

SECTION 2-B

ENGINE DESCRIPTION

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2-4 ENGINES AND MOUNTINGS

a. Engine Type

Series	Engine Code Number Prefix	Cubic Inch Displacement	Compression	Bore	Stroke	Horsepower	
						Tax.	Brake
Gran Sport Skylark	LR	400	10.25: 1	4.1875	3.640	56.11	325

b. Engine and Transmission Mountings

The engine and transmission assemblies are supported in the frame by three synthetic rubber pads. There is one mounting pad on each side of the engine near the front, approximately midway between the top and bottom of the cylinder crankcase. An adapter plate bolts to the engine crankcase to provide a mounting point for the rubber pad at the engine. The other side of the pad is secured to the frame bracket by a bolt. The front mountings are designed to support the weight of the engine and control its torsional characteristics.

2-5 ENGINE CONSTRUCTION

a. Cylinder Crankcase

The cylinder crankcase has two banks of four cylinders each, which form a 90 degree angle. The crankcase section extends below the centerline of the crank-

shaft to form a continuous flat surface with the rear bearing cap and the timing chain cover, permitting installation of the lower crankcase with a one-piece gasket. The upper portion of the flywheel housing is cast integral with the cylinder crankcase.

The right bank of cylinders (as viewed from rear) is set slightly forward of the left bank so that connecting rods of opposite pairs of cylinders can be connected to the same crankpin. Starting at front end, cylinders in the right bank are numbered 1-3-5-7 and cylinders in the left bank are numbered 2-4-6-8.

b. Crankshaft and Bearings

The crankshaft is supported in the crankcase by five steel-backed full precision type bearings, all having the same nominal diameter.

All bearings are identical except number three, which takes end

thrust and rear main, which has a different width and material. See Figure 2-3.

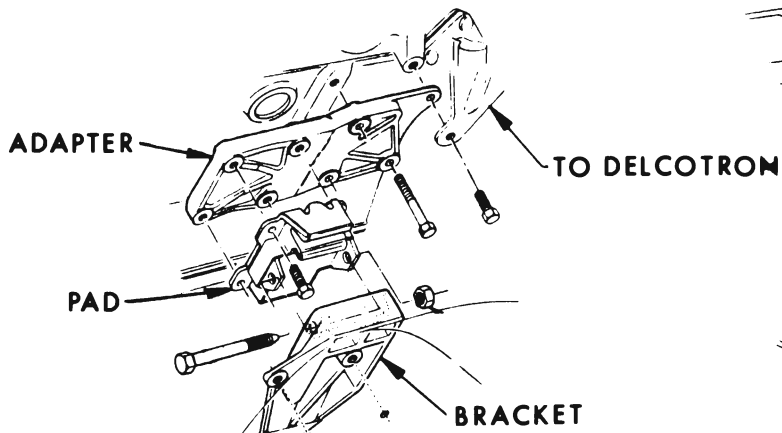
The crankshaft is counterbalanced by weights forged integral with crank cheeks. Maximum counterweighting in the space available is obtained by machining the weights to a contour which allows a minimum uniform clearance with cylinder barrels and piston skirts. Additional counterbalancing is obtained by an offset flywheel flange.

All engines are equipped with a harmonic balancer and fan pulley assembly.

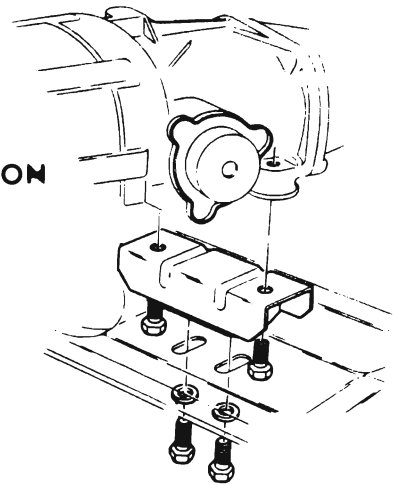
c. Connecting Rods and Pistons

Connecting rods are steel forgings of I-beam section, having bosses on each side so that metal can be removed as required to secure correct weight and balance during manufacture. The lower end of each rod is fitted with a steel-backed full precision type

