SIX-CYLINDER ENGINE

GENERAL

The 232 and 258 CID are six-cylinder, in-line, overhead valve engines. Cylinders are numbered from front to rear. Firing order is 1-5-3-6-2-4. Crankshaft rotation is counterclockwise, viewed from the rear. The crankshaft is supported by seven (two-piece) bearings. The camshaft is supported by four one-piece (line bored) bearings. Due to the similarity of these engines, service procedures have been consolidated and typical illustrations are used, except where specific procedures and illustrations are needed to clarify the operation (fig. 1A-1 and 1A-2).

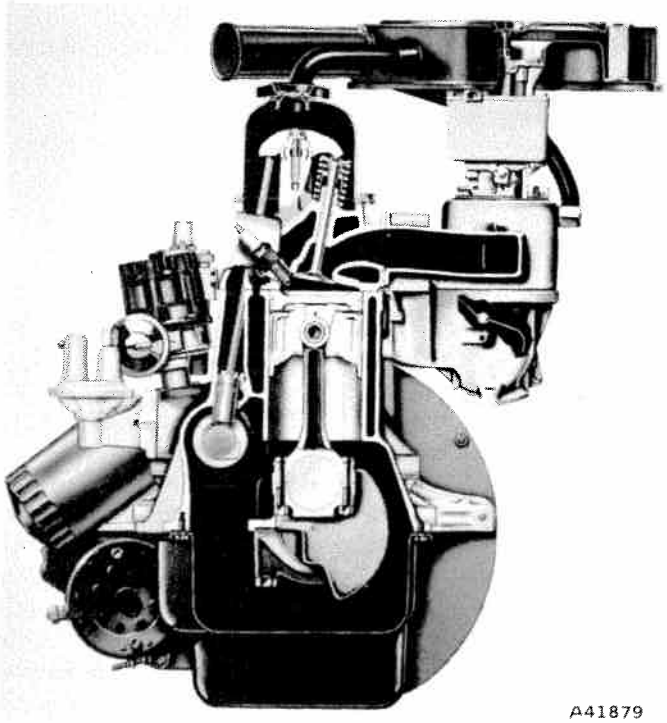

Fig. 1A-1 Engine Assembly-Sectional View

Service procedures for the 232 and 258 CID engines are basically the same. Procedures that differ are noted in the text.

Identification

Build Date Code

The engine Build Date Code is located on a machined surface on the right side of the block between the number two and three cylinders (fig. 1A-3).

The numbers of the code identify the year, month and day that the engine was built and are decoded as follows:

ENGINE BUILD DATE CODE EXPLANATION

1st Character (year)	2nd & 3rd Character (month)	4th Character (engine type)	5th Character (day)
7—1974	January	258 CID	21st Day
Example:	7	01	A	21

The letter (4th Character) contained in the code identifies the engine cubic inch displacement, carburetor type and compression ratio. The letters are decoded as follows:

Code	CID	Carburetor	Comp. Ratio
A	258	IV	8.0:1
E	232	IV	8.0:1

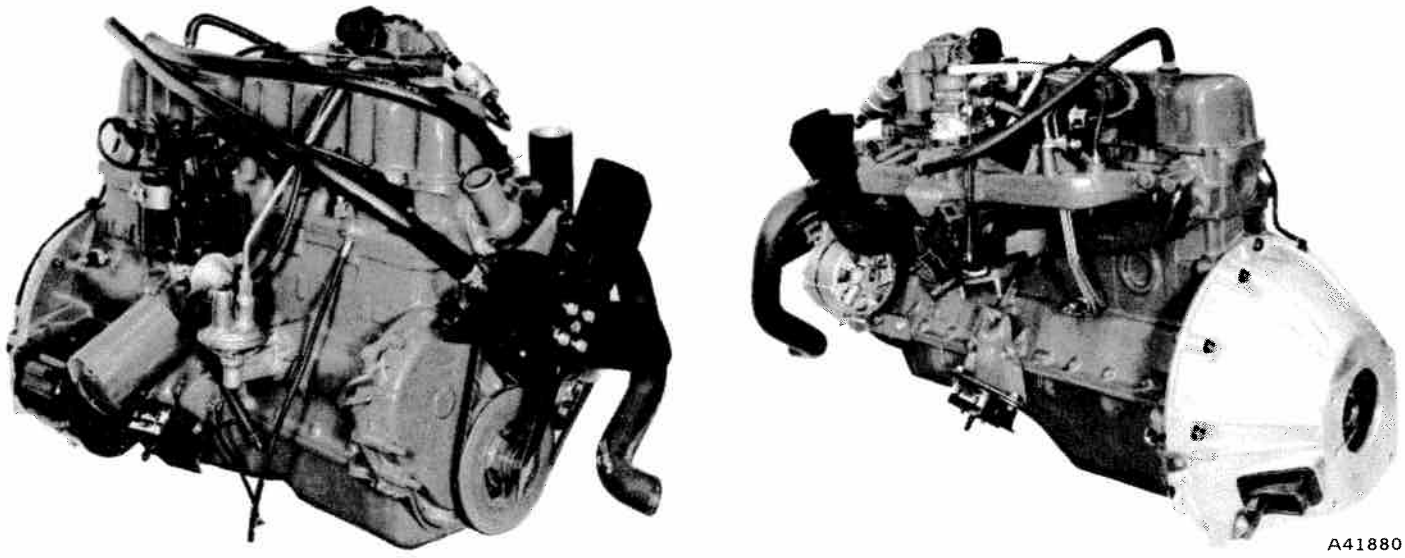

Fig . 1A-2 Engine Assembly

Oversize or Undersize Components

Some engines may be built with oversize or undersize components such as oversize cylinder bores, undersize crankshaft main bearing journals, undersize connecting rod journals or oversize camshaft bearing bores. These engines are identified by a letter code stamped on a boss (between the ignition coil and distributor) (fig. 1A-4). The letters are decoded as follows.

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

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

LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the block opposite to the number four main bearing. The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and the pump body, then is forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main oil gallery which extends the entire length of the block.

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is cross-drilled and internally passes oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing cap has a small squirt hole; oil passes through the squirt hole and is thrown off as the rod rotates. This oil throwoff lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

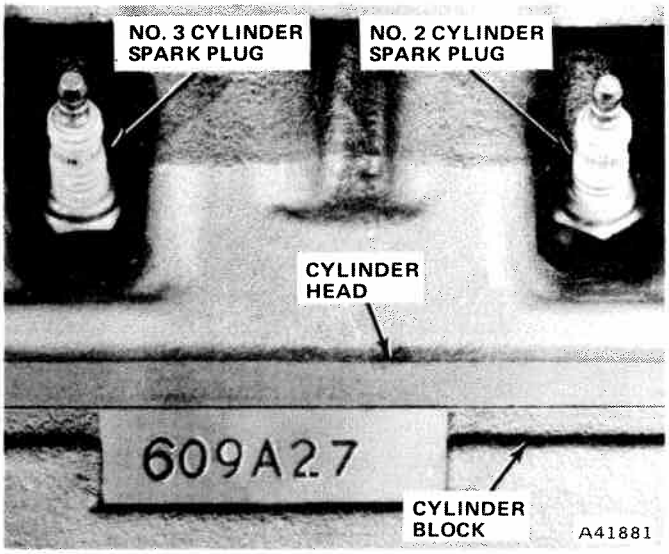

Fig. 1A-3 Build Date Code Location

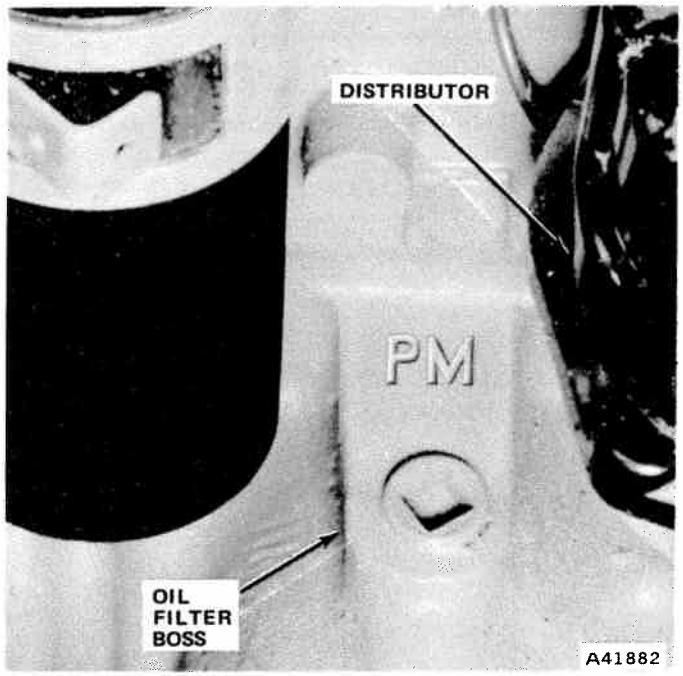

Fig. 1A-4 Oversize/Undersize Letter Code

The hydraulic valve tappets receive oil directly from the main oil gallery. Oil is provided to the camshaft bearings through galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Rotation of the sprocket lubricates the crankshaft sprocket and chain. Oil drains back to the oil pan under the number one main bearing cap.

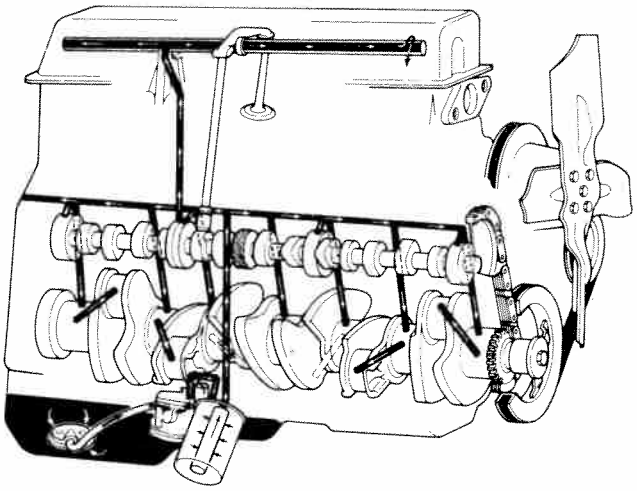

Fig. 1A-5 Lubrication System

The oil supply for the rocker arms and push rods is obtained from the number three cam bearing where oil is channeled from a groove in the camshaft bearing surface to a gallery extending upward and through the cylinder head gasket. At this point, the head gasket forms a seal joining the cylinder block gallery with the adjoining gallery in the cylinder head. Commencing at the number five rocker arm shaft support, the oil then flows into the rocker arm shaft to supply lubrication to the rocker arms and push rods. The push rod guide holes in the cylinder head return the oil to the crankcase through the valve tappet area (fig. 1A-5).

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
EXTERNAL OIL LEAK	(1) Fuel pump gasket broken or improperly seated.	(1) Replace gasket.
	(2) Cylinder head cover gasket broken or improperly seated.	(2) Replace gasket; check cylinder head cover gasket flange and cylinder head gasket surface for distortion.
	(3) Oil filter gasket broken or improperly seated.	(3) Replace oil filter.
	(4) Oil pan side gasket broken or improperly seated.	(4) Replace gasket; check oil pan gasket flange for distortion.
	(5) Oil pan front oil seal broken or improperly seated.	(5) Replace seal; check timing chain cover and oil pan seal flange for distortion.

SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
EXTERNAL OIL LEAK (Continued)	(6) Oil pan rear oil seal broken or improperly seated.	(6) Replace seal; check oil pan rear oil seal flange; check rear main bearing cap for cracks, plugged oil return channels, or distortion in seal groove.
	(7) Timing chain cover oil seal broken or improperly seated.	(7) Replace seal.
	(8) Oil pan drain plug loose or has stripped threads.	(8) Repair as necessary and tighten.
	(9) Rear oil gallery plug loose.	(9) Use appropriate sealant on gallery plug and tighten.
	(10) Rear camshaft plug loose or improperly seated.	(10) Seat camshaft plug or replace and seal, as necessary.
EXCESSIVE OIL CONSUMPTION	(1) Oil level too high.	(1) Lower oil level to specifications.
	(2) Oil too thin.	(2) Replace with specified oil.
	(3) Valve stem oil seals are damaged, missing, or incorrect type.	(3) Replace valve stem oil seals.
	(4) Valve stems or valve guides worn.	(4) Check stem-to-guide clearance and repair as necessary.
	(5) Piston rings broken, missing.	(5) Replace missing or broken rings.
	(6) Piston rings incorrect size.	(6) Check ring gap, repair as necessary.
	(7) Piston rings sticking or excessively loose in grooves.	(7) Check ring side clearance, repair as necessary.
	(8) Compression rings installed upside down.	(8) Repair as necessary.
	(9) Cylinder walls worn, scored, or glazed.	(9) Repair as necessary.
	(10) Piston ring gaps not properly staggered.	(10) Repair as necessary.
	(11) Excessive main or connecting rod bearing clearance.	(11) Check bearing clearance, repair as necessary.
NO OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Section 3, Oil Pressure Gauge and Sending Unit Test.
	(3) Oil pump malfunction.	(3) Refer to Oil Pump in this section.
	(4) Oil pressure relief valve sticking.	(4) Remove and inspect oil pressure relief valve assembly.
	(5) Oil passages on pressure side of pump obstructed.	(5) Inspect oil passages for obstructions.
	(6) Oil pickup screen or tube obstructed.	(6) Inspect oil pickup for obstructions.

SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
LOW OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil excessively thin due to dilution, pour quality, or improper grade.	(2) Drain and refill crankcase with recommended oil.
	(3) Oil pressure relief spring weak or sticking.	(3) Remove and inspect oil pressure relief valve assembly.
	(4) Oil pickup tube and screen assembly has restriction or air leak.	(4) Remove and inspect oil inlet tube and screen assembly. (Fill pickup with lacquer thinner to find leaks.)
	(5) Oil pump malfunctioning.	(5) Refer to Oil Pump in this section.
	(6) Excessive main, rod, or camshaft bearing clearance.	(6) Measure bearing clearances, repair as necessary.
HIGH OIL PRESSURE	(1) Improper grade oil.	(1) Drain and refill crankcase with correct grade oil.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Section 3, Oil Pressure Gauge and Sending Unit Test.
	(3) Oil pressure relief valve sticking closed.	(3) Remove and inspect oil pressure relief valve assembly.
MAIN BEARING NOISE	(1) Insufficient oil supply.	(1) Check for oil low level or low oil pressure.
	(2) Main bearing clearance excessive.	(2) Check main bearing clearance, repair as necessary.
	(3) Crankshaft end play excessive.	(3) Check end play, repair as necessary.
	(4) Loose flywheel or torque converter.	(4) Tighten flywheel or converter attaching bolts.
	(5) Loose or damaged vibration damper.	(5) Repair as necessary.
CONNECTING ROD BEARING	(1) Insufficient oil supply.	(1) Check for low oil level or low oil pressure.
	(2) Bearing clearance excessive or bearing missing.	(2) Check clearance, repair as necessary.
	(3) Crankshaft connecting rod journal out-of-round.	(3) Check journal measurements, repair or replace as necessary.
	(4) Misaligned connecting rod.	(4) Repair as necessary.
	(5) Connecting rod bolts tightened improperly.	(5) Tighten bolts to specified torque.
PISTON NOISE	(1) Piston-to-cylinder wall clearance excessive.	(1) Check clearance, repair as necessary.
	(2) Cylinder walls excessively tapered or out-of-round.	(2) Check cylinder wall measurements, repair as necessary.
	(3) Piston ring broken.	(3) Replace ring.

SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
PISTON NOISE (Continued)	(4) Loose or seized piston pin.	(4) Check piston-to-pin clearance, repair as necessary.
	(5) Connecting rods misaligned.	(5) Check rod alignment, repair as necessary.
	(6) Piston ring side clearance excessively loose or tight.	(6) Check ring side clearance, repair as necessary.
	(7) Carbon build-up on piston is excessive.	(7) Clean carbon from piston.
	NOTE: *A clicking noise, upon starting the engine, reducing in level and disappearing after a short period of time is normal. This noise is due to a slight oil leak-down condition caused by valve spring pressure exerted on the tappets.*	
VALVE TRAIN NOISE	(1) Insufficient oil supply.	(1) Check for: (a) Low oil level. (b) Low oil pressure. (c) Plugged rocker arm shaft. (d) Wrong hydraulic tappets. (e) Plugged oil gallery in block.
	(2) Push rods worn or bent.	(2) Replace worn or bent push rods.
	(3) Rocker arms or shaft worn.	(3) Replace worn rocker arms or shaft.
	(4) Dirt or chips in hydraulic tappets.	(4) Clean tappets.
	(5) Excessive tappet leak-down.	(5) Replace valve tappet.
	(6) Tappet face worn.	(6) Replace tappet; check corresponding cam lobe for wear.
	(7) Broken or cocked valve springs.	(7) Properly seat cocked springs; replace broken springs.
	(8) Stem-to-guide clearance excessive.	(8) Check stem-to-guide clearance, repair as necessary.
	(9) Valve bent.	(9) Replace valve
	(10) Loosen rocker arms and shaft assembly bolts.	(10) Tighten bolts to specified torque.
	(11) Valve seat runout excessive.	(11) Regrind valve seat/valves.

ENGINE ASSEMBLY

Resilient rubber cushions support the engine and transmission at three points: at each side on the centerline of the engine and at the rear between the transmission extension housing and the rear support crossmember. Replacement of a cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion (fig. 1A-6).

