V-8 ENGINE

GENERAL

The 304, 360, and 401 CID engines are 90-degree V-8 designs incorporating overhead valves. The 304 CID engines (CJ Model only) operate ONLY on unleaded gasoline. The cylinders are numbered from front to rear: 1-3-5-7 on the left bank and 2-4-6-8 on the right bank with cylinder firing order 1-8-4-3-6-5-7-2.

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

Bridged pivot assemblies control movement of intake and exhaust rocker arms that are paired by cylinders (fig. 1B-1 and 1B-2).

Service procedures for all V-8 engines are essentially the same.

Identification

The cubic-inch displacement of all V-8 engines is cast into each side of the cylinder block. These numbers are located between the engine mounting bracket bosses.

Build Date Code

The engine Build Date Code is located on a tag attached to the right bank cylinder head cover (fig. 1B-3).

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

Example: 1 05 H 13

The example code identifies a 304 CID with 2V carburetor and 8.4:1 compression ratio built on May 13, 1977.

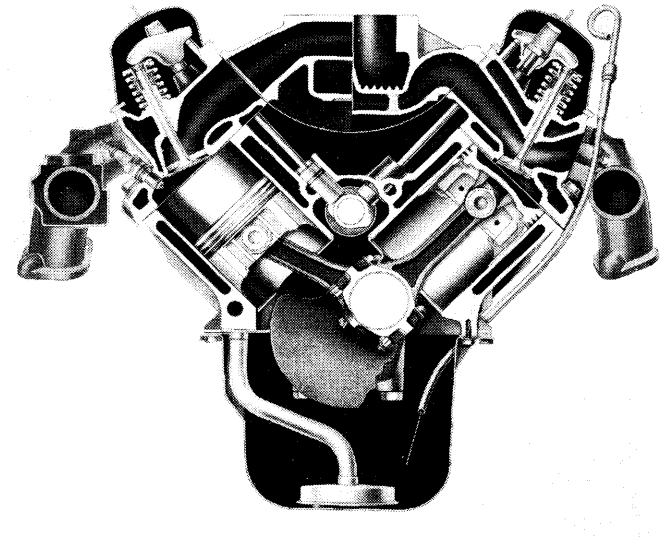

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Fig. 1B-1 Sectional View of V-8 Engine Assembly

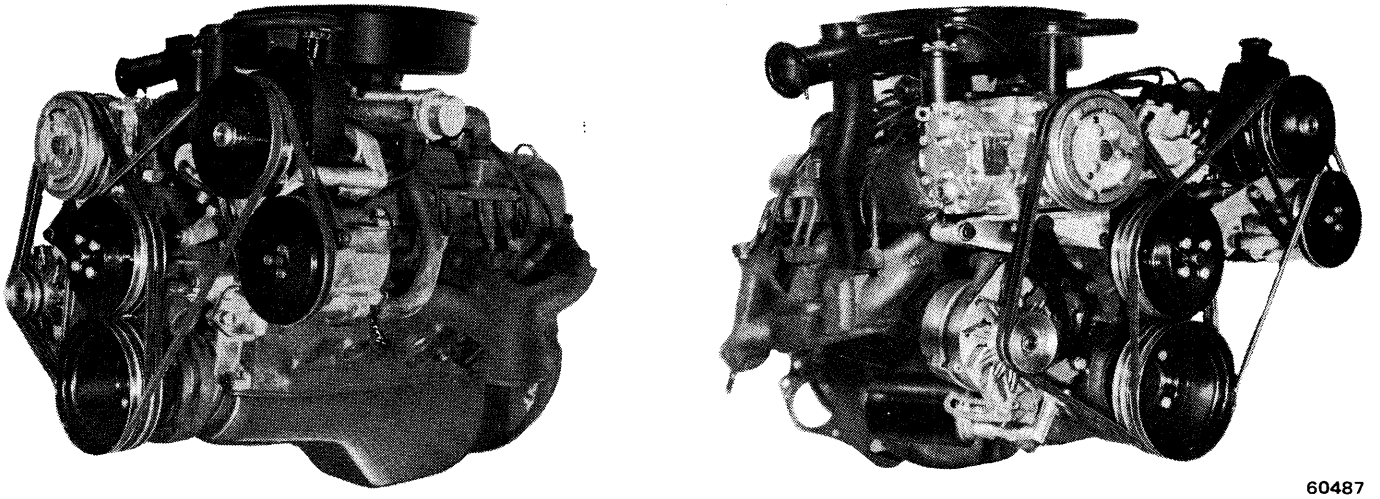

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Fig. 1B-2 Typical V-8 Engine Assembly

Engine Build Date Code Explanation

Letter Code	CID	Carburetor	Compression Ratio
H	304	2V	8.4:1
N	360	2V	8.25:1
P	360	4V	8.25:1
Z	401	4V	8.25:1

1st Character (Year)	2nd and 3rd Characters (Month)	4th Character (Engine Type)	5th and 6th Characters (Day)
9 – 1976 1 – 1977	01 – 12	H, N, P, V, or Z	01 – 31

60265

41922

Fig. 1B-3 Build Date Code Location V-8

Oversize or Undersize Components

It is sometimes necessary to machine all cylinder bores to 0.010-inch oversize, all crankshaft main bearing journals, all connecting rod journals to 0.010-inch undersize, or all camshaft bearing bores 0.010-inch oversize. These engines have a single or double letter code stamped adjacent to the Build Date Code on the tag attached to the right bank cylinder head cover. The letters are coded as follows:

Oversize or Undersize Letter Code

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

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LUBRICATION SYSTEM

A gear-type, positive displacement oil pump is incorporated in the timing case cover. A cavity in the cover forms the body of the pump while drive and idler gears rotate within the cavity. The drive gear shaft is driven by the distributor.

The oil pump cover seals the end of the oil pump cavity and also serves as a mount for the oil filter. The oil pressure relief valve assembly is located in the oil pump cover (fig. 1B-4).

Oil is drawn from the sump area of the oil pan through a tube and screen assembly to a horizontal oil

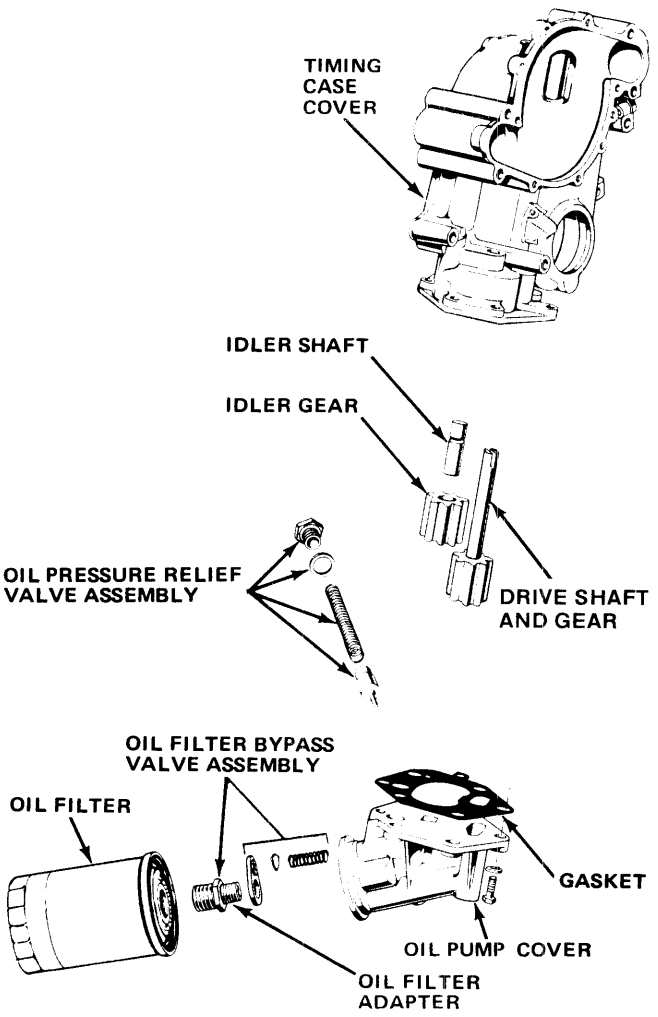


Fig. 1B-4 Oil Pump and Filter Assembly

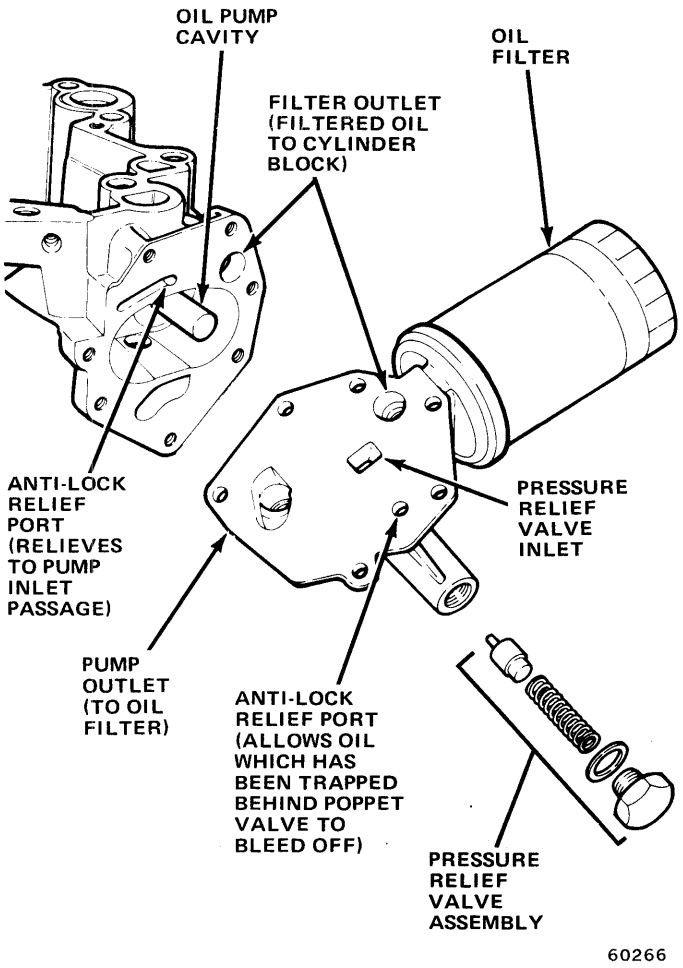


Fig. 1B-5 Oil Pump Passages

gallery located at the lower right side of the engine block. A passage in the timing case cover channels oil into the oil pump. Pressure is developed when oil is driven between the gears and pump body.

The oil is forced from the pump through a passage in the oil pump cover to the oil filter (fig. 1B-5).

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

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

A small passage within the front camshaft bearing journal channels oil through the camshaft sprocket to the timing chain cover area where the chain and sprockets throw off oil to lubricate the distributor gears and fuel pump eccentric. This oil returns to the oil pan by passing under the front main bearing cap.

The oil supply for the rocker arm assemblies is metered through the hydraulic valve tappets and routed through hollow push rods to a hole in the push rod end of the corresponding rocker arm. This oil lubricates the valve train, then returns to the oil pan through channels at both ends of the cylinder head (fig. 1B-6).

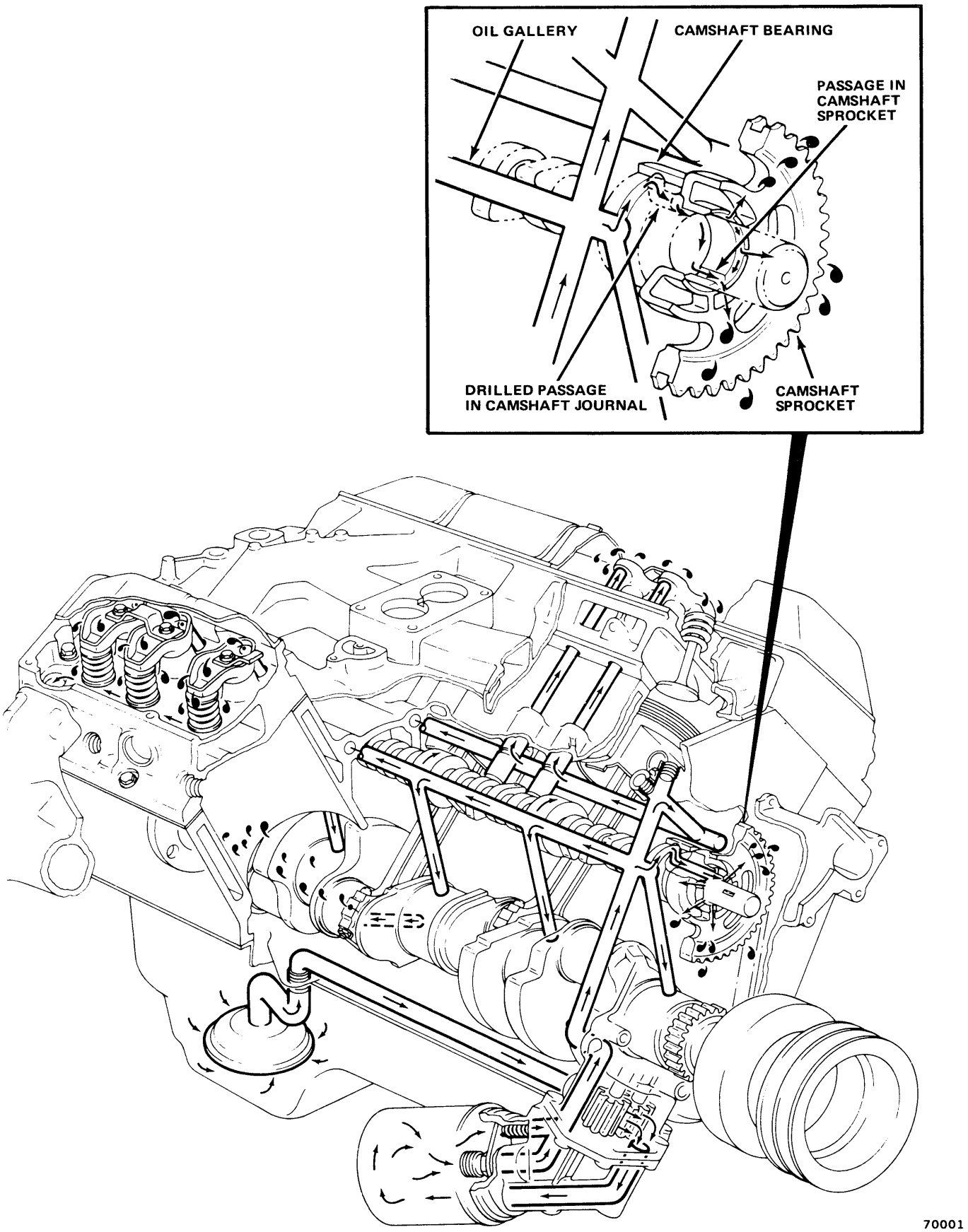


Fig. 1B-6 Lubrication System

ENGINE MOUNTING

Resilient rubber mounting cushions support the engine and transmission at three points. A cushion is located at each side on the centerline of the engine with the rear supported by a cushion between the transmission extension housing and the rear support crossmember (fig. 1B-7).

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

If necessary to remove the front engine mounts, an engine holding fixture may be fabricated as illustrated in figure 1B-8.

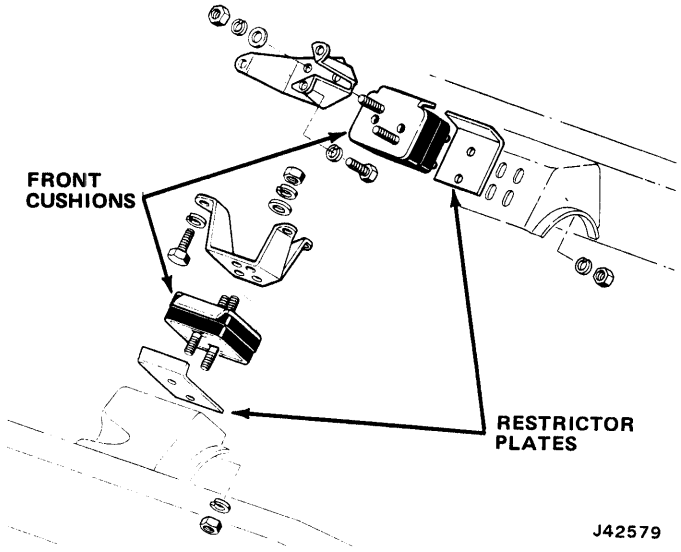
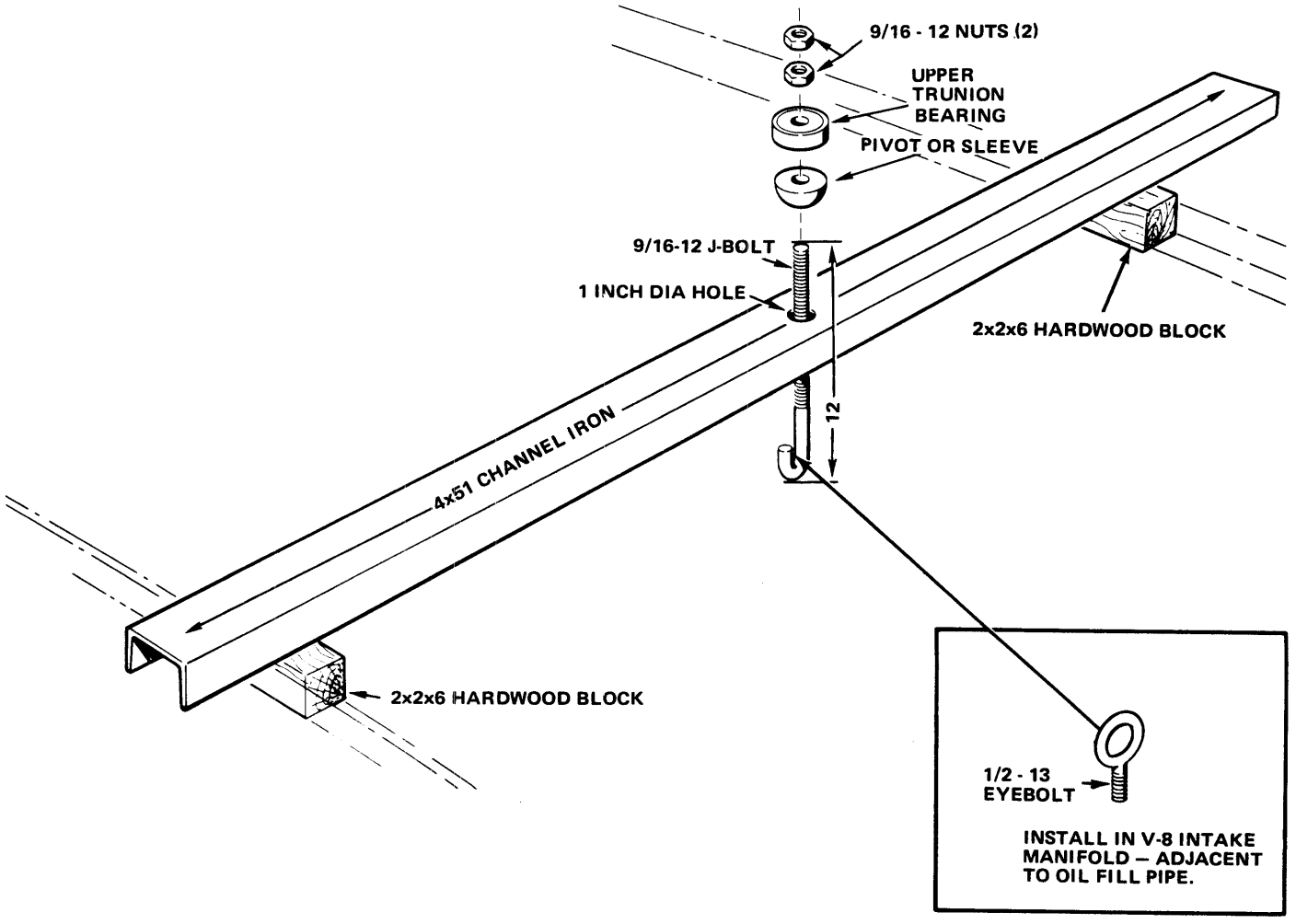


Fig. 1B-7 Typical Engine Mounting—V-8 Engine



NOTE: DIMENSIONS ARE IN INCHES

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Fig. 1B-8 Engine Holding Fixture

Service Diagnosis

Condition	Possible Cause	Correction
EXTERNAL OIL LEAKS	(1) Fuel pump gasket broken or improperly seated.	(1) Replace gasket.
	(2) Cylinder head cover gasket broken or improperly seated.	(2) Replace gasket or reseal; 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 case 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 case cover oil seal broken or improperly seated.	(7) Replace seal.
	(8) Oil pan drain plug loose or stripped threads.	(8) Repair as necessary and tighten.
	(9) Rear oil gallery plug loose.	(9) Use appropriate sealant on gallery plug and tighten.
	(10) Rear camshaft plug loose or improperly seated.	(10) Seat camshaft plug or replace and seal, as necessary.
	(11) Porosity in crankshaft pilot bushing hole.	(11) Seal with RTV Silicone and core plug or replace crankshaft 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 deflectors are damaged, missing, or incorrect type.	(3) Replace valve stem oil deflectors.
	(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.

