SIX-CYLINDER ENGINE

GENERAL

The 232 and 258 CID are six-cylinder, in-line, overhead valve engines. Both engines operate only on unleaded fuel when installed in CJ Models. All Cherokee and Truck Models equipped with six-cylinder engines may use leaded or unleaded fuel. 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 the 232 and 258 CID 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).

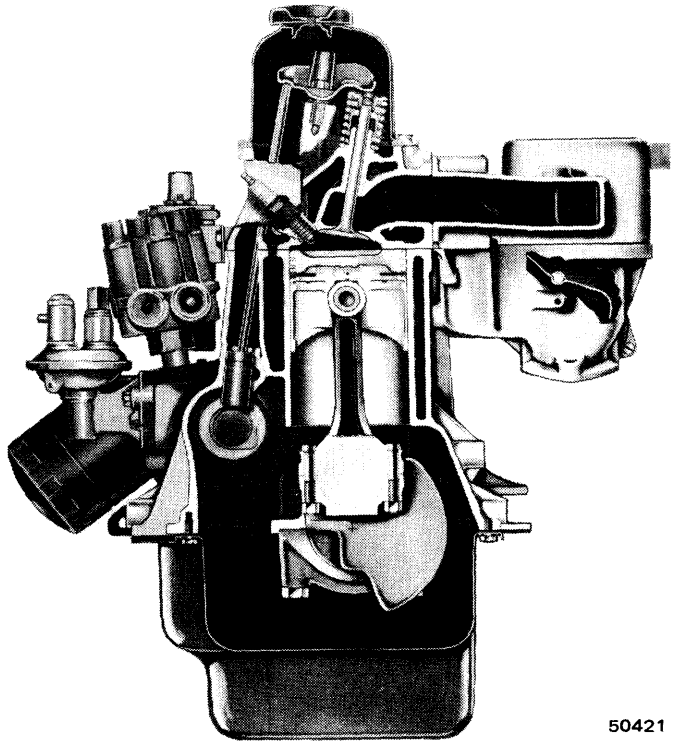

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Fig. 1A-1 Engine Assembly—Sectional View

For 1977, six-cylinder engines are built in two configurations, wedge-head and quench-head. The wedge-head is used on early production CJ models for California. This engine is identified by the temperature sending unit location at the front of the head. The quench-head is used on 49-state CJ models and all Cherokee and Truck models. It is identified by the temperature sending unit location on the left side at the rear of the head.

When replacing components, it is important to determine engine configuration. There are differences in head, pistons and block deck height.

A 258 CID engine with 2V carburetor is new for 1977. It is used on Cherokee and Truck models. This engine uses a camshaft with a lobe design different from the cam used in the 1V engine.

Identification

Build Date Code

The engine Build Date Code is located on a machined surface on the right side of the block between the No. 2 and No. 3 cylinders (fig. 1A-3).

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

The code letter identifies the cubic inch displacement,

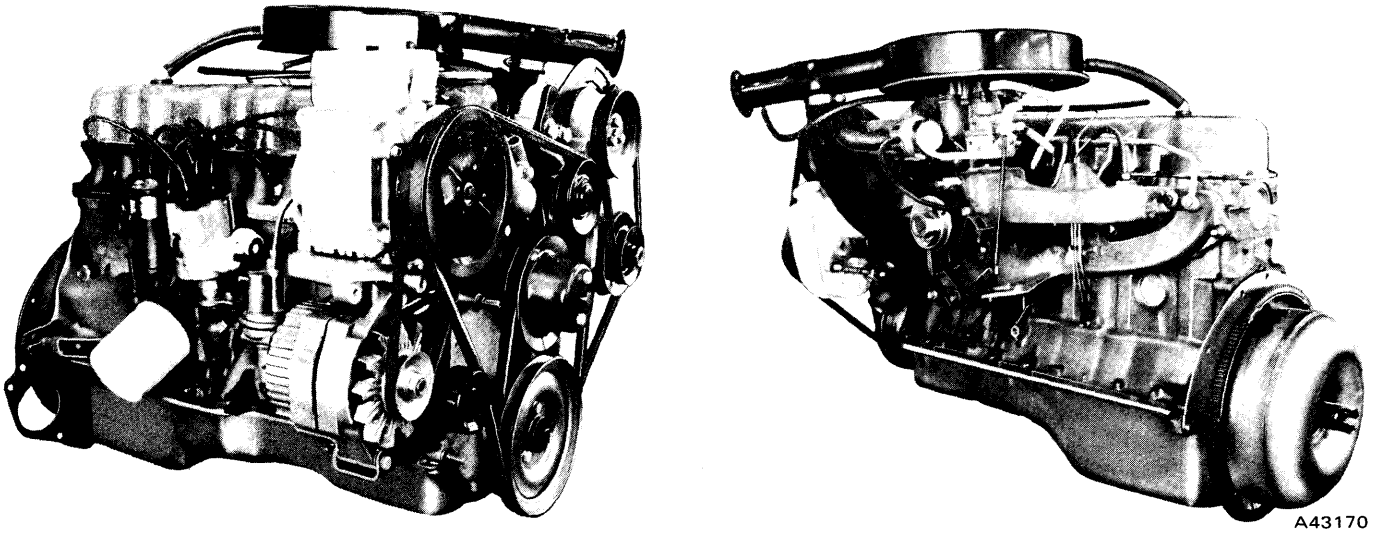

Fig. 1A-2 Engine Assembly

carburetor type and compression ratio. The letters are decoded as follows:

Engine Build Date Code

Letter Code	CID	Carburetor	Comp. Ratio
A	258	1V	8.0:1
C	258	2V	8.0:1
E	232	1V	8.0:1

1st Character (Year)	2nd and 3rd Characters (Month)	4th Character (Engine Type)	5th and 6th Characters (Day)
9 - 1976 1 - 1977	01 - 12	A, C, or E	01 - 31

EXAMPLE: 1 03 A 18

60257

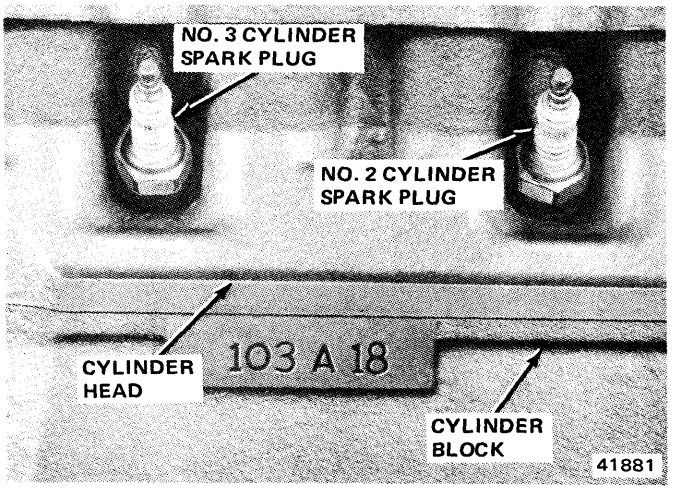

Fig. 1A-3 Build Date Code Location

The example code identifies a 258 CID with 1V carburetor and 8.00:1 compression ratio built on March 18, 1977.

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 (inside diameter of camshaft bearing is always standard). These engines are identified by a letter code stamped on a boss on the cylinder block between the ignition coil and distributor (fig. 1A-4). The letters are decoded as follows:

Oversize or Undersize Components

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.

60258

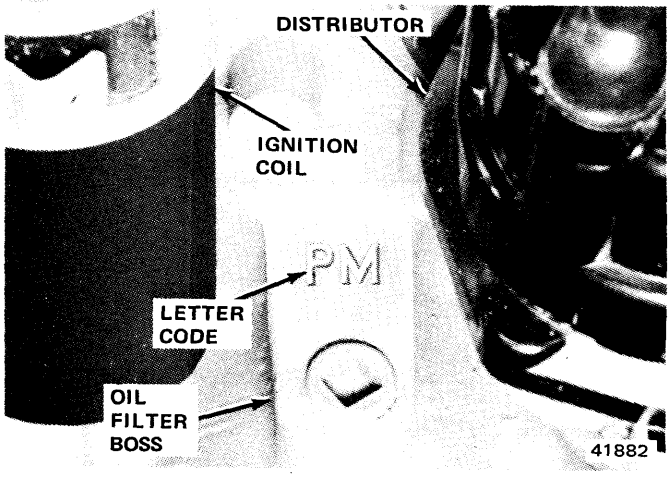

Fig. 1A-4 Oversize or Undersize Letter Code

LUBRICATION SYSTEM

A gear-type positive displacement pump is mounted at the underside of the block opposite the No. 4 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 drilled internally to pass oil from the main bearing journals (except number 4 main bearing journal) to the connecting rod journals. Each connecting rod bearing cap has a small squirt hole; oil passes through the squirt hole and is thrown off as the rod rotates. This oil throw-off lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. Oil is 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.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components, then passes down through the push rod guide holes in the cylinder head past the valve tappet area, and returns to the oil pan (fig. 1A-5).

CYLINDER LEAKAGE TEST

Satisfactory engine performance depends upon a mechanically sound engine. In many cases, unsatisfactory performance or rough idle is caused by combustion chamber leakage. A compression test alone may not show this fault. The cylinder leakage test provides an accurate means of testing engine condition. Cylinder leakage testing will poin out exhaust and intake valve leaks, leaks between cylinders or into the water jacket, or other causes of compression loss.

(1) Check coolant level and fill as required. Do not install radiator cap.

(2) Start and run engine until it reaches normal operating temperature.

(3) Remove spark plugs.

(4) Remove oil filler cap.

(5) Remove air cleaner.

(6) Set carburetor fast idle speed screw on top step of fast idle cam.

NOTE: *Shop air source for testing should maintain 70 psi minimum and 200 psi maximum (80 psi recommended).*

(7) Perform test procedure on each cylinder according to tester manufacturer's instructions.

NOTE: *While testing, listen for air escaping through carburetor, tailpipe, or oil filler cap opening. Check for bubbles in radiator coolant.*

(8) All gauge indications should be even with no more than 25% leakage. For example; at 80 psi input pressure, a minimum of 60 psi should be maintained in the cylinder. Refer to the following leakage diagnosis chart.

Cylinder Leakage Test Diagnosis

Condition	Possible Cause	Correction
AIR ESCAPES THROUGH CARBURETOR	(1) Intake Valve leaks.	(1) Refer to Valve Reconditioning under Cylinder Head.
AIR ESCAPES THROUGH TAILPIPE	(2) Exhaust Valve leaks.	(2) Refer to Valve Reconditioning under Cylinder Head.
AIR ESCAPES THROUGH RADIATOR	(3) Head Gasket leaks or crack in cylinder block.	(3) Remove cylinder head and inspect.
MORE THAN 25% LEAKAGE ON ADJACENT CYLINDER	(4) Head gasket leaks or crack in cylinder block or head between adjacent cylinders.	(4) Remove cylinder head and inspect.
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	(5) Stuck or broken piston ring(s); cracked piston; worn rings and/or cylinder wall.	(5) Inspect for broken ring(s) or piston. Measure ring gap and cylinder diameter, taper, and out-of-round.

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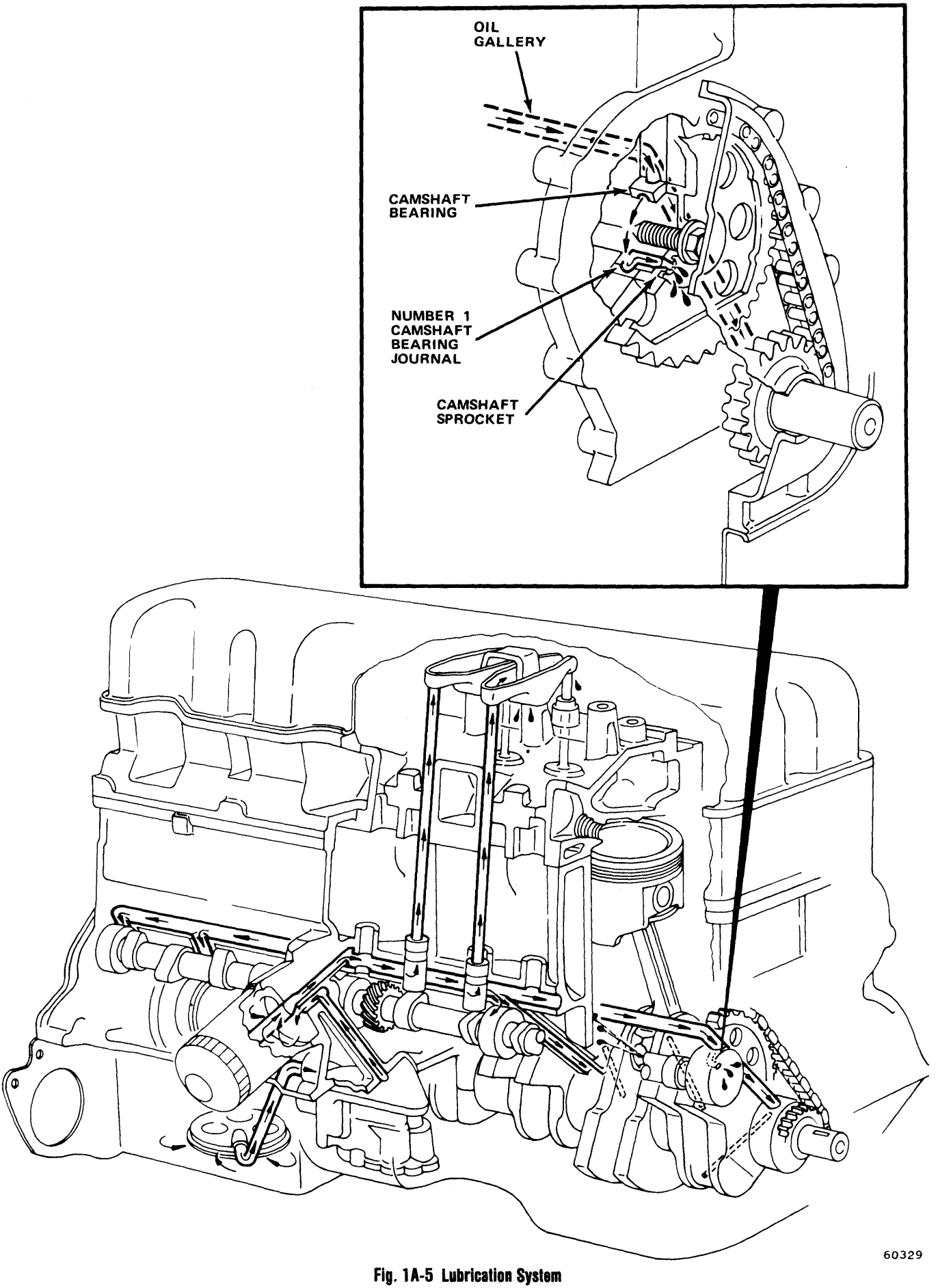

Fig. 1A-5 Lubrication System

BLOWN CYLINDER HEAD GASKET DIAGNOSIS

A blown cylinder head gasket usually results in a loss of power, loss of coolant or engine miss. A blown cylinder head gasket may develop between adjacent cylinders or between a cylinder and adjacent water jacket.

A cylinder head gasket blown between two adjacent cylinders is indicated by a loss of power or engine miss.

A cylinder head gasket blown between a cylinder and an adjacent water jacket is indicated by foaming of coolant or overheating and a loss of coolant.

Replace a blown cylinder head gasket using the procedures outlined in this chapter.

Cylinder-to-Cylinder Leak Test

To determine if the cylinder head gasket is blown between cylinders, perform a compression test as outlined under Compression Test. A cylinder head gasket blown between two cylinders will result in approximately a 50-70% reduction in compression in the two affected cylinders.

Cylinder-to-Water Jacket Leak Test

(1) Remove radiator cap and start engine. Allow engine to warm up until thermostat opens.

(2) If large compression leak exists, bubbles can be seen in coolant.

(3) If bubbles are not visible, install radiator pressure tester and pressurize system. If cylinder is leaking into water jacket, needle will pulsate every time cylinder fires.

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.
	(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 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.

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Service Diagnosis (Continued)

Condition	Possible Cause	Correction
EXCESSIVE OIL CONSUMPTION (CONTINUED)	(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 Warning Light 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.
LOW OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil excessively thin due to dilution, poor 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) Excessive oil pump clearance.	(5) Check clearances; refer to Oil Pump in this section.
	(6) Excessive main, rod, or camshaft bearing clearance.	(6) Measure bearing clerances, repair as necessary.
HIGH OIL PRESSURE	(1) Improper grade oil.	(1) Drain and refill crankcase with correct grade oil.

