SIX-CYLINDER ENGINE

GENERAL

The 258 CID (4.2 liter), in-line, overhead valve, lightweight six-cylinder engine (figs. 1B-42 and 1B-43) operates only on no-lead gasoline. The cylinders are numbered from front to rear and the firing order is 1-5-3-6-2-4. Crankshaft rotation is clockwise, viewed from the front. The crankshaft is supported by seven two-piece bearings (inserts). The camshaft is supported by four one-piece, line bored bearings.

The six-cylinder engine features a quench-head combustion chamber design. The combustion chamber shape, both in the head and in the piston crown, compresses the combustion mixture closer to the spark plug. In most applications, this permits the use of more advanced ignition timing for better fuel economy.

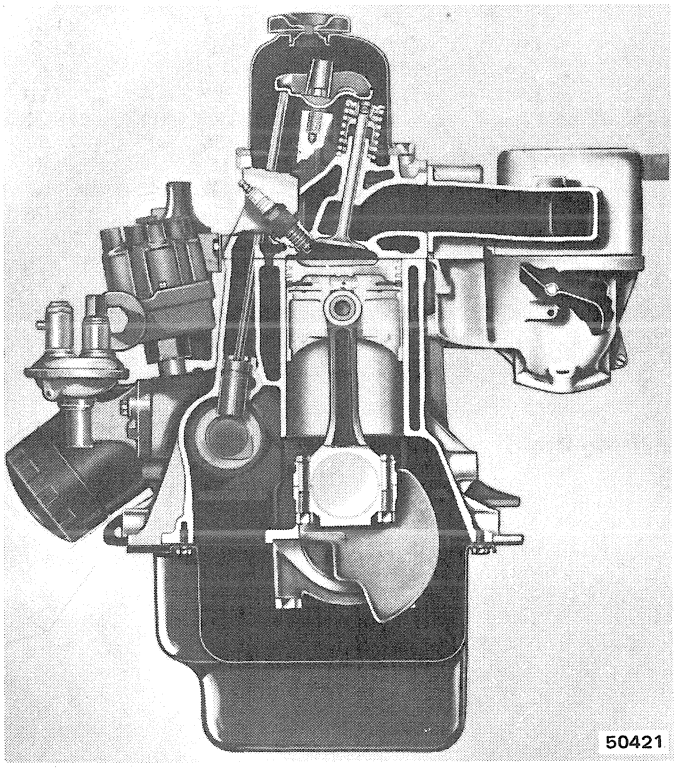
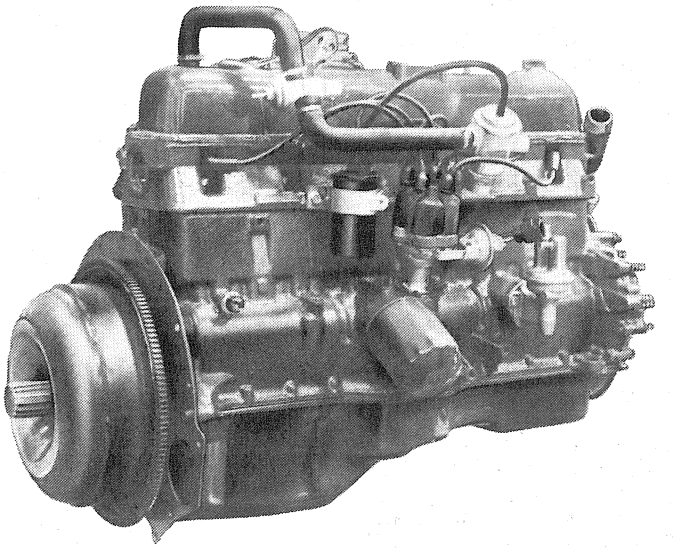


Fig. 1B-42 Six-Cylinder Engine Assembly—Sectional View



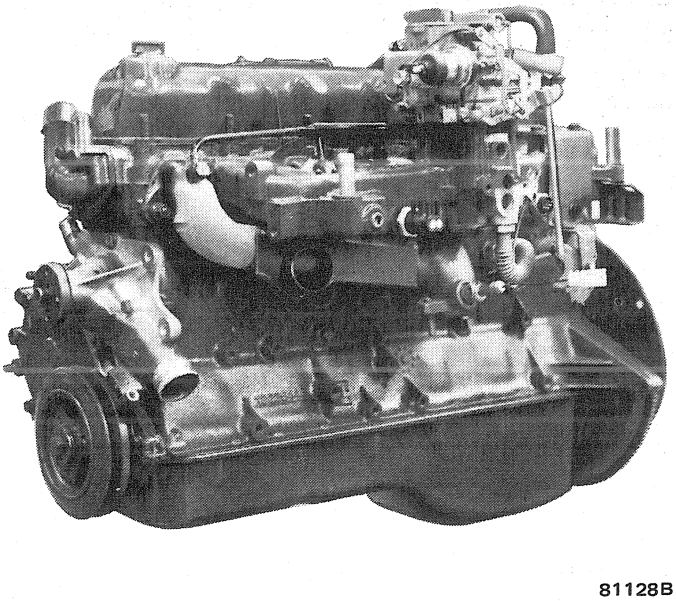


Fig. 1B-43 Six-Cylinder Engine Assembly—Typical

Identification

Build Date Code

The engine Build Date Code is located on a machined surface on the left side of the block (viewed from front) between the No. 2 and No. 3 cylinders (fig. 1B-44).

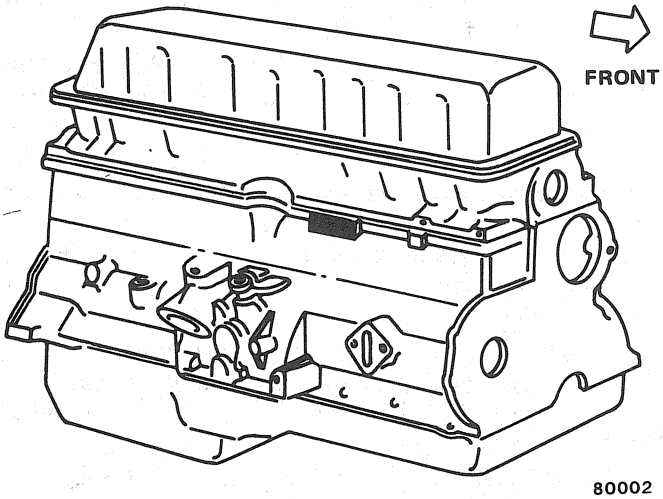


Fig. 1B-44 Engine Build Date Location

The numbers in the code identify the year, month and day that the engine was built.

The code letter identifies the cubic inch displacement, carburetor type and compression ratio. The data are decoded as listed in the Engine Build Date Code Chart.

Engine Build Date Code

Letter Code	CID	Carburetor	Compression Ratio
C	258	2V	8.0:1

1st Character (Year)	2nd and 3rd Characters (Month)	4th Character (Engine Type)	5th and 6th Characters (Day)
0 - 1980 1 - 1981	01 - 12	C	01 - 31

EXAMPLE: 4 10 C 18 60257

The example code identifies a 258 CID (4.2 liter) engine with 2V carburetor and 8.0:1 compression ratio that was built on October 18, 1980.

Oversize or Undersize Components

Some engines may be built with oversize or undersize components, such as oversize cylinder bores, undersize crankshaft main bearing journals, undersize connecting rod journals or oversize camshaft bearing bores. These engines are identified by a letter code stamped on a boss between the ignition coil and distributor (fig. 1B-45). The letters are decoded as listed in the Oversize or Undersize Components chart.

Oversize or Undersize Components

Code Letter	Definition	
B	All cylinder bores	-0.010-inch (0.254mm) oversize
M	All crankshaft main bearing journals	-0.010-inch (0.254mm) undersize
P	All connecting rod bearing journals	-0.010-inch (0.254mm) undersize
C	All camshaft bearing bores	-0.010-inch (0.254mm) oversize

EXAMPLE: The code letters PM mean that the crankshaft main bearing journals and connecting rod journals are 0.010-inch undersize.

60258

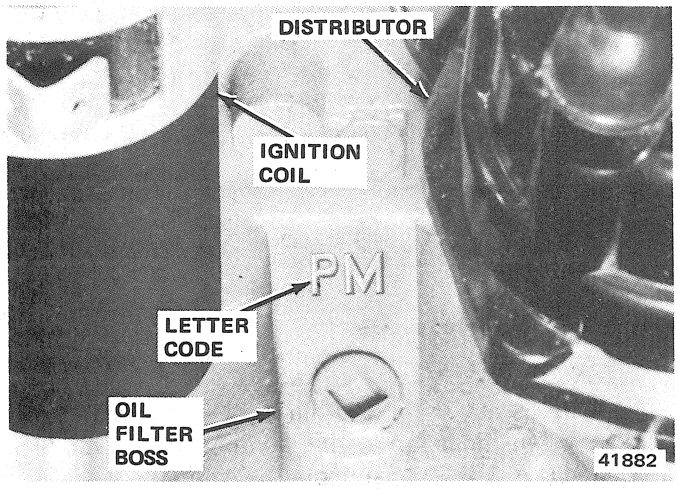


Fig. 1B-45 Oversize or Undersize Letter Code Location

SHORT ENGINE ASSEMBLY (SHORT BLOCK)

A service replacement short engine assembly (short block) may be installed whenever the original engine block is worn or damaged beyond feasible repair. It consists of engine block, piston and rod assemblies, crankshaft, camshaft, timing sprockets and chain.

NOTE: *Short engine assemblies have an S stamped on the same surface as the build date code for identification.*

Installation includes transfer of component parts from the worn or damaged original engine. Follow the appropriate procedures for cleaning, inspection, installation and tightening as outlined in this chapter.

ENGINE MOUNTING

Resilient rubber cushions support the engine and transmission at three points: at each side on the centerline of the engine and at the rear between the transmission extension housing and the rear support crossmember (fig. 1B-46). Replacement of a cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion.

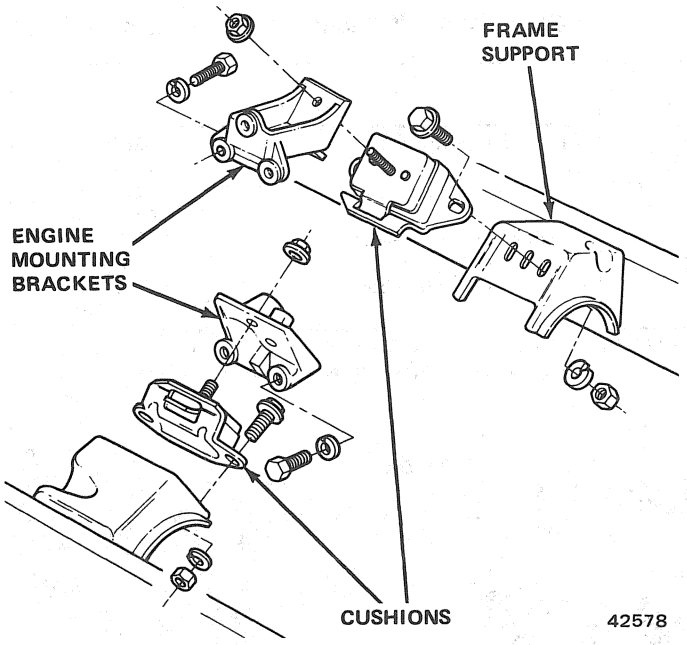


Fig. 1B-46 Engine Mounting—Typical

ENGINE HOLDING FIXTURE

If it is necessary to remove the front engine mounting brackets or cushions, an engine holding fixture may be fabricated (fig. 1B-47) to support the engine.

The engine also may be supported by a jack placed under the oil pan skid plate. Use a board between the jack and skid plate to distribute the weight evenly.

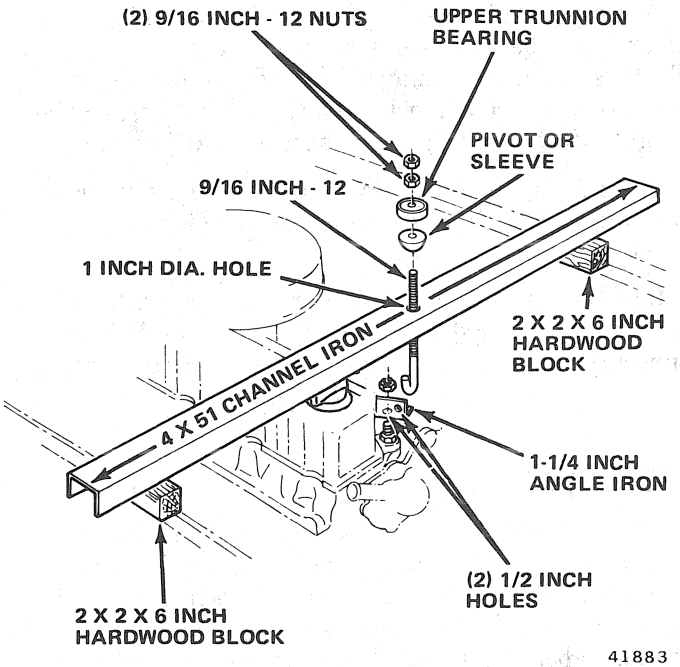


Fig. 1B-47 Engine Holding Fixture

ENGINE REMOVAL

The engine is removed without the transmission and flywheel/drive plate housing. Raise the vehicle slightly to provide working clearance.

(1) Drain cooling system.

NOTE: *Drain coolant in a clean container for re-use.*

(2) On all vehicles except CJ, remove hood. Mark hinge locations for installation alignment.

(3) Remove battery on Cherokee, Wagoneer and Truck vehicles. On CJ vehicles, disconnect battery negative cable.

(4) Remove air cleaner. Disconnect and plug fuel pipe connected to fuel pump. Disconnect fuel return pipe from hose at connection on frame.

(5) Disconnect heater hoses at front of engine and rear of intake manifold on CJ vehicles, and at heater on other vehicles.

(6) Disconnect throttle cable from engine.

(7) Disconnect throttle valve rod, if equipped.

(8) Disconnect wiring harness from engine and alternator and lay aside.

(9) Identify and tag vacuum hoses, and disconnect from engine.

(10) Disconnect shroud, if equipped, from radiator.

(11) Remove radiator, fan and shroud. Install bolt in pulley after fan is removed to maintain pulley in alignment with bolt holes in water pump.

(12) Disconnect cable from starter motor. Remove starter motor.

(13) Remove engine mount cushion-to-frame attaching nuts.

(14) Disconnect exhaust pipe.

(15) If equipped with manual transmission:

(a) Remove flywheel housing bolts.

(b) Remove clutch linkage and shield.

(16) If equipped with automatic transmission:

(a) Remove drive plate access cover.

(b) Mark converter and drive plate to facilitate correct installation alignment.

(c) Remove converter-to-drive plate bolts. Rotate crankshaft for access to each bolt.

(d) Remove drive plate housing-to-engine bolts. Remove oil pan screws that retain transmission fluid cooler lines.

(17) Support transmission with jack.

(18) If equipped with power steering, disconnect hoses at steering gear. Tie hoses to engine to prevent draining.

(19) If equipped with air conditioning:

(a) Turn compressor service fitting valve stem to seat position.

(b) Loosen service fitting.

(c) Allow compressor refrigerant to escape.

(d) Remove fittings from compressor.

(20) Attach engine lift device. Pull engine forward to disengage from transmission. Lift upward to remove.

ENGINE INSTALLATION

(1) Remove right mount from engine.
(2) Lower engine into compartment. Attach engine to transmission.
(3) Install flywheel/drive plate housing bolts and remove transmission jack.
(4) Attach engine mount to block. Lower engine and tighten all engine mount bolts and nuts.
(5) If equipped with manual transmission:
(a) Install flywheel housing shield and clutch linkage.
(b) Adjust clutch, if necessary.
(6) If equipped with automatic transmission:
(a) Align marks on converter and drive plate. Install converter-to-drive plate bolts.
(b) Install drive plate access cover.
(c) Attach transmission fluid cooler lines to engine with oil pan screws.
(7) Install exhaust pipe.
(8) Install starter motor and connect cable.
(9) Remove lifting device.
(10) Connect fuel supply and return pipes.
(11) If equipped with power steering, connect hoses to steering gear.
(12) Connect electrical wires and vacuum hoses.
(13) Connect heater hoses.
(14) Install fan. If equipped with shroud, position shroud over fan blades.
(15) Install radiator and attach shroud to radiator.
(16) Connect radiator hoses. If equipped with automatic transmission, connect fluid cooler lines to radiator.
(17) Install throttle linkage.
(18) Connect throttle valve rod and retainer. Install throttle valve and spring.
(19) If equipped with air conditioning:
(a) Connect service valves to compressor.
(b) Open valve to mid-position.
(c) Open service port slightly. Allow small amount of refrigerant to escape to purge compressor of air.
(d) Tighten port cap.
(20) Install battery, if removed, and connect cables.
(21) Install coolant.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(22) Start engine. While engine is warming up, install hood.
(23) Inspect for fuel, oil and water leaks. Turn engine off and check fluid levels.
(24) Install air cleaner and road-test vehicle.

VALVE TRAIN

General

The six-cylinder engine has overhead valves that are operated by push rods and rocker arms. A chain-driven camshaft is mounted in the cylinder block. Hydraulic valve tappets provide automatic valve lash adjustments.

Rocker Arm Assembly

The intake and exhaust rocker arms of each cylinder pivot on a bridge and pivot assembly that is secured with two capscrews as illustrated in figure 1B-48. The bridge and pivot assembly maintains correct rocker arm-to-valve tip alignment. Each rocker arm is actuated by a hollow steel push rod with a hardened steel ball at each end. The hollow push rods route oil to the rocker arm assemblies.

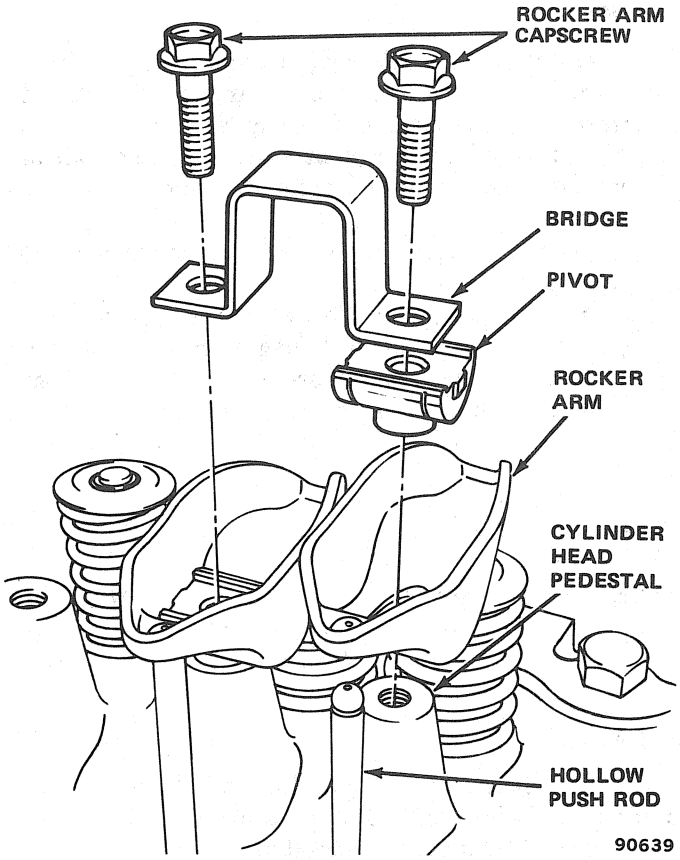


Fig. 1B-48 Rocker Arm Assembly

Removal

(1) Remove cylinder head cover and gasket.
(2) Remove two capscrews at each bridge and pivot assembly. Alternately loosen capscrews one turn at a time to avoid damaging bridge.
(3) Remove bridge and pivot assemblies and corresponding pairs of rocker arms and place on bench in same order as removed.

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

Cleaning and Inspection

Clean all parts with a cleaning solvent and use compressed air to blow out oil passages in the rocker arms and push rods.

Inspect the pivoting surface of each rocker arm and pivot. Replace any parts that are scuffed, pitted or excessively worn. Inspect 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 the push rod and inspect the corresponding tappet.

It is not normal to find a wear pattern along the length of the push rod. Examine the cylinder head for obstruction if this condition exists.

Installation

(1) Install each push rod in same location from where it was removed. **Ensure bottom end of each rod is centered in plunger cap of hydraulic valve tappet.**

(2) Install bridge and pivot assemblies and pair of rocker arms adjacent to same cylinders from where they were removed.

(3) Loosely install capscrews on each bridge and pivot assembly.

(4) At each bridge, tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten with 19 foot-pounds (26 N•m) torque.

(5) Install cylinder head cover and gasket.

Valves

NOTE: *The following procedures apply only after the cylinder head has been removed from the engine. Refer to Cylinder Head for removal procedure.*

Disassembly

(1) Compress each valve spring with Valve Spring Compressor Tool J-22534-01 and remove valve locks, retainers, springs and valve stem oil deflectors.

(2) Remove valves and place in rack in same order as removed from cylinder head.

Cleaning and Inspection

(1) Clean all carbon deposit from combustion chambers, valve ports, valve stems and head.

(2) Clean all foreign matter and gasket cement from cylinder head machined surface.

(3) Inspect for cracks in combustion chambers and valve ports.

(4) Inspect for cracks in gasket mating surface around each coolant passage.

(5) Inspect valves for burned, cracked or warped heads. Inspect for scuffed or bent valve stems. Replace valves displaying any damage.

Valve Refacing

Use a valve refacing machine to reface intake and exhaust valves to the specified angle. After refacing, at least 1/32-inch (0.787 mm) margin must remain. If not, replace the valve. Examples of correct and incorrect valve refacing are illustrated in figure 1B-49.

The valve stem tip can be resurfaced and rechamfered when worn. Do not remove more than 0.020 inch (0.508 mm).

