SIX-CYLINDER ENGINE

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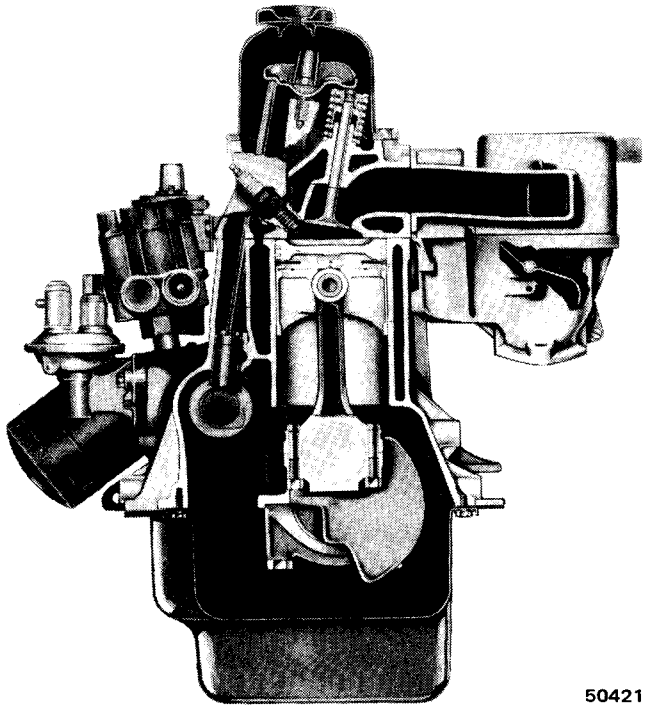
GENERAL

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).



50421

Fig. 1A-1 Engine Assembly—Sectional View

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, 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
E	232	1V	8.0:1

1st Character (Year)	2nd and 3rd Characters (Month)	4th Character (Engine Type)	5th and 6th Characters (Day)
8 - 1975 9 - 1976	01 - 12	A or E	01 - 31

EXAMPLE: 9 03 A 18

60257

The example code identifies a 258 CID with 1V carburetor and 8.00:1 compression ratio built on March 18, 1976.

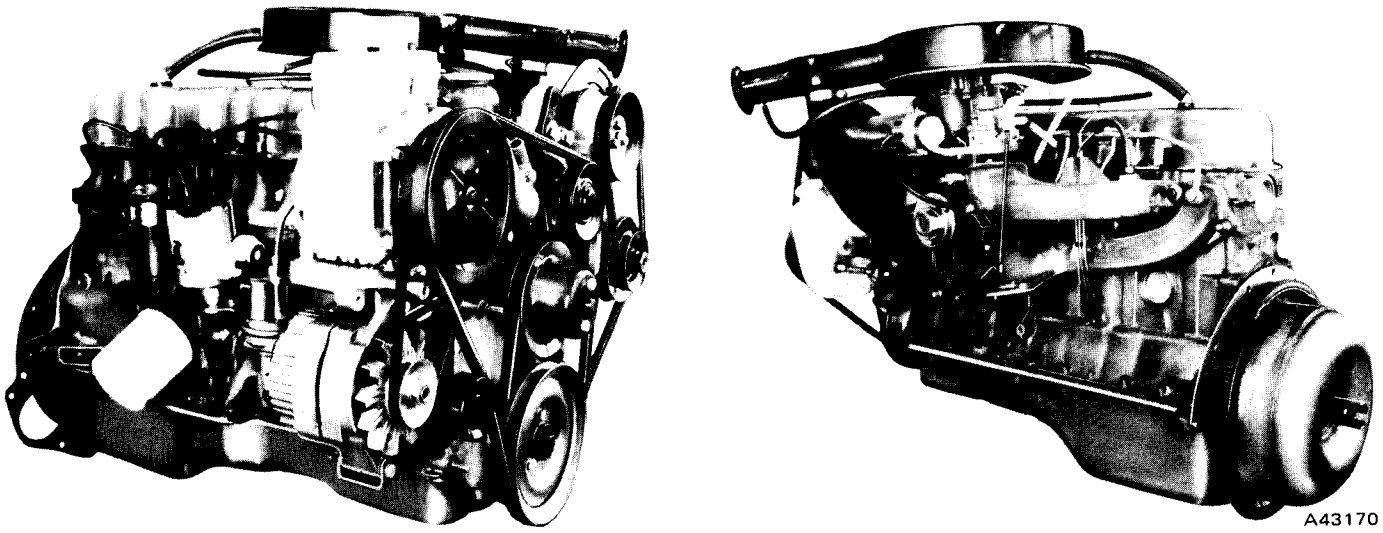


Fig. 1A-2 Engine Assembly

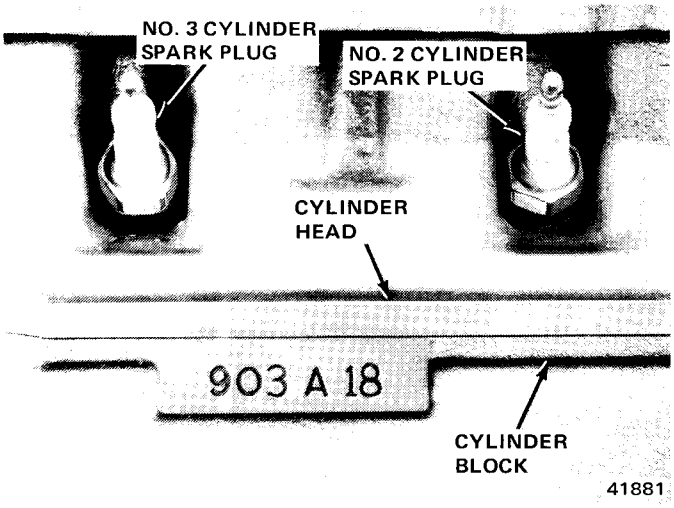


Fig. 1A-3 Build Date Code Location

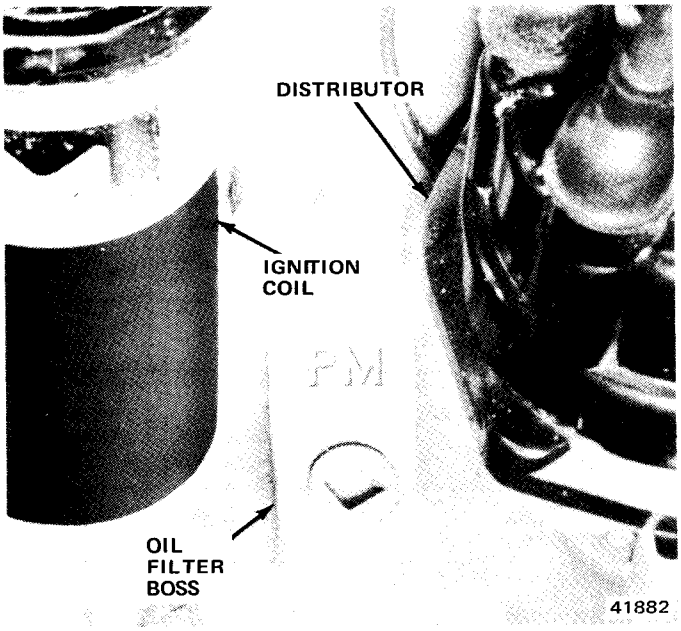


Fig. 1A-4 Oversize or Undersize Letter Code

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:

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

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 throwoff 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 point 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.

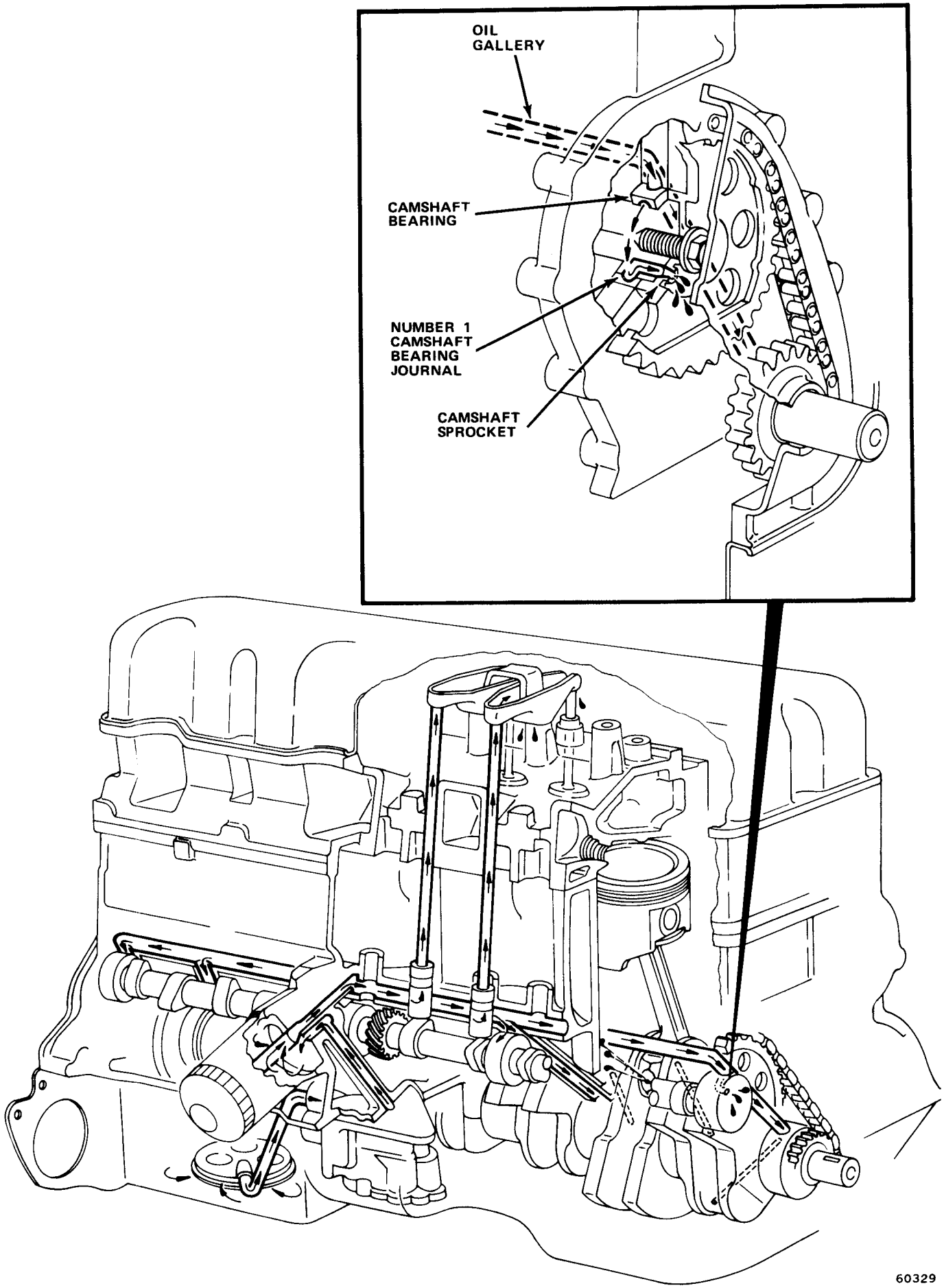


Fig. 1A-5 Lubrication System

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.
	(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.

