DETROIT DIESEL

Series 53 Service Manual
Sections 4-15

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SECTION 4

LUBRICATION SYSTEM

CONTENTS

LUBRICATION SYSTEM

IN–LINE AND 6V–53 ENGINES

The engine lubrication systems, illustrated in Figs. 1 and 2, include an oil intake screen and tube assembly, an oil pump, an oil pressure regulator valve, a full flow oil filter with a bypass valve, an oil cooler and oil cooler bypass valve.

The rotor type oil pump is bolted to the back of the engine lower front cover and is driven directly by the crankshaft. The pump width varies for the In–line engines and the 6V–53 engine, but otherwise is of identical design. By rotating the pump 180°, it can be used for either right–hand or left–hand rotation engines.

Lubricating oil from the pump passes from the lower front engine cover through short gallery passages in the cylinder block. From the block, the oil flows to the full flow filter, then through the oil cooler and back into the front engine cover and cylinder block oil galleries for distribution to the various engine bearings. The drain from the cylinder head and other engine parts leads back to the oil pan.

Clean engine oil is assured at all times by the use of a replaceable element type full flow filter. With this type filter, which is installed between the oil pump and the oil cooler, all of the oil is filtered before entering the engine. Should the filter become plugged, the oil will flow through a bypass valve, which opens at approximately 18–21 psi (124–145 kPa) directly to the oil cooler. Bypass filters are used in certain applications when additional filtration is required (Section 4.2).

On current engines, the oil cooler bypass valve is located on the right–hand side of the engine front cover and the oil pressure regulator valve is located on the left–hand side as viewed from the rear of the engine (Figs. 1 and 2). On former engines, both valves were located on the right–hand side of the cover (Figs. 1 and 2).

If the cooler becomes plugged, the oil flow will be to a bypass valve in the lower engine front cover and then to the cylinder block oil galleries. The bypass valve opens at approximately 52 psi (359 kPa) in the current In–line engines and 6V–53 engines. In the former In–line engines, the bypass valve opens at approximately 30 psi (207 kPa).

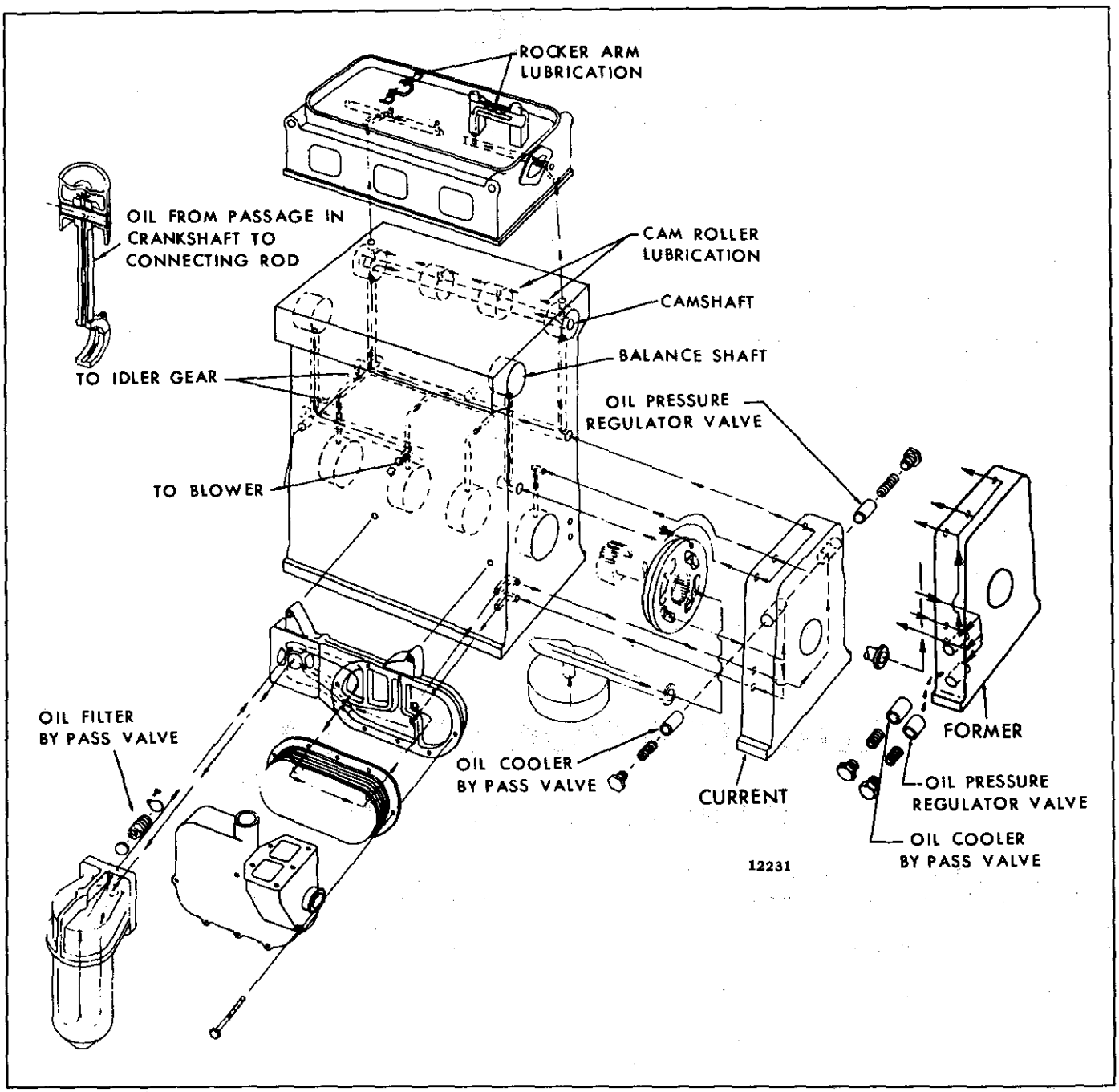

Fig. 1 – Schematic Diagram of Typical In–line Engine Lubrication System

The bypass valve opens at approximately 32 psi (221 kPa) on 6V–53 marine engines prior to engine number 6D–11074 and all 6V–53 engines prior to engine number 6D–17960.

Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of the oil temperature, by means of a regulator valve located in the lower front engine cover. The regulator valve, located in the pump outlet passage, opens at the pressure shown in the Table in Section 4.1.1 and returns excess oil directly to the crankcase.

Lubricating Oil Distribution

Oil from the oil cooler on the In–line engine is directed to the lower engine front cover and then to a longitudinal main oil gallery in the cylinder block. This gallery distributes the oil, under pressure, to the main bearings and to a horizontal transverse passage at one end of the block and to

vertical passages at each corner of the block which provide lubrication for the balance shaft and camshaft bearings (Fig. 1). The camshaft bearings incorporate small slots through which lubricating oil is directed to the cam follower rollers.

On a 6V–53 engine, oil from the pump enters a passage in the cylinder block and flows under pressure to the filter and oil cooler and returns through a passage in the block to the lower engine front cover. From a passage in the cover, the oil flows to the longitudinal main oil gallery in the block which distributes the oil, under pressure, to the main bearings. Oil passages branching off from the main oil gallery direct oil to the camshaft end bearings, idler gear and accessory drive gear bearings, blower, and cylinder heads.

In addition, oil is forced through an oil passage in each camshaft which lubricates the camshaft intermediate bearings. All of the camshaft bearings incorporate small slots through which lubricating oil is directed at the cam follower rollers.

Oil for lubricating the connecting rod bearings, piston pins, and for cooling the piston head is provided through the drilled crankshaft from the adjacent forward main bearings. The gear train is lubricated by the overflow of oil from the camshaft pocket through a communicating passage into the flywheel housing. Some oil spills into the flywheel housing from the bearings of the camshafts, balance shaft (In–line engine), idler gears and accessory drive gears (6V–53 engine).

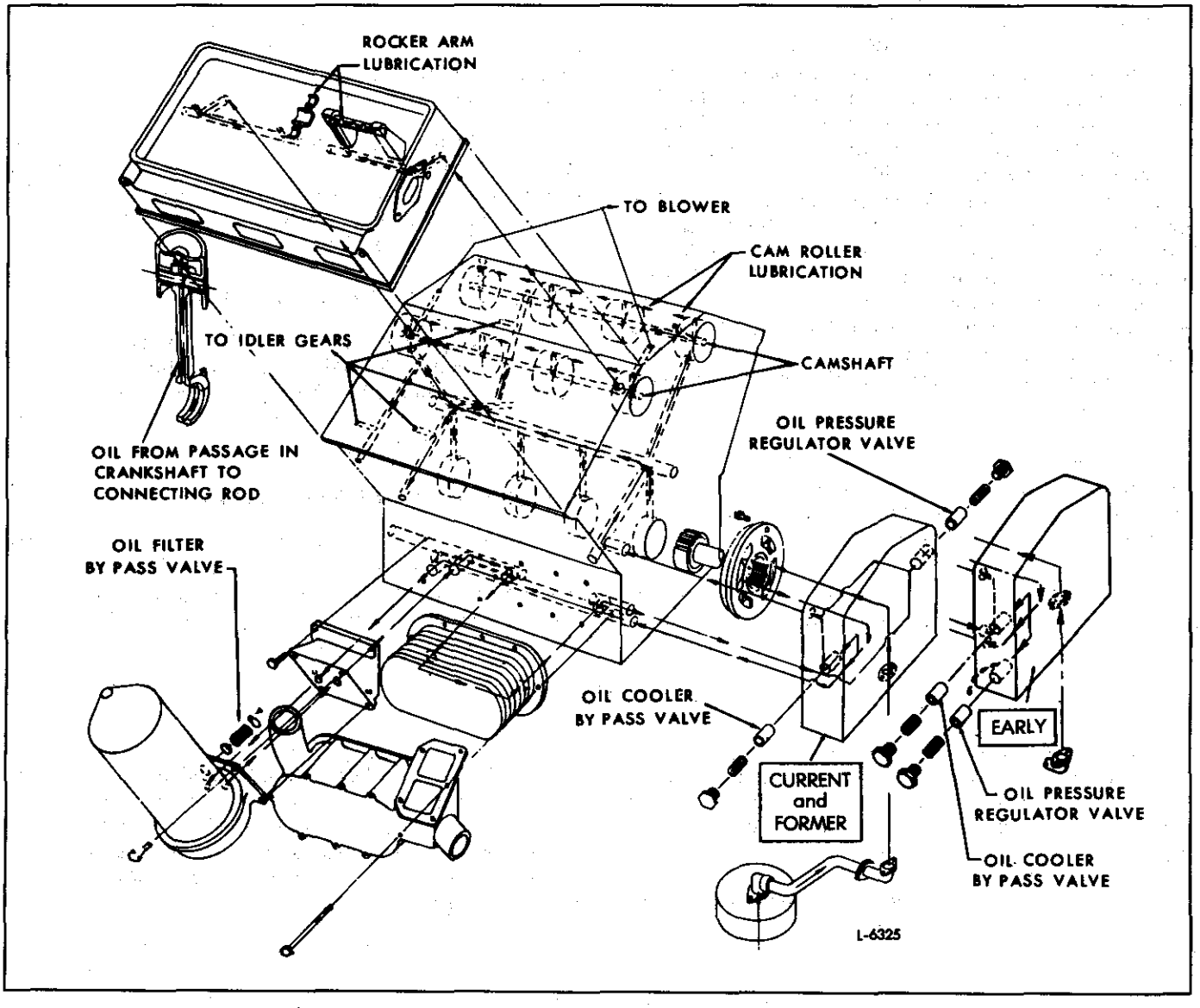

Fig. 2 – Schematic Diagram for 6V–53 Engine Lubrication System

Drilled oil passages on the camshaft side of the cylinder head (Figs. 1 and 2) are supplied with oil from the bores located at each end of the cylinder block. Oil from these drilled passages enters the drilled rocker shaft brackets at the lower ends of the drilled bolts and lubricates the rocker arm bearings and push rod clevis bearings.

Excess oil from the rocker arms lubricates the lower ends of the push rods and cam followers, then drains to cam pockets in the top of the cylinder block, from which the cams are lubricated. When these pockets are filled, the oil overflows through holes at each end of the cylinder block and then through the flywheel housing and front cover to the crankcase.

The blower bearings are pressure lubricated by oil from drilled passages in the cylinder block which connect matching passages in the blower end plates which, in turn, lead to the bearings. On current 6V–53 engines (built Jan. 77 and after) the lubricating oil is supplied from the main oil gallery to the right rear camshaft bushing (Fig. 2). This oil is forced through an oil passage in the camshaft and lubricates all camshaft bushings on the right bank as well as the blower. The left front bank camshaft bushing is supplied pressurized oil directly from the main oil gallery (Fig. 2). This oil then flows through the left bank camshaft and lubricates all left bank camshaft bushings as well as the blower. On former engines, the blower bearings received lubrication indirectly via the right rear camshaft end bearing only. Excess oil returns to the crankcase via drain holes in the blower end plates which lead to corresponding drain holes in the cylinder block (In–line engines) or the governor housing (6V–53 engines).

The blower drive gear hub in a 6V–53 engine is pressure lubricated through a connecting passage from the rear blower end plate, through the governor housing and into the blower and governor drive support.

Four tapped oil pressure take–off holes (three at the rear and one at the front) are provided in a 6V–53 cylinder block.

One tapped oil pressure take–off hole is provided in the lower engine front cover on some In–line engines. In addition, tapped oil holes in the cylinder block, on the side opposite the blower, are also provided as follows: three holes in the four–cylinder block and two holes in the three–cylinder block when the blower is on the left side of the engine or three holes when the blower is on the right side of the engine.

Lubricating System Maintenance

Use the proper viscosity grade and type of *heavy duty* oil as outlined in the *Lubrication Specifications* in Section 13.3. Change the oil and replace the oil filter elements at the periods recommended by the oil supplier (based on his analysis of the drained engine oil) to ensure trouble–free lubrication and longer engine life.

The oil level should never be allowed to drop below the *low* mark on the dipstick. Overfilling the crankcase may contribute to abnormal oil consumption and result in oil leaking past the crankshaft rear oil seal.

To obtain the true oil level, the engine should be stopped and sufficient time (approximately ten minutes) allowed for the oil to drain back from the various parts of the engine. If more oil is required, add only enough to bring it to the proper level on the dipstick.

Cleaning Lubrication System

Thorough flushing of the lubrication system is required at times. Should the engine lubrication system become contaminated by ethylene glycol antifreeze solution or other soluble material, refer to Section 5 for the recommended cleaning procedure.

Detection of Lube Oil Leaks

Detroit Diesel uses red dye to detect lube oil system leaks during engine test. Customers receiving new engines may notice some residual dye remaining in their lube oil systems. This dye should be quickly dispersed after the first few hours of engine oepration.

8V–53 ENGINE

The 8V–53 engine lubrication system, illustrated in Fig. 3, includes an oil intake screen and tube assembly, an oil pump with a an oil pump with a relief valve, an oil pressure regulator valve, a full flow oil filter with a bypass valve, an oil cooler and an oil cooler bypass valve.

The oil is circulated by a gear–type oil pump mounted on the number 4 and 5 main bearing caps and is driven by the crankshaft timing gear.

Lubricating oil is drawn by suction from the oil pan through the inlet screen and pipe to the pump where it is pressurized. The oil then passes from the pump to a gallery in the cylinder block, to the full–flow filter adaptor, through the filter, then through the oil cooler and into the engine front cover and cylinder block oil galleries for distribution to the various engine bearings, including the outboard bearing in the front cover. The oil drains from the cylinder head and other engine parts back to the oil pan.

A spring–loaded relief valve, located in the oil pump outlet pipe, bypasses excess oil back into the crankcase when the engine is cold or when the pressure in the engine oil gallery exceeds approximately 120 psi (827 kPa).

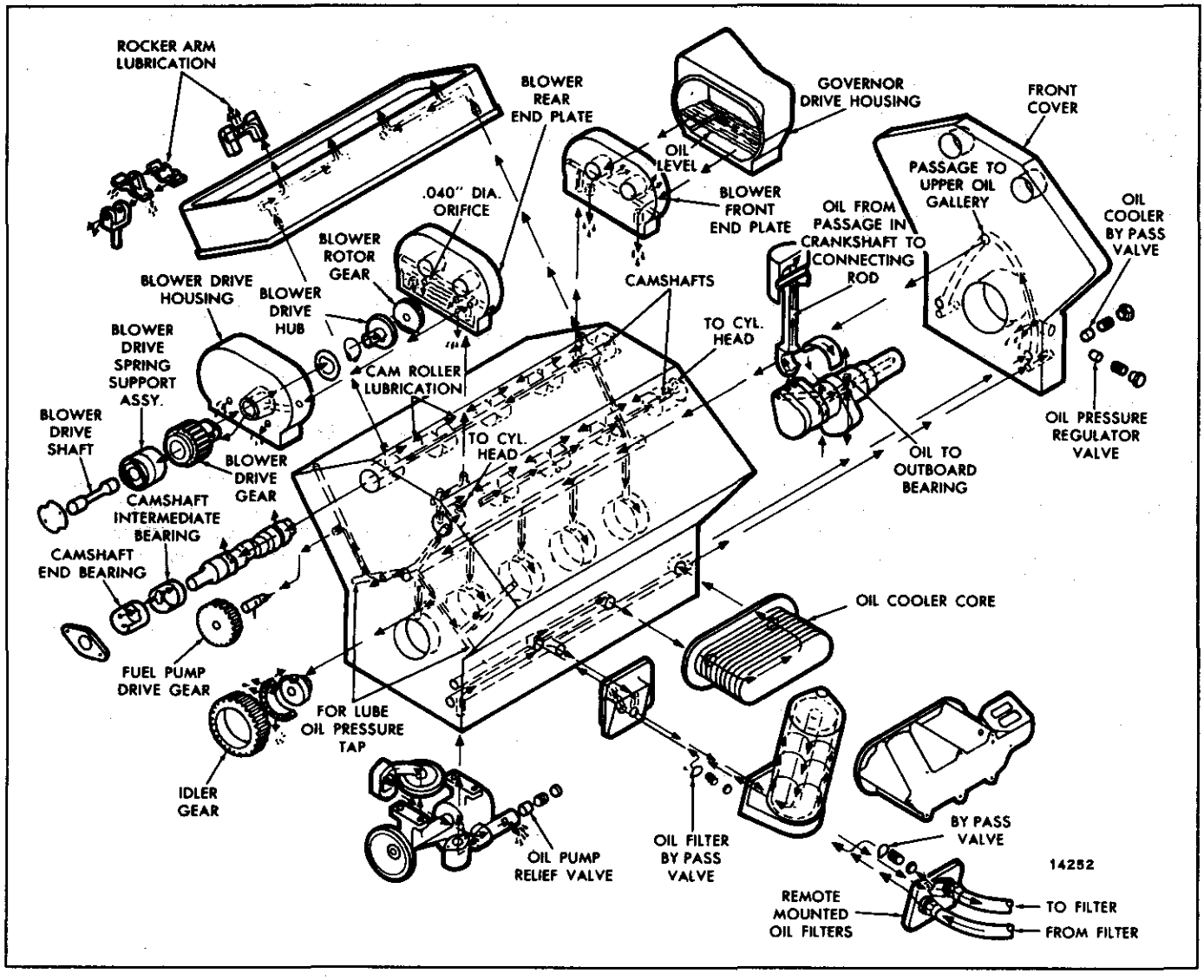

Fig. 3 – Schematic Diagram of Typical 8V–53 Engine Lubrication System

Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of the oil temperature, by means of an oil pressure regulator valve in the engine front cover which opens at approximately 52 psi (359 kPa).

Clean engine oil is assured at all times by the use of a replaceable element type full–flow filter which is installed between the oil pump and the oil cooler. All of the oil is filtered before entering the engine. Should the filter become plugged or before the engine is at operating temperature, the oil will flow through a bypass valve, which opens at approximately 18–21 psi (124–145 kPa), directly to the oil cooler.

The oil cooler bypass valve, which opens at approximately 52 psi (359 kPa), is located in the engine front cover. If the cooler becomes clogged or before the engine reaches operating temperature, the oil flow will be to the bypass valve, then through the engine front cover oil passage and the cylinder block oil galleries.

Lubricating Oil Distribution

Oil from the pump enters a passage in the cylinder block and flows under pressure to the filter and oil cooler, then through a passage in the cylinder block to the engine front cover. From a passage in the cover, the oil flows to the longitudinal main oil gallery which distributes the oil, under pressure, to the main bearings and the outboard bearing. Oil passages branching off from the main oil gallery direct oil to the camshaft end bearings, idler gear and fuel pump drive gear bearings, blower and cylinder heads.

In addition, oil is forced through an oil passage in each camshaft which lubricates the camshaft intermediate bearings. All of the camshaft bearings incorporate small slots

through which lubricating oil is directed to the cam follower rollers.

Oil for lubricating the connecting rod bearings, piston pins, and for cooling the piston head is provided through the drilled crankshaft from the adjacent forward main bearings. The gear train is lubricated by the overflow of oil from the camshaft pockets through a communicating passage into the flywheel housing. Some oil spills into the flywheel housing from the camshaft end bearings, idler gear, and fuel pump drive gear.

Drilled oil passages on the camshaft side of the cylinder heads are supplied with oil from the bores located at each end of the cylinder block (Fig. 3). Oil from these drilled passages enters the drilled rocker shaft brackets at the lower ends of the drilled bolts, and lubricates the rocker arm bearings and push rod shaft clevis bearings.

Excess oil from the rocker arms lubricates the lower ends of the push rods and cam followers, then drains to cam pockets in the top of the cylinder block, from which the cams are lubricated. When these pockets are filled, the oil overflows through holes at each end of the cylinder block and then drains back through the flywheel housing and front cover to the crankcase.

Oil is forced through drilled oil passages in the cylinder block to the blower. The oil level in the blower and the governor drive is maintained by two .040" diameter orifices in the blower end plates. Thus, the rotor timing gears and the governor weights turn in oil.

The splash of the oil and the vapor created lubricate the blower bearings and supplies oil to the blower drive gear, spring pack and drive shaft. Oil is returned to the blower drive support by a groove in the drive gear hub. Excess oil helps lubricate the gear train before returning to the crankcase. Two tapped oil pressure take-off holes are located at the rear of the cylinder block.

Cleaning Lubrication System

Thorough flushing of the lubrication system is required at times. Should the engine lubrication system become contaminated by ethylene glycol antifreeze solution or other soluble material, refer to Section 5 for the recommended cleaning procedure.

OIL PRESSURE TAKE–OFF LOCATIONS

The cylinder block illustrations in Fig. 4 show the main oil gallery pressure locations that are available for supplying oil under pressure to oil gages, Jacobs engine brake or other accessories.

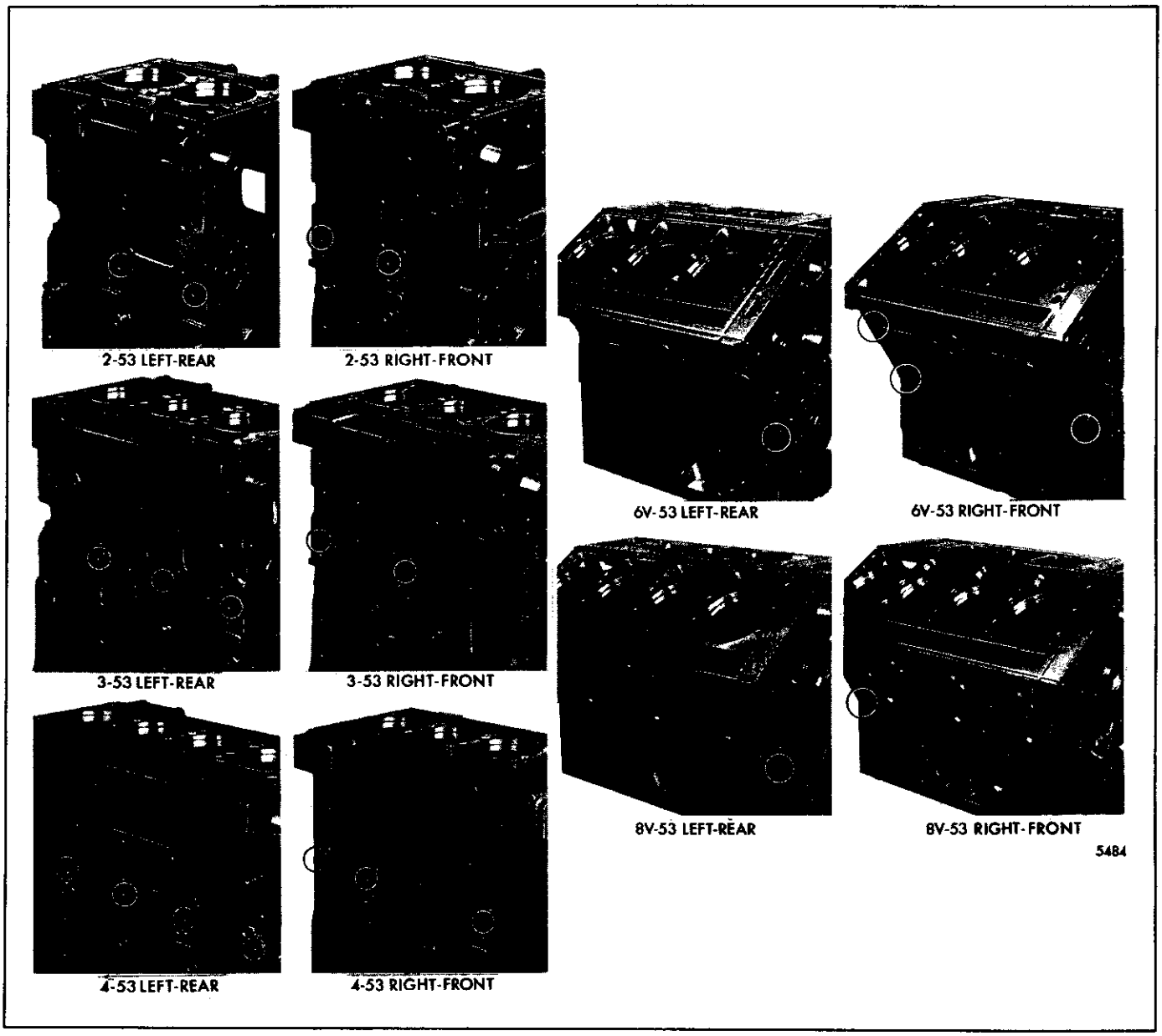

Fig. 4 – Oil Pressure Take–Off Locations

LUBRICATING OIL PUMP

IN–LINE AND 6V ENGINES

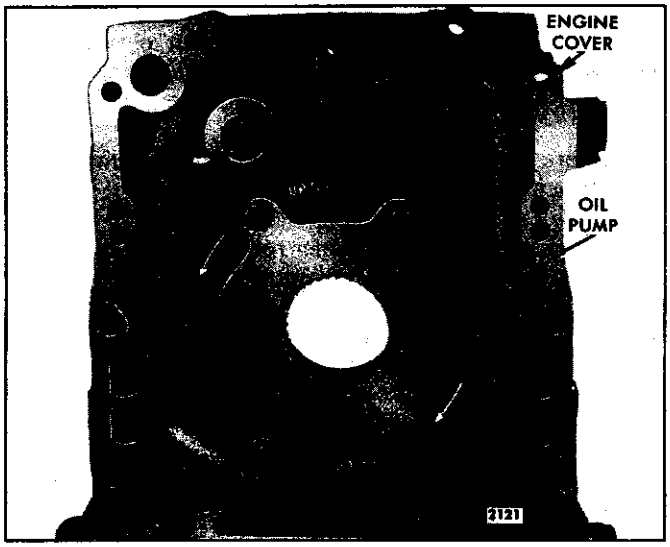

Fig. 1 – Typical Right–Hand Rotation Oil Pump Mounting

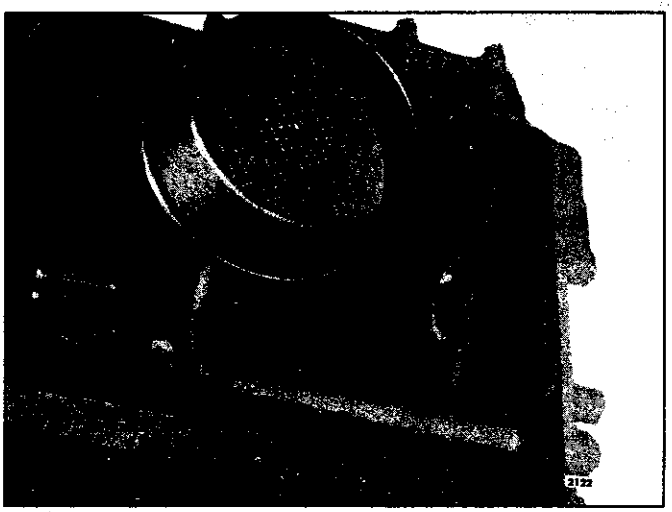

Fig. 2 – Typical Oil Pump Inlet Pipe and Screen Mounting

The lubricating oil pump, assembled to the inside of the lower engine front cover as illustrated in Fig. 1, is of the rotor type in which the inner rotor is driven by a gear pressed on the front end of the crankshaft. The outer rotor is driven by the inner rotor. The bore in the pump body, in which the outer rotor revolves, is eccentric to the crankshaft and inner rotor. Since the outer rotor has nine cavities and the inner rotor has eight lobes, the outer rotor revolves at eight–ninths crankshaft speed. Only one lobe of the inner rotor is in full engagement with the cavity of the outer rotor at any given time, so the former can revolve inside the latter without interference.

The pump width varies for the 2, 3 and 4 cylinder In–line and 6V–53 engines, but otherwise is of identical design. By rotating the pump 180°, it can be used for either a right–hand or left–hand rotation engine.

The 3, 4 and 6V–53 turbocharged engines use a higher capacity oil pump (which includes thicker inner and outer rotors) than the naturally aspirated engines.

Operation

As the rotors revolve, a vacuum is formed on the inlet side of the pump and oil is drawn from the crankcase, through the oil pump inlet pipe and a passage in the front cover, to the inlet port and then into the rotor compartment of the pump. Oil drawn into the cavities between the inner and outer rotors on the inlet side of the pump is then forced out under pressure through the discharge port into a passage in the front cover, which leads to the lubricating oil filter and cooler, and is then distributed throughout the engine.

