ENGINES

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STANDARD SERVICE PROCEDURES

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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

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

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

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

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

(4) Perform cylinder compression test:

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

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

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

CAUTION: DO NOT overspeed the engine.

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

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

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

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

(h) Repeat Step 4g for all remaining cylinders.

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

(j) If cylinder(s) have abnormally low compression pressures, repeat steps 4a through 4h.

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

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

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

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

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

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

(9) Perform a combustion analysis.

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

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

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

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

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

(15) Road test vehicle as a final test.

HONING CYLINDER BORES

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

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

CAUTION: DO NOT use rigid type hones to remove cylinder wall glaze.

(2) Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. Use a cylinder surfacing hone, Honing Tool C-3501, equipped with 280 grit stones (C-3501-3810). 20-60 strokes, depending on the bore condition, will be sufficient to provide a satisfactory surface. Using honing oil C-3501-3880 or a light honing oil available from major oil distributors.

CAUTION: DO NOT use engine or transmission oil, mineral spirits or kerosene.

(3) Honing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should INTERSECT at 50° to 60° for proper seating of rings (Fig. 1).

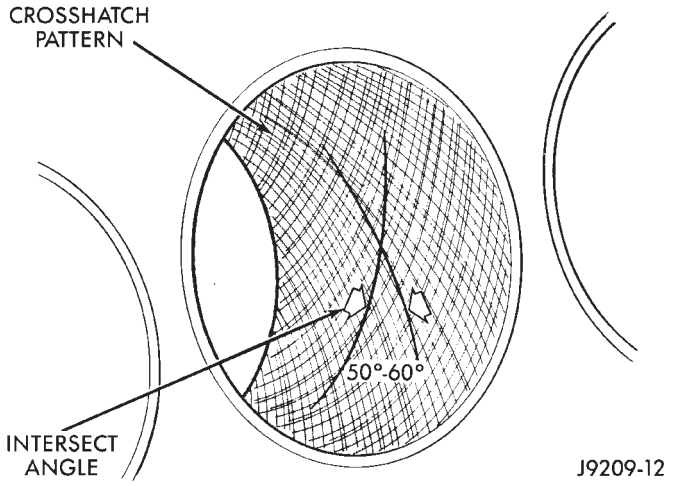

Fig. 1 Cylinder Bore Crosshatch Pattern

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

(5) After honing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting.

MEASURING WITH PLASTIGAGE

CRANKSHAFT MAIN BEARING CLEARANCE

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

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

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

METHOD - 1 (PREFERRED)—Shim the bearings adjacent to the bearing to be checked. This will remove the clearance between upper bearing shell and the crankshaft. Place a minimum of 0.254 mm (0.010 inch) shim between the bearing shell and the adjacent bearing cap. Tighten the bolts to 18 N●m (13 ft. lbs.) torque.

- **4.0L & 5.2L ENGINES**—When checking No.1 main bearing; shim No.2 main bearing.
- **4.0L & 5.2L ENGINES**—When checking No.2 main bearing; shim No.1 and No.3 main bearing.
- **4.0L & 5.2L ENGINES**—When checking No.3 main bearing; shim No.2 and No.4 main bearing.
- **4.0L & 5.2L ENGINES**—When checking No.4 main bearing; shim No.3 and No.5 main bearing.
- **5.2L 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.

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.

(3) Place a piece of Plastigage across the entire width of the bearing cap shell (Fig. 2). Position the Plastigage approximately 6.35 mm (1/4 inch) off center and away from the oil holes. In addition, suspect areas can be checked by placing the Plastigage in that area. Tighten the bearing cap bolts of the bearing being checked to 108 N●m (80 ft. lbs.) torque (4.0L Engine). Tighten the bearing cap bolts of the bearing being checked to 115 N●m (85 ft. lbs.) torque (5.2L Engine). **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

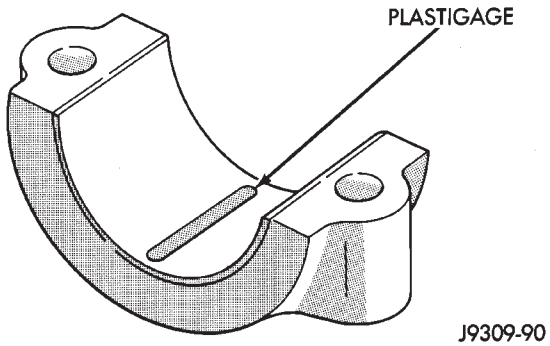

Fig. 2 Placement of Plastigage in Bearing Shell

(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.

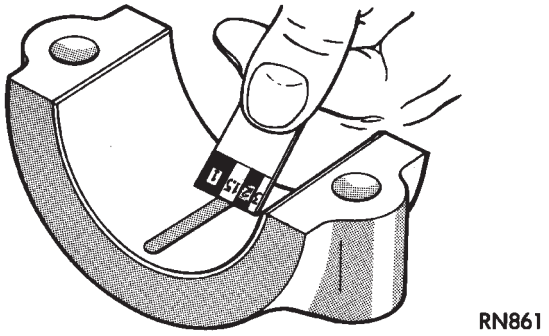

Fig. 3 Clearance Measurement

CONNECTING ROD BEARING CLEARANCE

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

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

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

(3) The crankshaft must be turned until the connecting rod to be checked starts moving toward the top of the engine. Only then should the rod cap with Plastigage in place be assembled. Tighten the 4.0L rod cap nut to 45 N●m (33 ft. lbs.) torque. Tighten the 5.2L rod cap nut to 61 N●m (45 ft. lbs.) torque. **DO NOT rotate the crankshaft or the Plastigage may be smeared, giving inaccurate results.**

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

This brings 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)—4.0L ENGINE

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

(2) Disconnect the negative cable from the battery.

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

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

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

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

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

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

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

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

(10) Install new spark plugs. Tighten the 4.0L engine spark plugs to 37 N●m (27 ft. lbs.) torque. Tighten the 5.2L engine spark plugs to 41 N●m (30 ft. lbs.) torque.

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

(12) Install the drain plug. Tighten 4.0L engine the drain plug to 41 N●m (30 ft. lbs.) torque. Tighten the 5.2L engine drain plug to 34 N●m (25 ft. lbs.) torque.

(13) Install a new oil filter.

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

(15) Connect the negative cable to the battery.

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

ENGINE DIAGNOSIS

SERVICE DIAGNOSIS

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.

METHOD 1

(1) Start the engine.

(2) Open the acetylene valve of an oxyacetylene torch. DO NOT ignite.

(3) Pass the torch tip over the exposed gasket area (EDGE) between the manifold and the engine cylinder head.

(4) If the engine speed increases, the manifold has an air leak.

METHOD 2

(1) Start the engine.

(2) Apply engine oil to the exposed gasket area (EDGE) between the manifold and the engine cylinder head.

(3) If oil is forced into the manifold and if smoke is visible from the exhaust tailpipe, the manifold has an air leak.

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 Test. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50-70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

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

Remove the radiator cap.

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

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

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

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

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

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

Combustion pressure leakage testing will detect:

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

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

Check the coolant level and fill as required. Do not install the radiator cap.

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

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

Perform the test 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.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST DIAGNOSIS

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

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SERVICE DIAGNOSIS—PERFORMANCE

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

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SERVICE DIAGNOSIS—MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Low oil pressure. 4. Dirt in tappets 5. Bent push rods. 6. Worn rocker arms. 7. Worn tappets. 8. Worn valve guides. 9. Excessive runout of valve seats on valve faces.	1. Check for correct oil level (refer to Group 0, Lubrication and Maintenance). 2. Change oil (refer to Group 0, Lubrication and Maintenance). 3. Check engine oil level. 4. Clean hydraulic tappets. 5. Install new push rods. 6. Inspect oil supply to rocker arms. 7. Install new hydraulic tappets. 8. Ream and install new valves with oversize stems. 9. Grind valve seats and valves.
CONNECTING ROD NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Misaligned connecting rods.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Replace crankshaft or grind journals. 6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round, worn. 7. Loose flywheel or torque converter.	1. Check engine oil level (refer to Group 0, Lubrication and Maintenance). 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary. 5. Check No. 3 main bearing for wear on flanges. 6. Grind journals or replace crankshaft. 7. Tighten to correct torque.
OIL PRESSURE DROP	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Worn parts in oil pump. 6. Thin or diluted oil. 7. Excessive bearing clearance. 8. Oil pump relief valve stuck. 9. Oil pump suction tube loose, bent or cracked 10. Oil pump cover warped or cracked.	1. Check engine oil level. 2. Install new sending unit. 3. Check sending unit and check main bearing oil clearance. 4. Install new oil filter. 5. Replace worn parts or pump. 6. Change oil to correct viscosity. 7. Measure bearings for correct clearance. 8. Remove valve and inspect, clean and install. 9. Remove oil pan and install new tube, if necessary. 10. Install new oil pump.
OIL LEAKS	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part.	1. Replace the gasket. 2. Tighten, repair or replace the part.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn, scuffed or broken rings. 2. Carbon in oil ring slot. 3. Rings fitted too tightly in grooves. 4. Worn valve guides. 5. Leaking intake gasket. 6. Leaking valve guide seals. 7. Dislodged valve guide seals.	1. Hone cylinder bores and install new rings. 2. Install new rings. 3. Remove the rings. Check grooves. If grooves are not proper width, replace piston. 4. Ream guides and replace valves with oversize valves and seals. 5. Replace gasket and tighten intake manifold to proper torque. 6. Replace seals. 7. Seat valve guide seals or replace, as needed.

J9209-14

4.0L ENGINE SERVICE PROCEDURES

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GENERAL INFORMATION

The 4.0 Liter (242 CID) six-cylinder engine is an In-line, lightweight, overhead valve engine (Fig. 1).

Engine Type	In-line 6 Cylinder
Bore and Stroke	98.4 x 87.4 mm (3.88 x 3.44 in.)
Displacement	4.0L (242 cu. in.)
Compression Ratio	8.8:1
Torque	305 N•m (225 ft. lbs.) @ 4,000 RPM
Firing Order	1-5-3-6-2-4
Lubrication	Pressure Feed - Full Flow Filtration
Engine Oil Capacity	5.7L (6.0 Qts.) with Filter
Cooling System	Liquid Cooled - Forced Circulation
Cooling Capacity	11.4L (12.0 Qts.)
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Iron
Camshaft	Cast Iron
Pistons	Aluminum Alloy (with Strut)
Piston Combustion Cavity	Double Quench
Connecting Rods	Cast Iron

J9309-8

Fig. 1 Engine Description

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. 2).

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.

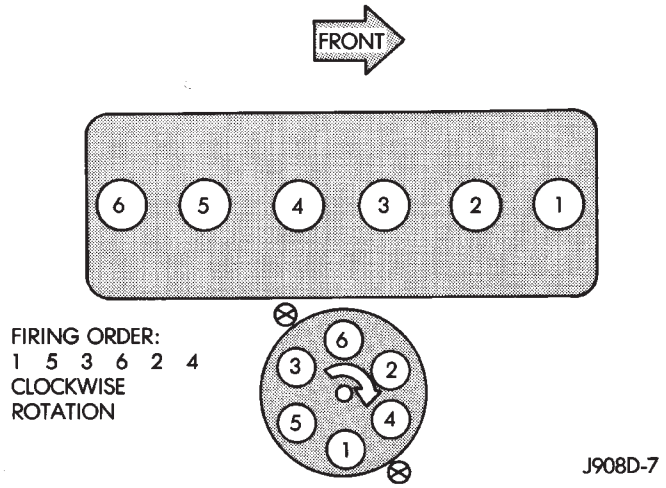

Fig. 2 Engine Firing Order

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. 3).

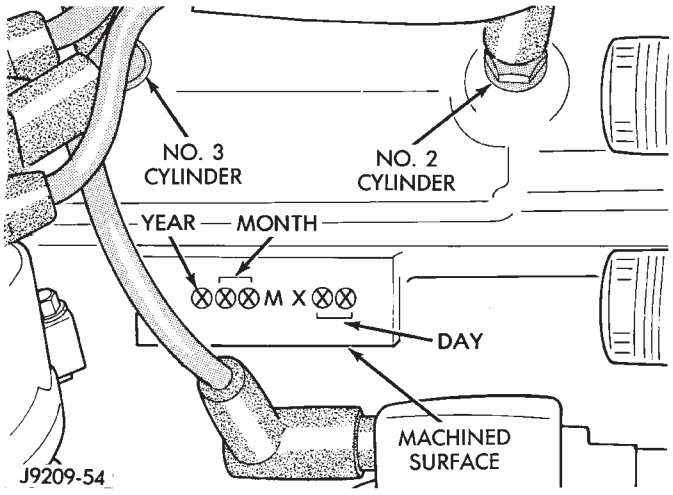

Fig. 3 Build Date Code Location

The digits of the code identify:

(1) 1st Digit—The year (2 = 1992).

(2) 2nd & 3rd Digits—The month (01 - 12).

(3) 4th & 5th Digits—The engine type/fuel system/compression ratio (MX = A 4.0 Liter (242 CID) 8.8:1 compression ratio engine with a multi-point fuel injection system).

(4) 6th & 7th Digits—The day of engine build (01 - 31).

FOR EXAMPLE: Code * 201MX12 * Identifies a 4.0 Liter (242 CID) engine with a multi-point fuel injection system, 8.8:1 compression ratio and built on January 12, 1992.

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. 4) stamped on a boss between the ignition coil and the distributor (Fig. 5).

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)

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Fig. 4 Oversize and Undersize Component Codes

ENGINE MOUNTS—FRONT

Resilient rubber insulator assemblies support the engine at each side (Figs. 6 and 7).

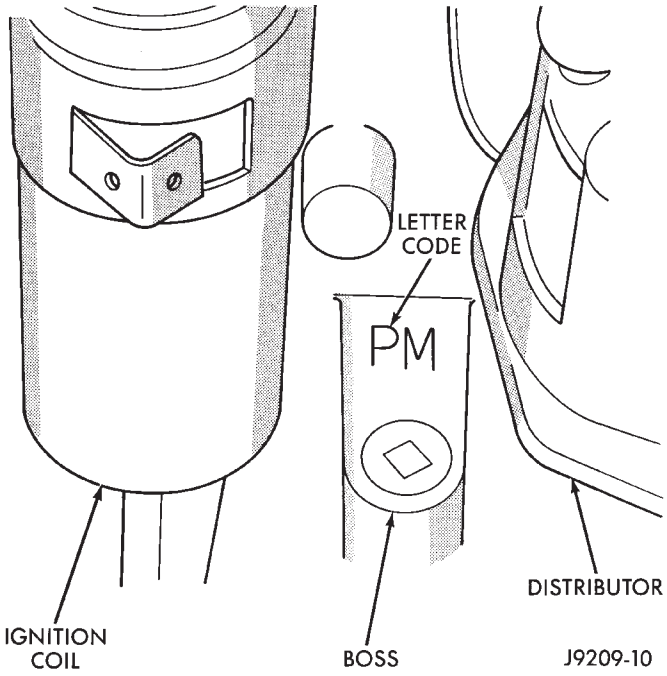

Fig. 5 Oversize and Undersize Component Code Location

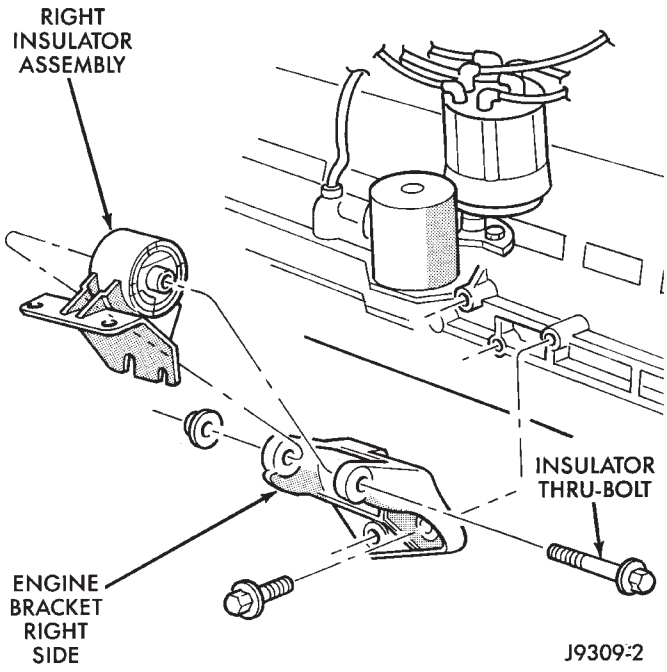

Fig. 6 Engine Mounts—Front (Right Side)

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle.

(3) Support and raise the engine slightly.

(4) Remove the nut from the through bolt (Fig. 6 or 7). DO NOT remove the through bolt.

(5) Remove the insulator assembly retaining bolts (Fig. 6 or 7).

(6) Remove the engine bracket attaching bolts (Fig. 6 or 7).

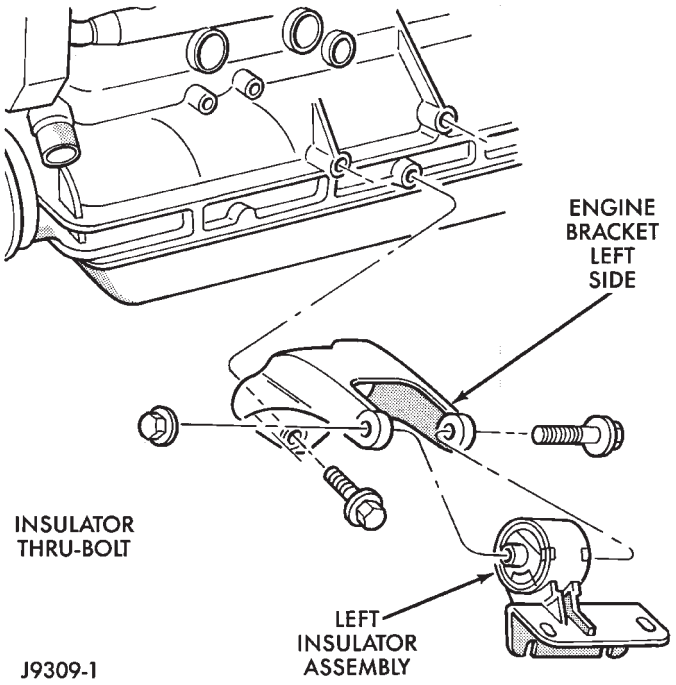

Fig. 7 Engine Mounts—Front (Left Side)

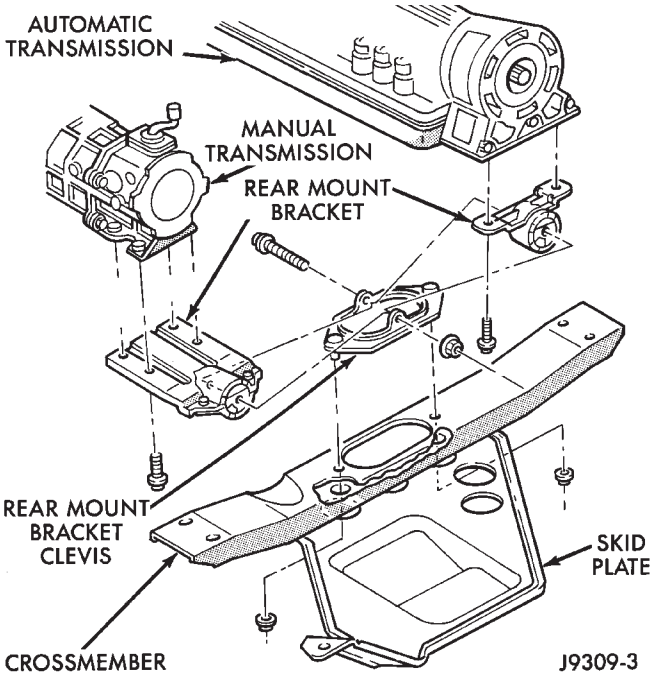

Fig. 8 Engine Mount—Rear

(7) Remove the through bolt.
(8) Remove the engine bracket.
(9) Remove the engine insulator assembly.

INSTALLATION

(1) With the engine insulator assembly and engine bracket in position, install the through bolt and the retaining nut (Fig. 6 or 7).
(2) Install the engine bracket attaching bolts (Fig. 6 or 7). Tighten the bolts to 61 N●m (45 ft. lbs.) torque.
(3) Install the insulator assembly retaining bolts. Tighten the retaining bolts to 54 N●m (40 ft. lbs.) torque.
(4) Lower and remove the engine support.
(5) Tighten the through bolt nut to 65 N●m (48 ft. lbs.) torque.
(6) Lower the vehicle.
(7) Connect the negative cable to the battery.

ENGINE MOUNT—REAR

A resilient rubber cushion bracket assembly supports the transmission at the rear. This bracket is attached to the crossmember (Fig. 8).

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Raise the vehicle and support the transmission.
(3) Remove the nuts holding the clevis bracket to the crossmember (Fig. 8).
(4) Raise the transmission SLIGHTLY.
(5) Remove the through bolt and nut (Fig. 8).
(6) Set the rear mount bracket clevis aside.
(7) Remove the bolts holding the rear mount bracket assembly to the transmission (Fig. 8).
(8) Remove the mount bracket assembly from the exhaust pipe hanger.

INSTALLATION

(1) Position the rear mount bracket assembly onto the exhaust hanger.
(2) Position the rear mount bracket assembly onto the transmission (Fig. 8). Install the bolts and tighten to 46 N●m (34 ft. lbs.) torque.
(3) Install the through bolt into the rear mount bracket and clevis (Fig. 8). Finger tighten the nut at this time.
(4) Lower the transmission until the clevis bracket studs are in position on the crossmember (Fig. 8).
(5) Install the clevis bracket stud nuts. Tighten the nuts to 41 N●m (30 ft. lbs) torque.
(6) Tighten the through bolt to 65 N●m (48 ft. lbs.) torque.
(7) Remove the transmission support.
(8) Lower the vehicle.
(9) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

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

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 radiator drain cock and radiator cap to drain the coolant. Do not waste usable coolant. If the solution is clean, drain the coolant into a clean container for reuse.

(4) Remove the upper radiator hose and coolant recovery hose (Fig. 9).

(5) Remove the lower radiator hose.

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

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

(8) Remove the fan shroud (Fig. 9).

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

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

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

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

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

(12) Disconnect the heater hoses at the engine thermostat housing and water pump (Fig. 9).

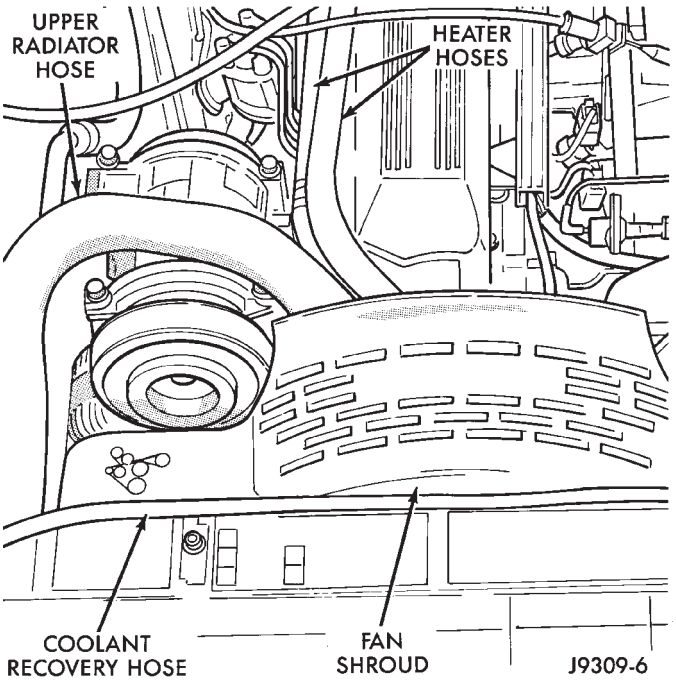

Fig. 9 Upper Radiator Hose, Coolant Recovery Hose, Fan Shroud & Heater hoses

(13) Disconnect the throttle linkages (Fig. 10).

(14) Disconnect the vehicle speed control cable (if equipped)—(Fig. 10).

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

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

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

(18) Disconnect the quick-connect fuel lines at the fuel rail and return line by squeezing the two retaining tabs against the fuel tube (Fig. 10). Pull the fuel tube and retainer from the quick-connect fitting (refer to Group 14, Fuel System for the proper procedure).

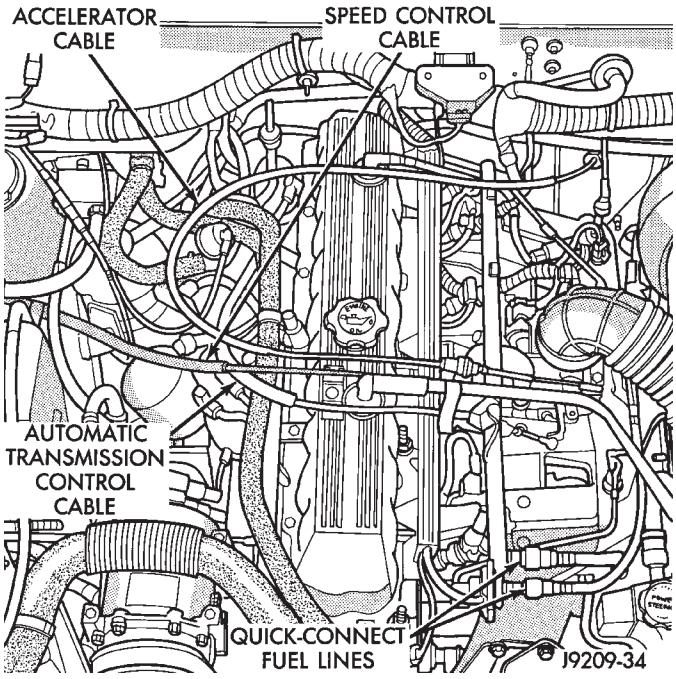

Fig. 10 Accelerator Cable, Vehicle Speed Control Cable, Automatic Transmission Control Cable & Quick-Connect Fuel Lines

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

(20) Remove the air cleaner assembly (Fig. 11).

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

(22) **Vehicles with Power Steering (Fig. 11):**

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

(b) Drain the pump reservoir.

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

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

(24) Raise and support the vehicle.

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

(26) Remove the engine starter motor.

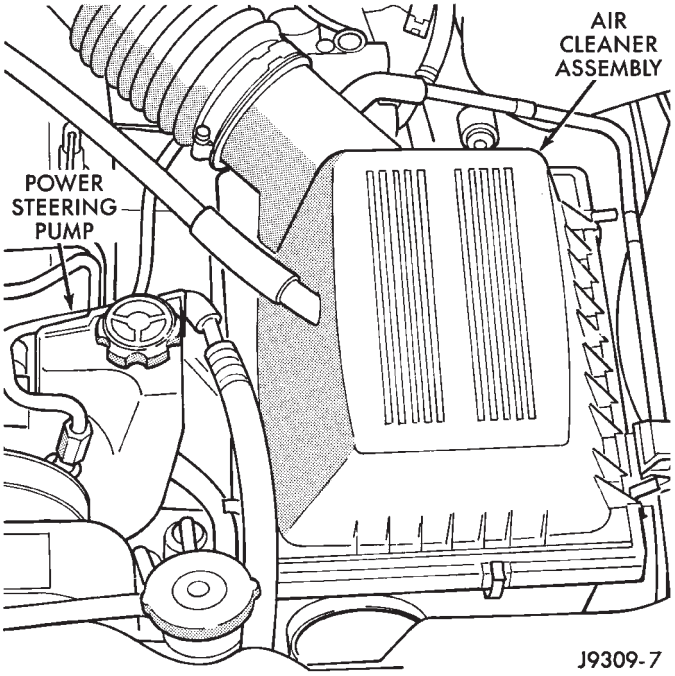

Fig. 11 Air Cleaner Assembly & Power Steering Pump

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

(28) Disconnect the exhaust pipe from the manifold.

(29) Disconnect the vehicle speed sensor wire connection.

(30) Remove the exhaust pipe support.

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

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

(a) Mark the converter and drive plate location.

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

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

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

(35) Lower the vehicle.

(36) Attach a lifting device to the engine.

(37) Raise the engine off the front supports.

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

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

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

INSTALLATION

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

(1) Attach a lifting device to the engine and lower the engine into the engine compartment. For easier installation, it may be necessary to remove the engine mount bracket as an aid in alignment of the engine to the transmission.

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

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

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

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

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

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

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

(c) Tighten all 4 bolts finger tight.

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

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

(6) Remove the engine lifting device.

(7) Raise and support the vehicle.

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

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

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

(b) Ensure the installation reference marks are aligned.

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

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

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

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

(14) Connect the exhaust pipe to the manifold.

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

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

(17) Lower the vehicle.

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

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

(a) Remove the protective caps

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

(c) Fill the pump reservoir with fluid.

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

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

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

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

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

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

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

(27) Connect the throttle cable linkages.

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

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

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

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

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

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

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

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

(36) Install upper radiator support.

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

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

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

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

(41) Connect the vacuum harness connector.

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

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

(42) Install the air cleaner assembly.

