ENGINE

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STANDARD SERVICE INFORMATION

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GENERAL INFORMATION

FORM-IN-PLACE GASKETS

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

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

MOPAR SILICONE RUBBER ADHESIVE SEALANT

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

MOPAR GASKET MAKER

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

SURFACE PREPARATION

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

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

GASKET APPLICATION

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

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

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

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

ENGINE PERFORMANCE

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

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

(2) Check intake manifold bolt torque; Refer to Group 11, Exhaust System and Intake Manifold.

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

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

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

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

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

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

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

(10) Road test vehicle as a final test.

HONING CYLINDER BORES

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

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

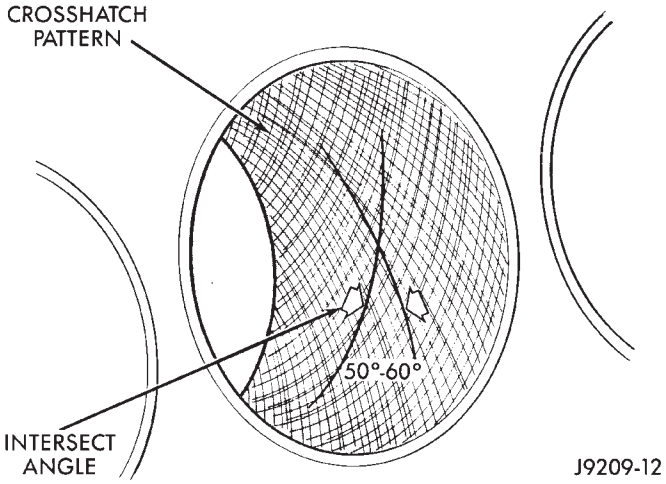


Fig. 1 Cylinder Bore Crosshatch Pattern

(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.

GENERAL INFORMATION (Continued)

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.
- **2.5L 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. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

(2) Remove the bearing cap and compare the width of the flattened Plastigage with the scale provided on the package (Fig. 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).

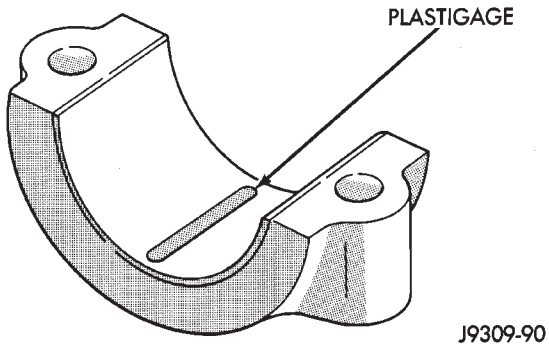


Fig. 2 Placement of Plastigage in Bearing Shell

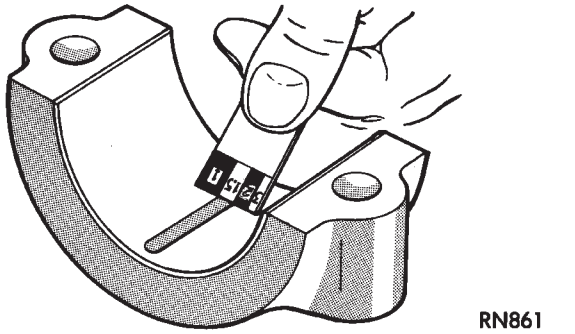


Fig. 3 Clearance Measurement

(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 rod cap nut to 45 N·m (33 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. 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).

(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.

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 spark plugs to 37 N·m (27 ft. lbs.) torque.

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

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

(13) Install a new oil filter.

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

(15) Connect the negative cable to the battery.

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

ENGINE 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.

GENERAL INFORMATION (Continued)

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).

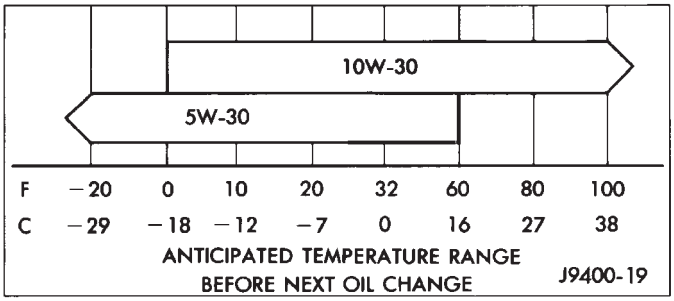


Fig. 4 Temperature/Engine Oil Viscosity

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).



9400-9

Fig. 5 Engine Oil Container Standard Notations

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.

CRANKCASE OIL LEVEL INSPECTION

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

The engine oil level indicator (Dipstick) is located at the right rear of both 2.5L engines and 4.0L engines. 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. 6) (Fig. 7).

(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. 6) (Fig. 7).

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

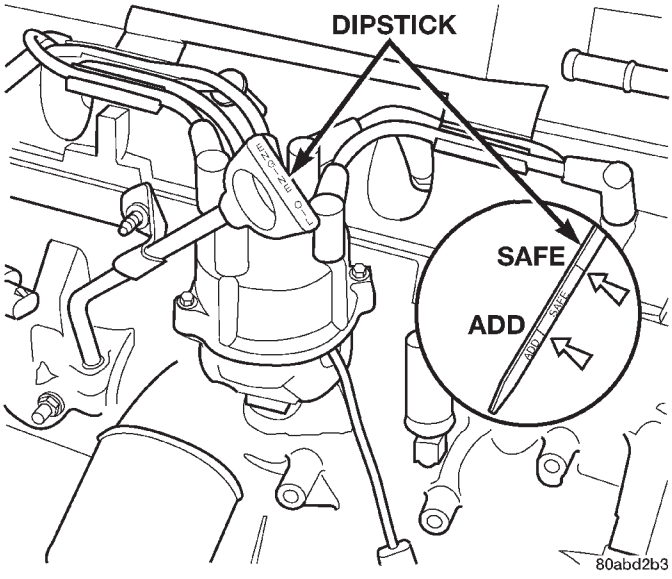


Fig. 6 Engine Oil Dipstick—2.5L Engine

GENERAL INFORMATION (Continued)

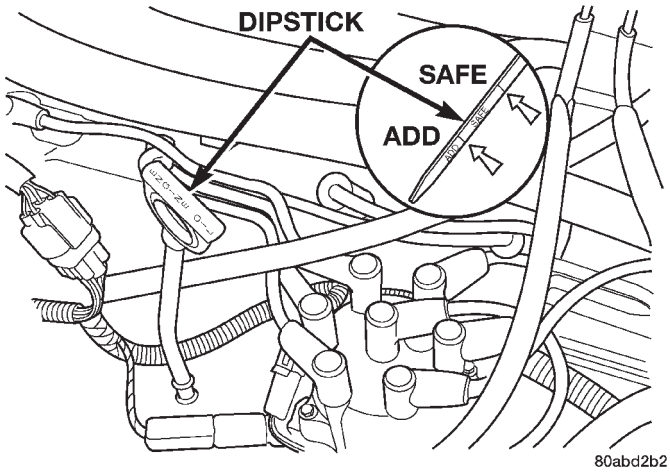


Fig. 7 Engine Oil Dipstick—4.0L Engine

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.

(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

CAUTION: Do not use oil filter with metric threads. The proper oil filter has SAE type 3/4 X 16 threads. An oil filter with metric threads can result in oil leaks and engine failure.

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

OIL FILTER REMOVAL

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

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

(3) Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss or filter adapter housing (Fig. 8) (Fig. 9).

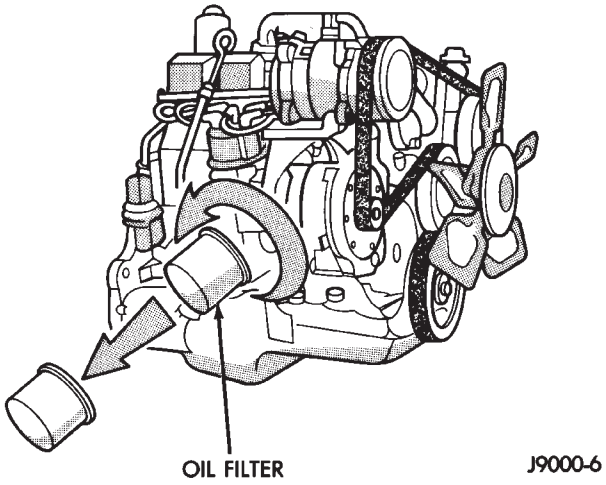


Fig. 8 Oil Filter—2.5L Engine

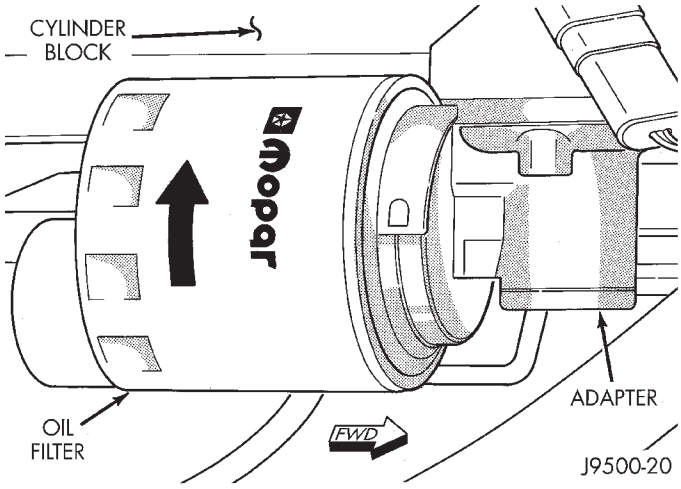


Fig. 9 Oil Filter—4.0L Engine

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

(5) Make sure old gasket comes off with oil filter. With a wiping cloth, clean the gasket sealing surface (Fig. 10) of oil and grime.

GENERAL INFORMATION (Continued)

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.

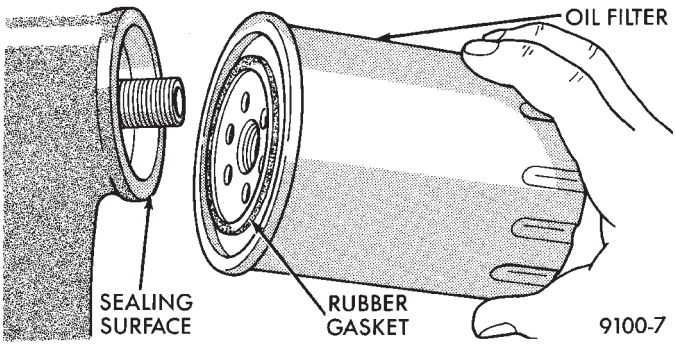


Fig. 10 Oil Filter Sealing Surface—Typical

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

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DIAGNOSIS AND TESTING

GENERAL INFORMATION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine 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 procedures outlined in Cylinder Compression Pressure

DIAGNOSIS AND TESTING (Continued)

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 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.

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 RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

DIAGNOSIS AND TESTING (Continued)

(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.

ENGINE OIL PRESSURE

(1) Remove oil pressure sending unit.

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

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—PERFORMANCE

ENGINE PERFORMANCE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
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 incorrect 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 replace 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 cylinder compression
	10. Burned, warped, or pitted valves	10. Install/Reface valves as necessary
	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 ignition coil	13. Test and replace, as necessary (Refer to Group 8D, ignition system)
	14. Faulty crank or cam sensor	14. Replace sensor
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 or stuck open	7. Test and replace, if necessary (refer to group 25, Emission Control Systems)
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 replace 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 cylinder compression
	10. Burned, warped or pitted valves	10. Reface/replace valves

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE LOSS OF POWER (CONT'D)	11. Plugged or restricted exhaust system 12. Faulty ignition cables 13. Faulty coil 14. Faulty crankshaft or camshaft sensor	11. Install new parts as necessary 12. Replace any cracked or shorted cables 13. Test and replace, as necessary 14. Replace sensor
ENGINE MISSES ON ACCELERATION	1. Dirty or gap set too wide in spark plug 2. Incorrect ignition timing 3. Dirt in fuel system 4. Burned, warped or pitted valves 5. Faulty coil	1. Clean spark plugs and set gap (refer to group 8D, Ignition System) 2. Refer to group 8D, Ignition System 3. Clean fuel system 4. Install new valves 5. Test and replace as necessary (refer to group 8D, Ignition System)
ENGINE MISSES AT HIGH SPEED	1. Dirty or gap set too wide in spark plug 2. Worn distributor shaft 3. Worn or burned distributor rotor 4. Faulty coil 5. Incorrect ignition timing 6. Dirty injector in throttle body 7. Dirt or water in fuel system	1. Clean spark plugs and set gap (refer to group 8D, Ignition System) 2. Remove and repair distributor (refer to group 8D, Ignition System) 3. Install new distributor rotor 4. Test and replace, as necessary (refer to group 8D, Ignition System) 5. Refer to group 8D, Ignition System 6. Clean injector 7. Clean system and replace fuel filter

DIAGNOSIS AND TESTING (Continued)

SERVICE DIAGNOSIS—MECHANICAL

ENGINE MECHANICAL DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	1. High or low oil level in crankcase	1. Check for correct oil level (refer to group 0, Lubrication and Maintenance)
	2. Thin or diluted oil	2. Change oil (refer to group 0, Lubrication and Maintenance)
	3. Low oil pressure	3. Check engine oil level
	4. Dirt in tappets/lash adjusters	4. Clean hydraulic tappets/lash adjusters
	5. Bent push rods	5. Install new push rods
	6. Worn rocker arms	6. Inspect oil supply to rocker arms
	7. Worn tappets/lash adjusters	7. Install new hydraulic tappets/lash adjusters
	8. Worn valve guides	8. Ream and install new valves with oversize stems
	9. Excessive runout of valve seats or valve faces	9. Grind valve seats and valves
CONNECTING ROD NOISE	1. Insufficient oil supply	1. Check engine oil level (refer to group 0, Lubrication and Maintenance)
	2. Low oil pressure	2. Check engine oil level. Perform manual oil pressure test
	3. Thin or diluted oil	3. Change oil to correct viscosity
	4. Excessive bearing clearance	Measure bearings for correct clearance. Repair as necessary
	5. Connecting rod journal out of round	5. Replace crankshaft or grind journals
	6. Misaligned connecting rods	6. Replace bent connecting rods
MAIN BEARING NOISE	1. Insufficient oil supply	1. Check engine oil level (refer to group 0, Lubrication and Maintenance)
	2. Low oil pressure	2. Check engine oil level. Perform manual oil pressure test if necessary
	3. Thin or diluted oil	3. Change oil to correct viscosity
	4. Excessive bearing clearance	4. Measure bearings for correct clearance. Repair as necessary
	5. Excessive end play	5. Check crankshaft thrust bearing for excessive wear on flanges
	6. Crankshaft main journal out of round or worn	6. Grind journals or replace crankshaft
	7. Loose flywheel or torque converter	7. Tighten to correct torque
LOW OIL PRESSURE	1. Low oil level	1. Check oil level and fill if necessary
	2. Faulty oil pressure sending unit	2. Install new sending unit
	3. Clogged oil filter	3. Install new oil filter
	4. Worn oil pump	4. Replace worn gears or oil pump assy
	5. Thin or diluted oil	5. Change oil to correct viscosity
LOW OIL PRESSURE (CONT'D)	6. Excessive bearing clearance	6. Measure bearings for correct clearance

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	7. Oil pump relief valve stuck	7. Remove valve to inspect, clean and reinstall
	8. Oil pump suction tube loose, broken, bent or clogged	8. Inspect suction tube and clean or replace if necessary
	9. Oil pump cover warped or cracked	9. Install new oil pump
OIL LEAKS	1. Misaligned or deteriorated gaskets	1. Replace gasket
	2. Loose fastener, broken or porous metal part	2. Tighten, repair or replace the part
	3. Front or rear crankshaft oil seal leaking	3. Replace seal
	4. Leaking oil gallery plug or cup plug	4. Remove and reseal threaded plug. Replace cup style plug
OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. PCV System malfunction	1. Refer to group 25, Emission Control System for proper operation
	2. Defective valve stem seal	2. Repair or replace seal
	3. Worn, scuffed or broken piston rings	3. Hone cylinder bores. Install new rings
	4. Carbon in oil control ring groove	4. Remove rings and de-carbon piston
	5. Worn valve guides	5. Ream guides and replace valves with oversize valves and seals
	6. Piston rings fitted too tightly in grooves	6. Remove rings and check ring end gap and side clearance. Replace if necessary

2.5L ENGINE

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DESCRIPTION AND OPERATION

ENGINE DESCRIPTION

The 2.5 liter (150 CID) four-cylinder engine is an In-line, lightweight, overhead valve engine.

Engine Description

Engine Type . . . . . .In-line 4 Cylinder
Bore and Stroke. . . . .98.4 x 81.0mm (3.88 x 3.19 in.)
Displacement . . . . . .2.5 (150 cu. in.)
Compression Ratio 9.1:1
Torque . . . . . .202 N·m (149 ft. lbs.) @ 3250 rpm
Firing Order 1–3–4–2
Lubrication . . . . .Pressure Feed–Full Flow Filtration
Engine Oil Capacity . . . . . .3.8 L (4 Quarts)
Cooling System . . .Liquid Cooled–Forced Circulation
Cooling System Capacity . . . . . .9.5L (10 Quarts)
Cylinder Block. . . . . .Cast Iron
Crankshaft . . . . . .Cast Nodular Iron
Cylinder Head . . . . . .Cast Iron
Camshaft. . . . . .Cast Iron
Pistons. . . . . .Aluminum Alloy (with Struts)
Engine Type . . . . . .In-line 4 Cylinder
Cylinder Combustion Cavity . . . . . .Double Quench
Connecting Rods . . . . . .Cast Malleable 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 4 from front to rear. The firing order is 1-3-4-2 (Fig. 1).

The crankshaft rotation is clockwise, when viewed from the front of the engine. The crankshaft rotates within five main bearings and 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.3 and No.4 cylinders (Fig. 2).

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 (HX = A 2.5 liter (150 CID) 9.1:1

DESCRIPTION AND OPERATION (Continued)

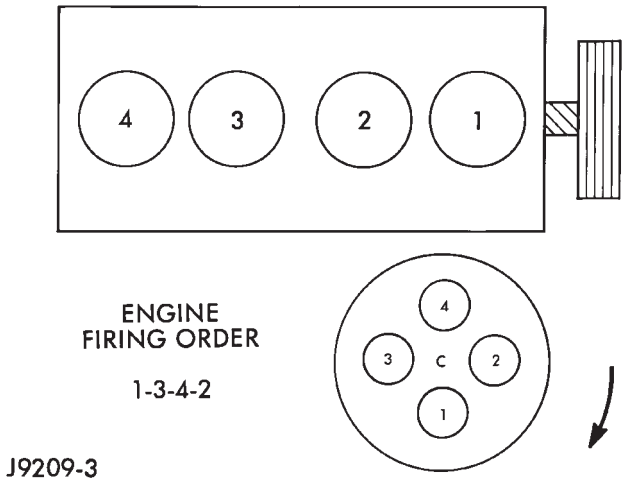


Fig. 1 Engine Firing Order

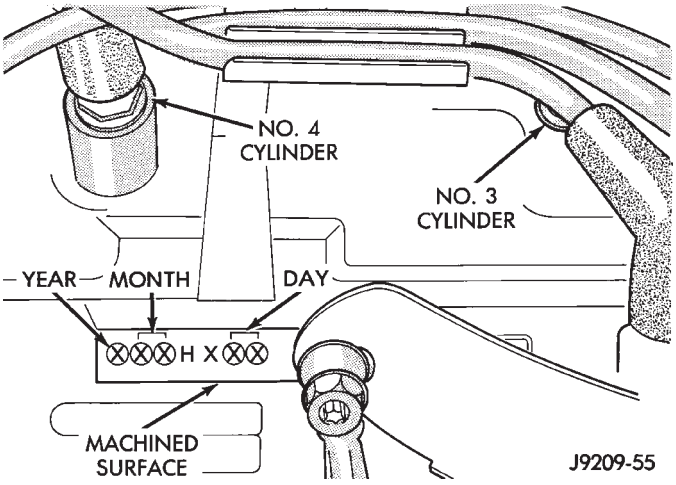


Fig. 2 Build Date Code Location

compression ratio engine with a multi-point fuel injection system).

- 6th & 7th Digits—The day of engine build (01 - 31).

FOR EXAMPLE: Code * 701HX23 * identifies a 2.5 liter (150 CID) engine with a multi-point fuel injection system, 9.1:1 compression ratio and built on January 23, 1997.

LUBRICATION SYSTEM

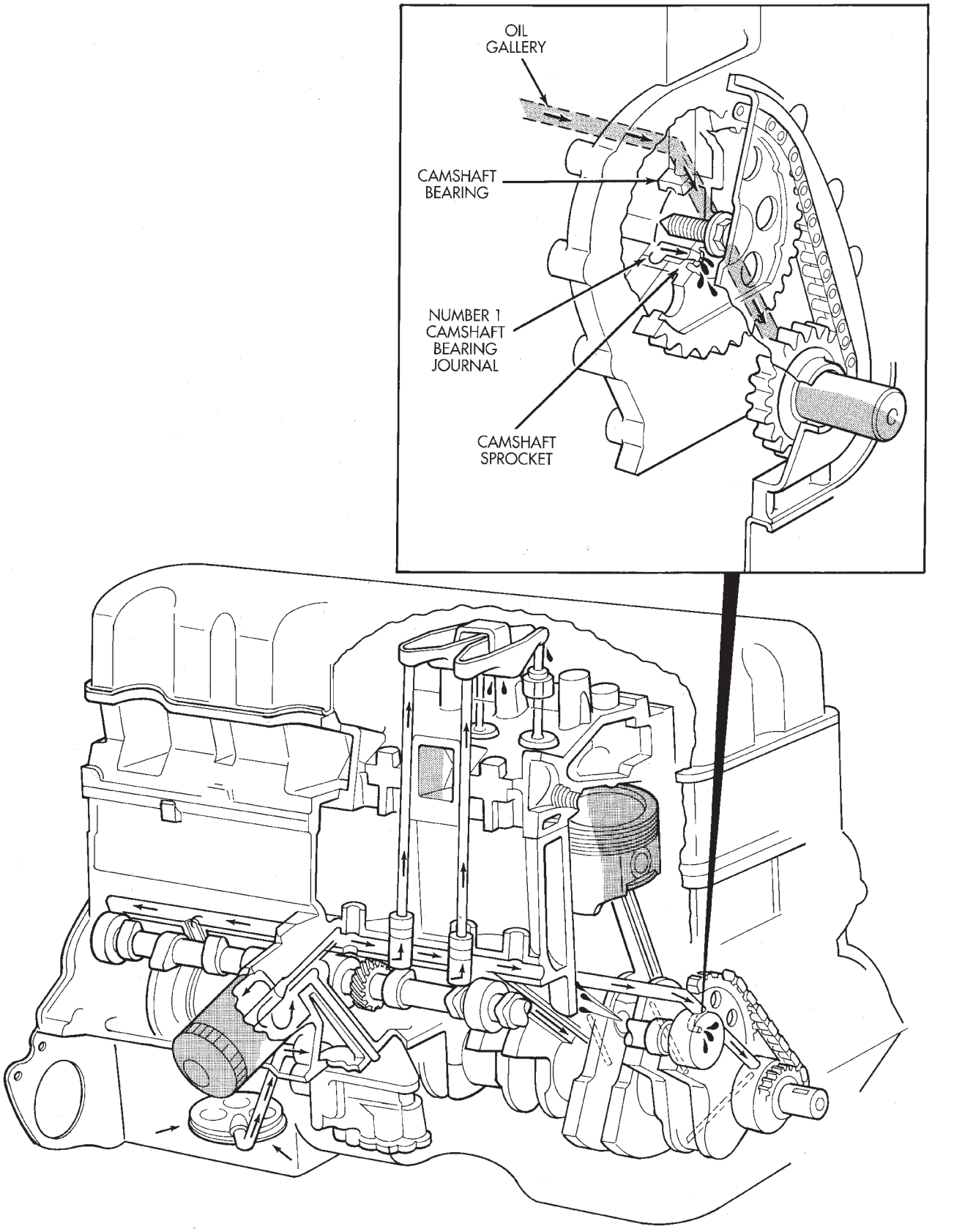
A gear—type positive displacement pump is mounted at the underside of the block opposite the No. 4 main bearing. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet 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.

DESCRIPTION AND OPERATION (Continued)



Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

OIL PUMP PRESSURE

The MINIMUM oil pump pressure is 89.6 kPa (13 psi) at 600 rpm. The NORMAL oil pump pressure is 255-517 kPa (37-75 psi) at 1600 rpm or more.

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 the oil filter boss near 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 Component Codes

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.4 piston is at top dead center (TDC) on the compression stroke.

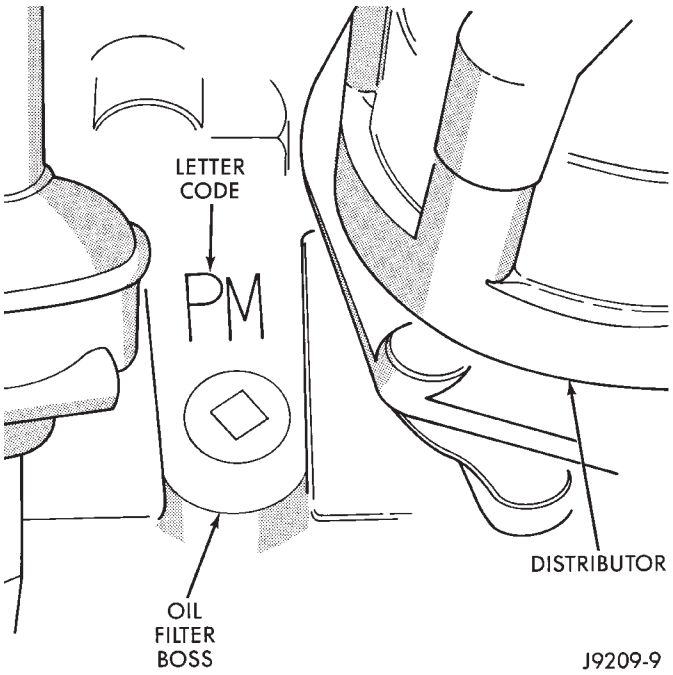


Fig. 4 Oversize and Undersize Component Code Location

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.

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 GAUGE 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).

SERVICE PROCEDURES (Continued)

(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 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.

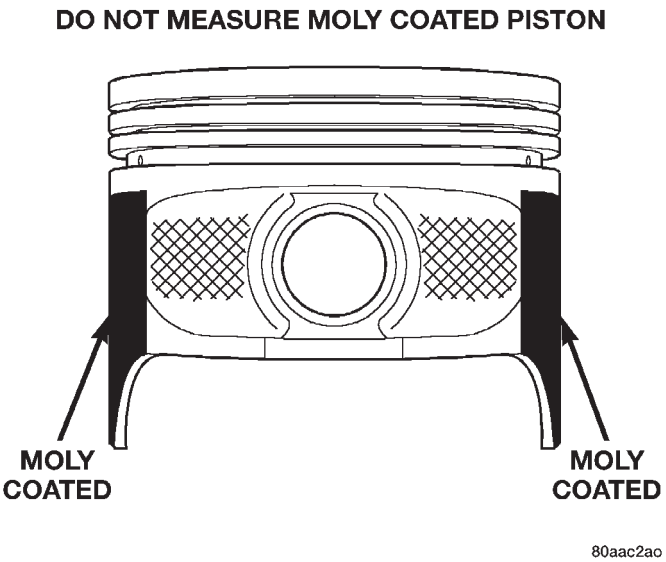


Fig. 5 Moly Coated Piston

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

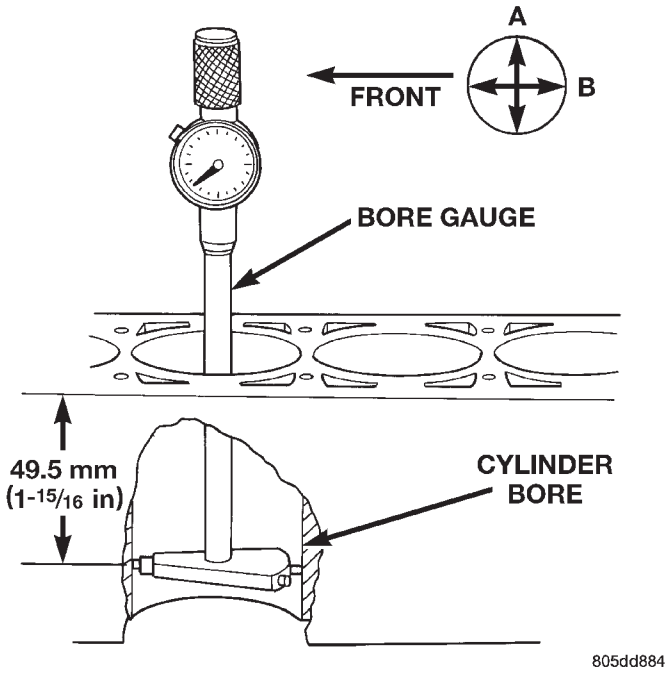


Fig. 6 Bore Gauge

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.

(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)

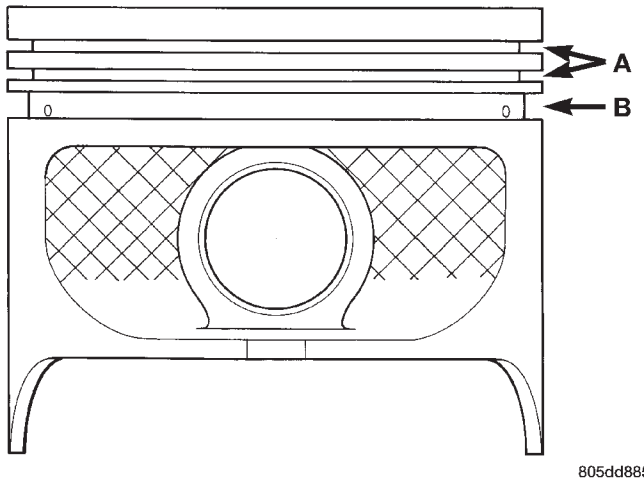


Fig. 7 Piston Dimensions

SERVICE PROCEDURES (Continued)

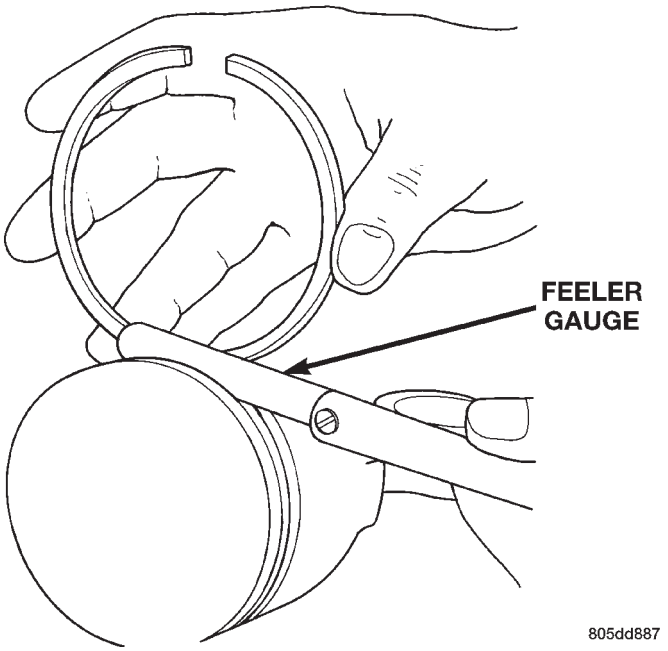


Fig. 8 Ring Side Clearance Measurement

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).

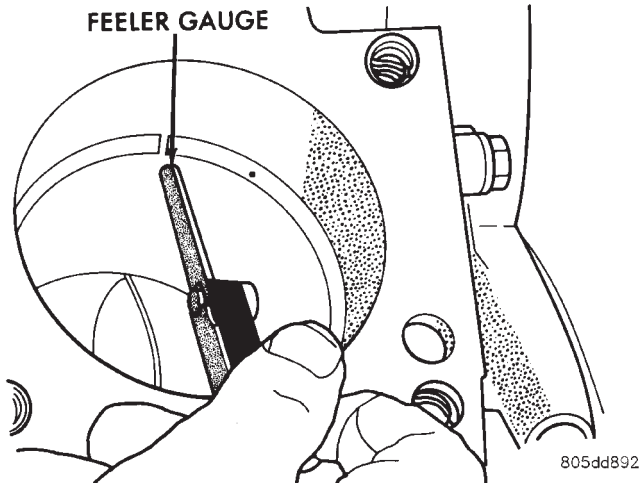


Fig. 9 Gap Measurement

Ring Gap Measurement

Top Compression Ring	0.229 to 0.610 mm (0.0090 to 0.0240 inch)
Second Compression 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).

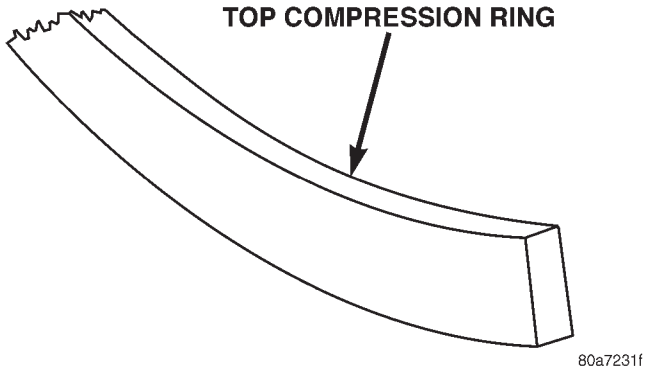


Fig. 10 Top Compression ring identification

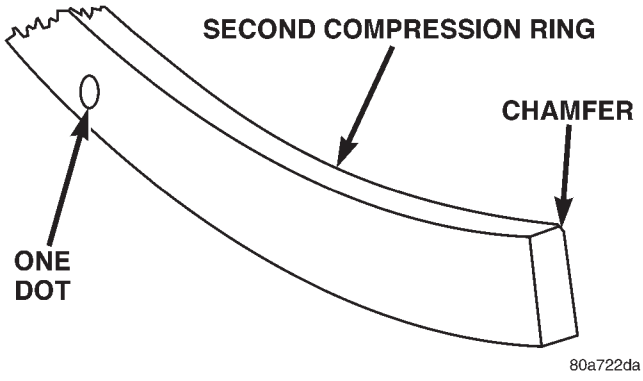


Fig. 11 Second Compression Ring Identification

SERVICE PROCEDURES (Continued)

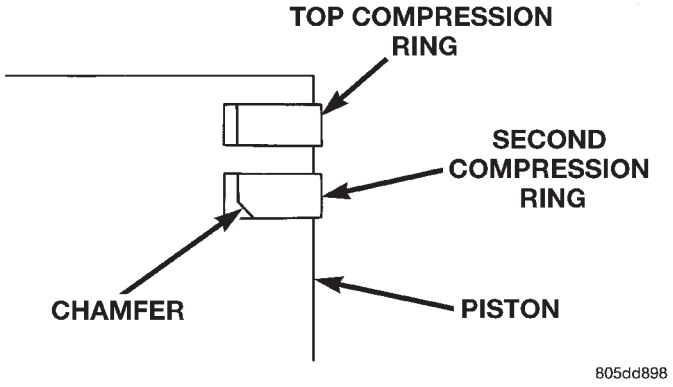


Fig. 12 Compression Ring Chamfer Location

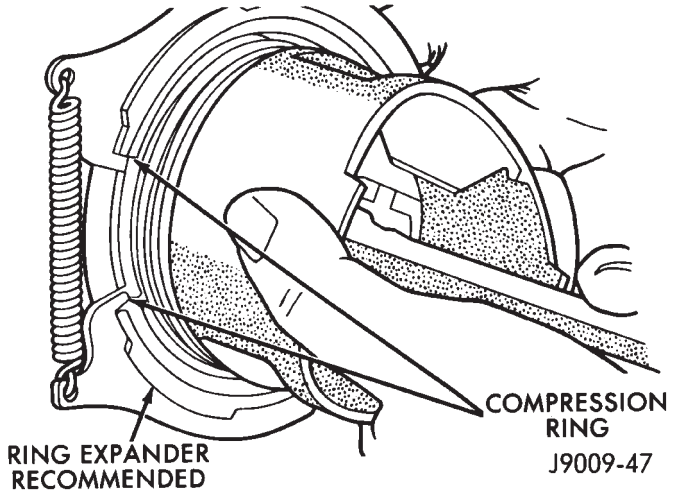


Fig. 13 Compression Ring Installation

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.

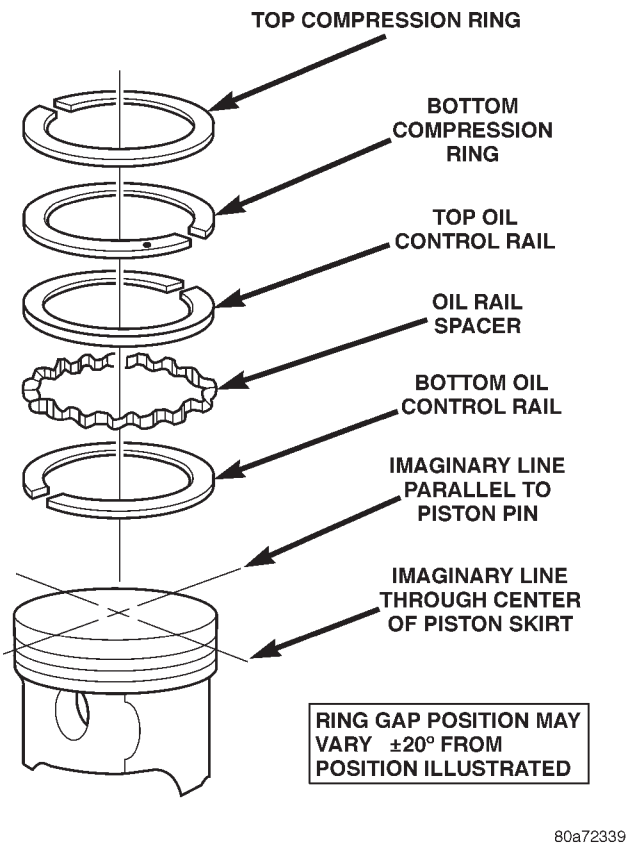


Fig. 14 Ring Gap Orientation

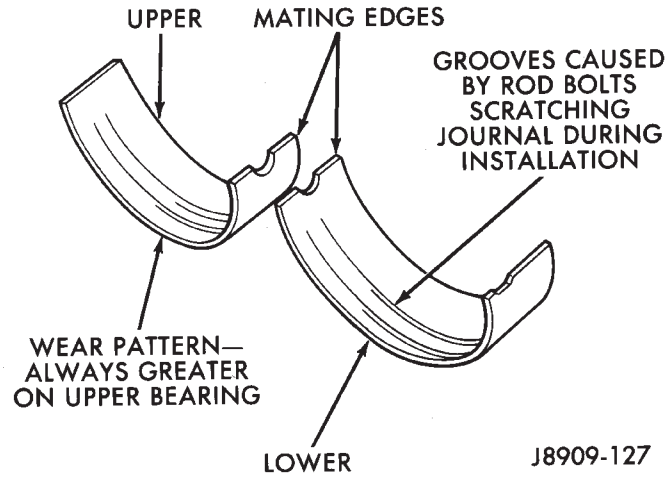


Fig. 15 Connecting Rod Bearing Inspection

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)

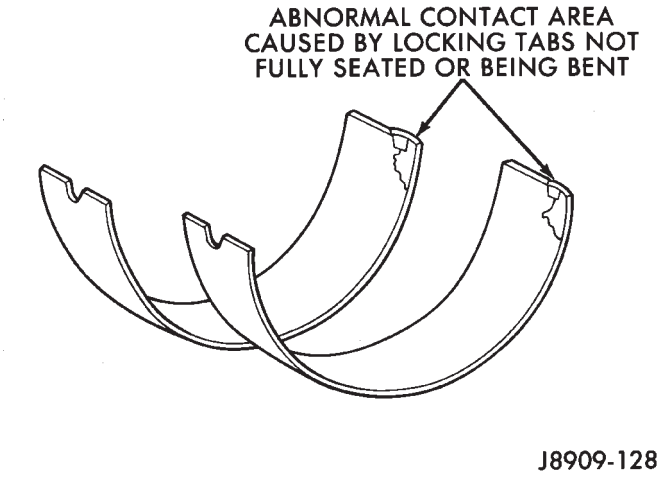


Fig. 16 Locking Tab Inspection

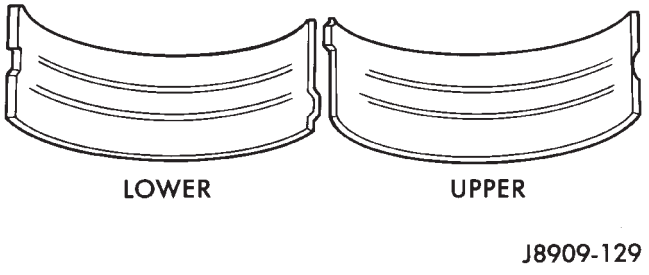


Fig. 17 Scoring Caused by Insufficient Lubrication or by Damaged Crankshaft Pin Journal

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.**

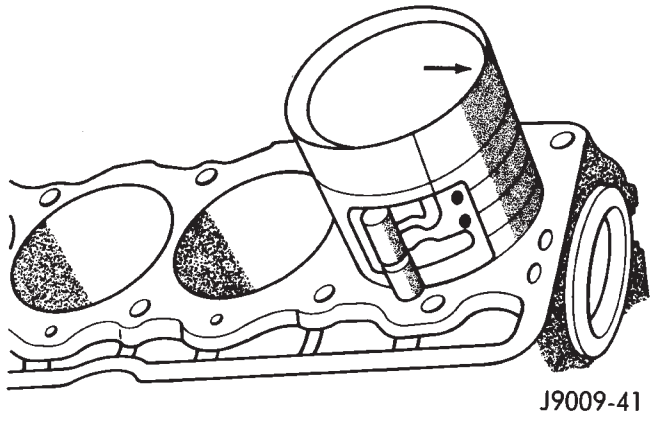


Fig. 18 Rod and Piston Assembly Installation

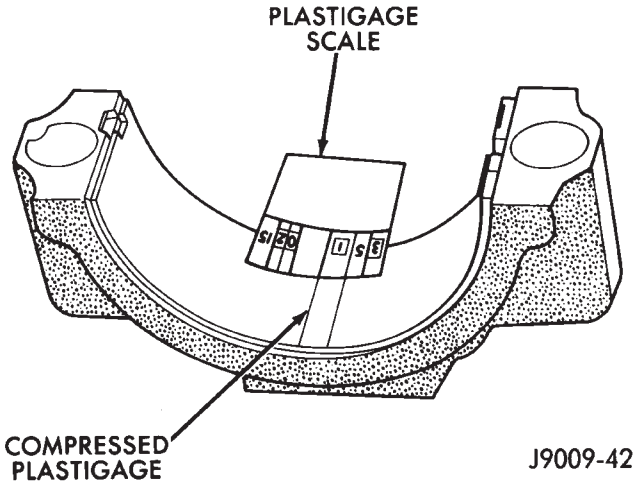


Fig. 19 Measuring Bearing Clearance with Plastigage

(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).