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Service Diagnosis (Continued)

Condition	Possible Cause	Correction
EXCESSIVE OIL CONSUMPTION (Continued)	(6) Incorrect piston ring gap.	(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) Remove glaze from cylinder wall and replace rings.
	(9) Cylinder walls worn, scored, or glazed.	(9) Remove glaze or rebore cylinders as necessary.
	(10) Piston ring gaps not staggered.	(10) Remove glaze, replace rings, and stagger ring gaps.
	(11) Blocked or restricted PCV valve or hose.	(11) Inspect hose, flow test PCV, and repair or replace as necessary.
	(12) Excessive main or connecting rod bearing clearance.	(12) Check bearing clearance, repair as necessary.
NO OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Section 3, Oil Pressure Gauge and Sending Unit Test.
	(3) Oil pump malfunction.	(3) Refer to Oil Pump.
	(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) Replace oil pickup tube assembly.
	(7) Loose oil pickup tube.	(7) Seal and tighten.
LOW OIL PRESSURE	(1) Low oil level.	(1) Add oil to correct level.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Section 3, Oil Pressure Gauge and Sending Unit Test.
	(3) Oil excessively thin due to dilution, poor quality, or improper grade.	(3) Drain and refill crankcase with recommended oil.
	(4) Oil pressure relief spring weak or sticking.	(4) Remove and inspect oil pressure relief valve assembly.

Service Diagnosis (Continued)

Condition	Possible Cause	Correction
LOW OIL PRESSURE (Continued)	(5) Oil pickup tube and screen assembly has restriction or air leak.	(5) Remove and inspect oil pickup tube and screen assembly. (Fill pickup with lacquer thinner to find leaks.)
	(6) Oil pump malfunctioning.	(6) Inspect and check clearances. Refer to Oil Pump.
	(7) Excessive main, rod, or camshaft bearing clearance.	(7) Measure bearing clearances, repair as necessary.
HIGH OIL PRESSURE	(1) Improper grade oil.	(1) Drain and refill crankcase with correct grade oil.
	(2) Oil pressure gauge or sending unit inaccurate.	(2) Refer to Section 3, Oil Pressure Gauge and Sending Unit Test.
	(3) Oil pressure relief valve sticking closed.	(3) Remove and inspect oil pressure relief valve assembly.
	(4) Pressure relief passage or anti-lock port restricted.	(4) Check for restriction in anti-lock port and repair as necessary.
MAIN BEARING NOISE	(1) Insufficient oil supply.	(1) Check for low oil level or low oil pressure.
	(2) Main bearing clearance excessive.	(2) Check main bearing clearance, repair as necessary. Make certain all upper inserts are installed.
	(3) Crankshaft end play excessive.	(3) Check end play, repair as necessary.
	(4) Loose flywheel or torque converter.	(4) Tighten flywheel or converter attaching bolts.
	(5) Loose or damaged vibration damper.	(5) Repair as necessary.
CONNECTING ROD BEARING 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 not tightened to proper torque.	(5) Tighten bolts to specified torque.

Service Diagnosis (Continued)

Condition	Possible Cause	Correction
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. Check piston lands.
	(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) Wrong hydraulic tappet. (d) Plugged oil gallery in block. (e) Plugged pushrod.
	(2) Push rods worn, bent or rubbing against cylinder head.	(2) Replace worn or bent push rods. Repair cylinder head as necessary.
	(3) Rocker arms or bridged pivots worn.	(3) Replace worn rocker arms or pivots.
	(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 capscrews to specified torque. Check for stripped threads.
	(11) Valve seat runout excessive.	(11) Regrind valve seat/valve.

Cylinder Leakage Test Diagnosis

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

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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 of fast idle cam.

(7) Calibrate tester according to instructions of manufacturer.

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

(8) 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.*

(9) 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 Cylinder Leakage Test Diagnosis chart.

BLOWN CYLINDER HEAD GASKET DIAGNOSIS

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

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

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

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

Cylinder-to-Cylinder Leak Test

To determine if the cylinder head gasket is blown betweeen cylinders, perform a compression test as outlined under Compression Test. A cylinder head gasket

blown between two cylinders will reult in approximately a 50-70% reduction in the two affected cylinders.

Cylinder-to-Water Jacket Leak Test

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

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

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

ENGINE REMOVAL

The engine is removed without the transmission and bell housing.

(1) On Cherokee, Wagoneer, and Truck models, 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 and disconnect upper and lower radiator hoses. Disconnect heater hoses.

(4) If equipped with automatic transmission, disconnect cooler lines from radiator and engine assembly.

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

(5) Remove radiator.

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

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

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

(9) On Cherokee, Wagoneer, and Truck models remove battery.

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

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

- Fuel supply and return lines at chassis tubing
- Vacuum line at power brake unit
- Vacuum line for heater damper doors at intake manifold

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

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

(14) Support weight of engine with a lifting device.

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

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

(17) On vehicles equipped with automatic transmissions, remove upper bolts securing the transmission bell housing to engine.

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

(18) Disconnect exhaust pipes at exhaust manifolds and support bracket.

(19) Remove starter motor.

(20) Support transmission with a floor jack.

(21) If equipped with automatic transmission, remove engine adapter plate inspection cover. Mark assembled position of converter and flex plate and remove the converter-to-flex plate capscrews.

(22) Remove remaining bolts securing transmission bell housing to engine.

If equipped with manual transmission, remove clutch housing lower cover and remaining bolts securing clutch housing to engine.

(23) Remove engine by pulling upward and forward.

CAUTION: *If equipped with power brakes, care must be taken to avoid damaging the power unit while removing the system.*

ENGINE INSTALLATION

(1) Lower engine slowly into engine compartment and align with transmission bellhousing (automatic transmission) or clutch housing (manual transmission). On manual transmissions, make certain clutch shaft is aligned properly with splines of clutch driven plate.

(2) Install the transmission bellhousing-to-engine bolts (automatic transmission) or clutch housing (manual transmission). Tighten bolts to specified torque (automatic transmission: 28 foot-pounds; manual transmission: 27 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 specified torque.

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

(6) Install starter motor.

(7) On CJ models, install left front support cushion and bracket to cylinder block. Tighten bolts to 28 foot-pounds torque.

(8) Lower engine onto frame supports, and remove the lifting device.

(9) Install front support cushion retaining nuts. Tighten nuts to 33 foot-pounds torque.

(10) Connect exhaust pipes at exhaust manifolds and support bracket.

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

(12) Install battery if removed.

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

(14) Connect all wires, lines, linkage, and hoses previously disconnected from engine.

(15) If removed, install air conditioning condenser and receiver assembly.

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

(17) Purge compressor of air as outlined in Section 13A—Air Conditioning.

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

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

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

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

(21) Fill cooling system to specified level.

(22) Install air cleaner assembly.

(23) Start engine. Check all connections for leaks. Stop engine.

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

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

CYLINDER HEAD COVER

All V-8 engines use a formed-in-place RTV (room temperature vulcanizing) silicone cylinder head gasket.

Removal

(1) Remove air cleaner assembly

(2) Disconnect air delivery hose at air injection manifold (if equipped).

(3) Left side:

(a) Disconnect power brake vacuum hose at intake manifold.

(b) Disconnect throttle stop solenoid wire (if equipped).

(4) Right side:

(a) Remove Thermostatically Controlled Air Cleaner (TAC) hot air hose.

(b) Remove heater hose from choke cover clamp.

(5) Disconnect spark plug wires and remove plastic wire separator from cylinder head cover bracket.

(6) Remove retaining screws and washers, separate cylinder head cover from cylinder head.

Installation

(1) Inspection for bent or cracked cover and repair as required.

(2) Clean cylinder head cover and cylinder head gasket surface of old gasket material.

(3) Apply a bead of Jeep Gasket-in-a-Tube, or equivalent, to cylinder head and cylinder head cover gasket surface.

NOTE: *If silicone gasket has not been badly damaged during removal, it is not necessary to clean and reseal cover completely. Use Jeep Gasket-in-a-Tube or equivalent, to repair small gaps in silicone gasket.*

(4) Position cylinder head cover on engine.

(5) Install retaining screws and tighten to 50 inch-pounds torque.

NOTE: *Do not overtighten screws as this will crack cylinder head covers and form gaps in sealer.*

(6) Connect spark plug wires and install plastic wire separator to cylinder head cover bracket.

(7) Right Side:

(a) Install heater hose to choke cover clamp.

(b) Install TAC hot air hose.

(8) Left Side:

(a) Connect power brake vacuum hose at intake manifold.

(b) Connect throttle stop solenoid wire (if equipped).

(9) Connect air delivery hose to air injection manifold.

(10) Install air cleaner assembly.

ROCKER ARM ASSEMBLY

The intake and exhaust rocker arms of each cylinder pivot on a bridged pivot assembly which is secured to the cylinder head by two capscrews as shown in figure 1B-9.

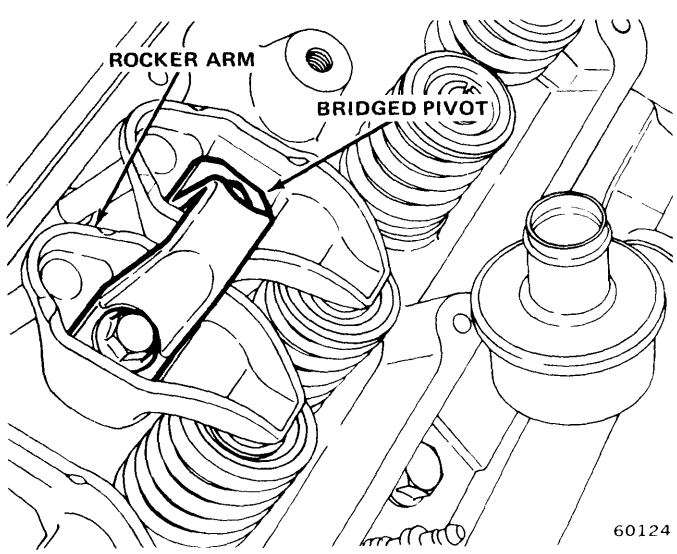

Fig. 1B-9 Rocker Arm Assembly—V-8 Engine

The bridged pivot maintains correct rocker arm-to-valve tip alignment.

The push rods are hollow and serve as oil galleries to lubricate the rocker arm assemblies.

Removal

(1) Remove cylinder head cover.

NOTE: *Keep all parts in the same order and position as removed from engine.*

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

(3) Remove push rods.

Cleaning and Inspection

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

Inspect the pivot surface of each rocker and pivot assembly and replace any part which is scuffed, pitted, or excessively worn. Inspect the valve stem contact surface of each rocker arm and replace any rocker arm which is deeply pitted.

Inspect each push rod end for scuffing or excessive wear and replace as required. It is not normal to find a wear pattern along the length of the push rod. Check the cylinder head for obstruction if this condition exists.

NOTE: *If a push rod is excessively worn due to lack of oil, the push rod as well as the matching hydraulic valve tappet and rocker arm must be replaced.*

Installation

(1) Install push rods. **Make certain the bottom end of each rod is centered in the plunger cap of hydraulic valve tappet.**

(2) Install rocker arms and bridge pivot assemblies.

(3) Install capscrews, tightening each capscrew for each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(4) Reseal and install cylinder head cover.

(5) Install retaining screws and washers. Tighten screws to 50 inch-pounds torque.

VALVE SPRING/VALVE STEM OIL DEFLECTOR

Nylon valve stem oil deflectors are installed on each valve stem to prevent the oil used for rocker arm lubrication from entering the combustion chamber through the valve guides. Replace oil deflectors whenever valve service is performed or if the deflectors become deteriorated.

Each valve spring is held in place on the valve stem by a retainer and a set of valve locks. Remove valve locks by compressing the valve spring.

Valve springs and oil deflectors can be removed without removing the cylinder head. Refer to Cylinder Head Reconditioning for removal procedure with the cylinder head removed.

Removal

(1) Remove cylinder head cover.

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

NOTE: *Keep rocker arm assemblies and push rods in the same order and position as removed.*

(3) Remove spark plug from cylinder which requires valve spring or oil deflector removal.

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

NOTE: *An adapter can be fabricated from the body of a spark plug from which the porcelain has been removed and an air hose fitting has been welded.*

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

(6) Use Valve Spring Remover and Installer Tools J-22534-1, J-22534-4, and J-22534-5 to compress the valve spring and allow removal of the valve locks (fig. 1B-10).

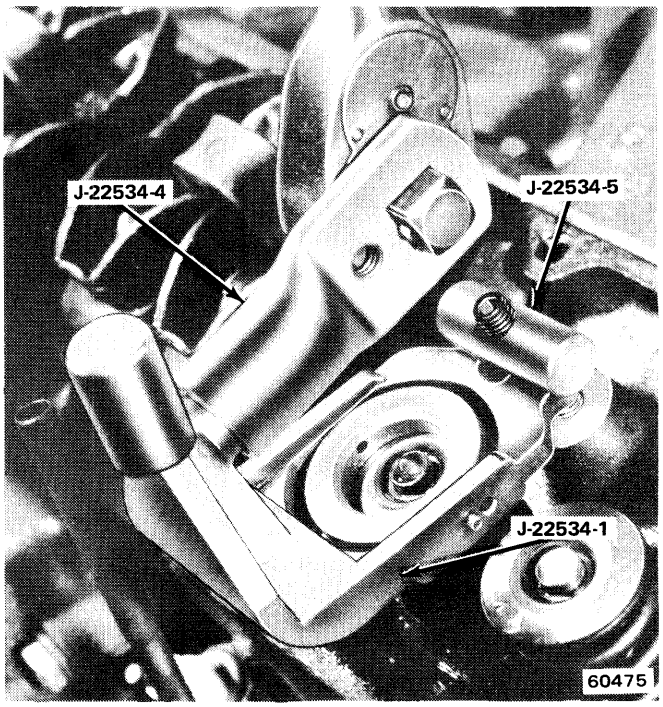

Fig. 1B-10 Valve Spring Removal

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

(8) Remove oil deflector.

Valve Spring Tension Test

Use Valve Spring Tester J-8056 to test each removed valve spring for the specified tension values, if required (fig. 1B-11). Replace all valve springs which are not within specifications. Replace springs which bind due to warpage.

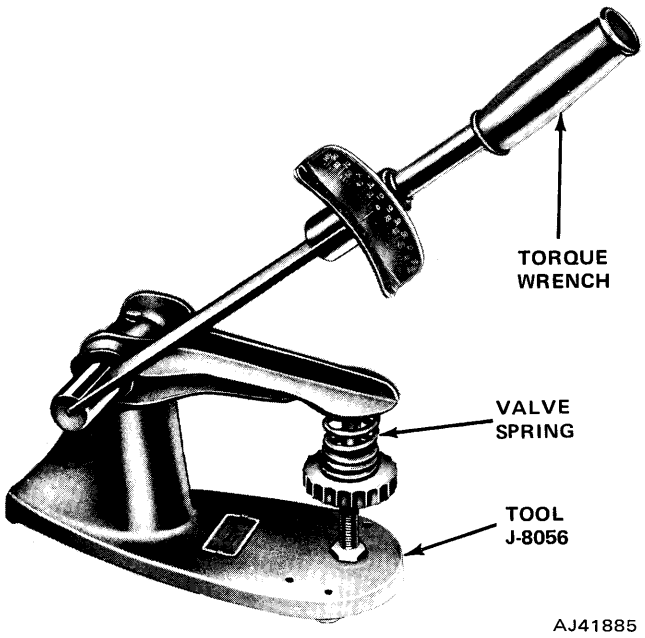

Fig. 1B-11 Valve Spring Tester

Installation

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

NOTE: *A close-coiled valve spring is used on all valves. The close-coiled end, identified by paint stripes, must face the cylinder head when installing the springs.*

(2) Install valve spring and retainer.

(3) Compress valve spring with Valve Spring Remover and Installer Tools J-22534-1, J-2234-4, and J-22534-5.

(4) Insert valve keepers.

(5) Release spring tension and remove tool.

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

(7) Disconnect air hose and remove air adapter from spark plug hole.

(8) Install spark plug.

(9) Install push rods making certain bottom end of each rod is centered in plunger cap of hydraulic valve tappet.

(10) Install rocker arms and bridged pivot assemblies. Install capscrews, tightening each capscrew for each bridge assembly a turn at a time, to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(11) Reseal and install cylinder head cover.

(12) Install retaining screws and washers. Tighten screws to 50 inch-pounds torque.

INTAKE MANIFOLD

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

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

Induction system passages uniformly distribute the fuel and air mixture to the combustion chamber of each cylinder. The left bore of the carburetor supplies a fuel-air mixture through passages in the intake manifold to the No. 1, 7, 4 and 6 cylinder intake ports and the right bore supplies the No. 3, 5, 2, and 8 ports.

Removal

(1) Drain coolant from radiator and cylinder block into suitable, clean container.

(2) Remove air cleaner assembly.

(3) Disconnect ignition wires.

(4) Remove ignition wire plastic separators from cylinder head cover brackets.

(5) Disconnect radiator upper hose and bypass hose from intake manifold.

(6) Disconnect and lay aside wire from temperature gauge sending unit.

(7) Disconnect ignition coil bracket and lay coil and bracket assembly aside.

(8) Remove TCS solenoid vacuum valve and solenoid control switch (if equipped) from right side cylinder head cover.

(9) Disconnect heater hose from rear of manifold.

(10) Disconnect all hoses, lines, and wires from the carburetor.

(11) Disconnect accelerator linkage and throttle valve linkage (if equipped) from carburetor and intake manifold.

(12) Disconnect air delivery hoses at the air injection manifold.

(13) Disconnect diverter valve from air pump output hose and lay valve and delivery hoses aside.

(14) Remove carburetor.

(15) Remove intake manifold, metal gasket and end seals.

(16) Clean mating surfaces of engine block and intake manifold.