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

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

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

ENGINE CYLINDER HEAD COVER

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. 12).

(3) Disconnect the fresh air inlet hose from the engine cylinder head cover (Fig. 12).

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

(5) Remove the engine cylinder head cover.

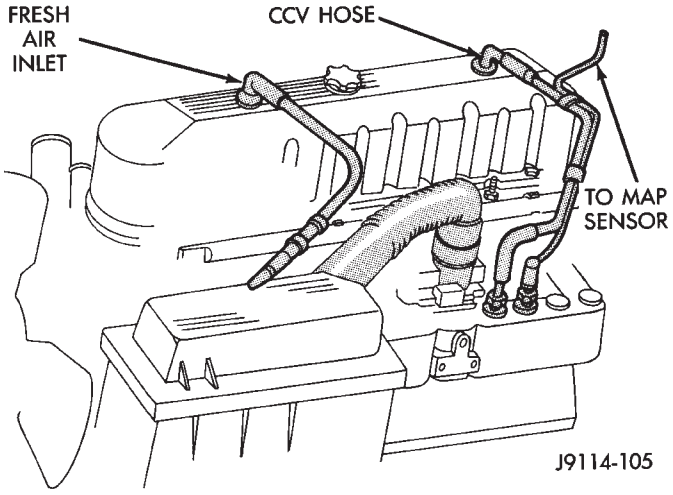

Fig. 12 Engine Cylinder Head Cover

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 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.

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 engine cylinder head cover. Tighten the mounting bolts to 9 N•m (75 in. lbs.) torque.

(3) Connect the CCV hoses (Fig. 12).
(4) Connect negative cable to battery.

ROCKER ARMS

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

REMOVAL

(1) Remove the engine cylinder head cover.
(2) Remove the capscrews at each bridge and pivot assembly (Fig. 13). Alternately loosen the capscrews one turn at a time to avoid damaging the bridges.
(3) Check for rocker arm bridges which are causing misalignment of the rocker arm to valve tip area.
(4) Remove the bridges, pivots and corresponding pairs of rocker arms (Fig. 13). 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.

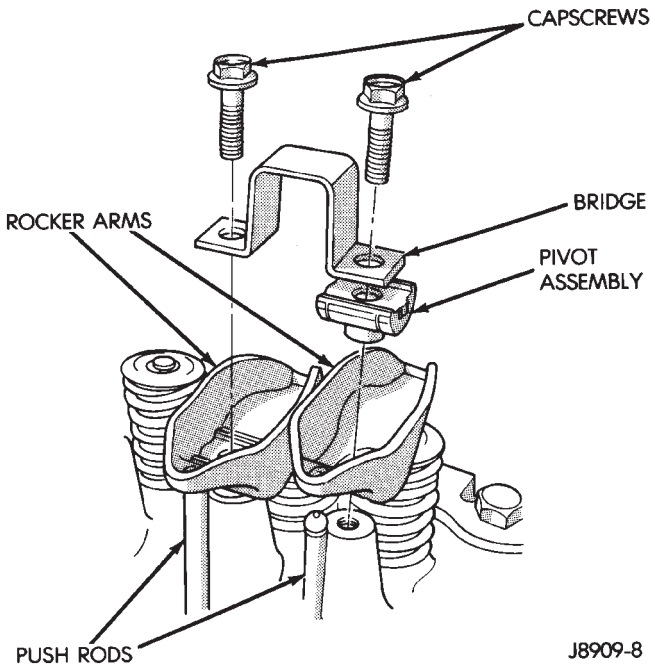

Fig. 13 Rocker Arm Assembly

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.

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.

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.
(5) Remove the capscrews, bridge and pivot assemblies and rocker arms (Fig. 13).
(6) Remove the push rods (Fig. 13). **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) Remove the fuel lines and vacuum advance hose.

(11) 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).

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

(13) Disconnect the temperature sending unit wire connector.

(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. 14). 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. 14).

(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.

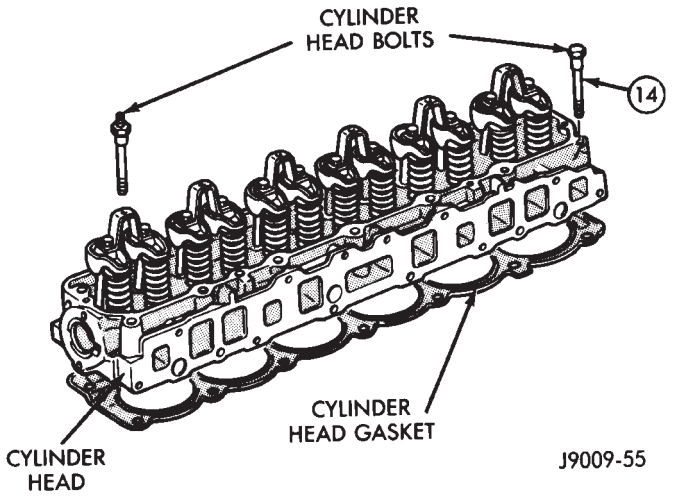

Fig. 14 Engine Cylinder Head Assembly

CLEANING

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

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

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

INSPECTION

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

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. 15):

(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 136 N●m (100 ft. lbs.) torque.
- Bolts 12 through 14 to 149 N●m (110 ft. lbs.) torque.

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.

(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.

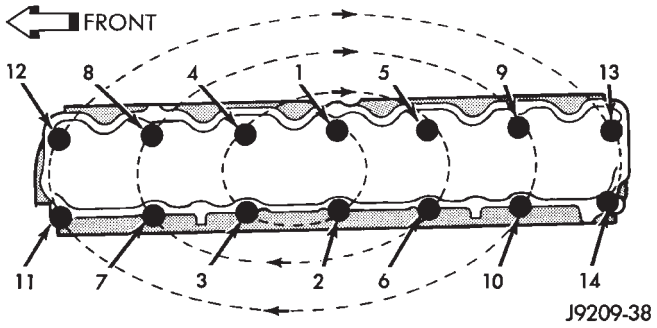

Fig. 15 Engine Cylinder Head Bolt Tightening Sequence

(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.

(13) Install the engine cylinder head cover.

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

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

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

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

(17) Install the air cleaner and ducting.

(18) Install the engine cylinder head cover.

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

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

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

(22) Connect the fuel pipe and vacuum advance hose.

(23) Connect negative cable to battery.

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

(25) 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.

(26) 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.

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.

(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. An adaptor can be constructed by welding an air hose connection to the body of a spark plug with the porcelain removed.

(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 6138 to compress the spring and remove the locks (Fig. 16). Use an old rocker arm pivot and the supplied bolt to attach the tool.

(9) Remove valve spring and retainer (Fig. 16).

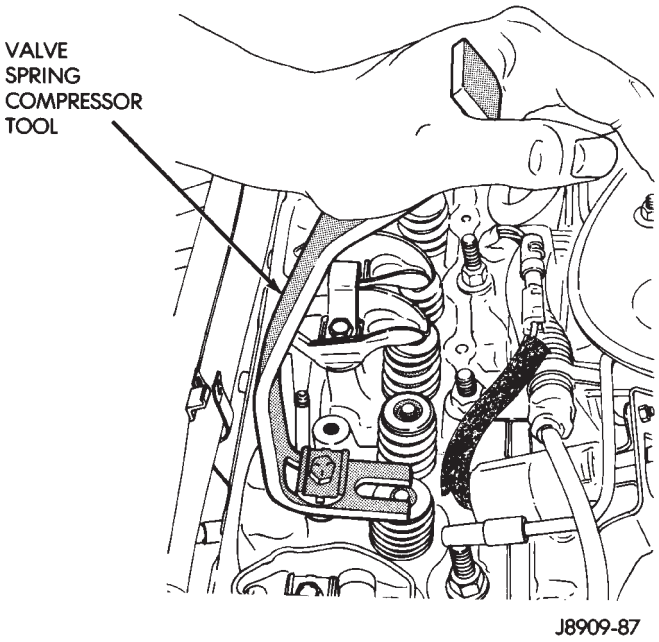

Fig. 16 Remove Valve Spring and Retainer

(10) Remove valve stem oil seals (Fig. 17). 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.

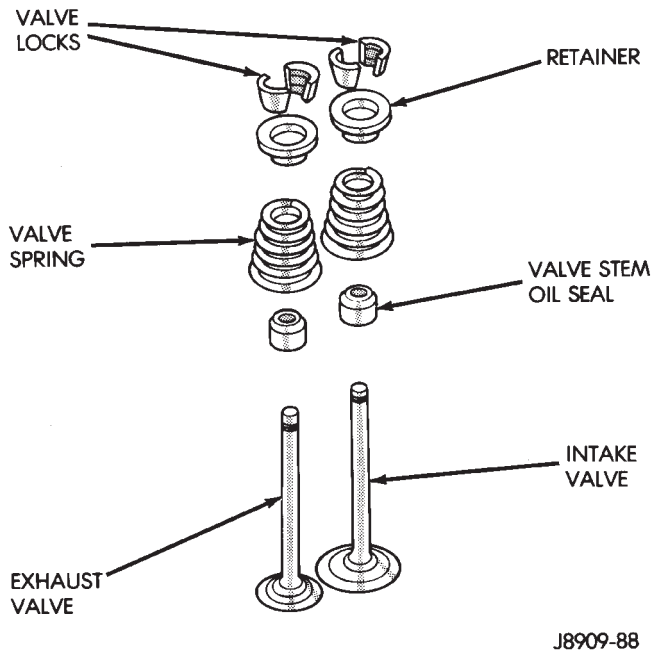

Fig. 17 Valve and Valve Components

INSPECTION

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

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 6138 and insert the valve locks. Release the spring tension and remove the tool. Tap the spring from side-to-side to ensure that the spring is seated properly on the engine cylinder head.

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

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

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

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

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

(9) Install the engine cylinder head cover.

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 the Valve Compressor Tool C-3422-B (J-8062 or 8014) and compress each valve spring (Fig. 18).

(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.

VALVE CLEANING

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.

INSPECTION

Inspect for cracks in the combustion chambers and valve ports.

Inspect for cracks on the exhaust seat.

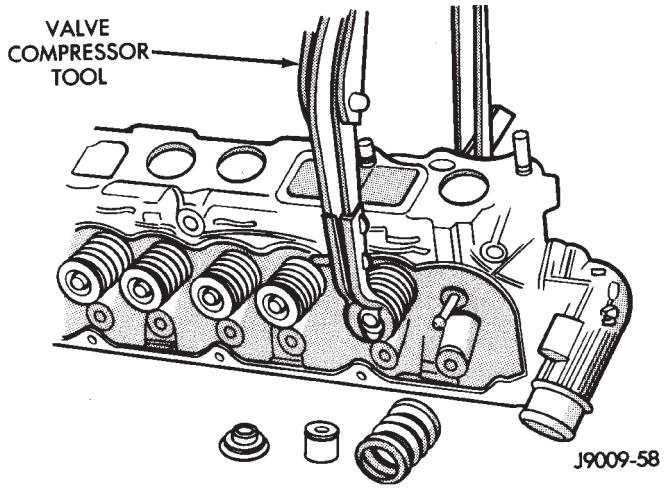

Fig. 18 Valve Compressor Tool C-3422-B (J-8062 or 8014)

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

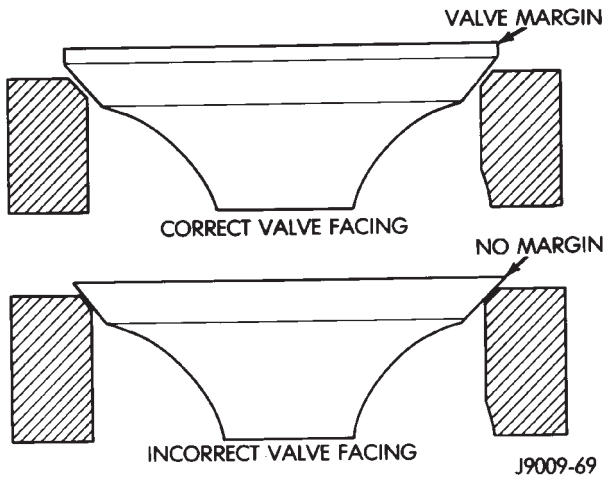

Fig. 19 Valve Facing Margin

VALVE SEAT REFACING

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

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

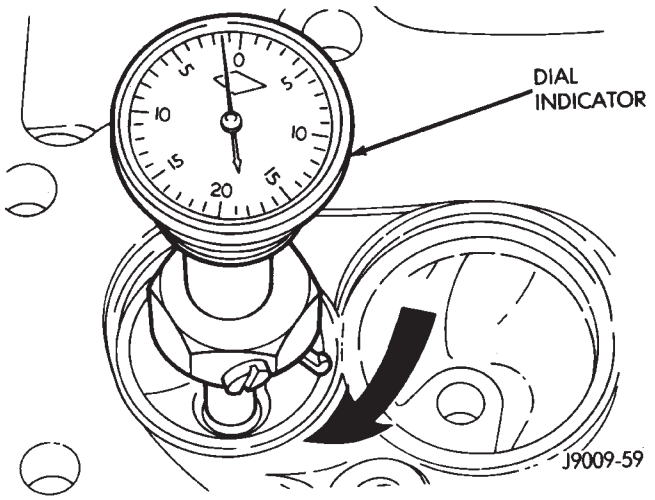

Fig. 20 Measurement of Valve Seat Runout

(3) Control valve seat runout to a maximum of 0.0635 mm (0.0025 in.)—(Fig. 20).

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.

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. 21).

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

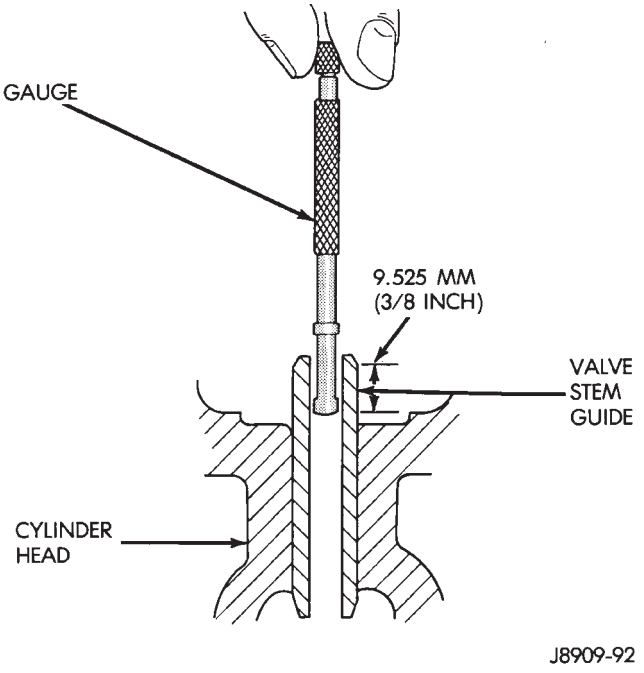

Fig. 21 Measurement of Valve Guide Bore Diameter

(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. 22).

(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.

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

VALVE SPRING TENSION TEST

Use Valve Spring Tester C-647 (J-22738-02) and a torque wrench to test each valve spring for the specified tension value (Fig. 23).

Replace valve springs that are not within specifications.

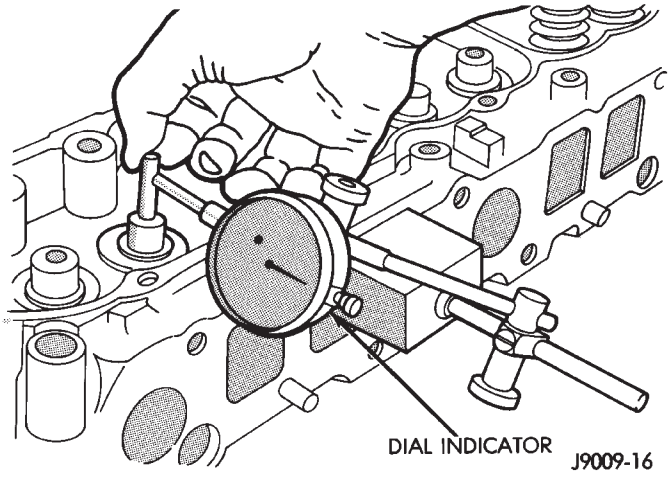

Fig. 22 Measurement of Lateral Movement of Valve Stem

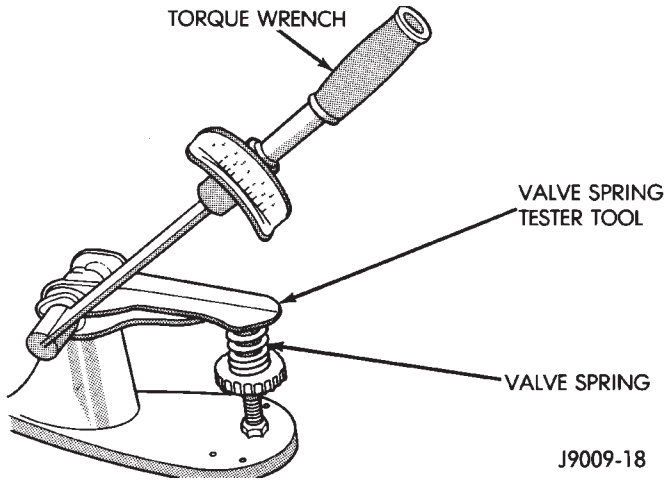

Fig. 23 Valve Spring Tester C-647 (J-22738-02)

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 (Fig. 24).

(4) Install the replacement valve stem oil seals on the valve stem (Fig. 24). 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 C-3422-B (J-8062 or 8014).

(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.

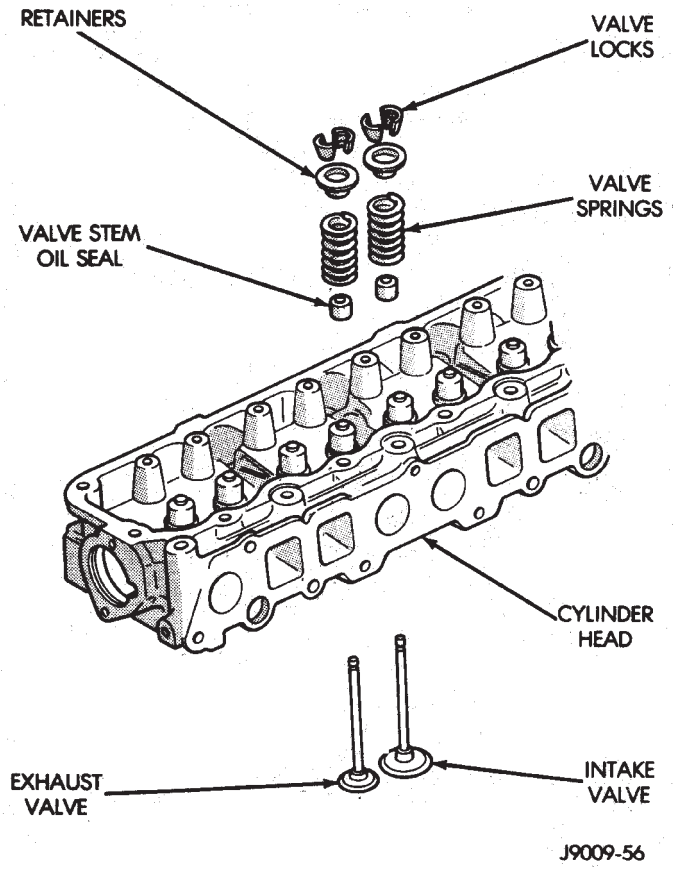

Fig. 24 Valve Components

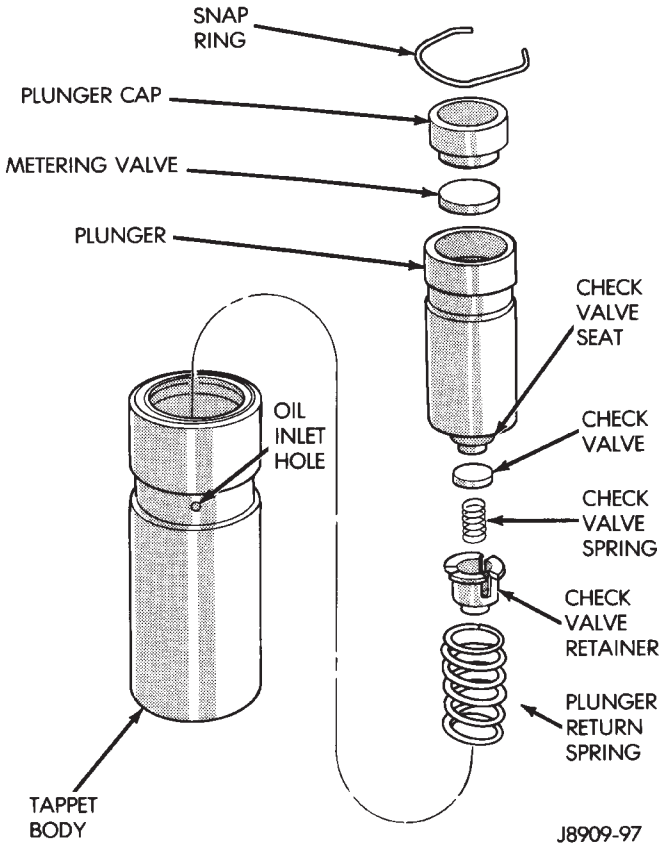

Fig. 25 Hydraulic Tappet Assembly

HYDRAULIC TAPPETS

Retain all the components in the same order as removed.

REMOVAL

(1) Remove the engine cylinder head cover.

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

(5) Remove the engine cylinder head and gasket.

(6) Remove the tappets through the push rod openings in the cylinder block.

DISASSEMBLE

Place the components of each tappet in a separate location. This will greatly assist in the installation operation.

(1) Release the snap ring.

(2) Remove the following from the tappet body (Fig. 25):

(a) The plunger cap.

(b) The metering valve.

(c) The plunger.

(d) The check valve assembly.

(e) The plunger return spring.

CLEANING

Clean the components of 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.

ASSEMBLY

(1) Install the plunger return spring, check valve assembly, plunger, metering valve and the plunger cap in tappet body.

(2) Compress the plunger assembly by exerting force on the plunger cap with the push rod and install snap ring.

LEAK-DOWN TEST

After cleaning, inspection and assembly, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 26).

Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the Leak-Down Tester 7980 (J-5790-B).

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

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

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

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

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

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

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

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

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

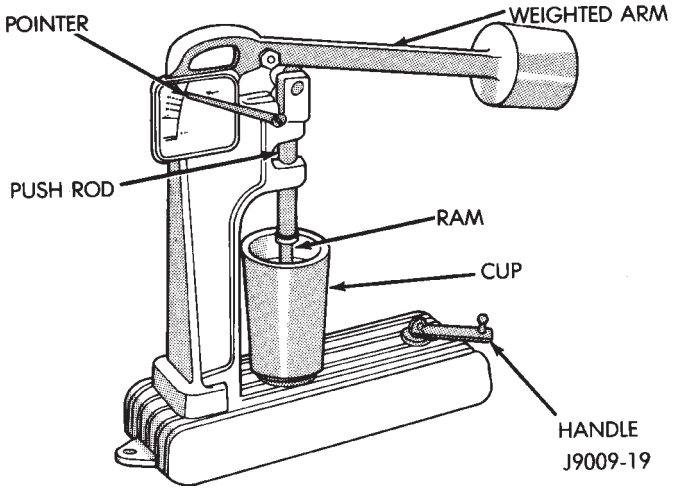

Fig. 26 Leak-Down Tester 7980 (J-5790-B)

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) Install each tappet in the same bore from where it was originally removed.

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

(4) Install the engine cylinder head and gasket.

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

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

(7) 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.

(8) 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.

(9) Install the engine cylinder head cover.

VALVE TIMING

Disconnect the spark plug wires and remove the spark plugs.

Remove the engine cylinder head cover.

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

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

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

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

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

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.

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 8068 (J-21791-01) to remove the damper from the crankshaft (Fig. 1).

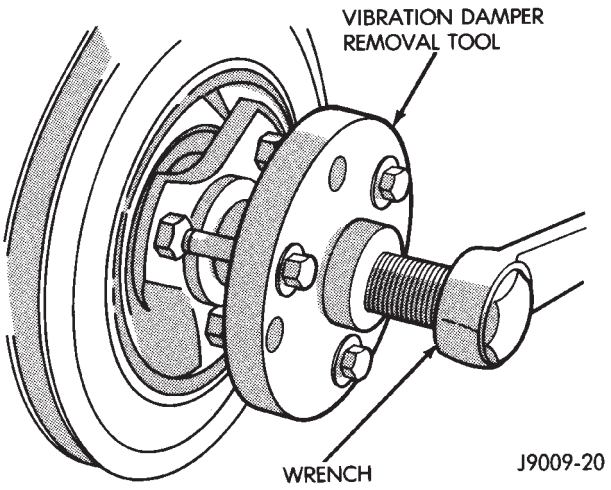

Fig. 1 Vibration Damper Removal Tool 8068 (J-21791-01)

INSTALLATION

(1) With the key in position, align the key slot of the vibration damper hub with the crankshaft key and tap the damper onto the crankshaft.

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

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

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

(5) Connect negative cable to battery.

TIMING CASE COVER OIL SEAL REPLACEMENT

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) Remove the oil seal (Fig. 2).

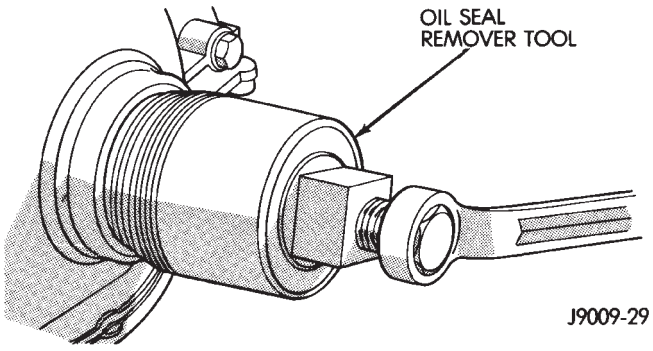

Fig. 2 Timing Case Cover Oil Seal Removal

(6) 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.

(7) Position the tool and seal over the end of the crankshaft and insert a draw screw tool into Seal Installation Tool 6139 (Fig. 3). Tighten the nut against the tool until it contacts the cover.

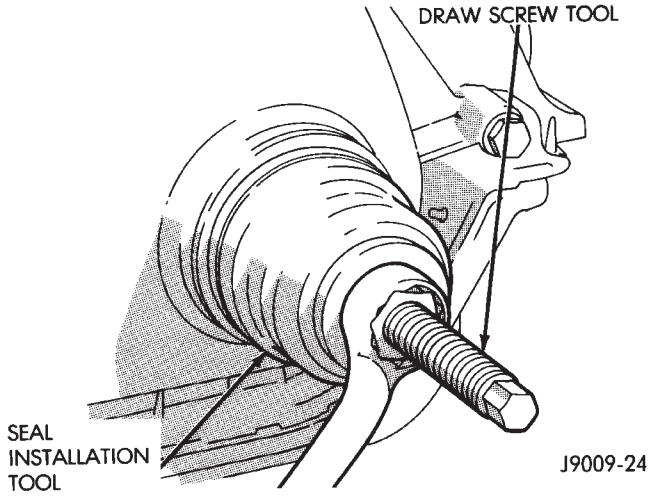

Fig. 3 Timing Case Cover Oil Seal Installation

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

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

(11) Install the radiator shroud.

(12) Connect negative cable to battery.

TIMING CASE COVER

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove the vibration damper (Fig. 4).

(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. 4).

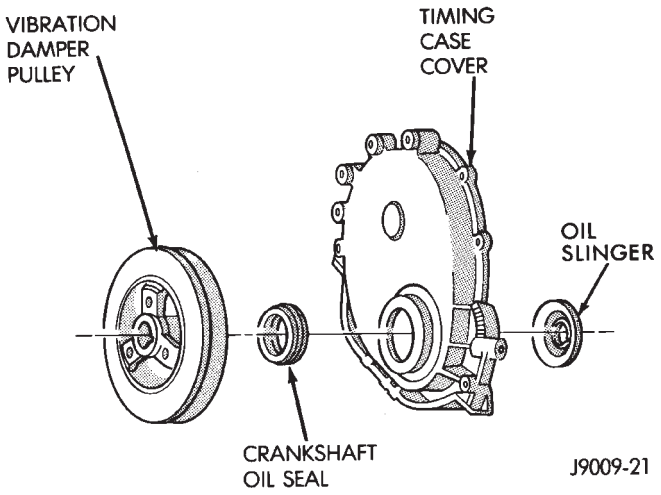

Fig. 4 Timing Case Cover Components

CLEANING

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

INSTALLATION

(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. 5).

