EIGHT-CYLINDER ENGINE

GENERAL

The 304 (5 liters) and 360 (6 liters) CID engines are 90-degree V-8 cylinder designs incorporating overhead valves (figs. 1B-99 and 1B-100). The cylinders are numbered from front to rear: 1-3-5-7 on the left bank and 2-4-6-8 on the right bank. The cylinder firing order is 1-8-4-3-6-5-7-2.

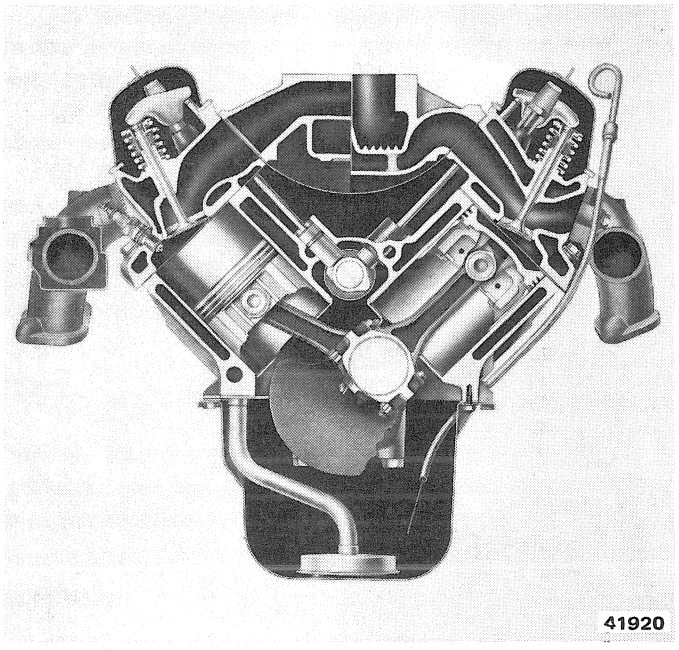

Fig. 1B-99 Sectional View of Eight-Cylinder Engine Assembly

The crankshaft, supported by five two-piece main bearing inserts, rotates in a counterclockwise direction as viewed from the rear. The camshaft is supported by five one-piece, line-bored bearings.

Bridge and pivot assemblies control movement of intake and exhaust rocker arms and are paired by cylinder.

Because of the similarity of the two engines, service procedures have been consolidated and typical illustrations are used to represent both engines.

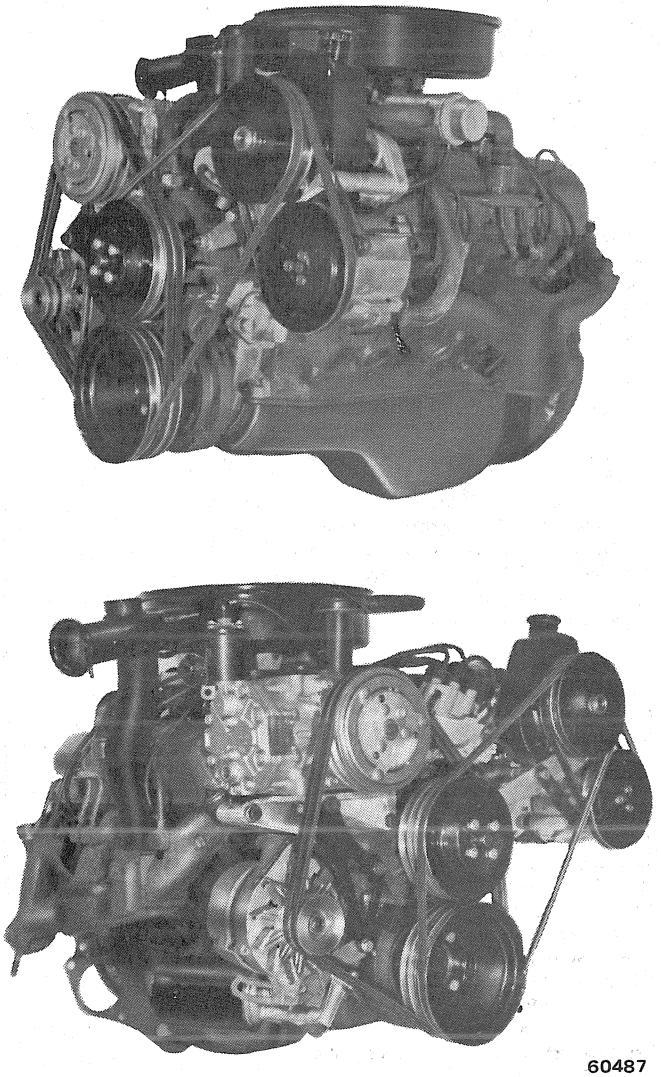

Fig. 1B-100 Typical Eight-Cylinder Engine Assembly

Engine Identification

The cubic-inch displacement numbers are cast into both sides of the cylinder block. These numbers are located between the engine mounting bracket bosses.

Engine Type and Build Date Code

The engine Type and Build Date Code is located on a plate attached to the right bank cylinder head cover (fig. 1B-101).

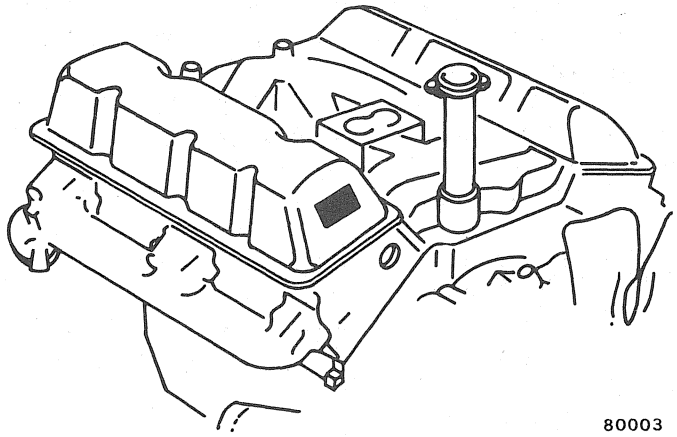

Fig. 1B-101 Engine Type and Build Date Code Location

The code numbers identify the year, month, and day that the engine was built. The code letter identifies the cubic inch displacement, number of carburetor venturi and compression ratio.

The example code identifies a 304 CID (5 liters) engine with 2V carburetor and 8.4:1 compression ratio built on October 15, 1980.

Engine Type and Build Date Code

Letter Code	CID	Carburetor	Compression Ratio
H	304	2V	8.4:1
N	360	2V	8.25:1

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

EXAMPLE: 4 10 H 15

60265

Oversize or Undersize Components

It is sometimes necessary to machine all cylinder bores 0.010-inch (0.254 mm) oversize, all crankshaft main bearing journals 0.010-inch (0.254 mm) undersize, all connecting rod journals 0.010-inch (0.254 mm) undersize, or all camshaft bearing bores 0.010-inch (0.254 mm) oversize. If so, the engine has a single or double letter code stamped adjacent to the Engine Type and Build Date Code on the plate attached to the right bank cylinder head cover. The code is explained in the Oversize or Undersize Components Code chart.

Oversize or Undersize Components Code

Single Letter B	cylinder bore 0.010-inch (0.254mm) oversize
Single Letter M	main bearings 0.010-inch (0.254mm) undersize
Single Letter F	connecting rod bearings 0.010-inch (0.254mm) undersize
Double Letters PM	main and connecting rod bearings 0.010-inch (0.254mm) undersize
Single Letter C	camshaft bearing bores 0.010-inch (0.254mm) oversize

60258

SHORT ENGINE ASSEMBLY (SHORT BLOCK)

A service replacement short engine assembly (short block) may be installed whenever the original engine block is damaged beyond feasible repair. A short engine assembly consists of an engine block, piston and connecting rod assemblies, crankshaft, camshaft, timing sprockets and chain. When installing a short engine assembly, always install a replacement oil pump pickup tube and screen assembly.

NOTE: *Short engine assemblies include a replacement engine type and build date code plate. Remove the original plate and attach the replacement plate to right cylinder head cover.*

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

ENGINE MOUNTING

Resilient rubber mounting cushions support the engine and transmission at three points. A cushion is located at each side on the centerline of the engine. The rear is supported by a cushion between the transmission extension housing and the rear support crossmember (fig. 1B-102).

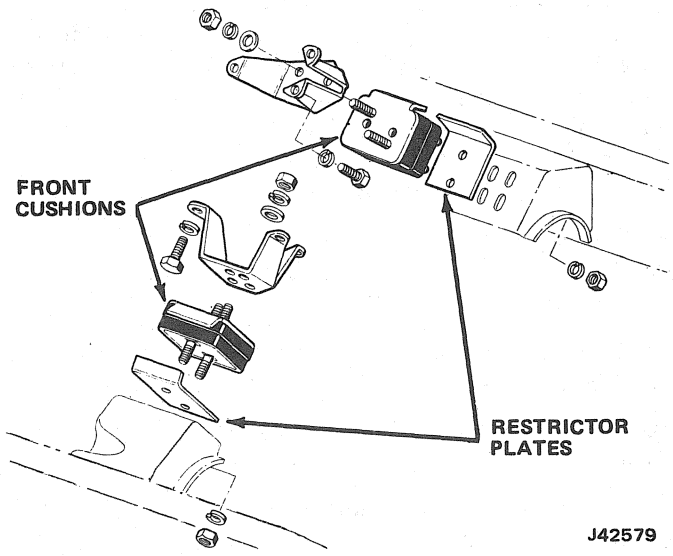

Fig. 1B-102 Typical Engine Mounting

Removal or replacement of any cushion may be accomplished by supporting the weight of the engine or transmission in the area of the cushion.

ENGINE HOLDING FIXTURE

If necessary to remove the front engine mounts to perform service such as oil pan removal, fabricate an engine holding fixture such as that illustrated in figure 1B-103.

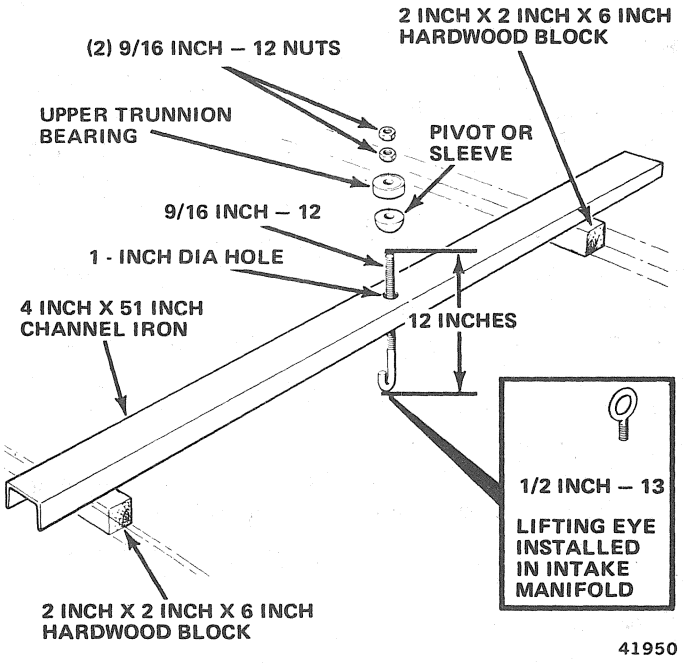

Fig. 1B-103 Engine Holding Fixture

ENGINE REMOVAL

The engine is removed with the transmission and flywheel/drive plate housing detached.

(1) On Cherokee, Wagoneer and Truck vehicles, mark hood hinge locations at hood panel for ease of alignment during installation. Remove hood from hinges. On CJ vehicles, hood will tilt far enough rearward to facilitate engine removal.

(2) Remove air cleaner assembly.

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(3) Drain cooling system and disconnect upper and lower radiator hoses. Disconnect heater hoses.

NOTE: *If coolant is reusable, drain into clean container.*

(4) If equipped with automatic transmission, disconnect fluid cooler tubing from radiator and where attached to engine.

NOTE: *If the vehicle is equipped with a radiator shroud, separate the shroud from the radiator to facilitate removal and installation of the radiator and fan assembly.*

(5) Remove radiator.

(6) Remove fan assembly. If equipped with power steering, remove fluid from pump reservoir and disconnect hoses.

(7) If equipped with air conditioning, turn both service valves clockwise to front-seated position. Vent compressor refrigerant charge by slowly loosening service valve fittings. Remove service valves from compressor.

(8) Remove Cruise Command vacuum servo bellows and mounting bracket as an assembly, if equipped.

(9) On Cherokee, Wagoneer and Truck vehicles, remove battery. On CJ vehicles, disconnect battery negative cable.

(10) Disconnect wire harness from engine and move aside.

(11) Disconnect following hoses, as applicable:

(a) Fuel supply and return hoses at chassis tubing.

(b) Vacuum hose at power brake unit.

(c) Vacuum hose for heater damper doors at intake manifold.

(12) If equipped with automatic transmission, disconnect transmission filler tube bracket from right cylinder head. Do not remove filler tube from transmission.

(13) Remove both engine front support cushion-to-frame retaining nuts.

(14) Support weight of engine with lifting device.

(15) On CJ vehicles, remove left front support cushion and bracket from cylinder block.

(16) On CJ vehicles equipped with manual transmission, remove transfer case shift lever boot, floormat (if equipped), and transmission access cover.

(17) On vehicles equipped with automatic transmission, remove upper screws securing drive plate housing to engine. If equipped with manual transmission, remove upper screws securing flywheel housing to engine.

(18) Disconnect exhaust pipe from exhaust manifolds and support bracket.

(19) Remove starter motor.

(20) Support transmission with floor jack.

(21) If equipped with automatic transmission:

(a) Remove drive plate housing inspection cover. Scribe mark to indicate assembled position of converter and drive plate and remove converter-to-drive plate bolts.

(b) Remove lower throttle valve and inner manual linkage support. Disconnect throttle valve rod at lower end of bellcrank.

(22) Remove remaining screws securing flywheel/drive plate housing to engine. If equipped with manual transmission, remove flywheel housing lower cover.

CAUTION: *If equipped with power brakes, avoid damaging the power unit while removing the engine.*

(23) Remove engine by lifting upward and forward.

ENGINE INSTALLATION

(1) Lower engine slowly into engine compartment and align with flywheel/drive plate housing. With manual transmissions, ensure clutch shaft is aligned properly with splines of clutch driven plate.

(2) Install flywheel/drive plate housing screws. Tighten screws with specified torque. Automatic transmission: 28 foot-pounds (38 N•m). Manual transmission: 27 foot-pounds (37 N•m).

(3) Remove floor jack used to support transmission.

(4) If equipped with automatic transmission, align scribe marks previously made on converter and drive plate, install converter-to-drive plate bolts and tighten with specified torque. Install throttle valve bellcrank and manual linkage support.

(5) Install inspection cover (automatic transmission) or flywheel housing lower cover (manual transmission).

(6) Install starter motor.

(7) On CJ vehicles, install left front support cushion and bracket on cylinder block. Tighten screws with 28 foot-pounds (38 N•m) torque.

(8) Lower engine onto supports. Remove lifting device.

(9) Install front support cushion retaining nuts. Tighten nuts with 33 foot-pounds (45 N•m) torque.

(10) Connect exhaust pipe to exhaust manifolds and support bracket.

(11) If equipped with automatic transmission, connect transmission filler tube bracket to right cylinder head.

(12) Install battery, if removed.

(13) Install Cruise Command vacuum servo bellows and mounting bracket, if removed.

(14) Connect all wires, tubing, linkage and hoses to engine.

(15) Connect receiver outlet to disconnect coupling. Connect condenser and evaporator lines to compressor.

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

(16) Purge compressor of air.

(17) If equipped with power steering, connect hoses and fill pump reservoir to specified level.

(18) Install radiator fan assembly and tighten retaining screws with 18 foot-pounds (24 N•m) torque.

(19) Install radiator and connect upper and lower hoses. If equipped with automatic transmission, connect fluid cooler tubing.

(20) Fill cooling system to specified level.

(21) Install air cleaner assembly.

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. Inspect all connections for leaks. Stop engine.

(23) If removed, install and align hood assembly.

(24) If removed, install transmission access cover, floormat and transfer case shift lever boot.

VALVE TRAIN

General

All eight-cylinder engines have overhead valves operated by hydraulic tappets, push rods and rocker arms. A chain-driven camshaft is mounted in the cylinder block. The hydraulic valve tappets provide automatic valve lash adjustment.

Rocker Arm Assembly

The intake and exhaust rocker arms for each cylinder pivot on a bridge and pivot assembly that is secured to the cylinder head by two capscrews (fig. 1B-104). The bridge and pivot assembly maintains correct rocker arm-to-valve tip alignment. Each rocker arm is actuated

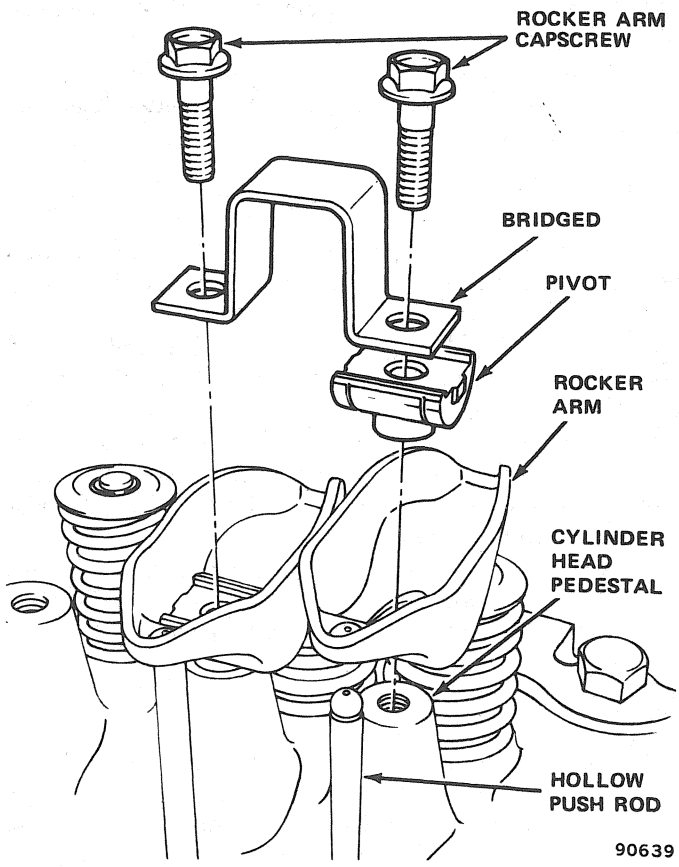

Fig. 1B-104 Rocker Arm Assembly

by a hollow steel push rod with a hardened steel ball at each end. The hollow push rods also route oil to the rocker arm assemblies.

Removal

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

Cleaning and Inspection

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

Inspect the pivot contact surface of each rocker arm and push rod. Replace parts that are scuffed, pitted or excessively worn. Inspect the valve stem contact surface of each rocker arm and replace if deeply pitted. Inspect each push rod end for scuffing or excessive wear. **If any push rod is excessively worn from lack of oil, replace the push rod as well as the corresponding hydraulic valve tappet and rocker arm.**

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

Installation

(1) Install push rods. **Ensure bottom end of each rod is centered in plunger cap of hydraulic valve tappet.**
(2) Install bridge and pivot assembly and pair of rocker arms adjacent to cylinder from where they were originally removed.
(3) Loosely install two capscrews through each bridge. Tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten with 19 foot-pounds (26 N•m) torque.
(4) Reseal and install cylinder head cover.
(5) Install retaining screws and washers. Tighten screws with 50 inch-pounds (6 N•m) torque.

Valves

The following procedures apply only after the cylinder head has been removed from the engine and the bridge and pivot assemblies, rocker arms and push rods removed from the head. If the head has not been removed from the engine, refer to Cylinder Head for removal procedure.

Removal

(1) Compress each valve spring with C-clamp type spring compressor tool. Remove valve locks and retainers. Release compressor tool.
(2) Remove valve springs.
(3) Remove valve stem oil deflectors.
(4) Remove valves individually and place in rack in same order as installed in cylinder head.

Cleaning and Inspection

Remove all carbon deposits from the combustion chambers, valve ports, and valve stems and heads.

Remove all foreign material and gasket cement from the cylinder head gasket mating surface.

Inspect for cracks in the combustion chambers and valve ports and in the gasket surface area at each coolant passage.

Inspect for burned or cracked valve heads and scuffed valve stems. Replace any valve that is bent, warped or scuffed.

Valve Refacing

Use a valve refacing machine to reface intake and exhaust valves to 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-105.

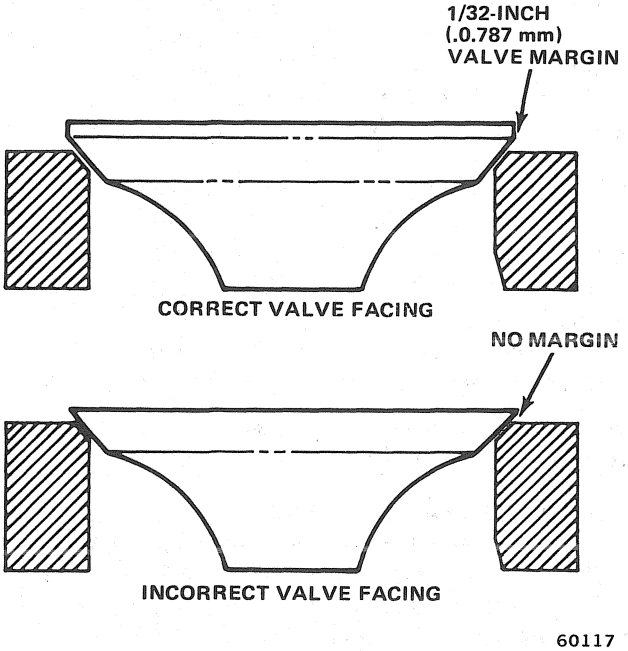

Fig. 1B-105 Valve Refacing

Resurface and rechamfer the valve stem tip when excessively worn. **Never remove more than 0.020 inch (0.508 mm).**

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. This is especially important on exhaust valve seats. The seat hardness varies in depth. Use tapered stones to obtain the specified seat widths when required. Maximum seat runout is 0.0025 inch (0.064 mm) (fig. 1B-106).