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.)

J9409-24

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) 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 (Fig. 20). Refer to Engine Specifications for the proper clearance. Replace the connecting rod if the side clearance is not within specification.

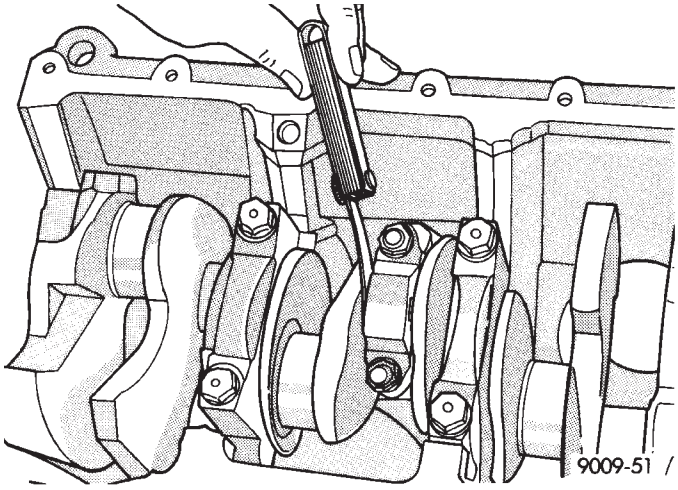


Fig. 20 Checking Connecting Rod Side Clearace—Typical

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. 21).

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.

FITTING BEARINGS (CRANKSHAFT INSTALLED)

The main bearing caps, numbered (front to rear) from 1 through 5 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

SERVICE PROCEDURES (Continued)

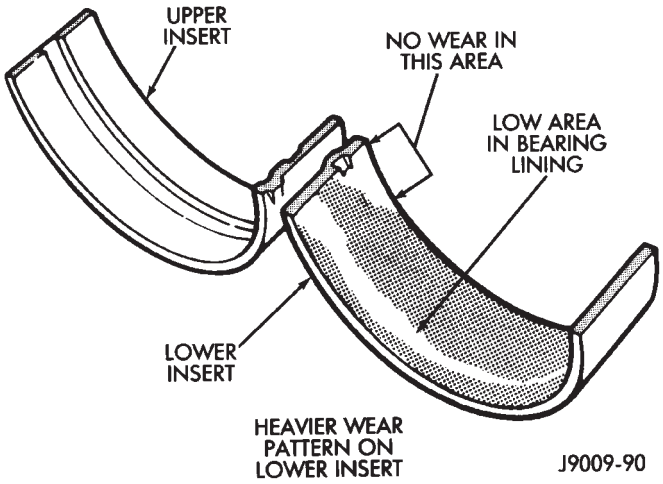


Fig. 21 Main Bearing Wear Patterns

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.**

The main bearing journal size (diameter) is identified by a color-coded paint mark on the adjacent cheek. 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.

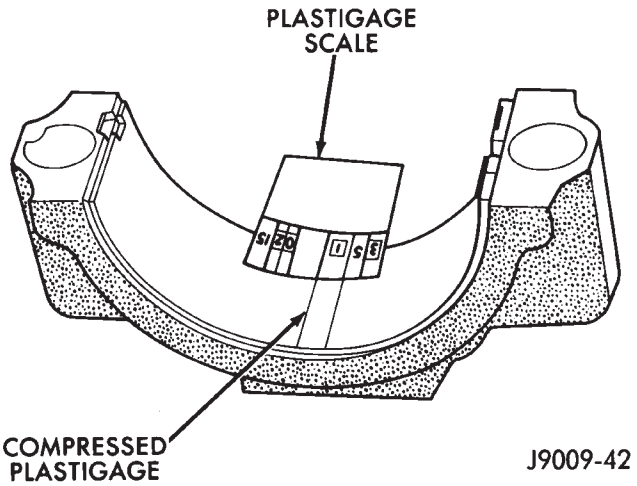


Fig. 23 Measuring Bearing Clearance with Plastigage

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.

The clearance indicated with the 0.025 mm (0.001 inch) undersize insert pair installed will determine if

SERVICE PROCEDURES (Continued)

this insert size or some other combination will provide the specified clearance. **FOR EXAMPLE:** If the clearance was 0.0762 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.

If journals 1 through 5 diameters are less than 63.4517 mm (2.4981 inches), replace crankshaft or grind crankshaft down to accept the appropriate undersize bearing inserts.

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.

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

SERVICE PROCEDURES (Continued)

MAIN BEARING FITTING CHART

CRANKSHAFT JOURNALS #1 - #4		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 - 63.4771mm (2.4996 - 2.4991 in.) 0.0127 mm (0.0005 in.) Undersize	Yellow - Undersize 0.025 mm (0.001 in.)	Blue - Standard
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 #5 ONLY		CORRESPONDING CRANKSHAFT 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 (2.4990 - 2.4985 in.) 0.0127 mm (0.0005 in. Undersize	Yellow - Undersize 0.025 mm (0.001 in.)	Blue - Standard
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 supports are made of resilient rubber.

REMOVAL

(1) Disconnect negative cable from battery.
(2) Raise the vehicle.
(3) Support the engine.
(4) Remove through bolt nut (Fig. 24). DO NOT remove the through bolt.
(5) Remove the retaining bolts and nuts from the support cushions (Fig. 24).
(6) Remove the through bolt.
(7) Remove the support cushions.

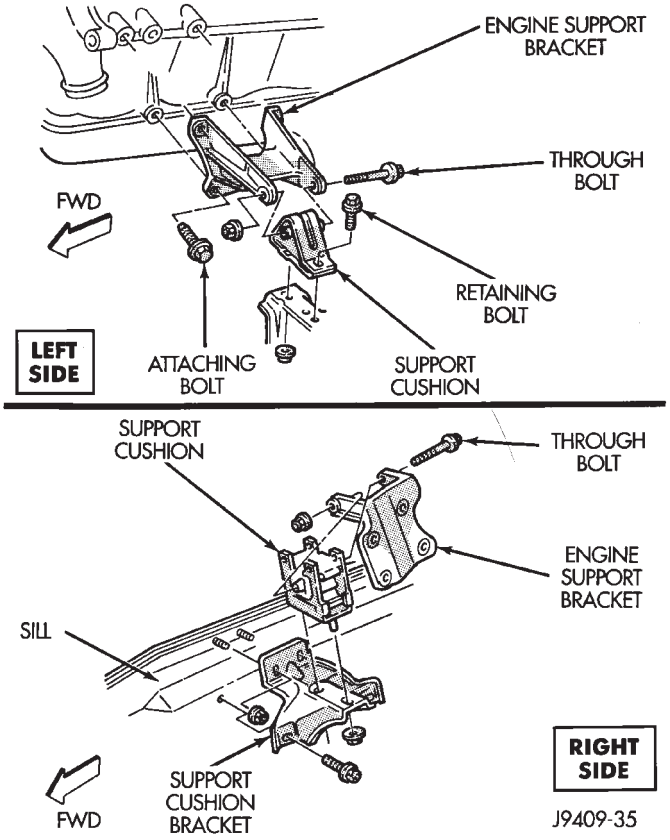


Fig. 24 Front Mounts

INSTALLATION

(1) If the engine support bracket was removed, position the LEFT bracket (Fig. 24) and the RIGHT bracket (Fig. 25) onto the cylinder block. Install the bolts and stud nuts.

(a) RIGHT SIDE (Fig. 25) —Tighten the bolts to 61 N·m (45 ft. lbs.) torque. Tighten the stud nuts to 46 N·m (34 ft. lbs.) torque.

(b) LEFT SIDE (Fig. 24) —Tighten the bolts to 61 N·m (45 ft. lbs.) torque.

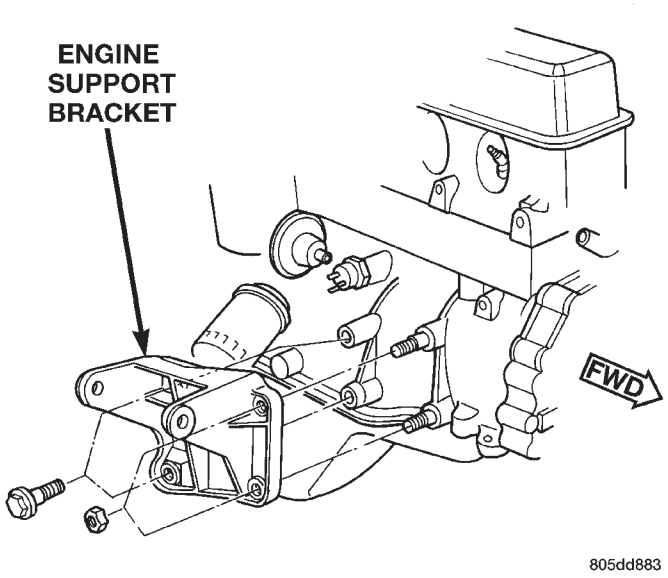


Fig. 25 Engine Support Bracket—Right Side

(2) If the support cushion brackets were removed, position the brackets onto the lower front sill (Fig. 24) (Fig. 26). Install the bolts and stud nuts. Tighten the bolts to 54 N·m (40 ft. lbs.) torque and the stud nuts to 41 N·m (30 ft. lbs.) torque.

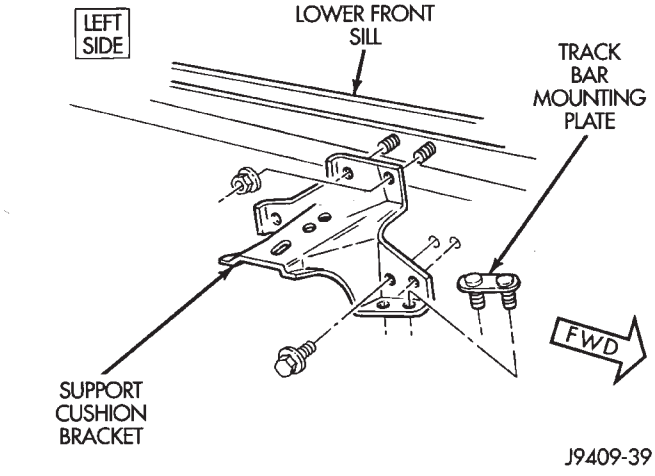


Fig. 26 Support Cushion Bracket—Left Side

(3) Place the support cushions onto the support cushion brackets (Fig. 24). Tighten the right support cushion nuts to 65 N·m (48 ft. lbs.) torque. Tighten the left support cushion bolt and nut to 41 N·m (30 ft. lbs.) torque.

(4) Install the through bolt and the retaining nut (Fig. 24). Tighten the through bolt nut to 65 N·m (48 ft. lbs.) torque.

(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 crossmember (Fig. 27) (Fig. 28). Remove the crossmember.

MANUAL TRANSMISSION:

a. Remove the support cushion nuts and remove the cushion.

b. If necessary, remove the bolts holding the transmission support bracket to the transmission (Fig. 27). Remove the bracket.

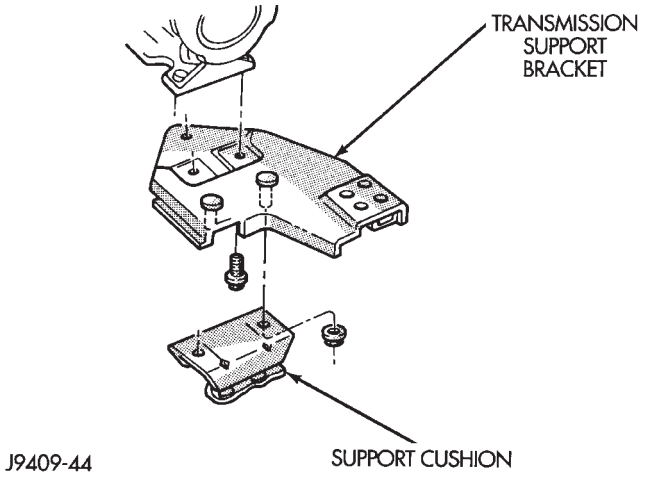


Fig. 27 Rear Mount (Manual Transmission)

AUTOMATIC TRANSMISSION:

a. Remove the support cushion bolts and remove the cushion and the transmission support bracket.

b. If necessary on 2WD vehicles, remove the bolts holding the transmission support adaptor bracket to the transmission (Fig. 28). Remove the adaptor bracket.

INSTALLATION

MANUAL TRANSMISSION:

a. If removed, position the transmission support bracket to the transmission and install the bolts. Tighten the bolts to 43 N·m (32 ft. lbs.) torque.

b. Position the support cushion onto the transmission support bracket. Install and tighten the nuts to 46 N·m (34 ft. lbs.) torque.

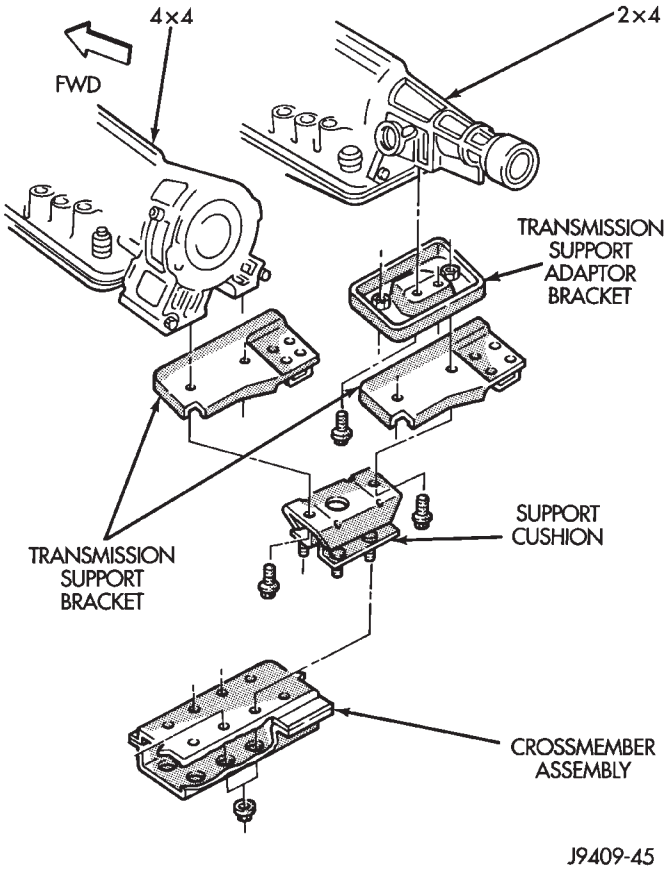


Fig. 28 Rear Mount (Automatic Transmission)

AUTOMATIC TRANSMISSION:

a. If removed, position the transmission support adaptor bracket (2WD vehicles) to the transmission and install the bolts. Tighten the bolts to 75 N·m (55 ft. lbs.) torque.

b. Position the transmission support bracket and support cushion to the transmission and install the bolts. Tighten the bolts to 75 N·m (55 ft. lbs.) torque.

(1) Position the crossmember onto the support cushion studs and install the nuts. Tighten the nuts to 22 N·m (192 in. lbs.) torque.
(2) Install the crossmember to sill bolts and tighten to 41 N·m (30 ft. lbs.) torque.
(3) Remove the transmission support.
(4) Lower the vehicle.
(5) Connect negative cable to 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.

REMOVAL AND INSTALLATION (Continued)

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) Loosen 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 air cleaner assembly.

(5) Remove the lower radiator hose.

(6) Remove the upper radiator hose and coolant recovery hose (Fig. 29).

(7) Remove the fan shroud (Fig. 29).

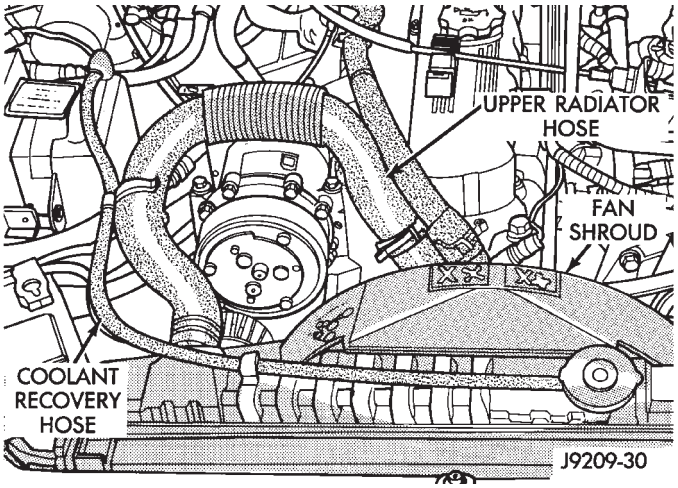


Fig. 29 Upper Radiator Hose, Coolant Recovery Hose & Fan Shroud

(8) Remove the radiator/condenser (if equipped with air conditioning).

(9) Remove fan assembly and install a 5/16 x 1/2-inch SAE capscrew through fan pulley into water pump flange. This will maintain the pulley and water pump in alignment when crankshaft is rotated.

(10) Disconnect the heater hoses.

(11) Disconnect the throttle cable, speed control cable (if equipped) and transmission cable (if equipped).

(12) Disconnect the body ground at the firewall.

(13) Disconnect the wires from the starter motor solenoid.

(14) Disconnect all fuel injection harness connections.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE DISCONNECTING FUEL LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

(15) Perform fuel pressure release procedure. (refer to Group 14, Fuel System for the proper procedure).

(16) Remove latch clip and disconnect the quick-connect fuel line at the fuel rail

(17) Recover refrigerant (if equipped with A/C). (Refer to group 24, Heating and Air Conditioning for proper procedures.)

(18) Disconnect suction/discharge hose from A/C compressor and cap off ports to prevent intrusion of foreign material or refrigerant oil loss.

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

(20) If equipped with power steering:

(a) Disconnect the power steering 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 material from entering the system.

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

(22) Raise the vehicle.

(23) Remove the oil filter.

(24) Remove the starter motor.

(25) Disconnect the exhaust pipe from the exhaust manifold.

(26) Remove the flywheel housing access cover.

(27) Remove the upper flywheel and converter housing bolts and loosen the bottom bolts.

(28) Remove the engine support cushion-to-engine compartment bracket bolts.

(29) Remove the engine shock damper bracket from the sill.

(30) Lower the vehicle.

(31) Attach a lifting device to the engine.

(32) Raise the engine slightly off the front supports.

(33) Place a support stand under the converter or flywheel housing.

(34) Lift the engine out of the engine compartment and install on an engine stand.

(35) Install the oil filter to keep foreign material out of the engine.

INSTALLATION

(1) Remove the oil filter.

(2) Lift the engine off the stand and lower it into the engine compartment. For easier installation, it may be useful to remove the engine support cushions from the engine support brackets as an aide for alignment of the engine-to-transmission.

(3) Insert the transmission shaft into the clutch spline. (M/T models)

(4) Align the flywheel housing with the engine.

(5) Install and tighten the flywheel housing lower bolts.

REMOVAL AND INSTALLATION (Continued)

(6) Install the engine support cushions (if removed).
(7) Lower the engine and engine support cushions onto the engine compartment brackets.
(8) Remove the engine lifting device.
(9) Raise the vehicle.
(10) Install the converter-housing access cover.
(11) Install the exhaust pipe support.
(12) Install the starter motor and connect the cable. Tighten the bolts to 45 N·m (33 ft. lbs.) torque.
(13) Tighten the engine support cushion through-bolt nuts.
(14) Connect the exhaust pipe to the manifold.
(15) Install the oil filter.
(16) Lower the vehicle.
(17) Connect the coolant hoses and tighten the clamps.
(18) If 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.
(19) Remove the pulley-to-water pump flange alignment capscrew and install the fan assembly.
(20) Install the fan shroud and radiator and condenser (if equipped with air conditioning).
(21) Connect the radiator hoses.
(22) Connect the oxygen sensor wire connector.
(23) Connect the throttle cable and install the rod. Connect the transmission and speed control cables (if equipped)
(24) Connect the fuel supply line to the injector rail. push until a “click” is heard. Re-install latch clip.
(25) Connect all the vacuum hoses and wire connectors.
(26) Connect suction/discharge hose to compressor. (if equipped)
(27) Fill the power steering reservoir.
(28) Connect the battery cables.
(29) Install the air cleaner.
(30) Install the hood.
(31) Add engine oil and coolant.
(32) Start the engine and inspect for leaks.
(33) Stop the engine and check the fluid levels. Add fluid, as required.
(34) Recharge air conditioning (Refer to group 24, Heating and Air Conditioning for proper procedures).

CYLINDER HEAD COVER

A cured gasket is part of the engine cylinder head cover.

REMOVAL

(1) Disconnect negative cable from battery.
(2) Disconnect the Crankcase Ventilation (CCV) vacuum hose from engine cylinder head cover (Fig. 30).
(3) Disconnect the fresh air inlet hose from the engine cylinder head cover (Fig. 30).
(4) Remove the engine cylinder head cover mounting bolts.
(5) Remove the engine cylinder head cover.

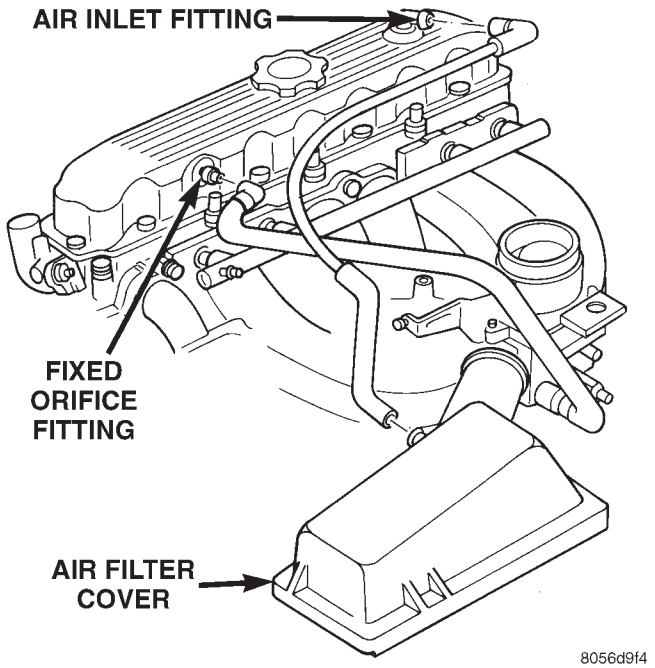


Fig. 30 Engine Cylinder Head Cover

(6) Remove any original sealer from the cover sealing surface of the engine cylinder head and clean the surface using a fabric cleaner.
(7) Remove all residue from the sealing surface using a clean, dry cloth.

INSTALLATION

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

NOTE: 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.

(2) If a replacement cover is installed, transfer the CCV valve grommet the oil filler cap from the original cover to the replacement cover.
(3) Install engine cylinder head cover. Tighten the mounting bolts to 13 N·m (115 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(4) Connect the CCV hoses (Fig. 30).
(5) 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. (Refer to procedure in this section)
(2) Check for rocker arm bridges which are causing misalignment of the rocker arm to valve tip area.
(3) Remove the capscrews at each bridge and pivot assembly (Fig. 31). Alternately loosen the capscrews one turn at a time to avoid damaging the bridges.
(4) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 31). 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.

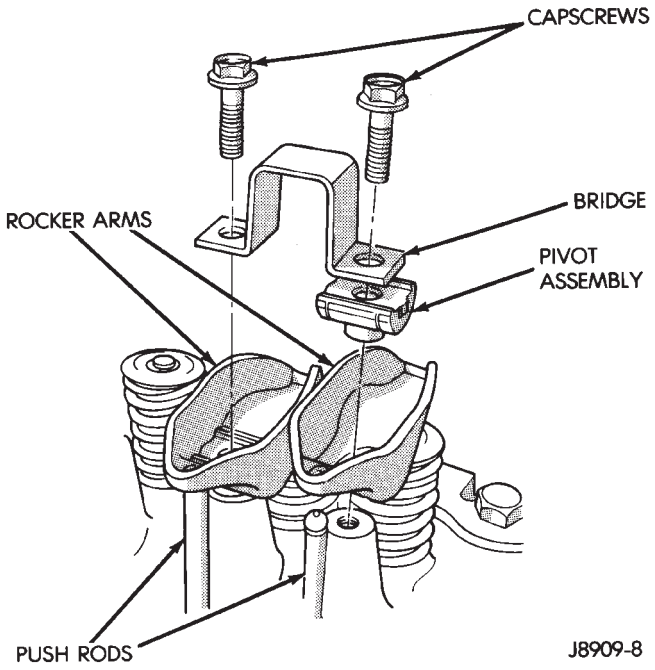


Fig. 31 Rocker Arm Assembly

(6) Clean all the components with cleaning solvent.
(7) Use compressed air to blow out the oil passages in the rocker arms and push rods.

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 original 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 SPRINGS AND OIL SEALS

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 procedure in this section)
(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) Install a 14 mm (1/2 inch) (thread size) air hose adaptor in the spark plug hole.
(7) 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.
(8) 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. 32).
(9) Remove valve spring and retainer (Fig. 32).
(10) Remove valve stem oil seals (Fig. 32). 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.

INSTALLATION

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

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

REMOVAL AND INSTALLATION (Continued)

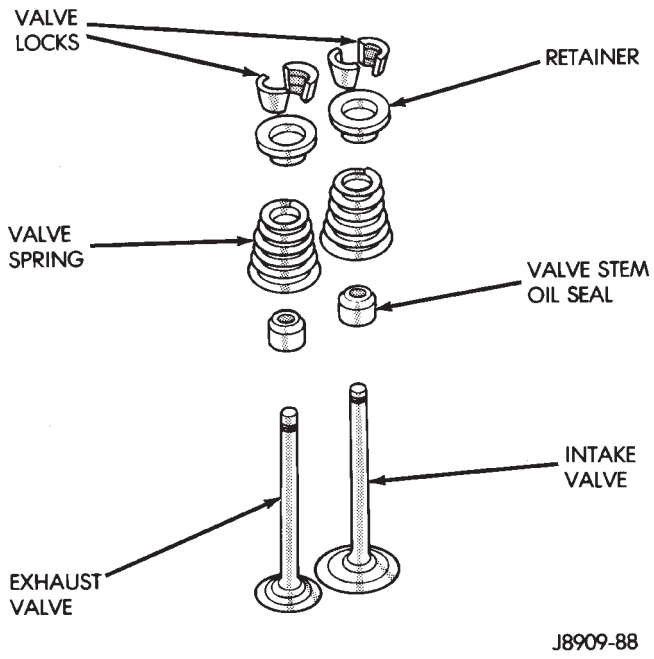


Fig. 32 Valve and Valve Components

(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) Release air pressure and 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

(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. (Refer to procedure in this section)

(5) Remove the capscrews, bridge and pivot assemblies and rocker arms (Fig. 33).

(6) Remove the push rods (Fig. 33). **Retain the push rods, bridges, pivots and rocker arms in the same order as removed.**

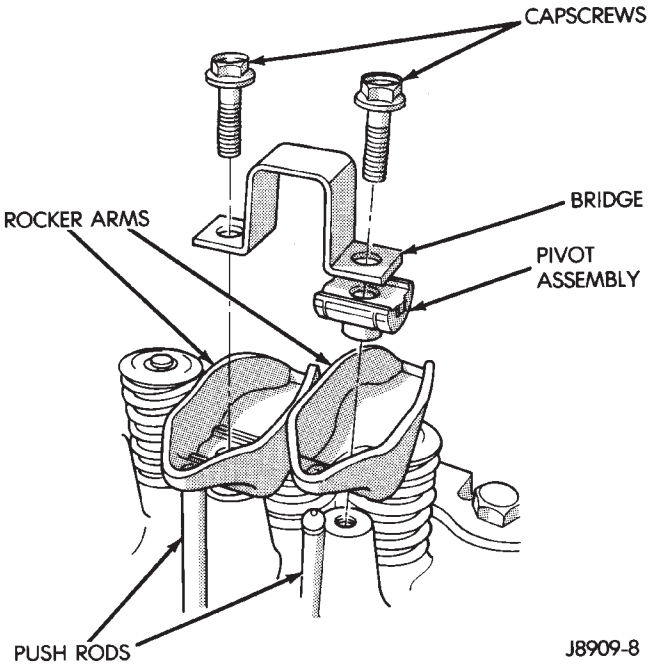


Fig. 33 Rocker Arm Assembly

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

(8) If equipped with air conditioning, perform the following:

(a) Remove the bolts from the A/C compressor mounting bracket and set the compressor aside.

(b) Remove the air conditioner compressor bracket bolts from the engine cylinder head.

(c) Loosen the through bolt at the bottom of the bracket.

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

REMOVAL AND INSTALLATION (Continued)

(10) Perform fuel pressure release procedure (Refer to Group 14, fuel systems for proper procedures).

(11) Remove the latch clip and disconnect the fuel supply hose.

(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) Number and disconnect the ignition wires and remove the spark plugs.

(14) Disconnect the coolant temperature sending unit connector.

(15) Remove the engine cylinder head bolts.

(16) Remove the engine cylinder head and gasket (Fig. 34).

(17) 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.

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

NOTE: If valves, springs, or seals are to be inspected/replaced at this time, refer to Valves and Valve Springs later in this section for proper procedures.

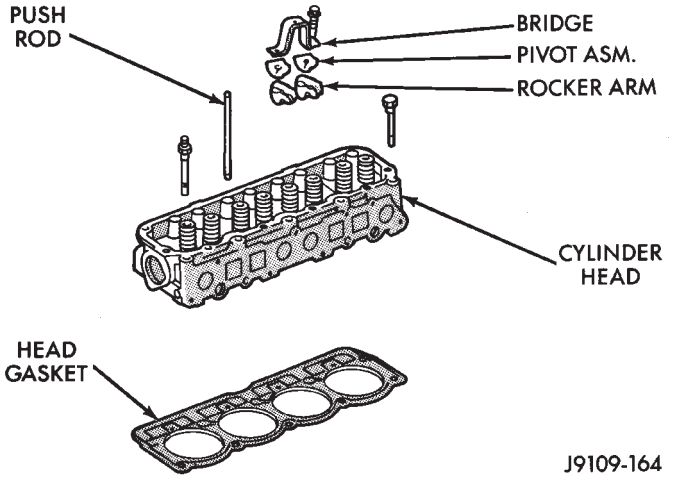


Fig. 34 Engine Cylinder Head Assembly

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) Fabricate two engine cylinder head alignment dowels from used head bolts (Fig. 35). Use the longest head bolt. Cut the head of the bolt off below the hex head. Then cut a slot in the top of the dowel to allow easier removal with a screwdriver.

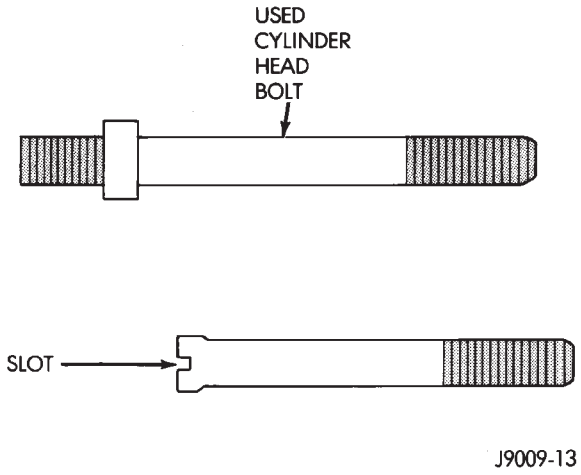


Fig. 35 Fabricate Alignment Dowels

(2) Install one dowel in bolt hole No.10 and the other dowel in bolt hole No.8 (Fig. 36).

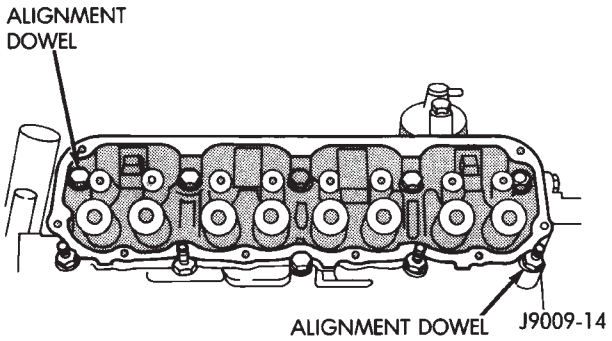


Fig. 36 Alignment Dowel Locations

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

(4) Place the engine cylinder head gasket (with the numbers facing up) over the dowels.

(5) Place the engine cylinder head over the dowels.

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.

(6) Coat the threads of bolt No.7, only, with Loctite PST sealant or equivalent.

(7) Install all head bolts, except No.8 and No.10.

(8) Remove the dowels.

(9) Install No.8 and No.10 head bolts.

REMOVAL AND INSTALLATION (Continued)

CAUTION: During the final tightening sequence, bolt No.7 will be tightened to a lower torque than the rest of the bolts. DO NOT overtighten bolt No.7.

(10) Tighten the engine cylinder head bolts in sequence according to the following procedure (Fig. 37):

(a) Tighten all bolts in sequence (1 through 10) to 30 N·m (22 ft. lbs.) torque.

(b) Tighten all bolts in sequence (1 through 10) 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 6 to 149 N·m (110 ft. lbs.) torque.
- Bolt 7 to 136 N·m (100 ft. lbs.) torque.
- Bolts 8 through 10 to 149 N·m (110 ft. lbs.) torque.

(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.

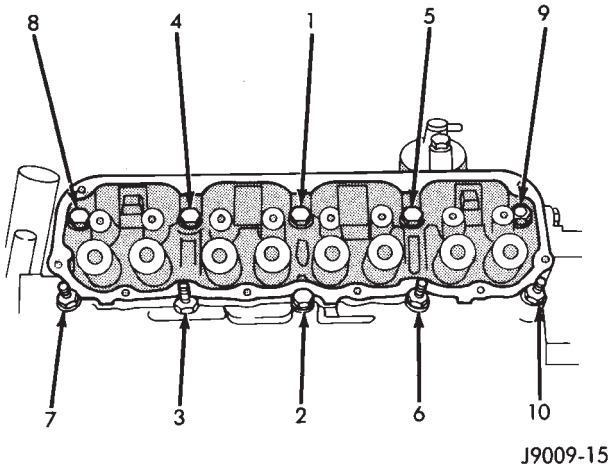


Fig. 37 Engine cylinder head Bolt Tightening Sequence

(11) Connect the coolant temperature sending unit connector.

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

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

(14) Install the fuel supply line. Push until a "click" is heard. Reinstall latch clip.

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

(16) Install the push rods, rocker arms, pivots and bridges in the order they were removed.

(17) Install the engine cylinder head cover.

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

(19) 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.

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

(21) Install the air cleaner and ducting.

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

(23) Install the coolant temperature sending unit connector.

(24) Connect negative cable to battery.

(25) Connect the upper radiator hose and heater hose at the 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 thermostat opens. Add coolant, if required.

VALVES AND VALVE SPRINGS

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

REMOVAL

(1) Remove the engine cylinder head from the cylinder block (Refer to procedure earlier in this section)

(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 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.

INSTALLATION

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

REMOVAL AND INSTALLATION (Continued)

(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

REMOVAL

Retain all the components in the same order as removed.

(1) Remove the engine cylinder head cover (refer to procedure earlier in this section)

(2) Remove the bridge and pivot assemblies and rocker arms by removing the capscrews at each bridge. Alternately loosen each capscrew, one turn at a time, to avoid damaging the bridges.

(3) Remove the push rods.

(4) Remove the tappets through the push rod openings in the cylinder head with a Hydraulic Valve Tappet Removal/Installation Tool (Fig. 38).

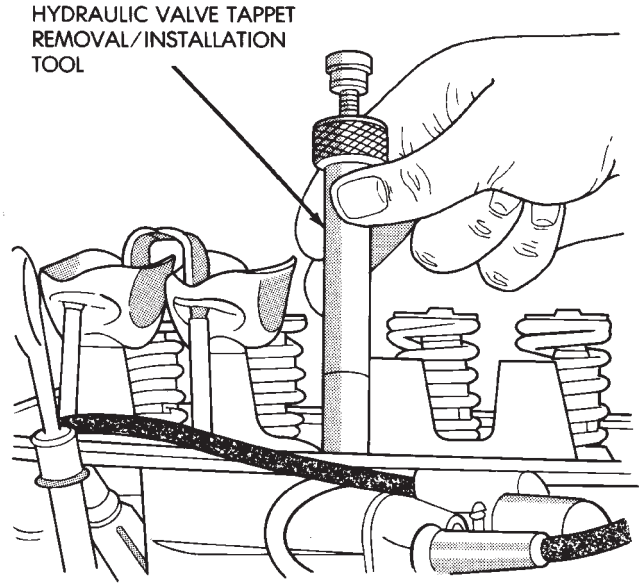


Fig. 38 Hydraulic Valve Tappet Removal/Installation Tool

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 push rods in their original locations.

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

(5) 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.

(6) 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 1 600 km (1,000 miles). The oil supplement need not be drained until the next scheduled oil change.

(7) 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. 39).

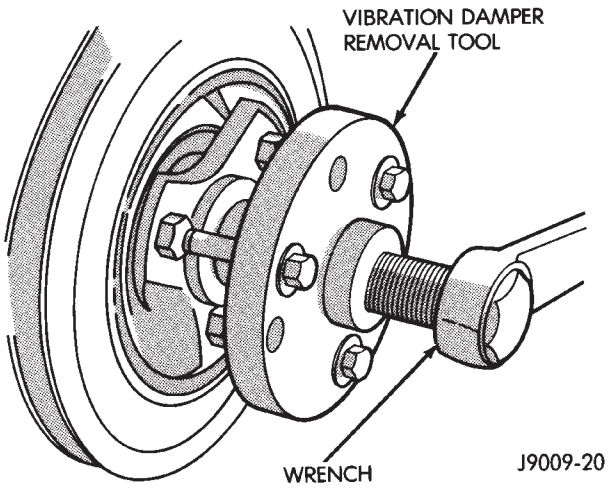


Fig. 39 Vibration Damper Removal Tool 7697

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

REMOVAL AND INSTALLATION (Continued)

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.

TIMING CASE COVER OIL SEAL

REMOVAL

This procedure is done with the timing case cover installed.

(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. 40). Tighten the nut against the tool until it contacts the cover.

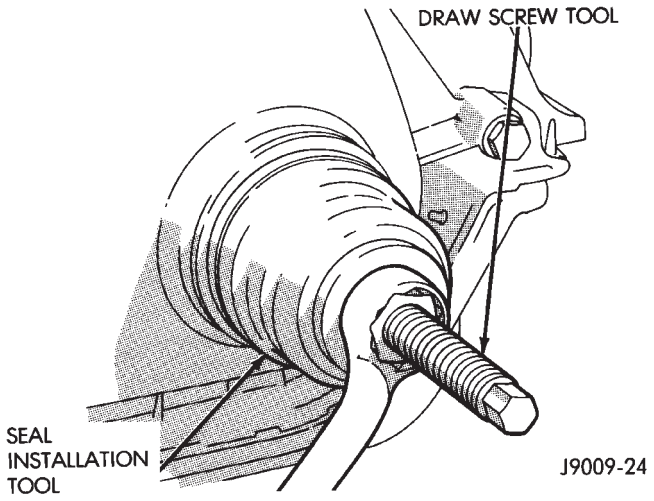


Fig. 40 Timing Case Cover Oil Seal Installation

(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.

TIMING CASE COVER

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove accessory drive belt (Refer to Group 07, Cooling System for proper procedure)

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

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

(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 vibration damper (Fig. 41).

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

(8) Remove the timing case cover and gasket from the engine.

(9) Pry the crankshaft oil seal from the front of the timing case cover (Fig. 41).

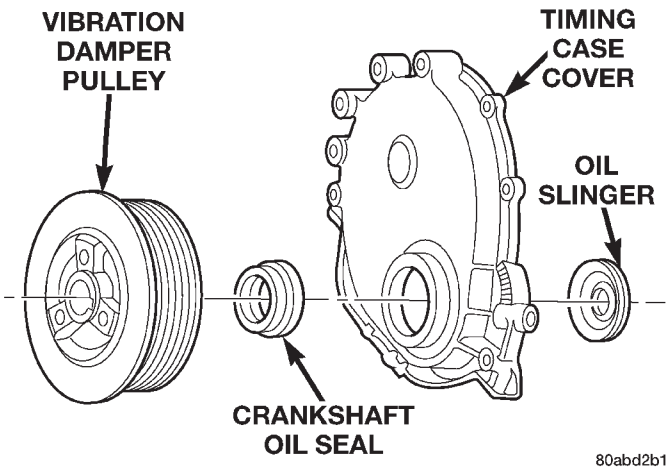


Fig. 41 Timing Case Cover Components

INSTALLATION

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

(2) 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

REMOVAL AND INSTALLATION (Continued)

area while installing the seal. Force it into position with Seal Installation Tool 6139.

(3) Position the gasket on the cylinder block.

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

(5) Insert Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening in the cover (Fig. 42).

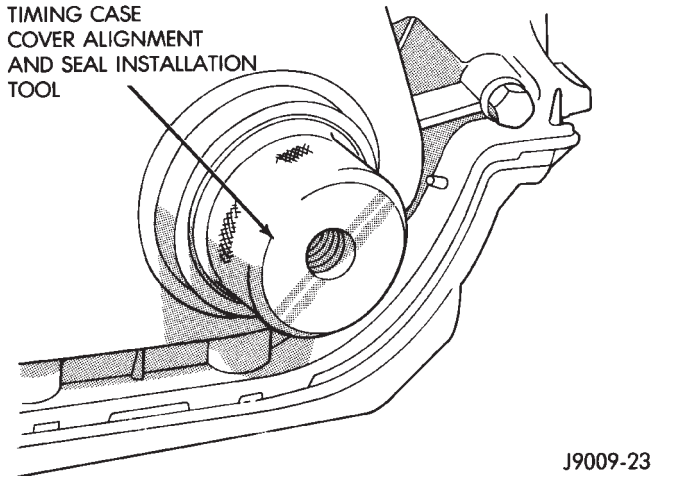


Fig. 42 Timing Case Cover Alignment and Seal Installation Tool 6139

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

(7) 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 bolts to 9.5 N·m (84 in. lbs.) torque.

(8) Remove the cover alignment tool.

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

(10) 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.

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

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

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

(14) Connect negative cable to battery.

TIMING CHAIN AND SPROCKETS

The timing chain tensioner reduces noise and prolongs timing chain life. In addition, it compensates for slack in a worn or stretched chain and maintains the correct valve timing.

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. 43).

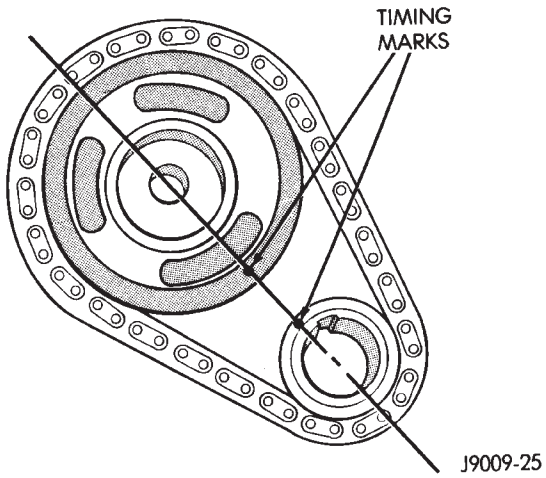


Fig. 43 Crankshaft—Camshaft Alignment

(7) Remove the oil slinger from the crankshaft.