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Service Diagnosis (Continued)

Condition	Possible Cause	Correction
HIGH OIL PRESSURE (CONTINUED)	(2) Oil pressure gauge or sending unit inacurrate.	(2) Refer to Section 3, Oil Pressure Warning Light 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 conveter.	(4) Tighten flywheel or converter attaching bolts.
	(5) Loose or damaged vibration damaged.	(5) Repair as necessary.
CONNECTING ROD BEARING NOISE	(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) Rebore or replace block.
	(3) Piston ring broken.	(3) Replace ring.
	(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.
VALVE TRAIN NOISE *NOTE: A clicking noise, upon starting the engine, reducing in level and disappearing after a short period of*	(1) Insufficient oil supply.	(1) Check for: (a) Low oil level. (b) Low oil pressure. (c) Plugged pushrods. (d) Wrong hydraulic tappets. (e) Plugged oil gallery in block.
	(2) Push rods worn or bent.	(2) Replace worn or bent push rods.

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Service Diagnosis (Continued)

Condition	Possible Cause	Correction
VALVE TRAIN NOISE (CONTINUED) *time is normal. This noise is due to a slight oil leak-down condition caused by valve spring pressure exerted on the tappets.*	(3) Rocker arms worn. (4) Dirt or chips in hydraulic tappets. (5) Excessive tappet leak-down. (6) Tappet face worn. (7) Broken or cocked valve springs. (8) Stem-to-guide clearance excessive. (9) Valve bent. (10) Loose rocker arms. (11) Valve seat runout excessive. (12) Worn rocker arm pivot(s). (13) Push rod rubbing or contacting cylinder head.	(3) Replace worn rocker arms. (4) Clean tappets. (5) Replace valve tappet. (6) Replace tappet; check corresponding cam lobe for wear. (7) Properly seat cocked springs; replace broken springs. (8) Ream guide, install oversize valve. (9) Replace valve. (10) Tighten bolts to specified torque. (11) Regrind valve seat/valves. (12) Replace rocker arm pivot(s). (13) Remove cylinder head and remove obstruction in head.

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ENGINE MOUNTING

Resilient rubber cushions support the engine and transmission at three points: at each side on the centerline of the engine and at the rear of the engine 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).

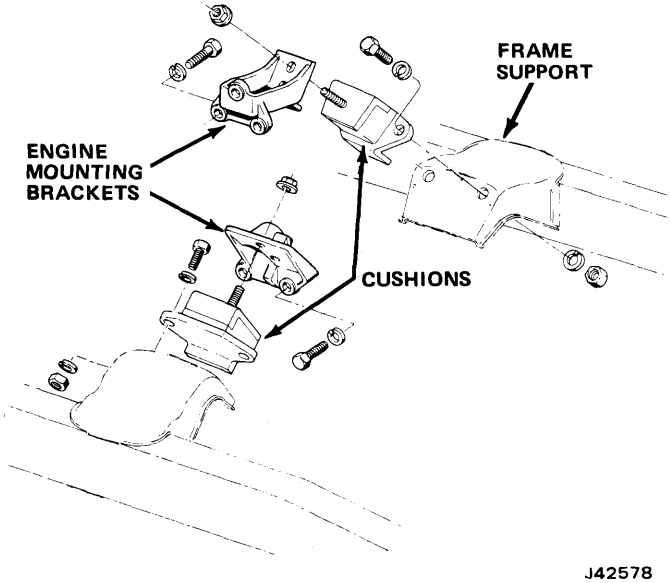

Fig. 1A-6 Engine Mounting—Typical

If it is necessary to remove the front engine mounts, an engine holding fixture may be fabricated as illustrated in figure 1A-7.

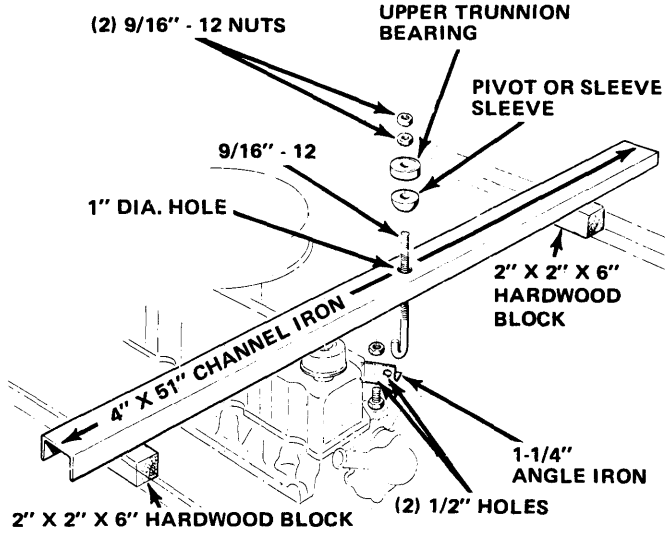

Fig. 1A-7 Engine Holding Fixture—Typical

ENGINE REMOVAL

The engine is removed without the transmission and bellhousing. Raise the vehicle slightly to gain working clearance.

(1) Drain cooling system.
(2) On all models except CJ, remove hood. Mark hinge locations for alignment during installation.
(3) Remove air cleaner. Disconnect and plug fuel line to fuel pump. Disconnect fuel return line from tubing at flexible hose connection to frame.
(4) Disconnect heater hoses at front of engine on CJ models and at heater on other models.
(5) Disconnect accelerator cable from engine.
(6) Disconnect harness wiring from engine and alternator and lay aside.
(7) Identify vacuum lines from dash panel and disconnect from engine.
(8) Remove battery, except on CJ models.
(9) Disconnect shroud, if equipped, from radiator.
(10) Remove radiator, fan and shroud. Install bolt in pulley after fan is removed to keep pulley in alignment with bolt holes in water pump.
(11) Disconnect cable from starter motor. Remove starter motor.
(12) Remove motor mount cushion-to-frame attaching nuts.
(13) Disconnect exhaust pipe.
(14) If equipped with manual transmission:
(a) Remove bellhousing screws.
(b) Remove clutch linkage and shield.
(15) If equipped with automatic transmission:
(a) Remove transmission cover.
(b) Mark converter and flex plate for alignment during installation.
(c) Remove converter drive screws. Rotate crankshaft for access to each screw.
(d) Remove converter housing-to-engine screws. Remove oil pan screws which retain transmission cooler lines.
(16) Support transmission with jack.
(17) If equipped with power steering, disconnect hoses at steering gear. Tie hoses to engine to prevent draining.
(18) If equipped with air conditioning:
(a) Turn compressor service fitting valve stem to seat.
(b) Loosen service fitting.
(c) Allow compressor refrigerant to escape.
(d) Remove fittings from compressor.
(19) Attach engine lift device. Pull engine forward to disengage from transmission. Lift upward to remove.

ENGINE INSTALLATION

(1) Remove right mount from engine.
(2) Lower engine into compartment. Engage engine to transmission.
(3) Install bellhousing screws and remove transmission jack.
(4) Install motor mounts to block. Lower engine and tighten all motor mount screws and nuts. Be sure ground strap is installed.
(5) If equipped with manual transmission:
(a) Install clutch housing shield and clutch linkage.
(b) Adjust clutch, if necessary.
(6) If equipped with automatic transmission:
(a) Align marks on converter and flex plate. Install converter drive screws.
(b) Install transmission cover.
(c) Install transmission cooler lines to engine oil pan screws.
(7) Install exhaust pipe.
(8) Install starter motor. Connect cable to starter motor.
(9) Remove lifting device.
(10) Connect fuel supply and return lines.
(11) If equipped with power steering, connect hoses to steering gear.
(12) Connect elecrical wires and attach vacuum hoses.
(13) Attach heater hoses.
(14) Install fan. If equipped with shroud, position shroud on fan blades.
(15) Install radiator and attach shroud to radiator.
(16) Connect radiator hoses. If equipped with automatic transmission, connect cooler lines to radiator.
(17) Install accelerator linkage.
(18) If equipped with air conditioning:
(a) Connect service valves to compressor.
(b) Open valve to mid-position.
(c) Open service port slightly. Allow small amount of refrigerant to escape to purge compressor of air.
(d) Tighten port cap.
(19) Install battery, if removed, and connect cables.
(20) Install coolant.
(21) Start engine. While engine is warming up, install hood.
(22) Check for fuel, oil or water leaks. Turn engine off and check fluid levels.
(23) Install air cleaner and road-test vehicle.

CYLINDER HEAD COVER AND GASKET

Removal

(1) Remove air cleaner and PCV molded hose.
(2) Disconnect distributor vacuum advance line at spark CTO tube and fuel line at fuel pump; rotate fuel line 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—Silicone Method

A room temperature vulcanizing (RTV) silicone rubber adhesive is required for this procedure. Use AMC Gasket-in-a-Tube or equivalent.

(1) Clean gasket surface of adhesive and gasket material.

(2) Wipe gasket surface of cylinder head with oily rag. This prevents adhesion but permits sealing.

(3) Apply 1/8 inch bead of silicone along entire length of cover flange.

(4) Before silicone begins to cure, install cover of cylinder head. Be careful to not touch rocker arms with silicone.

(5) Apply dab of silicone to each screw hole. Insert screw through silicone.

(6) Tighten all screws by hand. Then tighten all screws to specification.

Installation—Gasket Method

(1) Inspect cylinder head cover for cracks.

(2) Position gasket on cylinder head cover flange.

NOTE: *Silicone rubber may be applied to gasket for additional seal. If this is done, cement gasket to cylinder head and apply silicone to gasket.*

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

CAUTION: *Do not overtighten screws as this may crack cover and and split the cover gasket.*

(4) Connect fuel and distributor vacuum advance lines.

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

(6) Install air cleaner and connect PCV hose.

ROCKER ARM ASSEMBLY

The intake and exhaust rocker arms of each cylinder pivot on a bridged pivot which is secured with two capscrews as shown in figure 1A-8. The bridged pivots maintains correct rocker arm-to-valve tip alignment. The rocker arm assembly is actuated by hollow steel push rods with hardened steel balls at both ends. The push rods pass oil to rocker arm assemblies.

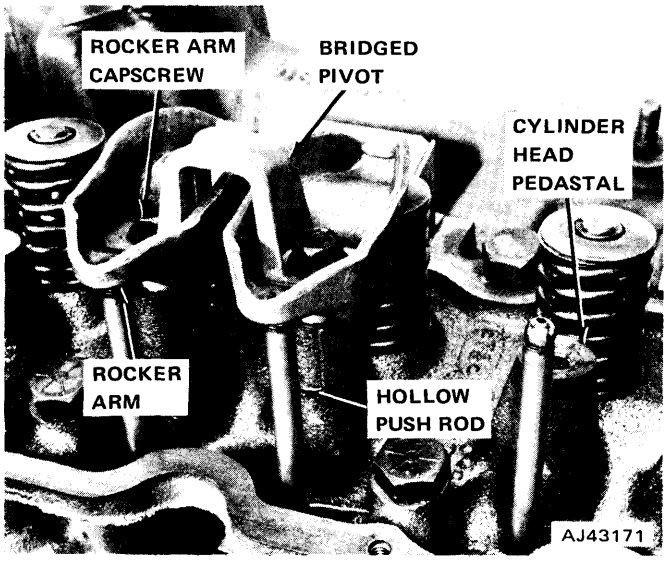

Fig. 1A-8 Rocker Arm Assembly

Removal

(1) Remove cylinder head cover and gasket.

(2) Remove two capscrews at each bridged pivot backing off each capscrew a turn at a time to avoid breaking the bridge.

(3) Remove each bridged pivot and corresponding pair of rocker arms and place on bench in same order as removed.

Cleaning and Inspection

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

Inspect the pivot surface of each rocker arm and bridged pivot, replace any parts which are scuffed, pitted, or excessively worn. Inspect valve stem tip contact surface of each rocker arm and replace any rocker arm which is deeply pitted. Inspect each push rod end for excessive wear and replace as required. If any push rod is excessively worn due to lack of oil, the push rod must be replaced and the corresponding lifter inspected.

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

Installation

(1) Install rocker arms and bridged pivots in the same order as removed.

(2) Install capscrews and tighten to 21 foot-pounds torque, tightening each of the two capscrews for each bridge a turn at a time time to avoid breaking the bridge.

(3) Install cylinder head cover and gasket.

VALVE SPRING/VALVE STEM OIL DEFLECTOR

Nylon valve stem oil deflectors 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 deflectors should be replaced whenever valve service is performed or if the deflectors 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 conical-type 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

258 CID engines installed in Cherokee and Truck models use exhaust valve rotators. Exhaust valve rotators perform two functions. Like ordinary valve spring retainers, they hold the valve spring in place. The second function is to induce positive 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).

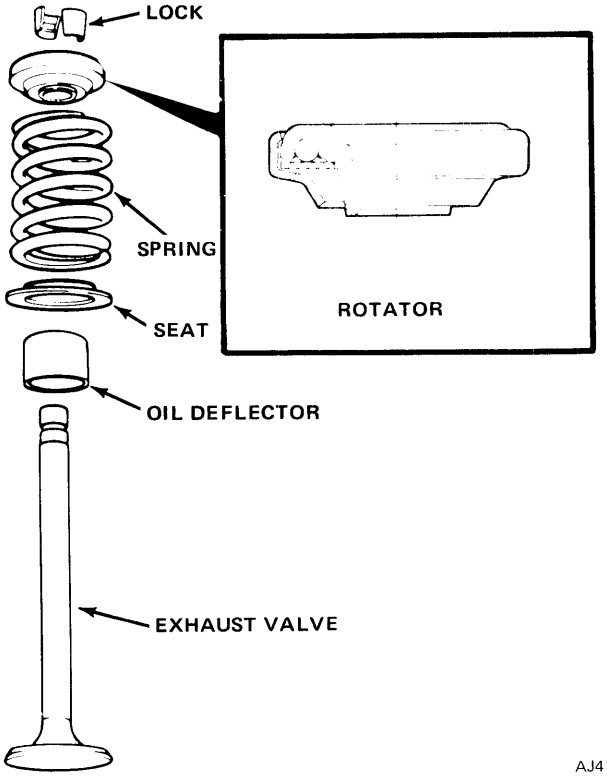

Fig. 1A-9 Exhaust Valve Rotator

Valve Spring Removal/Oil Deflector Replacement

(1) Remove cylinder head cover and gasket.

(2) Remove rocker arms and bridged pivot assembly, backing off each capscrew a turn at a time to avoid breaking the bridge.

(3) Remove push rods.

NOTE: *Retain push rods, bridged pivots, and rocker arms in same order and position 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 brazing 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.

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

(7) Use Valve Spring Remover and Installer Tools J-22534-1, J-22534-4, and J-22534-5 to compress valve spring and remove valve locks. (fig. 1A-10).

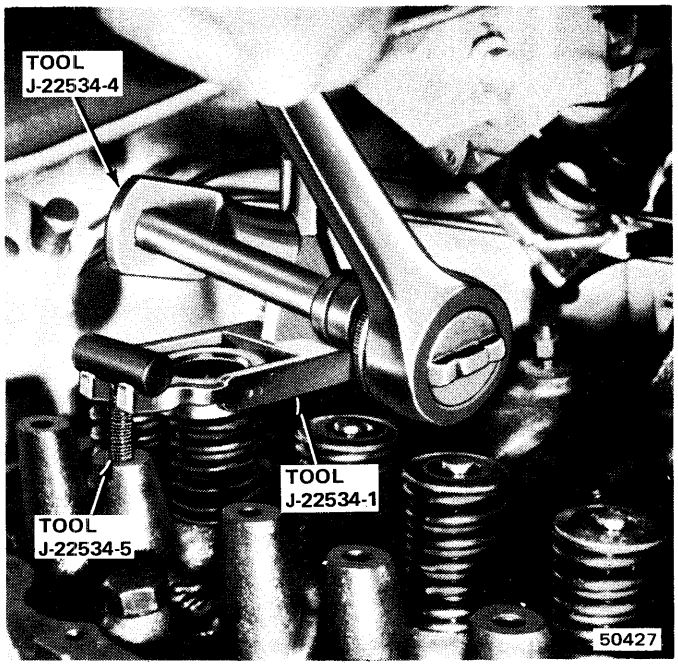

Fig. 1A-10 Valve Spring Removal

(8) Remove valve spring and retainer or rotator.