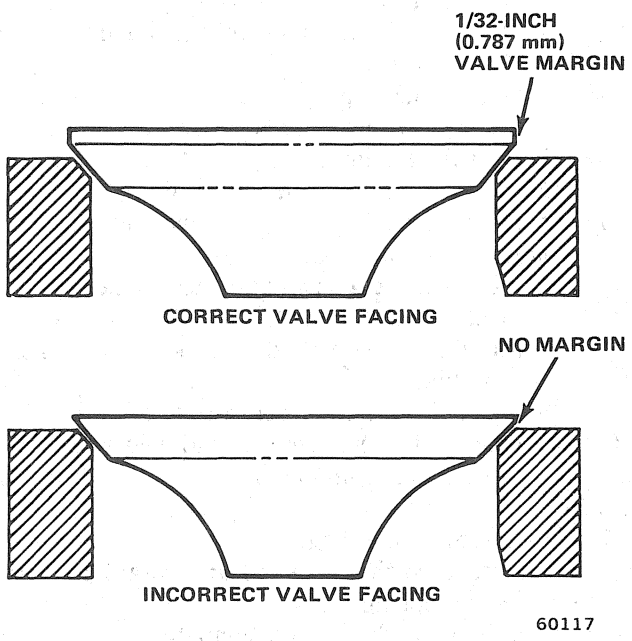


Fig. 1B-49 Valve Refacing

Valve Seat Refacing

Install a pilot of the correct size in the valve guide and reface the valve seat to the specified angle with a dressing stone in good condition. Remove only enough metal to provide a smooth finish.

Use tapered stones to obtain the specified seat widths when required.

Control seat runout to a maximum of 0.0025 inch (0.064 mm) (fig. 1B-50).

Valve Stem Oil Deflector Replacement

Nylon valve stem oil deflectors are installed on each valve stem to prevent lubricating oil from entering the combustion chamber through the valve guides. Replace the oil deflectors whenever valve service is performed or if the deflectors have deteriorated.

Valve stem oil deflector replacement requires removal of valve spring(s). Refer to Valve Springs for procedure.

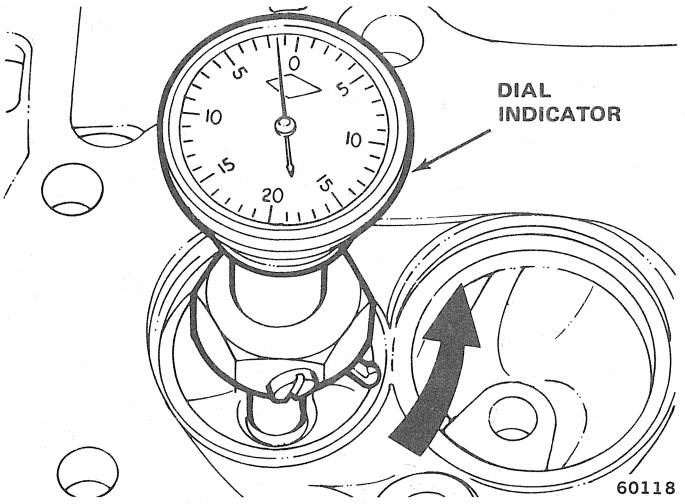


Fig. 1B-50 Measuring Valve Seat Runout

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable. When the stem-to-guide clearance is excessive, ream the valve guide bores to accommodate the next larger oversize valve stem. Oversize service valves are available with 0.003-inch (0.076 mm), 0.015-inch (0.381 mm), and 0.030-inch (0.762 mm) stem diameter sizes. Refer to Valve Guide Reamer Sizes chart for reamer sizes.

Valve Guide Reamer Sizes

Reamer Tool Number	Size
J-6042-1 J-6042-5 J-6042-4	0.003-inch (.076 mm) 0.015-inch (.381 mm) 0.030-inch (.762 mm)

60260

NOTE: *Ream valve guides in steps, starting with the 0.003-inch (0.076 mm) oversize reamer and progressing to the size required.*

Valve Stem-to-Guide Clearance

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

Preferred Method:

(1) Remove valve from head and clean valve guide bore with solvent and bristle brush.

(2) Insert telescoping gauge into valve guide bore approximately 3/8 inch (9.525 mm) from valve spring side of head (fig. 1B-51) with contacts crosswise to cylinder head. Measure telescoping gauge contacts with micrometer.

(3) Repeat measurement with contacts lengthwise to cylinder head.

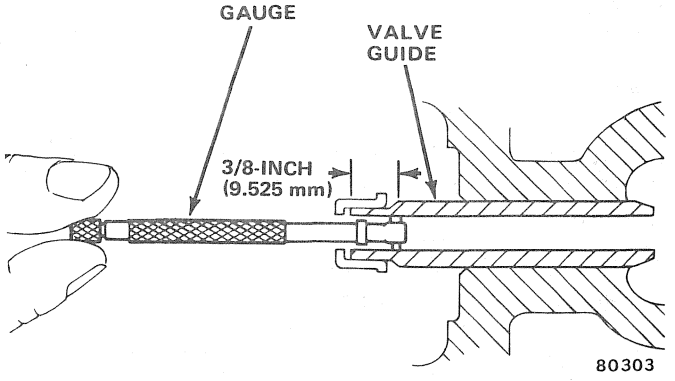


Fig. 1B-51 Valve Stem-to-Guide Clearance Measurement with Telescoping Gauge

(4) Compare crosswise to lengthwise measurements to determine out-of-roundness. If measurements differ by more than 0.0025 inch (0.064 mm), ream guide bore to accommodate oversize valve stem.

(5) Compare valve guide bore diameter with diameter listed in Specifications. If measurement differs more than 0.003 inch (0.076 mm), ream guide to accommodate oversize valve stem.

Alternate Method:

(1) Use dial indicator to measure lateral movement of valve stem with valve installed in its guide and barely off valve seat (fig. 1B-52).

(2) Correct clearance is 0.001 to 0.003 inch (0.025 mm to 0.076 mm). If indicated movement exceeds acceptable clearance, ream guide to accommodate oversize valve stem.

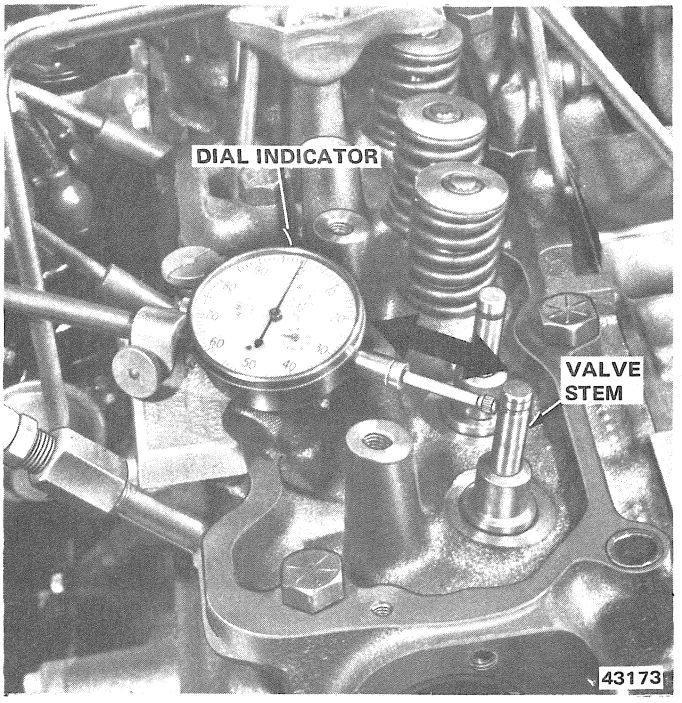


Fig. 1B-52 Valve Stem-to-Guide Clearance Measurement with Dial Indicator

Assembly

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

(2) Lightly lubricate stem and install valve in same valve guide bore from where it was removed.

(3) Install replacement valve stem oil deflector on valve stem.

NOTE: *If valves with oversize stems are used, oversize oil deflectors are also required.*

(4) Position valve spring and retainer on cylinder head and compress valve spring with compressing tool. Install valve locks and release tool.

(5) Tap valve spring from side-to-side with hammer to assure spring is properly seated on cylinder head.

Valve Springs

Valve Spring and Oil Deflector Removal

NOTE: *This procedure is for removal of valve springs and oil deflectors with the cylinder head installed on the engine. Refer to Valves for removal procedure with the head removed from the engine.*

The valve spring is held in place on the valve stem by a retainer and a pair of conical-type valve locks. The locks can be removed only by compressing the valve spring.

(1) Remove cylinder head cover.

(2) Remove bridge and pivot assemblies and rocker arms.

(3) Remove push rods.

NOTE: *Retain push rods, bridge and pivot assemblies and rocker arms in same order and position as removed.*

(4) Remove spark plug from each cylinder.

NOTE: *Steps (5) through (9) apply to each cylinder to be serviced.*

(5) Install 14-mm (thread size) air adapter in spark plug hole.

NOTE: *An adapter can be fabricated by welding an air hose connection to the body of a spark plug having the porcelain removed.*

(6) Connect air hose to adapter and maintain at least 90 psi (620 kPa) in cylinder to force valves against their seats.

NOTE: *On vehicles equipped with air conditioning, use a flexible air adapter when servicing No. 1 cylinder.*

(7) Use Valve Spring Remover and Installer Tool J-22534-01 to compress spring and remove locks (fig. 1B-53).

(8) Remove valve spring and retainer.

(9) Remove valve stem oil deflector.

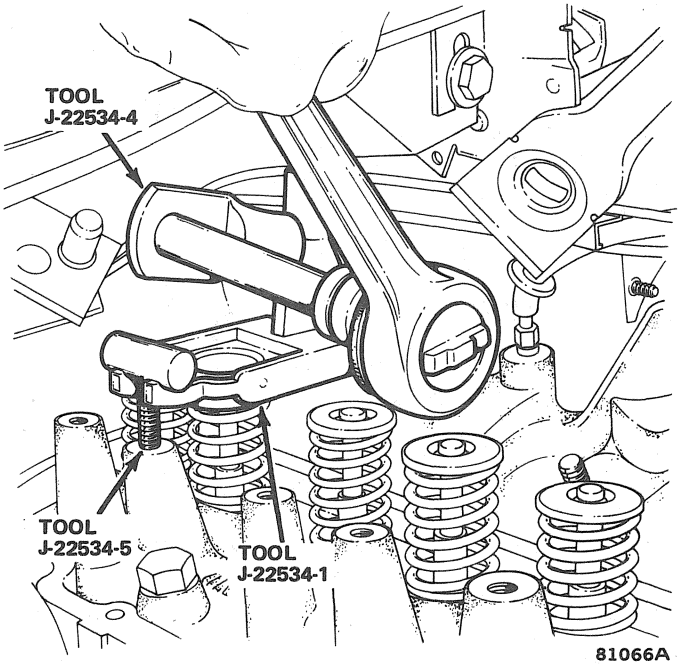


Fig. 1B-53 Valve Spring Removal

Valve Spring Tension Test

Use Valve Spring Tester J-8056, or equivalent, to test each valve spring for the specified tension value (fig. 1B-54). Replace valve springs that are not within the specification.

Oil Deflector and Valve Spring Installation

NOTE: *The following procedure applies to each cylinder being serviced.*

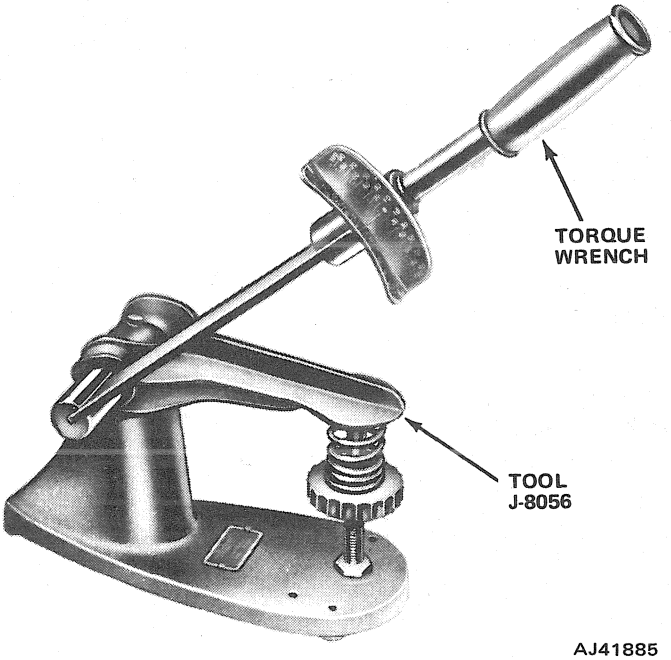


Fig. 1B-54 Valve Spring Tester—Typical

(1) Use 7/16-inch deep socket and small hammer to gently tap oil deflector onto valve stem.

CAUTION: *Install the deflector carefully to prevent damage from the sharp edges of the valve lock groove.*

(2) Install valve spring and retainer.

(3) Compress valve spring with tool J-22534-01 and position valve locks. Release spring tension and remove tool.

NOTE: *Tap spring from side-to-side to ensure spring is seated properly on cylinder head.*

(4) Disconnect air hose, remove adapter from spark plug hole and install spark plug.

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

(6) Install rocker arms and bridge and pivot assembly. At each bridge and pivot assembly tighten capscrews alternately, one turn at a time, to avoid damaging bridge.

(7) Install cylinder head cover. Refer to Cylinder Head Cover for procedure.

CAMSHAFT AND BEARINGS

The camshaft is supported by form steel-shelled, babbitt-lined bearings pressed into the block and line reamed. The step-bored camshaft bearing bores are larger at the front bearing than at the rear to permit easy removal and installation of the camshaft. Camshaft bearings are pressure lubricated.

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

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face. Camshaft end play is zero during engine operation.

Measuring Cam Lobe Lift

(1) Remove cylinder head cover.

(2) Remove bridge and pivot assemblies and rocker arms.

(3) Remove spark plugs.

(4) Install dial indicator on end of push rod. Use piece of rubber tubing to hold dial indicator plunger squarely on push rod (fig. 1B-55).

(5) Rotate crankshaft until cam lobe base (heel) circle (push rod down) is under valve tappet. Set dial indicator to zero.

(6) Rotate crankshaft until push rod reaches its maximum upward travel. Note distance on dial indicator. Correct cam lobe lift is 0.242 to 0.254 inch (6.147 to 6.451 mm).

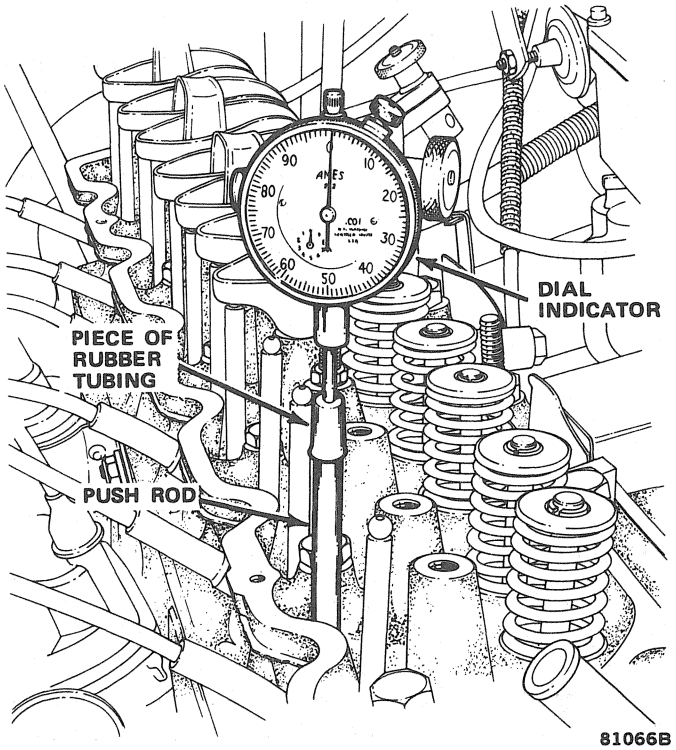


Fig. 1B-55 Cam Lobe Lift Measurement and Valve Timing

Valve Timing

(1) Disconnect ignition wires and remove spark plugs.

(2) Remove cylinder head cover.

(3) Remove bridge and pivot assembly and rocker arms from No. 1 cylinder.

(4) Rotate crankshaft until No. 6 piston is at TDC on compression stroke.

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

(6) Install dial indicator on end of No. 1 cylinder intake valve push rod. Set dial indicator to zero (fig. 1B-55).

(7) Rotate crankshaft clockwise (viewed from front of engine) until dial indicator pointer indicates 0.016-inch (0.406 mm) lift.

(8) Timing mark on vibration damper should be indexed with TDC mark on timing degree scale. If timing mark is more than 1/2 inch (12.7 mm) from TDC in either direction, valve timing is incorrect.

Camshaft Removal

(1) Drain cooling system.

NOTE: *Drain coolant in clean container if reusable.*

(2) Remove radiator and fan assembly.

(3) Remove air conditioner condenser and receiver assembly as charged unit, if equipped.

(4) Remove fuel pump.

(5) Remove distributor and ignition wires.

(6) Remove cylinder head cover.
(7) Remove rocker arms and bridge and pivot assemblies.
(8) Remove push rods.

NOTE: *Retain push rods, bridge and pivot assemblies and rocker arms in the same order as removed.*

(9) Remove cylinder head and gasket.
(10) Remove hydraulic tappets.
(11) Remove timing case cover. Refer to Timing Case Cover Removal for procedure.
(12) Remove timing chain and sprockets. Refer to Timing Chain Removal for procedure.
(13) Remove front bumper or grille as required.
(14) Remove camshaft.

Camshaft Inspection

Inspect the camshaft bearing journals for an uneven wear pattern or rough finish. If either condition exists, inspect camshaft bearings. Inspect loaded (bottom) side of bearing. This is the most probable location for bearing failure. Replace camshaft and bearings as required. Refer to Camshaft Bearing Replacement for procedure.

Inspect the distributor drive gear for damage or excessive wear. Replace if necessary.

Inspect each cam lobe and the corresponding hydraulic valve tappet for wear. If the face of the tappet(s) is worn concave, the corresponding camshaft lobe(s) will also be worn. Replace both the camshaft and the tappet(s).

If the camshaft appears to have been rubbing heavily against the timing case cover, examine the oil pressure relief holes in the rear cam journal. These holes relieve oil pressure between the end of the camshaft and the rear bearing plug.

Camshaft Installation

(1) Lubricate camshaft with Jeep Engine Oil Supplement (E.0.S), or equivalent.
(2) Install camshaft carefully to prevent damaging camshaft bearings.
(3) Install timing chain, crankshaft sprocket and camshaft sprocket with timing marks aligned. Refer to Timing Chain Installation for procedure.
(4) Install camshaft sprocket retaining screw and tighten.
(5) Install timing case cover with replacement oil seal. Refer to Timing Case Cover Installation for procedure.
(6) Install vibration damper.
(7) Install damper pulley, if removed.
(8) Install engine fan and hub assembly.
(9) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling Systems.
(10) Install fuel pump.
(11) Rotate crankshaft until No. 1 piston is at TDC position on compression stroke.
(12) Install distributor and ignition wires. Install distributor with rotor aligned with No. 1 terminal on cap when distributor housing is fully seated on block.
(13) Install hydraulic tappets. Lubricate tappets and all valve train components with Jeep Engine Oil Supplement (EOS), or equivalent.

NOTE: *The EOS must remain in the engine for at least 1,000 miles (1 609 km) but need not be drained until the next scheduled oil change.*

(14) Install cylinder head and gasket.
(15) Install push rods.
(16) Install rocker arms and bridge and pivot assemblies. Alternately tighten capscrews for each bridge one turn at a time to avoid damaging bridge.
(17) Install cylinder head cover. Refer to Cylinder Head Cover for procedure.
(18) Install air conditioner condenser and receiver assembly, if equipped.

CAUTION: *Open both service valves before the air conditioning system is operated.*

(19) Install radiator, connect hoses and fill cooling system with specified mixture. Refer to Chapter 1C—Cooling Systems.
(20) Install front bumper or grille, if removed.
(21) Check ignition timing and adjust as required.

Camshaft Bearing Replacement

Camshaft bearing replacement requires that the engine be removed from the vehicle. Remove timing case cover, crankshaft, camshaft and rear bearing plug. When installing bearings, use a screw-type tool that provides steady force. Do not use a driver-type tool to install bearings. Care must be taken to align oil holes in bearings with oil galleries in the block. It is not necessary to line ream camshaft bearings after installation.

HYDRAULIC VALVE TAPPETS

The hydraulic valve tappet consists of the tappet body, plunger, plunger return spring, check valve assembly metering disc, plunger cap and lockring (fig. 1B-56).

The tappet operates in a guide bore that intersects with the main oil gallery.

Operation

The operating cycle of the hydraulic tappet begins when the tappet is on the heel (base circle) of the cam lobe (engine valve closed). A groove in the tappet body aligns with the tappet oil gallery to admit pressurized oil into the tappet (fig. 1B-57). A hole and groove arrangement admits the oil to the inside of the plunger. Oil is

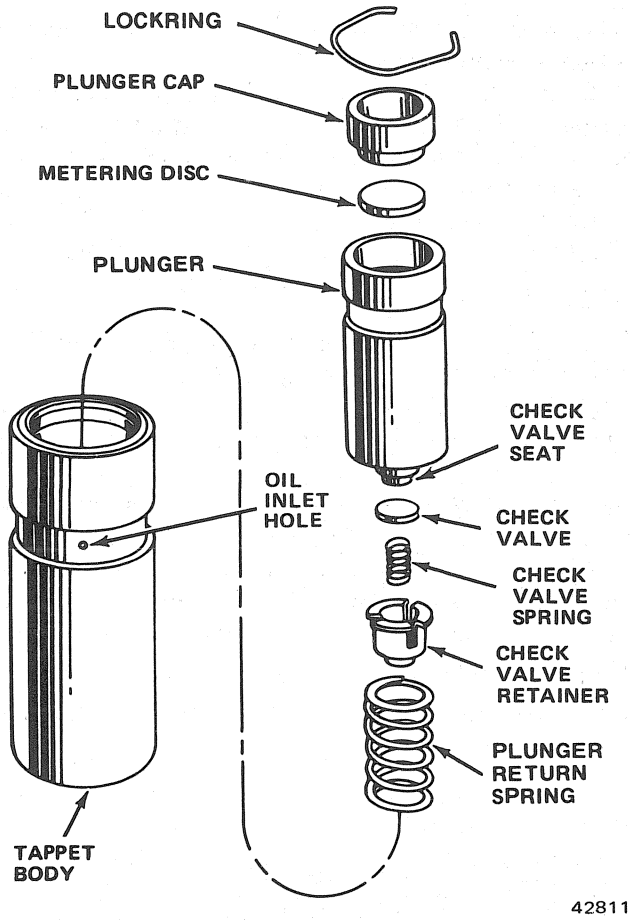


Fig. 1B-56 Hydraulic Valve Tappet Components

forced past the plunger check valve and fills the chamber between the plunger and tappet body. When the chamber is full, additional oil in the plunger body unseats the metering disc, and a spurt of oil flows up inside the push rod to lubricate the rocker assembly. These events described above all occur while the tappet is on the heel of the cam lobe. As the cam turns, the lobe begins exerting force on the tappet body. This force is transmitted by the trapped oil in the tappet chamber to the plunger and finally to the push rod and rocker assembly. The engine valve opens. While the valve is open, the trapped oil is subjected to considerable pressure and some of it escapes between the plunger and the tappet body (leak-down). The cycle is completed as the cam lobe rotates back to the starting position and another charging cycle begins. In this way, zero valve lash is maintained and engine noise is reduced.