Installation

NOTE: *When replacing intake manifold, transfer all components such as EGR value, EGR CTO, thermostat/housing and temperature gauge sending unit from original manifold. Clean and tighten as required.*

(1) Apply Perfect Seal compound, or equivalent, to both sides of new manifold gasket.

(2) Position gasket by aligning two rear locators at the rear of the cylinder head; then, while holding the rear locators in place, align the two front locators.

(3) Install the two end seals and apply Permatex No. 2, or equivalent, to seal ends.

(4) Install intake manifold and retaining bolts, making sure all bolts are started before tightening. Tighten bolts to 43 foot-pounds torque.

(5) Install carburetor. Tighten nuts to 15 foot-pounds torque.

(6) Install diverter valve and connect air pump output hose.

(7) Connect air delivery hoses to air injection manifolds.

(8) Connect all previously disconnected hoses, lines, linkages, and wires to intake manifold and carburetor.

(9) Install TCS solenoid vacuum valve and solenoid control switch (if equipped) to right side cylinder head cover.

(10) Install ignition coil and bracket assembly.

(11) Connect radiator upper hose and bypass hose.

(12) Install ignition wire plastic separators to cylinder head cover brackets.

(13) Connect ignition wires.

(14) Refill radiator and check coolant level.

(15) Install air cleaner assembly.

EXHAUST MANIFOLD

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

All V-8 engines are equipped with an Air Guard system and have air injection manifolds attached at the No. 1, 3, and 5 exhaust ports of the left exhaust manifold and the No. 2, 4, 6, and 8 of the right exhaust manifold. Refer to the Emission Control Section for description of the entire Air Guard System.

Removal

(1) Disconnect ignition wires.

(2) Disconnect air delivery hose at the injection manifold.

(3) Disconnect exhaust pipe at exhaust manifold.

(4) Remove exhaust manifold retaining bolts.

(5) Separate exhaust manifold from cylinder head.

(6) Separate injection manifold from exhaust manifold, if required.

Installation

(1) Install replacement gaskets on each air injection screw. Install air injection manifold and injection screws, if removed.

CAUTION: *Do not nick or scratch mating surfaces.*

(2) Clean mating surfaces of exhaust manifold and cylinder head.

(3) Install exhaust manifold and retaining bolts. Tighten bolts to 25 foot-pounds torque.

(4) Connect exhaust pipe using a new seal if required. Tighten nuts to 23 foot-pounds torque.

(5) Connect air delivery hose to air injection manifold.

(6) Connect ignition wires.

CYLINDER HEAD AND GASKET

Removal

(1) Drain cooling system and cylinder block.

(2) Remove ignition wires and spark plugs.

(3) Remove cylinder head cover.

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

(5) Remove push rods.

NOTE: *Keep rocker arm assemblies and push rods in same order and position as removed.*

(6) Remove intake manifold.

(7) Remove exhaust manifolds.

(8) Loosen all drive belts.

(9) Right side:

(a) If equipped with air conditioning, remove compressor mount bracket and battery negative cable from cylinder head.

(b) Disconnect alternator mounting bracket from cylinder head.

(10) Left side: Disconnect air pump and power steering mount bracket (if equipped) from cylinder head.

(11) Remove cylinder head retaining bolts.

(12) Remove cylinder head and gasket.

Cleaning and Inspection

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

Use a straightedge and feeler gauge to check the flatness of the cylinder head and block mating surfaces.

Refer to Specifications for flatness tolerances.

If the cylinder head is to be replaced and the original valves reused, remove the valves and measure the stem diameter. **Only standard size valves may be used with a service replacement head.** Replace oversize valves with standard size valves or ream valve guides to accomodate original oversize valves.

Remove all carbon buildup and reface the valves as outlined under Valve Refacing. Install the valves in the cylinder head using replacement valve stem oil deflectors. Transfer all attached components from the original head which are not included with the replacement head.

Installation

NOTE: *The 304 CID engine utilizes an aluminum coated embossed steel gasket and the 360 and 401 CID engines utilize an aluminum coated laminated steel and asbestos gasket. Retightening is not necessary with either gasket.*

(1) Apply an even coat of Perfect Seal sealing compound or equivalent to both sides of replacement head gasket.

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

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

(3) Install cylinder head and gaskets.

NOTE: *Wire brush the threads of bolts prior to installation as dirt will affect the torque readings.*

(4) Cylinder head capscrews must be tightened evenly to 80 foot-pounds torque following the sequence outlined in figure 1B-12; then, follow the sequence again and tighten screws to 110 foot-pounds torque.

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

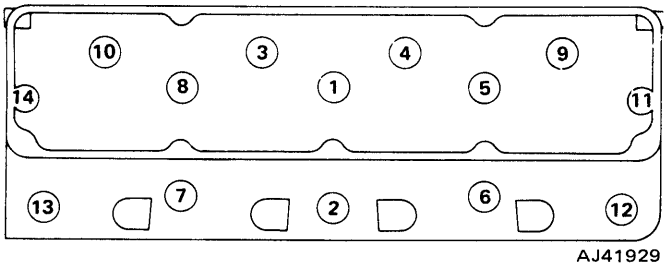

Fig. 1B-12 Cylinder Head Torque Sequence—V-8

(6) Right side:

(a) Connect alternator mounting bracket to cylinder head.

(b) Install air conditioning compressor mounting bracket (if equipped) and battery negative cable to cylinder head.

(7) Adjust all drive belts to specified tension.

(8) Install exhaust manifold and tighten retaining bolts to 25 foot-pounds torque.

(9) Install intake manifold. Tighten manifold retaining bolts to 43 foot-pounds torque.

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

(11) Install push rods and rocker arm assemblies in the same order and position as removed.

(12) Install rocker arms and bridged pivot assemblies. Install capscrews, tightening each capscrew for each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(13) Reseal and install cylinder head cover. Tighten retaining screws to 50 inch-pounds torque.

(14) Install spark plugs and connect ignition wires.

(15) Fill cooling system to specified level.

CYLINDER HEAD RECONDITIONING

The following procedures apply after the rocker arm has been removed from the engine.

Disassembly

(1) Compress each valve spring with C-clamp type spring compressor tool and remove valve locks and retainers.

(2) Release compressor and remove valve spring.

(3) Remove valve stem oil deflectors.

(4) Remove valves one at a time and place them in a rack in the same order as in cylinder head.

Cleaning and Inspection

Clean all carbon buildup from the combustion chambers, valve ports, valve stems, and heads.

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

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

Inspect for burned or cracked valve heads and scuffed valve stems. Replace any valve which is bent or scuffed along stem.

Reconditioning

Use a valve refacing machine to reface intake and exhaust valves to 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 1B-13.

Resurface and rechamfer the valve stem tip when worn. **Never remove more than 0.010 inch.**

Valve Seat Refacing

Install a pilot of the correct size in the valve guide and reface the valve seat to the specified angle with a good dressed stone. Remove only enough metal to provide a smooth finish. This is especially important on the hardened exhaust valve seats. Use 15° and 60° tapered stones to obtain the specified seat widths when required. Maximum seat runout is 0.0025 inch (fig. 1B-14).

Valve Guides

The valve guides are an integral part of the cylinder head and are not replaceable. Therefore, when the stem-to-guide clearance is excessive, ream the valve guides to the next larger size so that proper clearance can be

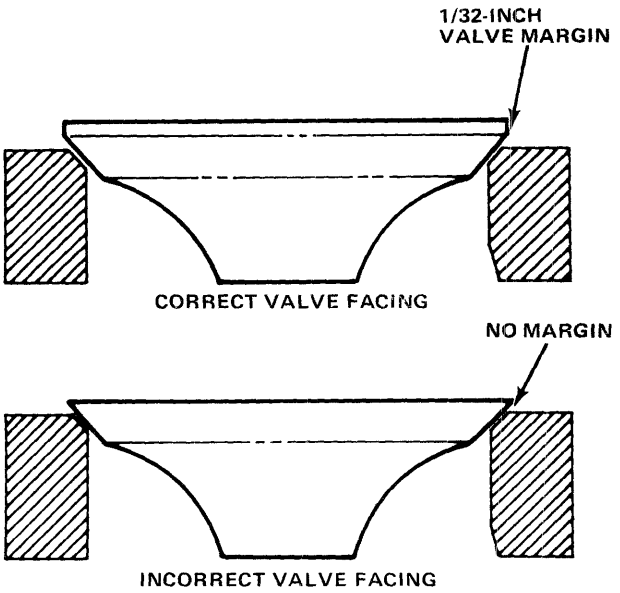

Fig. 1B-13 Valve Refacing

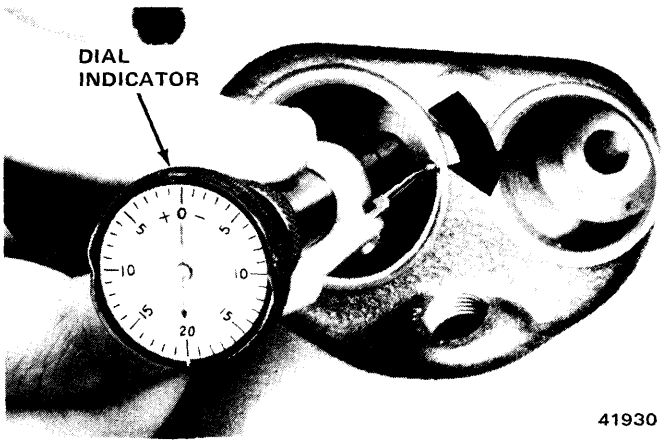

Fig. 1B-14 Valve Seat Runout

obtained. Service valves are available in 0.003 inch, 0.015 inch and 0.030-inch oversize.

The following oversize valve guide reamers may be used:

NOTE: *Ream guides in steps. Start with the 0.003-inch oversize reamer and progress to the size required.*

Valve Guide Reamers

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

60268

Valve-Stem-to-Guide Clearance

Valve-stem-to-guide clearance may be checked by either of two methods:

Preferred Method

(1) Mount dial indicator adjacent to valve guide to be checked.

(2) Position valve slightly off its seat with valve stem pushed laterally away from dial indicator.

(3) Set dial indicator push rod on stem of valve near tip and set gauge to zero (fig. 1B-15).

(4) Read dial indicator while moving valve stem laterally toward dial indicator. Stem-to-guide clearance is indicated on gauge.

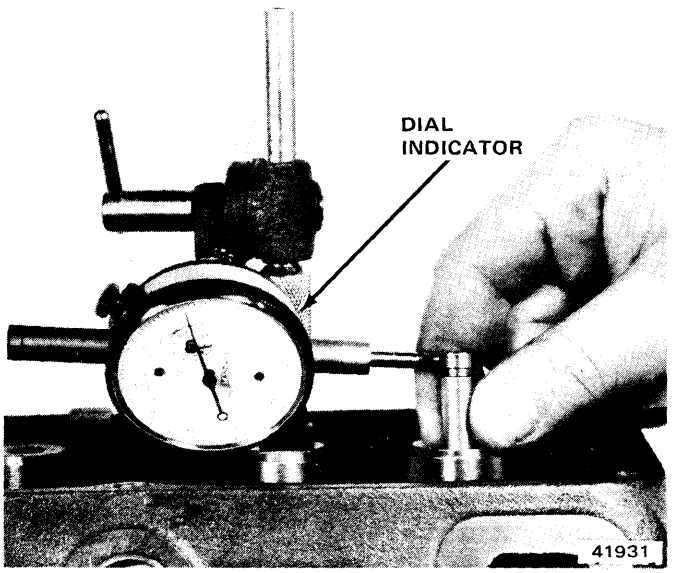

Fig. 1B-15 Valve Stem-to-Guide Clearance Measurement

Alternate Method

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

(1) Measure valve stem diameter with a caliper micrometer midway between valve head and tip.

(2) Select a pilot from a valve refacing kit which fits snugly in valve guide bore.

(3) Determine valve stem-to-guide clearance by subtracting diameter of valve stem from size of the pilot selected.

Assembly

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

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

(3) Install new valve stem oil deflector on each valve stem.

(4) Position each valve spring and retainer on cylinder head and compress the valve spring with compressor tool.

(5) Install valve locks and release tool.

(6) Tap each valve spring from side to side with a light hammer to set the spring properly at cylinder head.

HYDRAULIC VALVE TAPPETS

The hydraulic valve tappet consists of a body, plunger, metering disc, plunger cap, and lock ring (fig. 1B-16).

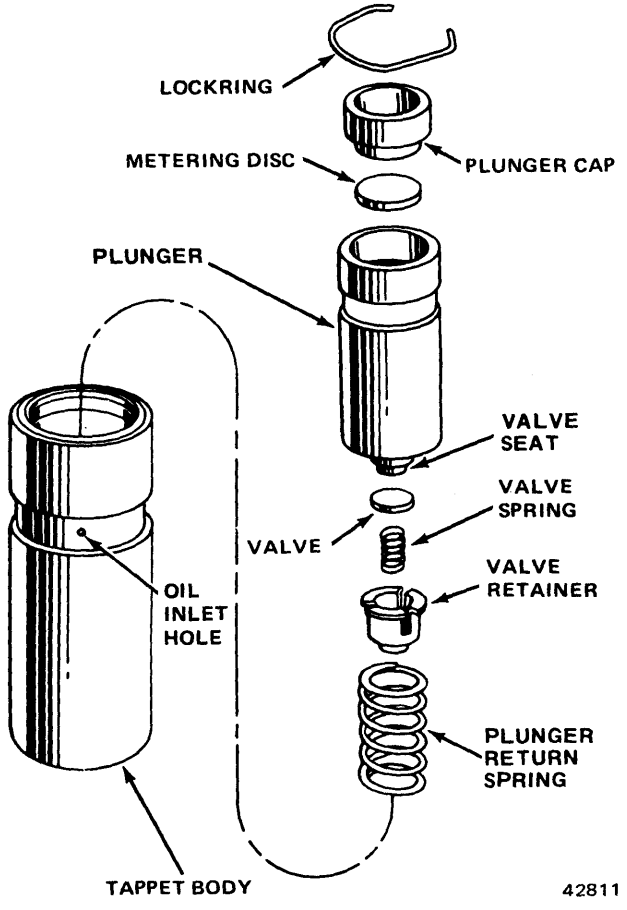

Fig. 1B-16 Typical Hydraulic Tappet Assembly

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

When the tappet is on the heel of the cam lobe, oil under pressure at the main oil gallery is admitted into the tappet through a hole in grooved portion of the tappet body. Oil flows into the plunger and through the check valve assembly maintaining the tappet fully charged (fig. 1B-17).

During the normal valve opening events the tappet leaks off oil. Contact with the cam lobe causes tappet

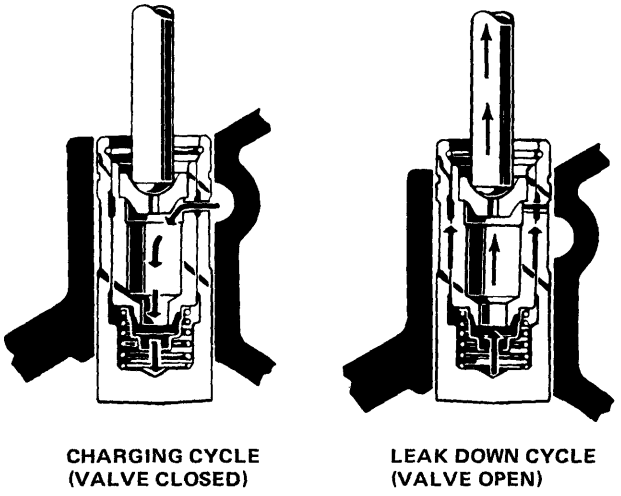

Fig. 1B-17 Hydraulic Tappet Operation Cycles

body movement, closing the check valve and transmitting zero-lash movement of 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

(1) Remove cylinder head cover.

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

(3) Remove push rods.

NOTE: *Keep rocker arm assemblies and push rods in the same order as removed.*

(4) Remove intake manifold.

(5) Remove tappet from guide bore in engine block.

Cleaning and Inspection

Release lock ring. Remove plunger cap, metering disc, plunger assembly, and plunger return spring from tappet body.

NOTE: *Keep the tappets and all components in the same order as removed.*

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

Visually inspect each tappet assembly for signs of scuffing on the barrel and face of the tappet. Inspect tappet face for wear using a straightedge across the tappet face. If the tappet face is concave, the corresponding lobe on the camshaft is worn and replacement of the camshaft and tappets is necessary.

If any components of a tappet assembly are noticeably worn or damaged, replace the entire assembly.

Install plunger return spring, plunger, metering disc, and plunger cap in tappet body. Using a push rod on plunger cap, compress plunger assembly and install lockring.

Hydraulic Tappet Leak-Down Test

After cleaning and inspection, leak-down test the tappet to ensure its zero-lash operating ability. Use Tool J-5790 to test tappet leak-down accurately (fig. 1B-18).

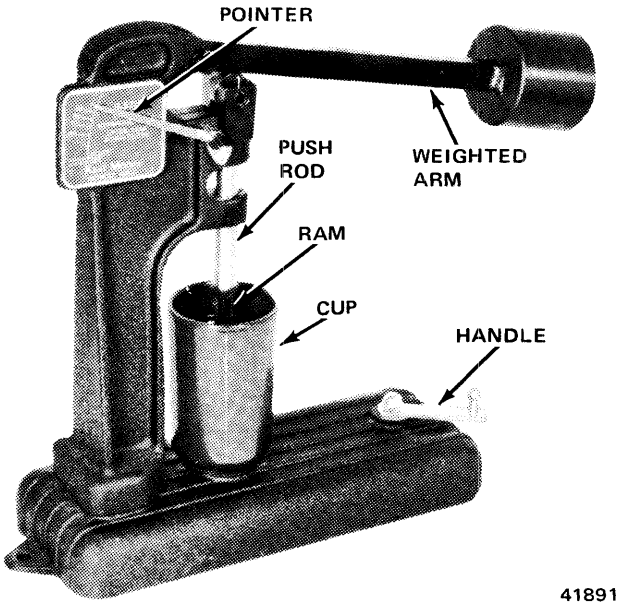

Fig. 1B-18 Hydraulic Tappet Leak-Down Tester J-5790

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

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

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

(4) Lower ram, then adjust nose of ram until it contacts ball bearing.

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

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

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

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

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

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 as they will charge themselves within three to eight minutes of engine operation.*

Installation

(1) Dip each tappet assembly in Jeep Engine Oil Supplement (EOS), or equivalent, and install tappet in same bore from which it was removed.

(2) Install push rods in the same order as removed.

(3) Install rocker arm and bridged pivot assemblies. Install capscrews, tightening each capscrew for each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

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

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

(5) Install cylinder head cover and gasket. Tighten retaining screws to 50 inch-pounds torque.

(6) Install intake manifold and new gasket and end seals. Tighten manifold retaining bolts to 43 foot-pounds torque.

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

VIBRATION DAMPER

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

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

Removal

(1) Loosen damper attaching screw with all belts attached.

(2) Loosen alternator drive belt.

(3) Loosen air conditioning drive belt (if equipped) and move aside.

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

(5) Remove damper drive pulley retaining bolts and damper pulley from vibration damper.

(6) Remove damper retaining bolt.

(7) Use Vibration Damper Removal Tool J-21791 to remove damper from crankshaft as shown in figure 1B-19.

Installation

(1) Apply a light film of engine oil to seal contacting surface of vibration damper.