(9) Remove valve stem oil deflector, if necessary.

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.

Installation

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

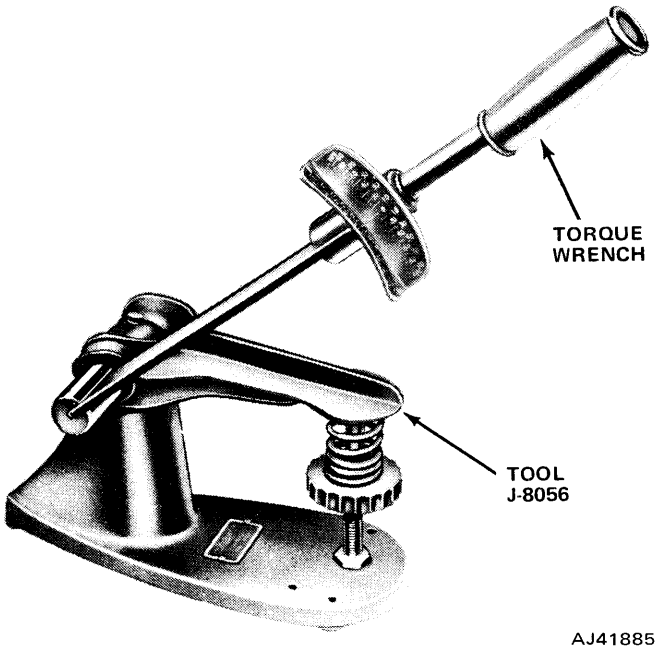

Fig. 1A-11 Valve Spring Tester

CAUTION: *Deflector must be tapped carefully to avoid damage caused by sharp edges of valve lock grooves.*

(2) Install valve spring and retainer or rotator.

(3) Compress valve spring with Tool J-22534-1, J-22534-4, and J-22534-5 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.*

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

(5) Install rocker arms and bridged assembly, tightening each of the two capscrews for each bridge a turn at a time to avoid breaking the bridge.

(6) Install cylinder head cover and gasket.

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 (fig. 1A-12).

The exhaust gas recirculation valve is mounted on the side of the intake manifold. All intake manifolds have a metal plate incorporated into the area above the exhaust manifold heat valve. This creates a hot spot that improves fuel vaporization during warmup and shortens choke operation time.

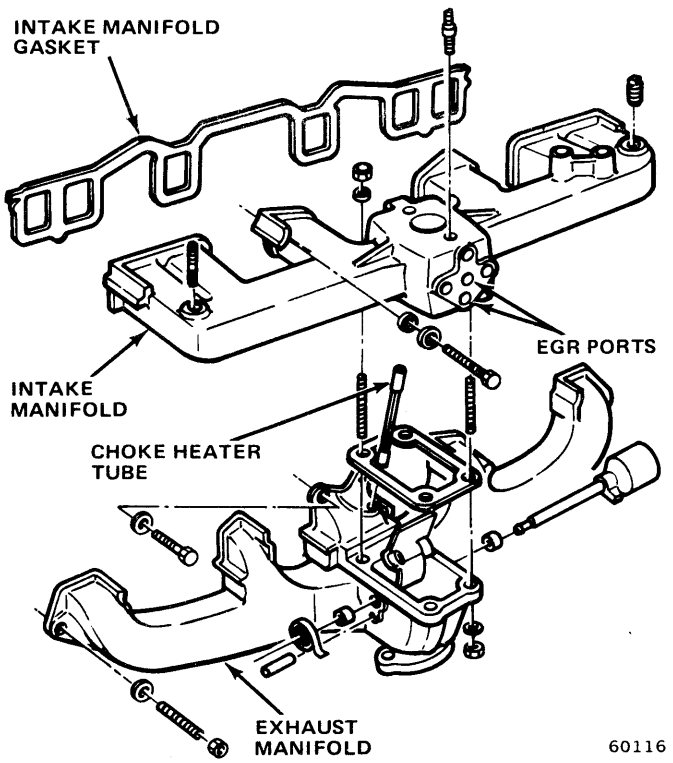

Fig. 1A-12 Intake and Exhaust Manifold Assembly

Intake and Exhaust Manifold Assembly Removal and Cleaning

(1) Remove air cleaner. Disconnect fuel line, carburetor air horn vent and solenoid wire, if equipped.

(2) Disconnect accelerator cable.

(3) Disconnect PCV vacuum hose from intake manifold.

(4) Remove spark CTO vacuum tubes and disconnect TCS solenoid vacuum valve wiring (if equipped).

(5) Disconnect vacuum hose from EGR valve.

(6) Remove power steering mounting bracket (if equipped).

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

(8) Remove air conditioning drive belt idler assembly from cylinder head (if equipped).

(9) Disconnect exhaust pipe from manifold flange.

(10) Remove manifold attaching bolts, nuts, and clamps and remove intake and exhaust manifold as an assembly. Discard gasket.

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

Intake and Exhaust Manifold Assembly Installation

(1) Position replacement intake manifold gasket on cylinder head and install manifold assembly. Tighten heat riser nuts to 5 foot-pounds torque. Tighten manifold attaching bolts and nuts in sequence (fig. 1A-13) to 23 foot-pounds torque.

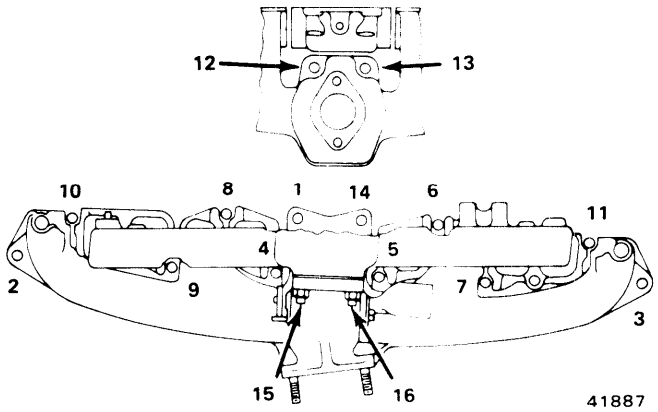

Fig. 1A-13 Intake Manifold Torque Sequence

(2) Install flange gasket and connect exhaust pipe to manifold flange.

(3) Connect fuel line, air horn vent and solenoid wire, if equipped.

(4) Install power steering pump (if equipped).

(5) Install AC drive belt idler assembly (if equipped).

(6) Install power steering pump mounting bracket (if equipped).

(7) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

(8) Install spark CTO vacuum tubes. Connect TCS wiring (if equipped).

(9) Connect vacuum hose to the EGR valve.

(10) Connect accelerator cable and PCV hose.

(11) Install air cleaner.

Intake Manifold Replacement

NOTE: *It is necessary to remove intake and exhaust manifold assembly from the engine before separating the manifolds. It is not necessary to remove the carburetor from the vehicle. After removing the carburetor from the intake manifold, it may be set to one side with vacuum lines still attached.*

(1) Remove air cleaner.

(2) Disconnect choke heater tube from choke coil housing. Disconnect clean air tube from carburetor.

(3) Disconnect accelerator cable from carburetor.

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

(5) Remove carburetor mounting studs from intake manifold.

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

(7) Separate manifolds.

(8) Install replacement gasket between manifolds. torque nuts to 5 foot-pounds torque.

CAUTION: *Do not overtorque. Manifolds must be held together loosely enough to slide when manifolds are attached to cylinder head.*

(9) Install vacuum fittings.

(10) Install manifold assembly to head.

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

(12) Install carburetor and connect cable.

(13) Connect clean air tube and choke heater tube to carburetor.

(14) Tighten intake manifold-to-exhaust manifold nuts. Start engine and check for leaks.

(15) Install air cleaner.

Exhaust Manifold Replacement

NOTE: *It is necessary to remove intake and exhaust manifold assembly from the engine before separating the manifolds. It is not necessary to remove the carburetor from the vehicle. After removing the carburetor from the intake manifold, it may be set to one side with vacuum lines still attached.*

(1) Remove air cleaner.

(2) Disconnect choke heater tube from choke coil housing. Disconnect clean air tube from carburetor.

(3) Disconnect accelerator cable from carburetor.

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

(5) Remove EGR valve.

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

(7) Separate manifolds.

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

(9) Remove distributor CTO tube clamp and install on replacement manifold.

(10) Install replacement gasket between manifolds. Torque nuts to 5 foot-pounds.

CAUTION: *Do not overtorque. Manifolds must be held together loosely enough to slide when manifolds are attached to cylinder head.*

(11) Install choke clean air tube into bottom of exhaust manifold and install tube clip.

(12) Install manifold assembly to cylinder head.

(13) Install EGR valve and carburetor spring bracket.

(14) Install accelerator cable. Install throttle return spring.

(15) Install choke heater tube and clean air tube to carburetor.

(16) Torque intake manifold-to-exhaust *manifold* nuts. Start engine and check for leaks.

(17) Install air cleaner.

CYLINDER HEAD ASSEMBLY

Two types of cylinder heads are used; one has a wedge-style combustion chamber and the other has a quench-style chamber. These heads are not inter-

changeable. They can be identified by temperature sending unit location:

- Wedge—front of cylinder head
- Quench—rear of cylinder head

All cylinder heads incorporate hardened exhaust valve seats and exhaust valves with flash chrome stems.

NOTE: *If equipped with exhaust valve rotators it is necessary to change exhaust valve assemblies when replacing cylinder heads.*

Removal

(1) Drain cooling and disconnect hoses at thermostat housing.

(2) Remove cylinder head cover and gasket.

(3) Remove rocker arms and bridged pivot assembly, backing off each screw a turn at a time to avoid breaking the bridge.

(4) Remove push rods.

NOTE: *Retain push rods, bridged pivots and rocker arm in the same order and position as removed.*

(5) Remove intake and exhaust manifold assembly from cylinder head.

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

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

(b) Loosen alternator drive belt.

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

(7) Disconnect ignition wires and remove spark plugs.

(8) Disconnect temperature sending unit wire and battery ground cable.

(9) Remove ignition coil and bracket assembly.

(10) 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 at the rear of this section.

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 deflectors.

(3) Transfer all attached components from the original head which are not included with replacement head.

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

(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.

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

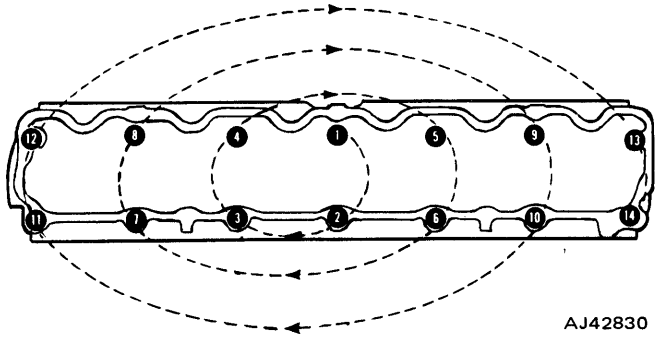

Fig. 1A-14 Cylinder Head Torque Sequence

(6) Connect temperature sending unit wire and battery negative cable.

(7) Install ignition coil and bracket assembly.

(8) Install spark plugs and connect ignition wires.

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

(10) Install intake and exhaust manifold assembly. (Refer to Intake and Exhaust Manifold Installation for the correct torque tightening sequence.)

(11) Install push rods in the order removed.

(12) Install rocker arms and bridged pivot assemblies in order removed, tightening each of the two capscrews for each bridge a turn at a time to avoid breaking the bridge. Tighten screws to 21 foot-pounds torque. Install cylinder head cover and gasket.

(13) Connect hoses to thermostat housing and fill cooling system to specified level (refer to Section 2—Cooling).

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 Spring Compressor Tool J-22534 and remove valve locks, retainers, rotators (if equipped), springs, valve stem oil deflectors and exhaust valve spring seats (if equipped).

(2) Remove 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 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 warped or cracked heads. Inspect for scuffed or bent valve stems. Replace scuffed, bent or warped valves.

Valve Reconditioning

Use a valve refacing machine to reface the intake and the exhaust valves to the specified angle. 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.

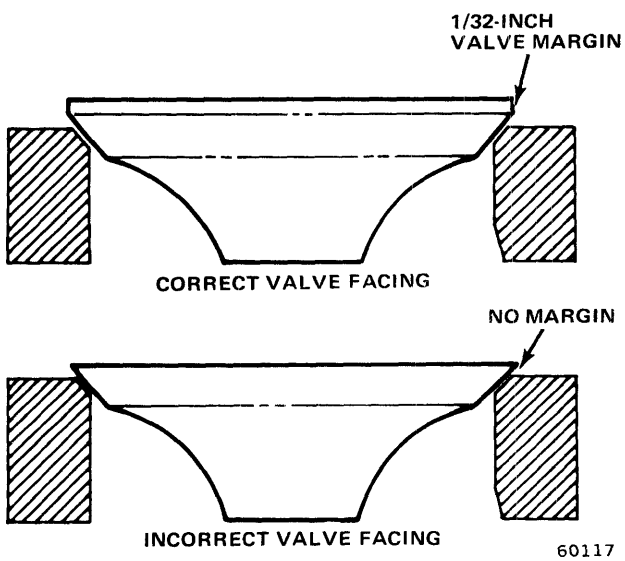

Fig. 1A-15 Valve Refacing

Valve Seat Refacing

Install a pilot of the correct size in the valve guide and reface the valve seat to the specified angle with a good dressing stone. Remove only enough metal to provide a smooth finish. This is especially important when refacing the hardened exhaust valve seats.

Tapered stones of 15° and 60° should be used to obtain the specified seat widths when required.

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

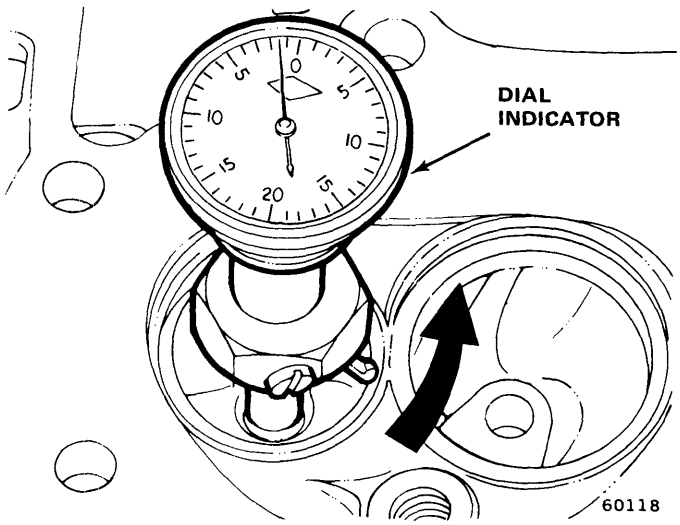

Fig. 1A-16 Checking Valve Seat Runout

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable. When the stem-to-guide clearance is excessive, 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.

Valve Guide Reamer Sizes

Valve Guide Reamer Size

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

60260

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.

Preferred Method

- 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). Correct clearance is 0.001 to 0.003 inch.

Alternate Method

- Measure the valve stem diameter with a caliper mi-

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

crometer midway between the valve head and tip. Select a pilot from a valve refacing kit which fits snugly in the valve guide bore.

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

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

Assembly

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

(2) Lightly lubricate stem and 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 deflector on valve stem.

(5) Position valve spring and retainer or rotator (if equipped) 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 hammer to be certain the spring is properly seated at cylinder head.