Removal

(1) Drain cooling system.

NOTE: *Drain coolant in clean container if reusable.*

(2) Remove cylinder head cover.

(3) Remove bridge and pivot assemblies and rocker arms.

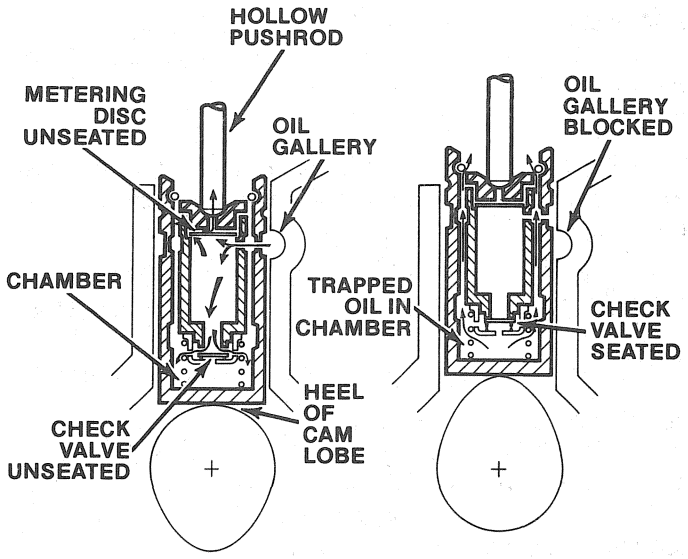


Fig. 1B-57 Hydraulic Valve Tappet Operation

NOTE: *When removing the two capscrews from each bridge, alternately loosen each screw one turn at a time to avoid damaging bridge.*

(4) Remove push rods.

NOTE: *Retain rocker arms, bridge and pivot assemblies and push rods in the same order as removed.*

(5) Remove cylinder head and gasket.

(6) Remove tappets through push rod openings in block with Hydraulic Valve Tappet Remover and Installer Tool J-21884 (fig. 1B-58).

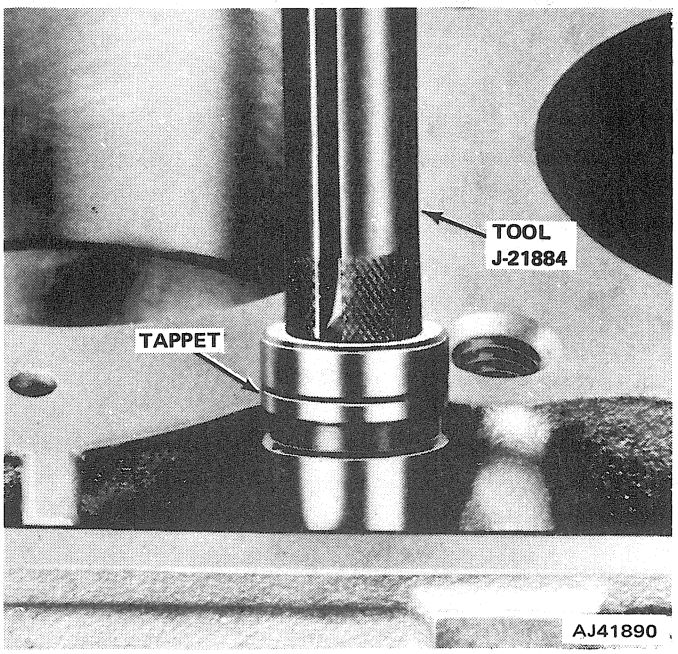


Fig. 1B-58 Hydraulic Valve Tappet Removal

Disassembly, Cleaning, Inspection and Reassembly

NOTE: *Retain tappet components in the same order as removed.*

(1) Release lockring and remove plunger cap, metering disc, plunger, check valve assembly and plunger return spring from tappet body (fig. 1B-56).

(2) Clean components in cleaning solvent to remove all varnish and gum deposits.

(3) Inspect for evidence of scuffing on side and face of tappet body.

(4) Inspect each tappet face for concave wear by laying straightedge across face. If face is concave, corresponding lobe on camshaft is also worn, and replacement of camshaft and tappet(s) is necessary.

(5) Install plunger return spring, check valve assembly, plunger, metering disc and plunger cap in tappet body (fig. 1B-56).

(6) Compress plunger assembly using push rod on plunger cap, and install lockring.

Hydraulic Valve Tappet Leak-Down Test

After cleaning, inspection and reassembly, leak-down test each tappet to ensure zero-lash operation. Figure 1B-59 illustrates tool J-5790, which can be used to accurately test tappet leak-down rate.

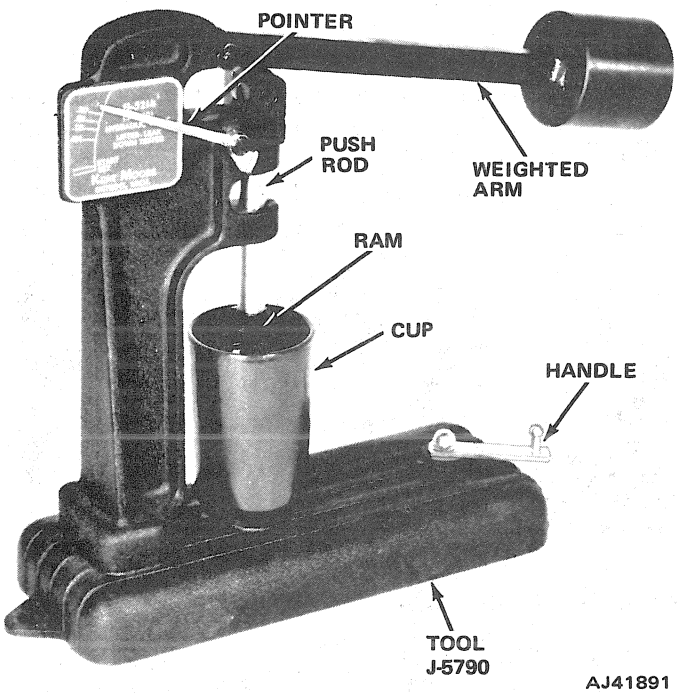


Fig. 1B-59 Hydraulic Valve Tappet Leak-Down Rate Tester

(1) Swing weighted arm of tester away from ram of tester.

(2) Place 0.312- to 0.313-inch (7.925 to 7.950 mm) diameter ball bearing on tappet plunger cap.

(3) Lift ram and place tappet with ball bearing inside tester cup.

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

(5) Fill tester cup with Valve Tappet Test Oil J-5268, or equivalent, until tappet is completely covered.

(6) Swing weighted arm onto ram and pump up and down on tappet to remove air. When air bubbles cease, swing weighted arm away and allow plunger to rise to normal position.

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

(8) Slowly swing weighted arm onto ram. Rotate cup by turning handle at base of tester clockwise one revolution every two seconds.

(9) Time leak-down interval from instant pointer aligns with START mark on scale until pointer aligns with 0.125 mark. Acceptable tappet will require 20 to 110 seconds to leak-down. Discard tappets that have leak-down interval outside this range.

NOTE: *Do not charge the tappet assemblies with engine oil. They will charge themselves within 3 to 8 minutes of engine operation.*

Installation

(1) Dip each tappet assembly in Jeep Engine Oil Supplement (EOS), or equivalent.

(2) Use Hydraulic Valve Tappet Remover and Installer Tool J-21884 to install each tappet in same bore from where it was removed.

(3) Install cylinder head and replacement gasket and tighten screws. Refer to Cylinder Head Installation for tightening sequence.

(4) Install push rods in same order as removed.

(5) Install rocker arms and bridge and pivot assemblies. Loosely install capscrews at each bridge. Tighten capscrews alternately, one turn at a time, to avoid damaging or breaking bridge.

(6) Pour remaining EOS over entire valve train.

NOTE: *The EOS must remain in the engine for at least 1,000 miles (1 607 km) but need not be drained until the next scheduled oil change.*

(7) Install cylinder head cover. Refer to Cylinder Head Cover for procedure.

(8) Install coolant.

TIMING CASE COVER

The timing case cover is provided with a seal and oil slinger to prevent oil leakage at the vibration damper hub (fig. 1B-60). A socket is attached in the cover for the use of a magnetic timing probe. A graduated timing degree scale is located on the cover for standard ignition timing.

It is important that the timing case cover be properly aligned with the crankshaft to prevent eventual damage to the oil seal. The oil seal may be replaced without removing the timing case cover.

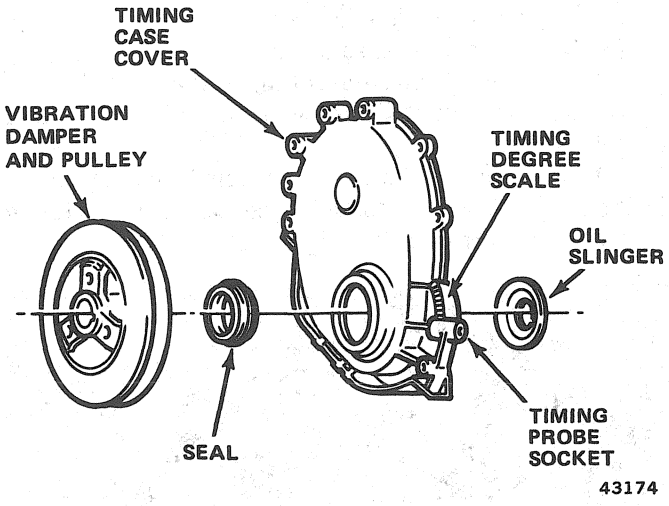


Fig. 1B-60 Timing Case Cover

Removal

(1) Remove drive belt(s), engine fan and hub assembly, damper pulley and vibration damper. Refer to Vibration Damper and Pulley Removal for procedure.

(2) Remove oil pan-to-timing case cover screws and cover-to-block screws.

(3) Remove timing case cover and gasket from engine.

(4) Cut off oil pan gasket end tabs flush with front face of cylinder block and remove gasket tabs.

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

(6) Remove crankshaft oil seal from timing case cover.

Installation

(1) Apply seal compound (Perfect Seal, or equivalent) to both sides of replacement timing case cover gasket and position gasket on cylinder block.

(2) Cut end tabs off replacement oil pan gasket corresponding to pieces cut off original gasket. Cement these pieces on oil pan.

(3) Coat oil pan seal end tabs generously with Permatex No. 2, or equivalent, and position seal on timing case cover (fig. 1B-61).

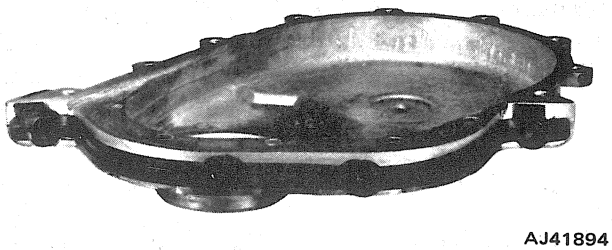


Fig. 1B-61 Oil Pan Front Seal Installation

(4) Position timing case cover on engine. Place Timing Case Cover Alignment Tool and Seal Installer J-22248 in crankshaft opening of cover (fig. 1B-62).

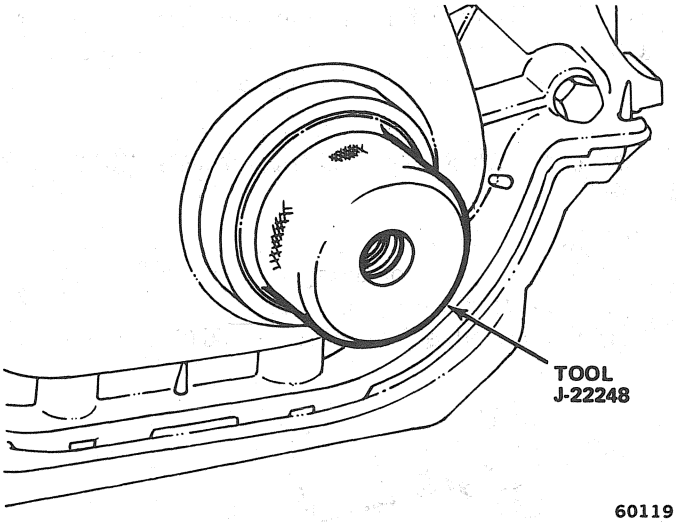


Fig. 1B-62 Timing Case Cover Alignment

(5) Install cover-to-block screws and oil pan-to-cover screws. Tighten cover-to-block screws with 5 foot-pounds (7 N•m) torque and oil pan-to-cover screws with 11 foot-pounds (15 N•m) torque.

(6) Remove cover aligning tool and position replacement oil seal on tool with seal lip facing outward. Apply light film of Perfect Seal, or equivalent, on outside diameter of seal.

(7) Insert draw screw from Tool J-9163 into seal installing tool. Tighten nut against tool until tool contacts cover (fig. 1B-63).

(8) Remove tools and apply light film of engine oil to seal lip.

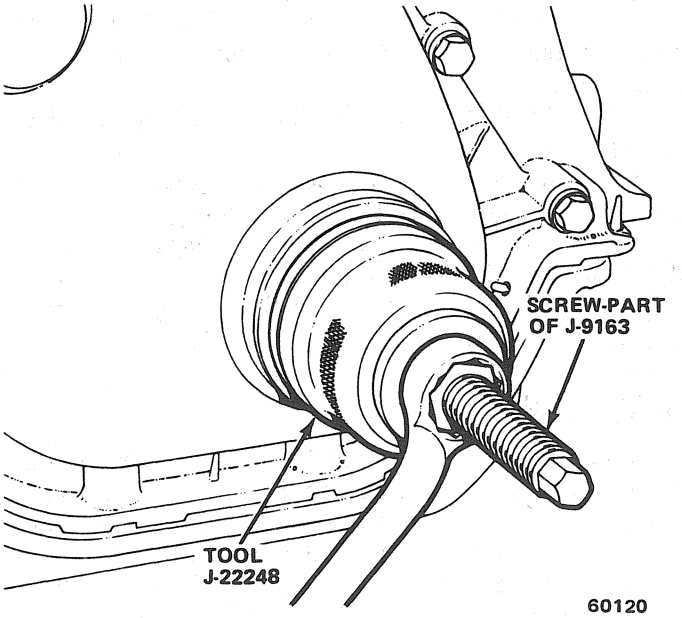


Fig. 1B-63 Timing Case Cover Oil Seal Installation

(9) Install vibration damper and tighten retaining screw with 80 foot-pounds (108 N•m) torque.

(10) Install damper pulley. Tighten capscrews with 20 foot-pounds (27 N•m) torque.

(11) Install engine fan and hub assembly.

(12) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling Systems.

Timing Case Cover Oil Seal Replacement (Cover not Removed)

(1) Remove drive belts.

(2) Remove vibration damper pulley.

(3) Remove vibration damper.

(4) Remove oil seal with Tool J-9256 (fig. 1B-64).

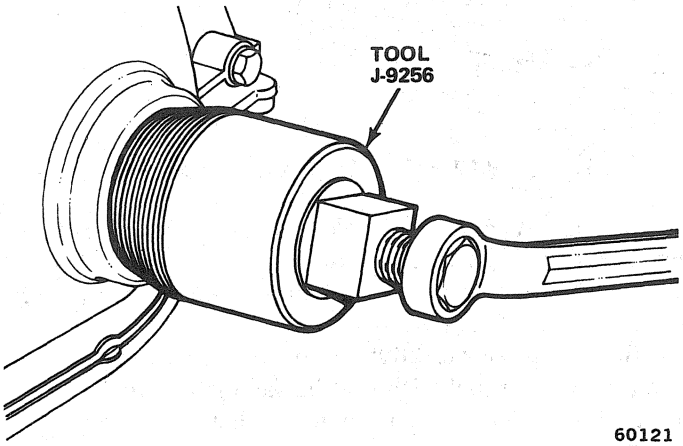


Fig. 1B-64 Timing Case Cover Oil Seal Removal

(5) Position replacement oil seal on Timing Case Cover Alignment Tool and Seal Installer J-22248 with seal lip facing outward. Apply light film of Perfect Seal, or equivalent, to outside diameter of seal.

(6) Insert draw screw from Tool J-9163 into seal installing tool. Tighten nut against tool until tool contacts cover.

(7) Remove tools. Apply light film of engine oil to seal lip.

(8) Install vibration damper and tighten retaining bolt with 80 foot-pounds (108 N•m) torque.

(9) Install damper pulley. Tighten capscrews with 20 foot-pounds (27 N•m) torque.

(10) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling Systems.

TIMING CHAIN

Installation of the timing chain with the timing marks of the crankshaft and camshaft sprockets properly aligned assures correct valve timing. A worn timing chain will adversely affect valve timing. Replace the timing chain if it deflects more than 1/2 inch (13 mm).

The correct timing chain has 48 pins. A chain with more than 48 pins will cause excessive slack.

Removal

(1) Remove drive belt(s).

(2) Remove engine fan and hub assembly.

(3) Remove vibration damper pulley.

(4) Remove vibration damper.

(5) Remove timing case cover.

(6) Remove oil seal from timing case cover.

(7) Remove camshaft sprocket retaining screw and washer.

(8) Rotate crankshaft until timing mark on crankshaft sprocket is closest to and on centerline with timing mark of camshaft sprocket (fig. 1B-65).

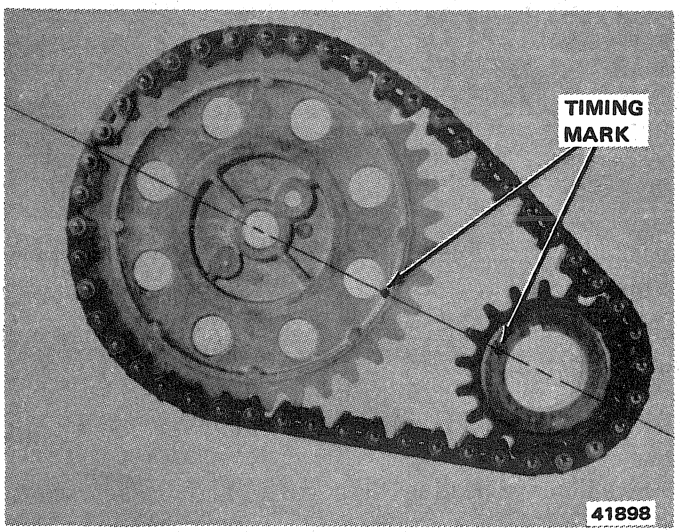


Fig. 1B-65 Timing Sprocket Alignment

(9) Remove crankshaft sprocket, camshaft sprocket and timing chain as assembly. Disassemble chain and sprockets.

Installation

(1) Assemble timing chain, crankshaft sprocket and camshaft sprocket with timing marks aligned (fig. 1B-65).

(2) Install assembly on crankshaft and camshaft.

(3) Install camshaft sprocket retaining screw and washer and tighten with 50 foot-pounds (68 N•m) torque.

NOTE: *To verify correct installation of the timing chain, position timing mark of the camshaft sprocket at approximately one o'clock position. This positions timing mark of crankshaft sprocket at a location where the adjacent tooth meshes with chain (fig. 1B-66). Count the number of chain pins between timing marks of both sprockets. There must be 15 pins.*

(4) Install timing case cover and replacement oil seal.

(5) Install vibration damper and tighten retaining bolt with 80 foot-pounds (108 N•m) torque.

(6) Install damper pulley and tighten capscrews with 20 foot-pounds (27 N•m) torque.

(7) Install engine fan and hub assembly.

(8) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling Systems.

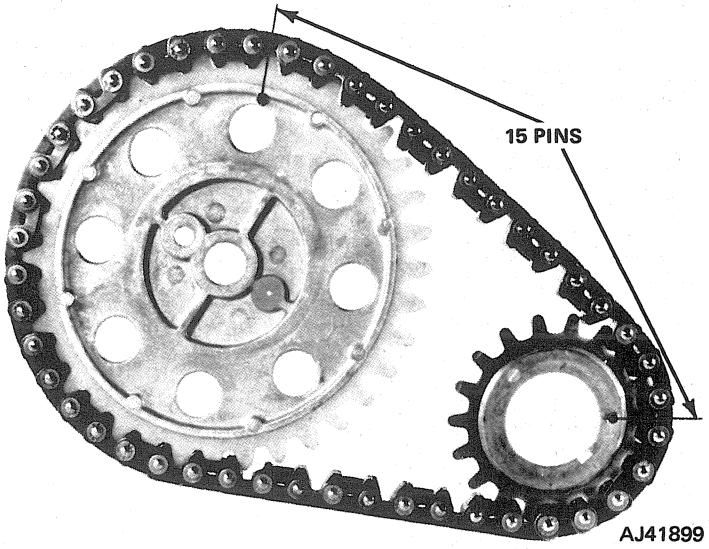


Fig. 1B-66 Timing Chain Installation

INTAKE AND EXHAUST MANIFOLDS

The aluminum intake and cast iron exhaust manifolds (fig. 1B-67) are attached to the cylinder head on the left side of the engine. A gasket is used between the intake manifold and the cylinder head. No gasket is used between the exhaust manifold and cylinder head.

