ENGINES 1B

SECTION INDEX

FOUR-CYLINDER ENGINE

GENERAL

The 151 CID (2.5 liter) four-cylinder engine (fig. 1B-1, 2 and 3) installed in CJ vehicles has a cross-flow cylinder head, five main crankshaft bearings, hydraulic valve tappets, conventional ball socket valve rocker arms, a camshaft that is gear driven directly from the crankshaft and a coolant heated aluminum intake manifold.

Identification

The three-character engine identification code is stamped into the left hand rear top corner of the block (fig. 1B-4).

In addition, engines built for sale in Georgia and Tennessee have a nonrepeating number stamped into the left rear block flange (fig. 1B-4).

Three-Character Engine Code

The following three-character engine ID codes represent the data listed adjacent to each code.

- WCP—49S, Manual Trans, WO/AC
- WCT—49S, Auto Trans, WO/AC
- WCU—Calif. Manual Trans, WO/AC
- WCW—Calif., Auto Trans, WO/AC

Engine Mounting

Resilient rubber cushions support the engine (fig. 1B-5) and transmission at three points: at each side on the centerline of the engine and at the rear between the transmission extension housing and the rear support crossmember. Replacement of a cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion.

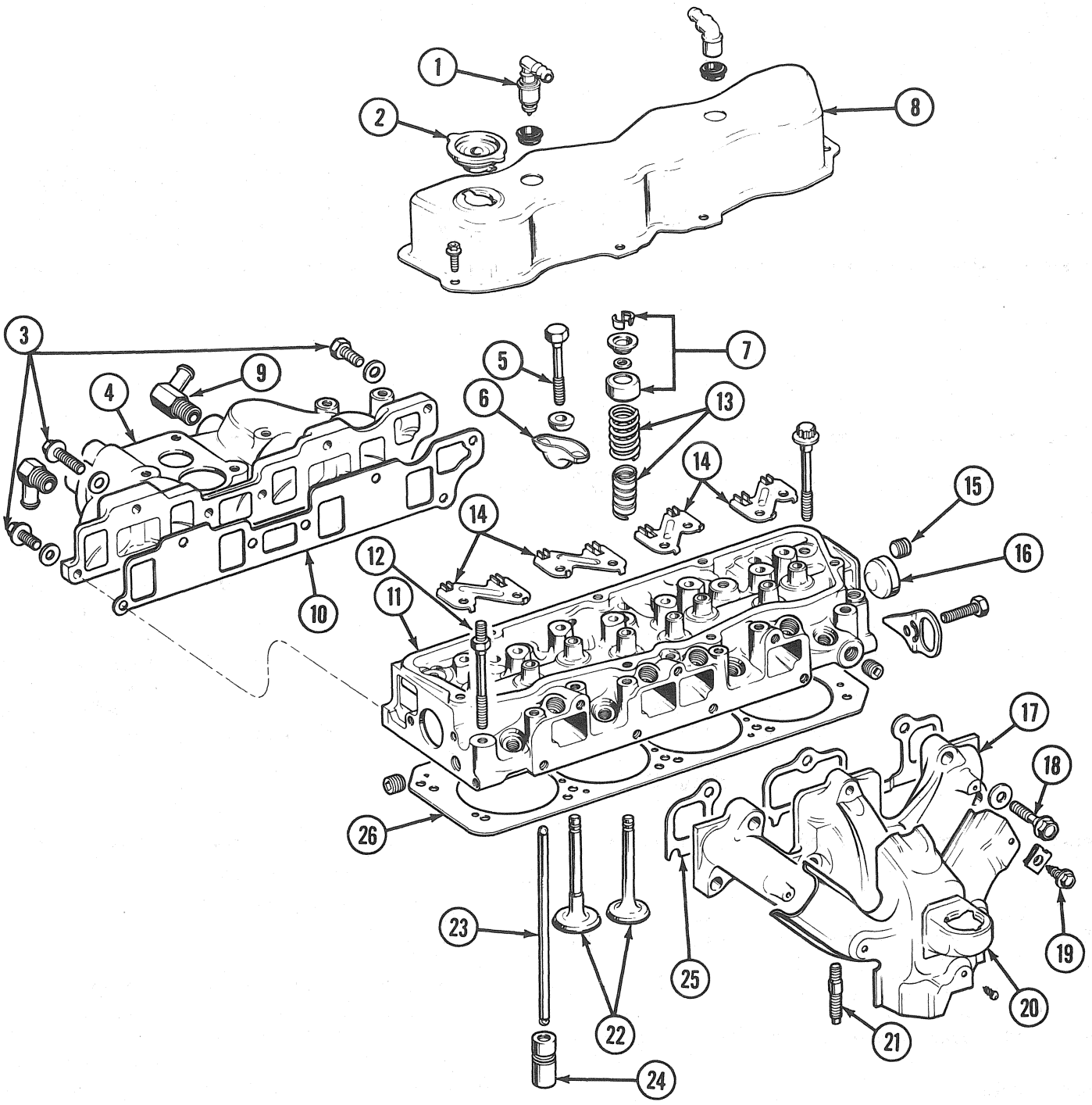
NOTE: *Remove the screws that attach the shroud to the radiator to prevent damage to the shroud by the fan.*

ENGINE REPLACEMENT

Removal

(1) Open hood.

(2) Remove battery negative cable from battery. Remove body ground wire from dash panel.



1. PCV VALVE
2. OIL FILLER CAP
3. INTAKE MANIFOLD ATTACHING BOLTS
4. INTAKE MANIFOLD
5. ROCKER ARM CAPSCREW
6. ROCKER ARM
7. VALVE SPRING RETAINER ASSEMBLY
8. CYLINDER HEAD COVER (ROCKER COVER)
9. COOLANT HOSE FITTING
10. INTAKE MANIFOLD GASKET
11. CYLINDER HEAD
12. CYLINDER HEAD STUD
13. VALVE SPRING
14. PUSH ROD GUIDE
15. CYLINDER HEAD PLUG
16. CYLINDER HEAD CORE PLUG
17. EXHAUST MANIFOLD
18. EXHAUST MANIFOLD BOLT
19. OIL LEVEL INDICATOR TUBE ATTACHING SCREW
20. EXHAUST MANIFOLD HEAT SHROUD (HEAT SHIELD)
21. EXHAUST MANIFOLD TO EXHAUST PIPE STUD
22. VALVES
23. PUSH ROD
24. TAPPET
25. EXHAUST MANIFOLD GASKET
26. CYLINDER HEAD GASKET

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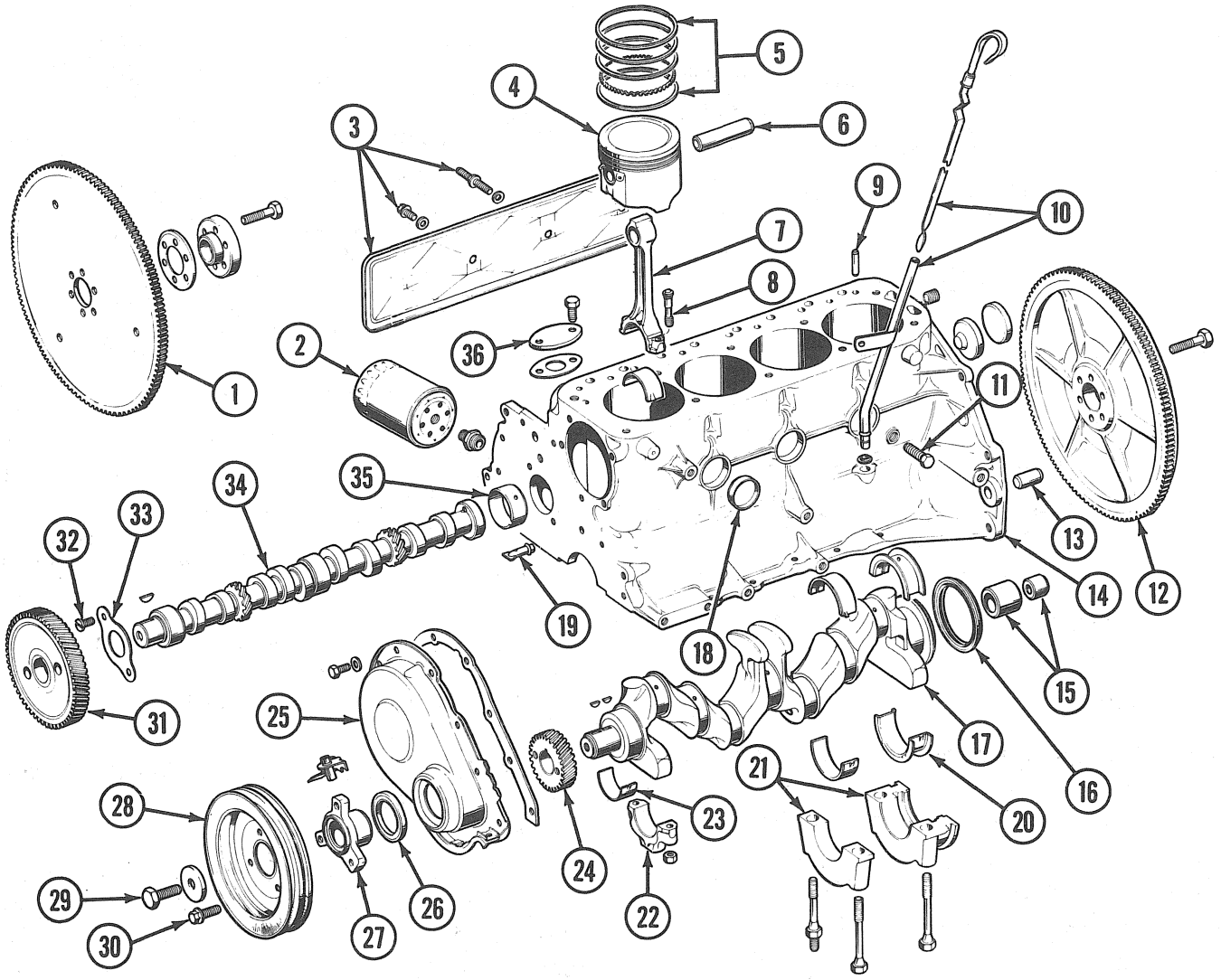
Fig. 1B-1 Four-Cylinder Engine Assembly—Head



1. DRIVE PLATE AND RING GEAR (AUTOMATIC TRANS)
2. OIL FILTER
3. PUSH ROD COVER AND BOLTS
4. PISTON
5. PISTON RING
6. PISTON PIN
7. CONNECTING ROD
8. CONNECTING ROD BOLT
9. DOWEL
10. OIL LEVEL INDICATOR AND TUBE
11. BLOCK DRAIN
12. FLYWHEEL AND RING GEAR (MANUAL TRANS)
13. DOWEL
14. CYLINDER BLOCK
15. PILOT AND/OR CONVERTER BUSHING
16. REAR OIL SEAL
17. CRANKSHAFT
18. BLOCK CORE PLUG
19. TIMING GEAR OIL NOZZLE
20. MAIN BEARINGS
21. MAIN BEARING CAPS
22. CONNECTING ROD BEARING CAP
23. CONNECTING ROD BEARING
24. CRANKSHAFT GEAR
25. TIMING GEAR COVER (FRONT)
26. TIMING GEAR COVER OIL SEAL
27. CRANKSHAFT PULLEY HUB
28. CRANKSHAFT PULLEY
29. CRANKSHAFT PULLEY HUB BOLT
30. CRANKSHAFT PULLEY BOLT
31. CRANKSHAFT TIMING GEAR
32. CAMSHAFT THRUST PLATE SCREW
33. CAMSHAFT THRUST PLATE
34. CAMSHAFT
35. CAMSHAFT BEARING
36. OIL PUMP DRIVESHAFT RETAINER PLATE, GASKET AND BOLT

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Fig. 1B-2 Four-Cylinder Engine Assembly—Block

(3) Remove air cleaner assembly.

(4) Raise vehicle and support with safety stands.

(5) Remove exhaust pipe from exhaust manifold. Disconnect oxygen sensor connector, if equipped.

(6) Disconnect battery cable and solenoid wire from starter motor solenoid.

(7) Remove starter motor bolts and rear bracket nut. Remove starter motor.

(8) Disconnect wire connector from distributor and from oil pressure sending unit.

(9) Remove engine mounting nuts.

(10) Remove hydraulic clutch slave cylinder and flywheel inspection plate (manual transmission only).

(11) Remove transmission clutch/converter housing-to-engine bolts. Automatic transmission, disconnect converter from drive plate.

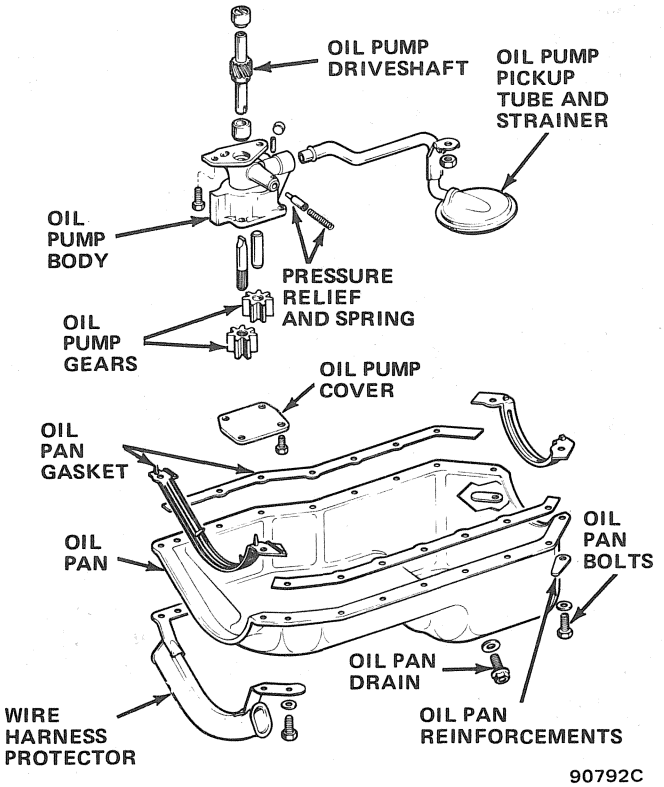

Fig. 1B-3 Four-Cylinder Engine Assembly—Oil Pan and Pump

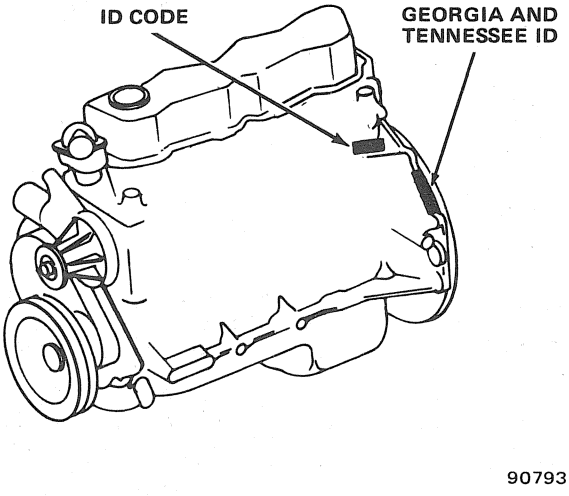

Fig. 1B-4 Engine ID Code Locations

(12) Lower vehicle.

(13) Support transmission with floor jack.

(14) Identify, tag and remove vacuum hoses from canister and carburetor.

(15) Remove bowl vent hose from carburetor. Disconnect mixture control solenoid wire connector from carburetor, if equipped.

(16) Remove wires from alternator.

(17) Disconnect throttle cable from bracket and from carburetor.

(18) Disconnect choke and solenoid wires at carburetor.

