0.9306 to 0.9307 in.)
Piston-to-Pin Clearance . . 0.0076 to 0.0178 mm—Loose (0.0003 to 0.0007 in. Loose)

SPECIFICATIONS (Continued)

Piston-to-Pin Clearance
(Preferred) . . . . . 0.013 mm (0.0005 in.)
Piston-to-Pin Connecting Rod
(Press Fit) . . . . . 8.9 kN (2000 lbf.)

Oil Pump

Gear-to-Body Clearance
(Radial) . 0.051 to 0.102 mm (0.002 to 0.004 in.)
Gear-to-Body Clearance (Radial)
(Preferred) . . . . . 0.051 mm (0.002 in.)
Gear End Clearance—
Plastigage . 0.051 to 0.152 mm (0.002 to 0.006 in.)
Gear End Clearance—
lastigage (Preferred) . . . . . 0.051 mm (0.002 in.)
Gear End Clearance—Feeler
Gauge . . . . . 0.1016 to 0.2032 mm (0.004 to 0.008 in.)
Gear End Clearance—Feeler
Gauge (Preferred) . . . . . 0.1778 mm (0.007 in.)

Oil Pressure

At Idle Speed (600 rpm) . . . . . 89.6 kPa (13 psi)
At 1600 rpm & Higher . . . . . 255 to 517 kPa (37 to 75 psi)
Oil Pressure Relief . . . . . 517 kPa (75 psi)

TORQUE SPECIFICATIONS

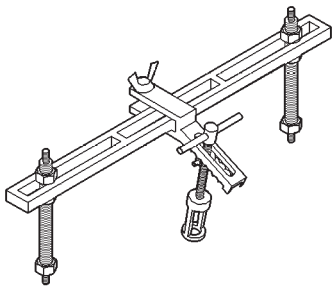
DESCRIPTION	TORQUE
A/C Compressor Bracket-to-Engine	
Bolts	.34 N·m (25 ft. lbs.)
A/C Compressor	
Mounting Bolts	.27 N·m (20 ft. lbs.)
A/C Low Pressure Service Valve	
Nut	.38 N·m (28 ft. lbs.)
Block Heater	
Nut	.2 N·m (16 in. lbs.)
Camshaft Sprocket	
Bolt	.108 N·m (80 ft. lbs.)
Clutch Cover to Flywheel	
Bolts	.54 N·m (40 ft. lbs.)
Coil Bracket to Block	
Bolts	.22 N·m (192 in. lbs.)
Connecting Rod	
Nuts	.45 N·m (33 ft. lbs.)
Cylinder Block	
Drain Plugs	.34 N·m (25 ft. lbs.)
Cylinder Head	
Bolts #1–10 & #12–14	.149 N·m (110 ft. lbs.)
Bolt #11	.135 N·m (100 ft. lbs.)
Cylinder Head Cover	
Bolts	.10 N·m (85 in. lbs.)
Distributor Clamp	
Bolt	.23 N·m (204 in. lbs.)
Engine Mounts—Front	
Support Bracket Bolts	.61 N·m (45 ft. lbs.)
Support Cushion Bolts/Nuts	.41 N·m (30 ft. lbs.)
Support Cushion Bracket Bolts	.54 N·m (40 ft. lbs.)
Support Cushion Bracket Stud Nuts	.41 N·m (30 ft. lbs.)
Support Cushion Thru-Bolt	.65 N·m (48 ft. lbs.)
Engine Mounts—Rear	
Crossmember-to-Sill Bolts (Automatic)	.41 N·m (30 ft. lbs.)
Insulator Stud Assembly Nut	.41 N·m (30 ft. lbs.)
Support Cushion/Crossmember Nuts	.22 N·m (192 in. lbs.)
Support Cushion/Bracket Nuts (Manual)	.75 N·m (55 ft. lbs.)
Transmission Support Bracket Bolt (Manual)	.46 N·m (34 ft. lbs.)
Transmission Support Bracket/Cushion Bolt (4WD Auto)	75 N·m (55 ft. lbs.)
Transmission Support Adaptor Bracket Bolts (2WD Auto)	75 N·m (55 ft. lbs.)
Exhaust Manifold/Pipe	
Nuts	.27 N·m (20 ft. lbs.)
Flywheel/Converter Housing	
Bolts	.38 N·m (28 ft. lbs.)
Flywheel/Crankshaft	
Bolts	.143 N·m (105 ft. lbs.)
Front Cover-to-Block	
Bolts 1/4–20	.7 N·m (60 in. lbs.)
Bolts 5/16–18	.22 N·m (192 in. lbs.)
Fuel Rail	
Bolts/Stud	.12 N·m (108 in. lbs.)
Generator	
Fixed Bolt	.24 N·m (18 ft. lbs.)
Thru Bolt/Nut	.38 N·m (28 ft. lbs.)
Main Bearing	
Bolts	.108 N·m (80 ft. lbs.)
Oil Filter	
Filter	.18 N·m (156 in. lbs.)
Connector (to adaptor)	.47 N·m (35 ft. lbs.)
Connector (to block)	.68 N·m (50 ft. lbs.)
Adaptor Bolts	.102 N·m (50 ft. lbs.)
Oil Galley	
Plug	.41 N·m (30 ft. lbs.)
Oil Pan	
1/4–20 Bolts	.10 N·m (84 in. lbs.)
5/16–18 Bolts	.15 N·m (132 in. lbs.)
Drain Plug	.34 N·m (25 ft. lbs.)
Oil Pump	
Short Attaching Bolts	.23 N·m (17 ft. lbs.)
Long Attaching Bolts	.23 N·m (17 ft. lbs.)
Cover Bolts	.8 N·m (70 in. lbs.)
Power Steering Pump Pressure Hose	
Nut	.52 N·m (38 ft. lbs.)
Rocker Arm Assembly-to-Cylinder Head	
Capscrews	.28 N·m (21ft. lbs.)

SPECIFICATIONS (Continued)

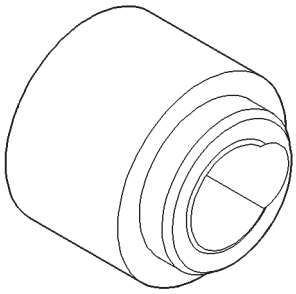
DESCRIPTION	TORQUE
Spark Plugs	
Plugs	37 N·m (27 ft. lbs.)
Starter Motor	
Mounting Bolts	45 N·m (33 ft. lbs.)
Thermostat Housing	
Bolts	18 N·m (156 in. lbs.)
Throttle Body	
Bolts	10 N·m (90 in.lbs.)
Vibration Damper	
Bolts	108 N·m (80 ft. lbs.)
Water Pump/Block	
Bolts	31 N·m (23 ft. lbs.)

SPECIAL TOOLS

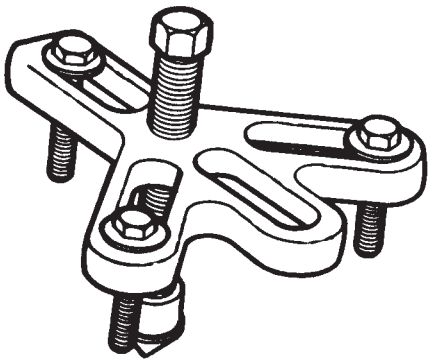
SPECIAL TOOLS



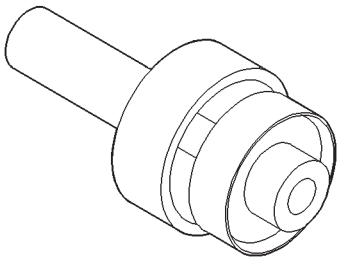
Valve Spring Compressor Tool MD-998772A



Timing Case Cover Alignment and Sealinstallation Tool 6139



Vibration Damper Removal Tool 7697



Rear Main Seal Installer Tool 6271A

5.2L ENGINE

INDEX

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

DESCRIPTION AND OPERATION (Continued)

This engine is designed for unleaded fuel.

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
Torque . . . . . 386 N·m (285 ft. lbs.) @ 3,600 rpm
Firing Order 1–8–4–3–6–5–7–2
Lubrication . . . Pressure Feed—Full Flow Filtration
Engine Oil Capacity . . . . . 4.7L (5.0 qts.) w/filter
Cooling System . Liquid Cooled—Forced Circulation
Cooling Capacity . . . . . 14.1L (14.9 qts.)
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

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

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

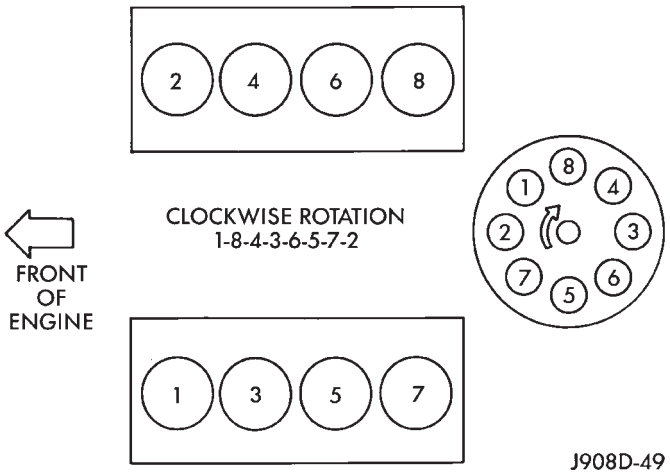


Fig. 1 Firing Order

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

LUBRICATION SYSTEM

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

X M 5.2L T XXXX XXXXXXXX

X = Last Digit of Model Year
M = Plant - M Mound Road
S Saltillo
T Trenton
K Toluca
5.2L = Engine Displacement
T = Usage - T Truck
XXXX = Month/Day
XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 2 Engine Identification Number

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)

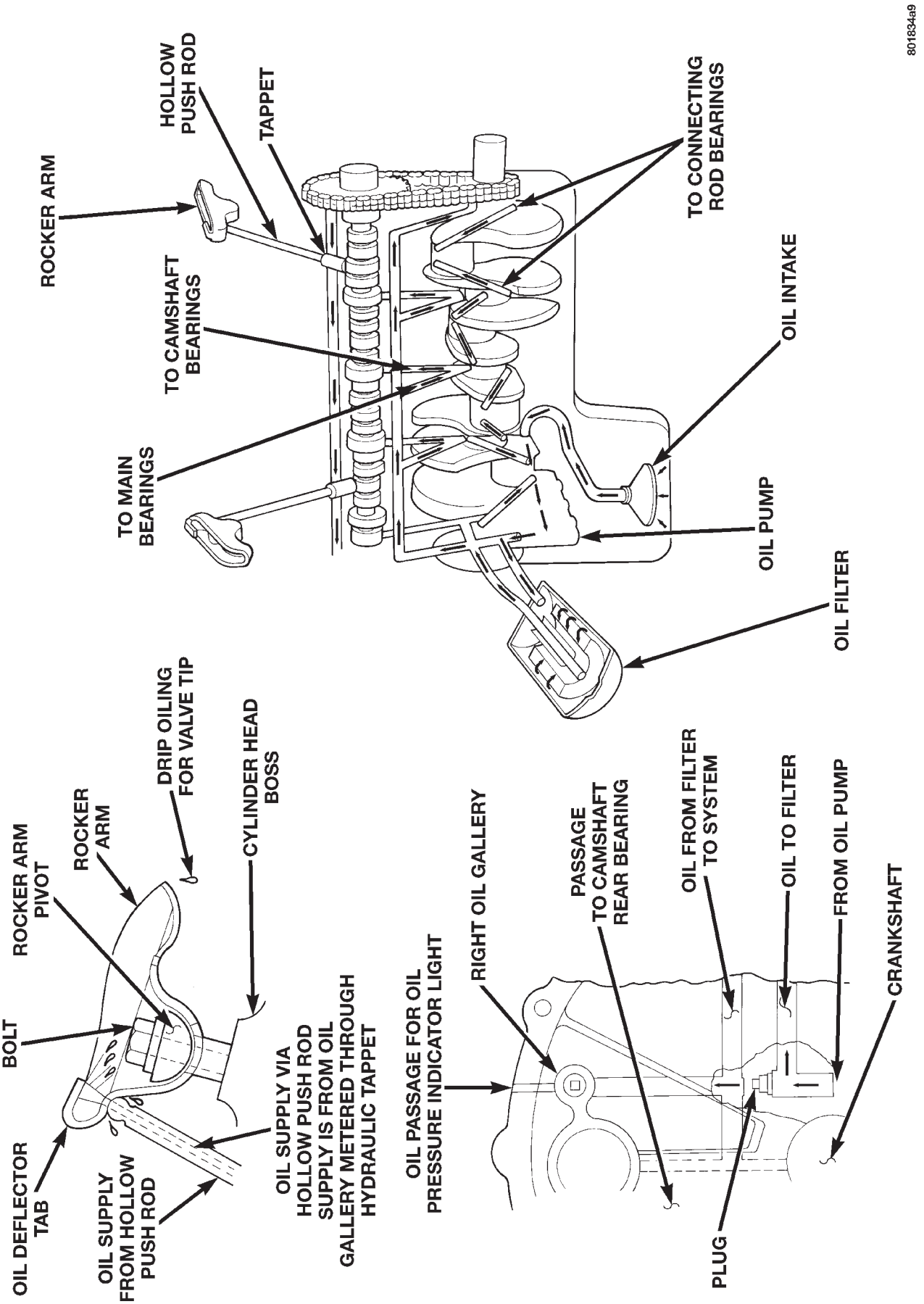


Fig. 3 Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

ENGINE COMPONENTS

CYLINDER HEAD

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

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

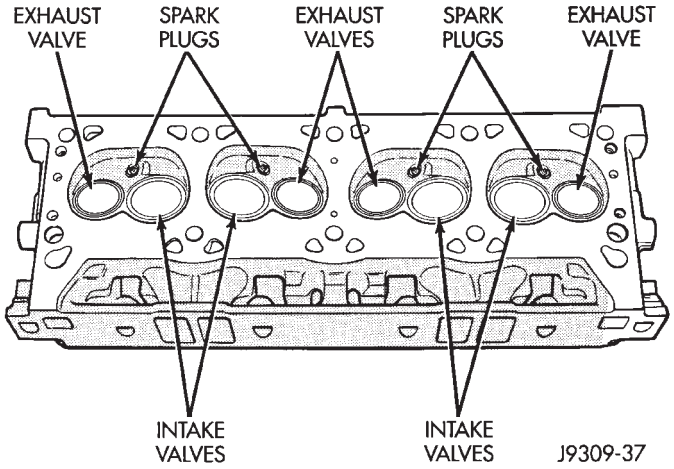


Fig. 4 Cylinder Head Assembly

PISTONS

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

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

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

SERVICE PROCEDURES

VALVE TIMING

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

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

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

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

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

If reading is not within specified limits:

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

MEASURING TIMING CHAIN STRETCH

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

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

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

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

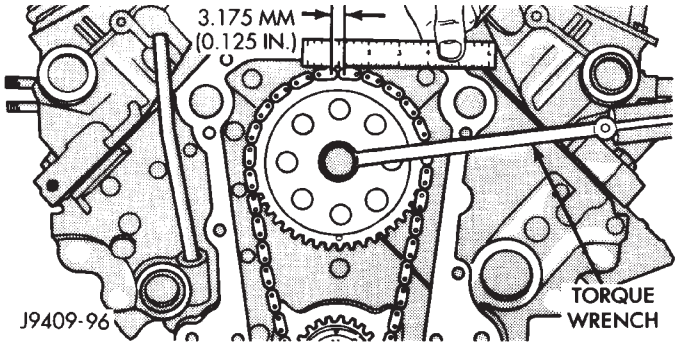


Fig. 5 Measuring Timing Chain Wear and Stretch

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

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

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

(7) Place timing chain around both sprockets.

SERVICE PROCEDURES (Continued)

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

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

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

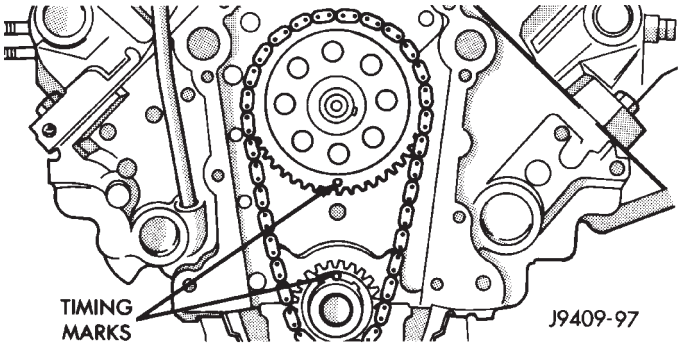


Fig. 6 Alignment of Timing Marks

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

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

FITTING PISTONS

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

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

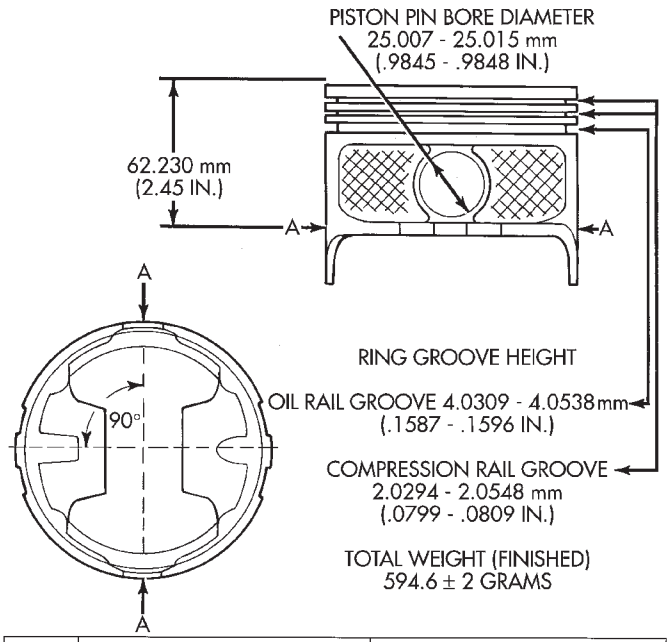
Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

FITTING PISTON RINGS

(1) Measurement of end gaps:

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

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



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

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Fig. 7 Piston Measurements

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

(2) Install rings and confirm ring side clearance:

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

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

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

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

SERVICE PROCEDURES (Continued)

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

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

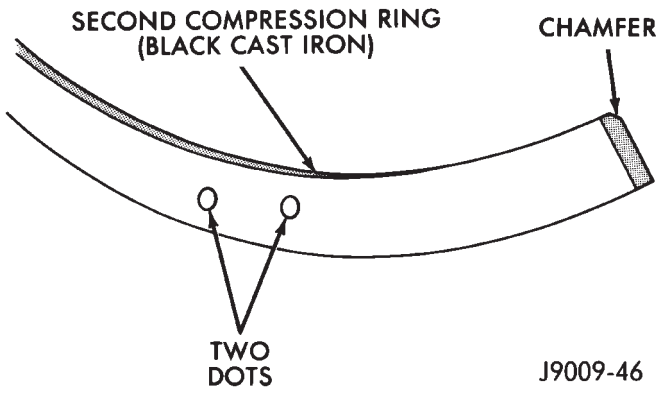

Fig. 8 Second Compression Ring Identification(Typical)

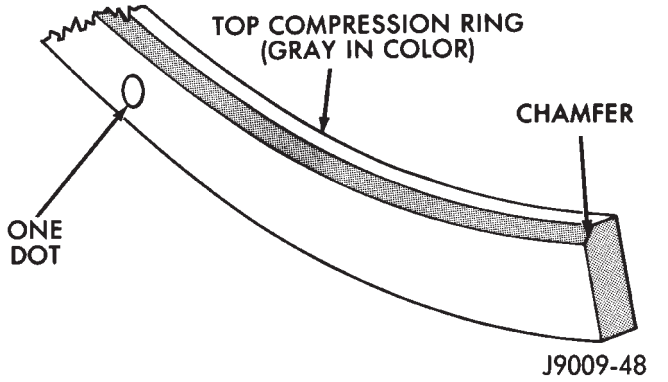

Fig. 9 Top Compression Ring Identification(Typical)

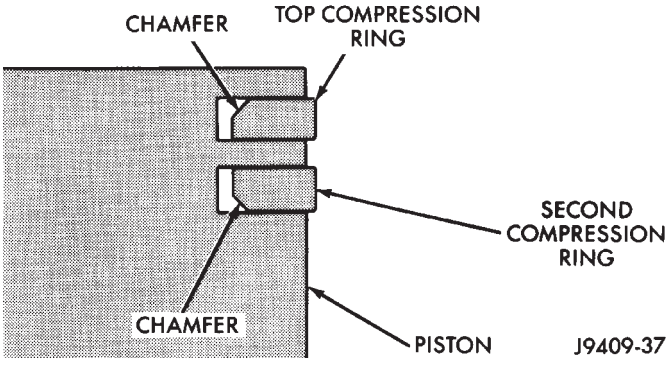

Fig. 10 Compression Ring Chamfer Location(Typical)

FITTING CONNECTING ROD BEARINGS

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

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

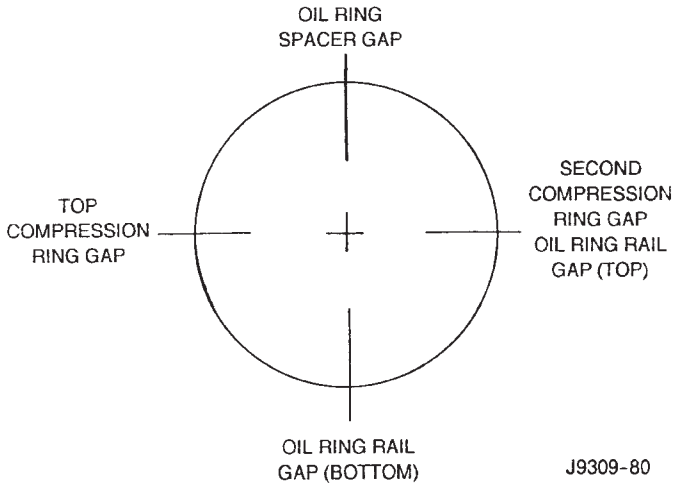

Fig. 11 Proper Ring Installation

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

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

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 inch). Bearings are available in 0.025 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch) 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.2 and 4 are interchangeable.

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

CRANKSHAFT

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

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

SERVICE PROCEDURES (Continued)

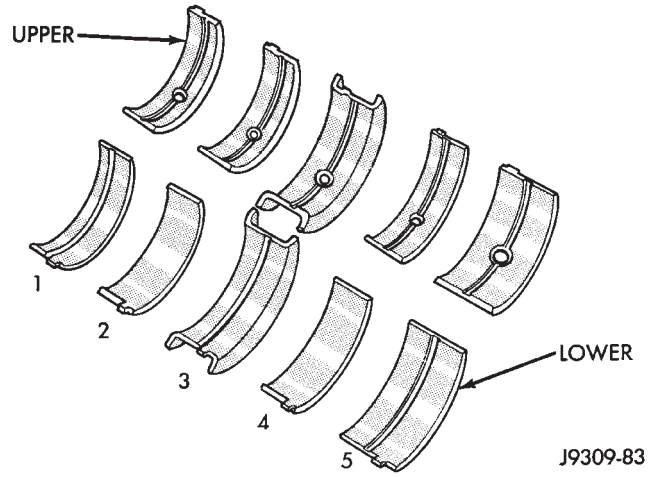

Fig. 12 Main Bearing Identification

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

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

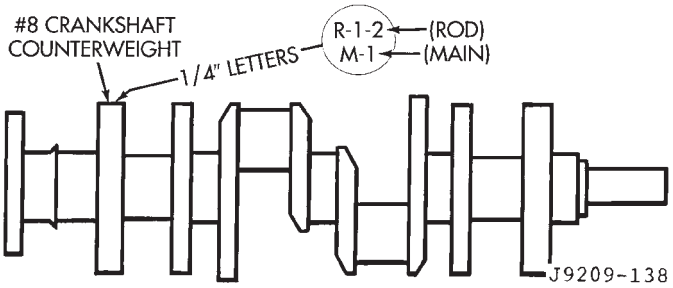

Fig. 13 Location of Crankshaft Identification

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

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

(1) Disconnect the negative cable from the battery.

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

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

(3) Install engine lifting fixture.

(4) Raise vehicle on hoist.

(5) Remove the engine support insulator thru-bolts and nuts (Fig. 14) (Fig. 15).

(6) Raise engine SLIGHTLY. Remove the engine support insulator bolts. Remove the engine support insulator assembly.

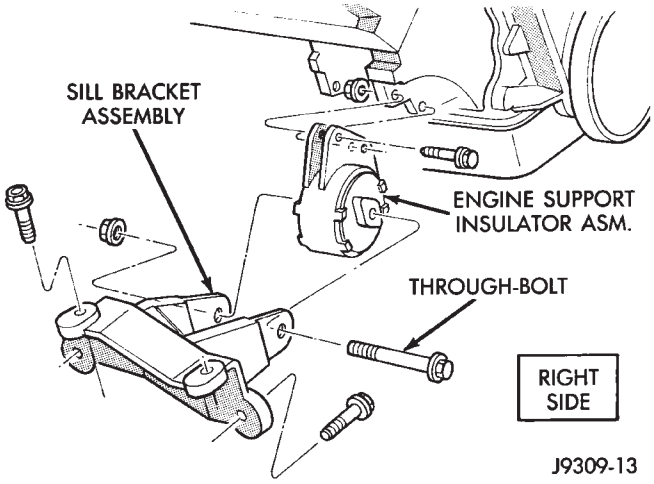

Fig. 14 Front Engine Mount—Right Side

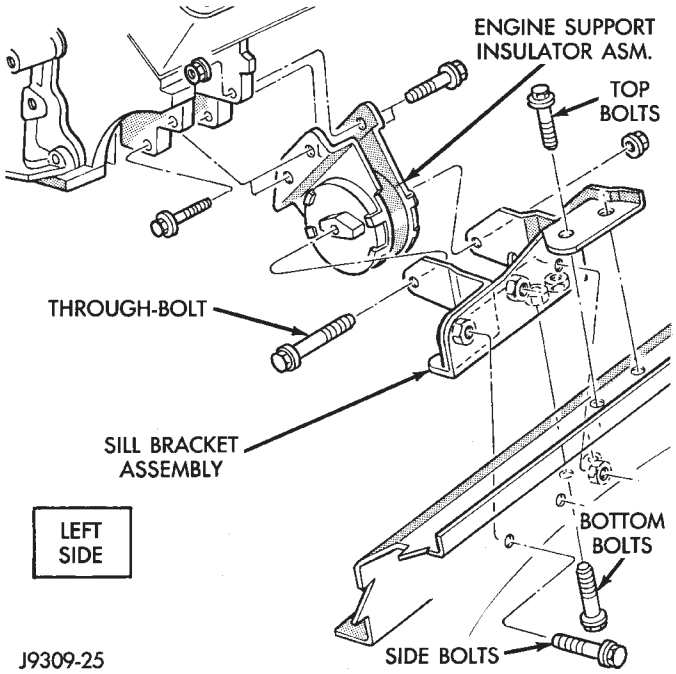

Fig. 15 Front Engine Mount—Left Side

(7) If required, remove the sill bracket assembly.

INSTALLATION

(1) If the sill bracket assembly was removed, install the bracket to the sill assembly.

REMOVAL AND INSTALLATION (Continued)

(a) RIGHT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 14). Install and tighten the bolts to 65 N·m (48 ft. lbs.) torque.

(b) LEFT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 15). Install and tighten the 2 top bolts to 65 N·m (48 ft. lbs.) torque. Install and tighten the 2 side bolts to 95 N·m (70 ft. lbs.) torque. Install and tighten the 2 bottom bolts to 121 N·m (89 ft. lbs.) torque.

(2) With the engine raised SLIGHTLY, position engine support insulator assembly onto the engine block (Fig. 14) (Fig. 15). Install bolts and tighten to 88 N·m (65 ft. lbs.) torque.

(3) Lower engine with lifting fixture while aligning engine support insulator assembly into sill bracket assembly.

(4) Install the thru-bolt and nut. Tighten the RIGHT SIDE nut to 81 N·m (60 ft. lbs.) torque. Tighten the LEFT SIDE nut to 81 N·m (60 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

(7) 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 jack.

(4) Remove stud nuts attaching engine mount to crossmember (Fig. 16). Remove mount.

(5) Raise the transmission and engine SLIGHTLY.

(6) Remove engine mount bracket thru-bolt (Fig. 16).

(7) Remove the engine mount assembly from the adaptor (Fig. 16).

(8) If required, remove the transmission support bracket adaptor.

INSTALLATION

(1) Position the rear mount bracket onto the exhaust hanger (if previously removed). Position the rear mount bracket assembly onto the transmission and install the bolts. Tighten the bolts to 46 N·m (34 ft. lbs.).

(2) Position mount into mount bracket and install thru-bolt and nut. DO NOT tighten the bolt at this time.

(3) Lower the transmission until the mount fastening studs are in position in the crossmember.

(4) Remove transmission jack.

(5) Install the mount fastening nuts and tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(6) Tighten the thru-bolt nut to 65 N·m (48 ft. lbs.) torque.

(7) Lower the vehicle.

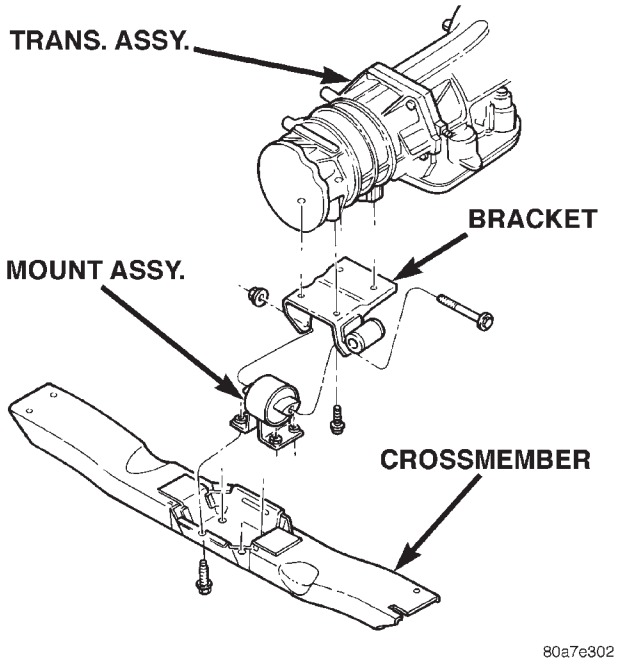

Fig. 16 Rear Engine Mount—V-8

(8) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

(1) Scribe hood hinge outlines on hood and remove the hood.

(2) Remove the battery.

(3) Drain cooling system.

(4) Remove the air cleaner and tube.

(5) Set fan shroud aside.

(6) Remove radiator and heater hoses. Remove the radiator (refer to Group 7, Cooling System).

(7) Remove the vacuum lines.

(8) Remove the distributor cap and wiring.

(9) Disconnect the accelerator linkage.

(10) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System).

(11) Remove throttle body.

(12) Remove the starter wires.

(13) Remove the oil pressure wire.

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

(15) Remove air conditioning hoses.

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

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

(18) Remove the generator (refer to Group 8C, Generator Service).

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

(20) Disconnect exhaust pipe at manifold.

REMOVAL AND INSTALLATION (Continued)

(21) Support automatic transmission with a transmission stand. This will assure that the torque converter will remain in proper position in the transmission housing.

(22) Remove bell housing bolts and inspection plate. Attach C-clamp on front bottom of transmission torque converter housing to prevent torque converter from coming out.

(23) Remove torque converter drive plate bolts from torque converter drive plate. Mark converter and drive plate to aid in assembly.

(24) Disconnect the engine from the torque converter drive plate.

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

(25) Install an engine lifting fixture.

(26) Remove the engine front mount thru-bolts.

(27) Lower the vehicle.

(28) Remove engine from engine compartment.

(29) Install on engine repair stand.

INSTALLATION

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

(2) Install engine support fixture.

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

(4) Position the torque converter and drive plate. Install torque converter drive plate bolts. Tighten the bolts to 31 N·m (270 in. lbs.) torque.

(5) Install the engine front mount thru-bolts.

(6) Install bell housing bolts. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(7) Remove C-clamp and install inspection plate.

(8) Remove stand from transmission.

(9) Install exhaust pipe to manifold.

(10) Lower the vehicle.

(11) Remove engine lifting fixture.

(12) Install the generator (refer to Group 8C, Generator Service).

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

(14) Install power steering hoses, if equipped.

(15) Install air conditioning hoses.

(16) Charge the air conditioner, if equipped (refer to Group 24, Heater and Air Conditioning for service procedures).

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

(18) Connect the accelerator linkage.

(19) Connect the starter wires.

(20) Connect the oil pressure wire.

(21) Install the distributor cap and wiring.

(22) Install vacuum lines.

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

(24) Install fan shroud in position.

(25) Install the battery

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

(27) Install the air cleaner.

(28) Warm engine and adjust.

(29) Install hood and line up.

(30) Road test vehicle.

CYLINDER HEAD COVER

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

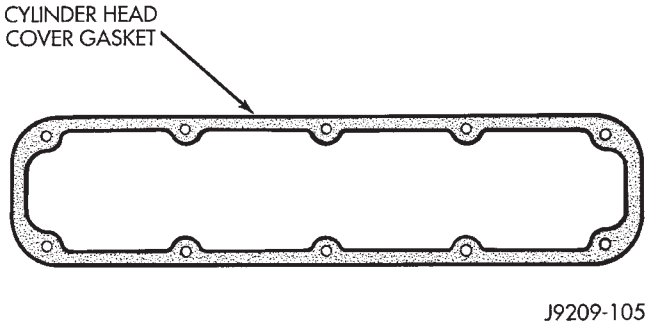

Fig. 17 Cylinder Head Cover Gasket

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) On the left cover, remove the coolant tube bracket.

(4) Remove the ignition wires from the holders.

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

(6) Clean cylinder head cover gasket surface.

(7) Clean head rail, if necessary.

INSTALLATION

(1) Inspect cover for distortion and straighten, if necessary.

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

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

(4) Position the cylinder head cover onto the gasket. On the left cover, install the coolant tube bracket (refer to Group 7, Cooling System). Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(5) Install the ignition wires onto the holders.

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

(7) Connect the negative cable to the battery.

REMOVAL AND INSTALLATION (Continued)

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.

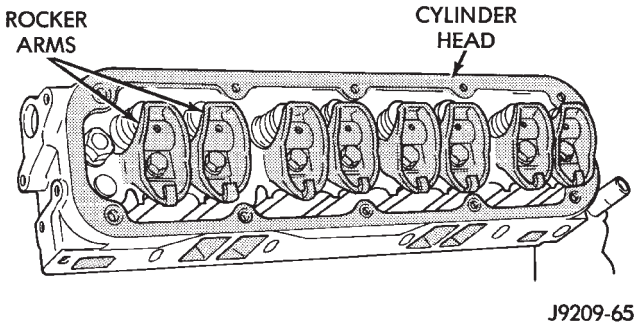

Fig. 18 Rocker Arms

INSTALLATION

(1) Rotate the crankshaft until the "V8" mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.

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

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

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

(4) Install cylinder head cover.

(5) Connect spark plug wires.

VALVE SPRING AND STEM SEAL REPLACEMENT-IN VEHICLE

(1) 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 with adaptor 6633, compress valve spring and remove retainer valve locks and valve spring.

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

(10) 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.

(11) 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.

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

(13) Install rocker arms.

(14) Install covers and coil wire to distributor.

(15) Install air cleaner.

(16) Road test vehicle.

CYLINDER HEAD

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

(6) Remove the air cleaner.

(7) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.

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

(9) Remove the return spring.

(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.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

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

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

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

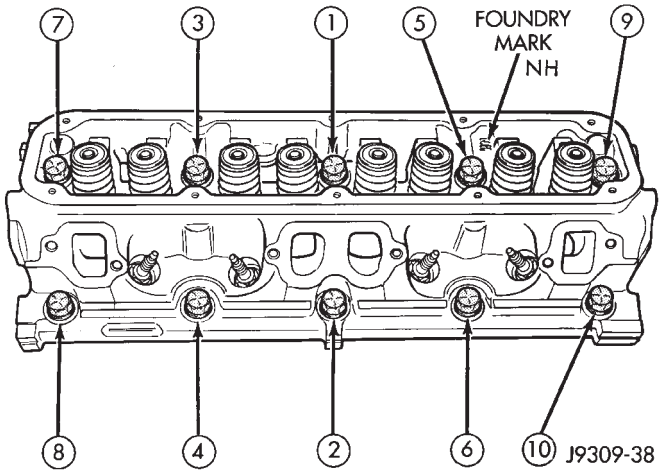

Fig. 19 Cylinder Head Bolt Tightening Sequence

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

(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) Hook up the return spring.

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

(14) Install the fuel lines.

(15) 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.

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

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

(18) Install closed crankcase ventilation system.

(19) Connect the evaporation control system.

(20) Install the air cleaner.

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

(22) Connect the negative cable to the battery.

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) 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, 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).

REMOVAL AND INSTALLATION (Continued)

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. 20).

(8) Pull vibration damper off of the crankshaft.

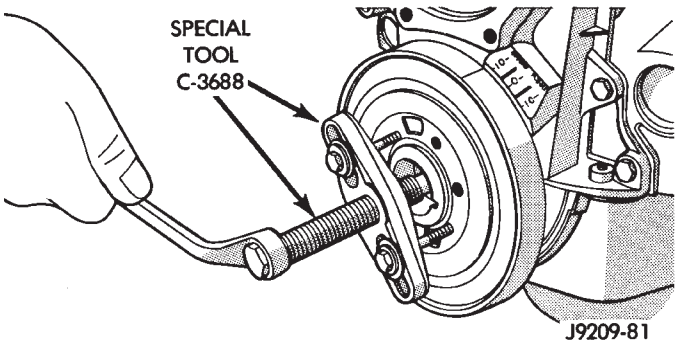

Fig. 20 Vibration Damper Assembly

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

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

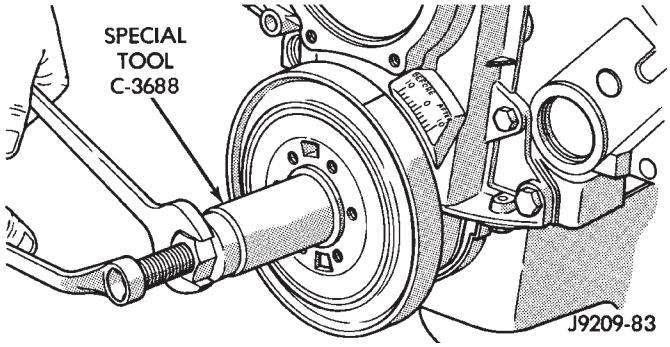

Fig. 21 Installing Vibration Damper

(3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

(4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.

(5) Install the 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 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).

REMOVAL AND INSTALLATION (Continued)

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

(6) Remove vibration damper.

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

(8) Remove the cover bolts.

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

(10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 22).

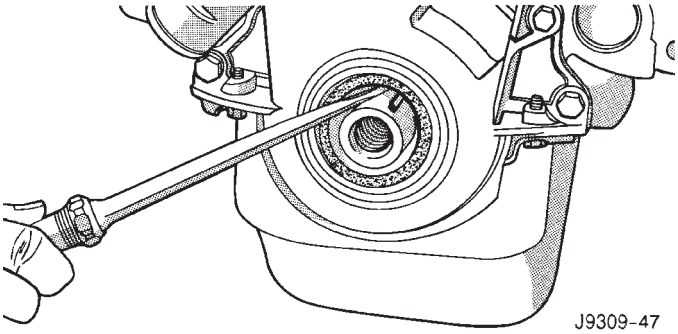

Fig. 22 Removal of Front Crankshaft Oil Seal

INSTALLATION

(1) 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.

(2) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 23). Seat the oil seal in the groove of the tool.

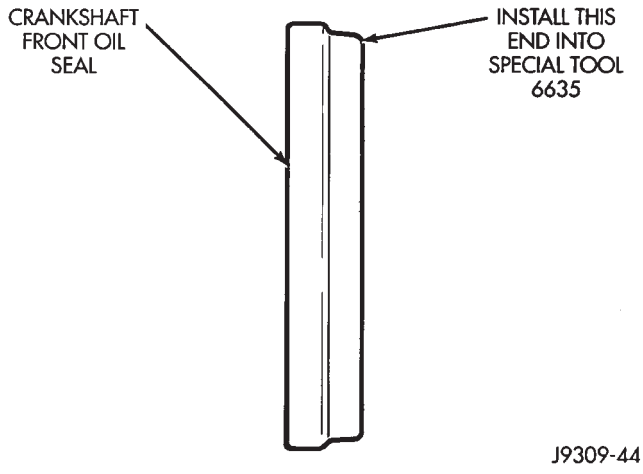

Fig. 23 Placing Oil Seal on InstallationTool 6635

(3) Position the seal and tool onto the crankshaft (Fig. 24).

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

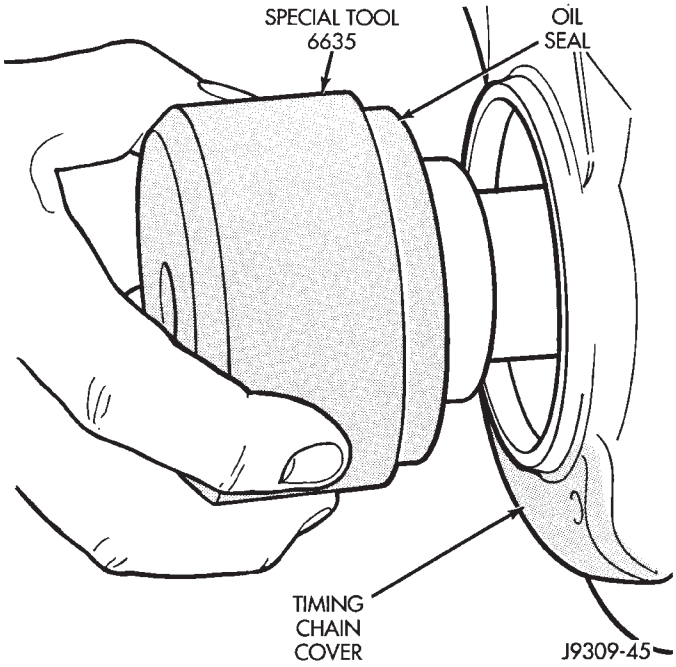

Fig. 24 Position Tool and Seal onto Crankshaft

(5) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 25).

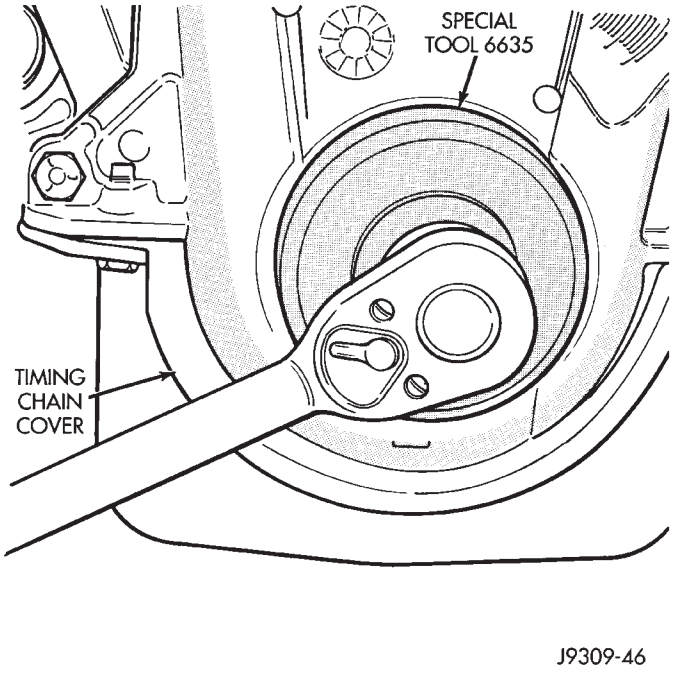

Fig. 25 Installing Oil Seal

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

(7) 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.

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

REMOVAL AND INSTALLATION (Continued)

(9) Install vibration damper.

(10) 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.

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

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

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

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

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

(16) Connect the negative cable to the battery.

TIMING CHAIN

REMOVAL

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

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

INSTALLATION

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

(2) Place timing chain around both sprockets.

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

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

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

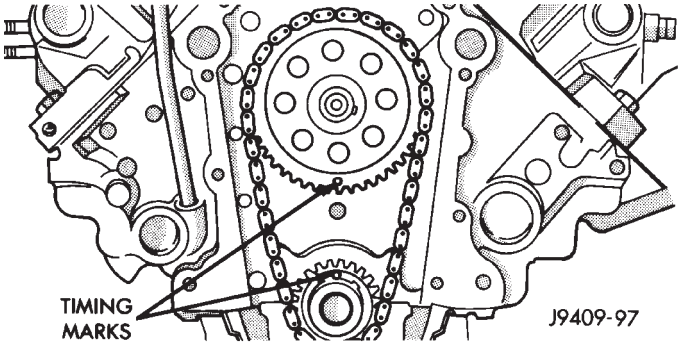

Fig. 26 Alignment of Timing Marks

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

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

CAMSHAFT

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

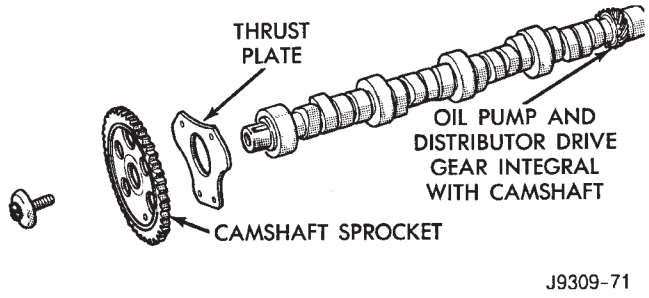

Fig. 27 Camshaft and Sprocket Assembly

REMOVAL

(1) Remove intake manifold.