If a check of the lubrication system indicates improper operation of the oil pump, remove and disassemble it as outlined below.

Remove Oil Pump

1. Drain the oil from the engine.
2. Remove the crankshaft pulley, fan pulley, support bracket and any other accessories attached to the front cover.
3. Remove the oil pan.
4. Refer to Fig. 2 and remove the four bolts which attach the oil pump inlet pipe and screen assembly to the main bearing cap and engine front cover or oil pump inlet elbow. Slide the flange and the seal ring on the inlet pipe and remove the pipe and screen as an assembly. Remove the oil pump inlet elbow (if used) and gasket from the engine front cover.
5. Remove the lower engine front cover.
6. Remove the six bolts and lock washers (if used) which attach the pump assembly to the engine front cover and withdraw the pump assembly from the cover (Fig. 1).

Disassemble Oil Pump

If the oil pump is to be disassembled for inspection or reconditioning, proceed as follows:

1. Refer to Fig. 5 or 6 and remove the two drive screws holding the pump cover plate to the pump body. Withdraw the cover plate from the pump body.

2. Remove the inner and outer rotors from the pump housing.

Inspection

Wash all of the parts in clean fuel oil and dry them with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

The greatest amount of wear in the oil pump is imposed on the lobes of the inner and outer rotors.

This wear may be kept to a minimum by using clean oil. If dirt and sludge are allowed to accumulate in the lubricating system, excessive rotor wear may occur in a comparatively short period of time.

Inspect the lobes and faces of the pump rotors for scratches or burrs and the surfaces of the pump body and cover plate for scoring. Scratches or score marks may be removed with an emery stone.

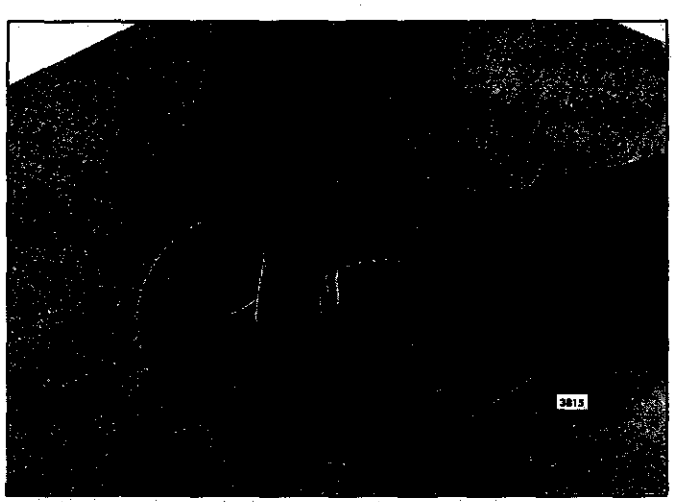

Fig. 3 – Measuring Rotor Clearance

Measure the clearance between the inner and outer rotors at each lobe (Fig. 3). The clearance should not be less than .0005" or more than .011". Measure the clearance from the face of the pump body to the side of the inner and outer rotor with a micrometer depth gage (Fig. 4). The clearance should not be less than .001" or more than .0035".

Inspect the splines of the inner rotor and the oil pump drive gear. If the splines are excessively worn, replace the parts. The rotors are serviced as matched sets, therefore, if one rotor needs replacing, replace both rotors.

Remove the oil inlet screen from the oil inlet pipe and clean both the screen and the pipe with fuel oil and dry them with compressed air. Replace the inlet pipe flange seal ring with a new seal ring.

Assemble Oil Pump

After the oil pump parts have been cleaned and inspected, refer to Fig. 5 or 6 and assemble the pump as follows:

1. Lubricate the oil pump outer rotor with engine oil and place it in the pump body.
2. Lubricate the oil pump inner rotor with engine oil and place it inside of the outer rotor.
3. Place the cover plate on the pump body and align the drive screw and bolt holes with the holes in the pump body. Since the holes are offset, the cover plate can be installed in only one position.
4. Install two new drive screws to hold the assembly together.

Remove Pump Drive Gear from Crankshaft

With the lower engine front cover and the lubricating oil pump removed from the engine, the oil pump drive gear may, if necessary, be removed from the end of the crankshaft as follows:

1. Thread the crankshaft pulley retaining bolt in the end of the crankshaft (Fig. 7).

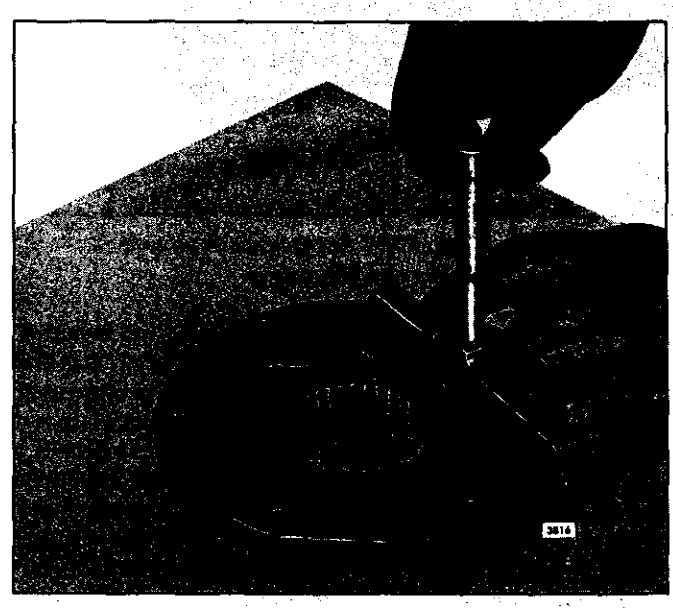

Fig. 4 – Measuring Clearance from Face of Pump Body to Side of Rotor

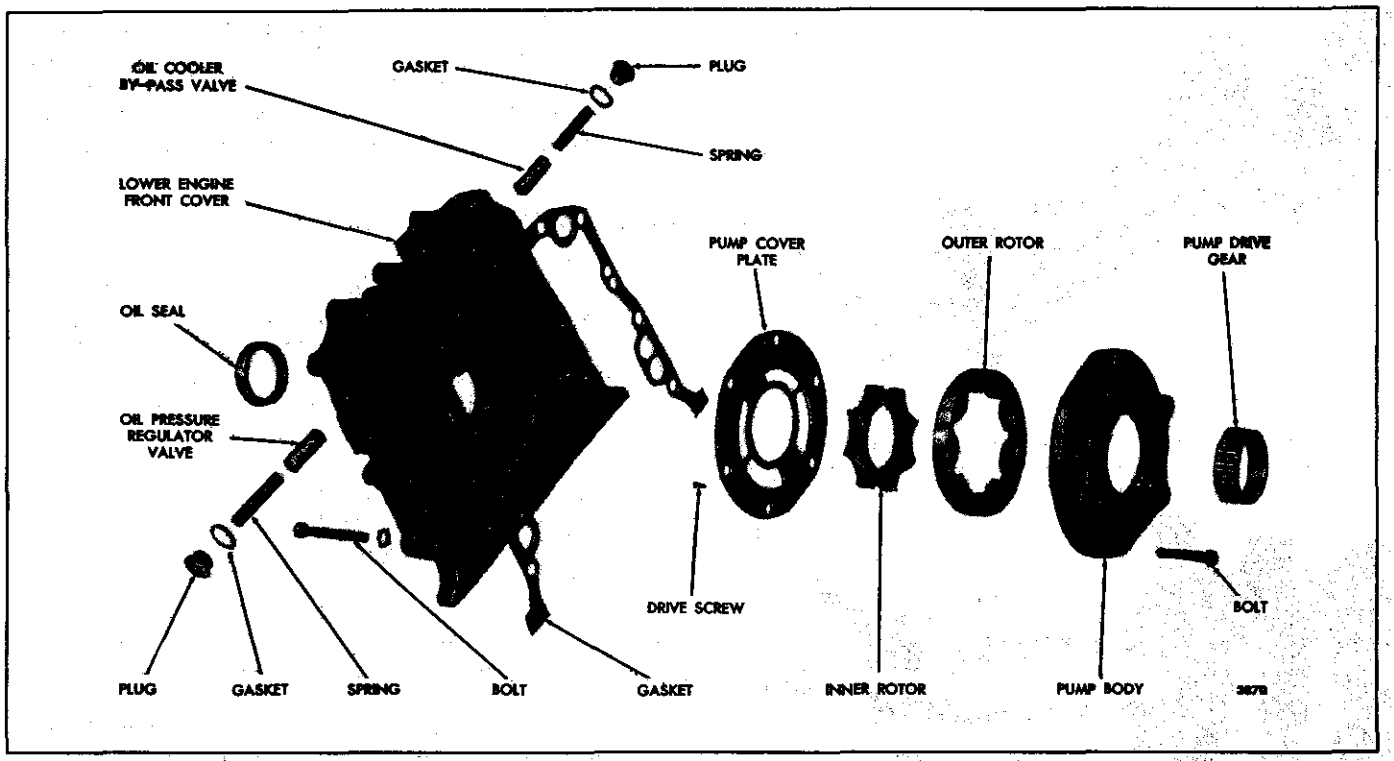

Fig. 5 – Oil Pump Details and Relative Location of Parts (Current)

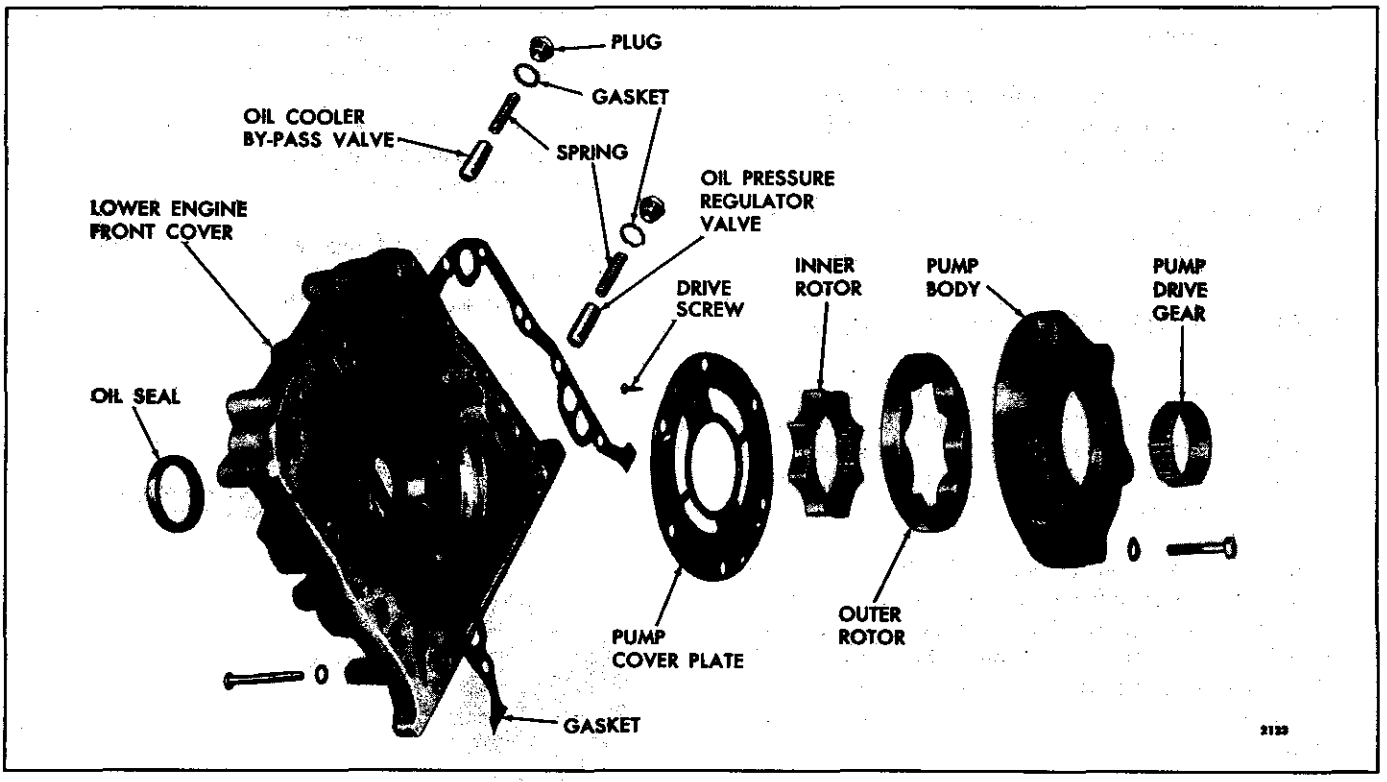

Fig. 6 – Oil Pump Details and Relative Location of Parts (Former)

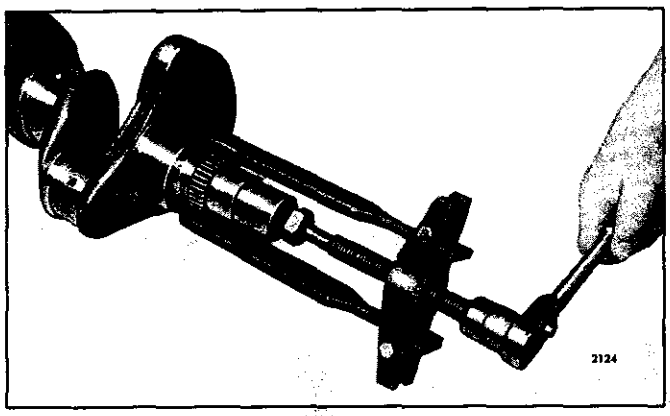

Fig. 7 – Removing Oil Pump Drive Gear

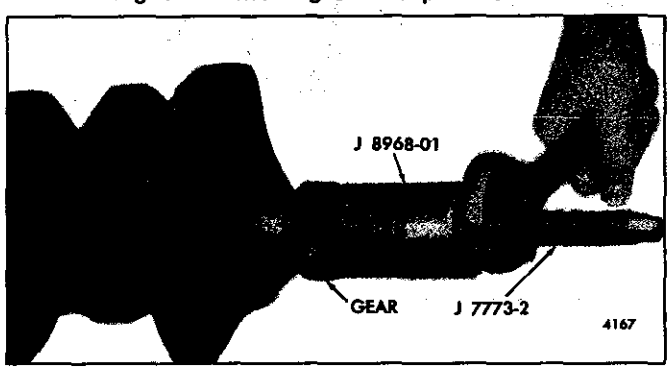

Fig. 8 – Installing Oil Pump Drive Gear Using Tools J 8968–01 and J 7773–2

2. Attach the jaws of a suitable gear puller behind the gear and locate the end of the puller screw in the center of the pulley retaining bolt.

3. Turn the puller screw clockwise to remove the gear from the crankshaft.

Install Pump Drive Gear on Crankshaft

1. Lubricate the inside diameter of a new oil pump drive gear with engine oil. Then, start the gear straight on the crankshaft with the chamfered edge of the gear toward the butt end of the crankshaft. Reinstallation of a used gear is not recommended.

2. Position the drive gear installer J 8968–01 over the end of the crankshaft and against the drive gear and force the gear in place (Fig. 8). When the end of the bore in the tool contacts the end of the crankshaft, the drive gear is correctly positioned (2.680″ from the front end of the crankshaft to the forward face of the gear).

3. It is important that the press fit of the drive gear to the crankshaft be checked to be sure that the gear does not slip on the crankshaft. It is recommended that the press fit (slip torque) be checked with tool J 23126. On in–line or 6V engines, the drive gear should not slip on the crankshaft at 100 lb–ft (136 N·m) torque. *Do not exceed this torque. If the gear slips on the shaft, another oil pump drive gear should be installed.*

Install Oil Pump

1. The markings on the pump body indicate the installation as pertaining to left or right–hand crankshaft rotation. Be sure that the letters "UP R.H." (right–hand rotation engine) or "UP L.H." (left–hand rotation engine) on the pump body are at the top (Fig. 1).

2. Insert the six bolts with lock washers (if used) through the pump body and thread them into the engine front cover. Tighten the bolts to 13–17 lb–ft (18–23 N·m) torque.

3. Install the lower engine front cover and pump assembly on the engine as outlined in Section 1.3.5.

4. Attach the oil inlet screen to the oil inlet pipe support with two locknuts (6V engine) or two bolts and lock washers (Fig. 9).

5. Use a new gasket and attach the oil pump inlet elbow (6V engine) to the underside of the engine front cover with the two bolts and lock washers.

6. Place the oil pump inlet pipe and screen assembly in position and fasten the support to the main bearing cap with the two bolts and lock washers.

7. Slide the inlet pipe flange and seal ring against the engine front cover (or oil pump inlet elbow on the 6V engine) and secure them with the two bolts and lock washers.

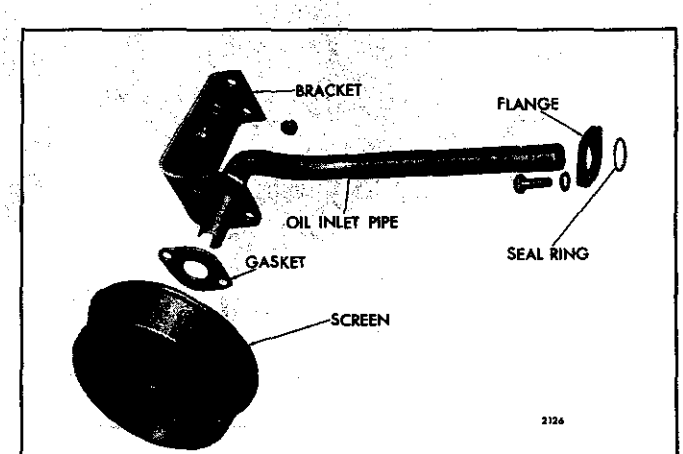

Fig. 9 – Oil Pump Inlet Pipe and Screen Details and Relative Location of Parts (In–Line Engine)

On In–line engines, the oil pump inlet tube and water bypass tube seals are the same size but of different material. *Be sure that the correct seal is used.* A new oil pump inlet tube seal may be identified by its white stripe.

8. Install the oil pan and refill the crankcase to the proper level.
9. Install the crankshaft pulley, fan pulley, support bracket and any other accessories that were attached to the front cover.

8V ENGINE

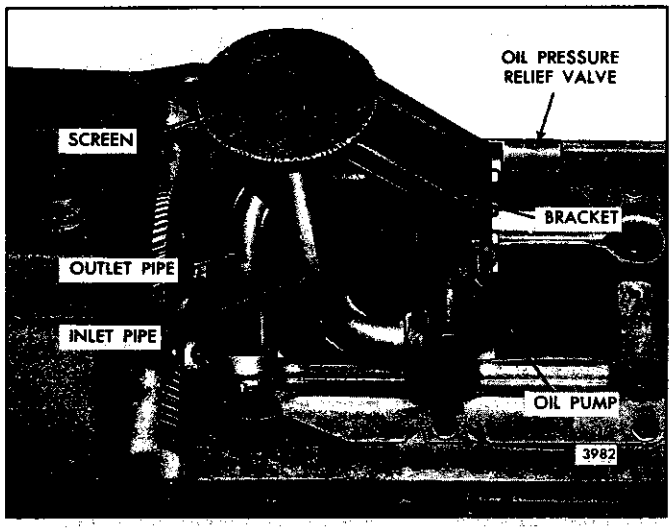

Fig. 10 – Lubricating Oil Pump Mounting (8V Engine)

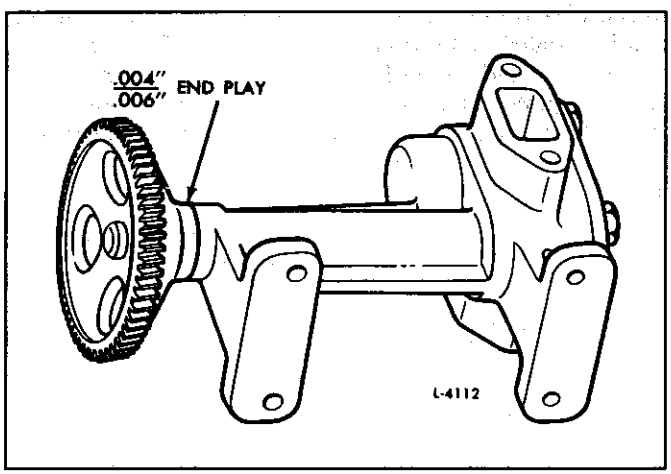

Fig. 11 – Oil Pump Gear End Play

The oil pump (Fig. 10) on an 8V engine is mounted on the No. 4 and No. 5 main bearing caps. The oil pump is driven by the crankshaft timing gear.

A spring–loaded relief valve, which is located in the oil pump outlet pipe assembly, bypasses excess oil back to the crankcase when the pressure in the engine oil gallery exceeds approximately 120 psi (827 kPa).

Effective with engine 8D–174, a new lubricating oil pump and inlet tube is used on the 8V engine. The pump has a new cover which supports the ends of the drive and driven shafts. The new drive shaft is longer and larger in diameter and the new drive gear has a larger inside diameter. When replacing an old oil pump with a new pump on an engine that has the inlet tube assembled to the pump cover, it will be necessary to install a new oil pump inlet system.

Effective with engine 8D–4611, a new high capacity oil pump with longer drive and driven gears is used on the 8V engines. The high capacity pump must be used in combination with the seven hole upper main bearing shells (Section 1.3.4). The new pump can be used with the former one hole upper main bearing shells.

Remove Oil Pump

1. Remove the bolts and lock washers securing the inlet pipe and the bracket to the oil pump. Then remove the inlet pipe, screen and bracket as an assembly from the pump.
2. Remove the two bolts and lock washers securing the oil pressure relief valve to the oil pump.
3. Remove the oil pump outlet pipe–to–cylinder block bolts. Then, remove the relief valve and outlet pipe as an assembly from the engine.
4. Remove the oil pump–to–bearing cap attaching bolts and lock washers and remove the pump assembly from the engine.

NOTICE: Shims are used between the oil pump mounting feet and the main bearing caps. Whenever the original pump from such an engine is reinstalled, the same shims or an equal number of new (identical) shims must be placed under both the front and rear mounting feet and the number then adjusted to obtain the proper clearance between the gears.

Disassemble Oil Pump

Remove the four bolts and lock washers and pull the cover off of the shafts. Slide the pump gear from the pump cavity.

Remove the oil pump driven gear by pressing the drive shaft through the gear.

Inspection

Wash all of the parts in clean fuel oil and dry them with compressed air.

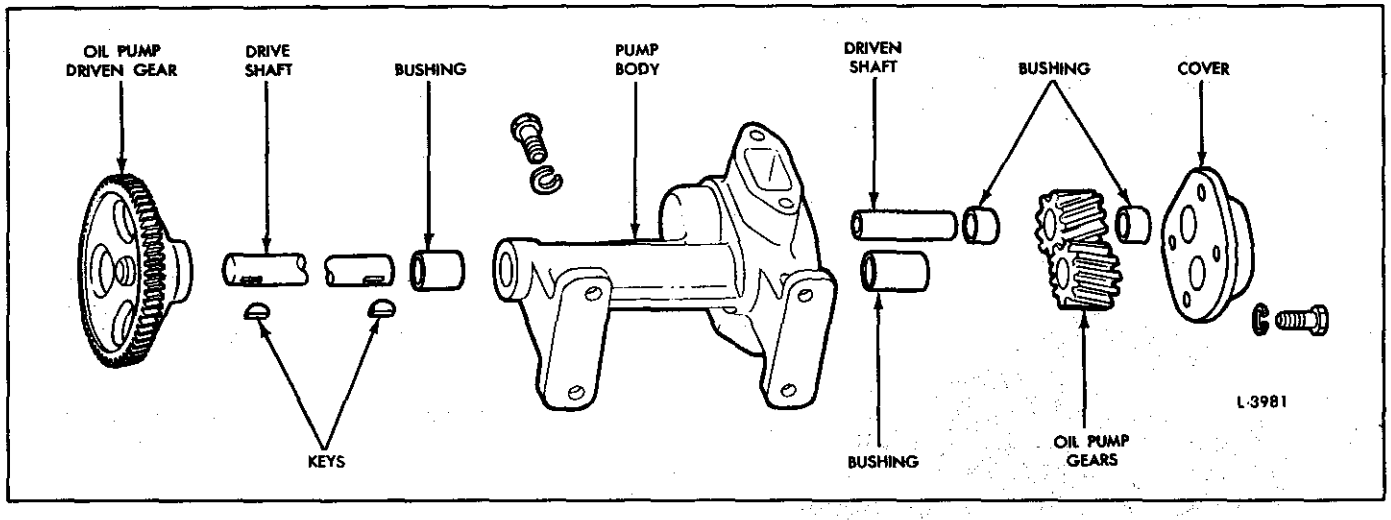

Fig. 12 – Lubricating Oil Pump Details and Relative Location of Parts (8V Engine)

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

The greatest amount of wear in the oil pump is imposed on the internal drive and driven gears. This wear may be kept to a minimum by keeping the lubricating oil clean and acid–free. If dirt and sludge are allowed to accumulate in the lubricating system, pronounced gear wear may occur in a comparatively short period of time. Proper servicing of oil filters will increase the life of the gears.

Examine the internal gear cavity of the pump body and scavenger pump, if used, for wear or scoring. Also, inspect the pump cover, or the spacer between the pump and scavenger bodies, for wear. Replace parts, if necessary.

Inspect the bushings in the pump body and cover (or scavenging pump body). If the bushings are worn excessively, replace the pump and cover (or scavenging pump body) unless suitable boring equipment is available for finishing the new bushings. When installing new bushings, replace all of the bushings in the pump bodies. The bushings must be located and positioned as shown in Fig. 13. Also, the gear bore and the bushing bore in both the pump body and scavenging pump body must be concentric within .001" total indicator reading. The shaft–to–cover or scavenging pump body to bushing clearance with new parts is .001" to .0027".

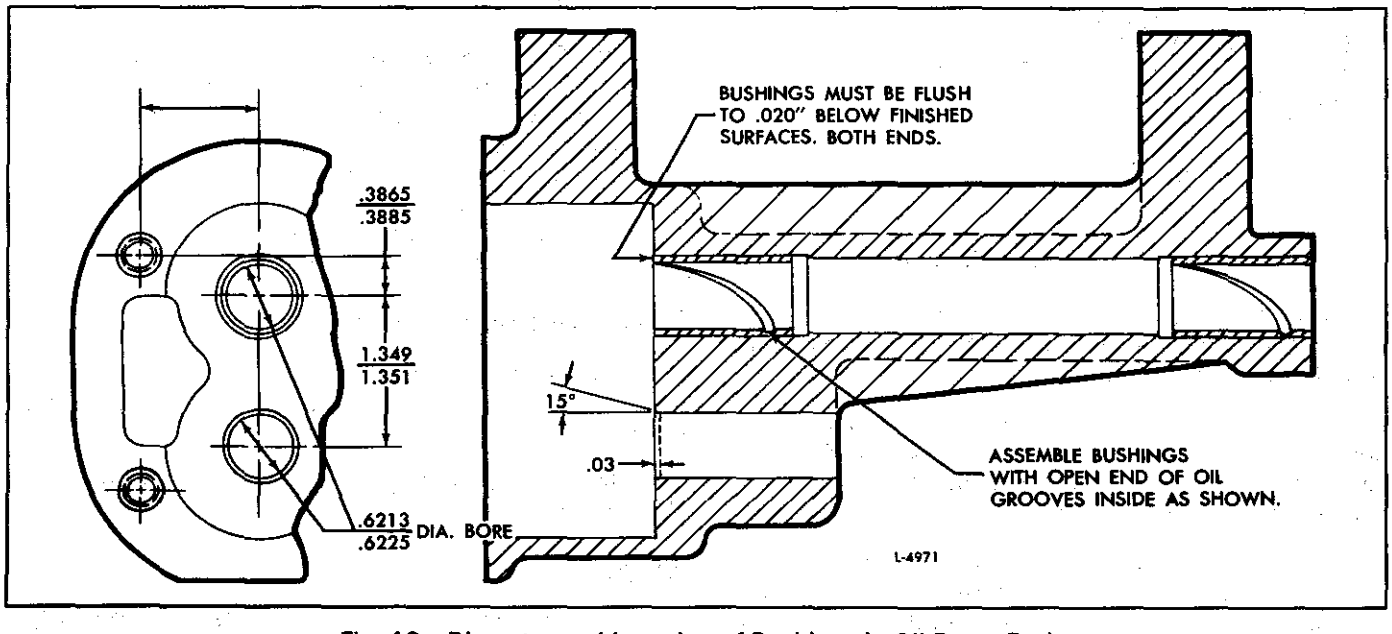

Fig. 13 – Diameter and Location of Bushings in Oil Pump Body

When installing the spacer between the oil pump body and the scavenging pump body, be sure the bleed hole is located on the discharge side of the oil pump assembly.

If the driven gear bushings are worn, replace the bushings. Then, ream the bushings to .625" ± .0005" diameter after assembly.

If the gear teeth are scored or worn, install new gears. The use of excessively worn gears will result in low engine oil pressure which, in turn, may lead to serious damage throughout the engine.

Inspect the external pump drive–driven gear for wear and replace it, if necessary.

Inspect the pump shafts for wear and check the keyways. Replace the shafts, if necessary.

Check to be sure the pressure relief valve moves freely in the valve housing. Replace it, if necessary.

Replace a pitted or fractured spring.

Assemble Oil Pump

Install the oil pump driven shaft and pump gear in the pump body. Install the other pump gear on the shaft in the pump cavity (Fig. 12).

Mount the cover on the two shafts, and fasten the cover on the pump with four bolts and lock washers.

Install a Woodruff key, if previously removed, in the shaft. Press the drive gear over the key on the shaft and place .006" feeler stock between the gear and the pump body. Press the gear on the shaft until the clearance between the gear and the pump body is .004" to .006" (Fig. 11).

Install Oil Pump

1. Place the pump on the No. 4 and No. 5 main bearing caps and, with shims in place, fasten the pump to the main bearing caps with four bolts and lock washers. Proper gear clearance is from .005"–.007".

   Always check the clearance between the crankshaft gear and the oil pump driving gear with the engine in the upright or running position.

2. Attach new gaskets to the oil pressure relief valve housing and fasten it to the pump and cylinder block with four bolts and lock washers.