If it is necessary to remove the front engine mounts and front crossmember to perform service such as oil pan removal, an engine holding fixture may be fabricated as illustrated in figure 1A-7.

ENGINE REMOVAL

The engine is removed without the transmission and bell housing.

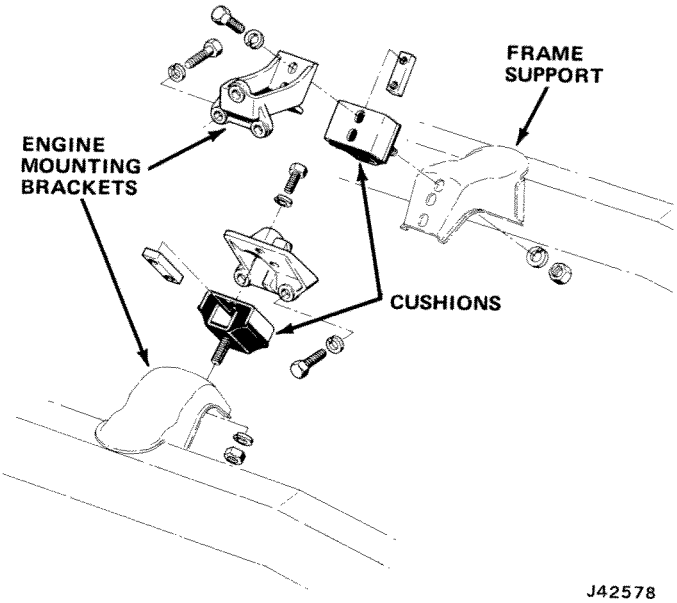

Fig. 1A-6 Engine — Front Mounts

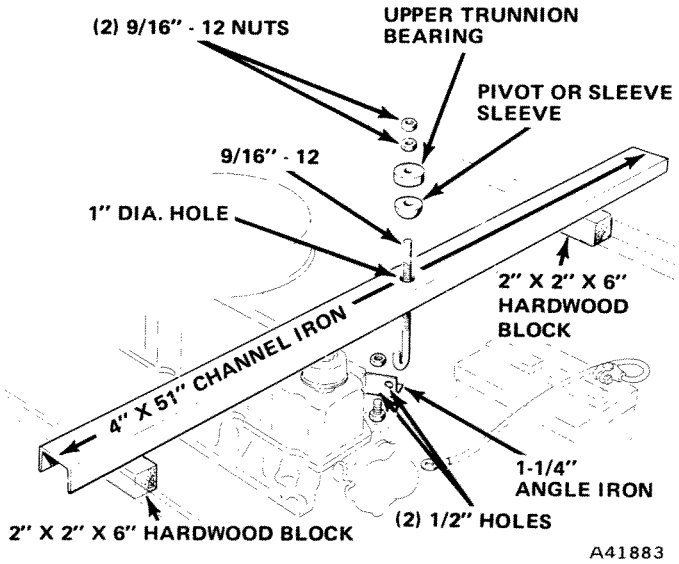

Fig. 1A-7 Engine Holding Fixture — Typical

(1) On the Cherokee, Wagoneer and Truck the hood must be removed. Mark hinge locations at hood panel for alignment during installation. Remove hood from hinges.

(2) Remove air cleaner assembly.

(3) Drain cooling system.

(4) Disconnect upper and lower radiator hoses.

(5) If equipped with automatic transmission, disconnect cooler lines from radiator.

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

(6) Remove radiator.

(7) Remove engine fan.

(8) If so equipped, remove power steering pump and drive belt from the engine and place aside. Do not disconnect the power steering hoses.

(9) If equipped with air conditioning:

(a) Turn both service valves clockwise to the front seated position.

(b) Bleed refrigerant charge from compressor by slowly loosening service valve fittings.

(c) Disconnect condenser and evaporator lines from compressor.

(d) Disconnect receiver outlet at disconnect coupling.

(e) Remove condenser and receiver assembly.

(10) Disconnect the following wires (if equipped).

- Starter motor
- Coil positive terminal
- Alternator
- Temperature gauge sending unit
- Oil pressure gauge sending unit
- Solenoid vacuum valve
- Solenoid control switch
- Throttle stop solenoid

(11) Disconnect the following lines (if equipped):

- Fuel line from tank at fuel pump
- Vacuum line for power brake unit at intake manifold
- Vacuum line for full vapor storage canister at air cleaner snorkel
- Vacuum line for heater damper doors at intake manifold

(12) Disconnect accelerator linkage at engine.

(13) Disconnect transmission linkage.

(14) Disconnect exhaust pipe at support bracket and exhaust manifold.

(15) Remove the oil filter.

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

(17) Disconnect exhaust pipe at support bracket and exhaust manifold.

(18) Support the weight of the engine with a lifting device.

(19) Remove front support cushion and bracket assemblies from engine.

(20) Remove transfer case shift lever boot, floor mat (if so equipped) and transmission access cover.

(21)
- If equipped with automatic transmission, remove upper bolts securing transmission bell housing to engine.
- If equipped with manual transmission, remove upper bolts securing clutch housing to engine.

(22) Remove starter motor.

(23) If equipped with automatic transmission:

- Remove the engine adapter plate inspection covers.
- Mark assembled position of converter and flex plate and remove converter-to-flex plate cap screws.

- Remove remaining bolts securing transmission bell housing to engine.

If equipped with manual transmission:

- Remove clutch housing lower cover and remaining bolts securing the clutch housing to engine.

(24) Support transmission with a floor jack.

(25) Remove engine by pulling forward and upward.

ENGINE INSTALLATION

(1) Lower engine slowly into engine compartment and align with the transmission bell housing (automatic transmission) or clutch housing (manual transmission).

NOTE: *On manual transmissions, make certain the clutch shaft is aligned properly with the splines of the clutch driven plate.*

(2) Install transmission bell housing-to-engine (automatic transmission) or clutch housing-to-engine bolts (manual transmission). Tighten the bolts to specified torque (automatic transmission — 28 foot pounds; manual transmission — top - 27, bottom - 43 foot pounds).

(3) Remove floor jack which was used to support transmission.

(4) If equipped with automatic transmission, align marks previously made on converter and flex plate, install converter to flex plate cap screws and tighten to 33 foot-pounds torque.

(5) Install inspection covers (automatic transmission) or the clutch housing lower cover (manual transmission).

(6) Install starter motor.

(7) Install front support cushion and bracket assemblies to engine; tighten retaining bolts to 28 foot-pounds torque.

(8) Lower engine onto frame supports, remove lifting device and install front support cushion retaining nuts. Tighten nuts to 33 foot-pounds torque.

(9) Connect exhaust pipe to support bracket and exhaust manifold using a new seal, if required.

(10) Install oil filter.

(11) Connect all wires, lines, linkage and hoses which were previously disconnected from engine.

(12) If removed, install air conditioning condenser and receiver assembly. Connect receiver outlet to the disconnect coupling. Connect condenser and evaporator lines to compressor. Purge compressor of air as outlined in Air Conditioning section.

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

(13) If removed, install power steering pump and drive belt; tighten belt to specified tension.

(14) Install engine fan and tighten retaining bolts to 18 foot-pounds torque.

(15) Install radiator and connect upper and lower hoses. If equipped with automatic transmission, connect the cooler lines.

(16) Fill cooling system to specified level.

(17) Inspect engine oil level and add oil as required.

(18) Install the air cleaner assembly.

(19) Start engine. Check all hose connections for leaks. Stop engine.

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

(21) Install the transmission access cover, floor mat and transfer case shift lever boot.

CYLINDER HEAD COVER AND GASKET

Removal

(1) Remove air cleaner and PCV molded hose.

(2) Disconnect fuel and distributor vacuum advance lines at carburetor; bend as required to allow removal of the cylinder head cover.

(3) Disconnect PCV valve from grommet in cylinder head cover.

(4) Remove cylinder head cover screws, cover, and gasket from engine.

Installation

(1) Position gasket on cylinder head cover flange. Gasket tabs are to be positioned in cut-out openings in flange of cover.

(2) Position cylinder head cover and gasket on engine and install screws. Tighten to 50 inch-pounds torque.

(3) Connect fuel and distributor vacuum advance line to carburetor.

(4) Connect PCV valve to grommet in cylinder head cover.

(5) Install air cleaner and connect PCV molded hose.

ROCKER ARMS AND SHAFT ASSEMBLY

The intake and exhaust rocker arms pivot on a common shaft. The shaft is secured to the cylinder head by six bolts. The rocker arms are designed to accommodate either ordinary valve spring retainers or exhaust valve rotators. Solid steel push rods with hardened ends actuate the rocker arms.

Removal and Disassembly

(1) Remove cylinder head cover and gasket.

(2) Loosen shaft assembly retaining bolts from the cylinder head and remove rocker arm and shaft assembly, including retaining bolts.

(3) Remove roll pin and spring washer from one end of the rocker arm shaft.

(4) Remove rocker arms, spacers, retainers, retaining bolts, and oil deflector and place on a bench in same order as removed.

Cleaning and Inspection

Clean all parts with solvent while retaining the order in which they were removed from rocker arm shaft.

Inspect rocker arm valve stem contact surface. If minor pitting has occurred, reface surface; if deeply pitted replace rocker arm.

Assembly and Installation

(1) Assemble rocker arms, spacers, retainers, retaining bolts, and oil deflector on rocker arm shaft in same order as removed (fig. 1A-8).

NOTE: *The rocker arm shaft oil holes must face toward the cylinder head.*

(2) Use two rubber bands to hold rocker arms in position as shown in figure 1A-8 and install rocker arm and shaft assembly to cylinder head. Make certain push rods are correctly aligned with rocker arms.

(3) Work from center of rocker arm shaft outward, and tighten to 21 foot-pounds torque.

(4) Install cylinder head cover and gasket.

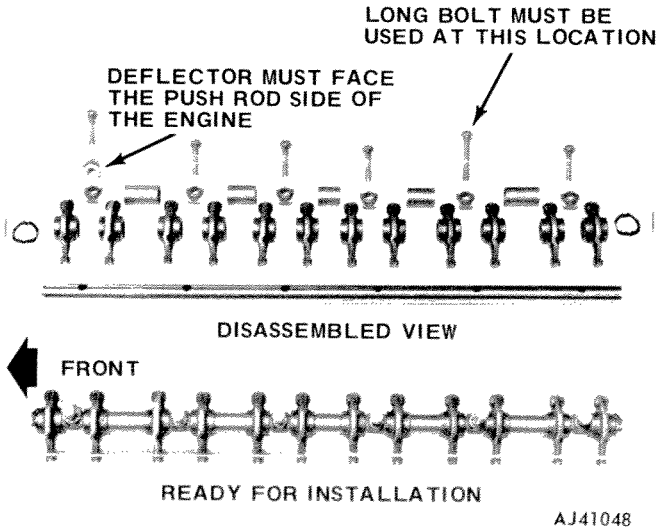

Fig. 1A-8 Rocker Arms and Shaft Assembly

VALVE SPRING—VALVE STEM OIL SEAL

Nylon valve stem oil seals are installed on each valve stem to prevent oil used for rocker arm lubrication from entering the combustion chamber through the valve guides. The oil seals should be replaced whenever valve service is performed or if the seals have deteriorated.

The valve spring is held in place on the valve stem by a retainer or an exhaust valve rotator and a set of valve locks. The locks can be removed only by compressing the valve spring.

NOTE: *Exhaust valve springs used with rotators are shorter than standard valve springs. Also, these springs use a removable spring seat that fits under the spring on the cylinder head. Refer to Specifications at the end of this section.*

Exhaust Valve Rotator

The 232 CID and 258 CID engines equipped with an EGR system, but without an Air Guard system use exhaust valve rotators. Exhaust valve rotators perform two functions. Like ordinary valve spring retainers, they hold the valve spring in place. However, the second function is to positively induce rotation of the exhaust valve to increase durability of the valve seat and face.

The outer housing of the rotator rides on the exhaust valve spring and remains stationary. The inner retainer with valve locks retains the exhaust valve and outer housing. In addition, the inner retainer rotates slightly when the exhaust valve is off its seat. This rotation is caused by the inner spring being crushed between the retainer and the inner washer when pressure is applied to the assembly during exhaust valve opening (fig. 1A-9).

Valve Spring Removal

(1) Remove cylinder head cover and gasket.
(2) Remove rocker arm and shaft assembly.
(3) Remove push rods.

NOTE: *Retain push rods in same order as removed.*

(4) Remove spark plug from cylinder.

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

NOTE: *An adapter can be made by attaching an air hose connection to a spark plug from which the porcelain has been removed.*

(6) Connect an air hose to adapter and maintain at least 90 psi in cylinder to hold the two valves against their seats.

(7) Use Valve Spring Remover and Installer Tool J-21931; compress valve spring, and remove valve locks (fig. 1A-10).

(8) Remove valve spring and retainer or rotator.

(9) Remove oil deflector (if necessary).

(10) Remove exhaust valve spring seat (if equipped with rotators).

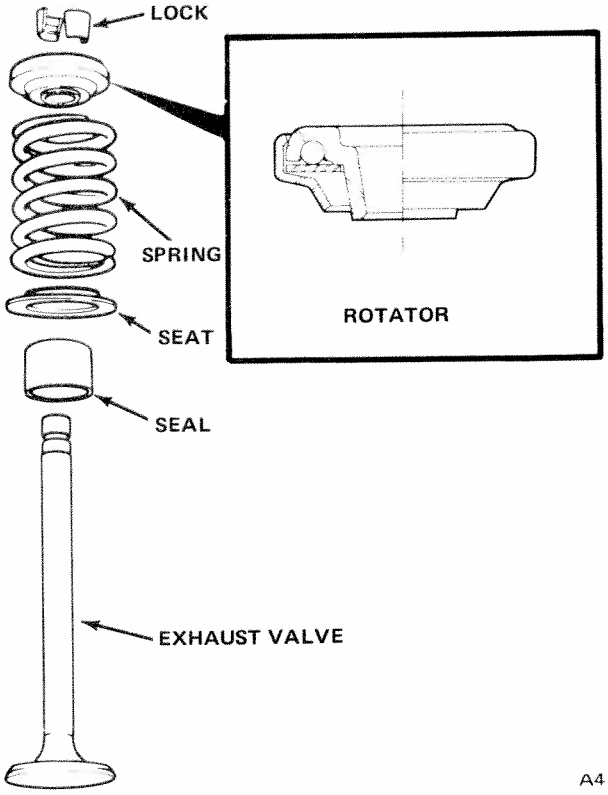

Fig. 1A-9 Exhaust Valve Rotator

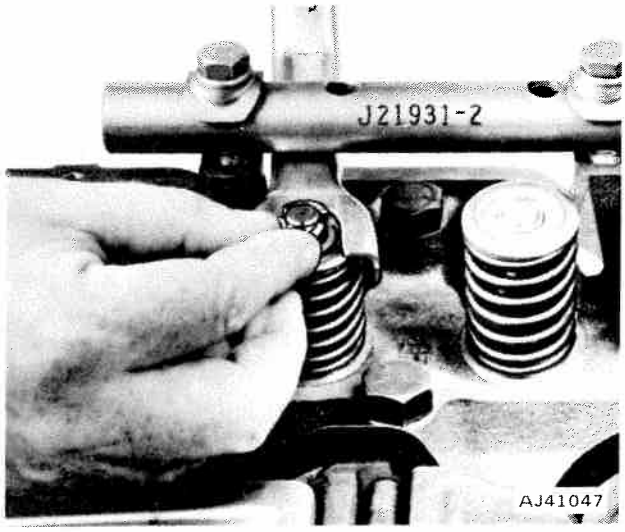

Fig. 1A-10 Valve Spring Removal

Installation

(1) Install exhaust valve spring seat, if so equipped.
(2) Install oil deflector on valve stem (if removed).
(3) Install valve spring and retainer or rotator.
(4) Compress valve spring with Tool J-21931 and insert valve locks. Release spring tension and remove tool.

NOTE: *Tap spring from side-to-side to be certain spring is seated properly at cylinder head.*

(5) Disconnect air hose, remove adapter from spark plug hole, and install spark plug.
(6) Install rocker arm and shaft assembly.
(7) Install cylinder head cover and gasket.

Valve Spring Tension Test

Use Valve Spring Tester J-8056 to test each valve spring for the specified tension value (fig. 1A-11). Replace valve springs that are not within specifications.

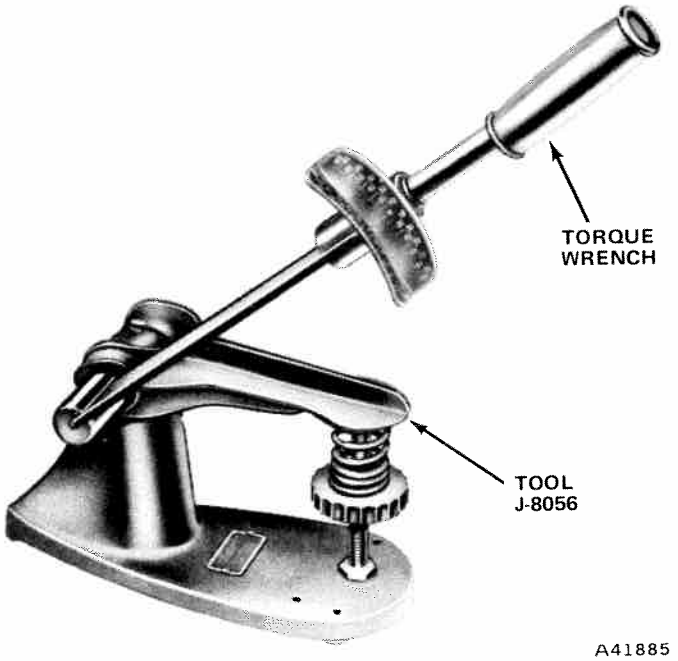

Fig. 1A-11 Valve Spring Tester

INTAKE AND EXHAUST MANIFOLDS

The intake and exhaust manifolds are attached to the cylinder head on the left side of the engine. A gasket is used between the intake manifold and the cylinder head; none is used between the exhaust manifold and cylinder head. An asbestos gasket is used at the mating surfaces of the intake manifold to exhaust manifold and also between the exhaust manifold and exhaust pipe (fig. 1A-12).

