SIX CYLINDER ENGINE
232-258 Cubic Inch Displacement

ENGINE ASSEMBLY

Description

The 232 and 258 CID six cylinder engines incorporate an overhead valve system in which the rocker arms operate on a common shaft.

The cylinders are numbered from front to rear with a firing order of 1-5-3-6-2-4. The crankshaft rotates in a counterclockwise direction, viewed from the rear of the engine.

Seven two-piece main bearings are used to support the crankshaft and the camshaft is supported by four one-piece line bored bearings.

Identification

The Engine Code is located on a machined surface of the block between number two and three cylinders.

The letter contained in the code identifies the engine by cubic inch displacement, carburetor type and compression ratio.

The letters used are coded as follows:

Code	CID	Carb.	Comp. Ratio
A (Standard)	258	IV	8. 0: 1
B (Optional)	258	IV	7. 6: 1
E (Standard)	232	IV	8. 0: 1
F (Optional)	232	IV	7. 5: 1

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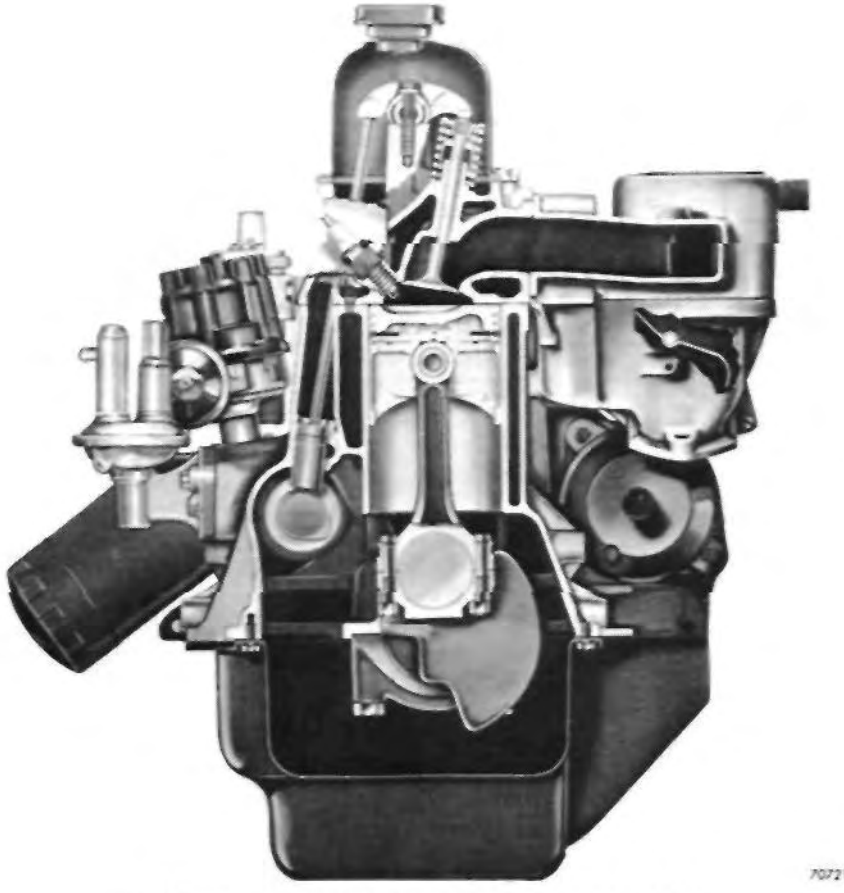

SECTIONAL VIEW OF ENGINE ASSEMBLY

FIGURE 1 - Engine Code Typical Location

All engines built for sale in California are painted "red. " All other engines are painted "blue. "

In the machining of cylinder blocks and crankshafts, it is sometimes necessary to machine the cylinder bores to . 010" oversize, and the crankshaft main bearing journals or crank pins to . 010" undersize.

These engines are marked with a single or two letter code (Fig. 2).

The code is located on a boss directly above the oil filter.

The letters used are coded as fol-

FIGURE 2 — Engine Letter Code

lOWS:

Single letter.. "B". . . . . Cylinder bore —. 010" Oversize

Single letter.. "M". . . . . Main bearings —. 010" Undersize

Single letter.. "P". . . . Connecting rod bearings —. 010" Undersize

Double letters.. "PM". . . . . Main and connecting rod bearings — . 010" Undersize

Single letter.. "C". . . . Camshaft block bores -. 010" Oversize

DIAGNOSIS GUIDE

Conditions and Probable Causes

Cannot Crank Engine

Electrical System
Trace circuits for faulty electrical units.

Coolant Leak into Cylinder
Remove spark plugs to check for coolant in cylinders. Crank with plugs removed. Cylinder heads must be removed to check gaskets, block, and head for a source of coolant leak. If permanent anti-freeze entered engine, complete disassembly will have to be accomplished.

Mechanical Seizure
Recondition.

Engine Will Crank Normally but Will Not Start

Ignition System
Check spark plugs and secondary circuit energy available at spark plugs.

Fuel System
air horn for choke condition. If water is present, clean out and substitute with a supply of new fuel.

Ignition or Valve Timing
Check ignition and valve timing.

Engine Starts and Runs for Short Periods Only

Fuel System
Check fuel pump and fuel lines from fuel tank for intermittent or constant restricting material or defect.

Ignition System
Check for leaky condenser and coil secondary. Check for faulty distributor contacts, ignition switch, and all connecting wires including battery connections.

Induction System
Check air leaks which may be too severe after choke enrichment is reduced.

Exhaust System
Check exhaust system for restrictions.

Engine Runs but Mis-fires at Low Speed Only

Fuel System
Check for dirty passages and jets in

the idle circuit.

Ignition System
Check spark plug heat range and gap.

Induction System
Check for intake manifold air leaks. Check for air leaks from units connected to intake manifold.

Valves
Check for poor valve seating.

Engine Runs but Misses at All Speeds

Fuel System
Dirt in carburetor or water in the fuel system.

Ignition System
Spark plugs, wiring, capacitor, coil, and ignition system wiring. Ignition switch.

Valves
Poor valve seating — sticking valves.

Cooling System
Coolant leak into intake sections or cylinders.

Camshaft
Worn lobes on camshaft.

Engine Rough Running at Low Speeds

Ignition System
Spark plug gap and heat range. Secondary system wiring. Distributor points or capacitor.

Fuel System
Idle circuits dirty. Choke sticking. Air leak below carburetor. Idle mixture adjustment.

Cooling System
Coolant system leaks into intake valve ports or cylinder.

Valves
Poor valve seating.

Exhaust System
Exhaust leaks into intake passages. Exhaust back pressure.

Engine Power Not Up to Normal

Valves
Valves not seating properly. Not timed properly.

Rings
Rings worn, broken, not seating.

Fuel System
Air cleaner restricted. Power mixture not proper.

Ignition System
Coil capacity, polarity, and distributor point spacing. Ignition timing.

Exhaust System
Restriction causing back pressure.

Cooling System
Thermostat not permitting proper operating temperature.

Engine Resistance
Bearing and piston ring and piston **fit** for oil clearance.

Rolling Resistance of Vehicle
Brakes dragging. Soft tires. Wheel alignment. Wheel bearings. Clutch or transmission slippage.

Engine Rough Running at Higher Speeds

Ignition System
Spark plug gap and heat range. Ignition timing. Distributor centrifugal and vacuum advance units. Coil polarity.

Fuel System
Improper fuel mixtures.

Fuel Induction System
Severe air leaks into intake system.

Valves and Camshaft
Sticky valves. Incorrect valve lift.

Engine will not Respond to Fast Positive Opening of Throttle

Fuel System
Carburetor accelerating circuits. Improper fuel. Throttle linkage. Restrictions and dirty air cleaner. Carbon build-up on floor of intake manifold.

Ignition System
Coil capacity and polarity, spark plug condition, gap, and heat range. Ignition timing. Distributor condition.

Exhaust System
Back pressure and leakage into the intake system.

Mounting

Resilient rubber mounting cushions support the engine and transmission at three points. A cushion is located at each side on the center line of the engine, (Fig. 3), with the rear supported by a cushion between the transmission extension housing and the rear support crossmember. Removal or replacement of any cushion may be accomplished by supporting the weight of the engine or transmission at the area of the cushion.

Removal

The engine is removed without the transmission and bell housing.

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

Remove the air cleaner assembly and drain the cooling system.

Disconnect the upper and lower radiator hoses. If equipped with automatic transmission, disconnect the cooler lines from the radiator.

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

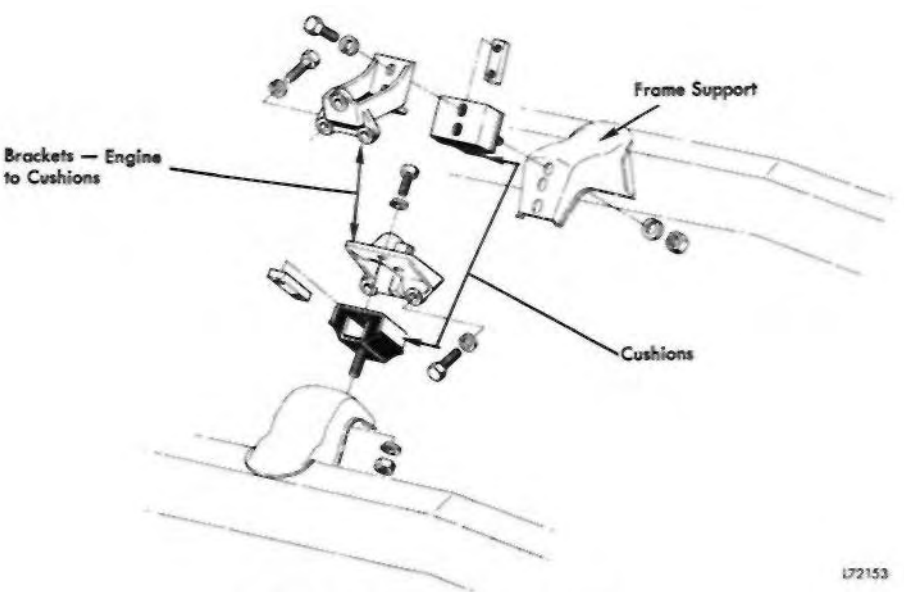

FIGURE 3 — Engine — Front Mounts

Remove the radiator.

Remove the engine fan.

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

If equipped with air conditioning, turn both service valves clockwise to the front seated position.

Bleed the compressor refrigerant charge by slowly loosening the service valve fittings. Disconnect the condenser and evaporator lines from the compressor. Disconnect the receiver outlet at the disconnect coupling. Remove the condenser and receiver assembly.

Disconnect all wires, lines, linkage and hoses which are connected to the engine.

Remove the oil filter.

Remove both engine front support cushion to frame retaining nuts.

Disconnect the exhaust pipe at the support bracket and exhaust manifold.

Support the weight of the engine with a lifting device.

Remove the front support cushion and bracket assemblies from the engine.

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

Remove the upper bolts securing the transmission bell housing to the engine adapter plate on vehicles equipped with automatic transmission. If equipped with manual transmission, remove the upper bolts securing the clutch housing to the engine.

Remove the starter motor.

If equipped with automatic transmission, remove the two (2) engine adapter plate inspection covers. Mark the assembled position of the converter and flex plate and remove the converter to flex plate cap screws. Remove the remaining bolts securing the transmission bell housing to the engine adapter plate.

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

Support the transmission with a floor jack.

Remove the engine by pulling forward and upward.

Installation

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

Install the transmission bell housing to engine adapter plate bolts (automatic transmission) or the clutch housing to engine bolts (manual transmission). Tighten the bolts to the specified torque. Remove the floor jack which was used to support the transmission.

If equipped with automatic transmission, align the marks previously made on the converter and flex plate, install the converter to flex plate cap screws and tighten to the specified torque.

Install the two (2) engine adapter plate inspection covers (automatic transmission) or the clutch housing lower cover (manual transmission).

Install the starter motor.

Install the front support cushion and bracket assemblies to the engine, tighten the retaining bolts to the specified torque.

Lower the engine onto the frame supports, remove the lifting device and install the front support cushion retaining nuts. Tighten the nuts to the specified torque.