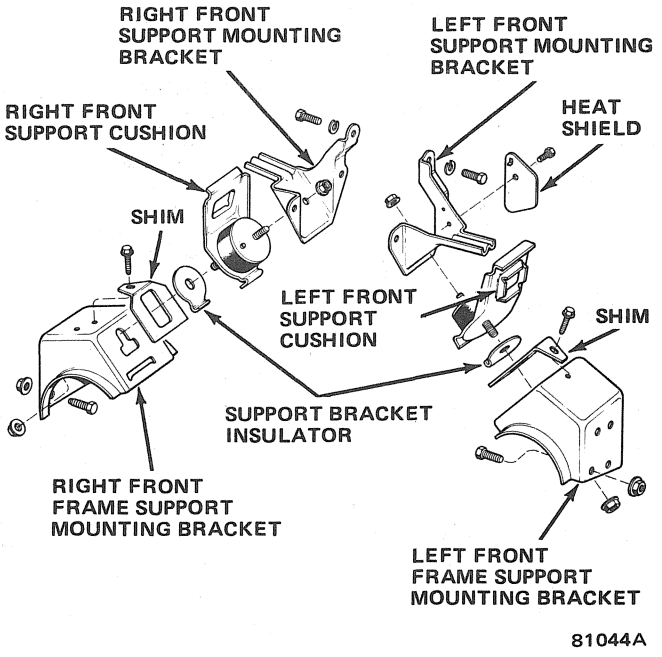

Fig. 1B-5 Four-Cylinder Engine Mounting

(19) Disconnect engine coolant temperature sender wire connector.

WARNING: *Do not loosen radiator draincock with system hot and under pressure because serious burns from coolant can occur.*

(20) Drain radiator and remove lower radiator hose.

(21) Remove heater hoses from heater core inlet and outlet tubes.

NOTE: *DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.*

NOTE: *It may be necessary to attach a flexible hose to draincock to route coolant to container.*

(22) Remove fan shroud bolts. Remove upper radiator hose, radiator and shroud.

(23) Remove power steering hoses at pump.

CAUTION: *Manual transmission may have to be raised to provide a smooth engine/transmission separation.*

(24) Attach engine hoisting sling and remove engine.

Installation

(1) Lower engine into engine compartment. If manual transmission, ensure that transmission shaft mates correctly with clutch disc and pilot bushing.

(2) Connect power steering hoses.

(3) Connect and secure heater hoses to heater core with clamps.

(4) Connect following wire connectors:

(a) Coolant Temperature sender

(b) Oil pressure sender

(c) Choke and solenoid
(d) Mixture control solenoid, if equipped.

(5) Connect vacuum hoses to canister and carburetor. Ensure hoses are connected correctly according to identifying tags that were attached prior to removal.

(6) Connect bowl vent hose to carburetor.

(7) Connect alternator wires.

(8) Attach throttle cable to carburetor. Secure cable in position with bracket.

(9) Position fan shroud over fan. Install radiator and connect upper and lower radiator hoses. Attach shroud to radiator. Fill system with coolant.

NOTE: *Refer to Chapter 1C—Cooling Systems for additional information.*

(10) Raise vehicle.

(11) Automatic transmission, connect converter to drive plate.

(12) Install transmission clutch/converter housing-to-engine bolts. Tighten bolts with 35 foot-pounds (47 N•m) torque.

(13) Install flywheel inspection plate and hydraulic clutch slave cylinder (manual transmission only). Tighten bolts with 225 inch-pounds (25 N•m) torque.

(14) Install engine mounting nuts. Tighten with 34 foot-pounds (46 N•m) torque.

(15) Install starter motor. Tighten bolts with 27 foot-pounds (37 N•m) torque and bracket nut with 40 inch-pounds (4.5 N•m) torque.

(16) Connect battery cable and solenoid wire to starter motor solenoid.

(17) Connect distributor wire connector.

(18) Connect exhaust pipe to exhaust manifold. Tighten securing nuts with 35 foot-pounds (50 N•m) torque. Connect oxygen sensor wire connector, if equipped.

(19) Connect battery negative cable and body ground wire.

(20) Install air cleaner.

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

(21) Start engine and inspect for leaks. Refill fluids as necessary.

VALVE TRAIN

General

Motion is transmitted from the camshaft through the hydraulic tappet and push rod to the rocker arm. Each rocker arm moves on its pivot ball and transmits the camshaft motion to the valve. The rocker arm and pivot ball are retained by a capscrew (fig. 1B-6).

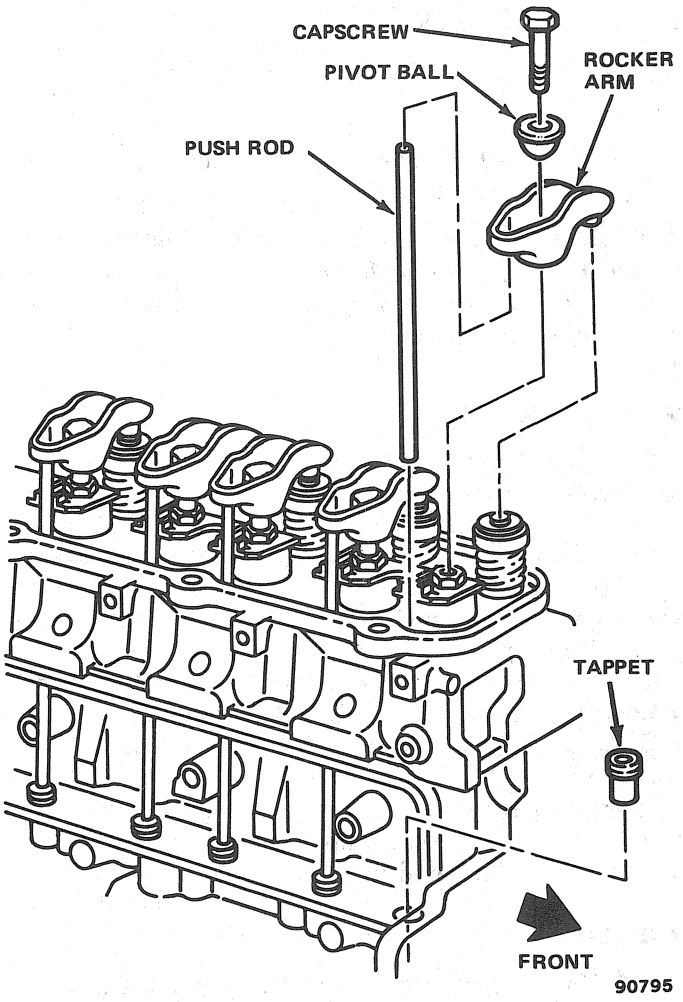

Fig. 1B-6 Valve Train

Rocker Arm and Push Rod

Removal

(1) Remove cylinder head cover.
(2) Remove rocker arm capscrew and ball.
(3) Remove rocker arm.

NOTE: *If only the push rod is to be replaced, loosen rocker arm capscrew and swing arm away from push rod. Remove push rod by pulling it up through the hole in the head.*

Cleaning and Inspection

Clean all parts with cleaning solvent. Use compressed air to clean out the oil passages.

Inspect the pivot contact surface of each rocker arm, pivot ball and push rod assembly. Replace components 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 to find a wear pattern along the length of the push rod. Inspect the cylinder head for obstruction if this condition exists.

Installation

(1) Insert push rod through hole in head and into tappet seat.
(2) Install rocker arm, pivot ball and capscrew. Tighten capscrew with 20 foot-pounds (27 N•m) torque. Do not overtighten capscrew.
(3) Install cylinder head cover.

Valve Springs, Shields and/or Seal Replacement

Removal

(1) Remove cylinder head cover.
(2) Remove rocker arms of valve spring components to be serviced.
(3) Remove spark plug(s) adjacent to cylinder(s) with valve spring components to be serviced.
(4) Install air hose Adapter J-22794 into spark plug hole and apply air pressure to hold valves in place. Apply minimum of 90 psi (621 kPa) air pressure.

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

(5) After removing rocker arm, screw rocker arm capscrew into cylinder head. Insert slotted end of Tool J-5892-1 under head of rocker arm capscrew. Compress valve spring (fig. 1B-7) and hold to allow removal of valve spring retainer cap locks. Remove tool, retainer locks, cap, shield, spring, and valve stem oil seal (fig. 1B-8).

NOTE: *Retain components in same order removed to facilitate installation in original position.*

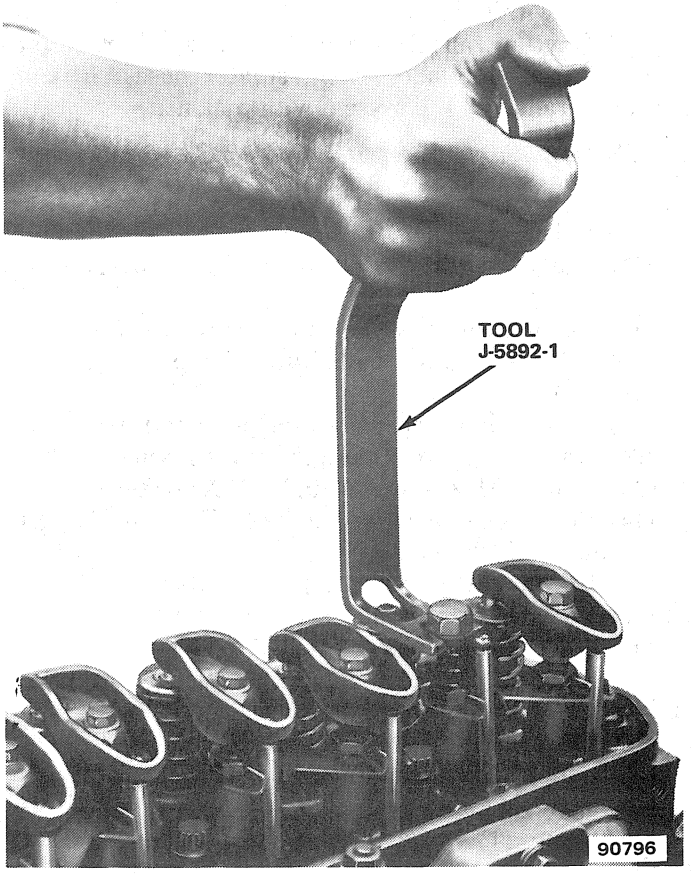

Fig. 1B-7 Compressing Valve Springs

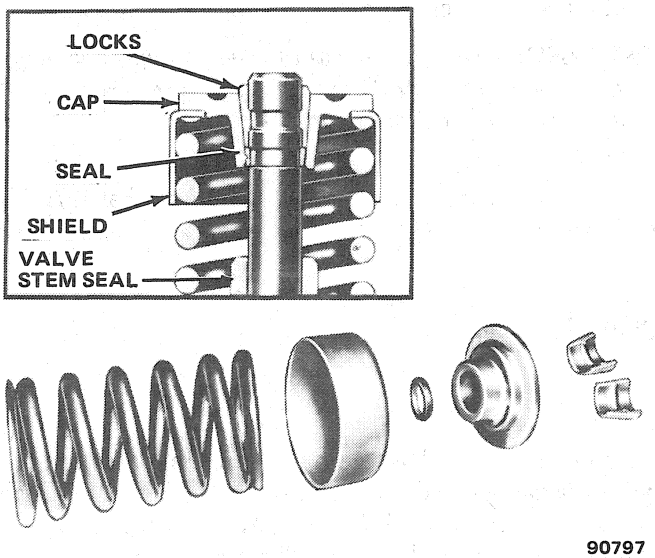

Fig. 1B-8 Upper Valve Train Components

Valve Spring Tension Test

Use Valve Spring Tester J-8056, or equivalent, to test each valve spring for the specified tension values (fig. 1B-9). Replace springs that are not within specification and that bind because of warpage.

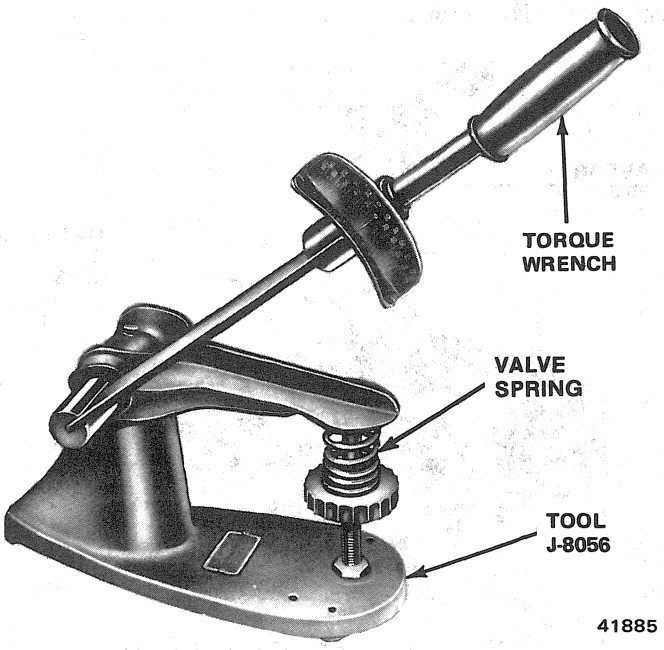

Fig. 1B-9 Testing Valve Spring—Typical

Installation

Always install a new valve stem oil seal whenever valve spring retainer cap locks have been disturbed.

(1) Position oil seal, spring, shield and cap over valve stem.

(2) With Tool J-5892-1, compress valve spring and install retainer cap locks. Remove tool.

(3) Install rocker arm, pivot ball and capscrew over stud. Tighten capscrew with 20 foot-pounds (27 N•m) torque. Do not overtighten.

(4) Install cylinder head cover.

(5) Remove air hose adapter and install spark plug.

CAMSHAFT AND DRIVE

The cast iron camshaft is supported by three bearings and is gear driven. An iron crankshaft gear drives the camshaft through a plastic composition timing gear with a steel hub (fig. 1B-10).

The cam lobes are ground, hardened and tapered with the high side toward the rear. This, coupled with the spherical face on the tappet, causes the tappets to rotate.

The camshaft bearings are lubricated through oil holes that intersect the main oil gallery.

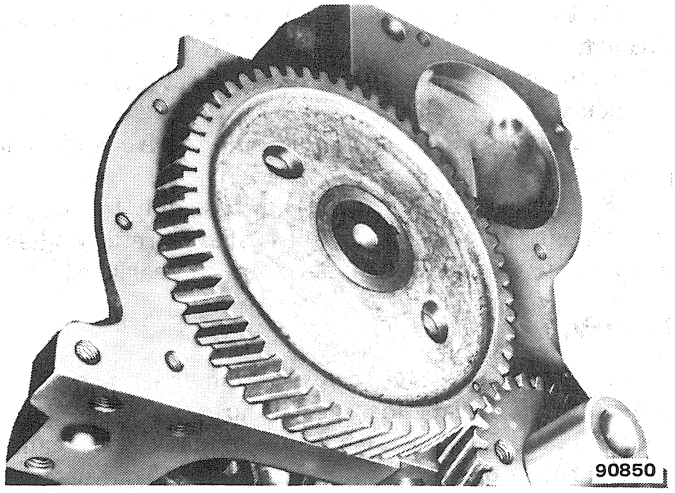

Fig. 1B-10 Camshaft and Crankshaft Gears

Camshaft Replacement

Removal

(1) Remove air cleaner.

WARNING: *DO NOT remove block drain plugs or loosen radiator draincock with system hot and under pressure because serious burns from coolant can occur.*

(2) Drain cooling system.

NOTE: *Do not waste reusable coolant. If solution is clean, drain coolant into a clean container for reuse.*

NOTE: *It may be necessary to attach a flexible hose to the drains to route the coolant to the container.*

(3) Remove timing gear cover. Refer to Timing Gear Cover Removal for procedure.

(4) Disconnect radiator hoses at radiator. Remove radiator. Refer to Radiator Removal in Chapter 1C—Cooling Systems.

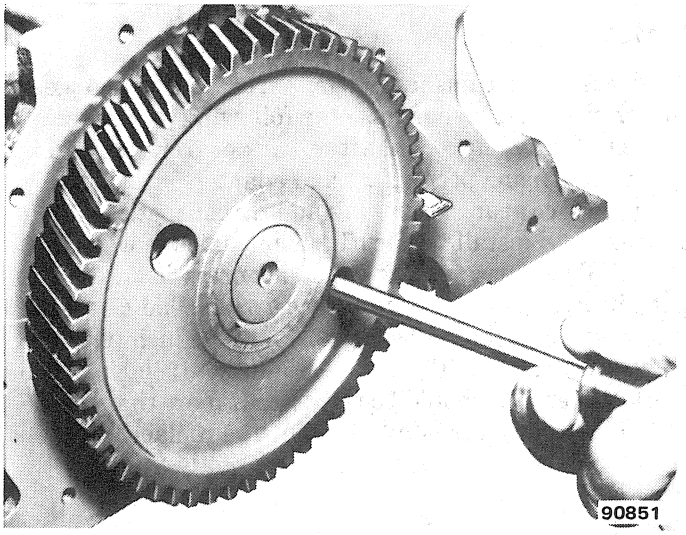

Fig. 1B-11 Removing Camshaft Thrust Plate Screws

(5) Remove two camshaft thrust plate screws through holes in camshaft gear (fig. 1B-11).