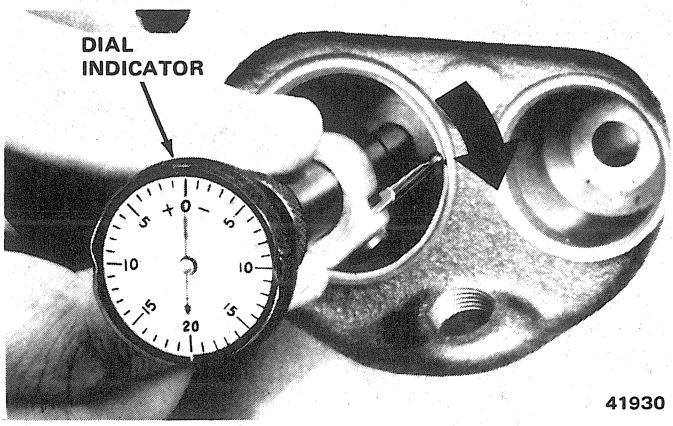

Fig. 1B-106 Valve Seat Runout Measurement

Valve Stem Oil Deflector Replacement

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

Oil deflector replacement requires removal of valve springs. Refer to Valve Springs for procedure.

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 the next larger valve stem size. Service valves are available with 0.003-inch (0.076 mm), 0.015-inch (0.127 mm) and 0.030-inch (0.760 mm) oversize stems.

Refer to the Valve Guide Reamer Size chart for listing of reamers.

Valve Guide Reamer Sizes

Reamer Tool Number	Size
J-6042-1	0.003-inch (0.076mm)
J-6042-5	0.015-inch (0.381mm)
J-6042-4	0.030-inch (0.762mm)

60268

NOTE: *Ream valve guide bores in steps. Start with the 0.003-inch (0.076 mm) reamer and progress to the size required.*

Valve Stem-to-Guide Clearance

Valve stem-to-guide clearance can be measured by either one of 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-107) with contacts crosswise to head. Measure telescoping gauge with micrometer.

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

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

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

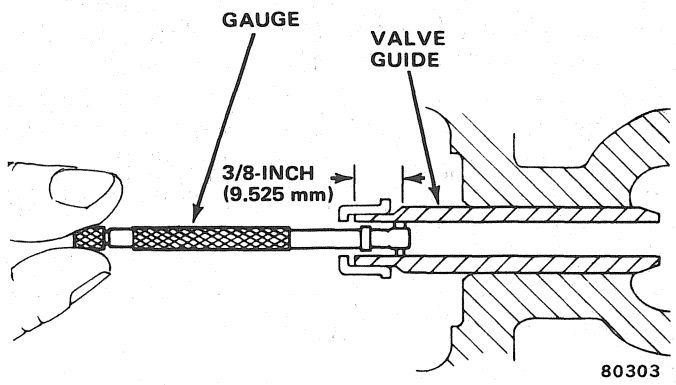

Fig. 1B-107 Measuring Valve Guide Bore with Telescoping Gauge

Alternate Method

Use a dial indicator to measure the lateral movement of the valve stem with the valve installed in its guide and barely off the valve seat (fig. 1B-108). Correct clearance is 0.001 to 0.003 inch (0.025 to 0.076 mm).

Installation

(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 originally removed.

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

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

(5) Tap valve spring from side to side with light hammer to seat spring properly on cylinder head.

Fig. 1B-108 Valve Stem-to-Guide Clearance Measurement with Dial Indicator

Valve Springs

Valve springs and oil deflectors can be removed without removing the cylinder head. Refer to Valves for the removal procedure with the cylinder head removed from the engine.

Valve Spring and Oil Deflector Removal

The valve spring is held in place on the valve stem by a retainer and a set of 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 from valves requiring valve spring or oil deflector removal. Remove two capscrews at each bridge. Alternately loosen capscrews, one turn at a time, to avoid damaging bridge.

(3) Remove push rods.

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

(4) Remove spark plug from cylinder that requires valve spring or oil deflector removal.

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

NOTE: *An adapter can be constructed 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 hold valves against their seats.

(7) Use Valve Spring Remover and Installer Tools J-22534-1, J-22534-4, and J-22534-5 to compress valve spring. Remove valve locks (fig. 1B-109).

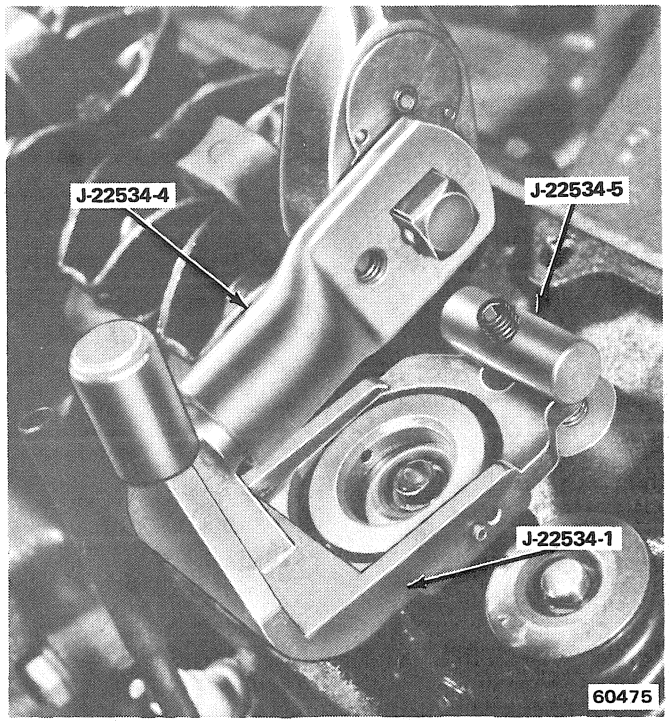

Fig. 1B-109 Valve Spring Removal

(8) Remove valve spring and retainer from cylinder head.

(9) Remove oil deflector.

Valve Spring Tension Test

Use Valve Spring Tester J-8056, or equivalent, to test each valve spring for the specified tension value (fig. 1B-110). Replace springs that are not within specification. Replace springs that bind because of warpage.

Installation

(1) Use 7/16-inch (11 mm) deep socket and hammer to gently tap oil deflector onto valve stem.

NOTE: *A close-coil valve spring is used with all valves. The close-coil end must face the cylinder head when installed.*

(2) Install valve spring and retainer.

(3) Compress valve spring with Valve Spring Remover and Installer Tools J-22534-1, J-22534-4 and J-22534-5. Insert valve locks. Release spring compression and remove tool.

(4) Tap valve spring from side to side with light hammer to ensure spring is seated properly on cylinder head.

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

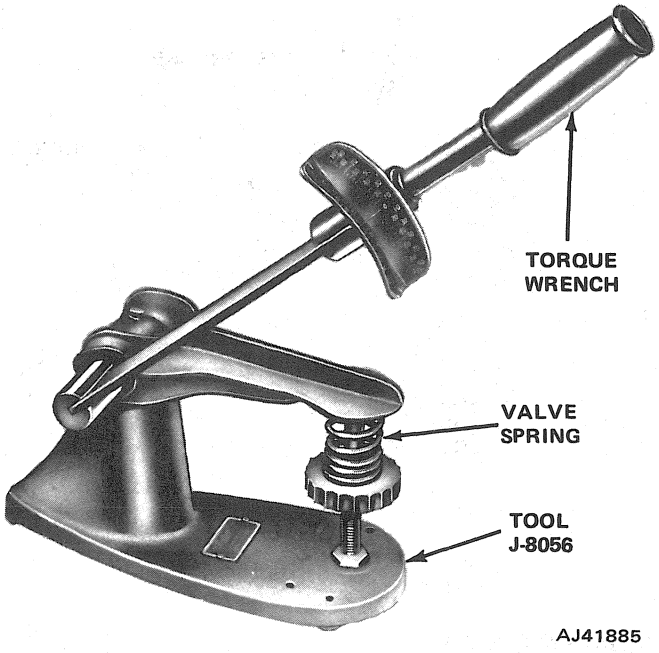

Fig. 1B-110 Valve Spring Tester

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

(7) Install rocker arms and bridge and pivot assembly. At each bridge, tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten capscrews with 19 foot-pounds (25 N•m) torque.

(8) Reseal and install cylinder head cover.

(9) Install retaining screws and washers. Tighten screws with 50 inch-pounds (6 N•m) torque.

CAMSHAFT AND BEARINGS

General

The 304 CID (5 liter) engine uses the same camshaft as the 360 CID (6 liter) engine. The camshaft is supported by five steel-shelled, babbitt-lined bearings pressed into the block and line reamed. The step bored camshaft journals are larger at the front bearing than at the rear to permit easy removal and installation of the camshaft. All camshaft bearings are pressure lubricated.

NOTE: *Do not replace camshaft bearings unless special removal and installation tools are available.*

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face to maintain zero camshaft end play during engine operation. The rear camshaft bearing journal has two holes drilled through it to relieve pressure that could develop between the journal and camshaft plug and force the camshaft forward.

Cam Lobe Lift Measurement

(1) Remove cylinder head cover and gasket.

(2) Remove bridge and pivot assemblies and rocker arms. Alternately loosen capscrews one turn at a time to avoid damaging bridge.

(3) Remove spark plugs.

(4) Use piece of rubber tubing to secure dial indicator on end of push rod (fig. 1B-111).

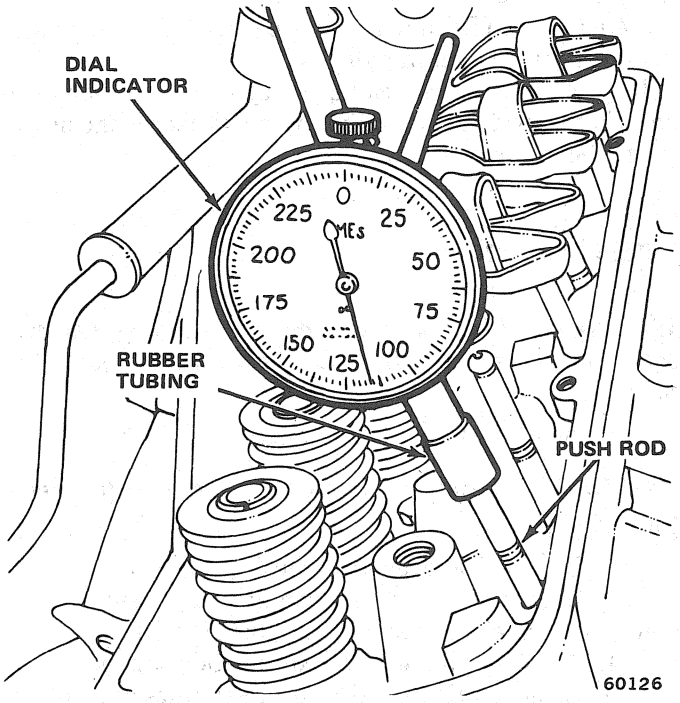

Fig. 1B-111 Cam Lobe Lift Measurement

(5) Rotate crankshaft until cam lobe base circle (push rod down) is under valve tappet.

(6) Set dial indicator to zero.

(7) Rotate crankshaft until point of maximum push rod upward movement occurs.

(8) Note travel on dial indicator. Correct lift is 0.260 to 0.270 inch (6.604 to 6.858 mm) for both 304 (5 liter) and 360 (6 liter) CID engines.

NOTE: *Rocker arm ratio is 1.6:1. Multiply cam lift by 1.6 to determine valve lift.*

Valve Timing

(1) Remove spark plugs.

(2) Remove cylinder head covers and gaskets.

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

(4) Rotate crankshaft until No. 6 piston is at top dead center (TDC) on compression stroke. This positions No. 1 piston at TDC on exhaust stroke in valve overlap position.

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

(6) Install dial indicator on No. 1 intake valve push rod end. Use rubber tubing to secure stem on push rod.

(7) Set dial indicator at zero.

(8) Rotate crankshaft slowly in direction of normal rotation (clockwise viewed from front) until dial indicator indicates 0.020 inch (0.508 mm).

(9) This should align milled timing mark on vibration damper with TDC mark on timing degree scale. If more than 1/2-inch (13 mm) variation exists in either direction from TDC mark, remove timing case cover and inspect timing chain installation.

Inspect for incorrect camshaft sprocket location. The sprocket keyway should align with the centerline of the first lobe of the camshaft.

Camshaft Removal

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain radiator and cylinder block.

NOTE: *If coolant is reusable, drain into clean container.*

(2) Remove radiator assembly.

(3) If equipped with air conditioning, remove condenser and receiver assembly as charged unit.

(4) Remove cylinder head covers and gaskets.

(5) Remove bridge and pivot assemblies and rocker arms. Alternately loosen capscrews, one turn at a time, to avoid damaging bridge.

(6) Remove push rods.

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

(7) Remove intake manifold assembly.

(8) Remove tappets.

(9) Remove drive belts.

(10) Remove fan and hub assembly.

(11) Remove distributor.

(12) Remove damper pulley and vibration damper.

(13) Remove timing case cover.

(14) Install vibration damper screw with two or more flat washers to provide means of rotating crankshaft.

(15) Rotate crankshaft until timing mark on crankshaft sprocket is closest to and on centerline with timing mark on camshaft sprocket (fig. 1B-121).

(16) Remove retaining screw from camshaft. Remove retaining screw from crankshaft.

(17) Remove distributor drive gear and fuel pump eccentric from the camshaft (fig. 1B-112).

(18) Remove crankshaft sprocket, camshaft sprocket and timing chain as assembly.

(19) Remove hood latch support bracket, front bumper or grille as required and remove camshaft.

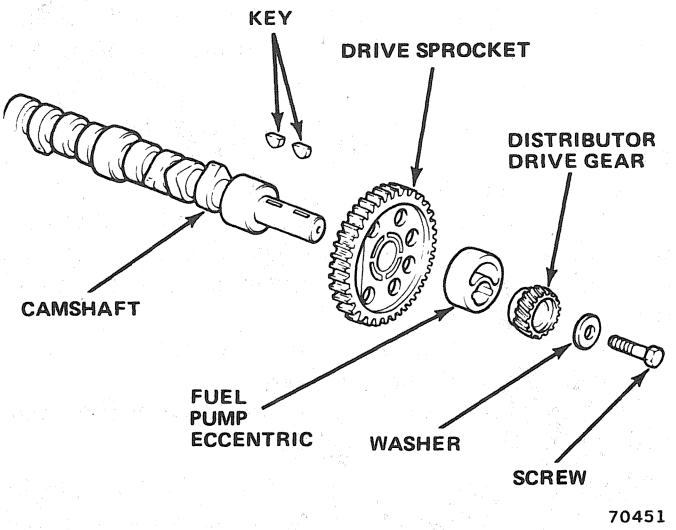

Fig. 1B-112 Camshaft Assembly

Camshaft Inspection

Inspect the camshaft bearing journals for an uneven wear pattern or rough finish. Replace camshaft if either condition exists.

Inspect the distributor drive gear for damage or excessive wear.

Inspect fuel pump eccentric for excessive wear.

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

Camshaft Installation

(1) Lubricate entire camshaft generously with Jeep Engine Oil Supplement (EOS), or equivalent.

(2) Carefully install camshaft into engine block.

(3) Assemble timing chain, crankshaft sprocket and camshaft sprocket with timing marks aligned. Refer to Timing Chain Installation for procedure.

(4) Install oil slinger on crankshaft.

(5) Install fuel pump eccentric and distributor drive gear on camshaft (fig. 1B-112). Tighten retaining screw with 30 foot-pounds (41 N•m) torque.

NOTE: *The fuel pump eccentric has the word "REAR" stamped on it to indicate proper installed position. The camshaft washer (fig. 1B-112) fits into the recess in the distributor drive gear.*

(6) Install replacement timing case cover gasket.

(7) Install timing case cover.

(8) Install replacement oil seal. Apply light film of engine oil to lips of seal.

(9) Install vibration damper.

(10) Install damper pulley with retaining bolts. Tighten bolts with 30 foot-pounds (41 N•m) torque.

(11) Install hydraulic valve tappets lubricated with Jeep Engine Oil Supplement (EOS), or equivalent.

NOTE: *Do not drain the EOS from the engine for at least 1,000 miles (1 609 km) or until the next scheduled oil change.*

(12) Install intake manifold assembly with replacement gasket.
(13) Install push rods.
(14) Install rocker arms and bridge and pivot assemblies. Tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten capscrews with 19 foot-pounds (26 N•m) torque.
(15) Reseal and install cylinder head covers.
(16) Install fuel pump.
(17) Rotate crankshaft until No. 1 piston is at TDC position on compression stroke.

NOTE: *After No. 1 intake valve has closed, TDC can be attained by rotating the crankshaft clockwise as viewed from the front until the timing mark on the vibration damper aligns with the TDC index on the timing degree scale.*

(18) Install distributor so that rotor is aligned with No. 1 terminal of cap when fully seated on block.
(19) Install distributor cap.
(20) Install ignition wires.
(21) If removed, install air conditioner condenser and receiver assembly.

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

(22) Install hood latch support bracket, front bumper or grille, if removed.
(23) Install radiator.
(24) Install fan and hub assembly.
(25) Fill cooling system to specified level.
(26) Install and adjust drive belts to proper tension. Refer to Chapter 1C—Cooling Systems for procedures.

HYDRAULIC VALVE TAPPETS

A hydraulic valve tappet consists of a tappet body, plunger, plunger return spring, check valve assembly, metering disc, plunger cap and lockring (fig. 1B-113).

The tappet operates in a guide bore that has an oil passage drilled into the adjoining oil gallery.

The operating mode 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, admitting pressurized oil into the tappet (fig. 1B-114). A hole and groove arrangement admits the oil to the inside of the plunger. Oil is 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 the pushrod to lubricate the rocker arm assembly. These events all take place 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 transferred by the trapped oil in the tappet chamber to the plunger and finally to the pushrod and rocker arm 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 (leakdown). 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.

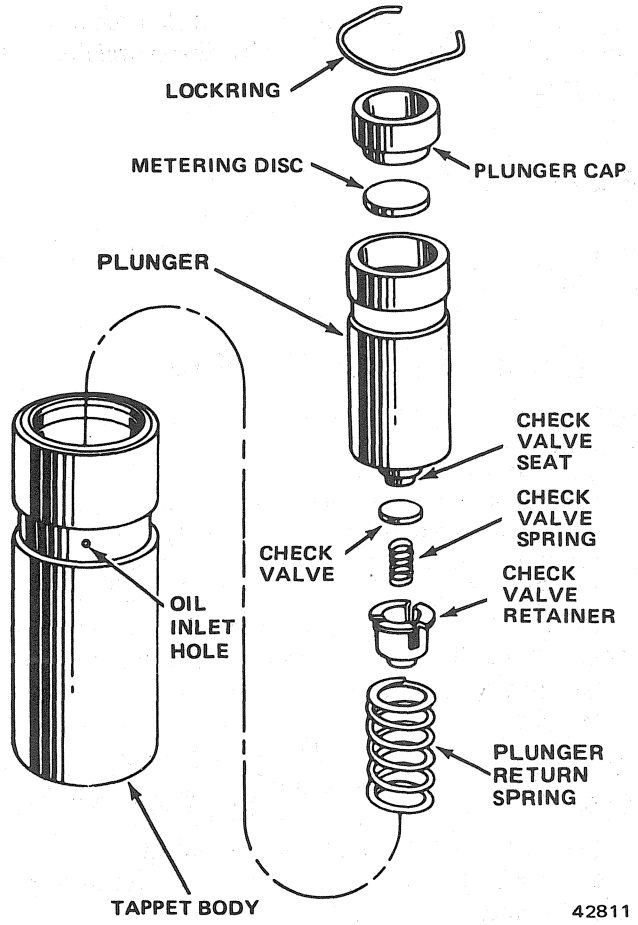

Fig. 1B-113 Hydraulic Tappet Assembly

Removal

(1) Remove cylinder head cover.
(2) Remove bridge and pivot assemblies and rocker arms. Alternately loosen capscrews, one turn at a time, to avoid damaging bridge.
(3) Remove push rods.

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

(4) Remove intake manifold.
(5) Remove tappet from guide bore in engine block with Tool J-21884.

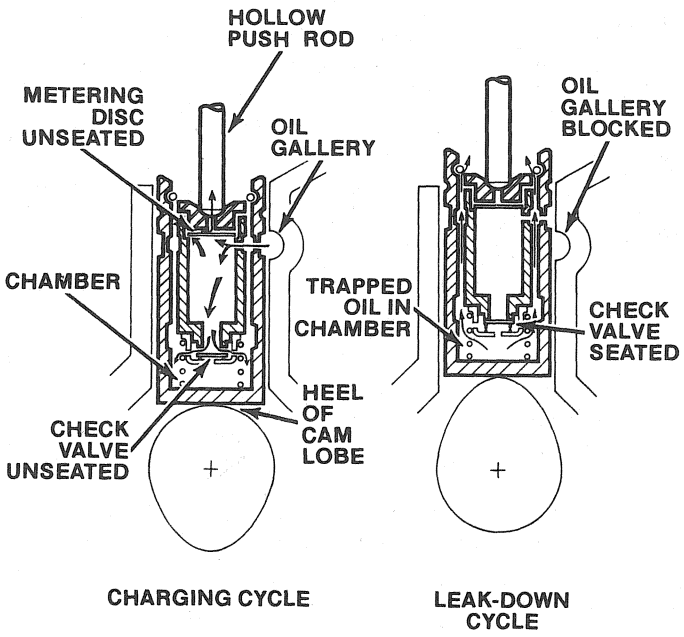

Fig. 1B-114 Hydraulic Tappet Operation

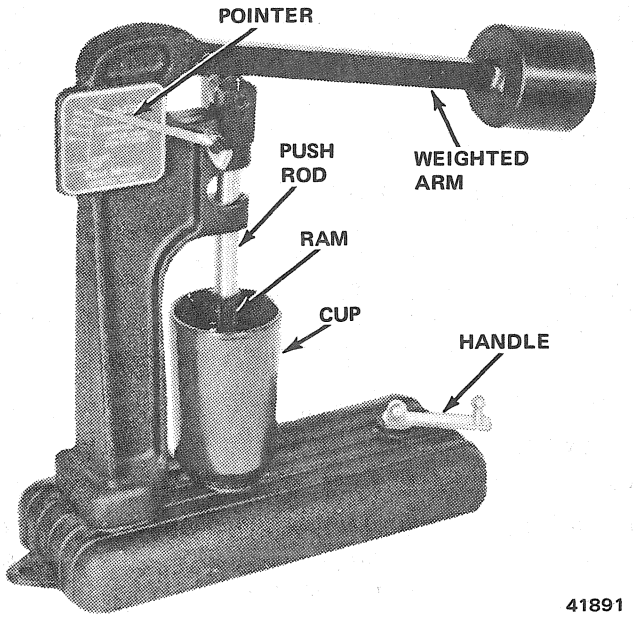

Fig. 1B-115 Hydraulic Tappet Leak-Down Rate Tester J-5790

Cleaning and Inspection

(1) Release lockring.