3. Place a new gasket under the oil pump inlet pipe and fasten it to the pump body with two bolts and lock washers.

4. Fasten the oil pump screen bracket to the oil pump cover with two bolts, lock washers and nuts.

LUBRICATING OIL PRESSURE REGULATOR

IN–LINE AND 6V ENGINES

Stabilized lubricating oil pressure is maintained within the engine at all speeds, regardless of the oil temperature, by an oil pressure regulator valve installed in the engine lower front cover (Figs. 1 and 2).

The oil pressure regulator consists of a hollow piston–type valve, a spring, gasket and plug. The valve is located in an oil gallery within the lower front cover and is held tight against a counterbored valve seat by the valve spring and plug. When the oil pressure exceeds a given value (Table 1), the valve is forced from its seat and the lubricating oil is bypassed into the engine oil pan.

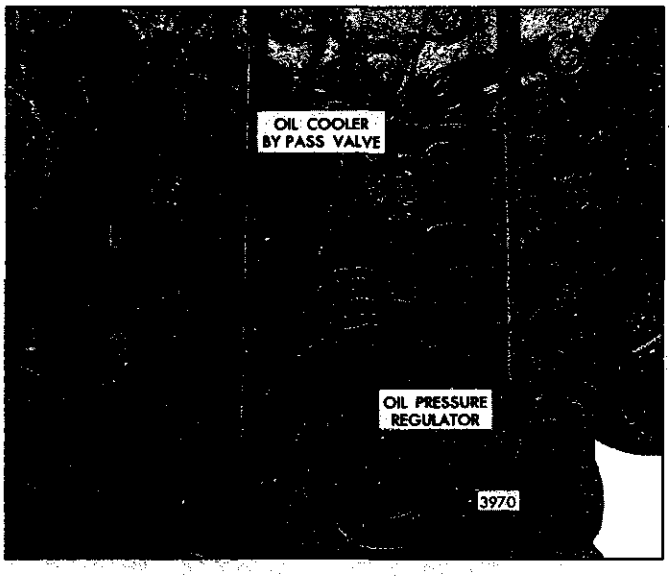

Fig. 1 – Location of Current Oil Pressure Regulator Valve (In–line Engine)

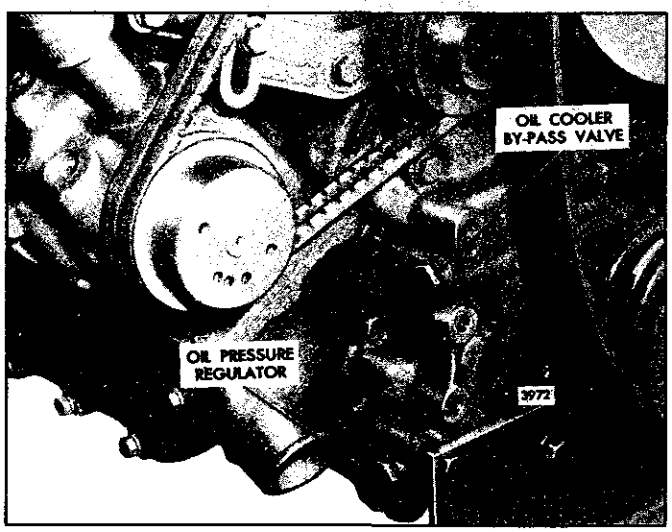

Fig. 2 – Location of Former Oil Pressure Regulator Valve (6V Engine)

Under normal conditions, the pressure regulator valve should require very little attention. If sludge accumulates in the lubrication system, the valve may not work freely, thereby remaining open or failing to open at the normal operating pressure.

Whenever the lubricating oil pump is removed for inspection, the regulator valve and spring should also be removed, thoroughly cleaned in fuel oil and inspected.

Remove Oil Pressure Regulator

1. Remove the plug and washer from the engine lower front cover.
2. Withdraw the spring and the valve from the cover.

Inspection

Clean all of the regulator components in fuel oil and dry them with compressed air. Then, inspect the parts for wear or damage.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

The regulator valve must move freely in the valve bore. If the valve is scored and cannot be cleaned up with crocus cloth, it must be replaced.

Replace a fractured or pitted spring.

Engine	Plug Marks	Front Cover	Valve Opening Pressure	
			psi	kPa
In-line		Former	78	538
		Current	51	352
6V	None	Early	32	221
	R	Former	52	359
	X	Current	62	427

TABLE 1

Install Oil Pressure Regulator

1. Apply clean engine oil to the outer surface of the valve and slide it into the opening in the engine lower front cover, closed end first.
2. Install a new copper gasket on the plug.
3. Insert the spring in the valve.
4. While compressing the spring, start the plug in the side of the cover, then tighten the plug.

8V ENGINE

The lubricating oil pressure regulator is located in the engine front cover (Fig. 3).

A regulator assembly consists of a piston–type valve, a spring, a plug and gasket.

When the oil pressure at the valve exceeds 52 psi (359 kPa), the valve is forced from its seat and oil from the gallery passage in the front cover is bypassed to the crankcase.

Whenever the lubricating oil pump is removed for inspection, the regulator valve and spring should also be removed, thoroughly cleaned in fuel oil and inspected.

Remove Oil Pressure Regulator

1. Remove the plug and gasket from the engine front cover.
2. Withdraw the spring and valve from the cover.

Inspection

Clean the parts thoroughly in fuel oil, dry them with compressed air and inspect them.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Check to be sure the regulator valve moves freely in the engine cover valve bore. If the valve is scored and cannot be cleaned up with crocus cloth, it must be replaced.

Replace a pitted or fractured spring.

Install Oil Pressure Regulator

1. Apply clean engine oil to the outer surface of the valve and slide it into the opening in the engine front cover, closed end first.
2. Install a new copper gasket on the plug.
3. While compressing the spring, start the plug in the side of the cover, then tighten the plug.

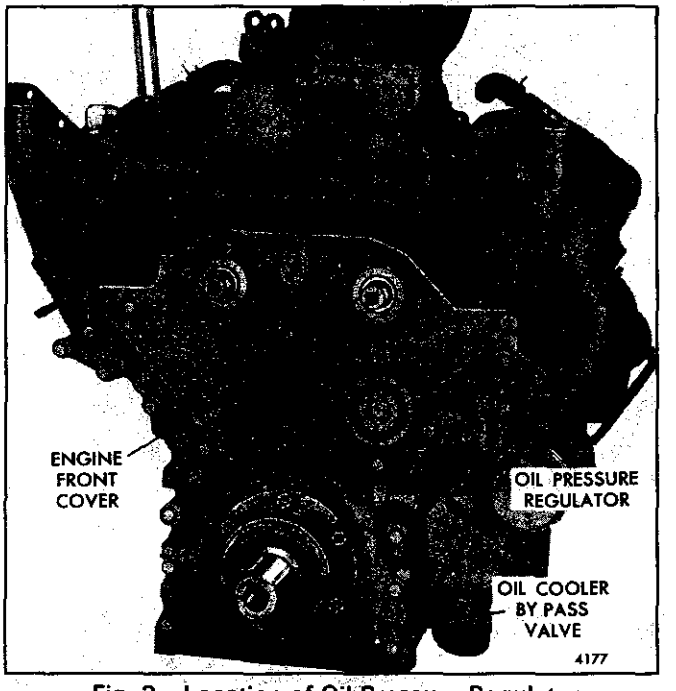

Fig. 3 – Location of Oil Pressure Regulator (8V Engine)

LUBRICATING OIL FILTERS

Series 53 engines are equipped with a full–flow type lubricating oil filter. A bypass type oil filter may be used in addition to the full–flow type filter when additional filtration is desired.

Full–Flow Oil Filter

The full–flow type lubricating oil filter is installed ahead of the oil cooler in the lubrication system (Fig. 1). On the two and three cylinder models, the oil filter shell is mounted in a downward or rearward position unless it has an adaptor to provide optional mounting positions. On the four cylinder models, the oil filter may be mounted with the filter shell up, down or toward the rear, except when on the blower side of the engine where the down and rearward positions are optional. On V–type engines, the filter is mounted at an angle down and towards the rear of the engine.

Do not reverse the flexible oil filter hoses at the filter hose adaptor on 6V and 8V marine engines equipped with a remote mounted lubricating oil filter. Refer to Fig. 2 for the proper installation of the hoses.

If the oil filter adaptor is removed from the engine for any reason, it must be reinstalled with the open half of the casting toward the top of the block. The word **TOP** is cast into the upper right corner of the adaptor. If installed in any other way, engine oil will not flow through the filter and may cause serious engine damage (Fig. 3).

The filter assembly consists of a replaceable element enclosed within a shell which is mounted on an adaptor or base. When the filter shell is in place, the element is restrained from movement by a coil spring.

All of the oil supplied to the engine by the oil pump passes through the filter before reaching the various moving parts of the engine. The oil is forced by pump pressure through a passage in the filter base to the space surrounding the filter element. Impurities are filtered out as the oil is forced through the element to a central passage surrounding the center stud and out through another passage in the filter base and then to the oil cooler.

A valve, which opens at approximately 18–21 psi (124–145 kPa), is located in the filter base on engine mounted filters or in the hose adaptor (7/8" hoses) with a remote mounted filter and will bypass the oil directly to the oil cooler should the filter become clogged.

The spin–on lubricating oil filter (throw–away type) and mounting adaptor are now being installed on certain engines. The spin–on oil filter requires a new mounting adaptor which in some cases is part of the oil cooler cover. The oil filter assembly is serviced in a package which consists of an element and gasket (seal).

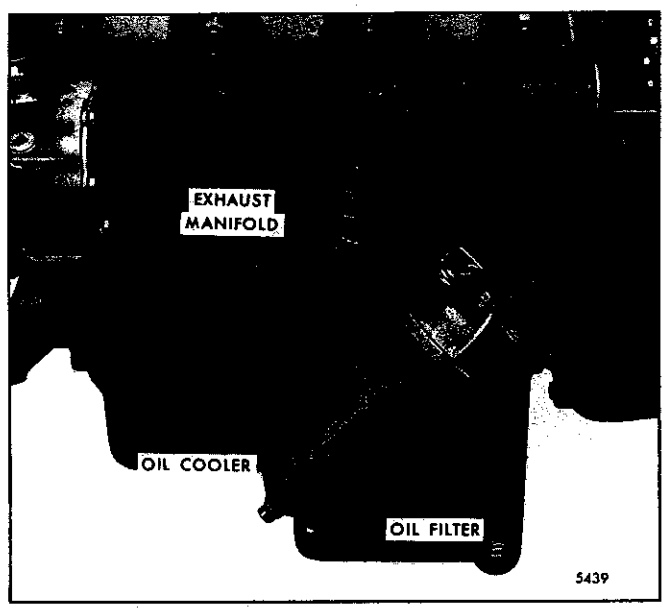

Fig. 1 – Typical Full–Flow Oil Filter Mounting (6V Engine Shown)

Bypass Oil Filter

When additional filtration is desired, an oil filter of the bypass type may also be installed on the engine (Fig. 4). However, *the size of the orifice on the discharge side of the filter must not exceed .062"* to control the oil flow rate and to provide sufficient oil pressure when the engine is running at idle speed.

When the engine is running, a portion of the lubricating oil is bled off the oil gallery and passed through the bypass filter. Eventually all of the oil passes through the filter, filtering out fine foreign particles that may be present.

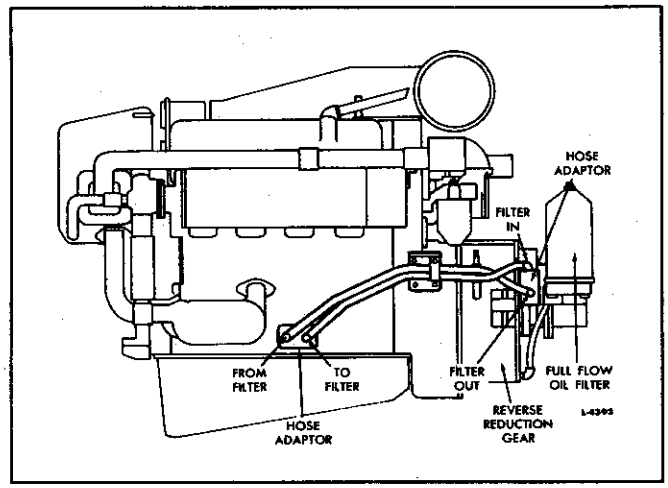

Fig. 2 – Proper Installation of Flexible Oil Filter Hoses

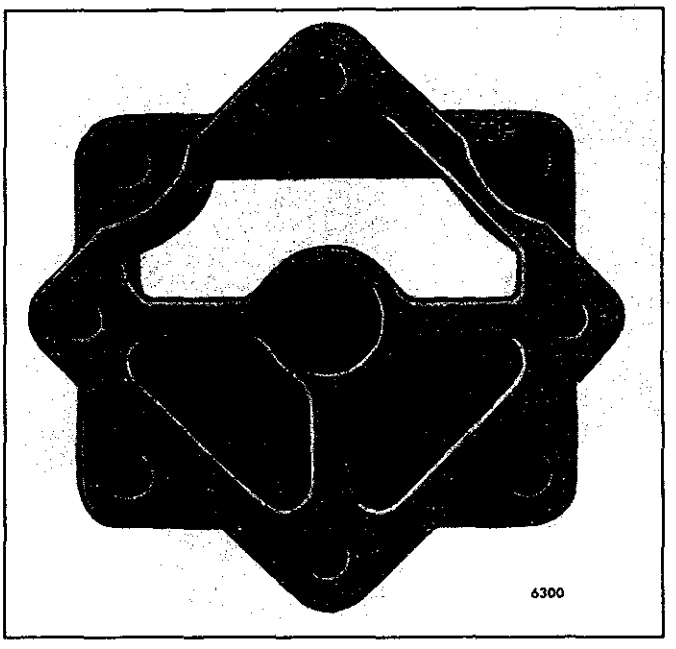

Fig. 3 – Proper Installation of Oil Filter Adaptor

The bypass filter assembly consists of a replaceable element contained in a shell mounted on a combination base and mounting bracket. When the shell is in place, the filter element is restrained from movement by a coil spring at the top. A hollow center stud serves as the outlet passage from the filter as well as securing the shell to the base.

On certain models, the filter assembly consists of a replaceable element contained in a shell and sealed in place by a cover. This type of filter assembly incorporates a mounting bracket attached to the filter shell. A hollow center stud serves as the outlet passage from the filter as well as positioning the filter element.

Oil Filter Maintenance

With the use of detergent lubricating oils, the color of the lubricant has lost value as an indicator of oil cleanliness or proper filter action. Due to the ability of the detergent compounds to hold minute carbon particles in suspension, heavy duty oils will always appear dark colored on the oil level dipstick.

Heavy sludge deposits found on the filter elements at the time of an oil change must be taken as an indication that the detergency of the oil has been exhausted. When this occurs, the oil drain interval should be shortened. The removal of abrasive dust, metal particles and carbon must be ensured by replacement of the oil filter elements at the time the engine oil is changed.

Selection of a reliable oil supplier, strict observation of his oil change period recommendations and proper filter maintenance will ensure trouble–free lubrication and longer engine life.

- An optional AC service filter is available which has a synthetic (fiberglass), rather than an organic (cellulose) filtering medium. The filter is available in spin–on or canister style and is otherwise identical to the current production filter. The new filter traps particles as small as 12 microns (at 98% efficiency per AC test procedures), compared to 45 microns for the production filter. Because of its increased filtering capacity, DDC recommends using it on new, rebuilt, or newly overhauled engines being placed in service.

NOTICE: The new service filter will improve oil filtration on a properly maintained and operated engine. It will not prevent wear or malfunctions caused by poor maintanence or improper engine operation.

Replace Oil Filter Element

Replace the element in either the full–flow or bypass type oil filter assembly (Figs. 4 and 5) as follows:

1. Remove the drain plug from the filter shell or the filter adaptor or base and drain the oil. If a type S–6 filter assembly is used, oil may be removed with a sump pump after the cover and element are removed.
2. Back out the center stud or the cover nut and withdraw the shell, element and stud as an assembly. Discard the element and the shell gasket.
3. Remove the center stud and gasket. Retain the gasket unless it is damaged and oil leaks occurred.
4. Remove the nut or snap ring on the full–flow filter center stud.

   The center stud on the current full–flow oil filter has been revised by removing the snap ring groove and increasing the 5/8"–18 thread length approximately 1/2". To conform with this change, a 5/8"–18 nut replaces the snap ring formerly used to retain the filter spring and seal.
5. Remove and discard the element retainer seal (Fig. 4). Install a new seal.
6. Clean the filter shell and the adaptor or base.
7. Install the center stud gasket and slide the stud (with the spring, washer, seal and retainer installed on the full–flow filter) through the filter shell.
8. Install a new shell gasket in the filter adaptor or base.

   Before installing the filter shell gasket, be sure all of the old gasket material is removed from the filter shell and the filter adaptor or base. Also, make sure the gasket surfaces of the shell and the adaptor or base have no nicks, burrs or other damage.
9. Position the new filter element carefully over the center stud and within the shell. Then, place the shell, element and stud assembly in position on the filter

adaptor or base and tighten the stud to 50–60 lb–ft (68–81 N·m) torque.

10. Install the drain plug.

11. Start and run the engine for a short period and check for oil leaks. After any oil leaks have been corrected and the engine has been stopped long enough (approximately 20 minutes) for the oil from various parts of the engine to drain back to the crankcase, add sufficient oil to bring it to the proper level on the dipstick.

Replace Spin–On Filter

1. Remove the oil filter using strap wrench tool J 24783 which must be used with a 1/2" drive socket wrench and extension.

2. Discard the used oil filter.

3. Clean the filter adaptor with a clean, lint–free cloth.

4. Lightly coat the oil filter gasket (seal) with clean engine oil.

5. Start the new filter on the adaptor and *tighten by hand* until the gasket touches the mounting adaptor head. Tighten an additional two–thirds turn.

   NOTICE: Mechanical tightening will distort or crack the filter adaptor.

6. Start and run the engine for a short period and check for oil leaks. After any oil leaks have been corrected and the engine has been stopped long enough for oil from the various parts of the engine to drain back to the crankcase (approximately ten minutes), add sufficient oil to raise the oil level to the proper mark on the dipstick.

Remove And Install Bypass Valve

1. Remove the four bolts and washers and detach the filter adaptor or filter junction housing from the oil cooler adaptor (Fig. 5).

2. Remove the plug and gasket (Fig. 6) or the screw and retainer (Fig. 7) and withdraw the spring and bypass valve.

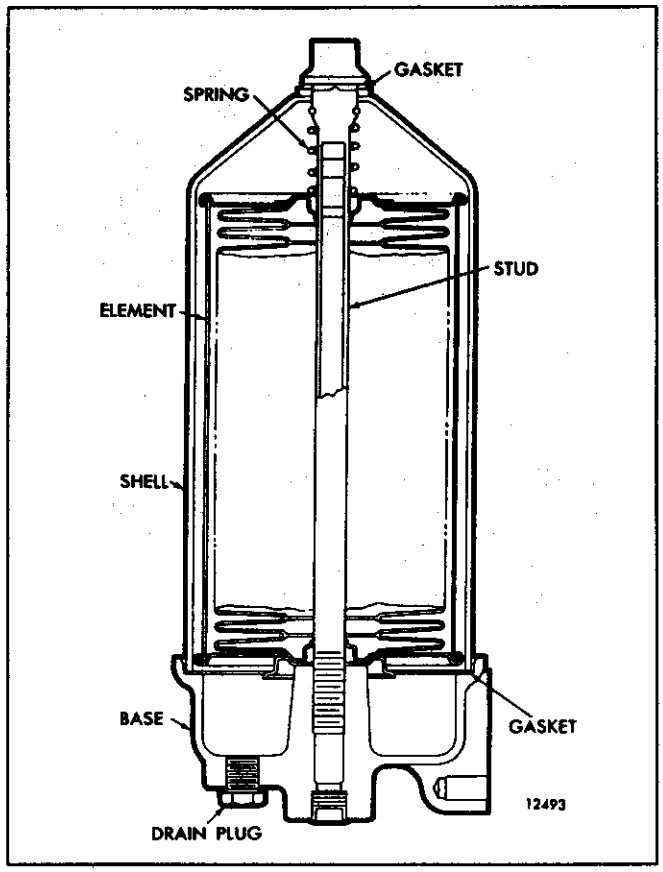

Fig. 4 – Bypass Oil Filter Details

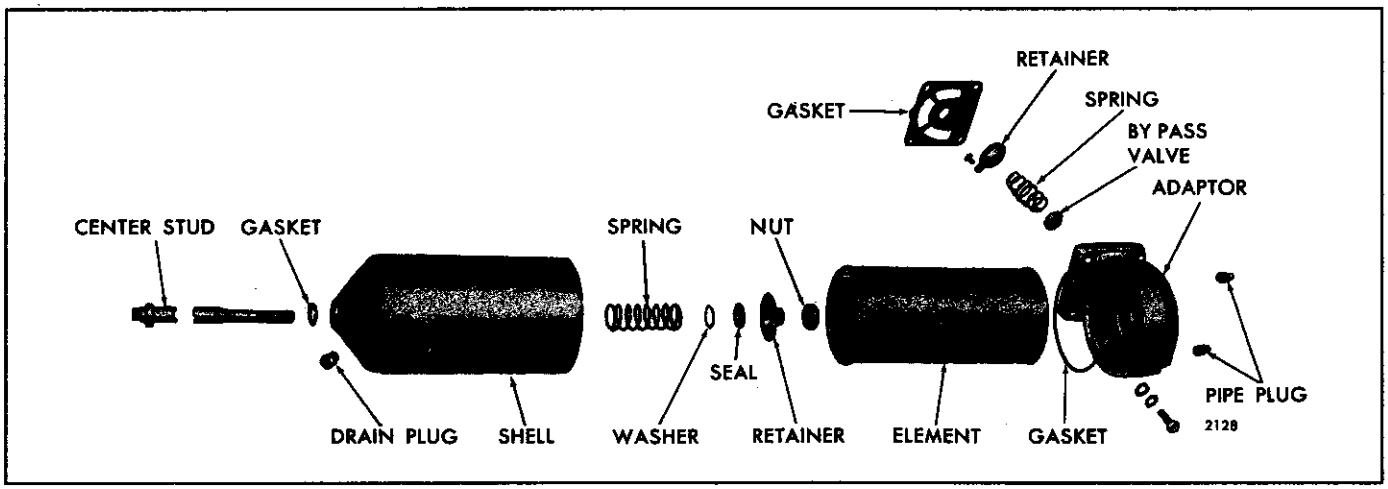

Fig. 5 – Full Flow Oil Filter Details and Relative Location of Parts

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

3. Wash all of the parts in clean fuel oil and dry them with compressed air.
4. Inspect the parts for wear. If necessary, install new parts.
5. Reassemble and install the bypass valve. Use only the current bypass valve and spring for service (Fig. 6). The current thicker valve and stiffer spring increase the bypass pressure from 13–18 psi (90–124 kPa) to 18–21 psi (124–145 kPa) to permit more efficient filtration. A thicker valve, stronger spring, heavier retainer and a longer retaining screw are currently used in the bypass valve assembly shown in Fig. 7. The filter adaptors and filter junction housings have been revised by deepening the valve cavity to accommodate the thicker valve and related parts.
6. Use a new gasket and install the filter adaptor or filter junction housing.

NOTICE: The small protrusion on the gasket must mate with the boss on the filter adaptor regardless of the position in which the filter is assembled. If the gasket is not correctly positioned, the flow of oil will be obstructed.

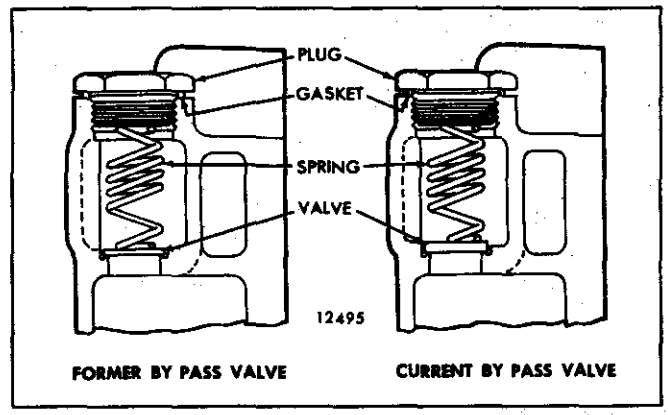

Fig. 6 – Bypass Valve Assembly Secured by Plug

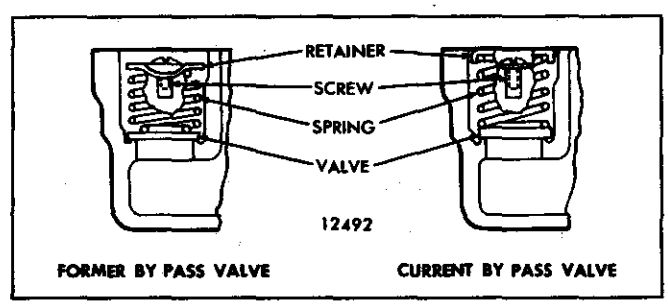

Fig. 7 – Bypass Valve Assembly Secured by Retainer and Screw

LUBRICATING OIL COOLER

Engine oil coolers are provided for all engines with the exception of certain 2–cylinder models which do not include or require an oil cooler. The oil cooler is mounted on the side of the cylinder block (Fig. 1).

To assure engine lubrication should the oil cooler become plugged, a bypass valve located near the top of the lower engine front cover bypasses oil from the oil pump discharge port directly to the oil galleries in the cylinder block. The bypass valve opens at approximately 52 psi (359 kPa) (current In–line engines), 30 psi (207 kPa) (former In–line engines) or 52 psi (359 kPa) (6V and 8V engines). The valve components are the same as and serviced in the same manner as the oil pressure regulator valve in Section 4.1.1.

The bypass valve opens at approximately 32 psi (221 kPa) on 6V marine engines prior to engine number 6D–11074 and all 6V engines prior to engine number 6D–17960.

Coolant circulated through the oil cooler completely surrounds the oil cooler core. Therefore, whenever an oil cooler is assembled, special care must be taken to have the proper gaskets in place and the retaining bolts tight to assure good sealing.

The oil cooler housing on an In–line engine is attached to an oil cooler adaptor which, in turn, is attached to the cylinder block. The flow of oil is from the oil pump through a passage in the oil cooler adaptor to the full flow oil filter, which is also mounted on the oil cooler adaptor, and then through the oil cooler core and the cylinder block oil galleries.

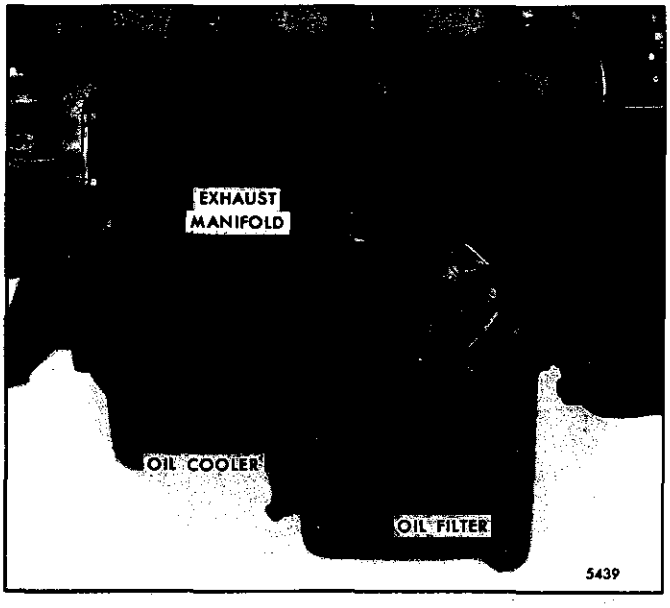

Fig. 1 – Typical Oil Cooler Mounting (6V Engine Shown)

The oil cooler housing on a V–type engine is attached directly to the cylinder block.

In order to standardize, a new aluminum oil cooler cover has replaced two cast iron covers. The new oil cooler cover has two inlet holes (to filter) and two outlet holes (from filter). One each of these holes must be plugged when the new cover is used (Fig. 2). Different attaching bolts are required because of varying cover flange thicknesses. Only the new aluminum oil cooler cover will be serviced.

Effective with engine serial number 4DB–48774 the 4–53 turbocharged engine uses a 12 plate oil cooler with a reinforced oil cooler core. When replacing an oil cooler on a 4–53 turbocharged engine built prior to the above serial number use the reinforced oil cooler assembly.

Remove Oil Cooler Core

1. Drain the cooling system by opening the drain cock at the bottom of the oil cooler housing.
2. Remove any accessories or other equipment necessary to provide access to the cooler.
3. On In–line or 6V engines, loosen and slide the clamps and hose back on the water inlet elbow on the cylinder block. On 8V engines, remove the bolt and lock washer attaching the water outlet flange and seal ring to the cylinder block.
4. Loosen and slide the clamps and hose back on the tube leading from the thermostat to the water pump.
5. Remove the bolts and lock washers which attach the water pump to the oil cooler housing.
6. Matchmark the end of the oil cooler housing, cooler core and adaptor with a punch or file so they can be reinstalled in the same position.
7. Remove the bolts and lock washers which attach the oil cooler housing to the adaptor or cylinder block and remove the housing and core as an assembly. Be careful when withdrawing the assembly not to drop or damage the cooler core.
8. If the adaptor (In–line engine) is to be removed, the oil filter must first be removed. Then, remove the bolts and lock washers which attach the adaptor to the cylinder block. Withdraw the adaptor and gaskets.
9. Remove all traces of gasket material from the cylinder block and the oil cooler components.