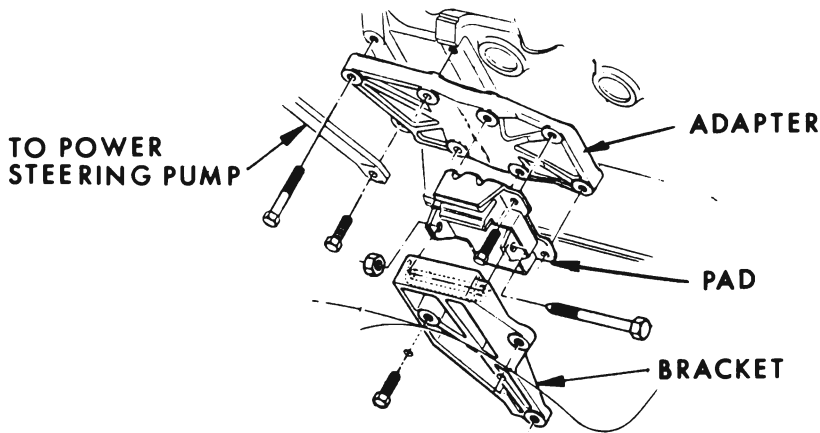
2-6 ENGINE DESCRIPTION



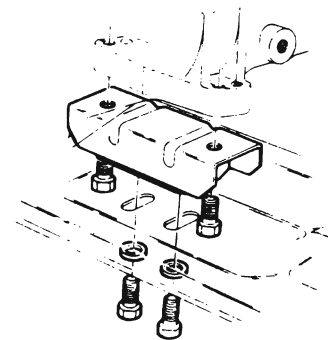
**FRONT RIGHT
ENGINE MOUNT**



**TRANSMISSION MOUNT
FOR AUTOMATIC CARS**



**FRONT LEFT
ENGINE MOUNT**



**TRANSMISSION MOUNT
FOR 3 AND 4 SPEED
MANUAL CARS**

Figure 2-2—Engine Mounting

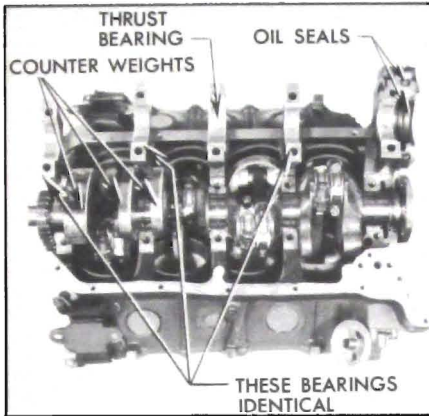


Figure 2-3—Engine Crankshaft and Bearings

bearing. The upper end of the connecting rod has a hole into which the wrist pin is pressed. The outer ends of the pin float in the bosses in the piston.

The tin plated aluminum alloy pistons have full skirts and are cam ground. Two compression rings and one oil control ring are located above the piston pin. Two transverse slots in the oil ring groove extend through the piston wall and permit drain back of oil collected by the oil ring. Shallow depressions cast into the head provide clearance between the piston and valves in operation.

The cast iron compression rings in the two upper grooves of piston are distinguished by a bevel cut around the inner edge on one side. The rings are installed with identification mark up.

The oil ring in the lower groove consists of two thin steel rails

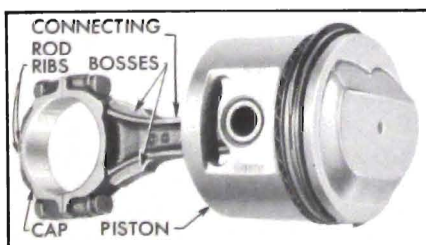


Figure 2-4—Connecting Rod and Piston Assembly

separated by a spacer and backed by an expander placed in the piston groove. The rails and spacer of a new ring are lightly held together with a cement which dissolves and releases the parts when oil is applied at start of operation.

d. Cylinder Heads

Both cylinder heads are identical except for treatment of the water inlet ports which exist in both ends of each head. When a head is prepared for installation on one bank of cylinders, the water inlet port on the rear end is plugged and the front port is left open for connection to the water pump. This places the plugs in opposite ends of the right and left heads; therefore, the heads cannot be interchanged.