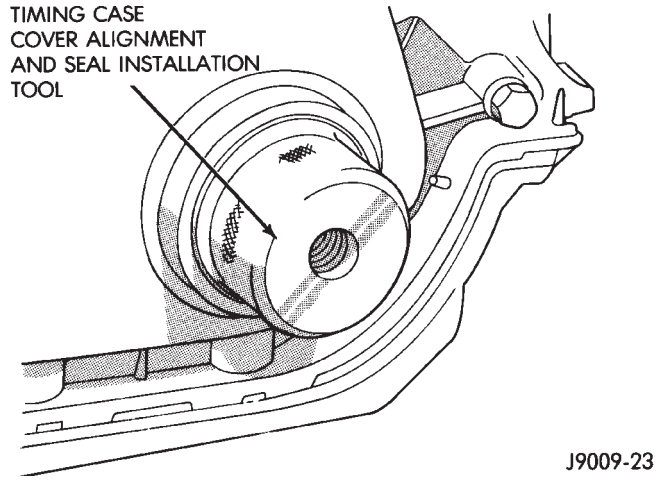

Fig. 5 Timing Case Cover Alignment and Seal Installation Tool 6139

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

(6) Tighten the cover-to-block bolts to 7 N●m (60 in. lbs.) torque. Tighten the oil pan-to-cover 1/4 inch bolts to 13 N●m (114 in. lbs.) torque. Tighten the oil pan-to-cover 5/16 inch bolts to 18 N●m (156 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) 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. 6).

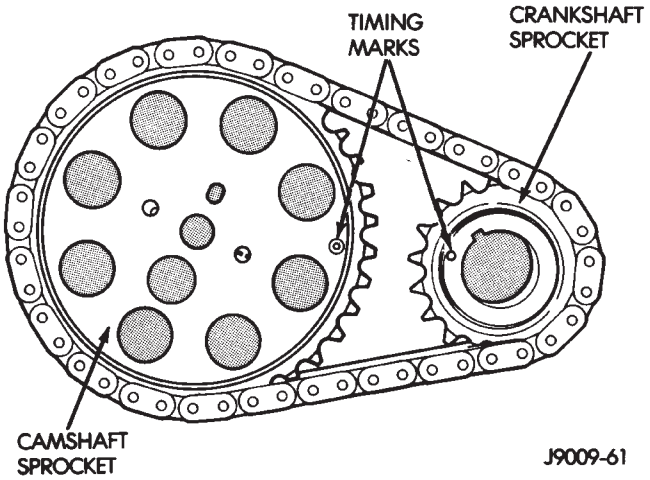

Fig. 6 Crankshaft/Camshaft Alignment

(7) Remove the oil slinger from the crankshaft.

(8) Remove the tension spring and thrust pin from the preload bolt (Fig. 7). Remove the camshaft sprocket retaining preload bolt and washer.

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

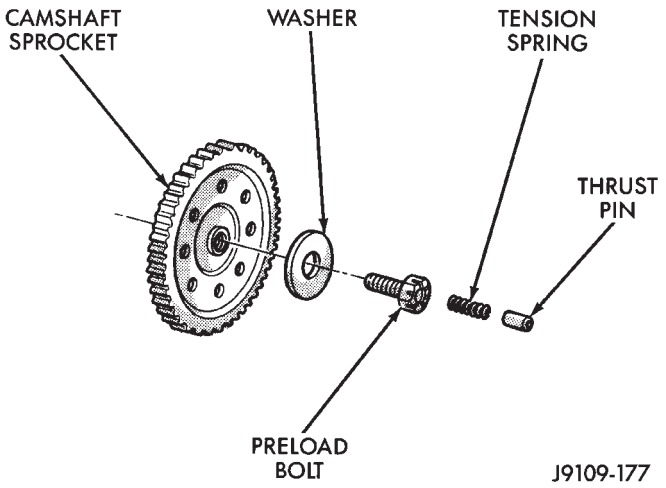

Fig. 7 Camshaft Sprocket Preload Bolt

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. 6).

(1) 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. 7). 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. 8. Count the number of chain pins between the timing marks of both sprockets. There must be 15 pins.

(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. 6).

(7) Install the timing case cover and gasket.

(8) With the key in the keyway on the crankshaft, 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 (or Tempatrol fan) assembly. Install the shroud.

(11) Connect negative cable to battery.

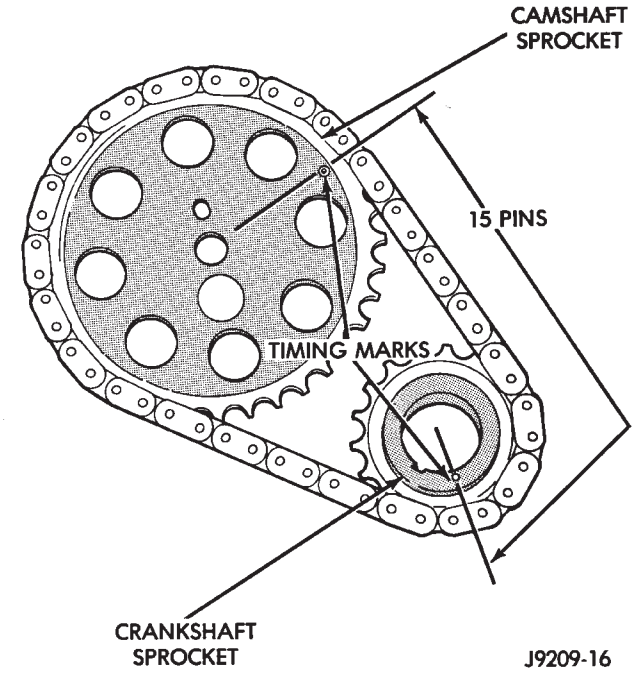

Fig. 8 Verify Sprocket/Chain Installation

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/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 head.

(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. 9).

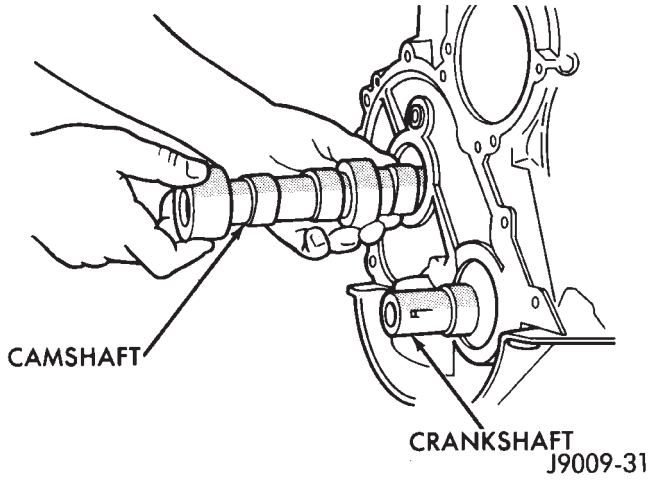

Fig. 9 Camshaft

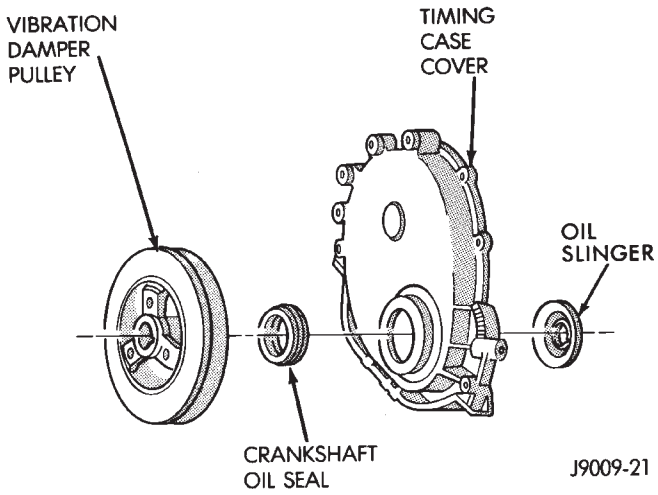

Fig. 10 Timing Case Cover Components

INSPECTION

Inspect the cam lobes for wear.

Inspect the bearing journals for uneven wear pattern or finish.

Inspect the bearings for wear.

Inspect the distributor drive gear for wear.

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.

INSTALLATION

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

(2) Carefully install the camshaft to prevent damage to the camshaft bearings (Fig. 9).

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

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

(5) 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.

(6) Install the timing case cover with a replacement oil seal (Fig. 10).

(7) Install the vibration damper (Fig. 10).

(8) Install the hydraulic valve tappets.

(9) Install the engine cylinder head.

(10) Install the push rods.

(11) 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.

(12) Install the engine cylinder head cover.

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

(14) Rotate the crankshaft until the No.1 piston is at the TDC position on the compression stroke.

(15) Install the distributor, cap and ignition wires. Install the distributor so that the rotor is aligned with the mark made during removal. The rotor should be aligned with the No.1 cylinder spark plug terminal on the cap when the distributor housing is fully seated on the cylinder block.

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 1 609 km (1,000 miles). The oil supplement need not be drained until the next scheduled oil change.

(16) 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.

(17) 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).

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

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

(20) 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. 11).

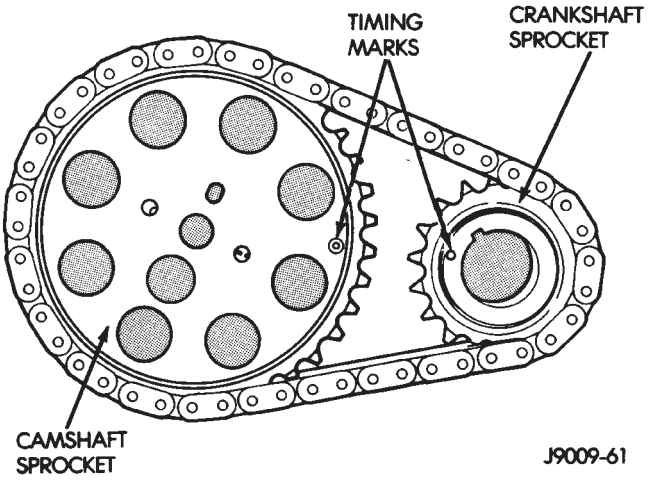

Fig. 11 Timing Chain Alignment

(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.

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.

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. 11).
(5) To verify correct installation of the timing chain, turn the crankshaft to position the camshaft sprocket timing mark as shown in Fig. 12. Count the number of chain pins between the timing marks of both sprockets. There must be 15 pins.
(6) Install the crankshaft oil slinger.
(7) Tighten the camshaft sprocket preload bolt to 108 N•m (80 ft. lbs.) torque.
(8) Check the valve timing.
(9) Lubricate the tension spring, the thrust pin and the pin bore in the preload bolt with Mopar Engine Oil Supplement, or equivalent. Install the spring and thrust pin in the preload bolt head.
(10) Coat both sides of the replacement timing case cover gasket with gasket sealer. Apply a 3 mm (1/8 inch) bead of Mopar Silicone Rubber Adhesive Sealant, or equivalent to the joint formed at the oil pan and cylinder block.

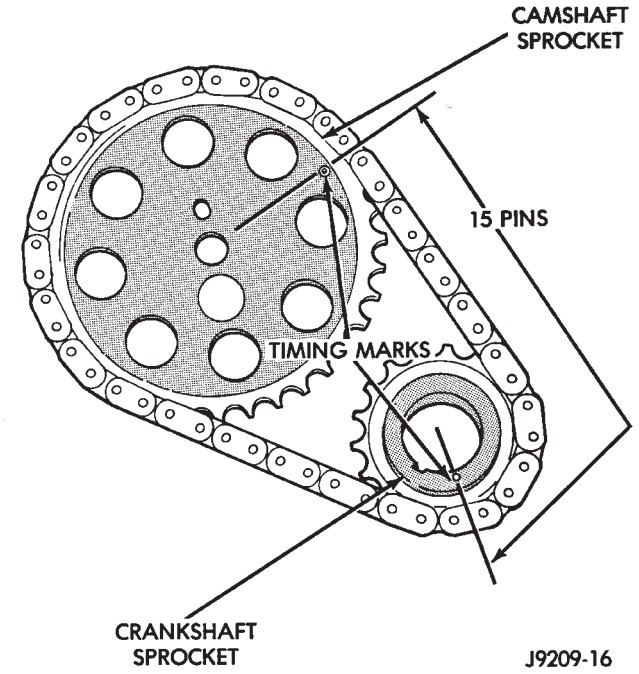

Fig. 12 Verify Crankshaft/Camshaft Installation

(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 (J-22248) in the crankshaft opening in the cover (Fig. 13).

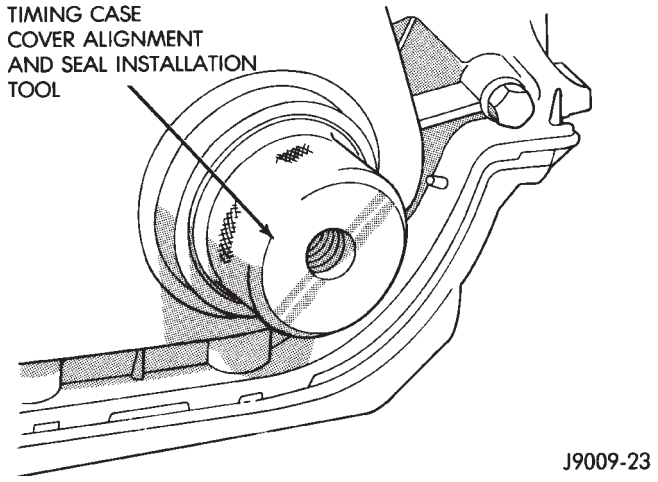

Fig. 13 Timing Case Cover Alignment and Seal Installation Tool 6139 (J-22248)

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

(14) Tighten the cover-to-block bolts to 7 N●m (60 in. lbs.) torque. Tighten the oil pan-to-cover 1/4 inch bolts to 13 N●m (114 in. lbs.) torque. Tighten the oil pan-to-cover 5/16 inch bolts to 18 N●m (156 in. lbs.) torque.

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

(16) Install the vibration damper on the crankshaft.

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

(18) If equipped with air conditioning:

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

(b) Install the generator.

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

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

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

(21) Install the fan and shroud.

(22) Connect negative cable to battery.

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 engine flywheel/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. The one-piece gasket is reusable.

CLEANING

Clean the block and pan gasket surfaces.

INSTALLATION

(1) 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. 1).

(2) Install two dowels in the timing case cover. Install the other two dowels in the cylinder block (Fig. 2).

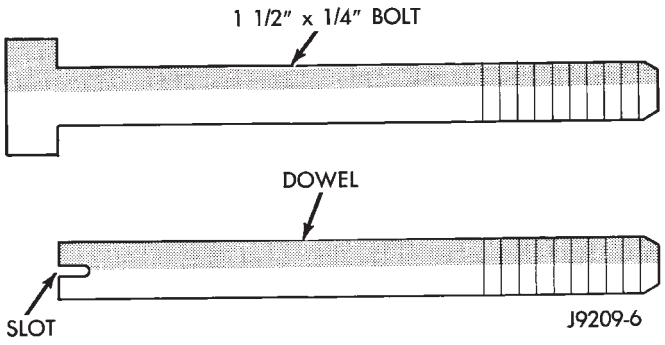

Fig. 1 Fabrication of Alignment Dowels

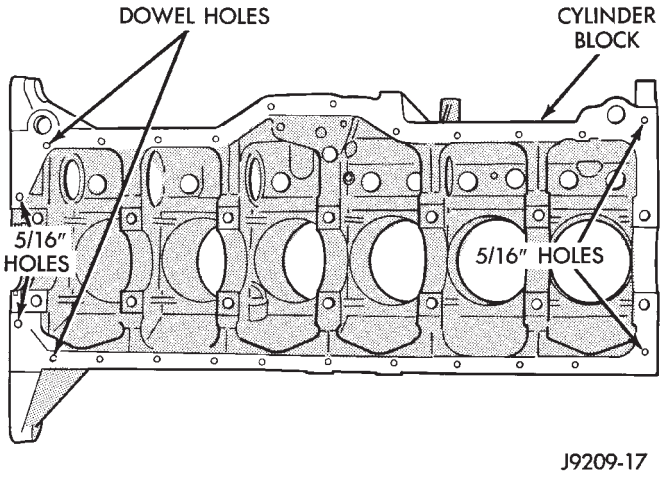

Fig. 2 Position of Dowels in Cylinder Block

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

(4) 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.

(5) Install the 1/4 inch oil pan bolts. Tighten these bolts to 13 N●m (114 in. lbs.) torque. Install the 5/16 inch oil pan bolts (Fig. 3). Tighten these bolts to 18 N●m (156 in. lbs.) torque.

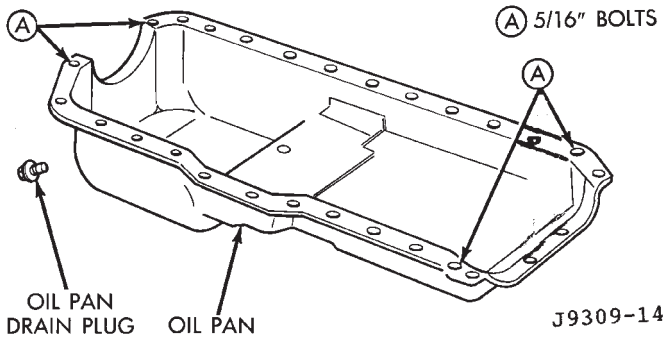

Fig. 3 Position of 5/16 inch Oil Pan Bolts

(6) Remove the dowels. Install the remaining 1/4 inch oil pan bolts. Tighten these bolts to 13 N●m (114 in. lbs.) torque.

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

(8) Install the through bolts and tighten the nuts to 65 N●m (48 ft. lbs.) torque.

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

(10) If equipped with an oil level sensor, connect the sensor.

(11) Install the engine flywheel/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. 3). Tighten the plug to 41 N●m (30 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

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.

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. 4).

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.

DISASSEMBLE

(1) Remove the cover from the pump body.

(2) Check the following clearances:

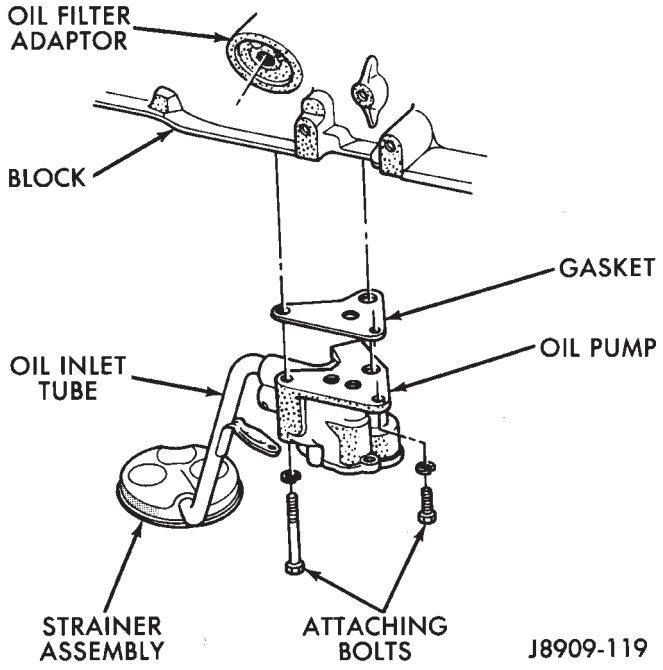

Fig. 4 Oil Pump Assembly

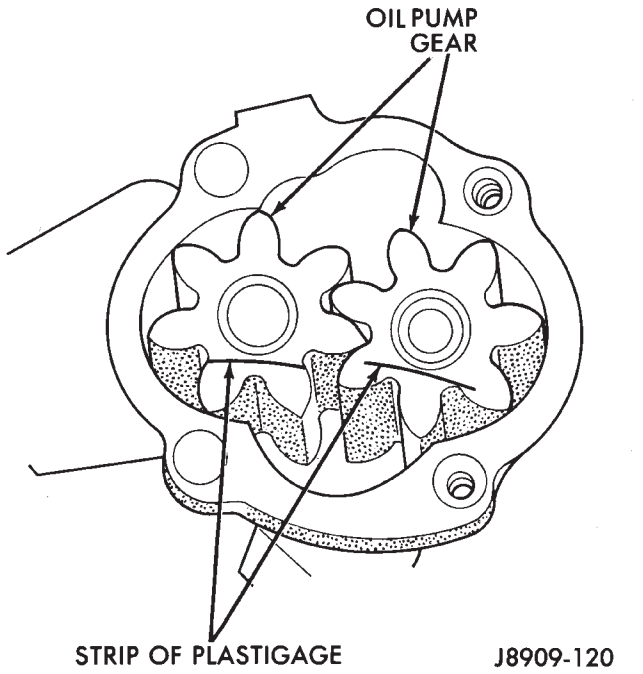

Fig. 5 Gear End Clearance Measurement—Preferred Method

GEAR END CLEARANCE MEASUREMENT

PREFERRED METHOD:

(a) Place a strip of Plastigage across the full width of each gear.

(b) Install the pump cover and tighten the bolts to 8 N•m (70 in. lbs.) torque.

(c) Remove the pump cover and determine the amount of clearance by measuring the width of compressed Plastigage with scale on the Plastigage envelope (Fig. 5).

(d) Correct clearance by this method is 0.051-0.152 mm with 0.051 mm preferred (0.002-0.006 inch with 0.002 inch preferred).

(e) If gear end clearance is excessive, replace the oil pump assembly.

ALTERNATIVE METHOD:

(a) Place a straightedge across the ends of the gears and the pump body.

(b) Select a feeler gauge that fits snugly but freely between the straightedge and the pump body (Fig. 6).

(c) Correct clearance by this method is 0.051-0.152 mm with 0.051 mm preferred (0.002-0.006 inch with 0.002 inch preferred).

(d) If gear end clearance is excessive, replace the oil pump assembly.

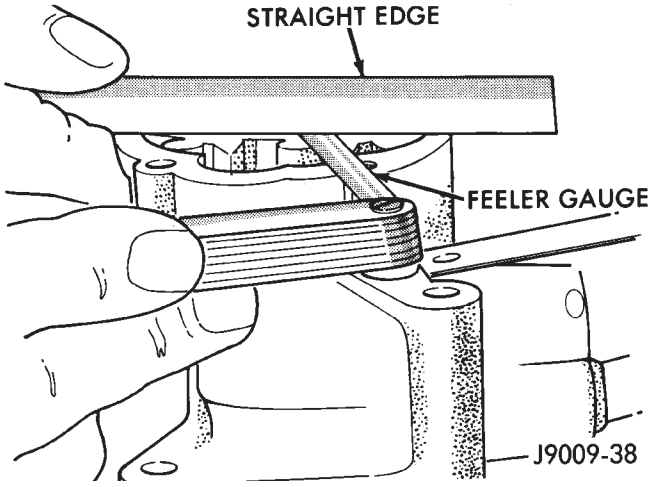

Fig. 6 Gear End Clearance Measurement—Alternative Method

GEAR-TO-BODY CLEARANCE MEASUREMENT

(a) Measure the gear-to-body clearance with both gears in place. Insert a feeler gauge between the gear tooth and the inner wall of the pump body directly opposite the point of gear mesh. Select a feeler gauge which fits snugly but freely. Rotate gears to measure each tooth-to-body clearance in this manner (Fig. 7).

(b) Correct clearance is 0.051-0.102 mm with 0.051 mm preferred (0.002-0.004 inch with 0.002 inch preferred).

(c) If the gear-to-body clearance is more than specified, replace oil pump.

DISASSEMBLE (CONT.)

(3) Remove the cotter pin and slide the spring retainer, spring and oil pressure relief valve plunger out of the pump body.

(4) Inspect for binding condition during disassembly. Clean or replace as necessary.

(5) The oil inlet tube and strainer assembly must be moved to allow removal of the relief valve.

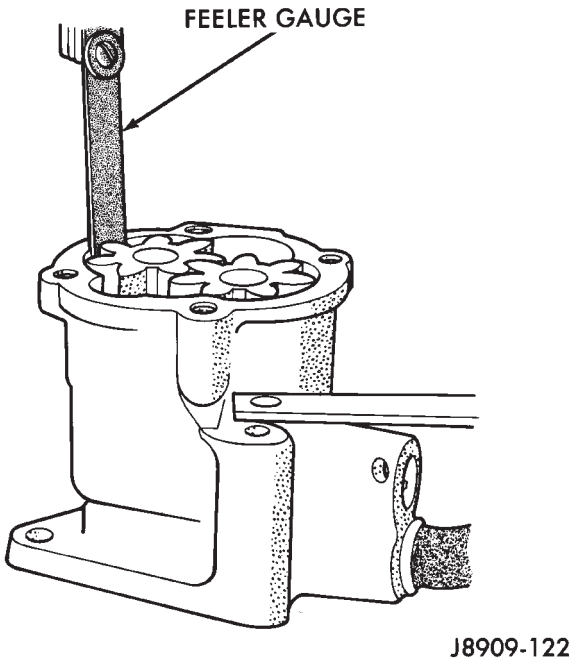

Fig. 7 Gear-to-Body Clearance Measurement

ASSEMBLY

Two relief valve plunger sizes (standard and oversize) are available. The oversize plunger diameter is 0.254 mm (0.010 inch).

(1) Install the oil pressure relief valve plunger, spring, retainer, and cotter pin.

(2) If the position of the inlet tube in the pump body has been disturbed, install a replacement inlet tube and strainer assembly. Apply a light film of Permatex No.2 sealant, or equivalent, around the end of the tube. Use Oil Pump Inlet Tube Installation Tool 7624 (J-21882) to drive the inlet tube into the body (Fig. 8). BE sure the support bracket is properly aligned.

(3) Install the idler gear and drive gear assembly.

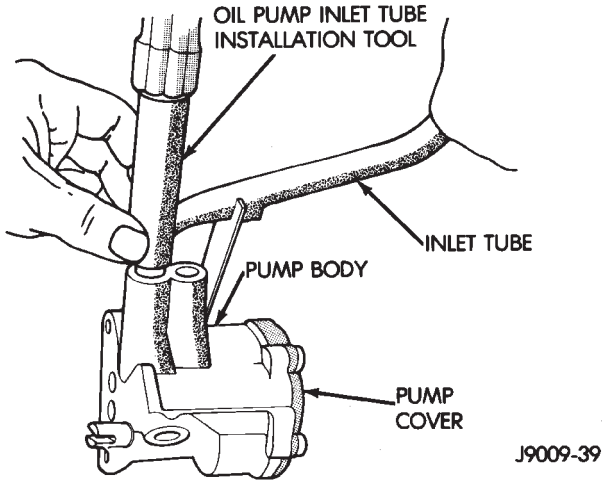

Fig. 8 Inlet Tube Installation Tool 7624 (J-21882)

(4) Spin the drive gear shaft to ensure a binding condition does not exist before installing the oil pump.

(5) To self-prime the oil pump, fill pump with petroleum jelly before installing the oil pump cover. **DO NOT use grease.**

(6) Apply a thin bead of Mopar Gasket Maker, or equivalent, to the top of the pump housing.

(7) Install the oil pump cover. Tighten the cover bolts to 8 N•m (70 in. lbs.) torque.

INSTALLATION

(1) Install the oil pump on the cylinder block using a replacement gasket. Tighten the short bolt to 14 N•m (10 ft. lbs.) torque and the long bolt to 23 N•m (17 ft. lbs.) torque.

(2) Install the oil pan.

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

OIL PUMP PRESSURE

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

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. Retain in the same order as removed. The connecting rods and caps are stamped with the corresponding cylinder number (Fig. 9).

(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/connecting rod assemblies up and through the top of the cylinder bores (Fig. 10).

INSPECTION—CONNECTING ROD

CONNECTING ROD BEARINGS

Inspect the connecting rod bearings for scoring and bent alignment tabs (Figs. 11 and 12). Check the

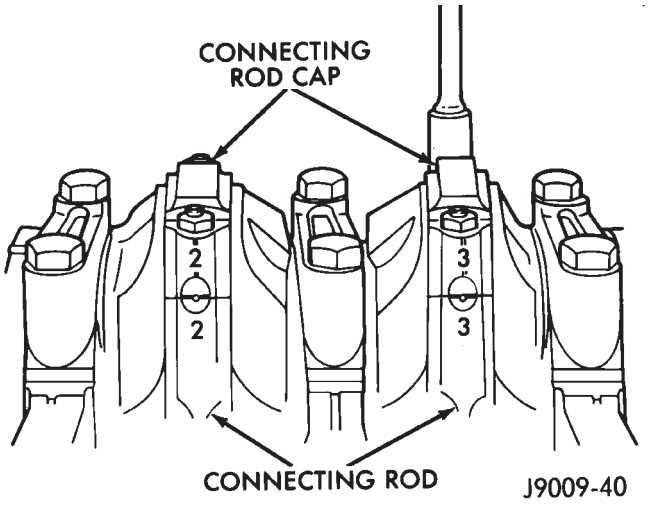

Fig. 9 Stamped Connecting Rods and Caps

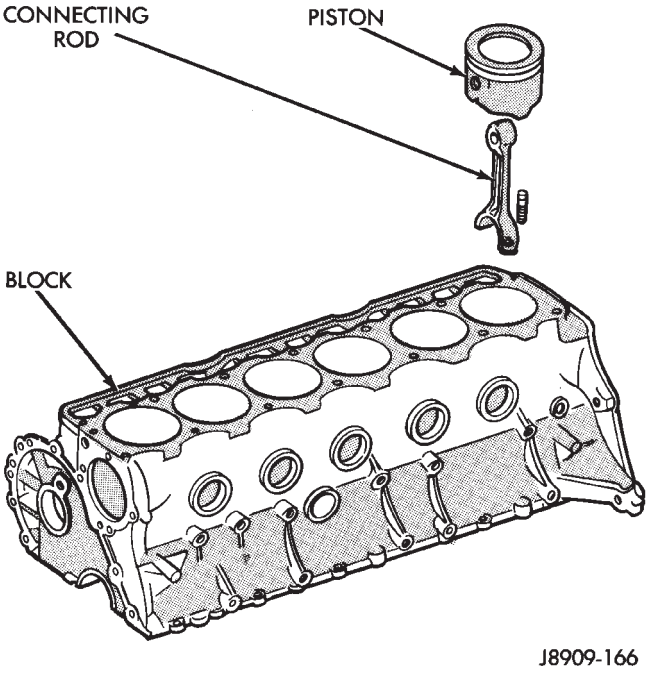

Fig. 10 Removal of Connecting Rod and Piston Assembly

bearings for normal wear patterns, scoring, grooving, fatigue and pitting (Fig. 13). 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.