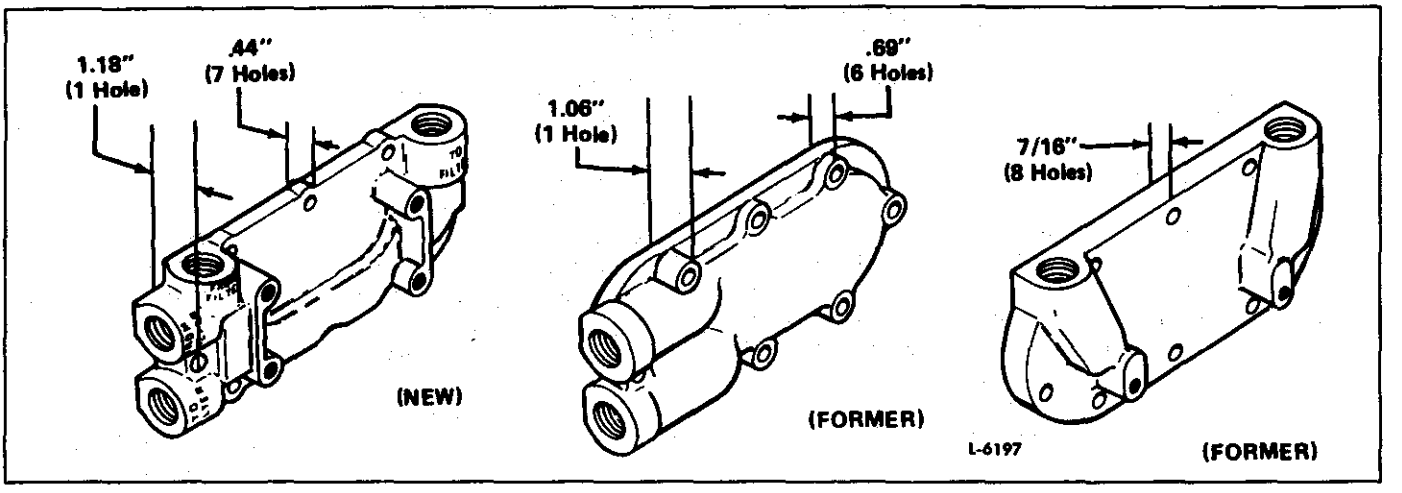

Fig. 2 – Oil Cooler Cover

Clean Oil Cooler Core

1. *Clean oil side of core* – Remove the core from the oil cooler. Circulate a solution of 1,1,1 tricholorethane through the core passages with a force pump to remove the carbon and sludge.

   CAUTION: To avoid personal injury, perform this operation in the open or in a well ventilated area. Avoid breathing the fumes or direct contact of the chemicals with your skin. Use recommended safety equipment as required.

   Clean the core before the sludge hardens. If the oil passages are badly clogged, circulate a cleaning solution through the core and flush thoroughly with clean, hot water.

2. *Clean water side of core* – After cleaning the oil side of the core, immerse it in the following solution:

   Add one–half pound of oxalic acid to each two and one–half gallons of solution composed of one third muriatic acid and two–thirds water. The cleaning action is evidenced by bubbling and foaming.

   Watch the process carefully and, when bubbling stops (this usually takes from 30 to 60 seconds), remove the core from the cleaning solution and thoroughly flush it with clean, hot water. After cleaning, dip the core in light oil.

   NOTICE: Do not attempt to clean or reuse an oil cooler core when an engine failure occurs in which metal particles from worn or broken parts are released into the lubricating oil. Replace the oil cooler core.

Pressure Check Oil Cooler Core

After the oil cooler core has been cleaned, check for leaks as follows:

1. Make a suitable plate and attach it to the flanged side of the cooler core. Use a gasket made from rubber to assure a tight seal. Drill and tap the plate to permit an air hose fitting to be attached at the inlet side of the core (Fig. 3).

2. Attach an air hose, apply approximately 75–150 psi (517–1034 kPa) air pressure and submerge the oil cooler core and plate assembly in a container of water heated to 180°F (82°C). Any leaks will be indicated by air bubbles in the water. If leaks are indicated, replace the core.

   CAUTION: When making this pressure test, be sure that personnel are adequately protected against any stream of pressurized water from a leak or rupture of a fitting, hose or the oil cooler core.

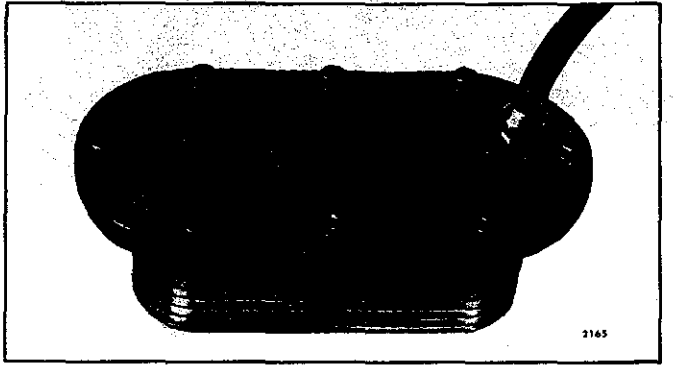

Fig. 3 – Preparing Oil Cooler Core for Pressure Test

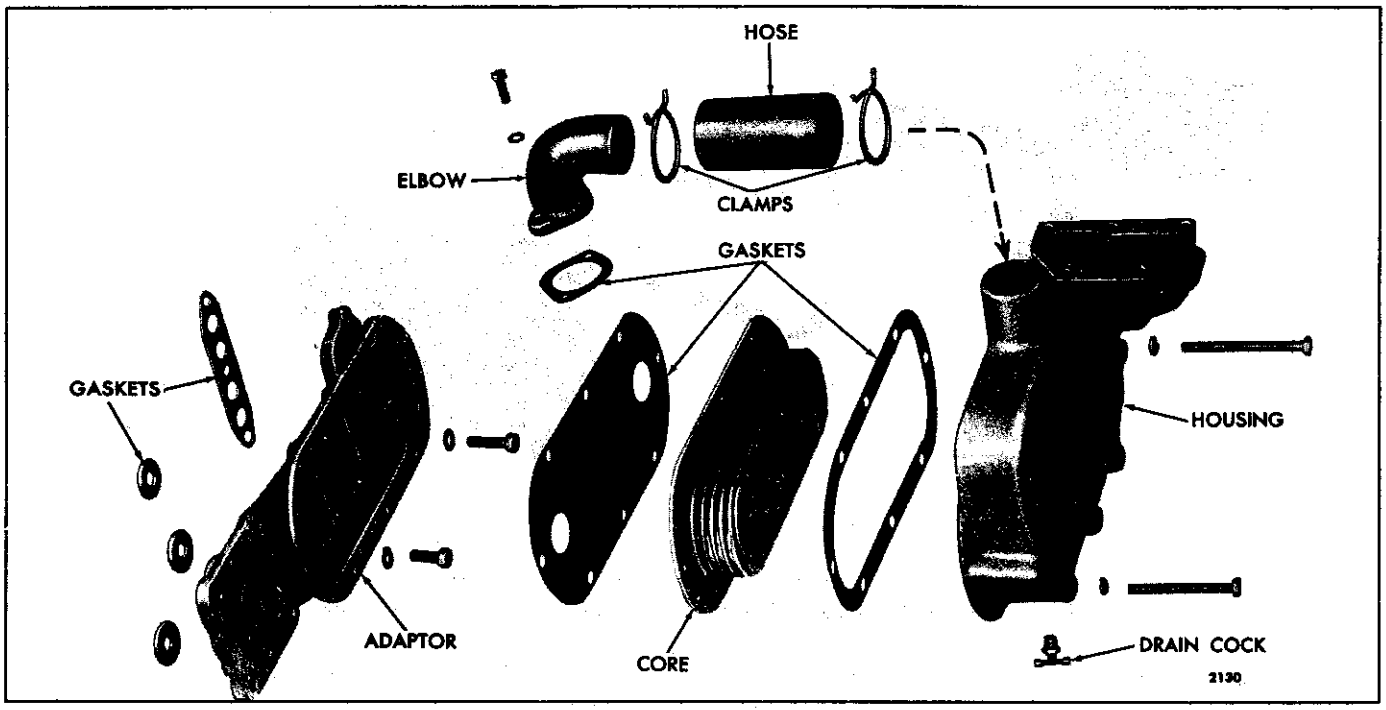

Fig. 4 – Oil Cooler Details and Relative Location of Parts (In–Line Engine)

3. After the pressure check is completed, remove the plate and air hose from the cooler core, then dry the core with compressed air.

   • **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

   NOTICE: Where a leaking oil cooler core has caused contamination of the engine, the engine must be immediately flushed to prevent serious damage (refer to Section 5).

Install Oil Cooler Core

To provide increased oil cooler capacity, an 18–plate oil cooler is being used in all 6V–53T units with engine–mounted oil coolers. DDC recommends replacing the former 16–plate core with the 18–plate core at time of engine overhaul or if the former core is damaged.

1. If the oil cooler adaptor (In–line engines) was removed from the cylinder block, remove the old gasket material from the bosses where the adaptor sets against the block. Affix new adaptor gasket and shims, then secure the adaptor to the cylinder block with five bolts and lock washers (Fig. 4). A nitrile base oil cooler to adaptor gasket is currently used on vehicle engines equipped with the AT540 transmission. The new gasket (charcoal colored) is more compatible with transmission fluid than the former gasket (beige color).

2. Clean the old gasket material from both faces of the core flange and affix new gaskets to the inner and outer faces (Figs. 4 and 5). Insert the core into the cooler housing.

   NOTICE: The inlet and outlet openings in the oil cooler core are stamped *in* and *out*. It is very important that the core be installed in the correct position to prevent any possibility of foreign particles and sludge, which may not have been removed in cleaning the fins of the core, entering and circulating through the engine.

3. Align the matchmarks previously placed on the core and housing and install the oil cooler core in the oil cooler housing.

4. With the matchmarks in alignment, place the oil cooler housing and core against the oil cooler adaptor (In–line engines) or cylinder block (6V or 8V engines). On 8V engines, slide the water outlet flange and a new seal ring over the outlet. Then, secure the housing in place with bolts and lock washers. Tighten the bolts to 13–17 lb–ft (18–23 N·m) torque. On 8V engines, secure the outlet flange in place with two bolts and lock washers.

5. Slide the hose and clamps in position between the cylinder block water inlet elbow and the oil cooler. Secure the clamps in place.

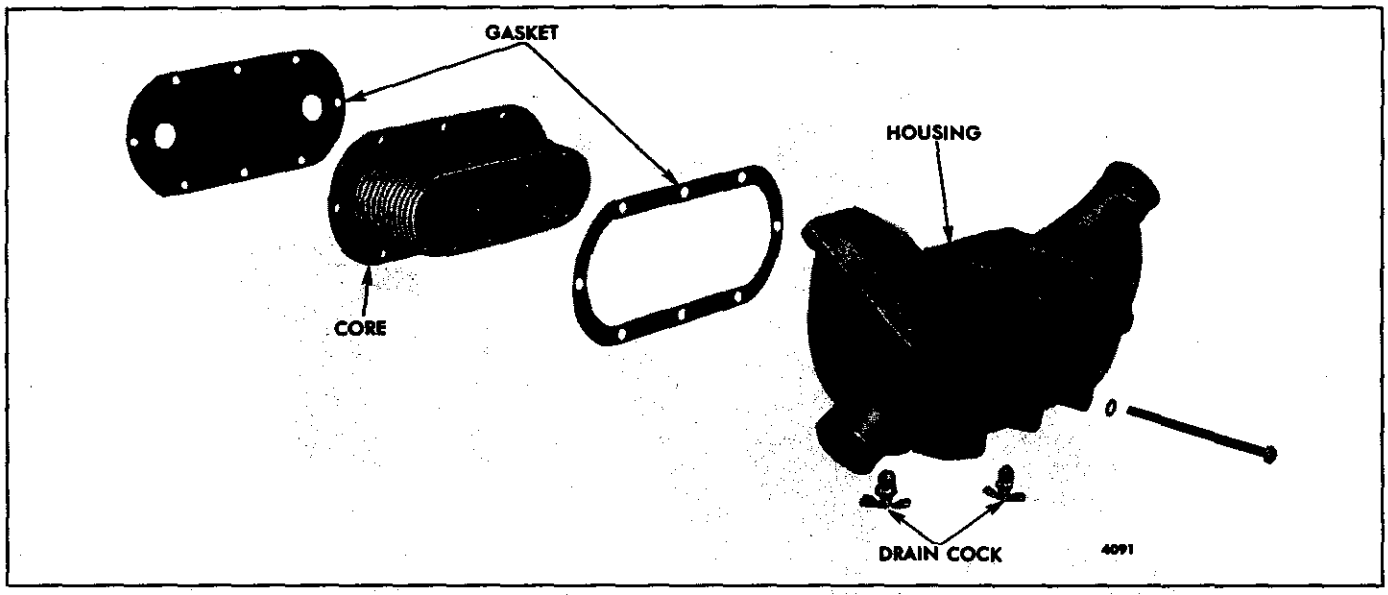

Fig. 5 – Oil Cooler Details and Relative Location of Parts (6V or 8V engine)

6. Place a new gasket between the water pump and the cooler housing and secure the pump to the cooler housing.

7. Position the hose and clamps in place between the water pump and the tube to the thermostat housing. Secure the clamps.

8. Install all of the accessories or equipment it was necessary to remove.

9. Reinstall the oil filter (In–line engine).

10. Make sure the draincock in the bottom of the cooler housing is closed. Then, fill the cooling system to the proper level.

OIL LEVEL DIPSTICK

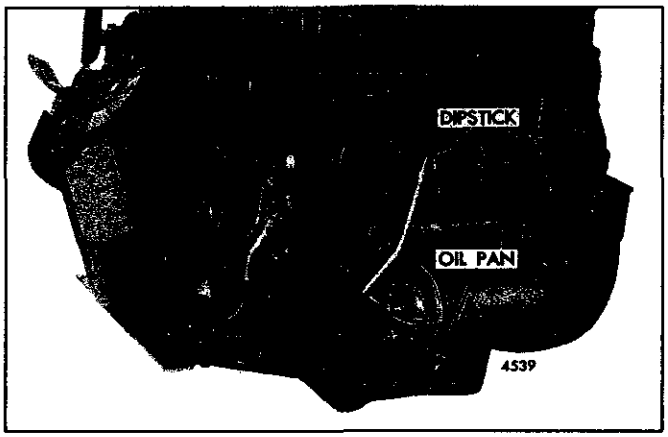

Fig. 1 – Typical Oil Dipstick Mounting

A steel ribbon type oil level dipstick is mounted in an adaptor on the side of the engine (Fig. 1) to check the amount of oil in the engine oil pan. The dipstick has markings to indicate the *Low* and *Full* oil level. Current engines include a 3/4" long rubber oil seal inside the cap of the dipstick. This prevents the escape of vapors carrying oil from the dipstick tube.

On 8V engines, effective with 8D–468, a new dipstick, adaptor and guide combination is used to raise the full mark on the dipstick approximately two quarts (1.893 litres). When replacement of any part of the combination is required on an early engine, the complete new combination is necessary.

Maintain the oil level between the *full* and *low* marks on the dipstick and never allow it to drop below the *low* mark. No advantage is gained by having the oil level above the *full* mark. Overfilling will cause the oil to be churned by the crankshaft throws causing foaming or aereation of the oil. Operation below the *low* mark will expose the pump pick–up causing aereation and/or loss of pressure.

Check the oil level after the engine has been stopped for a minimum of twenty minutes to permit oil in the various parts of the engine to drain back into the oil pan.

Dipsticks are normally marked for use only when the equipment the engine powers is on a level surface. Improper oil levels can result if the oil level is checked with the equipment on a grade.

Fill the crankcase with oil as follows:

1. Fill the oil pan to the full mark on the dipstick.
2. Start and run the engine for approximately ten minutes.
3. Stop the engine and wait a minimum of twenty minutes. Then add the required amount of oil to reach the *full* mark on the dipstick.

Marine Engines

Dipsticks in marine engines are located and marked to provide the proper oil level at any angle within the recommended maximum installation angle applicable to the specific boat.

In a properly filled crankcase, the oil level must be below the crankshaft rear oil seal when the boat is at rest.

OIL PAN

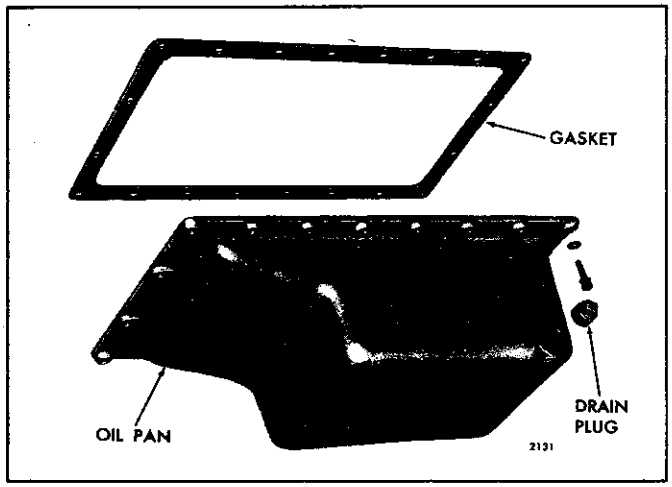

Fig. 1 – Typical Oil Pan

The oil pan (Fig. 1) may be made of steel, cast iron or cast aluminum. A shallow or deep sump type oil pan is used, depending upon the particular engine application. A one–piece oil pan gasket is used with stamped steel pans. A four–piece gasket is used with the cast oil pans.

Removing and Installing Oil Pan

On some engine applications, it may be possible to remove the oil pan without removing the engine. It is recommended that if the engine is to be removed, the oil pan be left in place until the engine is removed.

The procedure for removing the oil pan without taking the engine out and after taking the engine out of the unit will vary. However, the following will generally apply:

1. Remove the drain plug and drain the oil.
2. Detach the oil pan; take precautions to avoid damaging the oil pump inlet pipe and screen.

   NOTICE: Stamped oil pans used on some marine engines have a layer of lead or cadmium beneath the paint to protect the pans against the salt water atmosphere encountered in some marine applications. If this coating is scuffed or broken unknowingly, corrosion or electrolysis may result. Electrolysis in the form of small holes will eat through the pan at the scuffed area. Therefore, do not rest, slide or rock the engine on its oil pan when removing it. Every precaution should be taken before installation to prevent nicks and scratches on stamped marine oil pans. Also, exercise care when performing engine repairs to avoid scratching the outer surface of the oil pan.
3. Remove the oil pan gasket completely.
4. Clean all of the old gasket material from the cylinder block and the oil pan. Clean the oil pan with a suitable solvent and dry it with compressed air.

   • **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**
5. Inspect a cast oil pan for porosity or cracks. Check a stamped oil pan for dents or breaks in the metal which may necessitate repair or replacement. Check for misaligned flanges or raised surfaces surrounding the bolt holes by placing the pan on a surface plate or other large flat surface.
6. When installing the oil pan, use a new gasket and, starting with the center bolt on each side and working alternately toward each end of the pan, tighten the bolts to 10–20 lb–ft (14–27 N·m) torque. *Do not overtighten the bolts.* Once the bolts are tightened to the specified torque, do not retighten them as it could be detrimental to the current type gaskets. If a leak should develop at the oil pan, check if the lock washer is compressed. If not, the bolt may be tightened. However, if the lock washer is compressed and leaking occurs, remove the oil pan and determine the cause of the leakage.

   Current oil pan bolts (stamped metal pans) are coated with a locking material. To re–activate the locking ability of the bolts, apply a drop or two of Loctite J 26558–242, or equivalent, to the threads of the bolts at reassembly.
7. On 8V engines, if the oil pan and flywheel housing include outriggers for the installation of reinforcement bolts, be sure the oil pan butts up against the flywheel housing before tightening the oil pan bolts. Install and tighten the 1/2"–13 reinforcement bolts.
8. Install and tighten the oil drain plug. Tighten the plug (with nylon washer) to 25–35 lb–ft (34–47 N·m) torque.
9. Fill the oil pan with new oil (refer to Sections 4.6 and 13.3) to the full mark on the dipstick. Then start and run the engine for ten minutes and check for oil leaks.
10. Stop the engine and, after approximately twenty minutes, check the oil level. Add oil if necessary.

VENTILATING SYSTEM

Harmful vapors which may be formed within the engine are removed from the crankcase, gear train and valve compartment by a continuous pressurized ventilating system.

A slight pressure is maintained in the engine crankcase by the seepage of a small amount of air from the airbox past the piston rings. This air sweeps up through the engine and is drawn off through a crankcase breather.

In–line engines are equipped with a breather assembly attached to the valve rocker cover (Fig. 1) or a breather assembly mounted on the flywheel housing (Fig. 2).

On 6V engines, a breather assembly is mounted on the upper engine front cover (Fig. 3) or the rocker cover (Fig. 4).

The 8V engines have a breather tube attached to the valve rocker cover (Fig. 5) and a breather (with a filter pad) mounted on the governor. However, the marine engines did not include a filter pad until engine number 8D–2701. Early 8V engines were equipped only with a breather assembly mounted on the governor housing.

Service

It is recommended that the breather tube be inspected and cleaned, if necessary, to eliminate the possibility of clogging. This can best be done by removing the tube from the engine, washing it with a suitable solvent and drying it with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

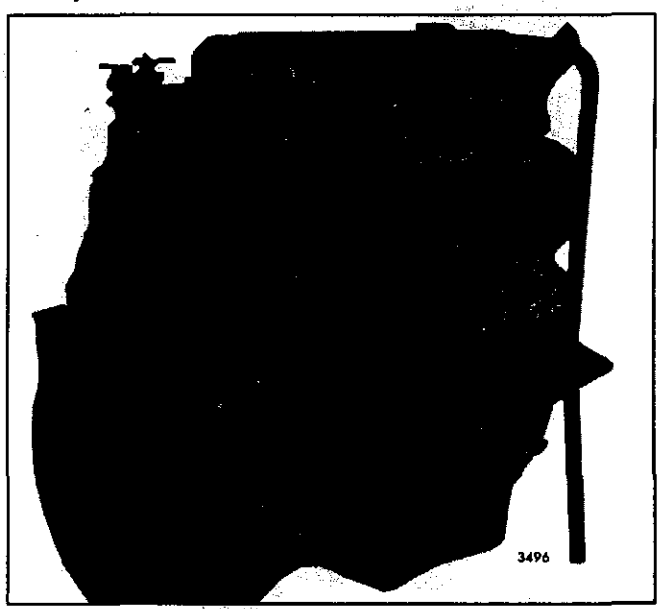

Fig. 1 – Typical Crankcase Breather Mounting (In–Line Engine)

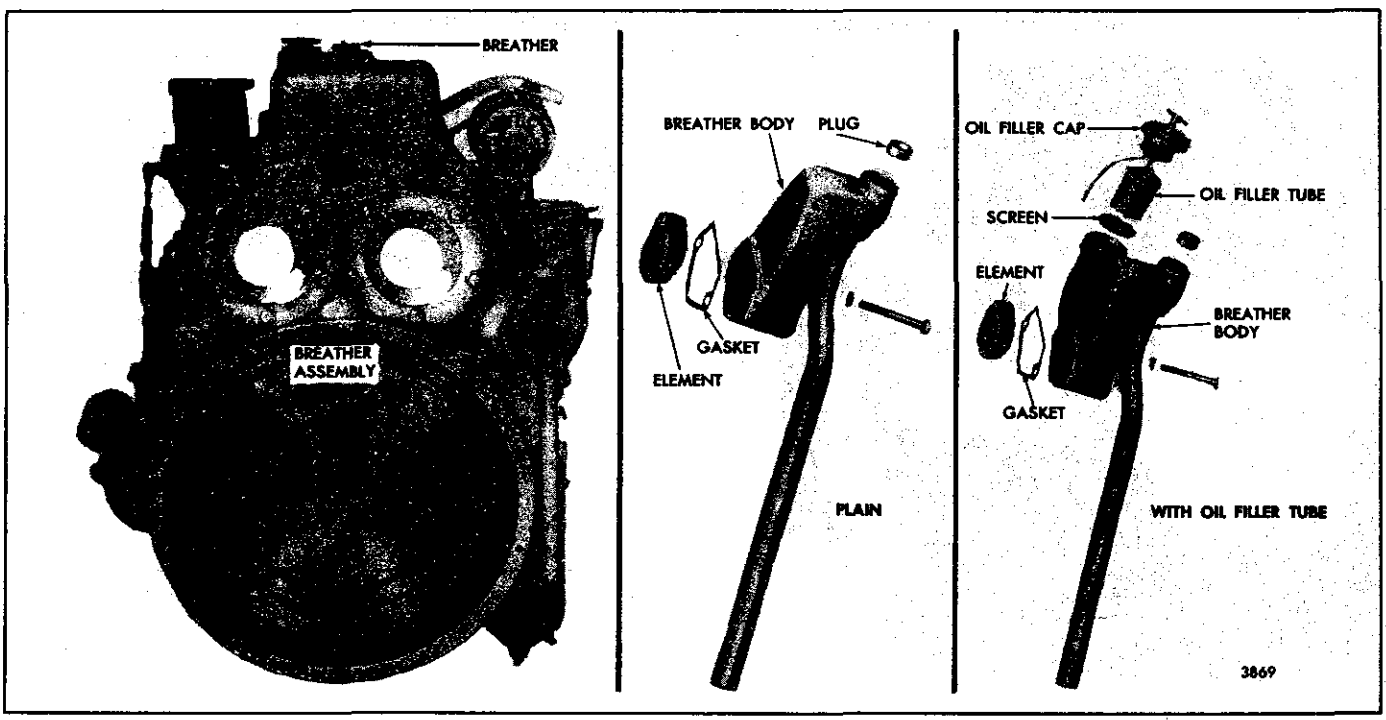

Fig. 2 – Crankcase Breather Mounting and Details (In–Line Engine)

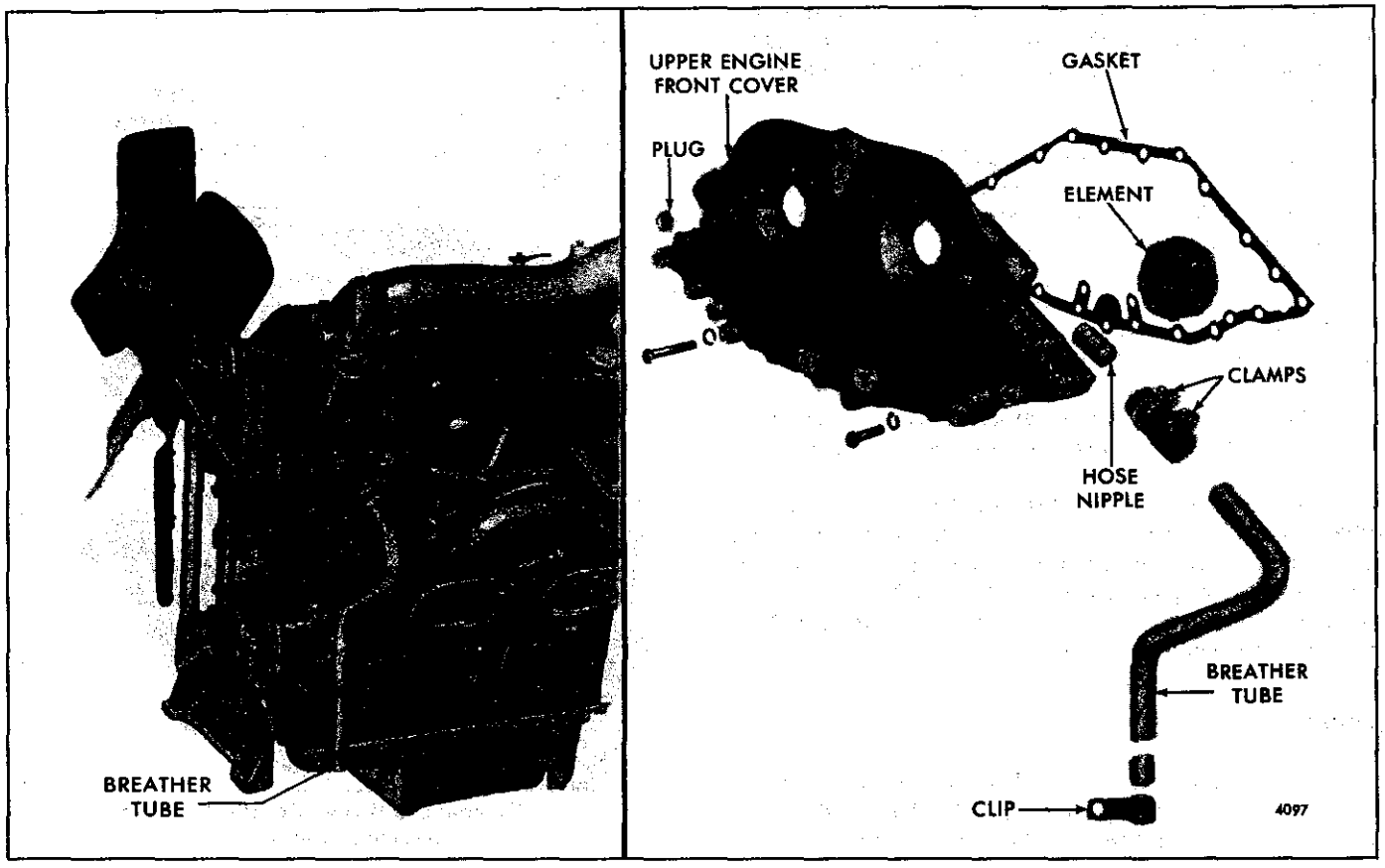

Fig. 3 – Typical Crankcase Breather Mounting and Details (6V–53 Engine)

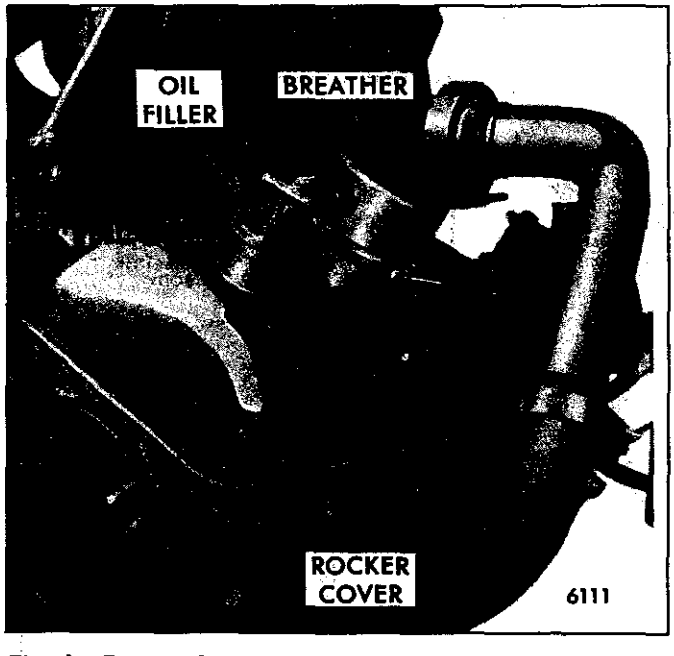

Fig. 4 – Rocker Cover Breather Mounting (6V–53 Engine)

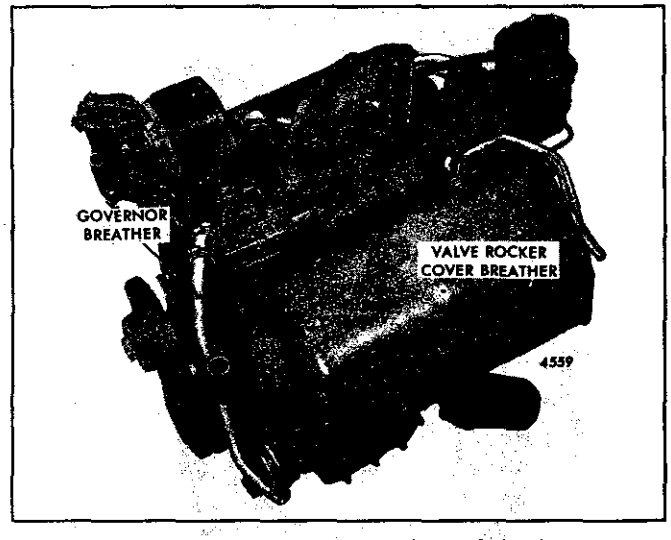

Fig. 5 – Typical Breather Mountings (8V–53 Engine)

The wire mesh pad (element) in the breather assemblies should be cleaned if excessive crankcase pressure is observed.