(8) Remove the camshaft retaining bolt and remove the sprockets and chain as an assembly (Fig. 44).

(9) To replace the timing chain tensioner, the oil pan must be removed.

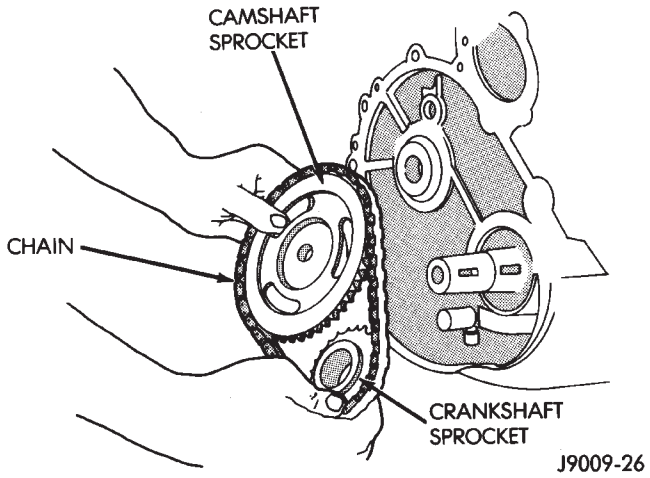


Fig. 44 Camshaft and Crankshaft Sprockets and Chain

INSTALLATION

(1) Turn the tensioner lever to the unlocked (down) position (Fig. 45).

REMOVAL AND INSTALLATION (Continued)

(2) Pull the tensioner block toward the tensioner lever to compress the spring. Hold the block and turn the tensioner lever to the lock position (Fig. 45).

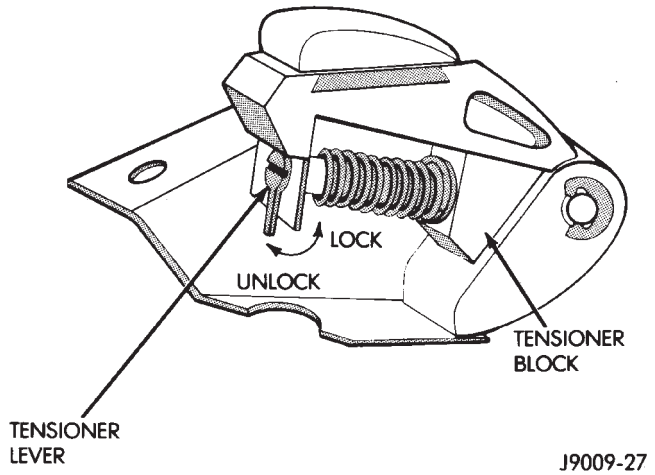


Fig. 45 Loading Timing Chain Tensioner

(3) Apply Mopar Silicone Rubber Adhesive Sealant to the keyway in the crankshaft and insert the key. With the key in the crankshaft keyway, install the crankshaft, camshaft sprockets and timing chain. Ensure the timing marks on the sprockets are properly aligned (Fig. 43).

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

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark as shown in (Fig. 46). Count the number of chain pins between the timing marks of both sprockets. There must be 20 pins.

(6) Turn the chain tensioner lever to the unlocked (down) position (Fig. 45).

(7) Install the oil slinger.

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

(9) Install the timing case cover and gasket.

(10) 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.

(11) Install the fan and shroud.

(12) 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.

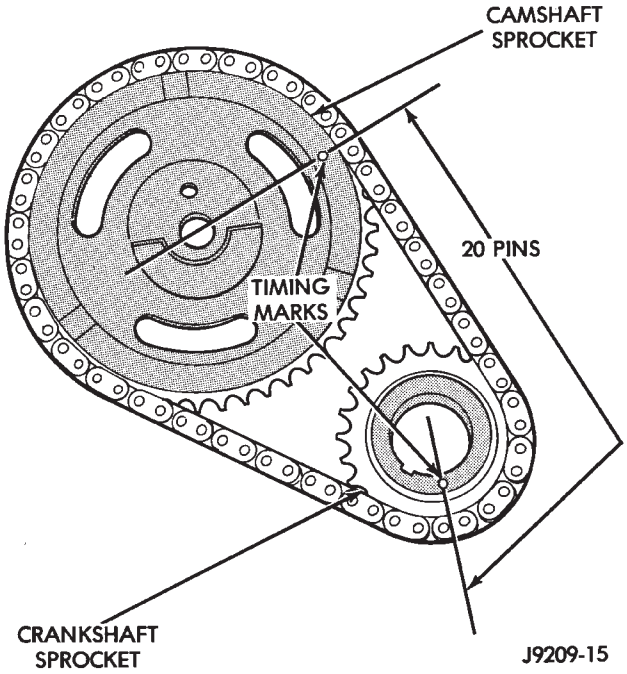


Fig. 46 Verify Sprocket—Chain Installation

(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.

(4) Scribe a mark on the distributor housing in line with the lip of the rotor.

(5) Scribe a mark on the distributor housing near the clamp and continue the scribe mark on the cylinder block in line with the distributor mark.

(6) For ease of installation, note the position of the rotor and distributor housing in relation to adjacent engine components.

(7) Remove the distributor and ignition wires.

(8) Remove the engine cylinder head cover.

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

(10) Remove the push rods.

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

(12) Remove the vibration damper.

(13) Remove the timing case cover.

(14) Remove the timing chain and sprockets.

(15) Remove the camshaft (Fig. 47).

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 pres-

REMOVAL AND INSTALLATION (Continued)

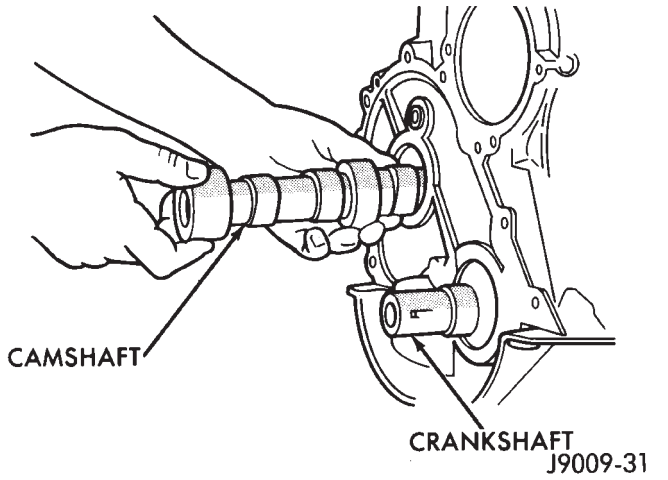


Fig. 47 Camshaft

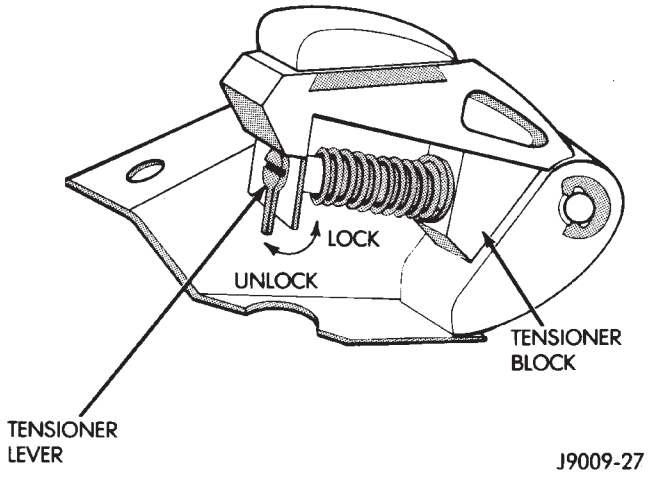


Fig. 48 Loading Timing Chain Tensioner

sure relief holes in the rear cam journal. The oil pressure relief holes must be free of debris.

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

(7) Carefully install the camshaft to prevent damage to the camshaft bearings (Fig. 47).

(8) Turn the tensioner lever to the unlocked (down) position (Fig. 48).

NOTE: Pull the tensioner block toward the tensioner lever to compress the spring. Hold the block and turn the tensioner lever to the lock position (Fig. 48).

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

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

(11) Install the timing case cover with a replacement oil seal (Fig. 49). Refer to Timing Case Cover Installation.

(12) Install the vibration damper.

(13) Install the hydraulic valve tappets.

(14) Install the push rods.

(15) Install the rocker arms, bridges and pivots.

(16) Install the engine cylinder head cover.

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

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

(19) Install the radiator or radiator and condenser, if equipped with A/C.

(20) Fill the cooling system.

(21) Connect negative cable to battery.

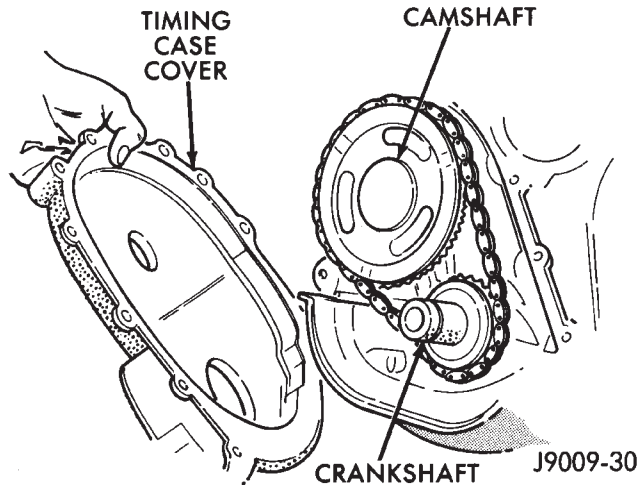


Fig. 49 Timing Case Cover

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.

REMOVAL AND INSTALLATION (Continued)

(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) Rotate crankshaft until the crankshaft sprocket timing mark is closest to and on the center line with the camshaft sprocket timing mark (Fig. 50).

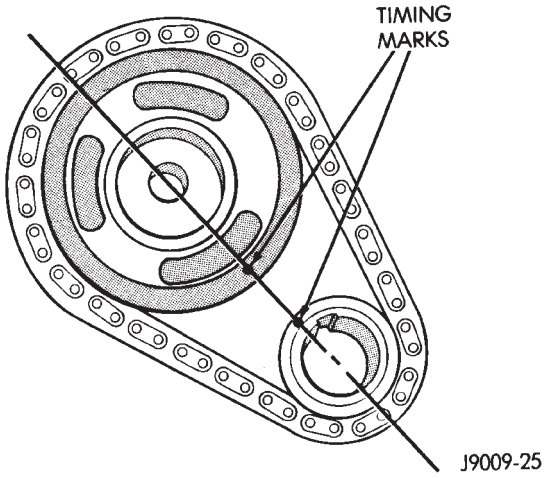


Fig. 50 Timing Chain Alignment

(11) Remove camshaft sprocket retaining bolt.

(12) Remove the crankshaft oil slinger.

(13) Remove the sprockets and chain as an assembly (Fig. 51).

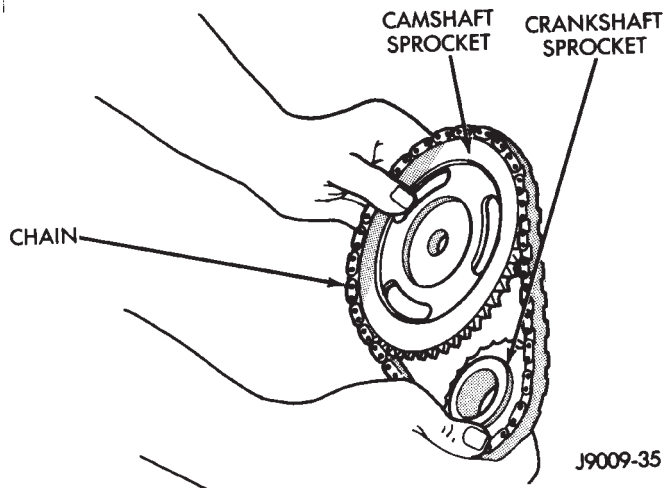


Fig. 51 Camshaft and Crankshaft Sprocket and Chain

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

(14) Inspect the damaged camshaft pin.

(15) 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.

(16) 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.

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

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

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. 50).

(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark as shown in (Fig. 52). Count the number of chain pins between the timing marks of both sprockets. There must be 20 pins.

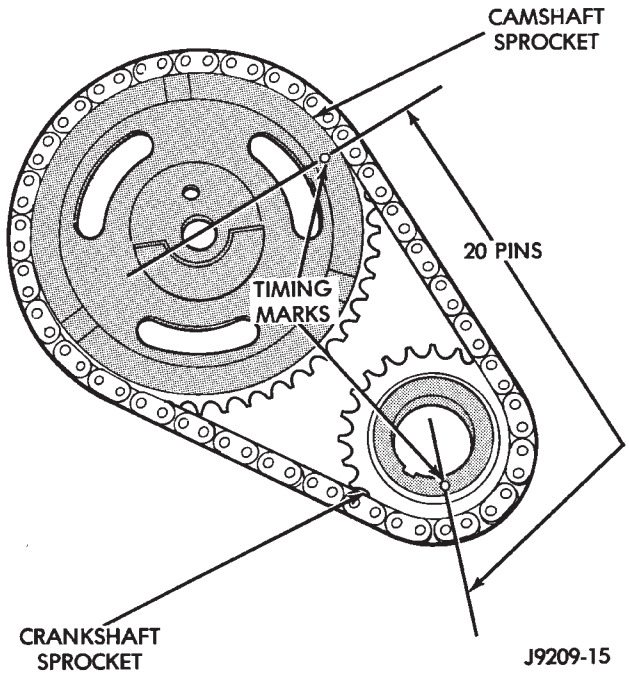


Fig. 52 Verify Crankshaft—Camshaft Installation

(6) Install the crankshaft oil slinger.

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

REMOVAL AND INSTALLATION (Continued)

(8) Check the valve timing.

(9) 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 Sealant, or equivalent to the joint formed at the timing case cover and cylinder block.

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

(11) Place Timing Case Cover Alignment and Seal Installation Tool 6139 in the crankshaft opening of the cover (Fig. 53).

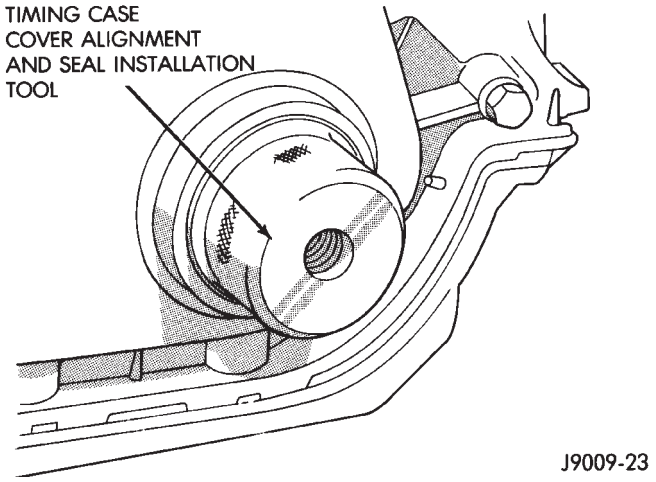


Fig. 53 Timing Case Cover Alignment and Seal Installation Tool 6139

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

(13) 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 (120 in. lbs.) torque. Tighten the oil pan-to-cover 5/16 inch bolts to 18 N·m (156 in. lbs.) torque.

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

(15) Install the vibration damper on the crankshaft.

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

(17) 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.

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

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

(20) Install the fan and shroud.

(21) Connect negative cable to battery.

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 oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face.

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 only one main bearing cap and lower insert at a time (Fig. 54).

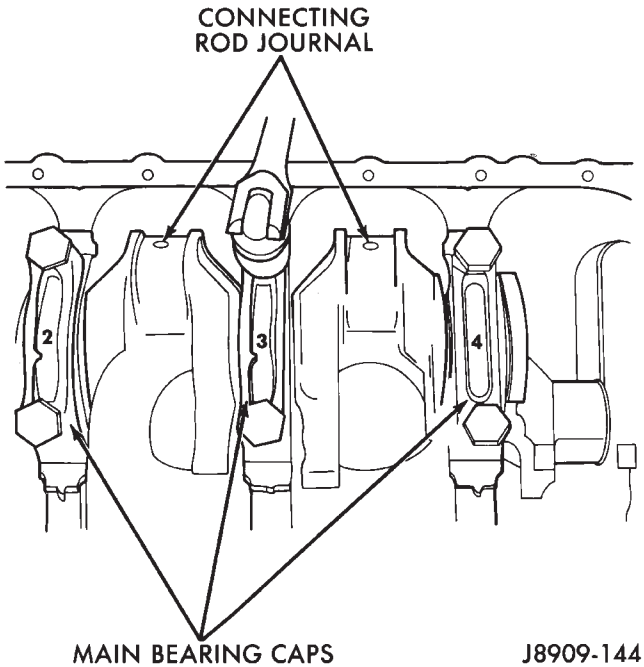


Fig. 54 Removing Main Bearing Caps and Lower Inserts

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

(7) Remove the upper insert by LOOSENING (DO NOT REMOVE) all of the other bearing caps. Now insert a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fab-

REMOVAL AND INSTALLATION (Continued)

ricate the tool (Fig. 55). 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. 55). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.

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

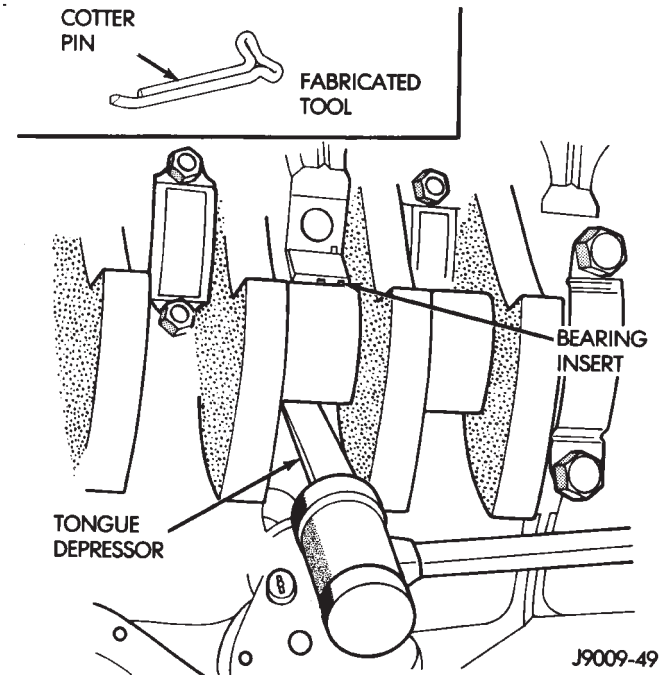


Fig. 55 Removing Upper Inserts

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) Clean the rear main bearing cap (No.5) mating surfaces.

(6) Apply Loctite 518, or equivalent on the rear bearing cap (Fig. 56). The bead should be 3 mm (0.125 in) thick. DO NOT apply Loctite 518, or equivalent to the lip of the seal.

(7) Install the rear main bearing cap. DO NOT strike the cap more than twice for proper engagement.

(8) Tighten the bolts of caps 1, 3, 4 and 5 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.

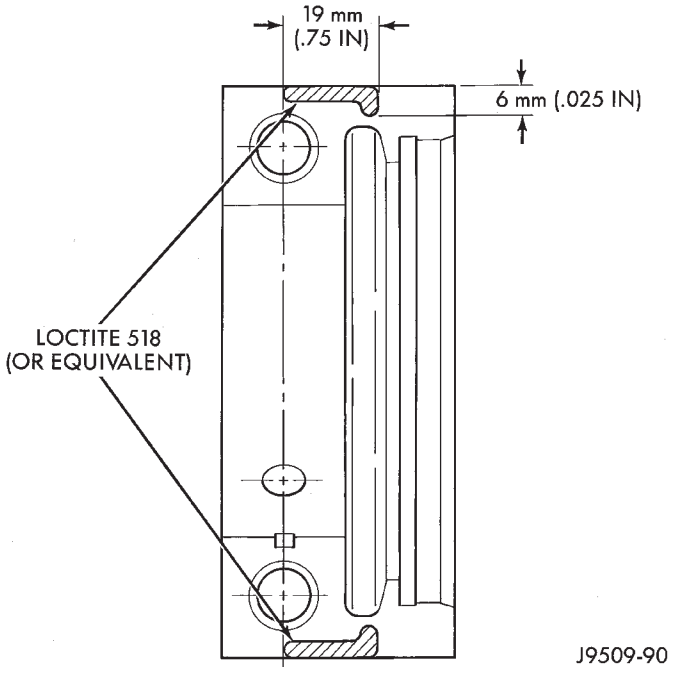


Fig. 56 Location of Loctite 518 (or equivalent)

(9) Push the crankshaft forward and backward. Load the crankshaft front or rear and tighten cap bolt No.2 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.

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

(11) 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. 57). 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.

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

REMOVAL AND INSTALLATION (Continued)

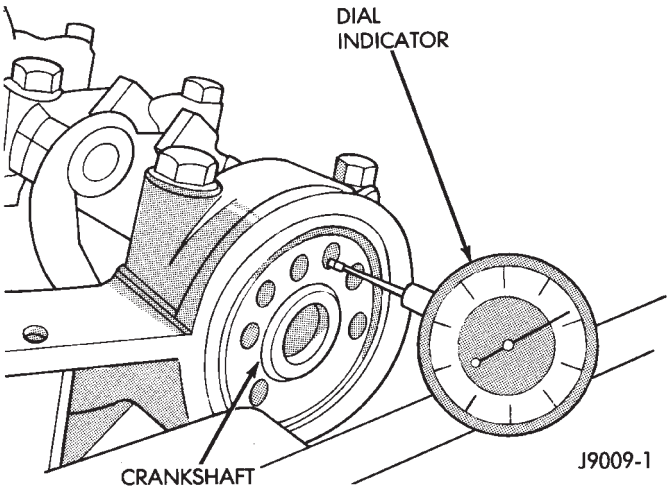


Fig. 57 Crankshaft End Play Measurement

(13) Install the oil pan.

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

(15) Lower the vehicle.

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

(17) Fill the oil pan with engine oil to the safe mark on the dipstick level.

(18) 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 engine exhaust manifold.

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

(6) Remove the engine starter motor.

(7) Remove the flywheel/torque converter housing access cover.

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

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

(10) Remove the engine mount through bolts.

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

(12) Remove the oil pan bolts. Carefully remove the oil pan and gasket.

INSTALLATION

(1) Clean the block and pan gasket surfaces.

(2) Fabricate 4 alignment dowels from 1/4 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. 58).

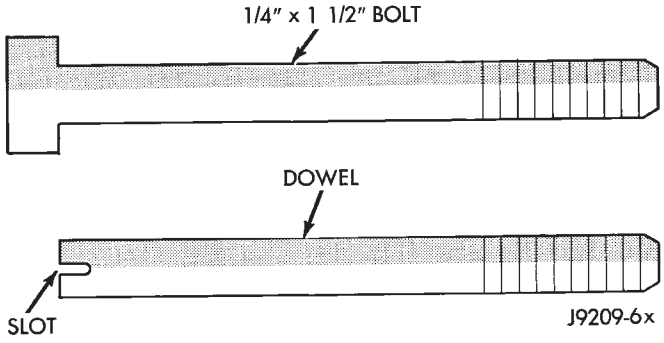


Fig. 58 Fabrication of Alignment Dowels

(3) Install two dowels in the timing case cover. Install the other two dowels in the cylinder block (Fig. 59).

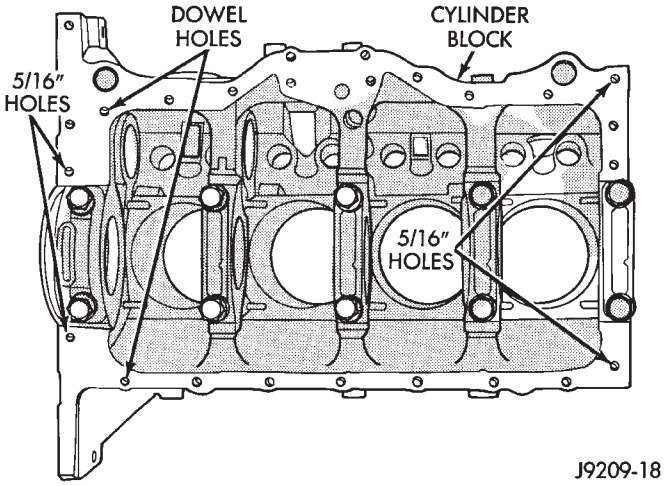


Fig. 59 Position of Dowels in Cylinder Block

(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.

(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. 60). 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.

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

(12) Install the engine starter motor.

REMOVAL AND INSTALLATION (Continued)

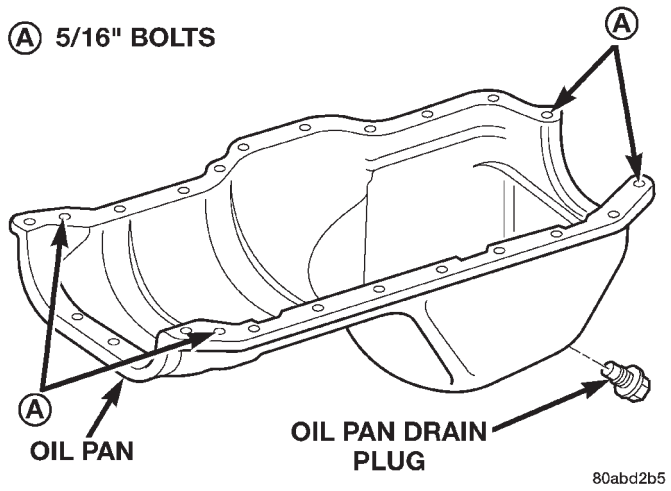


Fig. 60 Position of 5/16 inch Oil Pan Bolts

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

(14) Install the oil pan drain plug (Fig. 60). 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.

OIL PUMP

The positive-displacement gear-type oil pump is driven by the distributor shaft, which is driven by a gear on the camshaft. Oil is siphoned into the pump through an inlet tube and strainer assembly that is pressed into the pump body.

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 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.

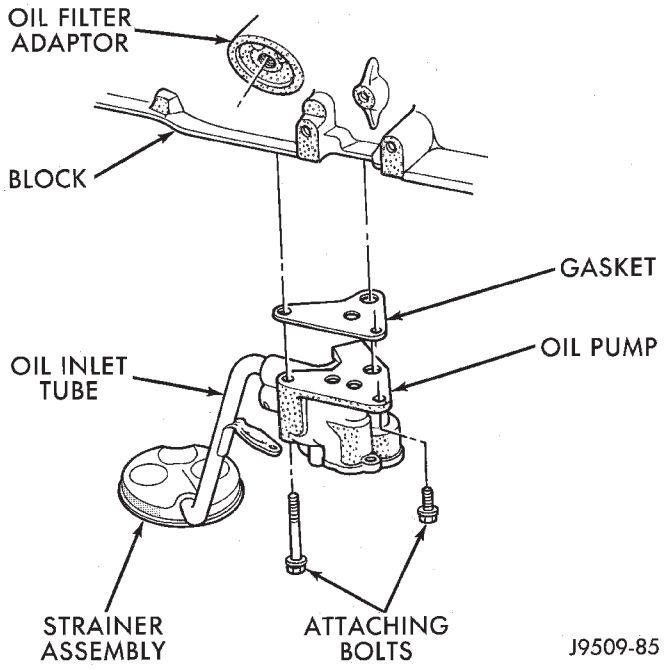


Fig. 61 Oil Pump Assembly

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 and gasket.

(3) Fill the oil pan with oil to the specified level.

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. 62).

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

REMOVAL AND INSTALLATION (Continued)

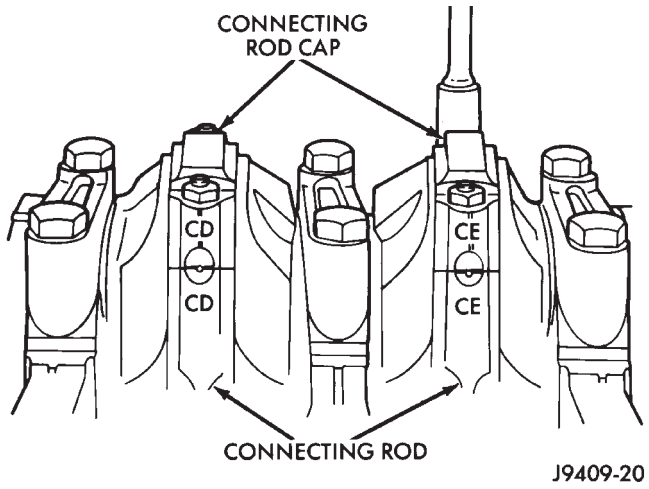


Fig. 62 Stamped Connecting Rods and Caps

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. 63).

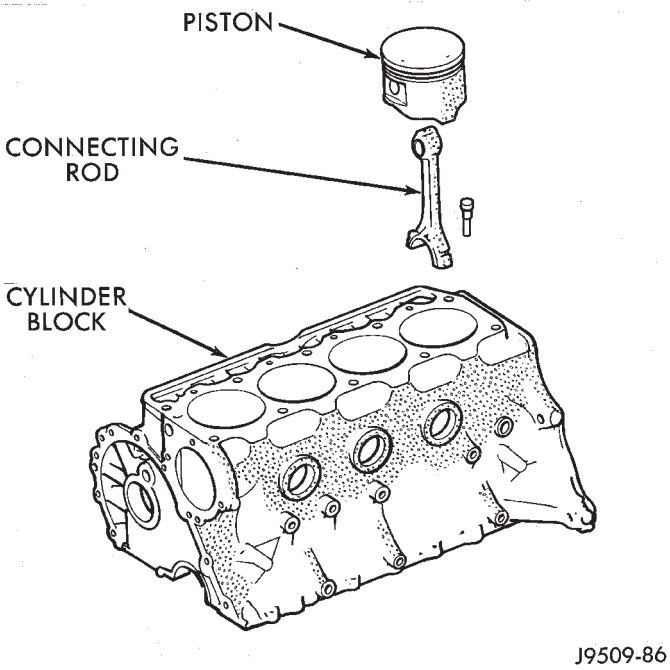


Fig. 63 Removal of Connecting Rod and Piston Assembly

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. 64).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 64).

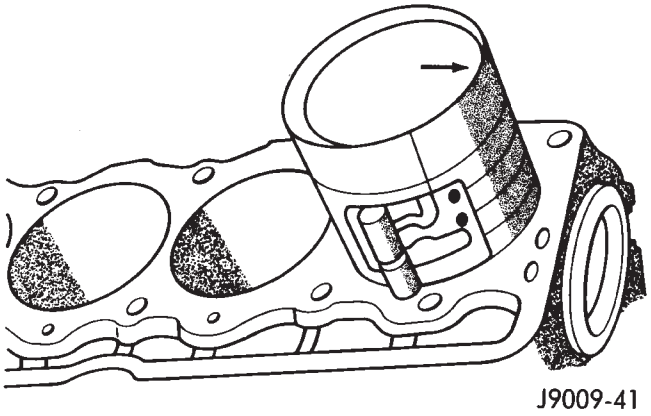


Fig. 64 Rod and Piston Assembly Installation

(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

REMOVAL

(1) Remove the flywheel or converter drive plate. Discard the old bolts.
(2) Pry out the seal from around the crankshaft flange (Fig. 65).

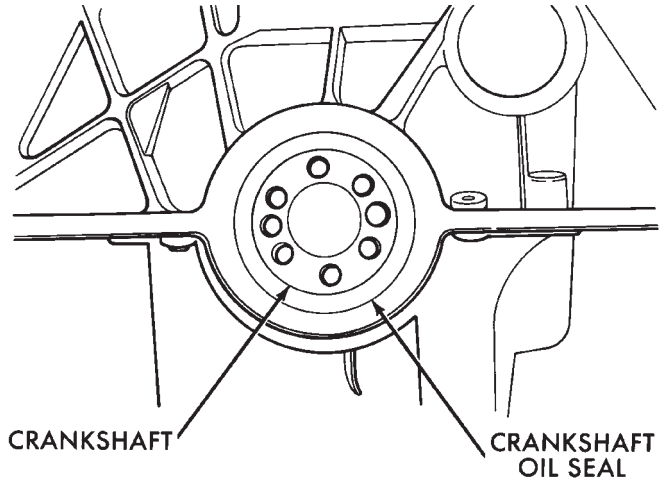


Fig. 65 Replacement of Rear Crankshaft Oil Seal

INSTALLATION

(1) Coat the outer lip of the replacement rear main bearing seal with engine oil.
(2) Carefully position the seal into place. Use rear main Seal Installer Tool 6271A to install the seal flush with the cylinder block.

CAUTION: The felt lip must be located inside the flywheel mounting surface. If the lip is not positioned correctly the flywheel could tear the seal.

(3) Install the flywheel or converter drive plate. New bolts MUST be used when installing the flywheel or converter plate. Tighten the new bolts to 68 N·m (50 ft. lbs.) torque. Turn the bolts an additional 60°.

DISASSEMBLY AND ASSEMBLY

VALVE SERVICE

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

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. 66). If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced.

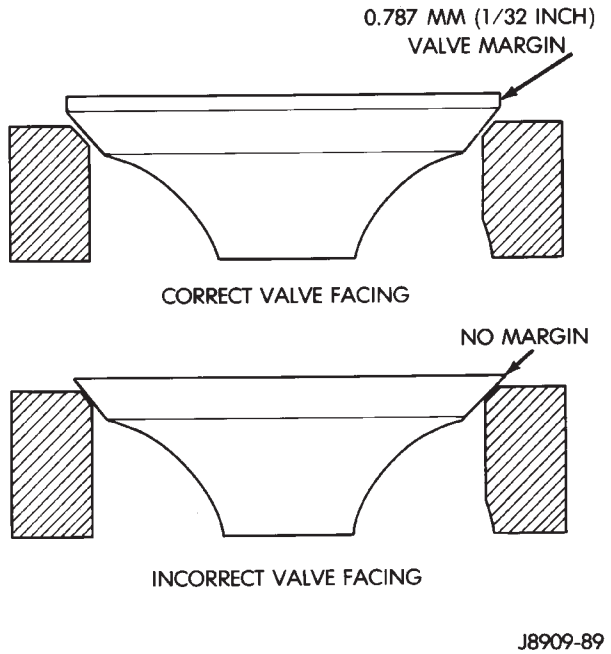


Fig. 66 Valve Facing Margin

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.

DISASSEMBLY AND ASSEMBLY (Continued)

(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. 67).

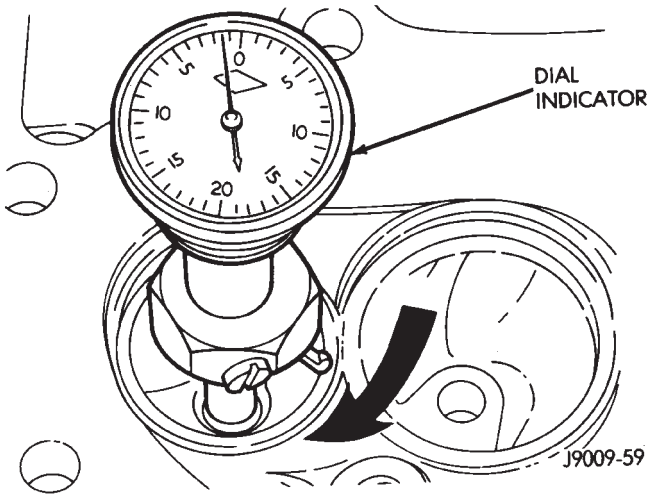


Fig. 67 Measurement of Valve Seat Runout

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.

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, 0.076mm (.003in.) oversize stems do not require oversize seals.

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. 68).

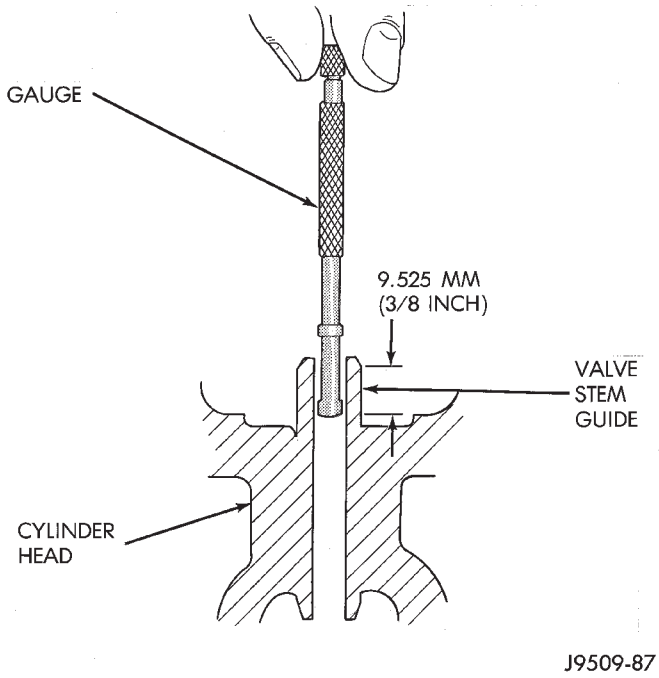


Fig. 68 Measurement of Valve Guide Bore Diameter

(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.

(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. 69).

(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.

DISASSEMBLY AND ASSEMBLY (Continued)

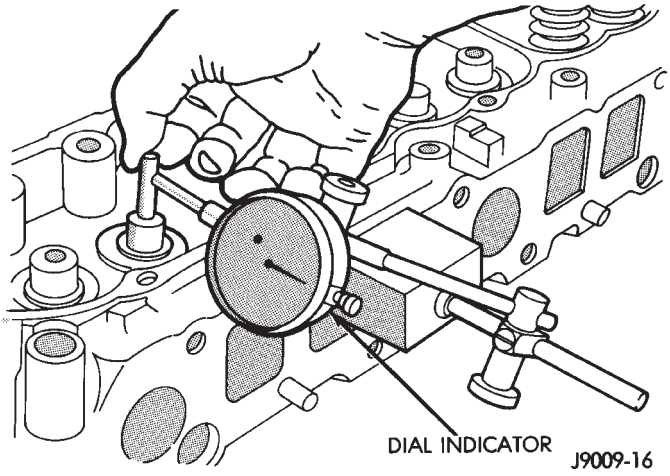


Fig. 69 Measurement of Lateral Movement Of Valve Stem

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. 70).

Replace valve springs that are not within specifications.

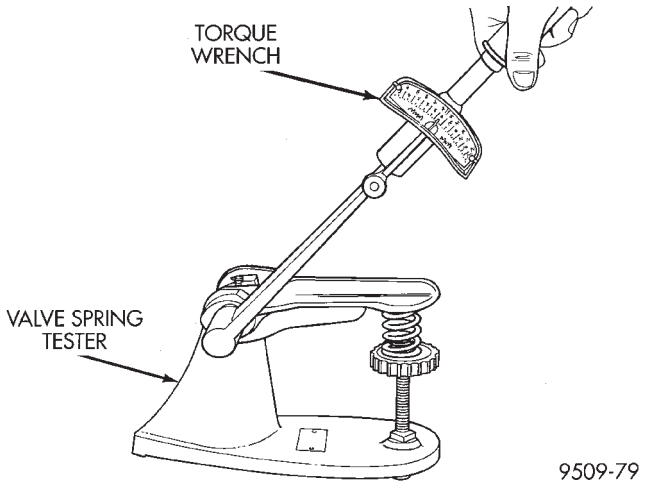


Fig. 70 Valve Spring Tester

CYLINDER BLOCK

Remove the Engine Assembly from the vehicle.

DISASSEMBLY

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

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

(3) Remove the distributor from the cylinder block.

(4) Remove the vibration damper.

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

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

(7) Remove the timing chain bumper.

(8) Remove the oil slinger from crankshaft.

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

(10) Remove the camshaft.

(11) Remove the oil pan and gasket.

(12) Remove the timing chain tensioner.

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

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

(15) Remove the crankshaft.

ASSEMBLY

(1) Install the crankshaft.

(2) Install the connecting rods and the pistons through the top of the cylinder bores.

(3) Install the front and rear oil galley plugs.

(4) Install the timing chain tensioner.

(5) Install the camshaft.

(6) Install the sprockets and chain as an assembly.

(7) Install the oil slinger to the crankshaft.

(8) Install the timing chain bumper.

(9) Install the timing case cover seal.

(10) Install the timing case cover.

(11) Install the oil pan gasket and oil pan.

(12) Install the vibration damper.

(13) Install the water pump. Tighten the mounting bolts to 31 N·m (270 in. lbs.) torque.

(14) Remove the distributor from the cylinder block.

(15) Lubricate the oil filter seal with clean engine oil. Tighten oil filter to 18 N·m (13 ft. lbs.) torque.

(16) Install the engine into the vehicle.

(17) Fill the engine with clean lubrication oil.

(18) Fill the cooling system.

CLEANING AND INSPECTION

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

CLEANING AND INSPECTION (Continued)

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.

ENGINE 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.

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 filter bypass hole (Fig. 71).

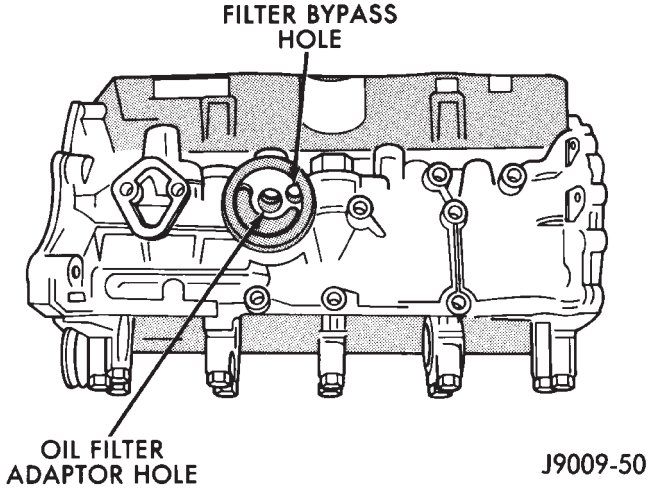


Fig. 71 Oil Filter Adaptor Hole

- The front and rear oil galley holes (Fig. 72) (Fig. 73).
- 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 41 N·m (30 ft. lbs.) torque.