All valves are mounted vertically in the cylinder head and in line from front to rear, so they operate at 45 degrees to the centerline of cylinders. The angle and location of the inlet valve and port causes the incoming fuel-air charge to sweep angularly downward to one side of the cylinder centerline, resulting in a whirling action which thoroughly mixes the charge and produces a beneficial turbulence during the compression stroke.

With the spark plug located centrally in top of the combustion chamber the point gap is well exposed to the sweep of the incoming charge. This reduces the concentration of exhaust gases that may have remained in this area after exhaust of the previous charge. As noncombustible exhaust products are removed from the area around the spark plug the tendency toward misfiring at part throttle is reduced.

The central location of the spark plug causes burning of the fuel charge to proceed uniformly out-

ward in all directions toward edges of the combustion space. The short flame travel speeds up the combustion process, causing the fuel mixture to burn in a shorter period of time than that at which detonation is likely to occur. High turbulence on the compression stroke and short flame travel following ignition permits the use of a high compression ratio with present day fuels.

e. Camshaft and Valve Mechanism

The camshaft is located in the angle of the cylinder block above the crankshaft where it is supported in five steel-backed, babbitt-lined bearings. It is driven from the crankshaft by sprockets and a single outside guide type chain. See Figure 2-5.

Hydraulic valve lifters and solid one-piece steel push rods are used to operate the overhead rocker arms and valves of both banks of cylinders from the single camshaft. This system requires no lash adjustment at time of assembly or in service; therefore, no adjusting studs or screws are provided in the valve train. Construction and operation of the hydraulic valve lifters are described in subparagraph f below.

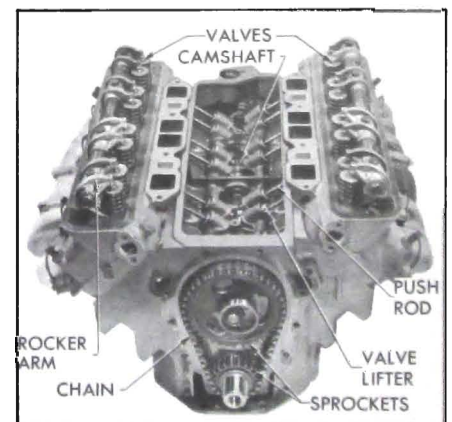


Figure 2-5—Valve Mechanism

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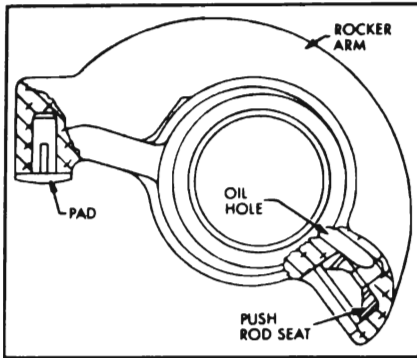


Figure 2-6—Valve Rocker Arm

The eight rocker arms for each bank of cylinders are mounted on a tubular steel shaft supported on the cylinder head by four die cast brackets. The rocker arms are die cast aluminum with inserts at the push rod socket and the valve stem contact face. See Figure 2-6. The rocker arms are offset to accommodate the different planes of movement of the valves and the push rods which pass through the cylinder head to one side of the valves.

The valves operate vertically in guides pressed into the cylinder head and each valve has two concentric springs to insure positive seating throughout the operating speed range. Inlet valve heads are 1-7/8" and exhaust valve heads are 1-1/2" in diameter. Valves and rocker arms are protected by a cover which seats against a raised horizontal surface on each cylinder head, and a cork gasket insures against oil leaks.

f. Hydraulic Valve Lifters

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 2-7, 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. See Figure 2-7.