If it is necessary to clean the element, remove the breather housing from the flywheel housing (In-line engines), the upper front cover (6V engines), the rocker cover (6V engines) or the governor housing and/or valve rocker cover (8V engines).

Wash the element in fuel oil and dry it with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Reinstall the element in the breather housing, the upper front cover or the governor housing and/or the valve rocker cover and install them by reversing the procedure for removal.

When the limiting speed governor assembly or the governor housing is replaced on an early 8V engine, it will be necessary to include the current thicker breather element.

SHOP NOTES - SPECIFICATIONS - SERVICE TOOLS

REWORK INSTRUCTIONS FOR 6V-53 OIL PUMP INLET TUBE SUPPORTS

When replacing the cylinder block or main bearing caps on an early engine, it will be necessary to either replace the oil inlet tube support or elongate the bolt holes in the support (Fig. 1) and use new support attaching parts.

In the old bearing caps, the holes were tapped 5/16"–18 with 1.680" between centers. In the new bearing caps, the holes are tapped 3/8"–16 with 2.240" between centers.

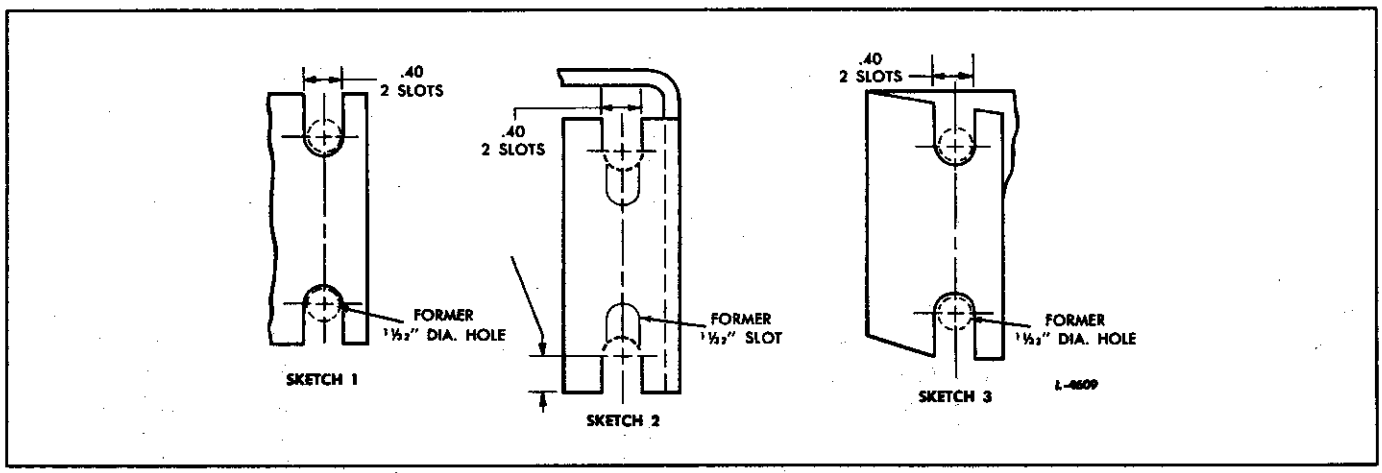

Fig. 1 – Oil Inlet Tube Supports

REWORKING 6V-53 CAST IRON OIL PAN FOR USE WITH CURRENT OIL PUMP INLET TUBE

When the seven hole upper main bearing shells (Section 1.3.4) are used in 6V marine engines prior to 6D–11074 and all 6V–engines prior to 6D–17960, a 1–3/8" diameter lubricating oil pump inlet tube must be used rather than the former 1" diameter inlet tube. To conform with the increased diameter of the oil pump inlet tube, the cast iron oil pan must be reworked to provide installation clearance by reducing the height of the integral cast baffle approximately .440" (Fig. 2).

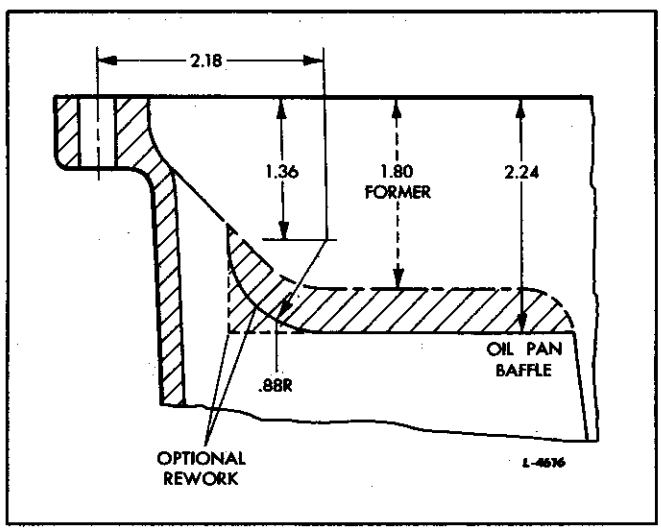

Fig. 2 – Rework Sketch for a Cast Iron Oil Pan

SPECIFICATIONS

STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

THREAD SIZE	260M BOLTS TORQUE (lb-ft)	N·m	THREAD SIZE	280M OR BETTER TORQUE (lb-ft)	N·m
1/4–20	5–7	7–9	1/4–20	7–9	10–12
1/4–28	6–8	8–11	1/4–28	8–10	11–14
5/16–18	10–13	14–18	5/16–18	13–17	18–23
5/16–24	11–14	15–19	5/16–24	15–19	20–26
3/8–16	23–26	31–35	3/8–16	30–35	41–47
3/8–24	26–29	35–40	3/8–24	35–39	47–53
7/16–14	35–38	47–51	7/16–14	46–50	62–68
7/16–20	43–46	58–62	7/16–20	57–61	77–83
1/2–13	53–56	72–76	1/2–13	71–75	96–102
1/2–20	62–70	84–95	1/2–20	83–93	113–126
9/16–12	68–75	92–102	9/16–12	90–100	122–136
9/16–18	80–88	109–119	9/16–18	107–117	146–159
5/8–11	103–110	140–149	5/8–11	137–147	186–200
5/8–18	126–134	171–181	5/8–18	168–178	228–242
3/4–10	180–188	244–254	3/4–10	240–250	325–339
3/4–16	218–225	295–305	3/4–16	290–300	393–407
7/8–9	308–315	417–427	7/8–9	410–420	556–569
7/8–14	356–364	483–494	7/8–14	475–485	644–657
1–8	435–443	590–600	1–8	580–590	786–800
1–14	514–521	697–705	1–14	685–695	928–942

Grade identification markings are normally stamped on the heads of the bolts. To aid identification of the various bolts used in Detroit Diesel engines, refer to the following chart.

Grade Identification Marking on Bolt Head		GM Number	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None		GM 255-M	1	No. 6 thru 1 1/2	60,000
None		GM 260-M	2	No. 6 thru 3/4 over 3/4 to 1 1/2	74,000 60,000
	Bolts and Screws	GM 280-M	5	No. 6 thru 1 over 1 to 1 1/2	120,000 105,000
	Hex Head Sems Only	GM 275-M	5.1	No. 6 thru 3/8	120,000
	Bolts and Screws	GM 290-M	7	1/4 thru 1 1/2	133,000
	Bolts and Screws	GM 300-M	8	1/4 thru 1 1/2	150,000
	Bolts and Screws	GM 455-M	None	No. 6 thru 1 1/2	55,000

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BOLT IDENTIFICATION CHART

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

APPLICATION	THREAD	(lb–ft)	(lb–in)	(N·m)
Oil pan bolts	5/16–18	10–20		14–27
Oil filter center stud	5/8–18	50–60		68–81
Oil pan drain plug (Nylon washer)	18 mm	25–35		34–47

SERVICE TOOLS

TOOL NAME	TOOL NO.
Crankshaft pulley installer set	J 7773
Oil pump drive gear adaptor	J 23126
Oil pump drive gear installer	J 8968–01
Strap wrench (spin–on filter)	J 24783
Universal puller (4″ diameter range)	J 24420
Universal puller (13″ diameter range)	J 8190

SECTION 5

COOLING SYSTEM

CONTENTS

COOLING SYSTEM

To effectively dissipate the heat generated by the engine, one of three different types of cooling systems is used on a Series 53 engine: radiator and fan, heat exchanger and raw water pump, or keel cooling. A centrifugal type water pump is used to circulate the engine coolant in each system. Each system incorporates thermostats to maintain a normal engine operating temperature (refer to Section 13.2). Typical In–line and V–type engine cooling systems are shown in Figs. 1 and 2.

Radiator and Fan Cooling System

The engine coolant is drawn from the lower portion of the radiator by the water pump and is forced through the oil cooler and into the cylinder block.

From the cylinder block, the coolant passes up through the cylinder head(s) and, when the engine is at normal operating temperature, through the thermostat(s) and into the upper portion of the radiator. The coolant passes down a series of tubes where the coolant temperature is lowered by the air stream created by the revolving fan.

Upon starting a cold engine or when the coolant is below operating temperature, the coolant is restricted at the thermostat(s) and a bypass provides water circulation within the engine during the warm up period.

Heat Exchanger Cooling System

In the heat exchanger cooling system, the coolant is drawn by the engine water pump from the lower portion of the expansion tank through the engine oil cooler, then through the engine the same as in the radiator and fan system. Upon leaving the thermostat housing, the coolant either passes through the heat exchanger core or bypasses the heat exchanger and flows directly to the water pump, depending on the coolant temperature.

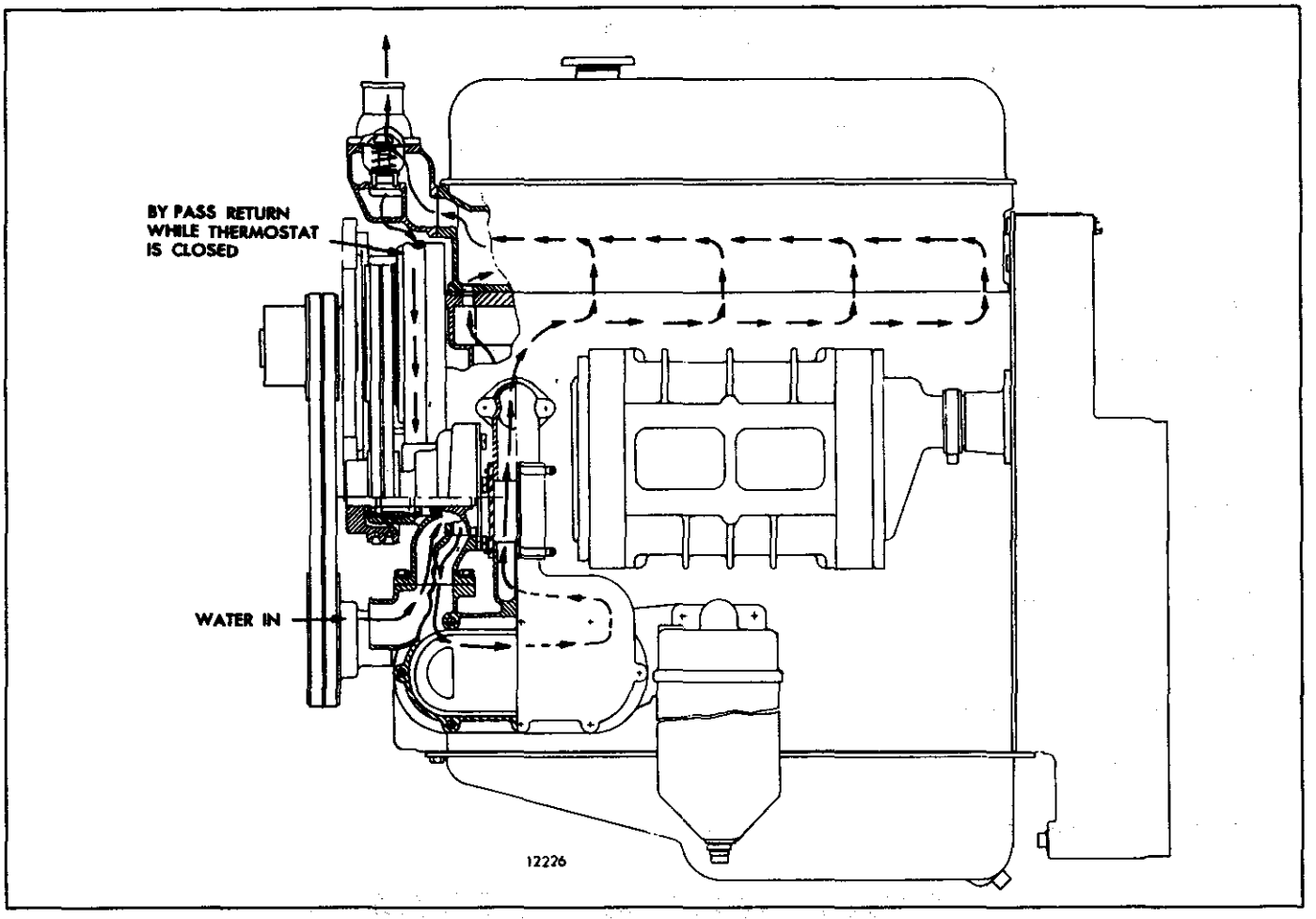


Fig. 1 – Typical Cooling System for an In–Line Engine

While passing through the core of the heat exchanger, the coolant temperature is lowered by raw water, which is drawn by the raw water (sea water) pump from an outside supply. The raw water enters the heat exchanger at one side and is discharged at the opposite side.

To protect the heat exchanger element from electrolytic action, a zinc electrode is located in both the heat exchanger inlet elbow and the raw water pump inlet elbow and extends into the raw water passage.

Keel Cooling System

The keel cooling system is similar to the heat exchanger system, except that the coolant temperature is reduced in the keel cooler. In this system the coolant is drawn by the fresh water pump from the lower portion of the expansion tank through the engine oil cooler. From the cooler the flow is the same as in the other systems. Upon leaving the thermostat housing, the coolant is bypassed directly to the lower portion of the expansion tank until the engine operating temperature, controlled by the thermostat, is reached. As the engine temperature increases, the coolant is directed to the keel cooler, where the coolant temperature is reduced before flowing back to the expansion tank.

ENGINE COOLING SYSTEM MAINTENANCE

A properly maintained and clean cooling system will reduce engine wear and increase the satisfactory engine operating time between engine overhauls. This is accomplished by the elimination of hot spots within the engine. Thus, when operating within the proper engine temperature range and when not exceeding the recommended horsepower output of the unit, all engine parts will be within their operating temperature range and at their proper operating clearances.

Engine Coolant

The function of the engine coolant is to absorb the heat, developed as a result of the combustion process in the cylinders, from the component parts such as exhaust valves, cylinder liners and pistons which are surrounded by water jackets. In addition, the heat absorbed by the oil is also removed by the engine coolant in the oil–to–water oil cooler. Refer to Section 13.3 for coolant recommendations.

COOLING SYTEM CAPACITY (BASIC ENGINE)		
ENGINE	CAPACITY	
	GALLONS	LITERS
2-53	1-1/2	5.7
3-53	2	7.6
4-53	2-1/4	8.5
6V-53	3-1/2	13.2
8V-53	5	18.9

TABLE 1

Cooling System Capacity

The capacity of the basic engine cooling system, (cylinder block, head, water manifold, thermostat housing and oil cooler housing) is shown in Table 1.

To obtain the total amount of coolant in the cooling system of a unit, the additional capacity of the radiator, hoses, etc. must be added to the capacity of the basic engine. The capacity of radiators and related equipment should be obtained from the equipment supplier.

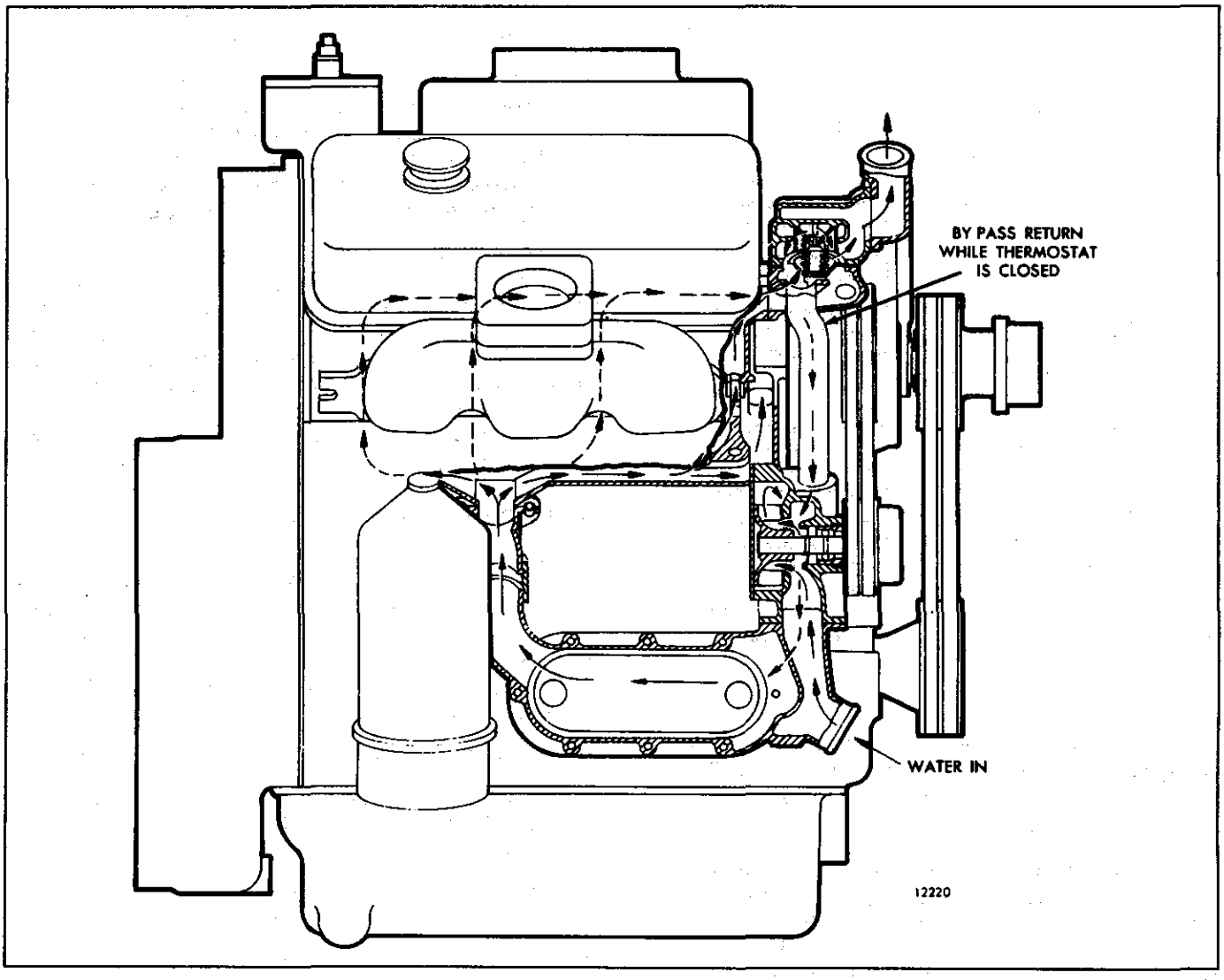


Fig. 2 – Coolant Flow Through a 6 or 8V Engine

Drain Cooling System

CAUTION: Use extreme care when removing a coolant pressure control cap. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

The engine coolant is drained by opening the cylinder block and radiator (heat exchanger) drain cocks and removing the cooling system filler cap. Removal of the filler cap permits air to enter the cooling passages and the coolant to to drain completely from the system.

Drain cocks are located as shown in Table 2.

COOLANT DRAIN VALVES		
Engine	Oil Cooler or Coolant Inlet Side of Block	Side of Block Opposite Oil Cooler or Coolant Inlet
2-53	Bottom of oil cooler or coolant inlet	*Water hole cover near front of block
3-53	Bottom of oil cooler and coolant inlet	Just forward of blower mounting pad
4-53	Bottom of oil cooler, coolant inlet, and behind blower drive or governor near rear of block	Behind blower drive or governor near rear of block
6V-53	Bottom of oil cooler, coolant inlet, and side of block near rear end	Water hole cover between hand hold covers and side of block near rear end
8V-53	Bottom of oil cooler, and side of block near rear end	Side of block near front end and below center of air box cover

*Most industrial units contain a 1/8" pipe plug at this location.

TABLE 2

In addition to the drains on the block, the oil cooler housing has a drain cock at the extreme bottom. Radiators, etc, that are not provided with a drain cock are drained through the oil cooler housing drain cock.

To ensure that all of the coolant is drained completely from a unit, all cooling system drains should be opened. Should any entrapped water in the cylinder block or radiator freeze, it will expand and may cause damage. When freezing weather is expected, drain all units not adequately protected by antifreeze. Leave all drain cocks open until refilling cooling system.

Marine engine exhaust manifolds are cooled by the same coolant used in the engine. Whenever the engine cooling system is drained, open the exhaust manifold drain cocks.

Raw water pumps are drained by loosening the cover attaching screws and tapping the cover gently to loosen it. After the water has drained, tighten the screws.

Fill Cooling System

Before starting the engine, close all of the drain cocks and fill the cooling system with coolant (refer to Section 13.3). If the unit has a raw water pump, it should be primed, since operation without water may cause impeller failure.

Start the engine and, after the normal operating temperature has been reached allowing the coolant to expand to its maximum, check the coolant level. The coolant level should be within 2" of the top of the filler neck.

CAUTION: Use extreme care when removing a coolant pressure control cap. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

Should a daily loss of coolant be observed, and there are no apparent leaks, there is a possibility of gases leaking past the cylinder head water seal rings into the cooling system. The presence of air or gases in the cooling system may be detected by connecting a rubber tube from the overflow pipe to a water container. Bubbles in the water in the container during engine operation will indicate leakage. Another method for observing air in the cooling system is by inserting a transparent tube in the water outlet line.

Flushing Cooling System

If a coolant filter is used and properly maintained, the cooling system need not be flushed. Otherwise, the the cooling system should be flushed each spring and fall. The flushing operation cleans the system of antifreeze solution in the spring and removes the summer rust inhibitor in the fall, thus cleaning the system for the next solution. The flushing operation should be performed as follows:

1. Drain the previous season's solution from the unit.
2. Refill with soft clean water. If the engine is hot, fill the unit *slowly* to prevent rapid cooling and distortion of the engine castings.
3. Start the engine and operate it for 15 minutes to thoroughly circulate the water.
4. Drain the engine completely.
5. Refill with the solution required for the coming season (refer to Section 13.3).

Cooling System Cleaners

If the engine overheats and the fan and water level have been found to be satisfactory, it will be necessary to clean and flush the entire cooling system. Scale formation should be removed by using a reputable and safe descaling solvent. Immediately after using the descaling solvent, neutralize the system with the neutralizer. It is important that the directions printed on the container of the descaler be thoroughly read and followed.

After the solvent and neutralizer have been used, completely drain the engine and radiator and reverse flush before filling the system.

Reverse Flushing

After the engine and radiator have been thoroughly cleaned, they should be reverse flushed. The water pump should be removed and the radiator and engine reverse flushed separately to prevent dirt and scale deposits clogging the radiator tubes or being forced through the pump.

Reverse flushing is accomplished by hot water, under air pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, thus loosening and forcing scale deposits out.

The radiator is reverse flushed as follows:

1. Remove the radiator inlet and outlet hoses and replace the radiator cap.
2. Attach a hose at top of the radiator to lead water away from the engine.
3. Attach a hose to the bottom of the radiator and insert the flushing gun in the hose.
4. Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
5. Turn on the water and, when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between air blasts.

   NOTICE: Apply air gradually. Do not exert more than 30 psi (207 kPa) air pressure. Too great a pressure may rupture a radiator tube.
6. Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages are reverse flushed as follows:

1. Remove the thermostats and the water pump.
2. Attach a hose to the water inlet of the cylinder block to drain the water away from the engine.
3. Attach a hose to the water outlet at the top of the engine and insert the flushing gun in the hose.
4. Turn on the water and, when the water jackets are filled, turn on the air in short blasts, allowing the engine to fill with water between air blasts.
5. Continue flushing until the water from the engine runs clean.

If scale deposits in the radiator cannot be removed by chemical cleaners or reverse flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate water through the radiator core from the bottom to the top during this operation.

Miscellaneous Cooling System Checks

In addition to the above cleaning procedures, the other components of the cooling system should be checked periodically to keep the engine operating at peak efficiency. The cooling system hoses, thermostats and radiator pressure cap should be checked and replaced if found to be defective.

When water connection seals and hoses are installed, be sure the connecting parts are properly aligned and the seal or hose is in its proper position before tightening the clamps. All external leaks should be corrected as soon as detected.

The fan belt must be checked and adjusted, if necessary, to provide the proper tension and the fan shroud must be tight against the radiator core to prevent recirculation of air which may lower the cooling efficiency.

Contaminated Engines

When the engine cooling or lubricating system becomes contaminated, it should be flushed thoroughly to remove the contaminants before the engine is seriously damaged. One possible cause of such contamination is a cracked oil cooler core. With a cracked oil cooler core, oil will be forced into the cooling system while the engine is operating and when it is stopped, coolant will leak into the lubricating system.

Coolant contamination of the lubricating system is especially harmful to engines when the cooling system is filled with an ethylene glycol base antifreeze solution. When mixed with the oil in the crankcase, this antifreeze forms a varnish which can cause the engine to seize or result in severe bearing wear.

Make certain that the cause of the internal coolant leak has been corrected before flushing the contaminated system(s).

Contaminants may be flushed from the engine systems as follows:

COOLING SYSTEM

If the engine has had a failure resulting in the contamination of the cooling system with lubricating oil, this flushing procedure is recommended.

1. Prepare a mixture of Calgon, or equivalent, and water at the rate of two ounces (dry measure) to one gallon of water.
2. Remove the engine thermostat(s) to permit the Calgon and water mixture to circulate through the engine and the radiator/heat exchanger.
3. Fill the cooling system with the Calgon solution.
4. Run the engine for five minutes.
5. Drain the cooling system.
6. Repeat Steps 1, 2, 3 and 4.
7. Fill the cooling system with clean water.
8. Let the engine run five minutes.
9. Drain the cooling system completely.
10. Install the engine thermostat(s).
11. Close all of the drains and refill the cooling system with fresh coolant (see Section 13.3).

LUBRICATION SYSTEM

When the engine lubricating system has been contaminated by an ethylene glycol antifreeze solution, or other soluble material, the following cleaning procedure, using DPM (Dipropylene Glycol Methyl Ether), or equivalent, is recommended.

CAUTION: Use extreme care in the handling of these chemicals to prevent serious injury to the person or damage to finished surfaces. Wash off spilled fluid immediately with clean water.

If the engine is still in running condition, proceed as follows:

1. Drain all of the lubricating oil.
2. Remove and discard the oil filter element. Clean and dry the filter shell and replace the element.
3. Mix two parts of DPM, or equivalent, with one part SAE 10 engine oil. Fill the engine crankcase to the proper operating level with this mixture.
4. Start and run the engine at a fast idle (1,000 to 1,200 rpm) for 30 minutes to one hour. Check the oil pressure frequently.
5. After the specified time, stop the engine and immediately drain the crankcase and the filter. *Sufficient time must be allowed to drain all of the fluid.*
6. Refill the crankcase with SAE 10 oil after the drain plugs are replaced and run the engine at the same fast idle for ten or fifteen minutes and again drain the oil thoroughly.
7. Remove and discard the oil filter element, clean the filter shell and install a new element.
8. Replace the drains and fill the crankcase to the proper level with the oil recommended for normal engine operation.
9. To test the effectiveness of the cleaning procedure, it is recommended that the engine be started and run at a fast idle (1,000 to 1,200 rpm) for approximately 30 minutes. Then, stop and immediately restart the engine. There is a possibility that the engine is not entirely free of contaminant deposits if the starting speed is slow.
10. If the procedures for cleaning the lubricating oil system were not successful, it will be necessary to disassemble the engine and to clean the affected parts thoroughly.

Make certain that the cause of the internal coolant leak has been corrected before returning the engine to service.

MAXIMUM ENGINE COOLANT TEMPERATURE

The heat-dissipating capacity of the engine cooling systems and related components must be sufficient to prevent the coolant temperature from rising above 210°F (99°C). This temperature must not be exceeded under any engine operating condition, regardless of altitude, type of coolant used or cooling system condition. Exceeding this limit can result in malfunction or serious engine damage.