HYDRAULIC VALVE TAPPETS

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

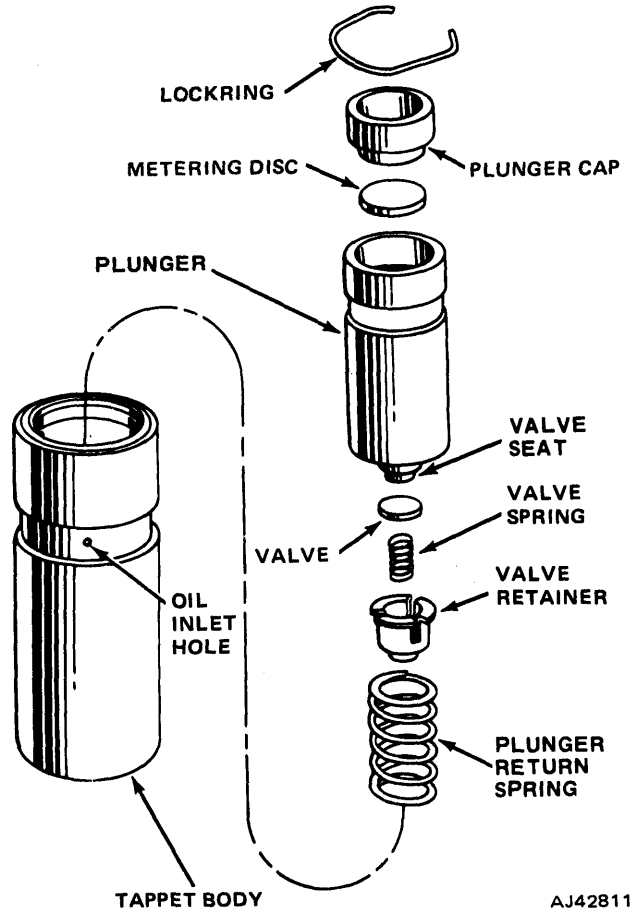

Fig. 1A-18 Hydraulic Tappet Assembly

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

When the tappet is on the heel of the cam lobe, the groove in the tappet body indexes with the main oil gallery and oil under pressure passes into the tappet through a hole. Oil flows into the plunger and through the check valve assembly, maintaining the tappet fully charged (fig. 1A-19).

The leak-down cycle occurs when the tappet leaks oil during normal valve opening. Lift from the cam lobe causes tappet body movement which closes the check valve and transmits movement to the push rod to open the intake or exhaust valve.

In addition, oil under pressure in the plunger also flows through the metering disc, plunger cap, and hollow push rod to the rocker arm assembly.

Removal and Disassembly

(1) Remove cylinder head cover and gasket.

(2) Remove rocker arms and bridged pivot assemblies, backing off each capscrew a turn at a time to avoid breaking the bridge.

(3) Remove push rods.

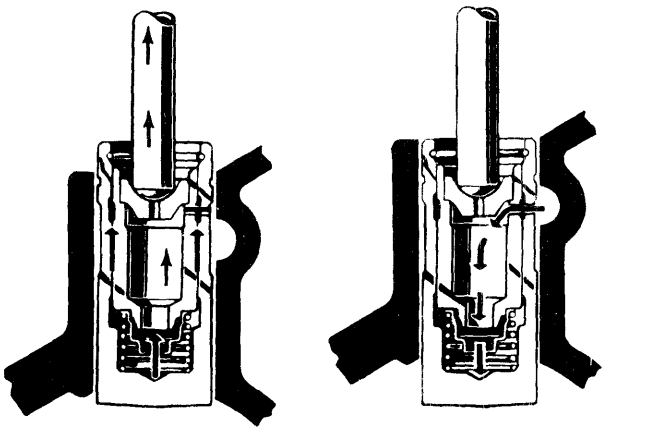

Fig. 1A-19 Hydraulic Tappet Operation

NOTE: *Retain push rods, bridged pivots, and rocker arms in the same order and position 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.

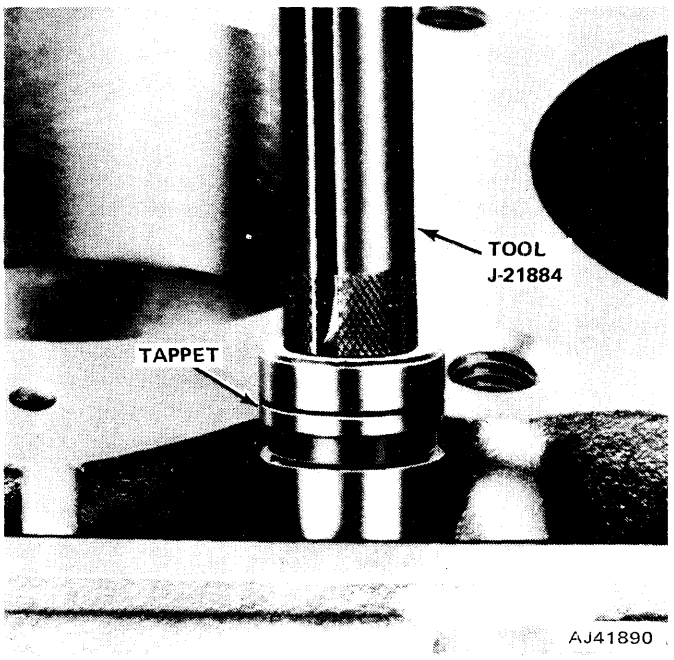

Fig. 1A-20 Hydraulic Tappet Removal

Cleaning and Inspection

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

Release lockring and remove plunger cap, metering disc, plunger, and plunger return spring from tappet body.

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 side and face of the tappet body.

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 replacement of camshaft and tappets is necessary.

Install plunger return spring, plunger, metering disc, and plunger cap in tappet body.

Using a push rod on plunger cap, compress plunger assembly and install lockring.

Hydraulic Tappet Leak-Down Test

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.

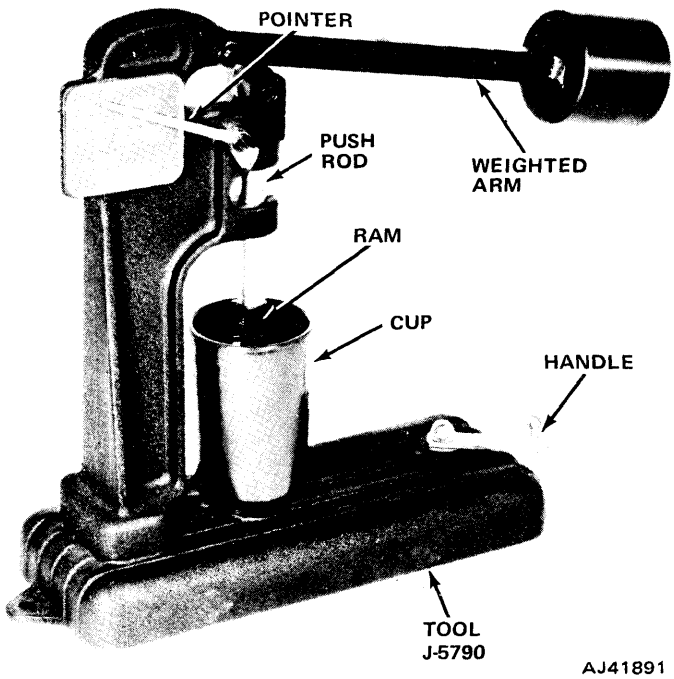

Fig. 1A-21 Hydraulic Tappet Leak-Down Test

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

(2) Place 0.312 to 0.313 diameter ball bearing on plunger cap of tappet.

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

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

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

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

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

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

(9) Time leak-down from instant pointer aligns with START mark on scale until pointer aligns with 0.125 mark.

(10) A good tappet will take 20 to 110 seconds to leak-down. Discard tappets outside this range.

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

Installation

(1) Dip 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 the same bores from which they were removed.

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

(4) Install rocker arms and bridged pivot assemblies and tighten retaining screws to 21 foot-pounds torque, tightening each of the two capscrews for each bridge a turn at a time to avoid breaking the bridge.

(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 (see Cylinder Head Torque Sequence, fig. 1A-14).

(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 the 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 vibration damper pulley from vibration damper (if equipped).

(3) Remove vibration damper retaining bolt and washer.

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

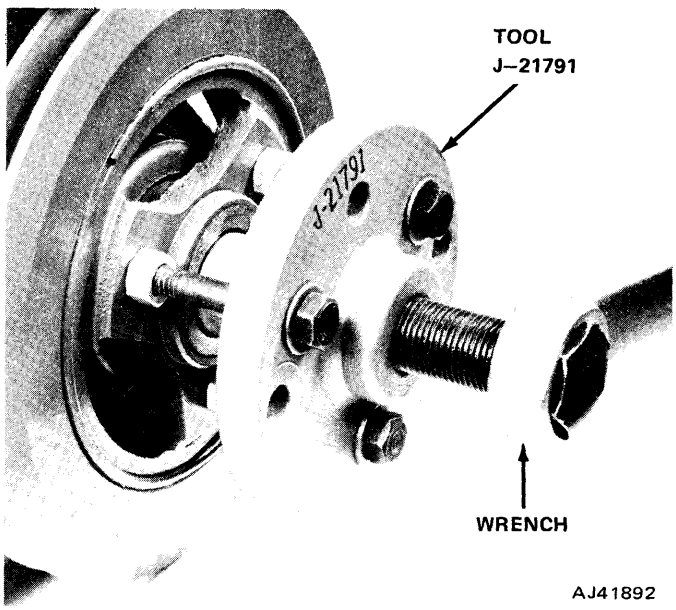

Fig. 1A-22 Vibration Damper Removal

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 80 foot-pounds torque.

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

(4) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

TIMING CASE COVER

The timing case cover is provided with a seal and oil slinger to prevent oil leakage at the vibration damper hub. A hole is provided in the cover for the use of a magnetic timing probe. A graduated degree scale cast into the cover is used for ignition timing (fig. 1A-23). Refer to Section 4A for magnetic timing probe usage and ignition timing procedure.

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

Removal

(1) Remove drive belt(s), radiator fan and hub assembly, damper pulley and vibration damper.

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

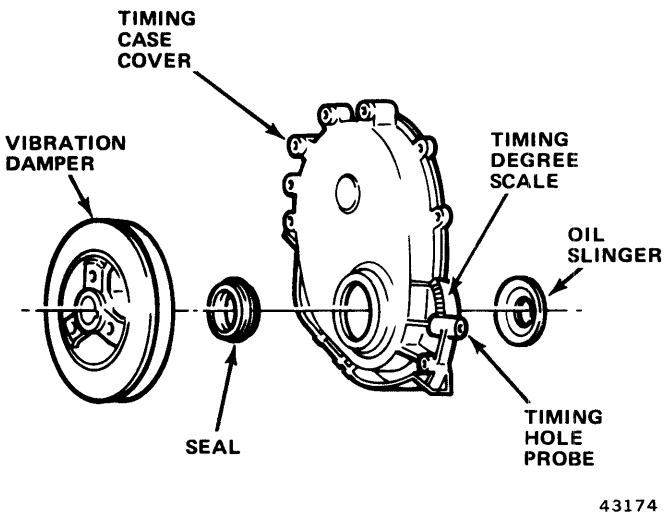

Fig. 1A-23 Timing Case Cover

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

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

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

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

Installation

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

(2) Cut end tabs of replacement oil pan gasket same as was cut off original gasket. Install these end tabs on oil pan and cement in place.

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

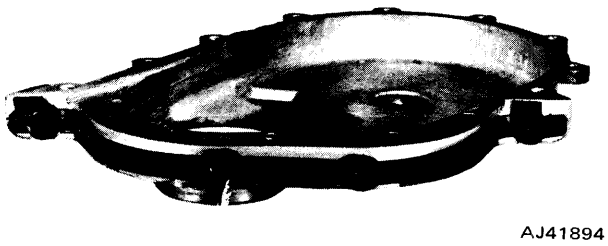

Fig. 1A-24 Oil Pan Front Seal Installation

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

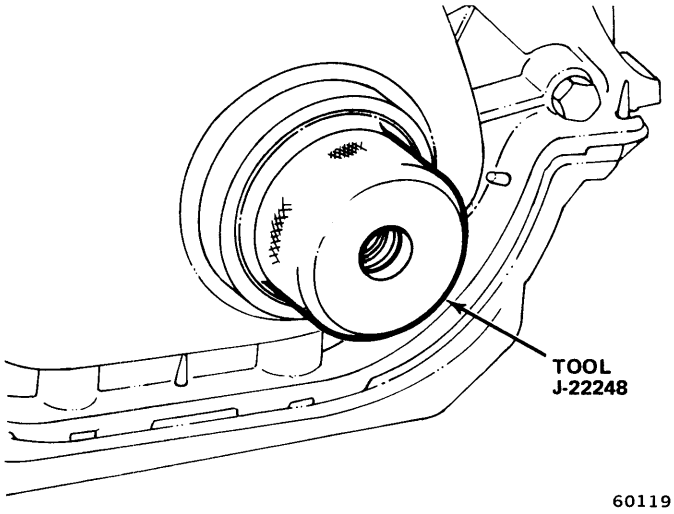

Fig. 1A-25 Timing Case Cover Alignment

(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.

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

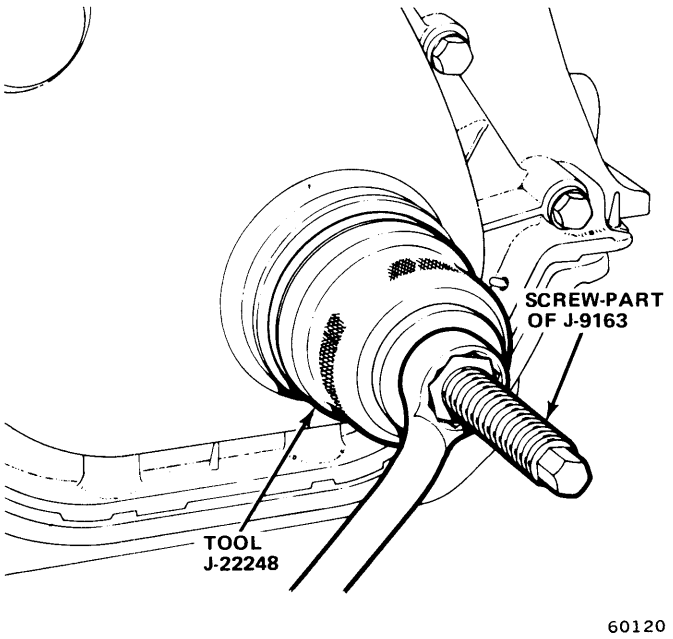

Fig. 1A-26 Timing Case Cover Oil Seal Installation

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

(9) Install vibration damper and tighten retaining bolt to 80 foot-pounds torque.
(10) Install damper pulley.
(11) Install radiator fan and hub assembly.
(12) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

Timing Case Cover Oil Seal Replacement (Cover not Removed)

(1) Remove drive belts.
(2) Remove vibration damper pulley.
(3) Remove vibration damper.
(4) Remove oil seal with Tool J-9256 as shown in figure 1A-27.

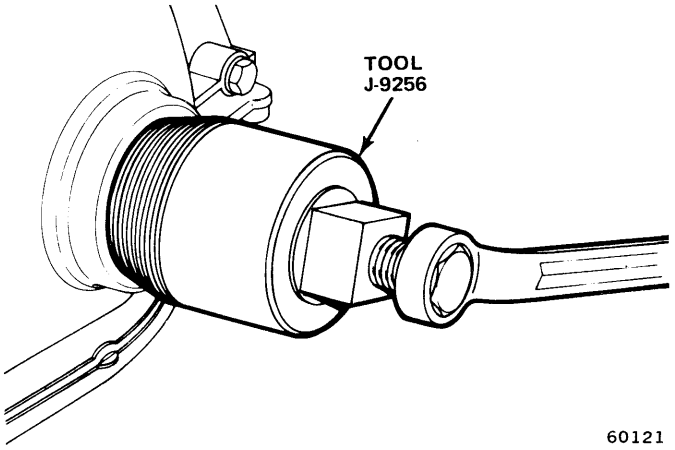

Fig. 1A-27 Timing Case Cover Oil Seal Removal

(5) Place new oil seal on Timing Case Cover Alignment Tool and Seal Installer J-22248 with seal lip facing inward. Apply a light film of Perfect Seal or equivalent on outside diameter of seal and apply light film of engine oil on seal lip.
(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.
(8) Install vibration damper and tighten retaining bolt to 80 foot-pounds torque.
(9) Install damper pulley.
(10) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

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

Checking Valve Timing

(1) Disconnect ignition wires and remove spark plugs.
(2) Remove cylinder head cover and gasket.
(3) Remove rocker arms and bridged pivot from No. 1 cylinder.
(4) Rotate crankshaft until No. 6 piston is at TDC on compression stroke.
(5) Rotate crankshaft counterclockwise (viewed from front of engine) 90 degrees.
(6) Install dial indicator with end of push rod touching No. 1 cylinder intake valve push rod end. Set dial indicator to zero.
(7) Rotate crankshaft clockwise (viewed from front of engine) until dial indicator shows 0.016-inch lift.
(8) Timing mark on vibration damper should index with TDC mark on timing case 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 radiator fan and hub assembly.
(3) Remove vibration damper pulley (if equipped).
(4) Remove vibration damper.
(5) Remove timing case cover.
(6) Remove oil seal from timing case cover.
(7) Remove camshaft sprocket retaining bolt and washer.
(8) Rotate crankshaft until 0 timing mark on the crankshaft sprocket is closest to and in 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.