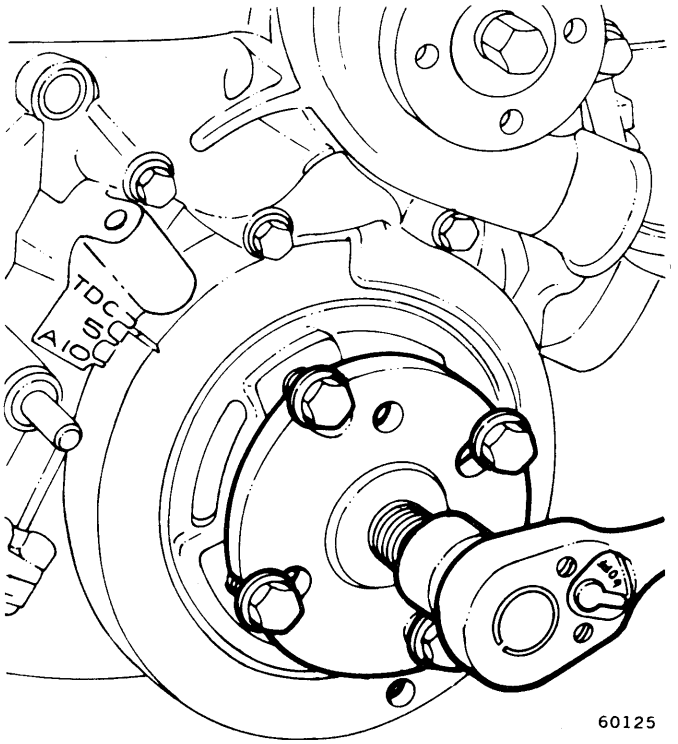

Fig. 1B-19 Vibration Damper Removal

(2) Align key slot of vibration damper with crankshaft.

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

(4) Install damper pulley and retaining bolts and **lockwashers**. Tighten bolts to 30 foot-pounds torque.

(5) Install drive belts and tighten to specified tension.

TIMING CASE COVER

The timing case cover is die-cast aluminum with a crankshaft oil seal to prevent oil leakage at the vibration damper hub (fig. 1B-20). The oil seal is installed from the back side of the timing case cover. It is necessary to remove the cover whenever oil seal replacement is required.

A graduated scale cast into the cover is used for ignition timing. A hole is provided for checking ignition timing with a magnetic timing probe. Refer to Section 4A for ignition timing procedure and magnetic timing probe description.

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

Removal

(1) Drain cooling system and cylinder block.

(2) Disconnect radiator hoses and bypass hose.

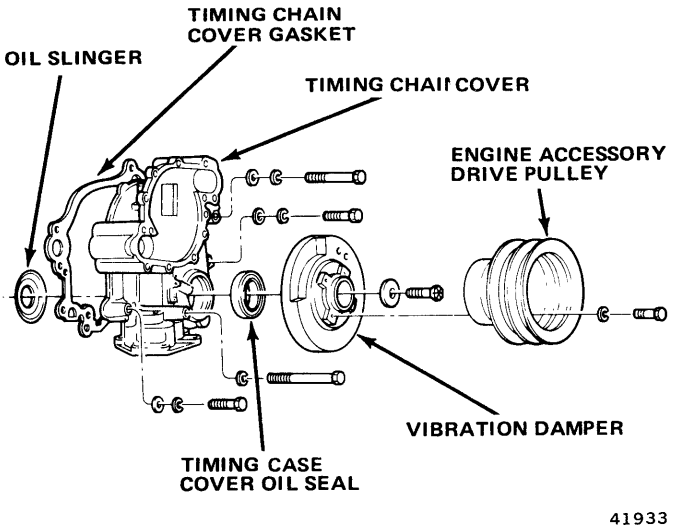

Fig. 1B-20 Timing Case Cover Assembly

(3) Remove all drive belts.

(4) Remove fan and spacer assembly.

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

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

(7) Disconnect heater hose at water pump.

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

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

(10) Remove distributor.

(11) Remove fuel pump.

(12) Remove vibration damper pulley and retaining bolts and lockwashers.

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

(14) Remove two front oil pan bolts.

(15) Remove bolts which secure timing case cover to engine block.

NOTE: *The cover retaining bolts vary in length and must be installed in the same location as removed.*

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

(17) Clean gasket surface of cover.

(18) Remove oil seal.

NOTE: *The oil seal always should be replaced whenever the timing case cover is removed. Refer to Oil Seal Replacement in this section.*

Installation

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

NOTE: *The dowel pin is required for correct cover alignment and either must be reused or a replacement dowel installed after the cover is in position.*

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

(3) Using original gasket as guide, trim replacement gasket to correspond to amount cut off at oil pan (fig. 1B-21).

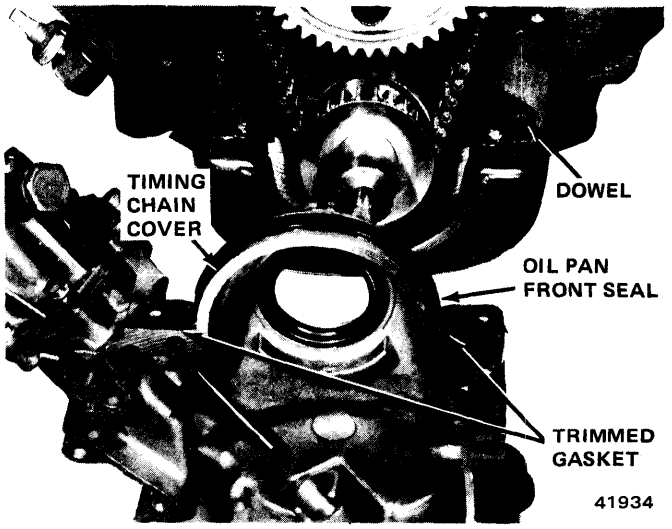

Fig. 1B-21 Oil Pan Front Seal Installation

(4) Apply sealer to both sides of new gasket and install gasket on timing case cover.

(5) Install new front oil pan seal.

(6) Align tongues of new oil pan gasket pieces with oil pan seal and cement into place on cover (fig. 1B-21).

(7) Apply a bead of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to cutoff edges of original oil pan gaskets.

(8) Place timing case cover into position and install front oil pan bolts.

(9) Tighten bolts slowly and evenly until cover aligns with upper locating dowel.

(10) Install lower dowel through cover and drive into corresponding hole in engine block.

(11) Install cover retaining bolts in the same location as removed. Tighten to 25 foot-pounds torque.

(12) Install vibration damper. Tighten retaining bolt to 90 foot-pounds torque.

(13) Install damper pulley and retaining bolts.

(14) Install fuel pump.

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

(16) Install distributor cap and connect heater hose.

(17) Install power steering pump and air pump and mount bracket (if equipped).

(18) Install alternator and alternator mount bracket.

(19) Install air conditioning compressor and bracket assembly (if equipped).

(20) Install fan and spacer assembly.

(21) Install all drive belts and tighten to the specified tension.

(22) Connect radiator hoses and bypass hose.

(23) Fill cooling system to specified level.

(24) Start engine and check for oil or coolant leaks.

(25) Adjust initial ignition timing to specified setting.

Oil Seal Replacement

Timing case cover must be removed to replace seal.

(1) Pry out original seal from inside timing case cover and clean seal bore.

(2) Apply a light coat of Perfect Seal compound, or equivalent, to outer surface of a new seal.

(3) Drive seal into place from inside the cover with Seal Installer Tool J-22533 until it contacts the outer flange of the cover (fig. 1B-22).

(4) Apply a light film of engine oil to lips of neoprene seal.

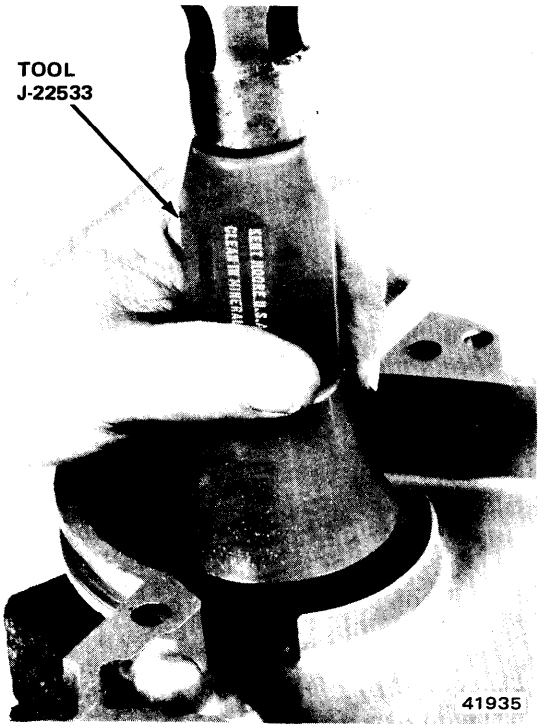

Fig. 1B-22 Timing Case Cover Oil Seal Replacement

TIMING CHAIN

The timing chain is of the single row type and has 62 links and pins. To ensure correct valve timing, install the timing chain with the timing marks of the crankshaft and camshaft sprockets properly aligned. 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) Remove spark plugs.
(2) Remove cylinder head covers and gaskets.
(3) Remove rocker arms and bridged pivot assemblies from No. 1 cylinder.
(4) Rotate crankshaft until No. 6 piston is at Top Dead Center (TDC) on compression stroke (this places No. 1 piston at TDC on the exhaust stroke in valve overlap position).
(5) Rotate crankshaft counterclockwise 90 degrees as viewed from front.
(6) Install dial indicator on No. 1 intake valve push rod end.
(7) Set dial indicator to zero.
(8) Crank engine slowly in direction of rotation (clockwise viewed from front) until dial indicator indicates 0.020 inch for 304 and 360 CID engines and 0.025 inch for 401 CID engines.
(9) At this point, milled timing mark on vibration damper should be in line with TDC marking on timing case cover.

If more than 1/2-inch variation in either direction exists, remove timing chain cover and inspect timing chain installation.

Check for incorrect camshaft sprocket indexing. The sprocket keyway should align with the centerline of the first lobe on the camshaft.

Removal

(1) Remove timing case cover.
(2) Remove crankshaft oil slinger.
(3) Remove camshaft sprocket retaining bolt and washer.
(4) Remove distributor drive gear and fuel pump eccentric.
(5) Rotate crankshaft until the zero timing mark on the crankshaft sprocket is closest to and in a centerline with the zero timing mark on the camshaft sprocket (fig. 1B-23).

NOTE: *Install crankshaft screw and several thick washers to facilitate turning crankshaft.*

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

Installation

(1) Assemble timing chain, crankshaft sprocket, and camshaft sprocket with timing marks aligned (fig. 1B-24).
(2) Install assembly to crankshaft and camshaft.
(3) Install fuel pump eccentric and distributor drive gear (fig. 1B-24).
(4) Install camshaft, washer and retaining bolt. Washer fits into recess in distrubutor drive gear. Tighten bolt to 30 foot-pounds torque.

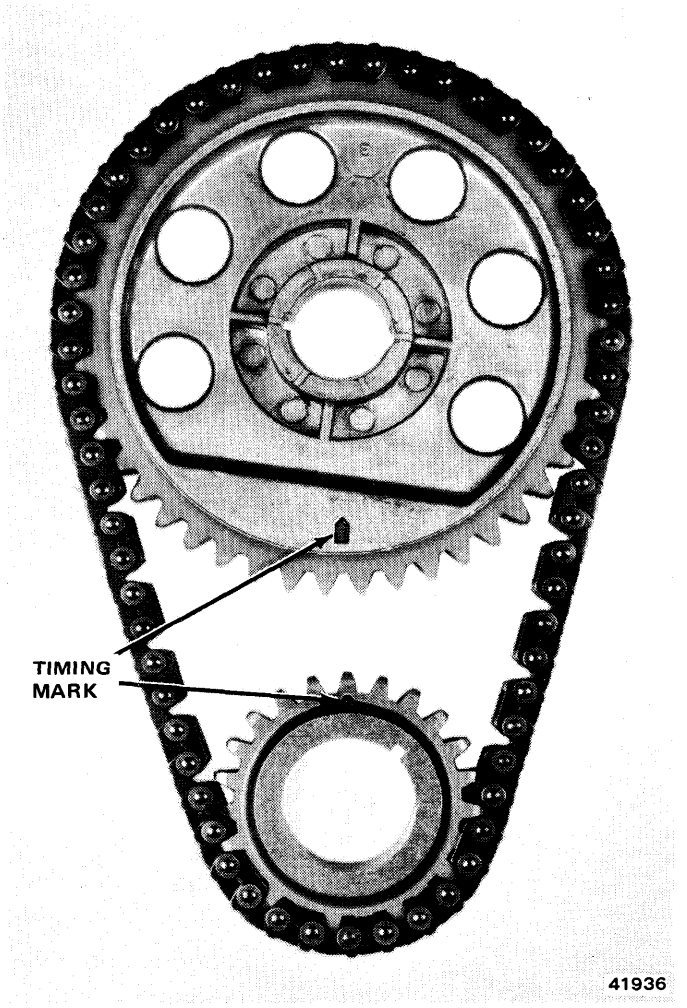

Fig. 1B-23 Sprocket Alignment

NOTE: *The fuel pump eccentric must be installed with the stamped word REAR facing the camshaft sprocket.*

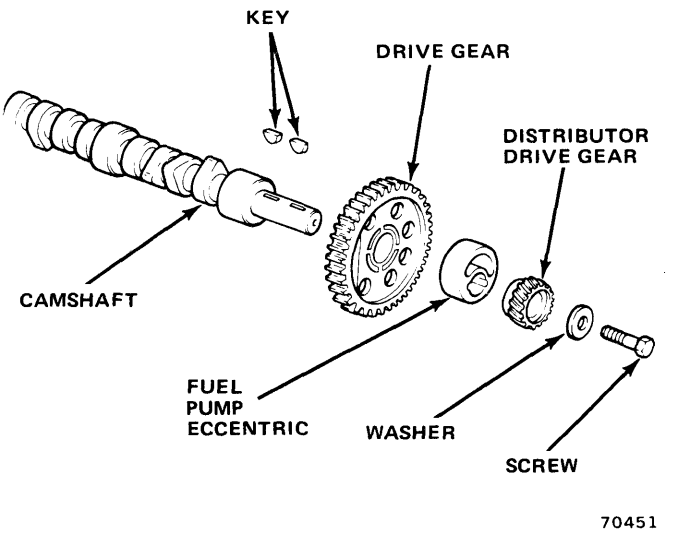

Fig. 1B-24 Camshaft Drive Gear

(5) To ensure correct installation of timing chain:

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

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

(c) There should be 20 pins between these two points. **The crankshaft sprocket timing mark must be between pins 20 and 21 (fig. 1B-25).**

(6) Install crankshaft oil slinger.

(7) Remove timing case cover oil seal. Install replacement oil seal.

(8) Install timing case cover using replacement gasket. Tighten retaining bolts to 25 foot-pounds torque.

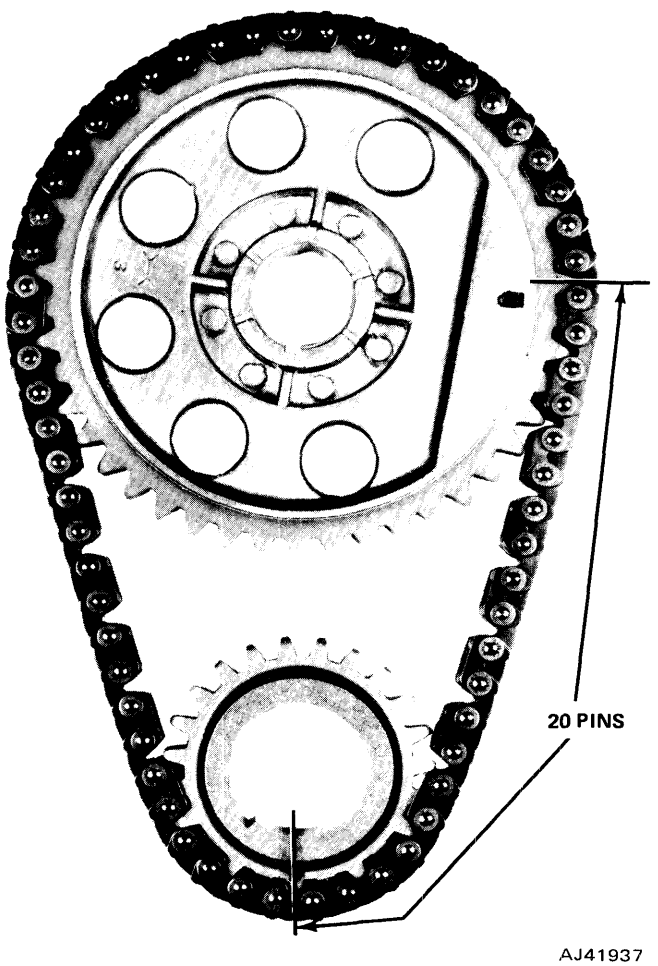

Fig. 1B-25 Correct Timing Chain Installation

CAMSHAFT AND BEARINGS

The camshaft is supported by five steel-shelled, babbit-lined bearings which have been pressed into the block and line reamed. The camshaft journals are step bored, being larger at the front bearing than at the rear, to permit easy removal and installation of the camshaft. All camshaft bearings are lubricated under pressure.

NOTE: *Do not replace camshaft bearings unless required special tools for removing and installing are available.*

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear. The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face to maintain zero end play during engine operation.

Camshaft Identification

The 401 CID engine camshaft is identified by white marks between the No. 3 and 4 camshaft bearings.

The 304 and 360 CID engine camshafts, which are the same, have no identifying paint marks.

Cam Lobe Lift Measurement

Cam lift may be checked with a dial indicator.

(1) Remove rocker arm cover and gasket.

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

(3) Remove spark plugs.

(4) Install a dial indicator on end of push rod (fig. 1B-26).

NOTE: *A piece of rubber tubing may be used to secure dial indicator plunger to push rod.*

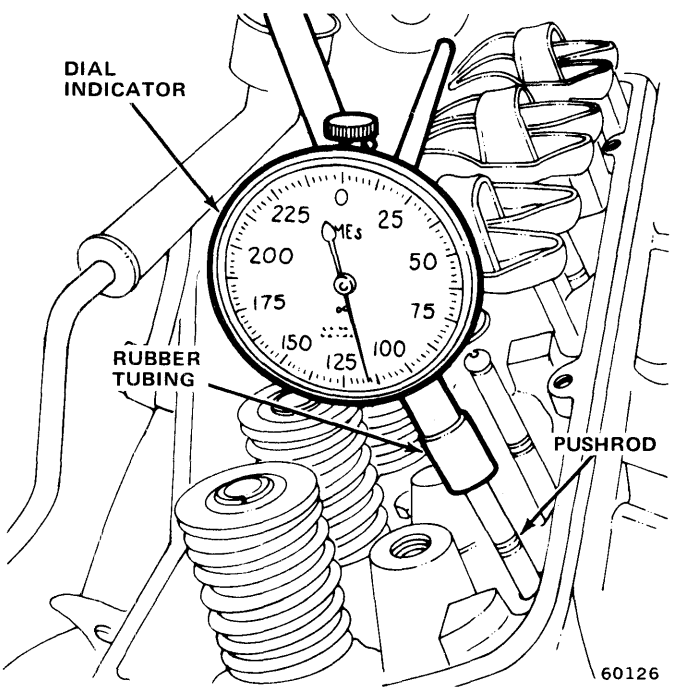

Fig. 1B-26 Cam Lobe Lift Measurement

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

(6) Set dial indicator to zero.