• WINTERFRONTS NOT RECOMMENDED

NOTICE: The use of winterfronts (cardboard, canvas, etc.) is not recommended with any DDC engine installation. Their use can result in excessive engine coolant, oil, and charge air temperatures. This can lead to turbocharger surge, poor fuel economy, loss of power, and reduced engine life. Winterfronts may also put abnormal stress on fan and fan drive components, creating the potential for premature malfunction and/or damage.

Blocking off the radiator is done to increase the cab heat level and improve driver/passenger comfort during severe cold weather operation. This practice is normally not necessary with a properly designed and operating cooling/heater system. Preventing air leakage and reducing exposed metal surfaces in the driver/passenger compartment, plus the use of properly installed shutters, can greatly improve the comfort level.

If winterfronts are used (NOT RECOMMENDED), they should never totally close off the grill frontal area. At least a 25% area of symmetrical shape in the center of the grill should remain open at all times. At no time should the air blockage device be applied directly to the radiator core. The **exception to this is an approved shutter system.**

Qualification tests should be run by the user to determine the minimum frontal opening area required. These are some of the factors that must be considered:

- Fluctuations in ambient air temperature and load
- Ice and snow intrusion
- Wind conditions
- Vehicle speed
- Cooling system degradation
- Fuel economy loss with air–to–air charge cooling

Under no conditions should engine specification limits be exceeded. Therefore, all warning and monitoring devices should be properly located and in good working condition.

All vehicle operators *must* be given notice to adjust and/or remove winterfronts as conditions warrant to ensure proper engine operation. This is especially important on air–to–air charge cooling systems. Elevated charge air cooling temperatures cause turbocharger surging and a loss in fuel economy.

Operators *must* be advised to minimize winterfront usage. If used, the grill opening should be restricted only enough to maintain cab heat. **Do not restrict the opening so much that the elevated temperature turns on the fan.**

TEMPERATURE CONTROL COMPONENTS

These engines are designed to operate with 170°F (77°C) or 180°F (82°C) thermostats which, combined with a radiator or heat exchanger, regulate coolant temperature within a range of 170°F–187°F (77°–86°C) or 180°–197°F (82°–92°C). Many engines also use radiator shutters, clutch fans or combinations of both to help control coolant temperature. These "add on" cooling system components must operate in proper sequence to prevent coolant temperature instability and/or engine overheating.

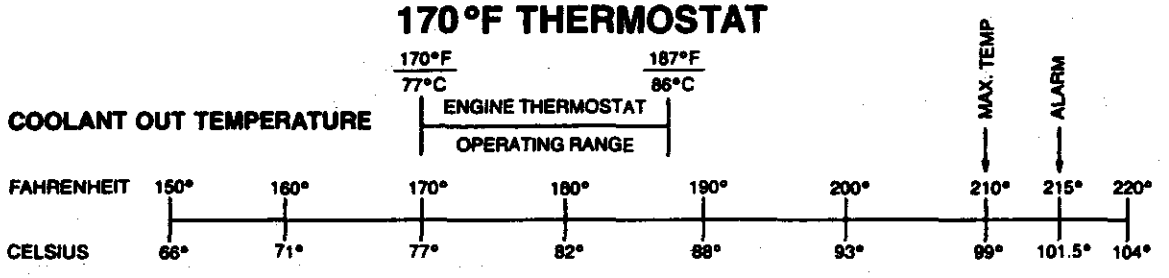
A badly adjusted operating sequence can also have a detrimental effect on the life of the "add on" components as well.

The following charts give the recommended normal temperature settings for various coolant temperature control devices. These settings should not be exceeded, since this will unnecessarily increase the engine coolant and lubricating oil temperature, possibly resulting in serious engine damage.

NOTICE: Coolant temperature instability will result from improper component operating sequence.

NOMINAL SETTINGS FOR COOLANT TEMPERATURE CONTROL DEVICES

170°F THERMOSTAT



SHUTTERS ONLY

OPTIONAL SHUTTERS		SHUTTERS	
CLOSE	OPEN	CLOSE	OPEN
160°F / 71°C	165°F / 74°C	178° - 183°F / 81° - 84°C	185° - 190°F / 85° - 88°C

CLUTCH FAN ONLY

MODULATING FAN		ON/OFF FAN	
START ON	FULL ON	OFF	ON
180°F / 82°C	192°F / 89°C	178° - 183°F / 81° - 84°C	185° - 190°F / 85° - 88°C

CLUTCH FAN AND SHUTTER COMBINATION

SHUTTERS		MODULATING FAN		ON/OFF FAN	
CLOSE	OPEN	START ON	FULL ON	OFF	ON
160°F / 71°C	165°F / 74°C	180°F / 82°C	192°F / 89°C	178° - 183°F / 81° - 84°C	185° - 190°F / 85° - 88°C

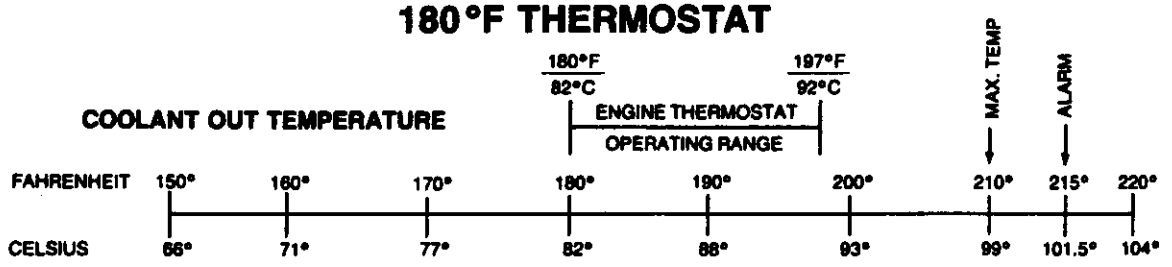
SHUTTER AND ON/OFF FAN CONTROL COMBINATION

SHUTTER CLOSED	FAN OFF	SHUTTER OPEN	FAN ON
178°F / 81°C	183°F / 84°C	185°F / 85°C	190°F / 88°C

CHART 1 – 170° Thermostat

NOMINAL SETTINGS FOR COOLANT TEMPERATURE CONTROL DEVICES

180°F THERMOSTAT



SHUTTERS ONLY

OPTIONAL SHUTTERS		SHUTTERS	
CLOSE	OPEN	CLOSE	OPEN
170°F / 77°C	175°F / 79.5°C	188° - 193°F / 87° - 89.5°C	195° - 200°F / 90.5° - 93°C

CLUTCH FAN ONLY

MODULATING FAN		ON/OFF FAN	
START ON	FULL ON	OFF	ON
190°F / 88°C	202°F / 94.5°C	188° - 193°F / 87° - 89.5°C	195° - 200°F / 90.5° - 93°C

CLUTCH FAN AND SHUTTER COMBINATION

SHUTTERS		MODULATING FAN		ON/OFF FAN	
CLOSE	OPEN	START ON	FULL ON	OFF	ON
170°F / 77°C	175°F / 79.5°C	190°F / 88°C	202°F / 94.5°C	188° - 193°F / 87° - 89.5°C	195° - 200°F / 90.5° - 93°C

SHUTTER AND ON/OFF FAN CONTROL COMBINATION

SHUTTER CLOSED	FAN OFF	SHUTTER OPEN	FAN ON
188°F / 87°C	193°F / 89.5°C	195°F / 90.5°C	200°F / 93°C

CHART 2 – 180° Thermostat

WATER PUMP

A centrifugal–type water pump (Figs. 1 and 2 or 3 and 4) is mounted on top of the engine oil cooler housing (Fig. 5). It circulates the coolant through the oil cooler, cylinder block, cylinder head(s) and radiator.

The pump is belt driven by either the camshaft or balance shaft (In–line engines) or by one of the camshafts (V–type engine).

An impeller is pressed onto one end of the water pump shaft, and a drive pulley is pressed onto the opposite end. The pump shaft is supported on a sealed double–row combination radial and thrust ball bearing. Coolant is prevented from creeping along the shaft toward the bearing by a seal. The shaft and bearing constitute an assembly, and are serviced as such, since the shaft serves as the inner race of the ball bearing. The sealed water pump shaft ball bearing is filled with lubricant when assembled. No further lubrication is required.

Effective with engine serial numbers 2D–27598, 3D–64888, 4D–66635, 6D–66897 and 8D–3815, the water pump assemblies include an impeller and ceramic insert combination (Figs. 4 and 6).

A new seal has been released for the fresh water pumps, effective with engine serial numbers 3D–189023, 4D–202708 and 6D–223092. The new seal has a high grade carbon face, a stainless steel case and a shroud. The former seal had a phenolic face, brass case and no shroud. Because of its design, the new seal provides improved resistance to leakage even after high engine hours or mileage. The former seal and the new seal are completely interchangeable and only the new seal will be available to service fresh water pumps.

Remove Water Pump

1. Remove the radiator cap, open the block and radiator drain cocks, and drain the cooling system.
2. Loosen and remove the water pump belts. An idler pulley is used on some engines to adjust the water pump drive belt tension.
3. Loosen the hose clamps and slide the hose up on the water bypass tube.
4. Remove the five bolts securing the water pump to the oil cooler housing and take off the pump.

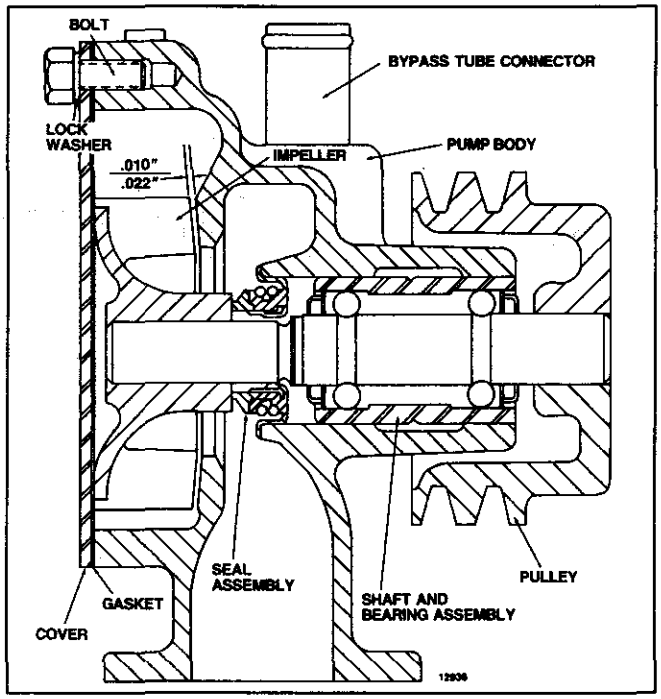


Fig. 1 – Former Water Pump Assembly

Disassemble Pump

1. Note the position of the pulley on the shaft so that the pulley can be reinstalled in the same position when the pump is reassembled. Remove the water pump pulley (Fig. 7).
2. Remove the pump cover and discard the gasket.
3. Press the shaft and bearing assembly, seal and impeller out of the pump body as an assembly, by applying pressure on the bearing outer race with remover J 1930.

   NOTICE: The bearing will be damaged if the pump is disassembled by pressing on the end of the pump shaft.
4. Use plates J 8329 and holder J 358–1 to press the shaft out of the impeller (Fig. 8).
5. Remove and discard the seal assembly from the pump shaft.

Inspection

Wash all of the pump parts, except the bearing and shaft assembly, in clean fuel oil and dry them with compressed air.

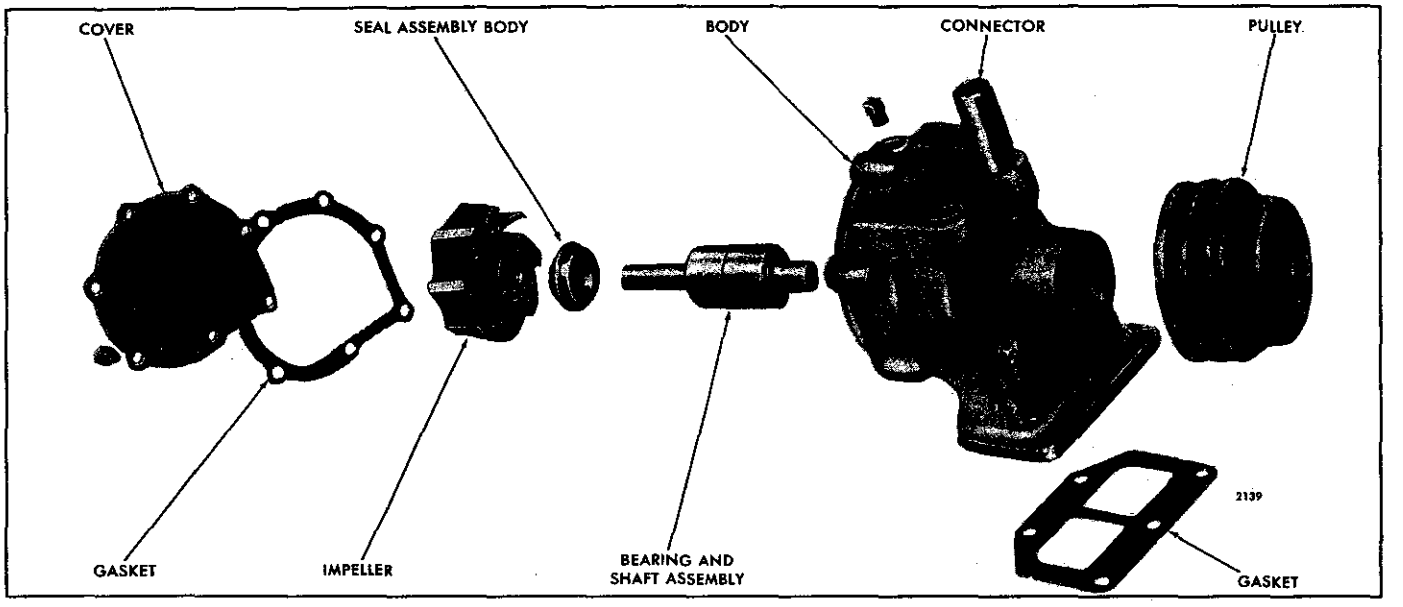


Fig. 2 – Water Pump Details and Relative Location of Parts

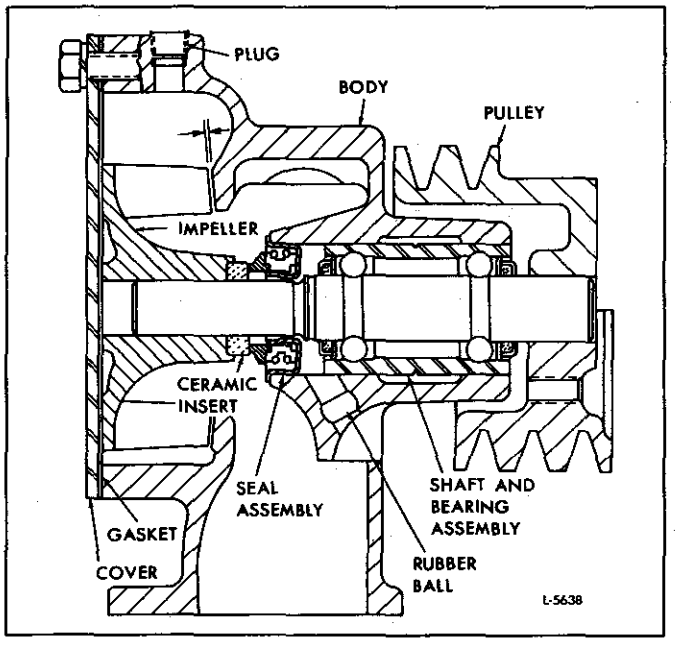


Fig. 3 – Current Water Pump Assembly

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

A permanently sealed and lubricated bearing is used in the bearing and shaft assembly and should not be washed. Wipe the bearing and shaft assembly with a clean lintless cloth. Discard the bearing if it has a general feeling of roughness, is tight, or has indications of damage.

A 7/16" rubber ball is installed in the weep hole of certain water pumps (Fig. 3). Examine the ball and replace if damaged or deteriorated.

Inspect the water pump impeller for wear (erosion) and reuse or replace, as required. If the impeller is reused, the ceramic impeller insert *must* be replaced.

- Never attempt to reuse the ceramic insert, regardless of its apparent condition. A worn ceramic insert may leak. Always replace the insert or impeller assembly (with insert) at time of water pump overhaul. Bond a new ceramic impeller insert to the impeller, as follows:

1. Bake the insert and impeller assembly at 500°F (260°C) for 90 minutes. The insert can be removed easily while the adhesive is hot. After removing the insert, clean the insert area of the impeller with sandpaper, wire brush or a buffing wheel to remove the old adhesive, oxide, scale, etc.
2. Wet a clean cloth with a suitable solvent such as alcohol and thoroughly clean the impeller insert area and the grooved side of a new ceramic insert. Then, wipe the parts with a clean, dry cloth.
3. Place two (2) adhesive washers in the impeller bond area with the ceramic insert on top. The polished face of the ceramic insert should be visible to the assembler (Fig. 6).

NOTICE: Adhesive washers are tan in color but have a white paper backing which must be removed and discarded before the washers can be used. Failure to remove the paper backing will result in a weak or ineffective bond between the insert and impeller.

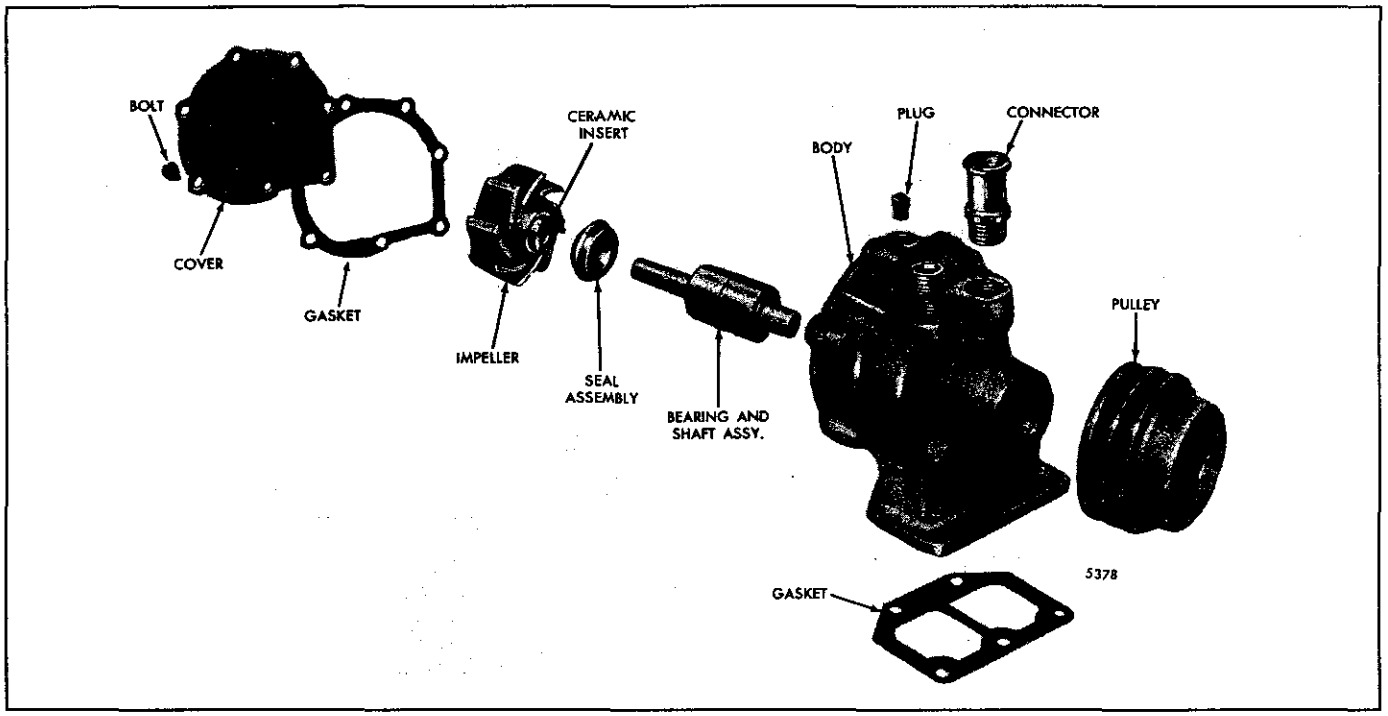


Fig. 4 – Details of Current Water Pump Assembly with Ceramic Seal

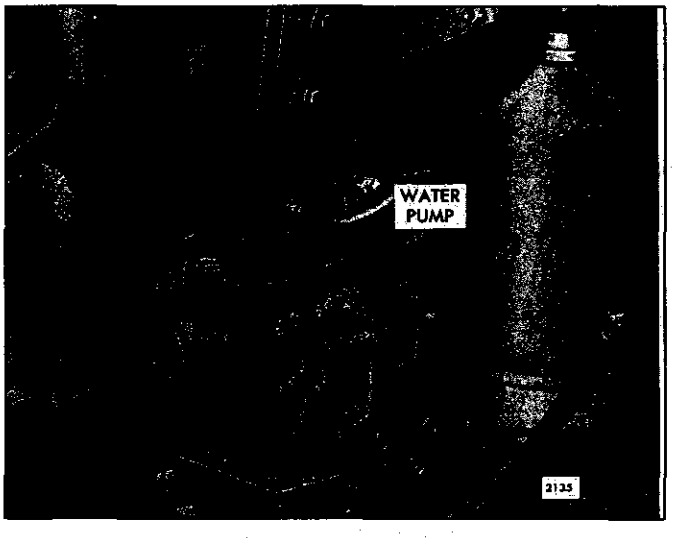


Fig. 5 – Typical Water Pump Mounting

4. Clamp the ceramic insert and impeller together with a 3/8" bolt and nut and two *smooth* .125" thick washers. The face of the ceramic insert must be square with the axis of the tapered bore within .004". The pump shaft may be used as a mandrel for this inspection. Tighten the bolt to 10 lb–ft (14 N·m) torque. Do not mar the polished surface of the ceramic insert.

5. Place the impeller assembly in a level position, with the ceramic insert up, in an oven preheated to 350°F (177°C) for one hour to cure the adhesive.

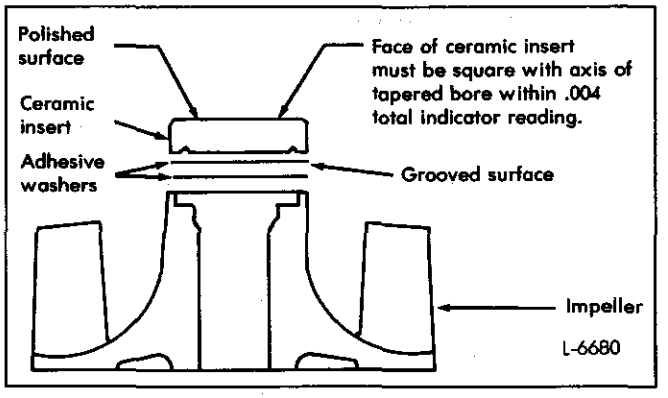


Fig. 6 – Insert, Adhesive Washer, Impeller Stackup

6. Remove the impeller from the oven and, after it has cooled to room temperature, install it in the pump. Do not loosen or remove the clamping bolt and washers until the assembly cools.

Assemble Pump

1. Use installer J 1930 to apply pressure to the outer race of the bearing (Fig. 9) and press the shaft and bearing assembly into the pump body until the outer race of the bearing is flush with the outer face of the body.

   NOTICE: The bearing will be damaged if the bearing and shaft assembly is installed by applying pressure on the end of the shaft.

2. To reduce possible coolant leakage, apply a light coat of non–hardening sealant on the outside of a new seal.

Then, with the face of the pump body and the bearing outer race supported, install the seal by applying pressure on the seal outer flange only, until the flange contacts the pump body (Fig. 1 or 3). Wipe the face of the seal with a chamois to remove all dirt and metal particles.

3. Support the pulley end of the shaft on the bed of an arbor press and press the impeller on the shaft until the impeller is flush with the large end of the body.

4. Place the pulley on the bed of an arbor press. Place a suitable rod between the ram of the press and the impeller end of the shaft, then press the shaft into the pulley until the pulley is in its original position on the shaft.

5. Install the cover and a new gasket on the pump body. Tighten the cover bolts to 6–7 lb–ft (8–9.5 N·m) torque.

6. Run the pump dry at 1200 rpm for a minimum of 30 seconds, or as required, to assure satisfactory seating of the seal.

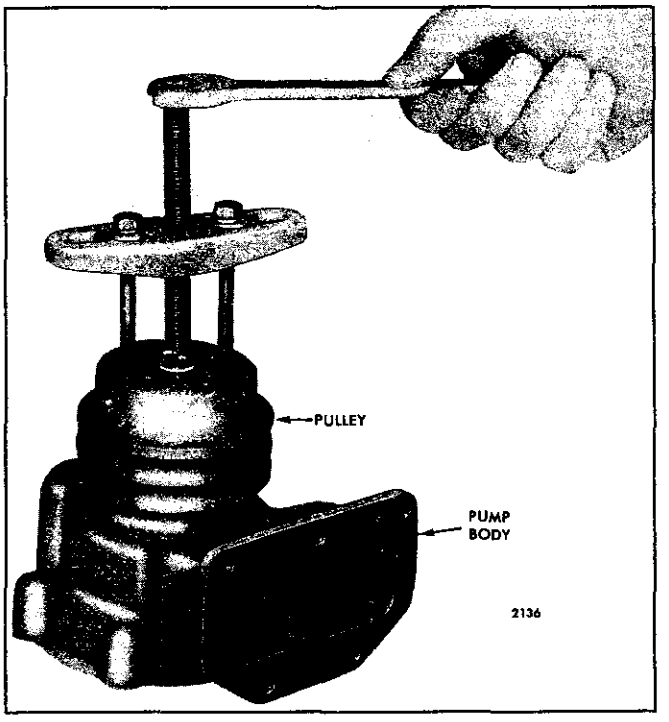


Fig. 7 – Removing Pulley Using Puller J 24420–A

Install Water Pump

1. Affix a new gasket to the flange of the water pump body.

2. Secure the water pump to the oil cooler housing with the five bolts and lock washers.

3. Install the hose between the water pump and water bypass tube and tighten the hose clamps.

4. Install and tighten the belts. An idler pulley is used on some engines to adjust the water pump drive belt tension.

5. Close all of the drain cocks and refill the cooling system.

6. Start the engine and check for leaks.

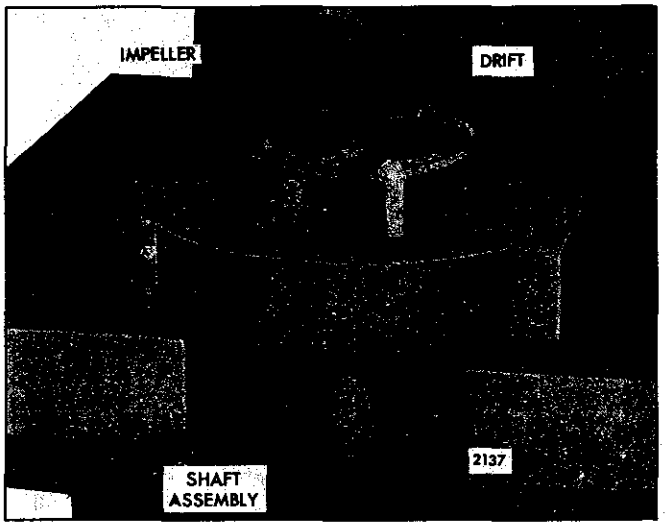


Fig. 8 – Removing Shaft from Impeller with Tools J 8329 and J 358–1

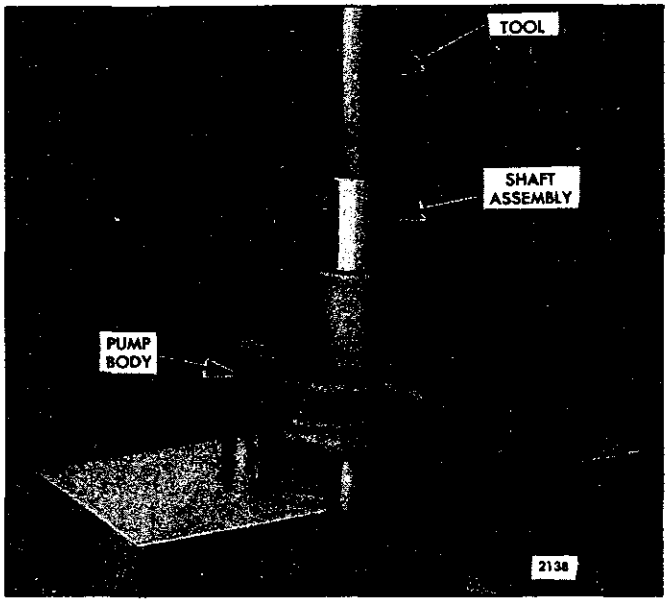
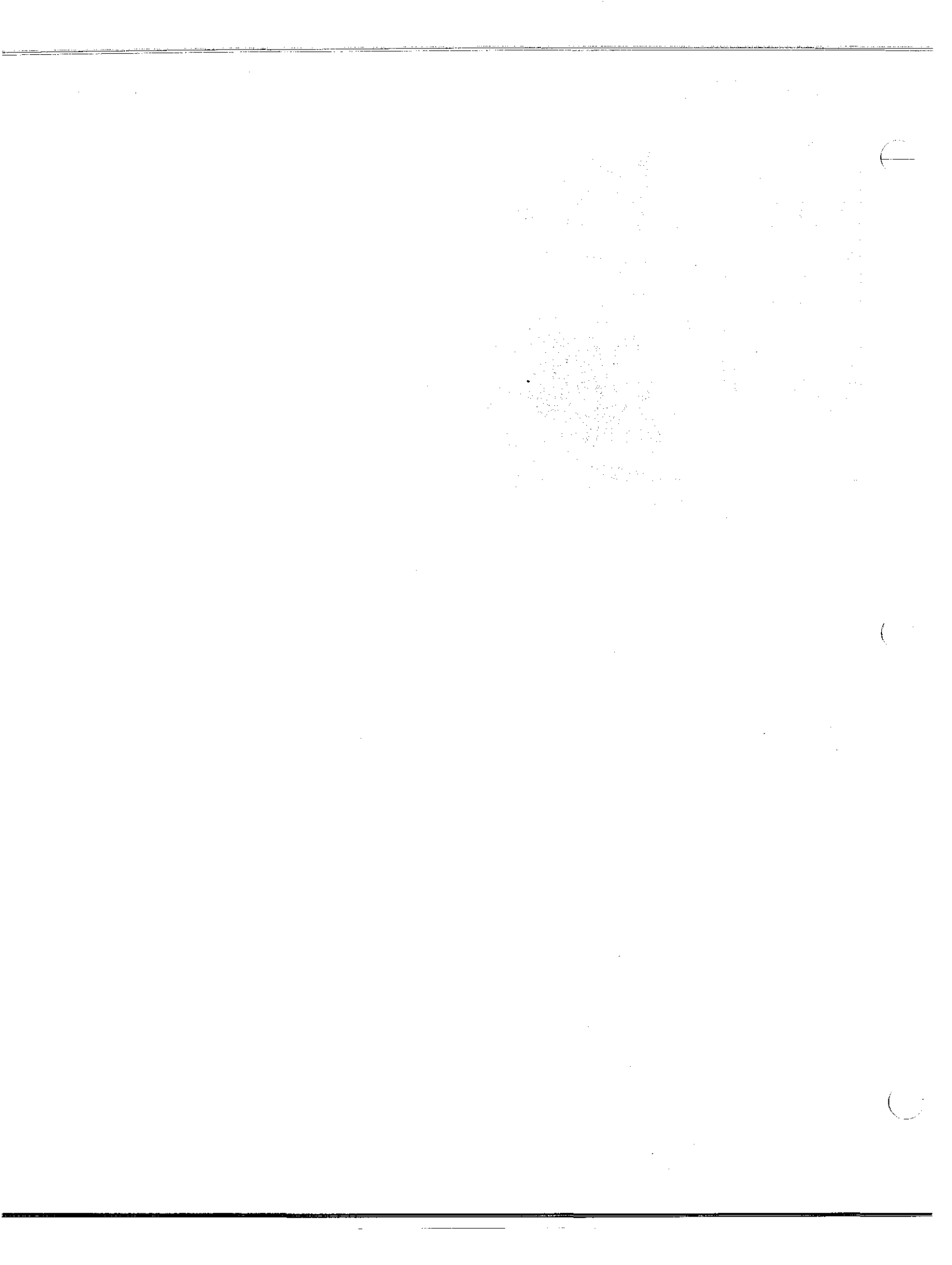


Fig. 9 – Pressing Shaft Assembly into Water Pump Using Tool J 1930



WATER PUMP IDLER PULLEY ASSEMBLY

The water pump idler pulley assembly is mounted on the upper engine front cover (Fig. 1).