Connect the exhaust pipe at the support bracket and exhaust manifold using a new seal, if required.

Install the oil filter.

Connect all wires, lines, linkage and hoses which were previously disconnected from the engine.

If removed, install the air conditioning condenser and receiver assembly. Connect the receiver outlet to the disconnect coupling. Connect the condenser and evaporator lines to the compressor. Purge the compressor of air as outlined in the "AIR CONDITIONING" section.

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

If removed, install the power steering pump and drive belt, tighten the belt to the specified tension.

Install the engine fan and tighten the retaining bolts to the specified torque.

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

Fill the cooling system to the specified level. Inspect the engine oil level and add oil as required.

Install the air cleaner assembly.

Start the engine. Check all hose connections for leaks. Stop the engine.

If removed, install and align the hood assembly.

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

LUBRICATION SYSTEM

A full pressure type lubrication system is used, except for the piston pins, which are lubricated through the connecting rod squirt holes and oil throw-off.

Pressure is applied by a gear type, positive pressure pump mounted on a boss adjacent to the number four main bearing location.

Lubrication Circuit

Oil, drawn through the inlet screen and tube to the inlet side of the oil pump, is driven between the gears and pump body to the pressure outlet portion of the oi' pump where it is routed through an oil gallery to the inlet side of the full flow oil filter; and on into the main oil gallery (Fig. 4).

Each main bearing and camshaft bearing is lubricated by oil from the main oil gallery.

Holes drilled in each connecting rod journal direct lubrication to the connecting rod bearings. Oil throw-off from each connecting rod bearing lubricates the cylinder walls and piston pins.

A small channel (squirt hole) located on the numbered side of the connecting rods and caps allows oil to lubricate the camshaft lobes, tappets, piston pins and distributor drive gear.

The hydraulic valve tappets are fed directly from the main oil gallery.

Lubrication is supplied to the timing chain and gears from the front camshaft bearing and returned to the crankcase through a cavity under the front main bearing cap.

The oil supply for the rocker arms and push rods is obtained from the number three cam bearing location,

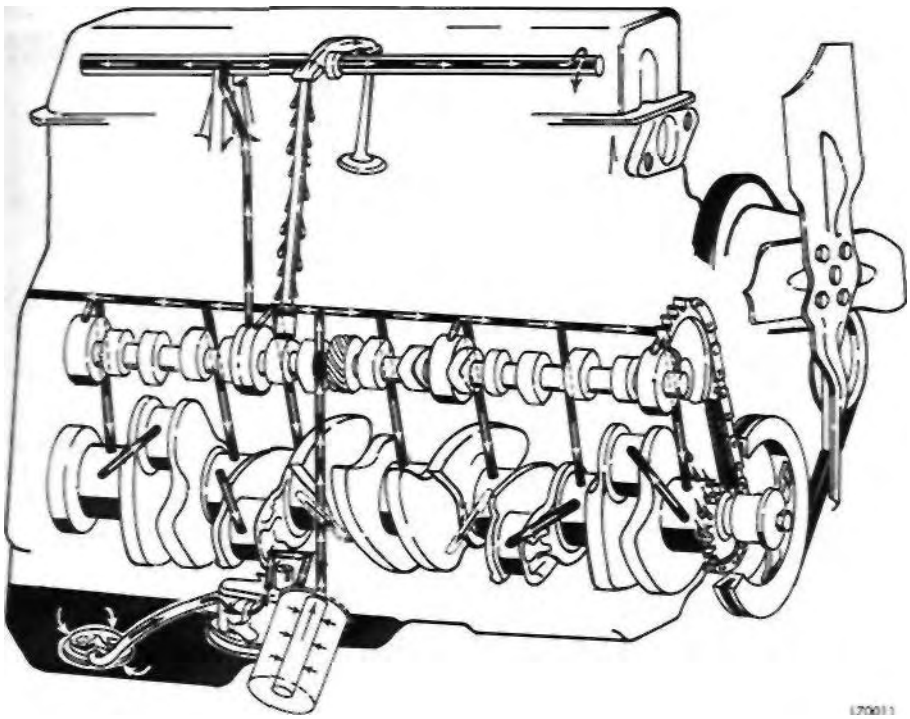

FIGURE 4 — Lubrication Circuit

where oil from the main lubrication gallery is metered through a groove in the camshaft bearing surface to a gallery extending upwards to the cylinder head gasket surface. At this point, the cylinder head gasket forms a seal joining the cylinder block gallery with the adjoining gallery in the cylinder head. Commencing at the number five rocker arm support, the oil then flows into the rocker arm shaft to supply lubrication to the rocker arm and push rods.

Holes cast in the cylinder head return the oil to the crankcase through the valve tappet area, which in turn lubricates the tappets.

Oil Filter

A full flow oil filter, mounted on the lower right hand side of the engine, is accessible through the hood opening. A by-pass valve, incorporated in the filter mounting boss, provides a safety factor in the event the filter becomes inoperative as a result of dirt or sludge accumulation. (Fig. 5.)

Oil Filter Removal Tool J-22700 will facilitate removal of the oil filter.

Apply a thin film of oil to the new filter gasket before installation.

Install filter until gasket contacts the seat of the adapter. Then tighten securely, by hand only.

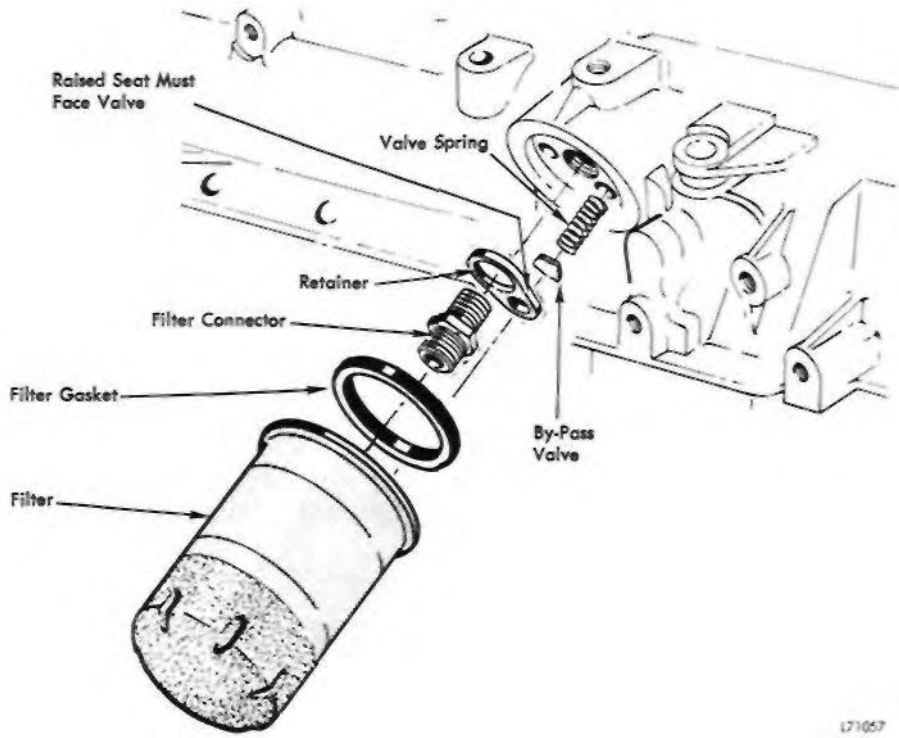

FIGURE 5 - Oil Filter Assembly

Operate engine at fast idle and check for leaks.

Oil Pump

A positive displacement gear type oil pump is used and is driven by the distributor shaft, which in turn is driven by a gear on the camshaft. The pump incorporates a pressure relief valve to regulate maximum pressure. Crankcase oil enters the pump through a pick-up tube and screen assembly which is a press fit in the pump body (Fig. 6).

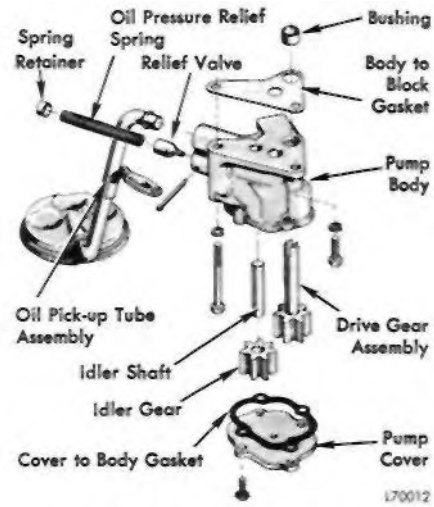

FIGURE 6 — Oil Pump Components

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 relief position, the valve permits oil to by-pass through a passage in the pump body to the inlet side of the pump.

The oil pump pick-up tube and screen assembly is a press fit in the oil pump body.

CAUTION: Do not *disturb the position of the tube assembly in the pump body unless absolutely necessary.*

In the event the tube is disturbed, it must be replaced with a new tube assembly.

POSITIVE CRANKCASE VENTILATION

This system prevents crankcase vapors from entering the atmosphere.

During periods of relatively high manifold vacuum, such as idle or cruise speeds, crankcase vapors are drawn through the cylinder head cover and PCV valve into the intake manifold where they are burned with the fuel-air mixture.

At this time, fresh air passing through the inlet filter in the connecting hose between the air cleaner and cylinder head cover, is routed through the cylinder head cover to the crankcase **(Fig. 7).**

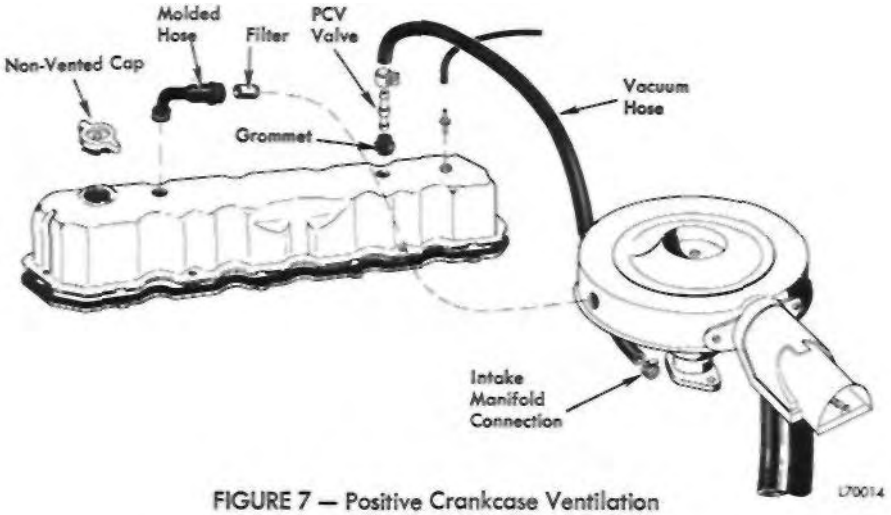

FIGURE 7 — Positive Crankcase Ventilation

During periods of low manifold vacuum, such as heavy acceleration, the flow is reversed.

Crankcase vapors are then drawn into the connecting hose between the air cleaner and cylinder head cover and through the air cleaner element to the intake manifold to be burned along with the fuel-air mixture.

The system will work effectively as long as all component parts are free from sludge and foreign material.

The oil filler cap, which is non-vented, requires no service. The air inlet filter and the PCV valve require service at periodic mileage intervals. The connecting hoses should be cleaned or replaced whenever necessary.

Air Inlet Filter

The wire gauze air inlet filter is located within the air cleaner end of the moulded rubber hose which is connected between the air cleaner and cylinder head cover. It must be cleaned in kerosene at the mileage intervals recommended in the "Mechanical Maintenance Schedule. "

NOTE: The air inlet filter must be removed from inside the carburetor air cleaner hose prior to removing the hose. The molded end of the air inlet hose will be damaged if the hose is pried out with the filter in place (Fig. 8).

PCV Valve

The PCV valve is located in a rubber grommet toward the rear of the cylinder head cover and is connected to a hose through which manifold vacuum is routed from a fitting at the intake manifold.

During periods of relatively low manifold vacuum, such as high speed or heavy acceleration, the valve provides an increased air flow to vent the high vapor pressure which develops in the crankcase.