(2) Remove plunger cap, metering disc, plunger assembly and plunger return spring from tappet body.

NOTE: *Retain the tappets and all components in the same order as removed. Do not interchange components.*

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

(4) Visually inspect each tappet assembly for evidence of scuffing on side and face of tappet body. Inspect tappet face for wear using straightedge across face. If tappet face is concave and corresponding lobe on camshaft is worn, replace camshaft and tappets.

(5) Replace entire assembly if any component is worn or damaged.

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

(7) Use push rod on plunger cap to compress plunger assembly and install lockring.

Hydraulic Tappet Leak-Down Rate Test

After cleaning, inspection and assembly, use Tester J-5790 to test tappet leak-down rate and to ensure zero-lash operating condition (fig. 1B-115).

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

(2) Place 0.312- to 0.313-inch (7.92 to 7.95 mm) diameter ball bearing on plunger cap of tappet.

(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.

(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.

(10) Acceptable tappet will require 20 to 110 seconds interval to leak down. Replace tappets with leak-down rate outside this range.

NOTE: *Do not charge the tappet assemblies with engine oil because they will charge themselves within three to eight minutes of engine operation.*

Installation

(1) Dip each tappet assembly in Jeep Engine Oil Supplement (EOS), or equivalent. Install tappet in same bore from where it was originally removed.

(2) Install push rods in same position as removed.

(3) Install rocker arm and bridge and pivot assemblies in same position as removed. Tighten capscrews alternately, one turn at a time, to avoid damaging bridge. Tighten with 19 foot-pounds (26 N•m) torque.

(4) Pour remaining EOS over entire valve train mechanism.

NOTE: *Do not drain the EOS from the engine for at least 1,000 miles (1 609 km) or until the next scheduled oil change.*

(5) Reseal and install cylinder head cover. Tighten retaining screws with 50 inch-pounds (6 N•m) torque.

(6) Install intake manifold using replacement gasket and end seals. Tighten manifold retaining screws with 43 foot-pounds (58 N•m) torque.

(7) Install all pipes, hoses, linkage and wires disconnected from intake manifold.

TIMING CASE COVER

The timing case cover is die-cast aluminum. A crankshaft oil seal is used to prevent oil leakage at the vibration damper hub (fig. 1B-116). The oil seal may be installed from either side of the timing case cover. It is not necessary to remove the cover whenever oil seal replacement is required.

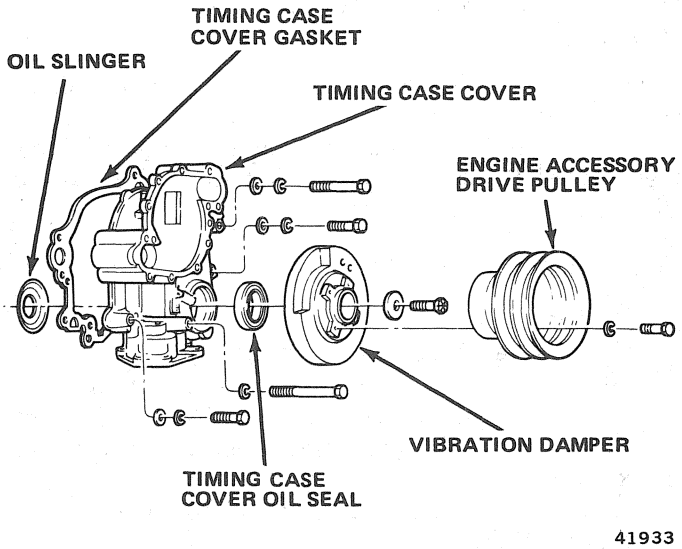

Fig. 1B-116 Timing Case Cover Assembly

A graduated timing degree scale cast in the cover is used for ignition timing. A socket is also provided for timing the ignition with a magnetic timing probe.

The engine oil pump, oil passages and coolant passages are incorporated within the timing case cover casting. The timing case cover casting is also used to mount the fuel pump, distributor and water pump.

Removal

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain radiator and cylinder block.

NOTE: *If coolant is reusable, drain into a clean container.*

(2) Disconnect radiator hoses and bypass hose.

(3) Remove all drive belts.

(4) Remove fan and hub assembly.

(5) If equipped with air conditioner, remove compressor and bracket assembly from engine and move aside. Do not disconnect air conditioner hoses.

(6) Remove alternator, alternator mounting bracket and back idler pulley.

(7) Disconnect heater hose at water pump.

(8) Remove power steering pump and bracket assembly, if equipped. Remove air pump and mounting bracket as assembly. Do not disconnect power steering pump hoses.

(9) Remove distributor cap. Note rotor and housing position.

(10) Remove distributor.

(11) Remove fuel pump.

(12) Remove vibration damper pulley.

(13) Remove vibration damper using tool J-21791.

(14) Remove two front oil pan screws.

(15) Remove screws that secure timing case cover to engine block.

NOTE: *The cover retaining screws are of various lengths and must be installed in the same location as removed.*

(16) Remove cover by pulling forward until clear of locating dowel pins.

(17) Clean gasket contact surface of cover.

(18) Remove oil seal.

NOTE: *Always replace the oil seal whenever the timing case cover is removed. Refer to Oil Seal Replacement for procedure.*

Installation

(1) Remove lower locating dowel pin from engine block.

NOTE: *The dowel pin is required for correct cover alignment. Dowel must be installed after the cover is in position.*

(2) Use sharp knife or razor blade to cut both sides of oil pan gasket flush with engine block.

(3) Apply Permatex No. 2, or equivalent, to both sides of replacement timing case cover gasket. Install gasket on timing case cover.

(4) Install replacement front oil pan seal to bottom of timing case cover.

NOTE: *There are two methods of sealing timing case cover to oil pan where oil pan gaskets were cut off. If replacement oil pan gaskets are used, perform step (5). If room temperature vulcanizing (RTV) silicone is used, perform step (6).*

(5) If oil pan gaskets are used:

(a) Using original gasket pieces as guide, trim replacement gaskets to correspond to amount cut off in step (2) above.

(b) Align tongues of replacement oil pan gasket pieces with oil pan seal and cement into place on cover (fig. 1B-117).

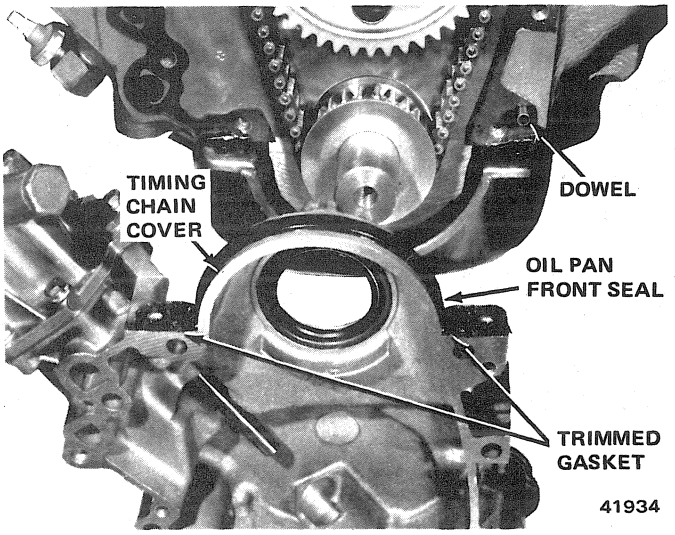

Fig. 1B-117 Oil Pan Front Seal Installation

(c) Apply Permatex No. 2, or equivalent, to cut off edges of original oil pan gaskets.

(d) Place timing case cover in position and install front oil pan screws.

(e) Tighten screws slowly and evenly until cover aligns with upper locating dowel.

(f) Insert lower dowel through cover and drive into corresponding hole in engine block.

(g) Install remaining cover retaining screws in same location as removed. Tighten all screws with 25 foot-pounds (34 N•m) torque.

(h) Proceed to step (7).

(6) If RTV is used:

(a) Apply coating of RTV silicone 1/8-inch (3.175 mm) thick on timing case cover flanges (fig. 1B-117). Use Jeep Gasket-in-a-Tube, or equivalent. Flanges must be clean and dry.

(b) Place cover in position. Align with top dowel.

(c) Loosely install front cover retaining screws in same locations as removed.

(d) Insert lower dowel through cover and drive into corresponding hole in engine block.

(e) Install remaining cover retaining screws and tighten all screws with 25 foot-pounds (34 N•m) torque.

(f) Apply small bead of RTV to joint between pan and cover and force into place with finger.

(g) Apply drop of Loctite, or equivalent, to oil pan screws and tighten until snug. *Do not over-tighten* because oil pan will distort.

(h) Proceed to step (7).

(7) Install vibration damper. Tighten retaining screw with 90 foot-pounds (122 N•m) torque.

(8) Install damper pulley. Tighten retaining bolts with 30 foot-pounds (41 N•m) torque.

(9) Install fuel pump.

(10) Install distributor with rotor and housing in same position as it was prior to removal.

(11) Install distributor cap and connect heater hose.

(12) Install power steering pump, air pump and mount bracket, if removed.

(13) Install alternator, alternator mounting bracket, and back idler pulley assembly.

(14) Install air conditioner compressor and bracket assembly, if removed.

(15) Install fan and hub assembly.

(16) Install all drive belts and adjust to specified tension. Refer to Chapter 1C—Cooling Systems.

(17) Connect radiator hoses and bypass hose.

(18) Fill cooling system to specified level.

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) Start engine and inspect for oil and coolant leaks.

(20) Adjust initial ignition timing to specified degrees BTDC. Refer to Chapter 1A—General Service and Diagnosis.

Oil Seal Replacement

(1) Loosen all drive belts.

(2) Remove vibration damper pulley.

(3) Remove vibration damper screw and washer.

(4) Install damper screw in crankshaft to prevent damper puller from damaging screw threads in crankshaft.

(5) Remove vibration damper with Tool J-21791. Remove damper screw.

(6) Remove oil seal using Remover J-9256 (fig. 1B-118).

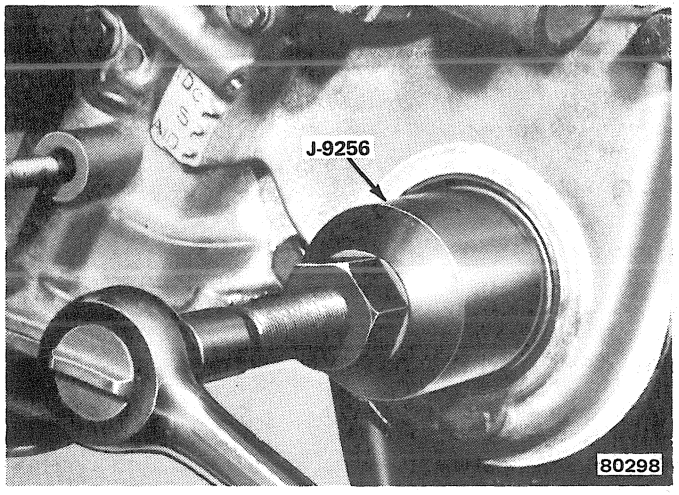

Fig. 1B-118 Removing Timing Case Cover Oil Seal

(7) Wipe crankshaft sealing area clean.

(8) Apply Permatex No. 2, or equivalent, to outer metal surface of replacement seal.

(9) Install seal using Installer Tool J-26562 (fig. 1B-119).

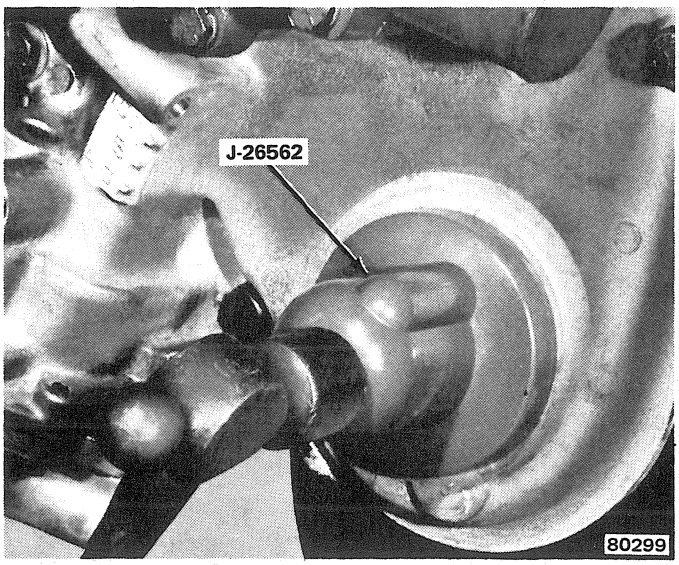

Fig. 1B-119 Installing Timing Case Cover Oil Seal

(10) Apply light coating of engine oil to seal contact surface of damper.

(11) Install damper, flat washer and screw. Tighten with 90 foot-pounds (122 N•m) torque.

(12) Install pulley and belts. Adjust belts to specifications. Refer to Chapter 1C—Cooling Systems.

TIMING CHAIN

To ensure correct valve timing, install the timing chain with the timing marks of the crankshaft and camshaft sprockets correctly positioned.

Timing Chain Wear Measurement

(1) Remove timing case cover. Refer to Timing Case Cover Removal for procedure.

(2) Rotate camshaft or crankshaft sprocket until all slack is removed from right side of chain.

(3) Determine reference point for deflection measurement according to following:

(a) Measure up from dowel on right side of engine 3/4 inch (19 mm) and mark location (fig. 1B-120).

(b) Position straightedge across timing chain from point at lowest root of camshaft sprocket to point marked in step (a) above (fig. 1B-120).

(c) Grasp chain where straightedge dissects chain and use as reference.

(d) Move chain inward toward centerline of engine and mark engine block at point of maximum inward chain deflection (fig. 1B-120).

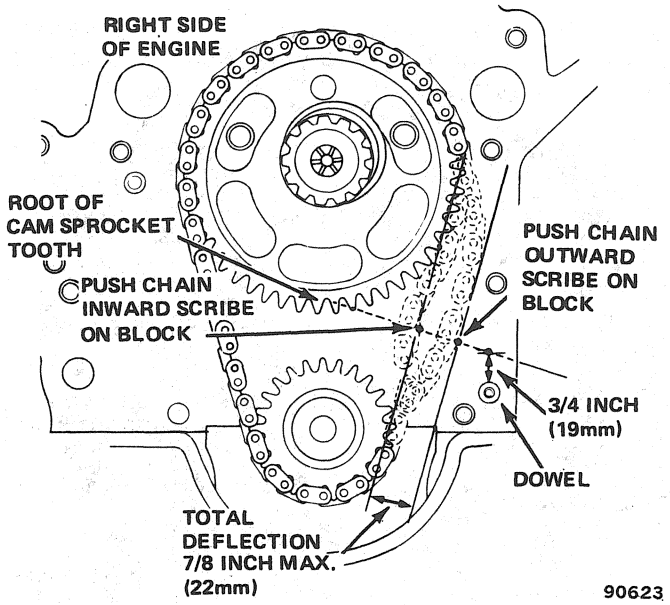

Fig. 1B-120 Timing Chain Wear Measurement

(e) Move chain outward from centerline of engine and mark engine block at point of maximum outward chain deflection (fig. 1B-120).

(f) Measure distance between two marks to determine total deflection.

(g) Replace chain assembly if deflection (wear) exceeds 7/8 inch (22 mm). Refer to Timing Chain Removal and Installation for procedure.

(h) Install timing case cover. Refer to Timing Case Cover Installation for procedure.

Removal

(1) Remove vibration damper pulley, damper, timing case cover and gasket.

(2) Remove crankshaft oil slinger.

(3) Remove camshaft sprocket retaining screw and washer.

(4) Remove distributor drive gear and fuel pump eccentric (fig. 1B-112).

(5) Rotate crankshaft until zero timing mark on crankshaft sprocket is closest to and on centerline with zero timing mark on camshaft sprocket (fig. 1B-121).

(6) Remove crankshaft sprocket, camshaft sprocket and timing chain as assembly.

Installation

(1) Assemble timing chain, crankshaft sprocket and camshaft sprocket with timing marks positioned as depicted in figure 1B-121.

(2) Install chain and sprocket assembly on crankshaft and camshaft.

NOTE: *Install the fuel pump eccentric with the stamped word REAR facing the camshaft sprocket.*

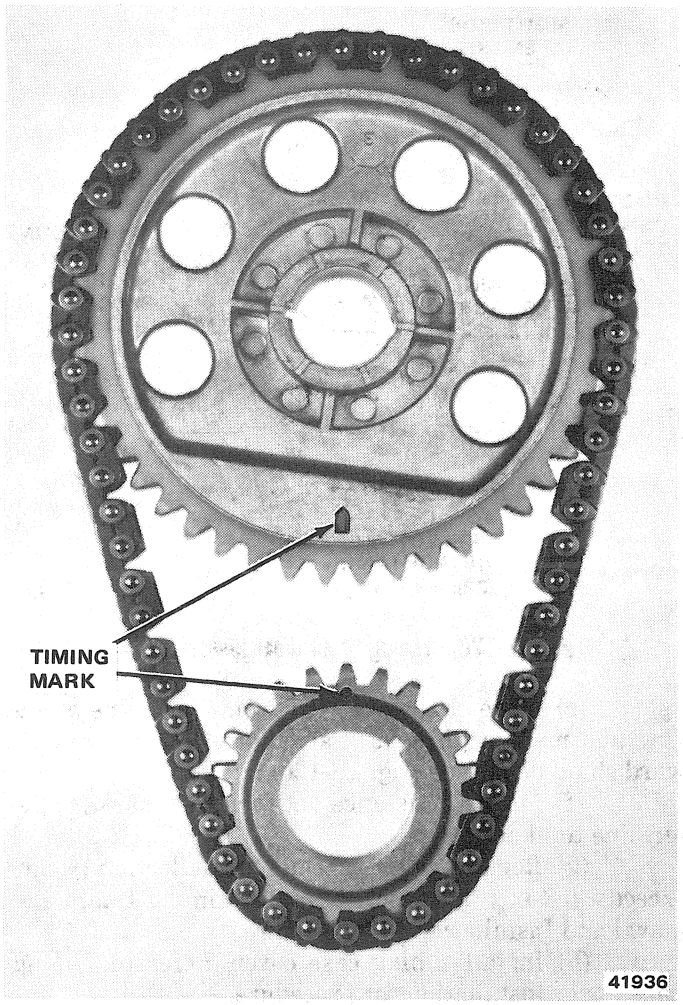

Fig. 1B-121 Timing Chain and Sprocket Alignment

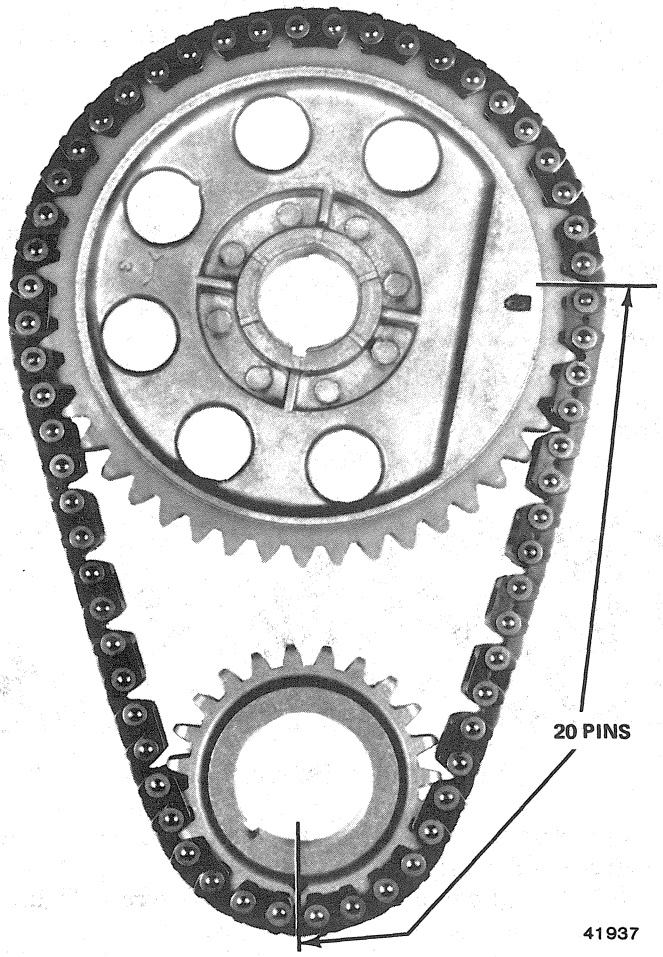

Fig. 1B-122 Correct Timing Chain Installation Verification

(3) Install fuel pump eccentric and distributor drive gear.

(4) Install camshaft washer and retaining screw. Tighten screw with 30 foot-pounds (41 N•m) torque.

(5) To verify correct installation of timing chain:

(a) Rotate crankshaft until timing mark on camshaft sprocket is on horizontal line at 3 o'clock position (fig. 1B-122).

(b) Beginning with pin directly adjacent to camshaft sprocket timing mark, count number of pins downward to timing mark on crankshaft sprocket.