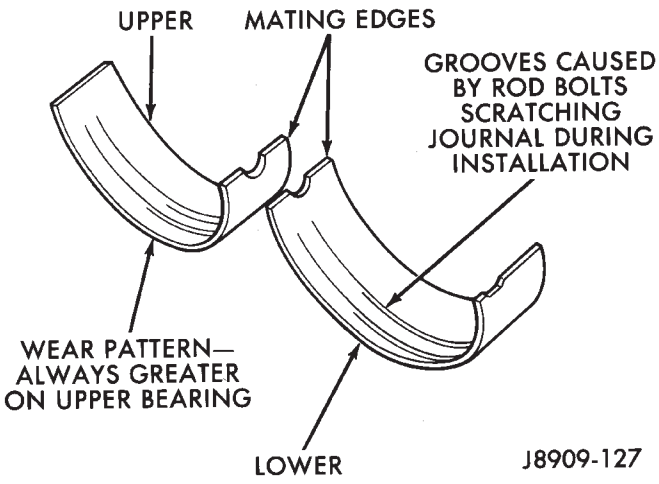

Fig. 11 Connecting Rod Bearing Inspection

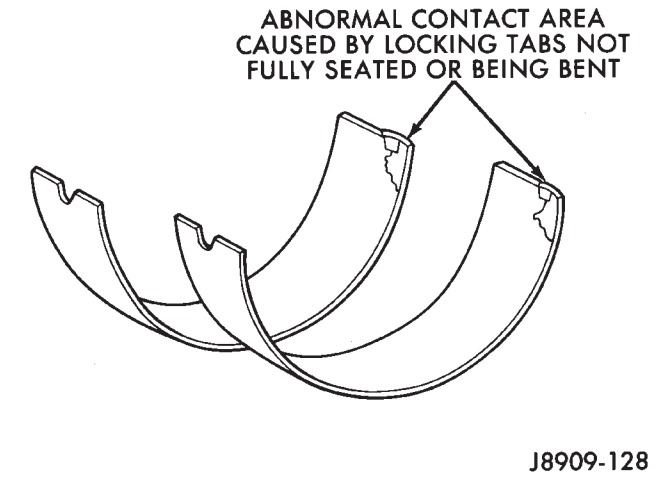

Fig. 12 Locking Tab Inspection

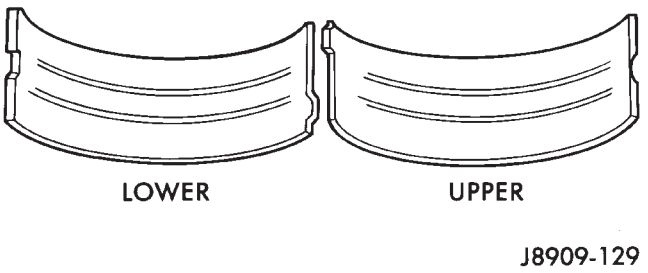

Fig. 13 Scoring Caused by Insufficient Lubrication or by Damaged Crankshaft Pin Journal

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.

14). 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.

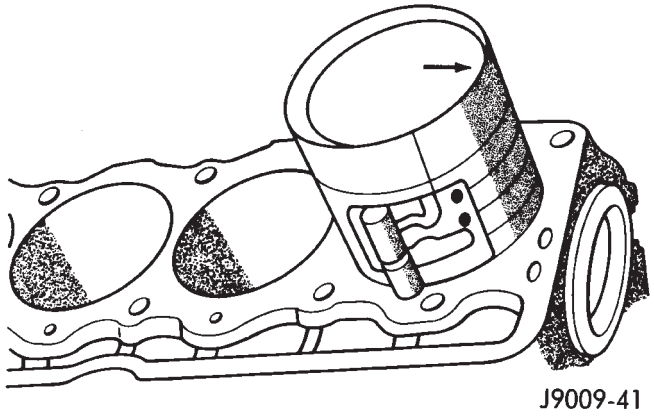

Fig. 14 Rod and Piston Assembly Installation

(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. 15). 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.**

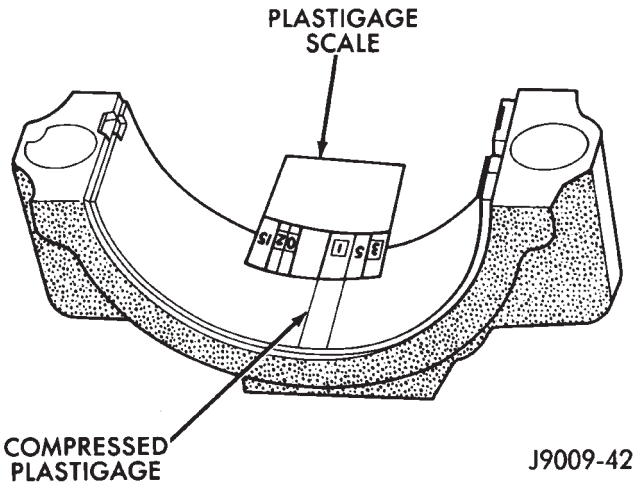

Fig. 15 Measuring Bearing Clearance with Plastigage

(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).

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).

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

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

SIDE CLEARANCE MEASUREMENT

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

PISTON FITTING

MICROMETER METHOD

(1) Measure the inside diameter of the cylinder bore at a point 58.725 mm (2-5/16 inches) below top of bore.

(2) Measure outside diameter of the piston. Because pistons are cam ground, measure at right angle to piston pin at center line of pin (Fig. 16).

The difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

FEELER GAUGE METHOD

(1) Remove the rings from the piston.

(2) Insert a long 0.025 mm (0.001 inch) feeler gauge into the cylinder bore.

(3) Insert the piston, top first, into cylinder bore alongside the feeler gauge. With entire piston inserted into cylinder bore, the piston should not bind against feeler gauge.

(4) Repeat steps with a long 0.051 mm (0.002 inch) feeler gauge. The piston should bind.

CONNECTING ROD BEARING FITTING CHART

Crankshaft Main Bearing Journal Color Code and Diameter	Corresponding Connecting Rod Bearing Insert Color Code	
	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.)
Black—53.1901-53.1723 mm (2.0941-2.0933 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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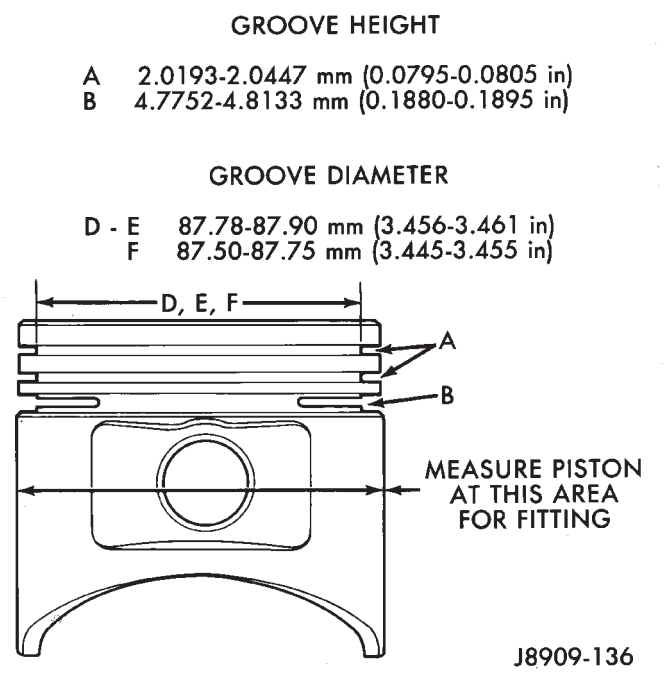

Fig. 16 Piston Dimensions

(5) If the piston binds on 0.025 mm (0.001 inch) feeler gauge, the piston is too large or cylinder bore is too small. If the piston does not bind on 0.051 mm (0.002 inch) feeler gauge, the piston is too small for cylinder bore. Pistons up to 0.102 mm (0.004 inch) undersize may be enlarged by knurling or shot-peening. Replace pistons that are 0.102 mm (0.004 inch) or more undersize.

PISTON PIN

REMOVAL

Piston pins are press-fitted into the connecting rods and require no locking device.

(1) Position the piston and connecting rod assembly on an arbor press.

(2) Apply force to a piloted driver and press the pin completely out of the connecting rod and piston assembly (Fig. 17). Note position of the pin through the gauge window of removal support tool.

INSPECTION

(1) Inspect the piston pin and pin bore in the connecting rod for nicks and burrs. Remove as necessary. Never reuse a piston pin after it has been installed in and removed from a connecting rod.

(2) With the pin removed from the piston and connecting rod, clean and dry piston pin bores and the replacement piston pin.

(3) Position the piston so that the pin bore is in vertical position. Insert the pin in bore. At room temperature, the replacement pin should slide completely through the pin bore in piston by force of gravity.

(4) Replace piston if pin jams in the pin bore.

INSTALLATION

(1) Insert the piston pin pilot through the piston and connecting rod pin bores. Ensure that the arrow on the piston crown is pointing up (Fig. 18).

(2) Position the pin pilot, piston and connecting rod on a support with the squirt hole of the connecting rod to the left-hand side (Fig. 18).

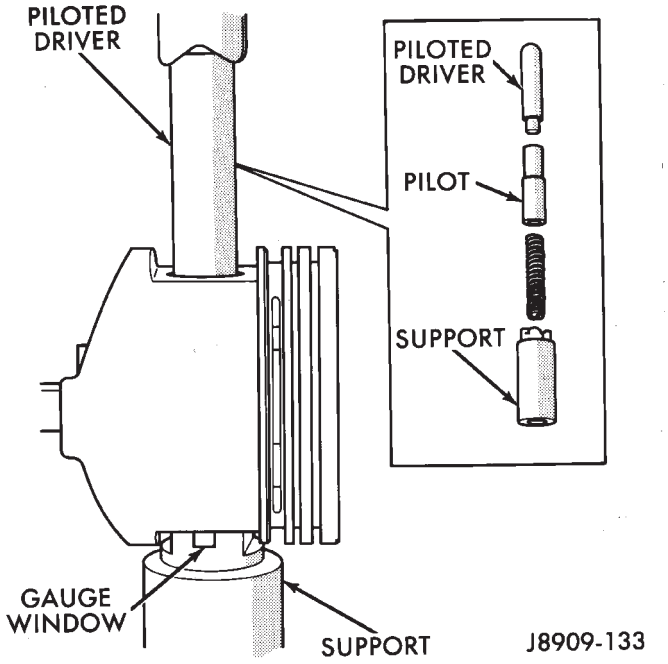

Fig. 17 Piston Pin Removal/Installation

(3) Insert piston pin through the upper piston pin bore and into the connecting rod pin bore.

(4) Position the piloted driver inside the piston pin (Fig. 17).

(5) Using an arbor press, press the piston pin through the connecting rod and piston bores until pin pilot indexes with mark on the support. The piston pin requires a 8 900 N (2,000 pounds) press-fit. If little effort is required to install piston pin in a connecting rod, or if the rod moves laterally on the pin, the connecting rod must be replaced.

(6) Remove the piston and connecting rod assembly from the press. The pin should be centered in the connecting rod (±0.792 mm or ±0.0312 inch) and float in the piston pin bore.

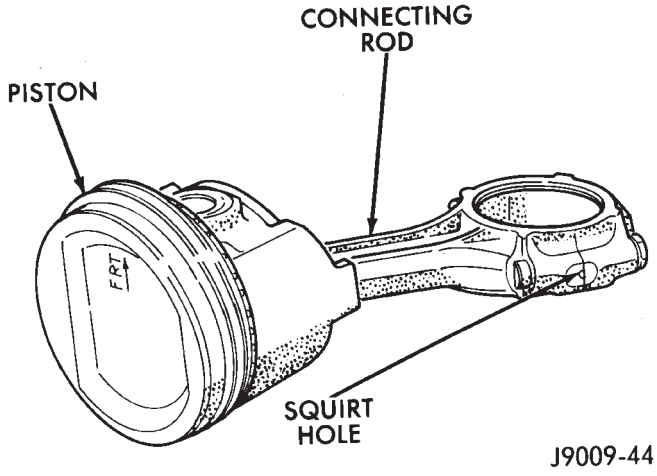

Fig. 18 Correct Alignment—Piston and Connecting Rod

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) Measure the ring side clearance with a feeler gauge fitted snugly between the ring land and ring (Fig. 19). Rotate the ring in the groove. It must move freely around circumference of the groove.

	Millimeters	Inches
No. 1 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
No. 2 Compression	0.025-0.081 (0.043 Preferred)	0.001-0.0032 (0.0017 Preferred)
Oil Control	0.025-0.241 (0.08 Preferred)	0.001-0.0095 (0.003 Preferred)

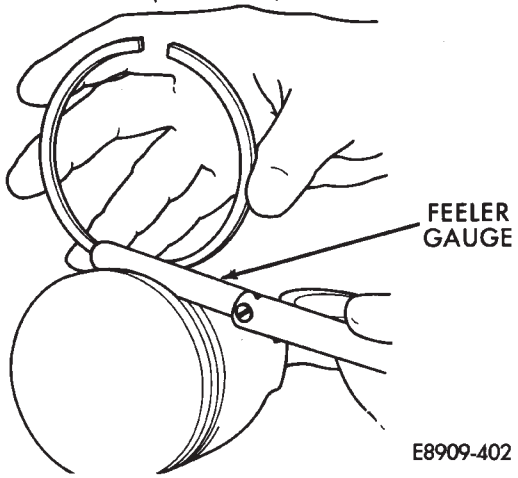

Fig. 19 Ring Side Clearance Measurement

(3) 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. 20). The correct compression ring end gap is 0.25-0.51 mm (0.010-0.020 inch). The correct oil control ring end gap is 0.381-1.397 mm (0.015-0.055 inch).

(4) Position the ring gaps and install piston rings (Fig. 21).

(5) Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert expander ring first, then side rails

(6) The two compression rings are different and cannot be interchanged (Fig. 22). The top ring is a moly ring (the scraping edge is gray in color). The second ring is a black cast iron ring (the scraping edge is black in color when new).

(7) The compression rings can be identified by a chamfer of either the top or bottom inside edge (Fig. 22). The rings may also be identified by 1 or 2 dots on the top surface of the ring.

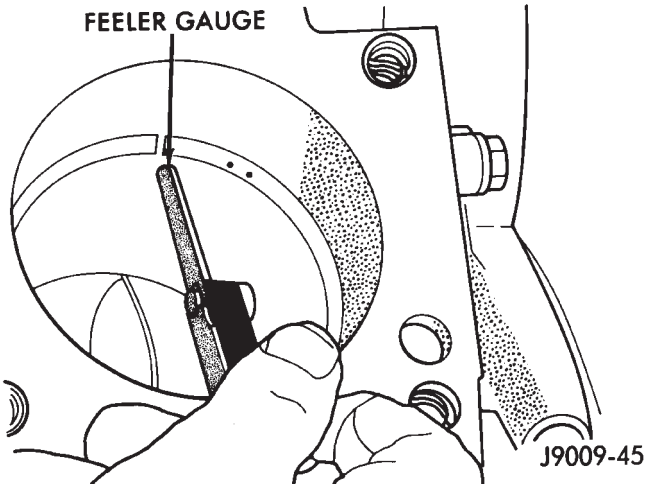

Fig. 20 Ring Gap Measurement

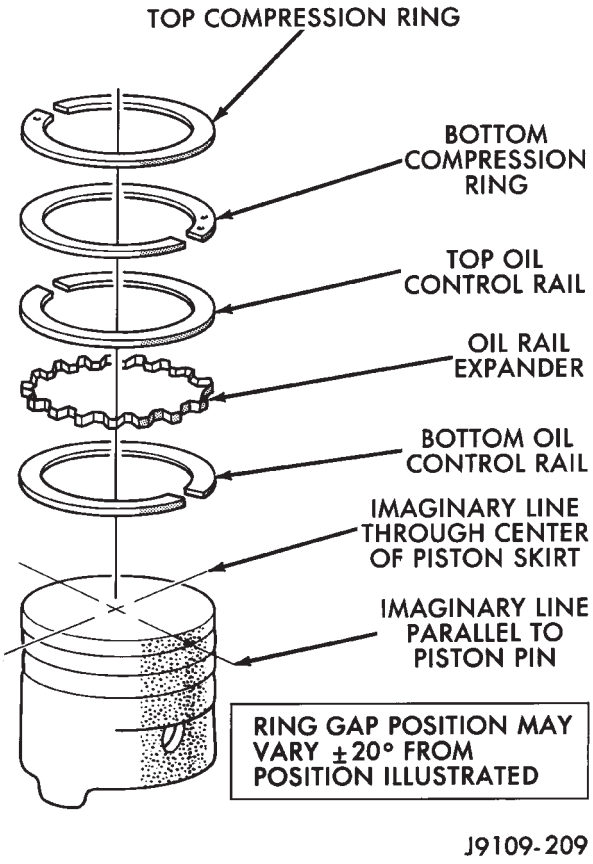

Fig. 21 Ring Gap Position

(8) The second compression ring (black cast iron) has a chamfer on the BOTTOM of the inside edge (Fig. 23). This ring may also have 2 dots located on the top surface.

(9) Using a ring installer, install the second compression ring with the chamfer facing down (Fig. 24). The dots will be facing up.

(10) The top compression ring (the scraping edge is gray in color) has a chamfer on the TOP of the inside edge. This ring has one dot located on the top surface.

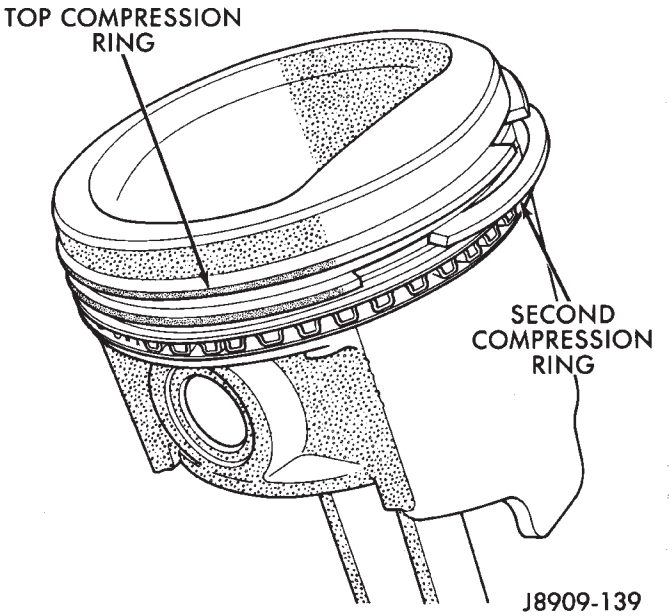

Fig. 22 Compression Ring Location

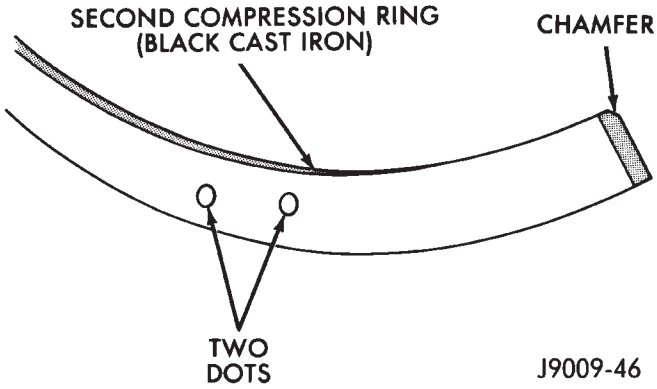

Fig. 23 Second Compression Ring Identification

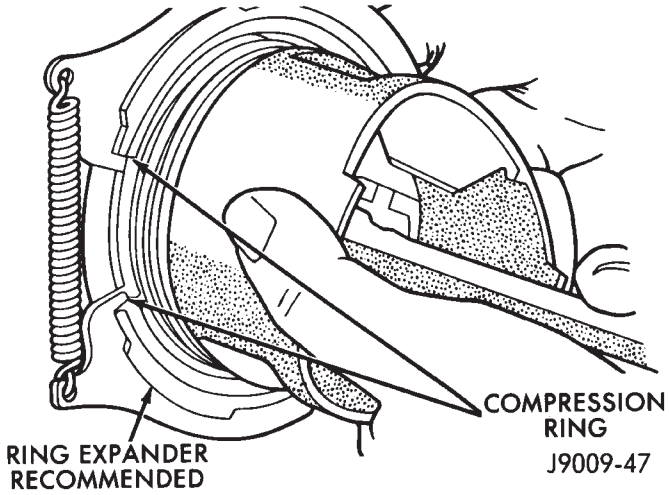

Fig. 24 Compression Ring Installation

(11) Using a ring installer, install the top ring with the chamfer facing up. The dot will be facing up.

(12) Position the ring end gaps on the piston.

CLEANING

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

INSTALLATION

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

(2) 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.

(3) Use a piston ring compressor to install the connecting rod and piston assemblies through the top of the cylinder bores (Fig. 25).

(4) Ensure the arrow on the piston top points to the front of the engine (Fig. 25).

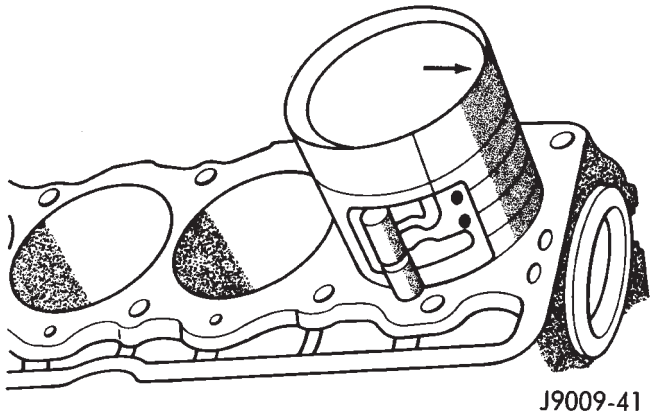

Fig. 25 Rod and Piston Assembly Installation

(5) Raise the vehicle.

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.

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.

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.

(6) 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.

(7) Install the oil pan and gaskets as outlined in the installation procedure.

(8) Lower the vehicle.

(9) Install the engine cylinder head, push rods, rocker arms, bridges, pivots and engine cylinder head cover.

(10) Fill the crankcase with engine oil.

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. 1).

(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. 2). 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. 2). 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.

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. 3).

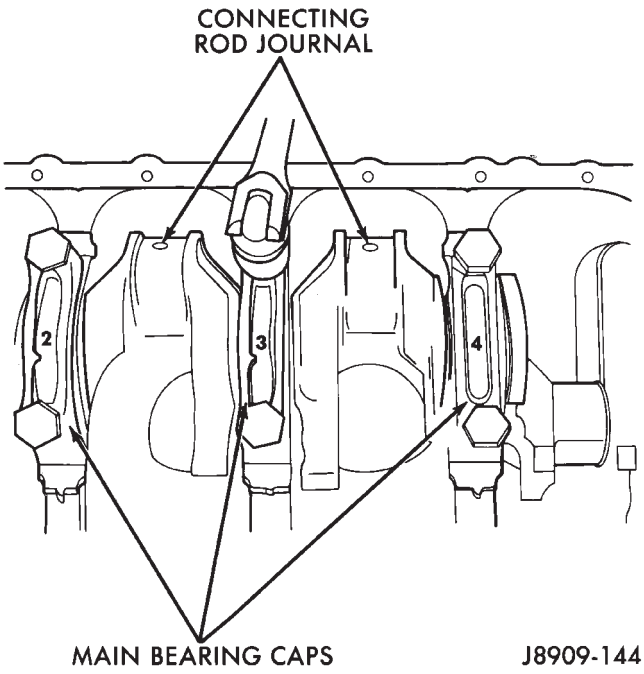

Fig. 1 Removing Main Bearing Caps and Lower Inserts

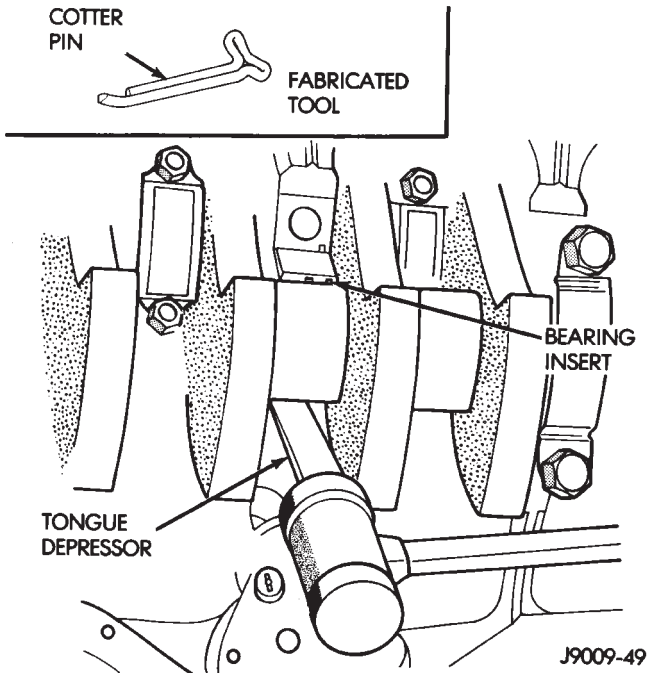

Fig. 2 Removing Upper Inserts

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 (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.

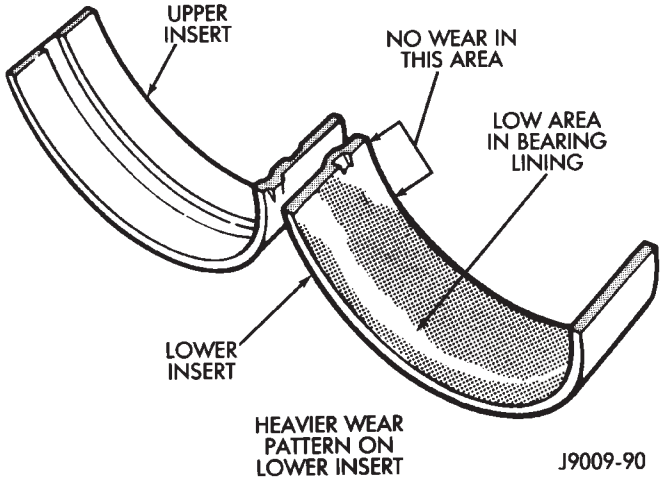

Fig. 3 Main Bearing Wear Patterns

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

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. 4).**

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. 4 Bearing Insert Pairs

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.

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

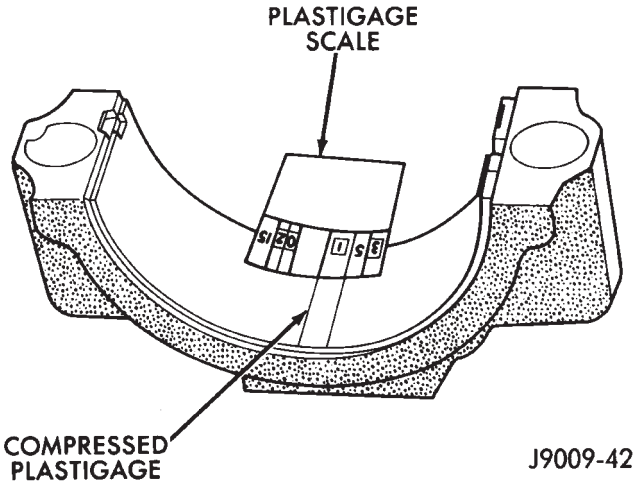

Fig. 5 Measuring Bearing Clearance with Plastigage

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 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).

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.

MAIN BEARING FITTING CHART

Crankshaft Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	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 (0.0005 in.) Undersize	Yellow - Standard	Blue - Undersize 0.025 mm (0.001 in.)
Black - 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 (2.4901-2.4966 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 Main Bearing Journal 7 Color Code and Diameter (Journal Size)	Bearing Insert Color Code	
	Upper Insert Size	Lower Insert Size
Yellow - 63.4873-63.4746 mm (2.499-2.4990 in.)	Yellow - Standard	Yellow - Standard
Orange - 63.4746-63.4619 mm (2.4990-2.4985 in.) 0.0127 mm (0.0005 in.) Undersize	Yellow - Standard	Blue - Undersize 0.025 mm (0.001 in.)
Black - 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.)