On certain engine applications, an exhaust gas recirculation valve (and back-pressure sensor on California cars) is mounted on the side of the intake manifold.

NOTE: *California intake manifolds differ from Nationwide. They have a metal plate rather than a cast floor above the exhaust manifold heat valve in order to improve driveability.*

Removal and Cleaning

(1) Remove air cleaner and carburetor.

(2) Disconnect accelerator cable from accelerator bellcrank.
(3) Disconnect PCV vacuum hose from intake manifold.
(4) Disconnect TCS solenoid vacuum valve and bracket from intake manifold.
(5) Disconnect vacuum hoses from EGR valve.
(6) Disconnect compressor and bracket assembly from intake manifold (if equipped with air conditioning).
(7) Disconnect exhaust pipe from manifold flange.
(8) Remove manifold attaching bolts, nuts and clamps and remove intake and exhaust manifold as an assembly. Discard gasket.
(9) Separate manifolds at riser area.
(10) Clean mating surfaces of manifolds and cylinder head.

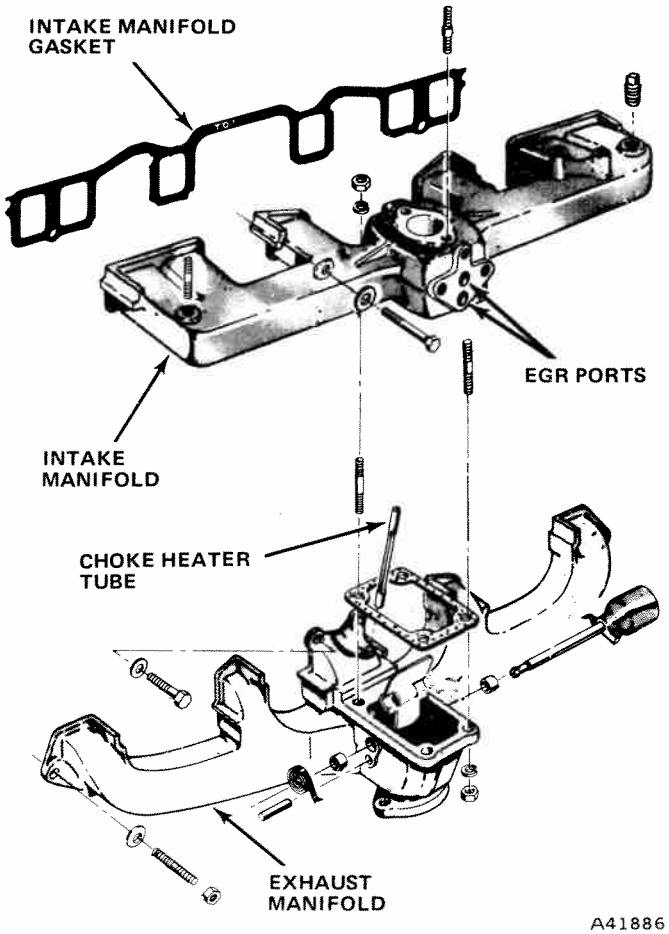

Fig. 1A-12 Intake and Exhaust Manifold Assembly

Installation

(1) Assemble manifolds and finger-tighten heat riser retaining nuts.
(2) Position new intake manifold gasket on cylinder head and install manifold assembly. Tighten manifold attaching bolts and nuts in sequence (fig. 1A-13) to 23 foot-pounds torque.
(3) Install flange gasket and connect exhaust pipe to manifold flange.
(4) Install carburetor.
(5) Install air conditioning compressor and bracket assembly to intake manifold (if equipped).
(6) Install drive belt and tighten to specified tension.
(7) Install TCS solenoid vacuum valve and bracket to intake manifold.
(8) Connect vacuum hoses to the EGR valve.
(9) Connect accelerator cable and PCV hose.
(10) Install air cleaner.

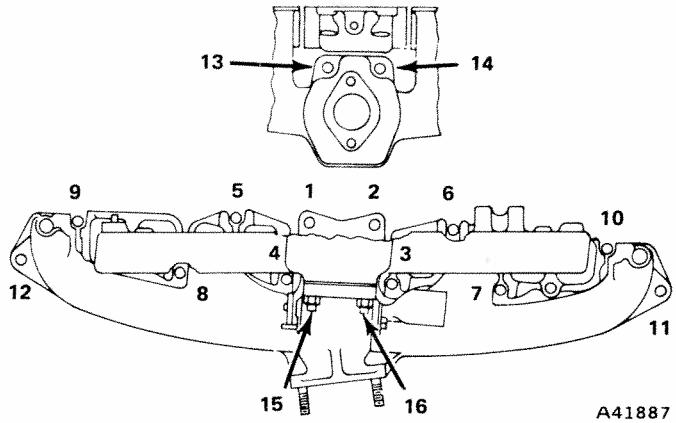

Fig. 1A-13 Intake Manifold Torque Sequence

NOTE: *Transmission throttle linkage must be adjusted after completing the manifold installation. Refer to Section 7 — Automatic Transmission.*

CYLINDER HEAD AND GASKET

Cylinder heads incorporating exhaust valve rotators do not differ from heads without rotators. These heads are interchangeable. The exhaust valve assemblies are the only difference. They have hardened exhaust valve seats and are used on either 232 or 258 CID engines.

Removal

(1) Drain cooling system system and disconnect hoses at thermostat housing.
(2) Remove cylinder head cover and gasket.
(3) Rocker arm and shaft assembly and push rods.

NOTE: *Retain push rods in the same order as removed.*

(4) Remove intake and exhaust manifold assembly from cylinder head.
(5) Disconnect spark plug wires and remove plugs.
(6) Disconnect temperature sending unit wire, battery ground cable, and ignition coil and bracket assembly.
(7) Remove cylinder head bolts, cylinder head, and gasket.

Cleaning and Inspection

(1) Thoroughly clean machined surface of cylinder head and block. Remove all dirt and gasket cement.
(2) Remove carbon deposits from combustion chambers and top of pistons.
(3) Use a straightedge and feeler gauge to check the flatness of the cylinder head and block mating surfaces. Refer to specifications.

Installation

(1) If cylinder head is to be replaced and the original valves re-used, remove valves and measure stem diameter. Replace valves if oversize as only standard size valves are to be used with a service replacement head. If original valves are standard size, remove all carbon buildup and reface as outlined under Valve Refacing.
(2) Install valves in cylinder head using new valve stem oil seals.
(3) Transfer all attached components from the original head which are not included with replacement head.
(4) Apply an even coat of Perfect Seal sealing compound or equivalent to both sides of new head gasket and position gasket on block with the word TOP facing upward.

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

(5) Install cylinder head. Tighten bolts (in sequence) to 105 foot-pounds torque (fig. 1A-14).

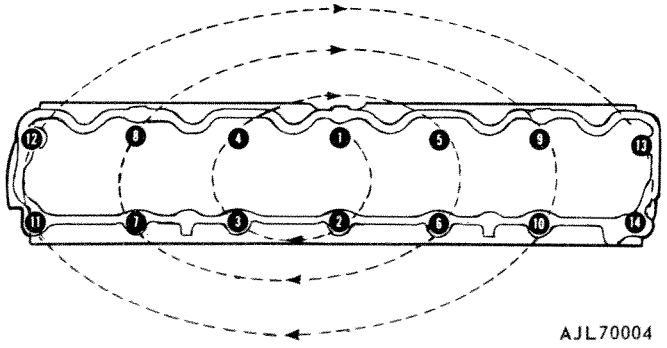

Fig. 1A-14 Cylinder Head Torque Sequence

(6) Connect temperature sending unit wire and battery ground cable.
(7) Install ignition coil and bracket assembly.
(8) Install spark plugs and connect plug wires.
(9) Install intake and exhaust manifold assembly. (Refer to Intake and Exhaust Manifold Installation for the correct torque tightening sequence.)
(10) Install push rods in the order removed.
(11) Install rocker arm and shaft assembly; tighten bolts to 21 foot-pounds torque. Install cylinder head cover and gasket.
(12) Connect hoses to thermostat housing and fill cooling system to specified level.

NOTE: *Transmission throttle linkage must be adjusted after completing the cylinder head installation. Refer to Section 7 — Automatic Transmission.*

CYLINDER HEAD RECONDITIONING

NOTE: *The following procedures apply after the cylinder head has been removed from the engine.*

Disassembly

(1) Compress each valve spring with a C-clamp type spring compressor tool and remove valve locks, retainers or rotators, springs, valve stem oil seals, and exhaust valve spring seats, if so equipped.
(2) Remove the valves.

NOTE: *Place valves in a rack in the same order as removed from cylinder head.*

Cleaning and Inspection

(1) Clean all carbon buildup from the combustion chambers, valve ports, valve stems and head.
(2) Clean all dirt and gasket cement from the cylinder head machined surface.
(3) Inspect for cracks in combustion chambers and valve ports.
(4) Inspect for cracks in gasket surface at each coolant passage.
(5) Inspect valves for burned or cracked heads. Inspect for damaged valve stems.

Valve Reconditioning

Use a valve refacing machine to reface the intake and the exhaust valves to the specified angle. Replace bent or warped valves. After refacing, at least 1/32-inch margin must remain or the valve must be replaced. Examples of correct and incorrect valve refacing are shown in figure 1A-15.

The valve stem tip can be resurfaced and rechamfered when worn. Do not remove more than 0.010 inch.

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 good dressing stone. Remove only enough metal to provide a smooth finish.

Tapered stones should be used to obtain the specified seat widths when required.

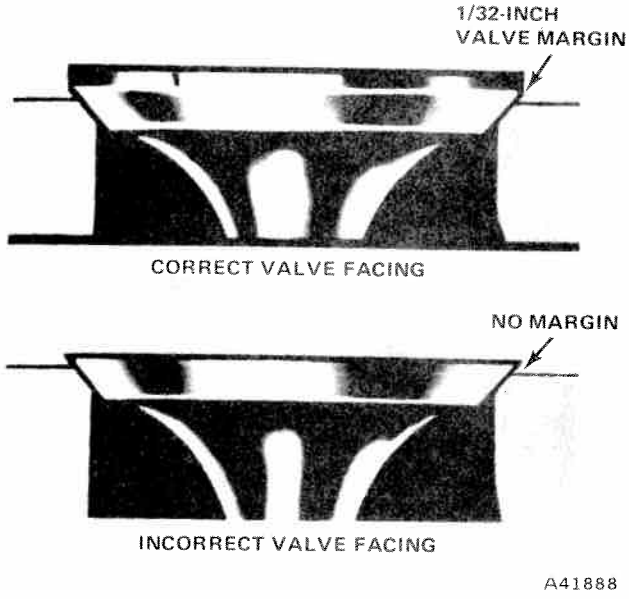

Fig. 1A-15 Valve Refacing

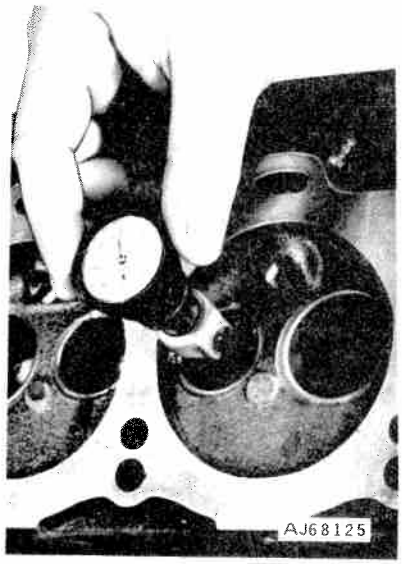

Fig. 1A-16 Checking Valve Seat Runout

Control seat runout to a maximum of 0.0025-inch (fig. 1A-16).

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, the valve guides must be reamed to the next larger size to obtain proper clearance. Oversize service valves are available in 0.003-inch, 0.015-inch and 0.030-inch sizes.

The following oversize valve guide reamers may be used.

Reamer	Size
J-6042-1	0.003-inch
J-6042-5	0.015-inch
J-6042-4	0.030-inch

NOTE: *Valve guides must be reamed in steps, starting with the 0.003-inch oversize reamer and progressing to the size required.*

Valve Stem-to-Guide Clearance

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

- Measure the valve stem diameter with a caliper micrometer midway between the valve head and tip and then select a pilot from a valve refacing kit which fits snugly in the valve guide bore.

NOTE: *Make certain the valve stem and guide bore are thoroughly cleaned before measuring.*

The valve stem-to-guide clearance can be determined by subtracting the diameter of the valve stem from the size of the pilot selected.

- Use a dial indicator to measure the lateral movement of the valve stem with the valve installed in its guide and just off the valve seat (fig. 1A-17). Refer to specifications.

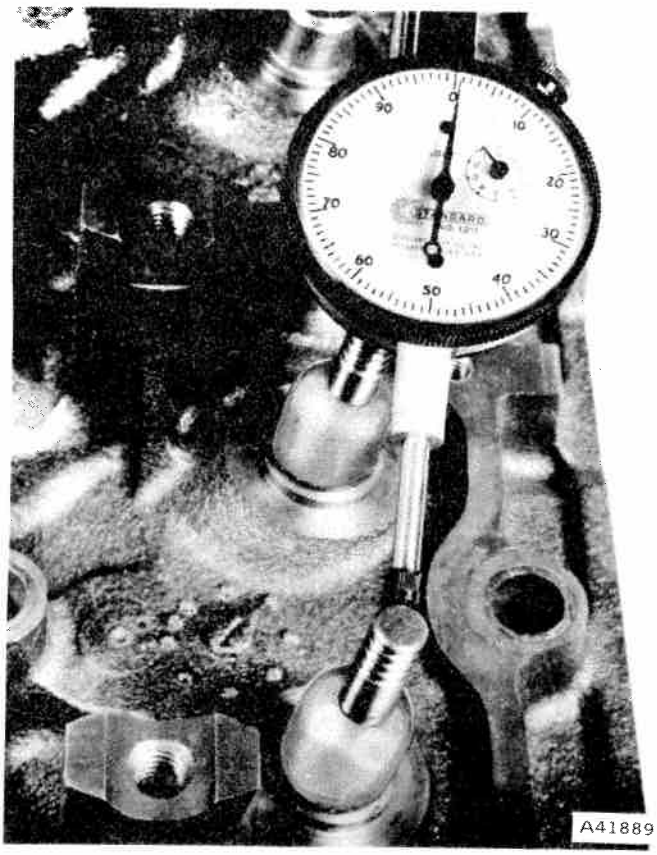

Fig. 1A-17 Checking Stem-to-Guide Clearance

Assembly

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

(2) Install valve in same valve guide from which it was removed.

(3) Install exhaust valve spring seat (if equipped).

(4) Install new valve stem oil seal on valve stem.

(5) Position valve spring and retainer (or rotator) on the cylinder head and compress valve spring with compressor tool. Install valve locks and release tool.

(6) Tap valve spring from side-to-side with a light hammer to be certain the spring is properly seated at cylinder head.

HYDRAULIC VALVE TAPPETS

The hydraulic valve tappet consists of a body, plunger, plunger return spring, check valve assembly metering disc, cap, and lock ring (fig. 1A-18).

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

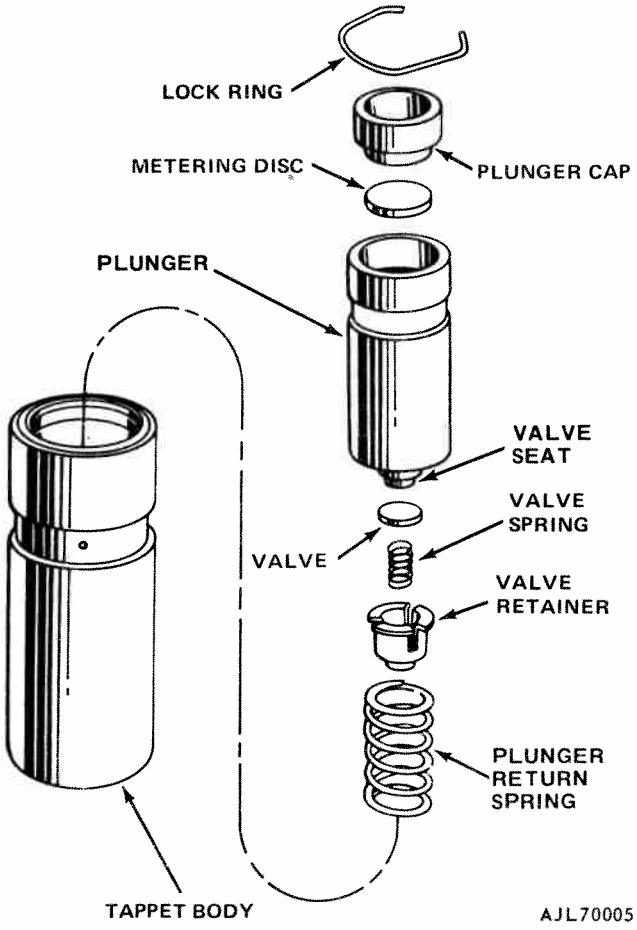

Fig. 1A-18 Hydraulic Tappet Assembly

When the tappet is on the heel of the cam lobe, the plunger return spring indexes with an oil hole undercut in the plunger and allows the oil supply to be admitted through the tappet body. Oil under pressure flows into the body through the check valve assembly, maintaining the tappet fully charged (fig. 1A-19). This cycle occurs when the tappet leaks oil during normal valve opening. Contact with the cam lobe causes tappet body movement, closing the check valve and transmitting zero-lash movement of the push rod to open the intake or exhaust valve.