60259A

Service Diagnosis (Continued)

Condition	Possible Cause	Correction
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.
	(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.

Service Diagnosis (Continued)

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

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).

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

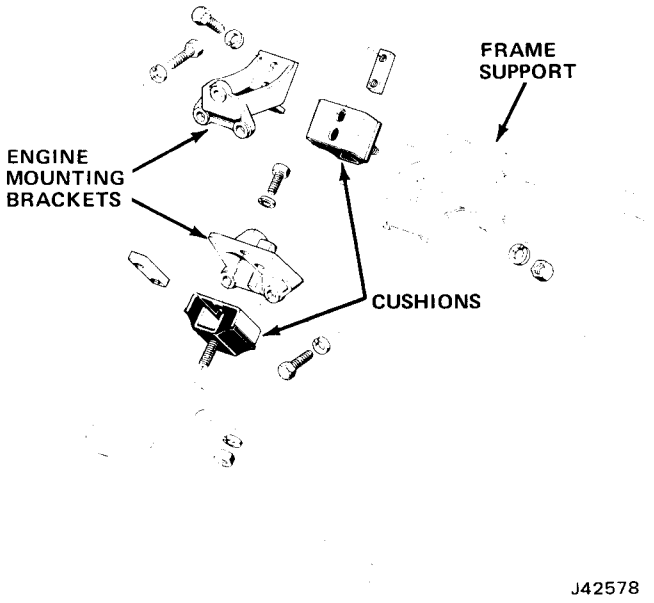


Fig. 1A-6 Engine Mounting—Typical

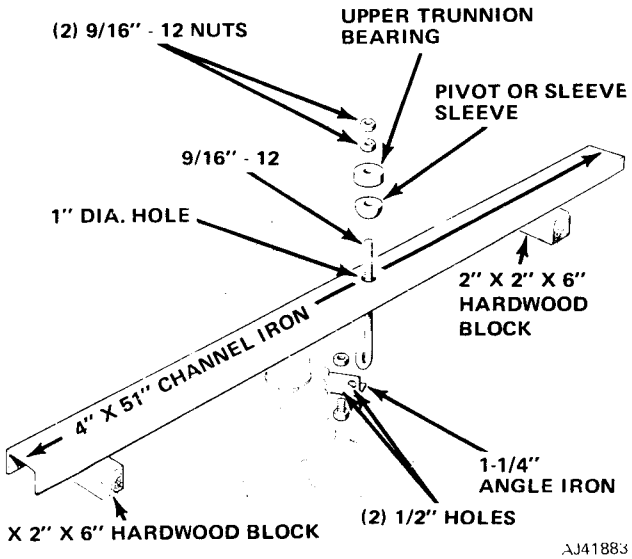


Fig. 1A-7 Engine Holding Fixture—Typical

ENGINE REMOVAL

The engine is removed without the transmission and bell housing.

(1) On the Cherokee and Truck, the hood must be removed. Mark hinge locations at hood panel for alignment during installation. Remove hood from hinges.
(2) Remove air cleaner assembly.
(3) Drain cooling system.
(4) Disconnect upper and lower radiator hoses.
(5) If equipped with automatic transmission, disconnect cooler lines from radiator.

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

(6) Remove radiator.
(7) Remove radiator fan.
(8) If equipped, remove power steering pump and drive belt from the engine and place aside. Do not disconnect the power steering hoses.
(9) If equipped with air conditioning:
(a) Turn both service valves clockwise to the front seated position.
(b) Bleed refrigerant charge from compressor by slowly loosening service valve fittings.
(10) Disconnect condenser and evaporator lines from compressor.
(11) Disconnect receiver outlet at disconnect coupling.
(12) Remove condenser and receiver assembly.
(13) Disconnect the following wires (if equipped):

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

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

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

(15) Disconnect accelerator linkage at engine.
(16) Disconnect transmission linkage.
(17) Disconnect exhaust pipe at support bracket and exhaust manifold.

(18) Remove oil filter.

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

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

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

(22) Remove transfer case shift lever boot, floormat (if equipped) and transmission access cover.

(23) If equipped with automatic transmission, remove upper bolts securing transmission bell housing to engine.

If equipped with manual transmission, remove upper bolts securing clutch housing to engine.

(24) Remove starter motor.

(25) If equipped with automatic transmission:

- Remove engine adapter plate inspection covers.
- Mark assembled position of converter and flex plate and remove converter-to-flex plate capscrews.
- Remove remaining bolts securing transmission bell housing to engine.

If equipped with manual transmission:

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

(26) Support transmission with a floor jack.

(27) Remove engine by pulling forward and upward.

ENGINE INSTALLATION

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

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

(2) Install transmission bell housing-to-engine (automatic transmission) or clutch housing-to-engine bolts (manual transmission). Tighten the bolts to specified torque (automatic transmission—28 foot-pounds; manual transmission: top, 17; bottom, 43 foot-pounds).

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

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

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

(6) Install starter motor.

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

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

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

(10) Install oil filter.

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

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

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

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

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

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

(16) Fill cooling system to specified level.

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

(18) Install air cleaner assembly.

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

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

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

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

(1) Inspect cylinder head cover for cracks.

(2) Position gasket on cylinder head cover flange. Gasket tabs are to be positioned in cutout openings in flange of cover.

(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 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 maintain 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.

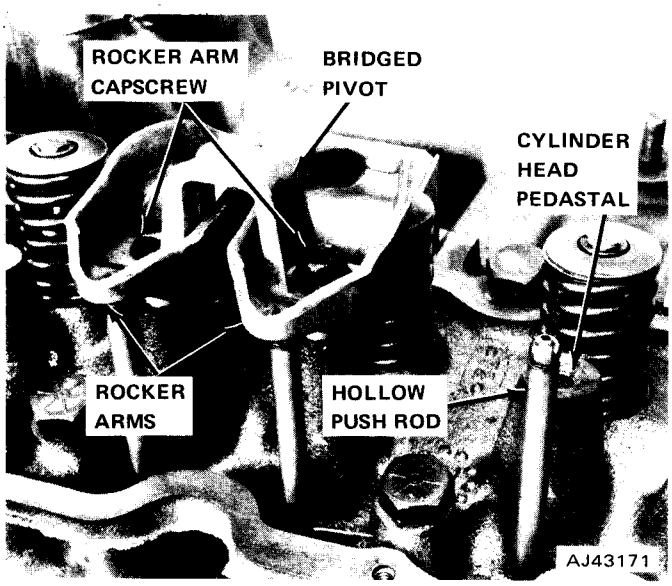


Fig. 1A-8 Rocker Arm Assembly

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. However, the second function is to positively induce rotation of the exhaust valve to increase durability of the valve seat and face.

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

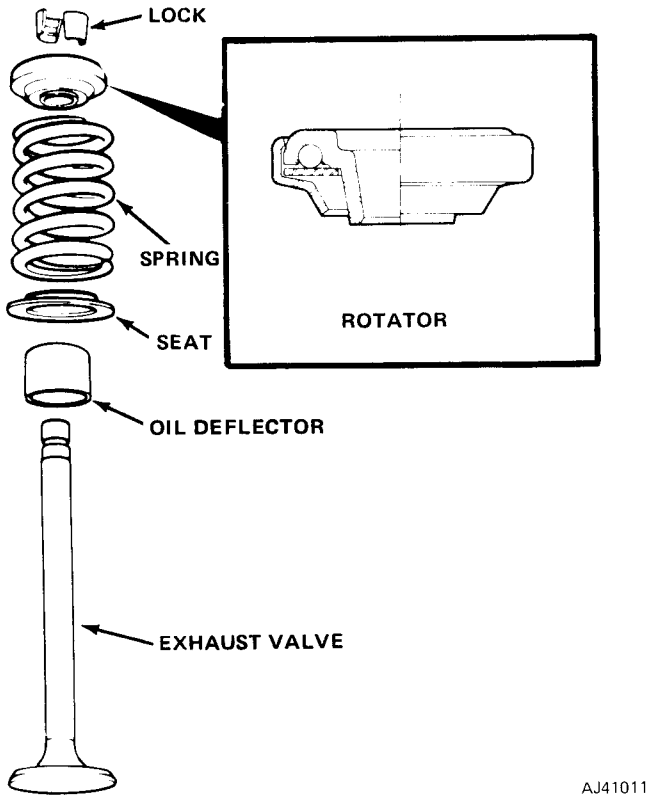


Fig. 1A-9 Exhaust Valve Rotator

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 attaching an air hose connection to a spark plug from which the porcelain has been removed.*

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

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).

(8) Remove valve spring and retainer or rotator.

Fig. 1A-10 Valve Spring Removal

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

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

Valve Spring Tension Test

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

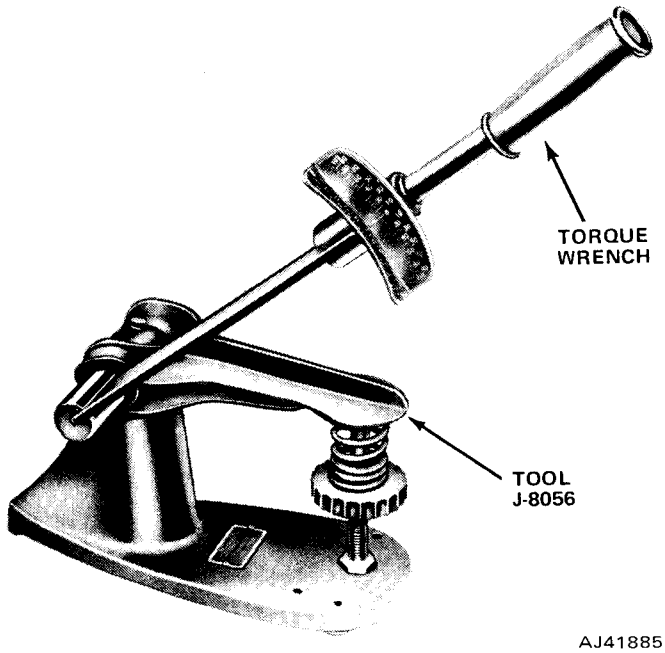


Fig. 1A-11 Valve Spring Tester

Installation

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

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

(2) Install exhaust valve spring seat (if equipped).
(3) Install valve spring and retainer or rotator.
(4) 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.*

(5) Disconnect air hose, remove adapter from spark plug hole, and install spark plug.
(6) 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.
(7) 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 and also between the exhaust manifold and exhaust pipe (fig. 1A-12).

The exhaust gas recirculation valve and back-pressure sensor (if equipped) are 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.