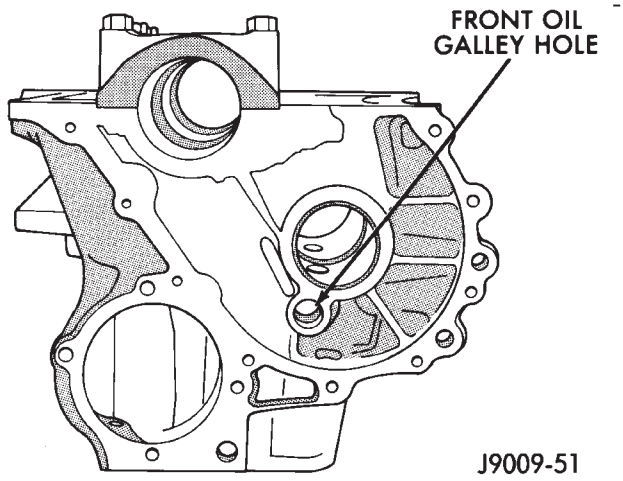


Fig. 72 Front Oil Galley Hole

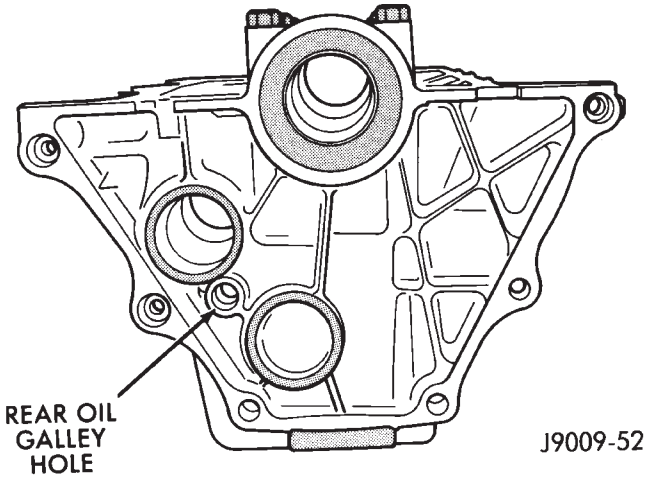


Fig. 73 Rear Oil Galley Hole

INSPECTION—CYLINDER BORE

(1) It is mandatory to use a dial bore gauge to measure each cylinder bore diameter (Fig. 74). To correctly select the proper size piston, a cylinder bore gauge, capable of reading in 0.003 mm (.0001in.) 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 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.

CLEANING AND INSPECTION (Continued)

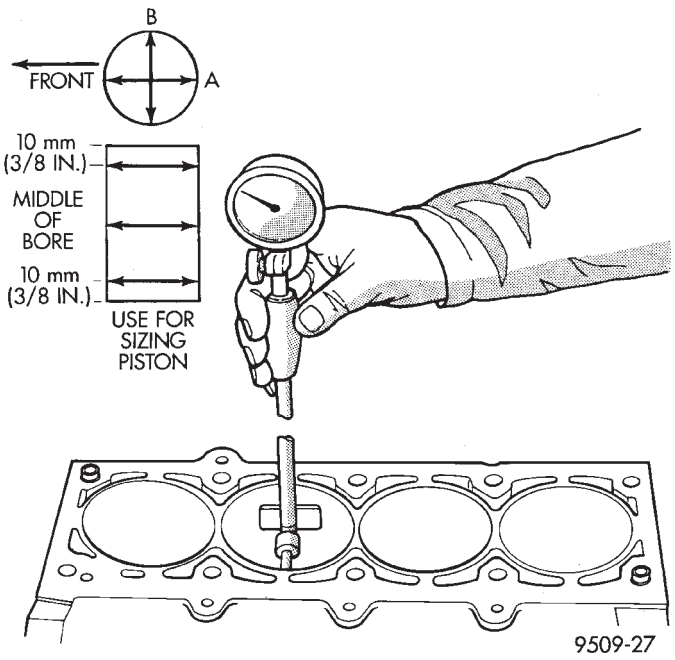


Fig. 74 Cylinder Bore Measurement

(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 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.

SPECIFICATIONS

2.5L 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.)

Camshaft Lobe Lift

Exhaust . . . . . .6.579 mm (0.259 in.)
Intake. . . . . .6.477 mm (0.255 in.)

Valve Lift

Exhaust . . . . . .10.528 mm (0.4145 in.)
Intake . . . . . .10.350 mm (0.4075 in.)

Intake Valve Timing

Opens. . . . . .15.4° BTDC
Closes . . . . . .58° ABDC

Exhaust Valve Timing

Opens . . . . . .52.8 BBDC
Closes . . . . . .26.2° ATDC
Valve Overlap . . . . . .41.6°
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 . . . . . .63.489 to 63.502 mm (2.4996 to 2.5001 in.)
Main Bearing Journal Width No. 1. . . . . .27.58 to 27.89 mm (1.086 to 1.098 in.)
Main Bearing Journal Width No. 2 . . . . . .32.28 to 32.33 mm (1.271 to 1.273 in.)
Main Bearing Journal Width No. 3-4-5 . . . . . .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 . . . . . .236.73 mm (9.320 in.)
Deck Clearance. . . . . .0.000 mm (0.000 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 (Max.) . . . . . 0.025 mm (0.001 in.)

SPECIFICATIONS (Continued)

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 for total length (0.008 in. 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.)

Cylinder Compression Pressure

Ratio 9.1:1
Pressure Range. . . . . .827 to 1,034 kPa (120 to 150 psi)
Max. Variation Between Cylinders. . . . . .206 kPa (30 psi)

Cylinder Head

Combustion Chamber . . . . . .49.9 to 52.9 cc (3.04 to 3.23 cu. in.)
Valve Guide I.D. (Integral) . . . . . .7.95 to 7.97 mm (0.313 to 0.314 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. . . . . .1.01 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 for total length (0.008 in. for total length)

Rocker Arms, Push Rods & Tappets

Rocker Arm Ratio 1.6:1
Push Rod Length . . . . . .241.300 to 241.808 mm (9.500 to 9.520in.)
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. . . . . 124.435 to 125.070 mm (4.899 to 4.924 in.)
Length (Tip-to-Gauge Dimension Line) Exhaust . . . . . .125.120 to 125.755 mm (4.927 to 4.952 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 pen. . . . . .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.)
Installed Height . . . . . .41.656 mm (1.640 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 0.610 mm (0.0090 to 0.0240 in.)

SPECIFICATIONS (Continued)

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 Ring. . . . . .0.06 to 0.21 mm (0.0024 to 0.0083 in.)
Piston Ring Groove Height—Compression Rings . . . . . 1.530 to 1.555mm (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 . . . . . 87.78 to 87.90 mm (3.456 to 3.461 in.)
Piston Ring Groove Diameter—Oil Control Ring . . . . . 87.50 to 87.75 mm (3.445 to 3.455 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 (0.0003 to 0.0007 in.)
Piston-to-Pin Clearance (Preferred). . . . . .0.015 mm—Loose (0.0006 in.—Loose)
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—Plastigage (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

Min. Pressure (600 rpm). . . . . .89.6 kPa (13 psi)
At Idle Speed (800 rpm) . . . . . .172 to 241 kPa (25 to 35 psi)
At 1600 rpm & Higher . . . . . .255 to 517 kPa (37 to 75 psi)
Oil Pressure Relief . . . . . .517 kPa (75 psi)

2.5L TORQUE SPECIFICATIONS

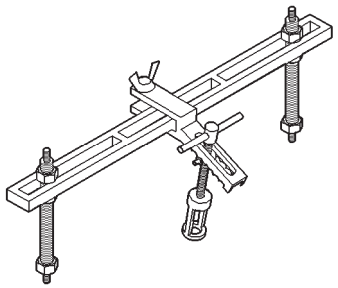
DESCRIPTION	TORQUE
A/C Compressor Bracket-to-Engine	
Bolts	.34 N·m (25 ft. lbs.)
A/C Compressor	
Mounting Bolts	.27 N·m (20 ft. lbs.)
Block Heater	
Nut	.1.8 N·m (16 in. lbs.)
Camshaft Sprocket	
Bolt	.108 N·m (80 ft. lbs.)
Connecting Rod	
Nuts	.45 N·m (33 ft. lbs.)
Clutch Cover to Flywheel	
Bolts	.31 N·m (23 ft. lbs.)
Cylinder Block	
Drain Plugs	.41 N·m (30 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	.13 N·m (115 in. lbs.)
Dipstick Tube Bracket to Cylinder Block	
Bolt	.19 N·m (168 in. lbs.)
Distributor Hold-Down Clamp	
Bolt	.23 N·m (204 in. lbs.)
Engine Shock Damper	
Stud Nuts	.23 N·m (17 ft. lbs.)
Engine Mounts—Front	
Insulator Bracket Bolts	.81 N·m (60 ft. lbs.)
Insulator Bracket Nuts	.47 N·m (35 ft. lbs.)
Insulator Thru-Bolt	.81 N·m (60 ft. lbs.)
Engine Mounts—Rear	
Support Cushion/Crossmember Nuts	.22 N·m (192 in. lbs.)
Support Cushion/Bracket Nuts	.46 N·m (34 ft. lbs.)
Transmission Support Bracket Bolts	.43 N·m (32 ft. lbs.)
Transmission Support Bracket/Cushion Bolt	.75 N·m (55 ft. lbs.)
Transmission Support Adaptor Bracket Bolts	.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 to 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.)
Generator	
Adjusting Bolt	.24 N·m (18 ft. lbs.)
Pivot Bolt/Nut	.38 N·m (28 ft. lbs.)

SPECIFICATIONS (Continued)

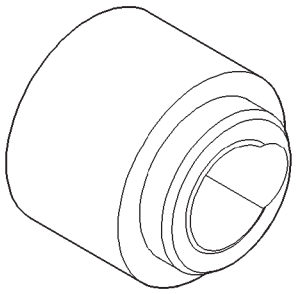
DESCRIPTION	TORQUE
Mounting Bracket-to–Engine Bolts	38 N·m (28 ft. lbs.)
Mounting/Head Bolts	45 N·m (33 ft. lbs.)
Main Bearing	
Bolts	108 N·m (80 ft. lbs.)
Oil Filter	
Adaptor Bolt	102 N·m (75 ft. lbs.)
Connector	68 N·m (50 ft. lbs.)
Filter	18 N·m (13 ft. lbs.)
Oil Galley	
Plug	41 N·m (30 ft. lbs.)
Oil Pan	
1/4–20 Bolts	9.5 N·m (84 in. lbs.)
5/16–18 Bolts	15 N·m (132 in. lbs.)
Drain Plug	34 N·m (25 ft. lbs.)
Oil Pressure Sending Unit	
Sending Unit	15 N·m (130 in. lbs.)
Oil Pump	
Short Attaching Bolts	23 N·m (204 in. lbs.)
Long Attaching Bolts	23 N·m (204 in. 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 (21 ft. lbs.)
Spark Plugs	
Plugs	37 N·m (27 ft. lbs.)
Starter Motor	
Mounting Bolts	45 N·m (33 ft. lbs.)
Tensioner Bracket ot Cylinder Block	
Bolts	19 N·m (168 in. lbs.)
Thermostat Housing	
Bolts	18 N·m (156 in. lbs.)
Throttle Body	
Bolts	10 N·m (90 in. lbs.)
Vibration Damper	
Bolt	108 N·m (80 ft. lbs.)
Water Pump to Block	
Bolts	31 N·m (23 ft. lbs.)

SPECIAL TOOLS

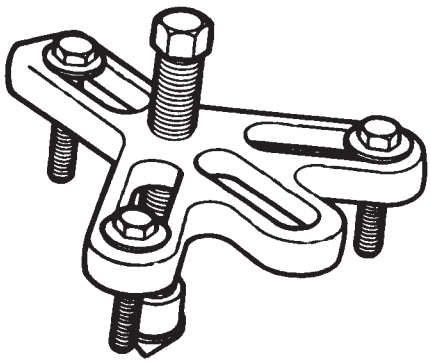
2.5L ENGINE



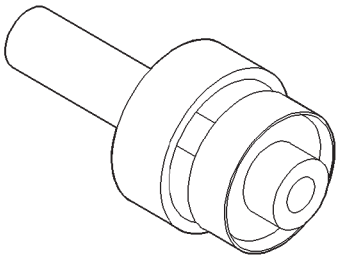
Valve Spring Compressor Tool MD-998772A



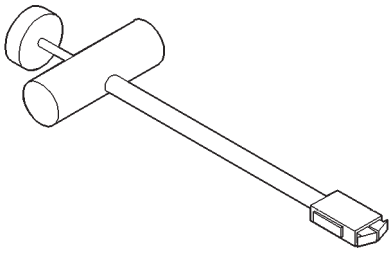
Timing Case Cover Alignment and Seal Installation Tool 6139



Vibration Damper Removal Tool 7697



Rear Main Seal Installer Tool 6271A



Hydraulic Valve Tappet Removal/Installation Tool C-4129-A

4.0L ENGINE

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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 (with Struts)
Pistons Combustion Cavity . . . . . .Double Quench
Connecting Rods . . . . . .Cast Malleable 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).

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).

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).

DESCRIPTION AND OPERATION (Continued)

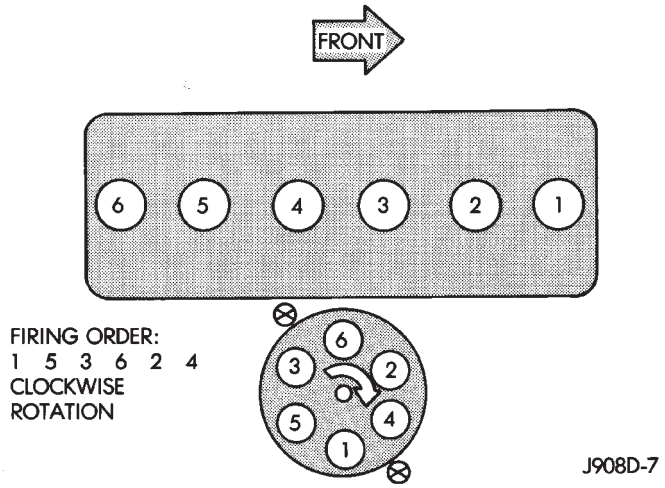


Fig. 1 Engine Firing Order

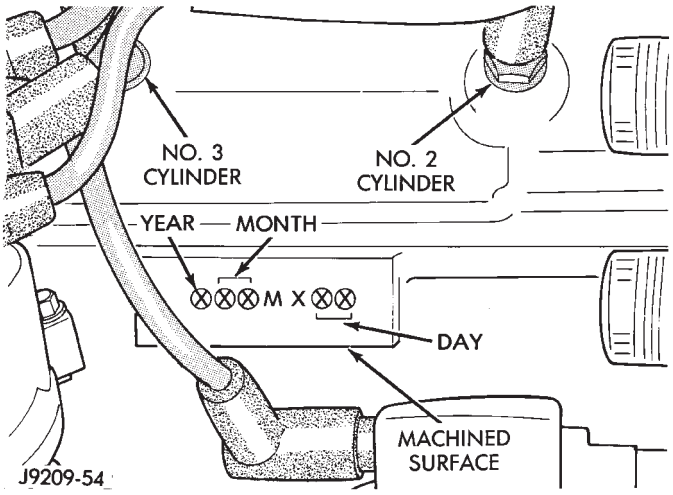


Fig. 2 Build Date Code Location

(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

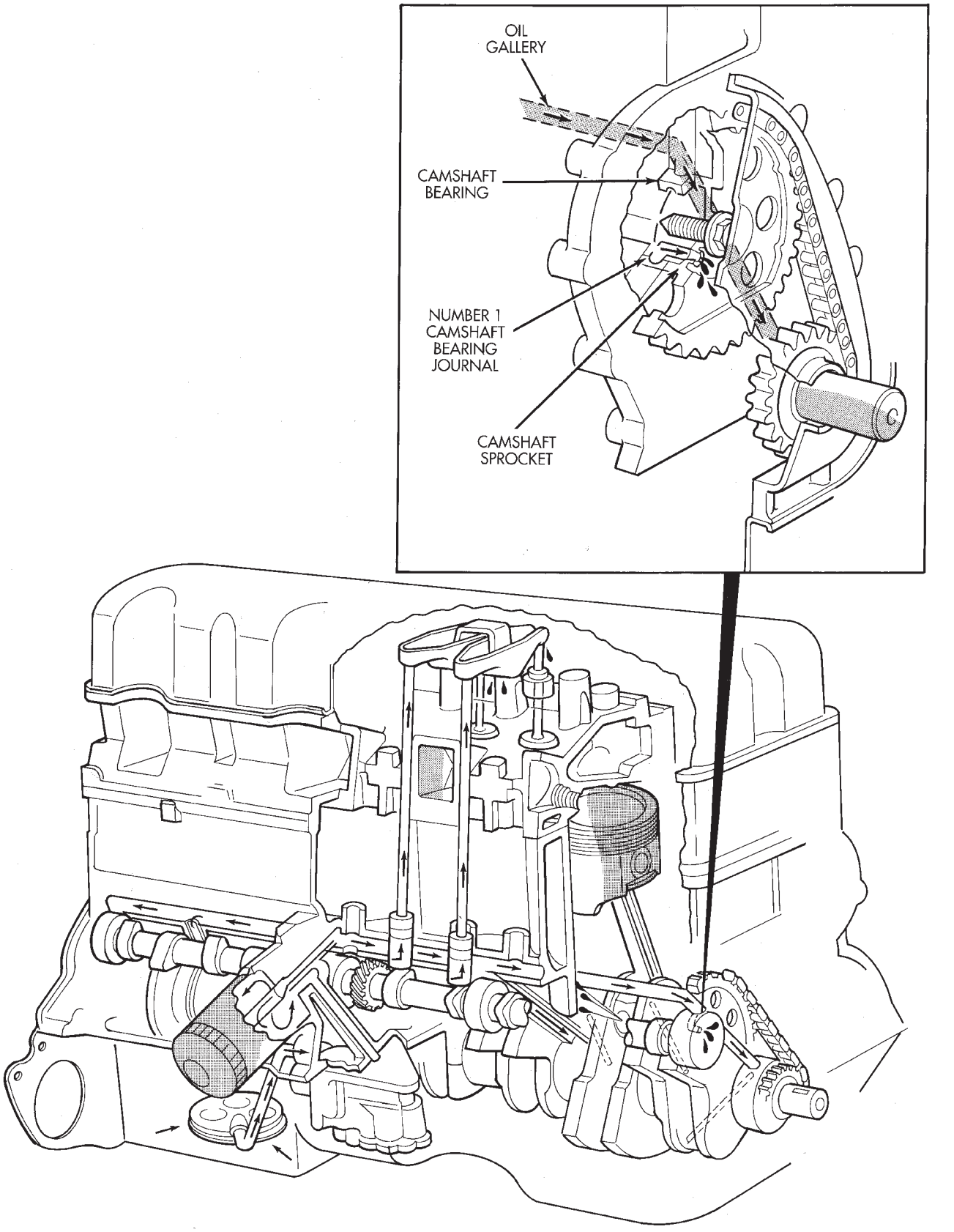
A gear—type positive displacement pump is mounted at the underside of the block opposite the No. 4 main bearing. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet 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.

DESCRIPTION AND OPERATION (Continued)



Oil Lubrication System

DESCRIPTION AND OPERATION (Continued)

OIL PUMP PRESSURE

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

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 Component Codes

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.

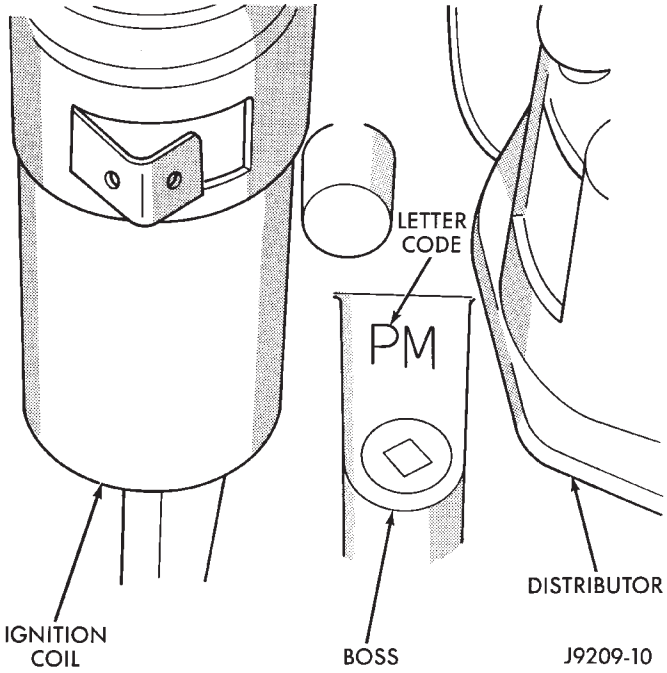


Fig. 4 Oversize and Undersize Component Code Location

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.

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

SERVICE PROCEDURES (Continued)

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 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.

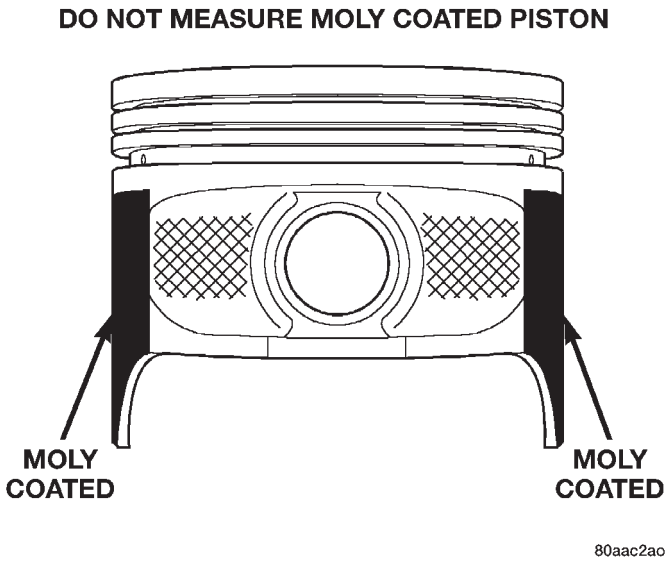


Fig. 5 Moly Coated Piston

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

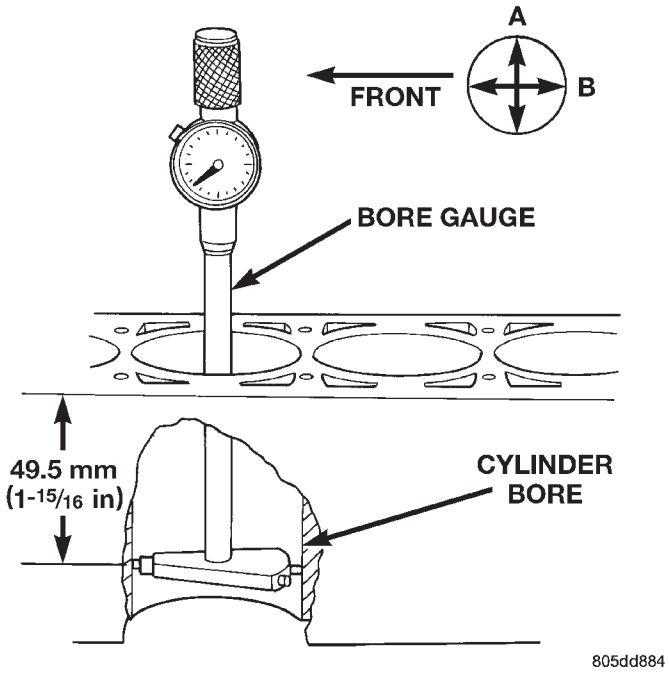


Fig. 6 Bore Gauge

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.

(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.

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).

SERVICE PROCEDURES (Continued)

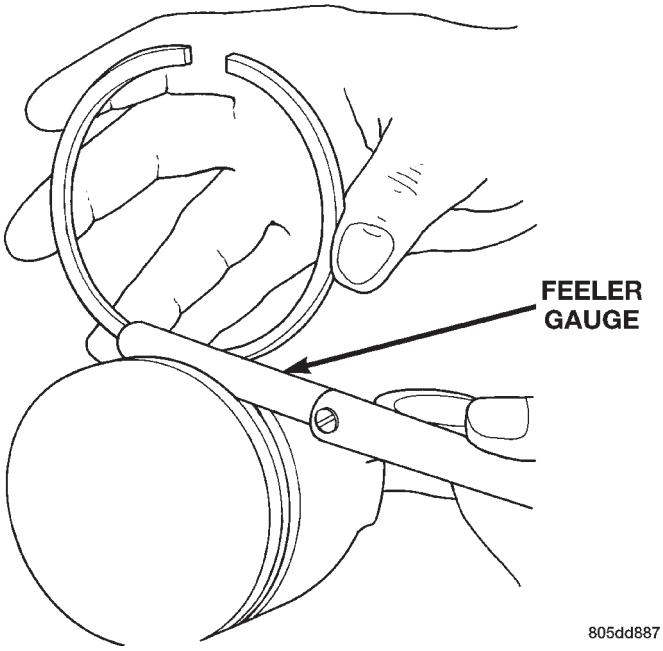


Fig. 8 Ring Side Clearance Measurement

GROOVE HEIGHT

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

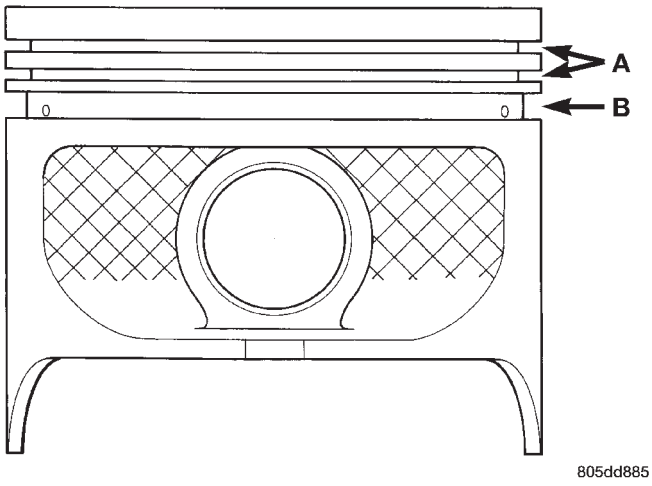


Fig. 7 Piston Dimensions

Ring Gap Measurement

Top Compression Ring . . . . . 0.229 to 0.610 mm (0.0090 to 0.0240 inch)
Second Compression 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)

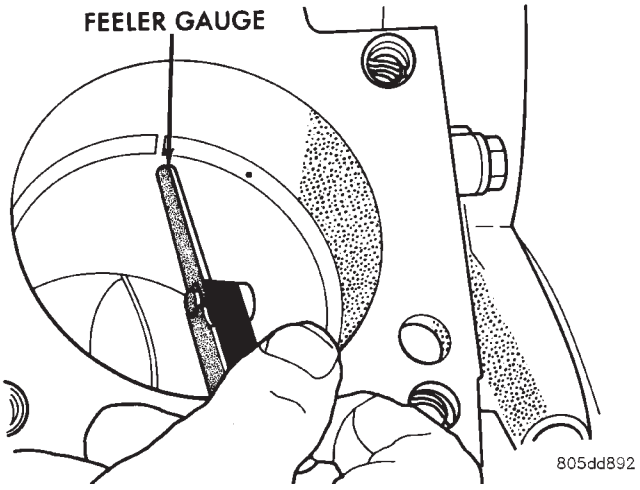


Fig. 9 Gap Measurement

(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).

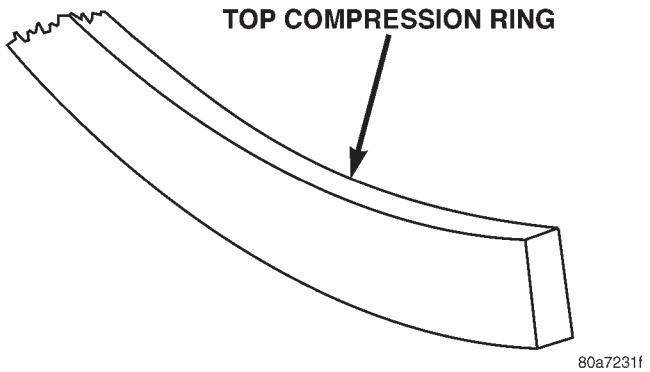


Fig. 10 Top Compression ring identification

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.

SERVICE PROCEDURES (Continued)

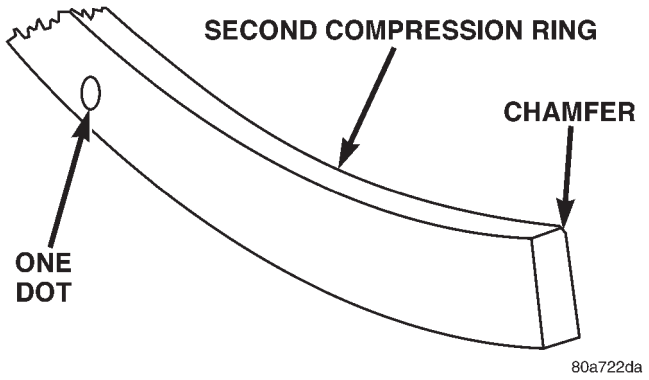


Fig. 11 Second Compression Ring Identification

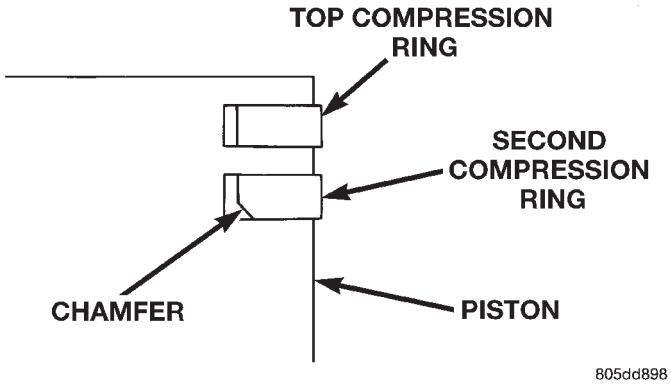


Fig. 12 Compression Ring Chamfer Location

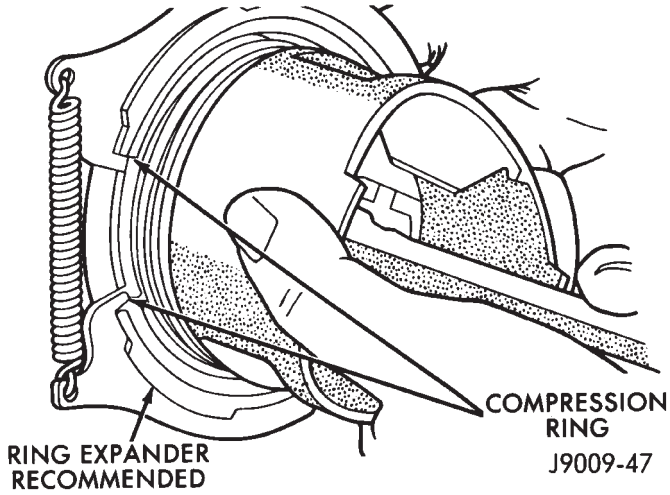


Fig. 13 Compression Ring Installation

- No. 2 Compression ring - Gap 180° from top oil rail gap.
- No. 1 Compression ring - Gap 180° from No. 2 compression ring gap.

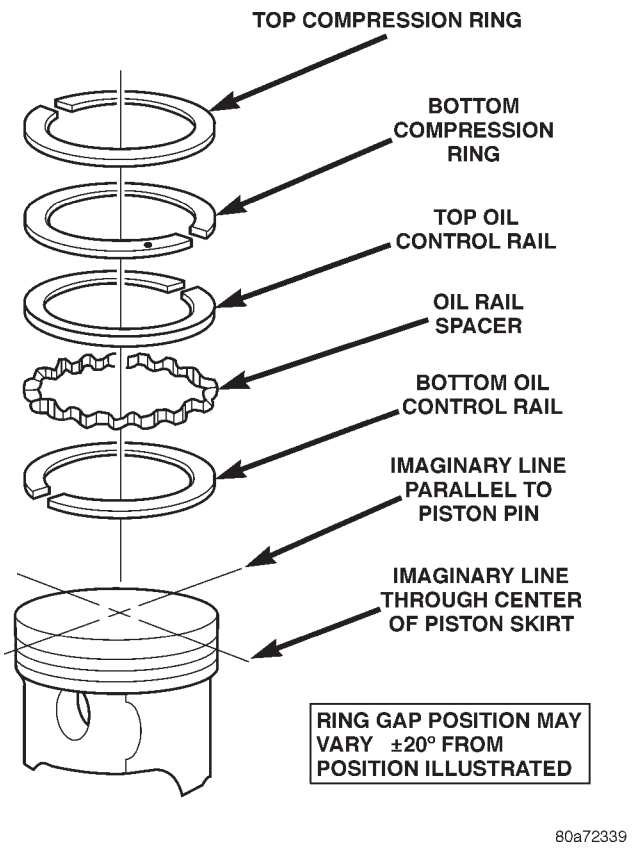


Fig. 14 Ring Gap Orientation

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.

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.

BEARING-TO-JOURNAL CLEARANCE

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

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

SERVICE PROCEDURES (Continued)

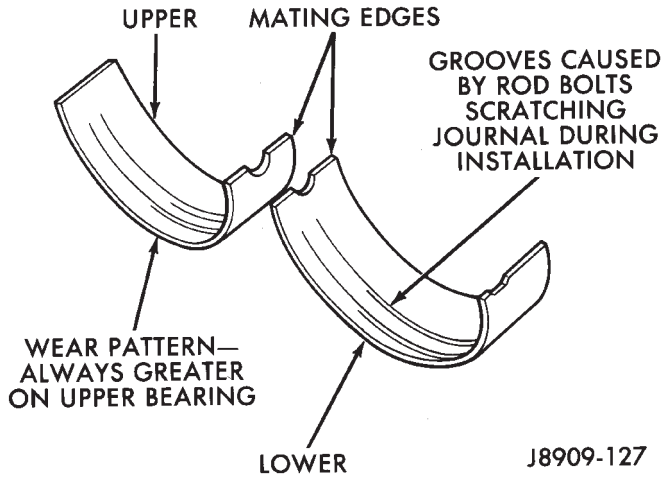


Fig. 15 Connecting Rod Bearing Inspection

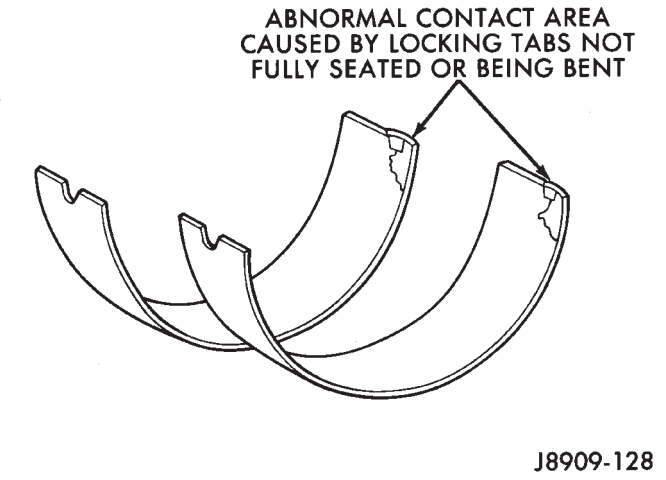


Fig. 16 Locking Tab Inspection

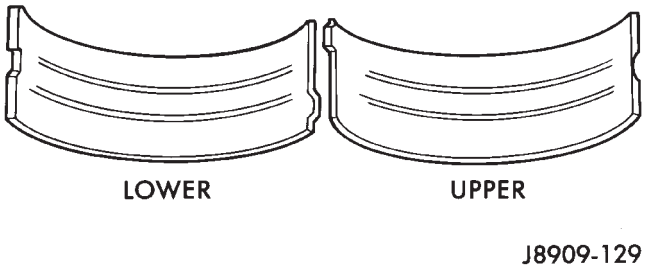


Fig. 17 Scoring Caused by Insufficient Lubrication or by Damaged Crankshaft Pin Journal

(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.

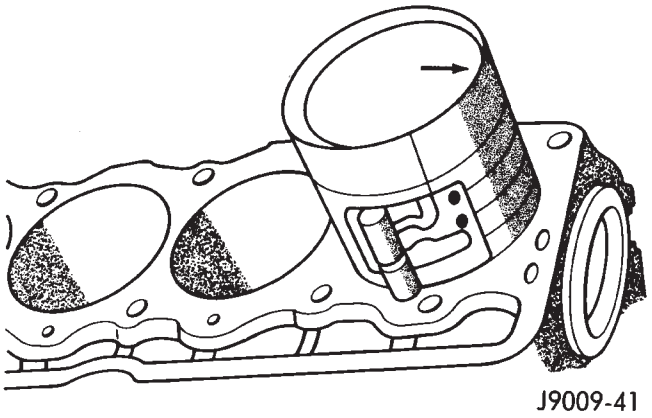


Fig. 18 Rod and Piston Assembly Installation

(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.**

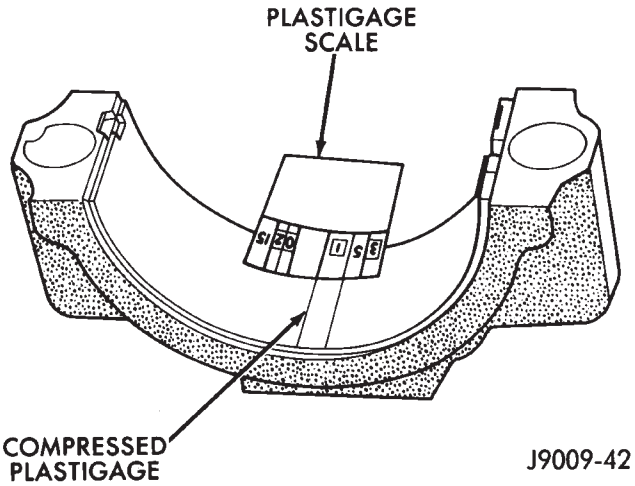


Fig. 19 Measuring Bearing Clearance with Plastigage

(8) If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove

SERVICE PROCEDURES (Continued)

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).

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

(11) **FOR EXAMPLE:** If the initial clearance was 0.0762 mm (0.003 inch), 0.025 mm (0.001 inch) 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 (Fig. 20). 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. 21).

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.

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

SERVICE PROCEDURES (Continued)

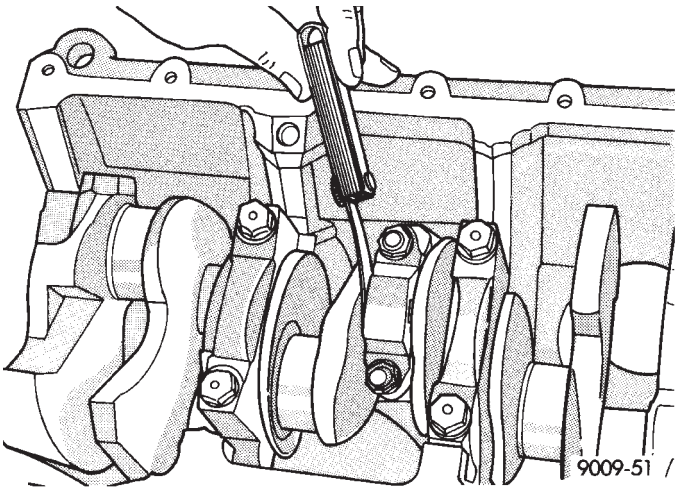


Fig. 20 Checking Connecting Rod Side Clearance—Typical

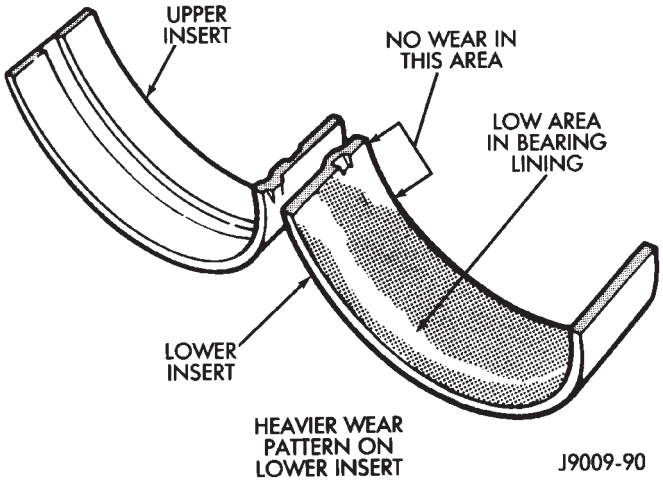


Fig. 21 Main Bearing Wear Patterns

bearing color code appears on the edge of the insert. **The size is not stamped on bearing inserts used for engine production.**

The main bearing journal size (diameter) is identified by a color-coded paint mark (Fig. 22) 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. 23).**

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. 23 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.

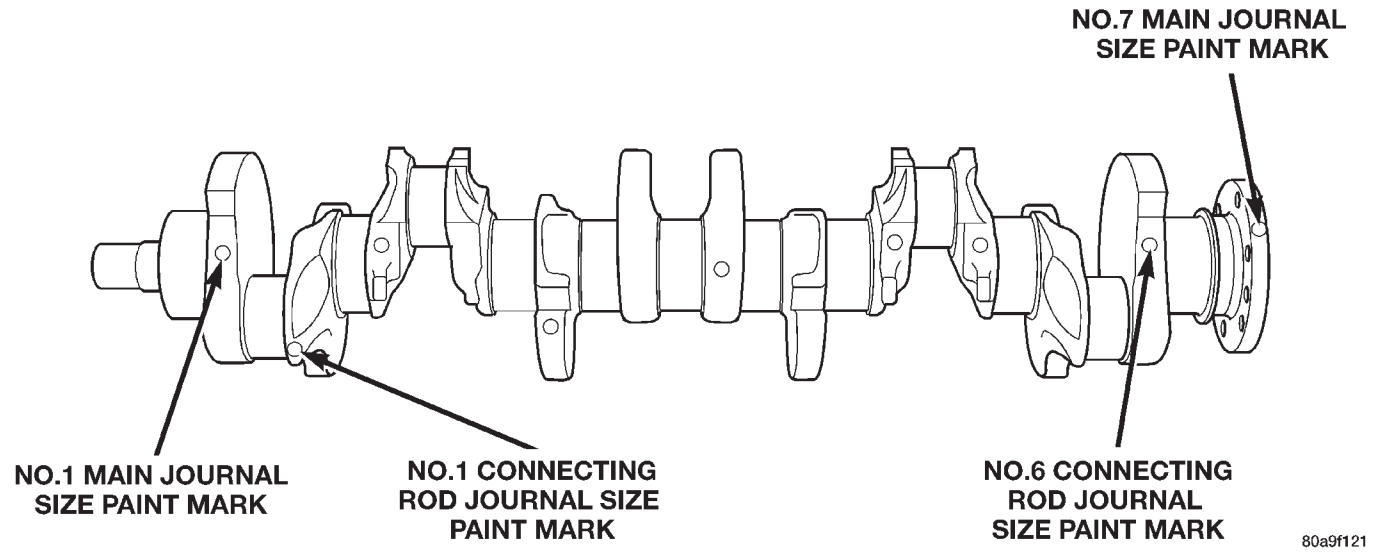


Fig. 22 Crankshaft Journal Size Paint I.D. Location

SERVICE PROCEDURES (Continued)

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. 24). Refer to Engine Specifications for the proper clearance.