FIGURE 8 — Removing Air Inlet Filter

During periods of relatively high manifold vacuum, such as during idle, the valve provides a reduced air flow since crankcase vapor pressure is low at this time and requires little venting. The reduced air flow also assures a smooth idle (Fig. 9).

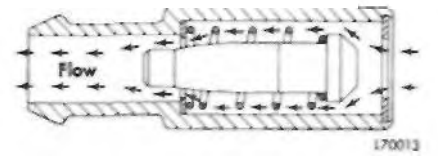

FIGURE 9 — Positive Crankcase Ventilation Flow-Valve

The PCV valve must be replaced at the mileage intervals recommended in the "Mechanical Maintenance Schedule. " It should be cleaned and tested at more frequent mileage intervals when driving under adverse conditions.

A cleaned or replacement PCV valve should always be tested with PCV Valve Tester J-23111 to determine correct air flow rate (Refer to the "Emission Control" section for a complete test procedure).

CYLINDER HEAD COVER AND GASKET

Removal

Remove the air cleaner and the PCV moulded hose.

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

Disconnect all other hoses or lines attached to the cylinder head cover.

Remove the retaining screws and

separate the cylinder head cover and gasket from the engine.

Installation

Place the gasket on the cylinder head cover flange making certain the gasket tabs are positioned in the cut out openings of the cover.

Position the cylinder head cover and gasket on the engine. Install the retaining screws and tighten to the specified torque.

Connect the fuel and distributor vacuum advance lines to the carburetor.

Connect all other hoses or lines which were previously disconnected from the cylinder head cover.

Install the air cleaner and connect the PCV moulded hose.

ROCKER ARM AND SHAFT ASSEMBLY

Removal and Disassembly

Remove the cylinder head cover and gasket.

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

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

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

Cleaning and Inspection

Clean all parts with a good cleaning solvent while retaining the order in which they were removed from the rocker arm shaft. Use compressed air to clean out the oil passages in the rocker arms and shaft.

Inspect each rocker arm mounting surface and the rocker arm shaft at each rocker arm location. If the shaft or any rocker arms are excessively scored or worn, they should be replaced. If the shaft is plugged by sludge which cannot be removed by cleaning, it should be replaced.

IMPORTANT: Always check for adequate *oil supply through the oil passage at number five (numbered from front to rear) rocker arm support whenever the rocker arms or shaft are worn due to oil starvation.*

Inspect the push rod contact surface of each rocker arm. Replace the rocker arm as well as the mating push rod if excessively worn.

Inspect the valve stem contact surface of each rocker arm.

Reface the contact surface if minor pitting has occurred. Replace the rocker arm if it is deeply pitted.

Assembly and Installation

Assemble the rocker arms, spacers, retainers, retaining bolts and oil deflector on the rocker arm shaft in the same order as removed. If the correct order is not known, refer to the disassembled view in Figure 10.

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

Use two rubber bands to hold the rocker arms in position as shown in Figure 11 and install the rocker arm and shaft assembly to the cylinder head. Make certain the push rods are correctly aligned with the rocker arms before tightening the retaining bolts.

Work from the center of the rocker arm shaft outward and tighten the retaining bolts evenly until the specified torque is obtained.

Install the cylinder head cover and gasket.

VALVE SPRING AND/OR VALVE STEM OIL DEFLECTOR

Rubber 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. The oil deflectors should be replaced whenever valve service is performed or if the rubber has become hard and brittle.

The valve spring is held in place on the valve stem by a retainer and a set of valve locks. The locks can be removed only by compressing the valve spring. Whenever valve springs are removed, they should be tested for correct tension and replaced if not within specifications.

Valve springs and oil deflectors can be removed without removing the cyl-

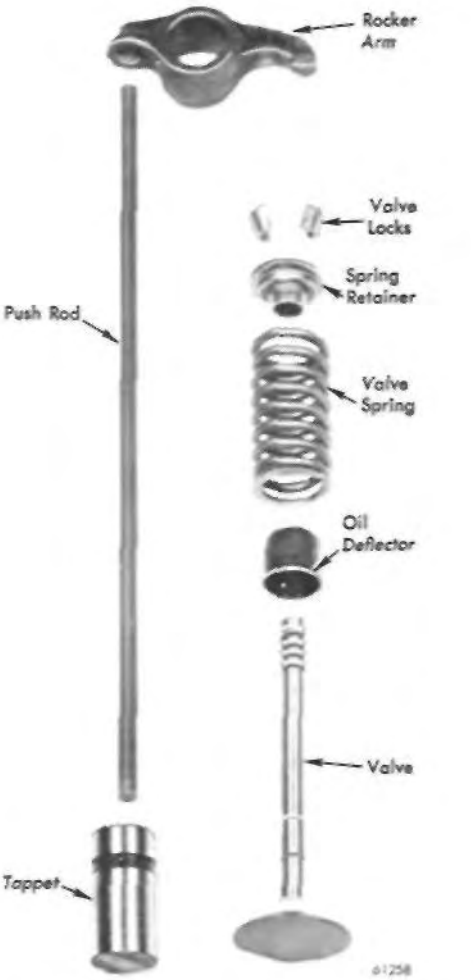

FIGURE 12 — Valve, Push Rod, and Tappet Assembly Sequence

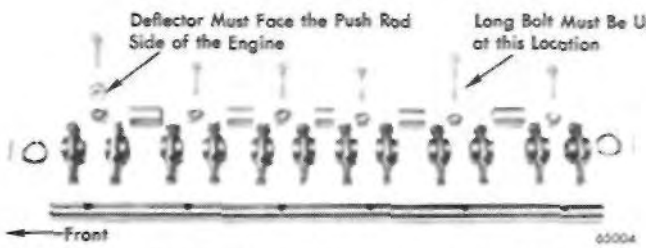

FIGURE 10 — Rocker Arm and Shaft Assembly — Disassembled View

FIGURE 11 — Holding Rocker Arms During Installation

inder head. Refer to "Cylinder Head Reconditioning" for removal procedure with the cylinder head removed.

Removal and Testing

Remove the cylinder head cover and gasket.

Remove the rocker arm and shaft assembly and the push rods.

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

Remove the spark plug from the cylinder which requires valve spring or oil deflector removal and install a 14 mm. thread size air adapter in the spark plug hole.

NOTE: The adapter can be made from the body of a spark plug from which the porcelain has been removed and an air hose connection fastened to the body of the spark plug.

Connect an air hose to the adapter and maintain at least 90 PSI in the cylinder to hold the valves against their seats.

Use Valve Spring Remover and Installer Tool J-21931 to compress the valve spring and allow removal of the valve locks (Fig. **13).**

FIGURE 13 — Valve Spring Removal

CAUTION: Do *not compress the valve springs more than required to remove the valve locks, as the oil deflectors may be damaged-*

Remove the valve spring and retainer from the cylinder head. Remove the oil deflector if replacement is required.

Use Valve Spring Tester C-647 to test each removed valve spring for the specified tension values (Fig. 14). Replace all valve springs which are not within specifications.

FIGURE 14 — Valve Spring Tester C-647

Installation

If removed, install the oil deflector on the valve stem.

IMPORTANT: The valve springs must be installed with the close coiled end facing the cylinder head.

Install the valve spring and retainer. Compress the valve spring with Valve Spring Remover and Installer Tool J-21931 and insert the valve locks. Release the spring tension and remove the tool. Tap the valve spring from side to side with a light hammer to be certain the spring is seated properly at the cylinder head.

Disconnect the air hose and remove the air adapter from the spark plug hole. Install the spark plug.

Install the rocker arm and shaft assembly.

Install the cylinder head cover and gasket.

INTAKE AND EXHAUST MANIFOLDS

The intake and exhaust manifolds are mounted externally on the left side of the engine and attached to the cylinder head. A gasket is used between the intake manifold and the cylinder head, none is required for the exhaust manifold to cylinder head. An asbestos gasket is used at the mating surfaces of the intake manifold to exhaust manifold and also between the exhaust manifold and exhaust pipe.

Removal and Cleaning

Remove the air cleaner and carburetor.

Disconnect the accelerator cable from the accelerator bellcrank.

Disconnect the PCV vacuum hose from the intake manifold.

Disconnect the distributor vacuum hose and electrical wires at the TCS solenoid vacuum valve.

If equipped with air conditioning, disconnect the compressor and bracket assembly from the intake manifold.

Disconnect the exhaust pipe from the manifold flange.

Remove the manifold attaching bolts, nuts and clamps; separate the intake and exhaust manifold from the engine as an assembly. Discard the gasket.

If either manifold is to be replaced, separate the manifolds at the riser area.

Clean the mating surfaces of the manifolds and the cylinder head.

Installation

If separated, assemble the two manifolds and finger tighten the retaining nuts.

Position a new intake manifold gasket on the cylinder head and install the manifold assembly. Tighten the manifold attaching bolts and nuts in the sequence shown in Figure 15. Torque to specifications.

Install the flange gasket and connect the exhaust pipe to the exhaust manifold flange.

Install the carburetor.

If removed, install the air conditioning compressor and bracket assembly to the intake manifold. Install the drive belt and tighten to the specified tension.

Connect the distributor vacuum hose and electrical wires to the TCS solenoid vacuum valve.

Connect the accelerator cable and PCV hose.

Install the air cleaner.

CYLINDER HEAD AND GASKET

Removal

Drain the cooling system and disconnect the hoses at the thermostat

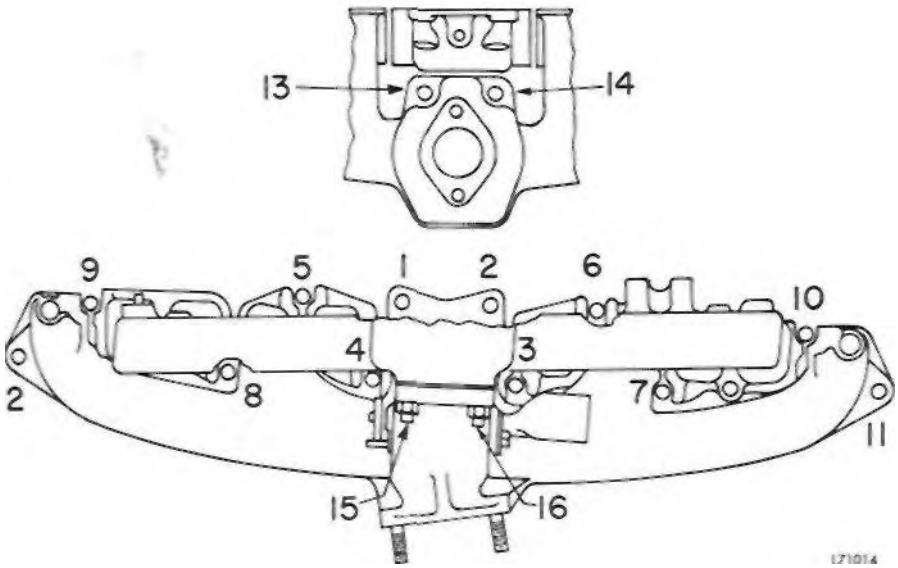

FIGURE 15 — Intake Manifold Torque Sequence

housing.

Remove the cylinder head cover and gasket, rocker arm and shaft assembly, and the push rods.

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

Separate the intake and exhaust manifold assembly from the cylinder head.

Disconnect the spark plug wires and remove the spark plugs.

Disconnect the temperature sending unit wire, ignition coil and bracket assembly from the cylinder head.

Remove the cylinder head bolts and separate the cylinder head and gasket from the block.

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 straight edge and feeler gauge to check the flatness of the cylinder head and block mating surfaces. Out of flatness must not exceed . 001" over a 1" length,. 003" over a 6" length and. 008" over the entire length.

Installation

If the cylinder head is to be replaced and the original valves re-used, remove the valves and measure the stem diameter. Replace the valves if they are oversize as only standard size valves are to be used with a service replacement head. If the original valves are standard size, remove all carbon buildup and reface the valves as outlined under "Valve Refacing. " Install the valves in the cylinder head using new valve stem oil deflectors. Transfer all attached components from the original head which are not included with the replacement head.

Apply an even coat of "Perfect Seal" sealing compound, or equivalent, to both sides of the new head gasket and position the gasket on the block with the stamped word "TOP" facing upward.