(c) There must be 20 pins between these two points. **The crankshaft sprocket timing mark must be between pins 20 and 21 (fig. 1B-122).**

(6) Install crankshaft oil slinger.

(7) Remove original oil seal from timing case cover.

(8) Install replacement oil seal in timing case cover.

(9) Install timing case cover using replacement gasket. Tighten retaining screws with 25 foot-pounds (34 N•m) torque.

(10) Install vibration damper and pulley.

INTAKE AND EXHAUST MANIFOLDS

Intake Manifold

The cast iron intake manifold is designed to enclose and seal the tappet area between the cylinder heads. A one-piece metal gasket, used to seal the intake manifold to the cylinder heads and block, also serves as an oil splash baffle.

The intake manifold contains coolant passages, a crankcase ventilator passage and an exhaust crossover passage. Passages are also incorporated within the intake manifold for the Exhaust Gas Recirculation (EGR) system.

Induction system passages distribute a uniform fuel and air mixture to the combustion chamber of each cylinder. The left side of the carburetor supplies the fuel/air mixture through passages in the intake manifold to numbers 1, 7, 4 and 6 cylinder intake ports. The right side supplies numbers 3, 5, 2, and 8 cylinder intake ports.

Removal

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain coolant from radiator and cylinder block.

NOTE: *If coolant is reusable, drain into clean container.*

(2) Remove air cleaner assembly.
(3) Disconnect ignition wires.
(4) Remove ignition wire plastic separators from cylinder head cover brackets.
(5) Disconnect radiator upper hose and bypass hose from intake manifold.
(6) Disconnect and move aside wire from coolant temperature gauge sending unit.
(7) Disconnect ignition coil bracket and move coil and bracket assembly aside.
(8) Disconnect heater hose from rear of manifold.
(9) Identify and disconnect all hoses, pipes and wire connectors from carburetor assembly.
(10) Disconnect throttle and throttle valve linkage from carburetor and intake manifold.
(11) Disconnect air hoses from air injection manifolds.
(12) Disconnect diverter valve from air pump output hose and move valve and air hoses aside.
(13) Remove carburetor.
(14) Remove intake manifold, metal gasket and end seals.
(15) Clean gasket mating surfaces of engine block, cylinder head and intake manifold.

Installation

NOTE: *When installing replacement intake manifold, transfer all components (i.e., EGR valve and back-pressure sensor, EGR CTO valve, thermostat housing and coolant temperature gauge sending unit) from original manifold. Clean and tighten as required.*

(1) Apply nonhardening sealer or RTV silicone sealant such as Jeep Gasket-in-a-Tube, or equivalent, to both sides of replacement manifold gasket.
(2) Position gasket by aligning locators at rear of cylinder head. While holding rear of gasket in place, align front locators.
(3) Install two end seals. Apply Permatex No. 2, Jeep Gasket-in-a-Tube, or equivalent, to seal ends.
(4) Install intake manifold and retaining screws. Ensure all screws are properly started before tightening. Tighten with 43 foot-pounds (58 N•m) torque.
(5) Install diverter valve and connect air pump output hose.
(6) Connect air hoses to air injection manifolds.
(7) Identify and connect all disconnected hoses, pipes, linkages and wires to intake manifold and carburetor.
(8) Install ignition coil and bracket assembly.
(9) Connect radiator upper hose and bypass hose.
(10) Install ignition wire plastic separators on cylinder head cover brackets.
(11) Connect ignition wires.
(12) Install air cleaner assembly.
(13) Add coolant as necessary.

Exhaust Manifold

The swept-flow designed cast iron manifold provides efficient removal of exhaust gases and minimizes back pressure. The mating surface of the exhaust manifold and the cylinder head are machined smooth to eliminate the need for a gasket.

All eight-cylinder engines are equipped with an air injection system and have air injection manifolds attached at number 1, 3 and 5 exhaust ports of the left exhaust manifold and numbers 2, 4, 6 and 8 of the right exhaust manifold. Refer to Chapter 1K—Exhaust Systems for description of the air injection system.

Removal

(1) Disconnect ignition wires.
(2) Disconnect air hose at injection manifold.
(3) Disconnect exhaust pipe at exhaust manifold.
(4) Remove exhaust manifold retaining screws.
(5) Separate exhaust manifold from cylinder head.
(6) Remove air injection manifold, fittings and washers.

Installation

(1) Clean mating surfaces of exhaust manifold and cylinder head. **Do not nick or scratch.**
(2) Install air injection manifold on exhaust manifold.

CAUTION: *The correct screws and washers must be used to allow the manifold to expand and prevent cracking.*

(3) Install exhaust manifold and retaining screws. Tighten two center screws with 25 foot-pounds (34 N•m) torque. Tighten four outer screws with 15 foot-pounds (20 N•m) torque.
(4) Connect exhaust pipe using replacement seal, if required. Tighten nuts with 20 foot-pounds (27 N•m) torque.
(5) Connect air hose to air injection manifold.
(6) Connect ignition wires.

CYLINDER HEADS AND COVERS

Cylinder Head Covers

The cylinder head covers are installed with a formed-in-place RTV (room temperature vulcanizing) silicone gasket.

Removal

(1) Remove air cleaner assembly.
(2) Disconnect air hose from air injection manifold.
(3) Left side:
(a) Disconnect power brake vacuum hose at intake manifold, if equipped.
(b) Disconnect throttle stop solenoid wire, if equipped.
(4) Right side:
(a) Remove thermostatically controlled air cleaner (TAC) hot air hose.
(b) Remove heater hose from choke cover clamp.
(5) Disconnect ignition wires and remove plastic wire separator from cylinder head cover bracket.
(6) Remove retaining screws and washers. Strike cover with rubber mallet to break loose from cylinder head. Remove cover and gasket.

Installation

(1) Inspect for bent or cracked cover and repair or replace as required.
(2) Remove gasket material from cylinder head cover and cylinder head gasket surface area.
(3) Apply bead of Jeep Gasket-in-a-Tube, or equivalent, to cylinder head and cylinder head cover gasket surface area.
(4) Position cylinder head cover on engine.
(5) Install retaining screws and tighten with 50 inch-pounds (6 N•m) torque.
(6) Connect ignition wires and install plastic wire separator on cylinder head cover bracket.
(7) Right side:
(a) Install heater hose on choke cover clamp.
(b) Install TAC hot air hose.
(8) Left side:
(a) Connect power brake vacuum hose at intake manifold.
(b) Connect throttle stop solenoid wire.
(9) Connect air hose to air injection manifold.
(10) Install air cleaner assembly.

Cylinder Heads

Removal

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.*

(1) Drain cooling system and cylinder block.

NOTE: *If coolant is reuseable, drain into clean container.*

(2) Remove ignition wires and spark plugs.
(3) Remove cylinder head cover and gasket.
(4) Remove bridge and pivot assemblies and rocker arms. Alternately loosen capscrews, one turn at a time, to avoid damaging bridge.
(5) Remove push rods.

NOTE: *Retain rocker arms, bridges, pivots and push rods in the same order as removed to facilitate installation in original locations.*

(6) Remove intake manifold.
(7) Disconnect exhaust manifold from head. It is not necessary to remove exhaust pipe from manifold.
(8) Loosen all drive belts.
(9) Right side:
(a) If equipped with air conditioning, remove compressor mount bracket and battery negative cable from cylinder head.
(b) Disconnect alternator support brace from cylinder head.
(10) Left side: Disconnect air pump and power steering mount bracket, if equipped, from cylinder head.
(11) Remove cylinder head retaining screws.
(12) Remove cylinder head and gasket.

Cleaning and Inspection

Thoroughly clean the gasket surfaces of the cylinder head and block to remove all foreign material and gasket cement. Remove carbon deposits from the combustion chambers and the top of each piston.

Use a straightedge and feeler gauge to determine the flatness of the cylinder head and block mating surfaces. Refer to Specifications for tolerances.

If the cylinder head is to be replaced and the original valves reused, remove the valves and measure the stem diameters.

NOTE: *Service replacement heads have standard-size valve guide bores. If valves with oversize stems from original head are to be installed in replacement head, ream valve guide bores to appropriate oversize diameter.*

If the original valves are used, remove all carbon deposits and reface the valves as outlined within Valve Refacing. Install the valves in the cylinder head using replacement valve stem oil deflectors. If valves with oversize stems are used, oversize deflectors are also required. Transfer all components from the original head that are not included with the replacement head.

Installation

NOTE: *Wire brush the threads of screws prior to installation. Unclean threads will affect the tightening torque indications. Blow coolant from screw holes to prevent trapping coolant.*

NOTE: *The 304 CID engine uses an aluminum coated embossed steel gasket and the 360 CID engine uses an aluminum coated laminated steel and asbestos gasket. Retightening head bolts after engine has been operated is not necessary for either gasket.*

(1) Apply even coat of nonhardening sealing compound to both sides of replacement head gasket.

NOTE: *Do not apply sealing compound to head and block surfaces. Do not allow sealer to enter cylinder bores.*

(2) Position gasket flush on block with stamped word TOP facing upward.

(3) Install cylinder head over gasket.

(4) Tighten cylinder head capscrews evenly with 80 foot-pounds (108 N•m) torque following sequence outlined in figure 1B-123. Then repeat sequence and tighten screws with 110 foot-pounds (149 N•m) torque.

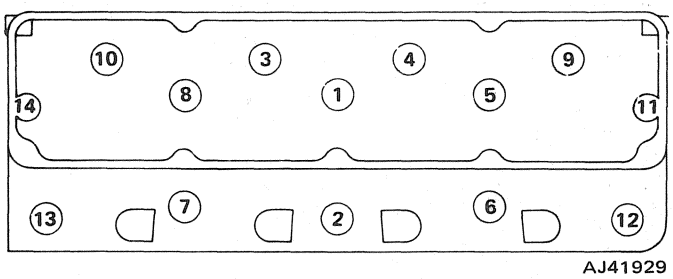

Fig. 1B-123 Cylinder Head Tightening Sequence

(5) Left side: connect air pump mount bracket and power steering pump, if removed, to cylinder head.

(6) Right side:

(a) Connect alternator support bracket to cylinder head.

(b) Install air conditioner compressor mounting bracket, if removed, and battery negative cable on cylinder head.

(7) Adjust all drive belts to specified tension. Refer to Chapter 1C—Cooling Systems.

(8) Install exhaust manifold and tighten retaining screws with 25 foot-pounds (34 N•m) torque.

(9) Install intake manifold. Tighten retaining screws with 43 foot-pounds (58 N•m) torque.

(10) Install all disconnected pipes, hoses, linkage and wires.

(11) Install push rods, rocker arms and bridge and pivot assemblies in original position. Loosely install capscrews through bridges. Tighten capscrews alternately, one turn at a time, to avoid damaging bridges. Tighten capscrews with 19 foot-pounds (26 N•m) torque.

(12) Reseal and install cylinder head cover. Tighten retaining screws with 50 inch-pounds (6 N•m) torque.

(13) Install spark plugs and connect ignition wires.

(14) Fill cooling system to specified level.

LUBRICATION SYSTEM

Oil is pumped from the sump of the oil pan through a pick-up tube and screen assembly to a horizontal oil gallery located at the lower right side of the engine block (fig. 1B-124). A passage in the timing case cover channels oil into the oil pump. Pressure is developed when oil is driven between the gears and pump body.

The oil is forced from the pump through a passage in the oil pump cover to the oil filter (fig. 1B-125).

The oil passes through the filtering element and on to an outlet passage in the oil pump cover. From the oil pump cover passage, the oil enters an adjoining passage in the timing case cover and is channeled into a gallery that extends up the left front of the cylinder block. This gallery channels oil directly to the right main oil gallery, which intersects with a short passage that channels oil to the left main oil gallery.

The left and right main oil galleries extend the length of the cylinder block. The left oil gallery channels oil to each hydraulic tappet on the left bank. The right oil gallery channels oil to each hydraulic tappet on the right bank. In addition, passages extend down from the right oil gallery to the five camshaft bearings and on to the five upper main bearing inserts. The crankshaft is drilled to allow oil to flow from each main journal to adjacent connecting rod journals. A squirt hole in each connecting rod bearing cap distributes oil to the cylinder walls, pistons and piston pins as the crankshaft rotates.

A small passage within the front camshaft bearing journal channels oil through the camshaft sprocket to the timing case cover area where the case and sprockets throw off oil to lubricate the distributor drive gear and fuel pump eccentric (see insert, fig. 1B-124). The oil returns to the oil pan by passing under the front main bearing cap.

Oil for the rocker arm assemblies is metered through the hydraulic valve tappets and routed through hollow push rods to a hole in the corresponding rocker arm. This oil lubricates the valve train, then returns to the oil pan through channels at both ends of the cylinder head.

Oil Filter

A full flow oil filter mounted on the oil pump at the lower right-hand side of the engine is accessible from below the chassis.

A bypass valve in the filter mounting base provides a safety factor in the event the filter should become inoperative as a result of restriction from sludge or foreign material accumulation (fig. 1B-126). Oil Filter Remover Tool J-22700 will facilitate removal.

Before installation, apply a thin film of oil to the filter gasket. **Do not use grease.** Rotate filter until the gasket contacts the seat of the filter base. Tighten by hand only, following instructions on replacement filter. If instructions are not printed on filter, tighten filter until gasket contacts seat and then tighten an additional 3/4 turn. Operate engine at fast idle and inspect for leaks.

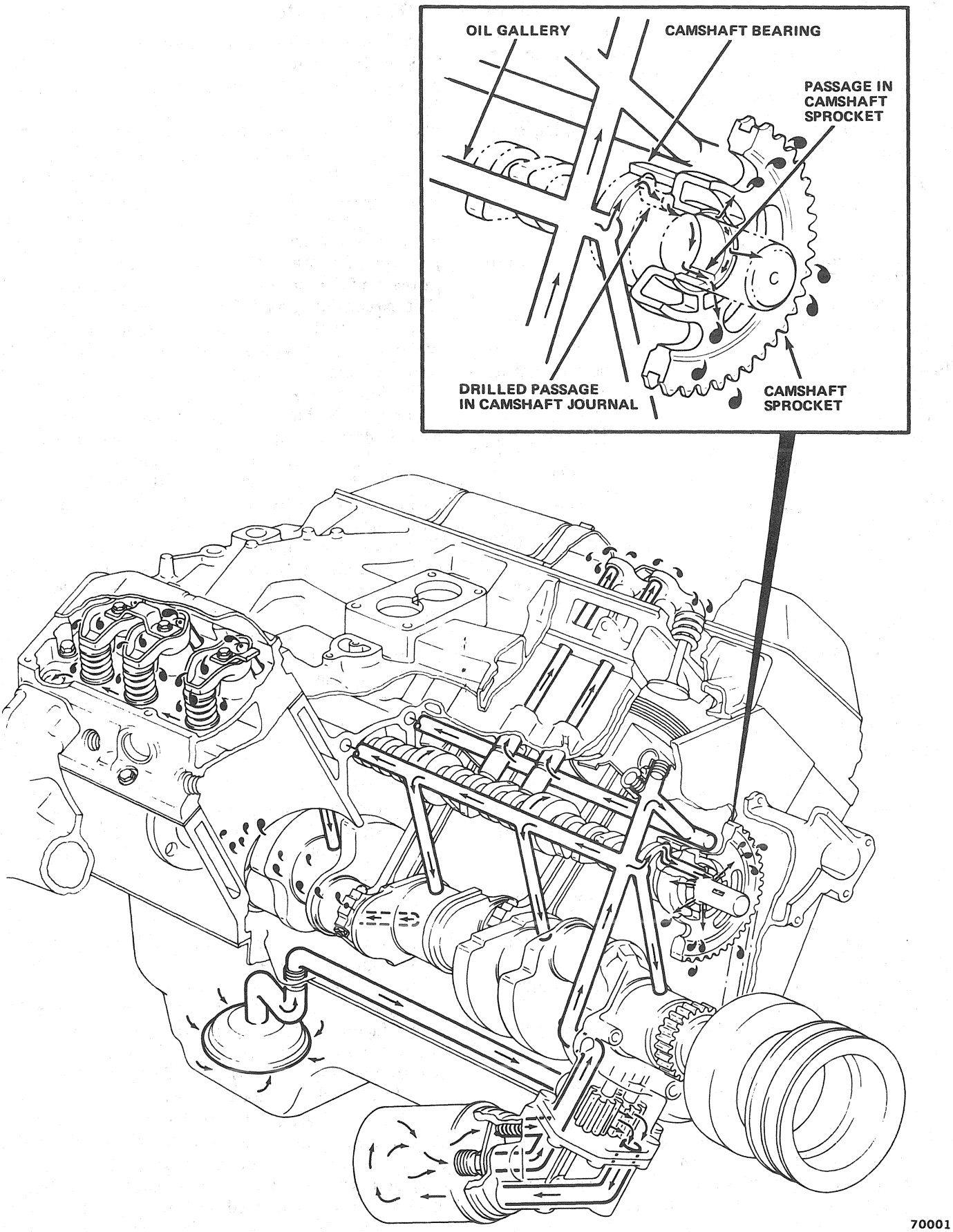

Fig. 1B-124 Lubrication System

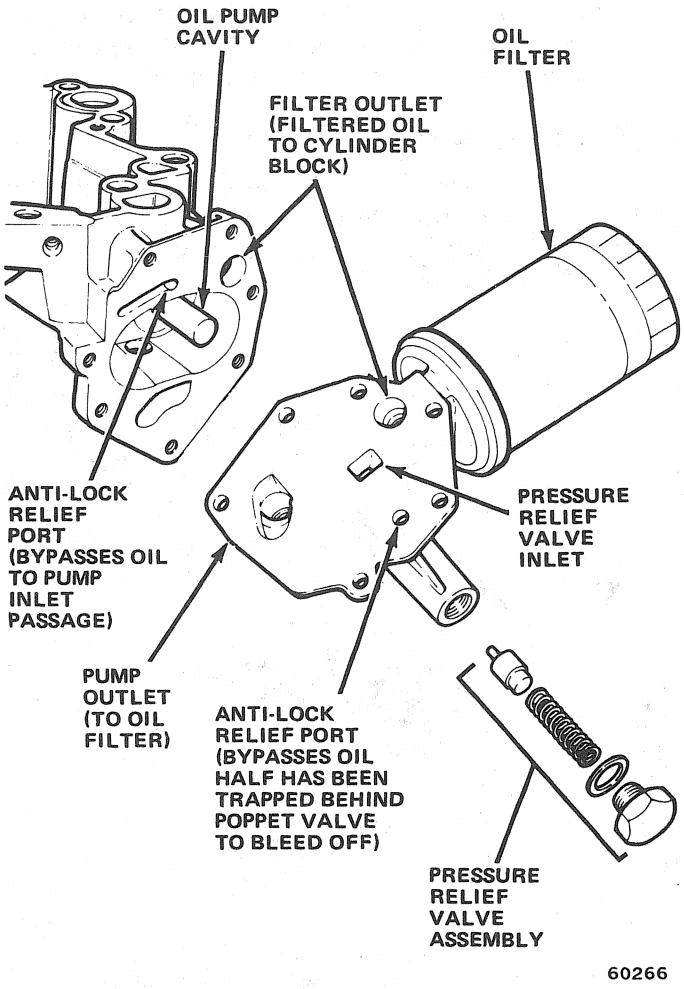

Fig. 1B-125 Oil Pump Cover

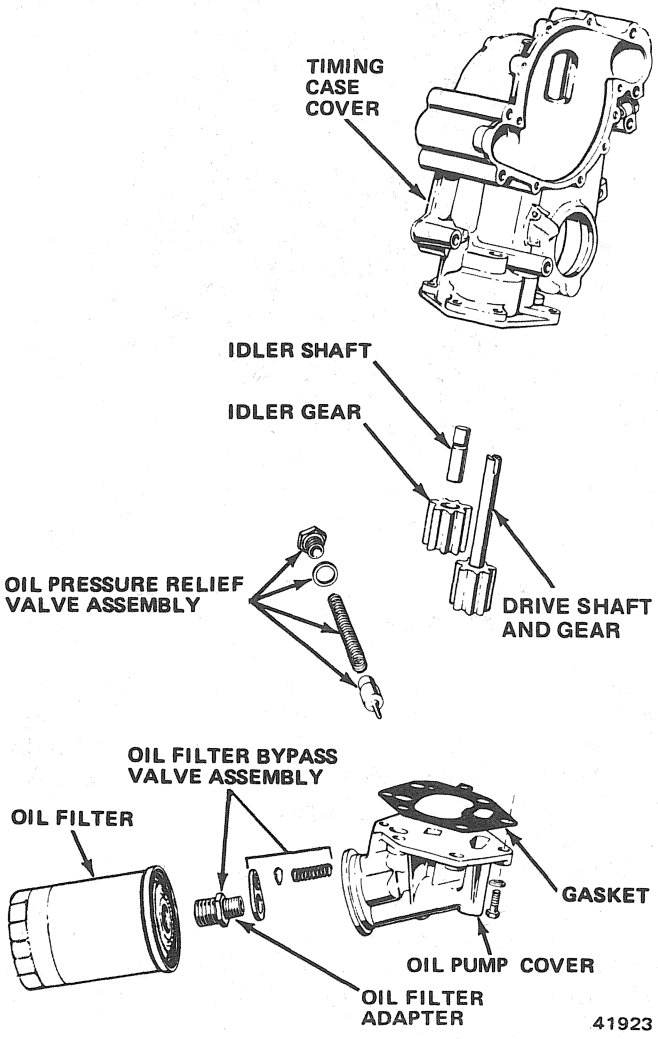

Fig. 1B-126 Oil Pump and Filter Assembly

Oil Pump

The positive-displacement gear-type oil pump is driven by the distributor shaft, which is driven by a gear on the camshaft (fig. 1B-126). The pump is integral with the timing case cover. A cavity in the cover forms the body of the pump. A pressure relief valve regulates maximum oil pressure.

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

Oil Pressure Relief Valve

The oil pressure relief valve is not adjustable. 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 cover to the inlet side of the pump (fig. 1B-126).