Removal and Cleaning

(1) Remove air cleaner and carburetor.
(2) Disconnect accelerator cable from accelerator bellcrank.
(3) Disconnect PCV vacuum hose from intake manifold.
(4) Remove spark CTO vacuum tubes and disconnect TCS solenoid vacuum valve wiring (if equipped).
(5) Disconnect vacuum hose from EGR valve or back-pressure sensor (if equipped).
(6) Remove power steering mounting bracket (if equipped).
(7) Detach power steering pump and set aside (if equipped). Do not remove hoses.

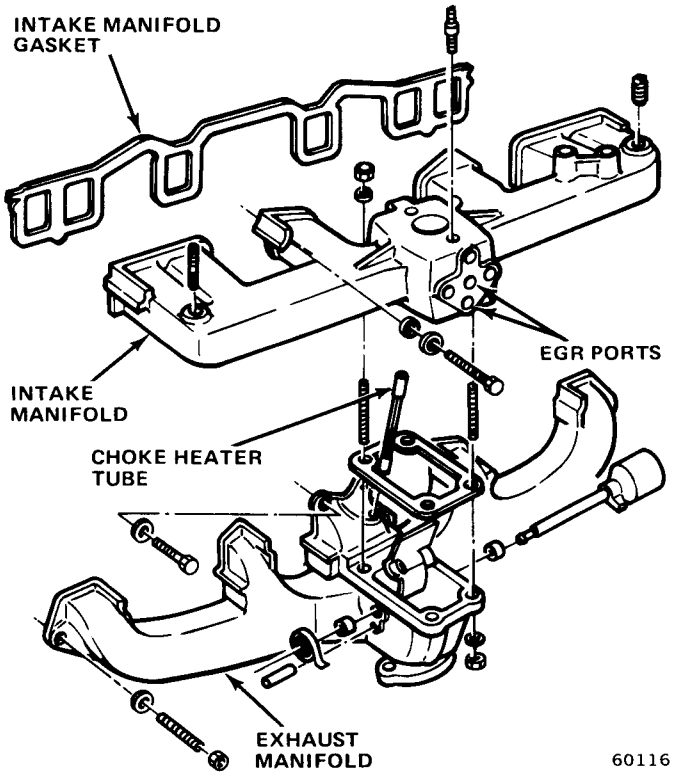


Fig. 1A-12 Intake and Exhaust Manifold Assembly

(8) Remove air conditioning drive belt idler assembly from cylinder head (if equipped).
(9) Remove EGR valve and back-pressure sensor (if equipped).
(10) Disconnect exhaust pipe from manifold flange.
(11) Remove manifold attaching bolts, nuts, and clamps and remove intake and exhaust manifold as an assembly. Discard gasket.
(12) Separate manifolds at riser area.
(13) Clean mating surfaces of manifolds and cylinder head.

Installation

(1) Assemble manifolds and finger-tighten heat riser retaining nuts.
(2) Position new intake manifold gasket on cylinder head and install manifold assembly. Tighten heat riser nuts to 5 foot-pounds torque. Tighten manifold attaching bolts and nuts in sequence (fig. 1A-13) to 23 foot-pounds torque.
(3) Install flange gasket and connect exhaust pipe to manifold flange.
(4) Install carburetor.
(5) Install power steering pump (if equipped).
(6) Install AC drive belt idler assembly (if equipped).
(7) Install power steering pump mounting bracket (if equipped).
(8) Install EGR valve and back-pressure sensor (if removed).

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

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

(11) Connect vacuum hose to the EGR valve and back-pressure sensor (if equipped).

(12) Connect accelerator cable and PCV hose.

(13) Install air cleaner.

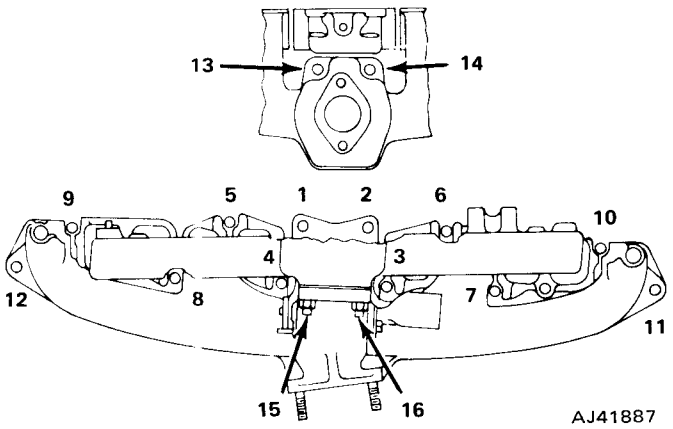


Fig. 1A-13 Intake Manifold Torque Sequence

CYLINDER HEAD ASSEMBLY

Cylinder heads for either 232 or 258 CID engines are interchangeable. All 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.

NOTE: *Due to emission control regulations, cylinder heads which exceed specifications for flatness must be replaced. Milling is not recommended.*

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).

(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).

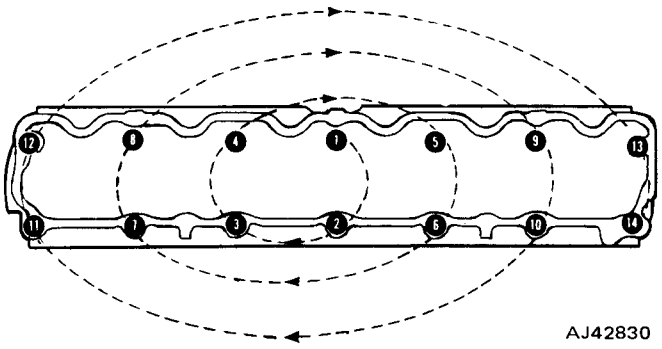


Fig. 1A-14 Cylinder Head Torque Sequence

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.

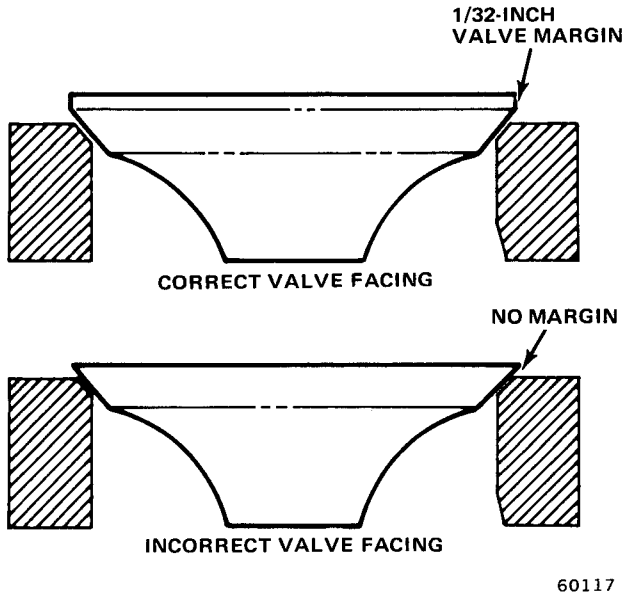


Fig. 1A-15 Valve Refacing

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).

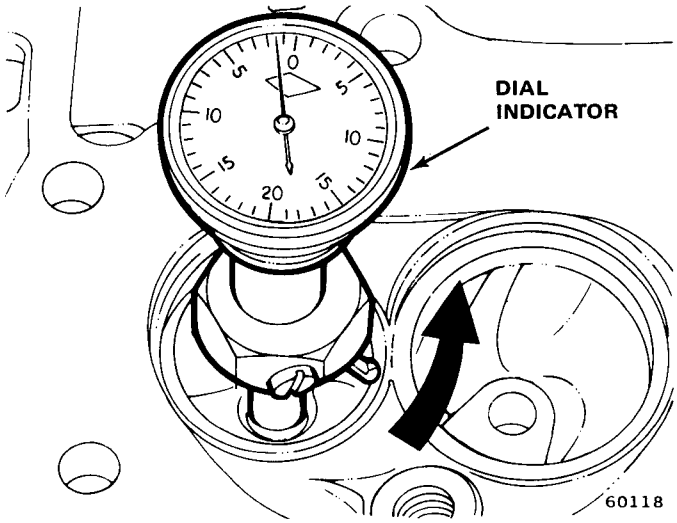


Fig. 1A-16 Checking Valve Seat Runout

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.

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

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

Valve Stem-to-Guide Clearance

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

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.

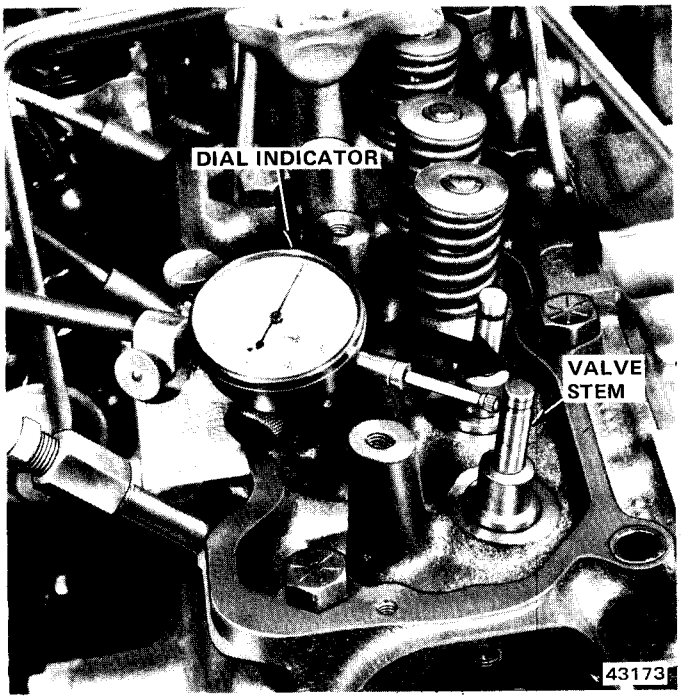


Fig. 1A-17 Checking Stem-to-Guide Clearance

Alternate Method

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

NOTE: *Make certain the valve stem and guide bore are thoroughly cleaned before measuring. The valve stem-to-guide clearance can be determined by subtracting the diameter of the valve stem from the size of the pilot selected.*

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).

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.

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.

