SECTION A
250 CUBIC INCH L-6 ENGINE

CONTENTS

DIVISION I

TROUBLE DIAGNOSIS

60-1 EXCESSIVE OIL CONSUMPTION

Possible Cause	Correction
External Oil Leaks at: Rocker Arm Covers Crankcase Front Cover Oil Pan and Gasket Around Starter Bolts Between Oil Pan and Flywheel Housing Intake Manifold Gasket	Tighten attaching bolts. If leaks persist, remove cover (or pan), check sealing surfaces for burrs or scoring, replace gasket, and seal attaching bolts with Permatex #2 or equivalent. Make sure oil level is not overfull.
Improper Reading of Dip Stick	Car may not be level when taking reading. Insufficient oil "drain-back" time allowed after stopping engine (three minutes must be allowed). Dip stick may not be completely pushed down against stop. Dip stick may be bent.
Oil Viscosity too Light	Use recommended S.A.E. viscosity for prevailing temperatures.
Continuous High Speed Driving	At speeds above 60 MPH, increased oil consumption can be expected with any engine. Inform customer of this fact.
High Speed Driving following Normal Slow Speed City Driving	When principal use of automobile is city driving, crankcase dilution from condensation occurs. High speed and temperatures will remove water, resulting in what appears to be rapid lowering of oil level. Inform customer of this fact.
Valve Guides Worn — Excessive Clearance	Ream out guides and install service valves with oversize stems. Refer to Paragraph 60-12.
Piston Rings not "broken in"	Allow engine to accumulate at least 4,000 miles before attempting any engine disassembly to correct for oil consumption.

60A-3

60-2 NOISY VALVES AND LIFTERS

a. Noisy Valve Train

The noise level of the valve mechanism cannot be properly judged where the engine is below operating temperature when the hood is raised, or when the valve rocker arm covers are removed.

Before attempting to judge valve noise level, the engine must be thoroughly warmed up (at least 20 minutes of operation at 1200 to 1500 RPM) to stabilize oil and coo-

lant temperatures and bring all engine parts to a normal state of expansion. When the engine is warmed up, listen for engine noise while sitting in the drivers seat with the hood closed. Run the engine at idle and at various higher speeds. It is advisable to observe the noise level in several engines that have been properly broken in, in order to develop good judgment for checking the noise level in any given engine.

Locate a noisy valve lifter by using a piece of garden hose approximately four feet in length. Place one end of the hose near the end of each intake and exhaust valve, with the other end of the hose to the ear. In this manner, the sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on the face of the valve spring retainer. If the lifter is not functioning properly, a distinct shock will be felt when the valve returns to its seat.

(1) *Excessive Oil In Crankcase.* Crankcase oil level high enough to allow the crankshaft to churn the oil will cause air bubbles in the lubricating system. Air bubbles entering the hydraulic lifters will cause erratic operation resulting in excessive lash in the valve train. Locate and correct cause of high oil level, then run engine long enough to expel air from system.

(2) *Sticking, Warped or Eccentric Valves, Worn Guides.* Sticking valves will cause irregular engine operation or missing on a low speed pull and will usually cause intermittent noise.

Pour penetrating oil over the valve spring cap and allow it to drain down the valve stem. Apply pressure to the one side of the valve spring and then the other, and then rotate the valve spring about 1/2 turn. If these operations affect the valve noise, it may be assumed that valves should be reconditioned.

(3) *Worn or Scored Parts in the Valve Train.* Inspect rocker arms, push rod ends for scoring. Check push rods for bends, valve lifters and camshaft surfaces for scoring. Replace faulty parts.

(4) *Faulty Hydraulic Valve Lifters.* If the preceding suggestions do not reveal the cause of noisy valve action, check operation of valve lifters as described in subparagraph b.

b. Noisy Valve Lifters

When checking hydraulic valve lifters, remember that grit, sludge, varnish or other foreign matter will seriously affect operation of these lifters. If any foreign substance is found in the lifters or engine where it may be circulated by the lubrication system, a thorough cleaning job must be done to avoid a repetition of lifter trouble.

To help prevent lifter trouble, the engine oil and oil filter must be changed as recommended in Group 00. The engine oil must be heavy duty type (MS marked on container) and must also conform to General Motors Specification 6041-M to avoid detrimental formation of sludge and varnish. A car owner should be specifically advised of these requirements when the car is delivered. Faulty valve lifter operation usually appears under one of the following conditions:

(1) *Rapping noise only when engine is started.* When engine is stopped, any lifter on the camshaft lobe is under pressure of the valve spring; therefore, leak down or escape of oil from the lower chamber can occur. When the engine is started, a few seconds may be required to fill the lifter, particularly in cold weather. If noise occurs only occasionally, it may be considered normal requiring no correction. If noise occurs daily, however, check for (a) oil too heavy for prevailing temperatures (b) excessive varnish in lifter.

(2) *Intermittent Rapping Noise.* An intermittent rapping noise that appears and disappears every few seconds indicates leakage at check ball seat due to foreign particles, varnish, or defective surface of check ball or seat. Recondition, clean, and-or-replace lifters as necessary.

(3) *Noise on idle and low speed.* If one or more valve lifters are noisy on idle and up to approximately 25 MPH but quiet at higher speeds, it indicates excessive leakdown rate or faulty check ball seat on plunger. With engine idling, lifters with excessive leakdown rate may be spotted by pressing down on each rocker arm above the push rod with equal pressure. Recondition or replace noisy lifters.

(4) *Generally noisy at all speeds.* Check for high oil level in crankcase. See subparagraph a (1) above. With engine idling, strike each rocker arm above push rod several sharp blows with a mallet; if noise disappears, it indicates that foreign material was keeping check ball from seating. Stop engine and place lifters on camshaft base circle. If there is lash clearance in any valve train, it indicates a stuck lifter plunger, worn lifter body lower end, or worn camshaft lobe.

(5) *Loud noise at normal operating temperature only.* If a lifter develops a loud noise when engine is at normal operating temperature, but is quiet when engine is below normal temperature, it indicates an excessively fast leakdown rate or scored lifter plunger. Recondition or replace lifter.

60-3 COOLING SYSTEM TROUBLE

a. Cooling System Trouble Diagnosis

If the radiator is filled too full when cold, expansion when hot will overfill the radiator and coolant will be lost through the overflow pipe. Adding unnecessary water will weaken the anti-freeze solution and raise the temperature at which freezing may occur.

If the cooling system requires frequent addition of water in order to maintain the proper level in the radiator, check

all units and connections in the cooling system for evidence of leakage. Inspection should be made with cooling system cold. Small leaks which may show dampness or dripping can easily escape detection when the engine is hot, due to the rapid evaporation of coolant. Tell-tale stains of grayish white or rusty color, or dye stains from anti-freeze, at joints in cooling system are almost always sure signs of small leaks even though there appears to be no dampness.

Air or gas entrained in the cooling system may raise the level in radiator and cause loss of coolant through the overflow pipe. Air may be drawn into the cooling system through leakage at the water pump seal. Gas may be forced into the cooling system through leakage at the cylinder head gasket even though the leakage is not sufficient to allow water to enter the combustion chamber. The following quick check for air leaks on suction side of pump or gas leakage from engine may be made with a piece of rubber tubing and a glass bottle containing water.

1. With cooling system cold, add water to bring coolant to proper level.

2. Block open the radiator cap pressure valve, or use a plain cap, and be sure radiator cap is on tight. Attach a suitable length of rubber hose to overflow pipe.

3. Run engine in neutral at a safe high speed until the engine reaches a constant operating temperature.

4. Without changing engine speed, put the free end of rubber hose into a bottle of water, avoiding kinks or low bends that might block the flow of air.

5. Watch for air bubbles in water bottle. A continuous flow of bubbles indicates that air is being sucked into the cooling system, or exhaust gas is leaking into the cooling system past the cylinder head gasket.

When stop leak material is added to the cooling system, in service, the presence of oil will be found in the surge tank, as well as the radiator, due to the stop leak material having an oil soluble base. This is normal.

Therefore, for this reason, the presence of oil in the cooling system does not necessarily mean that a head gasket has failed. Engine or transmission oil in the cooling system will be quite evident in that the amount of oil in the radiator and surge tank will vary considerably from the amount of oil deposited from the stop leak material. The soluble oil in the stop leak material will accumulate to a depth of 1/8 to 1/4 inch, whereas engine or transmission oil will generally be 3 to 5 inches in depth, depending on the severity of the leak and length of time the vehicle has been driven. Also, a loss of oil in these components will generally be noted.

b. Cooling System Overheating

It must be remembered that the Buick pressure system operates at higher temperatures than systems operating at atmospheric pressure. Depending on the pressure in cooling system, the temperature of permanent type anti-freeze may be considerably above 212 degrees F. without danger of boiling.

In cases of actual overheating the following conditions should be checked:

1. Excessive water loss.

2. Slipping or broken fan belt.

3. Radiator thermostat stuck, radiator air passages clogged, restriction in radiator core, hoses, or water jacket passages.

4. Improper ignition timing.

5. Shortage of engine oil or improper lubrication due to internal conditions.

6. Dragging brakes.

DIVISION II

DESCRIPTION AND OPERATION

60-4 ENGINE CONSTRUCTION

a. Engine Usage

An L-6 engine with a displacement of 250 cubic inches is supplied as standard equipment on all 433 and 43500 models. The same basic engine is used with either manual or automatic transmissions. All L-6 engines have a compression ratio of 8.5:1 which permits the use of "regular" grade gasoline.

b. Engine Mounting

For details of engine and transmission mounts, refer to Figure 60-50.

c. Engine Construction

The engine *crankcase* and *cylinder head* are made from cast iron.

The crankshaft is supported in the crankcase by seven steelbacked full precision bearings, all having the same nominal diameter. Except for the thrust bearing all bearings are identical. The thrust bearing takes end thrust and has flanges for that purpose. The number 7 bearing is designated as the thrust bearing.

The *crankshaft* is counterbalanced by weights cast inte-

gral with the crank cheeks. Maximum counter weighting in the space available is accomplished by precision casting the counterweights to a contour which allows a minimum uniform clearance with cylinder barrels and piston skirts.

Connecting rods are of I-beam section with bosses on each side so metal can be removed as required to secure correct weight and balance. The lower end of each rod is fitted with a steelbacked full precision- type bearing. The piston pin is a press fit into the upper end. The outer ends of the piston pin are a slide fit in the piston bosses.

The full skirted aluminum alloy *pistons* are cam ground and tin plated. The oil ring in the lower groove consists of two thin steel rails separated by a spacer.

The L-6 engine intake manifold and exhaust manifold are mounted as an assembly to the cylinder head. Since the intake manifold is cast iron, as is the carburetor throttle body, the exhaust manifold incorporates a heat control valve which allows the exhaust gas to warm the throttle body.

The manifold heat control valve regulates the amount of exhaust gas passing below the intake manifold. A bi-metal spring attached to the control valve shaft tends to gradually open and reduce the amount of exhaust gas warming the throttle body and intake manifold by slowing opening the valve. When engine operation temperature is reached, a small quantity of exhaust gas continues to warm the throttle body.

Intake manifold heat is necessary when operating the engine in cold temperature. Better fuel mixture vaporization, with resulting improved combustion is achieved.

The *valves* are in line and operate at an angle above the centerline of the cylinder bores. Each valve has a spring of ample capacity to insure positive valve seating throughout the operating speed range of the engine. Intake valve heads are 1.720 in diameter and exhaust valve heads are 1.500 in diameter.

The *rocker arms* are mounted on individual rocker arm studs which are pressed into the cylinder head. The rocker arms are sheet metal stamping.

The *camshaft* is supported in four steel back babbit bearings. It is driven at 1/2 crankshaft speed by the crankshaft sprocket.

Hydraulic valve lifters and one piece push rods are used to operate overhead rocker arms and valves. This system requires no lash adjustment at time of assembly or in service. Construction and operation of hydraulic valve lifters are described below.

In addition to its normal function of a cam follower, each hydraulic valve lifter also serves as an automatic adjuster which maintains zero lash in the valve operating linkage under all operating conditions. By eliminating all lash in the operating linkage and also providing a cushion of oil to absorb operating shocks, the hydraulic valve lifter promotes quiet valve operation. It also eliminates the need for periodic valve adjustment to compensate for wear of parts.

As shown in Figure 60-13 all parts of a hydraulic lifter are housed in the body, which is the cam follower. The body and the plunger are ground to very close limits, then a plunger is selectively fitted to each body to assure free movement with very little clearance. The push rod seat is free to move with the plunger in the body and, as its name implies, it provides a spherical seat to support the lower end of the push rod.

The plunger and seat are pressed toward the upper end of the lifter body by a coil spring which also holds a check ball retainer against the lower end of the plunger. When lifter is out of engine, a spring wire retainer holds all parts in the body. The ball retainer holds a spring loaded check ball in position over the lower end of a feed hole in the plunger.

When the valve lifter is installed in the engine, the push rod holds the seat and plunger downward and clear of the plunger retainer at all times. The plunger spring then presses the lifter body down against the camshaft and presses the plunger and seat up against the push rod with an eight pound load; this is enough to take up all lash clearances between parts in the valve linkage without affecting positive seating of the valve.

Oil is fed to all lifters through galleries in the crankcase. Oil enters each lifter through grooves and oil holes in the lifter body and plunger, flows down into the chamber below the plunger through the feed holes and around the check ball. The first few cycles of operation after the engine is started forces out all air and completely fills the plunger and lower chamber of each lifter with oil.

At the start of a cycle of valve operation, the lifter body rests on the camshaft base circle. The plunger spring holds all lash clearances out of the valve linkage.

As the rotating camshaft starts raising valve lifter body, oil in the lower chamber and the check ball spring firmly seat the check ball against the plunger to prevent appreciable loss of oil from the lower chamber. The lifting force against the body is then transmitted through the entrapped oil to the check ball and plunger so that the plunger and push rod seat move upward with the body to operate the linkage which opens the engine valve.

As the camshaft rotates further to close the engine valve, the valve spring forces the linkage and lifter to follow the cam down. When the engine valve seats, the linkage parts and lifter plunger stop but the plunger spring forces the body to follow the cam downward .002" to .003" until it again rests on the camshaft base circle. Oil pressure against the check ball from the lower chamber ceases when the plunger stops and allows passage of oil past the check ball into the lower chamber to replace the slight amount of oil lost by "leak-down".

During the valve opening and closing operation a very slight amount of oil escapes through the clearance between plunger and body and returns to the crankcase. This slight loss of oil (called "leak-down") is beneficial in providing a gradual change of oil in the lifter, since fresh oil enters the lower chamber when pressure is relieved on the check ball at the end of each cycle of operation.

When engine temperature increases and the valve linkage parts expand, the plunger must move to a slightly lower position in the lifter body to assure full closing of the engine valve. When engine temperature decreases and the linkage parts contract, the plunger must move to a slightly higher position in body to prevent lash clearances in the valve linkage. In either case, the capacity of the lower chamber changes and the volume of oil present is automatically controlled by passage of oil through the plunger feed hole.

60-5 LUBRICATION SYSTEM AND OIL PUMP

The engine lubrication system is the full pressure type in which oil is supplied through the main oil gallery to the crankshaft and camshaft to lubricate the bearings. The main oil gallery also feed the valve lifters which through hollow push rods, feed the individual mounted rocker arms.

The supply of oil is carried in the *lower crankcase (oil pan)* which is filled through a filler opening in the rocker arm cover. A removable oil gage rod on the right side of the crankcase is provided to check oil level.

The oil pump is located in the oil pan mounted to the front section of the cylinder block where it is connected to an oil screen housing and pipe assembly. The screen is submerged in the oil supply and has ample area for all operating conditions. A baffle is incorporated on the pickup screen to eliminate pressure loss due to sudden stops.

Oil supply is drawn into the pump through the screen and pipe assembly. All oil is discharged from the pump to the oil filter. The pump assembly consists of an oil pressure regulator valve and idler and drive gear. See Figure 60-1.

The spring loaded oil pressure regulator valve limits the oil pressure to a maximum of 45 pound per square inch. The oil filter by-pass, staked in the cylinder block, opens when the filter has become clogged to the extent that 15 pounds pressure difference exists between the filter inlet and discharge to by-pass the oil filter and channel unfiltered oil directly to the main oil gallery of the engine.

An *AC full flow oil filter* is externally mounted to the oil filter nipple on the lower right side of the engine. Normally, all engine oil passes through the filter element, however, if the element becomes restricted, a spring loaded by-pass valve opens as mentioned above. See Figure 60-2.

The engine main gallery intersects the tappet bores and serves as both the main gallery and the tappet gallery.

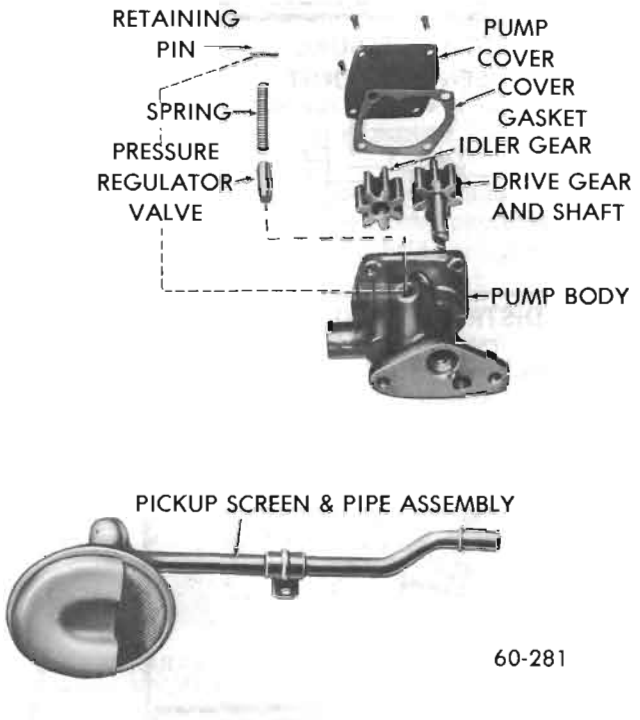


Figure 60-1 - Oil Pump

From this gallery, oil holes go directly to the camshaft bearings and the main bearings. The top half of the main bearing shell is grooved, therefore, registration of the oil hole in the crankshaft for connecting rod bearing lubrication is through a full 180 degrees.

The valve train is lubricated from the full pressure lifters through hollow push rods to the stamped rocker arms. Timing gears are lubricated by front camshaft bearing by-pass oil, fed through an orifice in the block to an outlet nozzle which directs oil down on the gears.

60-6 COOLING SYSTEM AND WATER PUMP

The engine cooling system is the semi-closed pressure type, with thermostatic coolant temperature control and water pump circulation. In such a system, coolant is checked and added to a separate reservoir bottle and not at the radiator. It should be noted, however, that if a quantity of coolant is needed because of a leak, repair, or for complete replacement, the coolant should be added directly to the radiator to insure that the system is filled.

A translucent plastic reservoir, similar to the familiar windshield washer bottle, is connected to the radiator by a hose. As the car is driven, the coolant is heated and expands. The portion of the fluid displaced by this expansion flows from the radiator into the reservoir. When the car is stopped and the coolant cools and contracts, the displaced coolant is drawn back into the radiator by vacuum. Thus, the radiator is kept filled with coolant to the desired level at all times, resulting in increased cooling efficiency.

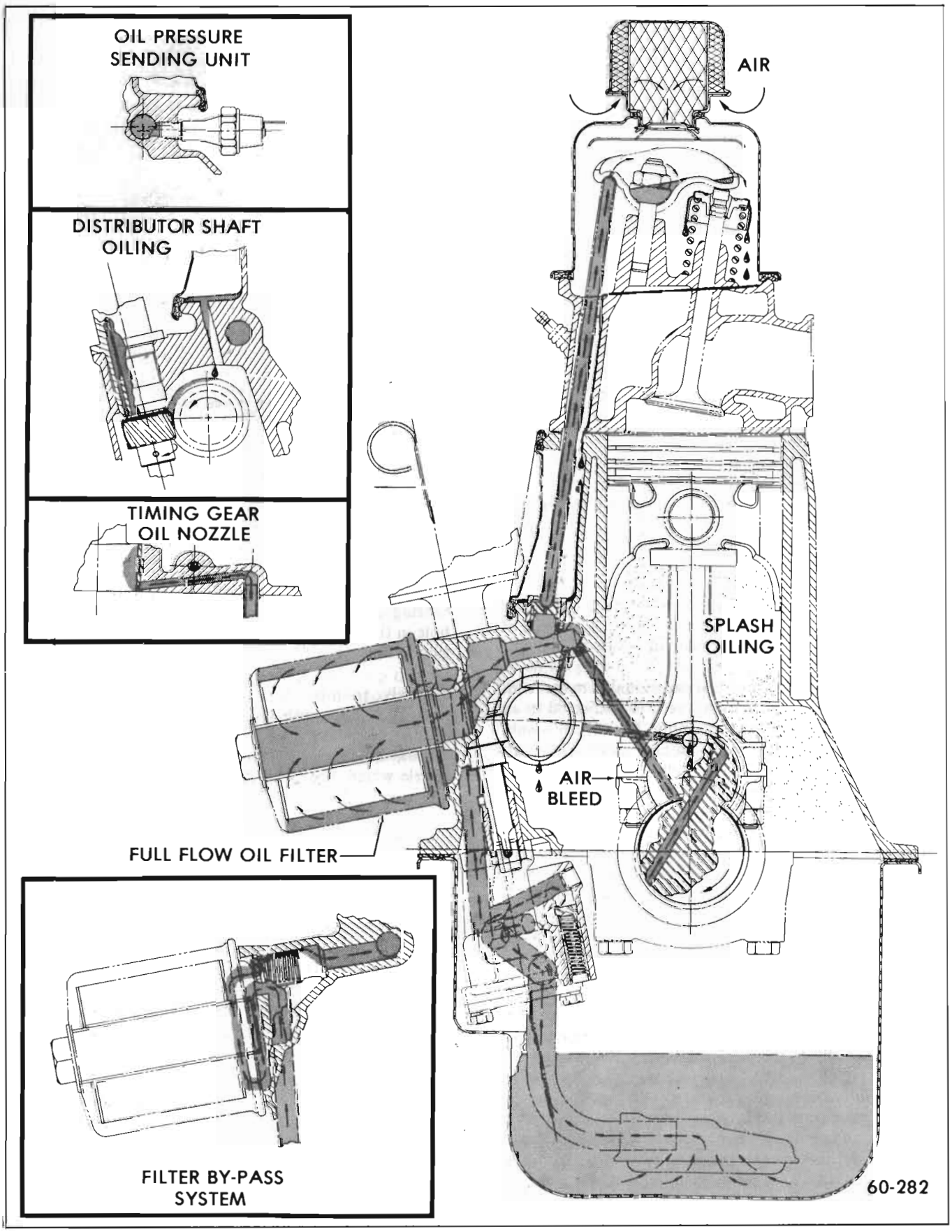


Figure 60-2 - Engine Lubrication System

A single contact temperature sensitive switch is located in the thermostat housing mounted to the front of the cylinder head. Engine water temperature above 245 degrees causes the set of contacts to close and light a red signal on the instrument panel.