Removal

(1) Remove retaining screws and separate oil pump cover, gasket and oil filter as an assembly from pump body (timing case cover).

(2) Remove drive gear assembly and idler gear by sliding them out of body.

(3) Remove oil pressure relief valve from pump cover for cleaning by removing retaining cap and spring. Clean cover thoroughly. Test operation of relief valve by inserting poppet valve and determining if it slides back and forth freely. If not, replace pump cover and poppet valve.

Gear End Clearance Measurement

This measurement determines the distance between the end of the pump gear and the pump cover. The ideal clearance is as close as possible without binding gears. The pump cover gasket is 0.009- to 0.011-inch (0.229 to 0.279 mm) thick. Symptoms of excessive pump clearance are fair to good pressure when the oil is cold and low or no pressure when the oil is hot.

Preferred Method:

(1) Place strip of Plastigage across full width of each gear (fig. 1B-127).

(2) Install pump cover and gasket. Tighten screws with 55 inch-pounds (6 N•m) torque.

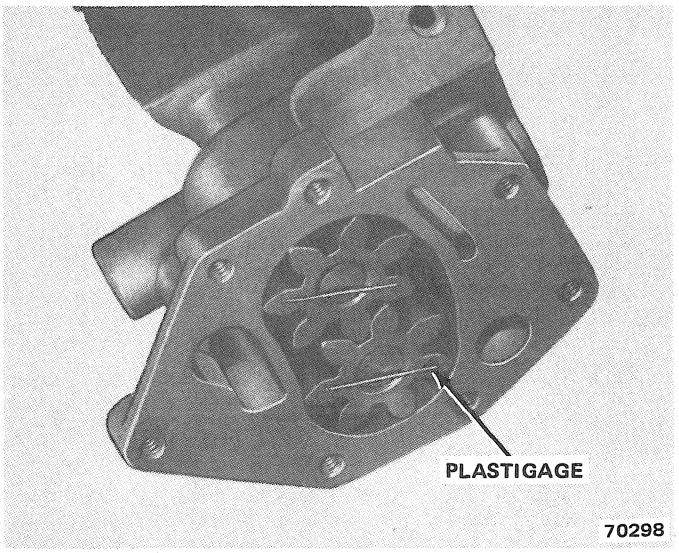

Fig. 1B-127 Oil Pump Gear End Clearance Measurement—Plastigage Method

(3) 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 0.008 inch (0.002 preferred) [0.051 to 0.203 mm (0.051 mm preferred)].

Alternate Method:

(1) Place straightedge across gears and pump body.

(2) Select feeler gauge that will fit snugly but freely between straightedge and pump body (fig. 1B-128). Correct clearance by this method is 0.004 to 0.008 inch (0.008 inch preferred) [0.102 to 0.203 mm (0.203 mm preferred)].

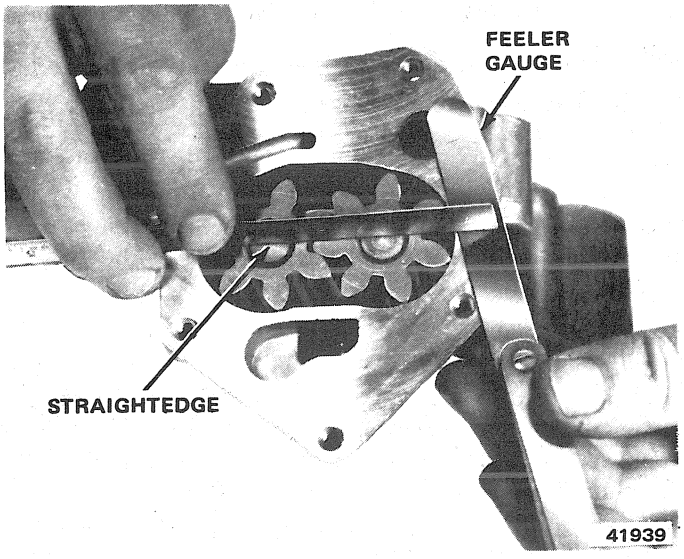

Fig. 1B-128 Oil Pump Gear End Clearance Measurement—Feeler Gauge Method

NOTE: *Ensure gears are up into body as far as possible for measurement.*

If gear end clearance is excessive, measure gear length. If gear length is correct, install thinner gasket. If gear length is incorrect, replace gears and idler shaft.

Gear Tooth-to-Body Clearance

(1) Insert feeler gauge between gear tooth and pump body inner wall directly opposite point of gear mesh. Select feeler gauge that fits snugly but can be inserted freely (fig. 1B-129).

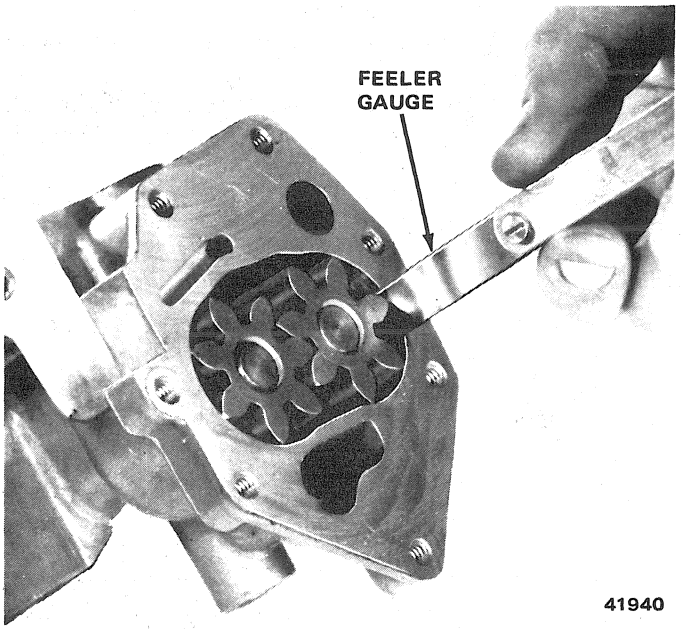

Fig. 1B-129 Gear Tooth-to-Body Clearance Measurement

(2) Rotate gears and measure clearance of each tooth and body in this manner. Correct clearance is 0.0005 to 0.0025 inch (0.0005 inch preferred) or 0.013 to 0.064 mm (0.013 mm preferred).

(3) If gear tooth-to-body clearance is more than specified, measure gear diameter with micrometer. If gear diameter is correct and gear end clearance is correct and relief valve is functioning properly, replace timing case cover. If gear diameter is incorrect, replace gears and idler shaft.

NOTE: *If the oil pump shaft or distributor drive shaft is broken, inspect for loose oil pump gear-to-shaft fit or worn front cover. Oversize pump shafts are not available.*

Installation

(1) Install oil pressure relief valve in pump cover with spring and retaining cap.

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

NOTE: *To ensure self-priming of the oil pump, fill pump with petroleum jelly prior to the installation of the oil pump cover.* **Do not use grease of any type.**

(3) Install pump cover and oil filter assembly with replacement gasket. Tighten retaining screws with 55 inch-pounds (6 N•m) torque.

Oil Pan

Removal

(1) Drain engine oil.
(2) Remove starter motor.
(3) On CJ vehicles:
(a) Remove frame cross bar.
(b) Remove automatic transmission fluid cooler tubing, if equipped.
(c) Cut corner of engine mount on right side with hacksaw to provide clearance for pan removal, if required.
(4) On all vehicles, bend tabs down on dust shield, if equipped with manual transmission.
(5) Remove oil pan attaching screws. Remove oil pan.
(6) Remove oil pan front and rear neoprene oil seals.
(7) 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 for timing case cover. Apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone sealant), or equivalent, to end tabs.
(2) Coat inside curved surface of replacement oil pan rear seal with soap or RTV silicone sealant. Apply generous amount of RTV silicone sealant to gasket contacting surface of seal end tabs.
(3) Install seal in recess of rear main bearing cap, ensuring it is fully seated.
(4) Apply RTV silicone sealant to oil pan contacting surface of front and rear oil pan seals.
(5) Cement replacement oil pan side gaskets into position on engine block. Apply generous amount of RTV silicone sealant to gasket ends.
(6) Install oil pan. Tighten 1/4-20 oil pan screws with 7 foot-pounds (9 N•m) torque and 5/16-18 oil pan screws with 11 foot-pounds (15 N•m) torque.
(7) Tighten drain plug securely.
(8) Install starter motor and connect cable.
(9) On CJ vehicles:
(a) Install frame cross bar.
(b) Install automatic transmission fluid cooler tubing, if removed.
(10) Fill crankcase to specified level with clean lube oil.

Oil Pressure Gauge

Refer to Chapter 1L—Power Plant Instrumentation for a description of operation, diagnosis and replacement procedure.

CONNECTING ROD AND PISTON ASSEMBLIES

Use the following procedures to service connecting rods and pistons with the engine installed in the vehicle.

Removal

(1) Remove cylinder head cover(s).
(2) Alternately loosen bridge and pivot assembly capscrews one turn at a time to avoid damaging bridges. Remove bridges, pivots and rocker arms.
(3) Remove push rods.

NOTE: *Retain bridges, pivots, rocker arms and push rods in same order as removed to facilitate installation in original locations.*

(4) Remove intake manifold assembly.
(5) Remove exhaust manifold(s). It is not necessary to disconnect exhaust pipe from manifold.
(6) Remove cylinder head(s) and gasket(s).
(7) Position pistons, one at a time, near bottom of stroke. Use ridge reamer to remove any ridge from top end of cylinder walls.
(8) Drain engine oil.
(9) Remove oil pan.
(10) Remove connecting rod bearing caps and inserts. Retain in same order as removed.

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

(11) Remove connecting rod and piston assemblies through top of cylinder bores. Ensure that connecting rod bolts do not scratch connecting rod journals or cylinder walls. Short pieces of rubber hose slipped onto rod bolts will provide protection during removal.

Installation

(1) Thoroughly clean cylinder bores. Apply light film of clean engine oil to bores with clean, lint-free cloth.
(2) Arrange spacing of piston ring gaps. Refer to Piston Rings for procedure.
(3) Lubricate piston and ring surfaces with clean engine oil.
(4) Use piston ring compressor tool to install connecting rod and piston assemblies through top of cylinder bores. Ensure that connecting rod bolts do not scratch connecting rod journals or cylinder walls. Short lengths of rubber hose slipped over connecting rod bolts will provide protection during installation.

NOTE: *Squirt holes in connecting rods must face inward (fig. 1B-130).*

(5) Install connecting rod bearing caps and inserts in original positions. Tighten retaining nuts with 33 foot-pounds (45 N•m) torque.
(6) Install engine oil pan using replacement gaskets and seals.

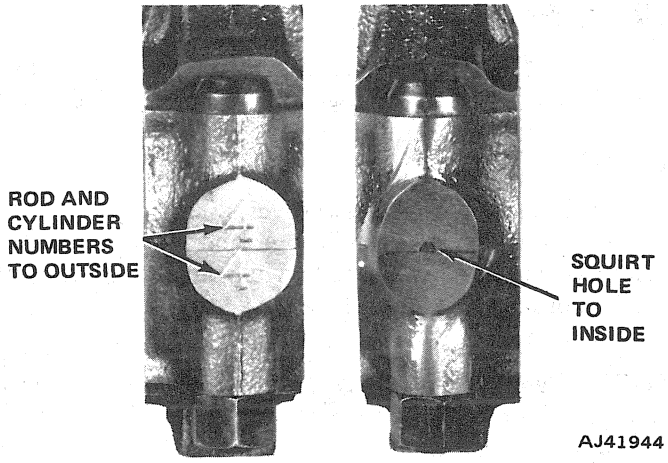

Fig. 1B-130 Rod Number and Squirt Hole Location

(7) Install cylinder head(s) and replacement gasket(s).

(8) Install push rods.

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

(10) Install intake manifold gasket and manifold assembly.

(11) Install exhaust manifold(s).

(12) Reseal and install cylinder head cover(s).

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

WARNING: *Use extreme caution when engine is operating. Do no stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(14) Start engine inspect for leaks.

CONNECTING RODS

The connecting rods are malleable iron and are independently balanced. The crankshaft end of the connecting rod incorporates a two-piece bearing insert. The number stamped onto the removeable bearing cap and onto the adjacent machined surface of the rod corresponds to the associated cylinder (fig. 1B-130). The piston end of the rod is connected to the piston with a 2000 pound (8.9 kN) press-fitted piston pin.

Have the connecting rod alignment checked by a competent machine shop whenever engine wear patterns or damage indicates probable rod misalignment. Always replace bent connecting rods.

Connecting Rod Side Clearance Measurement

(1) Rotate crankshaft to position where connecting rod journal is at bottom of stroke.

(2) Insert snug fitting feeler gauge between connecting rods (fig. 1B-131).

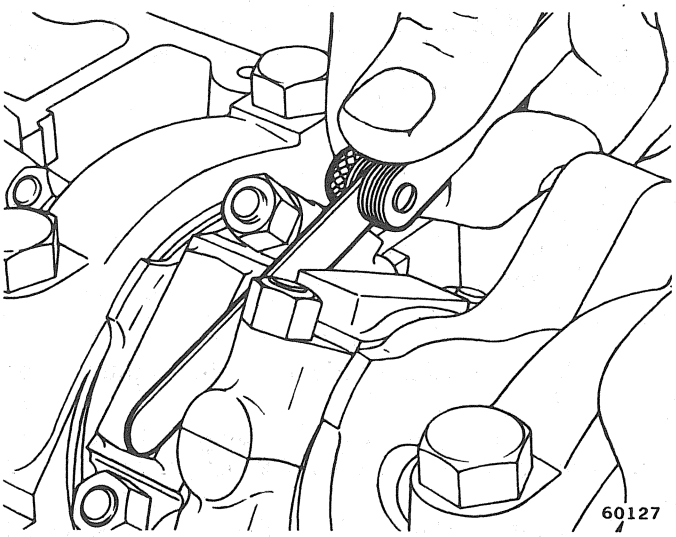

Fig. 1B-131 Connecting Rod Side Clearance Measurement

(3) Compare feeler gauge measurement to specified clearance. Replace rods that are not within specifications.

Connecting Rod Bearings

The connecting rod bearings are precision-type steel-backed aluminum alloy inserts. The connecting rod bearing inserts are selectively fitted to their respective journals to obtain the desired operating clearance. **In production,** the select fit is obtained by using various sized color coded bearing inserts as listed in the Bearing Fitting Chart. The bearing color code appears on the edge of the insert.

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

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. Refer to color codes listed in the Bearing Fitting Chart to identify journal size and select the correct bearing inserts to obtain correct clearances.

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

When required, different sized upper and lower bearing inserts 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 or 1/2 thousandth of an inch (0.013 mm). Example:

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

70242

Connecting Rod Bearing Fitting Chart

304 - 360 CID Engines

Crankshaft Connecting Rod Journal Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow —2.0955 to 2.0948 (53.2257 - 53.2079 mm) (Standard)	Yellow — Standard	Yellow — Standard
Orange —2.0948 to 2.0941 (53.2079 - 53.1901 mm) (0.0007 Undersize)	Yellow — Standard	Black —0.001-inch (0.025mm)Undersize
Black —2.0941 to 2.0934 (53.1901 - 53.1723 mm) (0.0014 Undersize)	Black —0.010-Inch (0.025mm)Undersize	Black —0.001-inch (0.025mm)Undersize
Red —2.0855 to 2.0848 (52.9717 - 52.9535 mm) (0.010 Undersize)	Red —0.010-Inch (0.254mm)Undersize	Red —0.010-inch (0.254mm)Undersize

Service replacement bearing inserts are available in pairs in the following sizes: standard, 0.001-inch (0.025 mm) undersize, 0.002-inch (0.051 mm) undersize, 0.010-inch (0.250 mm) undersize and 0.012-inch (0.305 mm) undersize. The size is stamped on the back of service replacement inserts.

NOTE: *The 0.002-inch (0.051 mm) and 0.012-inch (0.305 mm) undersize inserts are not used for production engine assembly.*

Removal

Use the following procedure to service connecting rod bearings with the engine installed in the vehicle.

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

NOTE: *Do not interchange bearing caps. Connecting rod and corresponding cap are stamped with the associated cylinder number (fig. 1B-130). The numbers are located on a machined surface opposite the squirt holes.*

Inspection

(1) Clean inserts
(2) Inspect linings and backs of inserts for irregular wear pattern. Note any scraping, stress cracks or distortion (fig. 1B-132). 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 abnormal piston, timing gear, distributor gear or oil pump gear wear. Figures 1B-133 and 1B-134 depict common score problems.
(4) Inspect fit of insert locking tab in rod cap. If result of inspection indicates that insert tab may have been pinched between rod and rod cap, replace upper and lower bearing inserts.

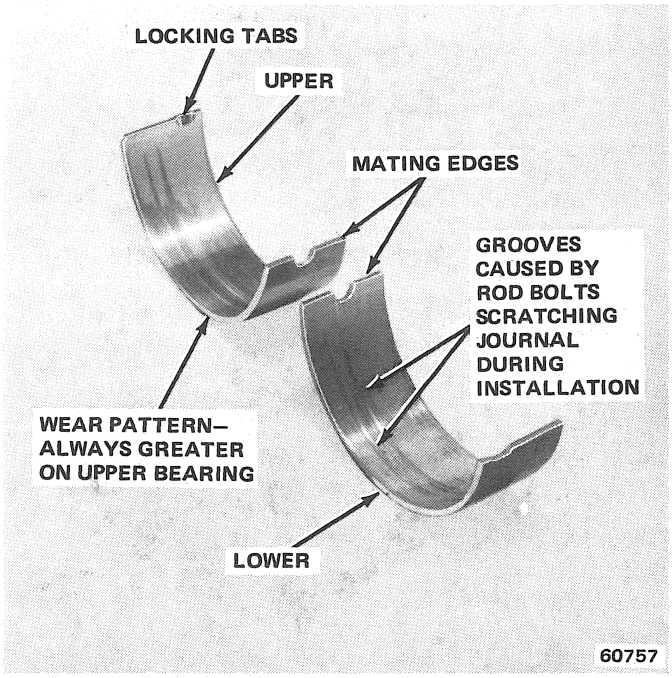

Fig. 1B-132 Connecting Rod Bearing Inspection

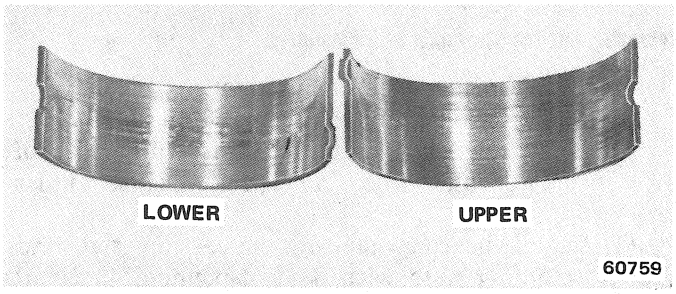

Fig. 1B-133 Scoring Caused by Insufficient Lubrication

(5) Inspect contact area of locking tab. Abnormal wear indicates bent tabs or improper installation of inserts (fig. 1B-135).
(6) Replace bearing inserts that are damaged or worn.

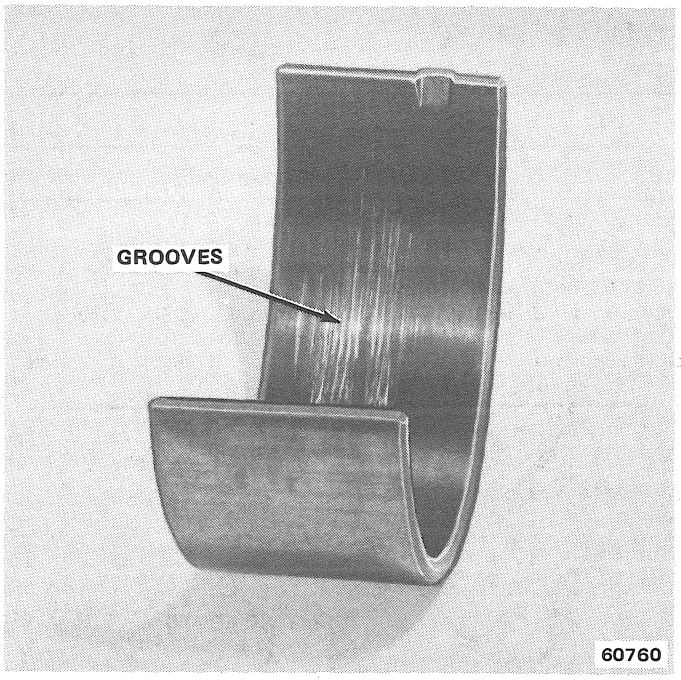

Fig. 1B-134 Scoring Caused by Foreign Material

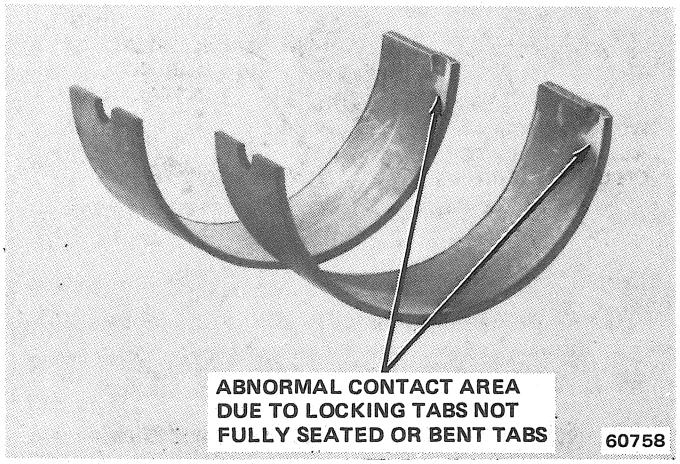

Fig. 1B-135 Locking Tab Inspection

Measuring Bearing Clearance with Plastigage

(1) Wipe bearing inserts and rod journal clean.

(2) Lubricate upper insert and install in rod.

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

(4) Install bearing cap on connecting rod and tighten retaining nuts with 33 foot-pounds (45 N•m) torque.

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

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (fig. 1B-136).