(6) Remove tappets. Refer to Tappet Removal for procedure.

(7) Remove distributor, oil pump drive and fuel pump. Refer to removal procedures.

(8) Remove camshaft and gear assembly by pulling out through front of block. Support shaft carefully when removing to prevent damaging camshaft bearings.

Disassembly

(1) If gear must be removed from shaft, use press plate and appropriate adapter with arbor press.

(2) Place tools on table of arbor press. Place camshaft through opening in tools. Press shaft out of gear using socket wrench or other suitable tool (fig. 1B-12).

NOTE: *Thrust plate must be properly aligned to ensure woodruff key in shaft does not damage it when the shaft is pressed out of gear.*

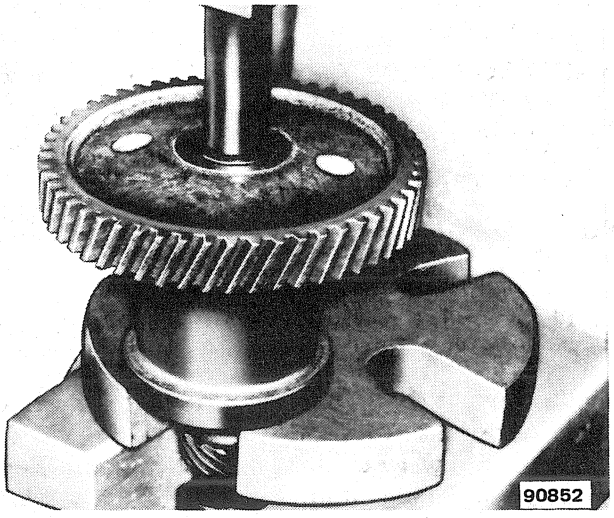

Fig. 1B-12 Removing Camshaft Timing Gear

Assembly

To assemble camshaft gear, thrust plate and gear spacer ring on camshaft, use the following procedure.

(1) Firmly support shaft at back of front journal in arbor press using press plate and adapter.

(2) Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway.

(3) Position camshaft gear and press it onto shaft until it bottoms against gear spacer ring. End clearance of thrust plate should be 0.0015 to 0.0050 inch (0.038 to 0.127 mm) (fig. 1B-13). If less than 0.0015 inch (0.038 mm), spacer ring should be replaced. If more than 0.0050 inch (0.127 mm), thrust plate should be replaced.

Installation

(1) Thoroughly coat camshaft journals with high quality engine oil supplement (EOS).

(2) Install camshaft assembly in engine block. Use care to prevent damaging bearings or camshaft.

(3) Turn crankshaft and camshaft so that valve timing marks on gear teeth are aligned. Engine is now in number four cylinder firing position. Install camshaft thrust plate-to-block screws and tighten with 75 inch-pounds (10 N•m) torque.

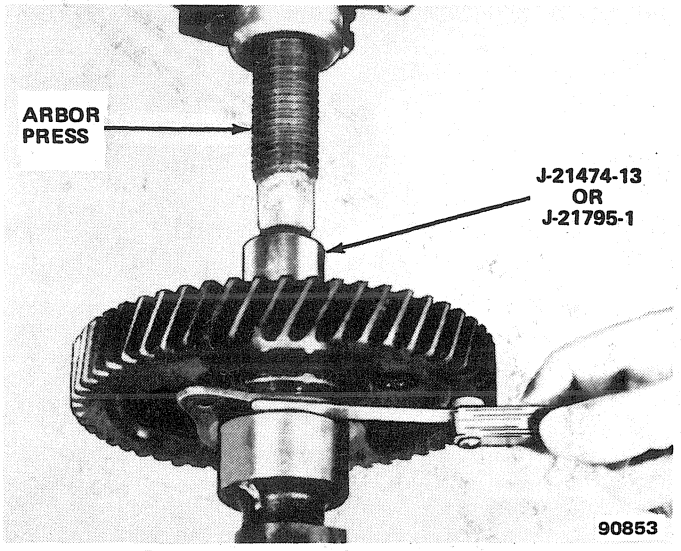

Fig. 1B-13 Installing Camshaft Timing Gear and Measuring Thrust Plate End Clearance

(4) Install timing gear cover and gasket.

(5) Line up keyway in hub with key on crankshaft and slide hub onto shaft. Install center bolt and tighten with 160 foot-pounds (212 N•m) torque.

(6) Install valve tappets, push rods, push rod cover, oil pump shaft and gear assembly and fuel pump. Install distributor according to following procedure.

(a) Turn crankshaft 360 degrees to firing position of number one cylinder (number one exhaust and intake valve tappets both on base circle (heel) of camshaft and timing notch on vibration damper indexed with top dead center mark [TDC] on timing degree scale).

(b) Install distributor and align shaft so that rotor arm points toward number one cylinder spark plug contact.

(7) Install rocker arms and pivot balls over push rods. With tappets on base circle (heel) of camshaft, tighten rocker arm capscrews with 20 foot-pounds (27 N•m) torque. Do not overtighten.

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

(9) Install intake manifold. Refer to Intake Manifold Installation for procedure.

(10) Install radiator and lower radiator hose.

(11) Install belt, fan and shroud. Tighten fan bolts with 18 foot-pounds (34 N•m) torque. Install upper radiator hose. Tighten belts.

NOTE: *The fan assembly and pulley must be installed with the drive belt(s) in position on pulleys.*

(12) Install engine coolant.

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

(13) Start engine. Inspect for oil and coolant leaks. Adjust ignition timing.

(14) Install air cleaner.

Camshaft Bearings

NOTE: *Engine must be removed for camshaft bearing service.*

Replacement

(1) With camshaft and flywheel/drive plate removed, drive out expansion plug from rear cam bearing from inside block.

(2) Using Bearing Remover J-21473-1, drive front bearing toward rear and rear bearing toward front.

(3) Install extension J-21054-1 and drive center bearing out toward rear (fig. 1B-14).

(4) Position replacement bearing on tool and install.

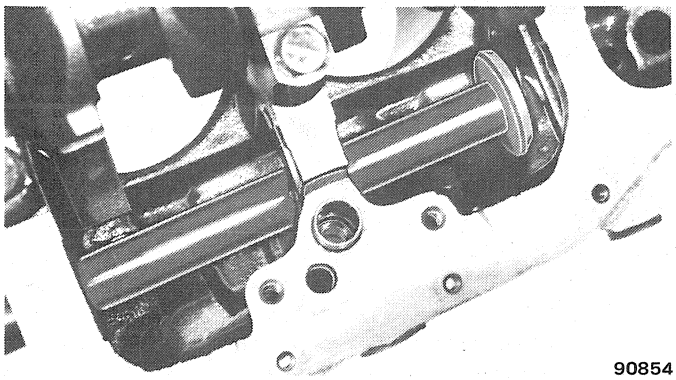

Fig. 1B-14 Removing Center Camshaft Bearing—Typical

NOTE: *Install bearings by reversing procedure listed above. Ensure oil holes are aligned.*

NOTE: *The front bearing must be driven approximately 1/8 inch (3.2 mm) behind front of cylinder block to expose oil hole for timing gear oil nozzle.*

HYDRAULIC VALVE TAPPETS

Hydraulic valve tappets are used to keep all parts of the valve train in constant contact. Each tappet automatically adjusts to maintain zero lash under all conditions.

The hydraulic tappet assembly (fig. 1B-15) consists of a steel body, plunger, push rod seat, metering valve, plunger spring, ball check valve and spring, ball check valve retainer, and retainer ring.

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

The operating cycle of the hydraulic tappet begins when the tappet is on the heel 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. 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, pressurized oil flows around the metering disc, which controls the amount of oil that flows up the push rod 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 transmitted 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 (leak-down). The cycle is completed as the cam lobe rotates back to the starting position and another charging cycle begins. In this way, zero valve lash is maintained.

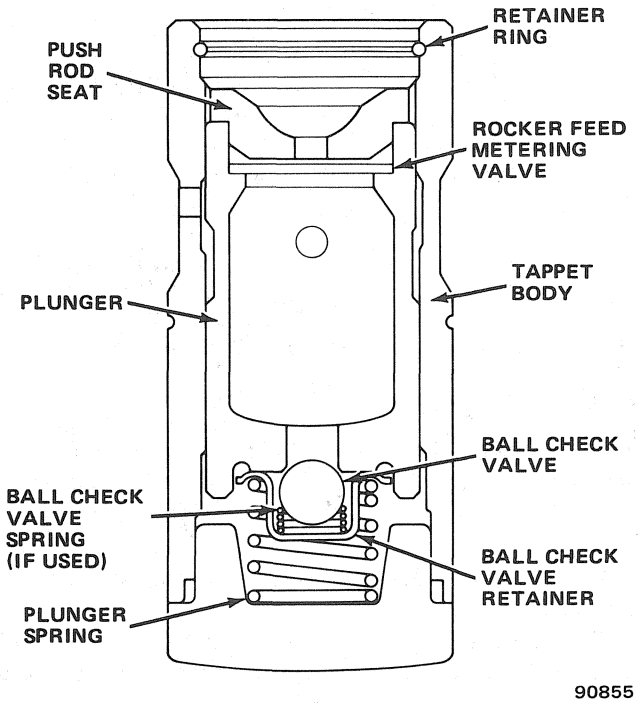

Fig. 1B-15 Hydraulic Valve Tappet

Replacement

(1) Remove cylinder head cover, intake manifold and push rod cover. Refer to removal procedures.

(2) Loosen rocker arm and rotate for access clearance to push rod.

(3) Remove push rod and valve tappet. Hydraulic Valve Tappet Remover J-3049 will facilitate removal of tappet.

NOTE: *If a replacement tappet is to be installed, ensure that all sealer coating is removed from inside of replacement tappet and test for correct leak-down rate.*

Disassembly

Because of the important function that hydraulic valve tappets have in the operation of an engine and the close manufacturing tolerances, proper handling, and above all, cleanliness, cannot be overstressed when servicing the components.

New tappets are serviced as individual units packaged with a plastic coating. Do not remove coating until ready to test the leak-down rate. It is not necessary to remove the oil from replacement tappets prior to testing the leak-down rate because it is special leak-down test oil.

Valve Tappet Cleaning Tank J-5821 is recommended for cleaning valve tappets. The tank should only be used for cleaning valve tappets and should be kept covered when not in use. All servicing should be done in an area isolated from grinders and other sources of dust and foreign material.

Tappets should at all times be stored in a covered box that will maintain them in a clean condition. The box should be kept dry and as free of oil as possible.

(1) Remove push rod seat retainer ring by holding seat down with push rod while dislodging ring from tappet body with pointed tool (fig. 1B-16).

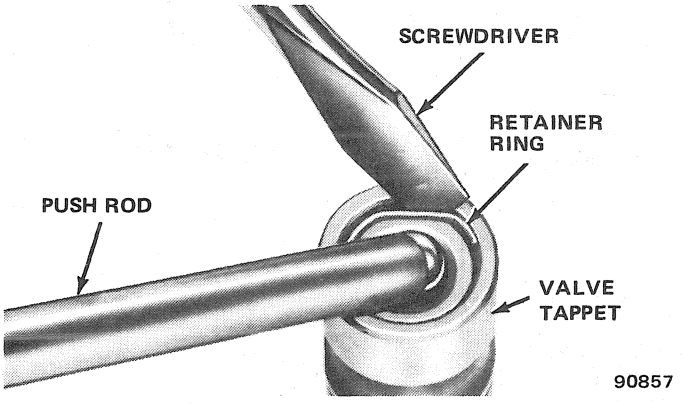

Fig. 1B-16 Removing Push Rod Seat Retainer

(2) Invert tappet and allow push rod seat and plunger to slide out of body. If plunger sticks in body, place tappet in large end of hydraulic valve tappet plunger remover Tool (J-4160) with push rod end of tappet downward. Hold tool firmly in hand with thumb over tappet body and sharply strike tool against block of wood until plunger falls out.

NOTE: *It may be necessary to soak a tappet that has a stuck plunger in cleaning solvent for several minutes before plunger can be removed.*

(3) With oil drained from tappet bodies, place all components of each tappet assembly in separate compartment of tray.

NOTE: *The valve tappet body and plunger are selectively fitted and must not be interchanged with other tappets. Also, keeping all components of each tappet separate will aid in trouble diagnosis.*

Cleaning and Inspection

Thoroughly clean and inspect tappet surfaces for nicks, scratches and scores. Inspection of the check ball and seat should be done with a magnifying glass. The tappet base should also be inspected for wear. If heavy wear is indicated on the cam mating surface, the same lobe of the cam should also be examined. Always clean tappets using only approved solvent and a soft brush. Never use a wire brush or sand paper.

Assembly

All components must be absolutely clean when assembling a hydraulic valve tappet. Because lint and dust may adhere to the components, they should not be dried with compressed air or wiped with a cloth. All parts should be rinsed in clean kerosene and assembled without drying. A small container with clean kerosene (separate from cleaning tank) should be used for each set of tappets being overhauled.

Figure 1B-17 illustrates the relative position of the components of a valve tappet. The recommended assembly procedure is listed in the following steps.

(1) Rinse plunger spring and ball retainer and position retainer in spring.

(2) Rinse tappet ball and place it and small spring in retainer.

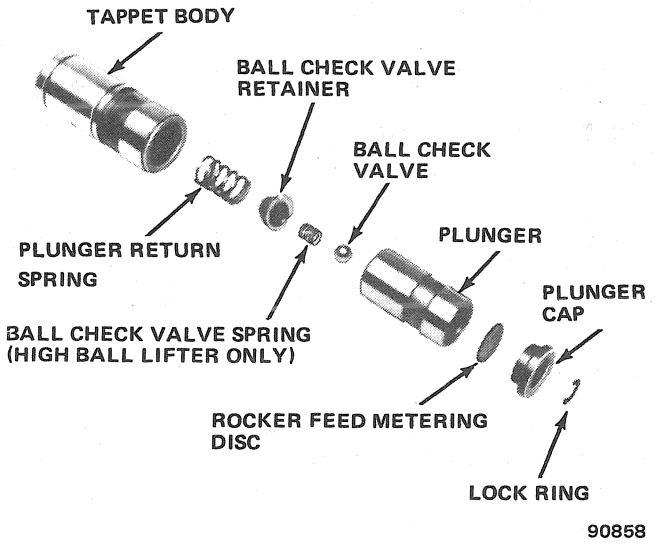

Fig. 1B-17 Hydraulic Valve Tappet—Exploded View

(3) Rinse plunger and place on retainer so that seat on plunger mates with ball.

(4) Invert plunger with parts assembled thus far and, after rinsing tappet body, position body over spring and plunger.

(5) Place tappet body on clean paper, rinse and install push rod seat and retainer ring.

(6) After tappet has been assembled, place in tappet box and close lid to preserve cleanliness.

Leak-Down Test

After all tappets have been assembled, the leak-down rate must be tested before they are installed in the engine. Hydraulic Valve Tappet Leak-Down Tester J-5790 (fig. 1B-18) is designed for testing the leak-down rate of tappets to determine whether or not they are within the specified limits. As with previous service operations involving tappets, cleanliness is paramount. The tester cup and ram should be thoroughly cleaned and testing should be done in an area free of dust and dirt. The testing procedure is described in the following steps:

(1) Fill tester cup to approximately one inch from top with special fluid (J-5268 or equivalent) that is available from tester manufacturer.

(2) Swing weight arm up out of way, raise ram, and position tappet into boss in center of tester cup.

(3) Adjust ram (with weight arm clear of ram) so that pointer is positioned at set line (marked "S"). Tighten jamnut to maintain set position.

