LUBE OIL SYSTEM (ALCO)

The lubricating oil, besides providing a film of soft slippery oil in between frictional surfaces to reduce friction and wear, also serves the following purposes –

- Cooling of bearings, pistons etc.
- Protection of metal surfaces from corrosion, surface damage and wear.
- Keep the components clean and free from carbons, lacquer deposits and prevent damage due to deposits.

The Lubricating Oil System of Diesel Locos essentially consists of –

- Gear type circulating pump (driven by the engine crankshaft).
- Spring loaded relief valve.
- Lube oil filter tank accommodating eight nos. of filter elements.
- Differential bypass valve across filter.
- Lube oil cooler.
- Spring loaded regulating valve.
- Lube oil strainer.
- Oil Pressure Switch (OPS) which is meant to automatically shut down the engine, in case of a drop of lube oil pressure below 1.3 kg/cm^2.
- Oil pressure gauge, which indicates the main header oil pressure.
- Oil sump having capacity 1270 Ltrs (WDM2, WDM2C, WDG2,WDG3 etc). And in case of newly introduced Alco WDM3D the capacity is 1450 ltrs.
- RR 606 multi grade oil is used in Alco locomotives.

Lubricating Oil System –

When the Engine is started, the lube oil pump (discharge rate 314 gallons/min) draws oil from the engine sump and delivers it to the filters. The delivery pressure of the pump is to be controlled as the pump is driven by an engine of variable speed and would often have higher delivery pressure on load than actually required. Higher pressure may endanger the safety of filters, pipe lines and joints.

The lube oil relief valve set at 7.5 Kg/cm^2 (in case of aluminium piston fitted in engine) release the delivery pressure above its setting and bypass it back to the oil sump. In case of steel cap pistons provided in engine, relief valve set at 9.0 Kg/cm^2.

The oil then flows through the filter tank containing eight Nos. paper type filter elements. The filter has a bypass valve across it, set at a differential pressure of 1.4 Kg/cm^2. In case the differential pressure across the filter housing is more than 1.4 Kg/cm^2 due to choking of filters, the valve opens up to bypass a part of lube oil without filtration to reduce pressure on filters, which increases the life of battery.

After the filtration, the oil passes through the lube oil cooler, gets cooled by transferring heat to the water.

A regulating valve (adjusted at 6.0 Kg/cm^2 in case of Aluminium pistons & 6.5 Kg/cm^2 in case of steel cap pistons provided in the engine block) is provided at the discharge side of cooler to regulate the pressure. Excess pressure is regulated by sending the oil back to the engine oil sump.

The oil then enters the main oil header after passing through another stage of filtration in the strainer type filter where it is distributed to various locations for lubrication.

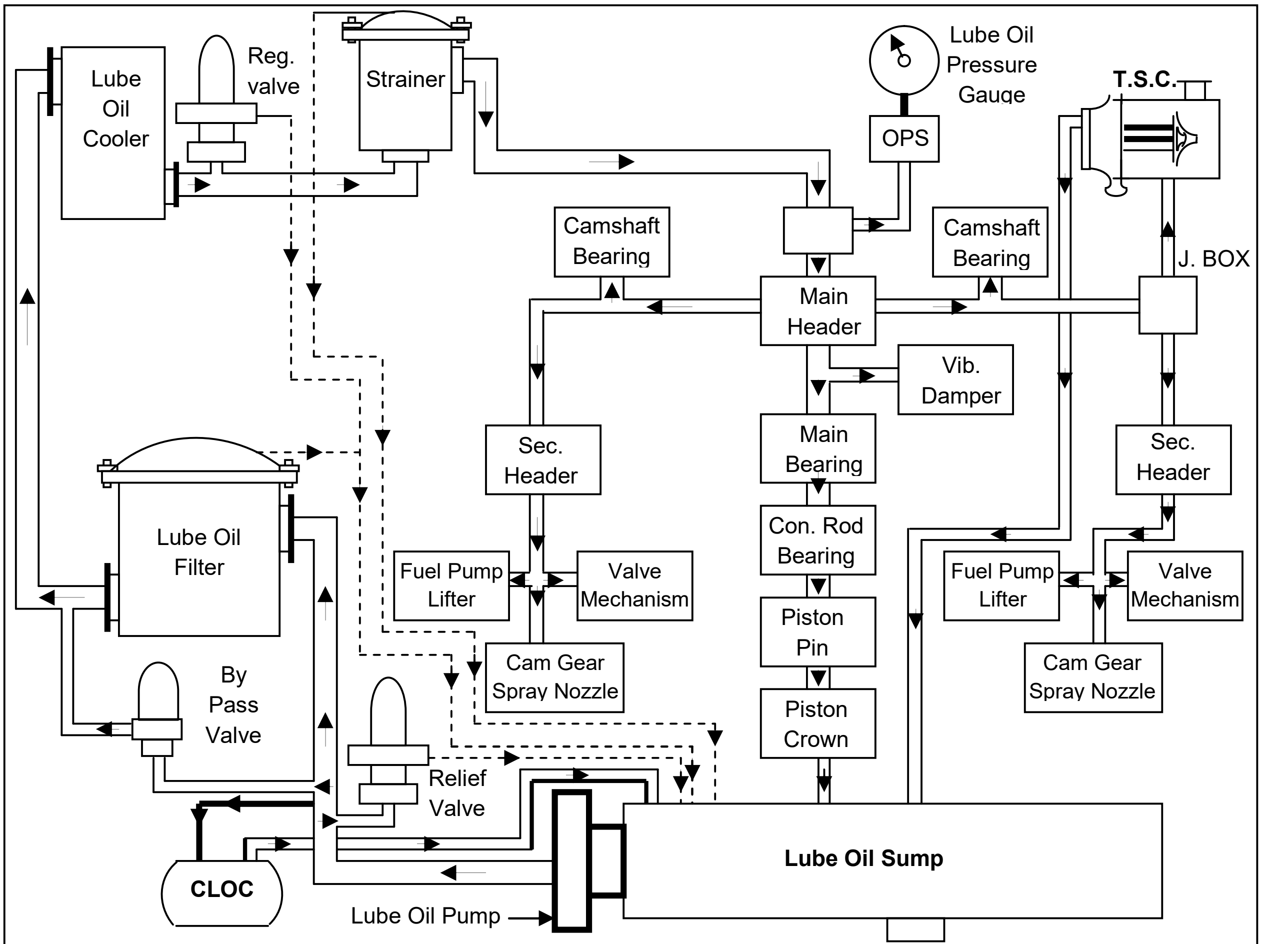
Direct individual connections are taken from the main oil header to all the main bearings. Oil thus pass through the main bearings supporting the crankshaft on the engine block, pass through the crankpin to lubricate the connecting rod big end bearing and the crank pin journals, reach the small end through rifle drill hole and after lubricating the gudgeon pin and bearings, enters into pistons. The pistons are provided with spiral oil passages inside them for internal circulation of lube oil. This is done with the purpose of cooling the pistons which are thermally loaded components. After circulating through the piston the oil returns to the sump, but in this process a part of the oil hits the running connecting rod and splashes on to the cylinder liners for their lubrication. A line from the main oil header is connected to a gauge in the driver's cabin to indicate pressure level. Lube oil pressure drop to less than 1.3 Kg/cm^2 would automatically shut down the engine through a safety device called "Oil Pressure Switch (OPS)" to protect it from damage due to insufficient lubrication.

From the main oil header, two branch lines are taken to the right and left side secondary headers to lubricate the components on both banks of the V-shaped engine block. Each branch line of the secondary header lubricate the cam shaft bearings, fuel pump lifters, valve lever mechanism and spray oil to lubricate the gears for cam shaft drive. A separate connection is taken to the TSC from the right side header for lubricating its bearings. After circulation to all the points of lubrication, the oil returns back to the sump for recirculation through the same circuit.

The kinematic viscosity of the lube oil is 166 cst at 37.4^0 C. The serviceable limit of the same is 150-237 cst at 37.4^0 C. At high temperature of 100^0C, the kinematic viscosity of the lube oil becomes 12.8- 20.5 cst. Due to this low viscous property at this high temperature, the lube oil is not able to function properly and not able to cool or lubricate the engine parts properly. As a result engine parts may get damaged. Thus high temperature is not desirable for proper functioning of the lube oil system, as well as the locomotives. In addition to the above, Indian Railway has started installation of Centrifugal Lube Oil Cleaner on all locomotives. The inlet port drawn oil from the main lube oil pipe from a point after the relief valve and outlet is terminated into the engine oil sump.

The benefits derived by Centrifugal lube oil cleaner is listed below –

- Most effective filtration – removal of contamination down to 0.5 micron.
- Reduced loading of full fins filters.
- Paper element life extended from 1 month to 3 months.
- 400 Litres of oil saved per loco per annum due to oil lost in filter changes.
- No operational cost.
- No consumable cost.



SCHEMATIC DIAGRAM OF LUBE OIL SYSTEM

Various causes leading to the failures of locomotives on account of Lube Oil System are as follows –

- External leakage resulting in failure of loco due to less oil in sump. (The point of external leakages – Valves lever cover, Crank case cover, Crank case explosion cover, Push rod grommets, Extension shaft / oil seal, face joint of lube oil relief / regulating and bye pass valves, from armoured / dresser or metallic joint, lube oil filter housing cover perished "O" ring / cracked / broken fly nuts / cracked filter housing, lube oil filter drain cock / strainer drain cock, bursting of flexible pipes, lube oil pump face joint or flange joint etc.)
- Leakage from lube oil cooler tubes, resulting in mixing of lube oil in water.
- Defective lube oil pump – pressure not building up or breakage of any of the components.
- Excessive oil through from CCE motor exhaust pipe – due to oil choking of return oil passage to the sump.
- Quality of lube oil – due to contamination in any form i.e. by fuel oil, cooling water, soot etc, change in properties like viscosity PH value etc.
- Improper setting of relief, regulating valve.
- Choking of filter elements.
- Improper setting of oil pressure switch.

SPECTROGRAPHIC ANALYSIS OF LUBE OIL

To ensure quality of lube oil, spectrographic analysis is carried out. The usual physics -Chemical analysis of used diesel engine crankcase oil provides following information regarding –

- Dilution with fuels.
- Contamination with cooling water.
- Extent of insoluble matter.
- Acidity.

It does not however give indication in respect of wear pattern of the engine components which may be resulting due to the above or from other cause.

With the help of spectrograph, it is possible to determine the various metal contaminations quickly and accurately. This analysis helps in—

- Predicting the required maintenance.
- Scheduling the overhauls thus avoiding unexpected down time and thereby increasing the locomotive availability & reliability.
- Eliminating the premature engine removal.
- Preventing costly engine failures resulting from the incipient wear of engine components.
- Controlling the quality of lube oil supplies.

The probable reasons against each wear metal concentrations are listed below.

Element	Abnormal ppm	Critical ppm	Comment
Copper	10	20	Bushing wear
Lead	5	10	Main/Connecting rod bearing wear.
Tin	5	10	Main/Connecting rod bearing wear.
Iron	20	50	Wear of Piston ring, Piston, Liners, Crankshaft journal, Gear trains, Cam etc. If only Iron is high, wear of gear train is suspected. If iron is high along with Copper and lead , Crankshaft is suspected. If iron is high along with Chromium and Aluminum , Piston

			rings/piston or liner are suspected.
Chromium	5	10	If Sodium is normal, Liner wear is indicated otherwise water leakage.
Sodium	30	50	Water leakage.
Aluminum	5	10	Piston wear.
Silicon	15	20	Inefficient air filtration.

LONG LIFE LUBRICATING OIL FILTER ELEMENT FOR DIESEL LOCOS.

Lube oil Filter is a critical item affecting g the life of power pack of locomotive. Long life lube oil filter elements use on the ALCO/DLW built diesel locomotives has been introduced with useful life as follows.

(A) 122 days life with at on board Centrifugal lube oil cleaner.

(B) 244 days life with at on board Centrifugal lube oil cleaner.

CONSTRUCTIONAL FEATURES:

- Structural strength of the element is such that the element having following properties.

  a) Not damaged by handling during transportation and installation.

  b) Not collapse in service.

  c) Not permit the lube oil to by-pass the filter paper.

- The filter paper is corrugated, impregnated with suitable resin on both sides. The filter paper is having a good dirt or contaminants retention efficiency. The mean pore size is 14 ± 2 microns and maximum pore size 45 microns. The filter element is not having a tendency to migrate into the lube oil system during service.

- The filter paper pleats is uniformly distributed around the centre tube and suitably joined together so as not to permit any films of oil through the joint.

- The paper pleats are encircled by flexible cottons nothing bonded to the peaks of the pleats by suitable adhesive and holding the pleated cylinder tightly.

- The perforated outer wrapper is made from a high density paper with round/ square holes perforation.

- Centre tube, made out of perforated steel tube of adequate thickness.

- The end caps are bonded by a suitable adhesive pleated paper and synthetic rubber gasket is provided at the bottom end cap extension piece. .

- The filter paper ,cotton netting and perforated outer wrapper should not be become brittle or rapture or get otherwise affected by hot engine oil at usual operating temperature in service up to a period of 130 days. The normal temperature of oil in service about 95°C but it can rise to about 150 °C at times.