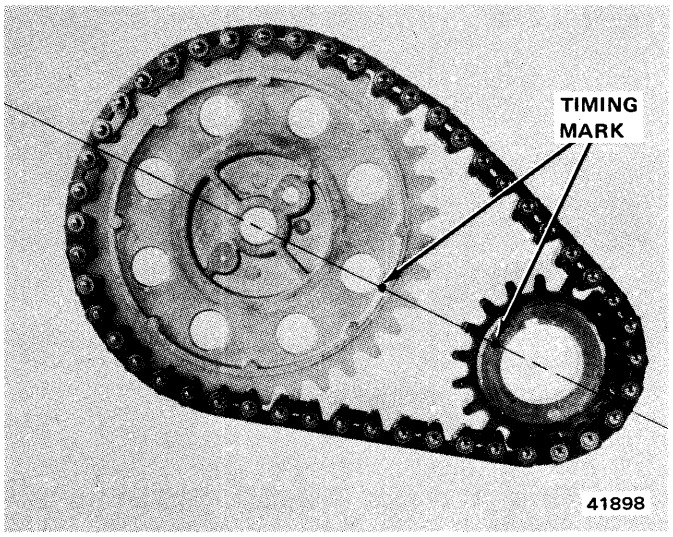

Fig. 1A-28 Sprocket Alignment

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 50 foot-pounds torque.

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.*

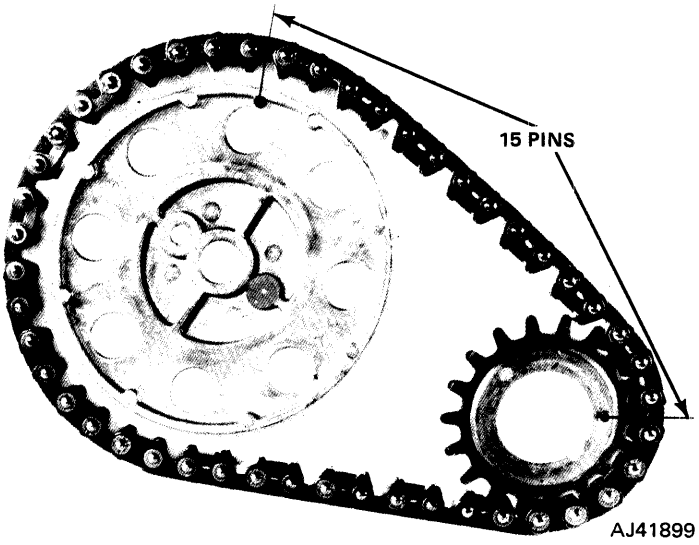

Fig. 1A-29 Timing Chain Installation

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

(5) Install vibration damper.

(6) Install damper pulley (if equipped).

(7) Install engine fan and hub assembly.

(8) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

CAMSHAFT AND BEARINGS

All 232 and 258 1V engines use the same camshaft. The camshaft used in the 258 2V engine is different. 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 bridged pivot assemblies.

(3) Remove spark plugs.

(4) Install a dial indicator on end of push rod using piece of rubber tubing between dial indicator plunger to push rod (fig. 1A-30).

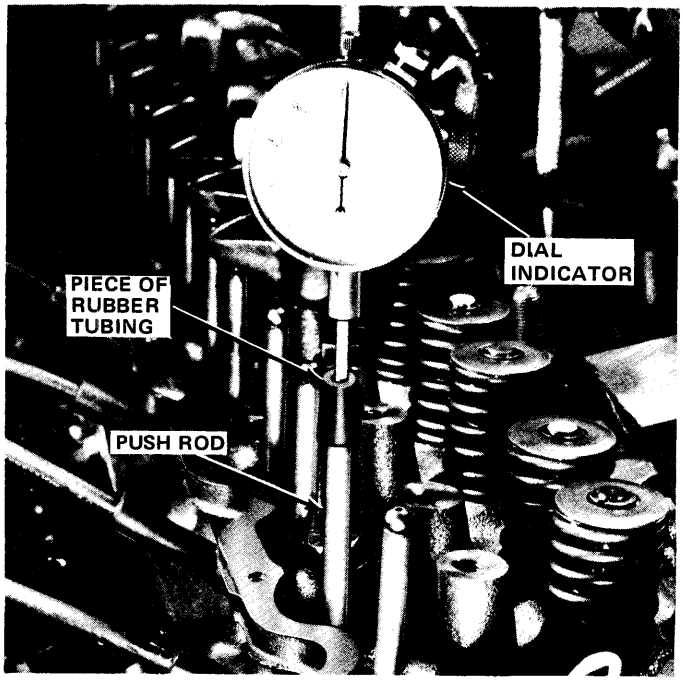

Fig. 1A-30 Cam Lobe Lift Measurement

(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. Correct cam lobe lift is 0.226 to 0.238 inch for 1V engines. Lift is 0.242 to 0.254 inch for 258 2V engine.

Removal

(1) Drain cooling system.

(2) Remove radiator.

(3) Remove air conditioning condenser and receiver

assembly as a charged unit (if equipped) (refer to Section 13A—Air Conditioning).

(4) Remove cylinder head cover and gasket.

(5) Remove rocker arms and bridged pivot assemblies, backing off each capscrew a turn at a time to avoid breaking the bridge.

(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 radiator fan and hub assembly.

(11) Remove damper pulley (if equipped).

(12) Remove vibration damper.

(13) Remove timing case cover.

(14) Remove timing case 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 in 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 front bumper or grille as required and remove camshaft.

Inspection

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

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

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, the matching camshaft lobe(s) is also worn, both the camshaft and all tappets must be replaced.

If the camshaft appears to be bearing heavily against the front cover, check the relief holes in the rear cam journal. These holes relieve oil pressure between the end of the camshaft and the rear bearing plug.

Installation

(1) Lubricate camshaft with Jeep Engine Oil Supplement or equivalent.

(2) Install camshaft carefully to prevent damaging camshaft bearing.

(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 case cover with new oil seal.

(6) Install vibration damper.

(7) Install damper pulley (if equipped).

(8) Install radiator fan and hub assembly.

(9) Install drive belt(s) and tighten to specified tension (refer to Section 2—Cooling).

(10) Install fuel pump.

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

(12) Install distributor cap and ignition wires.

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

(13) Install hydraulic tappets.

(14) Install cylinder head and gasket.

(15) Install push rods.

(16) Install rocker arms and bridged pivot assemblies, tightening each of the two capscrews for each bridge a turn at a time to avoid breaking the bridge.

(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 (refer to Section 2—Cooling).

(20) Install front bumper or grille (if removed).

OIL PAN

Removal

(1) Raise vehicle and drain engine oil.

(2) Remove the starter motor.

(3) On CJ Models:

(a) Place jack under transmission bellhousing.

(b) Disconnect engine right support cushion bracket from block and raise engine to allow sufficient clearance for oil pan removal.

(4) Remove oil pan.

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

(6) Thoroughly clean gasket surfaces of oil pan and

engine block. Remove all sludge and dirt from oil pan sump.

Installation

(1) Install a new oil pan front seal to timing chain cover and apply a generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to the end tabs.

(2) Cement new oil pan side gaskets into position on engine block and apply a generous amount of Jeep Gasket-in-a-Tube (RTV silicone), 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 Jeep Gasket-in-a-Tube (RTV silicone), 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.

(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 clean 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 on the cylinder block provides a safety factor if the filter becomes clogged 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.

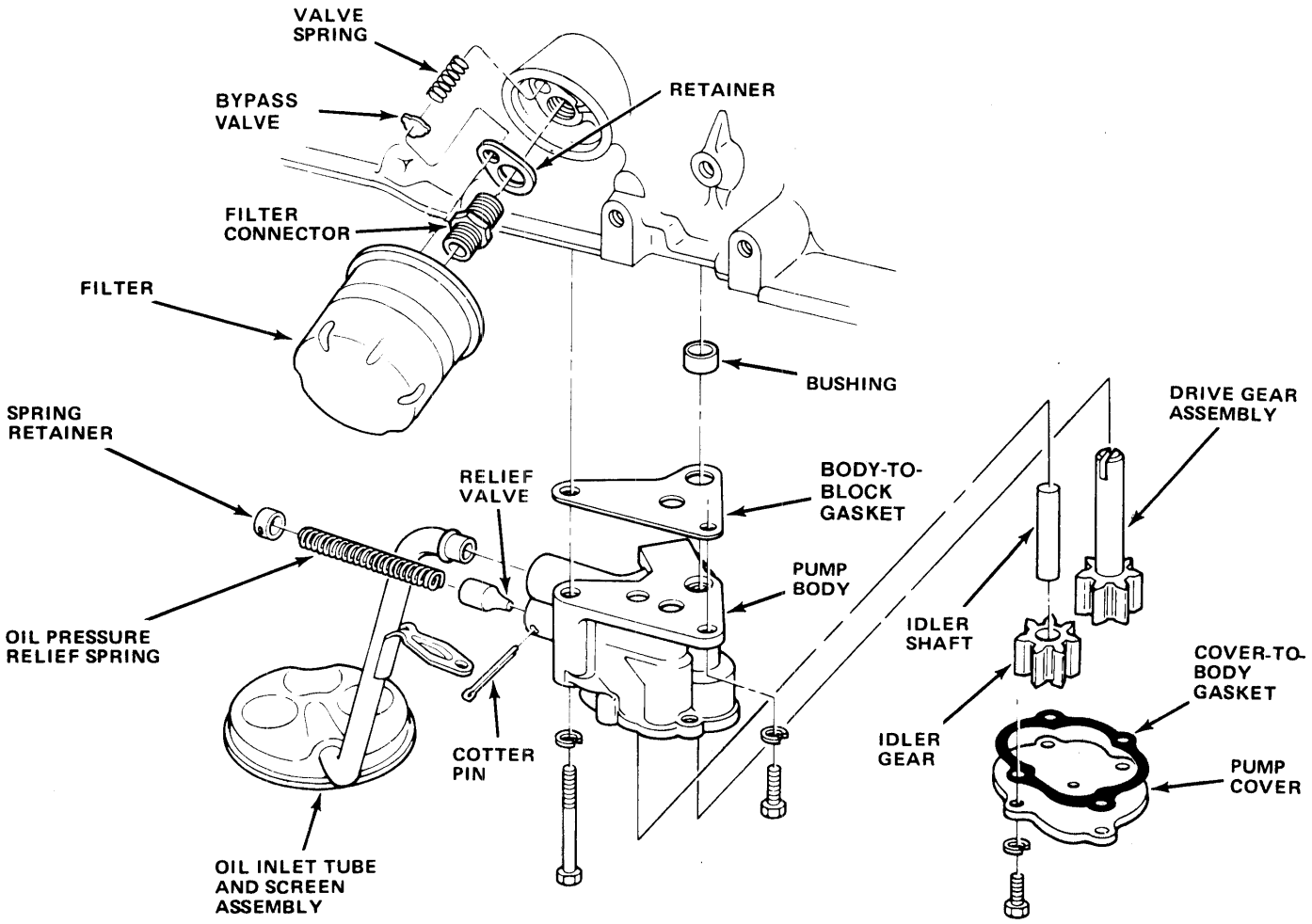

Fig. 1A-31 Oil Filter and Oil Pump Assembly

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 an 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. Refer to Oil Pan Removal in this section.

(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.

- **Preferred Method**

(a) Place strip of 0.002 to 0.006 inch Plastigage across full width of each gear (fig. 1A-32).

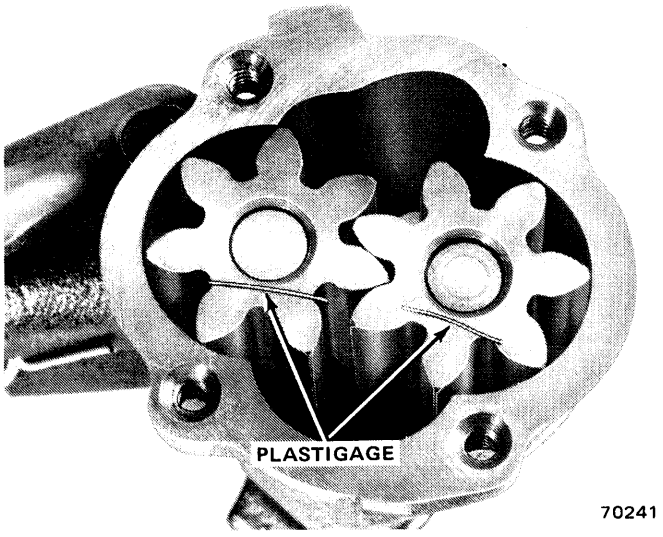

Fig. 1A-32 Oil Pump Gear End Clearance Measurement —Plastigage Method

(b) Install pump cover and gasket. Tighten screws to 70 inch-pounds.

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

- **Alternate Method**

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

(b) Select feeler gauge which fits snugly but freely between straightedge and pump body (fig. 1A-33). Correct clearance by this method is 0.004 to 0.008 inch (0.007 preferred).

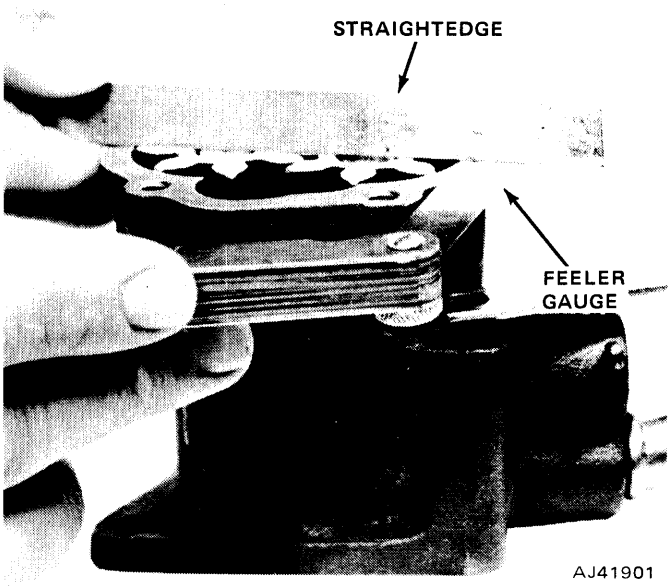

Fig. 1A-33 Oil Pump Gear End Clearance Measurement —Straightedge Method

If gear end clearance is not within specifications, replace the oil pump assembly.

NOTE: *If clearance is less than specifications, a thinner oil pump cover gasket may correct the clearance. The standard gasket is 0.010 inch thick. Thinner gaskets must be made from locally procured material.*

(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-34). Rotate gears to check each tooth in this manner. Correct clearance is 0.0005 to 0.0025 (0.0005 desired).

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

(4) Remove inlet tube and screen assembly.

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

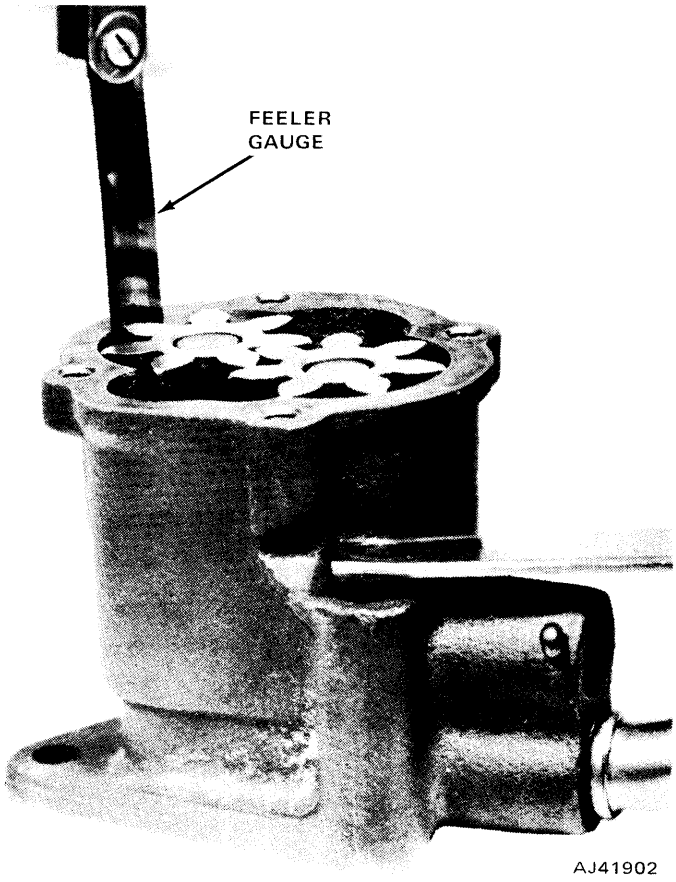

Fig. 1A-34 Oil Pump Gear-to-Body Clearance Measurement

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

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-35) drive tube into body making sure 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.*

(4) Install pump cover and replacement gasket. Tighten cover screws to 70 inch-pounds 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.