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(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.

(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. 6). 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.

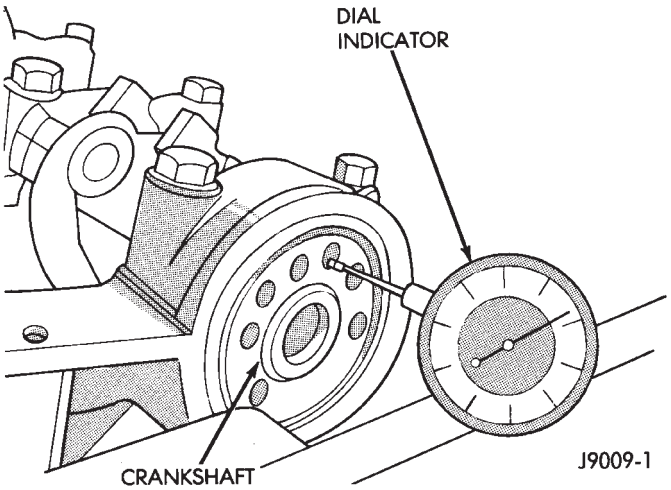

Fig. 6 Crankshaft End Play Measurement

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

(9) Install the oil pan.

(10) Install the drain plug. Tighten the plug to 41 N•m (30 ft. lbs.) torque.

(11) Lower the vehicle.

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

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

(14) Connect negative cable to battery.

REAR MAIN OIL SEALS

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

REMOVAL

(1) Remove the engine flywheel or converter drive plate.

(2) Remove the oil pan.

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

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

(5) Remove the lower half of the seal from the bearing cap.

INSTALLATION

(1) Wipe the seal surface area of the crankshaft until it is clean.

(2) Apply a thin coat of engine oil.

(3) Coat the lip of the seal with engine oil.

(4) Carefully position the upper seal into the groove in the cylinder block. The lip of the seal faces toward the front of the engine.

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

(6) Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil (Fig. 7).

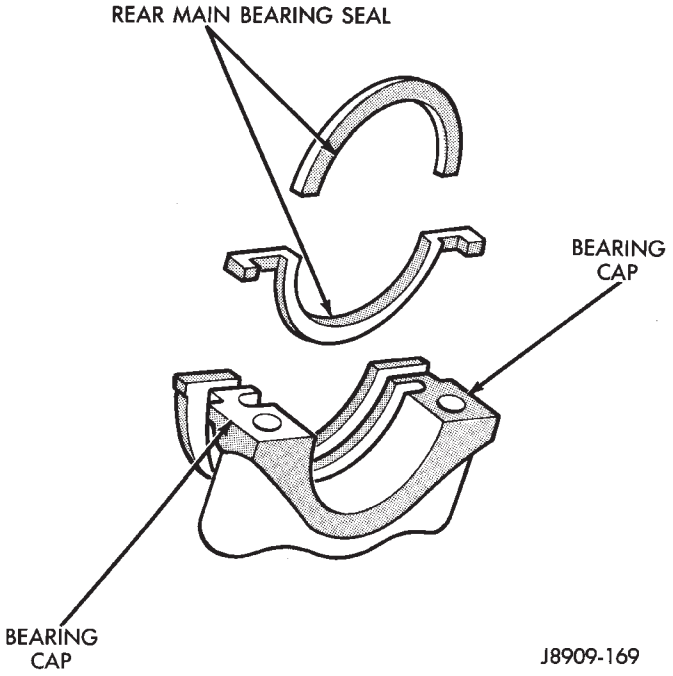

Fig. 7 Rear Main Bearing Oil Seal

(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 515, or equivalent on the rear bearing cap (Fig. 8). The bead should be 3 mm (0.125 in) thick. DO NOT apply Loctite 515, or equivalent to the lip of the seal.

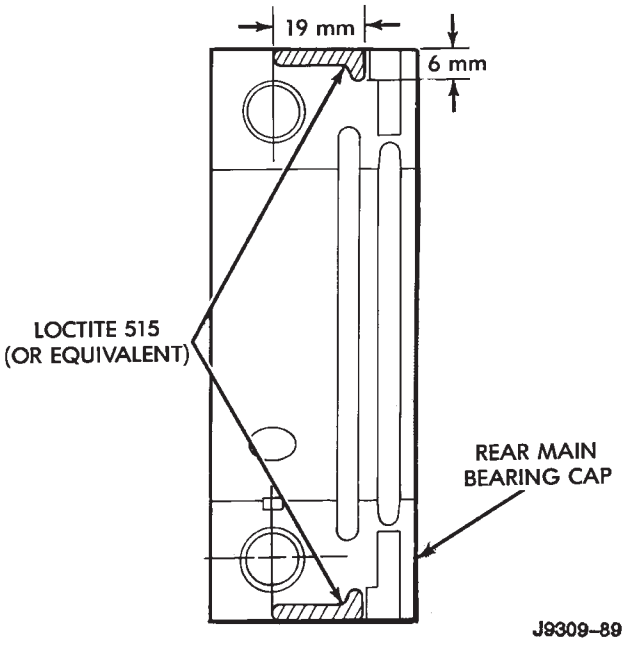

Fig. 8 Location of Loctite 515 (or equivalent)

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

(10) Tighten all main bearing bolts to 108 N•m (80 ft. lbs.) torque.

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

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

CYLINDER BLOCK

Remove the Engine Assembly from the vehicle.

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.

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.
- 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 41 N•m (30 ft. lbs.) torque.

INSPECTION—CYLINDER BORE

(1) Use a bore gauge to measure each cylinder bore diameter (Fig. 9). If a bore gauge is not available, use an inside micrometer.

(2) Measure the cylinder bore diameter crosswise to the cylinder block near the top of the bore. Repeat the measurement near the bottom of the bore.

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

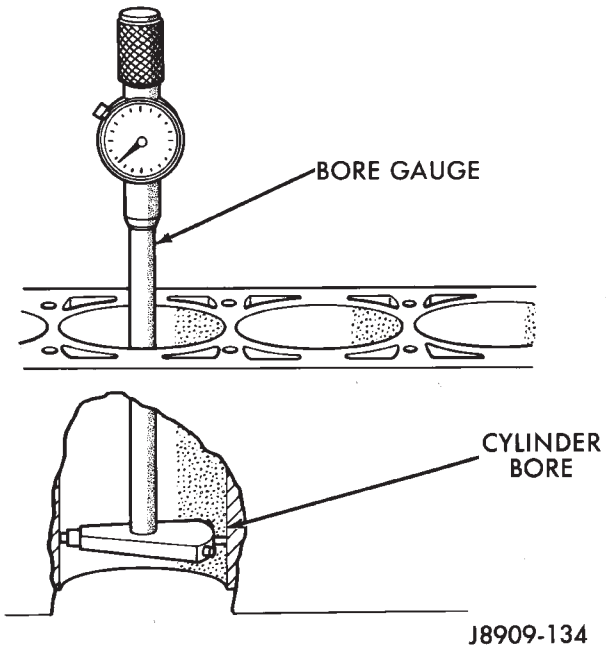

Fig. 9 Cylinder Bore Measurement

(4) Rotate measuring device 120° and repeat steps above. Finally, rotate the device another 120° and repeat measurements.

(5) Determine out-of-roundness by comparing the difference between each 120° measurement.

(6) 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.

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.
(12) Lubricate the oil filter seal with clean engine oil. Tighten oil filter to 18 N•m (13 ft. 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 (refer to Group 7, Cooling System for the proper procedures).

SPECIFICATIONS

ENGINE SPECIFICATIONS

Camshaft

Hydraulic Tappet Clearance	Zero Lash
Bearing Clearance	0.025 - 0.076 mm (0.001 - 0.003 in)
Bearing Journal Diameter	
No.1	51.54 - 51.56 mm (2.029 - 2.030 in)
No.2	51.28 - 51.31 mm (2.019 - 2.020 in)
No.3	51.03 - 51.05 mm (2.009 - 2.010 in)
No.4	50.78 - 50.80 mm (1.999 - 2.000 in)
Base Circle Runout	0.03 mm - max. (0.001 in - max.)
Camshaft Lobe Lift	6.43 mm (0.253 in)
Valve Lift	10.29 mm (0.405 in)
Intake Valve Timing	
Opens	15° BTDC
Closes	75° ABDC
Exhaust Valve Timing	
Opens	59° BBDC
Closes	31° ATDC
Valve Overlap	46°
Intake Duration	270°
Exhaust Duration	270°

Crankshaft

End Play	0.038 - 0.165 mm (0.0015 - 0.0065 in)
Main Bearing Journal Dia	63.489 - 63.502 mm (2.4996 - 2.5001 in)
Main Bearing Journal Width	
No.1	27.58 - 27.89 mm (1.086 - 1.098 in)
No.3	32.28 - 32.33 mm (1.271 - 1.273 in)
No.2-4-5-6-7	30.02 - 30.18 mm (1.182 - 1.188 in)
Main Bearing Clearance	0.03 - 0.06 mm
Preferred	0.051 mm (0.001 - 0.0025 in)
Preferred	(0.002 in)
Connecting Rod Journal Dia	53.17 - 53.23 mm (2.0934 - 2.0955 in)
Connecting Rod Journal Width	27.18 - 27.33 mm (1.070 - 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 - 240.18 mm (9.450 - 9.456 in)
Deck Clearance (Below Block)	0.546 mm (0.0215 in)
Cylinder Bore Diameter	
Standard	98.42 - 98.48 mm (3.875 - 3.877 in)
Taper (Max.)	0.025 mm (0.001 in)
Out-of-Round	0.025 mm (0.001 in)
Tappet Bore Diameter	23.000 - 23.025 mm (0.9055 - 0.9065 in)
Flatness	0.03 mm per 25 mm (0.001 in per 1 in)
	0.05 mm per 152 mm (0.002 in per 6 in)
	0.20 mm - max. for total length (0.008 in - max. for total length)
Main Bearing Bore Dia	68.3514 - 68.3768 mm (2.691 - 2.692 in)

Connecting Rods

Total Weight (Less Bearing)	657 - 665 grams (23.17 - 23.45 oz)
Length (Center-to-Center)	155.52 - 155.62 mm (6.123 - 6.127 in)
Piston Pin Bore Diameter	23.59 - 23.62 mm (0.9288 - 0.9298 in)
Bore (Less Bearings)	56.08 - 56.09 mm (2.2080 - 2.2085 in)
Bearing Clearance	0.025 - 0.076 mm
Preferred	0.044 - 0.050 mm
	(0.001 - 0.003 in)
Preferred	(0.0015 - 0.0020 in)
Side Clearance	0.25 - 0.48 mm (0.010 - 0.019 in)
Twist (Max.)	0.001 mm per mm (0.001 in per in)
Bend (Max.)	0.0005 mm per mm (0.0005 in per in)

Cylinder Compression Pressure

Ratio	8.8:1
Pressure Range	827 - 1 034 kPa (120 - 150 psi)
Max. Variation Between Cylinders	206 kPa (30 psi)

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ENGINE SPECIFICATIONS (CONT.)

Cylinder Head

Combustion Chamber ..... 64.45 - 67.45 cc (3.93 - 4.12 cu. in.)
Valve Guide I.D. (Integral) ..... 7.9 mm (0.312 in)
Valve Stem-to-Guide Clearance ..... 0.025 - 0.076 mm (0.001 - 0.003 in)
Intake Valve Seat Angle ..... 44.5°
Exhaust Valve Seat Angle ..... 44.5°
Valve Seat Width ..... 1.02 - 1.52 mm (0.040 - 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)
0.05 mm per 152 mm (0.002 in per 6 in)
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 - 245.364 mm (9.640 - 9.660 in)
Push Rod Diameter ..... 7.92 - 8.00 mm (0.312 - 0.315 in)
Hydraulic Tappet Diameter ..... 22.962 - 22.974 mm (0.904 - 0.9045 in)
Tappet-to-Bore Clearance ..... 0.025 - 0.063 mm (0.001 - 0.0025 in)

Valves

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

Valve Springs

Free Length (Approx.) ..... 46.22 mm (1.82 in)
Spring Tension
Valve Closed ..... 293 - 329 N @ 41.275 mm (66 - 74 lbf @ 1.625 in)
Valve Open ..... 911 - 978 N @ 30.48 mm (205 - 220 lbf @ 1.20 in)
Inside Diameter ..... 24.08 - 24.59 mm (0.948 - 0.968 in)

Pistons

Weight (Less Pin) ..... 563 - 567 grams (19.86 - 20.00 oz)
Piston Pin Bore (Centerline-to-Piston Top) ..... 40.61 - 40.72 mm 1.599 - 1.603 in)
Piston-to-Bore Clearance ..... 0.033 - 0.053 mm
Preferred ..... 0.033 - 0.038 mm (0.0013 - 0.0021 in)
Preferred ..... (0.0013 - 0.0015 in)
Piston Ring Gap Clearance
Compression Rings ..... 0.25 - 0.51 mm (0.010 - 0.020 in)
Oil Control Steel Rails ..... 0.25 - 0.64 mm (0.010 - 0.025 in)
Piston Ring Side Clearance
Compression Rings ..... 0.025 - 0.081 mm
Preferred ..... 0.025 mm (0.001 - 0.0032 in)
Preferred ..... (0.001 in)
Oil Control Ring ..... 0.025 - 0.241 mm
Preferred ..... 0.08 mm (0.001 - 0.0095 in)
Preferred ..... (0.003 in)
Piston Ring Groove Height
Compression Rings ..... 2.019 - 2.045 mm (0.0795 - 0.0805 in)
Oil Control Ring ..... 4.78 - 4.80 mm (0.1880 - 0.1895 in)
Piston Ring Groove Diameter
Compression Rings ..... 88.30 - 88.55 mm (3.476 - 3.486 in)
Oil Control Ring ..... 90.35 - 90.60 mm (3.557 - 3.566 in)
Piston Pin Bore Diameter ..... 23.647 - 23.655 mm (0.9310 - 0.9313 in)
Piston Pin Diameter ..... 23.637 - 23.640 mm (0.9306 - 0.9307 in)
Piston-to-Pin Clearance ..... 0.0076 - 0.0178 mm - Loose
Preferred ..... 0.013 mm (0.0003 - 0.0007 in - Loose)
Preferred ..... (0.0005 in)
Piston-to-Pin Connecting Rod (Press Fit) ..... 8.9 kN (2000 lb f)

ENGINE SPECIFICATIONS (CONT.)

Oil Pump

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

Oil Pressure

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

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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.)
Camshaft Sprocket Bolt	108 N•m (80 ft. lbs.)
Connecting Rod Nuts	45 N•m (33 ft. lbs.)
Crossmember-to-Sill Bolts	41 N•m (30 ft. lbs.)
Cylinder Head Bolts (#1 - 10 & #12 - 14)	149 N•m (110 ft. lbs.)
(#11)	135 N•m (100 ft. lbs.)
Cylinder Head Cover Bolts	9 N•m (75 in. lbs.)
Engine Support Bracket Bolts	61 N•m (45 ft. lbs.)
Exhaust Manifold-to-Exhaust Pipe Nuts	27 N•m (20 ft. lbs.)
Flywheel/Converter Housing Bolts	38 N•m (28 ft. lbs.)
Front Cover-to-Block Bolts	7 N•m (60 in. lbs.)
Front Support Bracket-to-Cylinder Block Bolts	61 N•m (45 ft. lbs.)
Front Support Cushion-to-Mount Thru-Bolt	65 N•m (48 ft. lbs.)
Front Support Cushion-to-Sill Bracket	41 N•m (30 ft. lbs.)
Fuel Pump Bolts	22 N•m (16 ft. lbs.)
Generator Adjusting Bolt	24 N•m (18 ft. lbs.)
Generator Pivot Bolt/Nut	38 N•m (28 ft. lbs.)
Main Bearing Bolts	108 N•m (80 ft. lbs.)

Description	Torque
Oil Filter	18 N•m (13 ft. lbs.)
Oil Filter Adaptor Bolt	65 N•m (48 ft. lbs.)
Oil Filter Connector	47 N•m (35 ft. lbs.)
Oil Galley Plug	41 N•m (30 ft. lbs.)
Oil Pan Bolts (1/4 - 20)	13 N•m (114 in. lbs.)
(5/16 - 18)	18 N•m (156 in. lbs.)
Oil Pan Cover Bolts	8 N•m (70 in. lbs.)
Oil Pan Drain Plug	34 N•m (25 ft. lbs.)
Oil Pump Attaching Bolts (Short Bolts)	14 N•m (10 ft. lbs.)
(Long Bolts)	23 N•m (17 ft. lbs.)
Power Steering Pump Pressure Hose Nut	52 N•m (38 ft. lbs.)
Rear Support Bracket Stud Nuts (Automatic Transmission)	75 N•m (55 ft. lbs.)
Rear Support Bracket Stud Nuts (Manual Transmission)	46 N•m (34 ft. lbs.)
Rocker Arm Assembly-to-Cylinder Head Capscrews	28 N•m (21 ft. lbs.)
Spark Plugs	37 N•m (27 ft. lbs.)
Starting Motor Mounting Bolts	45 N•m (33 ft. lbs.)
Timing Case Cover-to-Block Bolts	7 N•m (60 in. lbs.)
Vibration Damper Bolts	108 N•m (80 ft. lbs.)
Water Pump-to-Block Bolts	34 N•m (25 ft. lbs.)

J9309-88

5.2L ENGINE SERVICE PROCEDURES

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GENERAL INFORMATION

The 5.2 Liter (318 CID) eight-cylinder engine is a V-Type lightweight, single cam, overhead valve engine with hydraulic roller tappets (Fig. 1).

Engine Type	90° V-8 OHV
Bore and Stroke	99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement	5.2L (318 cu. in.)
Compression Ratio	9.1:1
Torque	386 N·m (285 ft. lbs.) @ 3,600 rpm
Firing Order	1-8-4-3-6-5-7-2
Lubrication	Pressure Feed — Full Flow Filtration
Engine Oil Capacity	4.7L (5.0 qts) w/filter
Cooling System	Liquid Cooled — Forced Circulation
Cooling Capacity	15.6L (16.5 qts)
Cylinder Block	Cast Iron
Crankshaft	Nodular Iron
Cylinder Head	Cast Iron
Combustion Chambers	Wedge-High Swirl Valve Shrouding
Camshaft	Nodular Cast Iron
Pistons	Aluminum Alloy w/Strut
Connectiong Rods	Forged Steel

J9309-16

Fig. 1 Engine Description

This engine is designed for unleaded fuel.

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

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

The engine serial number is stamped into a machined pad located on the left, front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 3).

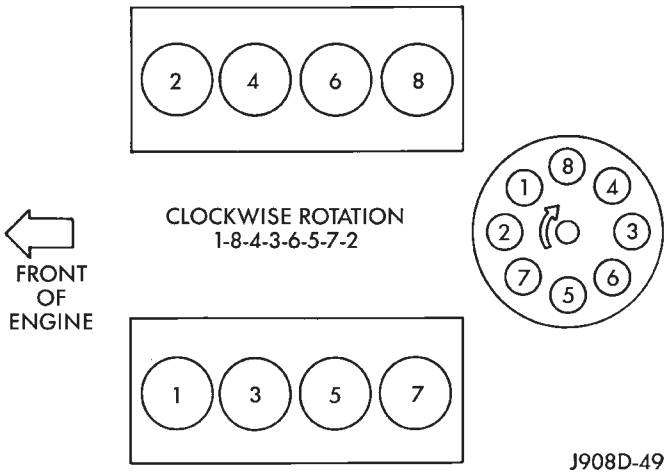

Fig. 2 Firing Order

X M 5.2L T XXXX XXXXXXXX

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

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Fig. 3 Engine Identification Number

ENGINE FRONT MOUNTS

REMOVAL

(1) Disconnect the negative cable from the battery.

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

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

(3) Install engine lifting fixture.
(4) Raise vehicle on hoist.
(5) Remove the engine support bracket through-bolts (Figs. 4 and 5).
(6) Raise engine with lifting fixture SLIGHTLY. Remove the engine support insulator assembly bolts. Remove the engine support insulator assembly.

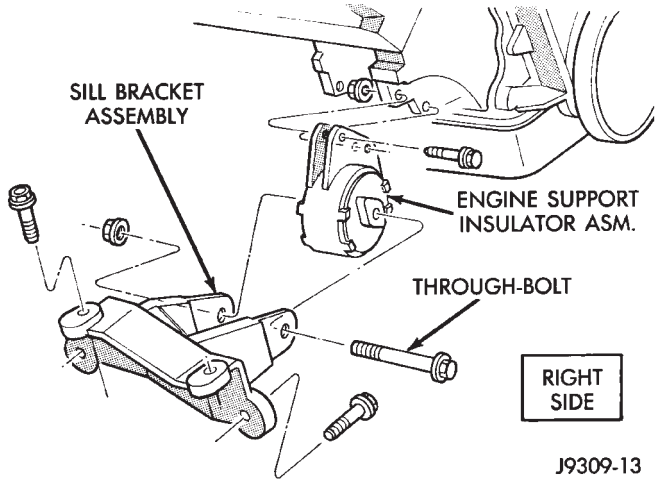


Fig. 4 Engine Front Mount (Right Side)

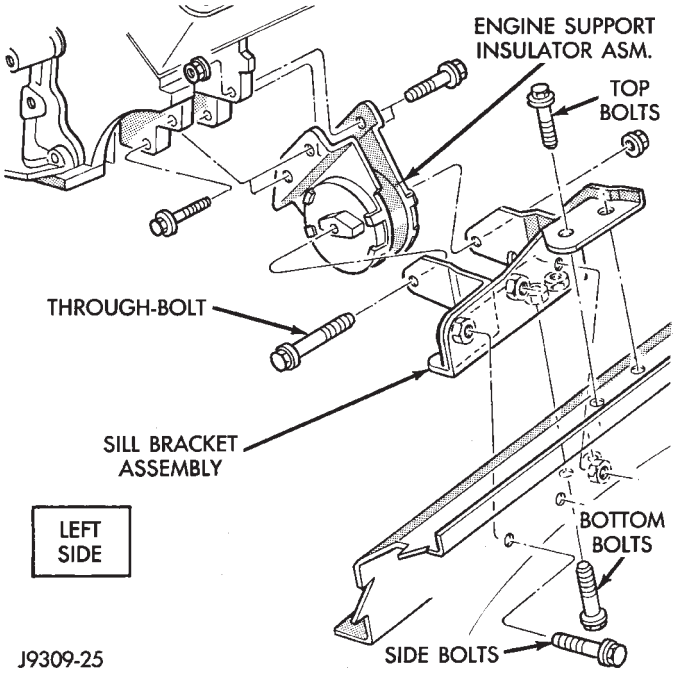


Fig. 5 Engine Front Mount (Left Side)

INSTALLATION

(1) If the sill bracket assembly was removed, install the bracket to the sill assembly.
(a) RIGHT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 4). Install and tighten the bolts to 54 N●m (40 ft. lbs.) torque.
(b) LEFT SIDE—Install the sill bracket assembly onto the sill assembly (Fig. 5). Install and tighten the 2 top bolts to 54 N●m (40 ft. lbs.) torque. Install and tighten the 2 side bolts to 95 N●m (70 ft. lbs.) torque. Install and tighten the 2 bottom bolts to 121 N●m (89 ft. lbs.) torque.
(2) With the engine raised SLIGHTLY, position engine support insulator assembly onto the engine block (Figs. 4 and 5). Install bolts and tighten to 88 N●m (65 ft. lbs.) torque.
(3) Lower engine with lifting fixture while aligning engine support insulator assembly into sill bracket assembly.
(4) Install the through-bolt and tighten the nut to 65 N●m (48 ft. lbs.) torque.
(5) Lower the vehicle.
(6) Remove lifting fixture.
(7) Connect the negative cable to the battery.

ENGINE REAR SUPPORT

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Raise the vehicle on a hoist.
(3) Support the transmission with a jack.
(4) Remove engine mount bracket through-bolt (Fig. 6).
(5) Raise the transmission and engine SLIGHTLY.
(6) Remove stud nuts attaching engine mount clevis bracket to crossmember (Fig. 6). Remove bracket.

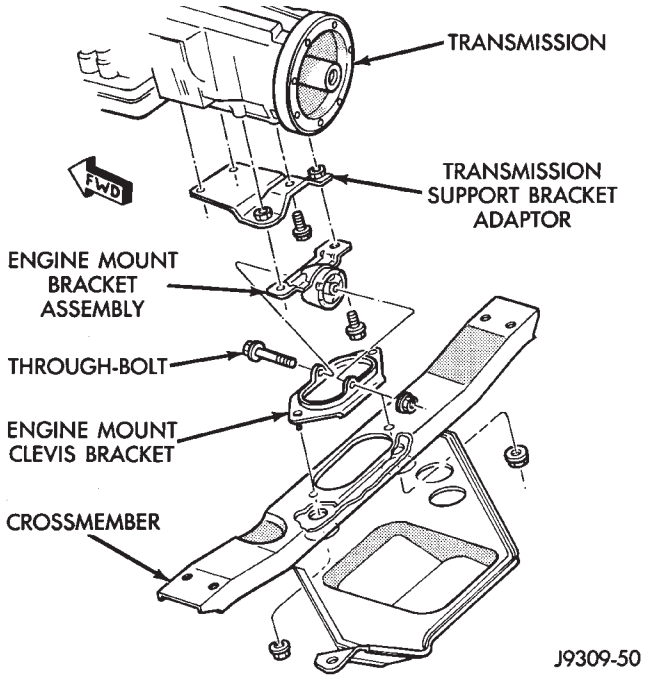


Fig. 6 Engine Rear Support Assembly

INSTALLATION

(1) If the transmission support bracket adaptor was removed, position the adaptor to the transmission (Fig. 6). Tighten the bolts to 95 N•m (70 ft. lbs.) torque.

(2) Install the engine mount clevis bracket onto crossmember. Tighten the stud nuts to 41 N•m (30 ft. lbs) torque.

(3) Install the engine mount bracket assembly to the adaptor. Install the 3 bolts and tighten to 75 N•m (55 ft. lbs.) torque.

(4) Lower the transmission and engine while aligning the engine mount bracket assembly to the engine mount clevis bracket.

(5) Install through-bolt and tighten the nut to 65 N•m (48 ft. lbs.) torque.

(6) Remove transmission jack.

(7) Lower the vehicle.

(8) Connect the negative cable to the battery.

ENGINE ASSEMBLY

REMOVAL

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

(2) Remove the battery.

(3) Drain cooling system.

(4) Remove the air cleaner and tube.

(5) Set fan shroud aside.

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

(7) Remove the vacuum lines.

(8) Remove the distributor cap and wiring.

(9) Disconnect the accelerator linkage.

(10) Remove MPI throttle body.

(11) Remove the starter wires.

(12) Remove the oil pressure wire.

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

(14) Remove air conditioning hoses.

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

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

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

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

(19) Disconnect exhaust pipe at manifold.

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

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

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

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

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

(24) Install an engine lifting fixture.

(25) Remove the engine front mount through-bolts.

(26) Lower the vehicle.

(27) Remove engine from engine compartment.

(28) Install on engine repair stand.

INSTALLATION

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

(2) Install engine support fixture.

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

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

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

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

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

(8) Remove stand from transmission.

(9) Install exhaust pipe to manifold.

(10) Lower the vehicle.

(11) Remove engine lifting fixture.

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

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

(14) Install power steering hoses, if equipped.

(15) Install air conditioning hoses.

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

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

(18) Connect the accelerator linkage.

(19) Connect the starter wires.

(20) Connect the oil pressure wire.

(21) Install the distributor cap and wiring.

(22) Install vacuum lines.

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

(24) Install fan shroud in position.

(25) Install the battery

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

(27) Install the air cleaner.

(28) Warm engine and adjust.

(29) Install hood and line up.

(30) Road test vehicle.

CYLINDER HEAD COVER

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

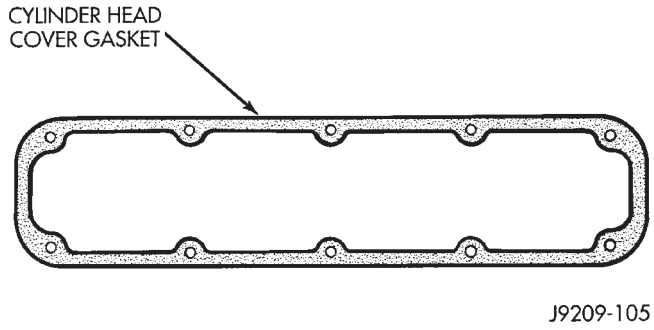


Fig. 7 Cylinder Head Cover Gasket

REMOVAL

(1) Disconnect the negative cable from the battery.

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

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

(4) Remove the ignition wires from the holders.

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

CLEANING

Clean cylinder head cover gasket surface.

Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

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

INSTALLATION

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

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

(3) Install the ignition wires onto the holders.

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

(5) Connect the negative cable to the battery.

ROCKER ARMS

REMOVAL

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

(2) Remove cylinder head cover and gasket.

(3) Remove the rocker arm bolts and pivots (Fig. 8). Place them on a bench in the same order as removed.

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

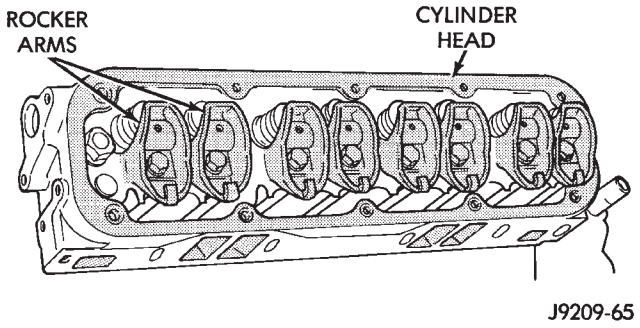


Fig. 8 Rocker Arms

INSTALLATION

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

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

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

(3) Install cylinder head cover.

(4) Connect spark plug wires.

CYLINDER HEADS

The alloy cast iron cylinder heads (Fig. 9) are held in place by 10 bolts. The spark plugs are located in the peak of the wedge between the valves.

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

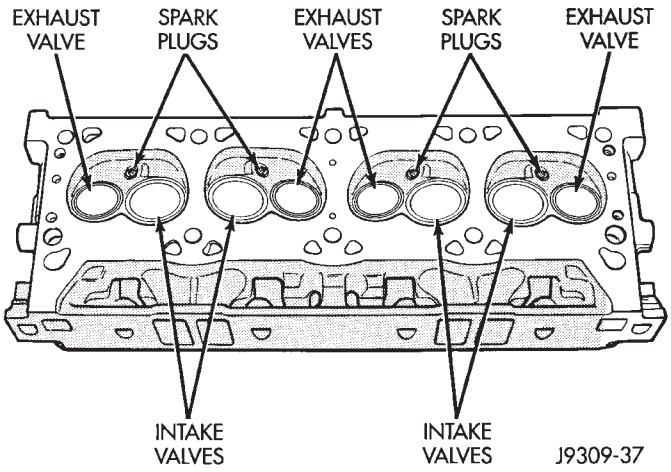


Fig. 9 Cylinder Head Assembly

REMOVAL

(1) Disconnect the negative cable from the battery.

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

(3) Remove the generator.

(4) Remove closed crankcase ventilation system.
(5) Disconnect the evaporation control system.
(6) Remove the air cleaner.
(7) Disconnect the fuel lines.
(8) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.
(9) Remove the return spring.
(10) Remove distributor cap and wires.
(11) Disconnect the coil wires.
(12) Disconnect heat indicator sending unit wire.
(13) Disconnect heater hoses and bypass hose.
(14) Remove cylinder head covers and gaskets.
(15) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.
(16) Remove exhaust manifolds.
(17) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.
(18) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.
(19) Remove spark plugs.

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

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

INSPECTION

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

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

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

Inspect push rods. Replace worn or bent rods.

INSTALLATION

(1) Apply Perfect Sealant No.5, or equivalent, to both sides of the gasket (Fig. 10),
(2) Position the new cylinder head gaskets onto the cylinder block.
(3) Position the cylinder heads onto head gaskets and cylinder block.
(4) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N●m (50 ft. lbs.) torque (Fig. 11). Repeat procedure, tighten all cylinder head bolts to 143 N●m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N●m (105 ft. lbs.) torque.

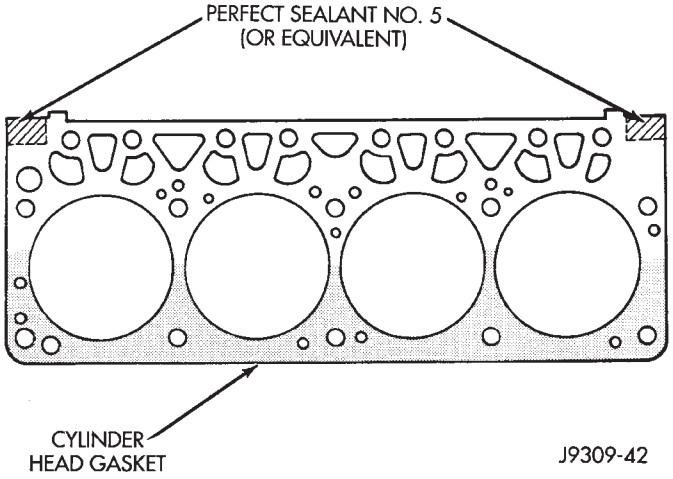


Fig. 10 Sealant Location on Cylinder Head Gasket

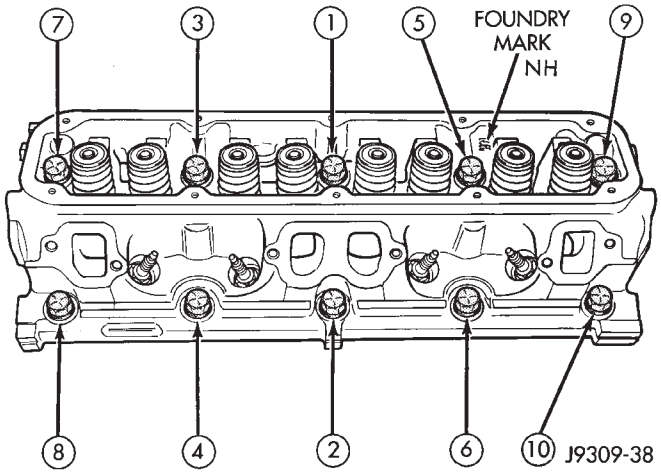


Fig. 11 Cylinder Head Bolt Tightening Sequence

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

(5) Install push rods and rocker arm assemblies in their original position. Tighten the bolts to 28 N●m (21 ft. lbs.) torque.
(6) Place the 4 plastic locator dowels into the holes in the block Fig. 12).
(7) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, to the four corner joints. An excessive amount of sealant is not required to ensure a leak proof seal. However, an excessive amount of sealant may reduce the effectiveness of the flange gasket. The sealant should be slightly higher than the cross-over gaskets, approx. 5 mm (0.2 in).
(8) Install the front and rear cross-over gaskets onto the dowels (Fig. 12).
(9) Install the flange gaskets. Be sure that the vertical port alignment tab is resting on the deck face of the block. Also the horizontal alignment tabs must be in position with the mating cylinder head gasket

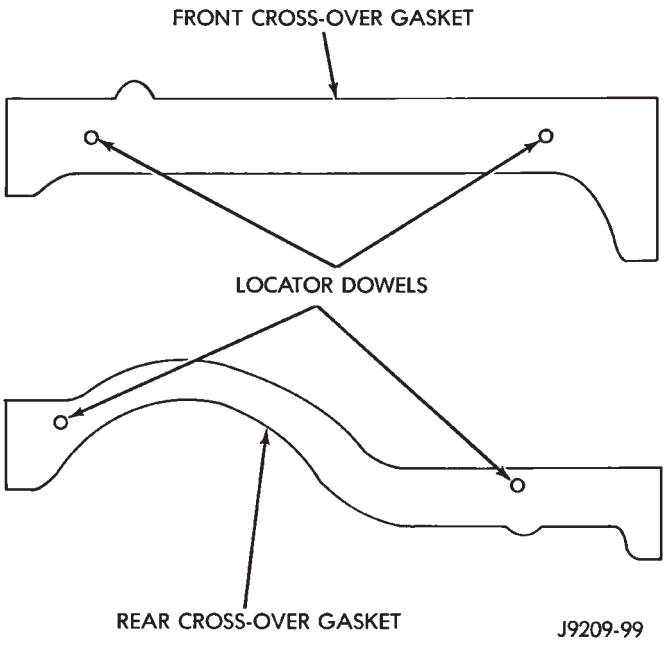


Fig. 12 Cross-Over Gaskets and Locator Dowels

tabs (Fig. 13). The words MANIFOLD SIDE should be visible on the center of each flange gasket.

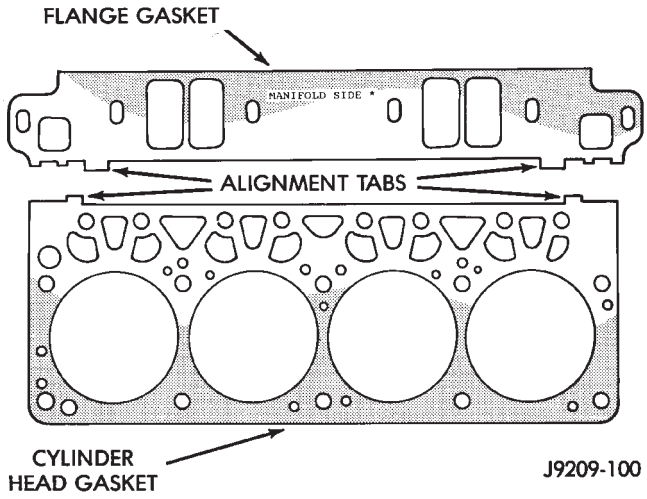


Fig. 13 Intake Manifold Flange Gasket Alignment

(10) Carefully lower intake manifold into position on the cylinder block and cylinder heads. Use the alignment dowels in the cross-over gaskets to position the intake manifold. After intake manifold is in place, inspect to make sure seals are in place.

(11) The following torque sequence duplicates the expected results of the automated assembly system (Fig. 14).

- Step 1—Tighten bolts 1 through 4, in sequence, to 8 N●m (72 in. lbs.) torque. Tighten in alternating steps 1.4 N●m (12 in. lbs.) torque at a time.
- Step 2—Tighten bolts 5 through 12, in sequence, to 8 N●m (72 in. lbs.) torque.
- Step 3—Check that all bolts are tighten to 8 N●m (72 in. lbs.) torque.

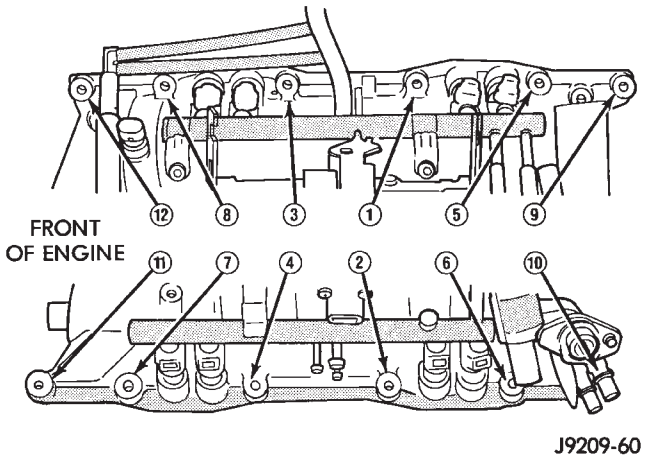


Fig. 14 Intake Manifold Bolt Tightening Sequence

- Step 4—Tighten all bolts, in sequence, to 16 N●m (12 ft. lbs.) torque.
- Step 5—Check that all bolts are tighten to 16 N●m (12 ft. lbs.) torque.

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

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

(14) Install coil wires.

(15) Connect heat indicator sending unit wire.

(16) Connect the heater hoses and bypass hose.

(17) Install distributor cap and wires.

(18) Hook up the return spring.

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

(20) Install the fuel lines.

(21) Install the generator and drive belt. Tighten generator mounting bolt to 41 N●m (30 ft. lbs.) torque. Tighten the adjusting strap bolt to 23 N●m (200 in. lbs.) torque. Refer to Group 7, Cooling System for adjusting the belt tension.

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

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

(24) Install closed crankcase ventilation system.

(25) Connect the evaporation control system.

(26) Install the air cleaner.

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

(28) Connect the negative cable to the battery.

VALVES / VALVE SPRINGS

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

This procedure requires the removal of the cylinder head.

REMOVAL

(1) Remove the cylinder head.

(2) Compress valve springs using Valve Spring Compressor Tool C-3422-B.

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

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

VALVE CLEANING

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

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

VALVE INSPECTION

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

Measure valve stem guide clearance as follows:

(a) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 15). The special sleeve places the valve at the correct height for checking with a dial indicator.

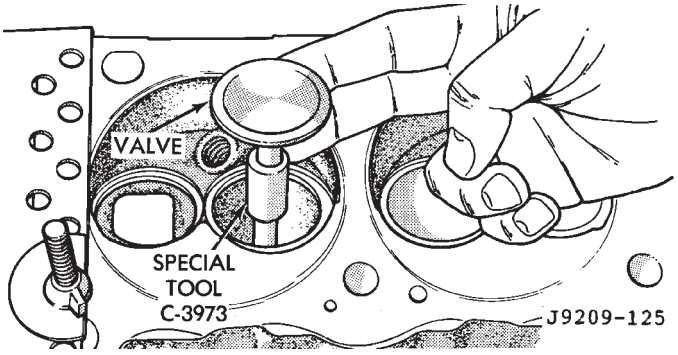


Fig. 15 Positioning Valve with Tool C-3973

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

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

Service valves with oversize stems are available (Fig. 17):

Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 inch). Use a 2 step procedure so the valve guides are reamed true in relation to the valve seat:**

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

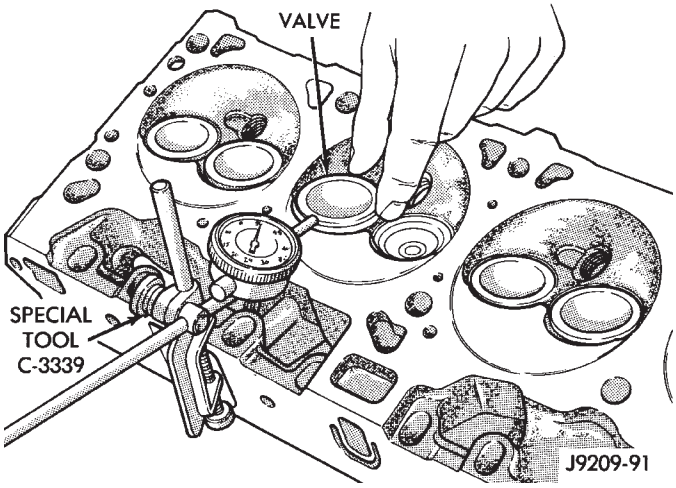


Fig. 16 Measuring Valve Guide Wear

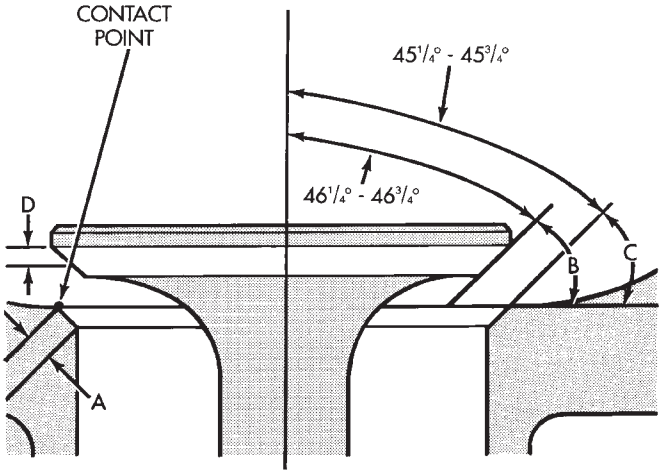
Reamer O/S	Valve Guide Size
0.076 mm (0.003 in.)	8.026 – 8.052 mm (0.316 – 0.317 in.)
0.381 mm (0.015 in.)	8.331 – 8.357 mm (0.328 – 0.329 in.)

J9309-30

Fig. 17 Reamer Sizes

REFACING VALVES / VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 18).



A - SEAT WIDTH – EXHAUST 1.524 – 2.032 mm (0.060 – 0.080 in.)
INTAKE 1.016 – 1.524 mm (0.040 – 0.060 in.)
B - FACE ANGLE (INTAKE & EXHAUST) 43¼° – 43¾°
C - SEAT ANGLE (INTAKE & EXHAUST) 44¼° – 44¾°
D - CONTACT SURFACE

J9309-49X

Fig. 18 Valve Face and Seat Angles

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 19). Valves with less than 1.190 mm (0.047 inch) margin should be discarded.

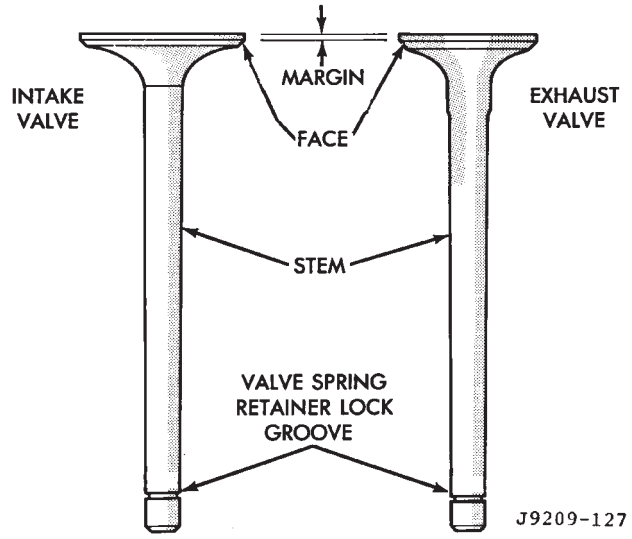


Fig. 19 Intake and Exhaust Valves

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 20).

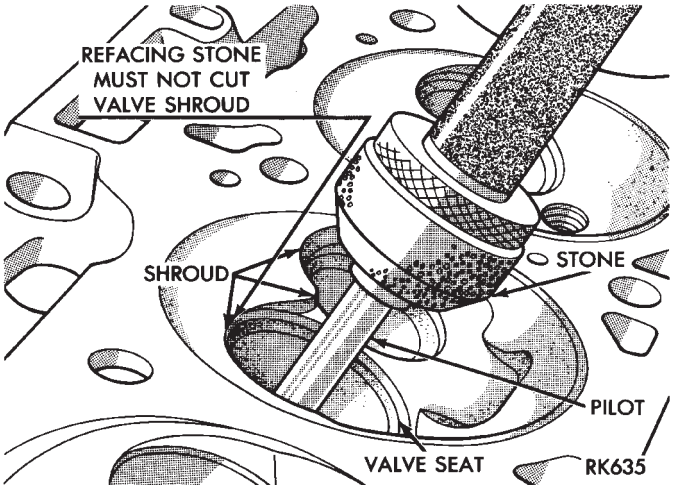


Fig. 20 Refacing Valve Seats

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

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

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

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

VALVE SPRING INSPECTION

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 inch. Turn table of Valve Spring Tester Tool C-647 (Fig. 21) until surface is in line with the 1-5/16 inch mark on the threaded stud. Be sure the zero mark is to the front. Place spring over stud on the table and lift compressing lever to set tone device. Pull on torque wrench until ping is heard. Take reading on torque wrench at this instant. Multiply this reading by 2. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to specifications to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.

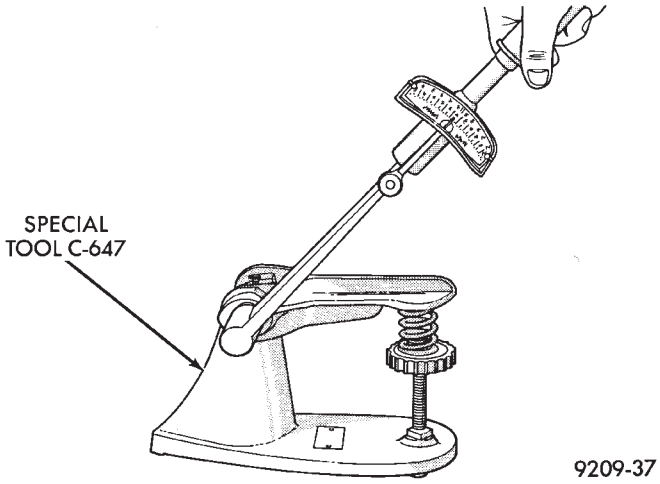


Fig. 21 Testing Valve Spring for Compressed Length with Tool C-647

INSTALLATION

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

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

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

(4) Compress valve springs with Valve Spring Compressor Tool C-3422-B, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder

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

VALVE STEM SHIELD / SPRING REPLACEMENT

This procedure is done with the cylinder head installed.

(1) Set engine basic timing to TDC and remove Air Cleaner.

(2) Remove cylinder head covers and spark plugs.

(3) Remove coil wire from distributor and secure to good ground to prevent engine from starting.

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

(5) Remove rocker arms.

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

(7) Using Valve Spring Compressor Tool C-4682-A, compress valve spring and remove retainer valve locks and valve spring.

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

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

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

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

(12) Install rocker arms.

(13) Install covers and coil wire to distributor.

(14) Install air cleaner.

(15) Road test vehicle.

HYDRAULIC TAPPETS

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

Check the oil level after the engine reaches normal operating temperature. Allow 5 minutes to stabilize oil level, check dipstick.

The oil level in the pan should never be above the FULL mark or below the ADD OIL mark on dipstick. Either of these 2 conditions could be responsible for noisy tappets.

OIL LEVEL

HIGH

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

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.

TAPPET NOISE DIAGNOSIS

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

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

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.

REMOVAL

(1) Remove the air cleaner.

(2) Remove cylinder head cover, rocker assembly and push rods. Identify push rods to ensure installation in original location.

(3) Remove intake manifold, yoke retainer and aligning yokes.

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

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

location.

(6) 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.

DISASSEMBLE

(1) Pry out plunger retainer spring clip (Fig. 22).

(2) Clean varnish deposits from inside of tappet body above plunger cap.

(3) Invert tappet body and remove plunger cap, plunger, check valve, check valve spring, check valve retainer and plunger spring (Fig. 22). Check valve could be flat or ball.

ASSEMBLE

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

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

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

(4) Assemble tappets (Fig. 22).

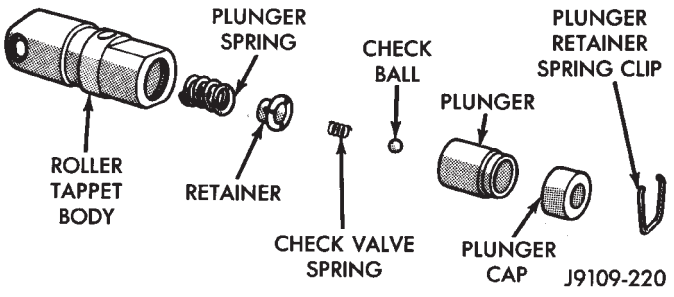


Fig. 22 Hydraulic Tappet Assembly

INSTALLATION

(1) Lubricate tappets.

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

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N●m (200 in. lbs.) torque. Install intake manifold.

(5) Install push rods in original positions.

(6) Install rocker arm.

(7) Install cylinder head cover.

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

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

VALVE TIMING

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

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

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

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

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

(5) If reading is not within specified limits:

(a) Check sprocket index marks.

(b) Inspect timing chain for wear.

(c) Check accuracy of DC mark on timing indicator.

VIBRATION DAMPER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Remove fan shroud retainer bolts and set shroud back over engine.

(3) Remove the cooling system fan.

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

(5) Remove the vibration damper pulley.

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

(7) Install bar and screw from Puller Tool Set C-3688. Install 2 bolts with washers through the puller tool and into the vibration damper (Fig. 1).

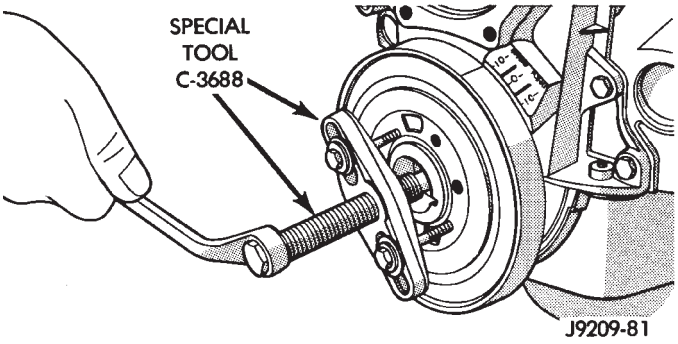


Fig. 1 Vibration Damper Assembly

(8) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

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

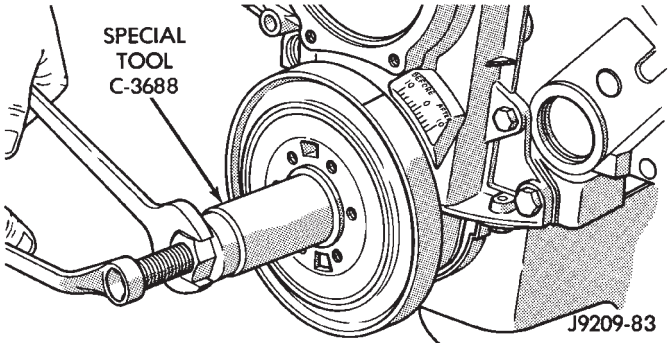


Fig. 2 Installing Vibration Damper

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

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

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

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

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

(8) Connect the negative cable to the battery.

TIMING CHAIN COVER

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Drain cooling system (refer to Group 7, Cooling System).

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

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

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

(6) Remove vibration damper.

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

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

(9) Remove the cover bolts.

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

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

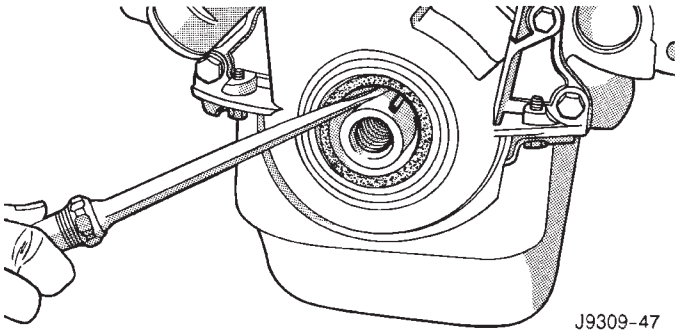


Fig. 3 Removal of Front Crankshaft Oil Seal

TIMING CHAIN STRETCH

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N●m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N●m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 4).

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

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

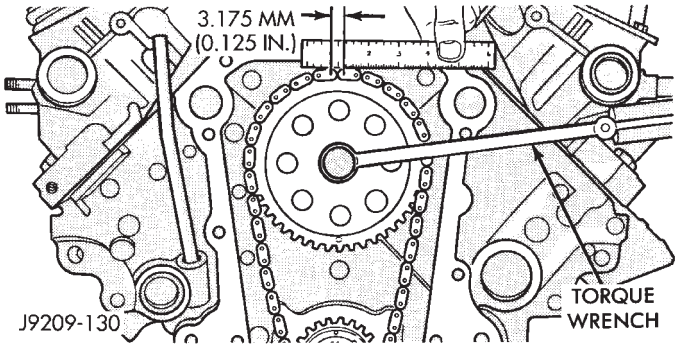


Fig. 4 Measuring Timing Chain Wear and Stretch

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

(7) Place timing chain around both sprockets.

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

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

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

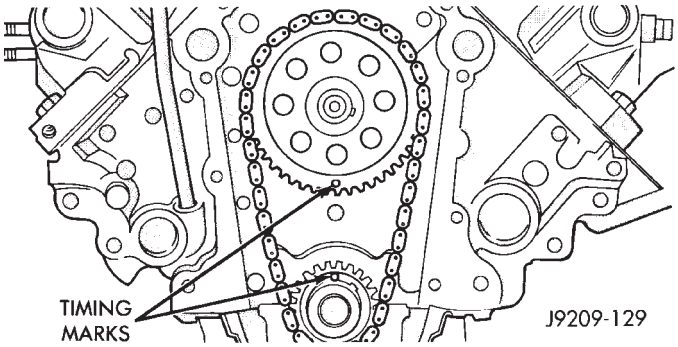


Fig. 5 Alignment of Timing Marks

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

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

CLEANING

Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.

INSTALLATION

(1) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan gasket. Finger tighten the timing chain cover bolts at this time.

(2) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 6). Seat the oil seal in the groove of the tool.

(3) Position the seal and tool onto the crankshaft (Fig. 7).