PERFORMANCE REQUIREMENT

1. **END LOAD TEST**: A tensile load of 20 Kgs applied at the end caps of the filter elements for 5 minutes shall not cause any damage.

2. **HIGH TEMPERATURE TEST**: The filter element shall be soaked in engine oil maintained at a constant temperature of 130°C ± 5 °C for a period of 24 hours. The filter shall be subjected to end load test before cools down below 70°C.

3. **PRESSURE DROP VS FLOW RATE:** The filter element shall be tested for determining its pressure drop vs flow rate characteristics with clean engine oil temperature of 80 ± 2 °C, the flow capacity of the filter element should be minimum 150 litre / min with pressure drop not exceeding 0.4 Kg/cm^2 across the element.

4. **RESISTANCE TO WATER CONTAMINATION**: Pleat collapse and premature plugging of filter element does not occur when the lubricating oil is contaminated with water.

LUBRICATING OIL SYSTEM (HHP)

DESCRIPTION

8, 12, and 16-Cylinder Engines

The engine lubricating oil system used on 8, 12, and 16-cylinder engines is a combination of three separate systems. These are the main lubricating system, the piston cooling system and the scavenging oil system. Each system has its own oil pump. The main lube oil pump and piston cooling oil pump, although individual pumps, are both contained in one housing and driven from a common drive shaft. These pumps take oil from the strainer housing at the right front of the engine. The scavenging oil pump is a separate pump which takes oil from the engine oil pan sump and pumps it through the off-engine lube oil filter and cooler assemblies before returning to supply the strainer housing. All the pumps are driven from the accessory gear train at the front of the engine. Parts of this oil system and a schematic arrangement of oil circulation are shown in Figure 9-1

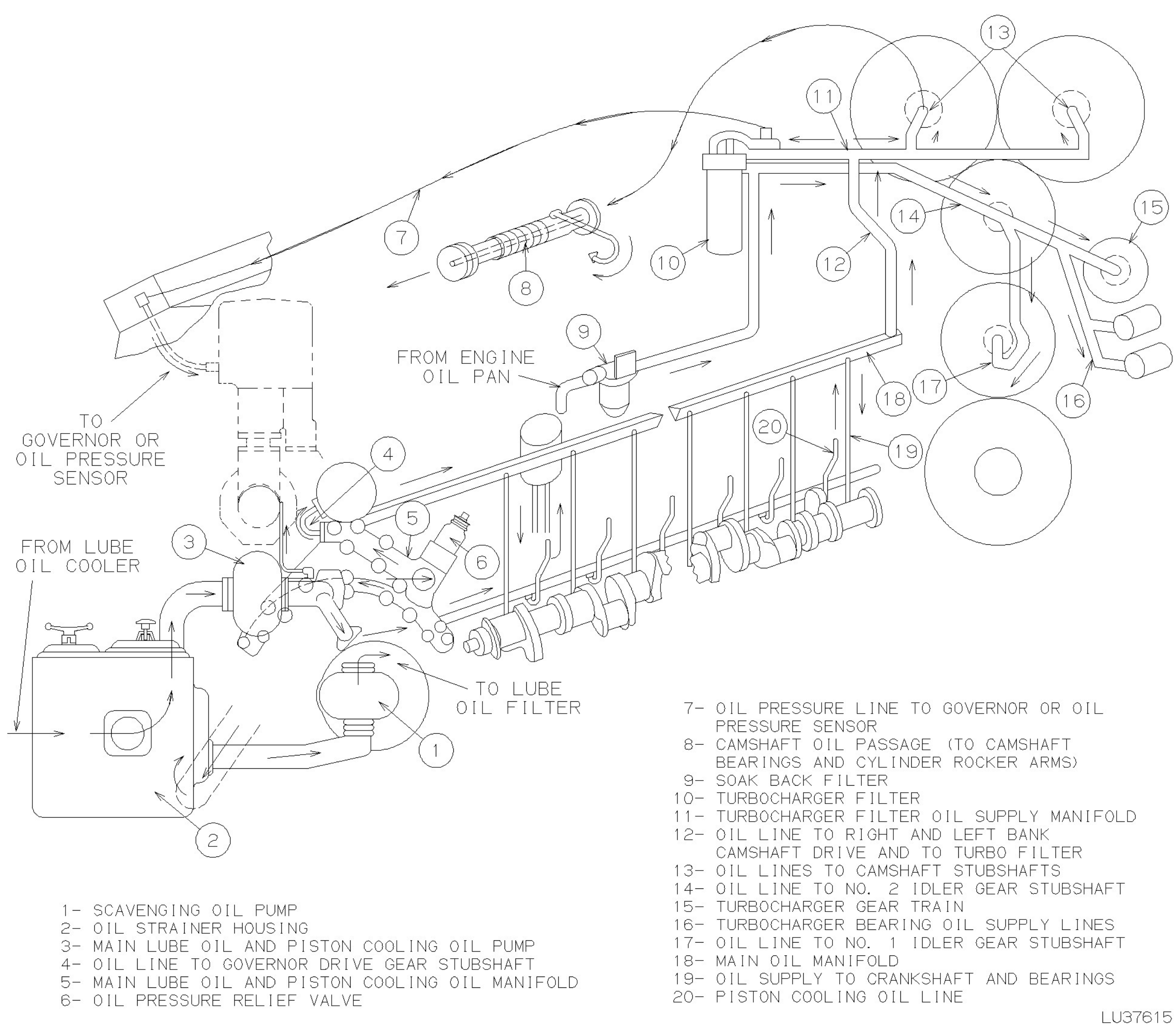


Figure 9-1. Typical Lubricating Oil System (8, 12, or 16-Cylinder Governor Controlled Engine Shown)

20-Cylinder Engines

The engine lubricating oil system used on 20-cylinder engines combines the three systems (main lubricating system, piston cooling system and the scavenging oil system) into one system using a single high capacity oil pump. This pump "scavenges" oil from the engine oil pan through the supply manifold and strainer assembly, then pumps it through the off-engine lube oil filter and cooler assemblies. Oil is returned to the engine through a "Y" branch manifold which divides it proportionally between the main lubricating oil system and the piston cooling oil system. The pump is driven from the accessory gear train at the front of the engine. Parts of this oil system and a schematic arrangement of oil circulation are shown below in Figure 9-2

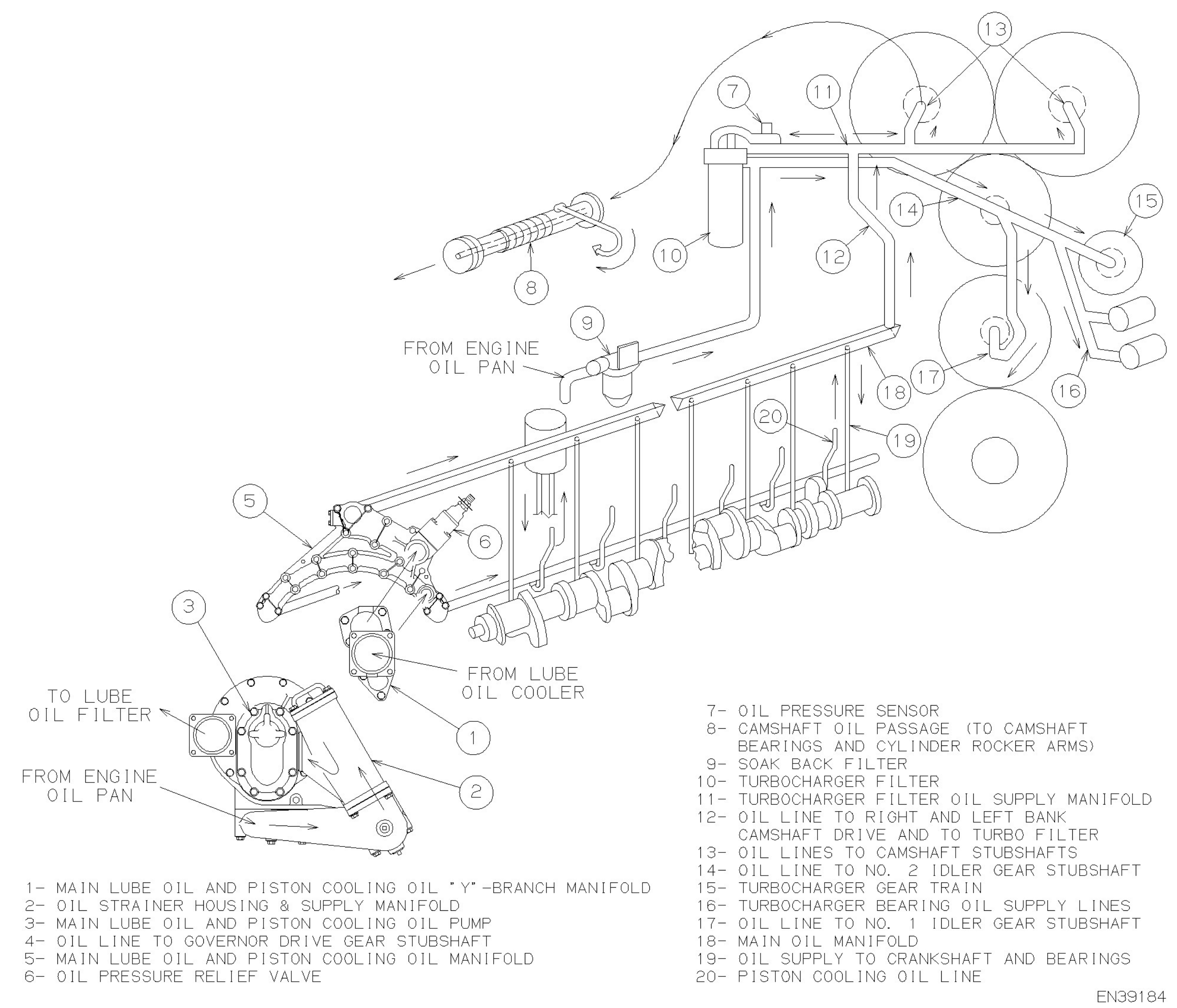


Figure 9-2. Typical Lubricating Oil System (20-Cylinder EMDEC Controlled Engine Shown)

MAIN LUBRICATING OIL SYSTEM

The main lubricating oil system supplies oil under pressure to most of the moving parts of the engine. Oil is pumped into the main oil manifold which is located above the crankshaft, and extends the length of the engine. Maximum oil pressure is limited by a relief valve in the passage between the pump and the main oil manifold.

Oil tubes at the center of each main bearing "A" frame conduct oil from the main manifold to the upper half of the crankshaft bearings. Drilled passages in the crankshaft supply oil to the connecting rod bearings, damper, and accessory drive gear at the front of the crankshaft. Leak-off oil from the adjacent main bearings lubricates the crankshaft thrust bearings.

Oil from the main lube oil manifold enters the gear train at the rear of the engine, at the idler gear stubshaft bracket. Oil passages in the stubshaft bracket distribute the oil. One passage conducts oil to both the right and left bank camshaft drive gear stubshaft brackets and to a manifold connected to the turbocharger oil filter. After passing through the filter, the oil enters the return line in the manifold and flows back to the idler gear stubshaft. A passage in the idler gear stubshaft bracket directs lube oil to the upper and lower stubshaft bearings. Filtered oil enters the turbocharger oil system from the upper idler gear stubshaft.

An oil passage in the turbocharger filter head, parallel to the filter output line, is connected to a passage in the turbocharger oil manifold. On governor controlled engines, an oil pressure line is connected between the manifold passage and the low oil pressure device in the governor. On EMDEC controlled engines, a sensor is used to detect low oil pressure directly at the manifold passage or connected to it by an oil pressure line. Descriptive information for each low oil pressure detection system is contained in Section 13, Protective Devices.

Oil enters the hollow bore camshafts from the camshaft drive stubshafts. Radial holes in the camshaft conduct oil to each camshaft bearing. An oil line from one camshaft bearing at each cylinder supplies oil to the rocker arm shaft, rocker arm cam follower assemblies, hydraulic lash adjusters, and the injector rocker arm button. Leak-off oil returns to the oil pan through passages between the top deck and the oil pan. Passages in the turbocharger conduct oil to the turbocharger bearings, idler gear, planet gear assembly, and auxiliary drive bore.

Considerable heat will remain in the metal parts of the turbine when the engine is shut down, and if the oil supply to the turbocharger was shut off suddenly, this heat would penetrate the turbocharger bearing area. To prevent possible overheating of the turbocharger, oil is automatically supplied to the turbocharger after stopping the engine.

Protection is provided against a hot oil condition by a thermostatic valve (on governor controlled engines) or a sensor (on EMDEC controlled engines). Descriptive information for each is contained in Section 13, Protective Devices.

PISTON COOLING OIL SYSTEM

The piston cooling oil system receives oil from a common supply with the main lube oil system and delivers it to the two piston cooling oil manifolds extending the length of the engine, one on each side. A piston cooling oil pipe at each cylinder directs a stream of oil through the piston carrier to cool the underside of the piston crown and the ring belt. Some of this oil enters the oil grooves in the piston pin bearing and the remainder drains out through holes in the carrier crown to the sump.