(2) Remove cylinder head covers.

(3) Remove timing case cover and timing chain.

(4) Remove rocker arms.

(5) Remove push rods and tappets. Identify each part so it can be installed in its original location.

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

(7) Remove camshaft thrust plate, note location of oil tab (Fig. 28).

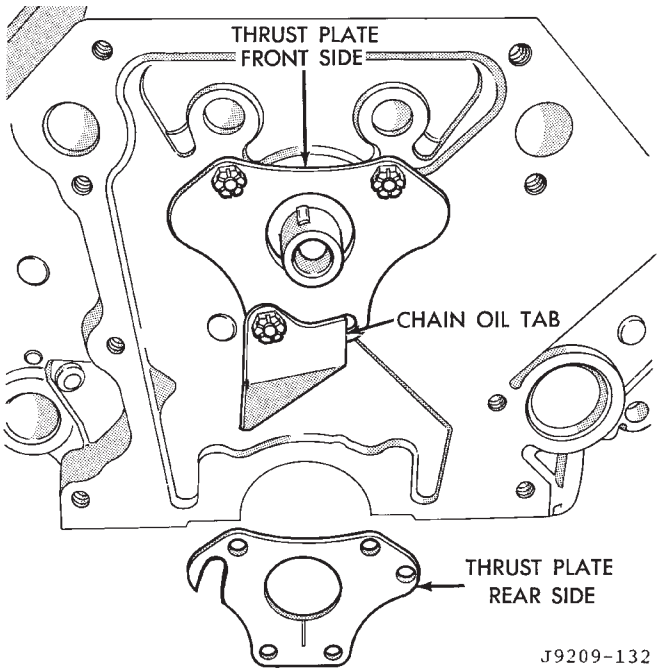

Fig. 28 Timing Chain Oil Tab Installation

(8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft,

REMOVAL AND INSTALLATION (Continued)

being careful not to damage cam bearings with the cam lobes.

INSTALLATION

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

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

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

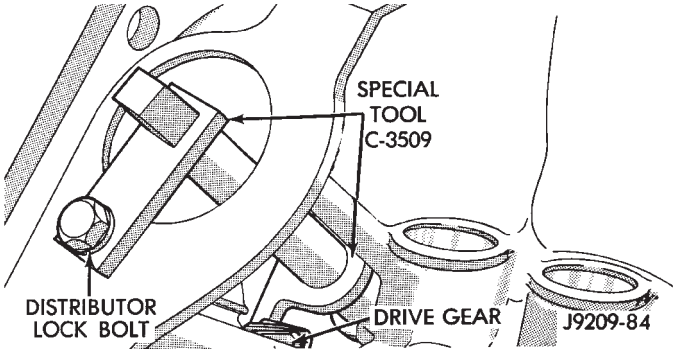

Fig. 29 Camshaft Holding Tool C-3509 (InstalledPosition)

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

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

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

(6) Place timing chain around both sprockets.

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

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

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 30).

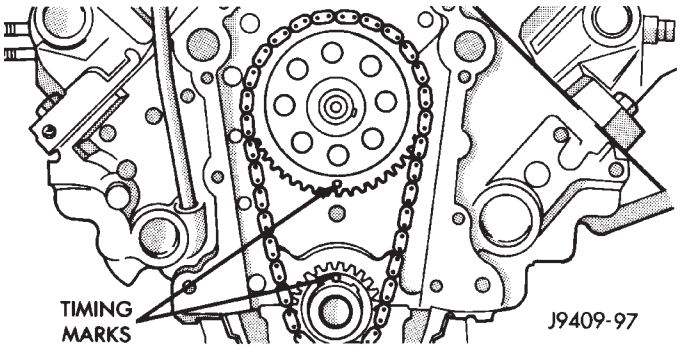

Fig. 30 Alignment of Timing Marks

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

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

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

CAMSHAFT BEARINGS

REMOVAL

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

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 31).

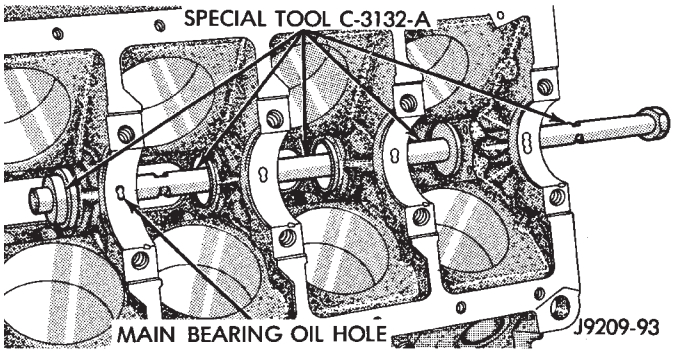

Fig. 31 Camshaft Bearings Removal/Installationwith Tool C-3132-A

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 horseshoe lock and by reversing removal procedure, carefully drive bearing shell into place.

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

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Remove the oil pan.

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

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

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 32).

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

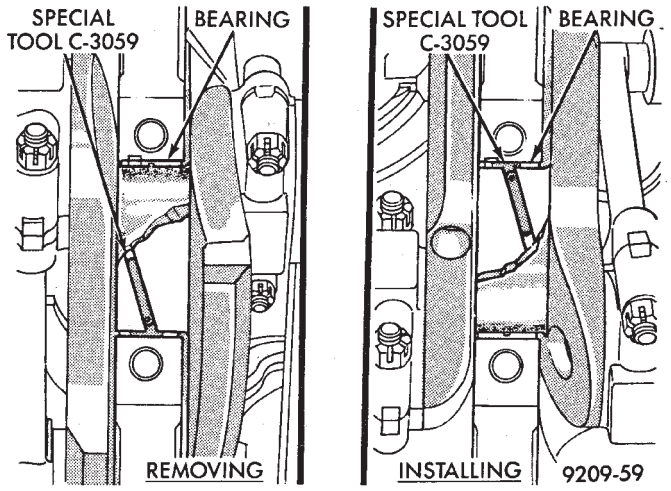

Fig. 32 Upper Main Bearing Removal and Installationwith Tool C-3059

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. 32).

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

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

(4) Install the oil pump.

(5) Install the oil pan.

DISTRIBUTOR DRIVE SHAFT BUSHING

REMOVAL

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

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

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

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

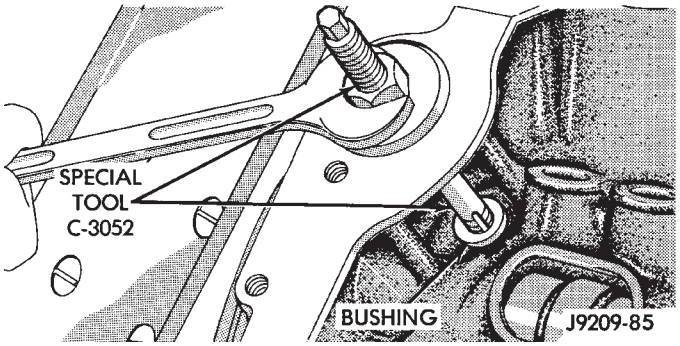

Fig. 33 Distributor Driveshaft Bushing Removal

INSTALLATION

(1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.

(2) Drive bushing and tool into position, using a hammer (Fig. 34).

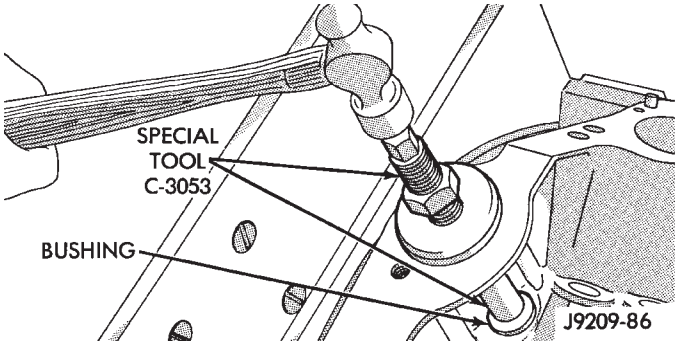

Fig. 34 Distributor Driveshaft Bushing Installation

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

REMOVAL AND INSTALLATION (Continued)

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

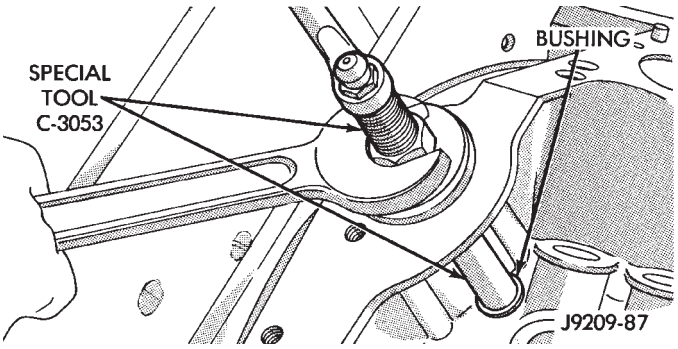

Fig. 35 Burnishing Distributor DriveshaftBushing

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

DISTRIBUTOR INSTALLATION

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

(1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.

(2) When in this position, the timing mark of vibration damper should be under "0" on the timing indicator.

(3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned towards the left front intake manifold attaching bolt hole (Fig. 36).

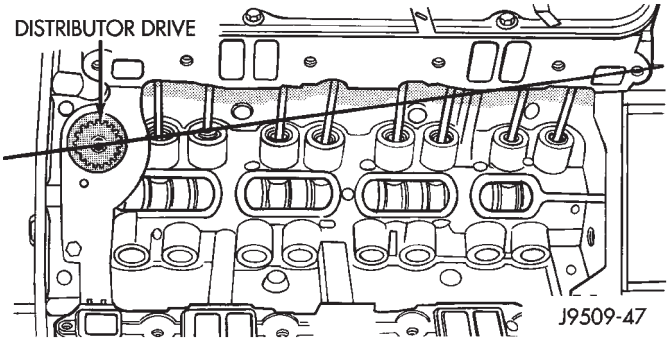

Fig. 36 Position of Oil Pump Shaft Slot

(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) Raise the vehicle.

(3) Remove the oil pan drain plug and drain the engine oil.

(4) Remove the oil filter.

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

(6) If equipped with an oil level sensor, disconnect the sensor.

(7) Position the cooler lines out of the way.

(8) Disconnect the oxygen sensor.

(9) Remove exhaust pipe.

(10) Remove the oil pan bolts. Carefully slide the oil pan and gasket to the rear. If equipped with an oil level sensor, take care not to damage the sensor.

INSTALLATION

(1) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 37).

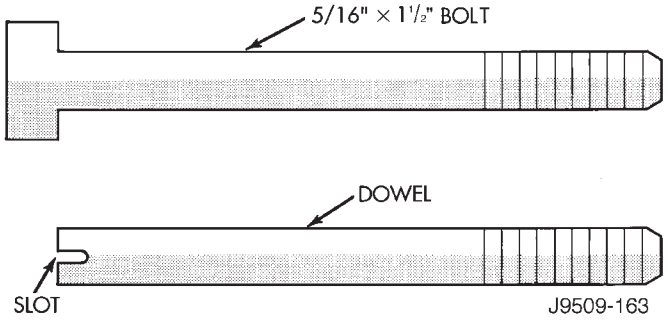

Fig. 37 Fabrication of Alignment Dowels

(2) Install the dowels in the cylinder block (Fig. 38).

(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. If equipped with an oil level sensor, take care not to damage the sensor.

(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.

REMOVAL AND INSTALLATION (Continued)

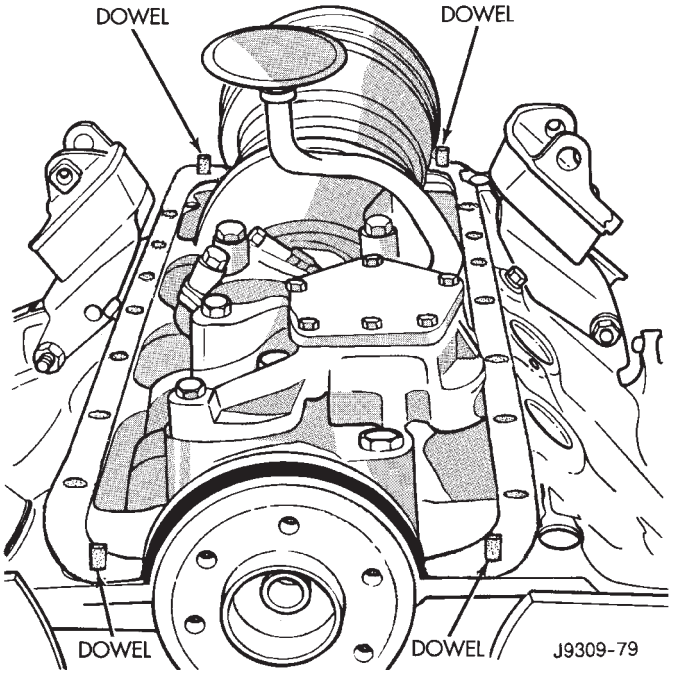

Fig. 38 Position of Dowels in Cylinder Block

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

(9) Install exhaust pipe.

(10) Connect the oxygen sensor.

(11) Install the oil filter.

(12) If equipped with an oil level sensor, connect the sensor.

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

(14) Move the cooler lines back into position.

(15) Lower vehicle.

(16) Connect the negative cable to the battery.

(17) Fill the oil pan with engine oil to the specified level.

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

(18) Start the engine and inspect for leaks.

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. 39).

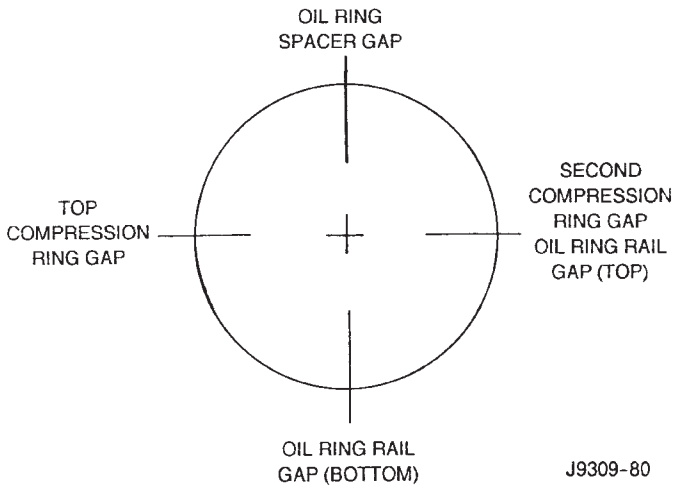

Fig. 39 Proper Ring Installation

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

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

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

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

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

REMOVAL AND INSTALLATION (Continued)

(8) Install rod caps. Be sure connecting rod, connecting rod cap and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.
(9) Install the oil pan.
(10) Install the cylinder head.
(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

(1) Remove the oil pan.
(2) Remove the oil pump from the rear main bearing cap.
(3) Remove the vibration damper.
(4) Remove the timing chain cover.
(5) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.
(6) Lift the crankshaft out of the block.
(7) Remove and discard the crankshaft rear oil seals.
(8) Remove and discard the front crankshaft oil seal.

INSTALLATION

(1) Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.
(2) Lightly oil the new upper seal lips with engine oil.
(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
(4) Position the crankshaft into the cylinder block.
(5) Lightly oil the new lower seal lips with engine oil.
(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
(7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 40). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.
(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.
(10) Install oil pump.
(11) Install the timing chain cover.
(12) Install the vibration damper.
(13) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to

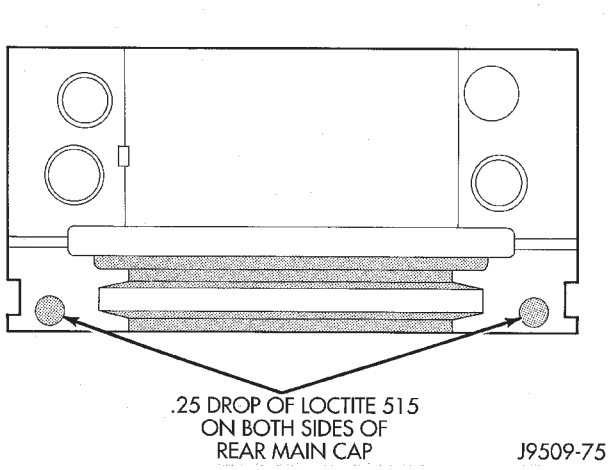

Fig. 40 Sealant Applicationto Bearing Cap

provide cap to block and oil pan sealing (Fig. 41). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
(14) Install new front crankshaft oil seal.
(15) Immediately install the oil pan.

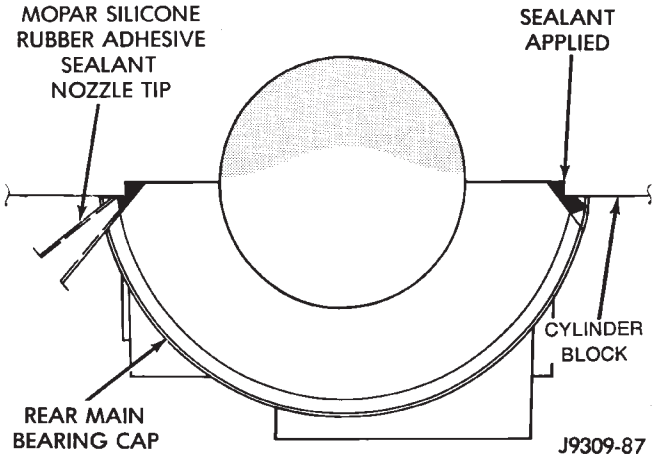

Fig. 41 Apply Sealant to Bearing Cap to BlockJoint

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.

REMOVAL AND INSTALLATION (Continued)

FRONT CRANKSHAFT OIL SEAL

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

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper.

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

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

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

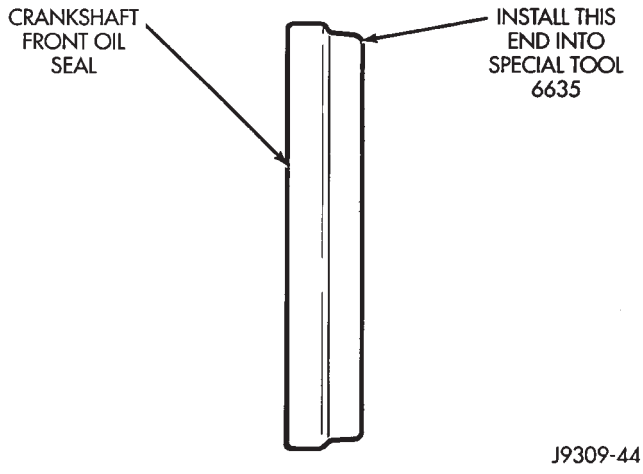

Fig. 42 Placing Oil Seal on InstallationTool 6635

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

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

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

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

(10) Install the vibration damper.

(11) Connect the negative cable to the battery.

CRANKSHAFT REAR OIL SEALS

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

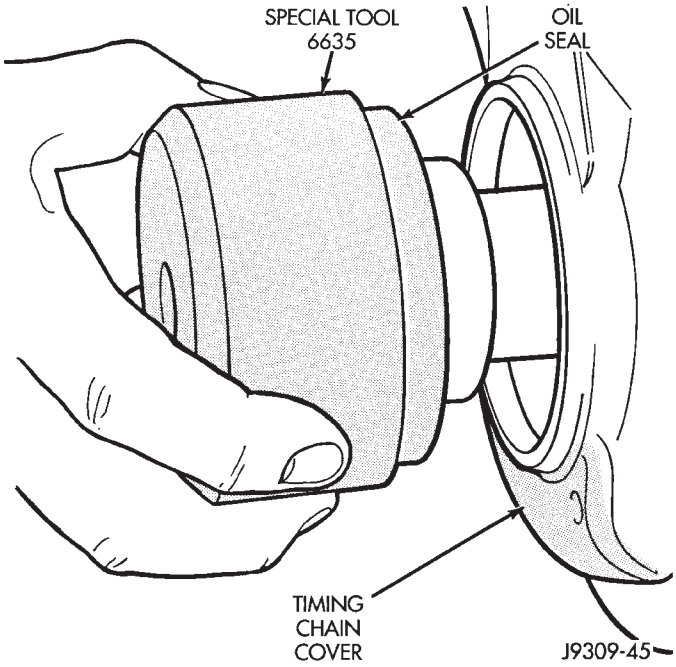

Fig. 43 Position Tool and Sealonto Crankshaft

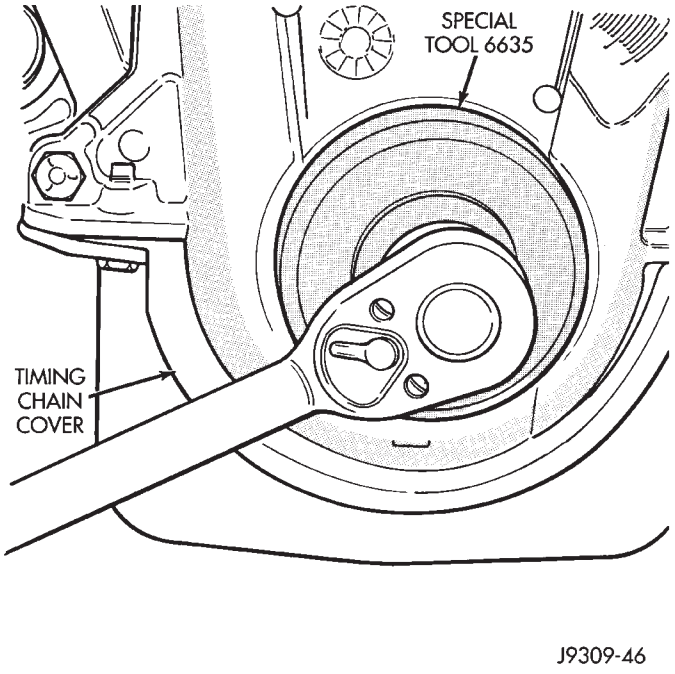

Fig. 44 Installing Oil Seal

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

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

INSTALLATION

(1) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.

REMOVAL AND INSTALLATION (Continued)

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

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

(4) Position the crankshaft into the cylinder block.

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

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

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

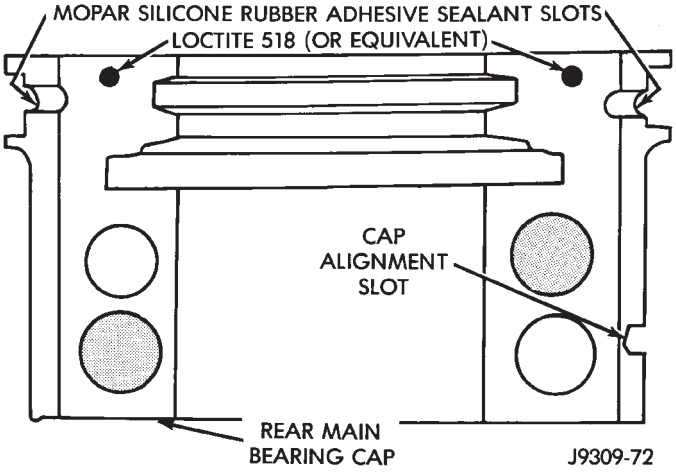

Fig. 45 Sealant Application to Bearing Cap

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(10) Install oil pump.

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

(12) Install new front crankshaft oil seal.

(13) Immediately install the oil pan.

UPPER SEAL —CRANKSHAFT INSTALLED

REMOVAL

(1) Remove the oil pan.

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

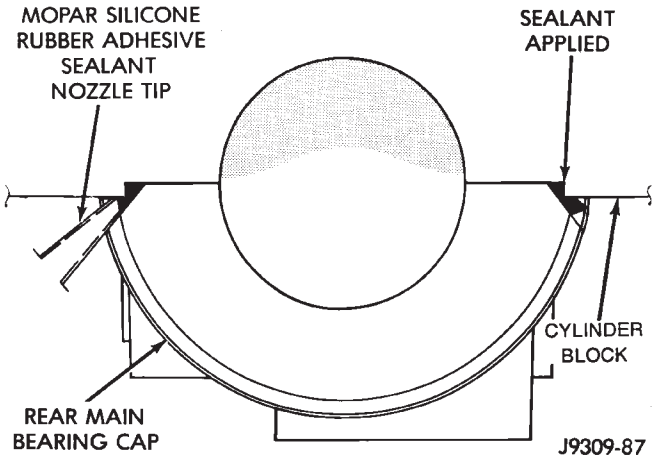

Fig. 46 Apply Sealant to Bearing Cap to BlockJoint

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

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

INSTALLATION

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

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

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

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

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

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

(9) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 46). Apply

REMOVAL AND INSTALLATION (Continued)

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

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

(1) Remove the oil pan.

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

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

INSTALLATION

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

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

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

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

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

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

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

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

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

REMOVAL

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

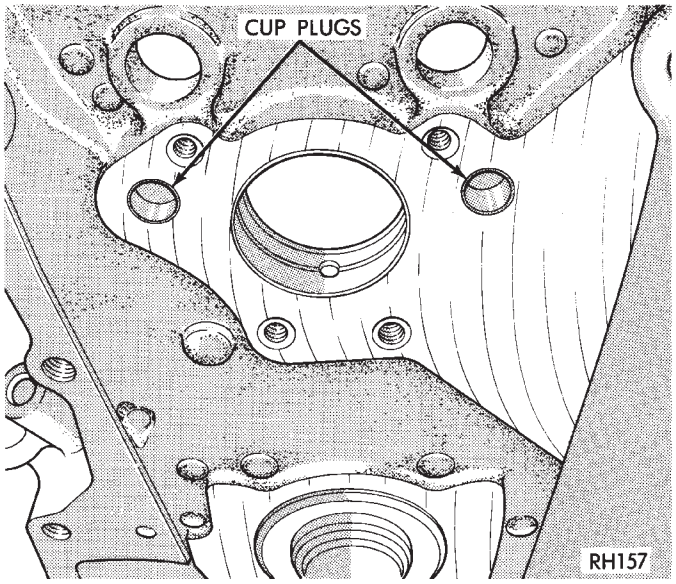

Fig. 47 Location of Cup Plugs in Oil Galleries

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

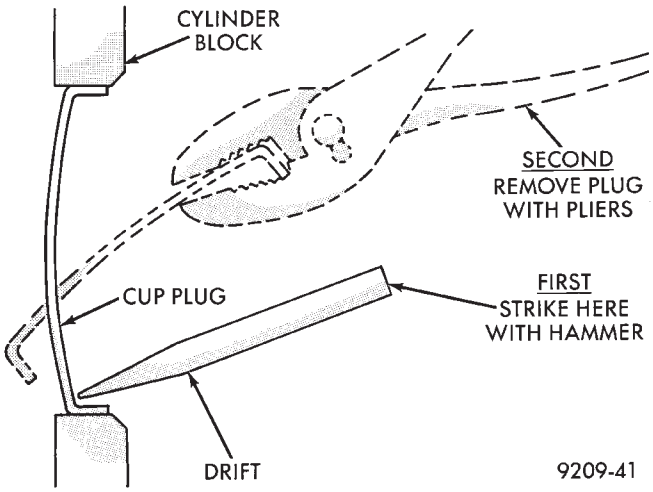

Fig. 48 Core Hole Plug Removal

INSTALLATION

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

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

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

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

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

REMOVAL AND INSTALLATION (Continued)

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

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

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

DISASSEMBLE

(1) Pry out plunger retainer spring clip (Fig. 49).

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

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

ASSEMBLE

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

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

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

(4) Assemble tappets (Fig. 49).

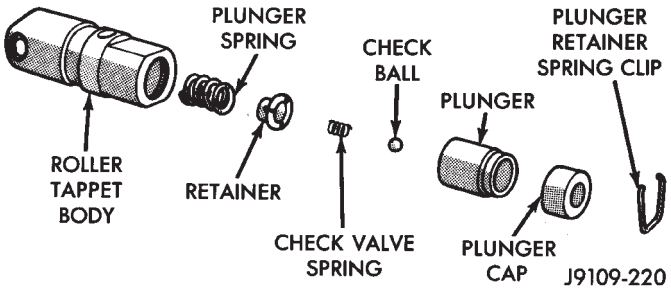

Fig. 49 Hydraulic Tappet Assembly

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

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

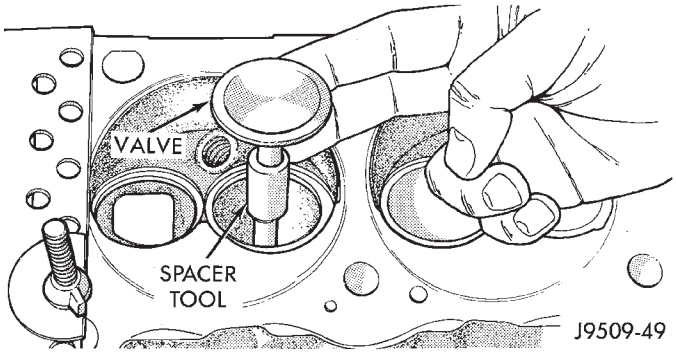

Fig. 50 Positioning Valve with Tool C-3973

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

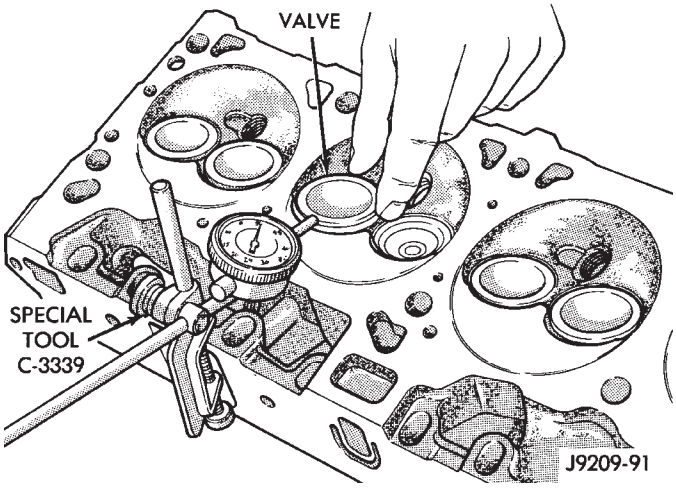

Fig. 51 Measuring Valve Guide Wear

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

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

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

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

DISASSEMBLY AND ASSEMBLY (Continued)

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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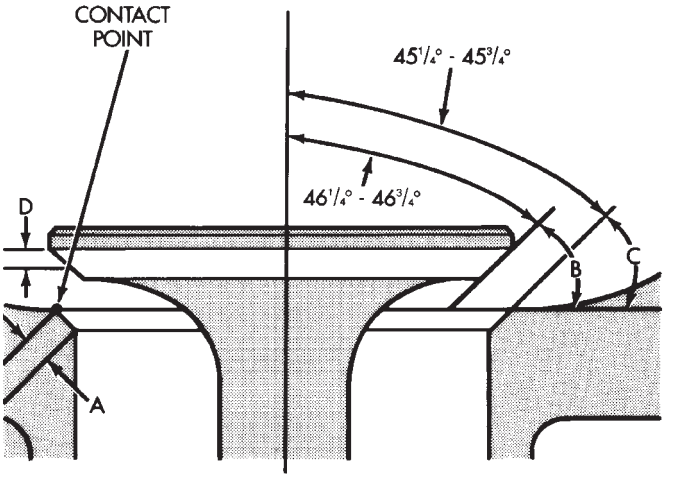
Fig. 52 Reamer Sizes



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 1/4° – 43 3/4°
C - SEAT ANGLE (INTAKE & EXHAUST) 44 1/4° – 44 3/4°
D - CONTACT SURFACE

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Fig. 53 Valve Face and Seat Angles

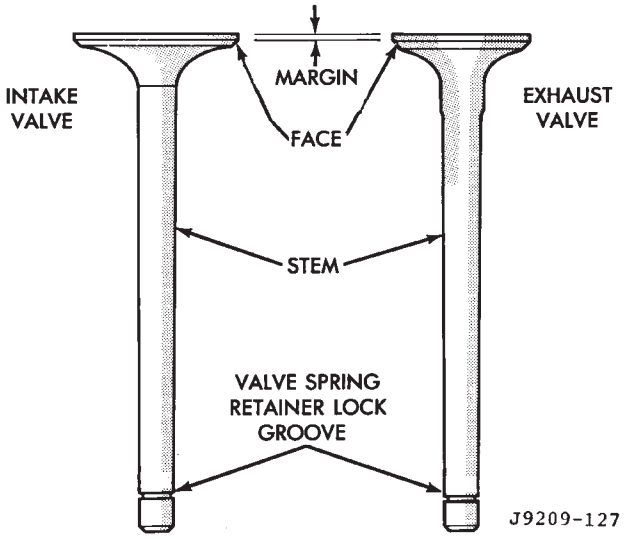


Fig. 54 Intake and Exhaust Valves

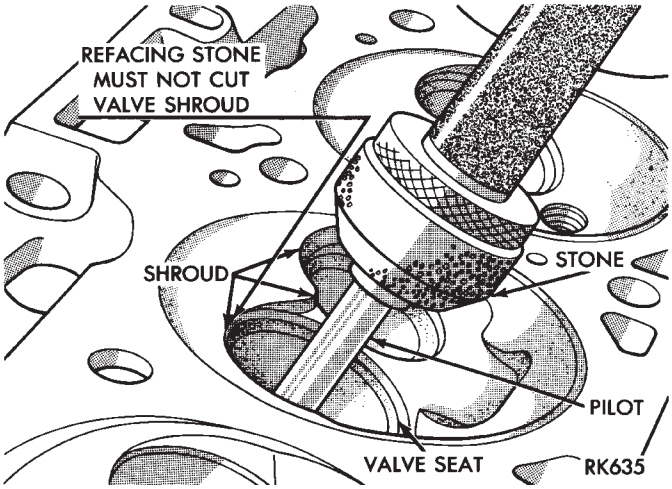


Fig. 55 Refacing Valve Seats

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.

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

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

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Universals Valve Spring Tester Tool until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front (Fig. 56). Place spring over stud on the table and lift compress-

DISASSEMBLY AND ASSEMBLY (Continued)

ing 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.

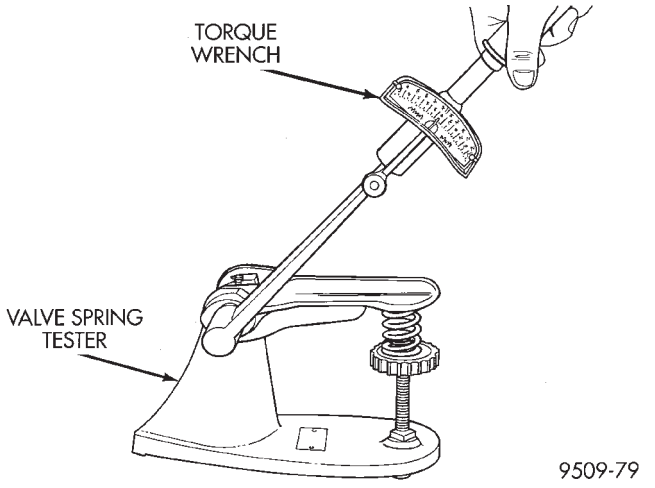


Fig. 56 Testing Valve Spring for CompressedLength

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).

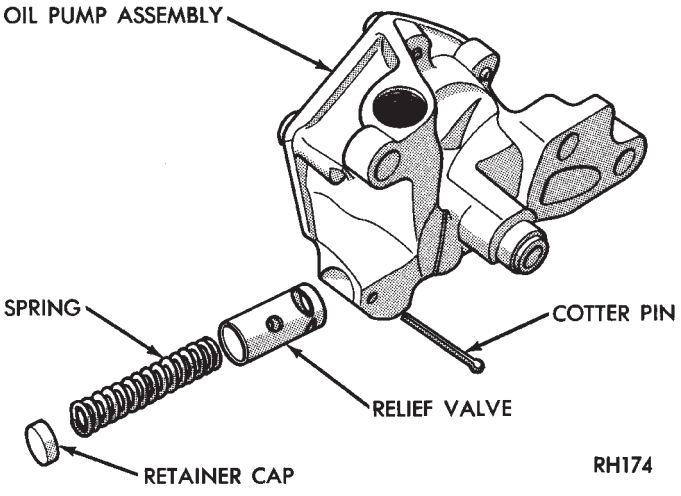


Fig. 57 Oil Pressure Relief Valve

(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.

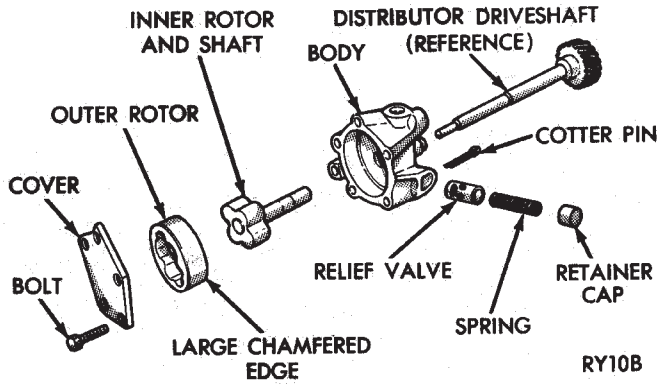


Fig. 58 Oil Pump

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.

CYLINDER BLOCK

DISASSEMBLE

Engine assembly removed from vehicle:

(1) Remove the cylinder head.

(2) Remove the oil pan.

(3) Remove the piston and connecting rod assemblies.

ASSEMBLE

(1) Install the piston and connecting rod assembly.

(2) Install the oil pan.

(3) Install the cylinder head.

(4) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEADS

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

CLEANING AND INSPECTION (Continued)

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.

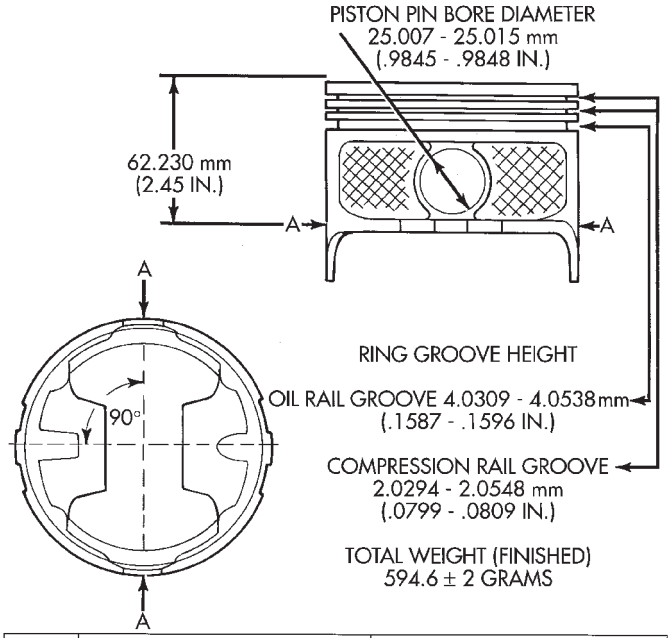
PISTON AND CONNECTING ROD ASSEMBLY

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. 59).



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

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Fig. 59 Piston Measurements

CRANKSHAFT JOURNALS

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

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

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

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

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

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

INSPECTION

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

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

OIL PUMP

INSPECTION

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

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

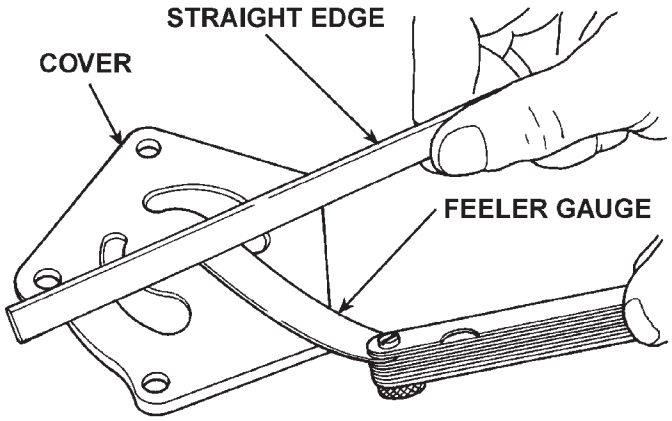

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Fig. 60 Checking Oil Pump Cover Flatness

CLEANING AND INSPECTION (Continued)

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).

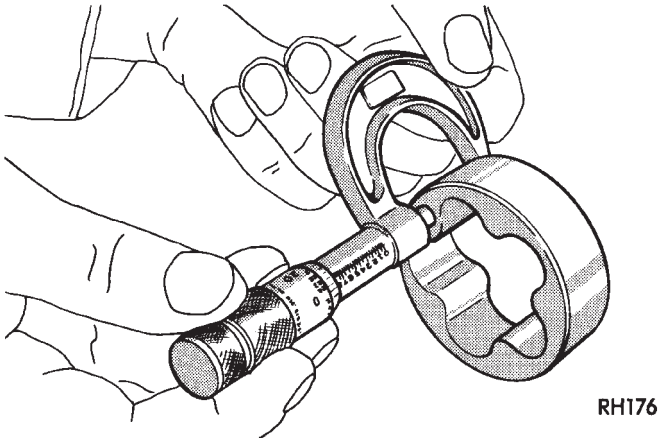

Fig. 61 Measuring Outer Rotor Thickness

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

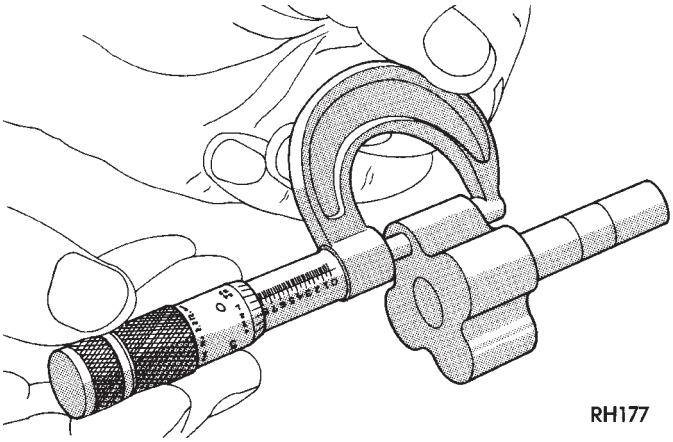

Fig. 62 Measuring Inner Rotor Thickness

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

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

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.

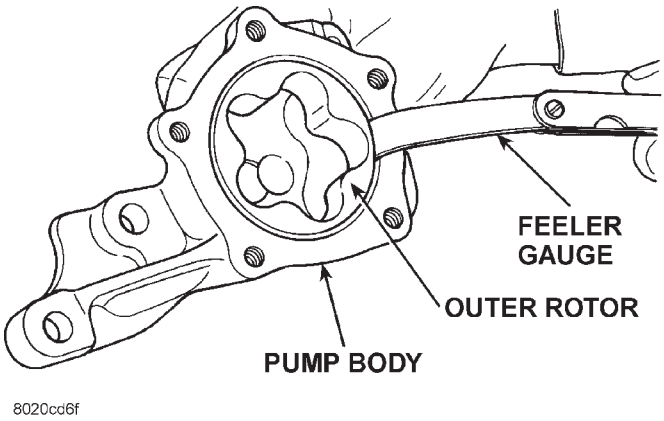

Fig. 63 Measuring Outer Rotor Clearance inHousing

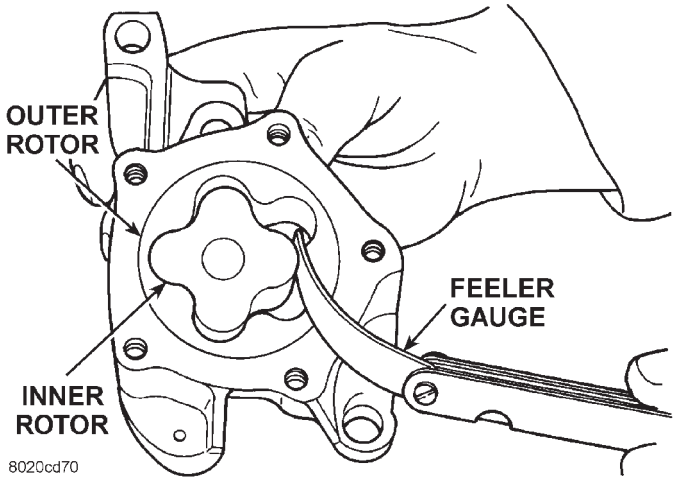

Fig. 64 Measuring Clearance Between Rotors

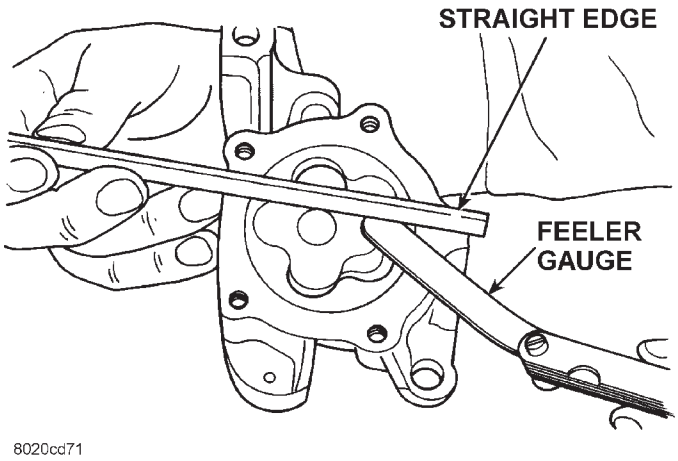

Fig. 65 Measuring Clearance Over Rotors

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

CLEANING AND INSPECTION (Continued)

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.