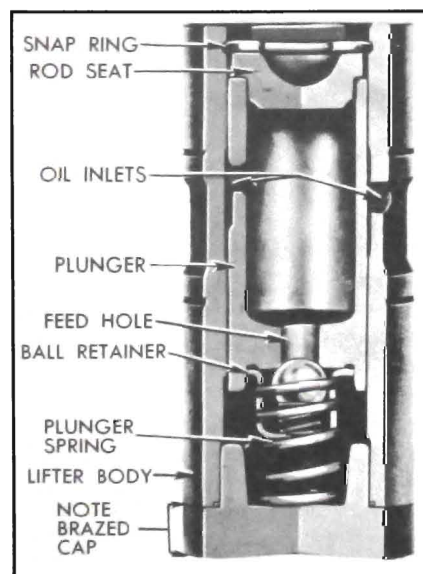


Figure 2-7—Hydraulic Valve Lifter, Sectional View

When the valve lifter is installed in engine the push rod holds the seat and plunger downward 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, which 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, as described in paragraph 2-6. Oil enters each lifter through grooves and oil holes in the lifter body and plunger, and flows down into the chamber below the plunger through the feed hole 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 seats the check ball against the plunger to prevent appreciable loss of oil from the chamber. The lifting force against the body is then transmitted through the entrapped oil to the check ball and 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.

It should be noted that during each cycle of operation the vertical movement between the body and plunger is only .002" to .003" but the check ball moves through its full travel of .004" to .008". Full opening of the plunger feed hole at the end of each cycle not only permits replacement of oil lost from the lower chamber, as previously described, but also permits control of the volume of oil in lower chamber to compensate for expansion and contraction of the valve linkage parts due to changes in engine temperature.

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 open plunger feed hole.

2-6 ENGINE LUBRICATION SYSTEM

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to crankshaft, connecting rods, and camshaft bearings, and is supplied under controlled volume to the valve lifters, rocker arm bearings, and push rods. All other moving parts are lubricated by gravity flow or splash.

a. Oil Supply

The supply of oil is carried in the lower crankcase (oil pan) which is filled through filler caps in the rocker arm covers. The filler openings are covered by combination filler and ventilating caps which contain filtering material to exclude dust. A removable oil gauge rod on right side of crankcase is provided for checking oil level.

b. Oil Pump

Oil is picked up and circulated by the spur-gear oil pump assembly which is mounted on the lower side of the cylinder crankcase at the rear end, where it extends down into the oil sump. The pump shaft is coupled to the ignition distributor shaft, which is driven from the camshaft through spiral gears. The pump inlet is equipped with a stationary screen of ample area. If the screen should become clogged for any reason, oil may be drawn into the pump over the top edge of the screen, which is held slightly clear of the screen housing by three embossments. The oil pump body contains a non-adjustable spring loaded pressure valve, which regulates the maximum oil pressure to 40 pounds.

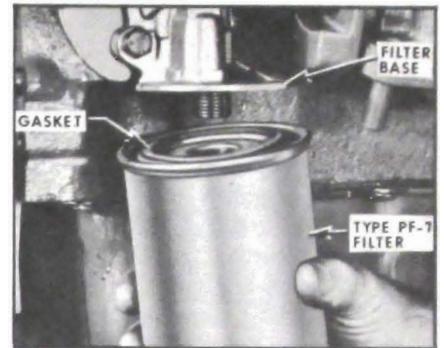


Figure 2-8—Oil Filter Installation

Drilled passages in the oil pump body and cylinder crankcase conduct all oil from the pump to the oil filter.

The oil pump is located in the timing chain cover where it is connected by a drilled passage in the cylinder crankcase to an oil screen housing and pipe assembly. The screen is submerged in the oil supply and has ample area for all operating conditions. If the screen should become clogged for any reason, oil may be drawn into the system over the top edge of the screen which is held clear of the sheet metal screen housing.