Remove Idler Pulley Assembly

Remove the two attaching bolts and lift the pulley assembly away from the front cover and drive belts.

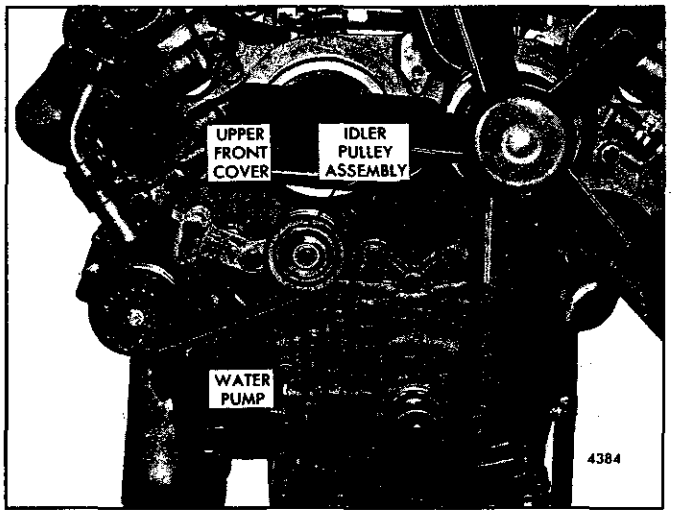


Fig. 1 – Typical Water Pump Idler Pulley Mounting

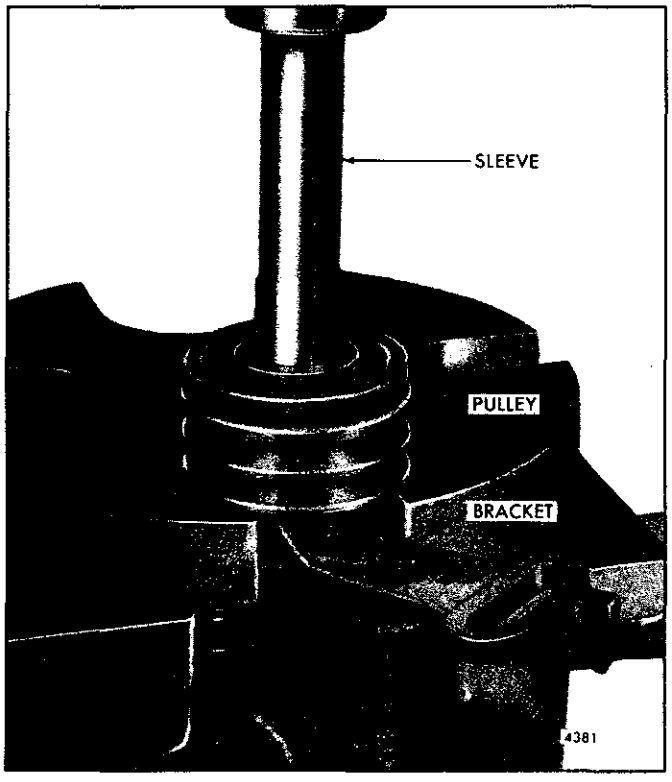


Fig. 2 – Removing Shaft and Bearing Assembly and Bracket from Idler Pulley

Disassemble Idler Pulley Assembly

1. Support the pulley, then press the shaft and bearing assembly and bracket from the pulley by applying pressure to the outer race of the bearing (Fig. 2).
2. Support the bracket and press the shaft and bearing assembly from the idler pulley bracket by applying pressure on the shaft only.

Inspection

Wash the idler pulley bracket and pulley in clean fuel oil and dry them with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

The idler pulley shaft and bearing assembly must not be washed in fuel oil. If the bearing is immersed in cleaning fluid, dirt may be washed in. The fuel oil and dirt may not be entirely removed from the bearing.

Examine the bracket and pulley for excessive wear or cracks.

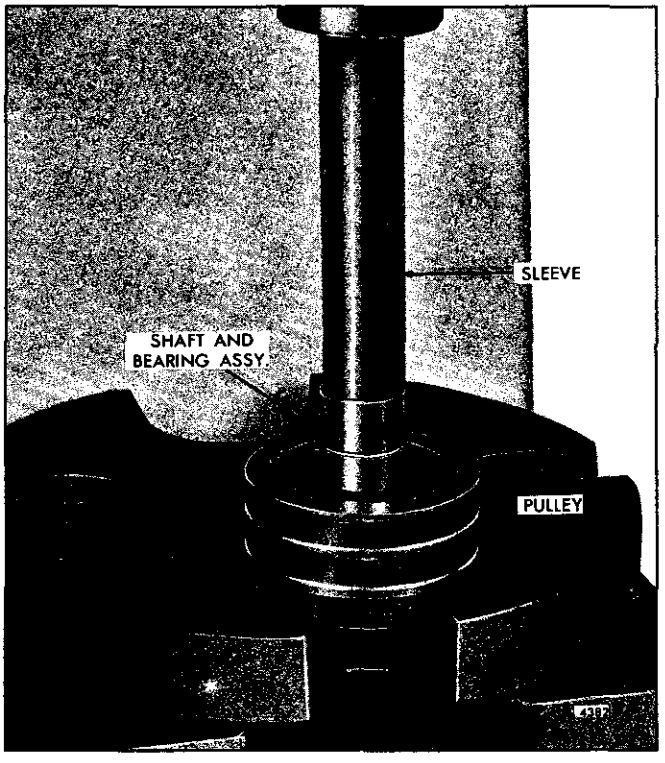


Fig. 3 – Installing Shaft and Bearing Assembly in Idler Pulley

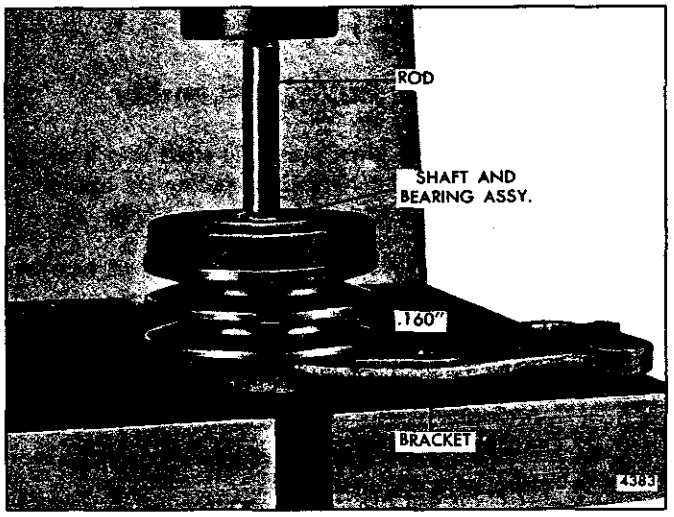


Fig. 4 – Installing Shaft and Bearing Assembly and Pulley in Bracket

Revolve the shaft slowly in the bearing by hand. If rough or tight spots are detected, the bearing and shaft assembly must be replaced.

On early engines, if the bracket or bearing assembly requires replacement, the complete idler pulley assembly must be replaced. The bearing bore diameter on the current bracket is .6237"–.6247". On the former bracket, the bearing bore diameter is .6242"–.6252".

Assemble Idler Pulley Assembly

1. Apply a minimum of 1600 lbs pressure only on the outer race of the bearing as shown in Fig. 3 and press the bearing and shaft assembly into the idler pulley until the outer race of the bearing is flush with the inside surface of the pulley.
2. With a short rod, apply pressure on the shaft only and press the shaft and bearing assembly with the pulley into the idler pulley bracket (Fig. 4). The distance between the outer edge of the pulley and the bracket must be .160".

Install Idler Pulley Assembly

1. Attach the idler pulley assembly to the front cover with two bolts and lock washers.
2. Install the water pump drive belts.
3. Adjust the idler pulley assembly so that the drive belts have the proper tension and tighten the bolts.

THERMOSTAT

The temperature of the engine coolant is automatically controlled by a blocking type thermostat located in a housing attached to the water outlet end of the cylinder head. A single thermostat is used in the in–line engines; the V–type engines use two thermostats, one at each cylinder head.

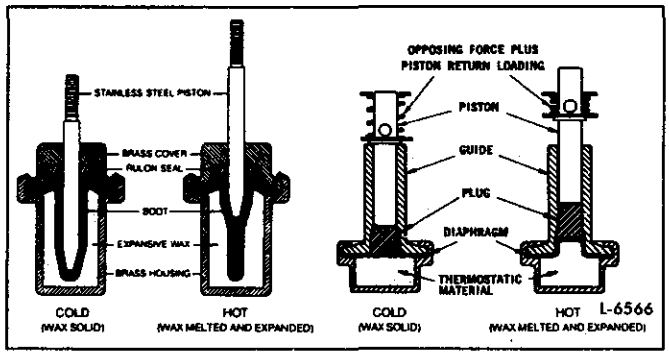


Fig. 1 – Thermostat Heat Motors

• Construction and Operation

A thermostat is a type of automatic valve which controls the flow of coolant through a radiator or other heat exchanger. The thermostat senses changes in engine coolant temperature and regulates coolant flow to maintain efficient engine operating temperature.

Thermostats used in Detroit Diesel engines consist of a brass cup filled with a heat–expansive wax–like material. The wax compound is retained within the cup by an elastometric seal. The valve of the thermostat is attached to a piston which is held on the elastomer by a spring.

Two thermostat heat motor (power element) designs are shown (Fig. 1). The basic principle (expansive wax) remains the same for all thermostats. The valve is in the closed position when the thermostat is cold (wax solid). When the wax–filled brass cup is heated by engine coolant, the wax–like material expands. As the coolant temperature in the engine reaches the calibrated "start to open" thermostat setting, the force of the expanding wax on the piston exceeds the closing force of the spring and the valve begins to open. As the coolant temperature continues to increase, the wax–like material continues to expand and the valve opens further until it reaches its maximum design travel.

As the temperature of the engine coolant drops, cooling of the wax causes it to contract. This reduces the pressure on the piston and allows the spring to draw the valve back toward its seat (closed thermostat).

Requirements

In order to perform effectively, a thermostat must meet the following requirements:

1. Start to open at a specified temperature.
2. Be fully open at a specified number of degrees above the "start to open" temperature.
3. Permit the passage of a specified amount of coolant under a specified pressure when fully open.
4. Depending on cooling system requirements, allow little or no coolant to flow to the radiator core when in the closed position.

Types

Two basic types of thermostats are used in Series 53 engines: full–blocking and non–blocking.

The full–blocking type thermostat simultaneously controls the flow of coolant to the radiator and the bypass circuit. During the engine warm–up, all engine coolant flows through the bypass circuit. As the thermostat opens, increasing amounts of coolant flow to the radiator, and the bypass flow is correspondingly reduced. At approximately 17°–20°F (9.4°–11.1°C) above the opening temperature of the thermostat, the bypass opening is fully blocked and the total flow of coolant is directed in the radiator.

The non–blocking (choke or poppet) type thermostat controls the flow of coolant only to the radiator, while the continuously open bypass sends coolant directly back to the fresh water pump and engine block. Coolant flow to the radiator discharges through the thermostat valve when coolant temperature is above the opening temperature of the thermostat (see illustration). This type is full open at 17°–20°F (9.4°–11.1°C) above the opening temperature of the thermostat.

Vented or Non–Vented

Thermostats may be vented or non–vented. Venting is accomplished with a small hole in the valve or a notch in the valve at its seat. Non–vented thermostats should be installed only in rapid warm–up type cooling systems. Vented thermostats are used primarily in conventional cooling systems.

The Rapid Warm–up Cooling System

The amount of coolant leaking to the radiator when the thermostat is in the "closed" position has a direct bearing on the ability of the engine to warm up. For suitable engine warm–up, coolant leakage past the thermostat valve must be at a minimum.

The rapid warm–up cooling system may use either of the two types of thermostats, which must generally be non–vented. This characteristic may allow the elimination of radiator shutters.

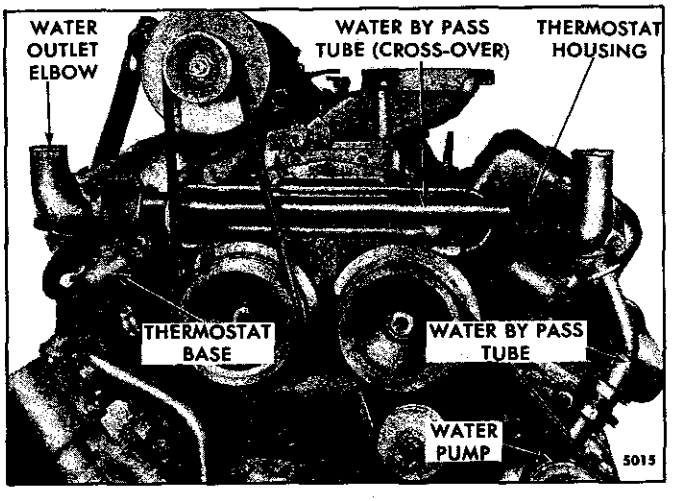


Fig. 2 – Thermostat Housings (6V Engine)

NOTICE: A 180° F (82° C) full blocking thermostat (no vent hole, valve face painted black) is currently used in rapid warm–up systems only, since these systems are externally vented to the top tank. Do not use non–vented thermostats in a conventional cooling system, since air binding of the cooling system and subsequent engine overheating and damage may occur.

The Bypass Circuit

The bypass circuit provides a route for coolant circulation before the thermostat opens. Coolant from the top of the engine flows back to the water pump without passing through the radiator or other heat exchanger. This flow of bypass coolant permits the engine to warm up to operating temperature while preventing "hot spots" which might damage the engine during this period of operation.

The bypass system on the V–type engine consists of a crossover tube connecting the two thermostat housings and an outlet tube attached between one thermostat housing and the water pump (Fig. 2). On the In–line engines, a bypass tube is attached between the thermostat housing and the water pump.

At coolant temperatures below approximately 170°F (77°C), the thermostat valve remains closed and blocks the flow of coolant through the radiator or heat exchanger. During this period, the coolant circulates through the cylinder block and head and then back to the suction side of the pump via the bypass tube. As the coolant temperature rises, the thermostat valve begins to open, restricting the bypass system and permits the coolant to circulate through the radiator or heat exchanger. When the valve is fully open, the bypass system of the V–type engine is completely blocked off and all of the coolant circulates through the radiator. However, with the valve fully opened in the In–line engine, a very small portion of the coolant will continue to circulate through the bypass tube, while the major portion will pass through the radiator.

A properly operating thermostat is essential for efficient operation of the engine. If the engine operating temperature deviates from the normal range (see Section 13.3), remove and check the thermostat(s).

NOTICE: There are areas where approved fuel (less than 0.5% sulfur) is not commercially available or economically feasible to obtain. It is important to keep the engine cooling system temperature of these engines on the high side of normal to prevent the condensation of sulfur trioxide gas, which combines with combustion water to form sulfuric acid. Therefore, install a 180° or 190°F (82° or 88°C) temperature thermostat and modify the cooling system to provide rapid warm–up in order to maintain coolant temperature at a minimum of 175°F (80°C).

Remove Thermostat

1. Drain the cooling system to the necessary level by opening the drain valves.
2. Remove the hose connections between the thermostat housing water outlet elbow and the radiator or heat exchanger.
3. Loosen the bolts and remove the water outlet elbow from the thermostat housing on the In–line engine (Fig. 3). Take out the thermostat.
4. On the V–type engine, remove the crossover bypass tube which is located between the thermostat housings. Also disconnect the bypass tube between the water pump and the thermostat housing (Fig. 4). Remove the gaskets. Then loosen the bolts and remove the thermostat housings from their bases. Remove the thermostats and remove and discard the thermostat seals.

• Inspection

1. Check the thermostats.

   A defective thermostat which remains closed, or only partially open, will restrict the flow of coolant and cause the engine to overheat. A thermostat which is stuck in a full open position may not permit the engine to reach its normal operating temperature. The incomplete combustion of fuel due to cold engine operation will result in excessive carbon deposits on the pistons, rings and valves. To check the operation of thermostats, refer to Section 5.0.

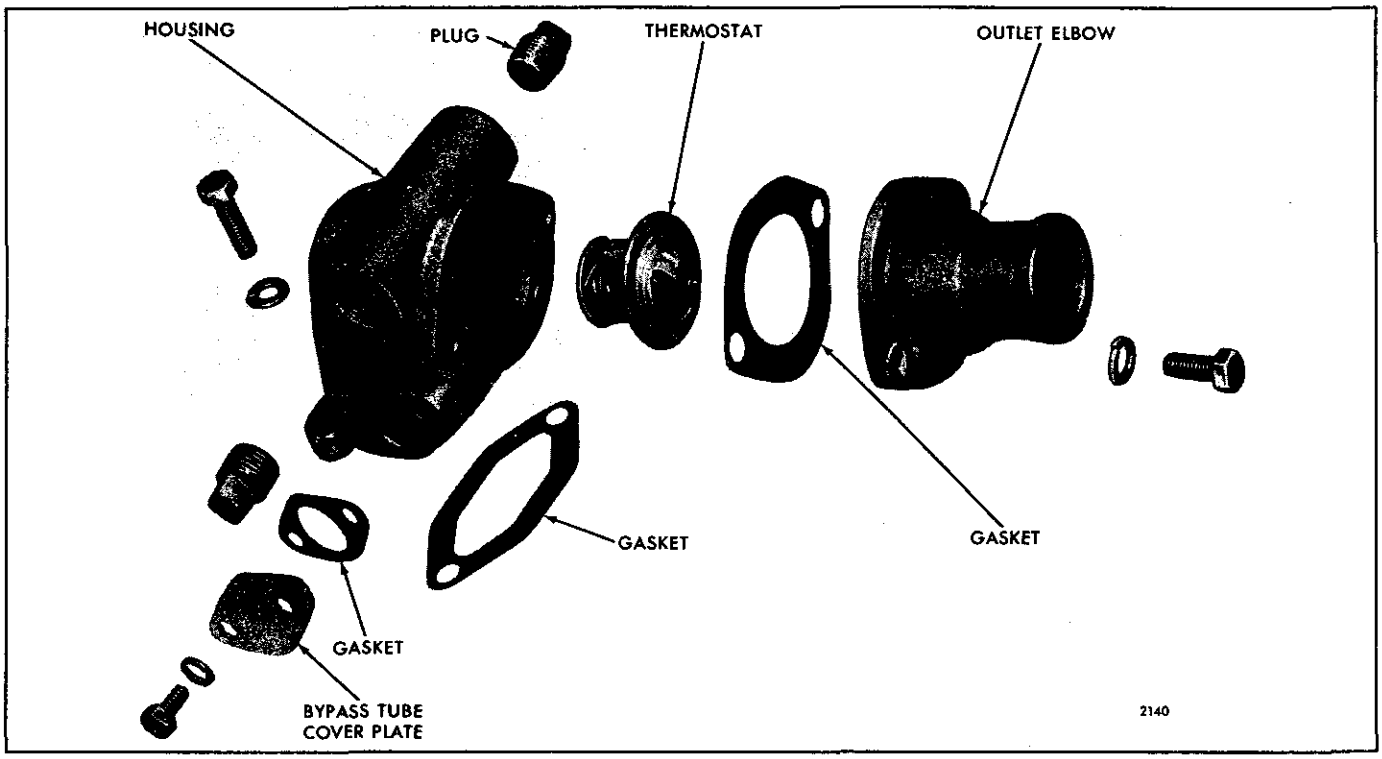


Fig. 3 – Thermostat Housing Details and Relative Location of Parts (In–Line Engine)

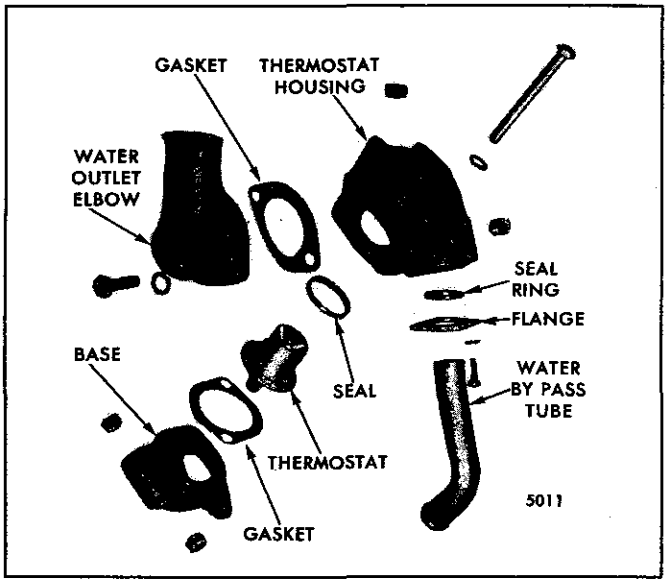


Fig. 4 – Thermostat Housing Details and Relative Location of Parts (V–Type Engine)

2. Check the thermostat flange counterbore in the housing and base or the water outlet elbow. Make sure it is clean and free from any obstructions that could prevent full seating of the flange.

3. Check the thermostat housing cover bypass cast seal ring. Check for wear and proper alignment of thermostat. Replace the cover if the thermostat will not properly block off the bypass cavity during full–open thermostat operation.

4. Check the bleed hole in the thermostat housing to make sure it is open (Fig. 5).

   The early 6V–53 themostat housing had three bleed holes. Current housings have one bleed hole. If an excessively long warm up period is encountered with the former thermostat housing (three bleed holes), plug two of the bleed holes with No. 4 drive screws.

   Drill a 3/32 diamter hole in the thermostat housing used on In–line industrial engines built prior to serial number 2D–603, 3D–011 or 4D–094 (refer to Fig. 6). This will provide a coolant drain hole for the bypass cavity in the housing.

Install Thermostat

Refer to Figs. 3 and 4 and install the thermostat(s) as follows:

IN–LINE ENGINE:

1. Place a new gasket on the thermostat housing.
2. Insert the thermostat into the housing.
3. Install the water outlet elbow and secure it to the housing with two bolts and lock washers.

4. Connect the hose from the radiator or heat exchanger to the water outlet elbow. Align and tighten the hose clamps.

V–TYPE ENGINE:

1. Install new seals in the thermostat housings. Position the seals so the lips face away from the thermostats. Press the seals in with seal installer J 22091 and handle J 7079–2.

2. Place a new gasket on each thermostat housing base.

3. Insert a thermostat in each base.

4. Install the thermostat housings and secure the housings with bolts and lock washers. *Exercise care to prevent damage to the thermostat seals.*

5. Place new seals on the crossover bypass tube, then reinstall the tube.

6. Use new gaskets and attach the water outlet elbows to the thermostat housings. Secure the elbows with bolts and lock washers.

7. Place a new seal on the upper end of the bypass tube and install the tube between the thermostat housing and the water pump.

8. Install the hoses between the radiator or heat exchanger and the water outlet elbows and secure them with the hose clamps.

After the thermostats have been installed, close all of the drain cocks and fill the cooling system. Vent the system as outlined in Section 5. Then start the engine and check for leaks.

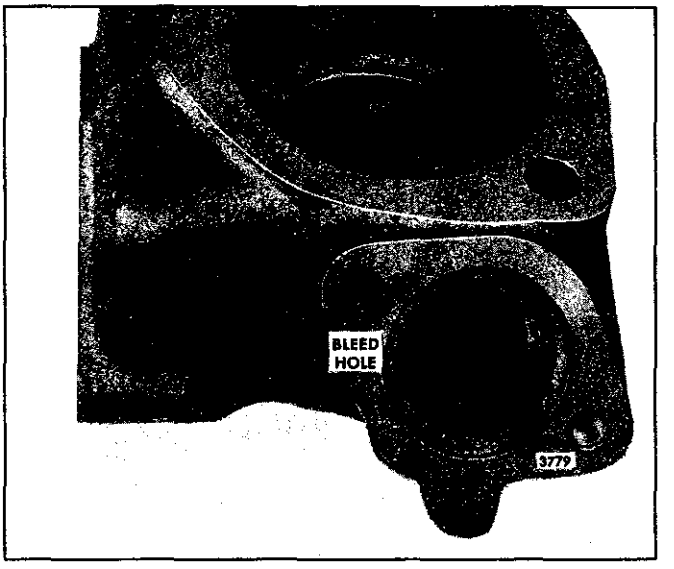


Fig. 5 – Bleed Hole in Thermostat Housing (V–Type Engine)

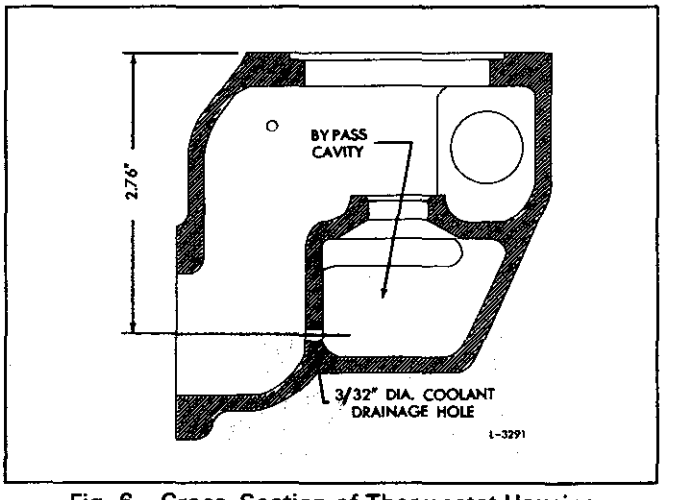


Fig. 6 – Cross–Section of Thermostat Housing (Early Industrial In–line Engine)

RADIATOR

On some engines the temperature of the coolant circulating through the engine is lowered by the action of the radiator and the fan. The radiator is mounted in front of the engine (Fig. 1) so that the fan will draw air through it, thereby lowering and maintaining the coolant temperature to the degree necessary for efficient engine operation.

The life of the radiator will be considerably prolonged if a recommended type coolant is used (refer to Section 13.3).

To increase the cooling efficiency of the radiator, a metal shroud is placed around the fan. The fan shroud must be fitted airtight against the radiator to prevent recirculation of the hot air drawn through the radiator. Hot air which is permitted to pass around the sides or bottom of the radiator and is again drawn through the radiator will cause overheating of the engine.

Another cause of overheating is slippage of the fan drive belts which is caused by incorrect belt tension, worn belts or worn fan belt pulley grooves, or the use of fan belts of unequal length when two or more belts are used. The belt tension and condition of the belts should be checked periodically (refer to *Preventive Maintenance*, Section 15.1). A faulty fan, inoperative or misadjusted shutterstats could also cause an engine to overheat.

A radiator that has a dirty, obstructed core or is leaking, a leak in the cooling system, or an inoperative thermostat will also cause the engine to overheat. The radiator must be cleaned, the leaks eliminated, and defective thermostats replaced immediately to prevent serious damage from overheating.

- **NOTICE: The use of winterfronts (cardboard, canvas, etc.) is not recommended with any DDC engine installation.** Their use can result in excessive engine coolant, oil, and charge air temperatures. This can lead to turbocharger surge, poor fuel economy, loss of power, and reduced engine life. Winterfronts may also put abnormal stress on fan and fan drive components, creating the potential for premature malfunction and/or damage.

The external cleanliness of the radiator should be checked if the engine overheats and no other causes are apparent.

Cleaning Radiator

The radiator should be cleaned whenever the foreign deposits are sufficient to hinder the flow of air or the transfer of heat to the air. In a hot, dusty area, periodic cleaning of the radiator will prevent a decrease in efficiency and add life to the engine.