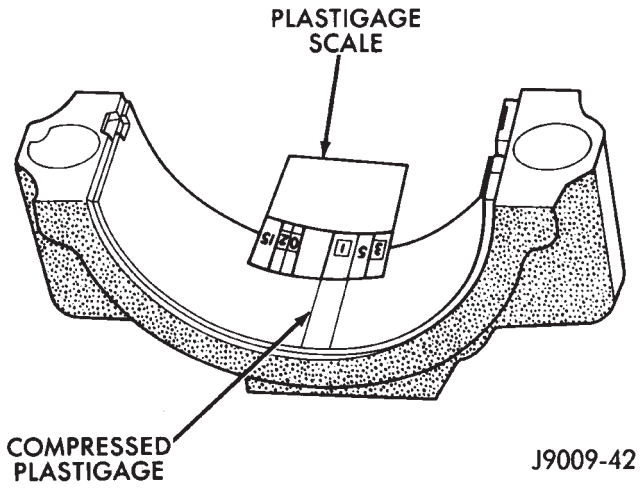


Fig. 24 Measuring Bearing Clearance with Plastigage

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.

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 0.0762 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 supports are made of resilient rubber.

REMOVAL

(1) Disconnect negative cable from battery.
(2) Raise the vehicle.
(3) Support the engine.
(4) Remove the nut from the through bolt (Fig. 25). DO NOT remove the through bolt.
(5) Remove the retaining bolts and nuts from the support cushions (Fig. 25).
(6) Remove the through bolt.
(7) Remove the support cushions.

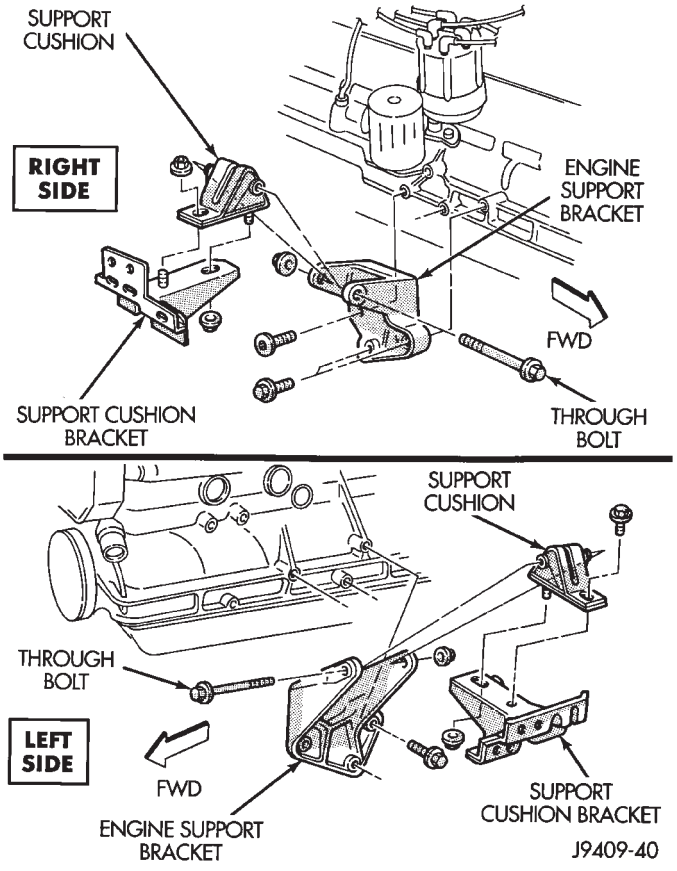


Fig. 25 Front Mounts

INSTALLATION

(1) If the engine support bracket was removed, position the bracket onto the block and install the attaching bolts (Fig. 25). Tighten the engine support bracket bolts to 61 N·m (45 ft. lbs.) torque.

(2) If the support cushion bracket was removed, position the bracket onto the lower front sill (Fig. 26). Install support cushion bracket bolts and nuts. Tighten the bolts to 54 N·m (40 ft. lbs.) torque. Tighten the nuts to 41 N·m (30 ft. lbs.) torque.

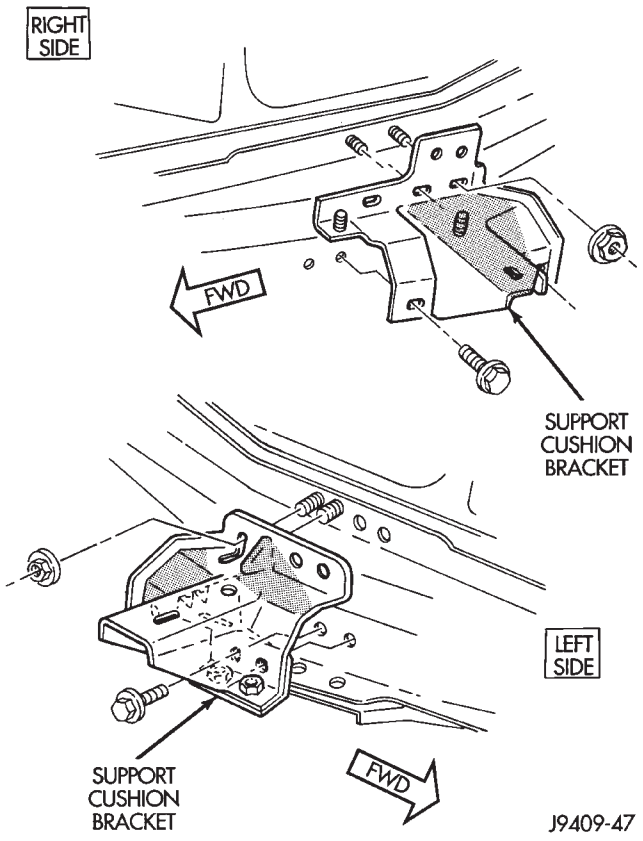


Fig. 26 Support Cushion Bracket

(3) Place the support cushion into position on the support cushion bracket (Fig. 25). Install and tighten the bolts and nuts to 41 N·m (30 ft. lbs.) torque.

(4) Install the through bolt and the retaining nut (Fig. 25). Tighten the through bolt nut to 65 N·m (48 ft. lbs.) torque.

(5) Remove the engine support.
(6) Lower the vehicle.
(7) Connect negative cable to battery.

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 crossmember (Fig. 27) (Fig. 28). Remove the crossmember.

MANUAL TRANSMISSION

(Fig. 27)

a. Remove the support cushion nuts and remove the cushion.

REMOVAL AND INSTALLATION (Continued)

b. Remove the transmission support bracket bolts and remove the bracket from the transmission.

AUTOMATIC TRANSMISSION

a. Remove the support cushion bolts and remove the cushion and the support bracket from the transmission (4WD) or from the adaptor bracket (2WD).

b. On 2WD vehicles, remove the bolts holding the transmission support adaptor bracket to the transmission (Fig. 28). Remove the adaptor bracket.

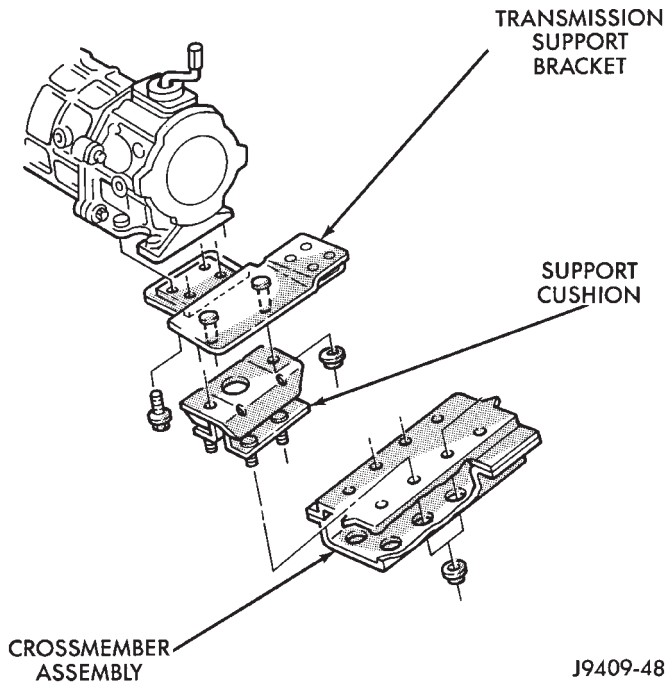


Fig. 27 Rear Mount(Manual Transmission)

INSTALLATION

MANUAL TRANSMISSION:

a. Install the transmission support bracket to the transmission. Install the bolts and tighten to 46 N·m (34 ft. lbs.) torque.

b. Install the support cushion to the support bracket. Install the nuts and tighten to 75 N·m (55 ft. lbs.) torque.

AUTOMATIC TRANSMISSION:

a. On 2WD vehicles, position the transmission support adaptor bracket to the transmission. Install the bolts and tighten to 75 N·m (55 ft. lbs.) torque.

b. Position the transmission support bracket and support cushion to the adaptor bracket (2WD) or the transmission (4WD). Install the bolts and tighten to 75 N·m (55 ft. lbs.) torque.

(1) Position the crossmember onto the support cushion studs. Install the stud nuts and tighten to 22 N·m (192 in. lbs) torque.

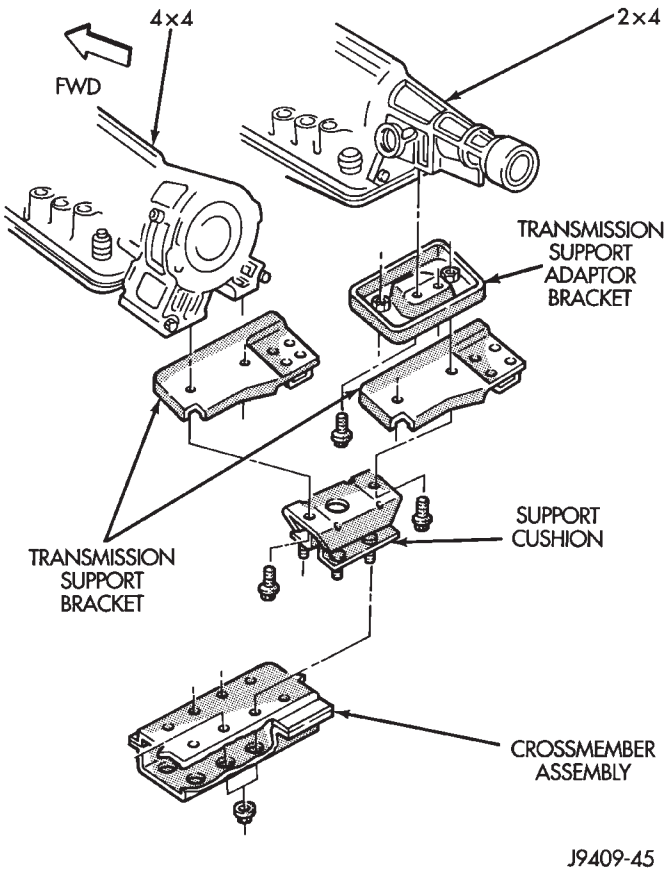


Fig. 28 Rear Mount(Automatic Transmission)

(2) Install crossmember-to-sill bolts and tighten to 41 N·m (30 ft. lbs.) torque.

(3) Remove the transmission support.

(4) Lower the vehicle.

(5) Connect negative cable to 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.

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) Remove the air cleaner assembly.

(4) Loosen 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.

(5) Remove the lower radiator hose.

REMOVAL AND INSTALLATION (Continued)

(6) Remove the upper radiator hose and coolant recovery hose (Fig. 29).

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

(8) Remove the fan shroud (Fig. 29) and electric cooling fan.

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

(10) Disconnect radiator fan switch wire connector.

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

(a) Discharge A/C system (refer to group 24, Heating and Air Conditioning for proper procedures)

(b) Disconnect the suction/discharge hose and cap off compressor ports to prevent foreign material and refrigerant oil loss.

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

(13) Remove the fan assembly from the idler pulley.

(14) Disconnect the heater hoses at the engine thermostat housing and water pump (Fig. 29) (Fig. 30).

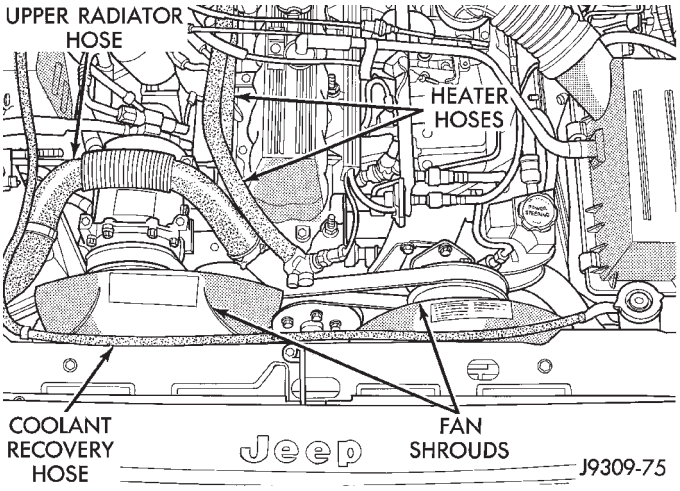


Fig. 29 Upper Radiator Hose, Coolant Recovery Hose, Fan Shroud & Heater hoses

(15) Disconnect the throttle cable.

(16) Disconnect the speed control cable (if equipped).

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

(18) Disconnect the fuel injector harness at the injectors.

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

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE DISCONNECTING FUEL LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

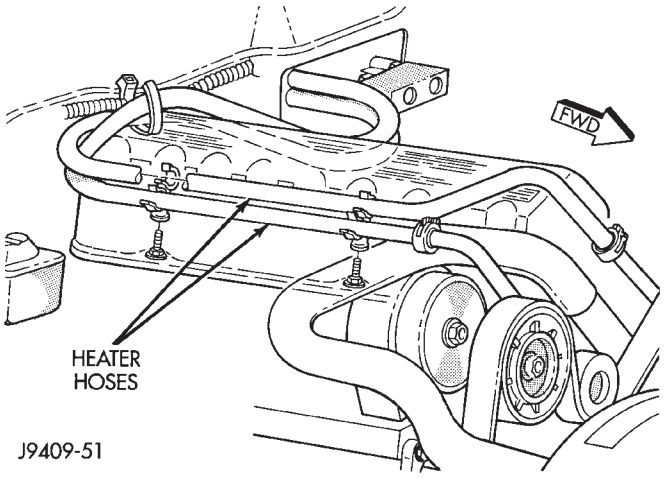


Fig. 30 Heater Hoses (RH Drive Vehicle)

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

(21) Remove the latch clip and disconnect fuel supply line.

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

(23) If equipped with power steering:

(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.

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

(25) Raise and support the vehicle.

(26) Disconnect the wires from the starter motor solenoid.

(27) Remove the starter motor.

(28) Disconnect the exhaust pipe from the manifold.

(29) Disconnect the engine speed sensor wire connection.

(30) Remove the exhaust pipe support.

(31) Remove the flywheel and 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 flywheel and 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 flywheel) housing.

REMOVAL AND INSTALLATION (Continued)

(39) Remove the remaining converter (or 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 flywheel.

(1) Attach a lifting device to the engine and lower the engine into the engine compartment. For easier installation, it may be necessary to remove the engine mount cushions from the engine mount bracket as an aide 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 flywheel housing with the engine.

(c) Install and tighten the 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 cushions (if removed).

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

(6) Remove the engine lifting device.

(7) Raise and support the vehicle.

(8) Install the remaining flywheel and 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 flywheel and 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 engine speed sensor wire connections and tighten the screws.

(14) Connect the exhaust pipe to the manifold.

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

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

(17) Lower the vehicle.

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

(19) **Vehicles 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 to the booster, if equipped.

(21) Connect the fuel supply hose the fuel rail. Push until a “click” is heard. Install latch clip

(22) Connect the fuel injector harness to the injectors.

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

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

(25) Connect the speed control cable, if equipped.

(26) Connect the throttle cable.

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

(28) Install the fan assembly to the idler pulley.

(29) Connect the suction/discharge hose to the compressor.

(30) Connect automatic transmission fluid cooler lines, if equipped.

(31) Install the fan shroud, electric cooling fan and radiator and condenser (if equipped with A/C).

(32) Connect the electric fan connector.

(33) Install upper radiator support.

(34) Connect the upper radiator hose.

(35) Connect the lower radiator hose.

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

(37) Install the air cleaner assembly.

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

(39) Add the proper amount of engine oil and coolant.

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.

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

(41) Charge the air conditioning system (refer to Group 24, Heating and Air Conditioning for proper procedures).

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.

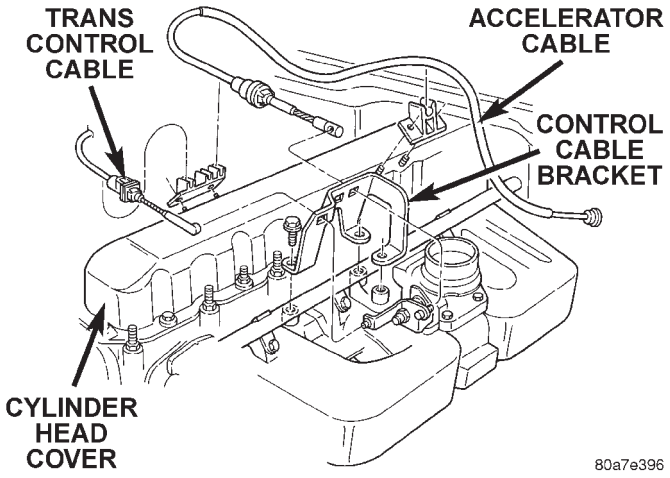


Fig. 31 Engine Cylinder Head Cover

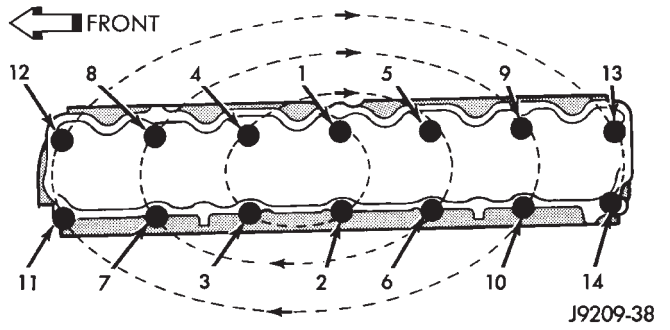


Fig. 32 Cylinder Head Cover Gasket Locator Pins at #8 & #9

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 10 N·m (85 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) Check for rocker arm bridges which are causing misalignment of the rocker arm to valve tip area.

(3) 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.

(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.

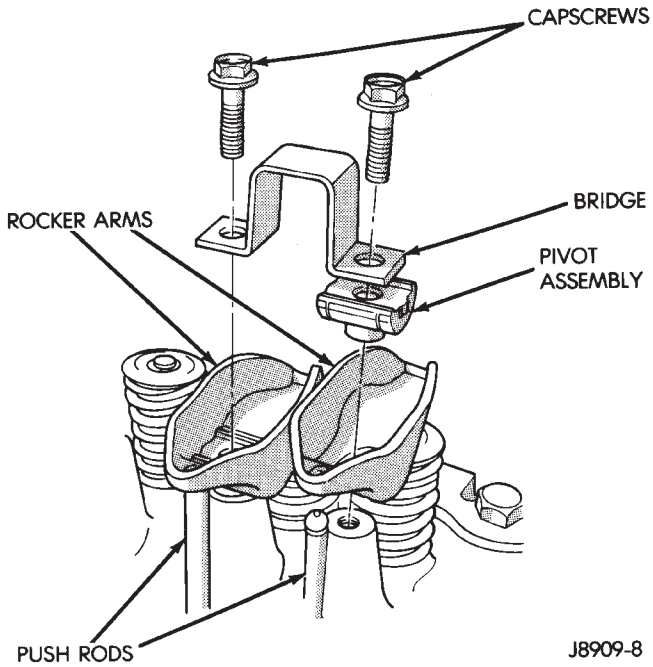


Fig. 33 Rocker Arm Assembly

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.

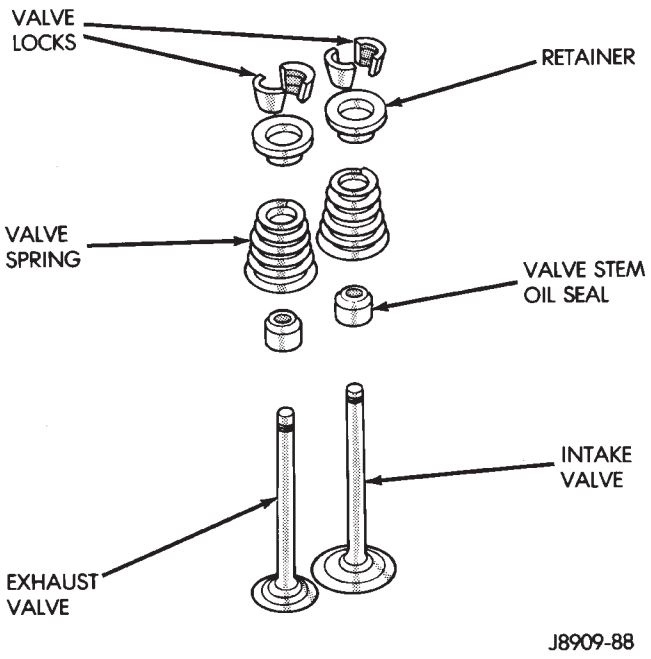


Fig. 34 Valve and Valve Components

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) Release air pressure and 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 and gasket.

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

(6) Remove the push rod. **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, perform the following:

(a) Remove the bolts from the A/C compressor mounting bracket and set the compressor aside.

(b) Remove the air conditioner compressor bracket bolts from the engine cylinder head.

(c) Loosen the through bolt at the bottom of the bracket.

(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 and vacuum advance hose.

(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) Remove the ignition coil and bracket assembly.

(15) 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).

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

(17) 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.

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

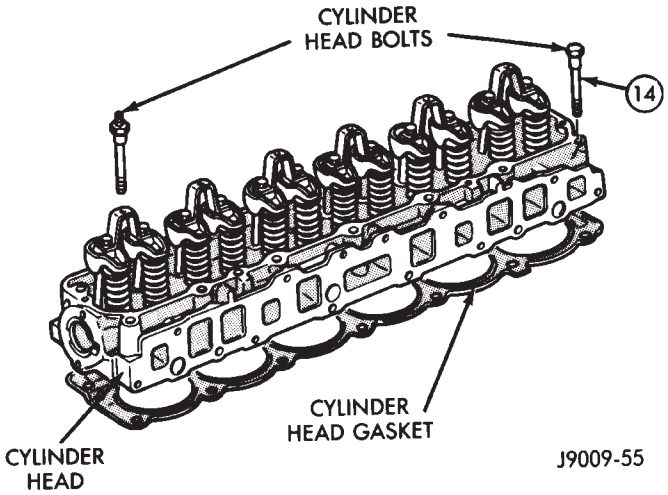


Fig. 35 Engine Cylinder Head Assembly

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) onto the cylinder block.

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. 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).

REMOVAL AND INSTALLATION (Continued)

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.

(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.

(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.

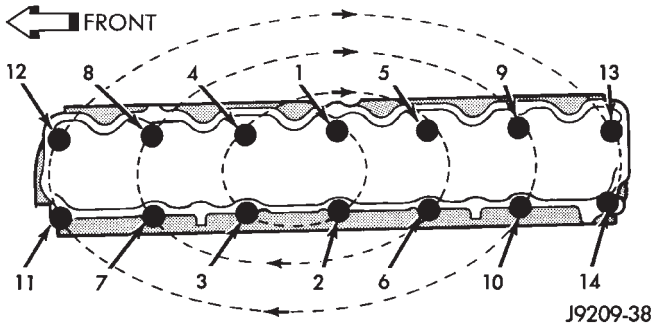


Fig. 36 Engine Cylinder Head Bolt Tightening Sequence

(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 and gasket.

(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) Connect the fuel line.

(22) Connect negative cable to battery.

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

(24) 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.

(25) 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

(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.

REMOVAL AND INSTALLATION (Continued)

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).

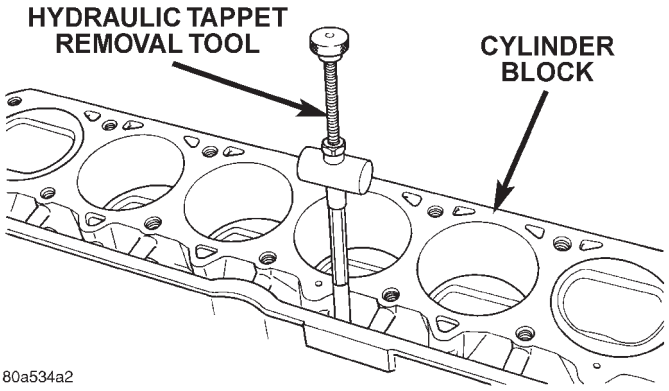


Fig. 37 Hydraulic Valve Tappet Removal—Installation Tool

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.

(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).

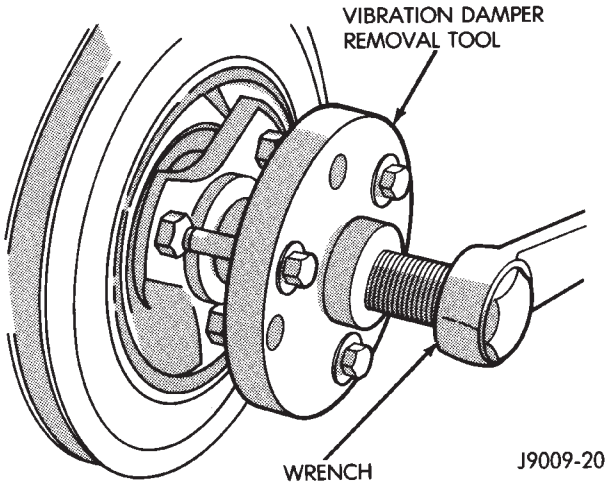


Fig. 38 Vibration Damper Removal Tool 7697

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.

REMOVAL AND INSTALLATION (Continued)

(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.

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).

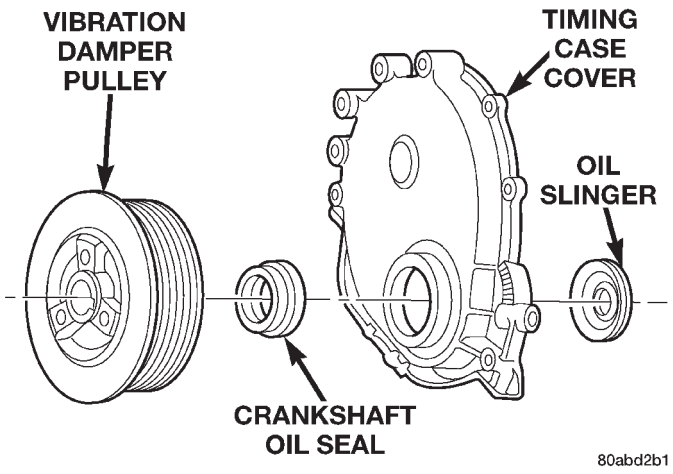


Fig. 39 Timing Case Cover Components

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).

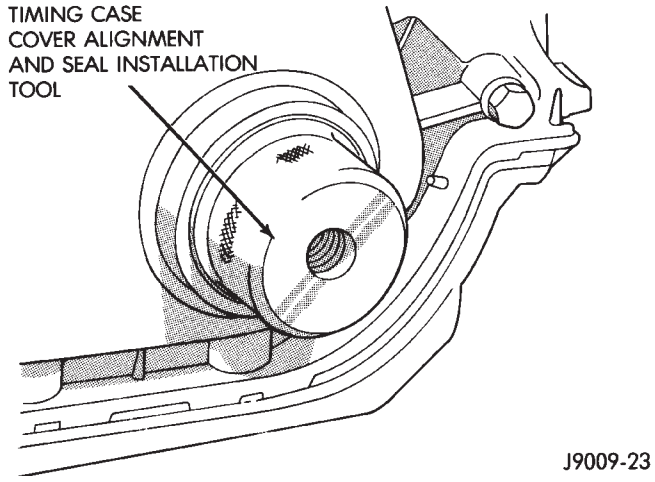


Fig. 40 Timing Case Cover Alignment and Seal Installation Tool 6139

(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.

(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.

(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).

REMOVAL AND INSTALLATION (Continued)

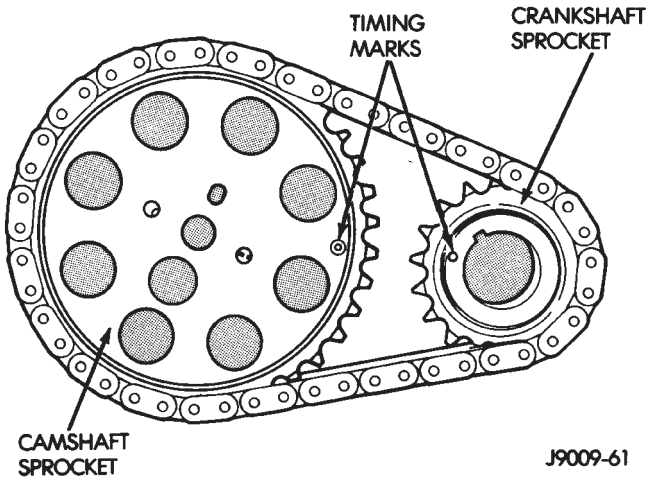


Fig. 41 Crankshaft—Camshaft Alignment—Typical

(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.

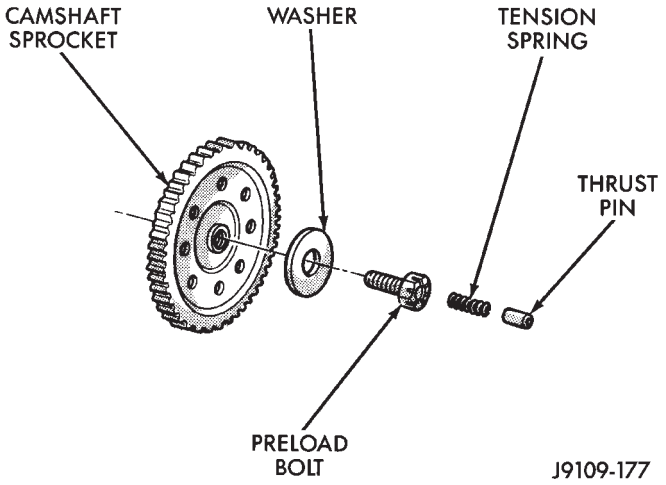


Fig. 42 Camshaft Sprocket Preload Bolt

(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.

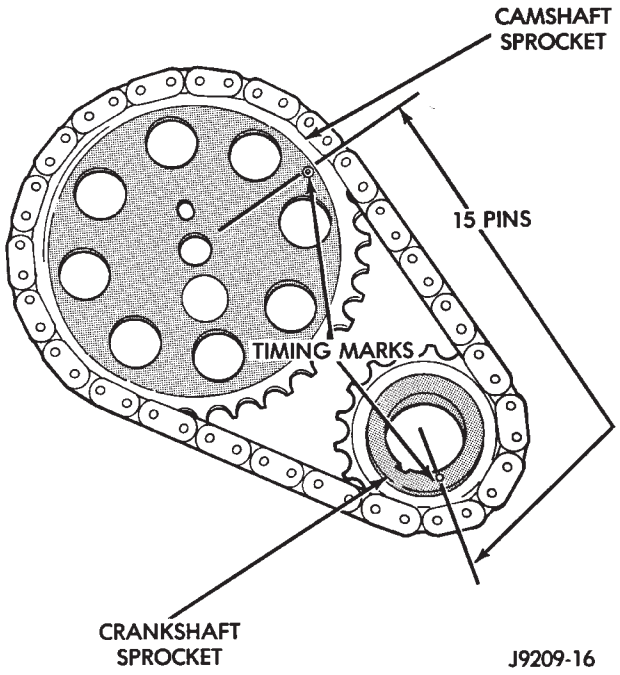


Fig. 43 Verify Sprocket—Chain Installation—Typical

(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.

(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.

REMOVAL AND INSTALLATION (Continued)

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).

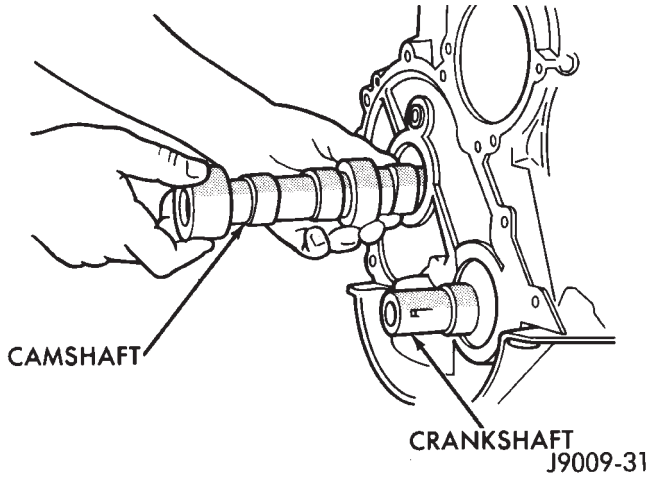


Fig. 44 Camshaft

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.
(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).

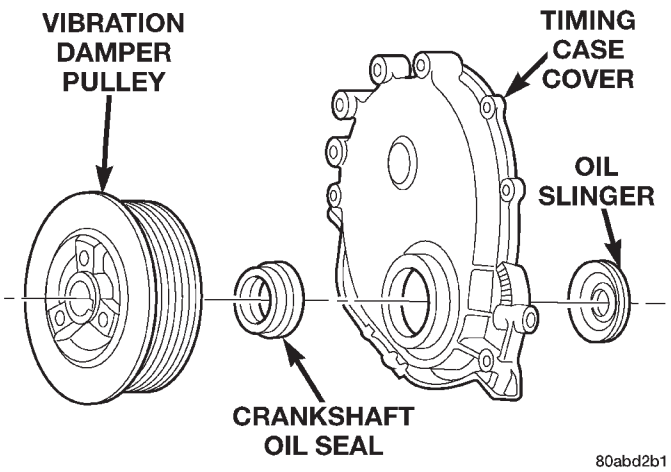


Fig. 45 Timing Case Cover Components

(13) Install the hydraulic valve tappets.
(14) Install the cylinder head gasket with the numbers facing up.
(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.

REMOVAL AND INSTALLATION (Continued)

(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).

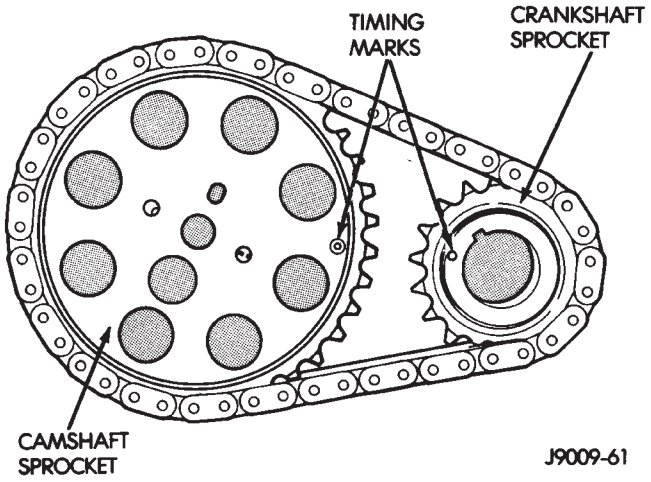


Fig. 46 Timing Chain Alignment—Typical

(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.

(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.

REMOVAL AND INSTALLATION (Continued)

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.

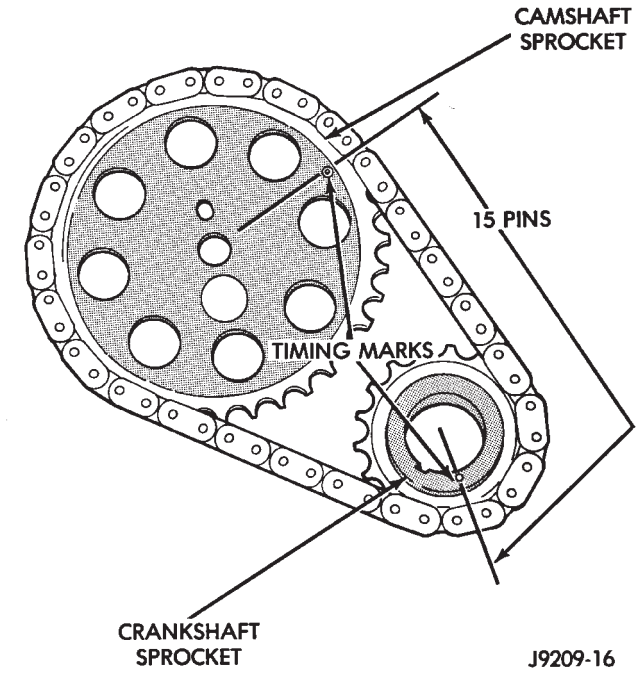


Fig. 47 Verify Crankshaft—Camshaft Installation—Typical

(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 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).

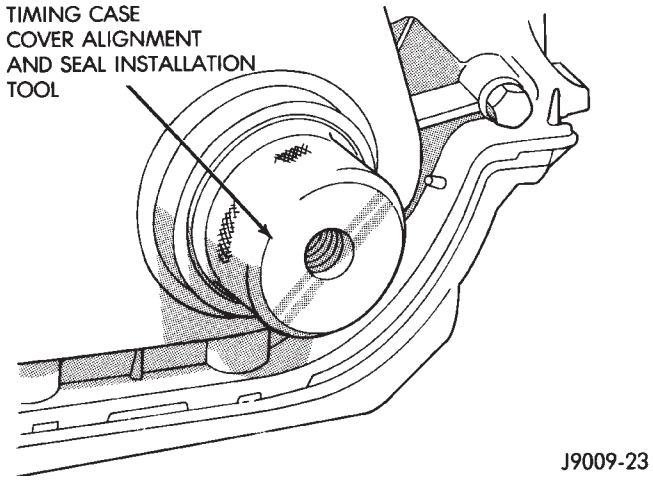


Fig. 48 Timing Case Cover Alignment and Seal Installation Tool 6139

(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 (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.

REMOVAL AND INSTALLATION (Continued)

(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 only one main bearing cap and lower insert at a time (Fig. 49).

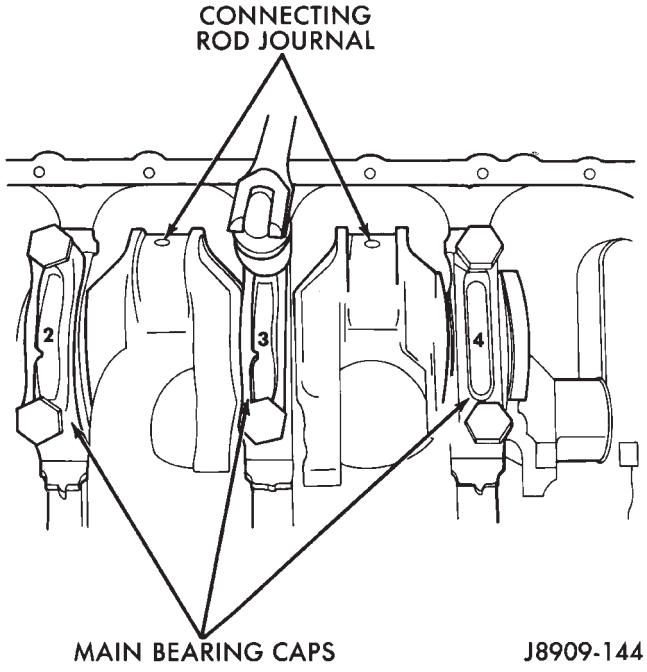


Fig. 49 Removing Main Bearing Caps and Lower Inserts

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

(7) Remove the upper insert by LOOSENING (DO NOT REMOVE) all of the other bearing caps. Now insert a small cotter pin tool in the crankshaft journal oil hole. Bend the cotter pin as illustrated to fabricate the tool (Fig. 50). 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. 50). After moving the insert approximately 25 mm (1 inch), it can be removed by applying pressure under the tab.

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

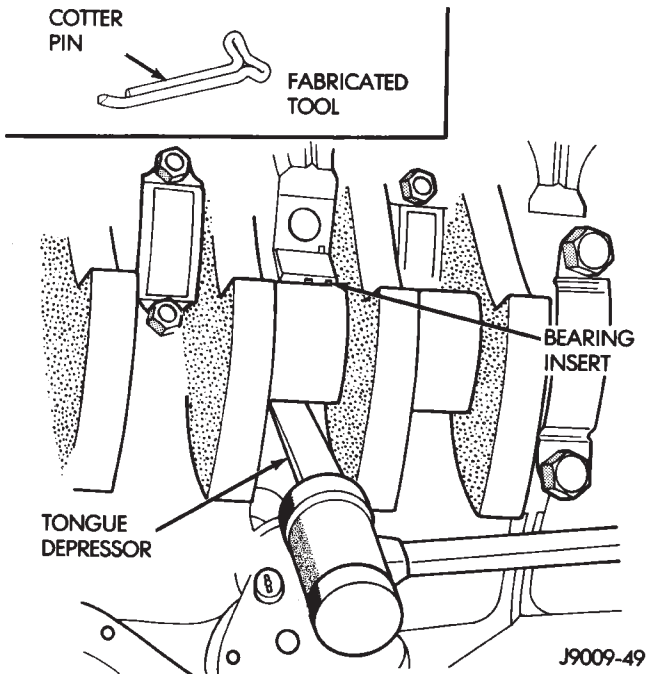


Fig. 50 Removing Upper Inserts

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.

(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.

REMOVAL AND INSTALLATION (Continued)

(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. 51). 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.

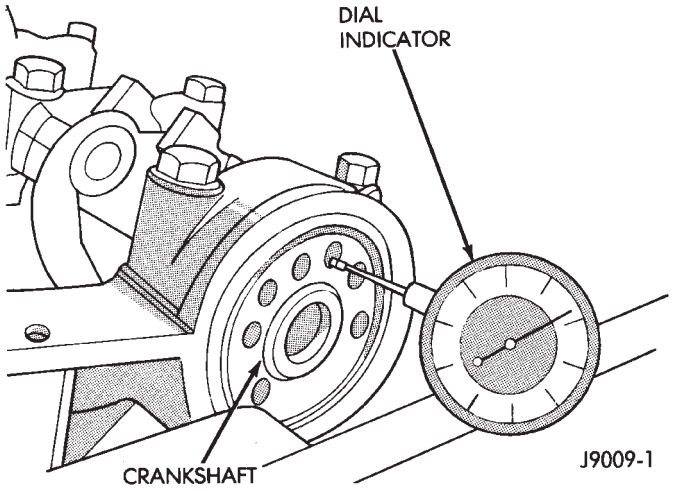


Fig. 51 Crankshaft End Play Measurement

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

(10) Install the oil pan.

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

(12) Lower the vehicle.

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

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

(15) 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.

(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. 52).

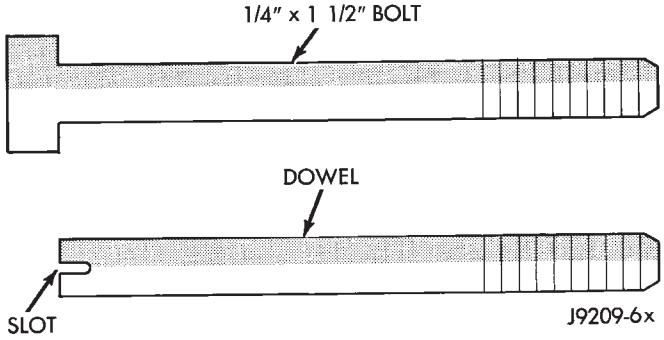


Fig. 52 Fabrication of Alignment Dowels

(3) Install two dowels in the timing case cover. Install the other two dowels in the cylinder block (Fig. 53).