A Harrison tube and center type of radiator core of brass and copper is used on all models. The outlet radiator tank houses the transmission oil cooler.

All engines are equipped with an 18", 4 blade fan. Air conditioned and heavy duty cooling cars are equipped with an 18", 7 blade fan driven by a torque and temperature sensitive clutch. See Figure 60-3.

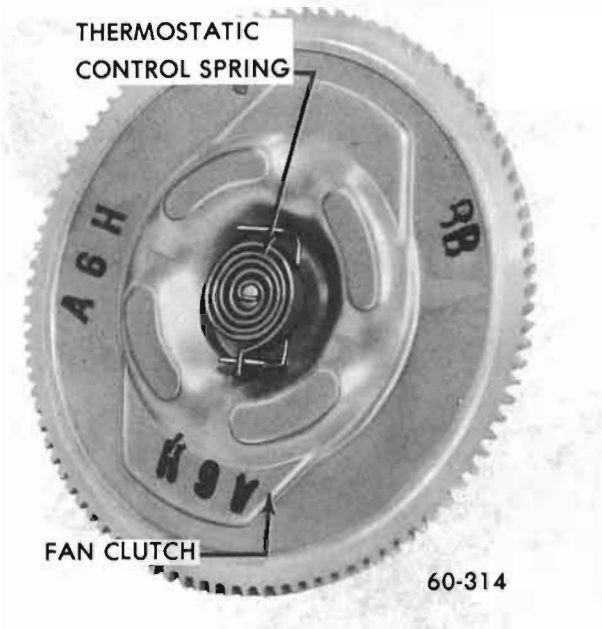


Figure 60-3 - Fan Clutch

NOTE: *A bent or damaged fan or fan clutch must always be replaced and repair not attempted. This is essential to maintain balance and durability.*

The torque sensitive fan clutch is equipped with a temperature sensitive coil which controls the flow of silicone through the clutch.

During periods of operation when radiator discharge air temperature is low, the fan clutch limits the fan speed to a maximum speed of 1200 RPM.

Operating conditions that produce high radiator discharge air temperatures cause the temperature sensitive coil to turn a shaft which opens a port inside the clutch. This open port allows a greater flow of silicone providing a maximum fan speed of approximately 2600 RPM.

The clutch coil is calibrated so that at road load with an ambient temperature of approximately 80 degrees F. the clutch is just at the point of shift between high and low fan speed.

The cooling system is sealed by a pressure type radiator filler cap which causes the system to operate at higher than atmospheric pressure. The higher pressure raises the boiling point of coolant and increases the cooling efficiency of the radiator. The fifteen pound pressure cap used on all series permits a possible increase of approximately 38 degrees F. in boiling point of coolant.

The pressure type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve. See Figure 60-4. The pressure valve is held against its seat by a spring of pre-determined strength which protects the radiator by relieving the pressure if an extreme case of internal pressure should exceed that for which the cooling system is designed. The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created in the system when it cools off and which otherwise might cause the coolant hoses to collapse.

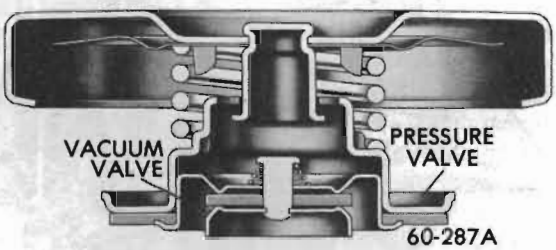


Figure 60-4--Pressure Type Radiator Cap

The coolant is circulated by a centrifugal pump mounted to the front of the crankcase. The fan and pulley(s) are bolted to the forward end of the pump shaft. In this manner both the fan and pump are belt driven by a crankshaft driven pulley integral with the harmonic balancer.

The pump shaft is supported on a double row ball bearing pressed fit in the cast iron water pump cover. The bearings are permanently lubricated during manufacture and sealed to prevent loss of lubricant and entry of dirt. See Figure 60-5.

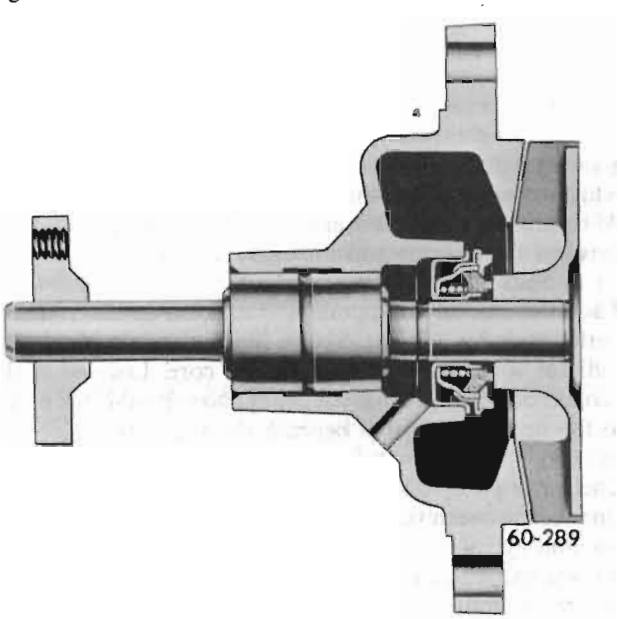


Figure 60-5 - Water Pump Assembly

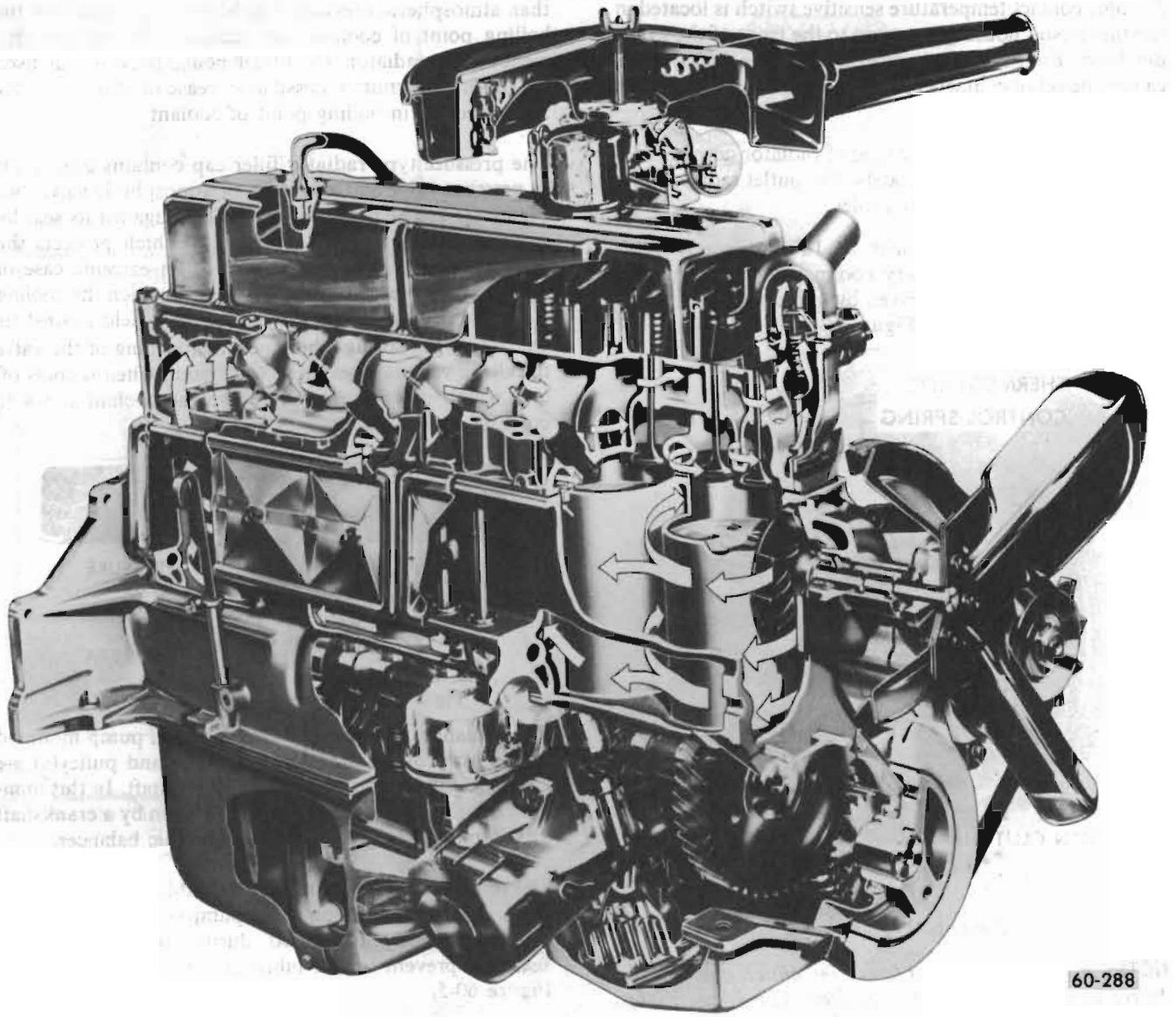


Figure 60-6 - Engine Coolant Flow

The centrifugal-type water pump contains an impeller which turns on a steel shaft which rotates in a ball bearing. A bellows-type seal is seated in the water pump body between the bearing and impeller. See Figure 60-6.

The inlet side of the pump is connected to the radiator outlet tank by a hose. Above the pump inlet from the radiator is the inlet from the heater core. Located in the coolant outlet at the front of the cylinder head is the outlet to the heater core from beneath the thermostat.

The water pump discharges coolant into the water jacket chamber between the front face of the block and the number one cylinder. Coolant then flows through the block toward the rear, passing through two large cast openings into the cylinder head to cool the valve seats and forward to the front of the head. Coolant then flows through the coolant outlet and the pellet-type thermostat to the radiator. Some coolant is directed through a small hole in the cylinder head gasket to an area around each spark plug.

During engine warm-up, when the thermostat is closed, water is redirected to the engine.

DIVISION III

ADJUSTMENTS AND MINOR SERVICE

60-7 COOLING SYSTEM SERVICE

a. Checking and Filling Cooling System

Engine coolant level is checked by raising the car's hood

and glancing at the translucent reservoir. The radiator cap is *not removed.* The design of the radiator cap has been changed to discourage inadvertent removal. The finger grips have been removed so the cap is round in shape. It must be pushed downward before it can be turned. A decal has been added to the cap cautioning against its being opened and indicating the proper closed position.

The proper coolant level at *normal operating temperature* is between the "Full" and the "Add" marks on the coolant reservoir. Since the level may be below the "Add" mark when the system cools and the coolant is below its normal operating temperature, *always* check the coolant level after the car has been driven.

NOTE: *Coolant freeze protection should be checked at the radiator and not at the reservoir.*

CAUTION: *Never remove the radiator cap quickly when the radiator is hot. Sudden release of cooling system pressure may cause the coolant to boil and escape with some force.*

If the cap must be removed when the engine is at normal or above temperature, a cloth should be placed over the cap. The cap should then be rotated *counterclockwise* without pressing downward until the relief position is reached. The pressure must be allowed to escape completely. This may take more than 10 minutes for a large, hot engine. The cap should then be depressed and rotated again *counterclockwise* to the removal position.

b. Draining and Flushing the Cooling System

When the coo ling system has been drained, reinstall an ethylene-glycol type anti-corrosion cooling system protection solution developed for year around use (General Motors Specification GM 1899-M). *Water alone, methanol, or alcohol type anti-freeze is definitely not recommended.* To drain the cooling system, remove radiator cap, open the drain at the bottom of the radiator and remove the drain plug on left side of cylinder block. If car is air-conditioned equipped set heater temperature control valve at "HOT" position.

After the cooling system is drained, plugs reinstalled, and drain cock closed, fill the system with clean water. Run the engine long enough to open the thermostat for complete circulation through the system then completely drain the cooling system.

c. Conditioning the Cooling System

It is very important to make certain that the cooling system is properly prepared before an anti- freeze solution is installed; otherwise, loss of solution through leakage may occur or seepage may result in damage to the engine. The cooling system should be drained and flushed as described above (subpar. b). All joints should be pressure checked for leakage and corrected.

Inspect the water pump, radiator core, heater core, drain cocks, water jacket plugs, and edge of cylinder head gaskets for evidence of leaks. Tighten all hose clamps in the cooling and heating systems and replace any deteriorated hoses.

d. Using and Testing Anti-Freeze Solutions

Inhibited year around ethylene-glycol type engine coolant solution which is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors should be used at all times (not less than 0 degrees F. to freeze protection should be provided to protect against corrosion). When adding solution due to loss of coolant for any reason or in areas where temperatures lower than minus 20 degrees F. may be encountered, a sufficient amount of any of the several brands of year around coolant (Ethylene-Glycol base) compatible to GM Specification 1899-M available on the market should be used.

NOTE: *Alcohol base coolants are not recommended for this vehicle at any time.*

If for any reason water is used as a coolant in an emergency, it is extremely important that Buick Heavy Duty Cooling System Protector and Water Pump Lubricant or equivalent be added to the cooling system as soon as possible. If any other coolant system protector is used, be certain it is labeled to indicate that it meets General Motors Specification GM 1899-M. It should be recognized that this is only a temporary measure. The manufacturer intends that permanent type coolant solution be used year around in the cooling system of your Buick.

The cooling system should be completely drained and the recommended coolant installed every two years. At this time, also add GM Cooling System Inhibitor and Sealer or equivalent.

It is advisable to check the anti-freeze solution at intervals during the winter to make certain that the solution has not been weakened by evaporization or leakage. Use only hydrometers which are calibrated to read both the specific gravity and the temperature. Obtain a table or similar means of converting the freezing point at various temperatures of the solution. Disregarding the temperature of the solution when making the test may cause an error as large as 30 degrees F. Care must be exercised to use the correct float or table for the particular type of anti-freeze being tested.

60-8 FAN BELT ADJUSTMENT AND REPLACEMENT

A tight fan belt will cause rapid wear of the Delcotron generator and water pump bearings. A loose belt will slip and wear excessively causing noise, engine over-heating, and unsteady generator output. A fan belt which is cracked or frayed, or is worn so that it bottoms in the pulleys should be replaced.

The fan belt may be replaced by loosening the generator

brace at both ends, slightly loosening the generator mounting bolts, and moving generator inward to provide maximum slack in the belt.

The Delcotron generator must be moved outboard to adjust the fan belt. After the Delcotron generator brace and mounting bolts are securely tightened the fan belt tension should be checked. See Figure 60- 7.

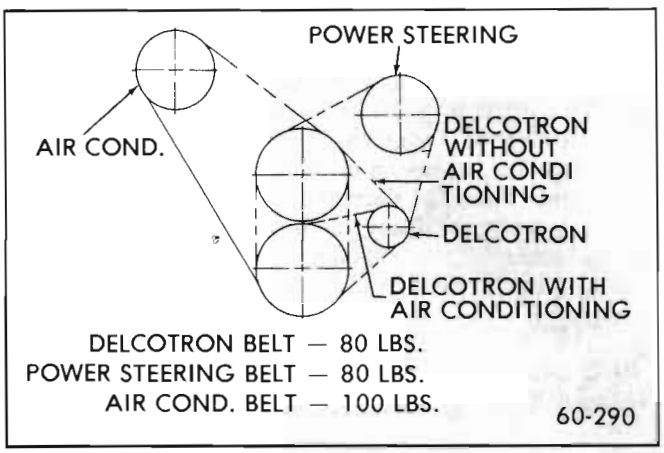


Figure 60-7 - Engine Belt Tension Chart

If the power steering oil pump belt is removed it should be adjusted to tension specified, in Figure 60-7.

If the Air Conditioner compressor belt is disturbed it should be adjusted as specified, in Figure 60-7.

60-9 RADIATOR THERMOSTAT INSPECTION AND TEST

A sticking radiator thermostat will prevent the cooling system from functioning properly. If the thermostat sticks in the open position, the engine will warm up very slowly. If the thermostat sticks in the closed position, overheating will result.

The thermostat may be removed for inspection by partially draning the cooling system and removing the thermostat housing.

If the thermostat valve does not fully close when cold, check for the presence of foreign material that could hold it open. If no foreign material is present and valve still does not close, replace the thermostat.

Test the thermostat for correct opening temperature by immersing the unit and a thermometer in a container of water. While heating the water do not rest either the thermometer or thermostat on bottom of container as this will cause them to register a higher temperature than the water. Agitate the water to insure uniform temperature of water, thermostat and thermometer.

The standard temperature (195 degrees) thermostat valve should start to open at approximately 195 degrees F., and should be fully open at approximately 212 degrees F. If thermostat does not operate at specified temperatures it must be replaced as it cannot be adjusted.

60-10 WATER PUMP REPAIRS

The water pump is cast iron into which the water pump bearing outer race is press fit. For this reason the cover, shaft bearing, and hub are not replaceable.

a. Removal of Water Pump

1. Drain coolant into a clean container.

2. Loosen belt or belts, then remove fan blade, and pulley or pulleys from hub on water pump shaft. Remove belts.

3. Disconnect hose from water pump inlet and heater hose from nipple. Remove bolts, pump assembly, and gasket from cylinder block.

4. Check pump shaft bearings for end play or roughness in operation. If bearings are not in serviceable condition, the assembly must be replaced.

b. Installation of Water Pump

1. Make sure the gasket surfaces on pump and cylinder block are clean. Install pump assembly with new gasket. Bolts must be tightened uniformly.

2. Connect radiator hose to pump inlet and heater hose to nipple. Fill cooling system and check for leaks at pump and hose joints.

3. Install fan pulley or pulleys and fan blade, tighten attaching bolts securely. Install belts and adjust for proper tension.

DIVISION IV

REMOVAL AND INSTALLATION

60-11 ENGINE ASSEMBLY REMOVAL AND INSTALLATION

a. Removal

1. Drain cooling system and engine oil.

2. Remove air cleaner and disconnect battery cables at battery.

3. Remove hood.

4. Remove radiator and radiator shroud.

5. Remove fan blade and belts.

6. Disconnect wires at:

a. Starter Solenoid

b. Delcotron

c. Temperature Switch

d. Oil Pressure Switch

e. Coil.

7. Disconnect:

a. Accelerator linkage at manifold bellcrank.

b. Exhaust pipe at manifold flange.

c. Fuel line at fuel pump.

d. Vacuum line to power brake unit at manifold (if so equipped).

e. Power steering pump and position to left (if so equipped).

f. Air conditioner compressor at bracket and position to right. Do not disconnect hoses (if so equipped).

g. Vacuum modulator line.

8. Raise vehicle and place on jack stands.

9. Support transmission with a suitable floor jack.

10. Remove flywheel cover pan.

11. Remove converter to flex plate bolts.

12. Remove transmission case to engine bolts.

13. Remove front engine mount through bolts.

14. Attach suitable chain and remove engine from vehicle.

15. Mount engine in stand.

b. Installation

1. Attach chain to engine and remove engine from engine stand.

2. Tilt and lower engine assembly into the chassis, guiding engine to align front mounts with frame supports.

3. Install front mount through bolt and torque to specification.

4. Install transmission case to engine bolts.

5. Install converter to flex plate bolts.

6. Install flywheel cover pan.

7. Remove jack stands and lower vehicle.

8. Connect:

a. Accelerator linkage at manifold bell crank.

b. Exhaust pipe at manifold flange.

c. Fuel line at fuel pump.

9. Connect Wires at:

a. Starter Solenoid

b. Delcotron

c. Temperature Switch

d. Oil Pressure Switch

e. Coil

10. Install fan belts and fan blade.

11. Install radiator and radiator shroud.

12. Replace hood.

13. Install air cleaner and connect battery cables.

14. Fill radiator using an ethylene-glycol type anti- corrosion cooling system protection solution developed for year around use (GM Specification GM 1899-M).