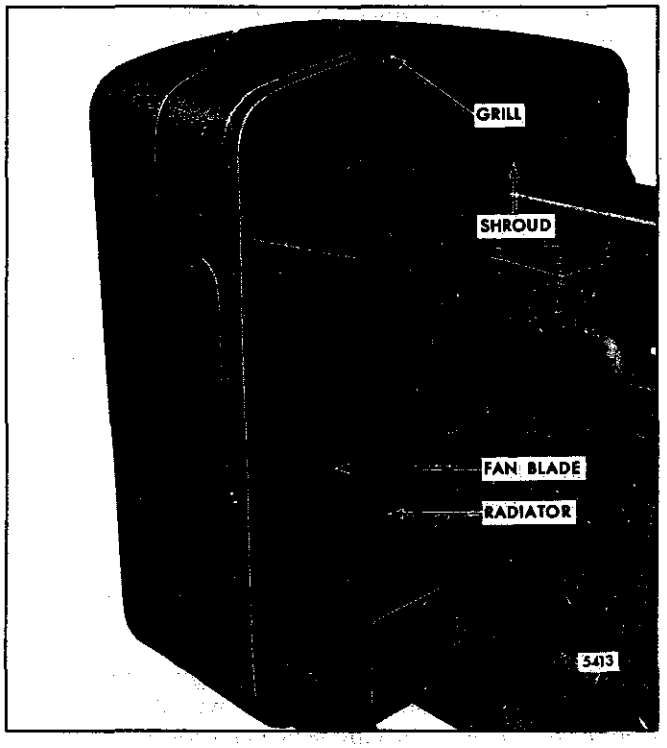


Fig. 1 – Typical Radiator Mounting (In-Line Engine)

The fan shroud and grill should be removed, if possible, to facilitate the cleaning of the radiator core.

An air hose with a suitable nozzle is often sufficient to remove loose dust from the radiator core.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Occasionally, however, oil may be present requiring the use of a solvent, such as mineral spirits, to loosen the dirt. *The use of gasoline, kerosene or fuel oil is not recommended as a solvent.* A spray gun is an effective means of applying the solvent to the radiator core. Use air to remove the remaining dirt. Repeat this process as many times as necessary, then rinse the radiator with clean water and dry it with air.

To avoid damage to the radiator fins, do not use high air or water pressure.

CAUTION: Provide adequate ventilation of the working area to avoid possible toxic effects of the cleaning spray.

Another method of cleaning the radiator is the use of steam or a steam cleaning device, if available. If the foreign deposits are hardened, it may be necessary to apply solvents.

The scale deposit inside the radiator is a result of using hard, high mineral content water in the cooling system. The effect of heat on the minerals in the water causes the formation of scale, or hard coating, on metal surfaces within the radiator, thereby reducing the transfer of heat. Some hard water, instead of forming scale, will produce a silt–like deposit which restricts the flow of water. This must be flushed out at least twice a year — more often if necessary.

To remove the hardened scale, a direct chemical action is necessary. A flushing compound such as sal–ammoniac, at the specified rate of 1/4 pound per each gallon of radiator capacity, should be added to the coolant water in the form of a dissolved solution while the engine is running. Operate the engine for at least fifteen minutes, then drain and flush the system with clean water.

Other flushing compounds are commercially available and should be procured from a reliable source. Most compounds attack metals and should not remain in the engine for more than a few minutes. A neutralizer should be used in the cooling system immediately after a descaling solvent is used.

For extremely hard, stubborn coatings, such as lime scale, it may be necessary to use a stronger solution. The corrosive action of a stronger solution will affect the thin metals of the radiator, thereby reducing its operating life. A complete flushing and rinsing is mandatory and must be accomplished skillfully.

After the solvent and neutralizer have been used and the cooling system is flushed, completely drain the entire system again and fill it with a recommended coolant (refer to *Engine Coolant* in Section 13.3). After filling the cooling system, inspect the radiator and engine for water leaks.

When draining or filling, the cooling system must be vented.

After the radiator core has been thoroughly cleaned and dried, reinstall the fan shroud and grill, if removed.

Remove Radiator

1. Remove the radiator filler cap and open the drain cock to drain the cooling system. Also open the drain cock on the oil cooler and the engine block.
2. Remove the bolts, lock washers and nuts which attach the fan guards to the fan shroud.
3. Loosen the hose clamps at the radiator inlet hose and remove the hose.
4. Loosen the hose clamps at the radiator outlet hose and remove the hose.
5. Use a chain hoist and a suitable lifting device (through the filler neck or otherwise) and draw the hoisting chain taut to steady the radiator.
6. Remove the bolts, lock washers, plain washers, nuts and bevel washers (if used) which attach the radiator shell to the engine base.

   NOTICE: Since the shroud is very close to the tips of the fan blades, to prevent damage to these parts great care must be exercised whenever the radiator is removed.

7. Lift the radiator enough to clear the engine base and move it directly away from the engine.
8. Remove the fan shroud and the radiator core by removing the bolts securing them in place.

Inspection

Clean all radiator parts thoroughly, removing dirt, scale and other deposits.

Examine the radiator for cracks or other damage. The core fins should be straight and evenly spaced to permit a full flow of cooling air. The core tubes should be clean inside and outside and have no leaks.

If repainting the radiator core becomes necessary, it is recommended that a thin coat of dull black radiator paint or another high quality flat black paint be used. Ordinary oil paints have an undesirable glossy finish and do not transmit heat as well.

Check all radiator hoses and clamps. Replace cracked and deteriorated hoses and damaged clamps.

Install Radiator

Assemble the radiator, grill and shroud. Then mount the assembly on the engine base by reversing the procedure given for removal.

Check for clearance between the tips of the fan blades and radiator shroud after the radiator is in place. There must be sufficient clearance or damage to the fan and shroud will result when the engine is started. Use shims between the radiator and base, if necessary, to obtain the proper clearance.

CROSS–FLOW DESIGN RADIATOR

Certain 6V–53 on–highway vehicle engines incorporate a cooling system radiator of a cross–flow design rather than the conventional down–flow design.

As the name implies, a cross–flow radiator has a core of horizontally positioned tubes and coolant flow moves across rather than down the radiator.

Two reasons for using the cross–flow design radiator are:

1. The reduced height of the radiator permits a lower hood line design, thus providing better road visibility.

2. The area ahead of the engine crankshaft and below the radiator is open for mounting a power take–off unit, if desired.

The intent here is to describe briefly how the cross–flow radiator functions and to identify some of the components unique in the cross–flow system.

One such component is a Y–shaped device called an aspirator (Fig. 2) which is mounted externally on the filler cap side of the radiator and serves to rid the cooling system of air. The aspirator directs coolant under pressure through a venturi where entrapped air inside the radiator is picked up and moved to the supply chamber of the radiator where it is vented. The coolant line providing the drive flow originates at the engine thermostat housing. This hookup provides a flow of coolant to the aspirator regardless of whether the thermostat is open or closed. As the coolant flow passes through the aspirator, its action pulls coolant and any air that is present from the top of the radiator core outlet chamber into an internal "U" tube which vents near the filler cap inside the radiator supply chamber to complete the deaeration process. This "U" tube insures that the entire cooling circuit, other than the supply chamber, remains completely full when the engine is stopped. Also, it keeps the coolant from seeking a common level throughout the system and, thereby, eliminates an aerated system at the next engine start–up.

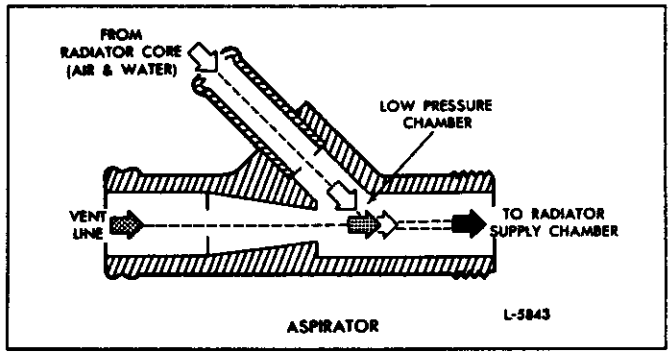


Fig. 2 – Aspirator for Cross–Flow Design Radiator

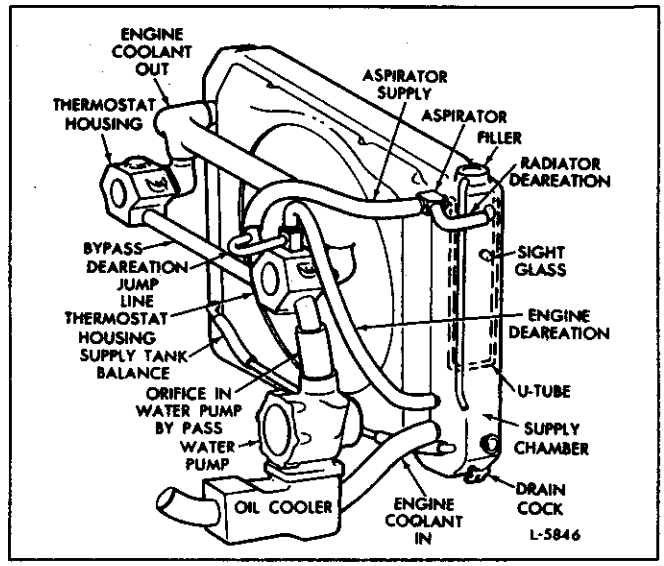


Fig. 3 – Cross–Flow Design Radiator

In order to provide adequate coolant flow through the engine deaeration line when the thermostat is closed, a restricting orifice is used in the engine water pump bypass (Fig. 3). This orifice is 5/8" I.D. and is brazed into the upper end of the water bypass tube that connects the right–hand thermostat housing to the water pump; thus, it becomes a permanent part of the water bypass tube assembly and *must* be used for adequate system performance.

Properly installed hose connections are required for adequate cross–flow radiator efficiency. Figure 3 illustrates the proper hose connections for the 6V–53 installation.

The cross–flow cooling system should always be drained at the radiator drain cock. This will insure that both the radiator and internal "U" tube is empty. If the "U" tube is not emptied, refilling the system will prove difficult.

Due to the design of the cross–flow radiator, air may be trapped inside of the radiator during the fill process resulting in a false coolant level reading. Therefore, after filling the cooling system, the engine should be run approximately ten minutes at 1200–1400 rpm so that any entrapped air can be vented. Generally, additional coolant (approximately 3 to 4 quarts or 2.8 to 3.8 liters) will be required to bring the coolant to the proper level.

For efficient operation of the cross–flow radiator system, it is important that no leak exists between the radiator core and the supply tank. If an internal leak has developed between the radiator core and the supply tank, it can cause the cooling system to become aerated at low speed and following engine shut down. The radiator should be tested periodically for possible internal leaks. To determine if a leak is present, proceed as follows:

1. Remove the radiator cap and run the engine for approximately ten minutes at high idle to completely deaerate the cooling system. While the engine is running, add additional coolant to the supply chamber to bring the coolant level to the bottom of the filler neck.

2. Stop the engine and drain 4 quarts (3.8 liters) of coolant from the radiator.

3. Start and run the engine at high idle for approximately ten minutes and observe the coolant level.

4. Stop the engine and again observe the coolant level. If the coolant rises substantially in the supply tank, an internal leak is present and immediate corrective action should be taken to repair the leak. If the coolant level remains constant or falls, the system is satisfactory.

5. After the test is completed, refill the cooling system to the proper coolant level.

If the leak situation is not corrected, the engine will be operating with an aerated coolant for abnormal periods of time which could lead to an engine failure.

COOLANT PRESSURE CONTROL CAP

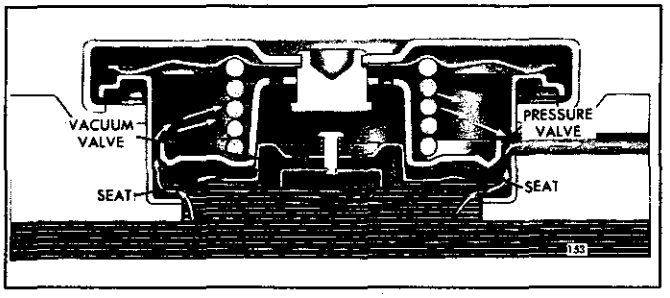


Fig. 1 – Pressure Control Cap (Pressure Valve Open)

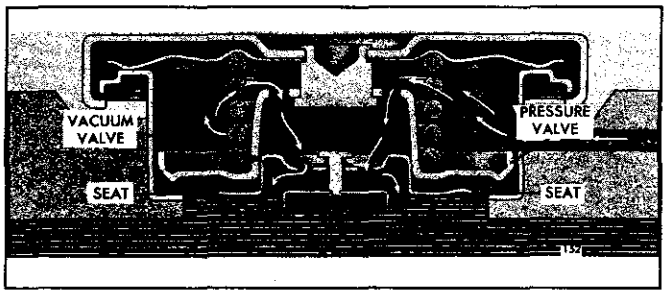


Fig. 2 – Pressure Control Cap (Vacuum Valve Open)

The radiator (or expansion tank) has a pressure control cap with a normally closed valve. The cap, with a number "7" stamped on its top, is designed to permit a pressure of approximately seven pounds (48 kPa) in the system before the valve opens. The cap with a number "9" stamped on its top, is designed to permit a pressure of approximately nine pounds (62 kPa) in the system before the valve opens. This pressure raises the boiling point of the cooling liquid and permits somewhat higher engine operating temperatures without loss of any coolant from boiling. To prevent the collapse of hoses and other parts which are not internally supported, a second valve in the cap opens under vacuum when the system cools.

CAUTION: Use extreme care while removing the coolant pressure control cap. Remove the cap *slowly* after the engine has cooled. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

To ensure against possible damage to the cooling system from either excessive pressure or vacuum, check both valves periodically with tester J 22460–01 for proper opening and closing pressures. If the pressure valve does not open between 6.25 psi (43.1 kPa) and 7.5 psi (51.7 kPa) or the vacuum valve is not open at .625 psi (4.3 kPa) – (differential pressure), replace the pressure control cap.

It is recommended that all 53 on–highway vehicle engines use a minimum 9 psi (62 kPa) pressure control cap. If the pressure valve does not open between 8 psi (55 kPa) and 10 psi (69 kPa) or the vacuum valve does not open at .625 psi (4.3 kPa) – (differential pressure), replace the pressure control cap.

ENGINE COOLING FAN

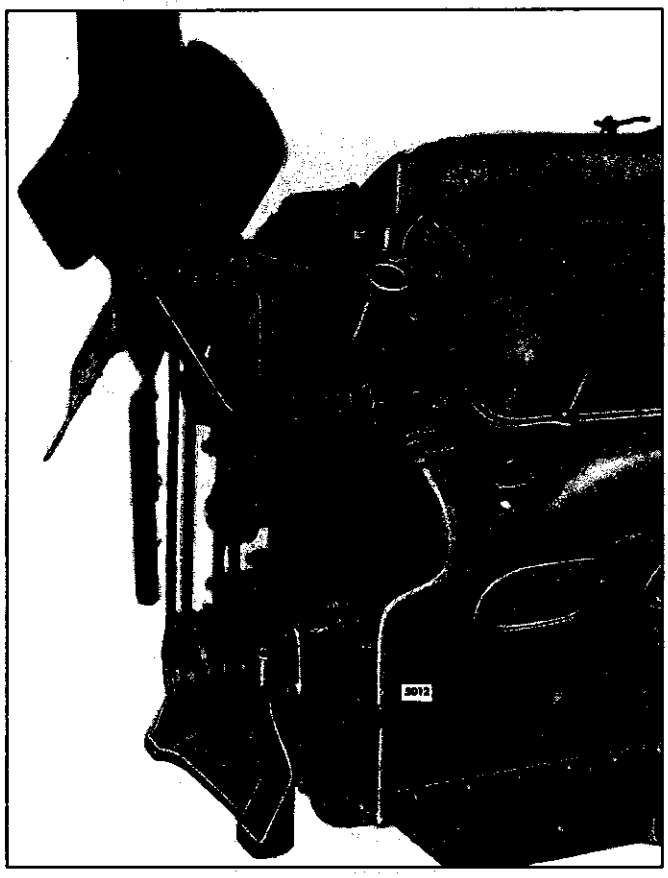


Fig. 1 – Belt–Driven Fan Mounting (V–Type Engine)

The engine cooling fan is driven by a pair of V–drive belts from the crankshaft pulley (Fig. 1) or driven directly by the crankshaft (Fig. 2). Because of high vibration loads on certain applications, a new 22" five blade fan with a thicker spacer is now being used on the In–line 53 engines as required. This is effective with engine serial number 4D–154007. The former and new fan assemblies are interchangeable on an engine, but only the new fan assembly is serviced.

Effective with engine serial numbers 2D–28185, 3D–66957 and 4D–68816, new fan hub assemblies are being used on the In–line engines. The new assemblies are similar to the integral cast shaft and bracket design, with tapered roller bearings, currently used on the V–type engines (Fig. 5). A new pulley hub assembly is now being used on certain four and six cylinder 53 Series engines to extend operational life under severe dirt conditions. It includes a front ball bearing and a rear roller bearing along with a hub cap (with relief valve), a dust cap and a grease fitting in the fan pulley hub (Fig. 8).

The belt–driven fan is bolted to a combination fan hub and pulley which turns on a sealed ball bearing assembly (former In–line engines), two tapered roller bearings (present V–type and In–Line engines) or a front ball bearing and a rear roller bearing (new 4–53 and 6V–53 engines). The crankshaft driven fan is bolted to the crankshaft pulley.

Lubrication

The sealed ball bearing, used in the fan hub assembly shown in Fig. 3, is pre–lubricated and requires no further lubrication.

Tapered roller bearings and the cavity between the bearings are packed with grease at the time the fan hub is assembled. Refer to Section 15.1 for the maintenance schedule.

Fan Belt Adjustment

Adjust the fan belts periodically as outlined in Section 15.1.

Remove Fan, Hub and Adjusting Bracket

The fan blades must rotate in a vertical plane parallel with and a sufficient distance from the radiator core.

> **NOTICE:** Bent fan blades reduce the efficiency of the cooling system, may throw the fan out of balance, and are apt to damage the radiator core.

Before removing the fan, check the blades for alignment. Do not rotate the fan by pulling on the fan blades.

1. Remove the fan belts and fan guards.
2. Remove the attaching bolts and lock washers and remove the fan and spacer (if used).

   If insufficient clearance exists between the fan and radiator, remove the fan, hub and adjusting bracket as an assembly.
3. Loosen the fan hub adjusting bracket bolts and remove the drive belts. Then, withdraw the bolts and washers and remove the hub and bracket assembly from the engine.

Disassemble Hub and Adjusting Bracket

IN–LINE ENGINES (Ball Bearing Type Hub):

1. Refer to Fig. 3 and measure the distance between the rear face of the rim on the pulley and the rear face (machined) of the fan adjusting bracket. Record this measurement for reassembly purposes.
2. Remove the fan hub from the shaft with a puller as shown in Fig. 4.

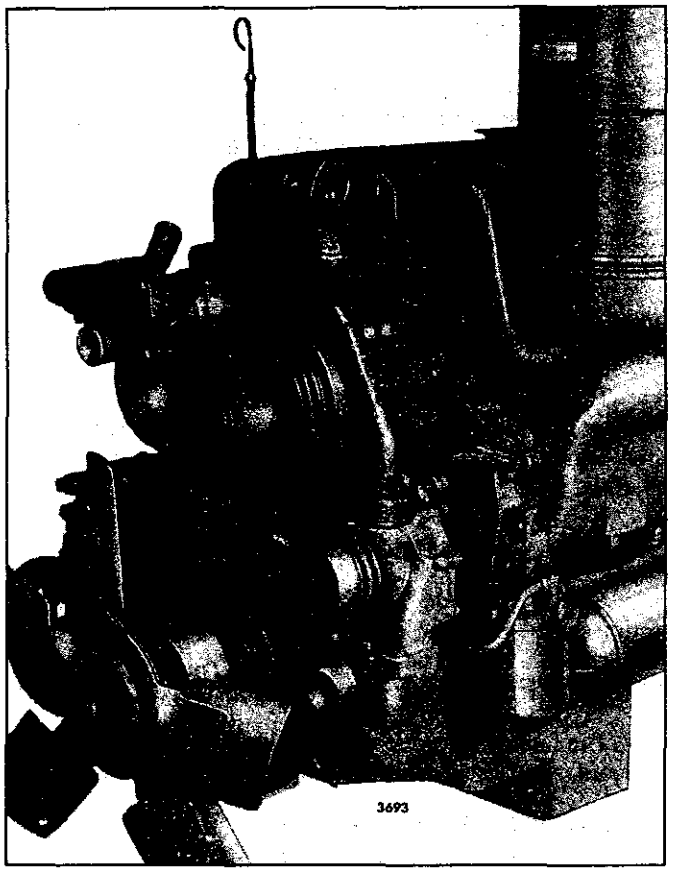


Fig. 2 – Crankshaft-Driven Fan Mounting (In-Line Engine)

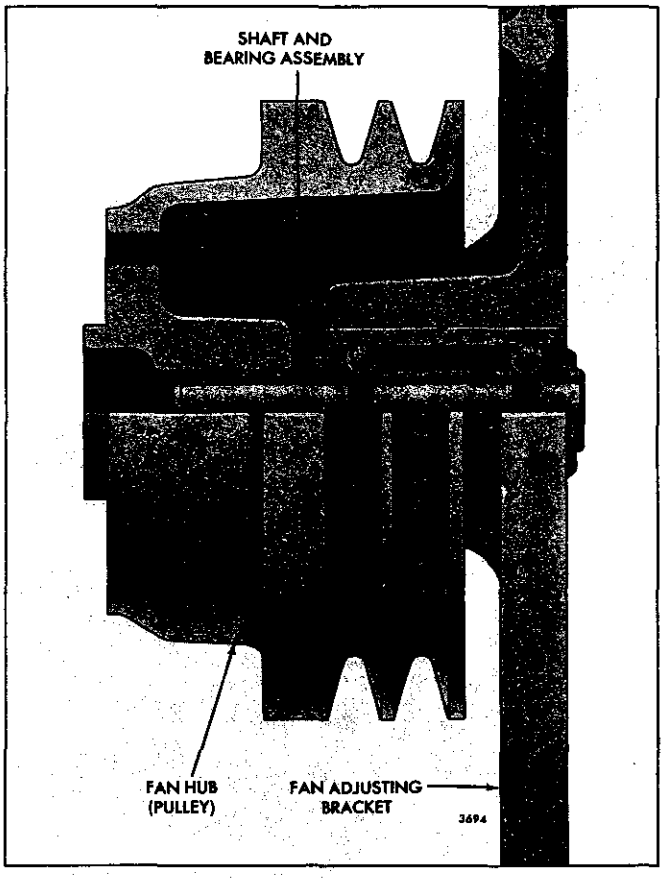


Fig. 3 – Ball Bearing Type Fan Hub Assembly (In-Line Engine)

3. Place the bracket assembly in an arbor press. Then, place a suitable sleeve over the shaft and against the outer race of the bearing and press the bearing and shaft assembly from the bracket.

NOTICE: Damage to the bearing will result if force is applied to the shaft.

IN-LINE ENGINES (Roller Bearing Type Hub):

1. Refer to Fig. 5 and remove the fan hub cap.
2. Remove the hub bolt and washer.
3. Withdraw the hub and bearing assembly from the shaft. It may be necessary to tap the end of the shaft with a soft hammer to loosen the hub assembly.
4. Remove the oil seal and bearing from the fan hub.
5. Remove the bearing spacer, shims and grease retainer.

4-53 and V-TYPE ENGINES:

1. Remove the fan hub cap (if a spacer and cap assembly were not used).

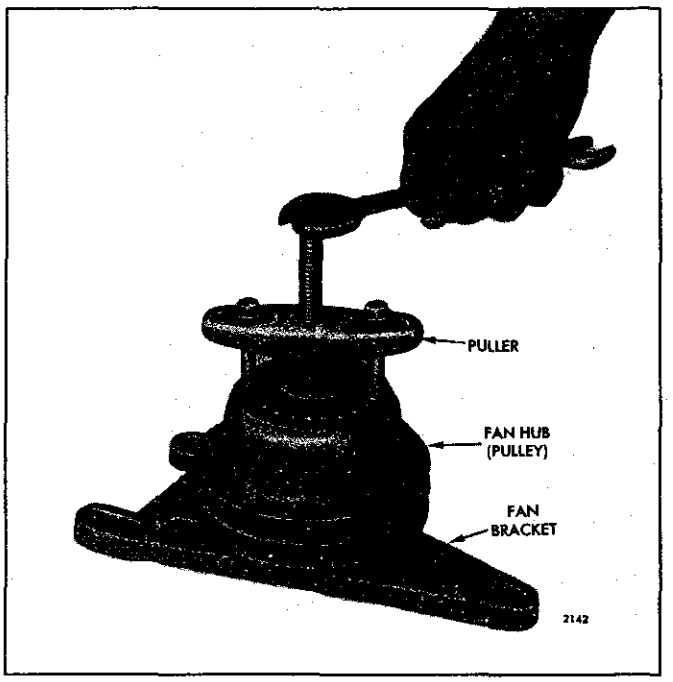


Fig. 4 – Removing Fan Hub (Pulley)

2. Remove the hub retaining cotter pin, nut and washer (Fig. 6) or the bolt and special washer (Fig. 7 and 8). Also, remove the shims if the former type fan hub assembly illustrated in Fig. 7 is used.

3. Withdraw the hub and bearing assembly from the shaft. It may be necessary to tap the end of the shaft with a soft hammer to loosen the hub assembly.

4. Remove the seal and bearings from the fan hub.

5. Remove the bearing spacer (Fig. 7 and 8) and shims (if the current type hub assembly is used).

Inspection

Clean the fan and related parts with clean fuel oil and dry them with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

NOTICE: To avoid bearing damage, do not wash the permanently sealed bearing which is used in the In-line engine roller bearing hub assembly. Wipe the bearing and shaft assembly with a clean lintless cloth.

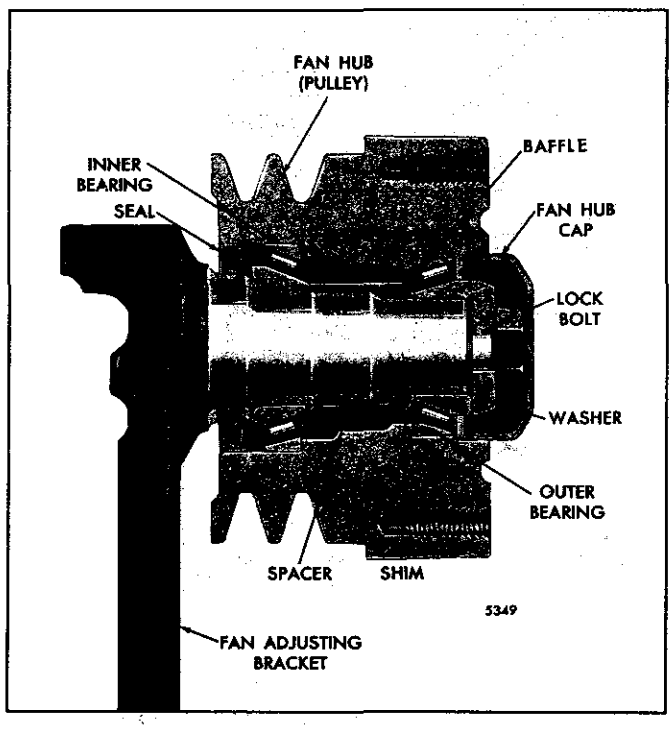


Fig. 5 – Shaft Type Fan Hub Assembly (6V Engine)

Hold the inner race (shaft of sealed ball bearing assembly) and revolve the outer race of the bearing slowly by hand. If rough or tight spots are detected, replace the bearing.

The current fan shaft rear bearing inner race should be inspected for any measurable wear. Replace the inner race if the outer diameter is less than 1.7299". *The inner and outer races are only serviced as a rear roller bearing assembly.*

When installing the rear bearing inner race, press it on the shaft and position it 1.35" to 1.37" from the end of the shaft.

Check the fan blades for cracks. Replace the fan if the blades are badly bent, since straightening may weaken the blades, particularly in the hub area.

Remove any rust or rough spots in the grooves of the fan pulley and crankshaft pulley. If the grooves are damaged or severely worn, replace the pulleys.

New .500" thick and .800" thick fan hub spacers and a new fan hub cap replace the former spacer and cap assemblies to provide spacers compatible with the six bolt hole mounting fan hub assemblies. The spacers (individually or in combination) also provide a means for setting the different clearances between the back of the fan blades and front groove of the crankshaft pulley.

The spacers have a flange on one side that serves as a pilot for the fan as well as a spacer pilot for the second spacer when two or more spacers are used together.

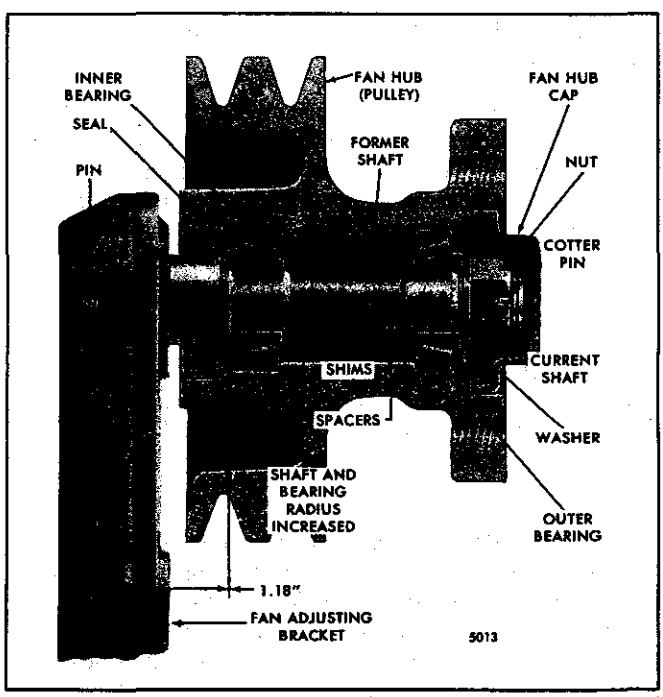


Fig. 6 – Shaft Type Fan Hub Assembly (6V Engines)