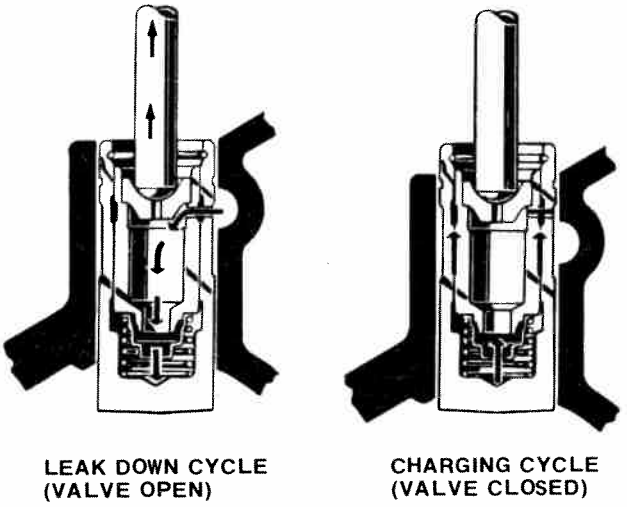

Fig. 1A-19 Hydraulic Tappet Operation

Removal and Disassembly

(1) Remove cylinder head cover and gasket.
(2) Remove rocker arms and shaft assembly.
(3) Remove push rods.

NOTE: *The push rods should be retained in the same order as removed.*

(4) Remove cylinder head and gasket.

(5) Remove tappets through push rod openings of block with Hydraulic Valve Tappet Remover and Installer Tool J-21884 as shown in figure 1A-20.

NOTE: *Tappet components must be retained in the same order as removed.*

(6) Release lock ring and remove plunger cap, plunger assembly, and plunger return spring from tappet body.

Cleaning and Inspection

Clean components of the hydraulic tappet assembly in a good cleaning solvent to remove all varnish or gum deposits.

Check for signs of scuffing on the barrel and face of the tappet.

Inspect tappet face for concave wear by laying a straightedge across the face. If the face is concave, the corresponding lobe on the camshaft is worn, and the replacement of the camshaft and tappets is necessary.

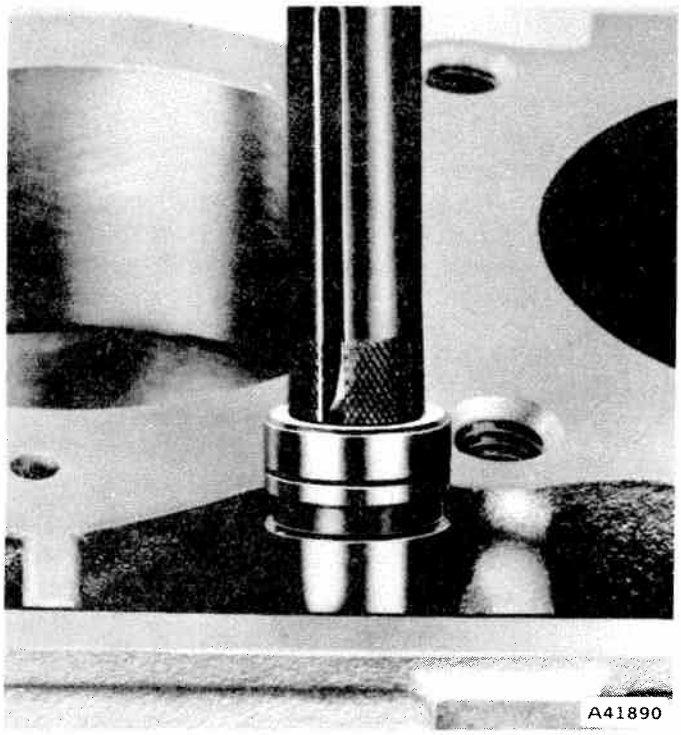

Fig. 1A-20 Hydraulic Tappet Removal

Hydraulic Tappet Leak-Down Test and Assembly

After cleaning and inspection, the tappet must be "leak-down" tested to ensure its "zero-lash" operating ability. Figure 1A-21 illustrates Tool J-5790 used to test tappet "leak-down" accurately.

(1) Fill tappet body with Valve Tappet Test Oil J-5268.

(2) Install plunger return spring, plunger assembly, and plunger cap in tappet body. Do not install lock ring for test.

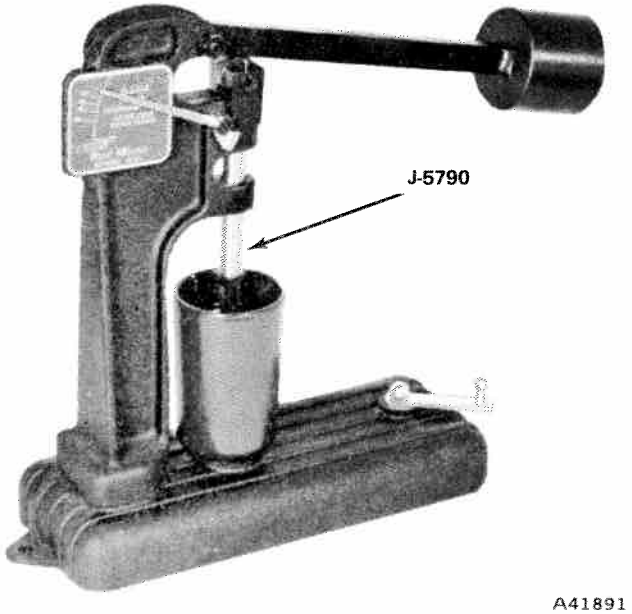

Fig. 1A-21 Hydraulic Tappet Leak-Down Test

(3) Place a 0.312 to 0.313-inch diameter ball bearing on plunger cap.

(4) Place tappet in tester.

(5) Lift weighted arm, place tester push rod on ball bearing in plunger cap, adjust push rod to set tester gauge to Start.

(6) Release weighted arm and time tappet leak-down.

(7) A good tappet will take 20 to 110 seconds to leak-down with a load travel of 0.125-inch as indicated on tester gauge.

(8) Install lock rings on acceptable tappets. Discard unacceptable tappets.

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

Installation

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

(2) Use Hydraulic Valve Tappet Remover and Installer Tool J-21884 and install tappets in same bores from which they were removed.

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

(4) Install rocker arms and shaft assembly and tighten retaining bolts to torque.

(5) Pour remaining EOS over entire valve train.

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

(6) Install cylinder head and gasket and tighten bolts to torque.

(7) Install cylinder head cover and gasket.

VIBRATION DAMPER

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

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

Removal

(1) Remove drive belt(s).

(2) Remove three retaining capscrews and separate accessory pulley from vibration damper, if so equipped.

(3) Remove the vibration damper retaining bolt and washer.

(4) Use Vibration Damper Remover Tool J-21791 to remove damper from the crankshaft as shown in figure 1A-22.

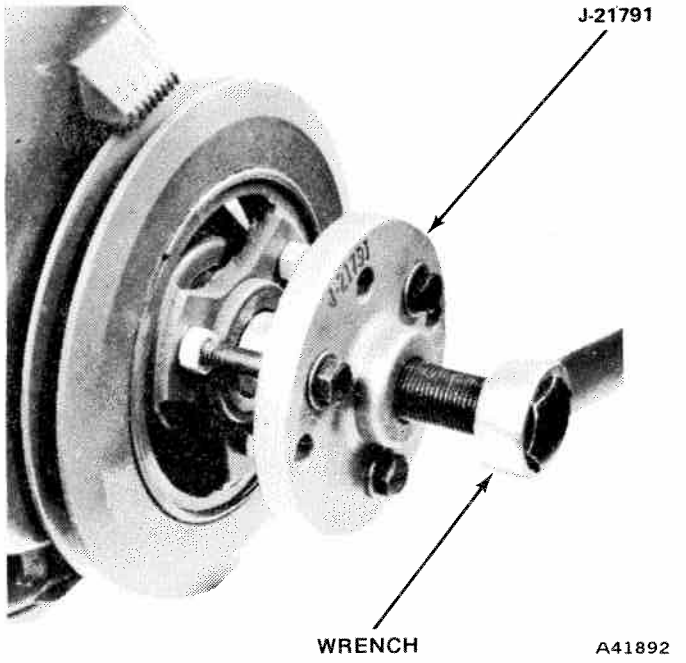

Fig. 1A-22 Vibration Damper Removal

Installation

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

(2) Install vibration damper retaining bolt and washer; tighten to 55 foot-pounds torque.

(3) If removed, install accessory pulley and retaining capscrews; tighten the screws to 23 foot-pounds torque.

(4) Install drive belt(s) and tighten to the specified tension.

TIMING CHAIN COVER

The timing chain cover is provided with a seal and oil slinger to prevent oil leakage at the vibration damper hub (fig. 1A-23).

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

Removal

(1) Remove drive belt(s), engine fan and hub assembly, accessory pulley (if equipped) and vibration damper.

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

(3) Raise timing chain cover enough to detach retaining nibs of oil pan seal from bottom side of cover (this must be done to prevent pulling the seal end tabs away from the tongues of the oil pan gaskets which would cause an oil leak and necessitate removal of the oil pan to correct).

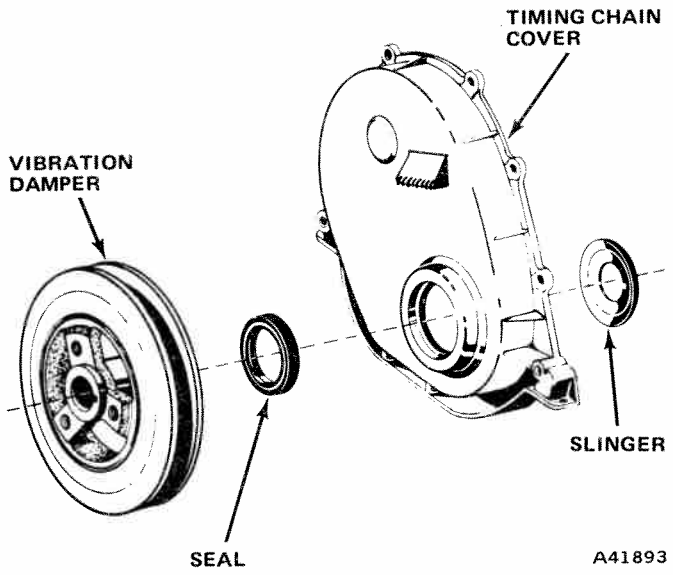

Fig. 1A-23 Timing Chain Cover

(4) Remove timing chain cover and gasket from engine.

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

(6) Clean timing chain cover, oil pan, and cylinder block gasket surfaces.

(7) Remove crankshaft oil seal from the timing chain cover.

Installation

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

(2) Cut end tabs of a new oil pan seal same as was cut off original seal.

(3) Coat seal end tabs generously with Permatex No. 2 (or equivalent) and position seal on timing chain cover (fig. 1A-24).

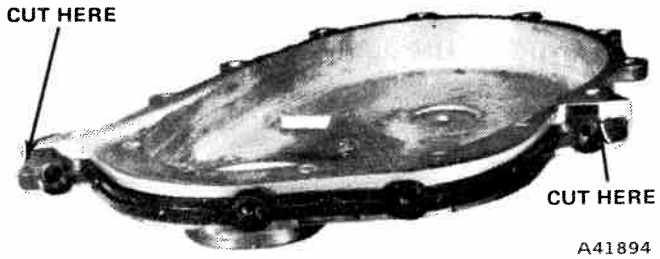

Fig. 1A-24 Oil Pan Front Seal Installation

(4) Position timing chain cover on engine. Place Timing Chain Cover Alignment Tool and Seal Installer J-22248 on crankshaft and seal opening of cover (fig. 1A-25).

(5) Install cover-to-block screws and oil pan-to-cover screws. Tighten cover-to-block screws to 5 foot-pounds torque and oil pan-to-cover screws to 11 foot-pounds torque.

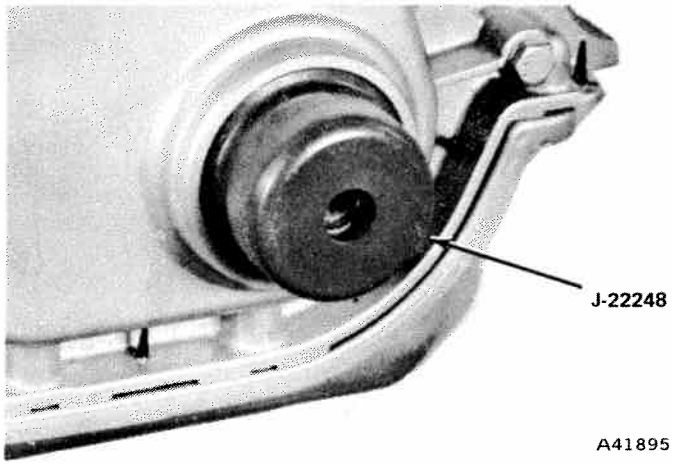

Fig. 1A-25 Timing Chain Cover Alignment

(6) Remove cover aligning tool and place a new oil seal on tool with the seal lip facing cover. Apply a light film of Perfect Seal or equivalent on the outside diameter of the seal.

(7) Insert draw screw from Tool J-9163 into seal installing tool and press seal into cover until bottomed in cover opening (fig. 1A-26).

(8) Remove tools, and apply a light film of engine oil on the seal lip.

(9) Install vibration damper and tighten retaining bolt to 55 foot-pounds torque.

(10) Install accessory pulley (if equipped).

(11) Install engine fan and hub assembly.

(12) Install drive belt(s) and tighten to specified tension.

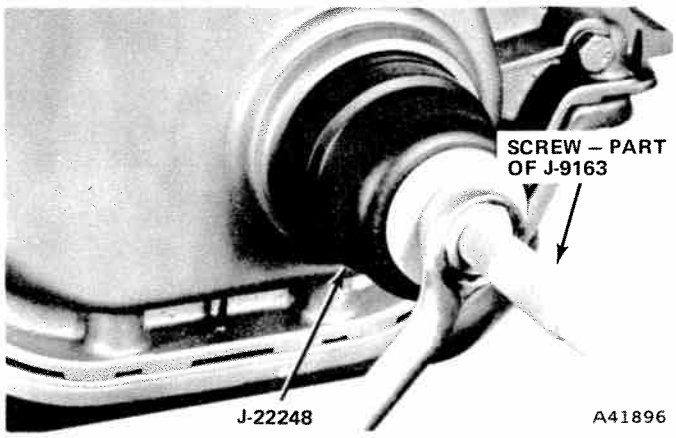

Fig. 1A-26 Timing Chain Cover Oil Seal Installation

Timing Chain Cover Oil Seal Replacement (Cover not Removed)

(1) Remove drive belts.

(2) Remove accessory drive pulley (if equipped).

(3) Remove vibration damper.

(4) Remove oil seal with Tool J-9256 as shown in figure 1A-27.

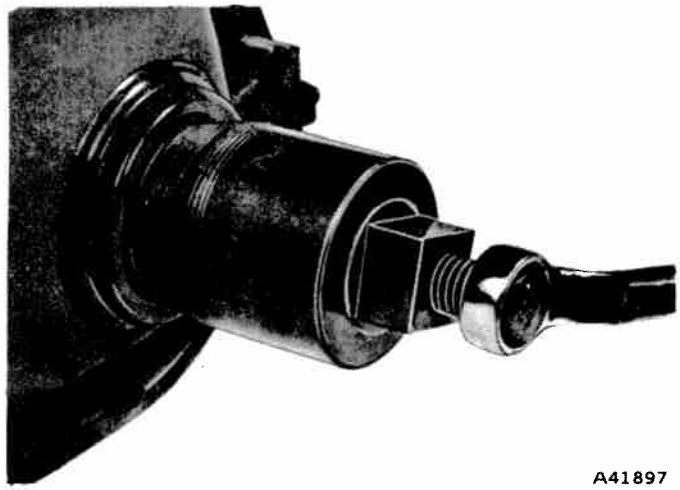

Fig. 1A-27 Timing Chain Cover Oil Seal Removal

(5) Place new oil seal on Timing Chain Cover Alignment Tool and Seal Installer J-22248 with seal lip facing outward. Apply a light film of Perfect Seal or equivalent on outside diameter of seal.

(6) Insert draw screw from Tool J-9163 into seal installing tool and press the seal into cover until bottomed in cover opening.

(7) Remove tools; apply light film of engine oil on seal lip.

(8) Install vibration damper and tighten retaining bolt to 55 foot-pounds torque.

(9) Install accessory pulley (if equipped).

(10) Install drive belt(s) and tighten to specified tension.