15. Fill crankcase with oil.

DIVISION V

OVERHAUL AND MAJOR SERVICE

61-12 INTAKE MANIFOLD, CYLINDER HEAD VALVE TRAIN AND LIFTERS

a. Intake Manifold Removal

1. Disconnect battery.

2. Remove air cleaner.

3. Remove power steering pump and bracket if equipped.

4. Disconnect both throttle rods at bellcrank and remove throttle return spring.

5. Disconnect fuel and vacuum lines at carburetor.

6. Disconnect crankcase ventilation hose at rocker arm cover.

7. Disconnect exhaust pipe at manifold flange and discard packing.

8. Remove manifold attaching bolts and clamps, then remove manifold assembly and discard gaskets.

9. Check for cracks in manifold castings.

10. Check operation of heat riser valve, if unable to free up, it will be necessary to replace the manifold.

11. If necessary to replace either intake or exhaust manifolds, separate them by removing one bolt and two nuts at center of assembly. Reassemble manifolds using a new gasket. Tighten finger tight and torque to specifications after assembly to cylinder head. Transfer all necessary parts.

b. Intake Manifold Installation

1. Clean gasket surfaces on cylinder head and manifolds.

2. Position new gasket over manifold end studs on head and carefully install the manifold in position making sure the gaskets are in place.

3. Install bolts and clamps while holding manifold in place with hand.

4. Torque bolts to specifications.

NOTE: *Center bolt and end bolt torque differ.*

5. Connect exhaust pipe to manifold using a new packing.

6. Install power steering pump and bracket if equipped and adjust for proper belt tension.

7. Connect crankcase ventilation hose at rocker arm cover.

8. Connect fuel and vacuum lines at carburetor.

9. Connect throttle rods at bellcrank and install throttle return spring.

10. Connect battery.

11. Install air cleaner, start engine, check for leaks and adjust carburetor idle speed and mixture.

c. Cylinder Head Removal

1. Drain coolant from radiator and block.

2. Remove manifold assembly as outlined in subparagraph a.

3. Remove air conditioning compressor if equipped and move it out of the way.

4. Remove air conditioning bracket bolts.

5. Disconnect spark plug wires from spark plugs.

6. Remove fuel and vacuum line from retaining clip at water outlet, then disconnect wires from temperature sending units.

7. Disconnect upper radiator hose at water outlet housing.

8. Remove coil.

9. Remove rocker arm cover.

NOTE: *Do not pry rocker arm cover loose. Gaskets adhering to cylinder head and rocker arm cover may be sheared by bumping end of rocker arm cover rearward with palm of hand or a rubber mallet.*

10. Remove rocker arm nuts, rocker arm balls, rocker arms and pushrods.

NOTE: *Place rocker arms, rocker arm balls, and pushrods in a rack so they may be reinstalled in the same location.*

11. Remove cylinder head bolts, cylinder head, and gaskets. Place cylinder head on two blocks of wood to prevent damage.

d. Cylinder Head Installation

1. Thoroughly clean off engine block gasket surface and be certain no foreign material has fallen in the cylinder bores or bolt holes. It is good practice to clean out bolt holes with an air hose.

2. Place new head gasket on cylinder block with the head up. Dowels in the block will hold the gasket in place.

NOTE: *Do not use gasket sealer on composition steel asbestos gasket.*

3. Clean gasket surface of cylinder head and carefully set in place on the engine block dowel pins.

4. Clean and lubricate the head bolts with "Perfect Seal" sealing compound.

NOTE: *Damage to the cylinder block threads can result if bolts are not lubricated with "Perfect Seal" prior to installation or if bolts are tightened excessively. Use an accurate torque wrench when installing head bolts. Uneven tightening of the cylinder head bolts can distort the cylinder bores, causing compression loss and excessive oil consumption.*

5. Install head bolts. Tighten the bolts a little at a time about three times around in the sequence shown in Figure 60-8. Give bolts a final torque in the same sequence. Torque to 95 lb. ft.

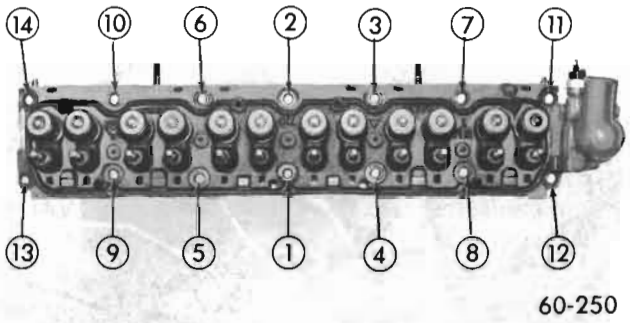


Figure 60-8--Cylinder Head Bolt Tightening

6. Assemble air conditioning mounting bracket.

7. Assemble air conditioning compressor to bracket and adjust proper belt tension.

8. Install coil.

9. Connect upper radiator hose and engine ground strap.

10. Connect temperature sending unit wires and install fuel and vacuum lines in clip at water outlet.

11. Install manifold assembly as outlined in subparagraph b. above.

12. Fill cooling system.

13. Install and adjust rocker arm assembly in the following manner.

NOTE: *Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with Molykote or its equivalent.*

a. Install push rods. Be sure push rods seat in lifter socket.

b. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.

14. Adjust valves when lifter is on base circle of camshaft as follows:

a. Mark distributor housing, with chalk, at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly (if not previously done).

b. Crank engine until distributor rotor points to number one cylinder position and breaker points are open. Both valves on number one cylinder may now be adjusted.

c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut. When play has been removed, turn adjusting nut in one full additional turn (to center lifter plunger).

d. Adjust the remaining valves, one cylinder at a time, in the same manner.

15. Install distributor cap and sparkplug wire assembly.

16. Install rocker arm cover using a new gasket. Torque bolts to specification.

17. Adjust carburetor idle speed and mixture.

e. Valve Stem Oil Seal and/or Valve Spring Replacement (on car)

1. Remove rocker arm cover.

2. Remove spark plug, rocker arm and push rod on the cylinder(s) to be serviced.

3. Apply compressed air to the spark plug hole to hold the valves in place using applicable air adapter.

4. Using a suitable compressor, such as J-22891, compress valve spring and remove valve spring cap keys. Release tool and remove shield spring and cap. See Figure 60-9.

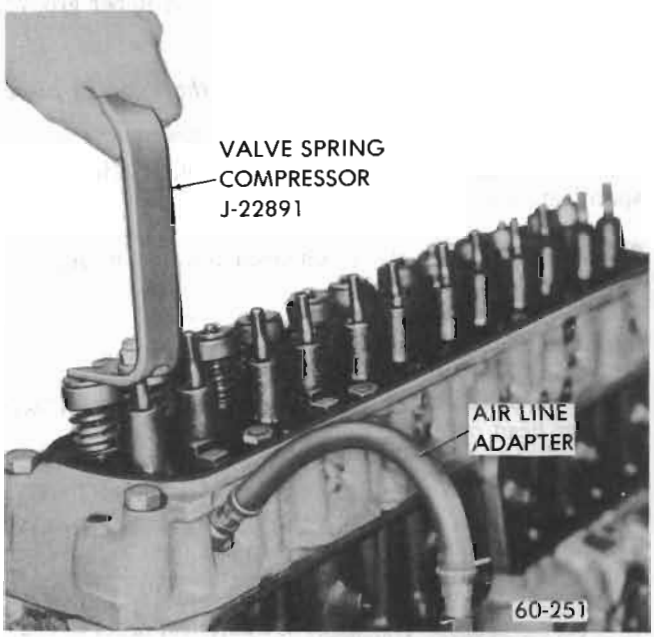


Figure 60-9 - Removing Valve Cap Retainers

5. Remove valve stem oil seal.

6. To replace, set the valve spring and damper, valve shield and valve cap in place. THE CLOSE COILED END OF THE SPRING IS INSTALLED AGAINST THE CYLINDER HEAD. See Figure 60-10. Compress the spring with J-22891 and install oil seal in the lower groove of the stem, making sure the seal is flat and not twisted.

NOTE: *A light coat of oil on the seal will help prevent twisting.*

7. Install the valve locks and release the compressor tool,

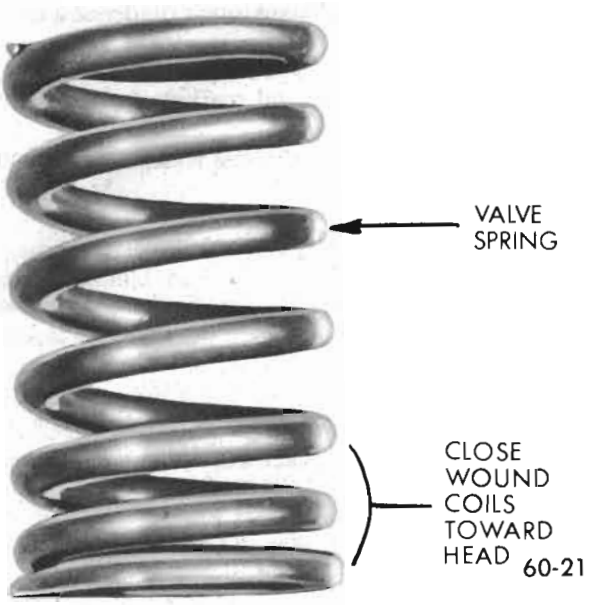


Figure 60-10 - Valve Spring

making sure the locks seat properly in the upper groove of the valve stem.

NOTE: *Grease may be used to hold the locks in place while releasing the compressor tool.*

8. Install spark plug, using a new gasket, and torque to specifications.

9. Install and adjust valve mechanism as stated in subparagraph d, Step 13.

f. Reconditioning Valves and Guides

1. Remove cylinder head per subparagraph c above. Place cylinder head on clean, smooth surface.

2. Using a suitable spring compressor, such as J-8062, compress valve spring and remove valve spring cap keys. Release tool and remove spring and cap then, remove oil seal. See Figure 60-11.

3. Remove valves. Place valves in numerical order so that they can be reinstalled in original locations.

4. Remove carbon from combustion chamber of heads. Be careful when performing this operation so that valve seats are not scratched.

NOTE: *A soft wire brush, such as J-8358 is suitable for this purpose.*

5. Clean carbon and gum deposits from valve guide bores.

6. Clean valves. Inspect valve faces and seats for pitting, burned spots, or other defects that could cause poor seating.

7. Grind or replace valves as necessary. If a valve head must be ground to a knife edge to obtain a true face, the valve should be replaced, as a sharp edge will run too hot. 45 degrees is the correct angle for valve faces.

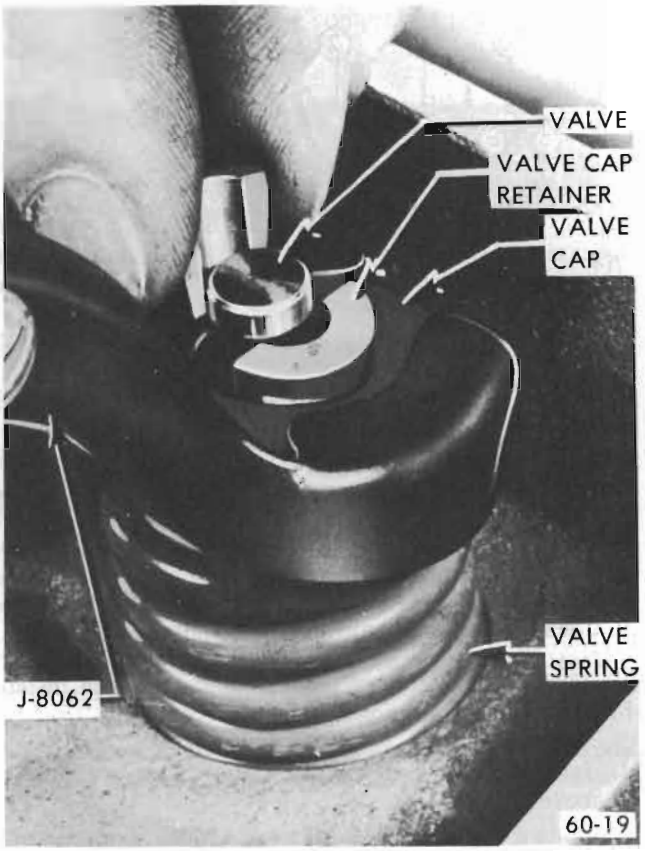


Figure 60-11 - Removing Valve Cap Keys

8. If a valve stem has excessive clearance in its guide, the guide must be reamed oversize. See Figure 60-12. Oversize valves of .003", .015" and .030" are available through the Parts Department.

J-5830-1 - .003" O.S.
J-5830-2 - .015" O.S.
J-5830-3 - .030" O.S.

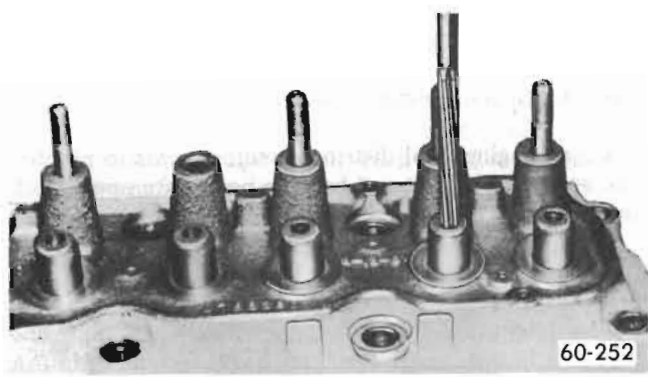


Figure 60-12 - Reaming Valve Guide

9. True up valve seats to 45. Cutting a valve seat results in lowering the valve spring pressure and increases the width of the seat. The nominal width of the valve seat is 1/16". If a valve seat is over 5/64" wide after truing up, it should be narrowed to specified width by use of 20 degree and 70 degree stones.

10. Lightly lap the valves into seats with fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that a minimum of lapping is required. Excessive lapping will groove the valve face preventing a good seat when hot.

11. Test valves for concentricity with seats and to tight seating. The usual test is to coat the valve face lightly with Prussian Blue and turn the valve against seat. If the valve seat is concentric with the valve guide, a mark will be made all around the seat; while if the seat is not concentric with the guide, a mark will be made on only one side of the seat. Next, coat the valve seat lightly with Prussian Blue. Rotate the valve against the seat to determine if the valve face is concentric with the valve stem and if the valve is seating all the way around. Both of these tests are necessary to prove that a proper seat is being obtained.

12. Lube with "Service MS" engine oil and reinstall valves, valve springs, cap, oil seal, and cap retainer, using same equipment used for removal. Install valve spring with closely wound coil toward the cylinder head. See Figure 60-10.

13. Install cylinder head as outlined in subparagraph d. above.

g. Valve Lifter Service

1. Remove valve mechanism as outlined in paragraph 60-12. (steps 9 and 10)

2. Mark distributor housing with chalk at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.

3. Crank engine until distributor rotor points to number one position, then disconnect distributor primary lead at coil and remove distributor.

4. Remove push rod covers. (discard gaskets)

5. Remove lifters and place in a wooden block with numbered holes or similar devise to keep them identified as to position in engine.

6. If less than a complete set of lifters is being removed, disassemble one or two and check for dirt or varnish. If this condition exists, it is advisable to remove all lifters for cleaning and inspection. Otherwise, service only those lifters that are not operating properly.

7. Examine the cam contact surface at lower end of lifter body. If this surface is excessively worn, galled, or otherwise damaged, discard the lifter assembly. In this case, also examine the mating camshaft lobe for excessive wear or damage.

NOTE: *Two types of hydraulic lifters are used. Both types of lifters operate on the same principle and are serviced basically in the same manner. The complete lifter assemblies are interchangeable but parts from one lifter are not interchangeable with another. Both lifters are easily identified by the outside configuration of the lifter body. For purposes of identification we refer to them as lifter "A" and lifter "B". See Figure 60-13.*

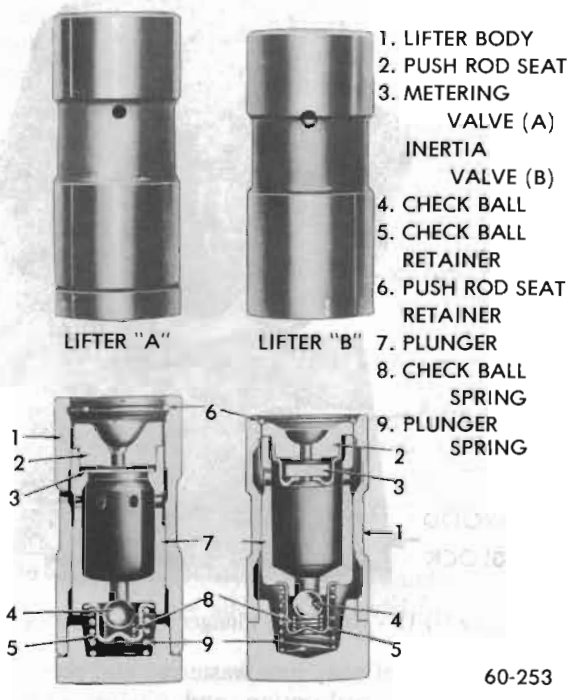


Figure 60-13 - Hydraulic Valve Lifter Parts

8. Disassemble each valve lifter by using a push rod to hold down the push rod seat while removing the plunger retainer from the lifter body using Retainer Remover J-5238. See Figure 60-14, View A.

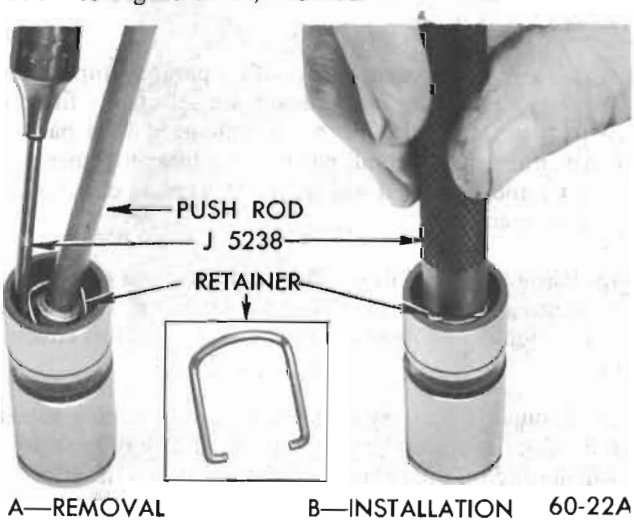


Figure 60-14 - Plunger Retainer

9. Remove the push rod seat and metering valve (lifter "A") or the inertia valve assembly (lifter "B"). See Figure 60-13.

10. If a plunger sticks in lifter body, place lifter in large end of Plunger Remover J-4160-A, with plunger inward. While holding lifter with thumb, rap the open end of remover against a block of wood with just enough force to jar the plunger from body. See Figure 60-15.

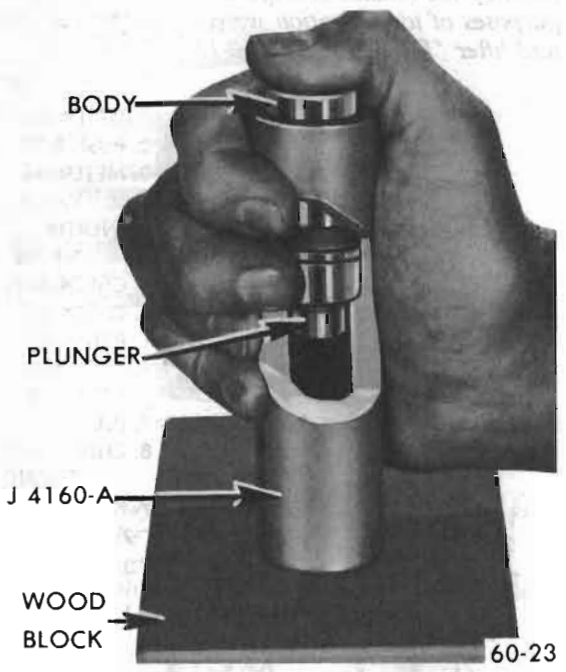


Figure 60-15 - Removing Plunger With J-4160-A

11. Drain oil out of body into waste can and remove the ball retainer, ball, ball spring, and plunger spring. A strainer placed over waste can will prevent dropping these parts into can.

NOTE: *Inertia valve and retainer (lifter "B") should not be removed from the push rod seat. To check the valve, shake the push rod seat and inertia valve assembly and the valve should move.*

12. Place all parts of each lifter in a separate compartment of a tray. The body and plunger are selectively fitted to each other and must not be interchanged with parts of other lifters. Keeping all parts of the lifter together until cleaned and inspected will aid in diagnosing cause of improper operation.

13. Rinse the tray full of lifter parts in a pan of kerosene to remove as much oil as possible. This will reduce contamination of the cleaning solvent and extend its effective life.

14. Submerge the tray and parts in the cleaning solvent and soak for approximately one hour. The time required will depend on the varnish on lifter parts and the effectiveness of the solvent.

15. After the varnish has dissolved or has softened sufficiently to permit removal by wiping, raise the tray and suspend it above the solvent by means of the hooks on tray handles. Allow tray and parts to drain so that solvent will be saved.

16. Rinse the tray of parts in the pan of kerosene to cut the solvent and avoid injury to hands, then place tray on the tank cover located on bench in front of cleaning tank.