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

(8) Read travel at dial indicator. (Correct lift is 0.260 to 0.270 inch for 304 and 360 CID engines and 0.0280 to 0.0290 inch for 401 CID engine).

Removal

(1) Drain cooling system and cylinder block.

(2) Remove radiator assembly.

(3) If equipped with air conditioning, remove condenser and receiver assembly as charged unit. Refer to Section 13A—Air Conditioning for detailed procedure.

(4) Remove cylinder head covers and gaskets.

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

(6) Remove push rods.

NOTE: *Keep push rods, rocker arm assemblies, and tappets in the same order as removed.*

(7) Remove intake manifold assembly.

(8) Remove drive belts.

(9) Remove fan and hub assembly.

(10) Remove distributor.

(11) Remove damper pulley.

(12) Remove vibration damper.

(13) Remove timing case cover. Remove oil seal.

(14) Install crankshaft screw and several thick washers to facilitate crankshaft rotation.

(15) Rotate crankshaft until timing mark on crankshaft sprocket is closest to and in a centerline with timing mark on camshaft sprocket.

(16) Remove retaining bolt from camshaft and crankshaft.

(17) Remove distributor drive gear and fuel pump eccentric from the camshaft (1B-24).

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

(19) Remove hood latch support bracket upper retaining screws and move bracket, as required, to allow removal of camshaft.

(20) Remove front bumper or grille, as required, and remove camshaft.

Inspection

Inspect the camshaft bearing journals for an uneven wear pattern or rough finish. Either condition will necessitate camshaft replacement.

Inspect the distributor drive gear for damage or excessive wear.

Inspect fuel pump eccentric for excessive wear.

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

Installation

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

(2) Carefully install camshaft into engine block.

(3) Assemble timing chain, crankshaft sprocket, and camshaft sprocket with the timing marks aligned as at time of removal.

(4) Install chain and sprockets assembly to engine. Recheck installation as shown in figure 1B-23.

(5) Install fuel pump eccentric and distributor drive gear to camshaft.

(6) Install replacement timing case cover gasket. Refer to Timing Case Cover in this section.

(7) Install replacement seal in timing case cover.

(8) Install timing case cover.

(9) Install vibration damper. Apply oil to damper screw washer and tighten screw to 90 foot-pounds torque.

(10) Install damper pulley and retaining bolts. Tighten bolts to 30 foot-pounds torque.

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

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

(12) Install intake manifold assembly.

(13) Install push rods.

(14) Install rocker arms and bridged pivot assemblies. Install capscrews, tightening each capscrew for each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(15) Install cylinder head covers and gaskets.

(16) Install fuel pump.

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

NOTE: *After No. 1 intake valve has closed, TDC can be reached by rotating the crankshaft clockwise as viewed from the front until the timing mark or the damper aligns with TDC on the timing case cover.*

(18) Install distributor so that rotor is aligned with No. 1 terminal of the cap when fully seated on block.

(19) Install distributor cap.

(20) Install ignition wires.

(21) If removed, install air conditioning condenser and receiver assembly. Refer to Section 13A—Air Conditioning for procedure to purge compressor air.

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

(22) Install hood latch support bracket retaining screws and tighten securely.

(23) If removed, install front bumper or grille.

(24) Install radiator.

(25) Fill cooling system to specified level.

OIL PAN

Removal

(1) Drain engine oil.
(2) Remove starter.
(3) Remove oil pan.
(4) Remove oil pan front and rear neoprene oil seals. Thoroughly clean gasket surfaces of oil pan and engine block. Remove all sludge and dirt from oil pan sump.

Installation

(1) Install oil pan front seal to timing case cover and apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to end tabs.
(2) Cement replacement oil pan side gaskets into position on engine block and apply generous amount of Jeep Gasket-in-a-Tube (RTV silicone), or equivalent, to side gasket contacting surface of seal end tabs.
(3) Install seal in recess of rear main bearing cap making certain it is fully seated.
(4) Apply engine oil to oil pan contacting surface of front and rear oil pan seals.
(5) Install oil pan and tighten drain plug securely.

NOTE: *Tighten 1/4-20 oil pan screws to 7 foot-pounds torque and 5/16-18 oil pan screws to 4 foot-pounds torque.*

(6) Install starter.
(7) Fill crankcase to specified level with clean oil.

OIL FILTER

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

A bypass valve, incorporated in the filter mounting base, provides a safety factor in the event the filter becomes inoperative as a result of dirt or sluge accumulation. Oil Filter Remover Tool J-22700 will facilitate removal.

Before installation, apply a thin film of oil to the filter gasket. **Do not use grease.** Install filter until gasket contacts the seat of the adapter. Tighten by hand only, following instructions on replacement filter. Operate engine at fast idle and check for leaks.

OIL PUMP

The positive-displacement gear type oil pump is driven by the distributor shaft, which in turn is driven by a gear on the camshaft (fig. 1B-4). The pump, which is part of the timing case cover, incorporates a pressure relief valve to regulate maximum pressure.

Crankcase oil enters the pump after being drawn through the pickup tube and screen assembly, the horizontal main oil gallery, and the connecting passage in the timing case cover.

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

Oil Pressure Relief Valve

The oil pressure relief valve is not adjustable. A setting of 75 pounds maximum pressure is built into the tension of the spring.

In the relieved position, the valve permits oil to bypass through a passage in the pump cover to the inlet side of the pump.

Removal

(1) Remove retaining screws and separate oil pump cover, gasket and oil filter as an assembly from pump body (timing case cover).
(2) Remove drive gear, drive gear shaft and driven (idler) gear by sliding them out of body.
(3) Remove oil pressure relief valve from pump cover for cleaning by removing retaining cap and spring.

Clean cover thoroughly. Check operation of relief valve by inserting release valve and checking to see that it slides back and forth freely. If not, replace pump cover and release valve.

Gear End Clearance Measurement

This procedure determines the distance between the end of the pump gear and the pump cover. Excessive pump clearance is indicated by good oil pressure when cold; low or no pressure after a hot engine start-up.

Preferred Method

(1) Place strip of Plastigage across full width of each gear (fig. 1B-27).

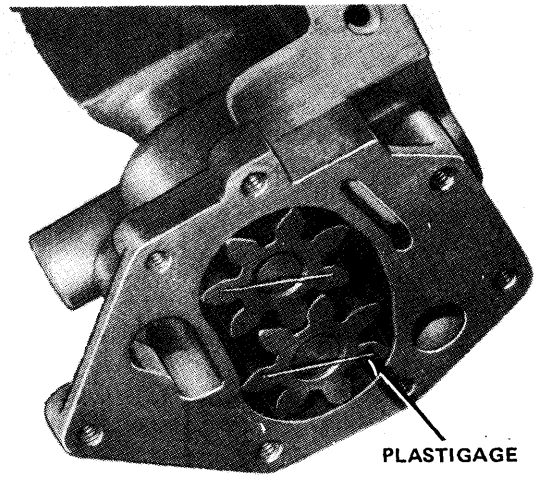

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Fig. 1B-27 Oil Pump Gear End Clearance Measurement—Plastigage Method

(2) Install pump cover and gasket. Tighten screws to 55 inch-pounds.

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

Alternate Method

(1) Place straightedge across gears and pump body.

(2) Select a feeler gauge which will fit snugly but freely between straightedge and pump body (fig. 1B-28).

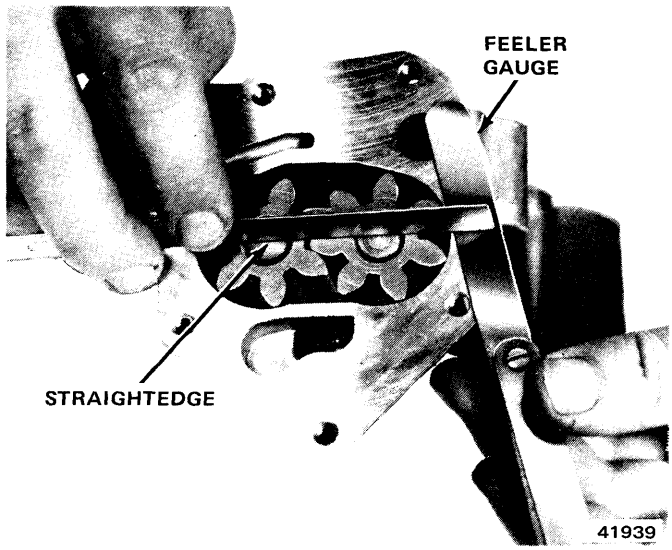

Fig. 1B-28 Gear Height Measurement

NOTE: *Make certain gears are up as far as possbile into body. Correct clearance is 0.004 to 0.008 inch (0.008 clearance desired).*

If clearance is excessive, measure gear length. If gear length is incorrect, replace gears. If gear length is correct, install a thinner gasket.

NOTE: *Make a thinner gasket from locally procured material.*

Gear-to-Body Clearance

(1) Insert feeler gauge between gear tooth and pump body inner wall directly opposite the point of gear mesh. Select feeler gauge which fits snugly but freely (fig. 1B-29).

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

(2) If gear-to-body clearance is more than specified, measure gear diameter. If diameter is incorrect, replace gears. If diameter is correct, check gear end clearance and correct. If gear end clearance is acceptable, replace timing case cover.

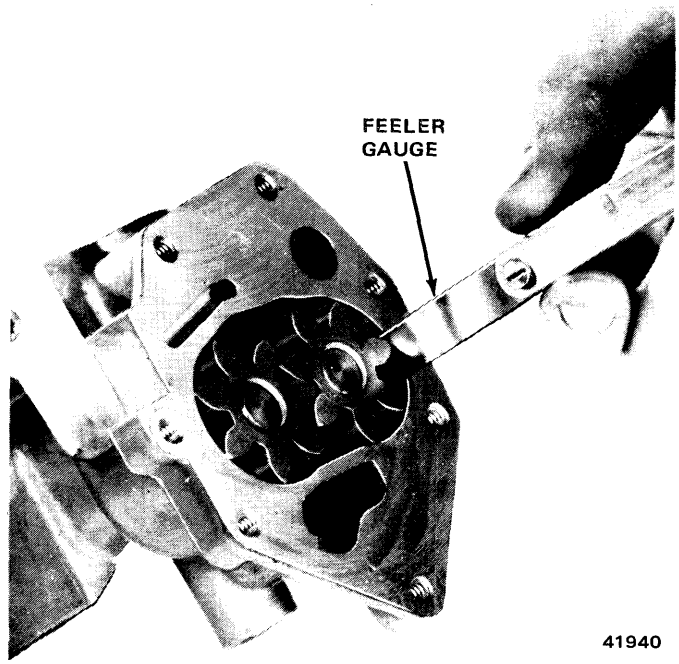

Fig. 1B-29 Gear-to-Body Clearance Measurement

Installation

(1) If removed, install oil pressure relief valve in pump cover with spring and retaining cap.

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

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

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

REAR MAIN BEARING OIL SEAL

The rear main bearing oil seal consists of a two-piece, neoprene, single-lip seal to seal the rear of the crankshaft. Correct installation of the seal will ensure leak-free engine operation (fig. 1B-30).

Removal

(1) Drain engine oil.

(2) Remove starter motor.

(3) Remove oil pan.

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

(5) Remove oil pan side gaskets.

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

(7) Remove rear main bearing cap.

(8) Remove and discard lower seal.

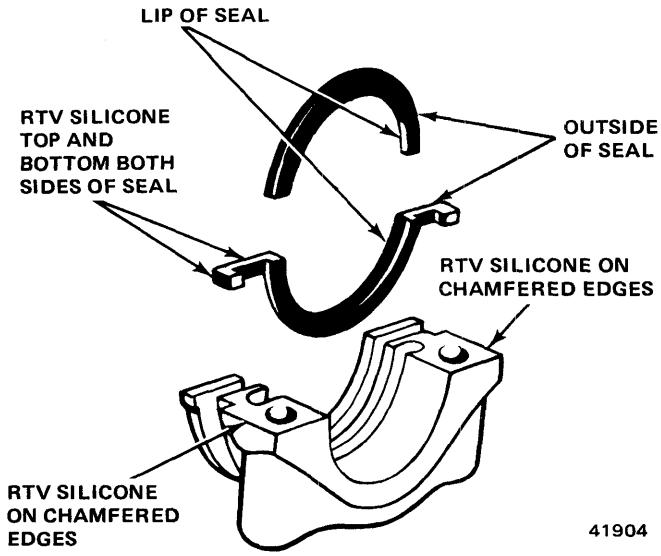

Fig. 1B-30 Rear Main Oil Seal Installation

NOTE: *To ensure leak-free operation, the upper and lower seal halves must be replaced in pairs.*

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

(10) Loosen all remaining main bearing capscrews.

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

Installation

(1) Wipe seal surface of the crankshaft clean and then oil lightly.

(2) Coat block contacting surface of the new upper seal with soap, and lip of seal with engine oil (fig. 1B-28).

(3) Install upper seal into engine block.

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

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

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

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

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

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

(8) Install rear main bearing inserts.

(9) Install rear main bearing cap.

(10) Tighten all main bearing capscrews to 100 foot-pounds torque.

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

(12) Install starter motor.

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

CYLINDER BLOCK

Disassembly

(1) Remove engine assembly as outlined earlier in this section.

(2) Use engine stand to support engine assembly.

(3) Remove distributor.

(4) Remove cylinder head covers.

(5) Remove rocker arms and bridged pivot assemblies. At each bridge, loosen capscrews alternately a turn at a time to avoid breaking bridge.

(6) Remove push rods.

(7) Remove intake manifold assembly.

(8) Remove valve tappets.

(9) Remove cylinder heads and gaskets.

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

(11) Loosen all drive belts. Remove power steering pump, air pump and AC compressor bracket, if equipped.

(12) Remove damper pulley and vibration damper.

(13) Remove timing case cover.

(14) Remove oil pan.

(15) Remove camshaft.

(16) Remove connecting rod bearing caps and inserts and keep in same order as removed.

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

(17) Remove connecting rod and piston assemblies through top of cylinder bores. **Be careful that connecting rod bolts do not scratch connecting rod journals or cylinder walls.**

NOTE: *Pieces of rubber hose can be pushed over the rod bolts to prevent damage to the rod journals.*

(18) Remove oil pickup tube and screen assembly.

(19) Remove main bearing caps and inserts.

(20) Remove crankshaft.

Cylinder Bore Reconditioning

Inspect the cylinder bores for scoring, taper, and out-of-round. Check with an inside micrometer or telescope gauge from the top to the bottom of the cylinders for taper. Check for an out-of-round condition by measuring across the cylinder bores at two points: parallel to the crankshaft and perpendicular to the crankshaft.

If cylinder taper does not exceed 0.005 inch and out-of-round does not exceed 0.003 inch, the cylinder bore may be corrected by honing.

If the cylinder taper or out-of-round condition exceeds these limits, the cylinder must be bored and then honed for an oversize piston.

Move the hone up and down at a sufficient speed to produce a uniform crosshatch pattern on the cylinder walls.

Removal of glaze from the cylinder wall for quicker 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 motion.

Successful ring installation depends upon cleanliness during the honing operation and careful handling of parts. The engine bearings and lubrication system must be protected from abrasives.

Rigid type hones are not be be used to remove cylinder glaze as there is always a slight amount of taper in cylinder walls after the engine has been in service.

Prior to fitting pistons, the cylinder bores should be scrubbed clean with a hot water and detergent solution. After cleaning, apply light engine oil to cylinder walls and then wipe with a clean, lint-free cloth.

NOTE: *If crankshaft remains in block, cover the connecting rod journals with clean cloths during honing and cleaning operation.*

Assembly

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

(2) Install crankshaft.

(3) Install main bearing caps and inserts. If replacement bearings and/or crankshaft are used, Plastigage each bearing.

(4) Install new oil pickup tube and screen assembly. Be sure plastic button is inserted in screen.

(5) Install camshaft.

(6) Prior to installing the connecting rod and piston assemblies into cylinder block, arrange piston ring gaps so that:

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

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

(c) Number 2 compression ring gap is 180°(±20°) from top oil rail gap.

(d) Number 1 compression ring gap is 180°(±20°) from the number 2 compression ring gap.

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

NOTE: *Be sure piston notch faces forward and oil squirt hole faces camshaft (fig. 1B-31).*

(8) Use a piston ring compressor tool to install connecting rod and piston assemblies through top of cylinder bores.

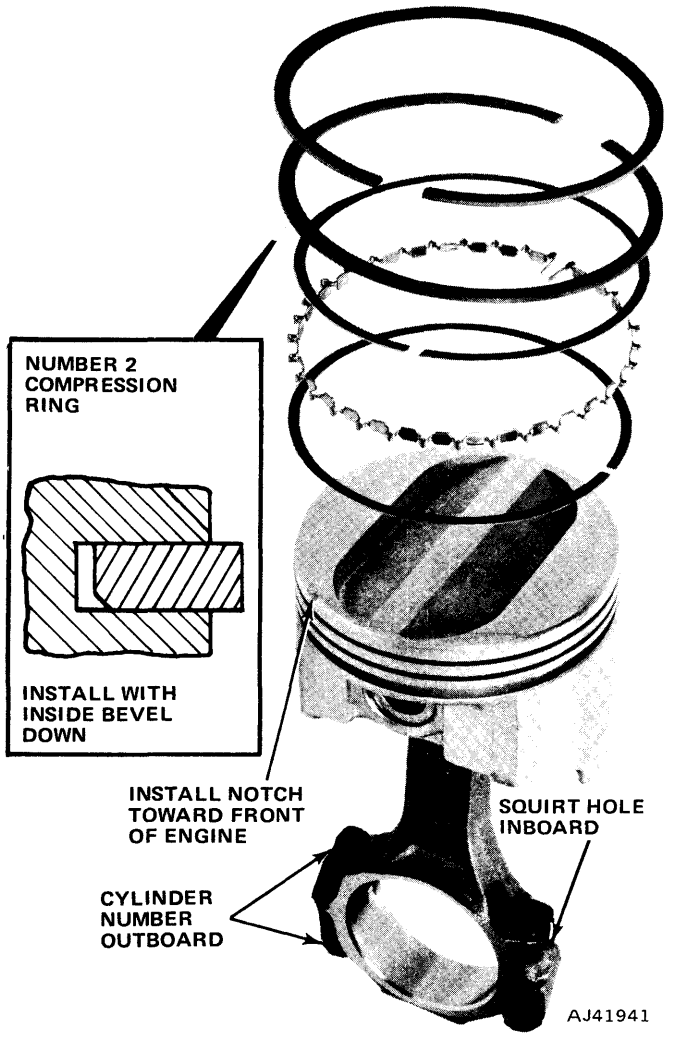

Fig. 1B-31 Connecting Rod and Piston Assembly

NOTE: *Be careful that connecting rod bolts do not scratch connecting rod journals or cylinder walls. Place length of rubber hose over the connecting rod bolts for protection during installation.*

(9) Install connecting rod bearing caps and inserts in same order as removed. Tighten nuts on 304 and 360 CID engines to 28 foot-pounds torque. Tighten nuts on 401 CID engines to 39 foot-pounds torque.

(10) Install camshaft and timing chain.

(11) Install timing case cover and gaskets. Refer to Timing Case Cover earlier in this section.

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

(13) Install vibration damper and damper pulley.

(14) Install cylinder head and gaskets.

(15) Install valve tappets.

(16) Install intake manifold and new gaskets.

(17) Install push rods.

(18) Install rocker arms and bridged pivot assemblies. Install capscrews, tightening each capscrew for

each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(19) Turn crankshaft to bring No. 1 piston to TDC of compresion stroke for later installation of distributor.