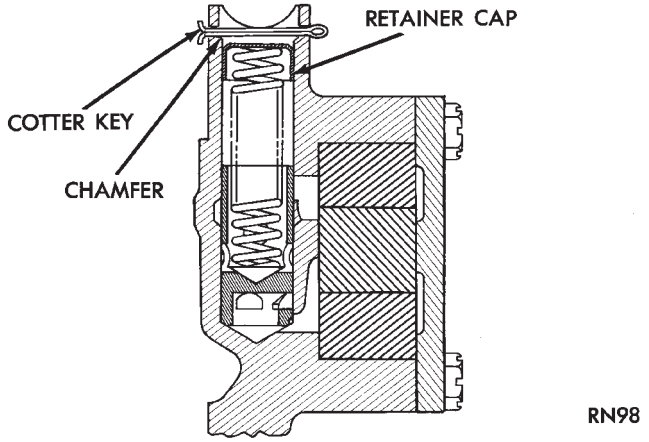

Fig. 66 Proper Installation of Retainer Cap

CYLINDER BLOCK

CLEANING

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

INSPECTION

Examine block for cracks or fractures.

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

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

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

OIL LINE PLUG

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

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

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 67). If plug is too high, use a suitable flat dowel to position properly.

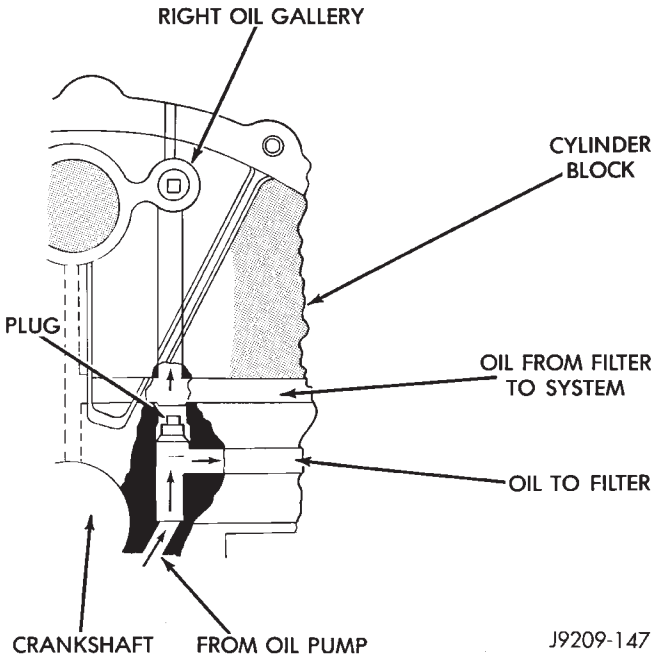

Fig. 67 Oil Line Plug

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

SPECIFICATIONS

5.2L ENGINE

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)
Diametrical Clerance . . . . . 0.0254 — 0.0762 mm (0.001 — 0.003 in)
Max. Allowable . . . . . 0.127 mm (0.005 in)
End Play . . . . . 0.051 — 0.254 mm (0.002 — 0.010 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)

Connecting Rods
Bearing Clearance . . . . . 0.013 — 0.056 mm (0.0005 — 0.0022 in)
Max. Allowable . . . . . 0.08 mm (0.003 in)
Piston Pin Bore Diameter . . . . 24.966 — 24.978 mm (0.9829 — 0.9834 in)
Side Clearance (Two Rods) . . . . . 0.152 — 0.356 mm (0.006 — 0.014 in)
Total Weight (Less Bearing) . . . . . 726 grams (25.61 oz)

Crankshaft
Connect 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)
Diametrical Clearance
No. 1 . . . . . 0.013 — 0.038 mm (0.0005 — 0.0015 in)
Nos. 2, 3, 4 and 5 . . . . . 0.013 — 0.051 mm (0.005 — 0.0020 in)
Max. Allowable (Nos. 2, 3, 4 & 5) . . . . . 0.064 mm (0.0025 in)
End Play . . . . . 0.051 — 0.178 mm (0.002 — 0.007 in)
Max. Allowable . . . . . 0.254 mm (0.010 in)
Main Bearing Journals
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)

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 (Max.) . . . . . 1.016 mm (0.040 in)
Distributor Lower Drive Shaft Bushing
(Press Fit in Block) . . . . . 0.0127 — 0.3556 mm (0.0005 — 0.0140 in)
Shaft-to-Bushing Clearance . . 0.0178 — 0.0686 mm (0.0007 — 0.0027 in)
Tappet Bore Diameter . . . . . 22.99 — 23.01 mm (0.9051 — 0.9059 in)

Cylinder Head
Compression Pressure . . . . . 689 kPa (100 psi)
Gasket Thickness (Compressed) . . . . . 1.2065 mm (0.0475 in)
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)

Hydraulic Tappets
Body Diameter . . . . . 22.949 — 22.962 mm (0.9035 — 0.9040 in)
Clearance in Block . . . . . 0.0279 — 0.0610 mm (0.0011 — 0.0024 in)
Dry Lash . . . . . 1.524 — 5.334 mm (0.060 — 0.210 in)
Push Rod Length . . . . . 175.64 — 176.15 mm (6.915 — 6.935 in)

Oil Pump
Clearance Over Rotors (Max.) . 0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.) . . . . 0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.) . 20.955 mm (0.825 in)
Outer Rotor
Clearance (Max.) . . . . . 0.3556 mm (0.014 in)
Diameter (Min.) . . . . . 62.7126 mm (2.469 in)
Thickness (Min.) . . . . . 20.955 mm (0.825 in)
Tip Clearance Between Rotors (Max.) . . . . . 0.2032 mm (0.008 in)

Oil Pressure
At Curb Idle Speed (Minimum)* . . . 41.4 kPa (6 psi)
At 3000 rpm . . . . . 207 – 552 kPa (30 – 80 psi)

SPECIFICATIONS (Continued)

Oil Pressure Switch
Actuating Pressure (Min.) . . . . . 34.5 — 48.3 kPa (5 — 7 psi)

*CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

Oil Filter
Bypass Valve Setting . . . . . 62 — 103 kPa (9 — 15 psi)

Pistons
Clearance at Top of Skirt . . . . 0.0127 — 0.0381 mm (0.0005 — 0.0015 in)
Land Clearance (Diametrical) . . . 0.635 — 1.016 mm (0.025 — 0.040 in)
Piston Length . . . . . 86.360 mm (3.40 in)
Piston Ring Groove Depth
Nos. 1 and 2 . . . . . 4.572 — 4.826 mm (0.180 — 0.190 in)
No. 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)
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 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) . . . . . 3.848 — 3.975 mm (0.1515 — 0.1565 in)

Valves
Face Angle . . . . . 43.25° — 43.75°
Head Diameter
Intake . . . . . 48.666 mm (1.916 in)
Exhaust . . . . . 41.250 mm (1.624 in)
Length (Overall)
Intake . . . . . 124.28 — 125.92 mm (4.893 — 4.918 in)
Exhaust . . . . . 124.64 — 125.27 mm (4.907 — 4.932 in)
Length (Overall)
Intake . . . . . 124.28 — 125.92 mm (4.893 — 4.918 in)
Exhaust . . . . . 124.64 — 125.27 mm (4.907 — 4.932 in)
Lift (Zero Lash) . . . . . 10.973 mm (0.432 in)
Stem Diameter . . . . . 7.899 — 7.925 mm (0.311 — 0.312 in)
Stem-to-Guide Clearance . . . . 0.0254 — 0.0762 mm (0.001 — 0.003 in)
Max Allowable (Rocking Method) . . . . . 0.4318 mm (0.017 in)
Guide Bore Diameter (Std) . . . . . 7.950 — 7.976 mm (0.313 — 0.314 in)

SPECIFICATIONS (Continued)

Valve Springs

Free Length (Approx.) . . . . . 49.962 mm (1.967 in)
Spring Tension (Valve Closed) . @ 41.66 mm = 378 N (@ 1.64 in = 85 lbs)
Spring Tension (Valve Open) . @ 30.89 mm = 890 N (@ 1.212 in = 200 lbs)
Number of Coils 6.8
Installed Height (Spring Seat o Retainer) . . . . . 41.66 mm (1.64 in)
Wire Diameter . . . . . 4.50 mm (0.177 in)

Valve Timing

Exhaust Valve . . . . . .
Closes (ATC) . . . . . 21°
Opens (BBC) . . . . . 60°
Duration . . . . . 264°
Intake Valve . . . . . .
Closes (ABC) . . . . . 61°
Opens (BTC) . . . . . 10°
Duration . . . . . 250°
Valve Overlap . . . . . 31°

OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

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

SPECIFICATIONS (Continued)

TORQUE

DESCRIPTION	TORQUE
Adjusting Strap Bolt	23 N·m (200 in. lbs.)
Bell Housing Bolts	41 N·m (30 ft. lbs.)
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.)
Cylinder Head Bolts	
1st Step	68 N·m (50 ft. lbs.)
2nd Step	143 N·m (105 ft. lbs.)
Cylinder Head Collar Studs	13 N·m (115 in. lbs.)
Cylinder Head Cover Bolts	11 N·m (95 in. lbs.)
Exhaust Manifold Bolts	27 N·m (20 ft. lbs.)
Exhaust Manifold Nuts	20 N·m (15 ft. lbs.)
Front Left Sill Bracket	
Top Bolts	65 N·m (48 ft. lbs.)
Side Nuts	95 N·m (70 ft. lbs.)
Side and Bottom Bolts	121 N·m (89 ft. lbs.)
Front Right Sill Bracket Bolts	65 N·m (48 ft. lbs.)
Front Left Through-Bolt Nuts	121 N·m (89 ft. lbs.)
Front Right Through-Bolt Nuts	65 N·m (48 ft. lbs.)
Front Support Insulator Bolts	88 N·m (65 ft. lbs.)
Generator Mounting Bolt	41 N·m (30 ft. lbs.)
Intake Manifold Bolts	Refer to Procedure in Service Manual
Oil Pan Bolts	24 N·m (215 in. lbs.)
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 Mount Bracket Through-Bolt Nut	65 N·m (48 ft. lbs.)
Rear Mount Bracket Assembly Bolts	75 N·m (55 ft. lbs.)
Rear Mount Clevis Bracket-to-Crossmember Stud-Nuts	41 N·m (30 ft. lbs.)
Rocker Arm Bolts	28 N·m (21 ft. lbs.)
Spark Plugs	41 N·m (30 ft. lbs.)
Starter Mounting Bolts	68 N·m (50 ft. lbs.)
Throttle Body Bolts	23 N·m (200 in. lbs.)
Torque Converter Drive Plate Bolts	31 N·m (270 in. lbs.)
Transmission Support Bracket Adaptor Bolts	60 N·m (44 ft. lbs.)
Transmission-to-Clutch Bolts	68 N·m (50 ft. lbs.)
Vibration Damper Retainer Bolt	183 N·m (135 ft. lbs.)
Water Pump-to-Chain Case Cover Bolt	41 N·m (30 ft. lbs.)

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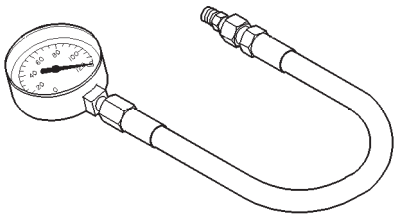
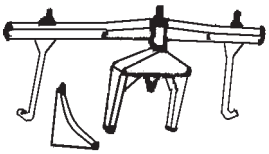
SPECIAL TOOLS

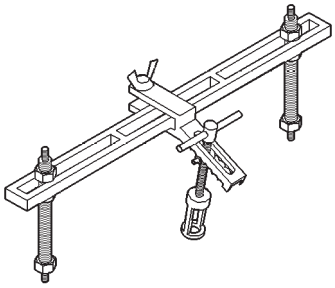
5.9L ENGINE



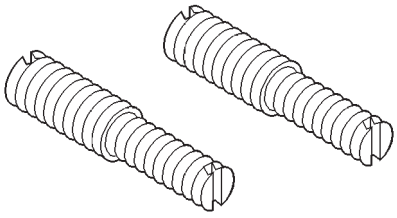
Oil Pressure Gauge C-3292



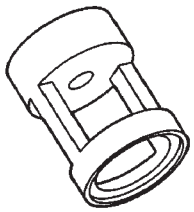
Engine Support Fixture C-3487–A



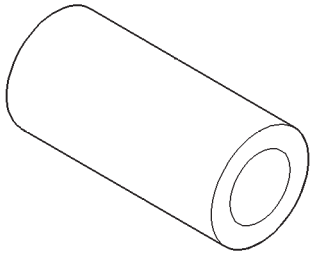
Valve Spring Compressor MD-998772–A



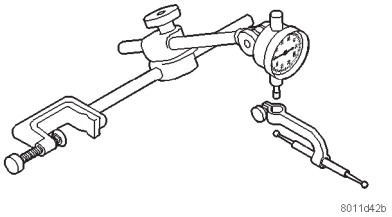
Adapter 6633



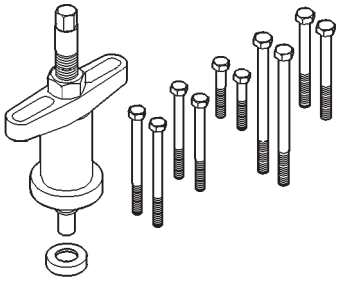
Adapter 6716A



Valve Guide Sleeve C-3973

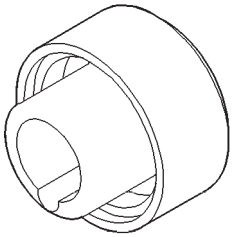


Dial Indicator C-3339

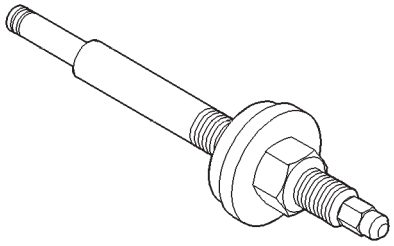


Puller C-3688

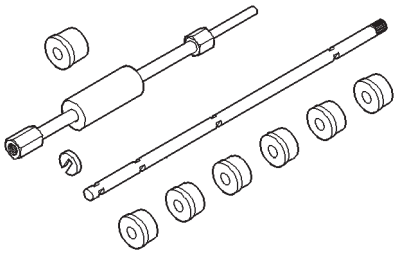
SPECIAL TOOLS (Continued)



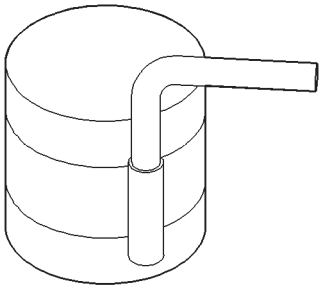
Front Oil Seal Installer 6635



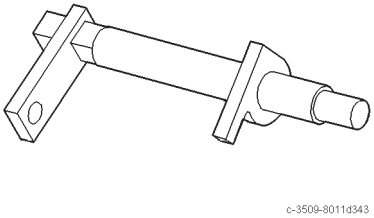
Distributor Bushing Driver/BurnisherC-3053



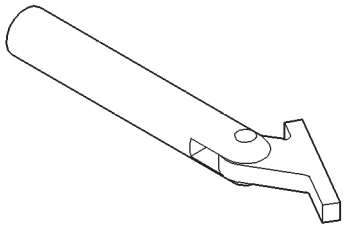
Cam Bearing Remover/Installer C-3132–A



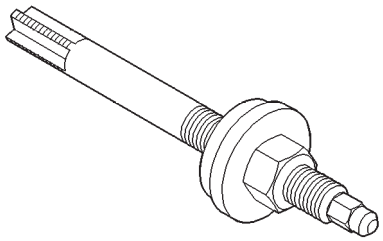
Piston Ring Compressor C-385



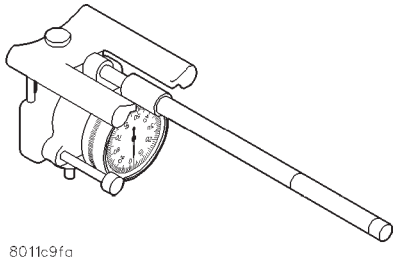
Camshaft Holder C-3509



Crankshaft Main Bearing Remover C-3059



Distributor Bushing Puller C-3052



Cylinder Bore Gauge C-119

5.9L ENGINE

INDEX

GENERAL INFORMATION

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 41.4 kPa (6 psi) at curb idle. The MAXIMUM 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 5.9 Liter (360 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets.

Engine Type . . . . . 90° V-8 OHV
Bore and Stroke . . 101.6 x 90.9 mm (4.00 x 3.58 in.)
Displacement . . . . . 5.9L (360 c.i.)
Compression Ratio 9.1:1
Torque . . . . . 448 N·m (330 ft. lbs.) @ 3,250 rpm

DESCRIPTION AND OPERATION (Continued)

Engine Type . . . . . 90° V-8 OHV
Firing Order 1–8–4–3–6–5–7–2
Lubrication . . . Pressure Feed – Full Flow Filtration
Engine Oil Capacity . . . . . 4.7L (5.0 Qts.) w/filter
Cooling System . Liquid Cooled – Forced Circulation
Cooling Capacity . . . . . 14.7L (15.5 Qts.)
Cylinder Block . . . . . Cast Iron
Cylinder Head . . . . . Cast Iron
Combustion Chambers . . . . . Wedge-High Swirl Valve Shrouding
Camshaft . . . . . Nodular Cast Iron
Pistons . . . . . Cast Aluminum Alloy
Connecting Rods . . . . . Forged Steel

This engine is designed for unleaded fuel.

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

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

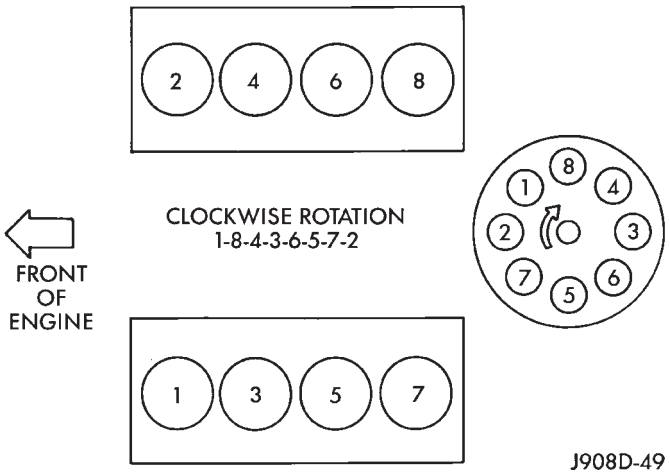


Fig. 1 Firing Order

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

LUBRICATION SYSTEM

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

X M 5.9L T XXXX XXXXXXXX

X = Last Digit of Model Year
M = Plant - M Mound Road
S Saltillo
T Trenton
K Toluca
5.9L = Engine Displacement
T = Usage - T Truck
XXXX = Month/Day
XXXXXXXX = Serial Code - Last 8 Digits of VIN No.

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Fig. 2 Engine Identification Number

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)

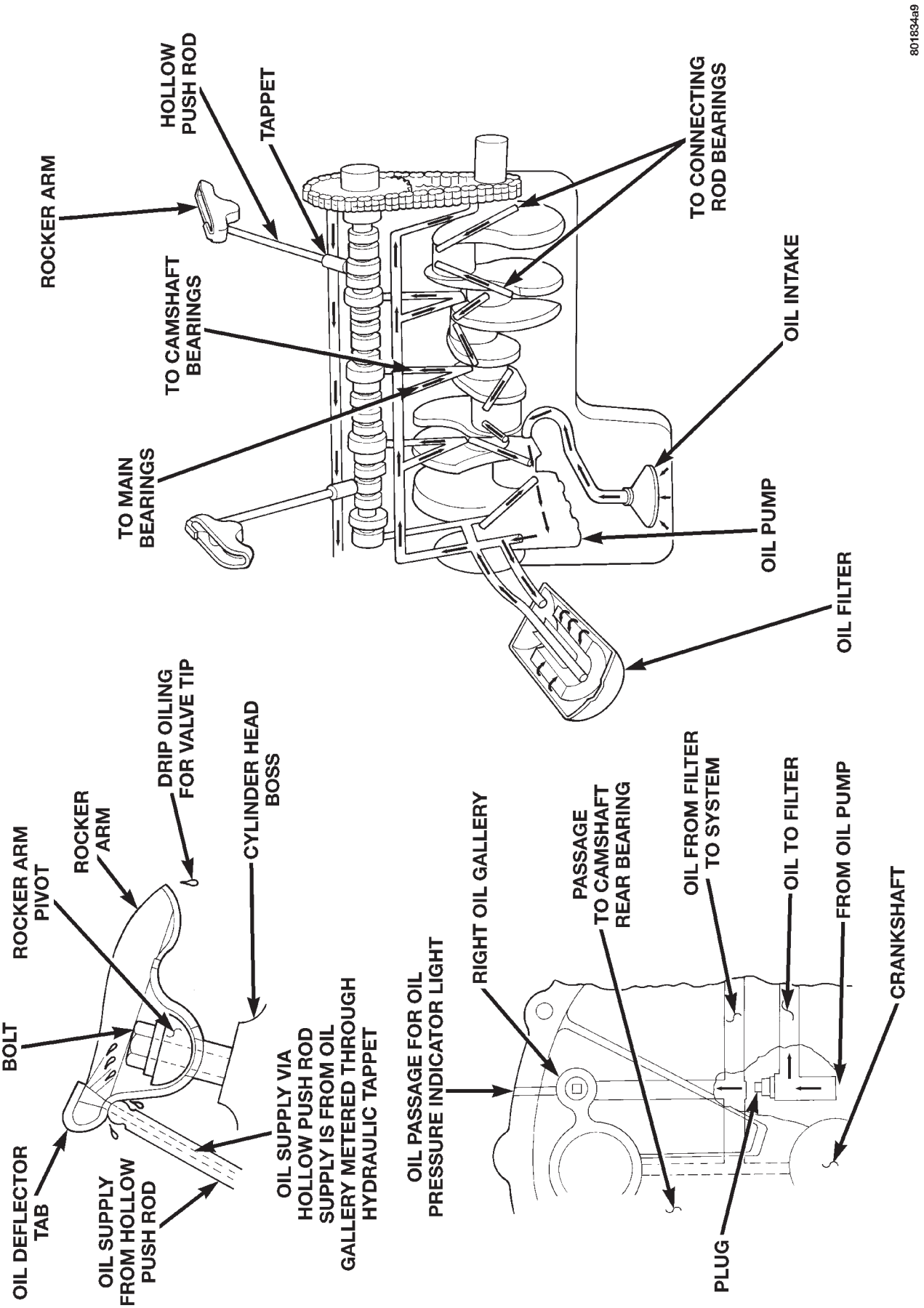


Fig. 3 Oil Lubrication System

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.

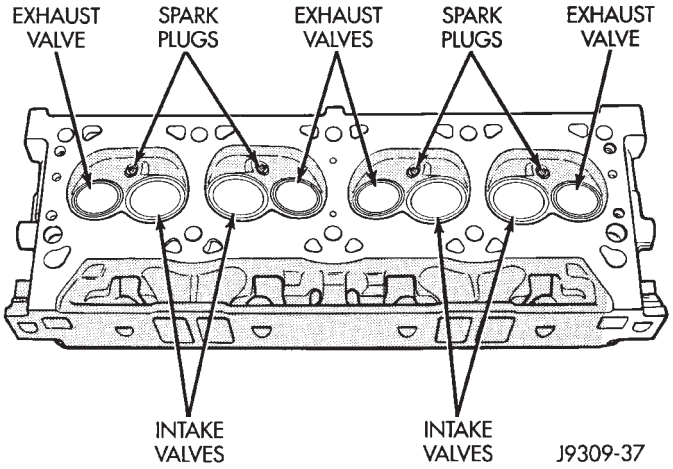


Fig. 4 Cylinder Head Assembly

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).

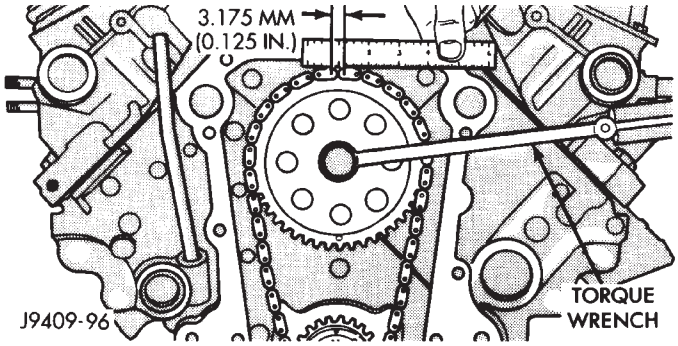


Fig. 5 Measuring Timing Chain Wear and Stretch

(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).

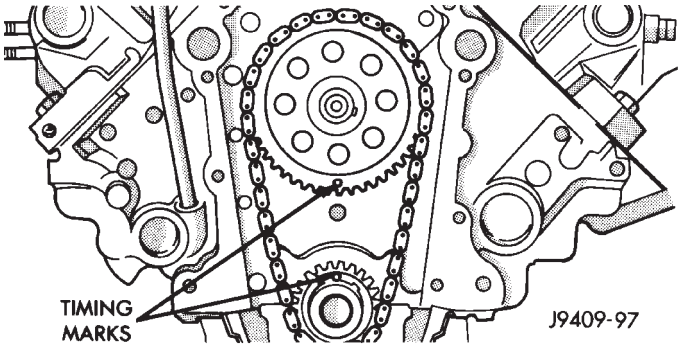


Fig. 6 Alignment of Timing Marks

(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).

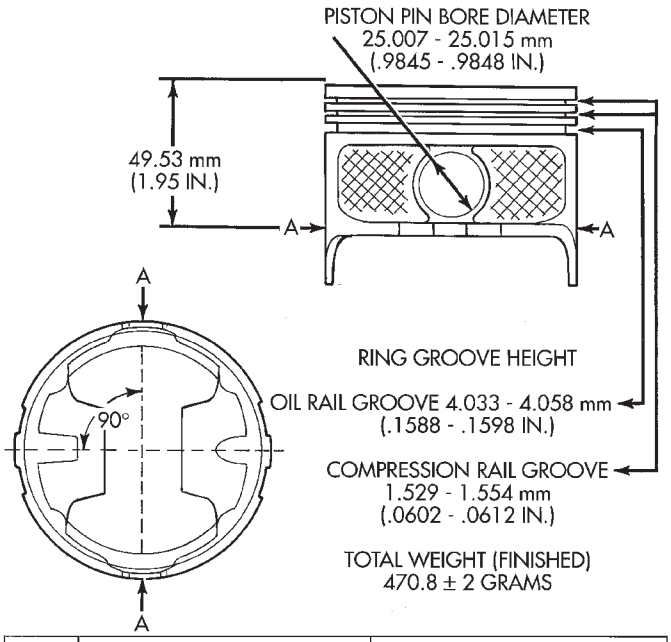
Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 7).

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



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

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.

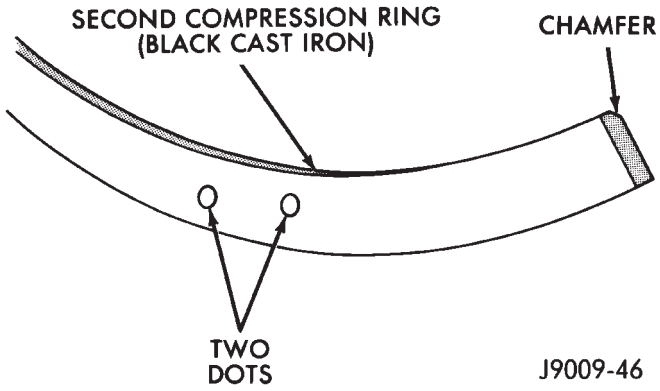


Fig. 8 Second Compression Ring Identification(Typical)

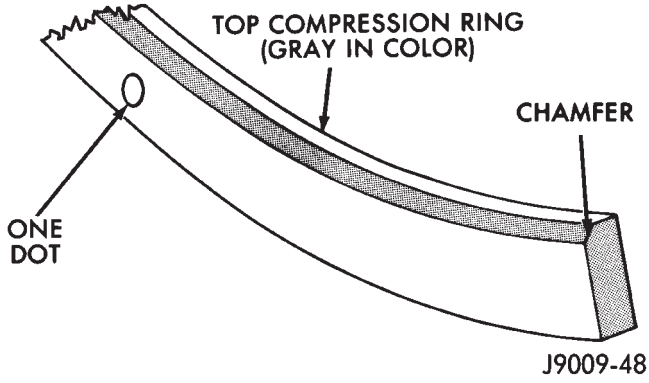


Fig. 9 Top Compression Ring Identification(Typical)

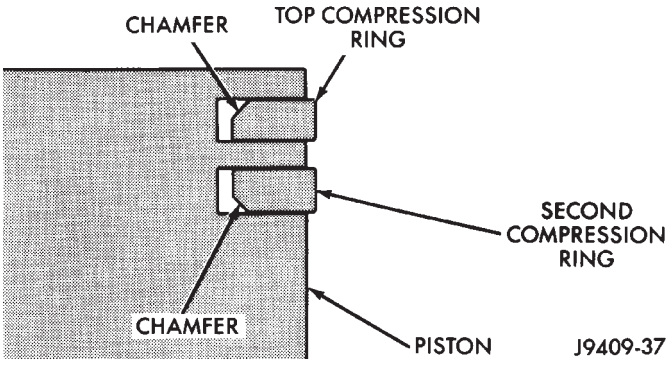


Fig. 10 Compression Ring Chamfer Location(Typical)

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.

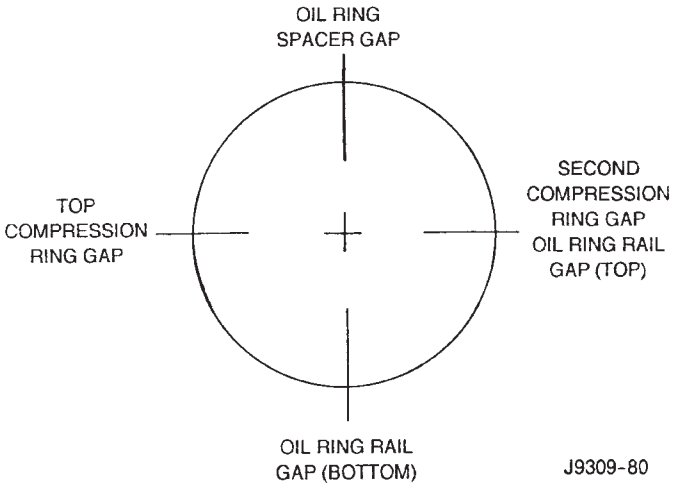


Fig. 11 Proper Ring Installation

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) 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.**

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)

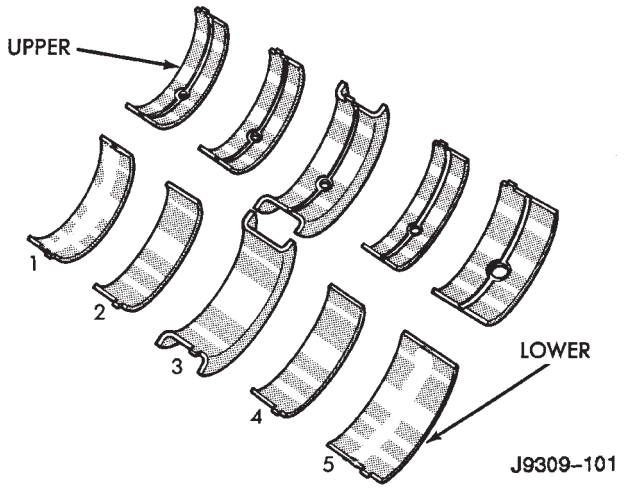


Fig. 12 Main Bearing Identification

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

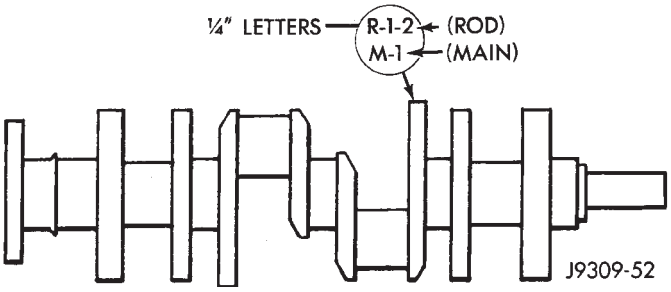


Fig. 13 Location of Crankshaft Identification

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 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.

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

REMOVAL

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

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

(3) Install engine lifting fixture.
(4) Raise vehicle on hoist.
(5) Remove the engine support insulator thru-bolts and nuts (Fig. 14) (Fig. 15).
(6) Raise engine SLIGHTLY. Remove the engine support insulator bolts. Remove the engine support insulator assembly.

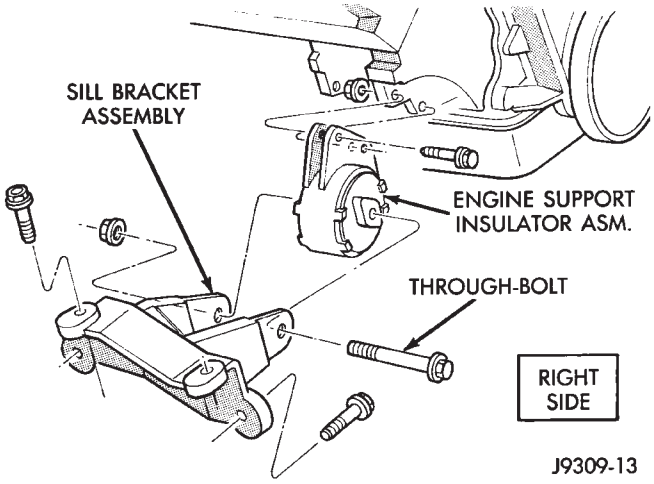


Fig. 14 Front Engine Mount—Right Side

(7) If required, remove the sill bracket assembly.

INSTALLATION

(1) If the sill bracket assembly was removed, install the bracket to the sill assembly.

REMOVAL AND INSTALLATION (Continued)

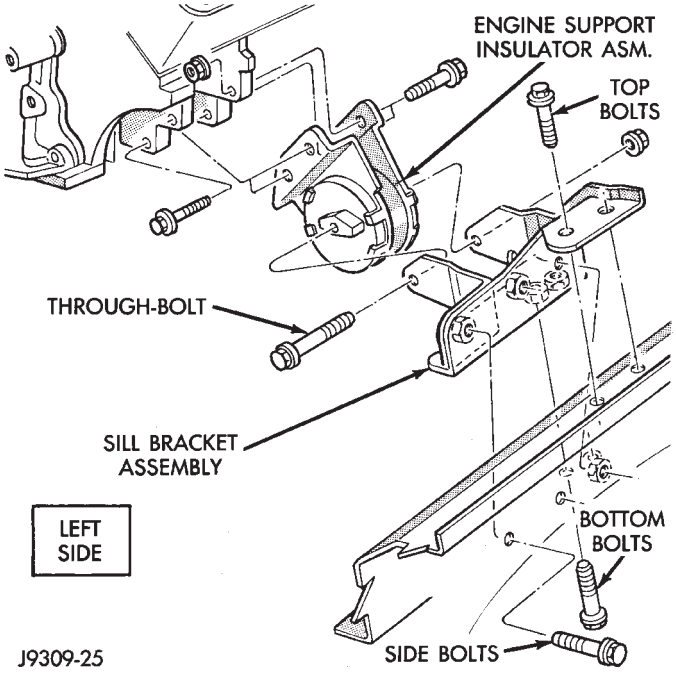


Fig. 15 Front Engine Mount—Left Side

(a) RIGHT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 14). Install and tighten the bolts to 65 N·m (48 ft. lbs.) torque.

(b) LEFT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 15). Install and tighten the 2 top bolts to 65 N·m (48 ft. lbs.) torque. Install and tighten the 2 side bolts to 95 N·m (70 ft. lbs.) torque. Install and tighten the 2 bottom bolts to 121 N·m (89 ft. lbs.) torque.

(2) With the engine raised SLIGHTLY, position engine support insulator assembly onto the engine block (Fig. 14) (Fig. 15). Install bolts and tighten to 88 N·m (65 ft. lbs.) torque.

(3) Lower engine with lifting fixture while aligning engine support insulator assembly into sill bracket assembly.

(4) Install the thru-bolt and nut. Tighten the RIGHT SIDE nut to 81 N·m (60 ft. lbs.) torque. Tighten the LEFT SIDE nut to 81 N·m (60 ft. lbs.) torque.

(5) Lower the vehicle.

(6) Remove lifting fixture.

(7) Connect the negative cable to the battery.

ENGINE MOUNTS—REAR

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle and support the transmission.

(3) Remove the bolts holding the mount assy. to the crossmember.

(4) Raise the transmission and engine SLIGHTLY.

(5) Remove engine mount bracket thru-bolt and nut (Fig. 16).

(6) Remove the rear mount assy.

(7) If necessary, remove the bolts holding the rear mount bracket to the transmission. Remove the bracket from the exhaust pipe hanger. Remove the bracket.

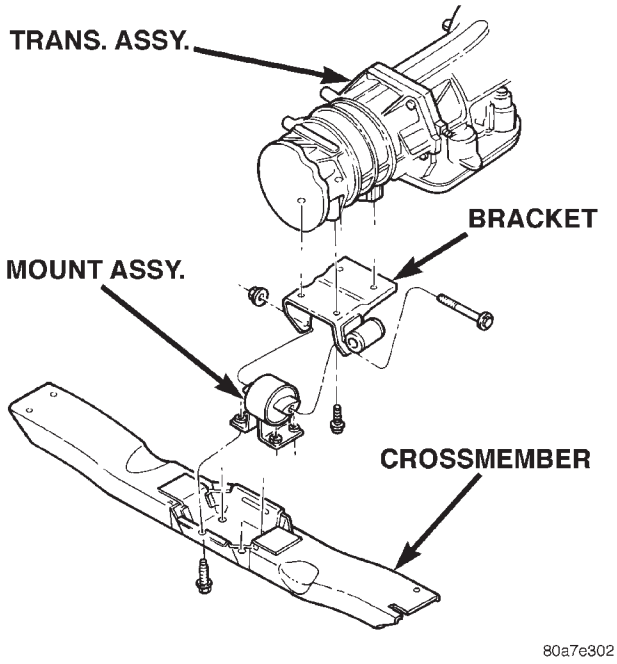


Fig. 16 Engine Rear Support Assembly

INSTALLATION

(1) Position the rear mount bracket onto the exhaust hanger (if previously removed). Position the rear mount bracket assembly onto the transmission and install the bolts. Tighten the bolts to 46 N·m (34 ft. lbs.).

(2) Position the mount into the mount bracket and install the thru-bolt and nut. DO NOT tighten the bolt at this time.

(3) Install the engine mount bracket assembly to the adaptor. Install the bolts and tighten to 75 N·m (55 ft. lbs.) torque.

(4) Lower the transmission until the mount fastening studs are in position in the crossmember.

(5) Remove the transmission support.

(6) Install the mount fastening nuts and tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(7) Tighten the thru-bolt nut to 65 N·m (48 ft. lbs.) torque.

(8) Lower the vehicle.

(9) Connect the negative cable to the battery.

REMOVAL AND INSTALLATION (Continued)

ENGINE ASSEMBLY

REMOVAL

(1) Scribe hood hinge outlines on hood and remove the hood.
(2) Remove the battery.
(3) Drain cooling system.
(4) Remove the air cleaner and tube.
(5) Set fan shroud aside.
(6) Remove radiator and heater hoses. Remove the radiator (refer to Group 7, Cooling System).
(7) Remove the vacuum lines.
(8) Remove the distributor cap and wiring.
(9) Disconnect the accelerator linkage.
(10) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System).
(11) Remove throttle body.
(12) Remove the starter wires.
(13) Remove the oil pressure wire.
(14) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
(15) Remove air conditioning hoses.
(16) Disconnect the power steering hoses, if equipped.
(17) Remove starter motor (refer to Group 8B, Battery/Starter Service).
(18) Remove the generator (refer to Group 8C, Generator Service).
(19) Raise and support the vehicle on a hoist.
(20) Disconnect exhaust pipe at manifold.
(21) Support automatic transmission with a transmission stand. This will assure that the torque converter will remain in proper position in the transmission housing.
(22) Remove bell housing bolts and inspection plate. Attach C-clamp on front bottom of transmission torque converter housing to prevent torque converter from coming out.
(23) Remove torque converter drive plate bolts from torque converter drive plate. Mark converter and drive plate to aid in assembly.
(24) Disconnect the engine from the torque converter drive plate.

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

(25) Install an engine lifting fixture.
(26) Remove the engine front mount thru-bolts.
(27) Lower the vehicle.
(28) Remove engine from engine compartment.
(29) Install on engine repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment.
(2) Install engine support fixture.
(3) Raise and support the vehicle on a hoist.
(4) Position the torque converter and drive plate. Install torque converter drive plate bolts. Tighten the bolts to 31 N·m (270 in. lbs.) torque.
(5) Install the engine front mount thru-bolts.
(6) Install bell housing bolts. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.
(7) Remove C-clamp and install inspection plate.
(8) Remove stand from transmission.
(9) Install exhaust pipe to manifold.
(10) Lower the vehicle.
(11) Remove engine lifting fixture.
(12) Install the generator (refer to Group 8C, Generator Service).
(13) Install starter motor (refer to Group 8B, Battery/Starter Service).
(14) Install power steering hoses, if equipped.
(15) Install air conditioning hoses.
(16) Charge the air conditioner, if equipped (refer to Group 24, Heater and Air Conditioning for service procedures).
(17) Using a new gasket, install throttle body. Tighten the throttle body bolts to 23 N·m (200 in. lbs.) torque.
(18) Connect the accelerator linkage.
(19) Connect the starter wires.
(20) Connect the oil pressure wire.
(21) Install the distributor cap and wiring.
(22) Install vacuum lines.
(23) Install radiator, radiator hoses and heater hoses (refer to Group 7, Cooling System).
(24) Install fan shroud in position.
(25) Install the battery
(26) Fill cooling system (refer to Group 7, Cooling System for the proper procedure).
(27) Install the air cleaner.
(28) Warm engine and adjust.
(29) Install hood and line up.
(30) Road test vehicle.

CYLINDER HEAD COVER

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

REMOVAL

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

INSTALLATION

(1) Clean cylinder head cover gasket surface.
(2) Clean head rail, if necessary.

REMOVAL AND INSTALLATION (Continued)

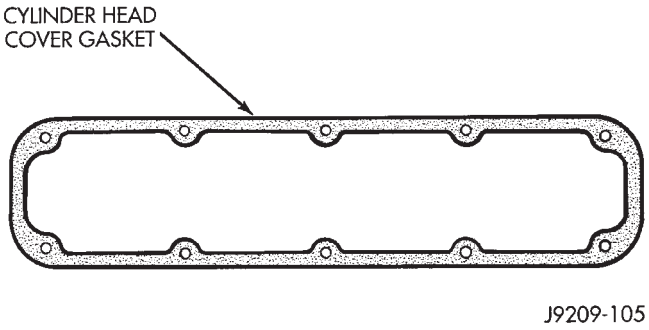


Fig. 17 Cylinder Head Cover Gasket

(3) Inspect cover for distortion and straighten, if necessary.

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

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

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

(7) Connect the negative cable to the battery.

ROCKER ARMS AND PUSH RODS

REMOVAL

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

(2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and pivots (Fig. 18). Place them on a bench in the same order as removed.

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

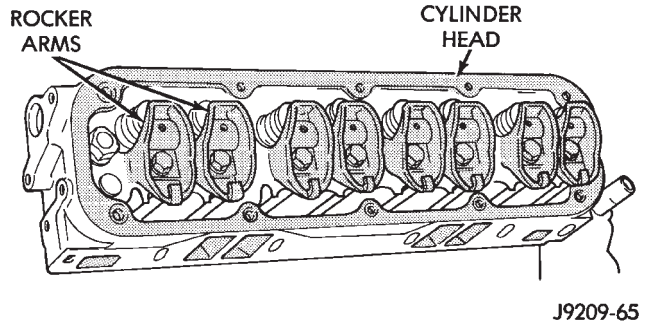


Fig. 18 Rocker Arms

INSTALLATION

(1) Rotate the crankshaft until the “V8” mark lines up with the TDC mark on the timing chain case cover. This mark is located 147° ATDC from the No.1 firing position.

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

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

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

(4) Install cylinder head cover.

(5) Connect spark plug wires.

VALVE SPRING AND STEM SEAL REPLACEMENT-IN VEHICLE

(1) 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 with adaptor 6633, compress valve spring and remove retainer valve locks and valve spring.

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

(10) 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.

(11) 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.

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

(13) Install rocker arms.

(14) Install covers and coil wire to distributor.

(15) Install air cleaner.

(16) Road test vehicle.

CYLINDER HEAD

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

(6) Remove the air cleaner.

REMOVAL AND INSTALLATION (Continued)

(7) Perform the Fuel System Pressure Release procedure (refer to Group 14, Fuel System). Disconnect the fuel lines.

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

(9) Remove the return spring.

(10) Remove distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect heat indicator sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Remove cylinder head covers and gaskets.

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

(16) Remove exhaust manifolds.

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

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

(19) Remove spark plugs.

INSTALLATION

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

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

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

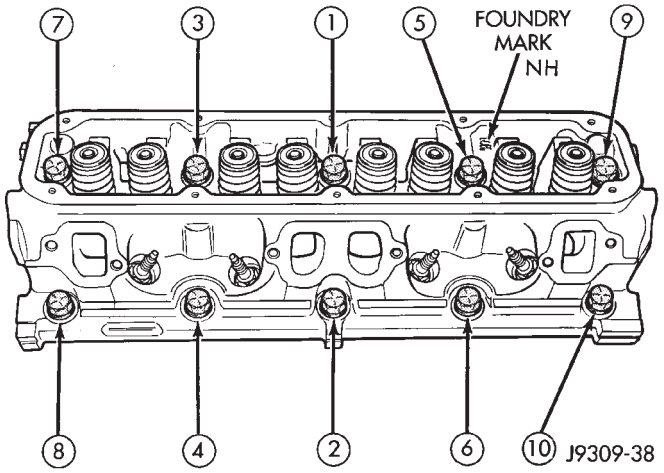


Fig. 19 Cylinder Head Bolt Tightening Sequence

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

(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) Hook up the return spring.