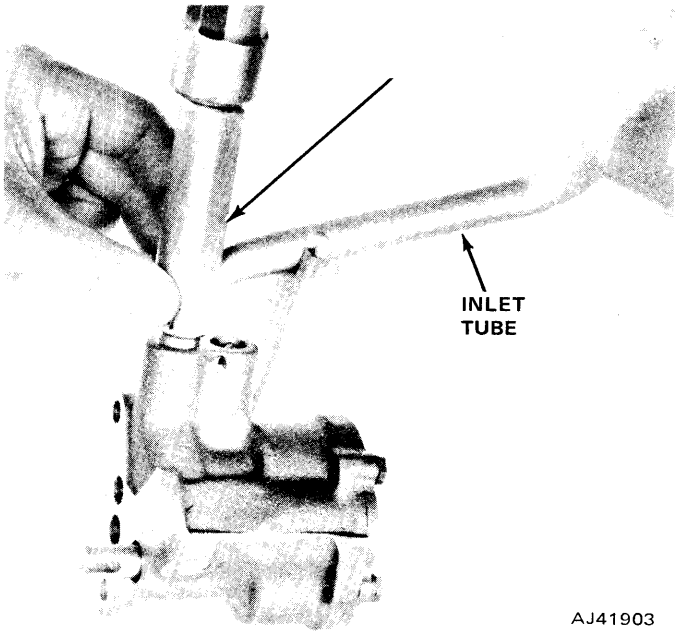

Fig. 1A-35 Oil Pump Inlet Tube Installation

(6) Install oil pan using replacement gaskets and seals. Refer to Oil Pan Installation in this section. Fill crankcase with clean oil to specified 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. Refer to Oil Pan Removal in this section.

(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 lip of seal with engine oil.
(6) Install upper seal into engine block.

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

(7) Coat both sides of lower seal end tabs with Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, being careful not to apply sealer to lip of seal.
(8) Coat outer curved surface of lower seal with soap and lip of seal with engine oil.
(9) Install seal into cap recess and seat it firmly.
(10) Coat with Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, on both chamfered edges of rear main bearing cap (fig. 1A-36).

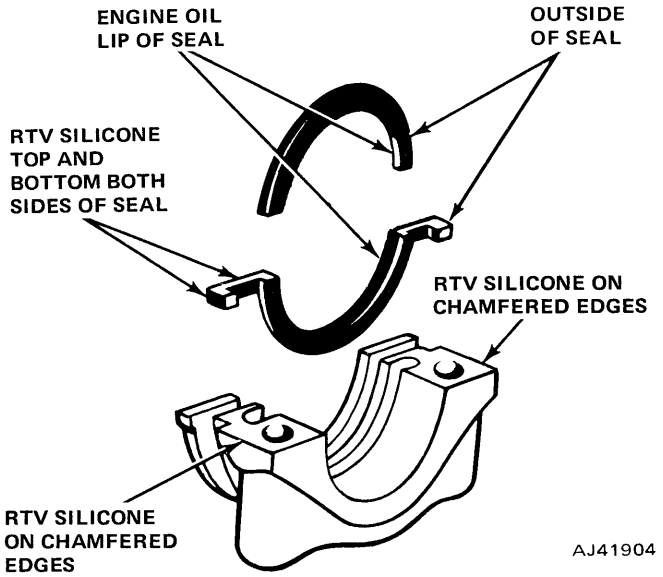

Fig. 1A-36 Rear Main Oil Seal and Cap Installation

NOTE: *Do not apply sealer to cylinder block mating surface of rear main cap as bearing clearance would be reduced.*

(11) Install rear main bearing cap.
(12) Tighten all main bearing capscrews to 80 foot-pounds torque.
(13) Install oil pan using replacement gaskets and seals. Tighten drain plug securely.
(14) Fill crankcase with clean oil to specified dipstick level.

CYLINDER BLOCK

Disassembly

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

NOTE: *Connecting rods and caps are stamped with the number of the cylinder to which they were assembled.*

(17) 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. Short pieces of rubber hose can be slipped over the rod bolts to prevent damage to the cylinder bores or crankshaft.*

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

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.
(5) Rigid type hones are not to be used to remove cylinder glaze since a slight amount of taper always exists in cylinder walls after engine has been in service.
(6) Prior to fitting pistons, 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.

Assembly

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

(2) Install crankshaft.

(3) Install main bearing caps and inserts. Plastigage all bearings. 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.

(5) Position piston rings on piston as follows:

(a) Oil spacer gap is on centerline (±20°) of piston skirt.

(b) Oil rail gaps are 180° apart and on centerline (±20°) of piston pin.

(c) No. 2 compression ring gap is 180°(±20°) from top oil rail gap.

(d) No. 1 compression ring gap is 180°(±20°) from No. 2 compression 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-37)

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

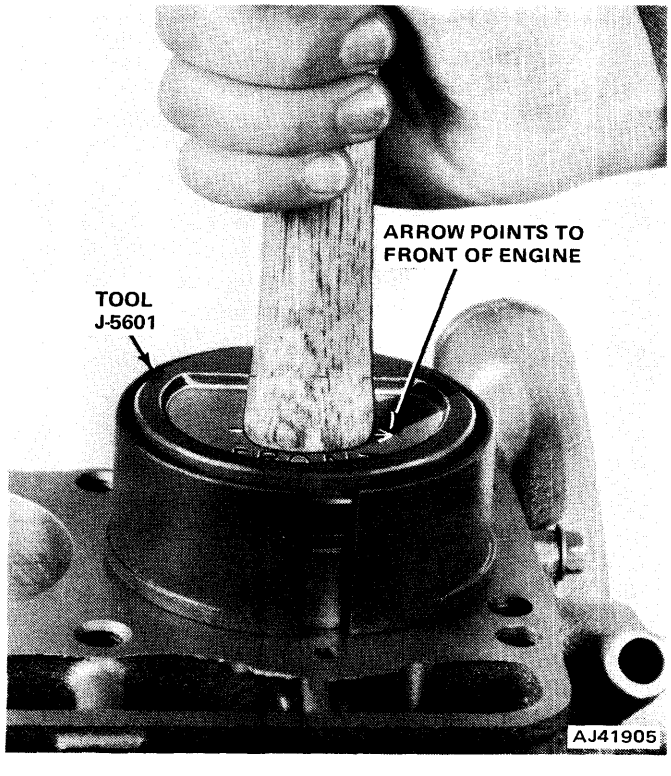

Fig. 1A-37 Piston-to-Bore Installation

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, timing chain and sprockets.

(12) Install timing case cover.

(13) Install vibration damper and drive pulley.

(14) Install valve tappets.

(15) Install gasket and cylinder head.

(16) Install push rods.

(17) Install rocker arms and bridged pivot assemblies, tightening each of the two capscrews for each bridge a turn at a time to avoid breaking the bridge.

(18) Install cylinder head cover and gasket.

(19) Install intake and exhaust manifolds.

(20) Remove engine from engine stand.

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

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.

(2) Remove rocker arms and bridged pivot assembly, backing off each capscrew a turn at a time to avoid breaking the bridge.

(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 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. Short pieces of rubber hose can be slipped over the rod bolts to prevent damage to the cylinder bores or crankshaft.*

Installation

(1) After thoroughly cleaning cylinder bores, apply

a light film of clean, engine oil to bores with a clean, lint-free cloth.

(2) Position piston rings on pistons as follows:

(a) Oil spacer gap is on centerline (±20°) of piston skirt.

(b) Oil rail gaps are 180° apart and on centerline (±20°) of piston pin.

(c) No. 2 compression ring gap is 180°(±20°) from top oil rail gap.

(d) No. 1 compression ring gap is 180°(±20°) from No. 2 compression 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. 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 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 bridged pivot assemblies, tightening each of the capscrews a turn at a time to avoid breaking the bridge.

(10) Install cylinder head cover and gasket or sealer.

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

CONNECTING RODS

The connecting rods are malleable iron, balanced assemblies with bearing inserts at the crankshaft journal end. A squirt hole in the crankshaft end provides lubrication for the camshaft lobes, distributor drive gear, cylinder walls, and piston pins. The squirt hole must face the camshaft when the connecting rod is installed.

The piston pin is a 2,000 pound press-fit. Replace any rod that requires little effort to install piston pins.

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

Slide snug-fitting feeler gauge between connecting rod and crankshaft rod journal flange. Correct clearance is 0.005 to 0.014 inch. Replace connecting rod if side clearance is not to specifications.

Connecting Rod Bearings

The connecting rod bearings are steel-backed, aluminum-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 bearing color code appears on the edge of the insert.

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

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

Bearing Insert Pairs

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

70242

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

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

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 rotating it out of connecting rod.

Connecting Rod Bearing Fitting Chart

Crankshaft Connecting Rod Journal Color and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow —2.0955 to 2.0948 (Standard)	Yellow — Standard	Yellow — Standard
Orange —2.0948 to 2.0941 (0.0007 Undersize)	Yellow — Standard	Black — .001-inch Undersize
Black —2.0941 to 2.0934 (0.0014 Undersize)	Black — .001-Inch Undersize	Black — .001-inch Undersize
Red —2.0855 to 2.0848 (0.010 Undersize)	Red — .010-Inch Undersize	Red — .010-inch Undersize

60261

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.*

Inspection

(1) Clean inserts.

(2) Inspect linings and backs of inserts for irregular wear pattern. Note any scraping, stress cracks or discoloration (fig. 1A-38). If bearing has spun in rod, replace bearing and connecting rod and inspect crakshaft journal for scoring.

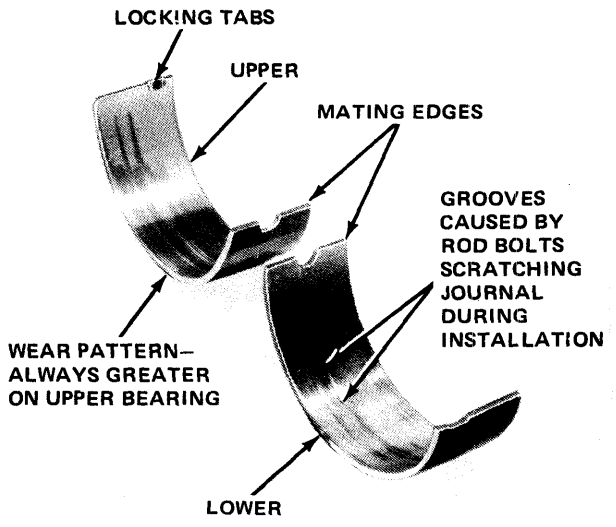

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Fig. 1A-38 Connecting Rod Bearing Inspection

(3) Inspect for material imbedded in linings which may indicate piston, timing gear, distributor gear or oil pump gear problems. Figures 1A-39 and 1A-40 show common score patterns.

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

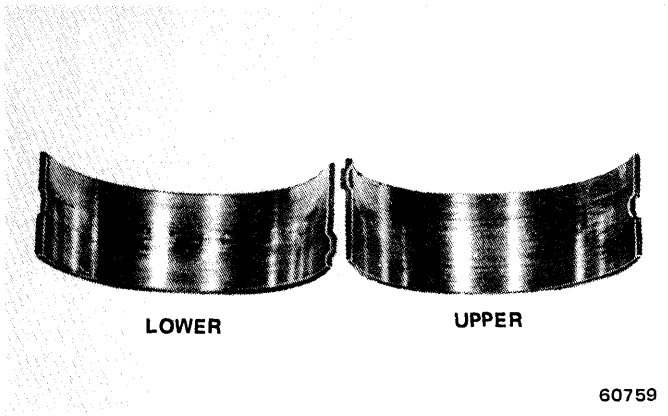

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Fig. 1A-39 Scoring Caused by Insufficient Lubrication

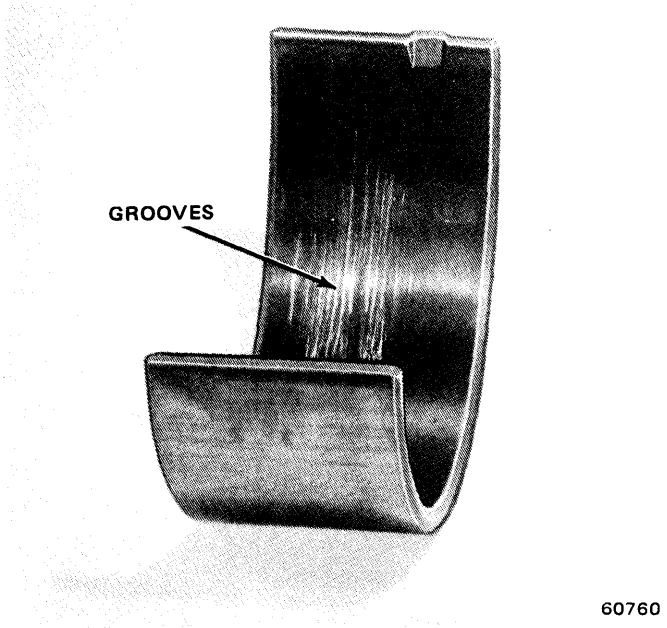

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Fig. 1A-40 Scoring Caused by Dirt

(5) Inspect insert in area of locking tab. Abnormal wear indicates bent tabs or improper installation of inserts (fig. 1A-41).

Measuring Bearing Clearance with Plastigage

(1) Wipe journal clean.

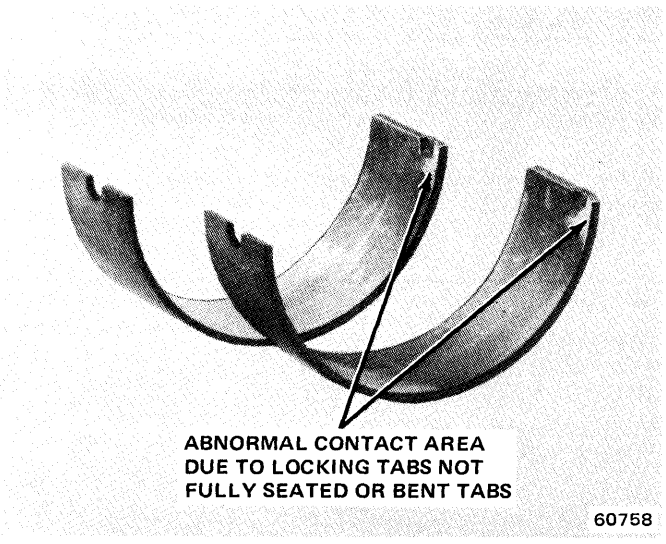

Fig. 1A-41 Locking Tab Inspection

(2) Lubricate upper insert and install in rod.

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

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

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

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (fig. 1A-42). Correct clearance is 0.001 to 0.0025 inch.

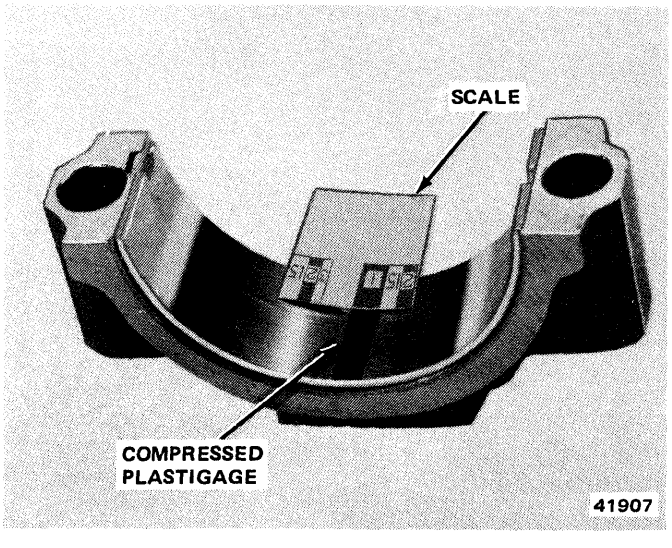

Fig. 1A-42 Bearing Clearance Measurement with Plastigage

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

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

(7) If oil clearance exceeds specification, install 0.001 inch undersize bearing inserts and check clearance as described in steps (1) through (5).