17. Working on one lifter at a time and using CLEAN lint-free cloths, thoroughly wipe off all parts. Clean the plunger and the external and internal surfaces of the body with a hard wiping action to remove any varnish deposits. Rinse the parts in kerosene using Cleaning Brush J-5099 to clean the bore of lifter body.

NOTE: *To insure absolute cleanliness of a reconditioned lifter assembly, it is advisable to inspect and assemble each lifter before cleaning the next lifter.*

18. The following list outlines the inspection of lifter parts. An inspection should be made at this point to determine whether or not a lifter is in need of replacement.

NOTE: *The hydraulic valve lifter is serviced as a complete assembly only. If one or more of the valve lifter components are faulty, the complete lifter must be replaced.*

(a) *Lifter Body.* Inspect inner and outer surfaces of body for blow holes and scoring. Replace lifter assembly if body is roughly scored or grooved, or has a blow hole extending through the wall in position to permit oil leakage from lower chamber. The prominent wear pattern just above lower end of body should not be considered a defect unless it is definitely grooved or scored; it is caused by side thrust of cam against body while the lifter is moving vertically in its guide.

Inspect the cam contact surface on lower end of lifter body. Replace the lifter assembly if this surface is excessively worn, galled, or otherwise damaged. A lifter body that has been rotating will have a round wear pattern and a non-rotating lifter body will have spalling on the lifter base.

NOTE: *The L-6 engine has valve lifters with a slight spherical shaped base that induces lifter rotation, which is caused by the tapered lobes on the camshaft producing camshaft thrust rearward, inducing lifter rotation.*

(b) *Lifter Plunger.* Using a magnifying glass, inspect the check ball seat for defects. Inspect outer surface of plunger for scratches or scores. Small score marks with a rough, satiny finish will cause the plunger to seize when hot but operate normally when cool. Defects in check ball seat or scores or scratches on outer surface of plunger which may be felt with a fingernail are causes for replacing the lifter assembly. This rule does not apply to the slight edge which may sometimes be present where the lower end of plunger extends below the ground inner surface of the body. This edge is not detrimental unless it is sharp or burred.

A blackened appearance is not a defective condition. Sometimes the discoloration serves to highlight slight grinder chatter marks and give the outer surface of plunger a ridged or fluted appearance. This condition will not cause improper operation, therefore it may be disregarded.

(c) *Push Rod and Seat.* Replace lifter if the area where the push rod contacts the push rod seat is rough, or otherwise damaged. Replace any push rod having a rough or damaged ball end.

(d) *Check Ball.* Using a magnifying glass, carefully examine the check ball for nicks, imbedded material or other defects which would prevent proper seating. Such defects would indicate the cause of intermittently noisy lifter operation.

(e) *Check Ball Spring.* Examine check ball spring for wear or damage. Replace lifter if any spring is distorted or shows evidence of wear.

(f) *Ball Retainer.* Replace lifter if a retainer is cracked or which has a heavily worn area. A small bright spot where the ball contacts the retainer is the normal condition.

(g) *Plunger Spring.* Replace lifter if the plunger spring is distorted or damaged. Exhaustive tests have shown that plunger springs seldom break down in service.

19. Rinse lifter plunger in the kerosene in middle compartment of cleaning tank and then give it a thorough final rinsing in the kerosene in right compartment.

20. Hold plunger in vertical position with feed hole up, then rinse and install the check ball, checkball spring, ball retainer, spring, and body over the plunger. See parts in Figure 60-13.

21. Rinse push rod seat and plunger retainer, place these parts in end of body and depress with handle of Remover J-5238 until retainer engages groove in body. See Figure 60-11.

22. Wrap the lifter in clean paper or otherwise protect it from dirt while reconditioning the other valve lifters, preparatory to testing all lifters for leakdown rate.

23. Check lifter leakdown rate according to subparagraph h below.

24. Make certain that valve lifter guide holes and adjacent area of cylinder block are clean. Liberally lubricate the camshaft and lifter bores with "Service MS" oil and install lifters. Each lifter must slide freely in its guide hole.

25. Following the procedure outlined in paragraph 60- 12, subparagraph d, reassemble engine.

h. Checking Valve Lifter Leakdown Rate

After a hydraulic lifter has been cleaned, inspected, and assembled, it must be tested before it is installed in an engine. Lifter Test Fixture J-5790 has been designed to test the leakdown rate of a lifter to determine whether it is within limits which assure satisfactory lifter operation.

The following procedure must be carefully followed to obtain an accurate test.

1. Thoroughly clean cup of test fixture, install cup on fixture, and fill it to within 1/2" of top with "Hydraulic Lifter Test Fluid" which is available under J-5268.

2. Remove rubber washer (used for larger lifters) and install Gauge Sleeve J-5180-5 in cup; also install J-5180-15 in ram.

3. Swing weight arm up out of way, raise ram and place valve lifter (top side up) in Sleeve J-5180-5. The lifter must be completely covered by fluid during test.

4. Lower ram to rest in lifter push rod seat, then lower the weight arm to rest on roller of ram.

5. Operate lifter plunger through its full travel to force all air out of lifter by using a vigorous pumping action on weight arm. Continue pumping action until considerable resistance is built up in lifter and a definite grab point is felt at the top of stroke when indicator pointer is at bottom of the scale.

Finally, pump vigorously for approximately 10 additional strokes to make sure all air is removed from lifter.

6. Raise weight arm to allow lifter plunger to come up to its retainer, then lower arm to rest on the ram roller. As pointer starts moving upward, start rotating fluid cup by turning handle one revolution every two seconds. See Figure 60-16.

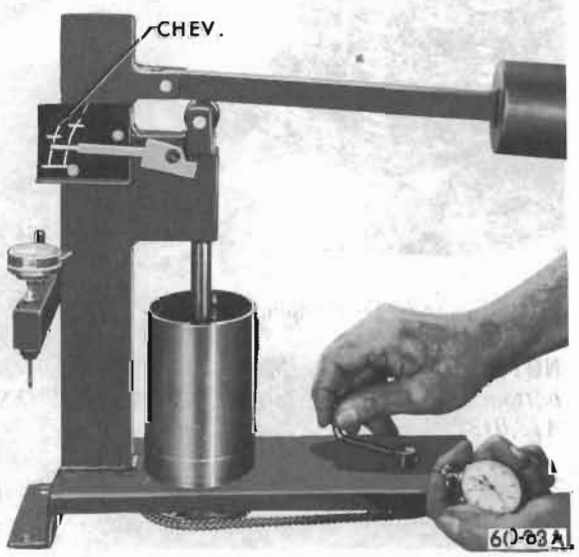


Figure 60-16--Checking Lifter Leakdown Rate

7. Use a stop watch to check time required for pointer to move from lower to upper mark on scale where marked "CHEV." The cup must be rotated during this test.

8. The leakdown rate (time between marks) must be between 10 and 45 seconds to assure satisfactory lifter performance.

NOTE: *The newer Model J-5790 leakdown tester will have a different scale than the one shown in Figure 60-16. In this case, time the pointer travel from the "Start" position to the .094 mark on the scale. The leakdown rate must still be between 10 and 45 seconds.*

A doubtful lifter should be tested three or four times. Replace any lifter which does not test within specified limits.

9. After all lifters have been tested, place cover over the test fixture to keep dirt out of cup and fluid. The fluid should be discarded and cup thoroughly cleaned after a few sets of lifters have been tested.

i. Removing and Installing Rocker Arm Stud

1. If rocker arm stud is loose or pulled out of head it will be necessary to ream stud hole to next largest size. See Figure 60-17.

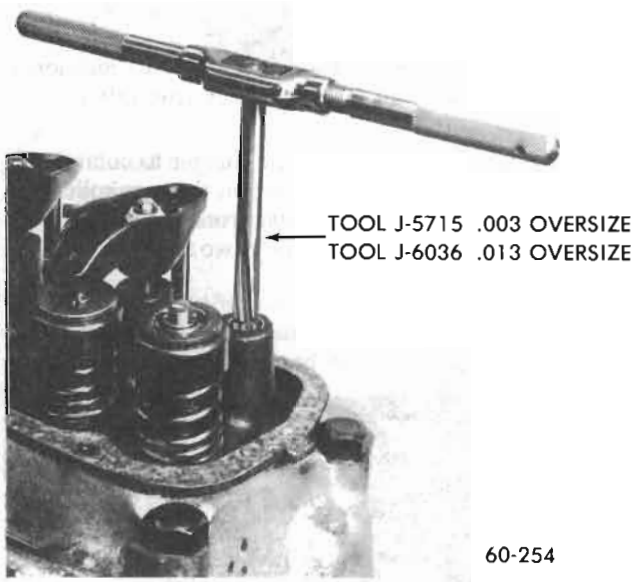


Figure 60-17--Reaming Rocker Arm Stud Hole

NOTE: *Oversize studs have the size marked on the bottom. Example: A1.001" O.S., A3.003" O.S. and A13.013" O.S.*

2. Install new O.S. stud as shown in Figure 60-18, tool should bottom on head.

3. If rocker arm stud is stripped refer to Figure 60-19 for rethreading and Figure 60-20 for pulling the stud.

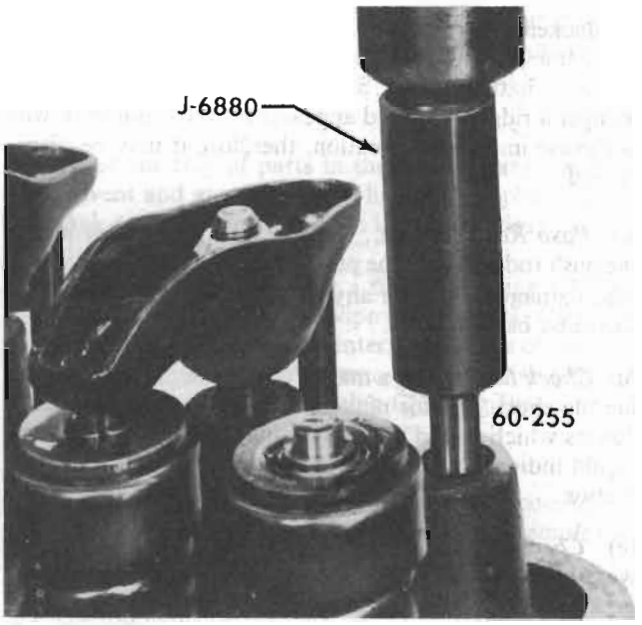


Figure 60-18 - Installing Rocker Arm Stud

4. Install new stud as shown in Figure 60-113; tool should bottom on head.

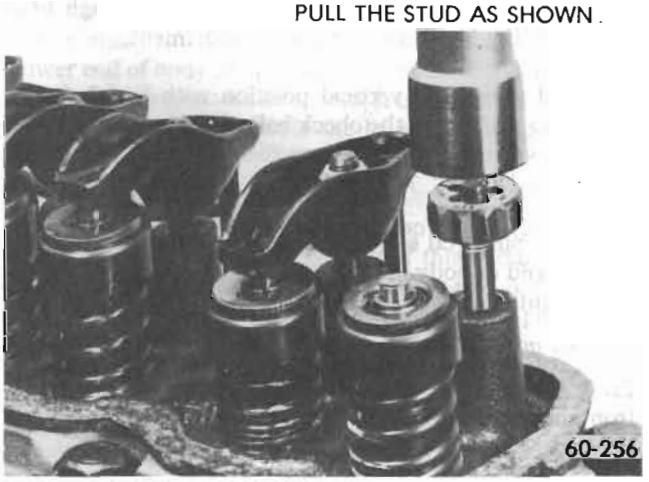


Figure 60-19 - Removing Stripped Rocker Arm Stud

j. Distributor Lower Bearing and Thrust Washer Replacement

The distributor lower bearing is a bronze bushing pressed into the lower side of the engine block. Its upper inside diameter pilots the distributor shaft and the outside diameter extending below the block pilots the oil pump.

Some engines have a thrust washer at the upper end of the bushing bore. The thrust washer, where used, may be replaced at the same time the bushing is replaced.

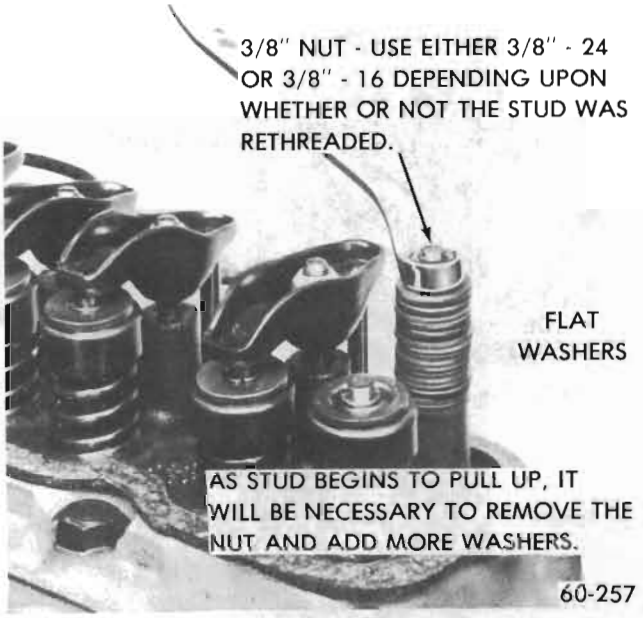


Figure 60-20 - Removing Rocker Arm Stud

The lower bushing will ordinarily require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .0035", the bushing should be replaced as follows with oil pump and distributor removed. See Figure 60-116.

1. Install Tool J-9534-01 into bushing and using a slide hammer, remove the bushing.

2. Using a drift up through bushing bore, drive thrust washer (if installed) out of bore and remove from block.

3. Clean bushing bore in block and check for burrs or damage.

4. If thrust washer was removed start new washer in position in bore and drive into place.

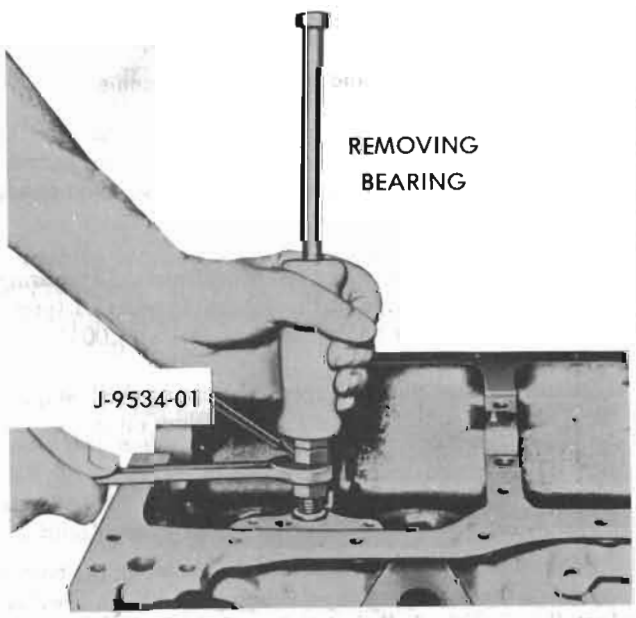
5. Position bushing and drive the bushing into position until 3/16" is extended below the crankcase rail.

6. Position bushing and driver to block and drive the bushing in position, which is determined by tool bottoming against the block.

60-13 CONNECTING ROD BEARINGS

A *connecting rod bearing* consists of two halves or shells which are alike and interchangeable in rod and cap. When the shells are placed in rod and cap, the ends extend slightly beyond the parting surfaces so that when rod bolts are tightened, the shells will be clamped tightly in place to insure positive seating and to prevent turning. *The ends of shells must never be filed flush with parting surface of rod or cap.*

If a precision type connecting rod bearing becomes noisy or worn so that clearance on crankpin is excessive, a new bearing of proper size must be selected and installed since no provision is made for adjustment. *Under no circumstances should the connecting rod or cap be filed to adjust the bearing clearance.*



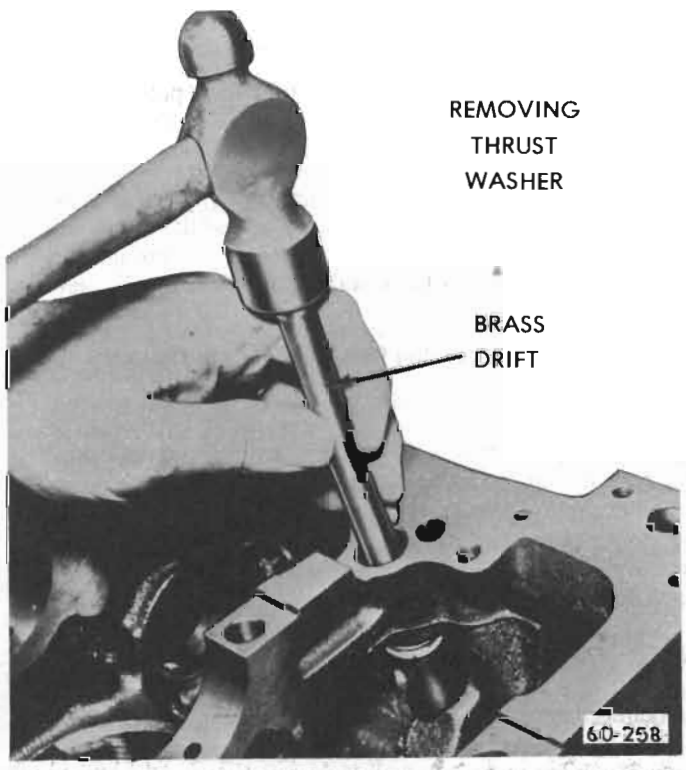


Figure 60-21--Replacing Distributor Bearing and Thrust Washer

a. Oil Pan Removal

1. Disconnect battery.

2. Remove air cleaner and disconnect throttle linkage.

3. Remove fan shroud to radiator tie bar screws.

4. Raise vehicle and support on stands.

5. Drain oil.

6. If equipped with automatic transmission:

a. Remove lower flywheel housing.

b. Remove shift linkage attaching bolt and swing out of way.

c. Disconnect exhaust pipe at manifold.

8. Remove front engine mounting bolts.

9. Raise engine as far as it will go by placing a jack under crankshaft pully mounting.

10. Remove engine mounts completely from frame. This is necessary for clearance of pan rail.

11. Remove oil pan bolts and oil pan.

b. Oil Pan Installation

1. Clean oil pan. Make sure gasket surfaces on pan and block are clean.

2. Install oil pan rear seal.

3. Apply non-hardening permatex to a few spots on the new pan gasket and install on block. *Make sure the new seal and gaskets are properly fitted. See Figure 60-22.*

4. Install oil pan. Torque bolts to 10 lb. ft. Do not over tighten.

5. Reverse procedures for installation.

c. Inspection of Connecting Rod Bearings and Crankpin Journals

After removal of engine oil pan, disconnect two connecting rods at a time from crankshaft and inspect the bearings and crankpin journals. While turning crankshaft, it is necessary to temporarily reconnect the rods to crankshaft to avoid possibility of damaging the journals through contact with loose rods.

NOTE: *Do Not interchange rod caps with rods.*

If connecting rod bearings are chipped or scored, they should be replaced. If bearings are in good physical condition, check for proper clearance on crankpin as described in subparagraph b below.

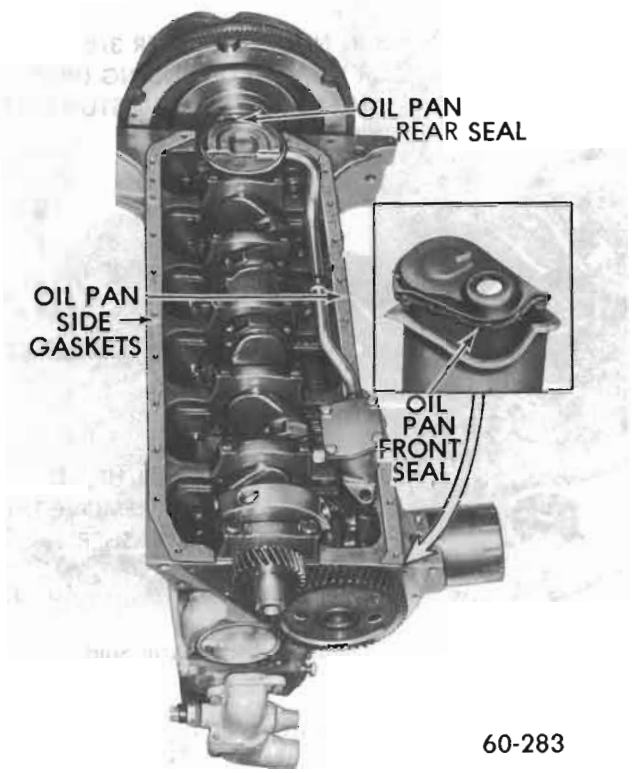


Figure 60-22 Pan Gasket and Seals

If crankpin journals are scored or ridged, the crankshaft must be replaced or reground for undersize bearings. Slight roughness may be polished out with fine grit polishing cloth thoroughly wetted with engine oil. Burrs may be honed off with a fine oil stone.

Use an outside micrometer to check crankpins for out-of-round. If crankpins are more than .001" out-of- round, satisfactory life of new bearings cannot be expected.

d. Checking Clearance and Selecting Replacement Bearings

Service bearings are furnished in standard size and several undersizes.

The clearance of connecting rod (and crankshaft) bearings may be checked by use of Plastigage, Type PG-1 (green) or equivalent which has a range of .001" to .003".

1. Remove connecting rod cap with bearing shell. Wipe oil from bearing and crankpin journal. Blow oil out of hole in crankshaft.