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

(14) Install the fuel lines.

(15) 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.

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

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

(18) Install closed crankcase ventilation system.

(19) Connect the evaporation control system.

(20) Install the air cleaner.

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

(22) Connect the negative cable to the battery.

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) 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.

REMOVAL AND INSTALLATION (Continued)

(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, 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. 20).

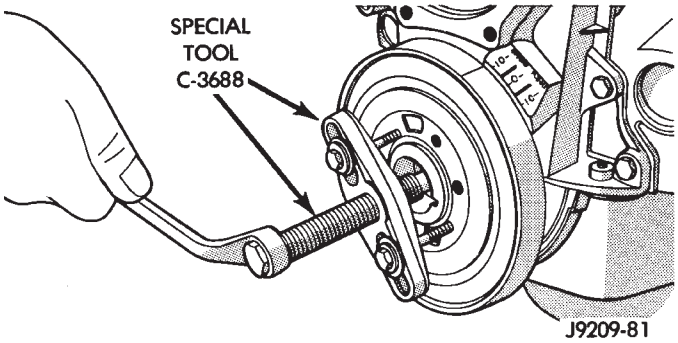


Fig. 20 Vibration Damper Assembly

(8) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

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

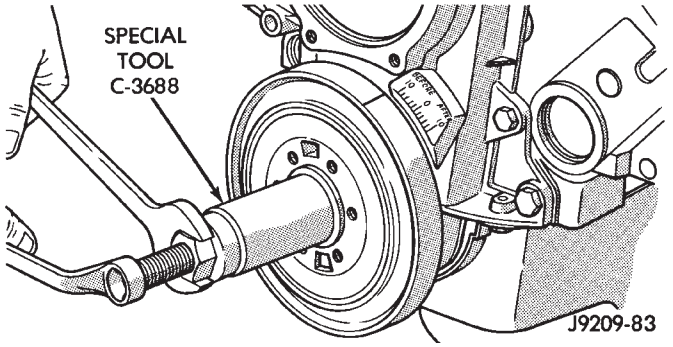


Fig. 21 Installing Vibration Damper

(3) Install the crankshaft bolt and washer. Tighten the bolt to 183 N·m (135 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(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 negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System).

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

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

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

(6) Remove vibration damper.

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

(8) Remove the cover bolts.

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

(10) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal surface of cover (Fig. 22).

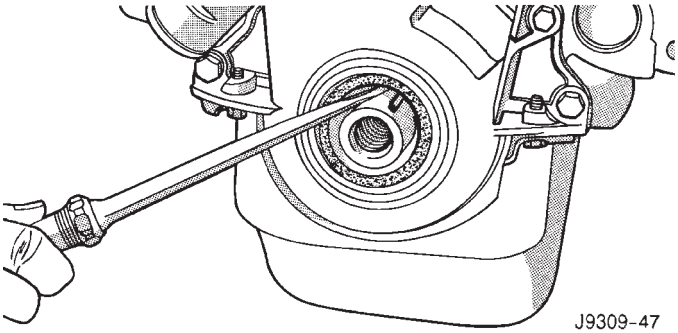


Fig. 22 Removal of Front Crankshaft Oil Seal

INSTALLATION

(1) 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.

(2) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 23). Seat the oil seal in the groove of the tool.

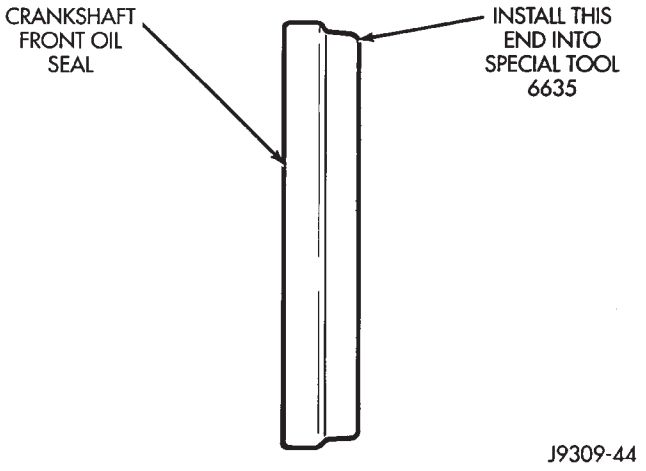


Fig. 23 Placing Oil Seal on InstallationTool 6635

(3) Position the seal and tool onto the crankshaft (Fig. 24).

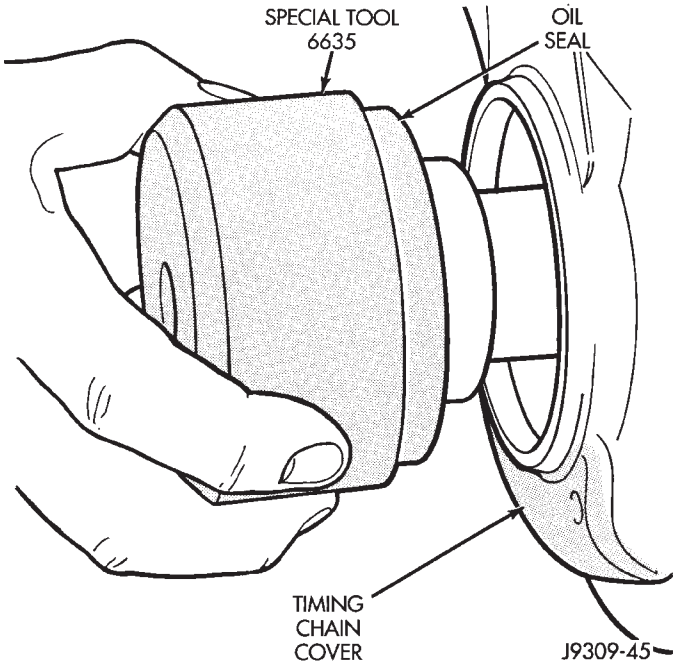


Fig. 24 Position Tool and Seal onto Crankshaft

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

(5) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 25).

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

(7) 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.

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

(9) Install vibration damper.

REMOVAL AND INSTALLATION (Continued)

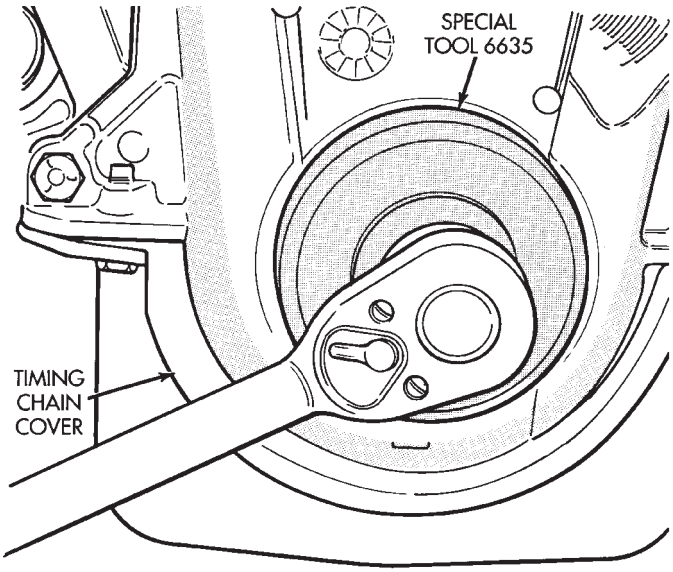


Fig. 25 Installing Oil Seal

(10) 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.

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

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

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

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

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

(16) Connect the negative cable to the battery.

TIMING CHAIN

REMOVAL

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

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

INSTALLATION

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

(2) Place timing chain around both sprockets.

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

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

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

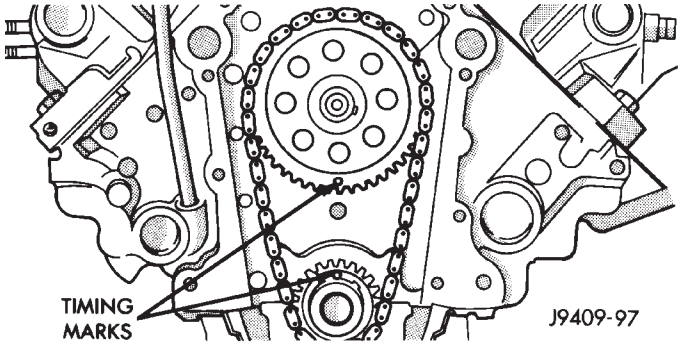


Fig. 26 Alignment of Timing Marks

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

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

CAMSHAFT

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

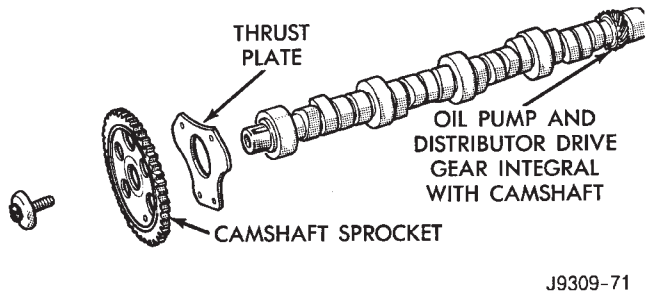


Fig. 27 Camshaft and Sprocket Assembly

REMOVAL

(1) Remove intake manifold.

(2) Remove cylinder head covers.

(3) Remove timing case cover and timing chain.

(4) Remove rocker arms.

(5) Remove push rods and tappets. Identify each part so it can be installed in its original location.

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

(7) Remove camshaft thrust plate, note location of oil tab (Fig. 28).

(8) Install a long bolt into front of camshaft to facilitate removal of the camshaft. Remove camshaft,

REMOVAL AND INSTALLATION (Continued)

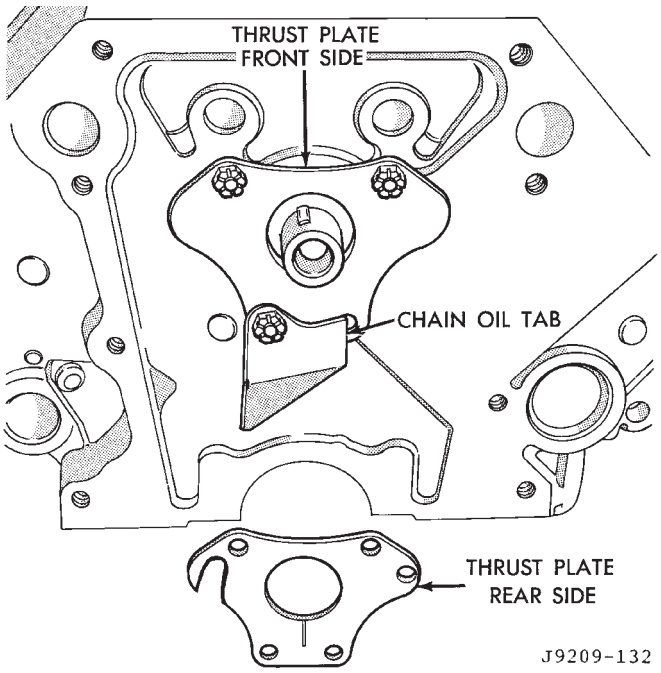


Fig. 28 Timing Chain Oil Tab Installation

being careful not to damage cam bearings with the cam lobes.

INSTALLATION

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

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

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

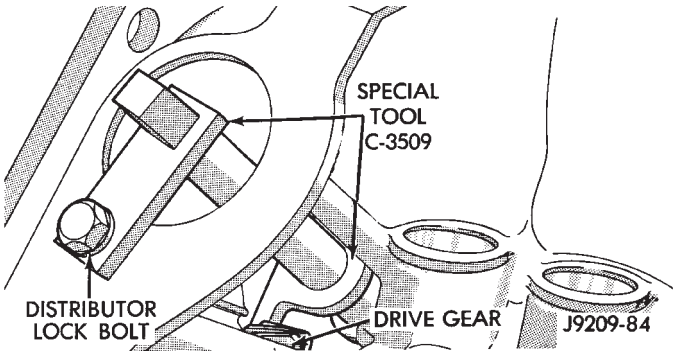


Fig. 29 Camshaft Holding Tool C-3509 (InstalledPosition)

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

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N·m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

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

(6) Place timing chain around both sprockets.

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

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

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 30).

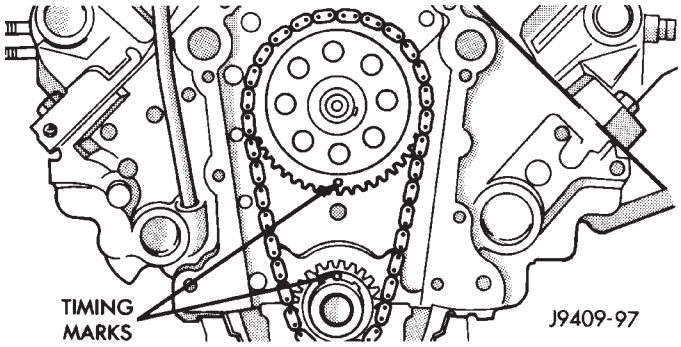


Fig. 30 Alignment of Timing Marks

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

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

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

CAMSHAFT BEARINGS

REMOVAL

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

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer

REMOVAL AND INSTALLATION (Continued)

Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 31).

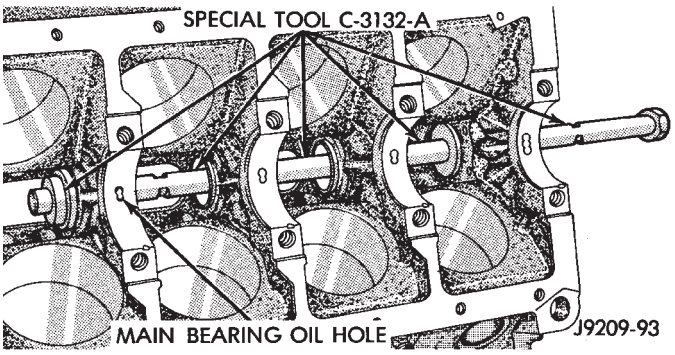


Fig. 31 Camshaft Bearings Removal/Installationwith Tool C-3132-A

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. 32).

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

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

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

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 32).

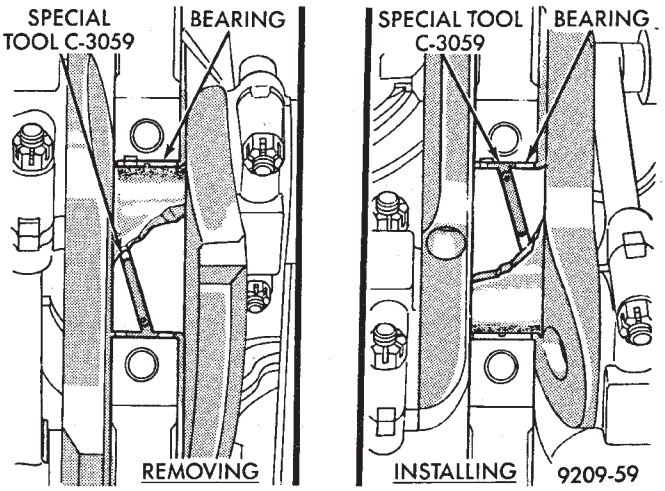


Fig. 32 Upper Main Bearing Removal and Installationwith Tool C-3059

(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.

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

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

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

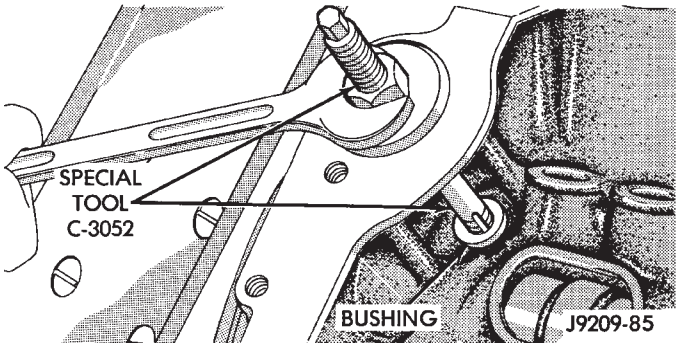


Fig. 33 Distributor Driveshaft Bushing Removal

INSTALLATION

(1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.

REMOVAL AND INSTALLATION (Continued)

(2) Drive bushing and tool into position, using a hammer (Fig. 34).

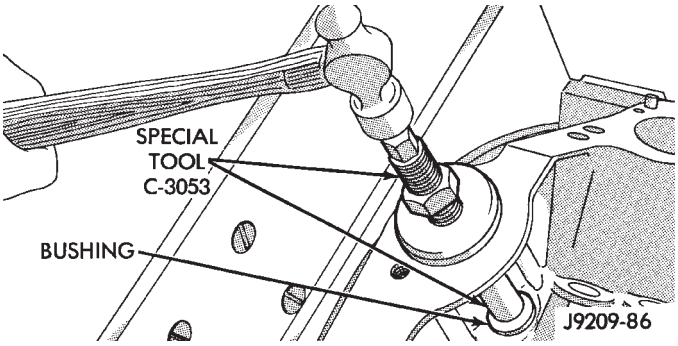


Fig. 34 Distributor Driveshaft Bushing Installation

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

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

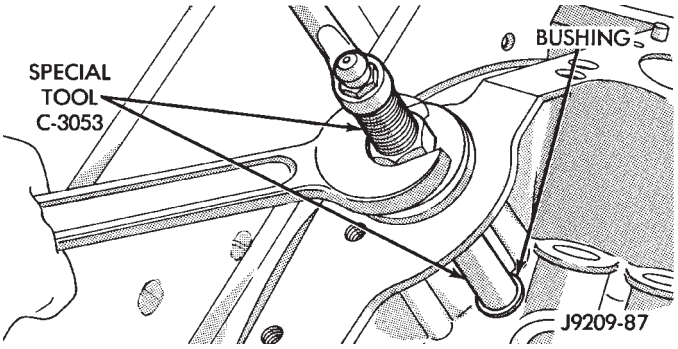


Fig. 35 Burnishing Distributor DriveshaftBushing

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

DISTRIBUTOR INSTALLATION

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

(1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.

(2) When in this position, the timing mark of vibration damper should be under “0” on the timing indicator.

(3) Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot on top of oil pump shaft should be aligned towards the left front intake manifold attaching bolt hole (Fig. 36).

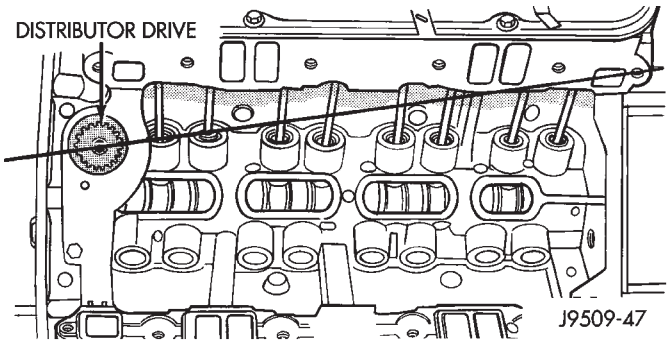


Fig. 36 Position of Oil Pump Shaft Slot

(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) Raise the vehicle.

(3) Remove the oil pan drain plug and drain the engine oil.

(4) Remove the oil filter.

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

(6) If equipped with an oil level sensor, disconnect the sensor.

(7) Position the cooler lines out of the way.

(8) Disconnect the oxygen sensor.

(9) Remove exhaust pipe.

(10) Remove the oil pan bolts. Carefully slide the oil pan and gasket to the rear. If equipped with an oil level sensor, take care not to damage the sensor.

INSTALLATION

(1) Fabricate 4 alignment dowels from 5/16 x 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 37).

(2) Install the dowels in the cylinder block (Fig. 38).

(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.

REMOVAL AND INSTALLATION (Continued)

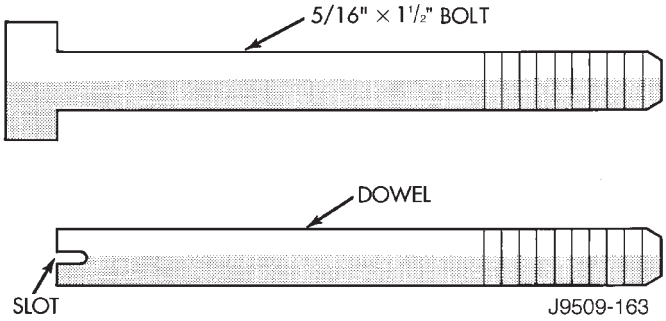


Fig. 37 Fabrication of Alignment Dowels

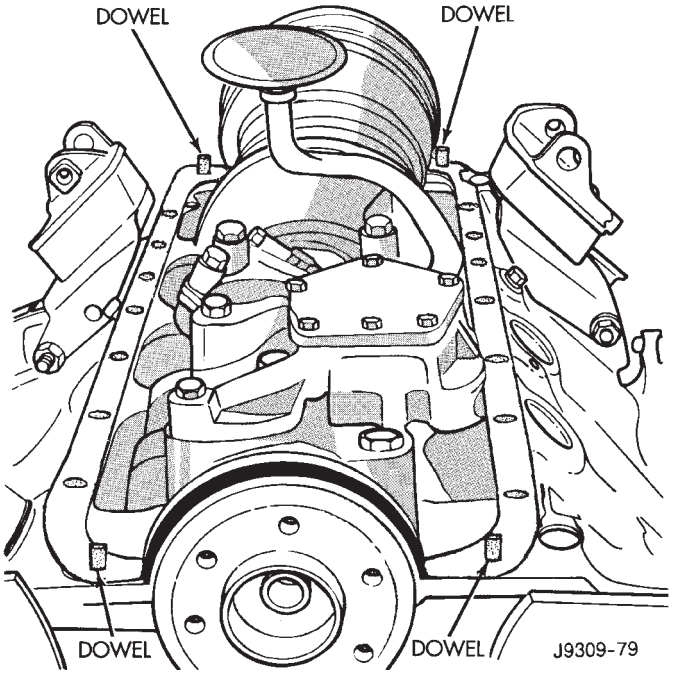


Fig. 38 Position of Dowels in Cylinder Block

(5) Position the oil pan over the dowels and onto the gasket. If equipped with an oil level sensor, take care not to damage the sensor.

(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 exhaust pipe.

(10) Connect the oxygen sensor.

(11) Install the oil filter.

(12) If equipped with an oil level sensor, connect the sensor.

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

(14) Move the cooler lines back into position.

(15) Lower vehicle.

(16) Connect the negative cable to the battery.

(17) Fill the oil pan with engine oil to the specified level.

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

(18) Start the engine and inspect for leaks.

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. 39).

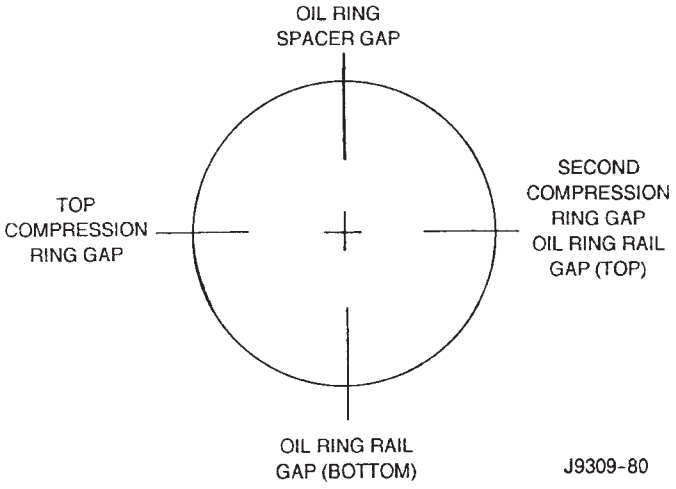


Fig. 39 Proper Ring Installation

REMOVAL AND INSTALLATION (Continued)

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

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

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

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

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

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

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

REMOVAL

(1) Remove the oil pan.

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

(3) Remove the vibration damper.

(4) Remove the timing chain cover.

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

(6) Lift the crankshaft out of the block.

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

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

INSTALLATION

(1) Clean Loctite 518 residue and sealant from the cylinder block and rear cap mating surface. Do this before applying the Loctite drop and the installation of rear cap.

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

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

(4) Position the crankshaft into the cylinder block.

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

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

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

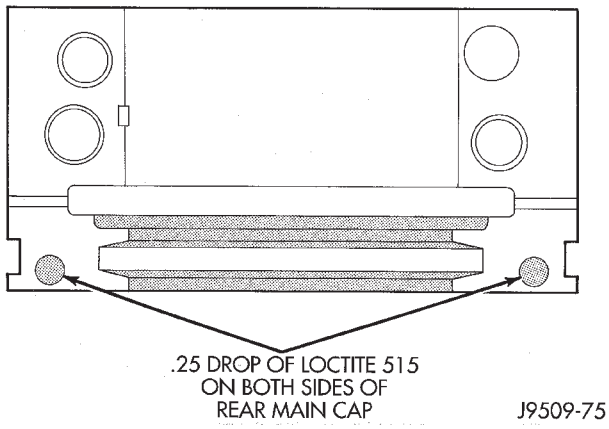


Fig. 40 Sealant Applicationto Bearing Cap

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

(14) Install new front crankshaft oil seal.

(15) Immediately install the oil pan.

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.

REMOVAL AND INSTALLATION (Continued)

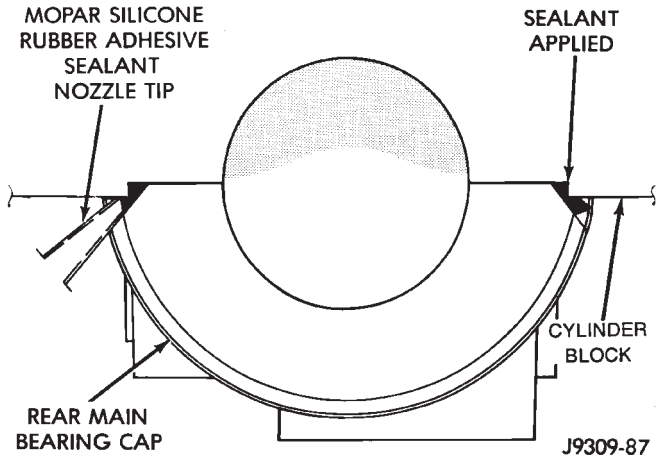


Fig. 41 Apply Sealant to Bearing Cap to BlockJoint

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

(3) Install the oil pan.

FRONT CRANKSHAFT OIL SEAL

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

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper.

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

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

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

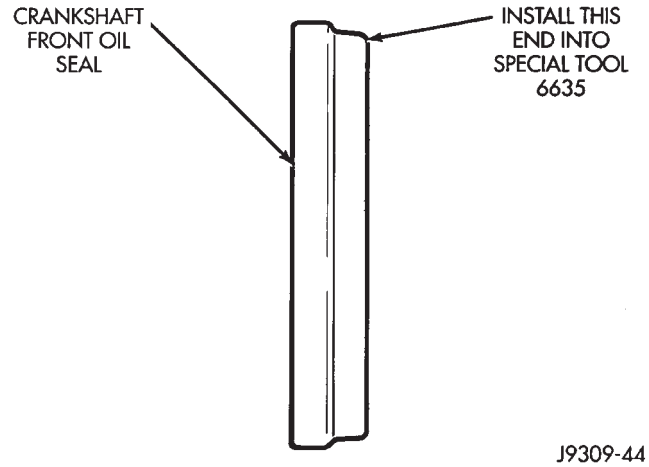


Fig. 42 Placing Oil Seal on InstallationTool 6635

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

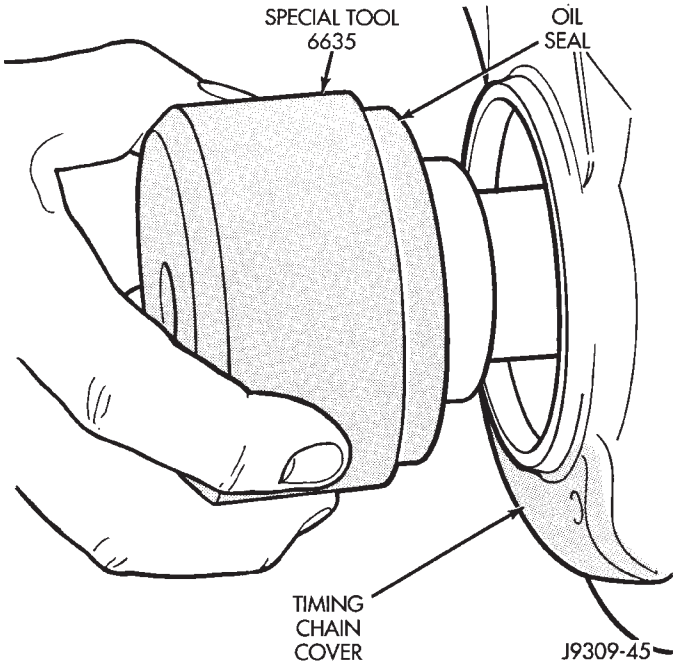


Fig. 43 Position Tool and Sealonto Crankshaft

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

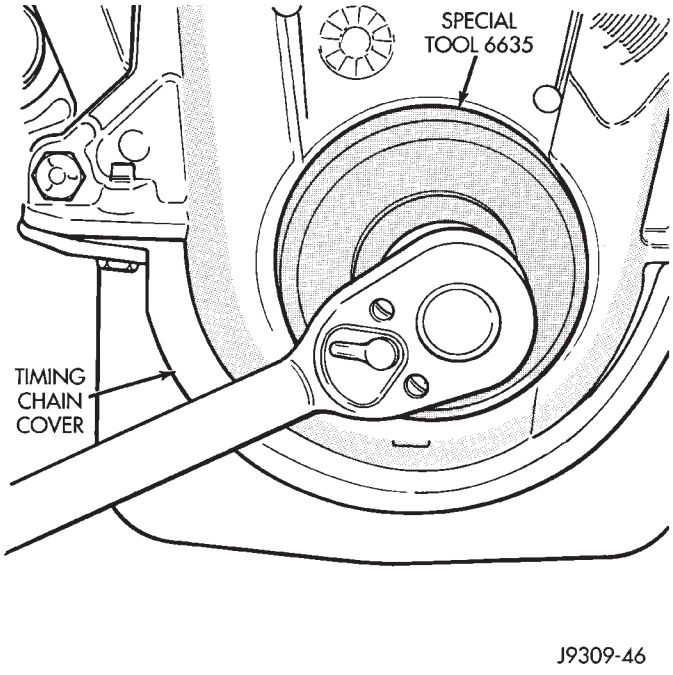


Fig. 44 Installing Oil Seal

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

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

REMOVAL AND INSTALLATION (Continued)

(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.

UPPER SEAL —CRANKSHAFT REMOVED

REMOVAL

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

INSTALLATION

(1) Clean the cylinder block rear cap mating surface. Make sure the seal groove is free of debris.
(2) Lightly oil the new upper seal lips with engine oil.
(3) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
(4) Position the crankshaft into the cylinder block.
(5) Lightly oil the new lower seal lips with engine oil.
(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
(7) Apply 5 mm (0.20 in) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 45). DO NOT over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

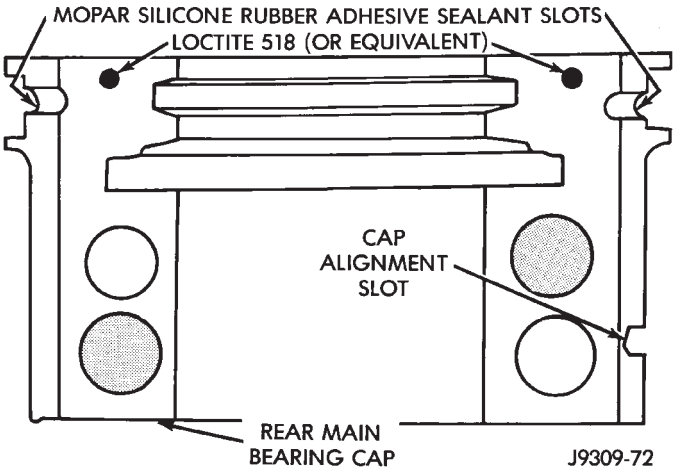


Fig. 45 Sealant Application to Bearing Cap

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.
(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.
(10) Install oil pump.
(11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 46). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
(12) Install new front crankshaft oil seal.
(13) Immediately install the oil pan.

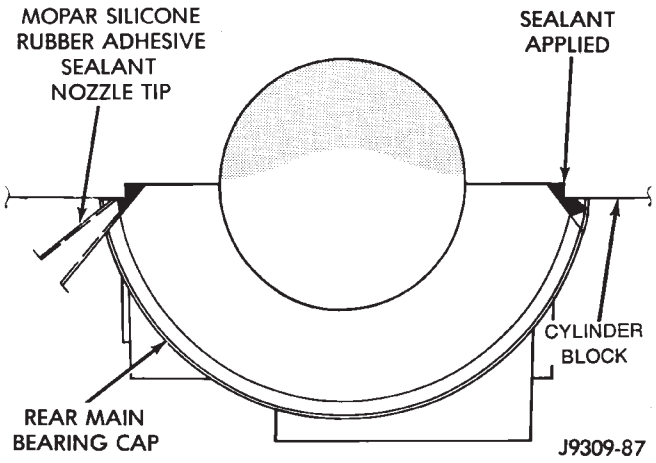


Fig. 46 Apply Sealant to Bearing Cap to BlockJoint

UPPER SEAL —CRANKSHAFT INSTALLED

REMOVAL

(1) Remove the oil pan.
(2) Remove the oil pump from the rear main bearing cap.
(3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
(4) Carefully remove and discard the old upper oil seal.

INSTALLATION

(1) Clean the cylinder block mating surfaces before oil seal installation. Check for burr at the oil hole on the cylinder block mating surface to rear cap.
(2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.
(3) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing towards the rear of the engine.

REMOVAL AND INSTALLATION (Continued)

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

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

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

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

(10) Immediately install the oil pan.

LOWER SEAL

REMOVAL

(1) Remove the oil pan.

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

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

INSTALLATION

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

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

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

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

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

(6) To align the bearing cap, use cap slot, alignment dowel and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than 2 times for proper engagement.

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

(8) Install oil pump.

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

(10) Immediately install the oil pan.

ENGINE CORE OIL AND CAMSHAFT PLUGS

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

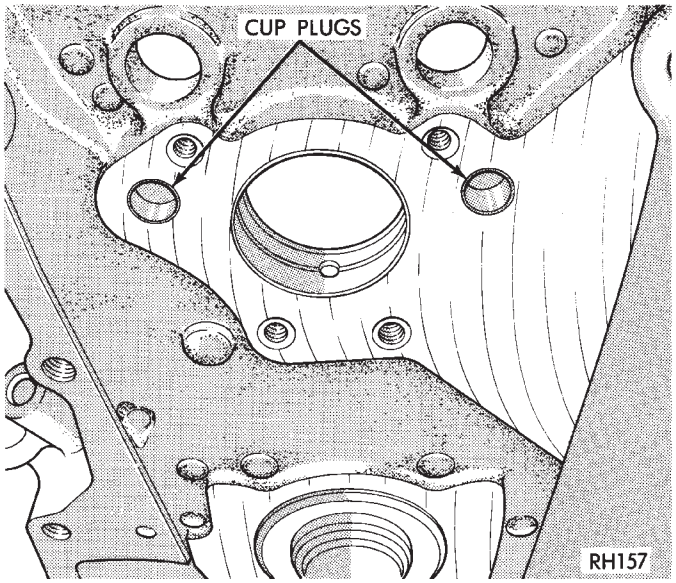


Fig. 47 Location of Cup Plugs in Oil Galleries

REMOVAL

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

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

INSTALLATION

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

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

(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.

REMOVAL AND INSTALLATION (Continued)

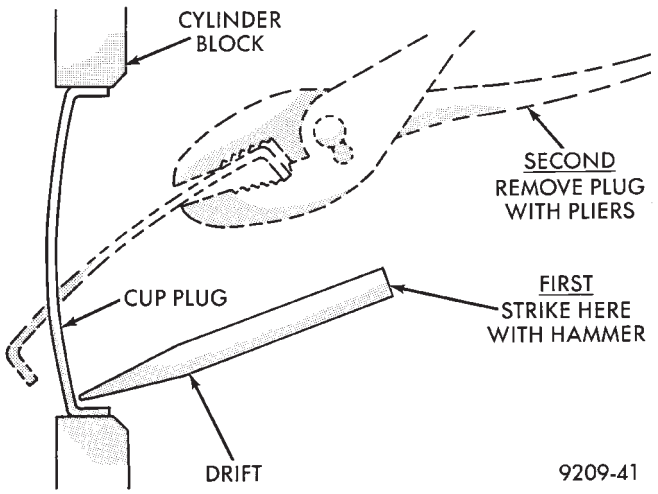


Fig. 48 Core Hole Plug Removal

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

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

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

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

DISASSEMBLE

(1) Pry out plunger retainer spring clip (Fig. 49).

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

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

ASSEMBLE

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

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

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

(4) Assemble tappets (Fig. 49).

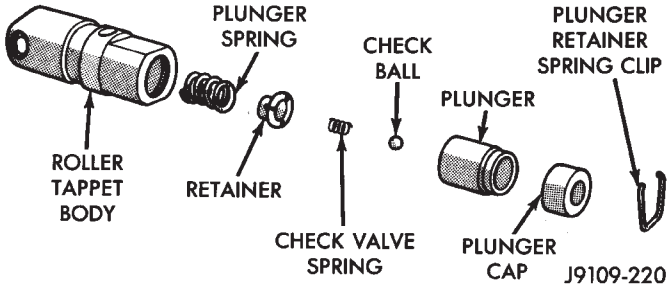


Fig. 49 Hydraulic Tappet Assembly

VALVE SERVICE

VALVE GUIDES

Measure valve stem guide clearance as follows:

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

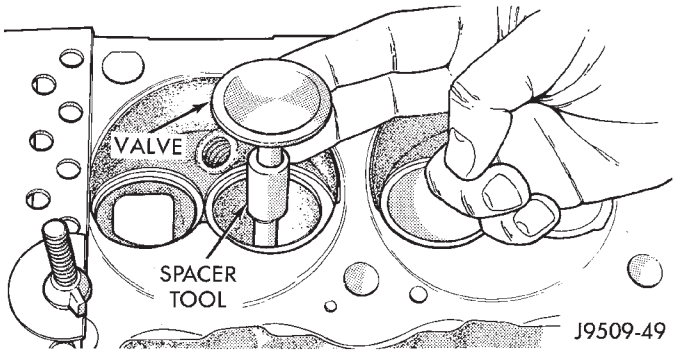


Fig. 50 Positioning Valve with Tool C-3973

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

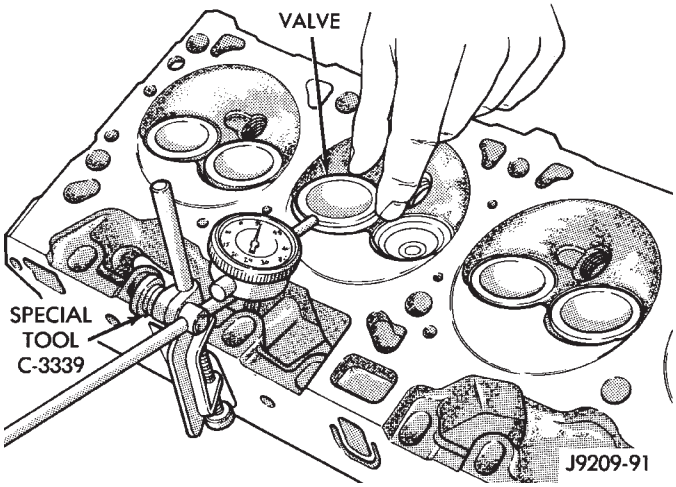


Fig. 51 Measuring Valve Guide Wear

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 inch). Ream the guides for valves with over-

DISASSEMBLY AND ASSEMBLY (Continued)

size stems if dial indicator reading is excessive or if the stems are scuffed or scored.

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

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

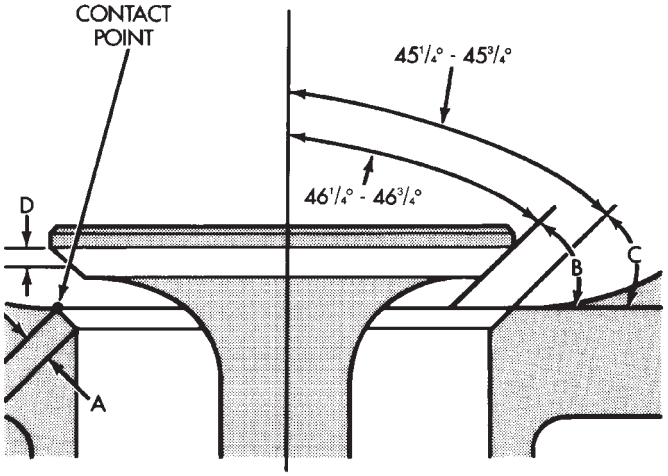
Fig. 52 Reamer Sizes

(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 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 53).



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) 43¼° – 43¾°
C - SEAT ANGLE (INTAKE & EXHAUST) 44¼° – 44¾°
D - CONTACT SURFACE

J9309-95

Fig. 53 Valve Face and Seat Angles

VALVES

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

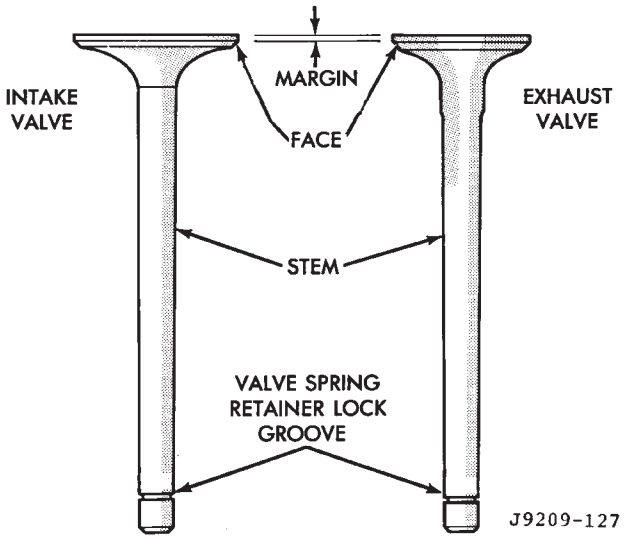


Fig. 54 Intake and Exhaust Valves

VALVE SEATS

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

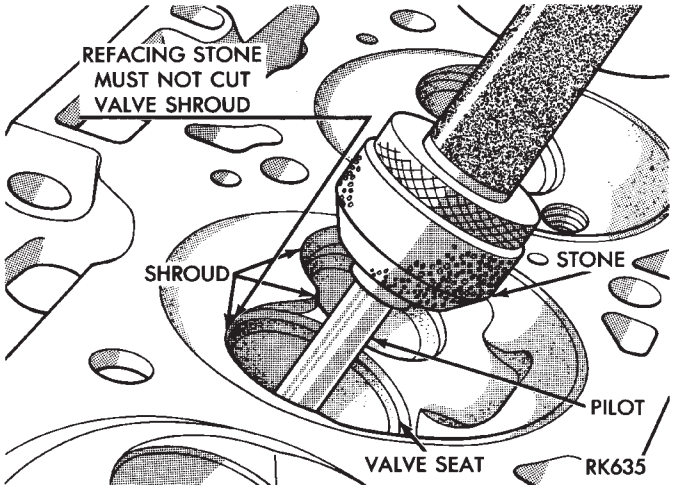


Fig. 55 Refacing Valve Seats

(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. 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.

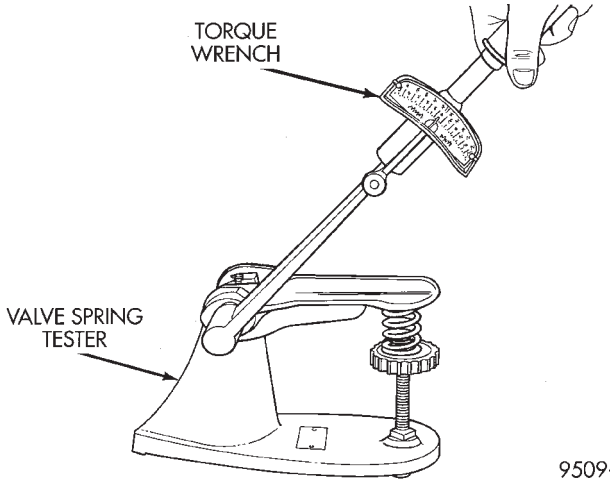


Fig. 56 Testing Valve Spring for CompressedLength

OIL PUMP

DISASSEMBLE

(1) Remove the relief valve as follows:

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

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

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

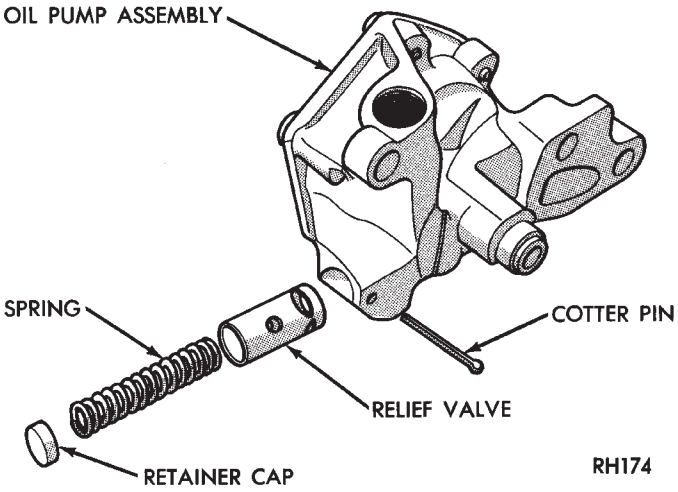


Fig. 57 Oil Pressure Relief Valve

(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.