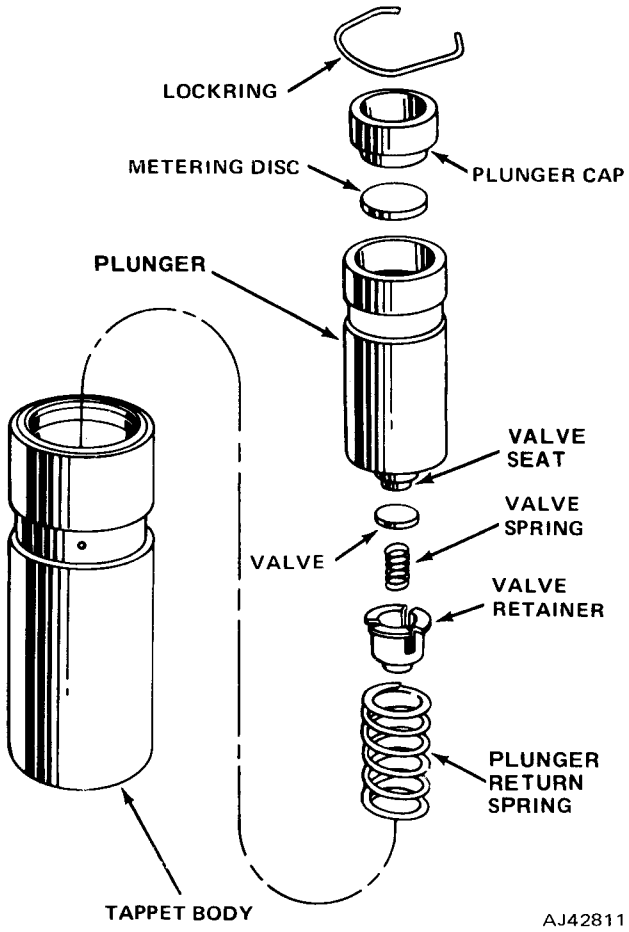


Fig. 1A-18 Hydraulic Tappet Assembly

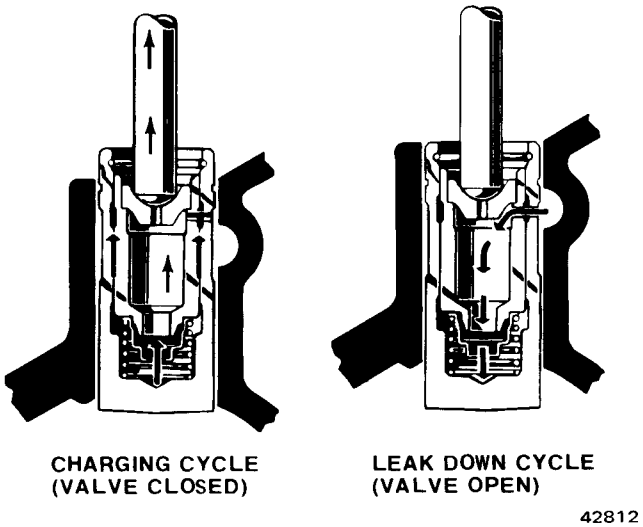


Fig. 1A-19 Hydraulic Tappet Operation

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.

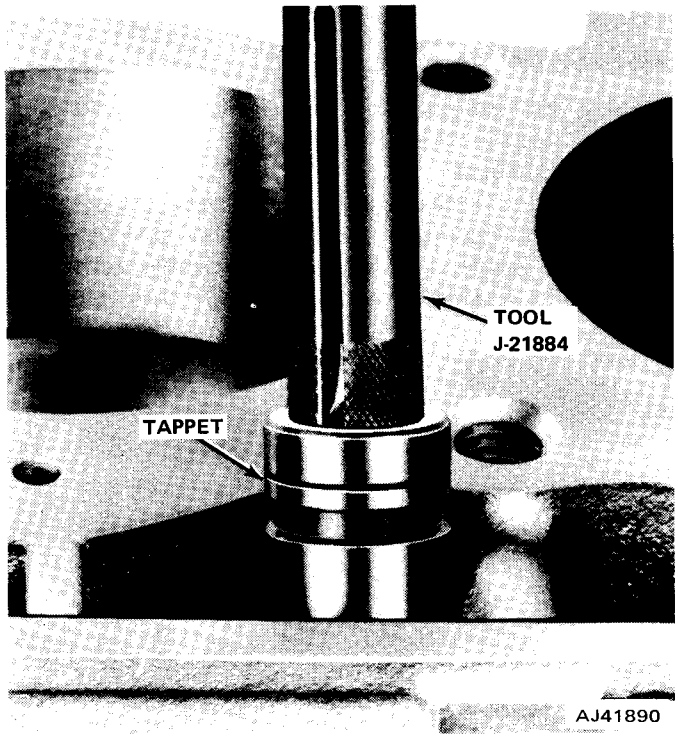


Fig. 1A-20 Hydraulic Tappet Removal

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.

(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.

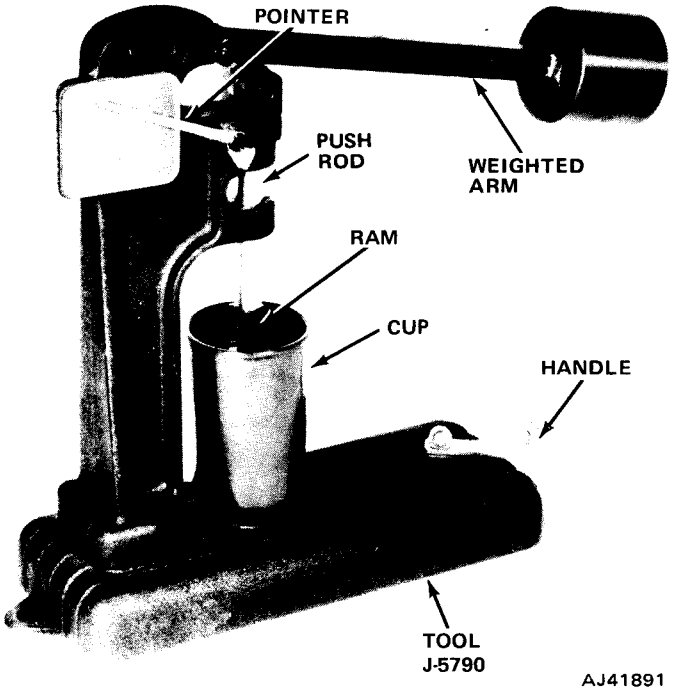


Fig. 1A-21 Hydraulic Tappet Leak-Down Test

(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 leas 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.

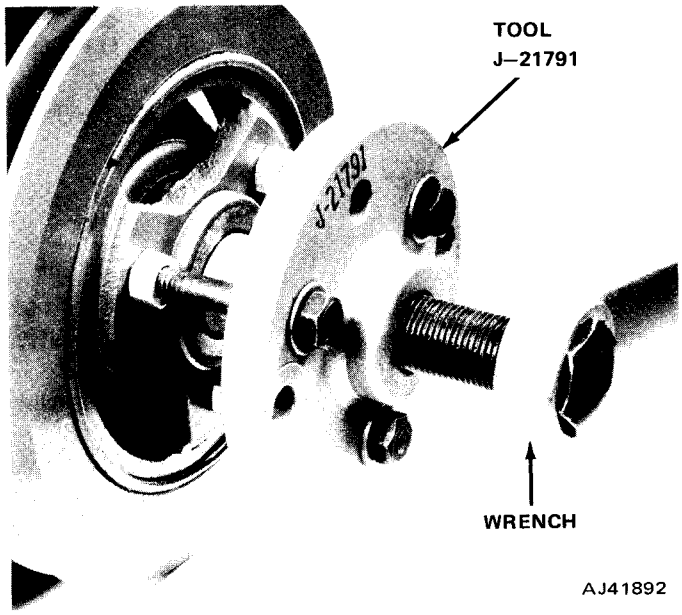


Fig. 1A-22 Vibration Damper Removal

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 55 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.

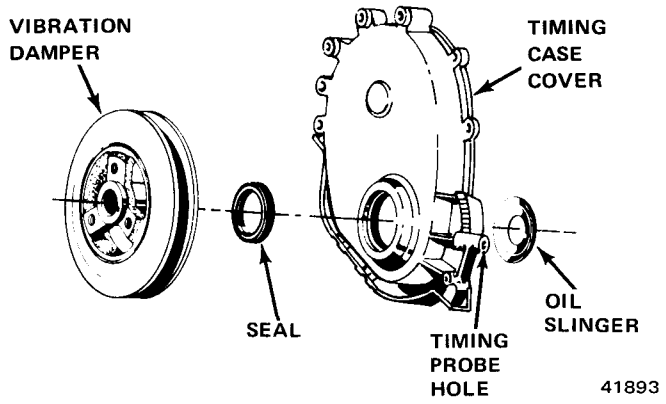


Fig. 1A-23 Timing Case Cover

Removal

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

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

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

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

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

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

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

Installation

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

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

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

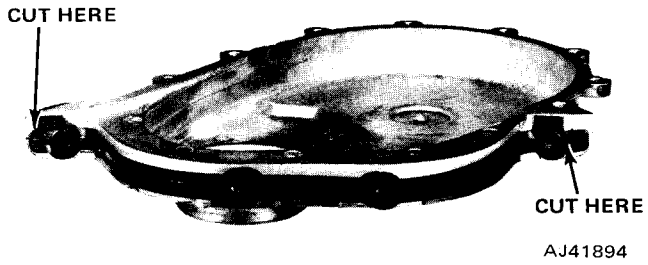


Fig. 1A-24 Oil Pan Front Seal Installation

(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).

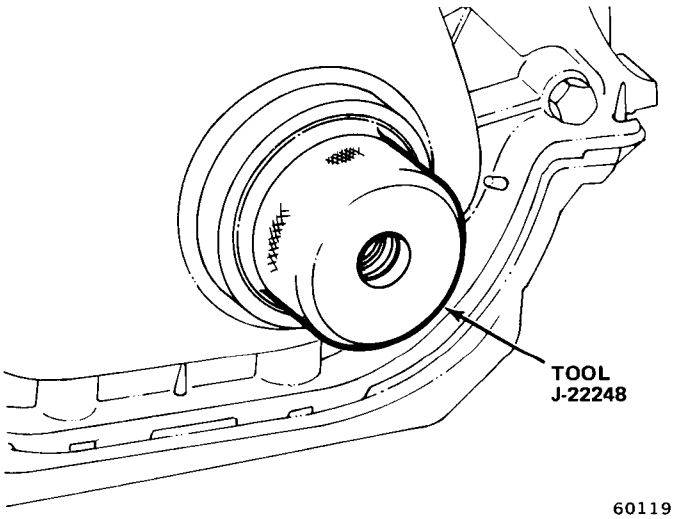


Fig. 1A-25 Timing Case Cover Alignment

(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).