NOTE: *Plastigage is soluble in oil.*

2. Place a piece of Plastigage lengthwise along the bottom center of the lower bearing shell (Figure 60- 23, View A). Install cap with shell and tighten bolt nuts to 35 lb. ft. torque.

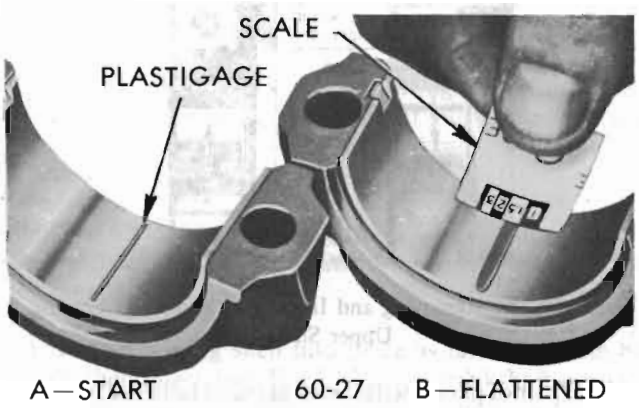


Figure 60-23--Checking Bearing with Plastigage

3. DO NOT TURN CRANKSHAFT with Plastigage in bearing.

4. Remove bearing cap with bearing shell, the flattened Plastigage will be found adhering to either the bearing shell of the crankpin. *Do not remove it.*

5. Using the scale printed on the Plastigage envelope, measure the flattened Plastigage at its widest point. The number within the graduation which most closely corresponds to the width of Plastigage indicates the bearing clearance in thousandths of an inch. See Figure 60-23, View B.

6. The desired clearance with a new bearing is .0007" to .0027". If bearing has been in service, it is advisable to install a new bearing if the clearance exceeds .004"; however, if bearing is in good condition and is not being checked because of bearing noise, it is not necessary to replace the bearing.

7. If a new bearing is being selected, try a standard size, then each undersize bearing in turn until one is found that is within the specified limits when checked for clearance with Plastigage.

NOTE: *Each undersize bearing shell has a number stamped on outer surface on or near the tang to indicate amount of undersize.*

8. After the proper size bearing has been selected, clean off the Plastigage, oil the bearing thoroughly, reinstall cap with bearing shell and tighten bolt nuts. See note in Step 2. Torque to 35 lb. ft.

9. With selected bearing installed and bolts tightened, it should be possible to move connecting rod freely back and forth on crankpin as allowed by end clearance. If rod cannot be moved, either the bearing is too much undersize or a misaligned rod is indicated.

10. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.

11. Measure all connecting rod side clearances (see specifications), between the connecting rod cap and side of crankpin. See Figure 60-24.

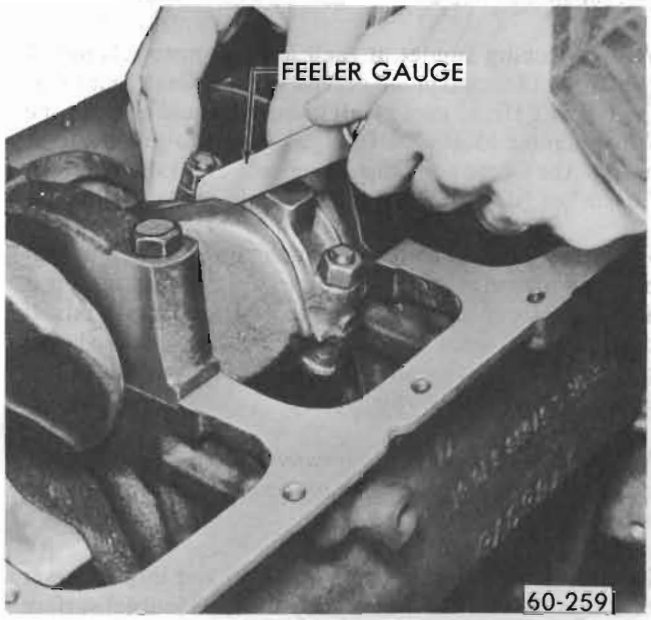


Figure 60-24 - Measuring Connecting Rod Side Clearance

60-14 CRANKSHAFT BEARINGS AND SEALS

a. Replacement of Crankshaft Bearings

A crankshaft bearing consists of two halves or shells which are not alike and not interchangeable between cap and crankcase. The upper (crankcase) half of the bearing is grooved to supply oil to the connecting rod bearings while the lower (bearing cap) half of the shell is not grooved. All crankshaft bearings except the rear main bearings are identical. The thrust bearing (No. 7) is flanged to take end thrust. When the shells are placed in crankcase and bearing cap, the ends extend slightly beyond the parting surfaces. When cap bolts are tightened, the shells will be clamped tightly in place to insure positive seating and to prevent turning. *The ends of shells must never be filed flush with parting surface of crankcase or bearing cap.*

Crankshaft bearings are the precision type which do not require reaming to size or other fitting. Shims are not provided for adjustment since worn bearings are readily replaced with new bearings of proper size. Bearings for service replacement are furnished in standard size and undersizes. *Under no circumstances should crankshaft bearing caps be filed to adjust for wear in old bearings.*

After removal of oil pan, see paragraph 60-13, oil pump and pick up screen assembly, perform the following removal, inspection and installation operations on each crankshaft bearing in turn so that the crankshaft will be well supported by the other bearings.

NOTE: *The following procedure is suggested when checking crankshaft for distortion.*

Rest crankshaft on "V-blocks" at No. 1 and No. 7 main bearing journals. Check indicator runout at No. 2 and 6 main bearing journals. Total indicator readings at each journal should not exceed .001".

When checking runout at each journal, note relation of "high" spot (or maximum eccentricity) on each journal to the others. "High" spot on all journals should come at the same angular location. If "high" spots do not come at nearly the same angular location, crankshaft has a "crook" or "dogleg" in it and is unsatisfactory for service.

1. Since any service condition which affects the crankshaft bearings may also affect the connecting rod bearings, it is advisable to inspect connecting rod bearings first. If crankpins are worn to the extent that crankshaft should be replaced or reground, replacement of crankshaft bearings only will not be satisfactory.

NOTE: *If replacement of cylinder block or crankshaft is required, always check main bearing clearance with Plastigage to obtain specified limits.*

2. Remove one bearing cap, then clean and inspect lower bearing shell and the crankshaft journal. If journal surface is scored or ridged, the crankshaft must be replaced or reground to insure satisfactory operation with new bearings. Slight roughness may be polished out with fine grit polishing cloth thoroughly wetted with engine oil, and burrs may be honed off with a fine stone.

3. If condition of lower bearing shell and crankshaft journal is satisfactory, check the bearing clearance with Plastigage as described for connecting rod bearings in paragraph 60-13.

4. When checking a crankshaft bearing with Plastigage, turn crankshaft so that oil hole is up to avoid dripping oil on Plastigage. Place paper shims in lower halves of adjacent bearings and tighten cap bolts to take the weight of crankshaft *off the lower shell of bearing being checked.*

5. If bearing clearance exceeds .004", it is advisable to install a new bearing; however, if bearing is in good condition and is not being checked because of bearing noise, it is not necessary to replace the bearing.

6. Loosen all crankshaft bearing cap bolts 1/2 turn, and remove cap of bearing to be replaced.

7. Remove upper bearing shell by inserting Bearing Shell Remover and Installer J-8080 in oil hole in crankshaft. Then slowly rotate crankshaft so that tool rotates the shell out of place by pushing against end without tang. See Figure 60-25.

NOTE: *The rear main journal has no oil hole. Replace the rear main bearing upper half as follows:*

a. Use a small drift punch and hammer to start the upper bearing half rotating out of block.

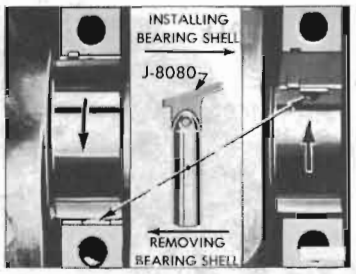


Figure 60-25 - Removing and Installing Crankshaft Bearing Upper Shell

b. Use a pair of pliers (with taped jaws) to hold the bearing thrust surface to the oil slinger and rotate the crankshaft to remove bearing. See Figure 60-26.

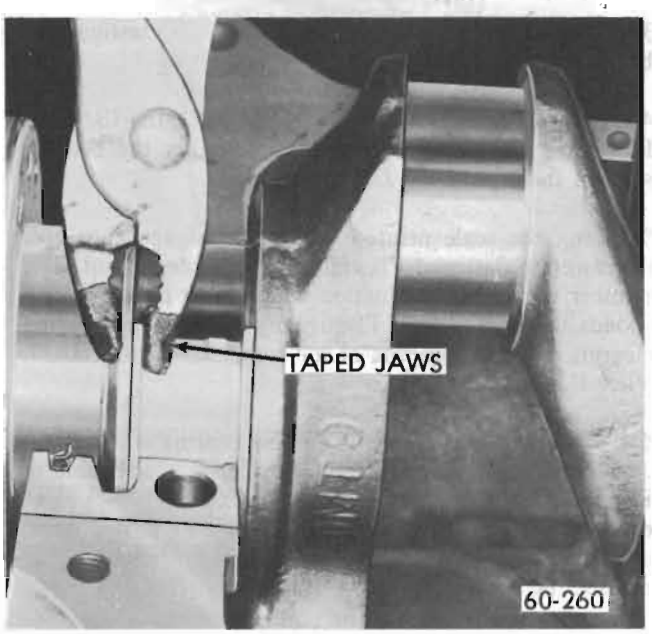


Figure 60-26 - Rear Main Bearing Replacement

c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and indented or notched side of block.

d. Use pliers as in removing to rotate bearing into place. The last 1/4" movement may be done by holding just the slinger with the pliers or tap in place with a drift punch.

8. The crankshaft journal cannot be measured with an outside micrometer when shaft is in place; however, when upper bearing shell is removed, the journal may be checked for out-of-round by using a special crankshaft caliper and inside micrometer. The caliper should not be applied to journal in line with oil hole.

If crankshaft journal is more than .001" out-of-round, the crankshaft should be replaced since satisfactory service cannot be expected from bearings used with an excessively out-of-round crankshaft.

9. Before installation of bearing shells, make sure that

crankshaft journal and the bearing seats in crankcase and cap are thoroughly cleaned.

10. Coat inside surface of upper bearing shell with engine oil and place shell against crankshaft journal so that tang on shell will engage notch in crankcase when shell is rotated into place.

IMPORTANT: *Upper bearing shells have an oil groove in their center, while lower shells are plain. They must not be interchanged.*

11. Rotate bearing shell into place as far as possible by hand, then insert Installer J-8080, in crankshaft oil hole and rotate crankshaft to push shell into place. See Figure 60-25.

CAUTION: *Bearing shell should move into place with very little pressure. If heavy pressure is required, shell was not started squarely and will distort if forced into place.*

12. Place lower bearing shell in bearing cap, then check clearance with Plastigage as previously described.

13. The desired clearance with a new bearing is .0029" to .003". If this clearance cannot be obtained with a standard size bearing, insert an undersize bearing and check again with Plastigage.

NOTE: *Each undersize shell has a number stamped on outer surface on or near the tang to indicate amount of undersize.*

14. When the proper size bearing has been selected, clean out all Plastigage, oil the lower shell and reinstall bearing cap. Clean the bolt holes and lube bolts, then torque cap bolts to 65 lb. ft. The crankshaft should turn freely at flywheel rim; however, a very slight drag is permissible if an undersize bearing is used.

15. After bearing is installed and tested, loosen all bearing cap bolts 1/2 turn and continue to install other bearings. When bearings have been installed and tested, tighten all bearing cap bolts to 65 lb. ft.

16. Refer to subparagraph b for replacement of rear bearing oil seals.

17. Install oil pump, pipe and screen assembly following procedure given in paragraph 60-12.

18. Thoroughly clean lower crankcase and flywheel housing and bell housing cover before installation.

19. Install oil pan per paragraph 60-13.

b. Installation of Rear Bearing Oil Seals

The rear main bearing oil seal can be replaced (both halves) without removal of the crankshaft.

NOTE: *Always replace the upper and lower seal as a unit. Install with the lip facing toward the front of the engine.*

1. With the oil pan removed, remove the rear main bearing cap.

2. Remove oil seal from the groove by lifting the end tab then clean seal groove. See Figure 60-27.

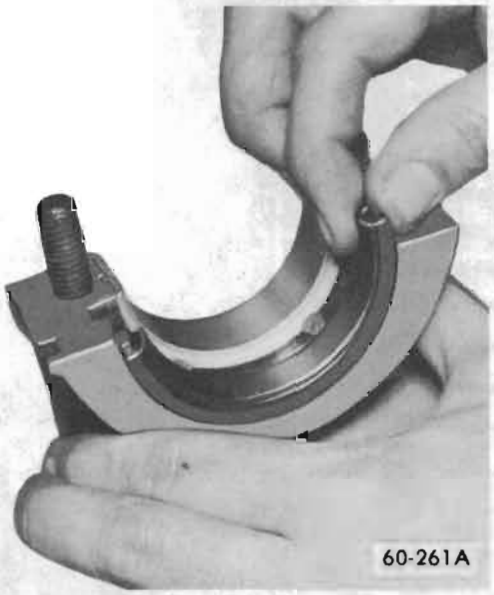


Figure 60-27 - Removing Rear Main Oil Seal (Lower)

3. Lubricate the lip and O.D. of a new seal with engine oil. Keep oil off the parting line surface. Insert seal in cap and roll it into place with finger and thumb, using light pressure so beads on seal O.D. are not cut by seal groove at cap parting line. Be sure tabs on seal are properly located in cross grooves.

4. To remove the upper half of the seal, use a small hammer to tap a brass pin punch on one end of seal until it protrudes far enough to be removed with pliers. See Figure 60-28.

NOTE: *Always clean crankshaft surface removing all foreign deposits before installing a new seal. Also clean seal grooves.*

5. Lubricate the lip and O.D. of a new seal with engine oil. Keep oil off the parting line surface. Gradually push with a hammer handle, while turning crankshaft, until seal is rolled into place (similar to installing a main bearing). Be careful that seal bead on O.D. is not cut. Compress seal towards crankshaft as much as possible.

6. Install the rear main bearing cap (with new seal) and torque to specifications. Be sure cross seal tabs are in place and properly seated.

60-15 CAMSHAFT AND CRANKCASE FRONT COVER

a. Crankcase Front Cover Removal

1. Remove engine from vehicle as outlined in paragraph 60-11.

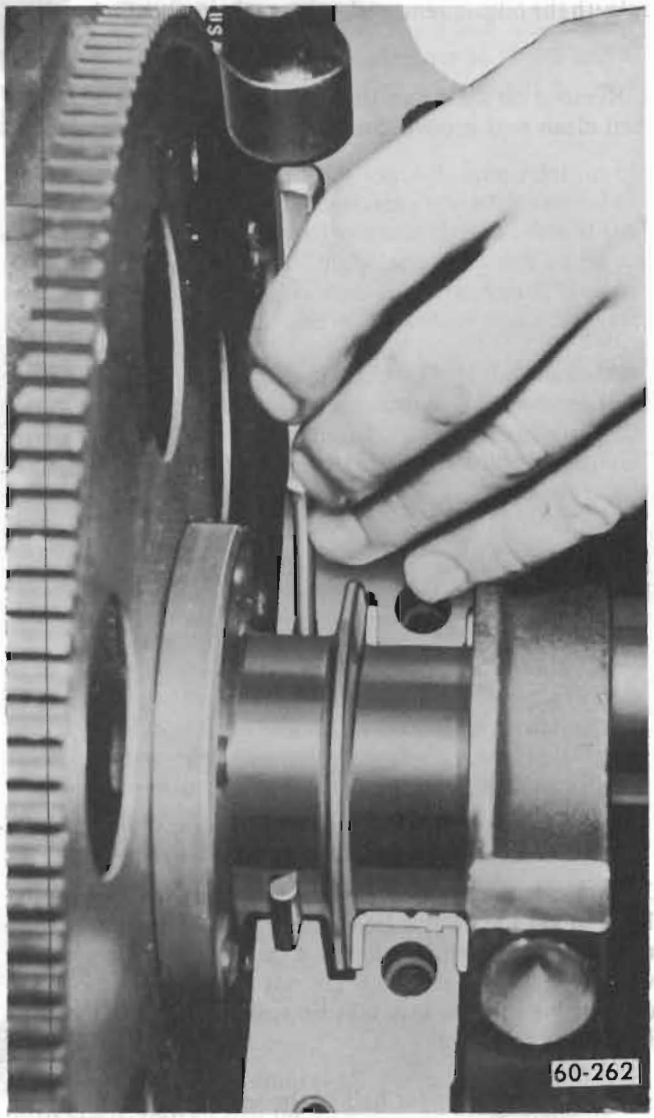


Figure 60-28 - Removing Rear Main Oil Seal (Upper)

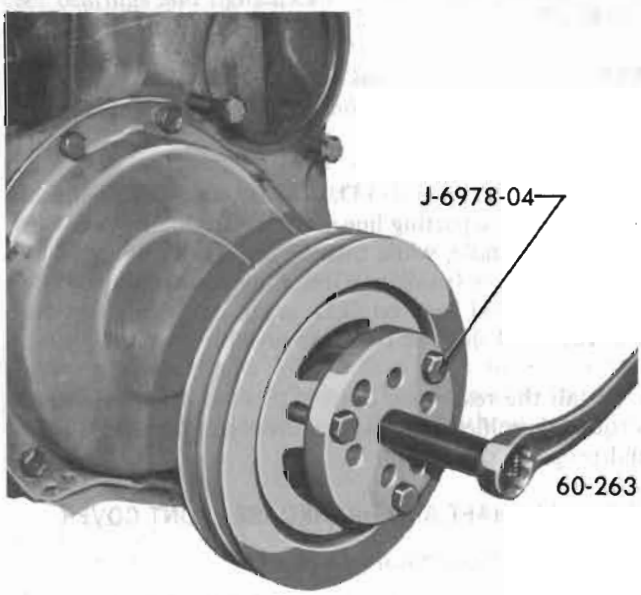


Figure 60-29 - Removing Torsional Damper

2. Remove oil pan.

3. Install Tool J-6978 to torsional damper and turn puller screw to remove damper. See Figure 60-29.

4. Remove crankcase front cover attaching bolts and remove cover and discard gasket. Thoroughly clean the cover, taking care to avoid damage to the gasket surfaces.

b. Crankcase Front Cover Installation

1. Clean gasket surfaces on block and crankcase front cover.

2. Install centering Tool J-21742 in crankcase front cover seal. See Figure 60-30.

Figure 60-30 - Installing Centering Tool in Cover

3. Coat the gasket with gasket sealer and place in position on cover, then install crankcase front cover to block and torque bolts to 80 lb. in.

4. Remove centering Tool.

NOTE: *It is important that centering tool be used to align front cover so that torsional damper installation will not damage seal and to position seal evenly around the balancer or hub surface.*

5. Coat front cover seal contact area of damper with engine oil.

6. Install torsional damper as follows:

CAUTION: *The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight section on the hub will destroy the tuning of the torsional damper.*

a. Coat front cover seal area (on damper) with engine oil.

b. Attach damper Installer Tool J-22197 to damper. Tighten fingers of tool to prevent weight from moving. See Figure 60-31.

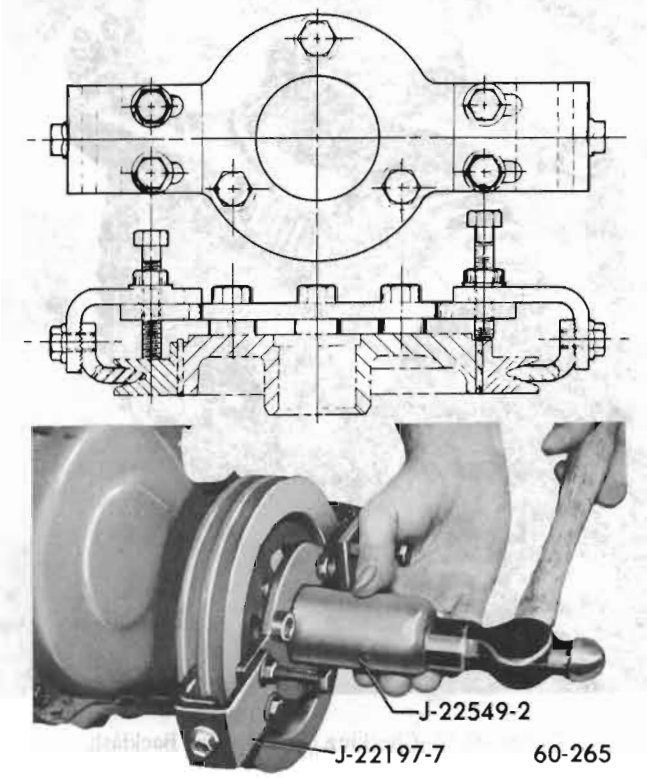


Figure 60-31 - Installing Torsional Damper

c. Crankshaft Front Oil Seal Replacement

1. With cover removed, pry old seal out of cover from the front with screwdriver being careful not to distort cover.

2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with Tool J-21426. See Figure 60-32.