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

Install the cylinder head and bolts to the block. Tighten the bolts to the specified torque following the sequence shown in Figure 16.

Connect the temperature sending unit wire.

Install the ignition coil and bracket assembly.

Install the spark plugs and connect the spark plug wires.

Install the intake and exhaust manifold assembly to the cylinder head. Refer to "Intake and Exhaust Manifold Installation" for the correct torque tightening sequence.

Install the push rods in the order removed.

Install the rocker arm and shaft assembly, tighten the retaining bolts to the specified torque and install the cylinder head cover and gasket.

Connect the hoses to the thermostat housing and fill the cooling system to the specified level.

CYLINDER HEAD RECONDITIONING

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

Disassembly

Compress each valve spring with a " C " clamp type spring compressor tool and remove the valve locks, retainers, springs and valve stem oil deflectors.

Remove the valves one at a time and place them in a rack in the same

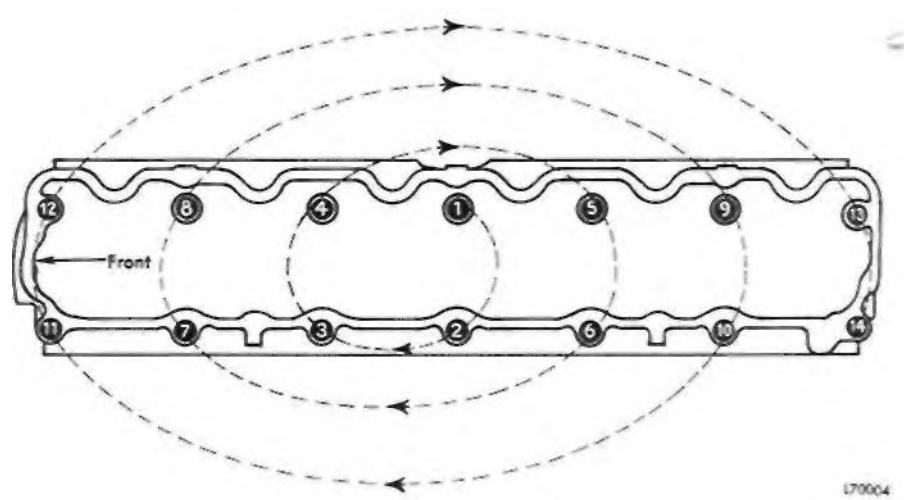

FIGURE 16 — Torque Tightening Sequence Chart

order as they were in the cylinder head.

Cleaning and Inspection

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

Clean all dirt and gasket cement from the cylinder head gasket surface.

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

Inspect for burned or cracked valve heads. Inspect for damaged valve stems.

Valve Refacing

Use a valve re-facing machine to reface the intake and exhaust valves to the specified angle. Replace any valve which is bent or warped. After refacing, at least $^{1}/_{32}$" margin must remain or the valve must be replaced. Examples of correct and incorrect valve refacing are shown in Figure 17.

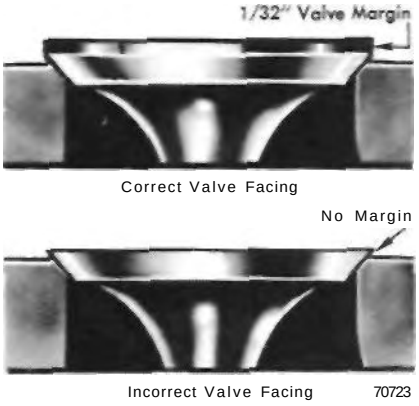

FIGURE 17-Valve Refacing

The valve stem tip can be resurfaced and rechamfered when worn. However, never remove more than. 010".

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.

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

Control seat run-out to a maximum of. 0025" (Fig. 18).

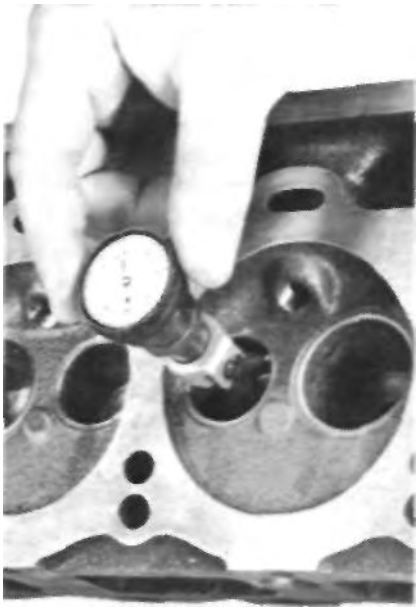

FIGURE 18 - Checking Valve Seat Runout

Valve Stem to Guide Clearance

Valve stem to guide clearance may be checked by two methods.

One method is to measure the valve stem diameter with a caliper micrometer midway between the valve head and tip and then select a pilot from a valve refacing kit which fits snugly in the valve guide bore.

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

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

Another method is to use a dial indicator to measure the lateral movement of the valve stem with the valve installed in its guide and off the valve seat (Figure 19).

The valve guides are an integral part of the cylinder head and are not replaceable.

Therefore, when the stem to guide clearance is excessive, the valve guides must be reamed to the next larger size so that proper clearance can be obtained. Oversize service valves are available in. 003",. 015" and. 030" sizes.

The following oversize valve guide reamers may be used.

J-6042-1. 003"
C-3430 .015"

FIGURE 19 — Checking Valve Guide Clearance

C-3427 .030"

IMPORTANT: Valve guides must be reamed in steps, starting with the. 003" O. S. reamer and progressing to the size required.

Assembly

Thoroughly clean the valve stems and the valve guide bores.

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

Install a new valve stem oil deflector on each valve stem.

Position each valve spring and retainer on the cylinder head and compress the valve spring with the compressor tool. Install the valve locks and release the tool.

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

HYDRAULIC VALVE TAPPETS

The hydraulic valve tappet consists of a body, plunger, plunger return spring, cap and lock ring (Fig. 20).

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

When the tappet is on the heel of the cam lobe, the plunger return spring indexes with an oil hole undercut in the plunger and allows the oil supply

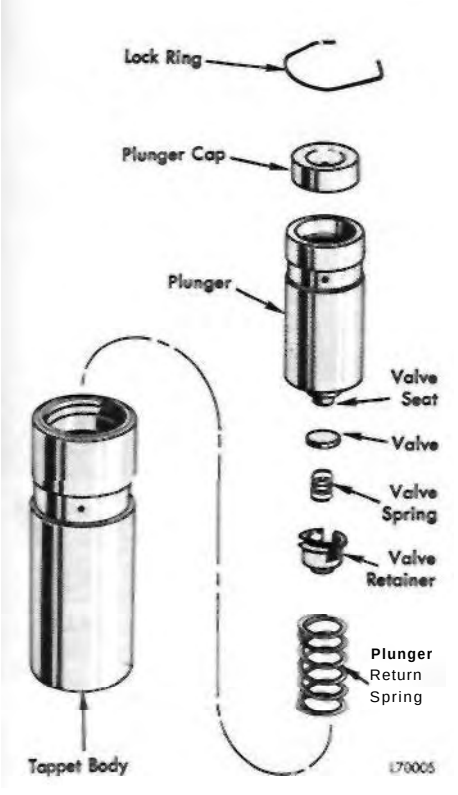

FIGURE 20 - Hydraulic Tappet Assembly Sequence (Typical)

to be admitted through the tappet body. Oil under pressure flows into the body through the check valve assembly, maintaining the tappet fully charged. (Fig. 21). This cycle of operation occurs when the tappet leaks off some oil during the normal valve opening events. Contact with the cam lobe causes tappet body movement, closing the check valve and transmitting "zero-lash" movement of the push rod to open the intake or exhaust valve.

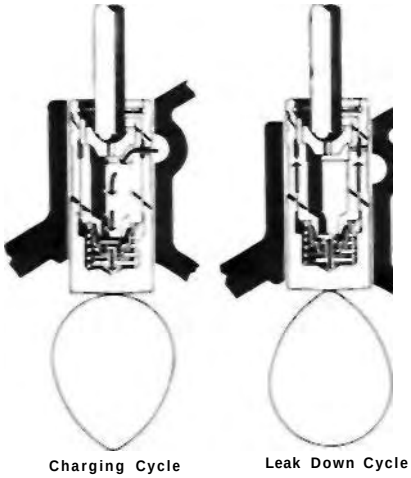

FIGURE 21 - Hydraulic Tappet Operation Cycle

Noise Diagnosis

A loud clicking noise is usually the result of the plunger stuck below its operating position or a check valve held open. A light clicking noise at idle is usually the result of excessive "leak-down" caused by wear or slight leakage at the check valve and its seat.

An intermittent noise is the result of dirt or chips stopping the check valve action or a lack of oil flow into the body. A general tappet noise is, in most cases, due to a lack of oil volume, pressure or cereation.

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.

An individual noisy tappet can readily be located by placing one end of a length of heater hose at the push rod end of the rocker arm and the other end to the ear.

The valve tappets should be cleaned and serviced at time of engine overhaul or whenever excessive noise exists.

Removal and Disassembly

Remove the cylinder head cover and gasket, rocker arm and shaft assembly, push rods and the cylinder head and gasket.

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

Remove the tappets through the push rod openings of the engine block with Hydraulic Valve Tappet Remover and Installer Tool J-21884 as shown in Figure 22.

IMPORTANT: The tappets and all components must be retained in the same order as removed.

Release the lock ring and remove the plunger cap, plunger assembly and plunger return spring from the tappet body.

Cleaning and Inspection

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

A visual inspection of each tappet assembly is required.

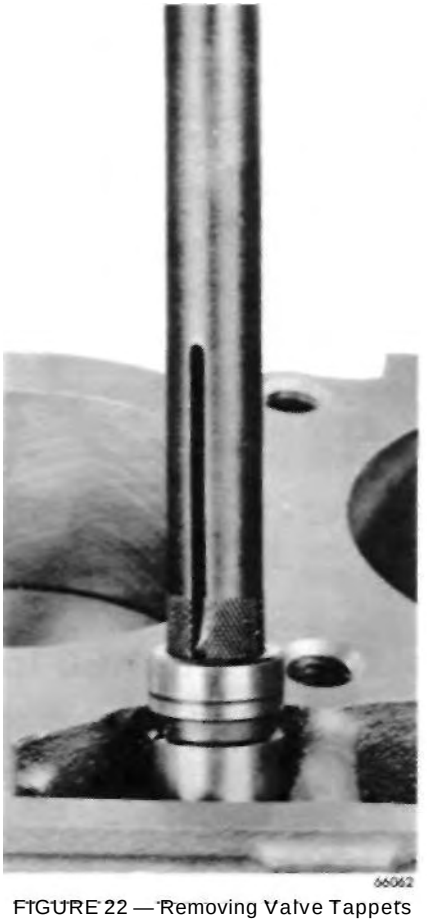

FIGURE 22 — Removing Valve Tappets with J-21884

The inspection should include checking for signs of scuffing on the barrel, and face of the tappet. Each tappet face should be inspected for wear as shown in Figure 23. If the tappet face is concave, the corresponding lobe on the camshaft is worn and the replacement of the camshaft and tappets is necessary.

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

After cleaning and inspection, the tappet must be "leak-down" tested to insure its "zerolash" operating ability. Valve Tappet Test Oil J-5268 should be used for this test.

Figure 24 illustrates Tool J-5790 used to accurately test tappet "leak-down. " They may be tested by filling the body with Valve Tappet Test Oil J-5268, installing the plunger return spring, plunger assembly, and plunger cap. Do not install lock ring for test. Place a. 312"-. 313" diameter ball bearing in the plunger cap. Place the push rod on the ball bearing.

Adjust the tester gauge on the

FIGURE 23 — Checking Tappet Face for Concave Wear

FIGURE 24 - Testing Valve Tappet "Leak-Down" with J-5790

start position and allow the weighted arm to *"leak,* down" the tappet.

If the tappet leaks down rapidly or collapses immediately, it must be replaced with a complete new tappet assembly. A good tappet will take approximately 20-110 seconds to "leak-down" with a 50 lb. load travel of **.125".**

Assembly and Testing

After testing the tappets, install the lock rings to those which have passed the test. Discard those which have failed the test and replace with new tappet assemblies.