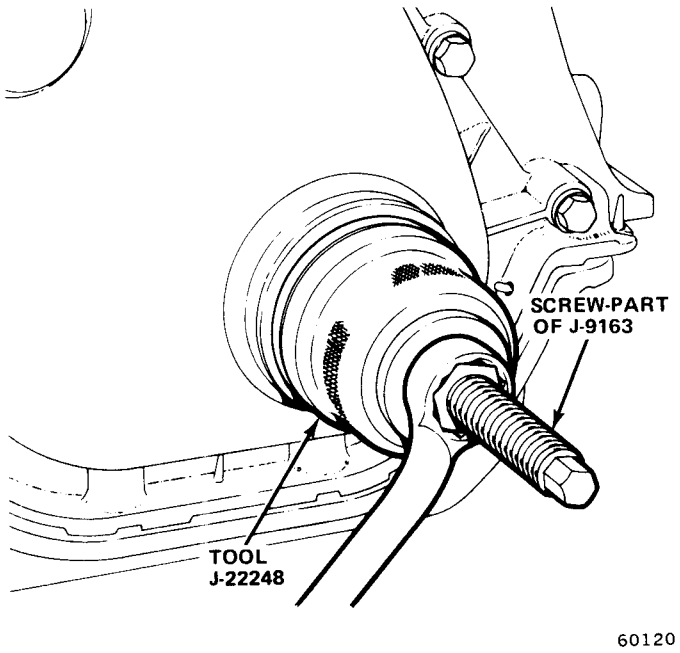


Fig. 1A-26 Timing Case Cover Oil Seal Installation

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

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

(10) Install damper pulley (if equipped).

(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 (if equipped).

(3) Remove vibration damper.

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

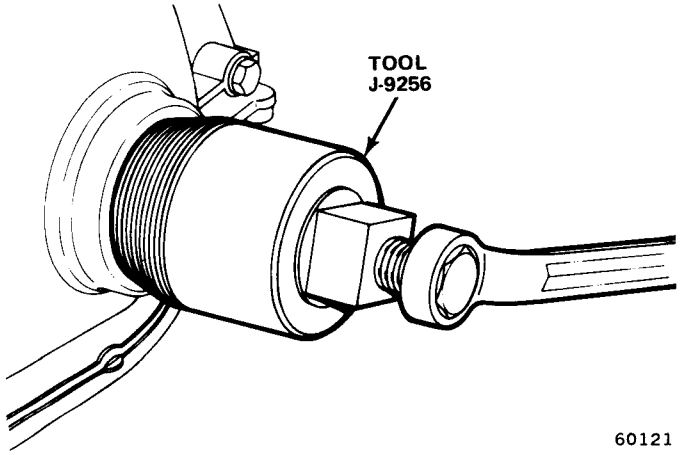


Fig. 1A-27 Timing Case Cover Oil Seal Removal

(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 55 foot-pounds torque.

(9) Install damper pulley (if equipped).

(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.

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).

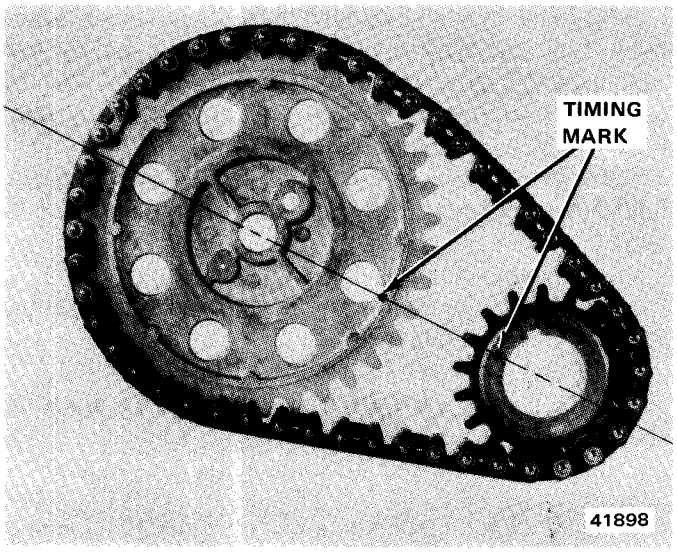


Fig. 1A-28 Sprocket Alignment

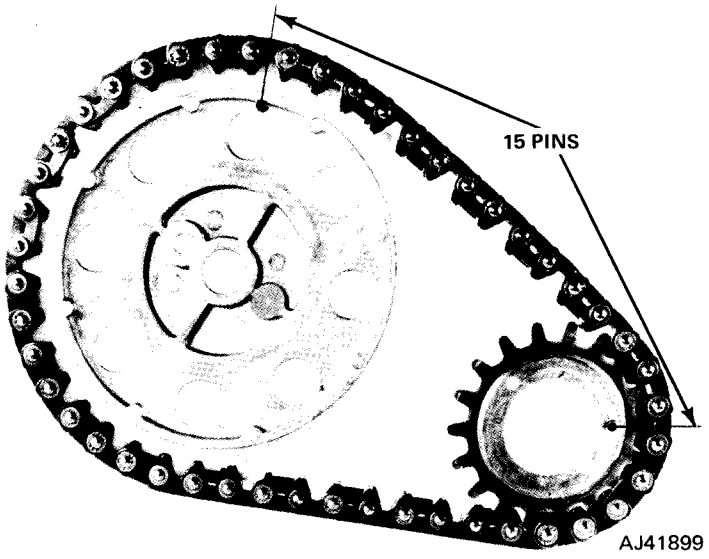


Fig. 1A-29 Timing Chain Installation

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

Installation

(1) Assemble timing chain, crankshaft sprocket, and camshaft sprocket with timing marks aligned as shown in figure 1A-28.

(2) Install assembly to the crankshaft and camshaft.

(3) Install camshaft sprocket retaining bolt and washer and tighten to 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.*

(4) Install timing case cover and new 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 engines use the same camshaft. 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 (use piece of rubber tubing between dial indicator plunger to push rod) (fig. 1A-30).

(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.

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.

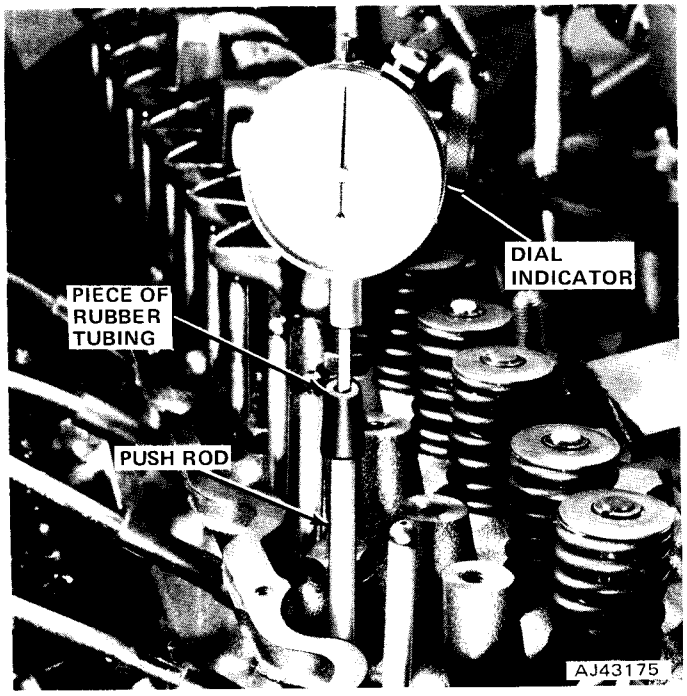


Fig. 1A-30 Cam Lobe Lift Measurement

Inspection

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

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

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

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.*

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.*

(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:

- Place a jack under the transmission bell housing.
- Disconnect engine right support cushion bracket from block and raise the engine to allow sufficient clearance for oil pan removal.

(4) Remove oil pan.

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

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

Installation

(1) Install a new oil pan front seal to timing chain cover and apply a generous amount of 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 new oil.

OIL FILTER

A full flow oil filter, mounted on the lower right hand side of the engine, is accessible through the hood opening. A bypass valve incorporated in the filter mounting boss 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.

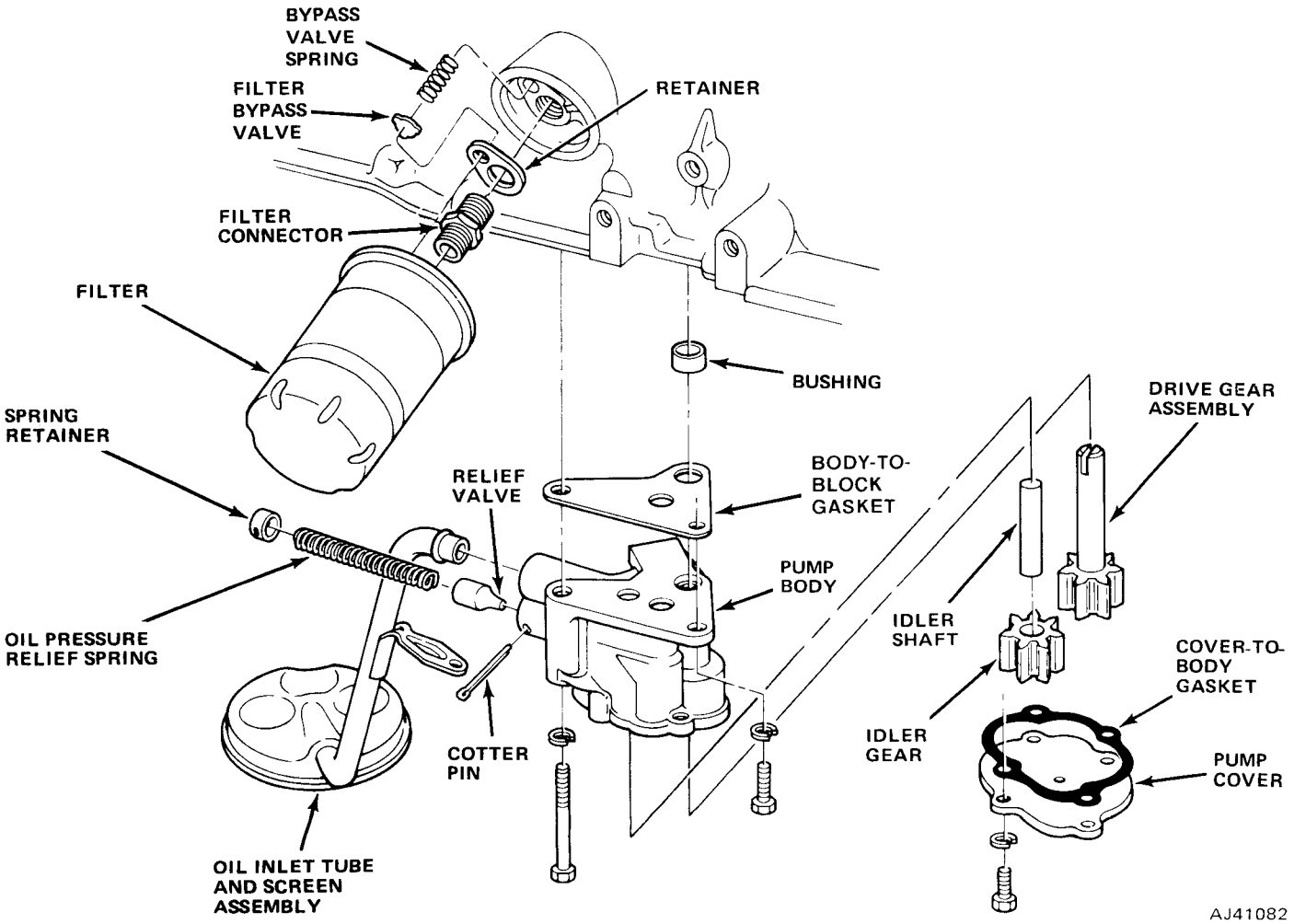


Fig. 1A-31 Oil Filter and Oil Pump Assembly

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 by placing a straightedge across ends of gears while pushing gears up into pump body. Select a feeler gauge which will fit snugly but freely between straightedge and pump body (fig. 1A-32). Correct clearance is 0.002 to 0.006 inch (0.006 desired).