An exhaust gas recirculation (EGR) valve is mounted on the side of the intake manifold. The intake manifold has an electric heater that improves fuel vaporization during warmup and shortens choke operation time. Coolant is also routed through the intake manifold to improve fuel vaporization.

Intake and Exhaust Manifold Removal

(1) Remove air cleaner. Disconnect fuel pipe, carburetor air horn vent hose, solenoid wire, if equipped, and choke heater wire.

(2) Disconnect throttle cable from throttle bellcrank. Disconnect throttle valve rod, if equipped.

(3) Disconnect PCV vacuum hose and heater wire from intake manifold.

(4) Drain coolant below intake manifold level.

NOTE: *Do not waste reusable coolant. Drain into clean container for reuse.*

(5) Disconnect coolant hoses from intake manifold.

(6) Disconnect spark CTO valve vacuum hoses.

(7) Disconnect vacuum hose from EGR valve. Disconnect EGR tube fittings from intake and exhaust manifold.

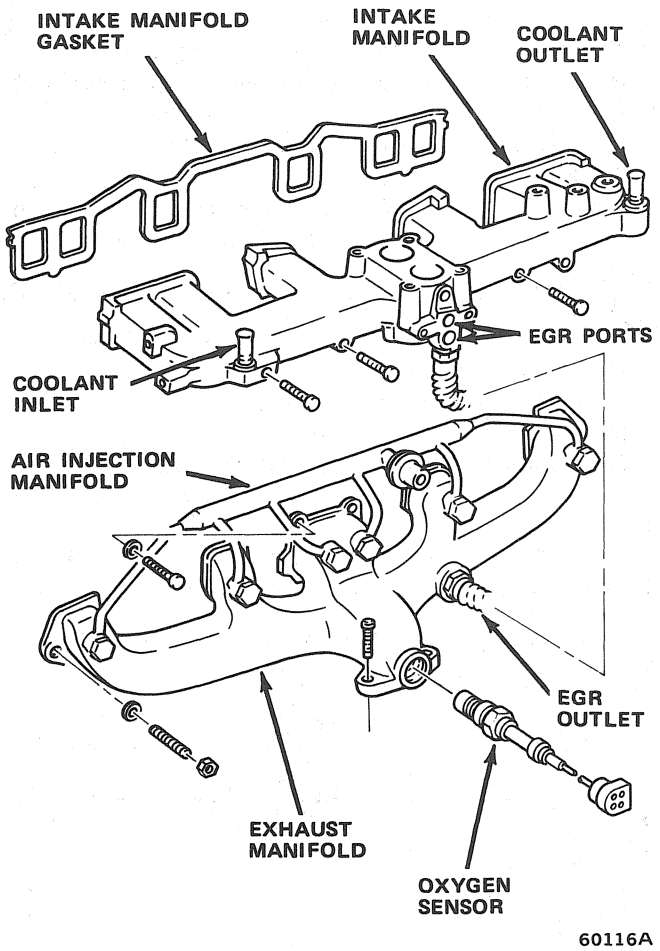


Fig. 1B-67 Intake and Exhaust Manifolds

(8) Disconnect air injection hoses at air pump and air injection manifold check valve. Disconnect diverter valve vacuum hose and remove diverter valve with hoses attached.

(9) Remove air pump/power steering mounting bracket, if equipped.

(10) Remove air pump.

(11) Detach power steering pump, if equipped, and set aside. Do not remove hoses.

(12) Remove air conditioner drive belt idler pulley assembly from cylinder head, if equipped.

(13) Disconnect exhaust pipe from exhaust manifold flange. Remove oxygen sensor, if equipped.

(14) Remove manifold attaching bolts, nuts and clamps. Remove intake and exhaust manifolds. Discard intake manifold gasket.

(15) Clean mating surfaces of manifolds and cylinder head.

Intake and Exhaust Manifold Installation

(1) Position exhaust manifold over end studs on cylinder head and install positioning sleeves over end studs.

(2) Secure exhaust manifold to head at positions 1 and 2 (fig. 1B-68). Tighten bolts with 23 foot-pounds (31 N•m) torque. Remove positioning sleeves.

(3) Loosely connect EGR tube to intake manifold.

(4) Position intake manifold gasket over dowels and flush against head.

(5) Position intake maifold over dowels and flush against gasket. Loosely connect EGR tube to exhaust manifold.

(6) Secure intake manifold to head at positions 3 and 4 (fig. 1B-68). Tighten bolts with 23 foot-pounds (31 Nm) torque.

(7) Install remaining bolts at positions 5 through 10 and nuts at positions 11 and 12 (fig. 1B-68).

(8) Tighten bolts and nuts according to sequence depicted in figure 1B-68 with 23 foot-pounds (31 N•m) torque.

(9) Tighten EGR tube fitting with 30 foot-pounds (41 N•m) torque.

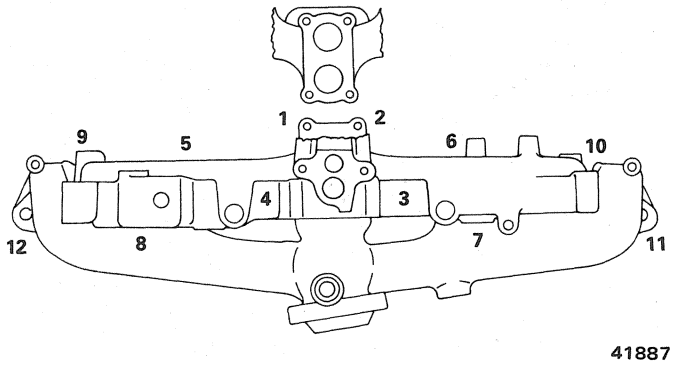


Fig. 1B-68 Manifold Tightening Sequence

(10) Position flange gasket and connect exhaust pipe to exhaust manifold flange. Tighten nuts with 20 foot-pounds (27 N•m) torque. Install oxygen sensor, if removed.

(11) Connect fuel pipe and air horn vent hose to carburetor. Connect solenoid wire, if equipped.

(12) Install AC drive belt idler pulley assembly, if removed.

(13) Install air pump, if removed.

(14) Install air pump/power steering pump mounting bracket, if removed.

(15) Install diverter valve. Connect air hoses to air pump and check valve. Connect vacuum hose.

(16) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling Systems.

(17) Install spark CTO valve vacuum hoses.

(18) Connect vacuum hose to EGR valve.

(19) Connect throttle cable and PCV hose. Connect throttle valve rod, retainer and spring. Connect intake manifold heater wire.

(20) Connect coolant hoses to intake manifold.

(21) Install air cleaner.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(22) Start engine and inspect for air leaks into vacuum fittings, and exhaust and coolant leaks.

Intake Manifold Replacement

NOTE: *It is necessary to disconnect both the intake and exhaust manifolds from the engine because they have common attaching hardware. It is not necessary to remove the carburetor from the intake manifold until after manifold is removed. After removing the carburetor from the intake manifold, it may be set to one side with vacuum hoses still attached.*

(1) Remove air cleaner.

(2) Disconnect heater wire from choke cover terminal and solenoid wire, if equipped.

(3) Disconnect carburetor control shaft from carburetor.

(4) Remove carburetor from intake manifold and set aside. Remove carburetor insulator block.

(5) Remove carburetor mounting studs from intake manifold.

(6) Remove intake and exhaust manifolds from engine. Refer to Intake and Exhaust Manifold Removal for procedure.

(7) Remove throttle control bracket.

(8) Remove EGR valve and studs and install in replacement manifold.

(9) Remove intake manifold heater and install in replacement manifold.

(10) Install throttle control bracket. Tighten nuts with 2 to 4 foot-pounds (3 to 5 N•m) torque.

(11) Install vacuum hose fittings.

(12) Install intake and exhaust manifolds. Refer to Intake and Exhaust Manifold Installation for procedure.

(13) Install vacuum hoses.

(14) Install carburetor studs, replacement gaskets and spacer.

(15) Install carburetor and connect linkage, fuel pipe and hoses.

(16) Tighten carburetor mounting nuts with 14 foot-pounds (19 N•m) torque.

(17) Connect and choke heater wire to choke cover terminal.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(18) Start engine and inspect for leaks.

(19) Install air cleaner.

Exhaust Manifold Replacement

NOTE: *It is necessary to disconnect both the intake and exhaust manifolds from the engine because they have common attaching hardware. It is not necessary to remove the carburetor from the intake manifold until after manifold is removed. After removing the carburetor from the intake manifold, it may be set to one side with vacuum hoses still attached.*

(1) Remove air cleaner.
(2) Disconnect choke heater wire from choke cover terminal.
(3) Disconnect carburetor control shaft from carburetor.
(4) Remove carburetor from intake manifold and set aside.
(5) Remove intake and exhaust manifolds from engine. Refer to Intake and Exhaust Manifold Removal for procedure.
(6) Remove throttle control bracket.
(7) Remove spark CTO valve hose clamp and install on replacement manifold.
(8) Remove air injection manifold and fittings and install on replacement manifold.
(9) Install throttle control bracket. Tighten nuts with 2 to 4 foot-pounds (3 to 5 N•m) torque.
(10) Install intake and exhaust manifolds. Refer to Intake and Exhaust Manifold Installation for procedure.
(11) Install carburetor spring bracket.
(12) Install carburetor on intake manifold.
(13) Tighten carburetor mounting nuts with 14 foot-pounds (19 N•m) torque.
(14) Install carburetor control shaft. Install throttle return spring.
(15) Connect choke heater wire to choke cover terminal.
(16) Connect exhaust pipe to exhaust manifold. Tighten nuts with 20 foot-pounds (27 N•m) torque.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(17) Start engine and inspect for leaks.
(18) Install air cleaner.

CYLINDER HEAD AND COVER

The cylinder head incorporates hardened exhaust valve seats and exhaust valves with flash chrome stems.

Cylinder Head Cover

CAUTION: *Cylinder head cover is molded plastic. Use care when removing and installing.*

Removal

(1) Remove air cleaner and PCV molded hose.
(2) Disconnect distributor vacuum spark advance hose at spark CTO valve. Disconnect fuel pipe at fuel pump and move aside to allow removal of cylinder head cover.
(3) Disconnect PCV valve from grommet in cylinder head cover. Disconnect hoses from canister.
(4) Remove cylinder head cover holddown nuts. Insert thin bladed tool (e.g., razor blade or putty knife) between cover and head and cut RTV sealant to loosen from head.

CAUTION: *Do not strike cover with mallet to loosen RTV sealant.*

(5) Inspect cylinder head cover for cracks.

Installation

A room temperature vulcanizing (RTV) silicone rubber adhesive is required for installation. Use Jeep Gasket-in-a-Tube, or equivalent.
(1) Remove adhesive and gasket material from sealing surface area.
(2) Wipe gasket mating surface on cylinder head with oily rag. This prevents adhesion but permits sealing.
(3) Apply 1/8-inch (3.2 mm) bead of silicone along entire length of cover flange.
(4) Before silicone begins to cure, install cover on cylinder head. Do not allow silicone to contact rocker arms.

CAUTION: *Do not overtighten nuts because cover may crack from excess stress.*

(5) Initially, tighten nuts by hand, then tighten with 24 inch-pounds (3 N•m) torque.
(6) Connect PCV valve to grommet in cylinder head cover, connect canister hoses.
(7) Install air cleaner and connect PCV hose.

Cylinder Head

Removal

(1) Drain coolant and disconnect hoses from thermostat housing.
(2) Remove air cleaner.
(3) Remove cylinder head cover and sealant. Refer to Cylinder Cover Removal for procedure.
(4) Remove bridge and pivot assemblies and rocker arms. Alternately loosen each capscrew one turn at a time to avoid damaging bridge.
(5) Remove push rods.

NOTE: *Retain push rods, bridge and pivot assemblies and rocker arms in same order as removed.*

(6) Disconnect power steering pump, air pump and brackets. Lay pumps and brackets aside. Do not disconnect hoses.

(7) Remove intake and exhaust manifolds from cylinder head. Refer to Intake and Exhaust Manifold Removal for procedure.

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

(a) Remove air conditioning drive belt idler pulley bracket from cylinder head.

(b) Loosen alternator drive belt. Remove alternator bracket-to-head mounting bolt.

(c) Remove bolts from compressor mounting bracket and set compressor aside.

(9) Disconnect ignition wires and remove spark plugs.

(10) Disconnect coolant temperature sending unit wire and battery negative cable.

(11) Remove ignition coil and bracket assembly.

(12) Remove cylinder head bolts, cylinder head and gasket.

Cleaning and Inspection

(1) Thoroughly clean machined surfaces of cylinder head and block. Remove all deposits and gasket cement.

(2) Remove carbon deposits from combustion chambers and top of pistons.

(3) Use straightedge and feeler gauge to determine flatness of cylinder head and block mating surfaces. Refer to Specifications.

Installation

(1) If cylinder head is to be replaced and original valves used, measure valve stem diameter. Only standard size valve stems can be used with service replacement cylinder head unless replacement head valve guide bores are reamed to accommodate oversize valve stems. Remove all carbon deposits and reface valves as outlined within Valve Refacing procedure.

(2) Install valves in cylinder head using replacement valve stem oil deflectors.

(3) Transfer all detached components from original head that are not included with replacement head. Do not install coolant temperature sending unit until coolant is installed. This permits trapped air to escape from block and head.

CAUTION: *Do not apply sealing compound on head and block mating surfaces. Do not allow sealing compound to enter cylinder bore.*

(4) Apply an even coat of Perfect Seal sealing compound, or equivalent, to both sides of replacement head gasket and position gasket flush on block with word TOP facing upward.

(5) Install cylinder head. Tighten bolts in sequence with 85 foot-pounds (115 N•m) torque (fig. 1B-69).

(6) Connect battery negative cable.

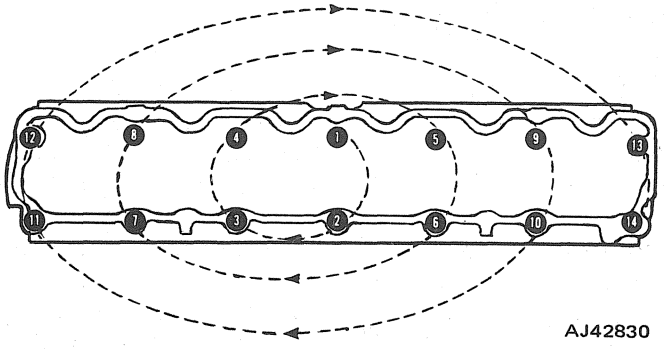


Fig. 1B-69 Cylinder Head Tightening Sequence

(7) Install ignition coil and bracket assembly.

(8) Install spark plugs and connect ignition wires.

(9) Attach air conditioning compressor mounting bracket to cylinder head, if removed.

(10) Install intake and exhaust manifolds. Refer to figure 1B-68 for correct tightening sequence. Refer to Intake Manifold Replacement for procedure.

(11) Install alternator bracket on head. Install alternator, belt and adjust tension. Refer to Chapter 1C—Cooling Systems for procedure.

(12) Install power steering bracket and pump. Adjust belt tension. Refer to Chapter 1C—Cooling Systems for procedure.

(13) Install air pump bracket on head. Install air pump and belt. Adjust belt tension. Refer to Chapter 1C—Cooling Systems for procedure.

(14) Install each push rod in its original location.

(15) Install rocker arms and bridge and pivot assemblies in original locations. Loosely install capscrews for each bridge and tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten screws with 19 foot-pounds (26 N•m) torque.

(16) Install cylinder head cover. Use silicone rubber (RTV) sealant.

(17) Connect coolant hoses to thermostat housing and fill cooling system to specified level. Refer to Cooling System Specifications, Chapter 1C. Install temperature sending unit.

NOTE: *The head gasket is constructed of aluminum-coated embossed steel and does not require the head bolts to be retightened after the engine has been operated.*

(18) Install fuel pipe and vacuum advance hose.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(19) Operate engine with radiator cap off. Inspect for leaks and continue operating engine until thermostat opens. Add coolant, if required. To vent air from system refer to Chapter 1C—Cooling Systems.

(20) Install air cleaner.

LUBRICATION SYSTEM

General

A gear-type positive displacement pump is mounted at the underside of the block opposite the No. 4 main bearing (fig. 1B-70). The pump brings oil up through the pickup screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and the pump body, then is forced through the outlet to the block. An oil gallery in the block routes the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil flows from the center outlet of the filter head through an oil gallery up to the main oil gallery, which extends the entire length of the block.

Smaller galleries extend downward from the main oil gallery to the upper insert of each main bearing. The crankshaft is drilled internally to route oil from the main bearing journals (except No. 4) to the connecting rod journals. Each connecting rod bearing cap has a small squirt hole. Oil passes through the squirt hole and is thrown off as the rod rotates. This oil throw-off lubricates the camshaft lobes, distributor drive gear, cylinder walls and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. Oil is also routed to the camshaft bearings through galleries. The front camshaft bearing journal directs oil through the camshaft sprocket to the timing chain. Rotation of the sprocket lubricates the crankshaft sprocket and chain. Oil drains back to the oil pan under the No. 1 main bearing cap.

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

Oil Filter

A full flow oil filter, mounted on the lower right side of the engine, is accessible through the hood opening. A bypass valve incorporated in the filter mounting head on the cylinder block provides a safety factor if the filter should become inoperative as a result of dirt or sludge accumulation (fig. 1B-71).

CAUTION: *Use the short, 4.25-inch (107.95 mm) filter on six-cylinder engine CJ vehicles. If the long, 5.44-inch (138.18 mm) filter is used, it may contact the engine support bracket or frame rail. This can puncture the filter and result in a loss of oil and possible engine damage.*

Tool J-22700 will facilitate removal of the oil filter. Before installation, apply a thin film of oil to the replacement filter gasket. Turn filter until gasket contacts the seat of the filter head. Tighten by hand only, following the instructions on the replacement filter. If the instructions are not printed on the filter, tighten the filter until the gasket contacts the seat and then tighten an additional 3/4 turn.

Operate engine at fast idle and check for leaks.

Oil Pump

The positive-displacement gear-type oil pump is driven by the distributor shaft, which is driven by a gear connected to the camshaft. Lubrication oil is pumped from the sump through an inlet tube and screen assembly that is pressed into the pump body (fig. 1B-71). The pump incorporates a non-adjustable pressure relief valve to regulate maximum pressure. The spring tension is calibrated for 75 psi (517 kPa) maximum pressure. In the relief position, the valve permits oil to bypass through a passage in the pump body to the inlet side of the pump.

Removal

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

(1) Drain engine oil.

(2) Remove oil pan. Refer to Oil Pan Removal for procedure.

CAUTION: *Do not disturb position of oil inlet tube and screen assembly in pump body. If tube is moved within pump body, a replacement tube and screen assembly must be installed to assure an airtight seal.*

(3) Remove oil pump retaining screws, oil pump and gasket.

Disassembly and Inspection

(1) Remove cover retaining screws, cover and gasket from pump body.

(2) Measure gear end clearance.

- **Preferred Method:**

(a) Place strip of Plastigage across full width of each gear end (fig. 1B-72).

(b) Apply a bead of Loctite 515, or equivalent, around perimeter of pump cover and install. Tighten screws with 70 inch-pounds (8 N•m) torque.

(c) Remove pump cover and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope. Correct clearance by this method is 0.002 to 0.006 inch (0.002 inch preferred) [0.051 to 0.203 mm (0.051 mm preferred)].

- **Alternate Method:**

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

(b) Select feeler gauge that fits snugly but freely between straightedge and pump body (fig. 1B-73).