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

Installation

Dip each tappet assembly in Engine Oil Supplement and use Hydraulic Valve Tappet Remover and Installer Tool J-21884 to install the assemblies in the same bores from which they were removed.

Install the push rods in the same *order as removed.*

Install the rocker arm and shaft assembly and tighten the retaining bolts to the specified torque.

Pour the remaining engine oil supplement over the entire valve train mechanism.

IMPORTANT: The E. O. S. must remain in the engine for at least 1, 000 miles but need not be drained until the next scheduled oil change.

Install the cylinder head cover and gasket.

VIBRATION DAMPER

The vibration damper (Fig. 25) is balanced independently and then rebalanced as part of the complete crankshaft assembly.

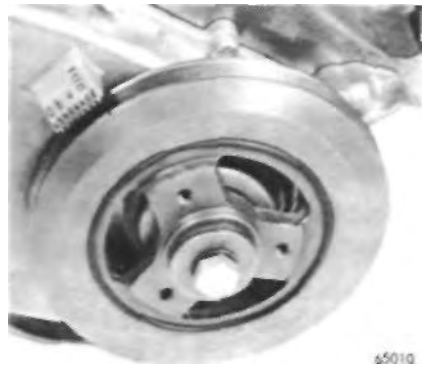

FIGURE 25 — Vibration Damper Assembly

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.

A loose vibration damper or damage to the damper cushions may be misdiagnosed as engine bearing noise.

Removal

Remove the drive belt(s).

If so equipped, remove the three retaining cap screws and separate the accessory pulley from the vibration damper.

Remove the vibration damper retaining bolt and washers.

Use Vibration Damper Remover Tool J-21791 to remove the damper from the crankshaft as shown in Figure 26.

FIGURE 26 — Removing Vibration Damper Assembly with Tool J-21791

Installation

Align the key slot of the vibration damper with the crankshaft key and install the damper on the crankshaft.

Install the vibration damper retaining bolt and washers, tighten to the specified torque.

If removed, install the accessory pulley and retaining cap screws, tighten the screws to the specified torque.

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

TIMING CHAIN COVER

The timing chain cover is provided with a seal and oil slinger to prevent oil leakage at the vibration damper hub (Fig. 27).

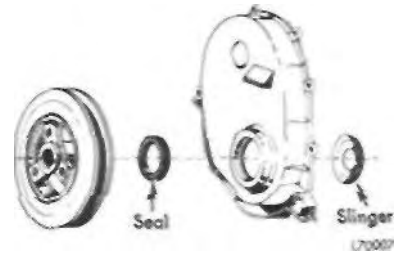

FIGURE 27 — Timing Chain Cover

It is important that the timing chain cover is properly aligned with the crankshaft to prevent eventual damage to the oil seal. The oil seal may be

replaced without removing the timing chain cover.

Removal

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

Remove the oil pan to timing chain cover screws and the cover to block screws.

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

Remove the timing chain cover and gasket from the engine.

Use a sharp knife or single edge razor blade to cut off the oil pan seal end tabs flush with the front face of the cylinder block as shown in Figure 28 and remove the seal. Clean the timing chain cover, oil pan and cylinder block gasket surfaces.

Remove the crankshaft oil seal from the timing chain cover.

FIGURE 28 — Cutting Oil Pan Front Seal

Installation

Apply "Perfect Seal" sealing compound, or equivalent, to both sides of a new timing cover gasket and position the gasket on the cylinder block.

Cut off the same amount from the end tabs of a new oil pan seal as was cut off the original seal. Coat the end tabs of the seal generously with "Permatex" No. 2 and install the seal to the oil pan.

Position the timing chain cover on the engine and place Timing Chain Cover Alignment Tool and Seal Installer J-22248 on the crankshaft and in the seal opening of the cover (Fig. 29).

FIGURE 29 — Aligning Timing Chain Cover

Install the cover to block screws and oil pan to cover screws, tighten the screws to the specified torque.

Remove the cover aligning tool, place a new oil seal on the tool with the seal lip facing the cover. Place a light film of "Perfect Seal" on the outside diameter of the seal. Insert the draw screw from Tool J-9163 into the seal installing tool and press the seal into the cover until bottomed in seal opening (Fig. 30). Remove the tools; apply a light film of engine oil on the seal lip. Install the vibration damper and tighten to the specified torque.

If removed, install the accessory pulley.

Install the engine fan and hub assembly.

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

Oil Seal Replacement

Remove the drive belt(s), accessory pulley (if so equipped) and the vibration damper.

Use Timing Chain Cover Oil Seal Remover Tool J-9256 to remove the oil seal from the cover as shown in Figure 31.

Place a new oil seal on Timing Chain Cover Alignment Tool and Seal Installer J-22248 with the seal lip facing the cover. Place a light film of "Perfect Seal" on the outside diameter of the seal.

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

Remove the tools; apply a light film of engine oil on the seal lip. Install the

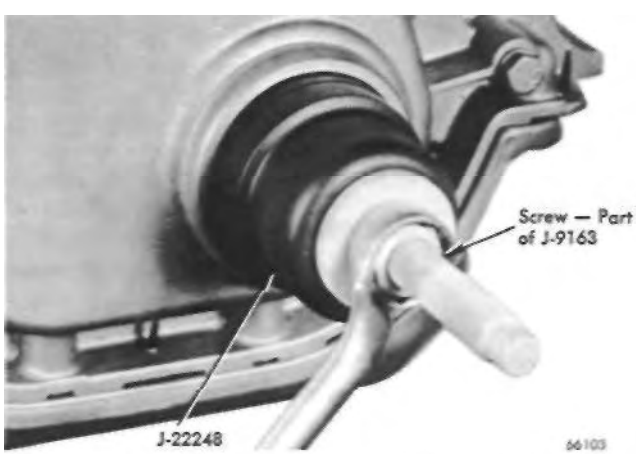

FIGURE 30 — Installing Timing Chain Oil Seal

FIGURE 31 — Removing Timing Chain Cover Oil Seal with J-9256 Remover

vibration clamper and tighten to the specified torque.

If removed, install the accessory pulley.

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

TIMING CHAIN

installation of the timting chain with the timing marks of the crankshaft and camshaft sprockets properly aligned assures correct valve timing. A worn timing chain will adversely affect valve timing. If the timing chain deflects more than y_2", it should be replaced.

Checking Valve Timing

Remove the spark plugs and the cylinder head cover and gasket.

Rotate the crankshaft until No. 6 piston is at TDC on the compression stroke.

Turn the crankshaft slowly counterclockwise (viewed from front) until No. 1 exhaust valve just begins to open. Note the distance between the timing mark on the vibration damper and the TDC mark on the degree scale of the timing chain cover.

Turn the crankshaft slowly clockwise (viewed from the front) past TDC position until No. 1 intake valve just begins to open. Note the distance between the timing mark on the vibration damper and the TDC mark on the degree scale of the timing chain cover.

If the valve timing is correct, the two distances will be equal.

Removal

Remove the drive belt(s), engine fan and hub assembly, accessory pulley (if so equipped), vibration damper and timing chain cover. Remove the oil seal from the timing chain cover.

Remove the camshaft sprocket retaining bolt and washer.

Rotate the crankshaft until the "0" timing mark on the crankshaft sprocket is closest to and in a centerline with the timing pointer of the camshaft sprocket as shown in Figure 32.

Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly. Disassemble the chain and sprockets.

Installation

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned as shown in Figure 32. Install the assembly to the crankshaft and camshaft. Install the camshaft sprocket retaining bolt and washer and tighten to the specified torque. To assure correct installation of the timing chain, locate the timing mark of the camshaft sprocket at approximately the one o'clock position. This should place the timing mark of the crankshaft sprocket where it meshes with the chain (Fig. 33). Count the number of pins between the timing mark of both sprockets. There should be 15 pins.

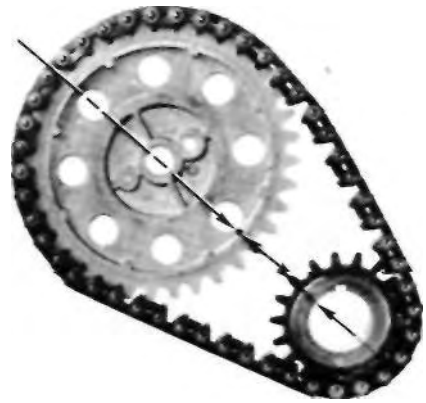

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FIGURE 32 - Place Marked Teeth on Center Line When Installing Sprockets and Chain

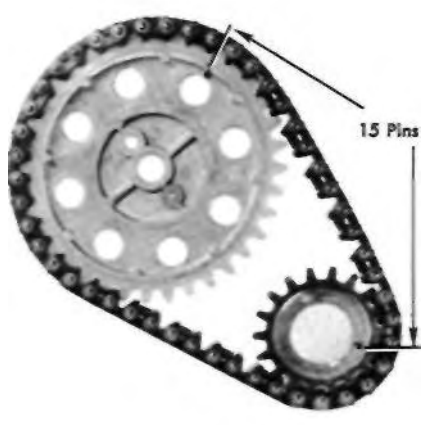

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FIGURE 33 — Correct Timing Chain Installation

Install the timing chain cover and a new oil seal. Install the vibration damper, accessory pulley (if so equipped), engine fan and hub assembly and the drive belt(s). Tighten the belt(s) to the specified tension.

CAMSHAFT AND BEARINGS

The camshaft is supported by four steel-shelled, Babbitt-lined bearings which have been pressed into the block and line reamed. The camshaft bearings *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; *It is* not *advisable to replace camshaft bearings unless equipped with special removing, installing and reaming tools.*

Camshaft end play is maintained by the load placed on the camshaft by the oil pump and distributor drive gear.

The helical cut of the gear holds the camshaft sprocket thrust face against the cylinder block face. Therefore, camshaft end play is zero during engine operation.

Measuring Cam Lobe Lift

Cam lift is a function of camshaft lobe dimensions.

Cam lift may be checked with a dial indicator.

To check cam lift, remove the cylinder head cover and gasket, rocker arm assembly and spark plugs. Install a dial indicator on the end of the push rod as shown in Figure 34. A piece of rubber tubing may be used to secure the dial indicator plunger to the push rod.

Rotate crankshaft until the cam lobe base circle (push rod down) is under the valve tappet. Set the dial indicator to zero and rotate the crankshaft to a point where maximum upward movement of the push rod occurs.

Read the travel at the dial indicator. An excess of minus. 006" from the specified dimensions indicates a defective cam.

Removal

Drain the cooling system and remove the radiator. If equipped with air conditioning, remove the condenser and receiver assembly as a charged unit. Refer to the "AIR CONDITIONING" section for detailed procedure.

Remove the cylinder head cover and gasket, rocker arm and shaft assembly,

FIGURE 34 - Installation of Dial Indicator for Checking Cam Lobe Lift

push rods, cylinder head and gasket, and hydraulic valve tappets.

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

Remove the drive belt(s), engine fan and hub assembly, accessory pulley (if so equipped), vibration damper and timing chain cover. Remove the oil seal from the timing chain cover.

Remove the fuel pump and distributor assembly (including spark plug wires).

Rotate the crankshaft until the "0" timing mark of the crankshaft sprocket is closest to and in a centerline with the timing pointer of the camshaft sprocket as shown in Figure 32.

Remove the crankshaft sprocket, camshaft sprocket and timing chain as an assembly.

Remove the front bumper or grille as required and remove the 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 each cam lobe and the matching hydraulic valve tappet for wear. If the face of the tappet(s) is worn concave, the matching camshaft lobe(s) is also worn, both the camshaft and the tappet(s) must be replaced.

Installation

Lubricate the entire camshaft generously with Engine Oil Supplement and install carefully into the engine block.

Assemble the timing chain, crankshaft sprocket and camshaft sprocket with the timing marks aligned as shown in Figure 32. Install the assembly to the engine.

Install the timing chain cover and a new oil seal.

Install the vibration damper. If removed, install the accessory pulley.

Install the engine fan and hub assembly and the drive belt(s). Tighten the belt(s) to the specified tension.

Install the fuel pump.

Rotate the crankshaft until No. 1 piston is at TDC position on the compression stroke. Install the distributor so that the rotor is aligned with the No. 1 terminal of the cap when fully seated on the block. Install the distributor cap and spark plug wires.