SCAVENGING OIL SYSTEM

The scavenging oil system takes oil through a scavenging oil strainer from the oil pan sump or reservoir. A pump then forces the oil through the oil filters and oil cooler which are located near the engine. Oil then returns to the engine to supply the main lube oil and piston cooling oil systems with cooled and filtered oil. On 8, 12, and 16-cylinder engines, the oil passes through the strainer housing to the main lube oil and piston cooling oil pumps. Excess oil spills over a dam in the strainer housing and returns to the oil pan. On 20-cylinder engines, the oil returns directly to the main lube oil and piston cooling oil systems.

OIL GAUGE

An oil level gauge, Figure 9-3, extends from each side of the oil pan into the oil pan sump. The oil level should be maintained between the low and full marks on the gauge, with the reading taken when the engine is at idle speed and the oil is hot.

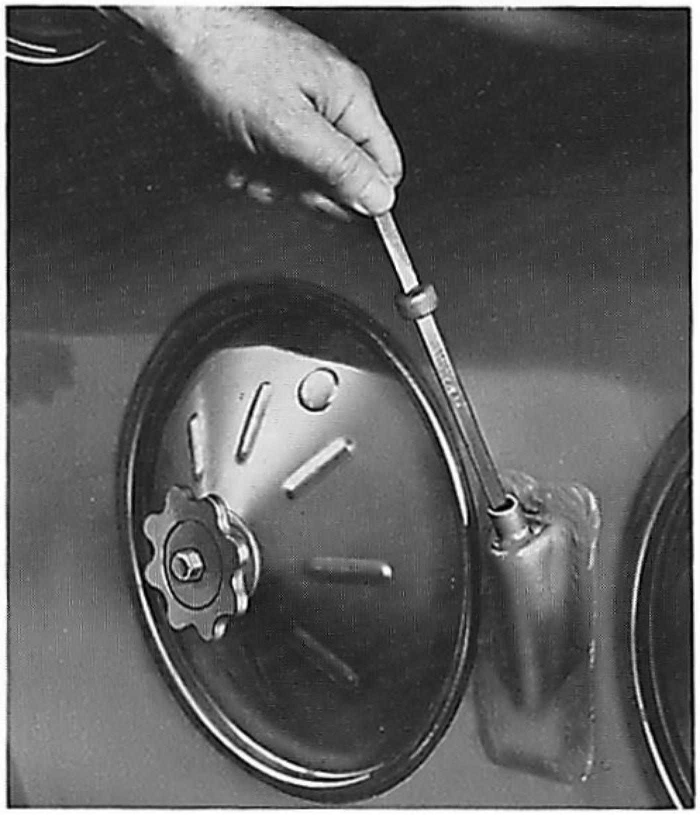


Figure 9-3. Typical Oil Level Gauge. (One Each Side Of Oil Pan)

MAINTENANCE

MAIN LUBRICATING OIL PRESSURE

Adequate lubricating oil pressure must be maintained at all times when the engine is running.

Upon starting and idling the engine, it should be noted that the oil pressure builds up almost immediately. In the event of cold oil, the pressure may rise to the relief valve setting of approximately 862 kPa (125 psi).

Lubricating oil pressure is not adjustable. The operating pressure range is determined by such things as manufacturing tolerances, oil temperature, oil dilution, wear, and engine speed. The pipe plug can be removed from the opening in the pump discharge elbow and a gauge installed to determine the pressure.

The minimum oil pressure is approximately 55-83 kPa (8-12 psi) at idle and 172-200 kPa (25-29 psi) at full speed. In the event of insufficient oil pressure, either a shutdown feature built into the governor or an EMDEC sensor will automatically protect the engine by shutting it down. Maximum pressure is determined by the relief valve setting.

PISTON COOLING OIL PRESSURE

Pressure of the piston cooling oil will be governed by oil viscosity, speed of engine, temperature of oil, and wear of pump parts. The pipe plug can be removed from the opening in the pump discharge elbow and a gauge installed to determine the pressure.

MAIN LUBE OIL AND PISTON COOLING OIL MANIFOLD

DESCRIPTION

The main lube oil and piston cooling oil manifold, Figure 9-4. is a one piece casting with cored passages. The manifold is mounted and doweled in the front end plate, under the accessory drive cover. Connecting tubes passing through the accessory drive cover, sealed by "O" rings, connect the manifold to a discharge elbow (on 8, 12, and 16-cylinder engines) or "Y" branch manifold (on 20-cylinder engines).

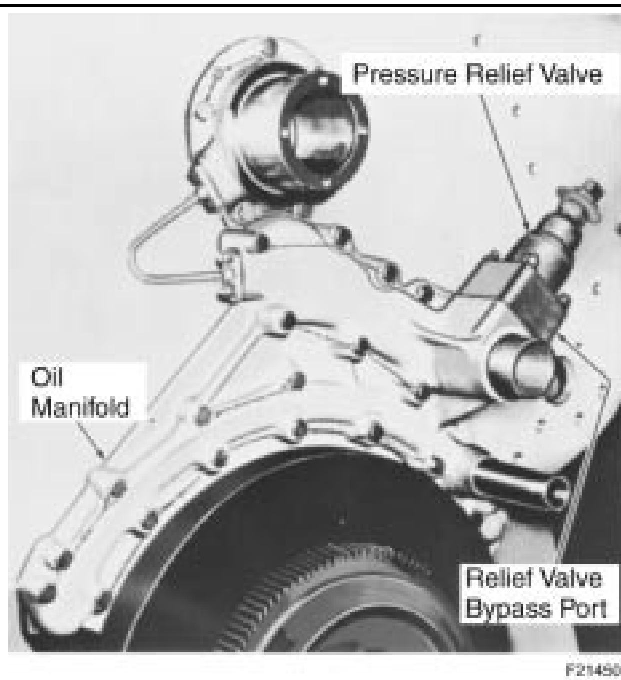


Figure 9-4. Lube Oil Manifold And Relief Valve .

The purpose of the manifold is to transfer the oil supplied by the pump(s) to the main bearing oil header in the center of the engine. The manifold also transfers oil to the piston cooling oil header pipes on each side of the crankcase, just inside the oil pan mounting flange.

LUBE OIL PRESSURE RELIEF VALVE

DESCRIPTION

The lube oil pressure relief valve, Figure 9-5., on page 9-8, is installed on the lube oil manifold, inside the accessory gear train housing on the left side of the engine, Fig. 9-1. Access for valve inspection and adjustment is provided by removal of the engine protector.

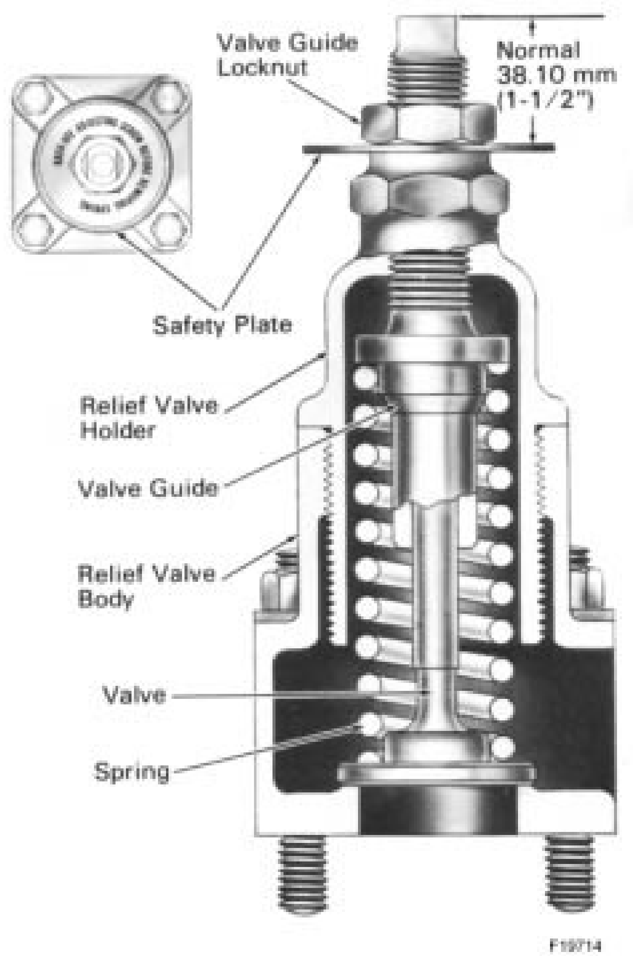


Figure 9-5. Lube Oil Pressure Relief Valve .

The purpose of the valve is to limit the maximum pressure of the lube oil entering the engine oil system. When the lube oil pump pressure exceeds the spring tension on the valve, the valve will be lifted off its seat and relieve the excess pressure. This oil drains into the accessory housing and then into the oil pan.

MAINTENANCE

The oil pressure relief valve should be removed and the parts inspected as specified in the Scheduled Maintenance Program.

Disassemble the valve and wash all the parts thoroughly. As stated on the safety plate on the valve, back off the valve guide all the way before removing the valve holder and spring.

Inspect the parts as follows to determine their condition for reuse:

VALVE SPRING

Check the valve spring for any nicks which could cause subsequent spring failure.

Test the valve spring by applying a load of 141 kg (310 lbs). Under this load, the spring length should not be less than 114.30 mm (4-1/2").

VALVE GUIDE

Using a telescoping gauge, check the valve guide inside diameter.

If the inside diameter is rough or lightly scuffed, clean up the bore but do not exceed the maximum diameter.

VALVE

Examine the valve stem for roughness and light scuffing. The stem may be hand-stoned and buffed to remove high spots. Replace the valve if the stem is badly galled.

Check that the outside diameter of the valve stem is not less than the minimum limit.

Also, check for a possible bent valve or distorted face by checking the squareness of the valve face to the stem, measuring from the outer edge of the valve face. Total indicator reading should be as specified.

INSTALLATION

When installing relief valve on engine, make sure that the bypass port is positioned in the downward direction, Figure 9-4., on page 9-7.

SETTING OIL PRESSURE RELIEF VALVE

The setting of the oil pressure relief valve, connected to the lube oil manifold, determines the maximum oil pressure at the main lube oil pump. It is not set by pressure gauges, but by a specific dimension from the top of the valve guide to the top of the valve holder.

To set valve, loosen the locknut, Figure 9-5., on page 9-8, and position the valve guide so that it extends 38.10 mm (1-1/2") above the safety plate.

This setting will permit a maximum oil pressure of about 862 kPa (125 psi) under cold oil conditions, and allow an adequate pressure for normal operation and hot oil.

Lubricating oil manifold pressure or pressure at the valve can be determined by applying a pressure gauge at the main lube oil pump discharge elbow.

PISTON COOLING OIL PIPE

DESCRIPTION

The piston cooling oil pipe is bolted at one end to a flange on the piston cooling oil manifold, and at the other end to the bottom of the cylinder liner.

A pipe is located at each cylinder to direct a stream of oil through the piston carrier to the undercrown of the piston. Alignment of the piston cooling oil pipe is very important.

MAINTENANCE

Unlike previous EMD engines, the alignment of the piston cooling oil pipe to the inlet hole in the piston carrier on 710G3B engines does NOT require the use of an alignment gauge as the oil pipe nozzle itself extends into the carrier at bottom dead center, as shown in Figure 9-6., on page 9-10.

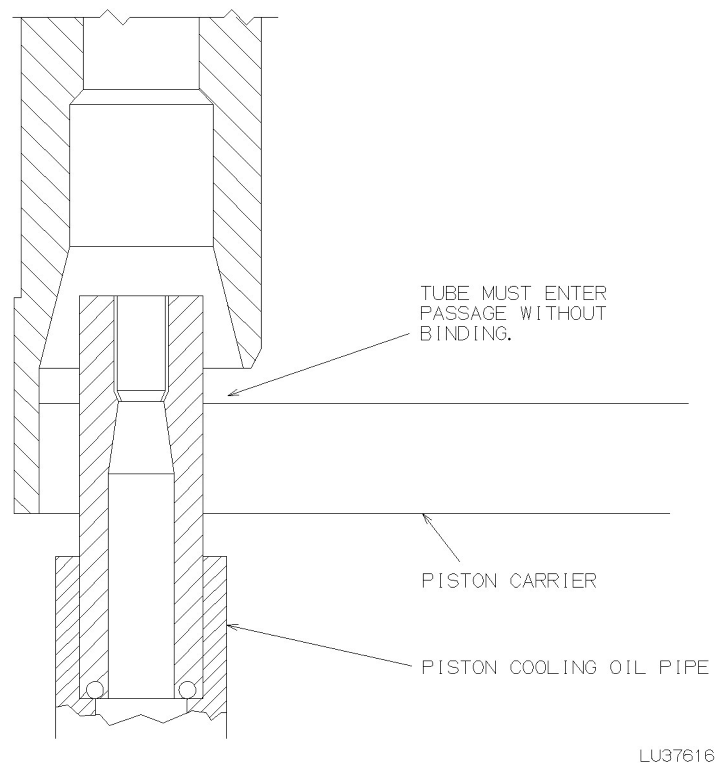


Figure 9-6. Piston Cooling Oil Pipe Alignment .

A visual inspection can be done by bringing the piston to bottom dead center. The nozzle of the oil pipe should enter the inlet hole in the piston carrier without binding in this position. If an interference exists, the pipe should be removed and replaced with a new or correctly aligned one.