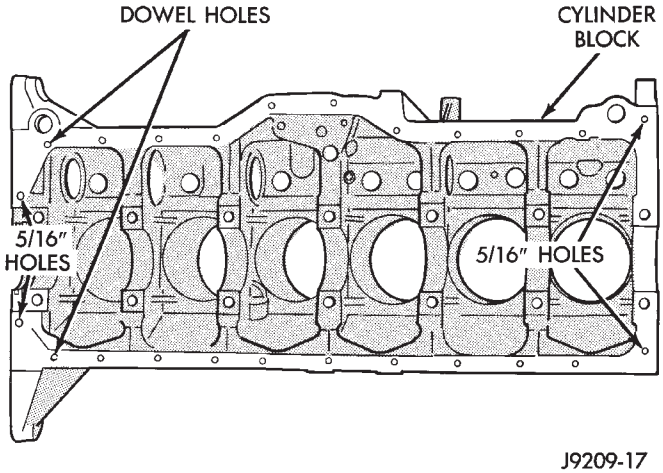


Fig. 53 Position of Dowels in Cylinder Block

REMOVAL AND INSTALLATION (Continued)

(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. 54). Tighten these bolts to 15 N·m (132 in. lbs.) torque.

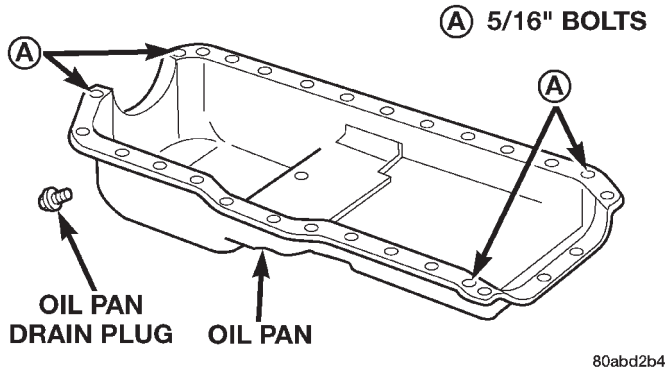


Fig. 54 Position of 5/16 inch Oil Pan Bolts

(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.

(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. 54). 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. 55).

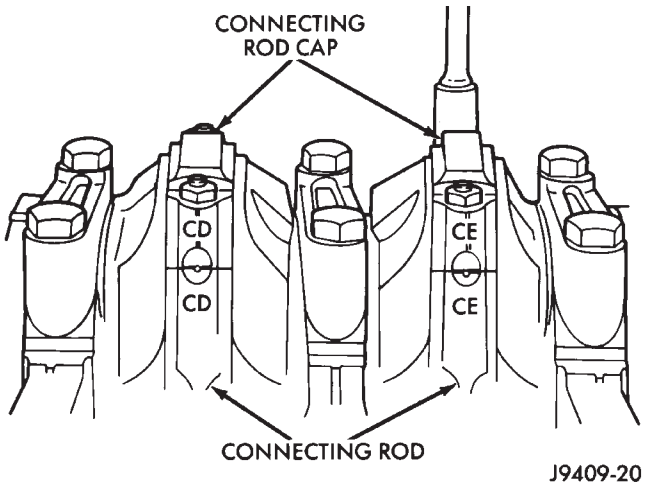


Fig. 55 Stamped Connecting Rods and Caps

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

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. 56).

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.

REMOVAL AND INSTALLATION (Continued)

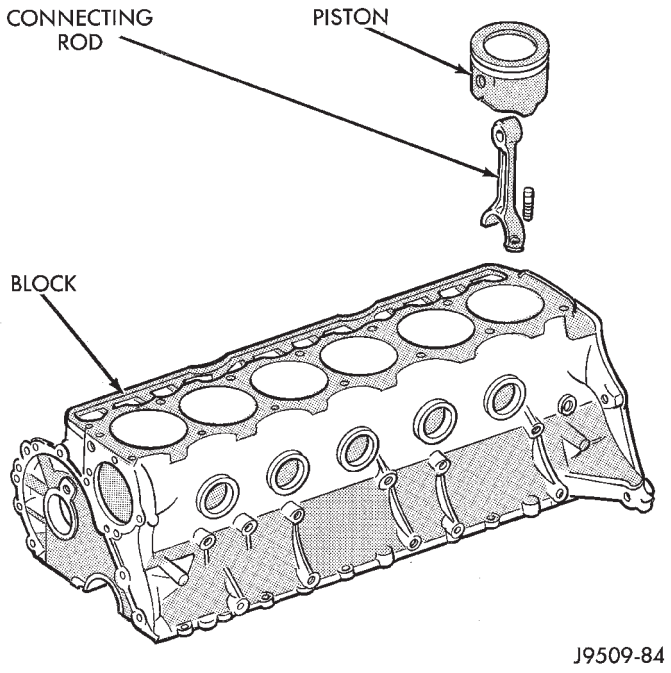


Fig. 56 Removal of Connecting Rod and Piston Assembly

(4) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 57).

(5) Ensure the arrow on the piston top points to the front of the engine (Fig. 57).

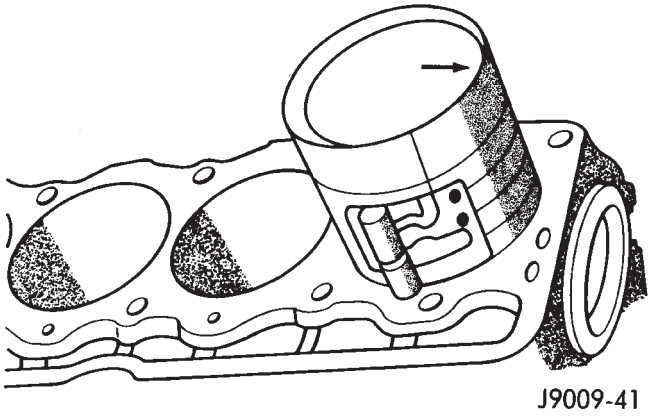


Fig. 57 Rod and Piston Assembly Installation

(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.

(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 SEAL

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 main bearing cap brace.

(4) Remove the rear main bearing cap (No.7).

(5) Push the upper seal out of the groove. Ensure that the crankshaft and seal groove are not damaged.

(6) 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.

REMOVAL AND INSTALLATION (Continued)

(5) Place the lower half of the seal into bearing cap No.7 (Fig. 58).

(6) Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil (Fig. 58).

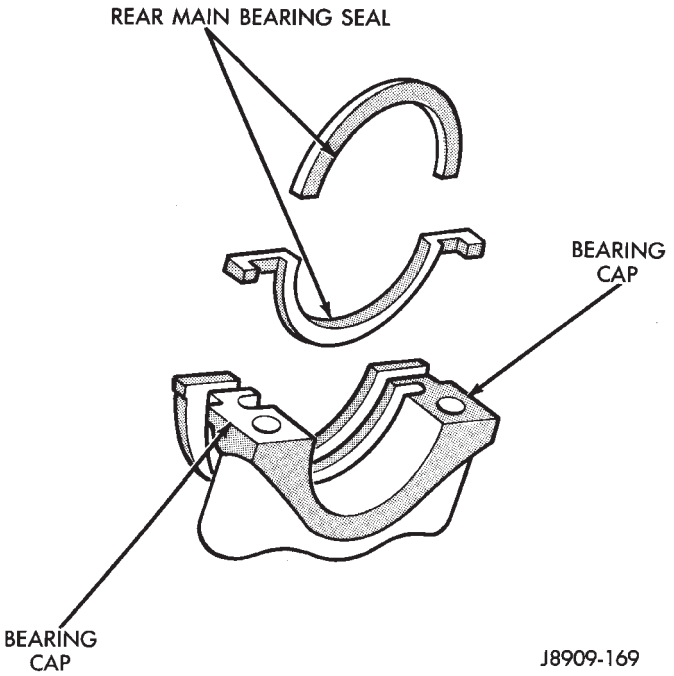


Fig. 58 Rear Main Bearing Oil Seal

(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. 59). 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 main bearing cap brace. Tighten nuts to 47 N·m (35 ft. lbs.).

(12) Install the oil pan gasket and oil pan. Tighten 1/4 – 20 screws to 14 N·m (120 in. lbs.). Tighten 5/16 – 18 screws to 18 N·m (156 in. lbs.)

(13) Install the engine flywheel or converter drive plate. Tighten bolts to 142 N·m (105 ft. lbs.)

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

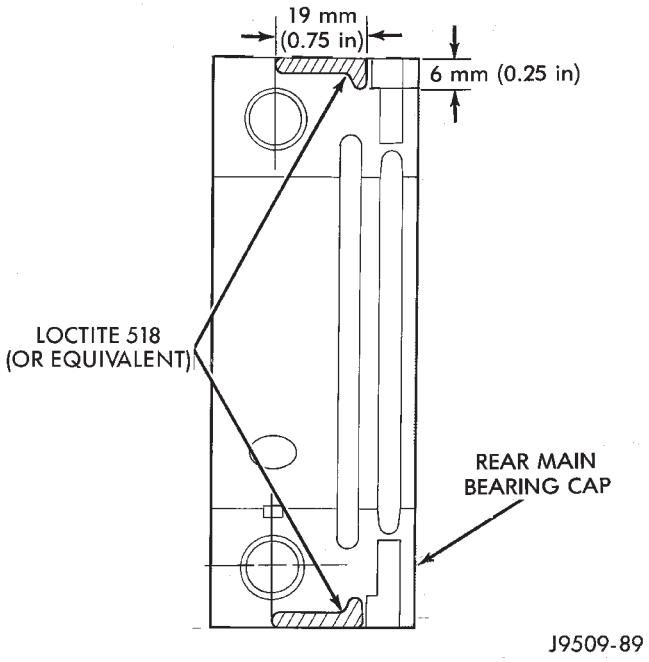


Fig. 59 Location of Loctite 518 (or equivalent)

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. 60).

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.

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.

REMOVAL AND INSTALLATION (Continued)

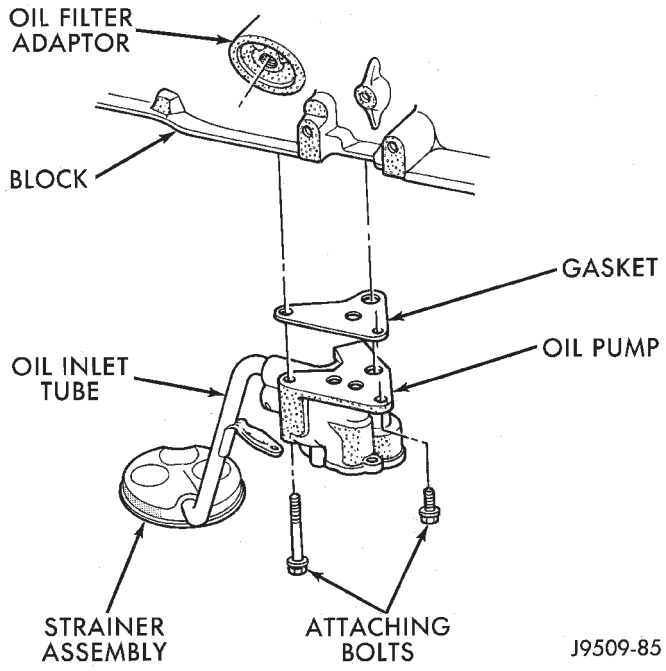


Fig. 60 Oil Pump Assembly

(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. 61). Tighten the nut against the tool until it contacts the cover.

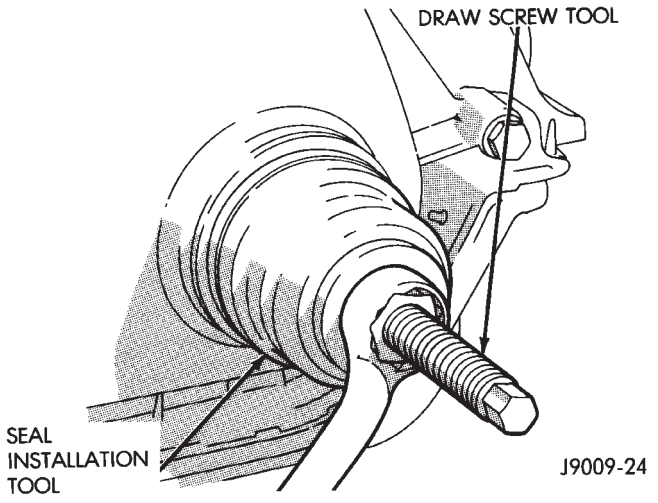


Fig. 61 Timing Case Cover Oil Seal Installation

(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.

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. 62). If the margin is less than 0.787 mm (0.031 inch), the valve must be replaced.

VALVE SEAT REFACING

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

(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. 63).

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

DISASSEMBLY AND ASSEMBLY (Continued)

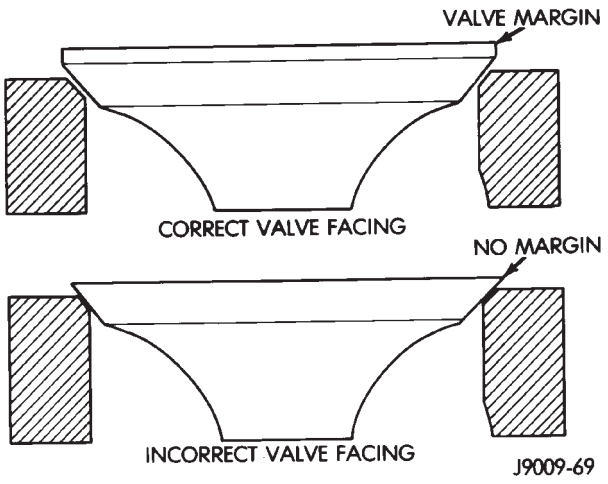


Fig. 62 Valve Facing Margin

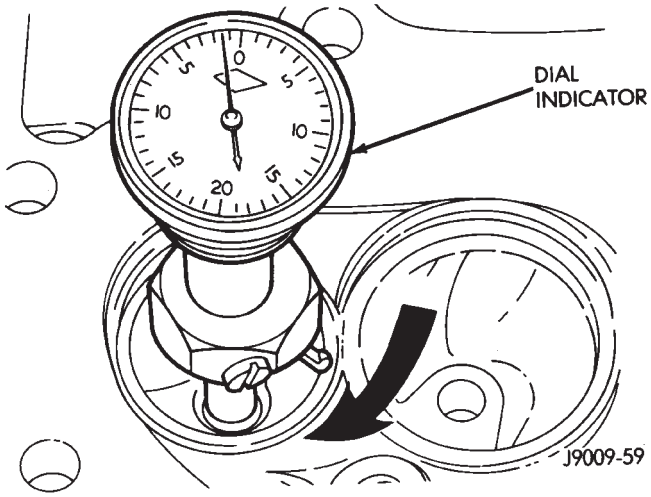


Fig. 63 Measurement of Valve Seat Runout

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.

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. 64).

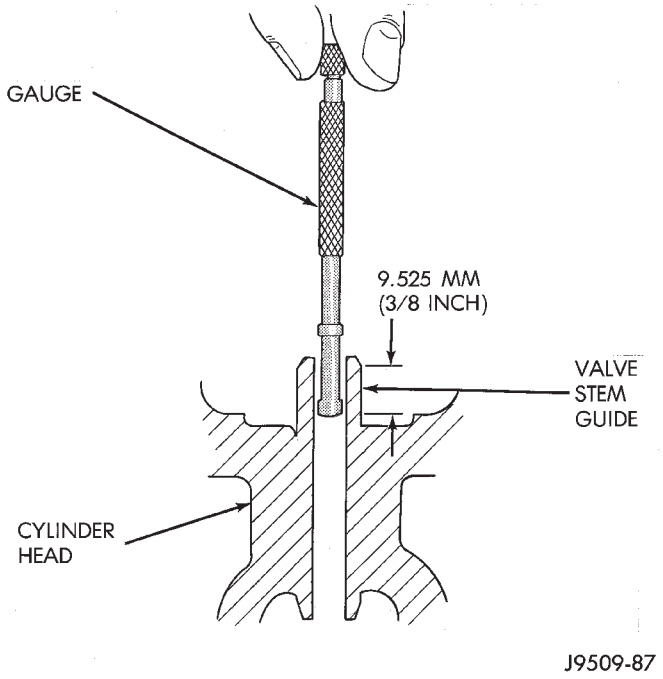


Fig. 64 Measurement of Valve Guide Bore Diameter

(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.

(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. 65).

DISASSEMBLY AND ASSEMBLY (Continued)

(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.

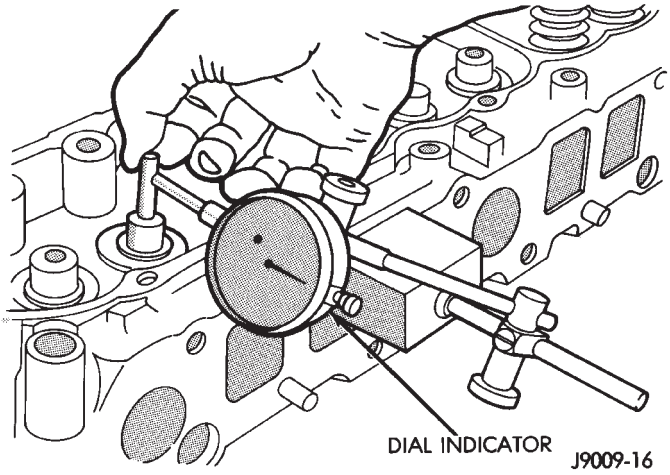


Fig. 65 Measurement of Lateral Movement of Valve Stem

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. 66).

Replace valve springs that are not within specifications.

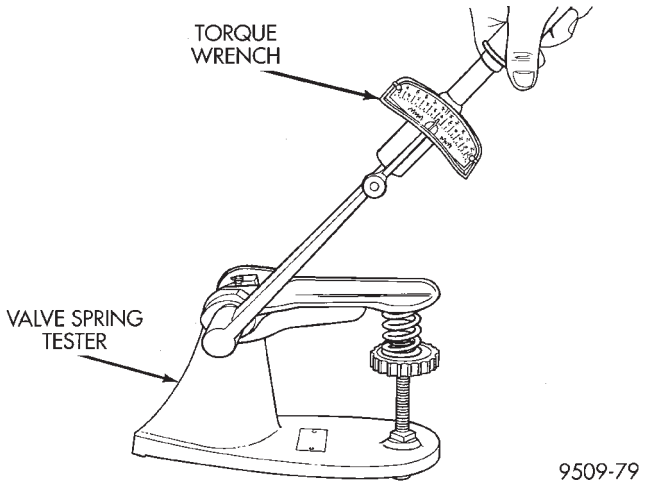


Fig. 66 Valve Spring Tester

CYLINDER BLOCK

DISASSEMBLY

Refer to the applicable sections for detailed instructions.

(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.

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.

CLEANING AND INSPECTION (Continued)

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. 67).

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

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

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

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

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

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

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

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

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

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

CYLINDER BLOCK

CLEANING

Thoroughly clean the oil pan and engine block gasket surfaces.

CLEANING AND INSPECTION (Continued)

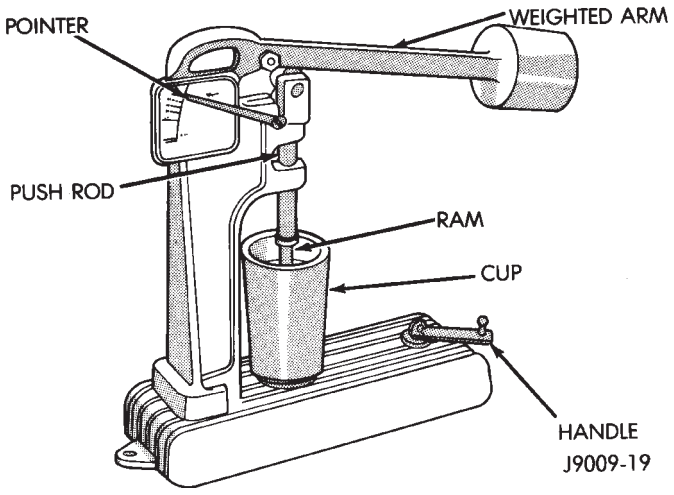


Fig. 67 Leak-Down Tester

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. 68). 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 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.

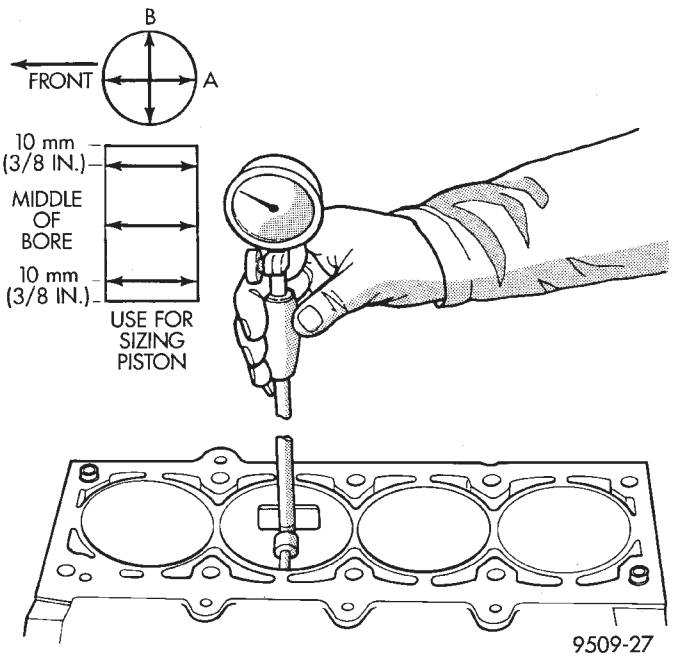


Fig. 68 Cylinder Bore Measurement

(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 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.)

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.)

SPECIFICATIONS (Continued)

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)
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.)

SPECIFICATIONS (Continued)

Gear End Clearance—
Plastigage .....0.051 to 0.152 mm (0.002 to 0.006 in.)
Gear End Clearance—Plastigage (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)

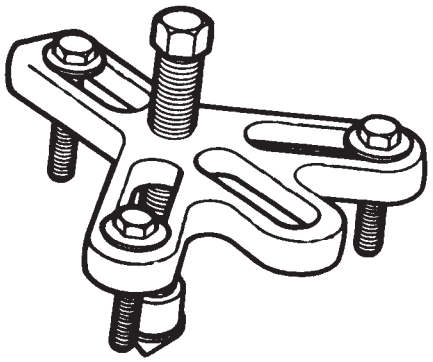
4.0L TORQUE SPECIFICATIONS

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	.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 to Converter Housing	
Bolts	.38 N·m (28 ft. lbs.)
Flywheel to 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 Cap	
Bolts	.108 N·m (80 ft. lbs.)
Main Bearing Brace	
Nuts	.47 N·m (35 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	.9.5 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 (204 in. lbs.)
Long Attaching Bolts	.23 N·m (204 in. 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.)
Spark Plugs	
Plugs	.37 N·m (27 ft. lbs.)

SPECIFICATIONS (Continued)

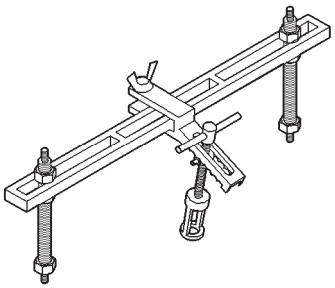
DESCRIPTION	TORQUE
Starter Motor	
Mounting Bolts	45 N·m (33 ft. lbs.)
Thermostat Housing	
Bolts	18 N·m (156 in. lbs.)
Throttle Body	
Bolts	10 N·m (90 in.lbs.)
Vibration Damper	
Bolts	108 N·m (80 ft. lbs.)
Water Pump/Block	
Bolts	31 N·m (23 ft. lbs.)



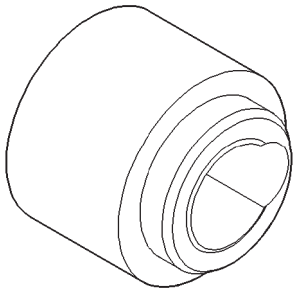
Vibration Damper Removal Tool 7697

SPECIAL TOOLS

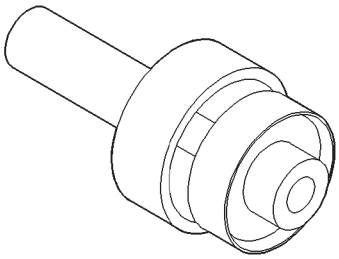
4.0L ENGINE



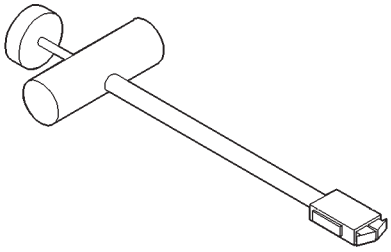
Valve Spring Compressor Tool MD-998772A



Timing Case Cover Alignment and Seal installation Tool 6139



Rear Main Seal Installer Tool 6271A



Hydraulic Valve Tappet Removal Tool C-4129-A

ENGINE

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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).

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:

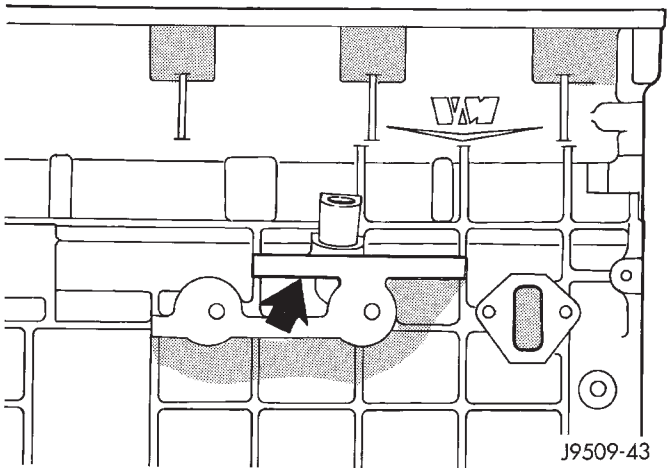


Fig. 1 Engine Code Location

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.

J9509-174

Engine Description

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).

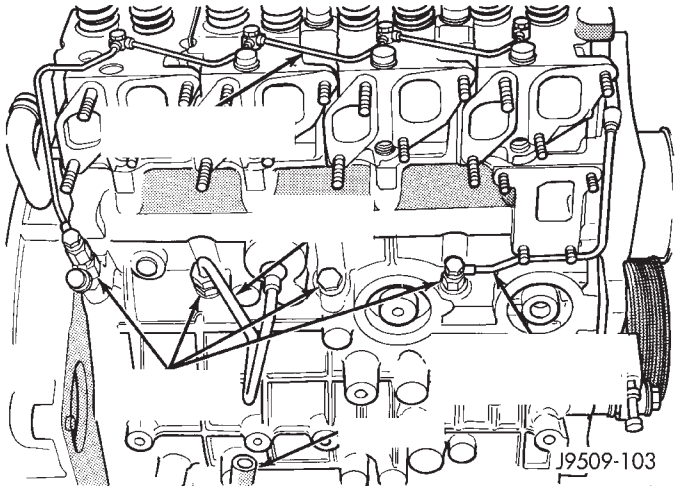


Fig. 2 Lubrication Lines

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

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.

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.

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

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

SERVICE PROCEDURES

VALVE SERVICE

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

DISASSEMBLY

(1) Remove the engine cylinder head from the cylinder block (refer to cylinder head removal 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.

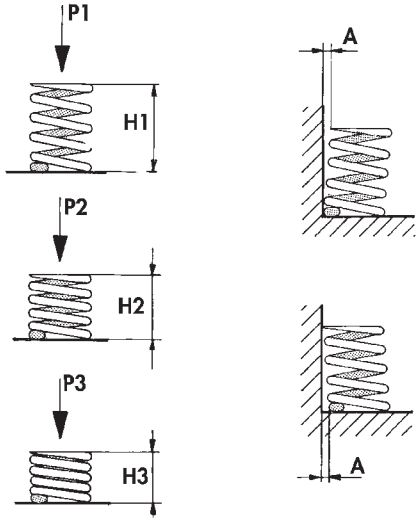
(3) Inspect for cracks in the gasket surface at each coolant passage.

(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).



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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.

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.

SERVICE PROCEDURES (Continued)

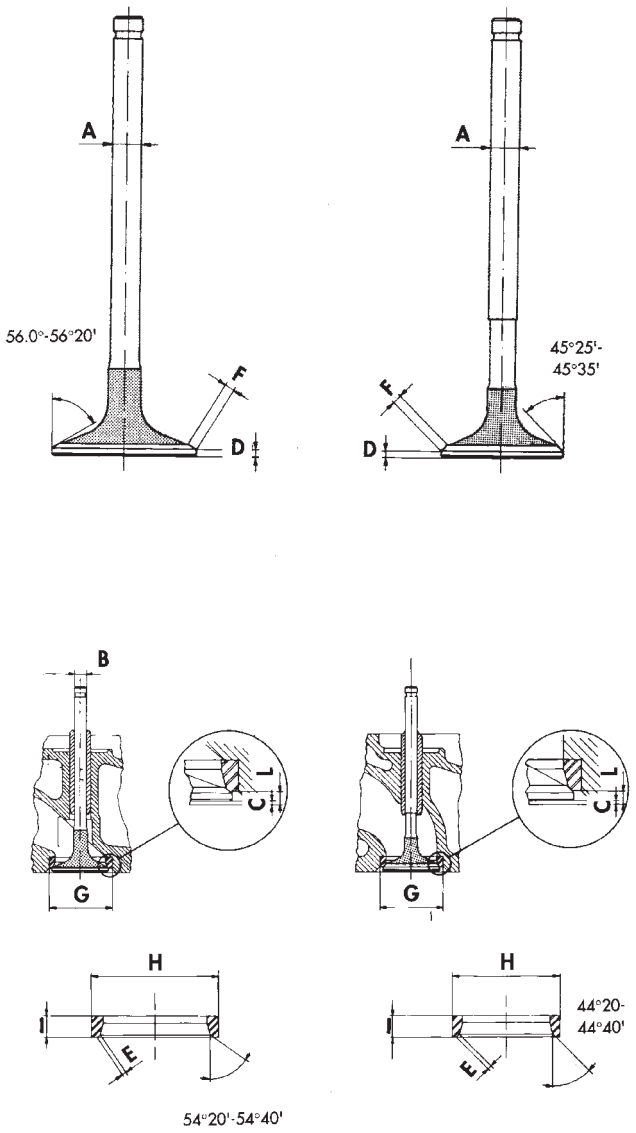


Fig. 4 Valve Specification

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.

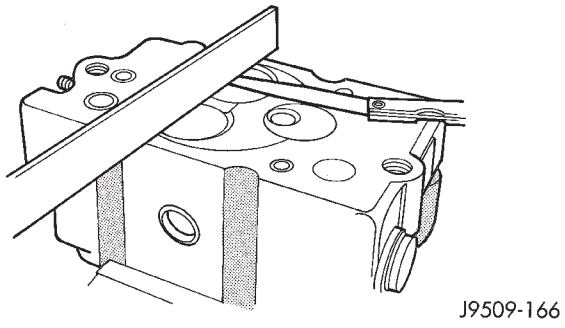


Fig. 5 Checking Valve Stand Down

VALVE GUIDES

(1) Valve Guides height requirement.

(2) Measurement A (Fig. 6): 13.50 - 14.00 mm.

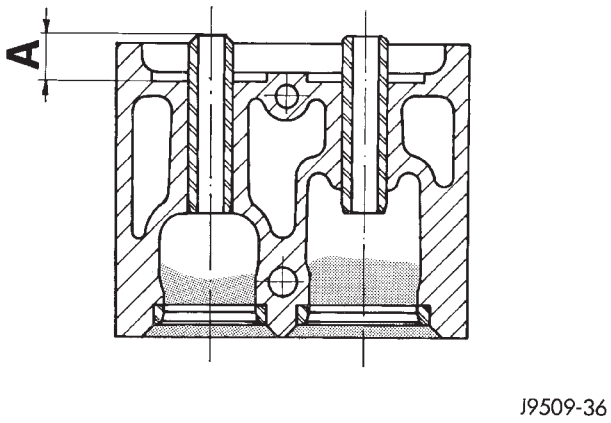


Fig. 6 Valve Guide Height

VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

(1) Measure and record internal diameter of valve guides. Valve guide internal diameter is 8.0 to 8.015 mm (.3149 to .3155 ins.).

(2) Measure valve stems and record diameters. Intake valve stem diameter 7.94 to 7.96 mm (.3125 to .3133 in). Exhaust valve stem diameter 7.92 to 7.94 mm (.3118 to .31215 in).

SERVICE PROCEDURES (Continued)

(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.

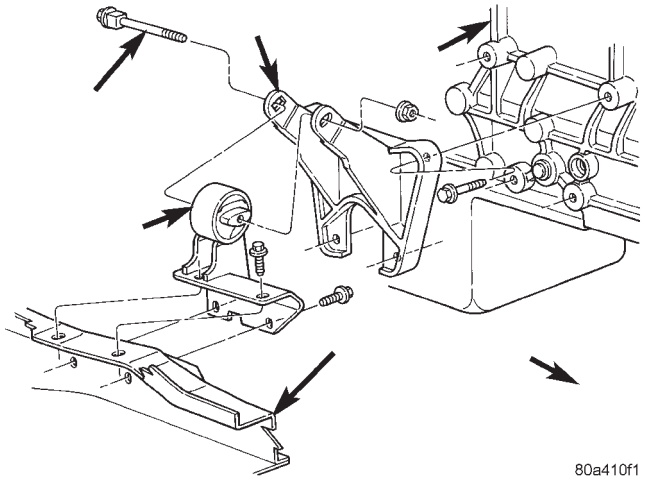


Fig. 7 Front Mount—Right Side

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.

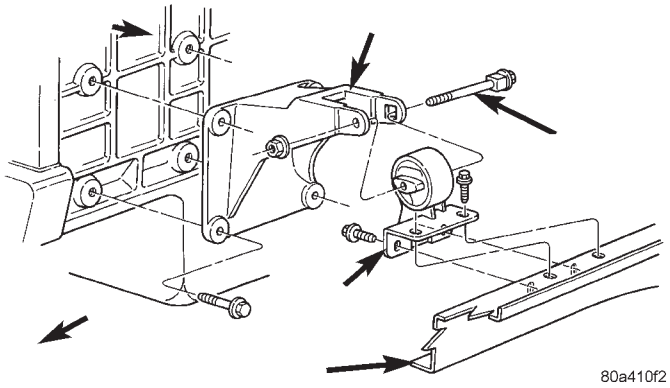


Fig. 8 Front Mount—Left Side

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

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.

REMOVAL AND INSTALLATION (Continued)

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

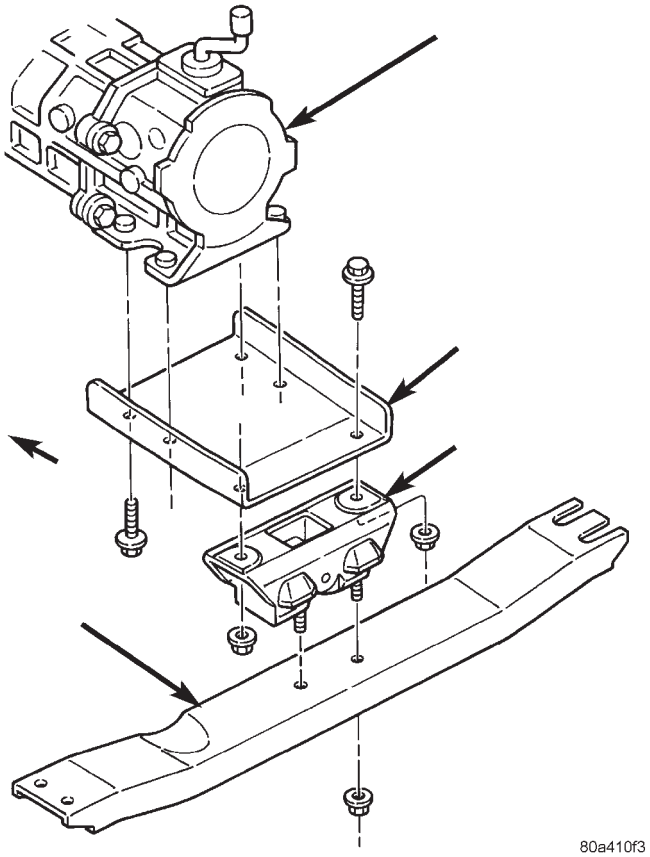


Fig. 9 Rear Mount

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.

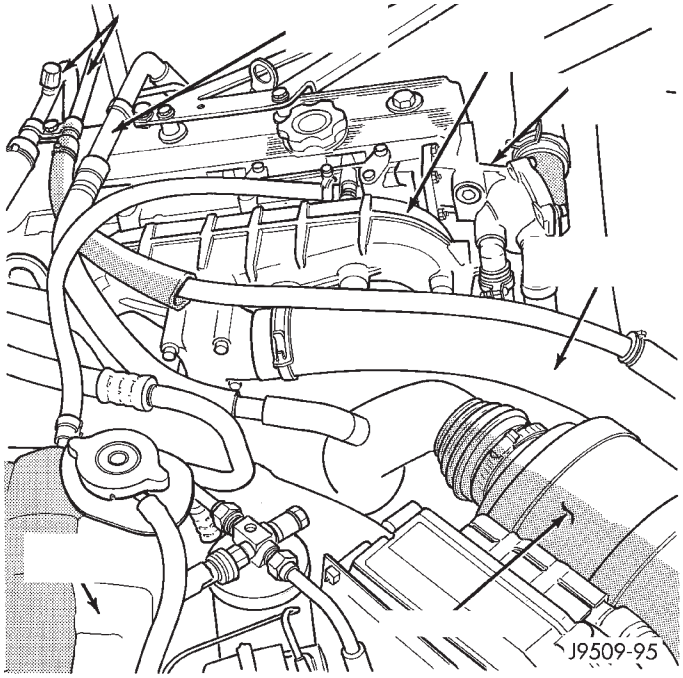


Fig. 10 Right side of Engine

(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).

REMOVAL AND INSTALLATION (Continued)

(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.

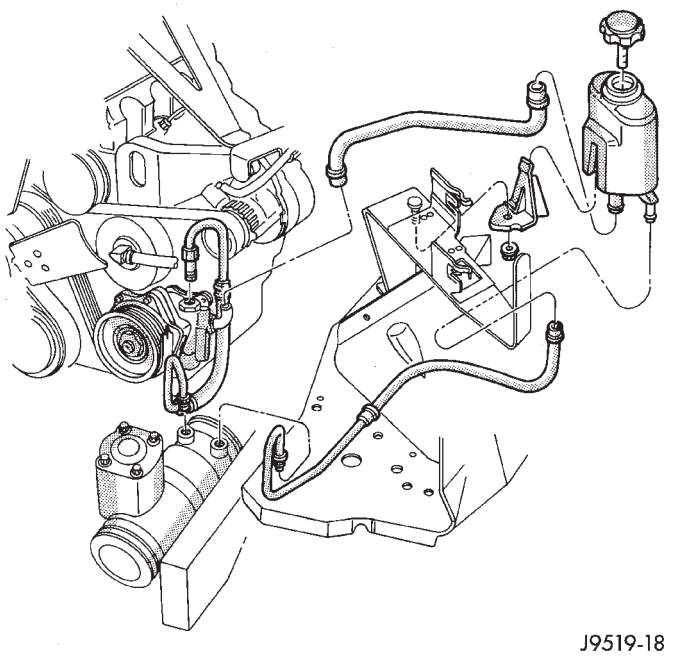


Fig. 11 Power Steering Lines

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

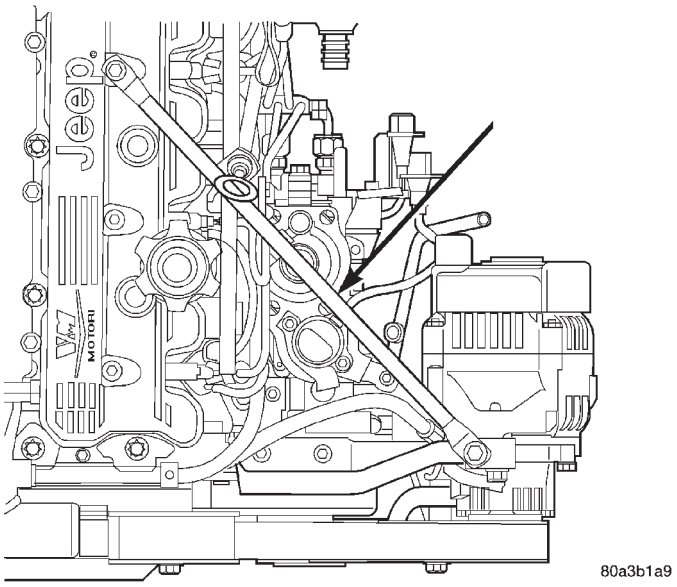


Fig. 12 Left Side of Engine

(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).

(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.

(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.

REMOVAL AND INSTALLATION (Continued)

(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).
(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.

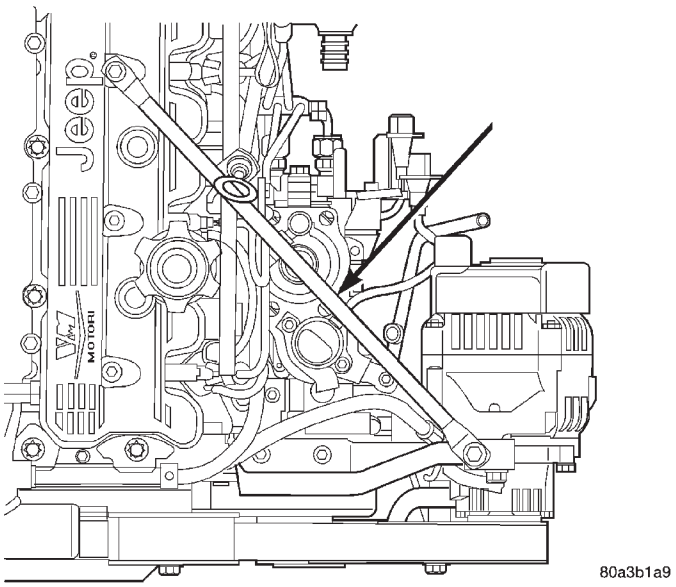


Fig. 13 Generator Brace

(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.
(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.