NOTE: *Support cover at sealing area.*

d. Camshaft Removal

1. Remove front cover per subparagraph a above.

2. Remove valve lifter per paragraph 60-12g.

3. Remove fuel pump.

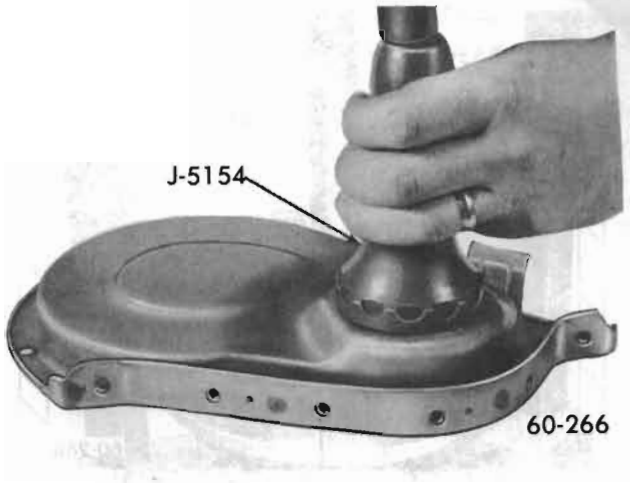


Figure 60-32--Installing Oil Seal

4. Align timing gear marks then remove the two camshaft thrust plate bolts by working through holes in the crankshaft gear. See Figure 60-33.

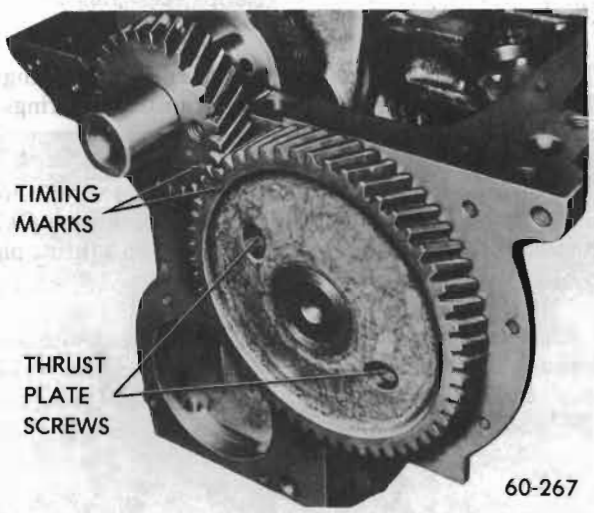


Figure 60-33 - Timing Gear Marks

5. Remove the camshaft and gear assembly by pulling out through the front of the block.

NOTE: *Support camshaft carefully when removing so as not to damage camshaft bearings.*

e. Camshaft Gear Replacement

1. If the inspection indicates that the shaft, gear, or thrust plate should be replaced, the gear should be removed from the shaft. Refer to Figure 60- 34 for gear removal.

NOTE: *Thrust plate must be positioned so that Woodruff key and shaft does not damage it when the shaft is pressed out of gear.*

2. To assemble camshaft gear and thrust plate, use a hydraulic press to press gear onto camshaft.

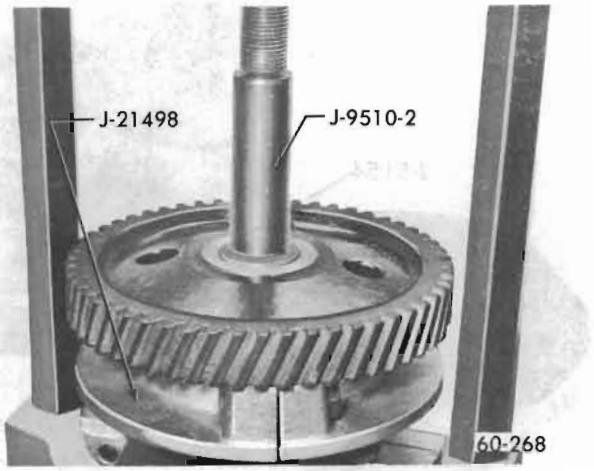


Figure 60-34 - Removing Camshaft Gear

3. Place the gear on the shaft until the correct clearance (.001" to .005") is obtained between the thrust plate and bearing.

f. Camshaft Installation

1. Install the camshaft and gear assembly in the engine block, being careful not to damage camshaft bearings or camshaft.

2. Turn crankshaft and camshaft so that the valve timing marks on the gear teeth will line up. See Figure 60-33. Push camshaft into position. Install camshaft thrust plate to block bolts and torque to specifications.

3. Check camshaft and crankshaft gear runout with a dial indicator. The camshaft gear runout should not exceed .004" and the crankshaft gear runout should not exceed .003". See Figure 60-35.

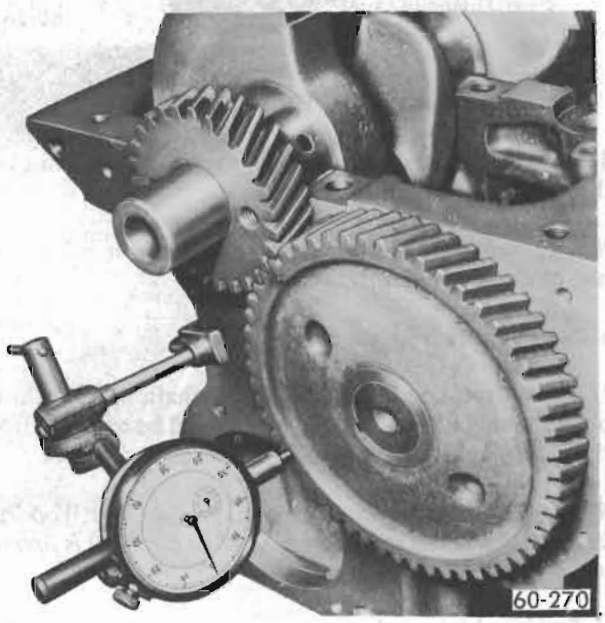


Figure 60-35 - Checking Camshaft Gear Runout

4. If gear runout is excessive, the gear will have to be removed and any burrs cleaned from the shaft or the gear will have to be replaced.

5. Check the backlash between the timing gear teeth with a dial indicator. The backlash should not be less than .004" nor more than .006". See Figure 60- 36.

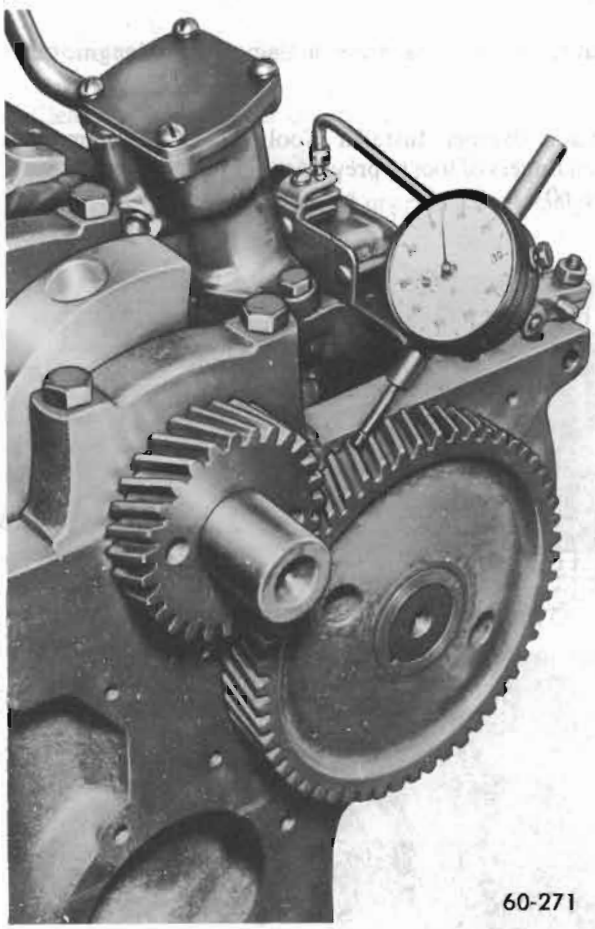


Figure 60-36--Checking Timing Gear Backlash

g. Crankshaft Gear Removal and Installation

1. With camshaft removed, crankshaft gear may be removed using Tool J-6978. See Figure 60-37. To install crankshaft gear use Tools shown in Figure 60- 38.

60-16 PISTON, RINGS, AND CONNECTING RODS

a. Disassembly, Inspection, and Replacement of Piston and Rod Assemblies Engine Removed

1. Remove oil pan, cylinder head (par. 60-12c) and oil pump (par. 60-5).

2. Examine the cylinder bores above the ring travel. If bores are worn so a shoulder or ridge exists at this point, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal. See Figure 60-39.

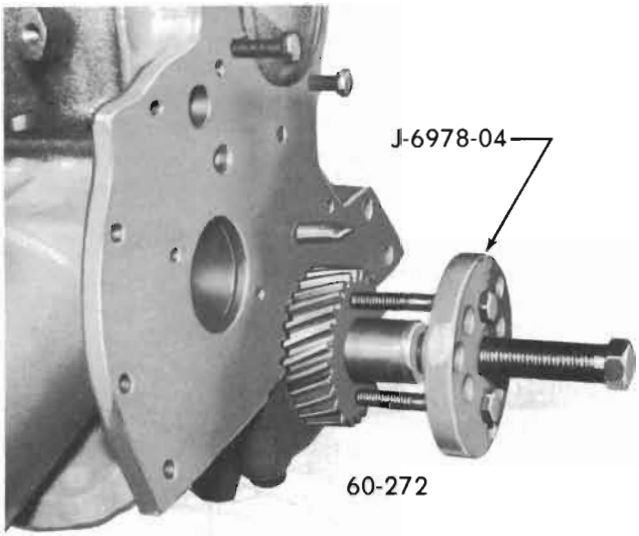


Figure 60-37--Removing Crankshaft Gear

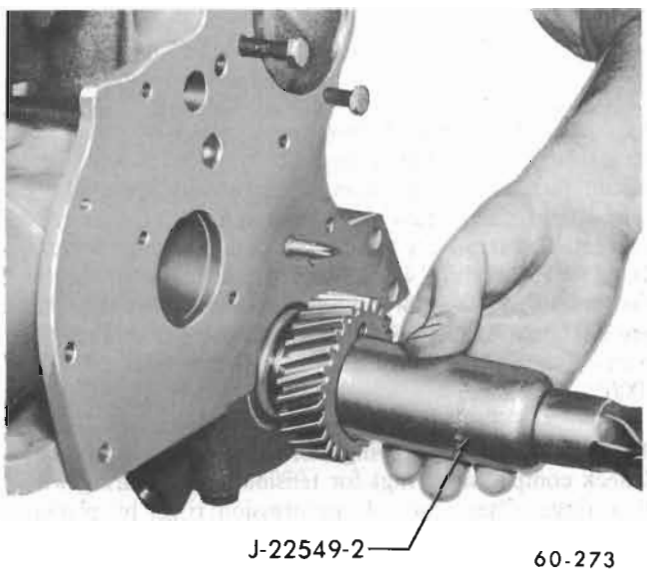


Figure 60-38--Installing Crankshaft Gear

3. Use a silver pencil or quick drying paint; mark the cylinder number on all pistons, connecting rods, and caps.

4. Remove cap and bearing shell from No. 1 connecting rod. Install connecting rod bolt guides on the bolts to hold the upper half of the bearing shell in place. See Figure 60-40.

5. Push the piston and rod assembly up out of the cylinder. Remove guides and reinstall cap and bearing shell on rod.

6. Remove other rod and piston assemblies in same manner.

7. Remove compression rings. Remove expander and oil ring by removing the two rails and spacer-expander.

8. Remove piston pin in following manner:

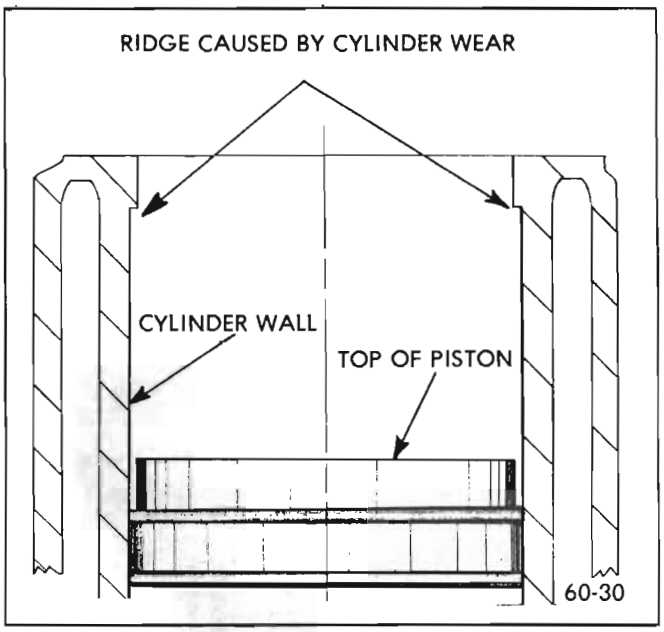


Figure 60-39 - Ridges Worn by Ring Travel

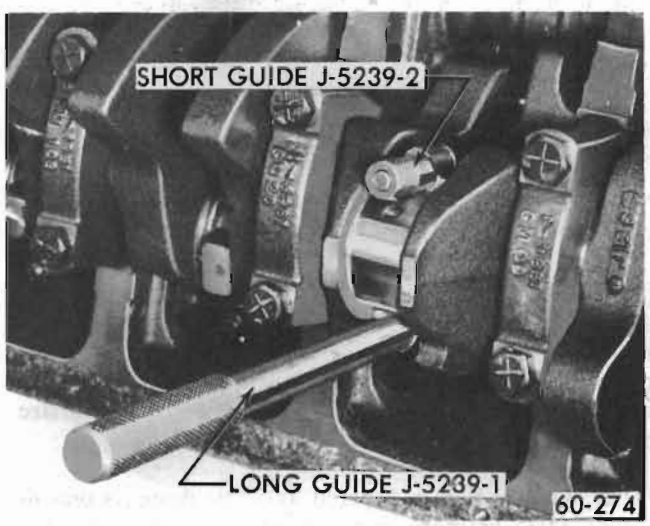


Figure 60-40--Connecting Rod Bolt Guides Installed

(a) Place connecting rod and piston assembly in a hydraulic press with piston on support (J-9510-1), then using remover (J-9510-3) press piston pin out. See Figure 60-41.

9. Inspect pistons and cylinder bores in the following manner:

(a) Inspect cylinder walls for scoring, roughness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-of-round using an accurate cylinder gage at top, middle and bottom of bore, both parallel and at right angles to the centerline of the engine. The diameter of the cylinder bores at any point may be measured with an inside micrometer or by setting the cylinder gage dial at

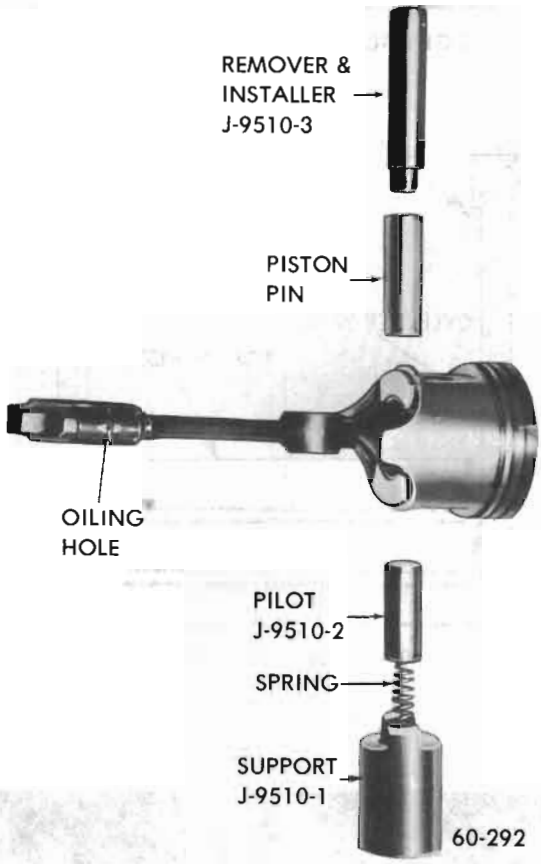


Figure 60-41--Piston Pin and Tool Layout

"O" and measuring across the gage contact points with outside micrometer while the gage is at same "O" setting.

(b) If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it is possible to repair the bore by honing to accept a standard service piston. If cylinder bore is very rough or deeply scored, it may be necessary to rebore the cylinder to fit an oversize piston in order to insure satisfactory results.

(c) If cylinder bore is tapered .005" or more, is out-of-round .002" or more, it is advisable to rebore for the smallest possible oversize piston and rings.

10. Clean carbon from piston surfaces and under side of piston heads. Clean carbon from ring grooves with suitable tool and remove any gum or varnish from piston skirts with solvent.

11. Carefully examine pistons for rough or scored bearing surfaces, cracks in skirt, head cracked or broken ring lands, and chipping or uneven wear which would cause rings to seat improperly or have excessive clearance in ring grooves. Damaged or faulty pistons should be replaced.

The pistons are cam ground, which means that the diameter at the right angle to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be measured with micrometers applied to the skirt at points 90 degrees to the piston pin. See Figure 60-42. The piston should be measured (for fitting purposes) 1/2" below the top of piston.

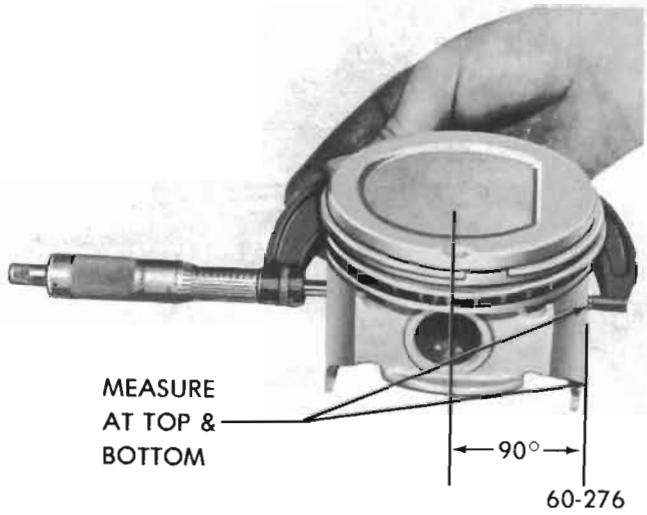


Figure 60-42--Measuring Piston

12. Inspect bearing surfaces of piston pins. Check for wear by measuring worn and unworn surfaces with micrometers. Rough or worn pins should be replaced. Check fit of piston pins in piston bosses. Occasionally pins will be found tight due to gum or varnish deposits. This may be corrected by removing the deposit with a suitable solvent. If piston bosses are worn out-of-round or oversize, the piston and pin assembly must be replaced. Oversize pins are not practical because the pin is a press fit in the connecting rod. Piston pins must fit the piston with .0004" to .0007" clearance.

13. Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gage. Gap should be between .010" and .020". If gaps are excessive (over .020") it indicates the rings have worn considerably and should be replaced.

b. Reboring Cylinder and Fitting New Pistons

If one or more cylinder bores are rough, scored, or worn beyond limits prescribed under subparagraph 9b above, it will be necessary to refinish such bores to fit new pistons.

If relatively few bores require correction it will not be necessary to rebore all cylinders to the same oversize in order to maintain engine balance. All oversize service pistons are held to the same weights as standard size pistons. If conditions justify replacement of all pistons, however, new pistons should all be the same nominal size.

Standard size service pistons are high limit or maximum diameter; therefore, they can usually be used with a slight amount of honing to correct slight scoring or excessive clearances. All service pistons are diamond bored and

selectively fitted with piston pins; pistons cannot be purchased without pins.

No attempt should be made to cut down oversize pistons to fit cylinder bores. This practice will destroy the surface treatment and affect the weight. The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearance.

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees to piston pin (Figure 60-140) then select the smallest piston for the first fitting. The slight variation usually found between pistons in a set may provide for correction if the first piston has excessive clearance before sediment has a chance to settle.

If wear of cylinder does not exceed .005" honing is recommended for truing the bore. If wear or out-of- round exceeds these limits, the bore should be trued up with a fly cutter boring bar, and then finish honed.

When reboring cylinders, all crankshaft bearing caps must be in place and tightened to proper torque to avoid distortion of bores in final assembly. Always be certain the crankshaft is out of the way of the boring cutter when boring each cylinder. When making the final cut with boring bar leave .001" on the diameter for finish honing to give the required clearance specified below.

When honing cylinders use clean sharp stones of proper grade for the required amount of metal to be removed, in accordance with instructions of the hone manufacturer. Dull or dirty stones cut unevenly and generate excessive heat. When using coarse or medium grade stones use care to leave sufficient metal so that all stone marks may be removed with the fine stones used for finishing in order to maintain proper clearance.

When finish honing, pass the hone through the entire length of cylinder at the rate of approximately 60 cycles per minute. This should produce the desired 45 degree cross hatch pattern on cylinder walls which will insure maximum ring life and minimum oil consumption.

It is of the greatest importance that refinished cylinder bores have not over .0005" out-of-round or taper. Each bore must be final honed to remove all stone or cutter marks and provide a smooth surface. During final honing, each piston must be fitted individually to the bore in which it will be installed and should be marked to insure correct installation.