(4) Operate tappet through full travel of plunger by pumping weight arm to fill tappet with test fluid and force out air (tappet must be completely submerged at all times). Continue pumping for several strokes after definite resistance is detected.

(5) Raise weight arm to allow plunger spring to expand fully; lower arm onto ram and turn handle slowly (1 revolution every 2 seconds).

Time indicator travel from lower line (first line above set line) to line marked 0.094 or 3/32 inch (2.39 mm), while still rotating cup with handle (fig. 1B-18). Tappet is satisfactory if leak-down interval is between 12 and 90 seconds.

Installation

(1) Place each tappet in original tappet boss.

(2) Replace push rods.

(3) Position rocker arms and pivot balls on push rods.

(4) With tappet on base circle (heel) of camshaft, tighten each rocker arm capscrew with 20 foot-pounds (27 N•m) torque. Do not over tighten.

(5) Replace push rod cover.

(6) Install intake manifold.

(7) Install cylinder head cover.

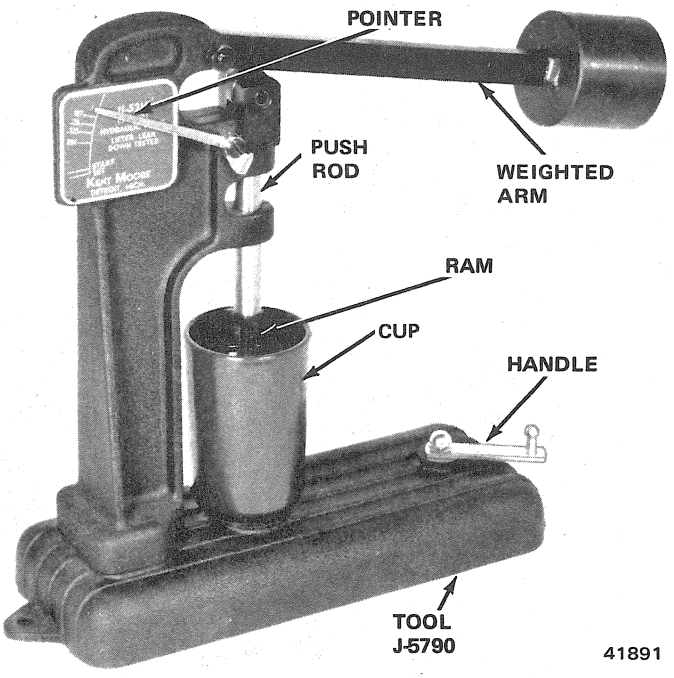

Fig. 1B-18 Testing Leak-Down Rate

CRANKSHAFT VIBRATION DAMPER PULLEY HUB AND OIL SEAL REPLACEMENT

(1) Remove drive belts.

(2) Remove center bolt and slide damper and hub from shaft.

(3) Carefully pry oil seal from front cover with a large screwdriver. Do not bend or distort sheet metal cover.

(4) Install new seal with helical lip toward rear of engine. Drive seal carefully into place using Tool J-23042.

(5) Coat oil seal contact area of vibration damper with engine oil.

(6) Position hub on crankshaft and slide into position until it contacts crankshaft gear.

(7) Install center bolt and tighten with 160 foot-pounds (212 N•m) torque.

(8) Install belts and adjust tensions. Refer to Chapter 1C—Cooling Systems for procedures.

NOTE: *Damper-to-hub bolts should have a locking agent applied to their threads. Coat threads with Drylock 299, or equivalent, before installing.*

TIMING CASE COVER REPLACEMENT

(1) Remove battery negative cable.

(2) Remove crankshaft vibration damper pulley hub. Refer to Crankshaft Vibration Damper Pulley Hub Replacement.

(3) Remove alternator bracket.

(4) Remove fan and shroud nuts. Loosen belts. Remove fan and shroud.

(5) Remove oil pan-to-timing case cover screws.

(6) Pull cover slightly forward only enough to permit cutting of oil pan front seal.

(7) Using sharp knife or other suitable cutting tool, cut oil pan front seal flush with cylinder block at both sides of cover (fig. 1B-19).

(8) Remove front cover and attached portion of oil pan front seal. Remove front cover gasket.

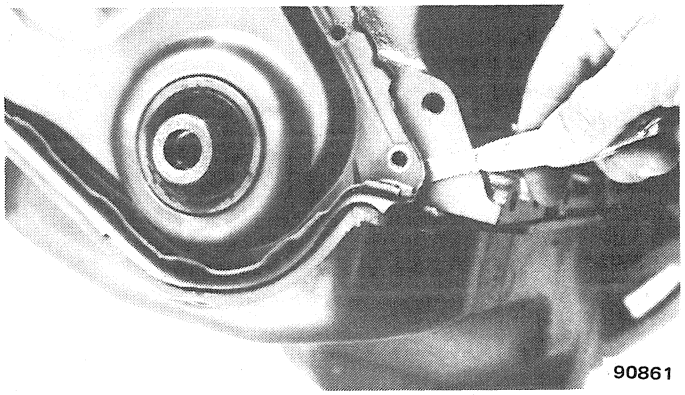

Fig. 1B-19 Cutting Pan Gasket

(9) Clean gasket surfaces on block and timing case cover.

(10) Cut tabs from replacement oil pan front seal (fig. 1B-20). Use sharp instrument to ensure clean cut.

(11) Install seal on timing gear cover. Press tips into holes provided in cover.

(12) Coat gasket with gasket sealer and place in position on cover.

(13) Apply 1/8-inch (3 mm) bead of RTV sealant to joint formed at oil pan and cylinder block (fig. 1B-21).

(14) Install Alignment Tool J-23042 in timing case cover seal (fig. 1B-22).

NOTE: *It is important that an alignment tool be used to align the timing case cover so that vibration damper hub installation will not damage seal and to ensure that seal is positioned evenly around hub.*

(15) Position timing case cover on block. Insert and partially tighten two oil pan-to-timing case cover screws.

(16) Install timing case cover-to-block attaching screws.

(17) Tighten all cover attaching screws to specifications and remove centering Tool J-23042.

(18) Install alternator bracket.

(19) Install pulley hub. Refer to Crankshaft Vibration Damper Pulley Hub Replacement.

(20) Install fan and shroud.

NOTE: *The fan assembly and pulleys must be installed with the drive belts in position on pulleys. Tighten attaching nuts with 18 foot-pounds (34 N•m) torque.*

(21) Tighten belts.

(22) Connect battery negative cable.

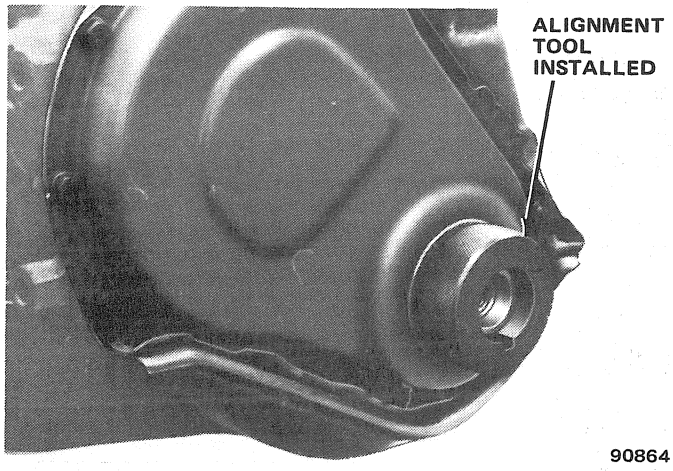

Fig. 1B-20 Oil Pan Seal Modification

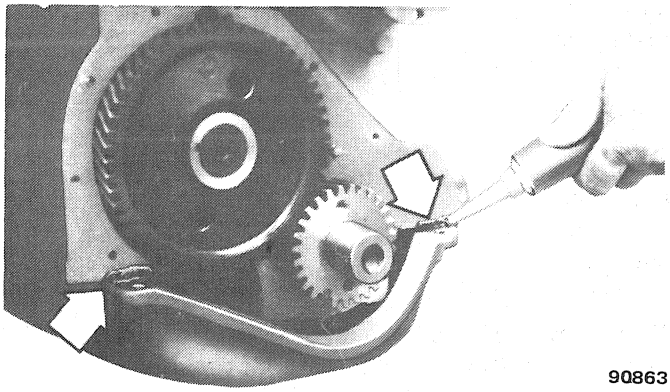

Fig. 1B-21 Applying RTV Sealant

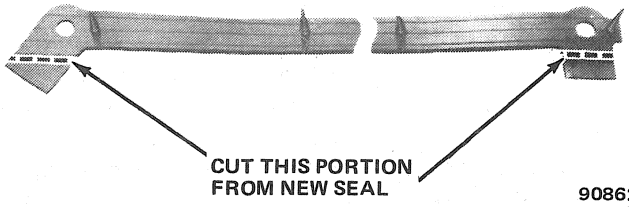

Fig. 1B-22 Timing Case Cover Alignment Tool Installed

INTAKE MANIFOLD

The intake manifold is cast aluminum and has a single level design. A cast passage in the manifold allows engine coolant to pass through to utilize hot coolant heat to warm the manifold and carburetor. This results in better fuel vaporization. An EGR port is also cast in the manifold and receives exhaust gas from an internal exhaust passage through the cylinder head.

Intake Manifold Replacement

WARNING: *The battery negative cable must be removed to prevent a potential fire hazard when the fuel pipe is disconnected.*

(1) Remove battery negative cable.
(2) Remove air cleaner and PCV valve hose.

WARNING: *DO NOT remove block drain plugs or loosen radiator draincock with system hot and under pressure because serious burns from coolant can occur.*

(3) Drain cooling system.

NOTE: *DO NOT WASTE reusable coolant. If solution is clean, drain into a clean container for reuse.*

(4) Tag and remove vacuum hoses (ensure distributor vacuum advance hose is removed).
(5) Disconnect fuel pipe and electrical wire connections from carburetor.
(6) Disconnect carburetor throttle linkage. Remove carburetor and carburetor spacer.
(7) Remove bellcrank and throttle linkage brackets and move to one side for clearance.
(8) Remove heater hose at intake manifold.
(9) Remove alternator. Note position of spacers for installation.
(10) Remove manifold-to-cylinder head bolts and remove manifold.
(11) Position replacement gasket and install replacement manifold on cylinder head. Start all bolts.
(12) Tighten manifold-to-cylinder head bolts using sequence illustrated in figure 1B-23. Tighten all bolts with 37 foot-pounds (50 N•m) torque.

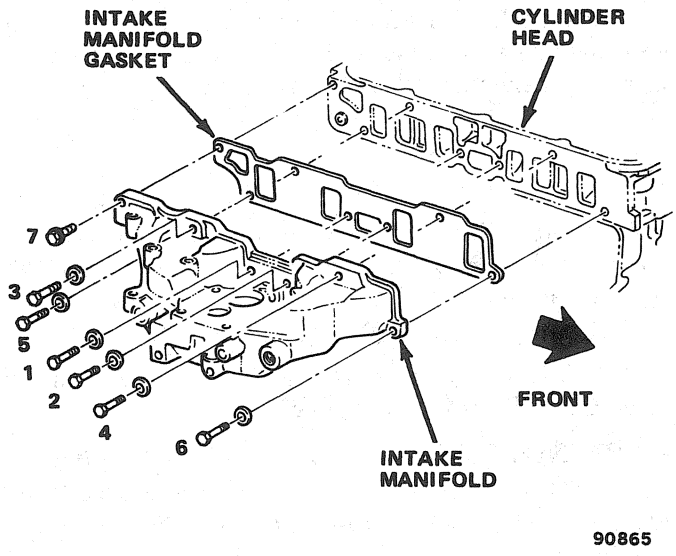

Fig. 1B-23 Intake Manifold Bolt Tightening Sequence

(13) Connect heater hose to intake manifold.
(14) Install bellcrank and throttle linkage brackets.
(15) Connect carburetor throttle linkage to brackets and bellcrank.
(16) Install carburetor spacer and tighten bolts with 15 foot-pounds (20 N•m) torque.
(17) Install carburetor and gasket. Tighten nuts with 15 foot-pounds (20 N•m) torque.
(18) Install fuel pipe and electrical wire connections. Install vacuum hoses.
(19) Install battery negative cable.

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.*

(20) Refill cooling system. Start engine and inspect for leaks.
(21) Install air cleaner and PCV valve hose.

EXHAUST MANIFOLD

The exhaust manifold is made of cast nodular iron. The manifold is equipped with a heat stove that is used to provide heated air for the carburetor air intake. This results in better fuel vaporization.

Exhaust Manifold Replacement

(1) Remove air cleaner and heated air tube.
(2) Remove engine oil dipstick tube attaching bolt.
(3) Remove oxygen sensor, if equipped.
(4) Raise vehicle and disconnect exhaust pipe from manifold. Lower vehicle.
(5) Remove exhaust manifold bolts and remove manifold and gasket.
(6) Install replacement gasket and exhaust manifold on cylinder head. Tighten all bolts with 39 foot-pounds (52 N•m) torque in the sequence illustrated in figure 1B-24.
(7) Install dipstick tube attaching bolt.

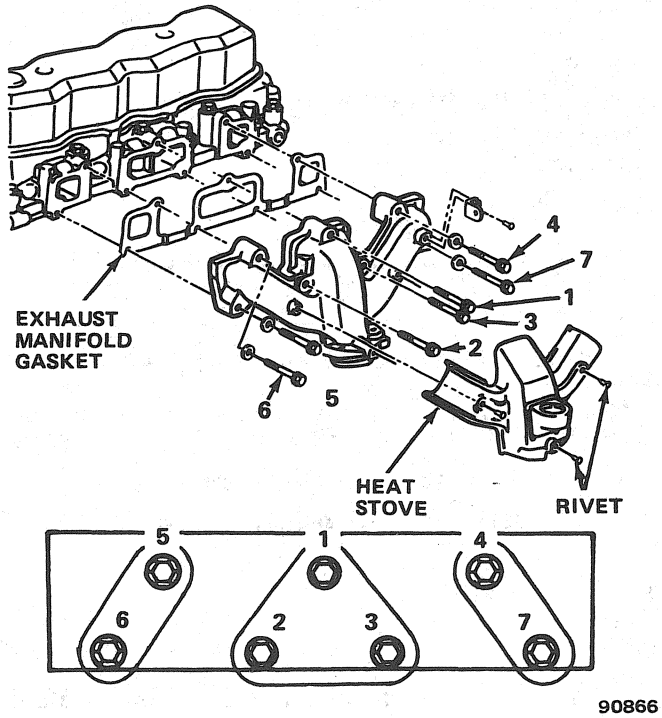

Fig. 1B-24 Exhaust Manifold Tightening Sequence

(8) Install heated air tube and air cleaner.
(9) Install oxygen sensor, if removed.
(10) Raise vehicle and connect exhaust pipe to manifold. Tighten bolts with 35 foot-pounds (50 N•m) torque. Lower vehicle.

CYLINDER HEAD COVER

Removal

(1) Remove air cleaner.
(2) Remove PCV valve (or hose).
(3) Remove cylinder head cover bolts.
(4) Remove spark plug wires from spark plugs and bracket clips.
(5) Remove cylinder head cover by tapping with a rubber hammer to loosen RTV gasket seal. Do not pry on cover.

Installation

(1) Thoroughly clean sealing surfaces on cylinder head cover and cylinder head.
(2) Apply continuous 3/16-inch (5 mm) diameter bead of RTV sealant on cylinder head cover as illustrated in figure 1B-25.
(3) Position cover on head, install retaining bolts and tighten with 7 foot-pounds (10 N•m) torque.
(4) Install spark plug wires, PCV valve (or hose) and air cleaner.