(20) Reseal and install cylinder covers.

(21) Install power steering pump, air pump and AC compressor, if removed.

(22) Install distributor.

(a) Point rotor to No. 1 spark plug wire position.

(b) Turn oil pump shaft with long screwdriver to allow distributor shaft to engage oil pump.

(c) With rotor pointing to No. 1 spark plug wire position, rotate housing counterclockwise until leading edge of trigger wheel segment is aligned with center of sensor.

(d) When engine is installed and running, check ignition timing as outlined in Chapter 4A.

(23) Remove engine from stand.

(24) Install engine assembly as outlined earlier in this section.

CONNECTING ROD AND PISTON ASSEMBLIES

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

Removal

(1) Remove cylinder head covers.

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

(3) Remove push rods.

(4) Remove intake manifold assembly.

NOTE: *It is not necessary to remove manifold from exhaust pipe.*

(5) Remove cylinder head and gasket.

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

(7) Drain engine oil.

(8) Remove oil pan.

(9) Remove connecting rod bearing caps and inserts. Keep in same order as removed.

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

(10) Remove connecting rod and piston assemblies through the top of cylinder bores. **Be careful that connecting rod bolts do not scratch connecting rod journals or cylinder walls.**

NOTE: *A piece of rubber hose can be pushed on over the rod bolts to avoid damage to the rod journals.*

Installation

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

(2) Prior to installing connecting rod and piston assemblies into engine, arrange piston ring gaps so that:

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

(b) Oil rail gaps are 180° apart and in line with piston pin centerline (±20°).

(c) Number 2 compression ring gap is 180°(±20°) from top oil rail gap.

(d) Number 1 compression ring gap is 180°(±20°) from the number 2 compression ring gap.

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

NOTE: *Be sure piston notch faces forward and oil squirt hole faces camshaft (fig. 1B-31).*

(4) Use piston ring compressor tool to install connecting rod and piston assemblies through top of cylinder bores. **Be careful that connecting rod bolts do not scratch connecting rod journals or cylinder walls.**

NOTE: *Place lengths of rubber hose over the connecting rod bolts for protection during installation.*

(5) Install connecting rod bearing caps and inserts in same order as removed. Tighten retaining nuts to 33 foot-pounds torque on 304 and 360 CID engines. Tighten retaining nut on 401 CID engines to 39 foot-pounds torque.

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

(7) Install cylinder heads and gaskets.

(8) Install push rods.

(9) Install rocker arms and bridged pivot assemblies. Install capscrews, tightening each capscrew for each bridge assembly a turn at a time to avoid breaking the bridge. Tighten capscrews to 19 foot-pounds torque.

(10) Install intake manifold assembly.

(11) Reseal and install cylinder head covers.

(12) Fill crankcase with new oil to specified level.

CONNECTING ROD

The connecting rods for 304 and 360 CID engines are malleable-iron and 401 CID engines are forged steel. Both types are independently balanced. The crankshaft end of the connecting rods incorporates a two-piece bearing insert. A squirt hole at the crankshaft end provides lubrication for the cylinder walls, pistons, and piston pins. It must face inward when the connecting rod is installed (fig. 1B-31). The removable bearing cap has a number from 1 through 8 stamped on it and the adjacent machined surface of the rod to identify the cylinder in which the rod was assembled. The piston end of the rod is a 2000-pound press-fit to the piston pin.

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

Connecting Rod Bearings

The connecting rod bearings for all V-8 engines are steel-backed, aluminum-alloy, precision type.

The connecting rod bearings are select fit to their respective journals to obtain the desired operating clearance. **In production,** the select fit is obtained by using various sized color coded bearing inserts as shown in the bearing fitting chart. The bearing color code appears on the edge of the insert. 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. Use color codes shown in the bearing fitting chart to identify journal size and select the correct bearing inserts to obtain proper clearances.

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 (1/2 thousandth of an inch).

CAUTION: *Never use bearing inserts with greater than 0.001-inch difference in size in pairs.*

Example:

Bearing Insert Pairs

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

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

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

Removal

Use this procedure to service connecting rod bearing with the engine in the vehicle.

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

NOTE: Do not mix bearing caps. *Each connecting rod and matching cap is stamped with the cylinder number on a machined surface which faces the camshaft side of the engine block. The numbers are located on a machined surface opposite the squirt holes (fig. 1B-32).*

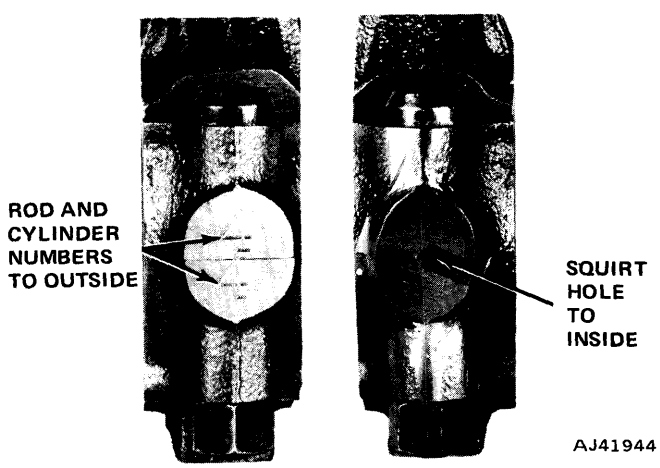

Fig. 1B-32 Rod Number and Squirt Hole Location

Connecting Rod Bearing Fitting Chart

Crankshaft Connecting Rod Journal Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
304 - 360 CID Engines		
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
401 CID Engine		
Yellow — 2.2485 to 2.2478 (Standard)	Yellow — Standard	Yellow — Standard
Orange — 2.2478 to 2.2471 (0.0007 Undersize)	Yellow — Standard	Black — .001-inch Undersize
Black — 2.2471 to 2.2464 (0.0014 Undersize)	Black — .001-inch Undersize	Black — .001-inch Undersize
Red — 2.2385 to 2.2378 (0.010 Undersize)	Red — .010-inch Undersize	Red — .010-inch Undersize

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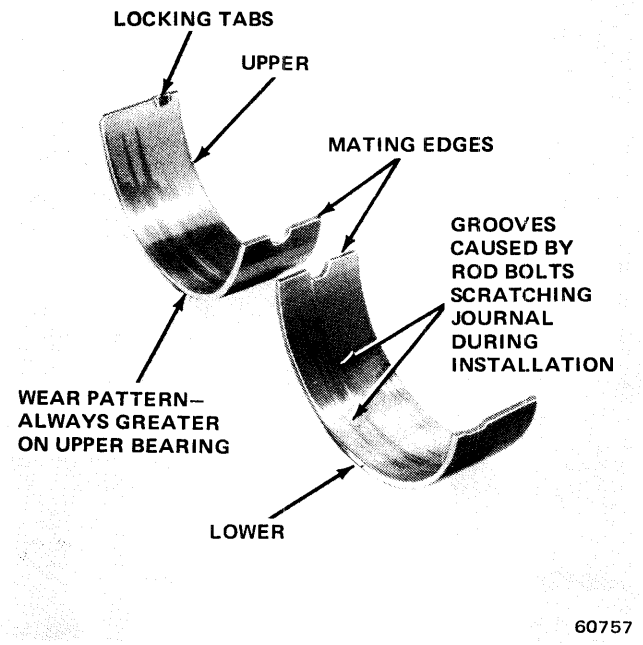

Fig. 1B-33 Connecting Rod Bearing Inspection

Inspection

(1) Clean inserts.

(2) Inspect linings and backs of inserts for irregular wear pattern. Note any scraping, stress cracks or distortion (fig. 1B-33). If bearing has spun in rod, replace bearing and connecting rod and inspect crankshaft journal for scoring.

(3) Inspect for material imbedded in linings which may indicate piston, timing gear, distributor gear or oil pump gear problems. Figures 1B-34 and 1B-35 show common score problems.

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

(5) Inspect insert area of locking tab. Abnormal wear indicates bent tabs or improper installation of inserts (fig. 1B-36).

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

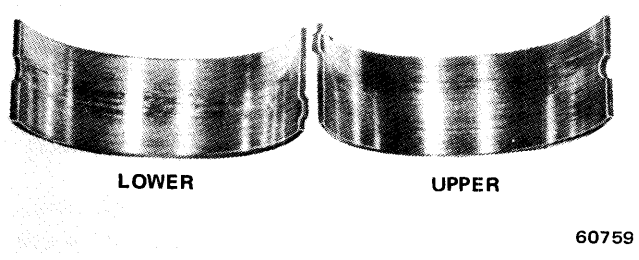

Fig. 1B-34 Scoring Caused by Insufficient Lubrication

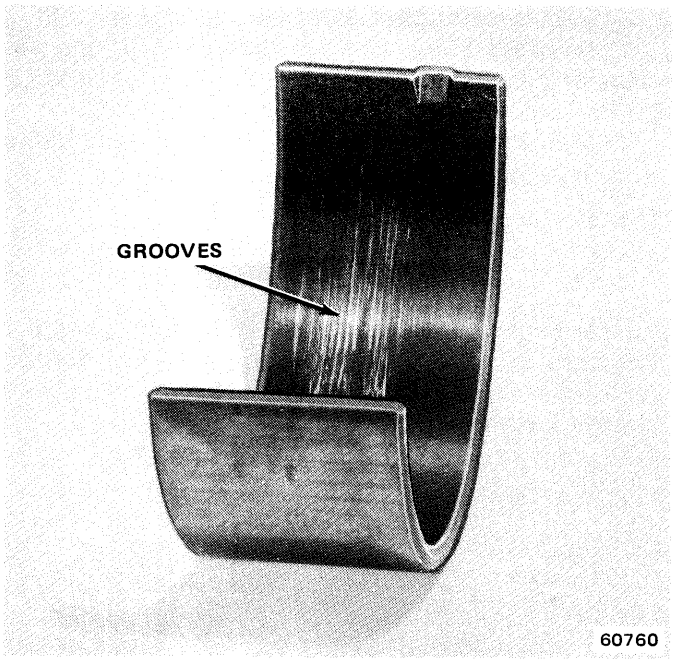

Fig. 1B-35 Scoring Caused by Dirt

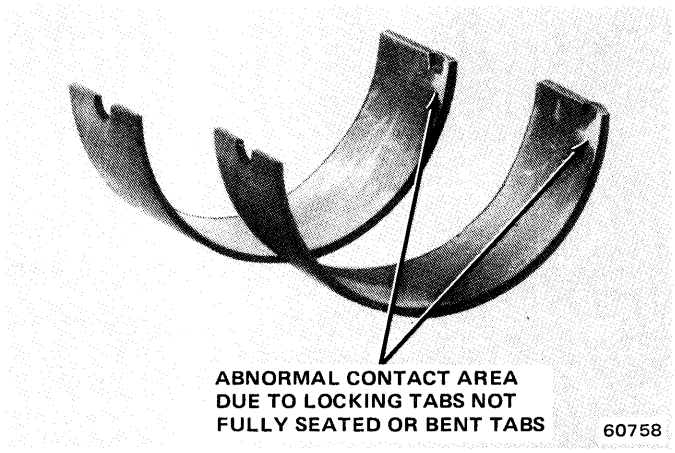

Fig. 1B-36 Locking Tab Inspection

Measuring Journal Size with Micrometer

(1) Wipe connecting rod journals clean.

(2) Using a micrometer, measure journal diameter at two points 90° apart at each end of journal. Note difference between maximum and minimum diameters.

(3) Refer to Specifications for maximum allowable taper and out-of-round. If any rod journal is beyond specifications, the crankshaft must be replaced or reconditioned and fitted with new undersize bearing inserts.

(4) Compare maximum reading obtained with journal diameters listed in bearing fitting chart.

(5) Select inserts required to obtain 0.002 to 0.0025 inch bearing clearance.

Measuring Bearing Clearance with Plastigage

(1) Wipe journal clean.

(2) Lubricate upper insert and install in rod.

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

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

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

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (fig. 1B-37). Correct clearance is 0.001 to 0.0025 inch.

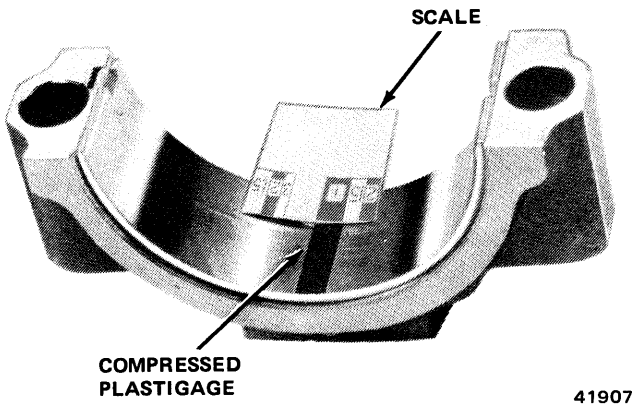

Fig. 1B-37 Connecting Rod Bearing Clearance Measurement with Plastigage

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

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

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

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

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

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

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

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

Connecting Rod Side Clearance Measurement

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

(2) Insert snug fitting feeler gauge between connecting rods (fig. 1B-38).

(3) Compare feeler gauge measurement to clearance specified. Replace rods not to Specifications.

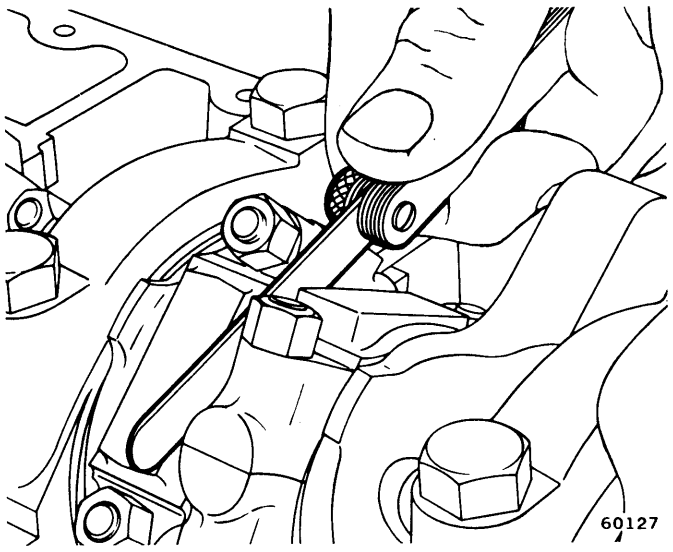

Fig. 1B-38 Connecting Rod Side Clearance Measurement

Installation

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

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

(3) Install bearing inserts, cap and retaining nuts. Tighten to 33 foot-pounds torque on 304 and 360 CID engines and 39 foot-pounds torque on 401 CID engines.

CAUTION: *Exercise care 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, which can cause bearing failure. Use of rubber hose on rod bolts is recommended to prevent damage to rod journals.*

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

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

PISTONS

Aluminum alloy Autothermic pistons, steel reinforced for strength and controlled expansion, are used.

The pistons are cam-ground and are not perfectly round. The ring belt area contains three piston rings, two compression and one oil control ring above the piston pin.

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

To ensure correct installation of the pistons in the bore, two notches are cast in the top perimeter of the piston on 304 and 360 CID engines and one notch on 401 CID engines. The notches must face forward (fig. 1B-39).

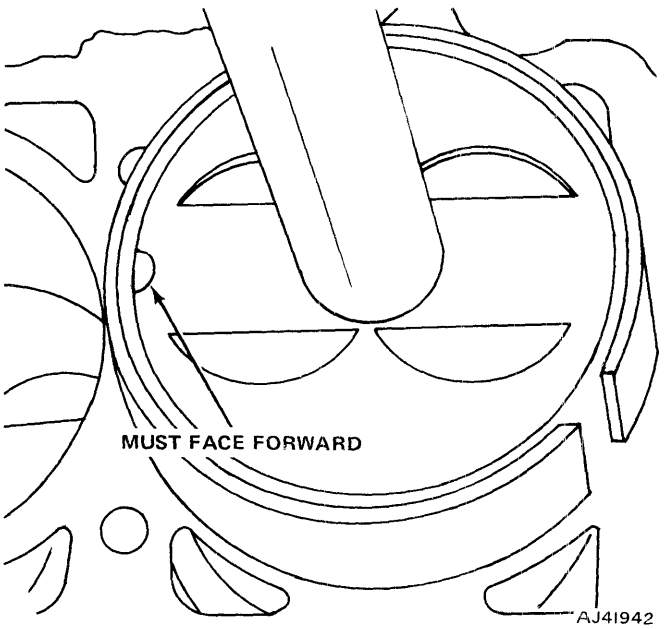

Fig. 1B-39 Installing Piston Assembly into Bore

Piston Fitting

Micrometer Method

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

(2) Measure outside diameter of piston.

NOTE: *Pistons are cam ground and must be measured at right angle to piston pin at centerline of pin (fig. 1B-40).*

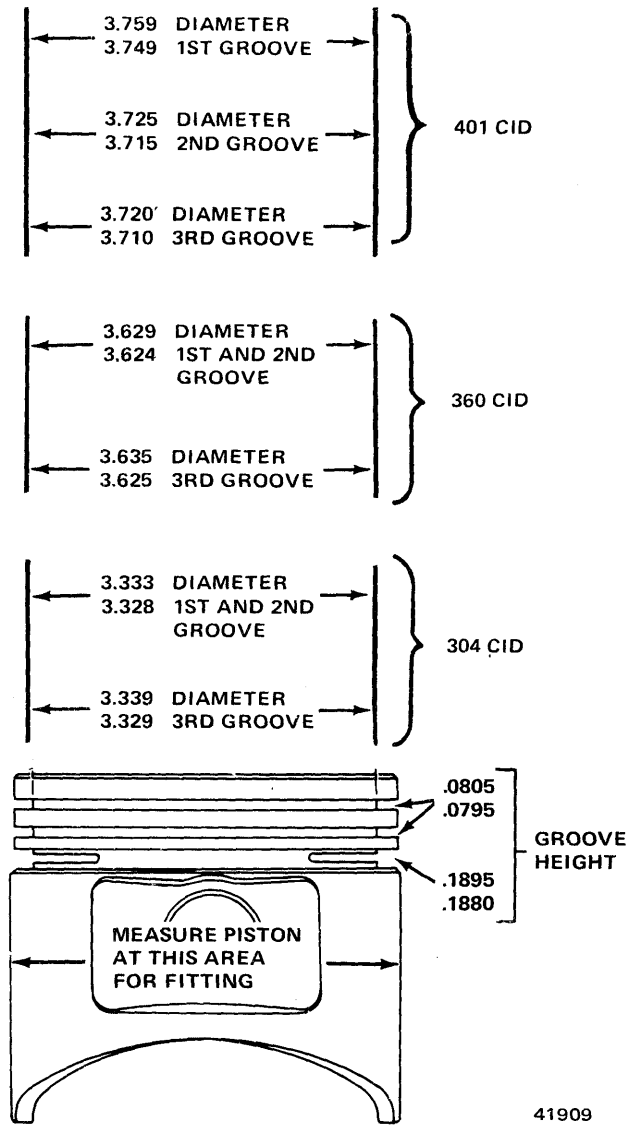

Fig. 1B-40 Piston Measurements (Inches)

(3) The difference betwen cylinder bore diameter and piston diameter is piston-to-bore clearance.

Feeler Gauge Method

(1) Remove rings from piston.

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

(3) Insert piston, top first, into bore alongside feeler gauge. With entire piston inserted in bore, piston should not bind against feeler gauge.

(4) Repeat steps (2) and (3) with long 0.002 inch feeler gauge. Piston should bind.