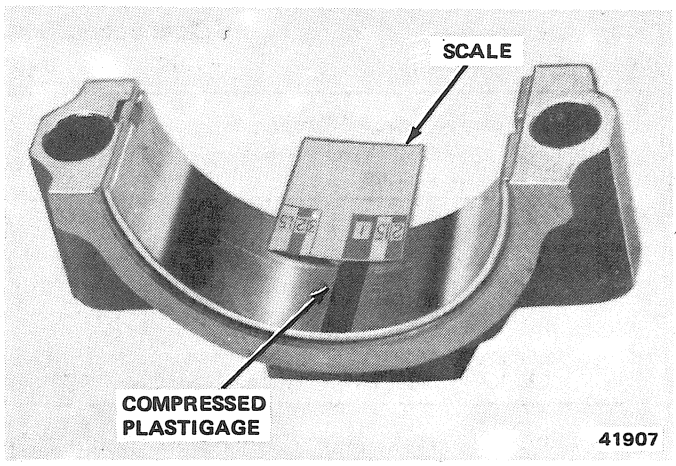

Fig. 1B-136 Connecting Rod Bearing Clearance Measurement with Plastigage

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

NOTE: *Traces of Plastigage left on bearing surfaces will dissolve in hot engine oil after engine is operating.*

(7) If oil 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 measured clearance with 0.001-inch (0.025 mm) undersize bearing inserts installed will determine if a pair of 0.001-inch (0.025 mm) undersize inserts or some other combination are 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 will reduce the clearance by 0.001 inch (0.025 mm). The oil clearance will be 0.002 inch (0.051 mm) and within specification. A combination of a 0.002-inch (0.051 mm) undersize insert and a 0.001-inch (0.025 mm) undersize insert will reduce the clearance an additional 0.0005 inch (0.013 mm). The oil clearance will then be 0.0015 inch (0.038 mm).*

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

(8) If oil clearance exceeds specification when 0.002-inch (0.051 mm) undersize inserts are installed, measure diameter of connecting rod journal with micrometer. If journal diameter is correct, inside diameter of connecting rod is incorrect and rod must be replaced.

Measuring Connecting Rod Journal with Micrometer

NOTE: *If the journal diameter does not conform to the specification, it may have been ground 0.010-inch (0.254 mm) or more undersize.*

If journal diameter is incorrect, replace crankshaft or grind journal to accept the appropriate undersized bearing insert pair.

(1) Wipe connecting rod journal clean.

(2) Use micrometer to measure journal diameter at two locations 90 degrees apart at each end of journal. Note difference between maximum and minimum diameters.

(3) Refer to Specifications for maximum allowable taper and out-of-roundness. If any rod journal dimension is not within specification, replace crankshaft or recondition crankshaft journals and fit with appropriate undersize bearing inserts.

(4) Compare largest diameter measurement with journal diameters listed in Bearing Fitting Chart.

(5) Select bearing insert pair required to provide specified bearing clearance.

NOTE: *Always measure clearance with Plastigage after installing replacement bearing inserts. Also, measure the clearance of each journal after installing a crankshaft kit (crankshaft supplied with bearings).*

Installation

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 finish, which can cause bearing failure. Short pieces of rubber hose slipped over the rod bolts will provide protection during installation.*

(1) Rotate crankshaft to position connecting rod journal at bottom of stroke.

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

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

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

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

PISTONS

The pistons used with all eight-cylinder engines are aluminum alloy Autothermic pistons. They are steel reinforced for strength and to control expansion.

The pistons are cam-ground and are elliptical in shape. The ring belt area contains three piston rings: two compression rings and one oil control ring located above the piston pin.

The piston pin boss is offset from the piston centerline so that it is nearer the thrust side of the piston. This minimizes piston slap.

To ensure correct installation of the pistons in the bore, two notches are cast in the top perimeter of the pistons for both the 304 (5 liter) and 360 (6 liter) CID engines. The notches must face forward when installed (fig. 1B-137).

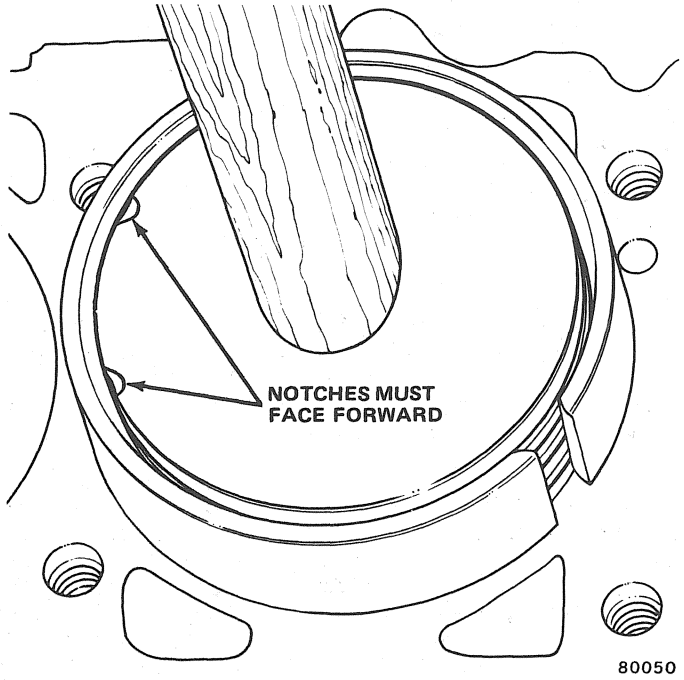

Fig. 1B-137 Installing Piston Assembly Into Cylinder Bore

Piston Measurements

Micrometer Method

(1) Use inside micrometer to measure cylinder bore inside diameter at location 2 5/16 inches (59 mm) below top of bore and crosswise to block.

(2) Measure outside diameter of piston.

NOTE: *Pistons are cam ground and must be measured at a right angle (90 degrees) to piston pin at centerline of pin (fig. 1B-138).*

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

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 cylinder bore alongside feeler gauge. With entire piston inserted in cylinder 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 the piston binds on the 0.0005-inch (0.013 mm) feeler gauge, either the piston is too large or the cylinder bore is too small. If the piston does not bind on the 0.002-inch (0.051 mm) feeler gauge, the piston may be enlarged by knurling or shot-peening. Replace any piston that is 0.004-inch (0.102 mm) or more undersize.

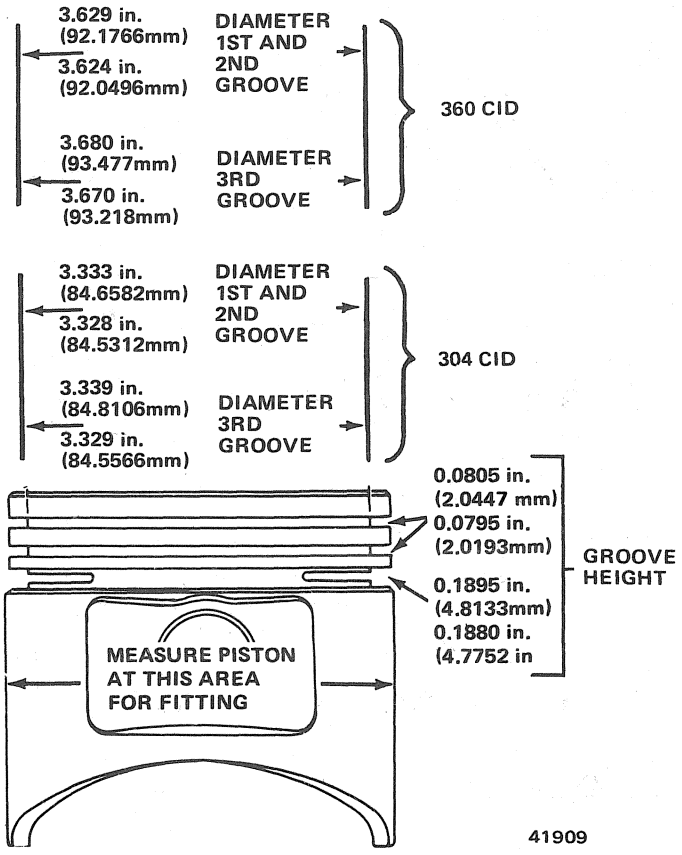

Fig. 1B-138 Piston Measurements

Piston Rings

The top compression ring is constructed of moly-filled iron. The second compression ring is constructed of cast-iron. The oil control ring has a three-piece steel design.

Ring Measurements

CAUTION: *Do not remove metal from grooves or lands. This will change ring groove clearances and will destroy ring-to-land seating.*

(1) Clean carbon deposits from all ring grooves. Ensure oil drain openings in oil ring grooves and pin boss are open.

(2) Measure ring side clearance with correct size feeler gauge that fits snugly between ring land and ring. Slide ring around groove. It must slide freely around circumference of groove (fig. 1B-139). Refer to Specifications for correct ring side clearance.

(3) Place ring in cylinder bore. Use inverted piston to push ring down near lower end of ring travel area. Measure ring gap (clearance) with feeler gauge fitted snugly in ring opening (fig. 1B-140). Refer to Specifications.

NOTE: *Insert each compression ring (not oil control rings) in its respective cylinder bore and measure end gap.*

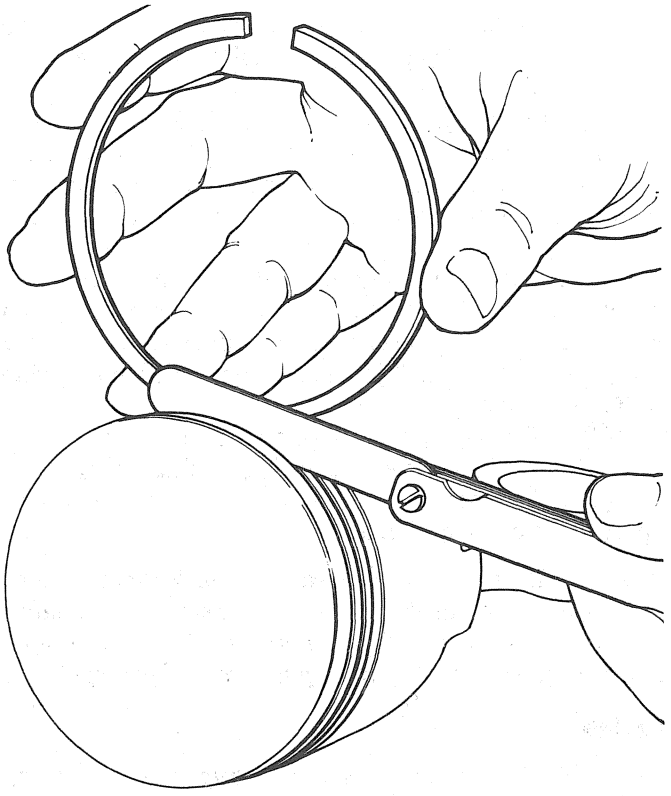

Fig. 1B-139 Ring Side Clearance Measurement

Installation

NOTE: *Ensure top and bottom compression rings are installed properly. Ideally, ring gaps should be spaced 180 degrees from each other. Correct ring gap spacing is depicted in figure 1B-141.*

(1) Install oil control rings according to instructions in package. Roll upper and lower rails into place without use of tool (fig. 1B-142).

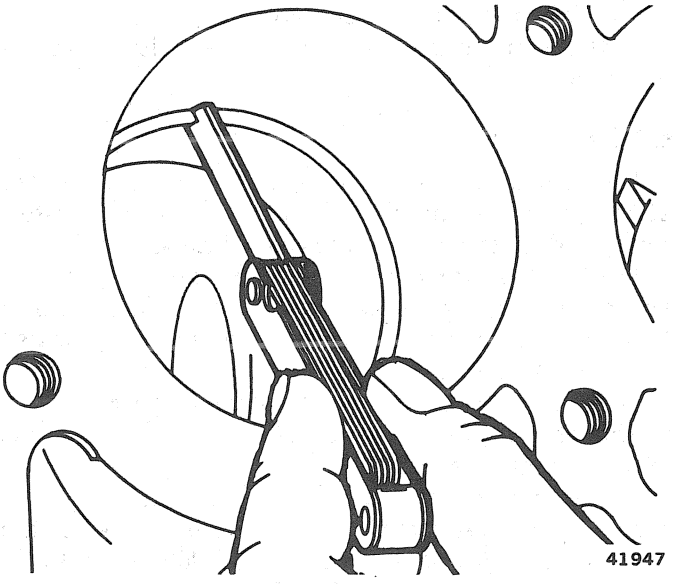

Fig. 1B-140 Compression Ring Gap Measurement

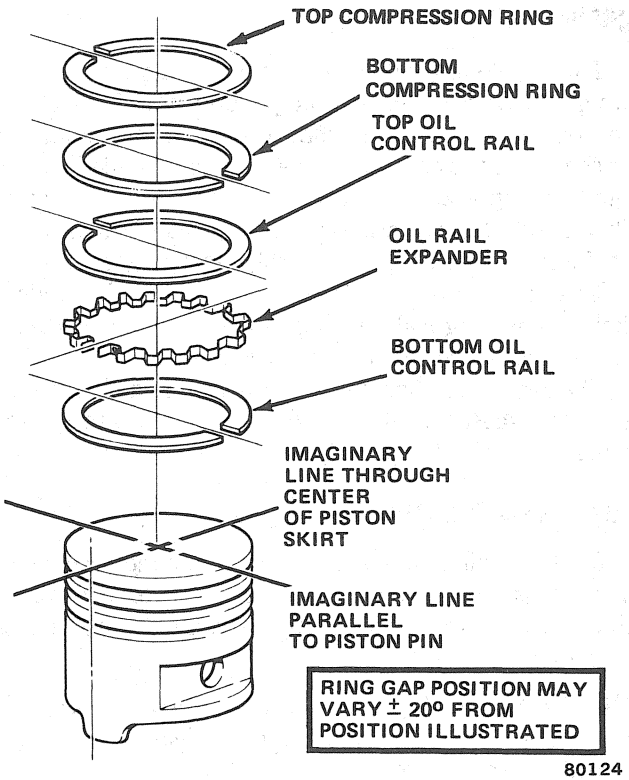

Fig. 1B-141 Ring Gap Spacing

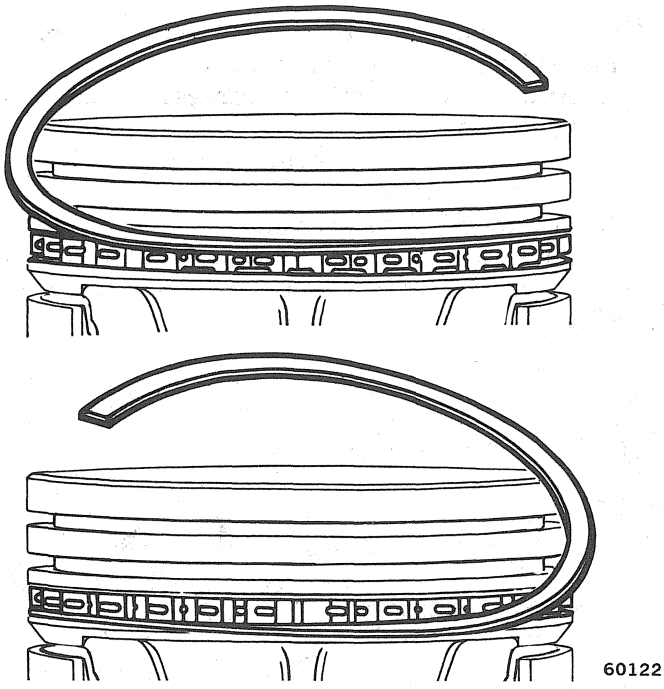

Fig. 1B-142 Installing Oil Control Ring Upper and Lower Rails

(2) Install bottom compression ring using ring installer to expand ring around piston (fig. 1B-143).

NOTE: *Ensure top and bottom compression rings are installed with* ***top*** *side up. Figure 1B-144 illustrates typical ring marks that indicate the* ***top*** *side of the ring.*

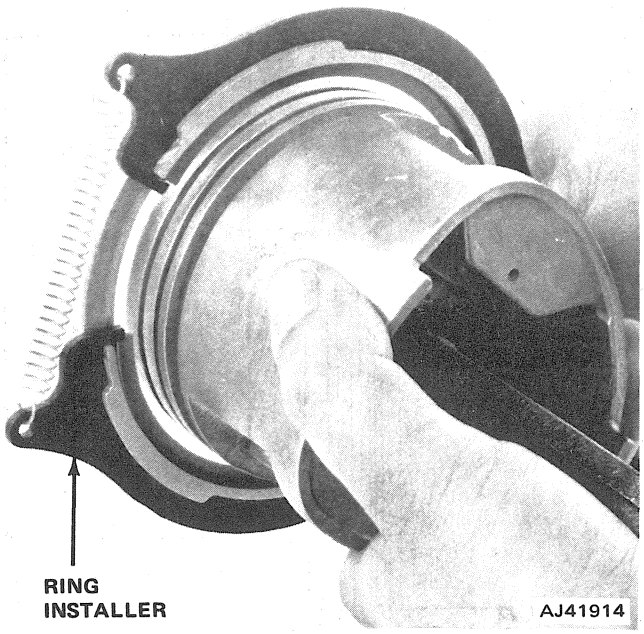

Fig. 1B-143 Compression Ring Installation

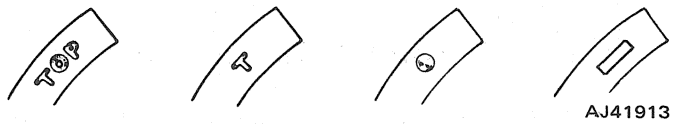

Fig. 1B-144 Typical Compression Ring Marks

(3) Install top compression ring using ring installer to expand ring around piston (fig. 1B-143).

Piston Pins

The piston pins are pressed into the rods with 2000 pounds force (8900 N) and do not require a retaining device.

Removal

(1) Using Piston Pin Remover Tool J-21872 and arbor press, place piston on Remover Support Tool J-21872-1 (fig. 1B-145).

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

Pin Fitting

(1) Inspect piston and connecting rod bores for nicks and burrs. Replace rod and piston if necessary.

NOTE: *Never reuse a piston pin after it has been pressed in and out of a connecting rod.*

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

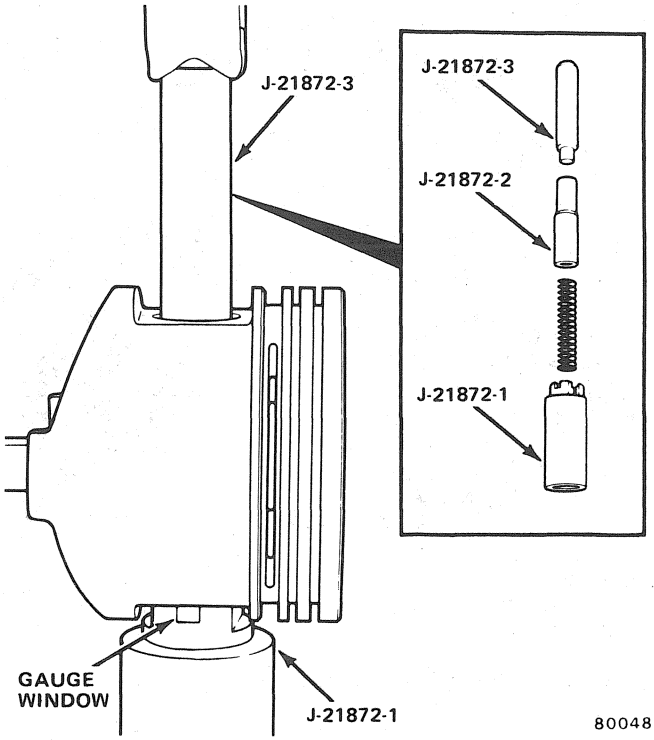

Fig. 1B-145 Piston Pin Removal and Installation

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

(4) Replace piston if pin jams in bore.

Installation

(1) Position piston and connecting rod so that piston notches will face forward and rod squirt hole will face inward when assembly is installed in engine.

(2) Place Pin Pilot Tool J-21872-2 through piston and connecting rod pin bores (fig. 1B-145).

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

(4) Insert piston pin into piston pin bore and into connecting rod pin bore.

(5) Insert Piloted Driver Tool J-21872-3 into piston pin.

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

NOTE: *The piston pin requires 2000 pounds force (8900 N) for installation. If insufficient force is required to press piston pin into connecting rod, or if rod slides along pin, replace connecting rod.*

(7) Remove piston and connecting rod assembly from press. Pin should be centered in rod ±1/32 inch (0.787 mm).

CRANKSHAFT

The crankshaft for eight-cylinder engines is counterweighted and balanced independently. The associated components for the crankshaft are also individually balanced, then the complete assembly is balanced as a unit. Service replacement vibration dampers, crankshafts, flywheels, drive plates and torque converters may be replaced without rebalancing the entire assembly.

The crankshaft has five main bearing journals and four connecting rod bearing journals. The end thrust is controlled by the No. 3 main bearing.

The rear main bearing oil seal is shielded from exposure to excessive oil by a slinger that is machined integral with the crankshaft.

Removal and Installation

Replace crankshafts that are damaged or worn beyond feasible reconditioning. Use the procedures outlined within Cylinder Block to remove and install a crankshaft.

NOTE: *Scribe mark the torque converter and drive plate prior to crankshaft removal. Install in the same position during assembly.*

Crankshaft End Play Measurement

Crankshaft end play is controlled by the No. 3 main bearing, which is flanged for this purpose.

(1) Attach dial indicator to crankcase adjacent to No. 3 main bearing.

(2) Set dial indicator stem on face of adjacent counterweight (fig. 1B-146).

(3) Pry crankshaft fore and aft.