Oil is drawn into the pump through the screen and pipe assembly and a drilled passage in the crankcase which connects to drilled passages in the timing chain cover. All oil is discharged from the pump to the oil pump cover assembly. The cover assembly consists of an oil pressure relief valve, an oil filter by-pass valve and a nipple for installation of an oil filter. The spring loaded oil pressure relief valve limits the oil pressure to a maximum of 33 pounds per square inch. The oil filter by-pass valve opens when the filter has become clogged to the extent that 4-1/2 to 5 pounds pressure difference exists between the filter inlet and exhaust to by-pass the oil filter and channel unfiltered oil directly to the main oil

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galleries of the engine. See Figure 2-9.

Oil Filter. An AC full flow type oil filter is externally mounted on the right side of crankcase. The filter permits rapid passage of oil with a minimum drop in pressure. Normally, ALL engine oil passes through the filter element. If the element becomes restricted enough to produce 4-1/2 to 5-1/2 pounds difference in pressure between the inlet and outlet ports of the filter, a spring-loaded ball type valve in

the filter base will open to bypass the element and route oil directly into the main oil gallery.

Main Oil Gallery. The main oil gallery runs full length of the crankcase in the angle below the camshaft. Through connecting passages drilled in the crankcase it distributes oil at full pressure to all crankshaft and camshaft bearings, from which oil is then distributed to all other working parts of the engine. See Figure 2-9.

Crankshaft, Rods, and Pistons. Holes drilled in the crankshaft carry oil from the crankshaft bearings to the connecting rod bearings. Pistons and cylinder walls are lubricated by oil forced through a small notch in the bearing parting surface on connecting rod, which registers with the hole in the crankpin once in every revolution. Piston pins are lubricated by splash.