The clearance indicated with 0.001-inch undersize bearing installed will determine if 0.001-inch undersize inserts or some other combination are needed to provide correct clearance. For example: if the initial clearance was 0.003 inch, 0.001-inch undersize inserts would reduce clearance by 0.001 inch. Oil clearance would be 0.002 inch and within specification. A 0.002-inch undersize insert and a 0.001-inch undersize insert would reduce this clearance an additional 0.0005 inch. Oil clearance would then be 0.0015 inch.

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

(8) If oil clearance exceeds specification when 0.002 inch undersize inserts are installed, measure connecting rod journal with micrometer. If journal size is correct (not under 2.0914 inch), inside diameter of connecting rod is incorrect and rod must be replaced.

NOTE: *Journal may have been ground 0.010 inch undersize.*

If journal size is incorrect, replace crankshaft or grind journal to accept a suitable undersized bearing.

Measuring Bearing Clearance with Micrometer

(1) Wipe connecting rod journal clean.

(2) Use micrometer to measure maximum diameter of rod journal at four points. Take two readings at each end of journal, 90° apart.

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

(4) 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 33 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. Rubber hoses installed over the connecting rod bolts will help prevent damage to crank journals.*

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

(4) Fill crankcase with clean oil to specified 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.

An arrow on the top surface of the piston or a notch on the top perimeter ensures correct installation in the bore. Arrow or notch must point toward front of engine when installed (fig. 1A-43).

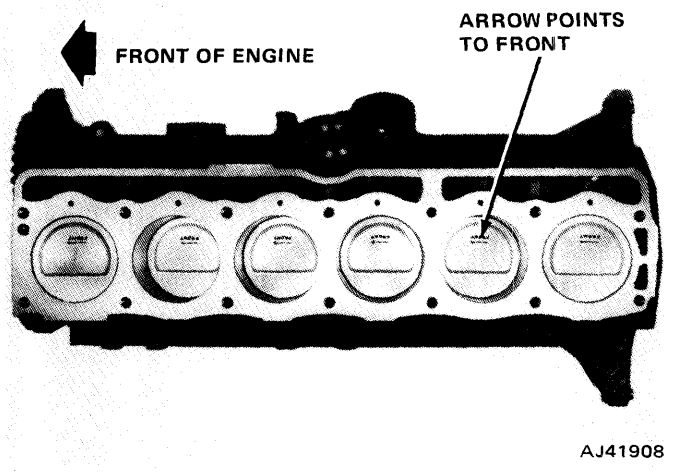

Fig. 1A-43 Pistons Correctly Positioned in Bores

Fitting Pistons

Micrometer Method

(1) Measure inside diameter of cylinder bore at a point 2-5/16 inches below top of bore, crosswise to block.

(2) Measure outside diameter of piston.

NOTE: *Pistons are cam ground and must be measured at right angle to piston pin at centerline of pin (fig. 1A-44).*

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

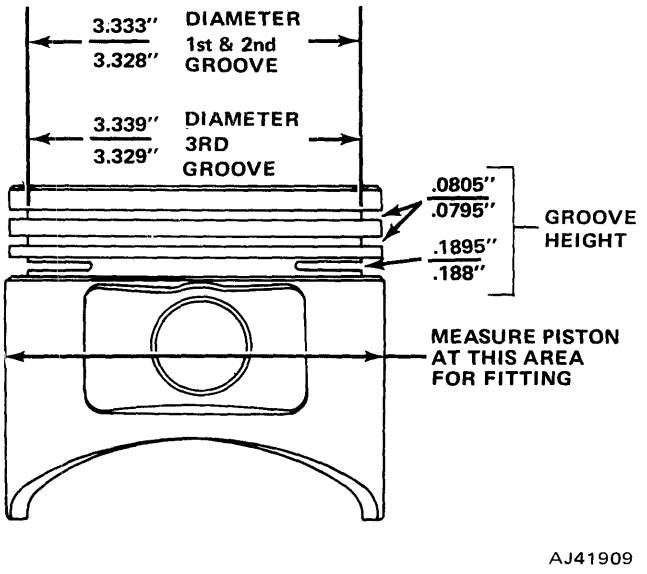

Fig. 1A-44 Piston Measurements

Feeler Gauge Method

(1) Remove rings from piston.

(2) Insert long 0.0005 inch feeler gauge into bore.

(3) Insert piston, top first, into bore alongside feeler gauge.

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.

(2) Check ring side clearance with a feeler gauge fitted snugly between ring land and ring. Rotate ring in groove. It must move freely at all points (fig. 1A-45). Correct side clearance between land and rings should be as listed in Specifications.

(3) Place ring in bore and push down with an inverted piston to a position near lower end of ring travel. Measure ring gap (joint clearance) with feeler gauge fitting snugly in ring opening (fig. 1A-46). Refer to Specifications for recommended gap.

Installation

(1) Install oil control rings as indicated by instructions in package. Install expander first, then side rails. It is not necessary to use a tool to install upper and lower rails (fig. 1A-47).

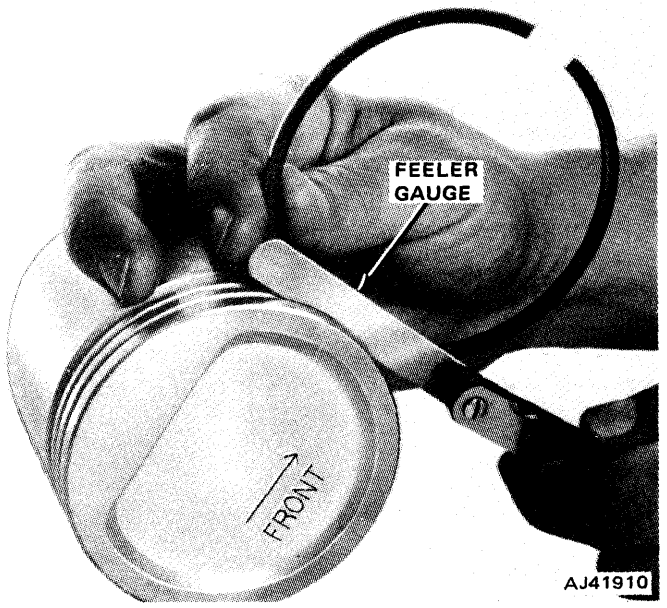

Fig. 1A-45 Ring Side Clearance

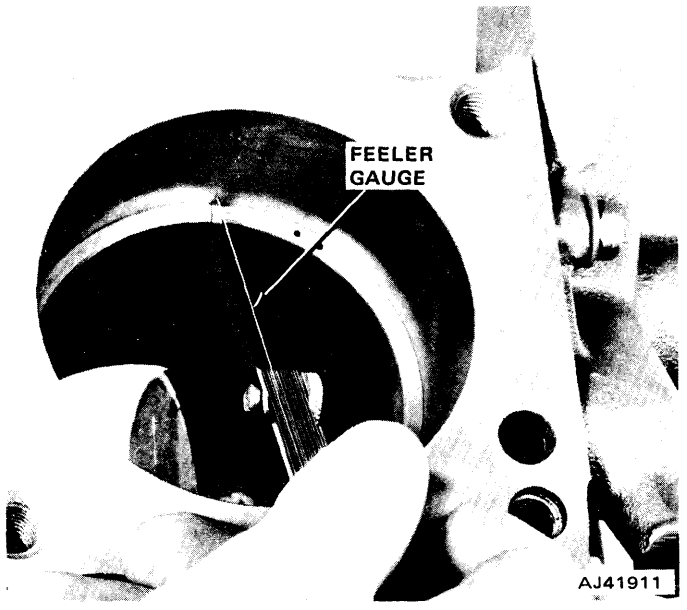

Fig. 1A-46 Ring Gap Clearance

(2) Install lower compression ring using ring installer to expand ring around piston (fig. 1A-48). Do not position ring gap over piston pin.

NOTE: *Make certain upper and lower compression rings are installed properly. Figure 1A-49 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-48). Ring gap should be 180° from second ring.

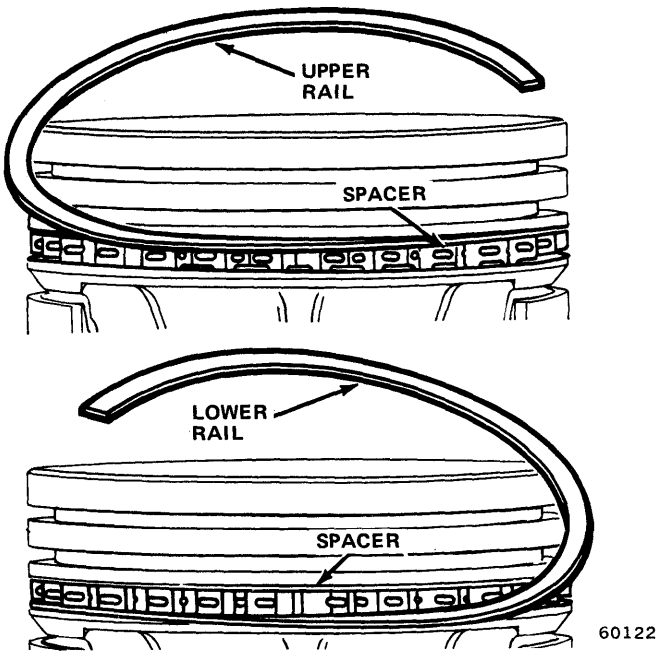

Fig. 1A-47 Oil Control Ring Rail Installation

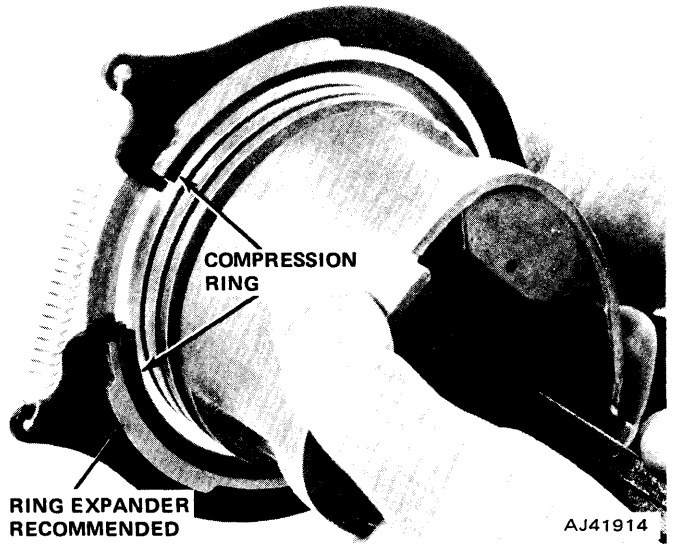

Fig. 1A-48 Compression Ring Installation

Piston Pins

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

Removal

(1) Using Piston Pin Remover J-21872 and arbor press, place piston on Remover Support J-21872-1 (fig. 1A-50).

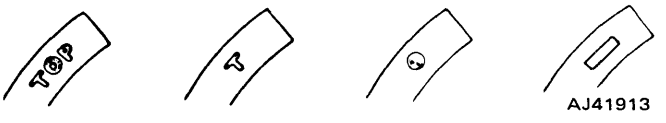

Fig. 1A-49 Typical Piston Ring Markings

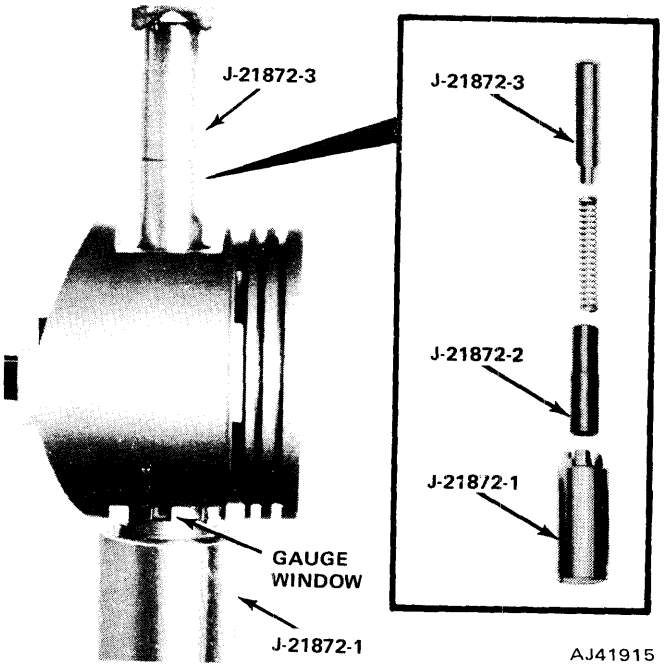

Fig. 1A-50 Piston Pin Removal or Installation

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

Pin Fitting

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

NOTE: *Never re-use piston pin after it has been removed from a connecting rod.*

(2) With pin removed from piston, clean and dry piston pin bore and replacement 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-50).

(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.

NOTE: *The piston pin is a 2,000 pound 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 nodular-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 bearing journals 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 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-51). The end play is the difference between the high and low readings.

(4) The correct crankshaft end play is 0.0015 to 0.0065 inch (0.002 to 0.0025 desired).

(5) If end play is incorrect according to specifications, inspect crankshaft thrust faces for wear. If no wear is apparent, replace thrust bearing and recheck end play. If end play is still outside specifications, the crankshaft must be replaced.

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

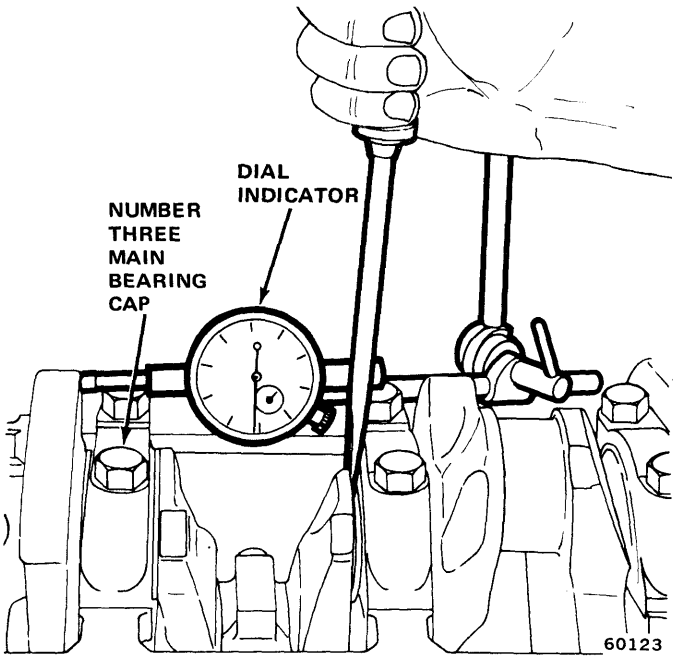

Fig. 1A-51 Measuring Crankshaft End Play

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 Main Bearing Fitting Chart and select inserts required to obtain specified bearing clearance.

Crankshaft Main Bearings

The main bearings are steel-backed, micro-babbitt, 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 Main Bearing Fitting Chart. The bearing code appears on the edge of the insert.

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

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 0.0005 inch.

Example:

Bearing Insert Pairs

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

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

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 service replacement inserts.

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

Crankshaft Removal

(1) Drain engine oil.

(2) Remove oil pan.

(3) Remove lower insert from bearing cap.

(4) Remove upper insert by loosening all other bearing caps and inserting small cotter pin in crankshaft oil hole. Cotter pin should be bent as shown in figure 1A-52.