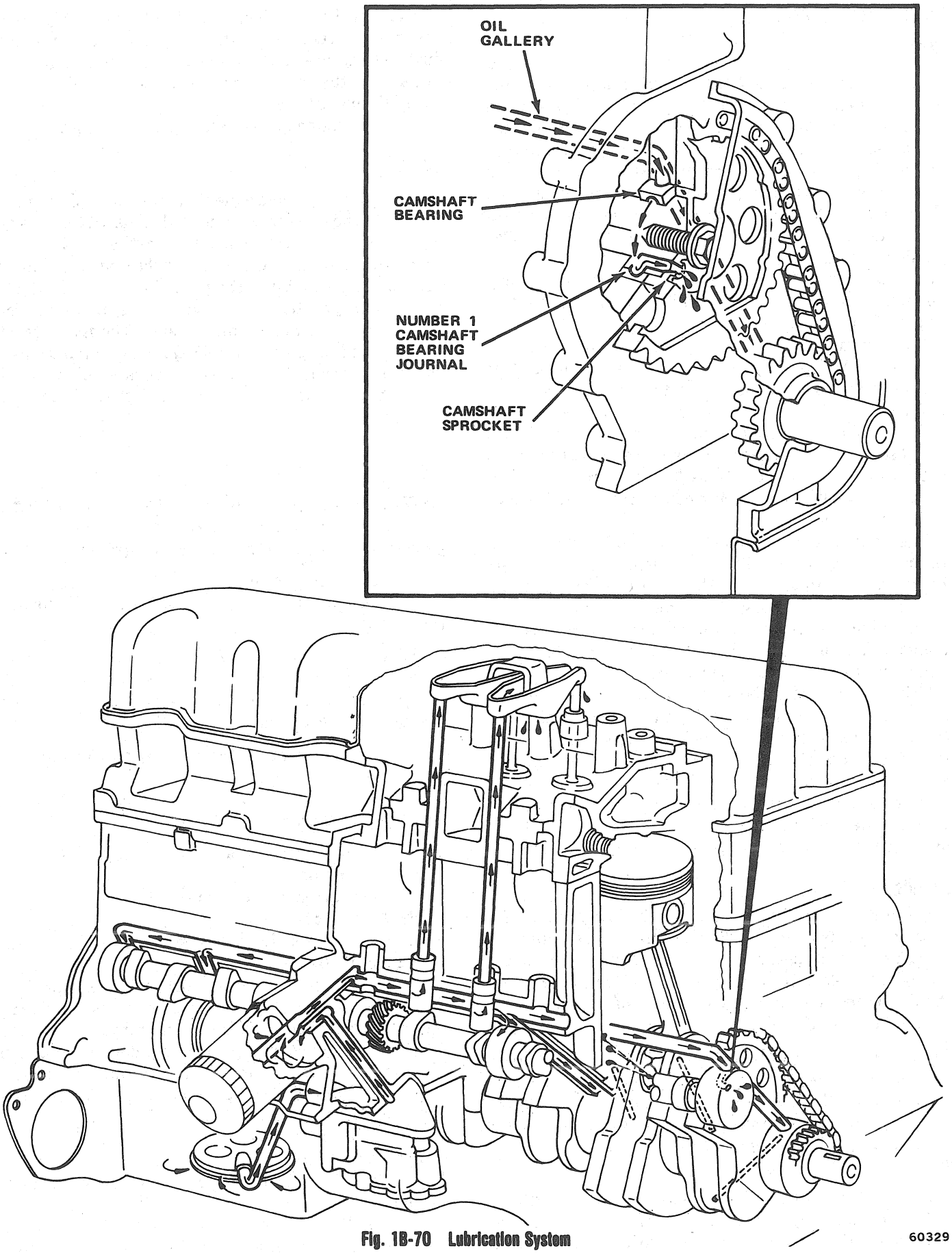


Fig. 1B-70 Lubrication System

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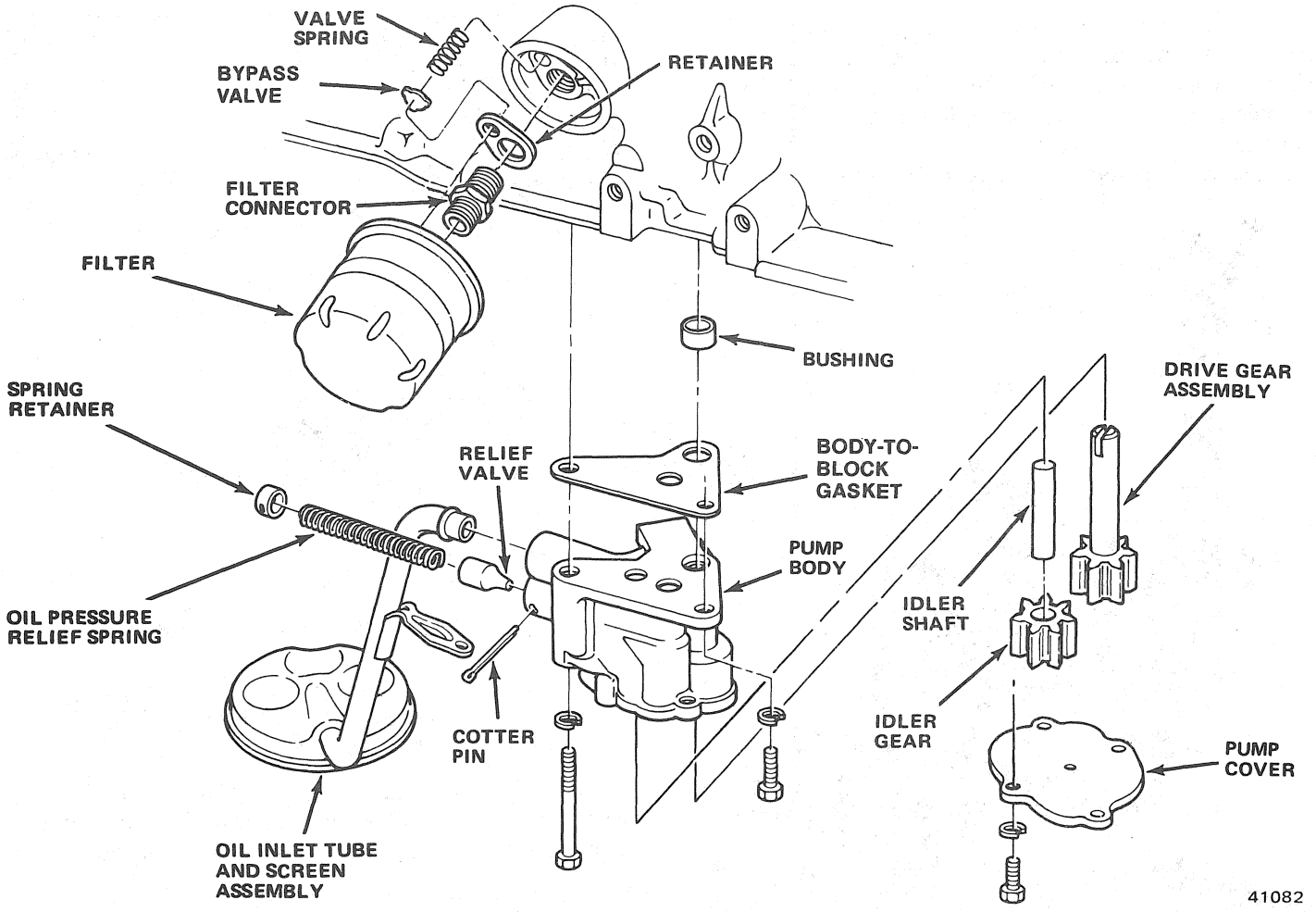

Fig. 1B-71 Oil Filter and Oil Pump Assembly

Correct clearance by this method is 0.004 to 0.008 inch (0.007 inch preferred) [0.102 to 0.203 mm (0.178 mm preferred)]. If gear end clearance is excessive, replace oil pump assembly.

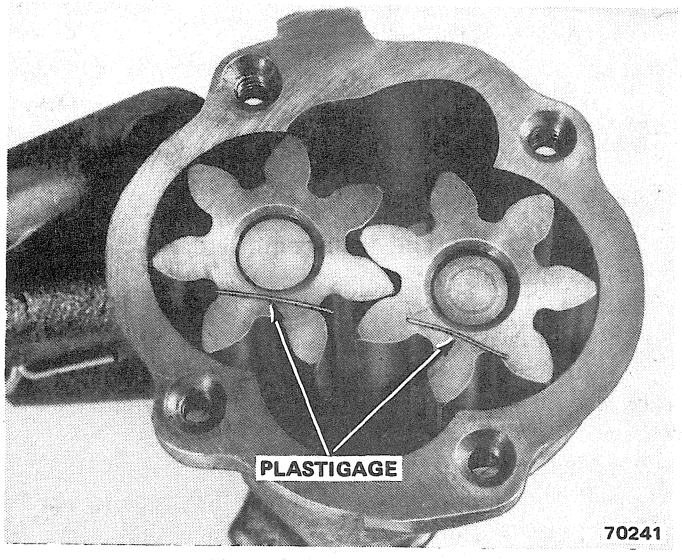

Fig. 1B-72 Oil Pump Gear End Clearance Measurement—Plastigage Method

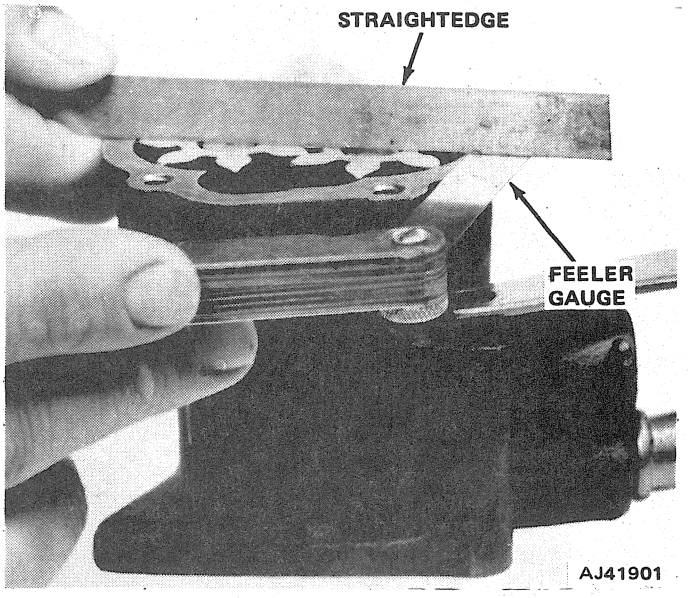

Fig. 1B-73 Oil Pump Gear End Clearance Measurement—Feeler Gauge Method

(3) Measure gear-to-body clearance by inserting feeler gauge between gear tooth and pump body inner wall directly opposite point of gear mesh. Select feeler

gauge that fits snugly but freely (fig. 1B-74). Rotate gears and measure each tooth clearance in this manner. Correct clearance is 0.0005 to 0.0025 inch (0.0005 preferred) [0.013 to 0.064 mm (0.013 mm preferred)]. If gear-to-body clearance is more than specified, replace idler gear, idler shaft and drive gear assembly.

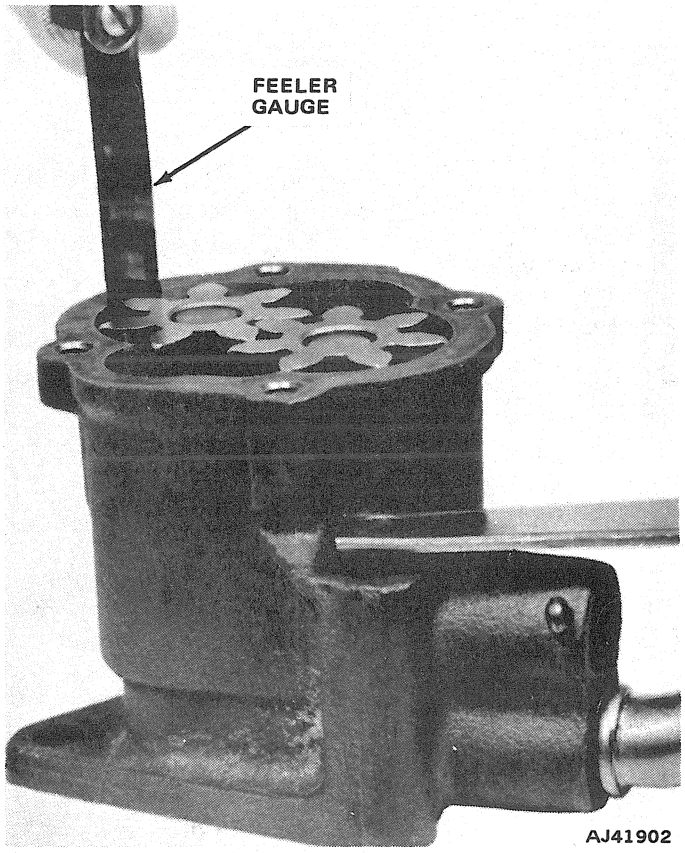

Fig. 1B-74 Oil Gear-to-Body Clearance Measurement

(4) Remove cotter pin and slide spring retainer, spring and oil pressure relief valve out of pump body. Examine for sticking condition during disassembly. Clean or replace as necessary.

NOTE: *The oil inlet tube must be moved to allow removal of the relief valve. Install a replacement pickup tube and screen assembly.*

Assembly and Installation

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

(2) If position of inlet tube in pump body has been disturbed, install replacement tube and screen assembly. Apply light film of Permatex No. 2, or equivalent, around end of tube. Use Tool J-21882 to drive tube into body. Ensure support bracket is properly aligned (fig. 1B-75).

(3) Install idler shaft, idler gear and drive gear assembly.

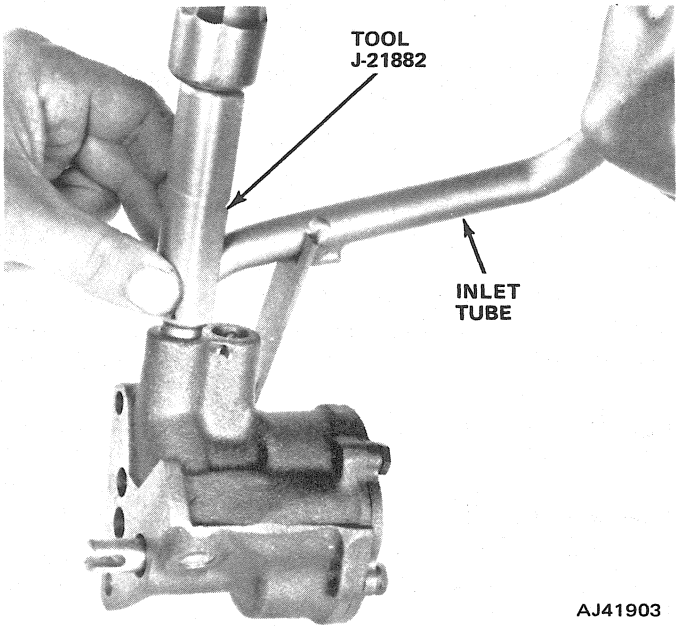

Fig. 1B-75 Oil Pump Inlet Tube Installation

NOTE: *To ensure self-priming of the oil pump, fill pump with petroleum jelly before installing the oil pump cover. Do not use grease.*

(4) Apply a bead of Loctite 515, or equivalent, around perimeter of pump cover and install. Tighten cover screws with 70 inch-pounds (8 N•m) torque.

NOTE: *Check for gear binding before installing the oil pump.*

(5) Install oil pump and replacement gasket. Tighten short screws with 10 foot-pounds (14 N•m) torque and long screws with 17 foot-pounds (23 N•m) torque.

(6) Install oil pan, using replacement gaskets and seals. Refer to Oil Pan Installation. Fill crankcase with clean lube oil to specified level.

Oil Pan

Removal

(1) Raise vehicle and drain engine oil.
(2) Remove starter motor.
(3) On CJ Vehicles:
  (a) Place jack under transmission.
  (b) Disconnect engine right support cushion bracket from block and raise engine to allow sufficient clearance for oil pan removal.
(4) Remove oil pan.
(5) Remove oil pan front and rear neoprene oil seals and side gaskets.
(6) Thoroughly clean gasket surfaces of oil pan and engine block. Remove all sludge and residue from oil pan sump.

Installation

(1) Install replacement oil pan front seal on timing case cover. Apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to end tabs.

(2) Cement replacement oil pan side gaskets into position on engine block. Apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to gasket ends.

(3) Coat inside curved surface of replacement oil pan rear seal with soap. Apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to side gasket contacting surface of seal end tabs.

(4) Install seal in recess of rear main bearing cap, ensuring it is fully seated.

(5) Apply engine oil to oil pan contacting surface of front and rear oil pan seals.

(6) Install oil pan and tighten drain plug securely.

(7) Lower engine and connect right support cushion bracket to block. Remove jack.

(8) Install starter motor.

(9) Lower vehicle and fill crankcase with clean lube oil to specified level.

Oil Pressure Gauge

Refer to Chapter 1L—Power Plant Instrumentation for operation, diagnosis and replacement of oil pressure gauge.

CONNECTING ROD AND PISTON ASSEMBLIES

NOTE: *The following procedure is used to service connecting rod and piston assemblies with the engine installed in the vehicle.*

Removal

(1) Remove cylinder head.

(2) Position pistons near bottom of stroke and use ridge reamer to remove ridge from top end of cylinder walls.

(3) Drain engine oil.

(4) Remove oil pan and gaskets.

(5) Remove connecting rod bearing caps and inserts and retain in same order as removed.

NOTE: *Connecting rods and caps are stamped with the corresponding cylinder number.*

CAUTION: *Ensure that connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short pieces of rubber hose slipped over the bolts will provide protection during removal.*

(6) Remove connecting rod and piston assemblies through top of cylinder bores.

Installation

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

(2) Install piston rings on pistons. Refer to Piston Rings for procedure.

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

CAUTION: *Ensure that connecting rod screws do not scratch the connecting rod journals or cylinder walls. Short pieces of rubber hose slipped over the screws will provide protection during installation.*

(4) Use Piston Ring Compressor Tool J-5601 to install connecting rod and piston assemblies through top of cylinder bores (fig. 1B-76).

(5) Install connecting rod bearing caps and inserts in same order as removed.

NOTE: *Oil squirt holes in connecting rods must face camshaft.*

(6) Install oil pan using replacement gaskets and seals. Tighten drain plug.

(7) Install gasket and cylinder head.

(8) Fill crankcase with clean oil to specified dipstick level.

CONNECTING RODS

The connecting rods are malleable iron, balanced assemblies with bearing inserts at the crankshaft journal end. The piston pin is 2,000 pound (907.2 kg) press-fitted.

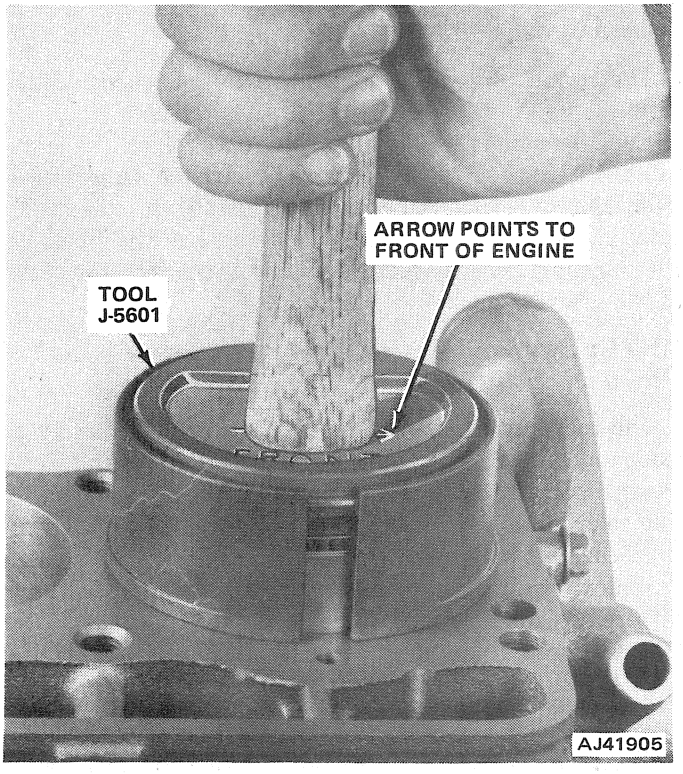

Fig. 1B-76 Piston Installation

Connecting Rod Bearing Fitting Chart

Crankshaft Connecting Rod Journal Color and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow —2.0955 to 2.0948 (53.2257-53.2079mm) (Standard)	Yellow —Standard	Yellow —Standard
Orange —2.0948 to 2.0941 (53.2079-53.1901mm) (0.0007 Undersize)	Yellow —Standard	Black —0.001-inch (0.025mm) Undersize
Black —2.0941 to 2.0934 (53.1901-53.1723mm) (0.0014 Undersize)	Black —0.001-inch (0.025mm) Undersize	Black —0.001-inch (0.025mm) Undersize
Red —2.0855 to 2.0848 (53.9717-52.9539mm) (0.010 Undersize)	Red —0.010-inch (0.254mm) Undersize	Red —0.010-inch (0.254mm) Undersize

60261

A squirt hole in the crankshaft end of the connecting rod provides lubrication for the camshaft lobes, distributor drive gear, cylinder walls and piston pins. The squirt hole faces the camshaft when the connecting rod is installed.

Misaligned or bent connecting rods 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, check rod alignment. Replace misaligned or bent rods.

Side Clearance Measurement

Slide snug-fitting feeler gauge between connecting rod and crankshaft journal flange. Correct clearance is 0.010 to 0.019 inch (0.25 to 0.48 mm). Replace connecting rod if side clearance is not within the specification.

Connecting Rod Bearings

The connecting rod bearings are steel-backed aluminum-alloy.

Each bearing is selectively fitted to its respective journal to obtain the desired operating clearance. **In production,** the select fit is obtained by using various-sized, color-coded bearing inserts as described in the Bearing Fitting chart. The bearing color code appears on the edge of the insert.

NOTE: *Bearing size is not stamped on inserts installed during production.*

The rod journal size is identified **in production** by a color coded paint mark on the adjacent cheek or counterweight toward the flanged (rear) end of the crankshaft. The color codes used to indicate journal size are listed in the Bearing Fitting chart.

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 0.001-inch (0.025 mm) undersize insert to reduce clearance 0.0005 inch. (0.013 mm)

NOTE: *Never use a pair of bearing inserts with more than 0.001-inch (0.025 mm) difference in size.*

Example:

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.001-inch (0.025mm) undersize	0.002-inch (0.051mm) undersize

70242

Service replacement bearing inserts are available as pairs in the following sizes: standard, 0.001-, 0.002-, 0.010- and 0.012-inch undersize. The bearing size is stamped on the back of service replacement inserts.

NOTE: *The 0.002- and 0.012-inch undersize inserts are not used for production assembly.*

Removal

(1) Drain engine oil.
(2) Remove oil pan and gaskets.
(3) Rotate crankshaft as required to position two connecting rods at a time at bottom of stroke.
(4) Remove connecting rod bearing cap. Remove lower bearing insert.
(5) Remove upper bearing insert by rotating it out of connecting rod.

NOTE: *Do not interchange bearing caps. Each connecting rod and its matching cap is stamped with the cylinder number on a machined surface adjacent to the oil squirt hole, which faces the camshaft side of the engine block.*

Inspection

(1) Clean inserts.
(2) Inspect linings and backs of inserts for irregular wear pattern. Note any scraping, stress cracks or discoloration (fig. 1B-77). If bearing has "spun" in rod, replace bearing and connecting rod and inspect crankshaft journal for scoring.
(3) Inspect for material imbedded in linings that may indicate piston, timing sprocket, distributor gear or oil pump gear problems. Figures 1B-78 and 1B-79 depict common score patterns.

(4) Inspect fit of bearing locking tab in rod cap. If inspection indicates that insert may have been caught between rod and rod cap, replace upper and lower bearing inserts.