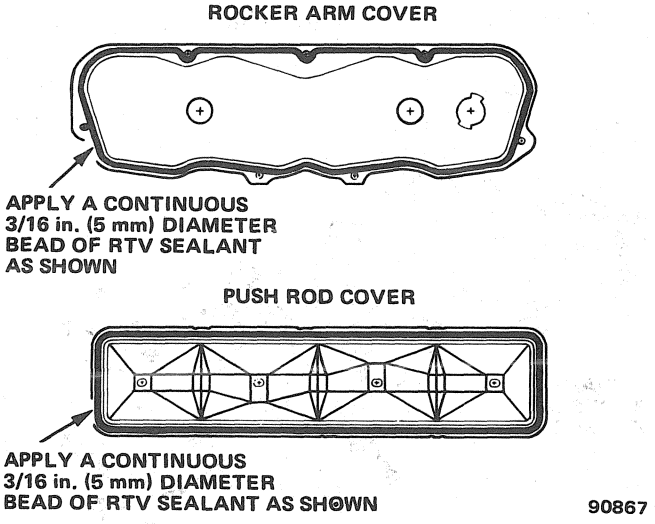

Fig. 1B-25 Cylinder Head Cover and Push Rod Cover RTV Sealant Application

PUSH ROD COVER

Removal

(1) Remove intake manifold. Refer to Intake Manifold for replacement procedure.
(2) Remove push rod cover bolts and remove cover.

Installation

(1) Thoroughly clean sealing surfaces on push rod cover and cylinder block.
(2) Apply continuous 3/16-inch (5 mm) bead of RTV sealant on push rod cover as illustrated in figure 1B-25.
(3) Install cover and cover-to-block bolts. Tighten bolts with 75 inch-pounds (9 N•m) torque.
(4) Install intake manifold. Refer to Intake Manifold for replacement procedure.

CYLINDER HEAD

The cast iron cylinder head is designed to provide a compression ratio of 8.3:1. It is cast with individual intake and exhaust ports for each cylinder. The valve guides are cast integral with the head and the rocker arms are retained on individual threaded studs. The combustion chambers are cast to ensure uniform shape for all cylinders. The spark plugs are located near the intake valves to provide maximum combustion efficiency. The intake valves have 46 degree seat angles and are large to provide sufficient air/fuel intake for high power requirements. The exhaust valve seat angle is also 46 degrees. The 46 degree seat angle assures valve-to-seat contact at the outer diameter of the seat.

External shields are used on both the intake and exhaust valves to reduce the amount of oil splashed against the stems. Valve stem seals are also used on both the intake and exhaust valves to prevent oil from entering the valve guides. The face angles of both the intake and exhaust valves are 45 degrees.

Removal

WARNING: *The battery negative cable must be removed to prevent a potential fire hazard when the fuel pipe is disconnected.*

(1) Disconnect battery negative cable.
(2) Remove cylinder head cover. Refer to Cylinder Head Cover Removal for procedure.

WARNING: *DO NOT remove block drain plugs or loosen radiator draincock with system hot and under pressure because serious burns from coolant can occur.*

(3) Drain block.

NOTE: *DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.*

(4) Remove exhaust pipe.
(5) Tag and disconnect vacuum hoses.

NOTE: *Ensure vacuum advance hose is tagged and disconnected.*

(6) Remove alternator and put aside. Do not misplace spacers.

(7) Disconnect fuel pipe from carburetor. Move pipe over and align with opening in intake manifold to facilitate cylinder head removal.

(8) Remove rear heater hose and upper radiator hose.

(9) Remove power steering pump and bracket assembly.

NOTE: *Do not disconnect power steering hoses from pump or gear.*

(10) Remove dipstick.

(11) Remove rocker arm assemblies and push rods.

NOTE: *Note location of rocker arms to facilitate installation in their original locations.*

CAUTION: *To prevent slipping, use a 12 mm 12-point socket wrench to ensure a tight fit on the bolt heads.*

(12) Remove cylinder head bolts.

(13) Remove cylinder head by inserting pry bar into alternator bracket and prying upward.

Installation

The gasket mating surfaces on both the head and the block must be smooth and clean, i.e., no foreign matter, nicks or heavy scratches. The cylinder head bolt threads in the block and on the cylinder head bolts must also be clean, if not, bolt tightening torque will be inaccurate.

(1) Place replacement cylinder head gasket in position over dowel pins and flat on cylinder block.

(2) Carefully guide cylinder head into place over dowel pins and gasket.

(3) Coat underside of heads and threads of cylinder head bolts with sealing compound and install finger-tight.

CAUTION: *To prevent slipping, use a 12 mm 12-point socket wrench to ensure a tight fit on the bolt heads.*

(4) Tighten cylinder head bolts in steps following sequence depicted in figure 1B-26. The final torque is 92 foot-pounds (125 N•m).

(5) Install push rods, rocker arm assemblies and cylinder head cover. Tighten rocker arm capscrews with 20 foot-pounds (27 N•m) torque. Refer to Cylinder Head Cover for procedure.

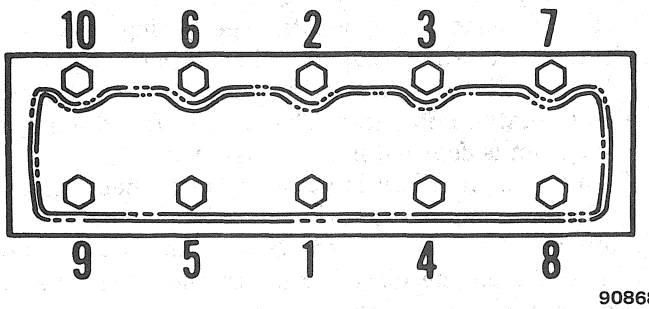

Fig. 1B-26 Cylinder Head Tightening Sequence

(6) Install power steering pump and bracket.

(7) Install alternator and tighten belt to specified tension. Refer to Chapter 1C—Cooling Systems for procedure.

(8) Connect fuel pipe to carburetor.

(9) Install heater hose and upper radiator hose, tighten clamps.

(10) Connect vacuum hoses.

(11) Install exhaust pipe. Tighten nuts with 18 foot-pounds (24 N•m) torque.

(12) Refill cooling system with coolant.

(13) Install dipstick.

(14) Connect battery negative cable.

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.*

(15) Start engine and inspect for leaks.

Valves and Seats

Reconditioning of valves and valve seats is very important because the seating of the valves must be precise for the engine to produce specified power and provide reliable performance.

Another important factor is the cooling of the valve heads. Close contact between each valve and its seat is imperative to ensure that the heat in the valve head will be properly transferred to the cylinder head.

Several different types of equipment are available for refacing valves and valve seats. The instructions provided by the manufacturer of the equipment being used should be carefully followed to attain proper results.

Regardless of the type of equipment used it is essential that valve bores be free from carbon and other foreign matter to ensure correct centering of the pilot in the guide.

Valve Guide Bores

Valves with oversize stems are available for both intake and exhaust valves. Guides should be reamed and replacement oversize valves installed whenever clearances exceed specifications.

Cylinder Head Disassembly

(1) With cylinder head removed, remove rocker arm capscrews, pivot balls and rocker arms. Install capscrews.

(2) Using Tool J-5892-1, compress each valve spring and remove locks. Release tool and remove spring cap, spring shield, spring, and oil seal. Wash all parts in cleaning solvent and dry thoroughly.

(3) Remove valves from cylinder head and place in rack in proper sequence to facilitate assembly in their original positions.

(4) Clean all carbon from combustion chambers and valve ports.

(5) Thoroughly clean valve guides using Tool J-8101.

(6) Clean all carbon and sludge from push rods and rocker arms.

(7) Clean valve stems and head on buffing wheel. Inspect valves for burned heads, cracked faces and damaged stems.

(8) Remove carbon and other deposits from head gasket mating surfaces.

(9) Inspect cylinder head for cracks in exhaust ports, combustion chambers, and external cracks in water jacket.

(10) Measure fit of valve stems in their respective guides.

NOTE: *Excessive valve stem-to-guide clearance will cause reduced power, rough idling and noisy valves, and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and cause rough idling.*

(a) Using a micrometer, measure diameter of valve stem in three places; top, center and bottom. Exhaust valves have tapered stems and are approximately 0.001-inch (0.025 mm) larger at top of stem than at head end.

(b) Insert telescoping gauge in valve guide bore to measure valve-to-valve guide clearance (fig. 1B-27).

(c) If clearance is not within specified limits, use next oversize valve stem size and ream bore to fit using suitable reamer with Tool J-5830-02. Service valves are available with standard, 0.003-inch (0.076 mm) and 0.005-inch (0.127 mm) oversize stem diameters.

(11) Test valve spring tension with suitable tester. Refer to Valve Spring Tension Testing.

NOTE: *Springs should be tested by compressing to a specified height, and measuring force required to maintain that height. (See Specifications.) Weak springs should be replaced if not within 10 force-pounds (44 N) of the specified load (without dampers).*

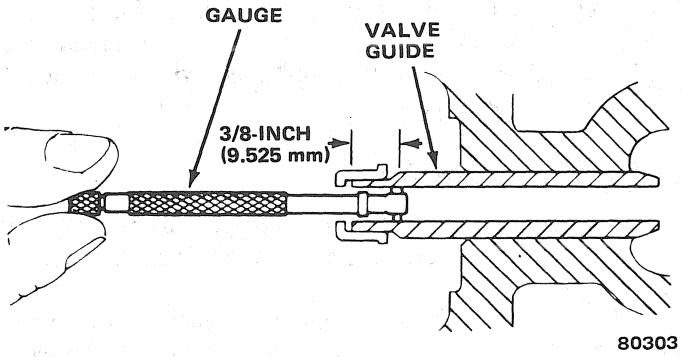

Fig. 1B-27 Measuring Valve Guide Bore with Telescoping Gauge

Cylinder Head Assembly

(1) Insert valve in original port.

(2) Assemble valve spring and related parts according to following procedure:

(a) Set valve spring, shield and cap in place.

(b) Compress spring with Tool J-5892-1.

(c) With Tool J-22330 install oil seal in lower groove of stem. Ensure seal is flat and not twisted.

(d) Install locks and release compressing tool. Ensure locks are seated properly in upper groove of valve stem.

(3) Install remaining valves according to procedure described above.

(4) Test each valve stem oil seal by placing Valve Seal Installer and Tester Tool J-22330 over end of valve stem and against cap.

(5) Measure installed height of valve springs using a narrow, thin scale. Use of a cutaway scale will help. Measure from top of spring seat to top of valve spring or oil shield. If spring exceeds specified height, install 1/16-inch (1.59 mm) valve spring seat shim.

CAUTION: *Never shim a spring excessively. Installed height should never be less than specified minimum height.*

ENGINE LUBRICATION SYSTEM

Engine lubrication is accomplished through a gear type pump that pumps engine oil from the oil pan sump, through the full flow oil filter and into an oil passage that runs along the right side of the block and intersects the hydraulic valve tappet bores. Oil from this passage is routed to the crankshaft main and camshaft bearings through smaller drilled passages. Oil is supplied to the rocker arms through holes in the hydraulic valve tappets, which force oil up through the tubular push rods to the rocker arms. The oil is metered by a disc located within each tappet body.

Two valves are incorporated into the lubrication system to ensure the proper flow of oil. A bypass valve is located within the oil filter mounting boss that will continue oil flow in the event that the filter becomes clogged or restricted. The pressure regulator valve located in the oil pump body maintains adequate pressure for the lubrication system and bypasses any excess oil back to the oil pan sump.

Many internal engine parts have no direct oil source and are either gravity or splash lubricated from other directly lubricated components. The timing gears are lubricated by oil that is supplied through a passage from the front of the camshaft to a calibrated nozzle above the crankshaft timing gear. The engine lubrication system diagram is depicted in figure 1B-28.

A full flow oil filter is standard equipment on the engine and is mounted on the right side of the engine. All oil from the pump passes through the filter before going to the engine oil galleries. In the filter, the oil passes through a filtering element that removes foreign particles.

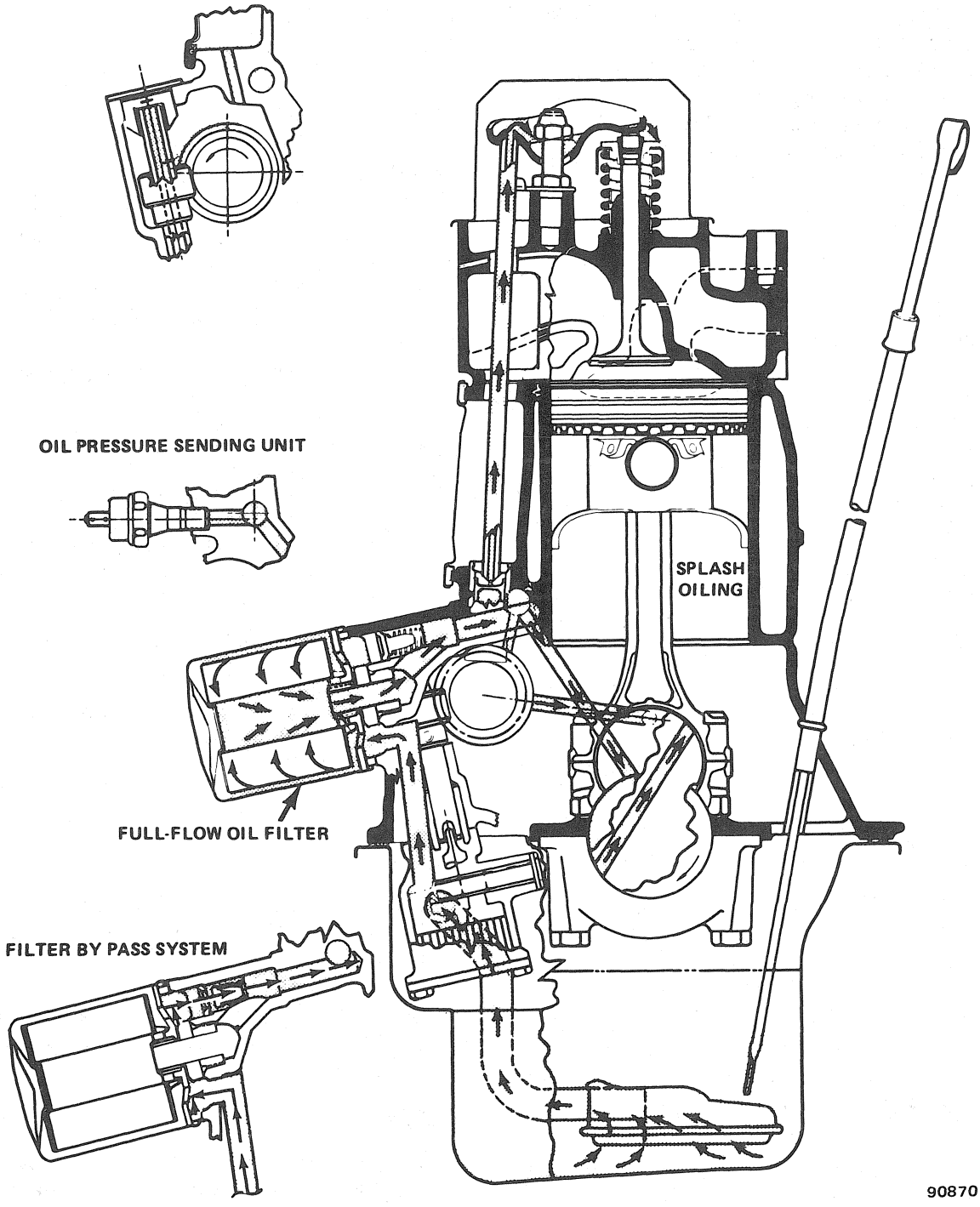

Fig. 1B-28 Engine Lubrication System Diagram

Oil Pump Drive Shaft

Removal

(1) Remove alternator and upper bracket.

(2) Remove oil pump drive shaft retainer plate bolts and remove bushing and shaft assembly.

Installation

(1) Install oil pump drive shaft assembly by turning shaft until it meshes with camshaft drive gear and inserts properly in oil pump body.

(2) Thoroughly clean sealing surfaces on cylinder block and retainer plate.

(3) Apply 1/16-inch (1.6 mm) diameter bead of RTV sealant to oil pump drive shaft retainer plate.

(4) Install retainer plate with bolts and tighten with 10 foot-pounds (14 N•m) torque.

(5) Install upper alternator bracket and alternator. Adjust belt tension. Refer to Chapter 1C—Cooling Systems for procedure.

Oil Pump

Removal

(1) Drain oil and remove oil pan. Refer to Oil Pan Removal for procedure.

(2) Remove two flange mounting bolts and nut from main bearing cap bolt and remove oil pump and pickup assembly as unit.