After final honing and before the piston is checked for fit, each cylinder bore must be *thoroughly* washed to remove all traces of abrasive and then dried. The dry bore should then be brushed clean with a power-driven fibre brush. If all traces of abrasive are not removed, rapid wear of new pistons and rings will result. Fit new pistons in the following manner:

1. Expand a telescope gage to fit the cylinder bore at right angles to the piston pin 2-1/2" from top. See Figure 60-43.

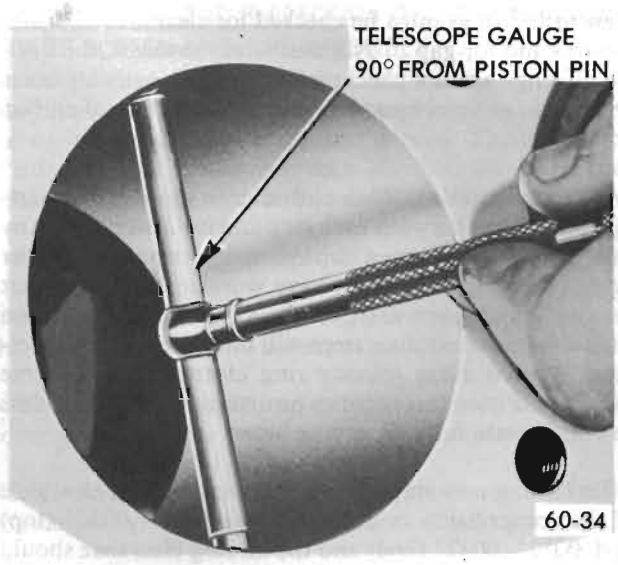


Figure 60-43 - Checking Cylinder Bores

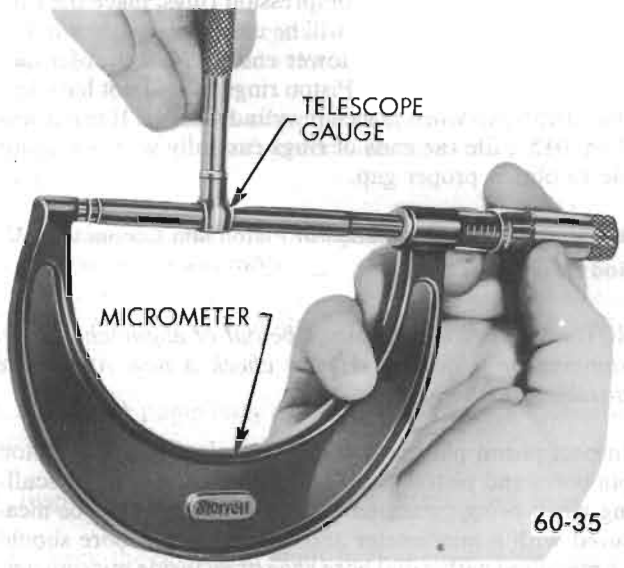


Figure 60-44 - Measuring Telescope Gage

2. Measure the piston to be installed. See Figure 60-42. The piston must be measured at right angles to the piston pin 2-1/2" below the top of piston. The piston must be between .0005" and .0011" smaller than the cylinder bore.

NOTE: *Both block and piston must be at approximately the same temperature when measurements are made or expansion errors will occur. A difference of 10 degrees F. between parts is sufficient to produce a variation of .0005".*

c. Fitting New Piston Rings

When new piston rings are installed without reboring cylinders, the glazed cylinder walls should be slightly dulled

without increasing the bore diameter by means of the finest grade honing stones.

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores; however, the flexible oil rings are not checked for gap. The cylinder bores and piston grooves must be clean, dry, and free of carbon and burrs.

With rings installed, check clearance in grooves by inserting feeler gages between each ring and its *lower* land. Any wear that occurs forms a step at inner portion of the lower land. If the piston grooves have worn to the extent that relatively high steps exist on the lower lands, the piston should be replaced since steps will interfere with the operation of new rings causing ring clearances to become excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

When fitting new rings to new pistons, the side clearance of the compression rings should be .0012"- .0027" (top) and .0012"-.0032" (2nd) and the oil ring clearance should be .000"-.005".

To check the end gap of compression rings, place the ring in the cylinder in which it will be used and square it in the bore by tapping with the lower end of a piston. Measure the gap with feeler gages. Piston rings should not have less than .015" gap when placed in cylinder bores. If gap is less than .015", file the ends of rings carefully with a smooth file to obtain proper gap.

d. Assembly and Installation of Piston and Connecting Rod Assemblies

NOTE: *Connecting rods may be out of alignment due to shipping or handling. Always check a new rod before installing piston and pin.*

Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when being measured. The piston pin should be measured with a micrometer and the piston pin bore should be measured with a dial bore gage or an inside micrometer. If clearance is in excess of the .001" wear limit, the piston and piston pin assembly should be replaced.

1. Lubricate piston pin holes in piston and connecting rod to facilitate installation of pin.

2. Using Tool J-9510, place support (J-9510-1) with spring and pilot (J-9510-2) in place on an arbor press. See Figure 60-41.

3. Position piston on connecting rod with appropriate side of piston and oiling hole in connecting rod aligned. See Figure 60-45.

4. Place piston on support, indexing pilot through piston and rod.

5. Place installer (J-9510-3) on piston pin, start piston pin into piston and press on installer until pilot bottoms in support.

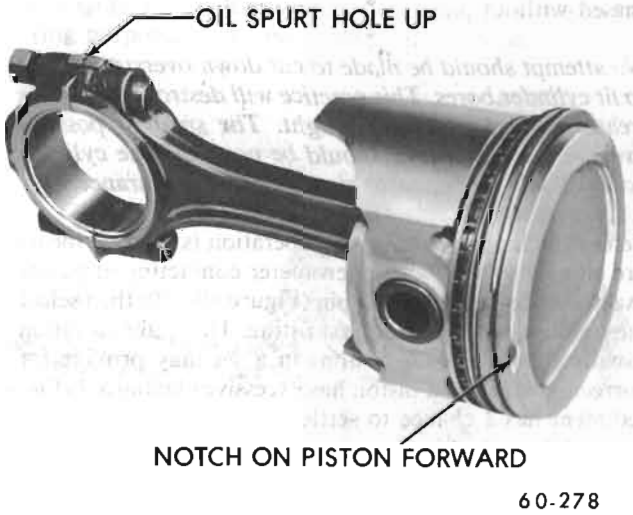


Figure 60-45--Piston and Rod Assembly

6. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin.

7. Install piston rings as shown in Figure 60-46.

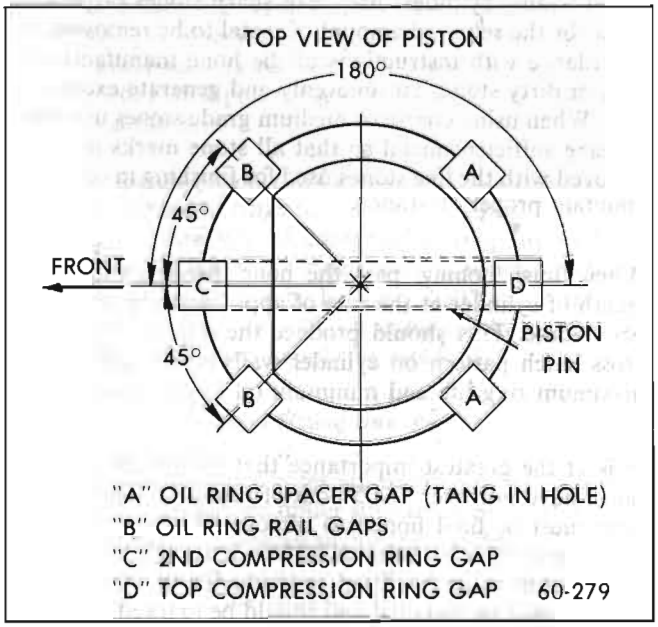


Figure 60-46--Ring Gap Positioning

8. *All compression rings are marked with a dimple, a letter "T", a letter "O" or word "TOP" to identify the side of the ring which must be assembled toward the top of the piston.*

9. Make sure cylinder bores, pistons, connecting rod bear-

ings and crankshaft journals are absolutely clean, then coat all bearing surfaces with engine oil.

10. Before installation of a piston and rod assembly in its bore, position the crankpin straight down.

11. Remove connecting rod cap, and with bearing upper shell seated in rod; install connecting rod guides. These guides hold the upper bearing shell in place and prevent damage to the crankpin during installation of the connecting rod and piston assembly.

12. Make sure the gap in the oil ring rails and the gaps of the compression rings are positioned as shown in Figure 60-46.

13. Lubricate the piston and rings and install in bore by compressing the rings either with a "wrap around" compressor or a split ring type such as shown in Figure 60-47.

Figure 60-47 - Installing Piston with Ring Compressor

14. Select a new connecting rod bearing, if necessary, as described in paragraph 60-13. Otherwise install cap with bearing lower shell on rod and tighten bolt nuts to 35 lb.ft. torque.

15. Install all other piston and rod assemblies in same manner. When piston and rod assemblies are properly installed, the oil spurt holes in the connecting rods will be "up" toward the camshaft.

16. Check end clearance between connecting rods in each crankpin using feeler gages. Clearance should be between .0085" and .0135".

17. Install cylinder head (paragraph 60-12). Install oil screen and oil pan (paragraph 60-5).

IMPORTANT: *After installation of new pistons and rings care should be used in starting the engine and running it for the first hour. Avoid high speeds until the parts have had a reasonable amount of "break- in" time. This practice will avoid unnecessary "scuffing" of new parts.*

60-17 REMOVAL AND INSPECTION OF OIL PUMP AND PICKUP SCREEN AND PIPE ASSEMBLY

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. The oil pump is driven by the distributor shaft which is driven by the helical gear on the camshaft. See Figure 60-1.

1. Remove oil pan as outlined in paragraph 60-13.

2. Remove two flange mounting bolts, pickup pipe bolt, then remove pump and screen as an assembly.

3. Remove the pump cover attaching screws, the pump cover and the pump cover gasket.

NOTE: *Mark gear teeth so they may be reassembled with the same teeth indexing.*

4. Remove the idler gear and the drive gear and shaft from the pump body.

5. Remove the pressure regulator valve retaining pin, pressure regulator valve and related parts.

6. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump.

NOTE: *Do not disturb the pickup screen on the pipe. This is serviced as an assembly.*

7. Wash all parts in cleaning solvent and dry with compressed air.

8. Inspect the pump body and cover for cracks or excessive wear.

9. Inspect pump gears for damage or excessive wear.

10. Check the drive gear shaft for looseness in the pump body.

11. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.

12. Inspect the pickup screen and pipe assembly for damage to screen, pipe or relief grommet.

13. Check the pressure regulator valve for fit.

NOTE: *The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.*

c. Oil Pump Assembly and Installation

Assembly

1. If the pickup screen and pipe assembly was removed,

mount the pump in a soft-jawed vise, apply sealer to end of pipe and tap pipe in place. See Figure 60-48.

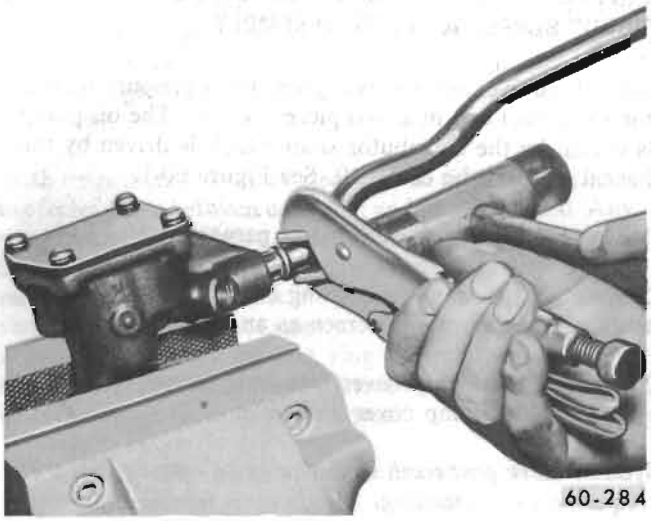


Figure 60-48 - Installing Pickup Screen and Pipe Assembly

NOTE: *Be careful of twisting, shearing or collapsing pipe while installing pump. Pickup screen must be parallel to bottom of oil pan.*

2. Install the pressure regulator valve and related parts.

3. Install the drive gear and shaft in the pump body.

4. Install the idler gear in the pump body with the smooth side of gear towards pump cover opening.

5. Install the pump cover with new gasket and torque attaching screws to specifications.

6. Align oil pump drive shafts to match with distributor tang, then install oil pump to block positioning flange over distributor lower bushing. Use no gasket.

7. Install oil pan using new gaskets and seal as outlined.

d. Oil Filter Bypass Valve Inspection and Replacement

With the oil filter removed, check the spring and fibre valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, remove valve by prying it out with a screwdriver. Install and seat a new valve by taping it in place, using a 9/16 thin-wall deep socket. See Figure 60-49.

60-18 ENGINE MOUNTING, FLYWHEEL, AND ENGINE BALANCING

a. Removal of Front Mounts

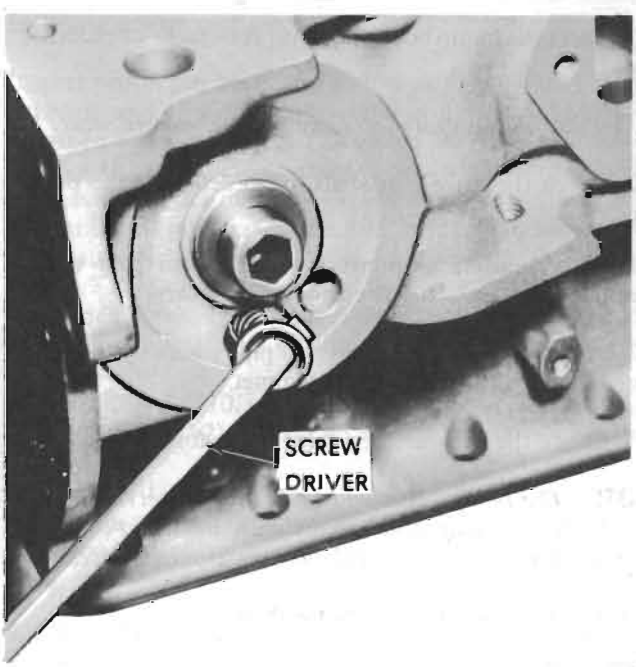
1. Raise car and provide frame support at front of car.

2. Remove nuts, washers, and engine mount through bolts. See Figure 60-50.

3. Raise engine at forward edge of oil pan. Place a piece of wood between jack and pan.

4. Remove mount from engine.

5. Install flywheel on crankshaft and position to align



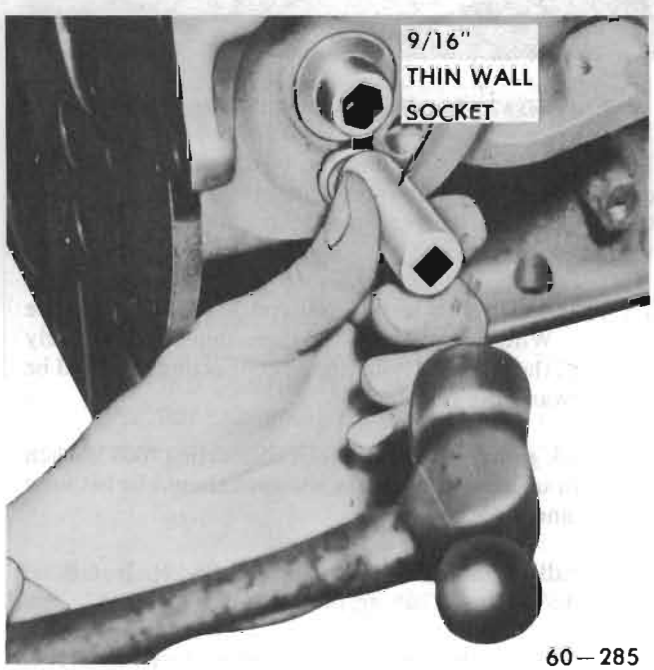
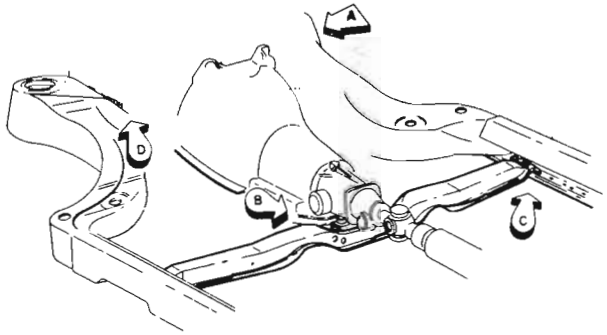
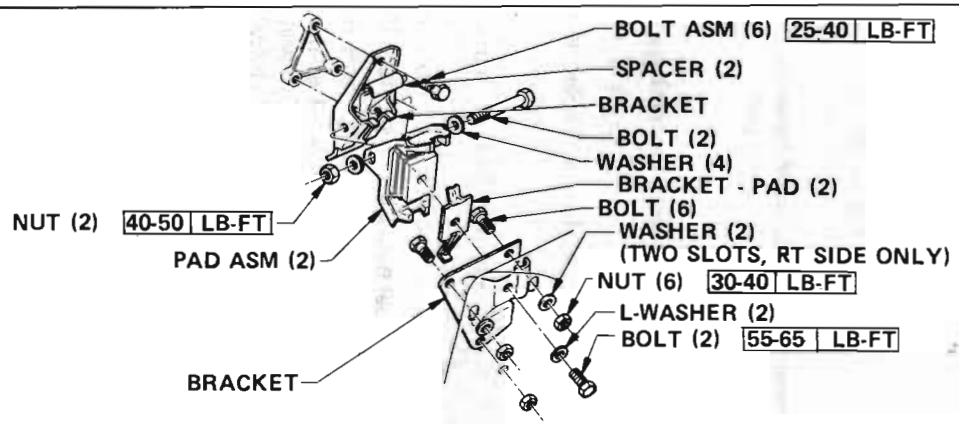
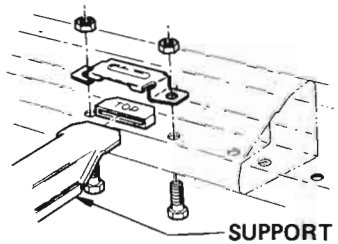


Figure 60-49 Oil Filter By-Pass Valve

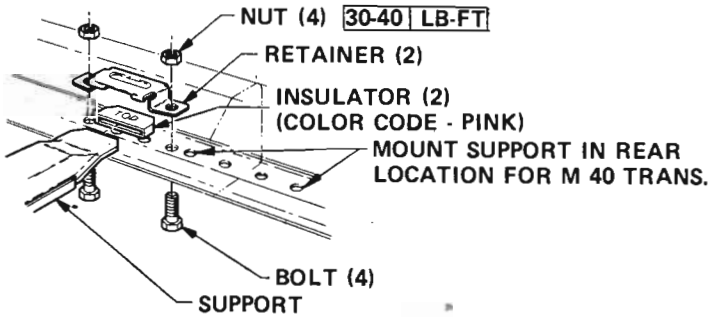




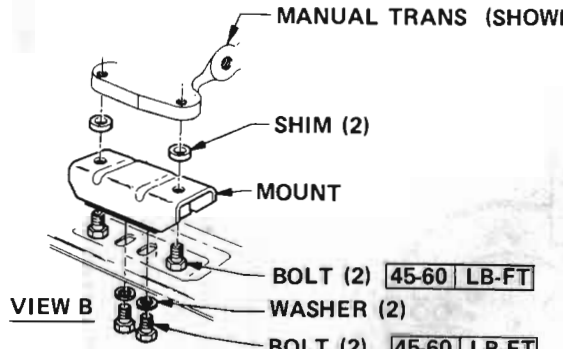
VIEW A
(250 - L6)
(RT SIDE SHOWN)



VIEW C
(CONVERTIBLE)



VIEW C
(REG - COUPES, SEDANS
& WAGONS)



VIEW B

60-291

Figure 60-50 - Engine and Transmission Mounting Details

dowel hole of crankshaft flange and flywheel. Install bolts and torque to 60 lb. ft. See Figure 60- 158.

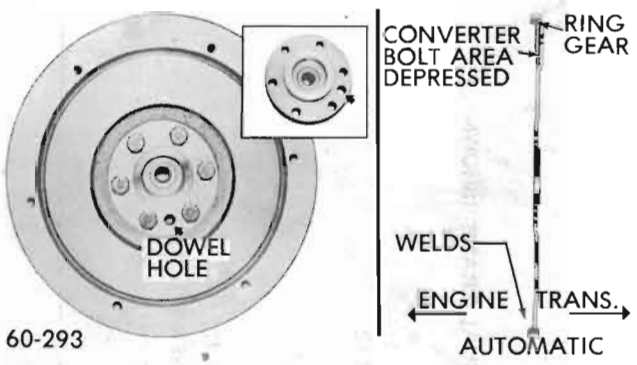


Figure 60-51 - Flywheel Installation

NOTE: *On automatic transmission equipped engine, the flywheel must be installed with the flange collar to transmission side. See Figure 60-51.*

b. Installation of Front Mount

1. Install mount to frame bracket and torque to specification. See Figure 60-50.

2. Lower engine so mounts rest on frame cross member in normal manner. Install mount to bracket bolt and torque to 45 lb. ft.