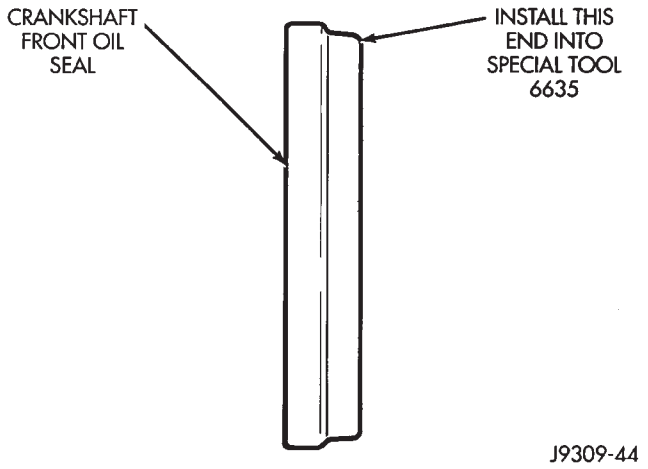


Fig. 6 Placing Oil Seal on Installation Tool 6635

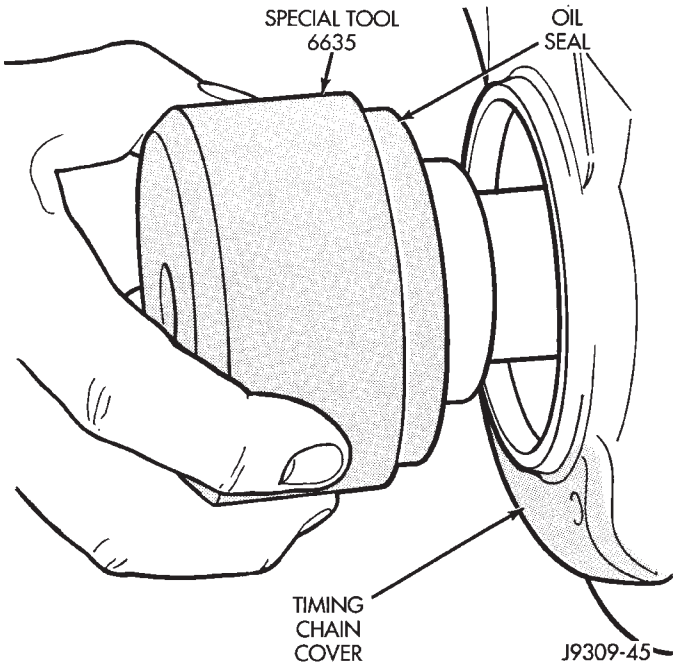


Fig. 7 Position Tool and Seal onto Crankshaft

(4) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 8).

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

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

(7) Install vibration damper.

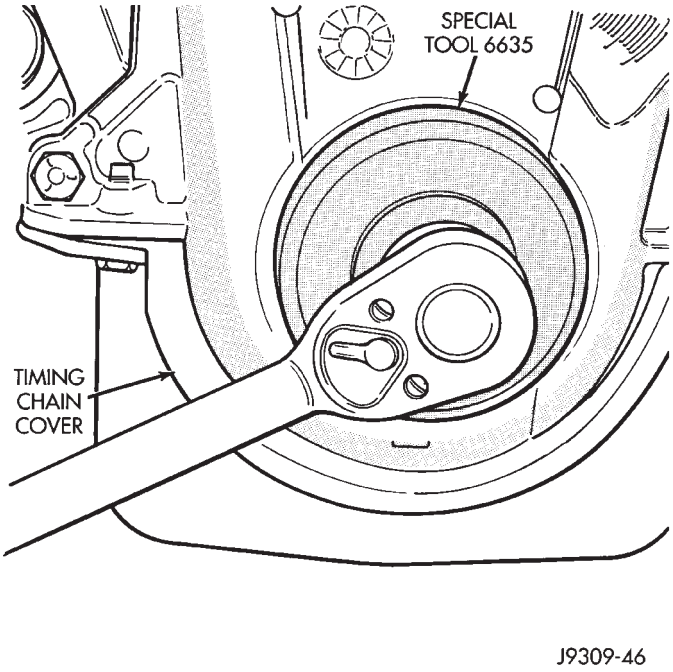


Fig. 8 Installing Oil Seal

(8) Install fuel lines (refer to Group 14, Fuel System).

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

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

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

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

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

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

(15) Connect the negative cable to the battery.

FRONT CRANKSHAFT OIL SEAL REPLACEMENT

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

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper.

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

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

(5) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 6). Seat the oil seal in the groove of the tool.

(6) Position the seal and tool onto the crankshaft (Fig. 7).

(7) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 8).

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

(9) Install the vibration damper.

(10) Connect the negative cable to the battery.

CAMSHAFT

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

The camshaft has an integral oil pump and distributor drive gear (Fig. 9).

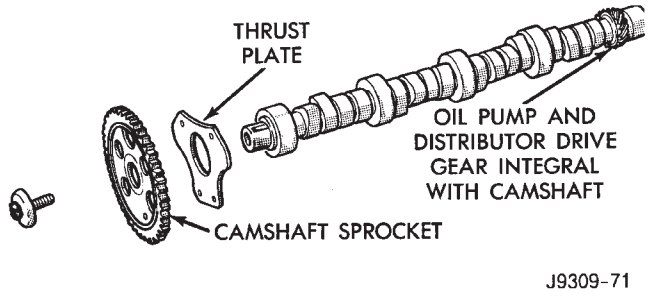


Fig. 9 Camshaft and Sprocket Assembly

REMOVAL

(1) Remove intake manifold.

(2) Remove cylinder head covers.

(3) Remove timing case cover and timing chain.

(4) Remove rocker arms.

(5) Remove push rods and tappets. Identify each part so it can be installed in its original location.

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

(7) Remove camshaft thrust plate; note location of oil tab (Fig. 10).

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

REMOVAL—BEARING

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 11).

INSTALLATION—BEARING

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

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

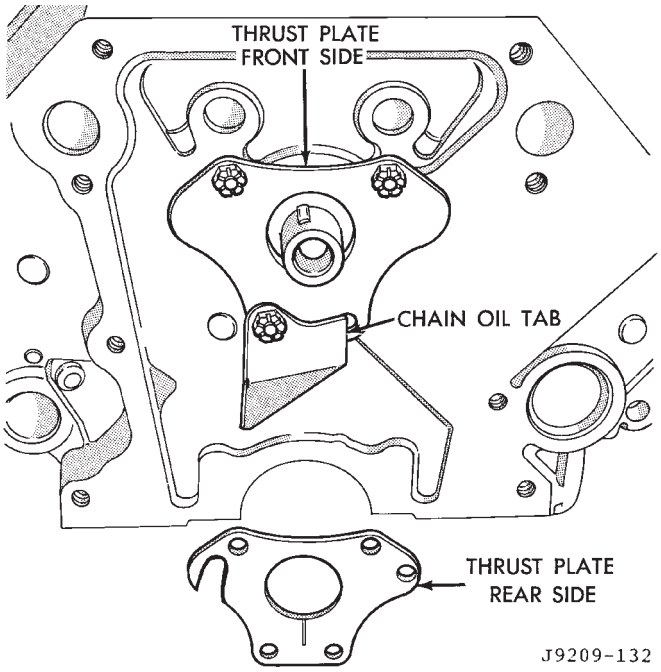


Fig. 10 Timing Chain Oil Tab Installation

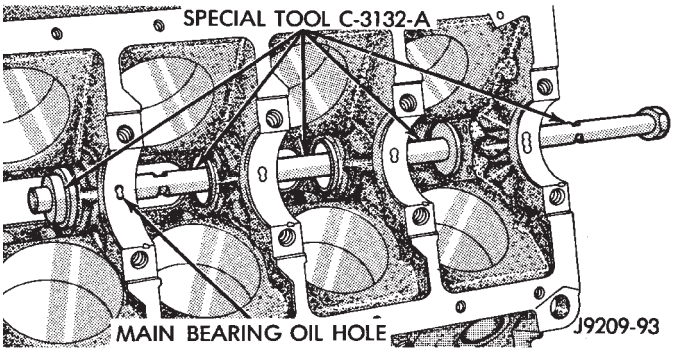


Fig. 11 Camshaft Bearings Removal and Installation with Tool C-3132-A

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

INSTALLATION

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

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

(2) Install Camshaft Gear Installer Tool C-3509 with tongue back of distributor drive gear (Fig. 12).

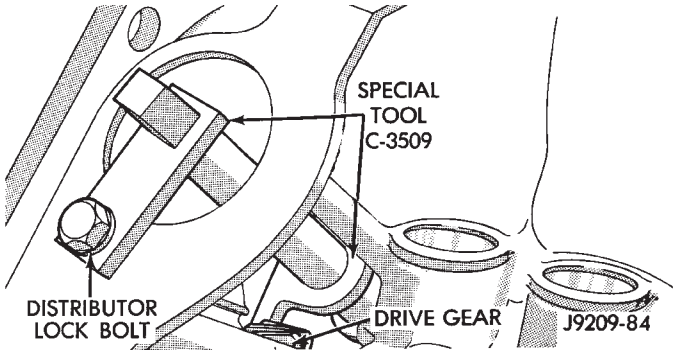


Fig. 12 Camshaft Holding Tool C-3509 (Installed Position)

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

(4) Install camshaft thrust plate and chain oil tab. **Make sure tang enters lower right hole in thrust plate.** Tighten bolts to 24 N●m (210 in. lbs.) torque. Top edge of tab should be flat against thrust plate in order to catch oil for chain lubrication.

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

(6) Place timing chain around both sprockets.

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

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

(9) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 13).

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

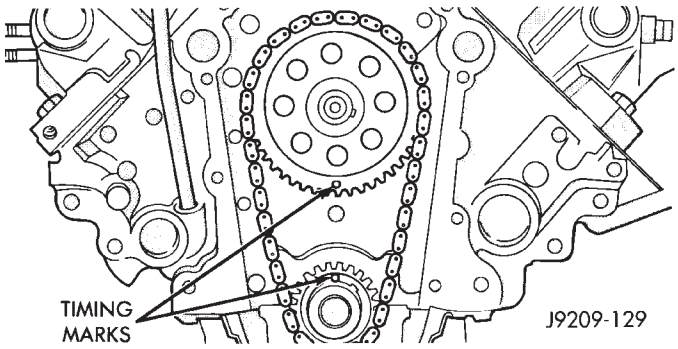


Fig. 13 Alignment of Timing Marks

(11) Measure camshaft end play. Refer to Specifications for proper clearance. If not within limits install a new thrust plate.

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

DISTRIBUTOR

REMOVAL

Refer to Group 8D, Ignition Systems for the proper procedure.

REMOVAL—DRIVE SHAFT BUSHING

(1) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 14).

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

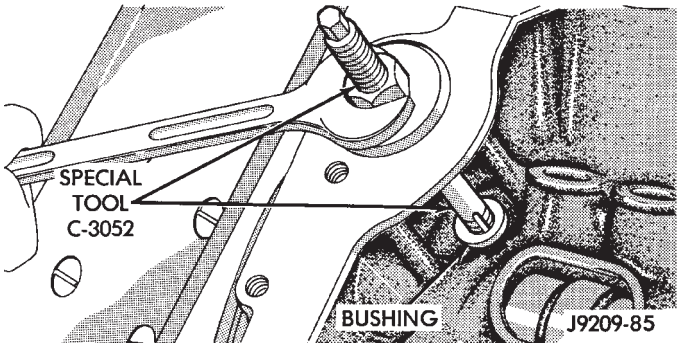


Fig. 14 Distributor Driveshaft Bushing Removal

INSTALLATION—DRIVE SHAFT BUSHING

(1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.

(2) Drive bushing and tool into position, using a hammer (Fig. 15).

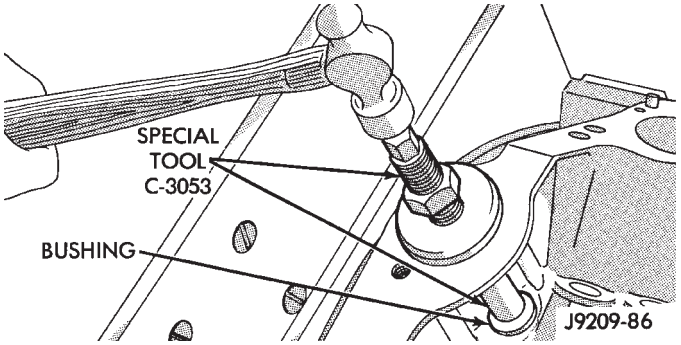


Fig. 15 Distributor Driveshaft Bushing Installation

(3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 16). **DO NOT ream this bushing.**

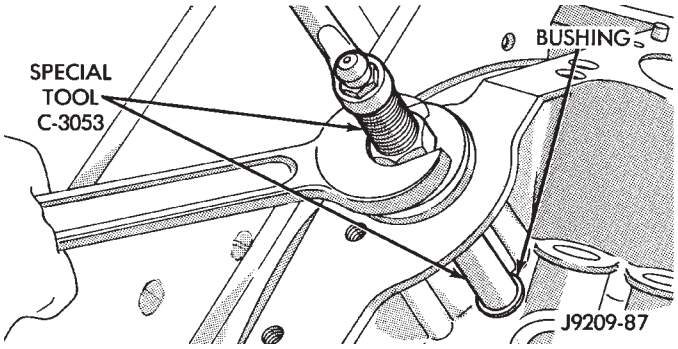


Fig. 16 Burnishing Distributor Driveshaft Bushing

DISTRIBUTOR TIMING

Before installing the distributor and oil pump drive shaft, time engine as follows:

(1) Rotate crankshaft until No.1 cylinder is at top dead center on the firing stroke.

(2) When in this position, the timing mark on vibration damper should be under "0" on the timing indicator.

(3) Coat shaft and drive gear with engine oil. Install the shaft so that after the gear spirals into place, it will index with the oil pump shaft. The slot in top of drive gear should be aligned towards left front intake manifold attaching bolt hole (Fig. 17).

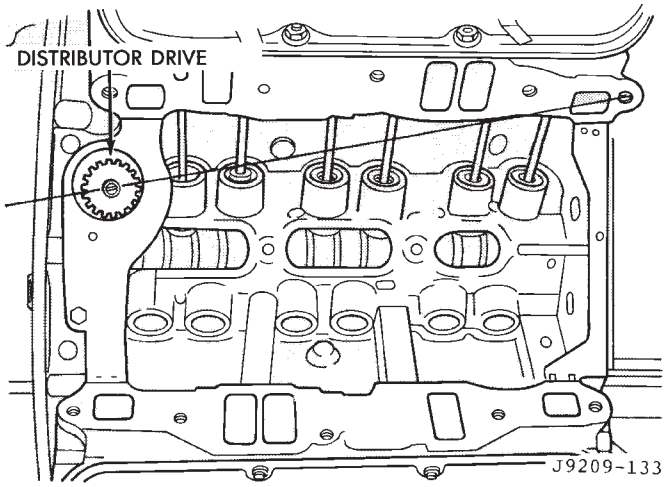


Fig. 17 Position of Installed Distributor Drive Gear

INSTALLATION

Refer to Group 8D, Ignition Systems for the proper procedure.

OIL PAN

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle.

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

(4) Remove the oil filter.

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

(6) If equipped with an oil level sensor, disconnect the sensor.
(7) Position the cooler lines out of the way.
(8) Disconnect the oxygen sensor.
(9) Remove exhaust pipe.
(10) Remove the oil pan bolts. Carefully slide the oil pan and gasket to the rear. If equipped with an oil level sensor, take care not to damage the sensor. The one-piece gasket is reusable.

CLEANING

Clean the block and pan gasket surfaces.

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

If present, trim excess sealant from inside the engine.

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

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

INSPECTION

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

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

INSTALLATION

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

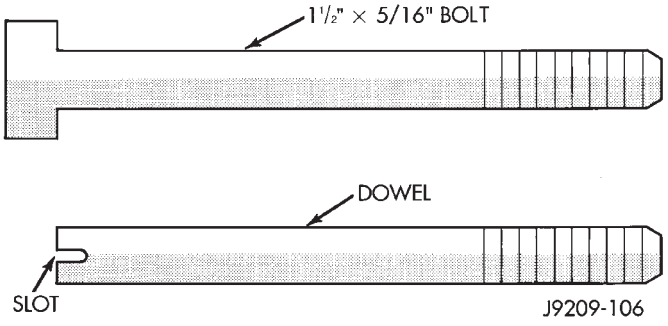


Fig. 1 Fabrication of Alignment Dowels

(2) Install the dowels in the cylinder block (Fig. 2).
(3) Apply small amount of Mopar Silicone Rubber Adhesive Sealant, or equivalent in the corner of the cap and the cylinder block.
(4) Slide the one-piece gasket over the dowels and onto the block.
(5) Position the oil pan over the dowels and onto the gasket. If equipped with an oil level sensor, take care not to damage the sensor.
(6) Install the oil pan bolts. Tighten the bolts to 24 N●m (215 in. lbs.) torque.

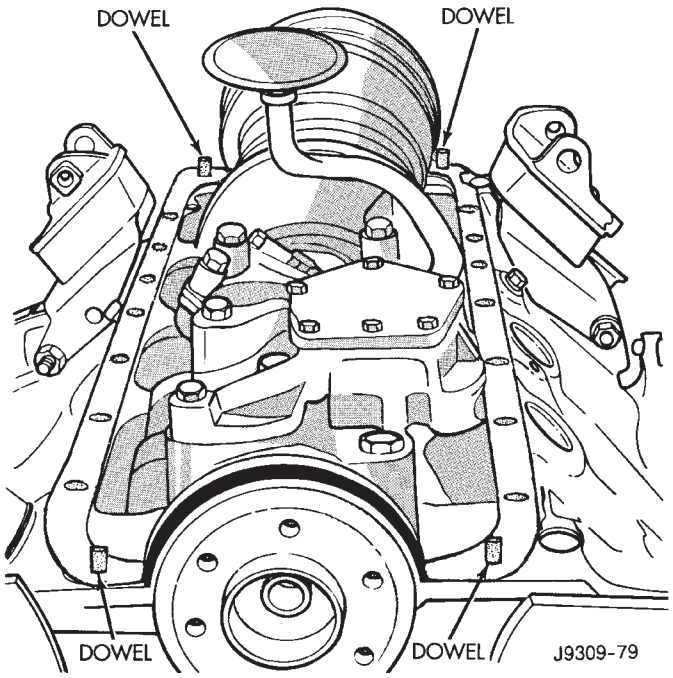


Fig. 2 Position of Dowels in Cylinder Block

(7) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N●m (215 in. lbs.) torque.
(8) Install the drain plug. Tighten drain plug to 34 N●m (25 ft. lbs.) torque.
(9) Install exhaust pipe.
(10) Connect the oxygen sensor.
(11) Install the oil filter.
(12) If equipped with an oil level sensor, connect the sensor.
(13) Install the starter (refer to Group 8B, Battery / Starter / Generator Service).
(14) Move the cooler lines back into position.
(15) Lower vehicle.
(16) Connect the negative cable to the battery.
(17) Fill the oil pan with engine oil to the specified level.

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

(18) Start the engine and inspect for leaks.

OIL PUMP

REMOVAL

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

DISASSEMBLE

(1) Remove the relief valve as follows:

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

(b) Clamp screw into a vise and while supporting oil pump, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 3).

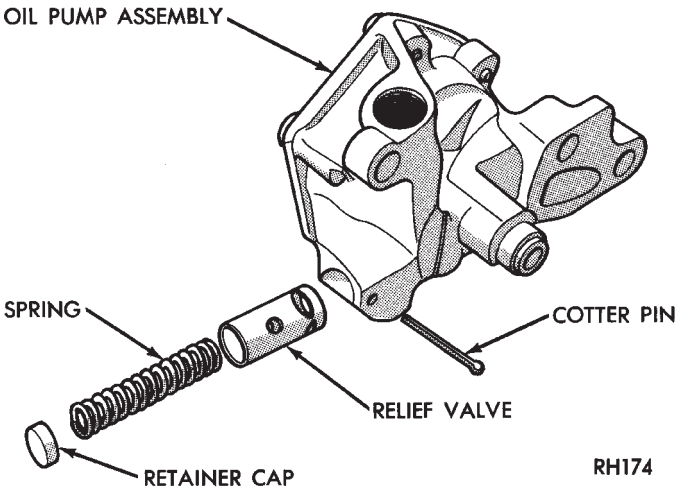


Fig. 3 Oil Pressure Relief Valve

(2) Remove oil pump cover (Fig. 4).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 4).

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

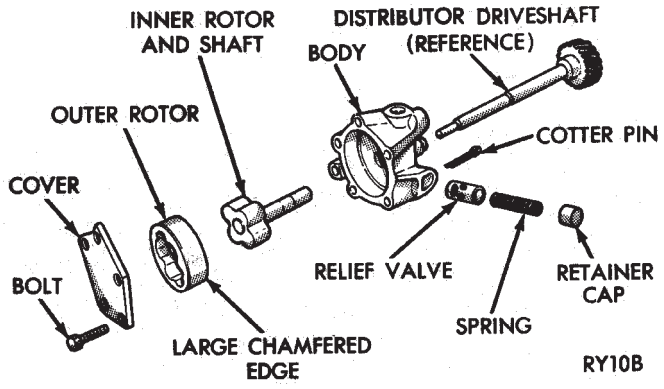


Fig. 4 Oil Pump

INSPECTION

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

Lay a straightedge across the pump cover surface (Fig. 5). If a 0.038 mm (0.0015 inch) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

Measure thickness and diameter of OUTER rotor. If outer rotor thickness measures 20.9 mm (0.825 inch) or less or if the diameter is 62.7 mm (2.469 inches) or less, replace outer rotor (Fig. 6).

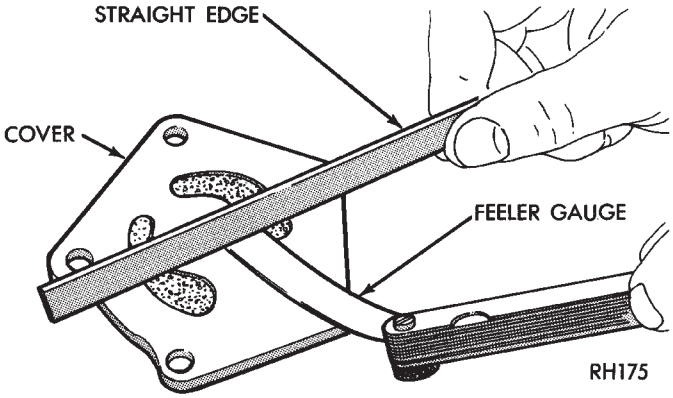


Fig. 5 Checking Oil Pump Cover Flatness

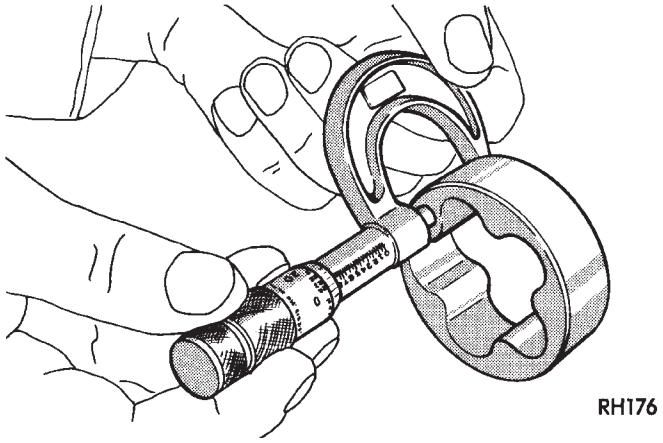


Fig. 6 Measuring Outer Rotor Thickness

If inner rotor measures 20.9 mm (0.825 inch) or less, replace inner rotor and shaft assembly (Fig. 7).

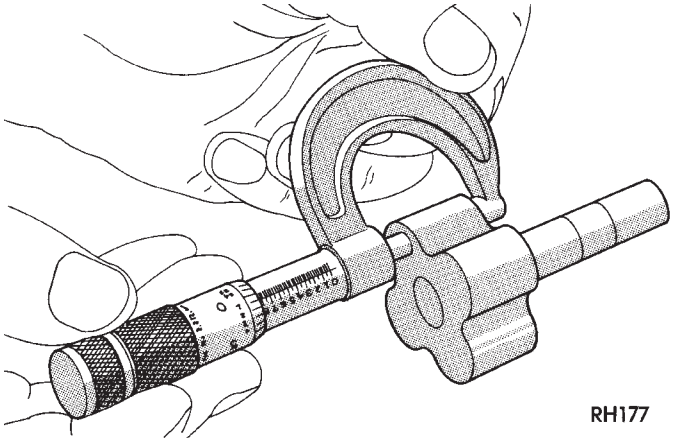


Fig. 7 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 8). If clearance is 0.356 mm (0.014 inch) or more, replace oil pump assembly.

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 inch) or more, replace shaft and both rotors (Fig. 9).

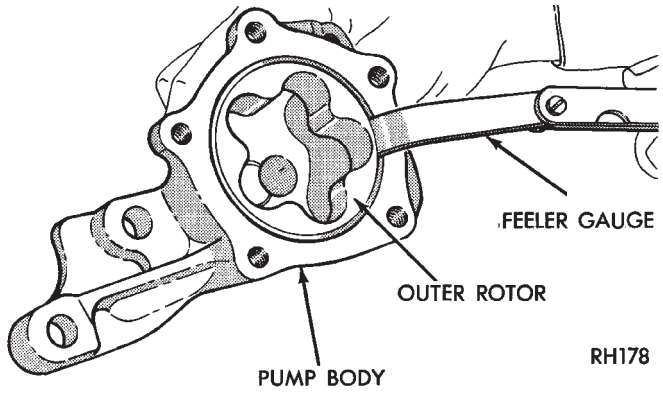


Fig. 8 Measuring Outer Rotor Clearance in Housing

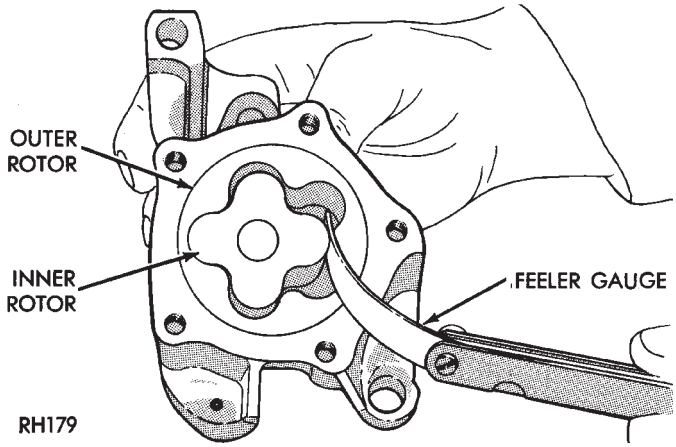


Fig. 9 Measuring Clearance Between Rotors

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 10).

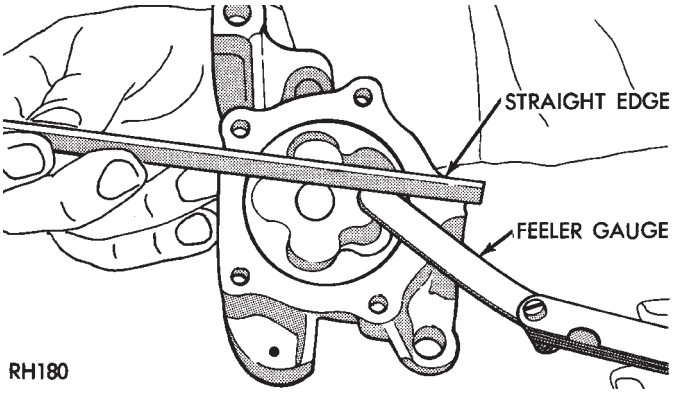


Fig. 10 Measuring Clearance Over Rotors

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

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

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

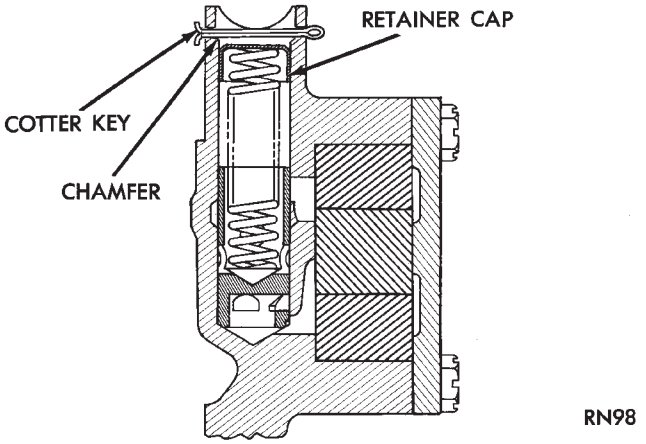


Fig. 11 Proper Installation of Retainer Cap

ASSEMBLE

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

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N•m (95 in. lbs.) torque.

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

(5) Prime oil pump before installation by filling rotor cavity with engine oil.

INSTALLATION

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

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

(3) Install the oil pan.

PISTON / CONNECTING ROD ASSEMBLY

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

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

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

REMOVAL

(1) Remove the engine from the vehicle.
(2) Remove the cylinder head.
(3) Remove the oil pan.
(4) Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. Be sure to keep tops of pistons covered during this operation.
(5) Be sure the connecting rod and connecting rod cap are identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.
(6) Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies, rotate crankshaft so that the connecting rod is centered in cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**
(7) After removal, install bearing cap on the mating rod.

INSPECTION

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

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

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 12).