Timing Chain and Sprockets. A small amount of oil which escapes

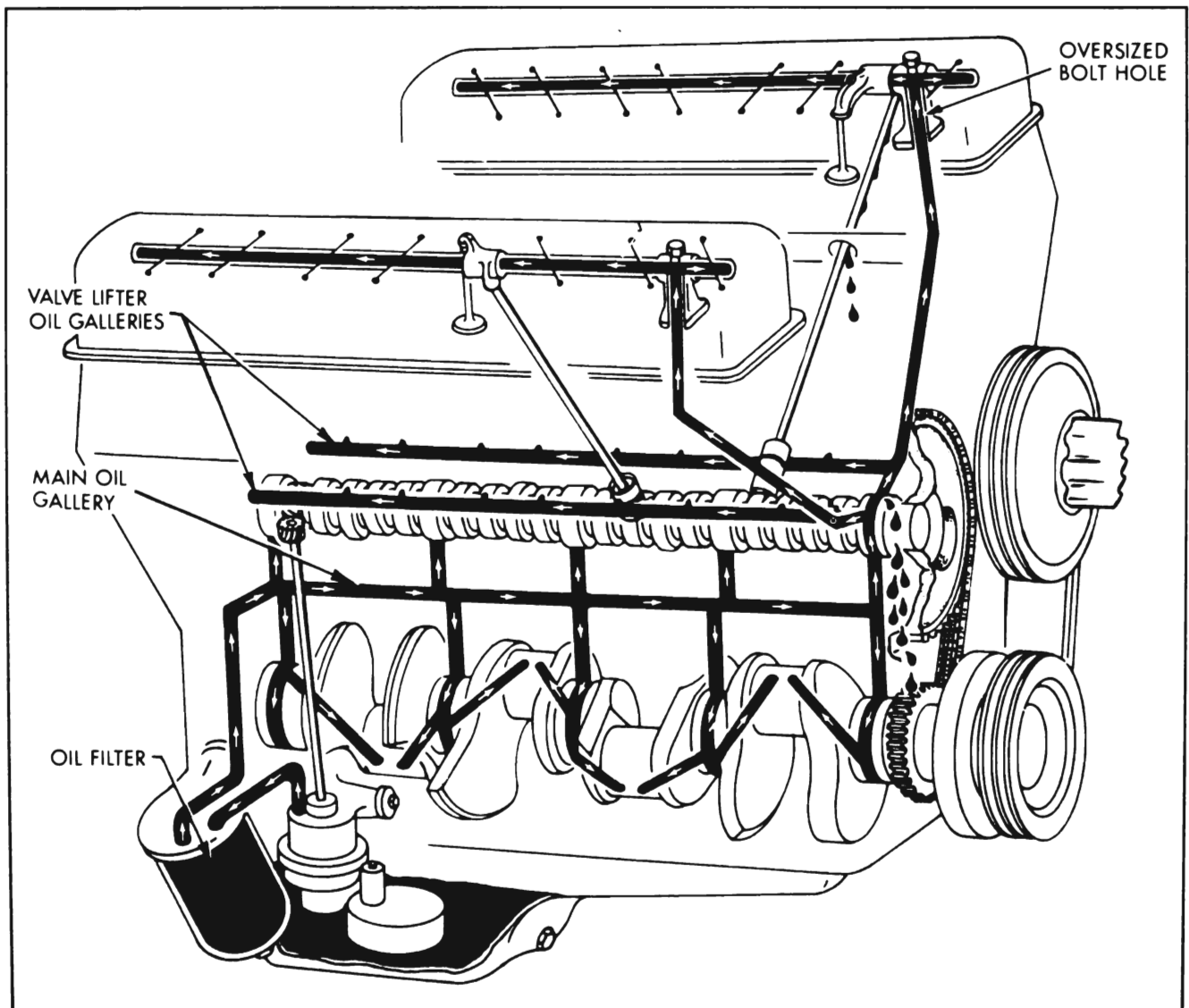


Figure 2-9—Schematic Diagram of Engine Oil Flow

from the camshaft front bearing flows down the front face of the cylinder crankcase to drop on the crankshaft sprocket, from which it is then transferred to the timing chain.

Valve Lifters and Oil Galleries. Oil holes in the crankcase and camshaft front bearing align with a groove in the camshaft front bearing journal which meters the flow of oil from the main oil gallery to the valve lifter oil gallery in each bank of cylinders. The drilled oil gallery, running full length of each cylinder bank, cuts into the lower sides of all valve lifter guide holes to supply an adequate volume of low pressure oil to each hydraulic valve lifter. Oil enters each lifter through grooves and holes in the lifter body and the plunger. See Figure 2-9.

Rocker Arms, Valves, and Push Rods. The rocker arms and valves on each cylinder head are supplied with low pressure oil from the valve lifter oil gallery through connecting passages drilled in the front end of cylinder block and head. See Figure 2-9.

The oil passage in cylinder head ends in a counterbored recess surrounding the bolt which attaches the rocker arm shaft front bracket. The oversize bolt hole through the bracket permits oil to flow up into the hollow rocker arm shaft, which is plugged at both ends.

Each rocker arm receives oil through a hole in the shaft, and parallel grooves in the rocker arm assure proper lubrication of the bearing surface. Oil is metered to the push rod ball seat and to the valve stem through holes drilled in the rocker arm. Excess oil drains off and returns to the oil pan through passages in cylinder head and cylinder block.

2-7 ENGINE COOLING SYSTEM

The engine cooling system is the pressure type, with thermostatic coolant temperature control and water pump circulation.

A temperature sensitive switch is located in the right cylinder head. Engine water temperature above 245° causes the set of contacts to close and light a red signal on the instrument panel.

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

All engines are equipped with an 18" fan. Air conditioned cars are equipped with a 20" fan driven by a torque and temperature sensitive clutch. See Figure 2-10.

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 800 to 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



Figure 2-10—Fan Clutch

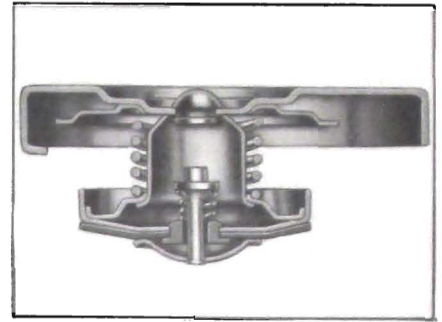


Figure 2-11—Pressure Type Radiator Cap

clutch. This open port allows a greater flow of silicone providing a maximum fan speed of approximately 2100 RPM.

The clutch coil is calibrated so that at road load with an ambient temperature of 80°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°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 2-11. 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 radiator to collapse.