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

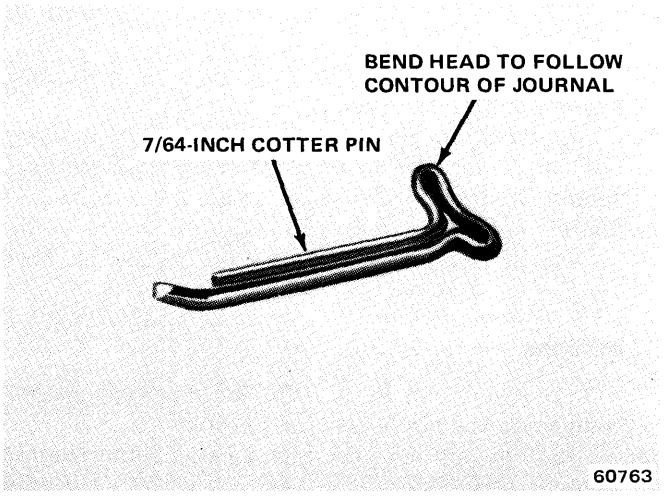

Fig. 1A-52 Upper Main Bearing Removal Tool

NOTE: *Since there is no hole in the number 4 main journal, a tongue depressor or similar soft-faced tool should be used to remove the bearing (fig. 1A-53). After moving the insert approximately one inch, the insert can be removed by applying pressure under the tab.*

Main Bearing Fitting Chart

Crankshaft Main Bearing Journal Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow —2.5001 to 2.4996 (Standard)	Yellow — Standard	Yellow — Standard
Orange —2.4996 to 2.4991 (0.0005 Undersize)	Yellow — Standard	Black — .001-inch Undersize
Black —2.4991 to 2.4986 (0.001 Undersize)	Black — .001-inch Undersize	Black — .001-inch Undersize
Green —2.4986 to 2.4981 (0.0015 Undersize)	Black — .001-inch Undersize	Green — .002-inch Undersize
Red —2.4901 to 2.4896 (0.010 Undersize)	Red — .010-inch Undersize	Red — .010-inch Undersize

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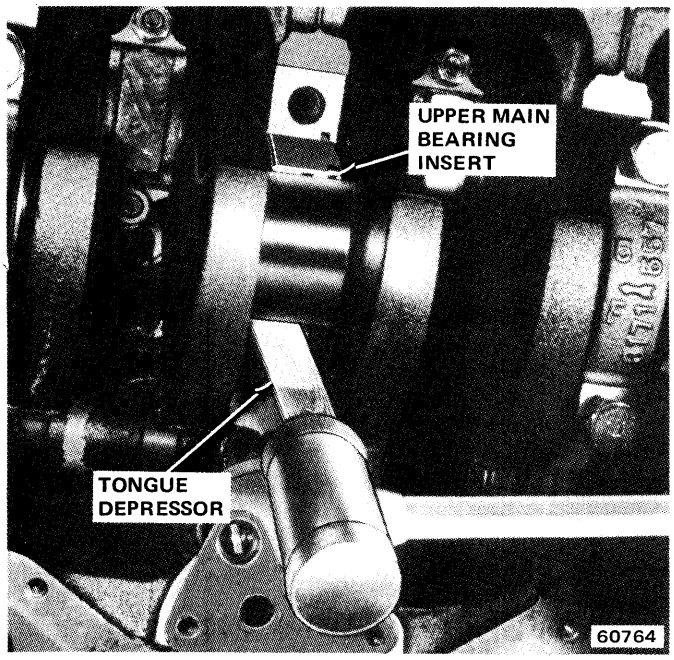

Fig. 1A-53 Removing Number 4 Main Bearing Insert

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

Inspection

(1) Wipe lower insert clean and inspect for abnormal wear pattern and for dirt or metal imbeddedd in lining. A normal main bearing wear pattern is shown in figure 1A-54.

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

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

(3) Inspect locking tabs for damage.

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

Measuring Bearing Clearance with Plastigage (Crankshaft Installed)

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

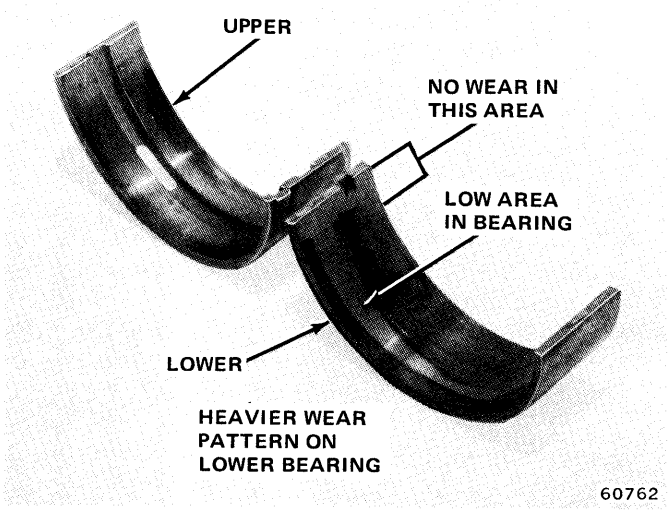

Fig. 1A-54 Normal Main Bearing Wear Pattern

(1) Remove main bearing cap and insert.

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

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

(4) Install bearing cap and tighten bolts to 80 foot-pounds torque.

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with furnished scale (fig. 1A-55).

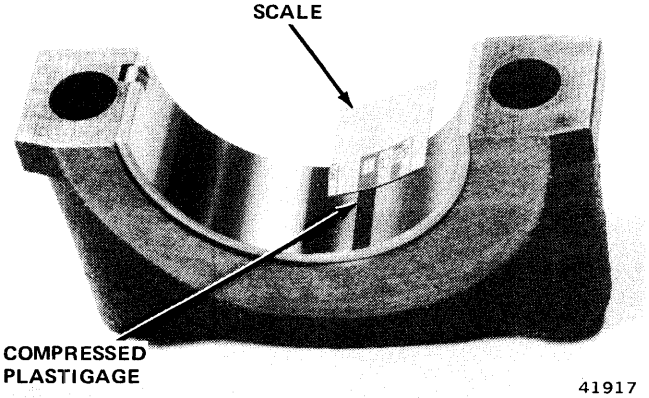

Fig. 1A-55 Checking Main Bearing Clearance with Plastigage

Correct clearance is 0.001 to 0.003 inch.The Plastigage should maintain the same size across the entire width of the insert. If size varies, it may indicate a tapered journal or dirt trapped behind the insert.

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

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

(7) If oil clearance exceeds specifications, install a pair of 0.001 inch undersize bearing inserts and check clearance as described in steps (4) through (6). The clearance indicated with the 0.001 inch undersize inserts installed will determine if the 0.001 inch undersize inserts or some other combination will provide correct clearance. For example, if the clearance was 0.0035 inch originally, a pair of 0.001 inch undersize inserts would reduce clearance by 0.001 inch. Oil clearance would by 0.0025 inch and within specification. A 0.002 inch undersize bearing half and a 0.001 inch undersize half would reduce this clearance an additional 0.0005 inch and oil clearance would be 0.002 inch.

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

(8) If oil clearance exceeds specification using 0.002-inch undersize bearings, measure crankshaft journal with micrometer. If the journal size is correct, the crankshaft bore of the cylinder block may be misaligned which requires cylinder block replacement or a machine shop operation to true the bore. If journal size is less than 2.4981 inch, the crankshaft must be replaced or reground to accept a suitable undersize bearing.

Measuring Main Bearing Journal with Micrometer (Crankshaft Removed)

(1) Clean main bearing journal.

(2) Measure maximum diameter of journal with micrometer. Measure at four points. Take two readings at each end of journal, 90° apart.

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

Crankshaft 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 to 40 foot-pounds torque. Then tighten to 60 foot-pounds. Finally, tighten to 80 foot-pounds. Rotate crankshaft after tightening each main cap to make sure crankshaft rotates freely.

NOTE: *When installing a crankshaft kit (crankshaft plus bearings) check bearing clearance with Plastigage.*

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

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

FLYWHEEL AND STARTER RING GEAR ASSEMBLY

The starter ring gear is a separate item 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 transmissions. The entire drive plate/ring assembly must be replaced on automatic transmission equipped vehicles. The transmission must be removed to service the ring gear.

Ring Gear Replacement—Manual Transmission

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

(2) Press flywheel through ring gear.

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

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

(4) Press flywheel onto replacement ring gear.

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

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

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, oil pump inlet tube and screen, timing gears, and chain.

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

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

Specifications

Type	In Line, OHV, Six-cylinder
Bore	3.75 inches
Stroke	
232	3.50 inches
258	3.895 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
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	
232/258 1V	0.232 inch
258 2V	0.248 inch
Intake Valve Timing - 232/258 1V	
Opens	12.12° BTDC
Closes	64.80° ABDC
Intake Valve Timing - 258 2V	
Opens	14.58° BTDC
Closes	68.79 ABDC
Exhaust Valve Timing - 232/258 1V	
Opens	53.12° BBDC
Closes	23.80° ATDC
Exhaust Valve Timing - 258 2V	
Opens	55.59° BBDC
Closes	27.78° ATDC
Valve Overlap	
232/258 1V	35.92°
258 2V	42.36°
Intake Duration	
232/258 1V	256.92°
250 2V	263.37°
Exhaust Duration	
232/258 1V	256.92°
258 2V	263.37°

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
Connecting Rod Bore (Less Bearings)	2.2085 to 2.2080 inches
Bearing Clearance	0.001 to 0.0025 inch (0.0015-0.002 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 0.0025 inch (0.0015-0.002 inch preferred)
Maximum Out-of-Round (All Journals)	0.0005 inch
Maximum Taper (All Journals)	0.0005 inch

Cylinder Block

Deck Height	
Wedge Head	9.528 to 9.534 inch
Quench Head	9.487 to 9.493 inch
Deck Clearance	
232 Wedge Head	0.0575 inch (below block)
Quench Head	0.165 inch (below block)
258 Wedge Head	0.110 inch (below block)
Quench Head	0.069 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	
Wedge Head	62.5 to 65.5 cc
Quench Head	67.84 to 70.84 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)

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Specifications (Continued)

Lubrication System

Engine Oil Capacity ..... 5 quarts
(Add 1 quart with filter change)
Normal Operating Pressure ..... 13 psi at 600 rpm;
37 to 75 psi (max) at 1600 rpm+
Oil Pressure Relief ..... 75 psi (max)
Gear-to-Body Clearance ..... 0.0005 to 0.0025 inch
(0.0005 inch preferred)
Gear End Clearance—
Feeler Gauge ..... 0.004 to 0.008 inch
(0.0007 inch preferred)
Gear End Clearance Plastigage ..... 0.002 to 0.008 inch
(0.002 inch preferred)

Pistons

Weight (less pin)
Wedge Head ..... 481 to 485 grams
Quench Head ..... 498 to 502 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 0.1895 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 1.6:1
Push Rod Length
Wedge Head ..... 9.615 to 9.595 inches
Quench Head ..... 9.640 to 9.660 inches
Push Rod Diameter ..... .313 to .312 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 — 232/258 1V

Free Length ..... 2.234 inches approx.
With Rotators ..... 2.00 inches approx.
Spring Tension
Valve Closed ..... 95 to 105 lbs at 1.786 inches
With Rotators ..... 80-88 lbs at 1-5/8 inches
Valve Open ..... 188 to 202 lbs at 1.411 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

Valve Springs—258 2V

Free Length ..... 1.987 inches approx.
Spring Tension
Valve Closed ..... 64-72 lbs at 1.786 inches
Valve Open ..... 197-210 lbs at 1.386 inches
Inside Diameter ..... 0.948 to 0.968 inches

70493B

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.

	Service Set-To Torque	Service In-Use Recheck Torque
Air Injection Tube-to-Manifold	20	15 to 20
Air Pump-to-Bracket	20	15 to 22
Air Pump Brackets-to-Engine (A. 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

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Torque Specifications (Continued)

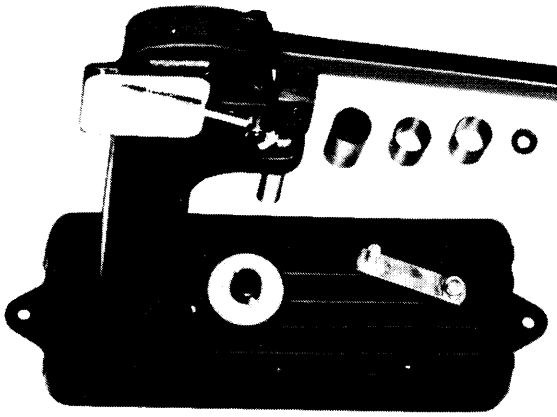
	Service Set-To Torques	Service In-Use Recheck Torques
Camshaft Sprocket Screw	50	45 to 55
Carburetor Hold-Down Nuts	14	12 to 20
Coil Bracket-to-Cylinder Head	14	10 to 18
Connecting Rod Bolt Nuts	33	30 to 35
Cylinder Head Capscrews	105	95 to 115
Cylinder Head Cover Screws	50 in-lb	42 to 58 in-lb
Crankshaft Pulley-to-Damper	20	15 to 25
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
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	20	15 to 25
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	35	25 to 40
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 Filter Adapter	48	42 to 55
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
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	19	16 to 26
Spark Plugs	28	22 to 33
Timing Case Cover-to-Block Screws	5	4 to 8
Timing Case Cover-to-Block Studs	16	13 to 19
Thermostat Housing Screw	13	10 to 18
Vibration Damper Screw, Lubricated	80	70 to 90
Water Pump Screws	13	9 to 18

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

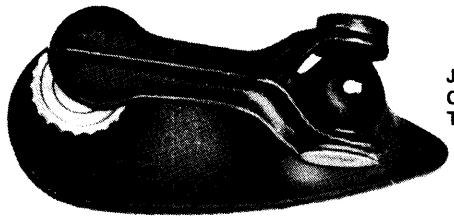
Refer to the Standard Torque Specifications and Capscrew Markings Chart in Section A of this manual for any torque specifications not listed above.

60264B

Special Tools



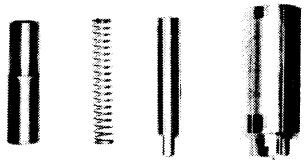
J-5790
HYDRAULIC VALVE
LIFTER TESTER



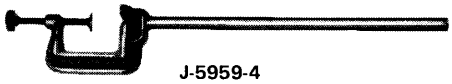
J-8056
VALVE AND CLUTCH
SPRING TESTER

J-21882
OIL PUMP INLET
TUBE INSTALLER

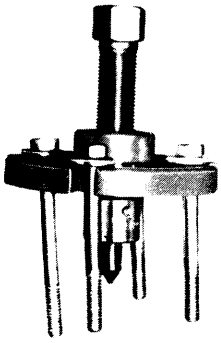
J-6042-1,4,5
VALVE GUIDE REAMERS



J-21872
PISTON PIN REMOVER
AND INSTALLER

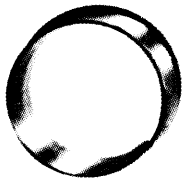


J-5959-4
C - CLAMP AND
ROD EXTENSION

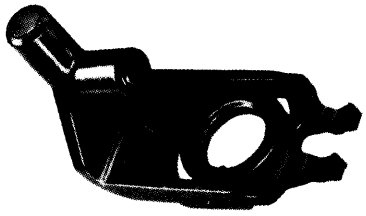


J-21791
VIBRATION DAMPER
REMOVER

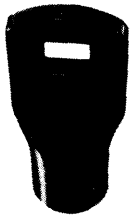
J-22248
TIMING CASE COVER
ALIGNMENT TOOL AND
SEAL INSTALLER



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



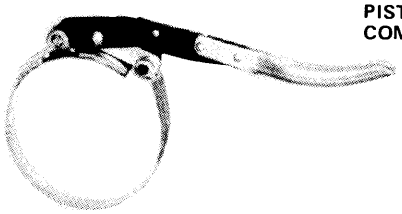
TOOL J-22534-1
VALVE SPRING REMOVER
AND INSTALLATION TOOL



TOOL
J-22534-4

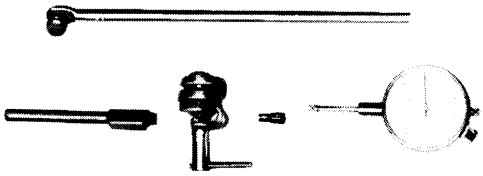
TOOL
J-22534-5

J-22534 VALVE SPRING REMOVER AND INSTALLATION TOOL



J-22700
OIL FILTER WRENCH

J-21884
HYDRAULIC VALVE TAPPET
REMOVER AND INSTALLER



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

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

J-9256
TIMING CASE COVER
OIL SEAL REMOVER

A50428