(4) Note dial indicator. End play is difference between high and low measurements. Refer to Specifications

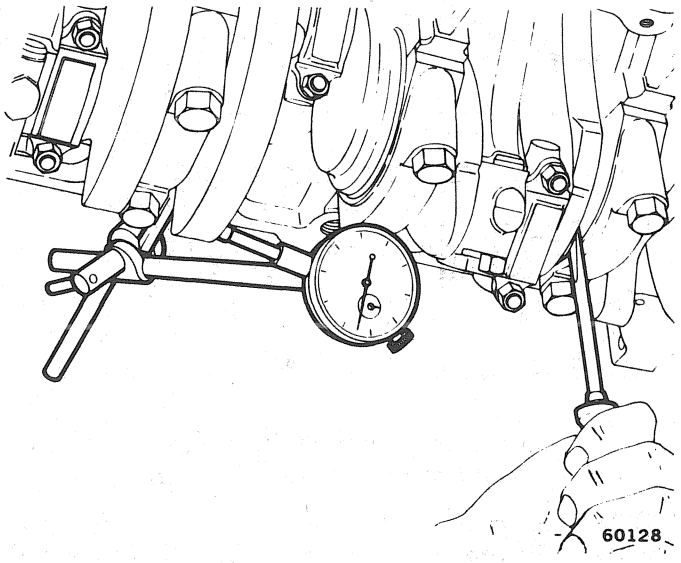

Fig. 1B-146 Crankshaft End Play Measurement

(5) If end play is not within specification, inspect crankshaft thrust faces for wear. If no wear is apparent, replace No. 3 (thrust) main bearing inserts and measure end play. If end play is not within specification, replace crankshaft.

NOTE: *When installing the No. 3 (thrust) main bearing inserts, pry the crankshaft fore and aft to align the thrust faces of the bearing inserts before final tightening.*

Crankshaft Main Bearings

The main bearing inserts are steel-backed aluminum-tin lined. Optional bearing inserts are available with overplated copper-lead linings. The main bearing caps are numbered 1 through 5, front to rear, with an arrow to indicate the forward position. The upper main bearing insert surfaces are grooved. The lower insert surfaces are smooth.

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

NOTE: *The bearing size is not stamped on production inserts.*

The main bearing journal diameter 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. The paint mark that identifies the rear main journal diameter is on the crankshaft rear flange.

Refer to the Main Bearing Fitting Chart to select the proper bearing inserts to obtain the specified bearing clearance. The correct clearance is 0.0015 to 0.0020 inch (0.038 to 0.051 mm) for No. 1 through No. 4 main bearings and 0.0025 to 0.0030 inch (0.064 to 0.076 mm) for the rear main bearing.

When required, use different sized upper and lower bearing inserts as a pair. Use a standard size upper insert in combination with a 0.001-inch (0.025 mm) undersize lower insert to reduce the clearance by 0.0005 inch or 1/2 thousandth of an inch (0.013 mm).
Example:

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

70242

NOTE: *When installing upper and lower inserts having different sizes, install undersize inserts either all on the top (upper) or all on the bottom (lower). Never use bearing inserts in combination with greater than 0.001-inch (0.025 mm) difference in size.*

Service replacement main bearing inserts are available as pairs in the following sizes: standard, 0.001-inch (0.025 mm) undersize, 0.002-inch (0.051 mm) undersize, 0.010-inch (0.250 mm) undersize, and 0.012-inch (0.305 mm) undersize. The bearing size is stamped on the back of service replacement inserts.

NOTE: *The 0.012-inch (0.305 mm) undersize insert is not used for production engine assembly.*

Removal

The following procedure can be used when the engine is installed in the vehicle.

(1) Drain engine oil and remove oil pan.
(2) Remove main bearing cap and lower insert.
(3) Remove lower insert from bearing cap.
(4) Remove upper insert by loosening all other bearing caps and inserting tool fabricated from cotter pin approximately 1/2-inch (14 mm) into crankshaft oil hole. Fabricate cotter pin as depicted in figure 1B-147.

Main Bearing Fitting Chart

Crankshaft Main Bearing Journal Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow —2.7489 to 2.7484 (69.8220-69.8093mm) (Standard)	Yellow —Standard	Yellow —Standard
Orange —2.7484 to 2.7479 (69.8093-69.7966mm) (0.0005 Undersize)	Yellow —Standard	Black 0.001-inch (0.025mm) Undersize
Black —2.7479 to 2.7474 (69.7966-69.7839mm) (0.001 Undersize)	Black 0.001-inch (.025mm) Undersize	Black 0.001-inch (0.025mm) Undersize
Green —2.7474 to 2.7469 (69.7839-69.7712mm) (0.0015 Undersize)	Black 0.001-inch (.025mm) Undersize	Green 0.002-inch (0.051mm) Undersize
Red —2.7389 to 2.7384 (69.5680-69.5553mm) (0.010 Undersize)	Red 0.010-inch (.254mm) Undersize	Red 0.010-inch (0.254mm) Undersize

60273

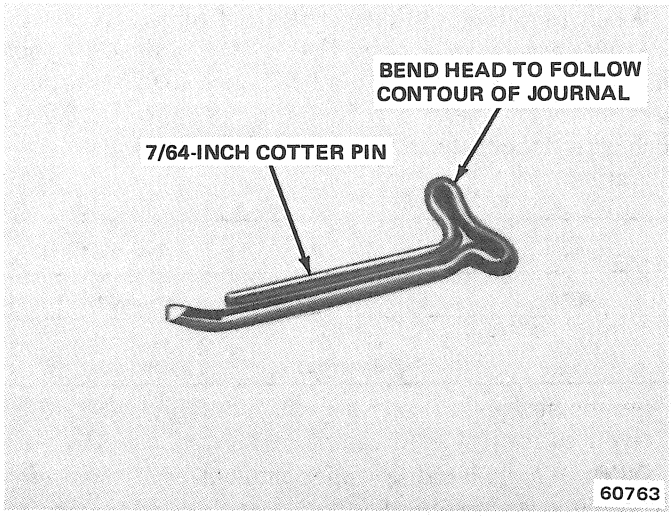

Fig. 1B-147 Fabricated Upper Main Bearing Insert Removal Tool

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

(6) Remove remaining bearings in same manner as outlined above.

Inspection

(1) Wipe inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in lining. Normal main bearing insert wear patterns are illustrated in figure 1B-148.

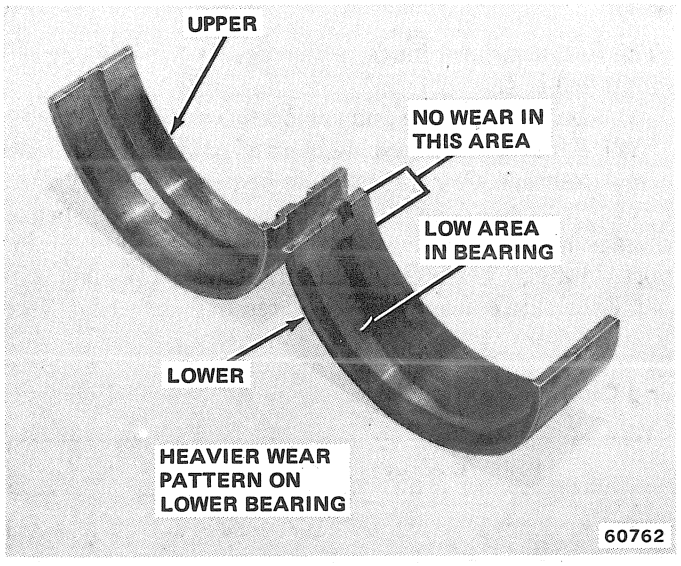

Fig. 1B-148 Normal Main Bearing Insert Wear Patterns

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

(2) Inspect back of inserts for fractures, scrapings or irregular wear patterns.

(3) Inspect upper insert locking tabs for damage.

(4) Replace all damaged or worn bearing inserts.

Measuring Main Bearing Clearance with Plastigage (Crankshaft Installed)

(1) Support weight of crankshaft with jack placed under counterweight adjacent to journal being measured.

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

(2) Remove main bearing cap and lower insert.

(3) Wipe insert and exposed portion of crankshaft journal clean.

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

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

(5) Install bearing cap and tighten retaining screws with 100 foot-pounds (136 N•m) torque.

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

(6) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope. Correct clearance is 0.0015 to 0.0020 inch (0.038 to 0.051 mm) for No. 1 through No. 4 main bearings and 0.0025 to 0.003 inch (0.064 to 0.076 mm) for rear main bearing (fig. 1B-149).

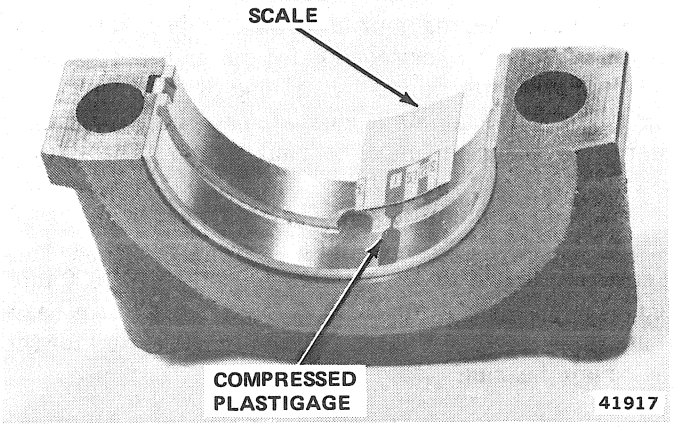

Fig. 1B-149 Measuring Main Bearing Clearance with Plastigage

NOTE: *The compressed Plastigage should maintain the same size across the entire width of the insert. If the size varies, this may indicate either a tapered journal or foreign material trapped behind the insert.*

(7) If correct clearance is indicated, bearing replacement is not necessary. Remove Plastigage from crankshaft and insert. Proceed to Installation.

NOTE: *Small pieces of Plastigage may remain on insert or journal surfaces. If so, they will dissolve in hot engine oil when the engine is operated.*

(8) If oil clearance exceeds specification, install pair of 0.001-inch (0.025 mm) undersize bearing inserts and measure clearance as described in steps (3) through (6) above.

(9) Clearance measured with 0.001-inch (0.025 mm) undersize inserts installed will determine if pair of 0.001-inch (0.025 mm) undersize inserts or some other size combination will provide correct clearance. For example, if clearance was 0.0035-inch (0.089 mm) originally, a pair of 0.001-inch (0.025 mm) undersize inserts will reduce clearance by 0.001 inch (0.025 mm). Oil clearance will be 0.0025 inch (0.064 mm) and within specification. Combination of 0.002-inch (0.051 mm) undersize insert and 0.001-inch (0.025 mm) undersize insert will reduce this clearance additional 0.0005 inch (0.013 mm) and oil clearance will be 0.002 inch (0.051 mm).

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

(10) If oil clearance exceeds specification with pair of 0.002-inch (0.051 mm) undersize inserts, measure crankshaft journal diameter with micrometer. Refer to Specifications. If journal diameter is correct, crankshaft bore in cylinder block may be misaligned, which requires cylinder block replacement. If journal diameter is incorrect, replace or grind crankshaft to standard undersize.

Installation

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

(2) Loosen all main bearing caps.

(3) Install main bearing upper insert(s).

(4) Install main bearing cap(s) and lower insert(s). Tighten retaining screws evenly with 100 foot-pounds (136 N•m) torque in steps of 30, 60, 90 and 100 foot-pounds (41, 81, 122 and 136 N•m) torque. Rotate crankshaft after each tightening step to determine if it rotates freely. If it does not rotate freely, examine inserts for proper installation and size.

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

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

Measuring Main Bearing Journals with Micrometer (Crankshaft Removed)

(1) Wipe main bearing journals clean.

(2) Measure each journal diameter with micrometer. Note difference between maximum and minimum diameters of each journal.

(3) Refer to Specifications for maximum allowable taper and out-of-roundness.

(4) Compare measured largest diameter dimensions with journal diameter dimensions listed in Main Bearing Fitting Chart.

(5) Select insert pairs that will provide specified bearing clearance. Correct clearance is 0.0015 to 0.0020 inch (0.038 to 0.051 mm) for No. 1 through No. 4 main bearings and 0.0025 to 0.0030 inch (0.064 to 0.076 mm) for rear main bearing.

Rear Main Bearing Oil Seal

The rear main bearing oil seal consists of a two-piece neoprene single lip seal. Correct installation of the seal is required for leak-free engine operation.

Removal

(1) Drain engine oil.

(2) Remove starter motor.

(3) Remove oil pan.

(4) Remove oil pan front and rear neoprene oil seals.

(5) Remove oil pan side gaskets.

(6) Thoroughly clean gasket mating surfaces of oil pan and engine block. Remove all sludge and residue from oil pan sump.

(7) Remove rear main bearing cap.

(8) Remove and discard lower seal.

NOTE: *To ensure leak-free operation, always replace the upper and lower seal halves as a pair.*

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

(10) Loosen all remaining main bearing capscrews.

(11) Use brass drift and hammer to tap upper seal half until sufficient portion of seal is protruding to permit pulling seal out completely.

Installation

(1) Wipe crankshaft seal surface area clean and apply light film of oil.

(2) Coat block contact surface area of replacement upper seal half with soap and lip of seal with clean engine oil (fig. 1B-150).

(3) Insert upper seal half into engine block.

NOTE: *The lip of the seal must face the front of the engine.*

(4) Coat both sides of replacement lower seal half end tabs with Jeep Gasket-in-a-Tube (RTV silicone), or equivalent. Do not apply sealer to lip of seal.

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

(6) Insert seal into cap recess and seat firmly.

(7) Apply Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to both chamfered edges of rear main bearing cap.

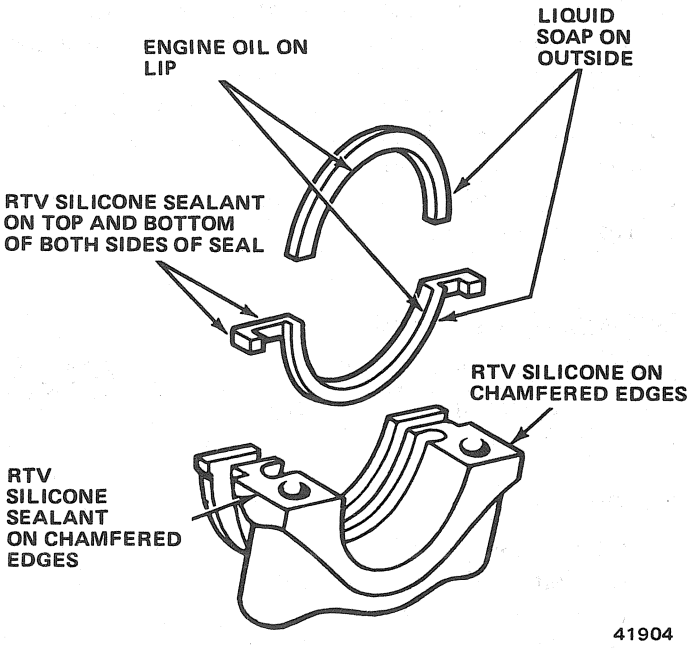

Fig. 1B-150 Rear Main Oil Seal Installation

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

(8) Tighten all main bearing capscrews with 100 foot-pounds (136 N•m) torque.

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

(10) Install starter motor.

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

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 original vibration damper balance holes when installing a service replacement damper. The vibration damper is not repairable and is serviced only as a complete assembly.

Removal

(1) Loosen damper retaining screw.

(2) Loosen alternator drive belt.

(3) Loosen air conditioner compressor drive belt, if equipped, and move aside.

(4) Loosen power steering pump drive belt, if equipped, and move aside.

(5) Remove damper pulley retaining bolts. Remove damper pulley from damper.

(6) Remove damper retaining screw and washer and loosely install screw to prevent damage to screw threads when removal tool is used.

(7) Use Vibration Damper Removal Tool J-21791 to remove damper from crankshaft (fig. 1B-151).

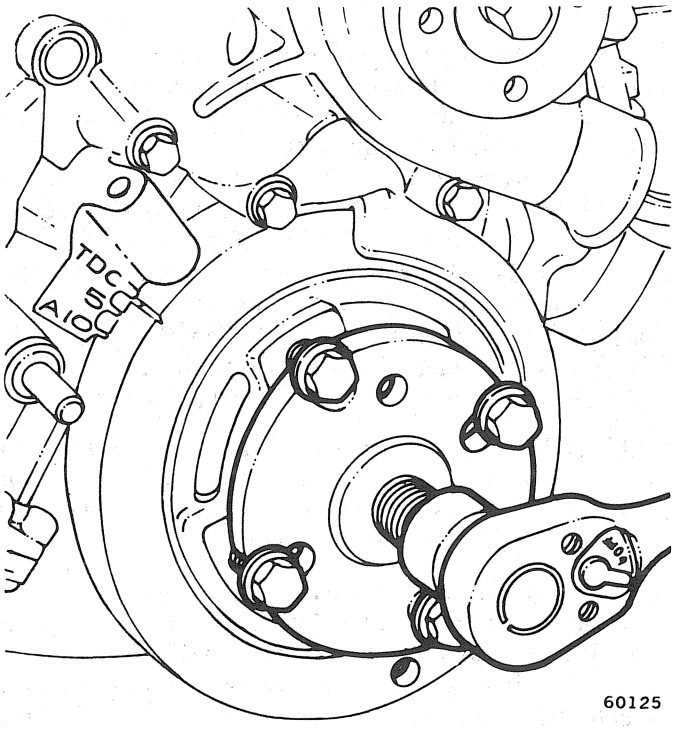

Fig. 1B-151 Vibration Damper Removal

Installation

(1) Polish damper hub with crocus cloth to prevent seal damage.

(2) Apply light film of engine oil to seal contact surface area of damper.

(3) Align key slot in damper hub with crankshaft key way.

(4) Position damper on end of crankshaft.

(5) Lubricate screw threads and washer with engine oil.

(6) Install damper retaining screw and washer and tighten with 90 foot-pounds (122 N•m) torque.

NOTE: *If crankshaft turns before specified torque is attained, proceed with belt installation. With belts installed, tighten damper retaining screw with 90 foot-pounds (122 N•m) torque.*

(7) Install damper pulley and retaining bolts. Tighten bolts with 30 foot-pounds (41 N•m) torque.

(8) Install drive belts and adjust to specified tension. Refer to Chapter 1C—Cooling Systems.

FLYWHEEL/DRIVE PLATE AND RING GEAR ASSEMBLY

The ring gear can be removed only from engines used with manual transmissions. With automatic transmissions, the ring gear is welded to and balanced as part of the drive plate and is not removeable.

Ring Gear Replacement—Manual Transmission (Flywheel Removed)

(1) Place flywheel on arbor press with steel blocks equally spaced around perimeter and under ring gear.
(2) Press flywheel down through ring gear.

NOTE: *The ring gear can also be removed by breaking it with a chisel.*

(3) Apply heat to expand inside perimeter of replacement ring gear.
(4) Press replacement ring gear onto flywheel.

NOTE: *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.*

CYLINDER BLOCK

Disassembly

(1) Drain engine oil.
(2) Remove engine assembly from vehicle as outlined in Engine Removal.
(3) Use engine stand to support engine assembly.
(4) Remove distributor.
(5) Remove cylinder head covers and gaskets.
(6) Remove bridge and pivot assemblies and rocker arms. Alternately loosen capscrews, one turn at a time, to avoid damaging bridge.
(7) Remove push rods.

NOTE: *Retain bridges, pivots, rocker arms, push rods and tappets in cylinder sets to facilitate installation in original locations.*

(8) Remove intake manifold assembly.
(9) Remove valve tappets.
(10) Remove cylinder heads and gaskets.
(11) Position pistons, one at a time, near bottom of stroke. Use ridge reamer to remove ridge, if any, from top end of cylinder walls.
(12) Loosen all drive belts. Remove power steering pump, air pump and air conditioner compressor, if equipped.
(13) Remove damper pulley and vibration damper.
(14) Remove timing case cover.
(15) Remove oil pan.
(16) Remove camshaft.
(17) 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 associated cylinder.*

(18) Remove connecting rod and piston assemblies through top of cylinder bores. Ensure that connecting rod bolts do not scratch connecting rod journals or cylinder walls. Short pieces of rubber hose slipped over rod bolts will provide protection during removal.
(19) Remove oil pickup tube and screen assembly.
(20) Remove main bearing caps and inserts.
(21) Remove crankshaft.

Cylinder Bore Reconditioning

Cylinder Bore Measurement

Use a bore gauge to measure the cylinder bores (fig. 1B-152). If a bore gauge is not available, use an inside micrometer.

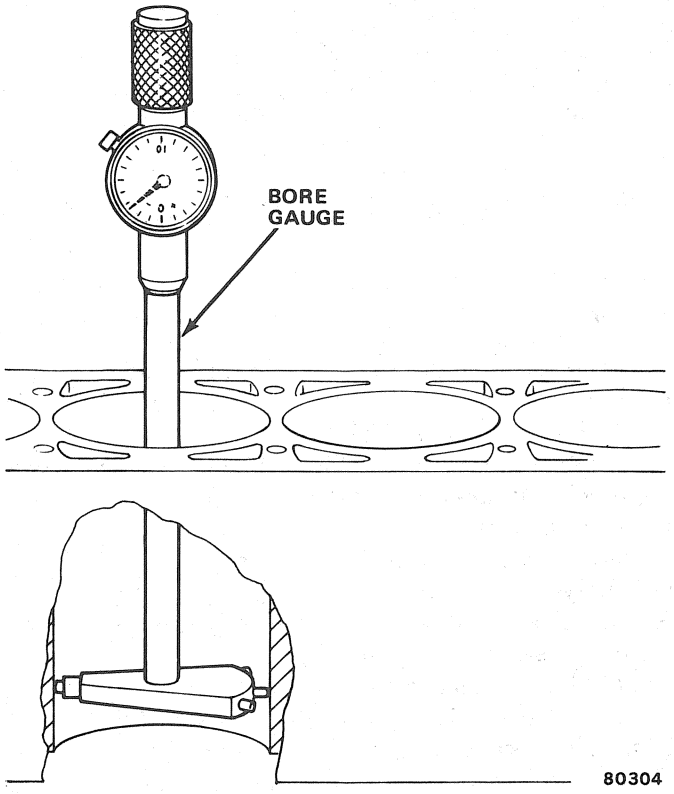

Fig. 1B-152 Measuring Cylinder Bore with Bore Gauge

(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-roundness by comparing difference between measurements taken 120° apart.