In addition to the alignment check, the piston cooling pipe nozzle should be examined for ragged edges which might cause the oil to spray out instead of shoot out in a stream.

CAUTION CAUTION

On 8, 12, and 16-cylinder engines, the piston cooling section of main lube oil pump has

been modified for use with the new piston cooling oil pipe used on 710G3B engines. Care must be used during any service of the oil pumps or piston cooling oil pipes on 710G3B engines to ensure that there is no intermix of parts with other EMD engine models. Do NOT apply any of the older type piston cooling oil pipes to 710G3B EMD engines. Do NOT apply any of the 710G3B main lube oil and piston cooling oil pump

CHECKING OIL VISCOSITY

Oil viscosity should be checked on a routine basis to monitor the suitability of the oil for continued use. By comparing the viscosity at different intervals taken at the same temperature, excessive dilution may be detected by an unusual drop in viscosity. Excessive oxidation of the oil may be detected by an unusual rise in viscosity within the recommended oil drain periods. The viscosity limits are directly related to the type of oil being used and the type of viscosity measurements being made. The oil suppliers will furnish these values, which should correspond to a maximum of 5% fuel dilution and a 35% viscosity rise.

Operating an engine with badly oxidized oil or poor oil filtration will result in oil cooler core plugging, carbon buildup on piston undercrowns, ring grooves, oil rings, and piston pin bearing grooves, and limitation of oil flow to the main and connecting rod bearings and subsequent engine damage.

To provide protection to the engine, the oil and system components should be carefully observed for proper functioning and corrective measures taken where necessary. Oil and filter change periods should be followed closely since the oil is not only oxidizing, but contaminants are coming into the engine from fuel combustion, as well as the normal airborne contaminants which are not caught by the air filters. It is therefore beneficial to drain the oil and eliminate these contaminants.

CHANGING OIL

Engine lube oil should be drained periodically, filters replaced, and strainers and/or screens cleaned as outlined in the Scheduled Maintenance Program. Before the oil is drained, its viscosity should be checked for any indication of fuel dilution. If fuel leakage is indicated, the leak should be corrected before charging the engine with new oil.

GENERAL PROCEDURE

1. Shut down the engine.
2. On engines provided with an engine mounted box style oil strainer housing, open drain valve in housing to drain oil into the engine sump.
3. Provide a container or oil runoff line for drained oil.
4. Remove pipe plug from oil drain valve and open valve to drain all the oil from the engine oil pan sump.

5. Remove pump strainer(s) from strainer housing, and remove the oil filters from the filter housing(s).

6. Clean the strainers using a suitable cleaner, and rinse thoroughly.

7. Wash down top deck, oil pan, and filter housings using fuel oil or kerosene. Drain off cleaning fluid and wipe areas free of excess fluid, using bound edge absorbent towels.

8. Replace pipe plugs in drain lines, where required, and close valve. Where neces- sary, renew gaskets.

9. Install clean strainers and/or screens. Install new elements in filter housing(s). Prepare system to receive new oil.

10. Recharge engine with new lubricating oil qualified for use. On 8, 12, and 16-cylinder engines, add oil through square filler opening in strainer housing box. On 20-cylinder engines, add oil through the capped filler opening on the upper right side of the accessory drive cover. Check engine oil level on the oil gauge.

CAUTION

On 8, 12, and 16-cylinder engines, ensure that strainer housing box internal

drain valves are closed and oil strainer is filled to overflow before starting engine. Sufficient oil will be retained in the housing to supply main lube

11. Pour a liberal quantity of oil over cylinder heads and top deck components before starting.

12. Inspect engine prior to starting, then start engine. Check oil level with engine at idle speed. If oil level is not to "full" mark on gauge, add oil to bring level to "full" mark, with engine at idle speed and with *hot* oil.

NOTE

Under some conditions the oil level may be above the bottom of the oil pan hand-

OIL STRAINER HOUSING

DESCRIPTION

8, 12, and 16-Cylinder Engines

The oil strainer housing used on 8, 12, and 16-cylinder engines, shown in Figure 9-7, page 9-13, is a large box-shaped cast aluminum housing which is mounted on the right front side of the engine on the accessory drive cover. It contains independent strainers for the main oil pump supply and scavenging oil pump. There are two strainers for the main lube pump oil and one strainer screen for scavenging pump oil, with a separate oil inlet and discharge for each of the systems.

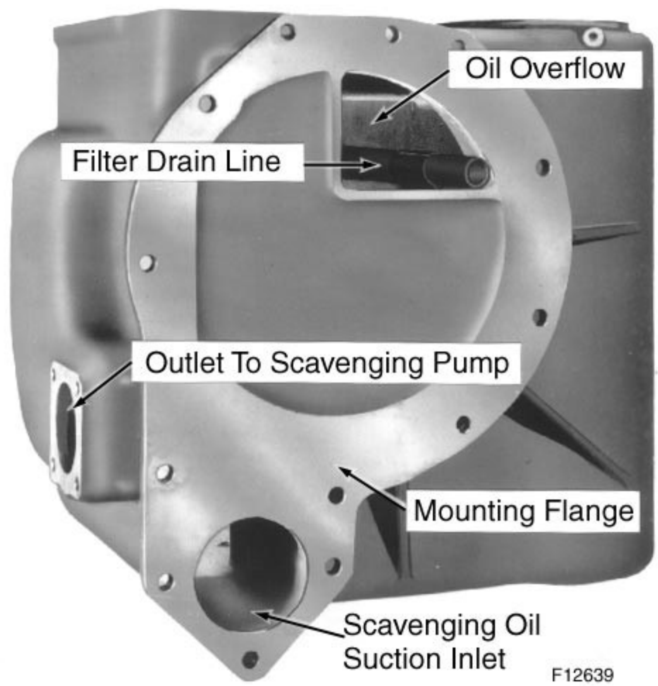


Figure 9-7. Oil Strainer Housing (8, 12, and 16-Cylinder Engines).

The two main lube oil pump strainers, Figure 9-8., on page 9-14, each consists of a replaceable element of a pleated perforated metal core covered with mesh screening, and a metal cylinder which encloses the element. The cylinder prevents collapse of the element in the event of a high pressure drop. The element is attached to the cylinder by a through bolt in the cylinder which runs through the base of the element and is secured with a locknut. The unperforated outer cylinder provides a constant head of oil since suction is from the bottom only and not through the entire length of the screen.

The flow of oil is from the bottom of the strainer between the cylinder and the mesh screen, through the mesh screen and the perforated metal core into the center of the element, then out the top of the strainer. When in place, they are held by a crab and handwheel on the stud between the holes. Each strainer is sealed at the top by a seal ring. Also, oil under pump pressure is admitted to a groove around each strainer, just below the seal, to prevent air entry in event of a leaky seal. A partition adjacent to the strainers, open at the bottom, separates them from the oil inlet area of the housing. Oil enters the strainers at the partition bottom and is taken up by the pump through a cast passage in the housing.

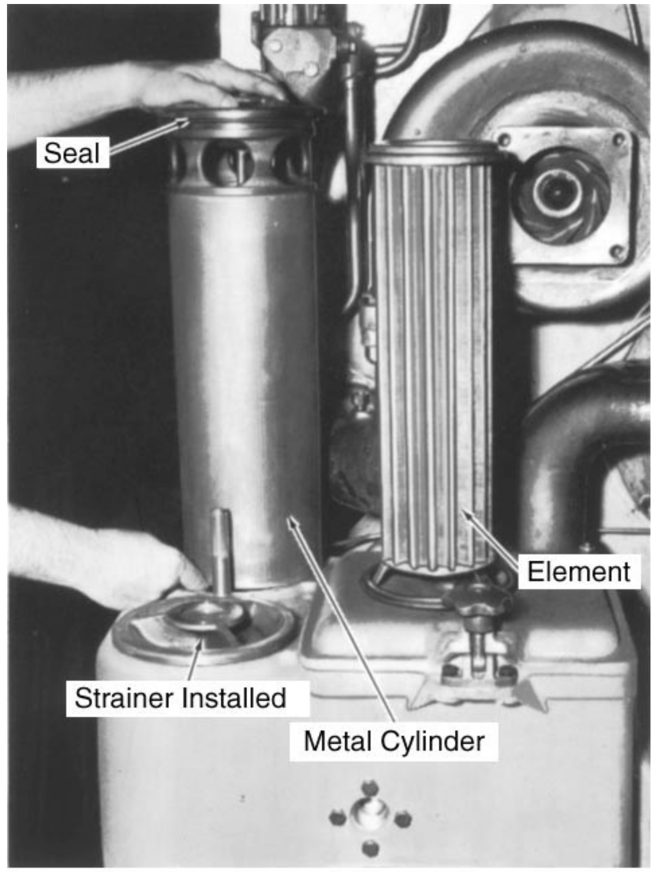


Figure 9-8. Main & Piston Cooling Oil Pump Strainers (8, 12, and 16-Cylinder Engines).

The scavenging oil pump strainer, Figure 9-9., on page 9-15, has a rigid perforated metal screen which retains its shape and is easily cleaned. When the strainer is installed in the housing, it is held in position with three nuts. Two handwheels on swivel bolts secure a cover over the strainer and drain valves. The scavenging oil strainer inlet and outlet openings are shown in Figure 9-7., on page 9-13.

An oil level is maintained in the strainer housing up to the bottom of the overflow opening Figure 9-7., on page 9-13. Excess oil returns to the oil pan sump. A spring-loaded valve, Figure 9-10., on page 9-16, is provided to drain the oil from the strainer housing into the oil pan sump, at the time of an oil change. An additional valve, Figure 9-10, is used to drain the oil filter housing. Both valves are located under the filler cover and must be kept closed at all times except for during the period of draining.

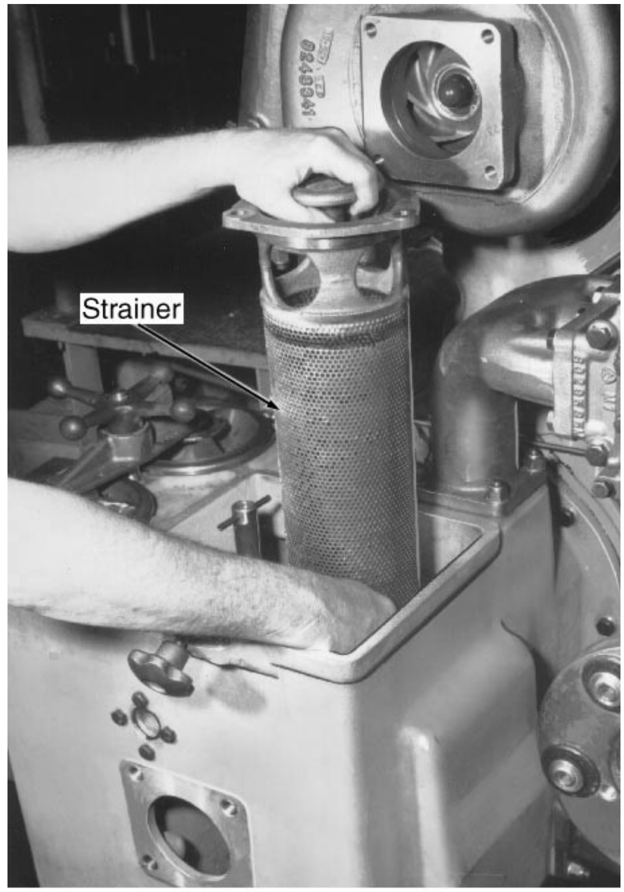


Figure 9-9. Scavenging Oil Pump Strainer (8, 12, and 16-Cylinder Engines).

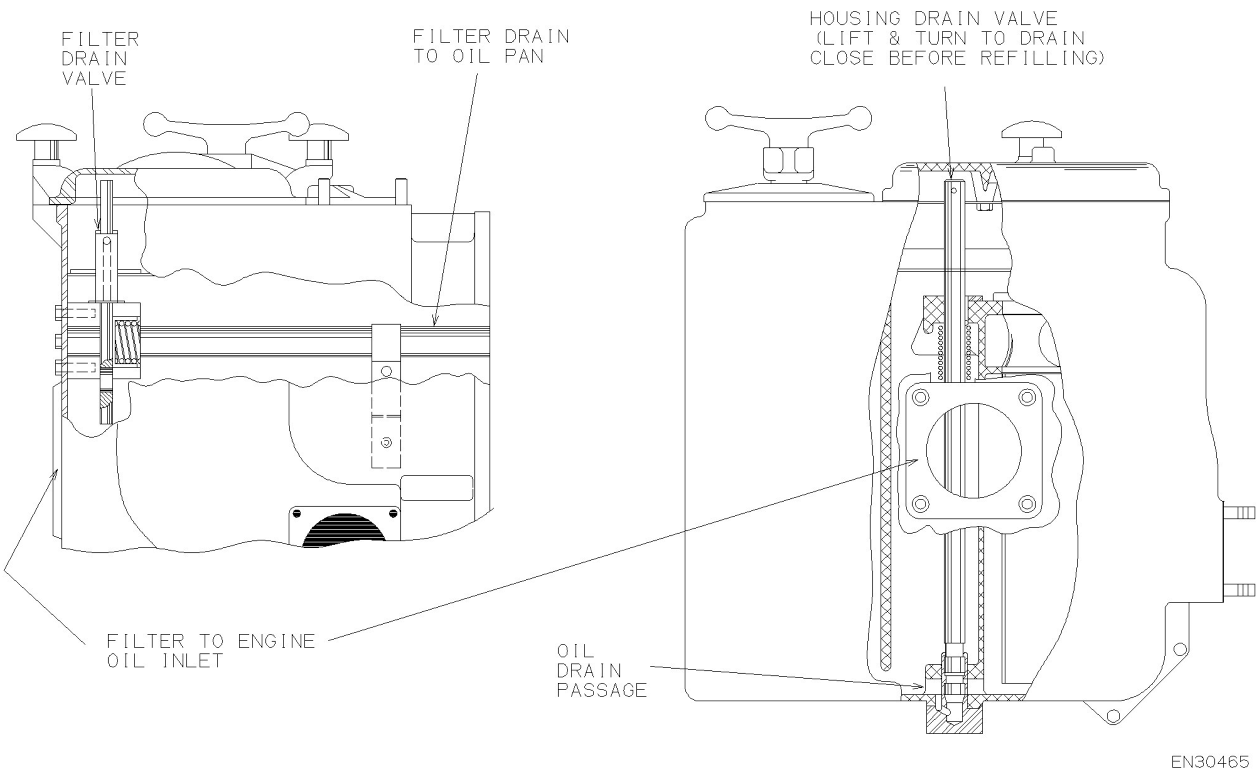


Figure 9-10. Strainer Housing Drain Valves (8, 12, and 16-Cylinder Engines).