TIMING CHAIN

Installation of the timing chain with the timing marks of the crankshaft and camshaft sprockets properly aligned assures correct valve timing. A worn timing chain will adversely affect valve timing. If the timing chain deflects more than 1/2 inch, it should be replaced.

Checking Valve Timing

(1) After disconnecting wires, remove spark plugs.

(2) Remove cylinder head cover and gasket.

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

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

(5) Install dial indicator with end of push rod touching No. 1 cylinder intake rocker arm at push rod end. Set dial indicator to zero.

(6) Rotate crankshaft clockwise (viewed from front of engine) until dial indicator shows 0.016 inch lift.

(7) Timing mark on vibration damper should index with TDC mark on timing chain cover. If timing mark is more than 1/2 inch off TDC in either direction, valve timing is incorrect.

Removal

(1) Remove drive belt(s).
(2) Remove engine fan and hub assembly.
(3) Remove accessory pulley (if equipped).
(4) Remove vibration damper.
(5) Remove timing chain cover.
(6) Remove oil seal from timing chain cover.
(7) Remove camshaft sprocket retaining bolt and washer.
(8) Rotate crankshaft until "0" timing mark on the crankshaft sprocket is closest to and on a centerline with timing pointer of camshaft sprocket (fig. 1A-28).
(9) Remove crankshaft sprocket, camshaft sprocket and timing chain as an assembly. Disassemble chain and sprockets.

Installation

(1) Assemble timing chain, crankshaft sprocket and camshaft sprocket with timing marks aligned as shown in figure 1A-28.
(2) Install assembly to the crankshaft and camshaft.
(3) Install camshaft sprocket retaining bolt and washer and tighten to specified torque.

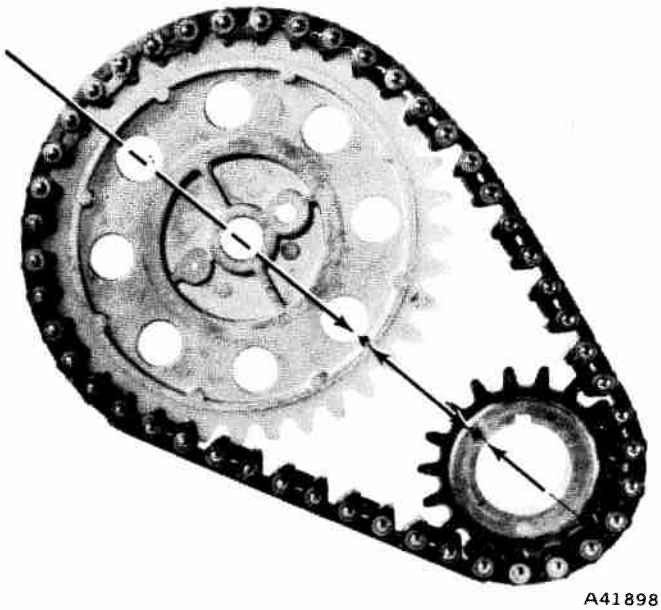

Fig. 1A-28 Timing Sprockets Alignment

NOTE: *To assure correct installation of the timing chain, locate timing mark of the camshaft sprocket at approximately one o'clock position. This should place timing mark of crankshaft sprocket where it meshes with chain (fig. 1A-29). Count number of chain pins between timing mark of both sprockets. There should be 15 pins.*

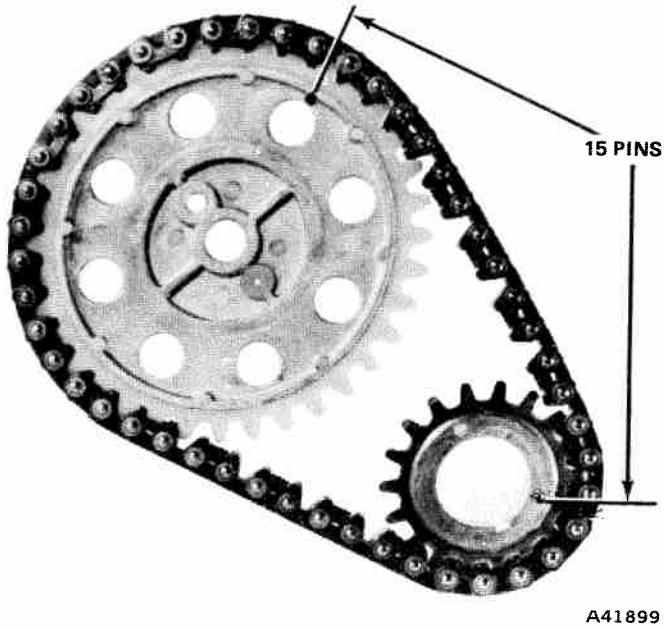

Fig. 1A-29 Timing Chain Installation

(4) Install timing chain cover and a new oil seal.
(5) Install vibration damper.
(6) Install accessory pulley (if equipped).
(7) Install engine fan and hub assembly.
(8) Install drive belt(s) and tighten to specified tension.

CAMSHAFT AND BEARINGS

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

NOTE: *It is not advisable to replace camshaft bearings unless equipped with special removing, installing, and reaming tools.*

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. Therefore, camshaft end play is zero during engine operation.

Measuring Cam Lobe Lift

(1) Remove cylinder head cover and gasket.
(2) Remove rocker arms and shaft assembly.
(3) Remove spark plugs.
(4) Install a dial indicator on end of push rod (use piece of rubber tubing between dial indicator plunger and push rod (fig. 1A-30)).

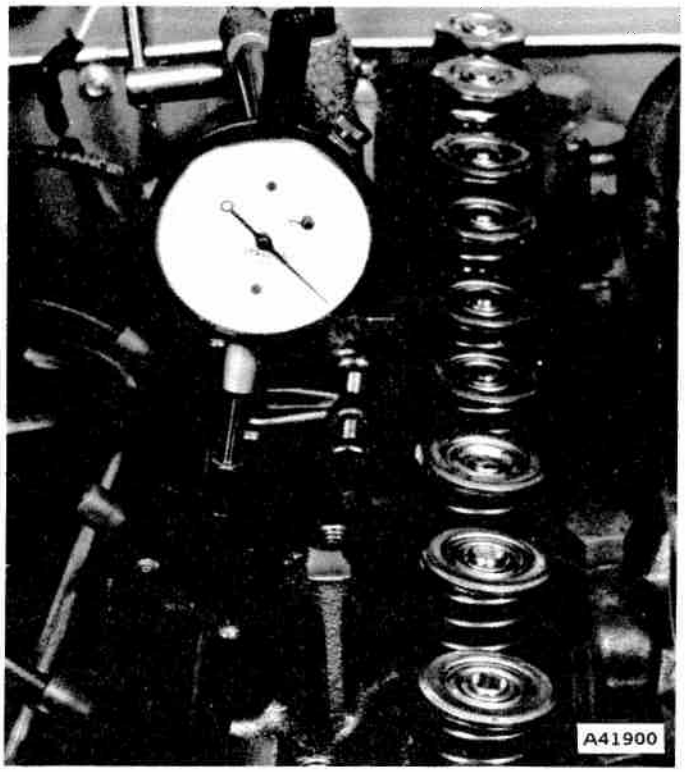

Fig. 1A-30 Cam Lobe Lift Measurement

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

(6) Rotate crankshaft until push rod reaches its maximum upward travel. Read travel at dial indicator. If the measurement is less than 0.248 inch, the camshaft is defective.

Removal

(1) Drain cooling system.
(2) Remove the radiator.
(3) Remove air conditioning condenser and receiver assembly as a charged unit (if equipped). Refer to section 13A—Air Conditioning.

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

(4) Remove cylinder head cover and gasket.
(5) Remove rocker arms and shaft assembly.
(6) Remove push rods.

NOTE: *Keep push rods and tappets in the same order as removed.*

(7) Remove cylinder head and gasket.
(8) Remove hydraulic tappets.
(9) Remove drive belt(s).
(10) Remove fan and hub assembly.
(11) Remove accessory pulley (if equipped).
(12) Remove vibration damper.
(13) Remove timing chain cover.
(14) Remove timing chain cover oil seal.
(15) Remove fuel pump.
(16) Remove distributor and ignition wires.
(17) Rotate crankshaft until "0" timing mark of crankshaft sprocket is closest to and on a centerline with timing pointer of camshaft sprocket (fig. 1A-28).
(18) Remove crankshaft sprocket, camshaft sprocket and timing chain as an assembly.
(19) Remove grille as required and remove camshaft.

Inspection

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

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

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

Installation

(1) Lubricate camshaft with Jeep Engine Oil Supplement (or equivalent).
(2) Install camshaft carefully.
(3) Install timing chain, crankshaft sprocket and camshaft sprocket with timing marks aligned (fig. 1A-28).
(4) Install camshaft sprocket retaining bolt and tighten to 50 foot-pounds.
(5) Install timing chain cover with new oil seal.
(6) Install vibration damper.
(7) Install accessory pulley (if equipped).
(8) Install engine fan and hub assembly.
(9) Install drive belt(s) and tighten to the specified tension.
(10) Install fuel pump.
(11) Rotate crankshaft until No. 1 piston is at TDC position on compression stroke.
(12) Install the distributor cap and ignition wires.

NOTE: *Install the distributor so that the rotor is aligned with the No. 1 terminal of the cap when fully seated on block.*

(13) Install the hydraulic tappets.
(14) Install cylinder head and gasket.
(15) Install push rods.
(16) Install rocker arm and shaft assembly.
(17) Install cylinder head cover and gasket.

NOTE: *The hydraulic valve tappets and all valve train components should be lubricated with Jeep Engine Oil Supplement (EOS) or equivalent during installation. The EOS must remain in the engine for at least 1,000 miles but need not be drained until the next scheduled oil change.*

(18) Install air conditioning condenser and receiver assembly (if equipped). Refer to section 13A—Air Conditioning.

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

(19) Install radiator, connect hoses, and fill cooling system to specified level.
(20) Install grille (if removed).

OIL PAN

Removal

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

Installation

(1) Install a new oil pan front seal to timing chain cover and apply a generous amount of "Permatex" No. 2, or equivalent, to the end tabs.
(2) Cement new oil pan side gaskets into position on engine block and apply a generous amount of Permatex No. 2 or equivalent to the gasket ends.
(3) Coat inside curved surface of a new oil pan rear seal with soap and apply a generous amount of Permatex No. 2 or equivalent to side gasket contacting surface of seal end tabs.
(4) Install seal in recess of the rear main bearing cap making certain it is fully seated.
(5) Apply engine oil to oil pan contacting surface of the front and rear oil pan seals.

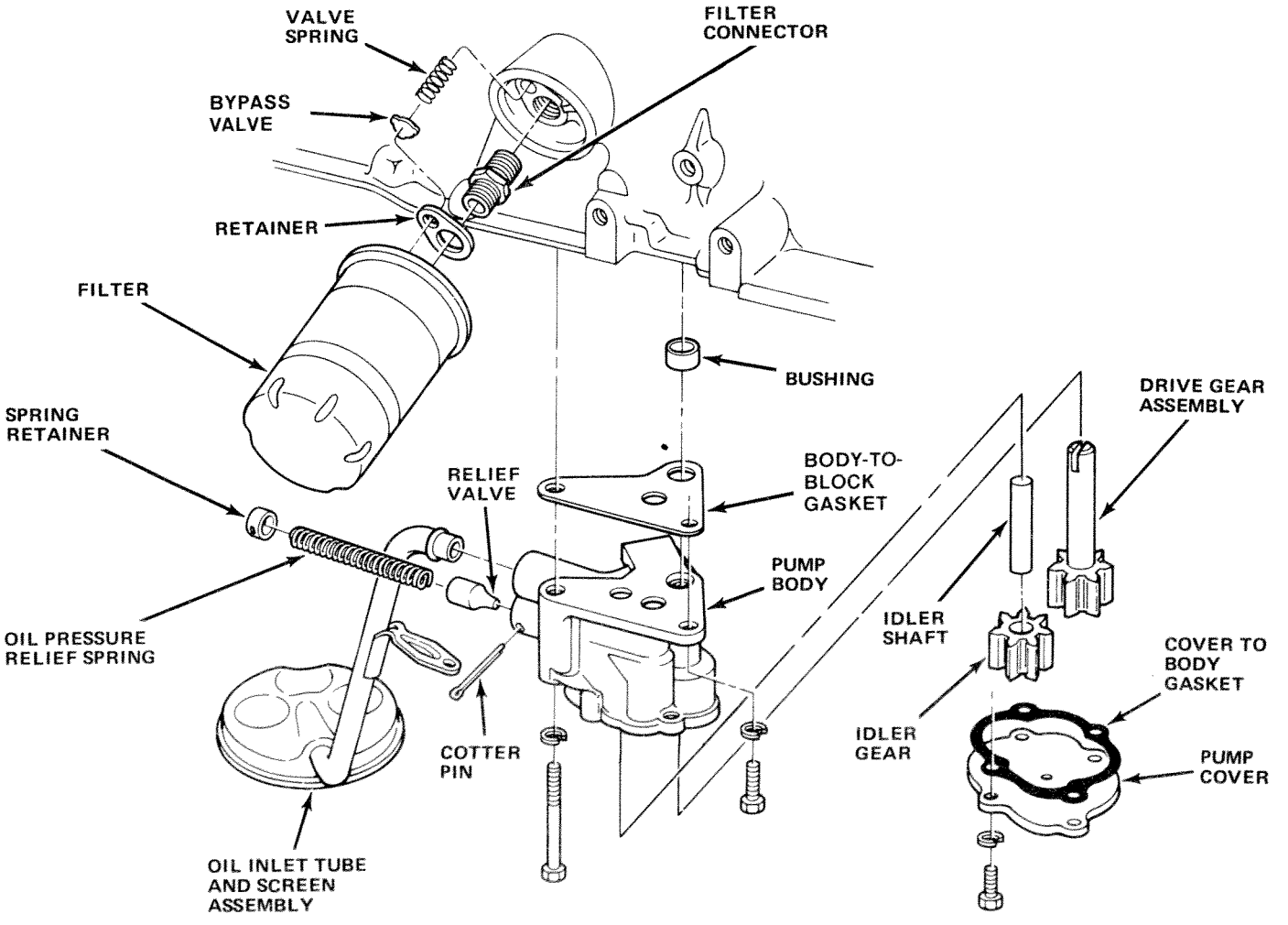

Fig. 1A-31 Oil Filter and Oil Pump Assembly

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

(7) If disconnected, lower engine and connect right support cushion bracket to block. Remove the jack.

(8) Install starter motor.

(9) Lower vehicle and fill the crankcase with new oil.

OIL FILTER

A full flow oil filter, mounted on the lower right hand side of the engine, is accessible through the hood opening. A bypass valve incorporated in the filter mounting boss provides a safety factor if the filter becomes inoperative as a result of dirt or sludge accumulation (fig. 1A-31). Tool J-22700 will facilitate removal of the oil filter.

Before installation apply a thin film of oil to the new filter gasket. Install filter until gasket contacts the seat of the adapter. Then tighten securely, by hand only. Operate engine at fast idle and check for leaks.

OIL PUMP

A positive displacement gear type oil pump is used and is driven by the distributor shaft, which in turn is driven by a gear on the camshaft. Crankcase oil enters the pump through a inlet tube and screen assembly which is a press fit in the pump body (fig. 1A-31). The pump incorporates a pressure relief valve to regulate maximum pressure. It is not adjustable. A setting of 75 pounds maximum pressure is built into the tension of the spring. In the relief position, the valve permits oil to bypass through a passage in the pump body to the inlet side of the pump.

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

Removal

(1) Drain engine oil.

(2) Remove oil pan.

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

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

Disassembly and Inspection

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

(2) Measure gear end clearance by placing a straightedge across gears and pump body. Select a feeler gauge which will fit snugly but freely between straight edge and oil pump body (fig. 1A-32). Refer to specifications for correct clearance.

If gear end clearance is less than specified, replace the oil pump assembly.

(3) Measure gear-to-body clearance by inserting a feeler gauge between gear tooth and pump body inner wall directly opposite the point of gear mesh. Select a feeler gauge which fits snugly but freely (fig. 1A-33). Rotate gears to check each tooth in this manner. Refer to specification for correct clearance.

If gear-to-body clearance is more than specified, replace idler gear, idler shaft, and drive gear assembly.

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

NOTE: *The oil inlet tube must be moved to allow removal of the relief valve; therefore, the pickup tube assembly must be replaced upon installation.*

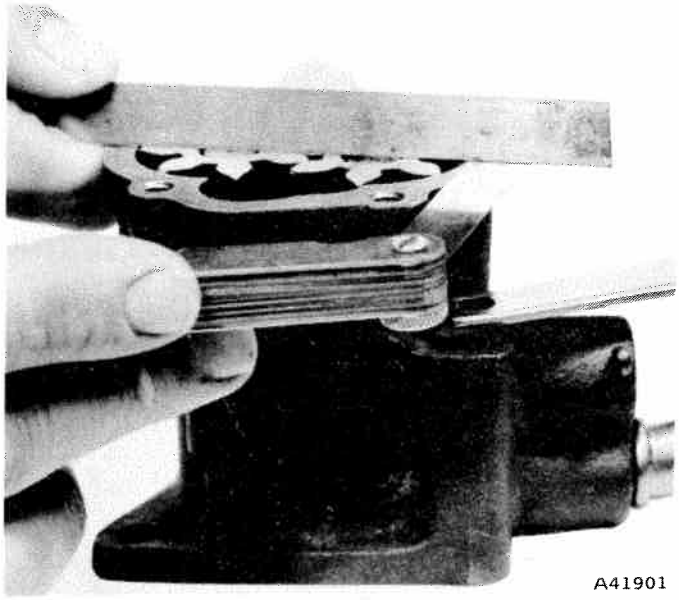

Fig. 1A-32 Oil Pump Gear End Clearance Measurement

Assembly and Installation

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

(2) If position of the inlet tube in the pump body has been disturbed, install new tube and screen assembly. Apply a light film of Permatex No. 2 or equivalent around end of tube. Using tool J-21882 (fig. 1A-34) drive tube into body making sure that support bracket is properly aligned.