If the cylinder taper does not exceed 0.005 inch (0.127 mm) and the out-of-roundness does not exceed 0.003 inch (0.076 mm), true the cylinder bore by honing. If the cylinder taper or out-of-round condition exceeds these limits, bore and then hone cylinder for an oversize piston.

Resurfacing Cylinder Bore

CAUTION: *Do not use rigid type hones to remove cylinder glaze. A slight amount of taper always exists in cylinder walls after the 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 the cylinder walls. Do not use more than ten strokes per cylinder. A stroke is one down-and-up motion.

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.

NOTE: *If crankshaft is not removed from block, cover connecting rod journals with clean cloths during cleaning operation.*

Assembly

(1) Install and lubricate upper main bearing inserts and rear main upper seal half. Lubricate seal lip.

(2) Install crankshaft.

(3) Install main bearing caps and inserts. If replacement bearings are installed, measure each bearing clearance with Plastigage.

(4) Install replacement oil pickup tube and screen assembly. Do not attempt to install original pickup tube. Ensure plastic button is inserted in bottom of replacement screen.

(5) Install camshaft.

(6) Position piston rings on pistons. Refer to Piston Rings for procedure.

(7) Lubricate piston and ring surfaces with clean engine oil.

(8) Use piston ring compressor tool to install connecting rod and piston assemblies through top of cylinder bores. Ensure that connecting rod bolts do not scratch connecting rod journals or cylinder walls. Short lengths of rubber hose slipped over connecting rod bolts will provide protection during installation.

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

(10) Install camshaft and crankshaft sprockets and timing chain as an assembly.

(11) Install timing case cover and gaskets. Refer to Timing Case Cover for procedure.

(12) Install engine oil pan using replacement gaskets and seals. Tighten drain plug securely.

(13) Install vibration damper and damper pulley.

(14) Install cylinder heads with replacement gaskets.

(15) Install valve tappets.

(16) Install intake manifold with replacement gasket.

(17) Install push rods.

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

(19) Turn crankshaft to position No. 1 piston at TDC on compression stroke.

(20) Reseal and install cylinder head covers.

(21) Install power steering pump, air pump and air conditioner compressor.

(22) Install distributor.

(a) Point rotor at No. 1 spark plug firing position.

(b) Turn oil pump drive shaft with long screw driver to engage with distributor shaft.

(c) With rotor pointing at No. 1 spark plug firing position, rotate distributor housing counterclockwise until leading edge of trigger wheel segment is aligned with center of sensor. Tighten distributor hold-down clamp.

NOTE: *When engine is installed and operating, check ignition timing as outlined in Chapter 1A—General Service and Diagnosis.*

(23) Remove engine from stand.

(24) Install engine assembly as outlined in Engine Installation.

SPECIFICATIONS

Eight-Cylinder Engine Specifications

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Bore		
304	3.75	95.25
360	4.08	103.63
Stroke		
304	3.44	87.38
360	3.44	87.38
Displacement		
304	304 cu.in.	5 liter
360	360 cu.in.	6 liter
Compression Ratio		
304	8.40:1	
360	8.25:1	
Compression Pressure		
304	120 - 140 psi (min)	827-1034 kPa
360	120 - 140 psi (min)	827-1034 kPa
Maximum Variation Between Cylinders	30 psi	206 kPa (
Taxable Horsepower		
304	45.00	33.56 kW
360	53.27	39.72 kW
Fuel	unleaded	
Camshaft		
Fuel Pump Eccentric Diameter	2.182-2.192	55.423-55.677
Tappet Clearance	Zero lash (hydraulic tappets)	
End Play	Zero (engine operating)	
Bearing Clearance	0.001-0.003 (0.0017-0.0020 preferred)	0.0254-0.0762 (0.0432-0.0508 preferred)
Bearing Journal Diameter		
No. 1	2.1195-2.1205	53.835-53.861
No. 2	2.0895-2.0905	53.073-53.099
No. 3	2.0595-2.0605	52.311-52.337
No. 4	2.0295-2.0305	51.549-51.575
No. 5	1.9995-2.0005	50.787-50.813
Maximum Base Circle Runout	0.001	0.0254
Cam Lobe Lift		
304/360	0.266	6.7564
Intake Valve Timing		
Opens 304/360	14.75° BTDC	
Closes 304/360	68.75° BTDC	
Exhaust Valve Timing		
Opens 304/360	56.75° BBDC	
Closes 304/360	26.75° ATDC	
Valve Overlap		
304/360	41.50°	
Intake Duration		
304/360	263.50°	
Exhaust Duration		
304/360	263.50°	

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Connecting Rods		
Total Weight (Less Bearings)		
304/360	681-689 grams	
Total Length (Center-to-Center)		
304/360	5.873-5.877	149.17-149.28
Bearing Clearance	0.001-0.003 (0.0020-0.0025 preferred)	0.03-0.08 (0.051-0.064 preferred)
Side Clearance	0.006-0.018	0.15-0.46
Maximum Twist	0.0005 per inch	0.013 per 25.4 mm
Maximum Bend	0.001 per inch	0.03 per 25.4 mm
Crankshaft		
End Play	0.003-0.008	0.08-0.20
Main Bearing Journal Diameter		
No. 1, 2, 3, 4	2.7474-2.7489	69.784-69.822
Rear Main	2.7464-2.7479	69.759-69.797
Main Bearing Journal Width		
304/360		
No. 1	1.2635-1.2695	32.093-32.25
No. 2	1.246-1.248	31.65-31.70
No. 3	1.273-1.275	32.33-32.39
No. 4	1.246-1.248	31.65-31.70
No. 5	1.215-1.217	30.86-30.91
Main Bearing Clearance		
No. 1, 2, 3, 4	0.001-0.003 (0.0017-0.0020 preferred)	0.03-0.08 (0.04-0.05 preferred)
Rear Main		
No. 5	0.002-0.004 (0.0025-0.003 preferred)	0.05-0.10 (0.06-0.08 preferred)
Connecting Rod Journal Diameter		
304/360	2.0934-2.0955	53.172-53.266
Connecting Rod Journal Width		
304/360	1.998-2.004	50.75-50.90
Connecting Rod Bearing		
Clearance	0.001-0.003 (0.0020-0.0025 preferred)	0.03-0.08 (0.051-0.064 preferred)
Maximum Taper (All Journals)	0.0005	0.013
Maximum Out-of-Round (All Journals)	0.0005	0.013
Cylinder Block		
Deck Height	9.205-9.211	233.81-233.96
Deck Clearance		
304/360	0.0145 (below block)	0.368 (below block)

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Eight-Cylinder Engine Specifications (Continued)

	(USA) Inches Unless Otherwise Specified	(METRIC) Millimeters Unless Otherwise Specified
Maximum Cylinder Taper	0.005	0.13
Maximum Cylinder Out-of-Round	0.003	0.08
Tappet Bore Diameter	0.9055-0.9065	22.999-23.025
Cylinder Block Flatness	0.001/1-0.002/6 0.008 (max)	0.03/25-0.05/152 0.20 (max)
Cylinder Head		
Combustion Chamber Volume		
304	57.42-60.42 cc	
360	58.62-61.62 cc	
Valve Arrangement	EI-IE-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 (max)	0.064 (max)
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 liters with filter change)
Normal Operating Pressure	13 psi at 600 rpm 37-75 psi at 1600+ rpm	90 kPa at 600 rpm 255-517 kPa at 1600+ rpm
Oil Pressure Relief	75 psi (max)	517 kPa (max)
Gear-to-Body Clearance	0.0005-0.0025 (0.0005 preferred)	0.013-0.064 (0.013 preferred)
Gear End Clearance, Feeler Gauge	0.004-0.008 (0.008 preferred)	0.010-0.2 (0.10 preferred)
Gear End Clearance, Plastigage	0.002-0.008 (0.002 preferred)	
Pistons		
Weight (Less Pin)		
304	1.1-1.12 lbs	506-510 grams
360	1.32-1.33 lbs	601-605 grams
Piston Pin Bore CL-to Piston Top		
304/360	1.599-1.603	40.62-40.72
Piston-to-Bore Clearance		
304	0.0010-0.0018 (0.0014 preferred)	0.025-0.46 (0.035 preferred)
360	0.0012-0.0020 (0.0016 preferred)	0.030-0.051 (0.041 preferred)
Piston Ring Gap Clearance		
No. 1 and No. 2	0.010-0.020 (0.010-0.012 preferred)	0.25-0.51 (0.25-0.305 preferred)
Oil Control Steel Rail		
304	0.010-0.025	0.25-0.64
360	0.015-0.045 (0.010-0.020 preferred)	0.38-1.14 (0.25-0.51 preferred)
Piston Ring Side Clearance		
340		
No. 1	0.0015-0.0035 (0.0015 preferred)	0.038-0.089 (0.038 preferred)
No. 2	0.0015-0.003 (0.0015 preferred)	0.038-0.076 (0.038 preferred)
Oil Control	0.0011-0.008	0.028-0.203
360		
No. 1	0.0015-0.003 (0.0015 preferred)	0.038-0.076 (0.038 preferred)
No. 2	0.0015-0.0035 (0.0015 preferred)	0.038-0.089 (0.038 preferred)
Oil Control	0.000-0.007	0.000-0.18
Piston Ring Groove Height		
No. 1 and No. 2	0.0795-0.0805	2.019-2.045
Oil Control	0.1880-0.1895	4.775-4.813
Piston Ring Groove Diameter		
304		
No. 1 and No. 2	3.328-3.333	84.53-84.66
Oil Control	3.329-3.339	84.56-84.81
360		
No. 1 and No. 2	3.624-3.629	92.05-92.18
Oil Control	3.624-3.635	92.05-92.33
Piston Pin Diameter		
304/360	0.9308-0.9313	23.649-23.655
Piston Pin Bore Diameter		
304/360	0.9288-0.9298	23.592-23.617
Piston-to-Pin Clearance	0.0003-0.0005 (0.005 preferred) loose	0.008-0.013 (0.013 preferred) loose
Piston Pin-to-Connecting Rod Fit	2000 lbf Press-Fit	8900 N Press-Fit
Rocker Arms, Push Rods, and Tappets		
Rocker Arm Ratio	1.6:1	
Push Rod Length	7.790-7.810	197.87-198.37
Push Rod Diameter	0.312-0.315	7.93-8.00
Hydraulic Tappet Diameter	0.9040-0.9045	22.962-22.974
Tappet-to-Bore Clearance	0.001-0.0025	0.025-0.064
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		
304	1.782-1.792	45.26-45.52
360	2.020-2.030	51.31-51.56
Intake Valve Face Angle	29°	
Exhaust Valve Head Diameter		
304	1.401-1.411	35.59-35.84
360	1.675-1.685	42.55-42.80
Exhaust Valve Face Angle	44°	
Valve Springs		
Free Length	1.99	50.55
Spring Tension		
Valve Closed	64-72 lbf at 1.786	282-317 N at 45.36
Valve Open	202-220 lbf at 1.356	889-968 N at 34.44
Inside Diameter (All)	0.948-0.968	24.08-24.59

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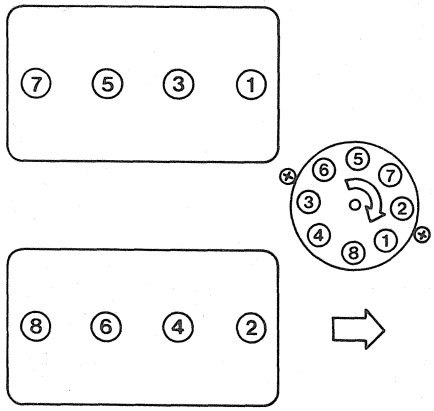
Torque Specifications

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	38	30-45	52	41-61
Air Pump-to-Bracket Pivot Screw	20	15-22	27	20-30
Air Pump Brackets-to-Engine—AC Compressor or Pedestals	25	18-28	34	24-38
Air Pump Adjusting Strap-to-Pump	20	15-22	27	20-30
Alternator Pivot Bolt or Nut	28	20-35	38	27-47
Alternator Adjusting Bolt	18	15-20	24	20-27
Alternator Mounting Bracket Bolt-to-Engine	28	23-30	38	31-41
Alternator Pivot Mounting Bolt-to-Head	33	30-35	45	41-47
Block Heater Nut, T-Screw Type	20 in-lbs	17-25 in-lbs	2	2-3
Camshaft Gear Retainer Screw	30	25-35	41	34-47
Carburetor Adapter-to-Manifold Screws—2V	14	12-15	19	16-20
Carburetor Holddown Nuts	14	12-15	19	16-20
Connecting Rod Bolt Nuts	33	30-35	45	41-47
Crankshaft Pulley-to-Damper	23	18-28	31	24-38
Cylinder Head Capscrews	110	100-120	149	136-163
Cylinder Head Cover Screws	50 in-lbs	42-58 in-lbs	6	5-7
Distributor Clamp Screw	20	18-24	18	14-24
Drive Plate-to-Converter Screw	22	20-25	30	27-34
EGR Valve-to-Manifold	13	9-18	18	12-24
Exhaust Manifold Screws				
Center (2)	25	20-30	34	27-41
Outer (4)	15	12-18	20	16-24
Exhaust Pipe-to-Manifold Nuts	20	15-25	27	20-34
Fan and Hub Assembly Bolts	18	12-25	24	16-34
Flywheel or Drive Plate-to-Crankshaft	105	95-115	142	129-156
Front Support Cushion Bracket-to-Block Screw	35	25-40	47	34-54
Front Support Cushion-to-Bracket-to-Frame	37	30-45	50	41-61
Fuel Pump Screws	16	13-19	22	18-26
Idler Pulley Bearing Shaft-to-Bracket Nut	33	28-38	45	38-52
Idler Pulley Bracket-to-Front Cover Nut	7	4-9	9	5-12
Intake Manifold Screws	43	37-47	58	50-64
Main Bearing Capscrews	100	90-105	136	122-142
Oil Pump Cover Screws	55 in-lbs	45-65 in-lbs	6	5-7
Oil Pan Screws				
1/4 inch - 20	7	5-9	9	7-12
5/16 inch - 18	11	9-13	15	12-18
Oil Relief Valve Cap	28	22-35	38	30-47
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
Rear Crossmember-to-Side Sill Nut	30	20-35	41	27-47
Rear Insulator Bracket-to-Trans. Screw	33	27-38	45	37-52
Rear Support Insulator-to-Bracket Nut	48	40-55	65	54-75
Rear Support Cushion-to-Crossmember Screw Nut	18	12-25	24	16-34
Rocker Arm Capscrew	19	16-26	26	22-35
Spark Plugs	28	22-33	38	30-45
Starter Motor to Converter Housing Screws	18	13-25	24	18-34
Thermostat Housing Screw	13	10-18	18	14-24
Throttle Valve Rod Adjusting Screw	40 in-lbs	30-50 in-lbs	5	3-6
Timing Case Cover-to-Block	25	18-33	34	24-45
Vibration Damper Screw (Lubricated)	90	80-100	122	108-136
Water Pump Screws	48 in-lbs	40-55 in-lbs	5	5-6

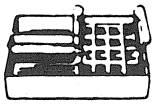
All Torque values given in foot-pounds and newton-meters with dry fits unless otherwise specified.
Refer to the Standard Torque Specifications and Capscrew Markings Chart in Chapter A of this manual for any torque specifications not listed above.

Eight-Cylinder Engine Firing Order

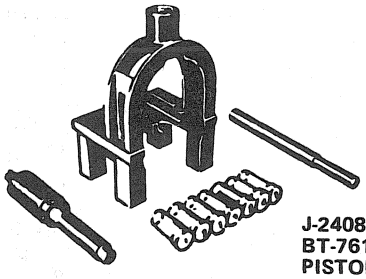


Tools

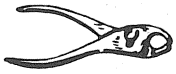
Four-Cylinder Engine



J-5821
VALVE LIFTER
CLEANING TANK

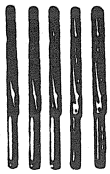


J-24086
BT-7612
PISTON PIN
TOOL



J-3049
VALVE LIFTER
REMOVER

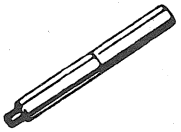
J-8087
CYLINDER BORE
CHECKING GAUGE
(RANGE 2-1/2"–9")



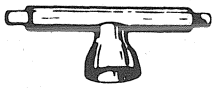
J-5830
VALVE GUIDE
REAMER SET

J-21473-1
CAMSHAFT BUSHING
REMOVER & INSTALLER
ADAPTER (USE WITH
J-21054-1)

J-6305-11
CONNECTING ROD
BOLT GUIDE SET



J-21054-1
HANDLE (CAMSHAFT
BUSHING REMOVER
& INSTALLER) (USE
WITH J-21473-1)



J-22330
VALVE SEAL
INSTALLER &
TESTER

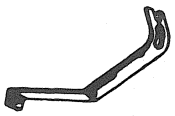
J-8101
VALVE GUIDE
CLEANING TOOL

J-23042
TIME COVER
SEAL ALIGNER
& INSTALLER

J-22794
AIR LINE
ADAPTER

J-4160
HYDRAULIC VALVE
LIFTER PLUNGER
REMOVER

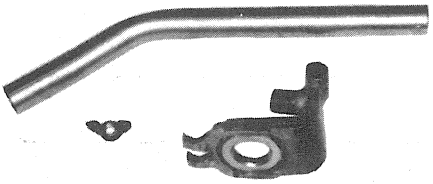
J-5569
PISTON RING
COMPRESSOR
(4")



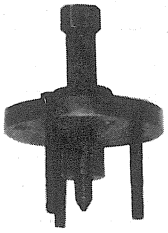
J-5892-1
VALVE SPRING
COMPRESSOR

50428B

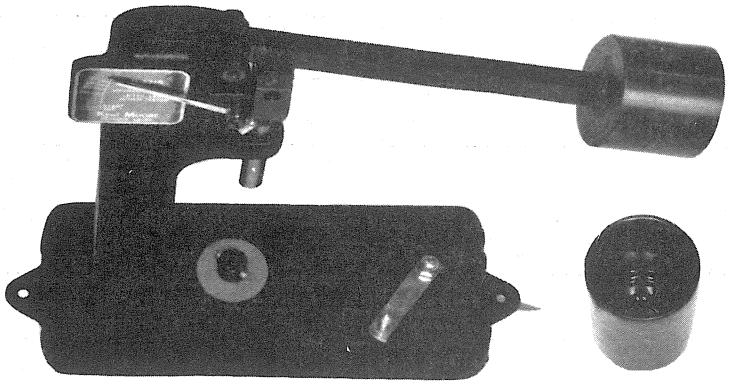
Tools
Six- and Eight-Cylinder Engine

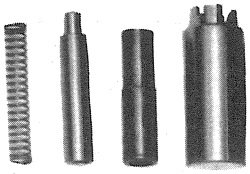


J-22534-1
VALVE SPRING
REMOVER AND
INSTALLER



J-21791
VIBRATION DAMPER
REMOVER





J-21872
PISTON PIN REMOVER AND INSTALLER

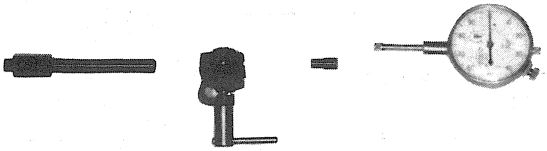
J-26562
TIMING CASE COVER
OIL SEAL INSTALLER

J-5790
HYDRAULIC VALVE LIFTER TESTER

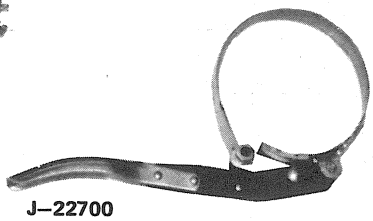
J–5959-4
DIAL INDICATOR
CLAMP AND ROD

J-26562
OIL SEAL INSTALLER

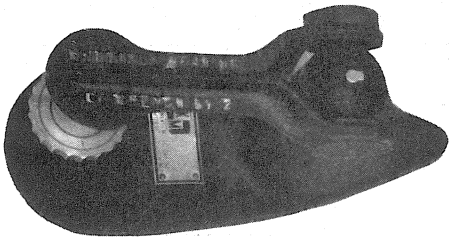
J–6042-1, 4, 5
VALVE GUIDE REAMERS



J–8520
DIAL INDICATOR SET
(0-1 INCH -.001 INCH GRADUATION)



J–22700
OIL FILTER WRENCH

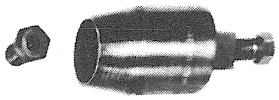


J–8056
VALVE AND CLUTCH
SPRING TESTER

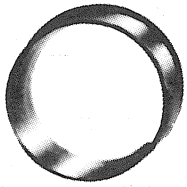
J-22248
TIMING CASE COVER
ALIGNMENT TOOL AND
SEAL INSTALLER

SCREW, TIMING CASE
COVER CRANKSHAFT
SEAL INSTALLER
PART OF TOOL J-9163

J-21882
OIL PUMP INLET
TUBE INSTALLER

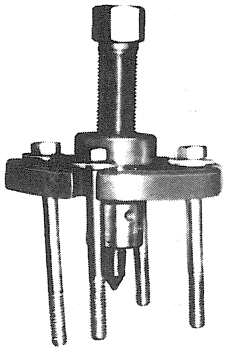


J-9256 TIMING CASE COVER
OIL SEAL REMOVER



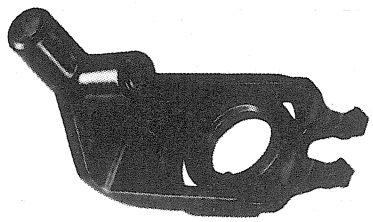
J-5601
PISTON RING
COMPRESSOR 3-3/4"

J-6042-1,4,5
VALVE GUIDE REAMERS



J-21791 VIBRATION
DAMPER REMOVER

J-21884 HYDRAULIC VALVE TAPPET
REMOVER AND INSTALLER



TOOL J-22534-1
VALVE SPRING REMOVER
AND INSTALLATION TOOL

TOOL
J-22534-4

TOOL
J-22534-5

J-22534 VALVE SPRING REMOVER AND INSTALLATION TOOL

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