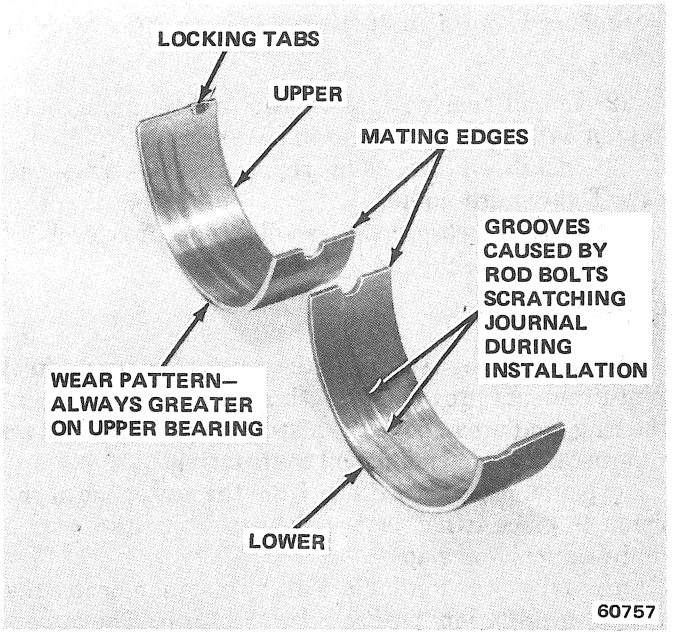

Fig. 1B-77 Connecting Rod Bearing Inspection

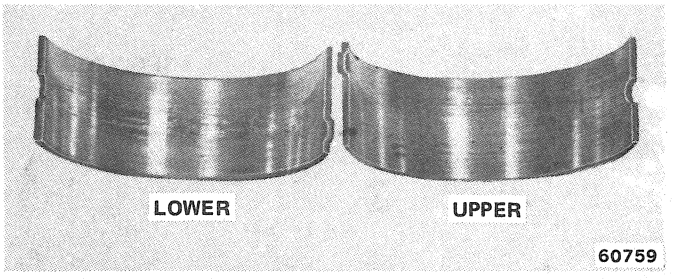

Fig. 1B-78 Scoring Caused by Insufficient Lubrication

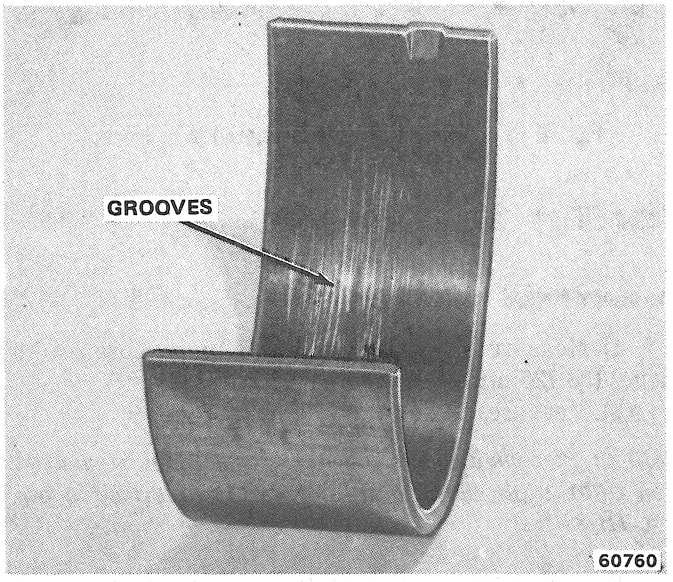

Fig. 1B-79 Scoring Caused by Imbedded Material

(5) Inspect insert in area of locking tab. Abnormal wear indicates bent tabs or improper installation of inserts (fig. 1B-80).

(6) Replace bearing inserts that are damaged or worn.

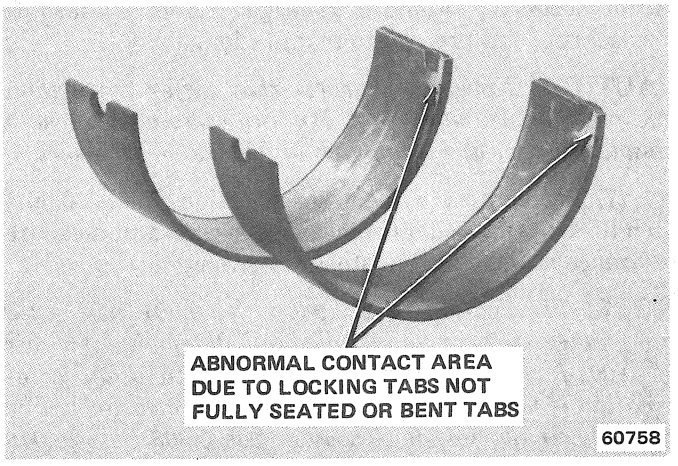

Fig. 1B-80 Locking Tab Inspection

Measuring Bearing Clearance with Plastigage

(1) Wipe journal clean.

(2) Lubricate upper insert and install in rod.

(3) Install lower insert in bearing cap. Lower insert must be dry. Place strip of Plastigage across full width of lower insert at center of bearing cap.

NOTE: *Plastigage must not crumble in use. If brittle, obtain a fresh stock.*

(4) Attach bearing cap to connecting rod and tighten nuts with 28 foot-pounds (38 N•m) torque.

NOTE: *Do not rotate crankshaft. Plastigage will shift, resulting in inaccurate clearance indication.*

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (fig. 1B-81). Correct clearance is 0.001 to 0.0025 inch (0.025 to 0.064 mm).

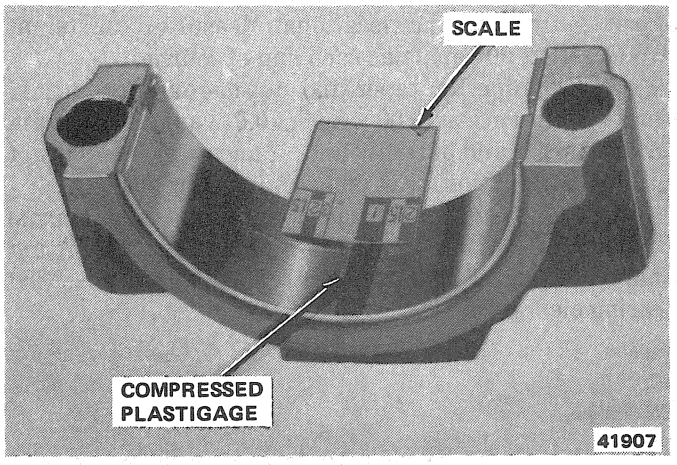

Fig. 1B-81 Rod Bearing Clearance Measurement with Plastigage

NOTE: *Plastigage should maintain the same size across the entire width of the insert. If size varies, it may indicate a tapered journal, bent connecting rod or foreign material trapped between the insert and rod.*

(6) If correct clearance is indicated, bearing fitting is not necessary. Remove Plastigage from crankshaft and bearing and proceed to Installation.

CAUTION: *Never use inserts that differ more than one bearing size as a pair. For example, do not use a standard upper and 0.002-inch undersize lower insert.*

(7) If clearance exceeds specification, install 0.001-inch (0.025 mm) undersize bearing inserts and measure clearance as described in steps (1) through (5) above.

NOTE: *The clearance indicated with a 0.001-inch (0.025 mm) undersize bearing installed will determine if a pair of 0.001-inch undersize inserts or some other combination is needed to provide the correct clearance. For example, if the initial clearance was 0.003 inch (0.076 mm), 0.001-inch (0.025 mm) undersize inserts would reduce clearance by 0.001 inch (0.025 mm). Oil clearance would be 0.002 inch (0.051 mm) and within specification. A 0.002-inch (0.051 mm) undersize insert and a 0.001-inch (0.025 mm) undersize insert would reduce this clearance an additional 0.0005 inch (0.013 mm). Oil clearance would then be 0.0015 inch (0.038 mm).*

(8) If oil clearance exceeds specification when pair of 0.002-inch (0.051 mm) undersize inserts are installed, measure connecting rod journal on crankshaft with micrometer. If journal size is correct (not less than 2.0934 inch or 53.172 mm), inside diameter of connecting rod is incorrect and rod must be replaced. If journal size is incorrect, replace crankshaft or grind journal to accept suitable undersize bearing.

Measuring Bearing Clearance with Micrometer

(1) Wipe connecting rod journal on crankshaft clean.

(2) Use micrometer to measure maximum diameter of rod journal at four locations. Measure diameter at two locations 90° apart at each end of journal.

(3) Examine for taper and out-of-round condition. Correct tolerance is 0.0005-inch (0.013 mm) maximum for both taper and out-of-round. If any rod journal is not within specification, crankshaft must be replaced.

(4) Compare measurement obtained with journal diameters listed in Connecting Rod Bearing Fitting Chart and select inserts required to obtain specified bearing clearance.

Installation

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

CAUTION: *Use care when rotating the crankshaft with bearing caps removed. Ensure the connecting rod bolts do not accidentally come in contact with the rod journals and scratch the surface. Bearing failure would result. Short pieces of rubber hose slipped over the connecting rod bolts will provide protection during installation.*

(2) Install bearing inserts, cap and retaining nuts. Tighten with 33 foot-pounds (45 N•m) torque.

(3) Install oil pan using replacement gaskets and seals. Tighten drain plug.

(4) Fill crankcase with clean oil to specified level.

PISTONS

Aluminum alloy Autothermic pistons are used. Steel reinforcements provide strength and control expansion. The ring land area above the piston pin provides for two compression rings and one oil control ring.

The piston pin boss is offset from the centerline of the piston to place it nearer the thrust side of the piston, minimizing piston slap.

An arrow on the top surface of the piston indicates the correct installation position in the bore. The arrow points toward the front of engine when installed correctly (fig. 1B-82).

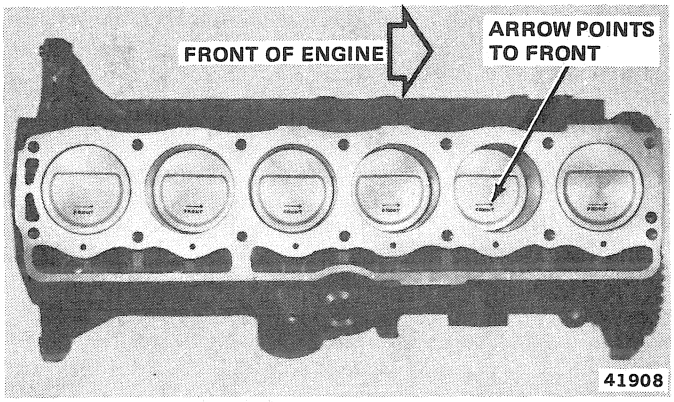

Fig. 1B-82 Pistons Correctly Positioned in Cylinders

Piston Fitting

Micrometer Method

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

(2) Measure outside diameter of piston.

NOTE: *Pistons are cam ground and must be measured at a right angle (90°) to piston pin at centerline of pin (fig. 1B-83).*

(3) Difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

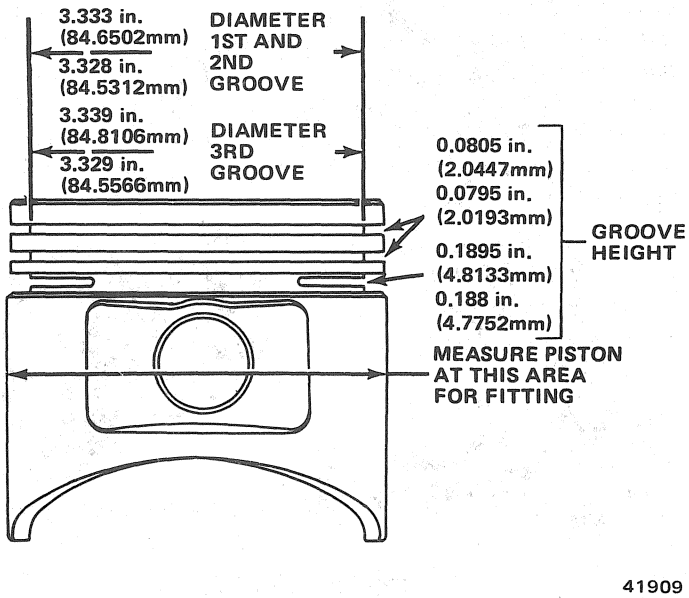

Fig. 1B-83 Piston Measurement

Feeler Gauge Method

(1) Remove rings from piston.

(2) Insert long 0.0005-inch (0.013 mm) feeler gauge into cylinder bore.

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

(4) Repeat steps (2) and (3) above with long 0.002-inch (0.051 mm) feeler gauge. Piston should bind.

If piston binds on 0.0005-inch (0.013 mm) gauge, piston is too large or bore is too small. If piston does not bind on 0.002-inch (0.051 mm) gauge, piston may be enlarged by knurling or shot-peening. Replace pistons that are 0.004 inch (0.102 mm) or more undersize.

Piston Rings

The two compression rings are made of cast iron. The oil control ring is a three-piece steel design.

Ring Fitting

(1) Clean carbon from all ring grooves. Oil drain openings in oil ring grooves and pin boss must be open. Do not remove metal from grooves or lands. This will change ring groove clearances and will damage ring-to-land seating.

(2) Measure ring side clearance with feeler gauge fitted snugly between ring land and ring. Rotate ring in groove. It must move freely at all points (fig. 1B-84). Refer to Specifications for correct ring side clearance.

(3) Place ring in bore and push down with inverted piston to position near lower end of ring travel. Measure ring gap (joint clearance) with feeler gauge fitting snugly in ring end gap (fig. 1B-85). Refer to Specifications for correct ring gap clearance.

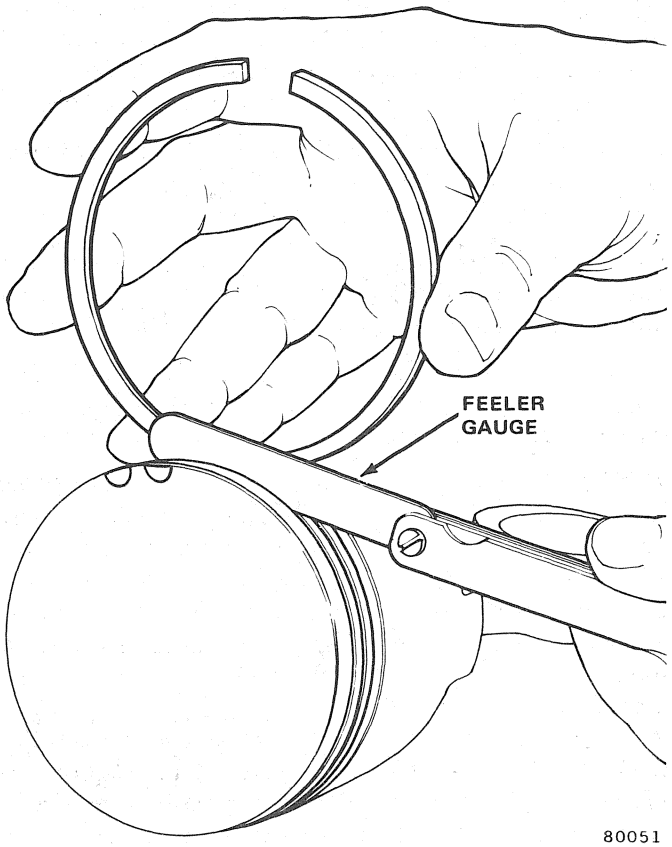

Fig. 1B-84 Ring Side Clearance

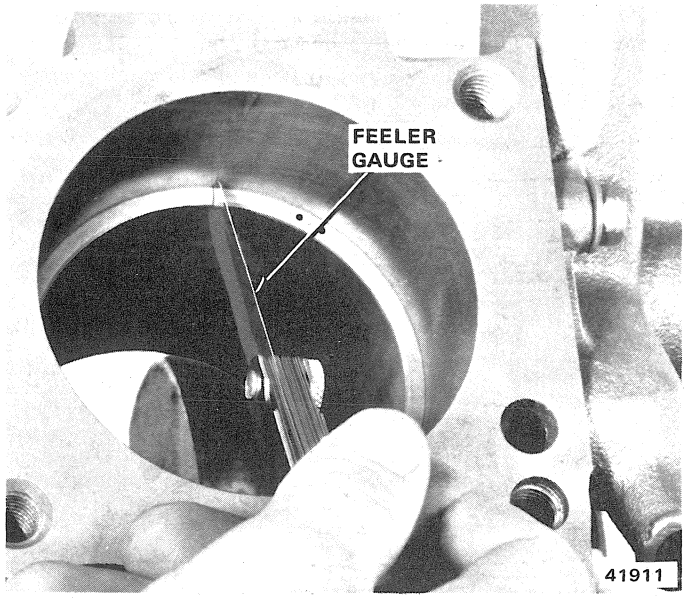

Fig. 1B-85 Ring Gap Clearance

Installation

Refer to figure 1B-86 for position of ring gaps when installing rings.

(1) Install oil control rings as indicated by instructions in package. It is not necessary to use tool to install upper and lower rails (fig. 1B-87). Insert expander ring first, then side rails.

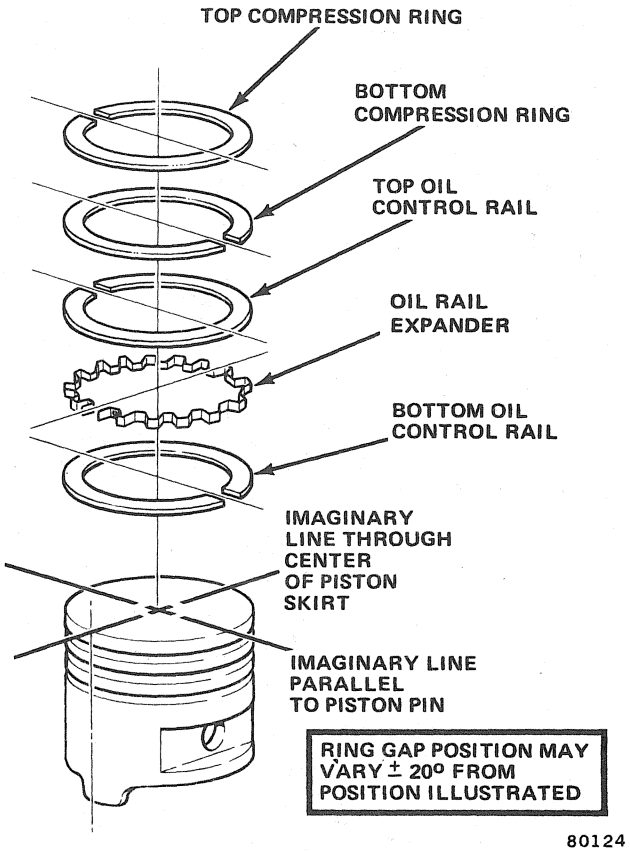

Fig. 1B-86 Piston Ring Gap Position

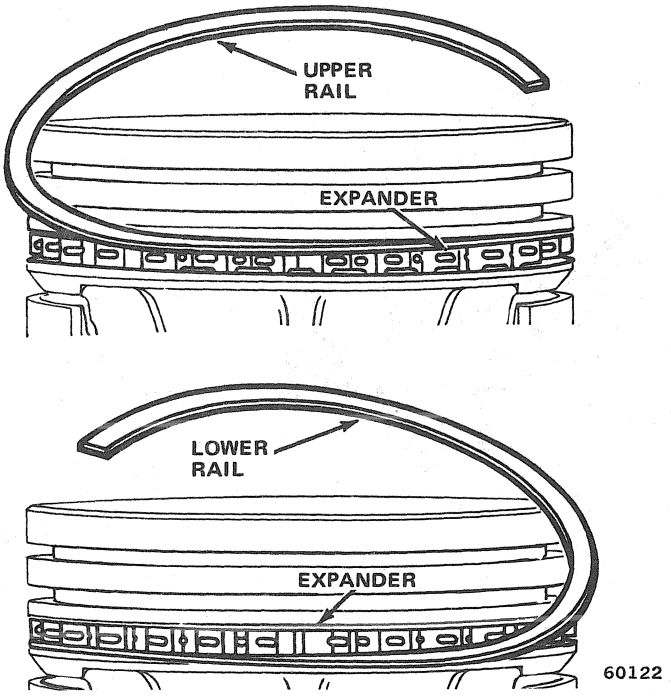

Fig. 1B-87 Oil Control Ring Rail Installation

(2) Install lower compression ring using ring installer to expand ring around piston (fig. 1B-88).

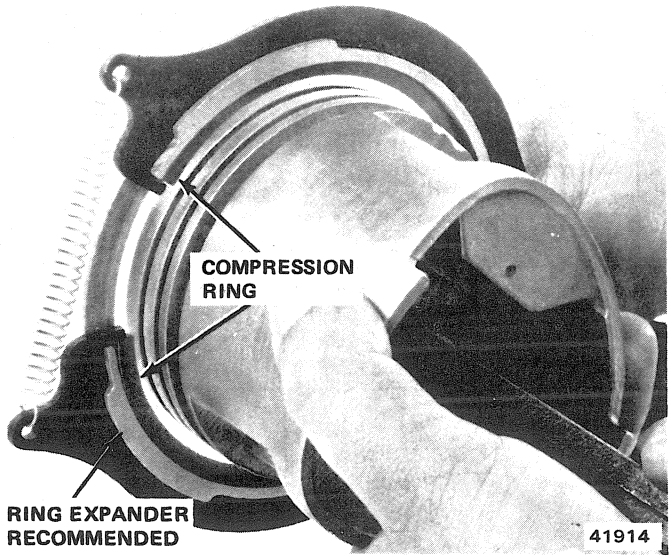

Fig. 1B-88 Compression Ring Installation

NOTE: *Ensure upper and lower compression rings are installed properly. Ideally, ring gaps should be located 180 degrees apart. Figure 1B-89 depicts typical ring markings that indicate the top side of each ring.*

(3) Install upper compression ring using ring installer to expand ring around piston (fig. 1B-88). Position ring gap 180° from lower compression ring.

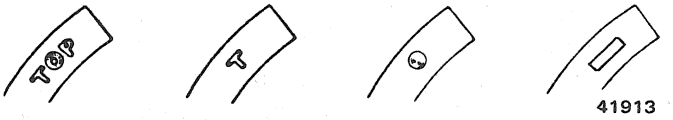

Fig. 1B-89 Typical Piston Ring Markings

Piston Pins

Piston pins are press fit into the connecting rod and require no locking device.

Removal

(1) Using Piston Pin Remover Tool J-21872 and arbor press, place piston on Remover Support Tool J-21872-1 (fig. 1B-90).

(2) Use Piloted Driver Tool J-21872-3 to press pin completely out of piston. Note position of pin through gauge window of remover support.

Pin Inspection

(1) Inspect pin and pin bore for nicks and burrs. Remove as necessary.

NOTE: *Never reuse piston pin after it has been installed in and removed from a connecting rod.*

(2) With pin removed from piston, clean and dry piston pin bore and replacement piston pin.