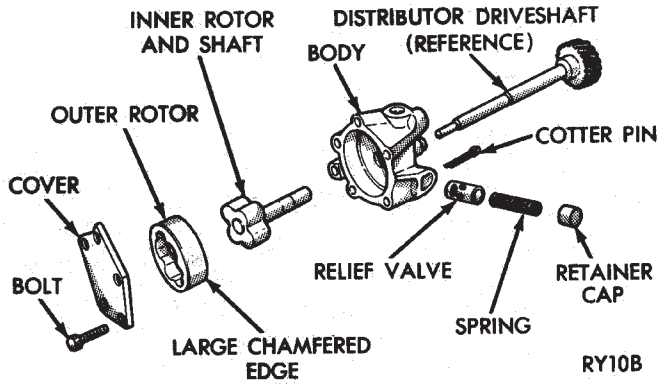


Fig. 58 Oil Pump

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.

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.

DISASSEMBLY AND ASSEMBLY (Continued)

ASSEMBLE

(1) Install the piston and connecting rod assembly.
(2) Install the oil pan.
(3) Install the cylinder head.
(4) Install the engine into the vehicle.

CLEANING AND INSPECTION

CYLINDER HEADS

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

INSPECTION

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

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

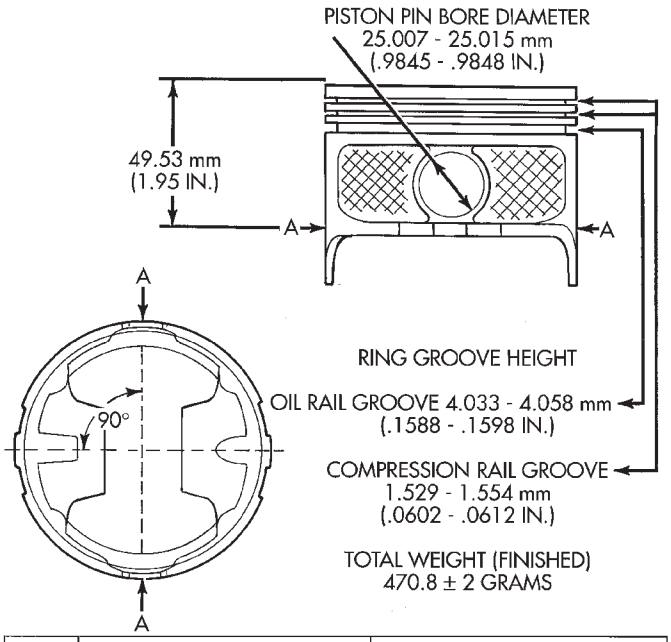
Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 59).

CRANKSHAFT JOURNALS

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

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

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



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

J9509-79

Fig. 59 Piston Measurements—5.9L

OIL PAN

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

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

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

INSPECTION

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

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

OIL PUMP

INSPECTION

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

Lay a straightedge across the pump cover surface (Fig. 60). If a 0.038 mm (0.0015 inch) feeler gauge

CLEANING AND INSPECTION (Continued)

can be inserted between cover and straightedge, pump assembly should be replaced.

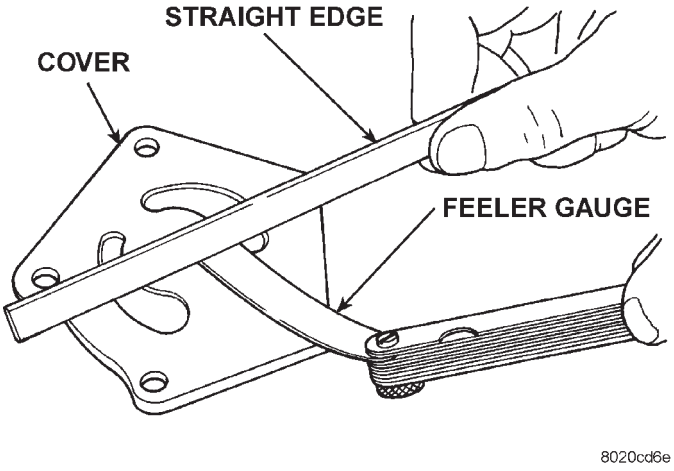


Fig. 60 Checking Oil Pump Cover Flatness

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

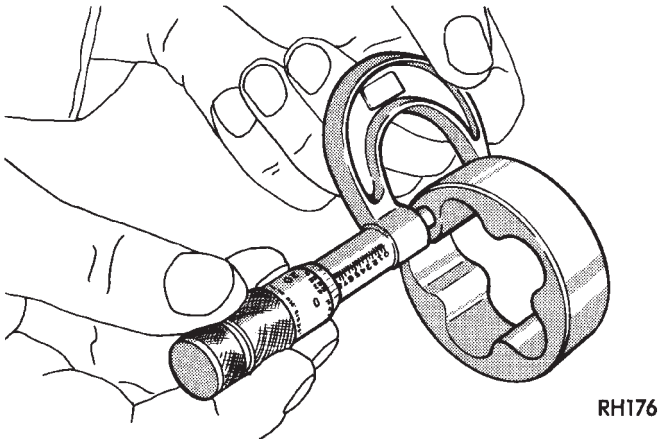


Fig. 61 Measuring Outer Rotor Thickness

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

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.

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).

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).

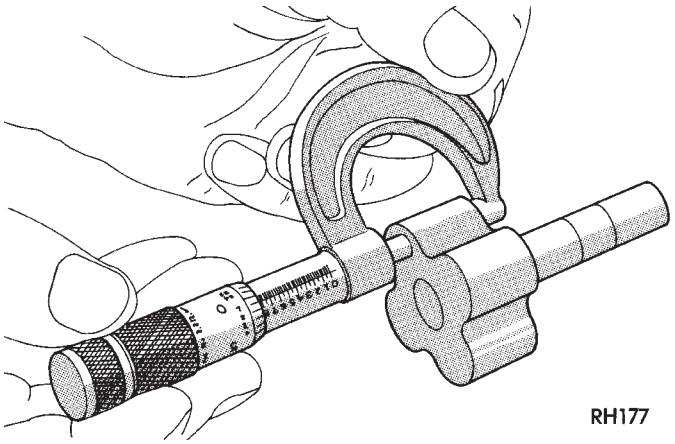


Fig. 62 Measuring Inner Rotor Thickness

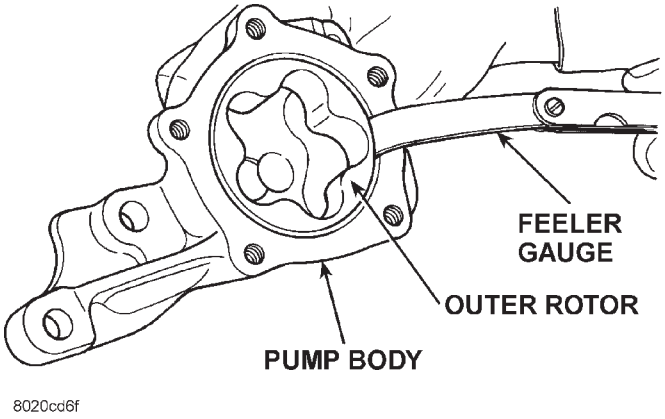


Fig. 63 Measuring Outer Rotor Clearance inHousing

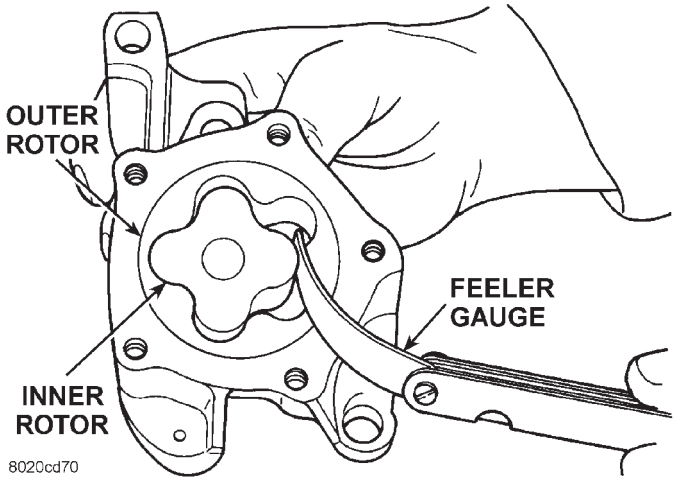


Fig. 64 Measuring Clearance Between Rotors

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

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

CLEANING AND INSPECTION (Continued)

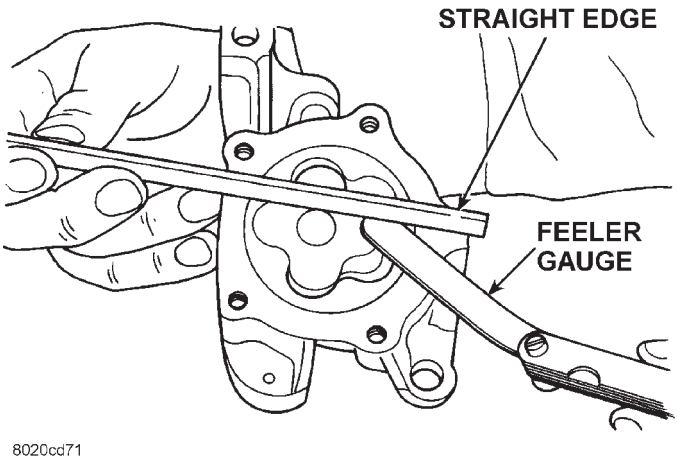


Fig. 65 Measuring Clearance Over Rotors

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

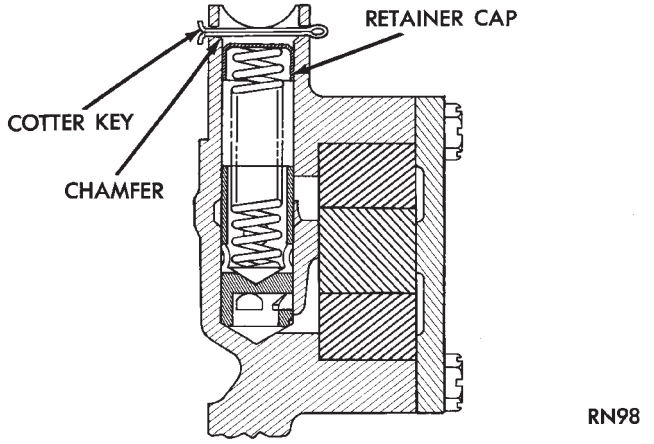


Fig. 66 Proper Installation of Retainer Cap

CYLINDER BLOCK

CLEANING

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

INSPECTION

Examine block for cracks or fractures.

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

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

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

OIL LINE PLUG

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

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

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 67). If plug is too high, use a suitable flat dowel to position properly.

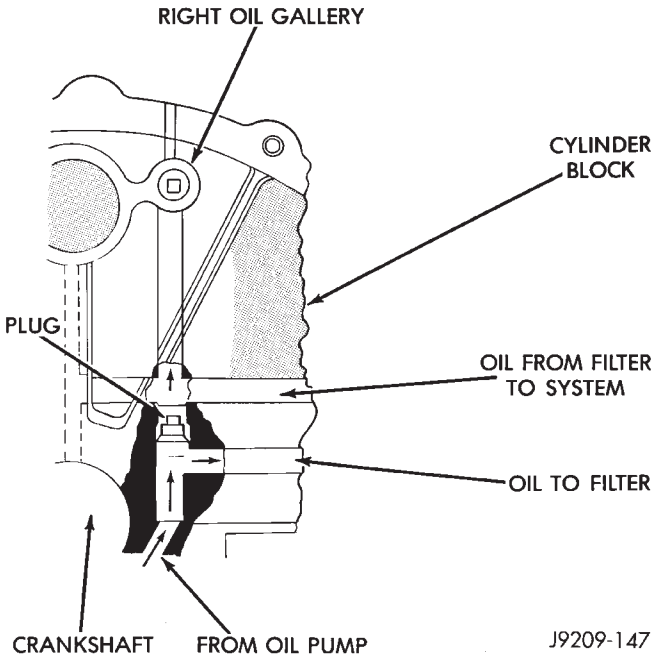


Fig. 67 Oil Line Plug

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

SPECIFICATIONS

5.9L ENGINE

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)
Diametrical Clearance . . . . . 0.0254 — 0.0762 mm (0.001 — 0.003 in)
Max. Allowable . . . . . 0.127 mm (0.005 in)
End Play . . . . . 0.051 — 0.254 mm (0.002 — 0.010 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)
Connecting Rods . . . . . .
Bearing Clearance . . . . . 0.013 — 0.056 mm (0.0005 — 0.0022 in)
Max. Allowable . . . . . 0.08 mm (.003 in)
Piston Pin Bore Diameter . . . . 24.966 — 24.978 mm (0.9829 — 0.9834 in)
Side Clearance (Two Rods) . . . . . 0.152 — 0.356 mm (0.006 — 0.014 in)
Total Weight (Less Bearing) . . . 758 grams (25.74 oz)
Crankshaft
Connecting 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)
Diametrical Clearance . . . . . .
No. 1 . . . . . 0.013 — 0.038 mm (0.0005 — 0.0015 in)
Max. Allowable (No. 1) . . . . . 0.0381 mm (0.0015 in)
Nos. 2, 3, 4 and 5 . . . . . 0.013 — 0.051 mm (0.005 — 0.0020 in)
Max. Allowable (Nos. 2, 3, 4 & 5) . . . . . 0.064 mm (0.0025 in)
End Play . . . . . 0.051 — 0.178 mm (0.002 — 0.007 in)
Max. Allowable . . . . . 0.254 mm (0.010 in)
Main Bearing Journals
Diameter . . . . . 71.361 — 71.387 mm (2.8095 — 2.8105 in)
Out-of-Round (Max.) . . . . . 0.0254 mm (0.001 in)
Taper (Max.) . . . . . 0.0254 mm (0.001 in)
Cylinder Block . . . . . .
Cylinder Bore . . . . . .
Diameter . . 101.60 — 101.65 mm (4.000 — 4.002 in)
Out-of-Round (Max.) . . . . . 0.127 mm (0.005 in)
Taper (Max.) . . . . . 0.254 mm (0.010 in)
Distributor Lower Drive Shaft Bushing (Press Fit in Block) . 0.0127 — 0.3556 mm (0.0005 — 0.0140 in)
Shaft-to-Bushing Clearance . . 0.0178 — 0.0686 mm (0.0007 — 0.0027 in)
Tappet Bore Diameter . . . . . 22.99 — 23.01 mm (0.9051 — 0.9059 in)
Cylinder Head
Compression Pressure . . . . . 689 kPa (100 psi)
Gasket Thickness (Compressed) . . . . . 1.2065 mm (0.0475 in)
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)
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 Pump
Clearance over Rotors (Max.) . 0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.) . . . . 0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.) . 20.955 mm (0.825 in)
Outer Rotor
Clearance (Max.) . . . . . 0.3556 mm (0.014 in)
Diameter (Min.) . . . . . 62.7126 mm (2.469 in)
Thickness (Min.) . . . . . 20.955 mm (0.825 in)
Tip Clearance between Rotors (Max.) . . . 0.2032 mm (0.008 in)

Oil Pressure
At Curb Idle Speed (Minimum)* . . . 41.4 kPa (6 psi)
At 3000 rpm . . . . . 207 — 552 kPa (30 — 80 psi)
Switch Actuating Pressure (Min.) . . 34.5 — 48.3 kPa (5–7 psi)
*CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

Oil Filter
Bypass Valve Setting . . . . . 62 — 103 kPa (9–15 psi)

Pistons . . . . . .
Clearance at Top of Skirt . . . . . 0.013 — 0.038 mm (0.0005 — 0.0015 in)
Land Clearance (Diametrical) . . . 0.508 — 0.660 mm (0.020 — 0.026 in)
Piston Length . . . . . 81.03 mm (3.19 in)
Piston Ring Groove Depth
Nos. 1 and 2 . . . . . 4.761 — 4.912 mm (0.187 — 0.193 in)
No. 3 . . . . . 3.996 — 4.177 mm (0.157 — 0.164 in)
Weight . . . . . 582 — 586 grams (20.53 — 20.67 oz)

Piston Pins
Clearance In Piston . . . . . 0.006 — 0.019 mm (0.00023 — 0.00074 in)
Diameter . . . . . 25.007 — 25.015 mm (0.9845 — 0.9848 in)
End Play . . . . . NONE
Length . . . . . 67.8 — 68.3 mm (2.67 — 2.69 in)

Piston Rings
Ring Gap
Compression Ring (Top) . . . . . 0.30 — 0.55 mm (0.012 — 0.022 in)
Compression Rings (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)

Valves
Face Angle . . . . . 43.25° — 43.75°
Head Diameter
Intake . . . . . 47.752 mm (1.88 in)
Exhaust . . . . . 41.072 mm (1.617 in)
Length (Overall)
Intake . . . . 126.21 — 126.85 mm (4.969 — 4.994 in)
Exhaust . . . 126.44 — 127.30 mm (4.978 — 5.012 in)
Lift (Zero Lash) . . . . . 10.414 mm (0.410 in)
Stem Diameter
Intake . . . . . 9.449 — 9.474 mm (0.372 — 0.373 in)
Exhaust . . . . 9.423 — 9.449 mm (0.371 — 0.372 in)
Stem-to-Guide Clearance . . . . . .
Intake . . . . 0.0254 — 0.0762 mm (0.001 — 0.003 in)
Exhaust . . . 0.0508 — 0.1016 mm (0.002 — 0.004 in)
Max. Allowable (Rocking Method) . . . . . 0.4318 mm (0.017 in)
Guide Bore Diameter (Std) . . . . . 9.500 — 9.525 mm (0.374 — 0.375 in)

Valve Springs
Free Length (Approx.) . . . . . 49.962 mm (1.967 in)
Spring Tension (Valve Closed) . @ 41.66 mm = 378 N (@ 1.64 in = 85 lbs)
Spring Tension (Valve Open) . . @ 30.89 mm = 890 N (@ 1.212 in = 200 lbs)
Number of Coils 6.8
Installed Height
(Spring Seat to Retainer) . . . . 41.66 mm (1.64 in)
Wire Diameter . . . . . 4.50 mm (0.177 in)

Valve Timing
Exhaust Valve . . . . . .
Closes (ATC) . . . . . 23°
Opens (BBC) . . . . . 61°
Duration . . . . . 264°
Intake Valve
Closes (ABC) . . . . . 80°
Opens (BTC) . . . . . 13°
Duration . . . . . 274°
Valve Overlap . . . . . 36.5°

SPECIFICATIONS (Continued)

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.

TORQUE

5.9L ENGINE

DESCRIPTION	TORQUE
Adjusting Strap	
Bolt	23 N·m (200 in. lbs.)
Camshaft Sprocket	
Bolt	68 N·m (50 ft. lbs.)
Camshaft Thrust Plate	
Bolts	24 N·m (18 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	
Step 1 – Initial	68 N·m (50 ft. lbs.)
Step 2 – Final	143 N·m (105 ft. lbs.)
Cylinder Head Cover	
Bolts	11 N·m (95 in. lbs.)
Exhaust Manifold to Cylinder Head	
Bolts/Nuts	34 N·m (25 ft. lbs.)
Flywheel	
Bolts	75 N·m (55 ft. lbs.)
Front Engine Mount Bracket to Block	
Bolts	81 N·m (60 ft. lbs.)
Front Engine Mount	
Through Bolt/Nut	68 N·m (50 ft. lbs.)
Generator Mounting	
Bolts	41 N·m (30 ft. lbs.)

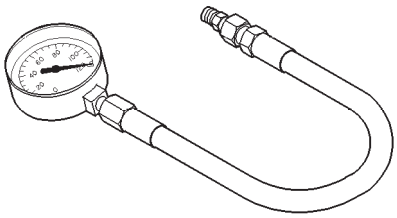
DESCRIPTION	TORQUE
Intake Manifold	
Bolts	Refer to procedure in this section
Oil Pan	
Bolts	24 N·m (215 in. lbs.)
Oil Pan Drain Plug	
Plug	34 N·m (25 ft. lbs.)
Oil Pump	
Bolts	41 N·m (30 ft. lbs.)
Oil Pump Cover	
Bolts	11 N·m (95 in. lbs.)
Rear Mount Insulator to Support Bracket	
Nuts	47 N·m (35 ft. lbs.)
Rear Mount Insulator to Crossmember	
Nut	47 N·m (35 ft. lbs.)
Rear Support Bracket to Transmission	
Bolts	102 N·m (75 ft. lbs.)
Rocker Arm	
Bolts	28 N·m (21 ft. lbs.)
Spark Plugs	
Plugs	41 N·m (30 ft. lbs.)
Starter Mounting	
Bolts	68 N·m (50 ft. lbs.)
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.)

SPECIFICATIONS (Continued)

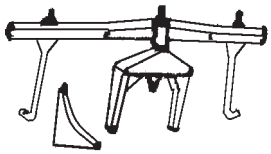
DESCRIPTION	TORQUE
Transmission Support Bracket	
Bolts	102 N·m (75 ft. lbs.)
Transmission Support Spacer to Insulator Mounting Plate – (4wd)	
Nuts	204 N·m (150 ft. lbs.)
Vibration Damper	
Bolt	183 N·m (135 ft. lbs.)
Water Pump to Chain Case Cover	
Bolt	41 N·m (30 ft. lbs.)

SPECIAL TOOLS

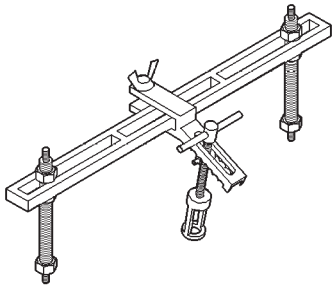
5.9L ENGINE



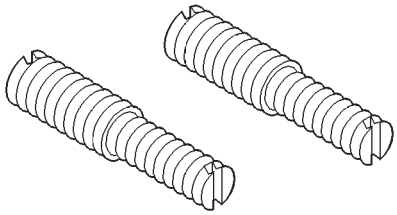
Oil Pressure Gauge C-3292



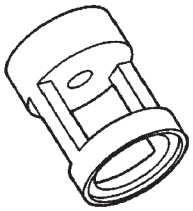
Engine Support Fixture C-3487–A



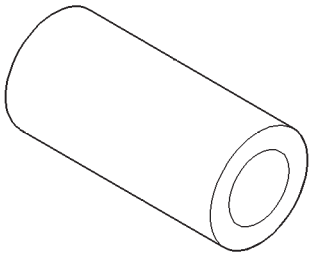
Valve Spring Compressor MD-998772–A



Adaptor 6633

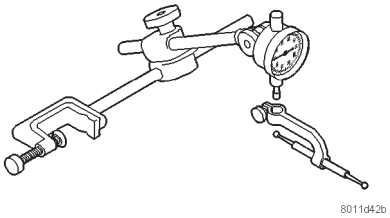


Adaptor 6716A

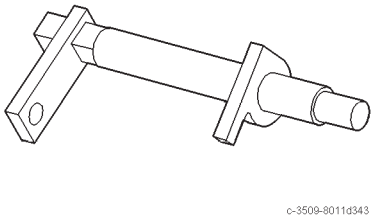


Valve Guide Sleeve C-3973

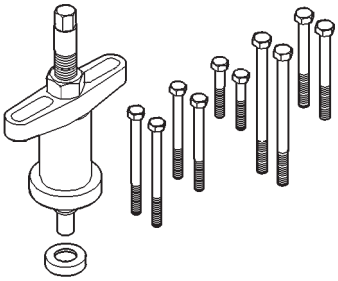
SPECIAL TOOLS (Continued)



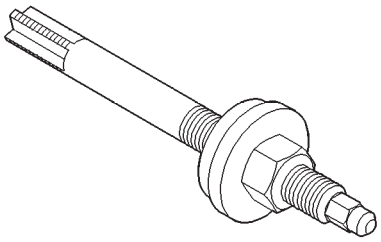
Dial Indicator C-3339



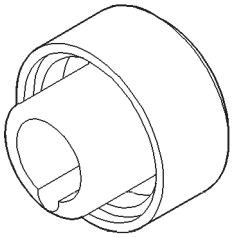
Camshaft Holder C-3509



Puller C-3688



Distributor Bushing Puller C-3052



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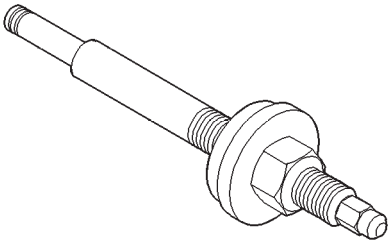

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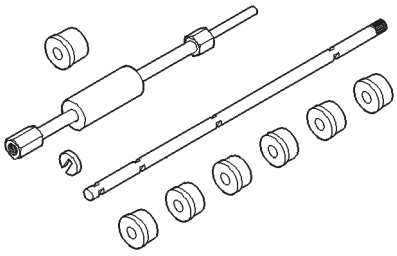
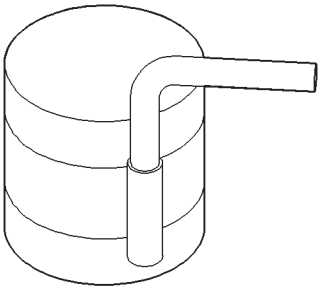
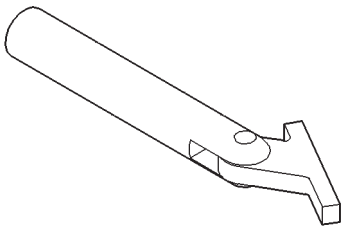


Cam Bearing Remover/Installer C-3132–A

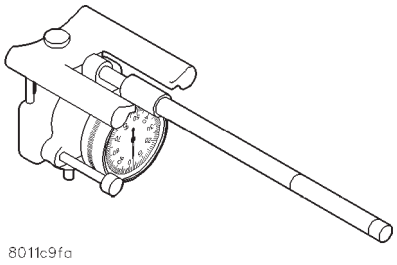


Piston Ring Compressor C-385

SPECIAL TOOLS (Continued)



Crankshaft Main Bearing Remover C-3059



Cylinder Bore Gauge C-119

ENGINE

CONTENTS

GENERAL INFORMATION

ENGINE IDENTIFICATION

The engine model code (3-digit number/letter code) and serial number are stamped on the forward facing side of the engine block (Fig. 1).

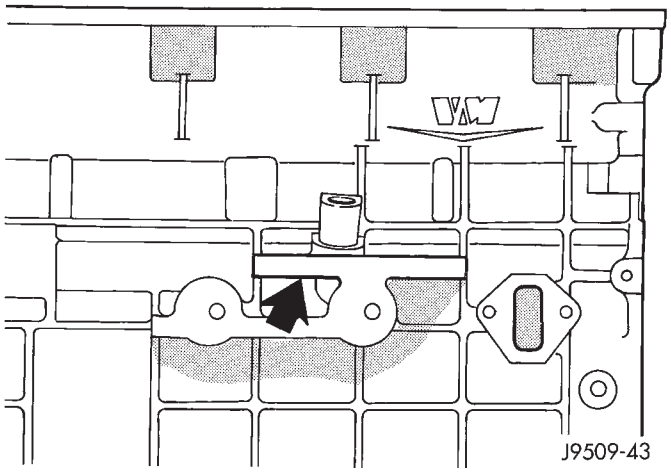


Fig. 1 Engine Code Location

GENERAL INFORMATION (Continued)

Displacement	2.5L (2499 cc)
Bore	92.00
Stroke	94.00
Compression Ratio	20.95:1
Vacuum at idle	600 mm/Hg (23.6 In/Hg)
Belt Tension	53 DaN - New 30 DaN - Used
Thermostat Opening	80°C ± 2°C
Generator Rating	Bosch 50/120 Amp
Cooling System Capacity	9.5 Liter
P/S Capacity	0.75 Liter
Engine Oil Capacity	6.8 Liter w/filter change
Timing System	Pushrod operated overhead valves, with gear-driven camshaft in crankcase.
Air Intake	Dry filter.
Fuel Feed	Vane pump incorporated in injection pump.
Fuel System	Indirect fuel injection (precombustion chamber).
Combustion Cycle	4 stroke.
Cooling System	Water cooling.
Injection Pump	Rotary pump with built-in mechanical regulator.
Lubrication	Pressure lubrication by rotary pump, full-flow filtration.
Engine Rotation	Clockwise viewed from front cover.

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Engine Description

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 4 bars (50 psi) at 3000 RPM.

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

OIL LEVEL HIGH

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

OIL LEVEL LOW

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

DESCRIPTION AND OPERATION

LUBRICATION SYSTEM

The pressurized system uses a rotary pump (3) located in the front of the engine block, driven by a gear which meshes directly with the crankshaft gear. All the oil sent to every lubricated part is filtered. The pump sends the oil through a pressure relief valve (2) to the filter (7) and through galleries in the crankcase to the crankshaft bearings (8), camshaft bearings (11) and turbocharger (10). The piston pins, connecting rod small ends and insides of the pistons are lubricated and cooled by oil sprayed out from jets (9) in the crankshaft mounting blocks. The lubricating oil is sent to the rockers (12) through an external pipe. A valve in the filter cartridge enables the oil to be circulated even when the cartridge is clogged.

Sump inlet (1). Pressure relief valve (2). Oil pump (3). Oil cooler (6). Filter cartridge (7). Crankshaft bearings (8). Jet valve (9). Turbocharger bearings (10). Camshaft bearings (11). Rockers (12).

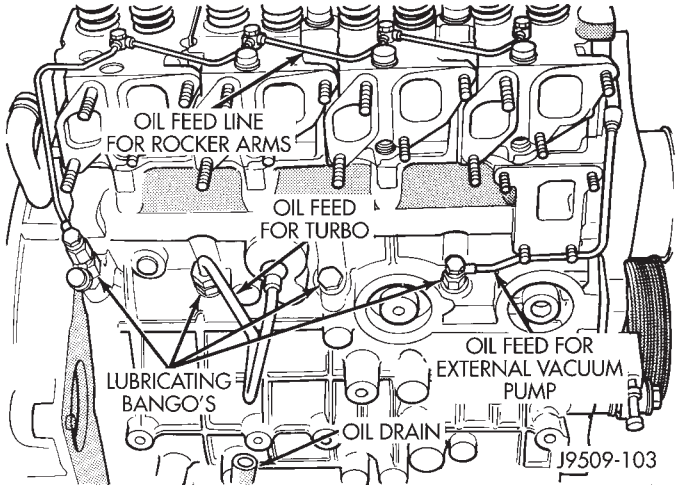

Fig. 2 Lubrication Lines

DIAGNOSIS AND TESTING

SERVICE DIAGNOSIS—DIESEL—PERFORMANCE

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK OR CRANKS SLOWLY	1. Starting motor operating, but not cranking the engine.	1. Remove the starter motor. Check for broken flywheel teeth or a broken starting motor spring.
	2. Crankshaft rotation restricted.	2. Rotate the engine to check for rotational resistance.
	3. Starting circuit connections loose or corroded.	3. Clean and tighten connections.
	4. Neutral safety switch or starter relay inoperative.	4. Check starter relay supply voltage and proper operation of neutral safety switch (if equipped). Replace defective parts.
	5. Battery charge low.	5. Check battery voltage. Replace battery if a charge cannot be held.
	6. No voltage to starter solenoid.	6. Check voltage to solenoid. If necessary, replace the solenoid.
	7. Solenoid or starter motor inoperative.	7. Replace starter motor.
ENGINE CRANKS, BUT WILL NOT START NO SMOKE	1. No fuel in supply tank.	1. Fill fuel supply.
	2. Electrical fuel shutdown solenoid not operating.	2. Check for loose wires and verify that the fuel shutdown solenoid and fuel shutdown solenoid relay is functioning.
	3. Air intake or exhaust plugged.	3. Remove the obstruction.
	4. Fuel filter plugged.	4. Drain fuel/water separator and replace fuel filter.
	5. Excessive fuel inlet restriction.	5. Check fuel inlet restriction. Correct cause.
	6. Injection pump not getting fuel or fuel is aerated.	6. Check fuel flow/bleed fuel system.
	7. One or more injectors worn or not operating properly.	7. Check/replace bad or improperly operating injectors.
	8. Worn or inoperative injection pump.	8. Visually check delivery with externally connected injector to one of the pump outlets. Repair or replace the pump if fuel is not being delivered.
	9. Camshaft out of time.	9. Check/correct gear train timing alignment.
ENGINE HARD TO START, OR WILL NOT START SMOKE FROM EXHAUST	1. Incorrect starting procedure.	1. The fuel shutoff solenoid control must be in the run position. Ensure proper procedure is being used.
	2. Cranking speed too slow.	2. (A) Verify that the transmission is not engaged. (B) Check the battery, starting motor and look for loose or corroded wiring connections.
	3. Cylinder heads heater plugs relay defective.	3. Verify system is working. Repair/replace inoperative parts.
	4. One or more cylinder head heater plugs defective.	4. Verify system is working. Repair/replace inoperative parts.
	5. Insufficient intake air.	5. Inspect or replace filter and check for obstruction to the air supply tube.

DIAGNOSIS AND TESTING (Continued)

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

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DIAGNOSIS AND TESTING (Continued)

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

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DIAGNOSIS AND TESTING (Continued)

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

DIAGNOSIS AND TESTING (Continued)

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

DIAGNOSIS AND TESTING (Continued)

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

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—DIESEL—MECHANICAL.

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

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DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL LOSS (CONT.)	6. Turbocharger leaking oil to the air intake. 7. Piston rings not sealing (oil being consumed by the engine).	6. Inspect the air ducts for evidence of oil transfer. Repair as required. 7. Perform blow-by check. Repair as required.
COMPRESSION KNOCKS	1. Air in the fuel system. 2. Poor quality fuel or water/gasoline contaminated fuel. 3. Engine overloaded. 4. Incorrect injection pump timing. 5. Improperly operating injectors.	1. Bleed the fuel system (refer to Group 14, Fuel System). 2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tanks. Replace fuel/water separator. 3. Verify the engine load rating is not being exceeded. 4. Check and time injection pump (refer to Group 14, Fuel System). 5. Check and replace inoperative injectors.
EXCESSIVE VIBRATION	1. Loose or broken engine mounts. 2. Damaged fan or improperly operating accessories. 3. Improperly operating vibration damper. 4. Improperly operating viscous fan drive. 5. Worn or damaged generator bearing. 6. Flywheel housing misaligned. 7. Loose or broken power component. 8. Worn or unbalanced driveline components.	1. Replace engine mounts. 2. Check and replace the vibrating components. 3. Inspect/replace the vibration damper. 4. Inspect/replace the fan drive. 5. Check/replace the generator. 6. Check/correct flywheel alignment. 7. Inspect the crankshaft and rods for damage that causes an unbalance. Repair/replace as required. 8. Check/repair driveline components.
EXCESSIVE ENGINE NOISES	1. Drive belt squeal, insufficient tension or abnormally high loading. 2. Intake air or exhaust leaks. 3. Turbocharger noise. 4. Gear train noise. 5. Power function knock.	1. Check the automatic tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub and generator turn freely. 2. Refer to Excessive Exhaust smoke (Engine Diagnosis Performance). 3. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required. 4. Visually inspect and measure gear backlash. Replace gears as required. 5. Check/replace rod and main bearings.

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DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
GENERATOR NOT CHARGING OR INSUFFICIENT CHARGING	1. Loose or corroded battery. 2. Generator belt slipping. 3. Generator pulley loose on shaft. 4. Improperly operating generator.	1. Clean/tighten battery connection. 2. Check/replace automatic belt tensioner. Check/replace and adjust belt. 3. Tighten pulley. 4. Check/replace generator.

DIAGNOSIS AND TESTING (Continued)

TAPPET NOISE

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

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

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

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

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

SERVICE PROCEDURES

VALVE SERVICE

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

DISASSEMBLY

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

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

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

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

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

VALVE CLEANING

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

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

INSPECTION

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

(2) Inspect for cracks on the exhaust seat.

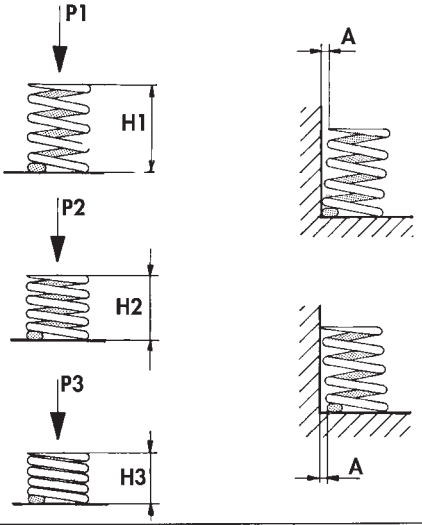
(3) Inspect for cracks in the gasket surface at each coolant passage.

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

(5) Inspect for scuffed or bent valve stems.

(6) Replace valves displaying any damage.

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



LOAD Kg		HEIGHT mm		STATE
P1	0.00	H1	44.65	FREE LENGTH
P2	33-35	H2	38.60	VALVE CLOSED
P3	90-95	H3	28.20	VALVE OPEN

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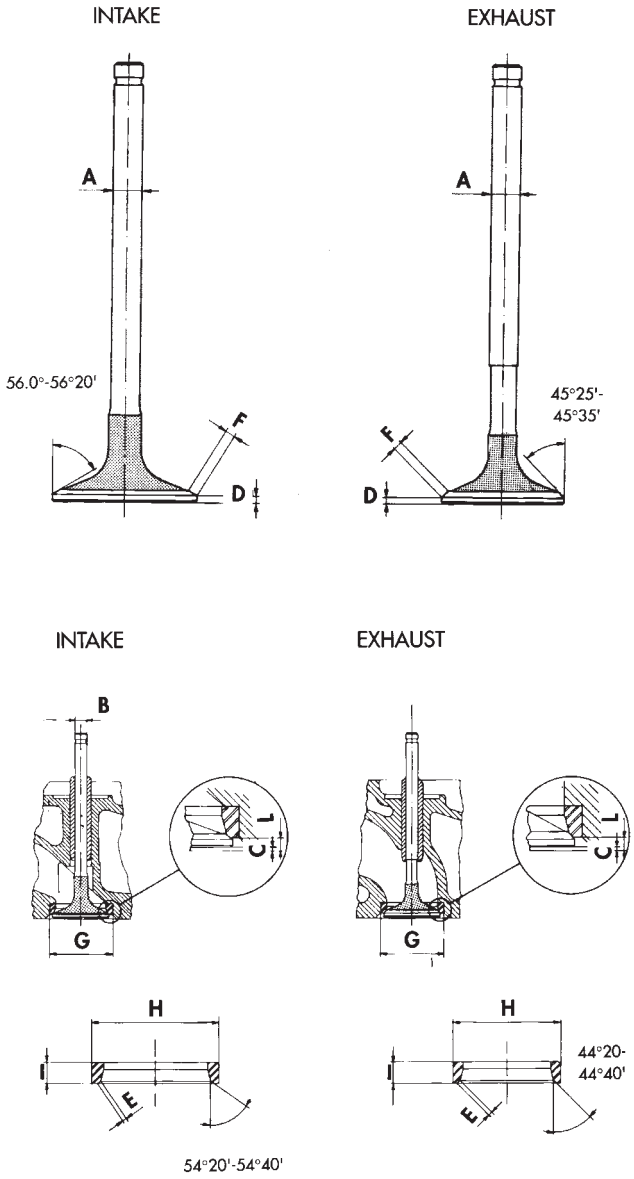
Fig. 3 Valve Spring Chart

VALVE REFACING

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

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

SERVICE PROCEDURES (Continued)



MEASUREMENT	INTAKE	EXHAUST
A	7.940-7.960	7.922-7.940
B	8.00-8.015	8.000-8.015
C	0.880-1.140	0.990-1.250
D	2.2±0.08	2.09 $^{+0.07}_{-0.09}$
E	1.80-2.20	1.65-2.05
F	2.73-3.44	2.45-3.02
G	41.962-41.985	35.964-35.987
H	42.070-42.086	36.050-36.066
I	7.14-7.19	7.00-7.05
L	3.11-3.26	3.10-3.25

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Fig. 4 Valve Specification

VALVE SEAT REFACING

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

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

VALVE STAND DOWN

Valve stand down is to maintain the adequate compression ratio.

(1) Invert cylinder head.

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

(3) Using a straight edge and feeler gauge (Fig. 5), check valve head stand down: Inlet valve head stand down .80 to 1.2 mm (.031 to .047 in.) and exhaust valve stand down .79 to 1.19 mm (.031 to .047 in).

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

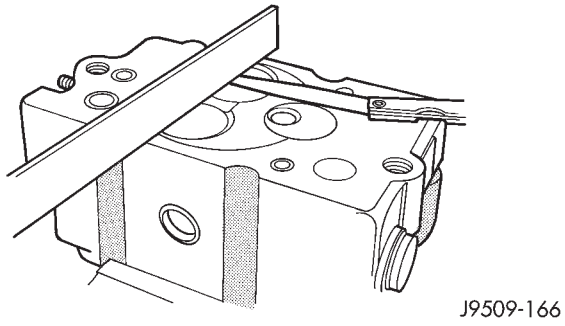

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Fig. 5 Checking Valve Stand Down

VALVE GUIDES

(1) Valve Guides height requirement.

(2) Measurement A (Fig. 6): 13.50 - 14.00 mm.

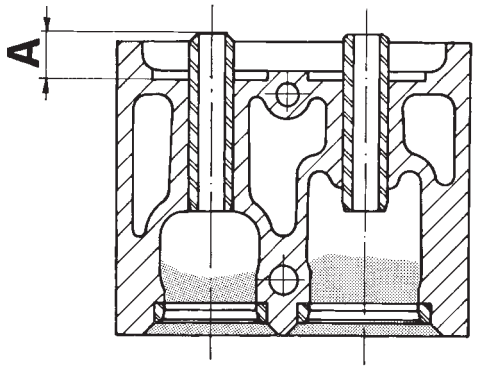

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Fig. 6 Valve Guide Height

SERVICE PROCEDURES (Continued)

VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

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

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

(3) Subtract diameter of valve stem from internal diameter of its respective valve guide to obtain valve stem clearance in valve guide. Clearance of inlet valve stem in valve guide is .040 to .075 mm (.0015 to .0029 in). Clearance of exhaust valve stem in valve guide is .060 to .095 mm (.0023 to .0037 in).

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

REMOVAL AND INSTALLATION

ENGINE MOUNTS—FRONT

The front mounts support the engine at each side. These supports are made of resilient rubber.

REMOVAL—RIGHT SIDE

(1) Disconnect negative cable from battery.
(2) Raise the vehicle.
(3) Support the engine.
(4) Remove through bolt nut. DO NOT remove the through bolt (Fig. 7).
(5) Remove insulator sill plate bolts.
(6) Remove engine mount bracket bolts.
(7) Raise engine up.
(8) Remove the through bolt.
(9) Remove insulator.
(10) Remove engine bracket.

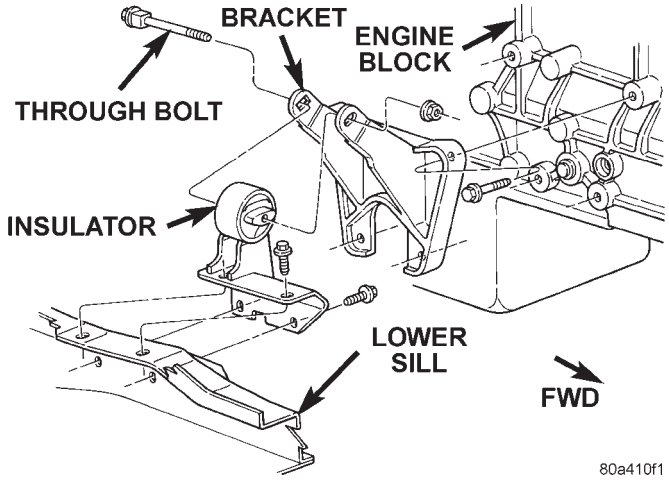

Fig. 7 Front Mount—Right Side

INSTALLATION—RIGHT SIDE

(1) Install the engine support bracket and bolts, tighten bolts to 61 N·m (45 ft. lbs.).
(2) Secure the insulator assembly on the lower sill. Tighten the bolts to 65 N·m (48 ft. lbs.).
(3) Lower engine and place the insulator assembly into the bracket.
(4) Install the through bolt nut. Tighten the through bolt nut to 65 N·m (48 ft. lbs.).
(5) Remove the engine support.
(6) Lower the vehicle.
(7) Connect negative cable to battery

REMOVAL—LEFT SIDE

(1) Disconnect negative cable from battery.
(2) Raise the vehicle.
(3) Support the engine.
(4) Remove through bolt nut. DO NOT remove the through bolt (Fig. 8).
(5) Remove insulator sill plate bolts.
(6) Remove engine mount bracket bolts.
(7) Raise engine up.
(8) Remove the through bolt.
(9) Remove insulator.
(10) Remove engine bracket.