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

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

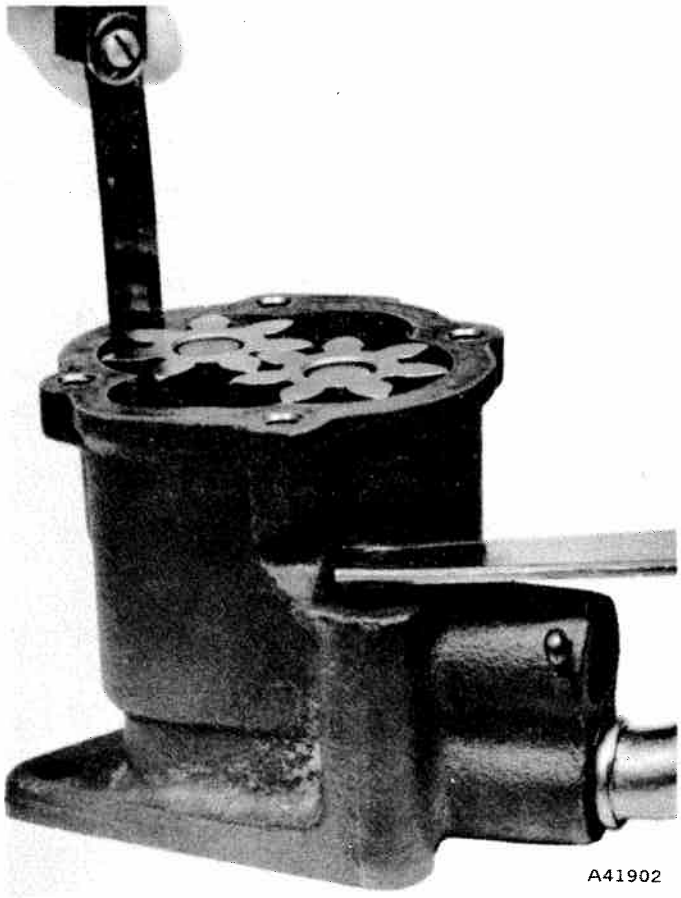

Fig. 1A-33 Oil Gear-to-Body Clearance Measurement

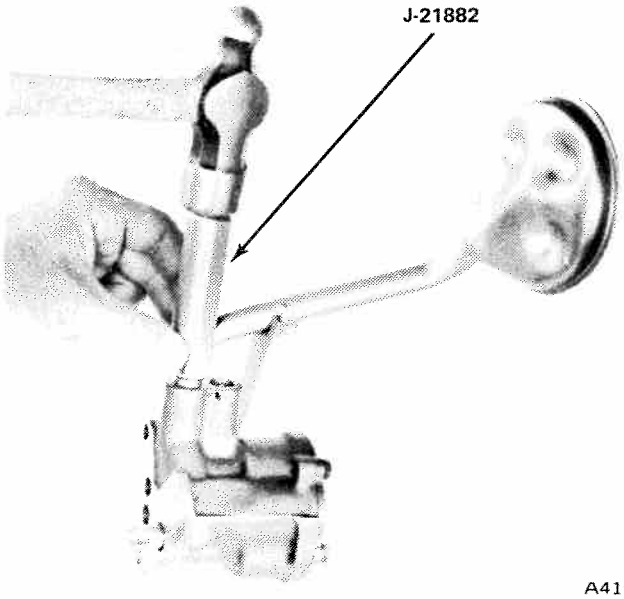

Fig. 1A-34 Oil Pump Inlet Tube Installation

(4) Install pump cover and new gasket. Tighten screws to specified torque.

NOTE: *Check operation prior to installing the oil pump.*

(5) Install oil pump and a new gasket. Tighten short screws to 10 foot-pounds torque, and long screws to 17 foot-pounds torque.

(6) Install oil pan using new gaskets and seals. Fill crankcase with new oil to specified dipstick level.

REAR MAIN BEARING OIL SEAL

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

Removal

(1) Drain engine oil.

(2) Remove oil pan.

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

(4) Loosen all remaining main bearing capscrews.

(5) With a brass drift and hammer, tap upper seal until sufficient seal is protruding to permit pulling it out completely.

Installation

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

(2) Clean gasket surfaces of oil pan and engine block. Remove all sludge and dirt from the oil pan sump.

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

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

(5) Coat block contacting surface of the upper seal with soap.

(6) Coat lip of seal with engine oil.

(7) Install upper seal into engine block.

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

(8) Coat both sides of lower seal end tabs with Permatex No. 2 or equivalent, being careful not to apply sealer to lip of seal.

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

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

(11) Coat Permatex No. 2 or equivalent on both chamfered edges of the rear main bearing cap (fig. 1A-35).

(12) Install rear main bearing cap and inserts.

(13) Tighten all main bearing capscrews to 80 foot-pounds torque.

(14) Install oil pan using new gaskets and seals. Tighten drain plug securely.

(15) Fill the crankcase with new oil to the specified dipstick level.

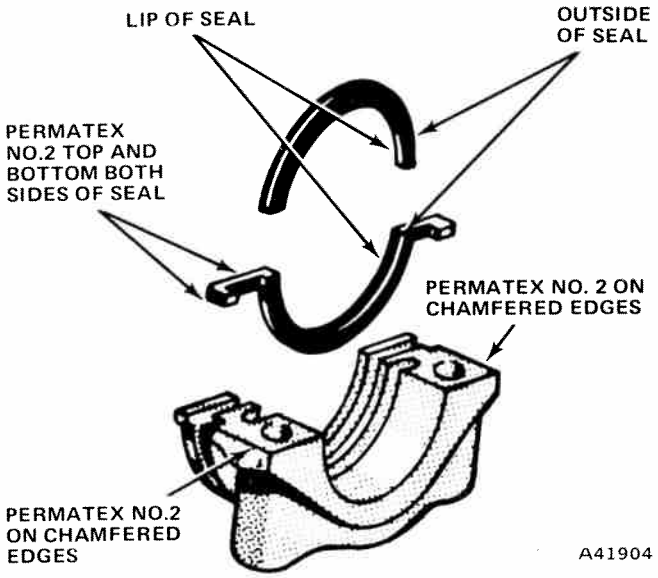

Fig. 1A-35 Rear Main Oil Seal and Cap Installation

CYLINDER BLOCK

Disassembly

(1) Remove engine as outlined under Engine Removal.

(2) Separate transmission from engine assembly. Refer to appropriate Transmission Section.

(3) Place engine assembly on engine stand.

(4) Remove intake and exhaust manifolds.

(5) Remove cylinder head cover and gasket.

(6) Remove rocker arms and shaft assembly.

(7) Remove push rods.

(8) Remove cylinder head and gasket.

(9) Remove valve tappets.

(10) Remove drive pulley and vibration damper.

(11) Remove timing chain cover.

(12) Remove timing chain and sprockets.

(13) Remove camshaft.

(14) Position pistons (one at a time) near bottom of stroke and use a ridge reamer to remove any ridge from top end of cylinder walls.

(15) Remove oil pan and gaskets.

(16) Remove oil pump.

(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 cylinder to which they were assembled.*

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

NOTE: *Be careful that connecting rod bolts do not scratch the connecting rod journals or cylinder walls.*

(19) Remove main bearing caps and inserts.

(20) Remove crankshaft.

Assembly

(1) Install upper main bearing inserts in cylinder block.

(2) Install crankshaft.

(3) Install main bearing caps and inserts. Tighten bolts to 80 foot-pounds torque.

(4) After thoroughly cleaning cylinder bores, apply a light film of clean engine oil to bores with a clean lint-free cloth, or paper towel.

(5) Position piston rings on piston as follows:

(a) No. 1 compression ring gap is 180° from No. 2 compression ring gap.

(b) Oil control ring spacer expander gap is at least 90° from No. 2 compression ring gap.

(c) Oil control ring gaps are 90° from expander gap with at least 30° between each ring gap.

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

(7) Use Piston Ring Compressor Tool J-5601 to install connecting rod and piston assemblies through the top of the cylinder bores (fig. 1A-36).

NOTE: *Be careful that connecting rod bolts do not scratch the connecting rod journals or cylinder walls.*

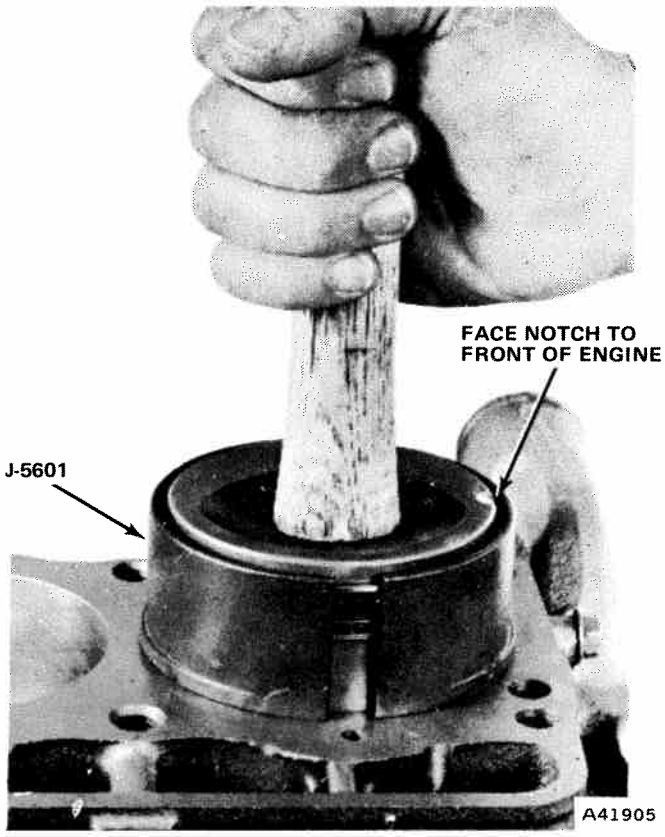

Fig. 1A-36 Piston-to-Bore Installation

NOTE: *Lengths of rubber hose over the connecting rod bolts will provide protection during installation.*

(8) Install connecting rod bearing caps and inserts in the same order as removed. Tighten retaining nuts to 28 foot-pounds torque.

(9) Install oil pump.

(10) Install engine oil pan using new gaskets and seals. Tighten drain plug securely.

(11) Install camshaft.

(12) Install timing chain cover.

(13) Install vibration damper and drive pulley.

(14) Install valve tappets.

(15) Install gasket and cylinder head.

(16) Install push rods.

(17) Install rocker arms and shaft assembly.

(18) Install cylinder head cover and gasket.

(19) Install intake and exhaust manifolds.

(20) Remove engine from engine stand.

(21) Reconnect transmission to engine assembly.

(22) Install engine assembly as outlined under Engine Installation.

Cylinder Bore Reconditioning

(1) Check cylinders for taper with an inside micrometer (from top to bottom).

(2) Check for an out-of-round condition by measuring across cylinder bores at two points (parallel to crankshaft and perpendicular to crankshaft).

(3) If cylinder taper does not exceed 0.005 inch and out-of-round does not exceed 0.003 inch, cylinder bore may be trued by honing. If cylinder taper or out-of-round condition exceeds these limits, cylinder must be bored and then honed for an oversize piston.

NOTE: *When finish-honing the cylinder bores, move the hone up and down at sufficient speed to produce a uniform cross hatch pattern on the cylinder walls.*

(4) Removal of glaze from the cylinder wall for faster ring seating can be accomplished by various methods. When an expanding type hone is used, do not use more than ten strokes to recondition a cylinder wall (a stroke is one down and up movement). The engine bearings and lubrication system must be protected from abrasives.

NOTE: *Rigid type hones are not to be used to remove cylinder glaze since a slight amount of taper always exists in cylinder walls after the engine has been in service.*

(5) Prior to fitting pistons, the cylinder bores should be scrubbed clean with a hot water and detergent solution. Immediately after cleaning, apply light engine oil to the cylinder walls and then wipe with a clean lint-free cloth or paper towels.

CONNECTING ROD AND PISTON ASSEMBLIES

NOTE: *The following procedures may be used to service connecting rod and piston assemblies with engine in the vehicle.*

Removal

(1) Remove cylinder head cover and gasket.

(2) Remove rocker arms and shaft assembly.

(3) Remove push rods.

(4) Remove cylinder head and gasket.

(5) Position pistons one at a time near bottom of stroke and use a ridge reamer to remove any ridge from top end of cylinder walls.

(6) Drain the engine oil.

(7) Remove oil pan and gaskets.

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

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

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

NOTE: *Be careful that connecting rod bolts do not scratch the connecting rod journals or cylinder walls.*

Installation

(1) After thoroughly cleaning cylinder bores, apply a light film of clean engine oil to bores with a clean lint-free cloth or paper towel.

(2) Position piston rings on pistons as follows:

(a) No. 1 compression ring gap is 180° from No. 2 compression ring gap.

(b) Oil control ring spacer expander gap is at least 90° from No. 2 compression ring gap.

(c) Oil control ring gaps are 90° from expander gap with at least 30° between each ring gap.

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

(4) Use Piston Ring Compressor Tool J-5601 to install connecting rod and piston assemblies through the top of the cylinder bores (fig. 1A-36).

NOTE: *Be careful that connecting rod bolts do not scratch the connecting rod journals or cylinder walls.*

NOTE: *Lengths of rubber hose over the connecting rod bolts will provide protection during installation.*

(5) Install connecting rod bearing caps and inserts in the same order as removed. Tighten retaining nuts to 28 foot-pounds torque.

(6) Install engine oil pan using new gaskets and seals. Tighten drain plug securely.

(7) Install gasket and cylinder head.

(8) Install push rods.

(9) Install rocker arms and shaft assembly.

(10) Install cylinder head cover and gasket.

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

CONNECTING RODS

The connecting rods are cast iron, balanced assemblies with bearing inserts at the crankshaft journal end.

The piston pin is assembled into the rod with 2,000 lbs. pressure (press-fit). Replace any rod that does not require such a press-fit.

Misaligned or bent connecting rods will cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearing, or crankshaft connecting rod journals. If wear patterns or damage to any of the above mentioned components indicate the probability of a misaligned connecting rod, check rod alignment. Misaligned or bent rods must be replaced.

Side Clearance Measurement

(1) Slide snug-fitting feeler gauge between connecting rod and crankshaft rod journal flange.

(2) Refer to specifications. Replace connecting rod if side clearance is not to specifications.

Connecting Rod Bearings

The connecting rod bearings are steel-backed, sintered copper, lead-alloy precision type.

Each bearing is selectively fitted to its respective journal to obtain the desired operating clearance. In production the select fit is obtained by using various sized, color coded bearing inserts as shown in the bearing fitting chart.

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

When required, different sized upper and lower bearing inserts may be used as a pair; therefore, a standard size insert is sometimes used in combination with a 0.001 inch undersize insert to reduce clearance 0.0005 inch.

NOTE: *Never use a pair of bearing inserts with more than 0.001 inch difference in size.*

Example:

	Correct	Incorrect
Upper	Standard	Standard
Lower	0.001 inch undersize	0.002 inch undersize

Service replacement bearing inserts are available as pairs in the following sizes: standard, 0.001-, 0.002-, 0.010- and 0.012-inch undersize.

Removal

(1) Drain engine oil.

(2) Remove oil pan and gaskets.

(3) Rotate crankshaft as required to position two connecting rods at a time at bottom of stroke.

(4) Remove connecting rod bearing caps and then remove lower bearing insert.

(5) Remove upper bearing insert by springing it out of connecting rod.

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

(6) Inspect bearing inserts for abnormal wear or damage. Bearing inserts with either condition should be replaced.

(7) Wipe connecting rod journals clean and use a micrometer to check for out-of-round condition. Refer to specifications. If any rod journal is not within specifications, it must be reconditioned and fitted with new undersize bearing inserts.

Measuring Bearing Clearance With Plastigage

(1) Wipe journal clean.

(2) Place a strip of Plastigage across full width of lower insert at the center of bearing cap.

(3) Install bearing cap to connecting rod and tighten retaining nuts to 28 foot-pounds torque.

(4) Remove bearing cap and determine amount of clearance by measuring the width of the compressed Plastigage with the scale furnished (fig. 1A-37).