Install the hydraulic valve tappets, cylinder head and gasket, push rods, rocker arm and shaft assembly, and cylinder head cover and gasket.

IMPORTANT: The hydraulic valve tappets and all valve train components should be lubricated with Engine Oil Supplement during installation. The E. O. S. must remain in the engine for at least 1, 000 miles but need not be drained until the next scheduled oil change.

If removed, install the air conditioning condenser and receiver assembly. Refer to the "AIR CONDITIONING" section for procedure to purge the compressor of air.

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

Install the radiator and fill the cooling system to the specified level.

If removed, install the front bumper or grille.

OIL PAN

Removal

Raise the vehicle and drain the engine oil.

Remove the starter motor.

On CJ-5/CJ-6 and Commando, place a jack under the transmission bell housing. Disconnect the engine right support cushion bracket from the block and raise the engine to allow sufficient clearance for oil pan removal.

Remove the oil pan.

Remove the oil pan front and rear neoprene oil seals and the side gaskets. Thoroughly clean the gasket surfaces of the oil pan and engine block. Remove all sludge and dirt from the oil pan sump.

Installation

Install a new oil pan front seal to the timing chain cover and apply a generous amount of "Permatex" No. 2, or equivalent, to the end tabs.

Cement new oil pan side gaskets into position on the engine block and apply a generous amount of "Permatex" No. 2, or equivalent, to the gasket ends.

Coat the inside curved surface of a new oil pan rear seal with soap and apply a generous amount of "Permatex" No. 2, or equivalent, to the gasket contacting surface of the seal end tabs.

Install the seal in the recess of the rear main bearing cap making certain it is fully seated.

Apply engine oil to the oil pan contacting surface of the front and rear oil pan seals.

Install the oil pan and tighten the drain plug securely.

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

Install the starter motor.

Lower the vehicle and use new oil to fill the crankcase to the specified level.

OIL PUMP

Removal

Drain the engine oil and remove the oil pan.

Remove the oil pump retaining screws and separate the oil pump and

gasket from the engine block.

CAUTION: Do not disturb the position of the oil pick-up tube and screen assembly in the pump body. If the tube is moved within the pump body, a new assembly must be installed to assure an air tight seal.

Disassembly and Inspection

Remove the cover retaining screws and separate the cover and gasket from the pump body.

Measure the gear end clearance by placing a straight edge across the gears and pump body. Select a feeler gauge which will fit snugly but freely between the straight edge and the pump body (Fig. 35). Refer to the Specifications pages for the correct clearance.

FIGURE 35 — Measuring Oil Pump Gear End Clearance

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

Measure the gear to body clearance by inserting a feeler gauge between the gear tooth and the pump body inner wall directly opposite the point of gear mesh. Select a feeler gauge which fits snugly but freely (Fig. 36). Rotate the gears to check each tooth in this manner. Refer to the Specifications pages for the correct clearance.

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

If required, the oil pressure relief valve may be removed from the pump body for cleaning. Remove the cotter pin and slide the spring retainer, spring and relief valve out of the pump body.

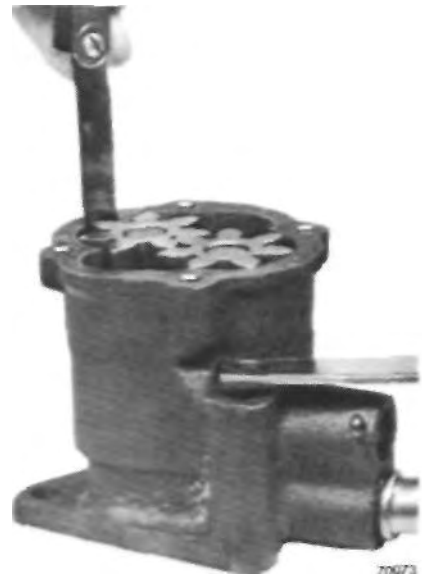


FIGURE 36 — Measuring Oil Pump Gear to Body Clearance

IMPORTANT: The oil pick-up tube must be moved to allow removal of the relief valve; therefore, the pick-up tube assembly must be replaced upon installation.

Assembly and Installation

If removed, install the oil pressure relief valve, spring, retainer and cotter pin.

If the position of the pick-up tube in the pump body has been disturbed, a new pick-up tube assembly must be installed.

Prior to installing the new assembly, place a light film of "Permatex" No. 2, or equivalent, around the tube at the joint. Using Tool J-21882 as shown in Figure 37, drive the tube into the body making sure that the alignment of the support bracket is correct during the entire installing operation.

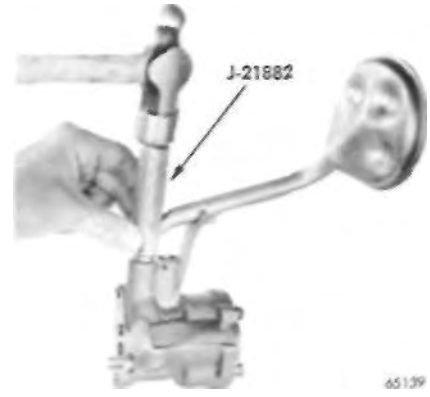


FIGURE 37 - Installing Pick-up Tube

Install the idler shaft, idler gear and drive gear assembly.

IMPORTANT: To ensure self-priming of the oil pump, the pump must be filled with "Petrolatum" prior to the installation of the oil pump cover. (Do not use grease of any type.)

Install the pump cover and new gasket. Tighten the retaining screws to the specified torque.

NOTE: Check for free operation prior to installing the oil pump to the engine.

Install the oil pump and a new gasket to the engine block. Tighten the retaining screws to the specified torque.

Install the oil pan using new gaskets and seals. Use new oil to fill the crank case to the specified level.

REAR MAIN BEARING OIL SEAL

The **rear** main bearing crankshaft seal consists of a two piece neoprene single lip seal to effectively seal the rear of the crankshaft. Correct installation of the seal will assure leak free engine operation (Fig. 38).

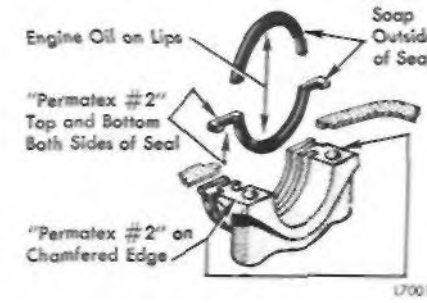


FIGURE 38 - Rear Main Oil Seal and Cap Installation

Removal and Installation

Drain the engine oil and remove the oil pan.

Remove the oil pan front and rear neoprene oil seals. Remove the oil pan side gaskets. Thoroughly clean the gasket *surfaces of the oil pan and* engine block. Remove all sludge and dirt from the oil pan sump.

Remove the rear main bearing cap. Remove and discard the lower seal.

IMPORTANT: To assure leak free operation, the upper and lower seal halves must be replaced in pairs.

Clean **the** main bearing **cap**

thoroughly to remove all sealer.

Loosen all remaining main bearing cap screws.

With a brass drift and hammer, tap the upper seal until sufficient seal is protruding to permit pulling the seal out completely. Wipe the seal surface of the crankshaft clean; then oil lightly.

Coat the block contacting surface of the new upper seal with soap, and the lip of the seal with engine oil. Install the upper seal into the engine block.

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

Coat both sides of the new lower seal end tabs with "Permatex" No. 2 or equivalent, being careful not to apply sealer to the lip of the seal.

Coat the outer curved surface of the lower seal with soap and the lip of the seal with engine oil. Install the seal into the cap recess and seat it firmly.

Place "Permatex" No. 2, or equivalent, on both chamfered edges of the rear main bearing cap. Install the rear main bearing cap and inserts. Tighten all main bearing cap screws to the specified torque.

Install a new oil pan front seal to the timing chain cover and apply a generous amount of "Permatex" No. 2, or equivalent, to the end tabs.

Cement new oil pan side gaskets into position on the engine block and apply a generous amount of "Permatex" No. 2, or equivalent, to the gasket ends.

Coat the inside curved surface of a new oil pan rear seal with soap and apply a generous amount of "Permatex" No. 2, or equivalent, to the gasket contacting surface of the seal end tabs.

Install the seal in the recess of the rear main bearing cap making certain it is fully seated.

Apply engine oil to the oil pan contacting surface of the front and rear oil pan seals.

Install the oil pan and tighten the drain plug securely.

Use new oil to fill the crankcase to the specified level.

CONNECTING ROD BEARINGS

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

Each bearing is selective 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 bearing fitting chart.

When required, different sized upper and lower bearing inserts may be used as a pair; therefore, a standard size upper insert is sometimes used in combination with a .001" undersize (U. S.) lower insert.

Service replacement bearing inserts are available as pairs in the following sizes: standard, .001" U. S., .002" U. S., .010" U. S. and .012" U. S. The size is stamped on the back of the inserts.

The bearing fitting chart may be utilized to select the bearing inserts required to obtain the specified bearing clearance.

CONNECTING ROD BEARING FITTING CHART

Diameter Of Rod Journal	Upper Bearing	Color Code	Lower Bearing	Color Code
2. 0955"-2. 0948"	Standard	Yellow	Standard	Yellow
2. 0948"-2. 0941"	Standard	Yellow	. 001 " U . S.	Black
2. 0941"-2. 0934"	. 001" U. S.	Black	. 001" U. S.	Black
2. 0855"-2. 0848"	. 010" U. S.	Red	. 010" U. S.	Red

It may be necessary, in some instances, to use different sized upper and lower inserts to reduce clearance by . 0005" (54 thousandth"). The bearing insert nearest to standard should always be installed in the upper location.

CAUTION: Never use bearing inserts with greater than. 001" difference in size in pairs.

Example

Correct	Incorrect
Upper — Std.	Upper — Std.
Lower -. 001" U. S.	Lower -. 002" U. S.

Removal and Inspection

Drain the engine oil and remove the oil pan.

Rotate the crankshaft as required to position two pistons at a time at the bottom of their stroke.

Remove the bearing caps and upper and lower inserts. The upper insert can be readily removed by spinning it out of the connecting rod.

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

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

Wipe the connecting rod journals clean and use a micrometer to check for an out of round condition. Refer to specifications. If any rod journal is beyond specifications, it must be reconditioned and fitted with new undersize bearing inserts.

Measuring Bearing Clearance With Plastigage

Wipe the bearing inserts and rod journal clean. Place a strip of Plastigage across the full width of the lower insert at the center of the bearing cap.

Install the bearing cap to the connecting rod and tighten the retaining nuts to the specified torque.

Remove the bearing cap and determine the amount of clearance by measuring the width of the compressed Plastigage with the scale furnished as shown in Figure 39.

FIGURE 39 — Checking Bearing Clearance with Plastigage

Measuring Connecting Rod Journal With A Micrometer

Wipe the connecting rod journal clean.

Use a micrometer, measure the maximum diameter of the rod journal.

Compare the reading obtained with the journal diameters listed in the bearing fitting chart and select the inserts required to obtain the specified bearing clearance.

Installation

Lubricate the bearing surface of each insert with clean engine oil. Install the bearing inserts, cap and retaining nuts. Tighten to the specified torque.

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

Install the oil pan using new gaskets and seals. Tighten the drain plug securely.

Use new engine oil to fill the crankcase to the specified level.

CONNECTING ROD AND PISTON ASSEMBLIES

Removal

Remove the cylinder head cover and gasket, rocker arm and shaft assembly, push rods and the cylinder head and gasket.

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

Drain the engine oil and remove the oil pan.

Remove the connecting rod bearing caps and inserts and retain in the same order as removed.

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

Remove the connecting rod and piston assemblies through the top of the cylinder bores being careful that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls.

Cylinder Bore Conditioning

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 . 005" and out of round does not exceed. 003", the cylinder bore may be trued 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.

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

Prior to fitting pistons, the cylinder bores should be scrubbed clean with a hot water and detergent solution. Cover the connecting rod journals with clean cloths during the cleaning operation.

After cleaning, apply light engine oil to the cylinder walls and then wipe with a clean lint free cloth.

Pistons

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

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

To ensure correct installation of the piston in the bore, a notch is cast into the top perimeter of the piston head. The notch must face forward as shown in Figure 40.