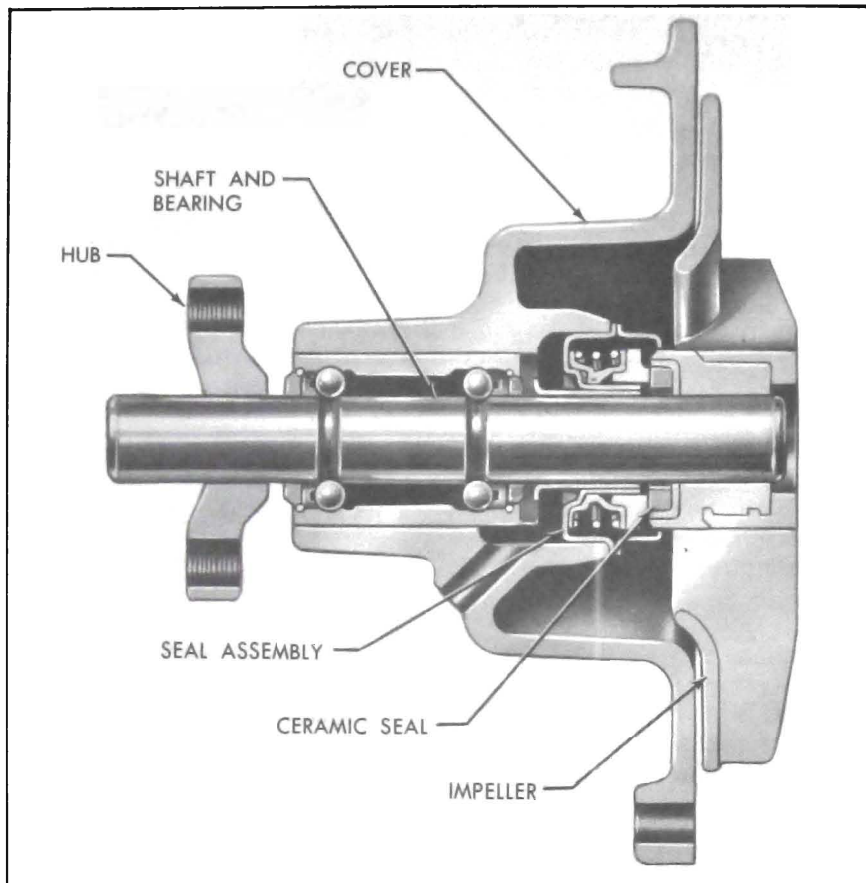
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Figure 2-12—Water Pump Cover Assembly

The coolant is circulated by a centrifugal pump mounted on the timing chain cover which forms the outlet side of the pump. 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 mounted forward of the harmonic balancer.

The pump shaft is supported on two single row ball bearings

pressed on the shaft and shrunk fit in the aluminum water pump cover. The bearings are permanently lubricated during manufacture and sealed to prevent loss of lubricant and entry of dirt.

The pump is sealed against coolant leakage by a packless non-adjustable seal assembly mounted in the pump cover in position to bear against the impeller hub. See Figure 2-12.

The inlet pipe cast on the pump cover feeds into the passage formed by the cover and the front face of the impeller, which is mounted on the bearing shaft with the vanes facing rearward. Coolant flows through the inlet passage to the low pressure area at the center, where it then flows rearward through three holes in the impeller. Vanes on the rotating impeller cause the coolant to flow radially outward into two discharge passages cast in the timing chain cover, and these passages deliver an equal quantity of coolant to each cylinder bank water jacket.

Cylinder water jackets extend down below the lower limits of piston ring travel and the coolant completely surrounds each cylinder barrel to provide uniform cooling.

The coolant leaves the cylinder heads through a water manifold that provides a common connection between both heads and the radiator. The water manifold also houses the "pellet" type radiator thermostat and provides the by-pass passage through which coolant returns to the water pump for recirculation whenever the thermostat valve closes to block circulation through the radiator. This thermostatically operated by-pass type of water temperature control permits the engine to reach its normal operating temperature quickly. The thermostat valve opens at 180 degrees F.