CONNECTING ROD BEARING FITTING CHART

CRANKSHAFT CONNECTING ROD JOURNAL COLOR CODE AND DIAMETER	BEARING COLOR CODE	
	UPPER INSERT SIZE	LOWER INSERT SIZE
YELLOW – 2.0955 TO 2.0948 INCHES ORANGE – 2.0948 TO 2.0941 INCHES BLACK – 2.0941 TO 2.0934 INCHES RED – 2.0855 TO 2.0848 INCHES	YELLOW – STANDARD YELLOW – STANDARD BLACK – .001-INCH UNDERSIZE RED – .010-INCH UNDERSIZE	YELLOW – STANDARD BLACK – .001-INCH UNDERSIZE BLACK – .001-INCH UNDERSIZE RED – .010-INCH UNDERSIZE

A41906

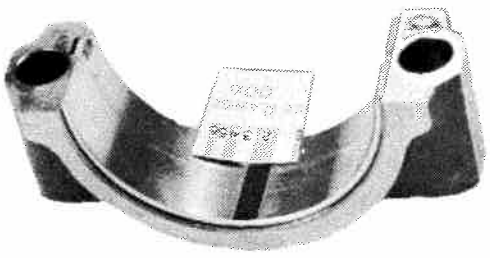

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Fig . 1A-37 Bearing Clearance Measurement with Plastigage

Measuring Bearing Clearance with Micrometer

(1) Wipe connecting rod journal clean.

(2) Use micrometer to measure maximum diameter of rod journal.

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

Installation

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

(2) Install bearing inserts, cap, and retaining nuts. Tighten to 28 foot-pounds torque.

CAUTION: *Care must be exercised when rotating the crankshaft with bearing caps removed. Be sure the connecting rod bolts do not accidentally come in contact with the rod journals and scratch the finish. Bearing failure would result.*

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

(4) Fill crankcase with new oil to specified dipstick level.

PISTONS

Aluminum alloy Autothermic pistons, steel reinforced for strength and controlled expansion, are used. The ring belt area above the piston pin provides for three piston rings: two compression and one oil control ring.

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

A notch in the top perimeter of the piston ensures correct installation in the bore. Notch must face front of engine when installed (fig. 1A-38).

Fitting Pistons

Pistons are fitted to their respective bores by measuring the inside diameter of the cylinder bore at a point 2-5/16-inches below the top of bore, and the outside diameter of the piston. Pistons are cam ground and must be measured at right angles to piston pin at centerline of pin (fig. 1A-39). The difference between cylinder bore diameter and piston diameter is piston-to-bore clearance.

Piston Rings

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

Ring Fitting

(1) Clean carbon from all ring grooves. The oil drain openings in the oil ring grooves and pin boss must be open. Be careful not to remove metal from the grooves or lands since this will change the ring groove clearances and destroy ring-to-land seating.

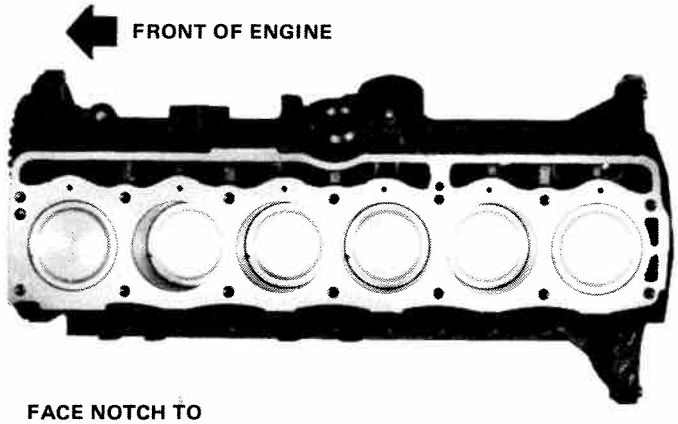

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Fig. 1A-38 Pistons Correctly Positioned in Bores

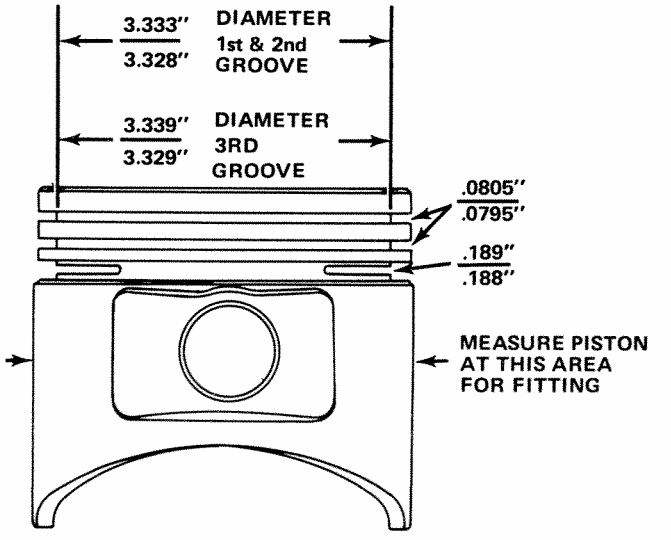

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Fig. 1A-39 Piston Measurements

(2) Check ring side clearance with feeler gauge fitted snugly between ring land and ring. Rotate ring in groove; it must move freely at all points (fig. 1A-40).

Side clearance between land and rings should be as listed in the specifications.

Fig. 1A-40 Ring Side Clearance

(3) Place ring in bore and push down with an inverted piston to a position near lower end of ring travel. Measure ring gap or joint clearance with feeler gauge fitted snugly in ring opening (fig. 1A-41).

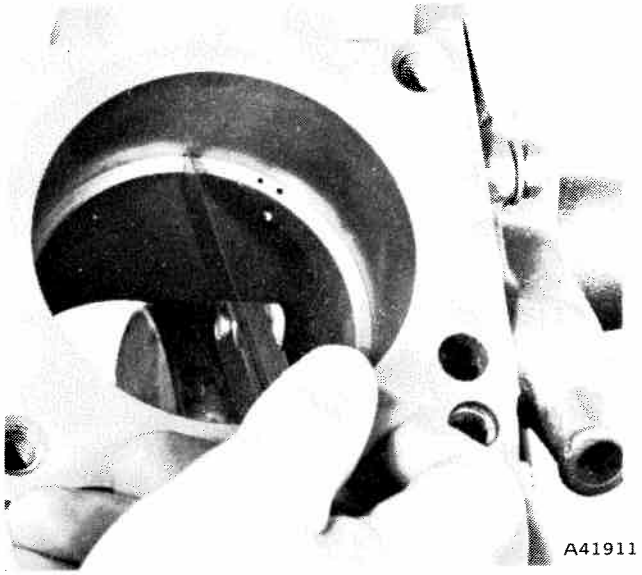

Fig. 1A-41 Ring Gap Clearance

NOTE: *When other than standard ring sizes are used, rings should be individually fitted to their respective bores.*

Installation

(1) Install oil control rings as indicated by instructions in package. It is not necessary to use a tool to install upper and lower rails (fig. 1A-42).

(2) Install lower compression ring using ring installer to expand ring around piston (fig. 1A-43).

NOTE: *Make certain upper and lower compression rings are installed properly. Figure 1A-44 shows typical ring markings indicating the top side of the ring.*

(3) Install upper compression ring using ring installer to expand ring around piston (fig. 1A-43).

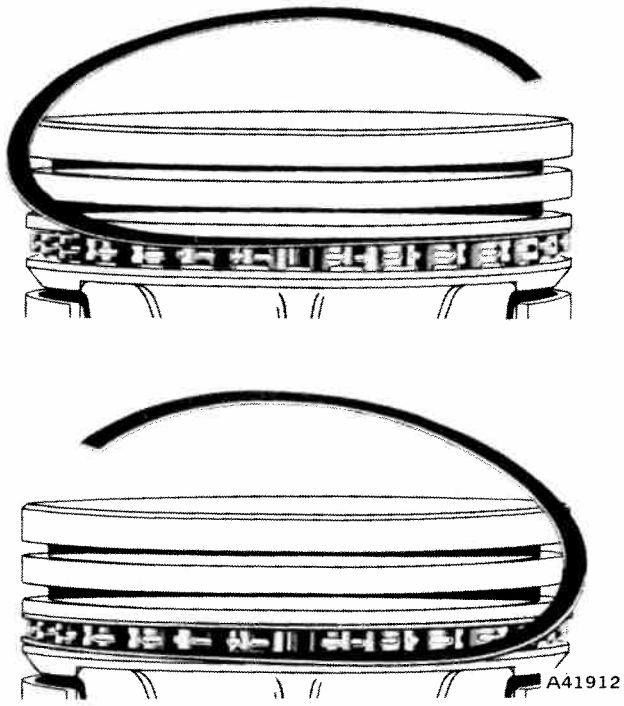

Fig. 1A-42 Oil Control Ring Rail Installation

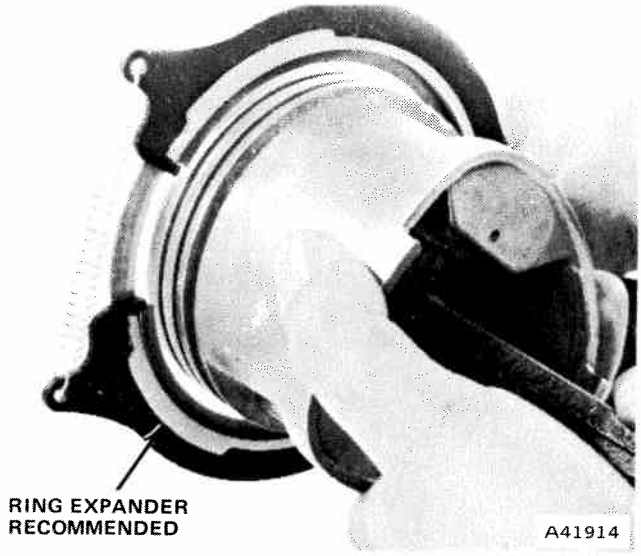

Fig. 1A-43 Compression Ring Installation

Piston Pins

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

Removal

(1) Using Piston Pin Remover J-21872 and an arbor

press, place piston on remover support J-21872-1 (fig. 1A-45).

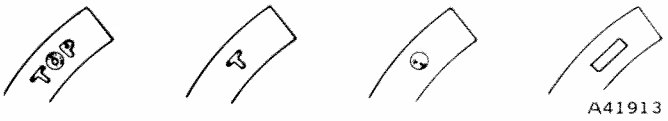

Fig. 1A-44 Typical Piston Ring Markings

(2) Using piloted driver J-21872-3, press pin completely out of piston. Note position of pin through gauge window of remover support (fig. 1A-45).

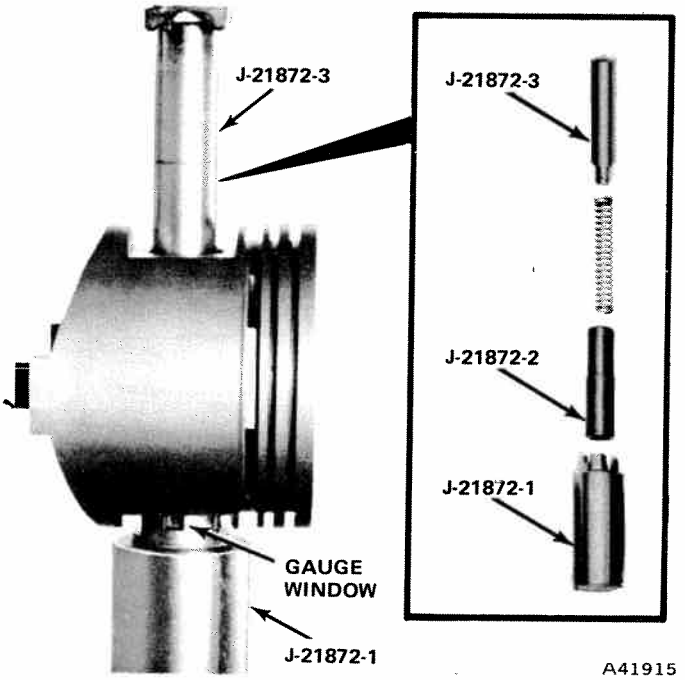

Fig. 1A-45 Piston Pin Removal or Installation

Pin Fitting

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

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

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

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

Installation

(1) Insert pin pilot J-21872-2, through piston and connecting rod pin bores (fig. 1A-45).

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

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

(4) Position piloted driver, J-21872-3, inside piston pin.

(5) Using arbor press, press piston pin through connecting rod and piston until pin pilot indexes with mark on support (fig. 1A-45).

NOTE: *The piston is a 2,000 lb. press-fit. If little effort is required to install piston pin in connecting rod, or if rod moves along pin, a new connecting rod is required.*

(6) Remove piston and connecting rod assembly from press. Pin should be centered in rod, plus or minus 0.0312 inch.

CRANKSHAFT

The crankshaft is cast-iron and is counterweighted and balanced. The 232 CID engine crankshaft has eight counterweights, and the 258 CID engine crankshaft has twelve counterweights. Both have seven main bearings and six connecting rod journals.

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

NOTE: *On engines equipped with automatic transmissions, the torque converter and converter flexplate must be marked prior to removal and re-installed in the same position.*

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

Removal or Replacement

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

Crankshaft End Play Measurement

The crankshaft end play is controlled at the No. 3 main bearing insert which is flanged for this purpose.

(1) Attach a dial indicator to cylinder block adjacent to No. 3 main bearing.

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

(3) Pry shaft fore and aft. Read dial indicator (fig. 1A-46).

(4) The correct crankshaft end play is listed in Specifications. Replace thrust bearing if end play is not to specifications.

NOTE: *When replacing the thrust bearings, it is recommended to pry the crankshaft fore and aft to align the faces of the thrust bearings.*

Measuring Main Bearing Journal With A Micrometer (Crankshaft Removed)

(1) Clean main bearing journal.
(2) Measure maximum diameter of journal with a micrometer.
(3) Compare reading obtained with journal diameters listed in the Main Bearing Fitting Chart and select inserts required to obtain the specified bearing clearance.

Crankshaft Main Bearings

The main bearings are steelbacked, sintered copper, lead alloy precision type. Each bearing is selectively fitted to its respective journal to obtain the desired operating clearance. In production the select fit is obtained by using various sized color coded bearing inserts as shown in the Main Bearing Fitting Chart.

The main bearing journal size is identified (in production) by a color coded paint mark on the adjacent cheek toward the flanged (rear) end of the crankshaft, except for the rear main journal which is on the crankshaft rear flange.

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 undersize insert to reduce clearance by 0.005 inch.

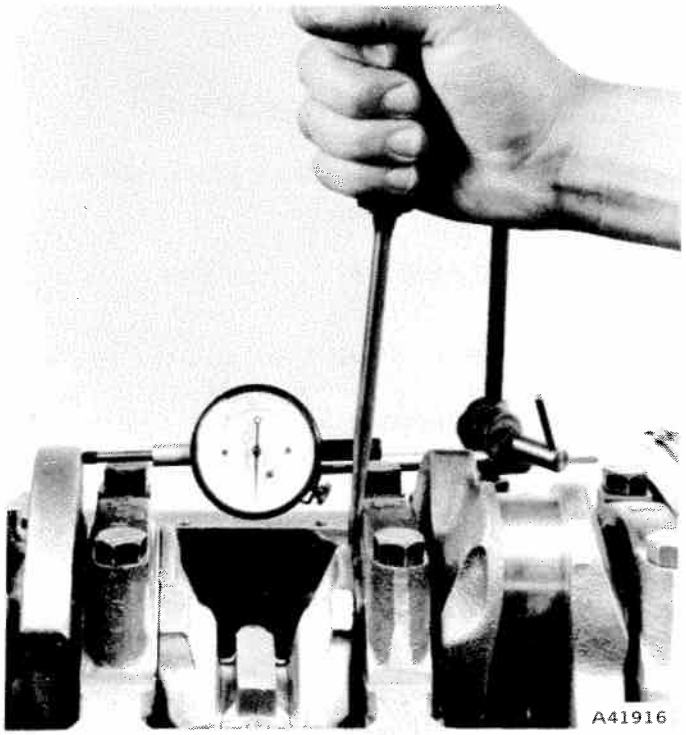

Fig. 1A-46 Crankshaft End Play Measurement

Example:

Correct	Incorrect
Upper—Standard	Standard
Lower—0.001 inch undersize	0.002 inch undersize

CAUTION: *Never use bearing inserts in pairs with greater than 0.001 inch difference in size. When replacing inserts, all the odd size inserts must be either on the top or the bottom.*

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

Removal and Inspection

(1) Drain the engine oil.
(2) Remove oil pan.
(3) Remove main bearing cap and insert.
(4) Inspect bearing insert for abnormal wear or damage. If either condition exists, both upper and lower inserts must be replaced. Refer to Measuring Bearing Clearance With Plastigage to select bearing inserts required to obtain the specified bearing clearance.
(5) Inspect crankshaft main journal. If damaged, it must be either reconditioned or replaced.
(6) Remove upper insert by loosening all of other bearing caps and inserting a small cotter pin in the crankshaft oil hole (head of pin should be large enough that it will not fall into oil hole, yet thinner than the thickness of the bearing).
(7) With pin in place, rotate crankshaft so that upper bearing insert will rotate in the direction of its locating tongue.
(8) Remove and inspect remaining bearings one at a time in the same manner.

Measuring Bearing Clearance With Plastigage (Crankshaft Installed)

(1) Support weight of crankshaft with a jack or stand place under counterweight (adjacent to main bearing being checked).

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

(2) Remove main bearing cap and insert.
(3) Clean insert and exposed portion of the crankshaft journal.
(4) Place a strip of Plastigage across full width of the bearing insert.
(5) Install bearing cap and tighten bolts to 80 foot-pounds torque.