20-Cylinder Engines

The oil strainer housing used on 20-cylinder engines, shown in Figure 9-11, page 9-17, is a cylindrical shaped cast iron housing which mounts between the oil pump and supply elbow on the right front side of the engine on the accessory drive cover. It contains a single "in-line" strainer for the oil pump supply.

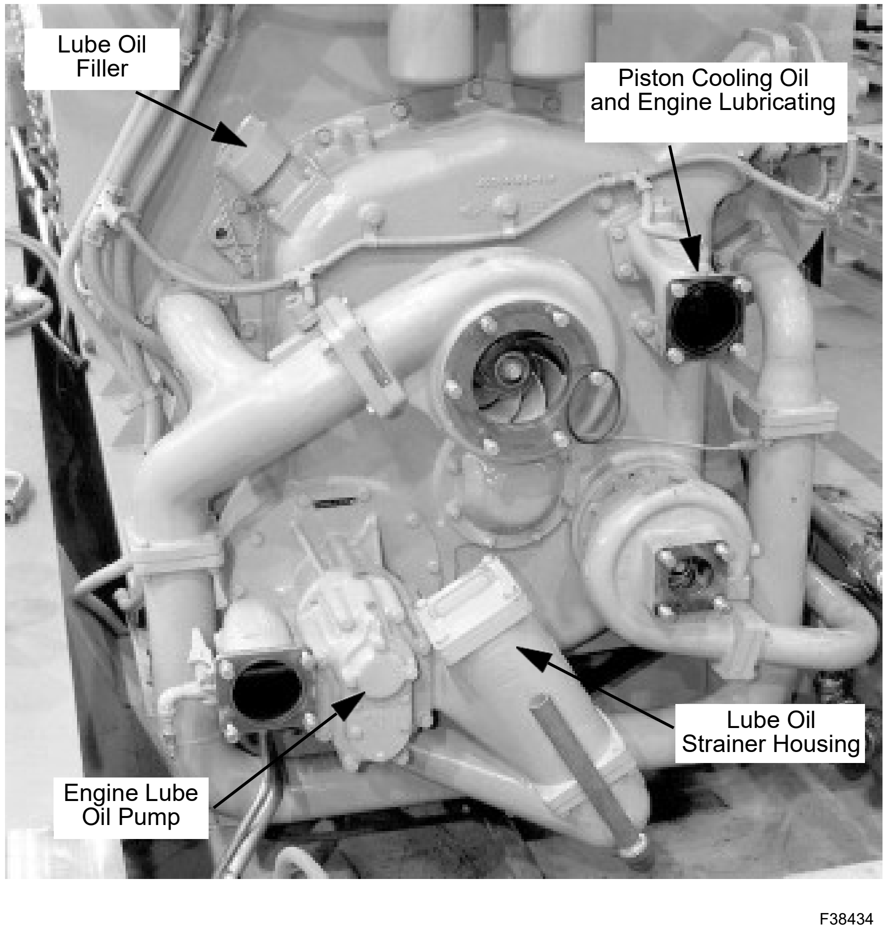


Figure 9-11. Oil Strainer Housing (20-Cylinder Engines).

MAINTENANCE

All lube oil strainers should be removed at each oil change, and strainers and housings thoroughly cleaned using a petroleum solvent.

As previously described, the engine lube oil strainers used in the strainer housing box of 8, 12, and 16-cylinder engines have a seal of oil under pressure in addition to the seal rings. The oil under pressure will leak out under the strainer flanges if the seal rings are not seated properly or are damaged. When strainers are replaced, care should be taken to see that the sealing surfaces are free from nicks and scratches and seal rings are in good condition. Also, ensure that the oil passages to the seals are open and clear.

The pressure oil seal may be checked, with the engine at idle speed, by loosening the large handwheel until the seal ring of the strainer furthest from the engine is free of the housing. Oil should leak out around the strainer flange. If no oil appears, the engine should be shut down and the oil supply passages inspected and cleaned.

Any air which might enter system at this location will be discharged with the lubricating oil and may cause damage, even though normal oil pressure is indicated.

When replacing the scavenging strainer, be sure the strainer is seated properly or the scavenging pump will lose suction causing a loss of lube oil pressure.

LUBE OIL SEPARATOR

DESCRIPTION

The oil separator, Figure 9-12, is an elbow-shaped housing containing a securely held wire mesh screen element. It is mounted on the turbocharger housing. An ejector assembly, mounted on the separator cover, is connected to the inner and outer eductor tubes in the exhaust stack by a flanged pipe elbow and flexible tube assembly.

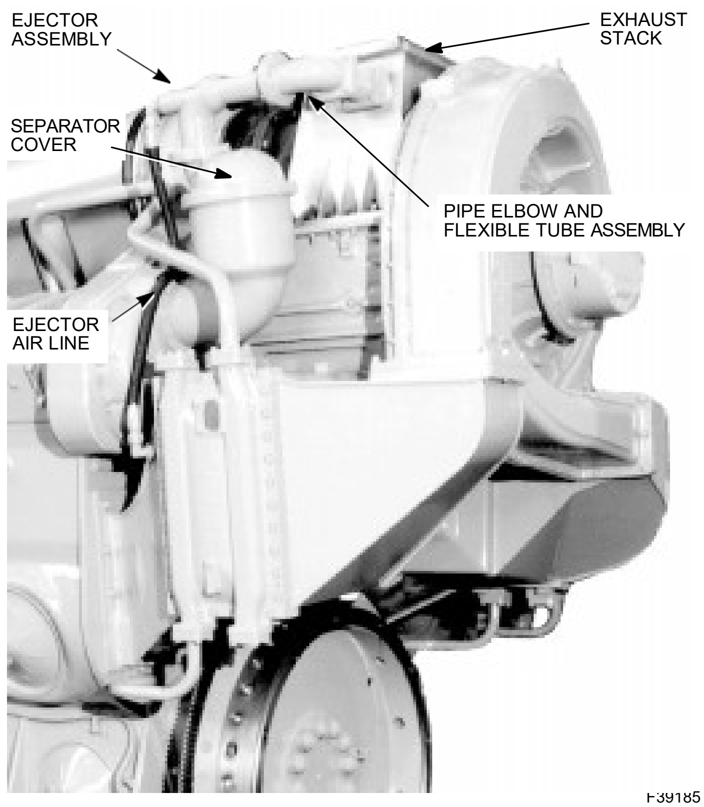


Figure 9-12. Typical Lube Oil Separator .

Air under pressure passing through the ejector assembly creates a suction which draws up engine oil vapors through the screen element. In addition, the eductor tube inserted into the turbine exhaust also creates a suction on the oil vapors. The oil collects on the screen element and drains back into the engine. The remaining gaseous vapor is discharged into the exhaust stack and vented to the atmosphere.

MAINTENANCE

The screen should be removed from the oil separator and cleaned at the interval specified in the Scheduled Maintenance Program.

1. Shut down the engine.
2. Disconnect the flexible air line at the ejector and remove the bolts from the sepa- rator cover.
3. Unbolt the flexible tube and elbow assembly from the exhaust stack. Remove the separator cover, ejector, flexible tube and elbow as an assembly.

4. Remove eductor assembly tubes from the stack.

5. Separate inner eductor tube from outer tube by inserting a screwdriver at the top of the eductor flanges.

NOTE

With exhaust stack connected to the silencer, viewing down the stack to inspect the

turbocharger diffuser is prevented. This inspection can be performed instead by

6. Clean carbon deposits from the inside and outside of both eductor tubes.

7. Remove screen element from separator cover and wash in petroleum solvent. Rinse element in hot water and blow dry with compressed air.

8. Insert inner tube into outer tube with hole in inner tube flange aligned with pin in outer tube flange.

9. Place eductor assembly into stack with the word TOP, stamped on the inner tube flange, facing upward.

10. Replace the element and cover, ejector, flexible tube and elbow assembly.

11. Connect the flexible air line to the ejector.

For lube oil separator to operate properly, crankcase suction needs to be in a range of from 50.8 mm (2") H_2O to 203 mm (8") H_2O. If crankcase suction falls outside of this range after engine maintenance work, a thorough engine inspection should be performed to determine the cause. If no obvious cause is found, crankcase suction can be brought back into range by substituting a different size air ejector nozzle. See Service Data for listing of available nozzles.

Crankcase suction can be measured by connecting a U-tube manometer to an oil dip-stick tube. Measurement should be taken at full load and speed, preferably after at least one hour of running time as crankcase suction tends to decrease as the engine temperature increases.

MAIN LUBE OIL AND PISTON COOLING OIL PUMPS

DESCRIPTION

The main lube oil and piston cooling oil pumps, Figure 9-13, are contained in one housing.

On 8, 12, and 16-cylinder engines, the two pumps are separated by a spacer plate between the sections of the pump body. Each has its individual oil inlet and discharge opening. The piston cooling pump gears at the end are narrower than the lube oil pump gears. This lube oil and piston cooling oil pump assembly is mounted in the center of the accessory drive housing and is driven by the accessory drive gear.

On 20-cylinder engines, the two sections of the pump perform the combined functions of the main lube oil, piston cooling, and scavenging oil pumps. No spacer plate is used between the sections and the divided inlet and outlet openings connect to common "Y"-branch suction and discharge manifolds. This pump assembly mounts on the lower right side of the accessory drive housing and is driven by the accessory drive gear.

CAUTION

On 8, 12, and 16-cylinder engines, the piston cooling pump section of this assembly has been modified for use with a new piston cooling oil pipe used on 710G3B engines. Care must be used during any service or rebuild of these pumps to ensure that there is no intermix of parts with other EMD engine model oil pumps. Do NOT apply any of the

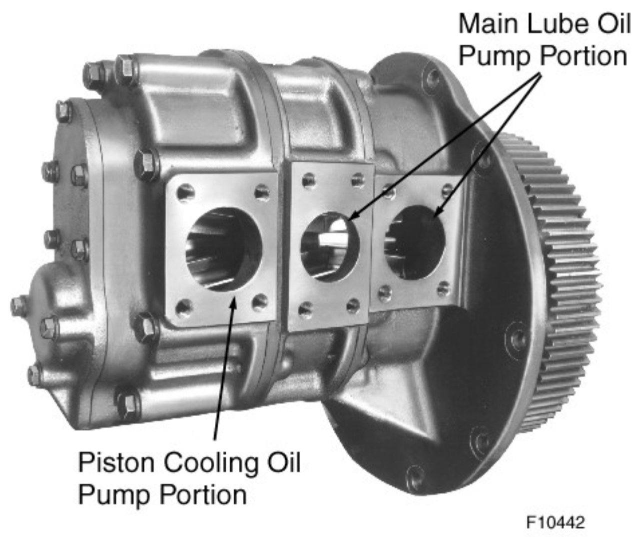


Figure 9-13. Main Lube Oil And Piston Cooling Oil Pumps. (12-Cyl. Shown)

MAINTENANCE

NOTE

In the following "Disassembly" and "Assembly" procedures, disregard references to "center body" for 8, 16 and 20-cylinder engines. Also, disregard "center gear"