Disassembly

(1) Remove cover attaching screws, cover, idler gear and drive gear and shaft (fig. 1B-29).

(2) Remove pressure regulator valve and valve parts.

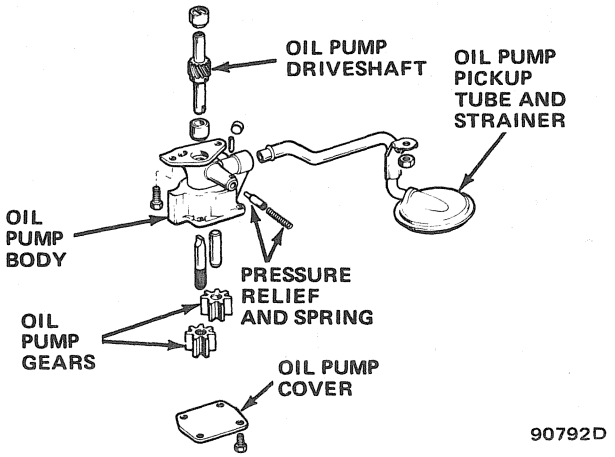

Fig. 1B-29 Oil Pump—Exploded View

NOTE: *Do not disturb oil pickup pipe on strainer screen or body. This pipe is attached during factory assembly.*

(3) If any of the following discrepancies are observed during inspection, complete pump assembly should be replaced.

(a) Pump body has cracks or excessive wear.

(b) Pump gears have cracks, excessive wear and damage.

(c) Shaft is loose in housing.

(d) Inside of cover has wear that would permit oil to leak past ends of gears.

(e) Oil pick-up assembly has damage to strainer screen or relief grommet.

NOTE: *If present, remove debris from strainer screen surface.*

(f) Pressure regulator valve plunger does not fit properly in body.

Assembly

(1) Place drive gear and shaft in pump body.

(2) Install idler gear so that smooth side of gear will be toward cover.

(3) Install cover and attaching screws. Tighten screws with 9 foot-pounds (17 N•m) torque and ensure that shaft turns freely.

(4) Install regulator valve plunger, spring, retainer and pin.

Installation

(1) Position oil pump gear shaft tang to align with oil pump drive shaft slot. Install oil pump-to-block positioning flange over oil pump drive shaft lower bushing. Do not use gasket. Tighten bolts with 18 foot-pounds (25 N•m) torque.

NOTE: *Oil pump should slide easily into place. If not, remove shaft and relocate slot.*

(2) Install oil pan using new gaskets and seals. Refer to Oil Pan Installation for procedure.

Oil Pan

Removal

(1) Remove battery negative cable.

(2) Raise vehicle and drain engine oil from oil pan.

(3) Remove starter motor.

(4) Remove oil pan.

(5) Thoroughly clean gasket surfaces of oil pan and cylinder block. Remove all sludge and debris from oil pan sump.

Installation

(1) Install rear oil pan gasket in rear main bearing cap and apply small quantity of RTV sealant in depression where pan gasket contacts block.

(2) Position gasket on oil pan. Apply 1/8 x 1/4-inch (3 x 6 mm) bead of RTV sealant at split lines of front and side gasket.

(3) Position oil pan. Insert and tighten screws with 45 inch-pounds (5 N•m) torque.

(4) Install starter motor. Tighten 3/8-inch bolts with 17 foot-pounds (24 N•m) torque. Tighten nut with 40 inch-pounds (4.5 N•m) torque. Connect battery cable and solenoid wire to starter motor solenoid.

(5) Lower vehicle.

(6) Connect battery negative cable. Refill crankcase with oil.

PISTONS AND CONNECTING RODS

The pistons are lightweight, cast aluminum with slipper skirt and cam ground so that the diameter across the thrust face is larger than the diameter fore and aft of the engine. Two compression rings and one oil control ring are used. All are located above the piston pin.

The piston pins are offset toward the thrust side (right-hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels within the cylinder. The piston pins are tempered steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

The connecting rods are made of Armasteel. Full pressure lubrication is directed to the connecting rods by drilled oil passages from the adjacent main bearing journal. Oil holes at the connecting rod journals are located so that oil is supplied to give maximum lubrication just prior to full bearing load.

Removal

(1) Remove cylinder head according to procedure described in Cylinder Head Removal.

(2) Remove oil pan according to procedure described in Oil Pan Removal.

(3) Remove ridge and/or deposits from upper end of cylinder bores with ridge reamer tool. Before ridge or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke and remove cloth and cuttings.

(4) Inspect connecting rod and piston for cylinder number identification and, if not identified, mark them.

(5) Remove bearing cap and install Connecting Rod Bolt Guide Set J-6305-11.

(6) Carefully remove connecting rod and piston assembly by pushing out with knurled handle of long guide.

Disassembly

CAUTION: *Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp rod or piston in vise because they may become distorted. Do not allow pistons to strike against one another, against hard objects or bench surfaces because distortion of piston contour or nicks in the soft aluminum material may result.*

(1) Remove piston rings using suitable piston ring removal tool.

(2) Install guide bushing of Piston Pin Removal and Installation Tool J-24086.

(3) Position piston and connecting rod assembly on support and place assembly on arbor press (fig. 1B-30).

(4) Press pin out of connecting rod with Piston Pin Removal Tool J-24086.

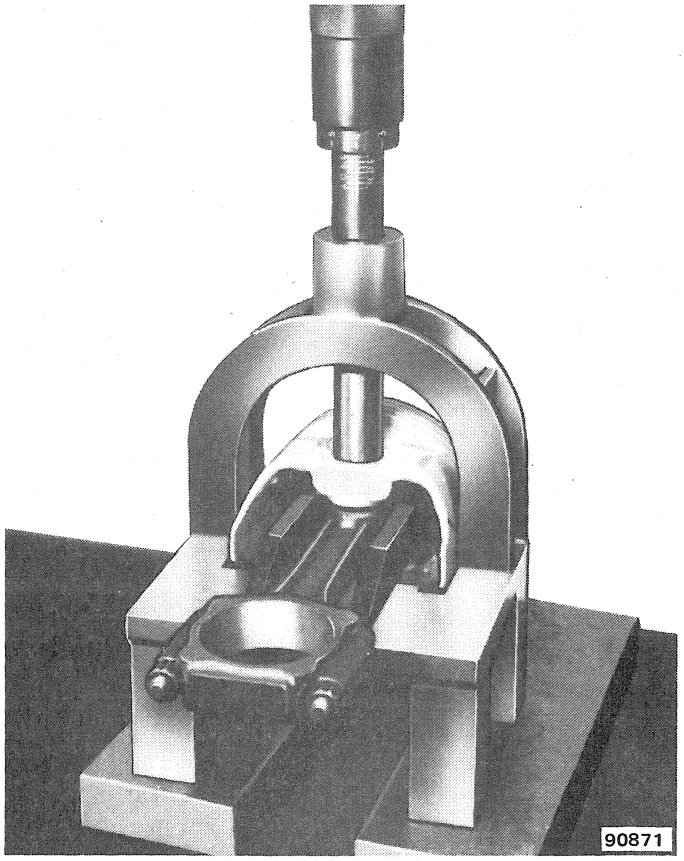

Fig. 1B-30 Removing Piston Pin

(5) Remove assembly from press, remove piston pin from support and remove tool from piston and rod.

(6) Clean carbon, varnish, and gum deposits from piston surfaces, including underside of piston head. Clean ring grooves and oil holes in oil ring groove with appropriate cleaning tools and solvent.

(7) Clean piston pin, rod, cap, bolts and nuts in appropriate solvent. Reinstall cap on connecting rod to prevent inadvertent mixing of caps and connecting rods.

(8) Carefully examine piston for rough or scored surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; and scored, galled, or worn piston bosses. Damaged or defective pistons should be replaced.

(9) Inspect piston pin for scoring, roughness, or uneven wear and proper fit.

(10) Inspect rod bearing inserts to ensure they are not damaged. Fit of bearings should be determined when engine is being assembled.

Assembly

There are two notches cast in the top of all piston heads to facilitate proper installation. The pistons should always be installed with the notches toward the front of the engine (fig. 1B-31).

(1) Lubricate piston pin holes in piston and connecting rod lightly with graphite lubricant.

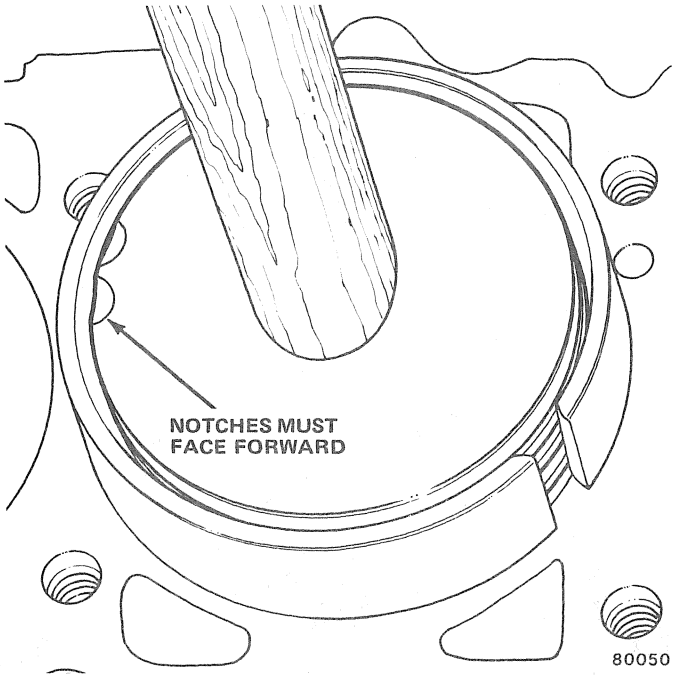

Fig. 1B-31 Installing Piston in Cylinder

(2) Position connecting rod in its original piston so that raised notch side of rod (fig. 1B-32) at bearing end is 180 degrees opposite notches in top of piston when installed.

(3) Position piston and rod on support, and insert pilot through piston and rod. Note positions of notches.

(4) Place support on arbor press, start pin into position and press on installation tool until guide bushing bottoms (fig. 1B-30).

(5) Remove installation tool and support assembly from piston and connecting rod assembly.

(6) Inspect piston pin for freedom of movement in piston bore.

(7) Install piston rings with appropriate installation tool. Refer to Piston Ring Installation for procedure.

Installation

(1) Install Connecting Rod Bolt Guide Set J-6305-11 on connecting rod bolts.

(2) Using appropriate piston ring compressor, insert rod and piston assembly into cylinder so that notches in top of piston is facing front of engine (fig. 1B-31).

(3) From beneath engine, position connecting rod with upper bearing insert in place against journal.

(4) Remove Guide Set J-6305-11 and install lower bearing insert and cap. Tighten capnuts with 30 foot-pounds (40 N•m) torque.

(5) Install oil pan.

(6) Install cylinder head, intake manifold and exhaust manifold.

(7) Connect fuel pipe and vacuum hoses to carburetor.

(8) Install push rods, place rocker arms in position and tighten rocker arm nuts. Do not over tighten nuts.

(9) Install cylinder head cover.

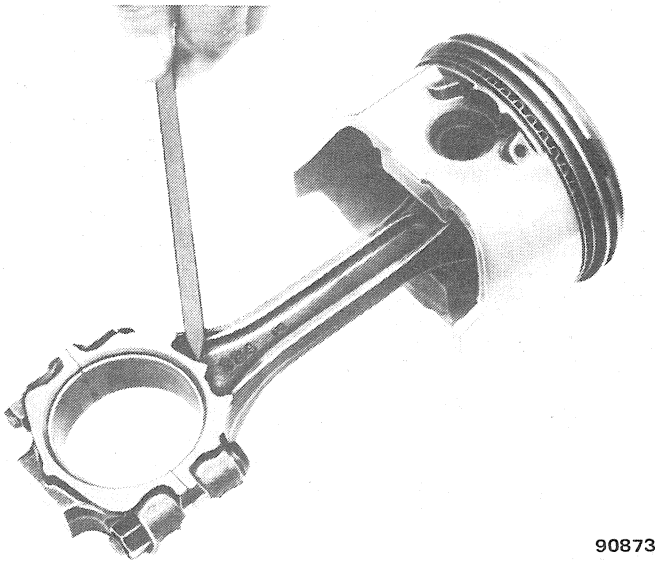

Fig. 1B-32 Raised Notch Location

Connecting Rod Bearings

The connecting rod bearings are the precision insert type and should be replaced if the clearances are excessive. Service bearings are available in standard size, 0.001-inch (0.025 mm), 0.002-inch (0.050 mm) and 0.010-inch (0.254 mm) undersize for use with replacement and remanufactured crankshafts.

Replacement and Inspection

Before removal of the connecting rod and cap, stamp the side of the connecting rod and cap with corresponding cylinder number to assure matched reassembly.

(1) With oil pan and oil pump removed, remove connecting rod cap and bearing.

(2) Inspect bearing inserts for evidence of wear or damage.

(3) Wipe bearings and journal clean of oil.

(4) Measure journal for out-of-round or taper with micrometer. If not within specification, replace or recondition crankshaft. If within specification and replacement bearing inserts are to be installed, measure maximum diameter of journal to determine required size of replacement bearing inserts.

(5) If within specification, measure replacement or original bearing clearances with Plastigage, or equivalent.

(6) If bearing is being fitted to out-of-round journal, allow for maximum diameter of journal. If bearing is fitted to minimum diameter and journal is out-of-round, interference between bearing and journal will result and rapid bearing failure will occur.

(a) Place strip of Plastigage on full width of journal on area that is contacted by bearing (parallel to crankshaft).

(b) Install bearing inserts in connecting rod and cap.

(c) Install rod and bearing cap and evenly tighten nuts with 30 foot-pounds (40 N•m) torque.

NOTE: *Do not turn the crankshaft with the Plastigage installed.*

(d) Remove bearing cap and, with scale on envelope, measure width of Plastigage strip at widest point (fig. 1B-33).

(e) If clearance exceeds specification, select correct replacement size bearing inserts and remeasure clearance.

NOTE: *Ensure that size of removed bearing is ascertained to determine correct size for replacement bearing inserts. If the clearance cannot be brought to specification, the journal must be ground undersize. If the journal is already at maximum undersize, the crankshaft must be replaced.*

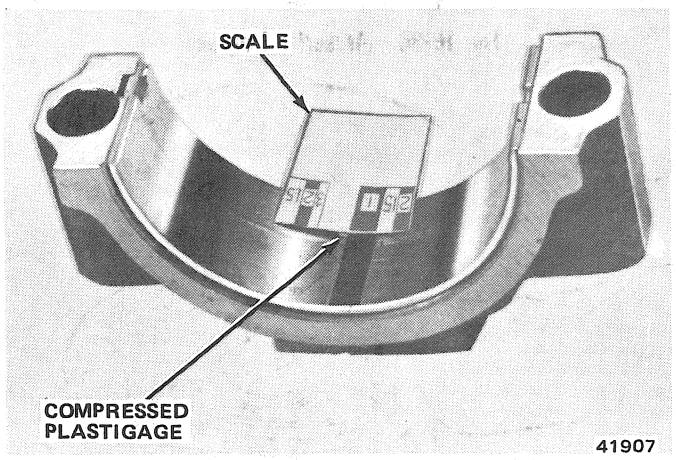

Fig. 1B-33 Connecting Rod Bearing Clearance Measurement with Plastigage

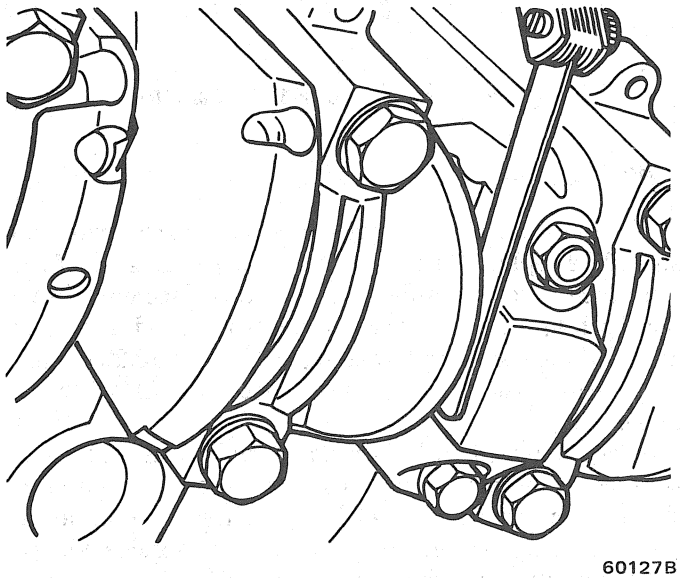

Fig. 1B-34 Measuring Connecting Rod Side Clearance

(7) Coat bearing surface with oil, install inserts, rod and bearing cap. Tighten nuts with 30 foot-pounds (40 N•m) torque.