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 gakset may correct the clearance. The standard gasket is 0.010 inch thick.*

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

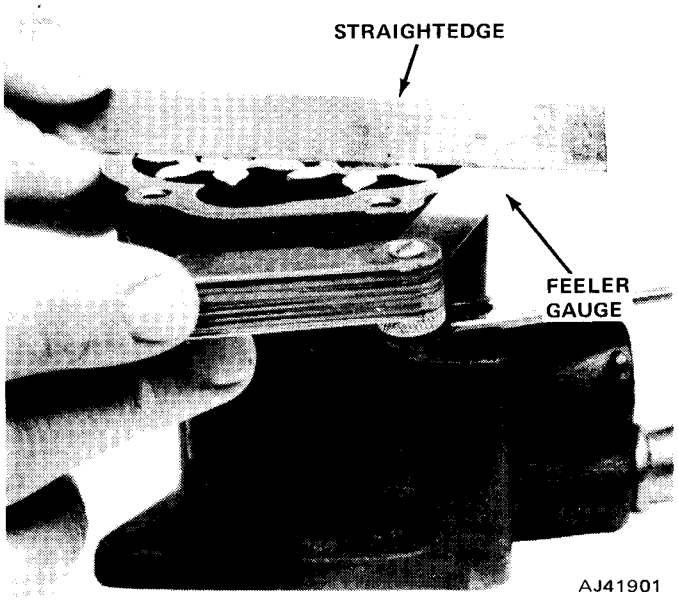


Fig. 1A-32 Oil Pump Gear End Clearance Measurement

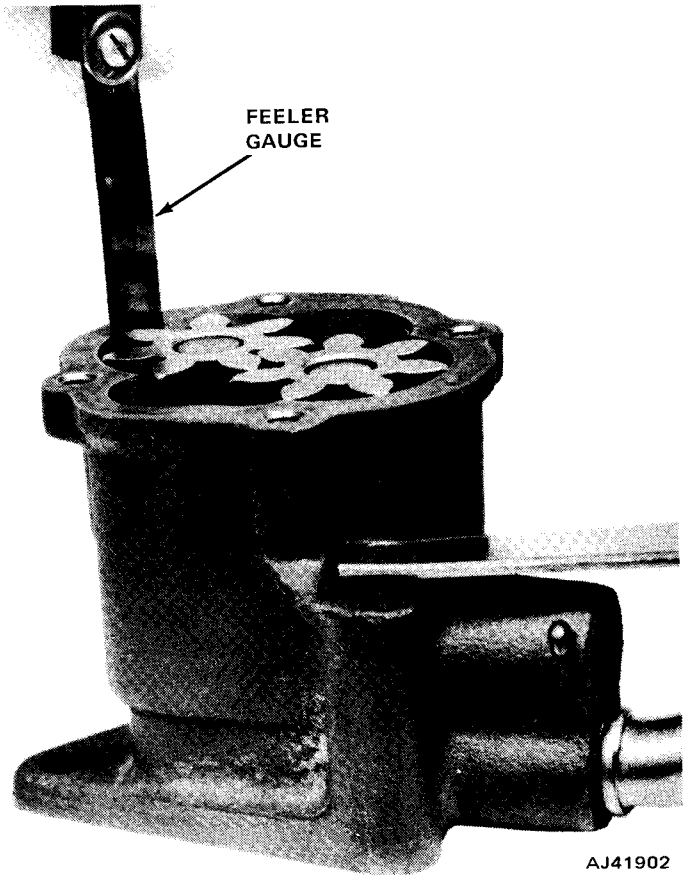


Fig. 1A-33 Oil Pump Gear-to-Body Clearance Measurement

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

Assembly and Installation

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

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

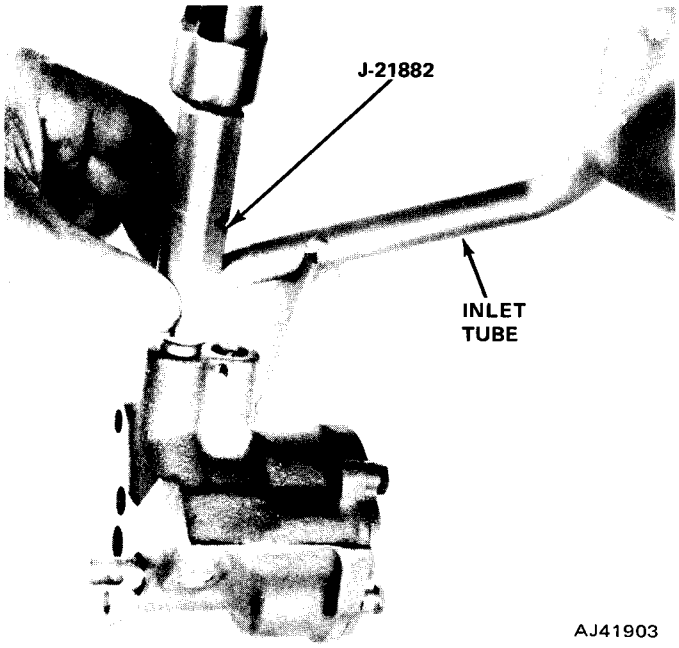


Fig. 1A-34 Oil Pump Inlet Tube Installation

(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 new 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.

(6) Install oil pan using new gaskets and seals (refer to Oil Pan Installation in this section). Fill crankcase with new 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 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-35).

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

(11) Install rear main bearing cap .

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

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

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

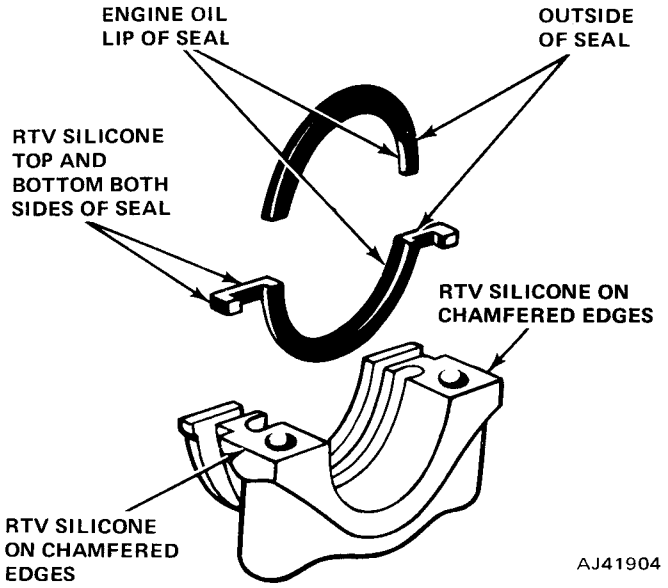


Fig. 1A-35 Rear Main Oil Seal and Cap Installation

CYLINDER BLOCK

Disassembly

(1) Remove engine as outlined under Engine Removal.

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

(3) Place engine assembly on engine stand.

(4) Remove intake and exhaust manifolds.

(5) Remove cylinder head cover and gasket.

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

(7) Remove push rods.

(8) Remove cylinder head and gasket.

(9) Remove valve tappets.

(10) Remove drive pulley and vibration damper.

(11) Removing timing case cover.

(12) Remove timing chain and sprockets.

(13) Remove camshaft.

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

(15) Remove oil pan and gaskets.

(16) Remove oil pump.

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

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

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

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

(19) Remove main bearing caps and inserts.

(20) 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. 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 with at least 30 degrees between each ring gap.

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

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

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

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

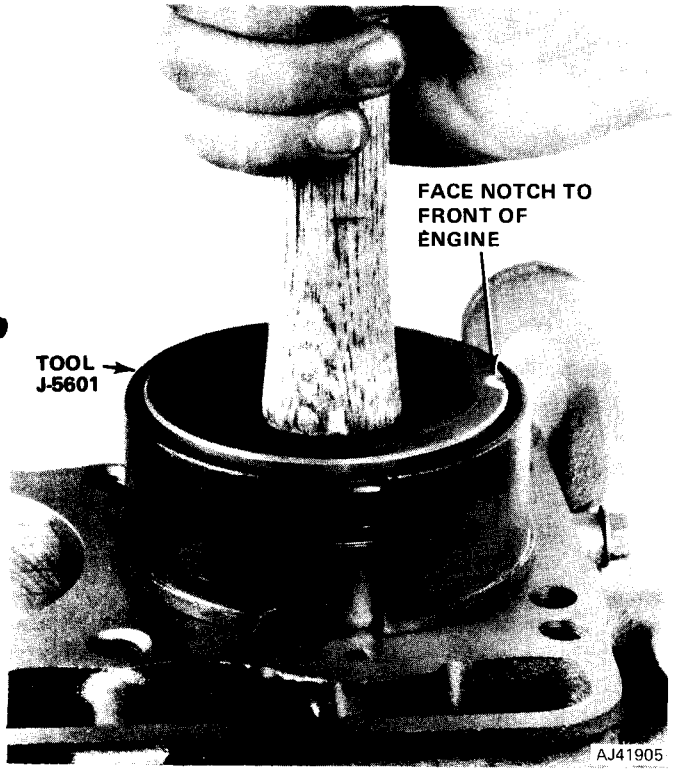


Fig. 1A-36 Piston-to-Bore Installation

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

(9) Install oil pump.

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

(11) Install camshaft.

(12) Install timing 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 transmission to engine assembly (refer to appropriate Transmission section).

(22) 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 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.

(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 with at least 30° between each ring gap.

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

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

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

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

CONNECTING RODS

The connecting rods are nodular 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

(1) 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:

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

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

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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.

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

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

Measuring Bearing Clearance with Plastigage

(1) Wipe journal clean.
(2) Place a strip of Plastigage across full width of lower insert at the center of bearing cap.
(3) Install bearing cap to connecting rod and tighten retaining nuts to 28 foot-pounds torque.
(4) Remove bearing cap and determine amount of clearance by measuring the width of the compressed Plastigage with the scale furnished (fig. 1A-37).