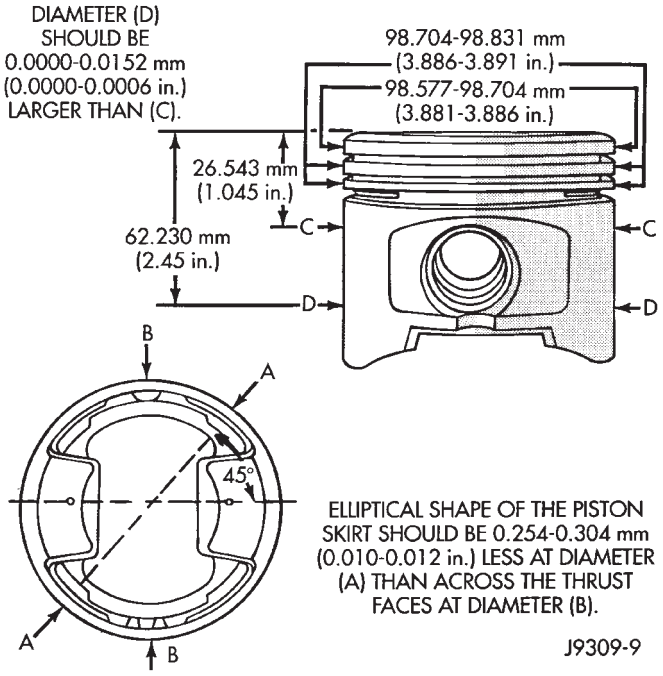


Fig. 12 Piston Measurements

FITTING PISTONS

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

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

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

FITTING RINGS

(1) Measurement of end gaps:
(a) Measure piston ring gap 2 inches from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.
(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 inch). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 inch). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 inch).
(c) Rings with insufficient end gap may be properly filled to the correct dimension. Rings with excess gaps should not be used.
(2) Install rings and confirm ring side clearance:
(a) Install oil rings being careful not to nick or scratch the piston.
(b) Install the compression rings using Installation Tool C-4184. The top compression may be installed with either side up. The second compression ring must be installed with the identification mark face up (toward top of piston) and the chamfer should face down. An identification mark on the ring is a drill point, a stamped letter “O”, an oval depression or the word TOP.
(c) Measure side clearance between piston ring and ring land (Fig. 13). Clearance should be 0.038-0.076 mm (0.0015-0.0030 inch) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.203 mm (0.0080 inch) side clearance.

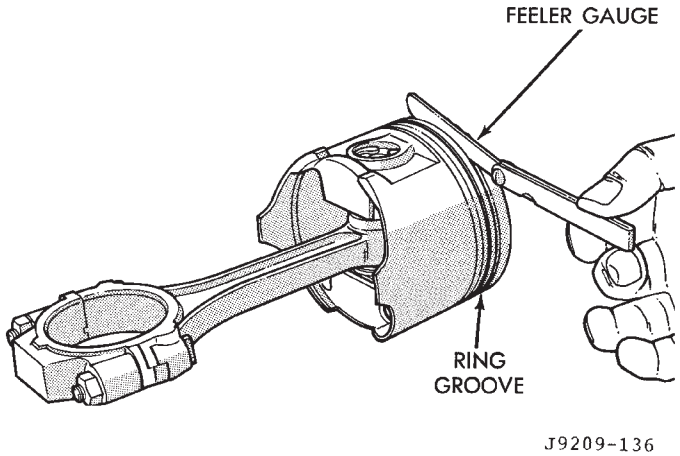


Fig. 13 Measuring Piston Ring Side Clearance

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

(3) Arrange ring gaps 90° apart as shown in Fig. 14.

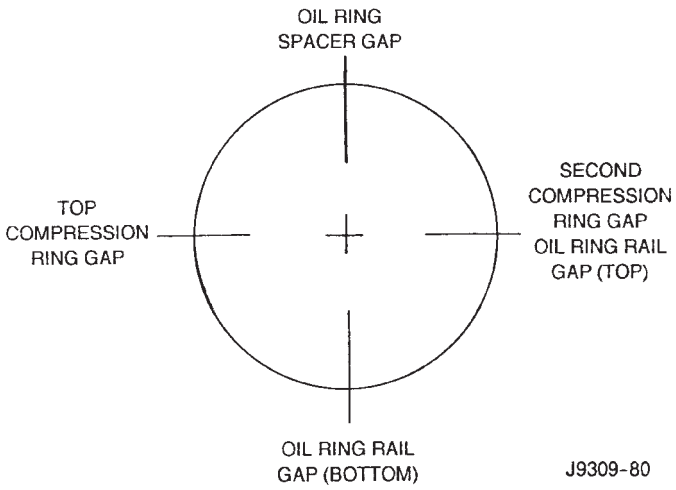


Fig. 14 Proper Ring Installation

CONNECTING ROD BEARINGS

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

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

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

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

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

INSTALLATION

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

(2) Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 14).

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

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

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

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

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

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

(9) Install the oil pan.

(10) Install the cylinder head.

(11) Install the engine into the vehicle.

CRANKSHAFT

A crankshaft which has undersize journals will be stamped with 1/4 inch letters on the milled flat on the No.8 crankshaft counterweight (Fig. 15).

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

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

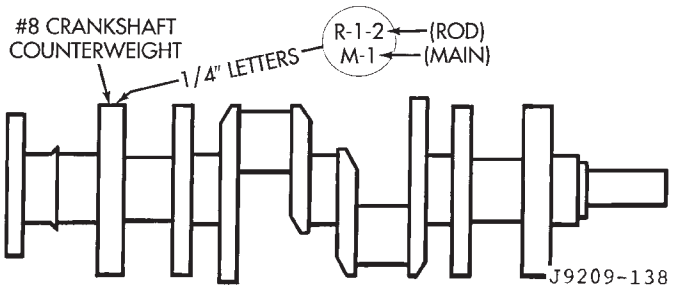


Fig. 15 Location of Crankshaft Identification

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

REMOVAL

(1) Remove the oil pan.

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

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

(4) Lift the crankshaft out of the block.

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

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

INSPECTION OF JOURNALS

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

Journal grinding should not exceed 0.305 mm (0.012 inch) under the standard journal diameter. DO NOT grind thrust faces of No.3 main bearing. DO NOT nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all oil passages.

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

INSTALLATION

Refer to Crankshaft Rear Oil Seals - Upper Seal Replacement (Crankshaft Removed) and Lower Seal Replacement.

CRANKSHAFT MAIN BEARINGS

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

Upper and lower No.3 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 16). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 inch), 0.051 mm (0.002 inch), 0.076 mm (0.003 inch), 0.254 mm (0.010 inch) and 0.305 mm (0.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

REMOVAL

(1) Remove the oil pan.

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

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

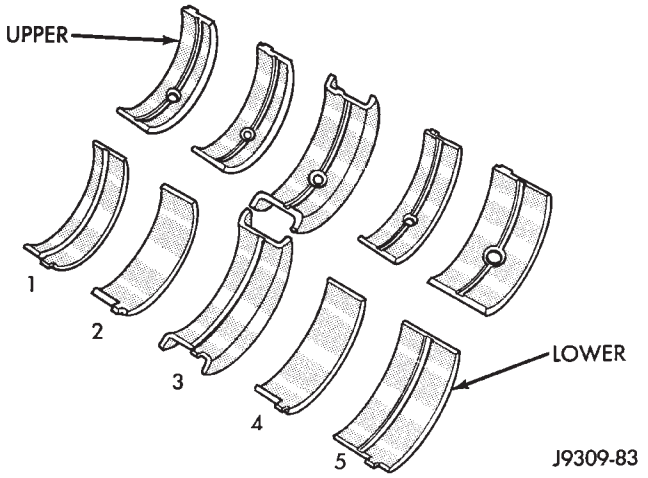


Fig. 16 Main Bearing Identification

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 17).

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

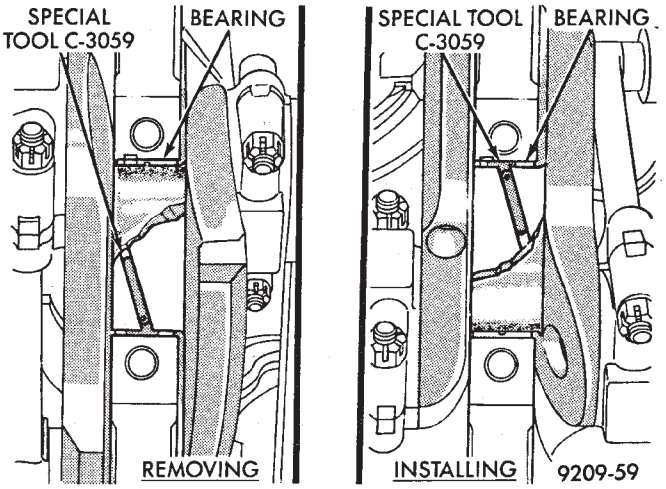


Fig. 17 Upper Main Bearing Removal and Installation with Tool C-3059

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before installation.

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

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 17).

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

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

(4) Install the oil pump.
(5) Install the oil pan.

CRANKSHAFT REAR OIL SEALS

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

UPPER SEAL REPLACEMENT (CRANKSHAFT REMOVED)

(1) Remove the crankshaft.
(2) Lightly oil the new upper seal lips with engine oil.
(3) Install the new upper rear bearing oil seal with the yellow paint facing towards the rear of the engine.
(4) Position the crankshaft into the cylinder block.
(5) Lightly oil the new lower seal lips with engine oil.
(6) Install the new lower rear bearing oil seal into the bearing cap with the yellow paint facing towards the rear of the engine.
(7) Apply 5 mm (0.20 in) drop of Loctite 515, or equivalent, on each side of the rear main bearing cap (Fig. 18). Do not over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

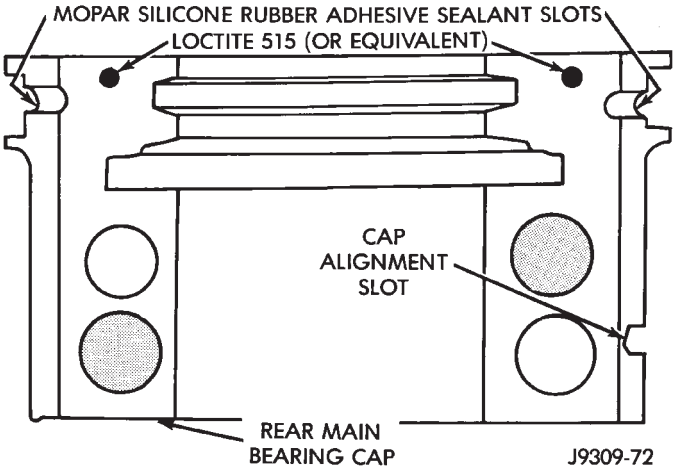


Fig. 18 Sealant Application to Bearing Cap

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. Do not remove excess material after assembly. Do not strike rear cap more than 2 times for proper engagement.
(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N•m (85 ft. lbs.) torque.
(10) Install oil pump.
(11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 19). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.
(12) Install new front crankshaft oil seal.
(13) Immediately install the oil pan.

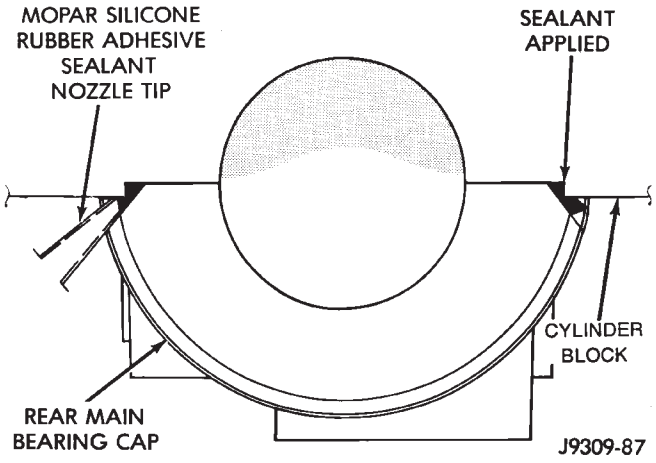


Fig. 19 Apply Sealant to Bearing Cap to Block Joint

UPPER SEAL REPLACEMENT (CRANKSHAFT INSTALLED)

(1) Remove the oil pan.
(2) Remove the oil pump from the rear main bearing cap.
(3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.
(4) Carefully remove and discard the old upper oil seal.
(5) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the 2 main bearing caps forward of the rear bearing cap.
(6) Rotate the new upper seal into the cylinder block being careful not to shave or cut the outer surface of the seal. To assure proper installation, use the installation tool provided with the kit. Install the new seal with the yellow paint facing towards the rear of the engine.
(7) Install the new lower rear bearing oil seal into the bearing cap with the yellow paint facing towards the rear of the engine.
(8) Apply 5 mm (0.20 in) drop of Loctite 515, or equivalent, on each side of the rear main bearing cap (Fig. 18). Do not over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the yellow paint faces toward the rear of the engine.
(9) To align the bearing cap, use cap slot, alignment dowel and cap bolts. Do not remove excess ma-

terial after assembly. Do not strike rear cap more than 2 times for proper engagement.

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

(11) Install oil pump.

(12) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 19). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(13) Immediately install the oil pan.

LOWER SEAL REPLACEMENT

(1) Remove the oil pan.

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

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

(4) Carefully install a new upper seal (refer to Upper Seal Replacement - Crankshaft Installed procedure above).

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

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

(7) Apply 5 mm (0.20 in) drop of Loctite 515, or equivalent, on each side of the rear main bearing cap (Fig. 18). Do not over apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(8) To align the bearing cap, use cap slot, alignment dowel and cap bolts. Do not remove excess material after assembly. Do not strike rear cap more than 2 times for proper engagement.

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

(10) Install oil pump.

(11) Apply Mopar Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap to block joint to provide cap to block and oil pan sealing (Fig. 19). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Immediately install the oil pan.

CYLINDER BLOCK

Remove the engine assembly from the vehicle.

DISASSEMBLE

(1) Remove the cylinder head.

(2) Remove the oil pan.

(3) Remove the piston/connecting rod assembly.

CLEANING

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

INSPECTION

Examine block for cracks or fractures.

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

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

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

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

OIL LINE PLUG

The oil line plug is located in the vertical passage at the rear of the block between the Oil-To-Filter and Oil-From-Filter passages (Fig. 20). Improper installation or plug missing could cause erratic, low or no oil pressure.

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

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

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 inches) from machined surface of block (Fig. 20). If plug is too high, use a suitable flat dowel drift to position properly.

(4) If plug is off location, remove oil pan and rear main bearing cap. Use suitable flat dowel to remove plug. Coat outside diameter of new plug with Mopar (Stud and Bearing Mount Adhesive), or equivalent. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 inches) from bottom of the block.

(5) Assemble engine and check oil pressure.

ENGINE CORE, OIL AND CAMSHAFT PLUGS

Engine core plugs have been pressed into the oil galleries behind the camshaft thrust plate (Fig. 21). This will reduce internal leakage and help maintain higher oil pressure at idle.

REMOVAL

(1) Using a blunt tool such as a drift or a screwdriver and a hammer, strike the bottom edge of the cup plug (Fig. 22).

(2) With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 22).

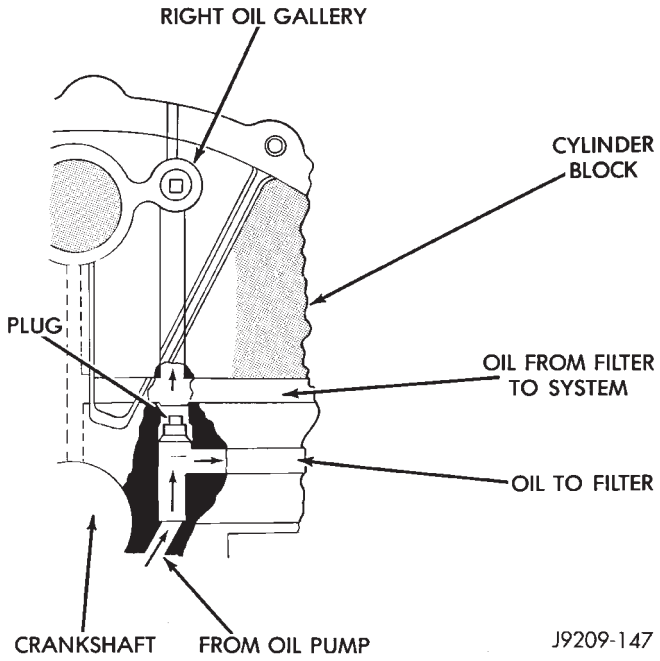


Fig. 20 Oil Line Plug

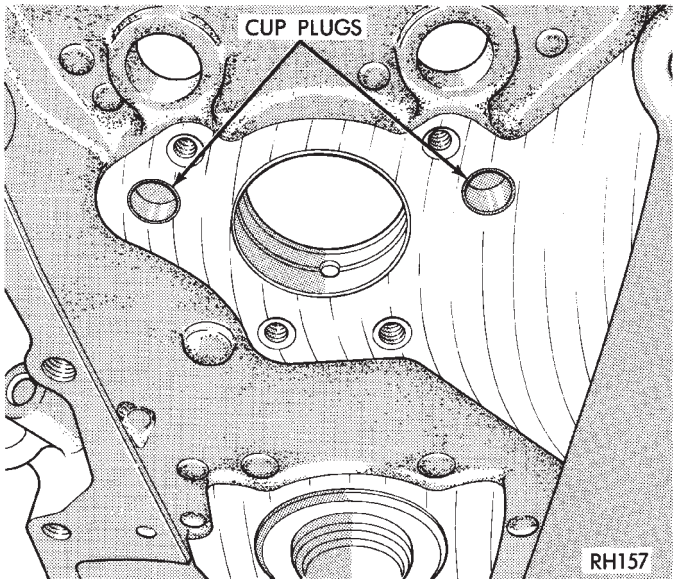


Fig. 21 Location of Cup Plugs in Oil Galleries

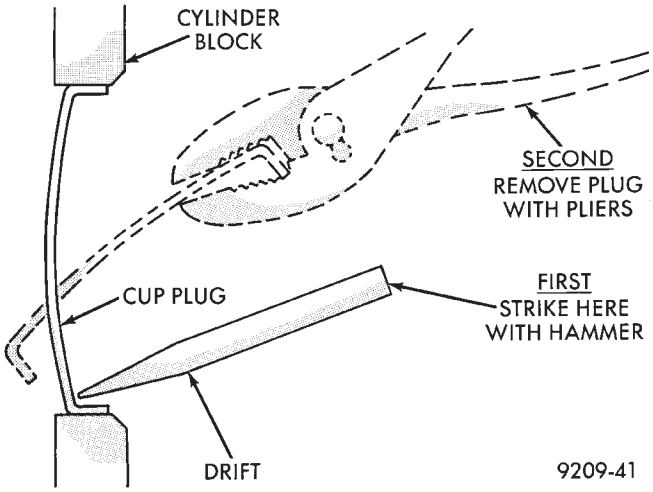


Fig. 22 Core Hole Plug Removal

CLEANING

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

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

INSTALLATION

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

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

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

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

ASSEMBLE

(1) Install the piston/connecting rod assembly.
(2) Install the oil pan.
(3) Install the cylinder head.
(4) Install the engine into the vehicle.

1993 Grand Cherokee/Grand Wagoneer
Publication No. 81-370-3147
TSB 09-08-93 May 28, 1993

SPECIFICATIONS—5.2L ENGINE

ENGINE SPECIFICATIONS

Camshaft

Bearing Diameter	
No. 1	50.800-50.825 mm (2.000-2.001 in)
No. 2	50.394-50.419 mm (1.984-1.985 in)
No. 3	50.013-50.038 mm (1.969-1.970 in)
No. 4	49.606-49.632 mm (1.953-1.954 in)
No. 5	39.688-39.713 mm (1.5625-1.5635 in)
Diametrical Clearance	0.0254-0.0762 mm (0.001-0.003 in)
Max. Allowable	0.127 mm (0.005 in)
End Play	0.051-0.254 mm (0.002-0.010 in)
Bearing Journal Diameter	
No. 1	50.749-50.775 mm (1.998-1.999 in)
No. 2	50.343-50.368 mm (1.982-1.983 in)
No. 3	49.962-49.987 mm (1.967-1.968 in)
No. 4	49.555-49.581 mm (1.951-1.952 in)
No. 5	39.637-39.662 mm (1.5605-1.5615 in)

Connecting Rods

Bearing Clearance	0.0127-0.0559 mm (0.0005-0.0022 in)
Piston Pin Bore Diameter	24.966-24.978 mm (0.9829-0.9834 in)
Side Clearance (Two Rods)	0.152-0.356 mm (0.006-0.014 in)
Total Weight (Less Bearing)	726 grams (25.61 oz)

Crankshaft

Connect Rod Journal	
Diameter	53.950-53.975 mm (2.124-2.125 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)
Diametrical Clearance	
No. 1	0.0127-0.0381 mm (0.0005-0.0015 in)
Nos. 2, 3, 4 and 5	0.0127-0.0508 mm (0.0005-0.0020 in)
Max. Allowable (Nos. 2, 3, 4 & 5)	0.0635 mm (0.0025 in)
End Play	0.051-0.178 mm (0.002-0.007 in)
Max. Allowable	0.254 mm (0.010 in)
Main Bearing Journals	
Diameter	63.487-63.513 mm (2.4995-2.5005 in)
Out-of-Round (Max.)	0.0254 mm (0.001 in)
Taper (Max.)	0.0254 mm (0.001 in)

Cylinder Block

Cylinder Bore	
Diameter	99.314-99.365 mm (3.910-3.912 in)
Out-of-Round (Max.)	0.127 mm (0.005 in)
Taper (Max.)	0.254 mm (0.010 in)
Oversize (Max.)	1.016 mm (0.040 in)
Distributor Lower Drive Shaft	
Bushing (Press Fit in Block)	0.0127-0.3556 mm (0.0005-0.0140 in)
Shaft-to-Bushing Clearance	0.0178-0.0686 mm (0.0007-0.0027 in)
Tappet Bore Diameter	22.99-23.01 mm (0.9051-0.9059 in)

Cylinder Head

Compression Pressure	689 kPa (100 psi)
Gasket Thickness (Compressed)	1.2065 mm (0.0475 in)
Valve Seat	
Angle	44.25° - 44.75°
Runout (Max.)	0.0762 mm (0.003 in)
Width (Finish) – Intake	1.016-1.524 mm (0.040-0.060 in)
Width (Finish) – Exhaust	1.524-2.032 mm (0.060-0.080 in)

Hydraulic Tappets

Body Diameter	22.949-22.962 mm (0.9035-0.9040 in)
Clearance in Block	0.0279-0.0610 mm (0.0011-0.0024 in)
Dry Lash	1.524-5.334 mm (0.060-0.210 in)
Push Rod Length	175.64–176.15 mm (6.915–6.935 in)

ENGINE SPECIFICATIONS (CONT.)

Oil Pump

Clearance Over Rotors (Max.)	0.1016 mm (0.004 in)
Cover Out-of-Flat (Max.)	0.0381 mm (0.0015 in)
Inner Rotor Thickness (Min.)	20.955 mm (0.825 in)
Outer Rotor	
Clearance (Max.)	0.3556 mm (0.014 in)
Diameter (Min.)	62.7126 mm (2.469 in)
Thickness (Min.)	20.955 mm (0.825 in)
Tip Clearance Between Rotors (Max)	0.2032 mm (0.008 in)

Oil Pressure

At Curb Idle Speed*	41.4 kPa (6 psi)
At 3000 rpm	207-552 kPa (30-80 psi)
Oil Pressure Switch	
Actuating Pressure (Min.)	34.5-48.3 kPa (5-7 psi)

*CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

Oil Filter

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

Pistons

Clearance at Top of Skirt	0.0127-0.0381 mm (0.0005-0.0015 in)
Land Clearance (Diametrical)	0.635-1.016 mm (0.025-0.040 in)
Piston Length	86.360 mm (3.40 in)
Piston Ring Groove Depth	
Nos. 1 and 2	4.572-4.826 mm (0.180-0.190 in)
No. 3	3.810-4.064 mm (0.150-0.160 in)
Weight	592.6-596.6 grams (20.90-21.04 oz)

Piston Pins

Clearance	
In Piston	0.00635-0.01905 mm (0.00025-0.00075 in)
In Rod (Interference)	0.0178-0.0356 mm (0.0007-0.0014 in)
Diameter	24.996-25.001 mm (0.9841-0.9843 in)
End Play	NONE
Length	75.946-76.454 mm (2.990-3.010 in)

Piston Rings

Ring Gap	
Compression Rings	0.254-0.508 mm (0.010-0.020 in)
Oil Control (Steel Rails)	0.254-1.270 mm (0.010-0.050 in)
Ring Side Clearance	
Compression Rings	0.038-0.076 mm (0.0015-0.0030 in)
Oil Ring (Steel Rails)	0.06-0.21 mm (0.002-0.008 in)
Ring Width	
Compression Rings	1.971-1.989 mm (0.0776-0.0783 in)
Oil Ring (Steel Rails)	3.848-3.975 mm (0.1515-0.1565 in)

Valves

Face Angle	43.25°-43.75°
Head Diameter	
Intake	48.666 mm (1.916 in)
Exhaust	41.250 mm (1.624 in)
Length (Overall)	
Intake	124.28-125.92 mm (4.893-4.918 in)
Exhaust	124.64-125.27 mm (4.907-4.932 in)
Lift (Zero Lash)	10.973 mm (0.432 in)
Stem Diameter	7.899-7.925 mm (0.311-0.312 in)
Stem-to-Guide Clearance	0.0254-0.0762 mm (0.001-0.003 in)
Max. Allowable (Rocking Method)	0.4318 mm (0.017 in)
Guide Bore Diameter (Std)	7.950-7.976 mm (0.313-0.314 in)

ENGINE SPECIFICATIONS (CONT.)

Valve Springs

Free Length (Approx.)	49.962 mm (1.967 in)
Spring Tension (Valve Closed)	@ 41.66 mm = 378 N (@ 1.64 in = 85 lbs)
Spring Tension (Valve Open)	@ 30.89 mm = 890 N (@ 1.212 in = 200 lbs)
Number of Coils	6.8
Installed Height (Spring Seat to Retainer)	41.66 mm (1.64 in)
Wire Diameter	4.50 mm (0.177 in)

Valve Timing

Exhaust Valve	
Closes (ATC)	16°
Opens (BBC)	52°
Duration	248°
Intake Valve	
Closes (ABC)	50°
Opens (BTC)	10°
Duration	240°
Valve Overlap	26°

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OVERSIZE AND UNDERSIZE ENGINE COMPONENT MARKINGS

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

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TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
Adjusting Strap Bolt	23 N·m (200 in. lbs.)
Bell Housing Bolts	41 N·m (30 ft. lbs.)
Camshaft Bolt	68 N·m (50 ft. lbs.)
Camshaft Thrust Plate Bolts	24 N·m (210 in. lbs.)
Chain Case Cover Bolts	41 N·m (30 ft. lbs.)
Connecting Rod Cap Bolts	61 N·m (45 ft. lbs.)
Crankshaft Main Bearing Cap Bolts	115 N·m (85 ft. lbs.)
Cylinder Head Bolts	
1st Step	68 N·m (50 ft. lbs.)
2nd Step	143 N·m (105 ft. lbs.)
Cylinder Head Collar Studs	13 N·m (115 in. lbs.)
Cylinder Head Cover Bolts	11 N·m (95 in. lbs.)
Exhaust Manifold Bolts	27 N·m (20 ft. lbs.)
Exhaust Manifold Nuts	20 N·m (15 ft. lbs.)
Front Left Sill Bracket	
Top Bolts	54 N·m (40 ft. lbs.)
Side Nuts	95 N·m (70 ft. lbs.)
Side and Bottom Bolts	121 N·m (89 ft. lbs.)
Front Right Inner Sill Bracket Stud-Nut	65 N·m (48 ft. lbs.)
Front Right Sill Bracket Bolts	54 N·m (40 ft. lbs.)
Front Support Bracket Through-Bolt Nuts	68 N·m (50 ft. lbs.)
Front Support Bracket-to-Engine Block Bolts	88 N·m (65 ft. lbs.)
Generator Mounting Bolt	41 N·m (30 ft. lbs.)
Intake Manifold Bolts	Refer to Procedure in Service Manual
Oil Pan Bolts	24 N·m (215 in. lbs.)
Oil Pan Drain Plug	27 N·m (20 ft. lbs.)
Oil Pump Attaching Bolts	41 N·m (30 ft. lbs.)
Oil Pump Cover Bolts	11 N·m (95 in. lbs.)
Rear Mount Bracket Through-Bolt Nut	65 N·m (48 ft. lbs.)
Rear Mount Bracket Assembly Bolts	75 N·m (55 ft. lbs.)
Rear Mount Clevis Bracket-to-Crossmember Stud-Nuts	41 N·m (30 ft. lbs.)
Rocker Arm Bolts	28 N·m (21 ft. lbs.)
Spark Plugs	41 N·m (30 ft. lbs.)
Starter Mounting Bolts	68 N·m (50 ft. lbs.)
Throttle Body Bolts (MPI)	23 N·m (20o in. lbs.)
Torque Converter Drive Plate Bolts	31 N·m (270 in. lbs.)
Transmission Support Bracket Adaptor Bolts	95 N·m (70 ft. lbs.)
Transmission-to-Clutch Bolts	68 N·m (50 ft. lbs.)
Vibration Damper Retainer Bolt	183 N·m (135 ft. lbs.)
Water Pump-to-Chain Case Cover Bolt	41 N·m (30 ft. lbs.)

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