REMOVAL AND INSTALLATION (Continued)

(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

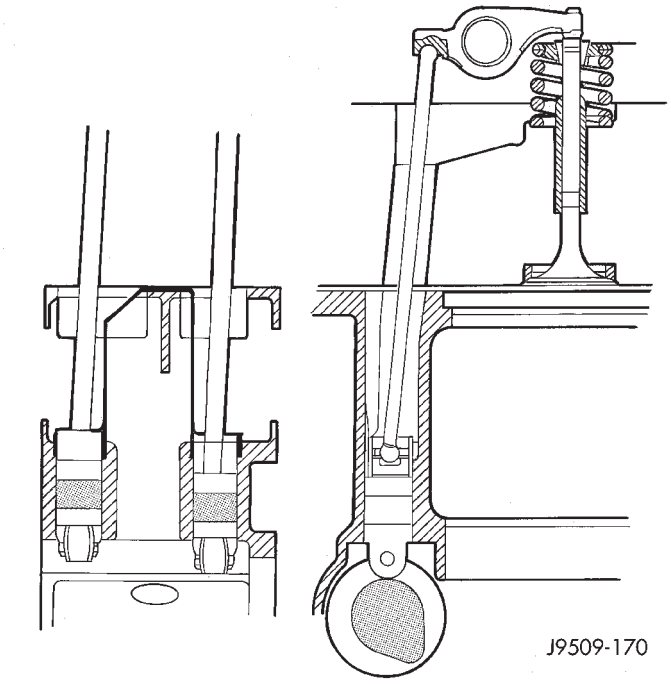


Fig. 14 Tappet And Rocker Arm Assembly

(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).

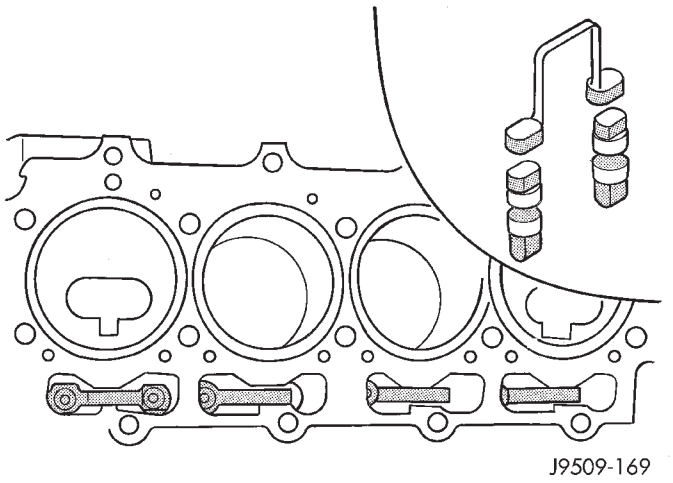


Fig. 15 Tappet And Yoke

(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.

(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.

REMOVAL AND INSTALLATION (Continued)

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).

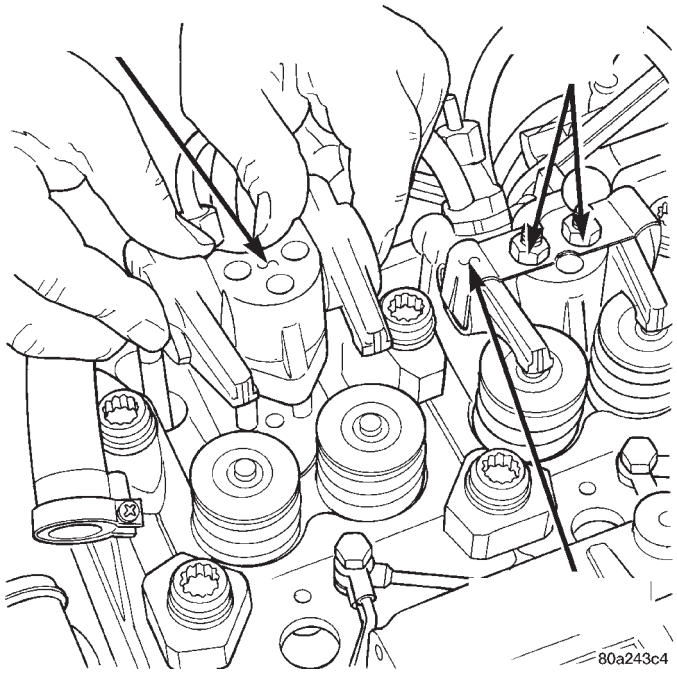


Fig. 16 Rocker Arm Retaining Nut

(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.

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.

REMOVAL AND INSTALLATION (Continued)

(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.

(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).

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

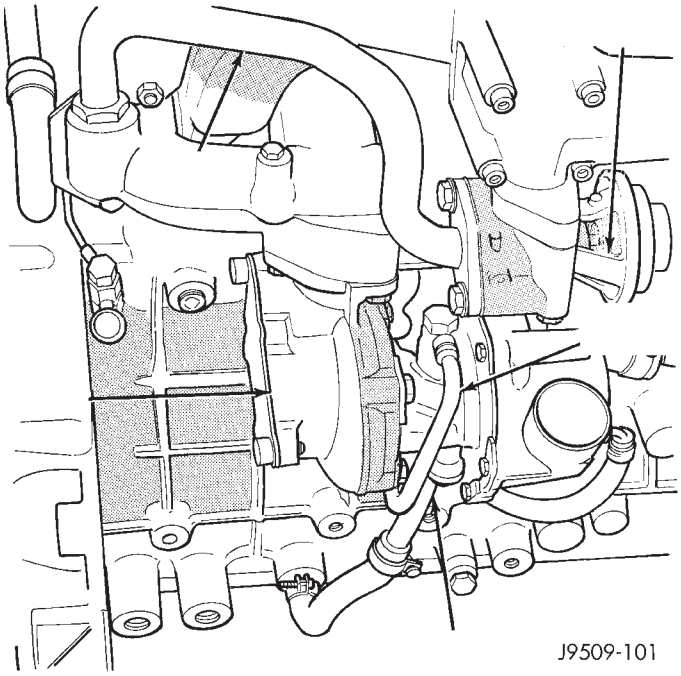


Fig. 17 Turbocharger

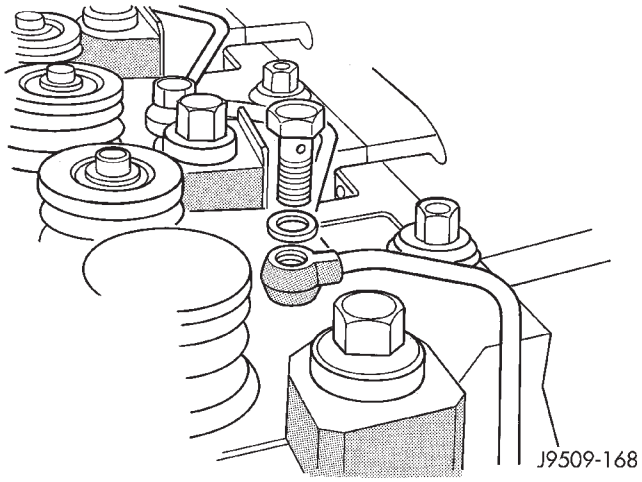


Fig. 18 Rocker Arm Oil Feed Lines

(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).

(29) Remove the engine cylinder head cover.

(30) Remove rocker retaining nuts (Fig. 21).

(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.

REMOVAL AND INSTALLATION (Continued)

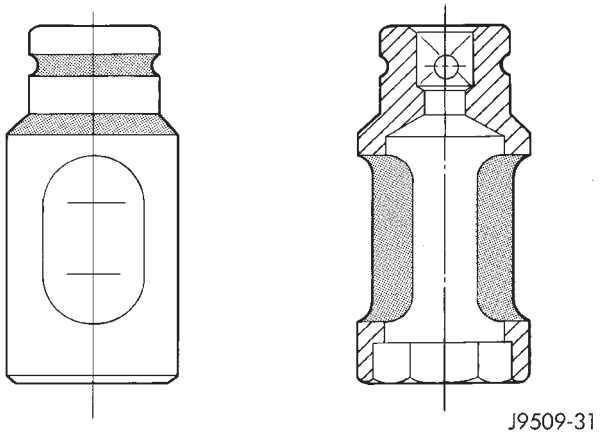


Fig. 19 Fuel Injector Tool VM-1012A

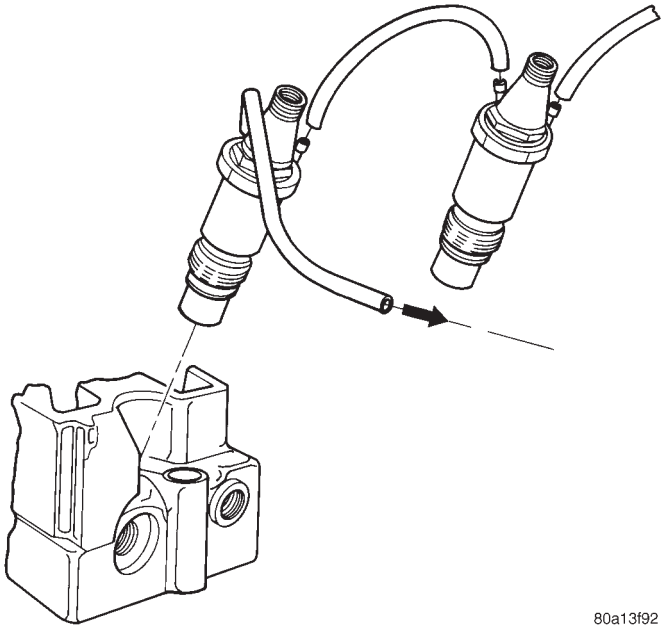


Fig. 20 Fuel Injector

(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).

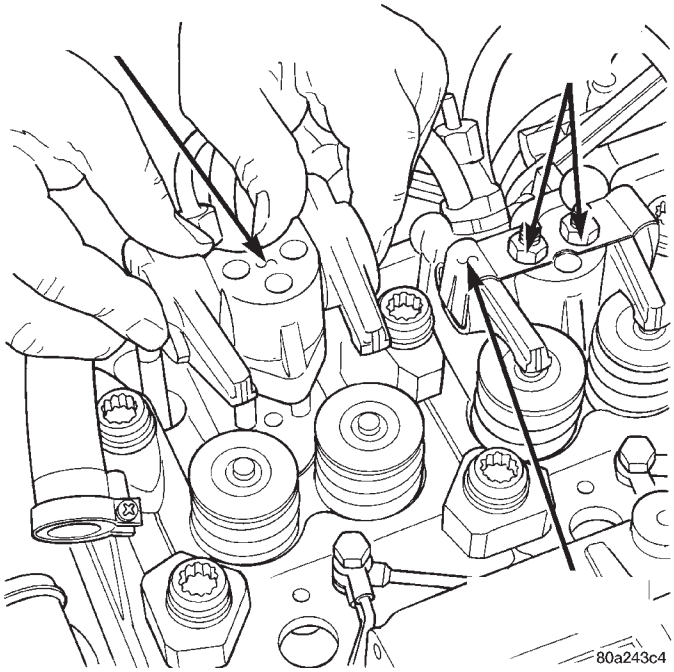


Fig. 21 Rocker Arm Retaining Nuts

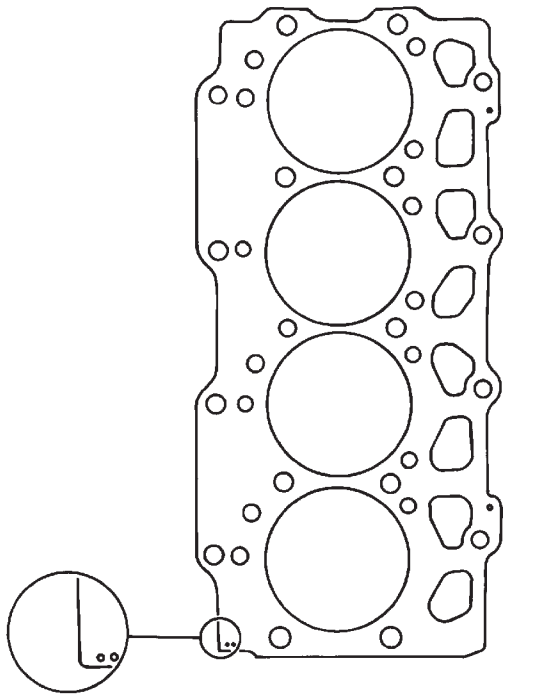


Fig. 22 Steel Type Cylinder Head Gasket—identification

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

REMOVAL AND INSTALLATION (Continued)

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).

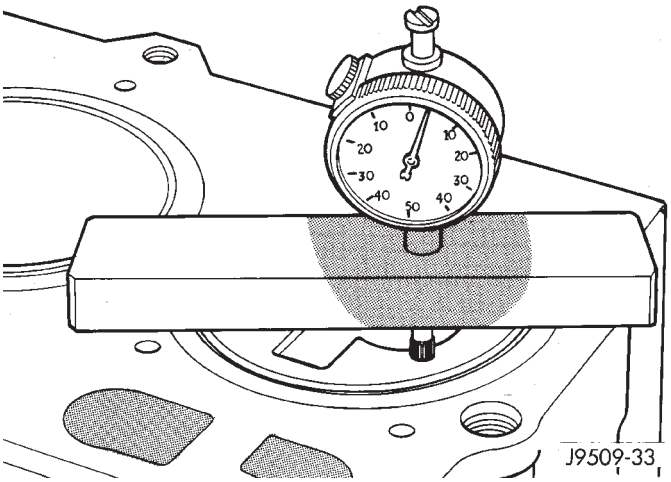


Fig. 23 Measuring Piston Protrusion

(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).

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 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

REMOVAL AND INSTALLATION (Continued)

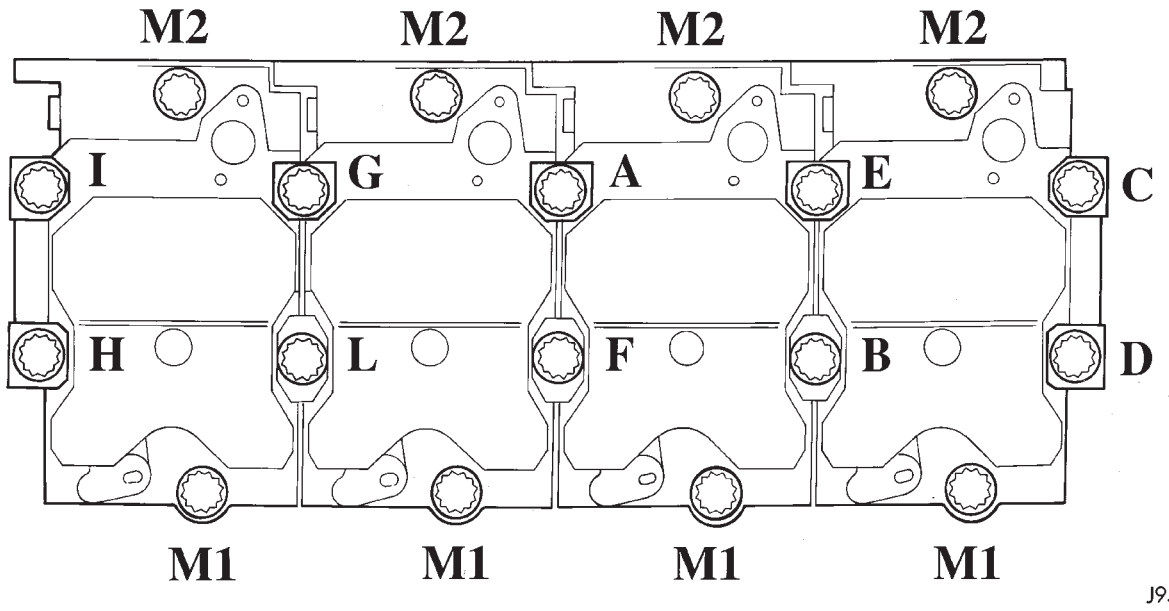


Fig. 25 Engine Cylinder Head Bolt Tightening Sequence

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.

(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.

REMOVAL AND INSTALLATION (Continued)

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).
(4) Remove vibration damper nut.
(5) Install tool VM-1000-2 to remove vibration damper (Fig. 27).

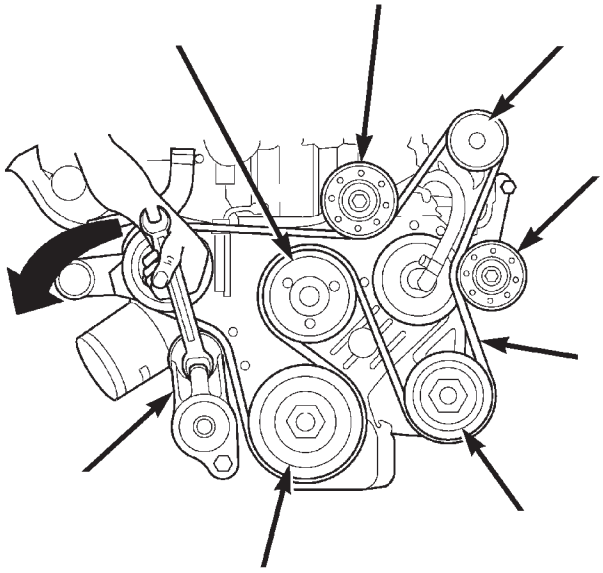
INSTALLATION

(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.

TIMING CASE COVER OIL SEAL

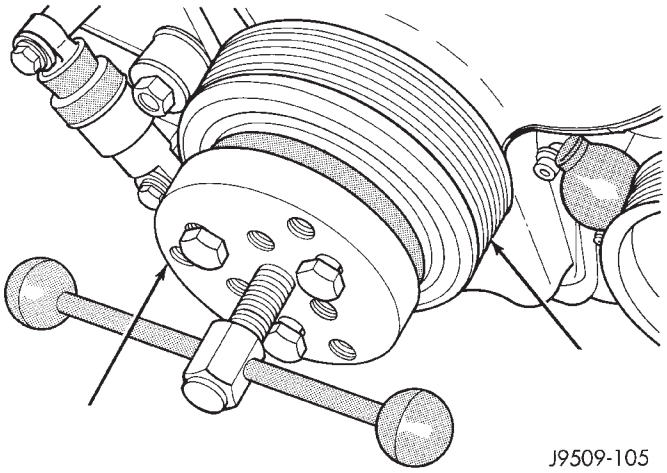
REMOVAL

(1) Disconnect the battery cable.
(2) Remove vibration damper (refer to vibration damper removal in this section).
(3) Pry out seal.



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Fig. 26 Accessary Drive System



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Fig. 27 Vibration Damper Removal With Tool VM-1000-2

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.

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.

REMOVAL AND INSTALLATION (Continued)

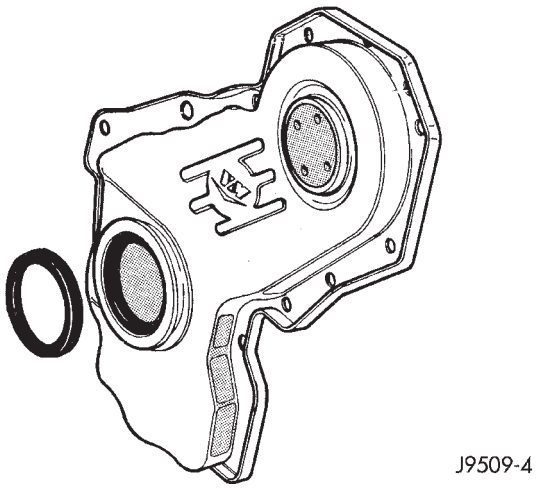


Fig. 28 Front Cover Seal

(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.).
(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.

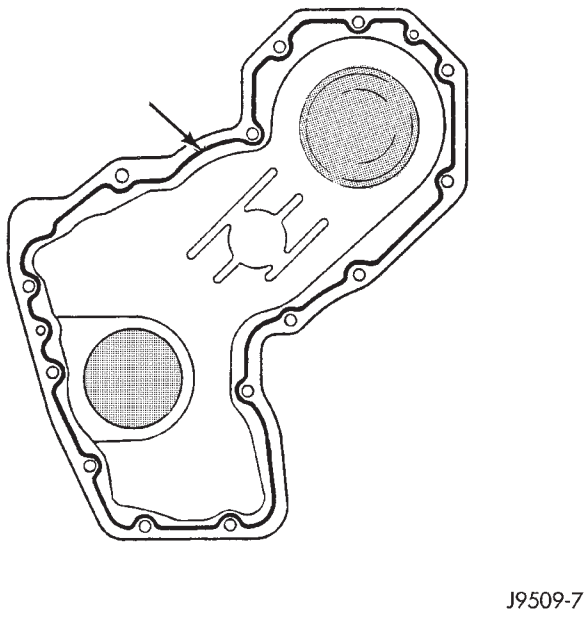


Fig. 29 Front Cover Sealer Location

CAMSHAFT

REMOVAL

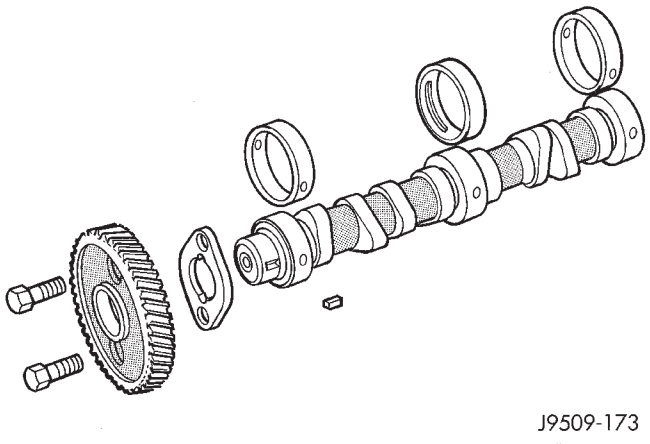


Fig. 30 Camshaft Assembly

(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).

REMOVAL AND INSTALLATION (Continued)

(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).

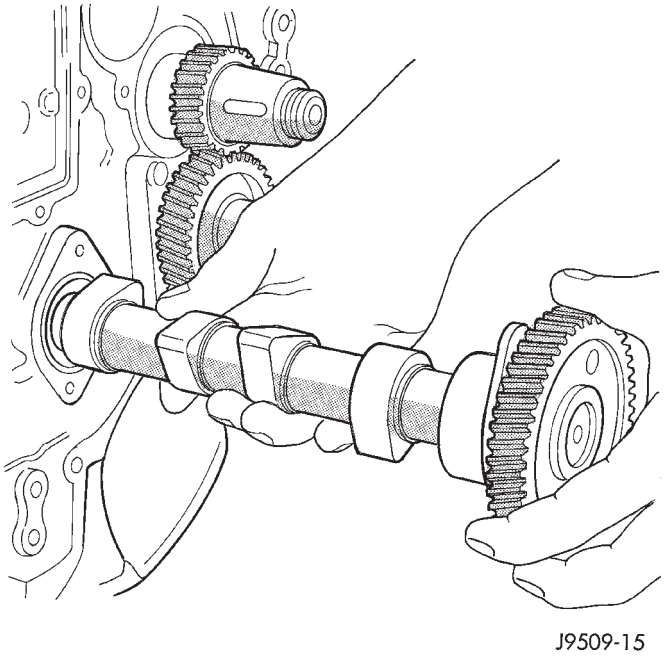


Fig. 31 Camshaft Removal

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.

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).

(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).

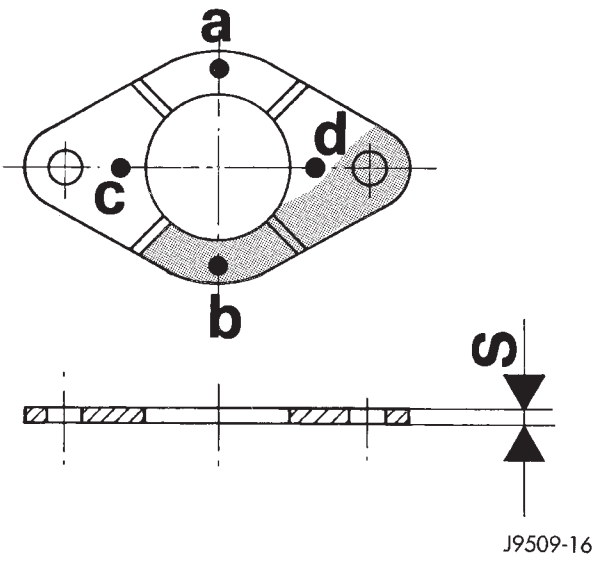


Fig. 32 Camshaft Thrust Plate

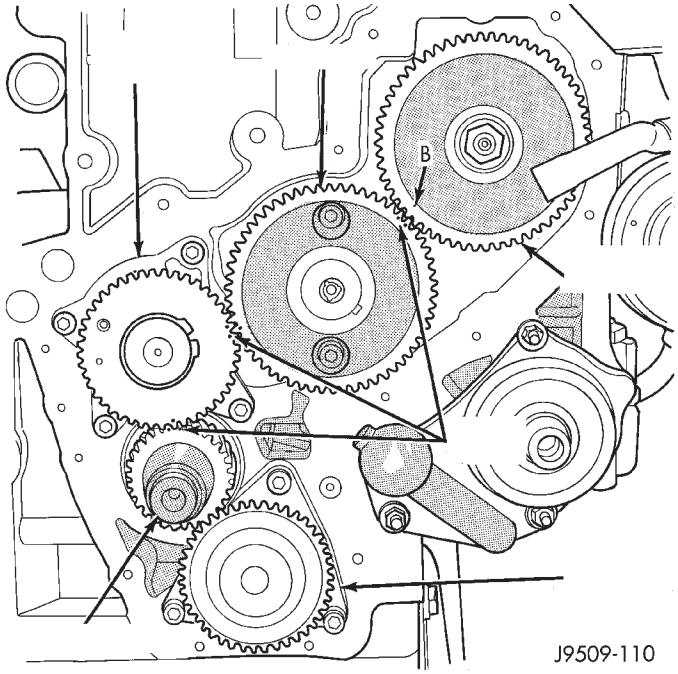


Fig. 33 Timing Marks

(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.

REMOVAL AND INSTALLATION (Continued)

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.

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.).

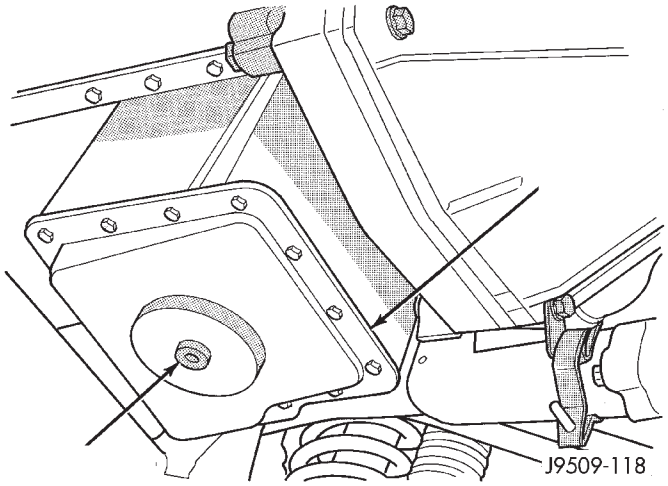


Fig. 34 Oil Pan

(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).

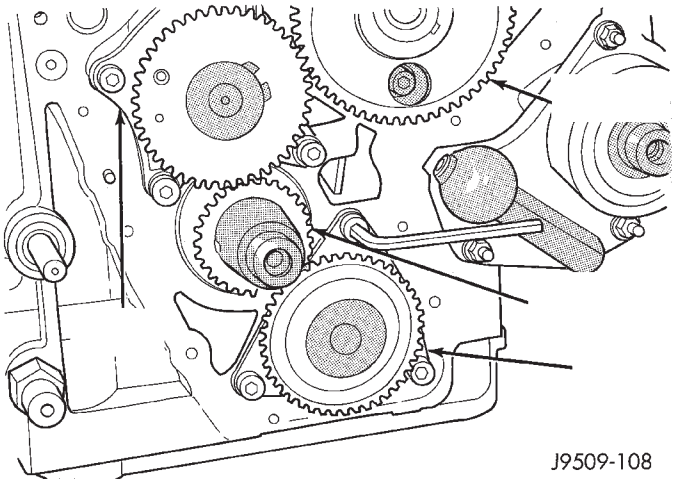


Fig. 35 Oil Pump Removal

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.

REMOVAL AND INSTALLATION (Continued)

(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.

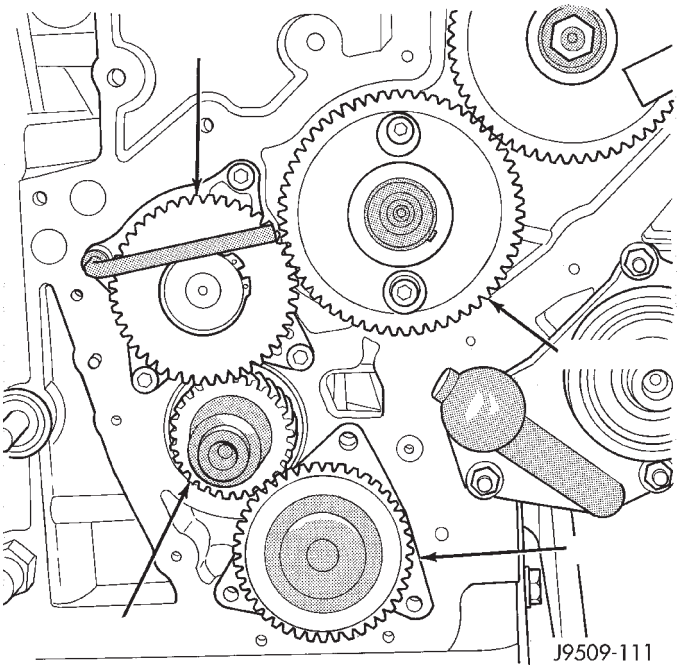


Fig. 36 Vacuum Pump

(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.

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.

(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.

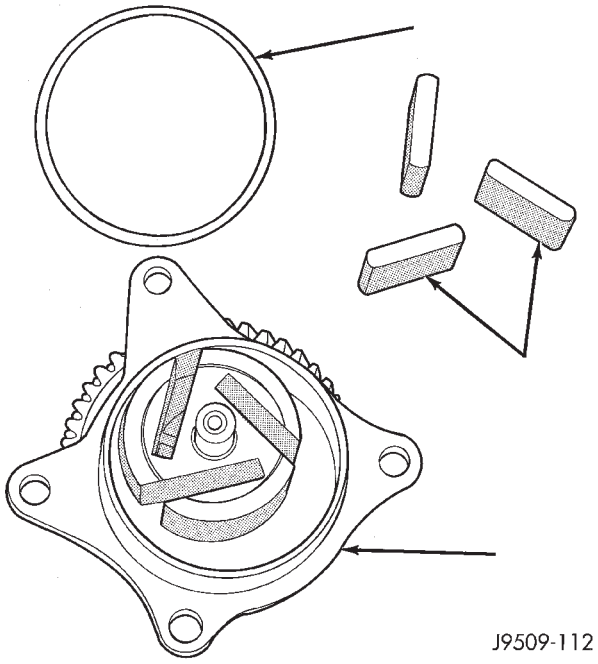


Fig. 37 Vacuum Pump Parts

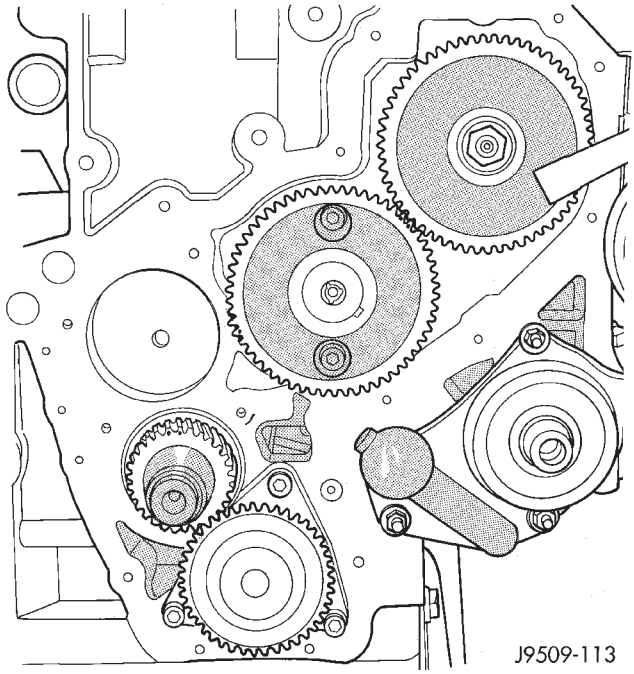


Fig. 38 Vacuum Pump Mounting Hole

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.

REMOVAL AND INSTALLATION (Continued)

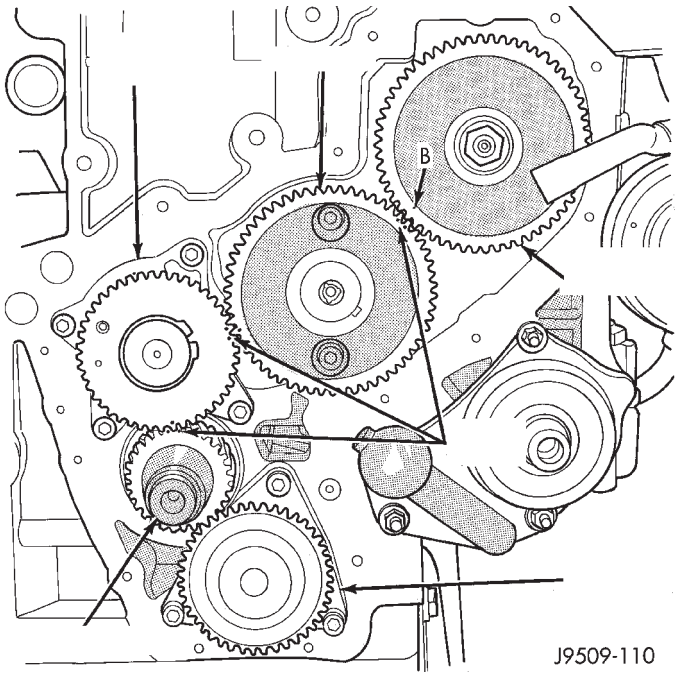


Fig. 39 Timing Marks

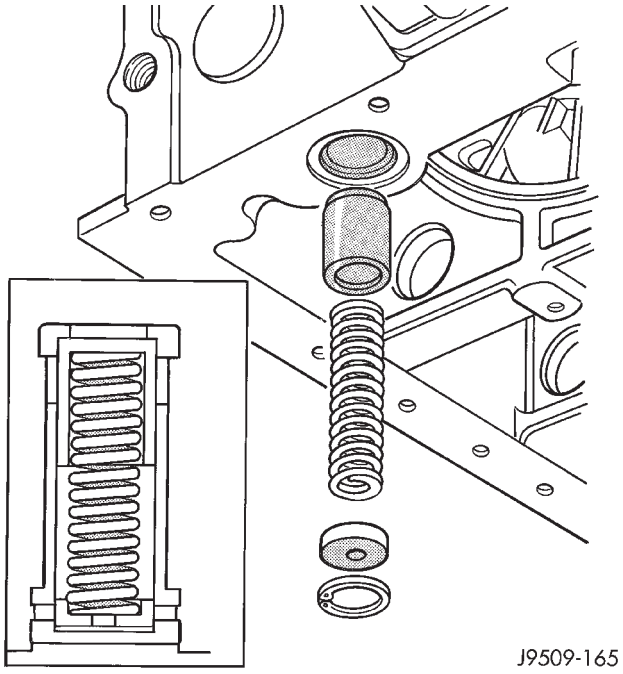


Fig. 40 Oil Pressure Relief Valve

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.

(4) Remove oil cooler adapter bolt.

(5) Remove oil cooler (Fig. 41).

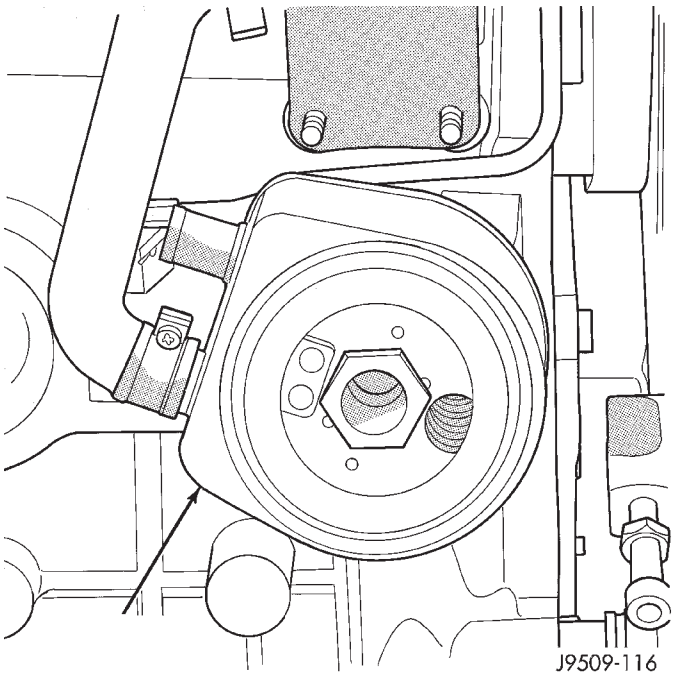


Fig. 41 Oil Cooler

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.

REMOVAL AND INSTALLATION (Continued)

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

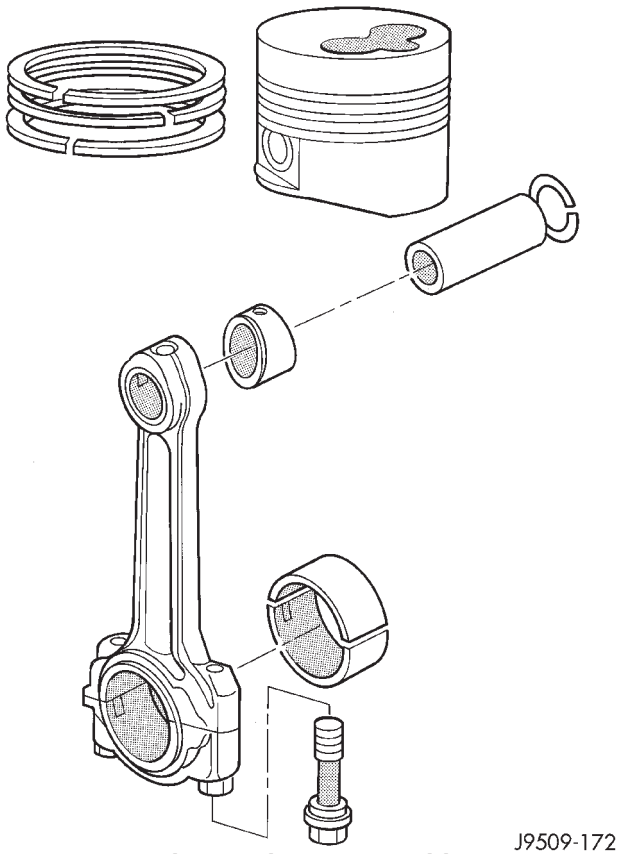


Fig. 42 Piston Assembly

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

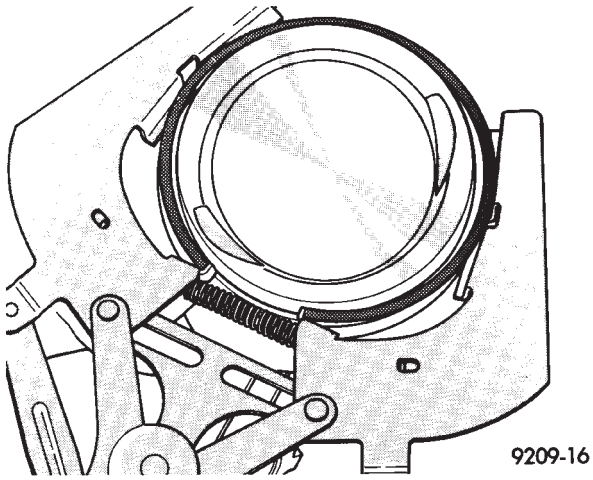


Fig. 43 Piston Rings—Removing and Installing

(1) ID mark on face of upper and intermediate piston rings must point toward piston crown.

(2) Using a suitable ring expander, remove upper and intermediate piston rings (Fig. 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.

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.).

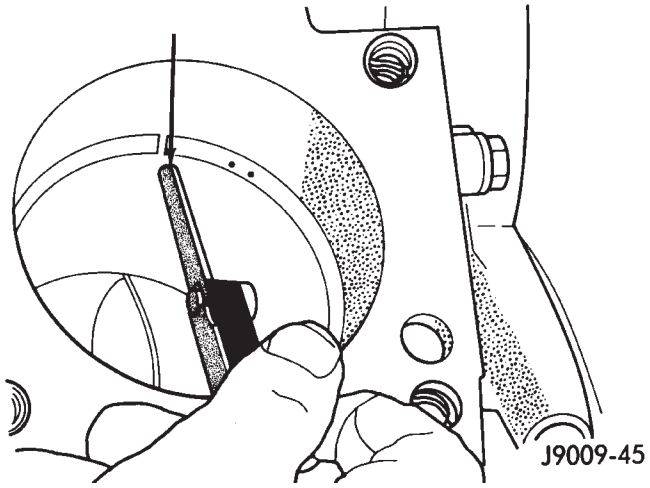


Fig. 44 Ring Gap Measurement

(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).

(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).

REMOVAL AND INSTALLATION (Continued)

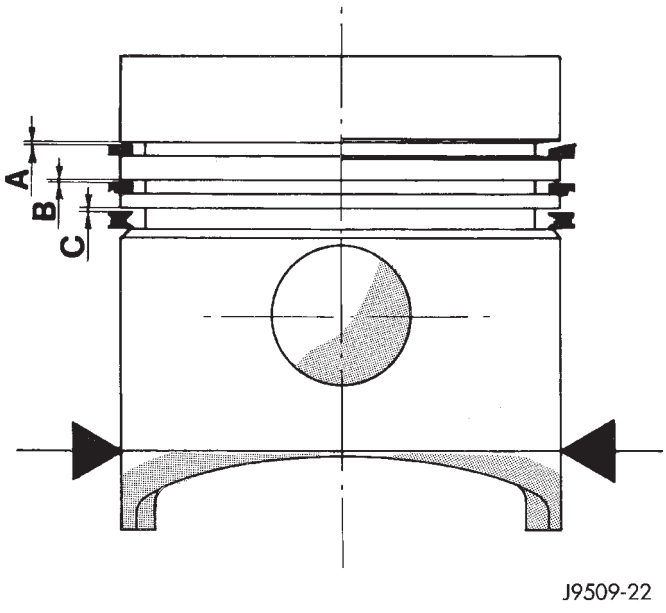


Fig. 45 Piston Ring Side Clearance

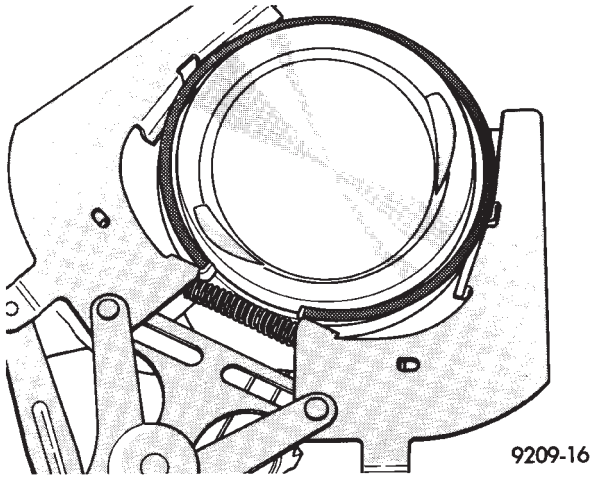


Fig. 46 Piston Rings—Removing and Installing

(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).