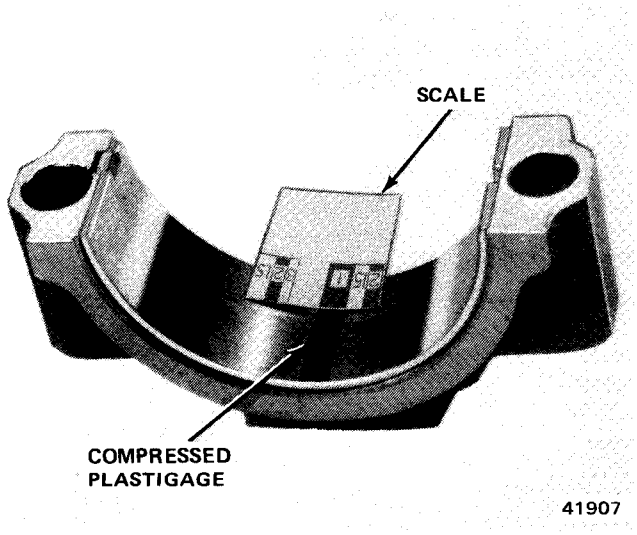

Fig. 1A-37 Bearing Clearance Measurement with Plastigage

Measuring Bearing Clearance with Micrometer

(1) Wipe connecting rod journal clean.
(2) Use a micrometer to check for taper and out-of-round conditions. Correct tolerance for both taper and out-of-round is 0.0005-inch maximum. If any rod journal is not within specifications, the crankshaft must be replaced or reconditioned and fitted with new undersize bearing inserts.
(3) Use micrometer to measure maximum diameter of rod journal.
(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 28 foot-pounds torque.

CAUTION: *Care must be exercised when rotating the crankshaft with bearing caps removed. Be sure the connecting rod bolts do not accidentally come in contact with the rod journals and scratch the finish. Bearing failure would result. Rubber hoses installed over the connecting rod bolts will help prevent damage to crank journals.*

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

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

Fitting Pistons

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

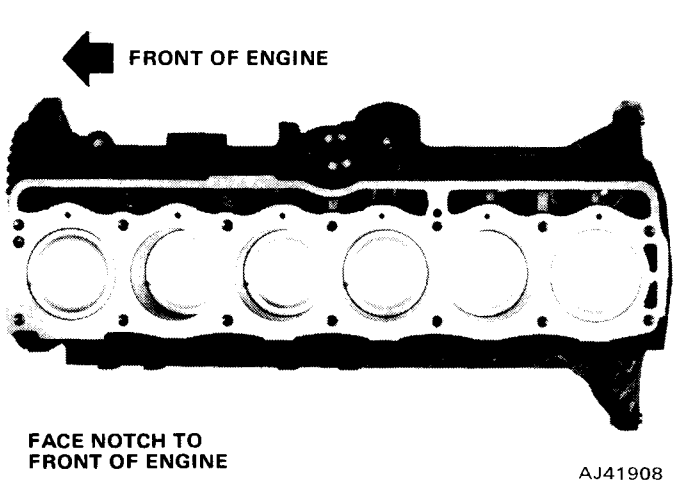

Fig. 1A-38 Pistons Correctly Positioned in Bores

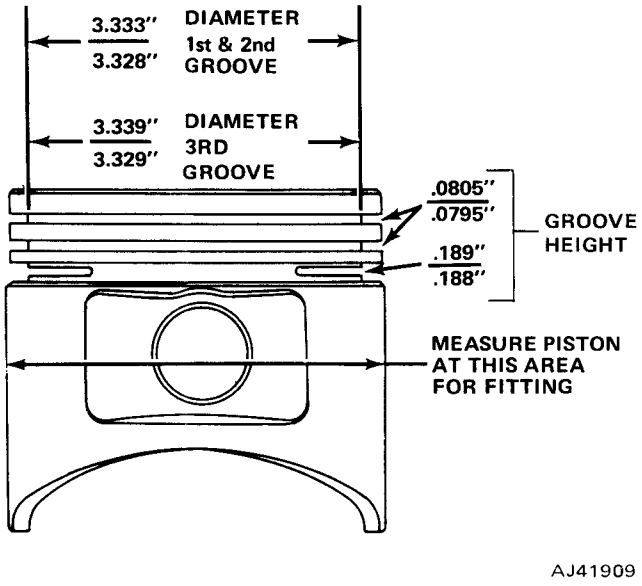

Fig. 1A-39 Piston Measurements

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-40). Correct side clearance between land and rings should be as listed in Specifications.

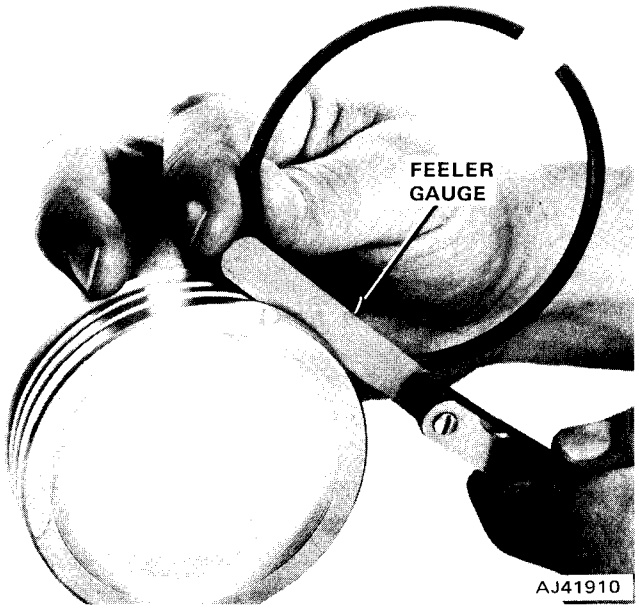

Fig. 1A-40 Ring Side Clearance

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

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

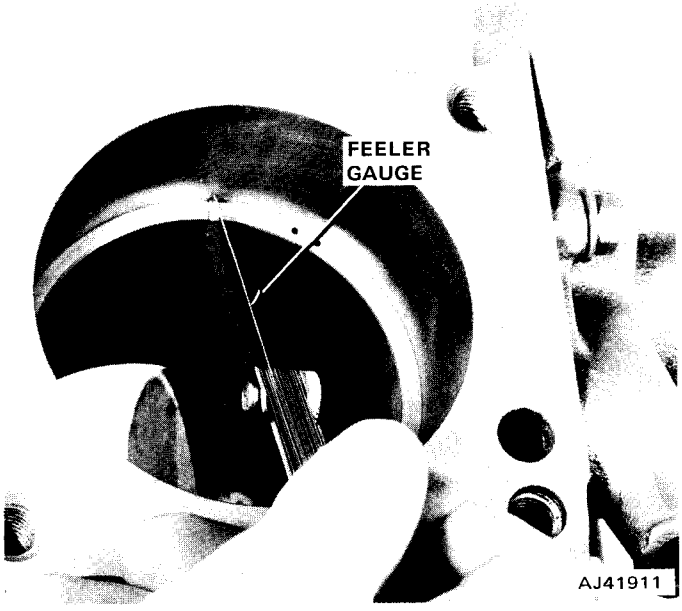

Fig. 1A-41 Ring Gap Clearance

Installation

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

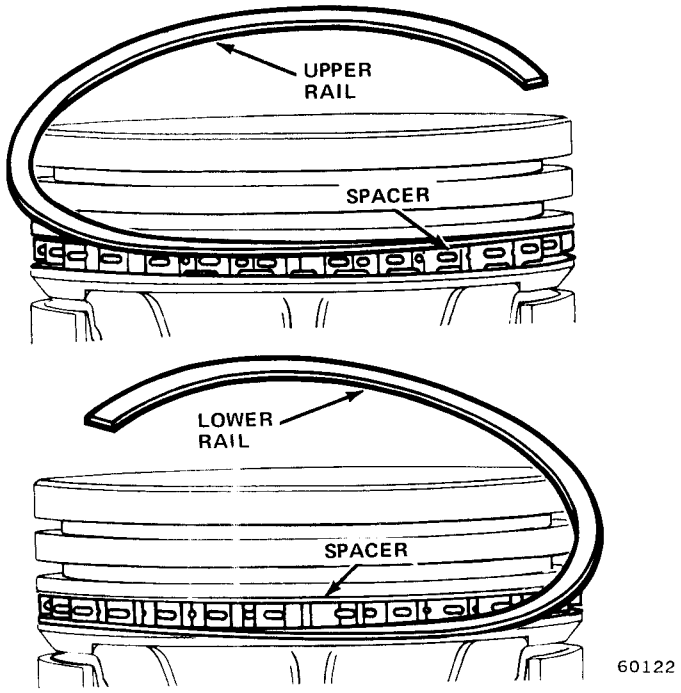

Fig. 1A-42 Oil Control Ring Rail Installation

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

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

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

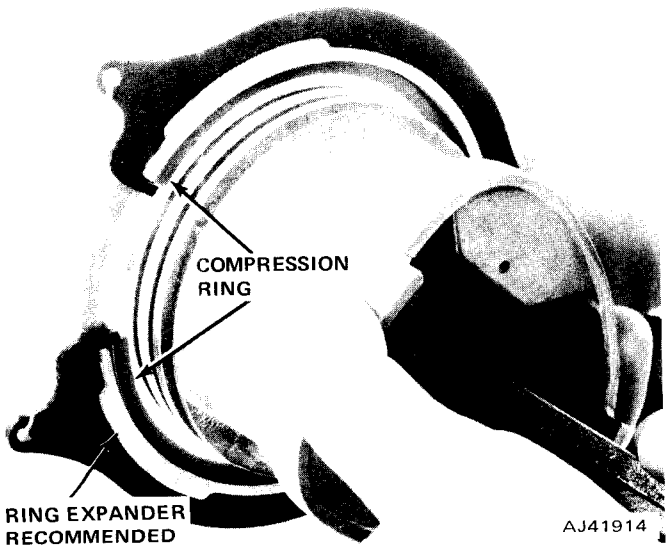

Fig. 1A-43 Compression Ring Installation

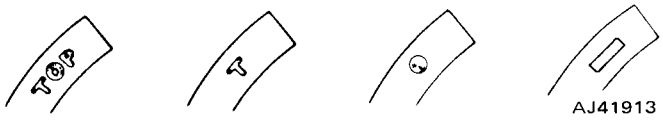

Fig. 1A-44 Typical Piston Ring Markings

Piston Pins

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

Removal

(1) Using Piston Pin Remover J-21872 and arbor press, place piston on Remover Support J-21872-1 (fig. 1A-45).