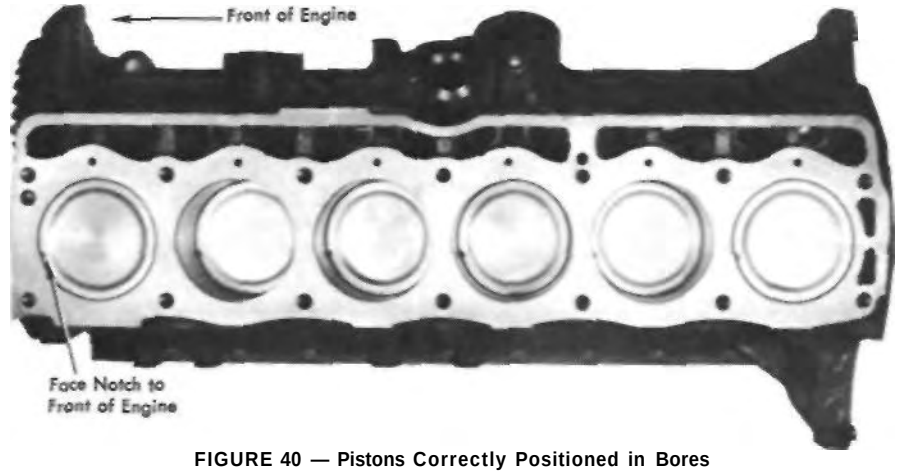


FIGURE 40 — Pistons Correctly Positioned in Bores

Pistons are fitted to their respective bores by measuring the inside diameter of the cylinder bore and the diameter of the piston.

Measure the cylinder bore inside diameter at a point $2^5/_{16}$" below the top of the bore.

Pistons are cam ground and, therefore, must be measured at right angles to the piston pin at the center line of pin as shown in Figure 41.

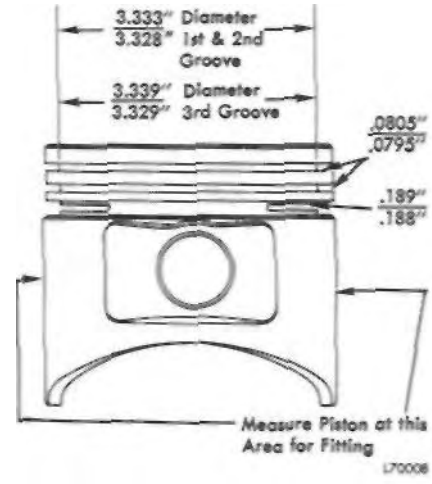


FIGURE 41 — Piston Measurements

The difference between cylinder bore diameter and piston diameter dimensions is the piston to bore clearance.

Piston Rings

Carbon must be cleaned from all ring grooves. The oil drain openings in the oil ring grooves and pin boss must be cleared. Care must be exercised not to remove metal from the grooves since this will change their depth; nor from the lands since this will change the ring groove clearance

and destroy ring to land seating.

Side clearance between land and compression rings should be as listed on the Specifications pages.

Roll the ring around the groove in which it is to operate. It must fit freely at all points (Fig. 42).

FIGURE 42 - Checking Ring Side Clearance

Piston ring gap or joint clearance is measured at the bottom of the cylinder near the end of the ring travel area. To square the ring in the bore for checking joint clearance, place the ring in the bore, then, with an inverted piston, push the ring down near the lower end of ring travel area (Fig. 43).

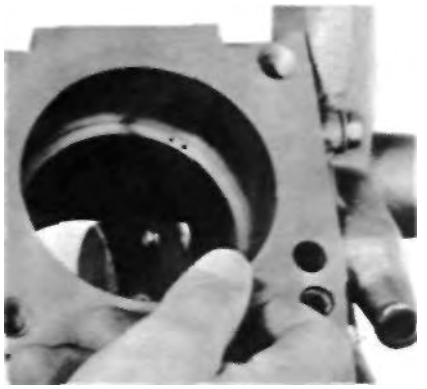


FIGURE 43 — Checking Ring Gap Clearance

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

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 (each stroke down and return) to recondition a cylinder wall.

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

Rigid type hones are not to 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.

After removing the cylinder glaze, install the rings on the pistons. Install the oil control rings first by following the sequence shown in Figure 44. Compression rings are marked to designate top of ring. Typical compression ring markings are shown in Figure 45.

FIGURE 44 - Oil Control Ring Installation

FIGURE 45 — Typical Piston Ring Markings

Rings must be installed on the pistons with a ring installing tool to prevent distortion and ring breakage (Fig. **46).**

Connecting Rods And Piston Pins

The connecting rods and caps are stamped with the cylinder numbers in which they were assembled.

The numbers are on the same machined surface as the squirt holes (Fig. 47).

The numbered sides and the squirt holes must face the camshaft.

Whenever new rings are installed or piston pins are replaced, it is necessary to check the alignment of the connecting rod and piston assemblies to ensure true operation in the cylinder bore.

FIGURE *46* — Installing Compression Rings on Piston Using Tool J-8028

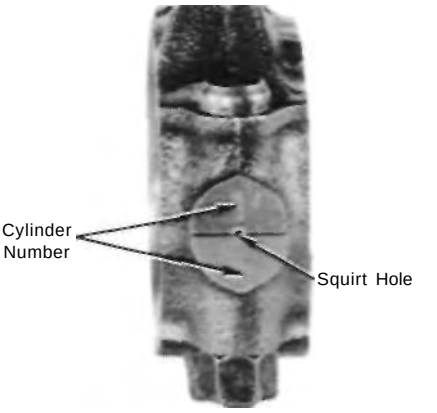


FIGURE 47 — Connecting Rod Numbering and Squirt Hole Location

Misaligned rods will cause uneven piston and ring wear which will result in oil consumption. The connecting rod should be inspected for a twisted or bent condition.

Assemble the connecting rods to the pistons with the notch on the pistons facing to the front of the engine and the numbered side of the rods facing the camshaft.

The piston pins are a press fit into the connecting rod, thus requiring no locking device.

Remove the piston pin with Piston Pin Remover J-21872 and an arbor press.

Place the piston on the remover support J-21872-1 so that the pin will enter the support when pressed out with the piloted driver J-21872-3 (Fig. 48).

To install the piston pin, place the piston pin pilot in the support and insert the piston and connecting rod. This

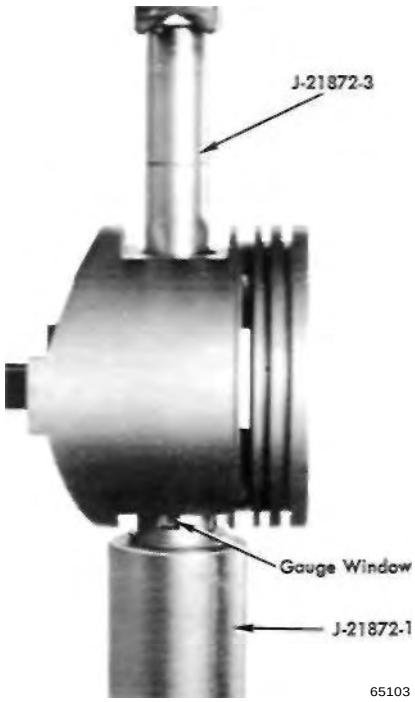


FIGURE 48 — Removing or Installing Piston Pin

aligns the piston and connecting rod piston pin bores. Press the piston pin into the connecting rod and piston assembly until the lower pilot enters the support and the index mark on the pilot is located at the lower edge of the gauge window of support J-21872-1. At this point, the connecting rod is centered on the piston pin. A plus or minus $^{1}/_{32}$" is allowed for centering the piston pin to connecting rod.

When fitting the pin, with all parts dry and free of nicks and burrs, the pin must not support its weight in a vertical position over its entire length in either of the bores.

CAUTION: The piston pins must be a tight *press fit (2000 lb.) into the connecting rod.*

Installation

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

Prior to installing the connecting rod and piston assemblies into the engine, arrange the piston ring gaps so that the #1 compression ring gap is 180° from the *#2* compression ring gap and the oil control ring spacer expander gap is at least 90° from the #2 compression ring gap. The oil control ring gaps are to be installed 90° from the spacer gap with at least 30° between each ring gap.

Lubricate the piston and ring surfaces with clean engine oil.

Use Piston Ring Compressor Tool C-385 to install the connecting **rod** and piston assemblies through the top of the cylinder bores being careful that the connecting rod bolts do not scratch the connecting rod journals or cylinder walls.

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

Install the connecting rod bearing caps and inserts in the same order as removed. Tighten the retaining nuts to the specified torque.

Install the engine oil pan using new gaskets and seals. Tighten the drain plug securely.

Install the cylinder head and new gasket, push rods, rocker arm and shaft assembly and cylinder head cover and gasket.

Use new oil to fill the crankcase to the specified level.

CRANKSHAFT MAIN BEARINGS

The main bearings are steelbacked, sintered copper, lead alloy precision type.

Each bearing is selective 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 bearing fitting chart.

When required, different sized upper and lower bearing inserts may be used as a pair; therefore, a standard size upper insert is sometimes used in combination with a. 001" undersize (U. S.) lower insert.

Service replacement bearing inserts are available as pairs in the following sizes: standard,. 001" U. S.,. 002" U. S., . 010" U. S. and 012" U. S. The size is stamped on the back of the inserts.

The bearing fitting chart may be utilized to select the bearing inserts required to obtain the specified bearing clearance.

It may be necessary, in some instances, to use different sized upper and lower inserts to reduce clearance by. 0005" (1/2 thousandth"). The bearing insert nearest to standard should always be installed in the upper location.

CAUTION: Never use bearing inserts with greater than. 001" difference in size in pairs.

Example:

Correct	Incorrect
Upper — Std.	Upper — Std.
Lower -. 001" U. S.	Lower -. 002" U. S.

Removal and Inspection

Drain the engine oil and remove the pan.

Remove one main bearing cap and insert.

Inspect the bearing insert for abnormal wear or damage. If either condition exists, both upper and lower inserts must be replaced. Refer to "Measuring Bearing Clearance With Plastigage" to select the bearing inserts required to obtain the specified bearing clearance.

Inspect the crankshaft main journal. If it is damaged, it must be either reconditioned or replaced. Refer to "Crankshaft. "

Remove the upper insert by loosening all of the other bearing caps and inserting a small pin about $^{1}/_{2}$" long in the crankshaft oil hole. The head of this pin should be large enough so that it will not fall into the oil hole, yet

CRANKSHAFT BEARING FITTING CHART

Diameter Of Main Journal	Upper Bearing	Color Code	Lower Bearing	Color Code
2. 5001 "-2. 4996"	Standard	Yellow	Standard	Yellow
2. 4996"-2. 4991"	Standard	Yellow	. 001" U. S.	Black
2. 4991 "-2. 4986"	. 001" U. S.	Black	. 001" U. S.	Black
2. 4986"-2. 4981"	. 001" U. S.	Black	. 002" U. S.	Green
2. 4901 "-2. 4896"	. 010" U. S.	Red	. 010" U. S.	Red

thinner than the thickness of the bearing.

With the pin in place, rotate the shaft so that the upper bearing insert will rotate in the direction of its locating tongue.

Remove and inspect the remaining bearings one at a time in the same manner.

Measuring Bearing Clearance With Plastigage

Support the weight of the crankshaft with a jack placed under the counterweight which is adjacent to the main bearing being checked.

IMPORTANT-. Check clearance of only one bearing at a time. All other bearings must remain tightened.

Remove the main bearing cap and insert. Wipe the insert and the exposed portion of the crankshaft journal clean.

Place a strip of Plastigage across the full width of the bearing insert. Install the bearing cap and tighten the retaining bolts to the specified torque.

Remove the bearing cap and determine the amount of clearance by measuring the width of the compressed Plastigage with the scale furnished as shown in Figure 49.


60291

FIGURE 49 - Checking Main Bearing Clearance With Plastigage

Installation

Lubricate the bearing surface of each insert with clean engine oil.

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

Install the main bearing cap(s) and lower insert(s). Tighten the retaining bolts evenly to the specified torque.

After installation, turn the crankshaft by hand to check for free operation.

Install the oil pan using new gaskets and seals. Tighten the drain plug securely.