(8) When all connecting rod bearings have been installed, tap each rod lightly (parallel with journal) to ensure they have correct clearance.

(9) Measure all connecting rod side clearances (refer to Specifications) between connecting rod caps (fig. 1B-34).

Piston Fit

Pistons should be fitted in the bores by actually measuring the fit (measure OD of piston at the measuring locations and ID of cylinder bore). Refer to engine specifications for correct clearances. If cylinder bores have been reconditioned, or if pistons are being replaced, reconditioning of bores and fitting of pistons should be closely coordinated.

If bore has been honed, it should be washed thoroughly with hot, soapy water and a stiff bristle brush. Thoroughly oil bores after washing.

Using a cylinder measurement gauge, measure the cylinder bore crosswise to the block to determine the smallest diameter. Record the smallest diameter of each bore.

NOTE: *When measuring cylinder bores and pistons, it is very important that the block and pistons be at room temperature. If any or all of the parts are warmer or cooler than normal room temperature, improper fitting will result.*

Measure the piston skirt perpendicular (90 degrees from) to the piston pin boss (piston pin removed) and at the measuring locations indicated in figure 1B-35.

NOTE: *Ensure the micrometer is in full contact.*

As the pistons are measured, they should be marked for size identification and the measurements recorded.

If there is excessive clearance between a cylinder bore and the piston that was originally installed, a replacement piston should be used. Replacement pistons are available in both standard size and oversize.

Because the sizes are nominal or basic sizes, it is important that replacement pistons be measured to ensure proper fit. All replacement pistons are equipped with selectively fitted piston pins.

After all measurements have been completed, match the replacement pistons with cylinders that will provide the correct clearance. Honing of the cylinder bore may be necessary to effect a proper fit. When properly mated, mark each piston with the matching cylinder number to ensure it will not become mis-matched.

Piston Pins

Piston pins normally do not become loose enough to cause a knock or tapping until after very high mileage accumulation on the engine and in such instances the piston and rod can be reamed and oversize pins installed.

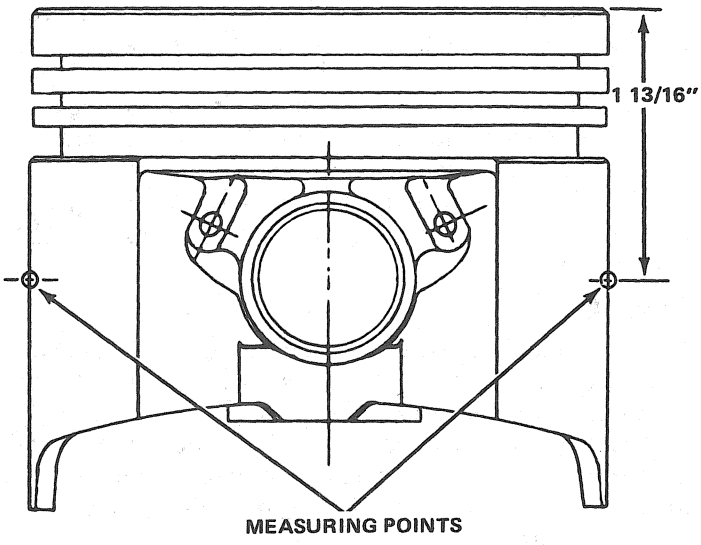

Fig. 1B-35 Piston Measurement Locations

The piston pin fit specification in the piston is 0.0002 to 0.0004 inch (0.005 to 0.010 mm) loose with pin and bosses clean and dry.

NOTE: *Piston and pin must be at room temperature when determining fit and pin must gravity-fall from the piston.*

Piston Rings

Installation

Replacement rings are available for standard size pistons and for 0.010-inch (0.254 mm) and 0.030-inch (0.762 mm) oversize pistons. When selecting rings, ensure they correspond to the size of the piston (i.e., standard rings for standard pistons, 0.010-inch oversize rings for 0.010-inch oversize pistons, etc.). Ring gap and side clearance should be measured when installing rings as follows:

(1) Inspect pistons to ensure that ring grooves and oil return holes have been properly cleaned.

(2) Place ring at lower end of ring travel area in cylinder bore. Level ring in bore by pushing it into position with inverted piston.

(3) Measure gap between ends of ring with feeler gauge (fig. 1B-36). Refer to Specifications.

NOTE: *An incorrect ring gap indicates that the wrong size rings are being used. If rings are selected according to the size of the bore, they should have the proper gap. It should not be necessary to alter ring gap by filing.*

(4) Install rings on piston with appropriate ring installation tool to prevent breakage or fracture of rings, or damage to pistons.

(5) Measure side clearance of rings in ring groove (fig. 1B-37). Refer to Specifications. If side clearance is excessive, piston must be replaced.

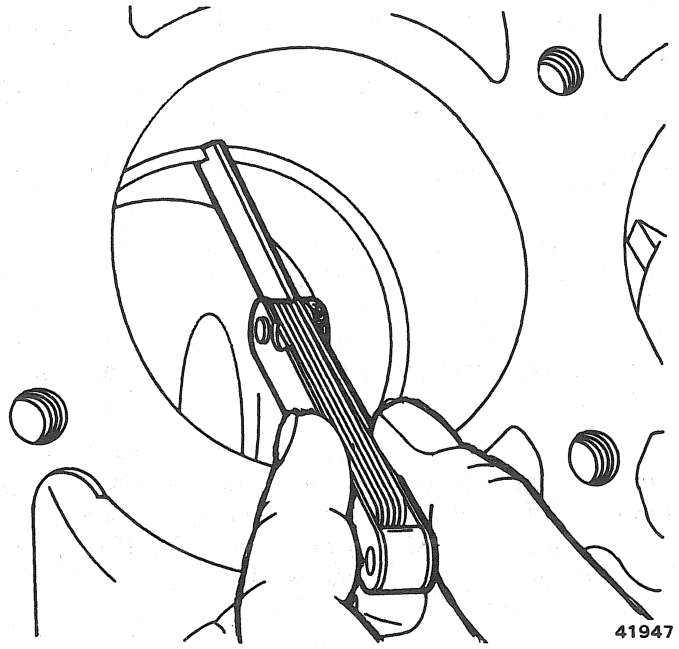

Fig. 1B-36 Measuring Ring Gap

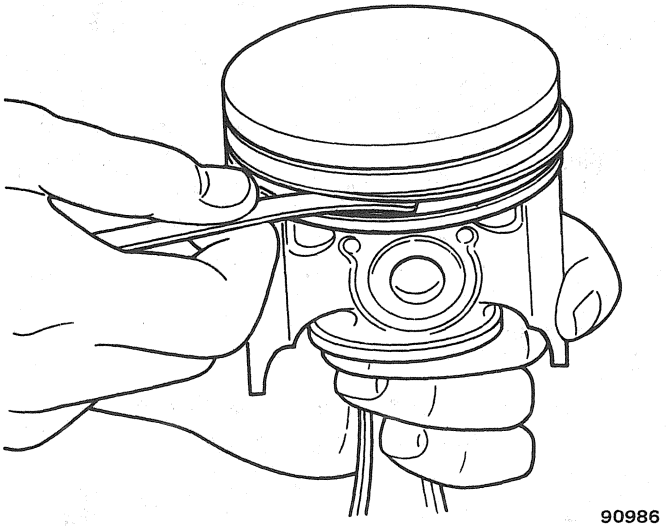

Fig. 1B-37 Ring Side Clearance Measurement

MAIN BEARINGS

The main bearings are the precision insert type and should be replaced if the clearances are excessive. If the clearance is found to be excessive, a replacement bearing, both upper and lower inserts, is required. Bearings are available in standard size, 0.001-inch (0.025 mm), 0.002-inch (0.051 mm), and 0.010-inch (0.254 mm) undersize.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason, a bearing may be comprised of a standard insert and a 0.001-inch (0.025 mm) undersize insert, which will decrease the clearance 0.0005 inch (0.013 mm) from that of two standard bearing inserts.

Inspection

In general, the lower insert (except No. 1 bearing) will have greater wear and the most distress from fatigue. If upon inspection the lower insert is suitable for use, it can be assumed that the upper insert is also satisfactory. If the lower insert has evidence of wear or damage, both upper and lower inserts should be replaced. Never replace one insert without replacing the other.

Clearance Measurement

To obtain the most accurate results with Plastigage, or equivalent, certain precautions must be observed. If the engine has been removed from the vehicle and turned upside down, the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing insert and journal. If the engine is installed in the vehicle, the crankshaft should be supported upward to remove the clearance from the upper bearing insert. The total clearance can then be measured between the lower bearing insert and journal.

To assure proper seating of the crankshaft, all bearing cap bolts must be tightened with the specified torque. In addition, before measuring the fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

(1) With oil pan and oil pump removed and starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.

(2) Place strip of Plastigage on full width of bearing surface area (parallel with crankshaft) on journal.

NOTE: *Do not rotate the crankshaft while the Plastigage is between the bearing and journal.*

(3) Install bearing cap and insert. Tighten retaining bolts evenly with 65 foot-pounds (88 N•m) torque.

(4) Remove bearing cap. Flattened Plastigage will be adhering to either bearing insert or journal.

(5) Without removing Plastigage, measure its compressed width (at the widest point) (fig. 1B-38).

NOTE: *Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal, fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter and the journal is out-of-round, interference between the bearing and journal will result and rapid bearing failure will occur. If the flattened Plastigage tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or an irregularity in the bearing or journal. Measure the journal with a micrometer if the flattened Plastigage indicates more than 0.0005-inch (0.013 mm) difference.*

(6) If bearing clearance is within specification, bearing inserts are satisfactory. If clearance is not within specification, replace inserts. Always replace both upper and lower inserts as a unit.

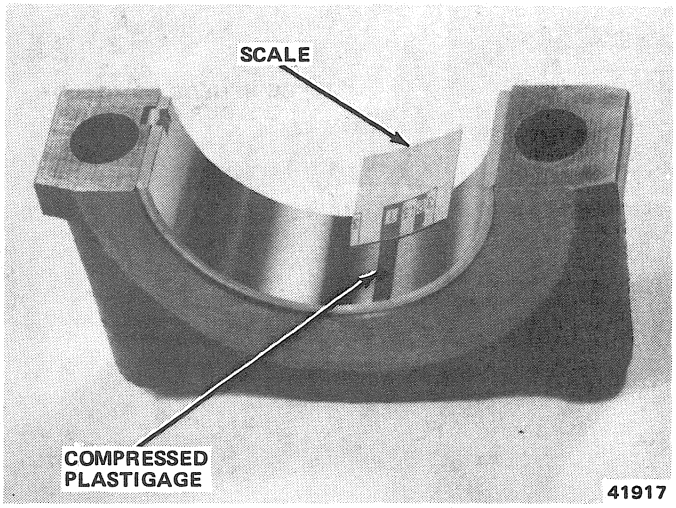

Fig. 1B-38 Measuring Bearing Clearance

(7) Standard 0.001-inch (0.254 mm) or 0.002-inch (0.508 mm) undersize bearing inserts should produce correct clearance.

(8) Proceed to next journal. After clearances of all journals and bearings have been measured, rotate crankshaft to ensure that there is no excessive drag.

(9) Measure crankshaft end play (refer to Specifications) by forcing crankshaft to extreme front position. Measure at front end of thrust bearing with feeler gauge.

Replacement

Main bearings may be replaced with either the crankshaft installed or removed from the engine.

Crankshaft Removed From Engine

(1) Remove and inspect crankshaft.

(2) Remove main bearing inserts from cylinder block and main bearing caps.

(3) Coat bearing surfaces of replacement main bearing inserts with oil and position in cylinder block and main bearing caps. Install crankshaft and caps with arrows pointing toward rear of engine. Tighten caps with 65 foot-pounds (88 N•m) torque.

Crankshaft Installed

(1) With oil pan, oil pump and spark plugs removed, remove cap from main bearing requiring replacement and remove lower bearing insert from cap.

(2) Insert upper main bearing insert removal and installation tool in oil hole in crankshaft journal. If tool is not available, tool (fig. 1B-39) may be fabricated from cotter pin by bending as required.

(3) Rotate crankshaft clockwise as viewed from front of engine. This will roll upper bearing insert out of block.

(4) Apply oil to replacement upper bearing insert and position plain (unnotched) end between crankshaft

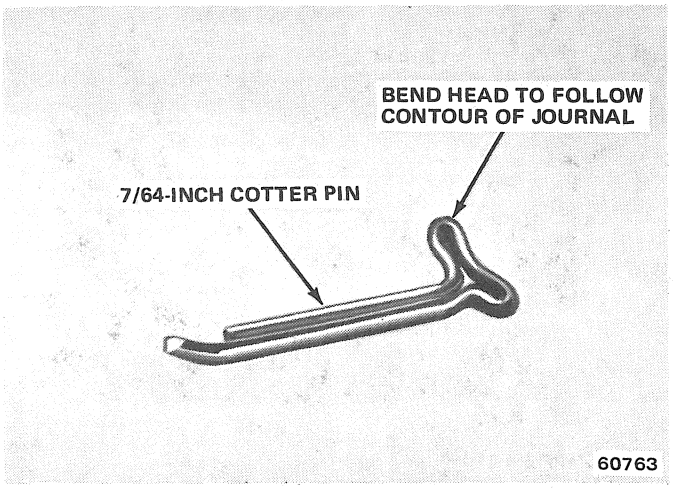

Fig. 1B-39 Fabricated Upper Main Bearing Insert Removal and Installation Tool

and indented or notched side of block. Rotate bearing into place and remove tool from oil hole in crankshaft journal.

(5) Apply oil to replacement lower bearing insert and install in bearing cap.

(6) Install main bearing cap with arrows pointing toward rear of engine.

(7) Tighten main bearing cap bolts with 65 foot-pounds (88 N•m) torque.

Rear Main Bearing Oil Seal Replacement

Removal

The rear main bearing oil seal is a one piece unit and can be removed and installed without removal of the oil pan or crankshaft.

(1) Disconnect battery negative cable.

(2) Raise vehicle.

(3) Remove transmission and transfer case as an assembly. Refer to Transmission Removal in Chapter 2B or 2C for procedure.

(4) Remove starter motor cable and solenoid wire. Remove starter motor.

(5) If manual transmission, remove inspection plate from flywheel housing.

(6) If manual transmission, remove hydraulic clutch slave cylinder from flywheel housing.

(7) Remove flywheel/drive plate housing bolts and housing from engine.

(8) If manual transmission, remove clutch pressure plate and disc assembly by loosening bolts 1/4 turn in equal amounts until pressure is relieved.

(9) Mark flywheel/drive plate location to facilitate correct assembly. Remove bolts and flywheel/drive plate.

(10) Using a small blade screwdriver, pry out rear main oil seal. Use care to prevent damaging seating groove or crankshaft.

Installation

(1) Center replacement seal over crankshaft with lip of seal facing toward front of engine. With a soft hammer (plastic), tap around perimeter of seal until it seats in groove. Use care to prevent seal from binding on crankshaft and not seating properly.

(2) Attach flywheel/drive plate to crankshaft and tighten bolts with 68 foot-pounds (93 N•m) torque.

(3) If manual transmission, install clutch pressure plate and disc assembly. Tighten bolts 1/4 turn in equal amounts until assembly is flush against flywheel. Tighten bolts with 18 foot-pounds (25 N•m) torque.

NOTE: *Use Alignment Tool J-5824-01, or equivalent, to align clutch disc prior to tightening bolts.*

(4) Install flywheel/drive plate housing and tighten bolts with 35 foot-pounds (47 N•m) torque.