(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 installed and removed from a connecting rod.*

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

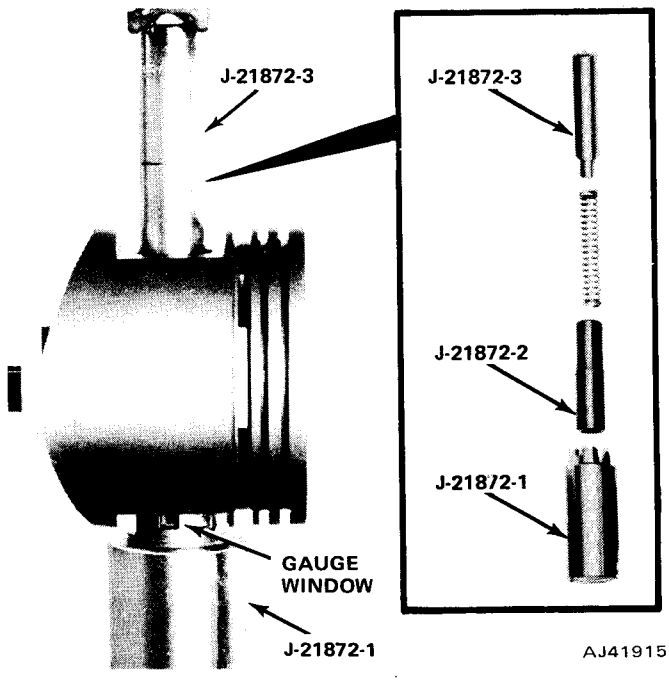

Fig. 1A-45 Piston Pin Removal or Installation

Installation

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

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

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

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

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

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-46). 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, it is recommended to pry the crankshaft fore and aft to align the faces of the thrust bearing.*

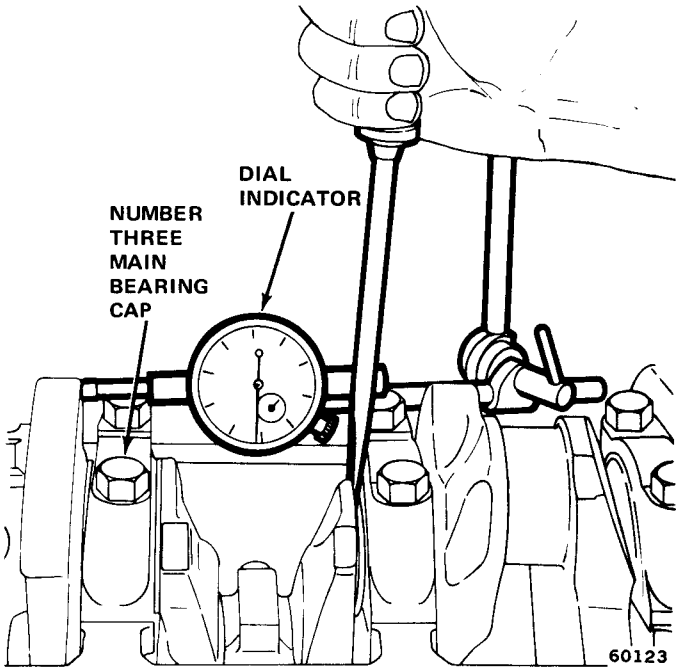

Fig. 1A-46 Measuring Crankshaft End Play

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:

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

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

Removal and Inspection

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

Measuring Bearing Clearance with Plastigage (Crankshaft Installed)

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

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

NOTE: *When checking number 1 main bearing, support crankshaft at the vibration damper.*

(2) Remove main bearing cap and insert.
(3) Clean insert and exposed portion of crankshaft journal.
(4) Place strip of Plastigage across full width of bearing insert.
(5) Install bearing cap and tighten bolts to 80 foot-pounds torque.
(6) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with furnished scale (fig. 1A-47).

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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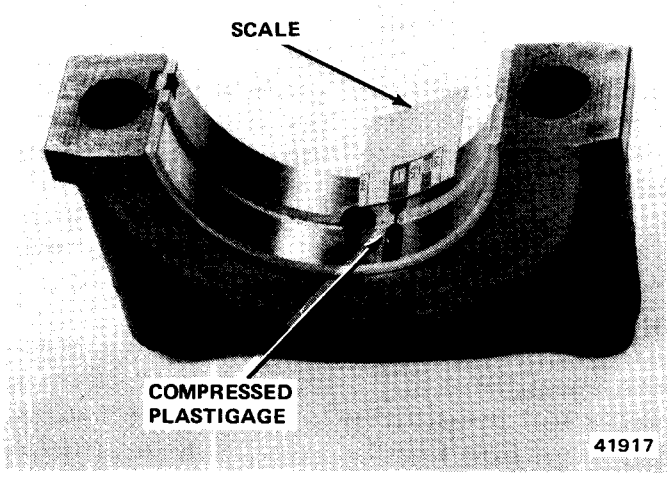

Fig. 1A-47 Checking Main Bearing Clearance with Plastigage

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 80 foot-pounds torque in 20 pound increments from 40 foot-pounds rotating crank after tightening each main cap to make sure crankshaft rotates freely.

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

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

FLYWHEEL AND STARTER RING GEAR ASSEMBLY

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

Ring Gear Replacement—Manual Transmission

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

(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

Specifications (Continued)

Camshaft (Continued)

Bearing Journal Diameter
- No. 1 ..... 2.029 to 2.030 inches
- No. 2 ..... 2.019 to 2.020 inches
- No. 3 ..... 2.009 to 2.010 inches
- No. 4 ..... 1.999 to 2.000 inches

Base Circle Runout ..... 0.001 inch (max)
Cam Lobe Lift ..... 0.232 inch
Intake Valve Timing
- Opens ..... 12.12° BTDC
- Closes ..... 64.80° ABDC

Exhaust Valve Timing
- Opens ..... 53.12° BBDC
- Closes ..... 23.80° ATDC

Valve Overlap ..... 35.92°
Intake Duration ..... 256.92°
Exhaust Duration ..... 256.92°

Connecting Rods

Total Weight (Less Bearings)
- 232 ..... 557 to 665 grams
- 258 ..... 695 to 703 grams

Total Length (Center-to-Center)
- 232 ..... 6.123 to 6.127 inches
- 258 ..... 5.873 to 5.877 inches

Piston Pin Bore Diameter ..... 0.9288 to 0.9298 inches
Bearing Clearance ..... 0.001 to 0.0025 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 ..... 9.528 to 9.534 inch
Deck Clearance
- 232 ..... 0.0575 inch (below block)
- 258 ..... 0.110 inch (below block)

Cylinder Block (Continued)

Cylinder Bore (standard) ..... 3.7501 to 3.7533 inches
- Maximum Cylinder Taper ..... 0.005 inch
- Maximum Cylinder Out-of-Round ..... 0.003 inch

Tappet Bore Diameter ..... 0.905 to 0.906 inch
Cylinder Block Flatness ..... 0.001/1 inch, 0.002/6 inch; 0.008 inch (max)

Cylinder Head

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

Lubrication System

Engine Oil Capacity ..... 5 quarts (Add 1 quart with filter change)
Normal Operating Pressure ..... 13 psi at 600 rpm; 37 to 75 psi (max) at 1600 rpm+
Oil Pressure Relief ..... 75 psi (max)
Gear-to-Body Clearance ..... 0.0025 to 0.0005 inch (0.0005 inch preferred)
Gear End Clearance ..... 0.002 to 0.006 inch (0.006 inch preferred)

Pistons

Weight (less pin) ..... 481 to 485 grams
Piston Pin Bore Centerline-to-Piston Top ..... 1.599 to 1.603 inches
Piston-to-Bore Clearance ..... 0.0009 to 0.0017 inch (0.0012 to 0.0013 inch preferred)
Piston Ring Gap Clearance –
- Compression (Both) ..... 0.010 to 0.020 inch

Piston Ring Gap Clearance–
- Oil Control Steel Rails ..... 0.010 to 0.025 inch

Piston Ring Side Clearance
- No. 1 Compression ..... 0.0015 to 0.003 inch (0.0015 preferred)
- No. 2 Compression ..... 0.0015 to 0.003 inch (0.0015 preferred)
- Oil Control ..... 0.001 to 0.008 inch (0.003 preferred)

Piston Ring Groove Height
- Compression (both) ..... 0.0795 to 0.0805 inch
- Oil Control ..... 0.188 to 0.189 inch

Piston Ring Groove Diameter
- No. 1 and No. 2 ..... 3.328 to 3.333 inches
- Oil Control ..... 3.329 to 3.339 inches

Piston Pin Bore Diameter ..... 0.9308 to 0.9313 inch

Specifications (Continued)

Pistons (Continued)

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 ..... 9.615 to 9.595 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

Valves (Continued)

Intake Valve Head Diameter ..... 1.782 to 1.792 inches
Intake Valve Face Angle ..... 29°
Exhaust Valve Head Diameter ..... 1.401 to 1.411 inches
Exhaust Valve Face Angle ..... 44°
Maximum Allowable Removed for Tip Refinishing ..... 0.010 inch

Valve Springs

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

Torque Specifications

Service Set-To Torques should be used when assembling components.

Service In-Use Recheck Torques should be used for checking a pre-torqued item.

	Service Set-To Torque	Service In-Use Recheck Torque
Accessory Drive Pulley Screws	18	12 to 25
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
Camshaft Sprocket Screw	50	45 to 55
Carburetor Hold-Down Nuts	14	12 to 15
Coil Bracket-to-Cylinder Head	14	10 to 18
Connecting Rod Bolt Nuts	28	26 to 30
Cylinder Head Capscrews	105	95 to 115
Cylinder Head Cover Screws	50 in-lb	42 to 58 in-lb
Crankshaft Pulley-to-Damper	23	18 to 28
Clutch Housing Spacer to Block Screws	12	9 to 15
Clutch Housing-to-Block Screws (top)	27	22 to 30
Clutch Housing-to-Block Screws (bottom)	43	37 to 47
Distributor Clamp Bracket Screw	13	10 to 18
EGR Valve	13	9 to 18
Exhaust Manifold Bolts	23	18 to 28
Exhaust Pipe-to-Manifold	23	18 to 28
Fan and Hub Assembly Bolts	18	12 to 25
Drive Plate-to-Converter Screw	22	20 to 25
Flywheel or Drive Plate-to-Crankshaft	105	95 to 120
Front Crossmember-to-Sill	65	55 min.
Front Support Bracket-to-Block	28	22 to 38
Front Support Cushion-to-Bracket	33	27 to 38
Front Support Cushion-to-Crossmember	37	30 to 45
Fuel Pump Screws	16	13 to 19
Idler Arm Bracket-to-Sill	50	35 to 60
Idler Pulley Bracket to Front Cover Nut	7	4 to 9
Idler Pulley Bearing Shaft-to-Bracket Nut	33	28 to 38
Intake Manifold Screws	23	18 to 28
Main Bearing Capscrews	80	75 to 85
Oil 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

Torque Specifications (Continued)

	Service Set-To Torques	Service In-Use Recheck Torques
Power Steering Pump Pressure Line Nut	38	30 to 45
Power Steering Pump Pulley Nut	58	40 to 65
Rear Crossmember-to-Side Sill Nut	30	20 to 35
Rear Support Cushion-to-Bracket	48	40 to 55
Rear Support Bracket-to-Transmission	33	27 to 38
Rear Support Cushion-to-Crossmember	18	12 to 25
Rocker Arm Assembly-to-Cylinder Head	21	18 to 26
Spark Plugs	28	22 to 33
Timing 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	55	48 to 64
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.

Fig. 1A-47 Six-Cylinder Engine Tools

A50428