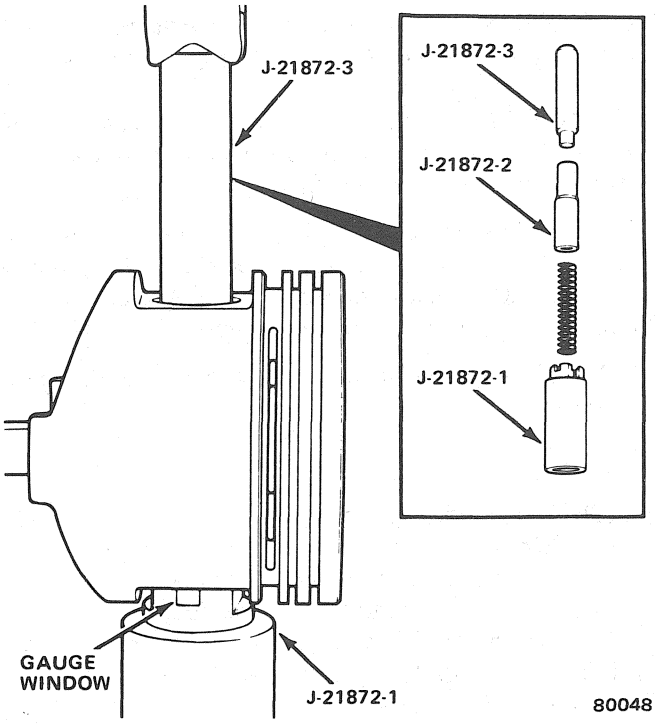

Fig. 1B-90 Piston Pin Removal or Installation

(3) Position piston so that pin bore is in vertical position. Insert pin in bore. At room temperature, the replacement pin should slide completely through pin bore without using force.

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

Installation

(1) Insert Pin Pilot Tool J-21872-2 through piston and connecting rod pin bores (fig. 1B-90).

(2) Position pin pilot, piston and connecting rod on Support Tool J-21872-1.

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

(4) Position Piloted Driver Tool J-21872-3 inside piston pin.

(5) Use arbor press to press piston pin through connecting rod and piston until pin pilot indexes with mark on support.

NOTE: *The piston pin requires a 2,000 pound (8.9 kN) press-fit. If little effort is required to install piston pin in connecting rod, or if rod moves along pin, replace connecting rod.*

(6) Remove piston and connecting rod assembly from press. Pin should be centered in rod, ±0.0312 inch (0.792 mm).

CRANKSHAFT

The nodular iron crankshaft is counterweighted and balanced. The crankshaft has four counterweights, seven main bearing journals and six connecting rod journals. End thrust is controlled by the No. 3 main bearing.

An oil slinger is located at the rear main journal, inboard of the rear oil seal. The component parts and crankshaft are first individually balanced and then the complete assembly is balanced as a unit.

Service replacement vibration dampers, crankshafts, flywheels, drive plates, torque converters and clutch components are balanced individually and may be replaced as required without balancing the complete assembly.

Removal or Replacement

If the crankshaft is damaged to the extent that reconditioning is not feasible, it must be replaced. Removal and installation procedures are outlined under Cylinder Block.

Crankshaft End Play Measurement

The crankshaft end play is controlled by the No. 3 main bearing inserts, which are flanged for this purpose.

(1) Attach dial indicator to cylinder block adjacent to No. 3 main bearing (fig. 1B-91).

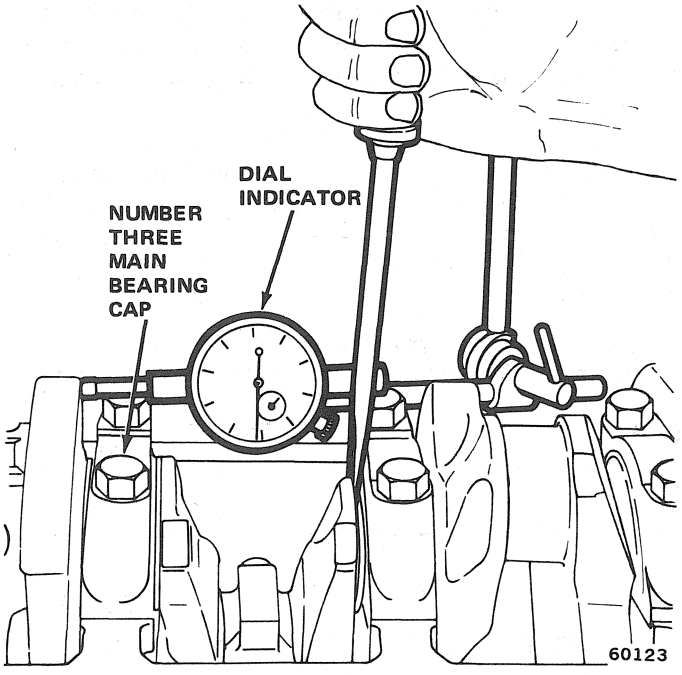

Fig. 1B-91 Measuring Crankshaft End Play

(2) Pry shaft forward with flat-bladed screwdriver and with dial indicator stem on face of crankshaft counterweight, set to zero.

(3) Pry shaft fore and aft and observe dial indicator. The end play is the difference between the high and low measurements. The correct crankshaft end play is 0.0015 to 0.0065 inch (0.0020 to 0.0025 desired) [0.038 to 0.165 mm (0.051 to 0.064 mm desired)].

(4) If end play is not within specifications, inspect crankshaft bearing thrust faces for wear. If wear is apparent, replace thrust bearing and measure end play. If end play is still not within specifications, replace crankshaft.

NOTE: *When replacing the thrust bearings, pry the crankshaft fore and aft to align the faces of the thrust bearings before the final tightening.*

Crankshaft Main Bearings

The main bearings are a steel-backed, micro-babbitt, precision type. The main bearing caps are numbered (front to rear) from 1 through 7, and an arrow indicates the forward position. The upper main bearing inserts are grooved while the lower inserts are smooth.

Each bearing is selectively fitted to its respective journal to obtain the desired operating clearance. **In production,** the select fit is obtained by using various sized color coded bearing inserts as described in the Main Bearing Fitting Chart. The bearing color code appears on the edge of the insert.

NOTE: *Bearing size is not stamped on inserts installed during production assembly.*

The main bearing journal size is identified **in production** by a color-coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal, where the paint mark is 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 0.001-inch (0.025 mm) undersize insert to reduce clearance by 0.0005 inch (0.013 mm).
Example:

Bearing Insert Pairs

Insert	Correct	Incorrect
Upper	Standard	Standard
Lower	0.001-inch (.025mm) undersize	0.002-inch (.051mm) undersize

70242

CAUTION: *Never use a pair of bearing inserts with greater than 0.001-inch (0.025 mm) difference in size.*

CAUTION: *When replacing bearing inserts, all the odd size inserts must be either all on the top (in block) or all on the bottom (in main bearing caps).*

Service replacement bearing inserts are available as pairs in the following sizes: standard, 0.001-, 0.002-, 0.010- and 0.012-inch undersize. The size is stamped on the back of service replacement inserts.

NOTE: *The 0.012-inch undersize insert is not used in production.*

Removal

(1) Drain engine oil.
(2) Remove oil pan.
(3) Remove main bearing cap and insert.
(4) Remove lower insert from bearing cap.
(5) Loosen other bearing caps and insert small cotter pin in crankshaft oil hole. Fabricate cotter pin as illustrated in figure 1B-92.

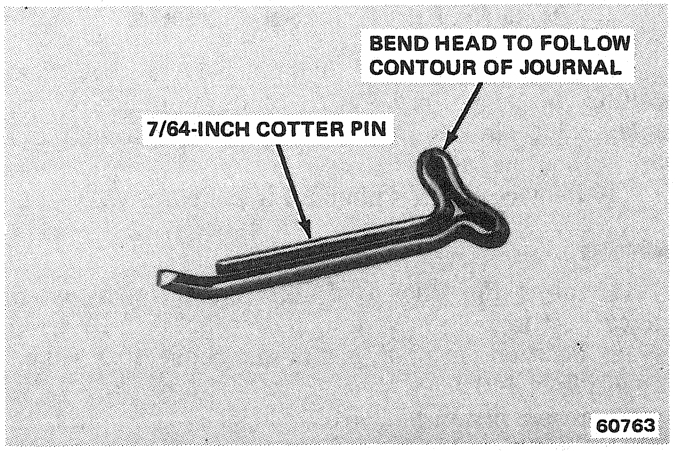

Fig. 1B-92 Fabricated Upper Main Bearing Removal Tool

(6) With cotter pin in place, rotate crankshaft so that upper bearing insert rotates in direction of its locking tab.

Main Bearing Fitting Chart

Crankshaft Main Bearing Journal 1-6 Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow — 2.5001 to 2.4996 (Standard) (63.5025 to 63.4898 mm)	Yellow — Standard	Yellow — Standard
Orange — 2.4996 to 2.4991 (0.0005 Undersize) (63.4898 to 63.4771 mm)	Yellow — Standard	Black — 0.001-inch Undersize (0.025 mm)
Black — 2.4991 to 2.4986 (0.001 Undersize) (63.4771 to 63.4644 mm)	Black — 0.001-inch Undersize (0.025 mm)	Black — 0.001-inch Undersize (0.025 mm)
Green — 2.4986 to 2.4981 (0.0015 Undersize) (63.4644 to 63.4517 mm)	Black — 0.001-inch Undersize (0.025 mm)	Green — 0.002-inch Undersize (0.051 mm)
Red — 2.4901 to 2.4896 (0.010 Undersize) (63.2485 to 63.2358 mm)	Red — 0.010-inch Undersize (0.254 mm)	Red — 0.010-inch Undersize (0.254 mm)

60262A

Crankshaft Main Bearing Journal 7 Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow — 2.4995 to 2.4990 (Standard) (63.4873 to 63.4746 mm)	Yellow — Standard	Yellow — Standard
Orange — 2.4990 to 2.4985 (0.0005 Undersize) (63.4746 to 63.4619 mm)	Yellow — Standard	Black — 0.001-inch Undersize (0.025 mm)
Black — 2.4985 to 2.4980 (0.001 Undersize) (63.4619 to 63.4492 mm)	Black — 0.001-inch Undersize (0.025 mm)	Black — 0.001-inch Undersize (0.025 mm)
Green — 2.4980 to 2.4975 (0.0015 Undersize) (63.4492 to 63.4365 mm)	Black — 0.001-inch Undersize (0.025 mm)	Green — 0.002-inch Undersize (0.051 mm)
Red — 2.4895 to 2.4890 (0.010 Undersize) (63.2333 to 63.2206 mm)	Red — 0.010-inch Undersize (0.254 mm)	Red — 0.010-inch Undersize (0.254 mm)

60262B

NOTE: *Because there is no hole in the number 4 main journal, use a tongue depressor or similar soft-faced tool to remove the bearing (fig. 1B-93). After moving the insert approximately one inch (25.40 mm), the insert can be removed by applying pressure under the tab.*

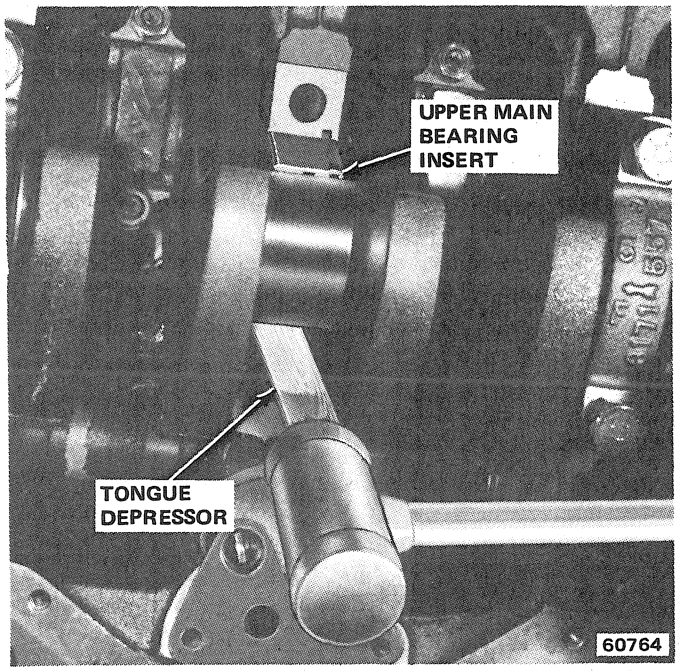

Fig. 1B-93 Removing No. 4 Main Bearing Insert

(7) In the same manner described above, remove remaining bearings one at a time for inspection.

Inspection

(1) Wipe lower insert clean and inspect for abnormal wear pattern and for metal or other foreign material imbedded in lining. Normal main bearing wear pattern is illustrated in figure 1B-94.

NOTE: *If the crankshaft journal is scored, remove the engine for crankshaft repair.*

(2) Inspect back of insert for fractures, scrapings or irregular wear pattern.

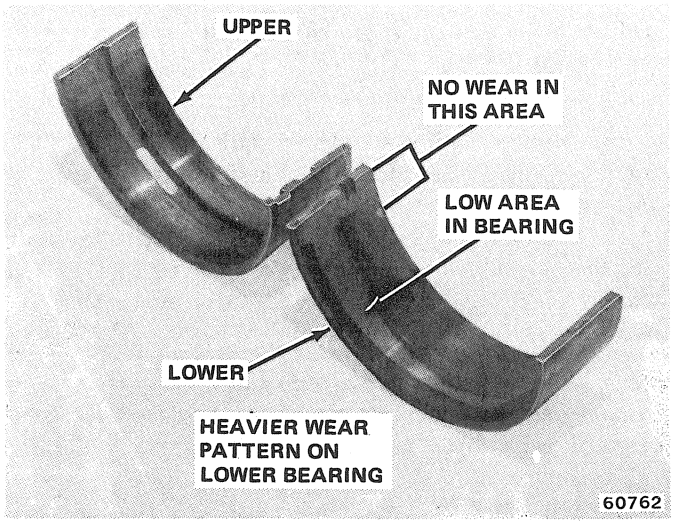

Fig. 1B-94 Normal Main Bearing Wear Pattern

(3) Inspect locking tabs for damage.

(4) Replace bearing inserts that are damaged or worn.

Measuring Bearing Clearance with Plastigage (Crankshaft Installed)

NOTE: *Measure clearance of one bearing at a time. All other bearings must remain tightened.*

(1) Remove main bearing cap and insert.

(2) Clean insert and exposed portion of crankshaft journal.

(3) Place strip of Plastigage across full width of bearing insert.

(4) Install bearing cap and tighten bolts with 80 foot-pounds (108 N•m) torque.

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (fig. 1B-95). Correct clearance is 0.001 to 0.003 inch (0.025 to 0.076 mm) . The Plastigage should maintain same size across entire width of insert. If size varies, it may indicate tapered journal or foreign material trapped behind insert.

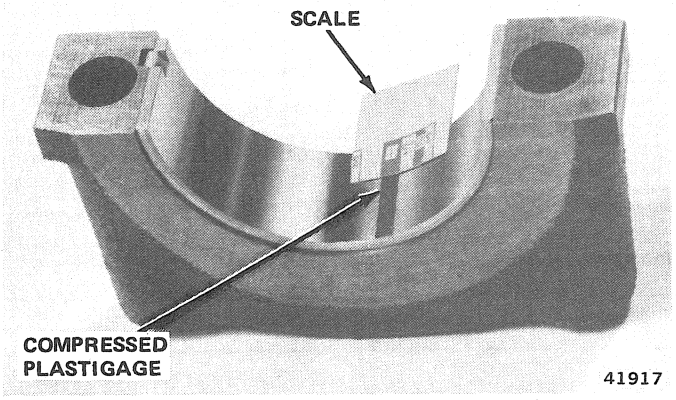

Fig. 1B-95 Measuring Main Bearing Clearance with Plastigage

NOTE: *Do not rotate crankshaft. Plastigage will shift, resulting in inaccurate indication. Plastigage must not crumble. If brittle, obtain fresh stock.*

(6) If correct oil clearance is indicated, bearing fitting is not necessary. Remove Plastigage from crankshaft and bearing and proceed to Installation.

(7) If oil clearance exceeds specification, install pair of 0.001-inch (0.025 mm) undersize bearing inserts and measure clearance as described in steps (4) through (6) above.

CAUTION: *Never use a pair of inserts that differ more than one bearing size as a pair. For example, do not use a standard upper and 0.002-inch (0.051 mm) undersize lower insert.*

NOTE: *The clearance indicated with the 0.001-inch (0.025 mm) undersize inserts installed will determine if the pair of 0.001-inch (0.025 mm) undersize inserts or some other combination will provide the correct clearance. For example, if the clearance was 0.0035 inch (0.089 mm) originally, a pair of 0.001-inch (0.025 mm) undersize inserts would reduce the clearance by 0.001 inch (0.025 mm). Oil clearance would be 0.0025 inch (0.064 mm) and within specification. A 0.002-inch (0.051 mm) undersize insert and a 0.001-inch (0.025 mm) undersize insert would reduce this clearance an additional 0.0005 inch (0.013 mm) and the oil clearance would be 0.002 inch (0.051 mm).*

(8) If oil clearance exceeds specification using 0.002-inch (0.051 mm) undersize bearing inserts, measure crankshaft journal with micrometer. If journal size is correct, crankshaft bore in cylinder block may be misaligned, which requires cylinder block replacement or machining to true bore. If journal size is less than 2.4981 inch (63.4517 mm), replace crankshaft or grind to accept suitable undersize inserts.

Measuring Main Bearing Journal with Micrometer (Crankshaft Removed)

(1) Clean main bearing journal.

(2) Measure maximum diameter of journal with micrometer. Measure at two locations 90 degrees apart at each end of journal.

(3) Compare measurements obtained with journal diameters listed in Main Bearing Fitting Chart and select inserts required to obtain specified bearing clearance.

Installation

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

(2) Loosen all main bearing caps and install main bearing upper insert(s).

(3) Install lower insert(s) and main bearing caps. Tighten bolts with 40 foot-pounds (54 N•m) torque. Then tighten with 60 foot-pounds (81 N•m) torque. Finally, tighten with 80 foot-pounds (108 N•m) torque. Rotate crankshaft after tightening each main bearing cap to ensure it rotates freely.

NOTE: *When installing a crankshaft kit (crankshaft plus bearing inserts), measure each bearing with Plastigage to determine if fit is correct.*

(4) Install oil pan, using replacement gaskets and seals. Tighten drain plug.

(5) Fill crankcase with clean lube oil to specified dipstick level.

Rear Main Bearing Oil Seal

The rear main bearing crankshaft oil seal consists of two pieces of neoprene with a single lip that effectively seals the rear of the crankshaft. To ensure leak-free operation, replace the upper and lower seal halves in pairs.

Removal

(1) Drain engine oil.

(2) Remove oil pan.

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

(4) Loosen all remaining main bearing caps.

(5) Use brass drift and hammer to tap upper seal until seal protrudes enough to permit pulling it out completely.

(6) Remove oil pan front and rear neoprene oil seals and oil pan side gaskets.

(7) Clean gasket surfaces of oil pan and engine block. Remove all sludge and residue from oil pan sump.

(8) Clean main bearing cap thoroughly to remove all sealer.

Installation

(1) Wipe seal surface of crankshaft clean and lightly coat with engine oil.

(2) Coat lip of seal with engine oil.

(3) Install upper seal into engine block.

NOTE: *Lip of seal must face toward front of engine.*

(4) Coat both sides of lower seal end tabs with RTV silicone (Jeep Gasket-in-a-Tube, or equivalent). Use care to prevent applying sealer to lip of seal.

(5) Coat outer curved surface of lower seal with soap and lip of seal with engine oil.

(6) Install seal into cap recess and seat it firmly.

(7) Coat both chamfered edges of rear main bearing cap with RTV silicone (fig. 1B-96).

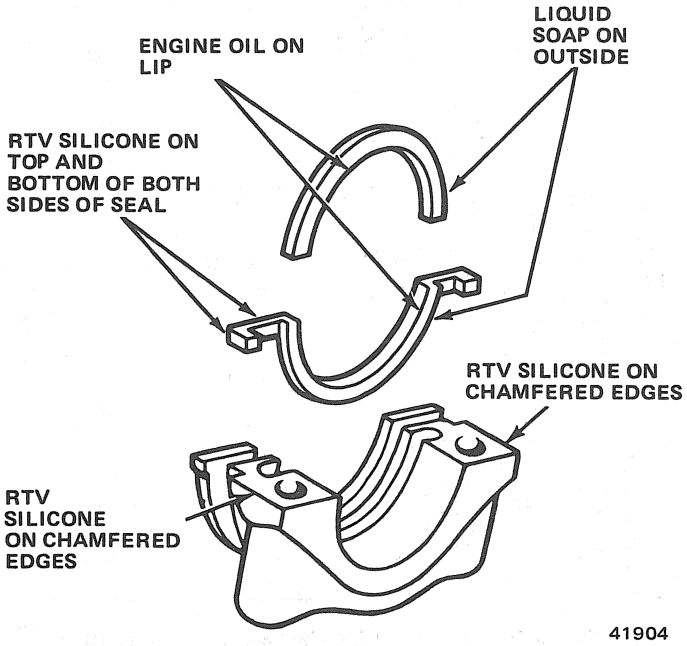

Fig. 1B-96 Rear Main Oil Seal and Cap Installation

CAUTION: *Do not apply sealer to cylinder block mating surfaces of rear main bearing cap because bearing clearance would be affected.*

(8) Install rear main bearing cap.

(9) Tighten all main bearing bolts in steps with 40, 60 and 80 foot-pounds (54, 81 and 108 N•m) torque.

(10) Install oil pan using replacement gaskets and seals. Tighten drain plug.

(11) Fill crankcase with clean oil to specified dipstick level.

Vibration Damper and Pulley

The vibration damper is balanced independently and then rebalanced as part of the complete crankshaft assembly.

Do not attempt to duplicate the vibration damper balance holes when installing a service replacement. The vibration damper is not repairable and is serviced only as a complete assembly.

Removal

(1) Remove drive belt(s).

(2) Remove three retaining bolts and separate vibration damper pulley from vibration damper.