Use new engine oil to fill the crankcase to the specified level.

CRANKSHAFT

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

An oil slinger is provided at the rear main journal inboard of the rear oil seal.

The component parts of the crankshaft assembly are individually balanced; then the complete assembly is balanced as a unit.

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

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

Replacement

If the crankshaft is damaged to the extent that reconditioning is not feasible, it must be replaced. The engine must be removed from the vehicle for crankshaft replacement.

Checking **End Play**

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

To check this clearance, attach a dial indicator to the crankcase and pry the shaft fore and aft with a screw driver (Fig. 50).

The crankshaft end play should be as listed on the Specifications pages.

IMPORTANT: When replacing the thrust bearings, it is recommended to pry the crankshaft fore end aft to align the thrust faces of the bearings.

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, timing gears and chain.


65126

FIGURE 50 - Checking Crankshaft End Play

Installation includes transfer of component parts from the original engine including cleaning and torque tightening as required.

IMPORTANT: Whenever installing a short engine assembly, always install a new engine oil pump pick-up tube and screen assembly.

FLYWHEEL AND STARTER RING GEAR ASSEMBLY

The starter ring gear can be replaced separately only on vehicles with manual transmission. The starter ring gear is welded to and balanced as part of the converter flexplate on vehicles with automatic transmission.

To remove, place the flywheel on an arbor press with steel blocks equally spaced under the gear and press the flywheel through. The ring gear can also be removed by breaking it with a chisel.

To install a new starter ring gear, apply heat to expand the inside diameter so that it can be pressed over the flywheel.

On manual transmission equipped vehicles, 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.

SIX CYLINDER ENGINE
232-258 Cubic Inch Displacement

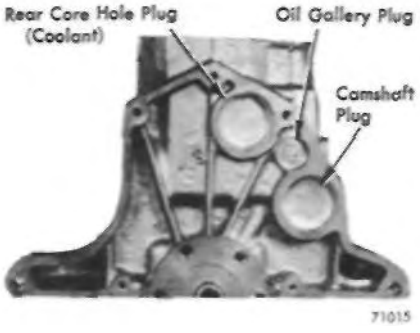


FIGURE 51 - Rear Camshaft and Oil Gallery Plugs

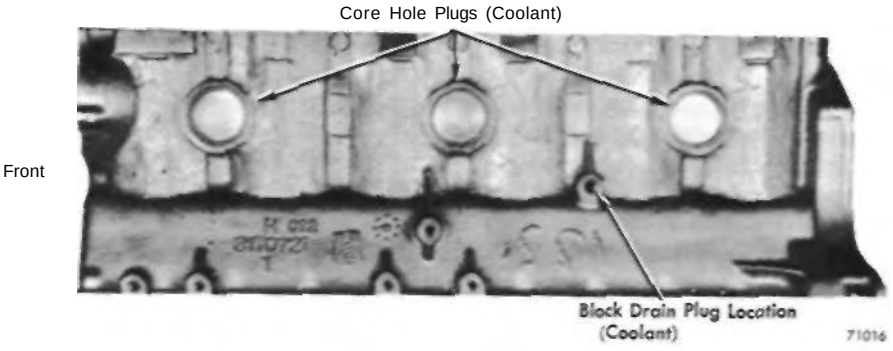


FIGURE 52 - Core Hole Plug Location

SIX CYLINDER ENGINE SPECIFICATIONS

	232 CID	258 CID
Type	OHV 6 Cyl.	
Bore	3.750"-3.753"	
Stroke	3.50"	3.895"
Firing Order	1-5-3-6-2-4	
Displacement	232	258
Compression Ratio	8.0:1 (7.5:1 Optional)	8.0:1 (7.6:1 Optional)
Net Horsepower	100 @ 3600	110 @ 3500
Net Torque	185 @ 1800	195 @ 2000
Taxable Horsepower	33.75	
Fuel	Regular	
Cylinder Head and Block Flatness	.008" Max. Full Length, .002" in 6", .001" in 1"	
VALVES		
Valve Arrangement (Front to Rear)	EI-IE-IE-EI-EI-IE	
Valve Stem Diameter	.3715"-.3725"	
Valve Length	4.7895"-4.8045"	
Valve Guide I. D. (Integral)	.3735"-.3745"	
Stem to Guide Clearance	.001"-.003"	
Intake Valve Face Angle	29°	
Intake Valve Seat Angle	30°	
Intake Valve Seat Width	.040"-.060"	
Exhaust Valve Face Angle	44°	
Exhaust Valve Seat Angle	44½°	
Exhaust Valve Seat Width	.040"-.060"	
Valve Seat Run-out	.0025"	
VALVE SPRING TENSION (LBS.)		
Closed	95 Lbs.-105 Lbs. @ 1 13/16"	
Open	188 Lbs.-202 Lbs. @ 1 7/16"	
INTAKE VALVE TIMING		
Opens	12° 30' BTDC	
Closes	66° 30' ABDC	
EXHAUST VALVE TIMING		
Opens	53° 30' BBDC	
Closes (California)	55° 30' ATDC	
Closes (Nationwide)	25° 30' ATDC	
Valve Opening Overlap (California)	68°	
Valve Opening Overlap (Nationwide)	48°	
CAMSHAFT		
Cam Lobe Lift	.254"	

	232 CID / 258 CID
End Play	.000" Engine Operating
Bearing Clearance	.001"-.003"
Intake Duration	259°
Exhaust Duration (California)	289°
Exhaust Duration (Nationwide)	259°
Base Circle Run-Out	.001" Max.
Tappet Clearance	Zero Lash (Hydraulic Lifters)
PISTONS AND RINGS	
Pistons to Bore Clearance (Right Angle to Center Line of Piston Pin)	.0009"-.0017"
Piston Ring Gap Clearance	
Top and Center (Compression)	.010"-.020"
Bottom (Oil Control)	.010"-.025"
Piston Ring Side Clearance	
#1 Compression	.0015"-.003"
#2 Compression	.0015"-.003"
Oil Control	.001"-.008"
Piston Pin to Connecting Rod	Press Fit 2000 Lbs.
Piston Pin to Piston	.0003"-.0005"
CRANKSHAFT AND BEARINGS	
Main Bearing Journal Diameter	2.4986"-2.5001"
Main Bearing Journal Width	#1 — 1.086"-1.098"
	#2-4-5-6-7 — 1.182"-1.188"
	#3 — 1.271"-1.273"
Main Bearing Clearance	.001"-.002"
Crankshaft End Play	.0015"-.0065"
Connecting Rod Journal Diameter	2.0934"-2.0955"
Connecting Rod Journal Width	1.073"
Connecting Rod Bearing Clearance	.001"-.002"
Connecting Rod Side Clearance	.005"-.014"
Connecting Rod Journal Out of Round	.0004" Max.
OIL PUMP AND LUBRICATING SYSTEM	
Oil Pump Type	Gear
Normal Operating Pressure @ 600 RPM	13 PSI
@ 1600 RPM or Higher	37 PSI Min.-75 PSI Max.
Oil Pressure Relief Maximum	75 PSI
Gear to Body Clearance	.0005"-.0025" (Each Tooth)
Gear End Clearance (Cover and Gasket Removed)	.002"-.006"
Oil Filter	Full Flow
Engine Oil Capacity	5 Quarts (One (1) Additional Quart With Filter Change)

TORQUE SPECIFICATIONS

(Torque Values given in Foot Pounds Unless Otherwise Specified)

Alternator Adjusting Strap and Water Pump to Stud.	18-25
Alternator Bracket Bolt	18-35
Alternator to Bracket Nut	30-35
Camshaft Sprocket Screw	45-55
Carburetor Hold-Down Nuts	12-15
Connecting Rod Nuts	26-30
Cylinder Head Cap Screws	80-85
Cylinder Head Cover Screws	45-55 In. Lbs.
Crankshaft Pulley to Damper	20-25
Clutch Housing Spacer to Block Screw	10-15
Clutch or Bell Housing Top	25-30
Bottom	40-45
Distributor Clamp Bolt	10-15
Distributor Bracket Screw	10-15
Exhaust Manifold Bolts	20-25
Exhaust Pipe to Manifold Nuts	20-25

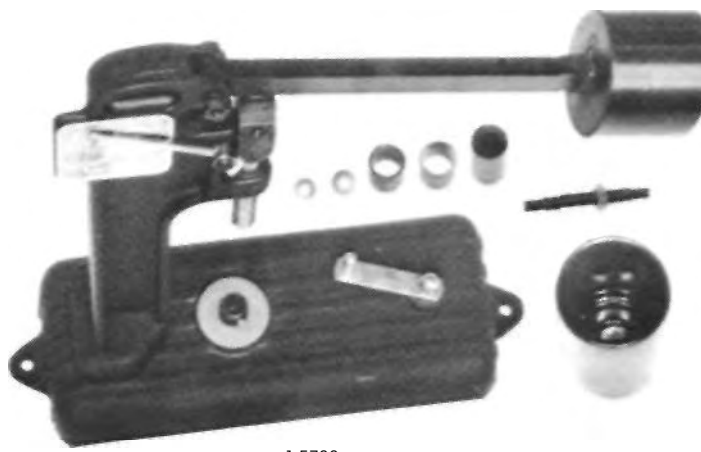
SIX CYLINDER ENGINE

232-258 Cubic Inch Displacement

Fan and Spacer to Pulley Hub Bolt	15-25
Flex Plate to Converter	270 In. Lbs.
Flex Plate to Crankshaft	100-110
Flywheel to Crankshaft Bolt	100-110
Front Cover to Block Screw	4-6
Fuel Pump Screws	15-17
Fuel Pump Clip to Oil Pan Bolt	5-8
Fuel Pump Clip to T/C Cover Bolt	5-8
Ground Strap and Alternator Bracket	18-35
Ignition Coil Bolt	18-25
Intake Manifold to Head Bolt	20-25
Main Bearing Cap Screws	75-85
Oil Pump;	
Cover to Body Bolt	5-8
Pump to Block Bolt	10-12
Mounting and Connecting Parts:	
Engine Mounting Brackets to Engine Bolt	25-30
Bracket to Plate Bracket to Crossmember Nut	30-50
Front Insulator to Frame Bracket Nut	25-30
Rear Insulator to Transmission Bolt	30-35
Insulator to Crossmember Locknut	25-30
Insulator to Transmission	30-35
Rear Insulator to Crossmember Hex Nut	30-35
Torque Reaction Bracket	25-30
Oil Pan Screws 1/4"-20.	5-8
5/16"-18.	10-12
Rocker Arm Assy, to Head - Bolt	20-23
Spark Plugs	25-30
Solenoid to Bracket Nut	18-25
Starter Nut	30-35
T. C. S. Solenoid Bracket and Accelerator Cable	
Bracket to Intake Manifold Bolt	18-25
Timing Chain Cover Bolt	5-8
Thermostat Housing	10-15
Vibration Damper Screw	50-60
Water Pump to Block Bolt	10-15

Screw, Front Cover Crankshaft Seal Installer
Part of Tool—J-9163

J-22248
Timing Chain Cover Alignment Tool and Seal Installer



J-5790
Hydraulic Valve Lifter Tester

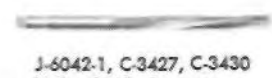
J-21832
Oil Pump Inlet Tube Installer

J-21872
Piston Pin Remover and Installer

J-9256
Timing Chain Oil Seal Remover

J-21931
Valve Spring Remover and Installer

J-22700
Oil Filter Wrench

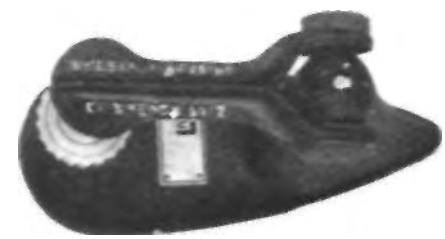


J-6042-1, C-3427, C-3430
Valve Guide Reamers

J-21884
Hydraulic Valve Tappet Remover and Installer

J-8520
Dial Indicator Set
(0-1"-.001" Graduation)

J-21791
Vibration Damper Remover



C-647
Valve and Clutch Spring Tester

J-5959-4
" C " Clamp and Rod Extension

69009

FIGURE 53 - Engine Tools