If piston binds on 0.0005 inch gauge, piston is too large

or bore is too small. If piston does not bind on 0.002 inch gauge, piston may be enlarged by knurling or shot-peening. Replace pistons that are 0.004 inch or more undersize.

Piston Pins

The piston pins are press-fit into the rods at 2000 pounds pressure and require no locking device. The piston pins for 304 and 360 CID engines are of the same diameter, while the piston pin for 401 CID engine is larger in diameter.

NOTE: *Two different tools are required to service piston pins: J-21872 is used on 304 and 360 CID engines and J-23194 is used on 401 CID engines.*

Removal

(1) Using Piston Pin Remover (J-21872 or J-23194) and an arbor press, place piston on remover Support (J-21872-1 or J-23194-1) (fig. 1B-41).

(2) Using Piloted Driver (J-21872-3 or J-23194-3), press pin completely out of piston. Note position of pin through gauge window of remover support.

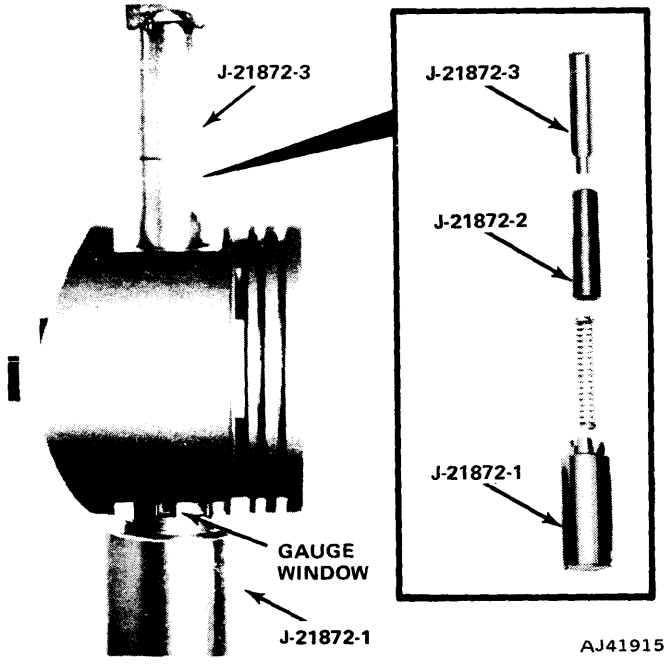

Fig. 1B-41 Piston Pin Removal and Installation

Pin Fitting

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

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

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

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

Installation

(1) Assemble piston and connecting rod so that piston notch will face forward and oil squirt hole will face inward when installed.

(2) Place Pin Pilot (J-21872-2 or J-23194-2) through piston and connecting rod pin bores (fig. 1B-41).

(3) Place Pin Pilot, piston, and connecting rod on Support (J-21872-1 or J-23194-1).

(4) Place piston pin through upper piston pin bore and into connecting rod pin bore (fig. 1B-41).

(5) Place Pilot Driver (J-21872-3 or J-23194-3) inside piston pin.

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

NOTE: *The piston is press-fit at 2000 pounds pressure. If little effort is required to install piston pin in connecting rod, or if rod moves along pin, a new connecting rod is required.*

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

Piston Rings

Both compression rings are made of cast iron while the oil control 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 cleared. Be careful not to remove metal from the grooves, or from the 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. Roll ring around groove in which it is to operate. It must fit freely at all points (fig. 1B-42). Side clearance between land and rings should be as listed in the Specifications.

(3) Place ring in bore. With an inverted piston, push ring down near lower end of ring travel area. Measure ring gap or joint clearance with feeler gauge fitted snugly in ring opening (fig. 1B-43). End clearance should be as listed in Specifications.

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. They are rolled into place (fig. 1B-44).

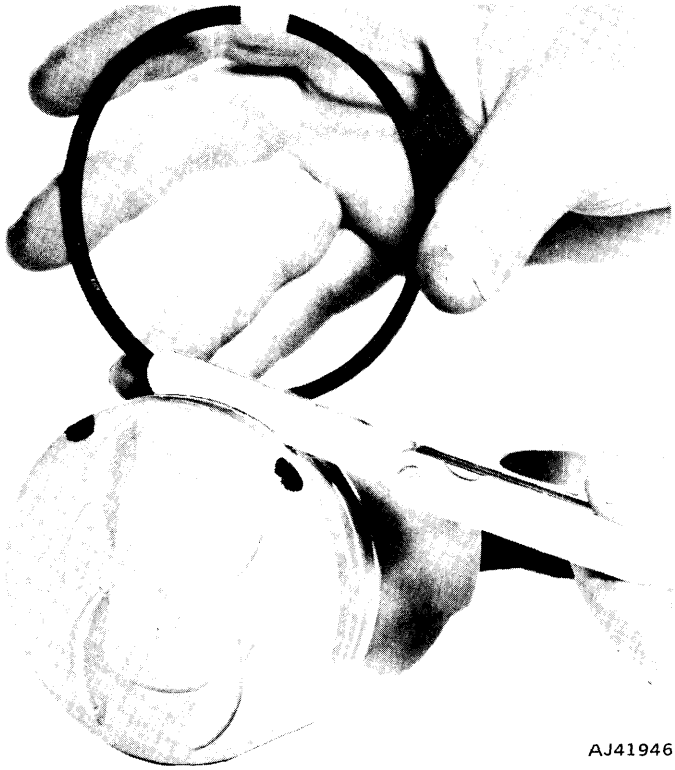

Fig. 1B-42 Ring Side Clearance Measurement

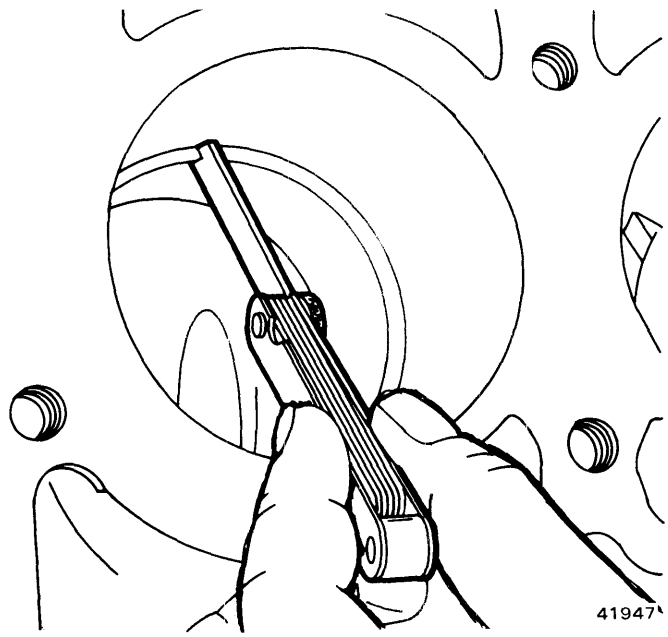

Fig. 1B-43 Ring Gap Measurement

(2) Install lower compression ring using ring installer to expand ring around piston.

NOTE: *Make certain upper and lower compression rings are not installed upside down. Figure 1B-45 shows typical ring markings to indicate the top side of the ring.*

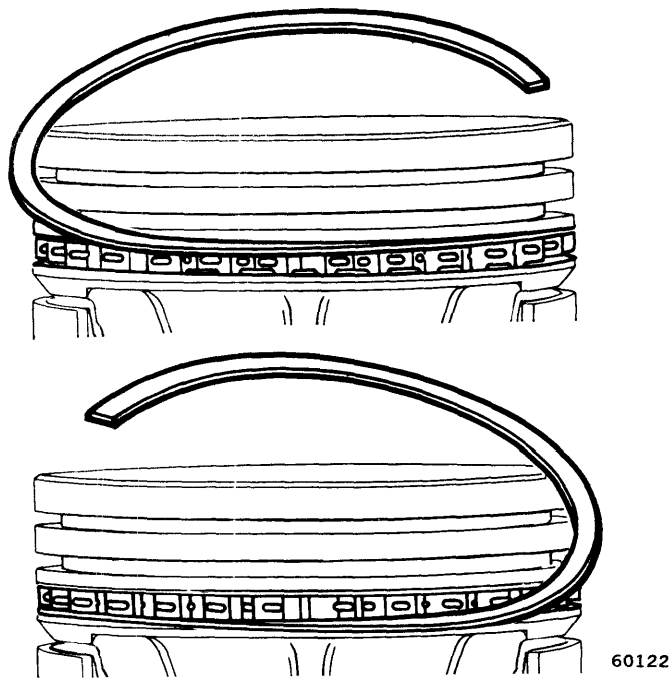

Fig. 1B-44 Installing Upper and Lower Rails

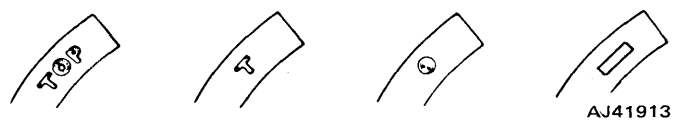

Fig. 1B-45 Typical Piston Ring Markings

(3) Install upper compression ring using ring installer to expand ring around piston (fig. 1B-46).

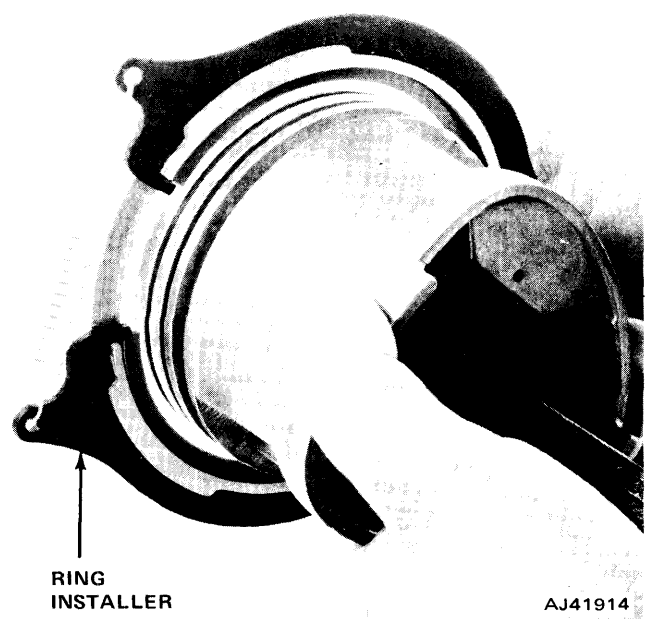

Fig. 1B-46 Compression Ring Installation

CRANKSHAFT

The crankshaft is counterweighted and balanced independently. The component parts of the crankshaft assembly are individually balanced, and then the complete assembly is balanced as a unit; therefore, service replacement dampers, crankshafts, flywheels, torque converters, and clutch components may be replaced without rebalancing the assembly.

There are five main bearings and four connecting rod journals. The end thrust is controlled by No. 3 main bearing.

The rear main bearing oil seal is protected from excessive oil by a slinger which is a machined part of the crankshaft.

NOTE: *On automatic transmission equipped engines, the torque converter and converter flexplate must be marked prior to removal and installed in this position upon assembly.*

Removal or Replacement

If the crankshaft is damaged beyond reconditioning, it must be replaced. Use the procedures outlined under Cylinder Block earlier in this section for removal and installation of the crankshaft.

Checking End Play

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

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

(2) Set dial indicator push rod on face of an adjacent counterweight (fig. 1B-47).

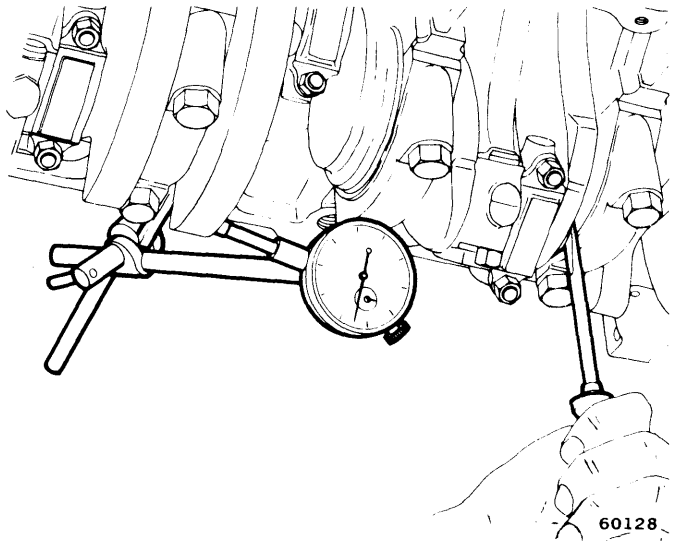

Fig. 1B-47 Crankshaft End Play Measurement

(3) Pry crankshaft fore and aft.

(4) Read dial indicator. End play is the difference of high and low readings.

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

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

Measuring Main Bearing Journal with Micrometer (Crankshaft Removed)

(1) Wipe main bearing journal clean.

(2) Using a micrometer, measure journal diameter at a number of points. Note difference between maximum and minimum diameters.

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

(4) Compare maximum reading obtained with journal diameters listed in bearing fitting chart.

(5) Select inserts required to obtain specified bearing clearance (0.0017 to 0.0020 inch desired on No. 1 through No. 4 main bearings and 0.0025 to 0.003 inch desired for the rear main bearing).

Crankshaft Main Bearings

The main bearing caps are numbered (front to rear) from 1 through 5, with an arrow to indicate forward position. The upper main bearing inserts are grooved while the lower insert surfaces are smooth for the 304-360 CID engines.

NOTE: *The 401 CID engine has a groove in both the upper and lower insert.*

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

NOTE: *Bearing size is stamped on production inserts.*

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. The paint mark for the rear main journal is on the crankshaft rear flange.

Use the Bearing Fitting Chart to select proper bearing inserts to obtain the specified bearing clearance (0.0017 to 0. 0020 inch desired on No. 1 through No. 4 main bearings and 0.0025 to 0.003 inch desired for the rear main bearing).

When required, different sized upper and lower bearing inserts may be used as a pair. A standard size upper

Main Bearing Fitting Chart (Inches)

Crankshaft Main Bearing Journal Color Code and Diameter in Inches (Journal Size)	Bearing Color Code	
	Upper Insert Size	Lower Insert Size
Yellow –2.7489 to 2.7484 (Standard)	Yellow – Standard	Yellow – Standard
Orange –2.7484 to 2.7479 (0.0005 Undersize)	Yellow – Standard	Black – .001-inch Undersize
Black –2.7479 to 2.7474 (0.001 Undersize)	Black – .001-inch Undersize	Black – .001-inch Undersize
Green –2.7474 to 2.7469 (0.0015 Undersize)	Black – .001-inch Undersize	Green – .002-inch Undersize
Red –2.7389 to 2.7384 (0.010 Undersize)	Red – .010-inch Undersize	Red – .010-inch Undersize

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insert may be used in combination with a 0.001-inch undersize lower insert to reduce clearance by 0.0005 inch (1/2 thousandth of an inch).

Example:

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

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NOTE: *When servicing upper and lower inserts of different sizes, install all same size inserts together either on the top (upper) or bottom (lower). Never use bearing inserts with greater than 0.001-inch difference in pairs.*

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

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

Removal and Inspection

This procedure may be used to check main bearings with engine in vehicle.

(1) Drain engine oil and remove pan.

(2) Remove main bearing cap and insert.

(3) Inspect bearing insert for abnormal wear or damage.

(4) If either condition exists, both upper and lower inserts must be replaced. (Refer to Measuring Bearing Clearance with Plastigage, as described later in this section, to select bearing inserts required to obtain specified bearing clearance.)

(5) Inspect crankshaft main journal. If damaged, either recondition or replace crankshaft.

(6) Remove upper insert by loosening all of the other bearing caps and inserting a cotter pin about 1/2-inch long in the crankshaft oil hole. Head of pin should be large enough so that it will not fall into oil hole, yet thinner than bearing (fig. 1B-48).

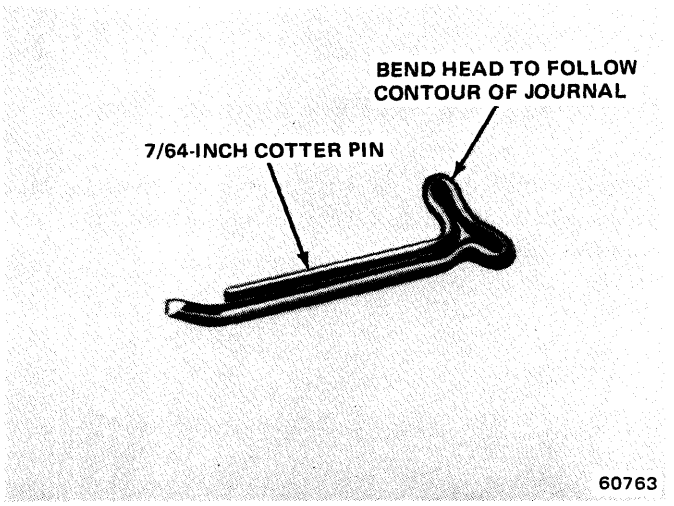

Fig. 1B-48 Upper Main Bearing Insert Removal Tool

(7) With pin in place, rotate shaft so that upper bearing insert will rotate in the direction of its locating tang.

(8) Remove and inspect remaining bearings in same manner (fig. 1B-49).

Measuring Main Bearing Clearance with Plastigage (Crankshaft Installed)

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

(1) Remove main bearing cap and insert.

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

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

(4) Install bearing cap and tighten retaining bolts to 100 foot-pounds torque.

(5) Remove bearing cap and determine amount of clearance by measuring width of compressed Plastigage with scale on Plastigage envelope (0.0017 to 0.0020 inch

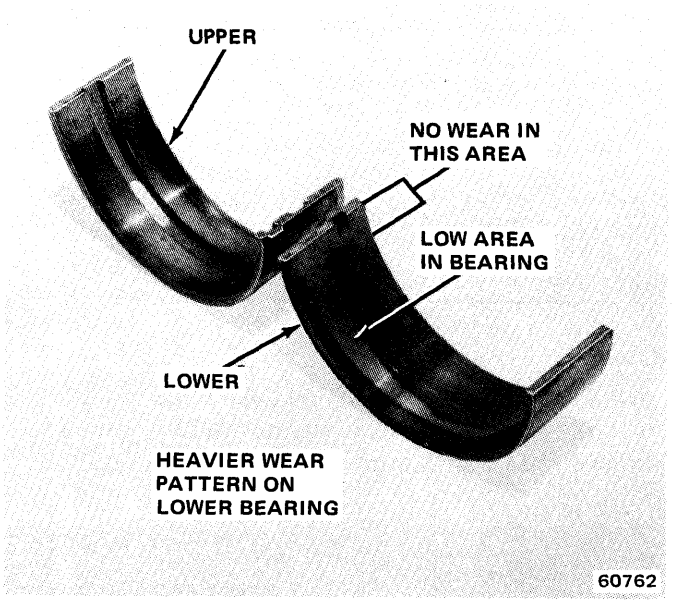

Fig. 1B-49 Normal Main Bearing Wear Pattern

clearance desired on No. 1 through No. 4 main bearings and 0.0025 to 0.003 inch desired for the rear main bearing) (fig. 1B-50).