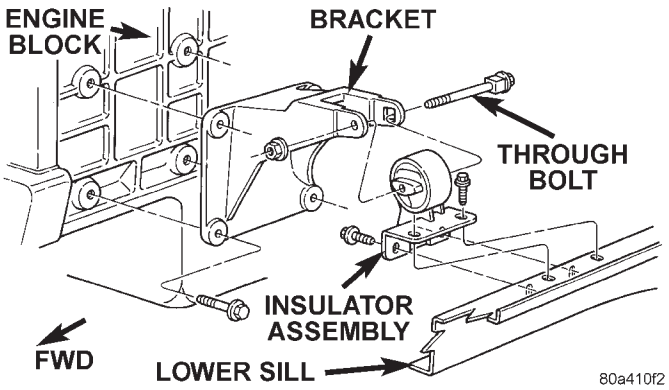

Fig. 8 Front Mount—Left Side

INSTALLATION—LEFT SIDE

(1) Install the engine support bracket and bolts, tighten bolts to 61 N·m (45 ft. lbs.).
(2) Secure the insulator assembly on the lower sill. Tighten the bolts to 65 N·m (48 ft. lbs.).
(3) Lower engine and place the insulator assembly into the bracket.
(4) Install the through bolt nut. Tighten the through bolt nut to 65 N·m (48 ft. lbs.).
(5) Remove the engine support.
(6) Lower the vehicle.
(7) Connect negative cable to battery

REMOVAL AND INSTALLATION (Continued)

ENGINE MOUNT—REAR

A resilient rubber cushion supports the transmission at the rear between the transmission extension housing and the rear support crossmember or skid plate.

REMOVAL

(1) Disconnect negative cable from battery.

(2) Raise the vehicle and support the transmission.

(3) Remove the nuts holding the support cushion to the bracket (Fig. 9). Remove the crossmember.

(a) Remove the support cushion nuts and remove the cushion.

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

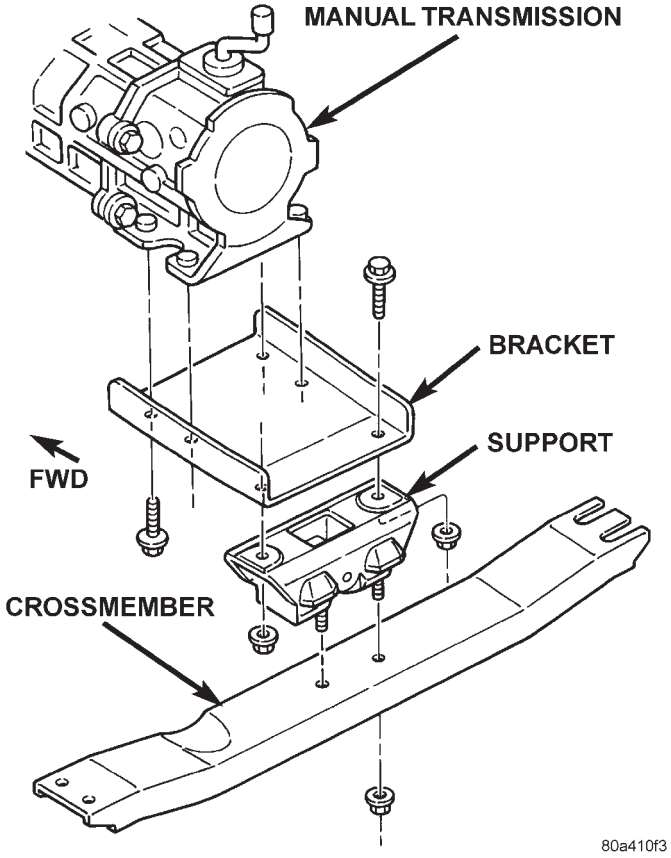

Fig. 9 Rear Mount

INSTALLATION

(1) If removed, position the transmission support bracket to the transmission and install the bolts. Tighten the bolts to 46 N·m (34 ft. lbs.) torque.

(2) Position the support cushion onto the transmission support crossmenber. Tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(3) Install crossmember.

(4) Secure support cushion to bracket. Tighten the nuts to 54 N·m (40 ft. lbs.) torque.

(5) Remove transmission support and lower vehicle.

(6) Connect negative battery cable.

ENGINE ASSEMBLY

REMOVAL

(1) Disconnect the battery cables. Remove the battery.

(2) Mark the hinge locations on the hood panel for alignment reference during installation. Disconnect the engine compartment lamp wiring connection. Remove the hood.

WARNING: THE COOLANT IN A RECENTLY OPERATED ENGINE IS HOT AND PRESSURIZED. USE CARE TO PREVENT SCALDING BY HOT COOLANT. CAREFULLY RELEASE THE PRESSURE BEFORE REMOVING THE RADIATOR DRAIN COCK AND CAP.

(3) Drain the cooling system (refer to Group 7, Cooling).

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

(5) Remove the lower radiator hose.

(6) Remove the upper radiator hose and coolant recovery hose (Fig. 10).

(7) Remove upper crossmember, refer to Group 23, Body Components for procedure.

(8) Remove air cleaner hose from turbocharger and breather hose.

(9) Remove the air cleaner assembly.

(10) Disconnect A/C lines from condenser (Refer to Group 24, Heating and Air Conditioning) cap lines to keep foreign particles out.

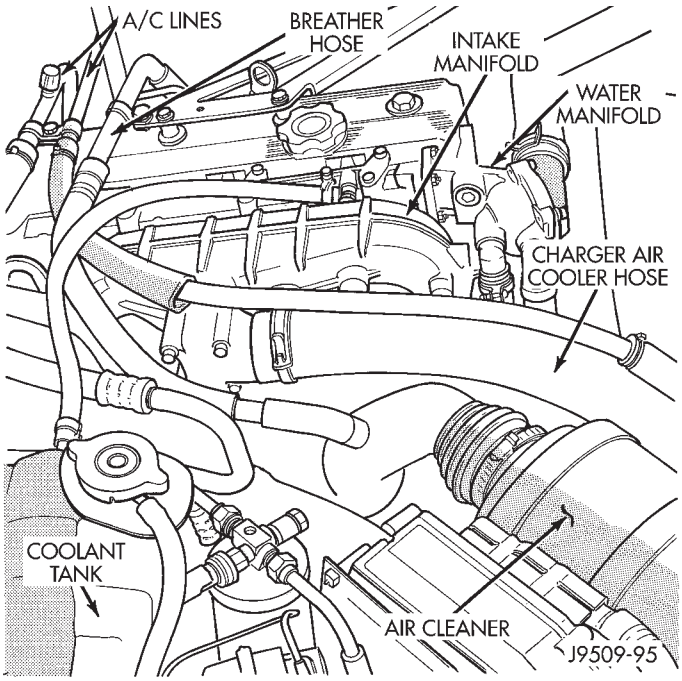

Fig. 10 Right side of Engine

REMOVAL AND INSTALLATION (Continued)

(11) Tip radiator, A/C condenser, and fan shroud assembly away from engine.

(12) Remove fan and set fan inside fan shroud.

(13) Remove fan, fan shroud, radiator, and A/C condenser as an assembly.

(14) Disconnect the heater hoses and coolant recovery bottle hose (Fig. 10).

(15) Remove fuel lines, fuel filter, refer to Group 14, Fuel Systems.

(16) If equipped with air conditioning, remove the service valves and cap the compressor ports (refer to Group 14, Fuel System).

(17) Remove the power brake vacuum check valve from the booster, if equipped.

(18) If equipped with power steering (Fig. 11):

(a) Disconnect the power steering pressure hoses from the steering gear.

(b) Disconnect return line from reservoir and drain the pump reservoir.

(c) Cap the fittings on the hoses and steering gear to prevent foreign material from entering the system.

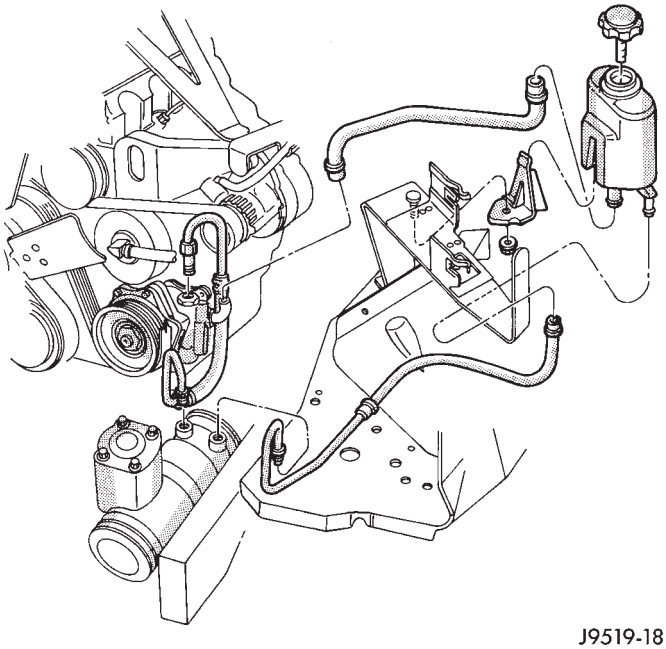

Fig. 11 Power Steering Lines

(19) Identify, tag and disconnect all necessary wire connectors and vacuum hoses.

(20) Remove gear shift levers (refer to Group 21, Transmissions).

(21) Raise and support the vehicle.

(22) Remove Prop shafts (refer to Group 2, Suspension and Driveshafts).

(23) Disconnect the exhaust pipe from the exhaust down manifold (refer to Group 11, Exhaust system and Intake Manifolds).

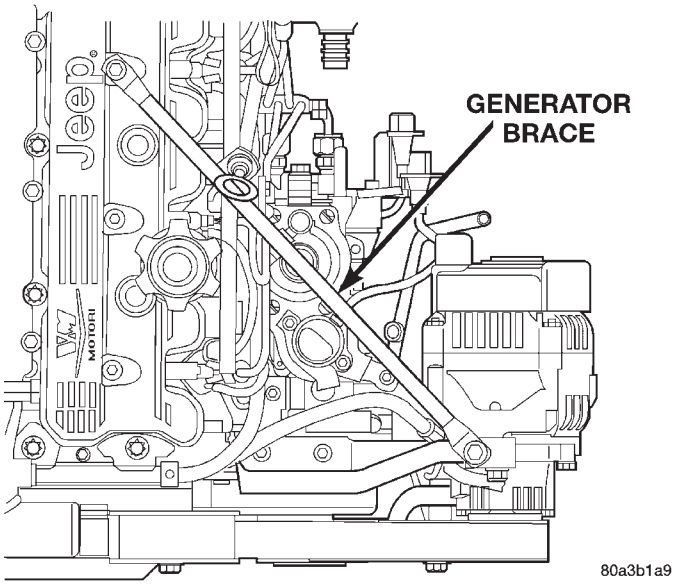

Fig. 12 Left Side of Engine

(24) Remove rear crossmember and transmission mount, support transmission.

(25) Tip transmission to remove four bolts on top of transmission to engine block. Disconnect wiring from transmission.

(26) Support transmission, remove lower bolts and brackets, remove transmission.

(27) Remove the engine support cushion-to-engine compartment bracket nuts.

(28) Lower the vehicle.

(29) Attach a lifting device to the engine.

(30) Lift the engine out of the engine compartment. Install the engine on an engine stand.

INSTALLATION

(1) Lift the engine off the stand and lower it into the engine compartment.

(2) Install the engine support cushions (if removed).

(3) Lower the engine and engine support cushions onto the engine compartment brackets.

(4) Raise the vehicle.

(5) Install transmission to engine refer to Group 21, transmissions.

(6) Support transmission.

(7) Remove the engine lifting device.

(8) Install rear crossmember tighten bolts to 42 N·m (31 ft. lbs.)

(9) Install transmission rear mount, for procedure refer to Engine Mount—Rear in this section.

(10) Tighten the engine support cushion through-bolt nuts 65 N·m (48 ft. lbs.).

(11) Install the exhaust pipe support.

(12) Connect the exhaust down pipe to the exhaust system refer to Group 11, Exhaust System and Intake Manifold.

REMOVAL AND INSTALLATION (Continued)

(13) Lower the vehicle.
(14) Connect all the vacuum hoses and wire connectors.
(15) If equipped with power steering:
(a) Remove the protective caps
(b) Connect the pressure hoses to the steering gear. Tighten the nut to 28 N·m (21 ft. lbs.).
(c) Connect return line from reservoir to the pump.
(d) Fill the pump reservoir with fluid.
(16) Connect the service valves to the A/C compressor ports, if equipped with air conditioning.
(17) Install fuel filter and bracket. Tighten bolts to 28 N·m (250 in. lbs.)
(18) Connect the fuel supply and return lines
(19) Connect brake booster hose.
(20) Connect the heater hoses and recovery bottle hose.
(21) Connect charge air cooler hoses to turbo and intake manifold.
(22) Install the fan, fan shroud and radiator/condenser (if equipped with air conditioning).
(23) Install fan, tighten to 56 N·m (41 ft. lbs.).
(24) Connect the upper and lower radiator hoses.
(25) Install upper crossmember, refer to Group 23, Body Components.
(26) Install air cleaner and bracket.
(27) Connect air cleaner hose to turbo and connect breather hose.
(28) Install battery tray and battery.
(29) Connect the battery cables.
(30) Fill the cooling system.
(31) If equipped, If system was opened, evacuate and charge the air conditioning system (refer to Group 24, Heater and Air Conditioning).
(32) Install the hood.
(33) Install the air cleaner.
(34) Start the engine and inspect for leaks.
(35) Stop the engine and check the fluid levels. Add fluid, as required.

CYLINDER HEAD COVER

REMOVAL

(1) Disconnect the battery cable.

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

(2) Drain the cooling system (refer to Group 7, Cooling).
(3) Discharge the air conditioning system, if equipped (refer to Group 24, Heating and Air Conditioning for service procedures).
(4) If equipped with air conditioning, remove the A/C lines at the compressor and cap (refer to Group 24, Heating and Air Conditioning). Remove A/C line bracket attached to cylinder head cover, and move A/C lines away from cylinder head.
(5) Remove generator support brace (Fig. 13).

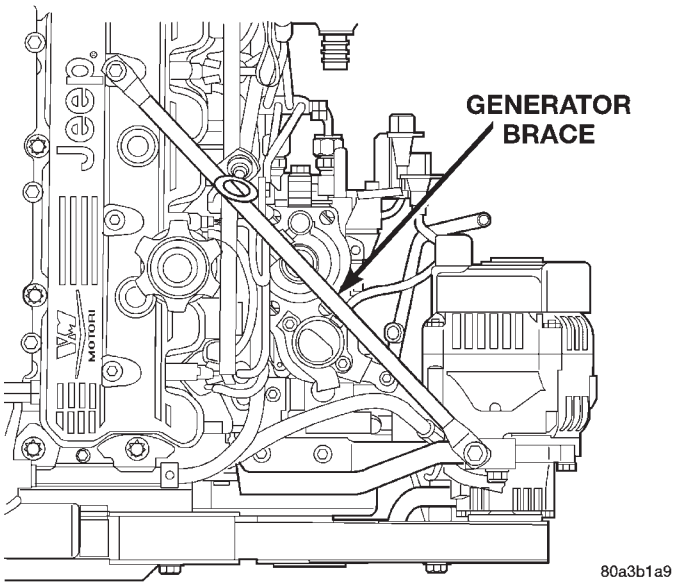

Fig. 13 Generator Brace

(6) Remove Crankcase breather hose from rear of the valve cover
(7) Remove the upper radiator hose and coolant tank hose.
(8) Remove water manifold.
(9) Loosen cylinder head cover bolts and raise cylinder head cover.
(10) Raise vehicle on hoist.
(11) Support transmission with a suitable jack.
(12) Remove lower attaching bolt.
(13) Remove entire crossmember.
(14) Take the lowest brake line on dash out of all the mounting clips (RHD Vehicles only).
(15) Lower the entire transmission and transfer case assembly approximately 130 mm.

WARNING: Ensure the transmission and transfer case are adequately supported.

(16) Remove the engine cylinder head cover.

INSTALLATION

(1) Position valve cover on cylinder heads.
(2) Raise the entire transmission and transfer case assembly approximately 130 mm.
(3) Reinstall the lowest brake line on dash into all the mounting clips (RHD Vehicles only).
(4) Install the entire crossmember.
(5) Install the lower attaching bolt.
(6) Install transmission support.

REMOVAL AND INSTALLATION (Continued)

(7) Lower vehicle.
(8) Install valve cover, tighten nuts to 19 N·m (168 in. lbs.).
(9) Connect crankcase breather hose.
(10) Install water manifold and tighten bolts to 12 N·m (106 in. lbs.).
(11) Install generator support brace.
(12) Connect coolant tank hose to water manifold.
(13) Connect the upper radiator hose.
(14) Connect the A/C lines to compressor and install bracket on cylinder head cover, if equipped with air conditioning.
(15) Connect negative cable to battery.
(16) If equipped with A/C, evacuate and charge the air conditioning system (refer to Group 24, Heater and Air Conditioning).
(17) Fill the cooling system. Check for leaks.

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

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

HYDRAULIC TAPPETS

REMOVAL

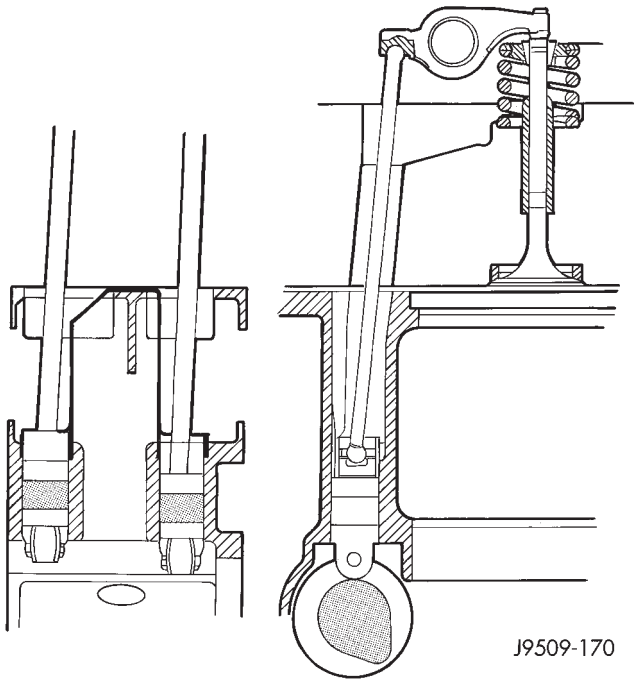

Fig. 14 Tappet And Rocker Arm Assembly

(1) Remove the air cleaner.
(2) Remove cylinder head cover (refer to cylinder valve cover removal in this section).
(3) Remove rocker assembly and push rods (Fig. 14). Identify push rods to ensure installation in original location.
(4) Remove cylinder head, intake manifold, and exhaust manifold, refer to cylinder head removal in this section.
(5) Remove yoke retainer and aligning yokes (Fig. 15).

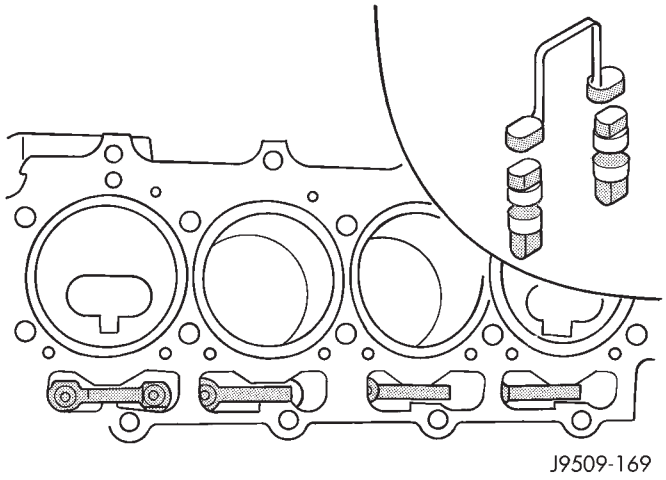

Fig. 15 Tappet And Yoke

(6) Slide Hydraulic Tappet Remover/Installer Tool through opening in block 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.

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

INSTALLATION

(1) Lubricate tappets.
(2) Install tappets and yoke retainers in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).
(3) Install cylinder head, intake manifold, and exhaust manifold, refer to cylinder head installation in this section.
(4) Install push rods in original positions.

REMOVAL AND INSTALLATION (Continued)

(5) Install rocker arms (refer to rocker arms in this section).

(6) Install cylinder head cover (refer to cylinder valve cover installation in this section).

(7) 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.

ROCKER ARMS AND PUSH RODS

REMOVAL

(1) Disconnect the battery cables.

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

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

(4) Remove generator bracket.

(5) Remove breather hose.

(6) Remove cylinder head cover.

(7) Remove rocker retaining nut (Fig. 16).

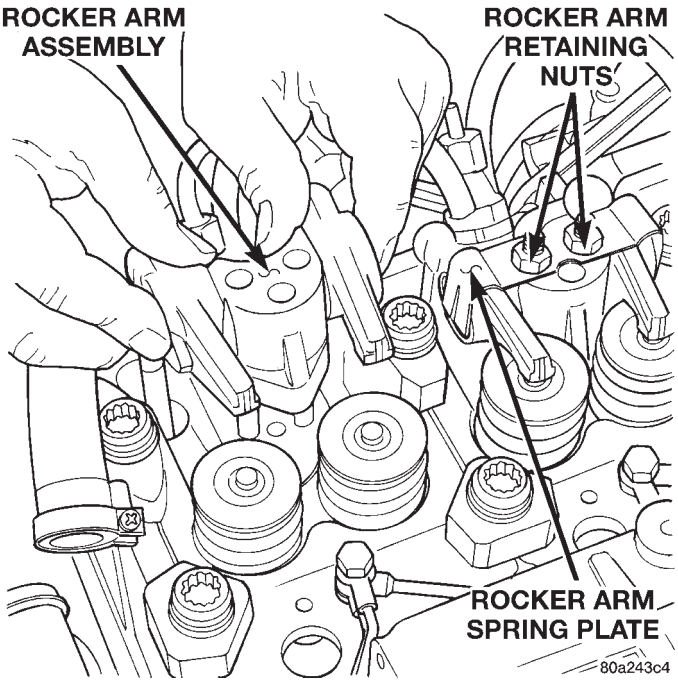

Fig. 16 Rocker Arm Retaining Nut

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

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

INSTALLATION

(1) Rotate the crankshaft until the mark lines up with the TDC mark on the timing cover.

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

(3) Install rocker arm assemblies in the same order as removed. Tighten the rocker arm nuts to 29.4 N·m (264 in. lbs.) torque.

(4) Install cylinder head cover, torque nuts to 19 N·m (168 in. lbs.).

(5) Install breather hose.

(6) Install generator bracket, tighten bolts to 7 N·m (4 ft. lbs.).

(7) Connect the service valves to the A/C compressor ports, if equipped with air conditioning.

(8) If equipped, evacuate and charge the air conditioning system (refer to Group 24, Heater and Air Conditioning).

(9) Connect battery cable.

VALVE SPRINGS

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

REMOVAL

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

(1) Remove the engine cylinder head cover, refer to cylinder head cover removal in this section.

(2) Remove rocker arms assemblies for access to each valve spring to be removed.

(3) Remove push rods. Retain the push rods, and rocker arms assemblies in the same order and position as removed.

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

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

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

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

(8) Remove valve spring and retainer.

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

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install valve spring and retainer.

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

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

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

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

(6) Install the rocker arm assemblies, at their original location.

(7) Tighten the rocker arm assembly nut to 35 N·m (26 ft. lbs.) torque.

(8) Install the engine cylinder head cover, refer to cylinder head cover installation in this section.

ENGINE CYLINDER HEAD

REMOVAL

(1) Disconnect the battery cable.

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

(2) Drain the cooling system (refer to Group 7, Cooling).

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

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

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

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

(7) Remove generator support bracket.

(8) Loosen cylinder head cover bolts.

(9) Raise vehicle on hoist.

(10) Remove transmission crossmember bolts, and lower rear of engine.

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

(12) Remove water manifold and recovery hose.

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

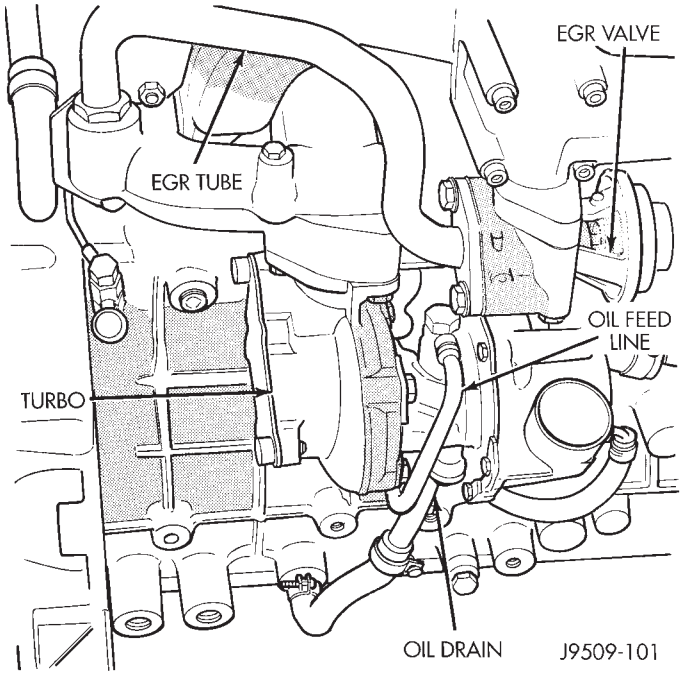

Fig. 17 Turbocharger

(14) Disconnect EGR tube from EGR valve.

(15) Remove EGR valve

(16) Remove exhaust heat shield from exhaust manifold.

(17) Remove exhaust heat shield from down pipe.

(18) Remove exhaust down pipe from turbocharger (Fig. 17).

(19) Disconnect oil feed line from turbocharger.

(20) Disconnect oil drain line from turbocharger.

(21) Remove Exhaust manifold (refer to Group 11, Exhaust System and Intake Manifold).

(22) Remove Intake manifold (refer to Group 11, Exhaust System and Intake Manifold).

(23) Remove oil feed line for rocker arm assemblies (Fig. 18).

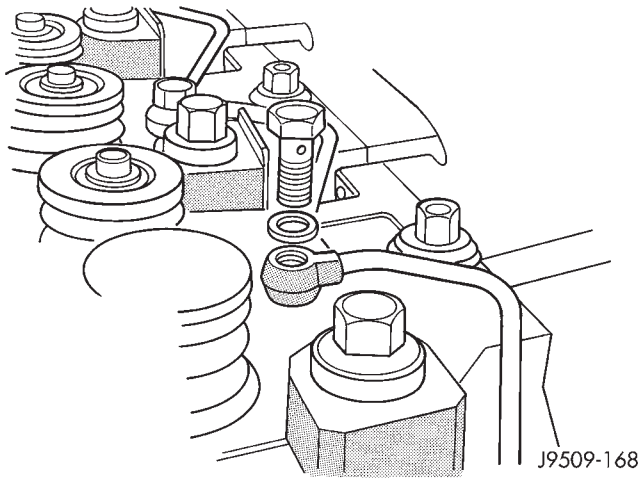

Fig. 18 Rocker Arm Oil Feed Lines

REMOVAL AND INSTALLATION (Continued)

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

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

(26) Remove fuel lines, fuel filter, refer to Group 14, Fuel Systems.

(27) Remove injector fuel lines from injectors to pump.

(28) Remove fuel injectors with tool VM-1012A (Fig. 19) (refer to Group 14, Fuel System).

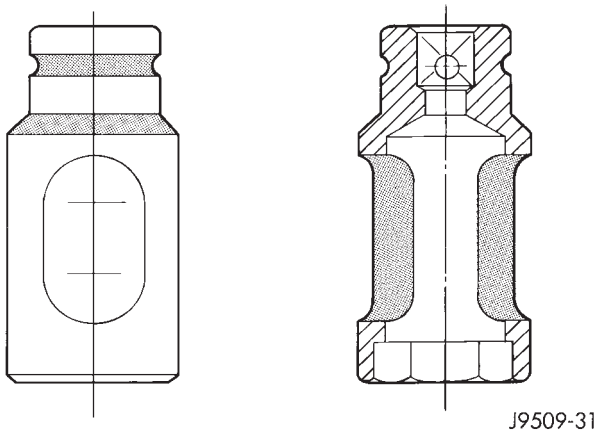

Fig. 19 Fuel Injector Tool VM-1012A

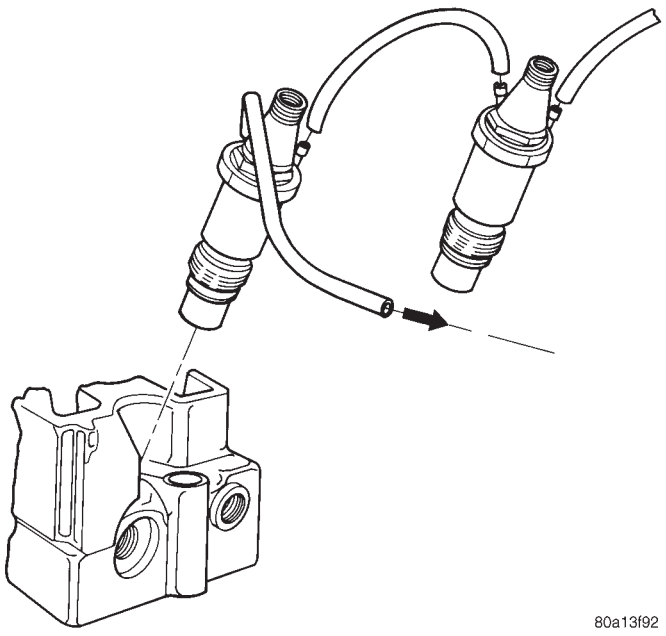

Fig. 20 Fuel Injector

(29) Remove the engine cylinder head cover.

(30) Remove rocker retaining nuts (Fig. 21).

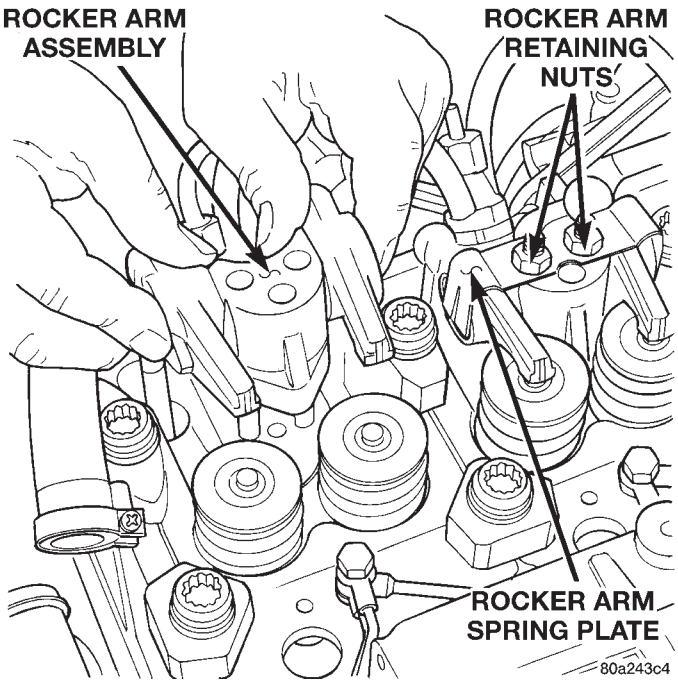

Fig. 21 Rocker Arm Retaining Nuts

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

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

(33) Mark cylinder head positions.

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

(35) Remove the engine cylinder head and gasket.

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

CYLINDER HEAD GASKETS

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

Cylinder head gaskets are available in three thicknesses. Identification holes in the right front corner of the gasket indicate the thickness of the gasket (Fig. 22).

REMOVAL AND INSTALLATION (Continued)

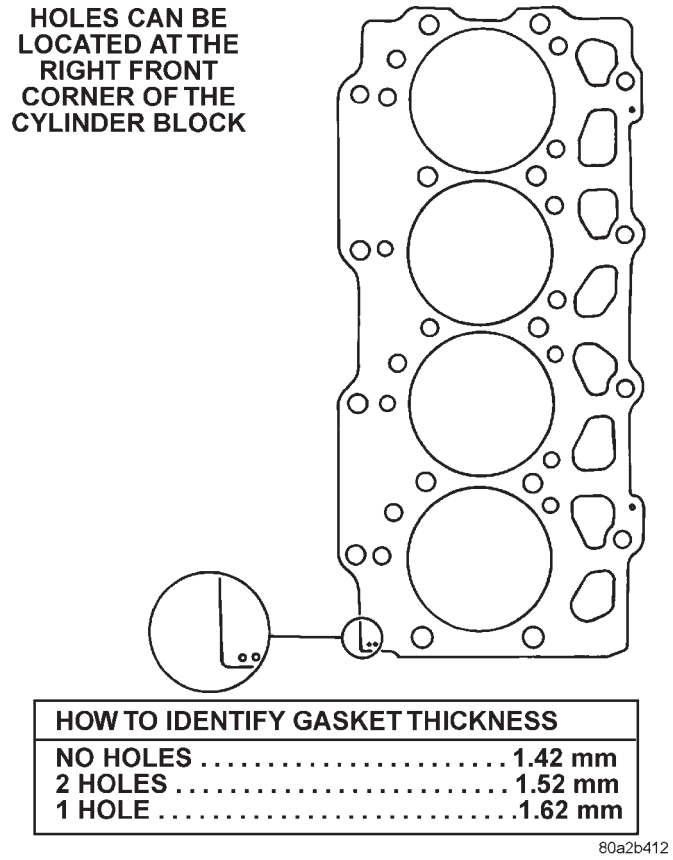

Fig. 22 Steel Type Cylinder Head Gasket—identification

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

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

MEASURING PISTON PROTRUSION

(1) Use special tool VM-1010 with dial indicator special tool VM-1013 (Fig. 23).

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

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

(4) Setup the dial indicator on the piston crown (above the center of the piston pin) 5mm (1/8 in.) from the edge of the piston and note the measurement (Fig. 24).

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

(6) Establish the thickness of the steel gasket for all four cylinder heads on the basis of the greatest piston protrusion (Fig. 22).

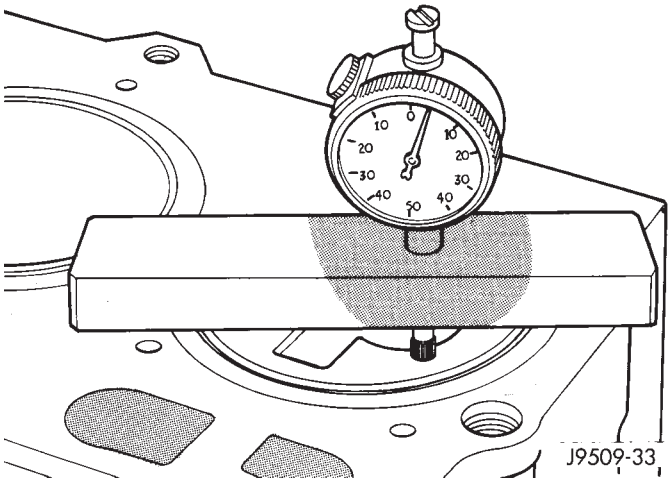

Fig. 23 Measuring Piston Protrusion

Measured dimension (mm)	0.53 - 0.62
Cyl. head gasket thickness (mm)	1.42
Piston clearance (mm)	0.80 - 0.89
Measured dimension (mm)	0.63 - 0.72
Cyl. head gasket thickness (mm)	1.52
Piston clearance (mm)	0.80 - 0.89
Measured dimension (mm)	0.73 - 0.82
Cyl. head gasket thickness (mm)	1.62
Piston clearance (mm)	0.80 - 0.89

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Fig. 24 Piston Protrusion Chart

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

INSTALLATION

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

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

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

(4) Place the engine cylinder head over the dowels.

CAUTION: New cylinder head bolts should be used.

(5) Tighten the engine cylinder head bolts in sequence according to the following procedure (Fig. 25):

(a) The threads and underside heads of the bolts should be lubricated. Use the cylinder head alignment studs tool number VM-1009. Position the heads on the block and secure with the ten large center bolts and spacers (clamps), finger tight only. Be sure that the various clamps are installed correctly and the head gaskets remain in their proper

REMOVAL AND INSTALLATION (Continued)

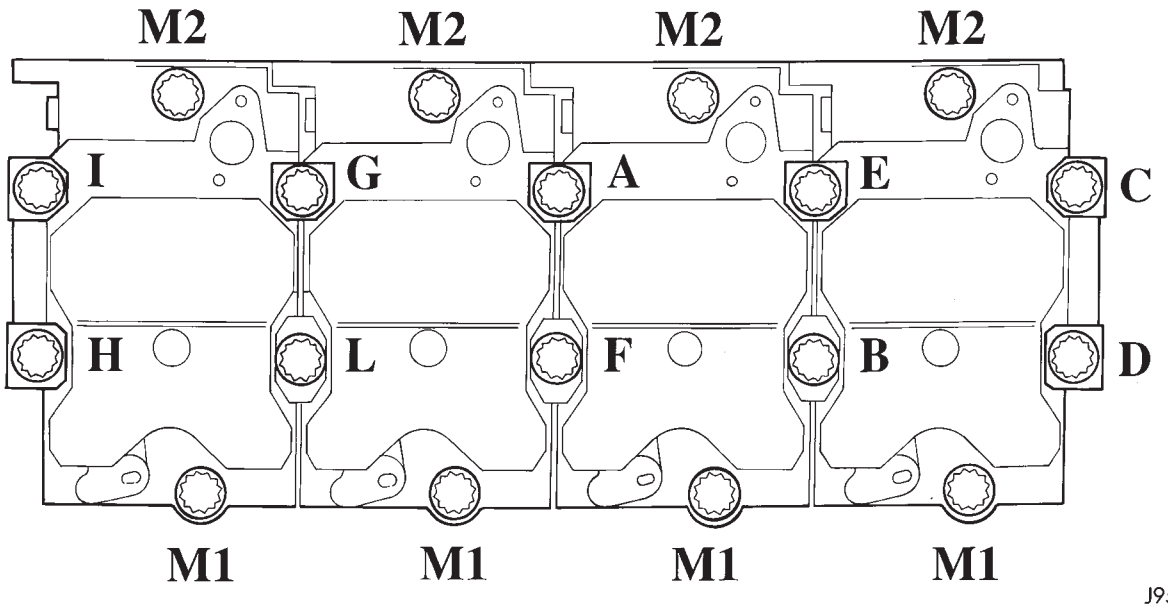

Fig. 25 Engine Cylinder Head Bolt Tightening Sequence

position, completely covered. Then, lubricate and install the eight small bolts, also finger tight.

(6) Hand tighten oil feed line for rocker arm assemblies

(7) Install the intake and exhaust manifolds with new gaskets, partially tightening the nuts to a maximum of 5 N·m (44 in. lbs.). This will align the heads (refer to Group 11, Exhaust System and Intake Manifold for the proper procedures).

(8) Then, tighten the 12mm bolts with special tool VM-1019 in the following manner:

1st Phase: Head Bolts Tightening -- (Fig. 25)

Central bolts (A-L): Tighten all bolts, starting with bolt A then B-C-D-E-F-G-H-I-L, to 30 N·m. Repeat the operation with the same torque. Following the same sequence rotate each bolt through an angle of 70° using angle torque tool. Then rotate the bolts an additional 70° following tightening sequence.

(9) Then, tighten the 14mm bolts with special tool VM-1018 in the following manner:

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

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

(10) 2nd Phase: After 20 minutes of engine operation at operating temperature, allow engine to cool down completely. Then re-torque the head bolts as follows:

Central bolts A-L: Starting from bolt A, slacken and re-torque it immediately to 30 N·m + 65°. Rotate the bolt an additional 65°. Then proceed in the same way, bolt by bolt, following alphabetical order, as indicated.

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

(11) Tighten intake nuts to 30 N·m (22 ft. lbs.) and exhaust manifolds nuts to 30 N·m (22 ft. lbs.) specified torque after completing Phase 2.

If the engine cylinder head is to be replaced and the original valves used, measure the valve stem diameter. Only standard size valves can be used with a service replacement engine cylinder head unless the replacement head valve stem guide bores are reamed to accommodate oversize valve stems. Remove all carbon buildup and reface the valves.

(12) Tighten oil feed lines for rocker arm assemblies to 13 N·m (112 in. lbs.).

(13) Install push rods and rocker arm assemblies, tighten nut to 35 N·m (26 ft. lbs.).

(14) Install valve cover, tighten nuts to 19 N·m (168 in. lbs.).

(15) Connect crankcase breather hose.

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

(17) Install turbocharger oil feed line, tighten banjo bolts to 27 N·m (20 ft. lbs), and install oil drain line to turbocharger.

(18) Install water manifold and tighten bolts to 12 N·m (106 in. lbs.).

(19) Install generator support bracket.

(20) Raise vehicle on hoist.

REMOVAL AND INSTALLATION (Continued)

(21) Install transmission crossmember bolts
(22) Install exhaust down pipe to turbocharger, tighten bolts to 22 N·m (16 ft. lbs.).
(23) Install exhaust down pipe heat shield.
(24) Install exhaust heat shield, Tighten bolts to 11 N·m (8 ft. lbs.).
(25) Install EGR valve to intake manifold, tighten bolts to 26 N·m (19 ft. lbs.).
(26) Install EGR tube to EGR valve, tighten bolts to 26 N·m (19 ft. lbs.).
(27) Install lower Charge air cooler hose to turbocharger.
(28) Install air cleaner assembly and hose.
(29) Install oil breather hose to air cleaner hose.
(30) Install upper charge cooler hose to turbocharger.
(31) Connect recover bottle hose to water manifold.
(32) Install fuel injectors use tool VM-1012 (refer to Group 14, Fuel System).
(33) Install fuel injector lines from the pump to injectors, tighten nuts to 23 N·m (17 ft. lbs.).
(34) Connect the A/C lines to compressor and install bracket on cylinder head cover, if equipped with air conditioning.
(35) Install fuel filter, Tighten bolts to 28 N·m (250 in. lbs.)
(36) Connect the fuel supply and return lines
(37) Connect the upper radiator hose.
(38) Connect negative cable to battery.
(39) If equipped with A/C, evacuate and charge the air conditioning system (refer to Group 24, Heater and Air Conditioning).
(40) Fill the cooling system. Check for leaks.

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

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

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

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

CYLINDER HEAD RE-TORQUE

Within the first 20,000 km after rebuild, retorque the head bolts as follows: (Fig. 25) Central bolts A-L: Without slackening the bolts, following alphabetical order tighten the bolts through an angle of 15°. Side bolts M1-M2: Without slackening, tighten M1 then M2 bolts through an angle of 15°.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the battery cable.
(2) Remove fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.
(3) Remove accessary drive belt, (refer to Group 7, Cooling).

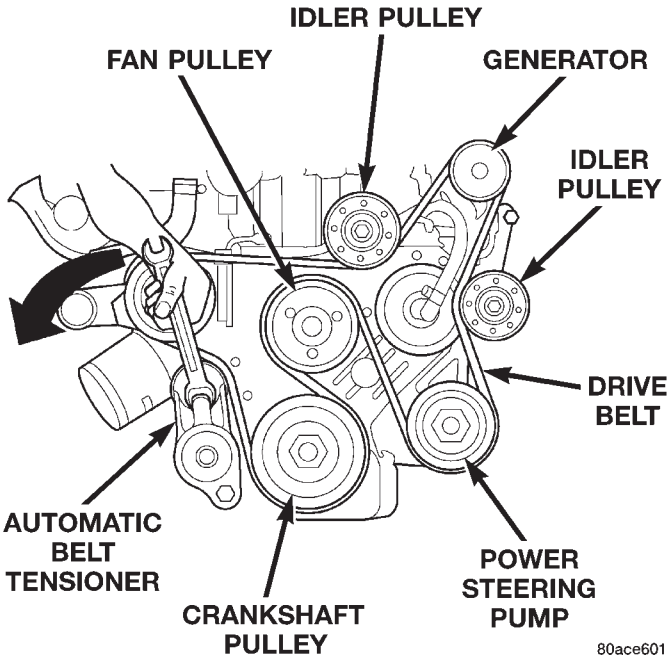

Fig. 26 Accessary Drive System

(4) Remove vibration damper nut.
(5) Install tool VM-1000-2 to remove vibration damper (Fig. 27).

INSTALLATION

(1) Install vibration damper and align with key way.
(2) Install vibration damper nut and tighten to 160 N·m (118 ft. lbs.).
(3) Install accessary drive belt (refer to Group 7, Cooling).
(4) Connect the battery cable.

REMOVAL AND INSTALLATION (Continued)

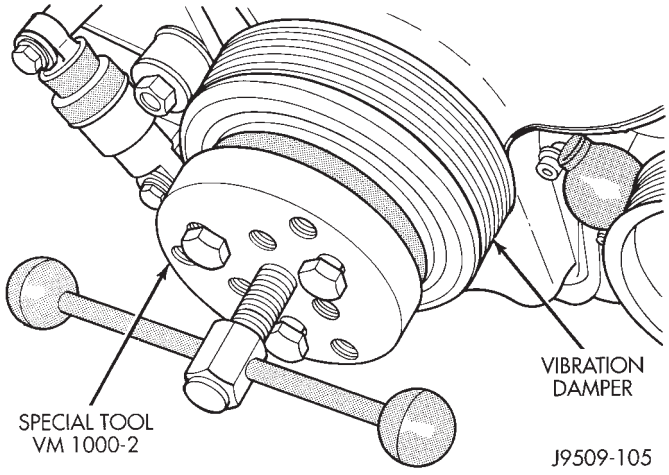

Fig. 27 Vibration Damper Removal With Tool VM-1000-2

TIMING CASE COVER OIL SEAL

REMOVAL

(1) Disconnect the battery cable.
(2) Remove vibration damper (refer to vibration damper removal in this section).
(3) Pry out seal.