3. Remove frame support and lower car.

For details of engine and transmission mounts and transmission support installation refer to Figure 60- 50.

d. Removal and Replacement of Transmission Flywheel

1. Remove transmission (GROUP 74).

2. Remove six bolts attaching flywheel to crankshaft flange.

3. Inspect flywheel if cracked at flywheel bolt holes, replace flywheel.

4. Inspect crankshaft flange and flywheel or burrs. Remove any burrs with a mill file.

e. Manual Transmission Flywheel Balance

All manual transmission flywheels are balanced at the factory by drilling holes at various points on the flywheel surface. *No attempt should be made to balance a flywheel after the initial factory balance.*

DIVISION VI SPECIFICATIONS

60-19 BOLT TORQUE SPECIFICATIONS

Use a reliable torque wrench when tightening the parts listed below. This will prevent strain or distortion of the parts or damage to the threads. The specifications given are for clean and lubricated threads only. Dry or dirty threads produce increased friction and prevent accurate measurement of tightness. It is important that these specifications be strictly observed. Overtightening may damage threads and prevent the attainment of the proper torque.

Items	Torque Lb. Ft.
Spark Plug	15
Crankshaft Bearing Caps to Cylinder Block	65
Connecting Rod Caps	35
Cylinder Head to Cylinder Block	95
Flywheel to Crankshaft (AUTO. & MANUAL)	60
Oil Pan to Cylinder Block (1/4-20) 7 (5/16-18)	10
Oil Pan to Front Cover	5
Oil Pan Drain Plug	20
Oil Pressure Switch to Cylinder Block	23
Oil Pump to Cylinder Block	10
Oil Filter Assembly	Hand Tight
Oil Pump Cover	6
Front Cover to Block	7
Water Pump to Cylinder Block	15
Thermostat Housing to Cylinder Head	30
Temperature Sending Unit	20
Fuel Pump to Cylinder Block	18
Motor Mount Bracket to Cylinder Block	33
Motor Mount to Bracket	45
Delcotron Mounting Bracket to Cylinder Head	30
Starter Motor Brace to Cylinder Block	18
Starter Motor Brace to Starter Motor	18
Starter Motor to Cylinder Block	35
Distributor Hold Down Clamp	13
Lower Flywheel Housing	7
Flywheel Housing to Cylinder Block	30
Rocker Arm Cover to Cylinder Block	5
Camshaft Thrust Plate to Cylinder Block	7
Push Rod Cover to Cylinder Block	7
Manifold (Exhaust to Inlet)	25
Manifold to Cylinder Head (Outer)	20
Manifold to Cylinder Head (All Others)	30

60-20 GENERAL SPECIFICATIONS

a. General

Engine Type	In-Line 6
Valve Arrangement	In Head
Bore and Stroke	3.875 x 3.530
Piston Displacement	250 Cu. In.
Compression Ratio	8.5 to 1
Torque at RPM	235 Lb. Ft. at 1600
Octane Requirement	82 Motor Method
Octane Requirement	91 Research Method
Taxable Horsepower	36
Cylinder Numbers Front to Rear	1-2-3-4-5-6
Firing Order	1-5-3-6-2-4

b. Piston and Piston Pin Specifications

Piston Material	Cast Aluminum Alloy
Piston Pin Material	Chromium Steel
Piston Pin Type	Locked In Rod

c. Connecting Rod Specifications

Material	Drop Forged Steel
Bearing Type	Removable Backed Babbitt on Steel
Bearing Material	Copper Lead Alloy or Sintered Copper Nickle

d. Ring Specifications

Compression Ring Material & Surface Treatment	
#1	Cast Iron—Chrome Plated
#2	Cast Iron—Wear Resistant Coating
Oil Ring Type	Dual Steel Rail with Spacer
Oil Ring Expander	Stainless Steel
Location of Rings	Above Piston Pin

e. Crankshaft Specifications

Material	Nodular Iron
Bearings	Steel Back—All Replaceable
Bearing Material	Copper Lead Alloy or Premium Aluminum
Bearing Taking End Thrust	#7

f. Camshaft Specifications

Material	Cast Alloy Iron
Bearings	Steel Backed Babbitt
Number of Bearings	4
Camshaft Location	Above and to Right of Crankshaft
Type of Drive	Gear
Crankshaft Sprocket	Steel Sintered Iron
Camshaft Sprocket	Brakelight and Fabric with Steel Hub

g. Valve Specifications

Intake Valve Material	Alloy Steel
Exhaust Valve Material	High Alloy Steel
Valve Lifter Type	Hydraulic
Valve Spring	Single Helical

h. Lubrication System Specifications

Type of Lubrication	
Main Bearings	Pressure
Connecting Rods	Pressure
Piston Pins	Splash
Camshaft Bearings	Pressure
Timing Chain	Splash & Nozzle
Cylinder Walls	Connecting Rod Bearing Throw-Off
Oil Pump Type	Gear Driven
Normal Oil Pressure	30-45 lbs. at 1500 RPM
Oil Pressure Sending Unit	Electrical
Oil Intake Type	Stationary
Oil Filter System	Full Flow
Filter Type	Throw Away Element & Can
Crankcase Capacity	
Less Filter	4 qts.
With Filter	5 qts.

i. Cooling System Specifications

System Type	Pressure
Radiator Cap Relief Pressure	15 psi
Thermostat	Choke Type Opening at 195°
Water Pump	
Type	Centrifugal
GPM at RPM	.60 at 4400
Drive	V-Belt
Bearings	Double Row
By-Pass Recirculation Type	Internal

Cooling System Capacity
With Heater ..... 16.4 qts.
With AC ..... 16.4 qts.

Fan Diameter and Number of Blades
Less AC ..... 17.6"—4
With AC ..... 18"—7

Fan Drive
Less AC ..... Water Pump Shaft
With AC ..... Torque and Temperature Sensitive Clutch

60-21 ENGINE DIMENSIONS AND FITS

Rings, Piston, and Piston Specifications

Piston Clearance Limits	
Top Land	.0345" — .0435"
Skirt — Top	.0005" — .0011"
Ring Groove Depth	
#1 — Compression Ring	.2153" — .2218"
#2 — Compression Ring	.2153" — .2218"
#3 — Oil Ring	.2093" — .2158"
Ring Width	
#1 — Compression Ring	.0628" — .0633"
#2 — Compression Ring	.0623" — .0625"
#3 — Oil Ring	.1870" — .1890"
Ring Gap	
#1 — Compression Ring	.010" — .020"
#2 — Compression Ring	.010" — .020"
#3 — Oil Ring	.015" — .025"
Piston Pin Length	2.990" — 3.010"
Diameter of Pin	.9270" — .9273"
Clearance	
In Piston	.00015" — .00025"
In Rod	None
Direction & Amount Offset in Piston	.060" Major Thrust Side

*All Measurements in Inches Unless Otherwise Specified.

Connecting Rod Specifications

Bearing Length	.807"
Bearing Clearance (Limits)	.0007" — .0027"
End Play — Total for both Rods	.009" — .013"

60-21 ENGINE DIMENSIONS AND FITS (Cont'd.)

Crankshaft Specifications

End Play at Thrust Bearing	.002" — .006"
Main Bearing Journal Diameter	2.300"
Crankpin Journal Diameter	1.999" — 2.000"
Main Bearing Overall Length	
#1	.752"
#2	.752"
#3	.752"
#4	.752"
#5	.752"
#6	.752"
#7	.760"
Main Bearing to Journal Clearance	.0003" — .0029"

Camshaft Specifications

Bearing Journal Diameter	
#1	1.8682" — 1.8692"
#2	1.8682" — 1.8692"
#3	1.8682" — 1.8692"
#4	1.8682" — 1.8692"

Valve System Specifications

Rocker Arm Ratio	1.75 to 1
Valve Lifter Diameter	.8422" — .8427"
Valve Lifter Clearance in Crankcase	.0005" — .0020"
Valve Lifter Leakdown Rate	10 to 45 Sec. in Test Fixture
Intake Valve	
Head Diameter	1.715" — 1.725"
Seat Angle	46°
Face Angle	45°
Stem Diameter	3.410" — 3.417"
Clearance in Guide	.0010" — .0027"
Eshaust Valve	
Head Diameter	1.495" — 1.505"
Seat Angle	46°
Face Angle	45°
Stem Diameter	3.410" — 3.417"
Clearance in Guide	.0010" — .0027"
Valve Spring	
Valve Closed — Pounds at Length	56-54 at 1.66"
Valve Open — Pounds at Length	180-192 at 1.27"

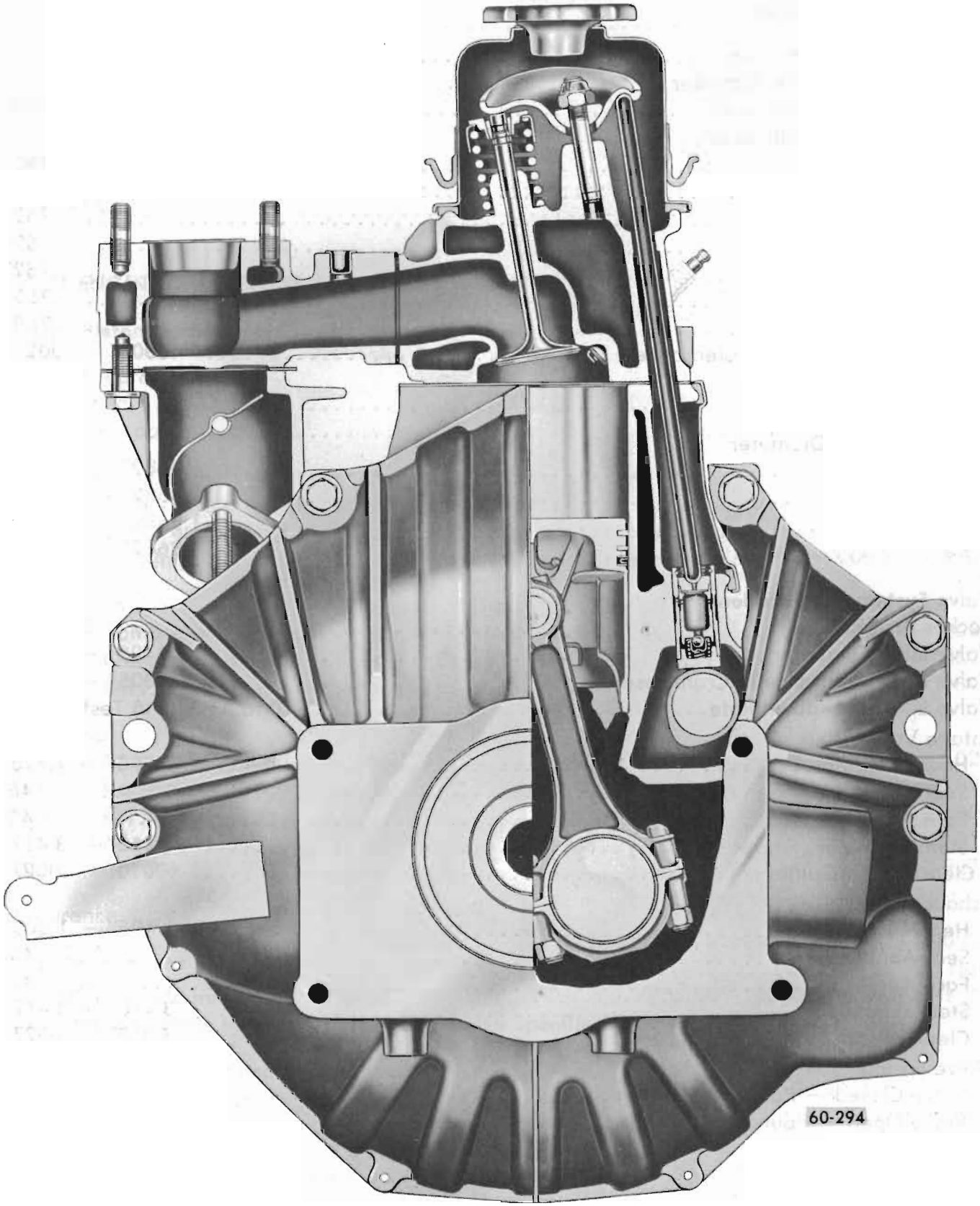


Figure 60-52 - 250 Cu. In. L-6 Engine Cross Section (Rear View)

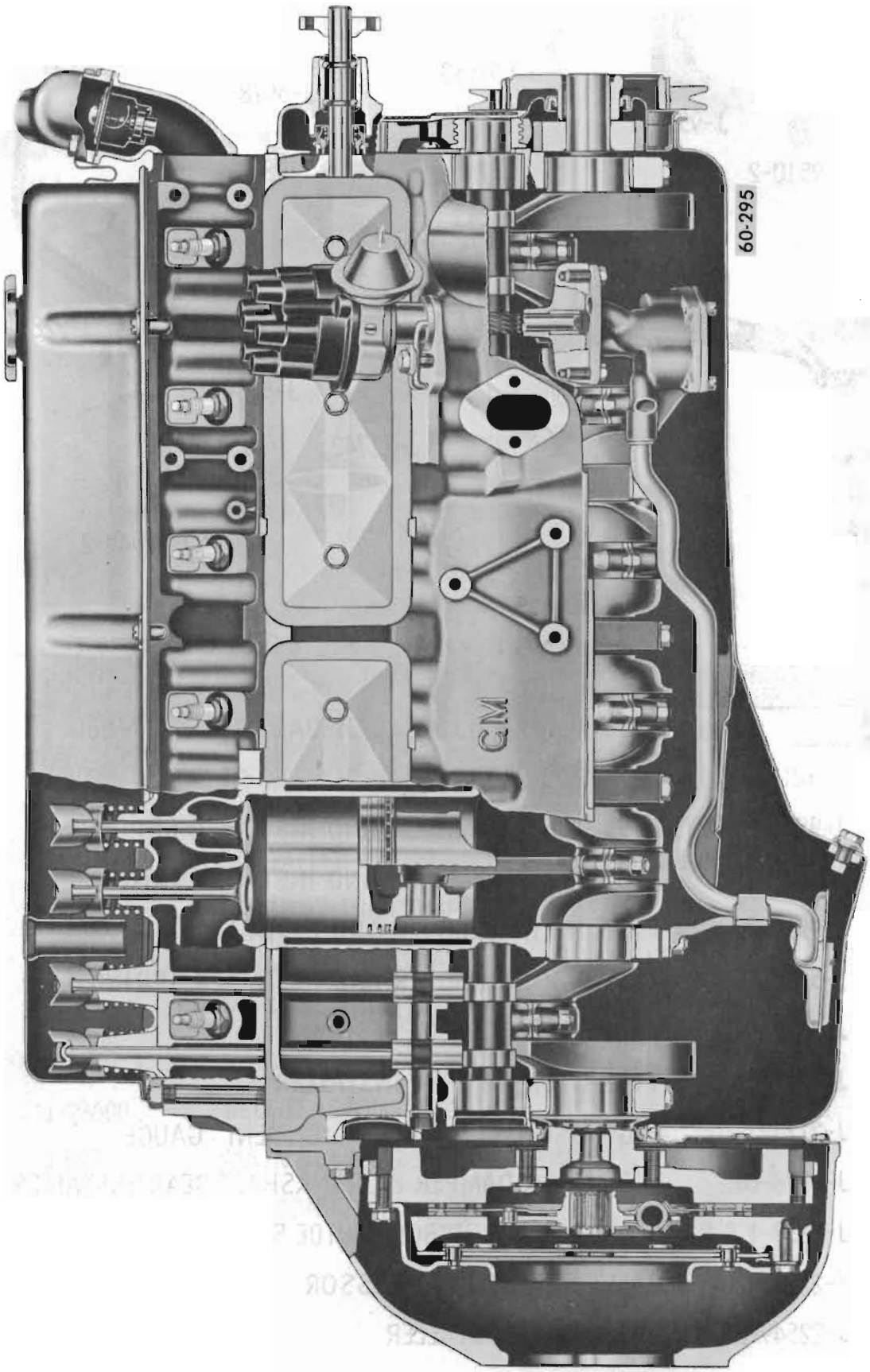
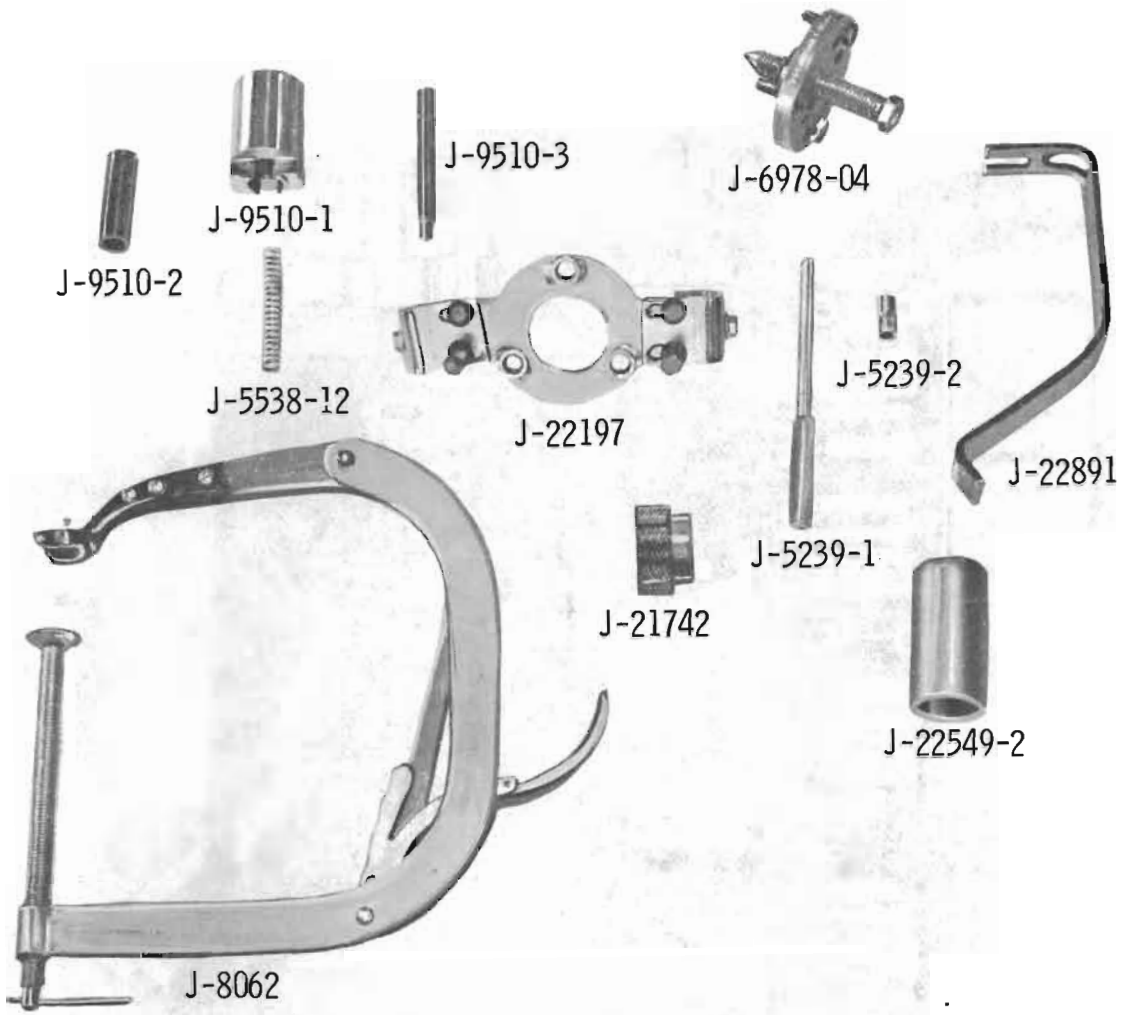


Figure 60-53 - 250 Cu. In. L-6 Engine Cross Section (Side View)



J-9510-1	PISTON PIN REMOVER AND INSTALLER SUPPORT
J-9510-2	PISTON PIN REMOVER AND INSTALLER PILOT
J-9510-3	PISTON PIN REMOVER AND INSTALLER
J-5538-12	PISTON PIN REMOVER AND INSTALLER SPRING
J-8062	VALVE SPRING COMPRESSOR
J-22197	VIBRATION DAMPER INSTALLER
J-21742	ENGINE FRONT COVER ALIGNMENT GAUGE
J-6978-04	VIBRATION DAMPER & CRANKSHAFT GEAR INSTALLER
J-5239-1 & 2	CONNECTING ROD BOLT GUIDE SET
J-22891	VALVE SPRING COMPRESSOR
J-22549-2	SHIFT TUBE INSTALLER

60-54

Figure 60-54 Special Tools - 250 Cu. In. L-6


J-8358


J-8080

J-23600


J-5099


J-5238


J-4160-A


J-5830-1


J-5830-2


J-5830-3


J-6647

J 4160-A	HYDRAULIC VALVE LIFTER PLUNGER REMOVER
J 5099	HYDRAULIC VALVE LIFTER BODY CLEANING BRUSH
J 5238	HYDRAULIC VALVE LIFTER PLUNGER RETAINER REMOVER & INSTALLER
J 6647	PISTON RING COMPRESSOR 3-7/8
J 5830-1	VALVE GUIDE REAMER .003 OVERSIZE
J 5830-2	VALVE GUIDE REAMER .015 OVERSIZE
J-5830-3	VALVE GUIDE REAMER .030 OVERSIZE
J-23600	BELT TENSION GAUGE
J 8080	MAIN BEARING SHELL REMOVER
J 8358	CARBON REMOVING BRUSH

60-55

Figure 60-55 Special Tools - 250 Cu. In. L-6