(5) If manual transmission, install inspection plate on flywheel housing.

(6) If manual transmission, install hydraulic clutch slave cylinder on flywheel housing. Tighten bolts with 18 foot-pounds (25 N•m) torque.

(7) Install transmission/transfer case assembly. Refer to Chapter 2B for procedure.

(8) Install starter motor, cable and solenoid wire. Refer to Chapter 2B or 2C for procedure.

(9) Lower vehicle.

(10) Connect battery negative cable.

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.*

(11) Start engine and inspect for leaks.

CRANKSHAFT REPLACEMENT

Removal

(1) Remove engine from vehicle.

(2) Mount engine on suitable stand.

(3) Remove spark plugs.

(4) Remove fan and pulley.

(5) Remove crankshaft vibration damper and hub assembly.

(6) Remove oil pan and oil pump assembly.

(7) Remove timing case cover.

(8) Remove crankshaft timing gear.

(9) Remove connecting rod bearing caps and bearing inserts. Mark each for installation identity.

(10) Move connecting rod and piston assemblies away from crankshaft.

(11) Remove main bearing caps with bearing inserts and mark for installation identity.

(12) Remove crankshaft and upper bearing inserts. Mark inserts for installation identity.

Installation

(1) With upper main bearing inserts installed, position replacement crankshaft in block.

(2) Install main bearing caps (with lower bearing inserts), but do not tighten cap bolts. Oil bearings prior to assembly.

(3) Move connecting rods (with upper bearing inserts installed) and pistons into place.

(4) Install rod bearing caps (with bearing inserts), but do not tighten nuts. Apply oil to bearings prior to assembly.

(5) With rubber mallet, strike both ends of crankshaft to center thrust bearing. Rearward first, forward last.

(6) Tighten main bearing caps (65 foot-pounds, 88 N•m), then measure crankshaft end play. It should be between 0.0015 inch (0.038 mm) and 0.0085 inch (0.216 mm).

(7) Tighten connecting rod bearing caps (30 foot-pounds, 40 N•m).

(8) Measure bearing clearances using Plastigage method.

(9) Install key from original crankshaft in replacement crankshaft keyway.

(10) Install crankshaft timing gear and ALIGN TIMING MARKS ON TIMING GEARS BY ROTATING CRANKSHAFT, IF NECESSARY.

(11) Install timing case cover using replacement seal and gaskets.

(12) Install oil pump assembly and oil pan using replacement rear seal in rear main bearing cap and replacement front seal for timing case cover. Press front seal tips into holes in timing case cover.

(13) Coat front cover oil seal contact area of vibration damper hub with oil and push into position.

(14) Install fan pulley and fan.

NOTE: *The fan assembly and pulley must be installed with the drive belt(s) in position on pulley.*

(15) Install spark plugs.

(16) Remove engine from stand.

(17) Install engine in vehicle.

CYLINDER BLOCK

The cylinder block is manufactured from cast iron and has 4 in-line cylinders that are numbered from front to rear, 1 through 4. Five main bearings support the crankshaft, which is retained by recessed bearing caps that are machined with the block for proper alignment and clearances.

The cylinders are completely encircled by coolant jackets. (For details of engine cooling system, refer to Chapter 1C—Cooling Systems.)

Cylinder Bores

Inspect cylinder bores for out-of-round or excessive taper with an accurate Cylinder Measurement Gauge Tool J-8087, or equivalent. Measure at top, middle and bottom of bore (fig. 1B-40).

Measure cylinder bore parallel and at right angles to the centerline of the engine to determine out-of-roundness. Variation in measurement from top to bottom of cylinder indicates the taper in the cylinder. Figure 1B-41 illustrates the areas in the cylinder bore where wear

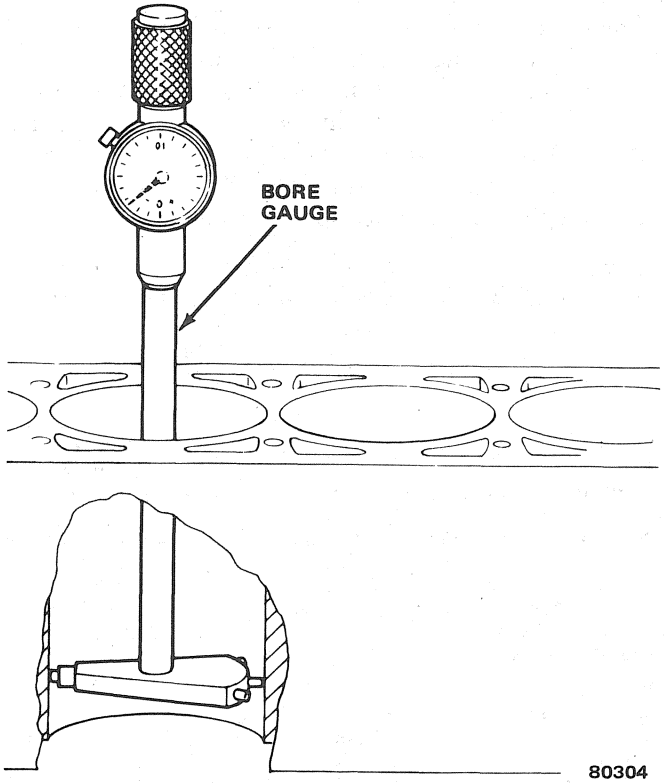

Fig. 1B-40 Measuring Cylinder Bore with Bore Gauge

normally occurs. If dimension **A** is larger than dimension **B** by 0.002 inch (0.051 mm) or more, it indicates the necessity for cylinder boring and installing replacement rings and pistons. Cylinder bores can be measured by setting the cylinder measurement gauge dial at zero in the cylinder bore at the location of desired measurement. Lock dial indicator at zero before removing from cylinder bore, and measure across the gauge contact points with outside micrometer (with the gauge at the same zero setting when removed from the cylinder).

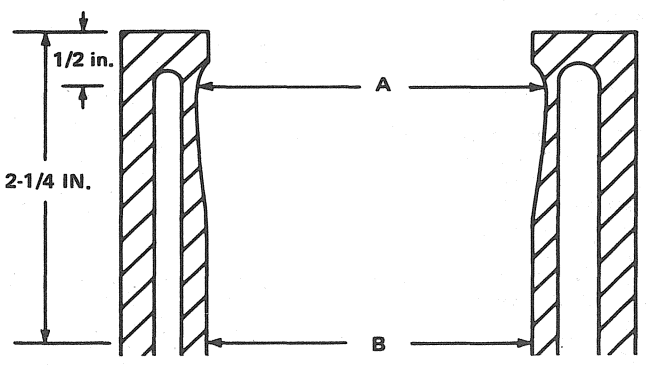

Fig. 1B-41 Normal Cylinder Bore Wear Pattern

Honing or Boring

If a piston other than standard size is to be installed, the cylinder should be bored, rather than honed, to obtain a true bore.

When honing to eliminate taper in the cylinder, use full strokes. Measure cylinder at top, middle and bottom of bore repeatedly during honing process.

When boring, always ensure the crankshaft is out of reach of the boring cutter. Crankshaft bearings and other internal parts must be covered or taped to protect them during a boring or honing operation. When boring, allow 0.001 inch (0.025 mm) to remain on the diameter for finish honing. This will provide for the required piston-to-cylinder clearance specifications.

NOTE: *A honing or boring operation must be performed carefully to ensure that the specified clearance between pistons, rings, and cylinder bores is maintained.*

By measuring the piston to be installed at the measuring locations and adding the mean of the clearance specification, the correct finish hone cylinder dimension can be determined. It is important that both the cylinder and piston be measured at normal room temperature.

After honing and before the piston is inserted for fit, each cylinder bore must be thoroughly cleaned. Use a hot, soapy water solution and wipe dry to remove all traces of abrasive. If all traces of abrasive are not removed, rapid wear of new rings and piston will result. After washing, thoroughly oil cylinder bores.

Intermixing different size pistons has no effect on engine balance because all pistons from standard size up to 0.030-inch (0.762 mm) oversize weigh exactly the same.

SPECIFICATIONS—FOUR-CYLINDER ENGINE

Type	In-Line
Bore	101.6 mm (4.00 in.)
Stroke	76.2 mm (3.0 in.)
Displacement	2.5 litre, 151 cu. in.
Compression Ratio	8.24:1
Compression Pressure, Desired	140 psi at 160 rpm
Firing Order	1, 3, 4, 2
Number One Cylinder	Front Cylinder
Cylinder Number, Front to Rear	1, 2, 3, 4
Cylinder Bore, Out-of-Round	0.038 mm (0.0015 in. max.)
Cylinder Bore Taper	0.051 mm (0.002 in. max.)
Piston	
Piston Clearance in Bore	
Top	.0635-.0838 mm (.0025 in.-.0033 in.)
Bottom	.043-.1041 mm (.0017 in.-.0041 in.)
Piston Diameter	101.519-101.580 mm (3.9968-3.9992 in.)
Compression Ring Side Clearance Top	.0762 mm (.0030 in.)
Compression Ring Side Clearance	
Bottom	.0762 mm (.0030 in.)
Compression Ring Width	
Top	1.9685-1.9812 mm (.0775-.0780 in.)
Bottom	1.9685-1.9812 mm (.0775-.0780 in.)
Upper Compression Ring Gap	.25-.56 mm (.010-.022 in.)
Lower Compression Ring Gap	.25-.71 mm (.010-.028 in.)
Oil Ring Gap	.381-1.397 mm (.015-.055 in.)
Piston Pin	
Diameter	23.547-23.557 mm (.92705-.92745 in.)
Length	76.2 mm (3.00 in.)
Pin to Piston	
Clearance	.003-.013 mm (.0003-.0005 in.)
Fit in Rod	Press
Crankshaft	
Main Bearing Journal	
Diameter	58.39 mm (2.2988 in.)
Out of Round	.0127 mm (.0005 in. max.)
Taper	.0127 mm (.0005 in. max.)
Clearance Limit New	.05588 mm (.0005-.0022 in. max.)
Crankshaft End Play New	.0889-.2159 mm (.0035-.0085 in. max.)
Rod Bearing Journal	
Diameter	50.8 mm (2.000 in.)
Out of Round	.0127 mm (.0005 in. max.)
Taper	.0127 mm (.0005 in. max.)
Clearance Limit New	.0127-.06604 mm (.0005-.0026 in.)
Rod Side Clearance	.1492-.4362 mm (.017 in.)
Lobe Lift	
Intake	5.842 mm (.230 in.)
Exhaust	5.842 mm (.230 in.)
Journal Diameter	47.4726 mm (1.869 in.)
Journal Clearance	.01778-.0685 mm (.0007-.0027 in.)
End Play Clearance	.031-0.127 mm (.0015-.1150 in.)
Valves	
Valve Train	
Lash Intake and Exhaust	0
Rocker Arm Ratio	1.75:1
Push Rod Length	226.746 mm (8.927 in.)
Valve Tappet	
Leak-Down Rate	12 to 90 sec. with 50 lb. load
Tappet Body Diameter	21.3868-21.4046 mm(.8120-.8427 in.)
Plunger Travel	3.175 mm (.125 in.)
Clearance in Boss	.635 mm (.0025 in.)
Tappet Bore Diameter	21.425-21.450 mm(.8435-.8445 in.)
Intake Valves	
Face Angle	45°
Seat Angle	46°
Head Diameter	43.688 mm (1.72 in.)
Stem Diameter	8.6995-8.68172 mm (.3425-.3418 in.)
Overall Length	115.75 mm (1.557 in.)
Stem-to-Guide Clearance	.0254-.06858 mm (.0010-.0027 in.)
Valve Seat Width	.897-1.897 mm (.353-.0747 in.)
Valve Installed Height (Spring Seat to Valve Tip)	52.265 mm (2.057 in.)
Exhaust	
Face Angle	45°
Seat Angle	46°
Head Diameter	38.4 mm (1.50 in.)
Stem Diameter	8.766-8.682 (3.418-3.125 in.)
Overall Length	114.02 (4.489 in.)
Stem-to-Guide Clearance Top	.0254-.06858 mm (.0010-.0027 in.)
Valve Seat Width	1.468-2.468 mm (.058-.097 in.)
Valve Installed Height (Spring Seat to Valve Tip)	44.024 mm (1.73 in.)
Valve Springs	
Intake and Exhaust	
Valve Spring Pressure and Length-Valve Closed	347-383 N at 42.16 mm (78-86 lb. at 1.66 in.)
Valve Spring Pressure and Length-Valve Open	.765-801 N at 31.85 mm (172-180 lb. at 1.254 in.)
Oil Capacity	
Without Filter Change	2.838 litre (3 qts.)
With Filter Change	2.838 litre (3 qts.)
Filter Type (full flow)	PF40 or equivalent
Oil Pressure at rpm	248-283 kPa (36-41 psi) at 2000 rpm
Oil Pump Gear to Body Clearance	0.10 mm (.004 in.) maximum
Gear End Clearance, Feeler Gauge Above Pump Body	0.05-0.13 mm (0.0020-.005 in.)

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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
Adapter to Intake Manifold Bolt	15	12-18	20	16-24
Camshaft Thrust Plate to Block Bolt	80 in-lb	77-83 in-lb	9	6-12
Carburetor to Manifold Nut	15	13-18	20	24
Clutch Housing-to-Engine Bolts	54	51-57	73	70-76
Connecting Rod Nut	30	27-33	40	37-43
Converter-to-Drive Plate Bolts	40	35-40	54	51-57
Crankshaft Pulley Hub Bolt	160	157-163	220	212-221
Cylinder Head Cover Bolt	7	4-10	10	7-13
Cylinder Head Cover Screws	7	5-10	10	7-14
Cylinder Head to Block Bolt	92	81-103	125	110-140
Distributor Clamp Pivot to Block Bolt	12	9-15	17	14-21
Distributor Retaining Clamp Bolt	9	6-12	12	9-15
Drive Plate Ring Gear Assembly to Crankshaft Bolt	45	42-48	60	57-63
EGR Valve to Manifold Bolt	150 in-lb	147-153 in-lb	12	9-15
Exhaust Manifold to Cylinder Head Bolt	39	36-42	52	49-55
Exhaust Pipe to Manifold Nut	35	30-40	47	41-50
Fan and Pulley to Water Pump Bolt	18	15-21	24	21-27
Flywheel to Crankshaft Bolt	68	65-71	93	90-96
Fuel Pump to Block Bolt	15	12-18	20	17-23
Intake Manifold to Cylinder Head Bolt	37	34-40	50	47-53
Main Bearing to Block Bolt	65	62-68	88	85-91
Oil Filter	12	9-15	17	14-20
Oil Filter to Block Connector	35	32-38	47	44-50
Oil Pan Drain Plug	25	23-28	34	31-37
Oil Pan Bolts	45 in-lbs	43-48 in-lbs	5	2-8
Oil Pump Cover Bolt	9	6-12	17	14-20
Oil Pump to Block Bolt	18	15-21	25	22-28
Oil Pump to Drive Shaft Plate Bolt	10	7-13	14	11-17
Oil Screen Support Nut	28	25-31	38	35-41
Pressure Plate to Flywheel Bolts	18	15-22	25	20-30
Pulley to Crankshaft Hub Bolts	25	22-28	34	31-37
Push Rod Cover to Block Bolt	80 in-lb	77-83 in-lb	9	6-12
Radiator Hoses All Clamps	25 in-lb	22-28 in-lb	3	1-6
Rocker Arm Capscrew	20	17-23	27	24-30
Starter to Block Bolt	17	14-20	24	21-27
Thermostat Housing Bolt	22	19-25	30	27-33
Timing Case Cover Bolt	45 in-lb	42-48 in-lb	5	2-8
Timing Case Cover to Block Bolt	80 in-lb	77-83 in-lb	9	6-12
Water Outlet Housing Bolt	17	14-20	23	20-26
Water Pump to Block Bolt	17	14-20	23	20-26

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

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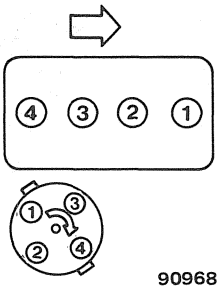
Four-Cylinder Engine Firing Order



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