INSTALLATION

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

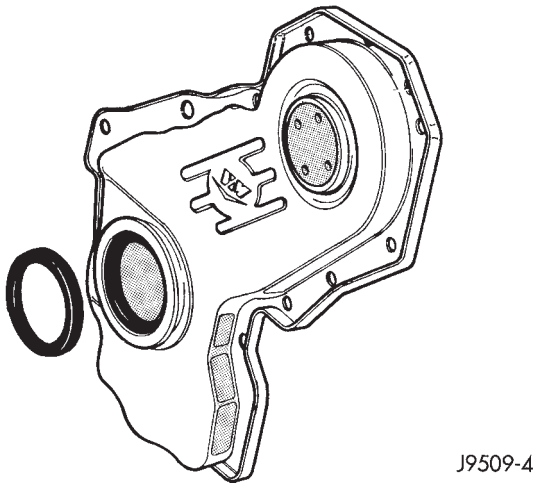

Fig. 28 Front Cover Seal

TIMING CASE COVER

REMOVAL

(1) Disconnect the battery cable.
(2) Remove fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.
(3) Remove accessary drive belt, (refer to Group 7, Cooling).
(4) Remove vibration damper nut.
(5) Install tool VM-1000-2 to remove vibration damper.
(6) Remove fan pulley.
(7) Remove idler pulley and bracket. Idler pulley bolt have left hand threads.
(8) Remove the automatic belt tensioner.
(9) Disconnect the oil drain back hose from external vacuum pump to timing cover.
(10) Remove Power steering pulley.
(11) Remove cover.

INSTALLATION

(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.
(2) Apply a continuous 3 mm bead of Silicone Sealer (Fig. 29) to timing cover, install within 10 minutes, tighten 6mm bolts to 10.3 N·m (91 in. lbs) and tighten 8mm bolts to 26.2 N·m (19 ft. lbs.).

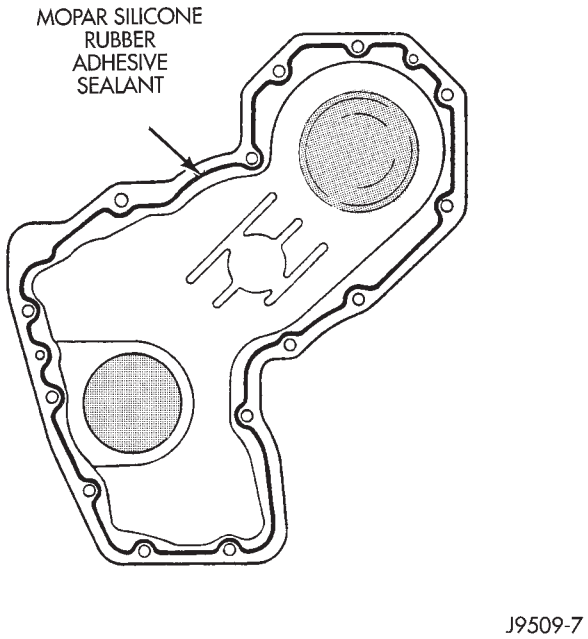

Fig. 29 Front Cover Sealer Location

REMOVAL AND INSTALLATION (Continued)

(3) Install Power steering pulley, tighten to 130 N·m (96 ft. lbs.).
(4) Connect oil drain to cover.
(5) Install automatic belt tensioner.
(6) Install idler pulley bracket, tighten bolts to 40 N·m (29 ft. lbs.).
(7) Install idler pulley, bolt has left hand thread, tighten to 65 N·m (48 ft. lbs.).
(8) Install fan pulley, tighten bolts to 56 N·m (41 ft. lbs.).
(9) Install vibration damper align with keyway.
(10) Tighten vibration damper nut to 160 N·m (118 ft. lbs.).
(11) Install accessary drive belt (refer to Group 7, cooling for procedure).
(12) Install fan and fan shroud (refer to Group 7, Cooling for procedure).
(13) Connect battery cable.

CAMSHAFT

REMOVAL

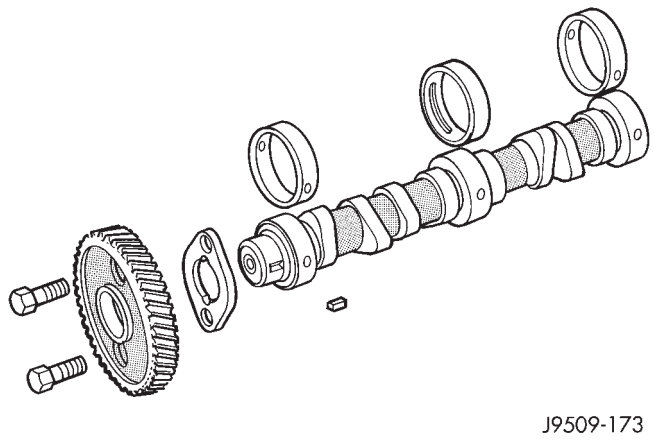

Fig. 30 Camshaft Assembly

(1) Disconnect the battery cable.
(2) Remove valve cover, refer to valve cover removal in this section.
(3) Remove cylinder head (refer to cylinder head removal in this section).
(4) Remove rocker arms, push rods, and hydraulic tappets, refer to the respective groups in this section.
(5) Remove fan and set fan inside fan shroud then remove fan shroud and fan as an assembly.
(6) Remove accessary drive belt.
(7) Remove radiator (refer to Group 7, Cooling).
(8) Remove A/C condenser (refer to Group 24, Heating and Air Conditioning).
(9) Remove vibration damper, refer to vibration damper removal in this section.
(10) Remove power steering pulley.
(11) Remove timing case cover, refer to timing case cover removal in this section.
(12) Unscrew flange bolts and remove camshaft (Fig. 31).

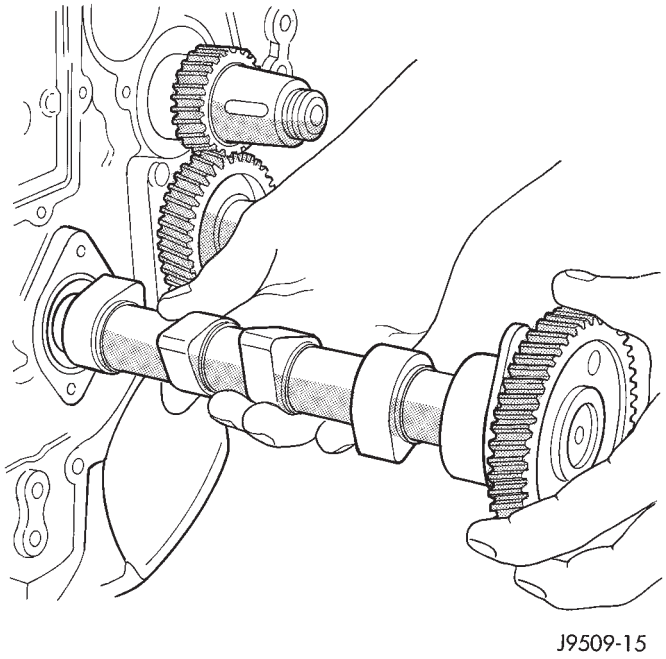

Fig. 31 Camshaft Removal

THRUST PLATE INSPECTION

Check the thickness (Fig. 32) of the plate at points a-b-c-d. If the measurement is not between 3.950 - 4.050 it must be changed.

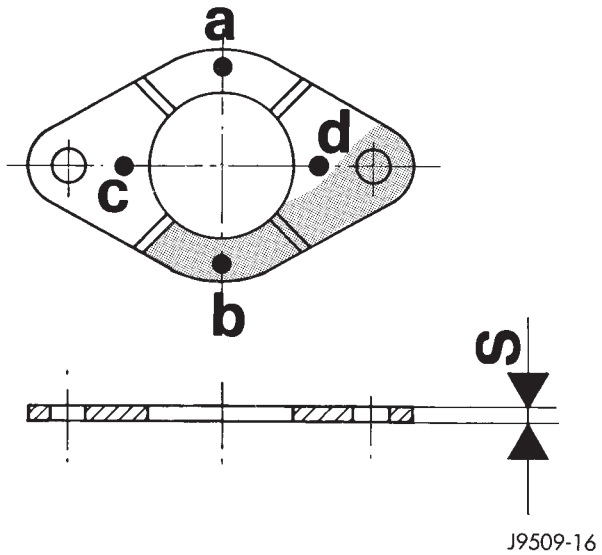

Fig. 32 Camshaft Thrust Plate

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Coat the camshaft journals with clean engine oil and carefully install the camshaft complete with thrust plate and gear. Tighten retaining bolts to 24 N·m (18 ft. lbs.) torque. Be sure to align the timing marks as shown (Fig. 33).

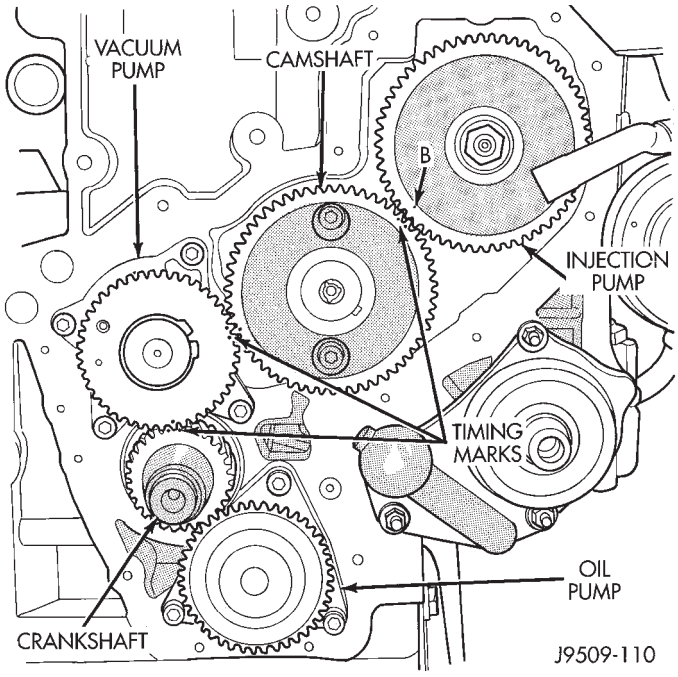

Fig. 33 Timing Marks

(2) Install hydraulic tappets and retaining yokes.

(3) Install cylinder heads (refer to cylinder heads in this section).

(4) Push rods, and rocker arm assemblies, refer to the respective sections.

(5) Install valve cover (refer to valve cover installation in this section).

(6) Install Timing case cover (refer to the timing case cover installation in this section).

(7) Install Vibration damper (refer to the vibration installation in this section).

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

(9) Install radiator (refer to group 7, Cooling).

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

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

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

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

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

CAMSHAFT BEARINGS

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

REMOVAL

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

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

INSTALLATION

(1) Install new camshaft bearings with Camshaft Bearing Remover/Installer Tool 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 rear plate o-ring at the rear of camshaft. **Be sure this seal does not leak.**

OIL PAN

REMOVAL

(1) Disconnect battery cable.

(2) Raise vehicle on hoist.

(3) Drain oil.

(4) Remove oil pan lower bolts on sump.

(5) Remove bolts from lower oil pan. Remove the 4 bolts that are on the inside of the oil pan.

(6) Remove oil pan.

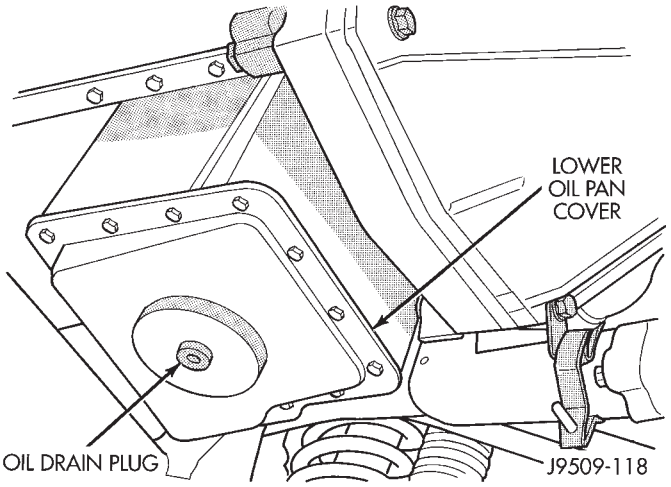

Fig. 34 Oil Pan

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Remove all gasket material from cylinder block. Be careful not gouge or scratch aluminum pan sealing surface.

(2) Install oil pan. Apply a continuous 3 mm bead of Silicone Sealer to oil pan, install within 10 minutes.

(3) Install inside oil pan bolts and torque bolts to 11 N·m (8 ft. lbs.).

(4) Install lower oil pan bolts and torque to 11 N·m (8 ft. lbs.).

(5) Install oil drain plug tighten to 79 N·m (58 ft. lbs).

(6) Lower vehicle.

(7) Fill engine with proper amount of oil.

(8) Connect battery cable.

OIL PUMP

REMOVAL

(1) Remove front cover, (refer to front cover removal in this section).

(2) Remove oil pump (Fig. 35).

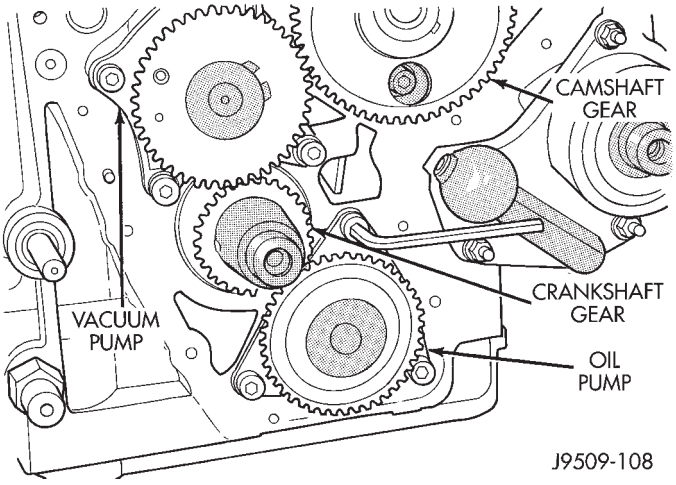

Fig. 35 Oil Pump Removal

INSTALLATION

(1) Install new O-ring and lubricate with clean engine oil.

(2) Install oil pump and tighten retaining screws to 24.5-29.9 N·m (22.7-28.3 ft. lbs.). Check for normal backlash between pump and crankshaft gears.

(3) Install front cover, refer to front cover installation in this section.

INTERNAL VACUUM PUMP

REMOVAL

(1) Remove the front cover refer to front cover removal in this section.

(2) Remove 4 bolts.

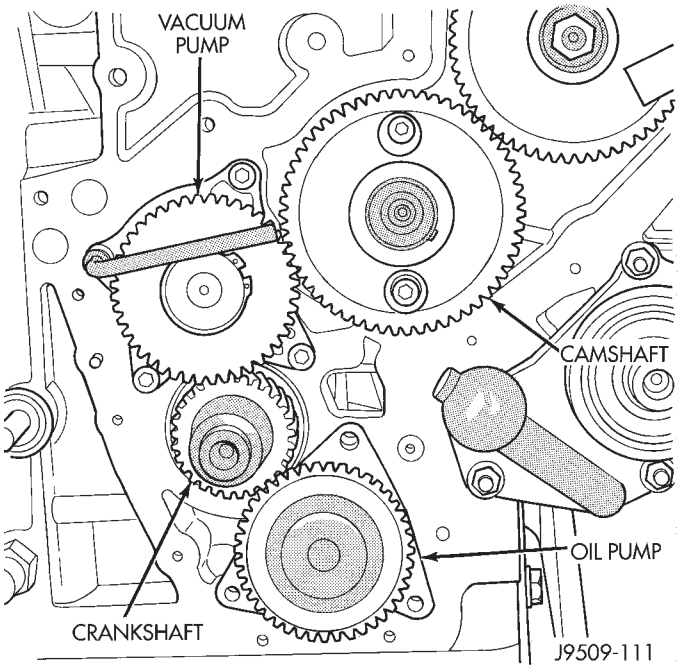

Fig. 36 Vacuum Pump

(3) Remove internal vacuum pump. Vacuum gear has a spring-loaded friction wheel which eliminates backlash and thus reduces running noise. This braces the two wheels against one another and offsets the teeth so that the backlash is eliminated between the meshing gears.

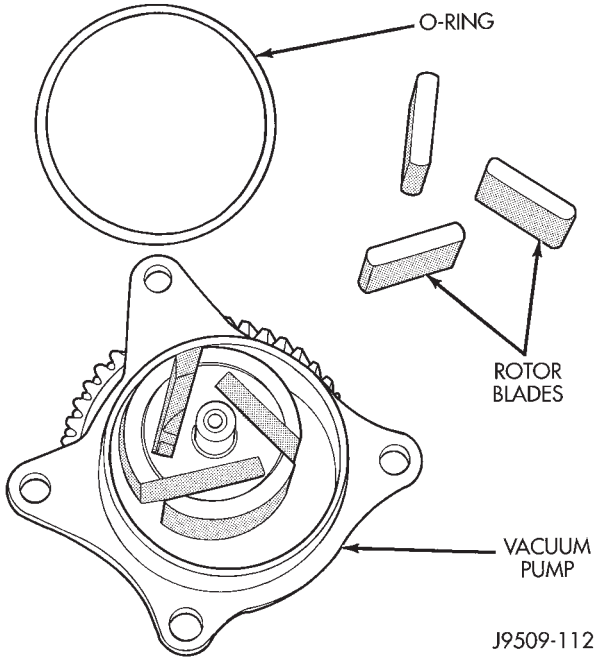

Fig. 37 Vacuum Pump Parts

REMOVAL AND INSTALLATION (Continued)

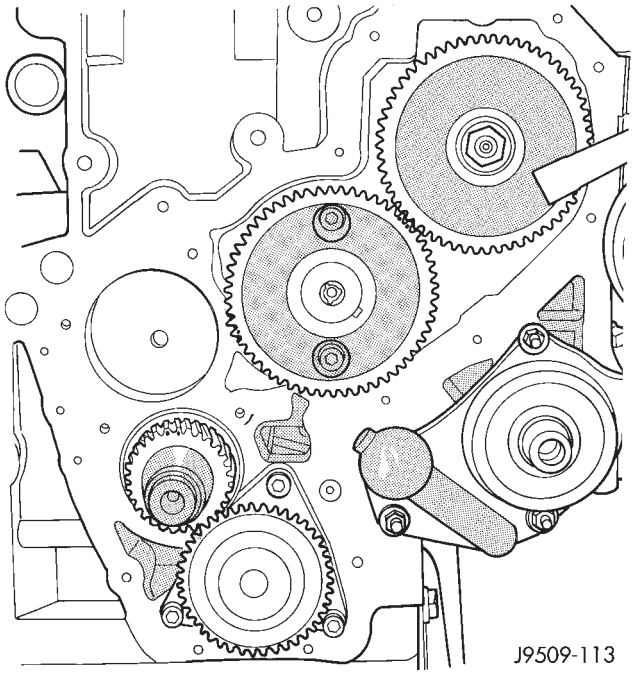

Fig. 38 Vacuum Pump Mounting Hole

INSTALLATION

(1) To install the vacuum pump, align the outer part of the gear with the inner part using a screwdriver or similar tool, align with timing marks on gear set and install.

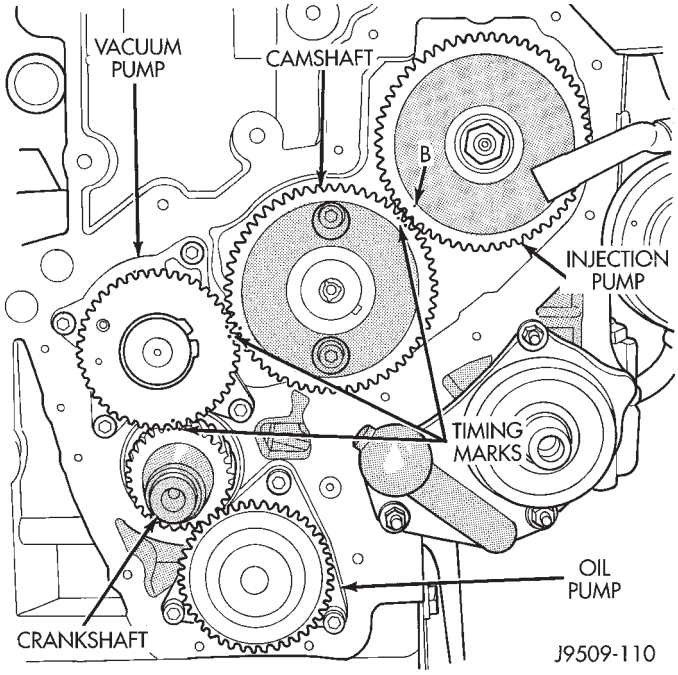

Fig. 39 Timing Marks

(2) Install bolts and tighten to 20 N·m (15 ft. lbs.).

(3) Install front cover.

OIL PUMP PRESSURE RELIEF VALVE

REMOVAL

(1) Remove oil pan.

(2) Remove clip retaining relief valve.

(3) Remove relief valve cap, spring, and plunger (Fig. 40).

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

(5) Check plunger for scoring, replace if necessary.

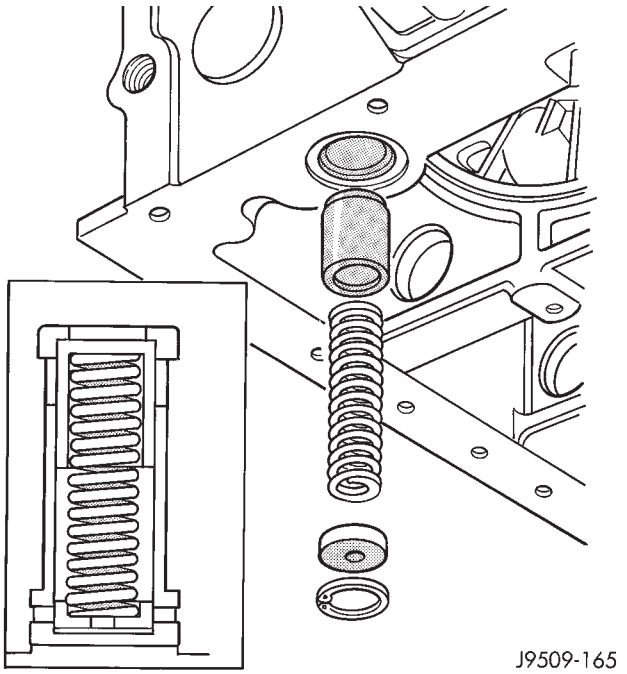

Fig. 40 Oil Pressure Relief Valve

INSTALLATION

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

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

(3) Compress spring and install retaining clip. Ensure clip is completely seated in groove.

OIL FILTER ADAPTER

REMOVAL

(1) Remove oil filter.

(2) Remove oil filter adapter with socket wrench.

(3) Remove oil filter base, allen bolt in center of adapter.

REMOVAL AND INSTALLATION (Continued)

(4) Remove oil cooler adapter bolt.
(5) Remove oil cooler (Fig. 41).

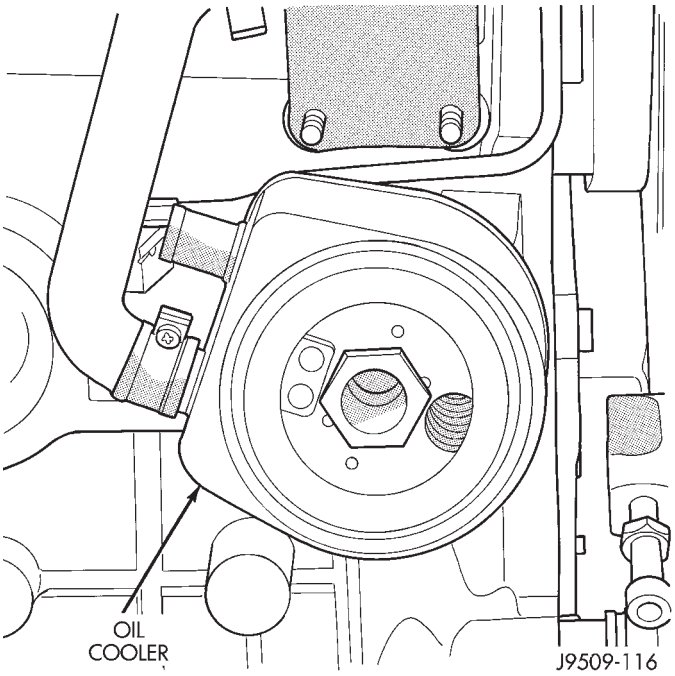

Fig. 41 Oil Cooler

INSTALLATION

(1) Install oil cooler with new gasket, tighten oil cooler adapter bolt to 60 N·m (44 ft. lbs.).
(2) Install oil filter base with new o-ring and tighten bolt to 46.6 N·m (34 ft. lbs.).
(3) Install oil filter adapter to oil filter base and tighten to 46.6 N·m (34 ft. lbs.).
(4) Install oil filter and tighten to 18 N·m (13 ft. lbs.) and add oil.

PISTONS AND CONNECTING ROD ASSEMBLY

REMOVAL

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

NOTE: Be careful not to nick crankshaft journals.

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

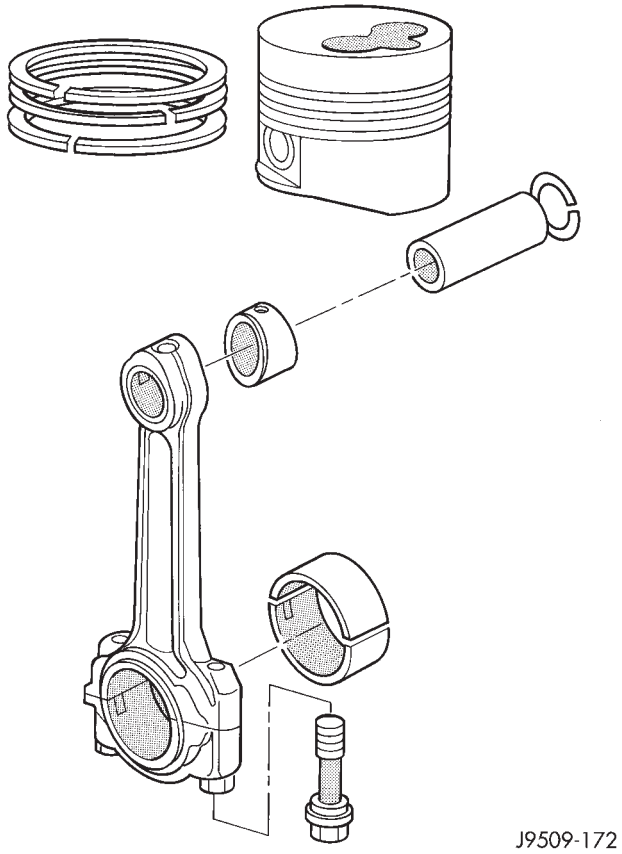

Fig. 42 Piston Assembly

PISTON PIN—REMOVAL

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

PISTON RING—REMOVAL

(1) ID mark on face of upper and intermediate piston rings must point toward piston crown.
(2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 43).
(3) Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
(4) Carefully clean carbon from piston crowns, skirts and ring grooves ensuring the 4 oil holes in the oil control ring groove are clear.

REMOVAL AND INSTALLATION (Continued)

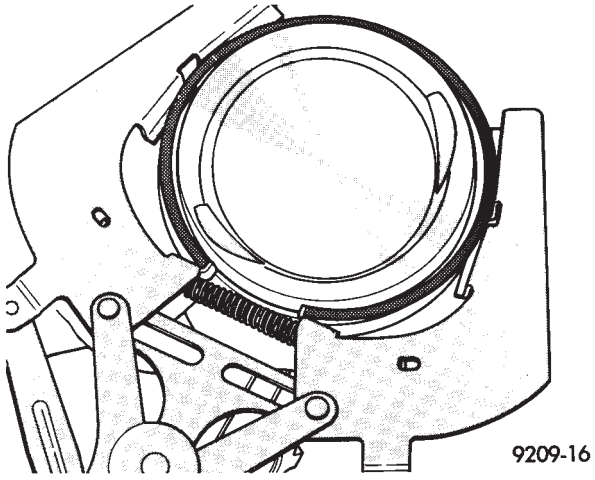

Fig. 43 Piston Rings—Removing and Installing

PISTON RING FITTING

(1) Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of cylinder bore. Check gap with feeler gauge. Top compression ring gap .25 to .50mm (.0098 to .0196 in.). Second compression ring gap .25 to .35mm (.0098 to .0137 in.). Oil control ring gap .25 to .58mm (.0098 to .0228 in.).

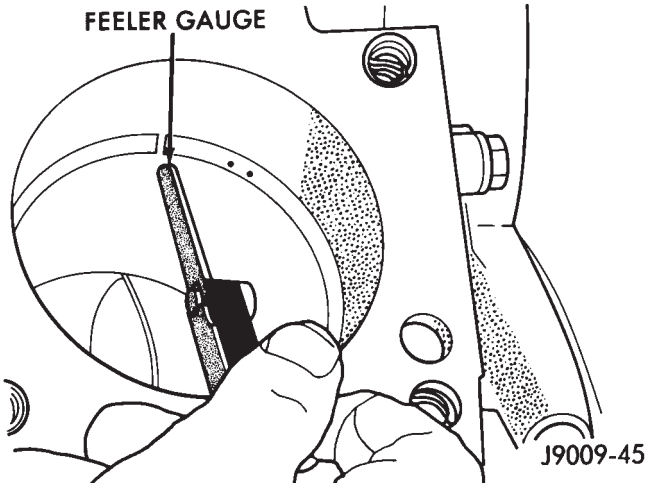

Fig. 44 Ring Gap Measurement

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

(3) Check piston ring to groove clearance. Top compression ring gap .08 to .130mm (.0031 to .0051 in.). Second compression ring gap .070 to .102mm (.0027 to .0040 in.). Oil control ring gap .040 to .072mm (.0015 to .0028 in.).

PISTON RINGS—INSTALLATION

(1) Install rings on the pistons using a suitable ring expander (Fig. 46).

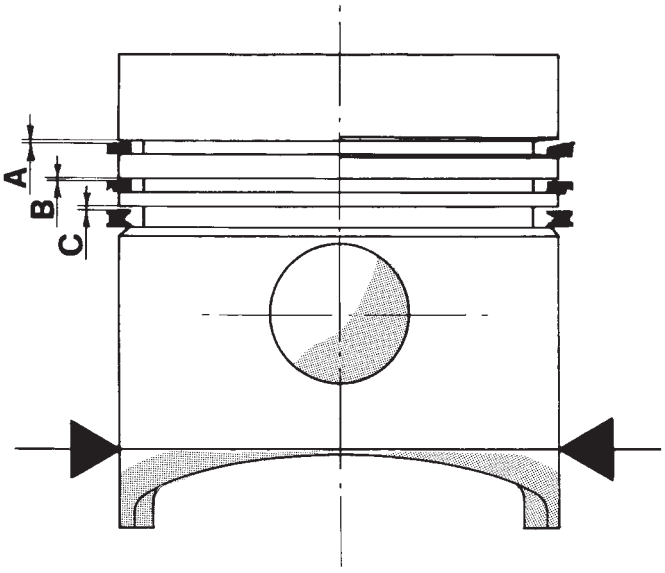

Fig. 45 Piston Ring Side Clearance

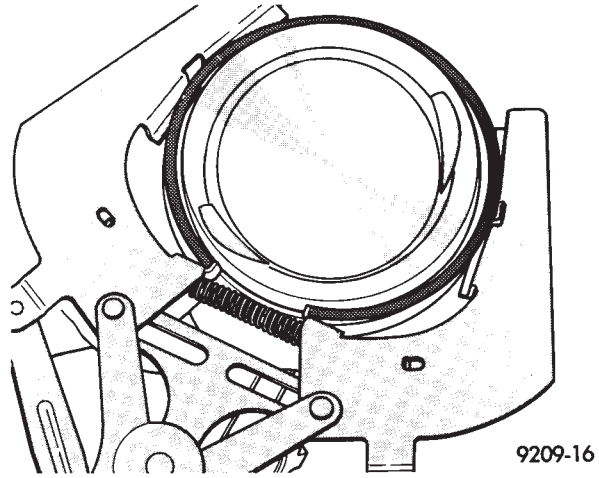

Fig. 46 Piston Rings—Removing and Installing

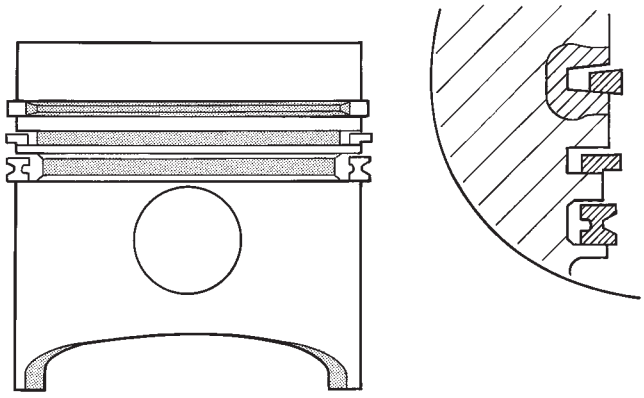

Fig. 47 Piston Ring Identification

REMOVAL AND INSTALLATION (Continued)

(2) Top compression ring is tapered and chromium plated. The second ring is of the scraper type and must be installed with scraping edge facing bottom of the piston. The third is an oil control ring. Ring gaps must be positioned, before inserting piston into the liners, as follows (Fig. 48).

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

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

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

(6) When assembling pistons check that components are installed in the same position as before disassembly, determined by the numbers stamped on the crown of individual pistons. Engine cylinders are numbered starting from gear train end of the engine. **Face chamber recess side of piston towards camshaft** . Therefore, the numbers stamped on con rod big end should also face in the same direction. To insert piston into cylinder use a ring compressor as shown in (Fig. 46).

PISTON PIN INSTALLATION

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

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

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

INSTALLATION

(1) Before installing pistons, and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap (Fig. 48).

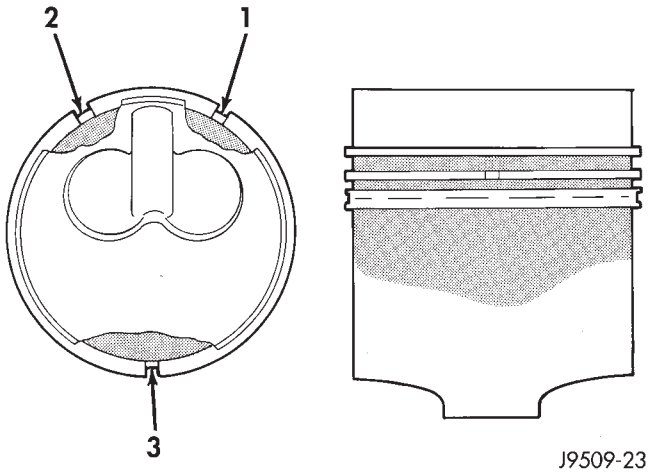

Fig. 48 Piston Ring Gap Location

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown in (Fig. 48).

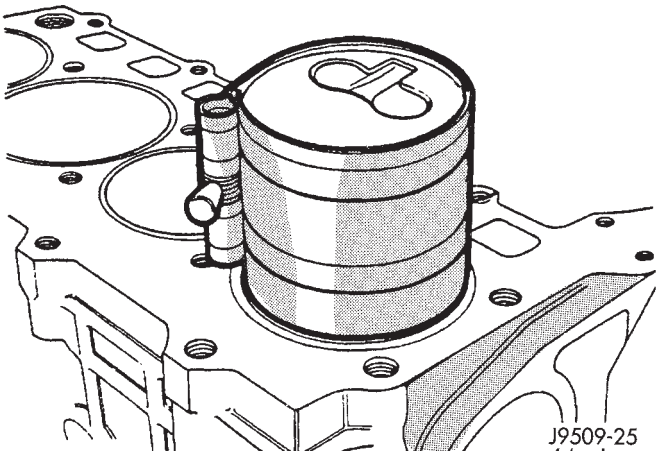

Fig. 49 Installing Piston

(3) Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston and tighten with the special wrench (Fig. 49). **Ensure position of rings does not change during this operation**.

REMOVAL AND INSTALLATION (Continued)

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

(5) Install connecting rod bolt protectors on rod bolts.

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

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

(8) Install rod caps. Install nuts on cleaned and oiled rod bolts and tighten nuts to 29.5 N·m (22 ft. lb.) plus 60°.

CYLINDER WALL LINER ASSEMBLY

REMOVAL

(1) Remove cylinder heads.
(2) Remove Oil pan.
(3) Remove pistons.
(4) Use tool VM-1001 to remove liners (Fig. 50).

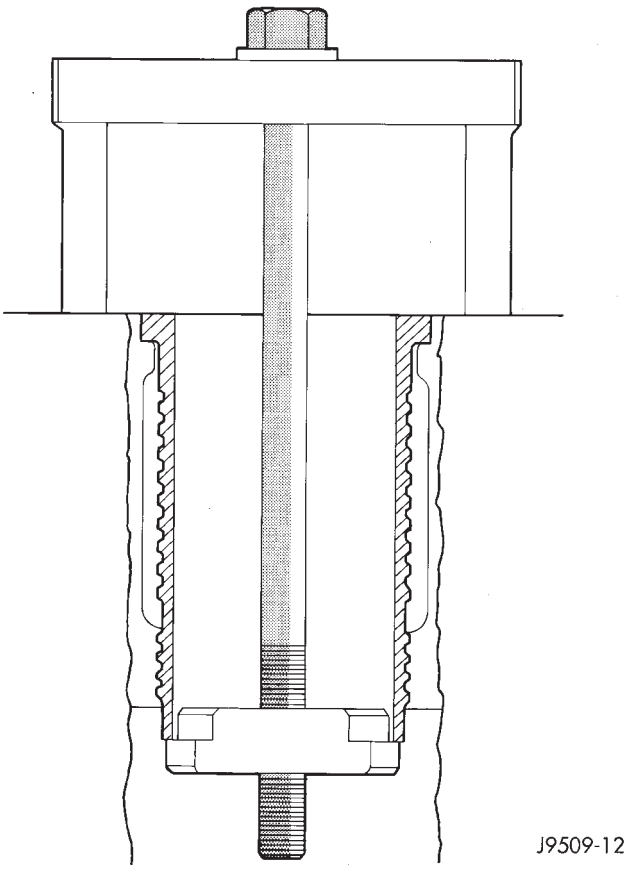

Fig. 50 Liner Removal Tool

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

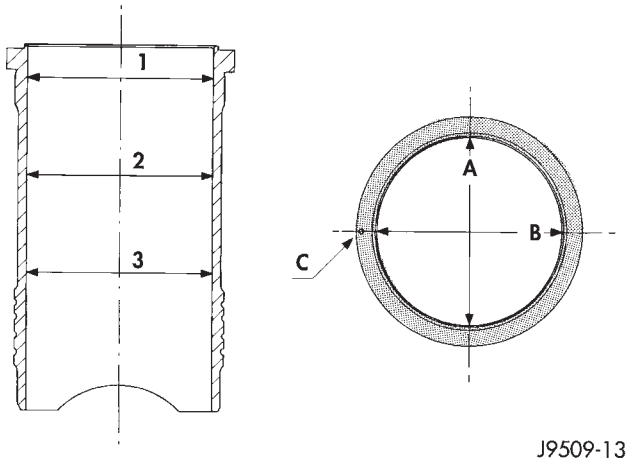

Fig. 51 Liner Inspection

INSTALLATION

(1) Carefully clean residual LOCTITE from liner and crankcase, and degrease the crankcase where it comes into contact with the liners. Install the liners in the crankcase as shown (A), rotating them back and forth by 45° in order to guarantee correct positioning (Fig. 52).

REMOVAL AND INSTALLATION (Continued)

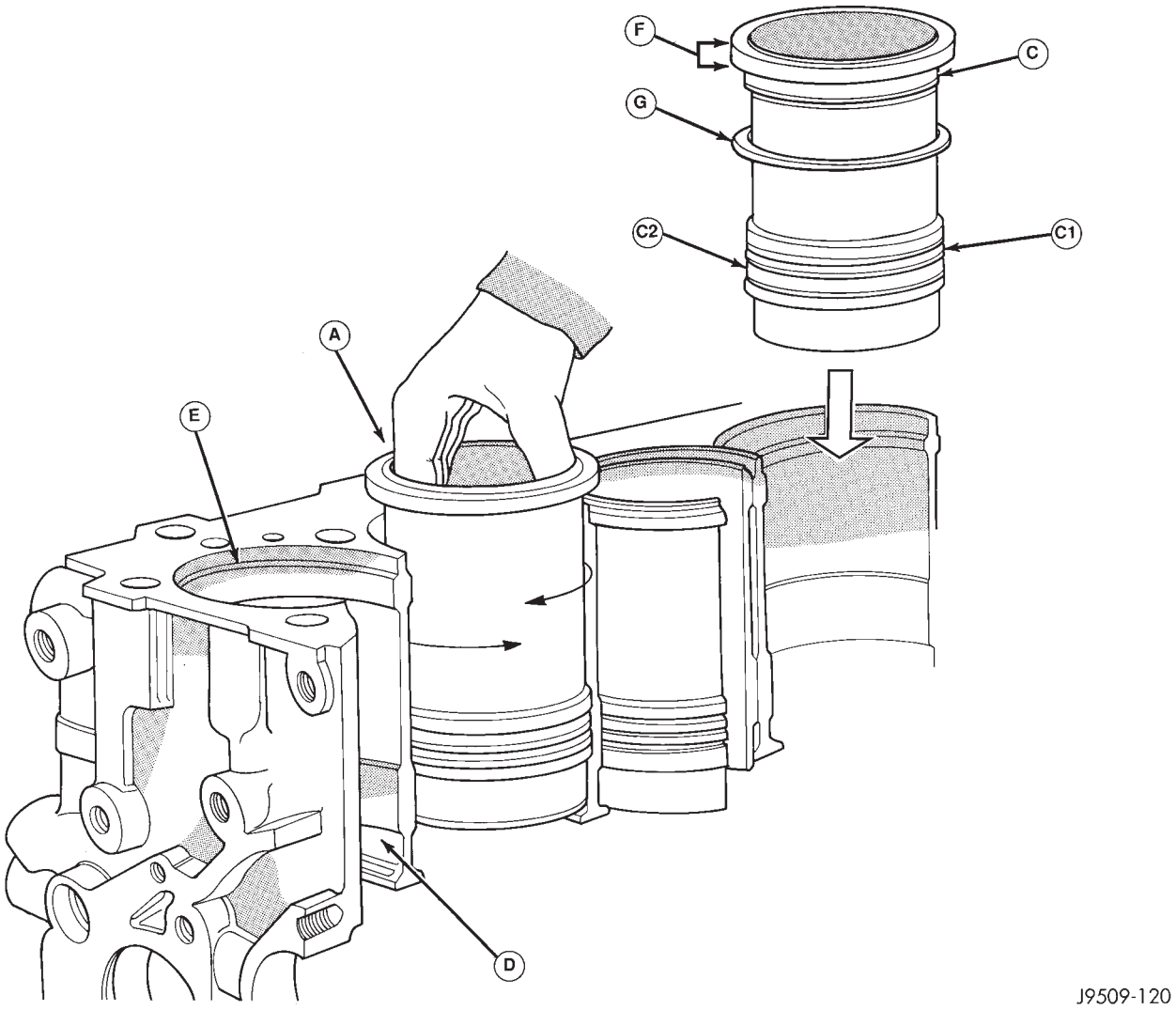

Fig. 52 Liner Installation

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

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

(4) Remove liner and special tool.

(5) Then select the correct shim thickness to give proper protrusion (0.01 - 0.06 mm).

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

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

(8) Fit the liners in the crankcase making sure that the shim is positioned correctly in the seat. Lock the liners in position using special tool (VM-1016) and bolts (Fig. 53). Clean the residual LOCTITE on the upper surface of the block deck.

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

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

REMOVAL AND INSTALLATION (Continued)

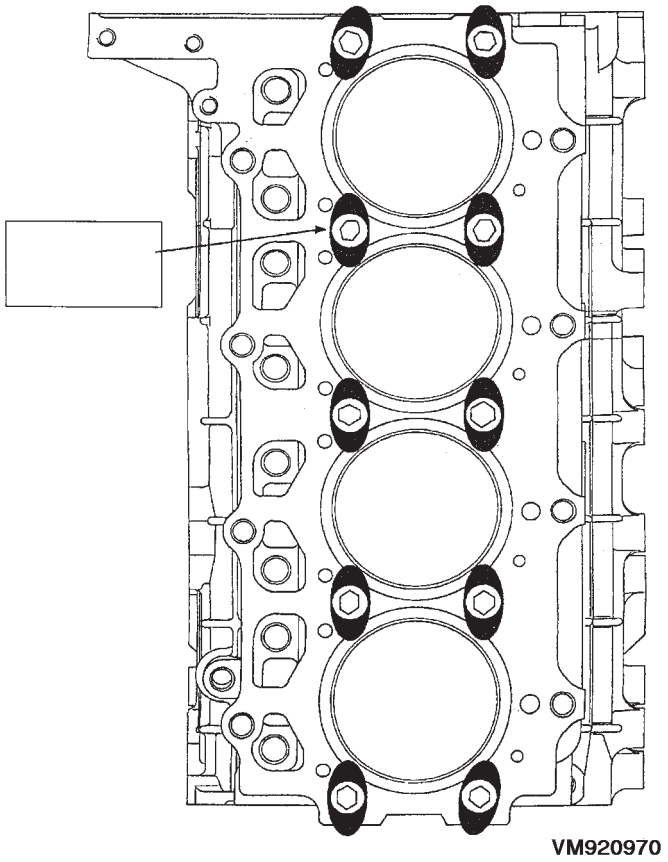

Fig. 53 Liner Clamp Location

CRANKSHAFT MAIN BEARINGS

REMOVAL

(1) Disconnect battery cable.
(2) Remove engine from vehicle, refer to engine removal in this section.
(3) Install engine to engine stand.
(4) Remove accessary drive system.
(5) Remove cylinder head cover, refer to cylinder head cover removal in this section.
(6) Remove rocker arm and push rods, refer to rocker arm and push rod section in this section.
(7) Remove intake, exhaust manifold and turbo-charger, refer to Group 11, Exhaust System and Intake Manifold.
(8) Remove water manifold.
(9) Remove oil feed lines to rocker arms.
(10) Remove cylinder heads.
(11) Remove oil pan and oil pick-up.
(12) Remove piston and connecting rods from crankshaft journals.
(13) Remove pistons and connecting rods from block.
(14) Remove vibration damper, refer to vibration damper removal in this section.
(15) Remove front cover, refer to front cover removal in this section.
(16) Remove oil pump and vacuum pump from block.