DISASSEMBLY

1. Clean the pump externally before disassembly.
2. Hold the pump in a suitable vise.

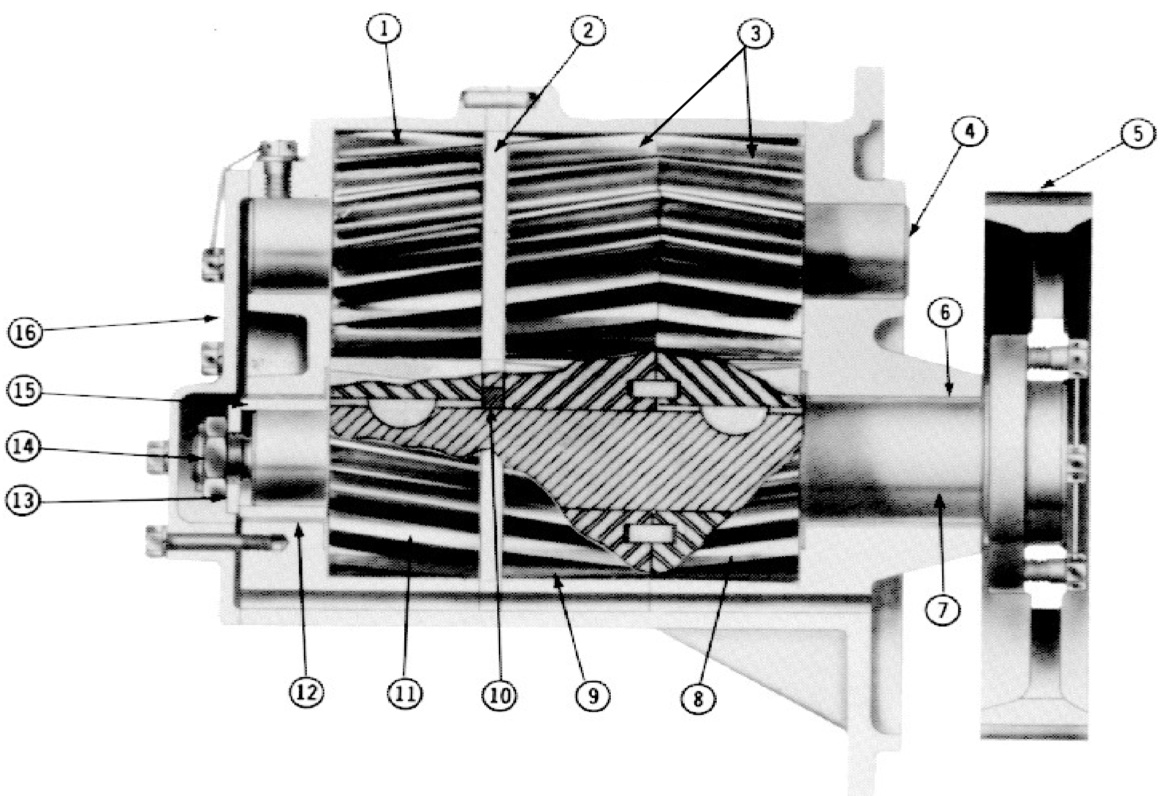
   As a safety precaution, provide an additional support at the center of the pump until the front body, bushing and piston cooling pump gears are removed.
3. Remove the long bolts holding the front body to the rear body.
4. Using a rawhide mallet, tap the front body at the inlet and outlet openings to remove the front body, cover, idler shaft, and outer driven gear as an assembly, Figure 9-14., on page 9-21.
5. Remove the drive shaft nut, and washer.
6. Support pump on its flange, pump drive gear down, so that gear is free to move downward.

7. Apply pressure to shoulder to drive shaft and press the shaft down a maximum of 12.7 mm (1/2").

CAUTION

If shaft is pressed down too far, the piston cooling pump gear key will shear

8. Manually raise pump drive gear and drive shaft until a 12.7 mm (1/2") clearance is obtained between the drive shaft sleeve and the piston cooling pump drive gear.
9. Attach a puller to the drive shaft sleeve and remove sleeve from the drive shaft.
10. Remove the piston cooling pump drive gear and its key.
11. Remove the spacer plate and collar.
12. Remove the lube oil pump center driven gear and drive gear assembly.
13. Using a rawhide mallet, remove the center body portion of the pump.



1. Piston Cooling Driven Gear
2. Spacer Plate
3. Lube Oil Pump Driven Gears
4. Idler Shaft
5. Drive Gear
6. Inner Bushing
7. Drive Shaft
8. Lube Oil Pump Drive Gear
9. Lube Oil Pump Drive Gear Assy.
10. Collar
11. Piston Cooling Drive Gear
12. Front Bushing
13. Washer
14. Shaft Nut
15. Shaft Sleeve
16. Cover

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Figure 9-14. Typical Main Lube Oil And Piston Cooling Oil Pump, Cross-Section (16-Cylinder Engine Shown.)

14. Remove the lube oil pump inner driven gear, drive gear, and key.
15. The pump drive gear and shaft assembly is then removed.

NOTE

Pump drive gear and shaft assembly should not be separated unless gear is being replaced or is required for use as a "dummy" gear during backlash

16. Keep all parts of the one pump assembly together. See note on page 9-20 regard- ing 710G3B oil pumps.

CLEANING

Clean all the individual parts of the pump using a petroleum solvent. After cleaning, dry the parts with compressed air.

INSPECTION

PUMP BODIES:

1. Check the surface of the pump bodies for nicks, dents or scratches which may have protrusions above the normal surface. Smooth down any evidence of rough- ness.
2. Inspect the drive shaft bushings for imbedded dirt, metallic particles, flaking or pitting.

   Bushings with light scratches and small quantities of imbedded dirt may be reused after smoothing up, provided bore sizes are within the maximum limits.
3. Replace the bushings if any other adverse conditions exist. Details of construc- tion and application of bushing installation and removal tools are shown in Fig- ure 9-15., on page 9-23.
4. Using fine abrasive cloth on a smooth surfaced tool, clean off the gasket face of the pump bodies.

SPACER (Where Used):

Inspect the sides of the spacer for smoothness. If necessary, smooth the sides using fine abrasive cloth held flat on a flat surfaced tool.

GEARS:

1. Inspect the gear teeth for nicks, pitting, and excessive wear. Light nicks are per- missible provided they are blended by filing and stoning.
2. Gears having tooth faces pitted in excess of 30% of tooth contact area should not be reused.
3. Inspect the driven gear bushing inside diameter for wear and possible damage.
4. Driven gear bushing installation and removal tool construction and application is shown in Figure 9-16., on page 9-24 .
5. Inspect the keyways in the drive gears for any damage which would interfere with the key application.
6. The drive shaft gear may be magnaflux inspected.

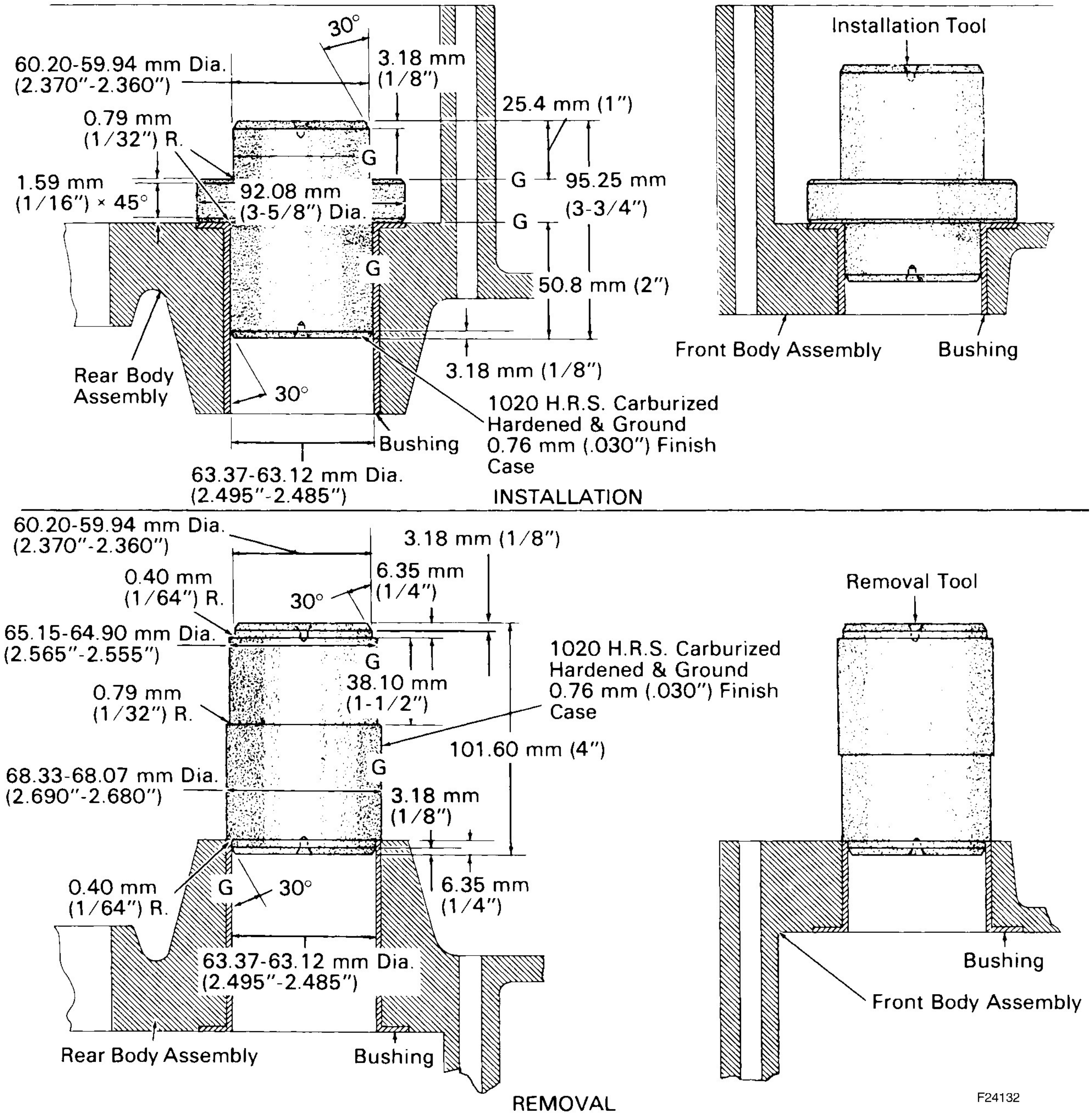

Figure 9-15. Oil Pump Body Bushing Tools

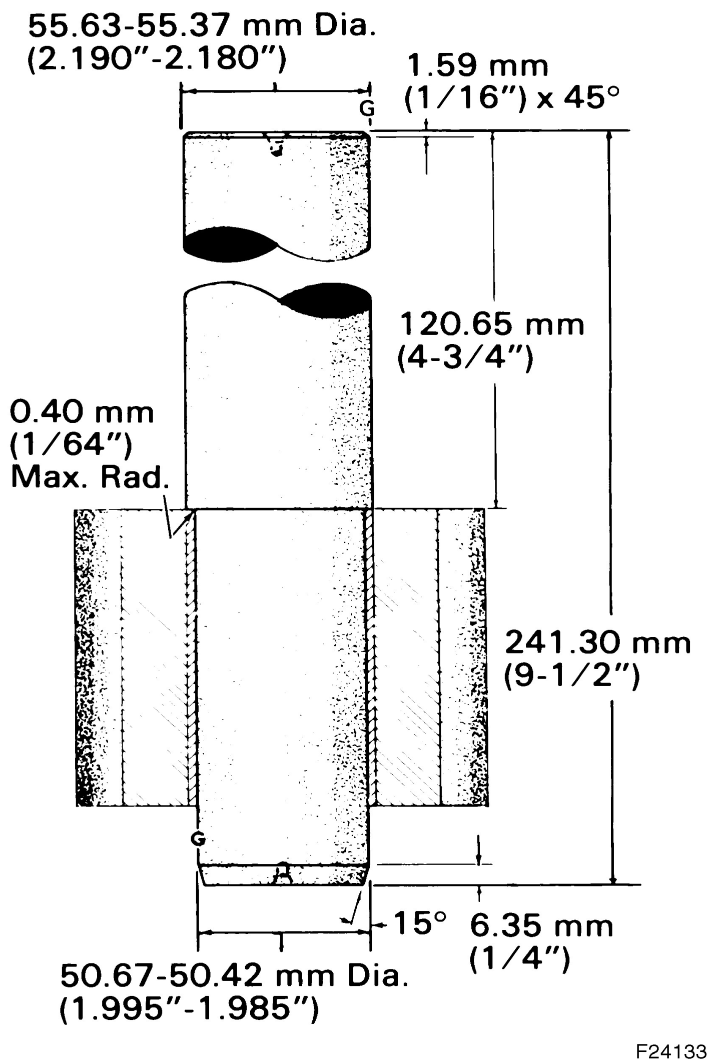

Figure 9-16. Oil Pump Driven Gear Bushing Tool .

DRIVE SHAFT KEYS, AND IDLER SHAFT:

1. Inspect the shafts for any roughness. Check the drive shaft keyways and key fit, making sure the keys fit snugly in the shaft.
2. Check the drive shaft diameter to determine whether the drive shaft to body bushing clearance is within maximum limits.
3. Also, check the idler shaft to make certain that the shaft to bushing clearance is within maximum limits.

ASSEMBLY

1. Place the mounting flange of the cleaned and inspected rear body, Figure 9-14., on page 9-21 , in the bench vise with the drive shaft bore facing up.

> **NOTE**
>
> If pump drive gear was removed from pump, reapply gear on drive shaft
>
> using four 1/2"-20 bolts. Apply thread lubricant to bolt threads and torque

2. With the pump drive gear applied to the drive shaft, lightly oil the shaft journal and insert the shaft in the rear body bushing.
3. Place the inner drive gear key in the drive shaft and install the inner drive gear on the shaft with the dowel holes in the gear facing toward the front of the pump.