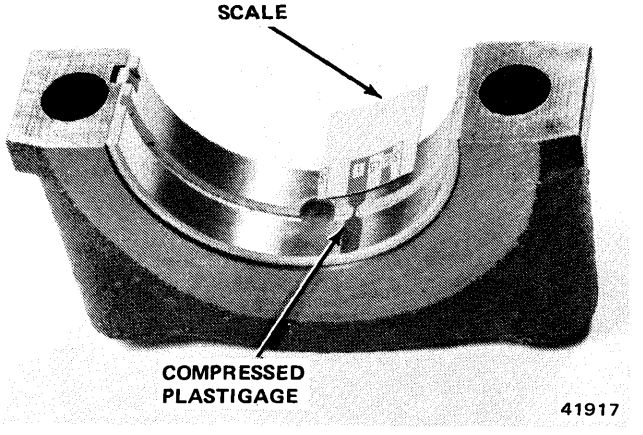

Fig. 1B-50 Main Bearing Clearance Measurement

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

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

(7) If oil clearance exceeds specification, install pair of 0.001-inch undersize bearing inserts and check clearance as described in steps (3) through (6).

(8) Clearance indicated with 0.001-inch undersize bearing installed will determine if 0.001-inch undersize inserts or some other combination will provide correct clearance. For example; if clearance was 0.0035 inch originally, a pair of 0.001-inch undersize inserts would reduce clearance by 0.001 inch. Oil clearance would be 0.0025 inch and within specification. A 0.002-inch undersixe insert half and a 0.001 inch undersize half woudl reduce this clearanc an addtional 0.0005 inch and oil clearance would be 0.002-inch.

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

(9) If oil clearance exceeds specification using 0.002 inch undersize bearings, measure crankshaft journal with micrometer. If the journal size is correct, the crankshaft bore of the cylinder block may be misaligned which requires cylinder block replacement. If journal size is incorrect, crankshaft must be replaced.

Measuring Main Bearing Journal with Micrometer (Crankshaft Removed)

(1) Wipe main bearing journal clean.

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

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

(4) Compare maximum reading obtained with journal diameters listed in bearing fitting chart.

(5) Select inserts required to obtain specified bearing clearance. Correct clearance is 0.0017 to 0.0020 inch on No. 1 through No. 4 main bearings and 0.0025 to 0.003 inch for rear main bearing.

Installation

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

(2) Loosen all main bearing caps.

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

(4) Install main bearing cap(s) and lower insert(s). Tighten retaining bolts evenly to 100 foot-pounds torque in steps of 30, 60, 90 and 100 foot-pounds torque increments, turning crankshaft at each step to determine if crank rotates freely. If crank does not rotate freely, check inserts for proper installation and size.

(5) After installation, turn crankshaft to check for free operation.

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

(7) Fill crankcase to specified level with new oil.

FLYWHEEL AND STARTER RING GEAR ASSEMBLY

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

Ring Gear Replacement—Manual Transmission (Flywheel Removed)

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

(2) Press flywheel through ring gear.

NOTE: *The 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 replacement ring gear onto flywheel.

NOTE: *On manual transmission, 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.*

SHORT ENGINE ASSEMBLY

A service replacement short engine assembly may be installed whenever the original engine block is damaged beyond repair. The short engine assembly consists of engine block, piston, and rod assemblies, crankshaft, camshaft, oil inlet tube and screen, timing gears, and chain. Whenever installing a short engine assembly, always install a new engine oil pump pickup tube and screen assembly.

NOTE: *Short engine assemblies include a replacement engine build date tag. Remove previous tag and attach replacement tag to right rocker arm cover.*

Transfer component parts from the original engine following procedures and clean and tighten as required.

V-8 Engine Specifications

Bore

304	3.75 inches
360	4.08 inches
401	4.165 inches

Stroke

304	3.44 inches
360	3.44 inches
401	3.68 inches

Displacement

304	304 cu. inches
360	360 cu. inches
401	401 cu. inches

Compression Ratio

304	8.40:1
360 (2V or 4V)	8.25:1
401	8.25:1

Compression Pressure

304	140 psi (min)
360 (2V or 4V)	140 psi (min)
401	140 psi (min)
Maximum Variation Between Cylinders	20 psi (min)

Taxable Horsepower

304	45.00
360	53.27
401	55.51

Torque

304	220 @ 2000 RPM
360	251 @ 1600 RPM
401	320 @ 2800 RPM

Camshaft

Fuel Pump Eccentric Diameter	2.182 inch to 2.192 inch
Tappet Clearance	Zero lash (hydraulic tappets)

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V-8 Engine Specifications (Continued)

Camshaft (Continued)

End Play ..... Zero (engine operating)
Bearing Clearance ..... 0.001 inch to 0.003 inch (0.0017-0.0020 inch preferred)

Bearing Journal Diameter

No. 1 ..... 2.1195 inch to 2.1205 inch
No. 2 ..... 2.0895 inch to 2.0905 inch
No. 3 ..... 2.0595 inch to 2.0605 inch
No. 4 ..... 2.0295 inch to 2.0305 inch
No. 5 ..... 1.9995 inch to 2.0005 inch
Base Circle Runout ..... 0.001 maximum

Cam Lobe Lift

304/360 ..... 0.266 inch
401 ..... 0.286 inch

Intake Valve Timing

Opens 304/360 ..... 14.75° BTDC
401 ..... 25.57° BTDC

Closes 304/360 ..... 68.75° BTDC
401 ..... 90.75° BTDC

Exhaust Valve Timing

Opens 304/360 ..... 56.75° BBDC
401 ..... 80.80° BBDC
Closes 304/360 ..... 26.75° ATDC
401 ..... 42.75° ATDC

Valve Overlap

304/360 ..... 41.50°
401 ..... 68.32°

Intake Duration

304/360 ..... 263.50°
401 ..... 296.32°

Exhaust Duration

304/360 ..... 263.50°
401 ..... 303.55°

Connecting Rods

Total Weight (Less Bearings)
304/360 ..... 681 to 689 grams
401 ..... 794 to 802 grams
Total Length (Center-to-Center)
304/360 ..... 5.873 inch to 5.877 inch
401 ..... 5.856 inch to 5.860 inch
Bearing Clearance ..... 0.001 inch to 0.003 inch (0.0020-0.0025 inch preferred)
Side Clearance ..... 0.006 inch to 0.018 inch
Maximum Twist ..... 0.0005 inch per inch
Maximum Bend ..... 0.001 inch per inch

Crankshaft

End Play ..... 0.003 inch to 0.008 inch
Main Bearing Journal Diameter
No. 1, 2, 3, 4 ..... 2.7474 inch to 2.7489 inch
Rear Main ..... 2.7464 inch to 2.7479 inch

Main Bearing Journal Width

304/360
No. 1 ..... 1.2635 inch to 1.2695 inch
No. 2 ..... 1.246 inch to 1.248 inch
No. 3 ..... 1.273 inch to 1.275 inch
No. 4 ..... 1.246 inch to 1.248 inch
No. 5 ..... 1.215 inch to 1.217 inch
401
No. 1 ..... 1.244 inch to 1.269 inch
No. 2 ..... 1.222 inch to 1.232 inch
No. 3 ..... 1.273 inch to 1.275 inch
No. 4 ..... 1.222 inch to 1.232 inch
No. 5 ..... 1.202 inch to 1.217 inch

Main Bearing Clearance

No. 1, 2, 3, 4 ..... 0.001 inch to 0.003 inch (0.0017-0.0020 inch preferred)

Rear Main

No. 5 ..... 0.002 inch to 0.003 inch (0.0025 inch preferred)

Connecting Rod Journal Diameter

304/360 ..... 2.0934 inch to 2.0955 inch
401 ..... 2.2464 inch to 2.2485 inch

Connecting Rod Journal Width

304/360 ..... 1.998 inch to 2.004 inch
401 ..... 1.846 inch to 1.852 inch

Connecting Rod Bearing

Clearance ..... 0.001 inch to 0.003 inch (0.0020-0.0025 inch preferred)
Maximum Taper (All Journals) ..... 0.0005 inch
Maximum Out-of-Round (All Journals) ..... 0.0005 inch

Cylinder Block

Deck Height ..... 9.205 inch to 9.211 inch

Deck Clearance

304/360 ..... 0.0145 inch (below block)
401 ..... 0.0045 inch (below block)
Maximum Cylinder Taper ..... 0.005 inch
Maximum Cylinder Out-of-Round ..... 0.003 inch
Tappet Bore Diameter ..... 0.9055 inch to 0.9065 inch
Cylinder Block Flatness ..... 0.001/1 inch; 0.002/6 inch; 0.008 inch maximum

V-8 Engine Specifications (Continued)

Cylinder Head

Combustion Chamber Volume
- 304 ..... 57.42 to 60.42 cc
- 360/401 ..... 58.62 to 61.62 cc

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

Lubrication System

Engine Oil Capacity ..... 4 quarts (add 1 quart with filter change)
Normal Operating Pressure ..... 13 psi at 600 rpm; 37 to 75 psi at 1600 rpm+
Oil Pressure Relief ..... 75 psi maximum
Gear-to-Body Clearance ..... 0.0005 inch to 0.0025 inch (0.0005 inch preferred)
Gear End Clearance
- Feeler Gauge Method ..... 0.004 inch to 0.008 inch (0.008 inch preferred)
- Plastigage Method ..... 0.002 inch to 0.006 inch (0.002 inch preferred)
- Gear Diameter ..... 1.526 inch to 1.578 inch
- Gear Length ..... 1.485 inch to 1.484 inch

Pistons

Weight (Less Pin)
- 304 ..... 506 to 510 grams
- 360 ..... 601 to 605 grams
- 401 ..... 590 to 594 grams

Piston Pin Bore CL - to Piston Top
- 304/360 ..... 1.599 inch to 1.603 inch
- 401 ..... 1.506 inch to 1.510 inch

Piston-to-Bore Clearance
- 304/401 ..... 0.0010 inch to 0.0018 inch (0.0014 inch preferred)
- 360 ..... 0.0012 inch to 0.0020 inch (0.0016 inch preferred)

Piston Ring Gap Clearance
- No. 1 and No. 2 ..... 0.010 inch to 0.020 inch (0.010-0.0012 inch preferred)

Oil Control Steel Rail
- 304 ..... 0.010 inch to 0.025 inch
- 360 ..... 0.015 inch to 0.045 inch
- 401 ..... 0.015 inch to 0.055 inch (0.010-0.020 inch preferred)

Piston Ring Side Clearance

304
- No. 1 ..... 0.0015 inch to 0.0035 inch (0.0015 inch preferred)
- No. 2 ..... 0.0015 inch to 0.003 inch (0.0015 inch preferred)
- Oil Control ..... 0.0011 inch to 0.008 inch

360/401
- No. 1 ..... 0.0015 inch to 0.003 inch (0.0015 inch preferred)
- No. 2 ..... 0.0015 inch to 0.0035 inch (0.0015 inch preferred)
- Oil Control ..... 0.000 inch to 0.007 inch

Piston Ring Groove Height
- No. 1 and No. 2 ..... 0.0795 inch to 0.0805 inch
- Oil Control ..... 0.1880 inch to 0.1895 inch

Piston Ring Groove Diameter

304
- No. 1 and No. 2 ..... 3.328 inch to 3.333 inch
- Oil Control ..... 3.329 inch to 3.339 inch

360
- No. 1 and No. 2 ..... 3.624 inch to 3.629 inch
- Oil Control ..... 3.624 inch to 3.635 inch

401
- No. 1 ..... 3.749 inch to 3.759 inch
- No. 2 ..... 3.715 inch to 3.725 inch
- Oil Control ..... 3.710 inch to 3.720 inch

Piston Pin Diameter
- 304/360 ..... 0.9308 inch to 0.9313 inch
- 401 ..... 1.0009 inch to 1.0012 inch

Piston Pin Bore Diameter
- 304/360 ..... 0.9288 inch to 0.9298 inch
- 401 ..... 0.9988 inch to 0.9998 inch

Piston-to-Pin Clearance ..... 0.0003 inch to 0.0005 inch (0.0005 inch preferred) loose

Rocker Arms, Push Rods, and Tappets

Rocker Arm Ratio 1.6:1
Push Rod Length ..... 7.790 inch to 7.810 inch
Push Rod Diameter ..... 0.312 inch to 0.315 inch
Hydraulic Tappet Diameter ..... 0.9040 inch to 0.9045 inch
Tappet-to-Bore Clearance ..... 0.001 inch to 0.0025 inch

Valves

Valve Length
- (Tip-to-Gauge Dim. Line) .... 4.7895 inch to 4.8045 inch

Valve Stem Diameter ..... 0.3715 inch to 0.3725 inch
Stem-to-Guide Clearance ..... 0.001 inch to 0.003 inch

V-8 Engine Specifications (Continued)

Intake Valve Head Diameter
304 ..... 1.782 inch to 1.792 inch
360/401 ..... 2.020 inch to 2.030 inch
Intake Valve Face Angle ..... 29°

Exhaust Valve Head Diameter
304 ..... 1.401 inch to 1.411 inch
360/401 ..... 1.675 inch to 1.685 inch

Exhaust Valve Face Angle ..... 44°

Valve Springs
Free Length ..... 2.200 inch

Spring Tension
Valve Closed ..... 80 to 88 pounds at 1-13/16 inch
Valve Open ..... 210 to 216 pounds at 1-23/64 inch
Inside Diameter (All) ..... 1.000 inch to 1.020 inch

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Torque Specifications

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

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

	Service Set-To Torque	Service In-Use Recheck Torque
Air Injection Tube-to-Manifold	38	30 to 45
Air Pump-to-Bracket Pivot Screw	20	15 to 22
Air Pump Brackets-to-Engine—AC 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 Bolt-to-Engine	28	23 to 30
Alternator Pivot Mounting Bolt-to-Head	33	30 to 35
Automatic Transmission-to-Block	28	22 to 38
Camshaft Gear Retainer Screw	30	25 to 35
Carburetor Adapter-to-Manifold Screws—2V	14	12 to 15
Carburetor Holddown Nuts	14	12 to 15
Clutch Housing Spacer-to-Block Screws	12	9 to 15
Clutch Housing-to-Block Screws	27	22 to 30
Connecting Rod Bolts Nuts	33 (304 & 360) 39 (401)	30 to 35 (304 & 360) 35 to 40 (401)
Crankshaft Pulley-to-Damper	23	18 to 28
Cylinder Head Capscrews	110	100 to 120
Cylinder Head Cover Screws	50 in-lb	42 to 58 in-lb
Distributor Clamp Screw	13	10 to 18
Drive Plate-to-Converter Screw	22	20 to 25
EGR Valve-to-Manifold	13	9 to 18
Exhaust Manifold Bolts	25	20 to 30
Exhaust Pipe-to-Manifold Nuts	20	15 to 25
Fan and Hub Assembly Bolts	18	12 to 25
Flywheel or Drive Plate-to-Crankshaft	105	95 to 120
Front Support Cushion Bracket-to-Block Screw	35	25 to 40
Front Support Cushion-to-Bracket	33	27 to 38
Front Support Cushion-to-Frame	33	27 to 37
Fuel Pump Screws	16	13 to 19
Idler Pulley Bearing Shaft-to-Bracket Nut	33	28 to 38
Idler Pulley Bracket-to-Front Cover Nut	7	4 to 9
Intake Manifold Screws	43	37 to 47
Main Bearing Capscrews	100	90 to 105
Oil Pump Cover Screws	55 in-lb	45 to 65 in-lb
Oil Pan Screws		
1/4 Inch - 20	7	5 to 9
5/16 Inch - 18	11	9 to 13
Oil Relief Valve Cap	28	22 to 35
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
Rear Insulator Bracket-to-Trans. Bolt	33	27 to 38
Rear Support Insulator-to-Bracket Nut	48	40 to 55
Rear Support Cushion-to-Crossmember Screw Nut	18	12 to 25
Rocker Arm Capscrew	19	16 to 26
Spark Plugs	28	22 to 33
Starter Motor to Bell Housing Screws	18	13 to 25
Thermostat Housing Screw	13	10 to 18
Throttle Valve Rod Adjusting Screw	40 in-lb	30 to 50 in-lb
Timing Case Cover-to-Block	25	18 to 33
Vibration Damper Screw	90	80 to 100
Water Pump Screws	48 in-lb	40 to 55 in-lb

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.

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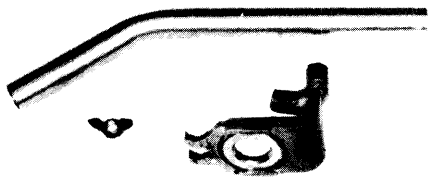
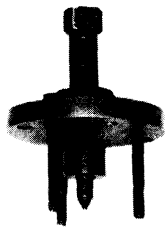
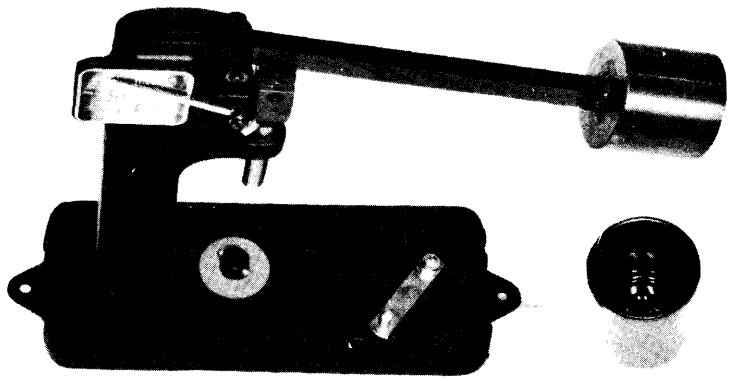
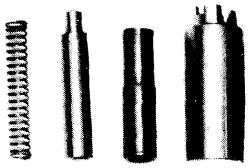


J–22534-1
VALVE SPRING
REMOVER AND
INSTALLER



J–21791
VIBRATION DAMPER
REMOVER

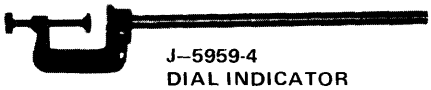




J–21872 – 304-360 CID (SHOWN)
J–23194 – 401 CID
PISTON PIN REMOVER AND INSTALLER

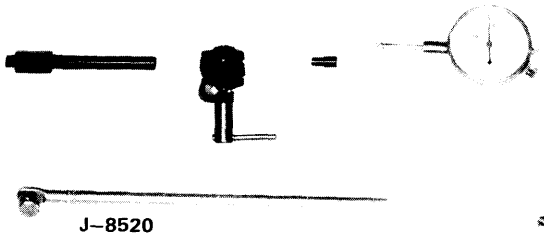
J–26562
TIMING CASE COVER
OIL SEAL INSTALLER

J–5790
HYDRAULIC VALVE
LIFTER TESTER

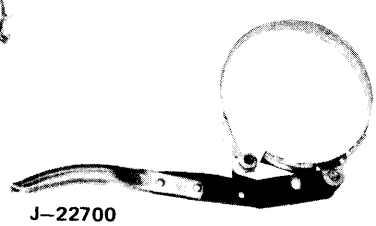


J–5959-4
DIAL INDICATOR
CLAMP AND ROD

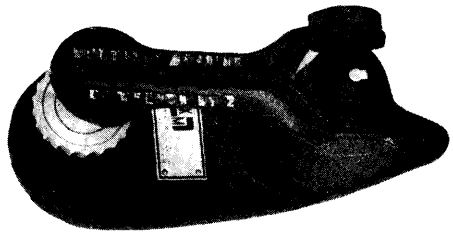
J–6042-1, 4, 5
VALVE GUIDE REAMERS



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



J–22700
OIL FILTER WRENCH



J–8056
VALVE AND CLUTCH
SPRING TESTER

AJ41951

Special Tools

TECHNICAL BULLETIN REFERENCE

Date	TB No.	Subject	Changes Information on Page No.