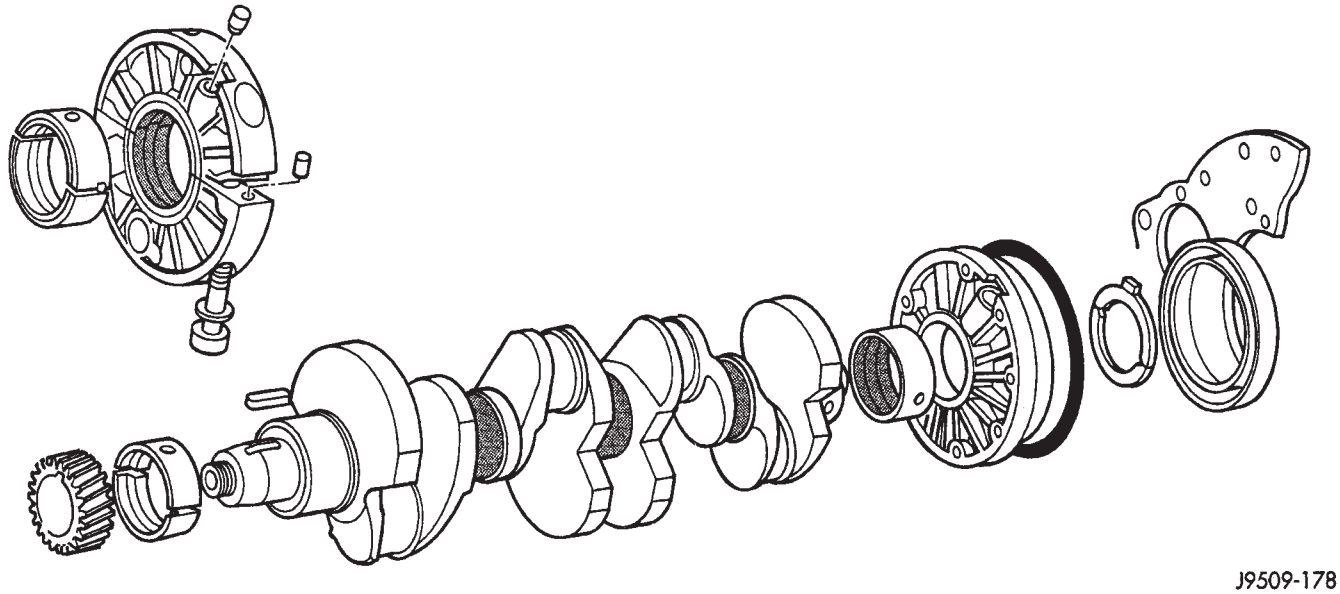

Fig. 54 Crankshaft and Bearing Assembly

REMOVAL AND INSTALLATION (Continued)

(17) Install special tool VM-1004 onto crankshaft over gear (Fig. 55).

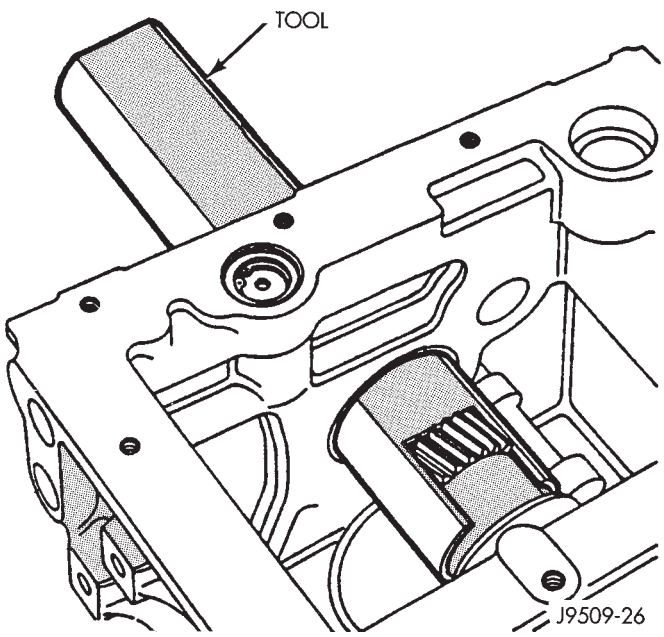

Fig. 55 Crankshaft Special Tool VM-1004

(18) Remove main bearing oil feed and carrier locators from block.

(19) Remove flywheel and adaptor plate from engine block.

(20) Remove thrust bearings from rear main bearing carrier.

(21) Slide crankshaft and bearing carriers rearward to rear of block. If you encounter difficulty in removing the complete assembly as previously described, slide the assembly rearward sufficiently to gain access to the main bearing carrier bolts. Mark the carriers for assembly and remove the bolts, two for each carrier (Fig. 56).

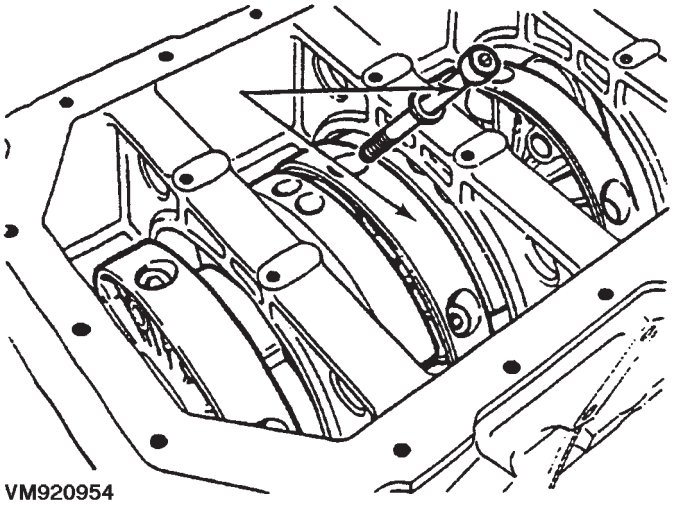

Fig. 56 Carrier Bolts

(22) Separate the two halves of each carrier, remove from the crankshaft and temporarily re-assemble the carriers (Fig. 57). Withdraw the crankshaft through the rear of the crankcase.

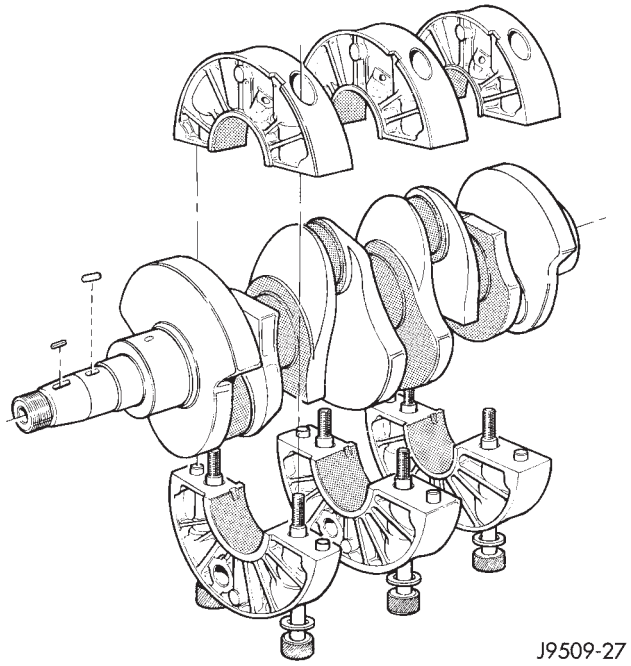

Fig. 57 Crankshaft and Carrier Bearing Assembly

INSTALLATION

(1) Fit main bearing carriers together and torque to 42 N·m (31 ft. lbs.)

(2) Check internal diameter of bearings.

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

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

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

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

(6) Install new main bearing shells in each of the carrier halves. Assemble the carriers to the crankshaft journals, ensuring that the carriers are installed in their original locations and that the **piston jet notch is towards the front of the crankshaft** . Secure each carrier with the two bolts tightening evenly to 42 N·m (31 ft. lbs.). Check that the oil jet is in position (Fig. 57).

REMOVAL AND INSTALLATION (Continued)

(7) Slide special tool (VM-1002) over the crankshaft gear and, insert the crankshaft and carrier assembly into the crankcase in the same manner used for removal.

(8) Align the holes in the lower carriers, with the center of the crankcase webs (Fig. 58).

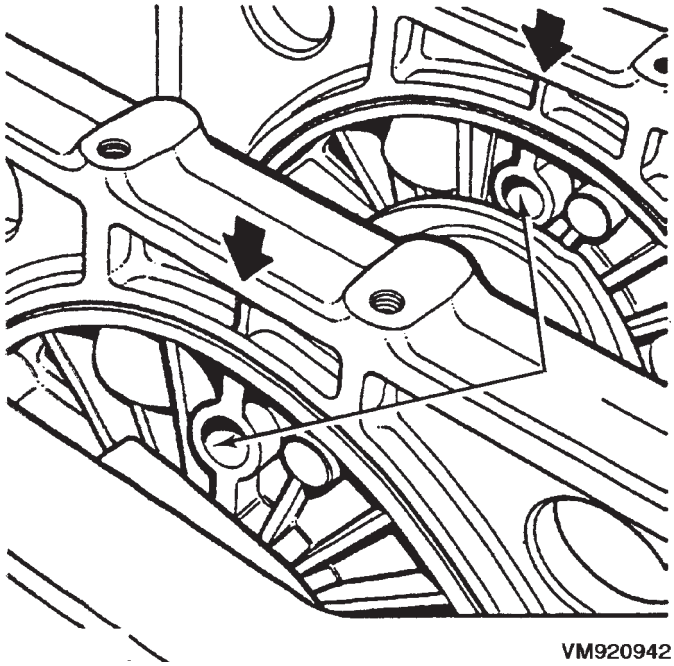

Fig. 58 Main Bearing Carrier Alignment

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

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

(11) Install rear oil seal.

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

(13) Install adaptor plate and tighten bolts to 47 N·m (35 ft. lbs.).

(14) Install bolts to main bearing carrier and tighten to 26.5 N·m (20 ft. lbs.).

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

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

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

(17) Attach dial indicator to engine block.

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

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

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

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

(22) Remove tools and flywheel.

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

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

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

(26) Measure crankshaft end play with a dial gauge. Crankshaft end play should not exceed .153 to .304mm (.0060 to .0119 in.) (Fig. 59).

(27) Mount flywheel on crankshaft. Lightly oil and install NEW bolts, tightening to 20 N·m in diametrically opposite pairs. Check that all bolts are at 20 N·m. Tighten each bolt a further 60° +0-5°, tightening bolts in diametral pairs. Check that all bolts are tightened to 130 N·m.

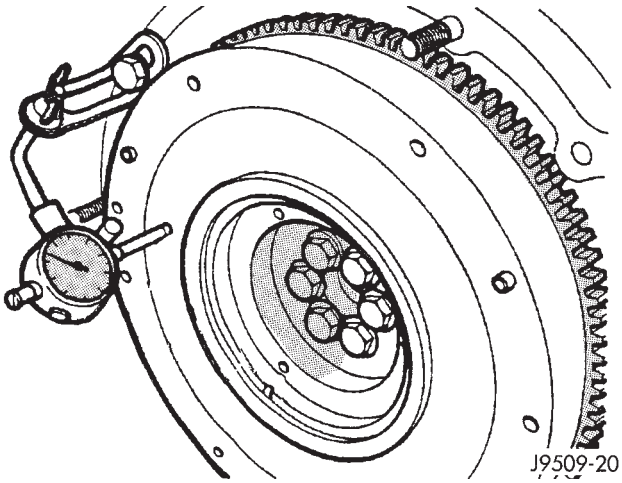

Fig. 59 Measuring Crankshaft End Play

(28) Install pistons and connecting rod assemblies, refer to piston and connecting rods in this section.

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

(30) Install oil pan, refer to oil pan installation in this section.

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

REMOVAL AND INSTALLATION (Continued)

(32) Before installing oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 60). Difference between A and B should be 0.020-0.082 mm (.0007 to 0032 in.).

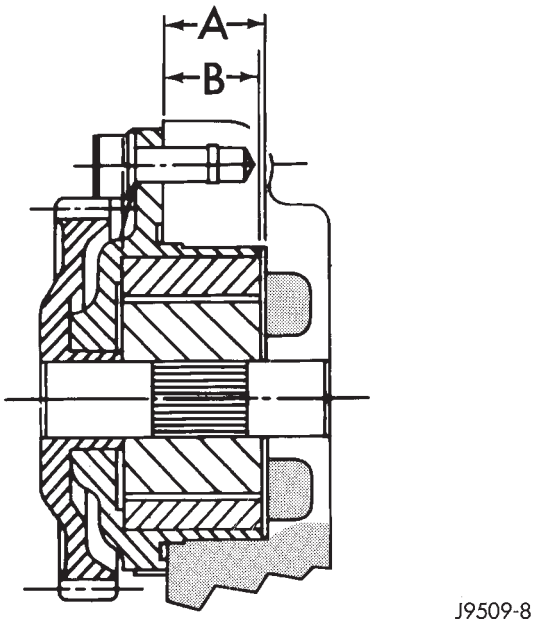

Fig. 60 Oil Pump Bore Depth

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

(34) Install front cover, refer to front cover installation in this section.

(35) Install vibration damper, refer to vibration damper installation in this section.

(36) Install cylinder heads, refer to cylinder head installation in this section.

(37) Install rocker arms and push rods, refer to rocker arm and push rod in this section.

(38) Install cylinder head cover, refer to cylinder head cover in this section.

(39) Install accessary drive system.

(40) Install engine in vehicle, refer to engine installation in this section.

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

(42) Connect battery cable.

DISASSEMBLY AND ASSEMBLY

HYDRAULIC TAPPETS

DISASSEMBLE

(1) Pry out plunger retainer spring clip.

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

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

ASSEMBLE

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

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

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

(4) Assemble tappets.

CLEANING AND INSPECTION

CYLINDER HEAD

CLEANING

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

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

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

INSPECTION

Use a straightedge and feeler gauge to check the flatness of the engine cylinder head and block mating surfaces (Fig. 61).

Minimum cylinder head thickness 89.95mm (3.541 in.)

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

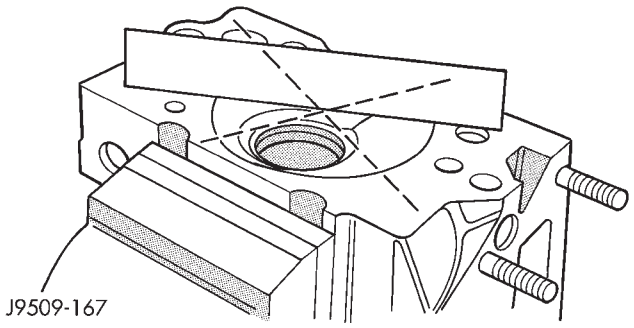

Fig. 61 Checking Cylinder Head Flatness

CLEANING AND INSPECTION (Continued)

ROCKER ARMS AND PUSH RODS

CLEANING

Clean all the components (Fig. 62) with cleaning solvent.

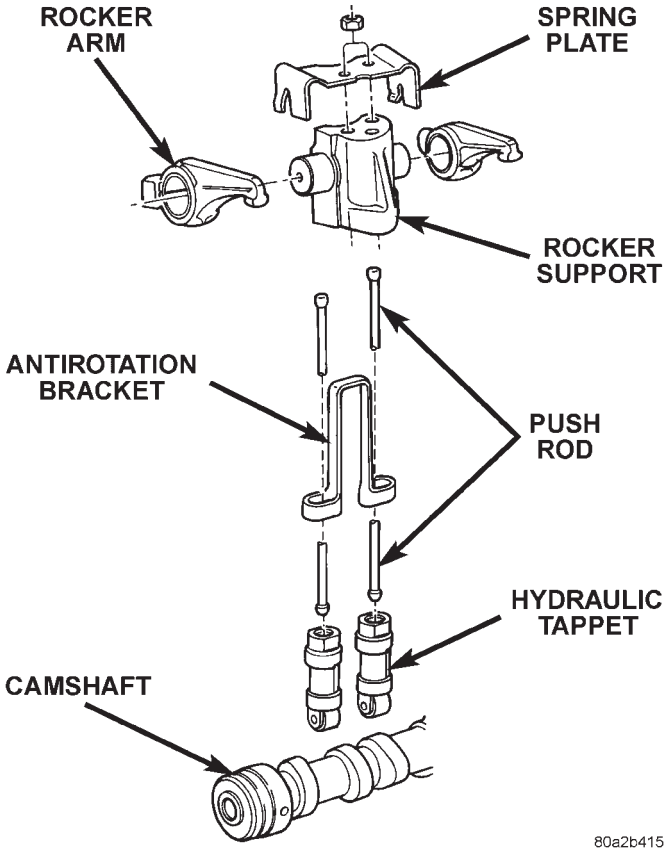

Fig. 62 Rocker Arm Components

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

INSPECTION

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

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

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

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

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

PISTONS AND CONNECTING ROD ASSEMBLY

INSPECTION—PISTONS

(1) Piston Diameter: Size Group A: 91.93-91.94mm (3.6191-3.6196 in.) Size Group B: 91.94-91.95mm (3.6196-3.6200 in.). Maximum wear limit .05mm (.0019 in.).

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

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

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

(5) The clearance between the cylinder liner and piston should not exceed 0.25 mm (.0009 in.).

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

INSPECTION—CONNECTING ROD

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

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

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

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

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

NOTE: On one side of the big end of the con-rod there is a two-digit number which refers to the weight category. On the other side of the big end there is a four digit number on both the rod and the cap. These numbers must both face the camshaft as well as the recess on the piston crown (Fig. 64). Lightly heat the piston in oven. Insert piston pin in position and secure it with provided snap rings.

CLEANING AND INSPECTION (Continued)

The Four digit numbers marked on con rod big end and rod cap must be on the same side as the camshaft (Fig. 64). After having coated threads with Molyguard, tighten con rod bolts to 29 N·m (21 ft. lbs.) plus 60°.

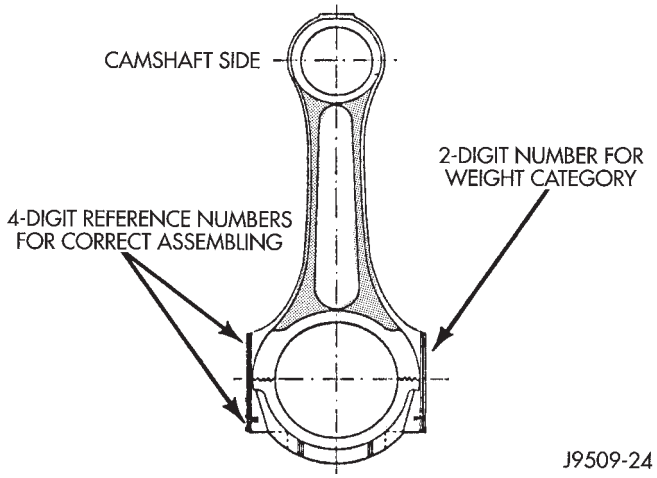

Fig. 63 Connecting Rod Identification

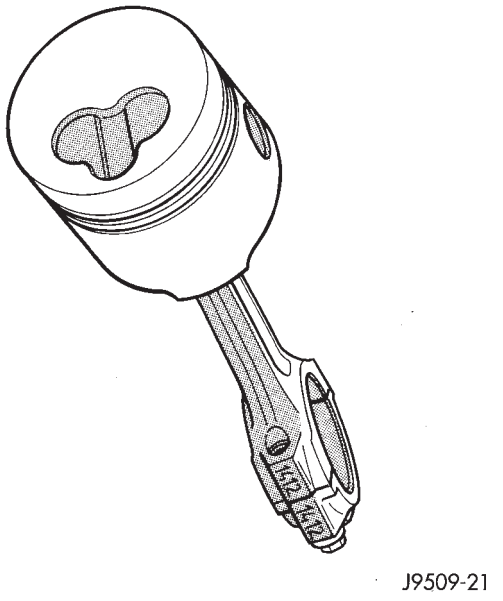

Fig. 64 Piston and Connecting Rod Assembly

INSPECTION—PISTON PIN

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

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

INSPECTION—CRANKSHAFT JOURNALS

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

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

BEARING-TO-JOURNAL CLEARANCE

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

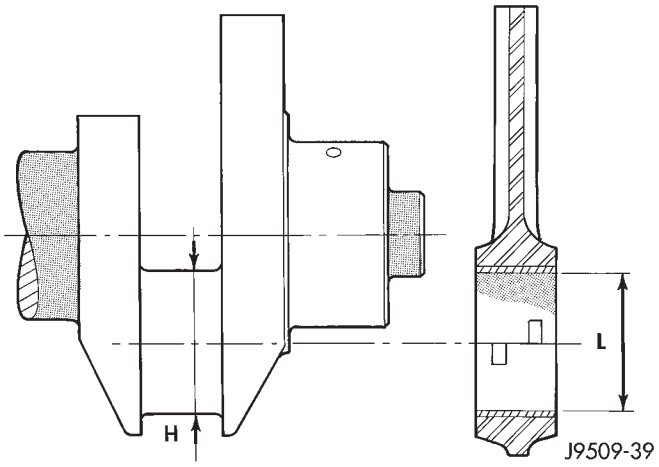

Fig. 65 Bearing Clearance

CYLINDER WALL LINER ASSEMBLY

INSPECTION

The cylinder walls should be checked for out-of-round and taper with dail bore gauge. The cylinder bore out-of-round is 0.100 mm (.0039 inch) maximum and cylinder bore taper is 0.100 mm (0.0039 inch) maximum. If the cylinder walls are badly scuffed or scored, new liners should be installed and honed, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B (Fig. 66). Top measurement should be 10 mm (3/8 inch) down and bottom measurement should be 10 mm (3/8 inch.) up from bottom of bore.

CLEANING AND INSPECTION (Continued)

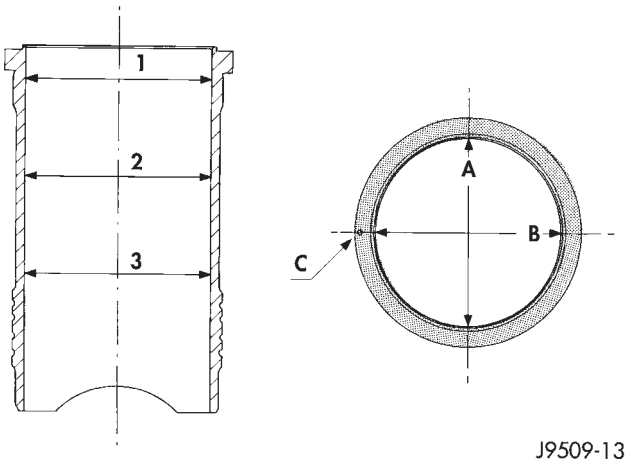

Fig. 66 Liner Inspection

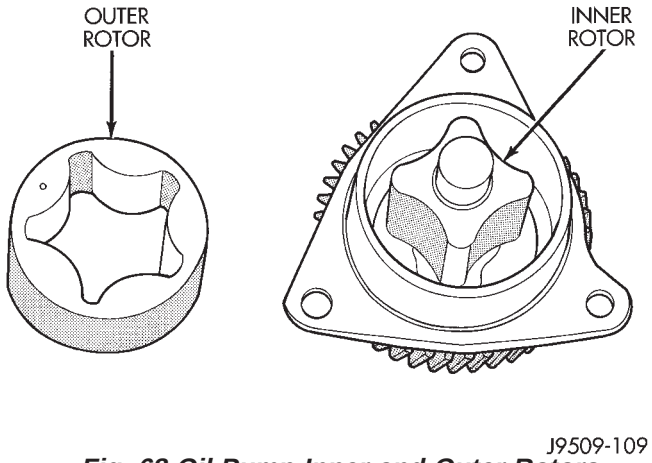

Fig. 68 Oil Pump Inner and Outer Rotors

OIL PUMP

CLEANING

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

INSPECTION

(1) Before installing oil pump check pump bore depth in block (A) and pump body height (B) (Fig. 67). Difference between A and B should be 0.020-0.082 mm.

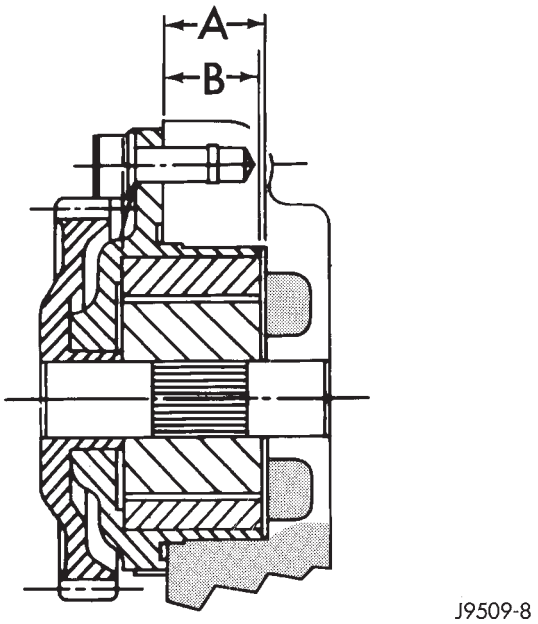

Fig. 67 Oil Pump Bore Depth

(2) Check clearance between rotors (Fig. 69).

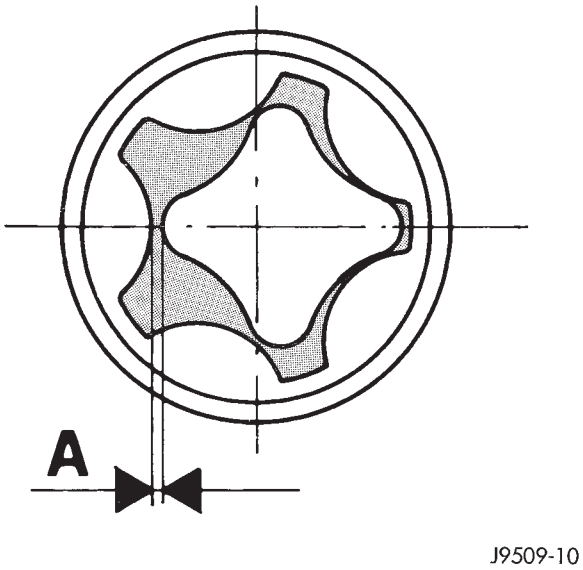

Fig. 69 Checking Rotor Clearance

SPECIFICATIONS
ENGINE SPECIFICATIONS

Description	Specifications
Type	425CLIRX (23B)
Number of cylinders	4
Bore	92 mm
Stroke	94 mm
Capacity	2499.5 cm3
Injection order	1-3-4-2
Compression ratio	21 : 1 (+/- 0.5)
Gasket	Asbestos free
Crankshaft	
Front journal diameter	
Nominal	62.985-63.000 mm
-0.25	62.745-62.760 mm
-0.125	62.860-62.875 mm
Front bearing diameter	
Nominal	63.043-63.088 mm
-0.25	62.810-62.860 mm
-0.125	62.918-62.963 mm
Clearance between journal and bearing:	0.043-0.103
Center journal diameter	
Nominal	63.005-63.020 mm
-0.25	62.755-62.770 mm
-0.125	62.880-62.895 mm
Center bearing diameter	
Nominal	63.050-63.093 mm
-0.25	62.800-62.843 mm
-0.125	63.550-62.968 mm
Clearance between journal and bearing:	0.030-0.088
Rear journal diameter	
Nominal	69.980-70.000 mm
-0.25	69.735-69.750 mm
-0.125	69.855-69.875 mm
Rear bearing diameter	
Nominal	70.030-70.055 mm
-0.25	69.780-69.805 mm
-0.125	69.905-69.980 mm
Clearance between journal and bearing:	0.030-0.075
Wear limit: 0.200 mm.	
Connecting rod journal	
Nominal	53.940-53.955 mm
-0.25	53.690-53.705 mm
-0.125	53.815-53.830 mm
Connecting rod bearing	
Nominal	53.977-54.016 mm
-0.25	53.727-53.766 mm
-0.125	53.852-53.891 mm
Clearance between journal and bearing:	0.022-0.076
Wear limit: 0.200 mm	

Description	Specifications
Crankshaft end play	
End play	0.153-0.304 mm
Adjustment	Thrust washers
Thrust washers available:	2.311-2.362 mm
	2.411-2.462 mm
	2.511-2.562 mm
Main bearing carriers	
Internal diameter	
Front	67.025-67.050 mm
Center	66.670-66.687 mm
Rear	75.005-75.030 mm
Liners	
Internal diameter	92.000-92.010 mm
Protrusion	0.01-0.06 mm
Adjustment	Shims
Available shims:	0.15 mm
	0.17 mm
	0.20 mm
	0.23 mm
	0.25 mm
Cylinder head	
Minimum thickness	89.95-90.05 mm
Gaskets thickness:	1.42 mm +/- 0.04, 0 notches
	1.62 mm +/- 0.04, 1 notches
	1.52 mm +/- 0.04, 2 notches
End plates:	
Height	91.26-91.34 mm
Connecting rods	
Weight (without the crank bearing):	1129-1195 grams
Small end bearing	
Internal diameter	
Minimum	30.035 mm
Maximum	30.050 mm
Crankshaft bearings	
Standard Internal diameter	53.977-54.016 mm
Pistons	
Skirt diameter	91.935-91.945 mm
(measured at approximately 15 mm above the bottom of the skirt).	
Piston clearance:	0.055-0.075 mm
Top of piston to cylinder head	0.80-0.89 mm
Piston protrusion	0.53 - 0.62 Fit gasket Number (1.42),0 notches
	0.73 - 0.82 Fit gasket Number (1.62),1 notches
	0.63 - 0.72 Fit gasket Number (1.52),2 notches

SPECIFICATIONS (Continued)

Description	Specifications
Piston pins	
Type	Fully floating
Pin diameter	29.990-29.996 mm
Clearance	0.039-0.060 mm
Piston rings	
Clearance in groove:	
Top	0.080-0.130 mm
Second.	0.070-0.102 mm
Oil control	0.040-0.072 mm
Fitted gap:	
Top	0.25-0.50 mm
Second.	0.20-0.35 mm
Oil control	0.25-0.58 mm
Camshaft	
Journal diameter, front	53.495-53.51 mm
Bearing clearance	0.030-0.095 mm
Center	53.45-53.47 mm
Bearing clearance	0.07-0.14 mm
Rear	53.48-53.50 mm
Bearing clearance	0.04-0.11 mm
Tappets	
Outside diameter	14.965-14.985 mm
Rocker gear	
Shaft diameter	21.979-22.00 mm
Bush internal diameter	22.020-22.041 mm
Assembly clearance	0.020-0.062 mm
Valves	
Intake valve:	
Opens	22° B.T.D.C.
Closes	46° A.B.D.C.
Exhaust valve:	
Opens.	60° B.B.D.C.
Closes	24° A.T.D.C.

Description	Specifications
Face angle:	
Intake	56° - 56° 20`
Exhaust.	45° 25` - 45° 35`
Head diameter:	
Intake	40.05-40.25 mm
Exhaust.	33.8-34.0 mm
Head stand down:	
Intake	0.88-1.14 mm
Exhaust.	0.99-1.25 mm
Stem diameter:	
Intake	7.940-7.960 mm
Exhaust.	7.922-7.940 mm
Clearance in guide:	
Intake	0.040-0.075 mm
Exhaust.	0.060-0.093 mm
Valve guide	
Inside diameter	8.0-8.015 mm
Fitted height	13.5-14 mm
Valve springs	
Free length	44.65 mm
Fitted length	38.6 mm
Load at fitted length	34 +/- 3% Kg
Load at top of lift.	92.5 +/- 3% Kg
Number of coils	5.33 Valve timing
Lubrication	
System pressure at 4000 rev/min	3.5 to 5.0 bar (oil at 90-100°C)
Pressure relief valve opens	6.38 bar
Pressure relief valve spring - free length	57.5 mm
Oil pump:	
Outer rotor end float	0.02-0.08 mm
Inner rotor end float	0.02-0.08 mm
Outer rotor to body diam. clearance	0.130-0.230 mm
Rotor body to drive gear clearance (pump not fitted)	0.30 - 0.56 mm

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

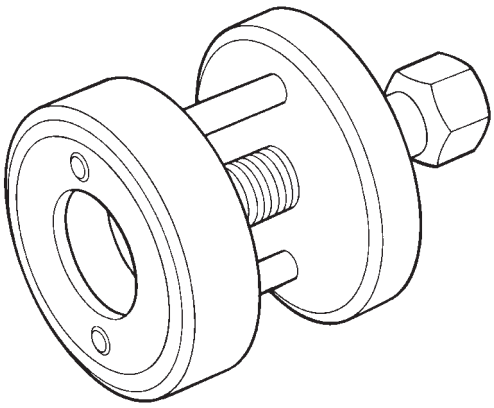
DESCRIPTION	TORQUE
Automatic Belt Tensioner to Block	
Bolts (2)	121 N·m
Automatic Belt Tensioner to Mounting Bracket	
Bolt (1)	75 N·m
Generator belt	
Tensioner	79 N·m
Generator bracket	
Mounting bolts (6 mm)	10 N·m
Mounting bolts (8 mm)	24.4 N·m
Generator	
Mounting bolt	47 N·m
Camshaft thrust plate	
Bolts	24 N·m
Connecting rod	
Mounting bolt	29.5 N·m +60°
Crankshaft bearing	
Carrier screw	42 N·m
Crankshaft pulley	
Locknut	160 N·m
Crossmember	
Bolts	42 N·m
Diesel delivery	
Union nut	18.5 N·m
EGR valve	
To intake manifold	26 N·m
EGR tube	
To EGR valve	26 N·m
Engine mount—Front	
Engine support bracket	61 N·m
Support Cushion	47 N·m
Support cushion bracket bolts	54 N·m
Support cushion bracket stud nuts	41 N·m
Support Cushion through bolt	65 N·m
Engine mount—Rear	
Transmission support bracket	46 N·m
Support Cushion nuts	75 N·m
Support Cushion through bolt	65 N·m
Exhaust down pipe	
To turbocharger	22 N·m
Exhaust heat shield	
Screws	11 N·m
Exhaust manifold collar	
Mounting nut	24.5 to 29.5 N·m
Exhaust manifold	
Mounting nut	32.5 N·m
Fan drive	
To fan hub	56 N·m
Flywheel	
Lock bolt	20 N·m +60°
Flywheel plate	
Mounting bolt	47 N·m
Front timing cover	
6 mm bolts	10 N·m
8 mm bolts	26 N·m
Fuel filter	
Nuts	28 N·m
Glow plug	
Torque	13.0 N·m
Idler pulley bracket	
Bolts	40 N·m
Idler pulley	
Bolt (left hand thread)	47 N·m
Injection pump fuel lines	
Nut	23 N·m
Injection pump gear	
Lock nut	86 N·m
Injection pump	
Mounting nut	27.5 N·m
Injector	
Torque	68.5 N·m
Intake manifold	
Mounting nut	32.5 N·m
Main bearing oil delivery	
Union	54 N·m
Water hose to cylinder head	
Nut	8 to 10 N·m
Oil cooler adaptor	
Bolt	60 N·m
Oil feed line	
For rocker arms	12 N·m
To block	27 N·m
To vacuum pump	15 N·m
Oil filter	
Torque	18 N·m
Oil filter adapter	
Torque	46.6 N·m
Oil filter base	
Torque	46.6 N·m
Oil pan	
Mounting bolts	13 N·m
Oil pickup tube	
Torque	25 N·m
Oil pump	
Mounting screw	27 N·m
Oil sump drain plug	
Torque	54 N·m
Power steering pressure hose	
Nut	28 N·m
Power steering pulley	
Nut	130 N·m
Rear crankshaft bearing carrier	
Torque	26.5 N·m
Rocker cover	
Bolts	19 N·m

SPECIFICATIONS (Continued)

DESCRIPTION	TORQUE
Rocker mounting	
Lock Nut	35 N·m
Steering pump	
Bolts	28 N·m
Turbocharger	
Mounting nuts	32.5 N·m
Turbocharger	
Oil delivery fitting	27.5 N·m
Turbocharger oil drain	
Plug	10.8 N·m
Vacuum pump	
Torque	27 N·m
Water manifold	
Bolts	12 N·m
Water pump pulley	
Nut	27 N·m

SPECIAL TOOLS

SPECIAL TOOLS



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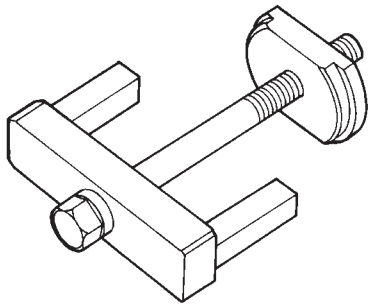
Crankshaft Pulley and Gear Remover VM. 1000A



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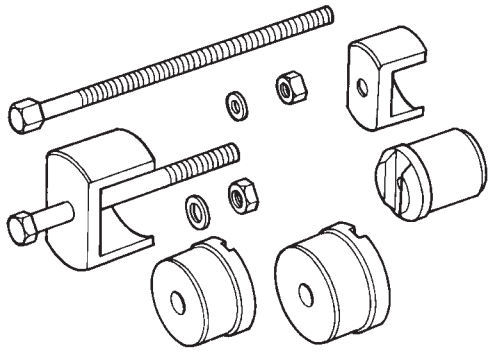
Cylinder Liner Puller VM, 1001



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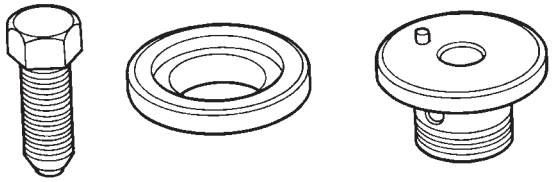
Crankshaft Bearing Remover/Replacer VM. 1002



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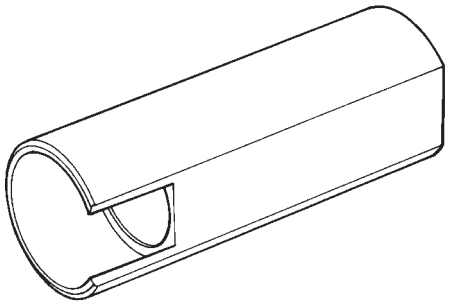
Injection Pump Puller and Gear retainer VM. 1003

SPECIAL TOOLS (Continued)



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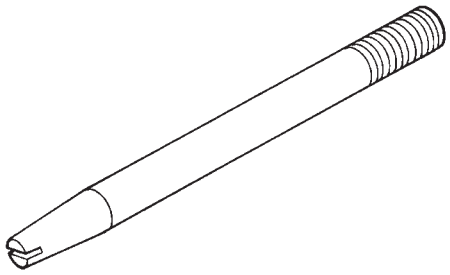
Crankshaft Remover/Replacer Sleeve VM. 1004



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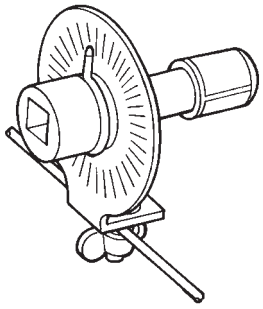
Cylinder Head Guide Studs VM. 1009



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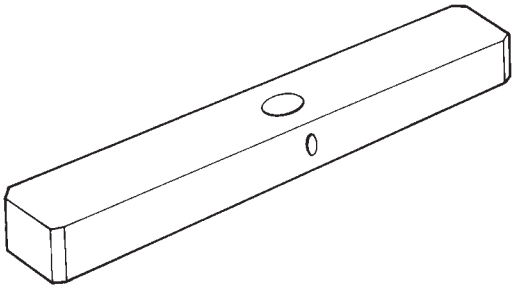
Torque Angle Gauge VM. 1005



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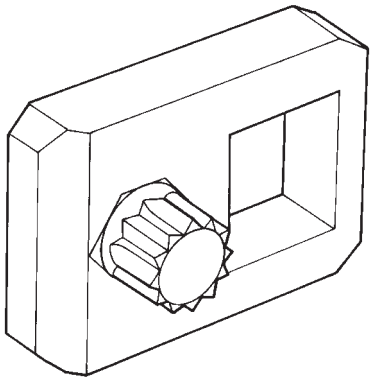
Cylinder Liner Protrusion Tool VM. 1010



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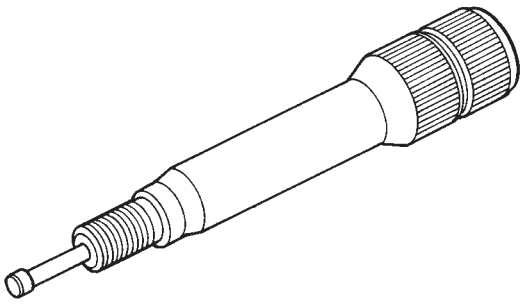
Cylinder Head Bolt Wrench VM. 1006A



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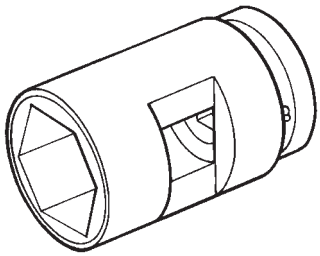
Bosch Pump Timing Adapter VM. 1011

SPECIAL TOOLS (Continued)



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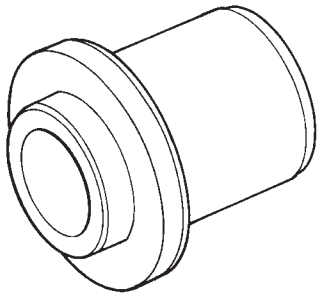
Injector Remover/Replacer Socket VM. 1012



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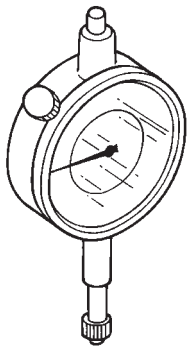
Timing Cover Oil Seal Replacer VM. 1015



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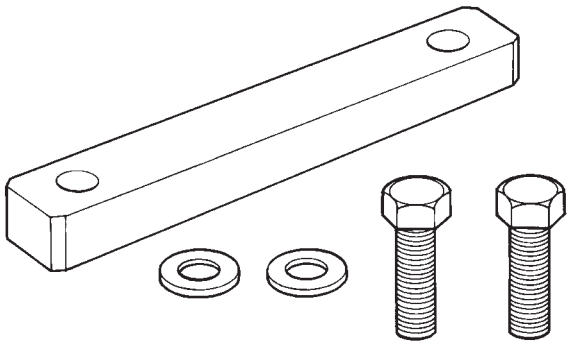
Dial Indicator Gauge VM. 1013



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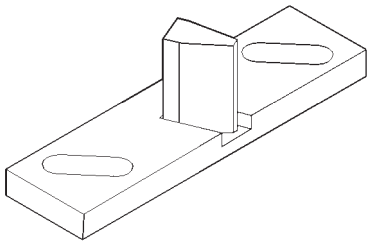
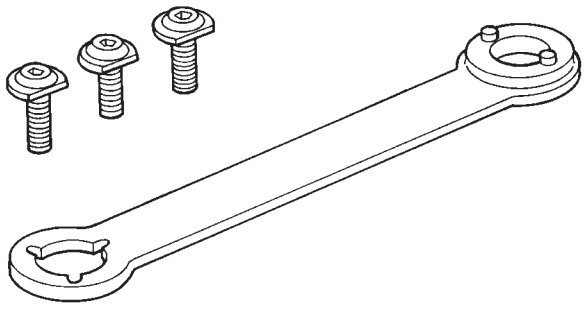
Cylinder Retainer VM. 1016



Flywheel Locking Tool VM. 1014



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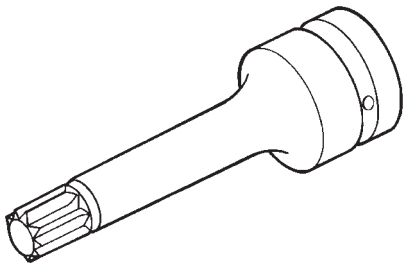
Crankshaft and Water Pump Pulley Holder VM. 1017

SPECIAL TOOLS (Continued)



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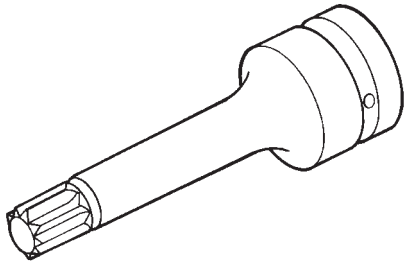
Cylinder Head Bolt Wrench M12 VM. 1018



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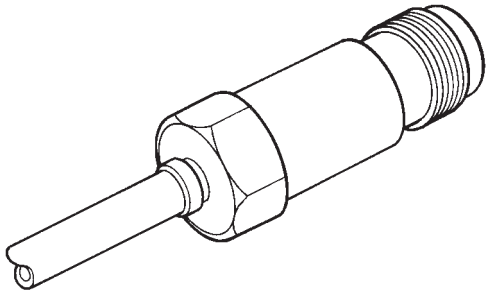
Cylinder Head Bolt Wrench M14 VM. 1019



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Cylinder Leakage Tester Adapter VM. 1021