> **NOTE**
>
> Refer to the Service Data for diagram of helix angle position of abutting

4. After oiling the bushing, apply the mating driven gear, meshing it with the drive gear.
5. Oil the pump rear body to center body gasket and apply it to the gasket face of the rear body, being careful to align the bolt and dowel holes.
6. Apply the center body to the rear body.
7. Apply center drive gear assembly to drive shaft with dowels aligned with holes in rear drive gear. Slide center gear toward rear of pump until dowels and dowel holes are fully mated.
8. Install center driven gear to mate with center drive gear assembly.
9. Oil the front body gasket and apply to the center body.
10. Apply the spacer plate to the center body and install the collar on the drive shaft.
11. Install the piston cooling drive gear key in the drive shaft and apply the drive gear.

> **NOTE**
>
> The use of the cleaner activator and sealing compound, as described in the

12. Make sure that sleeve and drive shaft are free of dirt, oil, and grease. Spray cleaner activator on the I.D. of the sleeve and the O.D. of the shaft, and wipe off.
13. Re-spray sleeve and shaft and allow to dry for about 10 minutes. Do “not” wipe off.
14. Coat entire surface of shaft, which is covered by the sleeve, by applying sealing compound in small amounts.

15. Apply sleeve and wipe off excess compound at each end of sleeve. Apply heavy duty washer and nut. Tighten nut to 441-475 N·m (325-350 ft-lbs). torque.

> **NOTE**
>
> Sealing compound sets quickly so that delay in torquing nut could result in

16. Check that all excess compound is removed before proceeding with assembly.

17. Oil the spacer plate gasket and apply to the spacer.

18. Completely coat the bushing in the front body with oil.

19. Apply the piston cooling pump driven gear to the idler shaft which was left assembled to the front pump body and cover, and apply this assembly to the pump. If the front body, cover, and idler shaft were disassembled, apply these parts individually using a new oiled gasket between the cover and the front body.

20. Complete assembly of the pump by installing the long bolts through the cover. Torque to specified value.

21. If possible, allow pump to remain unused for approximately 24 hours after torquing to ensure sleeve-to-shaft retention.

ASSEMBLY INSPECTION

1. After pump assembly, rotate the pump drive gear to check for gear noise or tight assembly.

2. Check the total thrust of the drive gears. This may be done by securing an indica- tor on the pump flange with the indicator button contacting the rim of the pump drive gear, Figure 9-17., on page 9-27. Push the drive gear inward so that all clearance is located at one end, then set the indicator to zero. Pull the drive gear outward to determine the amount of thrust clearance. Clearance

> **CAUTION**
>
> Excessive thrust clearance (exceeding maximum limit), can cause the roll

should bewithin specified limits.

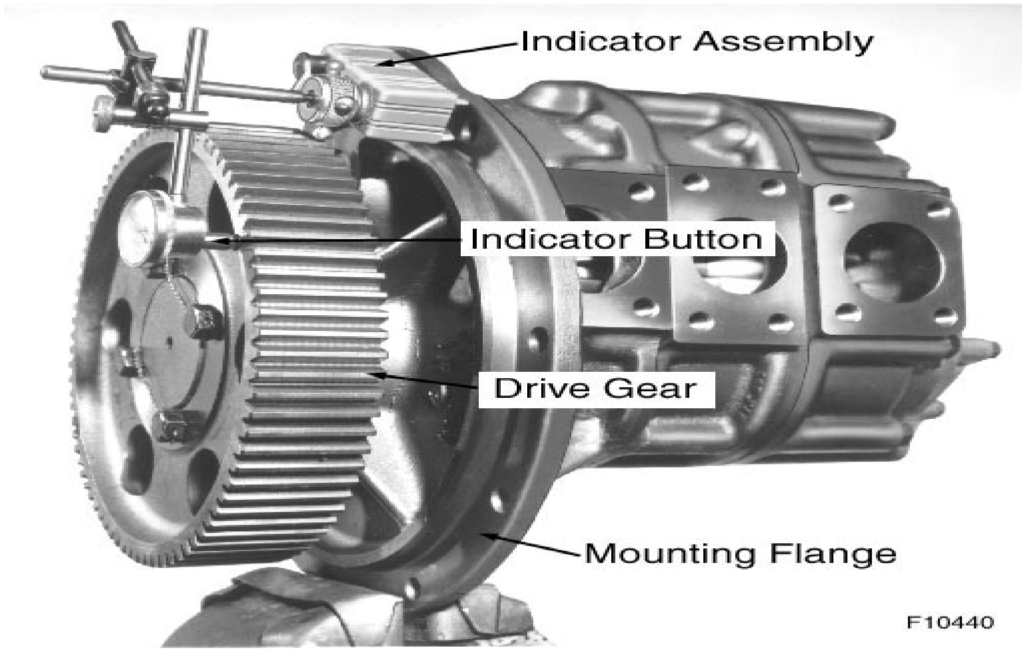

Figure 9-17. Checking Pump Drive Gear End Thrust .

3. Leaving the indicator button on the outside pump drive gear rim, rotate the drive gear to check the gear runout. Drive gear runout should not exceed specified total indicator reading, with thrust in one direction.

4. Check the pump flange runout. Mount the indicator clamp on the drive gear and place the indicator button in contact with the pump flange. Set the indicator to zero, and with the thrust held in one direction, rotate the drive gear. The runout of the pump flange face should not exceed specified total indicator reading.

5. Check the pump gears to body radial clearance. Clearance should be within the specified limits.

6. Additional clearances and limits are listed in the Service Data at the end of the section. Some clearances must be obtained by comparing the individual mating parts, or by assembly and disassembly using lead wire or other suitable means to obtain the part to part clearance.

7. After pump inspection, seal off the pump body openings, and provide protection for teeth of the drive gear.

SCAVENGING OIL PUMP (8, 12, and 16-Cylinder Engines)

DESCRIPTION

The scavenging oil pump, Figure 9-18., on page 9-28, is a positive displacement, helical gear type pump. The pump body, split transversely for ease of maintenance, contains sets of mated pumping gears. The driving gears are retained on the pump drive gear shaft by keys. The idler shaft is held stationary in the housing by a set screw, and the driven pump gears rotate on this shaft on bushings pressed into the gear bores. The drive shaft turns in bushings pressed onto the pump body. These bushings are made with thrust collars which protrude slightly above the pump body and absorb the thrust of the drive gears. The scavenging pump is mounted on the accessory housing in line with and to the left of the crankshaft, and is driven by the accessory drive gear.

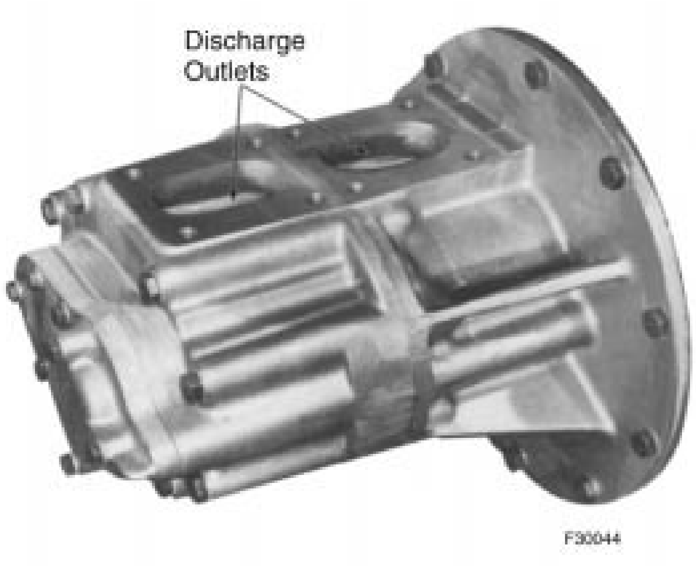

Figure 9-18. Typical Scavenging Oil Pump. (16-Cylinder Engine.)

MAINTENANCE

NOTE

In the following “Disassembly” and “Assembly” procedure, disregard references to “center body” for 8 & 16-cylinder engines. Also, disregard “center gear” for 8-cyl-

Construction and maintenances of the scavenging oil pump is similar to the main lube oil and piston cooling oil pump, except for the use of the spacer in some of the main lube oil pumps.

DISASSEMBLY

1. Clean the external surfaces of the pump before disassembly.
2. Hold the pump in a suitable vise. As a safety precaution, provide additional sup- port until the rear body is removed.
3. Remove the long bolts holding the pump bodies together.
4. Using a rawhide mallet, tap the front body at the oil inlet and outlet openings to remove the front body, idler shaft, and cover as an assembly.
5. Remove the drive shaft nut, washer, and sleeve from the drive shaft.
6. Remove the outer drive gear, key, and driven gear.
7. Remove the center body.
8. Remove the center drive gear, key, and the mating driven gear.

9. Remove the rear drive gear, key, and driven gear.
10. Remove the pump drive gear and shaft as an assembly from the rear pump body.
11. Keep all parts of the same pump together.

CLEANING

Clean all the individual parts of the pump using a petroleum solvent and rinse in hot water. Dry the parts, using compressed air.

INSPECTION

Refer to the corresponding procedures in the preceding "Main Lube Oil And Piston Cooling Oil Pumps" coverage. Also, refer to the Service Data at the end of the section. Check condition of star tolerance rings installed in counterbores of front body to dampen body bolt vibrations. If no signs of distress are apparent, rings may be reused when reassembling pump.

ASSEMBLY

1. Place the cleaned and inspected rear body in the vise with the drive shaft bore facing up.
2. Oil the drive shaft journal sparingly, and apply the pump drive gear and shaft as an assembly to the rear body.
3. Apply the drive gear key to the drive shaft and apply the inner drive gear. Apply the mating driven gear.

> **CAUTION**
>
> Refer to the Service Data for diagram of helix angle position of abutting

4. Fit the center drive gear key to the shaft.
5. Oil the body gasket and apply it to the rear body.
6. Apply the center body to the rear body.
7. Install the center drive gear to the drive shaft.
8. Place the center driven gear in the body in mesh with drive gear.
9. Apply an oiled gasket to the face of the center body.
10. Apply the outer drive gear key to the drive shaft and install the outer drive gear.
11. Apply the sleeve, heavy duty washer, and drive shaft nut to the shaft. Tighten nut to 441-475 N·m (325-350 ft-lbs).
12. Since the front body, idler shaft, and cover were left as an assembly, these parts may be applied to the pump together. Check to be certain star tolerance rings are in counterbores of front body, then apply the outer driven gear to the idler shaft and apply this assembly to the pump.
13. Install the long bolts through the cover and tighten securely.

ASSEMBLY INSPECTION

1. After pump assembly, rotate the pump drive gear to check for gear noise or tight assembly.
2. Check the total thrust of the pump drive gears. This is done using the same indi- cator arrangement shown in Figure 9-17., on page 9-27, for the main lube oil pump. Attach the indicator holder to the pump flange with the indicator button contacting the rim of the pump drive gear. Push the drive gear inward to take up all thrust in one direction. Set the indicator button to zero and pull the drive gear outward to determine clearance. Thrust clearance using new parts should be within the specified limits.
3. With the indicator button on the outside of the pump drive gear rim, as when checking thrust clearance, rotate the gear with the thrust held in one direction to check drive gear runout. Drive gear runout should not exceed specified total indi- cator reading.
4. Check the pump flange runout. Mount the indicator clamp on the drive gear and place the indicator button in contact with the pump flange. Set the indicator to zero, and with the thrust held in one direction, rotate the drive gear. The runout of the pump flange face should not exceed specified total indicator reading.
5. Check the pump gears to body radial clearance. Clearance should be within the specified limits.
6. Additional clearances and limits are listed in the Service Data at the end of the section. Some of the clearances must be obtained by comparing the individual mating parts, or by assembly and disassembly using lead wire or other suitable means to obtain the part to part clearance.
7. After pump inspection, seal off the pump body openings and provide protection for the drive gear teeth.

TURBOCHARGER OIL FILTER

DESCRIPTION

The turbocharger oil filter, Figure 9-19., on page 9-31, provides additional protection for the high speed bearings and other lubricated areas of the turbocharger, by filtering the oil just before it is admitted to the turbocharger. Oil enters the filter assembly through a cast manifold and, after passing through the filter element, returns to the upper idler gear stubshaft and into the turbocharger. The filter element is of the disposable (spin-on) type that mounts directly to an adapter on the filter head assembly. The filter assembly is mounted on the camshaft drive housing at the right bank of the engine.

NOTE

If turbocharger oil filter is of the disposable (cartridge) type, element will be of

pleated paper construction and is held in a removable container that mounts to

The filter head contains two check valves, Figure 9-19., on page 9-31, one to prevent lube oil from the soak back system from going into the turbocharger filter during soak back pump operation and the other to prevent lube oil from the turbocharger filter from entering the soak back system when the engine is running.

The turbocharger filter should be serviced as specified in the Scheduled Maintenance Program or more frequently if experience indicates it is necessary.