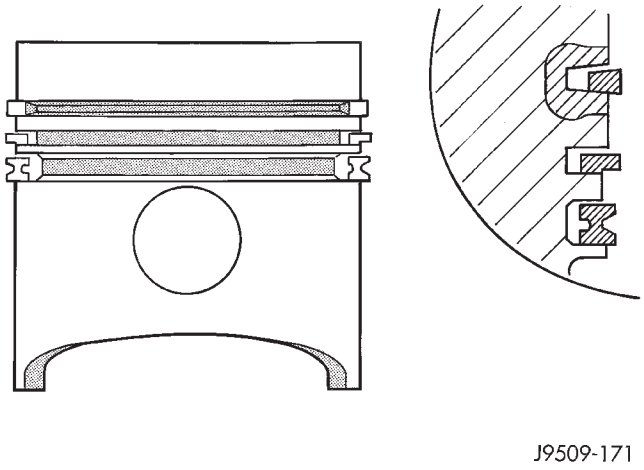


Fig. 47 Piston Ring Identification

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).

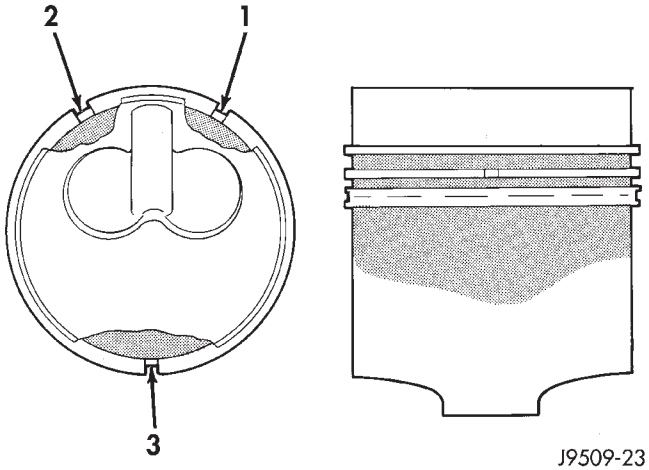


Fig. 48 Piston Ring Gap Location

REMOVAL AND INSTALLATION (Continued)

(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).

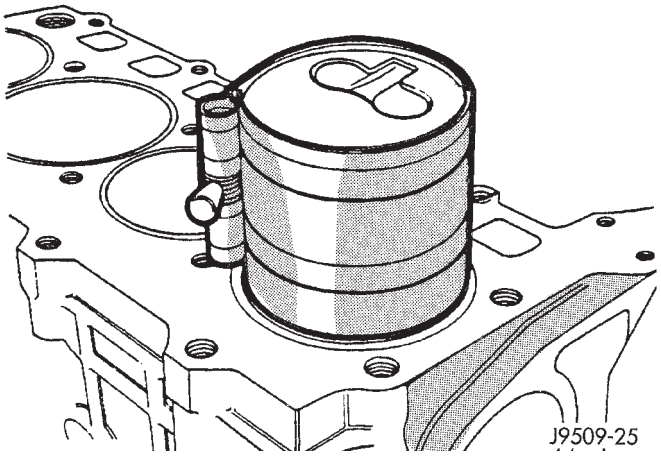


Fig. 49 Installing Piston

(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** .

(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).

(5) Remove shims from cylinder liner or cylinder block recess. Keep shims with each cylinder liner.

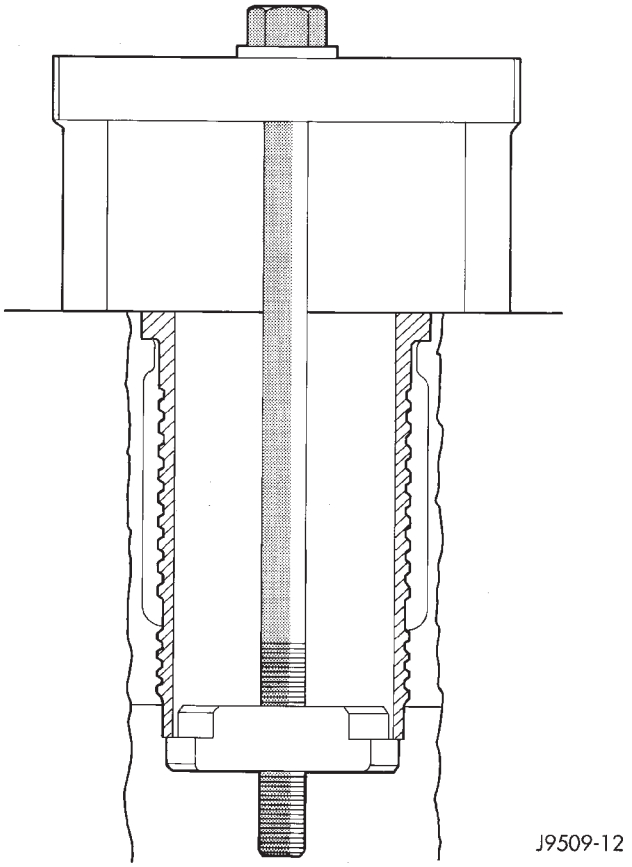


Fig. 50 Liner Removal Tool

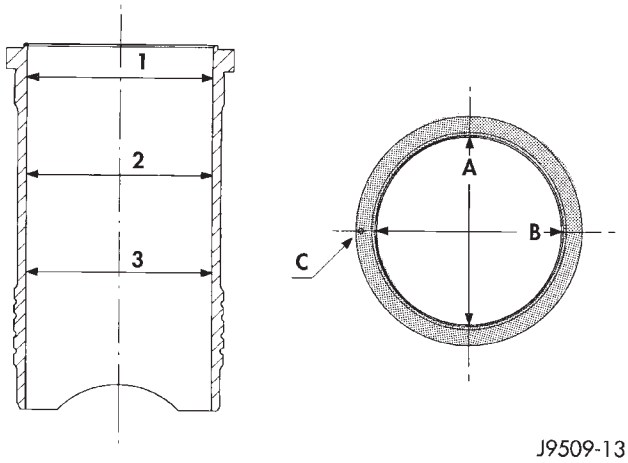


Fig. 51 Liner Inspection

REMOVAL AND INSTALLATION (Continued)

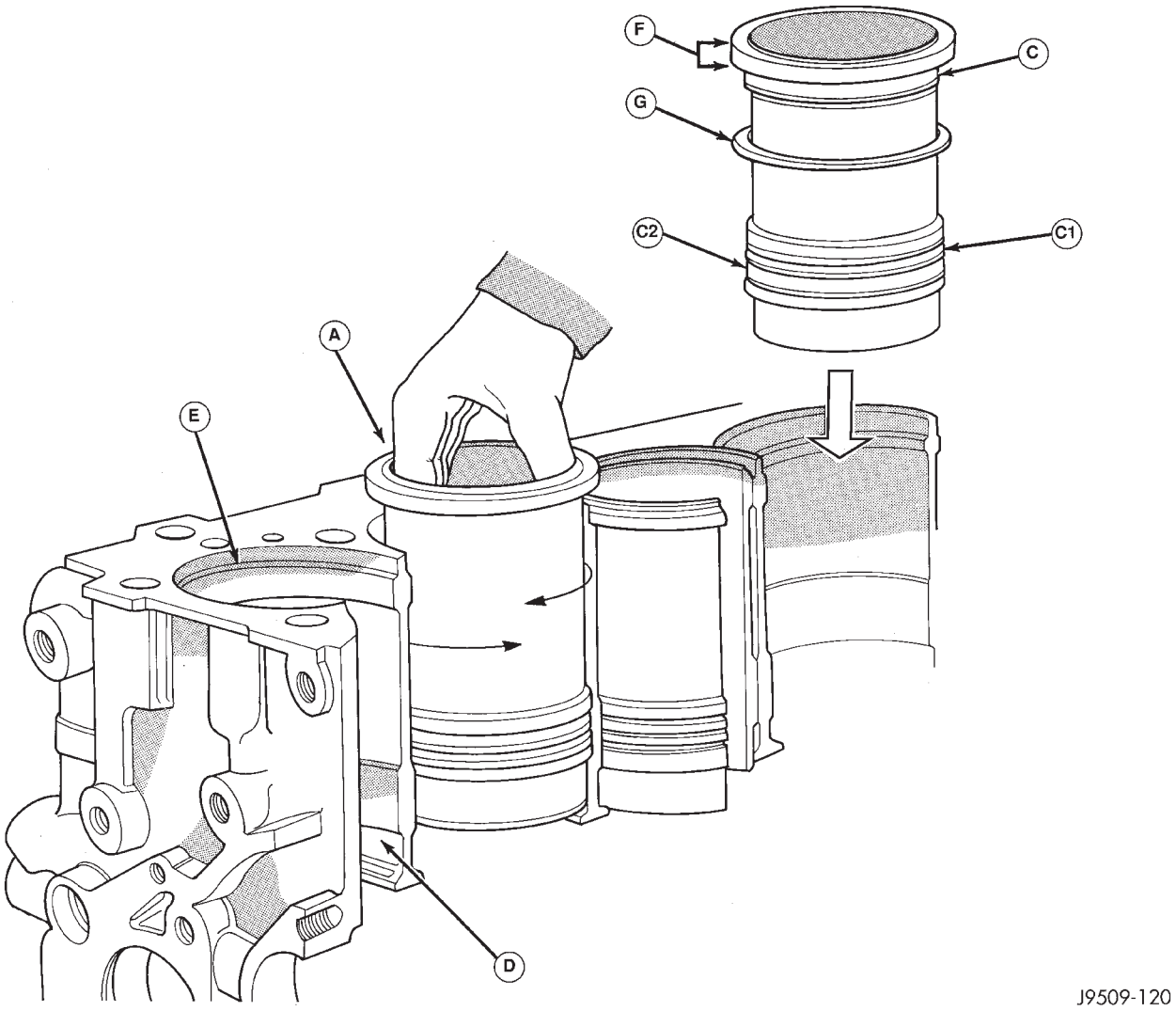


Fig. 52 Liner Installation

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).

(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)

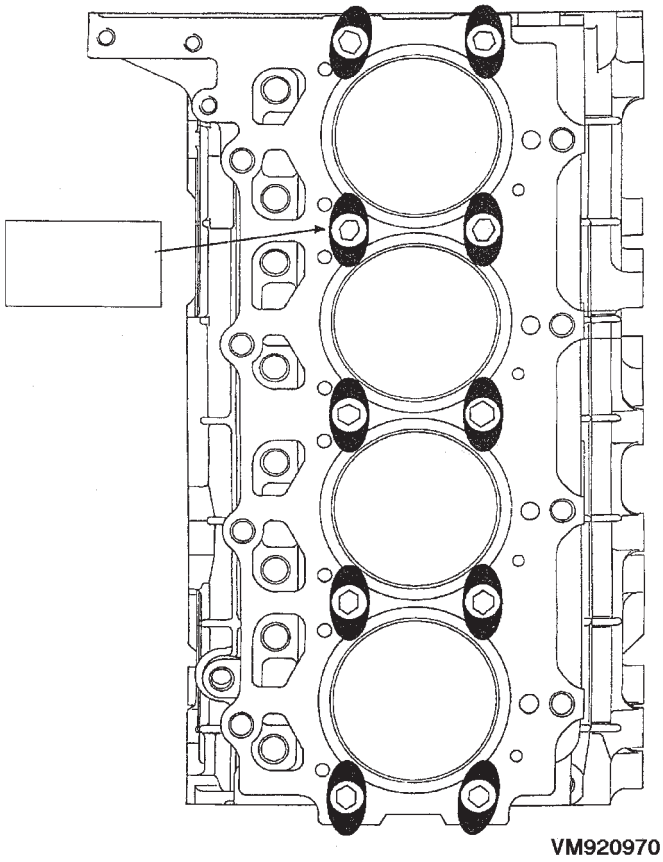


Fig. 53 Liner Clamp Location

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 turbocharger, 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.

(17) Install special tool VM-1004 onto crankshaft over gear (Fig. 55).

(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

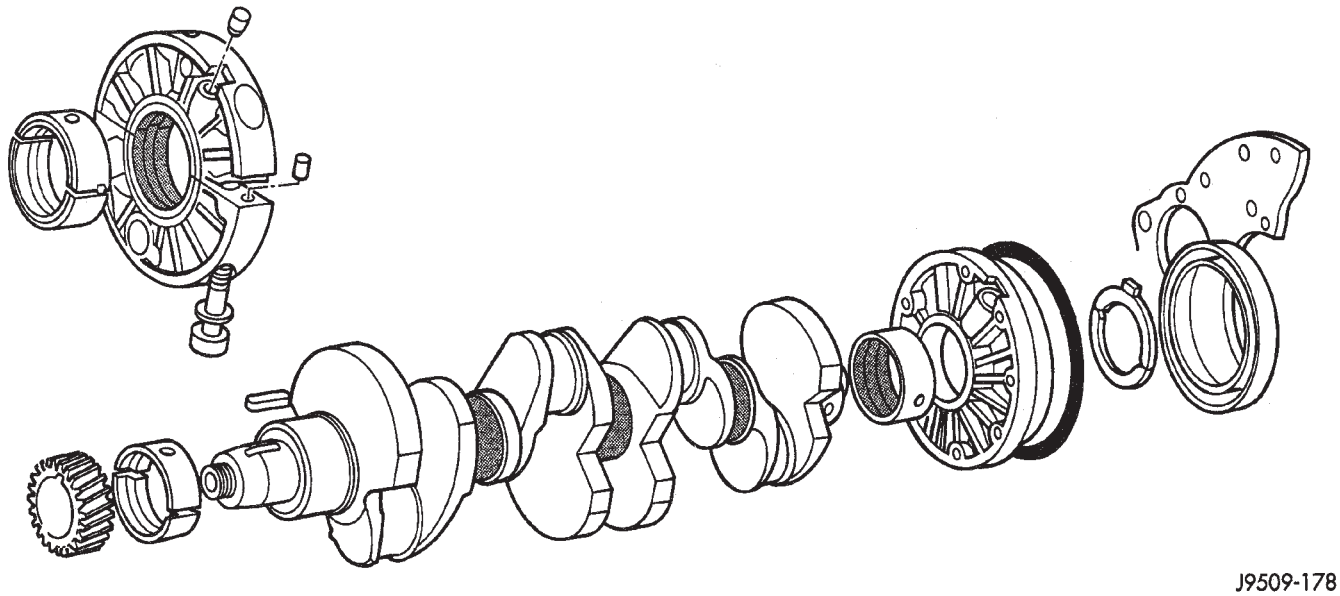


Fig. 54 Crankshaft and Bearing Assembly

REMOVAL AND INSTALLATION (Continued)

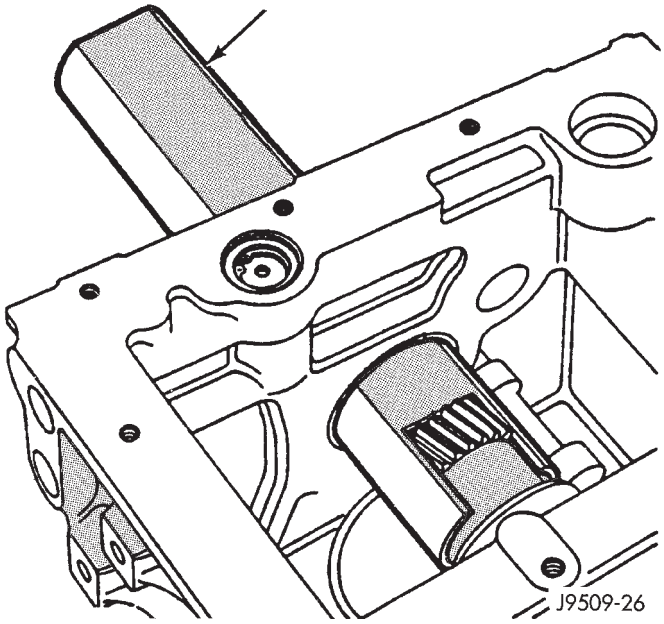


Fig. 55 Crankshaft Special Tool VM-1004

gain access to the main bearing carrier bolts. Mark the carriers for assembly and remove the bolts, two for each carrier (Fig. 56).

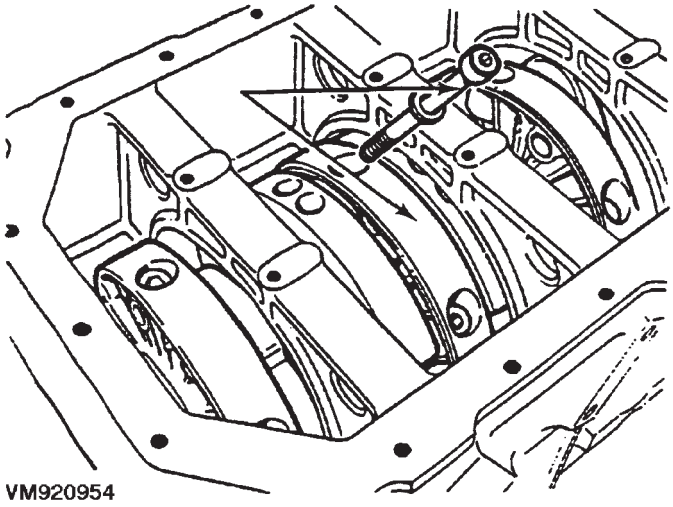


Fig. 56 Carrier Bolts

(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.

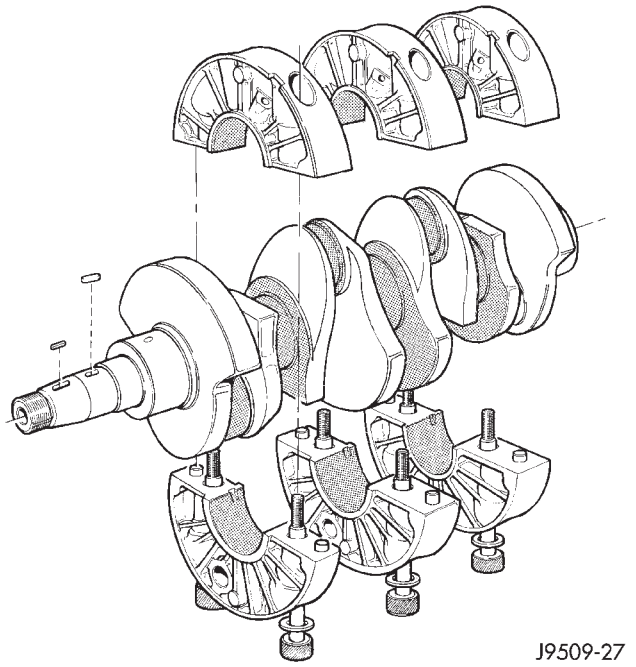


Fig. 57 Crankshaft and Carrier Bearing Assembly

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).

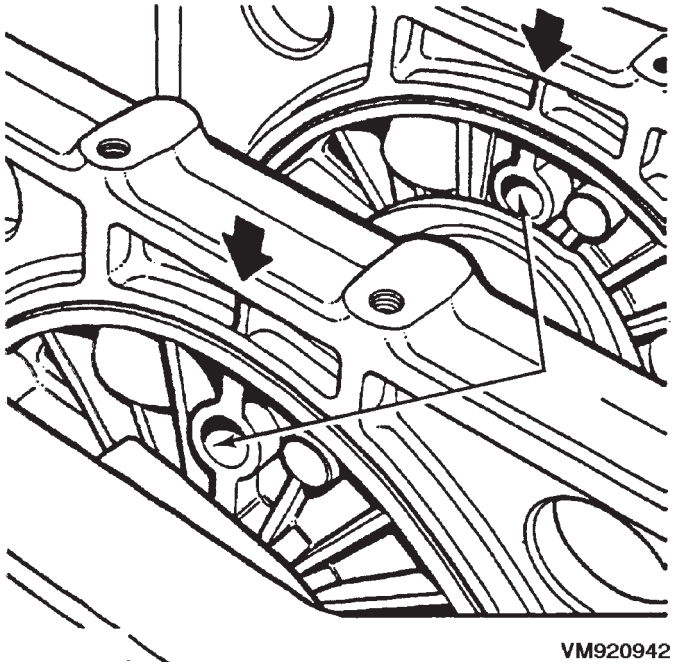


Fig. 58 Main Bearing Carrier Alignment

(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 to block and tighten nuts to 26.5 N·m (20 ft. lbs.).

(14) Install Allen bolts through adaptor plate to rear main bearing carrier and tighten to 11 N·m (97 in. 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.

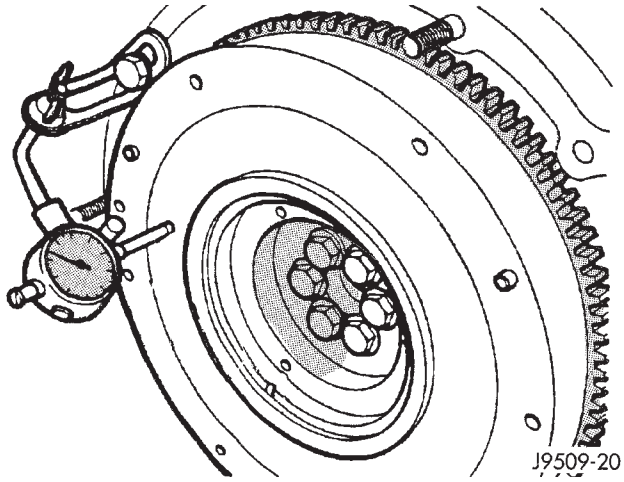


Fig. 59 Measuring Crankshaft End Play

(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.).

(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.).

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

REMOVAL AND INSTALLATION (Continued)

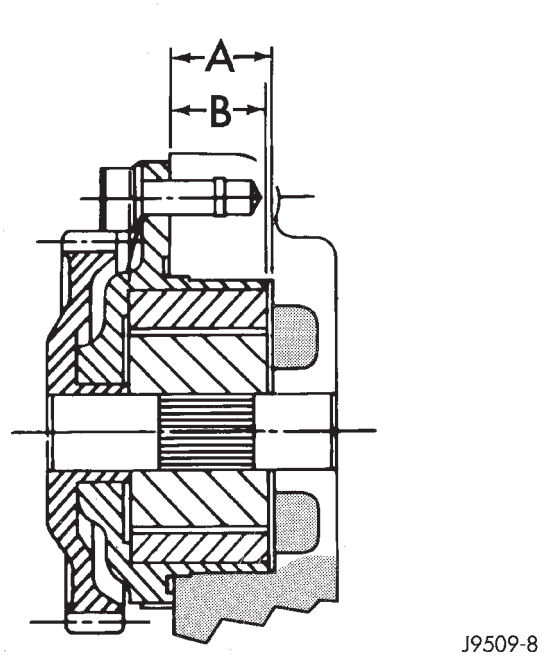


Fig. 60 Oil Pump Bore Depth

(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.

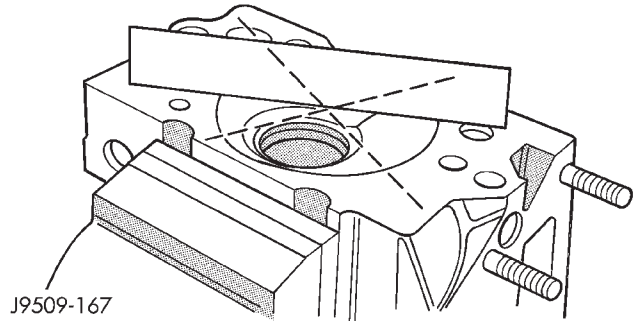


Fig. 61 Checking Cylinder Head Flatness

CLEANING AND INSPECTION (Continued)

ROCKER ARMS AND PUSH RODS

CLEANING

Clean all the components (Fig. 62) with cleaning solvent.

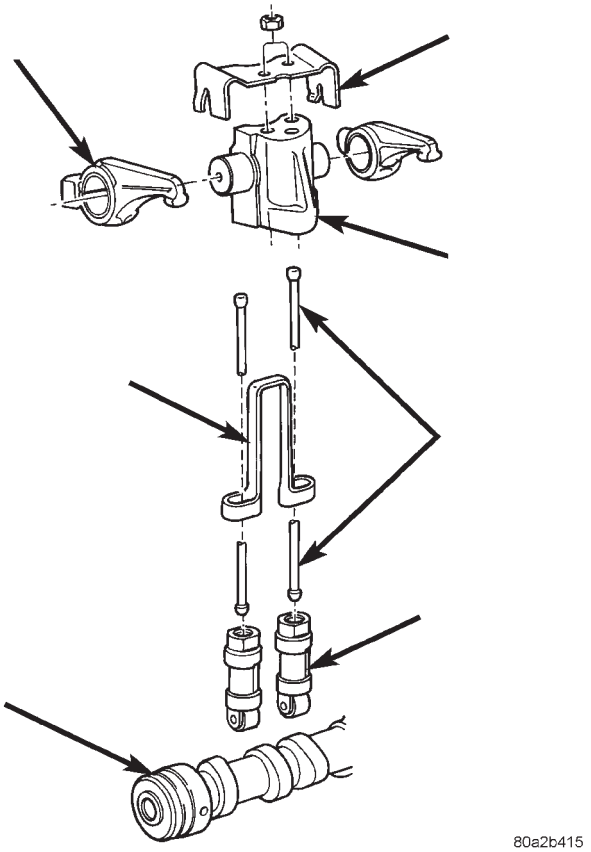


Fig. 62 Rocker Arm Components

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.

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°.

CLEANING AND INSPECTION (Continued)

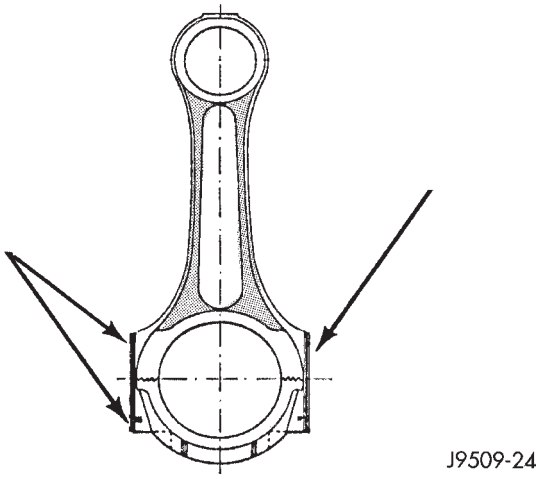


Fig. 63 Connecting Rod Identification

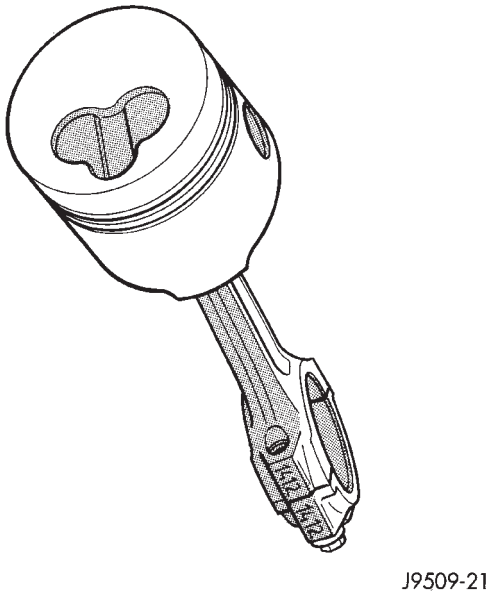


Fig. 64 Piston and Connecting Rod Assembly

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.).

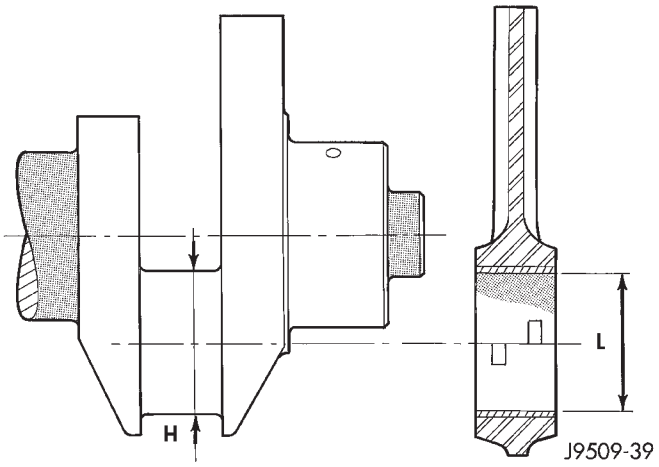


Fig. 65 Bearing Clearance

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.

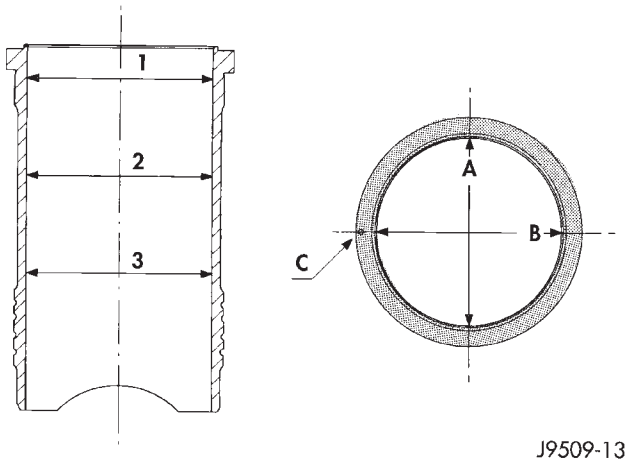


Fig. 66 Liner Inspection

CLEANING AND INSPECTION (Continued)

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.

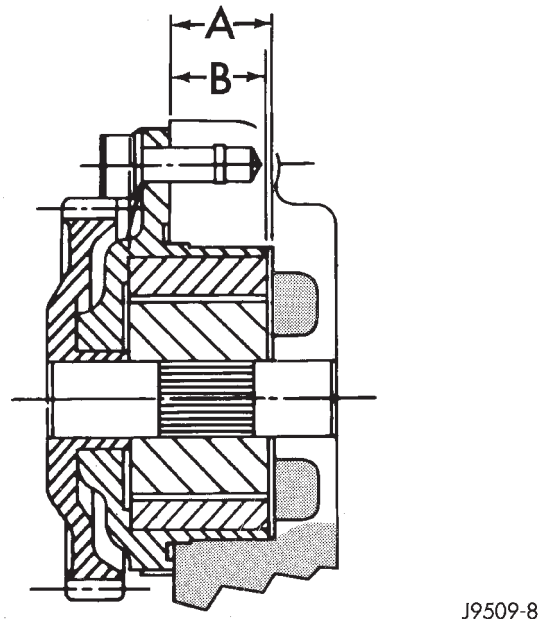


Fig. 67 Oil Pump Bore Depth

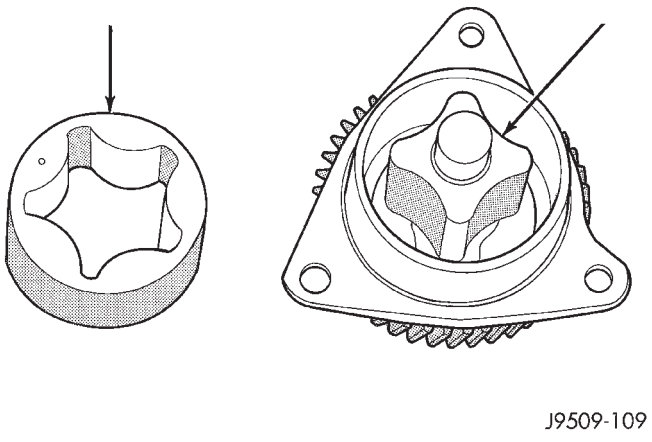


Fig. 68 Oil Pump Inner and Outer Rotors

(2) Check clearance between rotors (Fig. 69).

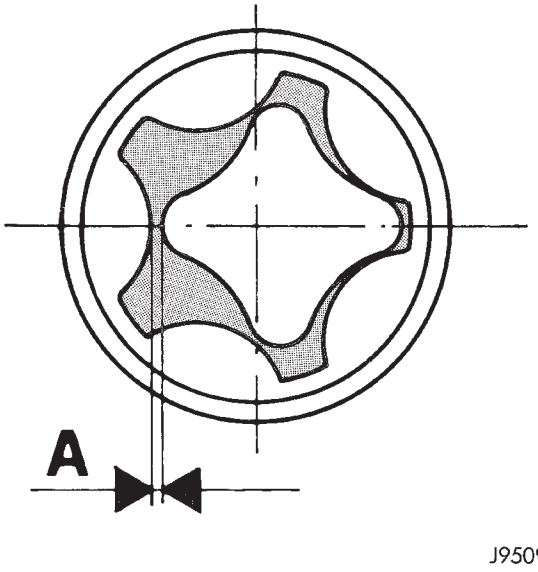


Fig. 69 Checking Rotor Clearance

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
Adaptor Plate to Block	
Nuts (6)	26.5 N·m (20 ft. lbs.)
Automatic Belt Tensioner to Block	
Bolts (2)	121 N·m
Automatic Belt Tensioner to Mounting Bracket	
Bolt (1)	75 N·m
Generator 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°

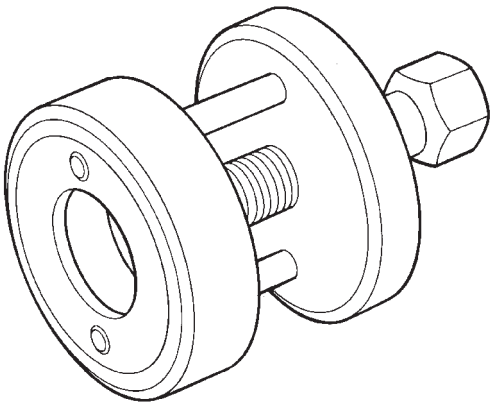
DESCRIPTION	TORQUE
Front timing cover	
6 mm bolts	10 N·m
8 mm bolts	26 N·m
Fuel filter	
Nuts	28 N·m
Glow plug	
Torque	13.0 N·m
Idler pulley bracket	
Bolts	40 N·m
Idler pulley	
Bolt (left hand thread)	47 N·m
Injection pump fuel lines	
Nut	23 N·m
Injection pump gear	
Lock nut	86 N·m
Injection pump	
Mounting 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

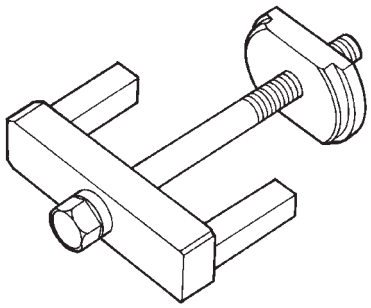
SPECIAL TOOLS

SPECIAL TOOLS



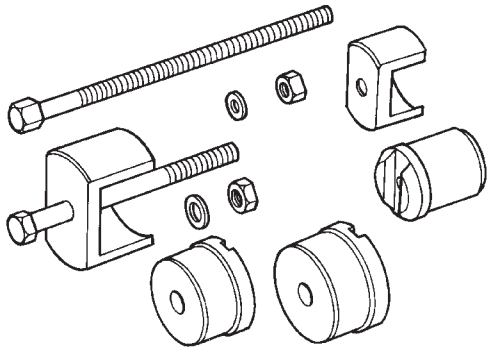
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Crankshaft Pulley and Gear Remover VM. 1000A



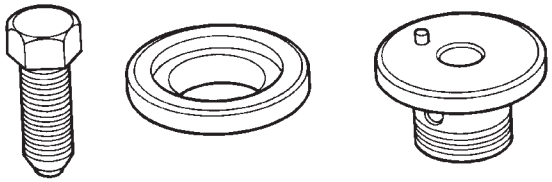
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Cylinder Liner Puller VM, 1001



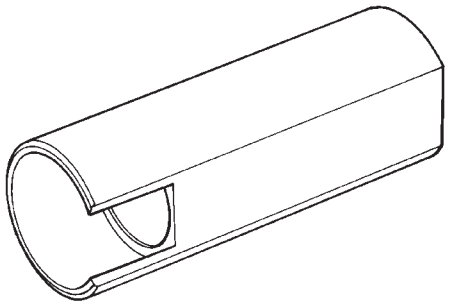
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Crankshaft Bearing Remover/Replacer VM. 1002



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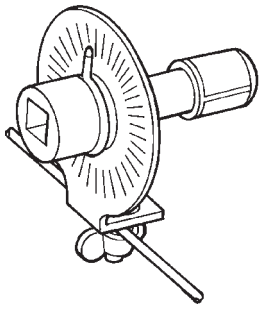
Injection Pump Puller and Gear retainer VM. 1003



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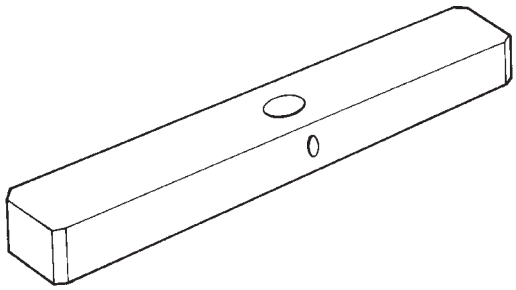
Crankshaft Remover/Replacer Sleeve VM. 1004

SPECIAL TOOLS (Continued)



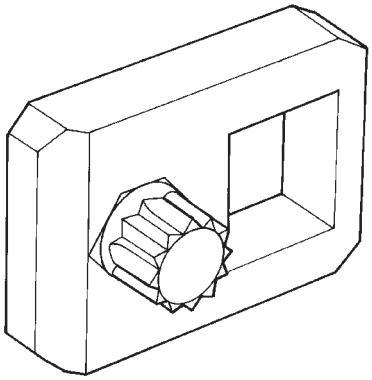
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Torque Angle Gauge VM. 1005



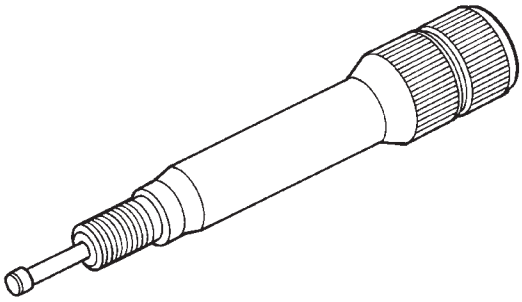
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Cylinder Liner Protrusion Tool VM. 1010



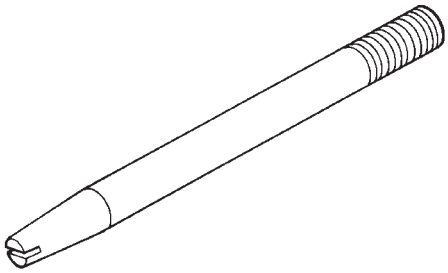
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Cylinder Head Bolt Wrench VM. 1006A



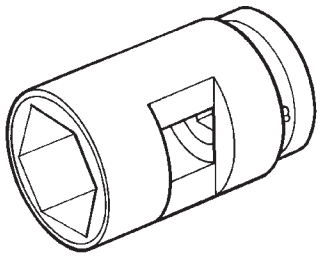
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Bosch Pump Timing Adapter VM. 1011



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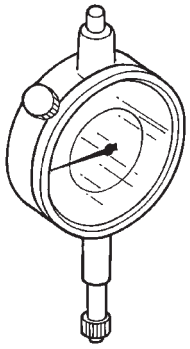
Cylinder Head Guide Studs VM. 1009



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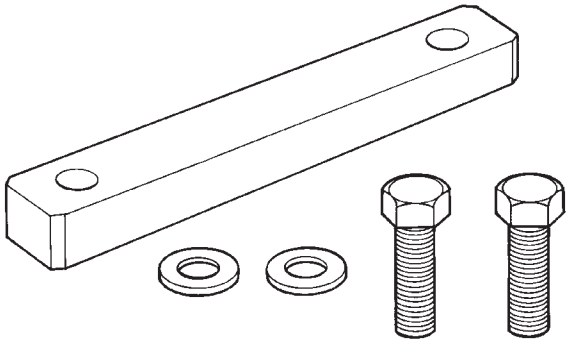
Injector Remover/Replacer Socket VM. 1012

SPECIAL TOOLS (Continued)



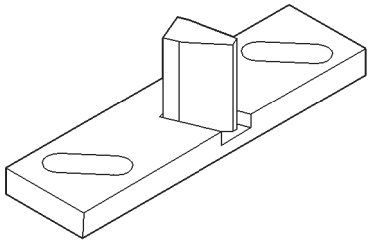
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Dial Indicator Gauge VM. 1013

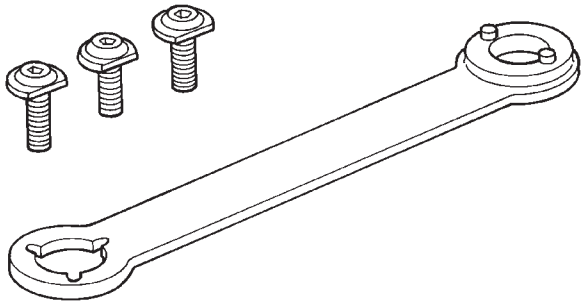


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Cylinder Retainer VM. 1016

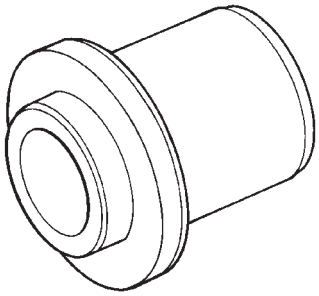


Flywheel Locking Tool VM. 1014



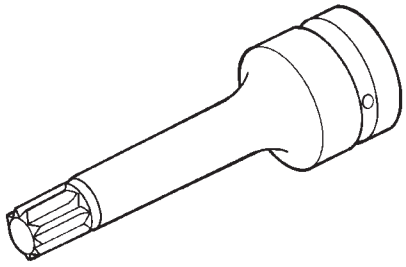
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Crankshaft and Water Pump Pulley Holder VM. 1017



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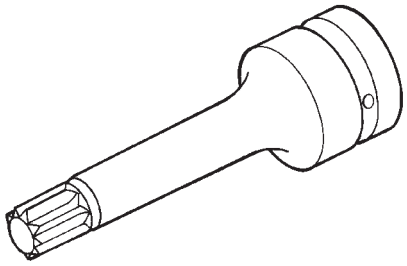
Timing Cover Oil Seal Replacer VM. 1015



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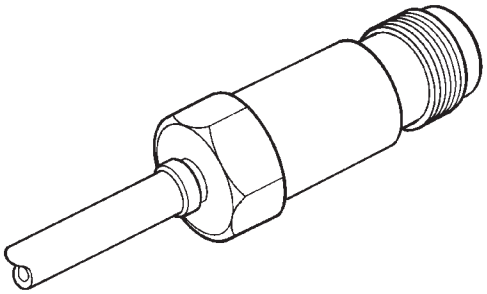
Cylinder Head Bolt Wrench M12 VM. 1018

SPECIAL TOOLS (Continued)



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Cylinder Head Bolt Wrench M14 VM. 1019



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Cylinder Leakage Tester Adapter VM. 1021