MAIN BEARING FITTING CHART

CRANKSHAFT MAIN JOURNAL COLOR CODE AND DIAMETER	BEARING COLOR CODE	
	UPPER INSERT SIZE	LOWER INSERT SIZE
YELLOW – 2.5001 TO 2.4996 INCHES	YELLOW – STANDARD	YELLOW – STANDARD
ORANGE – 2.4996 TO 2.4991 INCHES	YELLOW – STANDARD	BLACK – .001-INCH UNDERSIZE
BLACK – 2.4991 TO 2.4986 INCHES	BLACK – .001-INCH UNDERSIZE	BLACK – .001-INCH UNDERSIZE
GREEN – 2.4986 TO 2.4981 INCHES	BLACK – .001-INCH UNDERSIZE	BLACK – .002-INCH UNDERSIZE
RED – 2.4901 TO 2.4896 INCHES	RED – .010-INCH UNDERSIZE	RED – .010-INCH UNDERSIZE

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(6) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with the scale furnished (fig. 1A-47).

Installation

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

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

(3) Install main bearing cap(s) and lower insert(s). Tighten bolts evenly to 80 foot-pounds torque.

(4) After installation, turn crankshaft by hand to check for free operation.

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

(6) Fill crankcase with new oil to dipstick level.

FLYWHEEL AND STARTER RING GEAR ASSEMBLY

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

Removal (Manual Transmission)

(1) Position flywheel on an arbor press with steel blocks equally spaced under gear.

(2) Press flywheel through ring gear.

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

Installation (Manual Transmission)

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

(2) Press flywheel onto ring gear.

NOTE: *On manual transmission equipped cars, the flywheel is balanced as an individual component and also as part of the crankshaft assembly.*

Do not attempt to duplicate original flywheel balance holes when installing a service replacement. Service flywheels are balanced during manufacture.

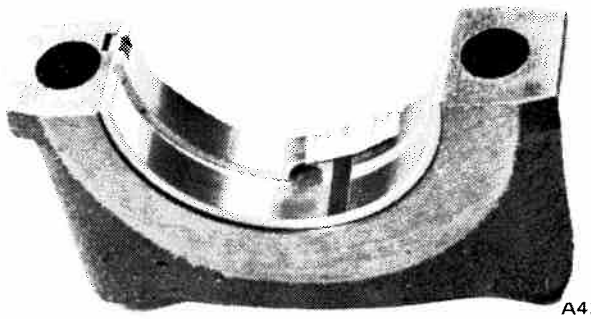

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Fig. 1A-47 Checking Main Bearing Clearance With Plastigage

SHORT ENGINE ASSEMBLY (Short Block)

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

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

NOTE: *Always install a new engine oil pump inlet tube and screen assembly when installing a short engine assembly.*

SPECIFICATIONS
(232 and 258 CID Engines)

Type . . . . . In-Line, OHV, 6-cylinder
Bore . . . . . 3.75 inches
Stroke
  232 . . . . . 3.50 inches
  258 . . . . . 3.395 inches
Displacement
  232 . . . . . 232 cubic inches
  258 . . . . . 258 cubic inches
Compression Ratio 8.0:1
Compression Pressure
  232 . . . . . 140 psi
  258 . . . . . 150 psi
Maximum Variation Between Cylinders . . . . . 20 psi
Firing Order 1-5-3-6-2-4
Net Brake Horsepower
  232 . . . . . 100 at 3600 rpm
  258 . . . . . 110 at 3500 rpm
Net Torque
  232 . . . . . 185 at 1800 rpm
  258 . . . . . 195 at 2000 rpm
Taxable Horsepower 33.75
Fuel . . . . . regular, low lead, or no-lead

CAMSHAFT

Fuel Pump Eccentric Diameter . . . 1.615 to 1.625 inches
Tappet Clearance . . . . . Zero Lash (Hydraulic tappets)
End Play . . . . . Zero (engine operating)
Bearing Clearance . . . . . 0.001 to 0.003 inch
Bearing Journal Diameter
  No. 1 . . . . . 2.029 to 2.030 inches
  No. 2 . . . . . 2.019 to 2.020 inches
  No. 3 . . . . . 2.009 to 2.010 inches
  No. 4 . . . . . 1.999 to 2.000 inches
Base Circle Runout . . . . . 0.001 inch (max)
Cam Lobe Lift . . . . . 0.254 inch
Intake Valve Timing
  Opens . . . . . 12.5° BTDC
  Closes . . . . . 66.5° ABDC
Exhaust Valve Timing
  Opens . . . . . 53.5° BBDC
  Closes (With EGR) . . . . . 25.5° ATDC
Valve Overlap
  With EGR . . . . . 38°
Intake Duration . . . . . 259°
Exhaust Duration . . . . . 259°

CONNECTING RODS

Total Weight (Less Bearings)
  232 . . . . . 557 to 665 grams
  258 . . . . . 695 to 703 grams
Total Length (Center-to-Center)
  232 . . . . . 6.123 to 6.127 inches
  258 . . . . . 5.873 to 5.877 inches
Piston Pin Bore Diameter . . . . . 0.9288 to 0.9298 inches
Bearing Clearance . . . . . 0.001 to 0.003 inch
(0.0025 inch preferred)
Side Clearance . . . . . 0.005 to 0.014 inch
Maximum Twist . . . . . 0.001 per inch
Maximum Bend . . . . . 0.0005 per inch

CRANKSHAFT

End Play . . . . . 0.0015 to 0.0065 inch
Main Bearing Journal Diameter 2.4986 to 2.5001 inches
Main Bearing Journal Width
  No. 1 . . . . . 1.086 to 1.098 inches
  No. 3 . . . . . 1.271 to 1.273 inches
  No. 2-4-5-6-7 . . . . . 1.182 to 1.188 inches
Main Bearing Clearance . . . . . 0.001 to 0.003 inch
(0.0025 inch preferred)
Connecting Rod Journal
  Diameter . . . . . 2.0934 to 2.0955 inches
Connecting Rod Journal Width . . . 1.070 to 1.076 inches
Connecting Rod Bearing Clearance 0.001 to 0.003 inch
(0.0025 inch preferred)
Maximum Out-of-Round . . . . . 0.0005 inch
Maximum Taper . . . . . 0.0005 inch

CYLINDER BLOCK

Deck Height . . . . . 9.528 to 9.534 inch
Deck Clearance
  232 . . . . . 0.575 inch (below block)
  258 . . . . . 0.110 inch (below block)
Cylinder Bore (standard) . . . . . 3.7501 to 3.7533 inches
  Maximum Cylinder Taper . . . . . 0.005 inch
  Maximum Cylinder Out-of-Round . . . . . 0.003 inch
Tappet Bore Diameter . . . . . 0.905 to 0.906 inch
Cylinder Block Flatness . . . . 0.001/1 inch, 0.002/6 inch;
0.008 inch (max)

CYLINDER HEAD

Combustion Chamber Volume . . . . . 62.5 to 65.5 cc
Valve Arrangement . . . . . EI-IE-IE-EI-EI-IE
Valve Guide ID (Integral) . . . . . 0.3735 to 0.3745 inch
Valve Stem-to-Guide Clearance . . . . 0.001 to 0.003 inch
Intake Valve Seat Angle . . . . . 30°
Exhaust Valve Seat Angle . . . . . 44.5°
Valve Seat Width . . . . . 0.040 to 0.060 inch
Valve Seat Runout . . . . . 0.0025 inch
Cylinder Head Flatness . . . . 0.001/1 inch; 0.002/6 inch;
0.008 inch (max)

LUBRICATION SYSTEM

Engine Oil Capacity . . . . . 5 quarts
(Add 1 quart with filter change)

Normal Operating Pressure. . . . . 13 psi at 600 rpm; 37 psi at 1600 rpm; 75 psi maximum
Oil Pressure Relief. . . . . 75 psi (max)
Gear-to-Body Clearance. . . . . 0.0025 to 0.0005 inch (0.0005 inch preferred)
Gear End Clearance. . . . . 0.002 to 0.006 inch (0.006 inch preferred)

PISTONS

Weight (less pin). . . . . 481 to 485 grams
Piston Pin Bore Centerline-to-Piston Top. . . . . 1.599 to 1.603 inches
Piston-to-Bore Clearance. . . . . 0.0009 to 0.0017 inch (0.0012 to 0.0013 inch preferred)
Piston Ring Gap Clearance—Compression (Both). . . . . 0.010 to 0.020 inch
Piston Ring Gap Clearance—Oil Control Steel Rails. . . . . 0.010 to 0.025 inch
Piston Ring Side Clearance
No. 1 Compression. . . . . 0.0015 to 0.003 inch (0.0015 preferred)
No. 2 Compression. . . . . 0.0015 to 0.003 inch (0.0015 preferred)
Oil Control. . . . . 0.001 to 0.008 inch (0.003 preferred)
Piston Ring Groove Height
Compression (both). . . . . 0.0795 to 0.0805 inch
Oil Control. . . . . 0.188 to 0.189 inch
Piston Ring Groove Diameter
No. 1 and No. 2. . . . . 3.328 to 3.333 inches
Oil Control. . . . . 3.329 to 3.339 inches
Piston Pin Bore Diameter. . . . . 0.9308 to 0.9313 inch
Piston Pin Diameter. . . . . 0.9304 to 0.9309 inch
Piston-to-Pin Clearance. . . . 0.0003 to 0.0005 inch loose (0.0005 inch preferred)
Piston Pin-to-Connecting Rod. . . . . 2000 lb. press-fit

ROCKER ARMS, PUSH RODS and TAPPETS

Rocker Arm Ratio. 1.5:1
Rocker Arm Shaft Diameter. . . . . 0.8575 to 0.8585 inch
Rocker Arm Bore Diameter. . . . . 0.8615 to 0.8625 inch
Push Rod Length. . . . . 9.656 to 9.666 inches
Push Rod Diameter. . . . . 0.294 to 0.303 inch
Hydraulic Tappet Diameter. . . . . 0.904 to 0.9045 inch
Tappet-to-Bore Clearance. . . . . 0.001 to 0.002 inch

VALVES

Valve Length
(Tip-to-Gauge Dim. Line). . . . 4.7895 to 4.8045 inches
With Rotator. . . . . 4.8095 to 4.8245 inches
Valve Stem Diameter. . . . . 0.3715 to 0.3725 inch
Stem-to-Guide Clearance. . . . . 0.001 to 0.003 inch
Intake Valve Head Diameter. . . . . 1.782 to 1.792 inches
Intake Valve Face Angle. . . . . 29°
Exhaust Valve Head Diameter. . . 1.401 to 1.411 inches
Exhaust Valve Face Angle. . . . . 44°
Maximum Allowable Removed for Tip Refinishing. . . . . 0.010 inch

VALVE SPRINGS

Free Length. . . . . 2.234 inches approx.
With Rotators. . . . . 2.00 inches approx.
Spring Tension
Valve Closed. . . . . 95 to 105 lbs at 1-13/16 inches
(With Rotators). . . . . 80 to 88 lbs at 1-5/8 inches
Valve Open. . . . . 188 to 202 lbs at 1-7/16 inches
(With Rotators). . . . 210 to 226 lbs at 1-3/16 inches
Inside Diameter. . . . . 0.948 to 0.968 inch
(With Rotators). . . . . 1.000 to 1.020 inches

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.

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

	Service Set-To Torque	Service In-Use Recheck Torque
Accessory Drive Pulley Screws	18	12 to 25
Air Injection Tube-to-Manifold	15	10 to 18
Air Pump-to-Bracket	20	15 to 22
Air Pump Brackets-to-Engine (A.C. Compressor or Pedestals)	25	18 to 28
Air Pump Adjusting Strap-to-Pump	20	15 to 22
Alternator Pivot Bolt or Nut	28	20 to 35
Alternator Adjusting Bolt	18	15 to 20
Alternator Mounting Bracket-to-Engine	28	23 to 30
Alternator Pivot Mounting Bolt to Head	33	30 to 35
Block Heater Nut	20 in-lb	17 to 25 in-lb
Camshaft Sprocket Screw	50	45 to 55
Carburetor Hold-Down Nuts	14	12 to 15
Coil Bracket-to-Cylinder Head	14	10 to 18
Connecting Rod Bolt Nuts	28	26 to 30
Cylinder Head Capscrews	105	95 to 115
Cylinder Head Cover Screws	50 in-lb	42 to 58 in-lb
Pulley-to-Damper Crankshaft	23	18 to 28
Clutch Housing Spacer to Block Screws	12	9 to 15
Clutch Housing-to-Block Screws (top)	27	22 to 30
Clutch Housing-to-Block Screws (bottom)	43	37 to 47

TORQUE SPECIFICATIONS (Continued)

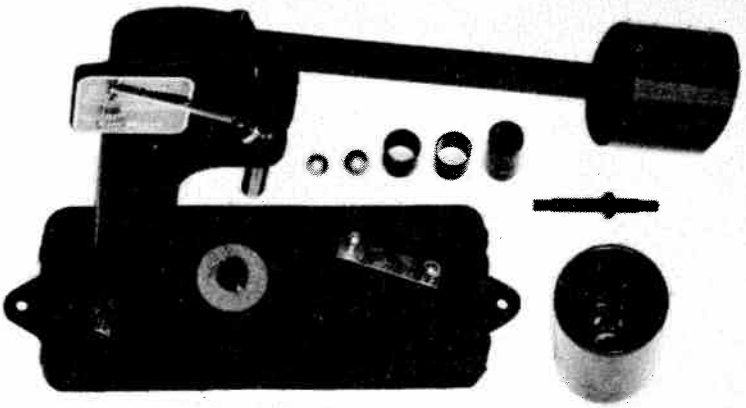
	Service Set-To Torque	Service In-Use Recheck Torque
Distributor Clamp Bracket Screw	13	10 to 18
EGR Valve	13	9 to 18
Exhaust Manifold Bolts	23	18 to 28
Exhaust Pipe-to-Manifold	23	18 to 28
Fan and Hub Assembly Bolts	18	12 to 25
Drive Plate-to-Converter Screw	22	20 to 25
Flywheel or Drive Plate-to-Crankshaft	105	95 to 120
Front Crossmember-to-Sill	65	55 min.
Front Support Bracket-to-Block	28	22 to 38
Front Support Cushion-to-Bracket	33	27 to 38
Front Support Cushion-to-Crossmember	37	30 to 45
Fuel Pump Screws	16	13 to 19
Idler Arm Bracket-to-Sill	50	35 to 60
Idler Pulley Bracket to Front Cover Nut	7	4 to 9
Idler Pulley Bearing Shaft-to-Bracket Nut	33	28 to 38
Intake Manifold Screws	23	18 to 28
Main Bearing Capscrews	80	75 to 85
Oil Pump Cover Screws	70 in-lb	60 to 80 in-lb
Oil Pump Attaching Screws (Short)	10	8 to 13
Oil Pump Attaching Screws (Long)	17	12 to 20
Oil Pan Screws—1/4-inch—20	7	5 to 9
Oil Pan Screws—5/16-inch—18	11	9 to 13
Oil Filter Adapter	48	42 to 55
Power Steering Pump Adapter Screw	23	18 to 28
Power Steering Pump Bracket Screw	43	37 to 47
Power Steering Pump Mounting Screw	28	25 to 35
Power Steering Pump Pressure Line Nut	38	30 to 45
Power Steering Pump Pulley Nut	58	40 to 65
Rear Crossmember-to-Side Sill Nut	30	20 to 35
Rear Support Cushion-to-Bracket	48	40 to 55
Rear Support Bracket-to-Transmission	33	27 to 38
Rear Support Cushion-to-Crossmember	18	12 to 25
Rocker Arm Assembly-to-Cylinder Head	21	18 to 26
Spark Plugs	28	22 to 33
Timing Chain Cover-to-Block Screws	5	4 to 8
Thermostat Housing Screw	13	10 to 18
Vibration Damper Screw	55	48 to 64
Water Pump Screws	13	9 to 18

TECHNICAL SERVICE LETTER REFERENCE

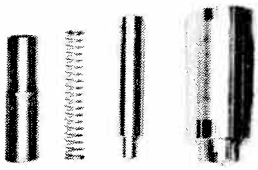
Date	Letter No.	Subject	Changes information on Page No.

J-22248
TIMING CHAIN COVER
ALIGNMENT TOOL AND
SEAL INSTALLER

SCREW, FRONT COVER
CRANKSHAFT SEAL
INSTALLER
PART OF TOOL—J-9183



J-5790
HYDRAULIC VALVE
LIFTER TESTER



J-21872
PISTON PIN REMOVER
AND INSTALLER

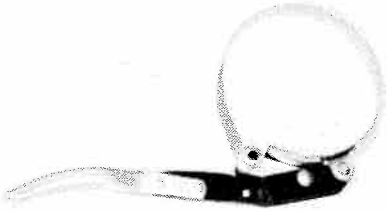
J-21882
OIL PUMP INLET
TUBE INSTALLER

J-21931
VALVE SPRING REMOVER
AND INSTALLER

J-9256
TIMING CHAIN OIL
SEAL REMOVER

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

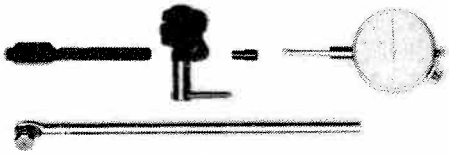
J-21884
HYDRAULIC VALVE TAPPET
REMOVER AND INSTALLER



J-22700
OIL FILTER WRENCH

J21791
VIBRATION DAMPER
REMOVER

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



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

J-5959-4
C - CLAMP AND
ROD EXTENSION

J-8056
VALVE AND CLUTCH
SPRING TESTER

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Fig. 1A-48 Six-Cylinder Engine Tools