(3) Remove vibration damper retaining screw and washer.

(4) Use Vibration Damper Remover Tool J-21791 to remove damper from crankshaft (fig. 1B-97).

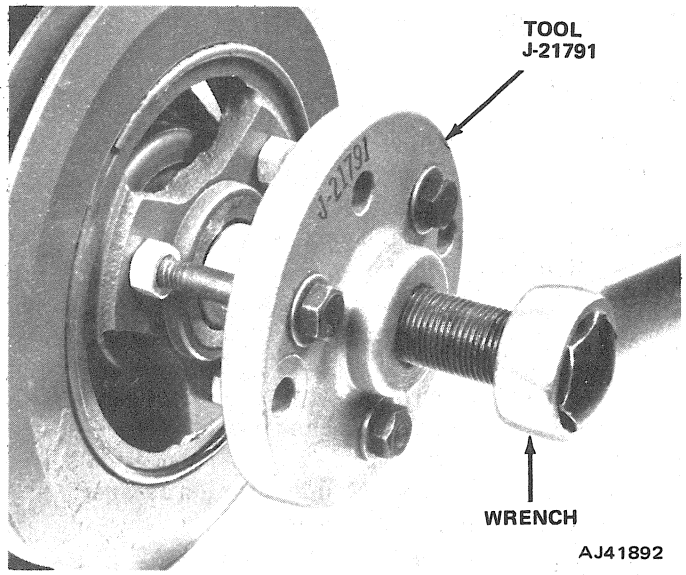

Fig. 1B-97 Vibration Damper Removal

Installation

(1) Align key way of vibration damper with crankshaft key and tap damper onto crankshaft.

(2) Install vibration damper retaining screw and washer. Tighten screw with 80 foot-pounds (108 N•m) torque.

(3) Install damper pulley with retaining bolts. Tighten bolts with 20 foot-pounds (27 N•m) torque.

(4) Install drive belt(s) and tighten to specified tension. Refer to Chapter 1C—Cooling System.

Flywheel/Drive Plate and Ring Gear Assembly

The ring gear can be replaced only for vehicles equipped with manual transmission. The ring gear is welded to and balanced as part of the converter drive plate on vehicles with automatic transmissions. The entire drive plate and ring gear assembly must be replaced on automatic transmission equipped vehicles.

Ring Gear Replacement (Manual Transmission)

(1) Position flywheel on arbor press with steel blocks equally spaced around perimeter and under ring gear.

(2) Press flywheel through ring gear.

NOTE: *Ring gear can also be removed by breaking with chisel.*

(3) Apply heat to expand inside diameter of replacement ring gear.

(4) Press flywheel into replacement ring gear.

NOTE: *On manual transmission equipped cars, the flywheel is balanced as an individual component and also as part of the crankshaft assembly. Do not attempt to duplicate original flywheel balance holes when installing a service replacement. Service flywheels are balanced during manufacture.*

CYLINDER BLOCK

Disassembly

(1) Remove engine as outlined within Engine Removal.
(2) Place engine assembly on engine stand.
(3) Remove intake and exhaust manifolds.
(4) Remove cylinder head cover.
(5) Remove bridge and pivot assemblies and rocker arms. Back off each capscrew one turn at a time to avoid damaging the bridge.
(6) Remove push rods.
(7) Remove cylinder head and gasket.
(8) Remove valve tappets.
(9) Remove drive pulley and vibration damper.
(10) Remove timing case cover.
(11) Remove timing chain and sprockets.
(12) Remove camshaft.
(13) Position pistons, one at a time, near bottom of stroke and use a ridge reamer to remove any ridge from top end of cylinder walls.
(14) Remove oil pan and gaskets.
(15) Remove oil pump.
(16) Remove connecting rod bearing caps and inserts and retain in same order as removed.

NOTE: *Connecting rods and caps are stamped with the number of the corresponding cylinder.*

(17) Remove piston and connecting rod assemblies through top of cylinder bores.

NOTE: *Ensure that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short pieces of rubber hose slipped over the rod bolts will prevent damage to the cylinder bores and crankshaft.*

(18) Remove main bearing caps and inserts.
(19) Remove crankshaft.

Cylinder Bore Reconditioning

Measuring Cylinder Bore

Use a bore gauge to measure the cylinder bore (fig. 1B-98). If a bore gauge is not available, use an inside micrometer.
(1) Measure cylinder bore crosswise to block near top of bore. Repeat measurement at bottom of bore.
(2) Determine taper by subtracting smaller dimension from larger dimension.
(3) Turn measuring device 120° and repeat step (1). Then turn another 120° and repeat measurements.
(4) Determine out-of-round by comparing difference between measurements taken 120° apart.
If the cylinder taper does not exceed 0.005 inch (0.013 mm) and the out-of-round does not exceed 0.003 inch (0.076 mm), the cylinder bore may be trued by honing. If

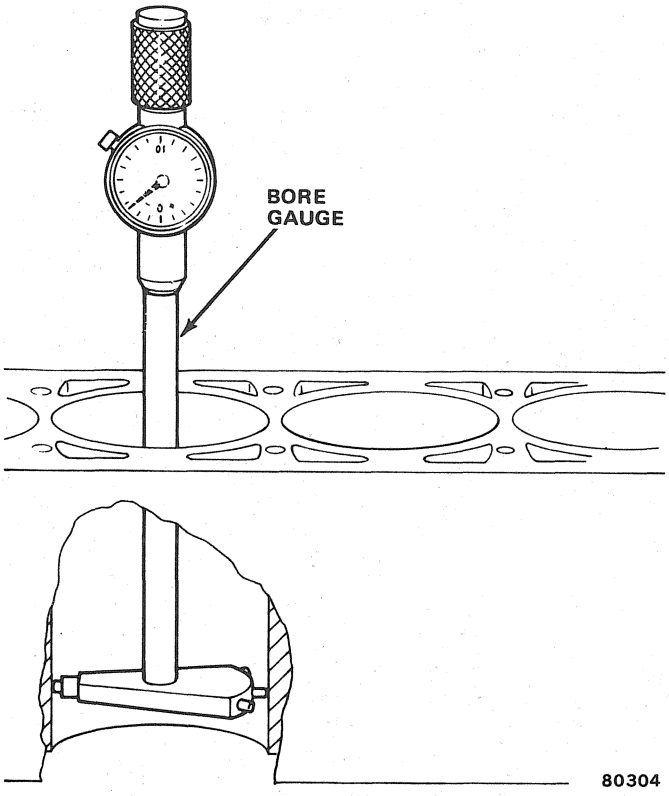

Fig. 1B-98 Measuring Cylinder Bore with Bore Gauge

the cylinder taper or out-of-round condition exceeds these limits, bore and then hone the cylinder for an oversize piston.

Resurfacing Cylinder Bore

CAUTION: *Do not use rigid type hones to remove cylinder wall glaze. A slight amount of taper always exists in cylinder walls after an engine has been in service for a period of time.*

(1) Use expanding hone to true cylinder bore and to remove glaze for faster ring seating. Move hone up and down at sufficient speed to produce uniform 60° angle crosshatch pattern on cylinder walls. Do not use more than ten strokes per cylinder (a stroke is one down and one up movement).

CAUTION: *Protect engine bearings and lubrication system from abrasives.*

(2) Scrub cylinder bores clean with solution of hot water and detergent.
(3) Immediately apply light engine oil to cylinder walls. Wipe with clean, lint-free cloth.

Assembly

(1) Install upper main bearing inserts in cylinder block.
(2) Install crankshaft.
(3) Install lower main bearing inserts and caps. Apply oil to insert before installing. Tighten bolts in steps

of 40, 60 and 80 foot-pounds torque (54, 81, 108 N•m). Plastigage all inserts if replacement inserts or crankshaft have been installed.

(4) Clean cylinder bores thorougly. Apply light film of clean engine oil to bores with clean, lint-free cloth.

(5) Install piston rings on piston. Refer to Piston Rings for procedure.

(6) Lubricate piston and rings with clean engine oil.

(7) Use Piston Ring Compressor Tool J-5601 to install connecting rod and piston assemblies through top of cylinder bores (fig. 1B-82).

NOTE: *Ensure that connecting rod bolts do not scratch the connecting rod journals or cylinder walls. Short lengths of rubber hose slipped over the connecting rod bolts will provide protection during installation.*

(8) Apply oil to inserts. Install connecting rod bearing inserts and caps in same location as removed. Tighten retaining nuts with 33 foot-pounds (45 N•m) torque.

NOTE: *Oil squirt holes in connecting rods must face camshaft.*

(9) Install oil pump with replacement pick-up tube and screen assembly.

(10) Install oil pan using replacement gaskets and seals. Tighten drain plug.

(11) Install camshaft and timing chain—sprocket assembly.

(12) Install timing case cover.

(13) Install vibration damper and drive pulley.

(14) Install valve tappets.

(15) Install gasket and cylinder head.

(16) Install push rods.

(17) Install rocker arms and bridge and pivot assemblies. Loosely install capscrews at each bridge, then tighten capscrews alternately, one turn at a time, to avoid damaging or breaking bridge.

(18) Install cylinder head cover, using silicone (RTV) rubber sealant.

(19) Install intake and exhaust manifolds.

(20) Remove engine from engine stand.

(21) Install engine assembly as outlined within Engine Installation.

SPECIFICATIONS

Six-Cylinder Engine Specifications

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Type	In Line, OHV, Six-Cylinder	
Bore	3.75	95.25
Stroke		
258	3.895	98.93
Displacement		
258	258 cubic inches	4.2 liters
Compression Ratio	8.0:1	
Compression Pressure		
258	120-150 psi	827-1034 kPa
Maximum Variation Between Cylinders	30 psi	206 kPa
Firing Order	1-5-3-6-2-4	
Taxable Horsepower	33.75 Bhp	25.2 kW
Fuel	unleaded	
Camshaft		
Fuel Pump Eccentric Diameter	1.615-1.625	41.02-41.28
Tappet Clearance	Zero Lash (Hydraulic tappets)	
End Play	Zero (engine operating)	
Bearing Clearance	0.001-0.003	0.025-0.076
Bearing Journal Diameter		
No. 1	2.029-2.030	51.54-51.56
No. 2	2.019-2.020	51.28-51.31
No. 3	2.009-2.010	51.03-51.05
No. 4	1.999-2.000	50.78-50.80
Base Circle Runout	0.001 (max)	0.03 (max)
Cam Lobe Lift	0.253	6.43
Intake Valve Timing		
Opens	9° BTDC	
Closes	73° ABDC	
Exhaust Valve Timing		
Opens	57° BBDC	
Closes	25° ATDC	
Valve Overlap	34°	
Intake Duration	262°	
Exhaust Duration	262°	

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Connecting Rods		
Total Weight (less bearings)		
258	695-703 grams	
Total Length (center-to-center)		
258	5.873-5.877	149.17-140.28
Connecting Rod Bore (less bearings)	2.2085-2.2080	56.09-56.08
Bearing Clearance	0.001-0.0025 (0.0015-0.002 preferred)	0.03-0.06 (0.044 preferred)
Side Clearance	.010-.019	.25-.48
Maximum Twist	0.001 per inch	0.025 per 25.4 mm
Maximum Bend	0.0005 per inch	0.0127 per 25.4 mm
Crankshaft		
End Play	0.0015-0.0065	0.038-0.165
Main Bearing Journal Diameter	2.4986-2.5001	63.464-63.502
Main Bearing Journal Width		
No. 1	1.086-1.098	27.58-27.89
No. 3	1.271-1.273	32.28-32.33
No. 2-4-5-6-7	1.182-1.188	30.02-30.18
Main Bearing Clearance		
No. 1 Main	.0005 to .0026 (.0015 preferred)	.013 to .066 (.04 preferred)
No. 2, 3, 4, 5, & 6 Mains	.0005 to .003 (.0017 preferred)	.013 to .076 (.045 preferred)
No. 7 Main	.0011 to .0035 (.0023 preferred)	.028 to .089 (.058 preferred)
Connecting Rod Journal Diameter	2.0934-2.0955	53.17-53.23
Connecting Rod Journal Width	1.070-1.076	27.18-27.33

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Six-Cylinder Engine Specifications (Continued)

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Maximum Out-of-Round (All Journals)	0.0005	0.013
Maximum Taper (All Journals)	0.0005	0.013
Cylinder Block		
Deck Height	9.487-9.493	240.97-241.12
Deck Clearance	0.0148 (below block)	0.376 (below block)
Cylinder Bore (standard)	3.7501-3.7533	95.253-95.334
Maximum Cylinder Taper	0.005	0.13
Maximum Cylinder (Out-of-Round)	0.003	0.08
Tappet Bore Diameter	0.9055-0.9065	23.0-23.025
Cylinder Block Flatness	0.001/1-0.002/6 (max)	0.03/25-0.05/152 0.20 (max)
Cylinder Head		
Combustion Chamber Volume	67.84-70.84cc	
Valve Arrangement	EI-IE-IE-EI-EI-IE	
Valve Guide ID (Integral)	0.3735-0.3745	9.487-9.512
Valve Stem-to-Guide Clearance	0.001-0.003	0.03-0.08
Intake Valve Seat Angle	30°	
Exhaust Valve Seat Angle	44.5°	
Valve Seat Width	0.040-0.060	1.02-1.52
Valve Seat Runout	0.0025	0.064
Cylinder Head Flatness	0.001/1-0.002/6 0.008 (max)	0.03/25-0.05/152 0.20 (max)
Lubrication System		
Engine Oil Capacity	4 quarts (Add 1 quart with filter change)	3.8 liters (Add 0.9 liter with filter change)
Normal Operating Pressure	13psi at 600 rpm; 37-75 psi (max) at 1600+ rpm	89.6 kPa at 600 rpm; 255.1-517.1 kPa (max) at 1600+ rpm
Oil Pressure Relief	75 psi (max)	517.1 kPa (max)
Gear-to-Body Clearance Radial	.002-.004 (.002 preferred)	.051-.102 (.051 preferred)
Gear End Clearance, Plastigage	0.002-0.006 (0.002 preferred)	0.051-0.152 (0.0508 preferred)
Gear End Clearance, Feeler Gauge	0.004-0.008 (0.007 preferred)	0.1016-0.2032 (0.1778 preferred)
Pistons		
Weight (less pin)	498-502 grams	
Piston Pin Bore Centerline-to-Piston Top	1.651-1.655	41.94-42.04
Piston-to-Bore Clearance	0.0009-0.0017 (0.0012-0.0013 preferred)	0.023-0.043 (0.030-0.033 preferred)
Piston Ring Gap Clearance — Compression (both)	0.010-0.020	0.25-0.51
Piston Ring Gap Clearance — Oil Control Steel Rails	0.010-0.025	0.25-0.64
Piston Ring Side Clearance No. 1 Compression	0.0017-.0032 (0.0017 preferred)	0.043-0.081 (0.043 preferred)
No. 2 Compression	0.0017-.0032 (0.0017 preferred)	0.043-0.081 (0.043 preferred)
Oil Control	0.001-0.008 (0.003 preferred)	0.03-0.20 (0.08 preferred)
Piston Ring Groove Height Compression (both)	0.0795-0.0805	2.019-2.045
Oil Control	0.188-0.1895	4.78-4.80
Piston Ring Groove Diameter No. 1 and No. 2	3.324-3.329	84.43-84.56
Oil Control	3.329-3.339	84.56-84.81
Piston Pin Bore Diameter	0.9308-0.9313	23.642-23.655
Piston Pin Diameter	0.9304-0.9309	23.632-23.645
Piston Pin-to-Clearance	0.0003-0.0005 loose (0.0005 preferred)	0.008-0.013 loose (0.013 preferred)
Piston Pin-to-Connecting Rod	2000 lbf press-fit	8.900 kN press-fit
Rocker Arms, Push Rods and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	9.640-9.660	244.856-245.364
Push Rod Diameter	.312-.315	7.92-8.00
Hydraulic Tappet Diameter	0.904-0.9045	22.96-22.97
Tappet-to-Bore Clearance	0.001-0.0025	0.03-0.05
Valves		
Valve Length (Tip-to-Gauge Dim. Line)	4.7895-4.8045	121.653-122.034
Valve Stem Diameter	0.3715-0.3725	9.436-9.462
Stem-to-Guide Clearance	0.001-0.003	0.03-0.08
Intake Valve Head Diameter	1.782-1.792	45.26-45.52
Intake Valve Face Angle	29°	
Exhaust Valve Head Diameter	1.401-1.411	35.59-35.84
Exhaust Valve Face Angle	44°	
Maximum Allowable Removed for Tip Refinishing	0.010	0.25
Valve Springs, Exhaust		
Valve Open	80-88 at 1.625	
Valve Closed	210-226 at 1.188	
I.D.	1.000-1.020 in.	
Valve Springs, Intake		
Free Length	1.99 approx.	50.55 approx.
Spring Tension Valve Closed	64-72 lbf at 1.786	285-320 N at 45.24
Valve Open	188-202 lbf at 1.411	836-898 N at 35.84
Inside Diameter	0.948-0.968	24.08-24.59

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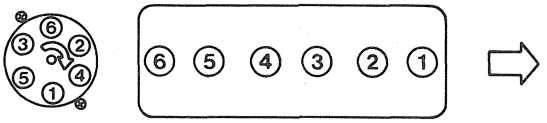
Six-Cylinder Engine Firing Order



Torque Specifications

Service Set-To Torques should be used when assembling components. Service In-Use Recheck Torques should be used for checking a pre-torqued item.

	USA (ft-lbs)		Metric (N·m)	
	Service Set-To Torque	Service In-Use Recheck Torque	Service Set-To Torque	Service In-Use Recheck Torque
Air Injection Tube-to-Manifold	20	15-20	27	20-27
Air Pump Adjusting Strap-to-Pump	20	15-22	27	20-30
Air Pump Brackets-to-Engine (A/C Compressor or Pedestals)	25	18-28	34	24-38
Air Pump-to-Bracket	20	15-22	27	20-30
Alternator Adjusting Bolt	18	15-20	24	20-27
Alternator Mounting Bracket-to-Engine	28	23-30	38	31-41
Alternator Pivot Bolt or Nut	28	20-35	38	27-47
Alternator Pivot Mounting Bolt-to-Head	33	30-35	45	41-47
Block Heater Nut	20 in-lbs	17-25 in-lbs	2	2-3
Camshaft Sprocket Screw	50	45-55	68	61-75
Carburetor Hold-Down Nuts	14	12-20	19	16-27
Clutch Housing Spacer to Block Screws	12	9-15	16	12-20
Clutch Housing-to-Block Screws (bottom)	43	37-47	58	50-64
Clutch Housing-to-Block Screws (top)	27	22-30	37	30-41
Coil Bracket-to-Cylinder Head	14	10-18	19	14-24
Connecting Rod Bolt Nuts	33	30-35	45	41-47
Crankshaft Pulley-to-Damper Bolts	20	15-25	27	20-34
Cylinder Head Capscrews	85	80-90	115	108-122
Cylinder Head Cover Nuts	28 in-lbs	25-31 in-lbs	32	2.8-3.5
Distributor Clamp Bracket Screw	13	10-18	18	14-24
EGR Valve	13	9-18	18	12-24
Exhaust Manifold Bolts	23	18-28	31	24-38
Exhaust Pipe-to-Manifold	20	15-25	27	20-34
Fan and Hub Assembly Bolts	18	12-25	24	16-34
Drive Plate-to-Converter Screw	22	20-25	30	27-34
EGR Tube Nuts	30	25-35	41	34-47
Flywheel or Drive Plate-to-Crankshaft	105	95-115	142	129-156
Front Support Bracket-to-Block Screw	35	25-40	47	34-54
Front Support Cushion-to-Bracket	33	27-38	45	36-52
Front Support Cushion-to-Bracket-to-Frame	37	30-45	50	41-61
Fuel Pump Screws	16	13-19	22	18-26
Idler Arm Bracket-to-Sill	50	35-60	68	47-81
Idler Pulley Bracket-to-Front Cover Nut	7	4-9	9	5-12
Idler Pulley Bearing Shaft-to-Bracket Nut	33	28-38	45	38-52
Intake Manifold Coolant Fittings	20	15-25	27	20-34
Intake Manifold Heater Screws	7	5-9	9	7-12
Intake Manifold Screws	23	18-28	31	24-38
Main Bearing Capscrews	80	75-85	108	101-115
Oil Filter Adapter	48	42-55	65	57-75
Oil Pan Drain Plug	30	25-35	41	34-47
Oil Pan Screws—1/4 inch—20	7	5-9	9	7-12
Oil Pan Screws—5/16 inch—18	11	9-13	15	12-18
Oil Pump Attaching Screws (Long)	17	12-20	23	16-27
Oil Pump Attaching Screws (Short)	10	8-13	14	11-18
Oil Pump Cover Screws	70 in-lbs	60-80 in-lbs	8	7-9
Oxygen Sensor	35	32-38	48	43-52
Power Steering Pump Adapter Screw	23	18-28	31	24-38
Power Steering Pump Bracket Screw	43	37-47	58	50-64
Power Steering Pump Mounting Screw	28	25-35	38	34-47
Power Steering Pump Pressure Line Nut	38	30-45	52	41-61
Power Steering Pump Pulley Nut	58	40-65	79	54-88
Rear Crossmember-to-Side Sill Nut	30	20-35	41	27-47
Rear Support Bracket-to-Transmission	33	27-38	45	37-52
Rear Support Cushion-to-Bracket	48	40-55	65	54-75
Rear Support Cushion-to-Crossmember	18	12-25	24	16-34
Rocker Arm Assembly-to-Cylinder Head	19	16-26	26	22-35
Spark Plug	11	7-15	15	10-20
Starter to Converter Housing Bolt	18	13-25	24	18-34
Thermostat Housing Screw	13	10-18	18	14-24
Timing Case Cover-to-Block Screws	5	4-8	7	5-11
Timing Case Cover-to-Block Studs	16	13-19	22	18-26
Vibration Damper Screw, Lubricated	80	70-90	108	95-122
Water Pump Screws	13	9-18	18	12-24

All Torque values given in foot-pounds and newton-meters with dry fits unless otherwise specified.

Refer to the Standard Torque Specifications and Capscrew Markings Chart in Chapter A of this manual for any torque specifications not listed above.