To replace a "spin-on" filter, unscrew element by hand to disengage it from the filter head adapter and discard. Fill replacement element housing with clean oil and apply a film of oil to the gasket. Apply new filter to adapter and turn by hand until gasket seats, then tighten it another half-turn ONLY

To replace a "cartridge" type filter, loosen the two nuts holding the container to the upper housing until, using the handles on each side of the container, the container can be rotated to disengage from the upper housing. Remove the paper element and dispose of it. Thoroughly clean the container, install a new element, check the seal and replace, if required. Fill the container with clean oil and reassemble to the upper housing. Do not overtighten attaching bolts as the seal may be damaged.

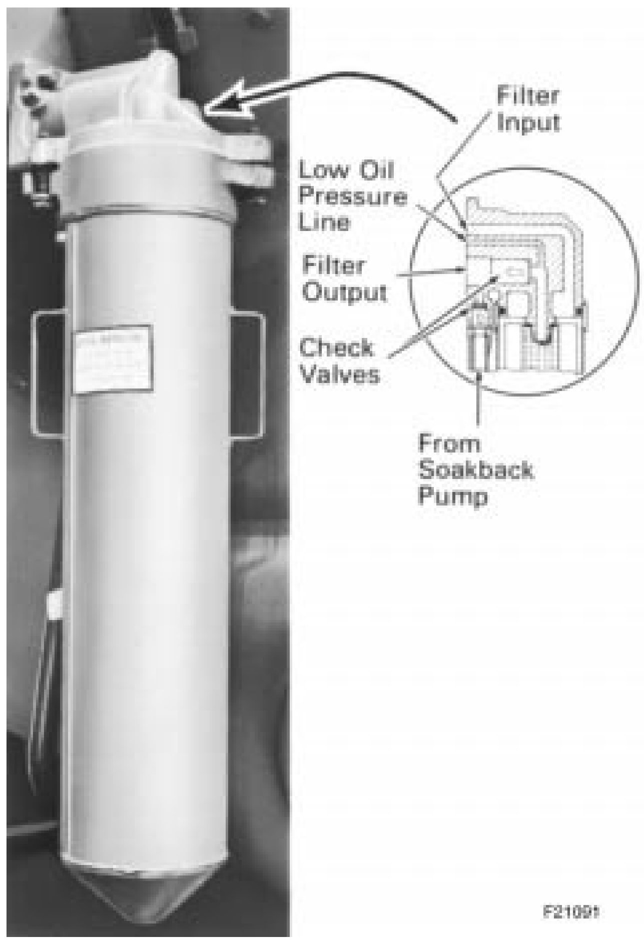

Figure 9-19. Turbocharger Oil Filter Assembly. (Cartridge Type Shown)

NOTE

NOTE

Whenever oil is detected coming from the camshaft bearings with the engine shut down and

SOAK BACK OIL SYSTEM

DESCRIPTION

To ensure lubrication of the turbocharger bearings prior to engine start, and the removal of residual heat from the turbo after engine shutdown, a separate lube oil pressure source is provided. This pressure source is controlled automatically through the engine "start" and "stop" controls.

An AC (or DC) electric motor driven pump draws lube oil from the oil pan, pumps the oil through a soak back filter, Figure 9-20, and the head of the turbocharger oil filter assembly directly into the turbocharger bearing area, Figure 9-1., on page 9-3 or Figure 9-2., on page 9-4. The motor driven soak back pump and filter are mounted on the side of the oil pan, Figure 9-20.

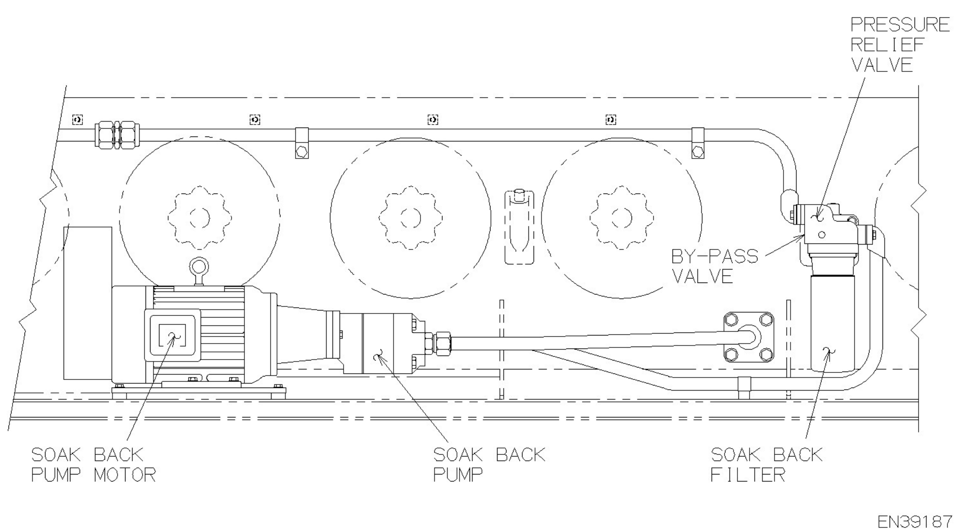

Figure 9-20. Soak Back Oil Pump, Motor, And Filter Installation. (Pump Shown W/ AC Electric Motor)

CAUTION

CAUTION

If the soak back pump should fail to operate when the engine is shut down, restart the engine immediately and allow it to run for 15 minutes at idle speed with no load, to prevent damage to the turbocharger.

If engine is not restarted within two minutes of shutdown, do not restart the

A pressure relief valve, Figure 9-20, set at 221 kPa (32 psi), is located in the head of the soak back filter assembly. When the engine starts, and the motor driven soak back pump is still running, main lube oil pressure from the engine driven pump becomes greater than the motor driven soak back pump pressure. As there is no outlet for the lower pressure oil, the relief valve will open when the pressure builds up to 221 kPa (32 psi), and the oil will return to the engine oil pan through a passage in the filter head mounting flange. Also located in the filter head is a bypass valve, Figure 9-20 , set at 483 kPa (70 psi). This valve will open to permit motor driven soak back pump pressure to bypass a plugged soak back filter element so that lubrication can continue to be supplied to the turbocharger (through the turbocharger filter) in order to prevent turbo damage.

MAINTENANCE

The soak back oil filter element should be serviced as specified in the applicable Scheduled Maintenance Program, or more frequently if experience indicates it to be is necessary.

To remove the element from the soak back filter, Figure 9-20., on page 9-32, remove the two bolts from the top of the filter head and remove the bowl, element, and spring from the upper housing.

PRELUBRICATION OF ENGINES

Prelubrication of a new engine, an engine that has been overhauled, or an engine which has been inoperative for more than 48 hours is a necessary and important practice. Prelubrication alleviates loading of unlubricated engine parts during the interval when the lube oil pump is filling the passages with oil. It also offers protection by giving visual evidence that oil distribution in the engine is satisfactory.

Perform prelubrication as follows:

1. Remove the pipe plug at the main lube oil pump discharge elbow, and connect an external source of clean, warm oil at the discharge elbow. Prelube engine at a minimum of 69 kPa (10 psi) for a period of not less than three and not more than five minutes (approximately 57 lpm [15 gpm] using a 1.1 to 1.5 kW [1-1/2 to 2 hp] motor).

2. While oil pressure is being applied, open the cylinder test valves and bar the engine over one complete revolution. Check all bearings at the crankshaft, cam- shafts, rocker arms, and at the rear gear train for oil flow. Also check for restric- tions and excessive oil flow. If fluid discharge is observed from any cylinder test valve, find the cause and make the necessary repairs.

3. On new or overhauled engines, remove the pipe plug at the piston cooling oil pump discharge elbow and connect the external oil source at that opening. Check for unrestricted oil flow at each piston cooling oil pipe.

4. Disconnect the external oil source and replace the pipe plugs at the pump discharge elbows. Close the cylinder test valves.

5. Pour a liberal quantity of oil over the cylinder (valve) mechanisms of each bank.

6. Check oil level in strainer housing and, if required, add oil to strainer housing until it overflows into the oil pan.

7. Replace and securely close all handhole covers and engine top deck covers.

NOTE

When an engine is replaced due to mechanical breakdown, it is important

that the entire oil system, such as oil coolers, filters, and strainers, be thoroughly cleaned before a replacement engine or the reconditioned engine is put in service. A recurrence of trouble may be experienced in the clean

In some cases engines have been removed from service and stored in the "as is" condition by draining and applying anti-rust compound. When these engines are returned to service, care must be taken to see that any loose deposits are flushed out before adding a new oil charge. The entire engine should be sprayed with fuel to break up any sludge deposits, and then drained, being careful that the drains are not plugged. Fuel should not be sprayed directly on the valve mechanism or bearings, as lubrication will be removed or dirt forced into these areas. The surfaces should then be wiped dry before new oil is added to the engine.

OIL SYSTEM INFORMATION

Additional information on the oil system and components is given in the latest revisions of Maintenance Instruction bulletins. These instructions cover important items such as the Scheduled Maintenance program, which outlines maintenance intervals, and flushing and cleaning information.

Engine lubricating oil should be qualified for use.

SERVICE DATA - LUBRICATING OIL SYSTEM

REFERENCES

Flushing Diesel Engine Lubricating Oil System..M.I. 1757
Lubricating Oil For Domestic Locomotive Engines... M.I. 1752
Lubricating Oil For Export Locomotive Engines .... M.I. 1761

SPECIFICATIONS

Clearance and dimensional limits listed below are defined as follows:

- *Minimum, maximum, and tolerance measurements are provided as service limits for requalified parts. At time of engine overhaul or any time unscheduled maintenance is performed, the service limits should not be exceeded. Engine components within these limits may be reused with the assurance that they will perform satisfactorily until the next scheduled overhaul. These limits are NOT intended to be used as a basis for component change-out on a running engine.*

Lube Oil Pressure Relief Valve

Valve guide inside diameter -Max. .... 12.764 mm (.5025")
Valve stem outside diameter -Max. .... 12.484 mm (.4915")
Valve face to stem squareness
(outer edge of valve face) -T.I.R. Max. .... 0.05 mm (.002")

Oil Pumps

Drive shaft to rear housing bushing clearance -
Min. .... 0.038 mm (.0015")
Max. .... 0.18 mm (.007")

Sleeve to bushing clearance -
Min. .... 0.038 mm (.0015")
Max. .... 0.18 mm (.007")

Idler shaft to gear bushing clearance -
Min. .... 0.038 mm (.0015")
Max. .... 0.18 mm (.007")

Driven gears - total thrust clearance

8 & 12-cyl. (scavenging pump assembled) -
Min. .... 0.41 mm (.016")
Max. .... 0.61 mm (.024")

16-cyl. (scavenging pump assembled) & 20-cyl. (lube oil pump assembled) -
Min. .... 0.41 mm (.016")
Max. .... 0.69 mm (.027")

Driven gears - total thrust clearance

8-cyl. (main lube oil and piston cooling pump gears) -
Min. .... 0.46 mm (.018")
Max. .... 0.56 mm (.022")

12-cyl. (main lube oil pump gears) -
Min. .... 0.41 mm (.016")
Max. .... 0.58 mm (.023")

12-cyl. (piston cooling pump gears) -
Min. .... 0.48 mm (.019")
Max. .... 0.58 mm (.023")

16-cyl. (main lube oil pump gears) -
Min. .... 0.41 mm (.016")
Max. .... 0.56 mm (.022")

16-cyl. (piston cooling pump gears) -
Min. .... 0.48 mm (.019")
Max. .... 0.61 mm (.024")

Thrust face of bushing to body clearance (front and rear) -
Min. .... 0.02 mm (.001")

Max. ....0.18 mm (.007")

8, 12 and 16-cyl. Drive and driven gear backlash -
Min. ....0.30 mm (.012")
Max. ....0.76 mm (.030")

20-cyl. Drive and driven gear backlash -
Min. ....0.30 mm (.012")
Max. ....0.41 mm (.016")

Radial clearance of drive and driven gear to body -
Min. ....0.038 mm (.0015")
Max. ....0.25 mm (.010")

<u>Drive shaft (gears) - total thrust clearance</u>

8 & 12-cyl. (scavenging pump assembled) -
Min. ....0.20 mm (.008")
Max. ....0.41 mm (.016")

16-cyl. (scavenging pump assembled) & 20-cyl. (lube oil pump assembled) -
Min. ....0.20 mm (.008")
Max. ....0.48 mm (.019")

Drive shaft (gears) - total thrust clearance - continued

16-cyl. (main lube oil and piston cooling oil pumps assembled) -
Min. .... 0.08 mm (.003")
Max... 0.43 mm (.017")

12-cyl. (main lube oil and piston cooling oil pumps assembled) -
Min. .... 0.10 mm (.004")
Max... 0.46 mm (.018")

8-cyl. (main lube oil and piston cooling oil pumps assembled) -
Min. .... 0.13 mm (.005")
Max... 0.56 mm (.022")

Pump drive gear face runout -T.I.R. Limit.. 0.08 mm (.003")

Pump flange face runout -T.I.R. Limit...0.13 mm (.005")

Pump flange pilot concentricity -
T.I.R. Limit .... 0.05 mm (.002")

Pump drive gear to accessory drive gear backlash - Min. .... 0.20 mm (.008")
Max... 0.64 mm (.025")

Pump/ motor assembly

Parallel coupling alignment - Max. .... 0.38 mm (.015")
Axial clearance between jaw and spider - Min. .... 0.76 mm (.030")

HELIX ANGLE POSITION OF OIL PUMP GEARS